THE KINGDOM OF THAILAND

MINISTRY OF AGRICULTURE AND COOPERATIVES

THE FEASIBILITY STUDY
ON
THE LAM DOM YAI BASIN IRRIGATION PROJECT

MAIN REPORT

DECEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

THE KINGDOM OF THAILAND

MINISTRY OF AGRICULTURE AND COOPERATIVES

THE FEASIBILITY STUDY
ON
THE LAM DOM YAI BASIN IRRIGATION PROJECT

MAIN REPORT

DECEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a feasibility study on the Lam Dom Yai Basin Irrigation Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a Study Team headed by Dr. Junichi Kitamura, Sanyu Consultants Inc., three times between February, 1991 and January, 1992.

The Team held discussions with the officials concerned of the Government of Thailand, and conducted a field survey at the study area. After the Team returned to Japan, further studies were made and the present report was prepared.

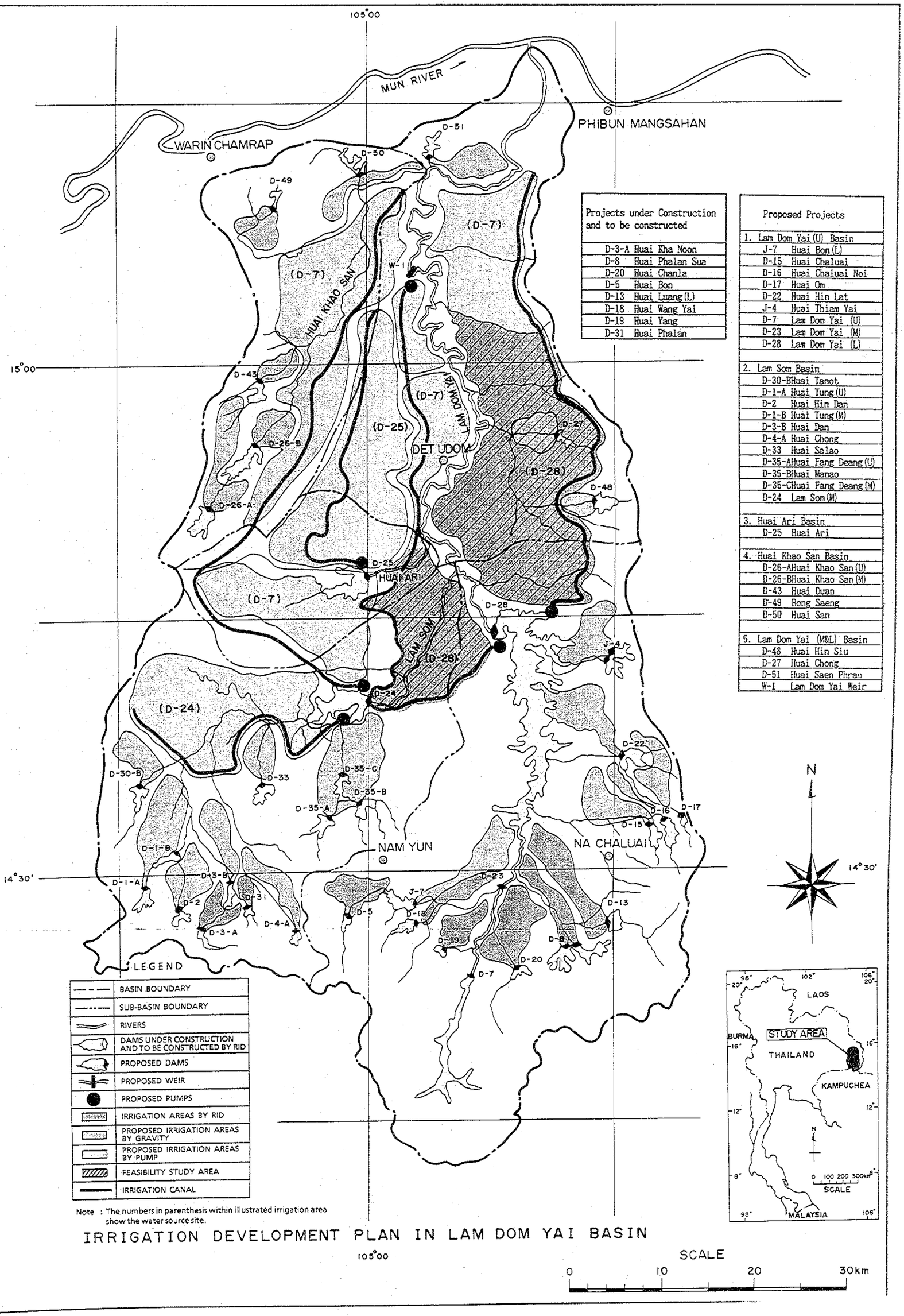
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the Team.

December, 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



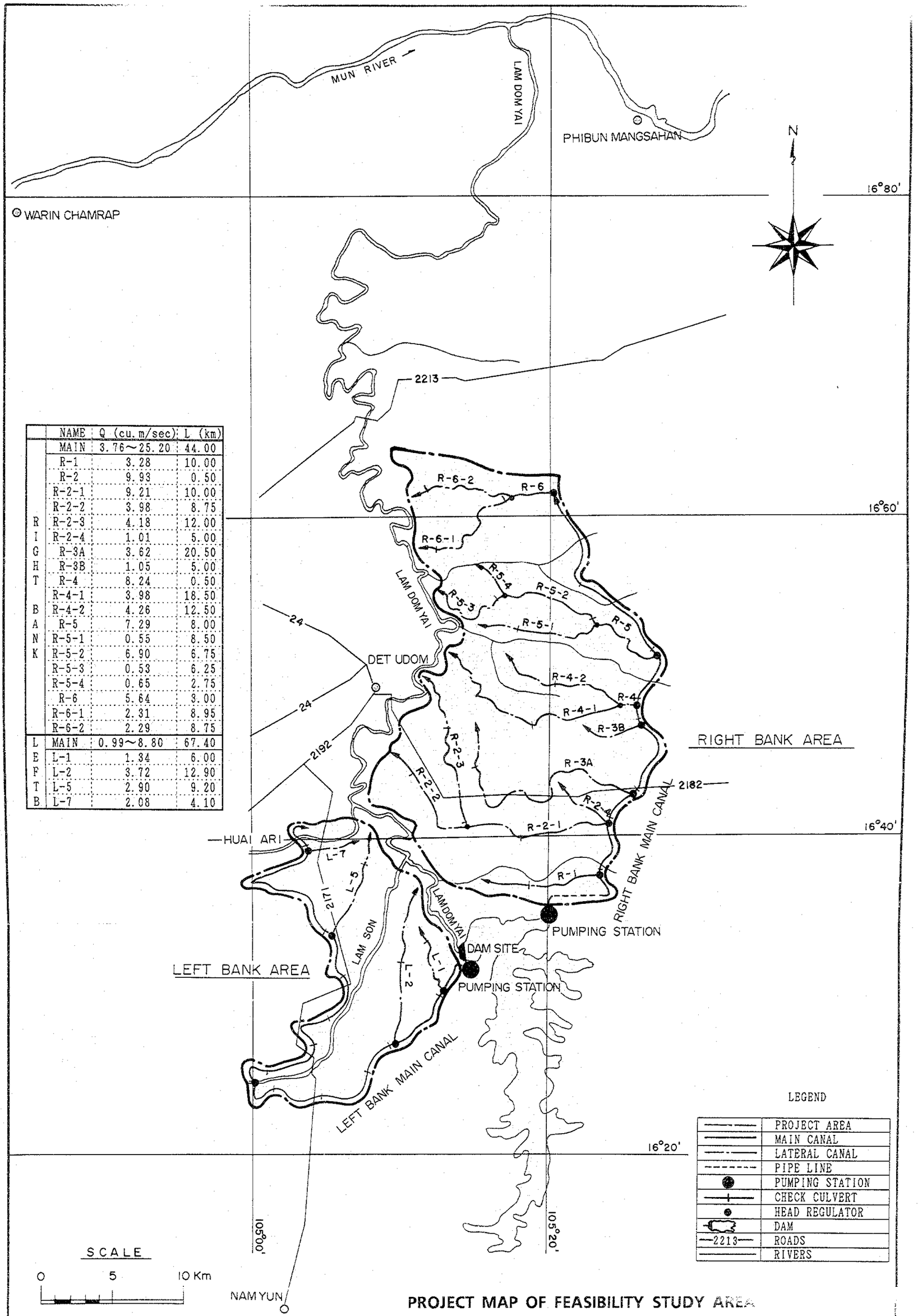
Projects under Construction and to be constructed	
D-3-A	Huai Kha Noon
D-8	Huai Phalan Sua
D-20	Huai Chanla
D-5	Huai Bon
D-13	Huai Luang (L)
D-18	Huai Wang Yai
D-19	Huai Yang
D-31	Huai Phalan

Proposed Projects	
1. Lam Dom Yai (U) Basin	
J-7	Huai Bon (L)
D-15	Huai Chaluai
D-16	Huai Chaluai Noi
D-17	Huai Om
D-22	Huai Hin Lat
J-4	Huai Thiam Yai
D-7	Lam Dom Yai (U)
D-23	Lam Dom Yai (M)
D-28	Lam Dom Yai (L)
2. Lam Som Basin	
D-30-B	Huai Tanot
D-1-A	Huai Tung (U)
D-2	Huai Hin Dan
D-1-B	Huai Tung (M)
D-3-B	Huai Dan
D-4-A	Huai Chong
D-33	Huai Salao
D-35-A	Huai Fang Deang (U)
D-35-B	Huai Wanao
D-35-C	Huai Fang Deang (M)
D-24	Lam Som (M)
3. Huai Ari Basin	
D-25	Huai Ari
4. Huai Khao San Basin	
D-26-A	Huai Khao San (U)
D-26-B	Huai Khao San (M)
D-43	Huai Duan
D-49	Rong Saeng
D-50	Huai San
5. Lam Dom Yai (M&L) Basin	
D-48	Huai Hin Siu
D-27	Huai Chong
D-51	Huai Saen Phran
W-1	Lam Dom Yai Weir

Note : The numbers in parenthesis within illustrated irrigation area show the water source site.

IRRIGATION DEVELOPMENT PLAN IN LAM DOM YAI BASIN

	NAME	Q (cu.m/sec)	L (km)
	MAIN	3.76～25.20	44.00
	R-1	3.28	10.00
	R-2	9.93	0.50
	R-2-1	9.21	10.00
	R-2-2	3.98	8.75
R	R-2-3	4.18	12.00
I	R-2-4	1.01	5.00
G	R-3A	3.62	20.50
H	R-3B	1.05	5.00
T	R-4	8.24	0.50
	R-4-1	3.98	18.50
B	R-4-2	4.26	12.50
A	R-5	7.29	8.00
N	R-5-1	0.55	8.50
K	R-5-2	6.90	6.75
	R-5-3	0.53	6.25
	R-5-4	0.65	2.75
	R-6	5.64	3.00
	R-6-1	2.31	8.95
	R-6-2	2.29	8.75
L	MAIN	0.99～8.80	67.40
E	L-1	1.34	6.00
F	L-2	3.72	12.90
T	L-5	2.90	9.20
B	L-7	2.08	4.10



LEGEND

	PROJECT AREA
	MAIN CANAL
	LATERAL CANAL
	PIPE LINE
	PUMPING STATION
	CHECK CULVERT
	HEAD REGULATOR
	DAM
2213	ROADS
	RIVERS

PROJECT MAP OF FEASIBILITY STUDY AREA

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEX

ABBREVIATION AND GLOSSARY

1) Agencies

ALRO	Agricultural Land Reform Office, MOAC
ARD	Accelerated Rural Development Office, MOI
BAAC	Bank of Agriculture and Agricultural Cooperatives
CDD	Community Development Department, MOI
CPD	Cooperative Promotion Division
DLD	Department of Land Development, MOAC
DMR	Department of Mineral Resources
DOA	Department of Agriculture, MOAC
DOAE	Department of Agricultural Extension, MOAC
DOF	Department of Fisheries
DOL	Department of Livestock, MOAC
DOLA	Department of Local Administration, MOI
EGAT	Electricity Generating Authority of Thailand
FAO	Food and Agriculture Organization of the United Nations
JICA	Japan International Cooperation Agency
MD	Meteorological Department
MI	Ministry of Industry
MOAC	Ministry of Agriculture and Cooperatives
MOE	Ministry of Education
MOF	Marketing Organization of Farmers
MOI	Ministry of Interior
MPH	Ministry of Public Health
NEA	National Energy Authority
NEB	National Environmental Board
NESDB	Office of National Economic and Social Development Board, PMO
NSO	National Statistic Office
OAE	Office of Agriculture Economy
PAEO	Provincial Agricultural Extension Office
PEA	Provincial Electric Authority
PMO	Prime Minister's Office
RFD	Royal Forestry Department, MOAC
RID	Royal Irrigation Department, MOAC
TDRI	Thai Development Research Institute

2) Other Abbreviations

DO	Dissolved Oxygen
F/S	Feasibility Study
EIS	Environmental Impact Study
GDP	Gross Domestic Product

GRP	Gross Regional Product
GPP	Gross Provincial Product
HYV	High Yield Product
LV	Local Variety
EIRR	Economic Internal Rate of Return
B/C	Benefit Cost Ratio
NPV	Net Production Value
GPV	Gross Production Value
NPV	Net Production Value
KWh	Kilowatt Hour
MW	Mega Watt
F. C	Foreign Cost
L. C	Local Cost
FY	Fiscal Year
CIF	Cost, Insurance and Freight
F. O. B	Free on Board
O/M	Operation and Maintenance
HWL	High Water Level
NWL	Normal Water Level
LWL	Low Water Level
EL	Elevation Above Mean Sea Level
MSL	Mean Sea Level
LSIP	Large-Scale Irrigation Project
MSIP	Medium-Scale Irrigation Project
SSIP	Small-Scale Irrigation Project
JICA Study Team	JICA Study Team assigned to the Study
Basin	Geographical area of Lam Dom Yai Basin, 4,905 sq.km
Study Area	Objective Area for Feasibility Study
Project Area	Selected Feasibility Study Area

3) Glossary

Park	Region
Changwat	Province
Muang	Capital of Province
Amphoe	District
Tambon	Sub-District
Muban	Village
Mae Nam	Large River
Nam	A Medium-size river
Lam	A small river
Kwae	A tributary of a river
Huai	A rivulet

4) Units of Measurements

mm	millimeter
cm	centimeter
m	meter
km	kilometer
sq.cm	square centimeter
sq. m	square meter
sq.km	square kilometer
rai	unit of land measurement
l, lit	liter
cu.m	cubic meter
MCM	million cubic meter
lit/sec	liter per second
m/sec	meter per second
ppm	part per million
pH	Potential of hydrogen
EC	electric conductivity
g	gram
kg	kilogram
ton, t	metric ton
sec	second
min	minute
hr.	hour
min.	minimum
max.	maximum
%	percent
No.	number
°C	degree centigrade
Cl	chlorine
HP	horse power
ET	evapotranspiration
ppm	parts per million
N	nitrogen
P	phosphate
K	potassium
Baht	unit of Thai currency
US$	US Dollar = 25 Baht

5) Conversion Factors

Unit	Comparison
Unit of Length :	
Millimeter (mm)	0.001 meter
Centimeter (cm)	0.01 meter
Meter (m)	
Kilometer (km)	1,000 meter
Unit of Area :	
Square centimeter (sq.cm)	0.0001 sq.m
Square meter (sq.m)	
Hectare (ha)	10,000 sq.m = 6.25 rai
Square kilomete (sq.km)	1,000,000 sq.m
Rai	0.16 ha
Unit of Volume :	
Cubic centimeter (cu.cm)	
Liter (lit)	0.001 cu.m
Cubic meter (cu.m)	1,000 liters
Unit of Weight :	
Gram (g)	
Kilogram (kg)	1,000 grams
Metric Ton (t)	1,000 kg
Unit of Flow :	
Liter per second (lit/sec)	cusecs
Cubic meter per second (cu.m/sec)	cusecs

SUMMARY AND RECOMMENDATIONS

CONTENTS

1. Introduction

1.1 Objectives of Study

The objectives of the Study are, firstly, to formulate an Overall Basin Study for the agricultural development plan of the Dom Yai river basin, which has an area of 4,905 sq.km (3,065.6 thousand rai) covering Ubon Ratchathani Province (Changwat) and a part of Si Sa Ket Province in the Lower Northeast Region of Thailand, and secondary, to carry out a Feasibility Study for the selected area(s) with high priority in the basin. During the Team's stay, technical transfers to the Team's counterparts, Thai Governmental officials was, made at various stages of the study.

1.2 Implementation of Study

The Study was carried out over a period of three years. The Scope of Work carried out each year was as follows;

In the First Year	:	The work from the preparatory works to Phase-I Field Works Stage-I (Overall Basin Study)
In the Second Year	:	The work from Phase-I Field Works Stage-II (overall Basin Study) to Phase-II Field Works (Feasibility Study)
In the Third Year	:	The work from Phase-II home office work to Final Report compilation.

2. Part-I (Overall Basin Study)

2.1 Present Conditions in the Basin

1) Location

The Lam Dom Yai basin is located in the south-western part of Ubon Ratchathani and the south-eastern part of Si Sa Ket Provinces. The catchment area of the Lam Dom Yai basin is 4,905 sq.km (3,065.6 thousand rai) covering seven administrative districts (Amphoe), and 58 sub-districts (Tambon).

2) Climate

The meteorological conditions in the basin are governed by the south-west monsoon from the Indian Ocean and the north-east monsoon from the China. The south-west monsoon brings proper rainfall, while the north-east one generates heavy dry spells over the basin.

There are two distinctive seasons; one is the wet season from May to October which brings more than 90 percent of annual rainfall and the other is the dry season from November to April. Monthly temperatures vary from 21.9 upto 32.4 °C.

3) Population

Population within the basin is estimated at about 395,000 and 69,000 households. Average family size is 5.7 and the population density is 91.7 habitants/sq.km.

Farm households in the basin account for 81.3 percent of total households.

4) Hydrology

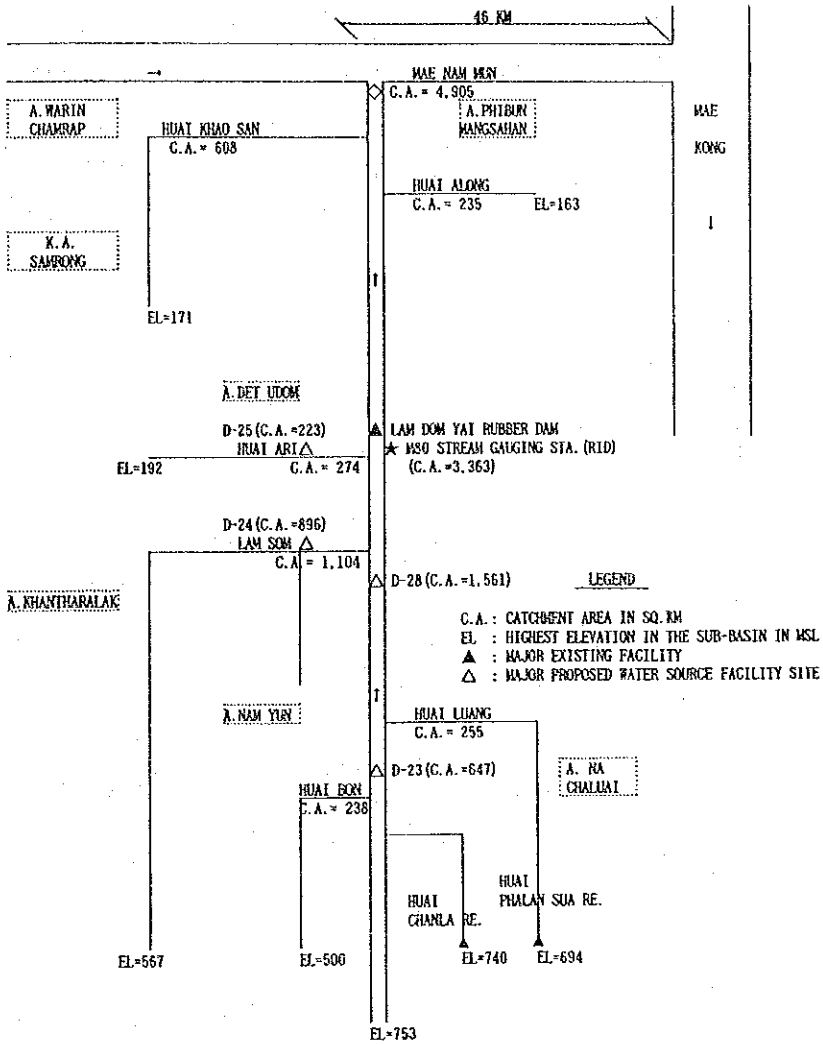
Run-off from the entire Lam Dom Yai basin is estimated at 2,652 MCM (543 mm) corresponding to areal rainfall of 1,468 mm in an average year, and 2,080 MCM (424 mm) corresponding to areal rainfall of 1,272 mm in a low water year of 1/5 probability. Over 90 percent of the basin run-off with the monthly basis distribution is concentrated in the wet season from May to October.

5) Water Resources

a) Surface Water

The outline of the six main tributaries and the river system are schematically shown in the following figure.

Schematic Diagram of River System



The river basin of 352 sq.km, corresponding to about seven percent of the entire river basin is regarded as the catchment area for the projects implemented, under construction, or to be constructed in the upper-basin. As a result, the remaining catchment area of about 4,553 sq.km can produce about 2,460 MCM a year as development potential to be utilized in the future.

b) Groundwater

It can be concluded that groundwater development for irrigation has less potential in the basin with the exception of small-scale irrigation in limited areas, where adequate yield can be secured with good water quality or where there is no potential for surface water.

6) Topography and Geology

The area including preliminarily selected dam-sites is a monotonous plane broken only by gentle rolling hills. The altitude of the area is between EL.130 and EL.180 m above mean sea level. These areas constitute a flood plain and thickly covered by fertile soil, and, in places by swamps. The bedrock forms low ridges, where the soil is less fertile, more sandy and less conductive to rice cultivation.

Basement rocks in the area consist mostly of fine to medium sandstone and siltstone of the Khok Krut Formation, however, the outcrops of the basement rocks are very poor.

7) Soil and Land-Use

Most soils in the basin are formed by alluvial sediments derived from sandstone and conglomerate. The land forms can be classified into four categories; alluvial plains, low terraces, middle terraces and hills, but major soils are those on low and middle terraces. They occupy about 75 percent of the of total area.

Present Land-Use

Land Category	Area (ha)	Percent (%)
Cultivation Area		
Paddy Field	186,800	38.1
Upland Field	45,400 1/	9.3
Sub-total	232,200	47.4
Non-Cultivation Area		
Forest	193,400	39.4
Residential Area	23,600	4.8
Public & Others Area	41,300	8.4
Sub-total	258,300	52.6
Total	490,500	100.0

Note: 1/ inclusive of fallow area of 12,200 ha

Most of the forest land in the basin is composed of national reserved forests. Some of this considerable area of forest, however, has been changed to farmland through illegal reclamation. These areas are still classified as forest.

8) Agricultural Conditions

The main agricultural crop in the basin is wet season paddy; it occupies 84.8 percent of the total planted area. Upland crops such as cassava, kenaf (including jute), maize, and groundnuts, correspond to 13.4 percent; they are cultivated for both wet and dry seasons. The main fruit trees include mango, cashewnut, and papaya; they correspond to 1.0 percent and are densely cultivated around farm households all over the basin.

Present Cropping Area

Crop	Planted Area	Proportion of Total
	(ha)	(%)
Paddy (Wet Season)	186,800	84.8
Non-glutinous	73,600	33.4
Glutinous	113,200	51.4
Paddy (Dry Season)	400	0.2
Sub-total	187,200	85.0
Upland Crops		
Cassava (Dry)	12,500	5.8
Kenaf 1/	13,000	5.9
Maize	2,500	1.1
Groundnuts	500	0.2
Others	800	0.4
Sub-total	29,500	13.4
Fruit Trees		
Mango	1,100	0.5
Cashewnut	200	0.1
Others	900	0.4
Sub-total	2,200	1.0
Vegetables	1,400	0.6
Total	220,300	100.0

Note: 1/ Kenaf includes jute.

Present Cropping Area

Crop	Production (ton)	Average Yield (kg/ha)
Paddy (Wet Season)	233,000	1,248
Non-glutinous	94,000	1,273
Glutinous	139,000	1,232
Paddy (Dry Season)	1,200	3,219
Sub-total	234,200	1,251
Upland Crops		
Cassava (Dry)	79,900	6,313
Kenaf 1/	17,000	1,300
Maize	7,100	2,900
Groundnuts	720	1,300
Fruit Trees		
Mango	5,000	4,675
Cashewnut	210	881
Vegetables	-	-

Note: 1/ Kenaf includes jute.

The average land holding size in Ubon Ratchathani Province is between 1.6 and 6.4 ha (10 and 40 rai), and the tenure form is mainly through ownership of land with no title deed (97.1 percent).

9) Agro-Economic Conditions

Net Income of Major Crops

Crop	Yield (kg/ha)	Farmgate Price (Baht/kg)	Gross Income (Baht/ha)	Variable Cost 1/ (Baht/ha)	Fixed Cost 2/ (Baht/ha)	Net Income (Baht/ha)
Annual Crop						
Paddy	1,250	3.20	4,000	9,694	713	- 407
Cassava	13,125	0.60	7,875	6,799	776	300
Kenaf	1,581	4.80	7,511	6,752	731	28
Maize	2,900	1.30	3,770	2,783	975	12
Groundnut	1,306	7.13	9,314	8,770	648	- 104
Perennial Crop						
Mango	4,675	3.00	14,025	12,851	742	432
Cashew nuts	881	13.00	11,444	6,452	2,244	2,748

1/ : Variable cost : Input materials and labor costs, etc.
2/ : Fixed cost : Tax and interest, etc.

10) Irrigation Conditions

The total cultivation area in the basin is about 232,200 ha (1,451.3 thousand rai), which is equivalent to 47.4 percent of the total basin area of

490,500 ha (3,065.6 thousand rai). The farming on most of the land is rainfed during the wet season from May to October, and irrigated farmland is estimated at only about 10,630 ha (66.3 thousand rai), in which the project executing agencies are RID, DLD, ARD, NEA, DOLA and ALRO.

2. 2 Overall Agricultural Development Plan

2. 2. 1 Objectives of the Development Plan

The factors impeding development in this area, which has serious poverty problems, were found to be the following:

- Shortage of irrigation water
- Deteriorated soil conditions
- Undeveloped farming practices
- Imbalance of farming crops and underdeveloped marketing

Therefore, the project objectives are to establish the following development plan to remove these impeding factors:

- To introduce as much irrigated agriculture in the area as possible.
- To construct water resource facilities which will utilize river run-off in the wet season effectively.
- To bring a supplemental irrigation water supply for paddy in the wet season, and to use the remaining irrigation water for upland farming in the dry season.
- To propose an adequate improvement plan for the area of rainfed agriculture.
- To formulate concrete land utilization plan for the forest.

2. 2. 2 Sectional Development Plan

1) Water Resource Development Plan

Considering the pattern of irrigation demand, the water sources for irrigation require equalization of run-off by means of water storage.

Implementation of the irrigation projects through reservoir construction should be proceeded.

For the upper-basin of the river, medium-scale irrigation projects with a benefited area of less than 4,000 ha (25.0 thousand rai) will be applied. Gravity irrigation from the reservoirs to these areas will be possible, but only to a small extent.

For the middle and lower-basins of the river, large and medium-scale irrigation projects are possible using abundant river run-off at the sites on the main Dom Yai river, or some tributaries with large catchment areas. Water resource development by pumping, however, will be essential:

For agricultural land not irrigable by the above-mentioned projects, water resource development through small-scale ponds, weir construction, etc. will be needed, as well as village pond construction for rural life improvement.

Five percent of the river run-off at the planned large and medium-scale reservoir sites should be released downstream.

2) Land Resources Development Plan

Proposed Land-Use Plan

Land Category	Area (ha)	Percent (%)
Cultivation Area		
Paddy Field	177,500	36.2
Upland Field	44,500	9.1
Sub-total	222,000	45.3
Non-Cultivation Area		
Forest	193,400	39.4
Residential Areas	23,600	4.8
Public & Other Areas	51,500	10.5
Sub-total	268,500	54.7
Total	490,500	100.0

3) Irrigation Plan

Annual Maximum Diversion Water Requirement

(unit: mm)

Item	Upper-Basin (Type-1)	Middle/Lower-Basin (Type-2)
Annual DWR		
Normal Year (1/2-Year)	478.5	332.8
Designed Year (1/5-Year)	546.4	386.2

The irrigation systems of main and lateral canals were planned on the basis of designed criteria and their canal density used in RID.

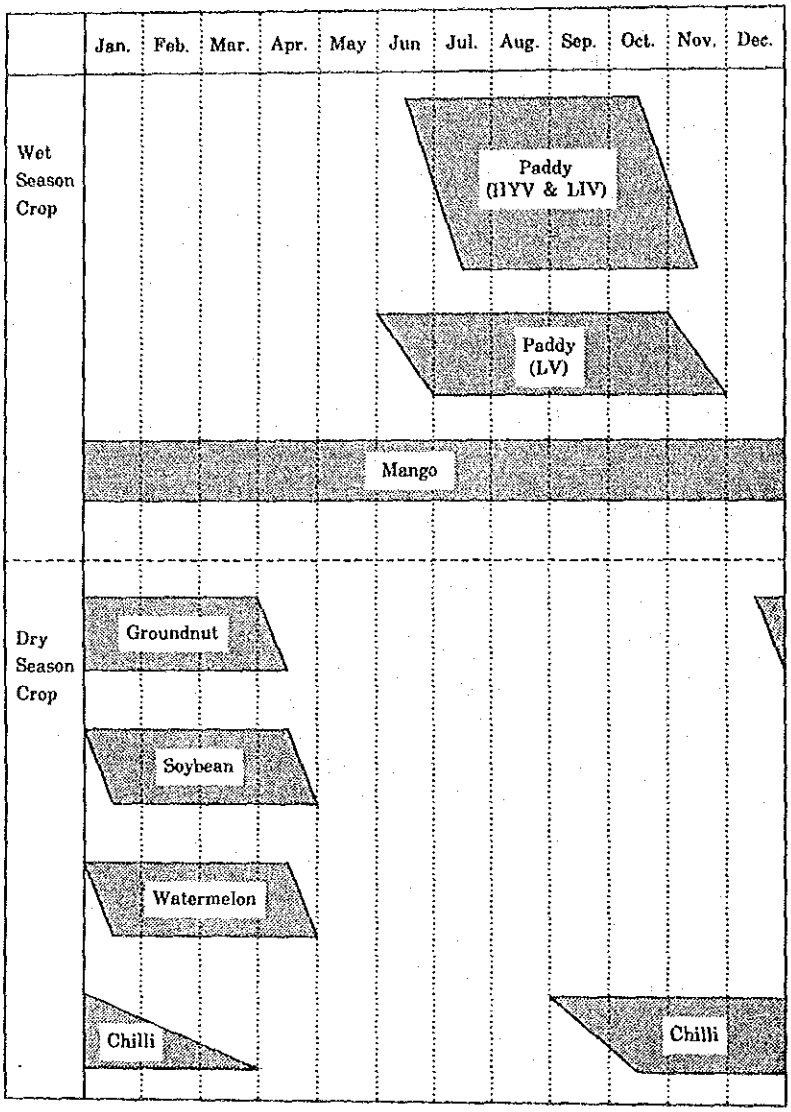
4) Irrigated Agricultural Plan

Proposed Target Yield of Crops

Crops	Yield		Remarks
	kg/ha	kg/rai	
Paddy	3,438	550	Present yield = 1,413 kg/ha 1/
Mango	9,375	1,500	
Groundnuts	1,563	250	1,363
Soybean	1,250	200	1,125
Watermelon	25,000	4,000	
Chilli	5,625	2,500	

Note: 1/ based on 1989/90 data in Ubon Ratchathani and Si Sa Ket Provinces

Proposed Cropping Pattern



Future Net Income for Irrigated Crops

Crops	Yield (kg/ha)	Farmgate Price (Baht/kg)	Gross Income (Baht/ha)	Variable Cost (Baht/ha)	Fixed Cost (Baht/ha)	Net Income (Baht/ha)
Paddy (wet)	3,438	3.4	11,689	5,448	713	5,528
Groundnuts	1,563	7.1	11,097	8,638	648	1,811
Soybean	1,250	7.3	9,125	6,656	648	1,821
Watermelon	25,000	0.9	22,500	14,830	706	6,964
Chilli	15,625	7.0	109,375	73,644	788	34,943

Farmer's Income in Future

(unit : Baht)

Item	Upper-Basin	Middle-Basin	Lower-Basin
Cropping Area	4.25 ha (26.58 rai)	5.24 ha (32.73 rai)	4.50 ha (28.13 rai)
Gross Income	60,106	65,803	61,690
Variable Cost	31,114	33,220	31,252
Overhead Cost	1,986	3,057	3,168
Net Income	27,006	29,526	27,270
Family Labor	12,902	14,756	14,021
Farmer's Income	27,006	29,526	27,270

5) Improvement Plan of Rainfed Agriculture

In order to improve the present rainfed agriculture, the following measures should be considered.

1) Moisture Preservation
   - Mulching method
   - Green manure cultivation

2) Small-scale village pond construction

2. 2. 3 Water Resource Development Plan

1) Selection of Reservoir Sites

New Water Resource Development Plan

Item	Water Source Site					
	Lam Dom Yai (U)	Lam Som	Huai Ari	Huai Khao San	Lam Dom Yai (M&L)	Total
Catchment Area (sq.km)	1,561	1,104	274	608	1.358	4,905
Water Storage Plan (place)						
-Larger-Scale	2	-	-	-	-	2
-Larger Medium-Scale	-	1	1	-	-	2
-Smaller Medium-Scale	6	10	-	4	4	24
Run-of-River Plan (place)						
-Smaller Medium-Scale	-	-	-	-	1	1
Total	8	11	1	4	4	29

Note: U: Upper-stream M: Middle-stream L : Lower-stream

2) Irrigation Areas by Water Source Development

Total Irrigable Area through Overall Basin Water Resource Development

Irrigation Project	Irrigable Area (ha)	Ratio to Planned Agri.Land (%)
1. Present Condition		
a) Existing samll-scale irrigation projects and other small-scale water resources development projects	6,700	3
2. Proposed Water Resource Development Plan		
a) Irrigation projects under construction or to be constructed by RID	8,960	4
b) Newly proposed projects	91,870	41
Sub-total	100,830	45

3) Water Resource Distribution Plan

The water resource distribution plan was drawn up and summarized from the viewpoint of irrigable areas by sub-basins. The proportion of irrigation area in the existing agricultural land in six sub-basins ranges from 37 to 58 percent.

4) Phased Development Plan

Phasing Development Plan of Water Resources in Overall River Basin

Phasing (Period)	Larger-Scale or Larger Medium-Scale Projects		Smaller Medium-Scale Projects		Irrigation Area Rate (%)
	Project Name	Irri. Area (ha)	Project Name	Irri. Area (ha)	
Under Construction/to be Constructed (1987-1995)	-	-	D-5, D-18, D-19, D-20, D-8, D-13, D-3-A, D-31	8,960	4
First-Phase Development (1993-2000)	D-28	30,970	D-15, D-16, D-17, D-1-A, D-2, D-4-A	5,770	21
Second-Phase Development (1998-2005)	D-7 D-24	24,200 4,770	D-22, J-4, D-33, D-35-A, D-35-B, D-35-C, D-26-A, D-51	9,630	38
Third-PhaseDevelopment (2003-2010)	W-1 D-25	2,500 7,160	Other 10 Projects	6,870	45
Total		69,600		31,230	

2. 2. 4 Water Source Facility Plans and Their Costs

1) Water Source Facility Plans

The dimensions of proposed dams are as follows:

- Dam type : Earthfill type with slopes of 1: 3.0 upstream and 1 : 2 .5 downstream
- Dam crest width : 6.0 m to 10.0m

The dams' height and volume roughly estimated are 10.0 to 48.0m and 8,000 to 1,038,000 cu.m, respectively.

The weir design in the lower-basin of the Lam Dom Yai river is of the rubber dam type, three meters in height.

In this plan, seven pumping stations are planned. The total head necessary for lifting the water ranges from 10.5 to 26.5 m.

2) Project Costs

For the purpose of assessing the priorities of respective projects, preliminary and rough project costs were estimated. For the estimate, the unit costs obtained at the site surveyed in June 1990 were used.

Development Cost per Hectare

Code No.	Project	Irrigable Area (A)	Project Cost (C)	Unit Development (C/A)
		(ha)	(million Baht)	(1,000 Baht/ha)
J-7	Huai Bon (L)	1,970	284	144
D-15	Huai Chaluai	850	95	112
D-16	Huai Chaluai Noi	590	102	173
D-17	Huai Om	650	124	191
D-22	Huai Hin Lat	2,240	245	109
J-4	Huai Thiam Yai	1,130	129	114
D-7	Lam Dom Yai (U)	24,200	2,822	117
D-23	Lam Dom Yai (M)	29,600	3,936	133
D-28 (A)	Lam Dom Yai (L)	30,970	4,209	136
D-28 (B)	Lam Dom Yai (L)	25,570	3,691	144

Code No.	Project	Irrigable Area (A) (ha)	Project Cost (C) (million Baht)	Unit Development (C/A) (1,000 Baht/ha)
D-30-B	Huai Tanot	380	78	206
D-1-A	Huai Tung (U)	2,00	195	97
D-2	Huai Hin Dan	630	103	163
D-1-B	Huai Tung (M)	210	75	359
D-3-B	Huai Dan	950	127	134
D-4-A	Huai Chong	1,050	451	430
D-33	Huai Salao	740	88	119
D-35-A	Huai Fang Deang (U)	1,100	127	116
D-35-B	Huai Manao	1,200	123	102
D-35-C	Huai Fang Deang (M)	1,490	237	159
D-24	Lam Som (M)	4,770	887	186
D-25	Huai Ari	7,160	935	131
D-26-A	Huai Khao San (U)	1,240	159	128
D-26-B	Huai Khao san (M)	380	99	261
D-43	Huai Duan	240	59	245
D-49	Rong Saeng	630	74	118
D-50	Huai San	650	81	125
D-48	Huai Hin Siu	370	54	147
D-27	Huai Chong	490	78	159
D-51	Huai Saen Phran	1,090	117	108
W-1	Lam Don Yai Weir	2,500	274	109

2. 2. 5 Selection of Priority Development Projects

1) Preliminary Selection of High Priority Projects

The irrigable areas from 29 new water resources were selected in the river basin, and the following six plans consisting of five projects were selected as preliminary agricultural development projects with high priorities.

Agricultural Development Project Area with High Priorities

Project			Irrigable Area
			(ha)
D-7	:	Lam Dom Yai (U)	24,200
D-23	:	Lam Dom Yai (M)	29,600
D-24	:	Lam Som	4,770
D-25	:	Huai Ari	7,160
D-28 (A)1/	:	Lam Dom Yai (L)	30,970
D-28 (B)2/	:	Lam Dom Yai (L)	25,570

1/ D-28 (A) : This is the D-28 project when D-28 reservoir is linked with D-7 and D-24 reservoirs.

2/ D-28 (B) : This is the D-28 project when D-28 reservoir is linked with D-23 and D-24 reservoirs.

2) Final Selection of Priority Development Project

Through a careful study using such criteria such as B/C ratio, scale of irrigable area, reservoir area condition, income level, soil suitability, civil work conditions and environmental conditions, it was found that the project plan for D-28 (A) is the one with highest priority, from technical, economic and social viewpoints.

The dimensions of D-28 (A) Plan are as follows;

Effective storage capacity	:	117.1 MCM
Reservoir area	:	39.1 sq.km
Normal full water level	:	EL.139.5 m
Dam height	:	21.5 m
Dam length	:	2,000 m
Irrigation area	:	30,970 ha

3. Part-II (Feasibility Study)

3. 1 Present Conditions in the Study Area

1) Location of the Study Area

The Study Area for the Feasibility Study on the Lam Dom Yai Basin Irrigation Project, which has an estimated area of 71,700 ha (448.1 thousand rai) in total is located on both the banks of the Dom Yai river; 18,810 ha (117.6 thousand rai) on the left bank and 52,890 ha (330.6 thousand rai) on the right bank.

These two areas administratively belong to four Amphoe (Districts), Amphoe Phibum Mangsahan, Det Udom, Na Chaluai and Nam Yun, and 17 Tambon (Sub-Districts).

2) Physical Conditions

The topography of the area is relatively flat with gentle slopes of about 1/1,500 in south to north direction, although some undulating topography is partially observed in the area. Elevation varies form about EL.150m to EL.120m above mean sea level. The present situation in the area is summarized as follows;

Present Situation of Study Area

	Left Bank Area	Right Bank Area	Total
Administration			
No. of Amphoe	3	1	4
No. of Tambon	9	8	17
Area (ha)			
Cultivation Area	14,400	35,920	50,320
Non-cultivation Area	4,410	16,970	21,380
Total	18,810	52,890	71,700
Population			
Population (person)	16,860	40,040	56,900
Density (person/sq.km)	89.6	75.7	79.4

The estimated areal rainfall in the watershed area of the proposed dam-site is 1,416.4 mm annually. Successive no-rain days during the proposed irrigation period for the wet season paddy are estimated at 50 days for 1/10-year return period.

Watershed area at the proposed dam-site	:	1,509.9 sq.km
Watershed areas of six reservoir projects (planned and / or completed in the upper-basin)	:	314.1 sq.km
Direct watershed area at the proposed dam-site	:	1,246.8 sq.km

The computed result of mean annual run-off is 591.0 MCM, run-off coefficient of 33 percent, and mean annual specific discharge of 0.474 MCM/sq.km.

3) Soil and Land Classification

The 12 soil series in the Study Area can be grouped into seven soil sub-groups. Most of these soil series are characterized by sandy loam and loamy sand soils. The soil texture is high in sand and silt, and the soil pH is around 4.5-6.0. Soil fertility and organic matters are low.

Most of these soils occupying about 44 percent of the total area are suitable for paddy rice and the next for upland crops.

To maintain or increase soil productivity as well as soil fertility in the Study Area, the following is suggested as appropriate measures:

- Increase in organic matter content
- Increase in soil fertility
- Increase in soil pH

4) Present Agriculture

The present land-use in the Study Area can be categorized as shown below:

Present Land-Use

Land Category	Left Bank Area (ha)	Right Bank Area (ha)	Total (ha)
Paddy Field	11,530	29,830	41,360
Upland Field	2,280	1,510	3,790
Fallow	590	4,580	5,170
Forest	4,240	16,450	20,690
Residential Area and Other	170	520	690
Total	18,810	52,890	71,700

The forest area has been utilized for cultivated land, mostly for paddy field, by local people's illegal occupation. A part of Lam Dom Yai right bank forest in the Study Area is under land appropriation procedure for agricultural purposes by the Agricultural Land Reform Office (ALRO).

Most of the land has been used only for wet season paddy cultivation relying upon rainfall except one part, which has small-scale irrigation facilities (854 ha in total) constructed by RID, ARD and farmer's groups, where groundnut, vegetable, watermelon, chilli, etc., have been planted.

The total population in the area is 56,900 persons, the number of households 9,670, family size 5.9 persons/households and population density 79.4 persons/sq.km. The number of farming households is 8,890 (92 percent of the total households) in the area.

The labor force per farm household is estimated at 3.9 persons from the household average of 5.8 persons per family, resulting in a total farm labor force of 34,800 in the Study Area. Farming in the area is characterized by wet season paddy cultivation fed by rain and such traditional crops as cassava and kenaf. On the other hand, in the dry season farming is difficult due to the lack of irrigation water. The average farm size in the area is about 4.6 ha (28.8 rai). Most farmers are owner-farmers but without title deeds. A few households in the villages have no land with households working at the farms of owner-farmers as farm laborers.

Present Planted Area

Crop	Left Bank Area (ha)	Right Bank Area (ha)	Total (ha)
Paddy (Wet Season)	11,532	29,826	41,358
Non-glutinous	5,305	12,780	18,085
Glutinous	6,227	17,046	23,273
Paddy (Dry season)		9	185
Upland Crops	2,124	1,235	3,359
Cassava	745	191	936
Kenaf	1,313	1,022	2,335
Maize	-	5	5
Groundnut	8	9	17
Others	58	8	66
Fruit Trees	136	238	374
Mango	75	71	146
Coconut	15	59	74
Others	46	108	154
Vegetables	23	41	64
Total	13,991	31,349	45,340

Production and Yield of Major Crops

Crop	Average Yield (kg / ha)	Production (ton)	Production (ton)
Paddy (Wet season)	1,250	14,400	37,300
Non-glutinous	1,277	6,800	16,300
Glutinous	1,233	7,600	21,000
Paddy (Dry season)	3,219	570	29
Upland Crops			
Cassava (dry)	5,629	4,200	1,080
Kenaf	1,431	1,900	1,460
Maize	2,919	-	15
Groundnut	1,312	10	12

Animal husbandry in the Study Area comprises cattle, buffalo, swine, chickens, and ducks, but the conditions of raising them are harsh owing to high temperatures and humidity.

Inland fisheries in the Study Area depend on freshwater fish in the rivers, swamps, ponds and flood areas. Rice bran and animal dung are used as feed for fish culture. The freshwater fish are a staple protein for farmers.

Most agricultural products, including paddy in the area, are shipped and dealt with directly by middlemen. Cassava, kenaf and groundnuts are

collected directly from farms by middlemen and processed by each marketing channel.

Agricultural supporting services in the Study Area are conducted by the following agencies:

- Agricultural Extension Office (DOAE)
- Freshwater Fishery Promotion Center
- Marketing Organization for Farmers (MOF)
- The Bank for Agriculture and Agricultural Cooperatives (BAAC)

In addition, there are two agricultural cooperatives in the area.

The farming households' economy including family labor shows both positive and negative figures. It means the economy is based on family labor.

3. 2 Development Plan

3. 2. 1 Objectives and Components of the Project

1) Objectives of the Project

The following factors impeding development in the Lam Dom Yai basin and causing serious poverty problems will be itemized;

- Shortage of irrigation water
- Deteriorated soil conditions
- Undeveloped farming practies
- Imbalance of farming crop disproportion and undeveloped marketing outlets

The objectives of the overall irrigated agricultural development plan in the Study Area are to remove the above-mentioned factors impeding developments and to establish the following;

- To introduce as much irrigated agriculture in the area as possible.
- To construct water resource facilities which will utilize river run-off in the wet season effectively.

- To bring a supplemental irrigation water supply for paddy in the wet season, and to use the remaining irrigation water for upland farming in the dry season.
- To propose an adequate improvement plan for the area for rainfed agriculture.
- To formulate concrete land utilization plan for the forest.

In order to meet the above requirements, the following facilities plans was proposed in the project plan.

- Dam construction
- Pumping station construction
- Canal networks establishment

2) Components of the Project

The components of the project will be made with the following development concept to achieve the development objectives mentioned above;

- Water resource development
- Irrigation and drainage canal system development
- Introduction of irrigated agriculture
- Establishment/strengthening of agricultural supporting service

3. 2. 2 Formulation of Optimum Project Scale

Selected Potential Areas for Feasibility Study

Area	Left Bank Area	Right Bank Area	Total
	(ha)	(ha)	(ha)
Gross Area	18,810	52,890	71,700
Cultivable Area	14,400	35,920	50,320

Alternative Cropping Pattern

Case	Wet Season	Dry Season	Total	IrrigationDemand
(%)	(%)	(%)	(%)	(mm)
Case-1	100	10	110	277
Case-2	100	15	115	333
Case-3	100	25	125	388

Note : Wet season crop : Paddy
Dry season crop : Groundnut, Soybean Watermelon, Chillli, and Stringbean
Perennial crop : Mango

The proposed cropping intensity for the project was decided at 115 percent taking into consideration stabilization of wet season paddy cultivation with an equal distribution of as much supplemental irrigation water as possible in the area, as well as the present and forthcoming marketing conditions of agricultural products, especially upland crops.

It was discovered that the following areas could be irrigated according to the corresponding water level, in the case of a cropping intensity of 115 percent under the designed year of 1/5-year return period.

Irrigable Area According to Water Level

Normal Water Level (NWL)	Reservoir Capacity		Irrigable Area
	Total	Effective	
(El.m)	(sq.km)	(MCM)	(MCM)
137.0	48.62	36.15	13,200
137.5	58.33	45.86	16.700
138.0	68.04	55.57	20,100
138.5	82.81	70.34	24,300
139.0	97.58	85.11	28,300
139.5	117.10	104.63	34,000
140.0	136.63	124.17	40,300
⋮	⋮	⋮	⋮
141.5 (max)	216.47	240.00	53,100

D-28 Reservoir Area and Capacity According to Water Level

Water Level	Water Surface Area	Reservoir Capacity (Gross)
(El.m)	(sq.km)	(MCM)
125.7	0.00	0.00
132.0	0.79	2.49
134.0	5.67	8.95
136.0	14.59	29.21
137.0	19.10	48.62
138.0	24.24	68.04
139.0	34.84	97.58
140.0	43.27	136.63
141.0	50.00	180.00
142.0	63.17	243.07

Note; Dead storage capacity is 12.47 MCM at low water level of EL 134.35 m

It was concluded through the study that the plan in which the normal water level is EL.139.5 m and a spillway overflow depth is 1.5 m, irrigation area is 34,000 ha (212.5 thousand rai) is the most optimum scale for the project

planning from viewpoints of project benefit, cost and social aspect, and is, therefore, most recommendable.

The compensation water level for the D-28 reservoir area is fixed at EL.140.0 m above mean sea level (overflow depth is 0.5 m), which correspond to the maximum water level during the last 30 years.

The selection of Project Area covering the irrigation area of 34,000 ha (212.5 thousand rai) was made taking into account physical facilities to be connected to the D-28 dam, namely, pumping stations and irrigation systems.

After careful studies of the four alternative plans in terms of construction costs and project locations, the following plan was evaluated as the most adequate plan; that is, the Project Area is selected on both the banks of the Lam Dom Yai with an independent pumping station each. The irrigation area is 8,800 ha (55.0 thousand rai) on the left bank and 25,200 ha (157.5 thousand rai) on the right bank.

3. 2. 3 Land-Use Plan

Land use plan in the Project Area is formulated paying due attention on the balanced development considering no expansion of cultivation land and soil conservation in the watershed. Following table shows the proposed land-use in the Project Area.

Proposed Land-Use Plan

(unit : ha)

Land Category	Present Land-Use	Proposd Land-Use				
		Cultivated Area		Forest	Village & Others	Total
		Irrigated	Rainfed			
1. Cultivated Area						
Paddy Field	31,430	25,740	2,200	1,900	1,580	31,430
Upland Field	3,570	2,620	770	-	180	3,570
Fallow Land	1,500	1,420	-	-	80	1,500
Sub-total	36,500	29,780	2,970	1,900	1,840	36,500
2. Non-cultivated Area						
Forest	18,410	4,220	-	14,190	-	18,410
Village/Others	590	-	-	-	590	590
Sub-total	19,000	4,220	-	14,190	590	19,000
Total	55,500	34,000	2,970	16,100	2,430	55,500

3. 2. 4 Water Resource Development Plan

The Dom Yai river has a length of 240 km and joins the Mae Nam Mun. The proposed dam-site is located about 180 km upstream of the junction. The summary of calculated results of the probable flood and sediment inflow are as follows:

Probable Flood

Probable Flood Discharge

Return Period (Year)	Peak Flood Discharge (cu.m/sec)	Specific Discharge (cu.m/sec/sq.km)
1000	1,143.8	0.733
500	1,086.7	0.696
200	1,010.1	0.647
100	819.6	0.525
50	781.5	0.501

Designed Flood Discharge of Spillway

Return Period	Probable Flood (cu.m / sec)
500	1,086.7

Designed Flood Discharge of Diversion Facilities

Return Period	Specific Discharge			Probable Flood at Dam-site
	53801	M80	Mean	
	(cu.m / sec/ sq.km)			(cu.m / sec)
10	0.225	0.258	0.242	377.0
5	0.196	0.187	0.192	298.9
3	0.172	0.142	0.157	245.1
2	0.150	0.109	0.130	202.1

Sediment Inflow

Watershed area at dam-site	:	1,246.8 sq.km
Average annual run-off	:	591.0 MCM
Average annual suspended sediment yield:		100.0 cu.m/sq.km (=110.0 ton)
Average annual sediment accumulation	:	124,680 cu.m
100-year sediment accumulation	:	12.5 MCM

Water shortages of reservoir water will occur seven times during the 30 year study period of water balance study. As the result of the water balance study, the reservoir operation rules were tentatively established. When the reservoir water level reaches EL.134.70 m, irrigation area on and after this date should be reduced to 50 percent of the target area.

3. 2. 5 Irrigation Development Plan

1) Irrigation for Paddy

The Project Area is selected on both the banks of the Dom Yai river with an independent pumping station in each area.

Left Bank Area	:	8,800 ha
Right Bank Area	:	25,200 ha
Total		34,000 ha

The following two types of cropping pattern were set up in the project;

Type-I : (for first five years after project implementation)
In wet season - - - Paddy rice + Perennial crop
In dry season - - - Upland crop + Perennial crop

Type-II : (for the following 45 years)
In wet season - - - Paddy rice + Upland crop + Perennial crop
In dry season - - - Upland crop + Perennial crop

The cropping intensity for the Type-I would be 115 percent, 100 percent in the wet season and 15 percent in the dry season, and that for Type-II would be 116 percent, 100 percent in the wet season and 16 percent in the dry season, respectively.

Annual diversion water requirement is summarized as follows;

Annual Diversion Water Requirement

Item	Cropping Pattern	
	Type-I	Type-II
	(MCM)	(MCM)
Designed Year	136.4	141.1
Normal Year	113.0	119.5

Two types of water distribution methods are proposed for paddy cultivation, simultaneous and rotational water supplies.

The peak irrigation water requirement was calculated at 0.930 lit./sec/ha in a return period of 1/10-year. Consequently, the designed water requirement for the main canal commanding about 5,000 to 6,500 ha (31.3 thousand to 40.6 thousand rai) was decided at 1.00 lit./sec/ha inclusive of domestic water requirement, and those for lower-graded canals were also decided.

2) Irrigation for Upland crops

The proposed cropping areas for upland crops are as follows;

Cropping Areas by Upland Crop

(unit : ha)

Crops	Type-I	Type-II	
	(Dry Season)	(Dry Season)	(Wet Season)
Groundnut	1,122	1,122	-
Soybean	3,417	3,757	-
Watermelon	357	357	-
Stringbean	153	153	1,050
Chilli	51	51	-
Total	5,100	5,440	1,050

The results of field surveys of upland irrigation are summarized as follows;

Obtained Basic Intake Rate (Ib)

	Location	Ib
		(mm/hr)
1.	Ban Rai Tai	14.7
2.	Ban Nachan	4.8
3.	Ban Kaon Charoon	33.1
4.	Ban Mai Pattana	15.1
5.	Ban Wari Udom	15.6
6.	Ban Non	54.1
7.	Ban Nong Khu	16.4

Physical Properties of Soils[1/]

Depth (D)	Real Specific Gravity (Sr)	Apparent Specific Gravity (Sa)	Porocity (P) 2/	Field Capacity (Fc)	Wilting Point (Wp)
(cm)	(g / cm3)	(g / cm3)	(%)	(%)	(%)
10	2.68	1.80	32.7	8.8	6.3
30	2.70	1.81	33.0	13.4	7.3
50	2.70	1.82	32.6	16.3	8.3
70	2.72	1.88	30.8	23.1	10.2

1/ : Average of seven samples
2/ : $P = (Sr - Sa) \times 100 / Sr$

As observed in the above table, furrow irrigation method would be suitable for water supply to upland crops, because the basic intake rate is less than 50 mm/hr.

Estimation of Irrigation Interval

Upland Crop	TRAM	Maximum Evapotranspiration	Irrigation Interval
	(mm)	(mm/day)	(day)
Groundnut	25.3	5.5	4.6
Soybean	25.3	6.2	4.1
Watermelon	40.8	5.2	7.8
Stringbean	25.3	6.2	4.1
Chilli	25.3	5.5	4.6

From the viewpoint of water management, the same irrigation interval of water supply is favorable, therefore, irrigation at five-day intervals was planned for the project upland irrigation in the project.

3) Pump Operation Plan

The two pump facilities to lift irrigation water were proposed adjacent to the D-28 reservoir.

The estimated pump operation hours are mainly concentrated in the land-soaking and preparation stages, around October corresponding to the late period of the wet season paddy and for the entire growing period of dry season upland crop.

4) Drainage Plan

Inundation by flood discharge is generally caused by the followings;

- No provision of terminal drainage canal.
- Insufficient drainage capacity of existing drainage creeks and small tributaries.
- Reverse flow of drainage discharge from the creeks and tributaries to the field due to their rising water levels.

For the drainage planning, the following countermeasures will be taken;

- Provision of farm drains.
- Dredging of important connecting drainage creeks and tributaries.
- Designed drainage modulus were decided at 8.14 lit./sec/ha for new farm drains.

3. 2. 6 Agricultural Development Plan

1) Agriculture

Proposed Target Yield

Crop	Target Yield	
	(kg/ha)	(kg/rai)
Wet season paddy	3,438	550
Groundnut (*)	1,563	250
Soybean (*)	1,250	200
Watermelon (*)	25,000	4,000
Chilli (fresh) (*)	15,625	2,500
Stringbean (*)	9,375	1,500
Mango	9,375	1,500
Cucumber (+)	15,625	2,500
Sweet Corn (+)	12,500	2,000
Stringbean (+)	9,375	1,5000

(*) Dry season crop (+) Wet season vegetable

Proposed Crop Production

Crop	Planted Area		Produciton		Yield
	Type-I	Type-II	Type-I	Type-II	
	(ha)	(ha)	(ton)	(ton)	(kg/ha)
Wet season paddy	32,750	31,700	112,595	108,985	3,438
Groundnut (*)	3,417	3,757	5,341	5,872	1,563
Soybean (*)	1,122	1,122	1,403	1,403	1,250
Watermelon (*)	357	357	8,925	8,925	25,000
Chilli (fresh) (*)	51	51	797	797	15,625
Stringbean (*)	153	153	1,434	1,434	9,375
Mango (*)	1,250	1,250	11,719	11,719	9,375
Cucumber (+)		300		4,688	15,625
Sweet Corn (+)		550		6,875	12,500
Stringbean (+)		220		1,875	9,375
Total	39,100	39,400			

Note: (*) Dry season Crops (+) Wet season vegetables

2) Livestock

The promotion of livestock in the area will be considered as follows:

- Raising of buffalo, swine, chicken and duck
- Improvement of breeding
- Introduction of beef cattle

3) Freshwater Fisheries

Freshwater fisheries in Ubon Ratchathani Province are planned as follows:

Breeding location	:	Fish ponds and paddy fields
Number of raising farmers	:	2,388 households
Total area	:	500 ha
Total production	:	500 ton

Since 1982, freshwater fish culture has been carried out in the Sirindhorn Reservoir of the Lam Dom Noi Project adjoining the Project Area. Considering the results, such species of freshwater fish as Telapia, local carp, common carp, and catfish will be encouraged in the area.

3. 2. 7 Resettlement Plan

About 4,330 ha (27.1 thousand rai) of land composed of 1,930 ha (12.1 thousand rai) of farmland and housing lots and 2,400 ha (15.0 thousand rai) of forest land will be submerged at EL.140.0 m, which is the compensation water level. The number of households affected by the water level is estimated to be 324 households, but this can be reduced to 122 households by the provision of low protection dikes, two meter in height.

One resettlement area is to located on the right bank covered by Ubon Ratchathani Land Reform Project Area, while the other on the left bank is categorized as reserved forest under the Royal Forestry Department (RFD).

3. 2. 8 Rural Development Plan

The road networks to be provided by the project are as follows:

Operation and Maintenance Roads

Item	Effective Width (m)	Road Length (km)	Remarks
Feeder Road (main)	6.0	111.4	
O & M Road (lateral)	4.0	188.4	Laterite pave.
Total		299.8	Letarite pave.
Road Density (m/ha)		8.8	

The total length of the on-farm roads in the Project Area to be provided by the Water Users' Association is estimated at 360 km (10.6 m/ha).

3.3 Project Engineering

3.3.1 Dam and Reservoir

Reservoir		
Average annual rainfall	1,416	m
Catchment area	1,245	sq.km
Average annual run-off	591	MCM
1/5-year probable annual run-off	501	MCM
High water level (HWL)	EL.141.0	m
Normal water level (NWL)	EL.139.5	m
Low water level (LWL)	EL.134.4	m
Reservoir area (at NWL)	39.1	sq.km
Total storage capacity	117.1	MCM
Effective storage capacity	104.6	MCM
Dead storage capacity	12.5	MCM
Dam		
Dam Type	Homogeneous earth fill type	
Crest length	2,000	m
Maximum height	21.5	m
Crest elevation	EL.143.0	m
Embankment volume	Approx. 850,000	cu.m
Spillway		
Spillway type	Chute type	
Crest length	170	m
Crest elevation	EL.139.5	m
Spillway capacity	641	cu.m/sec
Inflow designed flood (1/500-year probable flood)	1,087	cu.m/sec
Outlet Works		
Type	Concrete-encased pressure pipe conduit	
Function		

3.3.2 Pumps and Canals

1) Pumping Station

Judging from the comparative study results, electricity is more economical as the pump motive power; it was, therefore, adopted in the project.

Total Lift Head

Item	Left Bank Area	Right Bank Area
WL at delivery pipe outlet (m)	148.0	158.0
Low water level (m)	134.4	134.4
Actual lift head (m)	13.6	23.6
Total loss heads (m)	2.8	4.8
Total lift head (m)	16.4	28.4

Outline of Pumps

Item		Left Bank Area	Right Bank Area
Irrigation area	(ha)	8,800	25,200
Pumping Discharge	(cu.m/sec)	8.80	25.20
Total Lift Head	(m)	16.4	28.4
Diameter	(mm)	800	1,000
Number of Sets		6	12
Output	(kw/hr)	370	880

Summaries of Dimension of Pipelines

Diameter	(mm)	:	2,000
No. of Pipelines		:	3
Pipe Thickness	(mm)	:	20
Foundation		:	Sanbed at an angle of 180°

The proper dimension of the diversion channel for pump facilities will be B $\geqq$ 20.0 m in bed width, and 1 : 2.0 in side slope to be protected with rip-rap.

2) Irrigation Canals

Main canal L = 111.4 km, in which 67.4 km on the left bank and 44.0 km on the right bank (with trapezoidal cross section)
Mean gradient : I = 1/5,000
Designed discharge: q = 1.0 lit./sec/ha (0.16 lit./sec/rai)

Lateral canal L = 188.4 km, in which 32.2 km on the left bank and 156.2 km on the right bank
Mean gradient : I = 1/4,500
Designed discharge : q = 1.5 lit./sec/ha (more than 1,000 ha)
q = 2.1 lit/sec/ha (1,000~200 ha)
q = 2.9 lit/sec/ha (200~40 ha)

3.3.3 Resettlement Facilities

The required land for resettlement is estimated for each bank at about 300 ha (122 households × 2.4 ha/household).

About 300 ha (1.9 thousand rai) of the land mentioned above are needed for individual plots, and another 300 ha for agricultural and social infrastructures. Therefore, the total resettlement areas are planned to be two sites on the right and left banks of about 300 ha each.

The submerged properties are shown below;

- Structural properties

Privately-owned structural properties:		122 households
Public structural properties		
Roads and bridges:	:	6 km
Power transmission lines	:	6 km

- Land and tree crops

Farmland (paddy field)	:	1,930 ha (12.1 thousand rai)
Forest and others	:	2,400 ha (15.0 thousand rai)

3.4 Project Implementation and Operation

3.4.1 Project Implementation

The executing agency of the project will be the Royal Irrigation department (RID). The foreign currency portion of the project costs will be financed by an international financing agency, while the local portion will be provided by the Thai Government. A qualified contractor to construct the civil works of the project will be selected on the basis of international competitive bidding.

3. 4. 2 Construction Plan

Since the Lam Dom Yai Dam is 2,000 m in length, the construction will be planned first, using river diversion by an open channel crossing the dam axis. In the final stages of embankment in the dry season, an outlet structure on the right bank will be used to release low water discharge. Dam excavation and embankment will be carried out using combined heavy machinery. Spillway works will be carried out at any time, but will not be delayed.

3. 4. 3 Implementation Schedule of the Project

The implementation of the project is planned over a period of seven years, from 1993 to 1999. Irrigation water supply will commence in wet season paddy cultivation in 2000.

3. 4. 4 Operation and Maintenance Plan

The Project Area will be divided into about 34 Zone Area (average 1,000 ha each) and 170 Irrigation Blocks (average 200 ha each) under the responsibility of RID. The operation and maintenance costs were estimated at 32.6 million Baht per annum.

Operation and Maintenance Costs

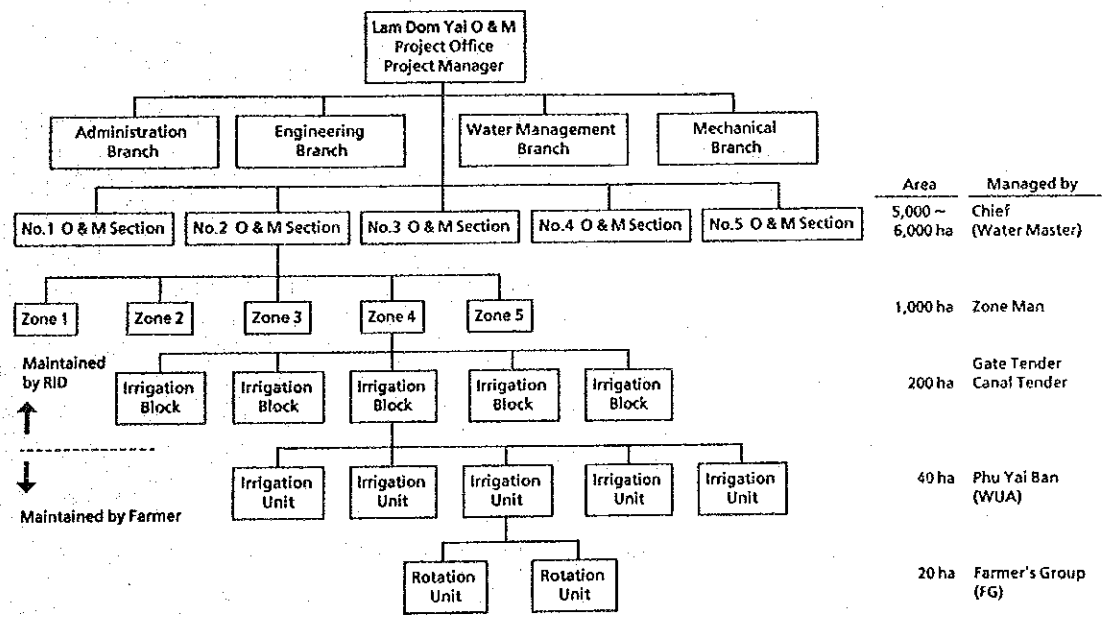
Depreciation	Cost ('000 Baht)
Salary and wages	10,404
Administration and general expenditure	1,561
Pump operation costs	14,963
Equipment repair and maintenance costs	4,421
Fuel costs	875
Office maintenance costs	380
Total	32,604

Implementation Program for the Project

Description	1992		1993		1994		1995		1996		1997		1998		1999	
	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8
1. Feasibility Study																
2. Evaluation by Thai Government 1/																
3. Detailed Design																
Budget Preparation, Others																
Consultant Recruitment																
Detailed Design Works																
4. Construction																
Budget Preparation, Others																
Consultant Recruitment																
Construction Tender																
Construction Work																
Dam																
Pumping Station																
Canal Systems																
On-farm																
5. Land Acquisition and Compensation																
6. Project Administration																
7. Consultant Services																

1/ : Including environmental aspects and economic viability

Proposed Organization Chart for Operation and Maintenance of Project Facilities



3.5 Project Costs

Project Costs

(unit: million Baht)

Item	F/C	L/C	Total
1. Civil Works			
1.1 Preparatory Works	2	19	21
1.2 Dam Works	150	135	285
1.3 Pump Facilities	595	24	619
1.4 Canal Works	612	536	1,148
1.5 Resettlement Works	29	350	379
Sub-Total	1,388	1,064	2,452
2. On-Farm Development			
2.1 On-Farm Facilities	307	218	525
2.2 Community Center	6	6	12
Sub - Total	313	224	537
3. Land Acquisition and Compensation	0	66	66
4. Engineering and Administration			
4.1 Consulting Services	97	34	131
4.2 Administration	7	14	21
Sub-Total	104	48	152
5. O & M Equipment	38	6	44
6. Total (1 - 5)	1,843	1,407	3,250
7. Physical Contingencies (10%)	184	141	325
8. Total (6 - 7)	2,027	1,548	3,575
9. Price Escalation	734	537	1,271
10. Grand Total			
With On-Farm and Rural Dev.	2,761	2,085	4,846
Without On-Farm and Rural Dev.	2,297	1,751	4,048

3.6 Project Evaluation

The project justification was made through a study of project feasibility from economic, financial and socio-economic aspects.

The economic feasibility was worked out by calculating the economic internal rate of return (EIRR). Sensitivity analysis was made in order to elucidate the economic viability of the project against the change in prices, delay in implementation, cost overruns and yield.

Financial analysis was also made by typical farm budget analysis and cost recovery including joint cost allocation.

The social effects and economic impacts from the implementation of the Project are treated in an intangible-benefit study and environmental impact evaluation.

3. 6. 1 Project Benefits

The following benefits to be produced by implementation were taken into account in the project.

- Crop benefits
  - : Cropping Type-I (Net production value) : 277,932 thousand Baht
  - : Cropping Type-II : 344,014 〃 〃

It is assumed that the target years of crop production will be attained five years after the completion of the project.

- Fishery benefits
  - : In paddy field (Annually) : 32,388 thousand Baht
  - : In reservoir : 1,015 〃 〃
  - : In village pond (community center) : 574 〃 〃

- Others benefits
  - : Feeder road benefit (Annually) : 3,737 thousand Baht
  - : Domestic water supply : 2,488 〃 〃

- Negative benefit by submersion : 918 〃 〃

In addition to the tangible benefits mentioned above, various intangible benefits and socio-economic impacts are expected from project implementation. The major intangible benefits will be as follows.

- Creation of new job opportunity
- Improvement of local transportation
- Improvement of sanitary condition
- Upgrading of water front environment

3. 6. 2 Economic Project Costs

- Capital Cost

The project costs consist of the direct project cost as well as the indirect project costs. All these costs are estimated on a financial basis.
Total economic costs of the project are estimated as follows;

F/C	1,684	million Baht
L/C	1,225	〃 〃
Total	2,909	〃 〃

- Annual Operation and Maintenance Costs

The financial cost does not include the depreciation cost of O & M equipment. This financial cost is converted into economic cost using a conversion factor of 0.9. Annual O & M costs are estimated at 31.1 million Baht.

- Replacement Costs

Pumps and gates are replaced at intervals of 25 years.
Equipment and instruments for O & M are replaced at intervals of 10 years.

3. 6. 3 Economic Internal Rate of Return

Economic indicators of the project will be presented by Net Present Value (NPV), Benefit/Cost Ratio (B/C) and Economic Internal Rate of Return (EIRR). The results of these calculation are shown as below;

EIRR = 9%

Item	Discount Rate		
	8%	10%	12%
N.P.V (1,000 Baht)	155,156	- 361,506	- 655,781
B.C ratio	1.06	0.84	0.67

3. 6. 4 Sensitivity Analysis

A sensitivity analysis was made based on the following four parameters;

- Increase of construction cost
- Overdue construction period- Reduction of benefits
- Delay in realization of benefits

Results of Sensitivity Analysis

Case	EIRR (%)
1. Original	9
2. Price/Yield of Farm Products	
10% of decline/decrease	8
20% of decline/decrease	7
3. Production Costs	
10% of increase	8
4. Construction Costs	
10% of increase	8
20% of increase	7
5. Delay of Production Target	
1 year	8
2 year	7
3 year	7
6. Combination with 2 and 4	
Each 10%	7
Each 20%	6

3. 6. 5 Financial Analysis of Typical Farmers

The farm budget of typical farmers was analyzed taking into account profit and loss statements and cash flows.

3. 6. 6 Project Justification

The economic internal rate of return (EIRR) for all sectors was estimated at nine percent.

The opportunity cost rate (OCR) of capital of the Northeast region is estimated at some 10 percent, taking into account that it is an autonomous regional economy with limited development potential. Consequently, this EIRR of nine percent shows that the project is economically feasible, as it may be expected to further the Northeast's economic development.

Furthermore, in order to improve the traditional farming practices and vitalize the depressed rural circumstances through poverty eradication, to increase agricultural productivity and income of rural people, and to contribute to the local economy, by the introduction of irrigated agriculture in the area, the project plan is recommended to be implemented in the early stage, although the estimated EIRR of nine percent seems to be a little bit low.

3. 7 Environmental Impact Analysis

3. 7. 1 Environmental Impact Evaluation

The proposed Lam Dom Yai Basin Irrigation Project has its main project features larger than the scale given in the guideline of National Environmental Board (NEB), and hence, the detailed Environmental Impact Statements or Environmental Impact Study (EIS) will be required by law. The following shows the main features of the Project and NEB's guideline;

Project Feature	Scale	Scale given in NEB's Guideline
Effective storage	104.6 MCM	100 MCM
Reservoir area	43.3 sq.m	15 sq.km
Irrigation area	34,000 ha	12,800 ha
	(212.5 thousand rai)	(80,000 rai)

The environmental study comprises manifold items of environmental impact evaluations. They are primarily classified into the following categories;

Preliminary studies on the following subjects were only carried out at the current stage of the study for the purpose of pointing out present environmental problems and constraints and the anticipated alternation in environmental resources, either positive or negative, probably to be caused by project implementation.

- Environmental setting
  - ° Aquatic ecosystem
  - ° Terrestrial ecosystem
  - ° Social setting

- Environmental integration in the Project

As a result, adequate countermeasures will be needed to cope with the above-mentioned problems and constraints. However, it can be considered that these environmental subjects will be solved by applying adequate procedures and countermeasures.

3.8 Conclusion and Recommendation

3.8.1 Conclusion

As a result of the Overall Basin Study for the Lam Dom Yai Basin Irrigation Development Project, the Lam Dom Yai Lower Project with D-28 reservoir was selected as one of top priority from the 29 sub-basin development projects.

The Feasibility Study of the Project was conducted carefully. The Project main purpose is to supply irrigation water with domestic and fishery uses.

As stated above, it has been ascertained that the Project is of high priority as the development of a water supply for attaining quick benefits is essential to the Project Area in order to accelerate regional development.

It is, therefore, concluded that after the above prudent findings, the Project is technically feasible and economically viable.

3.8.2 Recommendation

1) The project implementation schedule for the Lam Dam Yai overall basin development should be phased in conformity to water demand, urgency of water supply policy, effectiveness of investment, etc.

2) The facilities plan and cost estimates made in this Feasibility Study should be re-examined at the detailed design stage to enhance its precision, and also topographic survey and geological investigation should be carried out for further detailed design, land acquisition and construction works, if necessary.

3) Based on the understanding of the basic concept of good water management in which the limited water source should positively be utilized in the project, the irrigation and drainage plans should be implemented. Besides, RID should educate and cooperate with farmers to be benefited to implement the construction works and the proper operation and maintenance of the terminal irrigation and drainage facilities in order to execute quick yielding of the proposed crop production.

4) The organization of the project implementation and their operation and maintenance should be strongly functioned, because of fairly large irrigation schemes and technical implementation programs.

5) Especially, the water management for main project facilities as dam and main/lateral irrigation canals will be quite important. It should be unifiedly controlled by the RID technical officials.

6) The water management board on a provincial level should be organized to coordinate the water distribution plan based on the water demand requested from respective sectors and irrigation blocks for effective water utilization.

7) So as to bring the cultivation technic of diversification crops and transportation system on a higher level, administratively and financially assisting countermeasures by the related government agencies for such agricultural supporting services as agricultural extension, farmers' organization, credit, circulation system, etc. will be required.

8) In the time of the implementation of the Project with storage dam, pumps and irrigation canal constructions, not only the technical and economic examinations, but also social or environmental considerations should inevitably be needed according to the result of the environmental impact study to be carried out by the third party.

9) The resettlement areas for the people and the areas to be submerged by D-28 dam should be finally determined after the more detailed investigation and study.

10) Since any arrears in the planned construction schedule will have an influence upon the economy of the investment, construction work needs to be kept to schedule.

OVERALL BASIN STUDY

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

1.1 Background of the Study

The Lower Northeast Region of the Kingdom of Thailand located on the border of Cambodia has been regarded as one of the country's most remote and retarded areas. The Thai Government designated the area as the poorest rural area and established an agricultural development plan to dissipate the poverty in the Fifth-Five Year Development Program (1981 - 85). It has carried out the development project in the Sixth Five-Year Development Program (1986 - 90). Water resource development projects are the most important and urgent measures projects to secure irrigation water for agriculture, the staple economic activity in the area.

The Study Area covers the Dom Yai river basin. The river is a large tributary of the Mun river flowing into the Mekong river, and the river basin is located in the southwestern part of Ubon Ratchathani Province and south-eastern part of Si Sa Ket Province in the Lower Northeast Region.

A large agricultural area consisting of paddy fields of about 186,800 ha (1,167.5 thousand rai) and upland fields of 45,400 ha (283.8 thousand rai), which has a forested area converted by settlers' reclamation works stretches into the area. The agricultural productivity in the area, however, is remarkably low, due to the preponderance of rainfed farming.

Although the Dom Yai river has an abundant run-off of about 2,650 MCM per year, its water use for irrigation purpose is rather difficult owing to the large fluctuation of the run-off during the wet season and also scarce rainfall in the dry season. It is essential to supply the agricultural land with stable irrigation water by providing water source facilities, such as reservoirs, diversion dams and pumping facilities throughout the river basin.

The Thai Government requested the Japanese Government to carry out a Feasibility Study under a technical cooperation program to formulate an irrigated agriculture development plan for the basin. In response to this request, the Japan International Cooperation Agency (JICA) dispatched a Preliminary Survey Team in December, 1990 and concluded the agreement

between the Royal Irrigation Department (RID), Ministry of Agriculture and Cooperatives and JICA relating to the Scope of Works of the Study. In accordance with the agreement, JICA completed the Master Plan Study for the whole basin during the period from the end of February 1990 to the middle of October 1991, and the Feasibility Study on the selected priority project from the middle of October 1991 to the end of July 1992, in close cooperation with RID and other the government agencies concerned.

1.2 Objectives and Scope of the Work

The objectives of the Study are to formulate an overall agricultural development plan for the Dom Yai river basin which has an area of 4,905 sq.km (3,065.6 thousand rai) covering Ubon Ratchathani Province and a part of Si Sa Ket Province in the Lower Northeast Region of Thailand, and to carry out a Feasibility Study for the selected areas with top priority in the basin. During the Teams' stay, technical transfer to the counterparts, Thai Governmental officials, was carried out through the study work.

The Study was performed over a period of three years. The Scope of the Work carried out each year is mentioned below.

In the First Year: (The work from the preparatory work up to Phase I Field Works-Stage I (Overall Basin Study))

Major work in the first year was as follows;

- The Inception Report prepared by the Study Team through home office work was explained to, and discussed with the RID officials concerned. The outline of the study and its methodology were agreed upon by RID.
- The survey schedule to be conducted by RID, such as aerophoto mapping and soil surveys was also confirmed.
- The basic data collection and reconnaissance surveys were performed and their results were compiled as the Field Report.

In the Second Year: (The work from Phase I Field Works-Stage II (Overall Basin Study) up to Phase II Field Works (Feasibility Study))

- Detailed data relating to the Study was collected. Amount of available water resources and land resource capability in the basin were evaluated based on a review of works for the existing irrigation and drainage projects and the project plans formulated by RID. Consequently, water resource allocation plan in the whole river basin was roughly established. On the other hand, as a result of the study of the possibility of water resource development, the proposed projects for agricultural development were preliminarily selected.

- The Progress Report (I) including results of Phase I Field Works was prepared, explained to and discussed with RID.

- In the Teams' home office works, formulation of an overall agricultural development plan and selection of priority projects were made based on the result of field work and data analyses. The Interim Report was prepared in accordance with the results of this work.

- In Phase II field work, a preliminary study for the irrigated agriculture development plan of the priority projects was commenced by collecting detailed data and carrying out detailed site surveys in various aspects. The result of the site survey and preliminary study was summarized in Progress Report (II).

In the Third Year: (The work from Phase II home office work up to Final Report compilation)

- The Final Report involving the Overall Basin Study and the Feasibility Study was prepared by reviewing the preliminary study result obtained during the first and second years.

- The Report also incorporated all the provisions with respect to interim discussions held among the RID officials, the JICA Advisory Committee, and the Study Team.

1.3 National Policy on Agricultural Development

The national agricultural policy and the concrete production target were included in the Five-Year National Economic and Social Development Plan, which it was in the Fifth Five-Year Development Plan period (1981-85). The performances of agriculture, forestry and fisheries in gross domestic product (GDP) were set to attain an annual mean growth rates of 2.9 percent for the above period.

The agricultural policy in the Sixth Five-Year Development Plan (1986-90) allocated the areas to be developed, crops to be promoted, agricultural growth rate, etc. Agriculture, forestry and fisheries in GDP expected annual mean growth rates of 2.9 percent equivalent to the results in the Fifth Five-Year Development Plan. In terms of agricultural policy, development of the Northeast Region was regarded as especially important.

Agriculture, forestry and fisheries in Thailand account for 16.0 percent of GDP, and 34.1 percent of total export value in 1987, and still seem to be important industries. Agricultural income amounting to 5,343 Baht per capita of farming population in 1986 was quite low, corresponding only to about 1/9 of non-farming total of 47,237 Baht while that amount in the Lower Northeast Region of 3,122 Baht is still lower. Judging from the above facts, an increase of total income, above all agricultural income, and balanced areal income are extremely desirable. Ultimately the importance of this project has been confirmed.

1.4 National Policy for the Lower Northeast Region

1.4.1 Water Resources Development Project

The reason why there are so many poor farming households in the Lower Northeast Region, apart from the fact that they reside in an area where about half the paddy fields are fed by rain during the rainy season, is that land productivity is deteriorating due to newly reclaimed unstable paddy fields which are fed by rain in the hilly and forested areas. These reclaimed paddies result from sudden population increase after the 1950s as well as a saline soil problem in the northern part of the Region. Stable agricultural production based on with irrigation water, therefore, becomes very significant.

Emphasizing the main target as water resource development to secure a stable irrigation water supply for agricultural development in the country, the Thai Government advanced medium and small-scale storage dam construction plans (see Table 1-1) and included their construction work in the Sixth Five-Year Development Plan in the many sub-river basins along the border with Cambodia.

The basic plan for a water resource development project was set up for the Provinces of Nakhon Ratchasima and Buriram in the Feasibility Study for a medium-scale irrigation package project in the Lower Northeast Region by JICA in 1983 and the projects have been conducted using local funds from the Thai Government. Also small-scale irrigation projects have been implemented in this area using funds from OECF since the 1970s. The target of agricultural production, however, has not yet been achieved due to lack of proper water management and farming improvement. In the Seventh Five-Year Development Plan, RID aims to establish a water management system in order to utilize the stored water as effectively as possible.

For farming improvements, the projects for experiment, research and agricultural extension have been promoted by the Government in order to stabilize the wet season paddy cultivation and to introduce commercial crops using water resources developed during the dry season.

The large-scale water resources development projects implemented are described below.

1) Pak Mun Project

The Electricity Generating Authority of Thailand (EGAT) had a multipurpose dam construction plan for hydropower generation, irrigation and fisheries development. The dam is 17 m in height, and 300 m in length. It has 285 MCM in maximum storage capacity and four power stations will supply an annual amount of electricity of 280 GWH. This project plan was established in 1988 and the construction work began in 1991.

2) Lam Dom Noi Basin Irrigation Project

For the Lam Dom Noi Project Area, just east of Lam Dom Yai basin, Sirindhorn Dam with a storage capacity of 1,966 MCM was built by EGAT. The large-scale irrigation project, Lam Dom Noi Project using storage water by pumps was completed by RID in 1984. The outline of the project is as follows;

- Benefited area	:	32,430 ha (202.7thousand rai)
- Irrigation area	:	25,940 ha (8,000 ha in dry season)
- Farming households to be benefited	:	10 thousand households
- Main irrigation canal	:	90 km
- Lateral irrigation canal	:	140 km
- Pumps	:	10 sets 36 inches in diameter each
- Construction period	:	1968 - 84
- Total project cost	:	672 million Baht

1.4.2 Irrigation Development Projects in Lam Dom Yai Basin

RID of the Thai Government set up and promoted a large-scale irrigation project plan using the abundant water resources in the Dom Yai river. It was a plan to supply regular irrigation water to farmland in the basin by constructing the Dom Yai dam with 480 MCM in the middle-reaches of the Dom Yai river and Som dam on the Som river, a tributary. This plan, however, has not yet been activated due to difficulties of compensation for inundated

villages and farmland, and ecological conservation problems of forested zone which is to be submerged in reservoir areas.

Similar to other Provinces in the Lower Northeast Region, water resource development methods through which irrigation water is secured by constructing medium and small-scale dams at the upper and middle reaches of the river has less of the abovementioned problems. This approach has gradually been assessed as the best one.

Under such circumstances, development in this area has been subjected to constant in delays. Thus, RID requested technical cooperation from JICA. The Government of Japan knows the development method necessary to establish basic plans for water resource and agricultural development.

The irrigation project in the Kingdom of Thailand is usually implemented in accordance with the following classification of irrigation systems.

TABLE 1-1 IRRIGATION PROJECT SYSTEMS IN THAILAND

Division of Project	Criteria and Others		
Large-Scale Irrigation Project	Project to be adapted to any one item below.		
	1. Benefited area	:	above 12,800 ha (80,000 rai)
	2. Reservoir area	:	above 15 sq.km
	3. Reservoir capacity	:	above 100 MCM
Medium-Scale Irrigation Project	1. Benefited area	:	below 12,800 ha (80,000 rai)
	2. Reservoir area	:	below 15 sq.km
	3. Reservoir capacity	:	below 100 MCM
	4. Project cost	:	above 10 million Baht
Small-Scale Irrigation Project	1. Project cost	:	below 10 million Baht
	2. Construction period	:	one year
	3. Construction work	:	for reservoirs, diversion dams, etc. to secure irrigation water in a wet season as well as waters for farming households, livestock farming, fish raising.

1.5 Members of JICA Advisory Committee, Study Team and RID Committee

Members of the JICA Advisory Committee, Study Team and RID Committee assigned to the project are listed below;

JICA Advisory Committee

1.	Mr. Kenjiro Nakashima	Leader (for Phase-1), Director, Construction Department, Chubu Branch Office, Water Development Agency
2.	Mr. Hisashi Masui	Leader (for Phase-2), Director, Office of Construction Planning and Coordination, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry & Fisheries (MAFF)
3.	Mr. Tomoyoshi Fukumorita	Agronomy, Deputy Director, Fruit and Flower Division, Agricultural Production Bureau, MAFF
4.	Mr. Tomohiro Shibata	Irrigation and Drainage, Deputy Director, Construction Department, Kyushu Regional Agricultural Administration Office, MAFF

JICA Study Team

1.	Dr. Junichi Kitamura	Team Leader, Sanyu Consultants Inc. (SCI)
2.	Mr. Seiji Takeuchi	Irrigation, Drainage and Water Management/ Co-Team Leader, SCI
3.	Mr. Toyotaka Niwa	Water Resources Planning, SCI
4.	Mr. Toshinori Kawamura	Meteorology and Hydrology, Naigai Engineering Co. (NEC)
5.	Mr. Haruhiko Nakamura	Geology and Groundwater, SCI
6.	Dr. Vichan Vichukit	Soil and Land Use, Thai Consultants Engineering Co. (TCEC)
7.	Mr. Shozo Ogasawara	Agronomy, NEC
8.	Mr. Yukitugu Abe	Structure Planning and Cost Estimate, SCI
9.	Mr. Yoshihiro Uchida	Agro-Economy and Project Evaluation, NEC
10.	Mr. Pipat Pooripanyakun	Environment, TCEC

RID Committee Member

1.	Dr. Boonyok Vanthanaphuti	Former Special Expert for Project Planning
2.	Mr. Maitri Poolsup	Former Director, Project Planning Division (PPD)
3.	Mr. Kitla Thepalaglekha	Director, PPD
4.	Mr. Chat Sarikaphuti	Director, Regional Irrigation Office V
5.	Mr. Suthi Songvoravit	Chief, Project Planning 1, PPD
6.	Mr. Somphorn Thapthong	Chief, Engineering Section, Topographic Survey Division
7.	Dr. Thanu Harnpattanapanich	Civil Engineer 8, Research and Laboratory Division
8.	Mr. Mondhian Kangsasitiam	Civil Engineer 8, Research and Laboratory Division
9.	Mr. Phonchai Klinkhachorn	Hydrologist 5, Hydrology Division
10.	Mr. Osot Charnvej	Agronomist 6, Operation and Maintenance Division
11.	Mr. Surakarn Atsavavallobh	Civil Engineer 7, Design Division
12.	Mr. Suksun Phocharassaenkul	Engineer 5, Data Processing Division
13.	Mr. Manus Kurnnoetmanee	Engineer 5, Planning and Budget Division
14.	Mr. Theera Wongsamut	Chief, Engineering Section, Medium-Scale Construction Division
15.	Mr. Asni Molagool	Project Manager, Phanom Dong Rek, Large-Scale Construction Division
16.	Mr. Chamnuan Chaempaiboon	Lawyer, Law and Land Division
17.	Mr. Suppakiat Oransathian	Civil Inspector 6, Ubon Ratchathani Irrigation Project
18.	Mr. Vudhichai Chullakesa	Chief, Project Planning 3, PPD
19.	Miss Supha Sing-Intara	Chief, Economic Section, PPD
20.	Mr. Traibhun Mekjaroon	Chief, Environmental Section, PPD
21.	Mrs. Chawee Wongprasithiporn	Engineer 4, PPD
22.	Miss Patcharavee Pinyophummin	Engineer 4, PPD

CHAPTER II. GENERAL DESCRIPTION OF THE BASIN

CHAPTER II. GENERAL DESCRIPTION OF THE BASIN

2.1 Geography and Climate

2.1.1 Location and Geography

The basin of Dom Yai river is located in the southwestern part of Ubon Ratchathani Province (Changwat) and southeastern part of Si Sa Ket Province lying between the Lam Dom Noi basin to the east and the Huai Khayung basin to the west. The catchment area of the Lam Dom Yai basin is 4,905 sq.km (3,065.6 thousand rai) covering the seven administrative Districts (Amphoe), that is, Warin Chamrap, Det Udom, Phibun Mangsahan, Na Chaluai, Nam Yun and King Amphoe Samrong in Ubon Ratchathani Province and Kantharalak in Si Sa Ket Province.

The Lam Dom Yai river with a total length of about 238 km flows northward, passing through Det Udom township. It has undulating topography and a meandering river course from the mountainous areas near the Laotian and Cambodian borders, an elevation of about 700 m above mean sea level, and empties itself into the Nam Mun river at an elevation of about 110 m.

Present situation of the basin is summarized as follows;

Item		Outline of Area
Administration		
No. of Amphoe	:	7
No. of Tambon	:	58
Area (sq.km)		
Cultivation Area	:	2,322
Non-Cultivation Area	:	2,583
Total		4,905
Population		
Population (1,000 person)	:	395
Density (person/sq.km)	:	91.7

Irrigated areas of farmland are very limited, about 10,630 ha (66.4 thousand rai), which is equivalent to 4.6 percent of total farmland of about 232,200 ha (1,451.3 thousand rai), due to scarce existence of proper water resources in the basin. This fact is one of the major factors which perpetuates the lower farm incomes.

2. 1. 2 General Climate and Rainfall

Meteorological conditions in and around the basin are governed by the southwest monsoon from the Indian Ocean and the northeast monsoon from China. The southwest monsoon brings adequate rainfall, while the northeast one generates heavy dry spells over the basin. The dynamics of these monsoons greatly affect the meteorological environment of northeastern Thailand, including the basin.

As mentioned above, the basin shows two distinctive seasons; one is the wet season from May to October which brings more than 90 percent of annual rainfall and the other is the dry season from November to April. General climatological conditions represented by the Northeastern Region Meteorological Center in Ubon Ratchathani are as follows;

General Climatological Conditions

Items	Annual Mean	Mean Max.	Mean Min.
Temperature (°C)	26.7	32.4	21.9
Relative Humidity (%)	73	88	54
Evaporation (mm)	2,054.3	214/month	132/month
Sunshine Duration (hrs)	2,801.1	293/month	163/month
Cloudiness (Deca)	6.4	8.8	3.9
Rainfall (mm)	1,634.0	328/month	0.7/month

Generally, maximum and minimum temperature appear in April and January. The peak of relative humidity occurs out in August and the minimum values occurs in March.

Rainfall in the basin is measured by the three rainfall observatories, Nam Yun, Det Udom and Phibun Mangsahan. Based on the applied Thiessen Polygon in the basin, these observatories are also represented by the respective annual rainfall of upper, middle and lower-reaches of the Lam Dom Yai basin. Annual mean rainfall of the discussed basin are as follows;

Annual Mean Rainfall

Classification	Rainfall Station	Annual Mean Rainfall (mm)
Upper-Basin	Nam Yun	1,356
Middle-Basin	Det Udom	1,597
Lower-Basin	Phibun Mangsahan	1,730

This annual mean rainfall tends to decrease from the northeast to the southwest ends of the basin i.e. from the upper to lower reaches of the Lam Dom Yai basin.

2.2 Administration and Population

2.2.1 Administrative Division

The Lam Dom Yai basin constitutes the southern part of Ubon Ratchathani Province and a part of Si Sa Ket Province, which are situated in the Lower Northeast Region of Thailand. Ubon Ratchathani Province, occupying the majority of the basin, consists of 22 Amphoes (Districts), and six Amphoes out of 22 are included in the basin. A part of Si Sa Ket Province in an area of Amphoe Kantharalak is also included in the basin. The administrative divisions related to the basin are as follows;

Administrative Division in the Study Area

Province	Amphoe (District)	Number of Tambon (Sub-District)
Ubon Ratchathani	Warin Chamrap	9
	Det Udom	21
	Phibun Mangsahan	3
	Na Chaluai	6
	Nam Yun	9
	Samrong	2
Sub-total		50
Si Sa Ket	Kantharalak	8
Sub-total		8
Total		58

Data Source: National Statistic Office (NSO) and Ministry of Interior (MOI)

Details of the administrative divisions within the basin are shown in Annex H, Table H-7.

2. 2. 2 Population Distribution

According to the preliminary report of the 1990 Census, the population of Ubon Ratchathani Province is 1,870,000 in 384,000 households. The average family size is 4.9. The annual population growth rate over the past decade (1980/1990) is lower than two percent.

The provincial statistics of the National Statistical Office and the Ministry of Interior show a population, relating to the basin, of 427,086 (22.8 percent of the total provincial population). The number of these households is 75,994 (19.8 percent of the Province). Average family size is 5.7 and the population density is 92 habitants/sq.km. Population within the basin is estimated at about 395,000 people with 69,000 households, and the average family size is 5.7. The population density is 91.7 persons/sq.km.

With the exception of the urban area of Det Muang, Amphoe Det Udom and town areas such as Na Chaluai and Nam Yun, crop production is a core activity and most inhabitants are owner farmers and farm workers. Farm households in the basin account for 81.3 percent of the total households as shown below;

Number of Farm Households by Amphoe in the Study Area

Amphoe	Total Households	Farm Households	Percent (%)
Warin Chamrap	9,431	7,954	84.3
Det Udom	26,918	24,227	90.0
Phibun Mangsahan	3,355	2,874	85.7
Na Chaluai	6,604	5,992	90.7
Nam Yun	11,298	9,597	84.9
Samrong	1,873	1,829	97.6
Kantharalak	16,515	9,309	56.4
Total	75,994	61,782	81.3

Data Source : National Statistic Office(NSO)

Figure 2-1 shows the population distribution by Tambon in the basin.

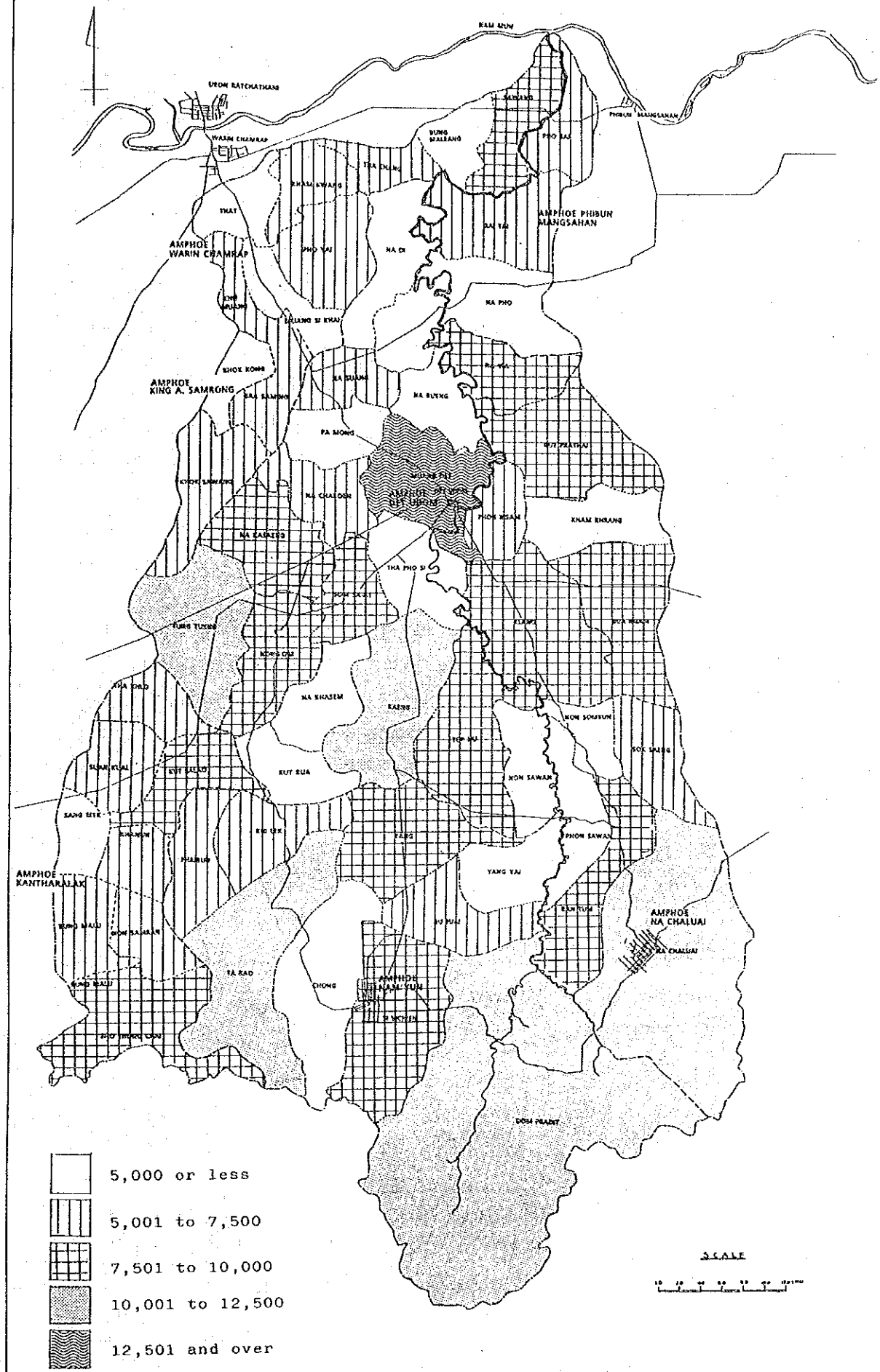


FIGURE 2-1 POPULATION DISTRIBUTION IN THE BASIN

2. 3 Meteorology and Hydrology

2. 3. 1 Meteorology

1) Climatological Data

Meteorological data observation in and around the basin are being carried out by the Meteorological Department (MD), Ministry of Communication, and other Governmental agencies such as Hydrology Division of RID. Most of the observatories are rainfall gauge stations equipped with eight inch standard rain gauges. Long-term synthetic climatological observation data is available only at the Meteorological Center of the North-eastern Region in Ubon Ratchathani located at Ubon Airport. Monthly climatological data from the Center is shown in Table 2-1.

2) Rainfall

Thirteen rainfall gauge stations are being operated by the MD and RID in and around the basin. Among the rainfall observatories related to the Lam Dom Yai basin, the basin is divided into six sub-areas by Thiessen Polygon using the seven rainfall observatories. Location of the selected observatories and the Thiessen Polygon are shown in Figure 2-2. General descriptions of the selected observatories are as follows;

Selected Observatories Around Study Area

Code No.	Name of Station	Observed Period	Mean Annual Rainfall*1 (mm)	Areal Ratio *2 (%)
67072	Warin Chamrap	1952 to date	1,417	8
67022	Phibun Mangsahan	1955 to date	1,730	6
67132	Det Udom	1952 to date	1,597	33
67142	Buntharik	1955 to date	1,503	6
67382	Nam Yun	1980 to date	1,356	41
57063	Kantharalak	1952 to date	1,303	6
Average			1,468	100

Note ; * 1 : Mean average value from 1960 to 1989.
Some lacking data are supplemented by the correlation method using the data of neighboring observatories.
* 2 : Percentage of area demarcated by the Thiesssen Polygon.

TABLE 2-1 CLIMATOLOGICAL DATA AT UBON RATCHATHANI

Station	UBON RATCHATHANI	Elevation of the Station above MSL	123.0 meters
Station Index	48407	Height of the Barometer above MSL	127.00 meters
Latitude	15°15'N.	Height of the Thermometer above GL	1.50 meters
Longitude	104°42'E.	Height of the Wind Vane above GL	15.00 meters
		Height of the Raingage above GL	0.80 meters

ITEM	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Mean	23.4	25.9	28.4	29.6	28.7	27.9	27.6	27.6	27.0	26.5	24.9	23.2	26.7
Mean Max.	31.0	33.3	35.4	35.9	34.3	32.6	32.0	31.4	31.3	31.3	30.7	30.0	32.4
Mean Min.	17.0	19.4	22.3	24.3	24.5	24.3	24.0	23.8	23.5	22.5	20.0	17.4	21.9
Extreme Max.	36.5	38.6	40.4	41.3	41.0	38.5	36.2	35.8	36.8	34.8	35.3	35.0	41.3
Extreme Min.	8.5	11.7	10.3	15.9	19.4	20.2	20.0	20.2	20.5	15.7	13.0	8.5	8.5
Relative Humidity (%)													
Mean	65	63	61	66	75	80	80	82	83	78	72	68	73
Mean Max.	86	83	80	83	90	92	92	94	94	90	87	87	88
Mean Min.	41	40	40	45	56	63	64	67	67	60	53	46	54
Minimum	16	22	20	21	27	37	47	42	41	30	26	24	19
Dew Point (°C)													
Mean	15.8	17.5	19.7	21.8	23.5	23.8	23.7	23.7	23.6	21.8	19.1	16.5	20.9
Pressure (Hectopascal)													
Mean	13.60	11.86	10.12	8.49	7.16	6.20	6.18	6.06	7.73	10.17	12.50	11.67	9.31
Evaporation (mm)													
Mean	172.7	171.9	214.4	209.0	183.8	160.0	162.6	148.8	132.3	157.4	168.7	172.7	2,054.3
Cloudiness (Deca)													
Mean	3.9	4.1	4.9	6.2	7.6	8.4	8.4	8.8	8.3	6.8	5.3	4.2	6.4
Sunshine Duration (hrs.)													
Mean	293.3	262.9	270.8	256.0	238.4	189.6	198.4	170.1	163.5	228.5	255.6	274.0	2,801.1
Visibility (km)													
Mean	10.3	8.4	7.4	9.0	11.8	12.0	12.0	11.8	11.6	11.9	11.9	11.2	10.8
Wind (knots)													
Mean Speed	3.8	3.3	3.4	3.3	3.5	4.1	4.3	4.2	2.8	3.9	5.8	5.2	-
Prevailing Wind	N	N	S	S	S	S	S	S, SW	S	N	N	N	-
Extreme Max.	32	43	42	50	60	55	52	37	50	40	45	42	60
Rainfall (mm)													
Mean Amount	0.7	11.4	30.6	86.6	214.7	267.0	273.2	328.0	297.4	98.5	24.0	1.9	1,634.0
Mean Rainy Days	0.8	1.1	3.2	7.6	15.4	18.6	19.2	21.8	19.7	10.7	3.8	0.7	122.3
Extreme Max.	4.8	62.0	87.0	100.2	136.0	189.4	203.9	141.1	130.3	113.4	71.8	8.2	203.9

Note : Data periods are from 1961 to 1990

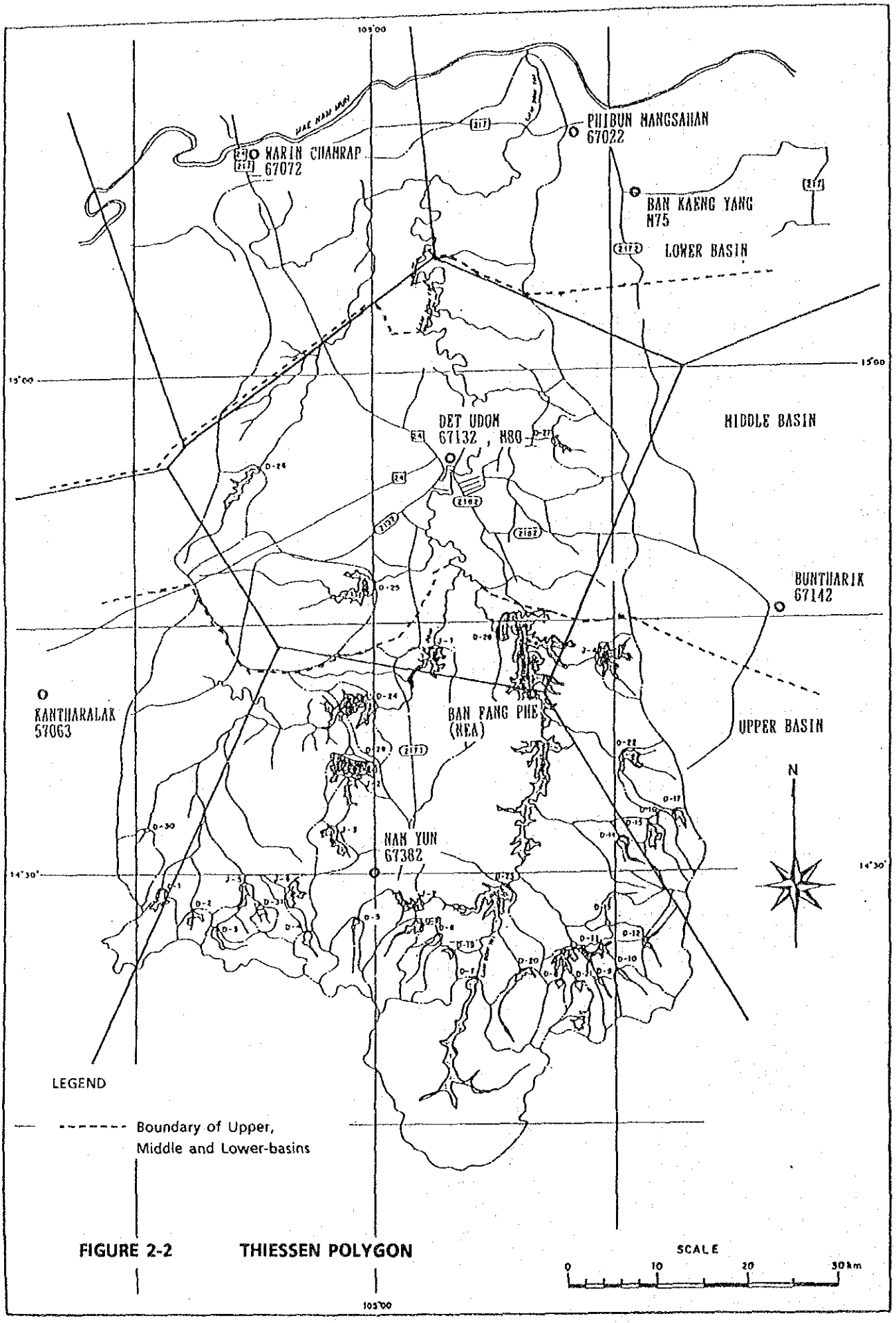


FIGURE 2-2 THIESSEN POLYGON

Mean annual rainfall in the Lam Dom Yai basin is estimated at 1,468 mm using the areal ratio mentioned above. Mean monthly rainfall of each rainfall observatory is tabulated below. Generally, more than 100 mm of monthly rainfall occurs in May, then increases up to August as the peak. Monthly rainfall decreases from September to January, and then during the mid-dry season (December to February) hardly occurs.

Monthly Average Rainfall

(unit : mm)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Warin Chamrap												
0.3	11.5	31.8	68.7	173.4	221.0	244.2	286.7	273.2	87.2	16.9	1.7	1,416.8
Phibun Mangsahan												
1.5	8.7	20.2	88.2	215.3	298.6	269.8	398.3	290.4	117.5	19.8	1.6	1,730.0
Det Udom												
0.7	1.7	21.3	91.8	207.0	265.3	254.2	302.2	288.6	129.2	34.0	1.5	1,597.4
Buntharik												
0.6	1.4	19.3	77.3	183.6	259.9	248.3	303.4	271.2	97.8	33.3	6.4	1,502.6
Nam Yun												
0.7	6.2	26.0	87.1	211.3	175.3	145.0	177.4	343.9	143.0	37.6	2.5	1,356.1
Kantharalak												
3.1	5.2	31.0	71.4	171.7	185.8	190.9	218.7	242.9	153.9	27.9	0.5	1,303.0

Probable rainfall for one-day, two-day and three-day are estimated using the data of each observatory as shown below;

Probable Rainfall

(unit : mm)

Station	Continuous day (s)	Return Period (Year) 5	10	50	100	500
Warin Chamrap	1 - day	119.2	132.0	158.5	169.2	193.5
	2 - day	155.7	179.7	233.8	257.4	313.8
	3 - day	175.2	204.0	271.4	301.6	375.9
Phibu Mangsahan	1 - day	154.8	186.1	268.1	308.4	415.1
	2 - day	193.3	236.9	356.7	417.1	583.1
	3 - day	214.2	259.3	378.7	438.0	596.3
Det Udom	1 - day	118.5	135.0	169.7	183.9	216.6
	2 - day	148.7	170.3	219.0	240.3	291.5
	3 - day	174.7	198.4	250.0	271.8	322.7
Buntharik	1 - day	132.6	158.5	215.5	239.8	297.2
	2 - day	168.2	201.1	272.9	303.5	375.5
	3 - day	195.0	229.7	304.3	335.6	408.6
Nam Yun	1 - day	117.8	128.8	149.1	156.4	171.5
	2 - day	140.7	159.2	201.2	219.7	264.2
	3 - day	167.5	187.7	229.2	246.0	283.8
Kantharalak	1 - day	101.6	118.8	160.1	179.0	226.3
	2 - day	134.7	157.3	210.1	233.7	291.8
	3 - day	161.9	187.2	243.2	267.1	323.5

2.3.2 Hydrology

1) Gauging Station

Measurement of water level, discharge and suspended sediment in the Lam Dom Yai basin is being completed by RID and NEA at Det Udom (M80) and Ban Fang Phe. The other gauging stations are located in the neighboring river basins of Lam Dom Yai such as Ban Kaeng Yang (M75) located in the eastern parts; Ban Nam Om (M66) and Ban Alang (M98) located in the western part of the basin are also available. Among these gauging stations, the measured data from the three gauging stations, Det Udom, Ban Fang Phe and Ban Kaeng Yang, will be used for the project planning in view of the scale of drainage area and the total volume of annual rainfall at each gauging station. Conditions of the selected gauging stations are as follows;

Selected Gauging Stations

Gauging Station	RID Code No.	Drainage Area	Mean Annual Areal Rainfall	Mean Annual Run-off	Run-off Coeff.
		(sq.km)	(mm)	(MCM)	(%)
Det Udom	M80	3,363	1,417	1,524	32
Ban Fang Phe	(NEA)	1,410	1,369	704	36
Ban Kaeng Yang	M75	388	1,696	312	49

Mean monthly run-off of each gauging station is shown below. Coincidentally with the monthly rainfall, the peak monthly discharge of Lam Dom Yai takes place in August, September and October, however, run-off in September is notable. Annual run-off volume has fluctuated from 470 MCM to 3,000 MCM during the past 25 years in the case of the observed records of M80. Also, the annual basis run-off coefficients of the abovementioned gauging stations vary from 0.3 to 0.4 depending on the total volume of annual rainfall.

Monthly Average Run-off Discharge

(unit: MCM)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Det Udom (M80)												
9.5	4.7	2.8	3.1	11.6	83.4	153.7	292.8	508.5	337.2	94.3	22.9	1,523.6
Ban Fang Phe												
6.3	2.5	1.3	1.3	14.8	68.8	103.8	135.0	127.0	140.0	85.2	18.1	704.0
Ban Kaeng Yang												
4.5	4.6	4.7	4.6	7.5	42.6	53.8	84.1	71.4	25.5	5.1	3.8	312.0

Peak flood discharge was recorded at 1,924 cu.m/sec at the M80 gauging station in 1973 and 1,186 cu.m/sec at the M75 station in 1970. These values correspond to return periods of about 100-years.

2) Sediment

Suspended sediment volume of the Lam Dom Yai basin has been measured at the gauging stations of Det Udom (M80) and Ban Fang Phe (NEA). The specific suspended sediments are as follows;

Specific Suspended Sediment

Station	Drainage Area (sq.km)	Annual Average (ton)	Range (100 ton)	Unit Sediment (cu.m/sq.km/year)
Det Udom (M80)	3,363	222,000	200 - 270	66.0
Ban Fang Phe (NEA)	1,410	70,000	15.4 - 133.4	49.6

3) Run-off Analysis of the Basin

Run-off of the Lam Dom Yai basin is estimated through the following procedures;

- Estimation of the unit rainfall in the basin
- Estimation of the unit run-off in the basin
- Run-off from the sub-basin
- Basin run-off

a) Estimation of the Unit Rainfall in the Basin

Based on the areas divided by the Thiessen Polygon, rainfall in the Lam Dom Yai basin is categorized into three rainfall types, such as upper, middle and lower basin rainfalls. Areal rainfall, the fundamental data for basin run-off estimation, is applied to the area categories and the sub-basin division.

Monthly Average Rainfall

(unit: mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Upper Basin (Num Yun)													
A:	0.7	6.2	26.0	87.1	211.3	175.3	145.0	177.4	343.9	143.0	37.6	2.5	1,356.1
B:	0.0	0.0	0.0	77.4	197.2	193.9	148.1	184.7	330.4	55.5	3.0	0.1	1,190.2
C:	0.0	2.8	46.0	92.7	244.0	171.1	172.7	192.3	380.9	144.7	48.8	5.0	1,501.1
Middle Basin (Det Udom)													
A:	0.7	1.7	21.3	91.8	207.0	265.3	254.2	302.2	288.6	129.2	34.0	1.5	1,597.4
B:	0.0	7.3	2.1	94.6	149.3	335.9	235.8	246.0	183.8	110.2	6.7	0.1	1,371.6
C:	0.0	2.9	25.8	102.1	242.6	201.8	422.4	309.2	311.8	135.3	48.3	0.0	1,802.2
Lower Basin (Phibun Mangsaban)													
A:	1.5	8.7	20.2	88.2	125.3	298.6	269.8	398.3	290.4	117.5	19.8	1.6	1,730.0
B:	3.3	3.4	12.0	56.1	195.7	234.3	334.0	292.6	189.1	67.7	0.0	0.0	1,388.3
C:	0.0	0.0	39.6	70.8	345.5	209.1	259.6	514.3	358.9	220.7	35.8	0.0	2,054.4

Note : A : Average Year (mean value of 30-year from 1960 to 1986)
B : Low-water year (1/5 probability of non-exceedance)
C : High-water year (1/5 probability of exceedance)

b) Estimation of the Unit Run-off in the Basin

To estimate the run-off of the specified sub-basin (tributaries) in the Lam Dom Yai basin, two run-off models are developed taking into account the scale of the drainage basin of the water source facilities. One is for the catchment area with less than 600 sq.km and the other is for an area with more than 600 sq.km. The Tank Model method is applied for the establishment of run-off models. The calibration of models was made using the discharge data of M75 and Ban Fang Phe. The former model will be mainly applied to both the catchment areas of less than 600 sq.km and mountainous basin, and the latter is for the basin area of more than 600 sq.km. Through the trial calculations, the Tank Model coefficient is finally calibrated as shown in Figure 2-3 by taking the shape of run-off, accumulated run-off value of the monthly basis and the annual run-off coefficient.

c) Run-off from the Sub-basin

The Lam Dom Yai basin is further divided into a number of sub-basin units (tributaries) on the basis of the existing and proposed water source facilities for the basin development plan. Run-off from the divided sub-basin