

BASIC DESIGN STUDY REPORT
ON
THE BANG NARA
IRRIGATION AND DRAINAGE PROJECT
IN
THE KINGDOM OF THAILAND

JULY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

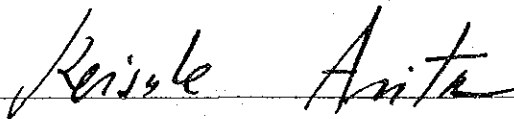
In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study on the Bang Nara Irrigation and Drainage Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a Study Team headed by Mr. Nagashi SAKAI, Deputy Director, Design Division, Construction Department, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry & Fisheries, Government of Japan, from 21st April to 14th May, 1987.

The Team had discussions on the Project with the officials concerned of the Government of the Kingdom of Thailand and conducted a field survey in the Project area. After the Team returned to Japan, further studies were made, a draft report was prepared, and for explanation and discussion of the report, a mission headed by Mr. Yukiya SAIKA, Grant-Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, Government of Japan, was sent to Thailand from 22nd June to 2nd July, 1987. As a result, the present report has been prepared.

I hope that this report will serve for the development of the Project 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 Kingdom of Thailand for their close cooperation extended to the Team.

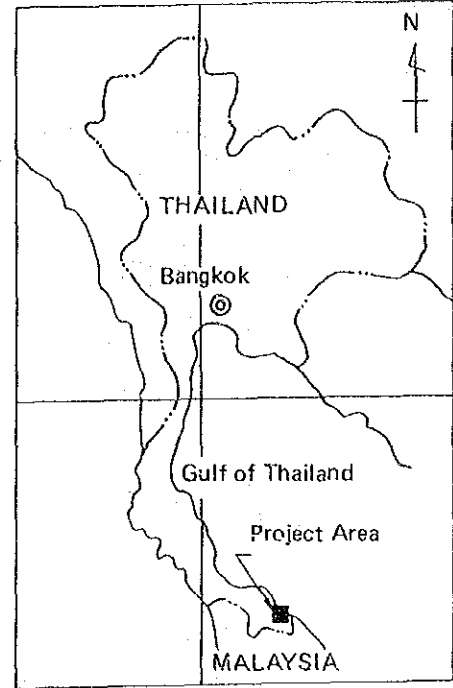
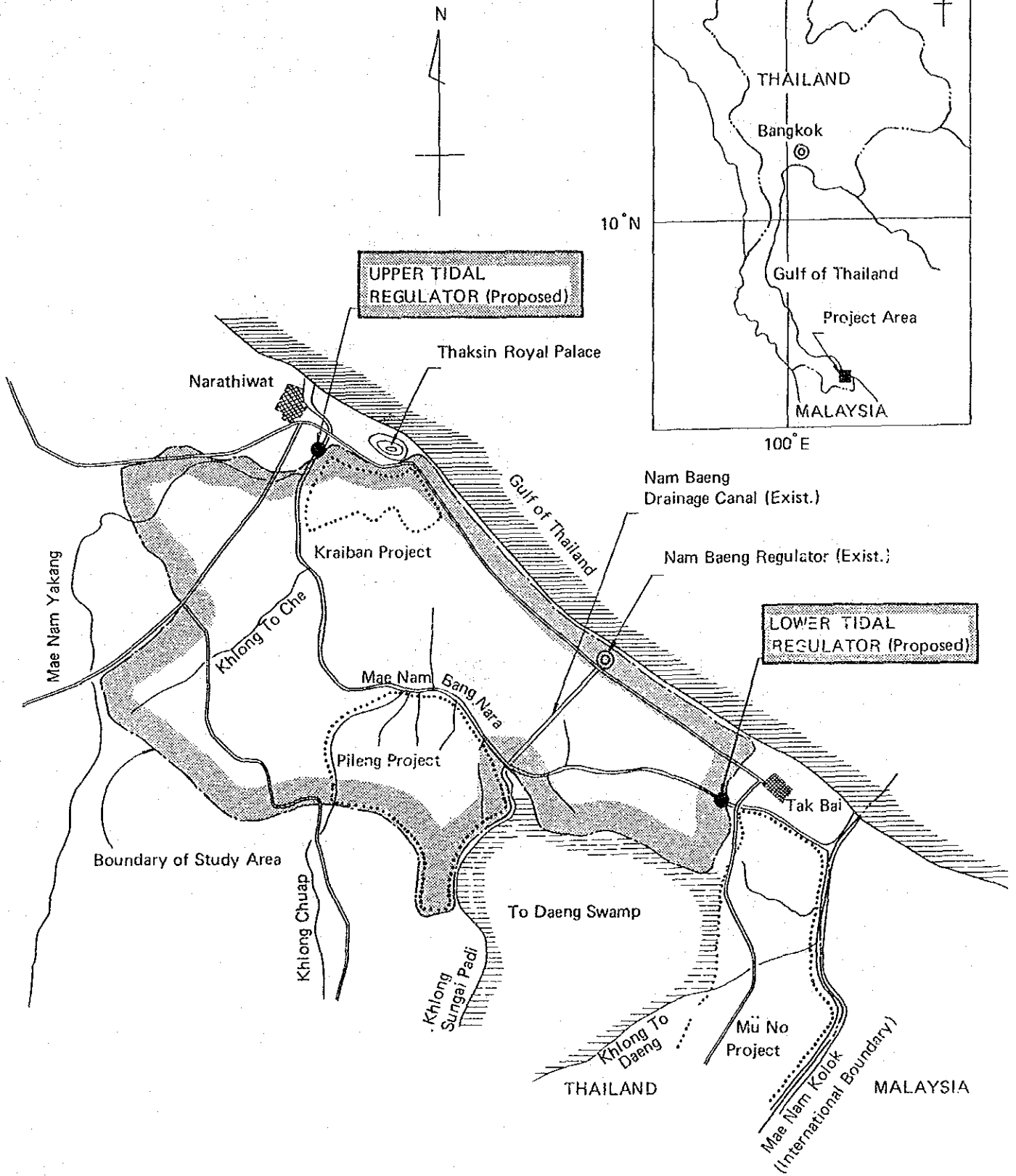
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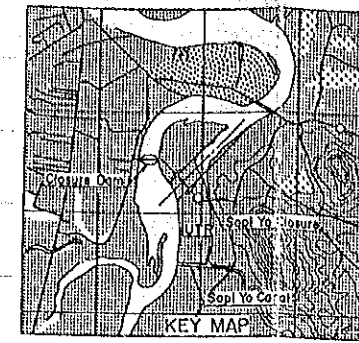
Keisuke ARITA
President
Japan International Cooperation Agency

GENERAL MAP

KEY MAP

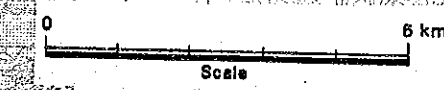


UPPER TIDAL
REGULATOR (UTR)
(Proposed)



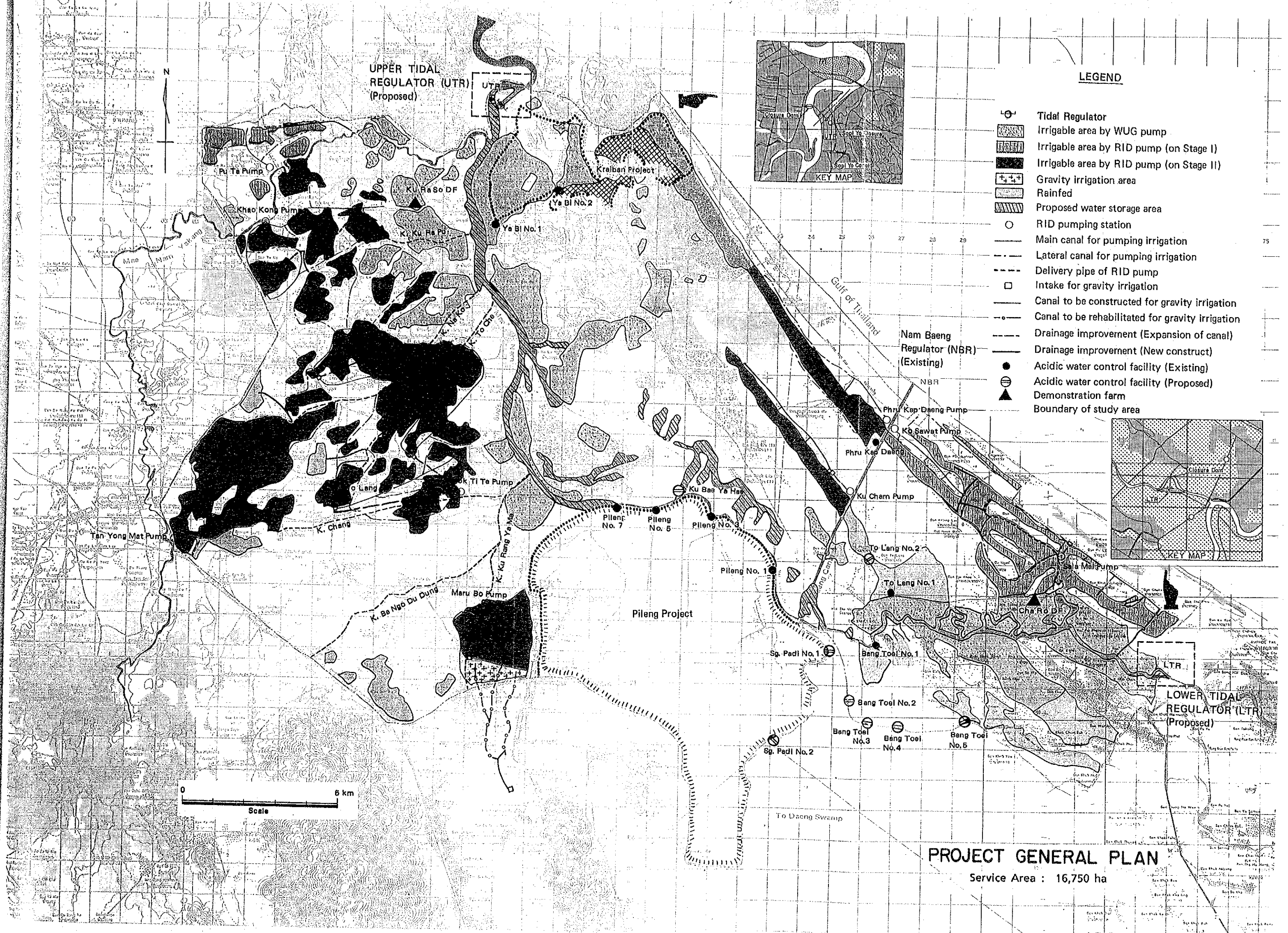
LEGEND

- Tidal Regulator
- Irrigable area by WUG pump
- Irrigable area by RID pump (on Stage I)
- Irrigable area by RID pump (on Stage II)
- Gravity irrigation area
- Rainfed
- Proposed water storage area
- RID pumping station
- Main canal for pumping irrigation
- Lateral canal for pumping irrigation
- Delivery pipe of RID pump
- Intake for gravity irrigation
- Canal to be constructed for gravity irrigation
- Canal to be rehabilitated for gravity irrigation
- Drainage improvement (Expansion of canal)
- Drainage improvement (New construct)
- Acidic water control facility (Existing)
- Acidic water control facility (Proposed)
- Demonstration farm
- Boundary of study area



PROJECT GENERAL PLAN

Service Area : 16,750 ha





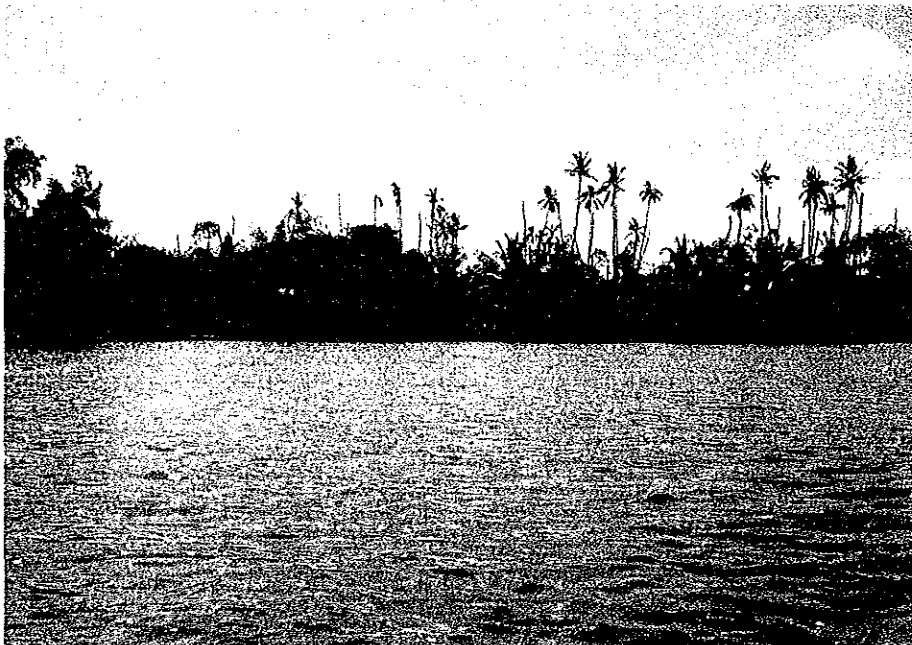
Site of UTR



Site of UTR's closure dam



Site of LTR



Site of LTR's closure dam

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ABBREVIATIONS AND ACRONYMS USED

ABBREVIATIONS

ADB	:	Asian Development Bank
ARD	:	Office of Accelerated Rural Development, MOI
BAAC	:	Bank for Agriculture and Agricultural Cooperatives
CDD	:	Community Development Department, MOI
CPD	:	Cooperatives Promotion Department, MOAC
COA	:	Committee of Official Assistance, MOAC
DOA	:	Department of Agriculture, MOAC
DLD	:	Department of Land Development, MOAC
DMR	:	Mineral Resources Department, Ministry of Industry
DOAE	:	Department of Agricultural Extension, MOAC
DOF	:	Department of Fisheries, MOAC
DOH	:	Department of Highway, MOC
DOL	:	Department of Lands, MOI
DOLA	:	Department of Local Administration, MOI
EEC	:	European Economic Community
EXIM	:	Export-Import Bank of Japan
HD	:	Harbor Department, MOC
IBRD	:	International Bank for Reconstruction and Development
IEA	:	International Energy Agency
IMF	:	International Monetary Fund
KFW	:	Kreditanstalt für Wiederaufbau
LDD	:	Livestock Development Department, MOAC
MD	:	Meteorological Department, MOC
MOAC	:	Ministry of Agriculture and Cooperatives
MOC	:	Ministry of Communications
MOF	:	Marketing Organization for Farmers, MOAC
MOI	:	Ministry of Interior
MOPH	:	Ministry of Public Health
NEA	:	National Energy Administration, Ministry of Science, Technology, and Energy

NEB : Office of National Environment Board, Ministry of
 Science, Technology and Energy
 NESDB : Office of National Economic and Social Development
 Board, Office of the Prime Minister
 NICA : National Institute of Coastal Aquaculture, DOF
 NRDC : National Rural Development Committee
 NSO : National Statistics Office, Office of the Prime
 Minister
 OAE : Office of Agricultural Economics, MOAC
 ODA : Overseas Development Administration
 OECF : Overseas Economic Cooperation Fund
 OPEC : Organization of Petroleum Exporting Countries
 ORRAF : Office of Rubber Replanting Aid Fund, MOAC
 PEA : Provincial Electricity Authority, MOI
 PSU : Prince of Songkhla University
 PWWA : Provincial Water Works Authority, MOI
 RFD : Royal Forestry Department, MOAC
 RID : Royal Irrigation Department, MOAC
 RTSD : Royal Thai Survey Department
 SRAO : Southern Region Agricultural Office, Office of the
 Permanent Secretary, MOAC
 UNDP : United Nations Development Programme
 UNICEF : United Nations Children's Fund
 UNITRA : United Nations Institute for Training
 USAID : US-Aid
 WEP : UN/FAO World Food Programme
 BM : Bench Mark
 EIRR : Economic Internal Rate of Return
 EL : Elevation above Mean Sea Level
 FAO : Food and Agriculture Organization
 GDP : Gross Domestic Product
 GNP : Gross National Product
 GRBDS : Golok River Basin Development Study
 HYV : High Yielding Variety
 JICA : Japan International Cooperation Agency

LTR	:	Lower Tidal Regulator
M.	:	Million
NBR	:	Nam Baeng Tidal Regulator
NPV	:	Net Production Value
Sg.	:	Sungai
SSIP	:	Small Scale Irrigation Programme
UTR	:	Upper Tidal Regulator, including Mae Nam Yakang
WUG	:	Water Users Group

ACRONYMS

฿	:	Thai Baht
cu.m	:	Cubic Meters
MCM	:	Million Cubic Meters
Ha	:	Hectare
m	:	Meter
kg	:	Kilogram
km	:	Kilometer
sq.km	:	Square Kilometers
sq.m	:	Square Meters
ton	:	Metric Ton
p.a.	:	per annum
Yr	:	Year
hr	:	Hour
min	:	Minute
sec	:	Second
°C	:	Degree Centigrade
ms/cm	:	Milli Siemens per Centimer (same as m.mho/cm)
HP	:	Horsepower
WL	:	Water Level

SUMMARY

The Bang Nara River Basin Irrigation and Drainage Project is located in Changwat Narathiwat in the south-western part of the Kingdom of Thailand and adjoins the border with Malaysia. The Changwat, having about 4,200km² in its land area, is inhabited with about 484,000 people which occupies 7.6 percent of the total population in the southern part of the country. The GNP growth rate of the Changwat in 1983 was 2.7 percent, which is lower than that of the national average of 5.6 percent. The per capita income was 12,900฿ which was lower than the national average by 32 percent. The agriculture sector plays the main role of the production activity of the Changwat, taking account about 46 percent, whereas the industry sector occupies about 9.0 percent only. Such being the case, the Changwat Narathiwat is extremely behind in socio-economic development to the other Changwats. The Government of the Kingdom of Thailand, in its Fifth Five-Year Development Plan, has designated the Changwat as the area requiring most urgent development. In February 1985, the Government of the Kingdom of Thailand requested the Government of Japan for executing the feasibility study of the Bang Nara River Basin Development Plan. In response to the request, the Government of Japan has decided to conduct the study and the Japan International Cooperation Agency (JICA) prepared the final study report of the Bang Nara River Basin Irrigation and Drainage Project in December, 1986.

The Bang Nara River Basin, bounded by the Malaysian border on the south and facing the Gulf of Thai on the east, has about 1,400km² in acreage and consists of the Bang Nara and Yakang River Basin Systems. The Bang Nara River is the mainstream running about 60km along the sea coast connected to the Yakang River in the northern part of the Basin, and also to the Colok River (international river) in the southern part. The annual river runoff of the Bang Nara River is about 1.8 billion cubic meters on an average, 60 percent of which takes place in the wet season as runoff in a range from 100m³ to 1,000m³/sec, and 15m³/sec in

the dry season. For the area in such runoff conditions, the Government of the Kingdom of Thailand is trying to promote the agricultural development for farmers' income increase and upgrading their living standards through the development of irrigated agriculture. For this purpose, the agricultural development through modern techniques is essentially required as well as those development and improvement in water resources, irrigation and drainage, etc. The aforesaid development components, project cost, implementation schedule, etc. are shown hereunder with 16,750 ha as objective areas for irrigation development and drainage improvement.

° Development components

Water Resources Development: Tidal regulators will be constructed near both estuaries of the Bang Nara River 60km long for freshening the water by preventing saline water intrusion and controlling the free discharge to the sea.

Irrigation Development and Drainage Improvement: The systematic irrigation networks and the pumping stations will be provided for 9,980ha of the existing paddy fields as well as drainage improvement for 6,670 ha of the area.

Agricultural Development: High yielding varieties and improved local varieties of paddy will be introduced together with dry season cash crops and perennial fodder crops. Demonstration farms will also be provided.

Other components: A countermeasure will be made for acid elimination from water and reservoir fisheries will be developed.

° Project Cost: about 1.2 billion Baht

° Implementation Period:

Stage I (Construction of Tidal Regulators and Other Facilities): 3 years

Stage II (Construction of Irrigation and Drainage Facilities): 5 years

In December 1986, the Government of Thailand has studied the project implementation after receiving the feasibility report. Whereas the Government of Thailand requested the Government of Japan the grant-aid cooperation for the implementation of tidal regulators construction in the Stage I taking into due consideration the construction works particularly the construction methods such as shut-off sheet piling on the soft foundation with high groundwater table, wellpoints watering and budgetary schedule.

In response to the request, the Government of Japan decided to conduct the basic design study of the tidal regulators and sent a study team to the field survey through JICA in April, 1987. The team while in field, made review and confirmation of those items requested by the Government of Thailand, including construction planning and implementation schedule as well as responsibility of the Government of Thailand. The team has prepared this report in home office, and the summary of the project by grant-aid cooperation is as stated below.

The grant-aid planning is composed of main body of tidal regulators, closure dams, gates structures and its related operation devices as well as operation houses building. The details and dimensions related to the tidal regulators are shown in the following table "Request and Planning". The implementation schedule of the maintenance roads, power and water supply lines between the existing points to the project sites will be constructed by the Government of Thailand.

(1) Responsibility of Government of Japan

Request and Planning

<u>Description</u>	<u>Request</u>	<u>Planning</u>	
<u>A. UTR</u>			
Regulator	Width	138.0 m	same as Request
Apron Length	Up/Downstream	8.0 m/10.0 m	same
Riprap	Up/Downstream	20.0 m/45.0 m	"
Bridge	Effective width/Span	6.0 m/23.0 m	"
Feeder Canal	Width	150.0 m	"
Closure Dam	Crest length	220.0 m	"
Gate	Dimension	20.0 m x 5.1 m	"
Gate No.	1/2 Stage Gate	5/1	"
O/M Road	Width	6.0 m	"
Operation Office	Area	212.0 m ²	220.0 m ²
Emergency Generator		1 set	same
Gate Operation Panel	Manual/Motor on site		"
	Remote operation		"
Monitoring Equipment	Panel		Panel & ITV
Telemeter	Wire		Radio System
Measuring	-		pH, EC value
<u>B. WATER Level Meter</u>			
(X 73 & X 162)	Water Level		same as Request
<u>C. Machinery & Equipment</u>			
Survey Equipment	Transit/Level		same as Request
Concrete Testing Equipment	Concrete compression		"
	Machine and others		"
Vehicle and boat	Land cruiser and others		"
Audio-visual aids	Video camera and others		"
Others	Copy machine		"
<u>D. LTR</u>			
Regulator	Width	29.0 m	same as Request
Apron Length	Up/Downstream	7.0 m/13.0 m	"
Riprap	Up/Downstream	20.0 m/40.0 m	"
Bridge	Width	6.0 m	"
Feeder Canal	Bottom Width	30.0 m	"
Closure Dam	Crest Length	75.0 m	"
Gate	Dimension	12.0 m x 6.6 m	"
"	1/2 Stage Gate	1/1	"
O/M Road	Width	6.0 m	"
Operation Office	Area	119 m ²	120 m ²
Emergency Generator		1 set	same
Gate Operation Panel	Manual/Motor on site		"
	Remote operation		"
Monitoring Equipment	Panel		"
Telemeter	Wire		Radio System
Measuring			pH, EC value

(2) Responsibility of Government of Thailand

<u>Description</u>	<u>Planning</u>	<u>Note</u>
1) O/M Road		
° UTR	Length 510 m, Width 9.0 m	From existing road to the site, including Sapi Yo closure dam
° LTR	Length 820 m, Width 9.0 m	From existing road to the site
2) Power Transmission Line		
° UTR	Length 1.0 km 50° x 3 W, 33 KV	From Narathiwat-Tak Bai line to the site
° LTR	Length 1.0 km 50° x 3 W, 33 KV	From Tak Bai-Muno line to the site
3) Water Pipeline		
° UTR	ø5" pipe	From Narathiwat main pipe to the site
° LTR	ø5" pipe	From Tak Bai main pipe to the site.

° Implementation Organization and Programme

In April 1987, the Government of Thailand has approved the implementation of the Bang Nara River Basin Irrigation and Drainage Project, excluding the tidal regulators construction works to be financed by Japanese grant-aid cooperation. A part of the works approved has been already under implementation. The implementing body of the grant-aid project will establish the Bang Nara River Basin Irrigation and Drainage Project Construction Office, the Royal Irrigation Department (RID), the Ministry of Agriculture and Cooperatives.

Under the direct contract with RID, the Japanese consultants will perform the detailed design and construction supervision, and the contractors will carry out the procurement, transportation of the necessary machineries/equipment and construction works, respectively. The project works will be implemented after mutual confirmation of the relevant Exchange Notes and following the regular procedures. The works will be commenced with detailed design for four months, and construction works for 23 months.

° Project Cost: 44.8 million Baht (to be financed by the Government of Thailand)

° Operation and Maintenance (O&M)

The O&M services of the facilities will be rendered comprehensively by Regional Irrigation Office-12 of RID. The operation houses at UTR and LTR will be provided with 21 and 13 staffs, respectively.

The O&M cost required is estimated at 3.6 million Baht including direct salaries, electricity charges, transportation including fuel cost, and other miscellaneous.

° Project Evaluation

After completion of the Bang Nara River Basin Irrigation and Drainage Project, the yields of paddy, rubber, upland crops and other tree crops will increase, especially paddy production which is expected to be increased to about 32,300 tons (almost three times than that of the present). Such a considerably large extent of paddy production increase will give favorable effect to balance the demand and supply of paddy in the local market. In other respect, as the water in the Bang Nara Reservoir is freshened, the flood damages in the areas will be largely mitigated, while the reservoir fish culture will bring a considerably benefit to the people. In addition to the direct socio-economic benefits, some indirect benefits can be anticipated from promotion and encouragement of the agri-related processing industry and marketing. Such socio-economic stimulation will increasingly provide labour opportunities and contribute greatly to the uplevelling of the farmers' living standards. As a result, the livelihood of the people will be stably ensured even in the sensitive border areas. Furthermore the effect on relief from flooding damage in the area will be worthy of special mention by the construction of tidal regulators. Therefore, the project execution by grant-aid cooperation will no doubt be justifiable.

CHAPTER 1. INTRODUCTION

CHAPTER 1. INTRODUCTION

The Study area on the Bang Nara Irrigation and Drainage Project is located in Narathiwat, a changwat in the southern Thailand. It has an acreage of 46,700ha in 1,400km² of the Bang Nara Basin. The Basin, which consists of Bang Nara River and Yakang River, has an even watershed acreage. The Bang Nara river, which has three river mouths (two are natural and one artificial), has a length of about 60km along the coastal plain. Agricultural activities in the Study area are mainly categorised into rainfed paddy, rubber plantation, rainfed paddy-rubber plantation mixture, and livestock breeding. However, the yields from these activities are blocked by saline water intrusion due to the tidal Bang Nara River, insufficient water, and flood damage in the rainy season.

The Government of the Kingdom of Thailand listed the area as an area to be urgently developed in the Fifth Five-Year Plan (1982/86) and requested feasibility study on the Bang Nara River Basin Development to the Government of Japan in February, 1986. In response to the request, the Government of Japan decided to conduct the study on the basin and entrusted the study to the Japan International Cooperation Agency (JICA), and JICA submitted the Report on Bang Nara Irrigation and Drainage Project in December, 1986. The Report recommended the development components as (1) water resources development, (2) irrigation development and drainage improvement, and (3) agricultural development. The project cost was estimated at 1,200 million Baht. The implementation schedule consists of the Stage I (tidal regulators and other related construction, 3 years) and the Stage II (irrigation and drainage facilities, 5 years).

After study on the implementation programme by the Government of the Kingdom of Thailand, they requested a grant-aid from the Government of Japan for the implementation of two tidal regulators in Stage I of the F/S report, taking into consideration the difficulties in the construction of soft-ground and budgetary schedule. In response to the request, the Government of Japan decided to conduct a basic design study on the Bang Nara Irrigation and Drainage project and entrusted the study to JICA.

JICA sent to the Kingdom of Thailand a survey team in April, 1987, and the team completed the basic design study of the tidal regulators based on the data and information in the F/S report and site survey in July 1987. The team studied the (i) sites survey of UTR and LTR, (ii) geological survey, (iii) additional hydrological and topographical data collected, (iv) collected data on construction equipment and materials required construction planning, (v) water operation, maintenance and control system for the Bang Nara Reservoir, and (vi) demarcation of both governments' responsibilities.

This report compiles the results of analysis based on the site survey and discussions with the officials concerned of the Government of Thailand.

CHAPTER 2. BACKGROUND OF THE PROJECT

CHAPTER 2. BACKGROUND OF THE PROJECT

2-1. Agriculture and Rural Economy in Thailand

2-1-1. Agriculture in Thailand

In 1985, the rural population was 42.6 million which was about 82.2% of the total population of 51.8 million and it is characterized as follows:

- It is a major exporter of food grains.
- It has grown and diversified rapidly in recent years.
- Farmers have been found to respond vigorously to relative price incentives.
- Ownership and usufruct of cultivated land are fairly distributed.
- Labor mobility within rural area and between rural and urban areas is high in both directions.

The growth of the agricultural sector in Thailand has been the determining factor in balancing the rural economy. During the years from 1960 to 1975, Thai's agricultural sector performed exceptionally well with the growth rate exceeding 5% per annum; however, the growth has slowed since 1975. The growth of the agricultural sector during the Fifth Plan period was 2.8% per annum, and the proportion of agriculture sector to GNP declined from 24% (1981), 23% (1982), 23% (1983), 20% (1984) to 18% (1985). The growth rate of agriculture sector, which is fundamental and supporting the rural population could not keep pace with those of mining, industry and commercial sectors, etc. However, the agriculture sector is still most important to Thai economy and society, because it contributes to employ about 60% of the country's labor force and to earn about 60% of the total export value.

The Sixth Plan (1986/91) which was commenced from October 1986 comprises the economic and social objectives and targets as follows:

Economic Targets

To maintain at least 5% economic growth. Emphasis will be given to the expansion to support job creation, income distribution and the stabilizing of economic equilibrium, so that they will have consistent progress.

Social Targets

To promote the social development so as to enable progress of living quality and to create peace and justice. These include three points; namely, (1) to promote social development continuously, (2) to expand the human basic needs to whole country, and, (3) to reduce inter-regional income disparities.

To achieve the aforementioned principal social and economic objectives and targets, it is necessary to set the development strategies such as to increase the country's efficiency in development, to improve production and marketing systems, and to distribute income and prosperity to regional and rural areas. In order to execute the strategies, the following 10 programmes are set:

- (1) Overall Economic Development
- (2) Human and Social Development Programme
- (3) Natural Resources and Environmental Development Programme
- (4) Science and Technology Development Programme
- (5) Programme to Improve Management and Review the Role of the State in Development
- (6) State Enterprise Development Programme
- (7) Production, Marketing, and Employment Development Programme
- (8) Basic Services Development Programme
- (9) Urban and Specific Zones Development Programme
- (10) Rural Development Programme

Among the aforementioned 10 programmes, the Rural Development Programme in the Sixth Plan is the most important. This programme is to improve the standard of living through increase in local inhabitant's income and acceptance of social services and to respond to the changes in economic and environmental conditions.

The contribution of this programme to the Sixth Plan is solution of poverty problem, fulfillment of social services, correction of regional imbalance and national security policy and arrangement of economic and social development for the local security problem, etc.

Agricultural development policy in the Sixth Plan are as follows:

- ° Development of poor rural areas
- ° Development of high rainfall areas
- ° Development of progressed agricultural areas
- ° 2.9% of growth rate of agricultural sector in GNP
- ° Shifting of development means from quantitative expansion to qualitative expansion of production.

2-1-2. Irrigation Facilities

In Thailand, the following 3 major river systems and numerous medium-small river systems are:

- ° Chao Phraya River System
 - Ping River, Wang River, Yom River, Nan River, Pasak River, etc. as tributaries.
- ° Maeklong River System (located in the west side of the Chao Phraya River Basin)
 - Khwai Yai River, Khwai Noi River as tributaries
- ° Mekong River System (flow along the border of Thailand and Laos)
 - Chi River, Mun River and medium-scale rivers as tributaries.

In these rivers, more than 300 water reservoirs for irrigation have been constructed to store 29,500 MCM and the irrigable area is about 3.45 million ha. The number and capacity of water reservoirs and the irrigable area by regional office of RID are shown in Table 2-1.

Table 2-1. Number and Capacity of Water Reservoirs and Irrigable Areas by RID

<u>Region</u>	<u>No. of Reservoir</u>	<u>Total Capacity</u> (MCM)	<u>Irrigable Area</u> (ha)
I	20	626.34	188,194
II	24	233.49	148,496
III	13	22,559.45	280,384
IV	63	307.09	99,662
V	77	2,237.15	205,780
VI	77	1,555.87	160,746
VII	4	403.08	665,360
VIII	11	42.36	513,361
IX	21	277.71	329,051
X	24	1,240.31	540,757
XI	9	17.68	113,426
XII	5	28.42	205,584
Total	<u>348</u>	<u>29,528.95</u>	<u>3,450,801</u>

Note: Water reservoirs constructed by EGAT such as Sri Nakarindra Dam and Ubolratana Dam are excluded.

Except for Bhumibol dam (13,460 MCM) and Sirikit dam (9,000 MCM) in Region III, the average capacity of water storage per reservoir is 20 MCM. In the Central Plain (Regions VII and VIII), water resource is less as compared with the irrigation area. This is due to the fact that water requirement of Naresuan dam (diversion dam) at Phitsanulok and Chao Phraya dam (diversion dam) at Chainat are dependent on release of Buhmibol dam and Sirikit dam.

The southern Thai covered by Regions XI and XII has less number and the total capacity of reservoirs than the other regions, because most lands in the southern Thai depend upon rainfall.

2-1-3. Irrigation Administration

The policies concerning irrigation facilities including water resources development are as follows:

- ° Economically and socially effective development and utilization of water resources.
- ° Efficient use of irrigation water at irrigation canals and on-farm facilities.

The Government has invested in utilizing the effect of medium-scale and large-scale projects. This gives full scope to the economic benefit of the projects and the development procedure helps to plan the long-term water resources development project. In small-scale development projects, on the other hand, the efforts to meet the basic requirement for water and to improve the operation and maintenance of facilities by water users' organization should be continued.

The following recommendations are made as guidelines based on the said policies:

- ° to increase the water use efficiency in water resources development projects;
- ° to establish the water users' organization to utilize the resources at the maximum;
- ° to make the regulations concerning water rights.
- ° to plan the development strategies of water resources development project by regions.

The Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperatives is the agency responsible for the implementation of irrigation projects including water resource.

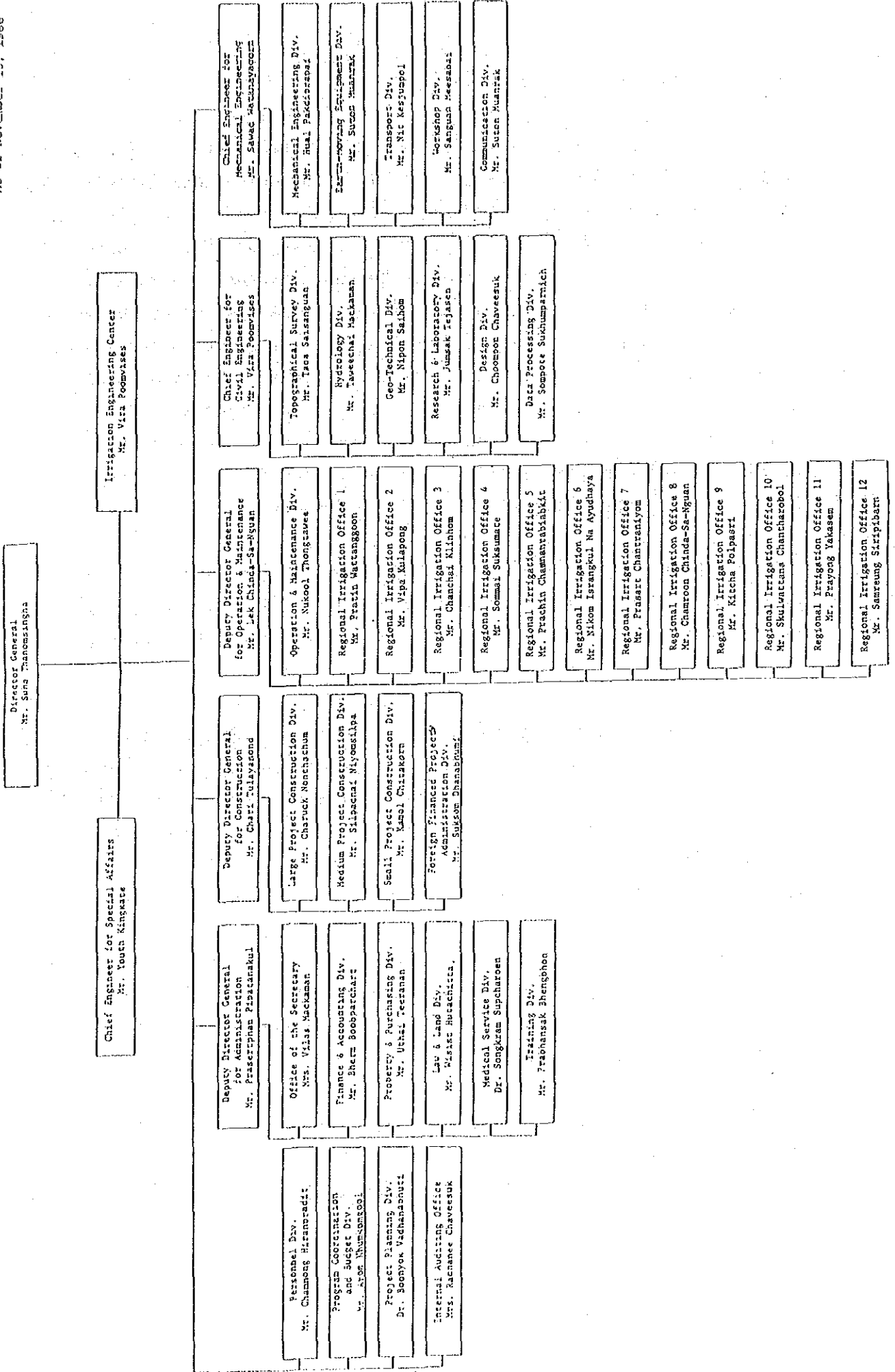
RID is also responsible for the above-mentioned guidelines such as to increase the water use efficiency in water resources development project, to assist the farmers technically, to establish and manage the water users organization, and to participate the planning of development strategies for water resources development project by region. The organization of RID is shown in Figure 2-1.

The budget of RID for 2530 (1987) FY (from October 1986 to September 1987) is about ¥ 8,570 million, which is about 53% of the total budget of the Ministry of Agriculture and Cooperatives. RID's share in the total national budget is about 4%. Table 2-2 shows the outline of RID budget.

Table 2-2. Budget of RID (1987 FY)

<u>Item</u>	<u>Amount (¥)</u>
General (Administrative)	1,988,886,800
Technical (Engineering)	628,274,500
Machinery & Equipment	33,472,300
Project Implementation	5,920,123,300
<u>Total</u>	<u>8,570,750,900</u>

The project implementation cost is separated into 76 large and medium scale projects and small-scale irrigation programme. The cost of initial year of implementation of the Bang Nara Project (mainly the construction cost of monument), ¥15,477,400 are included in the project implementation cost mentioned-above.



2-1-4. Irrigation Project Operation

The construction projects by RID are separated into 2 groups by the scale: (1) small-scale irrigation facilities of which cost is less than ฿ 4 million, and (2) medium or large-scale project of which cost is more than ฿ 4 million. For small-scale project, Changwat office requests to RID based on the request of Amphoe or Tambon. Because the investment for one project is limited, most of the works are limited to the water resources construction works. Designing of the project is carried out by Design Section of RID and the contract is made by Regional Office of RID. At present, there is Small-Scale Project Division in RID headquarter. This Division controls the small-scale project in whole country, determines the priority of construction and assists the operation and maintenance after the construction.

Except for the construction by RID, construction and operation & maintenance of irrigation ditches and on-farm facilities are carried out by the water users organization. Technical assistance for construction and operation & maintenance are done by RID.

Medium and large-scale projects (project cost: ฿ 4 million) are implemented by the project implementation organization after confirming the possibility of project implementation through the feasibility study if necessary. After completion of the construction, operation & maintenance of water resource facilities, intake facilities and canal facilities (up to turnout covering 300-500 rai) are done by RID.

Designing and preparation of construction contract are undertaken by RID, and the supervision and operation & maintenance during the construction period are done by implementing organization which is established for the project.

The construction of on-farm facilities after the regulator covering 300-500 rai and operation & maintenance after the completion of construction are done by water users organization.

2-1-5. Irrigation Facilities Improvement Plan

As mentioned in the previous section, about 3.45 million ha of agricultural land with water resources development have been carried out. However, there are still suitable lands for irrigation in Thailand and RID has projects for future development, as shown in Table 2-3.

Table 2-3. Major Irrigation Projects to be Developed

<u>Project Name</u>	<u>Beneficial Area</u>
Chanthaburi Basin Project	20,000 rai
Chao Phraya Flood Forecast Project	-
Chao Phraya Water Management Study Project	-
Dom Yai Project	50,000 rai
Sakae Krang Basin Project	230,000 "
Sebai Sebok Project	50,000 "
Bang Pakong River Basin Project	-
Sai Buri Multipurpose Project	50,000 "
Chonburi Upland Irrigation Promotion Project	-

2-1-6. Foreign Assistance to Thailand

Foreign assistance to Thailand was started in 1950 by the loan from IBRD after Thailand joined IBRD and IMF in 1949. After NESDB was established and the First Economic and Social Development 5-Year Plan (from October 1961 to September 1966) was planned in response to the recommendation of IBRD in 1961, the foreign assistance became on a full scale. Afterwards, many international organizations and foreign countries have been loan and grant-aid to Thailand.

As regards the international organizations, IBRD, ADB, IMF, OPEC Fund, IFAD, EEC, etc. have given loans and UNDP, UNTA, UNICEF, WFP etc. have given grant-aids. For the bilateral cooperation, major donor countries are Japan, Germany, USA, Australia, UK, Canada, Belgium, Netherland, Denmark (DAC countries), Kuwait, Saudi Arabia (OPEC countries), etc. Thailand has made effort to improve the infrastructure mainly power generation and transportation by utilizing such foreign assistance actively.

The annual average of receipts of ODA during 1980 to 1984 was US\$425 million from 75% of DAC countries, 21% from international organizations and 4% from OPEC countries. Among DAC countries, ODA from Japan amounted to US\$211 million per year which corresponds to 50% of the total ODA countries. Japan is the most important donor country for Thailand during the recent years. ODA of USA and Germany were US\$35 million and US\$23 million per year corresponding to 8% and 5% of the total, respectively.

In respect to the official debt in March 1986, the government debt was US\$3,843 million (38.7%) and government guarantee debt for state enterprises was US\$6,095 million (61.3%), totalling US\$9,938 million. Out of them, the debt to financial institutions such as IBRD, ADB (international organization) and USAID, EXIM, OECF, KFW (bilateral) occupied 51% of the total debt.

Thailand's debt from OECF and EXIM occupied 19% of the total foreign debt. It could be said that economic development of Thailand has been supported by Japan as well as IBRD and ADB.

The total amount of development assistance has been increased by 22% for the last 5 years. Among them, grant-aid was 15-22% of yearly development economic cooperation.

The major sectors of grant-aid were agriculture (30%), education (17%), health (16%) and social development (14%).

In the Sixth Plan, introduction of grant-aid is planned because the debt exceeded US\$12,000 million in 1985.

2-2. The Southern Region of Thailand

The Southern Region which consists of 14 Changwats covers about 71,000 sq.km with an estimated population of 6 million. The region would be economically, ethnically and politically rather different from the core of Thailand. The long distance from Bangkok, the economically different structures compared with the central parts, the fairly large share of Thai Muslim population and other factors have set the South relatively isolated from the rest of Thailand.

Until recently, the economic activity in the South was dominated by fishing, paddy and coconuts with forestry, livestock, fruit and field crops playing subsidiary roles. However, with construction of the railway and improvement of land transportation links, tin mining, large-scale planting of rubber, and introduction of irrigation brought far-reaching changes. These developments encouraged the movement of population from the coastal areas and superimposed an export-oriented economy upon traditional subsistence basis.

Communication with both Bangkok to the north and Malaysia to the south are steadily upgrading; therefore, the region has become increasingly integrated into the national economy.

The Southern regional economy is dominated by the primary sector. Crops, of which rubber is by far the most important, contributed 26 percent of the total value added. Paddy is another crop of importance, production of which still plays a crucial role in the smallholder economy although not as important as in other regions. Many farmers cultivate paddy field for their own subsistence and this guarantees their independence and security against fluctuations in international commodity prices.

Most crop farming with the exception of rubber in the South is done on the eastern coast accounting for nearly 90 percent of the region's paddy field. Paddy production was increased in response to an increase in the area under cultivation and not as a result of any significant increases in yield. It is generally considered that further major expansion of the paddy area is unlikely and increasing production will have to be achieved by intensifying the use of existing paddy field or from the use of high yielding varieties.

Since these existing paddy areas are economically backward in the Southern region, high priority has been accorded to their development by the Government. The Government's recent policy to accord priority to irrigation projects in this region is based upon its recognition of this potential.

The southern border province, Changwat Narathiwat in which the Bang Nara Irrigation and Drainage Project Area is included covers an area of 4,228 sq.km and has a population of 484,000 at the end of 1984 representing 7.6 percent of the Southern population. In 1983, the annual growth rate of Narathiwat was 2.7 percent, which is lower than 2.8 percent of the Southern region and 5.6 percent of the country. Per capita GNP of Narathiwat in 1983 that was ¥12,900 was 20 percent below the Southern region and 32 percent below the country as a whole. Likewise more details of the present condition in Changwat Narathiwat and project area are mentioned in chapter 3.

2-3. Government's Rural Development Policies and Development Needs of the Bang Nara River Basin

2-3-1. Rural Development Policies

The rural development policies in Thailand are formulated under the National Rural Development Committee (NRDC). There are formalized links between NRDC and Changwat and Amphoe level development committees and working groups with Tambon committees.

The rural development policy is an integral part of the national socio-economic policy, and its formulation and implementation have attracted a considerable political interest and support. The Fifth National Economic and Social Development Plan (1982-1986) represents a departure in that it puts less emphasis upon overall economic growth in terms of national output and income as a goal, and pays a considerable attention to the issues of equity, national long-term stability and operational efficiency.

The Fifth Plan has the following objectives:

- ° To adjust the Thai's economic structure to cope with the changing world economic conditions through the decentralization of industry, intensification of agricultural production, promotion of exports and reduction of imports.
- ° To develop a social structure in response to the economic change particularly through the rural infrastructural services.
- ° To alleviate the poverty with a particular emphasis upon the previously neglected rural areas.
- ° To coordinate the economic and social development efforts to meet the national security goals.
- ° To reform the national development administration system with the mobilization of private sector's cooperation.

The Fifth Plan includes three major implications of direct relevance to the development of the Bang Nara river basin under the subject Project:

The first theme is the need for structural adjustment as a means to reduce the disparity of income and social services both between and within the regions. At present, the Bang Nara basin has a very narrow economic base with the income levels and services lower than other areas in the Southern Thailand. The Fifth Plan suggests the following:

- ° Greater emphasis should be placed upon the intensification of agricultural production and the improvement of its productivity rather than the expansion of cultivated area.
- ° There should be the diversification of agriculture which is appropriate for the Bang Nara river basin.
- ° The Plan identifies the geographical target areas for rural development and poverty alleviation, one of which is the Southern border region where the Changwat Narathiwat is located.

The second is the poverty alleviation in the previously neglected rural areas. The Fifth Plan's rural development and poverty alleviation policy is directed at Muban level.

The third concerns the policy of reforms to the system of development administration, in particular, the Plan stresses the improved procedures for development planning and implementation with a major goal to improve the extent of local participation.

Greater decentralization of the decision-making is an integral part of the Government policy to encourage the rural communities to participate in development.

The guidelines:

- ° To develop major economic and social sectors following the Fifth Plan, and concurrently, new opportunities must be created to make the economic progress benefit the public as widely as possible with a top priority on the limits and stability of the fiscal and monetary systems.
- ° To increase efficiency, qualities of production, marketing and technology to enable Thailand to be competitive with other countries, including the agricultural sector; and,
- ° To restructure the development management of the Government to be suitable to the limits of its ability and fiscal position, by sharing the relevant burden between the Government, state enterprises and private sectors.

Ten main plans, in which the rural development sector is included and divided into three parts:

- ° To continue solving rural problems which remain after the Fifth Plan, and to develop areas along the border so as to increase the security for people in such areas.
- ° To improve the efficiency of the Government in solving the rural development problems; and,
- ° To improve the rural development mechanism so as to get better cooperation from the parties concerned.

2-3-2. Development Needs of Bang Nara River Basin

Ranfed paddy in the Bang Nara Basin can be mainly found in lower coastal area. However, its yield is limited by yearly flood, pest and vermin. This area has potential of water resource development because of 2,500 mm of rainfall, nevertheless, measures for flood control, domestic water supply, facilities for irrigation and drainage, and rural infrastructure, need more modernization.

Different social structure of the Bang Nara river basin has posed problems for the Government's development effort in terms of the management of education, family planning and social welfare programmes. The social development policy is specifically aimed at encouraging a Thai identity and social integration with Thai values while maintaining the religious harmony.

While the National Development Plan emphasizes the need to promote the diversification to enable the economic activities of the border area, the scope of development for the industrial and commercial sectors, however, is quite limited and the increases in agricultural productivity only remain the primary means for promoting the economic growth within the Bang Nara river basin.

The national policies and development strategies need to be examined within the context of specific conditions applying in the Bang Nara river basin. The Government specifies that the prime objective of the proposed Project is to improve the standard of living and socio-economic well-being of the inhabitants in the Bang Nara river basin through the development of agriculture and related infrastructure.

Particularly, the development of the Bang Nara river basin has been envisaged to encompass the following:

- ° To provide effective measures to alleviate the annual inundations prevailing in the low-lying land along the Mae Nam Bang Nara so as to safeguard the existing and future developments.
- ° To develop and manage the water resources of Mae Nam Bang Nara for agricultural and domestic use.
- ° To intensify the agricultural development and related activities such as livestock; and,
- ° To provide adequate rural infrastructure.

2-3-3. Development of Bang Nara River Basin

Taking into consideration of the rural development policies and the development needs of the Bang Nara river basin as mentioned in the previous section, the Government of Kingdom of Thailand had requested the feasibility study of agricultural development to the Government of Japan. In response to their request, the Government of Japan implemented the feasibility study through Japan International Cooperation Agency (JICA) and the Feasibility Study Report was completed in December 1961. The development plan of the basin based on the feasibility study report is outlined as follows:

It is necessary to establish the irrigated agriculture using the water resources in this basin for improving the agricultural production and farmer's income. It is also important to complete the drainage facilities for mitigation flooding damage of the Bang Nara river. Therefore, the river basin development project consists of the irrigation and drainage based on the water resources development of the Bang Nara river. The whole catchment area of the Bang Nara river is

about 1,400 km² that comprises 677 km² of mainstream and 724 km² of Yakang river. Annual discharge of the Bang Nara river is 700 million tons and that of Yakang river is 1,100 million tons, totalling 1,800 million tons. About 60% of the annual discharge concentrate during 3 months from November to January (rainy season) and the discharge reaches 100-1,000 m³/sec. On the other hand, it decreases to 10-15 m³/sec during dry season.

The Bang Nara river having 60 km of total length runs through the lowland area in parallel with the east coast of Thai Peninsular. The river gathers several tributaries at the upstream and flows into the Thai Gulf via Narathiwat in the north or via conjunction of the Kolok river in the south. While the discharge of the Bang Nara river fluctuate seasonally in a wide range, it is possible to use the water for irrigating the existing rainfed paddy fields in the Area. For this purpose, the following improvement measures should be undertaken:

(1) Water Resources Development

The seawater intrudes at high tide because the Bang Nara river has little gradient. During the dry season, in particular, the water becomes too saline to use the irrigation purpose. During the rainy season, on the other hand, the flooding water from Bang Nara river stagnates on the cultivation lands in lower elevation areas, resulting crop damages every year. Meanwhile, acid sulfate soils cover in the swampy areas in the Bang Nara river basin, and the drainage water from the areas show the strong acidity.

Taking into consideration such problems as aforementioned, the procedure of the water resources development is to establish the Bang Nara Water Storage by constructing 2 tidal regulators at both rivermouths, and to control the seawater intrusion. And it is to introduce the small river waters in the basin into the water storage and and to proceed the desalinization of the storage water and to promote the supply of irrigation water, control of flooding and prevention of

acidic water outflow. The dimensions of the water storage are planned as follows:

Full water level	: (+) 0.4 m
Water storage	: 15.8 million tons
Low water level	: (-) 0.2 m
Water storage	: 11.3 million tons
Effective water depth	: 0.6 m
Effective water storage	: 4.5 million tons
Water storage surface area	: about 1,400 ha

The irrigation water will be taken by pumping-up of the desalinated storage water. In the period when the inflow to the water storage reduces (less than 10 days consecutively), 4.5 million tons of storage water will be utilized for irrigation. In the rainy season or flooding period, on the other hand, the flooding damage will be mitigated by controlling the tidal gates and operating safty discharge of the flood water and at the same time by preventing the inflow of floodwater from the Kolok river.

The operation of the water storage is planned to be 0.2 m of low water level. This water level is higher than the present river bed elevation by about 4.0 m. This would keep the low water level at (-) 0.2 m with 11 million cu.m of dead water, maintain the groundwater table in the acid sulfate soils area, and finally control the acidification of the soils. Furthermore, the acidic water drained within the tributaries of Bang Nara river basin during the dry seasons will be stored within the area by planned acidic water flow checks to be constructed in the tributaries and will be discharged to the sea via tidal regulators at the time of flooding during rainy season.

(2) Irrigation and Drainage Plan and Agricultural Development

1) Irrigation Plan

As regards the irrigation plan, it is possible to irrigate supplementally 9,800 ha of existing paddy fields during rainy season and to irrigate upland crops cultivated in 25% of the existing paddy area.

The pump irrigation area (9,800 ha) is divided into 3,870 ha irrigated by pump directly from the Bang Nara water storage, of which elevation is below 2.0 m and 5,930 ha irrigated by ten fixed pumping stations, of which elevation is above 2.0 m. Among them, 3 fixed pumping stations get the water from the Yakang river. In addition to these land, 180 ha will be irrigated by gravity system, totalling 9,980 ha.

The lands below 2.0 m (3,870 ha) could be irrigated by the Bang Nara water storage immediately after the completion of two tidal regulators by the grant-aid. The introduction of mobile pumps (diameter 100 mm, 7 HP) are planned to distribute the water users groups which will be organized in village unit. The capacity of pump is $1.65 \text{ m}^3/\text{min}$, namely, to be possible to irrigate about 20 ha of paddy fields.

2) Drainage Improvement

Every year the flooding water from the Bang Nara river stagnates over the lower portion along the river. The peak depth sometimes reaches (+) 2.0 m. In the western part of the Area, the lands are submerged by the flooding water from Yakang river and the lands in the eastern part are submerged by poor drainage.

Based on the present situation, the area of drainage improvement only is 6,770 ha consists of 520 ha of paddy fields and 6,250 ha of rubber plantation. Irrigation and drainage project area is 4,330 ha in which 4,290 ha are irrigated by pumps and 40 ha are irrigated by gravity.

Control the submergence and flooding in the Area will be realized by improving the drainage networks and drainability. Therefore, the drainage networks were determined as earth canals, taking into consideration rainfall intensity, water use condition, topography and economic viewpoints.

3) Agricultural Development Plan

Agricultural development plan in the Bang Nara Irrigation and Drainage Project was planned as crop rotation system; namely, paddy in rainy season and mungbean, groundnut, corn, vegetables in dry season as well as fodder crops, taking into consideration the efficient use of water and improvement of soil productivity. Furthermore, fruit trees introduction of miscellaneous forests surrounding the village as indirect benefit of irrigation. The planned cropping areas are as follows:

Table 2-4. Planned Cropping Areas

<u>Items</u>	<u>Area (ha)</u>	<u>Remarks</u>
Rain-season paddy	9,780	Local, improved and high yielding varieties
Upland crops	2,480	Sweet corn, mungbean, groundnut, vegetables
Fodder crops	200	Torpedo and para-grass
Fruit trees	60	Lonkon

(3) Project Cost and Implementation Schedule

The total project cost of the Bang Nara Irrigation and Drainage Project was estimated at ¥1,210 million at the period of February 1986 in the feasibility study. The breakdown of the cost was estimated as the construction of tidal regulators at ¥460 million and the construction of irrigation and drainage facilities and others ¥750 million.

The project implementation schedule was divided into Stage I and Stage II. In Stage I for 3 years, the construction of tidal regulators for Bang Nara desalinization will be completed and 3,870 ha of lands will be irrigated by portable pumps by farmers group. And 3 pumping stations covering 1,240 ha and the necessary facilities of 3 drainage improvement areas will be constructed.

In the Stage II for 5 years, irrigation and drainage facilities mainly in higher portions in the Area will be constructed. Namely, pumping stations in 7 areas and irrigation facilities, gravity irrigation system in southern portion, and drainage improvement facilities in 4 small rivers will be constructed.

The construction cost of tidal regulators by grant-aid is 38% of the whole project cost and the construction period is about 2 years.

2-4. Outline of Request

The Government of the Kingdom of Thailand requested a grant-aid to the Government of Japan for the construction of tidal regulators which is a principal facility of the Bang Nara Irrigation and Drainage Project. The outline of the request is as follows (details are shown in Chapter 4):

(1) Responsibility of Japanese Government

1) Construction Implementation

- Main structure of tidal regulators in upstream and downstream forming Bang Nara water storage
- Closing dikes of old river for tidal regulators construction
- Maintenance road (both governments)
- Gate, operation equipment and emergency power source equipment
- Remote control room of tidal regulators

2) Materials and equipment

3) Designing and supervision of construction

(2) Responsibility of Thai Government

1) Land acquisition

2) Construction of maintenance road

3) Construction of facilities of electricity and water supply up to the site.

CHAPTER 3. PROJECT AREA

CHAPTER 3. PROJECT AREA

3-1. General

3-1-1. Socio-Economic Conditions

Changwat Narathiwat which lies in the southernmost part of Thailand, bordering on Malaysia has a land area of about 4,200 km² and situated some 1,200 km from Bangkok. Administratively, Changwat Narathiwat consists of 10 Amphoe, 2 King-Amphoe, 70 Tambon and 435 Muban. The Project Area is located in the northeastern part of Changwat Narathiwat and covers 4 Amphoe, that is, Muang Narathiwat, Yingo, Rangae and Takbai.

The predominant farm types in the Project Area are paddy rice and rubber/paddy rice farm as well as livestock raising farm. Most farmers depend on the family labor. During the peak period, however, female, child and old labor force are employed as well as some hired labor. Livestock and poultry raising are very popular, and many farmers are engaged in. The inland fishery in impounding waters or small stream is restricted to small-scale.

Because of low agricultural productivity due to flooding or seawater intrusion or problem soils, about 30% of farm household's income rely on the off-farm employment of male labor even during the peak period.

The farm size per household including the lease land ranges from 1.1 ha to 3.5 ha. The average farm size is 2.2 ha. The fragmentation of cultivated land is remarkable especially among the small and medium farm households. According to the 1983 Intercensus Survey of Agriculture, the owner operator dominates the landholding pattern accounting for more than 90% and the proportions of tenant and partial tenant are limited.

The population of Changwat Narathiwat is about 493,000 in 1985 and the population density is 110 per km². According to the labor force survey in 1982, agriculture sector occupies 74% of the total labor force and industry and commercial sectors are 7.6% and 18.4%, respectively. Comparing to other Changwat in the Southern Region, the dependence on agriculture sector is remarkable in Changwat Narathiwat.

According to the farm economic survey (144 sample farm households), farmers in the Project Area do not have difficulties in securing input supply such as seeds and fertilizers, etc. The farms in the Project Area is almost totally dependent on the rainfed. The adequate water supply could not be satisfied. In 1984, about a quarter of farmers made use of the credit for land preparation and for purchasing calves. About 10-20% of farmers make rental of cultivation land among neighbors or relatives. The rent is commonly paid in the form of share cropping of 50%. The summary of the annual average planted and harvested area and the yield for 1983-85 period among the sample households is given in Table 3-1.

Table 3-1. Summary of Annual Average Planted and Harvested Area and Yield (1983-1985)

<u>Crop</u>	<u>Planted Area (Rai)</u>	<u>Harvested Area (Rai)</u> (%)	<u>Planted Area Base Yield (Kg/Rai)</u>
Paddy, Local	998	794 (80)	190
Paddy, HYV	95	72 (85)	204
Rubber, Local	323	227 (70)	101
Rubber, HYV	230	90 (39)	57
Sweet Corn	0.7	0.7 (100)	743
Cucumber	5	5 (100)	1,219
Stringbean	2.8	2.8 (100)	682
Gourd	0.5	0.5 (100)	833
Coconut	9.5	9.5 (100)	870 fruit

Majority of rubber and some upland crops are sold to the market whereas about 90% of paddy are used for self-consumption.

Farm income comprises cash income (from the sale of crops and livestock) and non-cash income (value of home consumption). The total farm income occupies 60-70% of whole income of sample households. Off-farm income comprises income from off-farm agricultural work and from off-farm non-agricultural work. The former occupies about 10% of the household cash income and the latter occupies 20-30%. The sources of off-farm non-agricultural income are government services and selling home-made products. Annual average per capita income ranges from P4,700 to P5,300, the average being P5,100.

Serious agricultural problems are mostly confined to those relating to the physical factors, such as water shortage, flood, insect and rat damage and poor soil fertility. In general, as far as the agricultural production is concerned, the technical and distribution/marketing services are not considered as deterrent factors of production in the Project Area. The flood is concentrated in the November-February period with the average flood height in the paddy field of 1.2 m lasting for about 5 days, and it is noted that the flood has a considerable influence on spreading skin diseases. As high as 30% of the paddy field is damaged and unharvested, with 15% due to the flood and the remaining due to the drought and rat & insect. On an average, the productive days lost ranges from 4 to 7 days.

3-1-2. Institutional Aspects

There exist in the Project Area a number of different types of organization or group, which may be classified into economic, social and other minor groups. A farmer on average has membership of at least one or two groups.

The organization engage in a wide range of activities but the membership rate is high only among the economic groups such as Bank for Agriculture and Agricultural Cooperatives (BAAC), credit cooperative, and agricultural cooperative groups, but the meeting does not appear to be regularly held.

Among the above groups, BAAC, Tambon Council, and Village Development Groups are regarded as successful groups, for which the major reasons cited are: (1) committee has power, (2) good cooperation and (3) responsible members.

The activities of water users group under Small Scale Irrigation Project (SSIP) are very active under capable leader in general. Majority of the farmers showed interest in flood control and irrigated agriculture, because they know the effect of small or medium scale project in neighboring area. Nearly 70 percent of the respondents showed their willingness to pay the irrigation water charge, with the rate being higher for the dry season crop. The irrigation water charge is estimated to be about 10% of current paddy production, which in monetary terms, corresponds to about $\text{¥}1,200$ per hectare.

Majority of the farmers showed interest in growing dry season crops if adequate water supply is assured. For dry season crops, farmers wish to cultivate vegetables and legumes. Except for some cultivation techniques and marketing, there are no constraint to introduce off-season diversified cropping.

3-1-3. Social Services and Conditions

Most Muban have the primary educational institutions, but the secondary educational institutions are limited and exist only in the center of Amphoe and other limited locations. In 4 Amphoe concerned, there are 177 primary school and 35 secondary school in 193 Muban, out of them 30 are Islamic schools.

There is a Changwat Hospital (360 beds) in Muang Narathiwat and Amphoe Hospitals (10 beds) in Amphoe Rangae and Amphoe Tak Bai. These hospitals would be utilized as an emergency hospitals during the construction period by Japanese contractor in future. There is one Health Center in each Amphoe and one Midwife Center in each Tabmon. These numbers meet the country's target level.

The present social infrastructure in the Project Area is by no means low by the rural standard of Thailand. Road, health center, and sanitation are the three important facilities for which improvement is sought by comparatively a large portion of the inhabitants.

The farm households are visited monthly by the extension workers and community development workers and less frequently by other government officers. Many of the farmers have occasional or regular access to the credit and fertilizer provision and the general extension services.

3-1-4. Rural Sociology

The Muslim religious leader in the Project Area plays an important role similar to that of Buddhist monk as in other parts of Thailand and therefore is frequently better entrusted and heard by the villagers than the Government officers whenever some important advice is needed.

Other than Muban leaders, religious leaders, Tambon level extension workers, and Muban level volunteers in their respective field, the Government officers who enjoy the highest confidence among the villagers are Amphoe level officers, because of their frequent visit to Muban and thus closest communication with the villagers on their problems.

The Muban organization appears well established under the Muban council. The villagers in the Study area are typically divided into several sub-groups of about 10 farmers. The leader farmer of the group who is often the Muban council member represents and serves for the interest of the respective sub-group farmers. He may concurrently serve as a contact farmer through whom the extension worker provides the extension service.

In addition to the volunteer extension worker, community development volunteer, health volunteer, and education volunteer establish the network of communication and help strengthen the Muban organizational activities and improve the Muban living environment.

The generally low level of education and difference in language, culture and other behavioral patterns among the Muslim residents pose a considerable difficulty for the Government officers in general communication with and dissemination of information to the Muslim. This difficulty, however, has been gradually overcome as an increasing number of Muslim students enroll at the Thai Government schools and advance to higher educational institutions.

Although the two different ethnic groups, i.e. Muslim and Buddhist, generally reside in different Muban and carry out independent social and economic activities, they live in a harmonious manner and occasionally cooperate each other in the form of hired labor in paddy work and rubber tapping. Assimilation or friendly relationship can be observed in the agricultural youth extension group which typically consists of both the Muslim and the Buddhist young farmers.

3-2. Natural Condition

3-2-1. Topography and Geology

(1) General

The Project Area extends the lands from 0-20 m in elevation and geomorphologically classified into swamp, delta and flood plain, breach ridge and old lagoon, and monadnock. Bang Nara river flows within the delta at Narathiwat side, within the swamps in the mid-course, and within the beach ridges and old lagoon to its outlet to Kolok river. The geological information indicates that the Project Area is composed of alluvium, colluvium and residuum (Quaternary to Recent Age) and granite. To Daeng Swamp, an extensive inland freshwater forested peat swamp, is located outside the Project Area. This swamp is the largest in Thailand and its extent is 125 km². As far as the seismicity is concerned, the Project Area lies within the western portion of the seismically stable Sunda Shelf which are unlikely to experience ground accelerations greater than 0.03 g arising from the earthquake activity.

(2) Geology

The geology in the Project Area consists of granite which constitutes the bedrock as is seen outcropping in the mountains, colluvium and residuum forming the foothills and alluvium occupying the most of the area and forming the coastal plain.

3-2-2. Climate

(1) General

There are four meteorological observatories in and around the Project Area. The climatological elements such as temperature, rainfall, relative humidity, atmospheric pressure, wind direction, wind velocity and cloudiness, etc. have been observed there for long. The climatological data at Narathiwat Station are shown in Table 3-2.

FIGURE 3-1 GEOLOGY MAP

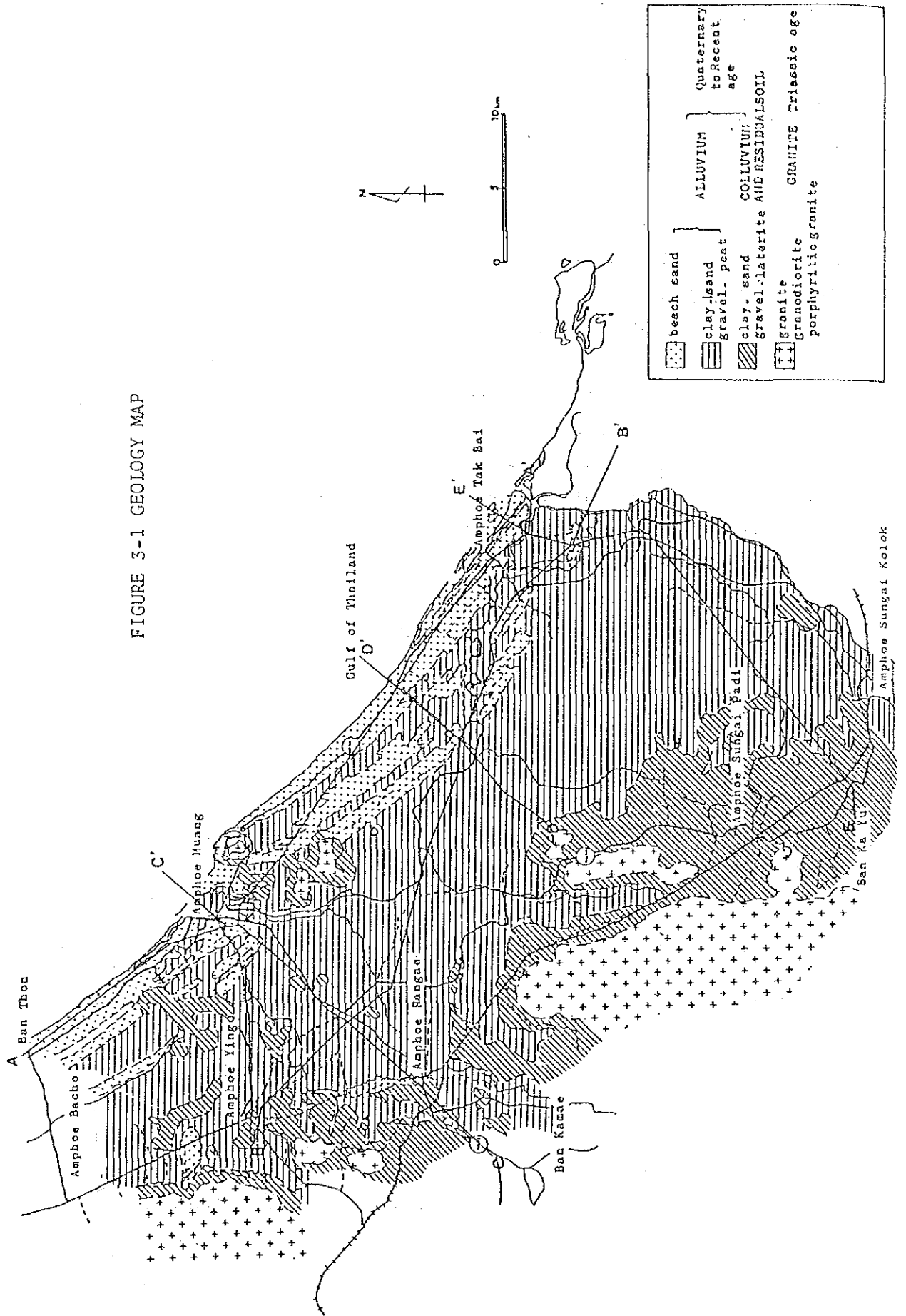


Table 3-2. CLIMATOLOGICAL DATA AT NARATHIWAT STATION

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Mean</u>
Temperature (°C)													
Max.	29.9	30.9	32.0	33.1	33.0	32.6	32.2	32.2	32.0	31.0	29.5	29.0	31.5
Mean	26.1	26.9	27.7	28.5	28.4	28.0	27.6	27.5	27.4	27.0	26.3	25.9	27.2
Min.	22.2	22.4	22.8	23.5	23.9	23.5	23.2	23.2	23.1	23.2	23.1	22.8	23.1
Monthly Mean Relative Humidity (%)													
81.0	79.1	78.3	77.9	79.3	79.0	79.6	79.8	80.3	83.1	86.1	84.6		80.7
Monthly Mean Evaporation* (mm/day)													
(Class A pan)	3.6	4.1	4.5	4.8	4.6	4.1	4.1	4.2	4.1	4.0	3.4	2.7	4.0
Monthly Mean Sunshine - Duration* (hr/day)													
8.3	9.1	8.7	8.9	7.6	6.8	6.8	6.8	6.3	5.8	5.3	5.8	5.8	7.2
Pressure (mbs. + 1,000)													
Mean	12.0	11.5	10.7	9.4	8.5	8.7	8.8	8.9	9.4	10.0	10.5	11.4	10.0
Extremely Max.	18.9	19.0	18.3	15.9	14.7	14.1	14.4	15.0	15.5	15.9	16.9	17.8	19.0
Extremely Min.	4.9	5.0	3.5	3.1	2.7	2.7	2.3	2.5	2.2	2.2	4.1	4.2	2.2
Mean daily range	3.5	3.7	4.1	4.1	4.0	3.7	3.7	3.9	4.3	4.3	3.9	3.6	3.9
Mean Cloudiness (%) Percentages of total sky covered with cloud													
70	63	59	58	73	75	75	78	78	79	81	79	79	72
Wind Speed (m/s) and Direction													
Mean	2.3	2.5	2.2	1.9	1.6	1.4	1.3	1.4	1.5	1.4	2.3	1.7	1.8
Max.	13.7	11.9	12.0	11.7	13.4	12.1	14.4	13.7	13.6	13.5	14.6	14.9	13.3
Extremely Max.	20.6	17.0	20.6	18.0	25.7	23.1	28.3	25.7	23.1	28.3	30.8	23.1	23.7
NE and E direction	100	100	100	100	72	50	47	31	38	59	85	97	
SW and S and W direction	0	0	0	0	20	42	42	58	54	24	9	3	

Note: * Annual mean evaporation = 1,465.5 mm, Annual mean sunshine hours = 2,628 hrs.

- Air Temperature

Annual average of air temperature at Narathiwat is 27.2°C, and annual mean maximum and minimum temperature are 31.5°C and 23.1°C, respectively. The monthly mean temperature ranges between 25.9°C in December and 28.5°C in April. The extreme maximum and minimum temperature were recorded at 36.9°C in May and 17.1°C in January during the period of 1951 to 1980.

- Relativity Humidity

Relatively humidity is generally high. The annual mean relative humidity for recent 34 years shows 80.7%. The minimum is 77.9% in April and the maximum is 86.1% in November. From January to September, it is almost 80%, and it becomes about 85% during the remaining three months owing to the effect of northeastern monsoon.

- Evaporation

The Class A pan evaporation was recorded at three stations of Narathiwat, Songkhla and X45, and the annual evaporation observed are 1,889 mm at Songkhla, 1,466 mm at Narathiwat, and 1,392 mm at X45 which is located at rather inland.

- Atmosphere Pressure

The annual mean atmospheric pressure is 1,010 mbs, while the monthly mean atmospheric pressure fluctuates between 1,008 mbs in May and 1,012 mbs in January. No remarkable low atmospheric pressure does not occur in this area since domestic depression, tropical storm or typhoon seldom takes place.

- Sunshine

Monthly mean sunshine hours at Narathiwat vary seasonally in wide range between 5.3 hrs/day in November and 9.1 hrs/day in February, with an annual total of 2,628 hours.

- Wind

Monthly mean wind velocity at Narathiwat vary in narrow range between 2.5 m/s in February and 1.3 m/s in July. The extreme maximum wind velocity during the last 35 years was recorded at 30.8 m/s from the northeast direction in November 1962. The wind direction is mainly northeast or east at the incidence of more than 85% between November and April so-called "Northeast Monsoon Season". It changes from south, southwest or west (total percentage is 42 to 58%) between June and September so-called "Southwest Monsoon Seson". The wind blows to every direction during the other months.

(2) Rainfall

The daily rainfall has been observed at the following 13 stations in the Bang Nara basin:

* Meteorological Department

Narathiwat, Tak Bai, Rangae, Yingo, Sg. Padi, Sg. Kolok, Waeng, Bacho, and Ruso.

* RID

Muno Project Office (X 119), Pileng Project Office, and X45.

* DLD

DLD Station near Nam Baeng tidal regulator.

Compared with the other regions in Thailand which have 1,000 to 2,000 mm of annual rainfall, the Southern Region has much rainfall as 2,000 mm to 3,000 mm. At Narathiwat, Bacho and X 119 stations which are located adjacent to the Gulf of Thailand, annual mean rainfall is about 2,500 mm. On the other hand, it is about 2,200 mm at the stations of Ruso, Yingo, Sg. Padi, DLD, Tak Bai, of which the first three stations are located between the mountainous area and the last two are along the coast.

The lowest rainfall (1,621 mm) was recorded at Rangae station among all these stations. High rainfall such as 2,861 mm was recorded at the Pileng Project Office which is located at the center of the Project Area although the observation period was the recent 4 years.

Monthly mean rainfall from September to December occupies about 60% of annual rainfall. It gradually increases from February to October and reaches maximum in December.

In the feasibility study, the analysis was carried out by using data from 1955 to 1985 at Narathiwat (observation period: 1910-1987), Tak Bai, Rangae and Yingo (observation period: 1922-1987). In this Basic Design Study, daily rainfall data at Narathiwat were collected after January 1986 and the daily rainfall probability analysis was carried out in order to supplement the last analysis.

The results are shown below:

Maximum daily rainfall	625.9 mm	(625.9 mm)
2-year probability daily rainfall	164.7 "	(163.0 ")
5-year	"	261.9 " (254.1 ")
10-year	"	337.6 " (323.0 ")
20-year	"	418.1 " (395.1 ")
50-year	"	533.9 " (496.8 ")
100-year	"	629.8 " (579.8 ")

Note: All figures in parenthesis are results in the Feasibility Study.

3-2-3. Soil

The soils and their distribution are highly correlated with the landform on which they occur. The landforms in the Project Area are classified into 6 types; namely, beach ridges and intervening depressions, former tidal flat, flood plain, low terrace, middle terrace, hills and foothill slopes and domed bogs.

(1) Soils of Beach Ridges and Intervening Depressions

Sand bars and dunes are found along the shores of the present coastline. Owing to the recession of coastline, a typical landform of the east coast of Peninsular Thailand, composed of a series of alternating parallel ridges and intervening depressions has been formed. The relief of beach ridge is undulating with slope ranging from 2 to 4%. The soils are grayish brown or yellowish brown, sand or loamy sand, showing little accumulation of organic matter. They are subject to moisture stress because of their excessive drainage and low water retaining capacity. In lower positions on old beach ridges, the Groundwater Podzols having a spodic horizon at various depth are found. In the intervening depressions and estuaries, soils are formed of marine and brackish water deposits.

(2) Soils of Former Tidal Flat

The soils of former tidal flat have been formed of brackish water deposits. During the rainy season, the soils are submerged at one meter depth. The relief is flat and slopes are less than 1%. The soils are poorly drained, gray to grayish brown clay with gley layer. They are Hydromorphic Alluvial Soils including actual and potential acid sulfate soils.

(3) Soils of Flood Plain

Flood plain and levee have formed of recent riverine alluvium. The lands are flooded by river and rainwater for short duration. The flood plains are flat to nearly flat relief and are characterized by poorly drained soils with gray, grayish brown or yellowish brown colors and clay loam texture. The levees are nearly flat relief having slopes less than 2%. The soils are moderately well drained, stratified and fine-loamy.

(4) Soils of Low Terrace

Low alluvial terraces have formed of riverine alluvium and have nearly flat relief with slopes not exceeding 2%. The soils are poorly drained and flooded during the rainy season. These soils are mainly used for rice growing, and some upland crops are grown during the off-season in the area where irrigation is available. Soil texture is either fine loamy or clayey and the color shows a wide range from gray to brown with distinct, prominent red and yellowish brown mottles occurring throughout the profile.

(5) Soils of Middle Terrace, Hills and Foothill Slopes

Middle terraces of old alluvium have undulating relief with slopes ranging from 2 to 8%. The soils are characterized by well drained, loamy soils that have yellowish brown or red colors. Gravel bands or plinthite horizon are present in places. Soil reaction is very strongly acid and natural fertility is low.

(6) Soils of Domed Bogs

Domed peat bogs consist of various thickness of organic layer. In the upper horizon, woody peat is undecomposed. Soils are saturated throughout the year. The organic layer has very low bulk density and commonly pH values lower than 5.0. The CEC is very high, but nutrient levels are low (oligotrophic). The underlying materials mostly consist of marine or brackish deposits enriched in pyrites.

3-3. Land Use and Agriculture

3-3-1. Land Use

The present land use in the Project Area is outlined below:

Table 3-3. Present Land Use

<u>Descriptions</u>	<u>ha</u>	<u>rai</u>	<u>%</u>
Paddy field outside Forest Reserve	11,030	69,000	23.6
-do- inside Forest Reserve	1,400	8,800	3.0
<u>Sub-total</u>	<u>12,430</u>	<u>77,800</u>	<u>26.6</u>
Rubber	8,320	52,000	17.8
Coconut	4,380	27,400	9.4
Orchard	1,180	7,400	2.5
Forest Reserved	12,400	77,500	26.6
Others	9,400	58,800	20.1
<u>Total</u>	<u>46,700</u>	<u>292,000</u>	<u>100.0</u>

3-3-2. Annual Crops

(1) Paddy Rice

The average farm (paddy) size is 1.8 ha, and 60% of farmers rely mainly on paddy for their income. In the main season, about 70% of the crop is native varieties including Sali and Kao, and 30% are improved photosensitive varieties like RDB and Nang Praya 132. At the end of the main season, only small areas are transplanted with improved non-photosensitive variety like RD7.

(2) Field Crops

The field crops, excluding annual fruit crops and vegetables, are annual and perennial crops. Corn is an important economic crop and occupies very large portion in export. In addition to corn, mungbeans and groundnut are grown in the Project Area.

(3) Vegetables

Vegetables are mainly cultivated in backyards. Vegetable production in the Project Area is largely divided into two groups; namely, for home consumption and for commercial. In case of home consumption, production in excess of family use is sold in the local market. Commercial vegetable growing is undertaken by a few farm families on a relatively small scale but under intensive care. Selection of varieties and application of fertilizers and chemicals are taken into consideration.

3-3-3. Perennial Crops

(1) Rubber

Rubber plantations within the Project Area are about 8,320 ha and are mainly concentrated in undulating to moderately steep areas in Amphoe Rangae and Amphoe Muang Narathiwat. Most rubber is processed only to unsmoked sheet (USS) on farm and sold through middlemen for further processing to ribbed smoked sheets (RSS).

(2) Fruit Trees

The area of fruit trees planted in the Project Area amounts to about 1,200 ha. Out of them, 800 ha are in Amphoe Rangae and 280 ha are in Amphoe Muang Narathiwat. Fruit growing is relatively important in the Project Area, especially in Amphoe Rangae from the viewpoint of the productivity and marketability. "Long Kong" is one of the most important fruits in the Area, followed by rambutan, durian and banana.

(3) Others

- Coconut

Coconut plantations in the Project Area are about 4,400 ha. They are mainly distributed in both Amphoe Tak Bai and Amphoe Muang Narathiwat. Most coconut plantations in both Amphoe are located within the beach ridges and intervening swales area.

3-3-4. Crop Production

Paddy cropped area is estimated to be about 8,500 ha in which about 80% are local varieties. The low crop yield is the result of unreliable rainfall, low quality seeds and the minimal usage of fertilizers.

3-3-5. Livestock

In the Project Area, the grazing cattle has rapidly expanded during the recent 10 years being the secondary source of income for smallholders. The livestock is largely dominated by cattle with minor population of buffalo, sheep, goat and swine.

3-3-6. Agricultural Extension and Credit Services

(1) Agricultural Extension

DOAE is the governmental organization directly concerned with the farmer-families in the process of agricultural extension. A large-scale extension operation system called the National Agricultural Extension Project (NAEP) is under operation at present. Their extension activities are done at the district level. The National Extension Program was started in 1978. This program aims at establishment of demonstration plots in each Muban (village). Individual Muban-based extension agent is responsible for about 10 Muban and visits some 100 selected contact farmers each of which is responsible for 10 neighbours. The ratio of extension agent to farmer clientele is 1 to 1,000.

(2) Credit Services

The main institutional sources of credit for farmers are BAAC which is supported by the government and another source is the Agricultural Cooperatives (AC). Commercial banks and local merchants or money lenders are also important credit sources for farmers. BAAC and AC provide 3 kinds of loans, that is, short-term loan, medium-term loan, and long-term loan. An individual farmer is a customer of BAAC or AC. Land title or person is required as the security for the loan, however, a loan secured by land title is provided in case of larger amount of money.

3-3-7. Agricultural Input, Storage, Processing and Marketing

(1) Agricultural Input

Agricultural input supply is generally provided by several sources. The Marketing Organization for Farmers (MOF) which is the largest input supply source provides its services through local agricultural institutions. A large amount of fertilizers are sold to farmers associations, agricultural cooperatives, etc. through MOF. Farmers who do not belong to any agricultural group or those who are unable to buy fertilizers from MOF depend on local merchants. Usually local merchants sell fertilizers, seeds and pesticides to their customers on credit and the prices are generally higher than from other sources.

The kinds of fertilizers are limited in the Project Area. Compound fertilizer (16-20-0) is the most popular in Changwat Narathiwat as recommendation for paddy by DOAE. Seed production is the responsibility of DOAE. Under the national program, DOAE is required to multiply seeds supplied by DOA via contract growers, and distribute to farmers.

(2) Marketing

Markets for farm produce in the Project Area are divided into two; namely, local and assembly markets. Local markets are commonly located

in the production areas. Assembly markets are located in towns and cities like Narathiwat with better transportation and communication networks. A number of middlemen operate in the local markets including local merchants, brokers, shippers, agencies, retailers, etc. Most important at this level of marketing is that the traders do not only purchase farm produce but also provide to the farmers such services as money lending and delivery of inputs.

The assembly markets deal with larger quantities than the local merchants and buy either directly from the farmers or from local market merchants. Besides buying, they also provide cash loans and furnish the basic link between the local markets and the terminal markets. One of the main functions they perform is the grading of produce as done in market in Narathiwat.

(3) Storage

Although storage and warehousing facilities are being provided by different agencies, a gap still exists between the availability and demand for it. Generally, large warehouse belong to the primary cooperative societies, the market committees or the government corporations. Cooperative storage provides an essential part for agricultural inputs, for marketing of farm produce and also for distribution of consumer goods at Amphoe and Muban levels.

(4) Processing

In the Project Area, farmers produce some kinds of food crops, vegetables and fruits which are perishable for further distribution and need the processing and preservation. However, food processing is not so active there except for rice milling. It is mainly due to non-availability of the raw materials for the development of food processing. On the other hand, rubber processing is popular, but the standards of on-farm processing are rather low.

3-4. Rural Infrastructure

3-4-1. General

Collectively, "Rural Infrastructure" forms an integral component of each of the three basic facet of development such as human settlement function, production oriented function, and area or regional development function. In general, the rural infrastructure is defined as those social and physical facilities and services that contribute to the well-being of the community, including roads, public transport and communication, electricity, water supply and sanitation, etc.

In Changwat Narathiwat, the provision of rural infrastructure has received some strengthening in recent years. Acceptance of the social benefits by rural people from improved health, sanitation education and other social services is a prerequisite for successful infrastructural implementation of these sectors.

3-4-2. Taba New Town Development Scheme

The Department of Town and Country Planning of the Ministry of Interior is currently preparing the zoning plans for future development of municipal areas in Muang Narathiwat and Sg. Kolok as well as Tak Bai/Taba. The private sector development of Taba New Town on the foreshore 1 km north-west of the ferry terminal located at the Kolok estuary is included in this plan.

3-4-3. Existing Irrigation and Drainage Projects

There are the following 3 types of existing irrigation and drainage projects in the Project Area.

(1) Medium Scale Irrigation Projects under RID

(costing between ฿4 - 200 million)

- ° Kraiban Project: irrigation water supply for paddy fields
- ° Nam Baeng Project: drainage of the mid-stream of Bang Nara river
- ° Pileng Project: agricultural development project for the new settlers

(2) Small Scale Irrigation Projects under RID

(costing between ฿ 0.5 - 4 million)

In the Project area, 11 projects are grouped by their objectives as follows:

Irrigation	2
Drainage and Conservation	8
Fisheries	1

(3) Koh Soh Choh (creating employment opportunity projects)

In the Project area, 14 projects are classified into 3 categories as follows:

Irrigation	5
Drainage ditch	2
Pond (fisheries)	7

3-4-4. Transport and Communications

(1) Roads

The Project area and its environs have a fairly well developed highway and local access road system, involving the activities of several governmental agencies such as Department of Highway (DOH), Office of Accelerated Rural Development (ARD), RID, RFD and Amphoe and Tambon authorities. The total length of national highway under DOH is

68 km. The total length of ARD roads is 89 km; moreover, 28 km is under planning.

(2) Transportation

The government-owned Express Transportation Organization (ETO) provides commercial transportation between Sg. Kolok, Narathiwat and the rest of the country. Local bus services are operated by the private sector on principal road networks between Amphoe central towns. These bus services are supplemented by taxis, mini-bus and other passenger carriers. The State Railway runs six local trains per day along the southern periphery of the Project Area. In addition, four express trains run from Bangkok per week. Furthermore, 4 flights per week linked Hat Yai and Narathiwat.

(3) Postal and Telephone Services

The Department of Post and Telegraph has one post office at every Amphoe center. Telephone Organization of Thailand (TOT) operates two telephone exchanges in Narathiwat and Sg. Kolok. At present, Tak Bai is served by 100 milliwatt transmitter radio, while other Amphoe offices are in radio contact with Narathiwat. Furthermore, there is a plan to start rural long distance telephone services via VHF radio.

3-4-5. Electricity, Water Supply and Sanitation

(1) Rural Electricity

The Provincial Electricity Authority (PEA) supplies the electricity from substation at Yala with a 115 KV single circuit transmission line to Narathiwat where it is dropped down to 33 KV to supply urban areas and then to 19 KV to rural areas. PEA expects that 95% of Muban in Changwat Narathiwat will be served by the end of 1980s with electricity network available on a 24-hour basis except for small Muban less than 20 houses. About 90% of Muban in the Project Area are provided with

electricity as favorably compared with the Changwat average of 80%. However, proportion of the households is greatly reduced to 60%.

(2) Water Supply and Sanitation

A general policy is to provide 70% of the people with at least 2 litres of safe water per head per day by the year 1986. In Changwat Narathiwat, Narathiwat, Sg. Kolok and Sg. Padi have a piped water supply system, while Tak Bai plans to draw water from the confluence of Bang Nara river and Puyu river to serve the Sanitary District area including Tak Bai and Taba. For the rural inhabitants, water is obtained from private and community hand-dug shallow wells, tubewells and surface water. The situation is regarded unsatisfactory particularly given the relatively high morbidity rate and incidence of preventable water-borne diseases.

(3) Provincial Water Works for Narathiwat Municipality

The inhabitants in the Project Area do not take water from Bang Nara river and Yakang river at present. They are usually taking drinking water from shallow or deep wells. The Provincial Water Works Authority (PWWA) constructed water works for a domestic water supply for Narathiwat municipality in 1975. PWWA supplies water of 0.84 MCM per annum for 11,500 persons for Narathiwat municipality at present.

3-4-6. Health and Education

(1) Health Facilities

The health facilities under Ministry of Public Health are one health office and one hospital at each Amphoe, one health center with 2 staffs capable of the first-aid treatment and public health promotion at each Tambon, and one health post single staffed at each Muban. In addition, some Amphoe have private clinic, dentist and pharmacies.

(2) Education

Attendance at primary school is compulsory. The primary schools are distributed on the basis of one large school (100 to 300 pupils) per Tambon acting as the focal point for a group of 6 to 8 smaller schools. The secondary school education for 6 years from age 12 is not free. About 25% of the children at the school age are enrolled in the Project Area.

Some vocational trainings are conducted by mobile units. Courses range in duration from short specialist training to long comprehensive skills training, including dressmaking, carpentry, vehicle repair, cooking, radio, hair dressing, building, Thai language and other subjects.

3-4-7. Community Development

About 80% of the Project Area population are Muslim, and this reveals that mosques significantly outnumber the Buddhist temples, while over 90% of Muban have a mosque and/or a temple.

Attitude to religion forms a component of the Central Government's policy with respect to the human development that is under the responsibility of Community Development Department (CDD) including the activities of pre-school child care, status/role of women, youth training, Muban level organization and cooperatives, development of local commercial skills, voluntary services for development, etc.

3-4-8. Rural Industry

The factories with an engine of more than 2 HP or 7 or more employees need to register with Department of Industry. The total number of factories registered is about 310 and that of employees is about 2,300. The rice mills make up the majority of the industrial establishments, and the large establishments in terms of employment are concerned with smoking rubber, to a less extent, saw mills, brickmaking, noodle-making and manufacturers of wood products. The industrial base is quite narrow and the related employment effect is also very limited.