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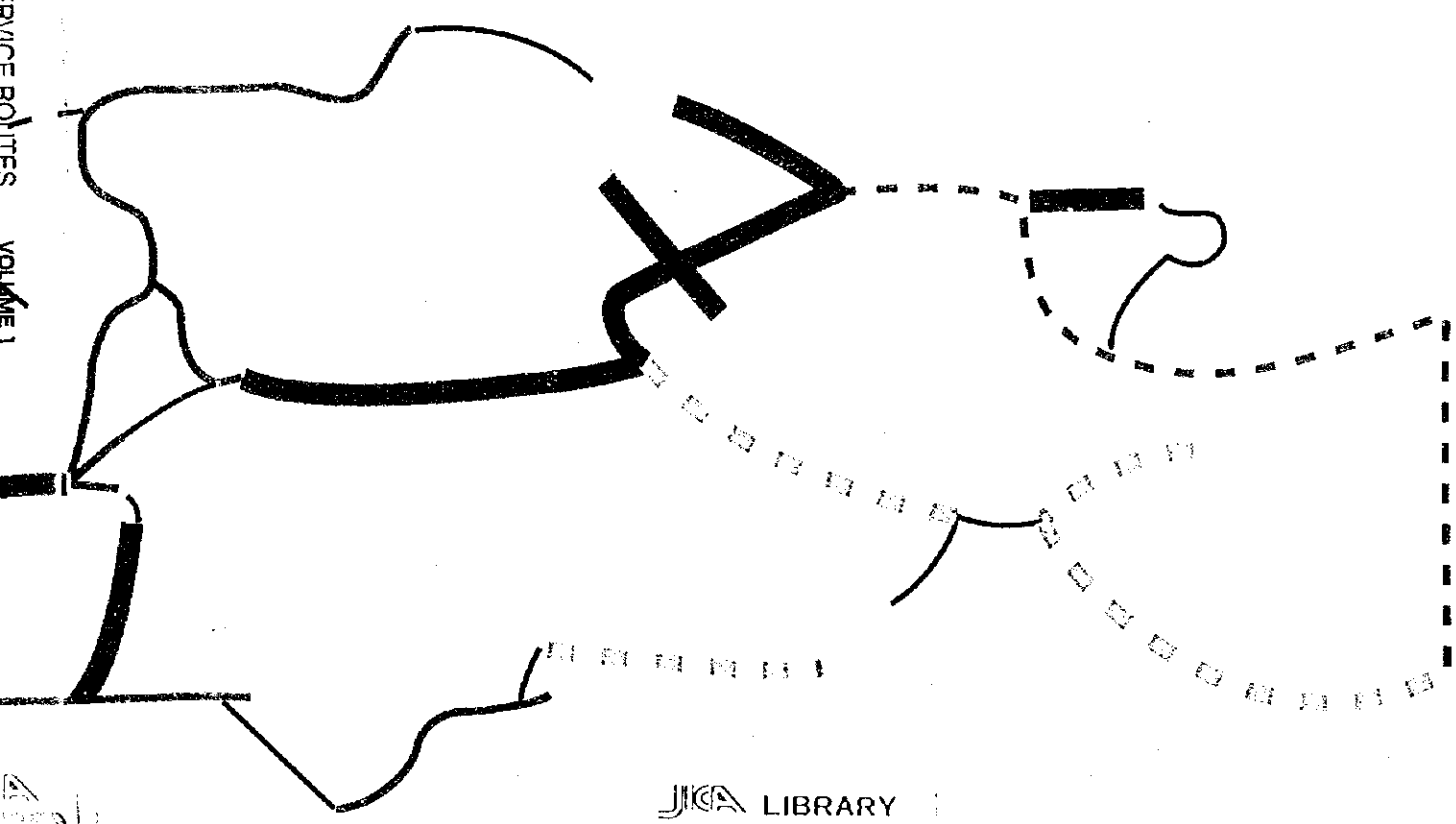
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF COMMUNICATIONS (MOC)

FINAL REPORT
THE DEVELOPMENT STUDY ON THE NATIONWIDE FERRY SERVICE ROUTES(STAGE II) IN THE REPUBLIC OF INDONESIA

VOLUME 1
PART1: PRESENT CONDITIONS
PART2: LONG-TERM DEVELOPMENT PLAN

OCTOBER 1998



THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN (OCDI)
PACIFIC CONSULTANTS INTERNATIONAL (PCI)

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PREFACE

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Development Study on the Nationwide Ferry Service Routes (Stage II) in the Republic of Indonesia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Republic of Indonesia a study team headed by Mr. Takao Hirota, President of the Overseas Coastal Area Development Institute of Japan (OCDI) and composed of members from OCDI and Pacific Consultants International (PCI) four times between March 1997 and July 1998.

The team held discussions with the officials concerned of the Government of the Republic of Indonesia and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between the two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for the close cooperation they extended to the team.

October, 1998

Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

October, 1998

Mr. Kimio FUJITA
President
Japan International Cooperation Agency

Dear Mr. Fujita:

It is my great pleasure to submit herewith the Final Report of the Development Study on the Nationwide Ferry Service Routes (Stage II) in the Republic of Indonesia.

The study team which consists of the Overseas Coastal Area Development Institute of Japan (OCDI) and Pacific Consultants International (PCI) conducted surveys in the Republic of Indonesia over the period between March 1997 and July 1998 as per the contract with the Japan International Cooperation Agency.

The findings of this study, which are compiled in this report, were fully discussed with the officials of the Ministry of Communications of the Indonesian Government and other authorities concerned to formulate the Long-term Development Plan for the ferry routes for the period up to the year 2019, and to formulate and examine the feasibility of the Short-term Development Plan for the period up to the year 2004.

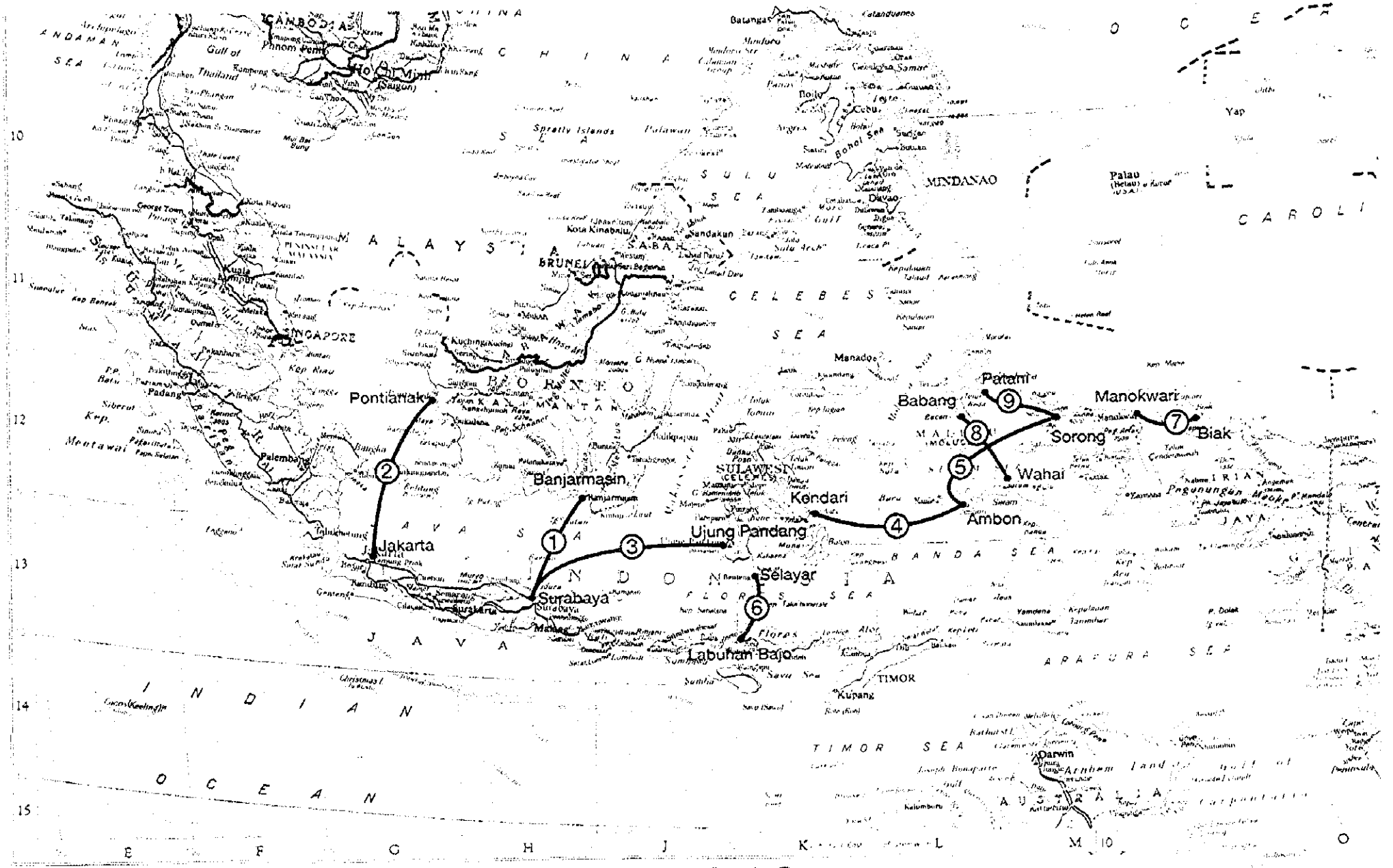
On behalf of the study team, I would like to express my heartfelt appreciation to the Government of the Republic of Indonesia, the Ministry of Communications and other authorities concerned for their diligent cooperation and assistance and for the heartfelt hospitality which they extended to the study team during our stay in Indonesia

I am also greatly indebted to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Transport and the Embassy of Japan in Indonesia for giving us valuable suggestion and assistance during the preparation of this report.

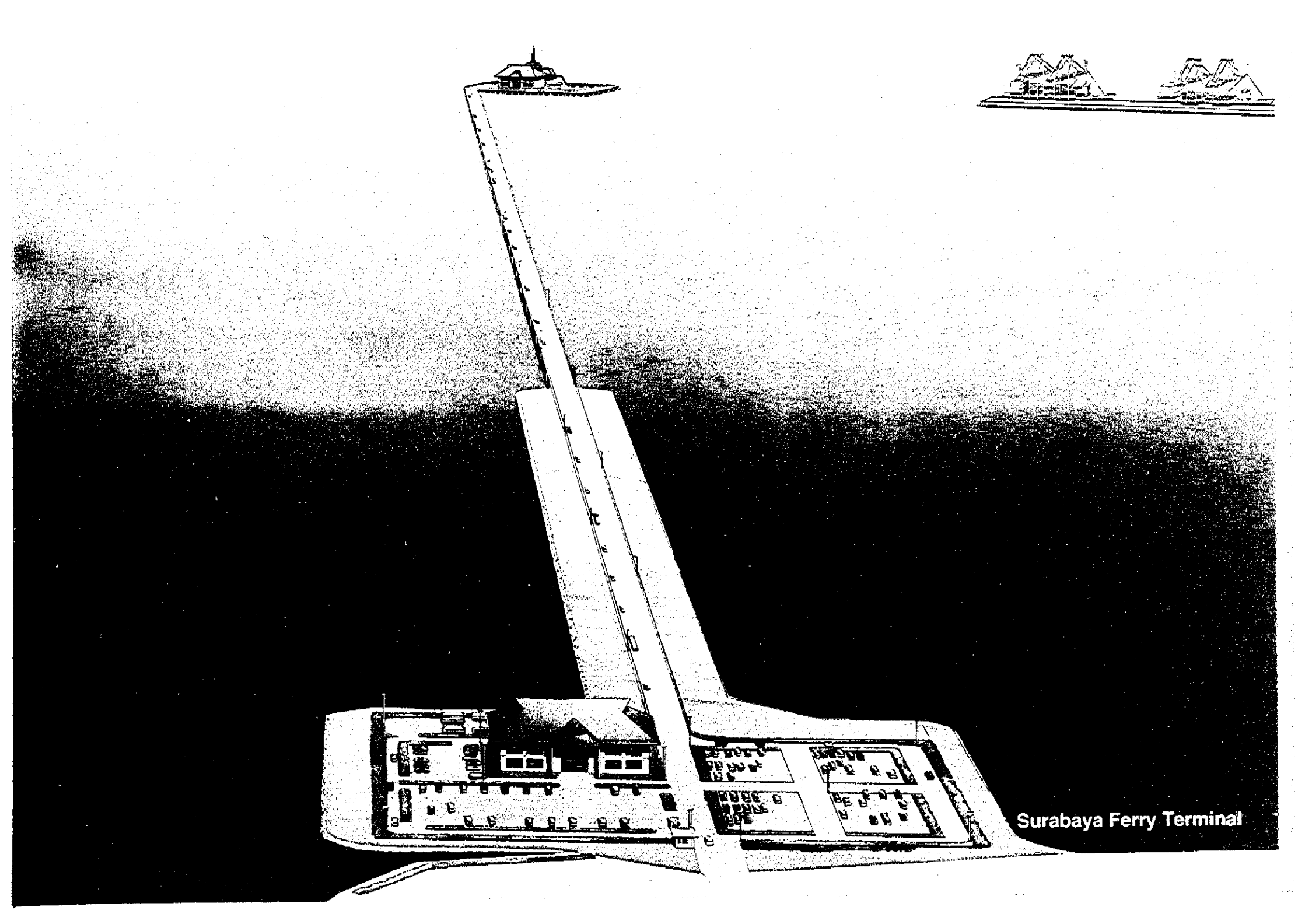
Yours faithfully,

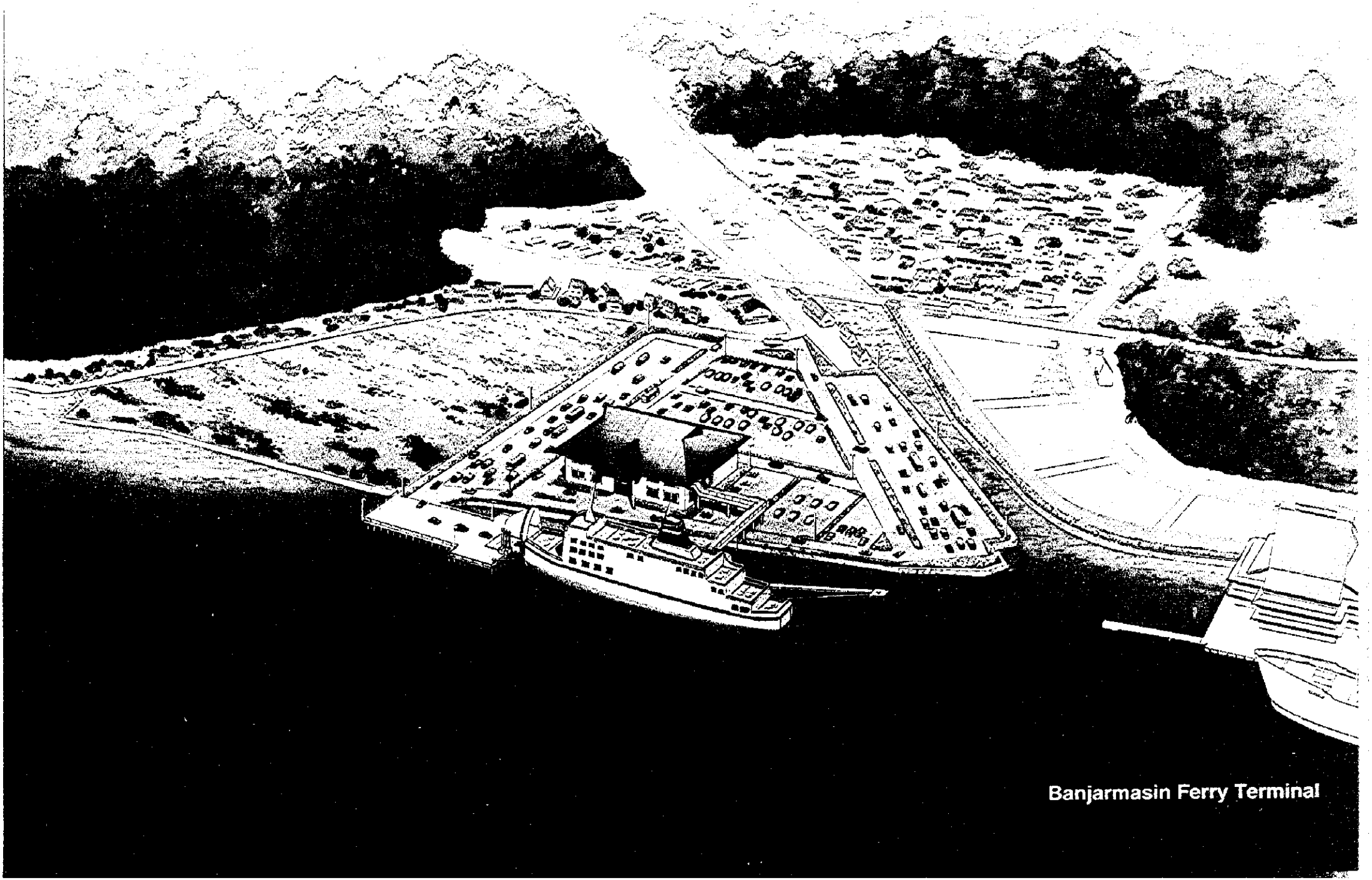
Takao Hirota

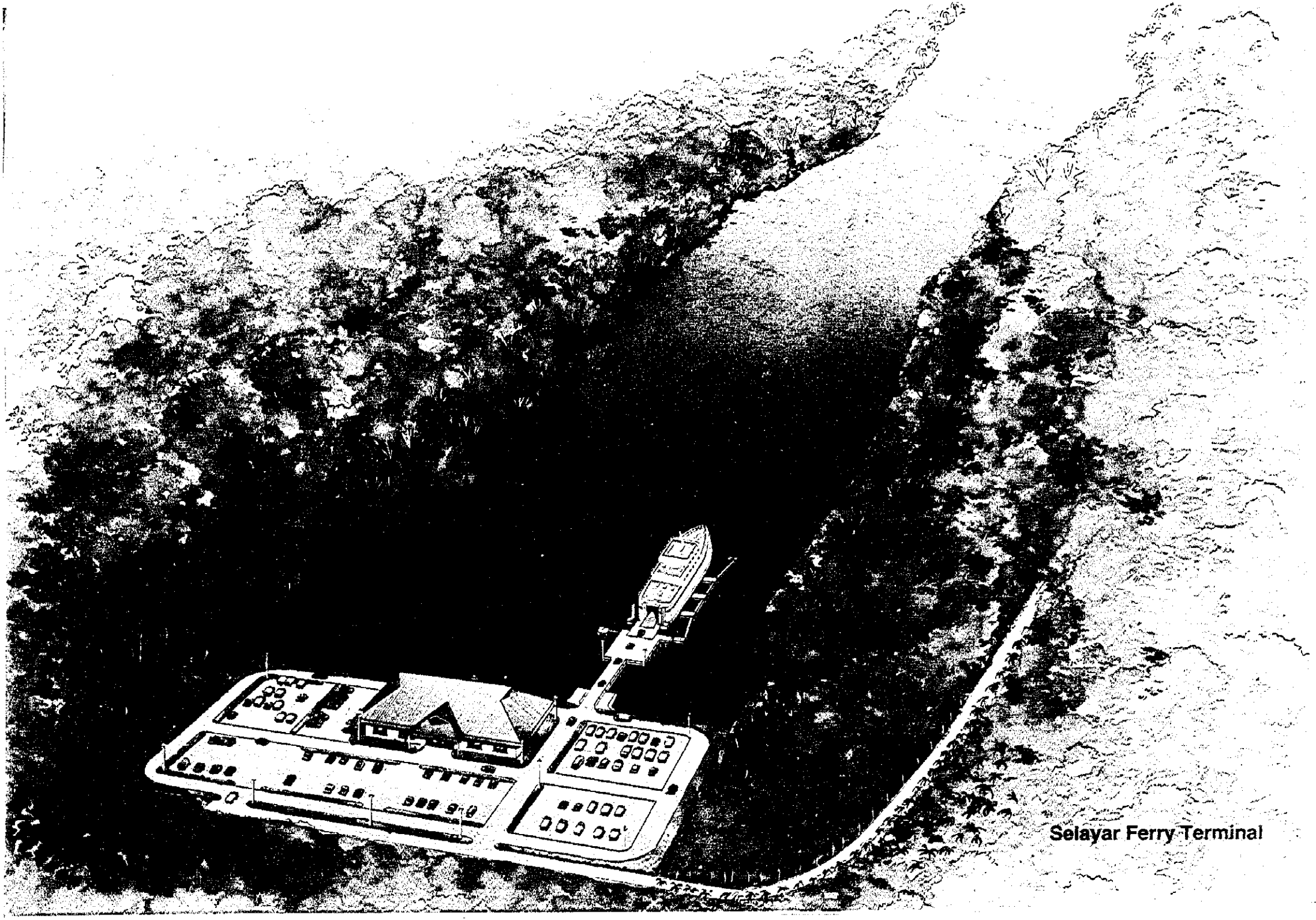
Takao Hirota
Team Leader for the Development Study
on the Nationwide Ferry Service Routes (Stage II)



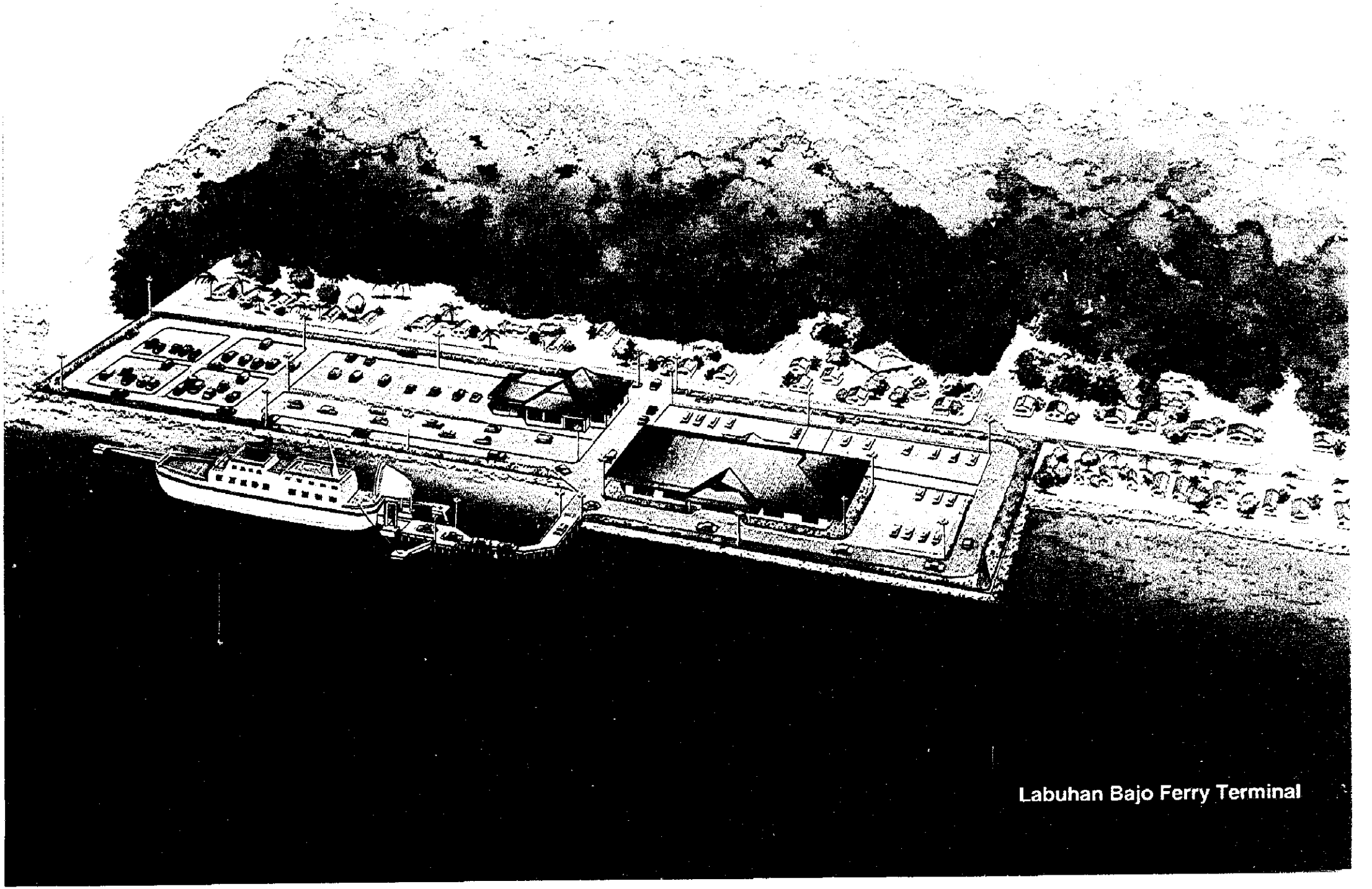
Location Map of Study Routes

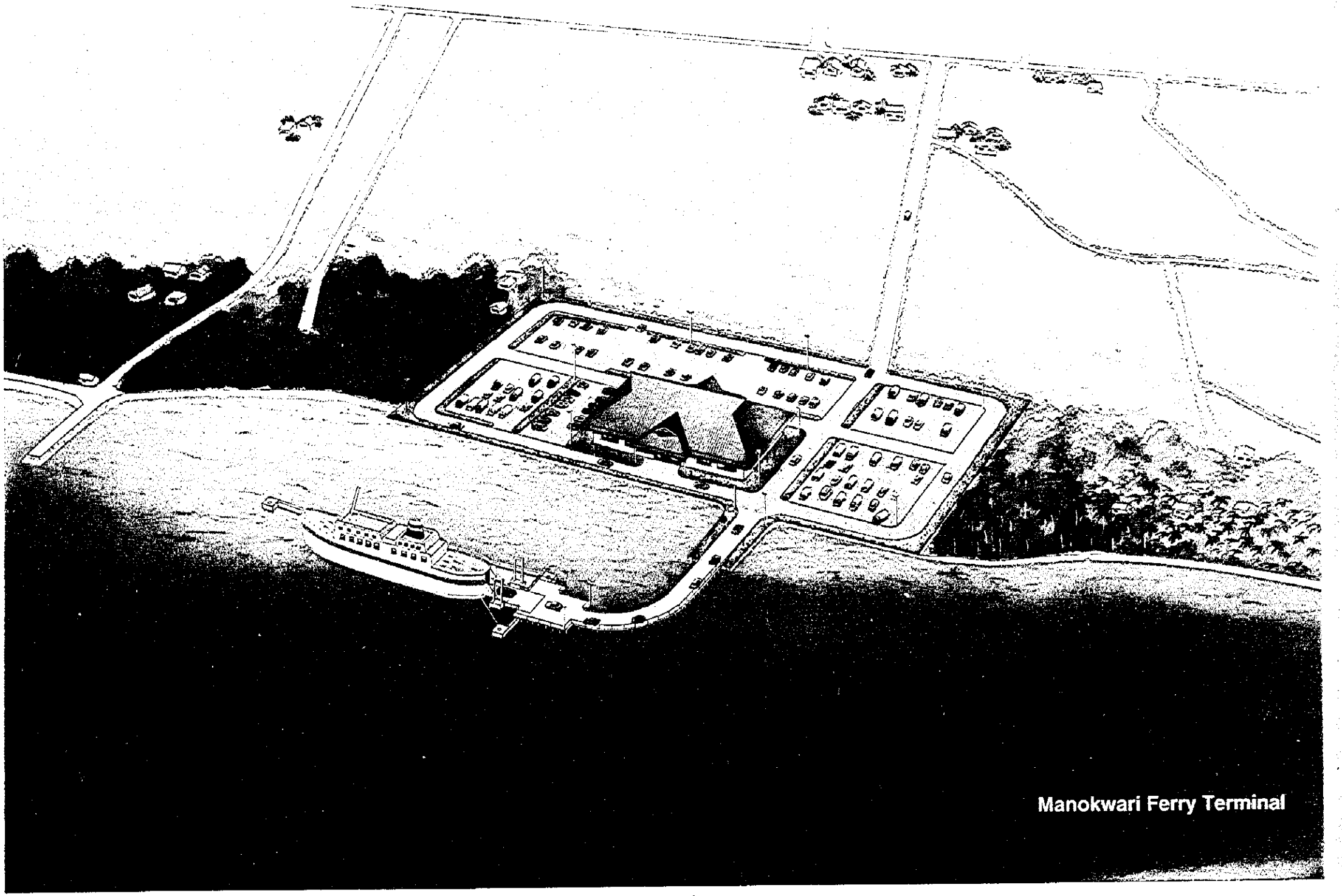

Surabaya Ferry Terminal

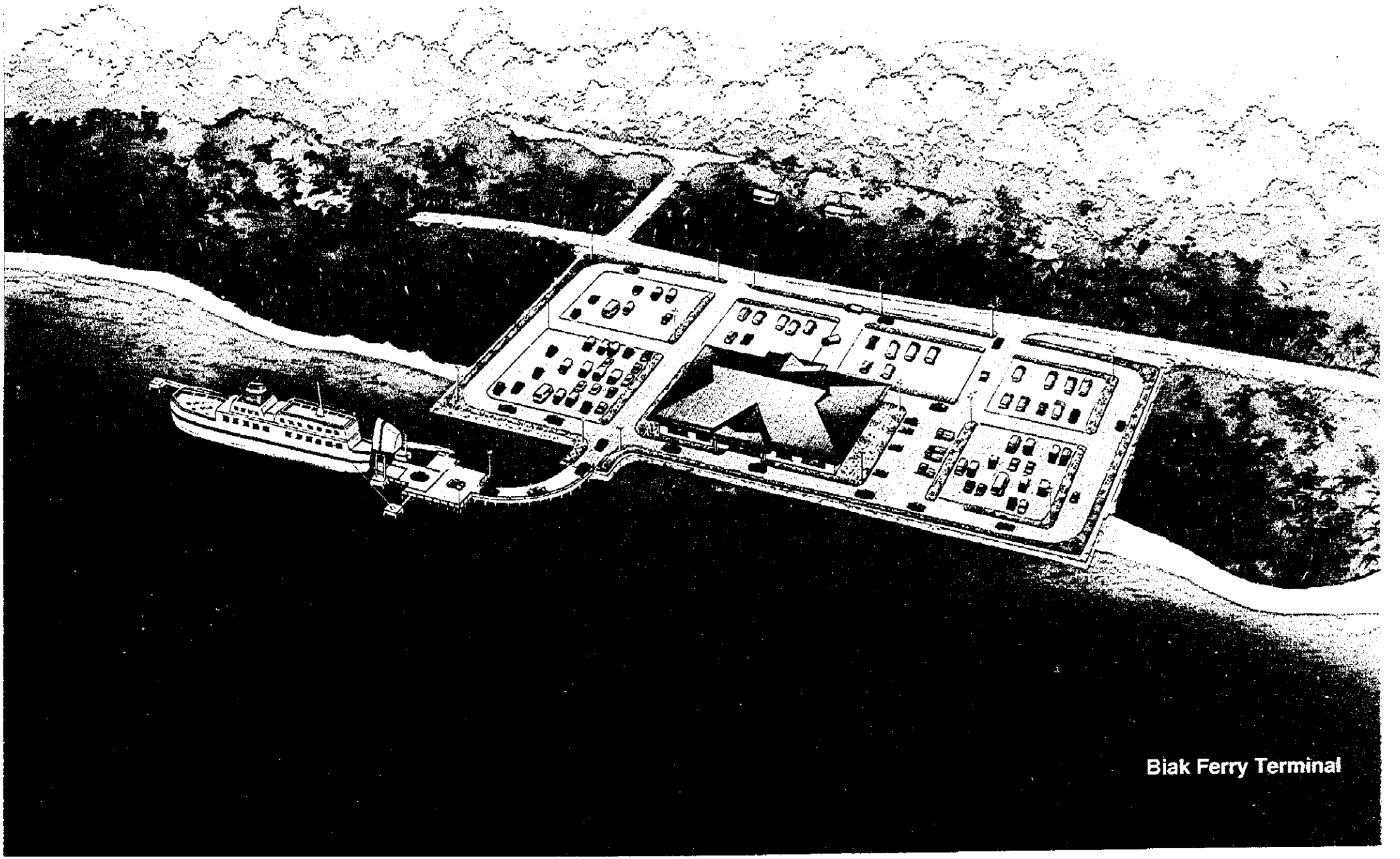

Banjarmasin Ferry Terminal

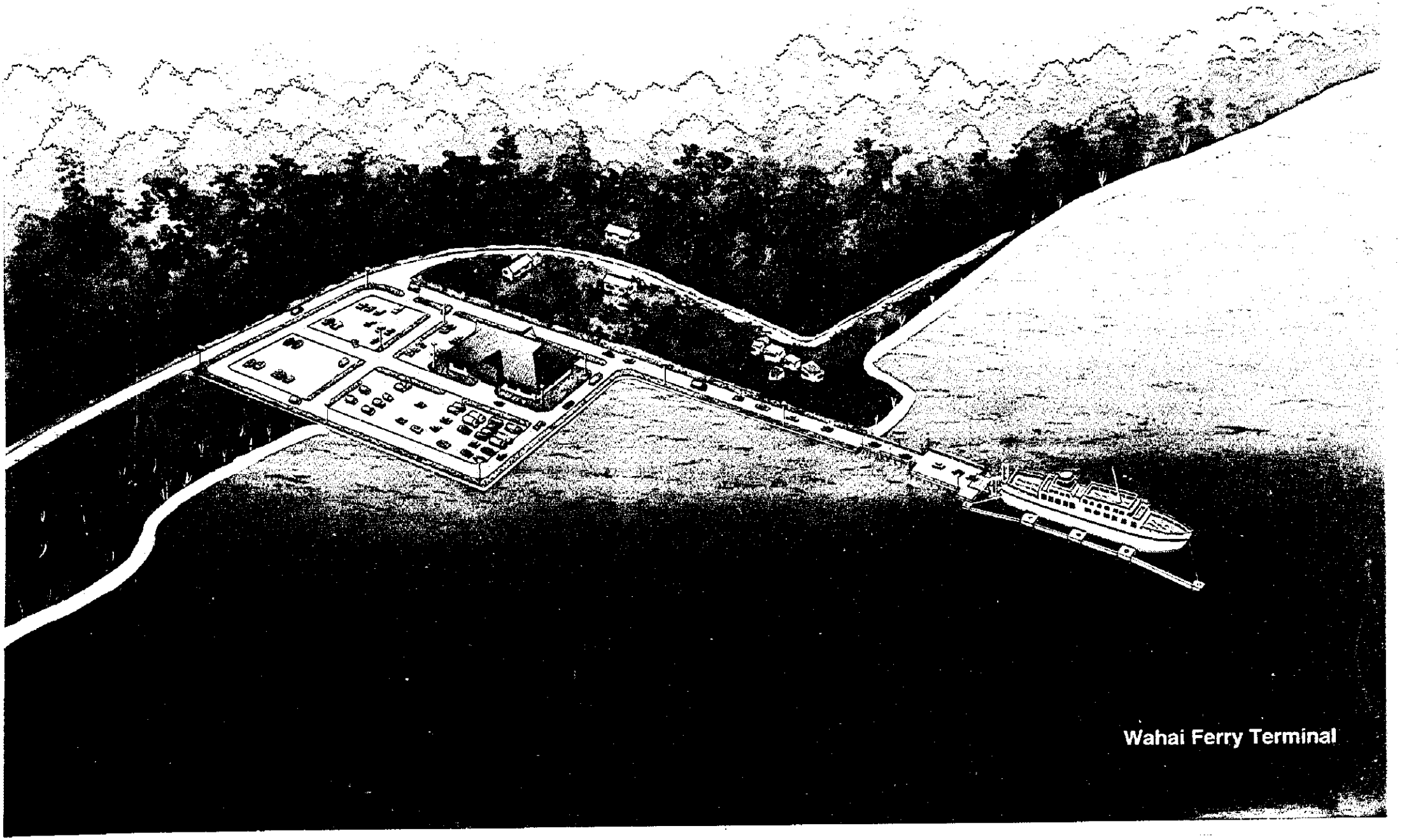


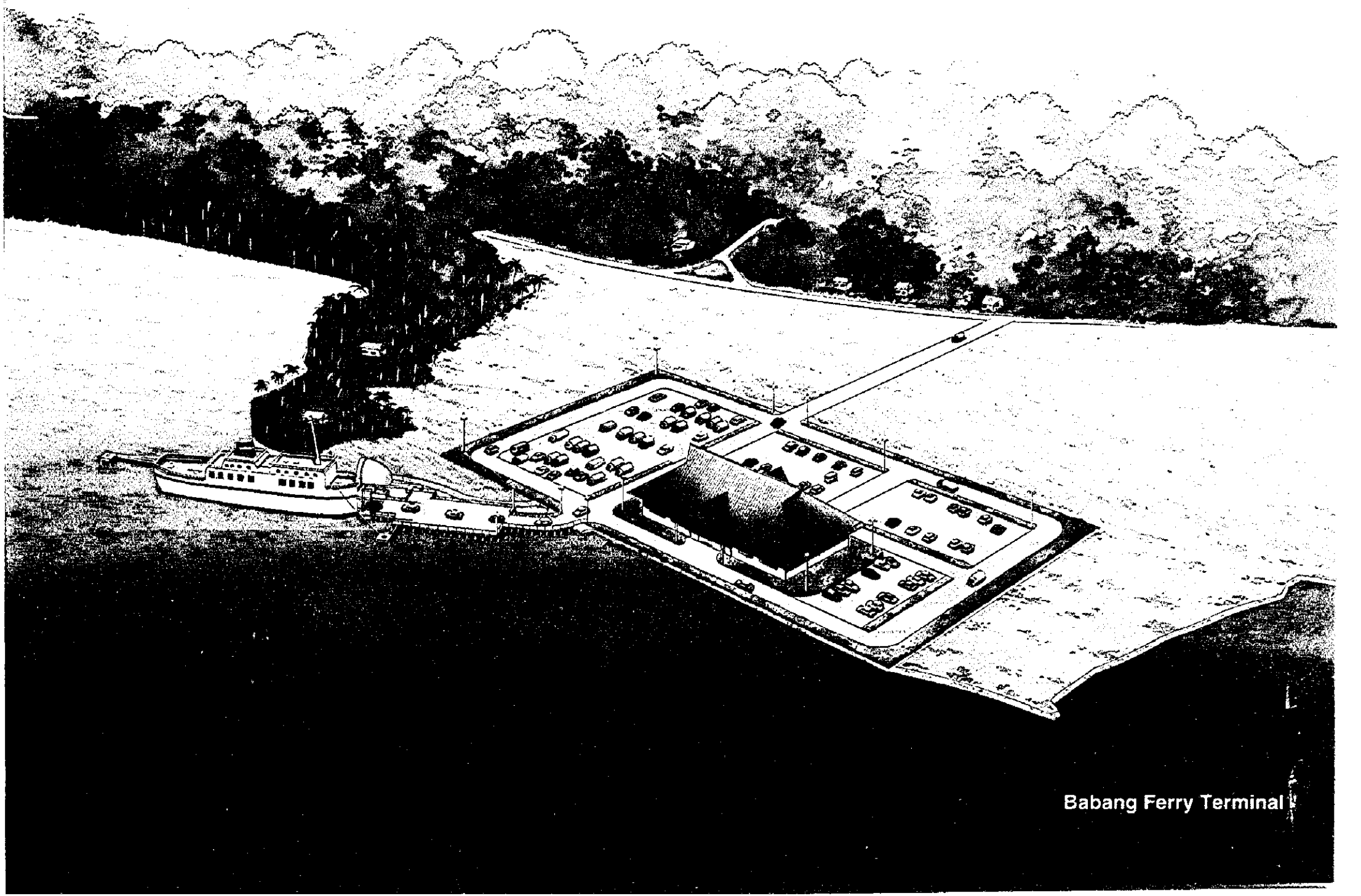
Selayar Ferry Terminal


Labuhan Bajo Ferry Terminal


Manokwari Ferry Terminal


Biak Ferry Terminal


Wahai Ferry Terminal


Babang Ferry Terminal

LIST OF ABBREVIATIONS

A		
	ADB	Asian Development Bank
	AMDAL	Environmental Impact Analysis
	ASDF	ASDP's antecedent project
	ASDP	State-owned Ferry Terminal Company
B		
	BAPEDAL	Environmental Impact Management Agency
	BAPENAS	National Development Planning Agency
	BAPPEDA	Provincial Development and Planning Board
	BKN	Province Treasurer
	BM.	Bench Mark
	BOT	Build Operate Transfer
	BPS	Central Bureau of Statistics
C		
	CBR	California Bearing Ratio test
	CFC	Conversion Factor for Consumption
	CIF	Cost, Insurance of Freight
	CONV	Conventional type boat
D		
	DIK	Activity of Filler List
	DEPKEN	Ministry of Finance
	DGAC	Directorate General of Air Communication
	DGLT	Directorate General of Land Transportation and Island Waterways
	DGSC	Directorate General of Sea Communication
	DL	Datum Level
	DUK	Activity of Proposal List
	DWT	Dead Weight Tonnage
E		
	EIA	Environmental Impact Assessment
	EIRR	Economic Internal Rate of Return
F		
	FOB	Free on Board
G		
	GDP	Gross Domestic Product
	GPS	Global Positioning System

	GRDP	Gross Regional Domestic Products
	GRT	Gross Registered Tonnage
H		
	HHWS	Highest High Water Spring
	HWS	High Water Spring
I		
	IBRD	International Bank for Reconstruction and Development
	IEE	Initial Environmental Examination
	ITCZ	Inter-tropical Convergence Zone
J		
	JICA	Japan International Cooperation Agency
K		
	KANWIL	Provincial Office
	KM	*Decree of the Minister*
	KVA	Kilo Volt Ampere
L		
	LCT	Landing Craft Transport
	LLAJ	Directorate of Highway Transportation
	LLAK	Directorate of City Transportation
	LLASDP	Directorate of River, Lake and Ferry Transportation
	LLJREL	Directorate of Railway Transportation
	LLWS	Lowest Low Water Spring
	LOA	Length over All
	LSL	Local Surface Level
	LWS	Low Water Spring
M		
	MOC	Ministry of Communications
	MOF	Ministry of Finance
	MSL	Mean Sea Level
N		
	NM	Nautical Mile (1852m)
	NPV	Net Present Value
O		
	OCC	Opportunity Cost of Capital
	OD	Origin and Destination
	OECF	Oversea Economic Cooperation Fund, Japan
P		
	PASS	Passenger vessel

	Pax.	Passenger
	P.C.	Precast Concrete
	PELINDO	Indonesian Sea Port Cooperation
	PELNI	Indonesian National Shipping Company
	PIANC	Permanent International Association of Navigation Congress
	PT.	Limited Company
R		
	RC	Reinforced Concrete
	REPELITA VI	Five Year National Development Plan in the Sixth
	Ro-Ro	Roll on Roll off type vessel
	Rp.	Rupiah
S		
	SCF	Standard Conversion Factor
	SMB	Srendrup Munk Bretschneider
T		
	T.A	Truk Air (non motor boat)
	TTM	Monthly Average Exchange Rate
U		
	UPT	Technical Implementation Unit
	USAID	United States Agency for International Development
	USD	US Dollar
V		
	VAT	Value Added Tax

CONTENTS

LIST OF TABLES

PART 1 PRESENT CONDITIONS

PART 2 LONG-TERM DVELOPMENT PLAN

LIST OF FIGURES

PART 1 PRESENT CONDITIONS

PART 2 LONG-TERM DVELOPMENT PLAN

LIST OF TABLES IN APPENDICES

PART 1 PRESENT CONDITIONS

PART 2 LONG-TERM DVELOPMENT PLAN

LIST OF FIGURES IN APPENDICES

PART 1 PRESENT CONDITIONS

PART 2 *LONG-TERM DVELOPMENT PLAN*

INTRODUCTION

Introduction

1. Background

1. Indonesia is an archipelago of over 17,000 islands stretching 5,000km from east to west and 2,000km from north to south. Air transport networks and maritime transport networks using passenger and cargo vessels have been spreading throughout the nation. In addition, the larger islands have land transport networks consisting of railroads, trucks and buses. To complement land transport, it is necessary to further develop ferry service routes.

2. In recent years, although Indonesia has seen steady economic growth, economic disparity between advanced regions and less developed areas of has been observed. Under these circumstances, one of the government's priorities is to develop the transport network as a means to eliminate regional economic disparity.

3. The Development Study on the Nationwide Ferry Service Routes (Stage I) was carried out from 1992 to 1993.

4. However, in accordance with the rapidly increasing motorization in Indonesia, greater demands are being put on ferry service: higher quality services including long distance express, formation of a reliable network between land and sea to link islands, and mitigation of congested land transport.

5. Considering the situation mentioned above, the government of Indonesia placed high priority on the improvement of the ferry service routes in Indonesia to ensure the accessibility of the region, and requested the government of Japan to conduct a study for formulating ferry services routes development plan.

6. In response to the request of the Government of Indonesia, the Government of Japan has decided to conduct the Development Study on the Nationwide Ferry Service Routes (Stage II) in the Republic of Indonesia (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan. Accordingly, the Japan International Cooperation Agency (JICA) dispatched the Study Team to Indonesia from March 1997.

2. Objects of the Study

7. In order to realize safer, steadier, more comfortable, and more frequent ferry services for the purpose of promoting regional/nationwide economic development in Indonesia, the objectives of the Study are :

(1) To set up the nationwide ferry service routes network for the target year of 2019

(2) To formulate a long-term development plan for the ferry routes for the target year of 2019

(3) To conduct a feasibility study on the short-term development plan for the target year of 2004

3. The Study Team Organization

8. The list of the Study team members is as follows:

Takao Hirota	Leader (OCDI)
Masayuki Fujiki	Port Planning/Environmental Consideration (OCDI)
Hisao Ouchi	Demand Forecast (I)/Ferry Network Planning (OCDI)
Takashi Kajiki	Economic Analysis/Demand Forecast (II) (OCDI)
Yoshiharu Iwami	Ferry Operation Plan (OCDI)
Yuji Mitsutake	Management and Operation/Financial Analysis (OCDI)
Koji Esaki	Management and Operation/Financial Analysis (OCDI)
Nobuaki Nagao	Port Facilities Design/Natural Condition Study (I) (PCI)
Masaaki Goshima	Port Facilities Design/Natural Condition Study (I) (PCI)
Atsushi Sato	Port Facilities Design/Natural Condition Study (I) (PCI)
Tooru Watanabe	Natural Condition Study (II) (PCI)
Shigeru Kanaya	Environmental Survey (PCI)
Kazutoshi Kashima	Construction Planning/Cost Estimation (PCI)
Akihiro Sujihara	Coordinator (OCDI)
Tsuyoshi Oki	Coordinator (OCDI)

4. Counterpart Team Organization

9. The list of the Counterpart team members is as follows:

(Planning Bureau, MOC)	
Ir. Soetjahjo Reksoprodjo	Head of Planning Bureau
Ir. Djoko Mulyanto	Chief of Data and Planning Division
Ir. P. Tarigan, MSTr	Chief of Sub Division Sectoral II
Ir. Dwi Budi Sutrisno, MSc	Chief of Sub Division
Drs. Riguntoro	Chief of Sub Division
Drs. Totok Lukito, MSTr	Chief of Sub Division
Ir. Djoko Sasono, MSc	Chief of Sub Division
Ir. Herman MK, MSc	Chief of Foreign and Technical Aids
Untung Margono, SH	Staff of Planning Bureau
Ir. Syafriwan	Staff of Planning Bureau
Ir. Triyono	Staff of Foreign and Technical Aids
(Legal Bureau, MOC)	
Hanung Cahyono, SH	Chief of Law Sub Division
(Finance Bureau, MOC)	
Drs. Nelson Barus	Chief of Finance Division
Drs. Sudarmadi	Chief of Financial Sub Division
Drs. Sukarno	Staff of Finance Division
Ir. Zulmeirinof	Staff of Finance Division
(Research, MOC)	
Ir. Nugroho Indrio, MSc	Chief of Land Transportation Division
Ir. Malisan	Chief of Research and Development Sub Division
Mrs. Poh Aye Tan	Staff of Land Transportation Division
(Logistic Bureau, MOC)	
Drs. Ruslan	Chief of Logistic Division
Ir. Agus Budiono	Chief of Logistic Sub Division
Ir. Juaksa Siahaan	Chief of Material Sub Division

(DGLT)

Ir. Anton Simbolon	Director of Traffic and River and Inland Waterways
Ir. Nugroho Basuki	Head of Traffic of Ferry and Inland Waterways
Ir. Siswanto Wanoyudo	Chief of Sub Directorate Ferry and Inland Waterways
Ir. Abdul Fatah	Chief of Ferry Sub Directorate
Ir. Toto N	Chief of Evaluation Sub Division
Ir. Harris Fabillah	Chief of Planning Division
Ir. As'ad, MSc	Chief of Ferry Section
Ir. Yoyo Sulaeman	Chief of Ferry and Inland Waterway Section
Ir. Heru Sasongko	Chief of Ferry and Inland Waterway Section
Ir. Amal Hamsyah	Chief of Engineering Ferryport Section
Ir. Sigit Iwansyah	Staff of Ferry Section
Ir. Cucu Mulyana	Staff of Planning Division

(DGSC)

Ir. Eko Hadi Rumekso, MSc	Chief of Planning Sub Division
Drs. A. Kadir Kateru	Chief of Sea Transport Section
Drs. Syukri Marzuki	Chief of Sea Transport Section
Ir. Isan Kamil	Chief of Ship Inspection Section
Ir. Sanoesi S.	Chief of Ship Inspection Section
Ir. Wijayanto	Chief of Port and Dredging Section
Capt. Piersyah SA	Chief of Ship Construction Section
Capt. Suranto	Chief of Ship Construction Section
Ir. Anwar, SA	Chief of Ship Construction Section
Drs. Simson Sinaga	Chief of Sea Traffic Section
Drs. Maman. D	Chief of Sea Traffic Section
Ir. Suwarno	Chief of Domestic Sea Transportation Section
Ir. Sugeng Wibowo	Staff of Ship Design Section
Ir. A. Samboh	Staff of Port and Dredging Section

(BAPPENAS)

Ir. Dail Umail A.	Staff of Transportation Bureau

(PELIND III)

Ir. Setiawan	Chief of Planning and Development Bureau

(PELIND III Banjarmasin Branch)

Ir. Suwandi	Chief of Banjarmasin Port
Ir. Jonggara Simanjuntak	Chief of Technical Division

(PERIND IV)

Ir. Muljono S.A.	Chief of Planning and Development Bureau
Ir. Sumardiyo	Staff of Planning Division

PART 1

PRESENT CONDITIONS

Chapter 1 Present Socio-economic Condition in Indonesia

1.1 Socio-economic Characteristics

1. Indonesia is spread over a wide area of South Eastern Asia and contains over 17,000 islands with a population of nearly 200 million. Indonesia, with a total land area of 1,919,317km^2, is comprised of the following provinces (See Figure 1.1.1):

Sumatra region	: 8 provinces (D.I. Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung),
Java region	: 5 provinces (D.K.I. Jakarta, West Java, Central Java, D.I. Yogyakarta, East Java),
Nusa Tenggara region	: 4 provinces (Bali, West Nusa Tenggara, East Nusa Tenggara, East Timor),
Kalimantan region	: 4 provinces (West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan),
Sulawesi region	: 4 provinces (North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi),
Maluku region	: 1 province, and
Irian Jaya region	: 1 province.

(1) Population

2. The population of Indonesia was 147 million in 1980, 179 million in 1990 and 195 million in 1995 (See Table 1.1.1). From 1980 to 1995 the population in Indonesia increased 47.4 million. At present, Indonesia is the forth populous country in the world. The annual population growth rate was 1.98% from 1980 to 1990 and 1.67% from 1990 to 1995.

Table 1.1.1 Trend of Population in Indonesia

		1980	1990	1995
Population	('000)	147,331	179,250	194,755
Growth Rate	(%)		1.98	1.67
Density	(Person/km^2)	77	93	101
Number of Household	('000)	30,303	39,695	45,653
Average Household Size		4.9	4.5	4.3

Source: Statistic Indonesia 1995

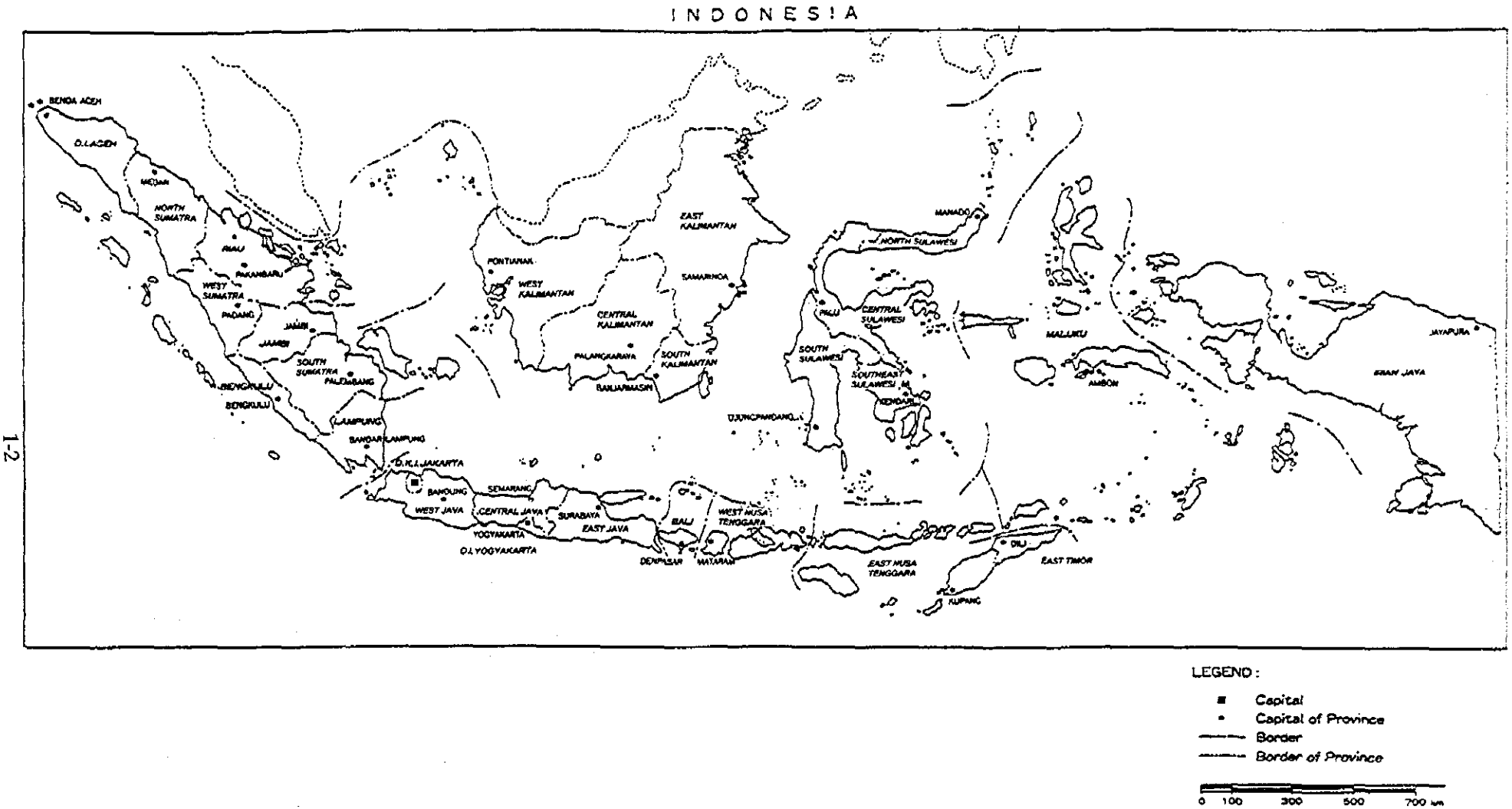


Figure 1.1.1 Administrative Division of Indonesia

3. Analyzing the population distribution over the provinces in 1995 (See Table A1.1.2), West Java had the largest population with 115 million persons, followed by East Java (33.8 million), Central Java (29.6 million) and North Sumatra (11.1 million). The population share of Java Island, which accounts for 7% of the national land area, is nearly 60%. Furthermore from 1990 to 1995 the populations of West Java, East Java and Central Java all increased by more than one million persons. This suggests that population is still concentrating in Java Island.

4. On the other hand, the population share of Kalimantan, Maluku and Irian Jaya is only 7.5%, though these areas account for 54% of the total land. These regions are characterized by their scarcely populated huge land area.

5. As shown in Table 1.1.2, while the number of household has gradually increased, the average size has tended to become smaller. The population density in Indonesia was 101 person/km^2 in 1995, with Jakarta having the highest population density at 15,445 person/km^2 and Irian Jaya the lowest at 5 person/km^2 (See Table A1.1.3).

6. Number of transmigrant families in Indonesia is shown in Table 1.1.2. In 1993, transmigrant families rapidly increased and reached nearly 200,000, which was 3.1 times greater than the year before. Many people migrated in Indonesia, 603,800 families between 1990 and 1995. Major destinations for migration are Sumatra (Riau, Jambi, and South Sumatra), Kalimantan (West, Central and East Kalimantan), Central Sulawasi and Irian Jaya (See Table A1.1.4).

Table 1.1.2 Number of Transmigrant Families by Region of Destination

Region	Number of Transmigrant Families ('000)						(b) Household Increased	(a)/(b)	Population Growth Rate
	1990 /1991	1991 /1992	1992 /1993	1993 /1994	1994 /1995	(a) Total ('90-'95)	('90-'95) ('000)	(%)	('90-'95) (%)
Sumatra	43.8	41.2	29.9	84.3	75.7	275.0	1,390	19.8	2.28
Nusa Tenggara *)	0.8	1.2	1.5	6.6	9.5	19.5	216	9.0	1.78
Kalimantan	13.5	16.9	17.4	62.2	56.2	166.1	409	40.6	2.85
Sulawesi	5.2	9.6	5.8	20.9	23.6	65.2	485	13.4	1.88
Maluku	0.5	1.7	2.8	6.0	9.8	20.8	65	31.9	2.41
Irian Jaya	3.9	4.6	6.1	19.8	22.8	57.2	108	53.0	3.58
Total	67.7	75.3	63.5	199.9	197.5	603.8	2,673	22.6	1.67

Source: Statistic Indonesia 1995
Note: *) Excluding Bali

7. Population growth rates between 1990 and 1995 by province are shown in Table A1.1.2. The high population growth rates are observed in East Kalimantan (4.30%), Bengkulu (3.63%), Irian Jaya (3.58%) and Jambi (3.53%). The above rates are more than twice the nationwide annual growth rate of 1.67%. As mentioned above these provinces have a high level of in-migration. Most of this is from the government sponsored agricultural transmigration program.

(2) Gross Regional Domestic Products (GRDP) (See Tables A1.1.5 and A1.1.6)

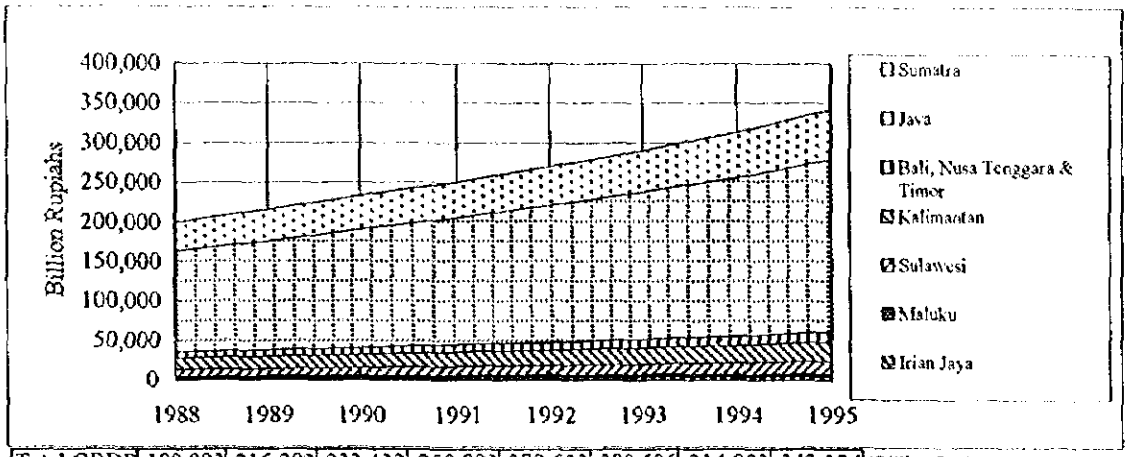
8. As shown in Table 1.1.3 and Figure 1.1.2, the national total of Gross Regional Domestic Product (GRDP) was Rp.342,124 billion in 1995 at 1993 constant price, which represented an increase of 1.71 times over the 1988 figure. The annual growth rate during the period from 1988 to 1995 ranged between 7.4% and 9.0%, and was upward recently. The average growth rate during the same period was 8.0%. This suggests that Indonesia's economy has been doing fairly well.

9. In terms of each province's GRDP (See Table A1.1.5), GRDPs of West Java, Central Java, East Java and D.K.I. Jakarta were over Rp.30,000 billion in 1995. The total GRDP of Java Island accounts for 60% of the national total. Also, GRDPs of D.I. Aceh, North Sumatra, Riau, South Sumatra and East Kalimantan were over Rp.10,000 billion. It should be noted that GRDP of these provinces are mainly comprised of oil and its products, with the exception of North Sumatra. On the other hand the smallest province in terms of GRDP' value is East Timor which generated Rp.620 billion.

Table 1.1.3 GRDP and Per Capita GRDP in 1995 at 1993 Constant Prices

Region	GRDP			Per Capita GRDP		
	(Bil. Rp.)	(Ex. Oil) (Bil. Rp.)	Growth Rate (Ex. Oil, '88-'95) (%)	('000 Rp.)	(Ex. Oil) ('000 Rp.)	Growth Rate (Ex. Oil, '88-'95) (%)
Sumatra	82,281 (21.9%)	62,815 (18.4%)	8.00	2,015	1,533	5.55
Java	222,110 (59.2%)	217,646 (63.6%)	7.86	1,936	1,893	6.49
Bali, Nusa Tenggara and Timor	12,660 (3.4%)	12,656 (3.7%)	8.18	1,155	1,152	6.60
Kalimantan	33,559 (8.9%)	24,876 (7.3%)	7.77	3,205	2,364	4.62
Sulawesi	15,488 (4.1%)	15,519 (4.5%)	8.02	1,128	1,127	5.97
Maluku	2,757 (0.7%)	2,742 (0.8%)	6.58	1,321	1,309	4.02
Irian Jaya	6,123 (1.6%)	5,871 (1.7%)	13.84	3,151	3,001	9.68
Total	374,978 (100.0%)	342,124 (100.0%)	7.97	1,925	1,752	6.19

Source: Statistic Indonesia 1995



Total GRDP	199,992	216,282	233,432	250,903	270,623	290,606	314,003	342,124 (Billion Rp.)
Annual Growth Rate		8.1%	7.9%	7.5%	7.9%	7.4%	8.1%	9.0%
Average Growth Rate (1988-1995)								8.0%

Source: Statistic Indonesia 1990 -1995

Note: Excluding oil and its products

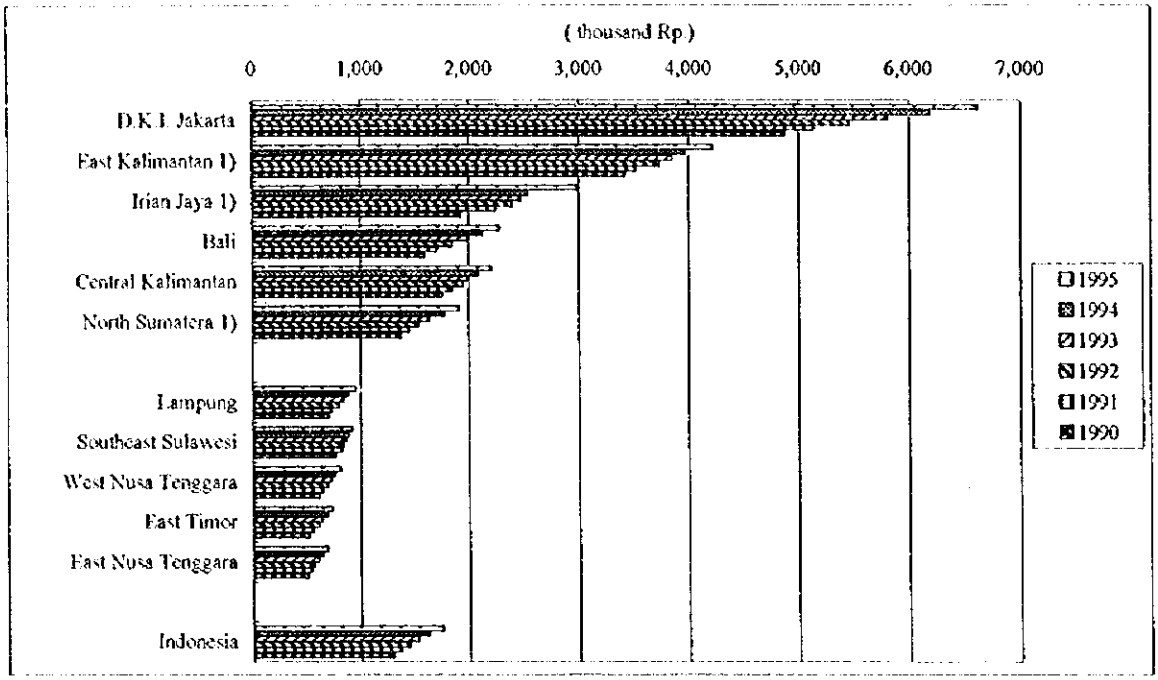
Figure 1.1.2 Trend of GRDP at 1993 Constant Prices

10. In 1995, the per capita GRDP in Indonesia was Rp.1,752,000 at 1993 constant prices. As shown in Figure 1.1.3 and Table A1.1.6, while the per capita GRDP of D.K.I. Jakarta had the highest level (Rp.6,620,000), per capita GRDP of several provinces (Lampung, West Nusa Tenggara and East Nusa Tenggara, East Timor and Southeast Sulawesi) was less than one million rupiahs. There is a gap between the urban and rural standards of production. Hereafter, this gap is likely to enlarge still if the GRDP of provinces is sustained at the present rate of increase.

11. During the 1988-1995 period per capita GRDP in Indonesia increased at an annual average rate of 6.2% excluding oil and its products. Provinces which perform relatively poor with per capita GRDP below average as well as low annual growth rates are four provinces of Sumatra (West Sumatra, Jambi, South Sumatra and Bengkulu), West Java, West Nusa Tenggara, West Kalimantan, two provinces of Sulawesi (Central Sulawesi and Southeast Sulawesi) and Maluku (See Tables A1.1.5 and A1.1.6).

(3) GDP by industrial origin

12. The share of GDP by sectors at current market prices is shown in Table 1.1.4 and Figure 1.1.4. While the share of Agriculture and Mining sectors gradually decreased during the period (1988-1995), Manufacturing Industries sector increased during the same period. In 1995, its share represented to a quarter of the whole GDP.



Source: Statistic Indonesia 1990 - 1995
Note : 1) Excluding oil and its product

Figure 1.1.3 Per Capita GRDP of Nation and Selected Provinces at 1993 Constant Prices

Table 1.1.4 Share of GDP by Industrial Origin at Current Market Prices

Industrial Origin	1988	1989	1990	1991	1992	1993	1994	1995
Agriculture, Livestock, etc.	24.1%	23.4%	21.5%	19.7%	19.5%	18.5%	17.3%	17.2%
Agriculture	18.8%	18.4%	16.7%	14.8%	14.7%	13.5%	11.9%	12.1%
Livestock and Product	2.5%	2.3%	2.2%	2.3%	2.3%	2.3%	1.9%	1.8%
Forestry	1.0%	1.0%	0.9%	0.9%	0.8%	0.8%	1.8%	1.6%
Fisheries	1.8%	1.8%	1.7%	1.7%	1.7%	1.8%	1.7%	1.7%
Mining and Quarrying	12.1%	13.1%	13.4%	13.8%	11.5%	10.2%	8.8%	8.4%
Crude Petroleum & Natural Gas	10.9%	11.5%	11.1%	11.5%	9.0%	7.7%	6.0%	5.4%
Other Mining and Quarrying	1.2%	1.5%	2.2%	2.3%	2.5%	2.5%	2.7%	3.0%
Manufacturing Industries	18.5%	18.1%	19.9%	21.0%	21.8%	22.3%	23.3%	24.2%
Manufacturing Without Petroleum & Gas	15.0%	14.9%	16.2%	17.2%	18.4%	19.2%	20.6%	21.7%
Petroleum Refinery and LNG	3.5%	3.3%	3.7%	3.7%	3.3%	3.1%	2.7%	2.5%
Electricity, Gas and Water Supply	0.6%	0.6%	0.6%	0.8%	0.8%	0.9%	1.2%	1.2%
Construction	5.0%	5.3%	5.5%	5.7%	5.9%	6.0%	7.3%	7.6%
Trade, Hotels and Restaurants	17.2%	17.3%	16.9%	16.2%	16.4%	16.5%	16.7%	16.8%
Transportation and / communications	5.7%	5.6%	5.6%	6.1%	6.6%	6.9%	7.2%	6.8%
Banking and Other Financial Service	3.7%	4.0%	4.2%	4.5%	4.8%	5.1%	4.7%	4.7%
Other Services	13.0%	12.7%	12.3%	12.3%	12.7%	13.7%	13.5%	13.1%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Statistic Indonesia 1990 - 1995

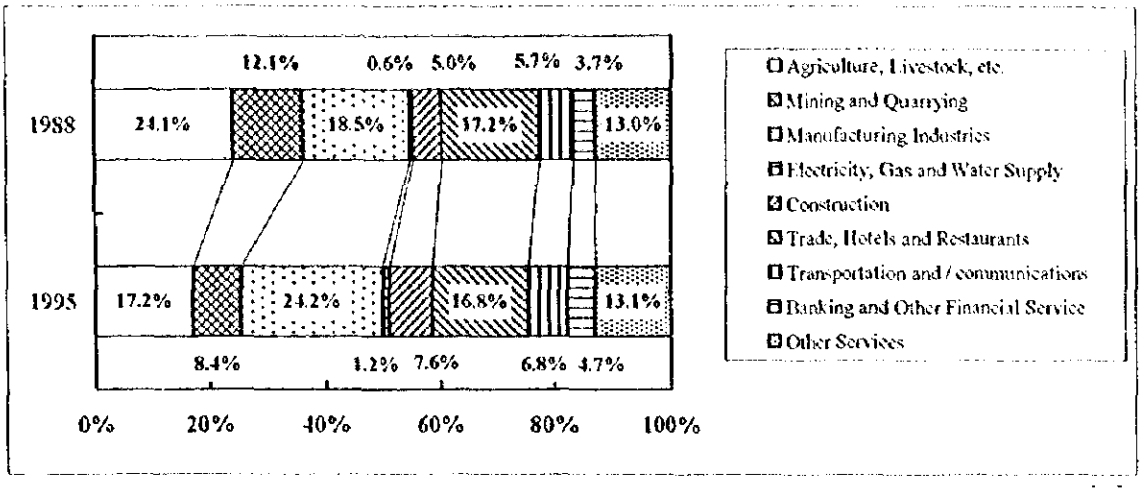


Figure 1.1.4 Share of GDP by Industrial Origin in 1988 and 1995

(4) Other economic indicator

13. Table 1.1.5 shows the summary of main economic indicators.

Table 1.1.5 Socioeconomic Indicators

			1988	1989	1990	1991	1992	1993	1994	1995
Exchange Rate [1]		(Rp./US$)	1685.7	1770.1	1842.8	1950.3	2029.9	2089.3	2164.2	2248.6
Population		(Million)	175.6	179.1	179.3	182.2	185.3	188.4	191.5	194.8
Wholesale Price Index		(1983=100)	156	166	176	194	206	218	231	256
Inflation Rate [2]			6.55	5.48	9.11	9.78	10.03	7.04	8.57	8.86
GRDP at 1993 Constant Prices		(Billion Rp.)	199,992	216,282	233,432	250,903	270,623	290,606	314,003	342,124
(Excluding Oil & Gas)		(Million US$)	9,572	10,352	11,173	12,009	12,953	13,909	15,029	16,375
	Growth Rate	(%)		8.15	7.93	7.48	7.86	7.38	8.05	8.96
	Per Capita	('000 Rp.)	1,151	1,223	1,298	1,372	1,455	1,536	1,634	1,752
		(US$)	551	585	621	656	696	735	782	839

Source: Statistic Indonesia 1990 - 1995
Monthly Statistical Bulletin FEB. 1997 BPS
ADB "Key Indicators of Developing Asian and Pacific Countries"

Note: [1] Average of period
[2] Fiscal Year

(5) Investment

14. Amount of investment contributes to the nation a economic growth and often reflects the regional growth potential. As shown in Table 1.1.6, Indonesian economy from domestic and foreign sources totaled just over US$274 billion from 1988 to 1995. Of this total, about US$164 billion (Rp.330.4 trillion) in cumulative projects was from domestic sources while US$110 billion came from overseas investors. Trends in approved investment moved up and down during the period from 1988 to 1995. On an annual basis, its value recorded US$71 billion in 1995.

15. On a sectorial basis, Indonesia's burgeoning manufacturing sector accounted for 64% of the value of approved investment in 1995, with the chemical, paper, textiles and non-mineral industries attracting most interest (See Table 1.1.7). The growing tertiary industries with hotels, restaurants, transportation and communications and financial service drew nearly 24% of total investment, while agriculture, forestry and fisheries accounted for just under 11%.

Table 1.1.6 Approved Investment (1988-1995)

	Domestic (1988-1995)			Foreign (1988-1995)		Total	
	No. of Projects	Capital (Bil. Rp.)	Capital *) (Mil. US$)	No. of Projects	Capital (Mil. US$)	No. of Projects	Capital (Mil. US$)
1988	822	15,681	9,302	141	4,501	963	13,803
1989	777	21,907	12,376	295	5,920	1,072	18,296
1990	1,329	59,878	32,493	432	8,750	1,761	41,243
1991	804	41,085	21,066	382	8,779	1,186	29,844
1992	436	29,342	14,455	305	10,313	741	24,768
1993	548	39,448	18,881	329	8,144	877	27,025
1994	823	53,289	24,623	449	23,724	1,272	48,347
1995	775	69,853	31,065	799	39,915	1,574	70,980
Total	6,314	330,484	164,262	3,132	110,046	9,446	274,308

Source: Statistic Indonesia 1990 - 1995

Note: *) Domestic approved investments converted into US dollar based on exchange rate (average of period)

Table 1.1.7 Approved Investment by Industrial Origin in 1995

Industrial Origin	Domestic			Foreign		Total		
	No. of Projects	Capital (Bil. Rp.)	Capital *) (Mil. US$)	No. of Projects	Capital (Mil. US$)	No. of Projects	Capital (Mil. US$)	Share (%)
Agriculture, Livestock, etc.	106	10,097	4,375	34	1,384	140	11,481	10.5
Agriculture	86	7,128	3,088	26	1,153	112	8,281	7.5
Forestry	7	1,476	640	0	0	7	1,476	1.3
Fisheries	13	1,493	647	8	231	21	1,724	1.6
Mining and Quarrying	14	205	89	0	0	14	205	0.2
Manufacturing Industries	360	43,342	18,779	454	26,892	814	70,234	64.0
Electricity, Gas and Water Supply	2	620	269	6	3,549	8	4,169	3.8
Construction	20	848	367	43	206	63	1,054	1.0
Trade, Hotels and Restaurants	65	3,945	1,709	89	1,029	154	4,974	4.5
Transportation & communications	156	3,966	1,718	47	5,540	203	9,505	8.7
Banking & Other Financial Service	18	5,337	2,312	25	1,192	43	6,529	5.9
Other Services	34	1,494	647	101	123	135	1,616	1.5
Total	775	69,853	30,266	799	39,915	1,574	109,768	100.0

Source: Statistic Indonesia 1990 - 1995

Note: *) Domestic approved investments converted into US dollar based on exchange rate (average of period)

16. On a regional basis, Table 1.1.8 shows both domestic and foreign investment being strongest in Java (65% of cumulative investments), led by West Java which is surrounded by the greater Jakarta area and includes the city of Bandung, followed by East Java, the capital of Java and Central Java. Outside Java, approved investment has been heaviest in Riau, followed by East Kalimantan, South Sumatra and North Sumatra. Conversely, approved investment has been weakest in Nusa Tenggara, Sulawesi, Maluku and Irian Jaya in Eastern Indonesia.

Table 1.1.8 Approved Investment by Provinces (1988-1995)

Province	Domestic (1988-1995)			Foreign (1988-1995)		Total		
	No. of Projects	Capital (Bil. Rp.)	Capital *) (Mil. US$)	No. of Projects	Capital (Mil. US$)	No. of Projects	Capital (Mil. US$)	Share (%)
D.I. Aceh	72	3,093	1,565	15	4,412	87	5,977	2.2
North Sumatra	224	8,790	4,367	56	2,211	280	6,578	2.4
West Sumatra	69	2,238	1,100	15	317	84	1,417	0.5
Riau	211	21,799	10,987	250	8,826	461	19,813	7.2
Jambi	42	4,510	2,261	2	64	44	2,324	0.8
South Sumatra	153	8,900	4,397	20	2,367	173	6,764	2.5
Bengkulu	39	1,794	835	5	62	44	897	0.3
Lampung	113	5,367	2,690	17	747	130	3,437	1.3
Sumatra	923	56,491	28,202	380	19,006	1,303	47,207	17.2
D.K.I. Jakarta	876	40,025	19,315	826	15,291	1,702	34,606	12.6
West Java	2,258	111,843	56,507	1,253	32,529	3,511	89,036	32.5
Central Java	365	26,450	13,045	82	4,643	447	17,688	6.4
D.I. Yogyakarta	98	1,792	915	15	228	113	1,144	0.4
East Java	671	30,595	15,013	266	21,020	937	36,033	13.1
Java	4,268	210,706	104,795	2,442	73,712	6,710	178,506	65.1
Nusa Tenggara	343	10,762	5,416	160	2,695	503	8,111	3.0
West Kalimantan	114	8,227	4,211	12	255	126	4,466	1.6
Central Kalimantan	47	3,193	1,479	2	182	49	1,660	0.6
South Kalimantan	79	3,959	1,968	18	2,560	97	4,528	1.7
East Kalimantan	95	15,902	7,753	20	2,617	115	10,371	3.8
Kalimantan	335	31,281	15,410	52	5,614	387	21,024	7.7
North Sulawesi	66	2,928	1,408	29	380	95	1,788	0.7
Central Sulawesi	47	2,444	1,188	12	146	59	1,333	0.5
South Sulawesi	146	2,393	1,211	13	146	159	1,357	0.5
Southeast Sulawesi	19	1,645	783	17	3,595	36	4,378	1.6
Sulawesi	278	9,410	4,589	71	4,267	349	8,855	3.2
Maluku, Irian Jaya and East Timor	156	11,431	5,621	24	4,711	180	10,332	3.8
Various Area	11	402	229	3	41	14	271	0.1
Total	6,314	330,484	164,262	3,132	110,046	9,446	274,308	100.0

Source: Statistic Indonesia 1990 - 1995

Note: *) Domestic approved investments converted into US dollar based on exchange rate (average of period)

1.2 *Transportation*

17. The logistics of transportation in a large, sprawling archipelago demand the comprehensive development of road, railway, sea and air.

(1) Road (See Tables A1.2.1 and A1.2.2)

18. Table 1.2.1 summarizes the present condition of road infrastructure. In 1995, the national total road length was 372,414km, which represented an increase of 1.46 times over the 1988 figure (254,934km). The average growth rate between 1988 and 1995 is 5.6%. However the road density in each Island varies widely. Each sq. km of land area on Java is served by about 800m of road, whereas the same land area is served by only 29m of road in Irian Jaya, and 72m in Kalimantan.

19. Indonesia's internal transportation network is best developed in Java, the northern and southern parts of Sumatra and Bali, where most cities are connected by highway or secondary roads. Most of the roads in Indonesia excluding Java and Sumatra, however, are still in poor condition. Only 30% to 40% of them have been asphalted. Also, nearly 40% of them are damaged. Furthermore, roads are limited to the areas around ports and other important towns.

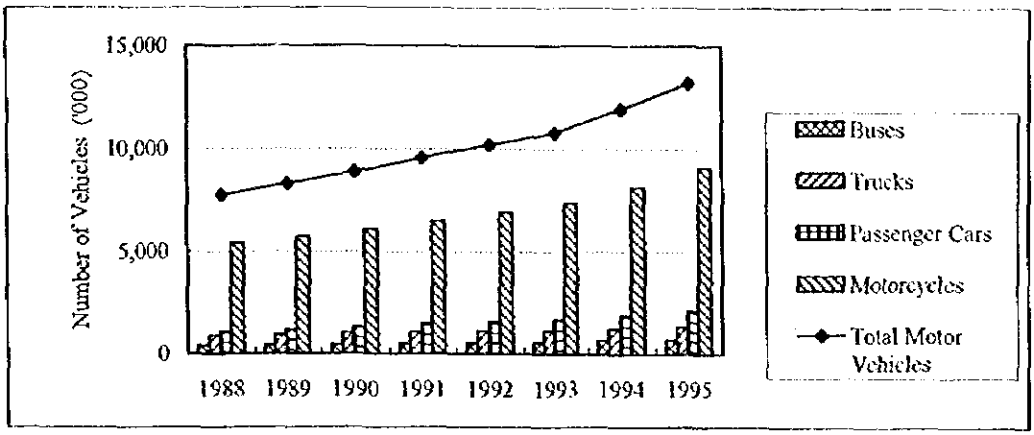
Table 1.2.1 Road Conditions in 1995

Region	Road Length (km)	% Length of National	Growth Rate (%) ('88-'95)	Density (m/km^2)	% of Asphalted	% of Damaged Road
Sumatra	114,649	30.8	5.2	242	45.5	35.5
Java	106,452	28.6	6.0	805	63.6	26.4
Nusa Tenggara	38,182	10.3	6.0	431	38.5	43.4
Kalimantan	38,956	10.5	7.0	72	33.9	43.1
Sulawesi	52,958	14.2	2.7	280	38.4	43.3
Maluku	8,968	2.4	7.8	120	43.3	44.7
Irian Jaya	12,249	3.3	6.4	29	27.9	32.8
Indonesia	372,414	100.0	5.6	194	47.1	35.8

Source: Statistic Indonesia 1995

20. As shown in Figure 1.2.1 and Table 1.2.2, number of registered motor vehicles in Indonesia has gradually increased. Also its annual growth rate has tended to become greater. In 1995, total number was 13.2 million, an increase of 1.7 times over the 1988 figure. By type, motor cycle, which is one of the most important land transportation means, has the largest share about 70%.

21. Among the seven regions (see Table 1.2.2), Java has the largest share of registered motor vehicles at 65%, followed by Sumatra (18%). However, Maluku and Irian Jaya account for less than 1% of total respectively. This result may be a clear reflection of the population, regional industrial activities and regional condition of road infrastructure.



Source: Statistic Indonesia 1990 - 1995

Figure 1.2.1 Trend of Registered Motor Vehicles

Table 1.2.2 Registered Motor Vehicles by Region

Region	Number of Motor Vehicles ('000)				Growth Rate (%) ('88-'95)	Per household (1995)
	1988	Share(%)	1995	Share(%)		
Sumatra	1,721	(22.1)	2,382	(18.0)	4.8	0.27
Java	4,832	(62.2)	8,586	(65.0)	8.6	0.31
Nusa Tenggara	339	(4.4)	688	(5.2)	10.7	0.28
Kalimantan	384	(4.9)	752	(5.7)	10.1	0.32
Sulawesi	428	(5.5)	683	(5.2)	6.9	0.22
Maluku	23	(0.3)	50	(0.4)	11.5	0.12
Irian Jaya	44	(0.6)	68	(0.5)	6.3	0.15
Indonesia	7,771	(100.0)	13,209	(100.0)	7.9	0.29

Source: Statistic Indonesia 1995

(2) Railway

22. Railways in Indonesia total 6,362km, of which 4,684 (73.6%) are on Java, with the remainder chiefly on Sumatra. The system is used for both passenger and freight transport. In 1995, number of embarking passenger was 140.5 million, and volume of railway freight transportation was about 16.9 million tons.

(3) Sea transportation

23. Indonesia's facilities for sea transportation include 349 ports, of which 127 are open to ocean-going ships. The port of Jakarta, at Tanjung Priok, is by far the largest port. In 1995, this port handled 27.65 million ton, which is about 9% of the national total. Table 1.2.3 shows the cargo volume by major ports. In addition, more than 125 industrial ports have been opened for loading commodities including cement, coal and oil.

24. River transportation plays a big role in Kalimantan because most of the local trade centers are located on the river banks. Ferries and coastal shipping dominate passenger traffic in Sulawesi and Maluku. Air transportation also plays a major role for inter-provincial passenger traffic.

Table 1.2.3 Cargo Volume by Major Ports (1988-1995)

(Unit: '000 ton)

Region	1988	1989	1990	1991	1992	1993	1994	1995
[Import]								
Java & Madura	13,794.9	17,146.4	19,749.8	21,794.2	23,357.7	24,587.4	30,849.6	38,402.0
Sumatra	6,630.2	7,572.3	8,647.7	9,550.3	9,951.6	10,274.2	10,710.6	10,637.7
Kalimantan	458.6	768.8	1,239.1	1,919.6	1,608.1	1,384.1	2,531.0	3,354.5
Sulawesi	581.7	518.1	507.2	692.3	710.0	677.6	838.6	1,025.4
Bali & Nusa Tenggara	36.1	64.6	81.8	70.7	49.2	786.2	895.7	1393.6
Malulu & Irian Jaya	16.3	12.1	54.0	187.9	339.7	251.7	303.0	547.0
Import Total	21,517.8	26,082.3	30,279.6	34,215.0	36,016.3	37,961.2	46,128.5	55,360.2
[Export]								
Java & Madura	14,386.5	16,288.2	14,070.7	14,427.5	18,510.3	17,208.8	17,445.9	16,874.3
Sumatra	79,637.6	62,604.8	67,120.4	69,697.4	91,773.8	116,322.5	152,295.9	169,916.6
Kalimantan	17,303.5	19,431.4	22,085.5	26,747.6	36,348.2	39,363.3	50,122.6	53,172.9
Sulawesi	816.0	777.7	801.1	819.0	859.3	1,023.0	1,129.6	1,053.2
Bali & Nusa Tenggara	12.7	32.0	28.5	23.7	22.5	34.4	33.7	44.7
Malulu & Irian Jaya	3,224.8	3,128.9	3,460.1	3,746.1	4,021.7	3,518.8	4,316.1	5,047.5
Export Total	115,381.1	102,263.0	107,566.3	115,461.3	151,535.8	177,470.8	225,343.8	246,109.2
Total	136,898.9	128,345.3	137,845.9	149,676.3	187,552.1	215,432.0	271,472.3	301,469.4

Source: Statistical Year Book of Indonesia 1995

Chapter 2 Overview of Natural Conditions and Environmental Aspects

2.1 Natural Conditions

2.1.1 Geography

(1) Territorial area

1. Indonesia is the biggest archipelagic country in the world, consisting of more than 17,000 islands that are spread across an area of about 5,100km from east to west and about 1,900km from north to south. The total land area is around 1.92 million km^2, of which main islands of Irian Jaya (22%), Sulawesi (9%), Kalimantan (28%), Java (7%) and Sumatra (24%) occupy 90% of the total land area; there are about 3,700 inhabited islands. The total sea area (Exclusive Economic Zone) of Indonesia is about 7.9 million km^2.

(2) *Tectonic activity*

2. Indonesia lies in the most active seismic zone in the world. Geologically, all the islands of the archipelago were created along several fault lines where the various tectonic plates of the earth collided and folded at the edges producing a great seismic instability of the region. Most of the islands, with the exception of a large part of Kalimantan, have been subjected to destructive earthquakes. In the last 90 years Indonesia has been subjected to 19 large intensity earthquakes of $M \geqq 7$.

2.1.2 Meteorology

(1) Climate

3. Indonesia belongs to the tropical monsoon climate region. Temperature and humidity are high with small seasonal variation. The climate is characteristically divided into the NW monsoon season from November through March, and the SE monsoon season from June to September. This is due to the seasonal shift of the Inter-tropical Convergence Zone (ITCZ), which represents the boundary between the wind circulation of the north and south hemispheres, *in north-south direction. In January, the ITCZ lies just south of Java (7°S), then* moves slowly north and by August the ITCZ has moved north across the whole of the South China Sea (5°N). Then the ITCZ starts to move south again in September.

(2) Air temperature

4. Average air temperature slightly fluctuates seasonally with the shift of the ITCZ. The mean air temperature over open sea lies between 26℃ and 29℃ throughout the year, and with the lowest temperatures experienced in the extreme north of the area in January. Mean air temperatures in the coastal waters are slightly more variable than over the open sea. The diurnal range is greater in the dry season with more comfortable temperatures at night. The temperature and humidity at any place along the coast is regulated by the strength of the land breeze at night and the sea breeze during the day.

(3) Tropical cyclone

5. Indonesian territorial regions are liable to be affected, although infrequently, by tropical cyclones, which do not, however, affect the majority of the area. These cyclones are liable to occur in the Indian Ocean south of Java and Nusa Tenggara between November and April, and the Arafura Sea, south of Irian Jaya during the period of March to May. Also, low latitude tropical cyclones in north of equator can form in any month, with a slight preference for November and December. Winds of 100 knots have been reported in the sea of this area, south of 7°N to near the equator, but they are rare.

(4) Cloud

6. The main features are the diurnal variations of cumulus cloud over the sea and land, and the effect of local topography. Cloud increases over the sea at night with maximum development towards dawn, then a dispersing tendency by day. The clouds over the land build up towards noon and reach maximum in the late afternoon. In the northern part of the area, there is little variation in the general cloudiness of the two monsoons. In the southern part of the area, however, the SE monsoon is less cloudy than the NW monsoon.

(5) Precipitation

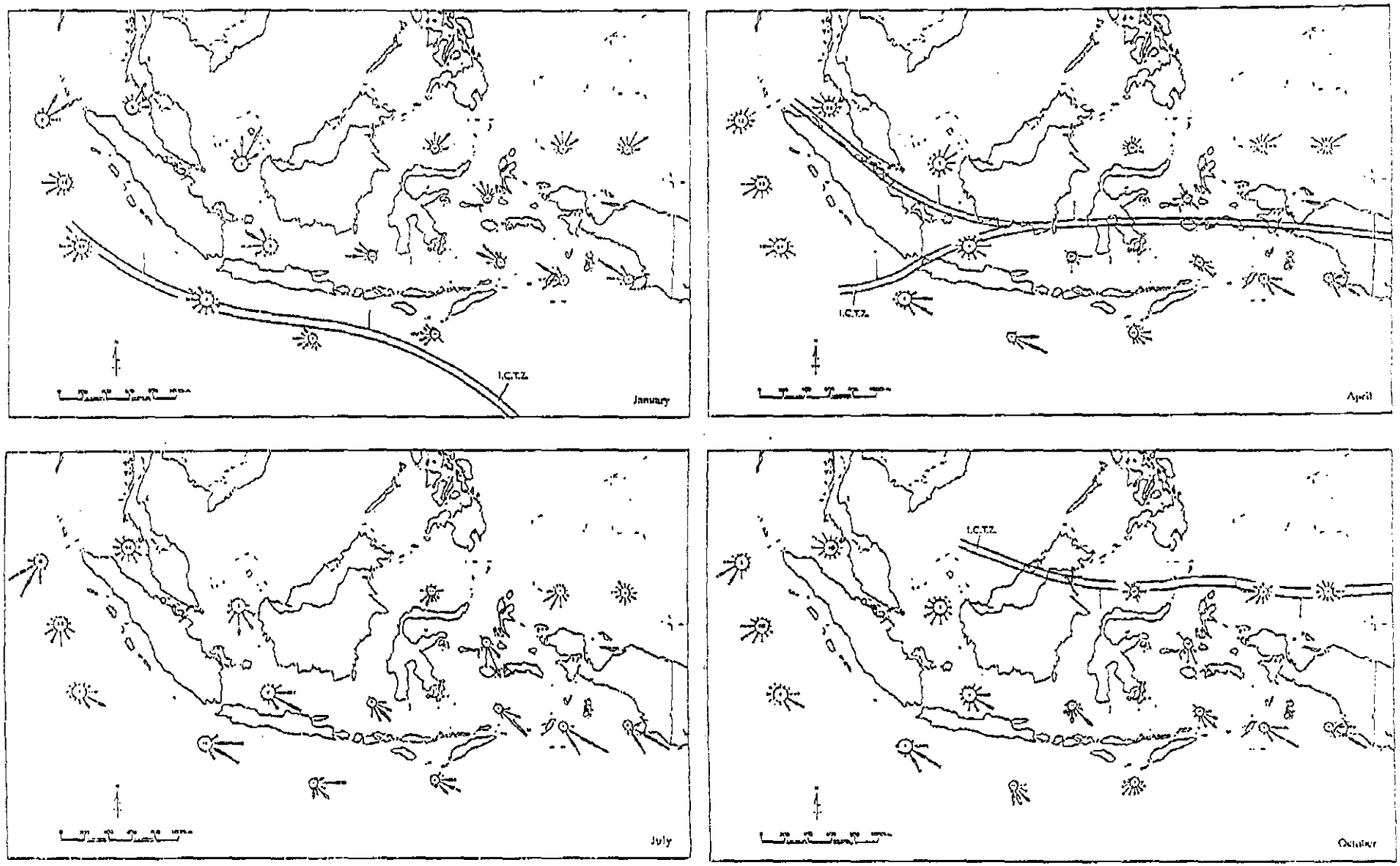
7. Rainfall is abundant with the average annual rainfall everywhere exceeding 1000mm and the annual total exceeds 4000mm in the mountainous areas inland. The region from Bali to Timor is the driest region with the annual rainfall of less than 1500mm and the prolonged dry period may result in serious shortages of drinking water in the period of June to October. In general, very heavy downpours occur in the NW monsoon season but rainfall is heavy in the SE monsoon season in Maluku and the northern half of Sulawesi.

(6) Fog and visibility

8. Fog is rare and visibility is generally good. Shallow fog patches develop during the night in river valleys, over marshy ground or at the foot of hills, and clear soon after sunrise. Visibility frequently drops below 2 miles in showers and below fog limits in heavy downpours. For the most part, during the NW monsoon, visibility is excellent unless it is raining. The SE monsoon tends to be hazy; the haze being more marked in the southeast parts of the country. It is especially thick in years of drought in Australia. The frequency of visibility over 5 nautical miles exceeds 95% throughout the year.

(7) Wind

9. The winds during the NW monsoon blow mainly from between NW and N over the northern part of the territory with occasional swings towards NE. Over the southern part the prevailing direction is between NW and W with temporary backing towards SW. Similarly the SE monsoon blows from SE and S in the vicinity of the equator, and from between SE and E over the southern part of territory. Winds are generally weak to moderate and gales seldom occur. Diurnal alterations due to land breezes in the nighttime and sea breezes in the daytime are distinct along the coast within the width of approximately 30km. Wind roses showing the frequency of winds of various directions and speeds January, April, July and October are shown in Figure 2.1.1.



Source: Indonesia Pilot I,II,III and Malacca Strait and West Coast of Sumatera Pilot, 1980-1996 published by the Hydrographer of the Navy, UK

EXPLANATION

Arrows fly with the wind. The frequency of wind from any direction is given according to the scale :

0 50%

The scale is further subdivided to indicate the frequency of winds of different Beaufort force according to the legend :-

Wind direction is towards the circle centre. The figure within the circle gives the percentage of calms.

Figure 2.1.1 Occurrence Frequency of Winds

2.1.3 Oceanography

(1) Seabed

10. The southeast half of Malacca Strait is generally less than 50m in depth and sand is the predominant bottom type. In the northwest approach to Malacca Strait depth increases gradually to the 100m depth contour, and sand predominates before the continental slope to the Andaman Sea. The southwest coast of Sumatra and the outlying islands have shallow coral fringes beyond where depth increases rapidly. Between these islands and Sumatra, sand is the dominant bottom type in the shallow water, with mud and clay predominating in the depths.

11. The sea area surrounded by south Sumatra, west Kalimantan and east Java have, for the most part, a very gentle sloping bottom, covered with a layer of unconsolidated sediment, chiefly soft mud but in some places mud and sand. River deltas along the coast of Kalimantan, Sumatra and the north coast of Java are severely affected by deposit of alluvial sediment causing coastline extensions seawards. In some shallower parts, chiefly in the vicinity of islands groups and on the sills that separate South China Sea and Java Sea, there are large stretches of sandy bottom; these are chiefly areas where the tidal streams are relatively strong. There are a few rocky or stony patches, particularly in the vicinity of islands and shoals. The largest stony area occupies the narrows of Sunda Strait, whilst the largest area of rocky bottom appears in the southwest extremity of Sumatra.

12. Bottom conditions in the eastern part of Java Sea, and in the shallow western part of Makasar Strait fronting the east coast of Kalimantan, are dominated by the processes of the shallow water deposition of river borne sediments, and of coral in those parts relatively remote from sources of sediment. There are a few patches of rock or stones, in the vicinity of offshore islets and shoals. Around the southern part of Celebes Sea, western part of Molukka Sea, western part of Banda Sea and Flores Sea, the bottom of these basins are partly covered with mud of both terrigenous and volcanic origin. However, there are also considerable areas of globigerina ooze, a deposit that is widespread in the open sea. The sills between these basins, usually coinciding with the straits between the islands, tend to have a hard bottom of rock or stones, with some coral, sand and shell, because the stronger currents over sills tend to sweep away the softer deposits. In the south side of Java and Nusa Tenggara, the seabed is formed of terrigenous mud, and further south the bottom is composed of red clay.

13. The submarine features of the seas of the Eastern Archipelago are relatively little known. Within the eastern area sediments of continental origin, formed principally in the

deeper parts of the seas, occur in Banda Sea. In the less deep parts of the seas sediments of animal origin, containing chalk and silicates, are widely distributed.

(2) Sea temperature

14. The sea surface temperatures does not vary much throughout the year, the biggest range being in the Arafura Sea where values vary from about 29℃ in December and January to about 25℃ in July and August. In other seas in and around Indonesia, the sea surface temperature reaches a maximum of between 28℃ to 29℃ in April and May and a minimum of between 26℃ to 28℃ in September. The mean temperature of the sea is usually between 0℃ and 1℃ higher than the overlying air over the open sea but with greater air temperature variations in coastal waters.

(3) Salinity

15. Throughout the area, surface salinity is extremely variable and contrasts with the uniformity of the sea temperature. Salinity is high (34.0 to 34.5‰) in Arafura Sea and gradually decreases to 33‰ in Sulawesi, below 29‰ along the southern coast of Kalimantan and 30‰ in the east part of Malacca Strait. The distribution of surface salinity is affected by the monsoon. Salinity is at its maximum during the SE monsoon and at its minimum during the NW monsoon. Low salinity values and rapid changes along the coasts may result from land drainage, river discharge, heavy rains and shallow depths.

(4) Tide

16. Elevations of the highest spring tide above Chart Datum at main tide observation stations in Indonesia are as follows:

Sumatra		Java	
Belawan	2.7m	Tanjung Priok	1.1m
Dumai	3.5m	Semaran	1.0m
Ujung Pandang	2.6m	Cilacap	2.2m
Bakauheni	1.0m	Surabaya	2.7m
Kalimantan		**Bali / Nusa Tenggara / Timor**	
Sungai Kapuas Kecil	1.8m	Benoa	2.6m
Sampit	2.8m	Bima	1.5m
Sungai Barito	2.8m	Kupang	2.1m
Balikpapan	2.8m	Dili	2.4m

Sulawesi		Maluku	
Ujung Pandang	1.4m	Ambon	2.0m
Donggara	2.4m	Ternate	1.6m
Bitung	2.6m	Tual	2.1m
Irian Jaya			
Sorong	1.8m		
Biak	1.8m		
Jayapura	1.1m		

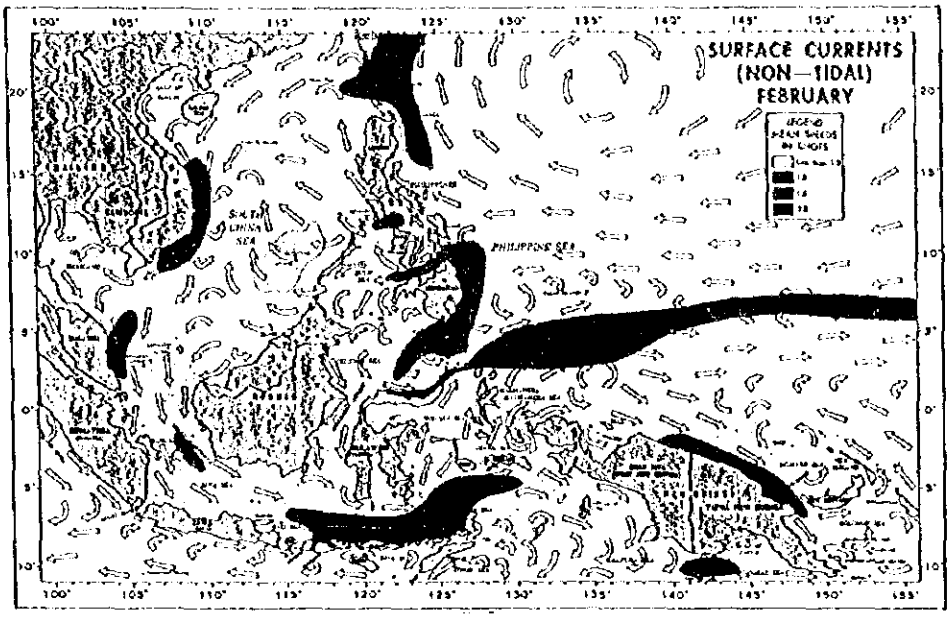
17. The tides are semi-diurnal in Sunda Strait and Singapore Strait, predominantly diurnal in Java Sea, semi-diurnal in Celebes Sea and Molukka Sea, and diurnal in Banda Sea and Arafura Sea.

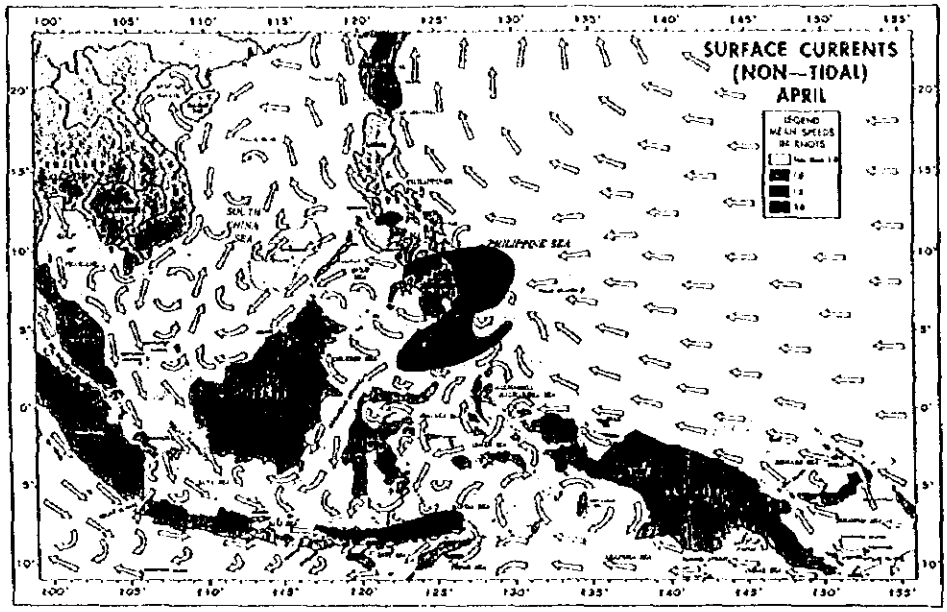
(5) Currents and tidal streams

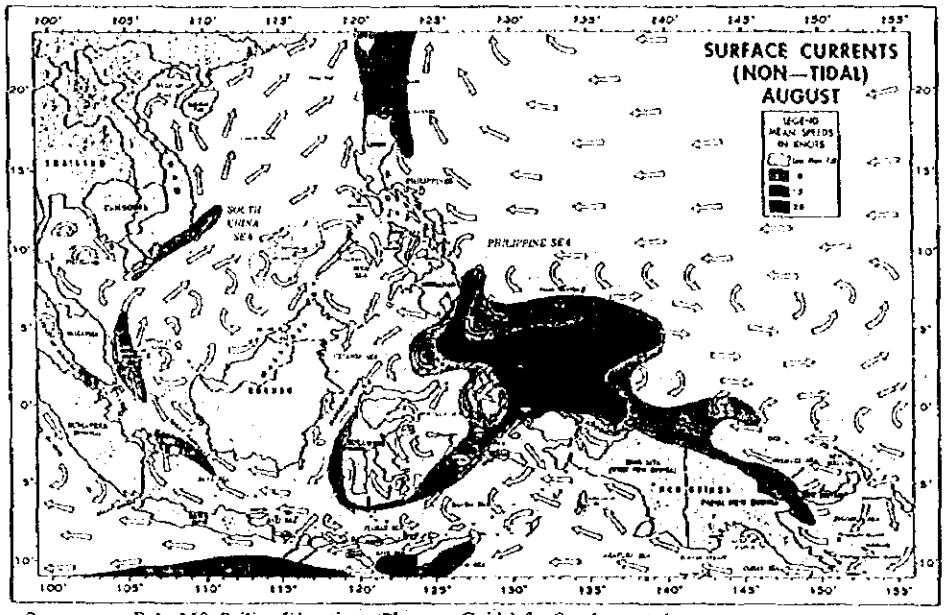
18. Currents are controlled to a very large extent by the monsoon, which affects most of the area. As a result over the greater part of the area the current directions are reversed twice each year in phase with the monsoon. The distribution of currents in February (NW monsoon), April (transitional period) and August (SE monsoon) are presented in Figure 2.1.2. In addition to the currents there are tidal streams, which are generally weak in the open sea but strong in the straits. Tidal streams in the area are semidiurnal, mixed and diurnal, and there speed and direction change during a day. The resultant streams due to the combined working of the currents and tides are less than 3 knots in all straits in the region except Bali and Nusa Tenggara where they are 6 to 10 knots.

(6) Waves

19. The generation of high waves is restricted in the region because there are no long fetches due to the many islands and no strong winds. In NW monsoon seasons the significant waves of 1.5m or higher occurs not more than 10% and predominant wave directions are west and northwest. In SE monsoon season, east and southeast waves predominate and the significant waves of 1.5m or higher occur less than 20%. Figure 2.1.3 shows the occurrence frequency of waves in the region.







Source: Pub. 160, Sailing Directions (Planning Guide) foe Southeast Asia, Fourth Edition, 1993 by Defense Mapping Agency, USA

Figure 2.1.2 Non-tidal Surface Current

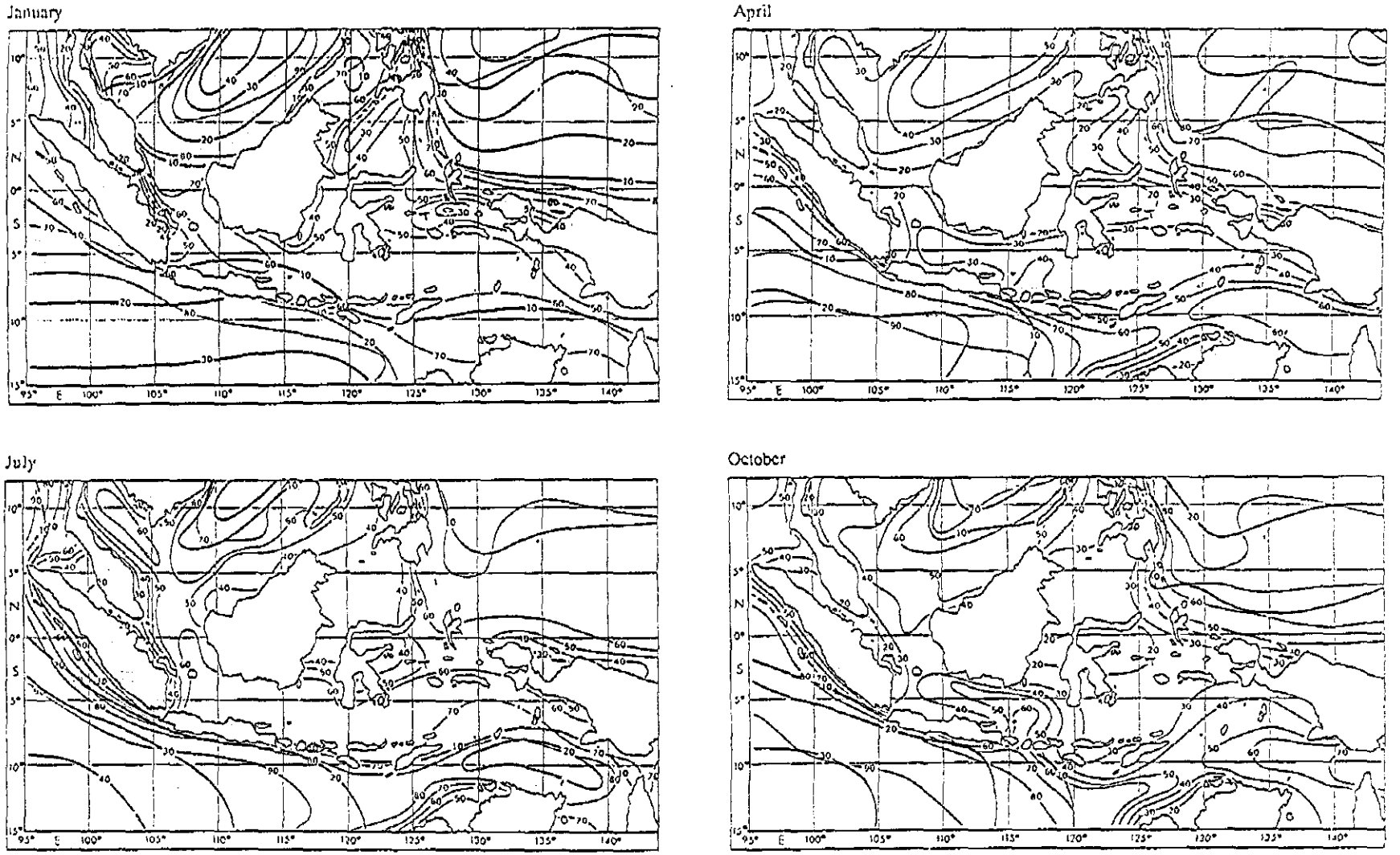


Figure 2.1.3 Occurrence Frequency of Waves