REPUBLIC OF INDONEISA

MINISTRY OF PUBLIC WORKS AND ELECTRIC POWER

FEASIBILITY REPORT

ON

ULAR RIVER FLOOD CONTROL

AND IMPROVEMENT OF IRRIGATION PROJECT

VOLUME I

MAIN REPORT

JULY 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

The Feasibility Report on Ular River Flood Control and Improvement of Irrigation Project is composed of three volumes.

Volume I : Main Report

Volume II : Study Report

Volume III : Supporting Report

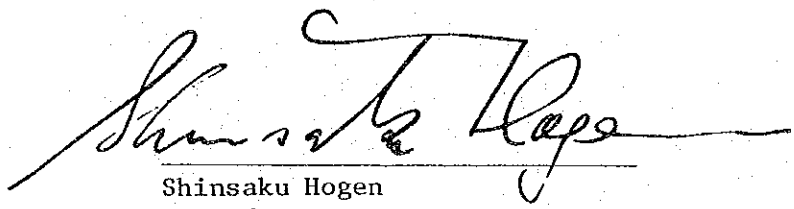
PREFACE

The Government of Japan, in response to the request of the Government of the Republic of Indonesia, decided to conduct a feasibility study for the Ular River Flood Control and Improvement of Irrigation Project and entrusted the Japan International Cooperation Agency to conduct the study.

The Agency organized a feasibility study team composed of experts in various fields headed by Dr. Seiichi Sato and carried out a field survey and studies over a period of about one year. The report I am submitting herewith has been compiled based on the results of the survey and studies as well as on the questions and answers voiced at the meetings held in Indonesia. I sincerely hope that this report would contribute to the development of the project.

Finally, I would like to express my heartfelt gratitude to the authorities and officials concerned in the Republic of Indonesia for the assistance and cooperation extended to the study team.

July 1978



Shinsaku Hogen
President
Japan International
Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Tokyo, July 1978

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency
Shinjuku Mitsui Building
Nishi-shinjuku 2-1
Shinjuku-ku, Tokyo, Japan

Dear Sir:

I have the pleasure to submit to you the final report entitled "Republic of Indonesia, Feasibility Report on Ular River Flood Control and Improvement of Irrigation Project". This report has been prepared by the Study Team in accordance with the contracts signed on August 5, 1977 and May 10, 1978 between the Japan International Cooperation Agency and the joint venture composed of NIKKEN Consultants, Inc. and Nippon Koei Co., Ltd.

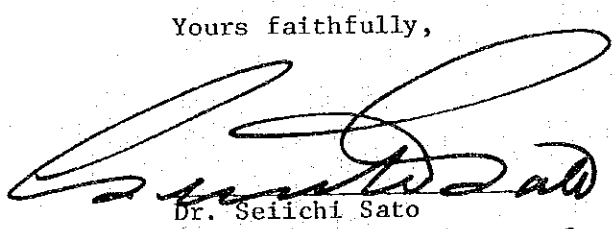
The Study Team carried out the studies including data collection and necessary surveys in Indonesia over a period of about six months from August 18, 1977 to February 6, 1978 in cooperation with the Indonesian Counterpart Team organized by the Ministry of Pulbic Works and Electric Power, the Government of Indoneisa. In Japan, studies were continued to finalize the feasibility report based on the Interim Report submitted to the Government of Indonesia prior to leaving Indonesia. The report was completed taking account of the conclusions obtained in the discussion meetings held in Jakarta and Medan and finally approved by the Advisory Committee of the Japan International Cooperation Agency.

The report is composed of three volumes. Volume I is Main Report which contains general description of the plan for flood control of the Ular river, irrigation/drainage improvement in the downstream area of the river, economic evaluation of the project

and conclusions. Volume II is Study Report which contains studies and planning of flood control and irrigation/drainage improvement and economic analysis of the project. Volume III is Supporting Report which contains details of topographic survey, soil survey and others.

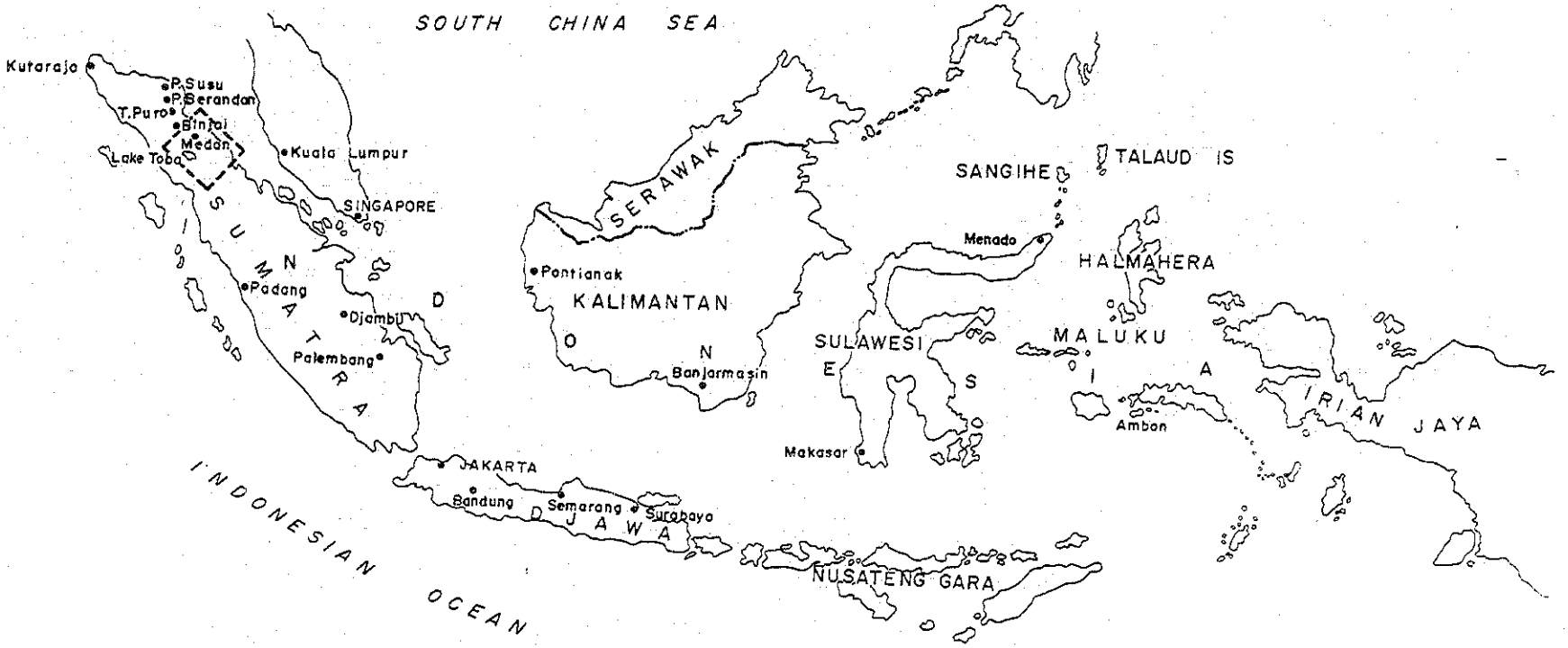
Lastly, the Study Team wishes to express its sincere appreciation to the Embassy of Japan in Jakarta, the Consulate of Japan in Medan and the Japan International Cooperation Agency for their wholehearted encouragement given to the Study Team during the period of study.

Yours faithfully,

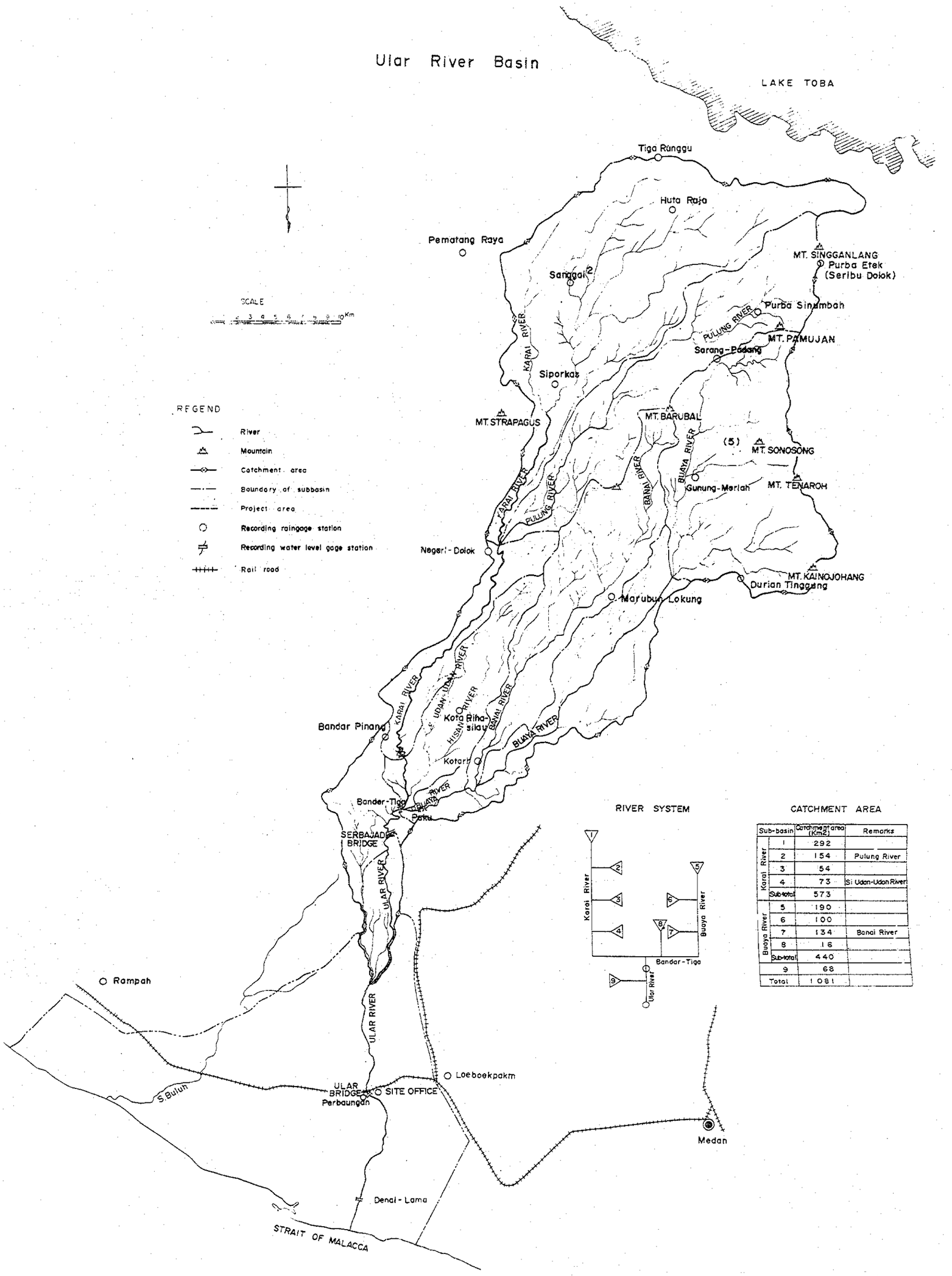


Dr. Seiichi Sato
Leader of the Study Team for
Ular River Flood Control and
Improvement of Irrigation Project

Location Map



Ular River Basin



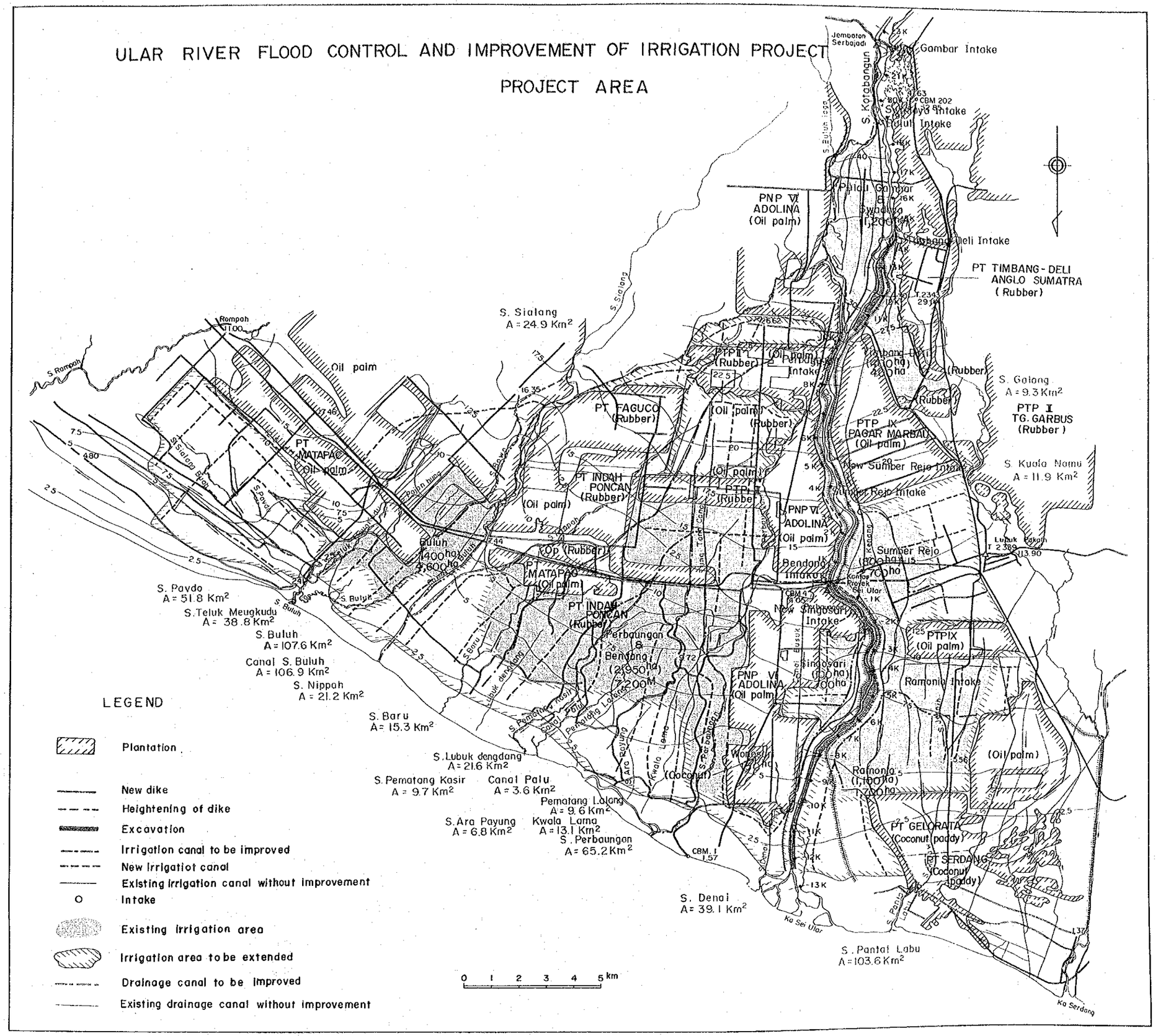
RIVER SYSTEM

CATCHMENT AREA

Sub-basin		Catchment area (Km2)	Remarks
Karai River	1	292	
	2	154	Pulung River
	3	54	
	4	73	Si Udon-Udon River
	Sub-total	573	
Buaya River	5	190	
	6	100	
	7	134	Banai River
	8	16	
	Sub-total	440	
	9	68	
Total		1081	

ULAR RIVER FLOOD CONTROL AND IMPROVEMENT OF IRRIGATION PROJECT

PROJECT AREA



CONCLUSION AND RECOMMENDATION

CONCLUSION AND RECOMMENDATION

1. Introduction

This report presents the results of the feasibility study on the Ular River Flood Control and Improvement of Irrigation Project. The study has been conducted with the view of identifying the required conditions for development in the project area and envisaging a prospective picture of the project area after the implementation of the project.

The report is composed of three volumes. Volume I is Main Report which contains general description of plan for flood control and irrigation/drainage improvement, economic evaluation and conclusions. Volume II is Study Report which contains study and planning of flood control and improvement of irrigation and drainage and economic analysis. Volume III is Supporting Report which contains details of topographic survey, soil survey and others.

2. History

The alluvial plain located downstream of the Ular river has suffered serious damages from floods which took place several times every year owing to breaches of levees of the Ular river. In order to rescue this area from flood, the Government of Indoensia planned an emergent flood control work under the name of Ular River Urgent Flood Control Project. This project was implemented in a period from 1972 to 1976 with the aid of a loan from the Overseas Economic Cooperation Fund of Japan.

On the other hand, the Government of Indonesia carried out the First Five Year Development Plan over a period extending from 1969 to 1974. During the period, the annual growth rate of rice production attained 3.5 % and, in 1974, the rice production amounted to 15.4 million tons. However, the population increased remarkably at a high rate of 2.4 % during the period. The demand for food stuff exceeded the growth of rice production, and about one million tons of rice is imported annually. The Second Five Year Development Plan was launched in 1974 aiming at the attainment of self-sufficiency in food stuff as one of the major targets of the Plan.

At this national demand of rice production and in view of the emergent character of the above-mentioned project, the Government of Indonesia intended to formulate a new plan which would be composed of flood control and irrigation/drainage improvement in the project area. This plan was studied under the name of Overall Ular River Improvement Project by the Japan International Cooperation

Agency in response to the request of the Government of Indonesia. The Agency dew out a conclusion that a project composed of two components of flood control and irrigation/drainage improvement has a high priority compared with any of the two components.

Based on the results of this study, the Government of Indoensia requested again the Government of Japan to cooperate in making a feasibility study a new plan for Ular River Flood Control and Improvement of Irrigation Project and the Government of Japan agreed to it. The feasibility study for the plan was carried out by the Japan International Cooperation Agency in a period from August of 1977 to July of 1978.

3. Feasibility Study

The objective of the study lies in justification of feasibility of the Ular River Flood Control and Improvement of Irrigation Project which covers a flood control work of the Ular river over a stretch of 35 km from near the river mouth to Serbajadi Bridge in the up-stream and an irrigation/drainage improvement work over an area of 18,500 ha situated in the downstream of the Ular river.

4. Project Area

The project area is located about 30 km in the east of Medan, the capital of North Sumatra Province and occupies the middle part of Deli-Serdang District. The project area of about 45,000 ha has already been cultivated and leaves no room for further reclamation. The area has estate field of 17,800 ha, paddy field of 18,500 ha and other area of 8,700 ha. The paddy field consists of technical irrigation area of 3,000 ha, semi-technical irrigation area of 1,500 ha and rain-fed area of 11,500 ha.

The project area is an alluvial plain formed by the Ular river. Its topography has a gentle slop ranging from 1/600 in the upper part to 1/1,200 near the seacoast. The elevation ranges from about 1 m to about 50 m above the sea level.

The climate in the project area is characterized by no definite distinction between the dry and the wet seasons. Annual rainfall averages 2,060 mm ranging from 1,700 mm to 2,400 mm. Mean monthly temperature is about 26°C throughout the year with a slight fluctuation. Mean monthly humidity is about 87 % throughout the year. Sunshine duration average 49 % ranging from 37 % to 57 %.

5. Present Condition of the River

The existing river channel of the Ular between Serbajadi Bridge and near the river mouth has a carrying capacity ranging from 200 m^3/s to 600 m^3/s. The temporary design discharge that was applied to the Urgent Project is evaluated at 8-year return period. The completion of the Urgent Project has brought a mitigation of flood damage and a large effect to the regional productivity and the stabilization of the people's livelihood. Nevertheless, the area stretching over 25,000 ha is still being threatened by flood of the Ular. The average annual flood damage is estimated to mount up to Rp 830 million at the 1977-price. The problem of flood is the primary constraint in the rice production as well as the people's life.

6. Present Condition of Irrigation and Drainage

The water sources for irrigation in the project area mostly depened on the Ular river, except some supplement of water from several streams running through the area. Mean discharge of the Ular river is 57.3 m^3/s at Serbajadi Bridge in the wet season and 50.4 m^3/s in the dry season.

The existing irrigation system in the area has 14 intake facilities, 33.9 km of main irrigation canals and 168.9 km of secondary canals, while eight natural rivers and drainage canals about 250 km in total length play an important role as drainage system in the area.

The project area is very suitable for paddy cultivation owing to adequate temperature, good soils and relatively long sunshine hours. However, an area of 14,000 ha out of 18,500 ha of paddy field has still one cropping of paddy per year. The unit yield of paddy is 3.6 tons per ha in the irrigated area and only 2.9 tons per ha in the rain-fed area. The major reasons for this low planting ratio and low unit yield of paddy are as follows.

a. There is not enough irrigation water in the dry season to go round the whole paddy field.

b. The existing canals are almost deteriorated by silting and scouring, and no irrigation canal exists in the non-technical irrigation and rain-fed area.

c. Water distribution system presents a complicated canal network owing to utilization in dual purposes for irrigation and drainage.

d. Institution activities are not satisfactory due to shortage of well-trained staff, lack of working fund and scarcity of mutual exchange of communication and coordination among the institutions.

e. An improved irrigation farming is found only partially in the project area.

7. The Project

(1) Flood Control

The adopted design discharge is 800 m^3/s based on the plan of Overall Ular River Improvement Project, whose study was reported by JICA in January 1978. The discharge of 800 m^3/s is evaluated at 33-year return period.

The proposed river improvement plan is composed of a channel improvement work on the Ular river over a length of about 35 km stretching from -12.5 km near the river mouth up to 22.65 km at Serbajadi Bridge in the up-stream and another channel improvement work on Pulau Gambar Canal (S. Kotabangun) over a length of about 3.5 km stretching from the confluence with the Ular river up to the Sennah Divergence. A stretch from -12.5 km to the river mouth is put out of planning by reason that this stretch is located in a too swampy area to fix a low-water channel.

In order to protect the land from flood of the Ular river, a continuous levee is planned over a distance from -12.5 km to 22.65 km on the right side of the river channel, and another continuous levee is planned over a distance from -12.5 km to 15.0 km on the left side of the channel. Pulau Gambar Canal is planned to join with the Ular river with a back-levee system applying a design discharge of 20 m^3/s. A channel improvement work is propsed on the stretch from the confluence to the Sennah divergence and a sluice is planned near the confluence with the Ular river in order to prevent the intrustion of flood water of the Ular and drain the inner water.

On the Ular river, it is planned to secure necessary carrying capacity by excavation and/or dredging works together with by building new levees or strengthening the existing levees. In planning the channel, the existing alignment is used as much as possible, setting the river width at 250 m as standard and a strengthening of the existing levees is proposed in places where the river width is enough. The longitudinal profile of the river is planned so as not to disturbe the present condition of the existing river bed, in particular paying an attention to the intake facilities. On the up-and-downstream reaches of the highway and railway bridges, necessary strengthening of levees is planned on condition that the present project of bridges has been completed.

(2) Irrigation and Drainage Improvement

The irrigation and drainage facilities are planned to provide a year-round irrigation to the project area and thereby provide the basis for double-cropping of paddy per year aiming at the achievement of a target yield of 4.5 tons of paddy per ha in 7 years after the completion of irrigation and drainage facilities and a target production of rice of 166,500 tons at the full stage.

As the discharge of the Ular river is considerably abundant, it is planned to supply necessary irrigation water by the existing free-intake system without any construction of particular structures such as dam or weir. However, with the view of smooth supply of irrigation water, an improvement of one intake, new construction of two intakes and new construction of ten settling basins are planned.

On the main irrigation canals, new construction over a total distance of 2.6 km and improvement of 20.4 km in total length are planned. On the secondary irrigation canals, new construction of 158.5 km in total length and improvement of 51.5 km in total length are planned. Further, new construction or improvement of the related structures such as diversion facilities, drops, aqueducts, siphons, conduits, check gates and bridges are planned.

The improvement of main drainage canals over a total length of 125 km and secondary drainage canals over a total length of 136 km are planned. Along with this improvement, new construction or improvement of the related structure such as bridges, drops, flap gates and cross syphons are planned. Farm ditches, farm drains and farm roads are planned to be constructed at a density of 40 m, 40 m and 30 m per ha respectively.

(3) Construction Schedule

The project is planned to be executed in 7 year a period of 7 years and on a full-contracting system. The construction schedule is as follows.

a. The detailed-design work will be commenced in January of 1979 and finished by the end of March of 1980.

b. The construction works will be started immediately after the completion of the detailed design and completed in five years by the end of March of 1985.

8. Economic Evaluation

The construction costs of the project are estimated at the 1977-price. These are shown in the following table.

Construction Cost

	Local currency (10^6Rp)	Foreign currency [10^3US$($10^6$Rp)]	Total (10^6Rp)
The project	8,092	11,730 (4,868)	12,960
Flood control component	1,655	6,648 (2,759)	4,414
Irrigation/drainage component	6,437	5,083 (2,109)	8,546

Notes: The project consists of the two components of flood control and irrigation/drainage improvement.

The flood control component means the river improvement work without irrigation/drainage improvement.

The irrigation/drainage component means the irrigation/drainage improvement works without flood control.

The average annual benefit of the project is estimated as follows.

Average Annual Benefit

Unit: (10^6Rp)

The project	3,722
Flood control component	830
Irrigation/drainage component	2,276

The internal rate of return of the project is calculated as follows based on the economic cost obtained from the sum of the above-mentioned construction cost and the operation, maintenance and replacement cost for the completed facilities and the economic benefit obtained from the above-mentioned average annual benefit.

IRR of the Project (%)

The project	20
Flood control component	18
Irrigation/drainage component	17

9. Required Fund

The fund required for the project is estimated as follows on the assumption that the fund is disbursed on the planned construction schedule, the prices used in the estimation of cost escalate at an annual rate of 18 % in the local currency portion and at an annual rate of 10 % in the foreign currency portion during the construction period and further the interst at an annual rate of 3 % to the capital invested in foreign currency is disbursed in local currency during the construction period.

Required Fund

	Local currency (10^6Rp)	Foreign currency [10^3US$($10^6$Rp)]	Total (10^6Rp)
The project	19,589	18,508 (7,681)	27,270
Flood control component	4,359	10,590 (4,395)	8,754
Irrigation/drainage component	15,230	7,918 (3,286)	18,516

10. Conclusion and Recommendation

The study proves that the Ular River Flood Control and Improvement of Irrigation Project is needed for the regional economic development and the public welfare, and the project is technically sound and economically feasible. It is therefore recommended that the Ular River Flood Control and Improvement of Irrigation Project is implemented as soon as possible.

PRINCIPAL FEATURES OF THE PROJECT

1. Flood Control Facilities

a. Dredging works	34,500 m	733,000 m^3
b. Excavation works	30,000 m	934,700 m^3
c. Embankment works	65,500 m	1,338,600 m^3
New	23,400 m	874,500 m^3
Heightening	42,100 m	464,100 m^3
d. Drain works	65,500 m	135,000 m^3
e. Revetment works		1,800 m
f. Sluice		1 place
g. Others		
Rain-gage stations		2 places
Water-level gage stations		5 stations
VHF-radio stations		6 stations

2. Irrigation and Drainage Facilities

2.1 Irrigation

a. Intakes		
New intakes		2 places
Intake to be improved		1 place
b. Settling basins		
New settling basins		10 places
c. Irrigation canals		
Irrigation area	18,500 ha	
Irrigation practice	Year-round irrigation by gravity	
Cropping pattern	Double cropping of paddy per year	
Main canals		36.5 km
New canals		2.6 km
Canals to be improved		20.4 km
Canals not to be improved		13.5 km

Secondary canal	327.4 km
New canal	158.5 km
Canals to be improved	51.5 km
Farm ditches	600.0 km
Farm roads	450.0 km
d. Related structures	
Main diversions	11 places
Secondary diversions	66 places
Drops	41 places
Acqueducts	37 places
Syphons	61 places
Conduits	3 places
Bridges	26 places
Check gates	6 places

2.2 Drainage

a. Drainage canals	
Main canals	195.1 km
Canals to be improved	125.0 km
Secondary canals	136.3 km
Canals to be improved	136.3 km
Collector drains	18.0 km
Farm drains	600.0 km
b. Related structures	
Bridges	16 places
Drops	29 places
Flap gates	11 places

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Fig. 4-2 Relation of river discharge and diversion requirement

Fig. 4-3 Diagram of irrigation distribution system

Fig. 4-4 Plan of irrigation system

Fig. 4-5 Plan of drainage system

Fig. 5-1 Construction schedule for flood control and irrigation/ drainage improvement components

Fig. 6-1 Organization chart for implementation of the project

Fig. 6-2 Organization chart for administration and operation after completion of the project

DEFINITIONS

Abbreviations

Inception Report	Inception Report on Feasibility Study of Ular River Flood Control and Improvement of Irrigation Project.
Overall Plan	Overall Ular River Improvement Plan mentioned in Study Report on Overall Ular River Improvement Project.
Overall Plan Study	Study of Overall Ular River Improvement Project (Including Flood Control, Reclamation of Downstream Plain and Possible Irrigation Project) conducted by JICA in 1977 and 1978.
Study Team	Feasibility Study Team of JICA for Ular River Flood Control and Improvement of Irrigation Project.
Urgent Project	Ular River Urgent Flood Control Project.

Administrative Districts

Propinsi	Province.
Kabupaten	District.
Kecamatan	Subdistrict.
Desa or Kampung	Village.
Kota Madya	Municipality.
Bupati	Head of Kabupaten.
Camat	Head of Kecamatan.
Walikota	Head of Municipality, Mayor.

Acronyms

ADC	Agricultural Development Center.
BIMAS	Bimbingan Massal (Mass Guidance Program).
BMTD	Badan Musyawarah Tani Desa (Village Agricultural Cooperation Association).

BRI	Bank Rakyat Indonesia (Indonesian People's Bank).
BUUD	Badan Usaha Unit Desa (Village Unit Executive Body).
CIF	Cost, insurance and freight.
CRIA	Central Research Institute of Agriculture.
DGWRD	Directorate General of Water Resources Development, Ministry of Pulbic Works and Electric Power.
DOLOG	Depot Logistik (Food Agency).
DPMA	Direktorat Penyelidikan Masalah Air (Directorate of Research of Water Problem).
DPU or PU	Dinas Pekerjaan Umum, Propinsi Sumatera Utara (Public Works Service, North Sumatra Province).
GDP	Gross Domestic Product.
IBRD	International Bank for Reconstruction and Development.
INMAS	Intensifikasi Massal (Agricultural Intensification Program).
IRR	Internal Rate of Return.
JICA	Japan International Cooperation Agency.
KUD	Koperasi Unit Desa (Village Unit Agricultural Cooperative).
NPV	Net Present Value.
PELITA	Pembanguan Lima Tahun (Five-Year Development Plan).
PNP	Persahaan Negara Perkebunan (State Estate Enterprise).
PPL	Penyuluh Pertanian Lapangan (Extension Worker).
PPM	Penyuluh Pertanina Madya (Extension Supervisor).
PPS	Penyuluh Pertanian Spesialis (Subject-matter Specialist).

PROSIDA	Proyek Irigasi IDA (IDA Irrigation Project).
PTP	Persahaan Terbatas Perkebunan (Private Estate Enterprise).
P3A	Petani Pengarap Pemakai Air (Water User's Association).
REC	Rural Extension Center.
RISPA	Research Institute of the Sumatran Planters Association.
S.	Sei or Sungai (river).
VHF	Very high frequency.
WUD	Wilayah Unit Desa (Village Unit).

Terminology

Balai Benih	Seed station.
Kebun Benih Sentral	Seed Center.
Polowijo	Second crop.

Datum of Elevation

LWS	Low Water Spring at Belawan Harbor.
UP	Reference datum of leveling for the Ular river project. No particular gage is installed for the UP, but the Bench Mark No.T-2339 installed in Lubuk Pakam is fixed to be 13.900 m UP in the reading.

Unit of Measurements

km	kilometer.
m	meter.
cm	centimeter.
mm	millimeter.
t	metric ton.

kg	kilogram.
gr	gram.
yr	year.
hr	hour.
s	second.
ha	hectare.
l	litter.
me	milligram equivalent.

Currency Equivalents

US$ 1 = Rp 415.

US$ 1 = ¥ 241.

CHAPTER I

INTRODUCTION

1.1. Feasibility Study.

The present feasibility study on the Ular River Flood Control and Improvement of Irrigation Project was carried out by the Study Team of the Japan International Cooperation Agency in accordance with the Scope of Work that was presented by the Government of Japan to the Government of Indonesia and agreed by the Government of Indonesia.

In the downstream plain of the Ular river, the primary constraint on rice production as well as people's livelihood is the flood problem. A large amount of crops, land, houses and other facilities were lost by floods. Among others, a flood in 1954 caused an extensive inundation stretching over an area of 25,000/1 ha including about 100 villages of four subdistricts. The flood damage reached an amount of Rp 6,196,000,000 at the 1977-price level. Such disastrous condition has strongly been requesting execution of flood control works such as construction of new levees, heightening of inadequate levees, widening of narrow channels, deepening of shallow channels and necessary bank protection.

On the other hand, paddy fields included in this area are generally farmed on one-cropping pattern, and only a part of them is technically irrigated mainly by water of the Ular river. If this area is protected from flooding of the Ular river, it will encourage the improvement of irrigation/drainage condition and lead to rice production increase.

Therefore, for the purpose of formulation of a plan for flood control of the Ular river and improvement of irrigation/drainage condition in an area governed by the river, the Overall Ular River Improvement Study was carried out in 1976 and 1977. This study proposed to make feasibility study of a project for improvement of the river channel extending from near the river mouth to Serbajadi Bridge and improvement of the irrigation and drainage condition in an area of 18,500 ha located in the downstream plain of the Ular.

The objective of the present study is therefore to justify the feasibility of the project proposed by the said Overall Plan Study.

The scope of work of the present study is, as mentioned in the Scope of Work given in Appendix C of Volume III of this report, fixed to cover such works as topographic survey and mapping, soil survey, hydrological study, planning of flood control and irrigation/drainage improvement, planning of exe-

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/1 : See Table 8-4, CHAPTER VIII.

cution of construction works, cost estimation, and economic evaluation. Along with this study, transfer of knowledge is incorporated.

The present feasibility report is composed of three volumes. Volume I is Main Report which contains general description of plan for flood control and irrigation/drainage improvement, economic evaluation and conclusions. Volume II is Study Report which contains study and planning of flood control and improvement of irrigation and drainage and economic analysis. Volume III is Supporting Report which contains details of topographic surveying, soil survey and others.

1.2. Progress of Study.

The first group of the Feasibility Study Team, JICA headed by Mr. K. Kasama, Co-leader of the Team arrived in Indonesia on August 18, 1977 and submitted to the Directorate General of Water Resources Development the First Draft Scope of Work for the Feasibility Study which was prepared based on the Terms of Reference (Vol.III, Appendix A) presented by the Government of Indonesia. After some discussions on the above, the Final Draft Scope of Work was sent to the Government of Indonesia through the Embassy of Japan in Jakarta (Vol.III, Appendices B and C). This was agreed by the Government of Indonesia.

On October 25, 1977 when topographical survey and soil survey had almost been finished by the first group of the Team, the main group of the Team headed by Mr. K. Kasama arrived in Indonesia for conducting the study. A little later, on November 4, 1977, the advisory group composed of Mr. S. Inoue, Chairman of the Advisory Committee of the JICA, Mr. Y. Takeuchi, Mr. K. Tanaka and Mr. Y. Suematsu, Members of the Committee arrived in Indonesia. A meeting was held in Jakarta on November 11, 1977 for discussing the Draft Inception Report of the Feasibility Study, and the Inception Report was accepted by the Directorate General on November 14, 1977 (Vol.III, Appendices D and E).

During the study in Medan, two meetings were held in Medan on December 20, 1977 and January 17, 1978 to discuss the interim conclusions obtained by the Study Team (Vol.III, Appendices F and G). On January 24, 1978, Mr. S. Inoue, Chairman of the Advisory Committee, Mr. Y. Suematsu, Mr. Y. Takeuchi, Mr. T. Okazaki and Mr. T. Jibiki, Members of the Committee and Dr. S. Sato, Leader of the Study Team arrived in Medan to review the draft ot the Interim Report. The Interim Report was submitted to the Directorate General of Water Resources Development on February 4, 1978 (Vol.III, Appendix H).

The Feasibility Report was finalized taking account of the conclusions of discussion on the Interim Report (Vol.III, Appendices H, J, K and L).

Before the Study Team left Indonesia, some equipment employed in the field study were delivered to the Indonesian Counterpart Team on January 30, 1978 (Vol.III, Appendix I) in accordance with the Note of Meeting dated November 14, 1977.

In performing the study, the organizations shown in Appendix C of Volume III were established respectively in the Government of Japan and in the Government of Indonesia.

In the organizations, the Advisory Committee of the JICA was composed of the members shown below.

Chairman	Mr. Shohei Inoue Ministry of Construction
Members	
River Engineer	Mr. Yoichi Takeuchi Ministry of Construction
Economist	Mr. Tetsuji Maruta Water Resources Development Public Corporation
Irrigation Engr.	Mr. Kiichiro Tanaka Ministry of Agriculture and Forestry
Drainage Engr.	Mr. Yusuke Suematsu Ministry of Agriculture and Forestry
Agronomist	Mr. Tadao Okazaki Ministry of Agriculture and Forestry
Coordination	Mr. Takanori Jibiki JICA

The Study Team of the JICA was composed of the members shown below.

Team Leader	Dr. Seiichi Sato NIKKEN Consultants, Inc.
Co-leader	Mr. Kiyomi Kasama NIKKEN Consultants, Inc.
Surveying Engineer	Mr. Masaru Yonai NIKKEN Consultants, Inc.
Surveying Engineer	Mr. Tokio Imai NIKKEN Consultants, Inc.
Surveying Engineer	Mr. Yasuji Suzuki NIKKEN Consultants, Inc.
Hydrologist (river)	Mr. Toshikatsu Imai NIKKEN Consultants, Inc.
Hydrologist (irrigation and drainage)	Mr. Shinroku Ohtsuki Nippon Koei Co., Ltd.

Soil-mechanics Engineer	Mr. Masahiko Nakagami NIKKEN Consultants, Inc.
River Engineer	Mr. Shigeaki Hisajima NIKKEN Consultants, Inc.
Irrigation Engineer	Mr. Takeshi Kawaguchi Nippon Koei Co., Ltd.
Drainage Engineer	Mr. Masayuki Kodama Nippon Koei Co., Ltd.
Structure Engineer	Mr. Akira Takubo Nippon Koei Co., Ltd.
Equipment Engineer	Mr. Kiyoto Yamazaki Nippon Koei Co., Ltd.
Agronomist	Mr. Kenjiro Onaka Nippon Koei Co., Ltd.
Agroeconomist	Mr. Masashi Shono Nippon Koei Co., Ltd.
Project Economist	Dr. Kinichi Ohno NIKKEN Consultants, Inc.
Assistant for River and Soil-mechanics	Mr. Kaoru Nakajima NIKKEN Consultants, Inc.

The Indonesian Counterpart Team was composed of the members mentioned below.

Management	Ir. Machmudin Makdurah DPU Sumatera Utara
Team Leader	Ir. B. Harahap DPU Sumatera Utara
Co-leader	Mr. M. Nainggolan M. E. DPU Sumatera Utara
Secretary	Drs. Dj. Siahaan DPU Sumatera Utara
Secretary (assistant)	Mr. Todung Nasution Proyek Sungai Ular
Secretary (assistant)	Mr. Sutrisno Proyek Sungai Ular
Surveying	Mr. Sahar BE DPU Sumatera Utara
Surveying	Mr. L. Pardosi BE DPU Sumatera Utara
Surveying	Mr. L. Sibarani BE DPU Sumatera Utara
Surveying (assistant)	Mr. Boas Nadagdap Proyek Sungai Ular

Surveying (assistant)	Mr. Ali Bugis Siregar Proyek Sungai Ular
Surveying (assistant)	Mr. Tumpal Silalahi Proyek Sungai Ular
Soil-mechnics	Ir. STP. Tambunan Direktorat Sungai
Soil-mechanics (assistant)	Mr. Abdul Hakim Lubis Proyek Sungai Ular
Soil-mechanics (assistant)	Mr. Albert Gultom Proyek Sungai Ular
Hydrologist (irr. & dra)	Ir. Aisyah Nasution DPU Sumatera Utara
Hydrologist (assistant)	Mr. Abner Hutajulu Proyek Sungai Ular
Hydrologist (river)	Ir. Widiastuti D Direktorat Sungai
Hydrologist (assistant)	Mr. P. Tampubolon Proyek Sungai Ular
River Engineering	Ir. Dartawan S. Direktorat Sungai
River (assistant)	Mr. Syamsubir Tanjung DPU Sumatera Utara
Irrigation	Mr. M. Nainggolan ME DPU Sumatera Utara
Irrigation	Mr. Sahar BE DPU Sumatera Utara
Irrigation (assistant)	Mr. Ridwan Tampubolon DPU Sumatera Utara
Drainage	Mr. B. Tampubolon BIE DPU Sumatera Utara
Drainage (assistant)	Mr. Paham Nainggolan Proyek Sungai Ular
Drainage (assistant)	Mr. M. Zain D. Proyek Sungai Ular
Structure	Ir. STP. Tambunan Direktorat Sungai
Structure	Mr. L. Sibarani BIE DPU Sumatera Utara
Structure (assistant)	Mr. Ch. Afdal Pohan Proyek Sungai Ular
Equipment	Ir. N. Bangun DPU Sumatera Utara
Equipment (assistant)	Mr. D. Nainggolan Proyek Sungai Ular

Agronomy	Ir. N. Ginting DPU Sumatera Utara
Agronomy (assistant)	Mr. Sugiono S. Proyek Sungai Ular
Agroeconomy	Ir. N. Ginting DPU Sumatera Utara
Agroeconomy	Mr. P. Simatupang DPU Sumatera Utara
Agroeconomy (assistant)	Mr. Maulana Purba Proyek Sungai Ular
Project Economy	Drs. Dj. Siahaan DPU Sumatera Utara
Project Economy	Mr. B.P.L. Tobing DPU Sumatera Utara
Project Economy (assistant)	Mr. Elasi Pakpahan Proyek Sungai Ular
General Administration	Ir. Soekrisno Rammelan Direktorat Sungai
General Administration	Mr. P. Simatupang DPU Sumatera Utara
General Administration (assistant)	Mr. Todung Nasution Proyek Sungai Ular
General Administration (assistant)	Mr. Sutrisno Proyek Sungai Ular

The Study Team wishes to express his sincere appreciation to the Counterpart Team and the officials of Directorate General of Water Resources Development, the Public Works Service of North Sumatra Province and other authorities concerned in Indonesia for the hearty cooperation and support extended to the Study Team.

CHAPTER II

PROJECT AREA

2.1. General Background.

North Sumatra Province, located between 1° and 4° North Latitude and between 98° and 100° Longitude, is the most developed one among seven provinces in Sumatra Island and consists of six municipalities and eleven districts (Kabupaten). This province has a large area of plantation and paddy field, and its major productions are rubber, palm-oil, tobacco and rice. Though some rivers in the province have been partially trained and improved, the low-lying land still has poor drainage, which causes hibitual flood damages resulting in loss of economic activities. The Ular river is one of those rivers. Almost in every rainy season from September to January, floodings have repeatedly occured on the Ular river due to breaches of levees, which caused a quantity of damages to farm land, the railway, the highway and other public facilities as well as inhabitants.

The record obtained by the DPU shows that the Ular river had four historical floods in the past. They are a flood in 1954, a flood in 1969, a flood in January of 1973 and a flood in December of 1973. Among them, the flood in 1954 was the biggest one and inundated an area extending over approximately 25,000 ha including about 100 villages which stretch over four subdistricts. The estimated damage amounted to Rp 6,196,000,000 in total at the 1977-price. This damage extended to houses and household effects, paddy, palm-oil and rubber, public facilities, facilities in plantation, upland crops, suspension of business activities and interruption of traffic. The major towns included in the inundated area were, in order of magnitude of towns, Lubuk Pakam, Perbaungan, Pantai Cermin and Galang.

In view of these damages, it was strongly requested to protect this area from the floods of the Ular river as a part of the economic rehabilitation within the framework of the PELITA-I started in 1969/70.

The Ular river originates from the Bukit Barisan mountains that form the somma of Lake Toba, running to the north, into the Malacca Strait at a point located about 30 km in the southeast of Medan, the capital of North Sumatra Province, playing an important role of supplier of irrigation water to the plain area downstream of Serbajadi.

For the purpose of flood control of this river, it was planned by the Indonesian Government to make a feasibility study with a technical assistance extended by the Japanese Government. The study conducted in 1971 proposed an urgent flood control plan to improve the river channel by rehabilitation, improvement and new

construction of levees and minor and major beds so as to meet the proposed temporary design discharge 600 m^3/s along with an additional recommendation to reconstruction of the highway and the railway bridges which were forming a restriction of the river channel.

In line with the proposal of the study, the urgent flood control plan was carried into execution starting in 1973 over a stretch of 10 km upstream from the highway bridge with the aid of a loan from the Overseas Economic Cooperation Fund of Japan. The works were finished in March 1976, and the reconstruction of the highway and railway bridges are to be completed in 1978 respectively by the Directorate General of Highway and the State Railway Company.

The completion of the urgent flood control project has produced a remarkably beneficial influence upon the stabilization of people's livelihood and the development of economic activities in this region owing to the effect of mitigation of flood damages. In particular, the start of the flood control work encouraged rehabilitation, improvement and extension of irrigation facilities as well as drainage facilities in the plantations.

In Indonesia, agriculture is the mainstay of the national economy. The agricultural product in the whole country accounts for about 40 % of the Gross Domestic Product (GDP). Agricultural sector in GDP has increased at an annual rate of 4 % during the period of the PELITA-I. With the exception of 1972 which was the most droughty year, rice production increased at a high annual growth rate of 3.5 % due to the improved unit yield and the expansion of the planted area. The total rice production obtained a level of 15.4 million tons in 1974. In spite of such high level of rice production, the Indonesian Government still had to import annually about one million tons of rice during the period from 1972 to 1976, because of the high demand for foodstuffs due to the rapid population growth rate of 2.4 % per annum together with an increase in rice consumption per capita resulting from the raised standard of living.

Following the PELITA-I, the current PELITA-II was launched in 1974/75 fiscal year. This plan also gave the highest priority to agriculture with special emphasis on rice production increase for domestic consumption, under the rice intensification program, marketing program and rapid expansion of irrigation facilities. The annual overall growth rate of GDP under this plan is projected at an increase of 44 % at an annual rate of 7.5 % in the final year. For agricultural sector, agricultural GDP is projected at an increase of 36 % with annual growth rate of 4.6 % in the final year.

In line with this plan, rice production in Indonesia has been increased. However, it is said that Indonesia, in the 1977/78 fis-

cal year, will import rice close to 2.4 million tons. The total amounts to one fourth of the world export supply. This rice in import was due partly to the prolonged drought and the serious damage brought by the "wereng" plague in many areas and partly to the government's plan to increase the national stockpile as a precaution against an expected extralong food-shortage period on account of the delayed planting time.

On the other hand, rice production in North Sumatra Privince has mainly been increased by crop intensification and expansion of irrigation facilities. Total production of rice reached a level of 1.69 million tons in 1973 and 1.38 million tons in 1975. The decline in 1975 was mainly due to the damage caused by "wereng" leaf hopper.

The population of North Sumatra Province is reported to be increasing rapidly year by year at an annual growth rate of 2.9 %. In 1975, it reached a level of 7.5 million. The shortage of rice occurs every year and about 0.12 million tons of rice are either imported or shifted from other provinces. In 2000, if the population increases at 2.9 % annually, nearly 15.3 million people will need nearly 2.3 million tons of rice per year to maintain their diet. It is estimated on the basis of the current increasing trend of rice production that a production of about 1.3 million tons can be expected in 2000. Consequently, shortage of rice is estimated at one million tons in 2000.

Taking account of the above-mentioned conditions of flood control and rice production, it is clear that the Urgent Flood Control Project is not enough to protect the land from flooding of the Ular river because that project was still only an emergent one based on a temporary design discharge, and on the other hand, production increase in foodstuff has become a serious problem also in North Sumatra Province.

From those standpoints, the Indonesian Government decided to make a study of an overall plan for flood control of the Ular river together with a wide utilization of the river water with emphasis on irrigation. The study was conducted in 1977/78 as Study on Overall Ular River Improvement Project (including Flood Control, Reclamation of Downstream Plain and Possible Irrigation Project) under the technical assistance of the Japan International Cooperation Agency.

This study recommended that the Overall Ular River Improvement Project should be a combined one of a river channel-improvement based on a new design discharge of 800 m^3/s (about 30-year return period) covering a stretch of about 32 km from near the river mouth and an improvement of irrigation and drainage

covering an area of 18,500 ha located in the downstream plain of the Ular river and between the two neighboring rivers, the Serdang and Rampah.

Further based on this study, it was decided by the Indonesian Government to make a feasibility study of the above-mentioned combined project. The study was conducted in the 1977/78 fiscal year also under the technical assistance of the Japanese Government.

2.2. Extent of River Channel for Improvement and Area for Irrigation/Drainage Improvement.

In accordance with the proposal of the Overall Plan Study, it was decided to ado t a stretch of river channel extending from -12.5 km near the river mouth (Ular Bridge is 0 km) to a point 22.65 km upstream from the bridge as the extent for improvement of river channel and an area of 45,000 ha located in the downstream of the Ular river as the project area for irrigation/drainage improvement. The stretch from -12.5 km to the river mouth was put out of planning because it is located in a too swampy area to fix a low-water channel. If circumstances demand in future, it may be necessary to reconsider this stretch, say, on the occasion of detailed design.

Also in accordance with the proposal, it was decided to make a study of only improvement of irrigation for paddy fields and related drainage canals in the agricultural sector. The area for improvement of irrigation was decided to be 18,500 ha out of the area of 45,000 ha which is a trangular area with its vertex at Serbajadi Bridge and located between the Serdang and Rampah rivers.

A coastal zone with a width of about 1 km was excluded from the project area for improvement of irrigation because the water quality analysis proved that the zone is strongly affected by sea water.

The river basin and the project area are shown in Map of Ular River Basin and Map of Project Area given at the beginning of this report.

The project area including the stretch of river channel for improvement administratively belongs to Deli/Serdang District and stretches over seven subdistricts of Lubuk Pakam, Pantai Cermin, Perbaungan, Galang, Tg. Beringin, S. Rampah and Teluk Mengkudu. A national highway and a national railway connecting Medan with other major towns run through the central part of the project area forming the important routes for supplying foodstuff and other commodities to the towns including Medan.

The population of the project area excluding estate area is estimated at 144,000 in 1976. The population density is about

530 persons per km^2, which is very high compared with the average density of 180 persons per km^2 in Deli/Serdang District and of 100 persons per km^2 in the whole area of North Sumatra Province.

There are no major cities in the project area, although there are a number of large towns, of which Lubuk Pakam and Pe Perbaungan are the largest. Most of inhabitants live in villages and hamlets which are scattered all over the project area. They are mostly engaged in agriculture and the related activities based on cultivation of rice. The major towns are usually Sub-district capitals, and they serve as commercial centers for the surrounding agricultural areas.

Ethnically, the majority of the people in the project area are Javanese clan (48.6 %), followed by Melayu clan (19.8 %), Batak clan (15.0 %), Banjar clan (11.0 %). From the religious viewpoint, most people are Moslem followed by protestant.

2.3. Physical Features.

2.3.1. Topography.

The Ular river basin is mainly composed of those of the Karai and the Buaya which originate in the northwestern somma of Lake Toba and its adjoining plateau about 1,200 m high in elevation. The Karai river flows to the northeast gathering the water from such tributaries as the Pulang and the Si Udan-Udan and joins with Buaya river which gathers the water from the tributary Banai. The Ular river, after joining the Karai and Buaya rivers, flows through the center of the agricultural area of the alluvial plain of the Ular river, and it debouches into the Strait of Malacca at a point about 30 km east from Medan. The basin stretches over both Districts of Simalungun and Deli/Serdan.

The river system is shown in the figure given at the beginning together with the sub-basins. The Ular river has a catchment area of 1,081 km^2 in total and a length of about 115 km from the river mouth to the headwaters. Profiles of the Ular river and its tributaries drawn based on the topographic maps on a scale of 1/50,000 are shown in Fig.2-1. As is seen from both figures, the Karai river basin is different from that of the Buaya in the shape and condition of the headwater region. The Karai river basin is long and narrow, and the headwater forms a plateau which has mean gradient of approximately 1/50, while the Buaya river basin is relatively short and wide, and the headwater forms steep-sloped mountains.

The project area for irrigation is an alluvial plain formed by the Ular river. The elevation ranges from about 1 m near the sea to the maximum of about 50 m near the Serbajadi intake. The area has a flat topography sloping from south to north with

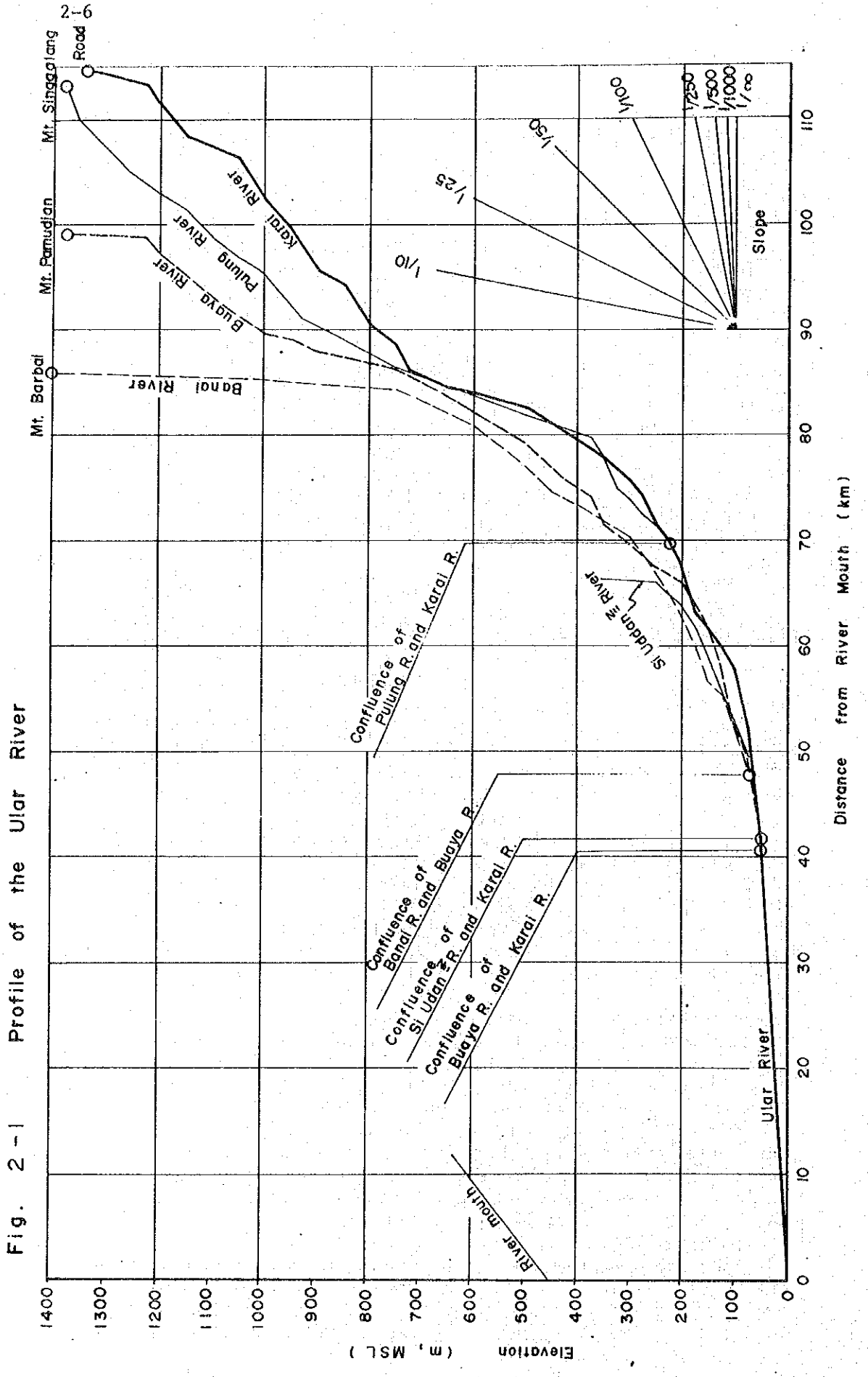


Fig. 2-1 Profile of the Ular River

a gradient ranging 1/600 at the upper part to 1/1,200 near the sea. There are undulations corresponding to natural drainage channels or hydromorphic depressions.

In spite of the relatively steep gradient, a number of minor elevations and depressions have been formed by the actions of the sea and rivers. Especially, the marine action has produced a distinctive topography characterized by several sand dunes along the coastal line, which inhibits surface drainage into the sea combined with the tidal action. The area enclosed between sand dunes turns to swampy land during the rainy season. In addition, roads and the railway also inhibit surface drainage.

2.3.2. Geology and Soils.

The Ular river runs through an area covered with andesite forming the Barisan volcano range, but the basin of the river is widely covered with acidic tuff, under which dacite and dacite tuff are found exposed on the banks. Near Mabar Bridge on the upstream course of the Buaya river, andesite mass is found (refer to the geological map in Study Report on Overall Ular River Improvement Project, JICA, 1978). The downstream area of the Ular river is covered with fluvial and alluvial deposits mainly consisting of clay, gravel and sand. Near the coastline facing the Strait of Malacca, marine deposits are found.

The topographical features are closely related to soil formation. Most of soils in the project area have been influenced by hydromorphic soil formation and are classified as gray hydromorphic soils in great soil group level. In addition, red yellow podzolic soils are scattered over the isolated hilly land in the upstream area of the Ular river. The hydromorphic soils have moderate pH value ranging from 5.1 to 6.8 for water. Cation exchange capacities are 10 to 30 me/100 gr. Base saturation degree shows a relatively high value. The soils generally have deep to moderately deep effective soil depths. As regards soil particle distribution, soils on the right side of the Buluh river consist of light to heavy clay. Soils in the area extending over the left side of the Buluh have been affected by sediments from the Ular river, and the soil texture is different depending on locations. Generally soils in such area are medium to fine in texture which are composed of intermittent layers. These soils are mostly used as paddy field at present and have low permeability in general. On the other hand, red yellow podzolic soils have relatively low pH value of about 5.5. Cation exchange capacities show less than 10 me/100 gr. Base saturation degree ranges from 40 to 60 %. The soils have generally large effective depths. The soil texture varies from sand to clay depending on locations. These soils are now under cultivation of upland crops or estate crops.

Most of soils in the project area are classified as gray

hydromorphic soils. In addition, red yellow podzoic soils are scattered over the isolated hilly land to small extent in the upstream area of the Ular river. Gray hydromorphic soils are deep to moderately deep effective soil depth, medium to fine in soil texture in general, high in base saturation degree, high in cation exchange capacity and low in soil permeability. These soils are not always high in their nutrient status, but are stable for irrigation farming of rice under the provision of proper fertilizer, water management, etc. Red yellow podzoic soils are now under cultivation of upland crops and estate crops. The soils of this group are also suitable for irrigation farming.

2.3.3. Rainfall and Other Climate.

In and around the Ular river basin, there are seventeen recording rain-gages and fourteen ordinary rain gages installed by the Ular River Project Office since 1972. At Silinda, the Directorate of Research of Water Problems (DPMA: Direktorat Penyelidikan Masalah Air) has a climatoligic station since 1975. These rain-gage stations are shown in the basin map given at the begining of this report. In addition, the PNP (Government-owned Estate Enterprise; Perusahaan Negara Perkebunan) has a number of ordinary rain-gage stations in the downstream area of the Ular river since more than 20 years ago.

The isohyetal map of annual rainfall (Fig.2-2) in the northern part of Sumatra Island, drawn by the Meteorological and Geophysical Institute based on the record from 1911 to 1940, shows that the mean annual rainfall is 1,500 mm to 2,500 mm in the downstream area of the Ular river and increases toward upstream to reach a maximum 2,500 to 3,000 mm in the hilly area and decreases toward further upstream to 2,000 mm or 2,500 mm in the upmost plateau. This variation implies a close relation between rainfall and topography.

The records of rainfall at the recording rain-gage stations of the Ular River Project Office and the ordinary rain-gage stations of the PNP indicate that (1) in the upstream plateau, rainy and dry seasons are not distinguishable, (2) the hilly area seems to have two rainy seasons in a year; the first rainy season has a maximum in April or May and the second one in October or November, and (3) the downstream plain seems to have one rainy season in a year though distinction between the dry and the wet seasons are not so definite.

In the downstream area of the Ular river, there are considerable variations in annual precipitations. Rainfall occurs irregularly in the form of intense local storm. Mean monthly temperature is about 26°C which only slightly varies during year. Mean monthly relative humidity is about 87 % during year. N and NE winds prevail in the project area all the year round. No strong wind or typhoon occurs with the exception of the seasonal wind which is incidental to the tropical climate. Sunshine duration averages 49 % ranging from 37 % to 57 %. Table 2-1

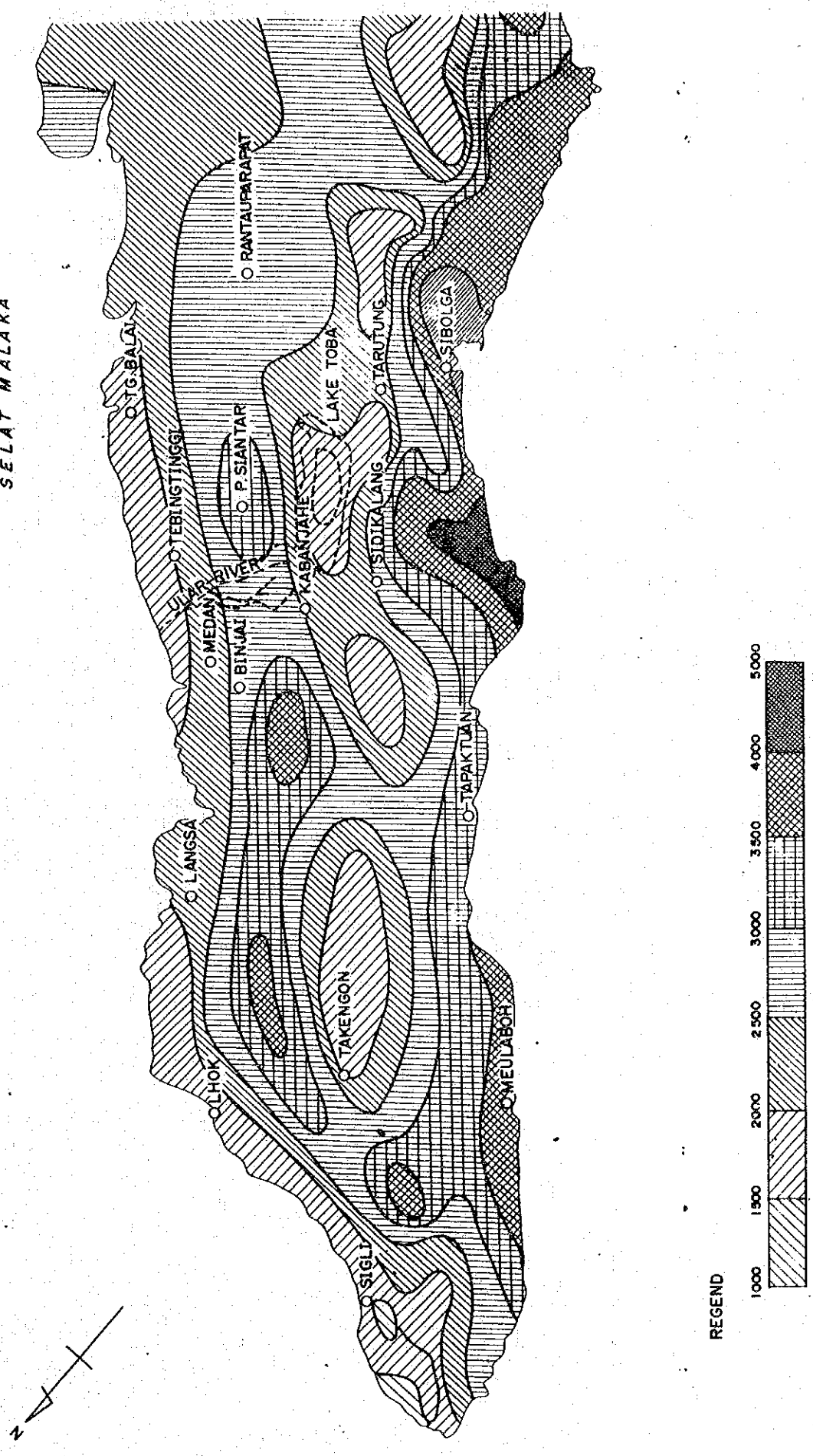


Fig. 2-2 Mean Annual Rainfall in the Northern Part of Sumatra

Table 2-1 Climatological Data

Item	Unit	J	F	M	A	M	J	J	A	S	O	N	D	Year	Wet	Dry
Monthly rainfall	mm	145	89	117	141	156	139	140	173	220	289	251	196	2,056	1,274	782
Rainy days		8	5	7	8	9	7	8	10	12	14	13	10	111	67	44
Air temperature	°C	25.2	25.7	26.1	26.5	26.6	26.5	26.2	26.2	25.9	25.8	25.5	25.4	25.9	25.7	26.3
Relative humidity	%	87	84	84	86	86	87	86	86	88	88	89	89	87	88	86
Wind direction																
Calm	%	6	2	7	-	5	5	1	5	3	2	3	4	3.5	3.8	3.3
N	%	31	22	28	31	24	11	22	17	21	25	15	24	22.5	22.2	23.0
NE	%	47	67	56	60	58	70	58	58	64	57	62	52	59.5	57.7	61.5
E	%	-	-	1	3	4	3	6	5	9	6	-	-	3.3	3.3	2.8
SE	%	1	-	-	5	2	6	6	6	1	3	3	1	2.8	2.5	3.2
S	%	-	-	1	1	1	-	1	1	-	-	-	-	0.3	0.1	0.7
SW	%	-	1	4	-	4	2	2	2	-	3	-	1	1.5	1.0	2.2
W	%	6	1	-	-	-	-	1	1	-	-	-	4	1.1	1.8	0.3
NW	%	9	7	3	-	2	3	3	5	2	4	17	14	5.7	8.5	3.0
Wind velocity	m/sec	1.05	1.12	1.13	1.00	1.00	0.95	0.95	0.97	0.88	0.86	0.83	0.93	0.98	0.92	1.03
Sunshine duration	%	45	48	57	38	53	55	57	52	43	40	40	37	49	43	55
Solar radiation	cal/cm^2	367	386	398	394	380	371	382	386	366	364	332	331	371	358	385
Evaporation	mm	2.00	2.52	2.44	2.20	2.07	2.26	2.41	1.96	1.71	1.68	1.69	1.67	2.06	1.80	2.32

Remarks : Rainfall and rainy days are the average values of rainfall stations in the project area and another climatic items are applied by the data in Sampali meteorological station.

gives the summary of climate in the project area. Fig.2-3 shows locations of climatological and rainfall stations.

2.3.4. Discharge of the Ular River.

(1) Flood Discharge.

The Ular River Project Office has six recording water-level-gage stations together with ordinary staff gages since 1972. These stations are shown in the said basin map given at the beginning of this report. For obtaining discharge rating curves, there are three gaging stations. One is located at Pulau-Tagor (Serbajadi Bridge) under the management of the DPMA, another at Ular Bridge and the other at Bandar Tiga both under the management of the Ular River Project Office.

The Bandar Tiga station is located just downstream of the confluence of the Karai and the Ruaya, the Pulau-Tagor station is located about 4 km downstream of the Pulau-Tagor station. About 12.5 km downstream of the Pulau-Tagor station, the Pulau Gambar canal (S. Kotabangun) joins to the Ular river.

As no correlation was found between rainfall and flood discharge, study was forcibly made on the return period of flood discharges directly by use of records of discharges knowing that it is only several years since the observation of flood discharges was commenced. In the present study too, the same method of study as adopted in the Overall Plan Study was taken, but adding the data obtained in 1977 and by use of the Gumbel and the Ven Te Chow methods beside the Thomas' plot method. The calculation indicated that the return period of 800 m^3/s is nearly 30 years just likewise the result obtained in 1976 . With regard to other discharges too, almost the same result as was obtained on the occasion of the study of Overall Plan was obtained this time too. It was decided, therefore, to adopt the return periods calculated on the occasion of the Overall Plan Study, as it cannot be said that the calculation in the present study is more accurate than that in the study of the Overall Plan.

The adopted return periods of discharges at Serbajadi Bridge are summarized as follows.

Discharge (m^3/s)	600	800	1,000	1,200
Return period (yr)	8	33	133	500

But it must be noted that the data on flood discharges used in this study are not sufficient for calculation of return periods by the orthodox procedure; therefore, data on hydrology must further be accumulated before the accurate prediction of return period can be made.

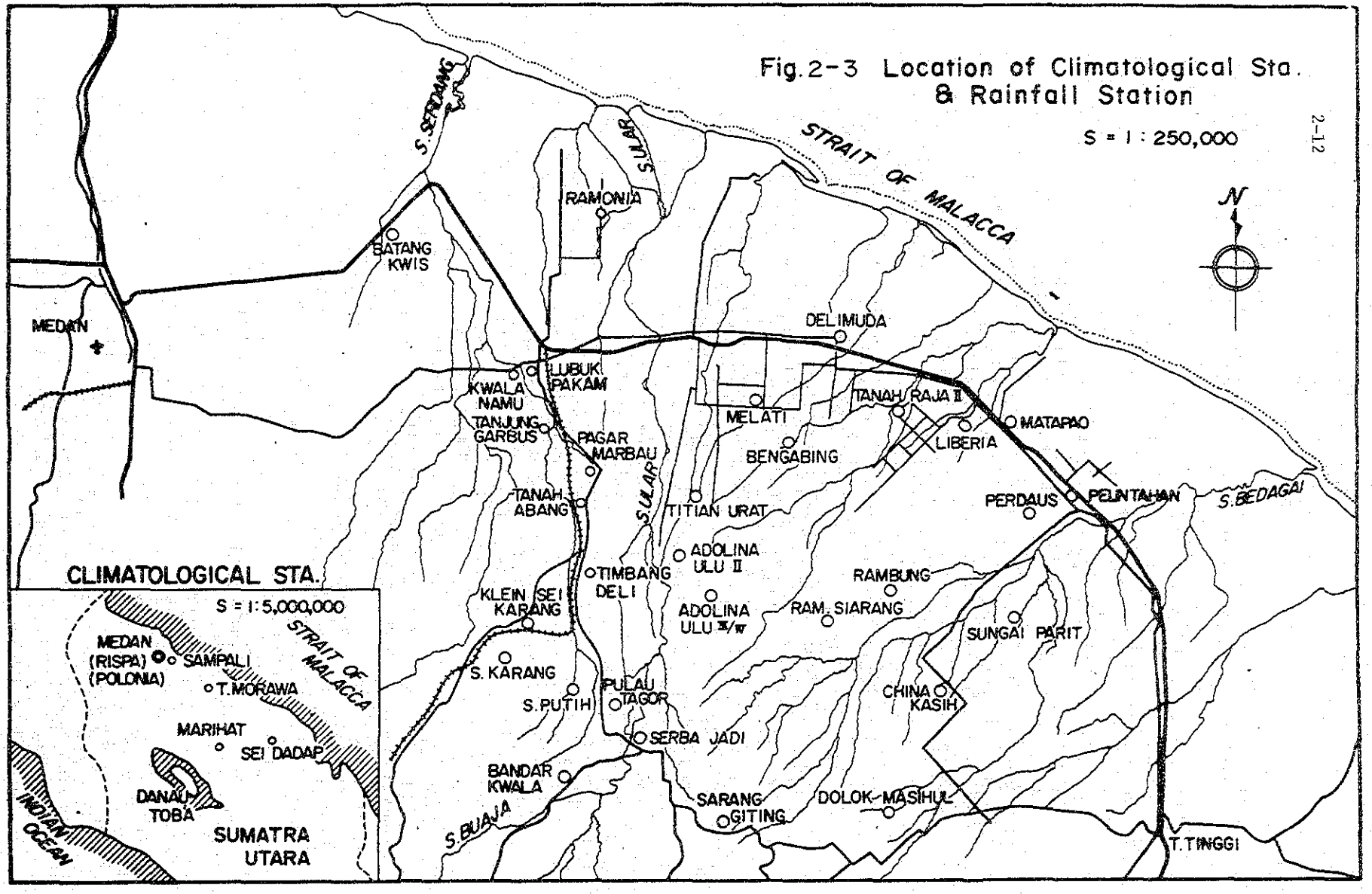


Fig. 2-3 Location of Climatological Sta. & Rainfall Station
S = 1 : 250,000
2-12
STRAIT OF MALACCA
S. SEDANG
S. ULAR
RAMONIA
BATANG KWIS
MEDAN
DELIMUDA
UBUK PAKAM
KWALA NAMU
TANJUNG GARBUS
PAGAR MARBAU
TANAH ABANG
MELATI
TANAH RAJA II
MATAPAO
LIBERIA
BENGABING
TITIAN URAT
PERDAUS
PELINTAHAN
S. BEDAGAI
ADOLINA ULU II
TIMBANG DELI
KLEIN SEI KARANG
ADOLINA ULU III/IV
RAMBUNG
RAM. SIARANG
SUNGAI PARIT
S. KARANG
S. PUTIH
PULAU TAGOR
SERBA JADI
CHINA KASIH
BANDAR KWALA
S. BUAJA
SARANG GITING
DOLOK MASIHUL
T. TINGGI
CLIMATOLOGICAL STA.
S = 1:5,000,000
MEDAN (RISPA) (POLONIA)
SAMPALI
T. MORAWA
MARIHAT
SEI DADAP
DANAU TOBA
SUMATRA UTARA
INDIAN OCEAN
STRAIT OF MALACCA

(2) Ordinary Discharge.

Almost all the water sources for irrigation in the project area depend on the Ular river although a little amount of water in the streams flowing down through the area has been used as supplement. For studying the existing irrigation systems and planning the improvement of them, two gaging stations are available. One is the Bandar Tiga station and the other is the Serbajadi station under the management of the DPMA, which is located a little downstream of the Bandar Tiga station. Comparing the records at both stations, it is found that the records obtained at the Serbajadi station give smaller values than those at Bandar Tiga. Therefore, the former was used for the study of irrigation for the sake of safety.

Table 2-2 shows mean ten-day discharges in the period of August 1971 to December 1977 at the Serbajadi station. It is found from this table that the Ular river has mean ten-day discharges exceeding 40 m^3/s throughout the observation period except from the middle of July to the beginning of September in 1972 and the mean discharges in the wet season from August to January and in the dry season from February to July are 57.3 m^3/s and 50.4 m^3/s respectively. This fact indicates that the Ular river expected discharge for irrigation in the project area.

Table 2-2 Mean Ten-Day Discharge at Serbadjadi Bridge of the Ular River (DPMA)

Unit: m^3/Sec.

Month	Period	1971	1972	1973	1974	Average
Jan	first		52.0	70.2	68.7	61.6
	middle		50.4	57.6	56.0	54.7
	last		57.5	49.8	54.7	54.7
Feb	first		55.8	44.7	60.2	53.6
	middle		52.0	39.7	63.5	51.7
	last		48.4	39.6	57.1	48.4
Mar	first		50.1	46.5	48.3	48.3
	middle		48.5	46.7	48.5	47.9
	last		47.5	60.3	46.7	51.5
Apr.	first		49.6	62.6	52.6	54.9
	middle		57.4	55.2	46.2	52.9
	last		63.7	56.9	45.6	55.4
May	first		53.6	52.3	45.7	50.5
	middle		61.2	48.0	54.2	54.5
	last		56.3	58.1	45.0	53.1

Month	Period	1971	1972	1973	1974	Average
Jun.	first		51.3	73.6	45.2	56.7
	middle		52.8	48.4	40.3	47.2
	last		47.3	47.1	49.8	48.1
Jul.	first		40.6	45.9	40.7	42.4
	middle		38.8	44.5	47.4	43.6
	last		31.3	54.3	49.3	45.6
Aug.	first	51.0	30.6	48.6	49.1	44.8
	middle	60.1	30.4	46.4	44.6	45.4
	last	53.3	38.3	46.9	46.1	46.2
Sep.	first	52.4	38.8	48.5	55.8	48.9
	middle	69.9	46.6	57.8	64.1	59.6
	last	69.5	45.6	48.2	76.5	60.0
Oct.	first	54.2	54.8	46.5	75.8	57.8
	middle	57.2	48.5	53.5	55.6	53.7
	last	58.1	58.0	79.5	52.6	62.1
Nov.	first	57.8	53.1	58.1	55.9	56.2
	middle	54.9	64.5	57.0	66.2	60.7
	last	51.8	76.6	61.0	66.5	64.0
Dec.	first	63.3	68.3	81.6	57.9	67.8
	middle	78.7	63.3	86.7	43.9	68.2
	last	66.0	55.9	96.4	45.8	66.0

2.3.5. Water Quality.

Quality analysis of water taken from the Pulau Gambar and Bendang intakes on the Ular river proved that there are no problems in utilizing it for irrigation.

2.3.6. Tide Level.

Tide level was observed on 23,24 and 25 of December in 1977 at S. Pantai Labu and at S. Buluh. The river mouth of S. Pantai Labu is located about 5 km northwest of the river mouth of the Ular river, and the river mouth of S. Buluh is located about 20 km southeast of the river mouth of the Ular river. On S. Pantai Labu, the observation was made at the river mouth and a point located about 2 km upstream from the river mouth. On S. Buluh, the observation was made at a point located about 60 m upstream from the river mouth.

By reason that the river mouth of the Ular is located between the river mouths of S. Pantai Labu and S. Buluh and the observed high-tide levels at the two river mouths are equal to each other, it was assumed based on the high-tide levels observed

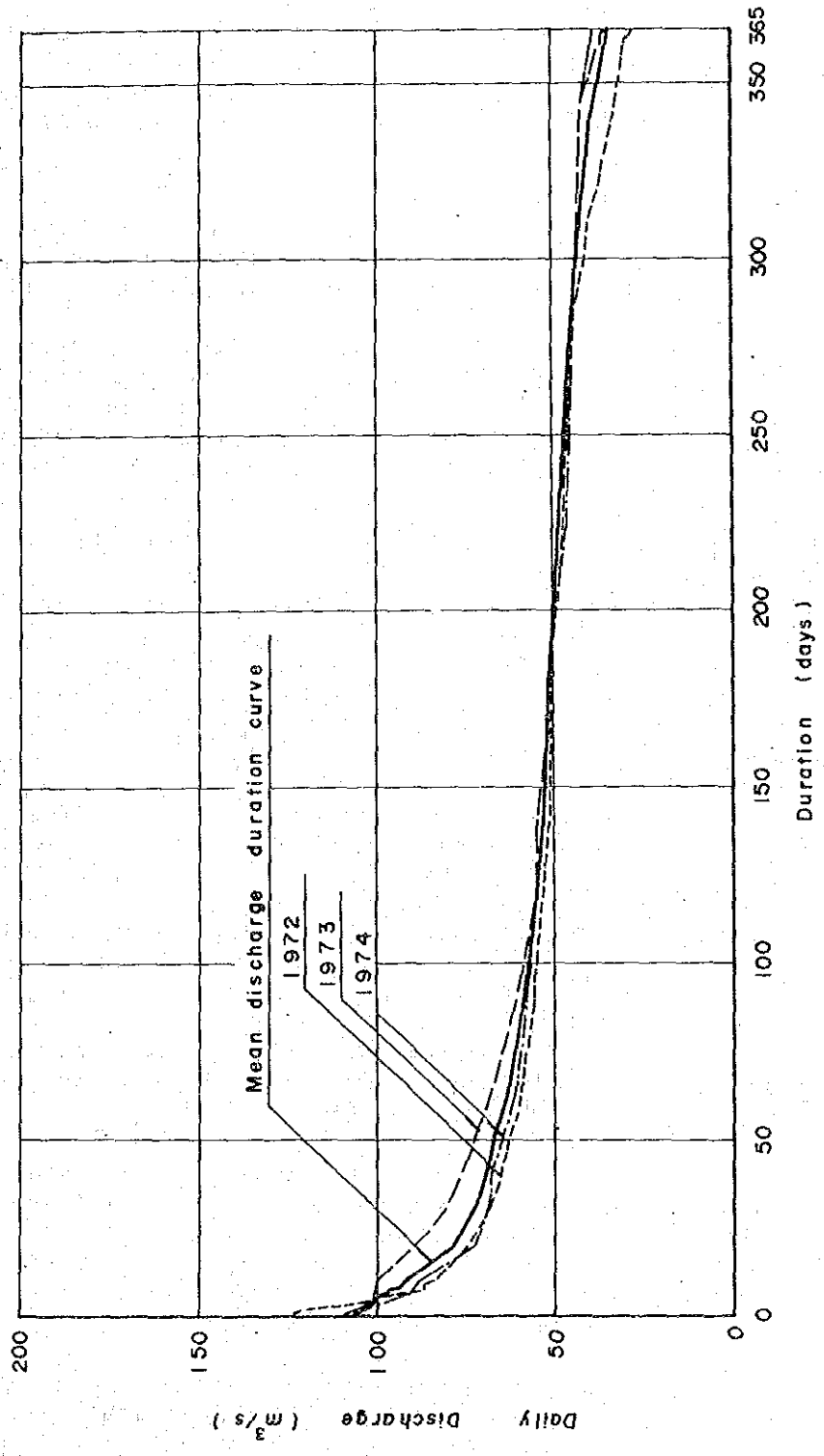


Fig. 2-4 Discharge Duration at Pulau-Tagor

at both the river mouths that the normal high-tide level at the river mouth of the Ular is about 0.2 m UP.

On the other hand, the comparison of the tide curves observed at the said two river mouths and the tide curve observed at Belawan Harbor during the same period revealed that there is the following relation between UP in meters and LWS in meters.

$$0 \text{ m UP} \fallingdotseq 2.1 \text{ m LWS}$$

In this expression, UP means the reference datum of leveling for the Ular River Project and LWS means Low Water Springs at Belawan Harbor and the datum level of tide at the harbor.

This relation is applicable to the case of the river mouth of the Ular. Also at Belawan Harbor, the tide records show that there occured a very high-tide level in the past to have reached 3.0 m LWS. Since the harbor is not so far from the river mouth, it can be assumed that this height of tide level occured in the past also at the river mouth of the Ular.

2.4. Present Condition of the River.

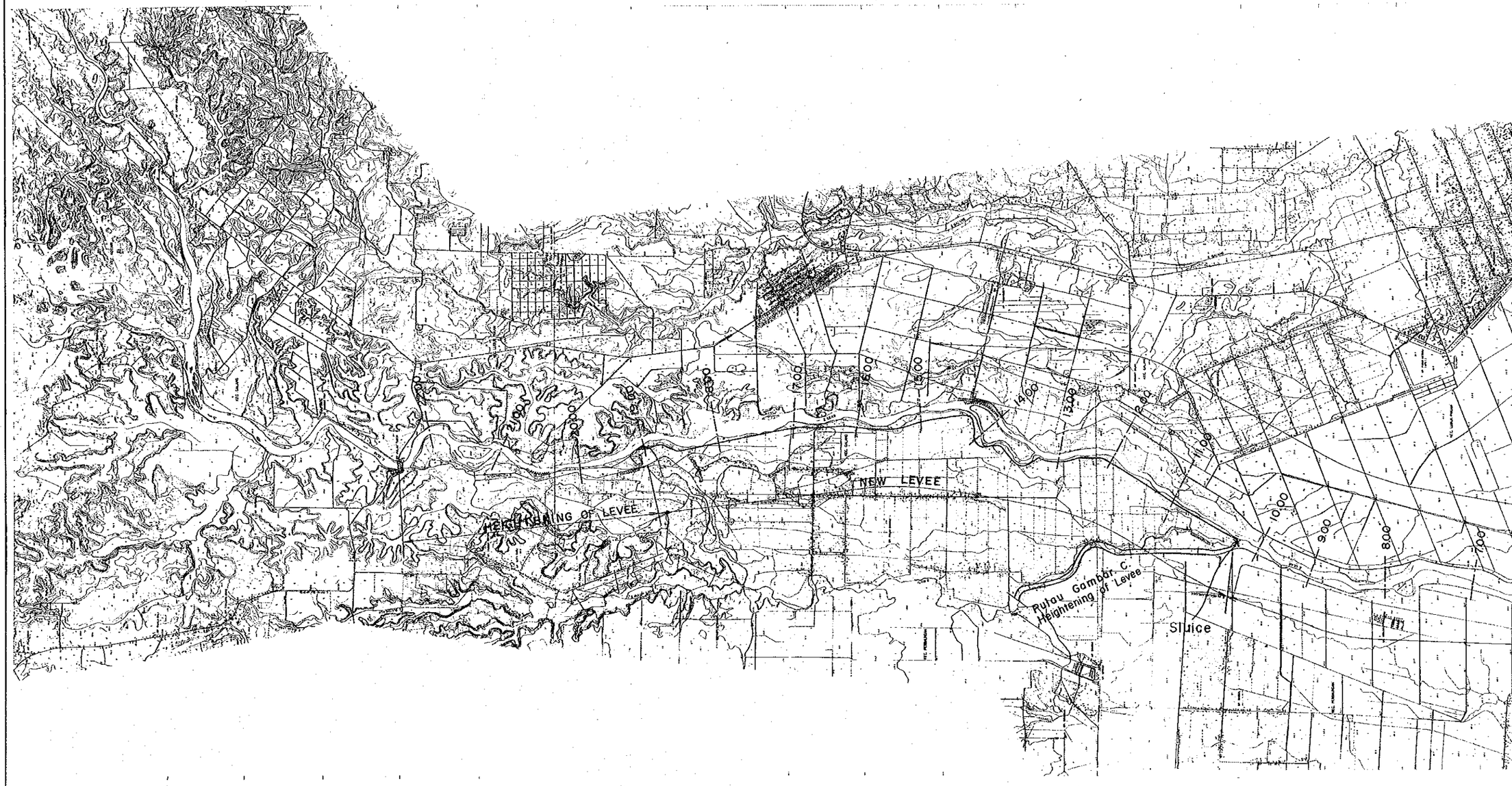
The stretches of river channels to be improved are shown in Fig.2-5, including Pulau Gambar Canal (S. Kotabangun). Slope of the river bed of the Ular varies from 1/700 at the upper end of the stretch for improvement to 1/1,200 at the lower end of the stretch.

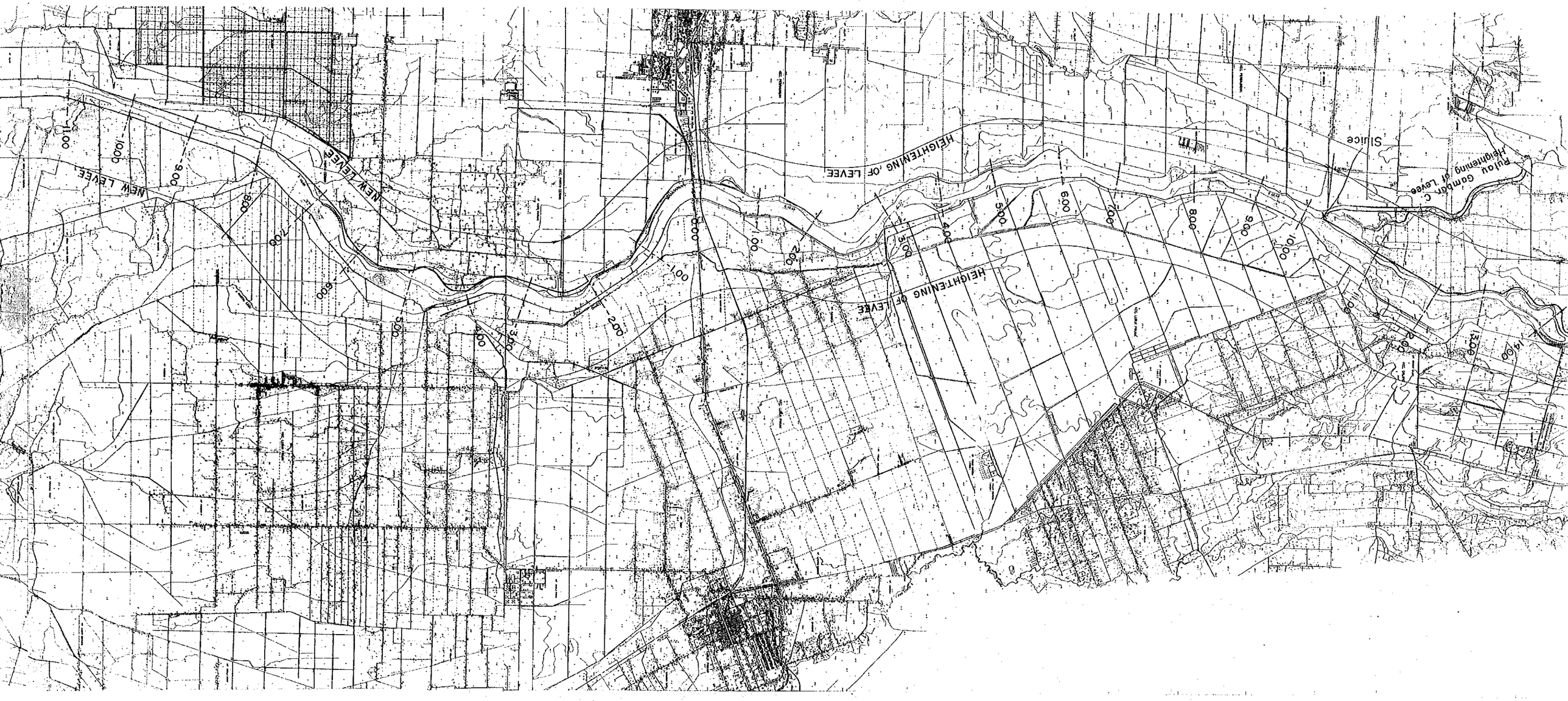
Based on the cross-sections drawn by the JICA Surveying Team in 1976 and 1977, the carrying capacity of the existing river channel of the Ular was calculated by use of the non-uniform flow method. In this calculation, the coefficient of roughness was, from the present condition of the river channel, assumed at $n = 0.033$ in case of 200 m^3/s and 400 m^3/s and $n = 0.030$ in case of 600 m^3/s and 800 m^3/s for the whole stretch of low-water channel and $n = 0.07$ for the high-water channel downstream from the distance-mark 15 km and $n = 0.06$ for the high-water channel upstream from 15 km both for all discharges.

At the lower end of the stretch, a stage-discharge curve was drawn by the uniform-flow calculation, on which water levels corresponding to several discharges were read and adopted as the starting water levels for calculation of water level on the upstream reaches. The profile of water level of the existing river channel is shown in Fig.2-6.

The condition of the existing levees and the carrying capacity judged from the results of the above-mentioned calculation are described below from the upstream part toward downstream.

The stretch from the confluence of the Buaya and the Karai to a point of 22.65 km has no problem of flooding because the stream runs through hilly land.


1400
1500
1600
1300
1200
1100
1000
900
800
700
NEW LEVEE
HEIGHTENING OF LEVEE
Rutau Gambar C.
Heightening of Levee
Sluice


NEW LEVEE
NEW LEVEE
HEIGHTENING OF LEVEE
HEIGHTENING OF LEVEE
Pulou Gambda C
Heightening of Levee
Slurce

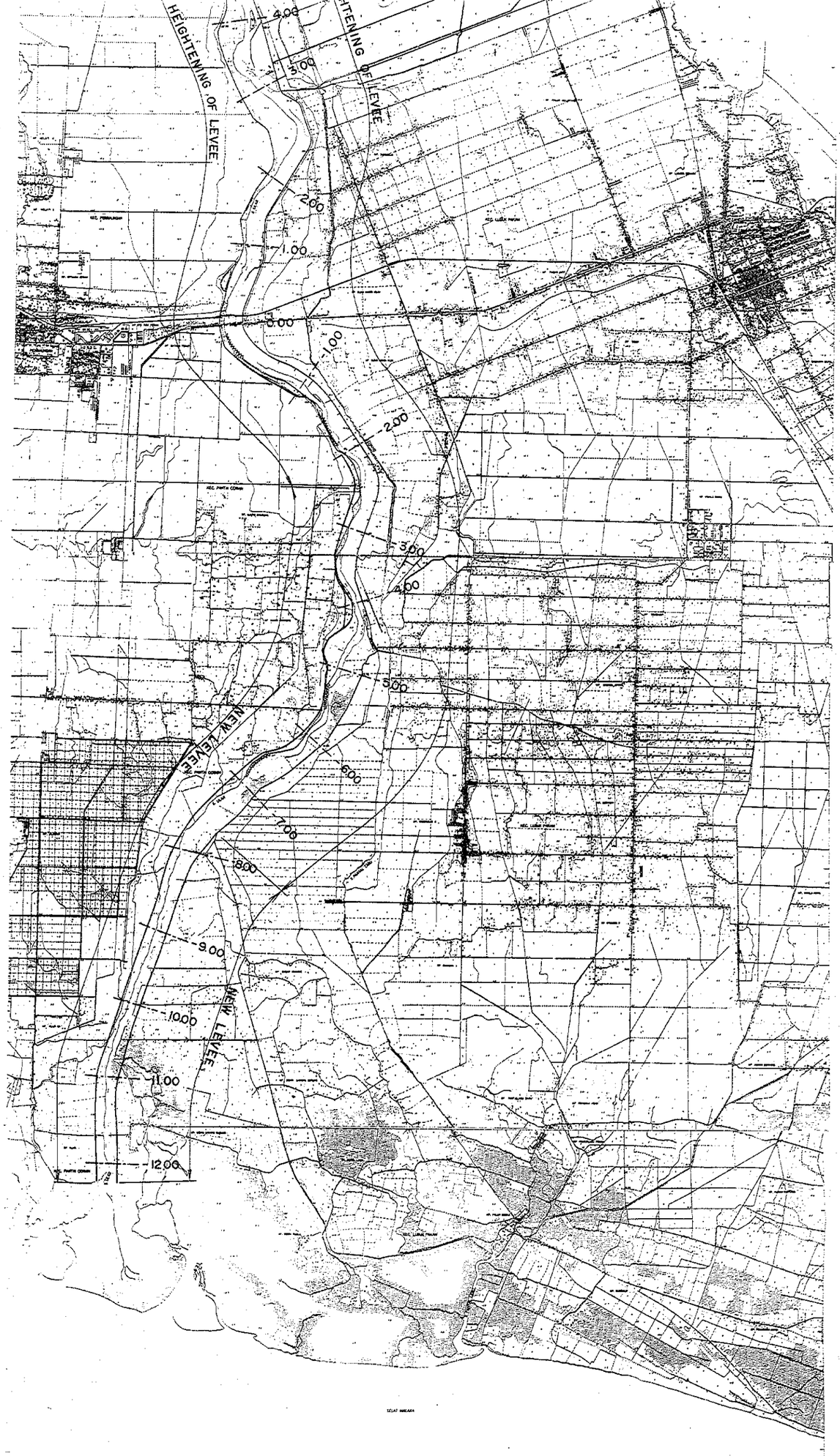


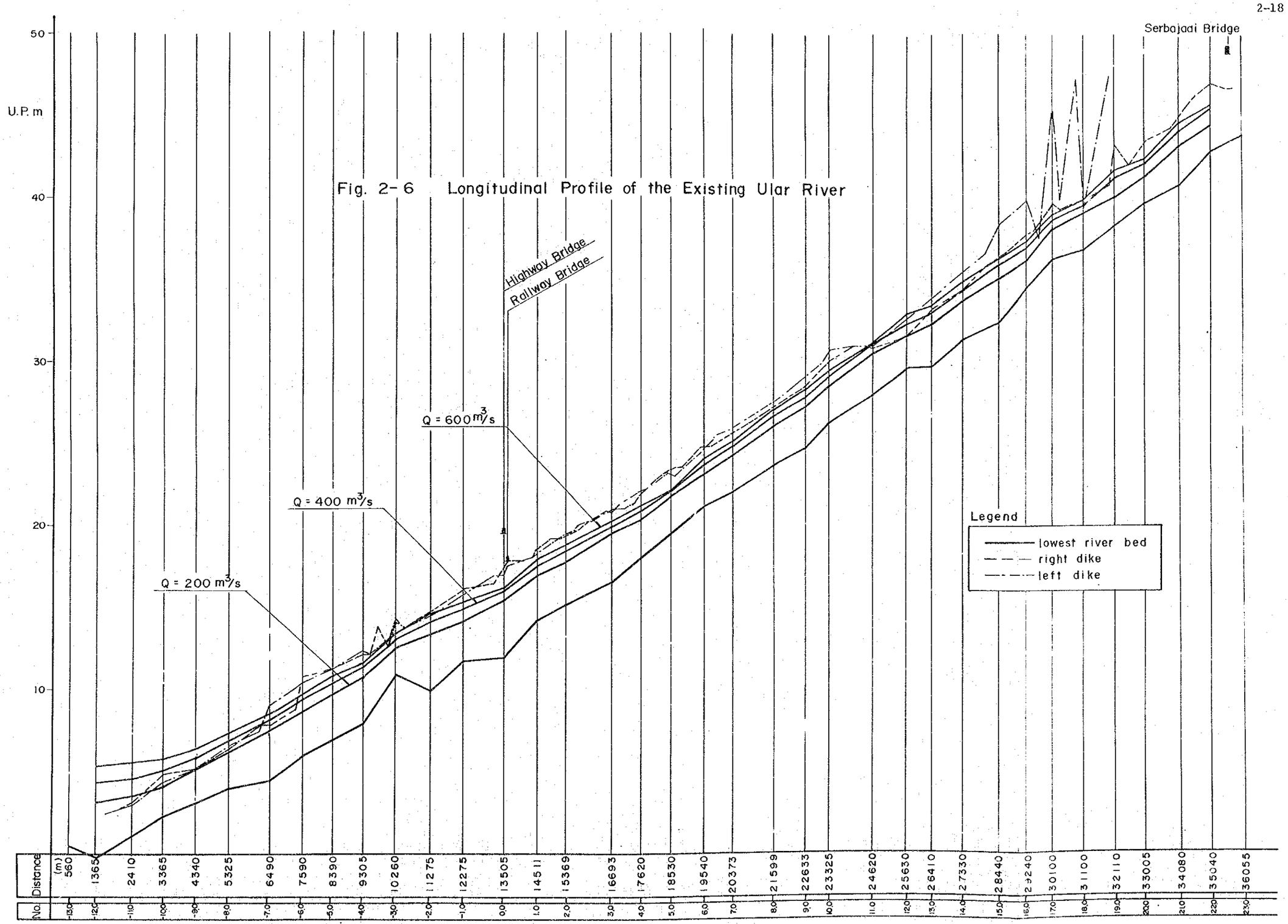
Fig. 2-5 Plan of River Improvement

Scale
0 500 1000 2000
1/50,000

Revetment

This map a reduced copy from the maps (scale 1:10,000) made by JICA, 1977

Fig. 2-6 Longitudinal Profile of the Existing Ular River



On the right side between 22.65 km and 19 km, there exists a levee which will meet a discharge of approximately 600 m^3/s; between 19 km and 10 km, there exists only a small levee with a height of 1 m to 1.5 m, which will meet a discharge of approximately 400 m^3/s. Though it is uncertain whether it was caused by the 1954-flood or the 1969-flood, a levee breach occurred at 13 km producing an anabranch which returns to the original stream at 10 km.

On the left side between 15 km and 10 km, there exists a levee constructed by the Seksi DPU Propinsi Sumatera Utara, which will meet a discharge of approximately 600 m^3/s.

Between 10 km and 0 km, construction of levees, arrangement of high-water channels and widening of low-water channels were executed during a period of 1973 to 1976 as Urgent Flood Control Project with a temporary design discharge under an aid of Yen Loan. Around 0 km, there are a railway bridge and a highway bridge. The railway bridge has been rebuilt and the reconstruction of the highway bridge is to be completed in 1978. The constrictions formed by the old bridges are to be mitigated by the rebuilding, but still remain some constrictions especially due to the railway bridge. However, the authorities have a plan to expand the total span further (refer to Study Report on Overall Ular River Improvement Project, JICA, 1977).

Between 0 km and -3 km, river improvement works are going on a scale of design discharge of 600 m^3/s.

On the left side between -3 km and Ramonia Intake at -4.8 km, a levee has been completed on the same scale as the Urgent Flood Control Project. Downwards from here, a levee under the control of Seksi of DPU continues up to -8 km; however, the levee is of small scale compared with the upstream.

On the right side between -3 km and -6 km, there is a small-scale levee. Downstream from -8 km on the left side and -6 km on the right side, the present river channel has no levees on both sides.

In the downstream plain, the largest area inundated by past floodings of the Ular is 25,000 ha which comprizes 7,600 ha of palm oil estates, 1,000 ha of rubber estates, 10,200 ha of paddy fields, 500 ha of second crops fields, 400 ha of town area and 5,300 ha of other area. Through this region, the railway and the highway run from east to west connecting Medan and other area. The said area of 25,000 ha as well as the railway and the highway are always threatened by flooding of the Ular.

Pulau Gambar Canal or S. Kotabangun, which pours into the Ular river at a point near 10.0 km on the right side, is a small tributary that has a drainage area of about 38 km^2 and a length of 15 km. It has two tributaries named S. Kotabangun and

S. Buluh Laga. S. Kotabangun is an irrigation canal diverted from the Ular river at a point near 22.5 km, while S. Buluh originates in low hills about 75 m high above the sea level. S. Kotabangun and S. Buluh join to the old Ular river which is now used as an irrigation canal named Buluh Canal. The old Ular river (Buluh Canal) is divided into two canals at Sennah divergence; one is Buluh irrigation canal and the other is Pular Gambar Canal (S. Kotabangun).

The Sennah divergence has gates for irrigation-water supply and drainage (spillway). When irrigation water is enough, drainage water collected by S. Kotabangun and S. Buluh Laga is discharged to Pulau Gambar Canal (S. Kotabangun) through the Sennah drainage gates (spillway).

At present, the lower basin of Pulau Gambar Canal (S. Kotabangun) plays a role of natural retarding basin since the right-side levee of the main river is not closed yet.

The carrying capacity of the lower reaches of Pulau Bambar Canal is estimated at 6 m^3/s, which is extremely small compared with the design discharge 25 m^3/s obtained by the study of drainage requirement.

2.5. Present Condition of Agriculture.

2.5.1. Land Use and Agricultural Products.

(1) Land Tenure and Land Holding.

According to the Land Reform Law as the Basic Agrarian Law No.5 of 1960, North Sumatra Province is classified as the less crowded area. Then, the limitation of private ownership of farm land was enacted on 10 ha for paddy field and 12 ha for up-land field. At present, there is no private large landload especially in paddy field in North Sumatra.

In the project area, the public land, which is mostly under the cultivation of the National Plantation Estates and several private Plantation Estates, occupies about 40 % of the Project area or 17,800 ha. The rest of about 19,700 ha of farmland including about 700 ha of fruits garden is owned by about 16,200 farmers that are more than 82 % of the total number of farmers. The tenant farmers account for only 6 % and farm labour households occupy about 12 %.

Average farming size in the project area is estimated at 1.132 ha of which 1.06 ha or 94 % is under the rice cultivation. Although the farming size in the project area is rather large in comparison with that of the Java Island, the problem for agricultural production is the lack of well-irrigated paddy field.

(2) Land Use.

The project area, about 45,000 ha has already been fully developed, so there leaves no room for further reclamation. The land under cultivation is estimated at 39,100 ha. The remaining area of 5,900 ha covers village areas, roads, infrastructural area, etc.

The land under cultivation mainly consists of estate crop area and paddy field. Estate crop area including small holder system occupies an area of 17,800 ha. Paddy field totals 18,500 ha of which 4,500 ha are the area cultivated by double cropping of paddy per year and the remaining 14,000 ha still remain under single cropping of paddy per year due to the shortage of irrigation facilities. Out of 14,000 ha, an area of 900 ha is cultivated by polowijo crops after harvesting rainy season paddy. In addition, 2,800 ha are being used as vegetables, fruits and forests.

Multi-cropping index for paddy field in the project area is about 1.3./1 The characteristics of the present land use are summarized in Table 2-3 and illustrated in Fig.2-7.

Table 2-3 Land Use in the Project Area

Item	Area (ha)
A) Rice Field	18,500
a) Technical irrigation area	3,000
b) Semi-technical irrigation area	1,500
c) Non-technical irrigation area	2,500
d) Rainfed area	11,500
B) Estate Field (P.N.P. Private estate and small holder farm)	17,800
a) Oil palm area	10,000
b) Rubber area	4,300
c) Coconut area	3,500
C) Other Crop Field	1,200
a) Vegetable	500
b) Fruits	700
D) Forest	1,600
E) Resident Area	4,300
F) Others	1,600
Total	45,000

/1 Multi-cropping index = $\frac{\text{annual crop planted area}}{\text{paddy field}}$

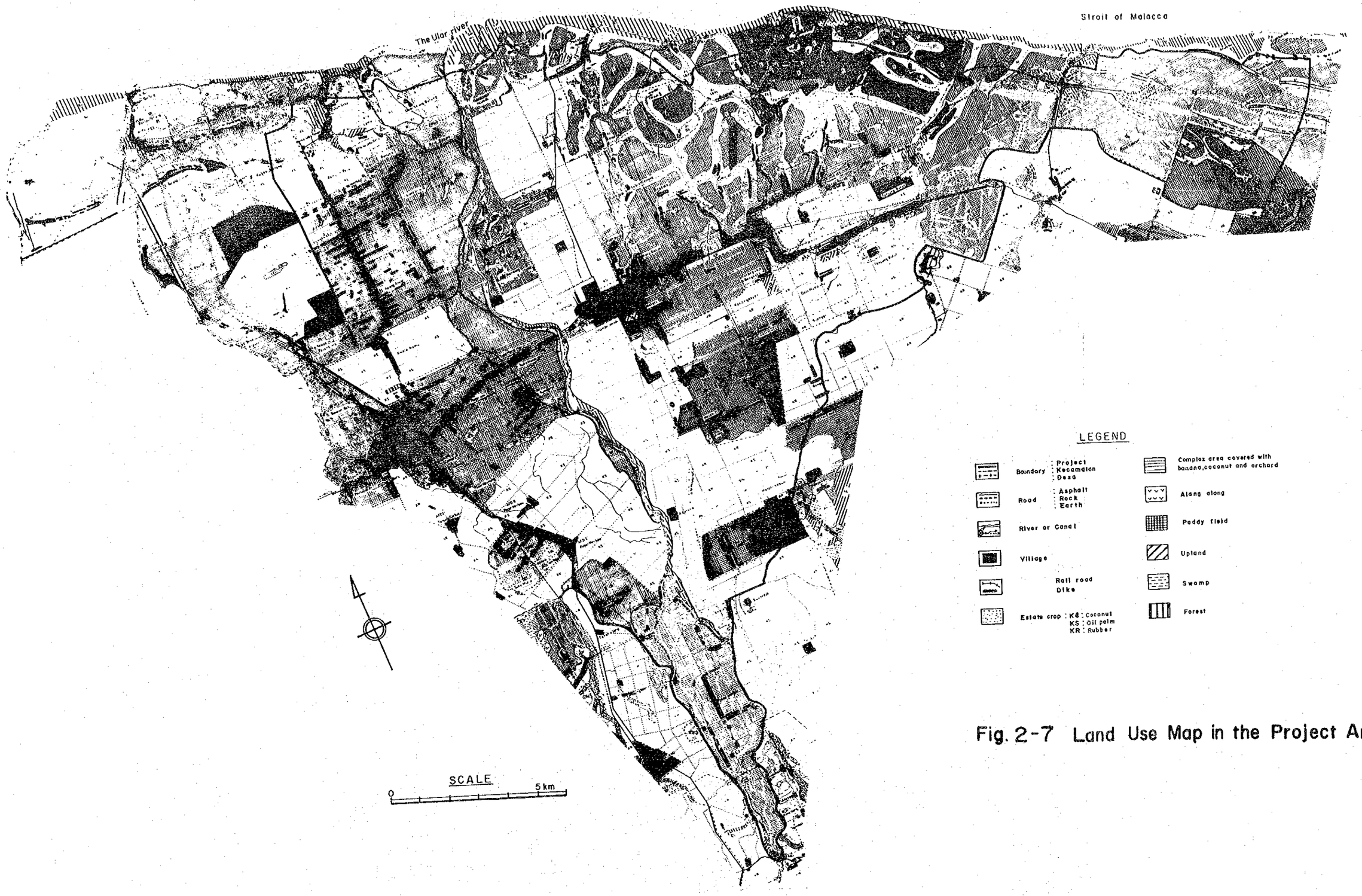


Fig. 2-7 Land Use Map in the Project Area

(3) Cropping Pattern and Farming Practices.

Major crops in the project area are paddy, polowijo and estate crops. The customary cropping pattern on the existing irrigated land is: rainy season paddy (Oct./Dec. to Feb./Mar.) and dry season paddy (Mar./Jun. to Jul./Sep.). On the rainfed or non-technical irrigation lands, the pattern is: net season paddy (Oct./Dec. to Feb./Mar.) and polowijo crops.

The BIMAS/INMAS programs have been implemented in the project area under Pelita I and II. As a result, high yielding varieties of rice have widely spread in the project area and the consumption of fertilizer has relatively increased. However, the level of fertilizer remains low. Dosage of fertilizer for paddy averages 50 kg of urea per ha for rain-fed land and 150 kg for irrigated land, respectively. Triple super phosphate application prevails into only irrigated lands. Farmers usually take less care of their polowijo crops because the yield is very uncertain. Details for farm inputs for each crops are explained in Volume II Study Report.

Farming in the project area is intensively carried out by labour from seedling to harvesting. Land preparation is carried out by draught animals or sometimes by manpower. Harvesting of paddy is done by sickles, not ani-ani equipment. Irrigation water control is not sufficiently conducted even in the irrigated land.

(4) Agricultural Production.

Due to the low level of farm inputs and inproper water control, the present production of paddy is low; the average yield of paddy on irrigated land and rain-fed area is estimated at 3.6 tons and 2.9 tons per ha, respectively. The average yield of polowijo crop is also low; for pea-nuts, cassava and soy-beans, it is as low as 1.09, 11.9 and 0.95 tons per ha, respectively. Total production of paddy and polowijo crops in the project area is about 73,000 tons and 8,000 tons, respectively.

Livestock breading and poultry raising are not popular in the project area, but they are important for the production of protein food and for provision of draught animals for land preparation.

(5) Marketing.

Main marketing farm product in the project area is rice. The amount of marketing rice is varied annually according to the variation of the yield of rice produced in each year. However, the price of rice is stabilized by the Government.

The DOLOG (DEPOT LOGISTIK) North Sumatra would purchase and sell the rice when the price of medium quality rice is down under the floor price or raised over the ceiling price at the central market in Medan. In 1977, the floor price and ceiling

price of rice are set to 110 Rp./kg and 145 Rp./kg respectively by the Government.

The paddy produced by the farmers is sold to rice mill and/or KUD (Village Unit Co-operative) through brokers. And then rice mill sells rice to wholesaler through middle brokers as mentioned in detail in the Vol.II Study Report.

(6) Farm Economy.

According to the available data provided by the Agricultural Office of Deli-Serdang District and the results of field survey, the farmers in the Project area earn most of their income from the sale of rice produced in excess of their requirements for consumption of the familities at present.

The gross annual farm incomes of the typical owner farmer Type I and Type II are estimated at about Rp. 314,090 (US$ 757 equivalent) and Rp. 347,630 (US$ 838 equivalent) respectively as shown in Table 2-4.

In addition to the farm income, farmers get their income from non-farm activities such as temporary hired labour for the Plantation Estates, trade and others. The non-farm income accounts for about 10 % of gross income for the average farmer in the project area.

The farming expenses except family labour cost are about Rp. 25,250 (US$ 61 equivalent) in Type I and Rp. 38,280 (US$ 92 equivalent) in Type II. Accordingly, the net income per farm household is estimated at about Rp. 283,470 (US$ 683 equivalent) in Type I and Rp. 302,450 (US$ 729 equivalent) in Type II, respectively.

Table 2-4 Present Annual Budget on Typical Owner Farmer

	TYPE I	TYPE II
Farm size	(Rain-fed 1.45ha 1.34ha Up-land field 0.11ha)	(Irrigated paddy 1.00ha 0.45ha Rain-fed paddy 0.5ha Up-land field 0.05ha)
Family size	5.55	5.25
1. Gross farm income	Rp.	Rp.
Intensive Paddy (Wet Season)	-	113,400
" (Dry Season)	-	113,400
Non-intensive Paddy	291,450	108,750
Up-land crops	22,640	12,080
Total	314,090	347,630