DRAFT

Environmental Profile

of

Burma

prepared by the

Arid Lands Information Center
Office of Arid Lands Studies
University of Arizona
845 North Park Avenue
Tucson, AZ 85719

National Park Service Contract No. CX-0001-0-0003
with U.S. Man and the Biosphere Secretariat
Department of State
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THE UNITED STATES NATIONAL COMMITTEE FOR MAN AND THE BIOSPHERE
Department of State, IO/UCS
WASHINGTON, D.C. 20520

An Introductory Note on Draft Environmental Profiles:

The attached draft environmental report has been prepared under a contract between the U.S. Agency for International Development (AID), Office of Forestry, Environment, and Natural Resources (ST/FNR) and the U.S. Man and the Biosphere (MAB) Program. It is a preliminary review of information available in the United States on the status of the environment and the natural resources of the identified country and is one of a series of similar studies now underway on countries which receive U.S. bilateral assistance.

This report is the first step in a process to develop better information for the AID Mission, for host country officials, and others on the environmental situation in specific countries and begins to identify the most critical areas of concern. A more comprehensive study may be undertaken in each country by Regional Bureaus and/or AID Missions. These would involve local scientists in a more detailed examination of the actual situations as well as a better definition of issues, problems and priorities. Such "Phase II" studies would provide substance for the Agency's Country Development Strategy Statements as well as justifications for program initiatives in the areas of environment and natural resources.

Comments on the attached draft report would be welcomed by USMAB and ST/FNR and should be addressed to either:

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BURMA
Division or state boundary
Division or state capital
Railroad
Road
0 100 200 Kilometers
0 100 200 Miles
CHINA
CHINA
BHUTAN
NEPAL
INDIA
BANGLADESH
Chittagong
Sagaing
Shan State
Mandalay
Pegu
Irrawaddy
RANGOON
Mon State
VIETNAM
LAOS
THAILAND
BANGKOK
CAMBODIA
VIETNAM
BAY OF BENGAL
ANDAMAN SEA
GULF OF THAILAND
PREPARIS ISLAND (Burma)
COCO ISLANDS (Burma)
Names and boundary representation are not necessarily authoritative

Table of Contents

List of Illustrations

List of Tables

Summary

A tropical nation with 33 million inhabitants, Burma has faced a number of problems stemming from its climate and surroundings, and aggravated by its political and administrative system. Traditionally an agricultural country whose economy has relied upon extensive rice cultivation and timber exploitation, Burma nevertheless possesses mineral and energy resources which remain largely untapped. Although the government recognizes the advantages of developing further the region's natural resources, it has been hampered by lack of capital, poor infrastructure, internal disorder, and administrative inefficiency. The major environmental problems affecting Burma, therefore, are not generally the results of large development schemes, but rather of natural, cultural, and political phenomena.

In decreasing order of importance, Burma's major environmental concerns include:

Natural disasters. Burma lies in a climatic zone which is frequently subjected to cyclones and river flooding. The former occur periodically, but unpredictably. They can cause extensive damage to property, soils, and crops, and take a heavy toll on human and animal life. Flooding, sometimes caused by cyclones, but more often by excessive precipitation in mountainous watersheds, is a regular feature of Burma's extensive riverine plains. Each year two million hectares of land are severely flooded and another 3.25 million hectares moderately inundated. These floods reduce agricultural production, cause erosion and sediment loading, and help spread infectious disease. Finally, much of Upper Burma lies on a tectonically active zone. Earthquakes are common and occasionally devastating. In the early 1970s one such quake destroyed the religious and historic site of Pagan. None of these disasters are treated systematically by the government which has no integrated plan for evacuation or relief.

Deforestation. Large parts of northern Burma are populated by communities which traditionally have engaged in shifting cultivation. Although this mode of farming has some ecologically beneficial side effects, its principal impact is extremely destructive to forest resources. In addition to the hill cultures who cut trees in order to farm, enterpreneurs deplete forests extralegally for economic gain. Together shifting cultivation, illegal exploitation, and natural fires have destroyed as much as two-thirds of Burma's tropical moist forests. Because deforestation facilitates erosion, removes soil nutrients, permits weed infestation, diverts runoff, and reduces water infiltration and percolation, subsequent reforestation is difficult and expensive. Financial resources for afforestation have typically remained scarce.

Isolationism, administrative problems, and shortage of capital. Burma's deliberate two-decade long isolationist policy has caused the nation serious problems in managing its environment and resources. Foreign technical publications are generally unavailable while research and exchange programs have been discouraged. Burma has avoided participating in regional development associations and usually has not sent delegates to international and regional conferences. For these reasons and because of governmental preoccupation with internal insurgency, Burma lags behind other countries in developing suitable techniques for studying, protecting, and managing its environment. Additionally, scarcity of financial resources and infrastructure, and administrative inefficiency limit public attempts to enforce existing regulations.

Public health problems. Although Burma has better medical facilities than many of its neighbors, it possesses insufficient water treatment and sewage processing plants. Concentrated rainfall accumulates in open sewers, ponds, and irrigation ditches, and combines with high temperatures to create a situation conducive to the spread of infectious disease. The incidence of malaria, temporarily brought under control in the early 1970s, has once again risen to dangerous levels. Together with gastrointestinal ailments and other water-borne and animal-borne illnesses, these diseases pose a continuing threat to the nation's public health.

1.0 Introduction

This draft environmental profile summarizes information available in the United States on the natural resources and environment of the Socialist Republic of the Union of Burma (SRUB). The report reviews the major environmental problems of Burma and the impact of the development process upon resources and the environment. This draft report represents the first step in developing an environmental profile for use by the U.S. Agency for International Development (U.S. AID) and SRUB government officials. The next step in this process should be a field study to evaluate the information presented here, obtain additional information, and define the issues, problems, and priorities in greater detail. This entire process should help provide direction in future efforts to deal with the management, conservation, and rehabilitation of the environment and natural resources.

The information and interpretations in this report are preliminary and are not intended to attain the detail and accuracy required for development planning. The report represents a cooperative effort by the Man and the Biosphere (MAB) project staff of the Arid Lands Information Center (ALIC). The primary research, writing, and analysis of the Burma profile were done by Robert G. Varady, through the resources of ALIC and the University of Arizona library. The text was edited by Mercy A. Valencia. The cooperation of James Corson, AID/MAB Project Coordinator, and other AID personnel is gratefully acknowledged.

2.0 General Description

2.1 Geography and Climate [1]

2.1.1 Boundaries and Administrative Divisions

Situated between the Indian subcontinent to the northwest and the Southeast Asian peninsula to the northeast, the Socialist Republic of the Union of Burma (hereafter, Burma) lies between 10° and 28°33' north latitude, and between 92°14' and 101°8' east longitude. Burma's area of 678 600 square kilometers (sq km)--a territory the size of Texas--ranks it as mainland Southeast Asia's largest nation. Between its northern and southern extremes, Burma stretches nearly 2,100 km--a distance equivalent to that between the Florida Keys and Toronto, Canada.

Burma shares a 5,850 km border with five other countries: Bangladesh and India on the northwest, China on the Northeast, Laos on the east, and Thailand on the east and southeast. All but the southernmost portion of Burma's borders lie in mountainous regions and generally follow natural features such as ridges and drainage basins. Occasionally, large rivers such as the Mekong and the Salween define portions of these boundaries. With the exception of a small undemarcated, but not disputed, segment of the Indian border, all of Burma's land frontiers have been demarcated.

The remainder of the nation's perimeter is its extensive 3,060 km western coastline along the Bay of Bengal and the Andaman Sea. Because the coast includes the mouths of the Irrawaddy, the Salween, and other rivers, it affords a number of natural harbors.

The Union of Burma, as its name suggests, consists of a confederation of administrative units. These

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[1] Sources: Chhibber. 1975.
Fisher. 1979.
Henderson et al. 1971.
Koteswaram. 1974.
Siddiqui and Jeet. 1978.
Silverstein. 1980.
Storz. 1967.
U.S. AID. 1980.

units are of two types--divisions and states. The former, of which there are seven, represent Burma "proper," and reflect both the major concentrations of ethnic Burmans and British colonial influence. The seven divisions are Irrawaddy, Magwe, Mandalay, Pegu, Rangoon, Sagaing, and Tenasserim. The remaining regions, which are situated predominantly on Burma's periphery are administered as seven states: Arakan, Chin, Kachin, Karen, Kayah, Mon, and Shan (Fig. 1 Table 1). The boundaries of these states were drawn so as to accommodate the major ethnolinguistic minorities for which they were named (cf. Fig. 8, and Sections 2.2.1 and 2.2.2). Two of the states, Arakan and Mon States, were created by the 1974 constitution from areas previously considered within Burma proper (Silverstein 1980).

The constitution of 1974, the nation's second, was promulgated chiefly in order to redefine the issue of national unity and to rectify previous inequities in the relationships between states and the center. Under the new federal system, Burma is administered at four levels. At the top, the national or people's assembly (Pytthu Hluttaw), composed of 451 elected members, is the nation's legislative body. The executive branch of government consists of a state council, headed by a chairman, who is currently also Burma's president. The central level of government further includes a judicial branch, comprised of: a Chief Court, a Council of People's Judges, a Council of People's Attorneys, and a network of People's Courts. Beneath this level, there are subordinate administrations within states and divisions, townships and wards, and villages. Local issues in villages are resolved by tract councils (Silverstein 1980; U.S. Dept. State 1978).

2.1.2 Geographic Features

Burma's major physical features, as H.L. Chhibber observed in 1933, are the surface expressions of the underlying strata. The country's topographical layout thus mirrors its geological formations (cf. Fig. 2 and Fig. 3). Accordingly, Burma can be divided into four elongated north-south physical regions: the Arakan Coastal Strip on the west, the Fold (or Western) Mountain Belt, the Central Belt in the center and the Shan Plateau on the east (Fig. 4).

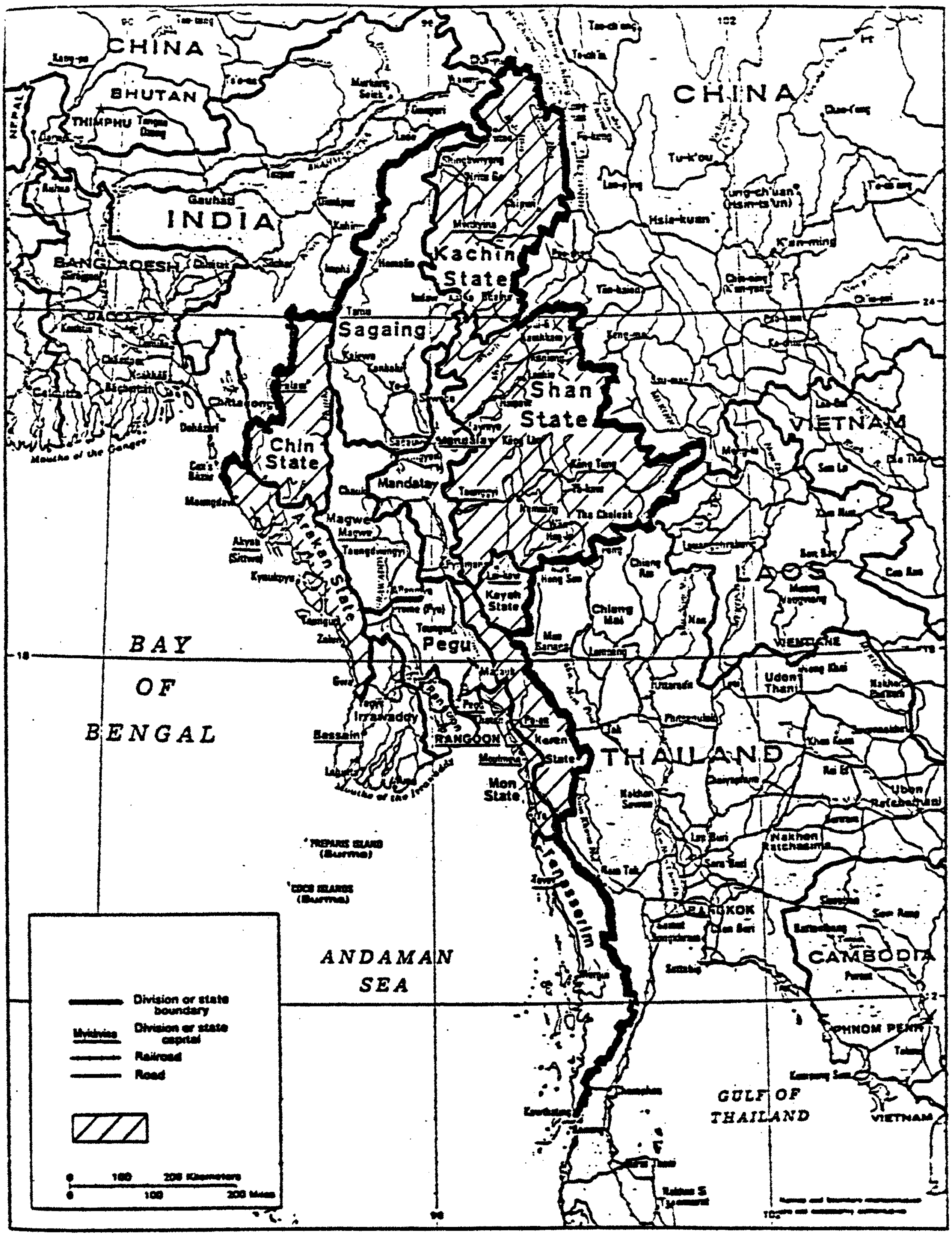


Figure 1. Administrative Divisions

Source: Available from U.S. GPO (1977).

Table 1. Areas and Headquarters of Major Administrative Units

Administrative unit	Administrative headquarters	Area (sq km)	Source	Population	Source
Burma	Rangoon	678,600	a	32,900,000	c
		670,180	b		
Divisions					
Irrawaddy	Bassein	34,760	b	4,162,000	d
Magwe	Magwe	44,280	b	2,630,000	d
Mandalay	Mandalay	33,856	b	3,662,000	d
Pegu	Pegu	49,723*	b	3,171,000	d
Rangoon	Rangoon			3,187,000	d
Sagaing	Sagaing	98,002	b	3,116,000	d
Tenasserim	Tavoy	54,520**	b	2,474,000	d
States					
Arakan	Akyab (Sittwe)	36,337	b	1,708,000	d
Chin	Falam	35,592	b	323,000	d
Kachin	Myitkyina	86,792	b	639,000	d
Karen	Pa-an	28,393	b	853,000	d
Kayah	Loi-kaw	11,535	b	120,000	d
Mon	Moulmein	**			
Shan	Taunggyi	156,390	b	4,287,000	d

Notes: a. U.S. State Dept. 1978 c. U.S. AID. 1981e.
b. Webster's. 1972. d. U.S. AID. 1980.

*Due to lack of available information, data for Pegu and Rangoon Divisions have been combined.

**For similar reasons data for Mon State are included in the figures for Tenasserim.

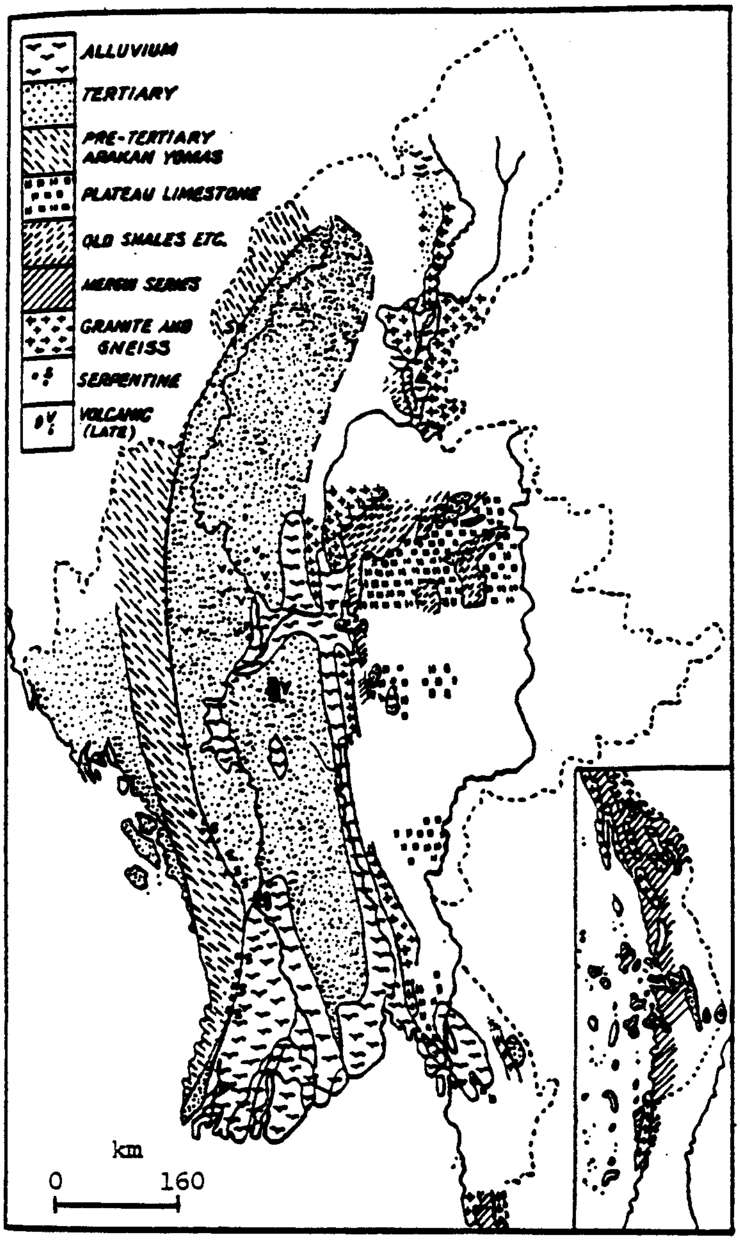


Figure 2. Geological Formations

Figure 3. Topography

Source: Chhibber. 1975.

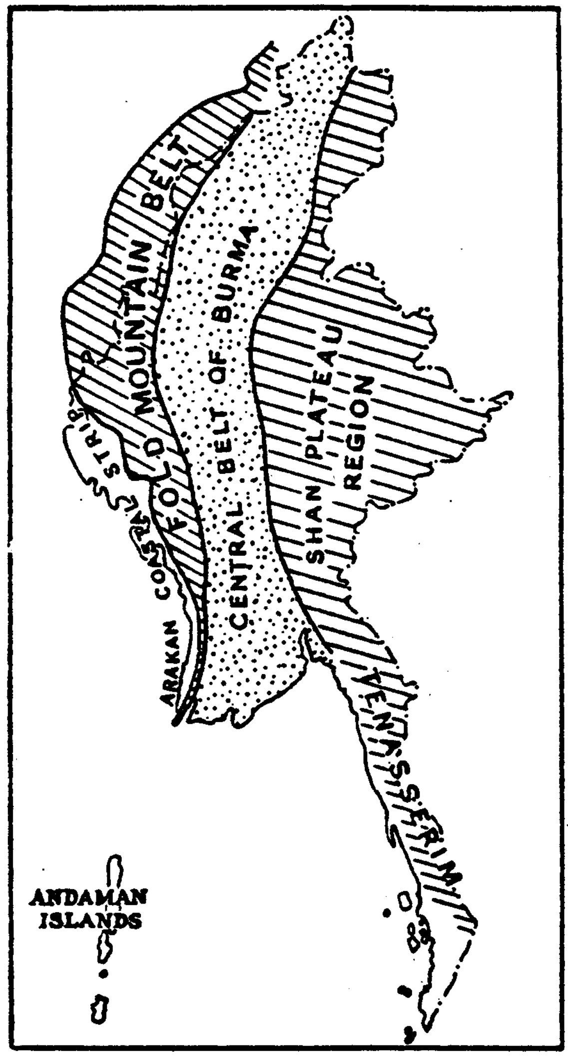


Figure 4. Physical Regions

Source: Chhibber. 1975.

(1) Arakan Coastal Strip. The Arakan Coastal Strip is a narrow band of alluvial deposits and Tertiary bedrock bounded on the west by the Bay of Bengal and on the east by the Arakan Yoma range. It rarely exceeds 50 km in width, and at places the Yomas extend almost to the coastline. The entire Arakan coastal region lies below 500 m, and most of the land is, in fact, less than 200 m in elevation. This zone extends beyond the coastline and includes hundreds of small offshore islands and several large islands such as Ramree, Cheduba, and Akyab.

(2) Western Mountain Belt. This geographic zone immediately east of the Arakan Coastal Strip is considered a southward extension of the Himalayan mountain range. At a right angle to the predominantly east-west Himalayas, these folded mountains continue to the southwestern corner of the Irrawaddy delta. At this point the hills are lower than 100 m in elevation and slope gently to the sea. The ridge continues underwater eventually reemerging as the Andaman and Nicobar island chains, and later as Sumatra, Java, Bali, and the remaining islands to the east. The Western Mountain Belt, therefore, is considered the northern portion of the 7,000 km long "Burmese-Java Arc" of the Himalayan system of folding.

The mountains within this belt have a variety of names. In the north, along the border with the Indian states of Arunachal Pradesh, Nagaland, Manipur, and Mizoram, there are the Patkai, Naga, Letha, and Chin Hills. As they begin to parallel the Burmese coastline, these mountains come together as a single range known as the Arakan Yomas and continue for 600 km to Cape Negrais at the westernmost mouth of the Irrawaddy.

Although the Western Mountain Belt is not nearly as elevated as the neighboring Himalayan range, the terrain is rugged and marked by steep slopes. Above the Yomas the land is generally between 1,000 m and 2,500 m above sea level; the highest peaks are Sarameti (3,862 m) on the Indian border, and Mt. Victoria (3,123 m) further south. The Arakan Yomas are considerably lower, rarely rising above 2,000 m.

The northern portion of this region is drained by the Chindwin, Manipur, and Lemro Rivers, and by numerous other north-south rivers cutting through the valleys. These are connected to each other by transverse streams that flow through the gaps between mountains. Except for the southernmost tip, the entire Western Mountain Belt is difficult to traverse. There are few all weather roads (see frontispiece map), and even the relatively low Arakan Yomas are not easily penetrated, with only four major passes.

(3) Central Belt. The Central Belt, lying to the east of the Western Mountain Belt, is the region bordering the Irrawaddy, Chindwin and Sittang Rivers. Until geologically recent times, most of this land was submerged and constituted an ancient sea known as the Burmese Gulf. Since that time, silting action has filled the gulf with Tertiary sediment. As a result, the entire belt is composed of sediment and alluvium deposited by the region's major rivers (Fig. 2).

The upper reaches of this zone include several mountain ranges, which at their northern extreme join the Himalayas and the origin of the Western Mountain Belt. At the edge of this belt lies the nation's highest peak, Hkakabo Razi (5,923 m), just 25 km south of Burma's northernmost tip. Within 150 km to the south, however, elevations drop sharply, seldom exceeding 1,500 m. From Bhamo, where the Irrawaddy becomes a major river, the land becomes less rugged. After the Irrawaddy's merger with the Chindwin beyond Mandalay, terrain within the Central Belt gradually descends to sea level. The Pegu Yoma, a low mountain range, parallels the course of the river 60 to 70 km to the east of it. Still further south, the Irrawaddy and Sittang Rivers form an extensive (26,000 sq km) and fertile deltaic plain, populated by nearly a third of the nation's inhabitants.

(4) Shan Plateau. The fourth distinct physical region, the Shan Plateau, is separated from the adjoining sedimentary Central Belt by a fault scarp running from the northern border with China to the mouth of the Sittang River. As Figure 3 illustrates, the drop in elevation

from the Plateau to the plain is severe, at times forming cliffs whose heights exceed 600 m. The plateau itself lies at an average elevation of 1,000 m and extends the full length of the country to its southern tip on the Malay Peninsula.

Throughout its expanse, the Shan Plateau is mountainous with several peaks exceeding 2,500 m. The Salween and Mekong Rivers are the principal waterways in this region. Tributaries of the Salween drain most of the plateau above Moulmein. All these rivers flow through steep channels and thus provide little, if any, cultivable land north of the mouth of the Salween. South of Moulmein, the extension of the Shan Plateau known as the Tenasserim Yoma is considerably lower and less mountainous. A single peak, Mt. Myinmoletkat, rises higher than 2,000 m. As in the Arakan region, the coastal strip is extremely narrow and hills frequently slope to the sea. Even more than the Arakan coast, the Andaman coastal waters are marked by inumerable islands, particularly those of the Mergui Archipelago.

2.1.3 Climate

Most of Burma lies below the Tropic of Cancer and, accordingly, the country's climate is considered tropical. One classification, by Thornthwaite (1948), divides Burma into a "monsoon rain" coastal zone, a "tropical savanna" interior, and two small northern pockets of "warm climate with dry winter," and "steppe." An earlier and simpler classification by Wladimir Koppen (1900) treats the entire region as "perhumid," "humid," and "moist subhumid" climatic zones (Koteswaram 1974). More recently, P. Legris has divided the area into "very humid," "humid," "subhumid," and "subdry and dry" zones (Fig. 5; Legris 1974).

Burma's climate is dominated by two subcontinental monsoons. As in neighboring South Asia, the more important of these is the moisture-laden southwest monsoon which induces most of the region's rainfall. It generally lasts from June to October and defines the summer wet season. The northeast monsoon usually arrives in November and lingers until March. Unlike the northwest monsoon, it is not characterized by significant rainfall. The November to May portion of the year is comprised of two

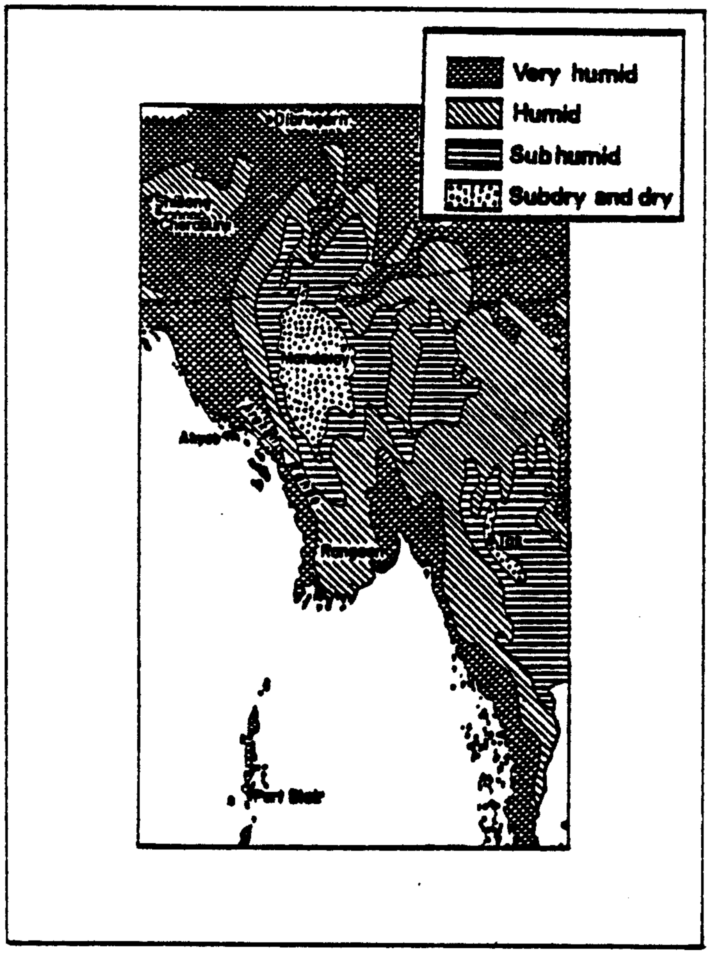


Figure 5. Climatic Zones

Source: Legris. 1974.

distinct seasons. November to mid-February is Burma's cool season, while the subsequent period preceding the summer monsoon is extremely hot.

The region's topography has an important effect on the climate. The mountains to the north and east shield Burma from the much colder climate which prevails in Tibet and western China. Elsewhere the Arakan Yomas and hills in Tenasserim cause heavy orographic rainfall along their western slopes. On the eastern slopes there is far less rainfall, thus, the Irrawaddy Valley--particularly between Mandalay and Prome--remains relatively dry throughout the year (see Figs. 6a and 6b, and Section 2.1.3.1).

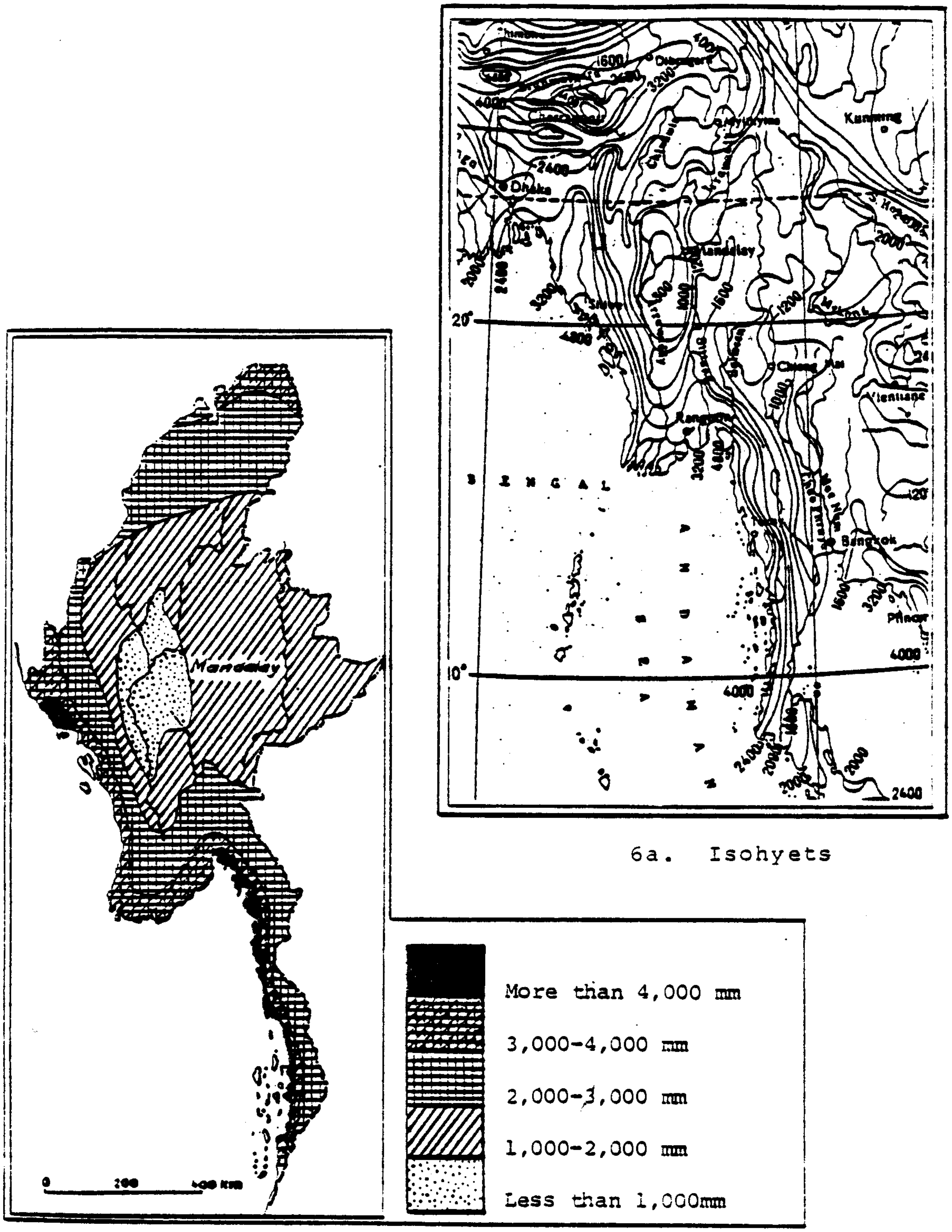
2.1.3.1 Rainfall

Except for a 500 km long oval-shaped region west of Mandalay, the entire nation receives more than 1,000 mm of annual rainfall (Figs. 6a and 6b). As in contiguous areas in southern Asia, Burma's precipitation relies heavily upon the annual southwest monsoon. By late May it arrives from the Indian Ocean and causes heavy rainfall throughout the country until the end of October. The coastal areas are particularly affected by monsoon winds, receiving 3,000 to 4,000 mm of precipitation each year. Further inland, average rainfall is lower; Magwe Province, situated within the rain shadow of the Arakan Yomas, is Burma's driest region, receiving just 800 to 1,000 mm of rain per year. To the east, the northern Shan Plateau gets up to 2,000 mm of precipitation (Fig. 6b).

Characteristically for a region possessing a monsoon climate, Burma receives the bulk of its rainfall during the wet season. Throughout the country, 88 to 97 percent of annual precipitation occurs from May to October. June to September are even wetter; 57 to 83 percent of rainfall is within these four months (Table 2).

2.1.3.2 Temperature

Except for the winter season in northern and central Burma, temperatures tend to remain high year-round. For Burma as a whole, the mean annual temperature is a warm 26.7°C. As Figure 7a shows, in fact, only the portion of the country which lies north of the Tropic of Cancer has average winter temperatures below 18°C. Below this latitude January temperatures range from 18°C to a maximum of 27°C,



6a. Isohyets

Figure 6. Isohyets and Average Annual Rainfall

Sources: a. Korzoun. 1977.

b. Adapted from Storz. 1967.

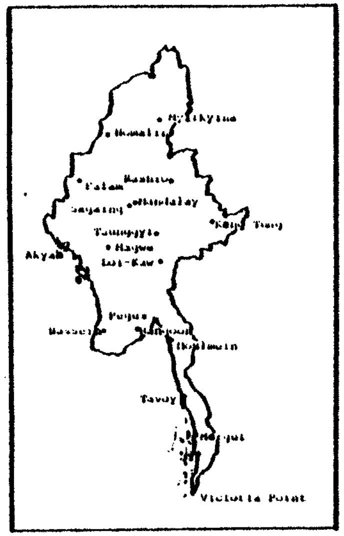


Table 2. Average Monthly Precipitation and Percentage Precipitation during Monsoon Season at Selected Locales

Locale	Annual precipitation (mm)	Monthly precipitation												Percentage of annual precipitation between:	
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	May & Oct.	June & Sept.
Akyab	5,166	1.5	3.0	12.4	53	354	1,192	1,392	1,140	573	277	139	19.3	88.7	83.3
Bassein	2,771	3.0	7.1	4.3	27	250	505	624	586	386	208	82	10.2	95.2	80.5
Falam	1,672	3.6	12.4	29.0	70	140	325	301	307	237	175	49	16.0	88.8	69.9
Homalin	2,296	5.8	10.8	20.1	42	179	465	485	466	377	192	25	20.8	94.3	78.1
Keng Tung	1,103	6.9	13.7	12.4	55	127	170	214	224	141	90	32	16.8	87.6	67.9
Lashio	1,572	6.9	7.6	15.0	55	176	240	305	323	199	145	70	21.8	88.8	68.4
Loi-Kaw	1,226	8.9	2.5	0.8	34	146	176	201	219	215	140	62	21.6	89.4	66.2
Magwe	798	0.8	1.3	4.3	20	124	137	106	119	132	106	38	11.4	90.5	61.8
Mandalay	825	1.3	3.3	4.8	32	146	159	70	103	136	109	51	9.7	87.7	56.8
Mergui	4,095	22.9	51.3	79.2	134	430	747	799	742	671	307	94	17.5	90.3	72.3
Moulmein	4,831	5.1	5.1	12.7	76	506	942	1,207	1,123	688	216	43	76.2	96.9	82.0
Myitkyina	2,006	10.4	21.6	23.9	50	154	384	487	416	246	174	30	10.7	92.7	76.4
Pegu	3,235	5.8	10.9	10.9	28	334	591	751	752	502	188	54	8.4	96.4	80.2
Rangoon	2,515	5.3	5.6	8.1	41	304	458	544	505	388	176	71	9.4	94.4	75.3
Sagaing	787	1.0	1.8	4.6	22	141	121	77	108	152	115	37	8.1	90.6	58.1
Taunggyi	1,748	2.3	1.8	15.7	51	201	259	296	385	279	225	98	15.7	89.4	65.1
Tavoy	5,454	5.1	11.2	40.4	67	577	1,124	1,250	1,202	840	271	58	9.1	96.5	81.8
Victoria Point	4,553	4.1	18.8	28.4	57	594	592	657	939	969	547	130	17.0	94.4	69.3

Source: Wernstedt, 1972.

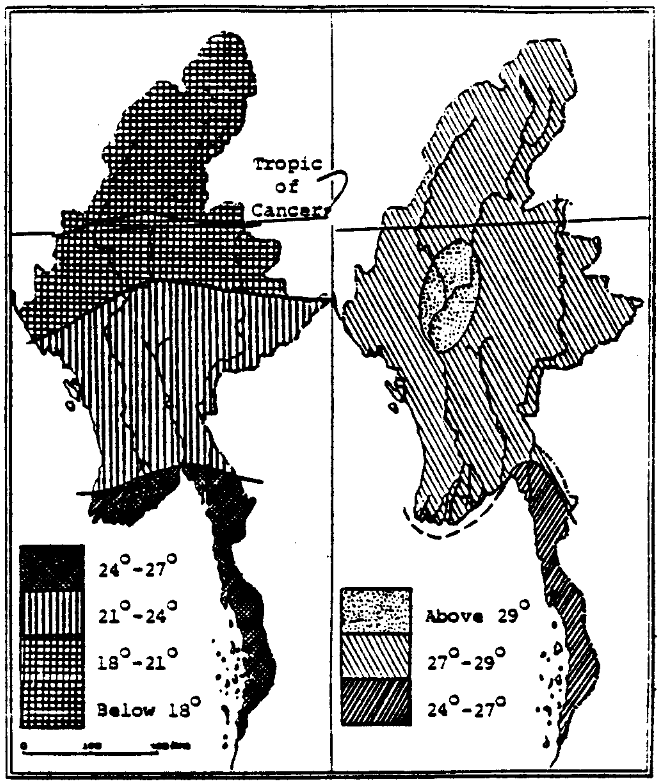
following a gradient along which temperature increases as latitude decreases.

Throughout Burma the hottest temperatures occur in May. In the vicinity of the confluence of the Chindwin and Irrawaddy Rivers, also the nation's driest area, maximum temperatures exceed 40°C while the mean is approximately 32°C. Within the entire region surrounding this zone summer temperatures are nearly uniform, averaging about 30°C. To the south along the Tenasserim coast, temperatures are slightly lower, remaining virtually constant through the year, averaging 24° to 27°. Figure 7b shows mean temperatures in Burma, while Figure 7c provides temperature profiles for three cities.

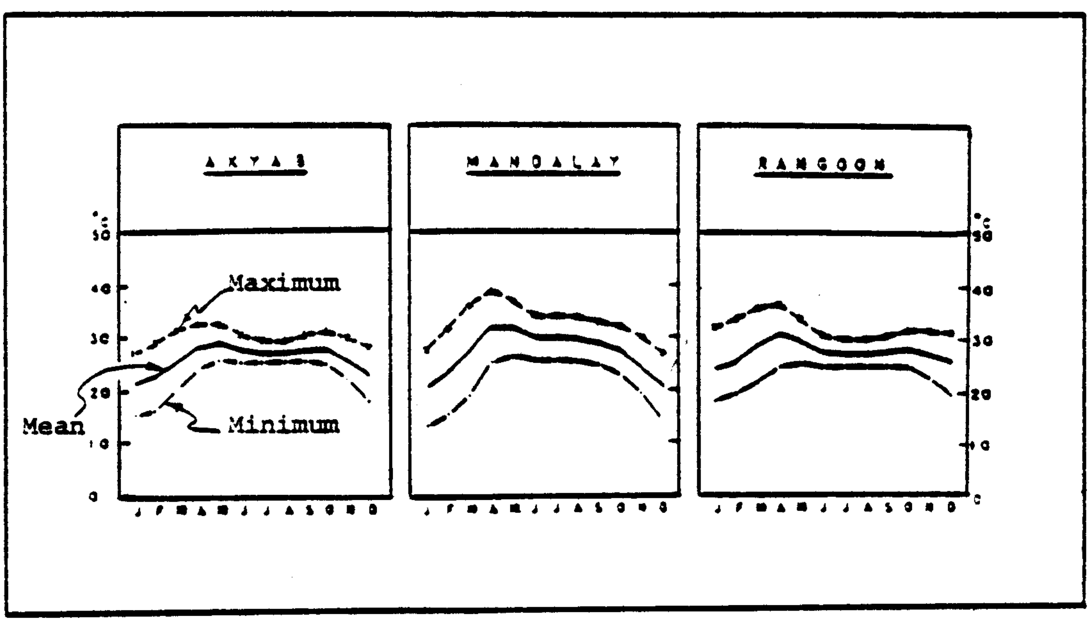
2.1.3.4 Humidity, Pressure, and Wind

Because the entire region is classified as tropical and humid, most of Burma experiences relatively high humidity throughout the year. The chief source of atmospheric water is the surface of the surrounding ocean. Water vapor from this source is transported over the land mass in large amounts. This movement of moisture assumes a higher rate of precipitation than of evaporation, and sustains high levels of humidity. Table 3 below shows the mean relative humidity at selected locations in Burma. As the tabulation indicates, at all but two of the 21 stations listed, average humidity exceeds 70 percent.

In Burma, as elsewhere in humid tropical Asia, air pressure and wind distribution vary according to the earth's position relative to the sun and the differential heating of land and sea. Twice annually, there are reversals of atmospheric pressure and air flow. These shifts induce the two yearly monsoons. During the transition between them, usually in April to May or October to December, monsoon winds are weak and variable. These are, however, the periods subject to tropical cyclones emanating in the Andaeman Sea. These storms move northeast and strike the Burmese coast with great force, causing heavy rainfall, flooding, and considerable damage to environment, life, and property (Koteswaram 1974).



7a. January 7b. July



7c. Temperature Profiles of Selected Locations

Figure 7. Mean Temperatures in January and July and Temperature Profiles of Selected Locations

Source: Storz. 1967.

Table 3. Mean Relative Humidity at Selected Locations

Location	Mean relative humidity (%)
Akyab	80.5
Bassein	78.0
Bhamo	79.0
Diamond Island	80.0
Haka	72.0
Kanpetlet	69.0
Lashio	76.5
Mandalay	74.0
Maymyo	80.5
Mergui	83.5
Minbu	75.0
Monywa	66.0
Moulmein	87.0
Myitkyina	86.0
Rangoon	77.5
Sandoway	80.0
Taunggyi	77.0
Tavoy	88.0
Thyetmyo	77.0
Toungoo	74.0
Yamethin	70.0

Source: U.S. AID. 1980.

2.2 Population

2.2.1 Historical and Cultural Background [2]

The Republic of the Union of Burma, the constitutional predecessor of the present Burmese state, achieved independence from Great Britain on January 4, 1948. As with all previous colonial entities in Asia, Burma inherited its boundaries, subdivisions, and ethnic balance from European notions rather than from indigenous socio-political development. The nation took its name from the Burmans, a northern people akin to the Tibetans, who settled the Irrawaddy plains between the ninth and eleventh centuries, A.D.. But although the Burmans established their military and political superiority over the lower Burmese plains by the eleventh century, they neither displaced nor eliminated the large kinship groups inhabiting the mountainous periphery of the present state. The new state of Burma, consequently, began its existence as a tenuous union of divergent cultural values, and political traditions. Alert to the inherent tensions in such a unit, the first Prime Minister, U Nu, cautioned the populace in 1947, "to strain every nerve to make this unity stand firm..." (Silverstein 1980).

The history of the region prior to the entry of the Burmans remains incompletely studied. It appears, however, that the land was occuppied previously by the Mons, or Talaings. The Mons' location along the coast exposed them to the highly developed culture of the Indian subcontinent, and specifically permitted Buddhism to penetrate Southeast Asia. When the invading Burmans subdued the Mons they adopted their version of Theravada (Hinayana) Buddhism, incorporating it as a permanent cultural feature of subsequent Burman civilization. In spite of Buddhist ethical teachings, Burman rule seems to have disregarded nonviolence (<u>ahimsa</u>) and tolerance whenever these interfered with political objectives. Not only the conquered Mons, but other groups such as Karens, Chins, Kachins, and Shans felt the weight of Burman dominance.

[2] Sources: Adas. 1974.
Bixler. 1971.
Henderson et al 1971.
Maung. 1961.
Silverstein. 1979.
—— -. 1980.

Throughout the period of Burma hegemony non Burmans were treated as inferiors and generally denied access to political authority. Although the Burman dynasties, centered in Pagan and later in Pegu, frequently sought to assimilate non-Burmans, their attempts were mostly unsuccessful. Virtually all of the ethnic communities within Burma "proper" (Lower Burma) have retained their identities. In Upper Burma, where Burman military and administrative influence were generally attenuated, the various populations remained even more identifiable and separate.

For centuries the Burmese frontiers and plains were penetrated by foreign influence. Religious, political, and commercial contacts with India to the west were paralleled by similar exchanges with China and Thailand to the east. Sustained encounters with European culture did not develop until the early fifteenth century. As in India and the East Indian archipelago, these contacts were chiefly commercial. But unlike the Dutch, Portuguese, French, and British experiences elsewhere in southern Asia, European traders were unable to establish permanent stations along the coast or upriver.

The first serious dispute with a European colonial power developed in the early nineteenth century. The ostensible issue concerned the desire of Burman authorities to pursue "criminals and rebels" across the mountains into territory administered by the private British East Indian Company. Conveniently for English policy-makers, this clash of interests over sovereignty came during a period of aggressive imperial expansion into South Asia. Burma, seen as an eastward extension of the subcontinent, was soon perceived along with the Punjab, Awadh, and Sind as provinces which were potentially annexable to the Company's growing Indian dominion. In 1826 a brief conflagration, the First Anglo-Burma War, established a British foothold along the Arakan and Tenasserim coast. By 1852, emboldened by military successes in the Punjab and Sind, Governor-General Lord Dalhousie precipitated a second war, one which cost the Burman dynasty its remaining lands in the fertile south. By the end of the year all of Lower Burma had come under Company rule. The Third Anglo-Burma War, more than thirty years later in 1885, undertaken by direct British Crown rule, exterminated the Kingdom of Burma and extended British boundaries to include Mandalay and the remainder of Upper Burma.

From 1885 to 1948, therefore, all of Burma was British overseas territory. Because of its proximity to India, Burma was treated as an organic part of Britain's Indian empire. Its administration, judicial system, commercial organization, educational and cultural policies were all modeled after India's, with minimal allowances for Burma's distinctly un-Indian tradition. Not until 1937, after significant nationalistic activity by Burma's educated elite, was its integration with the Indian empire overturned. A transitional period, interrupted by World War II, was intended to guide the Burmese toward eventual independence. As in India, anti-British sentiment accelerated the desire to eliminate colonial rule. When independence was achieved in 1948, therefore, the newly-formed government began steering the nation on a distinctly xenophobic course designed to encourage endemic responses to Burma's problems.

The nation promulgated its first constitution in 1947. In it, Burma defined itself as a democratic republic and adopted a federal approach to achieving political unity. The constitution of 1947 established conditions for Burmese citizenship and accorded a privileged position to Buddhism as the majority religion. Two decades after its adoption the constitution came under intense criticism from various sectors of society and from the government itself. The issue of minority rights was perhaps the single most important factor leading to the failure of Burma's first constitution. Traditional hostility and mistrust between the Burman majority and other ethnic communities remained unresolved and were, in fact, aggravated by legislation stemming from the 1947 constitution. A second constitution, promoted by the administration, sought to remedy some of the lingering inequities. In effect since 1974, this charter has also failed to alleviate the underlying tension resulting from centralized efforts at "Burmanization." As one long-time observer of Burmese political development (Silverstein 1980) has recently observed, "until a common solution [to the problem of national integration] is found, there will be struggle and unrest in Burma."

2.2.2 Ethnicity and Language [3]

As the preceding section has suggested, Burmese society is composed of numerous communities having varying traditions, different languages and religions, and frequently conflicting ideologies regarding participation in a centralized state. The ethnic groups currently residing in Burma are descended from various migratory settlers who descended from the Asian mainland to the Irrawaddy plains and the outlying mountain ranges.

Ancestors of the Mon people were perhaps the first settlers along the deltaic coast. The dates of their migration remain uncertain but were probably near the middle of the first millenium, A.D. (Fig. 8a). The Mons appear to be related to Khmer-speaking peoples inhabiting Kampuchea and adjacent regions of Thailand (Fig 8b).

At approximately the same time, a number of tribes left southern China and penetrated the region near the mouth of the Salween River. These communities, the Pwo, Bwe, and Sgaw are now known collectively as Karens. Another wave of settlers speaking Tibeto-Burman languages followed the Mons. Also emanating from the northeast, these groups of Burmans, Chins, Kachins, Lahu, Lisu, Naga, and Akha entered the plains and moved southward toward the coast. Still later, around the twelfth century, a Tai-speaking people--the Shans--entered the region and populated their present habitat, the Shan Plateau (Figs. 8a and 8b).

Table 4 shows the approximate numbers of members of Burma's major ethnic communities. As is evident, a large majority of the population (72 percent) is identified as Burman. The source of Table 4, however, indicates neither the means by which members of various communities were identified, nor the origin of the data. Since it remains in the Burmese government's interest to overstate the number of Burmans, the figures cannot be viewed with complete reliability.

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[3] Sources: Bixler. 1971.
Henderson et al. 1971.
Silverstein. 1980
-----. 1981.
U.S. AID. 1980.

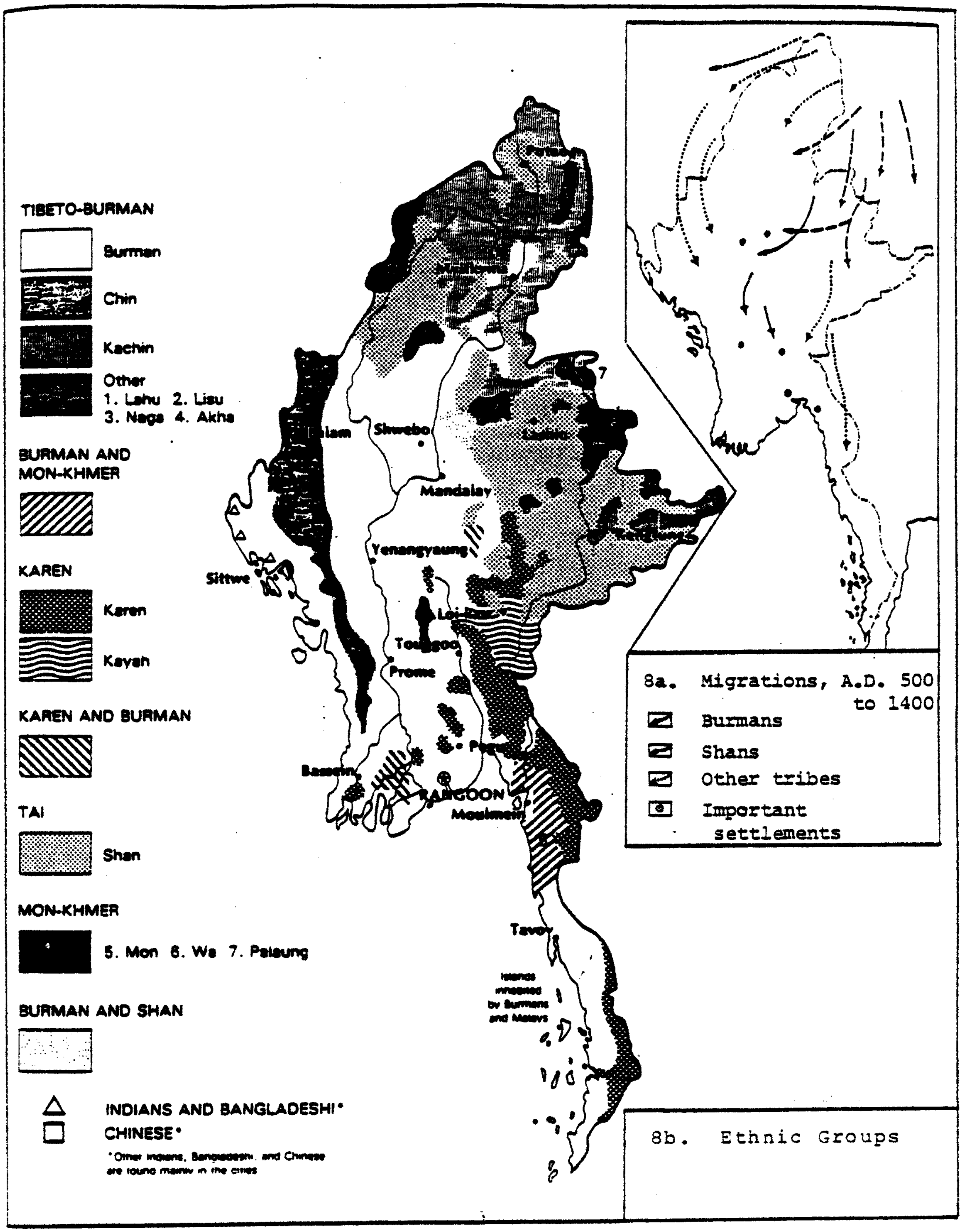

Figure 8. Migrations and Ethnic Groups

Sources: a. Storz. 1967.
b. Silverstein. 1980.

Table 4. Population of Ethnic Communities

Group	Number of persons	Percentage of total population
Burman (incl. Mon & Arakanese)	22,000,000	72.1
Karen and Kayah (Red Karen)	3,100,000	10.2
Shan	1,800,000	5.9
Kachin	600,000	2.0
Chin	600,000	2.0
Indian, Bangladeshi, & Pakistani	900,000	3.0
Chinese	600,000	2.0
Other	900,000	3.0
Total	30,500,000	100.0[a]

[a]Error due to rounding

Source: U.S. AID. 1980.

As has been indicated, the predominant religion of Burma is Theravada Buddhism. Approximately four-fifths of the population professes to be Buddhist and the religion enjoys special protection under the constitution. In May 1980 more than 1,200 monks participated in the First Congregation for the Purification, Perpetuation and Propagation of Buddhism, a convention designed to further strengthen the role of Buddhism within Burmese society (Silverstein 1981). Among non-Burmans, a number of other religions prevail. Many Karens and Nagas were converted to Christianity during the colonial period and have retained their Christian affiliations. Indians are either Hindu or Muslim, while former Palistanis and Bangladeshis are generally Muslim, as are a number of Chinese. Tribesmen other than Shans, Palaung, and Pa-o Karens, meanwhile, have maintained their traditional religious rites and customs.

2.2.3 Population Size, Growth, and Distribution 4/

Burma's population in mid-1980 was estimated to be 34.06 million ranking the nation as the world's 25th most populous (U.S. AID 1981e; World Bank 1981). The current annual population growth rate is estimated to be 2.5 percent by U.S. AID (1980). The World Bank and AID itself (1981e) list the average rate during the 1970-79 decade as a more moderate 2.2 percent per annum, a figure which compares favorably with the 2.6 percent growth rate in other "low-income" countries (World Bank 1981). Burma's rate of population increase appears to be constant, having averaged 2.2 percent between 1960 and 1970.

Although Burma accepted significant numbers of immigrants prior to independence, the practice has been severly curtailed. Similarly, emigration is restricted, and although perhaps a half million persons left Burma between 1962 and 1971, the flow appears to have decreased. As a result of tight control of movements in and out of the country, the growth rate reflects primarily natural growth related to fertility, health care, and life expectancy. Over the past two decades both crude birth rate and crude death rate have declined markedly. The former fell from 43 to 37 per thousand, while the latter dropped even more noticeably from 22 to 14 per thousand (World Bank 1981). Based upon these indicators the World Bank (1981) projects that Burma's population will grow to 50 million by the year 2000.

As elsewhere in low-income countries, Burma's population is young and growing younger. As Figure 9 illustrates, half of the inhabitants are under 18 years of age. If past trends continue, Burma's young people can expect to live considerably longer than their elders; between 1960 and 1979 life expectancy increased by 23 percent, from 44 to 54 years. The death rate among children aged one to four, moreover, has practically halved since 1960-- from 24 per 1,000 to just 13 per 1,000 in 1979. This phenomenon is due in large part to notable improvements in health care.

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[4] Source: U.S. AID. 1981e.
-----. 1980
World Bank. 1981.

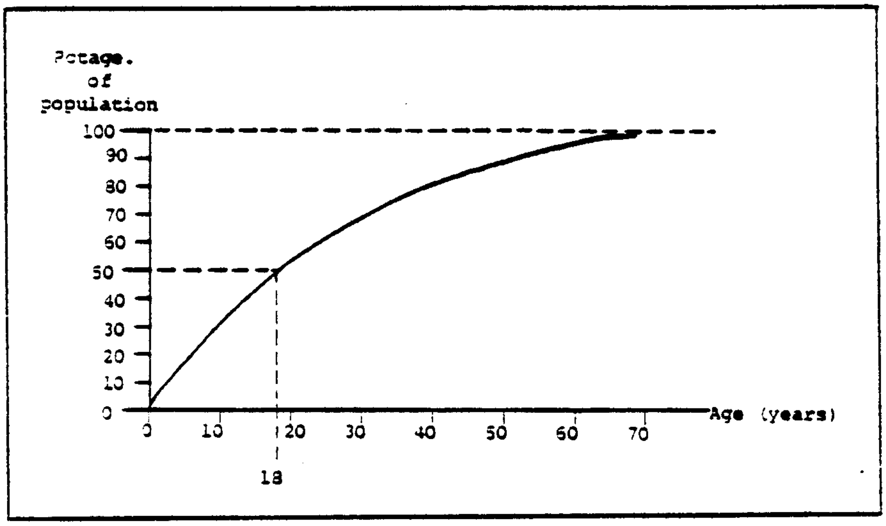

Figure 9. Cumulative Population Distribution by Age

Source: U.S. AID. 1981e.

Like most developing countries, Burma remains a predominantly rural nation. But in keeping with urbanization trends elsewhere an increasing number of Burmese are moving to cities. In 1969, 19 percent of the population was urban; by 1980 the proportion had grown to 27 percent. Nearly three of every ten city dwellers, furthermore, now reside in Burma's two largest centers--Rangoon and Mandalay (Table 5).

Table 5. Population of Major Urban Centers, 1973

City	Population
Rangoon	2,056,118
Mandalay	417,266
Henzada	283,658
Pegu	254,761
Myingyan	220,129
Moulmein	171,767
Prome	148,123
Bassein	126,152
Tavoy	101,536
Akyab	82,544
Total urban population (1980)	8,883,000

Sources: Anonymous. 1979.
U.S. AID. 1980.
World Bank. 1981.

Regionally, the population tends to cluster within the bounds of Burma proper, that is, within the divisions. Table 6 shows clearly that the most densely populated areas are the coastal strips and the central valleys of the Irrawaddy and Sittang Rivers. These regions naturally contain Burma's most productive agricultural lands. Figure 10 shows the geographical distribution of population density.

Table 6. Regional Population Distribution and Density

Region	Area (1,000 sq km)	Area (% of Total)	Popul. (1,000)	Popul. (% of total)	Ratio of % popul. % to area	Popul. density (#/sq km)
	1	2	3	4	5	6
Arakan State	36.3	5.4	1,708	5.6	1.04*	47.1
Chin State	35.6	5.3	323	1.1	0.21	9.1
Irrawaddy Division	34.8	5.2	4,162	13.7	2.63*	119.6
Kachin State	86.8	13.0	639	2.1	0.16	7.4
Karen State	28.4	4.2	853	2.8	0.67	30.0
Kayah State	11.5	1.7	120	0.4	0.24	10.4
Magwe Div.	44.3	6.6	2,630	8.7	1.32*	59.4
Mandalay Div.	33.9	5.1	3,662	12.0	2.35*	108.0
Pegu & Rangoon Divs.	49.7	7.4	6,358	20.9	2.82*	127.9
Sagaing Div.	98.0	14.6	3,116	10.3	0.71	31.8
Shan State	156.4	23.3	4,287	14.1	0.61	27.4
Tennasserim Div. & Mon State	54.5	8.1	2,474	8.1	1.00*	45.4
Burma	670.2	100.0	30,332[a]	100.0	1.00	45.3

*Regions having at least "their share" of the population; i.e., the ratio in column 5 is 1.0 or greater.

[a]This figure is the sum of the entries in column 3, and thus does not correspond to the total population indicated in Table 1.

Source: Table 1.

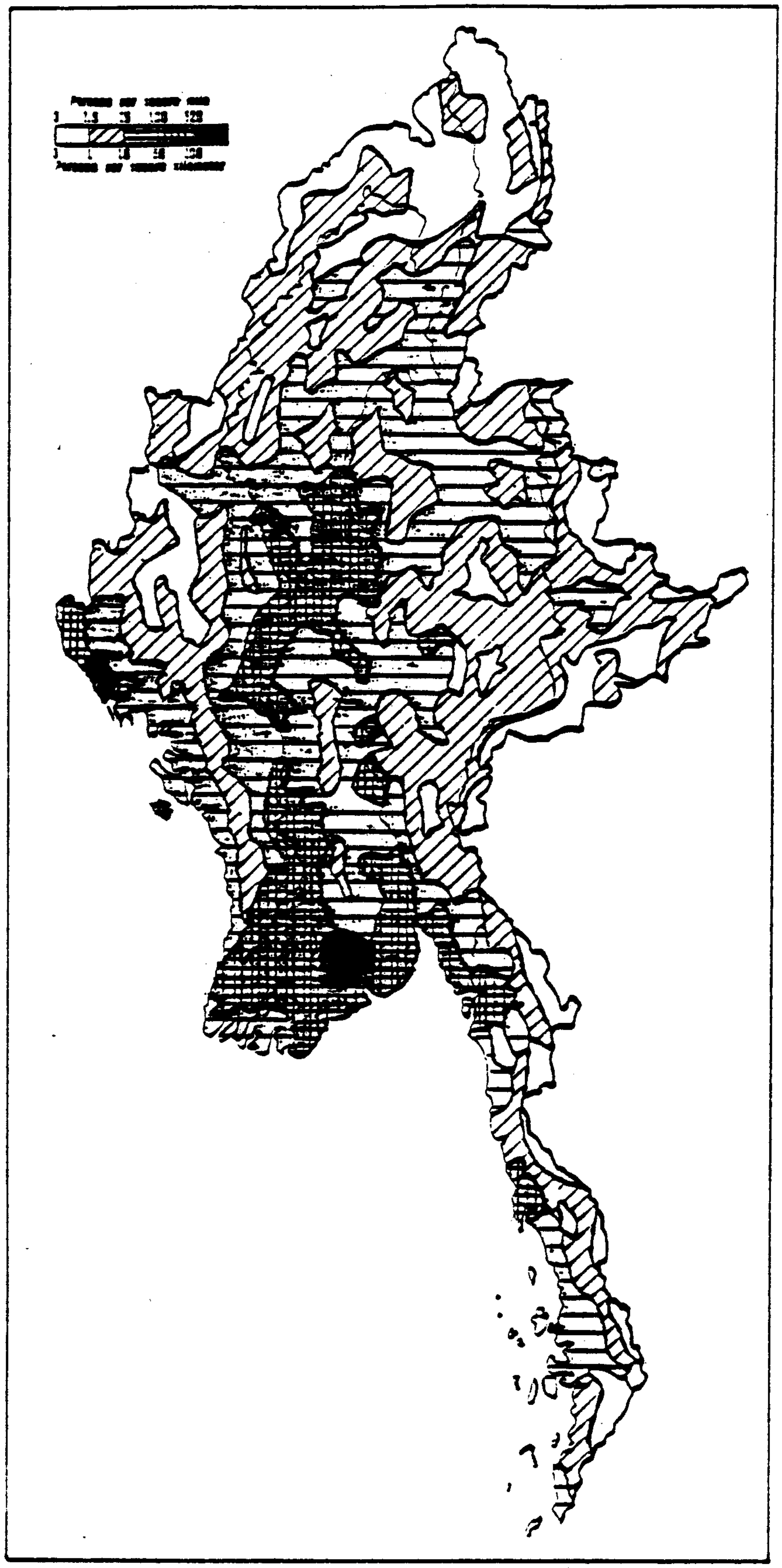

Figure 10. Population Density

Source: Available from U.S. GPO (1972).

2.2.4 Health and Nutrition [5]

During the past two decades Burma's public health facilities, and therefore its health-related indicators, have improved substantially. Perhaps the most noteworthy trend has been the increase in the number of physicians--from one to every 15,560 persons in 1960, to one per 5,120 by 1977 (World Bank 1981). The effective tripling of available physicians has been supported by a substantial rise in the number of hospitals (63 percent between 1969 and 1978) and by a modest increase in the number of hospital beds (5.3 percent for the same period; Henderson et al. 1971; U.S. AID 1980). Together, these improvements in health care since 1960 have: more than halved infant mortality (129.9 to 55.8 deaths per 1,000 between 1960 and 1975); reduced the death rate among children aged one to four from 24 to 13 per 1,000 (1960 to 1979); lowered crude death rate from 22 per 1,000 in 1960 to 14 per 1,000 in 1978; and thereby raised life expectancy from 44 to 54 years during the same period (U.S. AID 1981e; World Bank 1981).

It would be misleading, however, to infer that these generally favorable statistics indicate that Burma's serious public health problems have been eliminated. Infectious diseases remain prevalent throughout the nation. Inadequate facilities for fresh water supply and sanitation disposal are perhaps the most serious impediments to improved health conditions. As Table 7 shows, only a sixth of Burma's residents have access to treated drinking water, while just a third of the population benefits from sewage disposal. The resulting problems include high incidences of gastrointestinal diseases such as typhoid, dysentery, and cholera, and frequent outbreaks of other water-borne infections such as dengue, poliomyelitis, tuberculosis, typhus, and yaws. Malaria and filariasis, transmitted by mosquitoes bred in shallow stagnant waters, constitute perhaps the greatest public health concerns. Their incidence is

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[5] Sources: Kyaw et al. 1978.
Henderson et al. 1971.
Martinez Dominguez et al. 1980.
Self and Tun. 1970.
Than et al. 1980.
U.S. AID. 1980.
-----. 1981e.
World Bank. 1981.

most pronounced inland on the Shan plateau and in the Chin hills, and along the coastal strip. Past efforts to combat these diseases have focused on larvicidal treatment of breeding grounds and have resulted in serious pollution of groundwater and soil (Self and Tun 1970). As Table 7 indicates, most areas remain beyond the reach of proper sanitation, so that environments conducive to malarial and filarial vectors continue to exist. The population, consequently, has had little sustained relief from outbreaks of these two parasitic diseases.

Table 7. Water Treatment and Disposal Facilities, 1975

	Percentage of rural popul.	Percentage of urban popul.	Percentage of total popul.
Access to safe water	14.0	31.0	17.0
Access to sewage disposal	32.0	38.0	33.0

Source: U.S. AID. 1981e.

In addition to water-borne afflictions, much of the Burmese population suffers from chronic respiratory diseases such as tuberculosis and influenza, and from such varied infectious ailments as venereal disease, leprosy, otomycosis, plague, and trachoma. Since the 1960s the World Health Organization (WHO) has been active in sponsoring programs to prevent, control, and eradicate several of these endemic diseases (Kyaw et al. 1978; Martinez Dominguez et al. 1980; Than et al. 1980).

Undernourishment has become more prevalent as Burma's food production has failed to keep up with its population growth. According to U.S AID (1980a), per capita food production in 1976 was three percent under what it had been in 1952, and 14 percent below the peak achieved in 1964. Burma's population, meanwhile, rose from 21.8 million in 1960 to 32.9 million in 1979.

Rice is the dietary staple for most Burmese. Although its supply has remained generally plentiful, it is polished prior to consumption. The process has led to chronic deficiencies of B vitamins, iron, iodine, and other minerals. Standard meals are also typically low in both animal and plant protein, and in vitamin A. Cereal products account for 75 percent of the average daily caloric intake, which in 1977 was 2,286 calories, or 106 percent of the FAO's minimum daily requirement.

2.3 Land Use [6]

As in all Southeast Asian countries, agriculture remains the predominant sector of the economy. But unlike neighboring and other developing countries, Burma apparently is becoming increasingly dependent on agriculture. Whereas in 1960 a surprisingly low 33 percent of the GDP stemmed from agriculture, that figure had risen to 45 percent by 1979 (World Bank 1981). Although in 1979 two-thirds of the labor force was engaged in the agricultural sector, that proportion had remained relatively stable over the previous two decades (68.4 percent in 1960; U.S. AID 1980a).

Figure 11 and Table 8 show that in spite of Burma's continuing reliance on agriculture, only a small portion--ten million hectares, or 14.7 percent--of its total area, is considered cropland. Another 11.9 percent (8.1 million ha) is cultivable wasteland, terrain which remains unused but may be potentially productive A relatively small portion of land (362,000 ha, or 0.4 percent of the total) is used as permanent pasture, sustaining cultivated or wild herbaceous forage crops.

By far the largest amount of land is forest and woodland. Tropical and mountain evergreen, deciduous, scrub, and swamp forest cover 66.8 percent (45.3 million ha) of Burma's total area (68.7 percent of its land area). Approximately a fifth (9.3 million ha) of this land is officially reserved forest land. Half of Burma's forests and woodlands (22.7 million ha) are termed unreserved. Another 13.3 million ha included in this category can be considered only marginally forested and could as appropriately be treated as "unclassified" or "other" land.

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6 Sources: FAO. 1979.
UNESCAP. 1978.
U.S. AID. 1980.
-----. 1981a.
USDA. 1980.

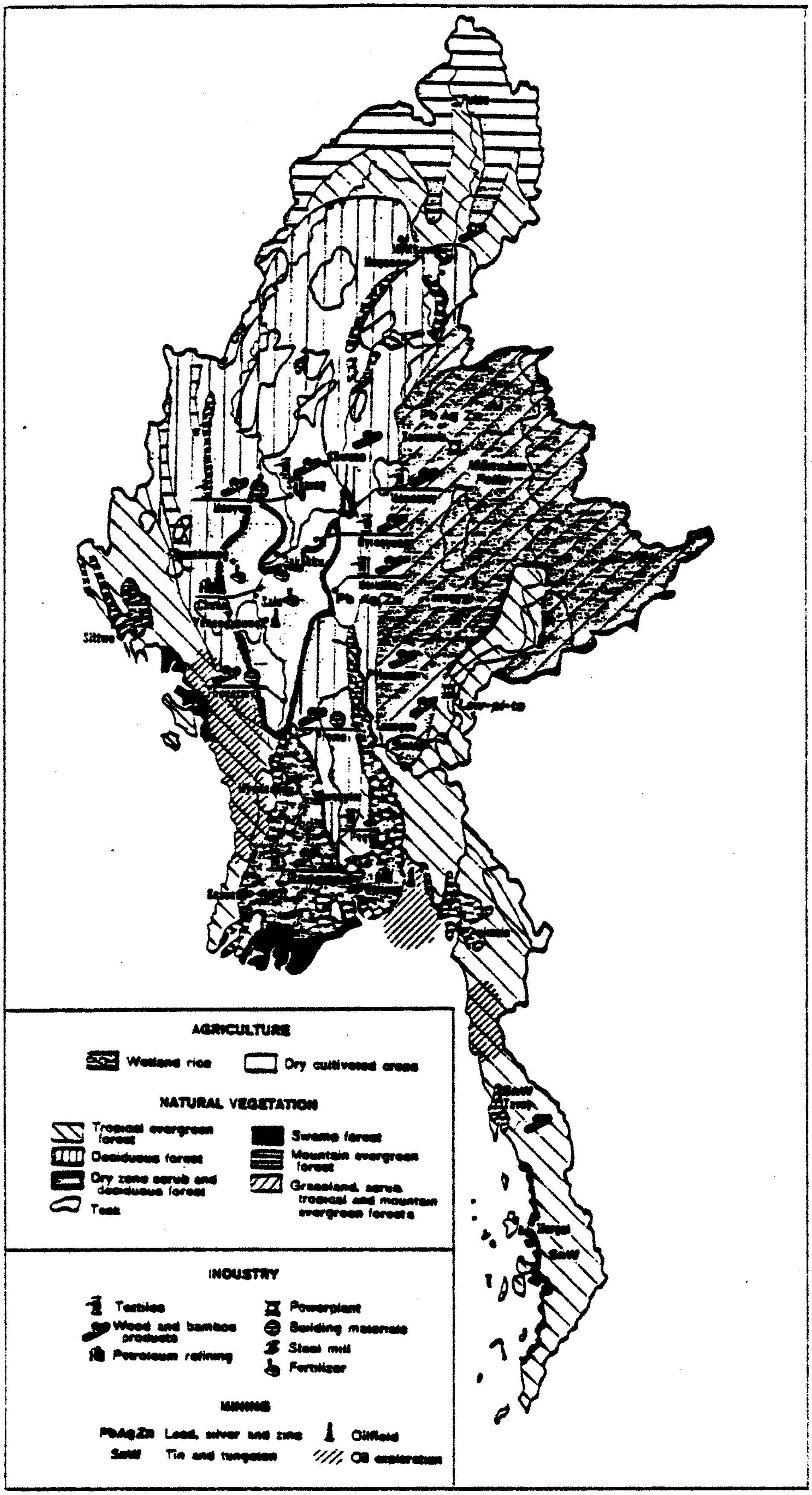

Figure 11. Land Use and Economic Activity

Source: Available from U.S. GPO (1972).

Table 8. Land Use, 1961 to 1977

Land Type	1961-65[a]	1967[a]	1972[a]	1977[b]	1978[c]	1977
	Area (in millions of hectares)					% of total
Cropland	10.2	10.4	10.4	10.0		14.7
Land under temporary crops	9.9	9.9	10.0	9.5		14.0
Cultivated land				7.5		11.1
Fallow land				2.0		2.9
Land under permanent crops	0.3	0.4	0.5	0.5		0.7
Permanent pasture	0.3	0.4	0.4	0.4		0.6
Forests and woodland	45.3	45.3	45.3	45.3		66.8
Reserved				9.3	9.7	13.7
Unreserved				22.7	29.0	33.5
Other[d]				13.3		19.6
Unclassified land	10.1	9.8	9.8	10.3		15.2
Cultivable waste				8.1		11.9
Other[e]				2.2		3.2
Inland water	1.8	1.8	1.8	1.8		2.7
Total area	67.7	67.7	67.7	67.8		100.0

[a] Source: FAO. 1979.
[b] Figures for 1977 have been drawn from two sources: UNESCAP (1978), and FAO (1979).
[c] Official SRUB figures from the Ministry of Agriculture and Forests (1978).
[d] FAO defines forests and woodlands to include deforested land and other lands which UNESCAP and other sources categorize as "unclassified" or "other" land.
[e] FAO's definition of unclassified or "other" land includes built-on areas, parks, ornamental gardens, barren land, and uncultivable wasteland.

But even without this last questionable terrain, forests and woodlands cover more of Burma's surface than any other land types shown on Table 8. Over the past two decades, the amount of land thus classified by FAO has remained constant. It is not possible to discern from Table 8, however, whether the number of hectares set asides as reserved forest land has undergone any change. As Table 8 indicates, FAO's figures for Burma's reserved and unreserved forest land are somewhat lower than those published by the Burmese government. Sections 2.3.4 and 3.3.1 below will treat natural forests in more detail.

Table 8 also fails to reveal any other noteworthy trends in land use. Other than a slight (1.9 percent) reduction in the amount of cropland and a corresponding rise in the number of hectares of unclassified land, Burma's gross land use patterns appear to have remained notably stable between 1961 and 1977. But because FAO does not provide data for cultivated and fallow land, it is not possible to know whether Burmese planters have been altering their allocations of fallow land.

The principal agricultural regions, as shown in Figure 11, lie within the deltas and floodplains of Burma's major rivers, the Irrawaddy and the Sittang. Along the lower valleys, the alluvial soils are particularly fertile and deep, and receive between 2,000 and 3,300 mm of annual rainfall. These areas are thus the most productive. To the north, as Figure 5 illustrates, there is a pocket of dry and subdry terrain. The northeastern portion of this zone, which corresponds to the white area of Figure 11, although drier than the lower valley, has been cultivated. For centuries this region has been irrigated by canals whose waters have permitted rice cultivation. Prior to World War II, total irrigated area had reached 0.63 million hectares (6.1 percent of the present agricultural area; Table 8). Wartime and post-war damage destroyed up to a quarter of Burma's canals, but subsequent reconstruction had increased irrigated land to 0.81 million ha by 1969. In 1970 the government, convinced of the advisability of further extensions in irrigation, planned to increase irrigation by more than 50 percent. By 1977 the program had succeeded in irrigating an additional 200,000 ha (Table 9).

Table 9. Irrigated Area, 1940 to 1977

Year	1940-41	1960-61	1961-65	1967	1968-69	1972	1977
Irrigated area (millions of ha)	0.63[a]	0.51[a]	0.68[b]	0.78[b]	0.81[a]	0.89[b]	1.00[b]

[a] Henderson et al. 1971.
[b] FAO. 1979.

2 3.1 Land Tenure 7/

Burma's traditional land ownership and management patterns were seriously disrupted by Britain's colonial rule. In an attempt to integrate Burma into its Indian empire, the British imposed alien modes of administration, ignored indigenous landholding systems, and introduced a trade-based cash economy. Together, these measures led to widespread peasant indebtedness and ultimately to forfeiture of productive land. The resulting redistribution of land transfered large holdings to the colonial administration, which in turn granted plots to individuals who were willing to farm them. Much of this newly-acquired land, however, soon came into the hands of wealthy moneylenders--many of them Indian settlers poised to take advantage of the scarcity of capital.

Immediately after independence, the Burmese government set out to redistribute land holdings. The vehicle for this program was the Burmese Constitution of 1947 which defined the state as the "ultimate owner of all lands." As a natural consequence of this view, the state had the right to "regulate, alter or abolish land tenures or resume possession of any land" for redistribution as it saw fit (Maung 1961).

In order to implement the spirit of this dictum, Parliament passed the Land Nationalization Act of

7 Sources: Henderson et al. 1971.
Maung. 1961.
Silverstein. 1980.
Steinberg. 1979.

1948. Its terms limited maximum land holdings to 50 acres (20.2 ha) per family and restricted reversion of land to moneylenders. In 1963 further legislation freed tenant farmers from rents and property seizures. Large (greater than 50-acre) holdings were nationalized except for some rubber plantations which were exempt in the interest of productivity. As a result, by the late 1960s most tenants effectively had become owners of the plots they farmed. Table 10 shows farmland distributions in 1967-68 and in 1978.

Table 10. Land Distribution, 1967-68 and 1978

Farm Size (in ha)	Number of Farms (% of total)		Area of Farms (% of total)	
	1967-68[a]	1978[b]	1967-68[a]	1978[b]
0-5*	88.0	88.6	60.0	64.0
5-10	8.0	8.5	20.0	19.0
10-20	3.0	2.8	18.5	13.0
Greater than 20	1.0	0.1	1.5	--

* Average farm size: in 1967-68 = 2.27 ha
in 1978 = 1.93 ha

[a] Adapted from Henderson et al (1971).
[b] Adapted from Steinberg (1979).

Although Table 10 excludes pre-independence figures, it is known that in 1939 half the cropland in lower Burma was owned in large lots by absentee landlords (Bixler 1971). It is clear, therefore, that the tabulated data reflect the effects of Burma's early land redistribution programs. The table reveals that these efforts have continued to raise the number of small (0 to 10 ha) plots at the expense of larger holdings, and thereby reduced average farm size from 2.27 ha to 1.93 ha in a decade. According to Henderson et al (1971), the fragmentation of large estates has led to increased subsistence farming and reduced productivity.

2.3.2 Agricultural Practices [8]

Centuries before British entry into Burma, rice had been established as the region's principal agricultural commodity. In those areas where rice grew best--the deltaic plains, the lower valleys of the Irrawaddy and Sittang Rivers, and along the coasts of the Bay of Bengal and the Andaman Sea- it was farmed according to traditional _le_ cultivation techniques (rainfall inundation irrigation) In these areas rice is the only important crop and grows on about 90 percent of cultivated land (Henderson et al. 1971). _Ye_ cultivation (shifting cultivation) is employed to grow rice in the drier regions of north central Burma (Figure 11).

In the remaining northern agricultural areas, farmers employ _kaing_ cultivating techniques (river overflow irrigation). There too rice is produced, but alongside other crops such as tobacco, peas, and beans. Terrain farmed according to the kaing mode tends to be erosion-free, well watered, and often double-cropped (Roberts et al. 1967).

In the inaccessible hill areas, particularly the "Golden Triangle" region of eastern Shan State, indigenous "slash and burn" patterns of settlement and farming persist (Miller et al. 1979; Steinberg 1979). Freshly cleared forestland is planted with cash crops such as opium and dry land rice. After just two or three years soil is stripped of its nutrients and inhabitants move on, repeating the cycle. Abandoned fields require two decades for natural reforestation. But whereas in the past most forests were minimally affected by these cycles of shifting cultivation, increasing demand for opium and population pressure have decreased the cultivation cycle time to six or seven years. These changes are seriously threatening large forested areas (Miller et al. 1979).

Because petroleum is expensive, much of the energy employed in farming remains bovine. Chemical fertilizer and insecticide use is still relatively low. Instead, farmers continue to rely on animal fertilizers and traditional methods of pest control.

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[8] Sources: Henderson et al. 1971.
Roberts et al. 1968.
Sasson. 1980.

2.3.3 Crops [9]

Rice. Paddy production, always Burma's chief agricultural enterprise, was strongly stimulated by British colonial administration. Appreciating the country's favorable climatic and soil conditions, Britain envisioned a major rice exporting capacity. Toward that end, farmers were encouraged to expand rice cultivation and land was brought under irrigation and drainage in order to increase yields. Table 11 demonstrates the growth of rice-planted area under colonial rule.

Table 11. Area of Rice Cultivation in Lower Burma, 1830 to 1940

Year	1830	1850	1860	1890	1900	1920	1930	1940
	Pre-colonial		Colonial period					
Area (1,000 ha)	26.7	40.5	539.7	1,780.6	3,461.5	3,476.9	4,012.6	5,182.2

Sources: Bixler. 1971.
Golay et al. 1969.

Large and continual increases in rice planting soon achieved British expectations. By the 1870s with world trade having benefited from the opening of the Suez Canal, Burmese rice was finding its way into European kitchens. By the turn of the century, approximately two million tons of rice and rice products were being exported (Adas 1974). As acreage and production continued to grow during the first three decades of the 20th century, exports kept pace, rising to three million tons by 1930-31, and to an all-time high of 3.3 million tons just

[9] Sources: Anonymous. 1979.
FAO. 1979.
Framji. 1977.
Golay et al. 1969.
Henderson et al. 1971.
Huysmans. 1965.
Steinberg. 1979.
UNESCAP. 1978a.
U.S. AID. 1981a.

prior to World War II (Bixler 1971). In the process, Burma's paddy cultivation changed from subsistence agriculture to a predominantly commercial venture.

The war however, put an end to agricultural expansion and instead destroyed large productive areas, irrigation systems, and supporting infrastructures. Burma's independent post-war economy, faced with rapid population growth, shortages of foreign currency, and internal political upheaval, has been unable to return to pre-war levels of growth. Table 12 shows that rice cultivation in 1978 is nearly equal to that in 1940. It was not until 1964, in fact, that pre-war levels were achieved, and since then, cultivated area has remained virtually constant. Gains due to expansion into marginal lands have been more than offset by losses of rice land to flooding and salt water intrusion (UNESCAP 1978).

Naturally, as the area under rice cultivation remained approximately constant, increases in rice production were limited to gains attained through improved productivity. Indeed, as Steinberg (1979) has pointed out, introduction of new varieties of rice has induced a "slow but steady" rise in production per hectare over the past two decades (Table 13). And although the nation's overall rice yield remains among Asia's lowest, there are indications of substantial gains in the past two years (U.S. AID 1981a).

Despite these improvements in rice productivity, Burma's growing population has diverted rice consumption to internal markets. Consequently exports, once the overwhelming foreign currency earner, have declined in magnitude and in relation to timber and other commodities. Although U.S. AID, in a current project paper, writes optimistically of Burma's prospects of once again exporting one million tons of rice, exports have been particularly unstable over the past ten years (Table 14).

The chief hopes for increasing the nation's rice production, and therefore its rice exports, rest with the lower Burma Paddyland Development Project (LBPDP). As envisioned in 1978, the undertaking would focus on improving rice farming on about 75,000 ha of once productive but now badly deteriorated paddyland (UNESCAP 1978a). Figure 12 shows the location of the LBPDP

Table 12. Area of Rice Cultivation in Independent Burma

Year	1962-63	1964	1966-67	1967-68	1968-69	1969-71	1976	1977	1977-78	1978
Area (1,000 ha)	4,839[b]	5,182[c]	4,990[b]	4,936[b]	5,021[b]	4,748[a]	5,180[a]	4,860[a]	5,157[c]	5,200[a]

Sources: [a]FAO. 1979
[b]Henderson et al. 1971.
[c]Steinberg. 1979.

Table 13. Rice Production, 1962 to 1980

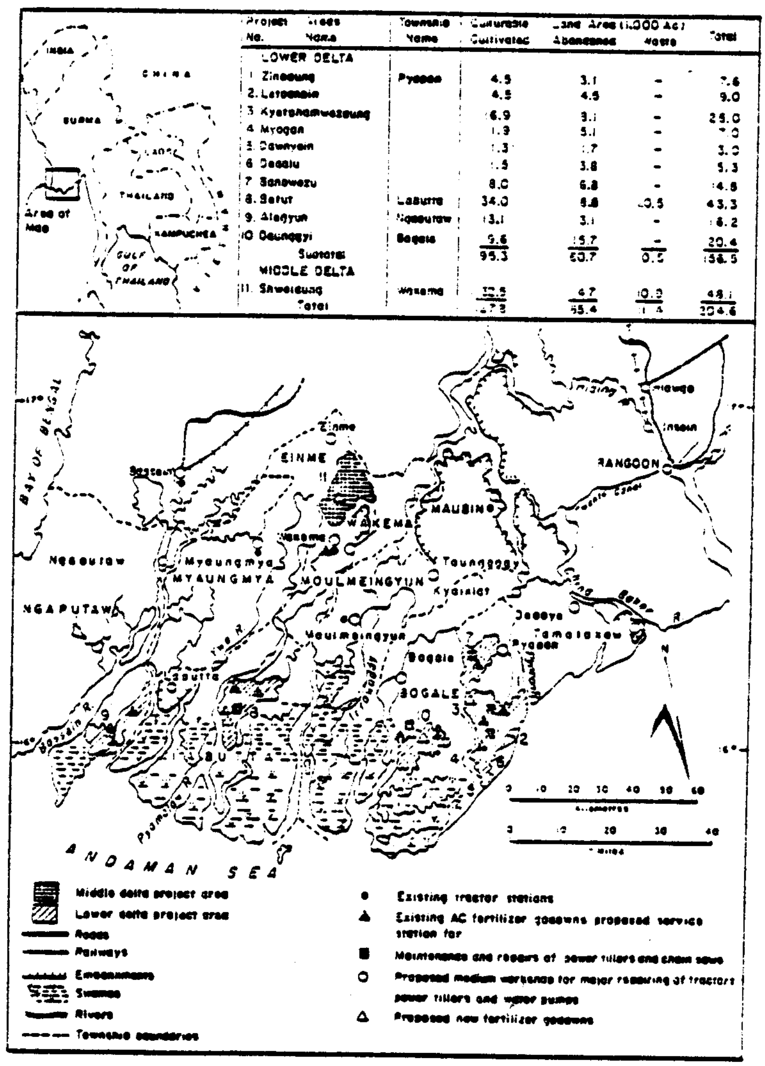
Year	1962-63	1966-67	1967-68	1968-69	1969-71	1976	1977	1977-78	1978	1978-79	1979	1980
Production (1,000 MT)	7,544[b]	6,532[b]	7,647[b]	7,896[b]	8,107[a]	9,320[a]	9,455[a]	9,489[c]	10,500[a]	10,300[a]	9,900[e]	13,000[d]
Normalized production (1962-63=100)	100	86.6	101.4	104.7	107.5	123.5	125.3	125.8	139.2	136.5	131.2	172.3

Sources: [a]FAO. 1979.
[b]Henderson et al. 1971.
[c]Steinberg. 1979.
[d]U.S. AID. 1981a.
[e]USDA. 1980.

Table 14. Rice Exports, 1939 to 1980

Year	1939	1964-65	1972-73	1975	1975-76	1976-77	1977-78	1980
Amount (1,000 MT)	3,300[a]	1,310[c]	260[c]	200[c]	440[e]	670[e]	660[b,e]	750[f]

Sources: [a]Bixler. 1971.
[b]Steinberg. 1979.
[c]UNESCAP. 1978a.
[e]U.S. AID. 1980.
[f]———, 1981a.



Project Area No. Name	Township Name	Culturable Land Area (1,000 Ac) Cultivated	Abandoned	Waste	Total
LOWER DELTA					
1 Zinbaung	Pyapon	4.5	3.1	-	7.6
2. Letpanbin		4.5	4.5	-	9.0
3 Kyatshamwezaung		16.9	8.1	-	25.0
4 Myogon		1.9	5.1	-	[illegible]
5. Dawnyein		1.3	1.7	-	3.0
6 Dedalu		1.5	3.8	-	5.3
7 Sanawezu		8.0	6.8	-	14.8
8. Setut	Labutta	34.0	8.8	0.5	43.3
9. Alegyun	Ngaputaw	13.1	3.1	-	16.2
10 Daungyi	Bogale	5.6	15.7	-	20.4
Subtotal		95.3	60.7	0.5	156.5
MIDDLE DELTA					
11. Shwelaung	Wakema	32.5	4.7	10.9	48.1
Total		127.8	65.4	11.4	204.6

Figure 12. Lower Burma Paddyland Development Project

Source: UNESCAP. 1978a.

More generally, the government plans to rely more heavily on high-yielding varieties (HYV) of rice throughout the country. While in 1979 only seven percent of paddyland was planted with HYV, officials hoped to increase this amount to 22 percent by 1981-82, and eventually to 60 percent. It should be noted, however, that in the past Burmese growers have been unable to meet the government's ambitious growth plans for the agricultural sector (Steinberg 1979; UNESCAP 1978a).

Other crops. As Table 15 amply demonstrates, rice remains by far Burma's predominant crop. Both rice acreage and production significantly exceed amounts for other agricultural commodities. The most important crops include sugarcane, vegetables, bananas and other fruits, pulses, groundnuts, sesame seeds, and jute.

Although agricultural production remained generally low (1.7 percent per annum) during the decade 1968 to 1978, recent indications have led to a more optimistic view of future output. Under the current Twenty-Year Plan begun in 1971, the second Four-Year Plan (1974-1978) inaugurated a series of reforms aimed at improving agricultural production. Partly as a result of these measures and partly due to favorable weather, annual agricultural growth rose to 3.6 percent by 1977, and to six percent by 1978 (Steinberg 1979; U.S. AID 1980). The most notable gain was in the sugarcane crop which rose from an average of 1.1 million tons during 1961 to 1965, to 1.6 million tons by 1979 (USDA 1980). The Asian Development Bank has funded a major sugar refining facility (Steinberg 1979). Other crops experiencing significant growth during this period were pulses (308,000 to 400,000 tons), jute (10,000 to 77,000 tons), sesame seeds (73,000 to 226,000 tons), and groundnuts (359,000 to 440,000 tons).

Of the agricultural products listed in Table 15, only rice, pulses, rubber, and jute are exported. Rice and rice products earned the country 730 million kyats (U.S.$112 million) in 1976-77 (Anonymous 1979). That same year pulses earned an estimated U.S.$9.9 million, rubber brought $5.6 million, and jute, $3.0 million (Steinberg 1979). Together, these products accounted for approximately 50 percent of Burma's total exports (Anonymous 1979). The U.S. Agency for International Development, in a long-term program, is currently assisting Burma through a Maize and Oilseeds Production Project (U.S. AID 1981a).

Table 15. Area and Production of Crops, 1978

Crop	Area (1,000 ha)	Amount (1,000 MT)
Rice	5,200	10,500
Wheat	91	94
Maize	80	75
Millet	173	60
Roots & tubers	17	90
Potatoes	11	54
Sweet potatoes	4	21
Cassava	2	15
Pulses	631	308
Beans	370	186
Peas, dried	22	19
Chick peas	147	71
Lentils	5	1
Soybeans	23	16
Groundnuts	570	450
Sunflower seeds	15	5
Rapeseed	1	1

Crop	Area (1,000 ha)	Amount (1,000 MT)
Sesame seed	606	111
Seed Cotton	140	42
Cotton seed	26	6*
Coconuts	84	n.a.
Vegetables & melons	1,825	n.a.
Fruits	652	n.a.
Treenuts	26	n.a.
Onions	23	136
Garlic	7	20
Sugarcane	50	1,791
Plantains	n.a.	448
Coffee	2	1
Tobacco	65	59
Jute	52	43
Cotton lint	16	n.a.
Natural rubber	20	15*
Tea	n.a.	9*

*From USDA (1980).

Source: FAO. 1979.

2.3.4 Forests [10]

As the general discussion in Section 2.3 above has already indicated, the exact amount of forest land in Burma is subject to some speculation. The government estimates that forests cover about 57 percent of the country, but as Table 8 shows this figure necessarily includes land which is not truly forested. Steinberg (1979) questions the apparent constancy of forest acreage since 1952, terming it improbable in view of the pressures exerted by a growing population, destructive practices, and widespread insurgent activities.

The most valuable products of land which is undisputedly forested (area listed as "reserved" and "unreserved" in Table 8) are teak and other hardwoods. The precise area of teak forest is difficult to estimate, but it is believed that Burma contains between 75 and 85 percent of the world's reserves (Steinberg 1979).

Burma's forest resources are discussed in greater detail in Section 3.3.1 below. Problems of deforestation and misuse of forested land are treated in Section 4 1.2. Figure 13 shows the distribution of Burma's forest types.

2.3.5 Rangeland and Livestock [11]

Burma has about 362,000 hectares of permanent pastureland, an area that represents just 0.6 percent of the country's total area (FAO 1979). Table 8 however, shows sizable stretches of terrain whose use is unspecified. Much of the area which is termed "other" forest land or "unclassified" land may be suitable for grazing.

It is not surprising therefore, that Burma's herds of cattle are substantial, particularly in comparison to those of neighboring Southeast Asian countries. The nation's nearly eight million head of cattle are almost as numerous as cattle in Kampuchea, Laos, Malaysia, Thailand, and Vietnam combined (FAO 1979). Water buffaloes, estimated at

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[10] Source: Steinberg. 1979.

[11] Sources: FAO. 1979.
Steinberg. 1979.

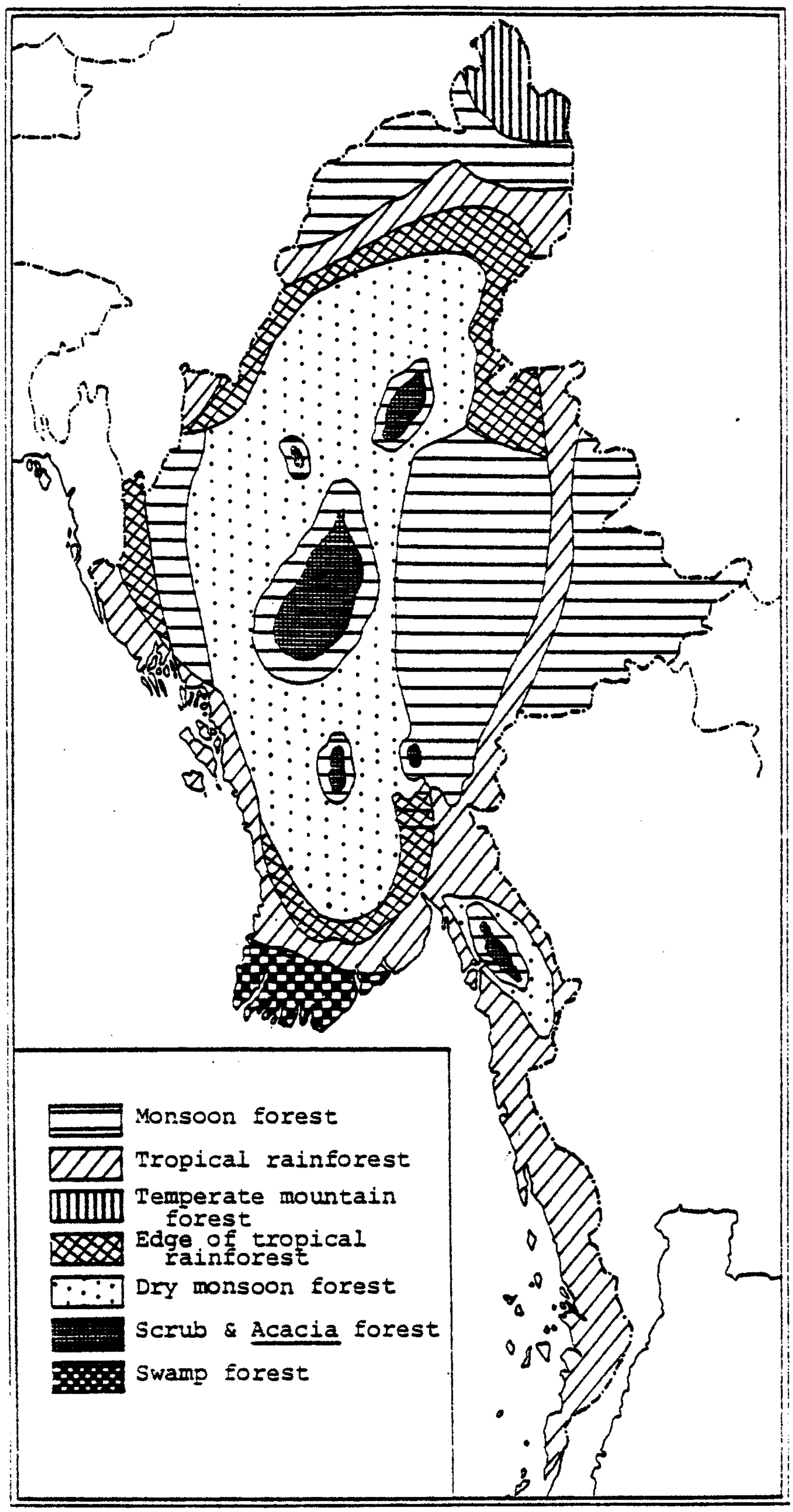

Figure 13. Forest Types

Source: Storz. 1967.

1.86 million head are not as common as in Thailand, where there are four times as many. The populations of other livestock animals are listed in Table 16. According to the tabulated data, cattle population has been the most nearly constant. Buffaloes, horses, pigs, sheep, and goats have all increased in numbers at a notable pace.

The Burmese livestock industry is not a large employer. Together with fishing, only 1.3 percent of the labor force is engaged in livestock rearing and processing. Table 17 provides figures of livestock product output.

Table 16. Livestock Population, 1947 to 1978

Livestock	Number of head (1 000s)					
	1947-52[a]	1957-58[a]	1960 61[a]	1969 71[b]	1976[b]	1978[b]
Cattle	6,007	n.a.	n.a.	6,949	7,526	7,865
Buffaloes	741	941	1,049	1,593	1,723	1,855
Horses	12	18	21	71	99	110
Mules	1	2	2	8	8	9
Pigs	419	569	652	1,562	1,781	1,915
Sheep	25	44	74	177	190	221
Goats	179	288	444	573	560	615

[a] Storz. 1967.
[b] FAO. 1979.

Table 17. Livestock Products, 1958 to 1978

Product	Amount (1,000 MT)			
	1958-59[a]	1969-71[b]	1976[b]	1978[b]
Beef and veal	8.9	67	74	78
Buffalo meat	n.a.	14	15	16
Mutton and lamb	n.a.	1	1	1
Goat meat	4.7	3	3	3
Pork	10.6	60	68	74
Cow's milk	240	185	214	221
Buffalo milk	18	43	49	51
Goat milk	n.a.	3	5	5
Butter and ghee	n.a.	4.1	4.7	4.9
Cheese	n.a.	11.6	13.4	13.9
Cattle and buffalo hide	n.a.	19.2	23.2	24.5
Sheepskins and goatskins	n.a.	0.5	0.5	0.5
Wool	n.a.	0.3	0.3	0.4

[a] Storz. 1967.
[b] FAO. 1979.

3.0 Environmental Resources and Policy

3.1 Geology, Soils, and Mineral and Energy Resources

3.1.1 Geologic Formations [12]

According to a recent study, the geology of Burma remains "hardly known" (Goossens 1978a) It is nevertheless possible to divide the country into five geotectonic and geomorphologic strips (cf. the four physical regions described in Section 2.1.2 above). These zones according to Goossens, are the: (1) Eastern Highlands; (2) Central Belt; (3) Arakan-Chin Ranges; (4) Northeastern Belt; and (5) the Arakan Coastal Plain (Fig. 14).

In the western portion of the Eastern Highlands belt, the rocks are principally Paleozoic sediments that are folded, partially metamorphosed, and highly faulted (Fig. 15). These sediments are intruded by granitic and dioritic rocks and rhyolitc plugs They may be grouped as two carbonate series (Ordovician-Silurian and "Plateau Limestones"), and two clastic series (Mawchi-Mergui and Cambrian) The Eastern Highlands are delineated on the west by the Shan Boundary Fault and on the north by the Lashio Fault (Fig. 15)

The Northeastern Belt (zone 4 of Fig. 14) north of the Eastern Highlands, is generally Precambrian igneous characterized by mafic, ultramafic, and granitic intrusions. Much of the land is of Precambrian origin

The Central Belt west of the above two zones (region 2 of Fig. 14) is considered a rift valley, or an extended graben. Its western edge is the Arakan Yoma-Chin Naga folded belt. Its southern extension continues into the Gulf of Martaban, beneath the deltaic alluvia of the Irrawaddy. The rocks of this belt are principally Cenezoic sediments. Along the central axis is a collection of andesitic volcanoes and volcanic hills. Pre-Tertiary greenschist volcanic complex makes up the basement of the Central Belt.

Region 3, the Arakan-Chin Ranges is a belt which is elongate folded and slightly arcuated. It is marked by Cretaceous-Tertiary flysch sediments containing

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[12]Sources: Garson et al. 1976.
Goossens. 1978a.

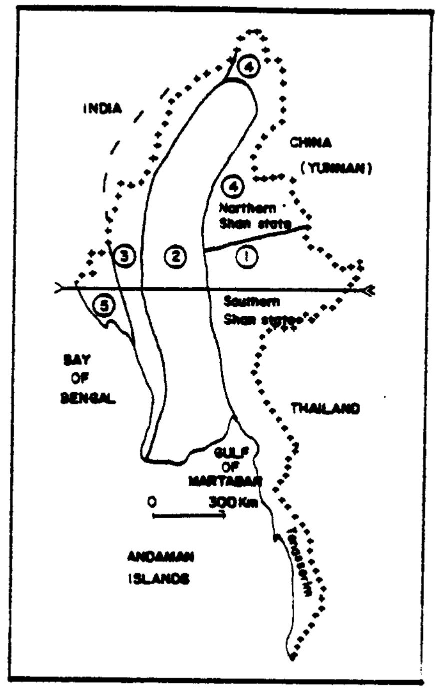

Figure 14. Geotectonic and Geomorphologic Belts
Source: Goossens. 1978a.

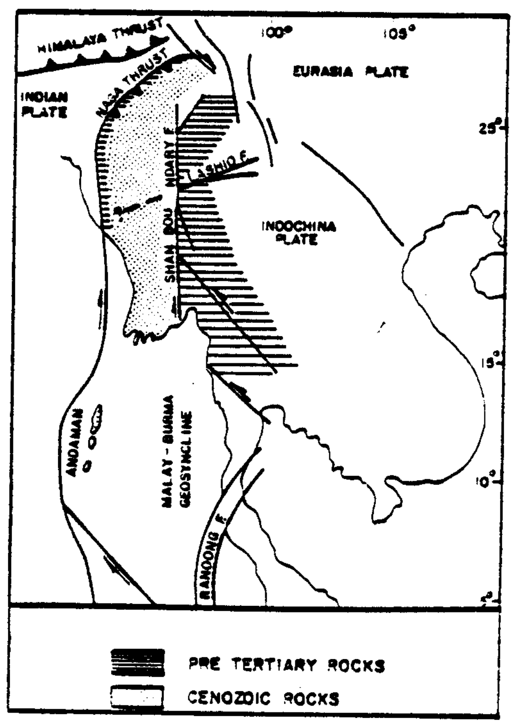

Figure 15. Major Fault System

Source: Goossens. 1978a.

basalt and ultramafic deposits as well as metamorphic rocks. This range continues southward to the Bay of Bengal, reemerging as the Andaman and Nicobar chain of islands.

The last geotectonic belt is the Arakan Coastal Plain (zone 5 of Fig. 14). It is a Cenezoic sedimentary basin whose northwestern extremus continues into Bangladesh. Figure 16 shows Burma's sedimentary and metamorphic rock formations.

3.1.2 Soils [13]

In general, Burma has three soil types: (1) Cambisols; (2) Acrisols-Fluvisols; and (3) Nitosols-Acrisols (Fig. 17).

Cambisols. These soils occur in elevated humid tropical regions having high precipitation. The soil pattern in northwestern Burma is influenced principally by topography and altitude. As Figure 18 shows, the region includes mostly Dystric, Humic, and Ferralic Cambisols.

The first of these soils, Dystric Cambisols, are found only in the extreme western corner of the country, near the Bangladeshi border. Unless properly terraced, they are vulnerable to extreme erosion. Left untouched they are suitable for forests. If properly managed, these soils can sustain grazing or terraced agriculture. Dystric Cambisols in the form of sandy clay loam or loam are favorable for growing tea. They are usually nutrient-poor, but respond well to fertilizer applications

Humic Cambisols, also found in mountainous terrain remain principally under forest cover. They tend to be sandy, and thus permeable and generally unsuitable for irrigated rice cultivation. Ferralic Cambisols occur to the east of the above soils in a north-south belt. They also are usually under forest, sometimes scrub cover. They tend to be low in phosphates and susceptible to drought. With appropriate management, these soils can sustain millet, wheat, and other crops.

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[13]Sources: Dudal et al. 1974
FAO-UNESCO. 1977.

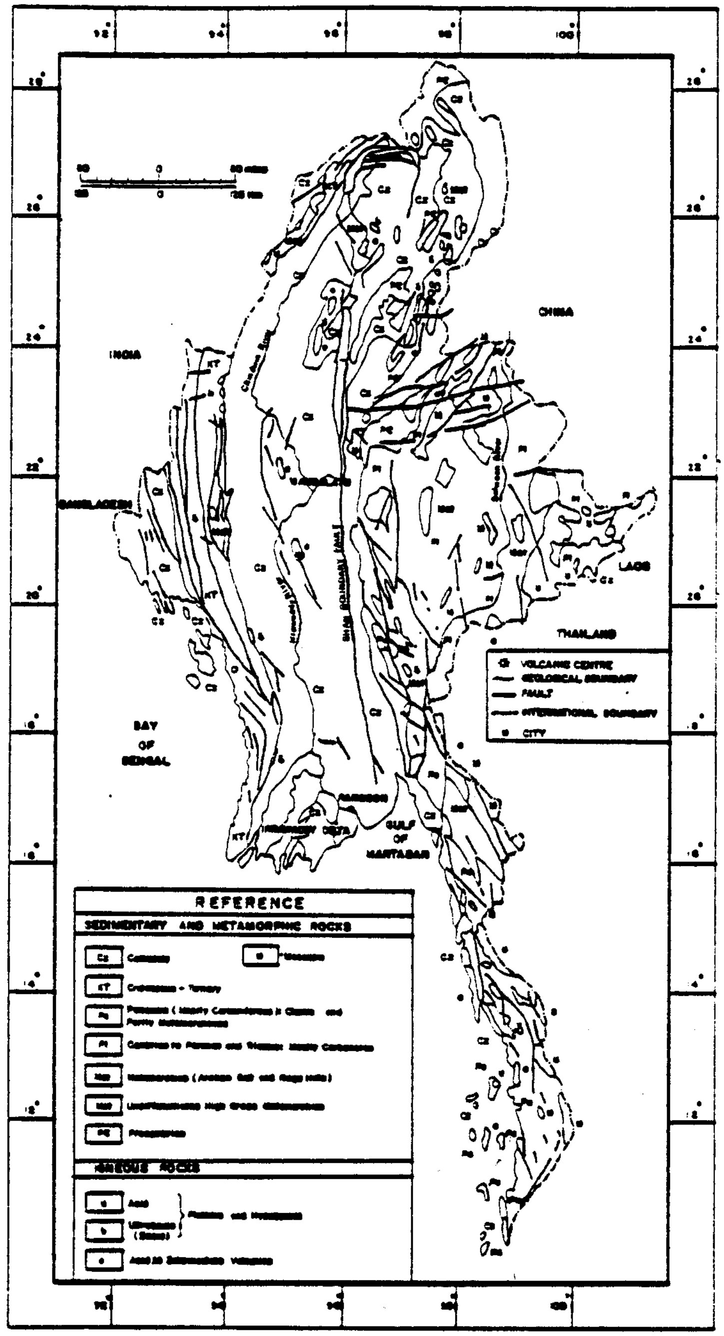

Figure 16. Sedimentary and Metamorphic Rocks

Source: Goossens. 1978a.

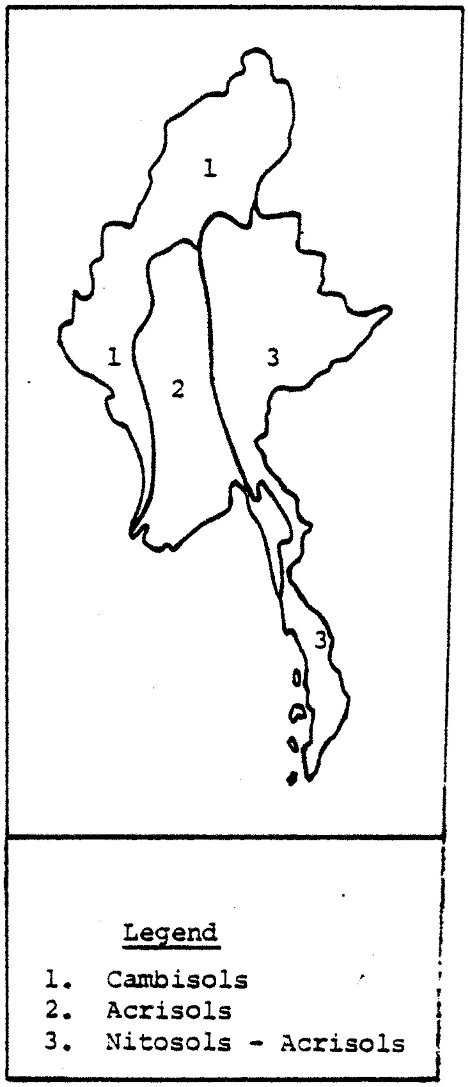

Figure 17. Broad Soil Regions

Source: Adapted from FAO-UNESCO (1977).

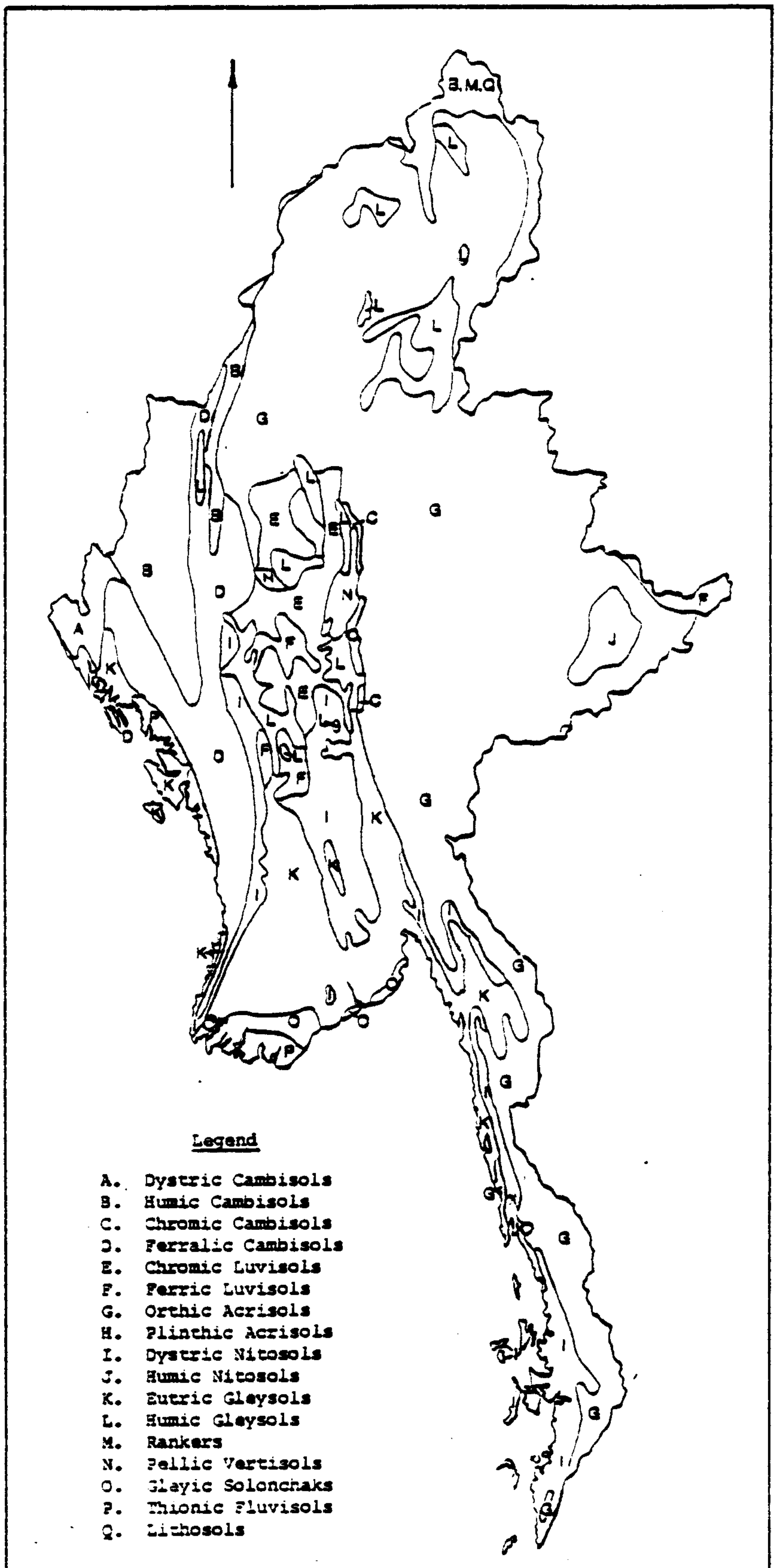

Figure 18. Soil Types

Source: Adapted from FAO-UNESCO (1977).

Acrisols-Fluvisols. The area marked "2" on Figure 17 is made up mostly of Gleysols, Luvisols, Nitosols, and in the north, Orthic Acrisols.

The Gleysols--Eutric and Humic--are alluvial soils deposited along the main river valleys. Eutric Gleysols in particular, are used to grow rice and are Burma's most important soils. There is an especially close correspondence between the areas marked "K" on Figure 18 and those shown as devoted to wetland rice cultivation on Figure 11. Rice may be grown without irrigation when rainfall is sufficient, or with it if necessary. In the latter case, the soil can support two crops per year. Dryland crops cannot be cultivated without irrigation. The natural fertility of Eutric Gleysols tends to be low, requiring fertilization in order to produce acceptable yields. In particularly wet areas artificial drainage is also needed to raise yields.

The Humic Gleysols found in small pockets north of the Eutric Gleysol regions are mainly suitable for forests. Because they are difficult to drain and deficient in nutritional elements they are not generally planted with rice In some areas near Shwebo however, these soils sustain various dry cultivated crop.

Interspersed with Humic Gleysols are regions covered with Chromic and Ferric Luvisols. The former occur in shallow layers and are highly susceptible to erosion. Although some of the Chromic Luvisols cover dryzone scrub and deciduous forest floor, others are planted with wheat, sorghum, pulses, oilseeds, and groundnuts. With supplemental irrigation, crop yield and choice are enhanced. Ferric Luvisols also found in certain portions of the central Irrawaddy floodplain, are highly weathered, high in iron, and low in alkaline content. They are primarily covered with bamboo and scrub forest, but occasionally support rubber plantations and fruit orchards. They generally require fertilization with phosphate, potassium, nitrogen and lime.

Dystric Nitosols cover the remaining portions of the central riverine plains, particularly in the vicinity of the low Pegu Yoma range. They are usually found on gentle slopes and are either forested or planted with rice pulses, or oilseeds. They are good deep soils when grades are not severe, and are erosion-resistant. They are relatively infertile and somewhat inpermeable. With proper management, irrigation, and application of lime, these soils can be made to produce high yields.

Nitosols-Acrisols. The upper reaches of zone "2" as well as the overwhelming portion of zone "3" of Figure 17 are covered with Orthic Acrisols. In zone "3," the only exceptions are isolated pockets of Ferric Luvisols and Humic Nitosols in the extreme east, and a coastal stretch of Dystric Nitosols along the western slopes of the Tenasserim Yoma range.

As Figure 11 illustrates, Burma's Orthic Acrisols occur either under grassland or scrub, or under tropical or mountain evergreen forest. Occasionally, these soils sustain rubber plantations or fruit orchards. Under shifting cultivation, Orthic Acrisols have supported vegetables, tobacco oilseed, and especially, rice.

Orthic Acrisols are extremely weathered and are therefore low in fertility. Planting on these soils requires application of phosphate, nitrogen, potassium, and lime. In sloping regions, soils require terracing to contain erosion. In Burma it is these soils which have suffered most from long-term shifting cultivation. As a consequence, these regions frequently suffer from drought despite adequate amounts of precipitation.

3.1.3 Mineral Resources [14]

Burma is generally regarded as an area rich in mineral resources. For a number of reasons, however, the nation has yet to exploit effectively its mineral wealth. Losses resulting from World War II, post-independence insurgencies in the mining regions, inadequate infrastructure, outdated technologies, and reductions in international demand have in the past combined to retard Burma's development of its mineral sector. Under the current Twenty Year Plan the government is

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[14] Sources: Asnachinda. 1978.
Goossens. 1978a.
-----. 1978b.
Kinney. 1980.
Steinberg. 1979.
Storz. 1967.

attempting to reverse these trends by stressing mineral development. The sector as a whole (including petroleum and other energy resources) received 5.4 percent of public expenditures between 1964 and 1974, and a much larger share, 13.3 percent under the current Four-Year Plan. The next Four-Year Plan calls for a reduction to just 6.6 percent.

Figures 19 and 11 show the geographical locations of Burma's principal mineral deposits. Table 18 provides data for mineral production. The discussion which follows treats the nation's principal mineral resources.

Gems. Perhaps the first mineral products to come to the attention of colonial merchants were the country's precious and semiprecious stones. Jade, diamonds, rubies, sapphires, tourmalines, amber, chrysoberyl, and other gems were among Burma's earliest and most valued exports. In 1969, well after independence, the government nationalized the gem industry, placing it under control of the Myanma Gems Corporation, a division of the Ministry of Mines. In order to limit black marketeering, the government instituted an annual emporium for foreign buyers.

In 1976 Burma produced some 9,000 kg of jadeite and approximately 76,000 carats of precious and semiprecious stones (Table 18). Most of the industrial diamonds, cut and uncut jade, rubies, and sapphires are exported to European and other Asian markets.

Tin and Tungsten. Historically, these were the minerals which came to be exploited after gems. The Mawchi Mine in Kayah State (Fig. 19), although mostly destroyed during the war, remains one of the world's largest mines of tungsten and tin. Prior to 1940 Burma's annual tin output was about 5,400 tons. At independence this figure dropped to 1,800 tons, and is presently about 785 tons (Table 18). Although the amounts of tin and tungsten concentrates produced have continued to decline, there has been a notable rise in the output of the combination of tin-tungsten concentrate. As Figure 20 shows, most of Burma's reserves of tin and tungsten are situated in the southern peninsular region and northeast of the Sittang River in Kayah State. In all, there are more than 120 known tin and tungsten deposit sites in Burma (Fig. 20). They occur in three forms: lodes in granitic margins and greisen, detrital deposits, and placer deposits (Goossens 1978a).

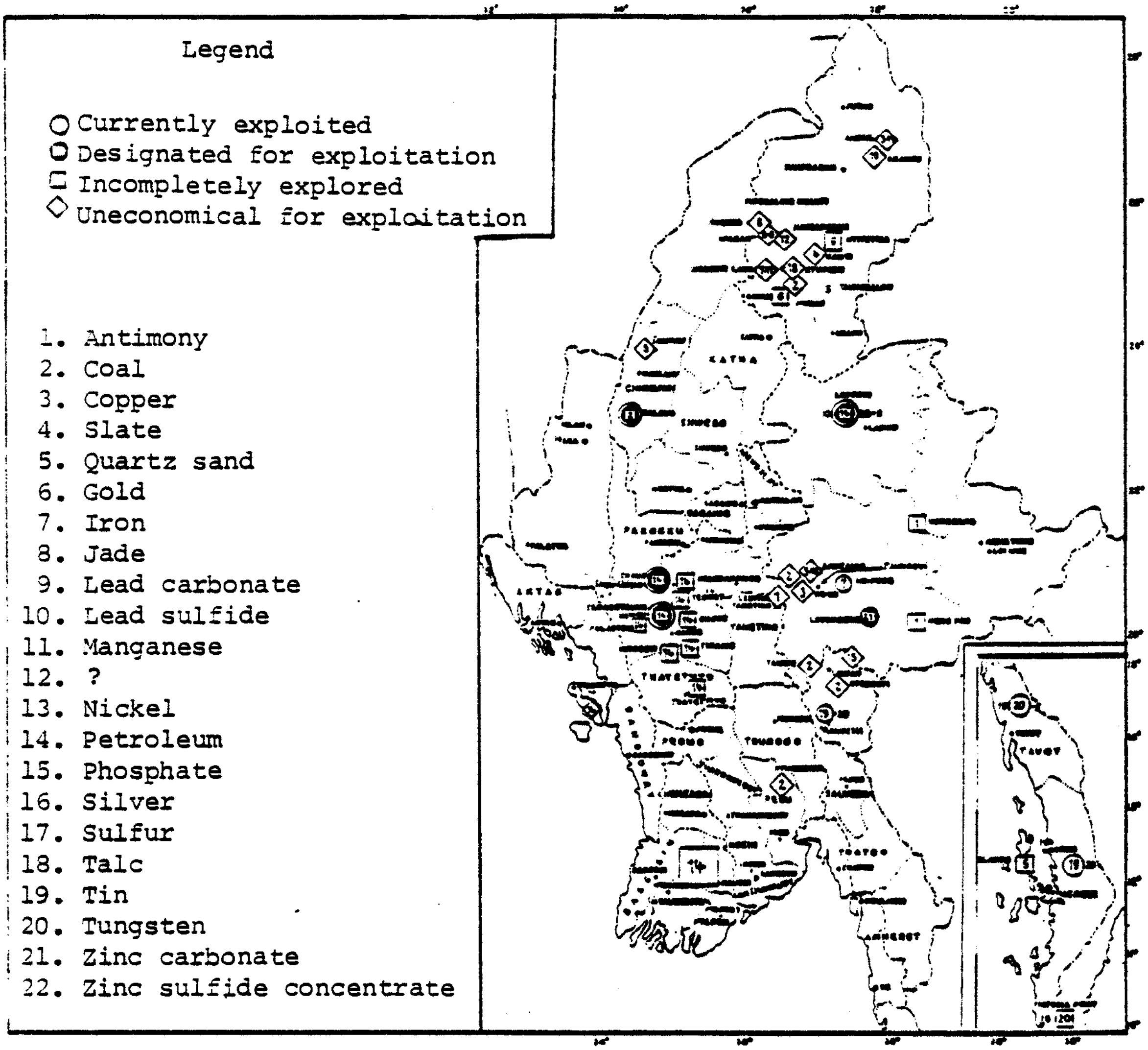

Figure 19. Mineral Deposits[a]

[a]Note that this map reflects conditions in 1953.

Source: Adapted from Storz (1967).

Table 18. Mineral Production

Mineral	Production (in MT unless otherwise specified)			
	1961-62[a]	1968-69[a]	1974[b]	1976[b]
Metals				
Antimony, mine output	*	*	420	570
Copper				
Mine output	*	*	70	90
Matte	354	160	159	205
Iron and steel				
Crude steel	*	*	40,000	40,000
Semimanufactures	*	*	30,000	35,000[c]
Lead				
Mine output	16,991	9,800	9,300	3,350
Refined lead	16,615	9,500	9,295	3,331
Antimonial lead	376	300	359	187
Manganese ore	*	*	280	—
Nickel				
Mine output	*	*	22	24
Speiss	520	115	87	94
Silver, mine output (kg)	44,626	37,395	22,422	6,553
Tin				
Mine output	900	499	734	785
Tin concentrate	*	*	482	262
Tin-tungsten concentrate	*	*	252	523
Tungsten				
Mine output	1,440	155	393	108
Tungsten concentrate	*	*	220	479
Tin-tungsten concentrate	*	*	173	587
Zinc, mine output	14,225	9,000	4,361	2,211
Nonmetals				
Barite	*	*	15,000	13,696
Clays				
Ball clay	*	*	2,055	5,080
Bentonite	*	*	512	955
Fire clay	*	*	2,496	2,792
Industrial white clay	*	*	1,536	4,393
Feldspar	*	*	198	904
Graphite	*	*	305	—
Gypsum	*	*	30,085	45,296
Precious and semiprecious stones				
Jadeite (kg)	51,000	1,000	8,808	9,046
Unspecified (1,000 carats)	*	*	*	76[c]
Salt	*	*	125	100
Sand				
Brown glass sand	*	*	*	5,283[c]
White glass sand	*	*	*	2,710[c]
Stone				
Dolomite	*	*	420	1,016
Limestone (1,000 MT)	*	*	524	802
Quartz	*	*	151	177
Talc and soapstone	*	*	347	355

Notes: * Not available
[a] Henderson et al. 1971.
[b] Kinney. 1980.
[c] 1975 figure.

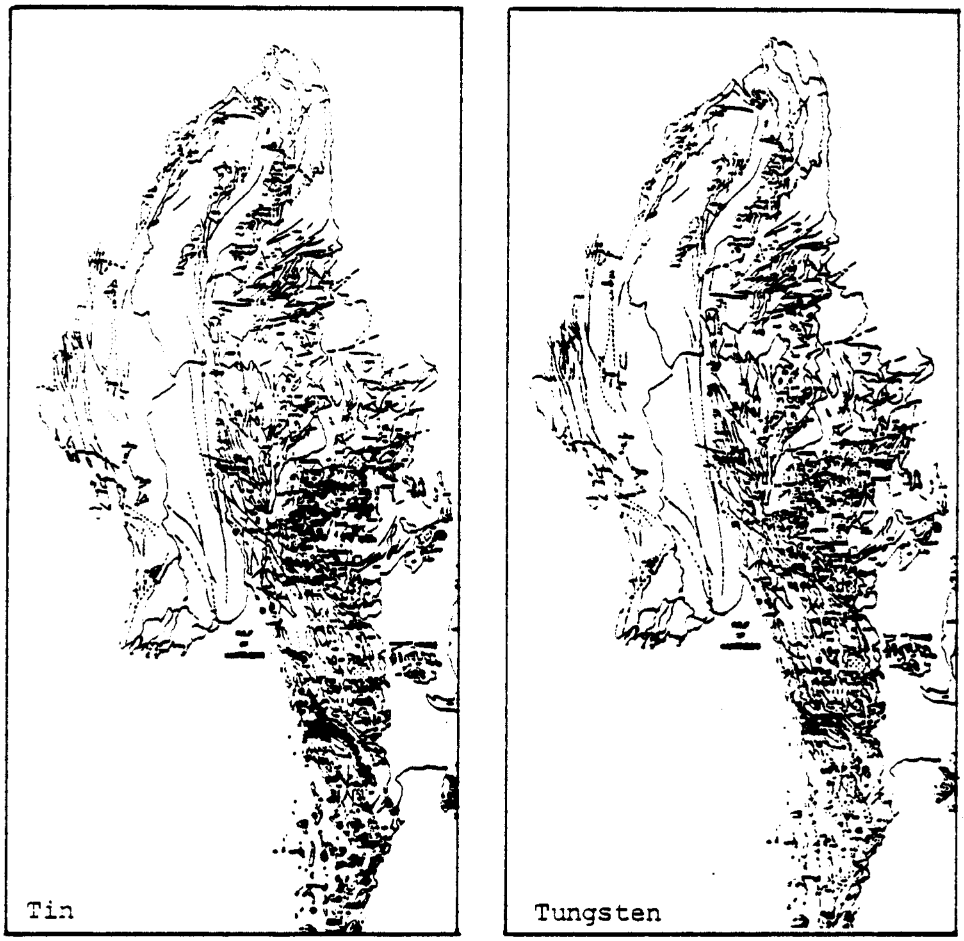

Figure 20. Tin and Tungsten Deposits

Source: Goossens. 1978a.

The government's recent emphasis on increased mineral production is manifest in the opening of the Myanma Tin and Tungsten Corporation's West German financed Heinda Mine. Production at this facility is slated to reach 1,000 tons of tin concentrate per year, an amount which far exceeds current national production. Other projects funded by the International Development Association (IDA) of the World Bank (IBRD) include new support facilities for tin-tungsten mines at Heinda Basin, Kanbauk, and Tavoy. Figure 21 shows the locations of Burma's major mines (Schreck 1980).

Iron, Lead, Zinc, and Other Metals. Iron has been mined and worked for many centuries. The earliest known iron deposits were in the region around Mount Popa, between Mandalay and Magwe. Recent iron exploration has centered further east in Shan State, where there are numerous hematite-limonite accumulations. These ores, however, are low-grade and reserves are not large (Appendix II).

Lead and silver, which generally occur together in galena, are mined throughout eastern Burma. At present most of these metals come from the Bawdin, Bawsaing, and Yedanatheingi Mines (Fig. 21). Of these, the first is the oldest and most important facility. Higher-grade ores are becoming less plentiful and equipment problems have further hampered operations. Although, as Table 18 shows, outputs of both lead and silver have declined since the early 1960s, both substances remain important to Burma's economy as a source of foreign currency.

Zinc mining has undergone a similar pattern of decline. This metal occurs with galena and was also formerly found in abundance at the Bawdin Mine. Zinc too, has been depleted from this facility, and its production has consequently fallen to a sixth of its 1961-62 level. Newly discovered deposits of zinc at Sagyin (20°06' N; 95°37' E) and Lough Keng (20°35' N; 97°29' E) are not fully established. Burma does not have zinc smelting facilities, but one is scheduled to be built at Ela (19°37' N; 96°13' E). In Appendix II Figures 7 and 9 show the locations of zinc and lead deposits in Burma.

Among other metals, there are 30 known occurrences of antimony-bearing stibnite, boulangerite, bournonite, pyragyrite, and tetrahedrite. With new discoveries and increased exploitation, antimony

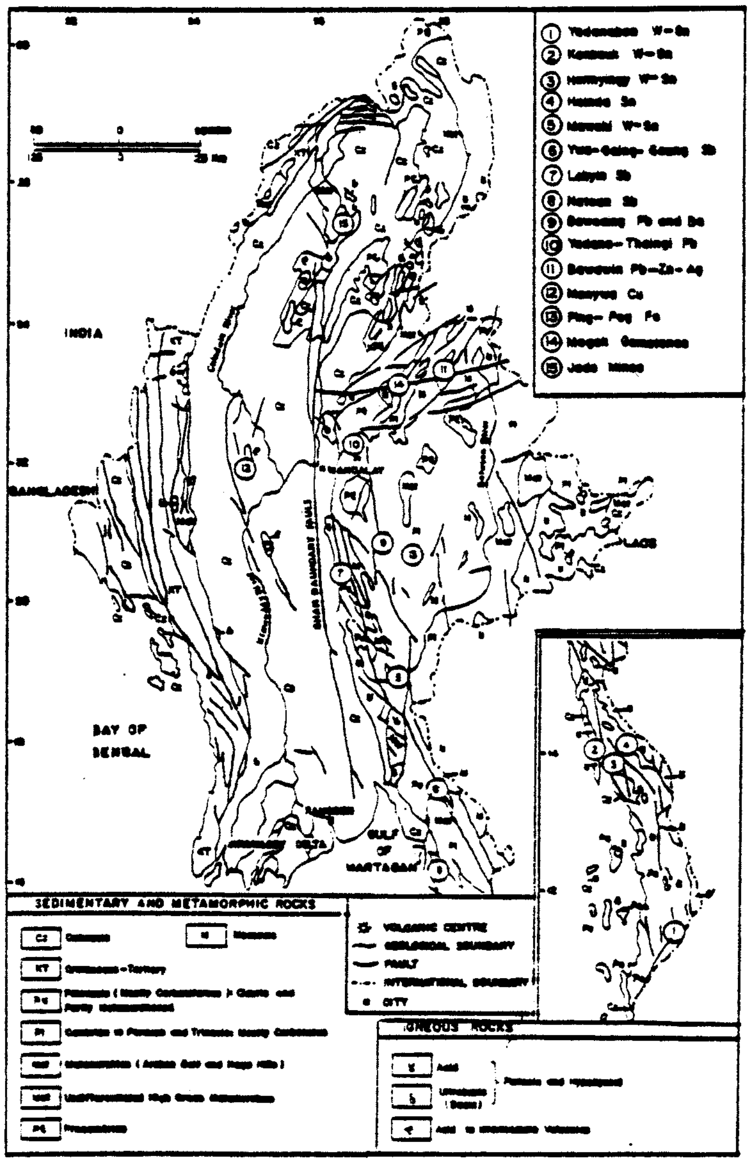

Figure 21. Location of Mines

Source: Goossens. 1978a.

production is increasing and had reached 570 tons by 1976 (Table 18).

Chromium, copper, and nickel are the only other metals of note. Chromite is found in a strip within the Arakan-Chin ranges, at 13 known locations. It is not presently being exploited significantly. Copper has not previously been produced in Burma, but there are 45 established occurrences in the country. With the development of the Monywa disseminated copper sulfide deposit (Fig. 21), Burma may become a copper producer (Goossens 1978a, 1978b). Nickel, arising from gersdorffite, is produced at the Bawdin Mine. It is smelted into speiss at Namtu, 15 km away. Other nickel deposits, in garnierite-bearing laterite, have recently been found in the Arakan-Chin belt.

Precious metals such as gold and platinum, along with other metals such as beryllium, cobalt, lithium, mercury, selenium, and titanium are found in small deposits, but to date have not been produced in significant amounts.

Nonmetals. As Table 18 indicates, Burma's chief nonmetals are barite, clays, fluorite, gypsum, sand, and stone. There are just 11 barite deposits, but these are substantially exploited. Bawsaing (Fig. 21) is the largest and most developed source. Since barite is required for oil drilling, the government is actively searching for new sources. As a result, the Rangoon Arts and Science University Geology Department's, Post Graduate Training in Mineral Exploration Program has been assisting in this search (Goossens 1978a). Burma's barite production in 1976 was reported as 13,696 tons (Table 18). In Appendix II Figures 2 and 5 show the geographical distribution of barite and fluorite.

Because of growing demand for cement, Burma has been increasing its exploitation of gypsum and sand resources. Cement production grew by 43 percent between 1975 and 1976, and as Table 18 shows, gypsum production kept pace. Sand is also employed in the country's glass and ceramic industries. A bilateral agreement with Japan's Asahi Glass Company to build a plant at Bassein is expected to permit Burma to become self-reliant in sheet glass production (Kinney 1980).

3.1.4 Energy Resources [15]

Beginning in the early 1960s Burma began relying more heavily than in the past on liquid sources of energy. Coal, which in 1963 supplied 18.2 percent of the nation's energy, accounted for only four percent of fuel use by 1974 (Siddayao 1978). The alternative to coal use during this time became petroleum, whose increasing presence off the Burmese coast has now made the nation into an oil exporter.

Table 19 shows the pattern of energy consumption between 1960 and 1979. It indicates that per capita energy consumption has been increasing over the past two decades. Both the rate of increase and average consumption however, remain relatively low in comparison to rates in other low-income countries and in most other Southeast Asian nations. Burma's trend toward increased reliance on liquid fuels is in keeping with trends elsewhere in the region. The rate of increase of oil consumption in particular, has been higher in Asia than in the rest of the developing world. In Burma as elsewhere in the area, part of this rise reflects the substitution of petroleum derivatives for coal (Siddayao 1978). The following sections examine Burma's resources in petroleum, coal, natural gas, hydroelectricity, and nuclear fuels.

3.1.4.1 Petroleum

Although petroleum was discovered in Burma in 1835, the first commercial exploitations were not undertaken until a half century later. The country's first wells at the Yenangyaung field were dug by hand through oilsands to a depth of 100

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[15] Sources: Asian Devel. Bank. 1981.
Brown and Dey. 1975.
Durdin. 1972.
Fletcher. 1978.
Kinney. 1980.
Siddayao. 1978.
Silverstein. 1981.
Simon and Rakoczi. 1972.
U.S. AID. 1980b.
World Oil. 1976.
-----. 1978.
-----. 1979.
-----. 1980.

Table 19. Energy Consumption, 1960 to 1979

	1960[a]		1963[b]		1974[b]		1979[a]	
	Consumption[c]	Percent of total	Consumption[c]	Percent of total	Consumption[c]	Percent of total	Consumption[c]	Percent of total
Coal	*	*	217	18.2	67	4.0	*	*
Liquid fuels	*	*	922	77.5	1,534	90.9	*	*
Natural gas	*	*	21	1.8	27	1.6	*	*
Hydroelectricity	*	*	29	2.4	57	3.4	*	*
Total consumption	1,300[d]	100.0	1,190	100.0	1,685	100.0	2,369[d]	100.0
Per capita consumption (kg)	58	--	50	--	56	--	72	--

Notes: *Not available.
[a]World Bank. 1981.
[b]Siddayao. 1978.
[c]Volume in 1,000 tons of coal equivalent, except where otherwise noted.
[d]Estimate based on per capita consumption and population figures.

meters. In their first year of operation in 1888, they yielded approximately ten million liters (59,500 barrels). Within a year the newly-formed Burmah Oil Company began drilling the first of its more than 4,000 wells. Other fields at Indaw, Sabe-Yenangyat, Lanywa, Chauk, Minbu, Palanyon, Yethaya, Padaukpin, and Yenanma were opened and began yielding petroleum (Fig. 22).

By the 1930s many of these fields were being depleted and soon after, World War II brought oil production to a virtual halt. Exploration and exploitation began anew after independence, but not until the 1960s did experts begin to suspect that Burma's petroleum reserves might be significant. By the middle of the decade, spurred by some favorable survey findings, the government commissioned a sustained program of exploration. These efforts, concentrated in the deltaic and Arakan coastal areas, along the continental shelf, and in the region near Shwebo, began to yield positive results. By the mid-1960s Burma's proven reserves of petroleum were estimated at 140 million barrels (Henderson et al. 1971).

The Gulf of Martaban soon became the focus of international exploration. In 1969 the Burmese government, employing a $10 million loan from Japan, contracted with a Japanese firm to survey the offshore shelf. A West German firm was retained in 1970 to continue the work. Two years later a U.S. oil-drilling operation began sinking test wells 80 km off the Tenasserim coast. Simultaneously efforts were under way to develop the inland Mann oilfield. A number of the test sites proved productive and by 1977 Burma was exporting petroleum again--the first time since the 1930s. Table 20 shows that production had more than doubled from 4.4 million barrels in 1962 to 9.5 million barrels in 1977, and reached 12 million barrels in 1980 (Silverstein 1981; Steinberg 1979).

By 1976, Burma's estimated proven petroleum reserves totalled 70 million barrels. Ultimately recoverable potential petroleum resources were far higher--between 10 and 100 billion barrels. About a tenth of these reserves were considered to lie offshore (Siddayao 1978).

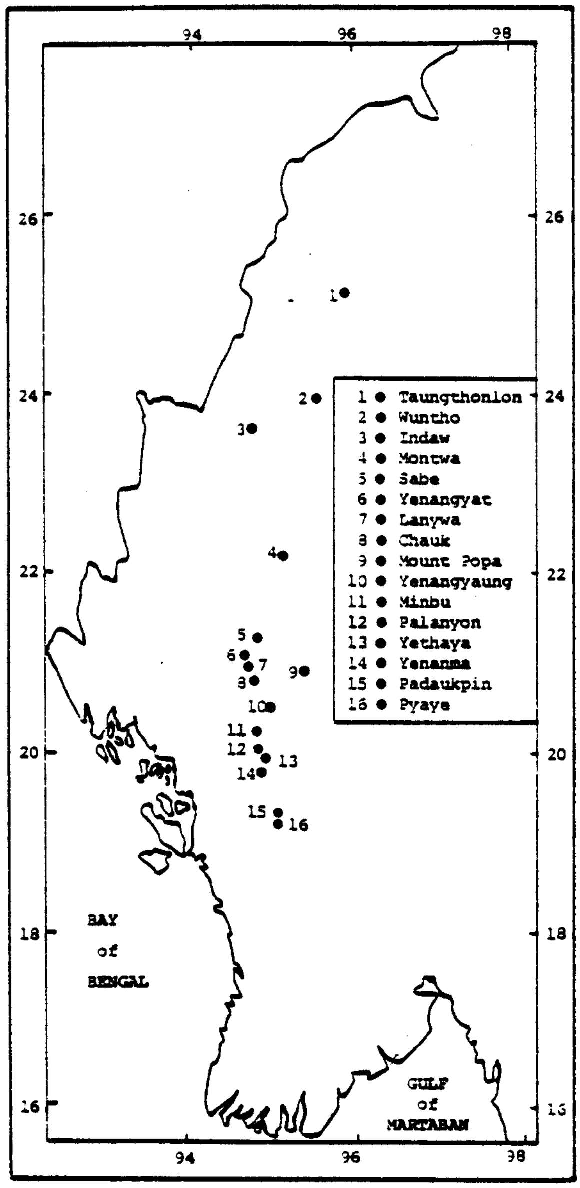

Figure 22. Early Oilfields

Source: Brown and Dey. 1975.

Table 20. Oil Production, 1962 to 1980

Year	1962	1963	1965	1967	1974	1975	1976	1977	1978	1979	1980
Production (10^6 barrels)	4.4[a]	4.8[a]	3.9[a,b]	4.5[a]	7.6[c]	7.8[c]	9.1[d]	9.5[b,e]	10.0[e]	10.8[f]	12.0[g]

[a]Brown and Dey. 1975.
[b]Steinberg. 1979.
[c]World Oil. 1976.
[d]World Oil. 1978.
[e]World Oil. 1979.
[f]World Oil. 1980.
[g]Silverstein. 1981.

3.1.4.2 Coal

Burmese coal deposits were discovered about the same time as the first oilfields, between 1855 and 1890. Jurassic coal seams were found in the Panlaung Valley, in Loian, and in the Henzada District. Tertiary deposits exist in several districts of northern and central Burma (Bhamo, Katha, and Minbu), and in the Upper Chindwin and Shwebo regions. In addition, lignite fields occur in the Theindaw-Kawmapyin, Mergui and Lenya areas, and in the Shan States (Brown and Dey 1975; see Fig. 19). According to the Asian Development Bank (1981), Burma's proven coal reserves are just 2.3 million tons; the same source estimates the country s "indicated and inferred" coal resources at a much higher 200 million tons.

Although as Table 19 indicates, Burma has reduced considerably its reliance on coal (from 18.2 percent of all energy consumption in 1963 to just four percent by 1974), production of coal has been increasing over the past decade. Under the administration of the government's No. 3 Mining Corporation, hard coal output rose by 50 percent between 1973 and 1975, then dropped slightly in 1976 (Table 21).

Table 21. Coal Production, 1973 to 1976

	Production (1,000 metric tons)			
	1973	1974	1975	1976
Hard coal[a]	10	13	15	14
All coal[b]		17	25	21

[a] Anonymous. 1979.
[b] Kinney. 1980.

Increased use of coal by the nation's railways account for most of the raised demand. Until recently Burma continued to import much of the coal it consumed. In 1974 the amount of hard coal imported stood at 152,000 metric tons, more than ten times the tonnage produced. In more recent years coal imports appear to have dropped from a high of 92 million kyats ($14.2 million) in 1975-76 to what one observer (Kinney 1980) has termed "an insignificant level" of just 2.1 million kyats ($0.3 million) by 1976-77 (Anonymous 1979).

3.1.4.3 Natural Gas

Table 19 indicates that as late as 1974, the most recent year for which data on consumption have been obtained, only 1.6 percent of Burma's energy was fueled by natural gas. Since then however, production has risen at a rapid pace--from 0.15 billion cu m in 1974 to 2.67 billion cu m by 1976--mostly in response to increased demand from fertilizer and cement plants and gas turbine powerplants (Kinney 1980).

Burma's natural gas resources, like its oil and coal deposits, were discovered and exploited early. By the end of World War I several fields had begun yielding sizable quantities of methane. Indaw, Yenangyaung, Chauk, Lanywa, Yenangyat-Sabe, Minbu, Palanyon, Yethaya, and Pyaye were among the earliest gas fields to be exploited. Other sources were found in Thayetmyo, Prome, Henzada, and Pegu Districts.

Table 22. Natural Gas Production, 1962 to 1976

Year	1962	1963	...	1974	1976	1978	1979
Production (10^6 cu m)	18[a]	16[a]	...	150[b]	267[b]	300[c]	400[c]

[a] Brown and Dey. 1975.
[b] Kinney. 1980.
[c] Asian Devel. Bank. 1981.

The above tabulation illustrates Burma's rapidly growing gas production. Much of the gas is found in conjunction with petroleum deposits and as more oil is exploited, it is likely that natural gas production will continue to rise. Until very recently some observers suspected that gas production was kept deliberately low on account of the shortage of downstream distribution facilities (Fletcher 1978).

3.1.4.4 Hydroelectric and Thermal Energy

In 1974 only 3.4 percent of the nation's energy needs were supplied by hydroelectric power. Along with most Southeast Asian nations Burma is turning increasingly to hydroelectricity as a viable source of energy (Siddayao 1978; Table 19). Because of its mountainous periphery, its marked drops in elevation, and its 13,000 kilometers of inland waterways, the country possesses substantial hydroelectric potential. To date most of this potential remains unexploited. In 1978 Burma's installed hydroelectric capacity was approximately 181 megawatts, or 40 percent of its total installed electric capacity. During the period 1968 to 1978 the nation increased its hydroelectric capacity by 80 percent (Van der Leeden 1975). The Asian Development Bank (1981) estimates the nation's ultimate hydropower capacity at 23,500 MW, the second highest amount in Asia.

Thermal energy, still relatively undeveloped, accounted for 18.7 percent of electric capacity. Current plans call for doubling the country s thermal capacity by 1982. The chief impediment to further exploitation of thermoelectric and hydroelectric resources is the persistent shortage of transmission and distribution facilities (U.S. AID 1980).

3.1.4.5 Nuclear Energy

Current investigations indicate that there appear to be few deposits of radioactive minerals in Burma. Monazite, a thorium bearing ore occurs in Tavoy and Mergui districts in Tenasserim. Other thorium deposits may exist in Shan State, and uraninite has been reported near Mogok (22°55' N; 96°30' E). In general, the presence of radioactive metals is associated with rare-earth bearing minerals found in stream sediments (Brown and Dey 1975; Goossens 1978).

At present there is no information indicating that Burma is seeking to develop commercial nuclear energy facilities. As of 1978 all of the nation's generated electric power was derived from hydro, thermal, gas turbine, and diesel facilities. The only known applications of nuclear technology relate to small crop development projects which employ irradiation. These efforts, begun in 1970 under a $15,000 grant from the International Atomic Energy Commission (IAEC), were conducted in conjunction with the Burmese Agricultural Research Institute

(Simon and Rákóczy 1972). In 1978 Burma established an Atomic Energy Committee to assist the Union of Burma Atomic Energy Centre in Rangoon. That center conducts research on nuclear minerology, nucleonic instrumentation, and radiation protection (Anonymous 1979).

3.1.5 Administration, Policy, and Planning [16]

Burma's mining sector is controlled by the Ministry of Mines. The Ministry operates through five public corporations, each having specific responsibilities, as outlined in Table 23 below.

Table 23. Public Administration of Mining and Petroleum Exploration

Ministry	Agency	Purview
Mines	No. 1 Mining Corporation	Non-ferrous metals
Mines	No. 2 Mining Corporation	Tin and tungsten
Mines	No. 3 Mining Corporation	Antimony and coal
Mines	No. 4 Mining Corporation	Clays, bentonite, and feldspar
Mines	Myanma Gems Corporation	Gems and semiprecious stones
Industry II	Petrochemical Industries Corporation	Petroleum refining and production
Industry II	Petroleum Products Supply Corporation	Petroleum product development and production
Industry II	Myanma Oil Corporation	Exploration and exploitation

Source: Steinberg. 1979.

The mining sector (including oil and natural gas production) contributes slightly over one percent of Burma's GDP. Its significance had been gradually declining during the decade preceding 1976, but now shows signs of improvement, partly owing to disproportionate infusion of public funds. Approximately 70,000 persons--0.6 percent of the total labor force--are employed in this sector of the economy (Kinney 1980).

[16]Sources: Fletcher. 1978.
Kinney. 1980.
Silverstein. 1981.
Steinberg. 1979.

Spurred by notable increases in agricultural production, Burma's economy has grown markedly under the current Twenty-Year Plan. This growth has raised the nation's energy requirements. Recognizing this demand, the government lately has shown added interest in developing the nation's energy resources. Oil exploration--both inland and offshore--perhaps the most promising strategy, has been strongly encouraged during the past few years. Initial enthusiasm and activity by American, European, and Japanese companies, however, has been dampered after the firms began experiencing bureaucratic difficulties leading to costly delays. As a result, in 1980 there were no international bidders for offshore leases. Therefore, consequent limitations on oil production increases may induce the government to forcibly reduce consumption, thereby reducing recent economic gains (Silverstein 1981).

Other attempts to stimulate exploitation of mineral resources have come from external sources. A $640,000 allocation by the United Nations Development Program (UNDP) in the late 1970s was aimed at improving Burma's technical capabilities in mining. The project is intended to accomplish the following objectives: to develop research and development facilities for mineral beneficiation and metallurgy; to train technicians; and, specifically, to establish a 20,000-ton per year metallurgical facility at the Monywa copper site.

3.2 Water Resources

3.2.1 Surface Water [17]

Burma is washed by eight principal river systems, all emanating in the mountainous regions and running essentially north to south. The three largest drainage systems are those of the Irrawaddy, Salween, and Sittang Rivers; smaller but nevertheless noteworthy systems are those of the Arakan, Bilin, Myitmaka, Pegu, and Tenasserim Rivers. The Mekong River, Asia's third largest at 4,350 km, forms part of Burma's border with Laos and China but does not contribute significantly to the nation's water resources. Table 24 outlines the characteristics of some of the major river systems.

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[17] Sources: Aki and Berthelot. 1974.
Bruneau and Bernot. 1972.
Korzoun. 1977.
UNECAFE. 1964.
Van der Leeden. 1975.

Table 24. River System Characteristics

River system	Length of river (km)	Source	Mouth	Drainage area (sq km)	Max. discharge (cumecs)	Min. discharge (cumecs)
Salween	2,419	Tibetan Plateau	Gulf of Martaban	*	22,650	*
Irrawaddy	2,016	Tibetan Plateau	Andaman Sea	417,534	63,713	1,303
Chindwin	1,161	Kumon Range	Irrawaddy	114,464	*	*
Mu	274	Mangin Range	Irrawaddy	18,991	7,700	0.8
Sittang	419	Northern Pegu Yoma	Gulf of Martaban	34,600	*	*
Tanasserim	403	Tennasserim Yoma	Andaman Sea	*	*	*
Pegu	322	Pegu Yoma	Gulf of Martaban	5,463	1,210	*

*Not available.

Sources: Aki and Berthelot. 1974.
Chhibber. 1975.
UNECAFE. 1964
Webster's. 1972.

As Table 2 in Section 2.1.3.1 indicates, throughout Burma rainfall is heavily concentrated during the May to October monsoon season. Not surprisingly, river flow reflects this intense seasonality, and maximum discharge rates are as much as fifty to sixty times higher than corresponding minimum rates (see, for example, discharge rates for the Irrawaddy in Table 24 and Fig. 23).

The country's average annual runoff is approximately one million million (10^{12}) cubic meters including runoff from contiguous states, and about 70 percent as much excluding contributions from neighboring countries (UNECAFE 1964). The distribution pattern of this runoff closely resembles the precipitation pattern (isohyets) shows on Figure 6a. Annual evapotranspiration is extremely high--varying from 600 mm in the extreme north, to 800 mm through most of the center, and to above 1,000 mm in Tennasserim. The coastal areas have surpluses of up to 3,000 mm of river water resources, while the relatively dry regions surrounding Mandalay are subject to deficits of up to 500 mm. The mountainous zones to the north have average surpluses of 500 to 2,000 mm, and the eastern highlands experience small net gains of perhaps 100 mm of water per year (Korzoun 1977).

The Irrawaddy River system which runs through the western portion of the country is Burma's largest, draining nearly two-thirds of the nation. Its fertile alluvial plain comprises most of Burma's cropland. Although the Salween River system is perhaps as extensive, it flows through the Shan Plateau, an area not readily suitable for agriculture. Of the 8,000 km of navigable waterways, the Irrawaddy itself can accommodate shallow-draught vessels for nearly 1,300 km. The Chindwin, its major tributary, is navigable for about 600 km.

Burma possesses few lakes. Lake Inle on the Shan Plateau (260 sq km) and Lake Indawgi in southern Kachin State are the largest. Lake Inle, a solution lake, is a shrinking body of water which is the source of the Nam Pilu River, a tributary of the Salween. In the dry belt surrounding Mandalay there are a number of small salt lakes of variable size. Some have been used to yield brine. Not far from these lakes in Chindwin District are several crater lakes marking extinct volcanoes. Other lakes exist at cut off parts of former river beds, marshy deltaic depressions, and at abandoned canals and man-made excavations. Artificial lakes are common

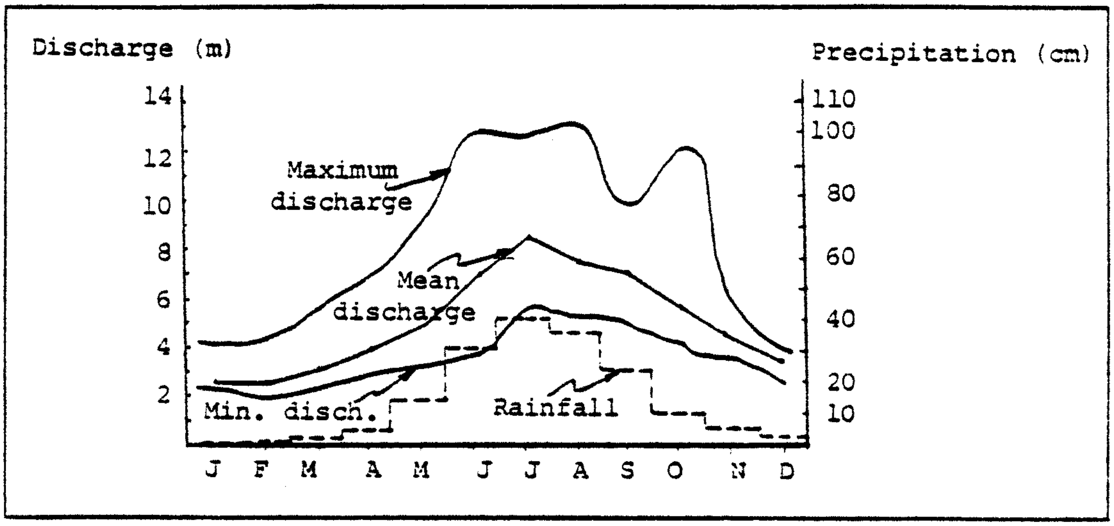

Figure 23. Discharge of the Irrawaddy and Rainfall in the Surrounding Area

Source: Storz. 1967.

in areas adjoining villages and are used for permanent water storage.

Because the water table is generally high and drainage poor, many lakes tend to overflow during the rainy season. These inundations coupled with inadequate sanitation facilitate the spread of infectious disease.

3.2.2 Groundwater [18]

Information on groundwater availability, quality, and use in Burma remains very scarce. In large measure, this may be due to the fact that the nation possesses plentiful surface water resources. There are indications that in the hinterlands of the Irrawaddy delta some groundwater has been used industrially and domestically (Storz 1967). In the Mount Popar region freshwater springs emanating from gneissic rocks provide fresh drinking water to neighboring villages (Chhibber 1975). The amount of water thus consumed is likely to be small, and there are no apparent systematic efforts to map the country's aquifers.

Two types of groundwater, nevertheless, have come to the attention of observers. The first indication of groundwater activity is the presence of limestone caves throughout the Shan Plateau and the Tenasserim regions. These caves have served religious, touristic, and economic purposes. Frequently they are the sites of pagodas, other Buddhist shrines, and monkish retreats. Consequently, they are often visited by pilgrims and other travelers. Additionally, the limestone caves are inhabited by bats and thus richly filled with bat guano, which has been used traditionally as fertilizer. The caves are also noted as habitats of exotic, highly specialized fauna and as archaeological repositories. The extraction of groundwater from caves or from adjoining areas is not mentioned in the literature.

A second notable form of groundwater is associated with volcanic activity, particularly along faults or cracks in rock formations. At such locations—on the Shan Plateau, in Tenasserim, within the Central

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[18] Sources: Chhibber. 1975.
Storz. 1967.

Belt, in Myitkyina District, in the extreme northern Hukawng Valley, and along the Arakan coast--hot springs occur frequently. Water emanating from these springs is highly laden with salts such as lime and magnesium sulfates and potash. In some places the high salinity of the springs has led to their exploitations for brine from which salt is extracted by boiling. Until recently hot springs were not commonly used for therapeutic purposes.

3.2.3 Irrigation [19]

Although numerous tracts of cropland have been irrigated for at least eight centuries, and despite the doubling of irrigated area over the past two decades (Table 9), only a tenth of Burma's cropland (one million ha in 1977), is irrigated. The government recognized the need to expand irrigated area and in 1970 undertook to increase this acreage by over half. Although the program essentially has achieved its goal, it is widely accepted that still more land must by irrigated if Burma's food production is to keep up with population growth. According to 1971 projections by the United Nations Economic Commission for Asia and the Far East, total irrigated area was expected to rise to 1.3 million ha by 1990 (Van der Leeden 1975). Because of Burma's ample precipitation, the water necessary to accomplish this level of irrigation is a small fraction (less than two percent) of the mean annual runoff. Adequate supply of fresh water therefore, is not expected to present a problem in the foreseeable future.

Ever since the 1960s, when the Burmese government began to rebuild and expand the nation's irrigation network, the principal emphasis has been on rice cultivation. Approximately four-fifths of total irrigated land is planted with rice. From the beginning of the current drive to improve irrigation, planners have concentrated their efforts on the dry zone around Mandalay. Their intent, verified by experiment, has been to obtain two annual rice harvests--a result which absolutely requires irrigation. Because irrigation schemes have

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[19] Sources: Henderson et al. 1971.
Storz. 1967.
UNESCAP. 1978.
Van der Leeden. 1975.

concentrated on increasing the number of harvests and improving yields, the country still possesses some two million ha of fallow land which, with enhanced water availability, could be made productive (Angladette 1974).

In order to achieve the doubling of irrigated area between 1960 and 1977, Burma has relied upon foreign assistance. In 1958 the U.S.S.R. lent between four and seven million dollars for construction of irrigation dams which were completed in 1967. Through the Colombo Plan and other multilateral agencies, Burma has expanded its efforts to construct canals, tap streams, and install pumps.

During the 1970s Burma's major long-term irrigation schemes included the following projects: Mu Valley (1.7 million ha), Sedawgyi Reservoir (367,000 ha), Kinywa Reservoir (319,000 ha), Nyaung-kyat Reservoir (295,000 ha), the Hanthanwaddy Flood Control Project (284,000 ha), and the 36,000 ha Yametin District Development Project (Henderson et al. 1971; Angladette 1974).

A current U.S. AID project to improve production of maize and oilseed includes a strong component in water management and irrigation (U.S. AID 1981a; Appendix V).

3.2.4 Industrial and Domestic Use and Water Quality [20]

Industrial Use. Apart from its use in generating electricity, water is employed in a number of industrial processes. Burma's mining, chemical, and manufacturing industries use water for cooling and temperature conditioning, product treatment and cleaning, and product manufacture. Table 25 shows the increase in industrial water use during the 1970 to 1980 decade.

Domestic Use and Water Quality. It is estimated that in 1980 house connections of fresh water served approximately 4.6 million persons, a modest increase of 8.6 percent since 1970. The population served by public standposts during that period doubled from 1.5 million to 3.1 million persons. Per capita consumption of drinking water in Burma is about average for Southeast Asian nations, but

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[20] Sources: Angladette. 1974.
Van der Leeden. 1975.

Table 25. Industrial Water Demand, 1970 to 1980

Type of use	Increase (million m^3)*
Total increase in industrial water use (1970 to 1980)	93
Cooling and temperature conditioning	54
Product treatment and cleaning	30
Consumed by products	1
Other industrial uses	15

*Note that the mean annual runoff is 680,000 million m^3.

Source: Van der Leeden. 1975.

considerably higher than in South Asia. Table 26 provides data on relative present and future drinking water consumption.

According to a survey published by Van der Leeden (1975) Burma's water quality control is administered solely by the public health authority. The nation has adopted <u>in toto</u> World Health Organization (WHO) standards of quality.

The quality of river water varies considerably, but the major rivers transport large amounts of silt. The Irrawaddy, from its source to Prome, carries between 0.22 and 1.04 kg of silt per cubic meter, an average of 0.57 kg per cu m, or an average total of 191 million tons per year. Most of Burma's rivers have relatively unvarying chemical composition; they are low in nitrogen and phosphoric acid, but high in lime and other bases while remaining nearly neutral (pH of 6.35 to 7.4). This characteristic of the river waters permits them to compensate for soil overacidity and thus sustain favorable rice crops (Angladette 1974).

Table 26. Consumption of Drinking Water in Burma and Neighboring Nations, 1970

Region and Country	Present consumption (liters per day)						Future consumption (liters per day)					
	Urban				Rural		Urban				Rural	
	With house connections		With public standposts				With house connections		With public standposts			
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Southeast Asia												
o Burma	100	180	45	100	22	60	150	220	70	120	50	100
Indonesia	50	150	5	20	--	--	86	150	--	100	60	100
Kampuchea	40	400	15	140	--	15	--	--	--	--	--	--
Malaysia	18	410	--	--	14	230	250	250	--	--	23	110
Philippines	110	540	--	--	40	110	360	1,100	--	--	180	360
Vietnam	--	150	--	60	--	--	--	300	--	60	--	--
South Asia												
Bangladesh	45	70	15	25	10	20	70	135	25	45	25	45
India	50	270	--	--	25	100	90	270	--	--	45	130
Nepal	60	100	40	60	40	60	100	200	60	100	60	100

Source: Van der Leeden. 1975.

3.3 Vegetation

3.3.1 Natural Forests [21]

As Sections 2.3 and 2.3.4 have already demonstrated, forests and woodlands cover by far the largest amount of land in Burma. According to FAO figures, in fact, the nation's forested area is the second largest in the region, exceeded only by Indonesia's vast woodlands (Table 27).

Table 27. Forested Areas in Southeast Asia, 1977

Nation	Forests and Woodlands (millions of ha)	Nation	Forests and Woodlands (millions of ha)
Burma	45.3	Malaysia	21.7
Bangladesh	2.2	Philippines	13.1
Indonesia	122.0	Thailand	21.1
Kampuchea	13.4	Vietnam	12.3
Laos	15.0		

Source: FAO. 1979.

Early attempts to classify forest types were based on the work of botanists and foresters and generally ignored ecological factors. Instead, those systems concentrated on identifying "standard types" of forests and locating them within certain geographic zones. The Burmese government, according to a 1978 publication, Notes on Forestry in Burma, still employs this standard system of classification. Before introducing the so-called "new system" based on work by H.G. Champion in the 1930s, the following discussion will outline the traditional types of forest in Burma.

[21]Sources: Davies. 1960.
Hundley. 1961.
Kermode. 1957.
Legris. 1974.
Ministry of Agriculture and Forests, SRUB. 1978.
Myers. 1980.
Nao. 1974.
Page and Rushforth. 1980.
Rosayro. 1974.

3.3.1.1 "Standard" Classification of Forest Types

This system of classification, which originated in 1877 with the publication of S. Kurz's Forest Flora of British Burma lists eight major forest types as occurring in Burma. The characteristics of each of these types is listed briefly below (Hundley 1961).

(1) Tidal forest, or mangrove. These forests occur only in the vicinity of the Irrawaddy delta (Fig. 13). They are comprised of a few highly specialized species which are capable of flourishing in waterlogged, salty soil.

(2) Beach and dune forest. As their name implies, these forests are found along the coastal strips, on sandy surfaces. The most common tree is *Casurina equisetifolia*.

(3) Swamp forest. In contrast to mangroves, swamp forests are chiefly located inland, on alluvial terrain or near lakes. Following the monsoon these lands are inundated and thus only specially adapted vegetation survives. Trees are typically short and sparse, while savannah grass grows densely.

(4) Evergreen forest. In Burma three types of evergreen forest may be identified: (a) riverine evergreen, in valley bottoms or along flood plains; (b) giant evergreen, above a second storey of smaller evergreens; and (c) typical evergreen, characterized by a thick understorey of various evergreens and bamboos.

(5) Mixed deciduous forest Because these forests include Burma's enormous teak reserves, they are commercially the most important. According to the standard classification system, they may be subdivided into upper mixed deciduous (moist and dry) and lower mixed deciduous forests.

(a) Moist, upper mixed deciduous forest. In Lower Burma this forest type is characterized by bamboos (*Bambusa polymorpha* and *Cephalostachyum pergracile*). In Upper Burma *Dendrocalamus hamiltonii* and *D. membranaceus* replace *B. polymorpha* and *C. pergracile* is the more common bamboo. These forests grow the best teak, *Tectona grandis*, in association with *Xylia dolabriformis*. Other forests of this type occur in the northern parts of the Arakan Yomas (Fig. 11). *Mellocanna bambusoides* grows abundantly in this region.

(b) Dry upper mixed deciduous forest. Generally, this forest type may be characterized by the prevalence of Dendrocalamus strictus and Thyrsostachis oliveri. Other common trees are Cephalostachyum pergracile, Bambusa polymorpha, and B. tulda. Other species include: Tectona grandis, Xylia dolabriformis, Terminalia pyrifolia, Pterocarpus macrocarpus, Adina cordifolia, Pentacme siamensis, Shorea obtusa, and Dipterocarpus tuberculatus.

(c) Lower mixed deciduous forest. Unlike the above two types, this forest cover occurs on lower ground and generally lacks bamboo. Teak may also be found among the trees of this forest type. Other characteristic species are: Xylia dolabriformis, Terminalia tomentosa, Anogeissus acuminata, Homalium tomentosum, Lagerstroemia speciosa, L. tomentosa, Dillenia pentagyna, and Albizzia procera.

(6) Dry forest. In Burma these forests are of three types, all occurring in regions of relatively light rainfall (less than 1,250 mm; Figs. 11 and 13). The first, known locally as than-dahat forest is characterized by Terminelia oliveri and Tectona hamiltoniana. The second dry forest type is in regions whose precipitation is under 250 mm. There, low growth thorn and scrub such as Acacia catechu, A. leucophoea, and Zizyphus jujuba predominate. A third dry forest, known as aukchinsathinwin is rare. It consists of Diospyros ehretioides, A. catechu, Milletia sp., and a stunted variety of Dendrocalamus strictus.

(7) Deciduous dipterocarp, or indaing, forest. Dipterocarpus tuberculatus characterizes this forest type. At places, it may be replaced by Pentacme siamensis or Shorea obtusa.

(8) Hill forest. The last of the standard forest types occurring in Burma, this category includes subtropical and temperate evergreen forests. Three classes may be identified: (a) hill evergreen forest in areas of heavy rainfall, with Quercus and Castanopsis spp., Schima wallichii, and Magnoliaceae spp. and Lauraceae spp; (b) dry hill forest characterized by Quercus serrata, C. spp., S. wallichii, Alnus nepalensis, and some Pentacme

siamensis; and, (c) pine forest containing *Pinus insularis*, *P. merkusii*, and a new temperate conifer, *Picea farreri* (Page and Rushforth 1980).

The approximate amounts of land under forest types similar to those described above are given in Table 28.

Table 28. Areas of Major Forest Types

Forest type	Area (1,000 sq km)	Percent of total area
Mixed deciduous	146.0	40.0
Montane evergreen	76.7	21.0
Evergreen dipterocarp	54.8	15.0
Deciduous dipterocarp	54.6	15.0
Coniferous	18.3	5.0
Mangrove	7.3	2.0
Swamp	3.7	1.0
Lowland evergreen rainforest	3.7	1.0
Total	365.1*	100.0

*Note: This total corresponds closely to the combined amounts of reserved and unreserved forest land listed by the Burmese government not the amounts provided by FAO (see Table 8).

Source: Myers. 1980.

3.3.1.2 "Modern" Classification of Forest Types

According to Rosayro (1974), Champion's 1936 classification scheme for Burma's forests remains the basic reference. Holdridge's system (1966), which has obtained wide acceptance, classifies neither vegetation nor climate, but characterizes the relationships between these variables. It provides a useful general framework for interpreting Champion's detailed analysis of Burma's forest types.

Employing Holdridge's scheme, the country's rainfall ranges from 607 mm to 5,740 mm, and except at the highest elevations near the Tibetan border, its temperatures vary from 17° to 27° C (Wernstedt 1972). According to Figure 24 then, Burma lies within the demarcated area and includes the

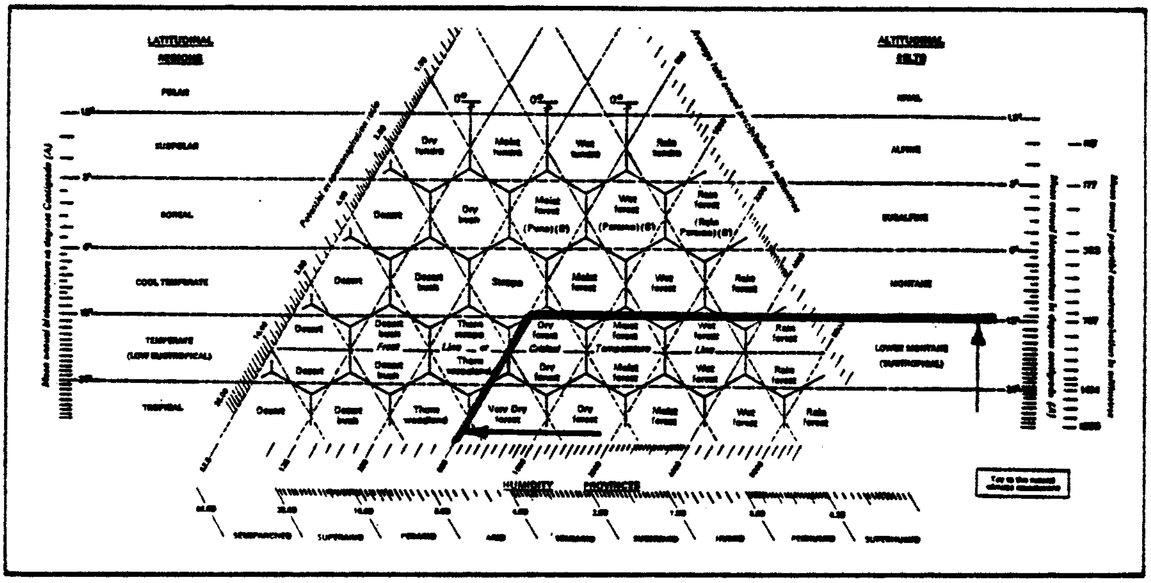

Figure 24. Holdridge's Scheme for Natural Life Zones

Source: Rosayro. 1974.

following natural life zones: very dry forest, dry forest, moist forest, wet forest, and rain forest.

Champion's classification of Burma's forests is far more detailed insofar as he provides categories for each vegetation and climate type. Because of its complexity and length, Champion's scheme is tabulated in outline form below (Table 29) and appears in its entirety in Appendix VI.

Since the late 1940s aerial photography techniques--both airplane- and satellite-derived--have been applied to prepare forest inventories. These techniques permit accurate determination of such features as crown closure, diameter, and tree height for dense tropical forests. In Southeast Asia aerial photography has been employed for studying forests in Indonesia, Kampuchea, Malaysia, the Philippines, Thailand, and Vietnam. As of this writing however, there have been no public releases of such surveys of Burma's extensive forests (Rosayro 1974).

3.3.1.3 Forest Exploitation.

Mixed deciduous forests. Because Burma s forests contain an estimated 75 to 85 percent of the world's teak (*Tectona grandis*) reserves (Steinberg 1979), the mixed deciduous forests which cover some 14.6 million ha are clearly the nation's most important. Thailand, once a competing producer, no longer exports teak and Burma now retains a virtual monopoly in world markets (Mackie 1978; Myers 1980). Although teak stands are found in each of the three subtypes of mixed deciduous forests (see 3.1.1.1), their quality varies considerably. The moist, north-facing slopes of upland mixed deciduous forests grow the most and the best .teaks, some attaining heights of 50 m and more (Kermode 1957). The teaks that grow on the southern, drier slopes of these uplands are inferior and more sparsely distributed; their maximum heights seldom exceed 30 m. Other stands of teak may be found on the lower slopes and in the alluvial plains, along with other hardwoods. These last stands are the lowest in quality and the most vulnerable to eradication due to agricultural pressure (Myers 1980).

Exploitation of the nation's teak reserves has been restricted for a number of reasons. Poor infrastructure and traditional modes of logging have been the most important factors limiting the efficiency and volume of exploitation. Elephants, rather than mechanized vehicles, remain the predominant source of power. Cut logs are then

Table 29. Champion's Classification of Burmese Forest Types

I. Tropical Forests

A. Tropical moist

1. Evergreen climax
2. Semi-evergreen climax and edaphic
3. Moist deciduous climax and edaphic
4. Cane and bamboo brakes
5. Seral

B. Tropical dry

1. Deciduous climax
2. Thorn
3. Evergreen climax
4. Edaphic
5. Seral

II. Montane Subtropical Forest

A. Wet hill climax

B. Moist hill climax and seral

III. Montane Temperature Forest

A. Wet temperate climax

B. Moist temperate climax and seral

IV. Alpine Forest

A. Climax

B. Scrub

Source: Hundley. 1961.

transported from the hinterlands by floating along riverways. The procedure is not only time-consuming (up to two years long), but risky--some observers have estimated that as much as a third of the timber is stolen by insurgents. For these and other reasons teak production has been somewhat erratic, as Table 30 below shows.

Table 30. Teak Production, 1965 to 1977

Year	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1974-75	1977
Production (1,000 cu m)	380.3	410.9	430.8	388.1	452.0	432.3	372.0	566.2	431.2	383.0[a]

[a]Myers. 1980.

Source: Min. of Ag. and For., SRUB. 1978.

Despite Burma's increased dominance of the international market, the nation's teak exports have been falling steadily. As compared to pre-World War II figures, exports fell to 64 percent in 1962, 53 percent in 1972-73, and to just 33 percent by 1978. The falls in export levels have been offset by increased prices, so that Burma earned $60 million in 1978, a $1.6 million rise over the previous year when more teak had been sold abroad (Steinberg 1979).

Burma's mixed deciduous forest--upland and lowland --are stocked with a number of commercially valuable species. In addition to teak, these forests contain _Xylia dolabriformis_ (acle or pyinkado), _Pterocarpus macrocarpus_ (kino), _Adina cordifolia_, _Pentacme siamensis_, _Shorea oblongifolia_ (red lauan), _Albizzia procera_ (silk tree or white siris), and _Anogeissus acuminata_ (Min. of Ag. and For., SRUB 1978).

Evergreen forests. Tropical evergreen forests containing large stands of dipterocarps are Burma's next most valuable forested areas. Covering nearly 55,000 sq km, these lands provide several commercially useful species such as _Dipterocarpus alatus_, _D. turbinatus_, _Hopea odorata_ (thingan), _Parashorea stellata_ (white seraya), _Lagerstroemia speciosa_ (pyinma), _Pentacme burmanica_, (thitka)

Swintonia floribunda (merpauk), and Tetrameles nudiflora (thitpok). Those trees growing in montane regions are frequently found in areas difficult to penetrate and are therefore likely to escape extensive logging. Many of the trees from tropical evergreen forests--especially dipterocarps--are important sources of lumber. Other trees supply gums, resins, turpentine, and medicines.

Other forests. Burma's 54,600 sq km of deciduous dipterocarp forest are also commercially significant Dipterocarpus tuberculatus, Pentacme siamensis, and Shorea oblongifolia are the chief species of economic value. Other trees mostly exploited as fuelwoods or as sources of tannin, are found in the coastal tidal forests. The main species are Heritiera fomes, Excoccaria agallocha, Rhizophora spp., Ceriops roxburghiana, and Xylocarpus moluccensis.

Table 31 provides Burma's annual non-teak timber production figures for the years 1965 to 1975.

ıe 31. Non-teak Timber Production, 1965 to 1975

Year	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1974-75
Production (1,000 cu m)	895.7	1,040.7	949.5	987.1	939.9	898.0	949.4	1,118.0	771.7

Source: Min. of Ag. and For., SRUB. 1978.

It should be noted that in Burma, as in all of Southeast Asia, usable timber production remains very low (Nao 1974).

Bamboos, which grow together with other trees or by themselves in patches, are another valuable product. Various species such as Mellocanna bambusoides, Bambusa polymorpha, Cephalostachyum pergracile are exploited for domestic use in scaffolding, piping, manufacturing, industry, paper pulp-production, and locally for making furniture, utensils, farm implements, baskets, vessels, binding, and food products (Whyte 1968).

Other important timber products obtained from Burmese forests are cane, cutch, tannin, and lac. Cane, derived from some 30 local species, is used primarily for furniture, wickerwork, and timber rafting. Cutch, an extract of Acacia catechu, is a tan and a dye used to preserve leather, canvas, tarpaulins, and fishing nets. Annual production of cutch is approximately 300,000 kg. Bark tan, drawn predominantly from mangrove bark, is an even more important tanning agent. Burma produces more than one million kg annually. Lac, a resinous derivative of Laccifer laccia, is a key ingredient in the manufacture of shellac. In 1978 Burma produced 28,600 kg of lac (Min. of Ag. and For., SRUB 1978).

3.3.1.4 Administration, Policy, and Planning 22/

Soon after the institution of British colonial rule a trained English forester was placed in charge of forest administration in the newly-acquired territories. In 1864 the government created the Department of Forestry and the post of Inspector-General of Forests and began an extensive survey of Burma's teak stands. Because the Department of Forestry recognized the economic value of the country's teak and other forest products it instituted a series of measures designed to estimate annual yields, manage existing resources, control fires, and train forest officers.

As early as 1894 the British government of Burma enunciated an explicit policy for administering and protecting the region's forest resources Under this policy the Department recognized four classes of forests: protection forests, commercial forests local supply forests, and pasture lands. That system of forest classification has remained in place to the present.

Even before the adoption of that policy the Department of Forestry recommended and the government passed special legislation aimed at managing Burma's forests. The Burma Forest Act of 1881, modeled after similar legislation adopted in British India, was revised in 1902 and with minor amendments has remained in force in independent Burma. The Act includes the following features: reservation of forest lands, definition of the rights and duties on these lands, protection of forests and their resources, control of exploitation

[22] Source: Min. of Ag. and For., SRUB. 1978.

and of forest produce transit, imposition of penalties for violation of restrictions, institution of procedures for training and investiture of forest officers, and performance of research. This last function is accomplished partly through the recently created Forestry Research Institute at Yeizen. The Institute, established by FAO and UNDP under contract with the State University of New York, conducts research on forest biology, biometrics, conservation, inventory, management, silviculture, and yield (Myers 1980; Anonymous 1980a). Management training assistance has been supplied by the U.S. MAB Program which conducted three-week seminars on techniques of resource inventory and watershed management (Ledec and Williamson 1979). Additional information on foreign assistance projects appears in Appendix V.

The present organization of the Department of Forestry follows the general framework laid out in the late nineteenth century. Table 32 shows the structure and sanctioned strength of this Department in 1978.

Table 32. Organization and Staffing of the Department of Forestry, 1978

Employee rank	Number of employees sanctioned
Director-General	1
Director	8
Deputy Director	44
Assistant Director	90
Range Officer	202
Deputy Range Officer	403
Forester	1,606

Source: Min. of Ag. and For., SRUB. 1978.

The Department of Forestry carries out its functions through 36 territorial forest divisions. Each division develops its own long-term forest working plan and administers itself through a number of "working circles" such as: (a) Teak Selection working circles, (b) Hardwoods Selection working circles, (c) Local Supply working circles. It is the responsibility of each working circle to:

survey resources, develop harvesting cycles, improve stocks, attend to regeneration when this is necessary, and satisfy local needs for forest products such as small timber and firewood.

Actual exploitation of Burma's timber resources--harvesting and sale--is undertaken by a public enterprise, the State Timber Corporation. Previously known as the State Timber Board, this body was formed in 1950 to assume the work of disenfranchised large European firms. Sinced 1962 this state agency has operated the nation's entire lumber industry. The present Corporation is organized into five functional divisions: the Office of the Managing Director, and the Departments of Accounts, Extraction, Marketing, and Engineering. U.S. AID currently is working with the State Timber Corporation on a project designed to improve teak production (see Appendix V).

During the decade from 1963 to 1974 the forestry sector of the economy received just two percent of public funds. The Second Four-Year Plan which followed this period raised the allocation to 6.7 percent. Under the current (Third) Plan government expenditures are down to five percent. In 1978 the forestry sector contributed seven percent of the nation's GDP while employing 1.2 percent of the labor force. According to Sundberg (1972), part-time workers predominated, especially in logging. To assist this sector in developing its resources the government receives foreign assistance from the Asian Development Bank and the World Bank (Steinberg 1979).

3.3.2 Plantations [23]

Nearly all of Burma's forests are allowed to regenerate naturally. In some instances, however, teak and other hardwood stands are grown on plantations. Especially in dry zone areas where depletion rates are high, the government is engaging in selective reforestation by means of introducing fast-growing species. In one such enrichment technique, known as taungya agro-forestry

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[23] Sources: Bixler. 1971.
Min. of Ag. and For., SRUB. 1978.
Nao. 1974.

seedlings of such species are planted at large intervals on rice or corn plots. The trees thus provide not only valuable timber and other by-products, but rehabilitate the soil used for cropping (Ledec and Williamson 1979).

To date these artificial regneration efforts have been of limited magnitude; average annual area planted between 1962 and 1975 was about 2,800 ha. Eucalyptus camaldulensis, teak, and Xylia dolabriformis have been the main species introduced. The productivity of these plantations can be enhanced by a combination of fertilization, genetic selection, and favorable site selection.

Among traditional plantation-grown trees, only rubber, bananas, and other fruits have sizable yields. Although Burma is contiguous with Malaysia and part of the nation extends into the Malayan peninsula, rubber plantations are far smaller and less numerous in Burma. Some observers have indicated that the nation lacks the labor resources to tap rubber trees (Bixler 1971). Whatever the reasons, the nation's rubber production has been extremely modest. Between 1961 and 1979 annual rubber production varied but slightly, averaging 15 000 tons (cf. Malaysian rubber production, which during this period averaged nearly 1.4 million tons per year; USDA 1980) Both the World Bank and the Asian Development Bank have been assisting Burma's rubber sector; the latter supplied $ 25.3 million in 1975 (Steinberg 1979).

Banana and other fruit production figures are presented in Table 33

Table 33. Banana and Other Fruit Production, 1961 to 1979

Product	Production (1,000 tons)										
	Avg. 1961-65	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Bananas	173	176	187	200	225	230	232	243	245	270	250
Other fruit	517	473	473	473	473	473	475	475	475	523	475

Source: USDA. 1980.

3.3.3 Vegetative, Floral, and Grassland Communities [24]

Data on vegetative and floral communities (excluding grasses) have not been published since independence. Prior to that time there was considerable interest in cataloging Burma's rich variety of floral species. The best works on the subject are those of C.E.C. Fisher whose fifteen year long series "Contributions to the Flora of Burma" appeared in the Kew Bulletin between 1926 and 1941, and studies by Stamp (1924) and Chatterjee (1939). As Legris (1974) has pointed out, there exist no recent general taxonomic surveys for the region. For that reason it is not possible to provide a precise current assessment on vegetative species other than trees.

Nevertheless, it is possible to state that Burma's floral variety remains great, and that most of the species there are also found elsewhere in South and Southeast Asia. Legris (1974) has estimated that only 9.6 percent (1,071 species) of Burma's species are specifically endemic. Extrapolating from that figure, there remain more than 11,000 floral species, including trees and grasses. A number of these plants have economic value as sources of medicines, dyes, fibers, and foods (Majumdar and Banerjee 1975).

Burma's grasses have been inventoried, although the major survey (by Rhind) also dates from the 1940s and is therefore likely to be inaccurate. The list of grasses compiled by Rhind, and appearing in Table 34, is incomplete, moreover; it includes few high altitude species and overrepresents grass flora occurring in easily accessible locations.

In all, the nation has approximately 362,000 ha of grassy terrain that can be termed permanent pastureland. As Section 2.3.5 has pointed out, Burma has a substantial number of cattle. These herds are grazed by sedentary residents; there are few if any true pastoral nomads.

3.4 Fauna and Conservation Measures

Burma's situation just south of the Himalayas and firmly within a tropical region assures the country not only of a large diversity of faunal species, but also of a sizable

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[24] Source: Legris. 1974.

Table 34. Grasses

Southern rain forests:	
Acroceras spp.	*Microstegium* spp.
Alloteropsis spp.	*Oplismenus* spp.
Coix spp.	*Saccharum* spp.
Centotheca sp.	*Sclerostachya* spp.
Imperata spp.	*Sorghum* spp.
Deltaic monsoon areas:	
Axonopus spp.	*I. globosa*
Chrysopogon aciculatus	*Ischaemum* spp.
Cynodon spp.	*Leersia* spp.
Dichanthium annulatum	*Neyraudia* spp.
D. caricosum	*Ottochloa* sp.
Echinochloa crusgalli	*Paspalidium* spp.
E. stagnina	*Phragmites* spp.
Eragrostis unioloides	*Rottboellia exaltata*
Hemarthria compressa	*Saccharum* spp.
Isachne albens	
Northern wet zone:	
Alloteropsis spp.	*Isachne globosa*
Arthraxon spp.	*Leersia* spp.
Bothriochloa intermedia	*Panicum auritum*
Elytrophorus sp.	*Sacciolepis* spp.
Eragrostis unioloides	*Themeda* spp.
Eulalia spp.	
Dry zone (600 to 1000 mm. rainfall):	
Aristida spp.	*Perotis indica*
A. depressa	*Ratzeburgia* sp.
Bothriochloa pertusa	*Saccharum spontaneum*
Chloris barbata	*Setaria glauca*
Cymbopogon spp.	*Sporobolus coromandelianus*
Echinochloa crusgalli	*S. tremulus*
E. stagnina	*Themeda* spp.
Eragrostis spp.	*Tragus biflorus*
Heteropogon contortus	*Vetiveria zizanioides*
Oropetium thomaeum	
Hills (1,200 to 1,800 m.) (1500 to 2500 mm.):	
Arthraxon lancifolius	*Microstegium nudum*
Arundinella spp.	*Muhlenbergia huegelii*
Chrysopogon aciculatus	*Panicum watense*
Coix spp.	*Paspalum scrobiculatum*
Eragrostis tenuifolia	*Pennisetum alopecuroides*
Erianthus spp.	*Saccharum spontaneum*
Eulalia spp.	*Sporobolus indicus*
Imperata spp.	*Themeda* spp.
Microchloa indica	*Thysanolaena* spp.

Source: Whyte. 1968.

total number of animals. As in all the surrounding areas, fauna are drawn from palaearctic, Aralo-Caspian, and Ethiopian types--the latter being prevalent, though numerous species can also be found in the Palaearctic zone. Because of the many varieties of habitat associated with Burma's diverse geographical regions, the environment has sustained many archaic and highly specialized forms of wildlife which have been of particular interest to zoologists.

Burma lies within a biogeographic/faunistic area termed Indo-Malaysia (Pfeffer 1974). This area may be further subdivided into coastal, inland swamp, humid forest, and savannah zones--each of which sustain forms of wildlife especially suited to the prevailing conditions of climate, soil, and vegetative cover.

In spite of the interest in Southeast Asian fauna, there exists no single authoritative survey of Burma's major wildlife. The information which appears below is therefore unavoidably incomplete and occasionally dated. It is safe to say, however, that in Burma as in many developing countries development has often come at the expense of faunal habitats and existence. In the more remote regions of the Shan Plateau and the northern mountains, wildlife is generaly less threatened.

3.4.1 Mammalian Fauna: Resources, Uses, and Status [25]

Far less numerous than birds or insects, Burma's mammals nevertheless represent a broad spectrum of types. The humid forests provide the most favorable habitats for larger species. Accordingly, there are: anthropoid apes such as gibbon (Hylobates) and siamang (Syndactylus); small monkeys; flying squirrels (Petaurista); giant squirrels (Ratufa, Rheithrosciurus); ungulates such as banteng (Bos banteng or Bos sondaicus), and gaur (Bos gaurus);

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[25] Sources: Anonymous. 1980b.
Brooks et al. 1979.
Hiep and Mo. 1968.
Lekagul. 1968.
McNeely. 1978.
McNeely and Sinha. 1981.
Pfeffer. 1974.
Schaurte. 1968.
Yin. 1974.

Cervidae such as sambar (Cervus unicolor), muntjak (Muntiacus muntjac) mouse-deer (Tragulus sp.); serow (Capricornis sumatraensis); and numerous small rodents and carnivores. Among the latter, palm civets (Viverricula malaccensis), mongooses, porcupines, bamboo rats, and squirrels are very common. Large carnivores such as clouded leopards (Neofelis nebulosa), bear civets (Arctitis binturong), sloth bears, and wild dogs, although endangered, continue to live in Burma's humid forests.

Other mammals found in Burma's dry forests and coastal areas include the water buffalo (Bubalus bubalis), swamp-deer (Cervus duvauceli), pig-deer (Axis porcinus), various monkeys, and several species of aquarian mammals such as the sea otter, sea-cow (Dungong dungong), and Burmese freshwater dolphin (Orcaella brevirostris). The latter may be found as far inland as 1,200 km north of the Irrawaddy delta (Thein 1977).

Tigers (Panthera tigris), which used to abound in Burma, have been significantly reduced in numbers. Three principal reasons have led to this reduction: their skins are highly valued domestically and internationally, their threat to settled communities have caused hunters to pursue and exterminate them, and finally their customary prey has been systematically eliminated by hunters and poachers. One estimate placed the number of tigers in Burma in 1962 at approximately 1,600; 426 of these were said to be within reserved areas (Yin 1973). The present number of tigers is not available, but it is undoubtedly much lower and the 1978 IUCN Red Data Book lists the species as threatened.

The fate of the rhinoceros has been similar. At one time rhinos were plentiful in humid and dry forests. Now each of the three species which formerly thrived (Rhinoceros unicornis, Rhinoceros sondaicus, and Didermocerus sumatrensis) is considered endangered, if not extinct after generations of poaching (IUCN 1978; Schaurte 1968). In Burma, as in China and India rhinoceros horn is widely used as an aphrodisiac, a property which has led to the destruction of virtually all of the animals (Schaurte 1968; Lekagul 1968).

The elephant, unlike the rhinoceros and the tiger, is prized not only for its physical features, but for its strength and intelligence. As a result it has been spared the fate of the tiger and the rhino. Although poaching is common and firearms have improved, the elephant's indispensability to Burma's teak production (40 percent are employed by the timber industry) has assured its survival (McNeely and Sinha 1981). Nevertheless, despite more than a century of official protection, the number of elephants continues to decline. In 1962 there were an estimated 9,050 elephants; by 1977 the number may have been under 5,000. Burma appears to be one of the few countries where the elephant is resisting human encroachment (Anonymous 1980b). Table 35 provides a listing of endangered faunal species.

Not all wildlife having economic value is threatened, however. Some animals such as deer have been domesticated by rural folk. The deer are housed and fed, and bred for their soft horns. The prices obtained for horns vary according to species. The most valuable horns are those of the spotted deer (Sika pseudaxis). Others whose horns are marketable ae the hog deer (Cervus porcinus annamensis) and the sambar. The value of the horn depends on its age and upon the diet of the animal; for the latter reason, horns from undomesticated deer remain more highly prized. There is evidence nevertheless, that deer raising has been a remunerative activity for centuries (Hiep and Mo 1968).

Not surprisingly, the most common mammal in Burma is one that needs no protection. The lesser bandicoot rat (Bandicota bengalensis), a large ground-dwelling rodent, has prospered particularly in urban and suburban environments. Extremely large numbers of bandicoots are found wherever there are human settlements--within households, markets, grain depots, storm drains, and all public places. These rodents comprise a major pest because of their consumption of grain and other foodstuffs, and on account of their destructive burrowing which damages foundations, sidewalks, plumbing, and sewer lines. The species, moreover, is a natural vector for plague-carrying fleas (Xenopsylla cheopis). In recent years there have been several experiments testing the effectiveness of various rodenticides on the bandicoot (Brooks et al. 1979). Other mammals such as badgers, ferrets, and artiodactyl mammals also frequently carry ticks, fleas, and other parasite-bearing insects (Hoogstraal and Kohl 1968; Hoogstraal and Dhanda 1970; Hoogstraal et al. 1970).

Table 35. Threatened Mammals

Common name	Scientific name	Source IUCN	Source FWS
Banteng	Bos javanicus	X	X
Bat, gray	Myotis grisescens		X
Buffalo, Asiatic	Bubalus bubalis	X	
Cat, marbled	Felis marmoranta	X	X
Cat, Temminck's	Felis temmincki	X	
Deer, Eld's brown-antlered	Cervus eldi		X
Deer, Himalayan musk	Moschus moschiferus moschiferus	X	
Dog Asiatic wild	Cuon alpinus	X	
Dugong	Dugong dugong	X	
Elephant, Asian	Elephas maximus	X	
Gaur	Bos gaurus	X	X
Gibbon	Hylobates spp.		X
Langur, capped	Presbytis entellur		X
Leopard	Pantherus pardus		X
Leopard, clouded	Neofelis nebulosa	X	X
Linsang, spotted	Prionodon pardicolor		X
Muntjac, Fea's	Muntiacus feae	X	X
Rhinoceros, Great Indian*	Rhinoceros unicornis		
Rhinoceros, Javan	Rhinoceros sondaicus	X	X
Rhinoceros, Sumatran	Didermocerus sumatrensis	X	X
Tapir, Asian or Malayan	Tapirus indicus	X	X
Tiger	Panthera tigris	X	X

*According to Schaurte (1968).

Sources: FWS. 1980.
IUCN. 1978.
Schaurte. 1968.

3.4.2 Avifauna [26]

B.E. Smythies, in his classic text on Burma's avifauna, stated in 1953 that because of its favorable situation straddling the Himalayan, Indochinese, and Malaysian regions, the variety of birds is one of the world's richest for a country that size. At that time, he estimated, Burma contained nearly 1,000 species -all of them termed palaearctic or oriental. The former are comprised of resident species found in the northern mountains, and migratory species such as ducks and waders that breed north of Burma and winter within the country.

Oriental birds are far more numerous and varied; they are classified according to their geographical origin--the Indian, Indochinese, or Malaysian subregions. Typical species found in the Indian subregion include: Corvus splendens splendens, Turdoides longirostris, Monticola cinclorhyncha, Coracina sykesi, Nectarinia zeylonicus, Brachypteryx benghalensis, Cuculus varius, Strix ocellatum, Glaucidium radiatum, and Amaurornis akool. Other related species occurring within the dry zone in central Burma typically include: Crypsirina cucullata, Pellorneum ruficeps hilarum, Turdoides gularis, Pycnonotus blanfordi blanfordi, Pericrocotus erythropygia albifrons, Prinia polychroa cooki, Anthus similis jerdoni, Mirafra assamica microptera, Athene brama pulchra, Falco jugger, Neohierax insignis insignis, Hieraaetus fasciatus fasciatus Butastur teesa, Streptopelia decaocto xanthocycla, Burhinus oedicnemus indicus and Anas poecilorhyncha haringtoni.

Most of the country, lies within the Indochinese subregion. The list of representative species within this area is too long to reproduce here but it includes birds from the orders and

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[26]Sources: Abdulali and Hussain. 1971.
Amstutz. 1973.
Davison. 1979.
King and Dickinson. 1975.
Pfeffer. 1974.
Smythies. 1953.
-----. 1975.
Walters. 1976.
Yin. 1970.
-----. 1977.

families appearing in Table 36 which has been drawn from Smythies' detailed appendix of existing species.

Table 36. Orders and Families of Birds

Order	Family		
Passeriformes	Corvidae	Prunellidae	Ploceidae
	Paridae	Muscicapidae	Fringillidae
	Sittidae	Pachycephalidae	Hirundinidae
	Timaliidae	Lamidae	Motacillidae
	Aegithinidae	Campephagidae	Ataudidae
	Pycnonotidae	Artamidae	Zosteropidae
	Certhiidae	Dicruridae	Nectariniidae
	Troglodytidae	Sylviidae	Dicaeidae
	Cinclidae	Oriolidae	Pittidae
	Turdidae	Sturnidae	Eurylaimidae
Piciformes	Picidae	Capitonidae	Indicatoridae
Cuculiformes	Cuculidae		
Psittaciformes	Psittacidae		
Coraciiformes	Coraciidae	Alcedinidae	Upupidae
	Meropidae	Bucerotidae	
Trogoniformes	Trogonidae		
Apodiformes	Apodidae	Hemiprocnidae	
Caprimulgiformes	Caprimulgidae	Podargidae	
Strigiformes	Tytonidae	Strigidae	
Falconiformes	Pandionidae	Accipitridae	Falconidae
Columbiformes	Columbidae		
Galliformes	Phasianidae		
Gruiformes	Turnicidae	Heliornithidae	Otididae
	Rallidae	Gruidae	
Charadriiformes	Jacanidae	Glareolidae	Vanellinae
	Rostratulidae	Stercoradiidae	Recurvirostridae
	Burhinidae	Laridae	Scolopacidae
	Rynchopidae	Charadriidae	

Order	Family		
Pelecaniformes	Pelecanidae Phalacrocoracidae	Anhingidae	Sulidae
Ciconiiformes	Threskiornithidae	Ciconiidae	Ardeidae
Anseriformes	Anatidae		
Podicipitiformes	Podicipitidae		

Source: Smythies. 1953.

Among recently investigated Burmese avifauna are: monal (Yin 1970); long-eared owl (Asio otus otus; Abdulali and Hussain 1971); whitewinged wood duck (Yin 1977); great whitebellied heron (Ardea insignis; Walters 1976); barredback pheasant (Syrmaticus humiae; Davison 1979); and Himalayan, black-nest, edible-nest, and whitebellied swiftlets (Collocalia brevirostris, C. maxima, C. fuciphaga, and C. esculenta, respectively; Smythies 1975). In addition, a three-year study (1968-71) of the birds of Inya Lake in Rangoon District identified 82 species of grebes, cormorants, darters, herons, egrets, bitterns, teals, kites, goshawks, vultures, ospreys, waterhen and other fowl, sandpipers, terns, doves, cuckoos, owls, kingfishers, bee-eaters, rollers, barbets, swallows, shrikes, orioles, drongos, starlings, mynas, crows, ioras, bulbuls, flycatchers, warblers, tailorbirds, robins, thrushes, wagtails, flowerpeckers, sparrows, weaverbirds, buntings, and munias (Amstutz 1973).

Species now considered endangered are listed in Table 37.

In comparison with the very large number of species cataloged by Smythies in 1953, the list in Table 36 appears small. It should be noted that the IUCN data are not current while the FWS information may be incomplete. It is likely that the actual number of endangered avifaunal species in Burma is considerably larger. There is evidence, however, that Burmese and other Southeast Asian birds are very adaptive and that few are seriously endangered (Ripley 1968). The greatest dangers to birds are the destruction of their habitats through deforestation, and the wild bird trade. There exist few if any figures on the magnitude of this commerce, but the Wild Birds and Animals Protection Act and the Burma Wildlife Protection Act attempt to control domestic and international trade in birds and their products.

Table 37. Threatened Birds

Common name	Scientific name	Source IUCN	Source FWS
Duck, white-winged wood	Cairina scutulata	X	
Monal, Sclater's	Lophophorus sclateri	X	X
Pheasant, Hume's (eastern)	Syrmaticus humiae burmanicus	X	X
Pheasant, Hume's (western)	Syrmaticus humiae humiae	X	X
Tragopen, Blyth's	Tragopan blythii blythii	X	X

Sources: FWS. 1980.
IUCN. 1968.

3.4.3 Other Terrestrial Fauna

Reptiles, amphibians, insects, mollusks, and annelids generally prosper in the Burmese environment. There have been no thorough inventories of the country's reptiles, but as in neighboring countries, the dry forests and savannahs contain numerous snakes, turtles, tortoises, lizards, agamas, and geckos. At one time the swamps were replete with crocodilians, but most species are now endangered (Table 36). Among snakes, there are cobras (Naja naja and Naja hannah), pythons (Python noluris and P. reticulatus), Russell's vipers (Vipera russellii), kraits (Bungarus spp.), coral snakes (Callophis spp.), whipsnakes (Dendrophis spp.), and about fifteen species of aquatic snakes. Of these, venomous snakes are so prevalent that Burma has the world's highest snakebite mortality rate (Pfeffer 1974; Henderson et al. 1971). Amphibians are less common, but nevertheless numerous; frogs, toads, and scutigers are the most ubiquitous (Dubois 1979). Table 38 identifies threatened reptiles.

Table 38. Threatened Reptiles

Common name	Scientific name	Source IUCN	Source FWS
Crocodile, estuarine	Crocodylus porosus	X	
Crocodile, marsh	Crocodylus palustris palustris	X	
Crocodile, Siamese	Crocodylus siamensis		X
Gavial	Gavialus gangeticus	X	X
Monitor, Bengal	Varanus bengalensis		X
Python, Burmese	Python molurus bivittatus	X	
Terrapin, river	Bagatur baska	X	X
Turtle, Burmese peacock	Morenia ocellata		X
Turtle, three-keeled Asian	Geoemyda tricarinata		X

Sources: FWS. 1980.
IUCN. 1975.

Insects, of course, thrive in Burma's tropical environment. Many are endemic to the primary forest, where they live in association with specific types of vegetation, and in turn, comprise a major dietary component of the rich avifauna. Among the forest insects are: longicorn Coleoptera, cetonia, buprestis beetles, cicadas, Orthoptera, and a large selection of Hymenoptera and Lepidoptera (Pfeffer 1974).

Other insects, particularly those found near human settlements and water resources, are less innocuous. Mosquitoes (Anopheles spp. and Culex spp.) are extremely numerous and carry malaria, filariasis, and dengue fever--all prevalent and and thus far ineradicable infectious diseases. Houseflies, bot flies (Gastrophilus equii), horse flies (Hippobosca maculata and H. capensis), sand flies (Leishmania donovani), rat fleas (Xenophylla cheopis), lice (Pediculus humanus capitis and P. humanus corporis) abound and transmit diseases such as trypanosomiasis, dysentery, typhoid, cholera, tuberculosis, encephalitis, elephantiasis, bubonic plague, typhus, and countless animal fevers (Pant 1974).

In addition to spreading infection, insects are a major cause of crop destruction. In neighboring Thailand, for example, insects are estimated to damage about 15 percent of the nation's annual agricultural yield. Rice, corn, vegetables, and rubber are all susceptible to insect pests. The important species are: seedling worms white borers, gall midges, harvest curworms, rice leaf-rollers, mauve borers, green and gray leafhoppers, rice thrips, rice bugs, and aphids (Pant 1974).

Mollusks, particularly the giant African snail (Achatina fulica) which spread to Burma after the turn of the century, also damage crops. Other molluscan species are generally more benign. In lower Burma alone more than 200 species have been studied recently (Ray 1977). Burmese earthworms, too, have been the subject of detailed research. Although most species are harmless or beneficial, several harbor infectious parasites (Gates 1972).

3.4.4 Aquatic Fauna and Fisheries [27]

In Burma, as in the rest of South and Southeast Asia, the number of fish species is great. Although there are no complete inventories of fish for the country, neighboring Thailand is believed to have 300 species, and Kampuchea nearly 200, including 36 having economic value (18 of those considered essential; Dussart 1974). Some of the freshwater species, such as the numerous genera of catfish (Siluroidea) and Cyprinidae are endemic while varieties of carp (Carassius carassius) and tilapia (Cichlidae) have been introduced since the late nineteenth century.

Many of the ichtyofauna are found in the country's estuarine systems. The mangrove communities in the Irrawaddy, Sittang, and Salween delta regions provide habitats for a number of permanent and transient species. The most common are barramundi (Lates calcarifer) and mullet (Mugil cephalus). The

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[27] Sources Anonymous. 1979.
Bixler. 1971
Dussart. 1974.
FAO. 1969.
Henderson et al. 1971.
Ling. 1969.
Meseck. 1969.
Sribhibhadh. 1969.
Steinberg. 1979.
Suratti and Menasveta. 1968.
Tranter. 1974.

deltas also support a large crustacean population of prawns and crabs (Tranter 1974).

The shallow offshore waters of the Gulf of Martaban, the Andaman Sea, and the Bay of Bengal are well stocked with fish and increasingly are being tapped for edible fish. The population, however, having originated in inland riverine communities traditionally have preferred freshwater fish. Nevertheless, beginning in the late 1950s the government encouraged and supported greater exploitation of the nation's offshore fish resources. Through investment in a fleet of seagoing ships, it has brought about a gradual shift in the balance of ocean to inland fishing tonnage. Thus, although the total catch of streams, river, pond, and lake fish has continued to increase, an ever larger percentage of the catch has been drawn from the sea (Table 39).

The level of domestic consumption of fish and other seafoods is relatively high. Ngapi, a seasoned paste made of prawn or fish, is a dietary staple, and other fish dishes are extremely popular. In 1969 approximate consumption of fish products stood at 18.3 kg annual per capita--average for the region, but about seven times the rate in South Asia (Meseck 1969). Because of that factor and the promise of high levels of export, the government has continued to invest heavily in the nation's freshwater and offshore fisheries. Administered by the People's Pearl and Fishery Croporation (PPFC), a public sector enterprise, Burma's fishing industry is expected to overtake rice exports as the country's chief foreign currency earner. Fisheries development has been financed with assistance from the Asian Development Bank, Japan, the United Kingdom, Norway, and Denmark. A Japanese firm has helped to establish the Martaban Fishing Company, and other plans call for a tuna cannery, fish meal and fish oil plants and cold storage facilities (Siddiqui and Jeet 1978). FAO estimates suggest that Burma's total catch ultimately could triple (FAO 1969; Steinberg 1979; Table 39).

The nation's shallow water shrimp and prawn resources have been studied since the 1950s (Kyaw 1956). Initial surveys were not encouraging (Sribhibhadh 1969), but recent catches have been noteworthy; in 1976-77 the shrimp and prawn catch reached 21,000 tons (Steinberg 1979).

Table 39. Fishing Tonnage, 1968 to 1977, and Projections

	Total catch (1,000 metric tons, live weight)											
	1968-69[1]		1971[2]		1973[2]		1975[2]		1977[2]		Estim. potentia	
	Amt.	(% of tot.)	Amt.	(% of tot.)	Amt.	(% of tot.)	Amt.	(% of tot.)	Amt.	(% of tot.)	Min.	Max.
Inland	114.0	(27.9)	122.9	(27.8)	125.3	(27.0)	130.0	(26.8)	138.9	(26.8)	862.0[3]	a 1,187.0
Offshore and deepsea	294.0	(72.1)	319.8	(72.2)	338.1	(73.0)	355.1	(73.2)	379.8	(73.2)	n.a.	600.0
Total	408.0	(100.0)	442.7	(100.0)	463.4	(100.0)	485.1	(100.0)	518.7	(100.0)	n.a.	1,787.0

[1]Henderson et al. 1971.
[2]Anonymous. 1979.
[3]FAO. 1969.
[4]Steinberg. 1979.

Another promising source of fish production is the exploitation of the country's sizable brackish water resources. Under tropical conditions the mangroves, swamps, lagoons, lakes, estuaries, coastal lowlands and tidal flats have enormous potential for sustaining fast-growing fish and crustacean species. In 1969 it was estimated that a hectare of brackish water was capable of yielding 400 kg of fish or shrimp. Among fish, the most successfully bred species in Southeast Asia have been Chanos chanos, Mugil cephalus, M. tade, M. dussumieri, Lates calcarifer, and Anguila spp.; commercially bred crustaceans include Penaeus monodon, P. merguiensis, P. semiculcatus, P. indicus, Metapenaeus brevicornis, M. ensis, and Macrobrachium rosenbergii (Ling 1969).

Accordingly, the stocking of ponds, lakes, rivers, and bays with these and other edible aquatic species has been supported by the government. By the beginning of the 1970s Burma operated more than 3,700 fisheries--a ten percent increase over the previous decade. Some 95 percent of these fisheries are operated privately under lease to the PPFC (Henderson et al. 1971; Steinberg 1979).

Information regarding Burma's endangered species of fish and other aquatic fauna is rare and unavailable to this report. In neighboring Thailand however, at least three species of freshwater fish are threatened with extinction (Scleropages formosus, Pangasius sanitwongsei, and Pangasianodon gigas). Although it can be expected that as in Thailand few Burmese fishermen appreciate the value of conservation and management, it must be stated that Burma's rate of industrialization and development has been far more subdued than Thailand's. As a result, there has been less pressure on the country's aquatic fauna.

3.4.5 Reserves and Protected Areas [28]

In accordance with long-standing legislation governing the use of public lands and the protection of vegetative and faunal species (see following section, 3.4.6), Burma has a well-developed

[28] Sources: IUCN. 1974.
IUCN. 1977.
IUCN. 1980.

tradition of setting aside and administering reserves and protected areas. Designated as game sanctuaries or wildlife sanctuaries, these lands restrict or forbid hunting and exploitation. The reserves range in size from the minuscule 88 ha Diamond Island Wildlife Sanctuary near the mouth of the Bassein River, to the 214,900 ha Tamanthi Wildlife and Game Sanctuary, the fourth largest reserve in mainland Southeast Asia. In all there are 25 reserves, covering a total of 717,800 ha. Table 40 summarizes available data on Burma's reserves. More detailed information appears in Appendix VII.

3.4.6 Legislation, Administration, and Planning 29/

As the previous section and Table 38 in particular have suggested, a number of statutes regulating wildlife have been in place throughout the twentieth century Modeled after similar legislation in British India, the Fisheries Act was adopted in 1905 and followed by the Wild Birds and Animals Protection Act of 1912, later amended in 1929, 1934, and 1936. Modified versions of both Acts remain in force today. The 1920s and 1930s also saw the institution of the Burma Game Rules (1927) and the Burma Wildlife Protection Act (1936). The former is still functional while a modified version of the latter forms the basis for the country's wildlife conservation policy. The Wildlife Protection Act, as amended in 1956, permits the establishment of reserves within which hunting is either forbidden or restricted; it stipulates seasons for and approved modes of hunting and fishing; it lists protected fauna; and regulates imports and exports of wildlife and animal products. The Act is supplemented by the Burma Wildlife Protection Rules (Johnson and Johnson 1977).

Governmental administration of wildlife and fisheries is accomplished through a ministry and several agencies. The Ministry of Agriculture and Forestry, headquartered in Rangoon, provides the primary structure for setting and carrying out policy. Supporting agencies are the Burma Wildlife Survey, the Directorate of Fisheries (within the Ministry of Agriculture of Forestry), the People's Pearl and

[29]Sources: IUCN. 1974.
IUCN. 1977.
Johnson and Johnson. 1977.

Table 40. Game and Wildlife Resources

Name of Reserve	Game sanctuary	Wildlife sanctuary	Area (1,000 ha)	Date of establishment
Tamanhi	X	X	214.9	1974
Kyauk Pandaung		X	132.6	1976
Yegauk (Taunggup)		X	91.4	*
Shwe Zettaw		X	55 3	1940
Shur-U Daung	X		42.0	*
Shwe-U Daung		X	32 6	*
Lemro		X	28.5	*
Kyatthin		X	26.9	*
Minwuntaung	X	X	20.6	1972
Kahilu		X	16.1	1928
Mulayit		X	13.9	1936
Maymyo	X		12 7	1918
Thitson		X	9.1	*
Moscos Island		X	4.9	1924
Zamual		X	3.9	*
Byingye		X	3.9	*
Kelatha		X	2.5	1942
Taunggyi	X		1.6	1930
Htu Lake		X	1.5	*
Rih Lake		X	1.0	*
Hlawga		X	0.5	*
Ngwedaung		X	0.5	*
Wettigan		X	0.5	*
Peikthanoe		X	0.3	*
Diamond Island (Thamila Kyun or Leik Kyun)		X	0.1	1970
Total area			717.8	

*Exact date unavailable, but prior to 1974.

Sources: IUCN. 1974.
IUCN. 1977.
IUCN. 1980.

Fishery Corporation (PPFC), the Office of the Chief Conservator of Forests, and the Land Use Bureau. Research and training on fauna, fisheries, management and conservation is carried out at the Rangoon Zoological Gardens, the Agricultural College and Research Institute in Mandalay, the Agricultural Research Institute in Gyogon, the newly-established Forest Research Institute at Yeizin the Forest Research and Training Circle in Rangoon, and at Rangoon University (Johnson and Johnson 1977; IUCN 1974; Anonymous 1980a). During the late 1970s the government began establishing an Institute of Marine Science at Moulmein (Tranter 1974).

Fisheries, as Section 3.4.4 has indicated, do receive considerable federal attention and support. This is due to their potential for earning foreign currency; in 1977-78 fishing accounted for 1.6 percent of Burma's exports. The government hopes that with additional development this figure can be increased to nearly five percent by 1982, the last year of the current Four-Year Plan. Other areas of wildlife administration and conservation, however, do not offer a potential for public profit. Necessarily then, a capital-short economy such as Burma's places a relatively low priority on conservation. With limited expenditures it is likely that enforcement of statutory violations are restricted to instances of reasonable loss. Protection of commercially valuable elephants, for example, is likely pursued more vigorously than protection of tigers or rhinoceri. Nevertheless local wildlife experts believe that protective measures--even for elephants--are inadequate and suggest that the 1936 Wildlife Protection Act is archaic and needs to be revised (Durdin 1980).

4.0 Environmental Problems

4.1 Environmental Problems in Rural Areas

4.1.1 Natural Disasters [30]

4.1.1.1 Cyclones

These early summer tropical storms originating in the South Andaman Sea form seasonally. They generally move in a north northeasterly direction and affect the Tenasserim coast. Infrequently cyclones move away from the coast and then curve back east. Having picked up force over the sea, these storms, characterized by heavy rains and high winds, are capable of causing serious destruction. The most serious cyclone in recent years hit the northern Arakan coastline in May 1968. The storm claimed 1,070 lives and over 61,000 victims (U.S. AID 1980).

As of 1979 Burma had no central plan for minimizing the hazard and damage caused by cyclones. Instead, efforts are improvised- radio stations broadcast warnings, and the government mobilizes a task force which includes medical and first aid personnel (U.S. AID 1979).

4.1.1.2 Floods

Because much of Burma lies in a zone which receives high annual rainfall which is intensely seasonal, and because the country is drained by several large rivers, the lowlands chronically are prone to severe flooding. During one particularly wet season in 1965 the Sittang overflowed its banks and displaced a half million persons. In 1974 all the areas of central Burma along the courses of the Chindwin, Irrawaddy, and Sittang Rivers were flooded in a catastrophe affecting an estimated 1.4 million residents (U.S. AID 1980). Table 41 indicates maximum river flood levels.

As in the case of cyclones, the Burmese government has no standing plan to mitigate the effects of floods. Instead in the event of disaster, the

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[30]Sources: Chhibber. 1975.
Koteswaram. 1974.
Roberts et al. 1968.
UNESCAP. 1978.
U.S. AID. 1979a.
U.S. AID. 1980.

Table 41. River Flooding

Name of river	Drainage area at gaging station sq km	Peak discharge m^3/s	Date
Mu	12,504	5,440	9 July 1928
Zawgyi	4,087	1,980	24 Sep. 1949
Paung laung	2,577	1,700	Oct. 1926
Meiktila Lake	620	4,000	4 Nov. 1935
Nyaungyan – Minhla Tank	1,200	6,000	5 May 1920
Thitson	378	510	1917
Salin	2,100	5,206	8 Oct. 1948
Mon	5,310	8,980	8 Oct. 1948
Man	1,500	897	25 Oct. 1950
Chaungmagyi	3,424	4,110	20 Oct. 1913
Yenwe	912	2,200	1937
Pegu	2,280	1,210	1926
Irrawaddy	380,000	63,700	1877

Source: Van der Leeden. 1975.

Council of Ministers, the nation's highest executive body is empowered to institute emergency measures. The primary agency responsible for disaster relief is the Department of Relief and Resettlement within the Ministry of Social Welfare. In purely local emergencies, power is vested in the State Councils and Township Authorities. At the district and township levels disaster management is left to the Executive Committees of the People's Councils. At each level, however, the government frequently appoints special task forces to deal with major disasters (Robinson 1980).

The late summer monsoon rains can be extremely intense. Along the non-deltaic coastlines, for example, rainfall measuring over 350 mm in a 24-hour period has been recorded. Inland, flooding results more from prolonged rainfall than from short bursts. In the deltaic lowlands heavy rain associated with typhoons and low pressure waves are particularly damaging to the autumn harvests.

In these regions, especially the rice producing districts of Pegu and Toungoo, flooding is a serious annual problem. Each year approximately 2 million hectares are severely flooded while another 3.25 million ha are moderately inundated. In an average year three quarters of a million ha of rice land are lost to flooding (Henderson et al. 1971). Beginning in the 1960s the government undertook a series of flood control projects, mostly constructing dams along the Irrawaddy and Sittang Rivers. These dams are also intended to serve as irrigation schemes. The Lower Burma Paddyland Development Project, currently underway, is the most ambitious such undertaking. When completed, it is expected to protect 75,000 ha of arable land in the Irrawaddy delta region (UNESCAP 1978).

In addition to destroying property, displacing residents, and ruining crops, recurrent flooding has depleted Burma's soil resources. In the hilly regions where shifting agriculture has been dominant, torrential rain has washed away much of the shallow topsoil Erosion will be examined in greater detail in Section 4.1.2 below.

4.1.1.3 Drought

As Section 2.1.3 on climate has indicated, there is only one region in Burma which can be properly termed "dry." This central zone receives less than 1,000 mm of annual precipitaiton (Fig. 6b), mostly during the summer monsoon season. Not surprisingly then this area is subject to periodic drought. Because of the chronic shortage of water in this dry zone, cultivators have irrigated the land for centuries and rendered it productive. There remain extensive areas, however, which are not served by irrigation systems and these are subject to drought.

4.1.1.4 Earthquakes

Except for the Shan Plateau, Burma lies on an unstable portion of the earth's crust. The bedrock has been folded by a continuing series of earthquakes. The capital city of Rangoon itself experiences minor quakes at least once a year. Inland there is evidence of serious tremors and quakes dating to the late 18th century. Other violent earthquakes have been recorded throughout the country in 1839, 1843, 1855, and on several occasions during the early part of this century (Chhibber 1975). The most serious earthquakes within the past decade struck Pagan, a historic site between Magwe and Mandalay on the banks of the Irrawaddy. Most of the town's thousand of abandoned pagodas were destroyed.

4.1.1.5 Volcanoes

Burma at one time abounded with active volcanoes. The country was considered the classic case for study of mainland Southeast Asian volcanoes. During the Tertiary there were ten active volcanic centers lying on the Shan Plateau, the central belt, the Arakan Yomas, and the Arakan coastal strip. Although some of the volcanoes are associated with hot springs, none are now considered active and there have been no eruptions during this century (Chhibber 1975).

4.1.2 Deforestation, Erosion and Misuse of Land [31]

Burma is in the precarious position of possessing at once vast expanses of exploitable foreign currency

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[31] Sources: Angladette. 1974.
Boonkird. 1968.
Dentan. 1968.
Gill. 1968.
Hafner. 1977.
Kermode. 1958.
Miller et al. 1978.
Miller et al. 1979.
NAS. 1979
Ranjitsinh. 1979.
Sabhasri. 1968.

yielding forests, and a mountain forest culture which still engages in shifting cultivation (taungya). Figure 25 is drawn from aerial photos of a portion of the Shan Plateau in Thailand just across the Burmese border. It illustrates clearly the measurable growth of shifting cultivation in this mountainous region. The dark areas, which represent areas brought under cultivation, were formerly forested.

While deforestation is not uniformly pronounced throughout the country, the remote areas inhabited by Naga. Chin, Karen, Shan, and other non-Burman tribal peoples all are affected by taungya (Dentan 1968). Fortunately for the Burmese timber industry, most of the valuable teak stands are not in areas most heavily subjected to these slash-and-burn techniques. Nevertheless C.W.D. Kermode, an expert on Burma's teak resources, observed in 1958 that some teak stands were being lost to taungya. Exact figures of the amount of forested land consumed by the practice are not available, but according to one estimate perhaps two-thirds of the country's tropical moist forest has been converted to other purposes (Sommer 1976).

Although taungya farming undoubtedly is destructive to timber, vegetative cover, and topsoil, more sympathetic observers have pointed its positive aspects. The crops grown, for example, feed not only the human population, but also birds, ungulates, rodents, and insects- many of these animals being beneficial to the ecology and the human environment. The hill peoples morever, raise domesticated animals which serve as prey to forest predators, and distribute seeds of edible fruits berries and vegetables (Eckholm 1979; Gill 1968).

Some recent theoretical approaches to environmental destruction such as Hafner s 1977 study of Thailand, have stressed the need to appreciate indigenous cultural perceptions of the environment. According to these formulations, deforestation by resident populations can be seen in a broader ecological context which highlights the beneficial aspects of seemingly destructive behavior.

But if the valuable teak forests generally have been spared from taungya, they have not escaped a second threat: illegal and extralegal commercial exploitation. Local enterprises sometimes extract more timber than their quotas permit, depleting

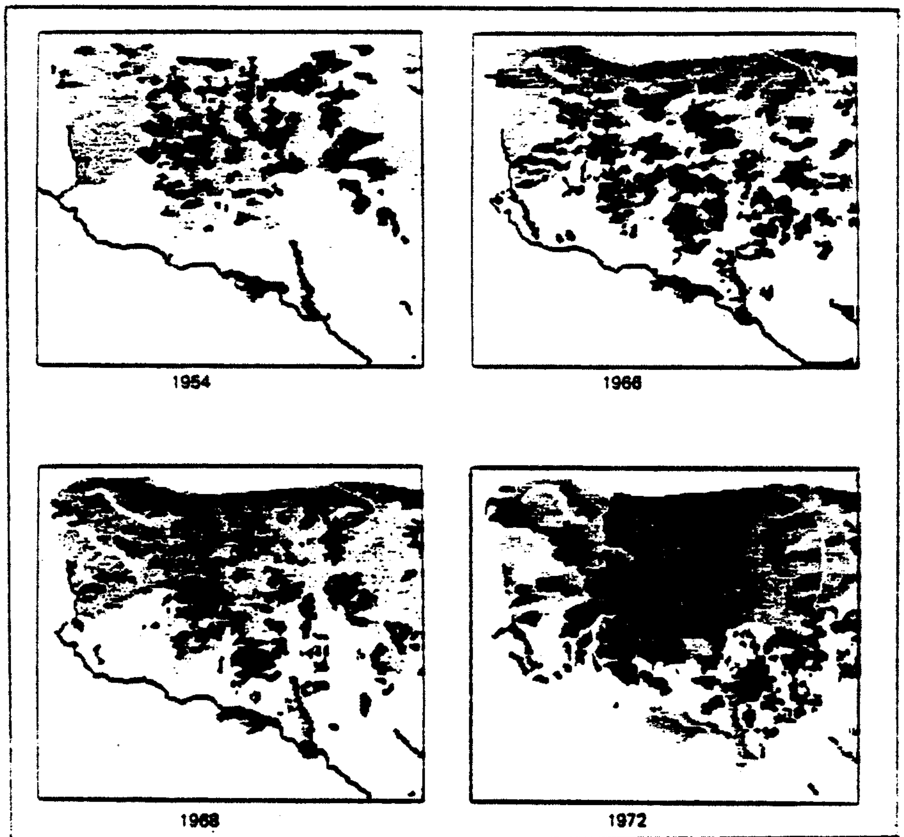

Figure 25. Shifting Cultivation on the Shan Plateau, 1954 to 1972

Source: Miller et al. 1979.

hardwood stands more rapidly than authorized. Regeneration is also impeded by illegal cropping on cleared areas, a practice which strips soils of their nutrition and prevents native trees from returning to their habitats. Oversized openings sustain an additional problem: they permit the growth of rapid growing fire-resistant weeds such as Lantana camara, Eupatorium odoratum, Mikania scandens, Cassia tora, and Strobilanthus collosus. These plants cover the ground, use up available water, and choke young trees and grasses (Ranjitsinh 1979).

A third cause of deforestation is natural fire. Quite apart from the deliberate incendiary techniques employed in taungya, forests are often decimated by fire. Stands of teak, other hardwoods, and commercially exploitable evergreens are frequently prevented from advancing beyond pre-climax state because of annual surface fires (Kermdle 1958).

Forest fires, whether deliberately set or natural, have several ecologically damaging consequences. In addition to the obvious loss of timber resources, fires affect soil quality and availability, water runoff, infiltration, and percolation. Erosion nearly always accompanies the loss of forest cover, and this has been shown to be especially true for Southeast Asia's deforested teak regions With trees felled or burned, rich topsoil is washed away by rain or blown away by wind and permanently lost. The high silt content of Burma's major rivers attests to this phenomenon (Angladette 1974).

An early (1960) study of teak forests in neighboring Thailand obtained the following conclusions regarding the effects of fires on runoff: (1) on teak plantations runoff in burned plots was five times that of unburned plots, and sediment was 14 times as much in burned plots; (2) in natural teak forests on sandy loam or shale, runoff and sediment were nearly twice as large on burned plots; (3) in natural teak forest on limestone soil, runoff was 33 percent greater and sediment 2.7 times as high on burned plots; and (4) in dry dipterocarp forest on lateritic soil, runoff on burned plots was 20 percent lower, and sediment was 40 percent higher (Boonkird 1968).

4.1.3 Pesticide, Herbicide, and Fertilizers Use [32]

Because manufactured insecticides, larvacides, rodenticides, and herbicides generally need to be imported and paid for with scarce foreign currency, their use is not prevalent in Burma. When such chemicals are employed, however, their effects are often hazardous to handlers of the substances, potentially harmful to surrounding populations, and detrimental to the environment

It has been shown that because tropical crops are grown in closer association with natural vegetation, the introduction of artificial pesticides and herbicides poses even more serious problems than in temperate regions (Conway 1968). Three additional factors have increased the potential damage of such chemicals. First there has been little local research on their use and consequently, not enough is known about the effects of specific agents on particular regional environments. Second, training facilities are insufficiently familiar with integrated and biological pest and weed management techniques (Pant 1974). Solutions to infestation problems are therefore too frequently short-sighted and inefficient Finally, the shortage of capital combined with the absence of regulations governing import and utilization of substances proven to be hazardous in the U.S. and elsewhere has led to widespread indiscriminate use of such materials. For example, endrin, aldrin, DDT, lindane, and other chlorinated hydrocarbons have each been suspended by the U.S. Environmental Protection Agency (EPA) and are no longer employed by U.S. agriculture. Yet these chemicals are used in Burma to enhance maize and oilseed production, and wherever insecticides are applied. During 1979-80 an estimated 60 percent of the chemicals used on maize and oilseed crops were chlorinated hydrocarbons (Glass 1981). U.S.

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[32]Sources: Aye. 1978.
Brooks et al. 1979.
Conway. 1968.
Glass. 1981.
Meijer. 1968.
Pant. 1974.
Self and Tun. 1970.
Thant. 1978.
U.S. AID. 1981b.
Yadava. 1978.

AID, in a current project designed to improve production of these two crops is attempting to convince the government to consider the long-term hazards of pesticide use (U.S. AID 1981b).

Overall figures for current insecticide and herbicide use are not available, but in 1968-69 Burma used 227,000 kg of powdered and 13,600 liters of liquid insecticide--all of it imported. There were indications in the early 1970s that environmental concerns led to a reduction of insecticide use, but no figures were available to substantiate this claim (Henderson et al. 1971).

Residual larvicides have also been employed to control populations of malarial vectors. Stagnant polluted waters within and outside major residential areas have been the targets for these organophosphorus larvicides and oils. These substances are extremely toxic and remain so for a week to 100 days. The persistence of toxicity is, in fact, a desirable quality from the point of view of its effectiveness against mosquito and other insect larvae. But this feature makes the chemicals hazardous and a source of pollution. When applied to concrete and earthern drains, and to pit latrines, the chemicals percolate into the soil and can infiltrate drinking water supplies. In view of the pervasiveness and seriousness of the malarial problem, application of larvicides remains one of the few effective means to combat the spread of infecting organisms (Self and Tun 1970).

Besides insects, bandicoot rats are perhaps the major faunal pest. As Section 3.4.1 has discussed, these vermin are a major source of disease, both in rural and urban areas. Beginning in the 1960s studies were conducted to evaluate the effects of various anticoagulant rodenticides. In 1979 a field study in Rangoon assessed the susceptibility of Bandicota bengalensis to such toxins. The research, however, did not consider the potential hazards of these rodenticides. Given the enormous population of bandicoots and other rats, large-scale eradication programs could introduce high levels of rodenticide such as brodifacoum difenacoum coumatetralyl, diphacinone, and warfarin into the soil as the burrowing animals succumb to these poisons.

Another potential chemical pollutant whose impact on the Burmese environment has yet to be examined is fertilizer. There are indications that use of these substances is now increasing after dropping substantially during the 1960s (Henderson 1971; Steinberg 1979). Generally, however, artificial fertilizer use on Burmese rice (the principal fertilized crop) remains below use in other countries (Framji 1977). Organic fertilizer, in fact, appears to be more popular than manufactured fertilizer. Most of this is made up of animal manure and crop residue. Appendix III lists levels of fertilizer use. Nightsoil is not commonly employed as fertilizer; Burmese farmers disdain upon its use, though Chinese farmers tend to apply it to vegetable plots. However, there has been a growing trend to apply untreated urban refuse and sewage to suburban crops. Such fertilization naturally introduces both chemical and organismic pollutants (Thant 1978; Yadava 1978).

4.2 Environmental Problems in Urban Areas

4.2.1 Water Contamination and Infectious Disease [33]

Sections 2.2.4 and 3.2.4 have already described the states of public health, the availability of drinking water, and sewage disposal. Figures for the number of persons with access to those facilities remain markedly low (17 percent and 33 percent, respectively; Table 7) and for that reason waterborne diseases continue as a serious environmental problem.

Although access to safe water and sewage treatment is higher in urban areas than in the countryside (Table 7), it is in the cities that the most serious infectious diseases are spread. With the exception of trachoma which afflicts large numbers--in some regions, a majority--of rural persons, most of the prevalent waterborne infections appear in cities and towns (Kyaw et al. 1978). Except in wealthy neighborhoods, drinking water is generally untreated and contaminated, sewers are often open or nonexistent, and rivers and canals frequently are used directly for disposal. Human disease

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[33]Sources: Henderson et al. 1971.
Kyaw et al 1978.
Martinez Dominguez et al. 1980.
Self and Tun. 1970.
Than et al. 1980.

organisms, present in fecal and urinal matter are then reintroduced into the environment and continues the infectious cycle (Johnson and Johnson 1977).

Malaria, perhaps the most ubiquitous disease has been under assault since the early 1950s. Since then the government has sponsored efforts to eradicate the vector both directly, by spraying DDT, and indirectly through the use of larvacides (Self and Tun 1970). As in neighboring countries in South Asia, these efforts at first were moderately successful and the incidence of malaria fell. But a combination of decreased control measures and new resistant strains of mosquitoes has brought about a resurgence in the incidence of disease (U.S. AID 1979b). Its occurrence is lowest along the coastal areas and in the central plains, and highest in the towns of the Shan Plateau and the Chin hills (U.S AID 1980b).

While spraying insecticides and larvacides has had some measure of success, the greatest impediment to effective control is the prevalence of open sewers and reservoirs, stagnant pools, defective plumbing, and flooded lowlands. These and other accumulations of water have served as breeding grounds not only for Culex pipiens fatigans, the malarial vector, but for flies and other airborne insects which transmit bacteria, viruses, parasites, and other infectious microorganisms. The diseases caused by these agents (dysentery, poliomyelitis, and dengue haemorrhagic fever) have been especially serious in Burma s large metropolitan centers. Outbreaks of these illnesses are particularly common during the monsoon season when heavy rainfall causes water storage tanks, sewers, rivers, and ponds to overflow.

As Section 2.2.4 has indicated, medical facilities have been gradually improving over the past few decades. The Ministry of Health, through its major organs--the Directorate of Health Services, Burma Medical Research Council, National Health Laboratories, and the Union of Burma Applied Research Institute--have attempted to raise the general health standards while conducting research on the nation's major infectious diseases (Henderson et al. 1971). A current program supported by UNICEF, WHO, and U.S. AID is aimed at further improving primary health care facilities (see Appendix V). To date, however, it appears that the thrust of Burma's public health efforts is aimed at treatment and care. Until major steps are undertaken to prevent thespread of disease by eliminating water habitats of carriers, prospects for improving the population's health remain limited.

4.2.2 Industrial Pollution [34]

Very little information exists concerning environmental pollution caused by industrial activity. Manufacturing, the largest component of the industrial sector (71 percent in 1979), more than doubled between 1971 and 1977 (Anonymous 1979). But although its share of the gross domestic product (GDP) has grown from eight to ten percent since 1960, manufacturing has not kept pace with the growth of the GDP during the past decade (World Bank 1981).

Burma's major industries include: cigarette, cement, soap and textile manufacturing; salt, sugar petroleum, and kerosene refining; and processing of timber pulp foods, beverages, and agricultural products. The plants, factories, and facilites engaged in these activities are generally situated in urban centers or along rivers. There are currently no statutes preventing discharging or dumping of either solid, liquid, or gaseous substances. Industries are thus free to dispose of hazardous and polluting materials and industrial by-products in the most economical fashion. Although Burma cannot be termed an industrialized nation and its manufacturing output is limited, residents of Rangoon, Mandalay, and some of the cities in the deltaic region may well be subjected to dangerous chemical pollution. In neighboring Thailand for example, sugar refineries along the Mae Klong River discharged so much effluent that local fisheries were nearly destroyed. Paper mills, vegetable and palm oil refineries, and food canneries in both Thailand and Malaysia have produced similar damage and affected public health. That such incidents have not been documented in Burma is primarily a reflection of the nation's persistent insularity (U.S. AID 1979b).

Industrial pollutants can be found in the air, water supply, soil, and food products. There is evidence,

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[34]Sources: Hayes. 1979.
Johnson and Johnson. 1977.
Suzuki et al. 1972.
U.S. AID. 1981d.

for example that toxic lead-containing industrial effluents discharged into rivers and streams have infiltrated urban water supplies (Johnson and Johnson 1977). Occasionally, unsanitary conditions in food processing plants affect edible products. In one documented instance, canned fish imported from Japan was contaminated with methyl mercuric chloride whose source was the dumping of mercury by a Japanese firm into a bay The dumping continued from as early as 1953 to 1971. Although its effects on local residents were well publicized, it is not generally known that contaminated fish products were canned and exported. A 1972 study showed that consumers of these foods in Burma, particularly Japanese immigrants, suffered from mercury poisoning (Suzuki et al. 1972).

4.3 Environmental Management Problems [35]

4.3.1 Communications

The first and perhaps the most meaningful barrier to environmental management in Burma is the problem of inadequate facilities for communications. Due to a combination of historical political, and financial factors, and the country's transportation infrastructure, postal, telephone, and telegraph networks suffer from shortages and disrepair. Additionally its apparent reluctance over the past two decades to participate in regional and extraregional dialogue and exchange has left Burma not only isolated, but lagging behind other developing nations in matters pertaining to development and environmentalism.

Virtually all of the country's facilities for ground, river, and air transport were developed during the colonial period. The railways, for example, were introduced by the British and eventually linked the Irrawaddy delta to Myitkyina and Lashio in the North. But the 4,300 km of track now in place is essentially the same length which

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[35] Sources: Anonymous. 1979.
Henderson et al. 1971.
Johnson and Johnson. 1977.
Ofosu-Amaah and Gruppe. 1981.
Shane. 1978.
Silverstein. 1979.
Silverstein. 1981.

existed prior to World War II. Postwar work on the rail network was almost exclusively devoted to replacement and repair, not on extension. Burma's well-developed inland waterway steam transport service similarly has existed since the early British period. Roads have been extended into hill regions, but many remain unserviceable due to the effects of bad weather and insurrection. Secondary roads are particularly lacking, but shortages of funds deter large investments in roadbuilding.

Since independence government efforts have been aimed at public control of transportation, rather than at extending existing networks. Accordingly, the Ministry of Transport and Communications now operates the Burma Railways Corporation, the Road Transport Corporation, the Inland Water Transport Corporation, and the Burma Airways Corporation, all state monopolies. In general all aspects of the transportation system are overburdened and therefore inefficient and unreliable. Breakdowns are frequent, as are shortages of vehicles, spare parts, materials, and trained personnel. These conditions impede public education, administration, and enforcement of environmental issues.

The situation regarding communications is similar. Mail and telegraph services remain the chief modes of transmitting information. The former is subject to the difficulties created by inadequate transportation facilities, while the latter employs outdated equipment which transmits signals over lines frequently in need of repair. The 277 telegraph offices around the country serve as the best means of sending rapid information. Telephones are few and mainly concentrated in Rangoon (72 percent). Radio service is considered very poor and until recently there was no television. In June 1980 Burma implemented color television service (Silverstein 1981). Transmission is over a series of microwave stations in Rangoon, Mandalay, Tanuggyi, Akyab, and Bassein. Despite this latest innovation it remains difficult to transmit ideas and messages in Burma.

The most serious communications problem relating to environmental management may well be Burma's persistent unwillingness, until recently to take part in international fora, conferences and joint research. Throughout the 1960s and 1970s the country was unrepresented at regional scientific and educational gatherings. Simultaneously research conducted in Burma often remained unpublished or inaccessible. In effect scientists, technicians, and administrators were cut off from developments elsewhere. Even with neighboring nations who experience similar environmental problems, the Burmese government has resisted cooperative ventures, showing no desire to join the Association of South East Asian Nations (ASEAN) or other regional associations (Silverstein 1979).

Finally, as Sections 2.2.1 and 2.2.2 have pointed out, Burma's is a multiethnic society. Various communities speak distinct languages and behave according to individual cultural perspectives. The government's continuing attempts to integrate the nation's resident populations have met with little success. Non Burmans generally view Burmans suspiciously and are not easily induced to cooperate with central objectives Any efforts to reduce or mitigate environmentally detrimental practices such as shifting agriculture and its resultant deforestation face inherent difficulties on account of these socio-ethnic considerations The antigovernment insurrections which have continued for more than two decades are manifestations of deep-seated cultural differences and are themselves responsible for causing measurable environmental damage (Silverstein 1979; 1981).

4.3.2 Training Facilities

Previous sections on mining, energy, irrigation, agriculture forestry, wildlife, and fishing have identified a number of institutes academies, and agencies which engage in education, research, and training. Some of these institutions were established during the British period, others since independence; most are public; some private. But as a whole, they are too few, too poorly staffed, and inadequately funded to train sufficient numbers of extension agents, foresters, game and fish wardens, mine supervisors, environmental lawyers, and the newly developed cadre of environmental professionals needed.

By restricting the penetration of foreign ideas, advisors, and technicians, the government has inpeded the natural development of institutions and programs. Furthermore, training facilities which exist are designed to increase capabilities in fields that are readily applicable, and whose products are marketable. For that reason, most training programs related to the environment are aimed at commercially valuable resources whose exploitation would benefit the economy. Chronic scarcity of capital precludes large investments in sectors which are perceived to be of mere academic interest.

4.3.3 Policy, Legislation, Enforcement, and Administration

As in most of the "poorer developing countries" (Ofosu-Amaah and Gruppe 1981), there has been little or no attempt by the Burmese government to adopt an integrated approach to managing the nation's environmental resources. Much like the nation's response to cyclones and floods (Section 4.1.1), the state's efforts in this regard are reactive, ad hoc, and piecemeal. With continued deployment of 160,000 soldiers in the field, nearly a third of the budget is spent on defense (Silverstein 1981), thereby relegating environmental concerns to a relatively low priority.

There is no overall central plan to deal with these concerns. In the absence of such a policy, concrete action is difficult to achieve. Legislation protecting environmental resources does exist (Appendix IV), but it is archaic. Virtually all the statutes date from the colonial period and only a few have been amended since independence. Burma, which at one time was ahead of its eastern neighbors in this respect has not kept pace with developments elsewhere. And when this issue was addressed at a 1977 regional conference on environmental law, Burma was characteristically unrepresented.

Although there have been indications that Burma's rulers are seeking to expand the nation's international contacts and open the country to foreign specialists and visitors, there is little likelihood that these developments will lead to any immediate adoption of environmental laws. Increased contact with the outside world may, however, improve the prospects for adhering to accepted international standards governing the use of hazardous substances and known pollutants. As Burma accepts more foreign assistance for its development schemes, it will be required to submit to pressure from donor nations and consortia. U.S. AID's attempts to limit use of toxic insecticides in its current maize and oilseeds project is an example of such a case (Section 4.1.3).

Scarcity of data prevents any conclusive assessment of the effectiveness of current measures to enforce existing statutes. In this regard, conditions in Burma are similar to those in other developing societies. Lack of manpower, insufficient capital, interagency competition, and conflicting directives, legal ambiguities, uncertain jurisdiction, insufficiently harsh penalization, administrative inefficiency, local corruption and hostility toward central government officers, difficulties of travel and communication, public apathy and insensitivity are the most common obstacles to effective enforcement of environmental legislation (Ofosu-Amaah and Gruppe 1981).

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Appendix I. Demographic and Economic Characteristics

Table 1. Vital Statistics

		Source
Total population, 1980 (millions)	34.1	b
Population density per sq km, 1980	50.4	b,c
Population density per sq km of cropland, 1980	341.0	a,b
Percentage of population in urban areas, 1980	27.0%	c
Urban population growth rate, 1970-80	3.9%	c
Average annual population growth rate, 1970-79	2.2%	c
Crude birth rate per 1,000, 1979	37.0	c
Total fertility rate, 1979	5.3%	c
Crude death rate per 1,000, 1979	14.0	c
Life expectancy at birth, 1979	54.0	c
Infant mortality rate per 1,000 live births (0-1 year), 1975	55.8	b
Population per physician, 1977	5,120.0	c
Average daily caloric intake, 1977	2,286.0	c
Percentage adult literacy, 1976	67.0	c
Per capita share of GNP, 1979 (U.S. $)	160.0	c

[a]Table 8, Section 2.3 above
[b]U.S. AID. 1980a.
[c]World Bank. 1981.

Table 2.

Midyear Population Estimates and Average Annual Period Growth Rates, 1950 to 1981 (Population in thousands, rate in percent)

Year	Population	Year	Population	Period	Average annual growth rate
1950	17,927	1974	29,760	1950–55	1.9
1955	19,682	1975	30,482	1955–60	2.0
1960	21,726	1976	31,226	1960–65	2.1
1965	24,167	1977	31,992	1965–70	2.3
1970	27,078	1978	32,782	1970–75	2.4
1971	27,718			1975–80	2.4
1972	28,378			1980–81	2.5
PROJECTED ESTIMATES		1979	33,590		
1973	29,059	1980	34,433		
		1981	35,289		

NOTES: 1950–81 - Based on the 1973 unadjusted census population, and growth rates derived from U.N. medium variant projection series (U.N., 1979, table 1-A).

Source: U.S. Department of Commerce. 1981.

Table 3. Economic Characteristics, 1979

Gross National Product (GNP), 1979	
Total (millions of U.S. $)	5,264.0
Per capita (U.S. $)	160.0
Gross Domestic Product (GDP), 1979	
Total (millions of U.S. $)	4,950.0
Agricultural sector, total (millions of U.S. $)	45.0
Agricultural sector, growth rate (1970-79)	3.9%
Industrial sector, total (millions of U.S. $)	14.0
Industrial sector, growth rate (1970-79)	5.4%
Manufacturing subsector, total (millions of U.S. $)	10.0
Manufacturing subsector, growth rate (1970-79)	5.0%
Services sector, total (millions of U.S. $)	41.0
Services sector, growth rate (1970-79)	4.3%
Structure of Labor Force	
Agriculture, 1979	67.0%
Industry, 1979	10.0%
Services, 1979	23.0%

Source: World Bank. 1981.

Table 4. Economically Active Population, 1975-76 and 1976-77

(official estimates—'000)

	1975/76	1976/77
Agriculture, hunting, forestry and fishing	8,238	8,400
Mining and quarrying	67	66
Manufacturing	872	878
Electricity, gas and water	14	14
Construction	176	160
Trade, restaurants and hotels	1,061	1,159
Transport, storage and communications	418	425
Financing, insurance, real estate and business services; Community, social and personal services	551	733
Activities not adequately described	536	548
TOTAL	11,933	12,383

Source: Anonymous. 1979.

Table 5. Annual Budget, 1975-76 and 1976-77

(million kyats, April 1st to March 31st)

RECEIPTS	1975/76	1976/77
Revenue (tax receipts)	1,859.9	2,494.5
Current account	10,366.7	13,777.7
Capital account	4.3	303.6
Debts	7.0	58.7
Loans and advances	16.8	42.9
Savings	—	—
TOTAL	12,254.7	16,677.4

EXPENDITURE	1975/76	1976/77
Current expenditure	11,807.8	14,733.2
of which:		
Economic enterprises	4,504.2	6,750.3
Trade	4,071.0	3,977.7
Social welfare	843.1	976.7
National defence	816.6	1,008.2
Transport and communications	586.0	747.1
Construction	371.5	476.7
Administration	615.4	796.7
Capital account	772.6	1,704.9
of which:		
Mines	124.1	173.5
Industry	122.3	504.6
Transport and communications	138.4	234.1
Agriculture	150.6	374.8
Administration	237.2	417.9
Investments	20.2	290.8
Debts	366.9	450.1
Contributions	20.5	20.5
Loans and advances	47.0	88.0
Savings	29.3	30.2
TOTAL	13,064.3	17,317.7

Source: Anonymous. 1979.

Appendix II. Mineral Deposits

Figure 1. Antimony
Figure 2. Barite
Figure 3. Chromite
Figure 4. Copper
Figure 5. Fluorite
Figure 6. Iron
Figure 7. Lead
Figure 8. Manganese
Figure 9. Tin
Figure 10. Zinc

Source: Goossens. 1978a.

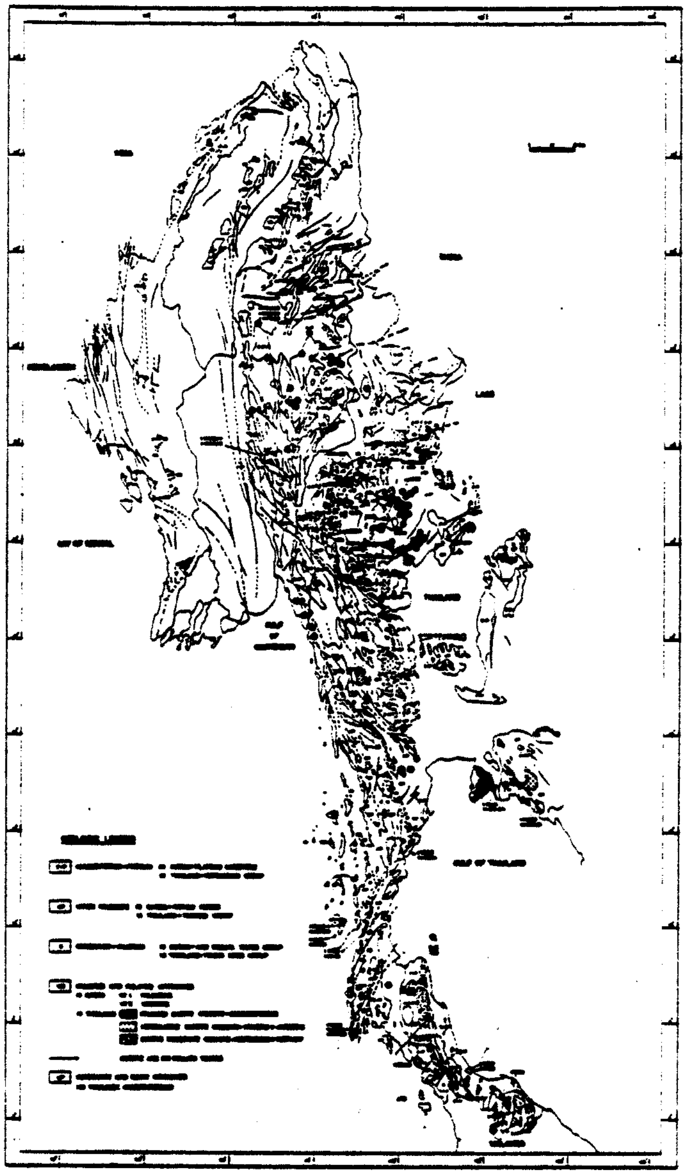

Figure 1. Antimony

Source: Goossens. 1978a.

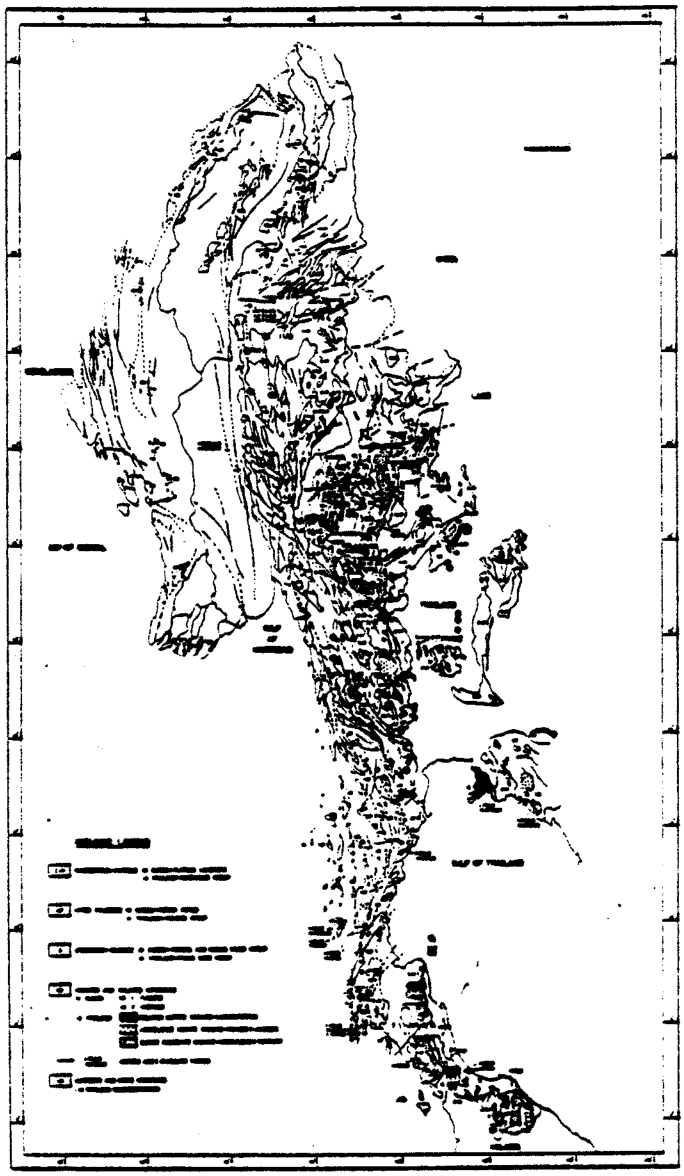

Figure 2. Barite

Source: Goossens. 1978a.

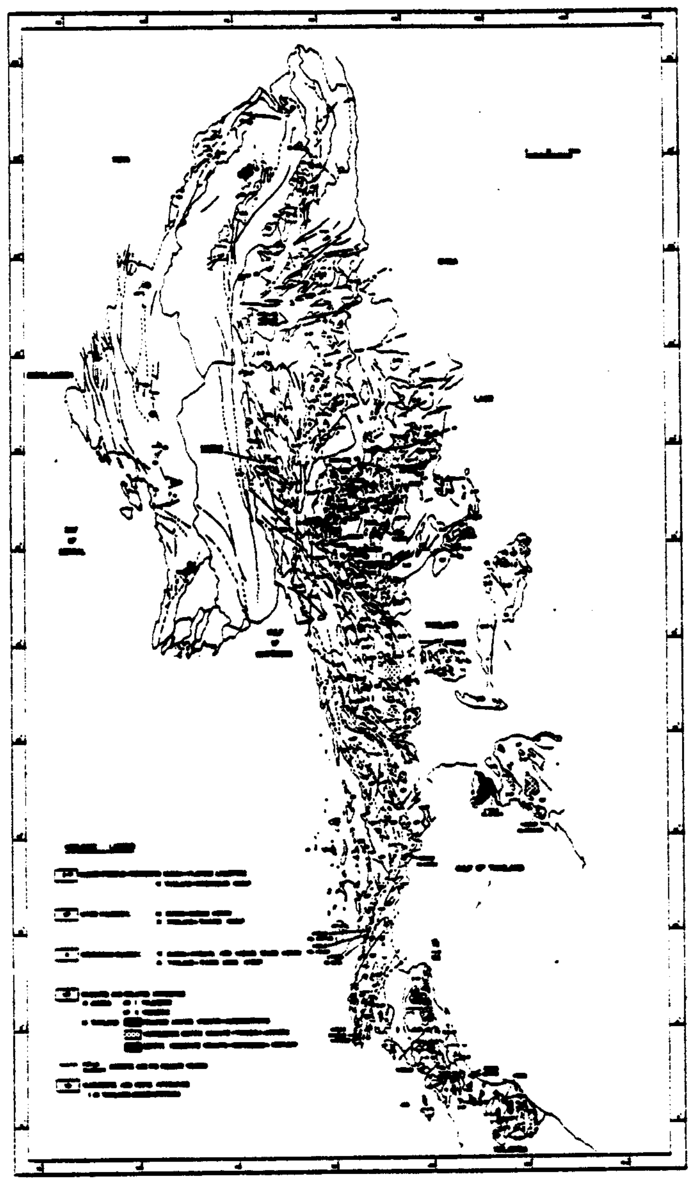

Figure 3. Chromite

Source: Goossens. 1978a.

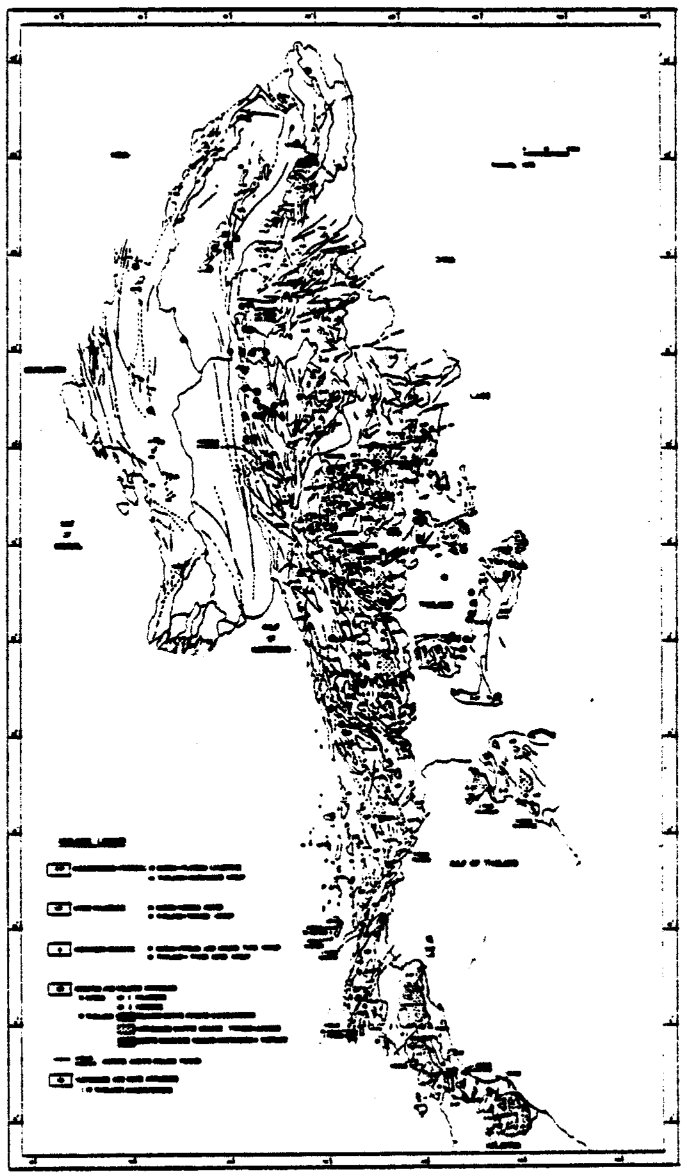

Figure 4. Copper

Source: Goossens. 1978a.

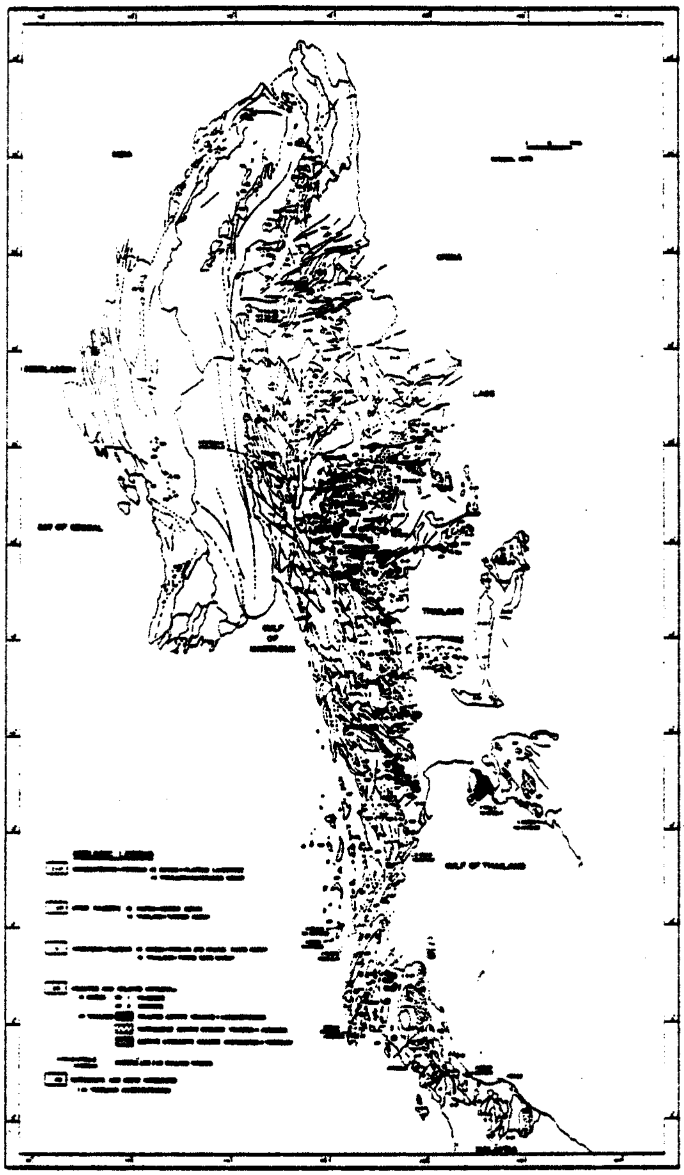

Figure 5. Fluorite

Source: Goossens. 1978a.

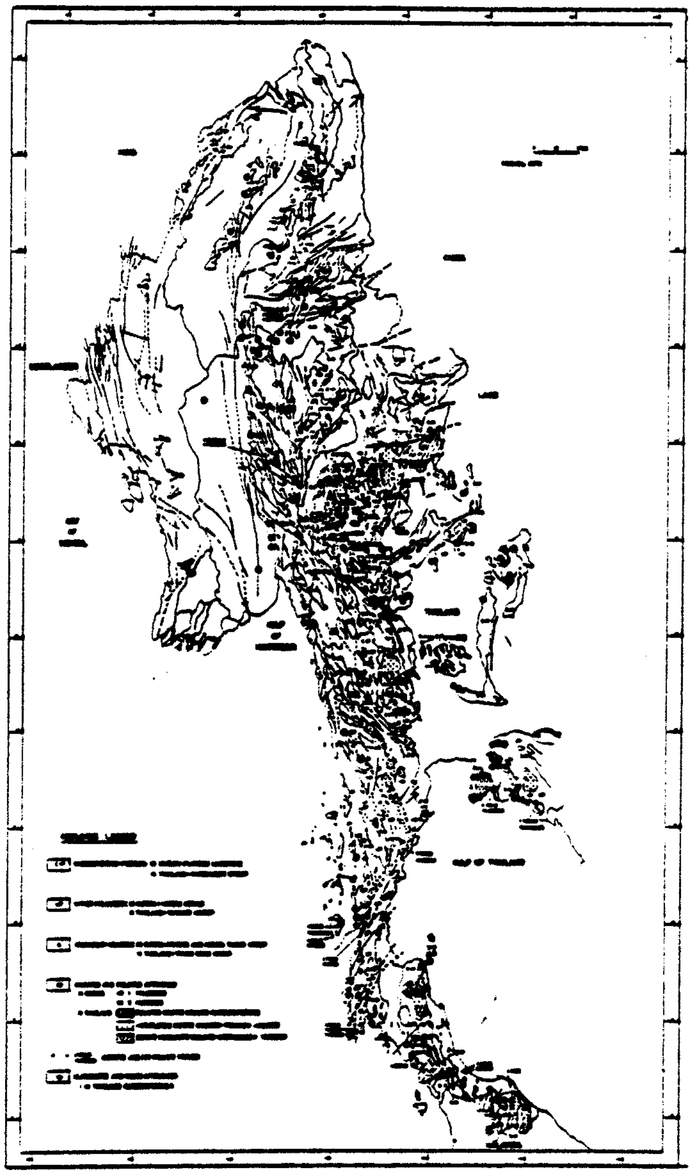

Figure 6. Iron

Source: Goossens. 1978a.

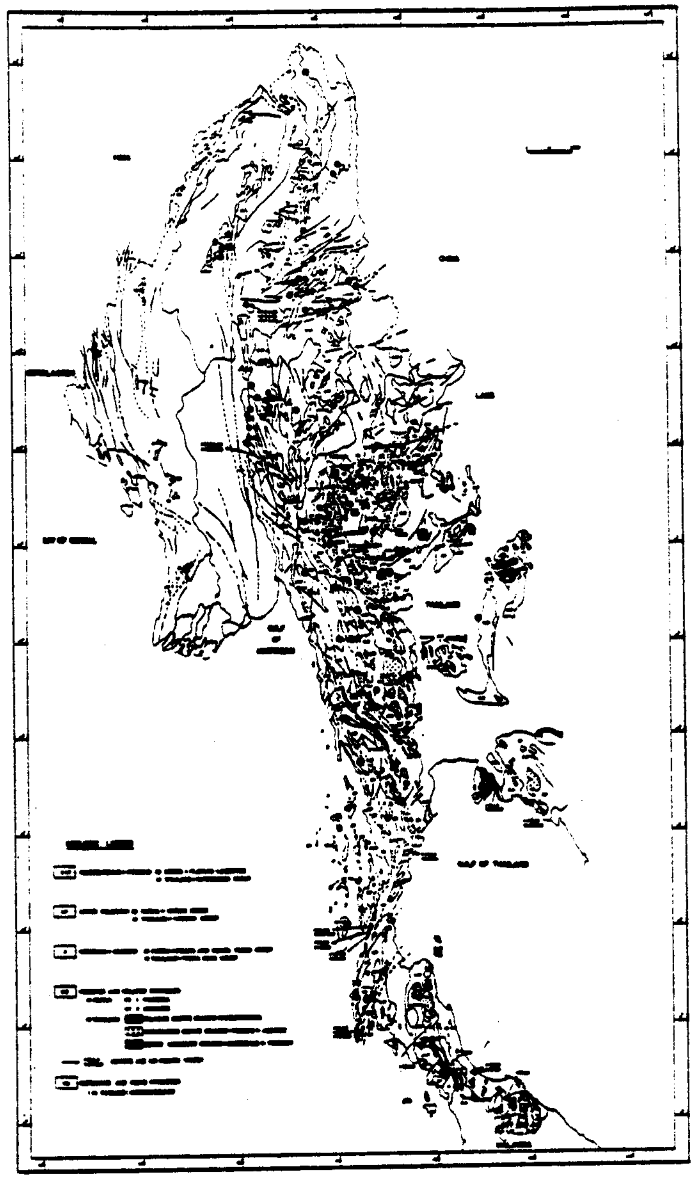

Figure 7. Lead

Source: Goossens. 1978a.

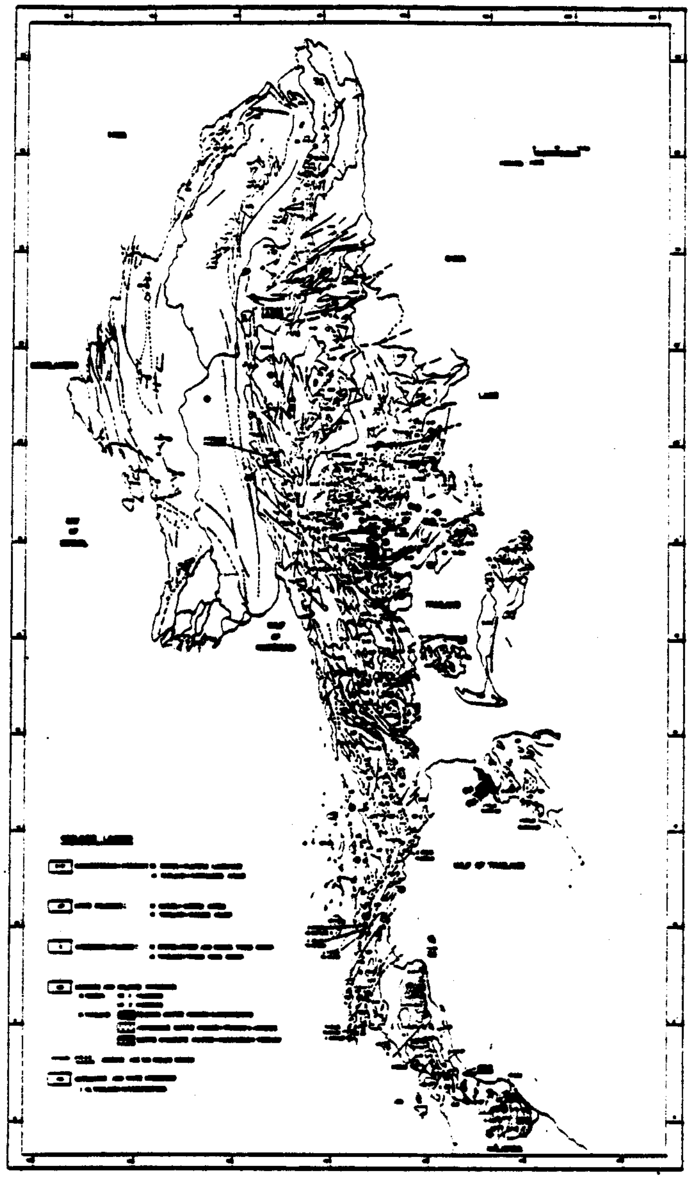

Figure 8. Manganese

Source: Goossens. 1978a.

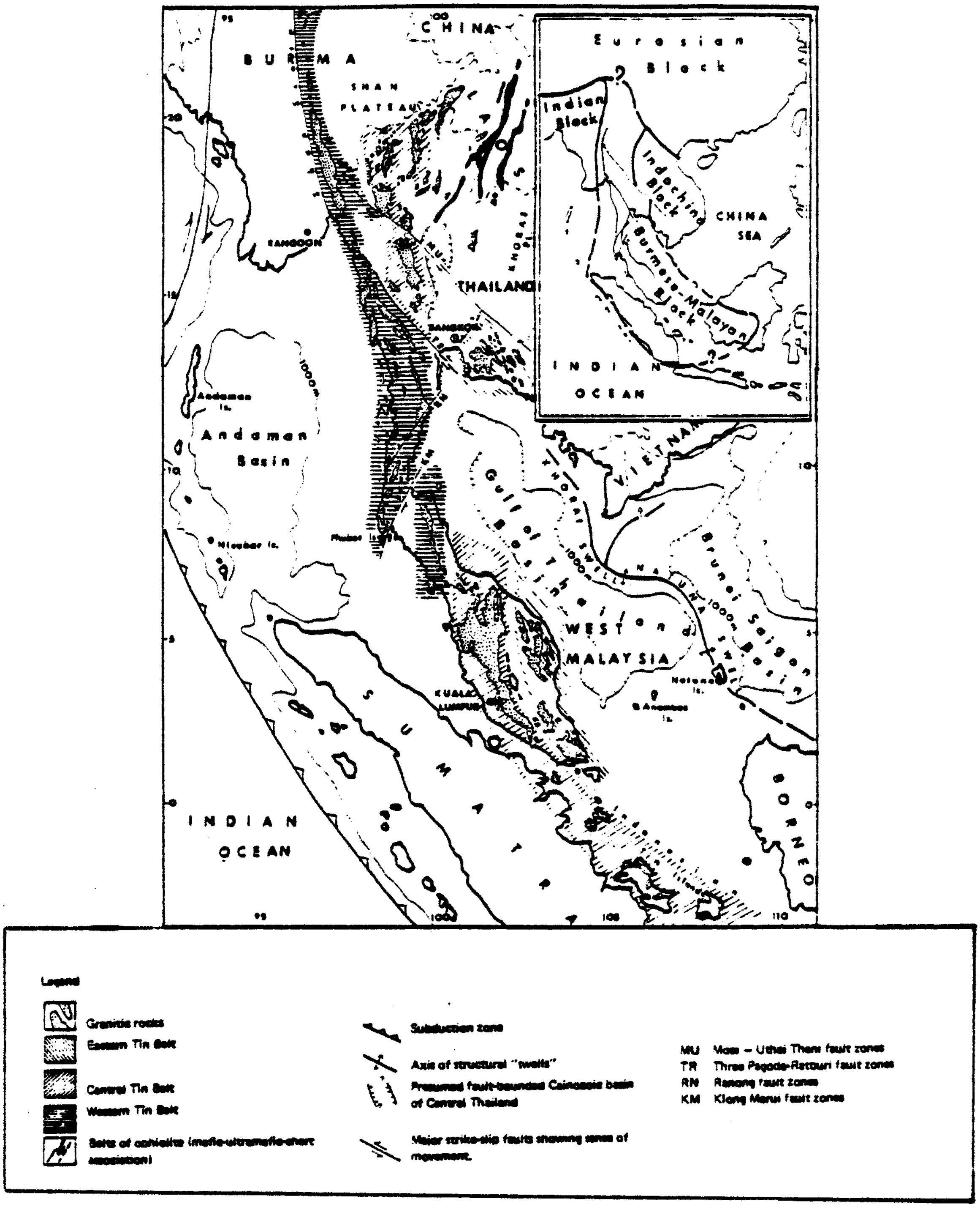

Figure 9. Tin

Source: Asnachinda. 1978.

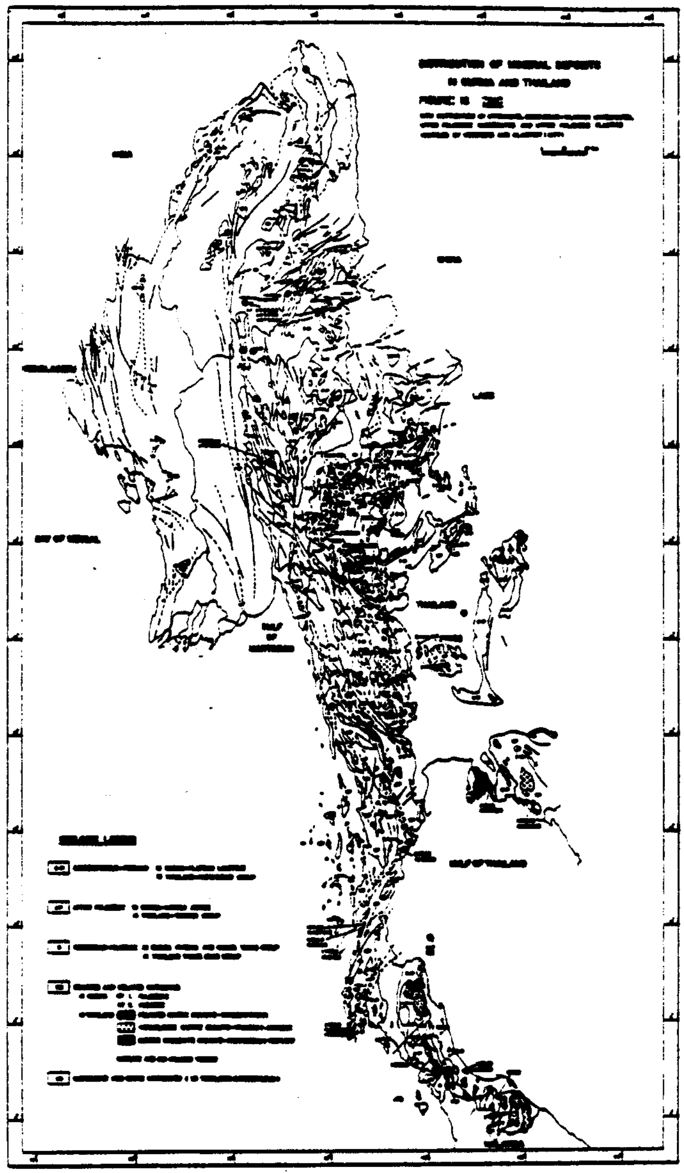

Figure 10. Zinc

Source: Goossens. 1978a.

Appendix III. Fertilizer and Pesticides Use

Table 1. Annual Fertilizer Consumption by Type, 1948 to 1968

Types of Fertilizer	Amount used annually		
	1948-1953	1963-64	1967-68
Nitrogenous (100 tons N)	1	50	200
Phosphate (100 tons P_2O_5)	1	10	10

Source: Angladette. 1974.

Table 2. Fertilizer Consumption, 1962 to 1986

(Metric Tons)

Year ACTUAL	Urea MT	TSP MT	MOP MT
1962-63	7,644	3,921	-
1963-64	8,769	4,322	-
1964-65	11,056	7,398	-
1965-66	9,607	5,935	-
1966-67	9,121	6,391	43
1967-68	14,641	6,703	396
1968-69	37,745	13,814	119
1969-70	27,845	8,076	586
1970-71	26,554	9,143	276
1971-72	59,162	34,918	2,254
1972-73	69,119	32,706	12,418
1973-74	19,368	9,517	1,174
1974-75	83,269	17,518	2,067
1975-76	92,327	23,954	2,459
1976-77	93,389	14,937	2,125
1977-78	108,636	23,727	2,933
1978-79	156,743	29,252	5,028
1979-80	151,462	46,047	3,627
1980-81	178,379	66,513	4,613
PROJECTED/1			
1981-82	248,000	93,000	21,000
1982-83	268,000	105,000	22,000
1983-84	306,000	111,000	34,000
1984-85	309,000	116,000	34,000
1985-86	316,000	124,000	44,000

/1 **Based on actual and expected supply, not on projected demand which is much higher.**

Source: U.S. AID. 1981a.

Table 3. Available Fertilizer Supply, 1965 to 1986

Domestic Production of Urea and Imports of Urea, TSP and MOP, 1965-66 to 1985-86

(Metric Tons)

	IMPORTS			PRODUCTION
Year ACTUAL	Urea MT	TSP MT	MOP MT	Urea MT
1965-66	7,500	1,500	-	
1966-67	11,000	10,000	250	
1967-68	120,884	78,854	28,079	
1968-69	22,000	18,300	-	
1969-70	-	-	-	
1970-71	-	-	-	
1971-72	-	30,000	-	
1972-73	-	22,500	-	
1973-74	-	15,000	-	
1974-75	-	-	-	
1975-76	-	-	-	118,800
1976-77	-	30,000	4,500	130,600
1977-78	8,363	20,000	4,500	135,100
1978-79	20,618	54,414	2,000	120,800
1979-80	39,000	54,118	4,000	132,300
1980-81	80,700	53,130	9,000	135,000
PROJECTED				
1981-82	118,360	92,790	20,660	135,000
1982-83	124,700	96,130	21,000	135,000
1983-84	127,000	102,000	33,000	135,000
1984-85	130,000	107,000	33,000	166,000 /1
1985-86	137,000	115,000	43,000	166,000 /1

/1 Does not include projected increase FRG-assisted urea plant scheduled to come on stream in 1985-86.

Source: U.S.AID. 1981a.

Table 4. Annual Consumption of Insecticides on Maize and Oil Crops, 1976 - 1980

Insecticides	Formation	Maize				Oil Crops			
		76-77	77-78	78-79	79-80	76-77	77-78	78-79	79-80
Endrin	19.5% EC	5	150	2418	2515	1335	1899	2643	1722
Malathion	90% EC	0	0	362	455	1059	1395	2931	1488
Lindane	P 1.30	0	20	4273	3797	62477	23694	68867	32568
Aldrin	5% D	0	0	28904	32489	151764	28138	1915	101018
DDT	25% EC	0	0	0	0	200	807	26	1000
DDT	75% WDP	1372	1276	1200	0	7153	5291	159	8000
Carbaryl	85% WP	0	0	0	0	1356	616	0	0
Diazinon	40% EC	0	0	0	2	0	0	0	12
Diazinon	10% G	0	0	0	993	0	10	0	0
Dimecron	50 SCW	0	0	0	0	35	0	31	114
EPN	45% EC	0	0	0	0	2	163	0	309

EC = emulsifiable concentrate (gallons)

P = powder (pounds)

D = dust (pounds)

WDP= wettable dry powder (pounds)

WP = wettable powder (pounds)

G = granules (pounds)

SCW= soluble concentrate (gallons)

Source: U.S.AID. 1981a.

Table 5.

ACRES OF MAIZE, GROUNDNUT AND SESAMUM TREATED WITH PESTICIDES, INSECTICIDES, FUNGICIDES, AND RODENTICIDES IN 1976-77 AND 1977-78 CROPPING SEASONS

	76-77 Acres			77-78 Acres		
	Sown	Treated	%	Sown	Treated	%
Maize	549,420	215	0.04	527,191	1,324	0.25
Groundnut	1,507,304	40,341	2.68	1,481,263	16,623	1.12
Sesamum	2,630,504	76	0.003	2,696,095	969	0.04

Source: U.S. AID. 1981a.

Table 6.

INSECTICIDES USED IN BURMA ON MAIZE AND CROPS DURING THE 1979-80 CROPPING SEASON

QUANTITY USED

Insecticide	Maize	Oil Crops
Endrin 19.5% EC	2515 gal.	1722 gal.
Malathion 90% EC	455 gal.	1488 gal.
Lindane P 130	3797 lbs.	32,568 lbs.
Aldrin 5% D	32,489 lbs.	101,018 lbs.
DDT 25% EC	0	1,000 gal.
DDT 25% WDP	0	8,000 lbs.
Sevin 85 WP	0	0
Diazinon 40% EC	2 gal.	12 gal.
Diazinon 10% G	993 lbs.	0
Dimecron 50SCW	0	114 gal.
EPN 45% EPN	0	309 gal.

Source: U.S. AID. 1981a.

Table 7.

STATUS OF PESTICIDES CURRENTLY USED ON MAIZE AND OIL CROPS IN BURMA

Common Name	Activity	Acute Oral LD50 (Mg/Kg)	USEPA Registration Status
Endrin	Ins.	7	All uses cancelled
Aldrin	Ins.	67	Most uses cancelled 6/
Lindane	Ins.	88	RPAR 7/
DDT	Ins.	113	Most uses cancelled 8/
Phosphamidon 1/	Ins.	17	Restricted
EPN	Ins.	14	Restricted, RPAR 9/
Diazinon	Ins.	300-400	Registered w/c restriction
Malathion	Ins.	1375	" " "
Carbaryl 2/	Ins.	850	" " "
Phenthoate 3/	Ins.	400	?
Cuprousoxide 4/	Fung.	470	Registered w/o restriction
Chorthalonil 5/	Fung.	10,000	Registered w/o restriction
Zinc phosphide	Rod.	46	Registered restriction

1/ Dimecron
2/ Sevin
3/ Elsan
4/ Pereno
5/ Daconil
6/ All uses cancelled except termites, non-food plant dip and moth proofing
7/ RPAR because of acute toxicity, oncogenicity, teratogenicity, reproductive effects toxicity
8/ All uses cancelled except public health and body lice
9/ RPAR because of neurotoxicity

Source: U.S. AID. 1981a.

Appendix IV. Environmental Legislation

Table 1. Legislation regarding Forests and Vegetation

1.	Burma Forest Act, 1902, No. 4. Amended 1906, 1912, 1926, 1938, 1941.
2.	Burma Laws (Adaptation) Act. 1940 No. 38.

Source: Johnson and Johnson. 1977.

Table 2. Legislation regarding Wildlife

1.	Fisheries Act (B.A. III. 1905), 1905.
2.	The Wild Birds and Animals Protection Act. 1912. Amended 1929, 1934; repeated 1936.
3.	Burma Game Rules, 1927.
4.	Burma Wildlife Protection Act, 1936, No. 7. Amended 1956.
5.	Burma Wildlife Protection Rules.

Source: Johnson and Johnson. 1977.

Table 3. Water Legislation

1. Land and Revenue Act (I.A. II. 1876), 1879.
2. Land Improvement Lands Act (I.A. XIX. 1883), 1883.
3. Rangoon Water Works Act (I.A. IX. 1884), 1885.
4. Railways Act (I.A. IX. 1890), 1890.
5. Burma Municipal Act (Burma Act III. 1898), 1898.
6. Burma Canal Act 1905 (B.A. II. 1905). Amended 1914, 1924, 1928, 1905.
7. Defile Traffic Act (B.A. III. 1907), 1907.
8. Indian Limitation Act 1908, No. 9 General Acts.
9. Burma Embankment Act 1909 (B.A. IV. 1909). Amended 1923, 1931.
10. Water Hyacinth Act (B.A. I. 1915), 1917.
11. India Steam Vessels Act (I.A.I., 1917), 1917.
12. City of Rangoon Municipal Act (B.A. IV. 1921), 1922.
13. Rural Self-Government Act (B.A. IV. 1921), 1922.
14. Cantonments Act (I.A. II. 1924), 1924.
15. Burma Water Power Act, 1927. (Act No. XI. 1927). Modified through 1940.
16. Underground Water Act (B.A. IV. 1930), 1930.
17. Burma Water Power (Generation of Energy) Rules, 1932. Modified through 1940.
18. Constitution of the Union of Burma, 1947.
19. Penal Code (India Act XLV, 1860), 1961.

Appendix V. Foreign Assistance Projects

Table 1. U.S. AID Projects

a. <u>The MAIZE and OILSEED Production Project</u>
<u>Project No. 482-0005</u>

AID is initiating a long-term agriculture sector strategy in Burma. The maize and oilseed production project is the first step. It represents an exceptionally interesting opportunity, but will require the best scientific expertise available in the U.S. Land Grant university, the USDA community, and strong institutional and management support.

A five-year project, the Burma Maize and Oilseed Production project will bring about a rapid rate of adoption of high-yielding inputs into village practices among an estimated 200,000 farm families who will be planting maize and oilseed crops in the 28 project townships. The goal of the project is to achieve substantial increases in production; and it is expected to have a positive effect on rural income and employment and on national food supply and nutrition. The crops involved initially are groundnuts, sesamum sunflowers, maize and soybeans.

Training requirements are projected for 11 new Ph.D degrees, 25 M.S. degrees and 70 individuals are to receive short-term, non degree training, varying in length from three to six months. Special emphasis will be placed on agricultural research. Training is to be done in U.S. universities and other countries.

The project will require an estimated 13 person-team of long-term technical assistance. It is proposed that a total of four individuals make up the project team. They are: a program agronomist for 4½ years; a water management/irrigation specialist for 4½ years; a seed technology specialist for two years; and a crop protection specialist for 2 years.

Fifty months of short-term technical assistance are anticipated in the following areas: seed technology, rhizobium, soil testing, agricultural mechanics, farming systems irrigation, cropping systems, computerization in management, research planning, extension subject matter and methods, integrated pest management, land use planning, weed control, insect control, land drainage, grain storage, rodent control, and disease control. A team from the Burma Agricultural Corporation Staff will be assigned as counterparts to the contractor project staff.

Again, this is a project that requires a team with a high level of expertise in extension and research, hands on experience, and with an emphasis on groundnuts and sesamum. The project also requires extensive back-stopping.

Source: U.S. AID. 1981f.

b. Other Projects

COUNTRY/BUREAU	BURMA
PROJECT NUMBER	4820002.00
PROJECT TITLE	PRIMARY HEALTH CARE
PROJECT SUMMARY	Grant is provided to Government of Burma (GSRUB) to improve and expand its primary health care system, with special attention to the health and nutrition needs of mothers and young children. Project will be implemented by Burmese health and medical officials, with financial and technical assistance provided by USAID, UNICEF, and the World Health Organization (WHO).The project will achieve four specific outputs: (1) A total of 1,400 auxiliary midwives (AMW's) and 7,418 community health workers (CHW's) (in addition to those already scheduled by GSRUB) will be trained and equipped with basic drug kits and will be resupplied with oral rehydration salts. In addition, 1,000 traditional Burmese birth attendants (let-thes) will be trained in safe delivery methods, and training will be expanded into two divisions. Provisions will be made for in-service training of CHW's/AMW's on an average of one day per month. Orientation programs will be held for village leaders in the project areas. (2) Division/State training teams, consisting of 26 doctors and 12 public health nurses, will be trained and equipped. These teams will supervise township, Rural Health Center (RHC) and public health care workers, and will conduct training-of-trainers programs for use in in-service training of AMW's/CHW's. (3) Centers and subcenters, staffed by paraprofessionals, will receive in-service training and supplies to improve their support and referral capabilities. Sixty station hospitals, each staffed by a doctor, will be provided with additional supplies and equipment. (4) The monitoring and evaluation capabilities of the health service system will be increased by the training of 20 health information specialists. In addition, USAID will finance supplies and equipment to complement a new computer supplied by WHO.USAID will assign short-term advisors to assist in the implementation of the in-country training programs. In addition, some Burmese Department of Health personnel will be offered participant training.As a result of the project, 147 of the country's 283 villages will have access to improved primary health care.

COUNTRY/BUREAU	BURMA
PROJECT NUMBER	4820012.00
PROJECT TITLE	EXPANSION OF TEAK PRODUCTION-PHASE I
PROJECT SUMMARY	THE STATE TIMBER BOARD, RESPONSIBLE FOR TIMBER PRODUCTION, ENGAGED IN TEAK INDUSTRY RECONSTRUCTION. PERFORMS SAWMILL TESTS TO MEASURE POTENTIAL HIGH-QUALITY TIMBER YIELD INCREASES. LOG GIRDLING AND EXTRACTION EQUIPMENT USED TO IMPROVE LOGGING PROCEDURES AND LOG STANDARDS/QUALITY. NEW SAWMILLS CONSTRUCTED AND INSTALLED TO IMPROVE AND DIVERSIFY TEAK CUT GRADES. HIGHER CUT GRADES EXPORTED TO EUROPEAN MARKETS, REDUCING NEED TO EXPORT LOWER, LESS PROFITABLE GRADES TO INDIA. A VENEER PLANT AND A PLYWOOD PLANT ALSO CONSTRUCTED PROVIDING PANELING FOR LOCAL CONSUMPTION. PRICES MADE FLEXIBLE TO SELL UNPOPULAR PRODUCTS. ENGINEERING TECHNICIANS TRAIN MILL STAFF IN INSTALLATION OPERATION, AND MAINTENANCE.

COUNTRY/BUREAU	BURMA
PROJECT NUMBER	4820012.00
PROJECT TITLE	BURMA-COMMODITY ASSISTANCE
PROJECT SUMMARY	PROJECT IS SECOND PART OF LARGER PLANS FOR EXPANSION OF TEAK MILLING FACILITIES. FIRST PROJECT REPAIRED ABANDONED MILLS AND INSTALLED NEW SMALL SAWMILLS. THIS PROJECT INSTALLS NEW LARGE SAWMILL AT OKKYIN TO SUPPLEMENT FIRST PROJECT. PROJECT INITIATED MAY 1963 BUT NO ACTION TAKEN UNTIL REACTIVATION UNDER REVISED PRO-AG OF 1967. FACILITIES CONSIST OF FIVE MAIN PRODUCTION BUILDINGS PLUS AUXILIARY AND SUPPORT FACILITIES. TARGET PRODUCTION IS 94,000 TONS OF ROUGH MILLED TEAK PER YEAR, BASED ON 2 SHIFTS PER DAY, 240 DAYS PER YEAR.

COUNTRY/BUREAU	BURMA
PROJECT NUMBER	4820011200
PROJECT TITLE	BURMA-RANGOON GENERAL HOSPITAL
PROJECT SUMMARY	TO RELIEVE OVERCROWDING OF OUTPATIENTS IN THE INPATIENT WARDS, A NEW OUTPATIENT BUILDING AND A NEW ADJUNCT SERVICES BUILDING CONSTRUCTED WITH IMPROVED LABORATORY, X-RAY, PHYSICAL THERAPY AND BLOOD BANK FACILITIES INCLUDED TO IMPROVE OUTPATIENT SERVICES. THESE IMPROVEMENTS AND ADDITIONS ARE MEANT TO CONTRIBUTE TO IMPROVED TRAINING OF MEDICAL PERSONNEL IN ABOVE MENTIONED SERVICES.

Source: U.S. AID. 1981c.

Table 2. World Bank Projects

Forestry I	1974
Irrigation I	1974
Livestock	1975
Paddyland Development I	1976
Seed Development	1977
Tin and Tungsten Expansion	1977
Paddyland Development II	1978
Rubber Rehabilitation	1878
Forestry II	1979

Table 3. FAO Projects

Grain Legumes	1977
New Rice Varieties	1977
Cotton Improvement	1978
ESCAP Atlas of Stratigraphy	1978
Food Legume Improvement	1978
Forestry Education	1978
Jute Improvement	1978
Maize Improvement	1978
Rice Improvement	1978
Soil Fertility	1978
Sugarcane Yield	1978
Veterinary Science and Agricultural Curriculum Development	1978

Table 4. Other Assistance

Donor	Project	Amount
Organization of Petroleum Exporting Countries (OPEC)	Outport development	US $6.32 million (loan)
Asian Development Bank (ADB)	Outport development	US $15.5 million (grant)
ABD	Rice storage improvement	n.a.
Norway	Copper smelting and refining	US $10 million (grant)
Great Britain	Devel. of fishing industry	3.1 million (loan)
Democratic People's Republic of Korea	Tin concentrate production plant	n.a.
International Development Association (IDA)	Improvement of telecommunications	US $35 million (grant)
Japan	Diverse projects	n.a.
West Germany	Heinda Mine Facility and diverse projects	n.a.

Source: Silverstein. 1981.

Appendix VI. Vegetative Community Surveys

Table 1. Burmese Forest Types according to Champion's Classification System

Table 2. Comparison of Champion and Standard Classification Systems

Table 1. Burmese Forest Types according to Champion's Classification System

GROUP I. TROPICAL FORESTS

This group is divided into two.

1. Tropical Moist Forests. 2. Tropical Dry Forests.

TROPICAL MOIST FORESTS

Under this heading are included the evergreen forest types, the semi-evergreen types and the moist deciduous types.

The list of types is given below.

NOTE:—The references shown in brackets after the types such as (C/33) (E/146) refer to the page numbers of Champion's and Edwards' publications.

A. Tropical Wet Evergreen Forest Climax types

Type	*Distribution.*
Evergreen Dipterocarp Forest (C/31) (Tropical Rain Forest).	Mainly in Tenasserim.
Eastern tropical evergreen (1) forest (C/33).	Throughout the moister parts of Burma and the Andamans.
Southern low tropical evergreen (2) forest (C/39).	Mergui Islands chiefly.
North Burma tropical evergreen (3) forest (C/45).	Kachin State and Chindwin.

B. Tropical Semi-Evergreen Forest. Climax types.

(4) South tropical semi-evergreen forest (C/56, E/146)	Pegu Yomas, etc.
Chittagong semi-evergreen (C/62).	Extends into Arakan.
(5) North Burma tropical semi-evergreen forest (E/146).	Chindwin, etc.

C. Tropical Moist Deciduous Forests. Climax Types

(6) Burma tropical upper moist deciduous forest (C/74, E/139).	Widely distributed over large areas.
(7) Burma tropical lower moist deciduous forest (E/139).	

Tropical semi-evergreen Edaphic types

(8) Eastern laterite tropical semi-evergreen C/89). (*)	Insein and elsewhere.

Tropical moist deciduous forest Edaphic types

(9) Burma tropical moist clay-soil forest (E/140).	Scattered.

Cane and Bamboo brakes

Cane brake (C/95).	Scattered.
(10) Southern tropical wet bamboo brake (C/96).	
(11) Southern tropical moist bamboo brake (C/96).	
(12) Northern tropical moist babmoo brake (C/97).	

Seral types of Tropical Moist Forest.

(a) Primary seral types

Beach Forest (C/98)	Tenasserim, Irrawaddy, Delta, Arakan.
Tidal Forests: Low Mangrove forest (C/103). Tree ,, ,, (C/104).	River deltas and sheltered muddy coasts.
Tidal Forests: Saltwater Heritiera Forest (C/105).	River deltas on landward side of above types.
Tidal Forests: Freshwater Hritiera (Forest (C/106).	Lwins in Irrawaddy delta.
Delta freshwater swamp for st (C/108).	Head of Irrawaddy delta on higher levels.
Tropical valley freshwater swamp forest (C/108).	Tharrawaddy, Zigon, Prome, etc.
Moist rivarain forest (C/111).	Banks of new alluvium along the larger rivers.
(13) Southern tropical moist deciduous riverain forest (C/111), (E/140).	Low-lying level areas. wide-spread.
(14) Southern tropical semi-evergreen riverain forest (C/114).	Lower Burma in the main valleys.

b. Secondary seral types

(15) Southern secondary tropical semi-evergreen for st (C/117).	Lower Burma in the main valleys.
Chittagong gurjan forest (C/118).	Arakan and adjoining hill tracts.
(16) Secondary tropical moist bamboo brakes (C/128)	Arakan and Upper Burma.

TROPICAL DRY FORESTS

A. Tropical Dry Deciduous Forests
Climax types

Dry teak forest (C/135)	Widespread.
Burma dry mixed deciduous forest (C/141).	The dry zone of Burma.

B. Tropical Thorn Forest

(17) Southern cutch thorn forest (C/155).	The dry zone of Burma.
(18) Southern *Euphorbia* semi-desert scrub (C/158).	Scattered on shallowest and poorest sites in foregoing types.

C. Tropical Dry Evergreen Forest
Climax types

(19) Tropical dry evergreen forest (C/165).	Limited areas in Mogok on dry limestone rocks.

Tropical Dry Forests.
Edaphic types

Indaing high forest (C/169).	Widespread throughout Burma.
Semi-*indaing* forest (C/170).	,, ,, ,,
Indaing scrub forest (C/171)	,, ,, ,,
Burma dry *Diospyros* forest (C/172).	Dry zone of Upper Burma
Burma *than-dhat* forest (C/173)	,, ,, ,, ,, ,,
(20) Tropical dry bamboo brake (C/180).	Locally throught the dry deciduous forests.

Seral types

Dry savannah forest (C/187).	Throughout the dry deciduous forests.

GROUP II. MONTANE SUB-TROPICAL FOREST

A. Sub-tropical Wet Hill Forest
Climax types

(21) Burma sub-tropical wet hill forest. (C/201).	Hills from 2,000′ to 5,000′.

B. Sub-tropical Moist Hill Forest
Climax types

Assam-Burma sub-tropical pine forest (C/208).	Hills of Upper Burma and Shan States.
Burma sub-tropical moist hill forest (E/140).	,, ,, ,, ,,

Seral types

Burma sub-tropical hills savannah forest (C/212).	Shan plateau and ridge tops elsewhere.

GROUP III. MONTANE TEMPERATURE FORESTS.

A. Wet Temperate Forest
Climax types

Assam-Burma wet temperate forest (C/223).

Burma temperate pine forest (E/157).

B. Moist temperate Forest.
Climax types

North Burma moist temperate forest (E/158).

North Burma mixed moist temperate forest (E/158).

North Burma fir forest (E/158).

Seral types

Temperate bamboo brake (C/265).

GROUP IV. ALPINE FORESTS

These are the highest level forests. They occur from about 9,500′ up to the limit of tree growth at about 12,000′. They consist typically of a dense growth of small crooked trees with patches of coniferous overwood. The forest is mainly evergreen. The usual conifer to be found is *Abies*. Rhododendrons of many species are abundant and pure Rhododendron forest up to about 30 feet high may cover large areas. Probably the most common one forming these pure forests is *R. arizelum*. Conifers rarely exceed 60′ in height. These forests are important as a protective cover on the upper slopes of the high mountains. They are of no commercial importance.

A. Alpine Forest
Climax types

Birch Rhododendron forest.

B. Alpine Scrub Forest

Moist alpine scrub forest.

For use in Working Plans, etc. it is not necessary to use the whole of the cumbersome titles. In ordinary use they can be abbreviated as shown:—

(1) Evergreen forest.
(2) Southern evergreen.
(3) Northern evergreen.
(4) South Burma semi-evergreen.
(5) North Burma semi-evergreen.
(6) Upper moist deciduous.
(7) Lower moist deciduous.
(8) Laterite semi-evergreen.
(9) Moist clay soil.
(10) Wet Bamboo brake.
(11) Wet hill forest.
(12) Northern moist bamboo brake.
(13) Moist deciduous riverain.
(14) Semi-evergreen riverain.
(15) Secondary semi-evergreen.
(16) Secondary moist bamboo brake.
(17) Cutch-thorn forests.
(18) *Euphorbia* scrub.
(19) Dry evergreen.
(20) Dry bamboo brake.
(21) Wet hill forest.

NOTE:—'Mixed' in the old classification is dropped: it is unnecessary.

I. CLIMAX TYPES OF MOIST TROPICAL FORESTS

Evergreen Diptrocarp Forest (C/31)

(Tropical Rain Forest) (Giant Evergreen D.I.)

Occurs in South Tenasserim with outliers extending into the next type elsewhere in Burma. It also occurs in sheltered moist valleys with a lower rainfall or longer dry season. It is typical of South East Asia. A rainfall of over 120" well distributed seems to be a essential and a sufficiently rentive soil on slopes. This is the most luxuriant type of forest met with. It is charactered by the presence of a large number of species of giant evergreen trees 150 feet or more high. The top canopy is almost evergreen and unbroken. The canopy is very dense; apart from a few scattered gaint there is little differentiation into definite canopy layers. Epiphytes are abundant. Climbers are usually present. Gronnd vegetation may be almost absent. Large cylindrical boles with smooth bark are typical but fluting and buttresses are common.

Characteristic Species: *Dipterocarpus alatus* (*kanyin*), *D. griffithii*, *Anisoptera* and *Parashorea* (both apparently known as *kadut, kuban, kaunghmu or thingadu*), *Hopea odorata* (*thingan*), *Pentace burmanica* (*thitka*). *Pentace griffithii* (*thitsho*), *Swintonia floribunda* (*shitle* or *taungthayet*), *Melanorrhoea glaba* (*thitsi*), *Mangifera calmeura* (*tawthayet*), *Eugenia grandis* (*thabyegyi*), *Dysoxylum granda* (*tagathi*), *Michelia champuca* (*saga* or *sagawa*), *Artocarpus calophylla* (*taungpein*) *Baccaurea sapida* (*kanazo*) and *Cinnamomum inunctum* (*karawe*). Bamboos when present are *Neohauzeana helferi* (*wathabut*), *Dendrocalamus brandisii* (*kyalowa* or Tabo), *Dendrocalamus giganteus* (*wabo* and *wapyugyi*) *Gigantochloa macrostachya* (*wabyauk* or *wade*).

There is an undergrowth of smaller trees and a tangle of canes, creeping bamboos and palms. The following are usually found in this:—

Pandanus sp. (*satthwa*), *Licuala peltata* (*salu*), *Salacca wallichiana* (*yingaw* or *yingan*), *Calamus erectus* (*ainloma*), *Calamuslatifolius* (*yamata kyein*), *Calamus viminalis* (*kyeinkha*) and *Strobilanthes* spp.).

Eastern Tropical Evergreen Forest (C/33): This is to be found in the moister parts of Central and Lower Burma. The central dry belt separates it from the north Burma tropical evergreen type. A rainfall of over 80" is required for its development. There is usually a more marked dry season than in localities covered by the foregoing type. This is the typical evergreen forest of Burma. It is interspersed with areas of forest which are practically indistinguishable from the evergreen Dipterocarp, but generally it is not so luxuriant as this type. There is either a dense understorey or evergreen trees of numerous species or a dense growth of bamboos.

Tree species found in this type are *Dipterocarpus alatus* and *turbinatus* (*kanyin*), *Parashorea stellata* (*kaunghmu*). *Anisoptera glabra* (*thingadu*). *Hopea odorata* (*thingan*). *Pentace burmanica* (*thitka*). *Swintonia floribunda* (*shitle* or *taungthayet*). *Artocarpus lakoocha* (*myauk-lok*) *Baccaurea* (*sapida*)*kanazo*), *Croton oblongifolius* (*thetyingyi*), *Amoora* sp., *Myristica* and *Eugenia* spp. (*thabye*).

The bamboos found are *Oxytenanthera nigrociliata* (*wanwe* or *waba*), *Neohauzeana* (*wathabut*). *Dendrocalamus brandisii* (*wabogyi* or *kyalowa*) and *Dinochloa m' clellandi* (*wanwe*). *Licuala peltata* (*salu*) is often found.

Southern Low Tropical Evergreen Forest (C/39): Occurs in parts of Burma particularly in the Mergui Islands. The rainfall in its habitat generally exceeds 100". Exposure to wind is one of the site factors.

This forest is a somewhat inferior edition of the typical wet evergreen. Descriptions of the type from Burma are inadequate.

Trees to be found are *Dipterocarpus* spp., *Mesua*. *Hopea*, *Eugenia* spp. and *Dillenia* spp.

Northern Burma Tropical Evergreen Forest (C/45): More detailed information on this forest is needed. It is found in Northern Burma in the Kachin State and the Chindwin drainage. It extends to Assam in the north and the Chittagong Hills and Arakan in the west. Though largely separated from the southern tropical evergreen by the dry zone of central Burma the two types link up in the west. Rainfall is 80" or more. Big tall often isolated evergreen trees from the main canopy which may be less continuous than that found in the sourthern type. Single giant Dipterocarps or other trees or small groups of them may stand up above the general level of the canopy. Middle and lower storeys are evergreen and dense. Many species occur in intimate mixture.

Species typically found are *Dipterocarpus turbinatus D. macrocarpus* (*kanyin*), *Shorea assamica* (*kyilan*) *Shorea buchanani*. *Dysoxylum binectariferum* (*aukchinsa*), *Acrocarpus fraxinifolius* (*yetama*), *Mesua ferrea* (*gangaw*), *Cedrela* spp., *Eugenia* spp., *Chuckrassia*, *Quercus* spp., *Castanopsis* spp., Bamboos if present are *Dendrocalmus hamiltonii* (*wabomyetsangye*) and *Caphalostachyum pergracile* (*tin*). Where bamboos are absent evergreen shrubs and tree ferns are common. There are dense masses of evergreen climbers and canes are abundant.

South Burma Tropical Semi-evergreen Forest (C/56. E/145): This type is recorded from the south and of the Pegu Yomas. parts of South Arakan, the west parts of Henzada and Bassein districts and northern Tenasserim. It is intermediate between eastern tropical evergreen and the moist deciduous forests. Evergreen and deciduous dominants occur usually mixed fairly intimately though local patches of almost pure dominants may occur. The lower storey is mainly evergreen and bamboos are usually present.

The common species are *Xylia dolabriformis* (*pyinkado*) which is particularly characteristic and may be found in almost pure patches. *Dipterocarpus alatus* and *D. turbinatus* (*kanyin*) are also common and form almost pure patches. Other species are *Homalium tomentosum* (*myaukchaw*). *Gmelina arborea* (*yemane*), *Lagerstroemia* spp , and *Careya arborea* (*bambwe*).

Bambusa polymorpha (*kyathaung*) is the most common bamboo *Dendrocalamus* (*wapyu*) is frequently met with and *Cephalostachyum pergracile* (*tin*) is also found.

Teak is notable by its absence or rarity It seems possible that this type of forest may not be suitable for making teak plantations in.

Chittagong Semi-evergreen Forest (C/62): This type extends from Chittagong into Arakan and adjoining tracts. Rainfall is always over 100" and up to 200" or more. The dry season is well marked. It normally occurs in close association with evergreen in hilly country occupying the most exposed and drier slopes. It is a dense, storeyed, high forest with evergreen species predominating particularly in the lower canopy. An appreciable proportion of the top canopy consists of species which are deciduous for a short time in the dry season. Canes are usual along streams and climbers are abundant. Groups and patches of giant Diperocarps tower above the general level of the top canopy.

Tree species are *Dipterocarpus turbinatus* (*kanyin*), *D. costatus* (*kanyin-ywetthe*), *D. pilosus* (*kanyin*), *Artocarpus chaplasha* (*taungpeinne*), *Salmalia insignis syn Bombax insigis* (*didu*), *Salmalia malabarica syn Bombax malabaracum* (*letpan*), *Albizzia procera* (*sit*), *Spondias magifera* (*gwe*), *Pterygota alata* (syn. *Sterculia alata*) (*letkok*) *Buchanania lancaefolia* (*thinbaung*), *Quercus* spp.

North Burma Tropical Semi-evergreen Forest (E/146): This bears some resemblance to the previous type. It occurs mainly in the Chindwin upper reaches and it needs more detailed study. Several variations are found.

(a) *Dipterocarpus* with *Cephalostachyum pergracile* (*tinwa*).

(b) *Dipterocarpus* with *Dendrocalamus hamiltonii* (*wabomyetsangye*).

(c) *Dipterocarpus* with evergreen species and without bamboo.

(d) Evergreen species with *tabindaingwa* (A single stemmed bamboo possibly *Melocanna*)

These sub-types intermingle.

Species to be found in addition to *Dipterocarpus* spp. are teak. *Quercus* (*sagat*), *Tetrameles nudiflora* (*baing*), *Eugenia* spp. (*thabye*), *Hydnocarpus* spp. (*kalaw*), *Garcinia xanthochymus* (*hmandaw*), and *Terminalia tomentosa* (*taukkyan*).

Burma Tropical Upper Moist Deciduous Forest (C/74.E/139): The type corresponds with the Departmental Instructions' Moist Upper mixed deciduous though the better quality of the Dry Upper mixed deciduous forest is also included under it.

This forest covers large areas in the Pegu Yomas and also extends across the Irrawaddy westwards to the lower foothills of the Arakan Yomas. Southwards it extends into north Tenasserim while in northern Burma it is to be found in Katha, Bhamo and Myitkyina. The usual habitat is hilly country with a drier type on the ridge tops. Rainfall varies from 60" to 80" but it also occurs on certain sites which have a higher rainfall.

The forest is a closed high forest of excellent quality both as regards height (100' to 120' or more) and as regards species of value occurring in it though the actual tonnage of valuable species per acre is low as compared with forests in other parts of the world. Teak and *Xylia dolabriformis* (*pyinkado*) attain their finest development in this type. There is a considerable mixture of species and, although occasional evergreen dominants occur, the majority of the species are deciduous. Although there are a large number of species usually mixed intimately quite a small number together form the greater part of the canopy and relatively pure associations are often met with over small areas. A bamboo undergrowth is characteristic, it may be locally absent; when this is the case evergreens are usually more in evidence.

The commonly occurring tree species are teak (*Tectona grandis* (*kyun*). *Zylia dolabriformis* (*pyinkado*), *Terminalia tomentosa* (*taukkyan*), *Terminalia belerica* (*thitsein*), *Terminalia pyrifolia* (*lein*), *Homalium tomentosum* (*myaukchaw*), *Salmalia insignis* (*didu*), *Gmelina arborea* (*yemane*), *Lannea grandis* (syn. *Odina wodier*) (*nabe*), *Vitex* spp. *Pterocarpus macrocarpus* (*padauk*), *Millettia pendula* (*thinwin*), *Berrya ammonilla* (*petwun*) and *Mitragyna rotundifolia* (syn. *Stephegyne diversifolia*) (*binga*).

The commonly occurring bamboos are, in the south, *Bambusa polymorpha* (*kyathaung*) and *Cephalostachyum pergracile* (*tin*) and in the north *Dendrocalamus hamiltonii* *wabomyetsangye*). *Dendrocalamus membranaceus* (*wapyu*) and *Cephalostachyum pergracile* (*tin*). In the undergrowth are often found *Leea* spp., *Barleria strigosa* and other *Acanthaceae*. In places where extraction has opened up the forest and left gaps dense thickets of the exotic weed *Eupatorium odoratum* (*bizat*) often develop. Climbers are always present but not usually in great abundnace. Typical species are *Acacia pennata* (*subokgyi*), *Combretum dasystachyum* (*simakan-nwe*) and *Millettia auriculata* (*wunu*).

Burma Tropical Lower Moist Deciduous Forest (E/139): This type corresponds most nearly with the lower mixed deciduous of the standard types. But the old type was a very wide one and a lot of forests, which were previously not adequately defined or recognized, had to be included in it. Champion omits it altogether and, under his classification, it had to be assigned partly to the tropical moist deciduous type and partly to the southern tropical moist deciduous reiverain forest. Edwards disagrees with this and the writer is in full agreement with him. Kermode distinguishes between a south Burma sub-type and a north Burma sub-type.

The forest is a closed high forest in which some of the pre-dominants may reach a height of nearly 180'. It is found on the flat plains above flood level. The rainfall of its habitat is 80" or more. The species Salmalia malabarica (*letpan*), *Anogeissus acuminata* (*yon*) *Tetrameles nudiflora* (*baing*), and *Albizzia procera* (*sit*) often stand out above the general level of the canopy as pre-dominants.

In these forests is found the highest percentage of teak in the crop of any forest type in Burma The Mohnyin reserve in Myitkyina division which contains a considerable area of the type is recorded as having 707 teak 3' and over girth per hundred acres. (Troup. Silviculture of Indian Trees Vol. II p. 704).Teak growing in this forest often exhibits a good deal of fluting at the base.

The best of the lower mixed forests are the finest forests in Burma from the points of view both of growth and stock of valuable species. Notable examples are some of the plains reserves in Zigon particularly the Kangyi reserve. In north Burma the Mohnyin reserve is a good example.

In the southern sub-type the three most abundant species are teak, *Xylia dolabriformis* (*pyinkado*) and *Terminalia tomentosa* (*tauk-kyan*). The latter two species are absent from the northern form as also is *Homalium tomentosum* (*myaukchaw*) which is a common constituent of the southern form.

Other species of common occurrence are; *Gmelina arborea* (*yemane*), *Adina cordifolia* (*hnaw*) *Mitragyna rotundifolia* (*binga*), *Careya arborea* (*bambwe*), *Lagerstroemia* spp., *Terminalia belerica* (*thitsein*) *Heterophragma* sp., (*petthan*) as well as many others.

Bamboo is normally absent but now and again a few clumps of *Cephalostachyum pergracile* (*tinwa*) or *Bambusa tulda* (*thaik*) are to be found.

The undergrowth is very variable and, if the canopy has been opened, becomes very dense. It may consist of grasses, shrubs like *Clerodendron*, *Desmodium* and *Flemingia*, a number of species of *Acanthaceae*, ferns and wild ginger. The latter two in places form pure carpets of undergrowth and effectively prevent regeneration of trees. The exotic *Eupatorium odoratum* (*bizat*) is apt to be invasive in gaps and may form dense thickets.

II. EDAPHIC TYPES OF MOIST TROPICAL FORESTS

Eastern Laterite Tropical Semi-Evergreen Forest (C/89): Under the old classification this forest might have been classified as lower mixed deciduous forest or as semi-evergreen. It has been described as "A complex form of the lower mixed formation which is on the verge of becoming evergreen Dipterocarp". That description fits some of the forests in the south of Tharrawaddy remarkably well. The type occurs in Insein Division also and probably extends across the end of the Pegy Yomas into the Pegu Divisions. The soil on which it is found consists of re-deposited laterite mixed with sand and silica in various forms. It is light or even coarse at the surface. The usual dominants in this forest consist of trees of no great height but here and there are found occasional *Dipterocarps* chiefly *Dipterocarpus turbinatus* (*kanyin*) towering well above the general level of the canopy.

Species commonly found are *Adinobotrys atropurpureus* (syn. *Millettia atropurpurea*), *Grewia microcos* (*myatya*), *Eugenia* spp.. (*thabye*) *Litsaea sebifera* (*ondon*), *Heterophragma* sp. (*petthan*), *Homalium tomentosum* (*myaukchaw*) *rotundifolia* (*binga*), *Carallia lucida* (*maniawga*), *Pterospermum semisagittatum* (*nagye*), *Mallotus phillippinensis* (*tawthidin*) and *Holarrhena antidysenterica* (*lettok-gyi*). Canes are fairly common in the lower lying wetter places. Grass is often locally abundant and climbers are extremely abundant in places.

Burma Tropical Moist Clay-soil Forest (E/140): In the standard classification this type would have had to be included in the lower mixed deciduous though it differs very considerably from the high quality teak—*Xylia-Terminalia* forests which are characteristic of the type. Patches of the new type occur in the typical lower mixed where the soil is clay and badly drained. Although the lower mixed type has been reintroduced it seems that this clay soil forest is a sufficiently distinctive one to merit separate recognition.

It occurs scattered throughout the country generally in association with the lower mixed forests.

Probably the most abundant species is *Terminalia tomentosa* (*taukkyan*) and on stiff clay almost pure associations of its are found. There is no babmoo and the ground cover is usually coarse grass.

Other species that occur are, teak, *Xylia dolabriformis* (*pyinkado*), *Dillenia* spp., *Careya arborea* (*bambwe*) *Heterophragma* spp., (*patthan*), *Diospyros* spp., (*te*), *Lannea grandis* (*nabe*). *Croton oblongifolius* (*thetyingyi*.). *Strychnos nux-blanda* (*kabaung*) and others.

Cane Brakes (C/95): These are impenetrable or almost impenetrable thorny thickets which sometimes have a few tall trees scattered in them. They occur in wet hollows throughout the evergreen and semi-evergreen forests and locally in moist deciduous forest. The soil is permanently wet and usually fine clay rich in humus. The stems of most species are typically trailing and may reach a length of 200'.

The chief species are canes *Calamus* spp.. (*kyein*) with sometimes the creeping bamboo *Teinostachyum* (*wathabut*). A few palms such as *Licuala peltata* (*salu*) and *Zalacca wallichiana* (*yingan*) occur.

Unless stockmapping in great detail for regeneration operations, cane brakes would usually be included as part of the forest type in which they occur.

Southern Tropical Wet Bamboo Brakes (C/96): These brakes contain a dense growth of bamboo usually of the smaller culmed types. They are to be found along streams or in badly drained hollows throughout the tropical evergreen types where they more or less displace the tree forest. Scattered trees of such species as *Dillenia pentagyna* (*zinbyun*), *Hopea odorata* (*thingan*) and *Xylia dolabriformis* (*pyinkado*) occur here and there.

In Tenasserin the bamboo *Oxytenanthera albociliata* (*wanwe*) is a characteristic species.

Southern Tropical Moist Bamboo Brakes (C/96): These brakes which occur locally in the semi-evergreen and moist deciduous types consist of more or less continuous forest of one or two species of tall clumped bamboos. Occasional scattered trees of *Terminalias*. teak and *Xylia dolabriformis* (*pyinkado*) and other species may occur. The brakes usually occupy stream banks or shady slopes. Many of them may be the result of *taungya* cutting in the past. The natural occurrence appears to depend on soil conditions.

Species of bamboos forming brakes are *Bambusa polymorpha* (*kyathaung*), *Cephalostachyum pergracile* (*tin*) and *Bambusa tulda* (*thaik*). In stockmapping for regeneration operations particularly in the case of *thaik* brakes it is advisable to distinguish them on the stock-map. Where it is clear that these brakes are due to soil conditions and not to old *taungya* operations they are not likely to afford suitable sites for plantations.

Northern Tropical Moist Bamboo Brake (C/97): In Northern Burma the chief brake forming bamboo is *Dendrocalamus hamiltonii* (*wabomyetsangye*). This bamboo has a low spreading habit and is able to hold its own against tree growth. The removal of teak after girdling or of hardwoods may result in an undergrowth of this species of bamboo becoming a bamboo brake under the shade of which no tree regeneration has a chance of becoming established.

III. SERAL TYPES OF TROPICAL MOIST FORESTS

((a) Primary seral types

Beach Forest (Dune Forest (C/98): This type is to be found all along the coasts wherever a fair width of sandy beach occurs. Sandy bars on the sea face of deltas are also occupied by it. Apart from the deltas this is a stable type as only the flora described is able to exist under the conditions of habitat which is an exposed one. The soil is sea sand with lime from shell fragments but lacking in mineral food. It is coarse, porous and dry at the su face but the water table is high. Strong winds are characteristic of the habitat. Rainfall varies within wide limits according to the locality.

The most characteristic species is *Casuarina equisetifolia* (*pinle kabwe*) which often forms and almost pure fringe on sandy beaches above the high tide level. Other smaller evergreen species are found and a few deciduous ones. Numerous shrubs are present and surface creepers are conspicuous especially *Ipomoea pes-caprae*.

Species commonly found are *Pongamia glabra* (*thinwin*), *Calophyllum inophyllum* (*ponnyet*), *Eugenia* spp., (*thabye*) *Erythrina indica* (*kathit* or *pinle-kathit*), *Thespesia populnea* (*swedaw*) *Hibiscus tiliaceus* (*thinban*), *Grewia microcos* (*myatya*) and *Pandanus tectorius* (*satthapu*). In the Irrawaddy delta *Albizzia procera* (*sit*) is common.

Tidal Forests: Along the coasts of lower Burma in the Irrawaddy delta and in tidal creeks occurs a very specialised type of forest. Specialised because it is able to grow in the mud brought down by rivers which is deposited and is periodically inundated by the tides with water more or less salt. This forest is characterised by the growth of mangroves. There are a number of species belonging to several families which are specially adapted to grow under such unfavourable conditions. Some of them have some form of aerial or stilt roots which spring out of the stem; others develop pneumatophores which grow upward from the underground roots in places in such abundance that walking amongst them may be a matter of some difficulty. A number of species are viviparous and the seedling develops on the parent plant producing a hypocotyl which is woody and may be up to a foot or more long. At a certain stage these fall off the parent tree, and, if the tide is down, anchor themselves in the mud by the impact of their fall. If the tide is up they float about in a vertical position with the leaves on the surface. As the tide falls the tip of the hypocotyl penetrates the mud and the action of the tide tends to force it deeper into the mud. As soon as the hypocotyl enters the mud root development starts and is very rapid. In this way, providing there is mud and that the tide is not too strong, the mangrove can go on progressively colonising seawards. As the colonisation seawards goes on the mud further back begins to get more stabilised by further deposits and by leaf fall so that the level rises slowly. As the level rises the mud becomes less and less subject to the influence of the tide. On the seaward side the forest may be almost completely inundated, on the landward side it is only flooded by high spring tides.

The composition of the forest depends chiefly on two factors the salinity of the water and the duration of inundation. It has therefore been necessary to split it up into a series of subtypes. The finest development, which is closed evergreen high forest, is found on ground flooded at every high tide with only moderately brackish water. *Heritiera fomes* or *H. littoralis* (*pinle-kanazo*) is characteristic. There may be an underwood forming a second storey. The soil is typically bare mud though abundant regeneration may cover it locally. At higher levels flooded only by high spring tides there is more undergrowth. On the seaward side with water more salt *Heritiera* does not occur. Here *Rhizophoraceae* (the true mangroves) are prevalent and colonise the mud flats.

(1) **Low Mangrove Forest (C/103):** This occurs in soft tidal mud submerged by salt water at every tide. It consists of a more or less dense forest of few species which only attain a height of 10 to 20 feet. Species are often gregarious. Characteristic are *Ceriops roxburghiana* (*baingdaung*) *Avicennia officinalis* (*Thame-net*), *Kandelia rheedii* (*baingdaungshe*) and *Bruguiera caryophylloides* (*madama*). There is often an undergrowth of *Acanthus ilicifolius* (*kaya*).

(2) **Tree Mangrove Forest (C/104):** Occurs on mud banks of tidal streams and over extensive areas on the seaward side where mud banks are in the process of being formed. Tides flood the ground daily with salt water. It consists of closed evergreen forest of moderate height. Stilt roots and vivipary are particularly frequent. *Rhizophora mucronata* and *R. candetaria* syn. *R. conjugata* (both known as *pyu* or *byuchidauk*) are very abundant as also is *Sonneratia apetala* (*kambala, lamu, laba*). Other species found are *Bruguiera parviflora* (*hnit*), *Carapa obovata* (*pinle-on*), *Sonneratia griffithii* (*talyu, lale*), *S. acida* (*lamu, lingu*) and *Avicennia officinalis* (*thame-net*). *Nipa fruticans* (*danipalm*) is usually abundant and *Acanthus ilicifolius* ((*kaya*) is also found.

(3) **Salt water Heritiera Forest (C/105):** This type is found on the landward side of the two previous in the big river deltas. The ground it occupies is flooded at every tide with water which is distinctly salt. There is less silt deposition than in the next type and the soil is apt to be a stiffish clay cracking on exposure. The forest may be dense but trees are not high or of big girth. Sixty feet is about the maximum height. Species tend to be gregarious. Pneumatophores are abundant but stilt roots rare. The characteristic species are *Heritiera fomes* (*kanazo*), *Xylocarpus mollucensis* syn. *Carapa moluccensis* (*kyana*) Excoecaria agallocha (*kayaw*), *tayaw*) and Bruguiera gymnorhiza ((*byuu-talon*). Others found are B. *parviflora* (*hnit*), *Avicennia officinalis* (*thame-net*) and *Carapa obovata* (*pinle-on*).

The Nipa *fruticans* (dani) palm is rare in this type but the *Phoenix paludosa* (*thinbaung*) plam is found.

(4) **Freshwater Heritiera Forest (C/106):** This type is found on areas which are flooded for a part of every day with water which is never very salt and in the rains may be quite fresh. Its best development is on the ground lower than the dry banks of tidal streams but not as low as the central depressions.

This type is the finest development of the mangrove forest and may exceed 100 feet in height. It is often a closed forest of chiefly *Aruquiera* and *Heritiera*. Pneumatophores are abundant.

The main species are *Heritiera fomes* (*kanazo*), *Bruguiera conjugata* syn. *Bruguiera gymnorhiza* (*byu-u-talon*), *Carapa moluccensis* (*kyana*) and *Ceriops roxburghiana* (*laingdaung*). Other species found are *Amoora cucullata* (*thitni*), *Barringtonia acutangula* (*kyi*) and *Cordia* and *Dysoxylum* spp., *Phoenix paludosa* (*thinbaung*) and *Acanthus ilicifolius* (*kaya*) occur.

Delta Freshwater Swamp Forest (konbyaik) (C/108): This forest occurs on clayey flats at the head of deltas on higher levels. They are inundated for a considerable period during the monsoon but not by the tide water during the rest of the year. The growth is generally poor. There is a dense undergrowth chiefly of canes. Frequent blanks filled with canes or grass occur. Tree species occurring are *Lauraceae*, *Calophyllum* spp., *Eugenia* spp.. *Elaeocarpus hygrophilus* (*budalet*) *Lagerstroemia speciosa* syn. *flos-reginae* (*pyinma*), *Mangifera caloneura* (*taw-thayet*), *Diospyros* spp., and *Amoora cucullata* (*thitni*).

Tropical Valley Freshwater Swamp Forest (Myaing) (C/108): This type occurs on low-lying alluvial land usually near rivers and lakes. Typical examples occur in depressions which were once probably old river beds. The areas are not permanent swamp but are under water continuously for considerable periods during the rains. Rainfall usually exceeds 50" but the water table never falls below 12–15 feet. The forest is a rather open one of medium height generally containing evergreen species.

Species found in the type are *Butea monosperma* syn. *frondosa* (*pauk*), *Barringtonia acutagula* (*kyi*), *Albizzia procera* (*sit*), *Anogeissus acuminata* (*yon*) and *Mitragyna parviflora* (*tein*). *Bambusa arundinacea* (*kyakat*) may be present.

Moist Riparian Forest (C/111): Is usually found in a narrow fringe on a new sandy alluvium on the banks of the larger rivers. The forest consists of a few species of large trees usually evergreen standing widely spread with smaller trees, shrubs and grass between. *Lagerstroemia speciosa* syn. *flos-reginae* (*pyinma*) is the most typical tree of the type.

Southern Tropical Moist Deciduous Riverain Forest (C/111 E./140): Under Champion's classification the old standard type lower mixed deciduous had to be included herein as there was no other type in his classification that approximated to it. This was a very unsatisfactory classification. With the reintroduction by Edwards of the lower moist deciduous type the present type becomes a more restricted one.

The forest occurs on flat river banks in the Pegu Yomas and elsewhere in the same climatic range as the semi-evergreen and moist deciduous types. The soil is usually alluvial and often clayey and is often waterlogged for short periods in the rains.

It is characterized by the abundance of *Lagerstroemia speciosa* syn. *L. flos-reginae* (*pyinma*). Other species are teak *Xylia dolabriformis* (*pyinkado*), *Terminalia tomentosa* (*taukkyan*), *Homalium tomentosum* (*myaukchaw*) *Anogeissus acuminata* (*yon*), *Albizzia procera* (*sit*), *Mitragyna rotundifolia* (*binga*) and others.

Southern Secondary Tropical Semi-Evergreen Riverain Forest (C/114): A forest containing many giant trees both deciduous and evergreen. It occurs on new alluvial soil and is therefore usually near steams. Owing to its accessibility it has usually been influenced by *taungya* cutting. No good description of the type in Burma is available. Species of *Dipterocarpus*, *Artocarpus*, *Albizzia* and *Lagerstroemia* occur.

(b) Secondary Seral Types.

Southern Secondary Tropical Semi-Evergreen Forest (C/117): It seems fairly certain that this is second growth forest resulting from *taungya* cutting in giant evergreen. It is intermediate between the giant evergreen and the moist deciduous. Giant trees are relatively scarce but evergreens are more abundant in the undergrowth than they are in the moist deciduous forest. Bamboo is generally present. The species occurring are those of the evergreen *Dipterocarp* forest. The following are common. *Schima noronhae* (*pyinma*), *Dillenia parviflora* (*linyaw*), *Cinnamomum inunctum* (*karawe*) and *Dysoxylum grande* (*tagatni*). *Wabo* bamboo often occurs.

Chittagong Gurjan Forest (C/118): This type extends from Chittagong into Arakan and the neighbouring hill tracts. It appears to have originated as the result of human interference with the evergreen or semi-evergreen types.

The forest is characterized by the gregarious occurrence of several species of *Dipterocarpus* with little else in the top storey. There is a lower storey consisting of species of the semi-evergreen type.

Secondary Tropical Moist Bamboo Brake (C/128): This type is of wide-spread occurrence in the Arakan hills where it cover many hundreds of square miles on both sides of the yomas. It can extend from sea-level up to 2,500 feet or higher. It consists of a continuous forest of *Melocanna bambusoides* (*kayin*) bamboo. This bamboo does not form clumps but sends up clums at intervals from a creeping underground root stock. This habit of growth causes it to form dense almost impenetrable brakes. Scattered trees of evergreen or deciduous species occur here and there. It is estimated that there are 5,000 square miles of this type in Arakan alone.

IV. CLIMAX TYPES OF DRY TROPICAL FORESTS

Dry Teak Forest (C/135) Champion's general description of the dry forest types gives the height as typically 50–75'. Dry teak forest he describes as "Dry mixed forest with teak poles". Examples quoted by him are from the North Pegu Yomas, Chindwin and Shwebo. These examples are typical of the old type upper mixed dry deciduous. In this forest teak grows to a much larger size than poles, and, Champion himself says later in his description, teak of 3rd and 4th quality is included. At the time he was writing the India and Burma yield tables for teak had not been published and what he refers to as height for site quality four is 86' at 100 years and maximum height 97 at the same age. This is considerably above what he gives as the typical height of the forest.

Like the upper moist deciduous forest dry teak forest is characteristic of hilly sites but it may also be found locally on low lying dry sites. Bamboos are always present and often dense. It is hard to fix a dividing line between dry teak and the upper mixed moist deciduous. In the old descriptions the presence of different species of bamboo was the main criterion. In the upper mixed moist forest the bamboos are *Bambusa polymorpha* (*kyathaung*) and *Cephalostachyum pergracile* (*tinwa*) in Lower Burma and *Dendrocalamus hamiltonii* and *tinwa* in upper Burma. In the old upper mixed dry deciduous they were *Dendrocalamus strictus* (*myinwa*) in lower Burma and *Thyrsostachys oliveri* (*thanawa*) in upper Burma.

The same criterion could be used to some extent in delimiting the new types but it is not by itself entirely satisfactory. For example poorly grown *B. polymorpha* can be found in forest which should be classified as dry teak while luxuriant *D. strictus* can be found in forest which should be considered moist.

Species commonly found are teak *Tectona grandis* (*kyun*), *Xylia dolabriformis* (*pyinkado*), *Pterocarpus macrocarpus* (*padauk*), *Cassia fistula* (*ngu*), *Terminalia tomentosa* (*taukkyan*), *Terminalia chebula* (*panga*), *Terminalia pyrifolia* (*lein*), *Salmalia insignis* (*idu*), *Salmalia malabarica* (*letpan*), *Spondias mangifera* (*gwe*), *Lannea grandis* syn. *Odina wodier* (*nabe*), *Vitex peduncularis* (*petlezin Sterculia* spp., *Shorea obtusa* (*thitya*), *Pentacme siamensis* (*ingyin*) and cutch (*sha*) *Acacia catechu*..

Bamboos. *Dendrocalamus strictus* (*myin*) is the most characteristic. *Bambusa tulda* (*thaik*) is found usually on stiff soil. Stunted *Bambusa polymorpha* (*kyathaung*) and *Cephalostachyum kergracile* (*tin*) occur. In Upper Burma *Thyrsostachys oliveri* (*thanawa*) is often characteristic. Climbers are often abundant.

Burma Dry Mixed Deciduous Forest (C/141): Occurs in the dry zone where the rainfall ranges from 35 to 50 inches. The upper canopy is closed though uneven and not dense. Bamboo understorey is often dense. Practically all the trees are deciduous for some months during the dry season and the same applies to the understorey.

Species to be found are *Vitex* spp., *Dalbergia* spp., *Albizzia* spp., *Lannea grandis* syn. *Odina wodier* (*nabe*), *Salmalia insignis* (*didu*), *Terminalia pyrifolia* (*lein*), *Terminalia chebula* (*panga*), *Dillenia pentagyna* (*zinbyun*) and *Eugenia* spp., (*Thabye*). The bamboo is *Dendrocalamus strictus* (*myinwa*). There is a good deal of grass where the bamboo is not too dense.

Southern Cutch Thorn Forest (C/155) Occurs locally in the dry zone notably south of Mandalay. It is an open low forest of 20 to 30 feet in which thorny hardwooded species predominate. Trees have short boles and low branching crowns nearly touching each other. There is a thin grass growth and some shrubs.

Acacia leucophloea (*tanaung*) is characteristic, other species are cutch (*sha*) *Acacia catechu*, *Tectona hamiltoniana* (*dahat*), *Jatropha gossypifolia* (*tawkanako*), *Randia dumetorum* (*thaminza*), *Limonia acidissima* (*thanatka*), *Boscia variabilis* (*thamon*), *Capparis* spp., and *Zizyphus jujuba* (*zi*).

Southern Euphorbia Semi-Desert Scrub Forest (C/158) Occurs scattered throughout the thorn forest types on the poorest sites where the soil is shallow and rocky or alkaline. It is an open formation with fleshy *Euphorbias* conspicuous. Thorny *Acacias* and other occur but in a very stunted condition. There is sometimes a thin cover of wiry grasses but often the soil is bare.

Species are *Euphorbia antiquorum* (*tazaunggyi*), other *Euphorbia* spp., cutch(*sha*) *Acacia catechu*, *Limonia acidissima* (*thanutka*), *Tectona hamiltoniana* (*dahat*), *Capparis* spp., *Zizyphus* spp., *Carissa spinarum* (*kan*).

Tropical Dry Evergreen Forest (C/165) The Burma occurrence of this type according to Troup is in limited areas in the Mogok District on dry limestone rocks.

V. EDAPHIC TYPES OF DRY TROPICAL FORESTS

Indaing High Forest (C/169) Occurs over extensive areas in the drier parts of Lower and Upper Burma and locally in regions of higher rainfall. There are several thousand square miles of this type. It is found on sandy and gravelly soils. The finest development occurs on recent sandy alluvium in the valleys of the main rivers.

The forest is deciduous but the length of time the trees remain bare varies considerably. In parts of Upper Burma the new flush of leaves may follow the shedding of the old leaves, which takes place very late, almost immediately so that it is almost evergreen. In dry areas leaves are shed earlier and the trees may be bare for several months but even in the driest areas the new flush appears in April considerably before the break of rains.

The forest takes its name from the characteristic species *Dipterocarpus tuberculatus* (*in*) and over large areas consists of a magnificent almost pure high forest of this species which on the most favourable sites may reach a height of 150 feet. In other areas more species are associated with it but *in* always constitutes the major part of the crop. In Upper Burma teak (*Tectona grandis*) occurs locally, while *Pentacme siamensis* (*ingyin*), *Shorea obtusa* (*thitya*), *Melanorrhoea usitata* (*thitsi*), *Lagerstroemia parviflora* (*kyettawsa*) are common associates. *Quercus* spp., and *Wendlandia* (*thitni*) appear as a dense understorey when favoured by fire protection. *Imperata cylindrica* (*thetke*) and *mwe* grass cover the ground, their density and luxuriance depending on the density of the canopy. In Lower Burma in localised areas pure associations of *Dipterocarpus obtusifolius* (*inbo*) take the place of *in*. In wetter areas with rainfall up to 80 inches *in* may be found associated with *Dipterocarpus turbinatus* or *D. alatus* (*kanyin*). Where this happens hybridising occurs and forms intermediate between the two species are common. In some of the Lower Burma *indaing* forests quite a fair proportion of the crop may consist of teak (*Henzada*) while *Xylia dolabriformis* (*pyinkado*) also makes an appearance and regenerates freely producing small, much branched and mis-shapen trees. Some of the undergrowth species in the type are common to Upper and Lower Burma. Such are *Phoenix acaulis* (*fhtinbaung*) which in Lower Burma may carpet the ground in some of the poorer quality areas, *Cycas siamensis* (*mondaing*), *Strychnos nux-blanda* (*kabaung*) and *Gardenia* spp. Ground orchids are abundant in the Lower Burma forests. Bamboo is occasionally found.

Semi-indaing Forest (C/170). Occurs throughout Burma in the drier tracts and locally in areas of higher rainfall. It is found very commonly on low ridge tops. It appears to be a transition type between dry teak forest and *indaing* and it is often impossible to draw a sharp dividing line between the two types. The rainfall of its habitat is from about 50 inches upwards and the soil is sandy or gravelly or laterite. It does not form such fine forest as the best *indaing* and is more mixed. More or less pure associations particularly of *Pentacme siamensis* (*ingyin*) occur. Bamboo is sometimes found.

The chief species are *Pentacme siamensis* (*ingyin*), *Shorea obtusa* (*thitya*), *Dipterocarpus tuberculatus* (*in*), *Terminalia tomentosa* (*taukkyan*), *Tectona grandis* (*kyun*), *Xylia dolabriformis* (*pyinkado*), *Lannea grandis* syn. *Odina wodier* (*nabe*), *Emblica officinalis* syn. *Phyllanthus emblica* (*zibyu*) and *Strychnos nux-blanda* (*kabaung*).

Of the bamboos *Dendrocalamus strictus* (*myinwa*) is the most usual one, but *Bambusa tulda* (*thaik*), *Bambusa polymorpha* (*kyathaung*) and *Cephalostachyum pergracile* (*tin*) may also occur locally.

An undergrowth of grass is commonly present. In addition *Pheonix acaulis* (*thinbaung*), *Flemingia* spp., *Desmodium* spp., *Indigofera* spp., and numerous members of the family *Acanthaceae* are found in the undergrowth.

Indaing Scrub Forest (C/171). This type occurs throughout Burma on suitable sites and soils. It is found on sites with rainfall as low as 25" and as high as 80 inches. Soil is the most important factor affecting its distribution and it is typical of shallow coarse sandy soils and laterite soils. It is also found on ridges in dry and exposed situations.

The composition of the forest is variable but is usually much the same as *semi-indaing* though it may approximate in places more to *indaing*. The growth is very much inferior to the foregoing types and it is little better than scrub being from 25 feet to 50 feet in height. For stockmapping purposes it is laid down that when *indaing* or *semi-indaing* approaches the stage where it is not capable of producing timber suitable for sawing it should be classified as scrub-*indaing*.

The forest is open with an uneven canopy and grassy blanks are commonly met with. The principal species are *Pentacme siamensis* (*ingyin*), *Shorea obtusa* (*thitya*), *Dipterocarpus tuberculatus* (*in*), *Melanorrhoea usitata* (*thitsi*), *Buchanania latifolia* (*lamhe*), *Diospyros burmanica* (*te*), *Aporosa macrophylla* (*inchin*), *Dillenia pulcherrima* (*linyaw*), *Dalbergia cultrata* (*yindaik*), *Terminalia tomentosa* (*taukkyan*) and *Xylia dolabriformis* (*pyinkado*).

Bamboo if present is *Dendrocalamus strictus* (*myinwa*). Shrubs such as *Strychnos nux-blanda* (*kabaung*) *Gardenia* spp., *Randia dumetorum* (*thaminza*), *Phoenix acaulis* (*thinbaung*) and *Flemingia* spp., are of common occurrence.

Burma Dry Diospyros Forest (C/172): Occurs in the dry belt of Upper Burma where the rainfall is below 40 inches and the soil is very light and sandy. A local variation known as *aukchinsa-thinwin* forest occurs under moister conditions in Henzada on low flat topped spurs with red ferruginous soil.

Species to be found are *Diospyros burmanica* (*te*), *Pentacme siamensis* (*ingyin*), *Terminalia tomentosa* (*taukkyan*), *Tectona hamiltoniana* (*dahat*), *Dalbergia paniculata* (*thitsanwin*), cutch (*Acacia catechu*), *Pterospermum semisagittatum* (*nagye*), *Miliusa velutina* (*thabutgyi*), *Limonia acidissima* (*thanatka*) and *Zizyphus jujuba* (*zi*). *Dendrocalamus strictus* (*myinwa*) is sometimes present.

Burma Than-Dahat Forest (C/173)] Is widely distributed in the dry belt usually on clay soil with a rainfall of 35 to 40 inches. It derives its name from the two principal species which are abundant in it, *Terminalia oliveri* and *Tectona hamiltoniana* (*dahat*). The forest is of poor quality with low branched trees widely spread and generally not much exceeding 30 feet in height. Shrubby bushes and low grass cover the ground. Other species found are cutch (*Acacia catechu*), *Dalbergia paniculata* (*thitsanwin*), *Bauhinia racemosa* (*palan*), *Osyris arborea* (*zaunggyan*), *Boscia variabilis* (*thamon*) and *Limonia acidissima* (*thanatka*) Bamboo. *Dendrocalamus strictus* (*myinwa*) is sometimes present.

Tropical Dry Bamboo Brake (C/180): These occur locally in the dry deciduous types mainly on dry hill sides. The soil is dry and shallow. The brakes are formed of only one species of bamboos, *Dendrocalamus strictus* (*myin*). Here and there an occassional tree characteristic of the dry forests such as *Vitex* spp., *Terminalia chebula* (*panga*) and *Tectona hamiltoniana* (*dahat*) occurs.

VI. SERAL TYPES OF DRY TROPICAL FORESTS

Dry savannah forests (C/187)] Are found locally throughout the dry deciduous forests. The *than-dahat* and *Diospyros* types are both liable to take on a savannah form. Where this happens trees typical of the types are to be found scattered singly or in small groups on grassland. Trees have short boles and are usually crooked and unsound. Thorny shrubs occur.

GROUP II. MONTANE SUB-TROPICAL FORESTS

I. CLIMAX TYPES OF MONTANE SUB-TROPICAL FORESTS

A. Sub-Tropical Wet Hill Forest

Burma Sub-Tropical Wet Hill Forest (E/149. K.W. 45/221): The distribution of this type is imperfectly known. Kingdon Ward has described it under the same Sub-tropical hill jungle for the hills lying north of Myitkyina. It is probable that it also occurs in the higher rainfall areas of the Shan hills, the hills of the Chindwin drainage and of the Arakan Yomas. There is said to be no sharp dividing line between the North Burma tropical evergreen forest and the present type. The transition seems to start at about 3,000 ft. when the proportion of *Quercus* spp., *Castanopsis* spp., *Lauraceae* and *Meliaceae* increases. The upper limit is between 5.000-6000 ft.. In the southern part of the Myitkyina hills trees of the tropical zone ascend to 3.000 to 4,000 ft. but in the far north tropical species decrease.

Species that are common to the plains and to this hill forest are *Quercus* spp., *Castanopsis* spp., *Ulmus lancifolia* (*thitkauknyin*), *Engelhardtia spicata* (*thitswelwe*), *Tetrameles nudiflora* (*baing*). Species peculiar to the hills include *Betula* spp., *Carpinus viminea*, *Magnolia pterocarpa*, *Michelia* spp., *Acer* spp., etc.

Bamboos of several species occur locally. Woody climbers, root climbers (*Ficus* spp., etc.) and epiphytes are abundant.

B. Sub-Tropical Moist Hill Forest

Assam-Burma sub-tropical: pine forest (C/208. E/149): In the Burma pine forests, two species of pine occur, *Pinus merkusii* and *Pinus insularis*, both species being known as *tinyu* or *tinshu*. In Burma. pine forest of *Pinus insularis* is not found below 4.000 feet but *Pinus merkusii*, which occurs in the hills of the Salween and Thaungyin drainages, extends to lower altitudes and may be found associated with *indaing* forest between 500 feet and 2,500 feet. It also occurs as almost pure pine forest. *Pinus insularis* forest occurs in the hills of Upper Burma, the Shan States, the hills between the Sittang and Salween and in the Arakan Yomas and Chin Hills (between the Si Chin Hills) at heights between about 5,000 and 8,000 feet. It may occur as almost pure pine forest or it may be associated with such species as *Alnus nepalensis* (*maibau*). *Quercus* spp., *Rhododendron arboreum* (*zalatni*). *Pteris aquilina* (bracken fern) is commonly present.

Burma Sub-Tropical Moist Hill Forest (C/210. E/149) This forest occurs in the hills from between about 3,000 feet to 6,000 feet. The old classification of hill evergreen and dry hill forest types are combined in this type.

The forest varies from evergreen to semi-evergreen with a fair number of briefly deciduous species which sometimes form small pure associations (*Quercus serrata*). In favourable sites a height of 120 feet may be attained. The forest is a much less dense one than the tropical evergreen and big trees rarely stand close together. A middle storey may be present and a shrubby undergrowth occurs. Climbers and epiphytes are numerous. It is characterized by the prevalence of oaks and chestnuts, *Quercus* spp. and *Castanopsis* spp., (the names *thite* and *thitcha* are used for a number of species of both genera).

Schima wallichii (*laukya*) is also very characteristic of the type though it also extends into the tropical forest. Other species found are *Ternstroemia japonica* (*taungkan*), *Albizzia chinensis* syn. *Albizzia stipulata* (*bonmeza*), *Eugenia* spp., (*thabye*), *Ficus* spp., (*nyaung*) and members of the *Lauraceae* and *Magnoliaceae*. *Wendlandia* is often found *Emblica officinalis* (*zibyu*) is of frequent occurrence in open drier patches.

II. SERAL TYPES OF MONTANE SUB-TROPICAL FORESTS

Burma Sub-Tropical Hill Savannah (C/212): Occurs on the Shan plateau and ridge tops at heights between 2,500 and 5,000 feet elsewhere. Champion describes the type as "grassy downs with scattered clumps or single trees usually pines and oaks or *Schima*. To the east, bracken fern (*Pteris aquilina*) seems to replace the grass."

GROUP III. MONTANE TEMPERATE FOREST.

CLIMAX TYPES OF MONTANE TEMPERATE FORESTS

A. Wet Temperate Forest.

Assam-Burma wet temperate forest (C/223): This forest is found on the higher hills of north Burma from about 5,000 feet upwards. The country is hilly but not excessively steep and the forest may be broken up by stretches of grassland. There is a well marked spring and a winter with occasional frosts.

The forest is a closed one with a fair proportion of deciduous species. Epiphytes are abundant of many different species. Where the canopy is not too dense there is an evergreen underwood. At higher elevations a dense growth of dwarf bamboo may be present.

Among the trees occurring are *Quercus*, *Castanopsis*, *Schima*. *Calophyllum*, *Bucklandia*, *Alnus nepalensis* (*maibau*). At higher elevations *Michelia*, *Magnolia*, *Acer*, *Prunus* and *Betula alnoides* are characteristic.

Rhododendron species are common and include epiphytic forms as well as large tree sized species such as *R. eriogynum* and *R. kyawi*.

Burma temperate pine forest (E/140. K.W. 45/29): The characteristic species of this forest is *Pinus wallichiana* syn. *Pinus excelsa*. Between 5,000 and 7,000 ft. it forms open parkland on exposed slopes as *P. insularis* does but associated with different species of trees. These open slopes often get burnt over.

P. wallichiana also occurs scattered throughout broad leaved forest on sheltered slopes and at 8,000 ft. it is found mixed with *Tsuga* and *Picea* in mixed coniferous forest. Fire does not occur in this forest. This species dominates the broad leaved species associated with it.

Broad leaved trees associated with it are *Quercus* spp., *Ilex*, *Lauraceae*, *Acer* spp., *Rhododendron* spp., *Prunus* sp.

There is usually an undergrowth of the bamboo (*Arundinaria*). Woody climbers are present. Epiphytes are not so abundant.

B. Moist Temperate Forest

North Burma mixed moist temperate forest (E/149. K.W.45/133) This forest is in the transition zone between the broad leaved forest and the high level *Abies* forest. It contains a mixture of deciduous and evergreen broad leaved trees as well as several conifers. Chief amongst the latter is *Tsuga dumosa* (hemlock). (Compare with Champion's Eastern Oak-Hemlock type (C/246). This was very imperfectly known from Burma, and Kingdon Ward's type is to be preferred).

This forest zone is the zone rich in *Quercus* spp., *Magnolia* spp., tree *Rhododendrons*, epiphytic *Rhododendrons*, *Acer* spp., *Prunus* spp., and *Ilex*. The uppermost part of it is sometimes almost pure *Tsuga* (*hemlock*) forest.

The lower limit of this forest is about 7,000 ft. and the upper about 9,000 ft. Frosts are prevalent in winter and snow occurs but does not lie for any great length of time.

North Burma fir forest (E/149. R.W. 45/137) This forest occurs at from 9,000 to 12,000 ft. At this altitude the winters are hard and at the higher levels snow covers the ground for part of the year. The forest is dominated by silver fir (*Abies fargesii*). Kingdon Ward states that looking at the forest across a valley nothing is seen but an apparent pure forest of this species. Seen from within the appearance is different. Inside there are a number of different species of Rhododendron which, in gaps in the forest when in flower, are a blaze of colour. Species of *Acer*, *Betula* and *Magnolia* occur at the lower levels but when silver fir is present these are absent.

II. SERAL TYPES OF MONTANE TEMPERATE FORESTS

Temperate bamboo brake (C/265. K.W. 45/135) The bamboos which grow at higher levels (*Arundinaria*) occur sometimes as an understorey in the preceding types. But they also form pure dense brakes with isolated shrubs like *Rhododendron* associated with the bamboo. When associated with forest the bamboo develops very thickly in gaps and acts as a check on tree regeneration.

After flowering fires may sweep through these brakes and what trees do exist in them get killed off.

One or more species of *Arundinaria* give rise to these dense almost impenetrable brakes and there may be practically no other woody plants. In the wetter areas much epiphytic moss may occur on the bamboo.

GROUP IV: ALPINE FORESTS

A. ALPINE FOREST

Climax types

Birch—Rhododendron forest (C/271): This type of Champion seems to correspond with what Kingdon Ward describes as *Rhododendron* Scrub. It is found throughout the whole length of the Himalayas and its altitudinal level in the north Burma hills is between 11,000 and 1,2000 feet.

The characteristic of the site is ample snowfall the snow remaining on the ground for several months. There is usually a thick layer of dark coloured very wet humus and soil. The forest is low in height, evergreen and consists mainly of *Rhododendron* species. Kingdon Ward states that in this zone more than twenty species occur.

In addition to the *Rhododendrons* a few birch (*Betula*) and other small deciduous trees occur. Trunks are short and branchy and rarely over 2 ft. in girth. Owing to snow pressure the stems curve up from a nearly horizontal base.

Seral Types

Moist Alpine scrub (C/273): This is not a tree forest type but it extends downward gradually merging into the fore-going. It is found at elevations of 11,000 and above and consists of a low evergreen scrub formations. *Rhododendrons*, *Juniperous* spp., and other shrubs are found.

Source: Hundley. 1961.

Table 2. Comparison of Champion and Standard Classification Systems

Burma Standard Types		Champion's Types
I. Tidal forest	... (i) Within tidal limits	Tidal. Low Mangrove forest.
	... Do ...	Tidal. Tree Mangrove forest.
	(ii) On slightly higher levels	Tidal. Salt water *Heritiera* forest.
	... Do. ...	Tidal. Fresh water *Heritiera* forest.
II. Beach & dune forest ...	Do. ...	Beach forest.
III. Swamp forest	... ...	Delta Fresh water swamp forest.
Do.	... ...	Tropical valley Fresh water swamp forest.
Do	... ...	*Moist riparian forest.*
IV. Evergreen forest	a. Riverain evergreen ...	Southern tropical semi-evergreen riverain forest
	b. Giant evergreen ...	Evergreen dipterocarp forest.
	c. Typical evergreen ...	Eastern tropical evergreen forest.
	... Do. ...	Southern low tropical evergreen forest.
	... Do. ...	North Burma tropical evergreen forest.
	... Do. ...	Chittagong semi-evergreen.
	... Do. ...	*North Burma tropical semi-evergreen forest.*
	Evergreen (general) ...	Cane brake.
	... Do. ...	Southern *tropical* wet bamboo brake.
	... Do. ...	*Northern tropical moist bamboo brake.*
	... Do. ...	Northern tropical semi-evergreen riverain forest.
	... Do. ...	Southern secondary tropical semi-evergreen forest.
	... Do. ...	Chittagong gurjan forests.
V. Mixed deciduous forest.	A. Upper mixed deciduous forest	
	(i) Moist ...	*South* Burma tropical semi-evergreen forest.
	Do. ...	*North Burma tropical semi-evergreen forest.*
	... Do. ...	Burma tropical *upper* moist deciduous forest.
	... Do. ...	Southern *tropical* moist bamboo brake.
	... Do. ...	*Northern tropical moist bamboo brake.*
	... Do. ...	Secondary *tropical* moist bamboo brake.
	(ii) Dry ...	Dry teak forest.
	... Do. ...	*Tropical dry bamboo brake.*

	Burma Standard Types.	Champion's Types
	B. Lower mixed deciduous forest.	Southern tropical moist deciduous riverain forest.
	... Do. ...	*Moist riparian forest.*
	... Do. ...	Eastern laterite *tropical* semi-evergreen forest.
	... Do. ...	Burma tropical moist clay soil forest.
	... Do. ...	Burma tropical lower moist deciduous forest.
	... Do. ...	Burma dry mixed deciduous forest.
	... Do. ...	*Tropical dry bamboo brake.*
	... ...	Southern tropical dry riverain forest.
	... ...	Dry savannah forest.
	(i) *Than-dahat* forest. ...	Burma *than-dahat* forest.
	(ii) Thorn forest	Southern cutch thorn forest.
	... Do. ...	Southern *Euphorbia* semi-desert scrub forest.
	(iii) *Aukchinsa-thinwin* forest ...	Burma dry *Diospyros* forest.
	... Do. ...	Tropical dry evergreen forest.
VII. Deciduous Dipterocarp forest.	a. High *indaing* forest semi-*indaing*.	(*Indaing* high forest.) (Semi-*indaing* forest.)
	b. Scrub *indaing* forest. ...	*Indaing* scrub forest.
VIII. Hill forest	(a) Hill evergreen forest	Burma sub-tropical *wet* hill forest.
	... Do. ...	Burma sub-tropical moist hill forest.
	(b) Dry hill forest ...	Burma sub-tropical hills savannah forest.
	(c) Pine forest.	Assam-Burma sub-tropical pine forest.

Source: Hundley. 1961.

Appendix VII. Faunal Reserves

NAME Shwezettaw Wild Life Sanctuary

TYPE NP BIOTIC PROVINCE 5.6.2.

LEGAL PROTECTION Total

DATE ESTABLISHED 1940

GEOGRAPHICAL LOCATION South central Burma, between Irrawaddy river and mountains to west, N 20°06'-20°19'; E 94°33'-94°37'

ALTITUDE 149.35-430.38 metres

AREA 55,270 ha

LAND TENURE

PHYSICAL FEATURES Hilly. Underlying rock of late Tertiary age

VEGETATION Dry tropical deciduous forest dominated by 'than' Terminalia oliveri and 'dahat' Tectona hamiltoniana. These forests reach an average height of 9 m. 'Cutch' Acacia catechu is also common but of poor quality.

NOTEWORTHY FAUNA Barking deer Muntiacus muntjak grandicornis, Burmese thamin or brow-antlered deer Cervus eldi thamin, Burmese gaur Bos gaurus readei and tsaine or Burmese banteng Bos banteng birmanicus. The Burmese thamin is the only race of eldi not classified in the Red Data Book as highly endangered, but this seems to be largely because of the absence of information on its status. The banteng and gaur belong to species rated by the Red Data Book as 'vulnerable' and an assessment of their populations in this Sanctuary would be most desirable.

ZONING

DISTURBANCES OR DEFICIENCIES

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. J. Bombay nat. Hist. Soc., 52(2-3): 264-284.

STAFF 2 deputy rangers

BUDGET Kyats 6500/- annually

LOCAL PARK ADMINISTRATION Territorial Forest Officer, Forest Department, Minbu, Burma.

NAME Taunggyi Game Sanctuary

TYPE NP BIOTIC PROVINCE 5.6.2

LEGAL PROTECTION Total

DATE ESTABLISHED 1930

GEOGRAPHICAL LOCATION Central Burma, N 20°42'-20°48'; E 97°03'-97°06'

ALTITUDE 1432.56 metres

AREA 1587 ha

LAND TENURE

PHYSICAL FEATURES A hill to the south-east of Taunggyi, the capital of the Shan states. Its slopes vary from fairly steep to very steep with a few precipitous crags commanding a fine view of the town.

VEGETATION Plantations of oak, chestnut and other tree species including a few pines, designated as a fuel reserve for the town.

NOTEWORTHY FAUNA The area was formerly noted for a variety of species, including leopard Panthera pardus fusca and the bar-tailed pheasant Syrmaticus humiae. It has been suggested as possibly a suitable place for the re-introduction of the latter, but up till now has, like other reserves, been considered by the Forest Department to be too subject to disturbance.

ZONING

DISTURBANCES OR DEFICIENCIES Possible exploitation of the tree plantations for fuel. See also under 'noteworthy fauna'.

TOURISM Much visited by the inhabitants of Taunggyi and many 'rides' and foot-paths have been provided for their use, but facilities still need to be improved.

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. J. Bombay nat. Hist. Soc., 52(2-3): 264-284.

STAFF No separate staff; sanctuary is managed by local Forest Department personnel.

BUDGET

LOCAL PARK ADMINISTRATION Divisional Forest Officer, South Shan State Forest Division, Burma.

NAME Shwe-U-Daung Game Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.6.2

LEGAL PROTECTION Total

DATE ESTABLISHED 1918

GEOGRAPHICAL LOCATION Central Burma, east of the Irrawaddy river, N 22°49'-23°05'; E 96°12'-96°21'

ALTITUDE 228.60-1684.93 metres

AREA 32,633 ha

LAND TENURE

PHYSICAL FEATURES An area of many hills culminating in Shwe-U-Daung peak. The more elevated portions form a watershed from which come a series of spurs and ridges. *The climate of the higher regions is cold and bracing, with a welcome* absence of insect pests except for a few biting flies. Scenically almost unequalled *in Burma.*

VEGETATION Evergreen forests clothe lower slopes of the reserve. They abound with various species of orchid, which are in full bloom in April and May. Upper slopes mainly open grassy areas without tree cover. The grasses are coarse and from 30 cm to 90 cm tall, but the 'kaing' or elephant grass Saccharum sp., which occupies hollows and the upper margins of the forest, is much taller.

NOTEWORTHY FAUNA Species believed still to occur in the Sanctuary and which it was designed to protect, include the Sumatran rhinoceros Didermoceros sumatrensis, as well as one other species in the 'endangered' category, the tiger Panthera t. tigris (the typical race must here be near the south-eastern extremity of its range). Other species or subspecies classified as 'vulnerable' in the Red Data Book, which occur in the Sanctuary are leopard Panthera pardus fusca, Asian elephant Elephas maximus and the Burmese races of banteng and gaur Bos banteng birmanicus and Bos gaurus readei. A subspecies, milne-edwardsi, of the Sumatran or black serow Capricornis sumatraensis is also reported, and it would be of special interest to have details of its population, since the typical subspecies of Sumatra is in the 'endangered' category.

ZONING

DISTURBANCES OR DEFICIENCIES "From local evidence it seems that since about 1940 at least 17 rhino have been killed .... it appears that there are now only two rhinos (some believe three) living inside the sanctuary" (Milton, 1959). Poaching by intruders from villages to the south-west and less often the north is reported to continue, despite efforts at protection and the local belief that guardian spirits live on the three main peaks of the Sanctuary.

Logging of teak has been permitted up to at least as recently as 1967, although regulations were prescribed to ensure minimum disturbance to wildlife. Enforcement, however, depends largely on the existing conditions at any one time and is left entirely to the discretion of the Divisional Forest Officer in charge.

SCIENTIFIC RESEARCH

SPECIAL FACILITIES

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STAFF Deputy ranger and 2 foresters (i.e. 3 game watchers) for the part of the Sanctuary in the East Katha Forest Division. 1 game watcher (forester) in Mong-mit Forest Division.

BUDGET In addition to staff salaries, about 200-300 kyats are provided annually for repair to inspections paths, and another 100-200 kyats for buying salt for *salt-licks.*

LOCAL PARK ADMINISTRATION *The section (19,000 ha) situated in the East Katha* Forest Division (Northern Circle) is administered by *the Deputy-director of that* Division; the section (13,630 ha) within the Mong-mit Forest Division (Eastern or Shan State Circle) is similarly administered by the divisional Deputy-director.

NAME Mulayit Game Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.7.2

LEGAL PROTECTION Total

DATE ESTABLISHED 1936, Notification No. 232 of 5 November 1935

GEOGRAPHICAL LOCATION Near the Thailand border ESE of Moulmein, N 16°03'-16°12'; E 98°26'-98°34'

ALTITUDE 152.4-2079.65 metres

AREA 13,859 ha

LAND TENURE

PHYSICAL FEATURES Western slopes of the Dawna range, the highest point being Mount Mulayit which is a place of pilgrimage. Many perennial streams. The climate is wet with probably more than 5000 mm of precipitation per annum.

VEGETATION Dense evergreen forests, moist deciduous forests, hill forests and open grassy screes depending on altitude and aspect.

NOTEWORTHY FAUNA Burmese tiger *Panthera tigris tigris*, leopard *Panthera pardus fusca* and Fea's muntjac *Muntiacus feae* are present; other species include bears and a variety of deer. The muntjac is classified in the Red Data Book as an endangered species; there is no recent information of its status in Burma, although its survival in wilder areas of neighbouring Thailand has been confirmed.

ZONING

DISTURBANCES OR DEFICIENCIES

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. *J. Bombay nat. Hist. Soc.*, 52(2-3): 264-284.

STAFF

BUDGET

LOCAL PARK ADMINISTRATION Deputy-director, Kawkareik Forest Division, Kawthoolei State, Burma.

NAME Pidaung Game Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.6.2

LEGAL PROTECTION Total

DATE ESTABLISHED A reserve was originally created in 1913, but the Game Sanctuary was not formally established until 1938, by a Notice dated 8 April.

GEOGRAPHICAL LOCATION Northern Burma, near the city of Myitkyina, N 25°15'-25°35'; E 97°04'-97°20'

ALTITUDE 147.83-1,362.15 metres

AREA 70,421 ha

LAND TENURE Public ownership

PHYSICAL FEATURES Valley of the Irrawaddy river with grassy plains near the river and forested hills.

VEGETATION Tropical broad-leafed evergreen forest with *Terminalia* spp., and *Shorea* spp., together with open areas covered with short grass and known as *lvins*.

NOTEWORTHY FAUNA Tiger *Panthera tigris tigris*, leopard *Panthera pardus fusca*, Indian elephant *Elephas maximus*, Malayan sambar *Cervus unicolor equinus*, Burmese gaur *Bos gaurus readei* and Burmese banteng *Bos banteng birmanicus*. The tiger is attributed to the typical or 'Bengal' subspecies, classified in the Red Data Book as 'endangered', but no reliable estimate of the population has been received. The leopard, gaur and banteng belong to species classified as 'vulnerable' and their survival and numbers in the Pidaung Sanctuary need confirmation and assessment, particularly the banteng on which the Red Data Book contains no recent data outside the confines of Indonesia.

ZONING

DISTURBANCES OR DEFICIENCIES Three tea plantations in southern part of the reserve. Six local villages have rights to use reserve.

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

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STAFF Head keeper and 5 assistants

BUDGET

LOCAL PARK ADMINISTRATION Divisional Forest Officer, Myitkyina Forest Division, Northern Circle, Myitkyina, Burma.

NAME Minwun Wild Life Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.6.2

LEGAL PROTECTION Total

DATE ESTABLISHED 1971. A and F Notification No. 259, 26 October

GEOGRAPHICAL LOCATION Central Burma, west of the Irrawaddy river and north-west of Mandalay, N 21°52½'-22°12'; E 95°56'-96°1¼'

ALTITUDE 76.2-405.99 metres

AREA 20,587 ha

LAND TENURE

PHYSICAL FEATURES Low hills

VEGETATION Dry scrub forest

NOTEWORTHY FAUNA Thamin *Cervus eldi thamin* and barking deer *Muntiacus muntjak grandicornis*, the former being the Burmese representative of a species of which the two other races, the Manipur and Thailand brow-antlered deer, are very gravely endangered: to what extent its status is appreciably better is not known, although it is not at present listed in the Red Data Book.

ZONING

DISTURBANCES OR DEFICIENCIES

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

STAFF

BUDGET

LOCAL PARK ADMINISTRATION Deputy-director, Shwebo Forest Division, Northern Circle, Burma.

NAME Moscos Islands Game Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.7.2

LEGAL PROTECTION Total

DATE ESTABLISHED 1924 (original notification), confirmed by Forest Department Notification No. 243 of 29 September 1927..

GEOGRAPHICAL LOCATION Northernmost islands of the Mergui Archipelago off the coast of Tenasserim and about 250 km south of Moulmein, N 13°47'-14°27'; E 97°46'-97°56'

ALTITUDES

Heinze Is.	15.24-310.90 metres
Maungmagan Is.	15.24-358.44 metres
Launglon Bok Is.	15.24-361.49 metres

AREA 4920.96 ha

LAND TENURE

PHYSICAL FEATURES Three groups of offshore islands, Heinze, Maungmagan and Launglon Bok, strung out over some 70 km of ocean from north to south. The largest island, in which the main settlement is situated, is in Launglon Bok, the most southerly group; it is also the highest, but all the islands rise steeply to their forested peaks.

VEGETATION Evergreen forest, some of which has been cleared

NOTEWORTHY FAUNA Best known, because heavily exploited, are edible nest swiftlets of two species, the 'grey-rumped' *Collocalia fuciphaga inexpectata* and the 'black-nest' or 'Low's' *C. maxima (rowi)*. Apart from these two cave-dwellers, the forest avifauna is very rich, the various hornbills (especially *Aceros* spp.) and flocks of Imperial pigeons (mainly the green *Ducula aenea*) being especially remarkable. Turtles, probably of several species, breed around the shores. The only mammal reported is the crab-eating monkey *Macaca irus*, but sambar *Cervus unicolor equinus* have been introduced from the neighbouring mainland.

ZONING

DISTURBANCES OR DEFICIENCIES The right to collect edible birds' nests, formerly auctioned by the Forest Department, in 1971-72 became a monopoly of the Launglon Township Cooperative Society. The nests taken in that season weighed over 572 kg and Grade 1 'white' nests of the grey-rumped swiftlet fetched Kyats 1800/-(US$ 360) per viss or 1.634 kg. The 'black' nests of *maxima* are much less valuable, but the quantity available is usually greater and would presumably account for a high proportion of the 572 kg quoted. Turtle eggs are also collected. The Water Products section of the Government Trading Corporation handles the grading, pricing and marketing of these products.

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. *J. Bombay nat. Hist. Soc.*, 52(2-3): 264-284.

STAFF

BUDGET

LOCAL PARK ADMINISTRATION Tavoy Forest Division, Tavoy, Burma.

NAME Kelatha Hill Wild Life Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.7.4

LEGAL PROTECTION Total

DATE ESTABLISHED 1942, on the suggestion of the abbot of a nearby monastery

GEOGRAPHICAL LOCATION South Burma, between the Sittang and the Salween rivers, north-east of Rangoon, N 17°11'-17°15'; E 97°04'-97°08'

ALTITUDE 15.2-359.97 metres

AREA 2447 ha

LAND TENURE

PHYSICAL FEATURES Low hills. The reserve is near the Kyaungdawya-Myathabeik monastery in the Kelatha Hills.

VEGETATION Evergreen forest

NOTEWORTHY FAUNA Barking deer *Muntiacus muntjak grandicornis* and black serow *Capricornis sumatraensis milne-edwardsi*, the latter a local race, reported from several of the listed areas, of a species which in Sumatra itself (the typical race) is classified as endangered. The Burmese red jungle fowl *Gallus gallus spadiceus* occurs.

ZONING

DISTURBANCES OR DEFICIENCIES

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. *J. Bombay nat. Hist. Soc.*, 52(2-3): 264-284.

STAFF

BUDGET

LOCAL PARK ADMINISTRATION Deputy-director, Thaton Forest Division, Burma.

NAME Maymyo Game Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.6.2

LEGAL PROTECTION Total

DATE ESTABLISHED 1918

GEOGRAPHICAL LOCATION Central Burma, north-east of Mandalay, N 21°55'-22°05'; E 96°25'-96°35'

ALTITUDE 1066.80-1197.25 metres

AREA 12,691 ha

LAND TENURE

PHYSICAL FEATURES Maymyo Plateau, a part of the Shan plateau, with undulating small hills and valleys.

VEGETATION Dry teak forest and chestnut, no bamboo, with fairly dense undergrowth during the rainy season but almost open during summer and winter.

NOTEWORTHY FAUNA Reported to serve mainly as a bird sanctuary at the present time, but no information received on the species.

ZONING

DISTURBANCES OR DEFICIENCIES Despite its sanctuary status, this reserve like all others in Burma was reported by the authorities in 1970 to be not sufficiently secure to provide a suitable place for the release of Mrs. Hume's bar-tailed pheasant *Syrmaticus humiae*, when an offer was made by The Pheasant Trust to provide a number of pairs for re-introduction into areas where the species has been exterminated.

TOURISM The reserve is close to the popular hill station of Maymyo and part of it is developed as a botanic garden and is the only section visited. But it is well suited for development into a national park if the public could be educated into an appreciation of wildlife and the appropriate facilities were provided.

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. *J. Bombay nat. Hist. Soc.*, 52(2-3): 264-284.

STAFF No separate staff has been allotted to the Sanctuary, but the local Range Staff of the Forest Department keep an eye on it.

BUDGET About Kyats 2000/- are made available annually for maintenance of boundaries and footpaths, including payment for one daily labourer, plus a further Kyats 100/- for the artificial feeding of animals.

LOCAL PARK ADMINISTRATION Range officer, Maymyo ranger, Mandalay Forest Division, Northern Circle, Burma.

NAME Diamond Island (Thamila Kyun or Leik Kyun) Wildlife Sanctuary

TYPE NP **BIOTIC PROVINCE** 5.7.4

LEGAL PROTECTION Total

DATE ESTABLISHED 1 December 1970, Agr. and Forests Notification No. 289

GEOGRAPHICAL LOCATION Extreme south-west of the country, off the mouth of the Bassein river, N 15°51'-15°52'; E 94°16'-94°17'

ALTITUDE Sea level to highest points of 15.24 metres and 30.48 metres, respectively

AREA 88 ha

LAND TENURE

PHYSICAL FEATURES Rocky island about 8 km from the coast, off the mouth of the Bassein river, the most western of the nine principal mouths of the Irrawaddy river. The central area rises to a few small hills with soil and vegetation.

VEGETATION Mostly grassland with few trees

NOTEWORTHY FAUNA Established to protect the turtles including the green turtle *Chelonia mydas*, the loggerhead *Caretta caretta* and the hawksbill *Eratmochelys imbricata* all of which are totally protected. Indigenous fauna includes lizards and hermit crabs.

ZONING

DISTURBANCES OR DEFICIENCIES Turtle eggs are collected for sale, but 10% are hatched for recruitment purposes each year. A number of birds and other animals, including peafowl *Pavo cristatus*, rhesus monkey *Macaca mulatta* and hog deer *Cervus porcinus*, have been introduced from the Rangoon Zoological Gardens and some have undoubtedly had an adverse effect on native biota. However the rhesus monkeys and, perhaps a greater threat to the Sanctuary, a dozen or so domestic goats are reported to have been removed or destroyed. Between 1969 and 1972 planting of fruit-bearing trees was undertaken, including 1500 in the final year, but these were of local forest species.

SCIENTIFIC RESEARCH Observation of turtle behaviour during nesting and assessment of female turtles and recruitment.

SPECIAL SCIENTIFIC FACILITIES Nursery tanks and equipment for physical oceanography

PRINCIPAL REFERENCE MATERIAL

STAFF

Department of Fisheries	:	1 officer and 4 staff
Department of Forests	:	5 staff (responsible to Ngaputaw Range Officer)
Police	:	1 officer and 5 staff

BUDGET Approximately Kyats 157,000/- (US$ 31,400) annually for staff

LOCAL PARK ADMINISTRATION 1) Forest Conservation and Department of Forests, Bassein - Henzada Forest Division, Maritime Circle; 2) Turtle Conservation and Department of Fisheries; 3) Security : Police

NAME Kahilu Game Reserve

TYPE NP **BIOTIC PROVINCE** 5.6.1

LEGAL PROTECTION Total

DATE ESTABLISHED 1 September 1928 under Notification No. 188 of 9 July

GEOGRAPHICAL LOCATION Southern Burma, on west bank of the Salween river about 120 km upstream from Moulmein, N 17°32'-17°35'; E 97°29'-97°37'

ALTITUDE 24.38-76.20 metres

AREA 16,057 ha

LAND TENURE

PHYSICAL FEATURES Low hills

VEGETATION Evergreen forest

NOTEWORTHY FAUNA No information later than 1962 is available, when the reserve was reported as giving protection to the Sumatran rhinoceros *Didermoceros sumatrensis*, classified in the Red Data Book as endangered, and the Burmese race of the Sumatran or black serow *Capricornis sumatraensis milne-edwardsi*, of which the typical race is similarly endangered. Other species recorded included the Malayan sambar *Cervus unicolor equinus* and larger Malayan chevrotain or mouse deer *Tragulus napu napu*.

ZONING

DISTURBANCES OR DEFICIENCIES

SCIENTIFIC RESEARCH

PRINCIPAL REFERENCE MATERIAL

TUN YIN, U. 1954. Wildlife preservation and sanctuaries in the Union of Burma. *J. Bombay nat. Hist. Soc.*, 52(2-3): 264-284.

STAFF

BUDGET

LOCAL PARK ADMINISTRATION Pa-an Forest Division, Kawthoolei State, Burma.

Source: IUCN. 1977.

Appendix VIII. Acronyms used in this Report

ADB	Asian Development Bank
AID	Agency for International Development (U.S.)
ASEAN	Association of South East Asian Nations
EPA	Environmental Protection Agency (U.S.)
FAO	Food and Agriculture Organization (United Nations)
FWS	Fish and Wildlife Service (U.S.)
GDP	Gross Domestic Product
GNP	Gross National Product
GPO	Government Printing Office (U.S.)
IAEC	International Atomic Energy Commission (United Nations)
IBRD	International Bank for Reconstruction and Development (World Bank)
IDA	International Development Association
IUCN	International Union for Conservation of Nature and Natural Resources
LBPDP	Lower Burma Paddyland Development Project
NAS	National Academy of Sciences (U.S.)
OPEC	Organization of Petroleum Exporting Countries
PPFC	People's Pearl and Fishery Corporation (SRUB)
SRUB	Socialist Republic of the Union of Burma
UNECAFE	United Nations Economic Commission for Asia and the Far East
UNEP	United Nations Environment Program
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
USDA	United States Department of Agriculture
WHO	World Health Organization (United Nations)

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