

**THE KINGDOM OF THAILAND  
MINISTRY OF AGRICULTURE AND COOPERATIVES**

**THE FEASIBILITY STUDY  
ON  
THE LAM DOM YAI BASIN IRRIGATION PROJECT**

**EXECUTIVE SUMMARY**



DECEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

AFA

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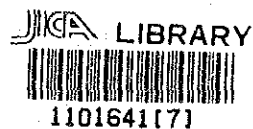
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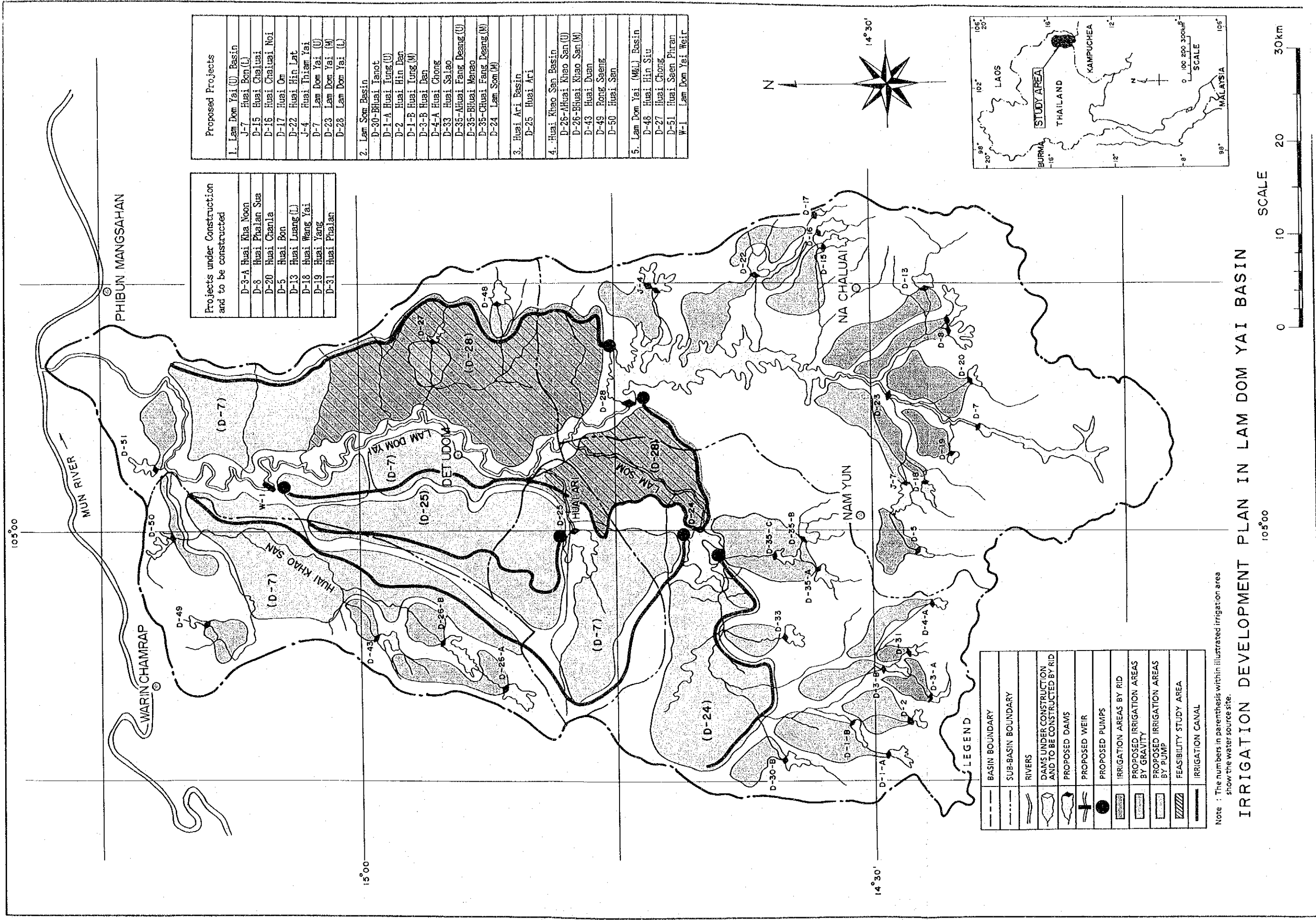
**DECEMBER 1992**

**JAPAN INTERNATIONAL COOPERATION AGENCY**



国際協力事業団

24453



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 Hin Lat
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 (U)
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	Bhuai Lanot
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	Ahuai Fang Deang (U)
D-35	Bhuai Manao
D-35	Chuai Fang Peang (M)
D-24	Lam Som (M)
3. Huai Ari Basin	
D-25	Huai Ari
4. Huai Khao San Basin	
D-26	Ahuai Khao San (U)
D-26	Bhuai Khao San (M)
D-43	Huai Duan
D-49	Rong Saeng
D-50	Huai San
5. Lam Dom Yai (M/L) Basin	
D-46	Huai Hin Siu
D-27	Huai Chong
D-51	Huai Saen Phran
W-1	Lam Dom Yai Weir

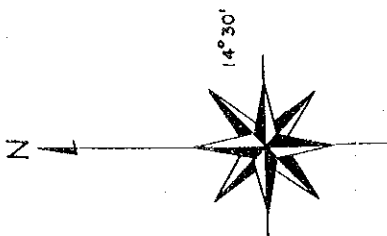
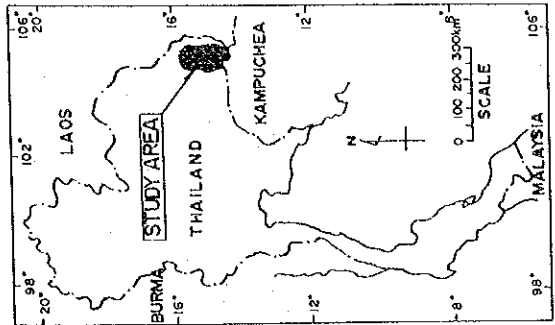
LEGEND	
---	BASIN BOUNDARY
- - -	SUB-BASIN BOUNDARY
—	RIVERS
▭	DAMS UNDER CONSTRUCTION AND TO BE CONSTRUCTED BY RID
▭	PROPOSED DAMS
▭	PROPOSED WEIR
●	PROPOSED PUMPS
▭	IRRIGATION AREAS BY RID
▭	PROPOSED IRRIGATION AREAS BY GRAVITY
▭	PROPOSED IRRIGATION AREAS BY PUMP
▭	FEASIBILITY STUDY AREA
—	IRRIGATION CANAL

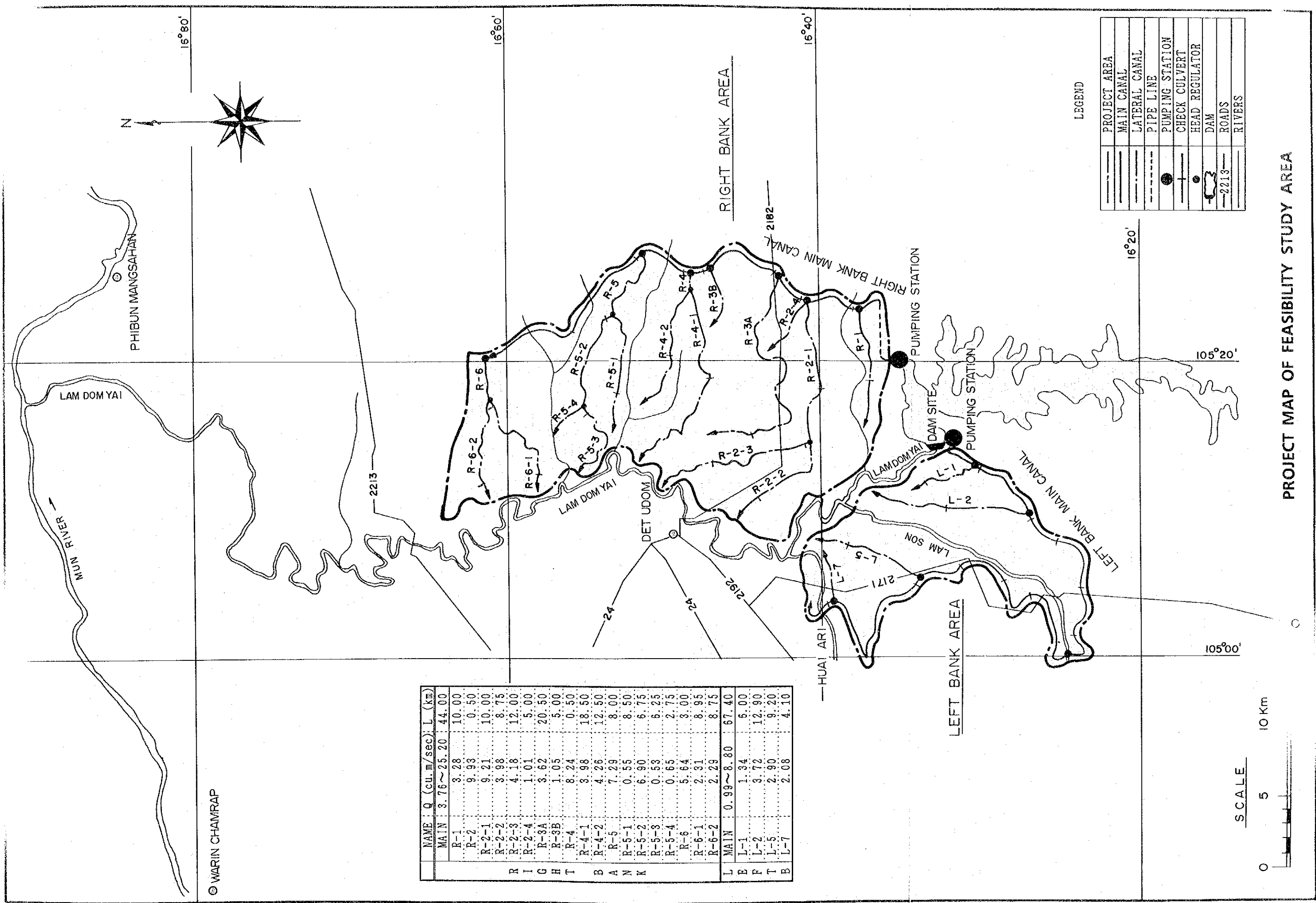
Note : The numbers in parenthesis within illustrated irrigation area show the water source site.

IRRIGATION DEVELOPMENT PLAN IN LAM DOM YAI BASIN

105°00

SCALE





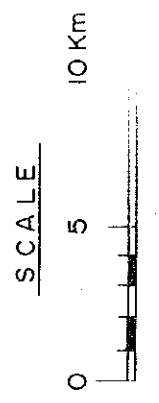
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NAME	Q (cu.m/sec)	L (km)
MAIN	3.76~25.20	44.00
R-1	3.28	10.00
R-2	9.93	0.50
R-2-1	9.21	10.00
R-2-2	3.98	8.75
R-2-3	4.18	12.00
R-2-4	1.01	5.00
R-3A	3.62	20.50
R-3B	1.05	5.00
R-4	8.24	0.50
R-4-1	3.98	18.50
R-4-2	4.26	12.50
R-5	7.29	8.00
R-5-1	0.55	8.50
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
L-1	1.34	6.00
L-2	3.72	12.90
L-5	2.90	9.20
L-7	2.08	4.10

R I G H T B A N K  
L E F T B A N K

LEGEND

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



PROJECT MAP OF FEASIBILITY STUDY AREA



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## **OVERALL BASIN STUDY**



## **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 also made through 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

#### 2.1.1 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 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 seven administrative districts (Amphoe) and 58 sub-districts (Tambon).

#### 2.1.2 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.

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 North-eastern Region Meteorological Center in Ubon Ratchathani are as follows:

Table 1-1 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

### 2.1.3 Population

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) and the number of 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 in 69,000 households. Average family size is 5.7 and the population density is 91.7 habitants/sq.km.

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

### 2.1.4 Hydrology

Composite run-off from the sub-basin is summarized below in conformity with the annual run-off of lower, middle and upper-basins in the Lam Dom Yai basin. Run-off distribution on a monthly basis is shown in Table 2-2.

Table 2-2 Run-off by Each Basin

Basin	Area (sq. km)	Average Year			1/5 Lower-Water Year			1/5 High-Water Year		
		R (A) (mm)	RF (B) (MCM)	B/A	R (A) (mm)	RF (B) (MCM)	B/A	R (A) (mm)	RF (B) (MCM)	B/A
Upper	2,740.7	1,356	1,346	0.36	1,190	1,151	0.35	1,501	1,490	0.36
Middle	1,537.4	1,597	896	0.36	1,372	677	0.32	1,802	1,061	0.38
Lower	626.9	1,730	410	0.38	1,388	252	0.29	2,054	539	0.42
Whole	4,905.0	1,468	2,652	0.37	1,272	2,080	0.33	1,666	3,090	0.38

Note: R : Rainfall      RF : Run-off

Based on the above-mentioned table, run-off from the whole Lam Dom Yai basin is estimated at 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.





## 2.1.5 Water Resources

### 1) Surface Water

The outline of the six main tributaries and the river system are schematically shown in Figure 2-2.

The whole river basin of 4,905 sq.km has mean annual run-off of 2,080 MCM. The river basin of 352 sq.km, corresponding to about seven percent of the entire river basin, as shown in the table below, 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.

Table 2-3 Potential for Developing Surface Water

Item	Dimension
Catchment Area (sq.km)	4,905
Mean Annual Run-off (MCM)	2,652
Projects Constructed (Small-Scale Water Source Development Projects)	
- Catchment Area (sq.km)	*1
- Storage Capacity (MCM)	20
Projects Under Construction and to be Constructed (MSIP, PDRP)	
- Catchment Area (sq.km)	352
- Storage Capacity (MCM)	98
Future Developing Potentials	
- Catchment area (sq.km)	4,553
- Mean Annual Run-off (MCM)	2,460

\*1 : Existing small-scale water source development project areas are to be included in the future water source development project areas. Then, the run-off from the catchment area of about 600 sq.km is estimated as future development potential.

### 2) Groundwater

The aquifer distribution in the area is composed of fine sandstone, siltstone and unconsolidated alluvial deposits. Fine sandstone and siltstone are generally semi- or impermeable layers, and the yield is low. The unconsolidated deposits also have low yield. It seems that the irrigable areas of each well are less than two hectares (12.5 rai), and one well is required for two farmers (average farmland of one farmer in the area is one hectare), therefore, large-scale construction and running costs are needed for groundwater development.

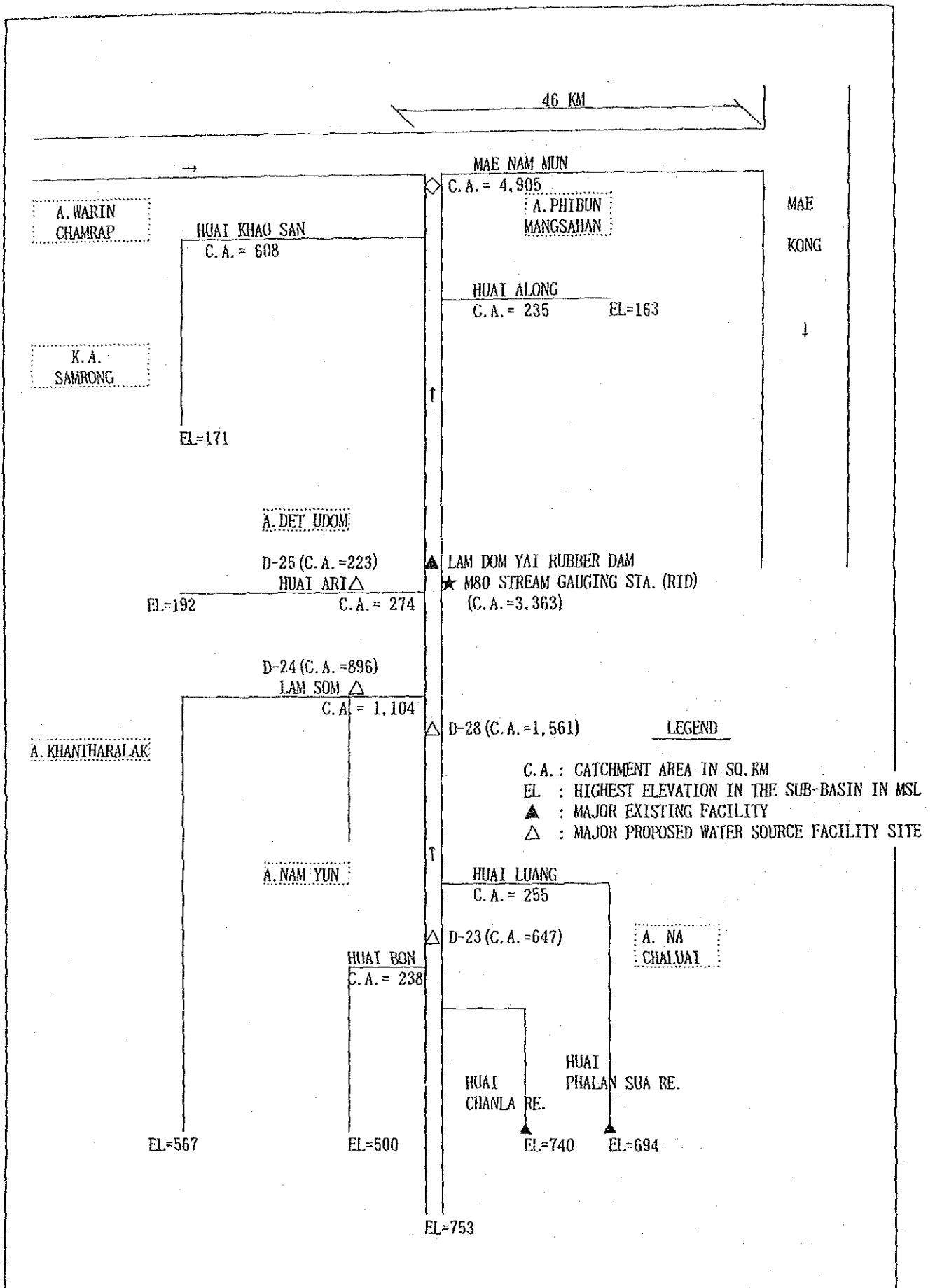


Figure 2-2 Schematic Diagram of River System

The EC value exceeds the acceptable limit of 250  $\mu\text{S}/\text{cm}$  in more than 50 percent of the area, and it seems that many of the wells drilled for irrigation are most likely to produce saline water.

From these results, it can be concluded that groundwater development for irrigation has less potential in the area 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.

### 2. 1. 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.

It is apparent from aero-photographs and topographical maps that the Lam Dom Yai and its tributaries have changed their courses back and forth across the basin. These areas constitute a flood plain and are 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 conducive to rice cultivation.

Basement rocks in the area consist mostly of fine to medium sandstone and siltstone of the Khok Kruat Formation, however, they are covered by lateritic soils, residual soils, river terrace deposits, flood plane deposits, tablus and recent river deposits. The outcrops of the basement rocks are, therefore, very poor.

### 2. 1. 7 Soil and Land-Use

#### 1) Soil Characteristics

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 total area.

Soils in the area belong to 24 soil series categorized into 15 soil sub-groups, according to USDA Taxonomic Units.

## 2) Land Classification

According to the land classification systems by DLD, the land suitability of the basin can be classified as follows; it is found that 40.0 percent of land is suitable for paddy rice, 44.6 percent is suitable for upland crops and vegetables, and the remaining area for fruits and trees. However, the area suitable for paddy rice may face water shortage as the monsoon trough moves away from the country.

## 3) Present Land-Use

Currently, in the basin, forested land amounts to 39.4 percent and for agriculture 47.4 percent, as shown below.

Table 2-4 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	<u>232,200</u>	<u>47.4</u>
Non-Cultivation Area		
Forest	193,400	39.4
Residential Area	23,600	4.8
Public & Other Area	41,300	8.4
Sub-total	<u>258,300</u>	<u>52.6</u>
Total	490,500	100.0

Note: \*1: inclusive of fallow area of 12,200 ha

Nevertheless, land-use for agriculture is constantly increasing and forest encroachment continues as the demand for land-use for growing crops remains.

## 2.1.8 Agricultural Conditions

### 1) Land Ownership

According to the Intercensal Survey of Agriculture in 1988, 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).

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.

### 2) Present Cropping Area

The planted area of each major crop for the agricultural land is shown below.

### 3) Crop Productivity

The gross production amount and yield per hectare of each major crop in the basin is tabulated below:

Table 2-5 Present Cropping Area

Crop	Planted Area (ha)	Proportion for Total (%)
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	<u>187,200</u>	<u>85.0</u>
Upland Crops		
Cassava	12,700	5.8
Kenaf *1	13,000	5.9
Maize	2,500	1.1
Groundnuts	500	0.2
Others	800	0.4
Sub-total	<u>29,500</u>	<u>13.4</u>
Fruit Trees		
Mango	1,100	0.5
Cashewnut	200	0.1
Others	900	0.4
Sub-total	<u>2,200</u>	<u>1.0</u>
Vegetables	<u>1,400</u>	<u>0.6</u>
Total	220,300	100.0

Note : \*1 Kenaf includes jute.

Figure 2-3 Present Cropping Pattern

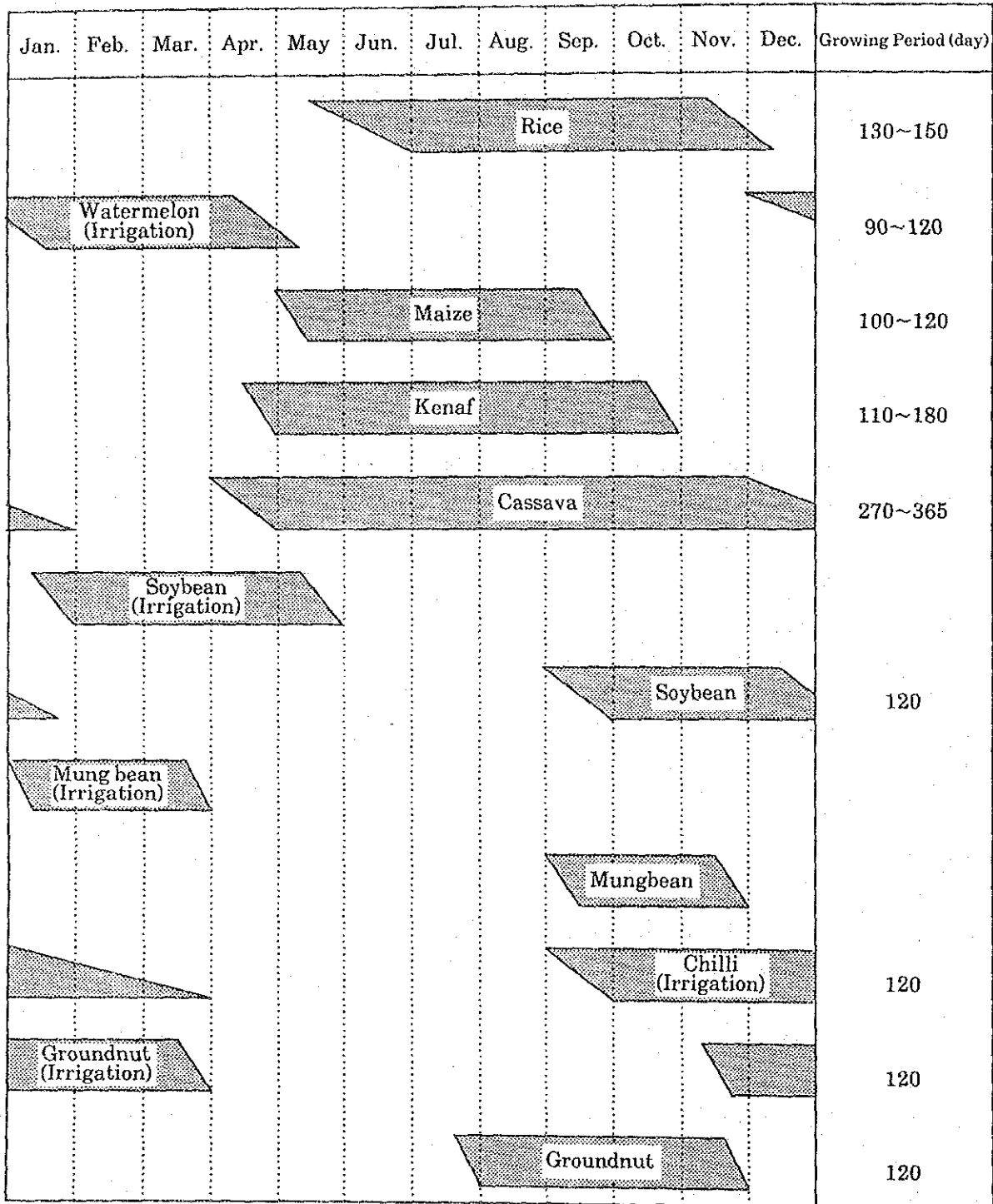


Figure 2-4

Distribution of Present Paddy Yield per Tambon in the Basin

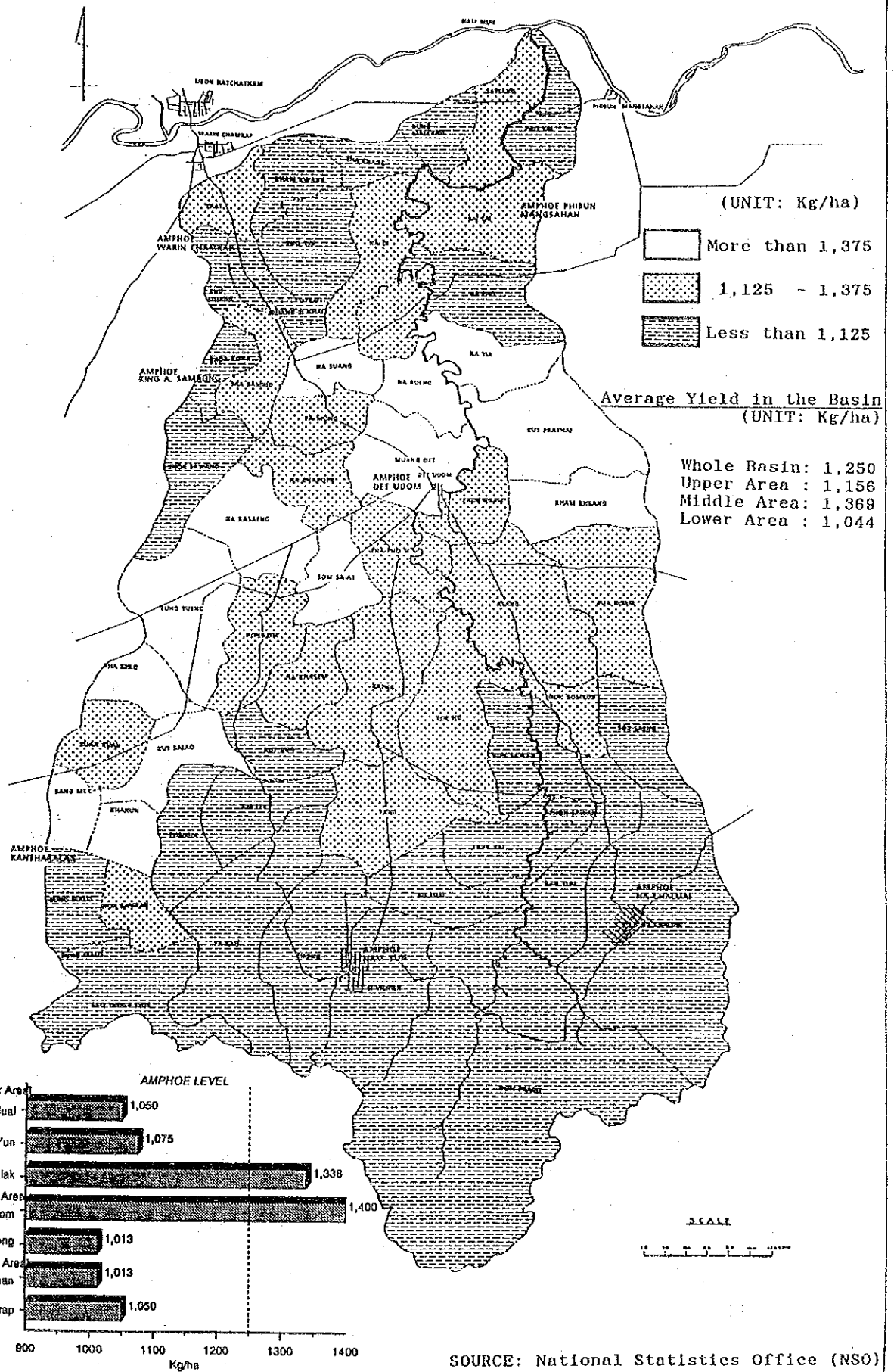




Table 2-6 Production and Yield of Major Crops

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	
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 & Others	210	881
Vegetables	-	-

Note: \*1 Kenaf includes jute.

#### 4) Livestock and Inland Fisheries

Livestock is an important practice following paddy and cassava cultivation in Northeast Thailand. Inland fisheries is also regarded as an important practice for supplying protein sources in the basin because of poor transportation from the seaside. The conditions of livestock and inland fisheries are shown below.

Table 2-7 Number of Livestock (1990)

Amphoe	Buffalo	Cattle	Swine	Ducks	Chicken	Geese
Warin Chamrap	15,500	4,326	3,586	38,660	84,795	349
Det Udom	50,117	9,083	9,663	50,062	222,128	507
Phibum Mungsahan	5,514	1,471	782	11,354	34,588	84
Na Chaluai	9,915	2,379	1,214	17,720	34,389	-
Nam Yun	14,884	3,381	6,912	11,046	39,094	345
King A. Samrong	3,637	557	601	4,225	13,584	-
Kantharalak	1,637	2,243	3,871	-	-	-
Total	119,204	23,440	26,629	133,067	428,578	1,285

Table 2-8 Condition of Inland Fishery (1989)

Amphoe	Number of Farmers (Persons)			Area (ha)		
	Pond	Paddy Field	Total	Pond	Paddy Field	Total
Warin Chamrap	116	3	119	18.0	30.0	48.0
Det Udom	142	3	145	21.3	0.6	21.9
Phibum Mungsahan	165	17	182	18.5	5.0	23.5
Na Chaluai	9	12	21	2.0	2.1	4.1
Nam Yun	9	5	14	1.6	1.4	3.0
King A. Samrong	13	2	15	1.1	0.2	1.3
Kantharalak *1	-	-	-	-	-	-
Total	454	42	496	62.5	39.3	101.8

#### 5) Supply and Demand of Products

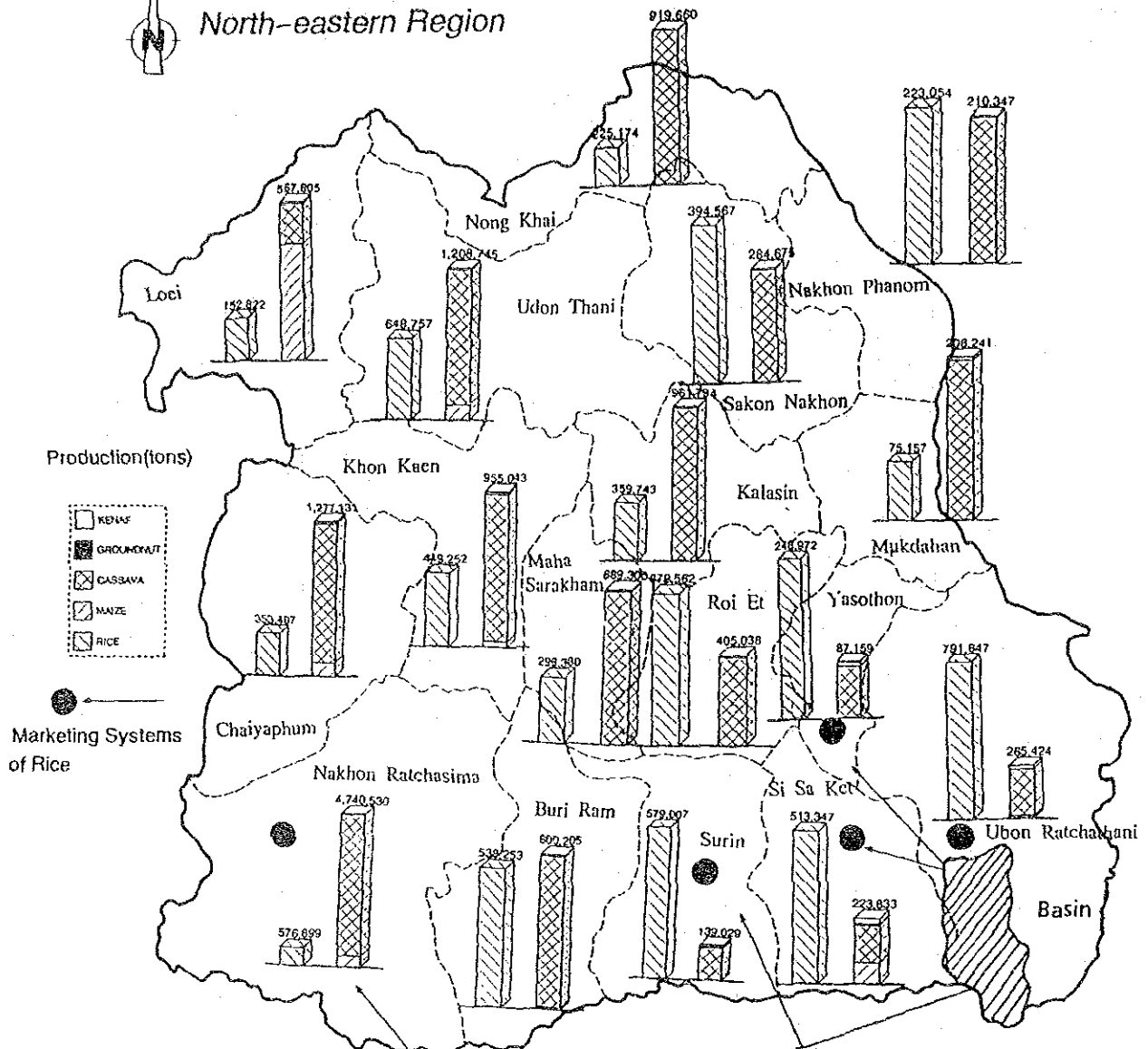
Ubon Ratchathani Province has retained the consumption of glutinous rice. Recently, non-glutinous rice production has been promoted by the agricultural extension office, but at present more than 90 percent of non-glutinous rice is sent to Bangkok for food supply to urban areas or export. The conditions are shown below;

Table 2-9 Farmer's Supply and Demand of Rice in the Basin

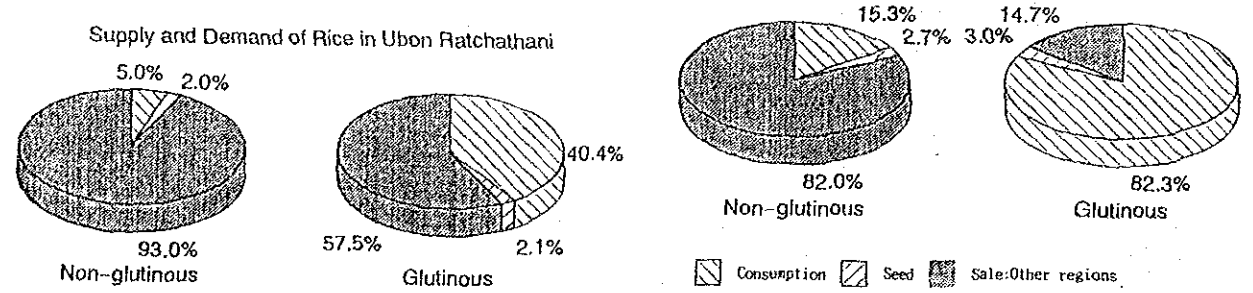
Item	Non-glutinous	Glutinous	Total/Average
Production (ton)(A)	3,550.4	3,467.6	7,018.0
Consumption (ton) (B)	542.5	2,852.5	3,395.0
Consumption rate (B/A) (%)	15.3	82.3	48.4
Seed (ton) (C)	94.9	102.3	197.2
Seed rate (C/A) (%)	2.7	3.0	2.8
Sale (ton)(D)	2,913.0	509.8	3,422.8
Sale rate (D/A) (%)	82.0	14.7	48.8
Wage and rent (E) (ton)	-	3.0	3.0
Wage and rent rate	-	0.1	-



### North-eastern Region



To Bangkok Market ← 50%



SOURCE: Agricultural Statistics of Thailand 1989/90 (DOAE)  
 Agricultural Statistics of Thailand 1989/90 (OAE)  
 Agro-Economic Survey 1991.6

Figure 2-5 Supply and Demand of Agricultural Products by Region and Basin

## 2.1.9 Agro-Economic Conditions

### 1) Valuable Cost and Income of Products

Table 2-10 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)
<b>Annual Crop</b>						
Paddy	1,250	3.2	4,000	3,694	713	- 407
Cassava	13,125	0.6	7,875	6,799	776	300
Kenaf	1,581	4.8	7,511	6,752	731	28
Maize	2,900	1.3	3,770	2,783	975	12
Groundnut	1,306	7.1	9,314	8,770	648	- 104
<b>Perennial Crop</b>						
Mango	4,675	3.0	14,025	12,851	742	432
Cashew nuts	881	13.0	11,444	6,452	2,244	2,748

### 2) Farmers' Income and Poverty Condition

Table 2-11 Average Farmers' Income in the Basin

Item	(unit: Baht)		
	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)
Farm Income	29,628	33,911	17,939
Non Farm Income	2,500	8,672	8,538
Gross Income	32,128	42,583	26,477
Production Cost <sup>1/</sup>	7,371	10,933	6,435
Living Expenses	24,705	24,930	20,875
Total Expenditure	54	6,720	- 833

Table 2-12 Poverty Distribution in the Basin

Amphoe (District)	(unit: %)		
	Poverty	Marginal	Total
Wartin Chamrap	48	31	79
Det Udom	34	34	68
Phibun Mangsahan	32	41	73
Na Chaluai	53	31	84
Nam Yun	36	35	71
King A. Samrong	39	39	78
Kantharalak	52	28	80
Average	42	34	76

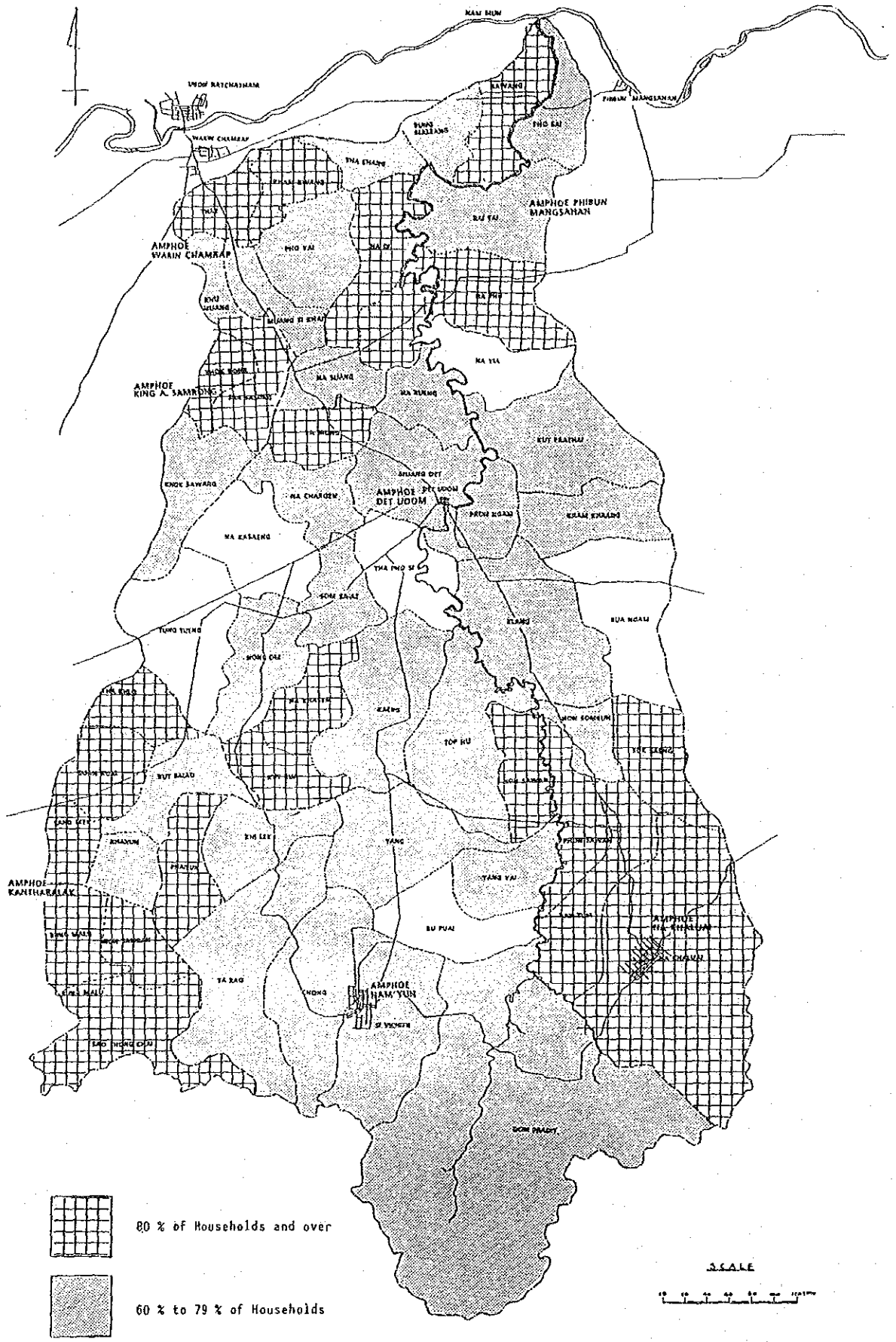


Figure 2-6 Poverty Distribution in the Basin

## 2.1.10 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.

Table 2-13 Summary of Present Irrigation Projects in Basin

Project	Irrigated Area		Canal Length (km)	Remarks
	Wet Season (ha)	Dry Season (ha)		
RID Project				
Medium-Scale	3,930	930	54	3 Projects
Small-Scale	4,220	-	-	52 Projects
Sub-total	8,150	930	54	
DLD Project	500	100	-	7 Projects
ARD Project	350	-	-	30 Projects
NEA Project	1,050	200	12	4 Projects
DOLA Project *1	(380)	(170)	-	34 Projects
ALRO Project	200	70	-	including groundwater
Total	10,630	1,470	66	

\*1 : Area in parenthesis shows a part of 34 projects.

### **3. OVERALL AGRICULTURAL DEVELOPMENT PLAN**

#### **3.1 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
- Inbalance of farming crops and underdeveloped marketing
- Illegal agricultural land reclamation by cutting down trees recklessly mostly in the national forest

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

- A water resource development plan of Lam Dom Yai basin should be established in order to introduce irrigated agriculture in the basin as far as possible.
- The river run-off has remarkably large fluctuations between dry and wet seasons. Accordingly, an approach for the study should be set up so as to secure as many water source facilities as possible.
- The introduction of upland farming in the dry season using remaining available water source should be planned.
- Improving ways for rainfed agriculture in the remaining area should be proposed.
- The establishment of a land utilization plan for forest is also of importance.
- For the following Feasibility Study, a staged development plan should be made and one or two high priority project(s) be selected.

#### **3.2 Sectional Development Plan**

##### **3.2.1 Water Resource Development Plan**

Although annual mean rainfall in the river basin amounts to 1,490 mm, the seasonal distribution fluctuates very widely. The effective utilization

of this surface water, however, is indispensable for the development plan. On the other hand, there is a slight possibility of groundwater resource development for irrigation.

The overall river basin of 4,905 sq.km has an annual mean run-off of 2,080 MCM in 1/5 probable drought years. Since an area of 352 sq.km corresponding to about seven percent of the whole river basin, has been utilized as the catchment areas for existing projects and the projects to be implemented soon, an annual mean run-off of about 1,930 MCM to be generated from the remaining river basin of 4,553 sq.km will constitute a potential for development in future projects.

Considering the pattern of irrigation demand, the water sources for irrigation require equalization of run-off by means of water storage. In order to utilize the limited water resources efficiently in the basin, implementation of the irrigation projects through reservoir construction should be proceeded.

There is agricultural land of 232,200 ha (1,451.3 thousand rai) corresponding to 47.3 percent of the whole river basin. The distribution situation of the agricultural land is shown in the table below. It is found that 87 percent of these areas is distributed in the upper and middle-basins of the river.

Table 3-1 Distribution Situation of Agricultural Land

Basin	Catchment Area A (sq.km)	Rate of Catchment Area (%)	Area of Agricultural Land B (sq.km)	Distribution Rate of Agricultural Land (%)	Rate of Agricultural Land Area B/A (%)
Upper	2,741	56	1,090	47	40
Middle	1,537	31	920	40	60
Lower	627	13	312	13	48
Total	4,905	100	2,322	100	47

The water resource development plan in the river basin is based upon the following concepts;

- For the upper basin of the river, a medium-scale irrigation project with a benefited area less than 4,000 ha (25.0 thousand rai) will be applied. Gravity irrigation from the reservoirs to the benefited 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 unavoidably.
- For agricultural land not irrigable by the above-mentioned projects, the water resource development by small-scale ponds, weir construction, etc. will be needed, as well as a 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 and be appropriated as water resources for the small-scale water resources development projects, such as the above-stated small-scale irrigation projects and village pond construction projects.

### 3.2.2 Land Resource Development Plan

The area suitable for paddy rice is situated in the basin, especially the east and west part of Amphoe Det Dom. Soil texture in the area ranges from sandy soil to loamy soil for top soil, while the sub-soil is clayey in texture. This area can be utilized for both paddy and upland crops, however, the paddy soil should be improved before planting and soil fertility should be maintained.

The area suitable for upland and tree crops lies in the central part and south of the basin, and is scattered around in the northern part. The texture of top-soil ranges from sandy to sandy loam and intermingles with clay. Soil pH is about 5.5 - 6.0 and the soil is deep and moderately well-drained.

Table 3-2 Proposed Land Use Plan

<u>Land Category</u>	<u>Area</u> (ha)	<u>Percent</u> (%)
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

### 3.2.3 Irrigation Plan

The proposed cropping pattern for overall agricultural development is planned with paddy sharing 30 percent of local variety and 70 percent of high yielding variety which will be planted for the whole irrigation area during the wet season, considering the climatological conditions in the region such as abundant rainfall from May to September.

On the other hand, during the dry season, upland crops are planned for an area of 15 percent of the whole irrigation area.

Potential evapotranspiration ( $ETo$ ) is estimated by applying the modified Penman Method using climatological data observed at Ubon Ratchathani meteorological station (1961 - 90).

Monthly consumptive use of water for crop (actual evapotranspiration  $ETa$ ) is calculated by multiplying the  $ETo$  value by crop coefficient ( $Kc$ ) corresponding to the growth stages of crops.

Crop water requirements on a 10-day basis are estimated based on the proposed cropping pattern, and taking percolation rate of 2.0 mm/day and additional water for land preparation of 250 mm.

The diversion water requirement is calculated by adding effective rainfall and irrigation efficiency to the crop water requirement.

The 10-day diversion water requirement for a period of 30 years (1960 - 89) are estimated. And annual diversion water requirement (DWR) in the case of the proposed cropping pattern with cropping intensity of 115 percent is shown in the table below.

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

**Table 3-3 Estimated Evapotranspiration (ET<sub>o</sub>)**

(unit: mm/day)

Month	ET <sub>o</sub>	Month	ET <sub>o</sub>
Jan.	4.3	Jul.	4.5
Feb.	5.3	Aug.	4.3
Mar.	5.9	Setp.	4.0
Apr.	6.1	Oct.	4.3
May	5.4	Nov.	4.5
Jun.	4.5	Dec.	4.1
Average 4.8			

**Table 3-4 Monthly Consumptive Use per Crop**

(unit: mm/day)

Month	Wet Season Crop			Dry Season Crop					Perennial Crop
	Paddy			Ground-nut	Soybean	Water-melon	Chilli	String-bean	
	HYV	LV	Vegetable						
Jan.				4.3	5.0	4.1	4.3	5.1	3.9
Feb.				5.5	6.2	5.2	5.5	6.2	4.7
Mar.				4.1	4.8	4.6	4.1	4.8	4.9
Apr.				2.8	4.0	4.0	2.8	4.0	5.2
May									4.6
Jun.			2.9						3.8
Jul.	4.0 (-)	4.3	5.3						3.8
Aug.	5.2 (3.8)	5.3	5.1						3.7
Sep.	5.2 (4.8)	5.3	3.2						3.4
Oct.	3.3 (5.6)	4.4	2.8						3.7
Nov.	- (3.4)	3.4							3.8
Dec.				2.7	2.7	2.7	2.7	2.7	3.5

Notes: Figures in parenthesis show the consumptive use for time-lagged crop planting.

**Table 3-5 Irrigation Efficiency**

Irrigation Efficiency	Paddy Field (%)	Upland Field (%)
Application efficiency	80	70
Operation efficiency	80	80
Conveyance efficiency	85	90
Overall efficiency	55	50

**Table 3-6 Annual 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

### 3. 2. 4 Irrigated Agricultural Plan

Irrigation water to be supplied by the proposed reservoir is mainly to be used for the wet season paddy to stabilize production. For dry season crops, such as groundnut, soybean, watermelon and chilli, 15 percent of the proposed area will be irrigated.

The target yield of crops to be irrigated are shown below;

Table 3-7 Proposed Target Yield of Crops

Crops	Yield		Present Yield
	kg/ha	kg/rai	
Paddy	3,438	550	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 (fresh)	15,625	2,500	

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

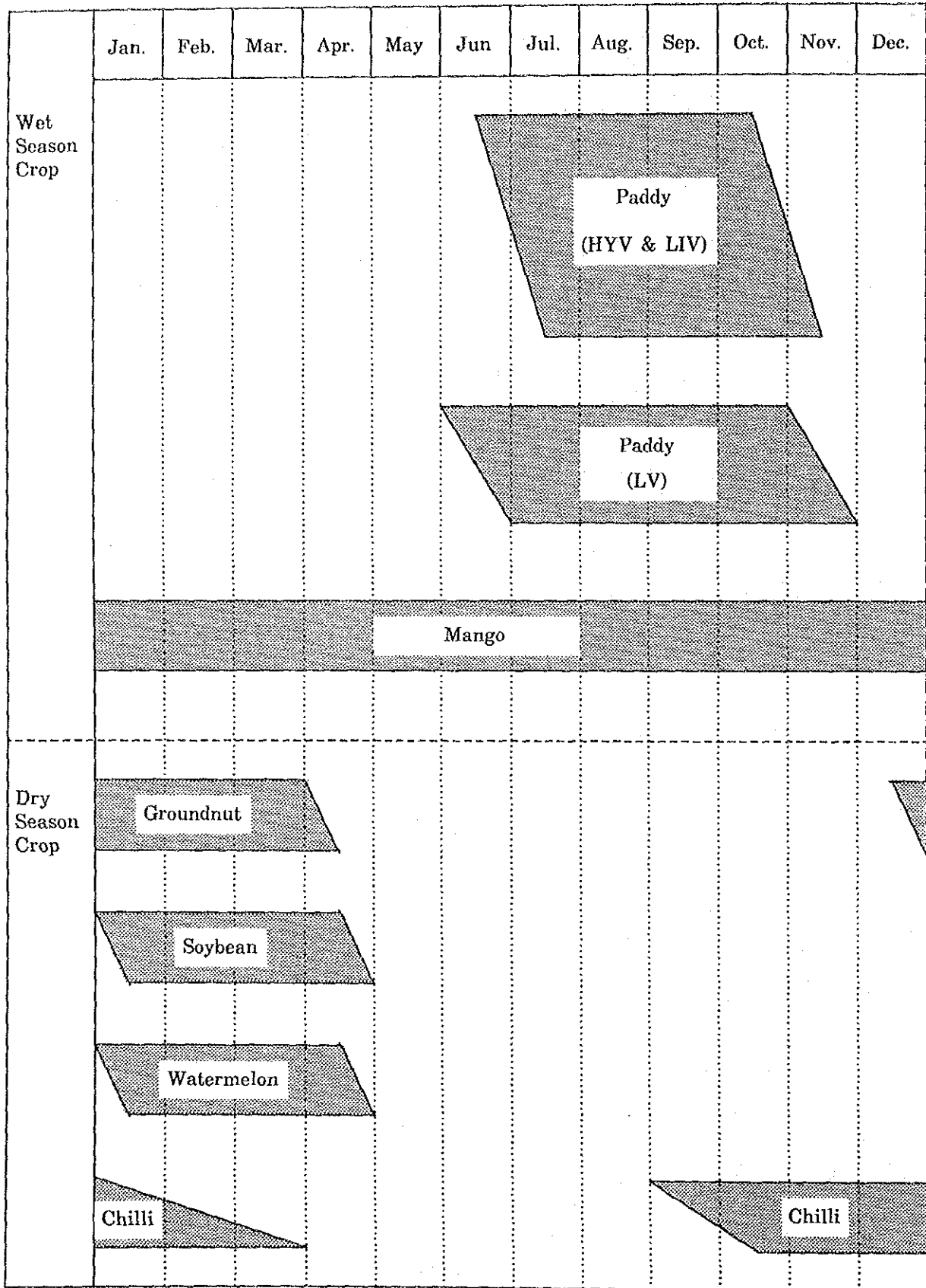
The proposed variable cost, corresponding to the target yield set up on the assumption that the favorable farming conditions are all provided, was estimated based on the data and information obtained. The results of the farm household economic survey are shown below:

Table 3-8 Future Net Income for Irrigated Crops

Crops	Yield (kg/ha)	Farmgate Price (Baht/kg)	Gross Income (Baht)	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	34,963

The farmers' income to be increased in the future can be correlated to an increase in the yield of crops despite the increase of agricultural inputs. As shown in the following table, gross income from wet season paddy production will be 49,555 - 57,035 Baht and its increased income attains 29,395 - 36,550

FIGURE 3-1 PROPOSED CROPPING PATTERN



Baht. Besides, the irrigated crops in the dry season, as represented those in the middle -basin, will produce the gross income of 9,120 Baht. This income is additional for farmers. Accordingly, the gross farm income of average farm in the middle-basin is to be 62,533 Baht.

**Table 3-9 Farmer's Income in the Future**

Item	(unit: Baht)		
	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
Farmers' Income	27,006	29,526	27,270

### 3. 2. 5 Improvement Plan of Rainfed Agriculture

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

- Moisture Preservation
  - o Mulching method
  - o Green manure cultivation
- Small-Scale Village Pond Construction

### 3. 3 Water Resource Development Plan

#### 3. 3. 1 Selection of Reservoir Sites

The selection of new water resource sites for water resource development was made based on 1/5,000 scale topographical map, and 29 new developable water resource sites were found in the basin as shown below. The locations of these sites according to their sub-basin are as follows:

**Table 3-10 New Water Resource Development Plan**

Item	Water Source Site					Total
	Lam Dom Yai (U) <sup>1/</sup>	Lam Som	Huai Ari	Huai Khao San	Lam Dom Yai (M&L) <sup>2/</sup>	
Catchment Area (sq.km)	1,561	1,104	274	608	1,358	4,905
Water Storage Plan (pls.)						
- Larger-Scale	2	-	-	-	-	2
- Larger Medium-Scale	-	1	1	-	-	2
- Smaller Medium-Scale	6	10	-	4	4	24
Run-of-River Plan (pls.)						
- Smaller Medium-Scale	-	-	-	-	1	1
Total	8	11	1	4	5	29

<sup>1/</sup>U: Upper-stream    <sup>2/</sup>M: Middle-stream    L: Lower-stream

### 3.3.2 Overall River Basin Water Resource Development Plan

The Lam Dom Yai basin is divided into five sub-basins, that is, Lam Dom Yai (Upper), Lam Som, Huai Ari, Huai Khao San and Lam Dom Yai (Middle and Lower).

#### 1) Reservoir Plan in Lam Dom Yai (Upper) Sub-Basin

In Lam Dom Yai (upper) sub-basin, six smaller medium-scale reservoirs are planned on the tributaries in the mountainous upper-basin, D-7 reservoir on the mainstream in the mountainous upper-basin and D-28, a large-scale reservoir on the mainstream in the middle-basin. (D-23 reservoir is regarded as an alternative to D-28 reservoir).

#### 2) Reservoir Plan in Lam Som Sub-Basin

The Lam Som sub-basin has a catchment area of 1,140 sq.km (712.5 thousand rai) and considerable water resources, that is, an annual mean run-off discharge of 463 MCM. There are two medium-scale reservoir construction plans on the upper-reaches of the sub-basin made by DID. In this study, ten smaller medium-scale reservoirs are newly planned. As a large medium-scale reservoir, D-24 reservoir is also planned, somewhat downstream from the middle-reaches.

### 3) Reservoir Plan in the Huai Ari Sub-Basin

The Huai Ari sub-basin consists of quite flat topography, and is occupied by large rainfed paddy field areas. D-25 reservoir is planned as the water resources for this sub-basin. A medium-scale reservoir with a large storage capacity of about 20 MCM can be technically constructed. As the reservoir area is occupied mostly by paddy fields, the land compensation will be a problem following dam construction.

The area benefited from this reservoir is not situated downstream of the reservoir. That is, since the agricultural land along the river downstream of the D-25 reservoir is planned to benefit from the D-28 reservoir, the benefited area from the D-25 reservoir must be rainfed farmland in a higher portion on the left bank of the Lam Dom Yai mainstream at the lower-basin of the D-28 reservoir. Consequently, this irrigation will use the storage water resulting from the pumping irrigation system.

### 4) Reservoir Plan in Huai Khao San Sub-Basin

The Huai Khao San sub-basin is located in the westernmost part of the Lam Dom Yai basin and is of flat topography occupied by rainfed paddy fields. Although five medium-scale reservoirs are planned in the upper-reaches of the sub-basin, the storage capacity is not enough to irrigate vast area of agricultural land stretching in the basin. As stated above, therefore, the water accumulating in the D-7 reservoir will be distributed to this area by way of D-28 and D-24. Also in this case, a pumping irrigation system from the reservoir of D-24 will be needed.

### 5) Reservoir Plan in Lam Dom Yai (Middle and Lower) Sub-Basin

The sub-basin at the middle and lower-basins of the Lam Dom Yai is located in the lowest part of the Lam Dom Yai basin, and is the flat and rainfed agricultural area. In this area at present, there are only three smaller medium-scale reservoir sites and one weir site.

The water to be accumulated in these sites will not be enough to irrigate agricultural land of 13,000 ha (81.3 thousand rai) in this sub-basin.



The agricultural land in the sub-basin, therefore, must be planned to be irrigated by water from D-28 reservoir.

### 3.3.3 Irrigation Areas According to Water Source Development

The summary of the water balance study is shown below, and the dimensions estimated for water resource development appraisal are summarized on the following table (including the projects under construction or to be constructed by RID).

Table 3-11. Total Irrigable Area by Overall River Basin Water Resource Development

Irrigation Project	Irrigable Area	Ratio to Planned Agri. Land
	(ha)	(%)
1. Present Conditions		
a) Existing small-scale irrigation projects and other small-scale water resources development projects	6,700	3
Sub-total	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

### 3.3.4 Water Source Distribution Plan

The total amount of developed water resources will be obtained by adding the water resources from 29 new water source sites to the source developed through eight reservoirs currently under construction or to be constructed by RID, will be distributed according to the provided courses.

As a result, the water resource distribution plan is made and summarized from the viewpoint of irrigable areas by sub-basins. The irrigation

TABLE 3-12 SUMMARY OF OVERALL RIVER BASIN WATER BALANCE STUDY AND IRRIGABLE AREA

Item	Lam Dom	Lam	Huai	Huai Khao	Lam Dom	Total
	Yai (U)	Som	Ari	San	Yai (M&L)	
<b>1. Smaller Medium-Scale Reservoirs</b>						
Total Run-off (MCM)	217	115	-	62	32	426
Total Effec. Storage Capa. (MCM)	106	36	-	14	6	162
Total Water Utili. Amount (MCM)	84	57	-	12	8	161
Total Reservoir Losses (MCM)	44	21	-	15	5	85
Total Overflow Amount (MCM)	89	37	-	35	19	180
Irrigable Area (ha)	15,630	10,510	-	3,140	1,950	31,230
<b>2. Larger Medium-Scale and Large-Scale Reservoirs</b>						
Total Run-off (MCM)	497	276	89	-	-	862
Total Effec. Storage Capa. (MCM)	205	7	19	-	-	231
Total Water Utili. Amount (MCM)	213	18	28	-	-	259
Total Reservoir Losses (MCM)	70	10	13	-	-	73
Total Overflow Amount (MCM)	214	248	48	-	-	510
Irrigable Area (ha)	55,170	4,770	7,160	-	-	67,100
<b>3. Smaller Medium-Scale Weirs</b>						
Total Run-off (MCM)	-	-	-	-	499	499
Total Effec. Storage Capa. (MCM)	-	-	-	-	10	10
Total Water Utili. Amount (MCM)	-	-	-	-	489	489
Irrigable Area (ha)	-	-	-	-	2,500	2,500
<b>4. Total</b>						
Total Run-off (MCM)	714	391	89	62	531	1,787
Total Water Utili. Amount (MCM)	297	75	28	12	18	430
Irrigable Area (ha)	70,800	15,280	7,160	3,140	4,450	100,830 <sup>1</sup>

\*1: Including the irrigable area of 8,960 ha by projects under construction or to be constructed by RID.

area rates of existing agricultural land in five sub-basins range from 37 to 58 percent.

i)	Lam Dom Yai (upper) sub-basin	:	37%
ii)	Lam Som sub-basin	:	41%
iii)	Lam Huai Ari	:	58%
iv)	Lam Khao San	:	58%
v)	Lam Dom Yai (Middle and Lower)	:	48%
	Average		45%

### 3.3.5 Phased Development Plan

The details of the phased development plan for water resources in the basin as determined according to the criteria provided is shown on the next table:

Table 3-13 Phased Development Plan of Water Resources in Overall Basin

Phasing (Period)	Large-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-Phase Development (2003-2010)	W-1 D-25	2,500 7,160	Other 10 Projects	6,870	45
Total		69,600		31,230	

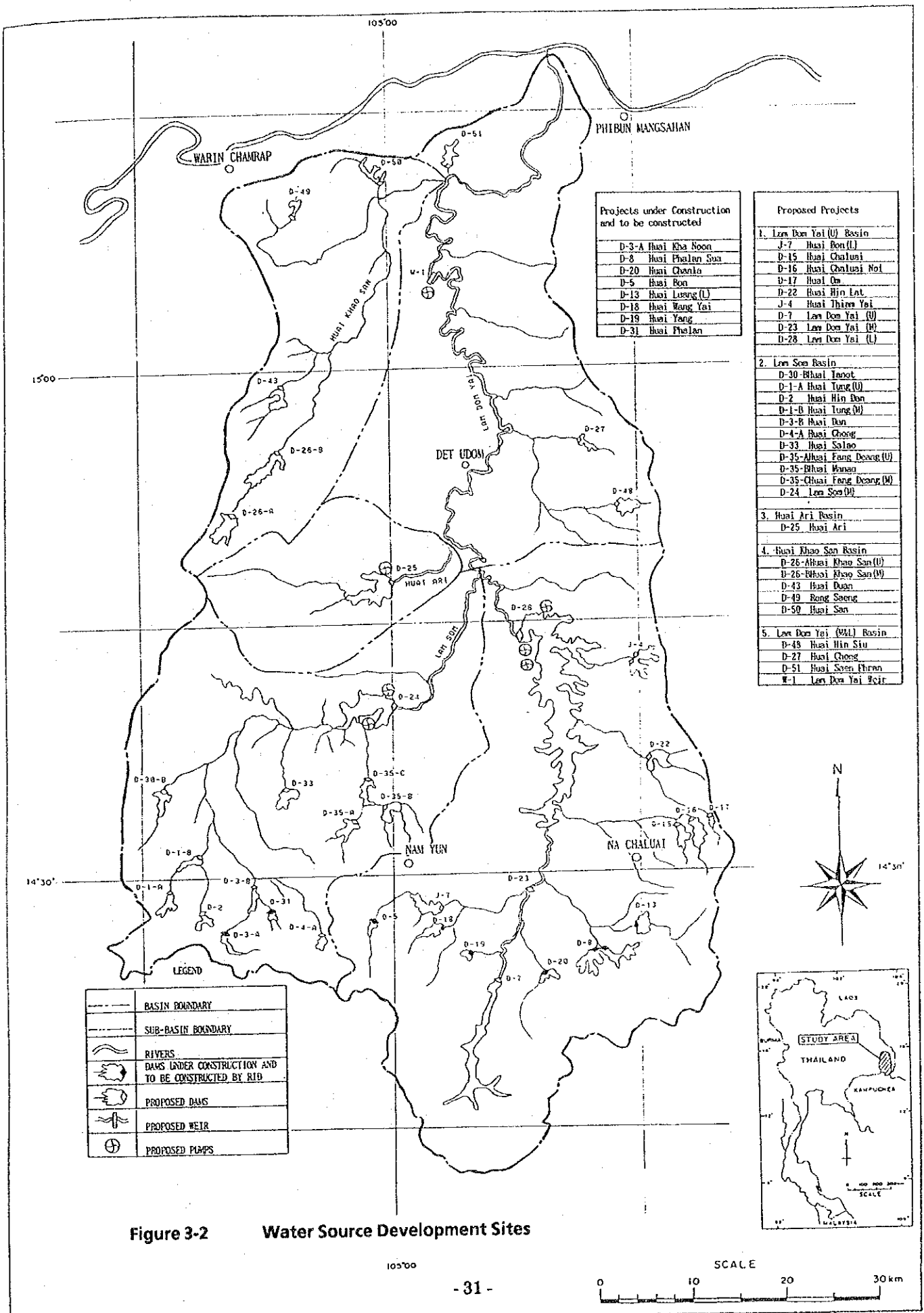
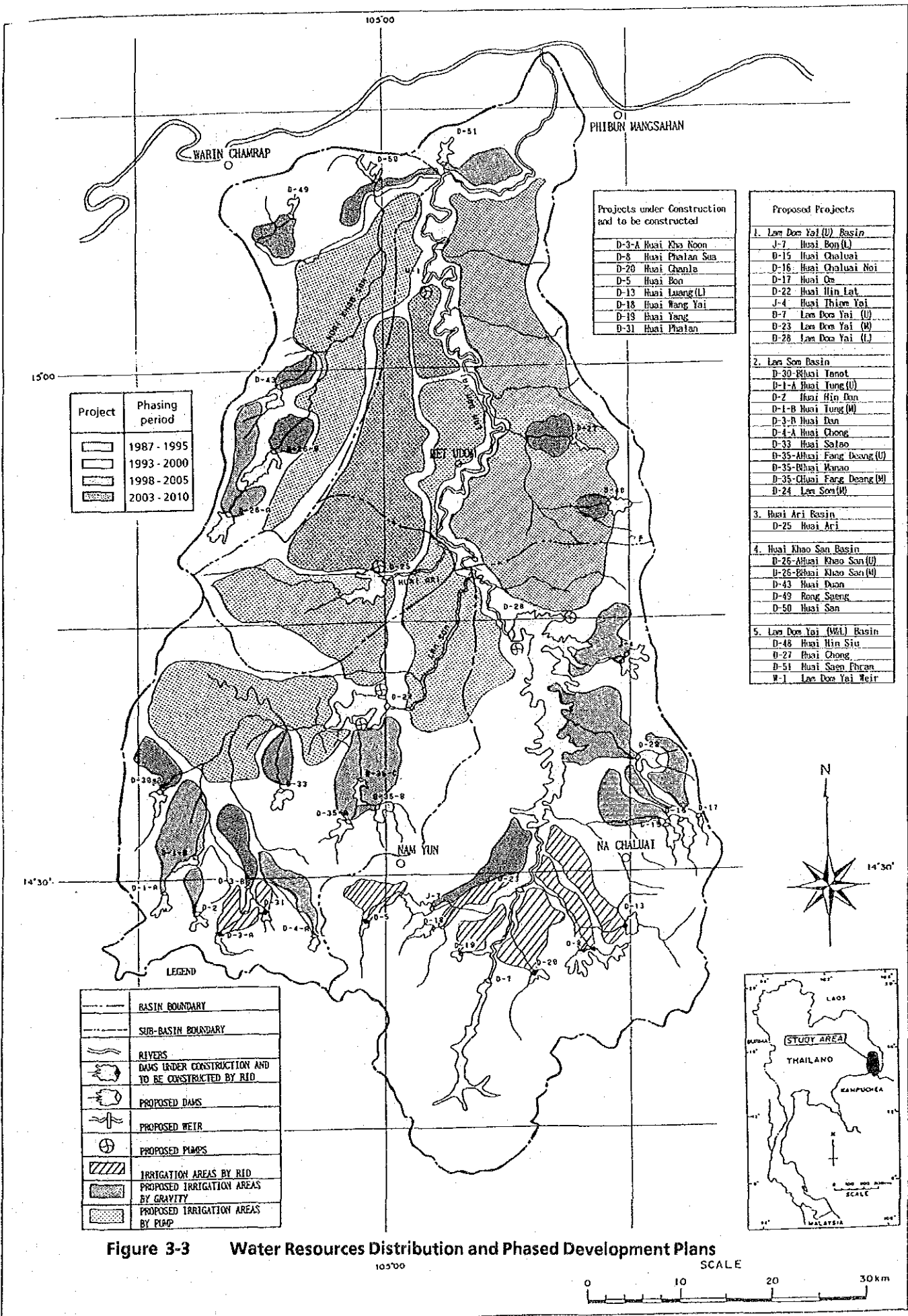


Figure 3-2 Water Source Development Sites







### 3.4 Water Source Facility Plans and Their Project Costs

#### 3.4.1 Water Source Facility Plans

##### 1) New Water Source Facility Plan

###### a) Reservoir Plan

The designed flood discharge of a dam is determined as follows; 1/500-year probable flood discharge is adopted, and the designed flood discharge for spillway is determined adding the storing effect of the reservoir.

The dimensions of dams to be adopted are as follows;

- Dam type : Earthfill type with slope of 1 : 3.0 upstream and 1 : 2.5 downstream
- Dam crest width : 6.0 m to 10.0 m
- Dam clearance : 2.0 m above highest water level
- Sediment volume:  $100 \text{ cu.m/year/sq.km} \times 100 \text{ years} \times \text{catchment area}$

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

###### b) Weir Plan

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

###### c) Pumping Station Plan

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



**Table 3-14 Pumping Station Plan**

Project	No. of Pumping Station	Location of Station
D-7 : Lam Dom Yai (U)	2	On the left bank of D-28 reservoir and on the left bank of D-24 reservoir.
D-24: Lam Som	1	On the right bank of D-24 reservoir.
D-25: Huai Ari	1	On the left bank of D-25 reservoir.
D-28: Lam Dom Yai (L)	2	On both of banks of D-28 reservoir.
W-1 : Lam Dom Yai Weir	1	On the left bank of W-1 weir.

## 2) Existing Water Source Facility Plan

### a) Midum-Scale Irrigation Projects (MSIP)

Although the reservoirs of Huai Chanla and Huai Phalan Sua have recently been constructed, the stored water in the reservoir is not effectively utilized for irrigation purposes.

### b) Small-Scale Irrigation Projects (SSIP)

The many small-scale irrigation projects which have been conducted throughout the country, aim mainly at stabilizing civil administration. The 52 SSIP with an irrigation area of 4,220 ha (23.4 thousand rai) executed by RID, require reservoir dredging and dam body improvement owing to age variations and from lack of operation and maintenance. There have been no irrigation canals to be built by the beneficiaries in any of the project areas. For this reason, the improvement of these water sources facilities and provision of the irrigation canals will be needed.

## 3.4.2 Project Costs

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

The project costs are composed of the construction cost of the main facilities, land acquisition, construction of terminal facilities, agricultural supporting facilities, O/M equipment, survey and design, administration, engineering services, physical contingencies and price escalation.

The unit development costs per hectare for the six plans selected in the following section range from 120,000 to 190,000 Baht/ha, ranked in the average position out of the 31 project plans (including two alternative project plans).

Table 3-15 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
D-30-B	Huai Tanot	380	78	206
D-1-A	Huai Tung (U)	2,000	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

### 3.5 Selection of Priority Development Projects

#### 3.5.1 Preliminary Selection of Priority Development Projects

For a priority development project area, an area with considerable irrigation areas and water resources with highly efficient utilizations of water resources should be selected.

The most important aspect of the basin development will be rapid development of irrigation projects for the agricultural land in the middle and lower-basins, which so far have no irrigation projects.

The development project to be selected as a priority should be a large medium-scale or large-scale irrigation project with a large irrigation area and highly efficient utilization of water resources at the middle and lower-basins of the river.

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

Table 3-16 Agricultural Development Project Areas with High Priority

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) : Lam Dom Yai (L)	30,970
D-28 (B) : 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. An area of 30,970 ha is the irrigable area only by the D-28 reservoir.

2/ D-28(B) : This is the D-28 project when D-28 reservoir is linked with D-23 and D-24 reservoirs. An area of 25,570 ha is the irrigable area only by D-28 reservoir.

### 3.5.2 Final Selection of Priority Development Project

Through the careful study using such criteria 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.

Evaluation results are summarized as follows;

- The D-7 project plan has the highest project economy with a B/C ratio of 0.98 in the case of an interest rate of seven percent; It is followed in the order of the project plan by D-23, D-28(A), D-25, D-28(B), and D-24.
- However, the D-7 project plan situated near the national border of Cambodia has a law and order problems, accordingly the necessary survey and investigation are not possible at present. On the other hand, the D-23 project plan, which is an alternative plan of the D-7 project plan has low project economy compared with that of D-7, because of high project costs (2,913 million Baht), and there also exists problems of compensation as a result of dam construction.
- The D-24 project plan has the lowest project economy, due to its relatively small benefited area in scale in comparison with the scale of project facilities, although such compensation problems are not observed.
- In the comparison of project economy between both the linked project plan of D-7 + D-28 + D-24 and D-23 + D-28 + D-24, the plans have almost equal B/C ratios of 0.76 ~ 0.80 (interest rate  $i = 7.0$  percent), however, the latter project plan is placed at a disadvantage due to the compensation problems resulting from D-23 reservoir.

The dimensions of selected 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 (193.6 thousand rai)



# **FEASIBILITY STUDY**



## 4. PROJECT AREA

### 4.1 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 Phibun Mangsahan, Det Udom, Na Chaluai and Nam Yun), and 17 Tambon (Sub-districts).

### 4.2 Physical Conditions

#### 4.2.1 Topography and Geography

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

There exists 50,320 ha (314.5 thousand rai) of land cultivated under rainfed conditions except a small part which has an irrigation system. Total irrigated land is estimated at about 850 ha (5.3 thousand rai) with ten irrigation systems overall.

#### Area

Cultivated Area	:	50,320 ha
Non-cultivated Area	:	21,380 ha
Total	:	71,700 ha

#### Population

Population	:	56,900 person
Density	:	79.4 person/sq.km



## 4.2.2 Hydrology

### 1) Rainfall

Rainfall in the Lam Dom Yai basin tends to increase from the upper to the lower-basins. The point rainfall values observed at Nam Yun, Buntharik and Det Udom are considered for the watershed area. Those at Det Udom can also be applied for the area proposed for irrigation.

Table 4-1 Areal Ratio of Watershed Area

Gauging Station	Areal Ratio (%)	Area (sq.km)
Nam Yun	76.7	956.3
Buntharik	19.5	243.1
Det Udom	3.8	47.4
Total	100.0	1,246.8*

\* : Direct watershed area

Monthly-basis mean rainfall values at each gauging station and the estimated areal rainfall in the watershed area of the proposed dam is as follows:

Table 4-2 Monthly Mean Areal Rainfall

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
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
Watershed area of the proposed dam	0.7	5.3	28.6	84.7	213.8	196.2	174.0	210.9	325.5	135.2	38.4	3.2	1,416.4

Successive no-rainfall days during the proposed irrigation period for the wet season paddy are estimated based on the 39-year rainfall records. The probable values of successive no-rainfall days in each return period are as follows:

**Table 4-3 Successive No-Rainfall Days**

Return Period (year)	May to June	May to December
2	6	27
5	10	41
10	14	50
50	25	70
100	30	79

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

2) Run-off

Watershed area at the proposed dam-site : 1,560.9 sq.km  
 Watershed areas of six reservoir projects  
 (planned and/or completed in the upper-reaches): 314.1 sq.km  
 Direct watershed area at proposed dam-site : 1,246.8 sq.km

Two water level gauging stations, M80 of RID at Det Udom and 53801 of NEA at Ban Fang Phe, are located near the proposed dam-site. General features of these gauging stations are as follows:

**Table 4-4 General Features of Gauging Stations**

Gauging Station	Code No.	Watershed Area (sq.km)	Mean Annual Areal Rain. (mm)	Mean Annual Run-off (MCM)	Run-off Coeff.
Det Udom	M80, RID	3,363	1,417	1,524	0.32
Ban Fang Phe	53801, NEA	1,410	1,369	687	0.36

To estimate the run-off discharge at the proposed dam-site, a run-off model using the Tank Model method was developed, and was calibrated by the observed record at Ban Fang Phe.

For the Feasibility Study of the project, a day-basis run-off from the proposed watershed area is recomputed by the developed model by taking the watershed area and areal rainfall into account. A summary of the computed results is as follows;

Table 4-5 Mean Monthly Run-off

(unit: MCM)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Average Year												
3.7	2.1	2.0	1.7	17.5	45.6	61.7	108.6	211.6	110.6	19.9	6.2	591.0
1/5 Low Water Year												
4.2	2.6	2.3	1.9	6.9	31.0	70.4	121.2	184.1	63.7	7.3	5.2	500.8
1/5 Hight Water Year												
5.4	3.4	3.0	3.5	40.1	93.9	84.7	119.4	184.1	149.2	13.2	8.1	699.1

Item	Annual Run-off (MCM)	Run-off Coefficient (%)
Max.	1,100.8	47
Min.	258.5	21
Mean	591.0	33

The computed result of mean annual run-off is 591.0 MCM with run-off coefficient of 33 percent and a mean annual specific discharge of 0.47 MCM/sq.km.

#### 4. 2. 3 Soil and Land Classification

##### 1) Soil Classification

The 12 soil series in the Study Area can be grouped into seven soil sub-groups.

- Oxic Paleustult (Kt)
- Aeric Paleaquult (Re, Re-1)
- Ustoxic Quartzipsamment (Ng)
- Typic Plinthustult (Pp)
- Aquic Quartzipsamment (Ub)
- Typic Plinthaquult (Pn)
- Oxic Plinthaquult (On)

Source: Guideline to Soil Series and Classification of Thailand, DLD (1981)

The distribution of each soil series in the area is as follows:

Table 4-6 Classification

Soil Classification	Left Bank Area	Right Bank Area	Total
1. Korat (Kt)	10,930	15,200	26,130
2. Korat - Phon Phisai Asso. (Kt/Pp)	-	17,730	17,730
3. Roi Et - On Association (Re/On)	-	7,560	7,560
4. Roi Et - (Re)	2,520	4,210	6,730
5. Roi Et - Phen Association (Re/Pn)	100	1,890	1,990
6. Nam Phong (Ng)	-	4,240	4,240
7. Phon Phisai (Pp)	2,220	200	2,420
8. Phen (Pn)	1,260	260	1,520
9. Alluvial Complex (Ac)	1,610	-	1,610
10. Ubon (Ub)	-	890	890
11. Roi Et, Loamy Phase (Re-1)	170	300	470
12. On (On)	-	410	410
Total	18,810	52,890	71,700

## 2) Characteristics of Soil

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.

## 3) Land Classification

Area covered, definitions and suggestions of each land class in the Study Area are as follows, according to the Land Classification System of the DLD.

Most of the soils in the Study Area are suitable for paddy rice occupying about 44% of the total area, and next for upland crops. An appropriate management of soils in each land class is suggested below:

Table 4-7 Land Classification

(unit: ha)

Land Class	Definition	Left Bank Area	Right Bank Area	Total
<u>Suitable for Paddy Rice</u>				
L1	Suitable for paddy rice, in areas where water resources exist; annual crops or vegetables can be grown in the dry season.	10	540	550
L2	Suitable for paddy rice with a risk of water shortage when rainfall is erratic as soils in most areas are sandy and some areas are high and steep.	7,520	19,300	26,820
L4	Suitable for paddy rice, upland crops and pasture.	4,010	40	4,050
<u>Suitable for Upland Crops</u>				
L5	Suitable for upland crops and vegetables.	910	980	1,890
L6	Suitable for upland crops and vegetables, although soils are sandy and fertility is low in nature.	4,940	3,260	8,200
L7	Moderately suitable for upland crops or suitable for pasture since soils are very sandy with very low fertility.	110	13,200	13,310
L8	Suitable for upland crops, however, land is currently renovated for growing rice.	1,310	13,240	14,550
<u>Suitable for Fruit and Trees</u>				
L12	Suitable or moderately suitable for fruits and trees as soil contains gravel or has layers of rock in the subsoil.	-	2,330	2,330
Total		18,810	52,890	71,700

Table 4-8 Appropriate Management of Soil by Land Class

- L1 : Apply fertilizer and maintain soil fertility.
- L2 : Water resources are needed if water shortages occur, or when land use is changed to more suitable operation.
- L4 : Exploit the land according to land suitability.
- L5 : Apply fertilizer and maintain soil fertility; in some areas, land should be used with soil and water conservation measures.
- L6 : Organic fertilizer and cover crops should be used; inorganic fertilizer should be used strictly as recommended (rate and time) so as to reduce nutrients loss.
- L7 : Organic fertilizer and cover crop should be used; inorganic fertilizer should be used strictly as recommended (rate and time) so as to reduce nutrients' loss.
- L8 : Land should be used according to land suitability and land should be fertilized.
- L12 : Planting should be prepared and organic and inorganic fertilizers be applied with measures of soil and water conservation.

#### 4) Soil Management

To maintain or increase soil productivity as well as soil fertility in the Study Area, the following are suggested as appropriate measures: Increase in organic matter content, in soil fertility, and in soil pH.

### 4.3 Present Agriculture

#### 4.3.1 Land-Use

Table 4-9 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).

#### 4.3.2 Water Use

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

The wet season paddy cultivation usually starts with land preparation work at the beginning of May, which corresponds to the start of the wet season in the Northeast region. In order to meet the rainfed farming in the area, the size of paddy field is relatively small, about 300 sq.m (20 m × 15 m), with high levees.

### 4.3.3 Social Conditions

#### 1) Population

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.

#### 2) Farm Households

The number of farm households is 8,890 (92 percent of the total households) in the area.

#### 3) Farm Labor Force

Farm labor force of each farm households is estimated at an average of 3.9 persons out of the 5.8 persons per family, resulting in a total farm labor force of 34,800 in the Study Area. Annual animal labor force per farm household is estimated at 2.64 head in the area.

#### 4) Farming Conditions

Farming in the area is characterized by rainfed agriculture in the Northeast region, which dominates the wet season paddy cultivation and traditional crops such as cassava and kenaf. On the other hand, in the dry season farming is difficult due to lack of irrigation water.

#### 5) Farm Size

The average farm size in the area is about 4.6 ha (28.8 rai).

#### 6) Farming Pattern

The crops grown in the area are paddy, cassava, kenaf, and a few dry season crops.



## 7) Land Tenure

Most farmers are owner-farmers but without title deeds. A few households in the villages have no land with household working at farms of owner-farmers as farm laborers. The actual conditions of land tenure obtained by the farm survey are as follows:

Table 4-10 Land Tenure Conditions in the Area

(unit: %)

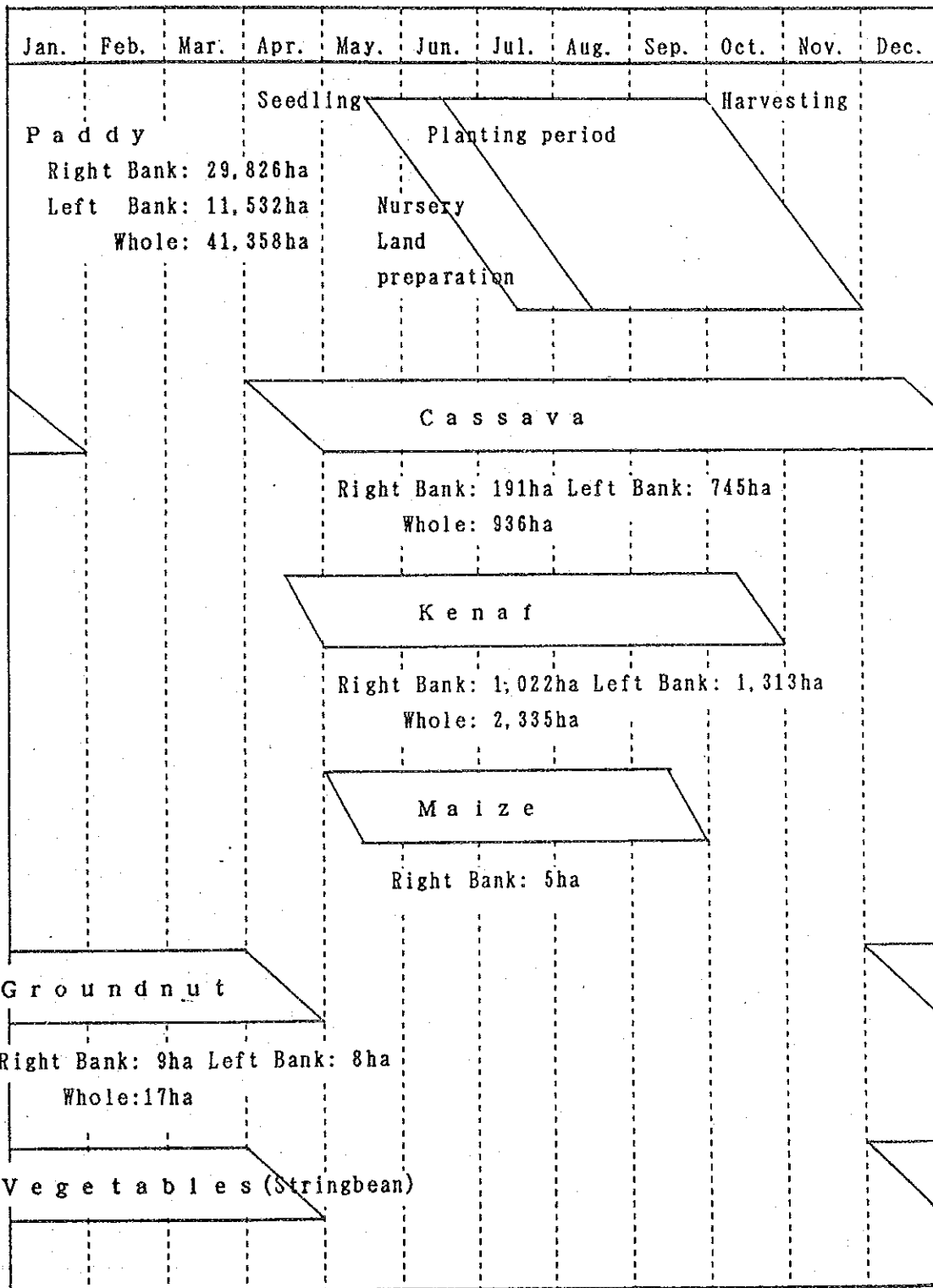
Type of Land Title Document	Right Bank		Left Bank
	Upstream Area	Downstream Area	
Title Deed <sup>1/</sup>	-	-	3.3
N. S. 3 K.	35.9	36.7	21.7
N. S. 3	31.3	26.8	27.8
N. S. 2 (ARLO)	-	-	-
S. K. 1	4.2	5.2	1.2
P. B. T. 6	27.6	20.4	41.9
S. T. K	-	-	-
No Certificate	1.0	10.9	4.1
Total	100	100.0	100.0

- <sup>1/</sup> Title Deed : Those possessing a complete land rights certificate.  
 N.S.3K : Those with land rights useable for transaction.  
 (whose land has already been surveyed)  
 N.S.3 : Those with a land rights usable for transaction.  
 (whose land has only been confirmed in aerophoto)  
 N.S.2 : Those with a only cultivation and dwelling rights  
 (whose land is located where land reform has been carried out)  
 S.K.1 : Those able to have only cultivation and dwelling  
 (who is obtainable when it is 10 to 15 years after illegal instruction,  
 and the good second generation only is able to apply for N.S.3 in  
 his/her generation)  
 P.B.T.6 : Those with only cultivation and dwelling rights unusable for  
 transaction.  
 S.T.K : Those with only cultivation and dwelling rights incapable of  
 dealing with.  
 No certificate: Illegal farmer

### 4.3.4 Agricultural Production

The present cropping patterns in the Study Area are shown in Figure 4-1.

Figure 4-1 Present Cropping Pattern



The total cultivated area at present is 45,340 ha (283.4 thousand rai), of which 13,991 ha (87.5 thousand rai) are on the left bank and 31,349 ha (195.9 thousand rai) are on the right bank, as shown in Table 4-11.

The production amount and yield per hectare of each major crop are also shown in the table.

Table 4-11 Present Planted Area

Crop	Left Bank Area	Right Bank Area	Total
	(ha)	(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)	176	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

Table 4-12 Production and Yield of Major Crops

Crop	Average Yield	Left Bank Area	Right Bank Area
	(kg/ha)	(ton)	(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

#### **4.3.5 Animal Husbandry**

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.

For the animal farms, buffalo and cattle are owned as property and as labor force. In the area, average raising buffalo and cattle per farm is about 3.2 head on the left bank and 3.1 head on the right bank, respectively. Currently, at least 50 percent of the energy for farming depends on buffalo and cattle.

Swine-raising in the area is generally practiced in home gardens and they are fattened on leftover food.

Chickens (1 to 20 chickens) are also fed in home gardens. Chickens are used as easy-to-obtain animal food and as source of cash income.

#### **4.3.6 Inland Fisheries**

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. To improve the present situation, some projects are being operated by the Freshwater Fishery Promotion Center.

#### **4.3.7 Marketing**

Most agricultural products, including paddy in the area, are shipped and dealt with directly by middlemen. On the other hand, the farmers living near rice mills sell paddy to them.

Cassava, kenaf and groundnuts are collected directly from farms by middlemen and processed by each marketing channel. In the case of cassava and kenaf, the factories adjoining the Study Area also buy them directly from the farms.

#### 4.3.8 Agricultural Supporting Services

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

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

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

#### 4.3.9 Farm Household Economy

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

Table 4-13 Present Farm Household Economy in the Study Area

Item	Left Bank Area	Right Bank Area	
		Upper Area	Lower Area
Cropping Area	4.70 ha (29.40 rai)	4.62 ha (28.88 rai)	5.20 ha (28.60 rai)
Farm Income	32,072	23,037	23,621
Off-farm Income	8,002	12,934	10,266
Gross Income	40,074	35,971	33,887
Expenditure			
Production Cost	7,123	7,142	5,577
Living Expense	24,000	18,856	17,259
Sub-total	31,123	25,998	22,835
Surplus of Farm Household Economy	8,951	10,692	11,051
Family Labor	16,740	9,973	12,095
Surplus of Farm Household Economy (including family labor)	-7,192	-2,806	-1,044

## 5. DEVELOPMENT PLAN

### 5.1 Objectives and Components of the Project

#### 5.1.1 Objectives of the Project

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

- Shortage of irrigation water
- Deteriorated soil conditions
- Inbalance of farming crop disproportion and undeveloped marketing
- Others

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 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 a concrete land utilization plan for the forest.

In order to meet the above requirement, the following facilities plans were proposed in the project.

- Dam construction
- Pumping station construction
- Canal network establishment

### 5. 1. 2 Components of the Project

The components of the project will be made with the following development concept to achieve the development objectives:

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

#### 1) Water Resources Development

The existing water resources available in the area are very limited and supply only about 850 ha (5.3 thousand rai), equivalent to only 1.2 percent of the area of 71,700 ha (448.1 thousand rai). Accordingly, water resource development through an adequate storage reservoir is essential for the project. In this direction, D-28 storage dam with top priority for water resource development should be constructed. After a prudent and precise survey, the resettlement plan should be established, and a model resettlement plot be planned in the area.

#### 2) Irrigation and Drainage Canal System Development

Irrigation and drainage canal systems have not yet been established except in the above-mentioned small areas. Therefore, new irrigation canal systems including pumping stations, irrigation and drainage canals should be newly provided for effectively utilizing the stored water resources. In addition, on-farm facilities, such as farm ditches, farm drains and farm roads are to be newly provided for the terminal farm area.

#### 3) Introduction of Irrigated Agriculture

The irrigated agricultural plan should be implemented in the context of the following considerations;

- An appropriate land-use plan and cropping pattern should be worked out to realize maximum utilization of water and land resources.

- An optimum farming practice plan considering farm mechanization should be formulated to increase the agricultural productivity and farmers' income. An increase in crop yields and cropping intensity during the dry season are planned by means of irrigation water supply and improved farming techniques. The cropping pattern for upland crops in the dry season should, therefore, be worked out and promoted.

#### 4) Improvement of Agricultural Supporting Services

It is essential to strengthen the following agricultural supporting services for the achievement of successful irrigated agricultural development and promotion of agricultural activities;

- Water Users' Association with farmer's participation should be organized with the support of the governmental agencies concerned, in order to carry out the operation and maintenance work for irrigation facilities and adequate water distribution and management.
- Also farming, processing and marketing activities should be improved and strengthened through the farmers' organization.
- Animal husbandry and reservoir and village pond fisheries should be set up in order to increase farm household income.

## 5.2 Formulation of Optimum Project Scale

### 5.2.1 Delineation of Project Area

According to the results of the Overall Basin Study, the Study Area for this Feasibility Study is conservatively delineated in the areas to include the development on both banks of the Dom Yai river, which seem to show potential for an irrigation project in terms of topographic, soil and available water resources. The following table indicates such delineated potential areas for the Feasibility Study.



**Table 5-1 Selected Potential Areas for Feasibility Study**

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

## 5.2.2 Alternative Plan

### 1) Proposed Cropping Pattern and Irrigation Demand

The following three cases of alternative cropping intensity utilizing Type-I cropping pattern were set up, in order to analyze the relationship between cropping intensity in the dry season and the areas of wet season paddy fields. Irrigation water requirement corresponding to each cropping intensity was estimated as shown below;

**Table 5-2 Alternative Cropping Intensity**

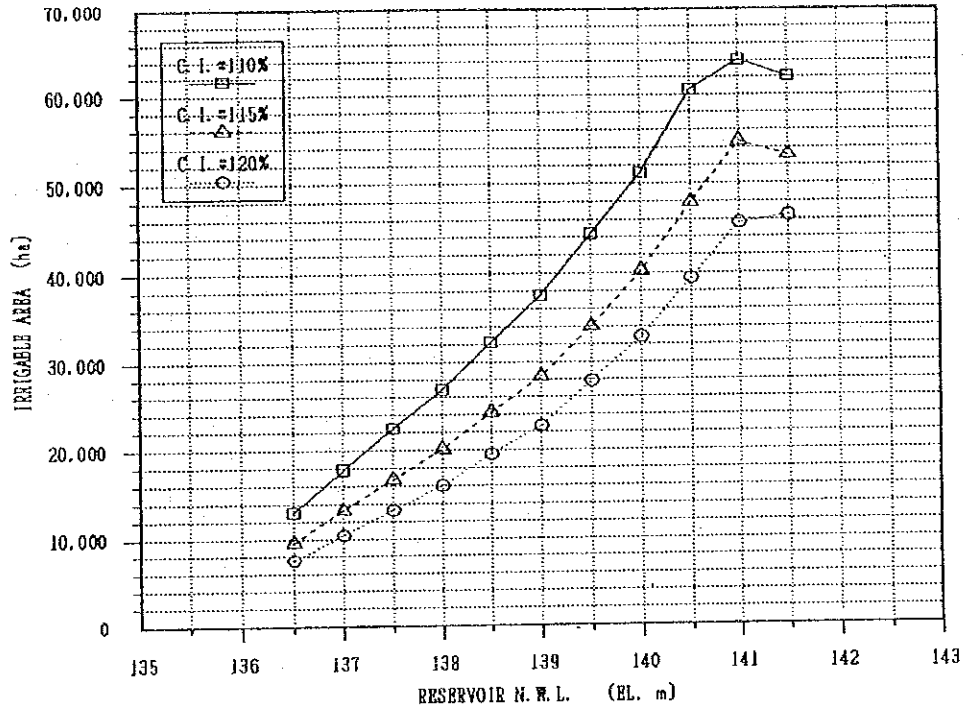
Case (%)	Wet Season (%)	Dry Season (%)	Total (%)	Demand (mm)
Case-1	100	10	110	277
Case-2	100	15	115	333
Case-3	100	25	125	388

Note: Wet season crop : Paddy  
 Perennial crop : Mango  
 Dry season crop : Groundnut, soybean watermelon, chilli, etc.

It was found that an increase in the dry season cropping area directly effects the reduction of the wet season irrigable area in the designed year of return period 1/5-year, as shown in Figure 5-1.

The proposed cropping intensity for the project was decided at about 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.

Figure 5-1 Irrigable Area by Normal Water Level of Reservoir



RESERVOIR N.W.L. (EL. m)		141.5	141.0	140.5	140.0	139.5	139.0	138.5	138.0	137.5	137.0	136.5	
RESERVOIR AREA	km <sup>2</sup>	58.20	53.22	48.25	43.27	39.06	34.84	29.54	24.24	21.83	19.42	17.00	
RESERVOIR TOTAL CAPACITY	MCM	216.46	189.85	163.24	136.63	117.10	97.58	82.81	68.04	58.33	48.62	38.75	
RESERVOIR EFFECT. CAPACITY	MCM	204.00	177.38	150.78	124.17	104.63	85.11	70.34	55.57	45.86	36.16	26.28	
IRRIGATION AREA (1/5 PROBABILITY)													
CROPPING INTENSITY	110%	ha	62,200	64,000	60,600	51,100	44,400	37,500	32,200	26,900	22,500	17,800	13,000
CROPPING INTENSITY	115%	ha	53,100	54,700	47,800	40,300	34,000	28,300	24,300	20,100	16,700	13,200	9,600
CROPPING INTENSITY	120%	ha	46,400	45,600	39,400	32,800	27,800	22,700	19,500	16,000	13,200	10,400	7,600
IRRIGATION DEMAND (1/5 PROBABILITY)													
CROPPING INTENSITY	110%	MCM	214.37	220.49	208.94	176.68	153.92	130.48	112.48	94.48	79.54	63.58	47.27
CROPPING INTENSITY	115%	MCM	213.16	219.49	192.20	162.53	137.61	115.06	99.24	82.63	69.18	55.33	41.09
CROPPING INTENSITY	120%	MCM	212.61	209.00	181.00	151.21	128.63	105.61	91.16	75.36	62.72	50.07	37.43

## 2) Dam and Reservoir Scale

The D-28 reservoir area and its capacity were estimated using RID and ARLO topographic maps, scale 1/10,000 as shown below. Alternative plans were formulated based on such conditions as reservoir storage capacity, size of spillway capacity to be determined by the overflow depth, and land and household compensation for submerged property.

Table 5-3 D-28 Reservoir Area and Capacity According to Water Level

Water Level (EL.m)	Water Surface Area (sq.km)	Reservoir Capacity (Gross) (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

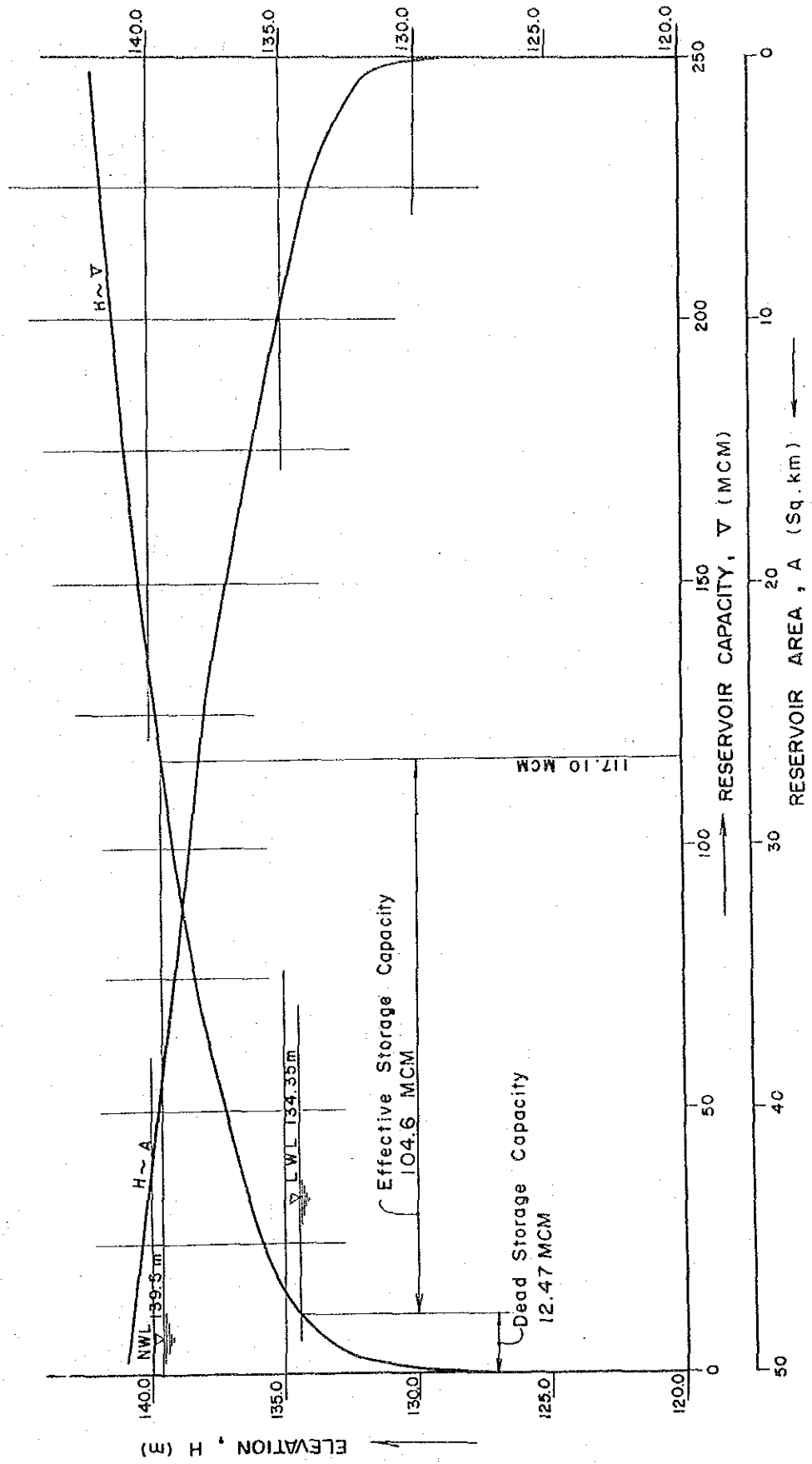
Note: Dead storage capacity is 12.47 MCM at low water level of EL.134.35 m

### 5. 2. 3 Reservoir Operation Study

#### 1) Irrigable Area

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.

Figure 5-2 Reservoir Area and Capacity Curve



**Table 5-4 Irrigable Area at Various Water Level**

Normal Water Level (NWL) (EL.m)	Reservoir Capacity		Irrigable Area (ha)
	Gross (sq.km)	Effective (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	204.00	53,100

## 2) Scale of Compensation

The quantities of compensation for land (Paddy field) and households are estimated based on the ALRO topographic map (scale 1/10,000), land-use map, aerial-photographs and field works. The quantities of those compensations by each water level are indicated below.

**Table 5-5 Quantity of Compensation**

High Water Level (EL.m)	Submerged Area	
	Paddy Field (ha)	Household (No.)
138.5	1,380	100
139.0	1,550	143
139.5	1,760	230
140.0	1,930	324
140.5	2,160	355
141.0	2,370	430
141.5	2,600	470
142.0	2,820	588
142.5	3,050	680
143.0	3,220	751

### 5. 2. 4 Optimum Scale of Project Planning

The optimum scale of project planning should be made considering the following factors;

- Available water and land resources

- Project economy
- Social aspects as land and household compensations

Under this situation, desirable normal water level will be in a range between EL.139.0 and EL.139.5 m having an irrigable area of between 28,300 ha (176.9 thousand rai) and 34,000 ha (212.5 thousand rai) as shown in Figure 5-4. Then, the following four plans were formulated as adaptable project plans;

Table 5-6 Comparison of Optimum Project Plan

Item	Normal Water Level EL.139.0 m (Plan-1)		Normal Water Level EL.139.5 m (Plan-2)	
	Plan 1-1	Plan 1-2	Plan 2-1	Plan 2-2
Normal Water Level (EL.m)	139.0	139.0	139.5	139.5
Spillway Overflow Depth (m)	1.5	2.0	1.5	2.0
Spillway Length (m)	180.0	80.0	170.0	70.0
Effective Capacity (MCM)	85.1 (100) <sup>3/</sup>	85.1 (100)	104.6 (123)	104.6 (123)
Irrigation Area ('000 ha)	28.3 (100)	28.3 (100)	34.0 (120)	34.0 (130)
Const. Cost ('000 Baht/ha) <sup>1/</sup>	12.3 (100)	11.6 ( 94)	10.6 ( 86)	10.0 ( 81)
Compensation Cost <sup>2/</sup>				
Farm Land (ha)	1,760 (100)	1,760 (100)	1,930 (110)	1,930 (110)
Household (h.h)	235 (100)	235 (100)	324 (138)	324 (138)

1/ : Construction costs include dam embankment cost, spillway cost, and compensation cost.

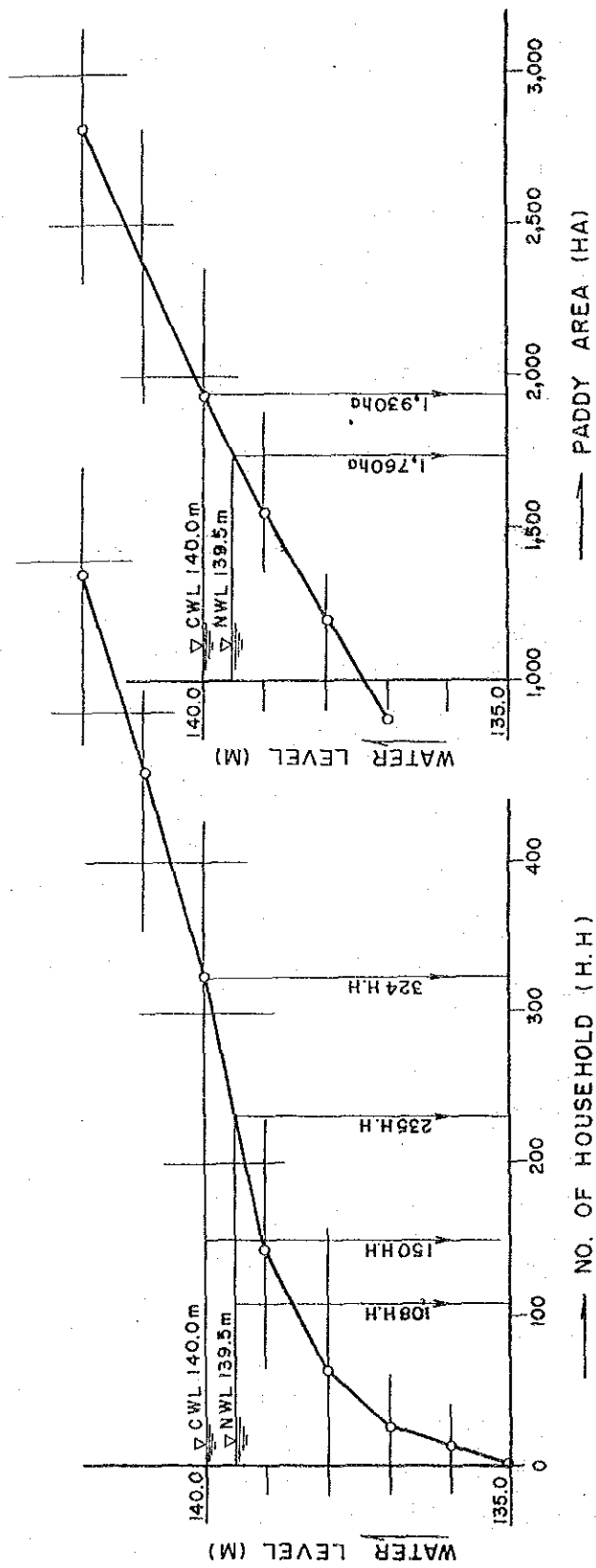
2/ : Compensation water level;  
       Plan-1 : EL.139.5 m  
       Plan-2 : EL.140.0 m

3/ : Figures in parenthesis show the proportion in case that the figures in Plan 1-1 is assumed to be 100.

The Plan, in which the normal water level is EL.139.5 m and spillway overflow depth is 1.5 m, irrigation area is 34,000 ha (212.5 thousand rai), is the most suitable scale for the project planning from a viewpoint of project benefit and social aspect, and is therefore most recommendable.

### 5. 2. 5 Selection of Project Area

The selection of a Project Area with an irrigated area of 34,000 ha (212.5 thousand rai) should be made taking into account physical facilities such as D-28 dam, pumping stations and irrigation systems.



Data Source : - Aero-photograph in 1/4,000 and topographic map in 1/10,000, 1983, ALRO  
 - Statistical data of household, 1983 - 1991, Statistical Province Office of Ubon Ratchathani

Figure 5-3 No. of Households and Paddy Field Area in Reservoir Area According to Elevation

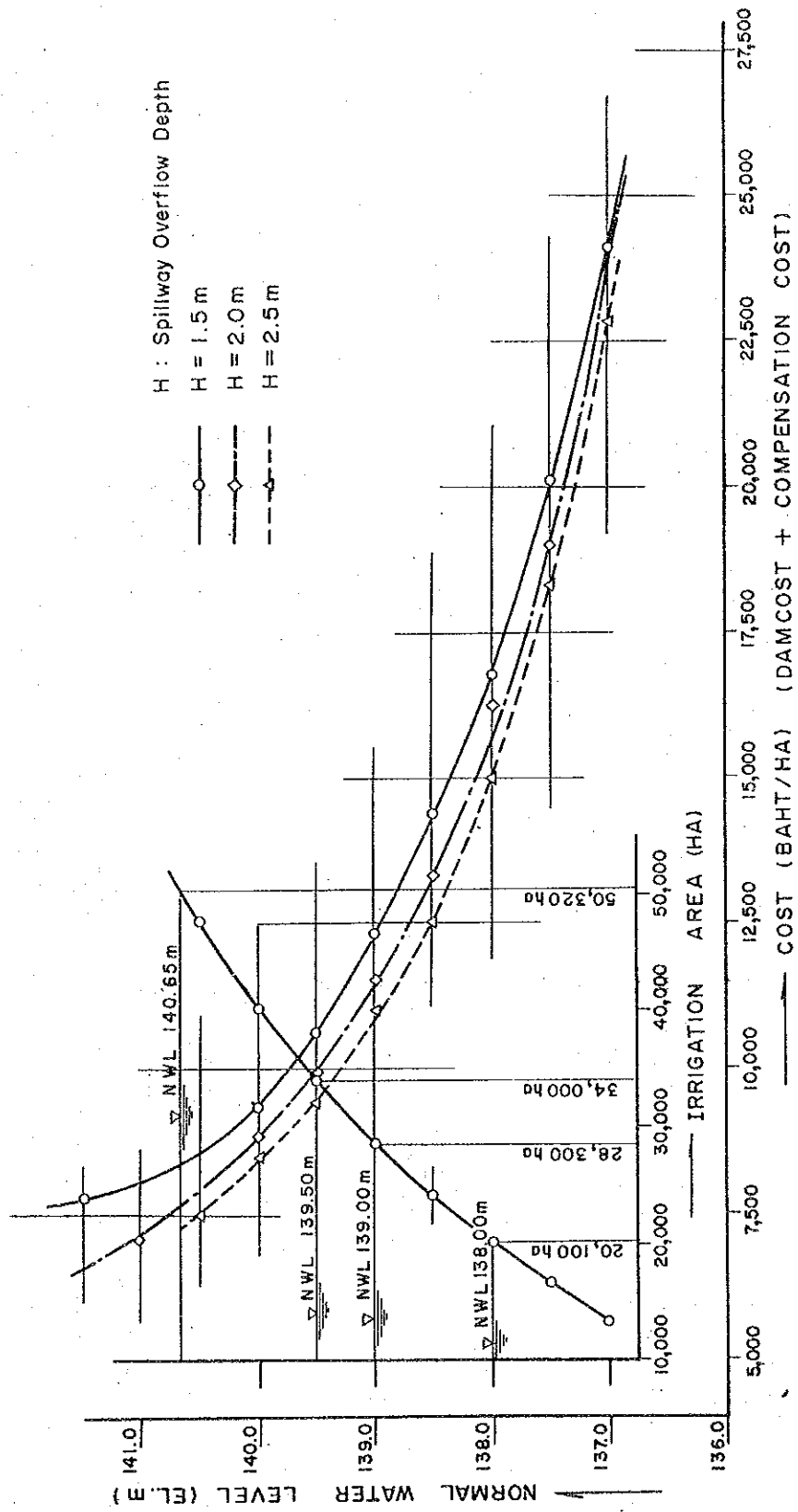


Figure 5-4 Relationships Among Normal Water Level, Irrigated Area, and Dam Costs



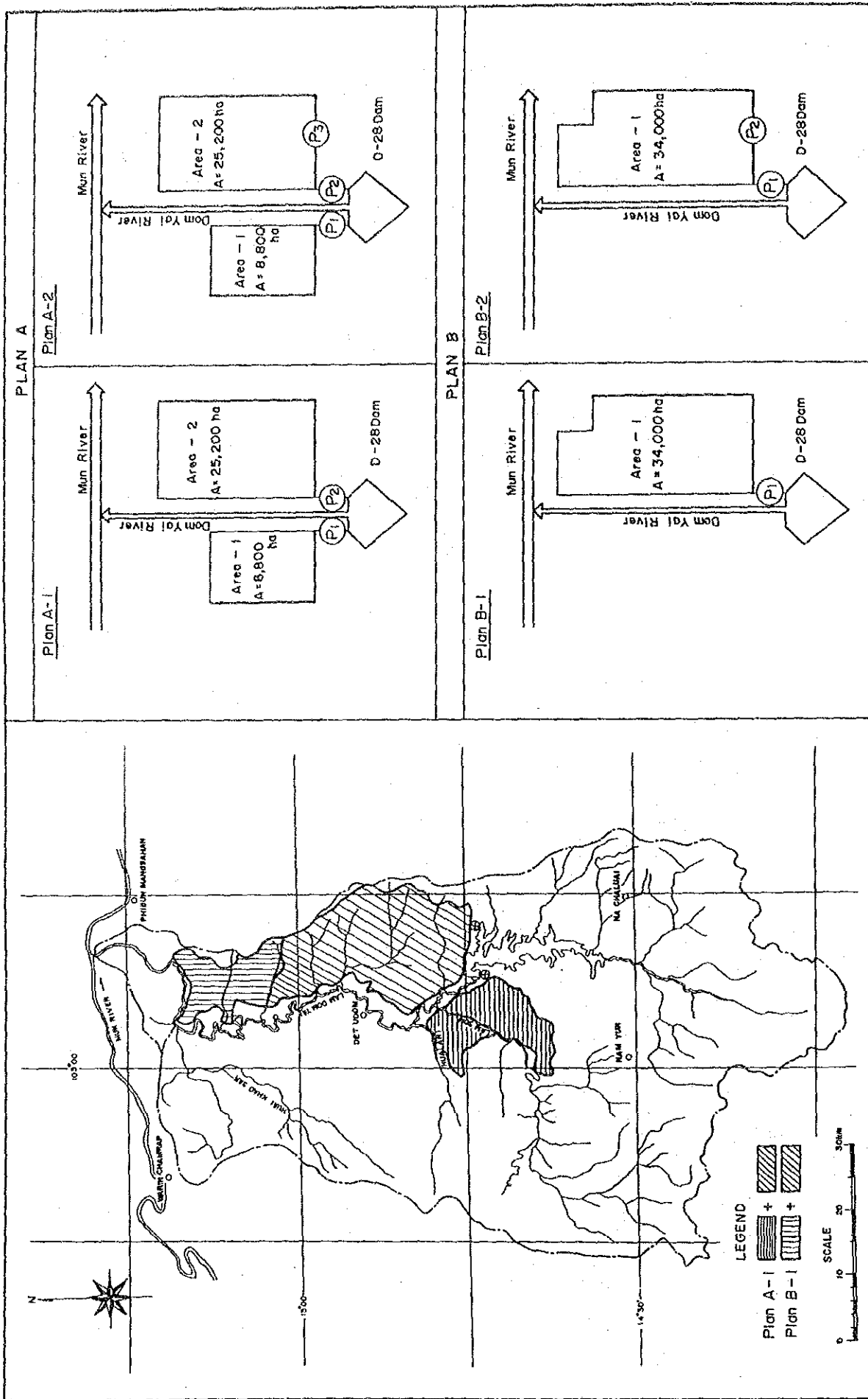


Figure 5-5 Location and Schematic Diagram of Alternative Irrigation System

location, so that the descriptions of project formation to be given hereinafter will be shown as follows;

The Project Area is selected on both the banks of the Lam Dom Yai with an independent pumping station in each. The irrigated 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 respectively, which mostly belong to Amphoe Det Udom.

### 5. 2. 6 Compensation water Level for D-28 Reservoir

Using these study results, the compensation water level (CWL) for the D-28 reservoir is fixed at EL.140.0 m above mean sea level ( $h = 0.5$  m), which corresponds to about the maximum water level during the last 30 years.

Table 5-7 Study on Compensation Water Level

Cases	Normal Water Level (NWL) (EL.m)	Rising Water Height (m)	Compen. Water Level (CWL) (EL.m)
Maximum	139.5	0.55	140.05
Minimum	139.5	0.12	139.62
Average	139.5	0.34	139.84

## 5. 3 Land-Use Plan

### 5. 3. 1 Basic Concept of Land-Use Plan

The proposed land-use for the project was formulated in accordance with prevailing topography, soil conditions, land classification, present land-use and the following considerations;

- The existing cultivated land is defined as the benefited area of the project, and no expansion of cultivated land by means of land reclamation is planned.

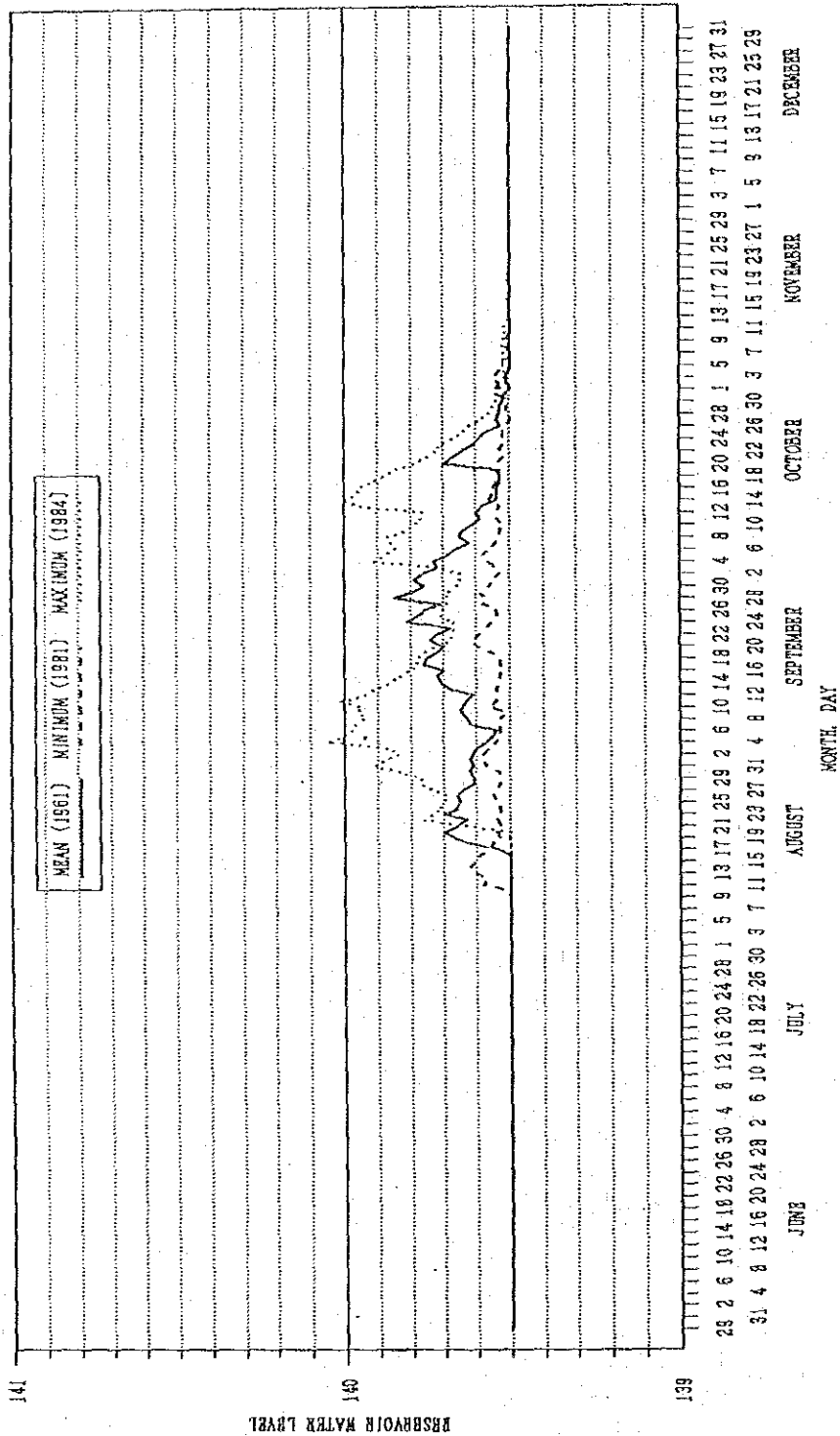


Figure 5-6 Reservoir Water Level above the Normal Water Level

- About 44 percent of the total Study Area of 71,700 ha (448.1 thousand ra) is earmarked as land for paddy cultivation. Therefore, especially L1, L2 and L4 class land will be used for wet season paddy fields.
- A part of the above-mentioned land classes of L1, L2, and L5 and L6 situated in relatively high land near the proposed irrigation canal will be utilized for crop diversification in both wet and dry seasons for upland crops such as stringbean.
- A part of the L1 land will be used for annual crops such as mango and other tree crops.
- The remaining upland crop area is planned to be fed by rain, so that cassava and kenaf will be planted here.
- About five percent of the cultivation land will be used as right-of-way for project facilities such as canals.

### 5.3.2 Proposed Land-Use Plan

Based on the above-mentioned concepts for proposed land-use, the proposed land-use for the Study Area is planned as shown below;

Table 5-8 Proposed Land-Use Plan

(unit: ha)

Land Category	Present Land-Use	Proposed Land-Use				Total
		Cultivated Area		Forest	Village & Others	
		Irrigated	Rainfed			
<b>1. Cultivated Area</b>						
Paddy Field	31,430	25,740	2,200	1,910	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	1,910	1,840	36,500
<b>2. Non-Cultivated Area</b>						
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
<b>Total</b>	<b>55,500</b>	<b>34,000</b>	<b>2,970</b>	<b>16,100</b>	<b>2,430</b>	<b>55,500</b>

## 5.4 Water Resource Development Plan

### 5.4.1 River Run-off

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:

Table 5-9 Estimated Probable Flood Discharge

Return Period (year)	Peak Flood Discharge (cu.m / sec)	Specific Discharge (cu.m / sec / sq.km)
1,000	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

Table 5-10 Designed Flood Discharge of Spillway

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

Table 5-11 Designed Flood Discharge of Diversion Facilities

Return Period	Specific Discharge			Probable Flood at Dam-site (cu.m/sec)
	53801 (cu.m/sec/sq.km)	M80	Mean	
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
Average annual sediment accumulation	:	124,680 cu.m
1/100-year sediment accumulation	:	12.5 MCM

#### 5.4.2 Water Requirement (cf. 5.5.2)

#### 5.4.3 Water Utilization Plan

The reservoir operation rule of the proposed D-28 reservoir is tentatively formulated through the water balance study of the project.

##### 1) Water Balance Study

Water balance study of the proposed D-28 reservoir was made for a period of 30 years from 1961 to 1990 on a daily basis. Summaries of the reservoir operation study are shown in the following table indicating the behavior of water level through the calculated periods. The reservoir water level recovers its normal water level of EL.139.5 m every year because of the normal flooding during the wet season.

##### 2) Spillage

An annual mean spillage from the reservoir is estimated at 396 MCM as against 591 MCM of annual mean inflow. Generally, the spillage from the reservoir will begin at the end of July and gradually cease forwards the end of November.

##### 3) Water Shortages

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

Table 5-13 Restricted Reservoir Water Level

Date	Reduction Ratio of Irrigation Area						(unit : WL.m)
	100%	90%	80%	70%	60%	50%	
Jan. 1	139.30						
Feb. 15	138.30						
Apr. 1	137.30						
May 1	136.70	137.10	136.80	136.50	136.10	135.60	
Jun. 15	136.00	136.45	136.20	135.80	135.45	135.05	
Jul. 1	135.00	135.70	135.45	135.15	134.90	-	
Jul. 15	134.70	134.80	-	-	-	-	
Aug. 1	134.70						
Aug. 15	139.50						
Oct. 15	139.50						

**Table 5-12 Summary Results of Water Balance Study**

SUMMARY OF THE WATER BALANCE STUDY		SUMMARY OF THE WATER BALANCE STUDY					
PROJECT SITE : D-28	RESERVOIR CAPACITY	PROJECT SITE : D-28	RESERVOIR CAPACITY				
DRAINAGE AREA : 1246.8 sq.km	TOTAL : 117.107 MCM	DRAINAGE AREA : 1246.8 sq.km	TOTAL : 117.107 MCM				
	EFFEC. : 104.639 MCM		EFFEC. : 104.639 MCM				
	DEAD : 12.468 MCM		DEAD : 12.468 MCM				
IRRIGATION AREA		IRRIGATION AREA					
CROPPING PATTERN TYPE-I		CROPPING PATTERN TYPE-II					
PADDY : 32750 ha	RESERVOIR WATER LEVEL	PADDY : 31700 ha	RESERVOIR WATER LEVEL				
UPLAND CROP (WET): 5100 ha	N.W.L. : 139.500 m	UPLAND CROP (WET): 1050 ha	N.W.L. : 139.500 m				
UPLAND CROP (DRY): 5400 ha	DEAD : 134.350 m	UPLAND CROP (DRY): 5440 ha	DEAD : 134.350 m				
PERENNIAL CROP : 1250 ha		PERENNIAL CROP : 1250 ha					
YEAR	RAINFALL	INFLOW	IRRIG. DEMAND	RESERV. LOSS	YEAR END STORAGE	SPILLAGE	SHORTAGE
	mm	MCM	MCM	MCM	m	MCM	MCM
1961	1455.5	622.199	120.915	61.082	138.895	95.249	430.957
1962	1472.7	635.505	112.367	55.547	138.773	91.187	439.888
1963	1496.1	630.378	84.700	51.850	138.928	95.415	457.091
1964	1446.8	629.504	119.203	55.708	138.862	94.152	425.380
1965	1337.9	513.342	140.944	48.374	137.232	94.706	341.800
1966	1606.5	663.850	136.455	46.102	138.881	94.787	422.005
1967	1535.3	632.620	87.537	56.788	138.910	95.759	455.694
1968	1347.0	604.153	84.691	55.900	138.747	90.347	436.773
1969	1328.6	505.276	89.067	53.265	138.842	93.488	334.535
1970	1401.6	555.757	131.921	55.998	138.297	76.431	357.101
1971	1242.4	475.285	89.673	47.689	138.593	85.388	308.223
1972	1413.4	521.965	85.960	50.274	138.958	97.384	348.723
1973	1637.9	285.521	117.293	46.827	138.689	88.463	124.961
1974	1355.7	435.328	82.969	47.022	138.853	94.189	277.842
1975	1808.7	919.322	81.351	51.331	139.084	101.791	733.069
1976	1460.8	614.927	89.429	54.992	139.042	100.309	441.238
1977	968.1	258.544	171.230	46.975	138.221	74.227	99.990
1978	1494.4	542.116	213.752	43.687	138.943	95.892	275.772
1979	1231.4	486.243	145.973	59.173	138.699	88.776	264.897
1980	1286.6	440.458	104.510	46.567	138.855	95.240	260.900
1981	1170.1	323.658	89.734	52.453	138.856	93.953	154.198
1982	1489.5	563.173	83.885	48.791	138.968	97.747	336.539
1983	1346.4	564.713	154.696	54.251	138.872	94.486	330.790
1984	1879.2	1100.850	177.525	47.344	139.019	99.501	816.434
1985	1220.9	479.518	134.975	58.746	138.922	95.176	265.154
1986	1509.5	674.611	88.423	56.868	139.016	99.415	492.553
1987	1504.9	712.752	91.339	56.123	139.086	102.185	526.876
1988	1582.8	790.047	181.148	62.663	139.013	99.278	509.662
1989	1260.8	540.806	115.523	54.005	138.971	97.846	345.692
1990	1889.9	1007.625	82.933	60.443	139.111	102.724	809.901
AVE.	1416.4	591.008	116.307	52.921	138.807	92.783	396.288
							-3.994

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UPLAND CROP (DRY): 5400 ha	DEAD : 134.350 m	UPLAND CROP (DRY): 5440 ha	DEAD : 134.350 m				
PERENNIAL CROP : 1250 ha		PERENNIAL CROP : 1250 ha					
YEAR	RAINFALL	INFLOW	IRRIG. DEMAND	RESERV. LOSS	YEAR END STORAGE	SPILLAGE	SHORTAGE
	mm	MCM	MCM	MCM	m	MCM	MCM
1961	1472.7	622.199	128.435	60.038	138.872	94.465	425.265
1962	1472.7	635.505	118.543	54.506	138.744	90.233	434.932
1963	1496.1	630.378	90.842	50.625	138.901	95.461	452.178
1964	1446.8	629.504	126.246	54.452	138.834	93.198	419.595
1965	1337.9	513.342	146.973	48.740	137.258	50.252	334.923
1966	1606.5	663.850	142.339	45.920	138.853	93.830	419.913
1967	1535.3	632.620	94.120	55.588	138.882	94.805	450.315
1968	1347.0	604.153	91.306	54.619	138.718	89.393	433.447
1969	1328.6	505.276	96.012	52.040	138.814	92.534	328.825
1970	1401.6	555.757	136.514	56.274	138.306	76.696	352.034
1971	1242.4	475.285	95.145	46.827	138.566	84.544	306.484
1972	1413.4	521.965	94.488	48.546	138.930	96.430	344.735
1973	1637.9	285.521	123.367	45.737	138.560	87.508	123.735
1974	1355.7	435.328	91.270	45.736	138.835	93.234	270.852
1975	1808.7	919.322	88.474	50.403	139.062	100.950	795.739
1976	1460.8	614.927	96.701	54.085	139.020	99.528	434.880
1977	968.1	258.544	176.947	45.896	138.203	73.702	99.559
1978	1494.4	542.116	216.885	42.880	138.915	95.938	275.748
1979	1231.4	486.243	153.511	58.224	138.671	87.861	258.270
1980	1286.6	440.458	111.809	45.072	138.866	94.286	255.193
1981	1170.1	325.496	96.760	51.229	138.828	92.999	150.502
1982	1489.5	563.173	90.359	47.402	138.940	96.793	393.443
1983	1346.4	564.713	161.930	52.911	138.844	93.532	324.891
1984	1879.2	1100.850	183.387	46.190	138.991	98.547	815.434
1985	1220.9	479.518	140.909	57.843	138.898	95.349	259.980
1986	1509.5	674.611	95.402	55.732	138.989	98.460	486.849
1987	1504.9	712.752	98.148	55.163	139.068	101.231	521.046
1988	1582.8	790.047	186.878	61.880	138.985	98.324	504.687
1989	1260.8	540.806	123.523	52.881	138.943	96.892	338.796
1990	1889.9	1007.625	87.955	59.716	139.084	101.770	804.690
AVE.	1417.0	591.064	122.840	51.876	138.783	91.960	391.525
							-4.709

## 5.5 Irrigation Development Plan

### 5.5.1 Selection of Irrigation Area

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	:	<u>25,200 ha</u>
Total		34,000 ha

### 5.5.2 Irrigation Plan

#### 1) Irrigation Water Requirement

##### a) Proposed Cropping Pattern

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

Type-I: (for first 5 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 Type-I would be 115 percent, 100 percent in the wet season and 15 percent in the dry season. That for Type-II would be 116 percent, 100 percent in the wet season and 16 percent in the dry season, respectively.

##### b) Crop Water Requirement

Reference crop evapotranspiration (ET<sub>o</sub>) is estimated by applying the modified Penman Method using climatological data observed at Ubon Ratchathani station (1961 - 1990).