No. 5 (1)

THE SOCIALIST REPUBLIC OF THE UNION OF BURMA

THE MASTER PLAN SURVEY REPORT ON THE IRRAWADDY BASIN INTEGRATED AGRICULTURAL DEVELOPMENT

ANNEX B
SOIL AND LAND USE

MARCH 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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ANNEX B

SOIL AND LAND USE

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JAPAN INTERNATIONAL COOPERATION AGENCY

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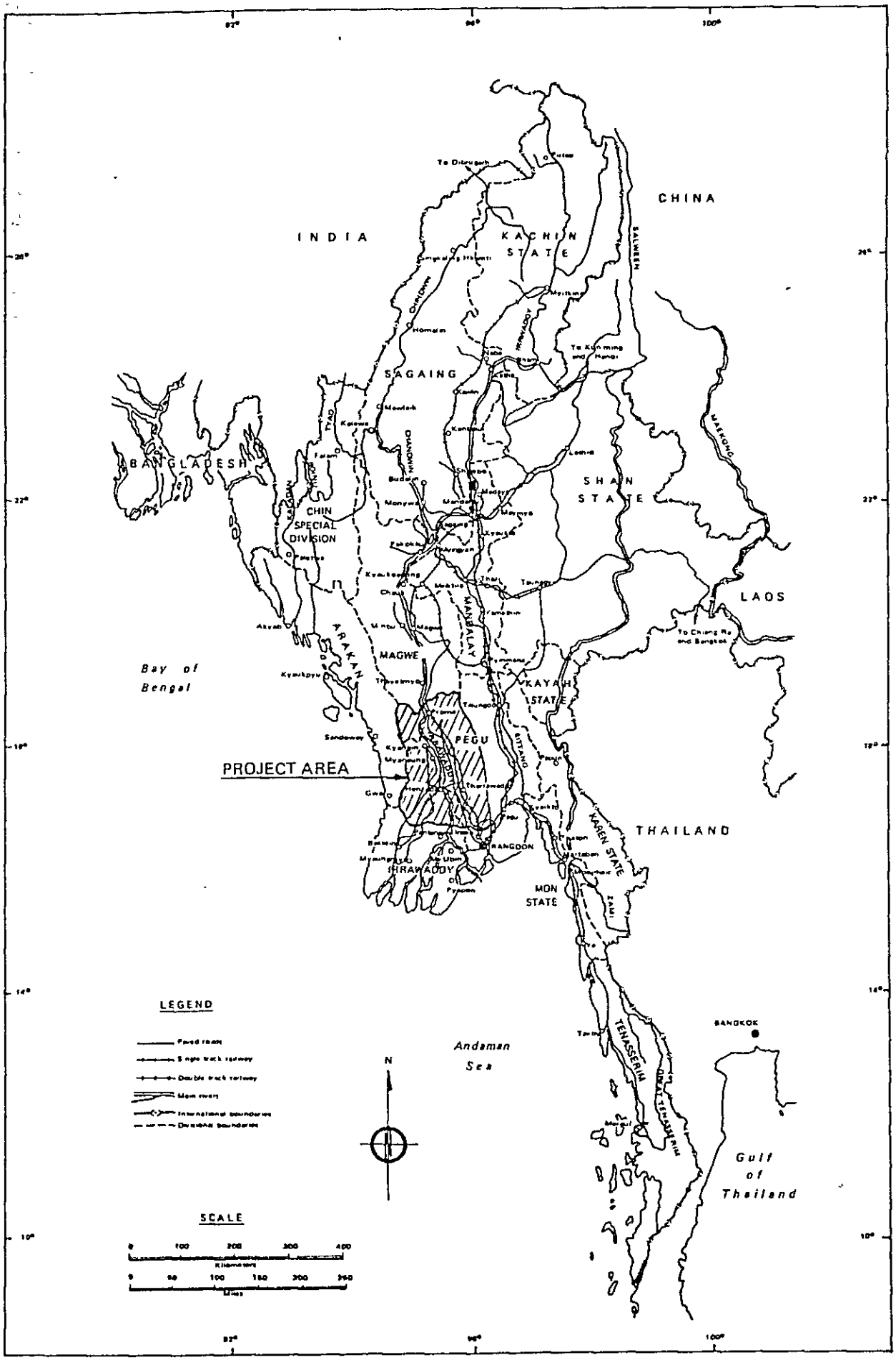
INDIA
CHINA
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SAGAING
SHAN STATE
CHIN SPECIAL DIVISION
LAOS
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PEGU
KAYAH STATE
PROJECT AREA
THAILAND
KAREN STATE
MON STATE
RANGOON
IRRAWADDY
Bay of Bengal
Andaman Sea
Gulf of Thailand
BANGKOK
ARAKAN
MANDALAY
SITTANG
TENASSERIM
CHINDWIN
IRRAWADDY
SALWEEN
MEKONG
To Dibrugarh
To Kunming and Hongkong
To Chiang Rai and Bangkok
LEGEND
Paved road
Single track railway
Double track railway
Main river
International boundaries
Divisional boundaries
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SCALE
Kilometers
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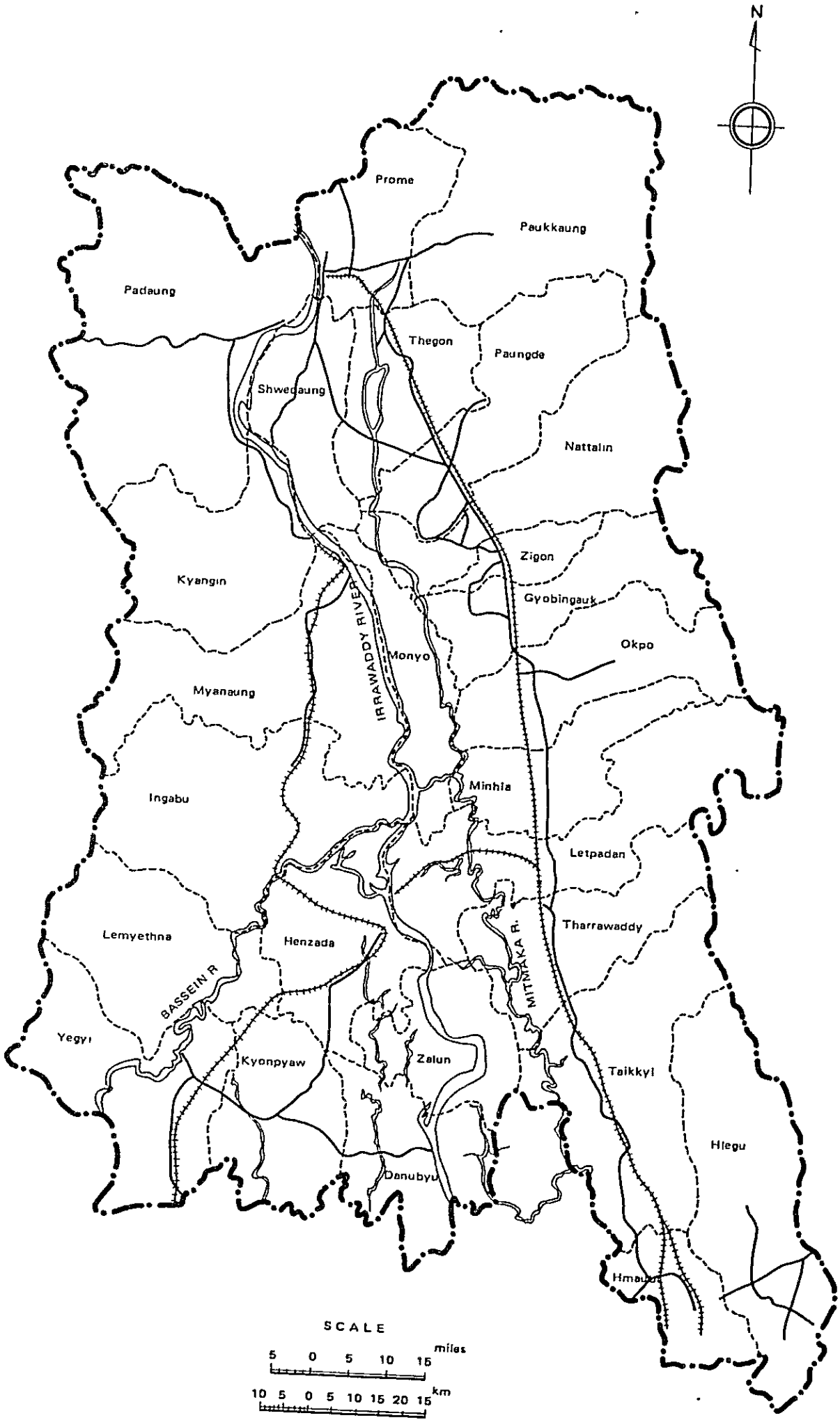
N
Prome
Paukkaung
Padaung
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Paungde
Shwegaung
Nattalin
Kyangin
Zigon
Gyobingauk
IRRAWADDY RIVER
Monyo
Okpo
Myanaung
Minhla
Ingabu
Letpadan
Tharrawaddy
Lemyethna
Henzada
BASSEIN R.
MITMAKA R.
Yegyi
Kyonpyaw
Zalun
Taikkyi
Hlegu
Danubyu
Hmawbi
SCALE
5 0 5 10 15 miles
10 5 0 5 10 15 20 15 km

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATION, MEASURES AND GLOSSARIES

AC	Agriculture Corporation
ADB	Asian Development Bank
AE	Assistant Engineer
AGM	Assistant General Manager
AFPTC	Agricultural and Farm Produce Trade Corporation
AMD	Agricultural Mechanization Department
APS	Advance Purchase System
Ave	Average
BAG	Bachelor of Agricultural University
BKT	Basket(s)
CIF	Cost Insurance and Freight
°C	Degree Centigrade
DAGM	Deputy Assistant General Manager
DG	Director General
DGM	Deputy General Manager
Dy	Deputy
EE	Executive Engineer
EL	Elevation
EPC	Electric Power Corporation
FC	Foreign Currency
FiD	Fishery Department
FERD	Foreign Economic Relations Department
FIC	Foodstuff Industries Corporation
FOB	Free on Board
FoD	Forest Department
F/S	Feasibility Study
FY	Fiscal Year from April to March
GM	General Manager
GNP	Gross National Product
GWH	Giga Watt Hour
HP	Horsepower

HWL	High Water Level
HYV	High Yielding Variety (of paddy)
Hz	Hertz per second
IBRD	International Bank for Reconstruction and Development
ID	Irrigation Department
IDA	International Development Association
KV	Kilo Volt
KW	Kilo Watt
KWH	Kilo Watt Hour
LC	Local Currency
LDMC	Livestock Development and Marketing Corporation
LIV	Local Improved Variety
LWL	Lower Water Level
LV	Local Variety
MAF	Ministry of Agriculture and Forests
MD	Managing Director
MHD	Meteorological and Hydrological Department
MI 1	Ministry of Industry No. 1
M/P	Master Plan
MPF	Ministry of Planning and Finance
MT	Ministry of Trade
MW	Mega Watt
MWL	Mean Water Level
PD	Project Director
pH	Potential of Hydrogen
PPFC	People's Pearl and Fishery Corporation, MAF
PPM	Part(s) per Million
%	Percent
PSD	Planning and Statistics Department
SD	Survey Department, MAF
SLRD	Settlements and Land Records Department, MAF
TC	Timber Corporation, MAF
TEM	Township Extension Manager
TSP	Triple Super Phosphate

UCC	University Computer Center
UGCF	Union Government Consolidated Fund
VAHD	Veterinary and Animal Husbandry Department
VTB	Village Tract Banks
WPSD	Working People's Settlement Department

MEASURES

Length

mm	millimeter (s)
cm.	centimeter (s)
m	meter (s)
km	kilometer (s)
inch	25.4 mm
ft	foot (feet) = 12 inch = 30.48 cm
mile	5,280 feet = 1.609 km

Area

sq.cm	square centimeter (s)
sq.m	square meter (s)
sq.km	square kilometer (s) = 100 ha
ac	acre (s) = 4,047 sq.m
sq.mile	square mile = 2.59 sq.km = 640 ac
ha	hectare

Capacity

ℓ	litter
cu.m	cubic meter
MCM	Million Cubic Meter
cu.ft	cubic foot (feet) = 28.32 ℓ
cu.yd	cubic yard = 0.765 cu.m
AF	Acre Foot (feet) = 1,233.48 cu.m
Qt	Quart = 1/4 gl = 1.136 ℓ (UK) = 0.946 ℓ (US)
gl	gallon = 4.543 ℓ (UK) = 3.785 ℓ (US)

Note: UK: British Measure
US: US Measure

Weight

g	gram (s)
kg	kilogram (s)
ton	metric ton
oz	ounce = 28.4 g
lb	Pound = 16 oz = 0.454 kg

Others

cm/sec	centimeter per second
m/sec	meter per second
km/sec	kilometer per second
mile /hr	mile per hour= 1.609 km/hr = 0.447 m/sec
ft/second	feet per second
cu.m/sec	cubic meter per second
cfs/cu.sec	cubic foot (feet) per second = 0.0283 cu.m/sec
gl/sec	gallon per second = 4.543 ℓ/sec = 0.0757 ℓ/min

Glossaries

lakh	100,000
crore	10,000,000
viss	1.633 kg
Pyi	2,127 kg
basket	20.9 kg (paddy)
basket	34.0 kg (rice)
bag	75.6 kg (rice)
Chaung	River or Stream
Kyat	Unit of Local Currency (about 30 Japanese Yen)
In	Lake or Swamp area
Yoma	Mountain range
1 US$	6.44 kyats

SUMMARY

There are two major mountain systems in the Area and each has a different charactor. These are the Arakan mountain range, running almost from north to south along the west border of the area, and the Pegu mountain range extending also from north-northwest to south-southeast along the east border of the Area.

Between the two mountain systems, the Irrawaddy River runs from north to south. At the center of the Area, the Bassein River starts from the Irrawaddy River and runs southwest along the foot of the Arakan mountain range. The Myitmaka River starts at Thegon township and runs south-southeast collecting streams from the Pegu mountain range. The Myitmaka River also receives much water from the Irrawaddy River through Thonet chaung and comes down to Rangoon harbor, where the river is called the Hlaing River.

A triangular area formed by the Bassein and Myitmaka River is called Irrawaddy delta, where the elevation is low and inundation can happen in many areas in the rainy season. In the rainy season, rainfall is very heavy, so that soils are continuously water-suturated or water-logged and depressed areas are inundated, temperature, winds, evaporation and sunshine-hours are considered.

The geological period of the Area belongs to Quaternary, Tertiary and Cretaceous periods. Rocks in the Arakan and Pegu mountains consist of rather soft sedimentary rocks. The rocks are rich in silica sands and receiving strong weathering. The severe erosion in the mountains is a big problem, and the erosion causes siltation in the plain areas.

The plains are mainly occupied by deposits of old alluvium and the recent alluviul deposits are found only near the river. These alluvium deposits provide agricultural lands of nearly flat relief.

The soils in the mountain and hills are light textured and laying on the severly weathered rocks rich in silica sands. Erosion is very severe under the heavy rain, when the soils are not protected by dense forests.

Soils in the plain have the nature to impede drainage because of heavier texture, nearly level topography and heavy rain, thus the plain soils are water sururated or water logged during the rainy season. Under these conditions, water-logged rice culture is generally the most suitable use of the soils in the rainy season. In the dry season ground water level comes down deep in the ground and the soil condition becomes good for both diversified crop cultures and water-logged rice culture, when irrigation water is available.

The fertile clay soils are found mainly at the area of inundation, where are fallow thorugh the year at present. The area can be utilized for water-logged rice culture in the rainy season by drainage works.

Total area of Area is about 7.13 million acres (about 2.91 million ha).

Most of the mountains and hills are covered by forests (35.8 percent of the total area). But the area of thin forests are better to be improved to prevent erosion.

The plain soils at the slightly elevated relief and clayey soil of lighter texture are generally used for rice culture in the rainy season and left as fallow in dry season (34.6 percent). However, the soils of the area can be utilized by both diversified crop culture and water-logged rice culture in dry season, when the irrigation water is available.

The area of heavy clay soils (4.1 percent) are subjected by inundation during rainy season and left fallow all through the year. However, some part of this area of fertile soils can be used for rice culture in the rainy season, when the drainage systems are achieved.

The areas of light textured soils (3.0 percent), where inundation occurs in the rainy season, are used as so called Kaing cultivation after inundation is over at the later part of the rainy season. The crops used in this cultivation are the diversified crops such as groundnut.

At some area on the most low hills, mountain soils are used as so called Ya-cultivations (0.4 percent) and Garden-cultivation (2.5 percent). The diversified crops are used for former cultivation and tropical fruit trees are used for latter cultivation.

At the small area (0.2 percent) in the mountains, the Shift cultivations are conducted at present, however, the cultivations are not favourable for the prevention of erosion, the areas are better to be planted by trees to make dense forests.

There are other lands consist of cultivable waste (8.4 percent) and uncultivable lands (11.0 percent).

In the dry season, the sunshine is very rich and cultivations of both water-logged rice and diversified crops will obtain higher yield than the rainy season, when irrigation water is supplied.

Irrigation proejcts, to irrigate the area of meadow soils and meadow gley heavy loam soils at the foot plains of both Pegu and Arakan mountains, will be a great help to increase crop production in the Area.

The inundation area about 119 thousand ha (about 293 thousand

ac) is left fallow through the year. Many parts of the area belong to heavy textured and fertile soils.

There have to be efforts to drain and reclamate inundation area for rice culture in the rainy season.

Soils and rainfall conditions result severe soil erosion at the hills and mountains and also result heavy siltation at the plain areas, where the shallow river beds are built at tributaris resulting vast inundation areas along the rivers. Thus the vast areas of fertile plain are covered with water in the rainy season.

As a conclusion, the light textured forest soils should be covered with dense forest to prevent soil erosion on the hills and mountains. The Ya-lands and Garden-lands should not be enlarged into the area of the forests and the shifting cultivation in the forest should be limited only in the small special places. Otherwise the erosion in high place and the siltation in the low plain will be accelerated and both of forests in highland and cultivated lands in lowland would be gradually injured.

The soil studies for future projects will have to be conducted using moderne international methods. For these purposes, modern tools for soil survey and instruments for physical, chemical and mineralogical soil tests have to be added. The training of soil surveyer personnels in advanced countries are quite adviserble to promote soil survey projects in this Area.

I. INTRODUCTION AND ACKNOWLEDGMENTS

The Area of 2,887,429 hectars (7,134,915 acres) in the Lower Burma contains cultivated lands of 1,177,411 hectars (2,909,414 acres), forest lands of 1,032,290 hectars (2,550,817 acres) and other lands.

The Area is one of the most productive areas in Burma for agriculture and forestry, with the appreciable amount of rainfall and high temperature. However, the most of the land in the area is under rainfed condition, and only one crop a year can be cultivated in the rainy season. The main crop in this area is paddy.

The irrigation facilities would be the first important need in the area, because the irrigation can provide second diversified crops or paddy in the dry season. The improvements of cultural practices, such as use of improved varieties of crops and proper application of fertilizers, would be important to increase agricultural production in the Area.

Responding to the request of the Government of the Socialist Republic of the Union of Burma, the Government of Japan despatched the preliminary survey team in September and October 1977 and the first survey team in February and March for the Master Plan Survey of the Irrawaddy River Basin Integrated Agricultural Development. However, the both team did not contain any personnel for soil study of the Area.

The second survey team was sent to the area from October 1978 to January 1979 for 100 days and a soil scientist of the team studied the soils of the Area. The results of soil study was reported in the main report and in the separate soil report of the second survey team. In the third survey team, a soil scientist continued soil study in the Area for 47 days from 25th to 6th September 1979.

The results of the soil studies in the second and the third survey team completed in this soil report.

In conduction of soil studies, the cooperation and assistance of Ministry of Agricluture and Forests and other Government Orgainzations and individuals is greatly appreciated. The cooperation of Agriculture Corporation, Irrigation Department, Settlement and Land Record Department, Livestock Development and Marketing Corporation and Planning and Statistic Department of Ministry of Agriculture and Forests should be especially mentioned. The authors also wish to thank Professor Kazutake Kyuma of Kyoto university, who permitted the use of his study results on soil of Burma in 1977.

Suggestions for improvements by associate professor Shoro Fukui (Kyoto university) of the advisory group of JICA were gratefully recieved and appreciated.

II. GENERAL DESCRIPTION OF THE AREA

II.1. Location

The Area of The Irrawdday River Basin Integrated Agricultural Development stretches from 16°50' to 19°10' north latitude and from 94°40' to 96°25' east longtitude.

The Area is surrounded by Arakan Mountain Range (Arakan Yoma) at the western border, Pegu mountain range (Pegu Yoma) at the eastern border, north Prome highland at the northern border and Maubin swampy area at the southern border.

The total land area is 2,887,357 hectares (7,134,915 acres) of which 1,177,382 hectares (2,909,414 acres) are cultivable lands.

The middle part of the Area is widest with about 150 kilometers (93 miles) at 17°30' north latitude, it is about 250 kilometers (160 miles) along 95°30' east longtitude. The distance from Rangoon is measured 25 kilometers at nearest (15 miles) border and 280 kilometers (175 miles) at the most far border.

In the South-East Asia, the north part of Luzon island (Cagayan River Basin) of the Philippines, the extreme north part of the Thailand (Chieng Mai area) and Bombay and Goa area of the India are found to be in the same range of north latitude with the Area.

The location of the Area of the Irrawaddy River Basin Integrated Agricultural Development is shown in the Key Map.

II.2. Areas by Administrative District

The Area is belong to three divisions, that is Pegu division (14 townships), Irrawaddy division (9 townships) and Rangoon division (3 townships). The Hectarage of total area and township area are shown in Table B-2-1.

The location of townships in the Area is shown in Figure B-2-1.

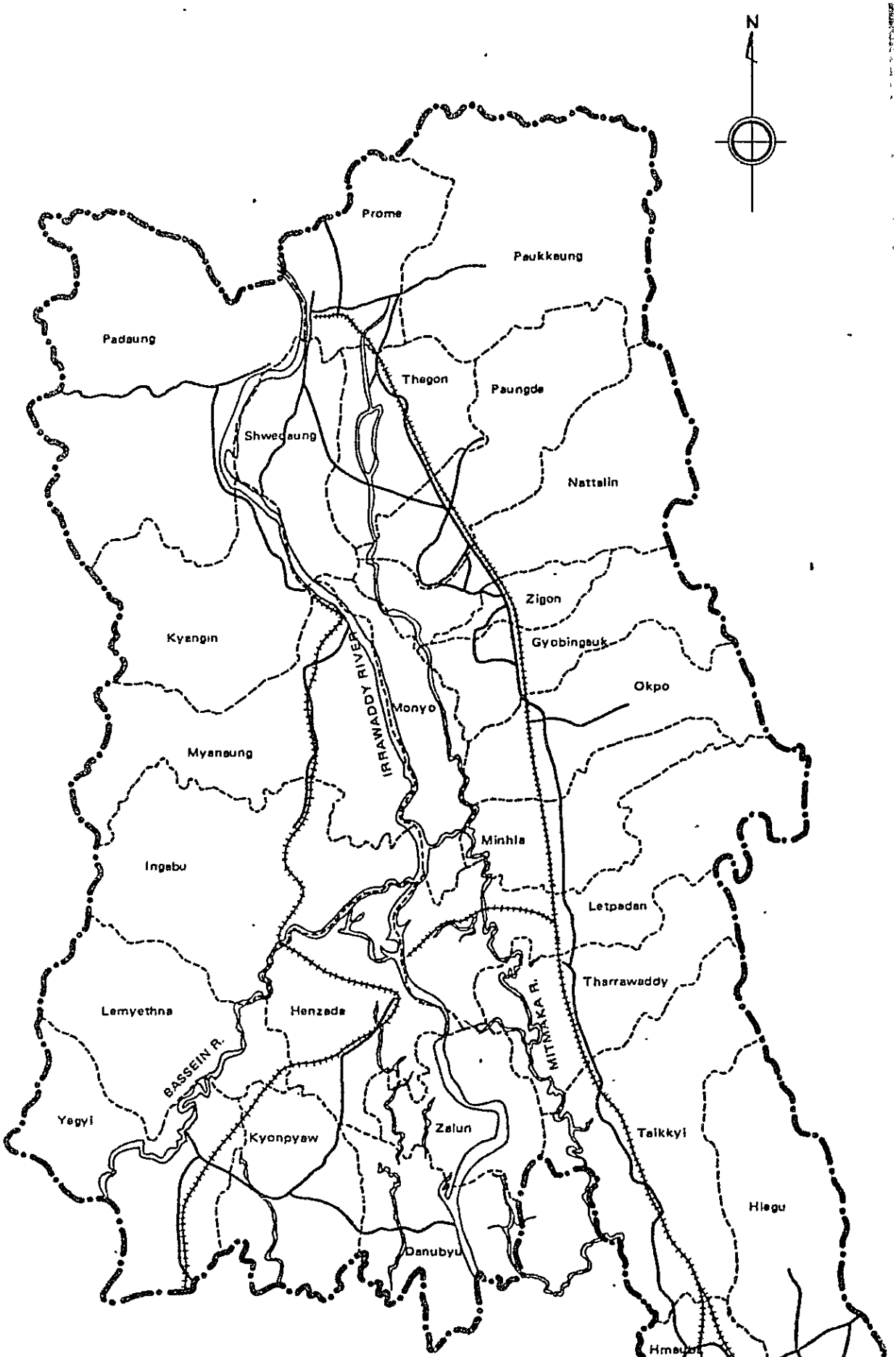


FIGURE B-2-1 LOCATION OF TOWNSHIP IN THE AREA

TABLE B-2-1 HECTARAGE OF THE AREA AND EACH TOWNSHIP

	Township	Hectarage	Acreage
PEGU DIVISION:	1. Paukkaung	190,759	471,370
	2. Prome	78,842	194,820
	3. Padaung	250,709	619,509
	4. Paungde	92,892	229,539
	5. Thegon	77,667	191,917
	6. Shwedaung	73,541	181,721
	7. Nattalin	137,738	337,883
	8. Zigon	24,518	60,584
	9. Gyobingauk	76,923	190,079
	10. Monyo	63,972	158,076
	11. Okpo	106,019	259,506
	12. Minhla	66,903	165,320
	13. Letpadan	148,688	367,413
	14. Tharrawaddi	103,313	255,290
RANGOON DIVISION:	15. Taikkyi	172,706	426,761
	16. Hlegu	178,812	441,849
	17. Hmawbi	50,330	124,367
IRRAWADDI DIVISION:	18. Kyangin	115,149	284,537
	19. Myanaung	155,223	383,561
	20. Ingabu	162,704	402,047
	21. Lemyethna	103,353	255,388
	22. Yegyi	128,190	316,762
	23. Henzada	98,083	242,365
	24. Zalun	74,633	184,419
	25. Kyonpyaw	82,819	204,648
	26. Danubyu	74,942	185,184
TOTAL		2,887,429	7,134,915

III. TOPOGRAPHY

III.1. Physiographic Division

There are two major mountain sustems in the Area and each has a different charactor. These are the Arakan mountain range, running almost from north to south along the west border of the area, and the Pegu mountain range extending also from north-northwest to south-southeast along the east border of the Area.

Between the two mountain systems the Irrawaddy River runs from north to sough. At the center of the Area, the Bassein River starts from the Irrawaddy River and runs southwest along the foot of the Arakan mountain range. The Myitmaka River starts at Thegon township and runs south-southeast collecting streams from the Pegu mountain range. The Myitmaka River also receives much water from the Irrawaddy River through Thenet chaung and comes down to Rangoon Harbor, where the river is called the Hlaing River.

A triangular area formed by the Bassein and Myitmaka Rivers is called Irrawaddy Delta, where the elevation is low and inundation can happen in many areas in the rainy season.

III.2. Mountain Area

(1) The Arakan Mountain Range (Arakan Yoma)

The Arakan Yoma runs 180 kilometers (110 miles) from north to south and forms the western border and watershed of the Irrawaddy River basin.

The Arakan Yoma of 180 kilometers, the north part of which forms an unbroken wall of mountains about 110 kilometers (70 miles) in length, attains hights of more than 1,200 meters (4,000 feet) and hence plays an important role in the climatology of the northern part of the Area. An area

of over 500 meters (1,500 feet) elevation consists of steep slope (20/100 slope).

The southern 70 kilometers (45 miles) of the Arakan Yoma is not higher than 800 meters (2,500 feet) and the mountain area of over 300 meters (100 feet) elevation is not so steep (10-15/100).

(2) Pegu Mountain Range (Pegu Yoma)

The Pegu Yoma, which runs 190 kilometers (120 miles) from north-northwest to south-southeast, forms the eastern border of the Area and watershed of the Area. Mountains are not high and the elevation ranges from 500 to 800 meters (1,500 - 2,500 feet) and the slope is not very steep (10-15/100). The Pegu Mountain Range tails off in Hlegu township, which locates at the southern part of the Area.

(3) Northern Border Hills

The elevation of hills at the northern border of the Area is about 300 meters (1,000 feet) and their slopes are gentle.

(4) Central Hills

The central hills of 20 kilometers in length runs from north to south forming boundary between Thegon and Shwedaung townships. The hills attain height of only 150 meters (500 feet) and hence the slopes are gentle.

III.3. Plain Area

(1) Prome and Paukkaung Round Valleys

The round valleys of Prome and Paukkaung townships are surrounded by low northern border hills and the foot hills of Pegu Mountain Range. The South Nawin Chaung passes two round valleys from east to west and she pours into the Irrawaddy River. These

round avlleys are not much flooded even under heavy rain in the rainy in the rainy season, as the elevation of valleys are more than 50 meters (150 feet) and the Irrawaddy River cuts in deep at the exit of the South Nawin River.

(2) Foot Plain of the Pegu Mountain Range

The western foot plain of the northern part of the Pegu mountain range forms a flat plain belt of 20-45 meters (50-150 feet) in elevation. The foot plain belt is 20-30 kilometers wide and 120 kilometers long along the Pegu mountain range. The slope of the foot plain belt is 1/1,000 to 12/10,000 and it is good cultivated land spread over Thegon, Paungde, Nattalin, Zigon, Gyobingauk, Okpo and Minhla townships.

The western foot plain of southern Pegu mountain range forms a narrower foot plain belt of 10-30 meters (30-100 feet) elevation. The foot plain belt is 15 kilometers (10 miles) wide and 80 kilometers (50 miles) long along the southern of Pegu mountain range. The slope of the plain is about 2/1,000 and it forms good cultivated land over Letpadan, Tharrawaddy, Taikkyi and Hmawbi townships.

Both of the western foot plain belts of Pegu mountain range slope down to a swampy area of the Myitmaka River, which flows from north-northwest to south-southwest for 190 kilometers (115 miles) along the foot plain belts.

The Pegu mountain range becomes as low as 100 meters (300 feet) in elevation and tails off in Hmawbi and Hlegu townships and the southern foot plain of the mountains continues into the marine alluvium plain.

(3) Foot Plain of the Arakan Mountain Range

The eastern foot plain along the northern part of Arakan mountain range of 50 kilometers (60 miles) forms only small flats in Padaung and Kyangin townships. The elevation of the flats are

about 30 meters (100 feet) and their east side is cut by the Irrawaddy River.

The eastern foot plain along the middle Arakan mountain range of about 60 kilometers (40 miles) slopes down to a alluvium swampy plain. The foot plain of over 15 meters (50 feet) in elevation and the alluvium plain of under 15 meters (50 feet) in elevation belong to Myanaung and Ingabu townships.

Along the foot hill of the southern Arakan mountain range of about 55 kilometers (35 miles), there is a foot plain belt of about 10 kilometers (6 miles) wide and the belt forms cultivated land in Lemyethna and Yegyi township. The foot plain is not higher than 15 meters (50 feet) from the sea level and slopes down to the Bassein River.

(4) Delta Plain between the Irrawaddy and Myitmaka River

The upper part of the delta plain between two rivers is about 60 kilometers (35 miles) long and 20 kilometers (12 miles) wide. Elevations are as low as 15 meters (50 feet) and the plain is rich in swamps. Most of this upper delta plain belongs to Monyo township.

The lower part of the delta plain between the Irrrawaddy and Myitmaka Rivers of about 50 kilometers (30 miles) long and 15 kilometers (10 miles) wide is lower in elevation (10-15 meters = 30-50 feet), and hence is very rich in swamps. The delta area belongs to a lower part of Letpadan and Tharrawaddy townships and east parts of both Zalun and Danubyu townships. The southern border of the delta area is located at the distance of 80 kilometers (50 miles) from the sea, so that some lowest parts of the land in this area are affected by brackish water.

(5) Delta Plain between the Irrawaddy and Bassein Rivers

A equilateral triangular area of about 70 kilometers (45 miles)

a side, between the two Rivers, is the lowest plain in the Area at at the elevations of 2-8 meters (6-25 feet).

The triangular plain is fully protected from inundation of both Rivers by long embankments of 10 meters (30 feet) in elevation, however, after heavy rain of 100-150 millimeters (4-6 inches) a day, the low land under 3 meters (10 feet) in elevation can be inundated in a mid-rainy season, because the rain water fall down on this plain can not be drained at the time of the high tide of the sea, locating at the distance of 80 kilometers (50 miles) to the south.

The plain contains Henzada, Kyonpyaw townships, the western part of Yegyi township and the eastern part of both Zalun and Danubyu townships.

IV. GEOLOGY AND LITHOLOGY

The geological period of the Area belongs to Quaternary, Terliary and Cretaceous. The geological series and lithology are summarized in Table B-4-1.

The area is for long time exposed to the tropical climate with heavy rain, and hence rocks at mountains and hills are fully weathered and received severe erosion. The plains mainly occupied by deposit of old alluvium and recent alluvium are found only at the riverside.

IV.1. Area of Mountains and Hills

(1) Arakan Mountain Area

(a) Arakan Mountain of High Elevation

The higher mountainous terrain in generally not lower than 150 meters (500 feet) above sea level and is made of steep slopes.

The higher mountainous areas belong to axial series of Cretaceous period, though it was used to be stated as Triassic period by Theobald. The formations are dominantly indurated sandstones and shales. In the lower axial series, shales are thin bedded and they are of flaggy nature and dark greenish colour. The upper axial series contain limestone bands and serpentine intrusions. At the place of contact with surpentines, there are silica as quartz vein and also there are mica and graphite schists. Bands of cristalline limestones are found.

(b) Foothilis of Arakan Mountain

The northern part of foothills (in Padaung township) belongs to Laungsha series of Eocene period and the series contain shales and sandstone. The northwestern part of hills consists of limestones of Pegu series of Oligo-Miocene. The base of the series consists of conglomerates with some grits and sandstones.

TABLE B-4-1 GEOLOGY AND LITHOLOGY OF THE AREA

	SERIES (EPOCH)		SYSTEM OF ARAKAN MOUNTAINS.			DELTA PLAIN		SYSTEM OF PEGU MOUNTAINS				
			High elevation	Foot hills	Foot plain	Between Bassein and Irrawaddi Rivers	Between Myitmaka and Irrawaddi Rivers	Foot plain	Prome and Pakkaung Round Valleys	Low flat hills	PEGU MOUNTAINS NORTHERN CENTER HILLS Foot hills	PEGU MOUNTAINS NORTHERN CENTER HILLS Body
CAINOZOIC	QUATERNARY	Late Alluvium (Holocene)			Coarse deposits		Clayey deposits	Clayey deposits				
		Old Alluvial (Holocene)			Clayey deposits	Sandy clay marine deposits		Silty clay deposits	Sandy deposits			
		Diluvium (Pleistocene)								Layerly deposits of light texture		
	TERTIARY	Pliocene		(Most low hills) Irrawaddi series SANDSTONES							Irrawaddi series SANDSTONES	
		Miocene and Oligocene		Pegu Series (Northern) LIMESTONES CONGLOMERATE (Southern) SANDSTONES SHALES								Pegu Series SANDSTONE SHALES
		Eocene		Langsha Series SHALES SANDSTONES								
MESO-ZOIC	CRETACEOUS		Axial Series SANDSTONES SHALES SERPENTINES									

Source: Land Use Division, Agricultural Corporation, Burma.

The middle and southern parts of foothills of Arakan mountains lie generally between 30-150 meters (100-500 feet) and belong to Eocene, Oligo-Miocene and Pliocene periods. The higher foot hills mainly consist of multi-coloured massive sandstones of Eocene period and they are intercalated with conglomerates. The Eocene sandstone hills continue east where they become lower hills, which belong to Pegu series of Oligo-Miocene period. The lower hills of Pegu series contain grits, sandstones, shales limestones and sometimes marls, conglomerates and blue shales. The lowest parts of foot hills of Arakan mountains are occupied by Irrawaddy sandstones of Pliocent period and they are in some cases consolidated and contain gravels in places.

(2) Pegu Mountain Area

(a) Pegu Mountain Range

The bodies of Pegu mountains mainly consists of sandstones of Pegu series, which belongs to Oligo-Miocene period. In the northern part of Pegu mountain range, the sandstones varies from fine to coarse texture and from soft to hard. They usually have varying propotions of argillaceous materials. Sometimes, the bands of hard calcareous strata, consisting of sand and oxide of iron with a calcareous matrix, are interbedded with the sandstones and shales.

In the southern part of the Pegu mountain range, the Pegu series are composed of the alternating layers of sandstones and caly shales. These rocks are rather soft and weatherable and give a light textured, but not very coarse parent materials for soil formation. However, the erosion is very serious here on unprotected slopes.

(b) Foot Hills of Pegu Mountain Range

Along the western side of Pegu mountain range, there are foot hills under 45-60 meters (150-200 feet) elevation. The hills consist of sandstones of Irrawaddy series, which belong to Pliocene

period. The sandstones differ from the above mentioned Pegu series in the relative propotions of sandstones and clay shales, as the sandstones are more abundant in Irrawaddy series.

(c) Low Flat Hills under Pegu Foot Hill

There is a transition belt between the foot hill of southern part of Pegu mountains and the central alluvium plain. This transitional narrow belt of low flat plateau consists of Diluvium deposit. The deposit are layery and the coarse layers are interbedded with silty and loamy layers. Thus the parent materials of soils are non-homogeneous, but light textured deposit are predominant. Some layer of finer texture between layers of coarser texture tends to form laterites during weathering of long time.

(3) Northern Border Hills

The northern border hills of only 300 meters (1,000 feet) elevation are a branch of Pegu mountain range and they consist of Pegu series sandstones (Oligo-Miocene period) at the higher elevation. The lower foot hills are made of Irrawaddy sandstones (Pliocene period).

(4) Central Hills

The bone of center hills belongs to Pegu series of Oligo-Miocene period and its foot hills consist of Irrawaddy sandstones of Piocene period.

IV. 2. Plains

(1) Prome and Paukkaung round Valley

The alluvium is an alternation of sand layers and clay fraction. The plain belongs to old alluvium and it was used to be a valley of pre-Irrawaddy River. The lower portion of the deposits is made of sand and coarse gravels.

(2) Foot Plain of the Pegu Mountain Range

The foot plain belt along the Pegu mountain range mainly belongs to old alluvium deposit of sand containing argillaceous materials. It is traversed by numerous streams flowing down from Pegu mountains. These streams often have their banks above the surrounding low plain at the west side of the belt, due to their alluvial activity. In such cases, the deposits near the streams have much lighter texture and the deposits in the lower area have much clayey texture, and hence the both deposits are recent alluvium. The foot plain belt is one of the most important area for agriculture in the Area.

(3) Foot Plain of the Arakan Mountain Range

The foot plain belongs to old alluvium deposits of argillaceous character. Due to the nearly level relief of the belt and the argillaceous character of the deposits, the terrain is poor drained and the large accumulations of water give many swampy areas in the comparatively lower depressed lands.

Numerous local new alluvium deposits of coarser texture are found along small streams, which flow down from Arakan mountains.

(4) Delta Plain between the Myitmaka and Irrawaddy Rivers

At the northern most of the foot plain belt of Pegu mountains (in Thegon township), a small Ze River starts. The river supplies water to Inma lake. The river runs out from the lake and flows down the depressed area to the south along the foot plain belt. In such a way, the Ze River grows wider and becomes the Myitmaka River. The river flows down further and becomes the Hlaing River and at last the river is called the Rangoon River, where she comes near the sea.

The area between the above mentioned river and the Irrawaddy River forms depressed belt covered by recent alluvium materials.

The depressed belt contains many swamps and plays a part of retarding basin for excess water supplied from Pegu mountains and the Irrawaddy River in the rainy season.

(5) Delta Plain between the Bassein and Irrawaddy Rivers

The deposits of old alluvium occupy most of the delta plain of triangular shape. The deposits consists sand containing much argillaceous materials and show brownish colour and a nature of good sort. The ratio between soluble magnesium and calcium in this deposit shows high in magnesium unlike the river deposit. The ratio of chemical composition suggests that the old alluvium was deposited under the influence of tidal activity of the sea.

Because of such reasons as the low elevation, the nearly level relief and the argillaceous nature of the deposits, large accumulations of water give wide swampy areas in the southern part of the delta plain.

V. CLIMATE

V.1. Rainfall

Rainfalls are brought by the south-west monsoon and start in May, and end in October.

In the southern part of the Area, the annual rainfall is over 2,000 millimeters and average monthly rainfall is about 500 millimeters in June, July and August in average year, but it reaches 900 millimeters in the heavy rain years (this figure suggest 30 mm per day).

In the northern part of the area, average annual rainfall is 1,300-1,500 milimeters and monthly rainfall reach 300 millimeters in average years, however, it reaches 500-600 millimeters in June, July, August and September in the heavy rain years.

These heavy rain causes water suturation or water-logging on plain soils through the rainy season. This condition of the soils and water is good for water-logged rice culture, however, it is a quite limitation for the diversified upland crop culture.

The heavy rain causes sever erosion in the soil of mountsins and hills and also causes heavy siltation and inundation in the low relief in the plain. (Ref. to Fig B-5-1)

V.2. Temperature

In the rainy season, the average monthly temperature stays at 26-27°C, but, it comes down under 25°C in the winter of December, and January. The average monthly minimum temperature comes down to about 15°C in December, January and February. The most hot season is March, April and May and the average monthly temperature reaches over 30°C, and average monthly maximum temperature comes up over 35°C and reaches to 40°C. (Ref. to Fig B-5-1)

All the soils are dried up to the deep layers and the ground water level also goes down very deep in the hot season, so that the cultivation of crops is very difficult in this season without irrigation.

V.3. Wind

Wind in the Area is generally gentle. In March, April and May wind comes from south-east and from South-southeast carring monsoon rain in June, July, August and September and makes rainy season. Wind comes from north or northeast in October, November, December, January and February and causes low temperature in this area.

V.4 Evaporation

The data of the evaporation are seldom found, however, the evaporation in Prome is obtained by 4 feet USA evaporation pan.

The evaporation per month reaches 250 millimeters (This will be 8 mm per day in average.) in hot season of March, April and May. In other season the evaporation is as high as 120 millimeters per month (This will be 4-5 mm per day in average).

V.5. Sunshine Hours

At Prome, the north part of the Area, sunshine hours are as low as 120-150 hours per month (4-5 hours per day in average) in the rainy season of June, July, August, and September. The sunshine hours will be more lower in the southern part of the area, and it will be supposed to be 2-3 hours per day in average.

However, the sunshine hours reach 280 hours per month (This will be 9-10 hours per day in average.) in the dry season of December, January, February, April and May, so that the crop culture in dry season will obtain higher yield than the rainy season in respect to sunshine.

Examples of climate data at Prome and Tharrawaddy are listed in Table B-5-1 and B-5-2.

TABLE B-5-1 CLIMATE OF PROME

PLACE Prome Prom, Pegu, COUNTRY BURMA

LATITUDE N 18° 49' LONGITUDE E 95° 14' METERS

°C	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.	23.9	25.8	29.6	32.2	30.7	30.6	29.4	28.0	27.9	27.5	26.1	23.6	27.8
Max.	31.6	34.9	38.5	40.0	37.1	36.7	30.4	31.6	31.6	32.0	31.3	30.0	33.8
Min.	16.2	16.7	20.6	24.4	24.2	24.5	24.4	24.3	24.1	23.0	20.9	17.2	21.7

Average Temperature

mm	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Ave.	5	1	1	10	152	246	254	219	219	157	26	7	1295
Max.	47	25	8	45	322	407	423	396	396	342	139	56	1749('73)
Min	0	0	0	0	25	93	143	116	80	41	0	0	816('72)

Rainfall per month (mm H_2O)

%	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
AM	41	61	48	55	65	85	88	89	86	86	77	70	71(24y)
PM	48	35	35	42	60	86	86	86	89	82	70	60	65(24y)

Humudity %

1970 Form - Prof.Dr.S.Nishigaki

(cont'd)

TABLE B-5-1 CLIMATE OF PROME (cont'd)

PLACE PROME , Prome, Pegu, COUNTRY BURMA

LATITUDE N 18° 49' LONGITUDE E 95° 14' METERS

Max/Min 31/2829/2731/3030/2729/1825/1323/1224/1326/1429/1930/2431/29 324'72/285'61

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Hours													Days
300													30d
200													20d
100													10d
0													
Hour	289	286	289	284	224	136	157	119	175	228	231	274	'66/'76
Days	30	28	30	29	24	18	17	19	19	24	28	30	302
300 mm													10mm/d
200													7.5mm/d
100													5.mm/d
0													2.5mm/d
													4m USA Pan
m m	140	162	248	264	220	126	121	121	123	127	120	121	1,893
12													
10													
m/s 8													
6													
4													
2													
0													
m/s	1.1	1.3	1.3	1.8	1.7	1.4	1.3	1.3	1.0	1.0	1.2	1.6	

Pan Evaporation (mm/month) Sunshine Hours or No Rain Days

Wind Velocity (m/sec.)

Prevaling Wind Direction (% in the month average)

Calm										30		
N	39	23									32	53
NE												
NW												
E												
W												
SE			37	56	44							
SW												
S						45	53	47	38			

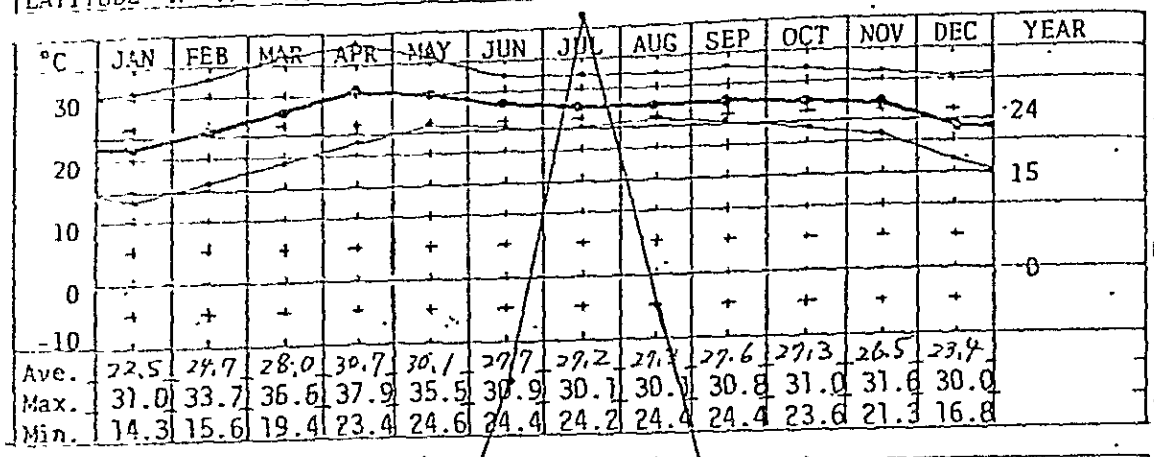
Wind Direction

1975 Form - Prof.Dr.S.Nishigaki

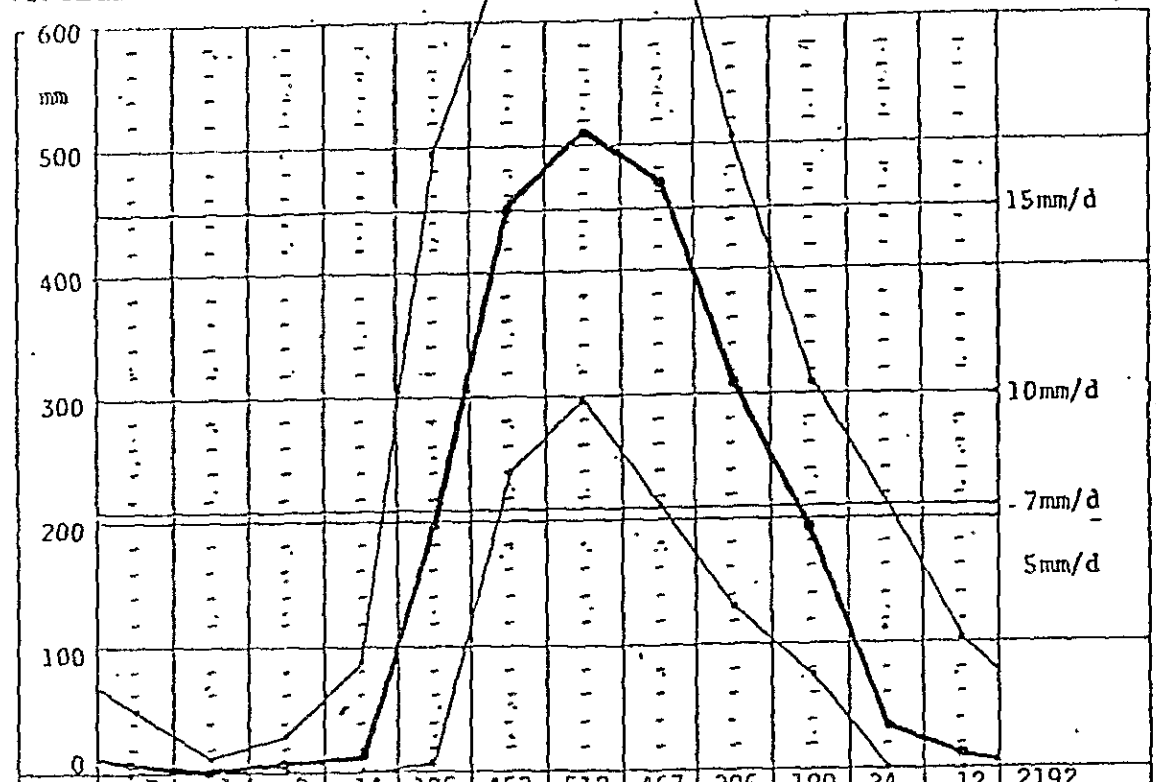
TABLE B-5-2 CLIMATE OF THARRAWADDY

PLACE Thorrawoddy Tharrawaddy, Pegu, COUNTRY BURMA

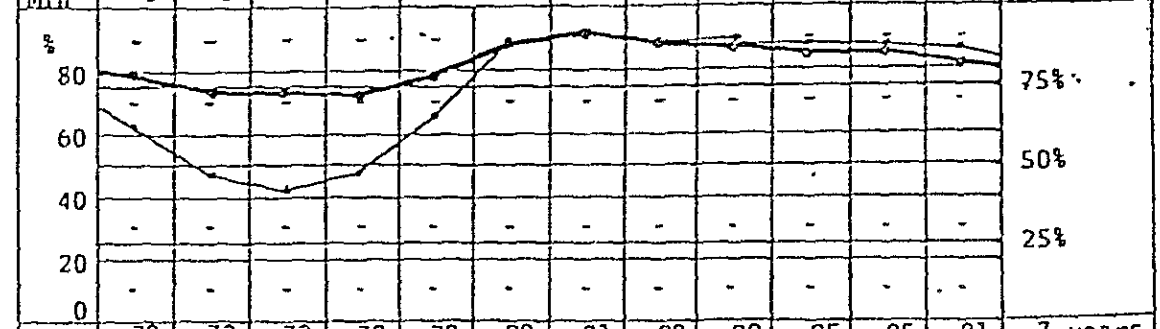
LATITUDE N 17° 43' LONGITUDE E 95° 47' METERS



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.	22.5	24.7	28.0	30.7	30.1	29.7	29.2	29.3	27.6	27.3	26.5	23.4	
Max.	31.0	33.7	36.6	37.9	35.5	30.9	30.1	30.1	30.8	31.0	31.6	30.0	
Min.	14.3	15.6	19.4	23.4	24.6	24.4	24.2	24.4	24.4	23.6	21.3	16.8	



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Ave.	7	1	3	14	196	453	512	467	306	189	34	12	2192
Max.	48	6	28	86	496	667	961	727	503	309	117	101	2191 : 48
Min	0	0	0	0	4	241	299	212	130	75	1	0	1753 : 55



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
AM	79	73	73	72	79	89	91	89	88	85	85	81	7 years
PM	62	48	42	48	76	90	91	90	90	88	87	86	

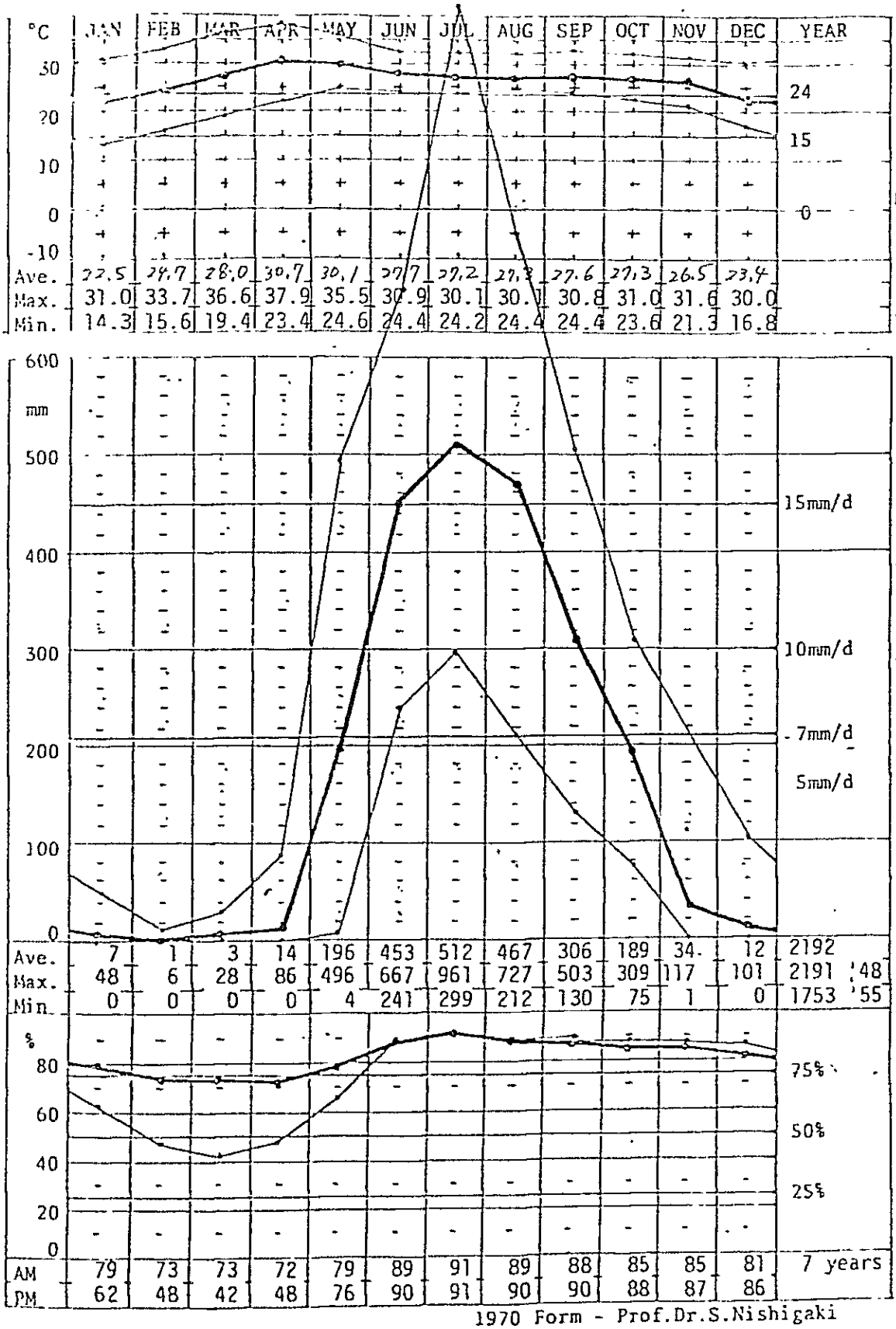
1970 Form - Prof.Dr.S.Nishigaki

(cont'd)

TABLE B-5-2 CLIMATE OF THARRAWADDY (cont'd)

PLACE Tharrawaddy Tharrawaddy, Pegu, COUNTRY BURMA

LATITUDE N 17° 43' LONGITUDE E 95° 47' METERS



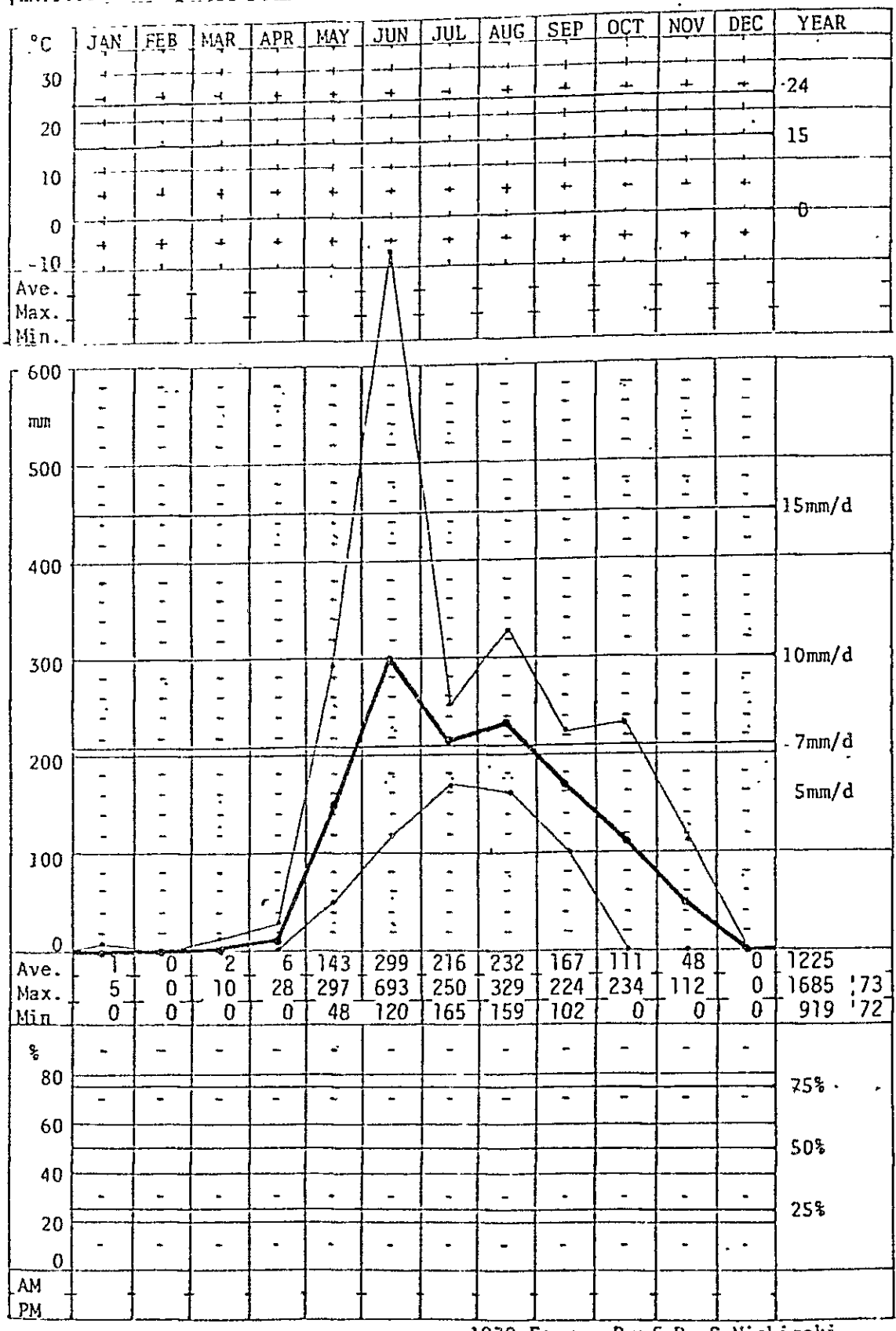
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.	22.5	24.7	28.0	30.7	30.1	27.7	27.2	27.3	27.6	27.3	26.5	23.4	
Max.	31.0	33.7	36.6	37.9	35.5	30.9	30.1	30.1	30.8	31.0	31.6	30.0	
Min.	14.3	15.6	19.4	23.4	24.6	24.4	24.2	24.4	24.4	23.6	21.3	16.8	
Ave.	7	1	3	14	196	453	512	467	306	189	34	12	2192
Max.	48	6	28	86	496	667	961	727	503	309	117	101	2191 '48
Min.	0	0	0	0	4	241	299	212	130	75	1	0	1753 '55
AM	79	73	73	72	79	89	91	89	88	85	85	81	7 years
PM	62	48	42	48	76	90	91	90	90	88	87	86	

1970 Form - Prof.Dr.S.Nishigaki

TABLE B-5-3 CLIMATE OF PAUKKAUNG

PLACE Paukkaung Paukkhaung, Pegu, COUNTRY BURMA

LATITUDE N 18° 54' LONGITUDE E 95° 33' METERS



1970 Form - Prof.Dr.S.Nishigaki

(cont'd)

TABLE B-5-3 CLIMATE OF PAUKKAUNG (cont'd)

PLACE Paukkaung, Paukkhaung, Pegu COUNTRY BURMA

LATITUDE N 18° 54' LONGITUDE E 95° 33' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Hours 300													Days 30d
200													20d
100													10d
0													
XXXX	30	28	30	29	24	17	17	19	20	26	28	31	304
Max/Min Days	31/30	29/28	31/30	30/29	29/20	25/14	20/15	24/16	24/15	31/22	30/26	31/31	321'72/291'73
300 mm													10mm/d
200													7.5mm/d
100													5.mm/d
0													2.5mm/d
m m													
12													
10 m/s													
8													
6													
4													
2													
0													
m/s													

Sunshine Hours or No Rain Days

Pan Evaporation(mm/month)

Wind Velocity (m/sec.)

Prevaling Wind Direction (% in the month average)

Calm													
N													
NE													
NW													
E													
W													
SE													
SW													
S													

Wind Direction

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TABLE B-5-4 CLIMATE OF ZIGON

PLACE Zigon Zigon, Pegu. COUNTRY BURMA

LATITUDE N 18° 20' LONGITUDE E 95° 38' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
°C Ave.													
Max.													
Min.													
mm Ave.	2	0	2	12	167	351	344	279	211	151	41	1	1561
Max.	19	8	33	127	373	543	582	483	395	286	149	7	2014 '60
Min	0	0	0	0	7	210	53	113	80	44	0	0	1291 '71
% Ave.													
Max.													
Min.													
AM													
PM													

Average Temperature: 30, 20, 10, 0, -10; 24, 15, 0

Rainfall per month (mm H_2O): 600, 500, 400, 300, 200, 100, 0; 15mm/d, 10mm/d, 7mm/d, 5mm/d

Humidity %: 80, 60, 40, 20, 0; 75%, 50%, 25%

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(cont'd)

TABLE B-5-4 CLIMATE OF ZIGON (cont'd)

PLACE Zigon, Zigon, pegu. COUNTRY BURMA

LATITUDE N 18° 20' LONGITUDE E 95° 38' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Hours													Days
300													30d
200													20d
100													10d
0													
XXXX	30	28	30	29	23	14	15	17	19	23	28	30	291
Max/Min Days	31/29	29/27	31/30	30/28	31/18	18/10	28/8	23/12	25/14	29/17	30/23	31/30	308'75/276-64
300 mm													10mm/d
200													7.5mm/d
100													5.mm/d
0													2.5mm/d
m m													
12													
10 m/s													
8													
6													
4													
2													
0													
m/s													

Sunshine Hours or No Rain Days

Pan Evaporation (mm/month)

Wind Velocity (m/sec.)

Prevaling Wind Direction (% in the month average)

Calm												
N												
NE												
NW												
E												
W												
SE												
SW												
S												

Wind Direction

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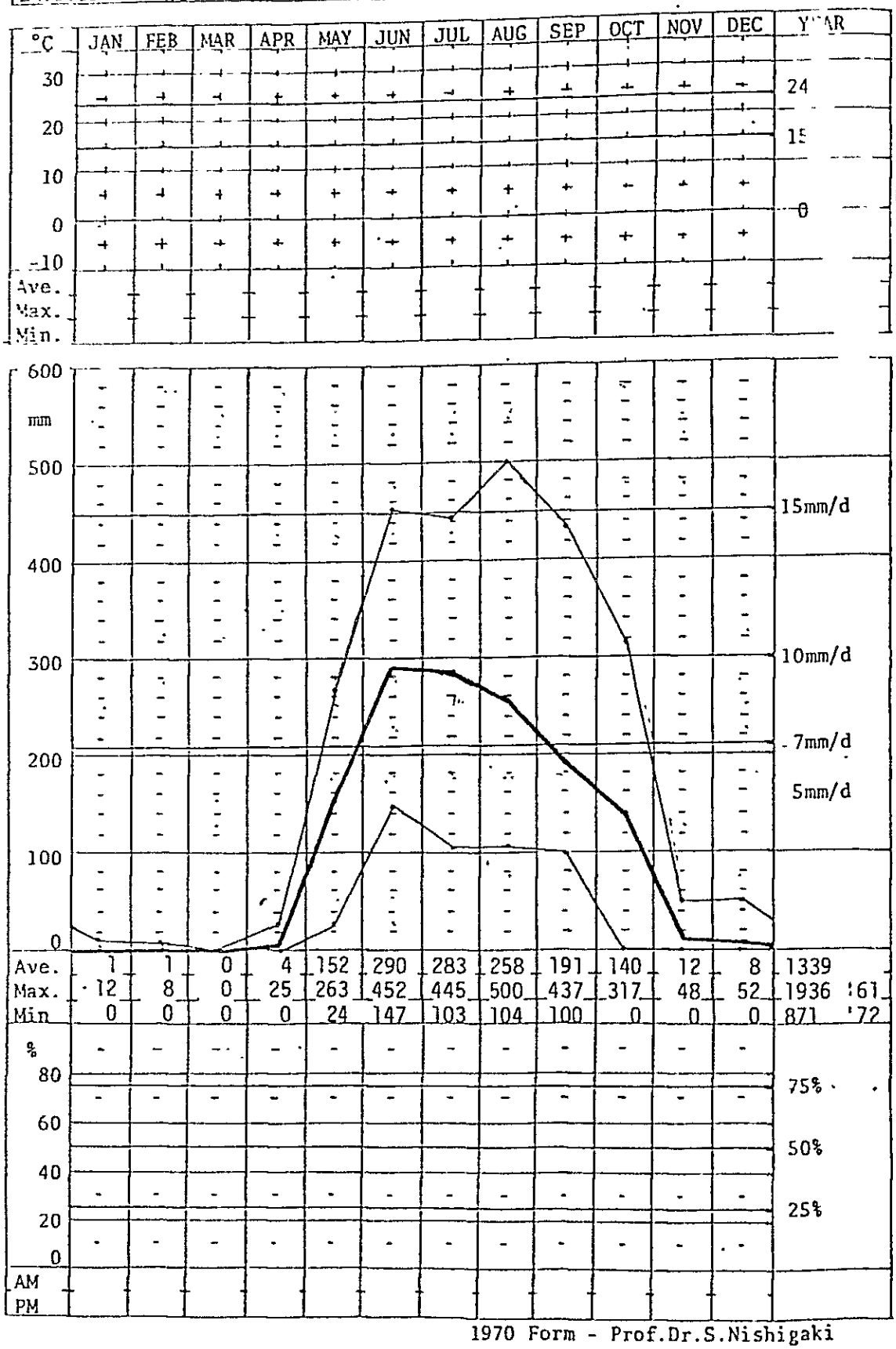
TABLE B-5-5 CLIMATE OF GYOBINGAUK

PLACE Gyobingauk Gyobingauk, Pegu COUNTRY BURMA

LATITUDE N 18° 14' LONGITUDE E 95° 38' METERS



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(cont'd)

TABLE B-5-5 CLIMATE OF GYOBINGAUK (cont'd)

PLACE Gyobingauk, Gyobingauk, pegu COUNTRY BUR

LATITUDE N 18° 14' LONGITUDE E 95° 38' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Hours 300												
200												
100												
0												
Max/Min	30	28	31	29	24	17	18	19	20	24	29	30
Days	31/30	29/27	31/31	30/28	30/20	23/14	26/12	28/5	25/14	31/19	30/28	31/29
mm 300												
200												
100												
0												
m m 12												
10												
m/s 8												
6												
4												
2												
0												
m/s												

Prevaling Wind Direction (% in the month average)

Calm												
N												
NE												
NW												
E												
W												
SE												
SW												
S												

Wind Direction

1975 Form - Prof.Dr.S.Nishigaki

TABLE B-5-6 CLIMATE OF OKPO

PLACE Okpo Okpo, Pegu COUNTRY BURMA

LATITUDE N 18° 8' LONGITUDE E 95° 41' METERS

°C	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.													
Max.													
Min.													

Average Temperature

30 — 24 — 20 — 15 — 10 — 0 — -10

mm

600 — 500 — 400 — 300 — 200 — 100 — 0

15mm/d — 10mm/d — 7mm/d — 5mm/d

Rainfall per month (mm H_2O)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.	2	0	7	3	213	198	254	286	233	129	35	7	1366
Max.	8	0	20	8	304	285	354	398	286	167	53	25	1542 '73
Min	0	0	0	0	83	55	128	223	145	82	7	0	1123 '77

%

80 — 60 — 40 — 20 — 0

75% — 50% — 25%

Humudity %

AM

PM

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(cont'd)

TABLE B-5-6 CLIMATE OF OKPO (cont'd)

PLACE Okpo', Okpo, Pegu, COUNTRY BURMA

LATITUDE N 18° 8' LONGITUDE E 95° 41' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Hours 300													Days 30d
200													20d
100													10d
0													
MEAN Days	30	28	30	30	23	19	19	16	19	24	27	30	299
Max/Min Days	31/30	28/28	31/30	30/30	24/23	26/15	26/16	22/11	23/15	25/23	29/26	31/29	311'75/281'73
300 mm													10mm/d
200													7.5mm/d
100													5.mm/d
0													2.5mm/d
m m													
12													
10 m/s													
8													
6													
4													
2													
0													
m/s													

Pan Evaporation (mm/month) - Sunshine Hours or No Rain Days

Wind Velocity (m/sec.)

Prevaling Wind Direction (% in the month average)

Calm												
N												
NE												
NW												
E												
W												
SE												
SW												
S												

Wind Direction

1975 Form - Prof.Dr.S.Nishigaki

TABLE B-5-7 CLIMATE OF HMAWBI

PLACE Hmawbi, Hmawbi, Rangoon COUNTRY BURMA

LATITUDE N 17° 6' LONGITUDE E 96° 3' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Hours 300													Days 30d
200													20d
100													10d
0													
Max Days	30	28	30	29	19	10	10	10	14	22	28	30	266
Min Days	31	29	31	30	26	18	20	16	21	27	30	31	283 '57
mm 300	29	26	29	27	9	4	4	3	8	19	25	25	241
200													7.5mm/d
100													5.mm/d
0													2.5mm/d
m m													
12													
10													
m/s 8													
6													
4													
2													
0													
m/s													

Max Min

Pan Evaporation (mm/month) Sunshine Hours or No Rain Days

Wind Velocity (m/sec.)

Prevaling Wind Direction (% in the month average)

Calm												
N												
NE												
NW												
E												
W												
SE												
SW												
S												

Wind Direction

1975 Form - Prof.Dr.S.Nishigaki

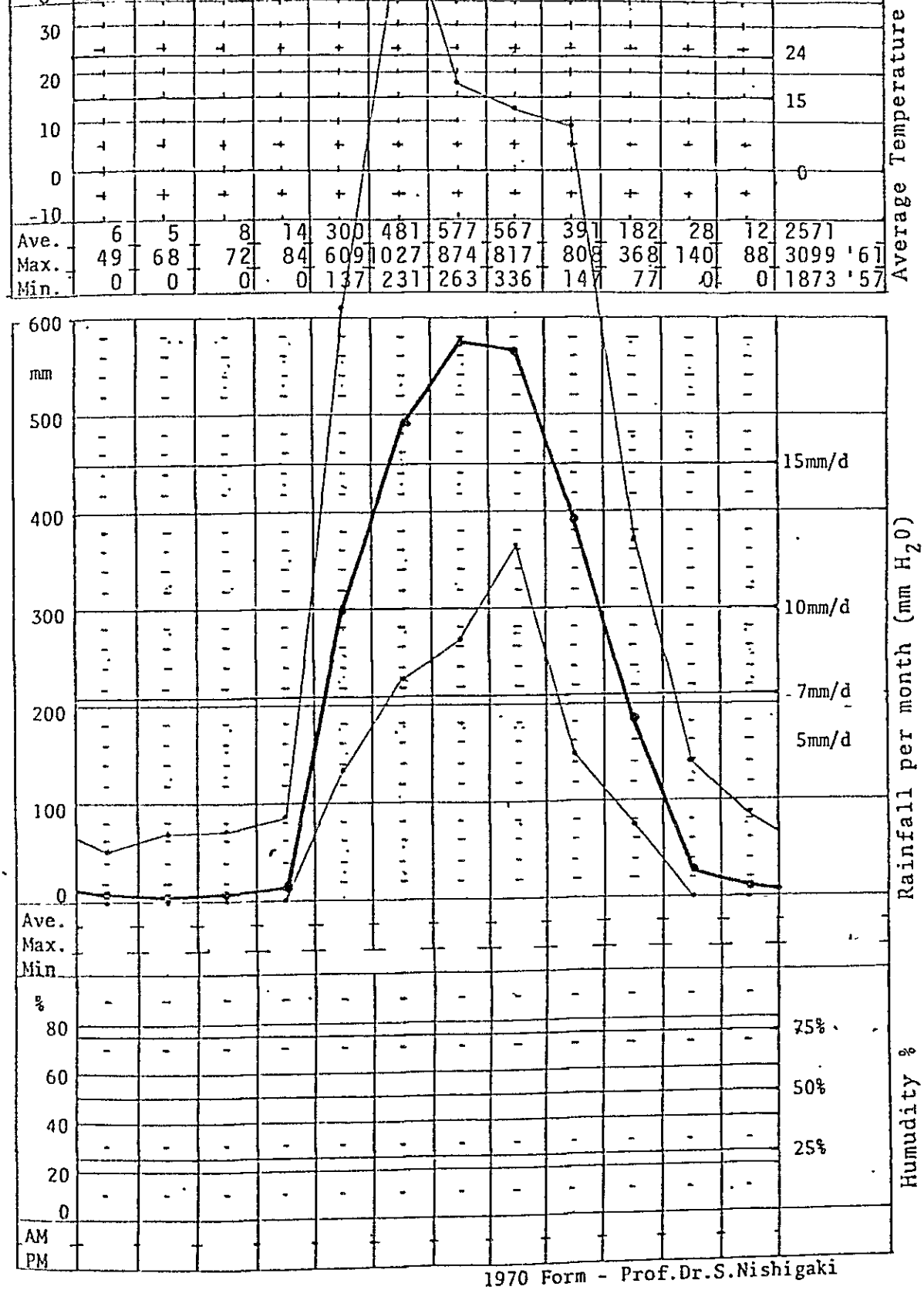
(cont'd)

TABLE B-5-7 CLIMATE OF HMAWBI (cont'd)

PLACE Hmawbi Hmawbi, Rangoon, COUNTRY BURMA

LATITUDE N 17° 6' LONGITUDE E 96° 3' METERS

°C	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.	6	5	8	14	300	481	577	567	391	182	28	12	2571
Max.	49	68	72	84	609	1027	874	817	808	368	140	88	3099 '61
Min.	0	0	0	0	137	231	263	336	147	77	0	0	1873 '57



1970 Form - Prof.Dr.S.Nishigaki

TABLE B-5-8 CLIMATE OF HENZADA

PLACE Henzoda Henzada, Irrawaddy COUNTRY BURMA

LATITUDE N 17° 38' LONGITUDE E 95° 28' METERS

°C	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Ave.	23.3	24.6	28.7	30.4	29.9	29.3	26.9	25.1	26.4	27.5	24.5	23.9	
Max.	30.3	33.8	36.5	38.3	34.9	30.5	29.6	29.9	30.4	30.6	31.1	29.7	
Min.	16.3	15.4	20.9	22.4	24.9	24.0	24.1	24.3	24.3	24.4	21.8	18.1	

Average Temperature

mm	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Ave.	6	0	6	8	216	471	549	496	300	186	33	5	2206
Max.	43	0	91	50	425	731	954	662	608	310	168	72	4114
Min	0	0	0	0	63	298	333	308	167	66	0	0	1235

Rainfall per month (mm H_2O)

%	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
AM	76	78	69	65	75	88	91	83	86	88	79	72	10 years
PM	66	45	46	54	65	91	93	82	88	77	79	72	" "

Humudity %

1970 Form - Prof.Dr.S.Nishigaki

(cont'd)

TABLE B-5-8 CLIMATE OF HENZADA (cont'd)

PLACE Henzada Henzada, Irrawaddy, COUNTRY BURMA

LATITUDE N 17° 38' LONGITUDE E 95° 28' METERS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Hours 300													Days 30d
200													20d
100													10d
0													
MAX/MIN Days	30 31/29	28 29/28	30 31/29	29 30/27	22 27/17	11 18/4	10 18/3	10 18/4	17 23/9	22 27/14	28 30/23	30 31/27	'62/'59
mm 300													10mm/d
200													7.5mm/d
100													5.mm/d
0													2.5mm/d
m/s 12													
10													
8													
6													
4													
2													
0													
m/s	1.1	1.6	1.6	3.4	1.9	2.4	1.6	1.6	1.8	1.1	1.6	1.8	

Prevaling Wind Direction (% in the month average)

Calm	52	50	32	25				37	48	58	53	50	%
N													
NE													
NW													
E													
W													
SE													
SW					26	30	29						
S													

Pan Evaporation(mm/month) Sunshine Hours or No Rain Days

Wind Velocity (m/sec.)

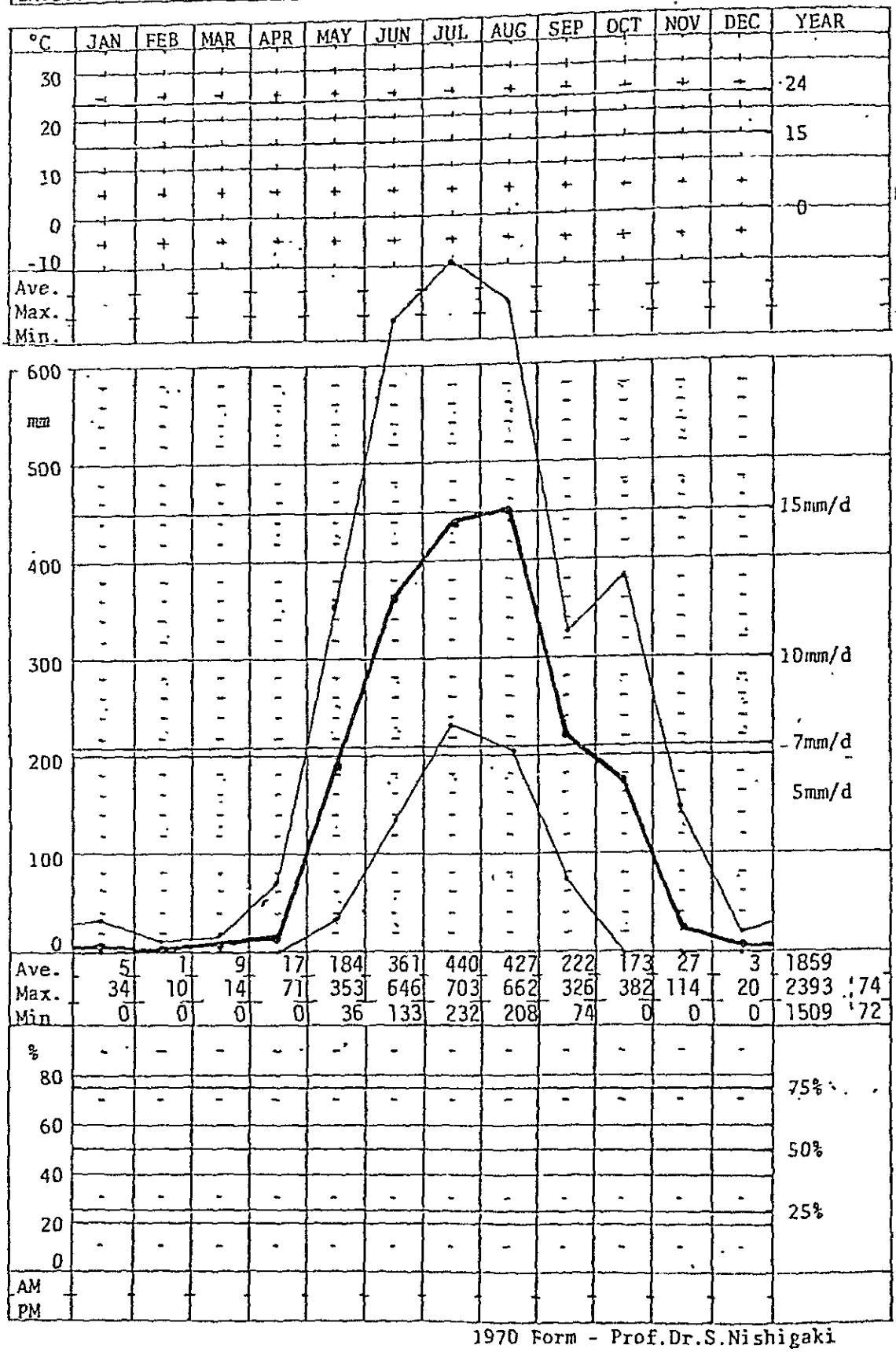
Wind Direction

1975 Form - Prof.Dr.S.Nishigaki

TABLE B-5-9 CLIMATE OF MINHLA

PLACE Minhla Minhla, Pegu, COUNTRY BURMA

LATITUDE N 17° 59' LONGITUDE E 95° 43' METERS



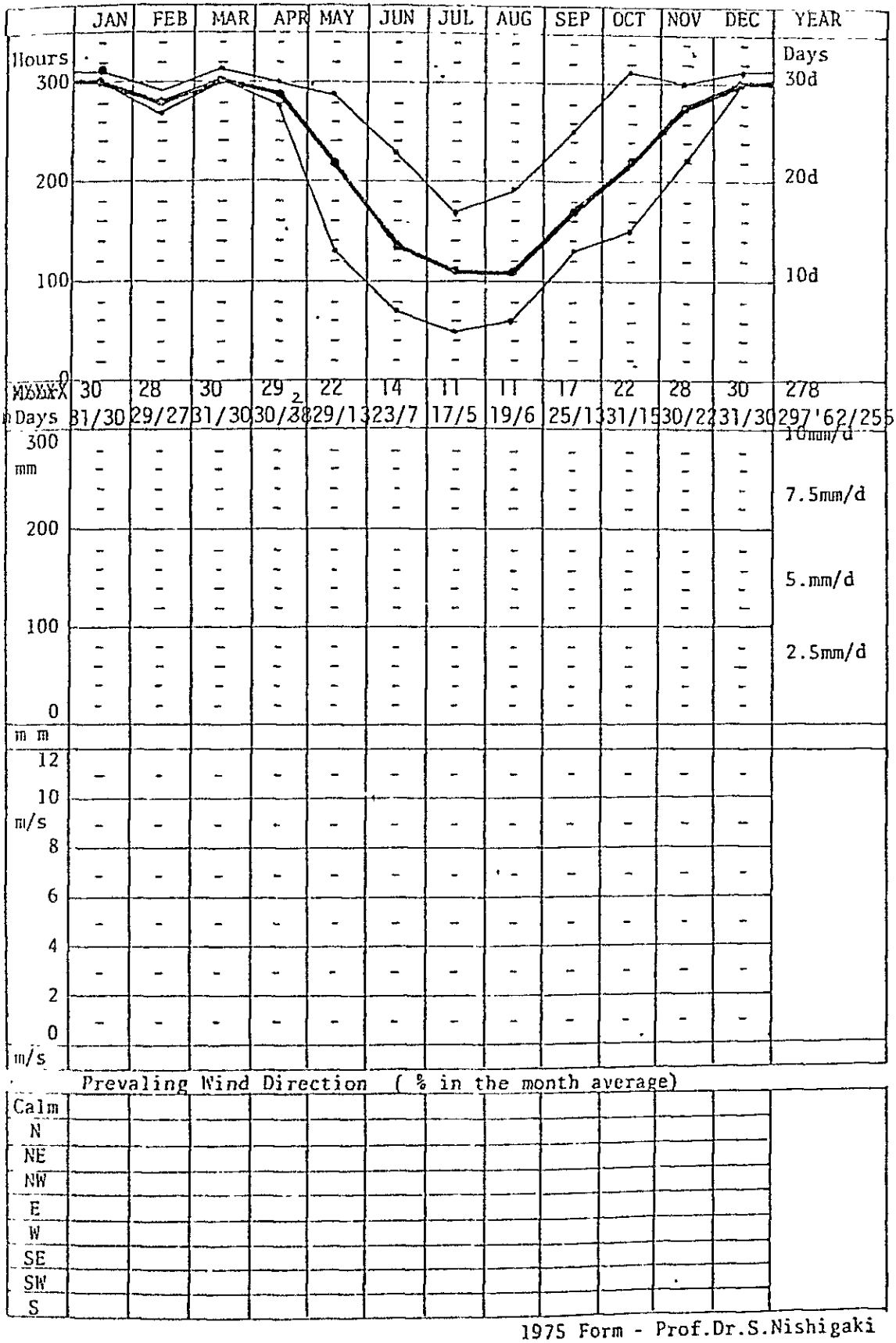
1970 Form - Prof.Dr.S.Nishigaki

(cont'd)

TABLE B-5-9 CLIMATE OF MINHLA (cont'd)

PLACE: Minhla, Minhla, Pegu — COUNTRY: BURMA

LATITUDE N 17° 59' — LONGITUDE E 95° 43' — METERS



1975 Form - Prof.Dr.S.Nishigaki

VI. SOIL STUDIES

VI.1. Introduction

The Land Use Bureau of Settlement and Land Records Department conducted a reconnaissance soil survey in the Area under the guidance of Mr. B.G. Rozanov, the Soviet soil expert, and published soil and land use reports on Prome, Henzada, Tharrawaddy, Insen and Maubin districts in 1959. Later, the western type of soil study has been introduced to Burma and soil surveies on this line were started to cover small areas in question, however, no new soil survey has been done for a large area such as the Area. The Center for Southeast Asian Studies, Kyoto University, conducted soil studies in the Area in 1976. The rice soils of Burma were reported by U Ye Goung, U Khin Win and U Win Htin in 1978.

The team of the Master Plan Survey of the second stage for the Irrawaddy Basin Agricultural Integrated Development studied soil of this area in 1978. The survey team of the third stage collected soil data to add necessary data for the completion of the soil report in 1979.

VI.2. Methods Used in the Soil Studies

(1) Soil Texture

The Soviet system of classification of soil texture was used for the reconnaissance soil sruvey of this Area published in 1959. In the Soviet system of mechanical classification of soil, the size is generally divided into three parts, namely sand (3.0-0.05 millimeters), silt (0.05-0.001 millimeters) and clay (under 0.001 millimeters).

However, in the case of soil classification, soil textures are classified into only two parts, physical sand (3.0-0.1 millimeters) and pysical clay (under 0.1 millimeters) and this was used in soil

survies in Burma.

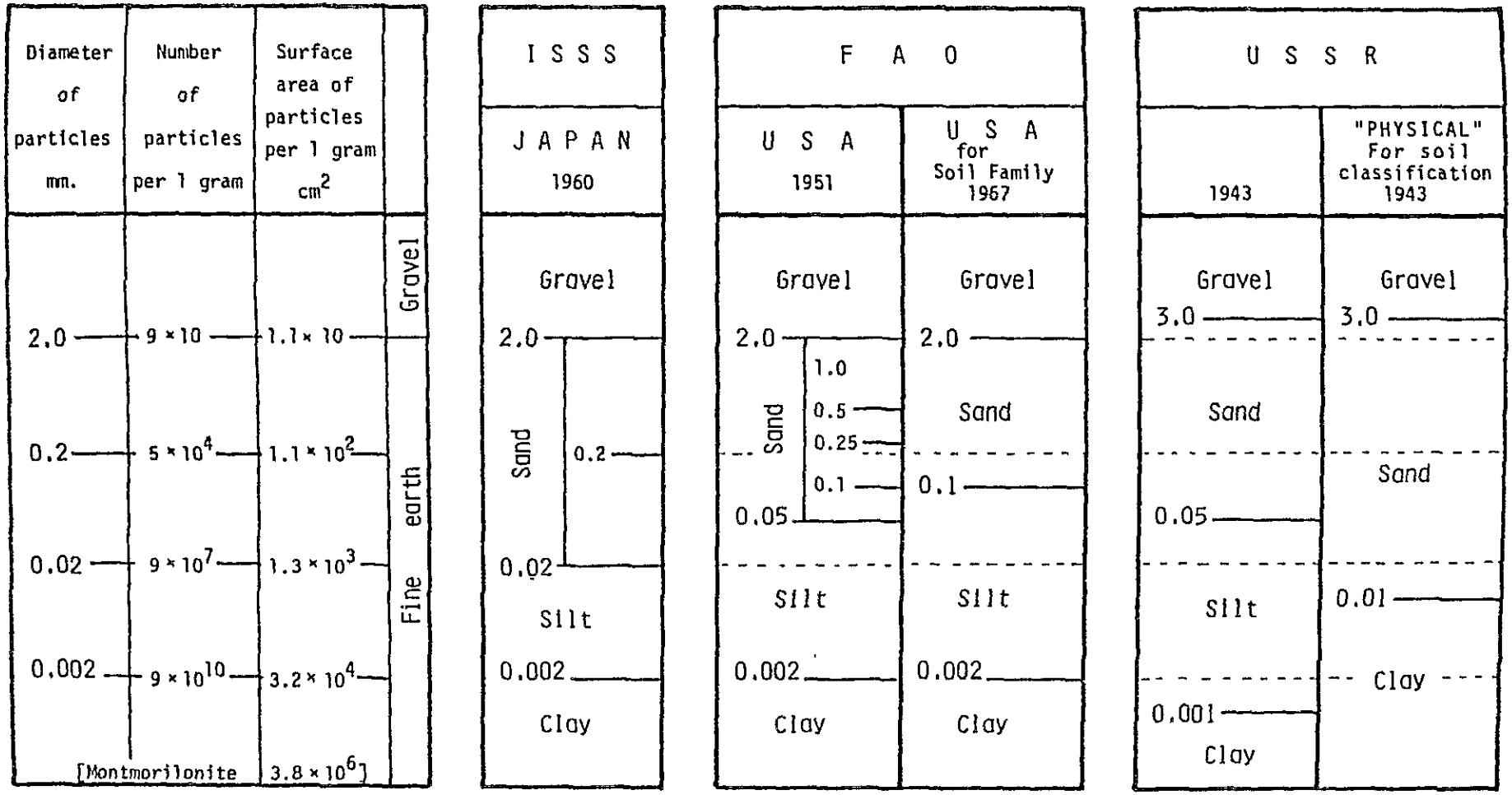
The mechanical classifications in size used by International Soil Science Society, FAO-USA and USSR system are compared in Figure B-6-1.

The nomenclature of soil texture in the International Soil Science Society (I.S.S.S.), FAO-USA, FAO soil map of the world and USSR systems are compared in Figure B-6-2.

The Burmese (Soviet) system of nomenclature of the soil texture also differs from the western style. The texture firstly diveded into three parts of clayey, loamy and sandy, and the clayey is divided into heavy, medium and light clay, and loamy is also divided into heavy, medium and light loam. (Refer to Figure B-6-2)

It is quite clear that the theoretical translation of soil texture between systems is difficult, however, the relation between systems can experimentally be obtained. The soil texture data obtained by the third team using a field method and by Dr. K. Kyuma using laboratory method are employed to get a mutual relation between Burmese and International Soil Science Society methods. The results are summarized in Figure B-6-3.

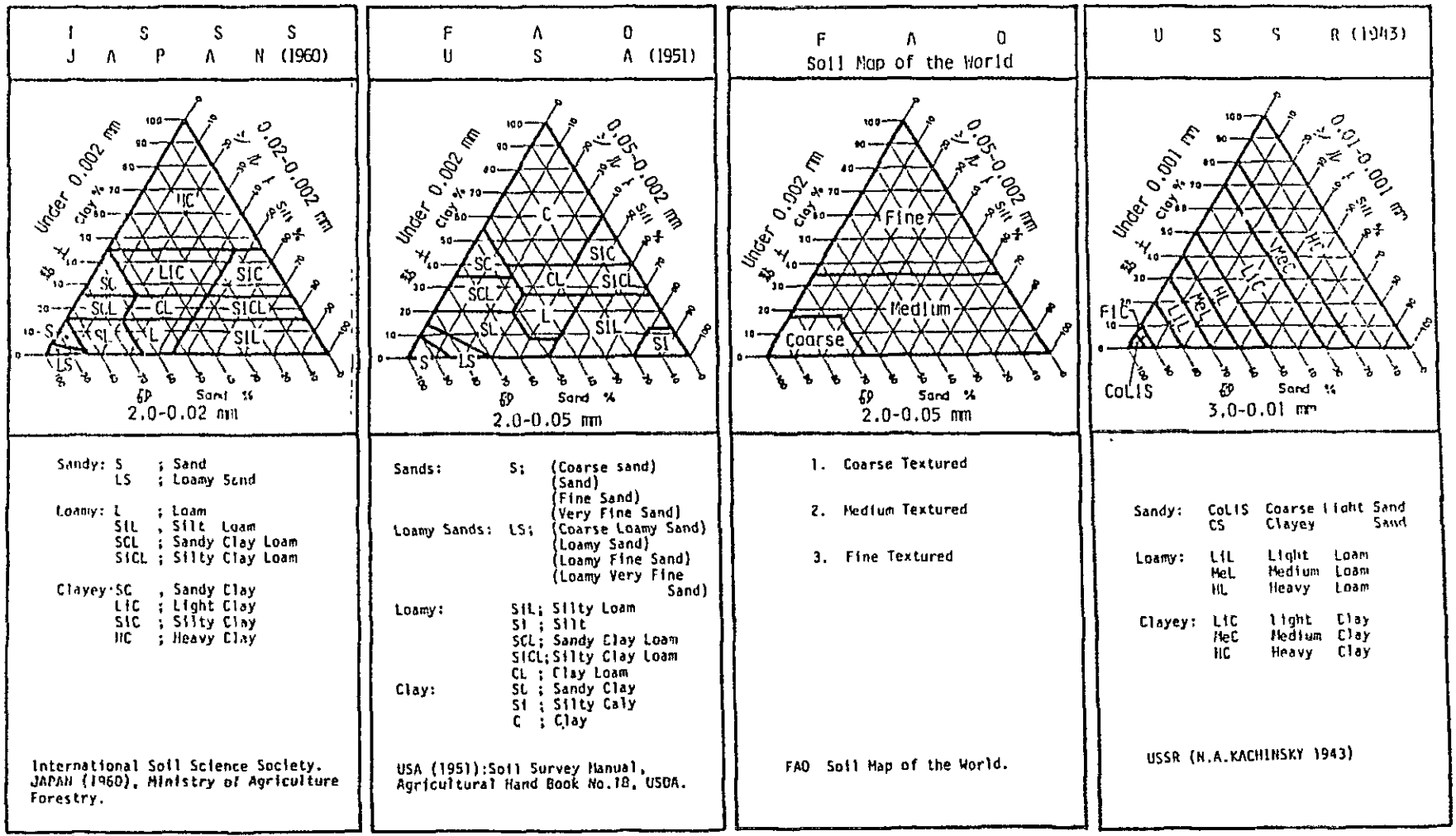
The clays of Burma (USSR) are mainly found to be heavy clay and silty clay of International Soil Science Society and these types of soil texture are suitable for water-logged rice culture. The heavy loam of Burma (USSR) is mainly found to be light clay or some more lighter texture of I.S.S.S. system, so that it is suitable for both water-logged rice culture and also for diversified crops. The medium loam of Burma is found to be clay loam and silty caly of I.S.S.S system, and this is also good for both water-logged rice culture and diversified crops. The light loam of Burma is found to be very coarse texture of I.S.S.S. system such as sandy loam, sandy clay loam and sandy clay, and they are not suitable for



Source: Prof.Dr.Susumu NISHIGAKI, Text of the lecture on soil science, University of Ryukyus, 1976.

[ISSS=International Soil Science Society, FAO=Food and Agriculture Organization of United Nations, USSR=The Union of Soviet Sosialist Republic]

FIGURE B-6-1 THE SIZE OF PARTICLES OF SOIL MECHANICAL SEPARATES



Source: Prof.Dr. Susumu NISHIGAKI, Text for Lecture on Soil Science, University of Ryukyus, (1976)

FIGURE B-6-2 NOMENCLATURE OF SOIL TEXTURE IN THE SYSTEMS OF VARIOUS INTERNATIONAL ORGANIZATIONS AND COUNTRIES

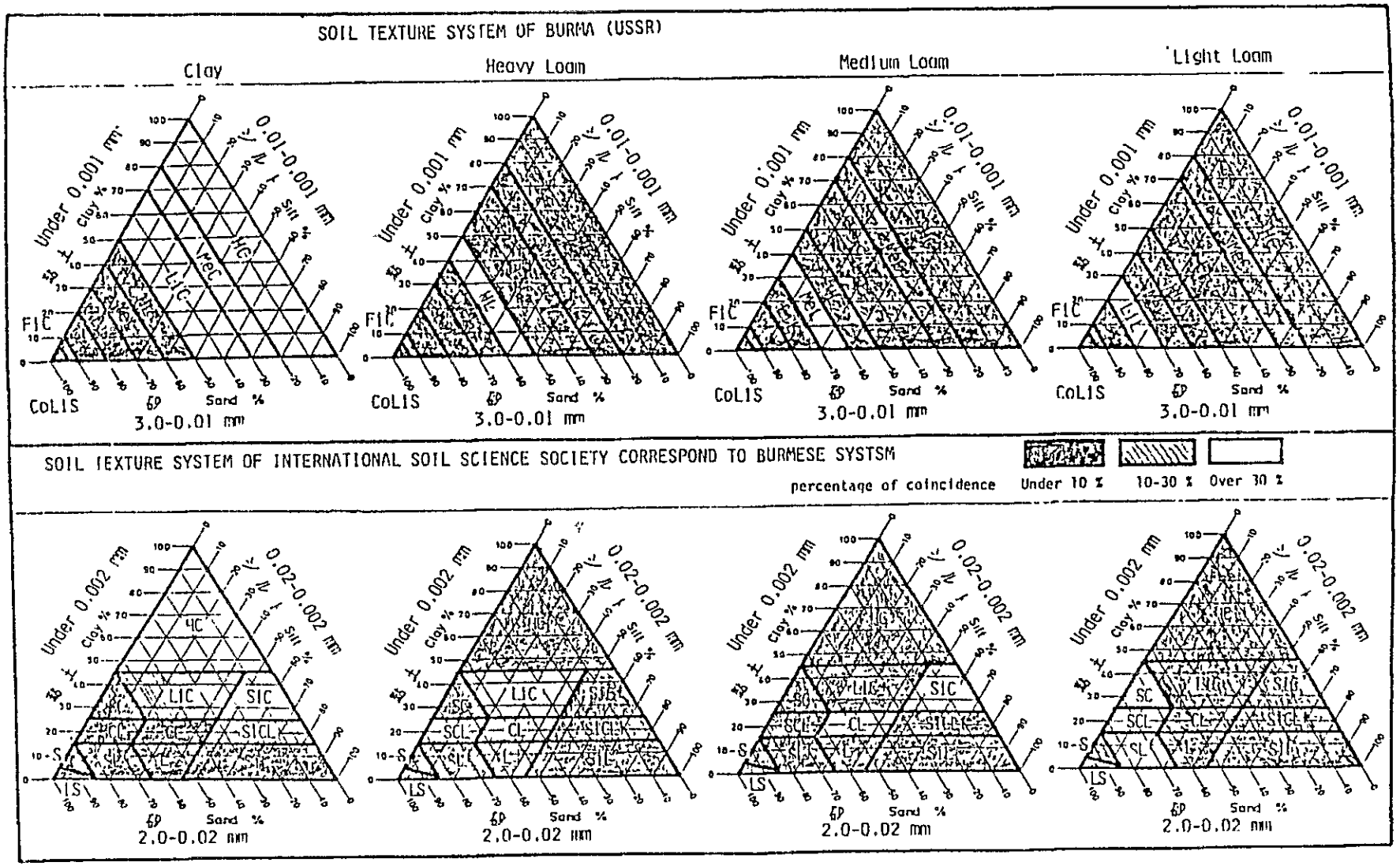


FIGURE B-6-3 COMPARISON OF SOIL TEXTURE SYSTEMS BETWEEN BURMA AND ISSS.

water-logged rice culture and suitable for diversified crops. unless the ground water level is very close to the surface of soil.

Through the above mentioned studies of soil texture, the nature of the Burmese soil texture system became so clear and understandable, that the Burmese nomenclature of soil texture can be used for further discussion.

(2) Soil Classification

(a) Introduction

The available Burmese soil reports and Burmese soil maps (1959) for the Area based on the soil survey, which was conducted under the guidance of Mr. B.G. Rozanov, the Soviet soil expert, is based on the USSR system. The great groups of soils in the system are described by Messrs. I.P. Gerasimov and M.A. Granovskaya and is listed in Appendix B-1.

The report on the soils of the whole Burma was published by Mr. I.I. Karmanov of USSR (1966), and the classified the whole Burmese soils into 13 great groups. (Appendix B-2)

FAO and UNESCO and International Soil Science Society have established the world soil classification and published the world soil maps and the maps containing Burma.

(b) Burmese Soil Classification and FAO Soil Classification

The relation between Burmese and FAO soil classifications is summarized in Table B-6-4. A topography map, Burmese soil map and FAO soil map of main part of Burma are shown in Figures B-6-4, B-6-5 and B-6-6 respectively. The tables and maps clearly show the correlation between the Burmese (USSR) and FAO systems of soil classification, so that the Burmese soil classification is used for further discussion.

TABLE B-6-1 LEGEND FOR SOIL MAP OF BURMA AND FAO SOIL MAP OF THE WORLD IN COMPARISON OF SOIL CLASSIFICATIONS OF BOTH SOIL MAPS.

Symbol	BURMESE NAME OF SOILS (USSR SYSTEM)	FAO SOIL MAP OF THE WORLD			
		NOTATIONS	MAIN SOILS	ASSOCIATED SOILS	SOILS OF SMALL AREA
NITOSOLS					
A	Lateritic Soils Laterites	Nd 55 -2/3b	Dystric Nitosols	Af Ferric Acrisols	Ap Plinthic Acrisols I Lithosols
B	Yellow Brown Forest Soils Mountainous Yellow Brown Forest Soils Turfy Primitive Soils	Nd 55 -2/3b	Dystric Nitosols	Af Ferric Acrisols	Ap Plinthic Acrisols I Lithosols
ACRISOLS					
C	Red Brown Forest Soils Mountainous Red Brown Forest Soils Turfy Primitive Soils	Ao 76 -2/3c	Orthic Acrisols	I Lithosols Nd Dystric Nitosols	Ah Humic Acrisols
D	Yellow Brown Forest Soils Mountainous Yellow Brown Forest Soils Turfy Primitive Soils	Ao 89 -2/3b	Orthic Acrisols	Af Ferric Acrisols Lf Ferric Luvisols	Fp Plinthic Ferralsols Gp Plinthic Gleysols
E	Red Eath Mountain Red Earth	Ao 90 -2/3c	Orthic Acrisols	Af Ferric Acrisols Lf Ferric Acrisols	Fp Plinthic Ferralsols Gp Plinthic Gleysols
F	Red Earth Mountain Red Earth	Ao 89 -2/3b	Orthic Acrisols	Af Ferric Acrisols Lf Ferric Luvisols	Fp Plinthic Ferralsols Gp Plinthic Gleysols

(cont'd)

LUVISOLS					
G	Red Brown Savanna Soils	Lc 12 -2/3ab	Chromic Luvisols Eutric Planosols Sodic Planosols	Lk Calcic Luvisols Vp Pellic Vertisols	We Eutric Planosols Z Solonchaks
H	Cinnamon Soils of Dry Forest	Lc 12 -2/3b	Chromic Luvisols	Lk Calcic Luvisols Vp Pellic Vertisols	We Eutric Planosols Z Solonchaks
I	Primitive Crushed Stone Red Brown Primitive Eroded Soils of savanna	Lf 59 -2/3b	Ferric Luvisols	Bf Ferralic Cambisols	I Lithosols Je Eutric Fluvisols
CAMBISOLS					
J	Red Brown Forest Soils Mountainous Red Brown Soils Turfy Primitive Soils	Bf 17 -2c	Ferralic Cambisols	Ao Orthic Acrisols Fr Rhodic Ferralsols	I Lithosols Je Eutric Fluvisols
K	Red Brown Forest Soils Mountainous Red Brown Soils Turfy Primitive Soils	Bd 61 -2c	Dystric Cambisols		
L	Cinnamon Soils of Dry Forest	Bc 11 -2a	Chromic Cambisols	Je Eutric Fluvisols Je Eutric Regosols	Jc Calcaric Fluvisols Rc Calcaric Regosols
M	Mountainous Meadow Alpic Soils	I-Bh-U-2c	Lithosols Humic Cambisols Rankers		
N	Turfy Primitive Soils	Bh 16 -2/3c	Humic Cambisols	Ah Humic Acrisols I Lithosols	U Rankers
VERTISOLS					
O	Dark Compact soils of Savanna	Vp 40 -3a	Pellic Vertisols	Je Eutric Fluvisols Vc Chromic Vertisols	Zg Gleyic Solonchaks
LITHOSOLS					
P	Turfy Primitive Soils	I	Lithosols		

(cont'd)

GLEYSOLS					
Q	Meadow Alluvial Soils	Gh 16 -2/3a	Humic Gleysols	Ge Eutric Gleysols	Je Eutric Fluvisols
R	Meadow Alluvial Soils	Gh 37 -2/3a	Eutric Gleysols	Gm Mollic Gleysols	Je Eutric Fluvisols Vp Pellic Vertisols
S&T	Dark Meadow Soils (Meadow Soils of Upper Burma)	Gh 16 -2/3a	Humic Gleysols	Ge Eutric Gleysols	Je Eutric Fluvisols
U	Light Coloured Meadow Soils (Meadow soils of Lower Burma and Simular soils)	Gh 16 -2/3a	Humic Gleysols	Ge Eutric Gleysols	Je Eutric Fluvisols
V	Light Coloured Meadow Soils (Meadow Soils of Lower Burma and Simular Soils)	Ge 37 -23a	Eutric Gleysols	Gm Mollic Gleysols	Je Eutric Fluvisols
W	Complex of Light Coloured Meadow Soils Meadow Swampy Soils, Meadow Alluvial Soils and Swampy Soils	Ge 50 -2/3a	Eutric Gleysols	Je Eutric Fluvisols	Jt Thionic Fluvisols Oe Eutric Histosols We Eutric Planosols
SOLONCHAKS					
X	Saline Soils	Zg 4 -3a	Gleyic Solonchaks		Je Eutric Fluvisols Jt Thionic Fluvisols
Y	Salty Mud	Zg 4 -3a	Gleyic Solonchaks		Je Eutric Fluvisols Je Thionic Fluvisols
THIONIC FLUVISOLS					
Z	Soils of Mangrove Forest	Jt 11 -3a	Thionic Fluvisols		Ze Gleyic Solonchaks

(cont'd)

Note: (1) Texture
1. Coase Textureed; Sands, Loamy sands and Sandy loam with less than 18 percent clay, and more than 65 percent sand.
2. Medium Textured; Sandy loams, Loams, Sandy clay loams, Silt loams, silt, Siltyclay loams with less than 35 percent clay and less than 65 percent sand: the sand fraction may be as high as 82 percent if a minimum of 18 percent clay is present.
3. Fine Textured; Clays, Silty clays, Clay loams, sandy clays and Silty clay loams with more than 35 percent clay.

Note: (2) Relief
a: Level to gently undulating; Dominant slopes ranging between 0 and 8 percent.
b: Rolling to hilly; Slopes ranging between 8 and 30 percent.
c: Steeply dissected to mountainous; Dominant slopes are over 30 percent.

Sourse: Soil map of Burma (Land Use Division, A.C.) and Soil Map of the World (FAO)

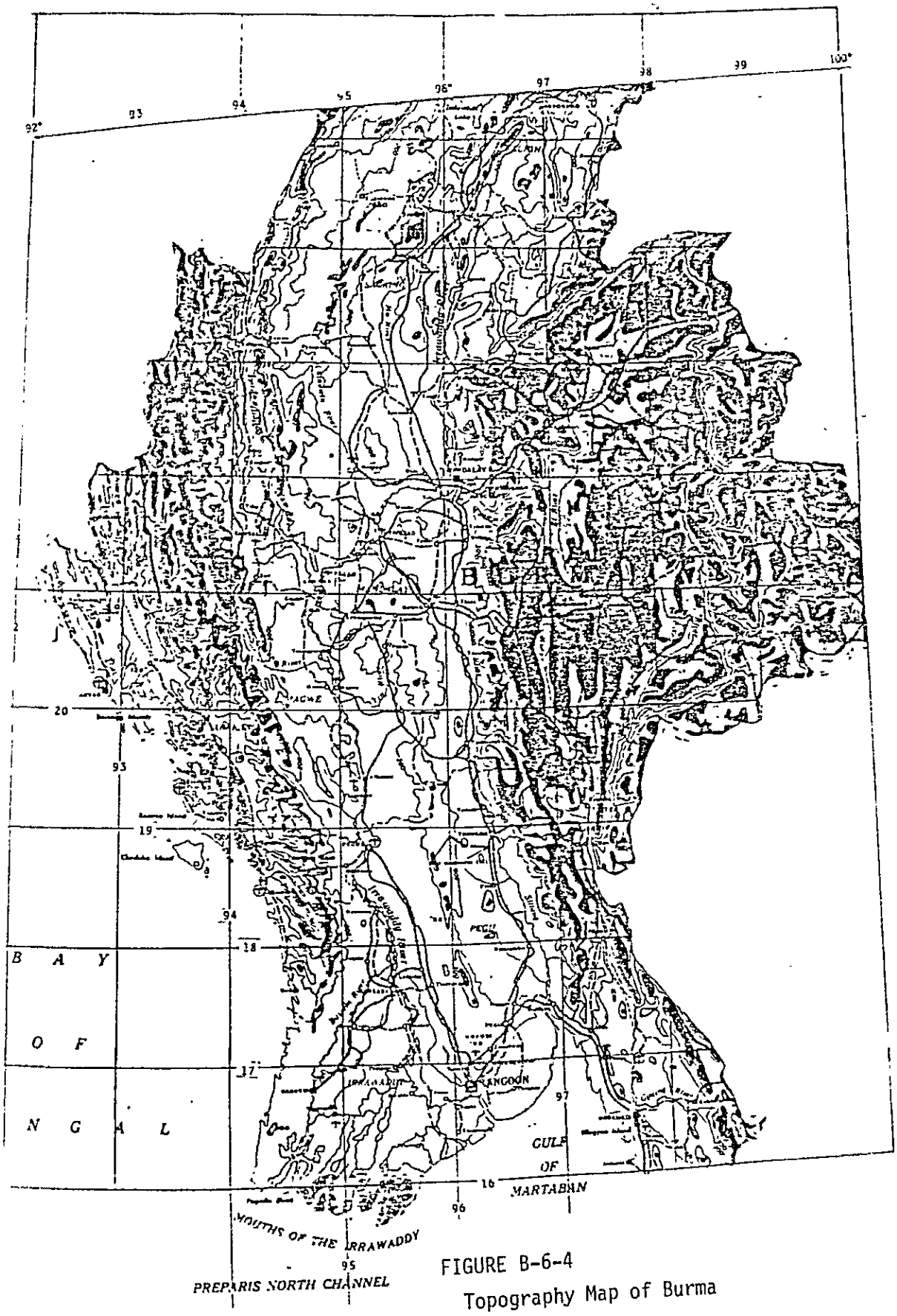


FIGURE B-6-4
Topography Map of Burma

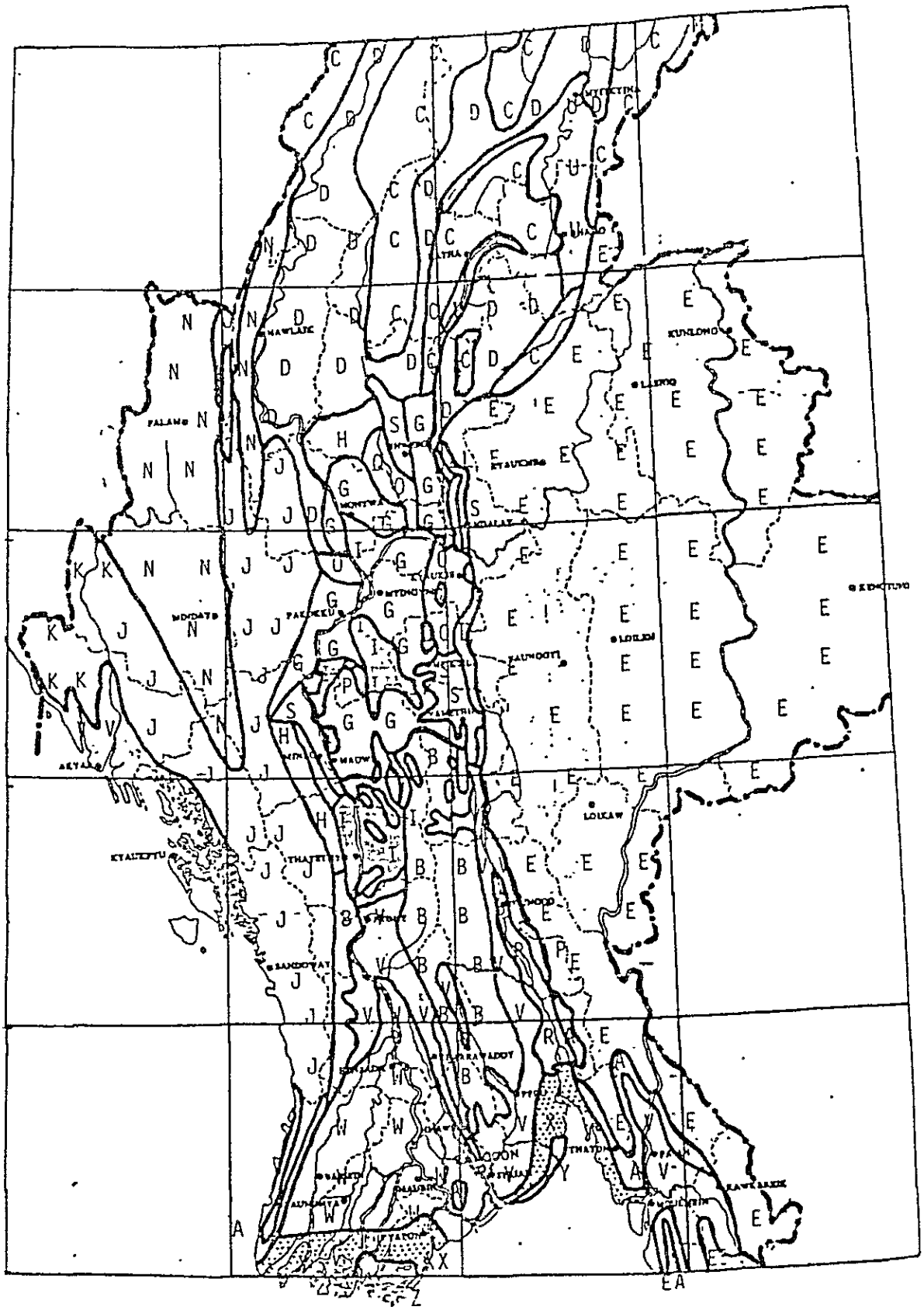


FIGURE B-6-5 Soil Map of Burma (Land Use Division, A.C.)

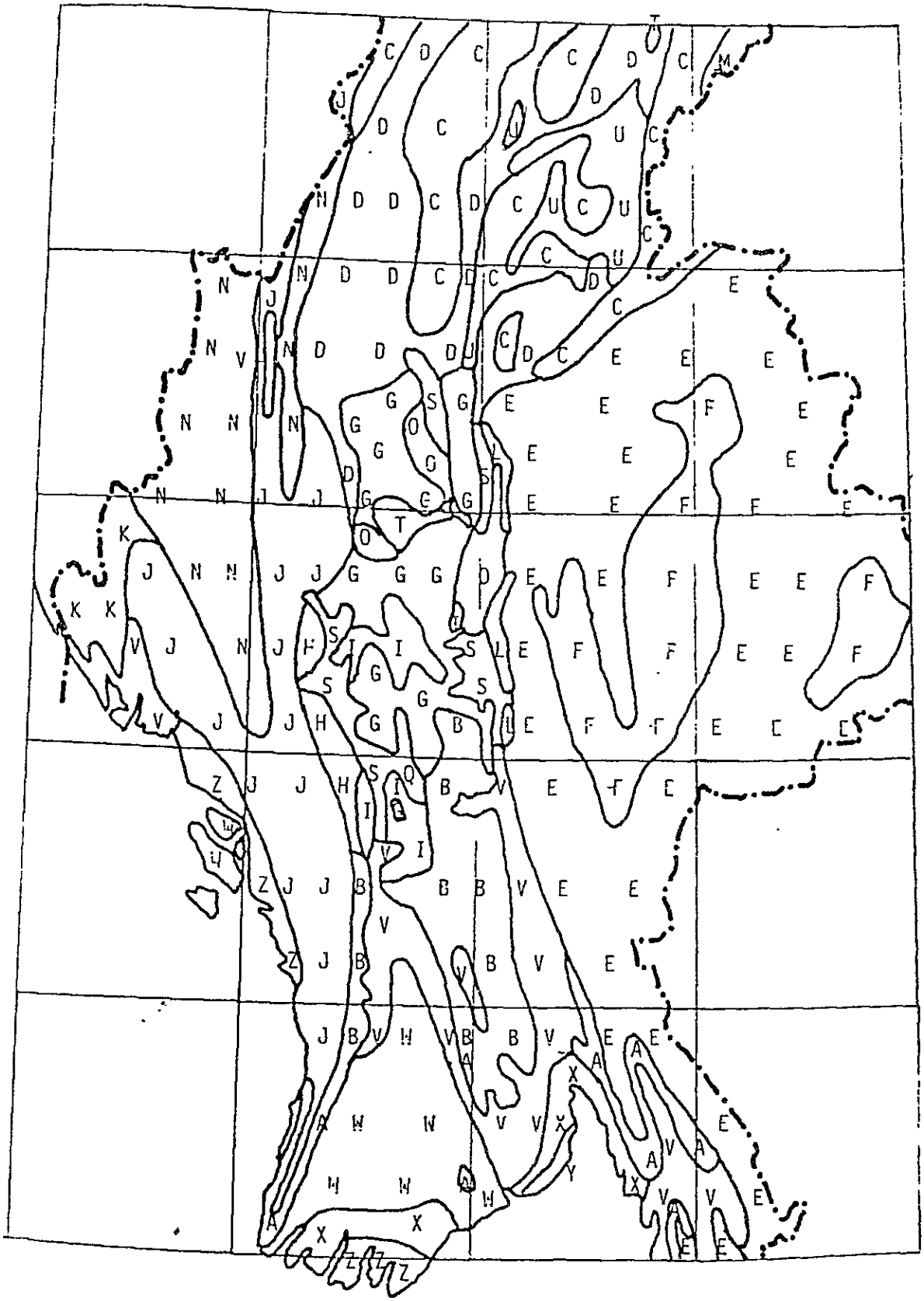


FIGURE B-6-6

FAO Soil Map of the World (1:5,000,000)

(3) Soil Investigations

Soil and Land Use Reports (1959) made by Land Use Bureau of Agriculture Corporation of Burma were used for the soil investigations as the basic data. The six volumes of Prome, Henzada, Tharrawaddy, Insen, Bassein and Maubin were used for the Area. The soil maps of one inch for four miles (1/253,440) were used. The maps had been made using one inch for one mile (1/63,360) in the field survey and they were summarized into the maps of one inch for four miles.

However, the original working field maps were lost. The density of soil survey was one soil profile per 5,000-10,000 acres, however, the original profile data also were lost and only typical profiles were listed in the soil reports. Soil texture (Burmese Method) and chemical analysis were reported on typical soil profiles. The soil pH, total nitrogen, humus, available constituents of nitrogen, phosphorus and potassium and exchangeable calcium, and magnesium. (Ref. to Appendix B-3)

The second survey team (1978) investigated 47 soil profiles in the Area and the soil samples were subjected to quick chemical tests on pH, nitrate nitrogen, ammonia nitrogen, available phosphorus and exchangeable calcium and magnesium. (Appendix B-3)

The Center for Southeast Asian Studies, Kyoto University (Professor Dr. K. Kyuma) studied the soils of Irrawaddy Delta (1977). Soil profile studies were made at 82 sites in the Delta and about 30 sites were in the Area. (Appendix B-3) The soil texture was determined for each layer of soils using the method of International Soil Science Society. Soil samples of surface layer were subjected under laboratory chemical analysis on soil pH, electric conductivity, total carbon, total nitrogen, ammonia liberation, total phosphorus, bray soluble phosphorus, hydrochloric acid soluble phosphorus, exchangeable calcium, magnecium, sodium and potassium, cation exchange capacity, degree of base suturation and available silica.

The third survey team studied soil texture by a field method and studied Yellow brown soils and lateritic soils.

The topography maps of one inch for one mile were studied on contour lines of every 50 feet for the plain area and other topographic factors such as lakes, rivers, bushes, swamps and so on. After the above mentioned procedure was taken place, the soils were studied referring given soil maps and also boundaries of soil areas were amended when necessary. Then the resulting maps of one inch for one miles were reduced in magnification and copied into a small scale map so that one map can cover the whole Area.

The whole area map received further correction referring both the maps made by satelite observation and Land Sat photography.

VII. SOILS IN AREA

VII.1. Soils on the Hills and Mountains

(1) Lateritic Soils (Dystic Nitosols)

The lateritic soils occur widely in the low hilly areas of the southern foot hills of the Pegu Mountain Range. In many cases, soils are developed on the light loamy and pervious diluvial deposits and clay content increases in the deeper soil layers. The lateritic soils contain about 10 percent of yellow brown forest soils in the soutnern part of the lateritic soil area, and they contain more (20-50 percent) in the northern part.

Because of a gentle slope, the area of lateritic soils seems to be good for reclamation to made farm lands, however, surface soils are taken off by severe erosion caused by heavy rains in a rainy season and a thin surface soil over the hard laterites was in many places. In such areas, the cultivation of the deversified crops is not suitable, but poor garden crops or tree corps can be only cultivated.

The lateritic soils are acid (pH 4.5-5.0) and most of the areas of the soils covered by dense forests and only these vegitation can prevent severe erosion in these areas, so that lateritic soils are better to be covered by good forests as a conclusion, instead of destroying them. Specially rubber can be successfully grown on those soils.

(2) Red Brown Forest Soils

Along the water shed of the Arakan Mountain Range, Red Brown Forest Soils are developed on the sandstones, shales of rather hard rocks. Northern part of the area of this soils is very steep and the soils contain Turfy Primitive Soils (Lithosols) at the rate of 10-25 percent. In the southern part of the area of the soils, soils are shallow at the water shed and are deeper at lower elevation. The red brown forest soils contain yellow brown forest soils at the

rate of 10-35 percent in the southern area.

The area of the red brown forest soils can be used as forests, because of the relief of steep slopes and good supply of water by the heavy rainfall of over 2,000 millimeter a year. The soils in the Arakan mountain have not been fully studied up to present, because of difficulty of transportation and security problem, so that the geology and soils have to be studied in future.

(3) Yellow Brown Forest Soils (Arakan Mountain)

The yellow brown forest soils occur at the foothills of Arakan mountain range and the hilly relief denominated by slope gradients of 9-19 percent. Sandstones and shales of the Eocene, Oligocene and Miocene age and Irrawaddy sandstones of the Pliocene age are the parent rocks of the soils. The soil texture belongs to medium or light loam, although the soils sometimes contain grits and gravels, as the parent rocks contain such materials, except the case of Irrawaddy sandstones.

The area of the soils receives precipitation of more than 2,000 millimeter a year and is covered with dense forests. Though soil conditions are such as hilly relief and lightness of soil texture, the soils found to be excessively drained and soil erosion is found to be generally serious in the area of the soils except places where preventive forest cover is comparatively dense.

The yellow brown forest soils in Arakan mountains is better to be left as good forest and should be taken care not to destroy it.

(4) Yellow Brown Forest Soil (Pegu Mountains)

Yellow brown forest soils occur in the main body of Pegu mountain range. The parent rocks consist of sandstone and shale of the Oligo-Miocene age and rocks are not hard and deeply weathered, resulting medium or light textured soils. In the higher elevation, the yellow brown forest soils are combined with rock out crops

forming primitive crushed stone soils (Lithosols). The dark yellow brown forest soils occur only on the low parts of slopes in the narrow valleys between hills.

Because of excess drainage, acidity and poor nutrients of soils, the forests on the soils are not dense and erosion is serious in the loose forests. This will be the origin of the heavy siltation in the Myitmaka River area and the inundation area along the river in the rainy season might be spread larger by further siltation.

The forests in the area of yellow brown forest soils (Pegu mountains) must be kept and must not be destroyed and must be improved and it is desirable that the Myitmaka River and agricultural environments in the foot plains can be thus kept.

(5) Yellow Brown Carbonate Forest Soils

The soils occur on the foothills of the Arakan mountain and the hills are dominated by slope gradient of 9-19 percent and therefore the relief of the terrain is not favourable for ordinary cultivations and only small areas of gentle slopes are used for Ya cultivation (cultivation of upland crops). The parent rocks are mainly are made of Oligo-Miocene limestones. The rocks contain clays interbedded with marls transversed by corbonaceous seams, grits and shales and recent gravels and sands.

The natural plant cover of the terrain of the soils is represented by decidous forests and erosion is fairly serious in the area of the soils.

Soil texture is dominated by medium loam and concretions of carbonate are found in the profile.

(6) Meadow Degraded Soils of Indain Forests

The meadow degraded soils developed on the foothill of Pegu mountains and the hills are made of Irrawaddy sandstones of the

Pliocent age. The soil texture is light loam reflecting the texture is light loam reflecting the texture of Irrawaddy sandstones which is rich in sand and poor in clayey materials. The soils are strongly leached and very poor in nutrients. The soils are generally strong acid in the top soil.

Most part of the soils are covered with forest of Dipterocarp (Indain) are excessively drained and have great porosity. The erosion is very sever where the forests are thin.

(7) Primitive Crushed Stone Soils

Along the watershed of Pegu mountains, the area of high elevation slopes very steeply and develops primitive crushed stone soils on the sandstones and shales of Pegu series of Oligo-Miocent age.

The main plants of the areas of the soils are forests except the places where the rocks are exposed.

VII. 2. Soils on the Plain

(1) Meadow Soils (Medium Loam and Heavy Loam)

Meadow medium and heavy loam soils developed on the old alluvial plains of over 30 meter elevation and on different friable deposits, mostly on old river alluvium and diluvial deposits derived from surrounding hills. Generally the soils developed on plain relief. The texture of surface soils belongs to heavy loam in the northern part and to medium loam in the southern part. The soils are inadequately drained and suturated by water in the mid-rainy season, however, better drained than meadow alluvial and meadow gley soils. The soils are good for rice culture in the rainy season and good for both rice and diversified crops in the dry season, when the irrigation water is available.

The meadow soils are generally acid or strong acid at the top layer of the soils.

(2) Meadow Gley Heavy Loam Soils

Meadow gley heavy loam soils generally developed on the alluvial plain relief of over 15 meters elevation and on the old river alluvium and on the diluvial deposits derived from higher hills. Due to the long time of paddy cultivations and to the conditions of impeded drainage, they accepted some specific features characteristic for the paddy soils.

They are completely suturated with water during rainy season. During dry season soils are dried to the deep layers. Meadow gley heavy loam soils are good for rice cultivations in the rainy season, however, they are good for both rice and diversified crops in the dry season, when irrigation water is provided.

(3) Meadow Gley Clay Soils

The meadow gley clay soils developed on the old alluvium and at the level and lower relief of the plain.

The soils are poorly drained and are water logged for the most of the rainy season. But in the dry season, the ground water level is generally 4-6 meter deep. All the horizons of the soils are clayey, muddy and almost no structure, and when the soils are dried, they become hard and blocky in the dry season. Kaolinite and hydrous mica are dominant in the soils.

Because of the clayey texture of soils, rice culture is suitable both in the rainy and dry seasons.

(4) Meadow Swampy Soils (Clayey)

The meadow swampy clayey soils occur in the depressed areas of the alluvial plain. Being situated in the lower part of the area, they are overmoistured for the most of the year and are subjected under inundation for about 6 to 9 months. Because of these reasons they are mostly not under cultivation and are covered by

meadow and swampy coarse grasses.

The whole profile is strongly gleyed from top to bottom. However, the potentially rich nutrients in the soils and the only limitation is excess of water in the rainy season. The regulation of water regime is of primary importance here. The main melioration here is a embankment and drainage control to take away an excess of water in the rainy season.

(5) Swampy Gley Soils (Clayey)

Swampy gley soils occupy meander belts, where the local rivers are winding in the broad depressions of the relief and waterlogged for the most part of the year. The soils are similar in water regime in the previously described meadow swampy soils. However, swampy gley soils are strongly gleyed contain poor nutrients. The area of swampy gley soils will not be suitable for drainage works, because firstly they locate at an unstable condition in the meander belt and secondly soils are not rich enough to support good yield of crops.

(6) Immautred Alluvial Soils

These soils occur on the inundated terraces and islands of the Irrawaddy River. It is purely made of river silty alluviums which have been deposited by alluvial activities of the Irrawaddy River. These alluvium generally show stratifications of little differing textures. Texture usually is light or medium loam. The terrain is inundated for about 4 to 5 months in the rainy season and well drained in the dry season.

These soils have long been cultivated with so called Kaing crops and the area is so called Kaing lands, which means upland crop cultivation starting immediately after inundation goes off.

The immatured alluvial soils are locating at the river course so that the lands are not stable and they are not suitable for any treatments.

(7) Medow Alluvial Soils (Light Loam and Medium Laom)

The area of the meadow alluvial light and medium loam soils is dominantly composed of meandering river alluviums which might be thought to have deposited during old alluvial age. The terrain of the soils is full of meander-scrolles, abandoned channels, ox-bow lakes and so on. These soils occupy comparatively elevated places and the most of meander-scrolles are also generally higher than surrounding areas. These alluvium are quite variable in perticle composition ranging from medium to light loams. Along the profile the alluvium are found to be fairly unform particle size.

Where the terrain of the soils is sufficiently higher than surrounding area, the terrain of the area is used for Ya cultivation and Graden cultivation. Where the terrain is level to ground water table in the rainy season, the soils are planted by rice plants. But after the floods, the area is easily drained due to comparatively lighter texture and more pronounced relief. In some lower places of the area of the soils are used Kaing land.

(8) Meadow Alluvial Soils (Clayey)

These soils occur under the same soil formation factors as the above mentioned medium and light loam meadow alluvial soils, except relief and parent material. They differ from the meadow alluvial soils of light texture in having lower relief or poorer drainage and heavier texture. The meadow alluvial clayey soils usually associated with swampy gley soils. Because of their comparatively lower relief and heavier texture, the terrain is poorly drained, and remains water-logged for 6 months during rainy season.

In the rainy season rice plants are cultivated in the shallow waterlogged area, however the area of deep inundation and the area of associated swampy gley soils are left fallow.

(9) Meadow Alluvial Soils (Sandy)

The soils occur in the Irrawaddy River as a most recent deposits.

Many areas of this soils are inundated druing rainy season and used as Kaing lands after inundation.

(10) Salty Muddy Swamps

The soils in the swamps occur along the river which is not far from the sea. The main plants are manglove forest and the soils contain salts but also contain ferrous sulfide. When the soils of the salty muddy swamps are dried, hydrogen sulfide is produced by oxydation resulting very acid soils.

These soils is difficult to use for cultivation of crops, because of salinity and strong acidity.

Short discriptions on profiles of the typical soils are shown in Table B-7-1. Soil map and the legend for it is shown in Figure B-7-1 and Table B-7-2.

TABLE B-7-1 Short Description on Tipical Soil Profiles

Symbol	Depth	Texture	Common colour	Mottled colour	Structure	Hardness	Pores	Conretions or Mottles	Roots	Boundary
LATERITIC SOILS No.1-B.										
Ap	0-25 cm	Light loam	Grayish yellow		Crumby	Friable	Porous			Clear
B	25-100 cm	Light loam	Yellow		Crumby Montnonous	Slightly hard	Porous			Sharp
L1	100-150cm	Fine earth	Yellowish		Pan	Hard		Small round iron concretion intermixed		Gradually
L2	150-250cm	Heavy loam	Pale-yellowish	Reddish	Spngy like					
L3	250-500cm	Heavy loam	Whitish	Reddish	Spongy like					
YELLOW BROWN FOREST SOILS (ARAKAN MOUNTAINS) No. 112.										
A	0-18 cm	Medium loam	Yellow brown		Blocky	Hard	Porous	(Gravel,grits)	Dense roots	Gradually
B	18-95 cm	Medium loam	Light yellow brown		Angular crumby	Very hard	Porous	(Gravel,grits)	Lesser roots	Gradually
B/C	95-123 cm	Light loam	Light yellow brown		Angular crumby	Less hard		(Gravel)	No roots	
YELLOW BROWN FOREST SOILS (PEGU MOUNTAINS)										
A1	0-23 cm	Light loam	Light yellowish Gray		Crumby	Friable	Thin pores		Many roots	Gradually
A/B	23-45 cm	Light loam	Yellowish brown		Crumby	Friable Slightly hard	Thin pores			Gradually
B1	45-63 cm	Light loam	Yellow-brown		Crumby	Friable More harder	Thin pores			Gradually
B2	63-120 cm	Light loam	Brownish yellow		Big Crumby	Friable				

(cont'd)

TABLE B-7-1 Short Description on Tipical Soil Profiles (Continued)

Symbol	Depth	Texture	Common colour	Mottled colour	Structure	Hardness	Pores	Concretion or Mottles	Roots	Boundary
YELLOW BROWN CARBONATE FOREST SOILS										
A	0-18 cm	Medium loam.	Grayish brown (3% Humus)		Crumby	Hard	Pourse	Carbonate concretions	Dense roots	Clear
B	18-55 cm	Medium Loam	Grayish brown		Crumby-natty	Hard	None pores	Some carbonate concretions	Less roots	Gradually
B2	55-113cm	Light loam	Yellow brown		Crumby-natty	Slightly hard	None pores	Much carbonate concretions	None	
MEADOW DEGRADED SOILS (Humic Planosols accordinn to H.E.U Ye Gounq, U Khin Win and U Win Htin 1978)										
Ap	0-18 cm	Light loam	Light yellowish brown	Yellowish and bleuish (spots)	Crumby-natty	Hard	Poures	Spots	Plenty roots	Clear
AB	18-58 cm	Light loam	Light grayish brown			Very hard	Strong-ly porous	Rusty concretion	Roots present	Clear
B	58-100cm	Light loam	Light brownish colour	Yellow-reddish & blueish spots	Angular blocky			Spots		Clear
Bg	100-156cm	Light loam	Yellow	Brown and blue colour mottls	Angular blocky	Very hard	Thin pores	Yellow concretions		
SOILS IN THE PLAINS										
MEADOW MEDIUM LOAM SOILS (167)										
Apg	0-14 cm	L	2.5Y 6/1	7.5YR 5/8 Fine tubular moyyles						
Bg	14-30 cm	L	10YR 7/1	5YR 7/4 Cloudy mottles				Mn sppoty mottles Mn concretions		
Cg	30-70+cm	L	10YR 7/1 10YR 8/1	5YR 4/6 Cloudy mottles				Mn concretions		
MEADOW HEAVY LOAM SOILS (Gleysoils according to H.E.U.Ye Gounq,U khin Win & U Win Htein 1978)										
Ap	0-20 cm	Heavy Loam	Light gray		Structureless cracks	Hard	Thin pores			Gradually
A	20-45 cm	Clay	Dark gray		Structureless	Hard	Thin pores	Small rusty spots		Gradually

(Cont'd)

TABLE B-7-1 Short Description on Tipical Soil Profiles (Continued)

Symbol	Depth	Texture	Common colour	Mottled colour	Structure	Hardness	Pores	Concretions	Roots	Boundary
MEADOW HEAVY LOAM SOILS (Continued)										
AB	15-75 cm	Clay	Dark gray brown	[illegible]	Blocky	Slightly hard	Thin pores			Gradually
B	75-101cm	Clay	Dark brown	Dove-bluish			Thin pores	Dove-bluish rusty spots		
BC	101-150cm	Clay	Reddish brown	Dove-bluish	Structureless			Dove-bluish rusty spots		
MEADOW GLEY HEAVY LOAM SOILS 22-A										
Ap	0-15 cm	Heavy Loam	Light gray		Structureless deep cracks	Very hard	Thin pores	Small rusty spots		
A	15-38 cm	Clay	Gray		Angular blocky many cracks	Very hard	Thin pores			Gradually
A/B	38-53 cm	Clay	Brownish Gray		Structureless many cracks	Hard	Thin pores			Gradually
Bg	53-125cm	Clay	Dark brownish gray	Dove shade	Structureless	Hard	Thin pores			Gradually
C	125-150cm	Clay	Deeper dark gray	Dove shade	Structureless			Many rusty spots		
MEADOW GLEY HEAVY CLAY LOAM SOILS (176) Gonminmyaung Tharrawaddi Township										
Apg	0-13 cm	SiCL	7.5Y 5.5/1	10YR 4/4 10YR 4/6				Fine tubular		
C1g	13-30 cm	SiCL	5Y 5/1	10YR 3/4				Cloudy Mn 5mm concretions		
C2g	30-60 cm	SiCL	2.5Y 5/2	Mottled by 10yR 5/8				Mn 5mm concretions		
MEADOW GLEY CLAY SOILS (Gleysols according to U.S.D.A Ye Goung, U Khin Min & U Win Htin 1978)										
Ap	0-13 cm	Light clay	Light brownish gray			Nutty hard	None	Rusty streaks Rusty spots	Dense roots	Gradually
A	13-30 cm	Light clay	Gray		Structureless	Slightly hard	None	Rusty streaks Rusty spots	Lesser roos	Gradually
A/B	30-85 cm	Medium clay	Gray	Mottled	Structureless or plyhedron	Slightly hard	None	Rusty spots	None	Gradually
Bg	85-135cm	Medium clay	Gray	Mottled	Structureless					

(cont'd)

TABLE B-7-1 Short Description on Tipical Soil Profiles (Continued)

Symbol	Depth	Texture	Common colour	Mottled colour	Structure	Hardness	Pores	Concretions or Mottles	Roots	Boundary
MEADOW GLEY CLAY SOILS (GLEYSOLS) Continued.										
Bg	85-135cm	Medium Clay	Gray	Mottled	Structureless	Weakly hard	None	Small iron concretion Rusty spots	None	Gradually
Cg	135-153cm	Medium clay	Grayish brown		Structureless or massive	Weakly hard	Thin pores		None	
MEADOW GLEY CLAY SOILS L&L Shagon Tegon Township										
Apg	0-15 cm	HC	5Y 5/1	7.5YR 5/6 fine tubular				Fine tubular Filmy		
C1g	15-30 cm	HC	5Y 5/1	10YR 5/4 cloudy				Mn concretions		
C2g	30-60 cm	HC	5Y 5/1	Mottled by 10YR 4/4				Few Mn concretions		
MEADOW GLEY SOILS 160 Mayin Henzada Township										
Apg	0-12 cm	HC	5Y 5/1	7.5YR 5/6 Fine tubular						
Cg	12-80 cm	HC	7.5Y 5/1	7.5Yr 5/6 Cloudy				Mn concretions		
MEADOW GLEY SOILS 153 Kodaung Nathainggyaung Yenyi Township										
Apg	0-10 cm	SiC	5Y 7/2	Fine tubular of 10YR 5/6						
C1g	10-30 cm	SiC	2.5Y 5/1	Cloudy of 10YR4/3: and 10YR 4/6				Mn Fine tubular Mn Filmy		
C2g	30-80+cm	Sic	5Y 6/2	Mottled by 10YR 5/4				Mn concentration Mn concretion		
MEADOW SWAMPY CLAY SOILS 506 Kawkat, Zalun Township.										
Ao	2-0 cm	Decade Grass litter								
A	0-18 cm	Heavy clay	Light gray		Nutty Cracks makes polygonous of 30cm dia.	Very hard	None	Fe concretions	Dense roots	Gradually

(cont'd)

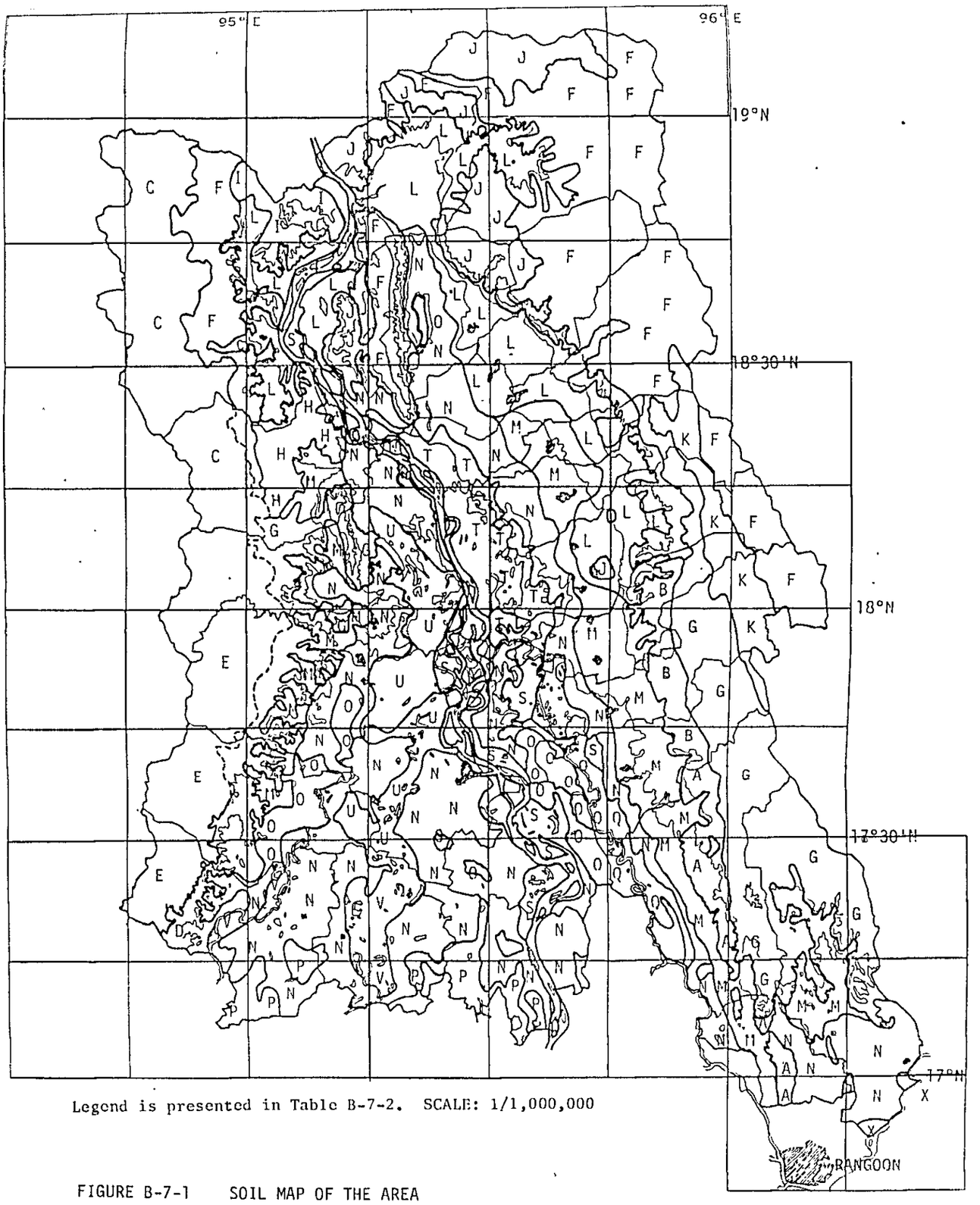
TABLE B-7-1 Short Description on Tipical Soil Profiles (Continued)

Symbol	Depth	Texture	Common colour	Mottled colour	Structure	Hardness	Pores	Concretions or Mottles	Roots	Boundary
MEADOW SWAMPY SOILS (Continued)										
AB	18-45 cm	Heavy clay	Grayish brown	Rusty spots	Structureless	Hard	None	Some small iron concretions	Rare	Gradually
Bg	45-115cm	Heavy clay	Grayish brown	Mottled with darker colour	Structureless	Slightly hard	None	Small iron concretions: Manganese concretions	Rare	Gradually
Cg	115-145cm	Heavy clay	Grayish brown	Mottled by Yellow colour	Structureless	Slightly hard	None	Rusty spots	None	
SWAMPY GLEY HEAVY CLAY SOILS 316 Kyannbyin Ingabu Township										
A	0-20 cm	Heavy clay	Grayish brown	Rusty and gray spots				Small iron and manganese concretions	Dense roots	Clearly
B	20-90 cm	Heavy clay	Dark Gray	Rusty and gray spots	Structureless	Hard	None	Small iron and manganese concretions	Rare roots	Gradually
C	90-155cm	Heavy clay	Gray	Mottled by Yellow	Structureless	Slightly hard	None		None	
MEADOW ALLUVIAL IMMATURED LIGHT LOAM SOILS 146 Scindaingkyan Myanaung Township										
Ap	0-13 cm	Light Loam	Yellow brown	Rusty and gray spots	Crumby Dusty	Friable	Porous		Much roots	Clearly
B1	13-30 cm	Medium Loam	Light yellow brown	Rusty and gray spots	Crumby Dusty	Weakly hard	Porous		Rare roots	Gradually
B2	30-60 cm	Light Loam	Yellow brown	Rusty and gray spots	Dusty Crumby	SLightly hard	Porous		Separate roots	Clearly
D1	60-110cm	Sand	Light yellow brown		Structureless	Friable			None	Gradually
D2	110-130cm	Medium Loam	Yellow brown		Structureless	Hard	Thin pores		None	
MEADOW ALLUVIAL MEDIUM LOAM SOILS 305 Yonthalin Henzada Township										
Ap	0-15 cm	Medium Loam	Light brown	Rusty spots	Crumby	Friable	Thin		Rare	Clearly
B	15-50 cm	Medium Loam	Dark brown		Blocky	Hard			Rare	Clearly
C	50-120cm	Medium Loam	Rusty brown		Structureless	Slightly hard	Thin		None	Gradually
D	120-150cm	Sand	Yellowish brown		Structureless	Slightly hard		(Ground water level)	None	

(cont'd)

TABLE B-7-1 Short Description on Tipical Soil Profiles (Continued)

Symbol	Depth	Texture	Common colour	Mottled colour	Structure	Hardness	Pores	Concretions or Mottles	Roots	Boundary
MEADOW ALLUVIAL GLEY CLAY SOILS										
Ap	0-13 cm	Light clay	Light Gray		Blocky	Slightly hard	Thin		Dense	Gradually
B1	13-38 cm	Medium clay	Yellow brown			Slightly hard	Thin		Rare	Gradually
B2	38-73 cm	Light clay	Dark yellow brown		Blocky	Hard	Thin		Rare	Gradually
B/C	73-98 cm	Light clay	Dark yellow brown			Slightly hard	Thin			Gradually
Cg	98-160cm	Light clay	Dark brown	Mottled	Blocky	Slightly hard			None	



Legend is presented in Table B-7-2. SCALE: 1/1,000,000

FIGURE B-7-1 SOIL MAP OF THE AREA

TABLE B-7-2 LEGEND FOR SOIL MAP OF THE AREA

MOUNTAIN SOILS.	
A.B. LATERITIC SOILS.	A. With 10 % Yellow brown forest soils. B. With 25-50 % Yellow brown forest soils.
C.D.RED BROWN FOREST SOILS. E.	C. With 10-25 % Turfy Primitive soils. D. With 25-35 % Yellow brown forest soils. E. Shallow soils: With 10-25 % Shallow yellow brown forest soils and 25-30 % Dark yellow brown forest soils.
F.G.YELLOW BROWN FOREST SOILS.	F. With 10-25 % Primitive crushed stone soils. G. With 10-50 % Dark yellow brown forest soils.
H. YELLOW BROWN CARBONATE FOREST SOILS.	H. With 10 % Turfy carbonate soils and 10 % Primitive crushed stone soils.
I. TURFY CARBONATE SOILS.	I. With 10 % Yellow brown forwst soils.
J. MEADOWISH DEGRADATED SOILS.	J. With up to 10 % Turfy primitive soils.
K. PRIMITIVE CRUSHED STONE SOILS.	K. With up to 50 % Dark yellow brown forest soils.
PLAIN SOILS.	
L. MEADOW SOILS.	L. Texture = Medium or Heavy Loam.
M. MEADOW GLEY HEAVY LOAM SOILS. N. MEADOW GLEY CLAY SOILS.	M. N.
O. MEADOW SWAMPY SOILS. P. MEADOW SWAMPY LIGHT LOAM SOILS.	O. Texture = Clay and Heavy Loam. P.
Q. SWAMPY GLEY SOILS.	Q. Texture = Clay and Heavy Loam.
R. ALLUVIUM SOILS. S. IMMATURED ALLUVIUM SOILS.	R. Texture = Medium and Light Loam. S. Texture = Light Loams and Sands.
T. MEADOW ALLUVIAL SOILS	T. Texture = Clay and Heavy Loam; With 10-25 % Swampy gley soils.
U. MEADOW ALLUVIAL SOILS. V. MEADOW ALLUVIAL SOILS.	U. Texture = Meadium Loam. V. Texture = Light Loam; With 10-25 % Swampy gley soils.
W. MEADOW ALLUVIAL SOILS.	W. Texture = Sandy.
X. SALTY MUDDY SWAMPS	X. Texture = Clay and Heavy loam; Manglove forests.

VIII. LAND USE

VIII.1. Present Land Use

The monsoon rainy season starts in May and ends in October and rainfall of 1,200-2,000 millimeters is given in this 6 months and no effective rainfall is given in other 6 months.

The present main crop of the Area is the rice crops cultivated under the monsoon rainy season. The soils in plains are suturated with water and are waterlogged in the depressed area. These water condition in rainy season is good for waterlogged rice culture but is not good for cultivation of diversified crops. The paddy field occupy about 35 percent (2.47 million acres) in the rainy season and the area is left fallow in the dry season. (Ref. to Appendix B-5.)

An area of about 7 percent (0.51 million acres) is under deep water in the rainy season, however, 42 percent of the area (0.22 million acres, 3.0 percent of total land) is cultivated as "Kaing lands", in which lands of loamy texture are planted with diversified upland crops such as groundnut, after the inundated water goes off at the later part of the rainy season. The other part of the area, that is 58 percent of the area (0.29 million acres, 4.1 percent of total area) is left fallow.

The "Ya-cultivations" (0.03 million acres, 0.4 percent of the total area), the "Garden cultivations" (0.18 million acres, 0.16 percent) are mainly conducted at low flat hill slopes under upland conditions. The "Ya-cultivations" are the cultivation of diversified crops at "Ya-land". The "Garden cultivations" are the cultivation of tropical fruit tree crops such as Banana, Papava and so on at "Garden land". The "Shifting-cultivations" are the cultivations of diversified crops at "Shifting-land", which is made by cutting and burning trees in the forests on hills and shifts it to new place in the forests in some later years.

The "Dani-cultivations" are the cultivation of Nipa-Palm in the swampy areas and the area of this cultivation is very small.

Forests cover the area of 2.55 million acres (35.7 percent of the total area).

Other lands, including cultivable waste and uncultivable land, occupy 1.67 million acres (23.5 percent of total area). [The area of no crops in the inundation area is included in the uncultivable lands.]

The inundation area, cultivated land and other land use are shown Table B-8-1, B-8-2 and B-8-3.

The present land use map is presented in Figure B-8-1.

VIII.2. Land Classification

The land classification method of FAO, which is established by FAO expert in Thailand, is used and the summarized table of classification is listed in Appendix B-4.

The land classification of mountain soils presented in Table B-8-4 and the land classification of plain soils are presented in Table B-8-5.

The control of erosion in the sloped area is very important and the sloped light soils have to be protected by good forest.

The foot plains of both Arakan and Pegu mountain ranges will be better to be irrigated in the dry season.

The meadow swampy soils are fertile and drainage constructions will be quite helpfull to improve large areas of these soils, which areas are fallow at present.

TABLE B-8-1 INUNDATION AREA OF THE AREA IN THE RAINY SEASON

(Unit: Acre)

No.	Name of Townships	Total Inundation Area	Area of Kaing Cultivation	Area of No Crops
1.	Paukkaung	6,979	1,358	5,621
2.	Prome	6,456	1,498	4,958
3.	Padaung	25,114	6,010	19,104
4.	Paungde	2,814	36	2,778
5.	Thegon	3,254	149	3,105
6.	Shwedaung	29,119	12,045	17,074
7.	Nattalin	3,424	0	3,424
8.	Zigon	1,231	23	1,208
9.	Gyobingauk	6,045	2,200	3,845
10.	Monyo	86,594	36,888	49,706
11.	Okpo	9,540	922	8,618
12.	Minhla	18,371	6,241	12,130
13.	Letpadan	28,713	11,589	17,124
14.	Tharrawaddy	12,465	5,917	6,548
15.	Taikkyi	10,585	1,001	9,584
16.	Hlegu	9,107	0	9,107
17.	Hmawbi	6,313	63	6,250
18.	Kyangin	11,777	2,222	9,555
19.	Myanaung	28,474	13,370	15,104
20.	Ingabu	28,732	22,077	6,655
21.	Lemyenthna	17,487	12,575	4,912
22.	Yegyi	25,576	19,450	6,306
23.	Henzada	49,870	26,791	23,079
24.	Zalun	52,910	25,231	27,679
25.	Kyonpyaw	6,789	0	6,979
26.	Danubyu	21,438	8,265	13,173
Total	7,134,915	509,357	215,921	293,436
	(100.00 %)	(7.14 %)	(3.03 %)	(4.11 %)

Source: Settlement and Land Record Dept.

TABLE B-8-2 LAND USE (CULTIVATED LAND)

(Unit: acre)

No.	Township	Total Occupied Area						
		Paddy	Ya	Kaing	Garden	Dani	Shift-ing	Total
1.	Paukkaung	45,610	2,909	1,358	1,260	-	6,939	58,076
2.	Prome	81,122	3,440	1,498	5,161	-	-	91,221
3.	Padaung	43,040	7,153	6,010	2,675	-	398	59,276
4.	Paungde	71,563	1,318	36	3,868	-	2,960	79,745
5.	Thegon	95,729	1,615	149	5,630	-	-	103,123
6.	Shwedaung	58,628	6,727	12,045	2,640	-	-	80,040
7.	Nattalin	111,983	802	-	4,533	-	-	117,318
8.	Zigon	45,303	199	23	1,521	-	-	47,046
9.	Gyobingauk	84,807	178	2,200	2,935	-	61	90,181
10.	Monyo	45,023	-	36,888	2,849	-	-	84,760
11.	Okpo	87,116	541	922	1,310	-	-	89,889
12.	Minhla	77,379	380	6,241	1,460	-	-	85,460
13.	Letpadan	107,906	228	11,589	2,395	-	1,119	123,237
14.	Tharrawaddy	98,343	1,052	5,917	1,765	-	-	107,077
	Sub-total	1,053,552	26,542	84,876	40,002	-	11,477	1,216,449
15.	Taikkyi	162,714	-	1,001	13,115	-	-	176,830
16.	Hlegu	174,594	-	-	7,660	3,263	-	185,517
17.	Hmawbi	74,473	-	63	10,831	103	-	85,470
	Sub-total	411,781	-	1,064	31,606	3,366	-	447,817
18.	Kyangin	42,074	777	2,222	6,562	-	-	51,635
19.	Myanaung	128,805	1,528	13,370	18,432	-	-	162,135
20.	Ingabu	136,269	1,289	22,077	8,797	-	-	168,432
21.	Lemyethna	61,403	60	12,575	7,812	-	-	81,850
22.	Yegyi	127,247	-	19,450	8,302	-	-	154,999
23.	Henzada	145,090	-	26,791	19,389	-	-	191,270
24.	Zalun	92,687	-	25,231	8,939	-	-	126,857
25.	Kyonpyaw	144,114	-	-	24,234	-	-	168,348
26.	Danubyu	128,116	-	8,265	3,241	-	-	139,622
	Sub-total	1,005,805	3,654	129,981	105,708	-	-	1,245,148
	Total	2,471,138	30,196	215,921	177,316	3,366	11,477	2,909,414

Source: Settlement and Land Record Dept.

TABLE B-8-3 LAND USE

(Unit: acre)

No.	Township	Cultivated land	Reserved Forest	Unreserved Forest	Cultivable Waste	Uncultivable Land	Township Area
1.	Paukkaung	58,076	181,016	45,010	134,294	52,974	471,370
2.	Prome	91,221	18,765	7,633	54,879	22,322	194,820
3.	Padaung	59,276	341,738	20,106	1,696	196,693	619,509
4.	Paungde	79,745	78,736	7,766	46,499	16,793	229,539
5.	Thegon	103,123	37,600	9,043	5,026	37,125	191,917
6.	Shwedaung	80,040	11,694	10,705	35,445	43,837	181,721
7.	Nattalin	117,318	169,374	23,481	9,647	18,063	337,883
8.	Zigon	47,046	8,396	184	689	4,269	60,584
9.	Gyobingauk	90,181	83,023	2,174	4,322	10,379	190,079
10.	Monyo	84,760	-	-	7,644	65,672	158,076
11.	Okpo	89,889	135,867	5,618	14,149	13,983	259,506
12.	Minhla	85,460	27,965	26,450	2,960	22,485	165,320
13.	Letpadan	123,237	174,219	19,559	10,433	39,965	367,413
14.	Tharrawaddy	107,077	80,867	23,149	21,854	22,343	255,290
	Sub-total	1,216,449	1,349,260	200,878	349,537	566,903	3,683,027
15.	Taikkyi	176,830	166,010	5,210	44,454	34,257	426,761
16.	Hlegu	185,517	120,891	12,325	72,107	51,009	441,849
17.	Hmawbi	85,470	1,763	-	7,645	29,489	124,367
	Sub-total	447,817	288,664	17,535	124,206	114,755	992,977
18.	Kyangin	51,635	164,323	555	1,789	66,235	284,537
19.	Myanaung	162,135	157,792	3,235	9,572	50,827	383,561
20.	Ingabu	168,432	129,726	12,008	36,134	55,747	402,047
21.	Lemyethna	81,850	112,550	23,830	19,648	17,510	255,388
22.	Yegyi	154,999	71,648	18,813	23,475	47,827	316,762
23.	Henzada	191,270	-	-	1,371	49,724	242,365
24.	Zalun	126,857	-	-	15,558	42,004	184,419
25.	Kyonpyaw	168,348	-	-	5,413	30,887	204,648
26.	Danybyu	139,622	-	-	12,291	33,271	185,184
	Sub-total	1,245,148	636,039	58,441	125,251	394,032	2,458,911
	Total	2,909,414	2,273,963	276,854	598,994	1,075,690	7,134,915

Source: Settlement and Land Record Dept.

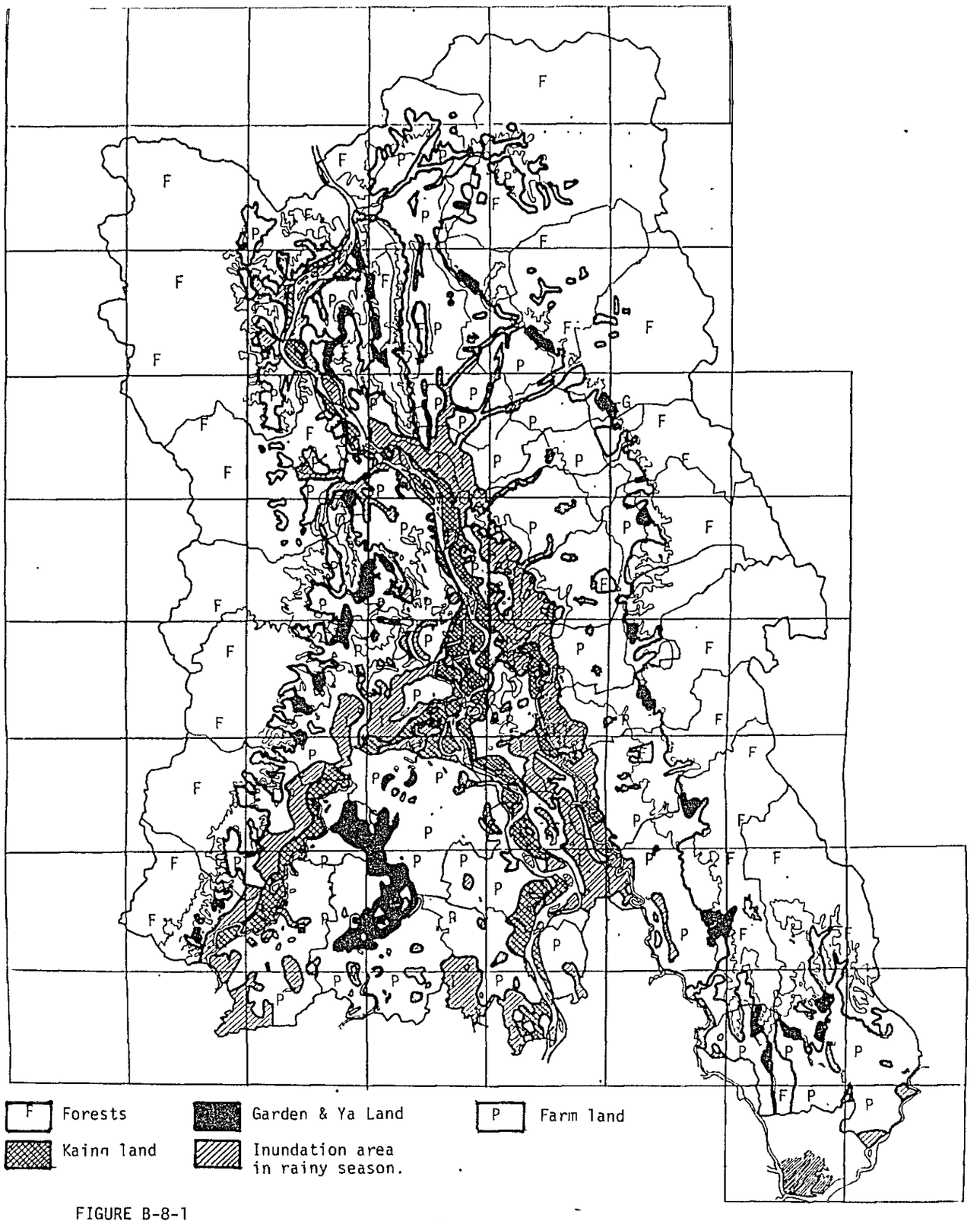


FIGURE B-8-1
LAND USE MAP OF THE SURVEY AREA AT PRESENT

TABLE B-8-4 LAND CLASSIFICATION OF FOREST SOILS

Mountain Soils	Dominant Pactors	Problem	Calss
A.B. Latetitic Soils	Light texture of surface soils Impeded drainage by sub-soils. Existence of laterite layer.	Erosion hazard	F-III
C.D. Red Brown Forest Soils	Very steep slope Severly weasered rocks Light textur of soils	Erosion hazard	F-III
E. Red Brown Sallow Forest Soils	Steep slopes Shallowness of soils Severly weathered rocks	Erosion hazard	F-III
F.G. Yellow Brown Forest Soils	Steep slope Severly weathered rocks Very light texture of soils	Erosion hazard	F-III
H. Yellow Brown Carbonate	Steep slope Light texture of soils Some nutrients in soils	Erosion hazard	F-II
I. Turfy Carbonate Soils	Steep slope Some nutrients in soils	Erosion hazard	F-II
J. Meadowish Degradated Soils	Steeply sloped Severly weathered rocks acid soils	Erosion hazard	F-II
K. Primitive Crushed Stone Soils	Very steep slopes Rock out tree crops	Erosion hazard	F-IV

Note: F-I Highly, F-II Moderately, F-III Low Productive, F-IV Unsuited for forest production. Erosion hazard in the forests also accelerate siltation hazard down the rivers and it will accelerate inundation of agricultural land in the plains under heavy rainfall.

TABLE B-8-5 LAND CLASSIFICATION OF PLAIN SOILS

Plain Soils	Dominant Factor	Problem	Rainy Season	Dry Season under Irrigation	
L. Meadow Soils	Medium or Heavy Loam Higher elevation than other soils Nearly level topography	Water suturation Short of nutrients	P-II	P-II	U-II
M. Meadow Gely Heavy Loam Soils	Heavy loam Nearly level topography	Water logged	P-I	P-I	U-I
N. Meadow Gley Clay soils	Clay Nearly level topography	Water logged	P-I	P-I	U-III
O. Meadow Swampy soils	Clay and Heavy loam	Inundation every year Rich in nutrients	P-V(After drainage system P-I)	P-I	
P. Meadow Swampy Light Loam Soils	Light Loam	Inundation every year	P-V(After drainage system P-I)	P-I	U-I
Q. Swampy Gley Soils	Locating in the meander belt of the river	Inundation every year	P-V	-	-
R. Alluvial soils S. Immatured Alluvial soils	Locating in the meander belt of the river		P-V(Kaing cultivation U-I)	-	-
T. Meadow alluvial soils	Clay and Heavy loam Depressed area	Water logged 50 % inundation every year	P-V & P-I	-	-
U. Meadow Alluvial Soils	Medium Loam Meander belt of old river	Water logged or inundated	P-III	-	-
V. Meadow Alluvial Soils	Light Loam Meader belt of old river but slightly elevated relief	Some short of nutrients	P-II(Kaing cultivation U-I) or Garden land	-	-
W. Meadow alluvial Soils	Sandy	Submerged and washed by river water	P-V(Kaing cultivation)	-	-
X. Salt Muddy Swamp Soils	Clay Salinity	Ferrous sulfide	--- Manglove only	-	-

IX. RECOMMENDATIONS

IX.1. Irrigation

In the dry season, the sunshine is very rich and there is no trouble with excess water problem. So that cultivations of both water logged rice plants and diversified crops will obtain higher yield than in the rainy season, when irrigation water is supplied.

Irrigation projects, to irrigate the area of meadow soils and meadow gley heavy loam soils at the foot plain of both Pegu and Arakan mountains, will be a great help to increase crop production in the Area.

IX.2. Drainage of the Inundation Area in the Rainy Season

In the rainy season, the lands of 509,357 acres are inundated and of which lands of 215,921 acres, where the soils have light texture, are cultivated as Kaing-agriculture after water has gone back.

However, the inundated area of 293,463 acres of heavy textured and fertile soils are left fallow at present.

There have to have efforts to drain and to reclamate the inundated area for the rice culture in the rainy season.

IX.3. Total Enviromental Problems in the Area

The weathering of rocks is very severe on the hills and mountains under the climate of wet tropics and the sedimentally rocks contining much silica sands resulted forest soils of light texture. In the year of heavy rain, the heaviest monthly rainfall of 500-1,000 millimeters was recorded in the plain area at the mid-rainy season and the more heavy rainfall is expected at the hills and mountains.

Both of the above mentioned soils and rainfall conditions result severe soil erosion at the hills and mountains and also result heavy siltation at the area of plains where the shallow river beds are built at local rivers resulting wide inundation areas along the rivers. Thus the wide areas of fertile plain are covered with water in the rainy season.

As a conclusion, the light textured forest soils should be covered with dense forest to prevent soil erosion on the hills and mountains. The Ya-lands and garden lands should not be enlarged into the area of the forests and the shifting cultivation in the forest should be limited only in the small special places. Otherwise the erosion in high place and the siltation in the low plain will be accelerated and both of forests in highland and cultivated lands in lowland would be gradually injured.

IX.4. Encouragement of Soil Survey Project

The precise knowledge on the soils is the base of agriculture. However, the soil survey on the whole Area was conducted in the reconnaissance level in 1950's and these data are not sufficient for the operation of future agriculture projects.

(1) Major Components

The soil studies for future projects will have to use more precise survey methods such as soil sruvey and classification of soil series level. To do so, firstly, the soil texture determination method of International Soil Science Society is better to be adopted instead of Burmese method. Secondly, the scale of soil maps for general use will be 1/50,000 and the survey density will be required to study one survey point per about 60 acres (25 hectars) in average. Thirdly, the soil classification will have to reach soil series. Fourthly, the soil maps would suggest not only land classification but also the divisions for soil managements and fertilizer applications. Thus the soil maps will serve not only to agricultural planning but also to agricultural extention.

For the more precise projects such as land consolidation, soil maps of 1/25,000 will be necessary and at the same time the density of survey point will be one point per 15-20 acres. In the projects of construction of central farm or experimental farm, map scale will be 1/5,000-1/10,000 and one survey point per 2-5 acres. Table B-9-1 and Figure B-9-1 will show the relation between precision of soil survey and use of soil maps.

(2) Major Dimensions

There will be necessary 2 survey teams, each team consists of 10 soil surveyers to meet with future projects. The teams have to be endowed with following modern materials and insturments.

Soil Auger	20
Soil Core sampler	4
Soil Colour Standard	10
Soil Survey Kit	4

Each Kit contain
a. NPK rapid chemical test outfit
b. Portable electric pH meter
c. Portable redox meter
d. Portable electric conductivity meter
e. Ferrous iron detecting reagent
f. Manganese detecting reagent
g. Soil hardness meter
h. Pocket lense
j. Scales
k. Hand level
l. Field camera

Land Cruiser Car	2

Soil samples have to be analysed in the laboratory not only on the conventional chemical analysis but also on the modern methods such as clay mineralogy analysis and soil moisture charastaristic snalysis. For the new laboratory works, following instruments have

TABLE B-9-1 SOIL MAP SCALE AND ITS USE

S. Nishigaki 1973

PURPOSE	MAP SCALE PUBLISHING	AREA FOR ONE CM^2 ON MAP	INTENSITY OF SURVEY	SAMPLING DENSITY FOR ONE SAMPLING	SAMPLING DENSITY NUMBER IN KM^2	WORKING MAP SCALE	MAPPING SOIL UNIT
Survey of large undeveloped area.	1/2,500,000 1/1,000,000	62,500 ha 10,000 ha	Synthesis of schematic surveys.	-	-	1/2,500,000 1/1,000,000	Great soil groups, their associations, physiografical associat.
Reconnaissance survey for new and undeveloped region	1/1,000,000 1/250,000	10,000 ha 625 ha	Exploratory surveys.	-	-	1/1,000,000 1/100,000	Great soil groups, their associations, land types
Regional development planning to form potential development area.	1/500,000 1/100,000	2,500 ha 100 ha	Reconnaissance very low intensity surveys.	1250 ha 200 ha	0.08 0.5	1/200,000 1/75,000	Great soil groups, subgroup of G.S.G., some soil series, some land type.
Possible appraisals of regional potentials. Adapt crops, estimate yield, irrigation potentials, drainage needs, management required.	1/100,000 1/50,000	100 ha 25 ha	Detailed reconnaissance very low intensity surveys.	200 ha	0.5	1/100,000 1/40,000	Soil families, soil series, soil variant, association of soil series, some phases of each, land type.
Evaluation of feasibility studies, for planning primary irrigation and drainage.	1/60,000 1/50,000 1/25,000	36 ha 25 ha 6 ha	Semi-detailed medium intensity surveys.	25 ha	4.0	1/50,000 1/25,000	Soil series, soil variants, soil associations soil complexes, some soil phase of above
Farm planning, detailed irrigation and drainage projects, agricultural experiment station, intensive land use.	1/30,000 1/20,000 1/10,000	9 ha 4 ha 1 ha	Detailed high-intensity surveys.	12.5 ha 8 ha	8.0 12.5	1/30,000 1/10,000	Phases of soil types, Soil series, soil variants, some associations or complexes.
Layout of agricultural experiment fields, detailed farm planning, detailed engineering operation.	1/10,000 1/5,000	1 ha 0.25 ha	Very detailed very high-intensity survey.	2 ha 0.8 ha	50 125	1/10,000 1/2,000	Phase of soil types, soil series, soil variants, some complexes.
Agricultural research plots, Detailed engineering projects.	1/5,000	0.25 ha	Special very detailed very high-intensity surveys.			1/5,000	Phase of soil type, soil series, soil variants, using very narrow ranges of phase criteria.

USDA, Soil Survey Staff, 1970, Selected Chapters from the unedited text of the Soil Taxonomy of the National Corporative Soil Survey.
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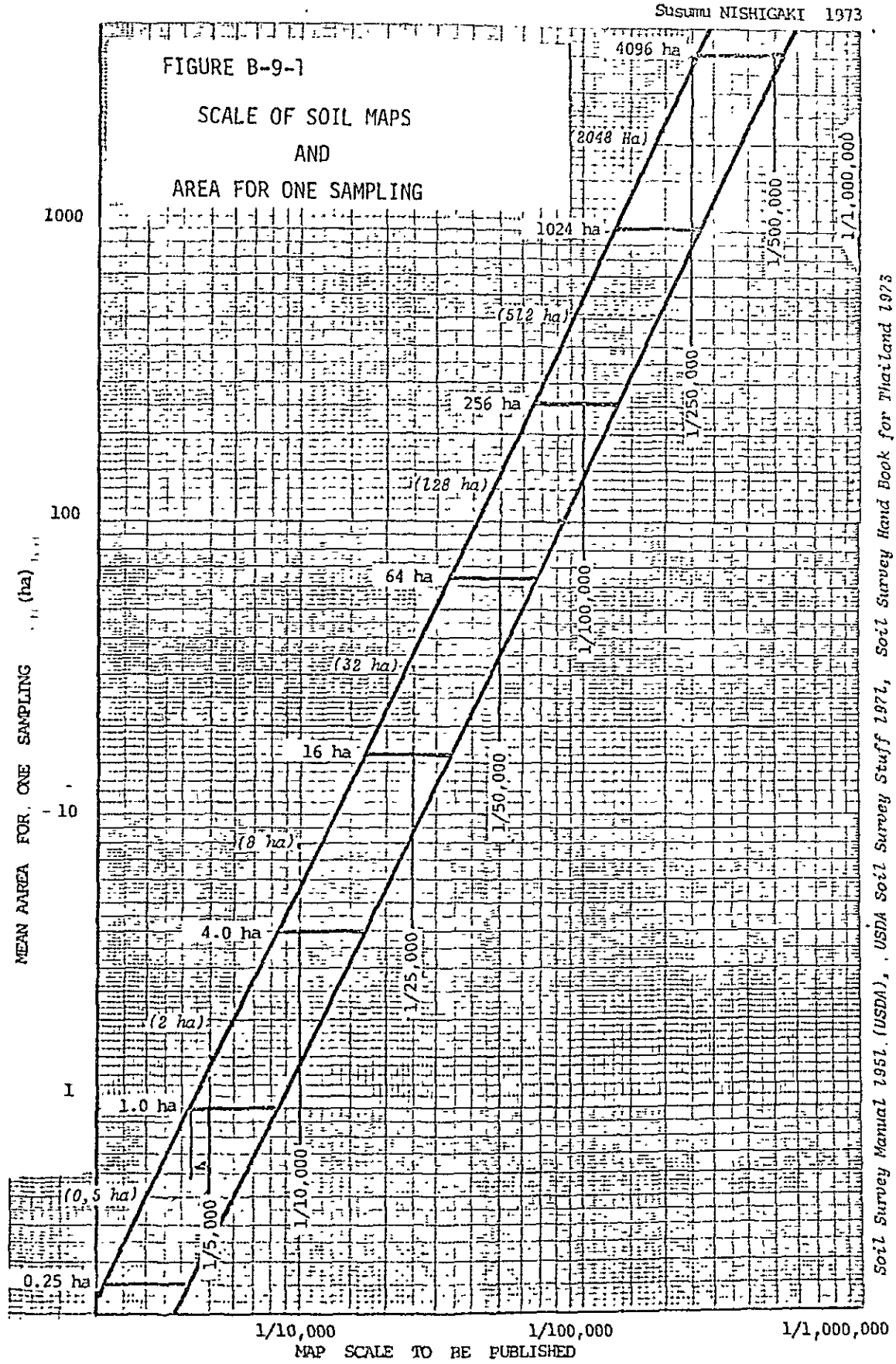

Soil Survey Manual 1951 (USDA), USDA Soil Survey Stuff 1971, Soil Survey Hand Book for Thailand 1973