

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF CHEMISTRY
 5712 S. UNIVERSITY AVENUE
 CHICAGO, ILLINOIS 60637

1970

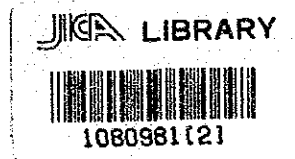
1970

THE UNIVERSITY OF CHICAGO
 DIVISION OF THE PHYSICAL SCIENCES
 DEPARTMENT OF CHEMISTRY
 5712 S. UNIVERSITY AVENUE
 CHICAGO, ILLINOIS 60637

1970
 1970

THE FEASIBILITY STUDY
ON
INDUSTRIAL PLANTATION FOREST DEVELOPMENT PLAN
IN
SOUTH SUMATERA AREA
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT



20944

MARCH, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

国際協力事業団

20944

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan has decided to conduct a feasibility study on Industrial Plantation Forest Development Plan in South Sumatera Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a survey team headed by Dr. Kinji Hachiya three times during the period from November 1, 1988 to March 30, 1990.

The team had a series of discussions on the project with the officials concerned of the Government of the Republic of Indonesia and conducted field surveys in the project area.

After the team returned to Japan, further studies were made and a mission was dispatched to Indonesia to explain and discuss a draft final report. As a result, the present report was prepared.

I hope that this report will serve for the progress of Industrial Plantation Forest Development in the Republic of Indonesia and contribute to the promotion of friendly relations between our two countries.

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

March, 1990



Kensuke Yanagiya
President
Japan International Cooperation Agency

CONTENTS

PREFACE

SUMMARY

CHAPTER 1 INTRODUCTION

1-1	Background	1
1-2	Objective	2
1-3	Study Area	2
1-4	Contents of the Study	5
1-5	Technology Transfer	7

CHAPTER 2 ROLE OF FORESTRY IN NATIONAL ECONOMY

2-1	Current Conditions of Indonesia	9
2-2	National Economy and Forestry	10
2-2-1	Position of Forestry in National Economy ..	10
2-2-2	Trends of Forestry and Forest Industry	12
2-3	Administrative Organization	25
2-4	Status of Industrial Plantations	30
2-5	Current Condition of the South Sumatera Province	32
2-5-1	General Conditions	32
2-5-2	Forestry and Forest Industries	34

CHAPTER 3 CURRENT CONDITION OF THE STUDY AREA

3-1	General Condition	39
3-2	Climate	40
3-3	Topography	42
3-4	Geology	44
3-5	Soil	46
3-6	Vegetation	50
3-7	Land Use	52
3-8	Local Inhabitants	56
3-9	Forestry and Forest Industries	62
3-10	Infrastructure	63

CHAPTER 4 INDUSTRIAL PLANTATION PLAN FOR BENAKAT AREA

4-1	Basic Policy	65
4-1-1	General Conditions of Benakat District	65
4-1-2	Production Goals	65
4-1-3	Land Use	67
4-1-4	Considerations for Local Inhabitants	68
4-1-5	Considerations for Natural Environment	69
4-1-6	Project Period	70
4-2	Basic Items for Project Planning	71
4-2-1	Establishment of Working Units	71
4-2-2	Compartmentalization	71
4-2-3	Selection of Planting Sites	74
4-2-4	Selection of Species	78
4-2-5	Planting Density	84
4-2-6	Growth Estimate	85
4-2-7	Forest Roads and Nursery Sites	86
4-2-8	Planting Areas	89
4-3	Work Plans (Project Component)	94
4-3-1	Nursery Stock Production Plan	94
4-3-2	Plantation Plan	108
4-3-3	Forest Protection Plan	117
4-3-4	Forest Road Plan	123
4-3-5	Felling Plan	131
4-3-6	Skidding and Logging Plan	131
4-3-7	Marketing Plan	138
4-3-8	Project Implementation Organization and Personnel	140
4-3-9	Local Development Promotion Measures	154
4-3-10	Implementation Schedule	158
4-4	Project Cost	159
4-4-1	Preconditions for Estimates	159
4-4-2	Project Cost Estimate	160

CHAPTER 5	PROJECT EVALUATION	
5-1	Cost and Benefit	165
5-2	Financial Analysis	167
5-3	Economic Analysis	168
5-4	Environmental Impact Assessment	172
CHAPTER 6	RECOMMENDATION	185

LIST OF FIGURES AND TABLES

Figures

1-1	Location of the Study Area	3
1-2	Boundaries of the Study Area	4
1-3	Study Flow	6
3-1	Mean Monthly Temperatures and Monthly Precipitation in Benakat	41
3-2	Drainage Pattern in the Study Area	43
3-3	Geology of the Study Area	45
3-4	Locations of Main Settlements	54
4-1	Forest Compartment Map	73
4-2	Planting Site Choice Flow	77
4-3	Outline of Industrial Plantation Plan for Benekat ..	92
4-4	Planned Area for Nursery Establishment	95
4-5	Schematic Layout of Nursery Facilities	99
4-6	Procedure for Nursery Work	100
4-7	Fire Prevention and Look-out System	117
4-8	Logging Route	137
4-9	Implementation Organization for Industrial Plantation Project in South Sumatera	145
5-1	Flow Chart of Environmental Impact Assessment	173

Tables

2-1	Transition of Indonesian GDP	10
2-2	Sectoral Contribution to GDP and Average Growth Rate	11
2-3	Transition of Export Amount	12
2-4	Log Production (Fifth 5 Year Forestry Development Plan)	14
2-5	Forestry Production in Fifth 5 Year Development Plan	14
2-6	Actual Achievements and Planned Areas for Afforestation and Revegetation	16
2-7	Log, Sawn Timber and Plywood Production	19
2-8	Production Capacities and Production Volumes of Sawing and Plywood Industries	20
2-9	Pulp and Paper Production Volumes	21
2-10	Local Product Flow of Wood and Wood Products in 1985	22
2-11	Volume and Unit Export Price (FOB) of Sawn Timber ..	23
2-12	Average Export Prices of Sawn Timber and Plywood ...	23
2-13	Average Price of Forest Products in South Sumatera	24
2-14	Afforestation Targets of General Plan for Forestry Development (1986)	31
2-15	Population by Kabupaten and Sex in South Sumatera Province, 1987	33
2-16	Forest Areas in South Sumatera Province	34
2-17	Industrial Plantation Forest Development Plan in South Sumatera	35
2-18	Wood Production in South Sumatera Province by 5 Year Plan Period	37
3-1	Area of Each Land Use Class in the Study Area	52
3-2	Land Use in Jirak	59
4-1	Number of Compartments and Sub-Compartments by Working Unit	72

4-2	Species to be Recommended for the Industrial Plantation in Indonesia	79
4-3	Species Potential	83
4-4	Planned Rotation and Yield Estimate	86
4-5	Survey Results on the Structure of Main Road	87
4-6	Forest Roads by Working Unit	88
4-7	Classification of Operation Site by Working Unit ...	91
4-8	Planting Area by Year - Total -	93
4-9	Main Nursery Facility by Working Unit	98
4-10	Seed Volume Required for Plantation	102
4-11	Nursery Work Standard	105
4-12	Nursery Stock Production Plan by Year - Total -	106
4-13	Summary of Materials and Inputs for the Nursery Works	107
4-14	Plantation Work Standard (1)	113
4-15	Plantation Work Standard (2)	114
4-16	Plantation Work Standard (3)	115
4-17	Summary of Materials and Inputs for the Plantation Works	116
4-18	Firebreak Establishment Plan	117
4-19	Firebreak Establishment Plan by Year	124
4-20	Summary of Materials and Inputs for Forest Protection	125
4-21	Total Length of Forest Roads and Number of Bridges by Working Unit	126
4-22	The Standard of Forest Road	127
4-23	Forest Road Construction Plan by Year	129
4-24	Summary of Materials and Inputs for Forest Road Work	130
4-25	Felling Area and Yield Volume from the Existing Man-made Forests	132
4-26	Thinning and Felling Plan	133
4-27	Summary of Materials and Inputs for Salvage Cutting, Thinning and Felling	134
4-28	Summary of Materials and Inputs for Skidding and Transportation	136
4-29	Marketing Plan	139

4-30	Number of Staff by Office	141
4-31	Amount of Work Required for Project Component	147
4-32	General Specification of Buildings	151
4-33	Building Construction and Facility Installment Plan for the Administration and Other General	152
4-34	Summary of Materials and Inputs for the Administ- ration and Other General	153
4-35	Finance Plan by Work and Year (Base Cost)	161
4-36	Comprehensive Finance Plan (Price Escalation)	163
5-1	Wood Prices of New Man-Made Forest	166
5-2	Sensitivity Analysis	168
5-3	Environmental Assessment Matrix	178
5-4	Prediction of the Impact on Natural Environment	180
5-5	Prediction of the Impact on Socioeconomic Environment	182

SUMMARY

SUMMARY

1. Contents of the Study

In January, 1986, the Government of the Republic of Indonesia made a formal request to the Government of Japan for the provision of cooperation for a feasibility study on industrial plantation forest development. In response to this request, the Government of Japan entrusted the Japan International Cooperation Agency (JICA) to send the Preliminary Study Team to Indonesia to examine the background of the request and other relevant issues. Following the study, the Preliminary Study Team concluded the S/W with the Indonesian side, paving the way for the present Feasibility Study.

The present report compiles the findings of the field surveys conducted by the Feasibility Study Team, the work plans (possible contents of an industrial plantation project) which were prepared based on these findings and the results of the evaluation of these plans.

The Benakat Area, i.e. the subject area of the Feasibility Study (Study Area), is located 180km southwest of Palembang, the capital of South Sumatera Province, and consists of some 50,000 ha. Field surveys were conducted in both fiscal 1988 and fiscal 1989 with special attention paid to the transfer of technology relating to methods to prepare an industrial plantation plan and to evaluate such a plan.

2. Current Conditions of Indonesia

2-1 Outline

Indonesia is the largest archipelago country in the world, consisting of some 13,000 islands which are scattered over

some 5,100 km in the east-west direction and some 1,600 km in the north-south direction with a total land area of 1.93 million km².

Indonesia belongs to the tropical rainy climate and is blessed with abundant natural resources, particularly forests which account for some 75% of the total land area.

As of 1988, Indonesia has a population of 176 million and the increasing population (annual increase rate of some 2%) and high population concentration in urban areas with resulting overcrowding are serious social problems.

The two main pillars of Indonesian industry are the rich oil and gas resources and agriculture in which a large proportion of the population is engaged.

2-2 Role of Forestry in National Economy

A GDP growth rate of 4% was achieved during the Fourth 5 Year Development Plan period and the achievement of a 5% growth rate is expected in the Fifth Plan period. The contribution rate to the GDP of agriculture, forestry and fisheries is around 23%. With a work force ratio of around 55%, this sector plays an important role in the national economy.

Forestry has been playing an increasingly important role in the national economy as both the absolute export value of such forest products as logs, sawn timber, plywood and rattan, etc. and the relative ratio of the export value of these products in the total export earnings have been rapidly increasing.

The export value of forest products amounted to 2,618 million dollars in 1987, 14.3% of the total export value,

and the role of these products in the national economy has become increasingly crucial in accordance with their increased importance as export items.

2-3 Trends of Forestry and Forest Industry

Despite Indonesia's rich forest resources, the problem of declining resources has arisen with the increased forest exploitation and the reduction of the forest area has become conspicuous due to the increase of farmland following the population increase and shifting cultivation and livestock raising in forest areas.

Indonesia has a long history of afforestation which commenced with teak afforestation on Java island in the 19th century. In more recent years, nationwide afforestation efforts have been underway to preserve not only the forest resources but also the environment.

The afforestation results of the Fourth 5 Year Development Plan and the planned afforestation work in the Fifth Plan are shown in the table below.

(Unit: ha)

	4th Plan (Repelita IV)	5th Plan (Repelita V)		5 Year Total
		1989	1993	
a) Afforestation				
Non-HTI	---	100,000	100,000	500,000
Replanting	69,160	116,000	116,000	580,000
Reforestation	1,804,540	50,000	50,000	250,000
Natural Forest Work	229,700	100,000	100,000	500,000
b) Revegetation	1,464,000			
Model Forests	---/4,470*	5/500	5/500	25/2,500
Social Forests	243,810	30,000	30,000	150,000
Distribution of Seedlings	---	560,000	560,000	2,080,000
c) Industrial Plantation Forests				
(HTI)	72,270	100,000	400,000	1,500,000

* 1,000ha/Number of Unit

With regard to the forest industry, measures to create a domestic wood processing industry have been actively promoted to increase the added value of Indonesian forest products in view of the effective utilization of forest resources and the creation of employment opportunities. The production volumes of sawn timber and plywood have consequently rapidly increased, by 3.7 times and 2.6 times respectively during the Fourth Plan period, making a substantial contribution to the Indonesian economy.

The production volumes of pulp and paper also conspicuously increased during the Fourth Plan period and this increase trend is continuing, stimulating hope for expanded wood production by means of industrial plantation forests. The Fifth 5 Year Plan estimates a total production volume of 2,539,000 tons during the Plan period, 5 times more than the actual production volume in the Fourth plan period.

Although the export of logs has been prohibited since 1985, Indonesian sawn timber and plywood still occupy important positions in the world market.

2-4 Administrative Organization and Forestry Related laws

Pursuant to the Indonesian Constitution enforced in 1945, the People's Consultative Assembly acts as the supreme organization under which Assembly (Parliament), Supreme Court and Cabinet consisting of 21 ministries are located. The Ministry of Forestry became an independent ministry in 1983.

The legal framework for the forestry and forest industry is well established and is based on the Basic Forestry Act (Law No. 5 of 1967). A number of decrees and regulations have also been issued relating to the promotion of industrial plantation.

2-5 Status of Industrial Plantation

A sawn timber production increase of some 19% and a plywood production increase of some 38% on the respective production volumes in the Fourth Plan period are intended in the Fifth Plan period, indicating the importance of the growth of the forestry sector in view of the planned 5% real growth rate of the Indonesian economy during the Fifth Plan period.

The promotion of industrial plantation, together with an attempt to increase forest resources through the proper control of natural forests, is therefore considered essential to secure an adequate supply for the rapidly expanding timber industry.

The industrial plantation of some 300,000ha a year has been in progress in the Fifth Plan period compared to a total of 72,000ha in the Fourth Plan period in order to achieve a total of 1.5 million ha of new industrial plantation in the Fifth Plan period.

3. Outline of South Sumatera Province

South Sumatera Province belongs to a tropical rainy climate with an almost constant mean temperature of 26° and relative humidity of 86% throughout the year. The rainfall is relatively low from May to August with an average of some 130mm/month. The rainfall begins to increase in September and reaches the peak period in March and April with over 350mm/month. The mean annual rainfall is some 2,000 - 3,000mm.

The total population of South Sumatera Province in 1987 was approximately 5,783,000 while the population of Kab. Muara Enim to which the Study Area belongs was approximately 515,000.

South Sumatera Province has a forest area of 5,214,700 ha (standing stock of 102,374,000 m³), accounting for 51% of the Province's total land area and 4% of Indonesia's total forest area. Its standing stock accounts for 2% of the total standing stock in Indonesia. Timber production in South Sumatera Province in 1986 consisted of 1,145,000 m³ of logs, 470,000 m³ of sawn timber and 225,000 m³ of plywood.

4. Current Conditions of Study Area

4-1 Natural Conditions

The Benakat area, i.e. Study Area, belongs to the South Sumatera Province and is located in the area between S. Musi (total length: some 700km), a large river traversing South Sumatera Province, and S. Lematang (total length: some 300km), a tributary of S. Musi. The elevation is generally 80m or less.

The Study Area and its vicinity consist of peneplains with hills and rolling land and is geologically characterized by the Palembang formation of the Neogene era.

In general, the rainy season in and around the Study Area is between November and March while the dry season is between April and October. According to 1984/85 data provided by the South Sumatera Reforestation Technical Centre, the mean annual temperature and annual rainfall are 25.8°C and 1,906 mm respectively. The mean monthly temperature is almost constant throughout the year.

As a result of the soil survey, Acrisols are predominant in the Study Area. Apart from the Plinthic Gleysols found near swamps, all the soil units are considered fairly suitable for afforestation purposes.

Vegetation in the Study Area consists of secondary forests, man-made forests, bush land and grassland.

4-2 Land Use

The current land use conditions in the Study Area are shown in the table below. Bush land and grassland (25,000 ha) account for 51% of the total area while forest (15,600 ha), farmland, including rubber forests (6,000 ha), and shifting cultivation sites (2,800 ha) account for 31%, 12% and 6% respectively.

Land Use Classes		Area (ha)	Ratio (%)
Forest	Secondary forest	7,970	16
	Man-made forest	7,621	15
Grass land/ Bush land	Bush land	24,500	49
	Grass land	965	2
Settlements		298	1
Shifting cultivation		2,822	6
Agriculture land		6,038	12
Oil fields		28	0.1
Total area of the Study Area		50,242	100

4-3 Infrastructure

A road section of some 161 km from Palembang towards the Study Area is paved, followed by an unpaved section before reaching the Study Area. While a well developed road network has been established within the Study Area following oil development all the roads are still unpaved.

There are 5 governmental general hospitals in Kab. Muara Enim. Branches of the health centers are also located in the main settlements of the Study Area.

Desa Jirak has 2 nursery schools, 37 primary schools and 6 secondary schools while Desa Sungai Baung has 3 primary schools and Desa Suban Ulu has only 1 primary school.

The Study Area has no public electricity service. However, the power transmission line from Pendopo of the National Petroleum Development Corporation reaches a point some 4 km east of the study Area.

The local inhabitants rely on small rivers for their water supply and there are no wells. There is an ample water supply during the dry season but the water quality is poor and the water requires boiling prior to drinking.

4-4 Local Inhabitants

There are 3 villages in the Study Area, i.e. Jirak, Sungai Baung and Suban Ulu. The population of each village in 1986 was 5,469 for Jirak (with 4 settlements), 3,492 for Sungai Baung (with 7 settlements) and 1,832 for Suban Ulu, totaling 10,793. Taking the population increase and scattered households into consideration, it is estimated that the Study Area has a current population of some 14,000, a 30%

increase on the figure for 1986. The average number of people per households is about 6.

According to the results of the interview surveys conducted in Simpang Solar and Jirak which are the main settlements, the number of people in one family varies from 4 - 10 and more than one family sometimes live together.

The main sources of income for the 2,300 households in the Study Area are 1) agriculture for some 1,850 households (some 80%), 2) employment by the oil company for some 150, 3) small- scale industrial or commercial undertakings for some 200 and 4) civil service and others for some 100.

Each farming household has 1 - 2 ha of farmland and the main crop is upland rice, meize, banana, etc.

The agricultural income varies extensively with low income households (less than 2.5 million Rp/year), middle income households (2.5 - 4.5 million Rp/year) and high income households (over 4.5 million Rp/year) accounting for 60%, 35% and 5% respectively. This agricultural income includes an average of 1 million Rp/year for each farming household for the value of agricultural products for own consumption.

Some 1,200 households (65% of the total number of farming households) are engaged in shifting cultivation and most are low income households. They have less than 1 ha of fixed farmland each and an additional some 2 ha for shifting cultivation. It is said that the people belonging to this social stratum strongly hope to find opportunities for wage labour.

While the trunks and branches felled by the local inhabitants are used to erect fences around farmland and gardens, for the construction of houses and other buildings and so on, they are most frequently used as fuelwood.

The main purposes of small-scale livestock raising are the use of cattle for farming and the keeping of family assets. In most cases, the number of cattle owned is frequently 1 - 3. The scale increases to 5 - 10 when continuous earnings from cattle raising are expected and this type of stock raising is mainly conducted by high income farmers. The possession of more than 10 cattle by a single family in the Study Area is almost non-existent.

There are 2 types of grazing in the Study Area. One is a small-scale grazing which is found in and around the settlements and farmlands. The other one is a large-scale grazing which is found in and around grasslands consisting more than 20 cattles.

5. Industrial Plantation Project for Benakat Area

5-1 Basic Policy

(1) Production Goal

In view of the measures currently being implemented by the Ministry of Forestry, the following production targets have been adopted for the Study Area to secure income in a relatively short period, to restore the land productivity and to conserve the local environment.

- 1) The central production target will be pulp wood.
- 2) The production of construction timber will also be considered where deemed appropriate.

(2) Land Use

The basic land use policies are as follows.

- 1) In view of efficient land use in the future, the Study Area will be divided into the operation sites and non operation sites.
- 2) The non operation sites will not be subject to afforestation in the future and will be exclusively used for agricultural purposes.
- 3) The operation sites will be subject to industrial plantation.

(3) Considerations for Local Inhabitants

In planning industrial plantation for the Benakat Area, therefore the following measures have been carefully considered to support the lives of the local inhabitants.

- 1) Public relations activities to facilitate understanding of and to enlist cooperation for afforestation work and the establishment of community organizations for the systematic and stable employment of local inhabitants.
- 2) Contribution to the improvement of the local infrastructure by means of constructing forest roads, water supply facilities and power supply facilities which are also required for the smooth implementation of the Project.
- 3) Inducement to change from shifting cultivation in the forests to fixed plot agriculture by means of introducing exclusive farmland, providing farming materials such as seeds and seedlings, etc.

(4) Consideration for Natural Environment

The Project has been prepared based on the following principles, taking the local requirements for environmental conservation into consideration.

- 1) The Project should assist the recovery of the original vegetation, i.e. forests, by conducting afforestation in artificially created bush land and grassland.
- 2) In the course of the afforestation of the Study Area, the natural and other conditions should be carefully examined. In deciding the land use plan, therefore, conservation forests and riparing reserved forest zones should be located and the natural forest management method should be employed in view of environmental conservation.
- 3) In deciding the work plans implementation, special attention should be paid to the prevention of disease and insect damage and also to the prevention of sediment outflow.

(5) Project Period

- 1) It has been decided that the project period will be 30 years during which the fast growing species will complete several rotations so that the financial aspect of the Project can be quickly stabilized and the progress of the Project can be readily checked.
- 2) It has been decided that the evaluation period of the Project will be 43 years on the grounds that harvesting from the first afforestation work will be completed in the 43rd year. The overall project cost will consist of the initial investment for the first afforestation work (lasting for 8 years) and the operation and

maintenance cost thereafter while the benefit will consist of the earnings from those trees planted during the above afforestation work.

5-2 Basic Items for Project Planning

(1) Establishment of Working Unit

In accordance with the basic principles, some 6,500 ha have been excluded from the sites for plantation establishment. The area of operation sites is, therefore, the remaining 43,800 ha.

For the convenience of the Project implementation, the area of operation sites is divided into three working units.

(2) Compartmentalization

The subject sites of these working units have been further divided into 60 compartments and 612 sub-compartments and the current stand conditions have been compiled in the Forest Inventory Book submitted separately from the present report.

(3) Selection of Planting Site

While the Project Area was newly designated a production forest in December, 1988 with the result that the entire Study Area may be subject to industrial plantation, the following stands have been excluded from the planting site selection process.

- a. secondary forests
- b. conservation forests
- c. riparian reserved forest zones and swamps
- d. experimental forests
- e. forest roads and fire breaks

(4) Selection of Species

It has been decided that the selected species for each production goal will all be planted in order to avoid possible damage resulting from disease, harmful insects and unfavourable climatic conditions in the case of the single species plantation of a vast area. In the case of construction timber which requires a long growth period, it is preferable that local species be planted instead of exotic species for which Indonesia has limited planting experience.

The usage, rotation periods and expected yields of the selected species are shown below.

Group	Species	Usage	Rotation period	Expected yield	Remarks
1	A. mangium	pulp wood	8 years	165m ³	7 years from second generation onwards
	A. auriculiformis	pulp wood	8 years	165m ³	
	A. falcataria	pulp/con. timber	8 years	165m ³	
2	P. canescens	con. timber	20 years	240m ³	
3	S. macrophylla	con. timber	35 years	272m ³	
	S. bancana	con. timber	35 years	272m ³	

Note: 'Con.' means 'construction'.

(5) Forest Roads and Nursery Site

With regard to the construction of forest roads, routes along ridgelines have been selected for better drainage so that the roads are passable even during the rainy season. The routes of the main forest roads have also been selected in view of their playing a central role in the forest road network and based on their convenience vis-a-vis local life. Branching out from the main forest roads, all working forest roads are planned to run through the central points of the plantation sites.

A nursery site has been selected for each working unit taking the water supply and topographical conditions into consideration in addition to project implementation convenience.

(6) Planting Areas

The following points were taken into consideration in deciding the annual planting areas.

- 1) All plantation work will be completed in 8 years in view of the rotation periods of the main species to be planted and the continuity of the Project.
- 2) The work volume in the first year will be less than in subsequent years in view of such requirements as land preparation and facility construction.
- 3) The planting sites for each year will be coordinated with the existing network of public roads and new forest roads to be constructed under the Forest Road Construction Plan.
- 4) At the view point of investment efficiency, forest protection, etc., the relative proportion of species with a short rotation period and those with a medium or long rotation period will be 80:20.

As a result, the total planting area will be 27,700ha (average: 3,500 ha/year) for the initial 8 years.

The specific areas of those sites subject to or outside the planned afforestation work for each Working Unit are shown in follow table.

(ha)

Classification		Working unit			Total	
		I	II	III		
Plan- ta- tion (Oper- ation site)	Planting site		8,806.86	10,582.27	8,287.38	27,676.51
	Non plant- ing site	Secondary forest	353.12	1,179.21	5,749.56	7,281.89
		Conservation forest	-	1,282.25	1,227.37	2,509.62
		Swamp	11.19	49.71	1.06	61.96
		Riparian reserved forest zone	335.18	590.98	468.06	1,394.22
		Forest road	244.51	289.86	227.87	762.24
		Fire break	151.72	175.79	113.94	441.45
		Trial plantation	-	3,625.59	-	3,628.59
		Sub-total	1,095.72	7,193.39	7,787.86	16,079.97
	Total		9,902.58	17,778.66	16,075.24	43,756.48
Non operation site Total		2,700.88	3,100.68	674.24	6,485.80	
Grand total		12,603.46	20,889.34	16,749.48	50,242.28	

5-3 Nursery Stock Production Plan

A nursery will be established for each working unit, about 3 ha resepctively.

) Although seeds of A. mangium and S. bancana can be obtained in and around the Study Area, most seeds of A. auriculi-formis, S. macrophylla and A. falcataria must be purchased from the Java area or elsewhere. A sufficient number of P. canescens cuttings will be secured from plantations in and around the Study Area.

The total seed production volume will be 33.7 million (average: 4.2 million/year) for the initial 8 years.

5-4 Plantation Plan

The extensive plantation of the same species has been avoided in the selection of the planting sites for the selected species to prevent damage due to disease or harmful insects.

In planning the plantation work, as the work involves the large-scale plantation of some 4,000ha a year in the peak year, it has been decided to incorporate as much mechanized work as possible taking the past performance of mechanized plantation work as well as the Study Area's topographical conditions into consideration.

) The plantation work standards have been decided for each group of species but the actual local conditions will be taken into consideration in the application of these standards.

5-5 Forest Protection Plan

The following measures have been decided to prevent forest fires.

- 1) 10m wide firebreaks will be constructed on both sides of the existing roads and the main forest roads to be newly constructed under the Project.
- 2) Look-out towers will be constructed for the early detection of forest fires.
- 3) As the main cause of forest fires in the Benakat Area is said to be burning for shifting cultivation and livestock raising purposes, public relating activities to increase the awareness of the importance of afforestation work as well as forest functions are necessary.

The following points must be noted to prevent damage due to disease or harmful insects.

- 1) Selection of highly resistant varieties
- 2) Avoidance of pure planting over an extensive area
- 3) Careful monitoring of those damage

5-6 Forest Road Plan

The effective width of each type of forest road is given below. The construction of bridges is planned in those areas where the crossing of a river or valley is necessary.

- | | | |
|---------------------|--------------------|-----------|
| 1) Main Forest Road | : effective width | - 6m |
| | right of way width | - 15m |
| | total length | - 161.6km |

- 2) Working Forest Roads : effective width - 4m
right of way width - 10m
total length - 394.9km
- 3) Construction Period : 7 years

5-7 Felling Plan

Harvesting from the existing man-made forests will continue upto the 8th year with an average felling volume of some 62,000m³/year (maximum volume: 140,000 m³/year). Harvesting from the plantation sites will commence in the 9th year with an average felling volume of some 588,000 m³/year upto the 30th year (maximum volume: 712,000 m³/year).

5-8 Skidding and logging Plan

The felled trees will be transported by following skidding and logging methods from the plantation sites to Palembang by S. Lematang.

- 1) The felled trees will be skidded by farm tractor.
- 2) The timber will be loaded onto a logging truck by log loader, unloaded at the dumping place by log loader and then loaded onto a barge.
- 3) 2 logging routes are planned to S. Lematang.

5-9 Marketing Plan

Timber from the existing man-made forests in the operation sites will be harvested and marketed during the initial 8 year period and the harvesting and marketing of timber from the plantation sites will commence in the 9th year of the Project.

The annual sales volume of pulp wood obtained from species with a short rotation period will be 383,000 m³ on average during the 30 year period while the sales volume of construction timber obtained from species with a medium or long rotation period will be 61,000 m³/year on average in the period between the 9th year and 30th year.

5-10 Project Implementation Organization, Personnel, etc.

In view of the fact that the Project will be conducted in 3 working units, an office will be established in each working unit. Each office will be responsible for the direct management and supervision of the work relating to the nursery, plantations and forest roads. In addition, its assignments will include the supervision of fire prevention patrols, the supervision and control of vehicle operation and repair and the control of the workers' performance and their welfare. The South Sumatera Industrial Plantation Centre will be established for supervision of the Project by each office and coordination of management in the whole Project Area. Both the Centre and each Working Unit Office will be provided with a repair shop.

The total labour requirement for all working units for nursery stock production and afforestation will be some 158,000 workers per year that can be basically obtained from the local provision of the labour force. Partially, however, it seems currently difficult to get the enough provision of labour force by the local recruitment. Therefore, accommodations will be facilitated for obtaining those labour force from outside the Project Area. Technical training will be provided for all workers.

It has been decided that consultants will be appointed to be responsible for the detailed design and work supervision,

etc. in view of the smooth and efficient implementation of the Project.

5-11 Local Development Promotion Measures

One of the objectives of the Project is to contribute to the development of local communities. The understanding of and cooperation for the Project by the local inhabitants will greatly assist the smooth implementation of the Project-related work. The following measures are, therefore, planned.

- 1) Organization of the local inhabitants to secure a stable work force in a systematic manner following the increased employment opportunities.
- 2) Improvement of the local infrastructure which has a direct connection with local life as part of the efforts to construct the Project-related facilities.
- 3) Implementation of measures to induce those farmers currently engaged in shifting cultivation in the forests to commence farming at fixed sites.

5-12 Implementation Schedule

The preparatory work, including the detailed design, will be conducted prior to the commencement of the nursery and planting work in view of the smooth implementation of the Project.

5-13 Project Cost

The base cost for the initial 8 years of the Project during which all the planned planting work will be completed will be some 32.7 million US\$, including the felling and logging costs.

6. Project Evaluation

6-1 Cost and Benefit

The project cost has been calculated to be some 33.1 million US\$ based on the initial investment cost for the first 8 years during which the first planting work will be completed and the running cost (including the operation and maintenance costs) for the 43 years which are required to complete the first harvest. The benefit has been calculated based on the standing tree prices of the species in both the existing and new man-made forests.

6-2 Financial Analysis

The financial internal rate of return (FIRR) for the first 43 years during which the species with the longest rotation period among those planted in the first 8 years become ready for harvesting has been calculated to be 9.45%.

6-3 Economic Analysis

The economic analysis has been conducted based on the following.

- 1) The economic prices are calculated based on international timber prices.

- 2) The labour cost is calculated based on the shadow wage rate (SWR) of 0.67.
- 3) The personnel cost is removed from the general administrative cost.
- 4) Trees from salvage cutting are considered a benefit since they may be used as firewood by the local inhabitants.

The resulting economic internal rate of return (EIRR) is 14.31%.

6-4 Environmental Impact Prediction and Assessment

Prior to the implementation of the Project, it is necessary to predict and assess the possible impact on the natural and socioeconomic environment in the Study Area.

(1) Natural Environment

The impact of the Project on the natural environment will be the establishment of new forests in the current vast tracts of grassland and bush land and the following positive effects can be anticipated.

- 1) creation of a mild climate
- 2) stabilization of the river discharge due to the increased soil permeability
- 3) improvement and restoration of land productivity
- 4) increase and diversification of fauna and flora in forests

In comparison, the implementation of the afforestation work may create the following problems.

- 1) increased sediment discharge due to various types of work
- 2) water pollution due to the use of agrochemicals and fertilizers
- 3) change of fauna and flora

However, with the employment of various measures, including the planned establishment of conservation forests and riparian reserved forest zones, natural forest management of secondary forests and prohibition of farming in forests, it is assessed that the Project is unlikely to cause any environmental problems.

(2) Social Environment

The possible positive effects on the social environment include the following.

- 1) creation of many employment opportunities
- 2) reduction of shifting cultivation
- 3) consolidation of the traffic infrastructure
- 4) stable supply of irrigation and domestic water
- 5) promotion of intensive agriculture at fixed farming plots

Considering the above effects, the Project is considered to be advantageous for both the local society and economy.

In conclusion, the comprehensive assessment of the Project's impact on the environment is that the Project does not have any adverse effects on other local environment while many positive effects can be anticipated.

Nevertheless, it will be necessary to conduct continuous monitoring as part of the project implementation process so that comprehensive measures can be quickly adopted should any adverse impact on the environment occur.

7. Recommendations

(1) Prior Requirements for Project Implementation

As the Project envisages large-scale and mechanized afforestation, proper understanding of and close cooperation with the Project by local inhabitants, especially those engaged in shifting cultivation in the subject area, will be essential. Therefore, priority should be given to the implementation of the following measures prior to the commencement of any Project-related work.

- 1) Training of inexperienced technicians and workers.
- 2) Establishment of smooth communications with local inhabitants, especially those engaged in shifting cultivation, through the provision of assistance by village chiefs and others and also the establishment of close links with people of related government institutions, including the Department of Agriculture.
- 3) Prior coordination of various works in the Project.

(2) Measures Vis-a-Vis Local Inhabitants

Since the Project should prove beneficial for not only the Project implementation agency but also for local inhabitants, the following measures should be implemented.

- 1) Preparation of an employment plan taking expansion of stable employment opportunities for local inhabitants into account.
- 2) Construction of forest roads and water supply facilities, etc. to upgrade local infrastructure.

- 3) Implementation of carefully thought out measures from a long-term perspective to induce local farmers currently engaged in shifting cultivation to switch to fixed plot farming with high productivity.

- (3) Consolidation of Exhibition Forest and Seed Collecting Forest in Benakat Experimental Forest

The forests created by the South Sumatera Afforestation Project of JICA are the result of the first mechanized afforestation efforts for alang-alang grassland and the techniques and technologies established through these efforts have been inherited by the South Sumatera Afforestation Technical Centre (BTR). The following measures should be adopted to further develop these techniques and technologies in order to provide useful lessons for the Project.

- 1) Integrated collection of various data through continuous observation at each experimental site.

- 2) Application of an experimental forest as an exhibition forest or a model forest to serve as a pilot forest for any afforestation project in the future.

- 3) Application of an experimental agroforestry site to seek possible means of coexistence between agriculture and forestry in the subject area.

- (4) Implementation of Large-Scale Afforestation Guidance Programme

As the Project is large-scale afforestation involving a large quantity of various types of machinery, the following types of international assistance will be essential for its success in addition to the provision of advice and work supervision by consultants.

- 1) Comprehensive technical cooperation which includes the training of engineers specializing in large-scale forestry management.
- 2) Continuous, as well as enhanced, assistance for forests established under the South Sumatera Afforestation Project through JICA's technical cooperation.

CHAPTER 1
INTRODUCTION

Chapter 1 INTRODUCTION

1-1 Background

Indonesia is one of the most prominent forest countries in the world with some 144 million hectares of forest land accounting for 75% of Indonesia's total land area. Forestry accordingly plays an important role in the national economy.

Economic development in Indonesia has been based on a series of 5 Year Plans since the commencement of the First 5 Year Development Plan in 1969.

The Fifth 5-year Development Plan (1989/90 - 1993/94) calls for increased afforestation, improved timber production and the promotion of sawmilling and other timber-related industries. With regard to increased afforestation, the completion of 4.4 million hectares of industrial plantation over a period of 15 years is planned through the Fifth, Sixth and Seventh Development Plans.

In this context, the Government of Indonesia made a formal request in January, 1986 to the Government of Japan to conduct a feasibility study for the Industrial Plantation Forest Development Plan.

In response to this request, the Government of Japan sent the Preliminary Survey Team to Indonesia in March, 1988 to conduct research and discussions on the background of the request, institutional arrangements for industrial plantation and the contents of the subsequent full-scale study. The Survey Team concluded the S/W with the Indonesian side on March 25, 1988.

1-2 Objective

The objective of the present Study is the preparation of the Industrial Plantation Forest Development Plan for the Benakat Area in South Sumatera, the Republic of Indonesia, through the clarification of the technical viability and financial and economic feasibility of the Plan and assessment of its national environmental and social environmental impacts with a view to contributing to the promotion of industrial plantation development and the improvement of the planning capability in Indonesia.

1-3 Study Area

The Study Area is located between 103°34' and 103°48'E and between 3°10' and 3°34'S and is some 130km southwest of Palembang, the capital of South Sumatera Province, and north of Muara Enim, the capital of Kab. Muara Enim, formerly Kab. LIOT (Kab stands for Kabupaten which means administrative district in Indonesian language).

Final identification of the Study Area boundaries was made by the Ministry of Forestry on November, 1988 and the total Study Area of 50,242ha covers parts of Kab. Musi Banyuasin, Kab. Musi Rawas, Kab. Muara Enim and Kab. Lahat.

The location and boundaries of the Study Area are shown in Fig. 1-1 and Fig. 1-2 respectively.

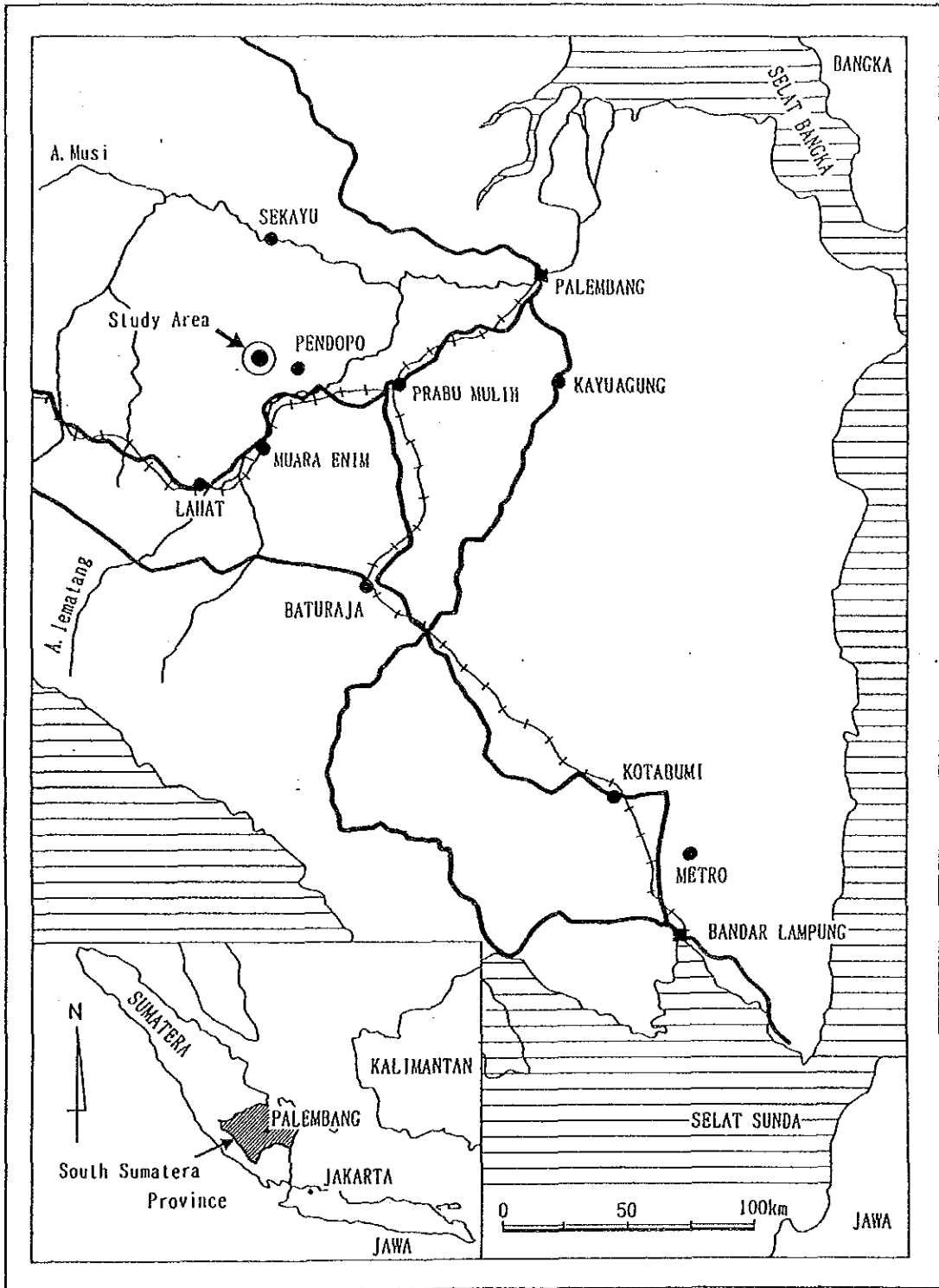


Fig. 1-1 Location of the Study Area

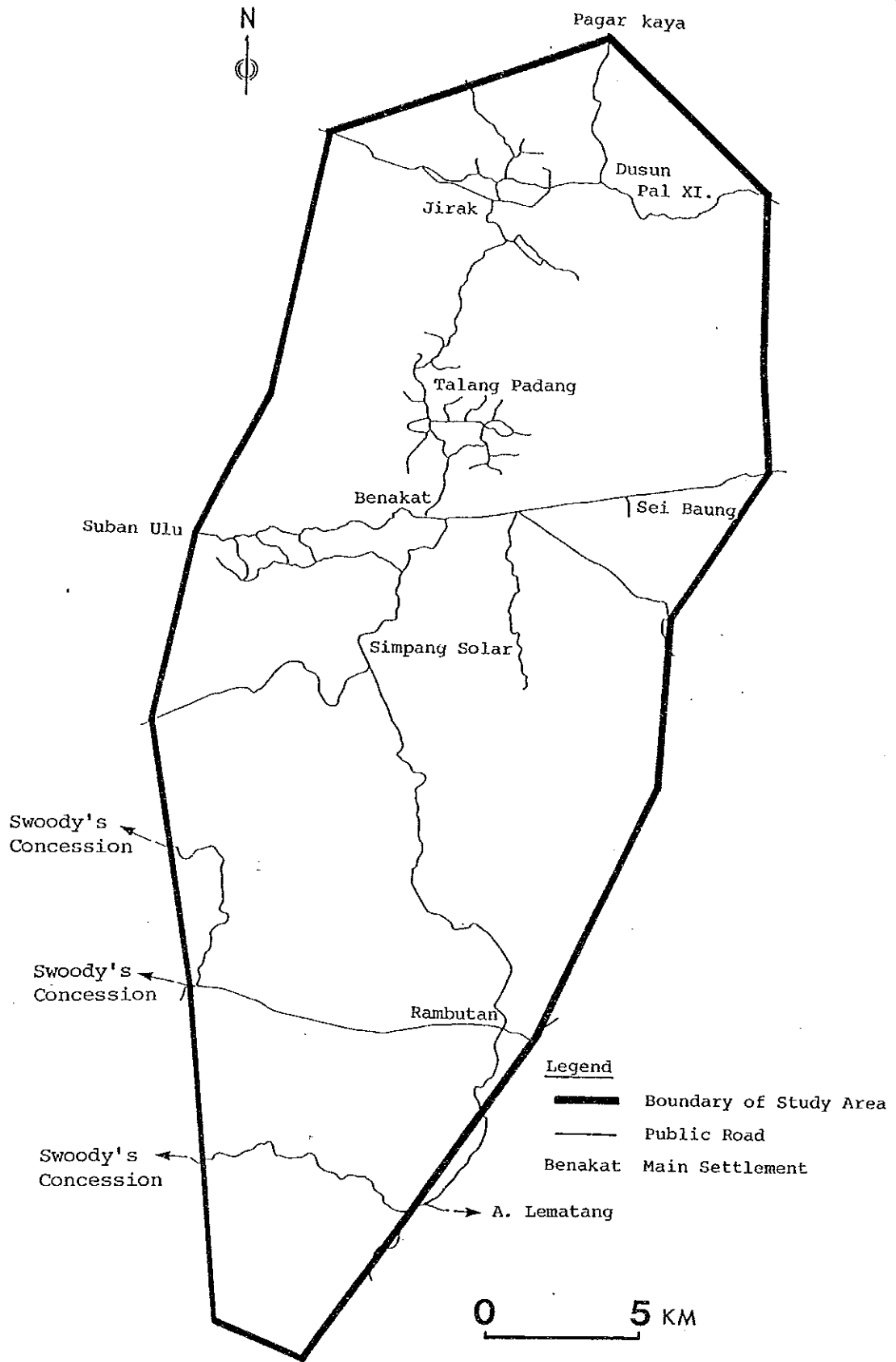


Fig. 1-2 Boundaries of the Study Area

1-4 Contents of the Study

The implementation of the Study is planned in 2 fiscal years with the following contents for each year.

(1) Study in Fiscal 1988

The following activities were conducted in the period between November 1988 and March 1989.

- preliminary preparations in Japan
- first phase field survey and second phase field survey
- preparation of topographic maps (1:20,000)
- preparation of land use / vegetation maps and soil maps
(1:20,000)

(2) Study in Fiscal 1989

The following activities commenced in July 1989 with planned completion in March 1990.

- compilation of Forest Inventory Books
- formulation of the Plan and Project evaluation
- submission of Draft Final Report
- submission of Final Report

The study flow of the above activities is shown in Fig. 1-3.

(1988) F/Y

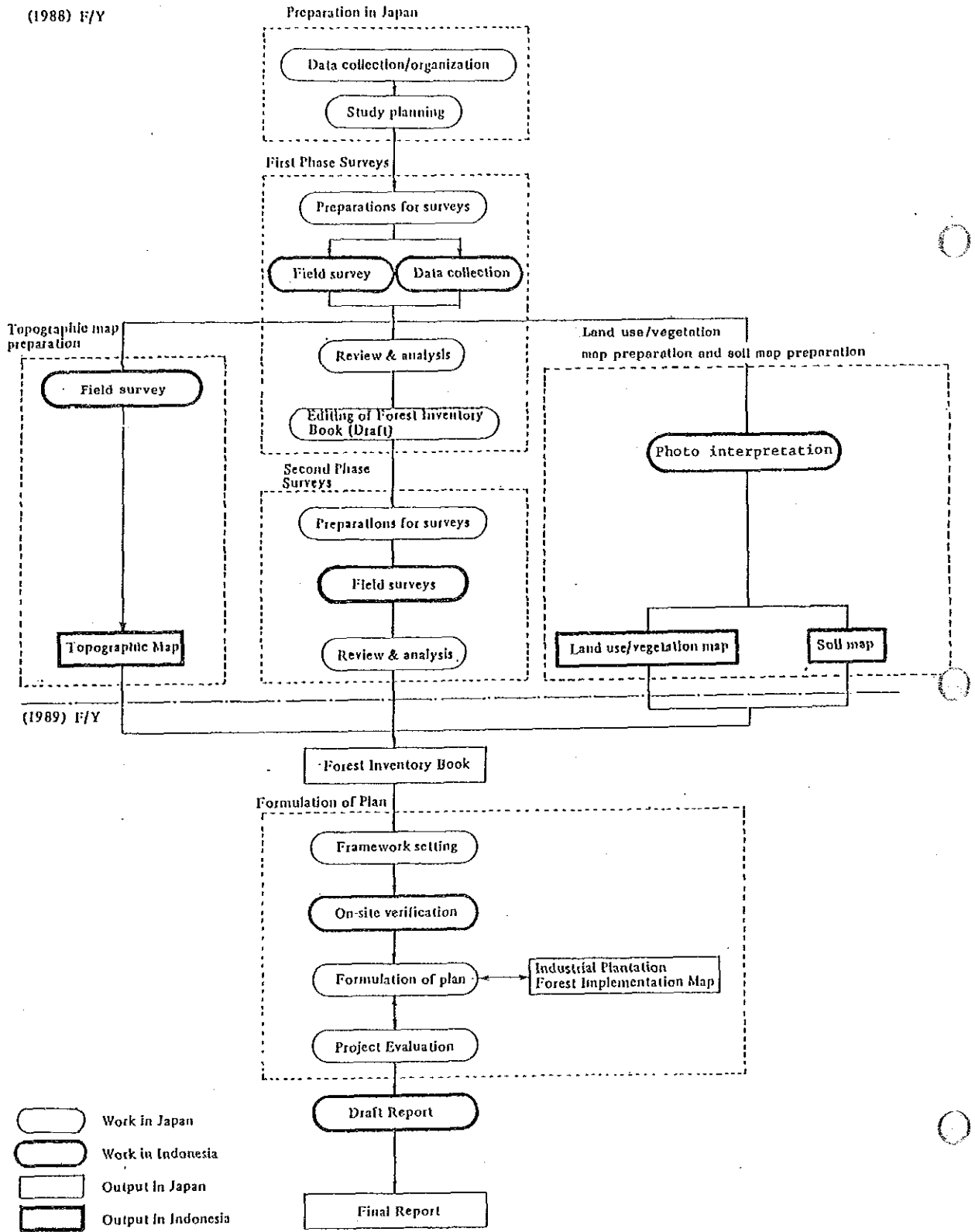


Fig. 1-3 Study Flow

1-5 Technology Transfer

Technology transfer from the Survey Team to the counterparts was conducted during the field survey period on the basis of practical training (i.e. learning by doing). Since the present Study aims at the preparation of the Industrial Plantation Forest Development Plan and examination of its feasibility, the following were stressed in the course of technology transfer.

- 1) study method and work process for plan preparation and evaluation method
- 2) preparation methods of various maps and forest inventory books which are the starting point of planning

In the course of the field survey in fiscal year 1988, discussions were held on the planning process of the Industrial Plantation Forest Development Plan specified in the Inception Report, previous Indonesian afforestation work, including fire-protection measures, and basic items such as the selection of appropriate tree species for the Plan. The Survey Team tried not to simply give an explanation but to listen to the opinions of the counterparts to fully utilize their knowledge and experience.

The actual contents of technology transfer in each survey field were as follows.

- 1) Afforestation Plan, Forest Management: forest inventory method, volume estimation method and work process of Industrial Plantation Forest Development Plan, etc.
- 2) Socioeconomic and Financial Analyses: compilation of basic items for financial planning and fund raising method, etc.

- 3) Forest Road and Facilities: construction standards for forest roads in the Study Area and problem-solving method for problems anticipated in construction work.
- 4) Soil: preparation process of soil maps and soil classification method, etc.
- 5) Land Use and Vegetation: aerial photo interpretation method, classification criteria principles, transfer technique and on-site confirmation method, etc.
- 6) Topographic maps: aerial triangulation and other necessary items required for the preparation of topographic maps with special emphasis on the on-site pricking method and on-site work procedure, etc.

In the course of the Study in fiscal 1989, the methodologies and processes relating to the compilation of the Forest Inventory Books, formulation of the Industrial Plantation Forest Development Plan and the project evaluation were explained to the Indonesian counterpart using the Interim Report in order to facilitate the understanding of the counterpart vis-a-vis the Plan and also to promote the technology transfer of the formulation method for an industrial plantation forest development plan.

CHAPTER 2

ROLE OF FORESTRY IN NATIONAL ECONOMY

Chapter 2 ROLE OF FORESTRY IN NATIONAL ECONOMY

2-1 Current Conditions of Indonesia

Indonesia is the largest archipelago country in the world, consisting of some 13,000 islands which are scattered over some 5,100km in the east-west direction and some 1,600km in the north-south direction on both sides of the equator. It has a total land area of 1.92 million km².

While the climate is tropical with little seasonal change, it is generally divided into the rainy season (November - March) and dry season (April - October). The mean monthly temperature is around 27°C throughout the year.

Indonesia is a multi-racial country consisting of many ethnic groups with diverse cultures, languages and customs. While the modernization process has been advancing, the religious ideas and cultures inherent in these ethnic groups still survive. Some 90% of the population are said to be moslems who have a strong influence on both Indonesian society and economy as shown by the fact that businesses, etc. close on Fridays.

As of 1988, Indonesia has population of 176 million, of which 60% lives on Java Island which accounts for less than 7% of the total land area. The ever increasing population (annual increase rate of some 2%) and the high population concentration in urban areas with resulting overcrowding are serious social problems.

The two main pillars of Indonesian industry are the rich oil and gas resources and agriculture in which a large proportion of the population is engaged.

Because of abundant forest resources timber related industries (producing sawn timber and plywood, etc) are also playing an important role in industrial development.

2-2 National Economy and Forestry

2-2-1 Position of Forestry in National Economy

Economic development in Indonesia has been based on a series of 5 Year Plans since the commencement of the First 5 Year Development Plan in 1969. The transition of the Indonesian GDP is shown in Table 2-1 while the general conditions of the Indonesian economy are summarized in Attached Table 1-1.

While the average annual real growth rate of the GDP during the Fourth Plan period was 4%, a real growth rate of 5% is expected for the Fifth Plan period.

Table 2-1 Transition of Indonesian GDP

(Unit: 1 billion Rp, %)

Year	Nominal GDP	Real GDP	
		Amount	Growth Rate
1973	6,753.4	6,753.4	-
1974	12,642.5	7,630.8	-
1978	22,746.0	9,566.5	-
1983A	71,214.7	12,842.2	-
1983B	73,697.6	73,697.6	-
1984	87,054.8	78,144.4	6.0
1985	94,491.5	79,910.8	2.3
1986	96,489.3	82,474.5	3.2
1987	114,518.5	86,307.1	3.6

Note: Figures for 1973 to 1983A are based on 1973 prices and figures for 1983 onwards are based on 1983 prices.

Source: B.P.S.

Table 2-2 shows the contribution of each industrial sector to the GDP. With the advancement of industrialization, the contribution ratio of agriculture, forestry and fisheries declined from 44% in 1974 to 23.2% in 1988 which was lower than the combined figure of 30.3% for the mining and manufacturing industries. The ratio of the work force in agriculture, forestry and fisheries, however, was as high as 55.1% in 1986 and dependence on this sector is still strong.

Table 2-2 Sectoral Contribution to GDP and Average Growth Rate

	(Unit: %)		
	1988	1993 (PLAN)	Annual Growth Rate in Fifth Plan Period
1. Agriculture, Forestry and Fisheries	23.2	21.6	3.6
2. Mining	15.9	12.6	0.4
3. Manufacturing	14.4	16.9	8.5
4. Construction	5.6	5.8	6.0
5. Commerce	15.9	16.7	6.0
6. Transportation and Telecommunications	5.7	6.0	6.4
7. Others	19.3	20.4	6.1
Total	100	100	5.0

Source: Fifth 5-Year PLAN

Agriculture in Indonesia is based on large plantations of palm oil and tea, etc. and on small-scale farmers cultivating rice and cassava, etc. Although advancement has been recorded in the increased production of food to achieve a self-sufficient supply of rice, Indonesian agriculture still faces a number of problems, including such inadequate infrastructure as poor irrigation facilities and roads, the poverty of small-scale farmers and poor employment opportunities outside the agricultural sector.

The Indonesian economy still largely depends on earnings from oil and gas exports although the break from this dependence and the increased export of non-oil/gas products are now given priority for future economic development. The export of forest products is strongly hoped for in this context.

Table 2-3 shows the role played by forest products in the national economy in terms of export earnings. The total export value of logs, sawn timber, plywood and rattan has been increasing and its ratio in the total export value has rapidly increased. The export value of forest products reached 2,618 million dollars in 1987, 14.3% of the total export value. The role of these products in the national economy has become increasingly crucial in accordance with their increased importance as export items (see Attached Table 1-2).

Table 2-3 Transition of Export Amount

(Unit: million dollars)

Item	Year						Annual Growth Rate (%)
	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89 (Estimate)	
Oil and Gas	14,449	13,994	12,437	6,966	8,341	7,473	-12.3
Non-Oil/Gas	5,367	5,907	6,175	6,731	9,502	11,225	15.9
Logs	250	135	2	3	3	-	
Rattan	87	96	80	99	160	231	21.7
Plywood	579	697	845	1,156	1,832	2,104	29.4
Sawn Timber	332	336	367	433	623	697	16.0
Forestry Product	1,248 (6.3)	1,264 (6.4)	1,294 (7.0)	1,691 (12.4)	2,618 (14.3)	3,032 (16.2)	
Total Export Amount	19,816	19,901	18,612	13,657	18,343	18,703	-1.1

Source: Fifth 5 Year Plan

Note: Figures in brackets are percentages of the total export amount.

2-2-2 Trends of Forestry and Forest Industry

(1) Forest Resources

Indonesia has some of the world's richest forest resources with current standing stock of 5,483 million m³ over a forest area of 144 million ha which accounts for some 75% of the national land. (Attached Table 1-3, 1-4) However, it is said that some 18 million ha has been converted to along-alang grassland due to burning for livestock raising and shifting cultivation purposes, suggesting the progressive deterioration of the forests and a reduction of the land productivity.

Indonesia classifies forests into the 5 categories in view of their main usage. The respective ratios of these 5 categories are 21% for protection forests, 13% for national parks and reservation forests, 21% for limited production forests, 24% for non-convertible production forests and 21% for convertible production forests.

(2) Forestry Production

The log production volume rapidly increased in the 1970's. Most logs were exported and Indonesia became a major wood exporting country for Japan, providing more than 50% of Japan's tropical wood imports. The rapid development however, led to grave concern regarding the extinction of forest resources, resulting in the control of log exports. Consequently, the export of logs and other forest products which was previously actively promoted was restricted to foster a highly value added domestic wood processing industry in order to effectively utilize the forest resources and to create employment opportunities. The starting point was the issuing of permission of log exports only to plywood manufacturers in 1981. Undried veneer sheet exports were prohibited in 1982, log exports were prohibited in 1985 and restrictions on sawn timber exports of certain species, including white meranti, were introduced in 1986. While restrictions on wood exports have accelerated as described above, the domestic timber industry has been aggressively promoted. (Table 2-4)

Table 2-5 shows the forestry production cited in the Fifth 5 year Forestry Development Plan and the Production of special purpose forest products has been increasing. In particular, a large increase has been recorded for rattan production (see Attached Table 1-5) and a further increase is strongly hoped for during the Fifth Plan period.

Table 2-4 Log Production (Fifth 5 Year Forestry Development Plan)

Year	Production Volume (m ³)
1983/84	23,462,000
1984/85	26,958,000
1985/86	23,500,000
1986/87	26,605,000
1987/88	32,300,000*
Average	26,000,000m ³ /year**

* including 4,734,000m³ which was not officially recorded

** additional 122,000,000m³/year was produced as fuel wood

Table 2-5 Forestry Production in Fifth 5 Year Development Plan

(a) Log Production	Production Forests:	145 million m ³
	Other Forests	: 12 million m ³
	Total	: 157 million m ³ (143.91)*
(b) Production Other Than Logs	Rattan	: 1,125,000 tons
	Resin	: 16,250 tons
	Oil (Seed):	15,000 tons
	Cocoons	: 1,500 tons
	Fuel Wood	: 511.28 million m ³

* actual production volume during Fourth 5 Year Plan

(3) Afforestation

Afforestation has a long history in Indonesia which commenced with teak afforestation on Java Island in the 19th century. Nationwide afforestation efforts have been particularly noticeable in recent years, not only to implement reafforestation but also to protect the environment. For example, the afforestation of 359,792ha was planned under an emergency plan based on a Presidential instruction budget in fiscal 1986/87, of which the afforestation of 281,374ha has been completed. The reforestation plan showed an achievement rate of 83% at 79,926ha against the planned 96,178ha while the afforestation plan achieved a rate of 75% at 177,838ha against the planned 236,321ha. The community forest plan stipulated by another presidential decree achieved a rate of 81% at 14,838ha against the planned 18,321ha while the joint afforestation plan with the Army achieved a rate of 98% at 8,772ha against the planned 8,972ha.

Table 2-6 shows the afforestation achievements during the Fourth 5 Year Plan period and the planned afforestation area during the Fifth 5 Year Plan period.

Table 2-6 Actual Achievements and Planned Areas for Afforestation and
Revegetation (Unit: ha)

	4th 5 Year Development Plan	5th 5 Year Development Plan		
		1989	1993	5 Year Total
a) Afforestation				
Non-HTI	---	100,000	100,000	500,000
Replanting	69,160	116,000	116,000	580,000
Reforestation	1,804,540	50,000	50,000	250,000
Natural Forest Work	229,700	100,000	100,000	500,000
b) Revegetation	1,464,000			
Model Forests	---/4,470	5/500	5/500	25/2,500
Social Forests	243,810	30,000	30,000	150,000
Distribution of Seedlings	---	560,000	560,000	2,080,000
c) Industrial Plantation Forests (HTI)	72,270	100,000	400,000	1,500,000

Afforestation projects in Indonesia are implemented either directly by central government agencies such as the Provincial Forest Services, by state forest enterprises such as Perm Perhutani or by private companies.

1) Central Government

Many afforestation projects are implemented by the central government with the Presidential Instruction Budget. In the case of the present administrative structure, the Ministry of Forestry (Departmen Kehutanan) commissions the project management and supervision to the Provincial Forestry Service (Dinas Kehutanan) via the Regional Forestry Office (Kanwil Kehutanan).

The Field Survey Team observed a number of afforestation sites which are managed by the South Sumatera Provincial Forestry Service, around the Study Area and in Subanjeriji. Afforestation in Subanjeriji was conducted between 1978 and 1987 by 4 local contractors under the supervision of the Provincial Forestry Service.

2) State Enterprises

In addition to Perum Perhutani, 4 other state enterprises are engaged in forestry work, i.e. PT Inhutani I, II, III and PT Marunda Wood Center. A major part of the budget of these 5 state enterprises is financed by the Ministry of Finance and their personnel and technical aspects are controlled by the Ministry of Forestry.

Excepting PT Marunda Wood Center, all these enterprises cover the entire scope of forestry work, ranging from planting to felling and further to the processing and sale of wood products, playing an important role in industrial plantation.

Perum Perhutani in particular has a long history of teak afforestation and production, mainly on Java Island, and is the oldest and largest state forest enterprise. It currently manages 3.18 million ha of forests and employs some 16,000 workers.

The activities of the PT Inhutani are also diverse, ranging from log production to product sale, and they have their own nurseries and afforestation sites. The main places of business are East Kalimantan for PT Inhutani I, South Kalimantan and Irian Jaya for PT Inhutani II and both Central and West Kalimantan for PT Inhutani III. Afforestation work near the Study Area is conducted by PT Inhutani I at Lampung in Lampung Province and by PT Inhutani II in Subanjeriji in South Sumatera Province.

The main business of PT Marunda Wood Center is log and timber transportation.

3) Private Companies

In view of the call for the promotion of industrial plantation by the Fourth 5-Year Development Plan, private companies have been actively conducting afforestation work in concessions and at other sites. Most industrial plantation work so far has been conducted by those companies with concessions (HPH) although the scale of the afforestation work is not as large as that conducted by the state enterprises and the work is mainly conducted on and around the concession owned by each company.

(4) Forest Industries

1) Log Production

Log production in Indonesia is mainly conducted by companies in the possession of concessions (HPH).

According to the Forestry Statistics of Indonesia, as of August, 1987, Indonesia has a total of 538 unit with a total forest area of 55,468,350ha (an average of 103,100ha/unit) in possession of concessions allowing the production of logs for supply to the timber

industry. South Sumatera Province has 22 unit with a total forest area of 2,041,000ha (an average of 92,773ha/unit) in possession of concessions and these unit produced 19,698,000m³ of logs in fiscal 1986/87.

2) Sawmills and Plywood Factories

The production of sawn timber and plywood has largely increased in recent years (Table 2-7) as described earlier, greatly contributing to the Indonesian economy.

Table 2-7 Log, Sawn Timber and Plywood Production

Year	Sawn Timber (m ³ , equivalent log)	Plywood (m ³ , equivalent log)
1982/83	3,686,400	2,309,000
1983/84	2,710,682	2,605,141
1984/85	2,119,074	2,400,110
1985/86	2,643,403	4,322,443
1986/87	7,442,000	5,302,000
1987/88	9,750,000	6,400,000

Source: Forestry Statistics of Indonesia 1987/88

Table 2-8 gives the Fifth 5 Year Plan forecast for sawn timber and plywood production.

Table 2-8 Production Capacities and Production Volumes of
Sawing and Plywood Industries (Unit: 1,000m³)

		4th 5 Year Development Plan (1987) 5 Year Total		5th 5 Year Development Plan (1989) (1993) 5 Year Total		
		a) Sawing	Production Volume	9,750	41,110	9,210
	Production Capacity	15,612				
	Operation Rate	62%				
	5 Year Average	48%				
b) Plywood	Production Volume	6,400	26,450	6,900	7,200	35,000
	Production Capacity	7,426				
	Operation Rate	86%				
	5 Year Average	75%				

Source: Fifth 5-Year Development Plan

3) Pulp and Paper Production

The production of pulp and paper also conspicuously increased during the Fourth Plan period. This is stimulating hope for enlarged wood production by means of industrial plantation forests. The Fifth 5 year Development Plan estimates a total production volume of pulp and paper of 2,539,000 tons during the plan period which is 5 times larger than the actual production volume of 551,000 tons during the Fourth Plan period, all products are to be domestically consumed (Table 2-9). While pulp and paper factories used to be concentrated on Java island with such large consumption areas as Jakarta and Sulavaya, new factories have

recently been constructed in other areas, including on Sumatera Island. The construction plans for the pulp and paper factories are shown in the attached table 1-6. In addition to the pulp and paper industry, the particle board and furniture industries are also given development priority and are expected to grow in the near future.

Table 2-9 Pulp and Paper Production Volumes
(Unit: 1,000 ton)

IV	1989/90	90/91	91/92	92/93	93/94	V Total
551	375	454	570	570	570	2,539

(5) Market, Commercial Distribution

Indonesian sawn timber and plywood are widely exported to many countries, including countries in Southeast Asia, Europe and North America, as shown by the export statistics. (Attached Table 1-7, 1-8).

Singapore replaced Japan and Italy as the top importer of sawn timber from Indonesia in the period between 1983/84 and 1987/88. In Asia, both Taiwan and Korea are large importers of Indonesian sawn timber. In the case of plywood, the main importing countries in the period between 1983/84 and 1987/88 were the U.S., Middle Eastern countries, Singapore, Hong Kong and other Asian countries.

Table 2-10 gives the domestic flow of wood and wood products in Indonesia, showing the extensive scale of the commercial distribution of these products within the country.

Table 2-10 Local Product Flow of Wood and Wood Products in 1985 (in tons)

In Out	Sumatra	Jawa	Kalimantan	Sulawesi	Flores- Timor	Maluku	Irian Jaya	Total
Sumatra	2,893,151	1,156,728	85,416	92	1,010	0	0	4,136,397
Jawa	8,108	576,150	6,683	6,468	22,175	6,084	1,554	627,222
Kalimantan	479,519	1,719,368	1,333,632	47,175	115,717	4,021	0	3,699,432
Sulawesi	2,207	7,127	10,925	512,838	3,688	12	91	536,888
Fl.-Timor	0	1,742	33	26	66,258	0	0	68,059
Maluku	2	135,627	72,832	52,723	101,527	135,468	6	498,185
Irian Jaya	0	387	180,018	3,435	2	11	126,344	310,197
Total	3,382,987	3,597,129	1,689,539	622,757	310,377	145,596	127,995	9,876,380

(6) Wood Products Prices

Table 2-11 gives the export prices (FOB) of sawn timber by species in 1987.

The average export price of sawn timber and plywood are shown in Table 2-12.

Although a straight comparison between domestic prices and export prices can be misleading in view of the price variation depending on grade and the latter's inclusion of various export expenses, there is a difference of some US\$ 100/m³ between the prices.

The average prices of logs, sawn timber and other wood products in South Sumatera Province are shown in Table 2-13.

Table 2-11 Volume and Unit Export Price (FOB) of Sawn Timber (1987)

Species	Volume (m ³)	Unit Price (\$/m ³)
Meranti	1,274,239	195.40
Ramin	298,165	288.48
Agathis	66,701	302.00
Teak	40,128	756.00
Pulai Group	49,561	176.17
Kapur	212,674	185.00
Others	891,652	223.24
Total/Average	2,833,120	223.29

Source: Forestry Statistics of Indonesia 1987/88

Table 2-12 Average Export Prices of Sawn Timber and Plywood

Classes	(Unit: \$/m ³)			
	1984	1985	1986	1987
Sawn Timber	138.8	154.5	186.5	223.3
Plywood	216.0	215.7	238.3	326.6

Source: Forestry Statistics of Indonesia 1987/88

Table 2-13 Average Price of Forest Products in South Sumatera

Forest Products	Unit	Price (Rp)
1. <u>Kayu Bulat</u>	m ³	
- Onglen		200,000
- Petanang		50,000
- Merawan		50,000
- Meranti		45,000
- Ramin		80,000
- Bintangur & LMSH		35,000
2. <u>Kayu Gergajian</u>	m ³	
- Onglen		300,000
- Petanang		170,000
- Merawan		170,000
- Meranti		100,000
- Ramin		100,000
- Bintangur & LMSH		70,000
3. Damar Mata Kucing	kg	3,000
4. Kayu Lapis Meranti	lbr	4,000
5. Kemiri Kupas	kg	1,350
6. Air Madu	ltr	2,750
7. Rotan Sega	kg	1,900
8. Rotan Manau	btg	2,500
9. Rotan Lacak	kg	700

Source: Dinas Kehutanan Dati I Sumatera Selatan

2-3 Administrative Organization

(1) National Administrative Organization

According to the Constitution of the Republic of Indonesia of 1945, the People's Consultative Assembly (MPR) is the supreme political institution in Indonesia.

Its main tasks are the sanctioning of the Indonesian Constitution, the determination of the Broad Guidelines of State Policy and the election of the president and Vice President.

The highest level of government also includes a Supreme Court as an independent judicial power; a Supreme Advisory Council which provides advice and proposals on national issues to the government; an Auditing Board as the controller of public finances with reporting responsibility to the House of the People's Representatives.

At the subsequent level of government there are 21 Departments, headed by Ministers with responsibility for the development of state policy and programmes in their respective sectors. (Attached Fig. 1-2)

(2) Regional Administrative Organization

For administrative purposes, Indonesia is divided into 27 provinces. Each province is again subdivided into Districts (Kabupaten), Municipalities (Kotamadya), Sub-districts (Kecamatan), and villages (Desa). A city has the status of a municipality if it is able to finance the expenditures of local administration from its own resources. The structure of these administrative units as per 1983 is shown in Attached Fig. 1-3.

(3) Forestry Administrative Organization

The Indonesian forestry administration developed in step with the growing significance of this economic sector. In 1966 a Directorate General of Forestry was first established within the Ministry of Agriculture, and the Ministry of Forestry was created as an independent ministry in 1983.

1) Ministry of Forestry

The overall structure of the Ministry of Forestry and subordinate and/or affiliated institutions is illustrated in Attached Fig. 1-4.

On headquarters level the Minister of Forestry is supported by inspectorate general and secretariat general of the ministry of forestry. Foreign cooperation like this project is conducted by bureau of foreign cooperation.

Apart from the above mentioned, the Ministry of Forestry are divided into 4 Directorates General and 3 additional Centres and/or Agencies.

The directorate general of reforestation and land rehabilitation, especially the directorate of industrial plantation are counterparts of this project.

2) Regional Forest Office

Recently the MOR has created 26 regional offices, one each in 22 provinces, and 4 in Java. The regional offices which are headed by Senior Regional Forest Officers are answerable directly to the Minister of Forestry. In their largest category the regional

offices are subdivided into 5 divisions (see Attached Fig. 1-5), namely:

- Programming Division
- Forest Utilization Division
- Reforestation and Land Rehabilitation Division
- Natural Resources Conservation Division
- Forest Administration and Land Use Division

Besides the regional forest offices there are Technical Execution Units of the MOF which work on the regional level. Each Technical Execution Unit has a Regional Center (Balai), and some have Sub-Centers (Sub-Balai) with functional groups which operate at field level.

3) Provincial Forest Services

The provincial forest services are responsible in direct line to the Provincial Governors and the Ministry of Home Affairs, respectively. Concerning technical aspects, however, they are controlled by the Ministry of Forestry, and the Regional Forest Officers are responsible for the coordination of their activities with the regional Technical Execution Units.

There are provincial forest services in each of the 22 provinces outside of Java, and in 2 of the 5 provinces on Java. The provincial forest services are structures as shown in Attached Fig. 1-6.

Their functions are derived from this structure, i.e. mainly:

- Monitoring of the activities of the concessionnaires
- Controlling wood movement

- Collection of forest royalties and taxes
- Protection and reforestation of forest areas.

(4) Laws and Regulation Relating to Forests, Forestry, Forest Industry etc.

1) Basic forestry laws

"Law No.5, Main Regulations for the Forestry Sector" issued in 1967 is Indonesia's basic forestry law.

The law entitles the government to the supervision and control of all Indonesian forests whether public or private, and authorises the government to delegate parts of its sovereignty for forestry to the provincial governments.

The law defines ownership as well as the different functions of forests in ecological, economic and social terms. The forests are classified according to their functions as protection forest, reserved forest and natural conservation forest. Laws and Regulation relating to forests, forestry, forest industry and other things are shown in Attached Table 1-9.

2) Laws concerning with industrial forest plantation

Based on the Basic Forestry Law and the decision No. 3201/KptsII (1986) of the Ministry of Forestry, several laws were enacted to promote the industrial plantation as shown in Attached Table 1-10.

3) Laws concerning with environmental impact assessment

Law NO.4 issued in 1982 is the basic law of Environment. Law No.29 and others are preparing and progressing to conserve and protect the natural, socio-economic condition from the Environmental impact in Indonesia. Laws concerning with environmental impact assessment is shown in Attached Table 1-11.

4) Laws concerning with land and other things

Indonesian land legislation is based on the Basic Agrarian Law of 1960, Law No.5, and Presidential Decree No.23 of 1980. Unlike land legislation in many Western countries, this law does not recognize the concept of freehold land rights. Instead the various rights attached to land are divided into separate elements and are subject to separate titles.

Laws concerning with transmigration is shown in Attached Table 1-12.

2-4 Status of Industrial Plantations

The Fifth 5 Year Development Plan (1989/90 - 1993/94) aims at (1) improving the national production and welfare level based on the principles of equality and justice and (2) creating a firm basis for the future stage of national development. With regard to the forestry sector, the plan states that afforestation and revegetation measures will contribute to the conservation of forest soils and water sources and the prevention of natural disasters, including floods. The plan further states that the obligation to establish extensive wood processing centers and to plant, rear and harvest trees will be added to the current concessions.

A sawn timber production increase of some 19% and a plywood production increase of some 38% on the respective production volumes in the Fourth Plan period are intended in the Fifth Plan period, indicating the importance of the growth of the forestry sector in view of the planned 5% real growth rate of the Indonesian economy during the Fifth Plan period.

In the General Plan for Forestry Development announced in 1986 with the prospect of forestry development for the subsequent 15 years upto 1999, a timber supply shortage was predicted for all Indonesian regions, except East Kalimantan, West Kalimantan and Irian Jaya, by the year 2000 assuming the continuation of the timber production pace at that time. The promotion of industrial plantation, together with an attempt to increase timber production through the proper control of natural forests, was therefore considered essential to secure an adequate supply for the rapidly expanding timber industries. Table 2-14 gives the afforestation targets of this 15 year plan.

Table 2-14 Afforestation Targets of General Plan for Forestry Development
(1986)

(Unit: 1,000ha)

Classes	-1989 (IV)	-1994 (V)	-1999 (VI)	Total
Conservation Forests	800	1,600	1,800	4,200
Industrial Plantation Forests	1,010	1,575	1,815	4,400
(for general purpose wood)	660	1,150	1,295	3,105
(for pulpwood)	350	425	520	1,295

These targets will be gradually achieved through a series of 5 Year Development Plans. Industrial plantation was firstly introduced in the second half of the Fourth 5 Year Forestry Development Plan period and an area of only 72,000ha of industrial plantation was completed at the end of the Fourth Plan period, however, to 300,000ha a year to complete the target 1.5 million ha of industrial plantation in the 5 year period.

In response to this ambitious plan, the Directorate of Industrial Plantation was newly established under the Directorate General of Reforestation and Land Rehabilitation at the time of the reorganization of the Ministry of Forestry.

2-5 Current Condition of the South Sumatera Province

2-5-1 General Conditions

South Sumatera Province has a tropical climate with an almost constant mean temperature of 26°C and relative humidity of 86% throughout the year. The rainfall is relatively low from May to August with an average of some 130mm/month and especially low in August with some 80mm/month. The rainfall begins to increase in September and reaches the peak period in March and April with over 350mm/month. The mean annual rainfall is some 2,000 - 3,000mm.

According to 1987 population statistics (Table 2-15), South Sumatera Province has a total population of 5,783,000 while Kab. Muara Enim (including the Study Area which also covers part of Kab. Musi Banyuasin) has a population of some 515,000 which accounts for 8.9% of the Province's population.

Kab. Muara Enim has a population density of 54 persons/km² which is almost the same as the average population density of South Sumatera Province of 53 persons/km². The population ratios by age group are 42.3% for between 0 and 14 years, 48.0% for between 15 and 49 and 9.7% for over 50.

Table 2-15 Population by Kabupaten and Sex
in South Sumatera Province, 1987

Regency/Municipality	Male	Female	Total
OGAN KOMERING ULU	448,459	451,301	899,760
OGAN KOMERING ILIR	360,117	382,752	742,869
MUARA ENIM	249,084	265,786	514,870
LAHAT	249,668	295,606	590,274
MUSI RAWAS	249,505	241,332	490,837
MUSI BANYUASIN	463,912	464,332	928,567
BANGKA	221,764	223,683	445,447
BELITUNG	92,945	87,691	180,636
PALEMBANG	433,649	447,072	880,721
PANGKAL PINANG	54,776	54,994	109,770
1987	2,868,879	2,914,872	5,783,751
1986	2,818,505	2,853,180	5,671,615
1985	2,706,589	2,751,723	5,458,312
1984	2,663,517	2,694,271	5,357,789
1983	2,590,331	2,618,157	5,208,488

Source: Kantor Statistik Provinsi Sumatera Selatan/Statistical
Office Province of South Sumatera

2-5-2 Forestry and Forest Industries

(1) Forestry

South Sumatera Province in which the Study Area is located has a forest area of 5,214.70ha (standing stock of 102,374,000m³), accounting for 51% of the Province's total land area and 4% of Indonesia's total forest area. Its standing stock accounts for 2% of the total standing stock in Indonesia.

Table 2-16 shows the land utilization in South Sumatera Province. The respective ratios of protection forests, national park and reservation forests, limited production forests, non-convertible production forests and convertible production forests are 15%, 15%, 6%, 41% and 23%.

Table 2-16 Forest Areas in South Sumatera Province

(Unit: ha)

Total National Land	Protection Forest	National Park & Reservation Area	Limited Production Forest	Non-Convertible Production Forest	Convertible Production Forest	Total Forest Area
10,277,500	774,700	796,500	333,000	2,124,000	1,186,500	5,214,700

Source: Forestry Statistics of Indonesia 1985/86

According to the Forestry Statistics of South Sumatera Province the afforestation of some 5,000ha was conducted in 1986. The breakdown of this 5,000ha is 1) 2,400ha by private companies possessing concessions, 2) 2,400ha by the Forestry Bureau using the Presidential special budget (INPRES) and 3) 200ha by the South Sumatera Department of Forestry for experimental purposes.

1) above is afforestation work classified as industrial plantation. Of the total 23 concession holders, 2 are currently engaged in industrial plantation. Actual afforestation work is usually conducted by those companies specializing in afforestation on the basis of subcontracting by concession holders or the Forestry Bureau. There are 19 such companies in South Sumatera Province and all are located in Palembang. The afforestation work referred to as 3) above is a technical cooperation project of JICA.

The following table shows the planned industrial plantations in South Sumatera Province.

Table 2-17 Industrial Plantation Forest Development Plan in South Sumatera

Name of Enterprise	Planned Area
PT. INHUTANI II	±51,000
PT. Palembang	±45,000
HTI Benakat/Semangus	±50,000
PT. Bumi Raya Utama	±29,000
PT. Swody	±20,000
CV. Dewi Sri Indah	±16,000
PT. Phala Wana Lestari	±15,000
PT. Komala Mas	± 7,406
PT. Wai Hitam	±26,300
Total	±259,706 ha

Source: South Sumatera Provincial Forest Service, 1989/90

(2) Forest Industries

Timber production in South Sumatera Province from the First through Fourth 5 Year Plans showed a general increasing tendency. Log production, however, suddenly declined in fiscal 1981 during the Third Plan period due to the introduction of export restrictions after maintaining the million m³ level since fiscal 1975 (Table 2-18).

The production of sawn timber was around 200,000m³ after the mid-1970's but suddenly increased to 450,000m³ in 1981. It has gradually increased since 1981 and slightly less than half is exported (half of the total exports go to Japan).

The production of plywood commenced in the Second Plan period and rapidly increased thereafter. Production in the first 4 years of the Fourth Plan period already exceeded the total production in the Third Plan period, indicating a further increase for the Fourth Plan period. Some 80% of the plywood is exported.

Table 2-18 Wood Production in South Sumatera Province by 5 Year Plan Period (Unit: 1,000m³)

5 Year Plan	Year	Log	Sawn Timber	Plywood	Veneer Sheet	Molding
First	1969/1970	511	14	-	-	-
	1970/1971	499	37	-	-	-
	1971/1972	500	58	-	-	-
	1972/1973	1,397	98	-	-	-
	1973/1974	943	285	-	-	-
	Total	3,849	492			
Second	1974/1975	800	96	8	-	-
	1975/1976	1,334	239	9	-	-
	1976/1977	1,075	258	11	-	-
	1977/1978	1,356	133	13	-	-
	1978/1979	1,709	204	66	-	-
	Total	6,274	928	109		
Third	1979/1980	1,222	271	27	-	-
	1980/1981	1,577	278	123	13	1
	1981/1982	995	447	106	59	2
	1982/1983	882	439	144	0	2
	1983/1984	907	561	151	-	4
	Total	5,572	1,997	551	72	9
Fourth	1984/1985	1,147	561	156	1	5
	1985/1986	1,234	464	121	2	2
	1986/1987	1,239	483	219	4	12
	1987/1988	978	470	203	4	12
	1988/1989					
	Total	4,587	1,978	699	11	31

Source: Dinas Kehutanan Propinsi Pati I Sumatera Selatan 1988

Note: The log production figure for 1987/1988 is upto November 1987.

As of 1987, 16 sawmills with a sawing capacity of 540,500m³/year are currently operating in South Sumatera Province, accounting for 6.1% of Indonesia's total sawing capacity (or 4.65% if the sawing capacities of mills under construction and application are taken into consideration).

There are 4 plywood factories in South Sumatera Province with a processing capacity of 202,700m³/year, accounting for 4.08% of the total plywood processing capacity of Indonesia (or 3.12% if the processing capacities of factories under construction and application are taken into consideration).

As shown in Table 2-10, the main market for wood products from South Sumatera Province is Jakarta, followed by Kalimantan and other areas.

The species for sawn timber in South Sumatera Province are diverse and include Meranti, Mersawa, Djeluton and Ramin, all of which are frequently found in tropical rain forest land.

D

CHAPTER 3
CURRENT CONDITION OF THE STUDY AREA

)

Chapter 3 CURRENT CONDITION OF THE STUDY AREA

3-1 General Condition

The Benakat area belongs to the South Sumatera Province and is slightly hilly consisting of grasslands, secondary forests and young afforestation areas. It is located between S. Musi (total length: some 700km, a large river traversing South Sumatera Province) and S. Lematang, a tributary of S. Musi.

The topography is characterized by numerous small rivers and swamps between low altitude hills with a gradient of upto 20°. the ridge areas are generally flat. Gentle hilly slopes and flat land around the hills occupy a large proportion of the land area. The soil is generally clayey with poor air and water permeability and the lowland becomes over saturated during the rainy season with adverse effects on local development efforts, including afforestation and road maintenance.

The Study Area covers part of 4 Kabupatens (District), i.e. Kab. Musi Banyuasin, Kab. Musi Rawas, Kab. Muara Enim and Kab. Lahat, and the section belonging to Kab. Muara Enim is the largest. The administrative establishments responsible for the Study Area are the South Sumatera Provincial office in Palembang and the Kab. MUara Enim Office in Muara Enim which s located in the southwest of the Study Area.

The Study Area is located some 180km from Palembang and access from Palembang is via Prabumulih and Pendopo. Many oil fields are scattered in the Study Area and the roads connecting these oil fields provide the transportation network. There are many small villages along these roads, together with cultivation sites of rice and vegetables,

agricultural plantations producing palm oil and rubber and grazing land for goats and cattle.

Agriculture in the Study Area is based on the slash and burn method which has resulted in the deterioration of the soil's fertility due to the spread of fires, in turn devastating the local forests. While government attempts have been made to settle the farmers in order to prevent the devastation of the forests, these attempts have been unsuccessful. A large tract of alang-alang grassland and bushland has, therefore, been generated.

3-2 Climate

The Study Area has a wet tropical climate and a rainfall type A (Schmidt & Farguson, 1951). According to the Köppen system the area has an Af climate i.e. a tropical rainy climate without pronounced dry months and with a daily temperature during the driest month constantly higher than 22°C. In general, the rainy season is between November and March while the dry season is between April and October.

According to 1984/85 data provided by the South Sumatra Reforestation Technical Center, the mean annual temperature and annual precipitation are 25.8°C and 1,906mm respectively. While the mean monthly temperature is almost constant throughout the year, the monthly precipitation largely varies from 6mm in August to 283.5mm in March. Precipitation is recorded on some 20 days a month in the rainy season and on less than 10 days a month in the dry season (Fig. 3-1).

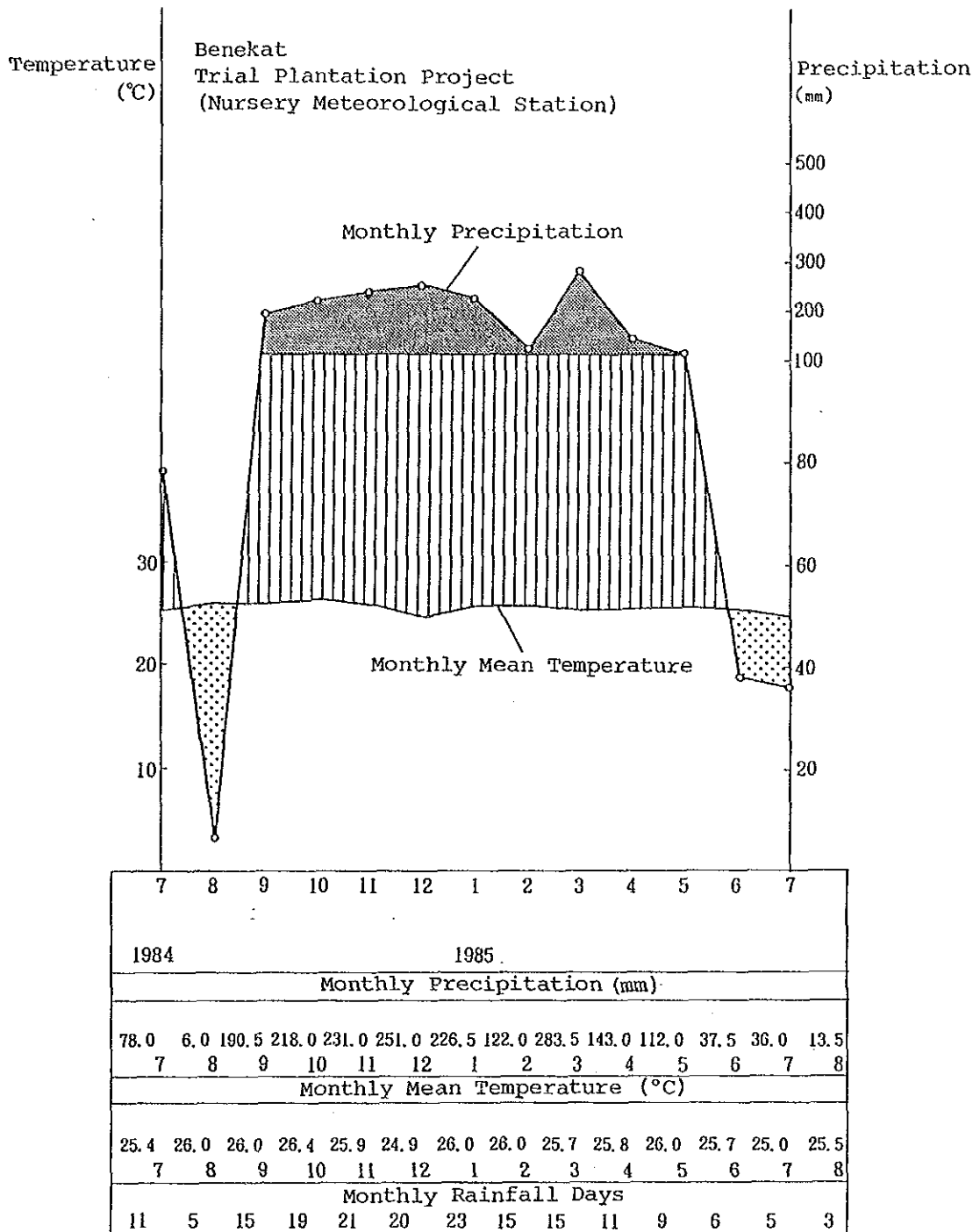


Fig. 3-1 Mean Monthly Temperatures and Monthly Precipitation in Benakat

3-3 Topography

The Study Area and its vicinity consists of peneplains with hills, rolling land and undulating land. In general, the relief energy is low while the valley density is high. The average elevation is 80m or less although the elevation of flat plane on hilltops sometimes reaches some 100m and the elevation of the flat plane of the valley bottoms is generally around 50m. Elevations of less than 5m are observed in places in the basin of S. Keruh (S stands for Sungai which means river in Indonesian language) in the north.

The Study Area is located in the Musi-Lematang river basin. Although there are no large rivers, tributaries of S. Lagan (S. Mambok, S. Kembangar and S. Kecil) and S. Benakat (S. Rambutan, S. Sepanggung and others), both of which are tributaries of S. Lematang, run through the Study Area. In addition, these tributaries have their own minor tributaries and S. Jirak, S. Manaukurang and S. Sapat, tributaries of S. Keruh (in turn a tributary of S. Musi) also run through the Study Area.

Small swamp areas are observed along roads.

Fig. 3-2 shows the drainage pattern in the Study Area.

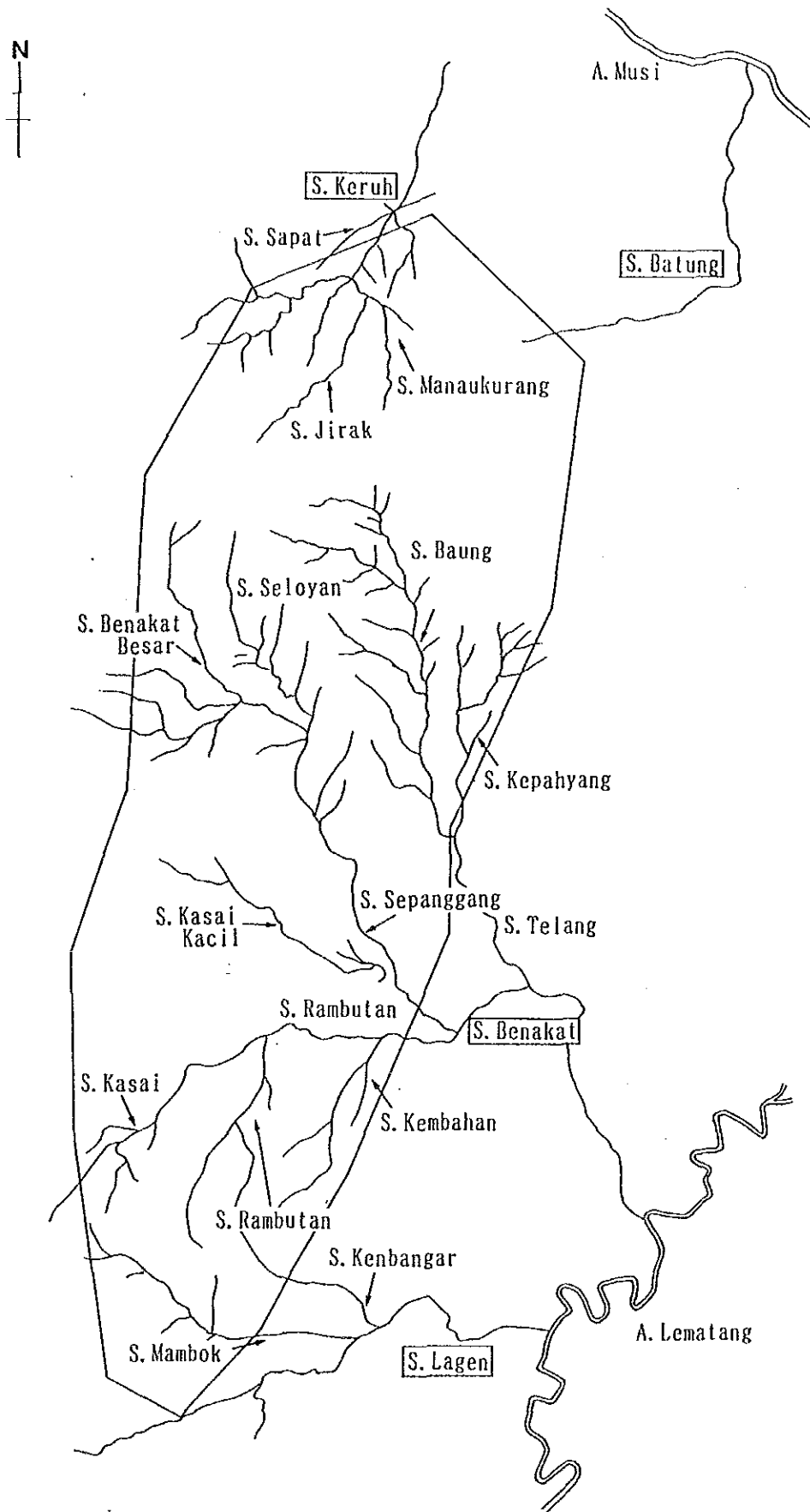
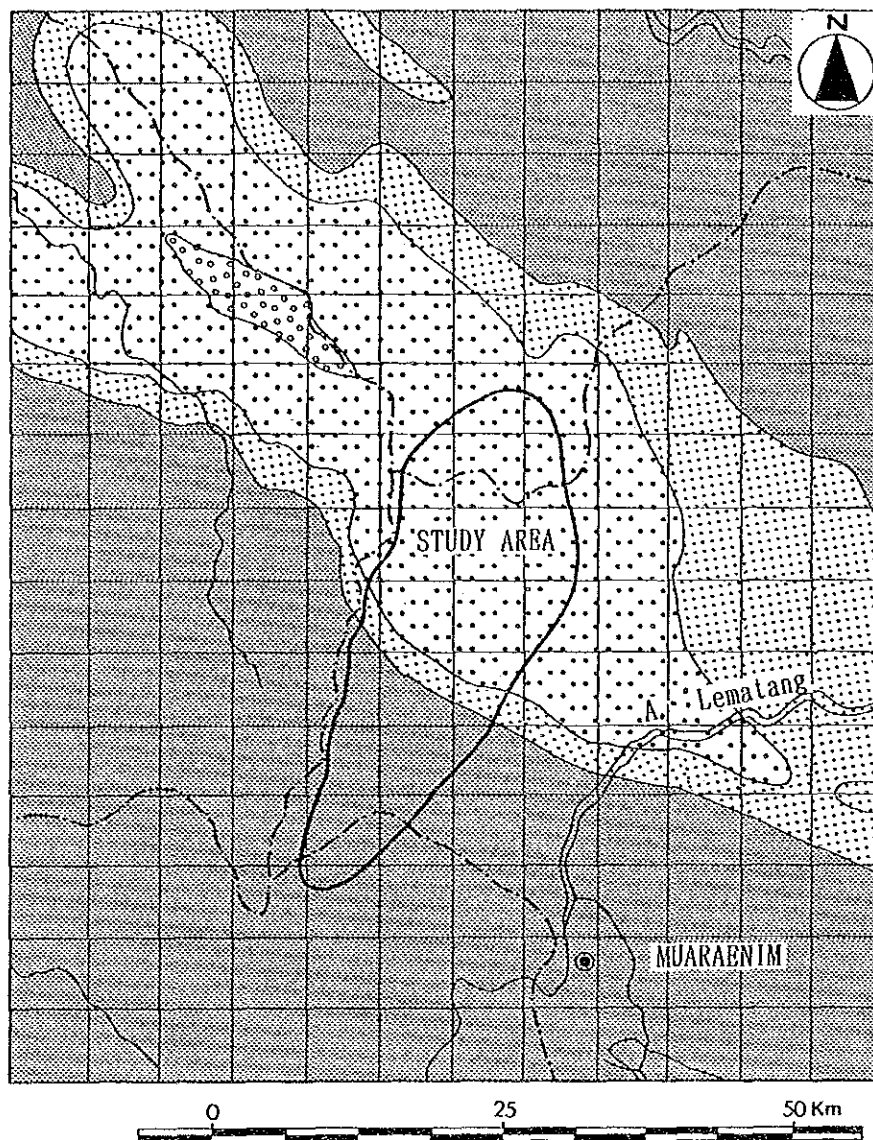


Fig. 3-2 Drainage Pattern in the Study Area

3-4 Geology

Based on a 1988 Soil Survey and Analysis Report (Laporan Survei Dan Analisa Tanah Calon Lokasi Hutan Tanaman Industri Daerah Benakat Sumatera Selatan) published by the Ministry of Forestry, the geology of the Study Area consist of the Palembang formation of Neogene era with many gentle folds. Oil is being produced in the area. According to a survey conducted by the Directorate of Geology in 1978, the lower part of the Palembang formation is distributed in the northern section of the area while the upper part of the Palembang formation is distributed in the southern section with the middle part of the same formation being distributed in the form of a belt in the boundary areas between these two parts. Groups of monadnocks are observed in the belt areas (Fig. 3-3).





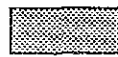

-  Lower Member of Palembang Formation
-  Middle Member of Palembang Formation
-  Upper Member of Palembang Formation
-  Upper Member of Telisa Formation

Fig. 3-3 Geology of the Study Area

3-5 Soil

(1) Soil Unit

At the result of Survey the soil type were classified into 5 units in this area. Acrisols were found to be dominant in the Study Area. In fact, Acrisols are the most dominant soils in the penneplains of the south of Sumatera Island. These soils are one of the most typical in humid tropics and are characterized by well progressed weathering and leaching. The soil is accordingly acidified and lacks Ca and K. Its activity is low due to deterioration of the clay quality, resulting in a poor water and nutrient holding capacity. The soil structure is unstable and it is easy to disperse in water and vulnerable to erosion.

a) Ferric Acrisols (Af)

Ferric Acrisols contain an ironstone horizon in the B horizon. The thickness, depth and ironstone volume of the ironstone horizon found in Ferric Acrisols in the Study Area varied. In some cases, the existence of the ironstone horizon appeared to hinder the growth of plant roots although this view cannot be supported. The subdivisions of the soil units based on difference in the ironstone horizon conditions were not established.

While the Ferric Acrisols showed a similar distribution tendency to the Orthic Acrisols, they were found to be dominant in old geomorphic surfaces believed to be summit levels.

b) Plinthic Acrisols (Ap)

Plinthic Acrisols contain plinthite in the lower horizon. In the Study Area, Plinthic Acrisols were found

at the middle and lower gentle hillside slopes and also further flat and lower gentle hillside slopes. In particular, the soil cover of undulating land almost exclusively consisted of these Acrisols.

c) Orthic Acrisols (Ao)

Compared to the other 2 types of Acrisols, Orthic Acrisols have no noticeable morphological character and are described as Acrisols of "common occurrence". Orthic Acrisols in the Study Area were found in the flat and gentle slopes on the hill tops and the upper part of the gentle hill side slope. However, they were not found in places of low elevation even though the topographical conditions were similar. An irregular mixture of Ferric Acrisols (Af) was generally observed with Orthic Acrisols and the mixture rate appears to be relatively high in hills and rolling land in the western part of the Study Area.

d) Plinthic Gleysols (Gp)

Plinthic Gleysols contain plinthite in the lower horizon and were only found near swamps in the Study Area.

e) Dystric Fluvisols (Jd)

The parent materials of Dystric Fluvisols are flood deposits and these Fluvisols were found along the main rivers in the Study Area. Since Acrisols were the origin of the deposits, the chemical and physical properties of the Fluvisols, while not particularly excellent, were found to be the best in the Study Area. Compared to other soil units, the clay content was found to be relatively low and every horizon were relatively soft. Several deposition layers were

observed and fine fragments of carbonized trees and grass were often found.

(2) Soil Map Preparation

As it was extremely difficult to precisely determine the distribution boundaries of the above soil units, mapping symbols combining multiple soil units were used for the soil map (Attached Fig. 1-9).

a) Mapping Symbol: Af

Indicates the coexistence of ferric Acrisols and Orthic Acrisols.

b) Mapping Symbol: Ap


Indicates the existence of Plingic Acrisols and the occasional existence of Orthic Acrisols.

c) Mapping Symbol: Jd

Indicates the existence of Dystric Fluvisols.

d) Mapping Symbol: S

Indicates swamps and paddy fields consisting of various soil units including Plinthic Gleysols.

e) Mapping Symbol: 

Indicates artificial immature soil found in oil fields, villages and fill-up grounds.

(3) Suitable Afforestation Sites

Apart from the Plinthic Gleysols found near swamps, all the other 4 soil units are suitable for afforestation purposes and these 4 soil units will not cause any essential difference in tree growth.

Topographically a general tendency was found that trees at the site on middle and lower part of hillside slopes show better growth than the ones on ridges, hilltops and upper part of hillside slopes. The same tendency was more clearly recognized in the case of alang-alang's growth performance in terms of the plant height and growing density.

3-6 Vegetation

(1) Secondary Forests

The secondary forests in the Study Area originate from either natural forests subjected to selective felling or from bush lands. Those originating from natural forests subjected to selective felling are found between the west of S. Rambutan and S. Lagan and also in the western part of the Study Area which is bordered by the administrative boundary of Kab. Lahat. The main tree species are Shorea sinkawang, Vitex pubescens, Artocarpus elasticus, Hopea mengarawan, Alstonia scholaris, Toona sureni and Artocarpus communis. The undergrowth includes Achasma megalochilos, Saliara (It's botanical name could not be identified). Many secondary forests originating from bushes are found, which are composed of various species.

(2) Man-Made Forests

Man-made forests are found between Simpang Solar and Sei Rambutan and were established mainly by the South Sumatera Provincial Forestry Service between 1976 and 1982. The main species are Acacia mangium, Pinus merkusii, Acacia auriculiformis and Albizia falcataria. JICA plantations were established between 1980 and 1987 around Benakat which cover a total area of 2,600ha (Plantation I: 2,100ha, Plantation II: 340ha and Agroforestry: 160ha). The main species are Albizia falcataria, Eucalyptus deglupta, Swietenia macrophylla, Pinus merkusii and Acacia mangium and experiments on dozens of other species are also in progress.

(3) Bush Lands

Bush lands are a stage in plant succession and consist of small Peronema canescens, Schima wallichii var bancana, Vitex pubescens, Dillenia eximia, Macaranga pruinosa and Ficus variegata. Banana trees and bamboos are sometimes found.

(4) Grassland

Formed by shifting cultivation, the grassland in the Study Area consists of true grasses together with Cente, Harendong, Jorong, Nawawidan and Ferns. The fertility of the soil is generally poor in those areas invaded by along-along (Imperata cylindrica).

The land use/vegetation map in the Study area was shown in Attached Fig. 1-11.

3-7 Land Use

The current land use conditions in the Study Area are shown in Table 3-1 and Attached Fig. 1-11. Bush lands and grassland (25,500ha) account for 51% of the total area while forests (15,600ha), farmland (6,000ha) and shifting cultivation land (2,800ha) account for 31%, 12% and 6% respectively.

Table 3-1 Area of Each Land Use Class in the Study Area

Land Use Classes		Area (ha)	Ratio (%)
Forest	Secondary forest	7,970	16
	Man-made forest	7,621	15
Grass land/ Bush land	Bush land	24,500	49
	Grass land	965	2
Settlements		298	1
Shifting cultivation		2,822	6
Agriculture land		6,038	12
Oil fields		28	0.1
Total area of the study site		50,242	100

Note: Alang-alang grassland where the invasion of ligneous plants (mostly pioneer species - mainly nanophanerophyte) was observed was included with bush lands in the classification of the Study Area's current land use based on the understanding that bush lands are one stage in plant succession from grassland to forest.

(1) Forests

The secondary forests cover a total area of approximately 8,000ha, some 16% of the Study Area.

Man-made forests are scattered in the central and southern parts of the Study Area with a total area of approximately 7,600ha, i.e. some 15%.

(2) Bush Lands and Grassland

Bush lands and grasslands occupy the largest part of the Study Area, covering approximately 25,500ha, i.e. 51%, and are observed throughout the Study Area.

(3) Settlements

Settlements in the Study Area are located along the main roads in the northern and central parts. From north to south, the main settlements are Pagarikaya, Jirak, Dusun Pal XI, Talang Pal VII, Talang Rejosari, Pal XIII, Sidomulyo, Talang Mandung, Talang Padang, Benakat, Sei Baung, Subanulu, Jambu Mente, Pabil, Simpang Solar and Rambutan (Fig. 3-4).

(4) Shifting Cultivation Sites

Shifting cultivation sites are scattered throughout the Study Area, particularly on both sides of roads running in the east-west direction in the north and south (Rambutan). It is estimated that shifting cultivation sites cover a total area of approximately 2,800ha (6%) of the Study Area.

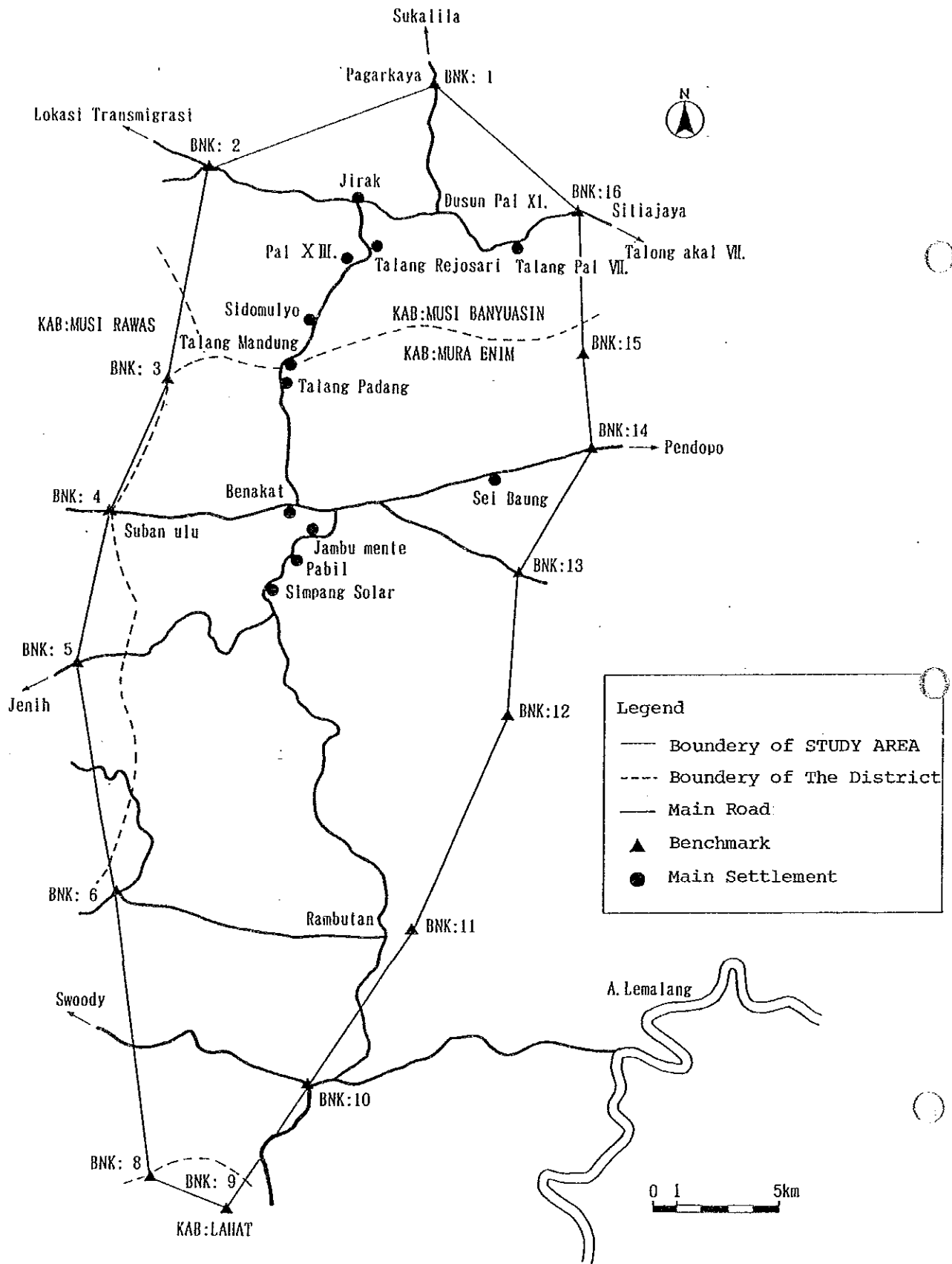


Fig. 3-4 Locations of Main Settlements

(5) Farmland

Extensive farmland is observed at the northern end of the Study Area and also around settlements in both the northern and central parts. Farmland occupies a total area of approximately 6,000ha, i.e. some 12% of the Study Area.

There are many types of farmland, i.e. rubber plantations, fruit orchards, coconut orchards, dry fields and paddy fields, of which rubber plantations occupy the largest area. Most of the rubber plantations consist of 4-10 year old trees. The size of the plantations varies from 0.5 - 3.0ha and are located among mixed bushland and secondary forest. Most of rubber plantations are managed extensively. Small paddy fields are scattered in the lowland areas near settlements.

(6) Oil Fields

PT Pertamina has many oil fields in the Study Area, particularly in the triangular area formed by Jirak to the north, Benakat and Sei Baung at the centre and Rambutan to the south. While the oil field size is usually around 1,000m², many of the fields near Rambutan are in the range of 6,000 - 7,000m².

Oil processing facilities have been constructed in such places as Talang Mandung to the south of Jirak and Rambutan. Based on the field survey and aerial photo interpretation results, there are believed to be some 82 oil fields with a total area of approximately 28ha (including processing facilities).

3-8 Local Inhabitants

(1) Settlement and Population

There are 3 villages in the Study Area as shown in Fig. 3-4, i.e. Desa Jirak which belongs to Kab. Musi Banyuasin and Desa Sungai Baung and Desa Suban Ulu which belong to Kab. Muara Enim administratively. Desa Jirak has 4 Dusun (lower administrative unit within a Desa) with a population of 5,469 while Desa Sungai Baung and Desa Suban Ulu have 7 and 1 Desuns and populations of 3,492 and 1,832 respectively, totalling 10,793 (1986).

The above population figures relate to those people living in authorized residential areas. However, there are in fact many hamlets outside these authorized areas, and homes of migrant farmers engaged in shifting cultivation. As a result, no accurate statistics are available for the Study Area. Based on the aerial photo interpretation results and the assumption that in average each family consists of 6 members, the actual number of people living in the Study Area is estimated to be some 14,000 which is an increase of approximately 30% on the official population figure of 10,793.

(2) Work Situation

The characteristics of the local work situation are considered to be as follows based on the interview survey results.

- 1) 1,850 households, accounting for some 80% of the total number of households of 2,300, support their living mainly by agriculture (cultivation of rice, dry field crops, rubber and fruit and cattle raising, etc.)

The annual income per household varies from 1.5 million Rp to 6 million Rp depending on the scale and type of agricultural activities involved and income from sources other than agriculture. This income figure includes food for own consumption, converted to an average income figure of 1 million Rp per household. Of these 1,850 are agricultural households, 1,100 (60%) are low income households (annual income of less than 2.5 million Rp) while 650 households (35%) are middle income households (annual income of 2.5 million Rp or more but less than 4.5 million Rp). The remaining 100 households (5%) are classified as high income households (annual income of 4.5 million Rp or more).

1,200 households (65%) of the 1,850 agricultural households are engaged in shifting cultivation. These 1,200 households consist of a large number of low income households and some middle income households. Households engaged in shifting cultivation have less than 1ha of fixed farmland and an additional some 2ha of farmland for shifting cultivation. These households may have additional employment opportunities in civil engineering work for the Pertamina, temporary work for large-scale farmers and commercial work such as transportation and shop sales. These work opportunities, however, are limited and there is severe competition among low income farmers for them.

- 2) The number of households with a stable income, mainly due to employment by the Pertamina, is some 150.
- 3) Some 200 households support their living by jobs in the transportation or commercial sectors or in small construction work. Some of them can operate a truck, a bulldozer or other machinery.

- 4) Some 100 households support their living by jobs in the public sector as teachers or civil servants.

(3) Farming Conditions

According to the results of the interview surveys conducted in Simpang Solar and Jirak, biggest settlements, the number of people in one family varies from 4 - 10 and more than one family sometimes live together. The mean of the number of people in one family is approximately 6 or 7. Each farming household has 1 - 2ha of farmland and the main crop is dry field rice which is generally grown for own consumption and the surplus, if any, is sold. The most popular cash crops are peanuts, maize, cassava and bananas.

The single or double harvesting of dry field rice and the double or triple harvesting of paddy rice are the standard practice. The study of farmers participation in agroforestry is reported that the annual yield per household is 0.79 tons of dry field rice (for a farming area of 1.09ha) and 1.12 tons of paddy rice (for a farming area of 0.67ha). The annual rice consumption of a family of 6 is some 800 - 900kg.

According to the 1986 Statistics of Jirak, Jirak has a population of 5,469 (690 families) and a total area of 7,400ha. The land use in Jirak is shown in Table 3-2. Of this 7,400ha, forest area (including bush lands) accounts for 4,400ha (59%) while farmland including rubber plantations accounts for 1,940ha (26%). The average farmland per household is 1.16ha and 350 families are engaged in shifting cultivation.

The felling and burning of secondary forests and bush lands are conducted by persons in view of rice cultivation. In addition to rice, rubber, maize, cassava, peanuts and bananas, etc. are often cultivated. Those persons engaged

in shifting cultivation tend to move to new sites after 2 or 3 years and the land left behind becomes alang-alang grassland, bush land or rubber plantation.

Farmers engaged usually have a permanent home in one of the settlements. The distance between the settlements and farming site varies from 3km to 15km with an average of some 5km.

Agriculture is currently in the midst of a fundamental change from traditional farming for self-sufficiency to market-oriented farming to meet the increased demand for agricultural products following the improved standard of living and to the expanded production of cash crops as a result of the brisk economic activities in Indonesia.

Table 3-2 Land Use in Jirak

Classes	Area (ha)	Ratio (%)
Total area in Jirak	7,400	100
Cultivated land	1,700	23
Sawah (Paddy field)	140	2
Tegalan (Grazing land)	660	9
Kebun campuran (Orchards and rice fields)	900	12
Perkarangan (Yard)	250	3
Pekabunan (Rubber plantation)	240	3
Forest	4,400	59
Belukar (Bush land)	3,400	46
Lebat (Forest)	1,000	14
Danau (Water bodies)	10	0.1
Road and others	800	11

(4) Utilization of Forests

The forests in the Study Area provide some materials which are useful in the daily lives of the inhabitants. While the felled trunks and branches are used for fences around farmland and gardens and for the construction of houses and other buildings, they are most frequently used as firewood. The local inhabitants use either kerosene or wood as fuel and wood appears to be an essential item in their daily lives.

This team conducted a survey on the firewood collection and consumption by 116 households in Simpang Solar (some of which belong to Pabil) and obtained an annual firewood consumption volume of $6.75\text{m}^3/\text{family}$ (4 members). The team found out that unlike the case of other settlements, thick trees are seldom seen. The obtained annual firewood consumption volume of $6.75\text{m}^3/\text{family}$ may well actually be some $5.5\text{m}^3/\text{family}$ when converted to firewood obtained from thick trees.

If this annual firewood consumption volume of some 5.5m^3 family is accepted, the annual firewood consumption volume per person is approximately 1.4m^3 . (Attached Table 1-20)

The charcoal was produced but extensively by heap charcoaling.

(5) Cattle Raising at Benakat

The current conditions of stock raising in the Study Area are described next. The main purposes of small-scale stock raising are the use of cattle for farming and the keeping of family assets. In most cases, the number of cattle raising are expected. This type of stock raising is mainly conducted by high income farmers. The possession of more than 10 cattle by a single family in the Study Area hardly exists. (Attached Table 1-21)

In the case of small-scale stock raising, the cattle are raised on land near the village or farming sites. When the number of cattle increases, they are raised on alang-alang grassland under the control of either adults or children who are usually commissioned by several households, resulting in herds of some 20 cattle and over 100 cattle in exceptional cases. For large-scale stock raising, fires are often set to alang-alang grassland, resulting in a high risk of fire to nearby afforestation sites or natural forests.

3-9 Forestry and Forest Industries

Man-made forests are widely observed from the northern part to the central part and also at the southern end of the Study Area. The trunk road running in the east-west direction which passes through Sei Baung, Benakat and Subanulu acts as an axis for the former man-made forests. The corridor-type afforestation method is observed in the case of the man-made forests in the north, those on the western side of the northern and central parts and those at the southern end. The man-made forest is also observed along the public road passed from north to south in the study area. Plantations are created by JICA's "Technical Cooperation for the Trial Plantation Project at Benakat, South Sumatera" are located from western side to east of the central part of the Study Area. (Planted between 1980 and 1988)

These man-made forests were originally created between 1976 and 1982 through projects of the South Sumatera Provincial Forest Service and actual planting was conducted by private companies, such as Swakelola, CV. Yosepa, CV. Sinar Teknik, PT. T. Indah Farm and CV. Harapan Baru.

Excepting the forests created by the JICA Project, the main species are Peronema canascens, Acacia auriculiformis, Albizia falcataria, Eucalyptus deglupta, Eucalyptus alba and Pinus merkusii. Some of these forests have become bush lands due to damage caused by burning for shifting cultivation or grazing purposes. The main species of the JICA project are Eucalyptus deglupta, Swietenia macrophylla, Acacia mangium, Pinus merkusii, Albizia falcataria, Schima wallichii var. bancana.

There is no sawmill in the Study Area, there is a sawmill in the Swody's concession to the west of the Study Area.

The total export value of logs, sawn timber and plywood amounted to US\$ 1,113 million in 1984, US\$ 1,112 million in 1985 and US\$ 1,443 million in 1986, accounting for 5.08%, 5.98% and 9.75% respectively of the total export value and indicating their importance in Indonesian exports next to oil products.

3-10 Infrastructure

(1) Roads

The Study Area is located 180km southwest of Palembang, the capital of South Sumatera Province. A road section of some 161km from Palembang towards the Study Area is paved while there is an unpaved section of 5km before reaching Pendopo, a town created for oil development. There is an asphalt paved section for some 5km from Pendopo, following by a 9km unpaved section before reaching the Study Area. A well developed road network within the Study Area has been established following oil development but all the roads are still unpaved. Forest roads in the southern part of the Study Area are mostly covered by stones or gravel.

(2) Hospitals

There are 5 governmental general hospitals with 232 beds in Kab. Muara Enim with medical staff consisting of 29 internal doctors and surgeons, 2 special engineers, 7 dentists, 69 medical and surgery nurses and 15 dental nurses. In addition, there are 15 governmental health centers and 50 auxiliary institutions. There are no private medical institutions in Kab. Muara Enim.

In the Study Area there is a auxiliary institution of the health center in the biggest settlements.

(3) Schools

Desa Jirak has 2 nursery schools (T.K.) with 23 pupils, 37 primary schools (S.D.) with 1,541 pupils and 6 secondary schools (S.L.) with 116 pupils while Desa Sungai Baung has 3 primary schools and Desa Suban Ulu has only 1 primary school.

(4) Electricity

There is no public electricity service in the Study Area. However, the power transmission line from Pendopo of the National Petroleum Development Corporation reaches a eastern point some 4km from the Study Area.

(5) Water Supply

The local inhabitants rely on small rivers for their water supply. while the use of pumps is observed at several sites, there appears to be no well. There is an ample water supply during the dry season but the quality of water is not suitable for drinking, requiring boiling prior to drinking. The local inhabitants lack any facility to use rainwater although some South Sumatera Reforestation Technical Center (BTR)-related buildings have such facilities.

CHAPTER 4

INDUSTRIAL PLANTATION PLAN FOR BENAKAT AREA

CHAPTER 4 INDUSTRIAL PLANTATION PLAN FOR BENAKAT AREA

4-1 Basic Policy

4-1-1 General Conditions of Benakat Area

The industrial Plantation Project has been proposed in above mentioned Study Area designated as Benakat industrial plantation area.

This Study Area is government owned land and designated as production forest area of which more than half is alang-alang grassland and bush land. The main purpose of the Project is to carry out plantation work in such area. In the Study Area, there are some 14,000 people mostly dependent on agriculture for their livelihood and it is considered important to secure their understanding and cooperation for the plantation works. The achievement of technical cooperation for plantation project, South Sumatera by JICA will be utilized. Above is one of the characteristics of the industrial plantation Project in the Study Area.

4-1-2 Production Goals

The production goals for the industrial plantation should be decided by careful examination of not only the timber supply and demand trends and the management efficiency of the plantation project but also the socioeconomic conditions of the planned plantation areas.

- 1) The Ministry of Forestry in Indonesia considers the production of pulp wood to be one of the most important goals for industrial plantation. While the present pulp and paper production levels in Indonesia are relatively low compared to those in industrialized countries, the total production of pulp and paper in the Fifth 5 Year Forestry Development Plan is estimated

to be 2,500,000 tons which is 4.5 times more than the production of 551,000 tons in the Fourth Plan period.

Consequently, 1.3 million ha (some 30% of the total area) are allocated for pulp wood production in the 15 year plan achieve the industrial plantation of 4.4 million ha and the ratio of the area for pulp wood production is high for South Sumatera Province. Of the planned afforestation area of 300,000ha in the 15 year plan for this Province, 250,000ha (83%) are allocated for pulp wood production.

The main target of the Industrial Plantation Forest Development Plan for the neighbouring Subanjeriji area (prepared in 1987 by the ADB and the Indonesian Ministry of Forestry) which has similar natural and social conditions to the Study Area is also the production of pulp wood.

- 2) The Study Area has hardly any forests producing early yields and in most cases afforestation of non-forest land are required. As a result, efficient investment for the plantation project is essential and the realization of income at the earliest possible time is also required to achieve stable operation.
- 3) The Study Area has vast tracts of unproductive bush land and grassland originating from forest fires and logging in the past.

Accordingly one of the important objectives of the present industrial plantation Project is to recover the productivity by the plantation works as early as possible.

- 4) The afforestation of bush land and grassland will positively contribute to the environmental conservation

of the area in terms of both water and soil conservation.

In view of the above considerations, it has been decided that the production goals in the Plan will centre on the production of pulp wood using fast growing tree species. In addition, taking the strong local expectations for a supply of construction timber into consideration, it has been decided that the production of construction timber should also be included as one of the production goals.

4-1-3 Land Use

Industrial plantation aims at not only the production of timber in an economic and efficient manner but also the promotion of the local community. However, careful consideration must be given to the conservation of the local environment in the implementation of industrial plantation.

As shown in Table 3-1, the land use of the Study Area of approximately 50,000ha consists of some 15,600ha of forests, some 25,000ha of grassland and bush land and some 9,000ha of settlements, farmland and shifting cultivation sites. In addition, oil fields and oil processing sites occupy some 30ha. Settlements and farmland are rather conspicuous in the north and central parts of the Study Area.

The existing land use conditions and possible coordination with the planned future land use have been carefully considered and the basic land use policies for the Plan are as follows.

- 1) The Study Area will be divided into the operation sites and the non operation sites (sites currently unsuitable for plantation establishment).

- 2) Non operation sites will be established in those locations where the existing settlements, farmland and oil processing facilities, etc. are mostly concentrated. These areas will not be subject to plantation establishment in the future and will be exclusively used for agricultural purposes.
- 3) The remaining area will be subject to the industrial plantation project. At present, agricultural land use, including shifting cultivation, is observed in this area. The activity of shifting cultivation will be transferred to the exclusive land for agricultural purpose to be newly provided.

4-1-4 Considerations for Local Inhabitants

As described earlier, some 14,000 people live in the Study Area. The implementation of the present industrial plantation Project is required to contribute to the increase of income and improvement of welfare of the local inhabitants. It is important to make the long ranged plan for the protection of forests, especially, prevention of forest fires for the successful implementation of the Project. For this purpose it is indispensable to secure the understanding and cooperation of the inhabitants for the plantation works.

Accordingly, the following measures will be necessary to provide a careful consideration for the local inhabitants in the planning of present industrial plantation.

- 1) The organizing of inhabitants to secure their understanding and cooperation for the plantation works and to program and stabilize the employment.

- 2) The contribution to the infrastructure development for the inhabitants through the provision of the forest roads, water supply and power supply facilities required in the plantation works.
- 3) The inducement from the forest shifting cultivation to fixed farming through the provision and development of exclusive land for agricultural purpose and supply of equipment and material for agricultural use, and seedlings and seeds.

4-1-5 Considerations for Natural Environment

The conservation or protection of tropical forests has been a subject of great global concern in recent years and urgent measures have already been implemented in some countries. In the case of Indonesia's laws and regulations the Basic Act on Control of Living Environment (Law No. 4 of 1982) and Regulation No. 29 of 1986 stipulate the basic principles for environmental conservation. The Ministry of Forestry, which requested the present Study, is preparing the necessary study items and evaluation methods in relation to the possible impact on the environment of forest development and has set up an Environmental Committee. The Project has, therefore, been prepared based on the following principles taking the above general requirements for environmental conservation into consideration.

- 1) The afforestation of artificially created bush land and grassland assists the recovery of the original vegetation, i.e. forests, and therefore contributes to the conservation of the local environment. As vast tracts of grassland and bush land have already emerged in the Study Area, the afforestation of this land is deemed an urgent requirement.

- 2) In the course of the afforestation of the Study Area, the natural and other conditions should be carefully examined as discussed in detail later. Those sites appearing unsuitable for planting due to their topographical, geological and other conditions should be made into conservation forests and riparian reserved forest zones should be established along rivers. Moreover, measures in view of conserving the environment, including the adoption of the natural forest management method (selective cutting, etc.) for secondary forests which are close to natural forests, should be introduced.
- 3) Such environmental conservation measures as the prevention of disease and insect damage and the prevention of sediment outflow should also play a vital role in all aspects of the formulation of the project implementation plan, including planting, forest roads and felling, etc.

4-1-6 Project Period

The long period is required for any plantation project from planting to felling. The present Project involves the production of not only pulp wood with a short rotation period but also wood for general building purpose with a long rotation period such as timber. As most of the present plantation are newly initiated project, the long period will be required for a series of works as planting, tending and harvesting to proceed stably.

Accordingly, it has been determined to make the planting work plan for 30 years involving several rotations for the pulp wood as mentioned in 4-2-4 envisaging production progress. In the financial and economic evaluation, the initial investment and related operation and maintenance costs for the years up to the completion of the first plant-

ing area assumed as Project costs and the yield from the first planting as Project benefits to be continued for 43 years, which is considered as evaluation period.

4-2 Basic Items for Project Planning

4-2-1 Establishment of Working Units

The Study Area is as large as some 50,000ha and stretches for 40km in the north-south direction. Although there are some roads in the Study Area which are passable by vehicles, transportation in the rainy season is difficult, making the planning of the long distance transportation of personnel and machinery under the Project difficult. As a result, while the Project will in principle be managed as a single entity, three working units have been introduced to facilitate project implementation. These working units are shown on the Forest Compartment Map given in Fig. 4-1.

In accordance with the basic principles, some 6,500ha have been excluded from the operation sites, including the sites of villages and oil fields, as exclusive areas for land use, farming and other purposes in the future. The operation sites is, therefore, the remaining 43,800ha.

4-2-2 Compartmentalization

The compartments and sub-compartments for each working unit have been decided as follows.

1) Compartments

Compartments have been decided using such topographical features as ridges and valleys, etc. as the main factors with the area of a single compartment being around 500 - 1,000ha.

2) Sub-Compartments

Sub-compartments have an area of less than 100ha and have been decided on the basis of topographical features. Sub-compartments are further divided in terms of the land use and vegetation.

The present conditions of the compartments and sub-compartments have been compiled in the Forest Inventory Book which is presented separately from the Report (see Attached Table 2-1 for the Inventory Form).

The number of compartments and sub-compartments in each working unit are given in Table 4-1 below.

Table 4-1 Number of Compartments and Sub-Compartments by Working Unit

Working unit Classification	I	II	III	Total
Compartments	15	23	22	60
Sub-compartments	131	258	223	612

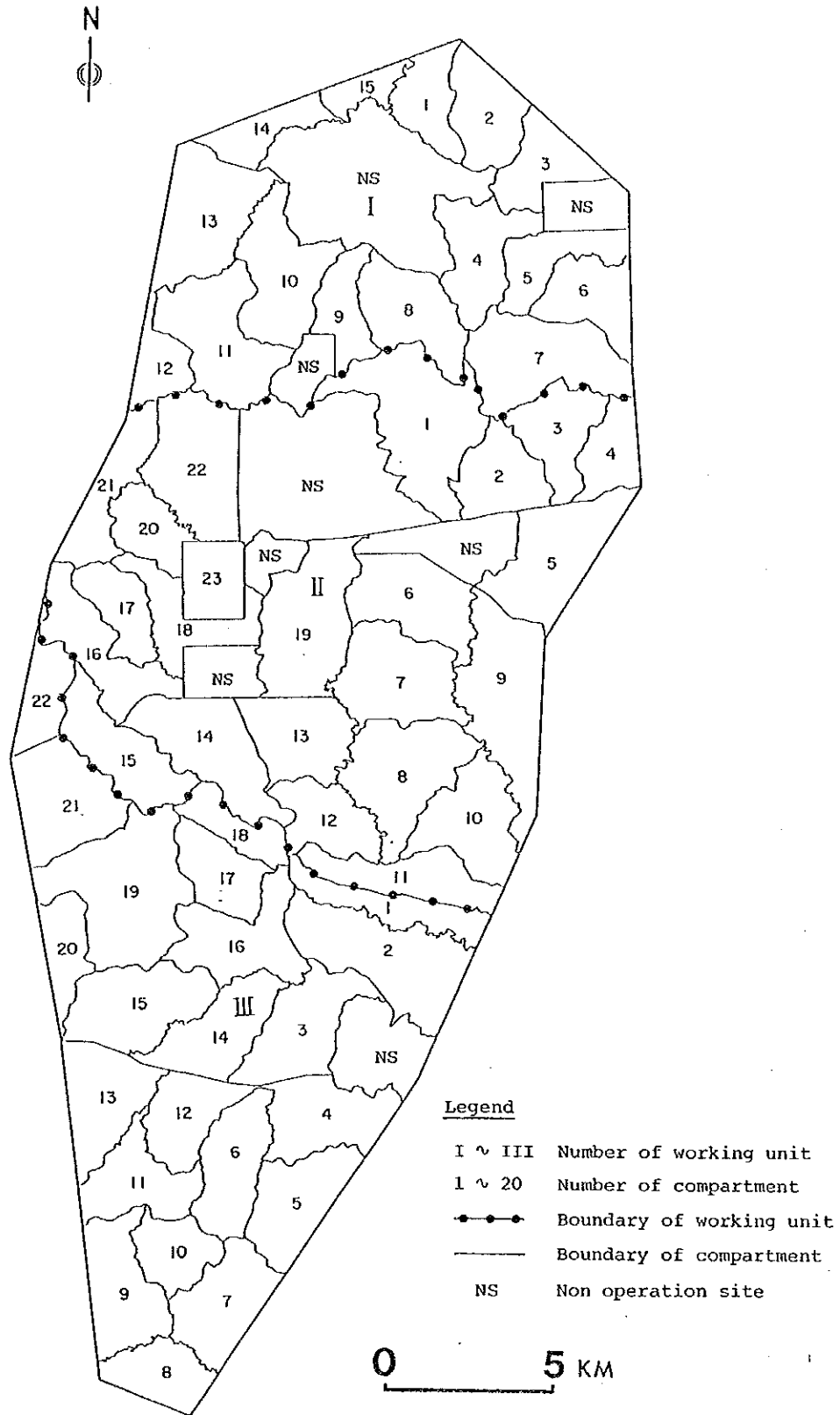


Fig. 4-1 Forest Compartment Map

4-2-3 Selection of Planting Site

The Government of Indonesia classifies forests into protection forests, national park and reservation forests, limited production forests and convertible/non-convertible production forests. Formerly a national park and reservation forest, the Study Area was newly designated a production forest in 1988.

The land use, vegetation and soil conditions for the some 43,800ha (obtained by deducting the exclusive areas for agricultural and other uses from the original 50,000ha) were examined taking the basic principles and environmental conservation requirements into consideration and the planting sites were then selected in accordance with the selection process shown in Fig. 4-2. The area excluded from the planting sites were as follows.

1) Secondary Forests

These are those forests where trees of commercial value were selectively felled 10 or more years ago. Living trees with a diameter of 35cm or more are found in stands with a density of 50 - 70/ha. The selective felling method (TPI) based on the rotation period is adopted in Indonesia together with regeneration under clear felling and, therefore, the work for these secondary forests must be conducted differently to the pure plantation establishment of alang-alang grassland and bush land.

Most of the stands are considered subject to exploitation by selective felling after a certain rotation period. In order to mitigate the impact of industrial plantation on the local environment, these secondary forests have been excluded from the planting sites for industrial plantation to allow the stand restoration.

In addition, the planting of new trees is planned where necessary.

2) Conservation Forests

The middle member of the Palembang formation, accompanied by monadocks, runs in a belt shape near the centre of the Study Area. Many steep hills are observed in this area and the area is geologically fragile, necessitating measures to preserve the forests for soil conservation. As a result, this area have been excluded from the planting sites for industrial plantation.

3) Riparian Reserved Forest Zones and Swamps

The series of lowlands along rivers in the Study Area have Dystric Fluvisols as the main soil unit which is favourable for tree growth. However, these lowland areas are generally narrow and are unsuitable for mechanized plantation work. The steep slopes along the valleys are also unsuitable for mechanized plantation work. These slopes have, therefore, been excluded from the planting sites for industrial plantation. These zones will also act as firebreaks.

Oversaturated soils, such as Plinthic Gleysols, are totally unsuitable for afforestation. Consequently, these areas have also been excluded from the planting sites for afforestation.

4) Experimental Forests

A trial plantation site initiated by JICA in 1979 to study the technical problems involve in the afforestation of alang-alang grassland and bush land is located in the Study Area. It is currently controlled

by the South Sumatera Reforestation Technical Centre (BTR) and various experiments and observations are in progress. As shown by the fact that the introduction of a seed forest is planned on the site, this site is expected to play a central role in the afforestation experiment in South Sumatera Province.

Some of the fast growing species planted at the beginning of JICA project have already reached the final felling age. This is one of the few successful plantation sites in South Sumatera Province and is extremely important in view of observing the growth conditions of the many species planted there.

The observation of the experimental agroforestry sites at the west of Benakat are essential to confirm the objectives and effects of settlement promotion efforts and to learn lessons for the local development aimed at by the present Project. The total area of some 3,600ha covering the compartments where these experimental sites are located has, therefore, also been excluded from the planting sites for industrial plantation so that the experimental sites can continue to serve their original purposes.

5) Forest Roads and Firebreaks

The forest roads to be newly constructed in accordance with the Forest Road Construction Plan and the existing public roads (constructed by the Pertamina and others) will be permanently used as forest roads and have been excluded from the planting sites for industrial plantation. In view of the planned provision of fire-breaks along these public roads and main forest roads, these firebreak sites have also been excluded from the planting sites for industrial plantation.

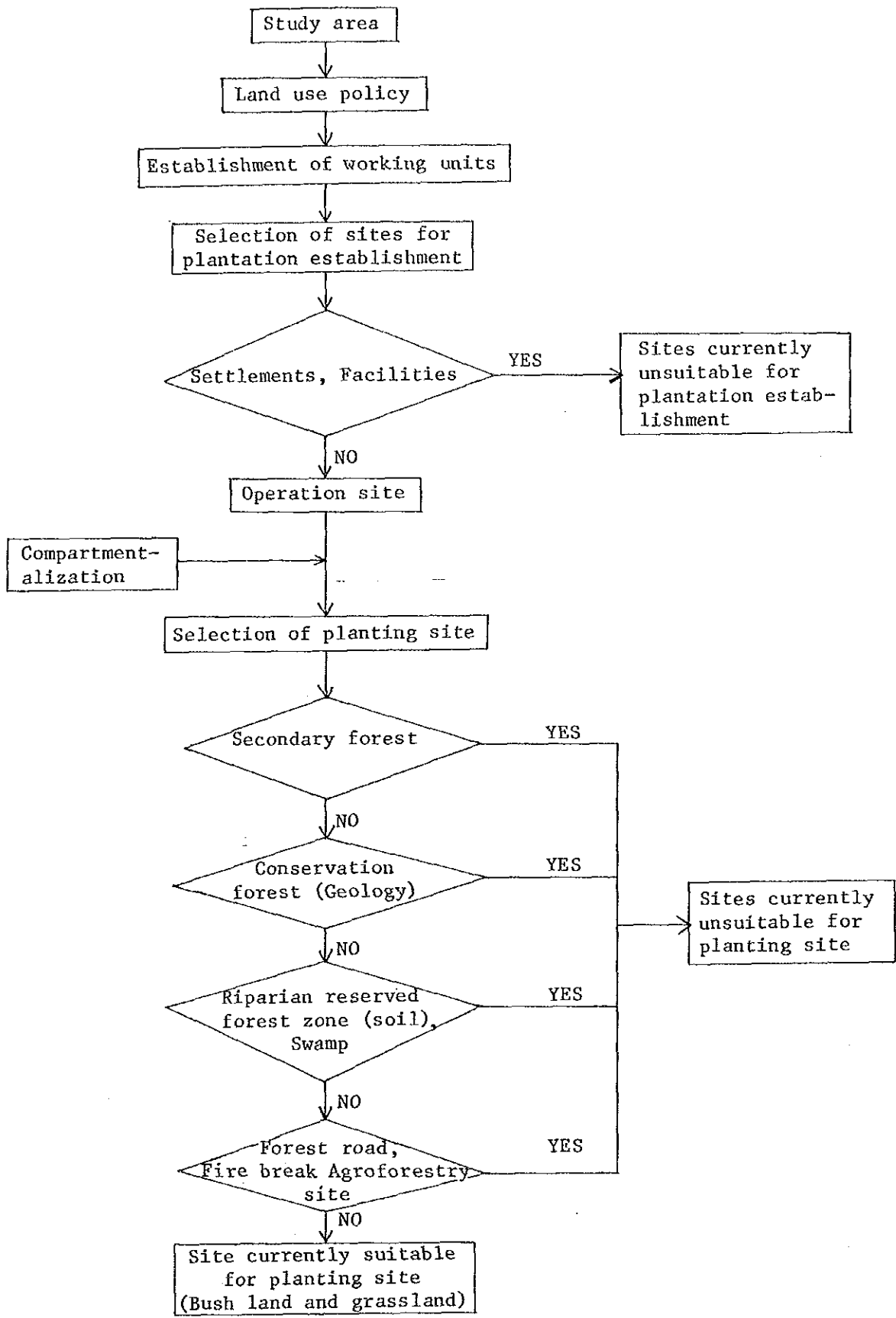


Fig. 4-2 Planting Site Choice Flow

4-2-4 Selection of Species

Suitable species for the production of pulp wood and construction timber to meet the production goals discussed earlier were examined with special attention paid to the recent world trend of tropical afforestation and planted species in Southeast Asia, etc. In addition to the 20 species listed in Table 4-2 which have been selected for industrial plantation purposes in Indonesia, the past performance of afforestation projects by JICA and the South Sumatera Provincial Forestry Service in the vicinity of Benakat was carefully examined to select the most suitable species for the Plan.

Table 4-2 Species to be recommended for the
Industrial Plantation in Indonesia

Botanical name	Indonesian name
1. <i>Shorea</i> spp.	Meranti
2. <i>Agathis</i> spp.	Damar
3. <i>Eucalyptus deglupta</i>	Leda
4. <i>Eucalyptus urophylla</i>	Ampupu
5. <i>Pinus merkusii</i>	Tusam
6. <i>Peronema canescens</i>	Sungkai
7. <i>Acacia mangium</i>	Mangium
8. <i>Tectona grandis</i>	Jati
9. <i>Santalum album</i>	Cendana
10. <i>Swietenia macrophylla</i>	Mahoni
11. <i>Araucaria</i> spp.	Damar laki-laki
12. <i>Albizzia falcataria</i>	Sengon
13. <i>Dalbergia latifolia</i>	Sonokeling
14. <i>Gonystylus bancanus</i>	Ramin
15. <i>Manikara kauki</i>	Sawo kecil
16. <i>Acacia auriculiformis</i>	Akasia
17. <i>Diospyros celebica</i>	Ebony
18. <i>Pometia</i> spp.	Kayu sapi/Mata kecing
19. <i>Dryobalanops</i> spp.	Kapur
20. <i>Dipterocarpus</i> spp.	Keruing

According to one JICA report, the following species are considered promising in view of seed collection, initial growth and use as timber.

- Acacia mangium
- Eucalyptus deglupta
- Swietenia macrophylla
- Schima wallichii var. bancana

It has been decided that the selected species for each production goal will all be planted in order to avoid possible damage resulting from disease, harmful insects and unfavourable climatic conditions in the case of the single species plantation of a vast area. In the case of construction timber which requires a long growth period, it is preferable that local species be planted instead of exotic species for which Indonesia has limited planting experience.

Much of the available data indicates that more species are suitable for planting even in alang-alang grassland provided that the soil is improved by means of land preparation or other methods. The findings of the forestry survey conducted by the Study Team also suggest that additional species can be expected to properly grow with appropriate care. The species considered suitable for industrial plantation in alang-alang grassland include the following.

- Acacia mangium
- Acacia auriculiformis
- Albizzia falcataria (Paraserienthes)
- Eucalyptus deglupta
- Eucalyptus urophylla

The following species are considered promising for industrial plantation in areas with fairly good conditions, including secondary forests.

- Shorea spp. (Meranti)
- Swietenia macrophylla

The provision of a substantial volume of seeds will be required for all the selected species for industrial plantation. Moreover, the nursery techniques for the species in question must be firmly established in addition to promising growth potential.

Strong interest was expressed during discussions with officials of the local Forestry Service in the use of such local species as Pinus merkusii, Peronema canescens and Schima wallichii var. bancana which have medium or long rotation periods and which are used as timber. Especially strong interest was shown in Peronema canescens (Sungkai) in view of its popular use for timber and furniture. While seed collection for Peronema canescens is difficult, propagation using cuttings is possible.

Based on the above examination and analysis, the following 3 species have been selected for pulp wood production in the present along-alang grassland and bush land in view of their growth prospect, suitability for pulp production, resistance to disease, harmful insects and forest fires and the degree of afforestation experience and afforestation technology in the Benakat Area.

- Acacia mangium (A. mangium)
- Acacia auriculiformis (A. Auriculiformis)
- Albizzia falcataria (A. falcataria)

Although A. falcataria has a problem of light volume weight vis-a-vis its use as pulp wood, it has been selected as a short rotation period species in view of its past use as pulp wood and also its prospective use for furniture and other purposes. The Eucalyptus species have been rejected

in view of their unsatisfactory growth performance at the JICA trial plantation in Benakat.

Possible species for construction timber production were also examined in terms of not only their growth prospect, timber quality and resistance to disease and harmful insects but also in terms of the afforestation experience and afforestation technology in the Benakat Area. The following 3 species have been selected taking the request by the Indonesian side for the selection of local species and the prospective demand of the construction timber and furniture industries into consideration.

- Peronema canescens (P. canescens)
- Swietenia macrophylla (S. macrophylla)
- Schima wallichii var. bancana (S. bancana)

While Pinus merkusii was also examined, it has subsequently been rejected because of its inadequate growth prospect. Although S. macrophylla tends to be damaged by Hypsipyla robusta, mass robusta outbreaks and damage through the robusta are relatively rare in the Study Area and S. macrophylla has been selected in view of its good growth potential. The selection of S. bancana is based on the local demand for its use for pillars and boards and also taking its performance at the JICA trial plantation into consideration.

Table 4-3 Species Potential

Tree species	Seed supply	Nursery diffi- culties	First growth	Characteristics for industrial purposes		Resistance to pests and diseases
				Pulp wood	Timber	
<i>A. mangium</i> ¹⁾	A	A	A	A	B	A
<i>A. auriculiformis</i> ¹⁾	A	A	A	A	C	A
<i>A. falcataria</i>	A	A	A	B	A	B
<i>P. canescens</i>	B ²⁾	A	B	C	A	A
<i>S. macrophylla</i>	B	A	C	C	A	B ³⁾
<i>S. bancana</i>	A	A	C	C	B	B ⁴⁾

Legend A: Easy or good

B: Common or not bad

C: Difficult or bad

These class is relatively categorized.

Notes:

- 1) As to characteristics for timber, *A. mangium* is better than *A. auriculiformis*. Because the form of *A. auriculiformis* is the worse. However characteristics for pulpwood and fuelwood of *A. auriculiformis* is better than *A. mangium*. Both species are utilized for pulpwood in some places in Indonesia.
- 2) As to *P. canescens*, seed supply is not good but collection of cutting is easy in and around the Study Area.
- 3) Although *S. macrophylla* tends to be damaged by the shoot borer (*Hypsipyla robusta*), it was evaluated that plantation establishment of *S. macrophylla* can be done because mass outbreaks and damage due to the shoot borer are relatively rare in and around the Study Area.
- 4) There are little knowledge of resistance to pests and diseases. In and around the Study Area there are many stands without damage to pests and diseases.

4-2-5 Planting Density

An attempt has been made at the JICA trial plantation to determine the best planting distance, i.e. the most appropriate number of planted trees per ha. The planting density at the trial plantation varies from 833 trees per ha with a planting distance of 4m x 3m to 2,500 trees per ha (4m x 1m) while the dominant density is 1,250 trees per ha (4m x 2m).

In some corridor type man-made forests, there are examples of a high density of 5,000 trees per ha (2m x 1m) to achieve crown closure at an early stage in order to suppress the growth of undergrass so that these forests can act as firebreaks.

The planting density for any industrial plantation plan must be decided by examination of the economic prospect and efficiency of mechanical work, etc. Based on the results of the examination of the JICA trial plantation in Benakat in terms of the growth conditions, residual stand conditions and degree of crown closure, etc., a planting distance of 3m x 3m (1,600 trees per ha) has been adopted as the standard planting distance for the Plan. While the introduction of a higher density for those species with medium and long rotation periods is feasible because of their slow growth at the initial stage, the same standard has been adopted for these species to achieve the high efficiency of such mechanical work as land preparation and weeding and also to minimize the required manpower for salvage cutting and thinning.

4-2-6 Growth Estimate

Yield tables are currently available in Indonesia for the following 10 industrial wood species and all the tables have been prepared using data from fixed experimental sites in Java. However, the application of these tables to an extensive plantation project in places other than Java requires certain adjustments based on field survey results.

- Tectona grandis (Jati)
- Altingia exelsa (Rosamala)
- Agathis loranthifolia (Damar)
- Pinus merkusii (Tusam)
- Darbergia latifolia (Sonokeling)
- Swietenia macrophylla (Mahoni)
- Acacia decurrens (Akasia)
- Albizzia falcataria (Sengon)
- Ochroma bicolor (Balsa)
- Anthocephalus cadamba (Jabon)

With regard to the species selected for the present Plan, ready-made yield tables (Attached Table 2-2, 2-3) were available for S. macrophylla and Al. falcataria. In addition to these tables, however, it was also necessary to survey the growth situation of man-made forests in and around the Study Area, to use collected data and to exchange opinions with staff of the Ministry of Forestry, including the counter-parts, in order to prepare the estimated yields and rotation periods for all the species. Attached Table 2-4 gives the results of the field survey on the selected species.

Although a yield table was unavailable for A. auriculiformis, the production and increment figures (Attached Table 2-5) are published by the Ministry of Forestry. Moreover, useful figures were also available on the selected species (Attached Table 2-6).

Based on the above reference materials, the rotation period and estimated yield for each of the species has been decided as shown in Table 4-4.

Table 4-4 Planned Rotation and Yield Estimate

Species	Planned rotation (years)	Yield estimate (m ³)	Remarks
Acacia mangium	8	165	7 years in other than the first rotation
A. auriculiformis	8	165	
Albizia Falcataria	8	165	
Peronema canescens	20	240	
Swietenia macrophylla	35	272	
Schima wallichii var. bancana	35	272	

4-2-7 Forest Roads and Nursery Sites

(1) Forest Road Network

1) Alignment Design by Road Classes

The survey results on the structure of the current main roads in and around the Study Area are given in Table 4-5.

Table 4-5 Survey Results on the Structure of Main Road

(Unit: m)

Right of way width	Effective width	Shoulder width	Cut width	Remark
6.70~9.60	3.50~8.00	1.00~4.80	4.00~12.20	Minimum~Maximum
8.15	5.75	2.90	8.10	Average

The steepest longitudinal gradient is 10% (approximately 6°) and retarding zones are provided depending on the topographical conditions. Indications of the original gravel laying were observed for some logging roads. The main roads are classified into those to maintain oil fields and pipelines and those for logging. While the former tend to be straight along the pipelines, the latter are constructed along ridgelines in view of protecting the roads from the damage by the transportation of heavy logs. These logging roads have many gentle curves for this reason and are partially gravelled.

Road standards similar to those of the existing logging roads are preferable according to the Study. In short, routes along ridgelines should be decided for the construction of forest roads for better drainage so that the roads are passable even during the rainy season.

Based on the above consideration, the following two forest road classes have been decided for the Plan.

a. Main Forest Roads

The routes of the main forest roads have been designed in accordance with the Plan to play a central role in the forest road network. All the routes of the newly constructed main forest roads have been decided based on their convenience vis-a-vis local life.

b. Working Forest Roads

Branching out from the main forest roads, all the working forest roads have been planned to run through the central points of the plantation sites. While the working forest roads will have a herring bone distribution, dead end routes will be avoided where possible so that each road is connected to either a main forest road or another working forest road. Bridges will be as small as possible.

2) Forest Road Length

The forest road routes have been decided based on the Design standards by road classes. The lengths of the forest roads to be constructed by working unit and also by road classes are shown in Table 4-6. The network of the main forest roads and working forest roads is shown in the Attached Industrial plantation forest implementation maps.

Table 4-6 Forest Roads by Working Unit

Working Unit	Main Forest road (km)	Working Forest road (km)
I	70.3	108.3
II	60.8	150.8
III	30.5	135.7
Total	116.6	394.9

(2) Selection of Nursery Sites

The nursery sites and necessary equipment have been selected based on the understanding that the stocks will be produced at permanent nurseries. As these nurseries will be used for a long period of time and as they require large areas, the nursery sites must satisfy the following conditions.

- near a river from which water intake is possible throughout the year
- no possibility of flooding during the rainy season
- flat ground, if possible
- near the centre of a plantation site as well as near a settlement in view of easy labour recruitment

Based on the above conditions, the permanent nursery sites have been selected as follows.

- Working Unit I : flat land near the public road to the south of Jirak
- Working Unit II : flat land near to the south of the public road and to the east of Benakat
- Working Unit III : flat land on the right bank of S. Kembahan and to the south of Rambutan

4-2-8 Planting Areas

The plantation areas by working units which have been decided based on the planting site selection process and forest road network, etc. are shown in Table 4-7, Fig. 4-3 together with the total area of sites excluded from the plantation establishment.

Table 4-8 shows the annual planting areas by species, calculated on the basis of the selected species and growth estimate, etc. The annual planting areas by working units are shown in Attached Table 2-7, 8, 9.

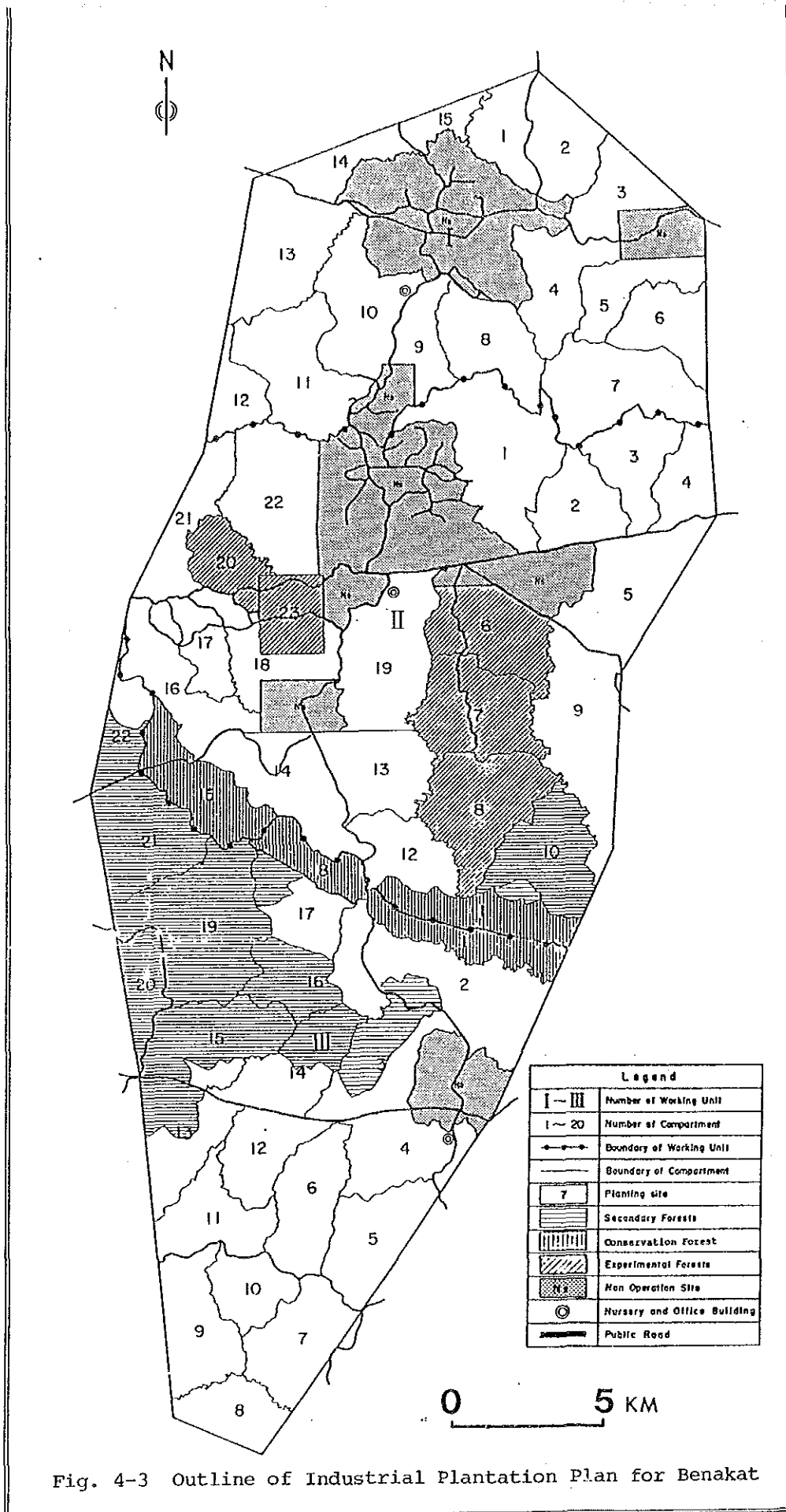
The following were taken into consideration in deciding the annual planting areas.

- 1) All plantation work will be completed in 8 years in view of the rotation periods of the main species to be planted, stable procurement of labour force and quick afforestation of grassland and bush.
- 2) The work volume for the first year will be less than subsequent years in view of such requirements as land preparation, building construction and facility installment.
- 3) The planting sites for each year must be coordinated with the existing network of public roads and the new forest roads to be constructed under the Forest Road Construction Plan.
- 4) In order to prevent forest fire, the Annual Planting Plan have been formulated by taking into account the idea that the sites of grassland should be planted in the earlier Project period as possible.
- 5) The relative proportion of species with a short rotation period and those with a medium or long rotation period will be 80:20. The share of each species to be planted will be almost the same in each tree group.

Table 4-7 Classification of Operation Site
by Working Unit

(ha)

Classification		Working unit		I	II	III	Total
Plan- ta- tion (Oper- ation site)	Planting site			8,806.86	10,582.27	8,287.38	27,676.51
	Non plant- ing site	Secondary forest		353.12	1,179.21	5,749.56	7,281.89
		Conservation forest		-	1,282.25	1,227.37	2,509.62
		Swamp		11.19	49.71	1.06	61.96
		Riparian re- served forest zone		335.18	590.98	468.06	1,394.22
		Forest road		244.51	289.86	227.87	762.24
		Fire break		151.72	175.79	113.94	441.45
		Trial plan- tation		-	3,625.59	-	3,628.59
		Sub-total		1,095.72	7,193.39	7,787.86	16,079.97
Total			9,902.58	17,778.66	16,075.24	43,756.48	
Non operation site Total			2,700.88	3,100.68	674.24	6,485.80	
Grand total			12,603.46	20,889.34	16,749.48	50,242.28	



Legend	
I ~ III	Number of Working Unit
1 ~ 20	Number of Compartment
—+—+—+—	Boundary of Working Unit
— — — — —	Boundary of Compartment
7	Planting site
▬▬▬▬▬▬	Secondary Forests
▮▮▮▮▮▮	Conservation Forest
▨▨▨▨▨▨	Experimental Forests
⊘	Non Operation Site
⊙	Nursery and Office Building
▬▬▬▬	Public Road

Fig. 4-3 Outline of Industrial Plantation Plan for Benakat

Table 4-8 Planting Area by Year - Total -

(Unit: ha)

Year	First Group			Second Group			Third Group			Sub Total	Total
	A	B	C	D	E	F	D	E	F		
1	617.59	617.59	594.73	160.11	160.11	137.25	160.11	160.11	137.25	297.36	2,287.38
2	927.83	927.83	893.46	240.54	240.54	206.20	240.54	240.54	206.20	446.74	3,436.40
3	954.68	954.68	919.32	247.51	247.51	212.14	247.51	247.51	212.14	459.65	3,535.84
4	969.60	969.60	933.71	251.38	251.38	215.46	251.38	251.38	215.46	466.84	3,591.13
5	1,044.10	1,044.10	1,005.42	270.70	270.70	232.00	270.70	270.70	232.00	502.70	3,867.02
6	1,065.18	1,065.18	1,025.74	276.16	276.16	236.70	276.16	276.16	236.70	512.86	3,945.12
7	973.33	973.33	937.26	252.34	252.34	216.31	252.34	252.34	216.31	468.65	3,604.91
8	920.35	920.35	886.27	238.61	238.61	204.52	238.61	238.61	204.52	443.13	3,403.71
9	617.59	617.59	594.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,829.91
10	927.83	927.83	893.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,749.12
11	954.68	954.68	919.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,828.68
12	969.60	969.60	933.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,872.91
13	1,044.10	1,044.10	1,005.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,093.62
14	1,065.18	1,065.18	1,025.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,156.10
15	973.33	973.33	937.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,883.92
16	1,229.15	1,229.15	1,183.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,641.93
17	1,236.62	1,236.62	1,190.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,664.07
18	954.68	954.68	919.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,828.68
19	969.60	969.60	933.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,872.91
20	1,044.10	1,044.10	1,005.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,093.62
21	1,065.18	1,065.18	1,025.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,156.10
22	973.33	973.33	937.26	160.11	160.11	137.25	160.11	160.11	137.25	0.00	3,316.21
23	1,229.15	1,229.15	1,183.63	240.54	240.54	206.20	240.54	240.54	206.20	0.00	3,124.46
24	1,236.62	1,236.62	1,190.83	247.51	247.51	212.14	247.51	247.51	212.14	0.00	3,889.44
25	954.68	954.68	919.32	251.38	251.38	215.46	251.38	251.38	215.46	0.00	3,915.45
26	969.60	969.60	933.71	270.70	270.70	232.00	270.70	270.70	232.00	0.00	3,099.38
27	1,044.10	1,044.10	1,005.42	276.16	276.16	236.70	276.16	276.16	236.70	0.00	3,149.07
28	1,065.18	1,065.18	1,025.74	238.61	238.61	204.52	238.61	238.61	204.52	0.00	3,345.96
29	973.33	973.33	937.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,394.71
30	1,229.15	1,229.15	1,183.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2,883.92
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,641.93

A: Acacia mangium B: Acacia auriculiformis C: Albizzia falcataria

D: Peronema canescens E: Swietenia macrophylla F: Schima wallichii var. barcana