THE SOCIALIST REPUBLIC OF THE UNION OF BURMA

REPORT
ON
THE MASTER PLAN SURVEY OF THE FIRST STAGE
FOR
THE IRRAWADDY BASIN
AGRICULTURAL INTEGRATED DEVELOPMENT PROJECT

MARCH 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

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His Excellecy U Ye Goung,
Minister of Agriculture and Forests,
The Socialist Republic of the Union of Burma.

Dear Sir,

Ref: Submission of Report on the Master Plan Survey of the First Stage for Irrawaddy Basin Agricultural Integrated Development Project.

I have a great pleasure to submit herewith the Report of 20 copies on the Master Plan Survey of the First Stage for Irrawaddy Basin Agricultural Integrated Development Project in accordance with the Scope of Works for the First Stage Survey Mission.

In the report, findings in the survey and Mission's view of Approach to the Master Plan Survey are briefly stated together with recommendations.

In our experience with other countries under similar circumstances to your country, we came to realize more and more the importance of Master Plan. By having such as master plan, we can place appropriate priority to various stages and aspects of development project.

I am also happy to inform you that according to your emphasis on quick-yielding projects, reconnaissance survey was carried out by

the Mission at five dam sites. Based on the results of survey and also the relevant data and information available, technical discussion regarding the priority of these irrigation projects were made between the Government of Burma concerned and the Mission. For a final decision the comprehensive discussion between His Excellency U YE GOUNG, Minister of Agriculture and Forests and His Excellency T. ARITA Ambassador of Japan were also made. Consequently, South Nawin area is decided as a feasibility Project site.

I should like to express my sincere thanks for the kind cooperation and assistance extended to us by agencies concerned during our stay in Burma.

With kindest regards,

Yours faithfully,

TOSHIKI SAITO
Mission Leader
The Master Plan Survey of the
First Stage for the Irrawaddy
Basin Agricultural Integrated
Development Project.

GENERAL MAP

KEY MAP

BURMA

PROME

Project Area

Bay of Bengal

RANGOON

N

PROME

Kyangin

Twepot C.

Paungde C.

Kanma

Gyobingauk

Myoung C.

Minhla

Holdo

Lepadan

Henzada

Tharrawaddy

Okkan

Taikki

Hlaing R.

Panhlaing C.

RANGOON

Bassein

Mauban

IRRAWADDY RIVER

BAY OF BENGAL

1 : 1,000,000

0 10 20 30 40 50 Kam

MEMBER OF THE MISSION

Mr. Toshiki SAITO Leader	Assistant Chief, Land Improvement & Consolidation Division Construction Department. Kyushu Regional Agricultural Administration Office. Ministry of Agriculture and Forestry.
Mr. Masao TAKAHASHI Hydrology	Section Chief, Land Improvement & Consolidation Division Agricultural Structure Improvement Bureau, Ministry of Agriculture and Forestry.
Dr. Hidehiko SHIRAISHI Hydro Analysis	Chief Researcher, Irrigation Department. National Research Institute of Agricultural Engineering. Ministry of Agriculture and Forestry.
Mr. Kiichi ITOH Drainage	Researcher, Irrigation Department National Research Institute of Agricultural Engineering. Ministry of Agriculture and Forestry.

Mr. Kazuo YAMADA Forestry	Controller Audit Division Forestry Agency Ministry of Agriculture and Forestry.
Mr. Heijiro YOSHIHARA Agro-Economy	Advisor (Economist) Sanyu Consultants Inc. (S.C.I.)
Mr. Hironori TAKAHASHI Hydrology	Computor Specialist. S.C.I.
Mr. Tetsuro HORI Geology	Director S.C.I.
Mr. Chuzo SAIKA Agronomy & Soil	Advisor (Acquaculture Specialist) S.C.I.
Mr. Masahiro IIDA Mapping Survey	Section Chief Engineer Third Technical Department S.C.I.
Mr. Yukio ASAKURA Inland Fishery	Advisor (Agriculture Specialist) S.C.I.
Mr. Tsugio HORII Coordination	Official of Planning and Survey Department for Agriculture & Forestry. Japan International Cooperation Agency.

LIST OF COUNTERPART

U Ba Toke	Assistant General Manager Agriculture Corporation.
U Tha Tun Oo	Assistant General Manager Agriculture Corporation.
U Tin Win Latt	Deputy Assistant General Manager Agriculture Corporation.
U Ba Aye	Executive Engineer Survey Section Irrigation Department.

ITINERARY OF THE MISSION

(1978)

Date	Description
6 February	Leave for Bangkok
7 February	Arrive in Burma Courtesy call to Japnese Embassy
8 February	Courtesy call to the Government of Burma
9 - 13 February	Collection of data from Department and Corporations concerned
14 February	Reconnaissance Survey by aircraft
15 - 17 February	First field Survey by all members
18 February	Meeting with all members
19 February	Holiday
20 February	Collection of data
21 - 25 February	Second trip
26 February	Holiday
27 February	Meeting with all members
28 February	Dr. Shiraish and Mr. Ito arrive in Burma.
1 March	Meeting with Hydraulic analysis team

Date	Description
2 - 4 March	Third field survey of the Irrawaddy River.
5 March	Holiday
6 March	Meeting with Mission and Irrigation Department.
7 March	Reconnaissance survey by aircraft.
8 - 10 March	Fourth field survey to right bank of the Irrawaddy river.
11 March	Dr. Shiraishi and Mr. Ito leave for Japan.
12 March	Mr. Asakura arrive in Burma.
13 - 15 March	Fifth field trip at Pyinmana, meeting with Mission members and Agricultural Corporation.
16 March	Courtesy call to the Government of Burma.
17 March	Visit the Hmawbi Experimental Farm.
18 March	Film show at Japanese Embassy.
19 March	Holiday.
20 - 22 March	Sixth field trip (Henzada).
23 March	National Holiday.
24 - 25 March	Report writing.

Date	Description
26 March	Holiday.
27 March	National Holiday.
28 - 29 March	Submit survey report and meeting with the Mission and the Government of Burma.
30 March	Leave for Bangkok
31 March	Arrive in Japan.

C O N T E N T S

ABBREVIATIONS AND CONVERSION TABLE

AC	=	Agriculture Corporation
APS	=	Advance Purchase System
BKT	=	Basket (s)
DG	=	Director General
DY	=	Deputy
FC	=	Foreign Currency
GM	=	General Manager
GNP	=	Gross National Product
HP	=	Horsepower
HYV	=	High Yielding Variety (Paddy)
IBRD	=	International Bank for Reconstruction and Development
ID	=	Irrigation Department
IDA	=	International Development Agency
JICA	=	Japan International Cooperation Agency
LC	=	Local Currency
LIV	=	Local Improved Variety
MAF	=	Ministry of Agriculture and Forests
MD	=	Managing Director
MPF	=	Ministry of Planning and Finance
PSD	=	Planning and Statistics Department (of MAF)
SD	=	Survey Department
TEM	=	Township Extension Manager

1 foot (ft)	=	30.48 centimeters (cm)
1 mile	=	1.609 kilometers (km)
1 acre (ac)	=	0.405 hectare (ha)
1 square mile (sq.mile)	=	2,590 square kilometers (sq. km)
1 cubic foot (cu. ft)	=	28.32 liters (l)
1 cubic yard (cu.yd)	=	0.765 cubic meters (cu.m)
1 acre-foot (ac-ft)(AF)	=	1,233.48 cu.m.
1 cubic foot per second (cu.sec)	=	0.025 cubic meter per second (cu.m/sec)
1 long ton (lg ton)	=	1,016 kilograms (kg)
1 lac (lakh)	=	100,000
1 crore	=	10,000,000
1 viss	=	1.633 kg
1 pyi	=	2,127 kg
1 pound (lb)	=	0.4536 kg
1 basket paddy	=	20.9 kg
1 basket rice	=	34.0 kg
1 bag rice	=	75.6 kg

I. INTRODUCTION

The unprecedented population explosion all over the world has created the attendant necessity for production of more food.

Consequently, Agriculure is drawing the attention of all the nations. All of them are endeavouring to find ways and means of improving the existing techniques and inventing new methods in their attempt to enhance agriculture production. As far as the Socialist Republic of the Union of Burma is concerned, there are not only vast extent of uncultivated land in the dry season but also enough water resources. If these resources are properly harnessed for the development of agriculture, Burma would have a very prosperous future.

(1) Dispatch of the Master Plan Survey Mission of the First Stage.

In response to the request made by Burmese Government for the technical cooperation for the Master Plan Survey for Irrawaddy Basin Agricultural Integrated Development Projects, Japanese Government dispatched a Survey Mission of the first stage to exchange views and experiences with the Burmese authorities concerned and to carry out necessary field survey.

(2) Scope of Works

a) Field investigation

b) Supplemental data collection

c) Hydrological survey

d) Crop and soil survey

e) Forestry investigation

f) Inland fishery investigation

g) Agro-economic survey

h) Other various surveys related to the Project.

II. PROJECT AREA

(1) An area which is identified by the flight and field reconnaissance survey is located in the upper delta between 17° 15' NL and surrounded by two mountain ranges, namely Arakan and Pegu as shown in the General Map attached. The area is estimated at around 2.5 million hectares in total acreage.

(2) The boundary of the Project Area is decided after consideration of factors mentioned below:

(i) East and West

Watersheds of Arakan mountain range and Pegu mountain range.

(ii) North

Boundary line near Prome dividing Irrawaddy Basin into wet zone and dry zone.

(iii) South

Approximate 17°15' line of north latitude which is presumed to be closed to the area of the Lower Burma Paddyland Development I Project investigated by IDA.

The Project Area also covers the areas of the Food Production Promotion Project as well as the Pig and Poultry Breeding Project in the Rangoon Division assisted by the Japanese Government.

III. MISSION'S VIEW OF APPROACH TO THE MASTER PLAN

The necessity, purpose and principle of The Master Plan described in the interim report of preliminary survey Mission. Therefore, what is described in said report will not be repeated in this report, but only some points that require elaboration, in view of the results obtained by Mission's survey and study will be dealt with.

(1) Among the natural resources in the Project Area, water resources which can be utilized effectively for agriculture is limited. From this point of view, the selection of irrigable area of each project in the Master Plan should be investigated in detail. If some extent of area located at lower region of a river can be irrigated by the using of pond, pump, etc., the Project Area which is irrigated by reservoir should be selected at upper region.

(2) The Project Area in the Master Plan can be classified as follows:-

i) Area which can be improved by irrigation facilities both during rainy season and also dry season.

ii) Area which can be converted to agricultural land by providing drainage system.

iii) Area which can be converted to agricultural land by the construction of polders with drainage facilities.

iv) Area which can be converted to the agricultural land by the flood control facilities of Myitmaka River, Irrawaddy River etc., with the construction of drainage system.

(3) For the drawing up the Master Plan, the hydrological analysis of Myitmaka River and Irrawaddy River should receive sufficient attention. A considerable amount of survey equipment will be required.

(4) Together with the irrigation projects other projects mainly with regard to Research and Extension as well as the rural development works, should be duly considered and involved in the Master Plan.

The Planning and Statistics Department and Agricultural Corporation are advised to try to identify the projects in the fields other than irrigation which would be suitable in association with the Master Plan.

The study and investigation of those projects will be conducted with the kind cooperation of the Department and Corporation concerned from the view point of integrating into the Master Plan.

In the area of the Feasibility Study of the irrigation projects, it is important to integrate the various aspects of the agricultural development, that is, the introduction of high yield varieties, the strengthening of the organization and function of the Research including those of the Central Farms and Seed Farms and Extension as well as the improvement of social infrastructure.

IV. FINDINGS IN THE PROJECT AREA

IV - 1 Climate and Hydrology

(1) Climate

Meteorological observation is carried out by the Meteorogical Department under the Ministry of Transport and Communication. There are three meteorological observatories: Prome, Henzada and Tharrawaddy observatories in the Project Area. The locations of the three observatories as well as observatories in the circumference are shown in the appendix. Daily observation is carried out for temperature, rainfall, atmosphere pressure, humidity, evaporation, actual sunshine time, wind speed and wind direction.

The climate conditions of the Project Area are tropical and strongly affected by the south west monsoon. There are three seasons: the rainy, the cold and the hot seasons. A well-defined rainy season starts in the middle of May and ends in the middle of October. It is a rare case to have rainfall in other seasons. The average rainfall at Henzada reaches to 2,287 milli-meters while that at Prome, 1,279 milli-meters respectively.

The cold season comes after the rainy season from November to January. The temperature falls down to the lowest in a year, and the humidity is also the lowest.

The hot season preceding the rainy season lasts from February to April which is the hottest in a year. The maximum temperature at Prome and Henzada is 40 degree centigrade respectively.

(2)

(2) Hydrology

Daily rainfall data is available at the following gauging stations.

	STATION	PERIOD
1)	Hmawbi	1954 - 1977
2)	Taikkyi	1947 - 1977
3)	Tharrawaddy	1947 - 1977
4)	Minhla	1959 - 1977
5)	Okpo	1972 - 1977
6)	Gyobingauk	1959 - 1977
7)	Zigon	1959 - 1977
8)	Prome	1947 - 1977
9)	Paukkau	1966 - 1977
10)	Shwedaung	1948 - 1977
11)	Henzada	1947 - 1977

Daily discharges for the proposed fourteen dam sites have been observed at the following water gauge stations.

STATION	RIVER	CATCHMENT (SQ.KM)	PERIOD
1) Kyaukpyintha	Okkan	313.4	1970-1976
2) Kaunglaungtine	Thegon	88.1	1971-1976
3) Kwetma	Kadinbilin	240.9	1972-1976
4) Chaungzauk	Gamon	80.3	1971-1976
5) Baubin	Baubin	261.6	1970-1976
6) Magyibin	Taungnyo	549.1	1972-1976
7) Temo	Wegyi	538.7	1970-1976
8) Yonbindet	Thegon	51.8	1971-1973
9) Thapangaing	Shwele		1972-1973
10) Myodaung	Dingyi	323.8	1973-1976
11) Magwe	Alonawin	274.5	1973-1976
12) Yatthit	South Nawin	639.7	1973-1976
13) Kyidaing	Kyun Chaung	72.5	1971-1973
14) Kwinlaygyi	Kyun Yaung	64.8	1971-1973

Water levels of the Irrawaddy River are observed by the Meteorological Department at Prome and Henzada in the Project Area. A rating curve has been established only for Prome station. It seems very difficult to establish a rating curve at Henzada, because the river course moves quite often during a flood season.

The Irrigation Department has four water gauge stations between Prome and Henzada. They are Seiktha, Kyangin, Myanaung Kanaung stations.

No observation data of rainfall is available in Pegu Yoma area in the left bank of the Irrawaddy River, where the fifteen dams are proposed. No accurate discharge analysis can be performed without any observation data. Observation data of more than one year give much contribution to the accuracy of the discharge analysis by taking a co-relation between the rainfalls in the flat area and those in the mountain area.

In the right bank of the Irrawaddy River, there are a few rain gauge stations along the River. It will be required to install new rain gauge stations both in the flat area and mountain area.

A co-relation analysis based on the observation data will reveal a local characteristic of the rainfall and auto-relation analysis will be performed in order to distinguish a pattern of the rainfall.

Such methods as multiple regression model and tank model simulation can be used for estimating the discharges from the rainfalls, and analysis will be performed by using computer.

IV - 2 Geology and Soil

(1) Geology

The Project Area mainly consists of two topographical units which are closely co-related with their geology; that is to say, plain and hilly areas. The first belongs to the Irrawaddy valley or rather to the northern part of the Irrawaddy Delta and the second belongs to the mountain range of Arakan and Pegu Yomas.

According to the Geological Map of Burma published by the Bureau of Mines, Rangoon, in one inch to four miles scale, the geology of the Project Area consists of Tertiary formations with sedimentary facies as base rocks. Quarternary formation with both Pleistocene and Holocene alluvials are unconformaly overlying on the base rocks across on both sides of the Irrawaddy River with strenching vast plain.

The basic stratigraphic succession of formations in the Project Area is shown in the following table.

Basic Stratigraphic Succession

Epoch	Period	Age	Series	Description
Quarternary		Holocene Plistocene		alluvium and plain located both sides of Irrawaddy River.
Tertiary	Neogene	Pliocene	Irrawaddy	almost sandstone, foot hill area of Pegu and Arakan Yoma.
		Miocene	Pegu	sandstone/shale, hilly and mountainous range of Arakan, Pegu Yoma.
	Palaeogene	Oligocene		
		Eocene	Longshay	Shale, foot of Arakan Yoma
		Palaeocene		

The Project Area can basically be divided into certain litho-stratigraphic units and remarkable geological features of each unit are as follows:

The Longshay Series spread on the transitional region between the Arakan Yoma and alluvial plain running from north to south with a narrow strip and belong to Eocene Age. The base of Eocene is composed of mainly conglomerates with some grits and sandstone, however, these conglomerates are overlain by a thick series of shales called Longshay shale.

The Pegu Series spreads around the Arakan and Pegu Yomas, adjoining the hilly and undulation area, and shoots up in the limited area at the south of Prome with a narrow strip, and belongs to Miocene Age. The Pegu Series is composed of shales and sandstones with greenish or gray colours, and exposed at many places. Those rocks are rather soft and weatherable and have varing distribution in places. The potential damsites are located on the alternation of shale and sandstone of the Pegu Series formation.

The Irrawaddy Series spreads near the foot of the Arakan and Pegu Yomas on the transitional region between the hilly area and alluvial plain adjoining to the Pegu Series region and the limited area along the Irrawaddy River at the South of Prome, belonging to Pliocene. The Irrawaddy Series is made up of almost sandstone and contains silicified fossil wood and mixture of ferruginous, calcareous and siliceous concretions and a quantity of pebbles can be observed.

The alluvium region occupies the central part of the Project Area along the Irrawaddy River forming the vast plain which is composed of the alluvial deposits derived from the Arakan and Pegu Yomas, and the Irrawaddy River itself. This region can be subdivided into two divisions from the view

points of its relief and composing deposits. The hilly alluvial plain is a transition from the hills of the Arakan and Pegu Yomas to the central alluvial plain and it occupies almost of the alluvium region. The deposits are mainly composed of the coarse layers interbedded with silty and loamy layers. However the upper portion becomes more clayey. Numerous young coarser local alluvial deposits are found along small stream in the area. This division is closely co-related with the agricultural products and almost irrigable areas are located in this division. Central alluvial plain - this division is spreaded along the Irrawaddy River, forming a narrow belt of south-north direction. The division is composed of fine sorted heavy textured alluvium which is rather homogeneous. It is traversed by numerous stream flowing from the hills.

The other minor lithostratigraphic units such as serpentine and limestone are distributed in limited places at the northern part of the Project Area.

According to the aforesaid Geological Map of Burma, there are three major paralled faults in the north-east part of the Project Area near Prome, mainly extending beyond the Project boundary with north-west direction, and it seems to have no direct effect for the potential damsites. However, numerous

minor derivative faults from the major faults exist around northern part of the Pegu Yoma in the Project Area where some of the potential dams are located.

(2) Hydrogeology

Ground water behavior is closely co-related to the characteristics of the geological formations. The shales and sandstones belonging to Tertiary unit are generally impervious, and more or less pervious respectively, and Quarternary unit is mainly composed of the coarse layers interbedded with silty and loamy layers, however, the upper portion becomes prevailing more clayey.

The ground water table in the Project Area is not so low, however the water table varies in the rainy season rising to the ground surface and dry season falling about six meters below ground surface. Thus, the domestic water supply in the Project Area is mostly from shallow wells, however these wells are often dried up during the dry season. No systematic and large scale irrigation from the ground water has been excuted in the Project Area.

Due to the above mentioned conditions at the Project Area, it can be considered that the possibility of large scale agricultural development from the ground water resources is evidently lower than that of the surface waters.

(3) Soils

The differentiation of the soils is closely connected with their geomorphological regions as follows:

(i) Yellow Brown Forest Soils are developed in the good drained condition under the influence of forest vegetation. These soils cover the Pegu Yoma and foothills of the Arakan Yoma. They are highly productive as the forest land, and should be kept under the forest for the water conservation.

(ii) Primitive Crushed Stone Soils are found in combination with the Yellow Brown Forest Soils, and exist especially on the steep slopes and hill tops. They should also be kept under the forest.

(iii) Lateritic Soils develop on the gentle slopes of the foothills of the southern part of the Pegu Yoma, and are combined with Yellow Brown Forest Soils. Upper horizon of the profile is light loamy and in the lower horizon there exist heavy soils. Mostly covered with bamboo brackets and dense shrubs, they are regarded as good Ya-lands which are suitable for orchard or rubber plantation. Lateritic Soils are also easily eroded because of their friable surface soils.

(iv) Cinnamon Soils occupy the under-hill alluvial - deluvial plain of the northern part of the Pegu Yoma. The soil texture varies with the various parent materials, however, light loamy texture predominates. These soils are now mostly under the forest with low productivity, but are regarded as Ya-land of good fertility, especially under irrigation.

(v) Meadow Soils occupy a vast area which stretches from the north to the south in the eastern part of the central plain of the Project Area. They are rather good drained, ranging from medium loam to heavy clay in texture. They are now utilized as paddy field of moderate fertility and also suitable for second cropping after paddy.

(vi) Meadow Gley Soils also occupy a vast stretched area by the west of the Meadow Soils belt. They are developed under rather humid conditions than the Meadow Soils. Their textures range from heavy loamy to clayey soils containing much silt. They are now fully utilized as paddy field of best fertility. Second crops after paddy are also possible but it is required to adopt the suitable sowing time and take some counter-measure for preserving the soil moisture.

(vii) Meadow Alluvial Soils are the recent and sub-recent alluviums which cover the Meandering Belt of the Irrawaddy River and Mitmaka River. These soils vary in their textures, degree of gleyness and swampiness in accordance with their locations on the microrelief geomorphology, but light loamy soils are predominant. These areas are not generally cultivated except higher places at present due to the inundation, but the fertility is rather higher than the other soils. These soils will, therefore, be suitable for upland crops as Kaing land of good fertility after taking counter-measures for the floods.

(viii) Meadow Swampy Soils are located in the depressed area in the Meandering Belt predominated with the Meadow Alluvial Soils, and the degree of the gleyness of the soil is far advanced than the Meadow Alluvial Soils. Texture of the soils is generally heavy clayey, and permeability is very low. As the content of nutrients and humus is rather high, it will become a good paddy field after amelioration.

(ix) Swampy Gley Soils are developed under the similar conditions to Meadow Swampy Soils but content of nutrients and humus is less than that of the Meadow Swampy Soils.

(x) Alluvial Soils are located on the Irrawaddy River banks and the islands. They are developed in the conditions of yearly inundation and deposition of a new alluvium, and fertility is still low.

Above explanation about the Soils is based upon the reports on the "Soil and Land Use Survey " of Prome, Tharawaddy, Insein and Henzada District, which are printed by the Land Use Bureau in 1959.

IV-3 General Feature of Agriculture

(1) Guideline for Crop Production

The Government has been taking a policy to encourage farmers to grow cotton, jute, sugar, pulses, and groundnut and sunflower (oil crops) besides paddy so as to increase export of farm products as well as to increase in their self-sufficiency ratio.

The measure for production increase has been carried out both by extensive development of new farm lands and by better utilization of existing farm lands; it is deemed reasonable to promote the policy by improvement of farming techniques including breeding, and extension of multiple cropping.

At present, however, most of the farmers are being engaged in the single cropping of the wet season paddy and the extension of multiple cropping has made very slow progress, although the authorities concerned have been making every possible effort.

	Net sown area (1)	Total sown area (2)	Ratio (2)/(1)
	(1,000)	(1,000)	
Union 1970-71	7,896 Ha	9,040 Ha	1.145
1975-76	8,129 Ha	9,441 Ha	1.161
Increasing rate/year	0.58	0.87	

(2) Kinds of Arable Lands and Their Cropping System

(a) Paddy fields: The most of arable lands are under paddy cropping and absence of irrigation facilities has not allowed to grow the second crops, excepting for only a small area cropped with pulses, chillies and so on after paddy cropping.

In some lands that the water is supplied from ponds or rivers, the farmers grow the pre-monsoon jute and late planting paddy after harvesting the jute.

In other places that the sowing of pre-monsoon jute is unavailable due to lack of irrigation water, the monsoon jute is sown after a little rainfall comes.

In 1980-81, after completion of the North Nawin Project will provide irrigation water available for some 39,200 hectares in the Project Area, of which about 33,800 hectares are planned to carry out the double cropping.

(b) Kaing Land: The land of this kind extends mainly along the Irrawaddy River and cultivation is easily practised there because of the sandy soil prevailing in the recent alluvial soil. In the wet season, there is a flood coming over the land, and in the plces places that the flooding water goes down quickly, the pre-monsoon sesamum is grown before the flood. After the water sinks completely, the lands are cultivated with groundnut, pulses, chillie, and Burmese tobacco as winter crops.

The Kaing land does not occupy so large part in the Project Area. Nutrient substances annually flooding into the land is

have allowed to carry out non-fertilizer farming to produce a considerable yield.

(c) Ya-land: The Ya-land develops in the slopes piedmont area and upland fields at the plateau, generally being cultivated with only monsoon crops owing to its property of good drainage. Mainly single cropping or mixed cropping by sesamum, pulses and cotton (local variety) are grown, and in some part, pulses are grown after harvesting early sesamum.

In the first year after land development, yield is rather high, however, since continuous cropping reduces the fertility of lands, sometimes the shifting field method has been employed. There are some perenial crops like fruit-trees found in this kind of land.

The Ya-land develops mainly on the left bank of the Irrawaddy River but occupies only a small part in the Project Area.

(3) Some findings on major crops in the Project Area.

(i) Paddy

The annual rainfall of the northern part of the Project Area is not necessarily sufficient to rainfed paddy production. As the rainy season is over in October that the late matured variety is still in ripening stage, and the surface of paddy fields goes dry, so that the paddy may result in incomplete mature at harvesting. Therefore, further investigation is required in this respect. The early matured variety growing will make it sure to be fully matured and HYV growing will make it more sure to produce much better yield.

The ratio of broken rice after milling is high and the causes of this are considered as,

1) Improper way of paddy drying,

2) Over matured harvesting, and

3) Poor facilities of rice mill.

It is desirable to take adequate counter-measures for the above facts.

Varieties which have less shattering habit are apt to be harvested in over-mature, because those are not easy to be threshed by the traditional method when harvested just at the matured time.

The Government encourages the farmers to grow HYV or LIV (Local Improved Varieties) and apply the improved techniques including fertilizing and pest-control so that the higher unit yield per acre can be obtained. In Taikkyi, as mentioned below, there are five High Yield Centres established which give farmers the intensive guidance of improved techniques and have succeeded in paddy production increase to a considerable extent.

The share of cropping acreages of HYV and LIV in 74 villages covered by these High Yield Centers is 30 per cent and 38 per cent respectively, in 1977-78. In the neighbouring Tharrawaddy Townships, however, the HYV and LIV will be introduced in 1978-79. The positive guidance and assistance by the Government will make it possible to carry out the successful extension in the line.

For references, the LIV seems more easy in extension works than the HYV from the view point of taste and preference of consumers.

(ii) Groundnut

There are four types included in the groundnut cropping pattern, that is, cropping for pre-monsoon, monsoon, late-monsoon and winter, and the winter groundnut cropping prevails in the Project area.

Most of winter groundnut is grown after paddy harvesting, and some are cropped in the Kaing lands. The growth of winter groundnut, however, can be more favourable than at present if irrigation is applied is not so good because of the dry climate.

It is urgently needed to introduce the desease resistant varieties in considering the fact that there are many occurrences of leaf spot on the plants.

(4) Some technical problems on the intensive crop production.

(i) Problems on multiple cropping

The reason why the multiple cropping is reluctantly extended is that the absence of water utilization facilities make it difficult for farmers to grow the winter crops after paddy, and their harvest to be uncertain. There are some counter-measures taken for this case; one of them is to strengthen the draft power. The Government has employed tractors for land preparation of the

paddy field for second crop sowing immediately after paddy harvesting. However, the tractors owned by Government or Cooperatives have been mostly time-worned by long operation and yet the spare parts for repair are short in quantity. On the other hand, the bullocks have not increased in number so quickly.

In considering these facts, it is deemed necessary to get the paddy harvest earlier by introduction of non-photosensitive varieties (HYV) so that the maturing can come earlier. Thus, the earlier sowing of the second crops, while soil moisture content being high, will allow to expand the acreage for double cropping, increase unit yield per acre, and keep it stablized.

In such process, problem arises in the paddy harvesting time; if the harvesting comes too early, the harvesting falls on the end of the rainy season, and it will be essential to solve the problem on how to manage post-harvesting practices of paddy.

(ii) Problems on paddy-paddy double cropping with irrigation facilities.

Varieties and cropping time of winter cropping paddy should be carefully decided lest the harvesting season should last into the rainy season.

The present winter cropping paddy, which has an estimated growth duration of 125 - 135 days, should be transplanted in the middle of December at the latest. When transplanting is behind the

above schedule, it will be necessary to establish the counter-measures for post-harvesting works in the rainy season.

(iii) Problems on intensive cropping.

As multiple cropping and high yielding culture are carried out, much dosing of fertilizer, introduction of disease resistant varieties and adequate pest control are essentially required. Naturally, the constant efforts for developing new techniques and their extension are necessary for successful intensive cropping.

(5) Land Tenure

All cultivated land in Burma is owned by Government. No farmer is allowed to sell or buy the farm lands. This institution leaves very limited rooms for any farmer to enlarge his farm land to get the most remunerative size of holdings.

On the other hand, this land tenure institution ensures every farmer the necessary certainty of tenure which is fundamentally important factor for the development of agriculture. In the interview with several farmers, any anxiety could not be found among them with regards to their land tenure. But at the same time, no strong will could not be seen among farmers to invest in the improvements of the land, for instance, minor irrigation and so forth.

Some of the Township area visited, is included in the irrigable area of the proposed irrigation projects by Government. When secondary or tertiary canals are constructed together with the land consolidation in these area, there may be some substitution of farm land necessitated. In this case the present land tenure institution may be conducive to this land substitution programme because all land is owned by Government.

(6) Size of Holding

When compared with the average size of holding of about 2.2 hectares in the whole of Burma, that of those Townships visited is a little smaller. But there could be no accurate figure available which are now in process of collecting from each Township.

The figure of the size of holding in whole Burma shows that about thirteen per cent of the farms is larger than about four hectares and they cover about 42 per cent of the cultivated land. Big farms more than about 40 hectares are negligible in number of farms and their coverage.

These figures show that land distribution among farmers is rather even, and the number of landless worker seems very small.

These conditions are rather favourable for introducing the intensified technology after the development of water resources.

(7) Paddy Procurement and Advance System

Compulsory paddy procurement and the Advance System are the mainstay of the agricultural administrative framework.

In hearing from the Township Manager of the Agricultural and Farm Produce Trade Corporation and the officer at the buying centre, the fairly clear-cut explanation was made about the buying, milling and transporting of paddy by the Government and Advance Payment System.

With regard to the transportation, milling and storage, there are so much to be done for the improvements of these facilities. These improvements will be studied in more detail in future study of the Master Plan.

Quota and procurement price are very important but difficult policy framework. In the Township where the high yield varieties have been introduced by the Government institution (High Yield Centre), the quota has been increased about 50 per cent in one year. This increase in quota seems to be very sharp and may have some unfavourable effect on the extension of the high yield varieties.

(8) Paddy High Production Programme

(Whole Township development Programme)

The very intensive project of increasing the production of paddy not only through the introduction of the high yield varieties but also by disseminating the improved agricultural techniques by five camps have been promoted in Taikkyi Township.

Four principles including the increased application of fertilizers and insecticides, and the increased number of village managers are the principle features of this programme.

It started from the very limited acreage in 1975 and in 1977 it covered the whole Township area of about 53 thousand hectares. In the year of 1977-78, this whole Township development programme of Taikkyi has raised the net profit of about 12.5 million Kyats with the input increment of about four million Kyats, of which three million Kyats was invested by farmers. This programme is very encouraging instance which tells the very important role to be played by the extension activities.

The demonstration of the improved agricultural techniques to farmers through the increment of personnel of extension and of input material has proved its effectiveness of increasing the production of paddy.

The Government of Burma has the plan to set up this paddy high yield production programme in 21 Township in whole Burma, including three in Okpo, Henzada and Kyonpyaw in this Project Area.

This type of development of extensions together with the development of research would be suitable for being taken up for discussion as the international projects of technical and financial co-operation.

(9) Data Collection

The statistical data with regard to agriculture are available only in the national level and divisional level. Those of the Project Area must, therefore, be collected anew, because there are Townships comprising of one Township of Rangoon Division, fourteen of Pegu Division (West) and nine of Irrawaddy Division in the Project Area. The statistical data of these 24 Townships are now being collected through the Agriculture Corporation. The collection of these data are still in process and the necessary complement study and investigation are to be conducted by the following mission. The item of the statistical data to be collected are shown in the Appendix.

IV-4 Irrigation

(1) Existing irrigation systems

According to the Irrigation Department and field survey, there exist no irrigated fields in the Project Area, except some minor village irrigation works which are currently rainfed. If the irrigation water is supplied to these fields, the second cropping in the dry season will be available with paddy, sesamum, groundnut, etc to increase farm production.

(2) Proposed irrigation project

The Irrigation Department has one on-going project and fifteen proposed projects in irrigation program on the light bank of the Irrawaddy River. The former is located at the east of Prome, involving those townships of Prome, Paukkaung, and Thegon, and scheduled to be completed in 1981-82 by the Irrigation Department. The project components are an earth dam with length of about 1.6 kilometers and gross storage capacity of about 360 million cubic meters, and irrigation and drainage networks serving irrigable areas of about 39 thousand hectares. Completion of the project will allow the irrigable areas to be converted into the double cropping areas. (Refer to Appendix)

The latter, fifteen projects prepared by the Irrigation Department, aims at irrigating some portion of

land potentiality about 400 thousand hectares that have more potentialities to produce much farm products.

After completion of these projects, the related areas will be able to supply Rangoon, the capital of the country, and other many municipalities with agricultural products.

The other irrigation systems than those mentioned above will be planned to employ the pumping irrigation method. The locations of the pumping stations along the Irrawaddy River, however, require further surveys and studies in taking into account the considerable river course shifting due to floodings in the rainy season.

IV-5 Flood and drainage

River dikes have been constructed long before in some area along the Irrawaddy River. A flood water from the Irrawaddy River sometimes flows over the dikes and it causes the destruction of the dikes. When the dikes were destructed, the new dikes have been reconstructed in the behind of the destructed ones. The dikes are used as roads and are connected with villages which are established on the natural levees.

The Myitmaka River is an old river course of the Irrawaddy River, running down the lowest parts of the area. An inundation along the Myitmaka River has been caused not only by the flood discharge from the catchment area itself but also by the overflow discharge from the Irrawaddy River. The inundation water cannot be drained in a short time. Swamps can be found in the lowland area along the Myitmaka River even in the dry season.

In order to grasp the existng condition of inundations and also to provide for the analysis of the future flood control methods, the longitudinal and cross sectional profile of the Myitmaka River and the topographical map of the inundation area will be required. Observation of the water stage of the Myitmaka River will be required at the several important points from a hydraulic and hydrological aspects and field survey must be carried out during a flood season.

A mathematical model can be considered most suitable to simulate the total system of the hydrological and hydraulic phenomena which consist of such sub-systems as rainfall, run-off, flood inundation and drainage. In this simulation, the flood control effects of the proposed fifteen reservoirs and such hydraulic structure as dikes, gates, pumping plants and retarding basins, if necessary, can be fully taken into account, and most effective flood control measures can be sought out by using a electric computer.

IV-6 Road Conditions

In the left bank of the Project Area, the asphalt-paved two-lane national road linking Rangoon with Mandalay runs from north to south through almost the center of the Area. However, other connecting roads, township roads and farm roads, have been poorly provided in physical conditions as well as density of networks.

Under the situation, transportation of agricultural inputs and outputs takes so long time and much labour. Particularly in the rainy season, muddy roads largely prevent inhabitants from not only doing smooth transportation but also positive social activities and production activities.

In the right bank area, the Ministry of Construction has started some construction works at Insein for national road linking Insein with the northern areas via Thongwa, Henzada and and Okshipin, and other national road construction project has been completed to link Shwebontio with Sandawa traversing over the Arakan mountain range. Poor farm road system can be found in the area.

It will be necessary to formulate a rural development project by establishing functionally connected networks of township roads and farm roads.

For inhabitants in the both banks of the Irrawaddy River, boats are the only means of transportation to haul the daily necessities and farm products because of no bridge available over the river. Therefore, the

improvement of living environment of the inhabitants requires to provide a bridge at any suitable place, and the construction site of the bridge should be decided by careful study on utilization coefficient of the bridge on the basis of living environment and improvement of farm products distribution of characteristic features of the river as well as the technical and economic aspects.

IV-7 Mapping

All maps to cover whole area of the country are prepared and controlled by the Survey Department. At present, there are three kinds of maps in different scales[1/] and the maps for the proposed Project Area are available in those three kinds.

All of those maps, however, were prepared in 1940's and the scale is indicated on the yard system, that is in inch and mile. The Survey Department has been making rectification of locations of road, rivers, etc on the basis of aerophotos taken in 1972.

The Master Plan Study requires the maps on a scale of about 1/250,000. The Survey Department will be able to develop the required scale maps for the Project Area within 1978 by rectifying the existing ones. Such rectification and mapping works will be carried out by the Survey Department in accordance with priority the Government takes.

Notes: [1/]

Inch Map	Scale: 1: 63,360
Half inch map	1:126,700
Quarter inch map	1:253,400

V. FORESTRY

The forest of the Project Area covers the area along the western Pegu and eastern Arakan mountains ranges and occupies 70 per cent of the whole Project Area. Most of the forests are mixed deciduos forests made up mainly of teak and hard wood trees. The teak largely grows on the hilly region of the Pegu mountain ranges and the other hard-wood trees mostly grow on the Arakan Mountain ranges.

The reserved forest which has been properly and strictly managed comprises of 38 per cent of the whole forest area. When compared with the average 25 per cent of the whole Burma, this is the region where forests are well cared and managed.

Moreover when viewed from the production to the forest area of the whole country, in the Project Area the percentage of production of teak wood is fairly high and it is also a very important part of the forest industry as it has the capacity and possibilities of development of hard wood trees apart from teak.

(1) Findings

(i) The condition of the forests of Teak Selection working circle and Hard Wood Selection working circle is good and the area can be described as a closed forest which means the land is almost all covered with forest trees without any bare land.

(ii) This is due to the fact that the selected felling of trees has been executed according to the principle for a long time and it can be considered as an indication of the appropriate forest management and the forest operation-technique of Burma.

(iii) The proposed dam site is located in that region of the forest which has been preserved in such a very good condition and the catchment area is the forest land which has an efficient function of water regulation.

(iv) Forest regeneration has been conducted mainly by natural regeneration along with Burma's selected forest-cutting system. But in those forests where forest stock is very low, planting of trees is carried out as a measure of artificial regeneration in order to replenish them. This technique brings good result and has been practised throughout a long history. The species of trees are mainly Teak and Pyinkado. It is presumed that the planting of such species will keep the forest in a very good condition.

(v) The forest pretty downstream of the proposed dam site is supposed to be a public forest mainly for extraction of wood for private construction of local houses. Hence the forest stock of this part is rather low. Recently the planting of quick growing species such as Eucaliptus is speeded up. It is found that such kind of forest is efficient showing good result, for it can meet the local communities' demand for forest produce.

(iv) Therefore considering the above points, it can be noted that in future the water-regulating function of the forest in the river basin and in the catchment area upstream of the dam site as well will be evidently maintained and improved.

(2) Forest working plan

The system of forest working planning is roughly as follows:

(i) As the result of the long time investigation the working plan of the forest has been formulated and established with due consideration on the forest growth and forest type and stock, and in accordance with this plan the proper forest management is executed.

(ii) A ten year forest working plan is made in each administrative divisional area and this is a long time system which is renewed every ten year.

(iii) The contents of the working plan and their system and the application of the sampling technique for forest investigation and the forest management map etc. are exactly the same as the system of the working plan and forest investigation of Japan.

And the forest working plan has much to do also with the development in other fields such as agriculture, industry, etc., with the overall development of the whole Project Area.

(3) The constraints and problems

(i) limited mechanization and the lack of cable logging techniques

(ii) rough forest roads network

(iii) poor nursery equipment

(iv) old and inefficient milling plant

(v) mechanization of plantation establishment.

To overcome the above mentioned constraints and problems, the investigation and study with regard to the following item may be useful.

(i) To review the forest working plan of the Project Area.

(ii) To improve nursery.

To have the central model nursery for the improvement of seedling production techniques including sprinkler system, the introduction of more exoitic quick-growing species and the training of technicians.

(iii) To make the processing and distribution of timber more efficient.

To have the model milling plants for the improvements of the processing and manufacturing technique.

(iv) To make the forest road network more intensive.

(v) To increase the acreage of plantation establishment, it is necessary to provide machinezies and equipment for its mechanization.

VI FISHERY

According to the field survey, there are the following three types of fish production practised in the inland areas:

(1) River fishing

Irrawaddy River: In the dry season, gill net fishing can be seen at Henzada port. In the rainy season (June O (June - August), two species of Indian carp fries are caught with bag nets in the River where photoplanktons are abundant.

Daka River: Cast net fishing can be seen at Kyanpyaw Township. Water hyacinth is growing on the both river-sides.

(2) Leasable fishing

Inyegyi Lake: The lake is linked with the Daka River by narrow channel. An estimated area is about seven square kilometers. The People's Pearl & Fishery Corporation is managing fishery at three fishing points with gill nets, trap nets and cast nets from production to sales. Annual production is about 60 tons of fish, in which Indian major carps are main species. The lake, where photoplanktons are abundant, seemsto provide a good fishing ground.

Duya Lake: This is a horn-shaped lake. The Fishermen Production Co-operative produces about 25 tons of

fish in a year. Water vegetation is so thick that big fishes can hardly be caught with existing fishing methods by various nets, although many big fishes are found. The lake, where photoplanktons are abundant, seems to provide a good fishing ground.

Ragwinpyin River: Trap net fishing is available only in a period from September to December.

(3) Fish Culture

Kanzu village fish pond: The fish pond is operated by Kanzu Village near Inyegyi. An estimated area is about six thousands square meters. Indian major carps caught in Inyegyi Lake are released to this fish pond, and about 500 kilograms of fish were harvested. Rice bran is given as a supplemental feed.

Private fish pond near Rangoon: An estimated total pond area is about 1.2 hectares by eleven ponds. Indian major carps fries are released in the rainy season and two years later fish weighing about two kilograms is caught and sold to Rangoon wholesalers. Rice bran and peanuts cake are given as supplemental feeds. Water is fertilized with cattle feces. Annual production is about sixteen tons.

River fishing and leasable fishing are very important in this country. The fish from inland water has been indispensable protein source for the habitants. According to the Department of Fisheries, annual flood of Irrawaddy River is an essential factor for natural fish production. So it is considered necessary that the harmony must be kept between agricultural developments and fishery in the Master Plan Study of the Project.

The Department of Fisheries stressed the necessity to resolve the following three problems:

i) Improvement of fishing ground

ii) Control water hyacinth

iii) Increase of seed production, especially Indian major carps.

After completion of the related agriculture development, fish culture will be established using such facilities as dams, irrigation reservoir, and so forth.

The data measured in the field survey are annexed to this Report.

VII PRIORITY FOR THE PROPOSED DAMS

To give a priority for the commencement of Feasibility Study for the dam construction in the Project Area, the reconnaissance survey has been carried out for five proposed dam sites which were selected from fifteen potential dam sites by the Irrigation Department in considering their basic priority. (Locations of the potential damsites are shown in the attached figures end of this chapter.)

VII-1 Results of the Reconnaissance Survey

As far as the reconnoitered damsites are concerned, it can be said that the topographical and geological conditions and available embankment materials are fairly similar to follows.

The proposed damsites are located in the hilly region where the flat plateau is well-spreading with undulation.

The river meander through the hilly region to the west where comparative narrow valley is carved in the bed rock formation with the maximum height of both banks is about 40 meters above the river bed.

The foundation rock of the proposed dam sites is composed of the alternation of shale and sandstone of the Upper Miocene to Pliocene, however, the distributed proportion of the aforesaid rocks varies in places.

The lithologic character of the bed rock at the proposed dam sites is almost fine grained medium hard to soft, comparatively massive and with less fractures.

Since there are no large faults but a few major joints at the proposed damsites, the permeability of bed rocks are rather lower order of $nx10^{-5}$ centimeter per second and this figure shows generally impervious.

The prevailing strike and dip at the proposed damsites is in north-south direction and 20 degree to 30 degree toward downstream respectively.

As for the embankment materials, a suitable borrow areas consisting of residual clayey soil originating from the shales are found abundantly around the proposed damsites for the use of the impervious fill.

However, the pervious fill and concrete aggregate materials are not distributed near the damsites. The sandy material consisting of closed fine grain originating from the sandstone is not suitable as the embankment material of fill dam due to avoiding the liquefaction and quicksand.

As the said facts, a homogeneous type fill dam is most suitable one for the proposed damsites, in this case, the height of dam may be limited less than 35 meters according to the topographic condition and soil mechanics of the embankment materilas.

As regards to the foundation rocks at the proposed damsites seem to have sufficient lithological character such as bearing capacity and shearing resistance to construct the fill dam with height of less than about 35 meters and also it

is probably free from the see page problem without taking any special counter measures for the leakage in reservoir except otherwise mentioned.

The summary for the reconnoitered damsites are described as follows: (Detailed descriptions of damsite geology for the proposed dams except Okkan and Kadin Bilin are seen in collecting data which were drew up by Engineering Geologists of the Irrigation Department.)

No.4 OKKAN Damsite (Okkan Chaung, Catchment area: 207.2 sq.km)

The proposed Okkan damsite is located on the Okkan Chaung, it is about 300 meters downstream from the confluence of the Okkan and Dat Chaung where the comparative narrow valley is carved in the shale formation.

The topographic survey and geological investigations are on going in the site on February, 1978, and finally total ten bore holes (total drilling length about 135 meters) will be drilled around dam axis. The bottom width between both banks is about 20 meters at the site and the slope angle of the right bank is about 30 degrees, contrarily the left bank about 15 degrees. Both banks have the same height of about 35 meters from the river bed and their upper parts become flat, however on the right bank, there is a narrow saddle where small dike should be constructed. The flat plateau is covered with varying thickness residual clayey soil originating from decomposition of the alternation of shale and sandstone formation. Alluvial deposits along the river

bed around the proposed damsite are generally scarce.

The foundation rock of the Okkan damsite is almost composed of shale with conformity belonging to the Pegu Series. The outcrop of shale is distributed around the river bed and almost of the right bank, however, on the left bank, the weathering depth seems to be rather thin.

The prevailing dip in this site is nearly 30 degrees toward downstream.

The shale formation is comparatively sound, massive and with less fractures, and generally impervious. As far as the results of pressure permeability tests on the river bed, the permeability of shales are rather lower order of $nx10^{-5}$ centimeter per second.

According to the nove mentioned facts, the shale formation in this site seems to have sufficiently lithologic characters such as bearing capacity and shearing resistance to construct either the fill type or concrete gravity type dam with height of about 30 meters, and also it is probably free from the see page problem without taking any special counter measures for the leakage in reservoir.

As for the embankment materials, a suitable borrow area for impervious material is found around the damsite abundantly, and also the rock material for the use of the rinrup is distributed about 2 kilometers of the upstream of the damsite, however the filter and concrete aggregates are not distributed near the damsite.

A homogenous type of earth fill dam appears most suitable to this site taking into account the topographical condition and an available embankment materials around the damsite.

No.13 Thegaw Damsite (Thegaw Chaung, a tributary of Kadin Bilin Chaung. Catchment area: 90.7 sq.km)

The proposed Thegaw damsite is located in a hilly region adjacent to the alluvial plain, it is about 250 meters downstream from the confluence of small stream of the Shawdon and Hmya Chaung where the valley is well-developed along the river course.

The topographic survey, geological investigations and soil tests had been conducted from 1975 to 1977 and total of ten bore holes (total drilling length about 270 meters) with permeability tests were drilled along the dam axis. The bottom width of valley is about fifteen meters at the site and the slope of both banks is very gentle of about fifteen degrees angle. Height of the both banks is almost 20 to 22 meters above the river bed and their summits become flat with rolling.

Area around the damsite is covered with residual sandy with varying thickness and comparative dense vegetation. Alluvial deposits in and around damsite are, in general, found scattered in small scale. The foundation rock of the Thegaw damsite is composed of the alternation of shale and sandstone belonging to the Pegu Series.

The outcrop of sforeso Formation is distributed around the river bed; however, in the slope and summit of both banks, the weathering depth to be rather thick in comparison with the expected dam height of about 20 meters. The prevailing dip in this site is nearly 20 degrees toward downstream.

The fine grained medium hard to soft bluish sandstones predominate in this site, in which the silt and hard calcareous sandstone are found interbedded. There are few major joints and minor fractures in the site, however the permeability of bed rock is normally impervious except the weathered sandstone portions. Since the both abutments consist of weathered sandstone layers, the curtain grouting should be considered in order to obtain an impervious curtain within the dam foundation rock. According to the results of permeability test, the weathered bed rock layer is in rather higher order ranging from 6.1×10^{-4} to $8.[illegible] \times 10^{-5}$ centimeter per second and the fresh bed rock layer is in order below 5.3×10^{-5} centimeter per second.

As regards to the embankment materials, a suitable borrow area for impervious materials which is classified into CL group by Unified Soil Classification System is found in a haulage distance about two kilometers from the damsite abundantly. However there are no materials for the use of the pervious fill and concrete aggregates in the vicinity of the damsite.

The most suitable dam type in this site is evidently homogeneous type fill dam, judging from the topography and available embankment materials near the damsite.

No.14 Kadin Bilin Damsite (Kadin Bilin Chaung, Catchment area: 155.4 sq.km)

As a result of reconnaissance survey, it seems to be difficult to find the damsite with the dam height applicable more than about 35 meters between Natthami community and confluence of the Kadin Bilin and Ngapyawdon Chaung. However, the field survey could find an adequate damsite with a height of about 30 meters near the upstream of Natthami community. A rough topographical survey will be carried out in order to select the most adequate damsite in considering the case giving high priority to this site. Therefore following description is concerned with the finding damsite which is located about 1.7 kilometers downstream from the confluence of the Kadin Bilin and Ngapyawdon Chaung. The possible damsite is located in the hilly plateau near alluvial plain where the comparative sharrow valley is carved in the alternation of shale and sandstone formation.

No topographic survey and geological investigation has been carried out in this site.

The bottom width of valley is about 20 meters at the site and the slope of both banks is considerably steep with about 40 degrees angle. Both banks have the same height of about 30 meters from the river bed and their summits become flat.

The hilly plateau is covered with residual clayey soil and comparatively poor vegetation. Alluvial deposits along the river course near the site are generally scarce.

The foundation rock of the Kadin Bilin damsite is composed of the alternation of shale and sandstone belonging to the Pegu Series.

The outcrop of aforesaid formation can be seen at the both banks and around river bed; however, in the top of slope and flat plateau of both banks, the weathering depth seems to be rather thick. The prevailing dip in this site is nearly 20 degrees toward downstream.

The fine grained comparative sound grayish sandstones in the site and this formation is mostly massive having less joints, and considerably impervious. However, the upper elevation of the valley consists of weathered sandstone and shale layers in rather thick, and it may be required to take some counter measures for the leakage in reservoir.

As for the embankment materials, a suitable borrow area consisting residual clayey soil originating from the shale formation is found around damsite for the use of the impervious fill. However, the pervious fill and concrete aggregate materials are not distributed near the damsite. A homogeneous type earth fill dam might be most suitable on this site taking into account the topographical limitation of the dam height and the quality and quantity of the available embankment materials around the damsite.

The hilly plateau is covered with residual clayey soil and comparatively poor vegetation. Alluvial deposits along the river course near the site are generally scarce.

The foundation rock of the Kadin Bilin damsite is composed of the alternation of shale and sandstone belonging to the Pegu Series.

The outcrop of aforesaid formation can be seen at the both banks and around river bed; however, in the top of slope and flat plateau of both banks, the weathering depth seems to be rather thick. The prevailing dip in this site is nearly 20 degrees toward downstream.

The fine grained comparative sound grayish sandstones predominates in the site and this formation is mostly massive having less joints, and considerably impervious. However, the upper elevation of the valley consists of weathered sandstone and shale layers in rather thick, and it may be required to take some counter measures for the leakage in reservoir.

As for the embankment materials, a suitable borrow area consisting residual clayey soil originating from the shale formation is found around damsite for the use of the impervious fill. However, the pervious fill and concrete aggregate materials are not distributed near the damsite. A homogeneous type earth fill dam might be most suitable on this site taking into account the topographical limitation of the dam height and the quality and quantity of the available embankment materials around the damsite.

However the above mentioned dam type is only applicable to dam of less than about 30 meters of height, while for higher dam of more than about 35 meters, a zone type fill dam would be considered suitable due to avoiding the effect of pore pressure and the diminution of the embankment volume.

No.15 South Nawin Damsite (Middle Nawin Chaung, Catchment area: 642.3 sq.km)

The proposed South Nawin damsite is located on the Middle Nawin Chaung, about 100 meters downstream from the confluence of the Dingyi and Alenawin Chaung where the comparative wide valley is carved in the alternation of shale and sandstone formation.

The topographic survey, geological investigation and soil tests have been carried out from 1974 to 1976, and total of 34 bore holes (total drilling length about 1,020 meters) with permeability tests were drilled along the dam axis, and also total of eight sampled materials from the proposed borrow areas were tested in the laboratory of the Irrigation Department.

As a result of reconnaissance survey, the already aligned dam axis on the valley would be shifted to the downstream of about 200 meters to avoid the improvement of permeability for the gravel and sand layer which is spreaded in limited range at the left bank of the valley and it seems to be difficult to obtain as impervious curtain in the layer.

The bottom width of valley is about 40 meters at the site and the slope of left bank is very steep of about 45 degrees, contrarily the right bank about 30 degrees. Height of the both bank is for the most part to 30 to 35 meters above the river bed and their top becomes flat with rolling.

The area around the damsite is covered with residual sandy and silty soil with varying taickness in rather thin and comparatively poor vegetation by timbers and scattered bushes. Alluvial deposits near the damsite are seen in the valley with shallow depth, however at the left bank near the valley, old river deposit of gravel mixed with coarse sand is underlain with the maximum thickness of about 25 meters, and fortunately the distribution of gravel layer is limited in a small scale.

The foundation rock of the South Nawin damsite is composed of the alternation of sandstone and shale belonging to the Pegu Series, however loose Irrawaddian Series sandstone is exposed about 1.2 kilometers west of the damsite. The outcrop of Pegu Series rocks is only found upstream of the river bed in a limited extent and the other area is covered with residual clayey soil in the thickness of one to six meters around the damsite. The prevailing dip in this site is nearly 20 degrees toward downstream.

The fine to medium grained and almost weak sandstones predominate in this site, in which 1.5 to four meters thick of the shale bands are alternated. The compressive strength of

sandstone is considerable low in the range of ten to 20 kilogram per square centimeter. Fracturing in the sandstone decreased in depth of 1.5 to three meters and below three meters becomes less fractured. Since the left abutment lies down the weathered sandstone layers, the shallow curtain will be required in order to obtain an impervious curtain within the dam foundation rock.

From the results of permeability tests, the permeability coefficient of the sandstone layers varies from 4.8×10^{-4} to 3.9×10^{-5} centimeter per second in accordance with the weathering condition.

According to the geological profile along the dam axis, two minor fold axis of the anticline and syncline structure were assumed on the left bank where the acting water head is very low. However, these places seem to have some problems for the leakage in reservoir and adequate counter measure should be considered.

As regards to the embankment materials, a suitable borrow area for impervious materials is found near the damsite abundantly. Eight samples have been carried to the soil laboratory of the Irrigation Department, where the physical and dynamical tests were performed.

On the other hand, there are no materials for the use of the pervious fill and concrete aggregates in the vicinity of the damsite.

The most suitable dam type in this site is evidently homogeneous type fill dam, judging from the topographical and geological condition, and available embankment materials near the dam site.

No.2 Wegyi Damsite (Magyi and Shabaung Chaung, tributaries of Shwele, Catchment area: 531.0 sq.km)

The proposed Wegyi damsite is located in a hilly region of the mature topography, and it is about 300 meters upstream from the confluence of the Magyi and Shabaung Chaung where the rivers are well developed with U-shape valley along the meandering river courses. The dam axis is passing through the two tributaries such as Magyi Chaung on the right side and Shabaung Chaung on the left side.

The topographic survey, geological investigations and soil test have been carried out from 1972 to 1974 and total of fourteen bore holes (total drilling length about 645 meters) with permeability test were drilled along the dam axis. Around the damsite, the topography generally represents valley with parallel homoclinal sandstone. This complicated topography has been caused mainly by the intensive epirogenic movements, different lithology and physical characteristic of bed rocks. At the Magyi Chaung, the bottom width of valley is about 40 meters at the site and the right bank is considerably gentle, where the flood plain terrace were found with maximum thickness about nine meters.

On the other hand, the left bank slope is very steep having no extension of the terrace. At the Shabaung Chaung, the bottom width of valley is narrow of about ten meters at the site and the slope of both banks is comparatively gentle.

Since the area around the damsite is covered by alluvial and residual clayey or silty soil of varying thickness, the distribution of outcrops is limited on the river beds except at few places at the river banks. Thetop of hilly range is well covered with the residual clayey soil with thicknessranging from three to fourteen meters originating from the alternation of shale and sandstone. The holding portion between both Chaungs is a slightly high terrain covered with mainly silty sand with depth about seven meters.

The foundation rock of the Kayyi damsite is composed of the alternation of shale and sandstone belonging to the Pegu Series. The upper portion of the bed rock consists of silty sandstone with thin shale layers and the sandstone is slightly hard and compact. In general the bedding and joint planes are tightly closed at the upper portion, however the weathering depth sometimes reaches about sixteen meters and the rocks become more soft. The lower portion of the bed rock is represented by argillaceous shale with few sandstone bands, the opening of joints fructures are narrow with mostly closed by clayey materials. Minor folds and local changes in dip angle are found at some places in the bed rock, however there are no supporting evidences of the existence of major faults around the damsite, but many liner folds are found.

The prevailing dip in this site is nearly 20-40 degrees toward downstream.

According to the results of permeability tests, the weathered bed rocks are in rather higher order ranging from 8.4×10^{-4} to 2.9×10^{-5} centimeter per second in accordance with weathering condition, however the fresh bed rock is in the order below 1.9×10^{-5} centimeter per second. In general it is concluded that the fresh and some of slightly weathered rock in this site could be considered as practically impervious layer.

However, the both abutments and the portion held between both Chaung lies down the weathered sandstone layer, and adequate counter measure such as replacement or grouting method should be considered in order to keep the water tight.

As for the embankment materials, a suitable borrow area for impervious fill which is classified into CL and ML group by Unified Soil Classification System is found around the damsite abundantly. However there are no materials for the use of the pervious fill and concrete aggregates in the vicinity of the dam site. The most suitable dam type in this site is homogeneous type fill dam, judging from the topography and available embankment materials near the damsite.

VII-2 Economic Evaluations

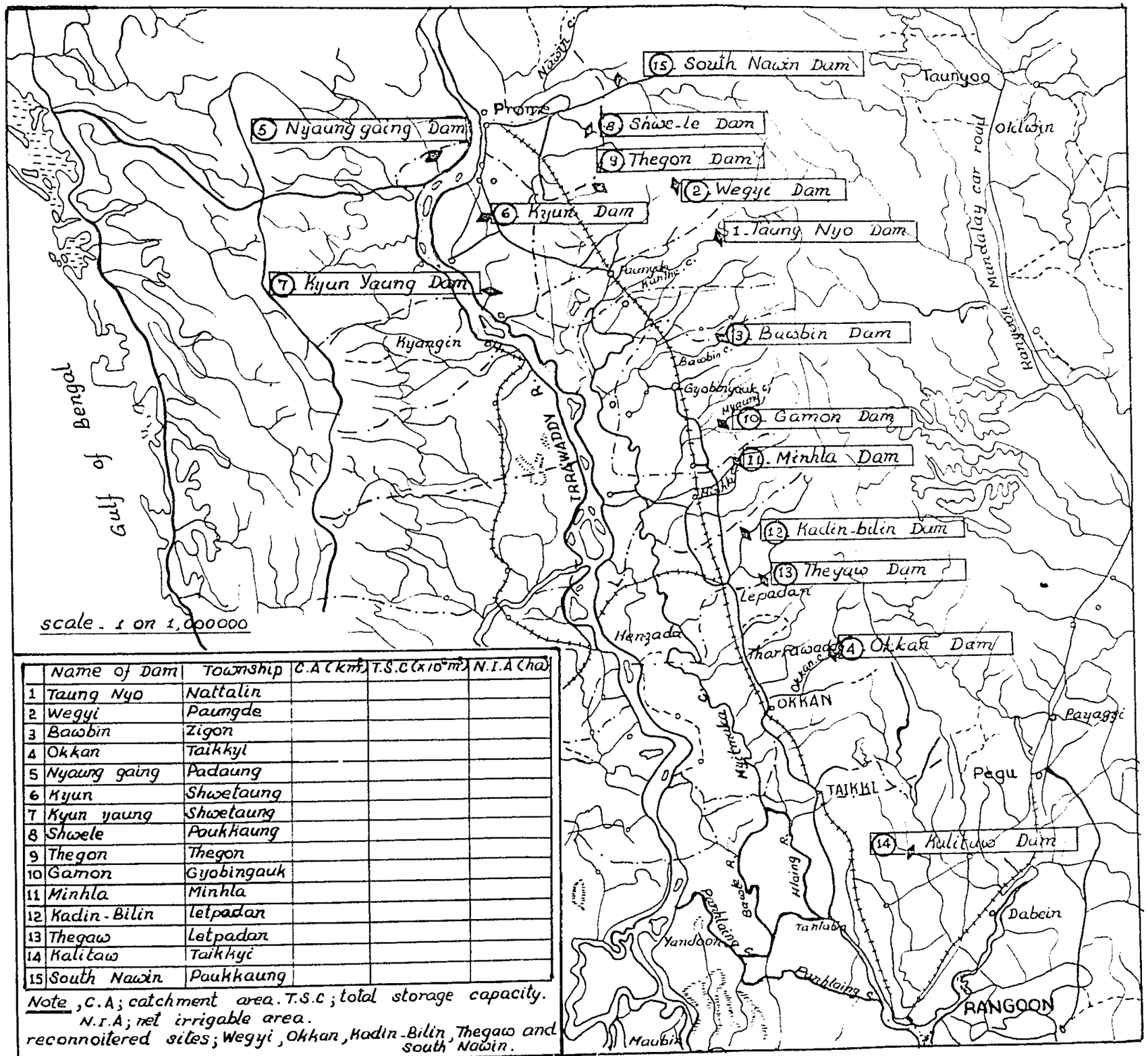
On the economic evaluation for giving priority to the commencement of Feasibility Study for the dam construction in the Project Area, primary study has been carried out by the Irrigation Department from the view point of irrigation water supply. As far as the reconnoitered dams are concerned, there are no major problems in regard to constructing the dam in the proposed damsites from the view point of engineering geology.

Therefore, the priority evaluation is mainly carried out based on the results of primary study from the view points of storage capacity, irrigation area, project ~~cost~~, B/C ratio and internal rate of return, in considering an irrigation water supply. And the relevant result is shown in the following table.

It is learned from the above mentioned table, that a higher priority will be given to No.4 Okkan dam, No.15 South Nawin dam and No.2 Nagyi dam from the aspect of irrigation water supply and these result are reasonable in comparison with the commenced construction of North Nawin dam, Sedawgyi dam and Kyaunggyat dam.

As mentioned above, it is recommended that the observation equipment such as automatic water level recorders, automatic rain gauges, evaporation pan and etc.

LOCATION OF POTENTIAL DAM SITE



scale. 1 on 1,000000

	Name of Dam	Township	C.A (km²)	T.S.C (x10⁶m³)	N.I.A (ha)
1	Taung Nyo	Nattalin			
2	Wegyi	Paungde			
3	Bawbin	Zigon			
4	Okkan	Taikkyi			
5	Nyaung gaing	Padaung			
6	Kyun	Shwetaung			
7	Kyun yaung	Shwetaung			
8	Shwele	Paukkaung			
9	Thegon	Thegon			
10	Gamon	Gyobingauk			
11	Minhla	Minhla			
12	Kadin-Bilin	letpadan			
13	Thegaw	letpadan			
14	Kalitaw	Taikkyi			
15	South Nawin	Paukkaung			

Note, C.A; catchment area. T.S.C; total storage capacity.
N.I.A; net irrigable area.
reconnoitered sites; Wegyi, Okkan, Kadin-Bilin, Thegaw and South Nawin.

EVALUATION TABLE OF PRIORITY FOR PROPOSED DAMS.

Dam Name.		Location. Division.	Township.	Catchment Area. (KM/2)	Total storage capacity Million Cum.	Net Irrigable Area. (ha)	Dam Dimension. Height. (m)	Length. (m)	Volume.	Project cost (XIDUS$)	Net.Agricultural Benefit. (XIDUS $/ Year).	Economical Evaluation. B.C. Ratio.	IRR (%).	Unit costs (US$/ ha)	Technical Judgemen.	Remarks.
1.Taung Nyo	2)	Pegu	Nattalin	551.7		20,250	30.5	914		10.71						
2.Wegyi	2)	Pegu	Paungde	531.0		24,300	30.5	1,067		12.86					C	Reconnoitered Higher Priority.
3.Nawbin	2)	Pegu	Zigon	261.6		24,300	18.3	1,524		12.86						
4.Okkan	1)	Pegu	Taikkyi	207.2	204.42	17.820	25.9	701.	387.1	12.89	6.89	9.50	24.5	723.1	A	Reconnoitered Higher Priority.
5.Nyaunggaing	2)	Pegu	Padaung	90.7		1.013	18.3	762		0.54						
6.Kyan	2)	Pegu	Shwedaung	72.5		4.050	13.7	2,434		2.14						
7.Kyun Yaung	2)	Pegu	Shwedaung	64.8		2.025	12.2	1,219		1.07						
8.Chwe Le	2)	Pegu	Paukkaung	75.1		1.013	13.7	1.067		0.54						
9.Thegon	2)	Pegu	Thegon	51.8		2.025	12.2	914		1.07						
10.Gamon	2)	Pegu	Gyobingauk	95.8		8.100	18.3	1,219		4.29						
11.Minhla	2)	Pegu	Minhla	27.7		8.100	15.2	914		4.29						
12.Kadin Pilin	1)	Pegu	Letpadan	155.4	175.78	17,010	38.4	265	392.9	12.47	6.58	9.40	24.3	733.2	C	Reconnoitered
13.Thegon	2)	Pegu	Letpadan	90.7	82.09	7,290	21.7	1,646	343.3	6.37	2.82	7.99	19.0	901.4	B	Reconnoitered
14.Kalitaw	2)	Pegu	Taikkyi	51.8		2.025	10.7	1,981		1.07						
15.South Nawin	3)	Pegu	Paukkaung	642.3		32,400	31.2	3,050		34.29				1058.2	B	Reconnoitered
North Nawin	4)	Pegu	Prome	592.1	358.95	39,178	35.1	6,616		35.71				911.6		Under construction.
Sedawgyi	5)	Mandalay	Madaya													Commenced construction
Nyaunggyat	6)	Mandalay	Kyaukse													Under construction.

Contd.

EVALUATION TABLE OF PRIORITY FOR PROPOSED DAMS

Data Sources:
1) Medium Size Reservoir Project, 197
Irrigation Dept.
2) Western Pegu Yoma Irrigation Project, 197
Irrigation Dept.
3) North Nawin Irrigation Project, 197
Irrigation Dept.
4) South Nawin Irrigation Project, 197
Irrigation Dept.
5) Sedawgyi Multi purpose Dam and Irrigation Project, 197, Irrigation Dept.
6) Nyaunggyat Irrigation Project, 197
Irrigation Dept.

Notes:
1) Project cost and Net Agricultural Benefit is estimated on 1977's Price.
2) Project economic life is calculated at 30 years.
3) Foreign exchange rate is assumed to one U.S.Dollar equal to seven Kyats.
4) A, B and C in the item of Technical Judgement show the rank of the hardness for foundation treatment according to the engineering geology. A, B and C mean to existing a few minor problems, some minor problems and several minor problems respectively.
5) At the underline damsites, survey and investigations are completed or on going. (Okkan dam)

VIII RECOMMENDATIONS

In consideration of the request from the Government of Burma and the results of economical and technical evaluation for the proposed dams, the South Nawin Project including dam construction is recommended to commence the Feasibility Study with the highest priority.

So as to improve the technical and economic accuracy of the Master Plan, the collecing basic data in the Project Area should be executed as follows:-

(1) Mapping from the aerial photo for the Project Areas.

(2) Soil map and land use map of the Project Area.

(3) Hydrological data for the runoff from the hilly and mountainous areas.

(4) Flood data for the inundated area including the effect of the Irrawaddy River.

(5) Sediment data for the Project Area such as bed load and suspended load.

(6) Geological investigations and embankment materials tests for the Project damsites.

As regards to the right bank of the Irrawaddy River, the vast irrigable areas are spreaded along the river course with almost similar conditions to the left bank topography, geology and pedology. There is no principal road running south to north in the right bank of the Project Area; however, the road planning had already been fixed and the constructions

of principal road are on going in many places. After completion of the road with improvement of the crossing facilities on the Irrawaddy River, the right bank area seems to have high potentiality for the agricultural development as well as left bank area, in addition to the forestry.

As mentioned above, it is recommended that the observation equipment would be installed in the right bank area to obtain the basic data.

PERSONNEL CONTACTED DURING THE SURVEY

NAME	STATUS
U Ye Goung	Minister Ministry of Agriculture & Forests
Dr. Bo Lay	Deputy Minister Ministry of Agriculture & Forests
U Kyaw Htein	Deputy Minister Ministry of Agriculture & Forests
U Khin Maung Latt	Director General, Planning and Statistics Department, MAF
U Hla Moe	Director, Planning and Statistics Department, MAF
U Khin Maung	Managing Director, Agriculture Corporation (AC), MAF
U Khin Win	General Manager, Extention, AC, MAF
U Aung Khin	General Manager, Agriculture Research Institute, AC
Dr. Myint Thein	General Manager, Research, AC,MAF
U Maung Maung Khin	Deputy General Manager, Statistics and Co-ordination, AC, MAF

NAME	STATUS
U Chit Saing	Deputy General Manager, Extension AC, MAF
U Sgin Hlaing	Director General, Settlement and Land Records Department, MAF
U Htwe Nyunt	Director, Settlement and Land Records Department, MAF
U Zaw Pe	Deputy Director, Settlement and Land Records Department, MAF
U Thein Han	Assistant Director, Settlement and Land Records Department, MAF
U Aung Ba	Director General of Irrigation Department (ID), MAF
U Hla Khin Maung	Director, (ID), MAF
U Yi	Deputy Director, (ID), MAF (Planning and Design)
U Paw Oo	Assistant Director, (ID), MAF (Working Officer)
U Than Aung	Assistant Director, (ID), MAF (Administration)
U Tin Maung	Assistant Director, (ID), MAF (Hydrology)

NAME	STATUS
U Thein Tun	Assistant Director, (ID), MAF (Planning and Design)
U San Lwin	Assistant Director, (ID), MAF (Geology)
U San Hla Thaw	Meteorological and Hydrological Officer, Meteological and Hydrology Department, (MHD)
Dr. Tin Maung	Director, University Computer Center (UCC)
U Soe Paing	System Manager, (UCC)
U Ko Ko Lay	Operation Manager, (UCC)
U Myo Min	Application Manager, (UCC)
U Mg Galey	Director General, Forest Department, MAF
U Tha Tun San	Director, Forest Department, MAF
U Myint Aung	Deputy Director, Forest Department, MAF
U Saw Han	Deputy Director, Forest Department, MAF

NAME	STATUS
U Mya Aung	Sub-Division Manager, Tharrawaddy Divisional Forest Office, Forest Department
U Tin Maung Kyi	Deputy Director, Prome Divisional Forest Office, Forest Department, MAF
Major Kyaw Shein	General Manager, Timber Corporation, MAF
U Hla Pe	General Manager, Timber Corporation, MAF
U Kyaw Nyein	Manager, Timber Corporation, MAF
U Hla Gyaw	Director General, Survey Department, MAF
U Lun Pe	Deputy Director, Survey Department, MAF
U Tint Hlaing	Director General, Department of Fishery, MAF
U Maung Maung Kyi	General Manager, People's Pearl & Fishery Corporation (PPFC), MAF
U Than Htike Pe	Deputy General Manager, PPFC, MAF
U Maung Maung San	Township Fishery Officer

LIST OF COLLECTED DATA

(1) Daily Rainfall

	Gauging Station	Observation period
1.	HMAWBI	1954-1977
2.	TAIKKYI	1947-1977
3.	THARRAWADDY	1947-1977
4.	MINHLA	1959-1977
5.	OKPO	1972-1977
6.	GYOBINGAUK	1959-1977
7.	ZIGON	1959-1977
8.	PROME	1947-1977
9.	PAUKKAUNG	1966-1977
10.	SHWEDAUNG	1966-1977
11.	HENZADA	1947-1977

(2) Daily Water table of Irrawaddy River

	Gauging Station	Observation Period
1.	PROME	1960-1977
2.	HENZADA	1960-1977
3.	SEIKTHA	1975
4.	KYANGIN	1975
5.	MYANAUNG	1975
6.	KANAUNG	1975

(3) Daily Run-off Discharge

	Gauging Station	Observation Period
1.	KYAUKPYI[illegible]MA	1970-1976
2.	KAUNGLAUNG[illegible]INE	1971-1976
3.	KWETHA	1972-1976
4.	CHAUNGZAUK	1971-1976
5.	BAUBIN	1970-1976
6.	MAGYIBIN	1972-1976
7.	TEME	1970-1976
8.	YONBINDET	1971-1973
9.	THAPANGAING	1972-1973
10.	NYODAUNG	1973-1976
11.	MAGWE	1973-1976
12.	YATTHIT	1973-1976
13.	KYIDAING	1971-1973
14.	KWINLAYAYI	1971-1973

(4) Rating Curve

PROME

(5) Cross Section of Irrawaddy River

PROME	23/3/1966
	7/8/1970
	17/11/1970
	13/2/1975
HENZADA	

(6) Monthly Temperature

Rainfall

Actual Sunshine Time

Wind Speed

Wind Direction

Humidity

Evaporation

Station	Location (LN)	(LE)
PROME	18° 48'	95° 13'
MENZADA	17° 29'	95° 27'
THARRAWADDY	17° 38'	95° 48'
PEGU	17° 20'	96° 30'
BASSEIN	16° 46'	94° 46'
HAUBIN	16° 44'	95° 39'
PYINMANA	19° 43'	96° 13'
TOUNGOO	18° 55'	96° 28'
MINGALADON	16° 54'	96° 11'
RANGOON	16° 46'	96° 10'
MINBU	20° 10'	94° 53'

(7) Engineering Geological Report on Thegaw Dam

(8) Engineering Geological Report on Nagyi Dam

(9) Engineering Geological Report on South Nawin Dam

(10) Engineering Geological Map on South Nawin Dam
(Scale 1 inch 800 feet, contour interval: 10 feet)

(11) Geological Cross-Section of Alignment No.2
(South Nawin Dam Project)

(12) Geological Cross-Section of Alignment No.3
(South Nawin Dam Project)

(13) Geological Log of Drill Holes, South Nawin Dam

(14) Soil Test Data (South Nawin Dam)

(15) Seismic Zonation of Burma

(16) Soil Laboratory Testing Equipment.

(17) Report to the Pyithu Hluttaw on
The Financial, Economic and Social Conditions of
The Socialist Republic of the Union of Burma
For 1977-78
1977 Ministry of Planning and Finance

(18) Notes on Agriculture in Burma
Dated the 10th January 1978
Ministry of Agriculture and Forests

(19) Land Revenue Rates in the Union of Burma

(20) A Brief Description of the Fixation of Land
Revenue Rates in Burma

(21) Current Rates of Land Revenue

(22) Higher Production Paddy Project in Taikkyi Township, Rangoon Division and Project Plan 1977-78.

(23) Actual Performance of High Production Paddy Project in Taikkyi Township and Progress of Paddy Production in Taikkyi Township from 1974-75 to 1977-78

(24) Crop Production in Taikkyi Township 1976-77 (Actual Performance) and 1977-78 (plan) and Double Cropping Acreage.

(25) Timber Production for the last 5 years nation wide and Project Area respectively

(26) Transportation and Shipment

(27) Road Network for Timber Industry in the Project Area

(28) Teak and Hardwoods Extraction

(29) List of Saw Mill in Ibaid Project Area

(30) List of Timber Ship in Ibaid Project Area

(31) Area of Forest Divisions

(32) Area of the Reserved and unclassed Forests

(33) Growth and Increment of Teak and others of the respective Division

(34) Annual Allowable Cut

(35) Stocking.

Data Source: 1 to 2, Meteorological Department

3 Irrigation Department

4 to 6, Meteorological Department

7 to 16, Irrigation Department

Data Source: 17 to 18, Agriculture Corporation

19 to 24, Land Records Department

25 to 30, State Timber Corporation

31 to 35, Forest Division

North Nawin Irrigation Project

1. Location : The Project is located in three townships of Pegu Division, namely Prome, Paukkhaung, and Thegon.

2. Objective : A water impounding dam is to be constructed across North Nawin Chaung near Sezongon Village in Prome Towship. The Project will serve 96769 acres of land on which it is projected to cultivate 182269 acres of crops under irrigation.

3. Project Description : The utilization of water resources of the North Nawin Chaung for irrigation purposes was first conceived by Government in 1953. In 1957 Energoproject was entertained by the Government to prepare a preliminary report for this project and again in 1963 the same firm was entrusted with the preparation of feasibility report and final designs of the Project. Feasibility report and final designs were submitted by the firm in 1967. Preliminary works were stated in 1967-68.

In 1970 Energoproject was again employed by the Government for giving construction guidance to the Irrigation Department in the Implementation of the Project.

The Project provides for the construction of an earth dam to impound the stream flow and utilize it for year-round irrigation and also an irrigation and Drainage network will be constructed under the project.

Main features of the reservoir and irrigation system are :-

(1)	Catchment Area	.. 228.6 sq. miles
(2)	Length of Dam	.. 5300 ft.
(3)	Height of Dam	.. 115 ft.
(4)	Maximum depth at full reservoir	.. 103.5 ft.
(5)	Top width of Dam	.. 20 ft.
(6)	Storage Capacity	.. 291000 acre ft.
(7)	Waterspread Area	.. 8800 Acres
(8)	Length of Conduit	.. 414 ft.
(9)	Diameter of Conduit	.. 8 ft.
(10)	Full Supply Discharge	.. 810 $ft^3/sec.$

(11)	Spillway Width	..	210 ft.
(12)	Main Canal	3 Nos.	45 miles
(13)	Distributaries	123 Nos.	278 miles
(14)	Lined Canal	..	120 miles
(15)	Syphons	103 Nos.	
(16)	Falls	140 Nos.	
(17)	Canal Head Regulators	220 Nos.	
(18)	Bridges	279 Nos.	
(19)	Outlets	2224 Nos.	

4. Cost Estimate .. The total estimated cost of the North Nawin Irrigation Project is about K 250 Millions.

5. Project Construction Period .. Implementation of the Project and Preliminary Works were started in 1967-68 and the Project is phased for completion in 1981-82.

Source : Planning and Design Division, Irrigation Department, MAF.

ITEM OF THE DATA COLLECTED FROM TOWNSHIPS.

No. 1 Population classified by ages and number of familes.

No. 2 Composition of estimated active labour forces of workers and peasants engaged in various sectors.

No. 3 Land Utilization.

No. 4 Net sown area specified by irrigated and rainfed area.

No. 5 Position of peasant families and land area occupied by them.

No. 6 Irrigated area by means of irrigation.

No. 7 Irrigated area by crops.

No. 8 Production of crops.

No. 9 Cropping pattern (including growth duration of each crop).

No. 10 High yielding variety paddy specified by Foreign H.Y.V. local improved varieties and Local ordinary varieties.

No. 11 Distribution of quality seeds of paddy, groundnut and Jute specified by varieties, by Government Agencies and Co-operatives.

No. 12 Mechanization.

1) Number of tractors and power tilters for agriculture use owned by Government co-operatives and group of farmers.

2) Draught cattle and agricultural implements.

No. 13 Utilization of Fertilizer and Chemicals by Crops.

No. 14 Procurement of paddy, pulses and jute by the State enterprises.

No. 15 Quota of paddy per acre for the farmers to sell to the buying centre.

No. 16 Total amount of Advance Payment of Trade Corporation for paddy.

No. 17 Agricultural Loans by Corporations. (Paddy, groundnut, sesamum, jute).

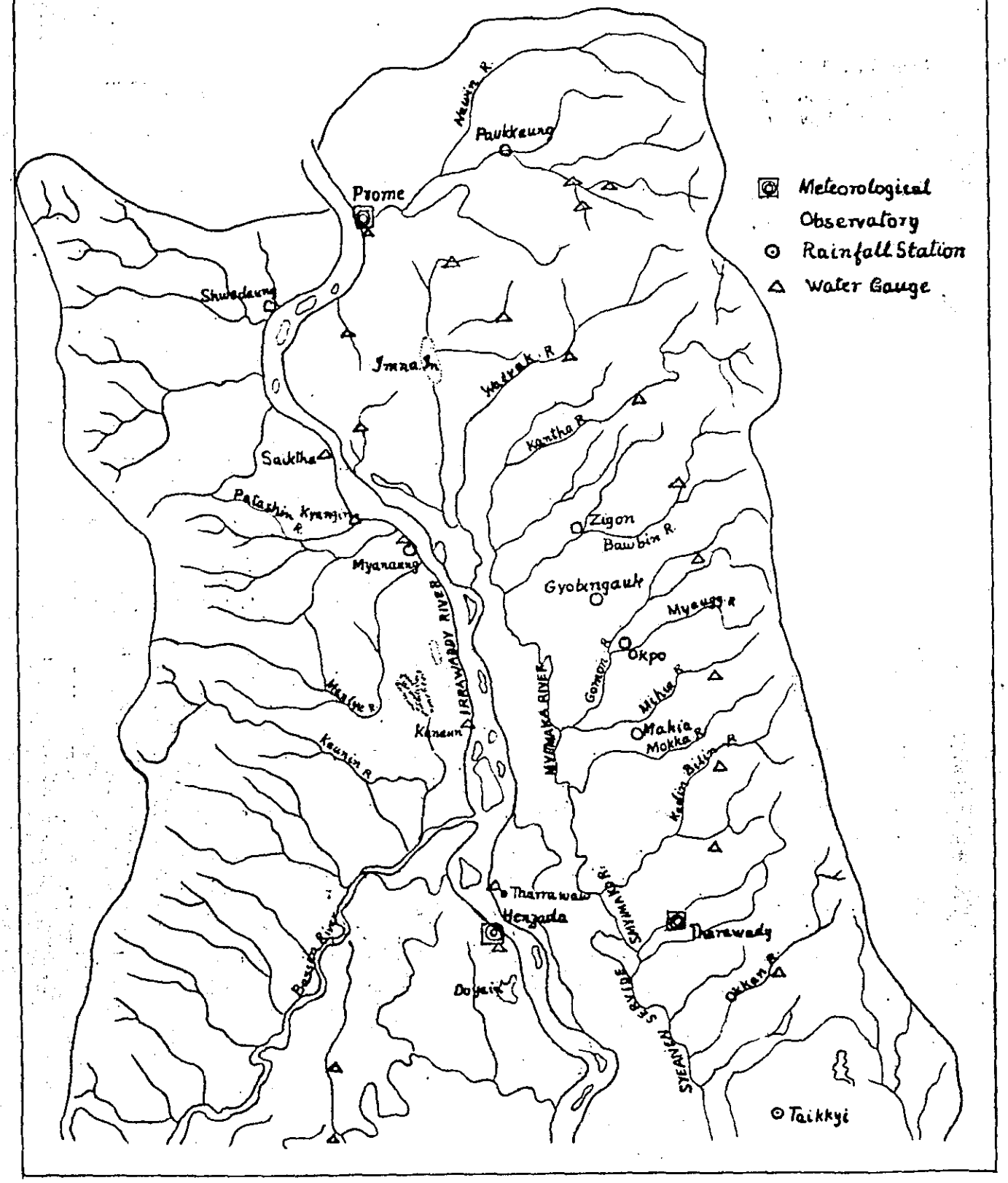
No. 18 Village Manager.

No. 19 Expenditure on Rural Development Works such as land reclaimation, road and bridges, health and education.

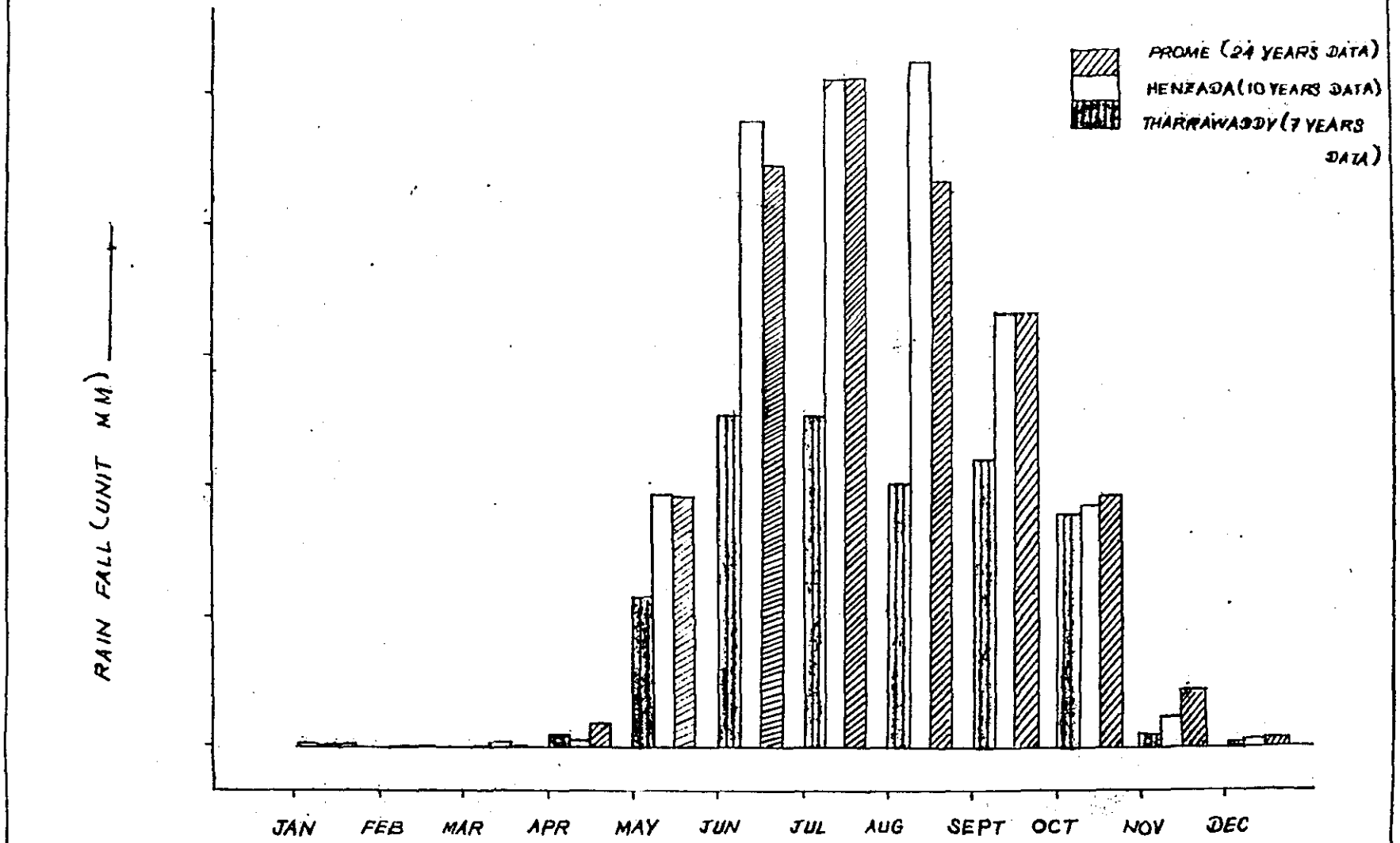
LOCATION OF OBSERVATORY

STATION	LATITUDE (N)	LONGITUDE (E)
Prome	18° 48'	95° 13'
Henzada	17° 29'	95° 27'
Tharrawaddy	17° 38'	95° 48'
Pegu	17° 20'	96° 30'
Bassein	16° 46'	94° 46'
Maubin	16° 44'	95° 39'
Pyinmana	19° 43'	96° 13'
Toungoo	18° 55'	96° 28'
Mingaladon	16° 54'	96° 11'
Rangoon	16° 46'	96° 10'
Minbu	20° 10'	94° 53'

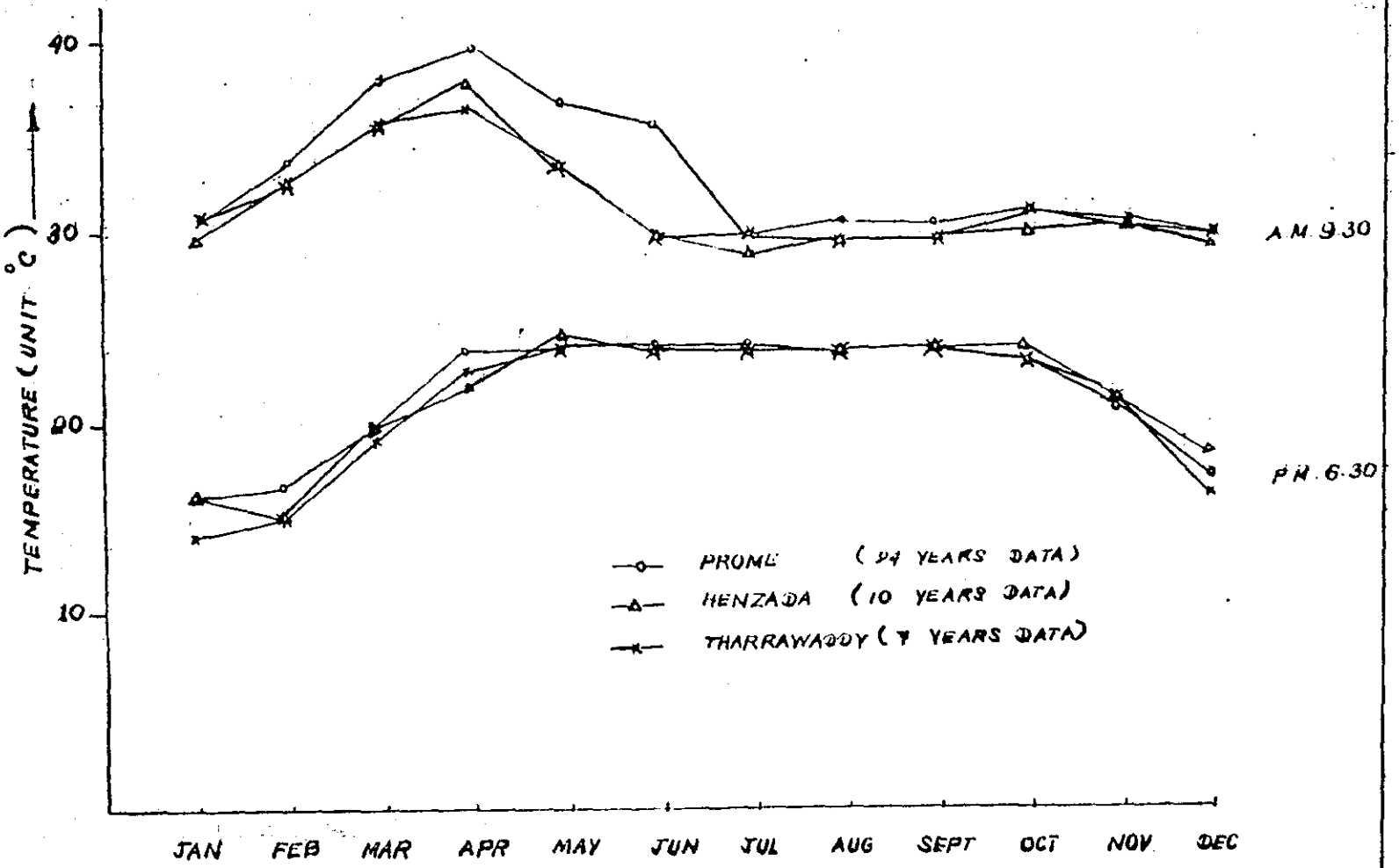
Location of Gauging Station



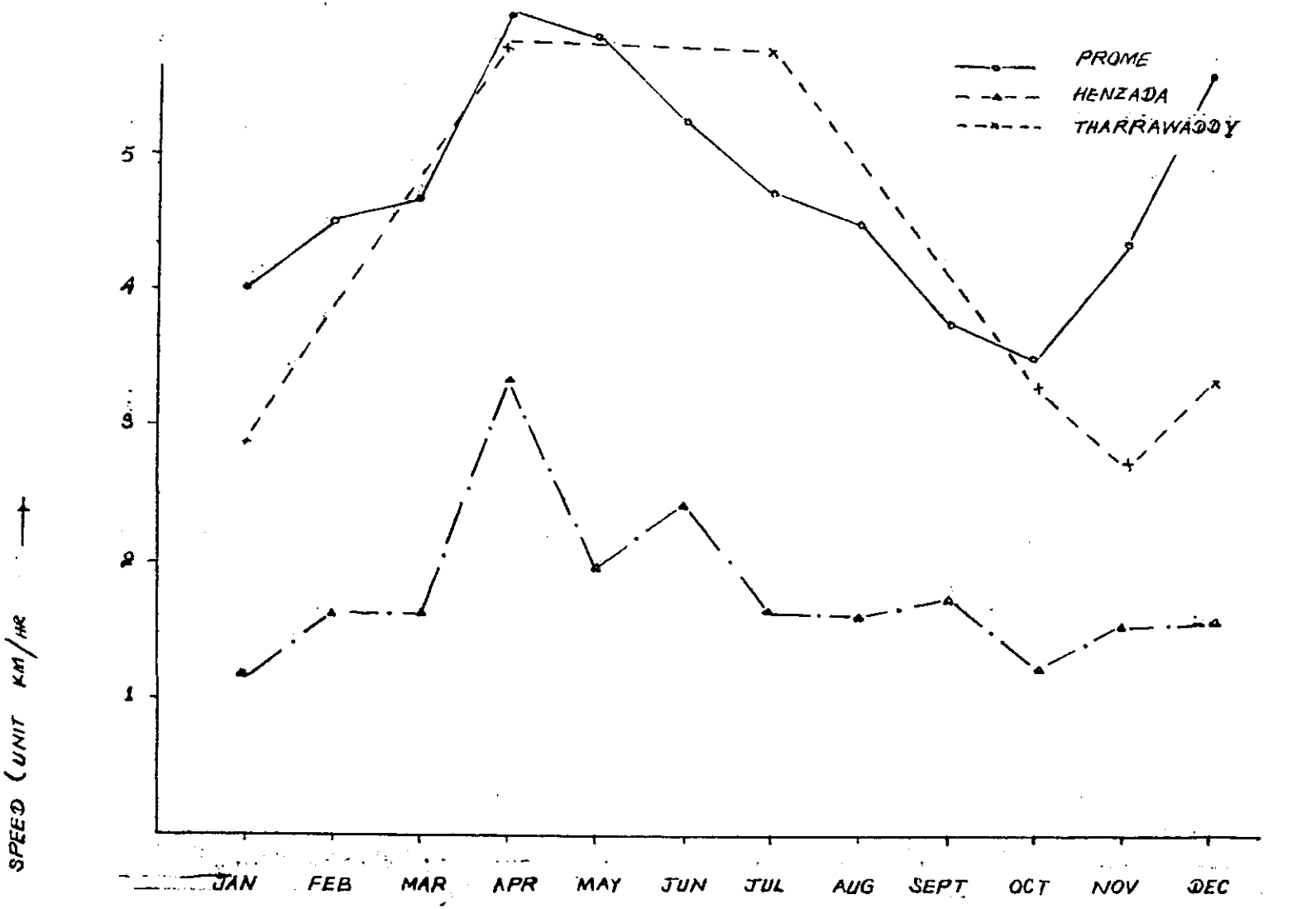
Monthly Mean Rainfall



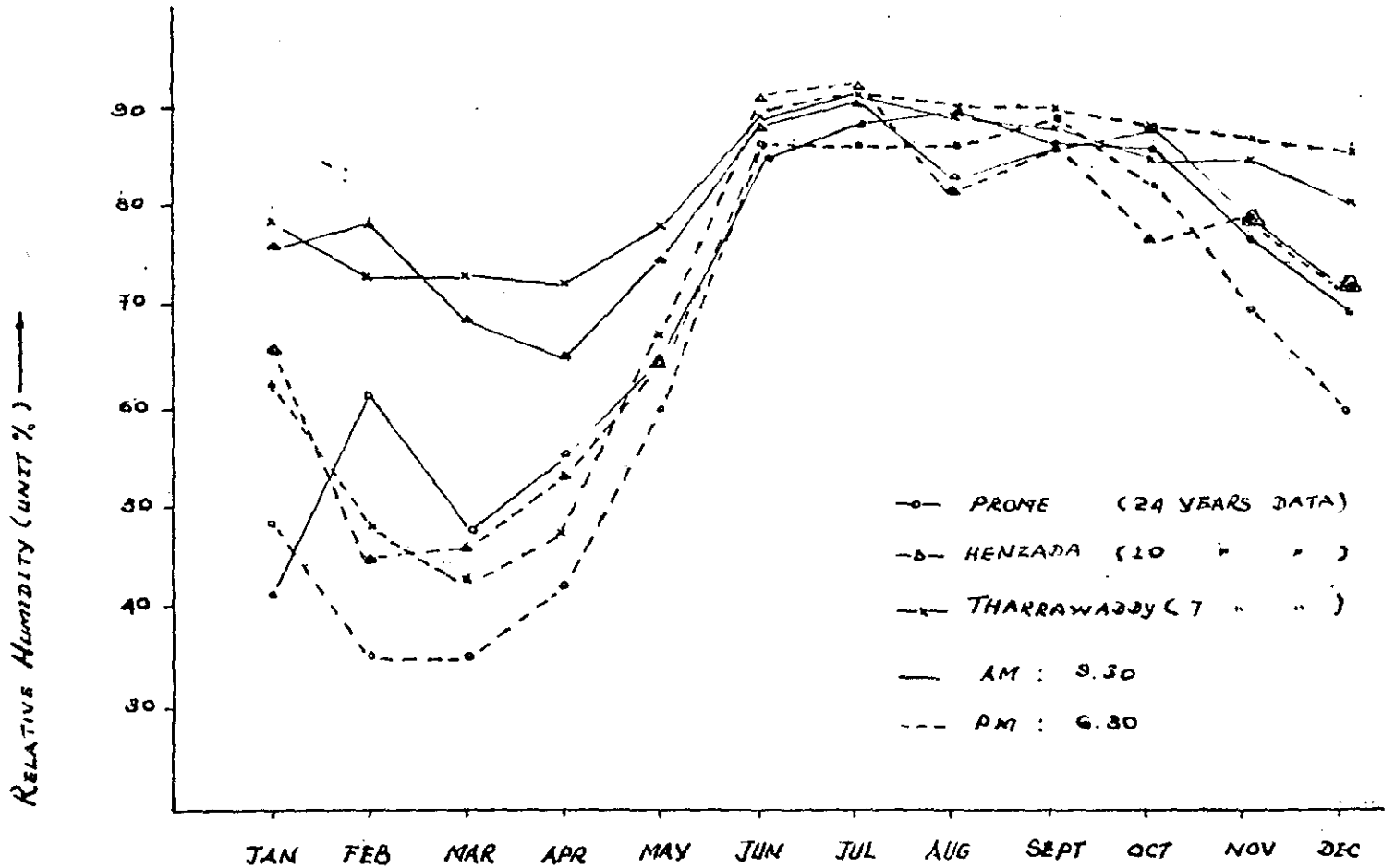
Monthly Mean Temperature



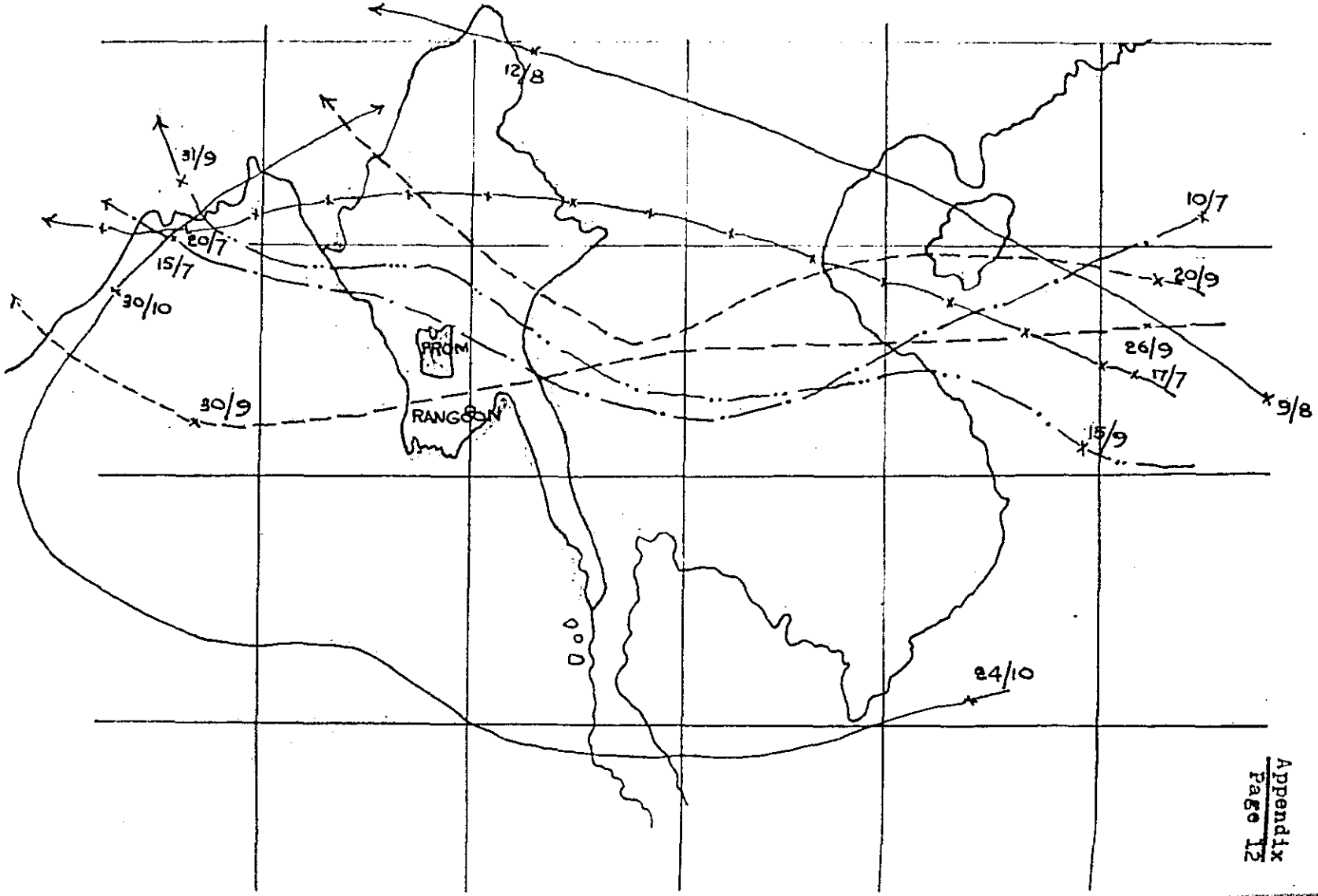
Wind Speed


PROME
HENZADA
THARRAWADDY
SPEED (UNIT KM/HR)
1
2
3
4
5
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC

Relative Humidity

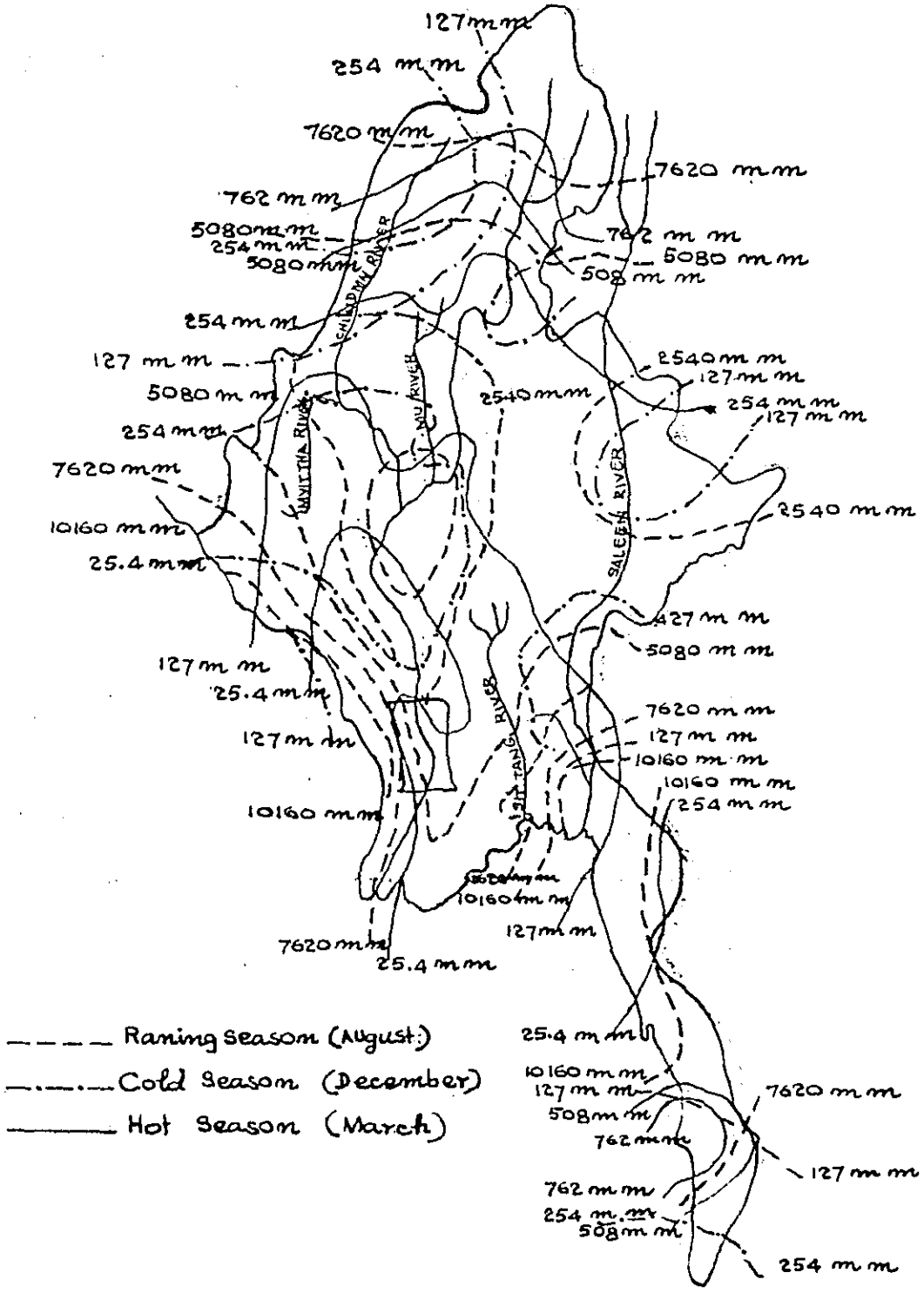


MAP SHOWING THE TRACT OF STORMS AND DEPRESSINOS WHICH PASSED OVER BURMA IN 1962

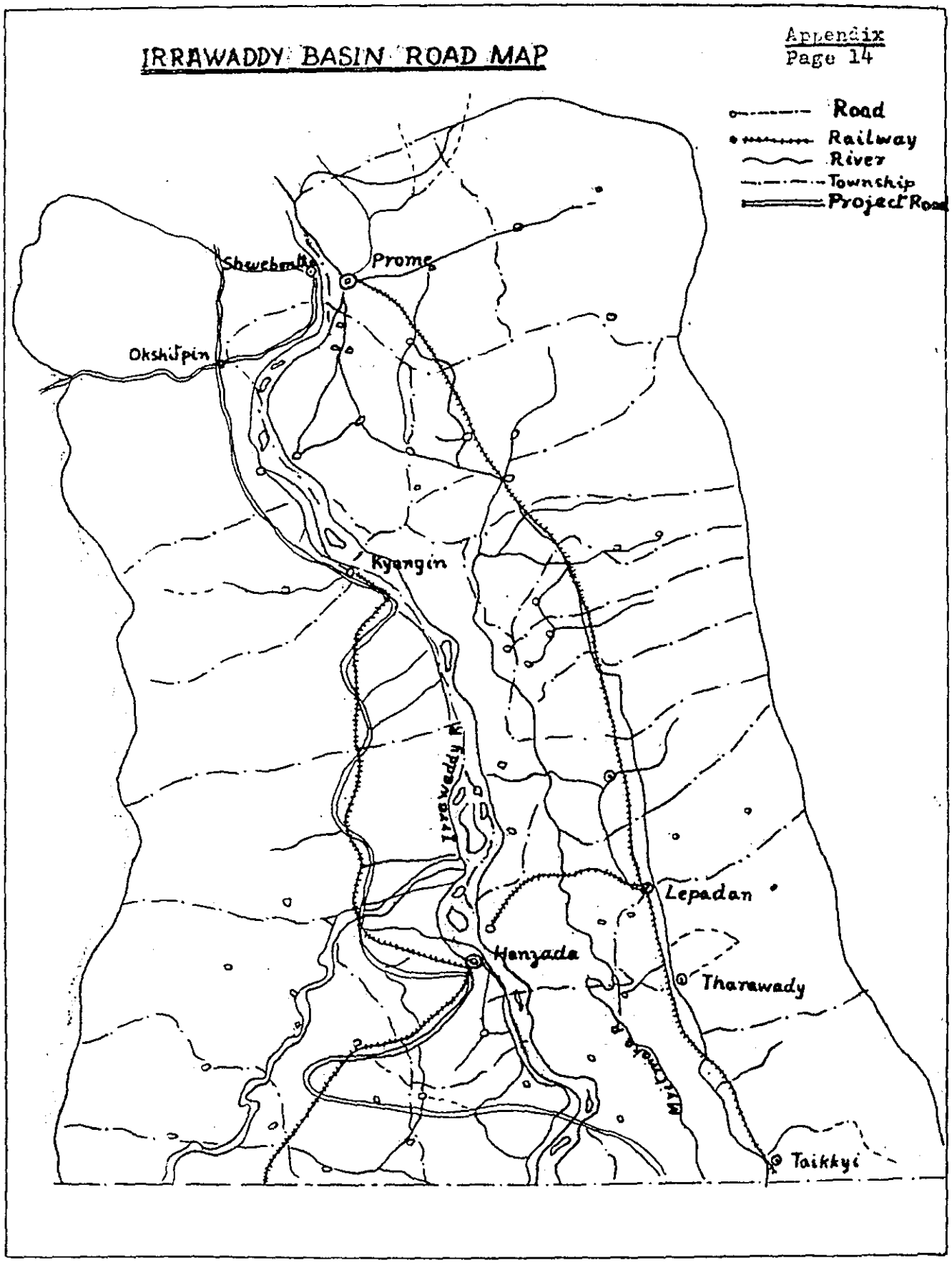


AVERAGE RAINFALL MAP OF BURMA

1951~1961



IRRAWADDY BASIN ROAD MAP



Water Measured in the Field Survey

(1978)

	Date	Time	Dissolved Oxygen	P H	Water Temperature	Remarks
Irrawaddy	Mar.20th	12:30	8.5 PPM	8.3	27.3 C°	
River	Mar.22nd	12:20	8.5	8.5	27.4	
Daka	Mar.20th	16:00	6.9	7.6	31.0	
River	Mar.21st	07:30	5.3	7.5	27.9	
Inyegyi	Mar.21st	09:00	7.3	8.5	28.5	Kanzu Village
Lake	"	10:15	5.4	8.1	27.7	Sai-Lay Station
	"	12:00	4.2	7.9	29.3	Inyegyi Station
	"	14:00	8.0	8.5	32.7	Kanzu Village
Duya Lake	Mar.22nd	09.20	7.3	8.4	27.5	
Ragwinpyin River	Mar.24th	11.10	5.4	7.4	30.9	
Kanzu Village fish pond	Mar.21st	14.30	6.0	7.1	33.6	
Private fish pond	Mar.24th	08.00	5.5	8.1	28.3	
near Rangoon	"	08.30	6.6	8.4	27.4	