CHAPTER 4 CURRENT CONDITION IN THE STUDY AREA

4.1 Natural Condition

(1) Topography and Geology

The Lam Pa Chi River basin is a part of the Mae Klong Basin located in the western edge. The basin is bounded in the west by the mountain range forming the border with Burma, and on the south by mountains forming the boundary between Ratchaburi and Phetchaburi Provinces. The eastern and northern boundaries of the basin are not so clear but surrounded by a chain of small mountains with the total area of around 2,500 km^2 of the basin area, the western half of it is occupied by mountainous zone continuing to Myanmar. Mountains are low but rather steep, ranging from 700 to 1,100 m msl. Eastern half of the basin is mostly plain with many small isolated mountains scattered. Minor tribes namely Kalin, Mon, Barma are the inhabitants in the area. The standard of living remains very low.

Most of the river systems in Thailand, including the Mae Klong and the Kwae Yai/Noi Rivers from the upstream, flow down roughly towards south from north. However, the Lam Pa Chi River is, solely and remarkably, flows up to north from south, suggesting rather complicated history of river development. Basic geology of the basin is classified into two categories, sedimentary sequences including metamorphic phases and intrusive rocks, mainly granite bodies. The sedimentary sequences form low but steep mountains in the west of the basin, consisted of sandstone, quartzite, shale, and limestone, accompanied with metamorphic rocks of slate, phyllite, gneiss and schist. Granite bodies form also low but gentle mountains located in the south of the basin

(2) Meteorology and Hydrology

(a) Location of the Meteorology and Hydrology Stations

There are 3 meteorological stations around the Study Area and 4 streams gauging stations, 3 out of 4 are in the Study Area and one station of K37 is located at the confluence of Khwae Noi river and Lam Pa Chi River. Ban Bueng station (K25) had suspended observation in 1993. Instead of K25, Ban Kha station has started its observation in 1994. Location of the stations and observation periods etc. are shown in Figure 4.1.1.

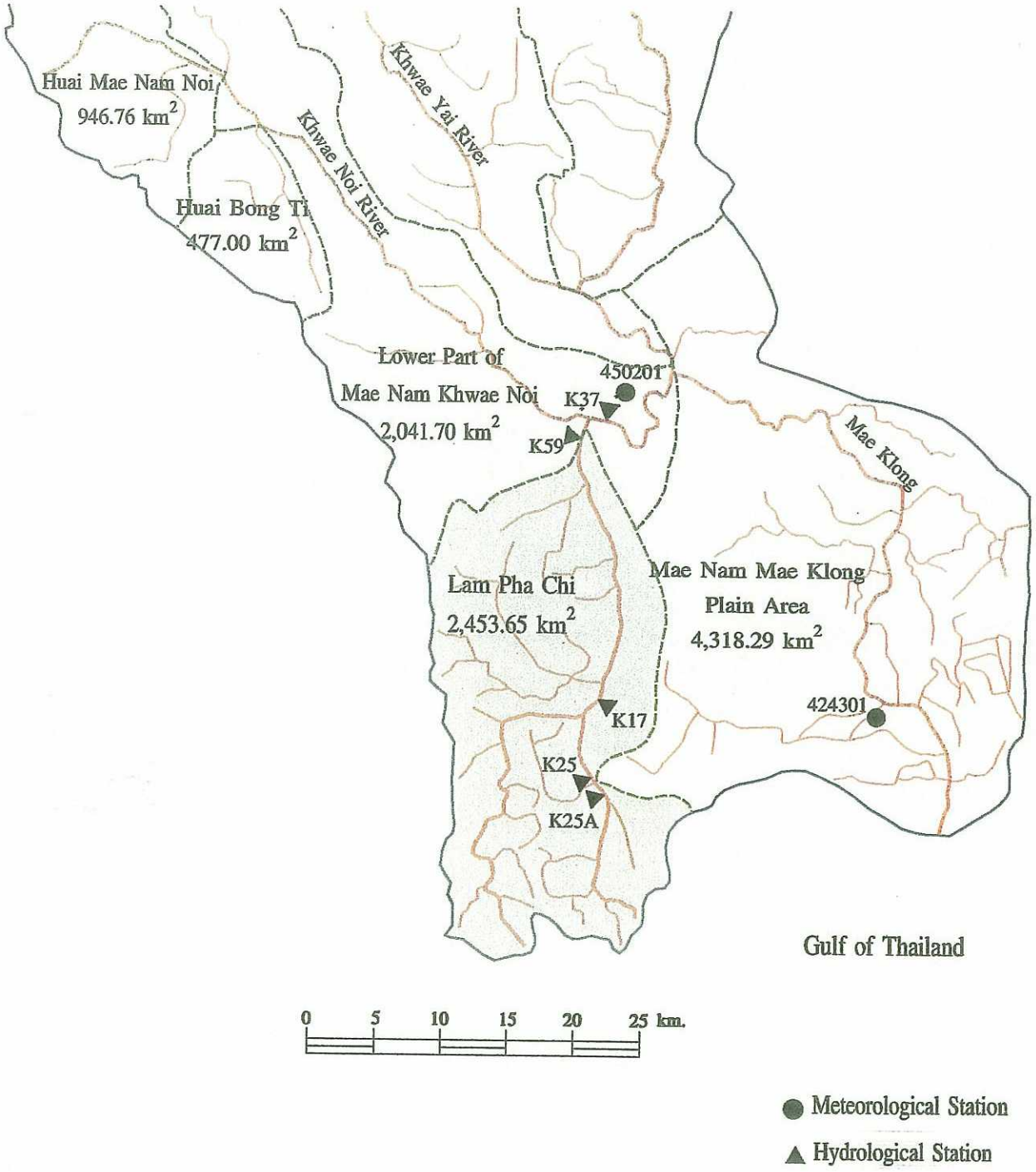


Figure 4.1.1 Location Map of Meteorological and Hydrological Stations

Table 4.1.1 List of Meteorological and Hydrological Stations

Code	Station Name	Tambon / Province	Watershed (km^2)	Period	Latitude	Longitude
1. Meteorology						
424301	Ratchaburi	Ratchaburi		1992-present	13 - 30 - 00	99 - 48 - 00
450201	Kanchanaburi	Kanchanaburi		1955-present	14 - 01 - 00	99 - 32 - 00
450401	Thong Pha Phum	Kanchanaburi		1965-present	15 - 45 - 00	98 - 38 - 00
2. Hydrology						
K.17*	Ban Bo	T. Suan Phueng / Ratchaburi	1355	1966-present	13 - 32 - 41	99 - 21 - 22
K.25*	Ban Bueng	T. Ban Kha / Ratchaburi	482	1982 - 1993	13 - 25 - 42	99 - 24 - 25
K.25A	Ban Kha	T. Ban Kha / Ratchaburi	250	1994-present	13 - 24 -07	99 - 25 - 14
K.59	Chorakhe Phuek	T. Chorakhe Phuek / Kanchanaburi	N/A	2000-present	N/A	N/A

Note: Station of K17 and K25 has also rainfall record.

(b) Meteorology

1) Rainfall

The climate of the Lam Pa Chi River basin is dominated by monsoon. The southwest wind during the wet monsoon season from May to October brings a lot of rainfall, whereas the northeast wind during the dry monsoon season from November to April brings little rainfall. Based on the table below, the rainfall on the lower part of the basin is roughly 1,000 mm, and it increases with latitude to roughly 1,200 mm in the upper part of the basin. The rainfall pattern is mainly caused by the mountain ridges at west of the basin and the southwest monsoon wind with highly moist air. According to the Rainfall data of K17, 47252, and K25A in the Study Area, maximum rainfall occurs in July, minimum in October and the mean annual rainfall varies from 1,140 mm to 1,190 mm.

Table 4.1.2 Rainfall Record at Each Station

Sta. Name		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Ratchaburi (424301)	Max.	8.0	16.0	190.1	157.8	297.9	255.9	298.7	197.9	375.4	405.4	348.7	24.5	1,521.5
	Mean	1.2	4.4	40.0	46.8	154.5	137.9	119.4	122.6	248.7	268.0	62.6	5.2	1,180.9
	Min.	0.0	0.0	0.0	0.0	21.7	62.9	45.0	31.1	109.6	80.3	0.0	0.0	743.6
Kanchanaburi (450201)	Max.	22.3	79.3	101.6	271.7	224.4	169.0	209.5	204.1	469.7	455.8	360.4	44.3	1,496.2
	Mean	2.8	14.2	18.8	75.7	131.0	75.8	98.2	99.4	221.5	223.4	60.1	7.8	1,003.9
	Min.	0.0	0.0	0.0	2.2	15.6	3.2	40.4	16.9	75.4	85.9	0.2	0.0	659.4
Thong Pha Phum (450401)	Max.	50.4	60.7	110.2	267.9	394.7	585.0	695.2	599.3	406.1	358.8	137.4	31.9	2,130.6
	Mean	7.0	16.5	41.2	105.9	214.0	276.3	316.8	328.9	238.2	191.2	32.3	4.0	1,748.1
	Min.	0.0	0.0	0.0	21.0	59.5	147.5	108.3	103.5	127.5	83.4	0.0	0.0	1,155.0
K17 (47161)	Mean	4.1	14.5	51.0	80.8	150.0	76.8	98.0	99.2	200.0	267.4	95.8	8.7	1,146.4
47252	Mean	3.4	9.7	52.2	93.0	164.3	69.4	106.0	112.9	181.4	296.4	78.4	6.1	1,173.2
K25A(47271)	Mean	2.9	9.1	55.3	101.4	168.7	73.6	104.9	83.8	193.2	301.7	83.0	6.8	1,184.4

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: mm)

Note: Observation periods at each station are shown in Table 4.1.1.

2) Temperature

Kanchanaburi station located in the north of the basin has an annual mean temperature of 28.0°C. The monthly mean temperature varies from 24.6°C in December to 31.0°C in April. Ratchaburi station located in the east of the basin has almost the same temparatures as in Kanchanaburi.

Table 4.1.3 Air Temperature

Sta. Name		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean
Ratchaburi (424301)	Extreme Max.	36.6	38.9	38.7	40.9	39.8	39.0	37.0	36.2	37.0	36.2	34.9	34.9	40.9
	Mean Max.	32.5	34.1	35.1	36.4	35.2	33.9	33.4	33.0	32.7	31.4	30.5	30.5	33.2
	Mean	26.3	27.6	29.2	30.7	30.2	29.5	29.1	28.9	28.6	27.7	26.4	25.4	28.3
	Mean Min.	19.9	21.1	23.4	24.9	25.2	25.0	24.8	24.8	24.5	24.0	22.2	20.2	23.3
	Extreme Min.	15.4	17.1	19.8	22.7	23.9	23.5	23.6	23.5	23.2	21.6	18.9	14.9	14.9
Kanchanaburi (450201)	Extreme Max.	38.4	40.8	42.1	43.5	42.8	40.6	39.7	39.4	39.8	36.0	38.0	36.4	43.5
	Mean Max.	33.3	35.8	37.6	38.5	36.3	34.5	34.1	33.7	33.6	32.1	31.5	31.4	34.4
	Mean	25.9	27.9	29.7	31.0	29.8	28.9	28.6	28.2	27.9	27.1	26.1	24.6	28.0
	Mean Min.	20.0	21.9	24.2	26.0	25.9	25.6	25.2	25.1	24.6	23.8	22.2	19.5	23.7
	Extreme Min.	10.5	14.1	13.9	21.6	21.5	23.0	21.1	22.2	20.2	17.0	12.4	9.2	9.2
Thong Pha Phum (450401)	Extreme Max.	37.0	39.2	40.9	42.0	41.5	38.0	36.5	36.2	35.4	36.0	36.0	39.2	42.0
	Mean Max.	33.0	35.0	36.8	37.1	34.2	31.4	30.7	30.4	31.6	32.1	31.7	31.5	33.0
	Mean	24.9	26.3	28.7	29.7	28.3	27.1	26.5	26.2	26.6	26.5	25.0	23.6	26.6
	Mean Min.	16.6	17.9	20.4	22.6	23.4	23.2	22.8	22.6	22.5	21.8	19.2	16.0	20.8
	Extreme Min.	7.4	8.1	11.5	17.7	19.5	19.5	20.0	19.5	19.2	13.9	9.9	5.2	5.2

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: °C)

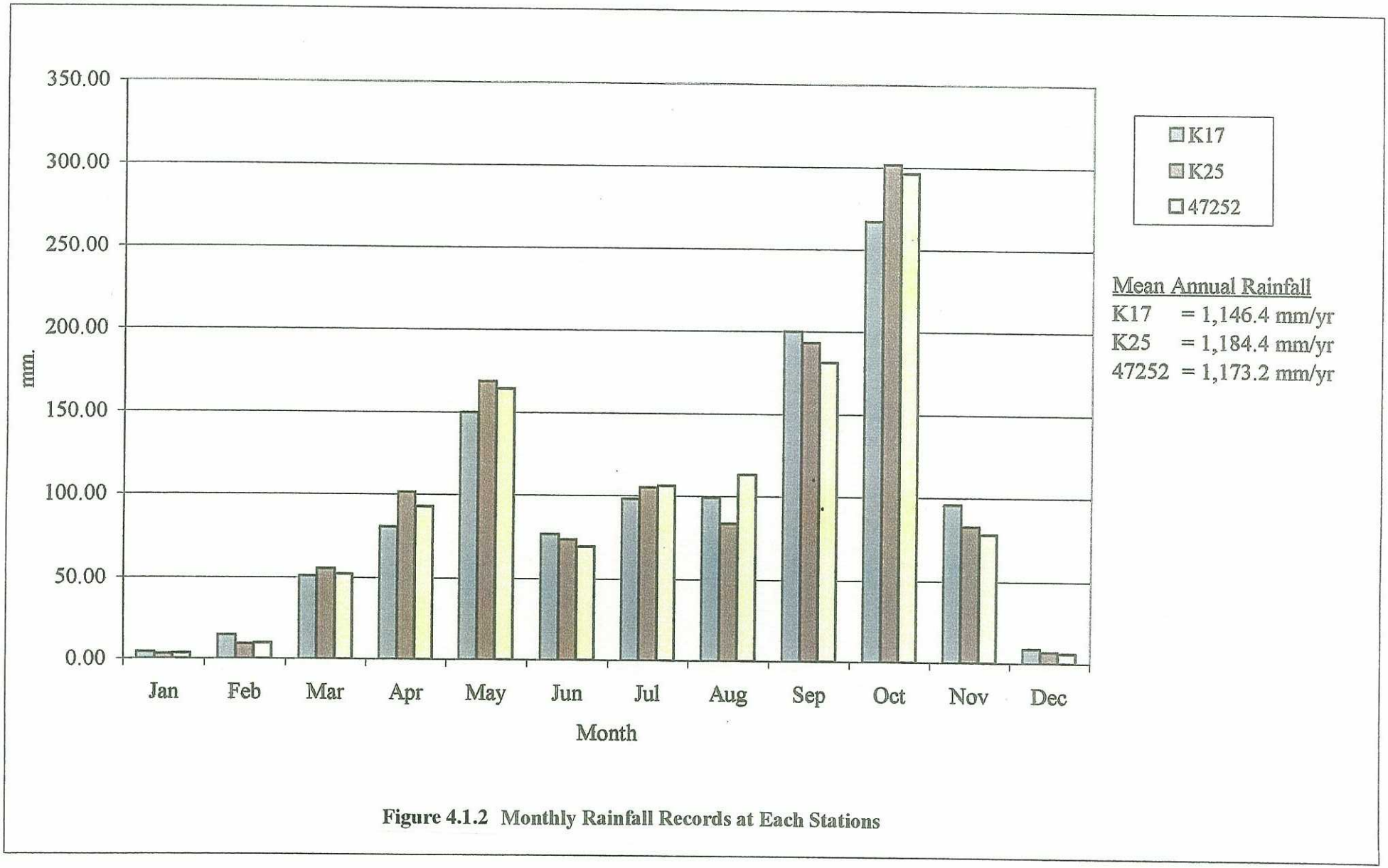


Figure 4.1.2 Monthly Rainfall Records at Each Stations

3) Evaporation

Mean annual evaporations at the 3 stations are 1,694.0 mm, 1,856.5 mm and 1,405 mm, respectively. In the basin, annual evaporation increases from southern to northern parts. The maximum value occurs in August while the minimum one occues in October.

Table 4.1.4 Evaporation

Sta. Name		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Ratchaburi	Max.	139.5	162.4	217.0	231.0	207.7	198.0	179.8	161.2	153.0	127.1	135.0	145.7	2,057.4
	Mean	133.0	140.3	167.1	179.4	166.8	144.6	147.3	135.2	123.0	108.2	116.0	133.3	1,694.0
	Min.	127.1	103.6	136.4	141.0	133.3	123.0	120.9	124.0	87.0	93.0	102.0	124.0	1,415.3
Kanchanaburi	Max.	164.8	182.9	223.7	262.8	225.0	218.2	197.1	200.1	164.1	174.1	178.0	194.7	2,064.3
	Mean	139.3	149.3	200.3	212.5	184.1	155.0	158.2	151.6	138.5	119.8	125.7	140.5	1,856.5
	Min.	112.7	67.4	146.5	152.7	148.1	114.6	126.1	118.9	102.7	84.5	94.1	122.2	1,402.0
Thong Pha Phum	Max.	130.3	175.1	210.6	228.1	177.7	125.3	111.6	128.7	125.0	126.8	112.5	124.8	1,673.9
	Mean	119.1	139.5	178.2	182.5	139.4	97.4	91.7	86.3	104.4	107.8	102.5	107.7	1,404.7
	Min.	105.2	116.5	137.1	135.3	96.7	57.2	65.1	61.7	79.4	91.4	90.6	91.9	1,038.6

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: mm)

4) Humidity

Mean annual humidity shows 69.1% in Kanchanaburi and 71.8 % in Ratchaburi and 77.7 % in Thong Pha Phum. Maximum value occurs in October and Minimum in March or April.

Table 4.1.5 Humidity

Sta. Name		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Ratchaburi	Mean Max.	92.4	91.9	92.6	92.3	91.3	92.7	92.2	93.3	93.5	94.6	94.2	92.3	92.8
	Mean	66.9	65.0	66.2	67.1	69.9	73.1	73.5	75.0	76.8	79.3	75.3	69.4	71.8
	Mean Min.	40.8	37.7	39.7	41.3	48.2	53.1	54.5	56.1	59.9	63.6	55.8	46.3	50.3
Kanchanaburi	Mean Max.	84.2	81.8	80.2	79.7	84.7	85.1	85.6	86.4	89.4	92.4	88.6	85.2	85.3
	Mean	64.0	60.8	60.0	61.7	69.9	71.4	71.7	73.3	76.7	80.5	73.4	66.2	69.1
	Mean Min.	39.8	35.3	35.2	38.0	49.5	54.0	53.9	56.0	58.0	62.9	53.6	43.0	48.3
Thong Pha Phum	Mean Max.	92.3	88.6	86.4	89.1	93.1	94.9	95.6	95.9	95.9	96.0	95.2	94.1	93.1
	Mean	71.4	64.7	62.8	68.4	79.6	85.2	86.8	87.8	86.0	84.7	79.8	75.2	77.7
	Mean Min.	42.4	37.0	37.7	43.6	59.4	68.0	71.1	72.1	67.4	64.2	53.6	46.3	55.2

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: %)

5) Wind

The southwest to west wind during the wet monsoon season from May to October brings a lot of rainfall, whereas the north to northeast wind during the dry monsoon season from November to April brings little rainfall. Mean maximum wind velocity of about 2.0 m/sec occurs in August and minimum one occurs in October.

Table 4.1.6 Direction and Wind Velocity

Sta. Name		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Ratchaburi	Mean	1.6	2.0	2.1	1.8	1.8	1.5	1.7	1.9	1.3	1.3	2.4	2.7	1.9
	Prevailing	N	SE	SE	SE	SE-W	W	W	W	W	N-NE	N	N	
Kanchanaburi	Mean	1.2	1.6	1.9	2.0	1.7	1.7	2.0	2.0	1.4	1.1	1.6	1.6	1.7
	Prevailing	NE	SE	SE	W	W	W	W	W	W	NE	NE	NE	
Thong Pha Phum	Mean	0.5	0.8	1.1	1.0	0.5	0.3	0.3	0.3	0.3	0.3	0.8	0.7	0.6
	Prevailing	SE	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: m/sec)

6) Sunshine

Sunshine data are only available in Ratchaburi station and sunshine duration of more than 11 occurs 5 months from April to August.

Table 4.1.7 Sunshine

Sta. Name		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Ratchaburi	Max.	10.0	10.3	10.6	11.0	11.5	11.6	11.2	11.3	9.9	10.5	10.3	10.2	11.6
	Mean	7.6	8.1	7.8	8.2	6.4	5.0	4.5	3.8	4.3	4.8	6.7	7.5	6.2

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: hours)

(c) River Discharge

River discharge at (4) four stations is summarized below. According to the table below, monthly mean maximum discharges occur in October, which caused flood damages in the downstream basin, and minimum discharges show in March at K17 and K25A and in January at K25. Observation of K25A was started in 1994 instead of K25 which observation was suspended in 1993.

Table 4.1.8 Discharge Records at Each Gauging Station

Sta. N		APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Total
K.17	Max.	20.07	49.78	94.05	115.37	58.75	172.02	236.23	168.45	22.90	13.90	10.50	9.60	706.85
	Mean	4.44	14.10	14.80	15.54	16.07	28.63	91.52	53.43	10.34	4.57	2.65	2.56	258.64
	Min.	0.35	2.40	1.47	1.31	0.82	1.87	11.40	1.16	0.50	0.25	0.20	0.17	55.92
K.25	Max.	1.95	18.19	28.62	8.63	3.87	27.46	75.40	35.87	21.70	4.17	12.67	25.47	175.19
	Mean	0.99	4.65	4.87	1.94	1.38	6.37	33.11	14.54	4.80	1.34	2.03	3.64	79.68
	Min.	0.09	0.24	0.49	0.10	0.26	0.27	2.60	1.96	0.72	0.38	0.19	0.28	14.07
K.25A	Max.	4.80	20.10	6.95	19.94	10.40	65.99	71.59	50.73	5.20	1.60	0.97	1.08	224.05
	Mean	1.25	4.16	1.97	3.18	2.59	13.67	34.61	19.74	2.62	0.98	0.59	0.63	85.97
	Min.	0.10	0.20	0.14	0.14	0.28	0.72	5.99	1.27	0.40	0.17	0.07	0.06	14.80
K.59	Max.	45.52	71.00	21.15	16.61	9.12	37.64	101.30	66.42	8.33	3.83	1.77	4.95	350.14
	Mean	24.37	37.36	11.95	10.87	8.43	28.65	92.24	48.00	5.98	2.23	0.89	2.70	273.65
	Min.	3.22	3.72	2.74	5.13	7.73	19.66	83.17	29.58	3.63	0.62	0.00	0.45	197.15

Source: Meteorological Center in Ratchaburi and Kanchanaburi (Unit: MCM)

Table below shows comparison on volume of rainfall and run-off in Lam Pa Chi basin (2,511.54 km2) estimated by Land Department. As indicated, the maximum monthly discharge occurs in October or 76.39 MCM, minimum shows in January, and an average mean run-off is estimated as 357.30 MCM/year which is about 11% in Total. Monthly base discharge flows and specific river discharges at each gauging station are shown in Figure 4.1.3 and Figure 4.1.4.

Table 4.1.9 Comparison Table between Rainfall and Run-Off in Lam Pa Chi River Basin

Month	Average Rainfall (mm)	Average Run-off	
		(mm)	(MCM)
April	86.05	9.61	24.13
May	168.45	18.95	47.60
June	87.10	9.73	24.43
July	144.38	16.22	40.74
August	119.39	13.39	33.62
September	262.50	29.62	74.40
October	269.50	30.42	76.39
November	66.00	7.33	18.41
December	8.54	0.81	2.04
January	2.24	0.10	0.25
February	12.20	1.23	3.09
March	44.20	4.86	12.20
Total	1,270.55	142.27	357.30

Remarks: The Equation for Run-off Evaluation are shown as following

Q_m = -154.9041+113.4349R (r=0.7007**), Q_m = Monthly Run-off (m^3/km^2), R = Monthly Rainfall (mm.)

Table 4.1.10 indicates the estimated mean discharge at each gauging station. Depending on the topography, rainfall, etc the mean annual year discharge at each watershed is characterized. According to the table, K25A shows maximum discharge of 0.332 MCM/km^2 and K17 as well as K25 shows same discharge values of 0.191 and 0.165 MCM/km^2, respectively.

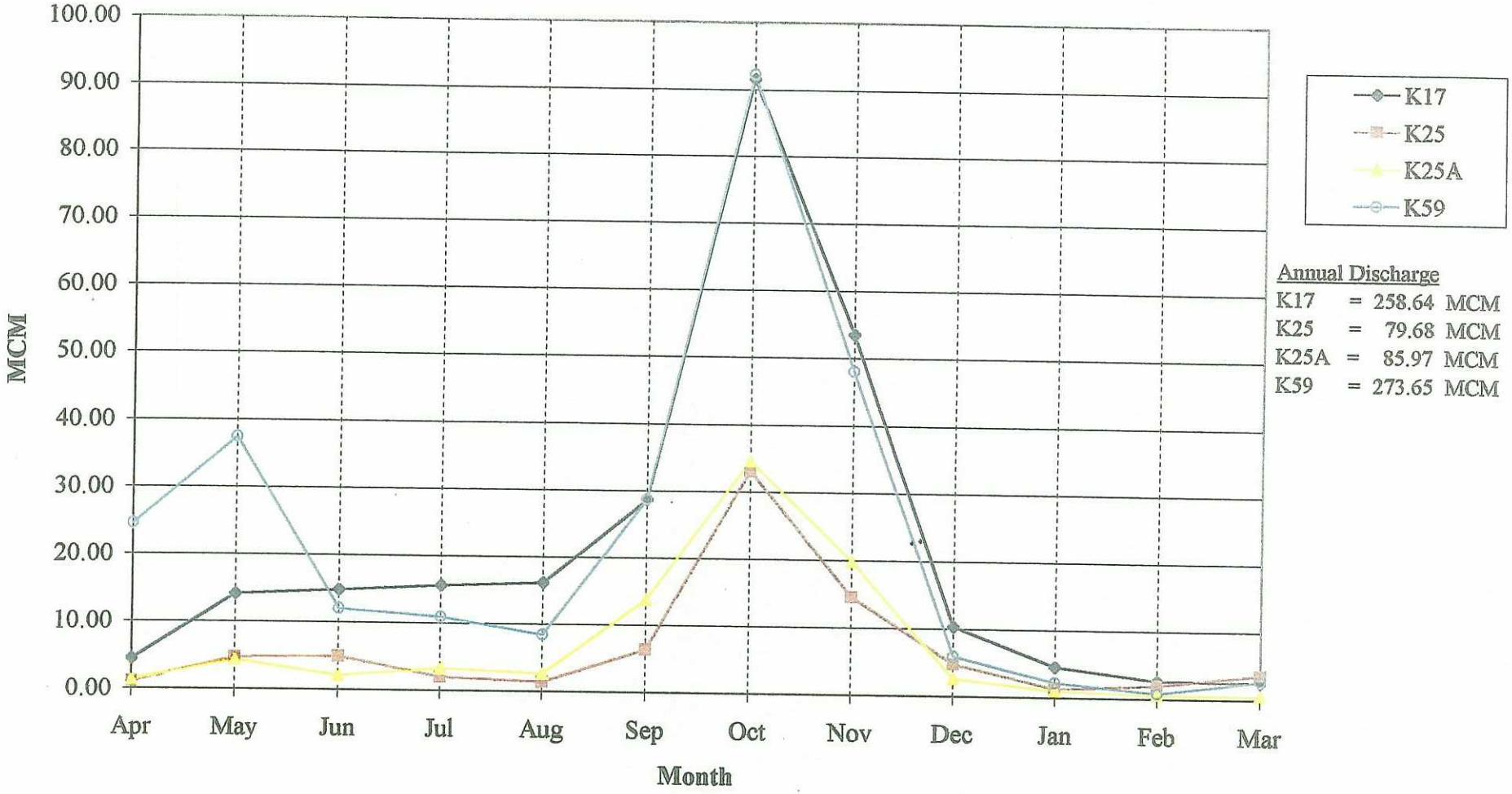


Figure 4.1.3 River Discharge at Each Gauging Station

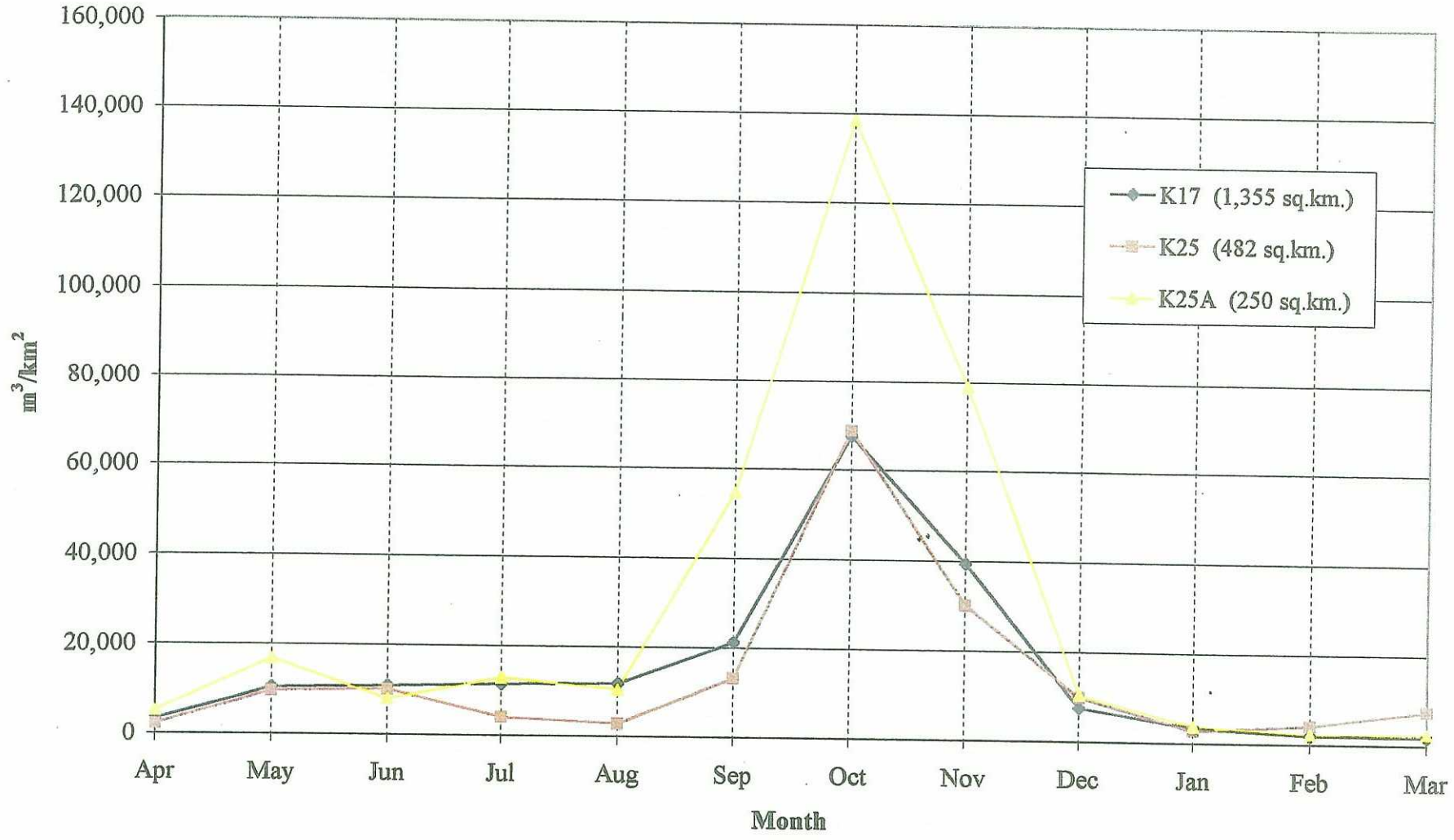


Figure 4.1.4 Specific River Discharge at Each Gauging Station

Table 4.1.10 Mean Discharge at Each Gauging Station

Name of Station	Catchments Area (km^2)	Annual Mean Discharge (MCM)	Mean Discharge (MCM/km^2)
K 17	1,355	258.64	0.191
K 25	482	79.68	0.165
K25A	259	85.97	0.332
K59	n.a.	273.65	n.a
Estimation*	2511.54	357.30	0.142

Estimation*: Sourced by Land Development Department

(3) River Conditions

(a) Erosion Conditions

There are many places experiencing erosion, mainly on Lam Pa Chi and Tha Khoei rivers. Table 4.1.11 shows the places with severe erosion in Lam Pa Chi basin.Most of the places are located at downstream portion, Lam Pa Chi and Tha Khoei rivers, at boundary Amphoe Ban Kha and Sua Phueng. It is reported that erosion advanced by 4 to 5 meters after occurrence of flood at the severe place. River erosion is advancing remarkably along Lam Pa Chi river at three (3) Tambons, namely; Nong Phai, Dan Makham Tia, and Chorakhe Phuek in Kanchanaburi Province.

Major flood occurred in 1996 and 1999 of the last decade. At the places occurring severe erosion located at Tambon Chorakhe Phuek, width of erosion were measured at about 40 m and 20 m at river bank in 1996 and 1999 respectively. Some bridges under the same conditions crossing Lam Pa Chi River, therefore, were insisted to extend.

There is no remarkable erosion in mountainous area such as landslide and soil erosion other than sheet and/or rill erosion in Pineapple field at Amphoe Ban Kha.

Table 4.1.11 Conditions of Lam Pa Chi River on Erosion on Flood by Tambon

Amphoe Tambon	Place in Severe Erosion (Coordinate in approximate)	Length and Width (m)	Information on Flood and Erosion in relevant Tambon
Ratchaburi Province			
A.Suwan Phung			
1. Bha Kha	2 places at right banks of Tha Khoei river (440:840), (395:925) A right bank of Lam Pa Chi (425:895)	A total length of erosion portion is about 1,000m.	1)There is river erosion but no soil erosion in this Amphoe
2. Ban Bueng			1) There is no severe flood and erosion.
3. Nong Phan Chan			1) There is no severe flood and erosion.
A.Pak Tho			
5. Yang Hak			1) There is no severe flood and erosion.
A.Suan Phueng			
4. Tha Nao Si	2 places of land slide (270:885), (220:120)		
6. Suan Phueng	A land slide (305:935)		1) There is no severe flood and erosion.
7. Tha Khoei	A right bank of Lam Pa Chi (385:970)	A length of erosion portion is about 400m, width of 40m.	1) Bridge crossing Lam Pa Chi was extended due to erosion. 2) Flood occurs every year with depth of about 50cm.
8. Pa Wai	Both banks of Lam Pa Chi (420:010)	A total length of erosion portion is about 1,800m in both banks.	
A.Chom Bueng			
9. Dan Thap Tako	A right bank of Lam Pa Chi (480:150)	A length of erosion portion is about 1,000m.	1) There is flood due to flash water from mountain. 2) Progress of erosion is about 4 to 5 m in a year.
10.Rang Bua			1) There is no severe flood and erosion.
11.Kaem On	2 places at right banks of Lam Pa Chi (475:200), (475:170)	A total length of erosion portion is about 2,200m.	1) Duration of inundation is 2 to 3 weeks in normal flood. 2) There is flood due to flash water from mountain. 3) Sedimentation problem due to eroding Lam Pa Chi river bank.
12.Boek Phrai			1) There is no severe flood and erosion.
Kanchanaburi Province			
A.Dan Makham Tia			
13.Nong Phai	Both banks of Lam Pa Chi (460:230)	A total length of erosion portion is about 1,600m in both banks.	1) In 1999 flood, farm land is inundated with a area of 220 ha area and 96 houses and road with a length of 31km were under water with depth of 50 cm for 1 week. 2) There is flood due to flash water from mountain. 3) Bridge crossing Lam Pa Chi was extended due to erosion. 4) Flow capacity is reduced due to sedimentation.
14.Dan Makham Tia	A right bank of Lam Pa Chi (440:300) A left bank of Lam Pa Chi (410:310)	A total length of erosion portion is about 1,400m.	1) Duration of inundation is 1 to 2 weeks in normal flood. 2) Lam Pa Chi river course was changed due to sedimentation.
15.Chorakhe Phuek	A left bank of Lam Pa Chi (400:355)	A length of erosion portion is about 1,000m.	1) In 1996, about 40m of river bank is eroded, then in 1999, advanced another 20m. 2) In 1999 max. flood, 20-30 houses were under water with a depth of 50 cm for 1 month.
16.Klon Do	2 places at right banks of Lam Pa Chi (415:365), (415:380)	A total length of erosion portion is about 1,500m.	1)Flood occurs every year with depth of about 50cm.

Source: Information collected by JICA Study Team from TAO and Amphoe offices

1) Annual Maximum Peak Discharge

(b) Flood Condition

Annual maximum peak flood and its probability of K17 and K37 (Khwae Noi Basin) are summarized below. The probability of peak discharges is estimated by Iwai Method. According to the table, annual maximum peak flood occurred mainly in October at K17 and from the end of August to middle of October at K37. Locations of the gauge stations are shown in Figure 4.1.1.

Table 4.1.12 Annual Maximum Peak Flood of Main Tributaries from 1985 to 1995

Station	Catchments Area (Km^2)	1st	2nd	3rd	4th	5th
K37	10,603	1530.4	1119.0	1081.0	1054.6	1034.0
		19/10/'88	5/9/'94	2/9/'95	22/8/'91	15/10/'85
		1/16.2	1/6.0	1/5.4	1/5.1	1/4.9
K17	1,355	1484.0	432.1	374.6	357.4	271.5
		13/10/'85	20/10/'88	11/10/'95	8/11/'81	16/11/'83
		1/31.1	1/5.9	1/5.1	1/4.9	1/3.7

Note: Discharge records at K17 are not available in 1991
Sourced by ADCA Study Team in March 1998

2) Flood Damages in the Study Area

There is no formal record on flood damages, even flood occurred every year. When severe flood occurs, surveys on damages at some places such as farmland, road, bridge and house are carried out. There is, however, no well-organized report on flood damages in each Tambon. Once severe flood occurred, flood damage record is prepared by Amphoe offices by collecting raw data through TAOs. RID is not concerned in this process.The cost for necessary emergency works for damages caused by flood is offered by DOLA (Department of Local Administration) of the Province, if the cost was beyond TAOs' annual budget capacities.Rehabilitation works are executed as a project by Department of Public Works, RID and so on along with long term strategies.

Table 4.1.13 shows flood damages in Tambon, summarizing available information and data collected by the JICA Study Team. Estimates were shown in the Table for Amphoe Suwan Phueng which is located at the upstream of Lam Pa Chi River Basin, the data reveals that they have not experienced severe flood so far. Location of flood damage is shown in Figure 4.1.5.

Table 4.1.13 Flood Damages by Tambon

Amphoe Tambon	Occurred year	Flood Damages			
		Affected house (no.)	Farm land (ha)	Fish Pond(ha)	Total loss ('000Bt)
Ratchaburi Province					
A.Suwan Phueng	**-**	**326**	**664**		**18,600**
1. Bha Kha	Estimate	199	344	n.a.	10,600
2. Ban Bueng	Estimate	87	224	n.a.	5,600
3. Nong Phan Chan	Estimate	40	96	n.a.	2,400
A.Pak Tho					
5. Yang Hak	n.a.	n.a.	n.a.	n.a.	n.a.
A.Suan Phueng	**-**	**4,194**	**892**		
4. Tha Nao Si	1999	705	53	n.a.	n.a.
6. Suan Phueng	1999	1,563	83	n.a.	n.a.
7. Tha Khoei	1999	1,084	427	n.a.	n.a.
8. Pa Wai	1999	842	329	n.a.	n.a.
A.Chom Bueng	**-**	**(701)**	**(685)**		
9. Dan Thap Tako	1999	283	203	n.a.	n.a.
10.Rang Bua	n.a.	n.a.	n.a.	n.a.	n.a.
11.Kaem On	1999	418	482	n.a.	n.a.
12.Boek Phrai	n.a.	n.a.	n.a.	n.a.	n.a.
Kanchanaburi Province					
A.Dan Makham Tia	**-**	**324**	**771**	**125**	**23,208**
13.Nong Phai	2002	88	500	37	5,136
14.Dan Makham Tia	2002	100	122	23	2,195
15.Chorakhe Phuek	2002	44	48	30	5,993
16.Klon Do	2002	92	101	35	9,884

Source: Flood damage record collected from each TAO n.a.: Data not available

The following Table shows annual flood damages in the case of Tambon Chorakhe Phuek in Amphoe Dan Makham Tia in the last 8 years. The table shows that damages by flood in 1996 and 1999 were remarkably higher than the other years.

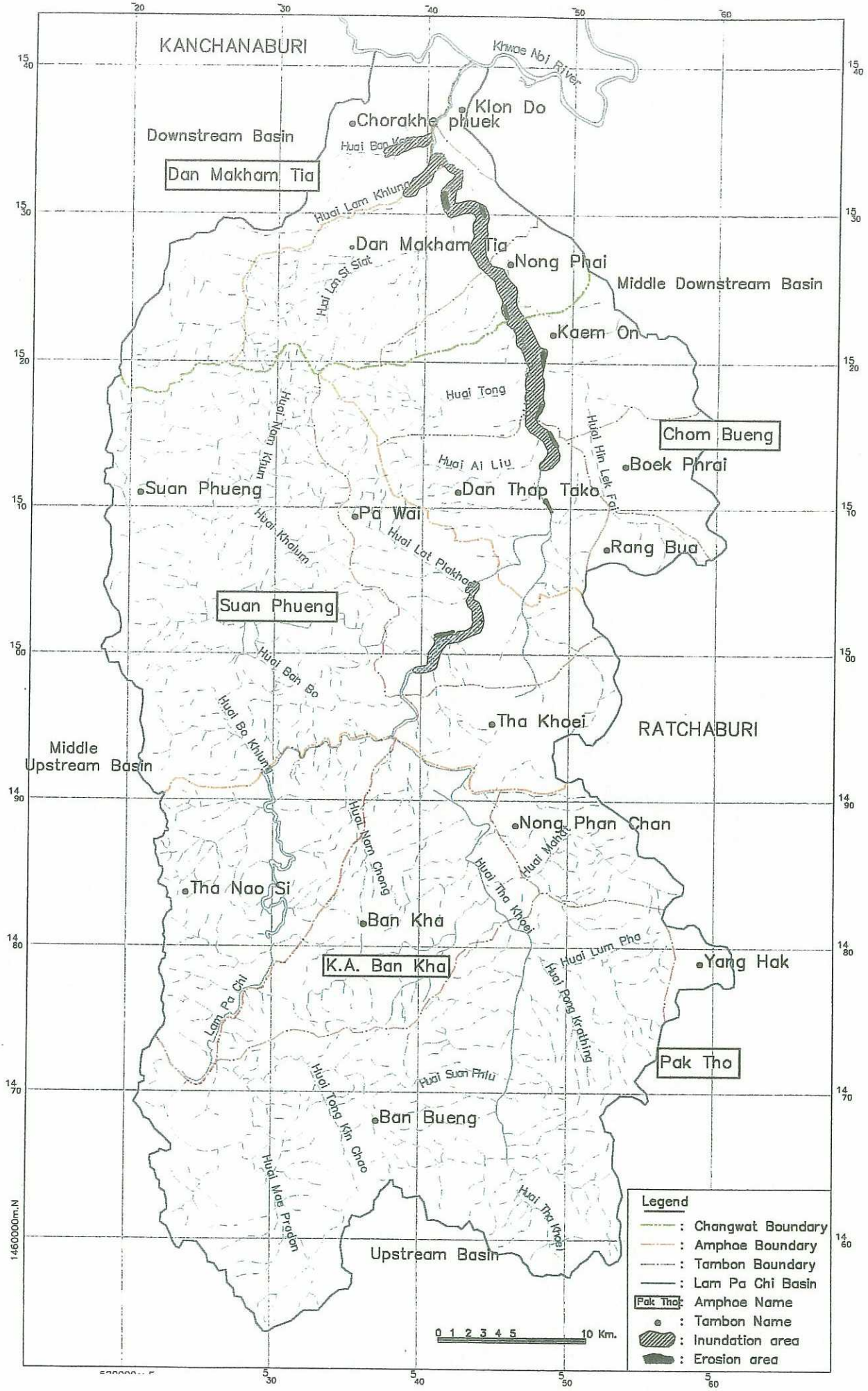


Figure 4.1.5 Location of the Inundations and Eroded Riverbank by Flood

Table 4.1.14 Flood Damages at Tambon C. Phuek during last 8 years

Year	Flood Damages			
	Affected house (No.)	Farmland (ha)	Road (place)	Fish pond (No.)
1995	167	174	35	32
1996	220	1,027	42	36
1997	214	255	32	22
1998	97	103	29	22
1999	87	622	29	24
2000	55	87	30	22
2001	28	126	26	21
2002	44	48	21	30
Total	**912**	**2,442**	**244**	**209**

Source: Flood damage record collected from Chorakhe Phuek TAO

Following Table shows damages of crops and its amount of loss by flood in case of Amphoe Dan Makham Tia in 1996 when severe flood occurred.

Table 4.1.15 Farmland and Crops Damaged by Flood in 1996

Tambon	**13. Nong Phai**		**14. Dan Makham Tia**		**15. Chorakhe Phuek**		**16. Klon Do**	
Crop	Damaged farmland (ha)	*Loss 1,000 Bt	Damaged farmland (ha)	*Loss 1,000 Bt	Damaged farmland (ha)	*Loss 1,000 Bt	Damaged farmland (ha)	*Loss 1,000 Bt
Paddy	7	3	36	16	74	32	737	322
Sugarcane	383	2,391			123	768	173	1,081
Maize			8	8	61	60	8	8
Cassava	320	1,999	133	831	629	3,929	884	5,527
Sweet corn			124	186			230	345
Baby corn	217	325	33	49			174	261
Pineapple			5	289				
Asparagus			51	640				
Vegetable	175	417	71	169	105	249	93	223
Spring onion					13	948	2	156
Fruit tree	1	1	4	0	22	0	73	0
Flower							15	0
Total	**1,103**	**5,136**	**465**	**2,188**	**1,027**	**5,986**	**2,389**	**7,923**

Source: Flood damage record collected from Agricultural Provincial Office at Dan Makham Tia *Unit of Loss is in 1,000 Bt

(c) Sedimentation and Water Quality

1) Sedimentation

Watershed degradation and sedimentation resulted mostly from water erosion caused mainly by excessive exposure of bare soils due to poorly managed logging operations, indiscriminate forest cutting, and widespread use of annual crops in farms. In the Study Area, sheet rill erosion from pineapple fields was found but not serious. There are no other causes found except that the most serious problem happens on riverbank erosions were caused by flood. It is therefore important to reduce water velocity on Lam Pa Chi River and its tributaries as well as to manage riverbank protection to prevent the sedimentation. According to the data from RID, annual suspended sediment yields at 3 watersheds in Mae Klong Basins are summarized as below. The Mean annual suspended sediment yield on Lam Pa Chi River shows 99ton/ km^2/year which is a little bit less than the other basins of Khwae Noi and Khwae Yai.

Table 4.1.16 Annual Mean Suspended Sediment Yield in Mae Klong Basins

Watershed Name	River Name	Station Code	Amphoe Name	Period	Basin Area (km^2)	Annual Mean susp. Sedi. Yield (ton)	
						Total	ton/ km^2 /year
Khwae Noi	Khwae Noi	K10	Sai Yok	1965-1991	7,008	766,881	109.0
Khwae Yai	Khwae Yai	K20	Si Sawat	1967-1975	11,184	1,330,359	119.0
Lam Pa Chi	Lam Pa Chi	K17	Suan Phung	1978-1986	1,355	134,238	99.0
	Huai Tha Khoei	K25	Suan Phung	1991-1993	482	44,223	92.0
	Huai Tha Khoei	K25A	Suan Phung	1994-1995	250	13,367	53.5
	Mean						99

Sourced by Workshop on Sustainable Development of Agricultural Infrastructure and Organization Management of Chao Phraya and Mae Klong Basins October 30, 1998.

2) Surface Water Quality

Water quality is observed at the Lam Pa Chi Bridge. According to the data, almost all kind of water quality is within the range of allowables and classified into class 2 or 3 by the standards in Thailand Act. The description of these classes is presented in Section 4.7 Environmental Survey. Recently, water deterioration was worsened by wastewater from villages as well as the factories, thus it is recommended that wastewater should be collected and purified by wastewater treatment plant in the future.

Table 4.1.17 Quality of Surface Water in Lam Pa Chi River

Sample Area	Important Index							
	pH	DO	BOD	Sediment (ppm)	Coliform, Fecal coliform (MPN/100 ml.)	Turbid	Lead (mg./litre)	Observed Year
1. Lam Pa Chi River Bridge	7.2	9.32	-	394	-	-	-	1998
2. Lam Pa Chi River Bridge	7.4	7.64	-	286	-	45	-	1998

Remarks: Standard for Surface Water, pH = 5.0-9.0 ; DO >= 6.0
Coliform<2000, Fecal coliform <= 4,000, 0.005<Cadmium <= 0.005 ; Lead <= 0.05
Source : Land Development Department

4.2 Socio-Economic Condition

(1) Administrative Units

Hierarchy of the local administration is in the order of province, district (Amphoe), Tambon and village (or Muban). For local administration, a municipality is organized to administer a large and densely populated community, while a Tambon Administration Organization (TAO) is organized to administer all villages within the Tambon without overlapping with the municipal area. The Lam Pa Chi River basin area belongs to Amphoe Suan Phueng, Ban Kha, Pak Tho and Chom Bueng in Ratchaburi province and Amphoe Dan Makham Tia in Kanchanaburi province. The entire river basin area covers about 2,527 km^2 or 1,579,348 rais. The total area of Lam Pa Chi River basin in Ratchaburi province is 1,354,870 rai or 85.8% and other 224,478 rai or 14.2% is in Kanchanaburi province. The five (5) districts in two (2) provinces cover 16 Tambons and are further divided into 145 villages located in the Study Area. Ratchaburi province covers 4 districts, 12 Tambons and 118 villages, while Kanchanaburi province covers 1 district, 4 Tambons and 27 villages. The largest Tambon in Lam Pa Chi River basin is Tambon Ban Bueng, which covers 553 km^2 or 345,625 rai and the smallest Tambon is Tambon Yang Hak, with the area of 13.16 km^2 or 8,225 rai. The administrative units in the Lam Pa

Chi River basin are summarized below.

Table 4.2.1 Summary of Administrative Units in the Lam Pa Chi River Basin

Province	Amphoe	Tambon	Nos. of Village	Area (km^2.)	Area (rai)
Ratchaburi	Suan Phueng	1. Tha Khoei	12	57.64	36,025
		2. Pa Wai	9	194.20	121,375
		3. Suan Phueng	8	426.00	266,250
		4. Tha Nao Si	7	202.15	126,344
	Chom Bueng	5. Kaem On	15	129.51	80,940
		6. Dan Thap Tako	20	172.51	107,820
		7. Boek Phrai	7	14.50	9,065
		8. Rang Bua	6	35.98	22,496
	KA.Ban Kha	9. Ban Kha	12	277.63	173,518
		10. Ban Bueng	12	553.00	345,625
		11. Nong Phan Chan	9	91.50	57,187
	Pak Tho	12. Yang Hak	1	13.16	8,225
Subtotal			118	2,167.78	1,354,870
Kanchanaburi	Dan Makham Tia	13. Klon Do	2	17.65	11,039
		14. Dan Makham Tia	11	156.00	97,500
		15. Chorakhe Phuek	8	127.50	79,689
		16. Nong Phai	6	58.00	36,250
Subtotal			27	359.15	224,478
Total			145	2,526.93	1,579,348

(2) Demography

The existing population of the Lam Pa Chi River basin is estimated at 70,138 with a population density of 27.8 person/km^2, sourced from Kor Chor Chor data 2001. The number of households is estimated at 15,873. In Ratchaburi area, total population in Lam Pa Chi River basin is 50,734 and total number of households is 11,982, while in Kanchanaburi area. The total population is 19,404 and total number of households is 3,891. The percentage of population dwelling in Lam Pa Chi River basin divided in Ratchaburi and Kanchanaburi are 72% and 28%, respectively. However, the average population density of the Study Area in Ratchaburi is 23.4 person/km^2; which is less than Kanchanaburi by 200% where the population density is 54.0 person/ km^2. The population and number of households distributed in each Tambon are shown below.

Table 4.2.2 Population and Number of Households in Each Tambon

Province	Tambon	Population	Pop. Density (person/.km^2)	Nos. of H/H	Average Size of H/H (No.)	Provincial Basis
Ratchaburi	1. Tha Khoei	4,337	75.2	982	4.4	
	2. Pa Wai	3,230	16.6	821	3.9	
	3. Suan Phueng	3,457	8.1	933	3.7	
	4. Tha Nao Si	3,692	18.3	802	4.6	
	5. Kaem On	7,961	61.5	1,835	4.3	
	6. Dan Thap Tako	6,168	35.8	1,375	4.5	
	7. Boek Phrai	2,678	184.7	713	3.8	
	8. Rang Bua	2,722	75.7	617	4.4	
	9. Ban Kha	5,926	21.3	1,348	4.4	
	10. Ban Bueng	5,287	9.6	1,320	4.0	
	11. Nong Phan Chan	4,741	51.8	1,106	4.3	
	12. Yang Hak	535	40.7	130	4.1	
Subtotal		50,734	23.40	11,982		

Province	Tambon	Population	Pop. Density (person/.km^2)	Nos. of H/H	Average Size of H/H (No.)	Provincial Basis
Kanchanaburi	13. Klon Do	932	52.8	188	5.0	
	14. Dan Makham Tia	6,994	44.8	1,335	5.2	
	15. Chorakhe Phuek	8,273	64.9	1,664	5.0	
	16. Nong Phai	3,205	55.3	704	4.6	
Subtotal		19,404	54.03	3,891		
Total		70,138	27.76	15,873		

As indicated in the above table, Tambon Chorakhe Phuek has the maximum population as 8,273 people and Tambon Yang Hak has minimum population as only 535 people. The highest population density is 184.7person/km^2 in Tambon Boek Phrai, while the lowest population density is 8.1person/km^2 in Tambon Suan Phueng. The highest number of households is 1,835 located in Tambon Kaem On and on the contrary, the least number of households is 130 in Tambon Yang Hak. The biggest average family size is 5.2 person/house in Tambon Dan Makham Tia and the smallest average family size is 3.7 person/house in Tambon Suan Phueng.

Nationality of the people in the Lam Pa Chi River basin in the past was comprised of several nationalities such as Chinese, Laotian, Cambodian and minorities. However, at present the people nationality is mixed and turns to be Thai. The remaining people so called Thais hill tribe are still living in Amphoe Suan Phueng and King Amphoe Ban Kha with approximately 9.4 % of total population in Lam Pa Chi River basin.

(3) Income and Expenditure

As of Khor Chor Chor data year 2001, the income data of each Tambon are depicted in the following Table 4.2.3. As seen in the mentioned table, the total income obtained from more than one occupation of sixteen (16) Tambons is 11,021,296 Bt/year. The Tambon that obtained the highest income is Tha Khoei, while Nong Phai obtained the lowest income comparing with other 15 Tambons in Lam Pa Chi River basin. Considering on income obtained from only one occupation, it can be seen that the main income of the households in Lam Pa Chi River basin gained from crops, livestock, trading and employment, respectively. Tambon Tha Khoei obtained the highest income per household from crop plantation, while Tambon Nong Phan Chan obtained the highest income from livestock, trading as well as employment. Only 348 households in the Study Area could earn more than 40,000 Bt/year and the biggest number of 99 households out of 348 households is in Tambon Rang Bua. The expenditures collected from Khor Chor Chor data were concerned only on agriculture cost such as expense on fertilizer and chemical substance to manage insects which were small amount comparing with the total cost as shown in the Table 4.2.3.

(4) Industry and the main products

Factories in Lam Pa Chi River basin are mainly concerning with agricultural production and minor activities are service and construction industries. The agricultural industry has the biggest number of factories as 61% or 59 % of total number of factories. Various kinds of agricultural product factories are comprised of pineapple, canned fruits, rice mill, cassava and sugarcane. The second main industry is service, which occupies 22 factories in the Study Area, while the third is construction industry, which has total 13 factories and have highest investment cost of about 137 MBt. The other categories of industries in Lam Pa Chi River basin are log and wood production, food and drugs production and others.

The main productions in Lam Pa Chi River basin are comprised of agricultural production and industry. The main plantations in Lam Pa Chi River basin are upland crop, horticultural crop and paddy. The most important upland crop is sugarcane and the second is pineapple. The third major crop is cassava. Besides, livestock also play a vital role in this area. The major livestock are chicken, cows and swine. However, fishery activity is much less comparing with crop plantation and livestock.

(5) Land Holding System

Historically, all the land in Thailand has belonged to The King. The concept of individual ownership of the land was introduced during the reign of the Great King Chulalongkorn (Rama V, 1868-1910), and a titling system was introduced in 1901. The possessions of land in Thailand are based on a principal land administration code promulgated in 1954. The land documents are recognized under the land code, including land titles (Nor Sor 4), certificates of utilization (Nor Sor 3 or Nor Sor 3 Kor) and certain documents issued prior to the Land Code.

By 1960 the total number of title deeds was about 1 million, although it was estimated that there were 3.4 million agricultural households. The demand for titles of various kinds increased during 1960s and 1970s as the number of farm holding expanded rapidly. In an effort to expedite the processing of title deeds, The Department of Lands (DOL) of the Ministry of Interior used the aerial photography instead of land surveys in the 1970s. This program was very successful and from 1975 to 1985 about 7.4 million certificates were issued. By the middle of 1980s, the Land titling project was introduced to meet the increasing demand for titles. Under this project 8.5 million new titles were issued.

In 1961 the Thai cabinet set a policy that 50 percent of the country be reserved for forestry. The Royal Forestry Department (RFD) was then charged with the responsibility of undertaking surveys and having areas declared by Cabinet as “National Forests”. This work is still incomplete, pre-reserved and National Forest boundaries are unclear and there has been substantial encroachment on the land legally reserved as forest. It is generally recognized that much of the lands classed as forest is now not forest and is very difficult to return to forest uses.

Table 4.2.3 Basic Economic Condition of Sixteen Tambons From Kor Chor Chor Data

Basic Economic Condition	(unit)	Ban Bueng	Ban Kha	Tha Nao Si	Nong Phan Chan	Yang Hak	Suan Phueng	Tha Khoei	Pa Wai	Dan Thap Tako	Rang Bua	Kaem On	Boek Phrai	Nong Phai	Dan Makham Tia	Chorakhe Phuek	Klon Do	Average
1 Income obtained from more than one occupation	Bt/year	783,000	660,000	275,500	1,930,000	398,200	542,600	2,182,806	330,890	500,300	591,000	913,000	341,000	212,000	450,000	333,000	578,000	688,831
2 Income obtained from only one occupation	Bt/year	282,773	572,100	-	2,100,000	391,600	129,000	668,189	468,920	380,000	368,500	807,000	210,000	176,500	305,000	269,000	358,000	467,911
2.1Income per household from Planting paddy	Bt/year	-	-	-	-	-	-	-	-	-	198,000	-	-	-	55,000	20,000	217,000	30,625
2.2 Income per household from Plantation Crop	Bt/year	125,000	535,000	-	520,000	363,000	75,000	1,198,200	924,540	306,000	170,000	1,017,000	110,000	143,000	227,000	185,000	326,000	389,046
2.3 Income per household from Livestock	Bt/year	170,000	95,000	-	4,000,000	-	-	317,000	50,000	180,000	178,000	135,000	100,000	20,000	70,000	53,000	92,000	341,250
2.4 Income per household from Fishery	Bt/year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2.5 Income per household from Agriculture	Bt/year	-	113,000	-	40,000	-	-	80,000	-	45,000	20,000	160,000	-	-	-	-	-	28,625
2.6 Income per household from Trading	Bt/year	116,000	680,000	-	800,000	50,000	-	573,350	637,740	390,000	310,000	400,000	205,000	193,000	129,000	78,000	376,000	308,631
2.7 Income per household from Industry	Bt/year	-	-	-	-	-	-	-	-	-	50,000	-	-	-	-	-	-	3,125
2.8 Income per household from Employment	Bt/year	138,080	324,000	-	830,000	297,500	129,000	331,689	197,420	358,000	240,000	329,000	192,000	151,000	262,000	301,000	328,000	275,543
3 Earning more than 40,000 B/year	H/H	20	-	-	32	39	31	21	14	6	99	21	-	-	25	40	-	22
4 Average Household expense on fertilizer	Bt/rai	-	-	-	-	-	800	310	1,420	2,000	1,565	1,840	2,100	1,970	3,050	2,150	3,150	1,272
5 Chemical Expense	Bt/rai	-	-	-	-	-	480	360	420	1,580	2,290	640	1,170	2,250	2,250	2,300	2,950	1,043

The titles issued under the Land titling project were all in non-forest lands. However, in fact many traditional farmers and also hill tribes group still occupies. It makes the Agricultural Land Reform Program, which focused on agricultural landholders in forests, occurred and then the act was promulgated in 1975. The legislation called for the establishment of the Agricultural Land Reform Office (ALRO) under the Ministry of Agriculture and Cooperatives to serve as the implementing agency.

The DOL records show that in December 2001, there were 18,629,088 titles covering 11.3 million ha, 1,894,960 Nor Sor 3 covering 2.69 million ha and 7,332,669 Nor Sor 3 Gor covering 6.34 million ha. However, there likely is some duplication in these numbers of land documents. The major land administration service provider is DOL. It is responsible for the implementation of the Land Code and the registration of rights under the Land Code for non-forest land throughout Thailand. The DOL includes a survey, mapping function, a registration function and a central valuation function. Other government agencies issues land-related documents that include the Sor Por Gor 4-01 certificates issues by ALRO, which is responsible for land in reformed area zones and there is coordination with DOL and RFD. The RFD is responsible for the management of land within pre-reserved and national forest zones and there is cooperation with DOL in marking and delineating forest boundaries. The District Offices, Municipalities and Tambon Administration Organization (Or Bor Tor) look after public land zones in their own areas.

All land under the control of these governmental departments have no effect as to the rights of people who owned land before the government appointed the land as a forest, public or reformed zone. The law has no retrospective effect on the individual's rights to land under the law before it became a forest zone. That individual person still maintains its rights to the land. There are two types of rights to private land: The first is the right of possession (Possessive right), i.e. people who possess and use the benefit of land will have the right to possess such land under the Civil and Commercial Code. The second is ownership by a person who has a title deed and documents concerning the land. The various land ownership documents can be depicted as follows.

(a) Land Title Deed is a certificate for ownership of land. A person having their name shown on the deed has the legal right to the land, and can use it as evidence to confirm the right to government authorities. A land title deed giving unrestricted ownership rights was issued only after a cadastral survey. At least two prior steps were required before the prospective landholder could obtain a full title deed. Application was first made to occupy and cultivate a piece of unused land, and a temporary occupancy permit that carried no title rights was received. After 75 percent of the land had been cultivated, the landholder could obtain exploitation testimonial. This gives him the right to occupy the land permanently and to pass the property on to heirs; it was an assurance that a title deed eventually would be forthcoming. In the case of squatters, a special occupancy permit could also be obtained, unless the land was in a permanent reserved forest or was intended for public use. Satisfactory development could then lead to the issuance of an exploitation testimonial and finally a full land title deed.

(b) Sor Kor 1 is a notification form of possessed land. There is a certificate to show the right to the land. This maintains existing rights. Notification of Sor Kor 1; on December 1st 1954, the government advised all land proprietors to notify such possession to the government as form Sor Kor 1. After it was proven that such a proprietor had possessed the land legally and used the benefit of the land, then the government would issue Nor Sor 3 or Nor Sor 3 Gor as evidence.

(c) Nor Sor 3 is an instrument certifying the use of land issued by the government to the proprietor of land not a possessory title, i.e. it is confirmed by law that a person holding Nor Sor 3 has the legal right to possess the land. This land title can be used as a legal document or to use the benefit of the land as an owner. Nor Sor 3 is a floating map with no parcel points. It is issued for a specific plot of land and is not connected to other land plots. This causes problems in verifying the land area. Any legal acts must be publicized for 30 days.

(d) Nor Sor 3 Gor is a legal land title with the same legal basis as Nor Sor 3. The difference being that Nor Sor 3 Gor has parcel points on the map, and is set by using an aerial survey to set the points and the land area. It is possible to verify a nearby land area. It always uses the same scale of 1:5000. There is no need to publicize any legal acts, and it is possible to divide the land into smaller plots.

(e) Sor Por Gor 4-01 is an allotment of land from the land reformative committee, and this land can not be bought or sold. It may be transferred to heirs only. This kind of land title is under the responsibility of ALRO, which was established and has been undertaking the land reform works since 1975 under the Agricultural Land Reform Act.

(f) Por Bor Tor 5 is evidenced by the issuance of a tax number for the purpose of paying tax for using the benefit of the land. Such land has not yet been assessed as to the person's right to possess such land. In the event that there is no title for the land, then it may be land in a conserved forest, public land or land which existed under Sor Kor 1, Nor Sor 3, Nor Sor 3 Gor or a title deed. Any of these titles must have a Por Bor Tor 5 as tax must be paid, the same as any land without a title. Purchase of such land is possible by handing over the possession of the land to the buyer along with the tax number. The right to land under Por Bor Tor 5 can not be used as evidence in any dispute with authorities.

However, in fact squatters had established the land acquisition of farm holdings outside recognized areas. Not only the poor farmer but also the hill people encroaches the reserved forests, which according to the central government were not eligible for titling. The squatters were therefore unable to acquire legal title to the land they used.

In the Study Area, Lam Pa Chi River basin covers some part of the central region and the western region. These areas include the international boundary between Thailand and Myanmar namely Tambon Suan Phueng, Tha Nao Si and Ban Bueng. The river basin is mostly the reserved forest area and the deteriorated land, which is under the responsibility of RFD and ALRO respectively. Besides,

the other main government agency is The Department of Lands that controls other kinds of the land ownership.

At present, the existing land ownership documents in Lam Pa Chi River basin are mostly Nor Sor 3, Sor Por Gor and Por Bor Tor 5. In addition some areas are still unidentified land ownership. The areas of each types of land holding system can be collected by site surveys from 16 TAO. However due to unsystematic data recording and new establishment of TAO, the 11 Tambons data could be obtained while the 5 Tambons data were unavailable namely Klond Do, Suang Phueng, Pa Wai, Nong Phan Chan and Yang Hak.

The collected data are shown in the Table 4.2.4. As seen on the mentioned table, the land ownership areas in the Study Area are combined among several types of ownership documents. However the legal land titles like title deed or Nor Sor 3 are very much less than the new distributed land ownership documents like Sor Por Kor and Por Bor Tor, because these areas are mostly still the forest land and deteriorated land. Especially compared with the total area, the legal land titles are only about 5 percent of the total Study Area.

Table 4.2.4 Condition of Land Holding Types and Related Agency

Land Holding Types	Related Agency	Condition
Nor Sor 3	DOL	This land title is the certificates of utilization given to the proprietor of land not a possession title. It can be used as a legal document or to use the benefit of the land as an owner. This type of land can be sold.
Sor Por Gor	ALRO	It is an allotment of land reform area under the Agricultural Land Reform Office to farmers who own no land or have small pieces of land that are insufficient to earn their living. Majority of land are located in former national conservation forest areas and deteriorated areas where soils are poor and water resources are insufficient for domestic and agricultural purposes. This land cannot be bought or sold. It may be transferred to heirs only.
Por Bor To	DOL, TAO	It is evidenced by the issuance of a tax number for the purpose of paying tax for using the benefit of the land. All types of land ownerships and also any land without ownership must have a Por Bor Tor as tax to be paid. The right to land under Por Bor Tor cannot be used as evidence for loan to any agencies without land title. This land can be bought or sold if the land ownership were title deed or Nor Sor 3 while only Por Bor Tor document is prohibitive for sale.

Table 4.2.5 Existing Land Holding Areas of 16 Tambons in Lam Pa Chi River Basin

Amphoe	Tambon	Land Holding Areas (rai)							Total Area (rai)
		Land Title Deed	Nor Sor 3	Nor Sor 3 Kor	Sor Por Kor	Por Bor Tor 5	Reserved Forest	Others	
Kanchanaburi					(ALRO)	(DOL)			
Dan. Makha. Tia	Nong Phai	6,420	2,380		2,000	5,000		20,450	36,250
	Klon Do								70,000
	C, Phuek		3,070		27,150	49,870		16,785	96,875
	D. M. Tia	2,760		17,403	22,840	48,431		6,066	97,500
Ratchaburi									
Chom Bueng	B. Phrai	219	9,038	1,888	10,088	4,505		40,260	65,998
	Rang Bua	27,124	846	11,941	28,300	17,724		25,655	111,590
	Kaem On		15	58	36,100	30,230		14,538	80,941
	D. T.Tako	615	78		18,200	30,886		58,041	107,820
Suan Phueng	S. Phueng								266,250
	Tha Khoei	12,000	7,075		5,800	41,200		800	66,875
	Pa Wai								180,178
	T. Nao Sri		182	1,673		35,574	88,914		126,343
K. A. Ban Kha	N. P.Chan							89,375	89,375
	Ban Kha	870	1,454	4,633	7,600	32,801		171,124	218,482
	B. Bueng				42,000	56,199	247,426		345,625
Pak Tho	Yang Hak								218,760
Total		50,008	24,138	37,596	200,078	352,420	336,340	443,094	2,178,862

Remark; Land Holding Area data of Tambon Klon Do, Suan Phueng, Pa Wai, Nong Phan Chan and Yang Hak are unavailable.
Data taken from TAO

4.3 Water Resources

(1) Surface Water

(a) Current Water Use

Table below shows the summary of water use conditions in the Study Area at each small watershed basin sourced by Khor Cho Chor data. Piped water supply system has covered about 87% in total but using ratio of this system is only 58%. This means that only 50 % of the people in the Study Area could use this system and the remaining 50% use shallow wells or clay pots to store rainfall, but almost all of them could get clean drinking water. As for short-term crops as well as long-term crops, farmers have suffered from lack of irrigation water, which shows 68.7% and 76.5%, respectively. In vegetables and fruits farming, about 50% of farmers have also suffered from lack of irrigation water.

Table 4.3.1 Current Water Use Condition in the Study Area

Water use conditions	(unit)	U.B		U.M.B		L.M.B		D.B		Total	
No. of Village	(No.)	47		29		54		36		166	
Number of Household	H/H	5980		2736		5878		5552		20146	
Number of residents	People	24928		11024		25170		27814		88936	
Without piped-water supply system	village	8	17.0%	1	3.4%	8	14.8%	5	13.9%	22	13.3%
With piped-water supply system	village	39	83.0%	28	96.6%	46	85.2%	31	86.1%	144	86.7%
Use piped water supply system	H/H	3258	54.5%	2020	73.8%	3503	59.6%	2899	52.2%	11680	58.0%
Piped-water supply constructed by Public Works Public Work Dept.	village	2	4.3%	0	0.0%	11	20.4%	8	22.2%	21	12.7%
No surface or ground water sources	village	0	0.0%	1	3.4%	9	16.7%	0	0.0%	10	6.0%
Have surface or ground water sources	village	47	100.0%	28	96.6%	45	83.3%	36	100.0%	156	94.0%
Clean drinking water for domestic use	H/H	5356	89.6%	2566	93.8%	5546	94.4%	5560	100.1%	19028	94.5%
Insufficient water for short-term crops	village	37	78.7%	17	58.6%	37	68.5%	23	63.9%	114	68.7%
Sufficient water for short-term crops	village	10	21.3%	12	41.4%	17	31.5%	12	33.3%	51	30.7%
Insufficient water for long-term crops	village	41	87.2%	25	86.2%	40	74.1%	21	58.3%	127	76.5%
Sufficient water for long-term crops	village	6	12.8%	4	13.8%	14	25.9%	15	41.7%	39	23.5%
Insufficient water for vegetables or fruits	village	30	63.8%	17	58.6%	19	35.2%	11	30.6%	77	46.4%
Sufficient water for vegetables or fruits	village	15	31.9%	5	17.2%	10	18.5%	17	47.2%	47	28.3%
Insufficient water for fruits	village	32	68.1%	17	58.6%	18	33.3%	11	30.6%	78	47.0%
Sufficient water for fruits	village	11	23.4%	4	13.8%	8	14.8%	13	36.1%	36	21.7%

U.B:Upstream Basin, UMB: Middle Upstream Basin, L.M.B: Middle Dowestream Basin, D.B: Downstream Basin

As for water resources, there are medium to small dams, weirs, natural swamps, farm ponds, shallow wells and deep wells in the Study Area. Details are shown as follows.

(b) Dams and Weirs Constructed by RID

1) Medium Scale Dams and Weirs

There are 5 (five) medium scale reservoirs constructed by RID in the Study Area. Total storage capacity of 32.7 MCM or only 9.2 % against the mean annual flow of 357.3 MCM, which is estimated as former chapter in Lam Pa Chi River basin useful for domestic, fish, and irrigation. Locations of medium-scale facilities are shown in Figure 4.5.1.

Table 4.3.2 Medium Scale Dams and Weirs in Ratchaburi Province of the Study Area

Tambon	Amphoe	Name of Scheme	Watershed Area (km^2)	Capacity (MCM)
1) Ban Bueng	Ban Kha	Tha Khoei Reservoir	147.0	23.40
3) Tha Nao Si	Suan Phueng	Huai Ha Na Reservoir	26.0	2.45
4) Nong Pan Chan	Ban Kha	Huai Ma Hat Reservoir	34.0	4.30
7) Tha Khoei	Suan Phueng	Chat Pa Wai Reservoir	4.0	2.50
9) Dan Thap Tako	Chom Bueng	Tong Kra Tin Weir(Pump up)	1,814.0	-
Total			2,025.0	32.65

There is no medium scale dam and weir in Kanchanaburi Province

2) Small Scale Dams and Weirs

There are 33 small-scale dams and 19 small-scale weirs constructed by RID in the Study Area. Storage capacities of these are approximately 12.35 MCM, which occupied only 3.5 % in the mean annual flow of 357.3MCM. Locations of small-scale facilities are shown in Figure 4.3.3.

Table 4.3.3 Small Scale Dams and Weirs in the Study Area

Tambon	Amphoe	Small Dam			Weir		
		No.	Watershed (km2)	Storage (MCM)	No.	Watershed (km2)	Storage (MCM)
1. Ratchaburi							
1) Ban Bhueng	Ban Kha	9	149.50	4.82	0	-	-
2) Ban Kha	Ban Kha	5	544.75	1.54	1	66.25	0
3) Tha Nao Si	Suan Phueng	3	40.50	0.82	2	18.04	0
4) Nong Phan Chan	Ban Kha	3	33.00	1.01	0	-	-
5) Yang Hak	Pak Tho	0	-	-	0	-	-
6) Suan Phueng	Suan Phueng	5	35.25	1.55	1	126.00	0
7) Tha Khoei	Suan Phueng	1	9.50	0.21	0	-	-
8) Pha Wai	Suan Phueng	2	25.75	1.34	1	33.25	0
9) Dan Thap Tako	Chom Bueng	2	15.00	0.35	0	-	-
10) Rang Bua	Chom Bueng	0	-	-	0	-	-
11) Kaem On	Chom Bueng	1	4.00	0.18	1	143.00	0
12) Boek Phrai	Chom Bueng	0	-	-	0	-	-
Sub-total		31	847.75	11.61	6	386.54	0
2. Kanchanaburi							
13) Nong Phai	Dan Makham Tia	0	-	-	1	n.a.	0
14) Dan Makham Tia	Dan Makham Tia	1	1.50	0.21	0	-	-
15) Chorakhe Phuek	Dan Makham Tia	1	32.50	0.53	12	n.a.	0
16) Klon Do	Dan Makham Tia	0	-	-	0	-	-
Sub-total		2	34.00	0.74	13	-	0
Total		33	881.75	12.35	19	386.54	0
Small scale dams and weirs Total					52	1,268.29	12.35

Unit: MCM

(c) Other Water Resources Facilities

1) Weirs constructed by Province

There are 125 weirs constructed extensively crossing the tributaries of Lam Pa Chi River in the Study Area. An average dimension of weirs is 15 to 20 meters in width and 2 m in height. According to the policy of decentralization, responsibility of all weirs has been shifted from Province to TAO. To date, TAO is supposed to operate and maintain all the facilities of weir. Intake capacity of weir is not clear in the inventory survey, but taking into account the dimension in weir, it was estimated at 3,000 m^3/weir/season.

Table 4.3.4 Weirs Constructed by Provinces

Watershed	Tambon	No.	Weir Dimension L (m)	Weir Dimension H (m)	Construction Cost (BT)	Shift to TAO
Ratchaburi Province						
Upstream Basin	Ban Bueng	17	18-20	1.5-2.0	362,500	2002
	Ban Kha	11	15-20	1.5-2.0	408,200	2002
	Ta Nao Si	3	16-50	2.0-4.9	n.a.	n.a.
	N. P.Chan	0				
	Yang Hak	0				
Sub-Total		31			(385,350)	
Middle Upstream Basin	Suan Phueng	5	18-20	1.5-2.0	604,000	2002
	Tha Khoei	2	n.a.	n.a.	n.a.	n.a.
	Pa Wai	18	8-20	n.a.	n.a.	n.a.
Sub-Total		25			(604,000)	
Middle Downstream Basin	D. Thap Tako	20	n.a.	n.a.	n.a.	n.a.
	Rang Bua	10	n.a.	n.a.	n.a.	n.a.
	Kaem On	13	n.a.	n.a.	n.a.	n.a.
	Boek Phrai	4	8-18	1.5-2.0	243,000	2002
Sub-Total		47			(243,000)	
Kanchanaburi Province						
Downstream Basin	Nong Phai	4	18-20	2	380,000	2002
	D. M. Tia	4	15-20	1.5-2.0	435,000	2002
	C. Phuek	14	15-29	1.5-2.5	362,000	
	Klon Do*	n.a.	n.a.	n.a.	n.a.	n.a.
Sub-Total		22			(393,000)	
Total		125			(406,338)	

Sourced by each TAO

2) Farm Ponds

There are so many farm ponds in the Study Area, mostly are concentrated in Middle Downstream Basin to Downstream Basin because of easy construction at plain area as well as more water resources potentiality compared than Upstream to Middle Upstream Basins. According to the survey results, almost all of farm ponds has size of one (1) rai and 2.5 to 3.0 m in depth. Based on the figures, and consideration of the evaporation of 1.5 m in depth, estimated available water at each basin is shown below. Total available water is estimated at about 2.14 MCM only. A pond, less than 1 rai is difficult to use through a year for after 6 months from the end of rainy season, water will be dryng up.

Table 4.3.5 Farm Pond at each Tambon

Watershed	Tambon	Pond Ratio		Estimated Available Water (m3)
		No.	Ratio	
Upstream Basin	Ban Bueng	3	0.3%	7,200
	Ban Kha	7	0.8%	16,800
	Tha Nao Sri	4	0.4%	9,600
	Nong Phan Chan	7	0.8%	16,800
	Yang Hak	1	0.1%	2,400
	Sub-Total	22	2.5%	52,800
Middle Upstream Basin	Suan Phueng	8	0.9%	19,200
	Tha Khoei	0	0.0%	0
	Pa Wai	21	2.4%	50,400
	Sub-Total	29	3.3%	69,600
Middle Dowestream Basin	Dan Thap Tako	66	7.4%	158,400
	Rang Bua	10	1.1%	24,000
	Kaem On	157	17.6%	376,800
	Boek Phrai	46	5.2%	110,400
	Sub-Total	279	31.3%	669,600
	Nong Phai	8	0.9%	19,200
	Dan Makham Tia	299	33.5%	717,600
	Chorakhe Puek	255	28.6%	612,000
	Klon Do	0	0.0%	0
	Sub-Total	562	63.0%	1,348,800
Total		892	100.0%	2,140,800

(d) Surface Water Resources Availability

Surface water resources availability at present is roughly estimated at 51 MCM, which is about 14% of mean annual runoff estimated as 357.3 MCM in the Study Area. Ratio of medium and Small-scale dams and weirs constructed by RID is 13.6% (9.2%+4.4%) and presently, these facilities are the most important ones as water sources for irrigation. As for the farm pond, almost all are around 1 rai and dried up during the dry season, it is therefore recommended to install intake facility to introduce water into the pond during rainy season as well as to expand its area and depth larger and deeper. As in this case, it can be said that about 306.5 MCM of water will be available to use for irrigation purpose.

Table 4.3.6 Current Availability for Surface Water Resources

Water Resources	Mean annual Discharge	Storage Capacity	Ratio (%)	Balance
Medium Dams & Weirs by RID	357.3	32.74	9.2	306.47
Small Scale Dame & Weirs by RID		15.79	4.4	
Weirs by Provinces		0.50	0.1	
Farm Pond		1.80	0.5	
Total		50.83	14.2	

(Unit: M.C.M.)

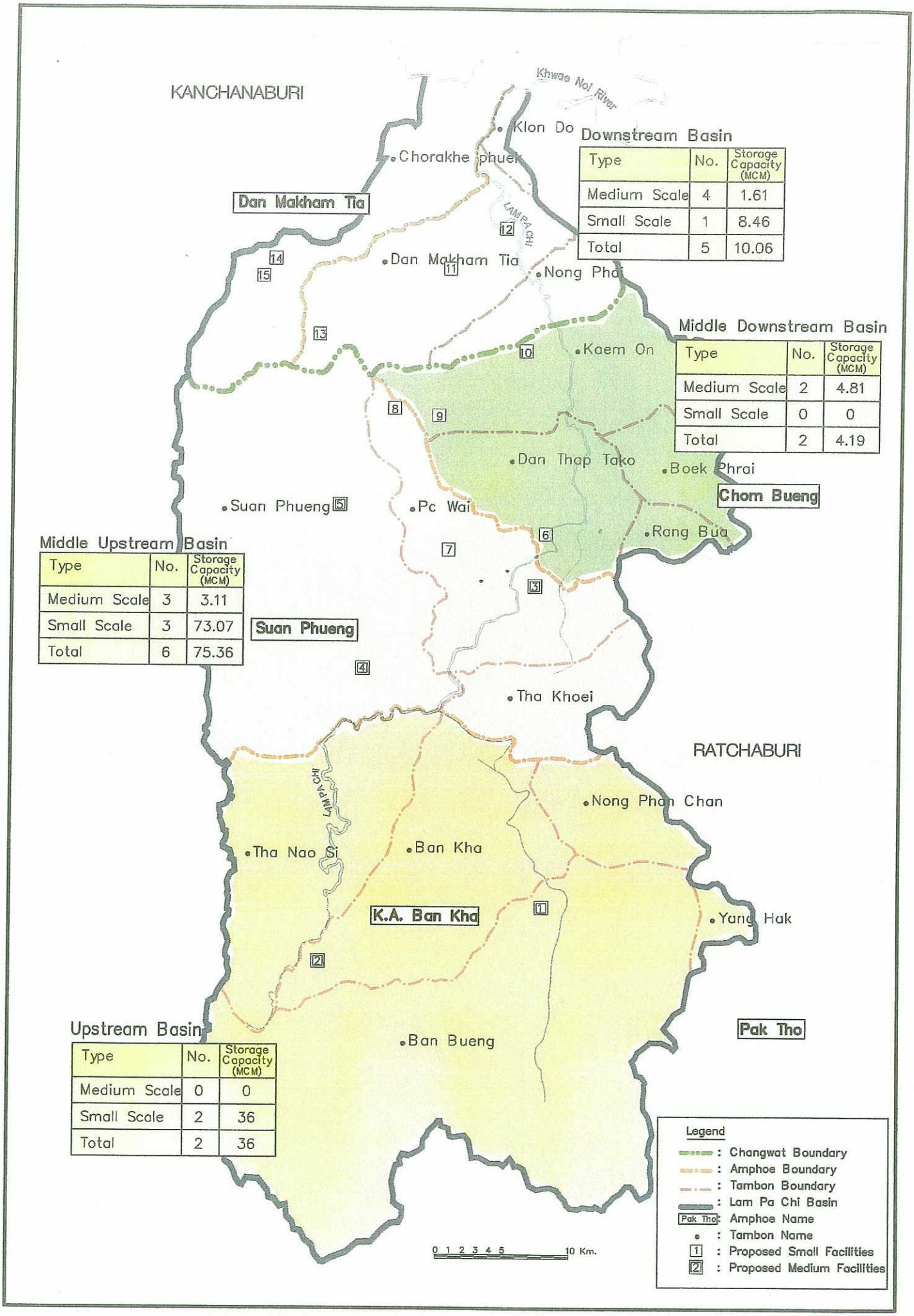
(e) Water Resource Development Plan Proposed by RID

At present RID has planned to construct 9 small-scale dams/weirs and 6 medium scale dams in the Study Area (see Table 4.3.7). The former total storage capacity is estimated at 8.46 MCM, which were able to irrigate 4,130 ha, the latter was estimated at 127.69 MCM, which could irrigate about 33,410 ha, and in totality it could irrigate about 37,540 ha. But due to strong emphasis on decentralization, strengthening of local level administration and community-based development, as well as the environmental issue in the reservoirs area, construction plan of said dams/weirs has not been decided yet. To develop water resources in the Study Area, these constructions are seemed inevitable. Location of the proposed dams and weirs are shown in Figure 4.3.7.

Table 4.3.7 Proposed Dams and Weirs by RID

Location		Name of Project	Type	Watershed	Storage	Beneficiaries1)	
Amphoe	Tambon		No.	Area(km2)	Capacity (MCM)	Area (rai)	Area(ha)
Small Scale Dam/ Weir :Less 10 MCM							
Ratchaburi Province							
Suan Phueng	8.Pa Wai	Huai Phu Mhen	R	4.0	0.82	4,000	640
		Ban Phu Kan	R	4.0	0.96	4,000	640
		Ban Phu Takian	R	7.1	1.33	6,500	1,040
Chom Bueng	11.Keam On	Ban Nong Pak Dong	R	2.6	4.79	2,500	400
		Huai Hin Dance	W	9.5	0.02	2,000	320
Ratchaburi Sub-total			5	27.2	7.92	19,000	3,040
Kanchanaburi Province							
Dan Makham Tia	14.Dan Makham Tia	Huai Sam Phao Tong	W	14.0	0.01	1,200	190
		Ban Wang Phla	R	45.0	0.48	600	100
	15.Chorakhe Phuek	Ban Pu Tei	R	3.0	0.56	3,000	480
		Ban Nern Sa Wun	R	7.0	0.56	2,000	320
Kanchanaburi Sub-total			4	69.0	1.61	6,800	1,090
Small Scale Dam/Weir Total			9	96.2	9.53	25,800	4,130
Medium Scale Dam/ Weir : 10 - 100 MCM							
Ratchaburi Province							
Ban Kha	1.Ban Bueng	Lower Huai Tha Khoei	R	370.0	10.00	15,400	2,460
Suan Phueng	3.Tha Nao Si	Pa Chi	R	54.0	26.00	40,200	6,430
	6.Suan Phueng	Ban Tun Laem	R	1,500.0	20.00	30,900	4,940
		Ban Bo	R	119.0	22.31	62,200	9,950
		Ban Huai Khalum	R	164.1	30.76	47,500	7,600
Ratchaburi Sub-total			5	2,207.1	109.07	196,200	31,380
Kanchanaburi Province							
D. M. Tia	14.D.M. Tia	Huai Lam Si Siat	R	45.1	8.46	12,700	2,030
Medium Scale Dam/Weir Total			6	2,252.2	118.16	208,900	33,410
Ground Total			15	2,348.40	127.69	234,700	37,540

R: Reservoir, W: Weir, Sourced by RID Remarks 1): Expected potential Area



Downstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	4	1.61
Small Scale	1	8.46
Total	5	10.06

Middle Downstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	2	4.81
Small Scale	0	0
Total	2	4.19

Middle Upstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	3	3.11
Small Scale	3	73.07
Total	6	75.36

Upstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	0	0
Small Scale	2	36
Total	2	36

Figure 4.3.1 Location of the Proposed Dams and Weirs by RID

(2) Groundwater

(a) Inventory of Wells and Review of Previous Studies

1) Data and Information Collection

In Thailand, the government agencies that drill wells and construct water supply facilities are DMR, PWD, ARD, ALRO, and DH. All of the agencies have drilled and constructed well facilities in the whole country for their own purpose and under their policies. Among them, however, the former Groundwater Division of DMR, which is now transferred to the new Ministry of Natural Resources and Environment (MONRE), is the main agency in charge of the development of groundwater. In the Study Area, all of those agencies have wells or water supply facilities, but DMR has the most of the existing wells, as well as the data and information on groundwater in the area. Thus, the data and information collection was started mainly from DMR, followed by PWD and ARD. The remaining two agencies; ALRO and DH were excluded in this time, because they have quite limited facilities and data in the target site. Through direct visitation and discussions with officers in charge, many data on the existing wells and information on hydrogeology and groundwater, such as Geological maps, Groundwater Potential map, Geomorphologic map, and so on, were collected.

2) Well Inventory

Based on the data of existing wells collected before site survey, “well Inventory” was brought by the Study Team to get an actual condition of existing wells in the Lam Pa Chi River Basin, such as information on their locations, depths, major purpose, yield, and roughly the groundwater quality. However, the collected information was combined with a condition of shallow well and deep well as well as density of well compared by area of each Tambon.

3) Previous Studies

Concerning the hydrogeology and groundwater conditions in the Lam Pa Chi River Basin, DMR has published a series of Geological maps of 1:250,000 scale, which covers all of the country. And particularly, DMR has completed the groundwater study on the Lam Pa Chi River Basin and arranged its results as a “Groundwater Potential Map of Lam Pa Chi River Basin” with 1:100,000 scale. While, the Engineering Geology Division of RID also curried out a hydro-geologic survey on the Lam Pa Chi River Basin, immediately after the study by DMR. And, RID has prepared two study reports,

There are mainly two (2) updated-reports concerning the Lam Pa Chi River Basin from Engineering Geology Division, Office of Topographical and Geological Survey, Royal Irrigation Department on October 2002. The first report is “Field Reconnaissance Report” that mentioned the hydro-geological condition in the Lam Pa Chi River Basin and the second one is “Groundwater Potential Study Report”, which expressed with primary geomorphology by aerial photo in the Lam Pa Chi River Basin. Summary of the reports is presented as follows.

a) The Study of Hydro-geological Condition

The study reveals that the Lam Pa Chi River Basin consists of both aquifers of unconsolidated rock and hard rock. The unconsolidated rock is normally found along the narrow river channel of middle and downstream portion of floodplain. During rainy season, the river flow has transported the sediment to sand-gravel deposition. The alluvial and colluvial deposits are composed of gravel, sand, silt and clay which the groundwater is capped among their porosities. The alluvial deposit covers the area of Ban Thung Fag, Ban Thung Ree in Amphoe Chom Bung and rather small portions are distributed to Ban Nong Phai, Ban Tha Mai Yao, Ban Tha Phu and etc. in Amphoe Dan Makham Tia. The colluvial deposit can be found in small portion at the right-bank of the river around Ban Nong Pak Chat, Ban Kam-on and Ban Thung Chaeng. For hard rock aquifer, it consists of 4 types from the upstream to downstream 1) Igneous aquifer can be found along upstream and at the right bank of the river of Ban Tha Koei, Ban Kluay, Ban Huai Sai ect. The capacity yielded to 0-2 m^3/hr. depending on thickness of weathered zone. 2) Metamorphic aquifer can be found in middle portion of the basin at Amphoe Suan Phung and Amphoe Chom Bung. The yield capacity is 2-5 m^3/hr. normally in joint and fault. 3) Metasediments aquifer can be found in wide area at downstream portion of Amphoe Dan Makham Tia. The yield capacity was not mentioned but estimated in the range of 10-30 m^3/hr. 4) Sedimentary aquifer can be found around NW-SE of Amphoe Dan Makham Tia. The yield capacity was not mentioned but estimated in the range of 30-60 m^3/hr.

b) The Study of Primary Geomorphology by Aerial Photo

The general condition of Lam Pa Chi River Basin is an elongated intermountain basin consists of many tributaries on southern part of basin such as Huai Tha Kod, Huai Nam Chong, Huai Haeng, Huai Nak, Huai Nam Bo, Huai Muang which flows into Lam Pa Chi River at Amphoe Suan Phung, Ratchaburi province. The basin characteristic is rather huge to reserve totally 1,000 km^2. The upstream portion is comprised of mountainous area i.e. Huai Sua mountainous area served as borders between Thailand and Myanmar. On the western part is also mountainous area consisting of many tributaries i.e. Huai Rok, Huai Lad Pla Kao, Huai Ay Liew, which flow into Lam Pa Chi at the middle of basin. The unconformable mountainous area on eastern part is located in NW-SE direction which control the Lam Pa Chi and flew directly into Khaew Noi river at Amphoe Dan Makham Tia, Kanchanaburi province.

The geomorphology of the study area can be divided into 3 major landforms of photo-characteristic properties by terrain mapping unit 1) Flood plain, terrace, natural levee and channel filled belong to low terrain portion. 2) Colluvial slope and alluvial fans belong to moderately low terrain. 3) Mountainous area belongs to high terrain.

4) Field Reconnaissance

Field reconnaissance survey has been carried out during November 2002, by the hydro-geologist of the Study Team, his counterpart from RID, and a local hydro-geologist. In conducting the field survey in the study area, the Lam Pa Chi River Basin was roughly divided into three zones as upper, middle, and lower basins. After observation of the natural conditions, interviews to the villagers on wells, water supply systems, conditions of groundwater in dry season, etc, and direct measuring of water

depth and quality using portable water meter were conducted. Most of villages have already some kind of pipe water supply system, and only a few villages are still utilizing directly the groundwater through dug well. Most of all, the water supply systems in the basin were groundwater, but using of stream or pond water are prevailing in the middle to lower basin. However, almost all of the villagers use pipe water for domestic purposes.

In case of dug well, the depths are usually ranging from 5 to 10 m, and water table draws down to almost to their bottom in dry season. In some places, water in dug well is available throughout the year with good enough quality to drink. Water qualities of groundwater, checked through dug-wells, were mostly good enough indicating from 200 to 500 μS/cm of EC. Only in some zones, it has rather high EC value of more than 1,000 μS/cm was observed. The results of field water quality check are described in Table 4.3.8 below.

Table 4.3.8 Results of Field Water Quality Check

No.	Village	Sample	X, Y	EC (μS/cm)	pH*	Yieldm 3/h
1	Ban Bo	Dug well	37.828/96.500	1,250	7.4	<2
	Ditto	rainwater		10	7.1	
2	Ban Huai Heang	Pipe water	36.072/94.826	1,900	7.6	
	Ditto	rainwater		80	6.9	
3	Ban Huai Klum	Dug well	36.055/500.429	430	7.5	<2
4	Ban Kluay	Dug well	41.319/500.144	250	7.8	<2
5	Ban Nong Sinuan	Dug well	46.430/05.606	900	7.5	2-10
6	Ban Thung Makhan Thao	Pipe water	42.157/38.617	1,720	8.3	
7	Ban Chuk Kraphrao	Dug well	41.973/35.180	1,400	8.6	2-10
8	Ban Sai Thong	Deep well	31.414/28.102	910	7.4	2-10
	Ditto	rainwater		130	7.4	
9	Ban Nong Hin	Dug well	38.755/24.219	360	7.0	2-10
10	Ban Hub Prik	Deep well	40.367/13.354	280	7.5	2-10

*: pH value is not so accurate because the device is not calibrated.

(b) Estimated Current Groundwater Potential

1) General Condition of Groundwater in Lam Pa Chi River Basin

Most of the villages in the Lam Pa Chi River Basin already have a simple pipe-borne water supply system. More than half of their water resources for drinking are groundwater, except villages in the mountainous area, where they use a gravity water supply system. However, significant numbers of villages mainly in upper to middle basin, still utilize surface water (rivers or ponds) as their water sources. There is no water treatment facility in most of the cases, and the people use the pipe water mainly for domestic purpose. They still depend on rain for drinking water kept in clayed pots. The water qualities of most of the shallow wells were, however, rather clean and good except for a few cases which indicated high EC value more than 1,500 μS/cm through field measurement by portable water meter.

Besides the domestic water use, many farmers are utilizing groundwater for irrigation though dug-wells. Most of the cases, they dug shallow wells of 5 to 10 m depth near around the stream, which means the groundwater is directly connected from the water of the river. However, in some cases, several dug wells were made in wide plain and supply water through a year. According to the inventory results, total number of shallow wells and deep wells are 2,621 and 1,901, respectively in the Study Area. Almost all of wells are located at Middle Down to Down Stream Basin (see Table 4.3.10, Figure 4.3.2 and 4.3.3).

In the study area, high-elevated tanks are seen in some places that were constructed by public sector such as DMR, PWD, or Province, but at present all facilities are transferred to TAO. These are mostly sourced from groundwater through deep wells but some are sourced from shallow wells. In these cases, some of the systems have a filter tank or filter/aeration facilities together.

2) Estimated Current Groundwater Potential

The volume of groundwater in the aquifers should be determined in estimating how much yields could be increased during periods of drought. The thickness of the aquifer, its area extent and its specific yield must be known to consider how much water is available for domestic use. Generally, a specific yield of less than 2.0 m^3/hr is assumed for most metamorphic and granite aquifer in the Study Area. A slightly smaller specific yield may be appropriate for metamorphic rock and granite, depending on the degree of fracture and weathering. But in case of alluvial aquifer it can provide the specific yield 2-10m^3/hr or more than 10 m^3/hr. Based on the 1,270 mm/year in average of rainfall, total water volume in 3,190 MCM and mean annual discharge in 357 MCM are estimated in the Study Area and also 2,753 MCM or 86 % will be assumed by evapotranspiration. Remaining 96 MCM or 3% are infiltrated into ground. On the other hand, based on the present condition of the number of well and its yield and operating period, current groundwater use of well are roughly estimated as 13 MCM. Finally 83 MCM of groundwater will be still possible to be developed in the Study Area (Refer to Table 4.3.10 (3)).

Table 4.3.9 Number of Shallow Well and Deep Well at Each Tambon

Changwat		Ratchaburi																				Kanchanaburi								Grand Total by Type
Basin		Upstream Basin										Middle Upstream Basin						Miidle Downstream Basin								Downstream Basin					
Amphoe		K.A.Ban Kha								Pak Tho		Suan Phueng						Chom Bueng								Dan Makham Tia					
Tambon		T01		T02		T03		T04		T05		T06		T07		T08		T09		T10		T11		T12		T13		T14		T15		T16	
Condition		Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	Total	Func.	
Shallow well	Small dia.(private)	24	24	88	86	84	79	31	31	0	0	35	35	55	49	184	183	468	460	34	33	150	150	388	388	113	113	340	322	85	85	225	221	
	Large dia.(public)	37	33	30	23	7	4	22	22	0	0	17	17	34	18	9	7	42	36	31	25	64	64	27	27	16	14	26	25	25	24	24	23	
Sub-Total of Functional Shallow well		57		109		83		53		0		52		67		190		496		58		214		415		127		347		109		244		
Total shallow well		**302**										**309**						**1,183**								**827**								**2,621**
Deep well	Small dia.(private)	0	0	0	0	8	7	8	8	0	0	1	1	2	2	4	4	156	156	3	2	287	287	32	32	436	435	186	186	63	63	269	269	
	Small dia.(public)	63	24	27	24	7	5	11	11	32	27	17	17	32	25	33	16	62	50	46	37	53	52	43	41	12	11	46	42	40	37	37	30	
Sub-Total of Functional Deep well		24		24		12		19		27		18		27		20		206		39		339		73		446		228		100		299		
Total of Functional well		81		133		95		72		27		70		94		210		702		97		553		488		573		575		209		543		
Total deep well		**106**										**65**						**657**								**1,073**								**1,901**
Grand Total by Basin		**408**										**374**						**1,840**								**1,900**								**4,522**

Source : Database of Kor-Chor-Chor 2Cor (Tambon level) in 2002, Ministry of Interior

Meaning for definition :
Small dia. is diameter less than or equal 4 inch.(10 cm) Usually, casing is made of PVC or bamboo.
Large dia. is diameter more than or equal 40 inch.(100 cm) Usually, casing is made of concrete ring.

T01	Ban Bueng	T09	Dan Thap Tako
T02	Ban Kha	T10	Rang Bua
T03	Ta Nao Si	T11	Kaem On
T04	Nong Phan Chan	T12	Boek Phrai
T05	Yang Hak	T13	Nong Phai
T06	Suan Phueng	T14	Dan Makham Tia
T07	Tha Khoei	T15	Chorakhe Phuek
T08	Pa Wai	T16	Klon Do

Table 4.3.10 Summary of Wells in the Study Area

(1) Number and Density of Wells at Each Tambon

Rank	Tambon	No. of Functional well	Area (km^2)	Density of well by area (No./km^2)
1	Boek Phrai	488	14.50	33.66
2	Klon Do	543	17.65	30.76
3	Nong Phai	573	91.50	6.26
4	Kaem On	553	129.51	4.27
5	Dan Thap Tako	702	172.51	4.07
6	Dan Makham Tia	575	156.00	3.69
7	Rang Bua	97	35.98	2.70
8	Yang Hak	27	13.16	2.05
9	Chorakhe Phuek	209	127.50	1.64
10	Tha Khoei	94	57.64	1.63
11	Nong Phan Chan	72	58.00	1.24
12	Pa Wai	210	194.20	1.08
13	Ban Kha	133	277.63	0.48
14	Ta Nao Si	95	202.15	0.47
15	Suan Phueng	70	426.00	0.16
16	Ban Bueng	81	553.00	0.15
Total		4,522	2,526.93	

(2) Number of Well and Density at Each Subbasin

Rank	Basin	No. of Functional well			Area (km^2)	Density of well by Basin (No./km^2)
		Shallow	Deep	Total		
1	Downstream Basin	827	1073	1900	359.16	5.29
2	Middle Downstream Basin	1183	657	1840	352.51	5.22
3	Middle Upstream Basin	309	65	374	677.84	0.55
4	Upstream Basin	302	106	408	1137.44	0.36
Total		2,621	1,901	4,522	2,526.95	

(3) Underground Balance in the Study Area

Unit : MCM

Total Water Volume	Mean Annual Discharge	Volume of Recharge	Consumption of Wells			Balance
			Shallow	Deep	Total	
3,190	357*	96**	7.50	5.50	13.00	83

* Sourced by Department of Land Development, Report of Land Use Plan on Lam Pa Chi Basin in 1999

** Established by the Study Team, yield 2.0 m^3/hr, operating period 6 hr/day, 240 days/year

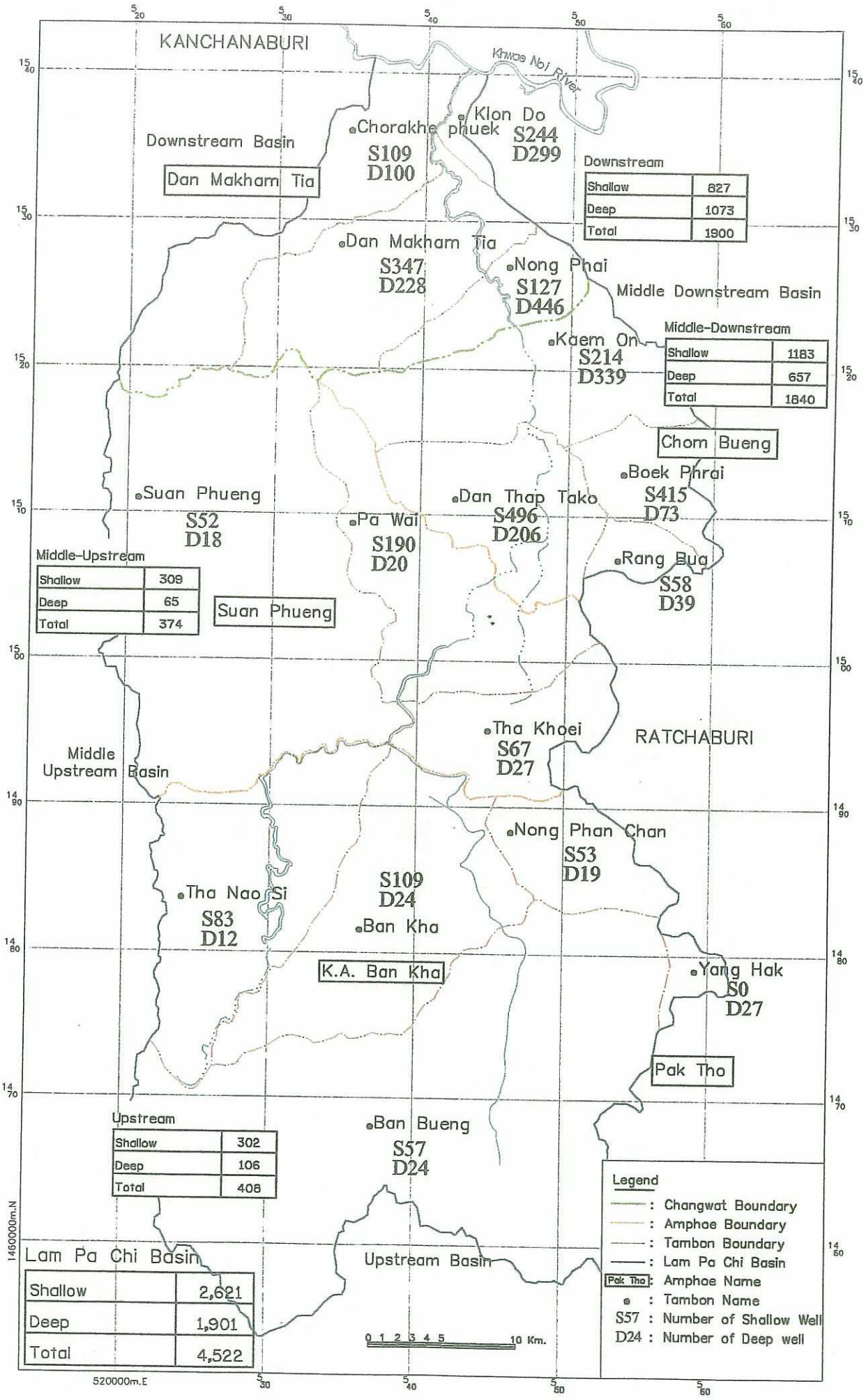


Figure 4.3.2 Number of Shallow Well and Deep Well

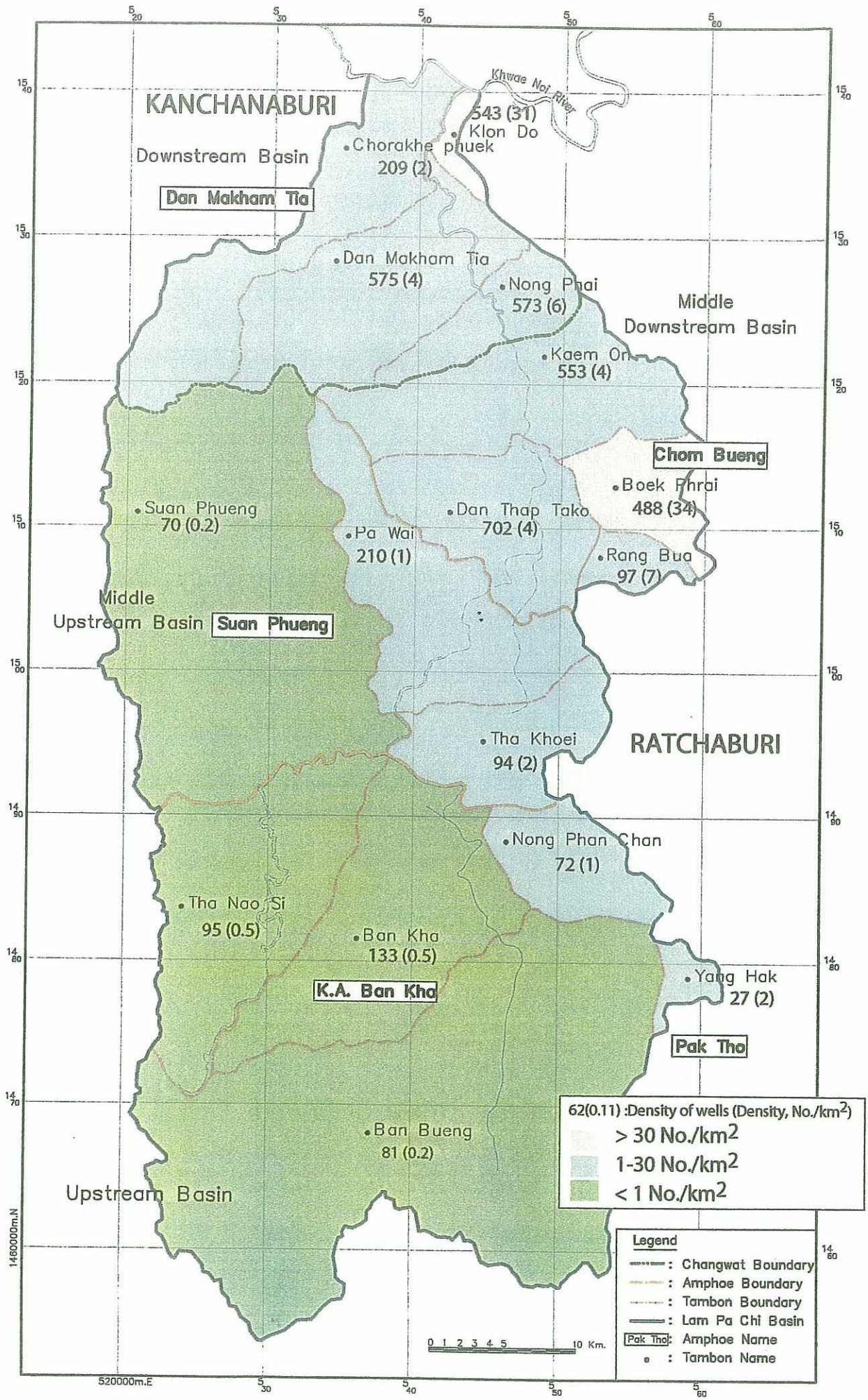


Figure 4.3.3 Density of Function Well

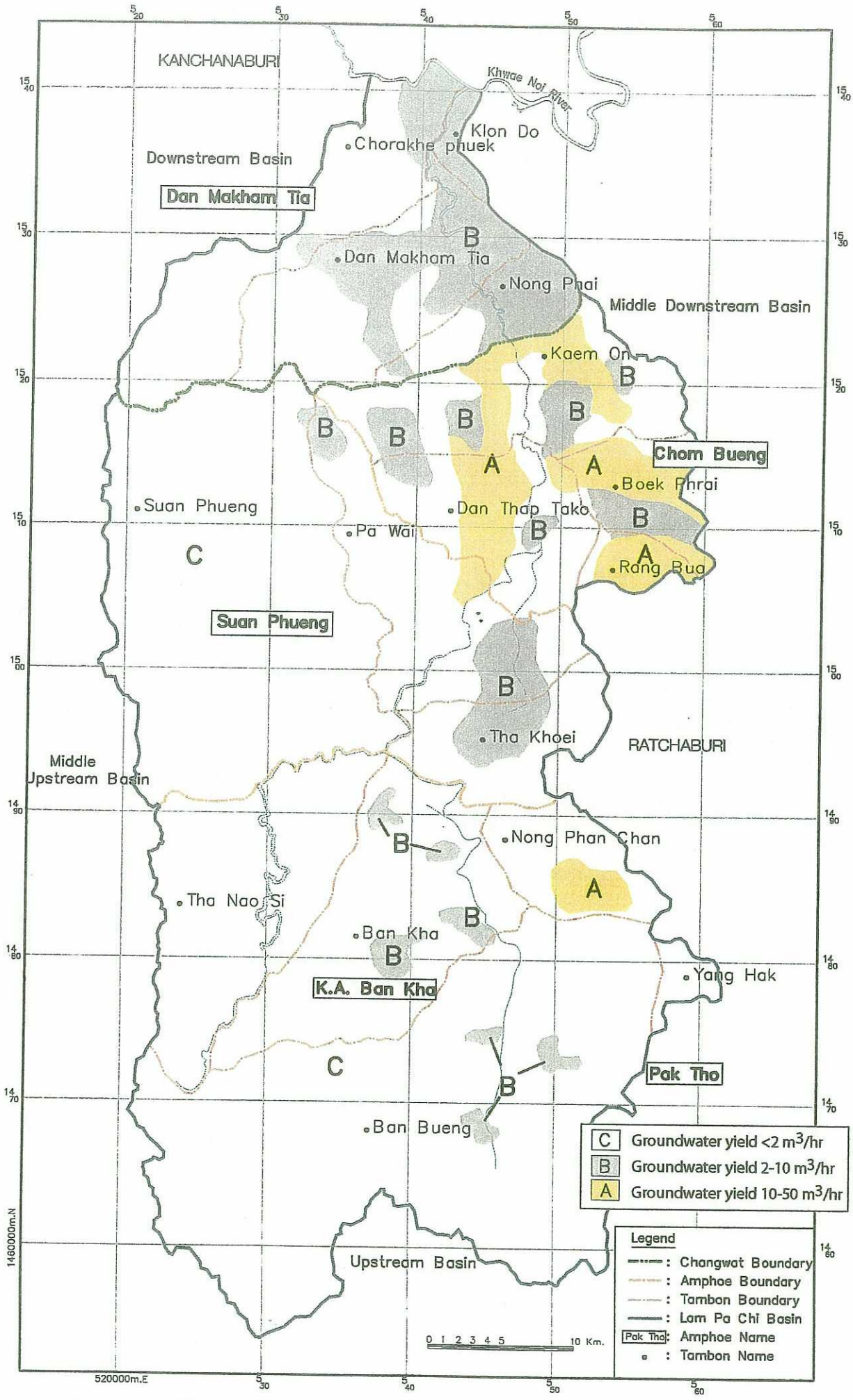


Figure 4.3.4 The Potential Area for Groundwater Development in the Study Area

(c) Factors Restricting the Groundwater Development

1) Hydro-geological Situation

As explained in the previous section, the Lam Pa Chi River Basin is enclosed by mountains for its west and south boundaries, and its eastern and northern boundaries are also roughly enclosed by chain-mountains. The Lam Pa Chi River is flowing out to the Khwae Noi Basin through a narrow path formed by a discontinuity of the chain mountain ranges. The situation suggests that the Lam Pa Chi River Basin is just like a dish, and the main flow can go out through only a break of the dish. Such condition allows groundwater to be kept inside the basin because the impervious hedge of the basin is higher than the basin center, like a natural underground dam. On the contrary, there are many small isolated mountains scattered in the basin. All of these mountains outcrops of bedrock and the situation suggest the bedrock surface is rather shallow in general, in other words; there is no large-scale underground valley in the basin. The former suggests easiness of groundwater storage but the potential of development is just depending upon the depth of aquifer and its characteristics. While the later suggests the general tendency of shallow bedrock surface, it does not exclude the existence of significant scale underground valleys along with geological structure line.

2) Conditions for Development

As the most important factor for the groundwater development, the characteristics of aquifer in the basin must be discussed. There are two major kinds of aquifers that can be distinguished in the basin, one is a river deposit by the Lam Pa Chi River and another is a weathered rock zone of a granite body. The river deposit is quite popular in the basin; it scattered everywhere in the eastern half of the basin. However, most of the deposit in the basin looks like middle to fine sand. For effective groundwater development, at least coarse sand, or sand-gravel layer, and more than 30 m of thickness are desired. For another possibility, the heavily weathered zone of granite can be an excellent aquifer sometimes, and the thickness of weathered zone of granite is usually deep. On the other hand, weathered condition of granite is not homogeneous and the depth of weathered zone is deep in ridge and shallow in valley portions, and not so convenient for effective groundwater use. As the results, the last two conditions required rather deep underground valley filled by sand-gravel. To find out such underground valley, filled by coarse deposits is the most primary subject for groundwater development in the Lam Pa Chi River Basin.

3) The Potential of Groundwater Development

The groundwater potential studies by DMR and RID figured out the potential areas for groundwater development at the middle to lower approaches of the basin as shown in Figure 4.3.4. Both studies mentioned that the groundwater quality is not very much clean. Supposed yields of groundwater in the potential zones are ranging from 10 to 50 m^3/hour, partly more than 50 m^3/hour, but the Total Dissolved Solid (TDS) is ranging from 500 to 1,000 mg/lit, a little bit high for a groundwater quality. Besides the potential zones, the studies suggest that the groundwater is available in almost all zones in the basin, inclusive of the mountainous zone, but yields are mostly less than 10 m^3/hour, most possibly less than 2 m^3/hour, except near along the streams where it yield some more of the groundwater. Through the field reconnaissance survey, two of the remarkable sites are pointed out by the Study

Team, one is at almost center of the flat basin, near Ban Nong Sinuan, and another is at eastern hedge of the basin, near Ban Nong Pru. In both sites, the Study Team found out very coarse river deposits, consists of sand and gravel underlain by boulders. Already some deep wells were drilled and several shallow wells were dug. Depending upon the depth to the bedrock, these two sites are deemed to have rather high potential for groundwater development, supposedly around 30 m^3/hour of yield can be expected based on the porosity of the sand-gravel.

For the relatively small scale groundwater development through dug wells or medium deep tube wells, said two zones suggested by the Study Team or the potential areas shown in the DMR's "Groundwater Potential Map" are to be the suitable sites. If further wide and large groundwater development is required, any underground valleys formed along geological structure lines and filled up by coarse deposits must be searched. As mentioned above, large scale underground valley must not exist but medium scale structural valleys with depth of 30 to 50 m may exist. To search such underground valley, a geophysical prospecting shall be effective (refer to figure 4.3.4).

As mentioned so far, there are some potential zones of groundwater studied by DMR and RID, which yield groundwater ranging from 10 to 50 m^3/hour. For relatively small-scale groundwater development, including the pilot projects to be involved in this Project, these areas shall be suitable. For further progressive groundwater use or management in the Lam Pa Chi River Basin, revealing the feature of underground valleys is the most basic subject. Another is to check the characteristics of the aquifer, only when significant scale of underground valley(s) is found out. If such underground valley(s) exist in the basin, several scenarios for groundwater development and management can be formulated, not only common groundwater development by well-and-pumping but further progressive development schemes such as underground dam and storage, artificial recharging in rainy season, and the combination of these. Followings are recommended to reveal the underground condition of the basin for further groundwater development:

- Systematic field reconnaissance survey, together with aerial photo interpretation, to make the geophysical prospecting plan,
- A preliminary geophysical prospecting by "Geo-electric Sounding, vertical method", covering all possible areas. The prospecting density shall be around 2.0 km grid, survey depth shall be 100m.
- Main geophysical prospecting works to reveal the underground valley, using TDEM, under the synthetic survey plan formulated after the preliminary geophysical prospecting works. The prospecting density shall be less than 1.0 km, survey depth shall be 150 m.
- Test well drilling at the most deep underground valley to confirm the results of geophysical prospecting and to know the characteristics of the aquifer.

4.4 Agriculture

(1) General Condition of Agriculture

(a) Land Use

According to the Land Use data in Lam Pa Chi River Basin in 1997 (LDD), 94.6% of the areas are categorized into forest and agricultural land. Forest particulalry accounts to 53.1% and agricultural land up to 41.5% in the Study Area. Current land use in Lam Pa Chi River Basin is shown below.

Table 4.4.1 Land Use in Lam Pa Chi River Basin

Item	Kanchanaburi		Ratchaburi				Total	
	Muang	Dan Makham Tia	K.A. Ban Kha	Chom Bueng	Pak Tho	Suan Phueng		
Residence	12.2	394.4	899.8	678.1	-	1,481.3	3,466	(1.4%)
Agricultural Area	835.4	24,525.8	25,671.0	28,477.8	23.2	25,403.7	104,937	(41.5%)
Forest	4,018.6	5,155.8	62,481.0	5,597.9	1,267.0	55,696.0	134,216	(53.1%)
Water reservers	42.6	141.9	365.0	25.4	-	374.2	949	(0.4%)
Others	321.8	467.0	2,795.8	472.2	25.6	5,043.7	9,126	(3.6%)
Total	5,231	30,685	92,213	35,251	1,316	87,999	252,694	(100.0%)

Source: Land Use Map Report: 1997 (Land Development Department), (Unit: ha)

In all sub basins, Long-term crops such as sugarcane, pineapple and cassava are the major crops. Share of the long-term crops reached 78%, while vegetable and orchard marked only 6% each. Outstanding crops of short-term are asparagus, baby corn, shallot and cabbage. The planted areas of each crop in each sub basin are shown in Table 4.4.2.

Table 4.4.2 Planted Areas of Each Crop in Each Sub-basin

Items	Upstream Basin		Middle Upstream Basin		Middle Down stream basin		Downstream basin		Total	
Short-term crop	11,933	(10%)	6,621	(15%)	9,967	(12%)	11,350	(8%)	39,871	(10%)
Long-term crop	90,715	(77%)	28,661	(65%)	61,499	(73%)	117,134	(86%)	298,009	(78%)
Orchard	10,167	(9%)	6,644	(15%)	3,601	(4%)	1,153	(1%)	21,565	(6%)
Vegetable	5,023	(4%)	1,832	(4%)	9,423	(11%)	6,717	(5%)	22,995	(6%)
Flowers	74	(0%)	53	(0%)	0	(-)	98	(0%)	225	(0%)
Total	117,912	(100%)	43,811	(100%)	84,490	(100%)	136,452	(100%)	382,665	(100%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: rai)

In addition, shares of the households engaging in each major crop are also the greatest at long-term crop. However, while the share of the land area on long-term crop reached nearly 80%, share of the household marked only 50%. Given the fact, the scale of farmland on long-term crop seems to be much larger than that of short-term crop. Number of households on each main crop is shown in the Table as follows:

Table 4.4.3 Number of Household on Each Crop

Items	Upstream Basin		Middle Upstream Basin		Middle Down stream basin		Downstream basin		Total	
Total H/H	5,980	(100%)	2,736	(100%)	5,878	(100%)	5,552	(100%)	20,146	(100%)
Short-term crop	1,377	(23%)	522	(19%)	882	(15%)	953	(17%)	3,734	(19%)
Long-term crop	2,960	(49%)	1,017	(37%)	2,563	(44%)	3,281	(59%)	9,821	(49%)
Orchard	1,058	(18%)	537	(20%)	321	(5%)	125	(2%)	2,041	(10%)
Vegetable	1,018	(17%)	366	(13%)	919	(16%)	953	(17%)	3,256	(16%)
Flowers	32	(1%)	24	(1%)	-		27	(0%)	83	(0%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: household)

Sugarcane, pineapple and cassava are main crops of the Study Area: maize, some fruit trees and vegetables follow the three main crops. According to the field survey, paddy is few in the Study Area. In addition, statistical data and field survey figured out that each sub basin has its own unique characteristics on its agricultural practices. Describes below are the main crops of each Amphoe resulted from average land use in each Amphoe in latest five years (1997-2001) (DOAE Kanchanaburi and Ratchaburi).

- Pineapple in Upstream Basin

  Pineapple is cultivated mainly at hilly area depending upon the factor that pineapple is one of the alternative crops at inferior condition with less water resources. --- K.A. Ban Kha is the greatest at pineapple plantation as well as Suan Pheng.

- Sugarcane in Downstream Basin

  Sugarcane is widely planted in all the Tambons at lower River Basin, especially at Chom Bueng and Dan Makhan Tia, in which share of the sugarcane comes up with 40% and 50% respectively.

- Paddy in lower area

  Although paddy are few in the Study Area, there are relatively much paddy in lower area since water resources must be relatively favorable--- Pak Tho and Chom Bueng, which locates eastern side of the Study Area, includes rice in their top three main crops, while K.A. Ban Kha and Suan Phuneg, which is located next to the mentioned Amphoe at western side don't have much paddy.

- Cassava in whole basin

  Cassava was found out to be one of the top three crops in every Amphoe except in Pak Tho, which is located at the upstream basin but not in mountainous area.

Table 4.4.4 shows the top three main crops in each Amphoe located in and around the Study Area.

Table 4.4.4 Main Crops in each Amphoe

Sub-basin	Amphoe	Three Main crop	
Upstream basin:	K.A. Ban Kha	Pineapple	(47.2%)
		Sugarcane	(21.2%)
		Cassava	(8.8%)
	Pak Tho	Major Rice	(48.8%)
		Second Rice	(24.6%)
		Sugarcane	(7.2%)
Middle Upstream basin:	Suan Phueng	Cassava	(31.1%)
		Sugarcane	(21.1%)
		Pineapple	(8.5%)
Middle Downstream basin:	Chom Bueng	Sugarcane	(40.7%)
		Cassava	(30.0%)
		Major Rice	(17.6%)
Downstream basin:	Dan Makham Tia	Sugarcane	(50.9%)
		Cassava	(28.7%)
		Major Rice	(5.5%)

Source: DOAE in Ratchaburi and Kanchanaburi (1997 to 2001)

(b) Farming Condition

1) Farmers Practices on Agriculture

42% of households in the river basin are engaged in agriculture and 73% of households are associated with a sort of agricultural occupation. It shows one aspect of the people's lives in the river basin and that is, more than half of households don't follow the agriculture by themselves although there is no main industry at all in the study area. Furthermore, although more than 70% of households have their own land (Table 4.4.6), only some 40% households are working as full-time farmer. Note that 60% to 80% of households devoting their time to agriculture as any kind or form of labor. According to the RRA survey, many farmers appealed their desire to have any kind of industry in this region. Although agriculture is absolutely the most important industry, people wish to have choices other than agriculture too. The number of household, which are doing agriculture or cultivating occupation, is shown in Table 4.4.5.

Table 4.4.5 Number of Household Engaged in Agricultural Operation

Items	Upstream basin		Middle Upstream Basin		Middle down stream basin		Downstream basin		Total	
No. of H/H	5,980	(100%)	2,736	(100%)	5,878	(100%)	5,552	(100%)	20,146	(100%)
Agriculture	2,838	(47%)	1,421	(52%)	2,383	(41%)	1,735	(31%)	8,377	(42%)
Labor for Agriculture	4,614	(77%)	2,093	(76%)	4,635	(79%)	3,424	(62%)	14,766	(73%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: households)

2) Farmland

An average of seventy two percent (72%) of households owns their land and it could be universal among the Study Area. Households living in Upstream Basin and Middle-downstream basin marked 75% and the lowest is 59% at Up-middle stream basin. It is likely high rate but actually there are levels of controversies on the land titling system in Thailand. According to the study, most of the

households own their land under the "So Bo Ko," "Nor Sor 3, or "Por Bor Tor," some of which are actually not official land title but just permit owning, or moreover, using the land. This complicated land titling system is briefly explained at the Section 4.2 (5). Note that there is no household in this statistic who rent the whole land for their life. The number of household, which own or rent their farmland is presented in Table 4.4.6.

Table 4.4.6 Land Owning Situation

Items	Upstream Basin		Middle Upstream Basin		Middle Down stream basin		Downstream basin		Total	
Total H/H	5,980	(100%)	2,736	(100%)	5,878	(100%)	5,552	(100%)	20,146	(100%)
Have own land	4,506	(75%)	1,625	(59%)	4,395	(75%)	3,924	(71%)	14,450	(72%)
Rent some land	552	(9%)	321	(12%)	1,053	(18%)	1,128	(20%)	3,054	(15%)
Rent whole land	-	(-%)	-	(-%)	-	(-%)	-	(-%)	-	(-%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: Household)

3) Water Resource

In general, water resources is likely insufficient for long-term crops at most (68% of the villages stated) as well as short-term crops (55% as well). About the other crops such as vegetable, fruits and second paddy, there is difference in sufficiency between upper river basin and lower river basin. In details, while 63% to 67% of the villages in the Upstream Basin stated to be insufficient in water resource for such kind of crops, it is in contrast, to villages in Downstream Basin with only 36% to 39%. This illustrates the difference of water resource availability within the river basin. The number of villages where water was insufficient on agriculture is stated in Table 4.4.7.

Table 4.4.7 Number of Village in Water Insufficiency on Agriculture

Items	Upstream Basin		Middle Upstream Basin		Middle Down stream basin		Downstream basin		Total	
Number of villages	48	(100%)	30	(100%)	58	(100%)	28	(100%)	164	(100%)
Second paddy rice	-	(0%)	4	(13%)	4	(7%)	10	(36%)	18	(11%)
Short-term crops	32	(67%)	11	(37%)	30	(52%)	18	(64%)	91	(55%)
Long-term crops	36	(75%)	19	(63%)	37	(64%)	20	(71%)	112	(68%)
Vegetables	30	(63%)	17	(57%)	19	(33%)	11	(39%)	77	(47%)
Fruits	32	(67%)	17	(57%)	18	(31%)	11	(39%)	78	(48%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: village)

Since 47% up to 68% of villages are suffering from water shortage for every type of crops other than second rice, it would be important to note what kind of water resources the farmers are using. There is a difference on the situation among the upper stream basin to lower stream basin. Down stream basin has more opportunity to use reserved water, while upstream basin depend solely on surface and ground water. In upstream basin, 58% of villages depend on surface and ground water while villages in middle-down stream basin reached only up tp 25%. In contrary, while 36% of villages in down steam basin use surface, ground and reserved water, only a number of 10 villages could get such water resources. Table 4.4.8 indicates the number of village using particular type of water resources.

Table 4.4.8 Villages Using Water Resources for Agriculture in Dry Season

Items	Upstream Basin		Middle Upstream Basin		Middle Down stream basin		Downstream basin		Total	
Total village (H/H)	48	(100%)	30	(100%)	58	(100%)	28	(100%)	164	(100%)
Surface/ground water	28	(58%)	13	(43%)	10	(17%)	7	(25%)	58	(35%)
Surface/ground and reserved water	5	(10%)	4	(13%)	7	(12%)	10	(36%)	26	(16%)
Sub-total	33	(68%)	17	(56%)	17	(29%)	17	(61%)	84	(51%)
Rainfed (no water)	15	(32%)	13	(44%)	17	(71%)	17	(39%)	22	(49%)
Total H/H	5,980	(100%)	2,736	(100%)	5,878	(100%)	5,552	(100%)	20,146	(100%)
H/H farming in dry-season	937	(16%)	236	(9%)	608	(10%)	261	(5%)	2042	(10%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: village)

4) Crop Calendar

Crop Calendar of major crops in the Study Area was found throughout the agricultural survey and is shown in Figure 4.4.1.

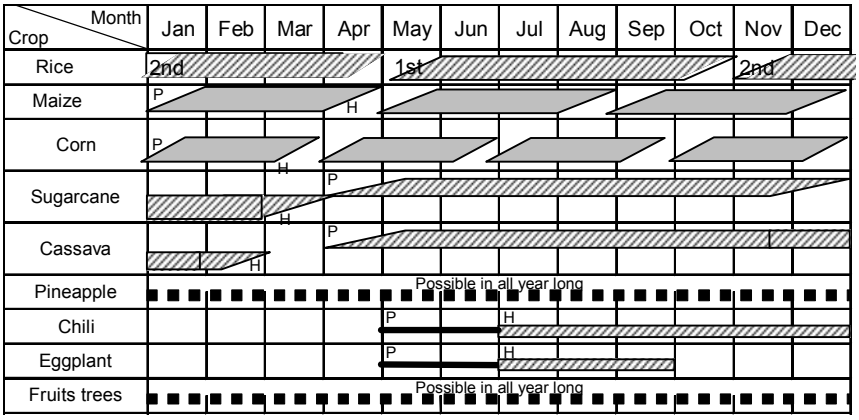


Figure 4.4.1 Cropping Calendar

(2) Trend of Main Crops

(a) Sugarcane

Kanchanaburi ranked first place in the year 1996 to 1997 and Ratchaburi followed at ninth place. This reflects that these two provinces, especially Kanchanaburi, could be naturally regarded as one of the main provinces, which strongly leads sugarcane industry in Thailand. Not just in whole province but also in concerned area, the field survey cleared up that sugarcane is one of the fundamental crops in the Study Area, especially in the down stream basin. Top ten provinces producing sugarcane are presented

Table 4.4.9 Top 10 Provinces Producing Sugarcane in 1996/97 (Unit: ton)

Rank	Province	Production	Ratio
1	**Kanchanaburi**	7,113,885	12.6
2	Suphan Buri	6,414,039	11.4
3	Kamphaeng Phet	4,975,791	8.8
4	Udon Thani	4,139,408	7.3
5	Chaiyaphum	4,030,402	7.1
6	Nakhon Ratchasima	3,615,865	6.4
7	Nakhon Sawan	3,554,445	6.3
8	Khon Kaen	2,800,441	5.0
9	**Ratchaburi**	2,716,465	4.8
10	Lop Buri	2,279,775	4.0
	Others	14,753,422	26.2
	Whole kingdom	56,393,938	100.0

Source: Pocket Thailand in Figure 2001

in Table 4.4.9.

On the other hand, considering the yield of Sugarcane, both provinces regrettably disappeared from first ten provinces of the ranking note. This disadvantage implies something about production at farm level in both provinces. Also this would be resulted in illustrating that in Sugarcane agriculture, people in this area tend to expand its cultivating area regardless of the fertility of the land. Actually, according to an interview to a Sugar factory in northeastern Thailand, the fertility of sugarcane in central Thai, in terms of sugar contents rate, behinds those in northeastern area. Infacts, eight factories out of sixteen had moved out from Kanchanaburi and went to the central region which demonstrated the disadvantage of this area. Top ten provinces having highest yield on sugarcane is shown in Table 4.4.10.

Table 4.4.10 Top 10 Provinces Having High Yield on Sugarcane in 1995/96 - 1996/97

(Unit: kg/rai)

Rank	Province	Yield	
		1996/97	1995/96
1	Prachin Buri	11,434	14,756
2	Ang Thong	11,229	12,716
3	Sing Buri	11,013	12,931
4	Suphan Buri	11,003	10,145
5	Kamphaeng Phet	10,667	10,649
6	Nakhon Pathom	10,159	9,594
7	Chaiyaphum	10,126	10,137
8	Chai Nat	9,757	12,751
9	Yasothon	9,638	9,063
10	Phichit	9,515	9,261
	Whole kingdom	9,205	9,417

Source: Pocket Thailand in Figure 2001

As a whole, planting area of sugarcane in this area had decreased at 14 points during the last five years. In details, while lower river basin is the main source of sugarcane such as Dan Makham Tia and Chom Bueng, its production decreased so much in contrary to the upper river basin which increased its planting area. The balance as a source of sugarcane in the Study Area has appeared to be slightly changing. One big reason od this decrease could be stated that, generally, sugar-processing factories have tendency to shift to northeastern part of Thailand because of relatively high potential in that region supported by low cost on labors and farmland and high quality of sugarcane. Actually, eight out of sixteen sugar factories, which had been in Kanchanaburi in the late 1980's had moved to northeastern region. Five-year trend of sugarcane in each Amphoe is shown in Table 4.4.11.

Table 4.4.11 Trend of Sugarcane Farming in Each Amphoe (1997-2001)

Year / Amphoe	97-98	98-99	99-00	00-01	01-02	Ave	Share
K.A. Ban Ka		5,300	5,725	6,020	43,046	15,023	7%
Pak Tho	8555	17,500	12,700	11000	14,061	12,763	6%
Suan Phueng	9,000	8,140	13,501	7,943	32,468	14,210	7%
Chom Bueng	72,950	102,578	108,090	86,570	51,060	84,250	41%
Dan Makham Tia	120,179	88,134	89,444	71,069	39,510	81,667	39%
Total	210,684	221,652	229,460	182,602	180,145	207,913	100%
Index	100	105	109	87	86		

Source: Agricultural and Extension Office in Kanchanaburi and Ratchaburi (Unit: rai)

(b) Pineapple

Quite similar with the Sugarcane, Kanchanaburi and Ratchaburi marked sixth and seventh place respectively in the whole nation in the year 1997 in production. It shows that pineapple would also be one of the main crops in these provinces. The importance of pineapple industry had also been confirmed by the field survey especially at the upstream basin however, in Kanchanaburi, since the field survey didn't observe so much of pineapple fields in the downstream basin, other area in the province may support this high production. Top ten provinces producing the most pineapple are shown in Table 4.4.12.

Table 4.4.12 Top 10 Provinces Producing Pineapple in 1997

Rank	Province	Production	Ratio
1	Prachuap Khiri Khan	819,798	39.3
2	Rayong	323,448	15.5
3	Chon Buri	201,337	9.7
4	Phetchaburi	119,327	5.7
5	Uthai Thani	93,453	4.5
6	Kanchanaburi	85,301	4.1
7	Ratchaburi	84,007	4.0
8	Chumphon	62,581	3.0
9	Chachoengsao	60,638	2.9
10	Nong Khai	53,270	2.6
	Others	180,230	8.7
	Whole kingdom	2,083,390	100.0

Source: Pocket Thailand in Figure 2001 (Unit: ton)

On the other hand, considering the yield, both provinces had dropped out of top ten provinces. This totally have the same situation with those of sugarcane that implies less fertility. Top ten provinces having highest yield on pineapple is presented in Table 4.4.13.

In addition, quite different from those of sugarcane, planting area of pineapple is doubled throughout the five years. Actually, it has reached three times in the year 2000. This increase depends greatly upon expansion of planting area in K.A. Ban Kha. This Amphoe accounts about 80% of land area within five Amphoe and it increased planting area of pineapple more than three times within only five years. This could highly depend upon the recent trend of high price on pineapple products, which was stated by the pineapple farmers. Five-year trend of pineapple farming is located in Table 4.4.14.

Table 4.4.13 Top 10 Provinces Having High Yield on Pineapple in 1995/96 - 1996/97

Rank	Province	Yield	
		1997	1992
1	Chon Buri	7,144	6,163
2	Chachoengsao	6,910	7,502
3	Rayong	5,982	5,668
4	Suphan Buri	4,836	-
5	Uthai Thani	4,596	4,787
6	Nong Khai	4,374	4,453
7	Trat	4,274	3,713
8	Chanthaburi	4,065	5,364
9	Lampang	3,775	4,385
10	Chumphon	3,614	3,942
	Whole kingdom	3,936	3,888

Source: Pocket Thailand in Figure 2001 (Unit: kg/rai)

Table 4.4.14 Trend of Pineapple Farming in Each Amphoe (1997-2001)

Year / Amphoe	97-98	98-99	99-00	00-01	01-02	Ave	Share
K.A. Ban Ka	11,300	37,505	38,200	42,530	37,900	33,487	79%
Pak Tho	1915	4,115	4,800	450	680	2,392	6%
Suan Phueng	3,900	8,500	5,235	8,850	2,155	5,728	13%
Chom Bueng	100	673	506	150	280	342	1%
Dan Makham Tia	133	704	420	990	310	511	1%
Total	17,348	51,497	49,161	52,970	41,325	42,460	100%
Index	100	297	283	305	238		

Source: Agricultural and Extension Office in Kanchanaburi and Ratchaburi (Unit: rai)

c) Cassava

As a whole, although planting area of cassava decreased at 16 points within 5 years, in details on the other hand, indeed it increases at some point in some Amphoe. Chom Buen, the leading Amphoe of cassava, and another two Amphoe in upstream basin increased certainly its planting area. Note that Dan Makham Tia, the leading Amphoe in 1997, decreased its planting area of cassava almost by half. Five-year trend of cassava farming in each Amphoe is located in Table 4.4.15.

Table 4.4.15 Trend of Cassava Farming in Each Amphoe (1997-2001)

Year / Amphoe	97-98	98-99	99-00	00-01	01-02	Ave	Share
K.A. Ban Ka	800	2,130	4,780	7,020	16,470	6,240	5%
Pak Tho	787	1,665	1,215	650	4,550	1,773	1%
Suan Phueng	27,025	24,900	26,040	10,650	16,190	20,961	15%
Chom Bueng	39,700	82,782	71,700	70,810	43,550	61,708	45%
Dan Makham Tia	71,617	46,106	27,791	48,384	36,380	46,056	34%
Total	139,929	157,583	131,526	137,514	117,140	136,738	100%
Index	100	113	94	98	84		

Source: Agricultural Extension Office in Kanchanaburi and Ratchaburi (Unit: rai)

d) Vegetable

Various vegetables are grown in the Study Area. According to the five-year land use data (1997 to 2001: Agricultural and Extension Office in Kanchanaburi and Ratchaburi), 108 kinds of crops are listed up in Ratchaburi and 91 is in Kanchanaburi. Asparagus is one of the most raised vegetables in the downstream basin. Kanchanaburi province strongly promotes asparagus cultivation and farmers could make a consignment contract with private companies and be able to trade the product for guaranteed price. As a result, asparagus irrigated by sprinkler system occupies so much farmland in downstream basin. Shallot is also widely spread out within whole river basin, mainly in downstream basin. Introducing vegetables is highly dependent upon the availability of water resources. Therefore, although there is no definite statistics, various kinds of vegetables are observed mainly in down stream basin where irrigation facilities are widely possible.

(3) Fishery

No statistical data were available to illustrate prosperous activities of fishery in the Study Area, and confirmed during the field survey for there were no active practices of fishery as a solid industry. However, small-scale fisheries were actually found through the study to have wide appeal among the Study Area. Considerable numbers of farmers who have a sort of farm pond where to cultivate fish for home consumption and/or individually sell it to local market were seen in the study area. Since there are thousands of ponds in the Study Area, total scale aggregates could be numerous, although it is difficult to grasp the precise number of this multipurpose pond. On the other hand, some type of fishery was found to be under experiment.

For example, at Ban Tung Sara Dam (Tambon Pa Wai, Amphoe Suan Phueng), village committee manages the fishery activity. The Dam is opened for fishing only in dry season and closed in wet season for nursery (May15 to November1). The committee of the village collects fishing fee at 50 Bt/person/season for only three days at the beginning of the season in order to manage the fish raising in the reservoir. Penalty for illegal fishing such as fishing in closed season is 5,000 Bt per time. Several kinds of fish such as Tilapia, fresh water shrimp and catfish but not snakehead fish nor carp are living in the reservoir. Some kind of them are nursed and released by DOF tapping into the fund the village committee collected. Villagers can use fishing net, if its mesh is more than 7 cm^2. The village also encourages the fishery as one of the main activities and holds fishing competition sometime.

(4) Livestock

Number of households, which are engaged in livestock, is less than 20% of total households in Lam Pa Chi River basin. Fowls and cows are most popular and share about 8% and 6% respectively. Number of households in upstream basin, which are engaged in cows, swines and fowls, predominates over the ones in the other sub basin. The number of household, which breeds some type of livestock, is shown in Table 4.4.16.

Table 4.4.16 Number of Household Raising Livestock

Items	Upstream Basin		Middle Upstream Basin		Middle down stream basin		Downstream basin		Total	
Total H/H	5,980	(100%)	2,736	(100%)	5,878	(100%)	5,552	(100%)	20,146	(100%)
Cow	474	(8%)	263	(10%)	255	(4%)	172	(3%)	1,164	(6%)
Buffalo	3	(0%)	-	(-%)	3	(0%)	35	(1%)	41	(0%)
Swine	423	(7%)	167	(6%)	52	(1%)	39	(1%)	681	(3%)
Fowl	784	(13%)	561	(21%)	75	(1%)	169	(3%)	1,589	(8%)
Othres	-	(-%)	2	(0%)	-	(-%)	-	(-%)	2	(0%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: household)

Eighty-six percent which is a decent number of villages in Lam Pa Chi River Basin are insufficient in pasture for livestock feeding. Notwithstanding, more than 90% of villages located in Upstream Basin and Middle Upstream Basin raise livestock under such insufficient situation. However, while farmers in many village breed livestock, actual number of households in each village is quite few as

stipulated in Table 4.4.17. In upper stream basin, there is a considerable range of forest but not pasture. Typical style of pasturage was found out that individual farmers raise a few cattle in their property where there is not enough pasture. Farmers often bring their cattle to common property or neighbors land to feed them. Situation of pasture and livestock farming is shown in Table 4.4.17.

Table 4.4.17 Situation of Pasture and Livestock Farming (Unit: village)

Items	Upstream Basin		Middle Upstream Basin		Middle down stream basin		Downstream basin		Total	
Total village	48	(100%)	30	(100%)	58	(100%)	28	(100%)	164	(100%)
There is no Pasture	42	(88%)	25	(83%)	52	(90%)	22	(79%)	141	(86%)
There is Pasture	5	(10%)	4	(13%)	4	(7%)	5	(18%)	18	(11%)
Area of Pasture (rai)	1,220		655		2,730		3,100		7,705	
Raise Livestock	2	(4%)	2	(7%)	29	(50%)	4	(14%)	37	(23%)
Don't Raise Livestock	45	(94%)	27	(90%)	26	(45%)	22	(79%)	120	(73%)

Source: Khor Chor Chor Tambon level data (2001)

(5) Marketing

(a) Transportation

In Lam Pa Chi River basin, more than 18% of households own pick-up truck. In contrary, this data also shows that about 80% of households in Lam Pa Chi River basin don't have pick-up truck. It implies that considerable number of farmer is insufficient in transportation for marketing as well as carrying any kind of agricultural materials eventhough 80% of households are not always farmer (see Table 4.4.5). Moreover, this could be one of the reasons why most of the farmers have to deal with merchants and are suffering with high cost for transportation. The number of household, which has vehicles, is shown in Table 4.4.18.

Table 4.4.18 Number of Household, Which Has Vehicles

Items	Upstream Basin		Middle Upstream Basin		Middle down stream basin		Downstream basin		Total	
Total H/H	5,980	(100%)	2,736	(100%)	5,878	(100%)	5,552	(100%)	20,146	(100%)
Pick-up truck	1,706	(29%)	556	(20%)	1,269	(22%)	N/A	N/A	3,531	(18%)
Motorcycle	3,853	(64%)	2,054	(75%)	4,012	(68%)	4,480	(81%)	14,399	(71%)
E-tan vehicle*	116	(2%)	13	(0%)	122	(2%)	108	(2%)	359	(2%)
Others	376	(6%)	155	(6%)	264	(4%)	262	(5%)	1,057	(5%)

Source: Khor Chor Chor Tambon level data (2001) (Unit: household (H/H))

Note*: E-tan vehicle: Special type of pick up truck usually used for agricultural purpose only.

(b) Marketing System of Major Crops

Based on the RRA survey, baseline survey and agricultural survey, it is suggested that marketing should be considered as one of the most important factor on living condition of the farmers in the Study Area. It is absolutely important to indicate not only how and when farmers plant their crops, but also how they deal with middlemen, merchants or factories. Some constraints were observed on marketing between small-scale farmers and middlemen. It is revealed that small-scale1 farmers are

1 Scale of the farmland

highly dependent upon and affected by middlemen compared with relatively large-scale farmers. Even if a farmer could cultivate appropriate quantity and quality of the product, always, they could not be able to get appropriate income.

Main marketing channel is quite simple as there are two main general market places in Kanchanaburi and Ratchaburi. Regarding vegetables and fruits, farmers brought their products directly and/or indirectly to these two main market places. Considering the sugarcane, pineapple, and cassava, farmers bring their products, in any ways, to the factory, which are also located in Kanchanaburi and Ratchaburi province. Figure 4.4.2 shows major market places related with the Study Area. It should be cleared up how pineapple and sugarcane farmers deal their products after harvesting and how middlemen and factories play their role on marketing. Discussed below are the current conditions of marketing on vegetable, pineapple and sugarcane agriculture.

1) Vegetable

Figure 4.4.2 shows the most ordinary marketing route on vegetable. There are two main key market places in the vicinity of the Study Area, one in Kanchanaburi and the other in Ratchaburi. Since 86% of the Study Area is included in Ratchaburi province, most of farmers brought their products to "Sri Muang" wholesale market in Ratchaburi. The farmers living in downstream, on the other hand, brought their products to "Muang" wholesale market in Kanchanaburi or district market in Dan Makham Tia. The Sri Muang market is biggest in this area and opens twenty-four hours a day. This market deals not only the products from Lam Pa Chi River basin but also from other provinces, moreover, from other country such as Australia and Malaysia.

In many cases, farmers brought their products to the market by pick-up truck. Some brought their products by their own vehicles; some charters a vehicle and the other deals with merchants. "1 Bt/kg" is well known among the farmers as a price for transportation fee when they deal with merchants. However, transportation fee is the issue which the farmers think is not clear. This can be shown in case farmers deal with merchant. Firstly, farmers sold their product to the merchant but would not get any money at this point. Afterwhich, the merchant brought the products to the market and later on informed the farmer how much has been the price of the commodities he was able to sell at the market. Then, the merchant pays back the farmer with some money deducting the cost of transportation fee. The problem occured is that, the farmer has never been able to know how much the merchant really sold the product at the market.

Regarding the scale of farmers, sugarcane factory gave us a good example that they regard the farmers, who cultivate some 100 rai as "Middle scale." The Study Team had observed a farmer who had been planting pineapple about 500 rai and was called "Large scale." In this circumstances, let fix a tentative standard of farmland size as follows:

- Small scale: 0 up to 20 rai
- Middle scale: 20 up to 100
- Large scale: More than 100

Since baseline survey revealed average land size of farmers in the river basin at 1 to 60 rai, most of the farmers in the river basin should be regarded as middle-scale farmers in this regard.

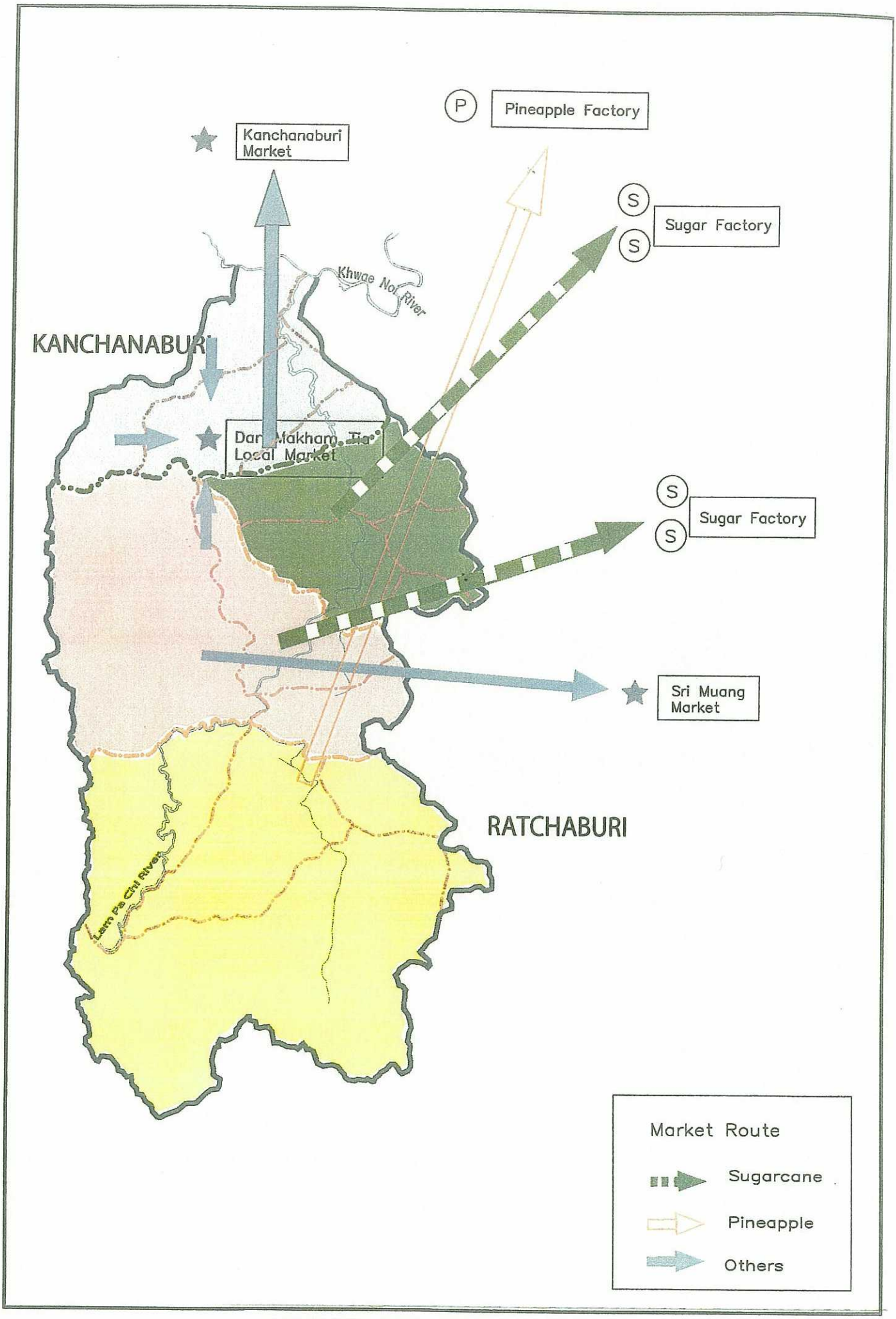
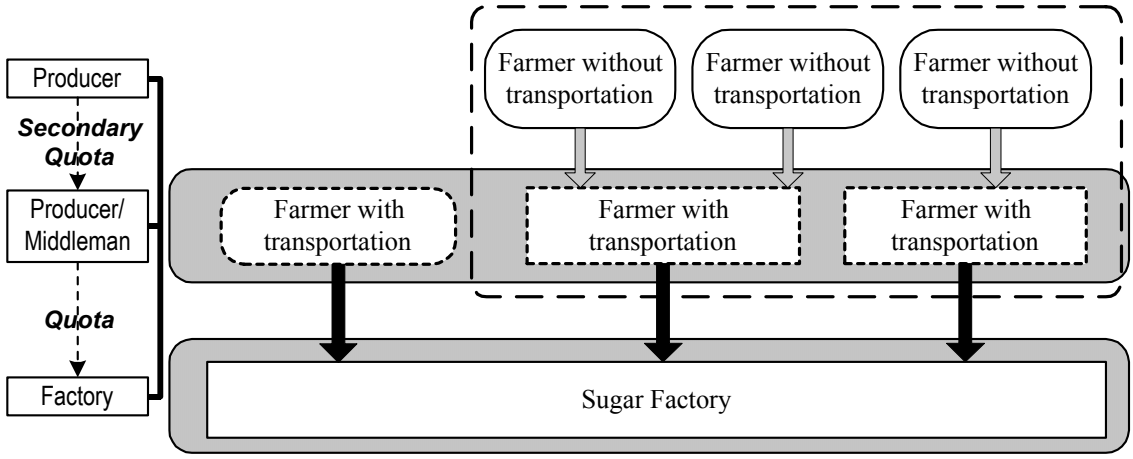


Figure 4.4.2 Major Marketing Route

2) Sugarcane

It is said that there is a "Quota2" system in sugarcane market as for strict control of quantity so that sugar factory could secure the exactly amount of the new material in every season. However, according to an interview to a sugar factory, this system is not so strict but much more flexible. In fact, due to the current high-demand situation, factory is surely in need of the product as much as possible. Given the fact, the point of current quota system is that factory would more likely to secure the minimum amount of the product. Take note that factory would even accept from farmers, products they brought which are much more than the expected from quota. From the factory's point of view, marketing channel of sugarcane seems to be quite simple as just like a collateral relationship between producer and factory. However, in fact, there are three levels of steps in actual circulation. Producers' side is abundant as being involved with the factory directly and/or indirectly, according to its farming scale and possession of transportation. Following is the typical circumstances of marketing observed through the study. The Typical circumstance of marketing system on sugarcane is shown in Figure 4.4.3.



Most of farmers factory deals with directly are middle-scale farmers who own about 100 rai.

Figure 4.4.3 Typical Circumstance of Marketing on Sugarcane

Relatively middle to large-scale farmers who possess proper transportation undertake contract for certain amount of quota with the factory. In many cases and on the same time, these farmers seldom deal with factory alone but make up a group and are accompanied by a several small-scale farmers. A sugar factory explained that the factory makes contract not only with the representative of the group but also every participant, so that they could know the exact details of whom they deal with and ensure to bring any services directly to the farmers. The other factory stated that they deal mostly with middle scale farmers. In that case, the medium scale farmers, who got contract with the factory, makes

2 "Quota" system in Sugarcane market

Before the planting season, factory orders the deals in terms of cultivated area to someone such as farmer and middleman. The deals itself or sometimes agreement between factory and farmers are called "Quota." The farmer who has got the quota from factory would try to cultivate the area how much he/she agreed. One of the reason why factory orders in terms of "area" but not "product" is that factory wants to secure the farmers who would deal their product for the factory and refer the quota just to grasp the approximately amount in next harvest. Factory would gratefully accept the surplus products.

another quota-like contract with small-scale farmers, by their own responsibility. The relationships could be illustrated as enclosed by dot-line in figure 4.4.3 above (hereinafter referred as "Secondary Quota").

This secondary quota exaggerates fate of each actor in both preferable and disagreeable meaning. In taking a rosy view, there could be several advantages such as:

(1) Even small-scale farmer, who may not be able to have quota from factory could sell products
(2) Even the farmer who doesn't possess any transportation could join to sugarcane business
(3) The farmer who have a proper transportation could make the most of their facility
(4) Factory could deal only with suitable farmers, namely medium to large-scale farmers

In this closed world on the other hand, there are undesirable aspects too. Most of the farmers who deal with the "middleman" are relatively insufficient in funds and in general, are small-scale. Given the fact, relationship between middleman and such farmers is, in many cases, in subordinate. In most cases, small-scale farmers suffered from shortage in capital especially during the commencement of planting. They tends to borrow some money from middleman in order to launch new season. Since small-scale farming has disadvantage on its profitability, some issues, related with the relationship with middleman as stated below, are sometime very severe on farmers' economy.

(1) Interest for borrowing money
(2) Transportation fee

In addition, the system of secondary quota could naturally caused gap of opportunity between those who can bring the product directly to the factory and those who are not in such situation. Although sugar factory prepares a series of supporting services to the farmers such as extension and credit support services for small-scale irrigation, if there was no direct relationship between the two, any kind of service could hardly reach the small-scale farmers.

3) Pineapple

Pineapple industry is much more aggressive than sugarcane industry particularly in middle to upper basin area where sandy soil is the most prominent and rain fed farming is mostly exercised. Comparing the scale of factory, about 3,000 employees are working in pineapple processing factory in Kanchanaburi, while about 750 workers are engaged in a factory in Ratchaburi. As a result, marketing system of pineapple has been developed with emphasis on the role of middlemen. Middlemens' role is highly developed and is clear especially when dealing with those who want and whom to deal which is very much different from marketing of sugarcane.

Marketing system of pineapple also maintains a "Quota3" system to control and secure the quality and quantity control. Most differently from those of sugarcane, middlemen are rarely farmers but just focused on dealing the products. Also they deal to anyone who wants to sell the product. In other word, farmer has an opportunity to choose whom they would want to sell their products. Therefore, farmer usually checks the buying price of each middleman and possibly chooses the best one, although it does not differ among the middleman so much. The typical circumstance of marketing system on pineapple is shown in Figure 4.4.4.

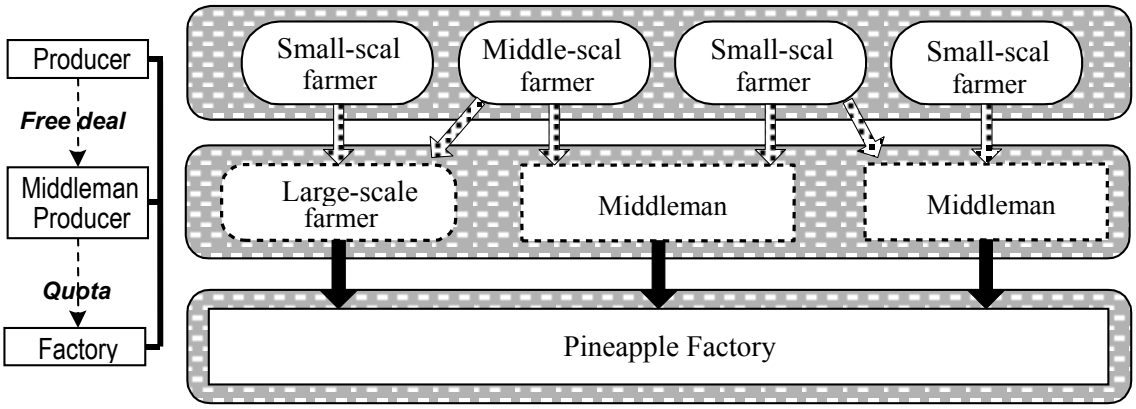


Figure 4.4.4 Typical Circumstance of Marketing on Pineapple

(c) Marketing Price

Another topic, which is completely different between sugarcane and pineapple, is the trend of the price. While the price of sugarcane is stable as being decided by the government, that of pineapple is frequently changing. The graft on the right side shows the trend of farm gate price in whole Thailand. While the price of sugarcane stably progresses, the price of pineapple is changing drastically. An interview to a pineapple farmer disclosed that, just after the year of 1998 when market price marked its highest peak, farmers expanded broadly their planting area of pineapple. The price of pineapple went extremely down and many farmers ended up do nothing but through away the products. Trend of the market price on sugarcane and pineapple in last ten years is shown in Figure 4.4.5.

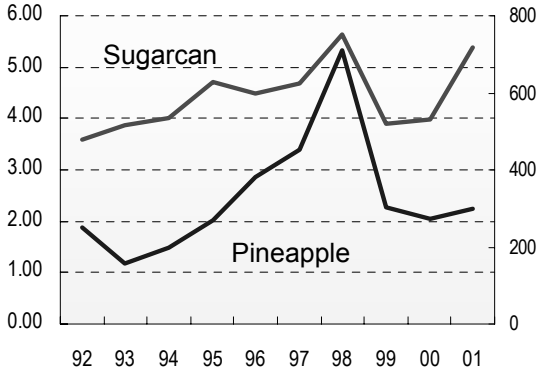


Figure 4.4.5 Trend of price on Sugarcane and Pineapple in Last Ten Years

Year	92	93	94	95	96	97	98	99	00	01
Pineapple (Bt/kg)	1.88	1.18	1.48	2.01	2.86	3.38	5.33	2.28	2.05	2.23
Sugarcane (Bt/ton)	480	516	533	629	598	624	750	520	529	719

Source: Sugarcane (farm gate price) ---Sugar and Sugarcane Committee Office
Pineapple---Center for Agricultural Information

[3] "Quota" System in Pineapple Market

At the beginning of the planting season, factory orders the deals in terms of production to middleman. The deals itself or sometimes agreement between factory and farmers are called "Quota." The farmer who has got the quota from factory

In addition, new style of marketing station had appeared in the Study Area. One of a small-scale farmer established pineapple-processing company in Tambon Ban Kha. They carry out some sort of processing before they transport the products to a factory in Kanchanaburi. They peel, slice and pull out the core of pineapple taking into consideration the standard of pineapple. This demonstrates one of the other possibilities as a way of new income generation in the future.

4.5 Irrigation

(1) General Condition

Based on the Khor Chor Chor, Baseline Survey data and field survey results, current situation of irrigation practices in the Study Area is divided into 3 types/sub basins, namely upstream basin, middle basin and downstream basin. The water user's associations were not established at present but farmers are members of organizations such as water users' groups, pineapple growers, asparagus growers, and cassava growers. Current situation of irrigation practice is summarized below.

(a) Upstream Basin

~ Ban Bueng, Ban Kha, Tha Nao Si, Nong Phan Chan and Yang Hak~

Small scale sprinkler and drip irrigations within the area of 10 rai for orchards such as guava, jujube, shaddock, longan, citrus are practiced but very few in the hilly area. Water resources are mainly small tributaries as well as mountain torrents and farm ponds are very few. There are few irrigation systems in mountainous area. In Ban Kha and a part of Ban Bueng, rain fed pineapple farming is very popular.

(b) Middle Upper Basin

~ Suan Pheng, Tha Khoei, and Pa Wai~

Small scale sprinkler for vegetables such as cowpea, cucumber, egg plant, chilly, Chinese cabbage etc. or drip irrigations for citrus etc. within 20 rai are dominant but few. Water resources are mainly tributaries of Lam Pa Chi river and farm ponds. During dry season, small tributaries are dried up and only downstream fields of dams and weirs are able to use irrigation water. According to the result of the interviews from farmers, price of mobile pump in 75mm diameter is 4,000 Bt and sprinkler pipe system is 5,000 to 6,000 Bt/rai. This refers specially to investors in Bangkok who have been reclaiming the hilly area for orchards along the Huai Ban Bo river in Tambon Suan Phueng introducing sprinkler irrigation systems. Reclamation fields are more than 100 rai. Sugarcane and cassava in the plain area are planted through rain fed.

(c) Middle Down to Downstream Basin

~ Rang Bua, Dan Thap Tako, Kaem On, and Boek Phrai Nong Phai, Dan Makham tia and Chorakhe Puek~

Small-scale sprinkler irrigation practices are remarkable in this area. Along the Huai Lam Khlung river throughout the year, water for irrigation is available and almost all farmers plant asparagus, sugarcane as well as many kind of vegetables. Especially wetland at the right bank of Khwae Noi and on the mouth of Lam Pa Chi River, rice cultivation is practiced in the Study Area. Water resources are dams, weirs, farm ponds and shallow wells. Compared with the upstream and Middle Upstream Basin, water resources potentiality is much higher, and irrigation practices are the most active in the Study Area.

(2) Irrigation Facilities

In the Study Area, there are medium to small-scale dams and weirs constructed by RID and small weirs and ponds constructed by other agencies to be used for irrigation purpose.

(a) Medium Scale Dams and Weir constructed by RID

There are 5 medium scale dams and a weir in the Study Area with a potential irrigable area of 29,600 rai (4,730 ha) in total. Out of the total area, 18,400 rai (about 60%) has already been benefited by irrigation system undertaken by RID. Other 11,200 rai are not irrigated so far. Among them Tha Khoei Reservoir constructed in 2002 is the biggest one with the storage capacity of 23.40 MCM, however, water resources development plan has not been established yet. Location of the dams and a weir are shown in Figure 4.5.1.

Table 4.5.1 Medium Scale Dams and Weirs constructed by RID

Name of Project	Location		Storage Capacity (MCM)	Beneficial Area			
	Amphoe	Tambon		With Irrigation system		Planned	
Ratchaburi Province				rai	ha	rai	ha
Tha Khoei Reservoir	Ban Kha	Ban Bueng	23.40			10,000	1,600
Huai Ha Na Reservoir	Suan Phueng	Tha Nao Si	2.45	2,500	400		
Huai Ma Hat Reservoir	Ban Kha	Nong Pan Chan	4.30	5,900	940		
Chat Pa Wai Reservoir	Suan Phueng	Tha Khoei	2.50			1,200	190
Tong Kra Tin Weir	Chom Bueng	Dan Thap Tako	-	10,000	1,600		
Ratchaburi total			32.65	18,400	2,940	11,200	1,790
Lam Pa Chi Basin Total				29,600 rai (4,730 ha)			

Sourced by RID

(b) Small Scale Dams and Weirs Constructed by RID

There are 33 small-scale dams and 19 weirs constructed by RID. Eleven (11) out of the total 19 weirs were especially constructed at Huai Lam Khlung tributary, Tambon Chorakhe Phuek, and Amphoe Dan Makham Tia where sprinkler irrigation farming is prospering well in the Study Area. In total, 3,670 ha or 22,910 rai in small scale dams and 3,060 ha or 19,160 rai in small scale weirs of farmland are beneficial. However, out of beneficial areas, only 1,060 ha (about 30%) by small scale dams and 540 ha (about 20%) by weirs are irrigated by irrigation system respectively. Other beneficial areas are irrigated by pump directly from tributaries or not developed at all. Location of the dams are shown in Figure 4.5.1

Table 4.5.2 Small Scale Dams Constructed by RID

Location		No.	Beneficial Area			
Amphoe	Tambon		With Irrigation system		Planned	
			(rai)	(ha)	(rai)	(ha)
Ratchaburi						
Ban Kha	1.Ban Bhueng	9	350	60	6,000	960
	2.Ban Kha	5	-	-	3,260	520
Suan Phueng	3.Tha Nao Si	3	3,450	550	-	-
Ban Kha	4.Nong Phan Chan	3	-	-	2,050	330
Suan Phueng	6.Suan Phueng	5	2,800	450	470	70
	7.Tha Khoei	1	-	-	250	40
	8.Pha Wai	2	-	-	2,000	320
	9.Dan Thap Tako	2	-	-	1,300	210
Chom Bueng	11.Kaem On	1	-	-	180	30
Sub-total		31	6,600	1,060	15,510	2,480
Kanchanaburi						
Dan Makham Tia	14.Dan Makham Tia	1	-	-	500	80
	15.Chorakhe Phuek	1	-	-	300	50
Subtotal		2			800	130
Total		33	6,600	1,060	16,310	2,610
Lam Pa Chi Basin Total		22,910 rai (3,670 ha)				

Sourced by RID

Table 4.5.3 Small Scale Weirs constructed by RID

Location		No.	Beneficial Area			
Amphoe	Tambon		With Irrigation system		Planned	
			(rai)	(ha)	(rai)	(ha)
Ratchaburi Province						
Ban Kha	2.Ban Kha	1	-	-	400	60
Suan Phueng	3.Tha Nao Si	2	400	60	360	60
Suan Phueng	6.Suan Phueng	1	-	-	4,500	720
	8.Pha Wai	1	3,000	480	-	-
Chom Bueng	11.Kaem On	1	-	-	5,000	800
Sub-total		6	3,400	540	10,260	1,640
Kanchanaburi Province						
Dan Makham Tia	13.Nong Phan Chai	1	-	-	1,000	160
	14.Dan Makham Tia	6	-	-	2,300	370
	15.Chorakhe Phuek	6	-	-	2,200	350
Subtotal		13			5,500	880
Total		19	3,400	540	15,760	2,520
Lam Pa Chi Basin Total		19,160 rai (3,060 ha)				

Sourced by RID

(c) Small Scale Weirs Constructed by Provinces

There are 125 numbers of small weirs in the Study Area. Ratchaburi and Kanchanaburi Provinces constructed all weirs. Because of decentralization policy, weirs have been transfered to TAO from 2002 and TAO has the responsibility of maintaining and operating these facilities. At present, TAO has not maintained these facilities well and irrigation area as well as beneficiaries at each weir is not clear. Farmers still strongly request to construct new weirs. Construction cost is approximately 400,000 Bt/weir in average.

Table 4.5.4 Weirs Constructed by Province

Amphoe	Tambon	No.	Weir Dimension				Construction Cost (BT)	Shift to TAO
			L(m)	H(m)	Construction	Capacity(m^3)		
Ban Kha	Ban Bueng	17	18-20	1.5-2.0	1992-1999	38,140	362,500	2002
	Ban Kha	11	15-20	1.5-2.0	1994-2002	73,000	408,200	2002
Suan Phueng	Ta Nao Si	3	16-50	2.0-4.9	n.a.	n.a.	n.a.	n.a.
Sub-Total		31				111,140	385,350	
Suan Phueng	Suan Phueng	5	18-20	1.5-2.0	1997-2001	36,000	604,000	2002
	Tha Khoei	2	n.a.	n.a.	n.a.	4,500	n.a.	n.a.
	Pa Wai	18	8-20	n.a.	n.a.	n.a.	n.a.	n.a.
Sub-Total		25				40,500	604,000	
Chom Bueng	D. T. Tako	20	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Rang Bua	10	n.a.	n.a.	1993-2001	205,000	n.a.	n.a.
	Kaem On	13	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Boek Phrai	4	8-18	1.5-2.0	1990-1994	6,500	243,000	2002
Sub-Total		47				211500	243000	
Dan Makham Tia	Nong Phai	4	18-20	2	1991-1993	14,440	380,000	2002
	D. M. Tia	4	15-20	1.5-2.0	1994-2001	n.a.	435,000	2002
	C. Phuek	14	15-29	1.5-2.5	1992-1999	n.a.	362,000	
	Klon Do*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sub-Total		22				14,440	393,000	
Total		125				377,580	406,338	

Sourced by each TAO

(d) Pumping Station by DEDP

Table below shows the pumping stations constructed by Department of Energy Development and Promotion (DEDP). Due to reorganization of ministries and government offices in October of 2002, these facilities have shifted form DEDP to RID. At present RID has a responsibility to O & M of these facilities. Pumping Station in Kanchanaburi has 10 and its total irrigable area is about 2,180 ha.

Table 4.5.5 Hydro-electric Pumping Station Constructed before Year 1997

Name	Tambon	Amphoe	River Source	Estab. Year	Year Operated	Irrigable Area (rai)	Ir.Area (ha)
1 Ban Dan Makham Tia	Dan Makham Tia	D. M.T	Lam Pa Chi	1991	1993	1,500	240
2 Ban Chorakhe Phuek (1)	Chorakhe Phuek	D. M.T	Khwae Noi	1982	1984	1,780	280
3 Ban Tha Sadet	Chorakhe Phuek	D. M.T	Khwae Noi	1990	1992	1,380	220
4 Ban Lam Phao	Chorakhe Phuek	D. M.T	Khwae Noi	1992	1995	1,400	220
5 Ban Chorakhe Phuek (2)	Chorakhe Phuek	D. M.T	Khwae Noi	1996	-	0	0
6 Ban Yan Chao - Yang Koh	Klon Do	D. M.T	Khwae Noi	1980	1983	1,490	240
7 Ban Tha Sao Meru	Klon Do	D. M.T	Lam Pa Chi	1981	1984	1,680	270
8 Ban Klon Do	Klon Do	D. M.T	Khwae Noi	1985	1987	1,410	230
9 Ban Laem Thong	Klon Do	D. M.T	Khwae Noi	1987	1989	2,000	320
10 Ban Yan Chao, Moo 7	Klon Do	D. M.T	Khwae Noi	1994	1996	1,000	160
Total						13,640	2,180

Source: Department of Energy Development and Promotion (DEDP), D.M.T.; Dan Makham Tia

(e) Ponds and Shallow Wells

Table below shows an example of the size, number, and water surface area in the wet and dry season, duration of stored water of farm ponds in Tambon Chorakhe Puek, Amphoe Dan Makham Tia, and Kanchanaburi Province. There are 252 farm ponds in total and they are mainly used for irrigation purpose. 29 or 11.5% of ponds with sizes of more than 3 rai are able to use water throughout the year but 198 or 78.5% of ponds with sizes of 1 to 2 rai are only used during 6 to 7 month only. 25 or 9.9% of ponds which size is less than 1 rai are difficult to use for irrigation and necessary to expand the size of pond. As for the construction of ponds, many related agencies such as DOF, DOA, ARD, ALRO, RID, MOAC have been concerned.

Table 4.5.6 Scale and Condition of Farm Ponds in Chorakhe Puek

No.	Muban	Size		Surface Area (rai)		Duration of Storage Water			Construction Agency
		rai	No	Min	Max	All year	7-6 Mon.	<6 Mon.	
1	Ta Sadet	15	1	2	13	○			DOF
		5	2	2	4	○			DOA
2	Cho	10	1	2	8	○			ARD
		5	2			○			ARD
		1	10				○		ALRO
3	Tha Pony	5	3	2	4	○			ALRO
		1	30	1	2		○		ALRO
4	Tha Msfai	10	2	2	8	○			ARD
		5	1	2	4	○			ALRO
		1	20	0.25	0.5		○		ALRO
5	Sai Thong	130	1	50	100	○			RID
		5	2	2	4	○			RID
		1	20	0.25	0.5		○		ALRO
6	Nong Sa-no	10	2	2	8	○			ARD
		5	1	2	4	○			ALRO
		1	40	0.25	0.5		○		ALRO
		1	25	0.25	0.5			○	MOAC
7	Nong Yapong	10	1	2	8	○			ARD
		5	2	2	4	○			RID
		1	18	0.25	0.5		○		ALRO
8	Nong Kwang	8100	1	1000	6000	○			-
		3	1			○			ALRO
		1	10	0.25	0.5		○		ALRO
9	Noen Sawan	5	3	2	4	○			-
		1	20	0.25	0.5		○		ALRO
10	Thung Thong Pattana	5	1	2	4	○			MOAC
		10	1	2	8	○			RID
		8	1	2	6	○			RID
		1	30	0.25	0.5		○		ALRO
11	Suan Nguiw	5	1	2	4	○			ALRO
Total			252			29	198	25	

Sourced by TAO Chrakhe Puek

According to the inventory survey and development plan at each TAO, developed water resources of ponds for irrigation are shown below. For farm ponds, almost all are concentrated at middle downstream to downstream basin such as Tambon Kaem On, Dan Makham Tia, and Chorakhe Puek. They are mainly used for irrigation by small-scale pump and pipelines with irrigable area of about 1rai.

Table 4.5.7 Developed Ponds at Each Tambon

Sub basin	Amphoe	Tambon	No. of Pond
Upstream	Ban Kha	Ban Bueng	3
	Ban Kha	Ban Kha	7
	Suan Phueng	Tha Nao Sri	4
	Ban Kha	Nong Phan Chan	7
	Pak Tho	Yang Hak	1
	Sub-Total		22
Middle Upstream	Suan Phueng	Suan Phueng	8
	Suan Phueng	Tha Khoei	0
	Suan Phueng	Pa Wai	21
	Sub-Total		29
Middle Downstream	Chom Bueng	Dan Thap Tako	66
	Chom Bueng	Rang Bua	10
	Chom Bueng	Kaem On	157
	Chom Bueng	Boek Phrai	46
	Sub-Total		279
Downstream	Dan Makham Tia	Nong Phai	8
	Dan Makham Tia	Dan Makham Tia	299
	Dan Makham Tia	Chorakhe Puek	255
	Dan Makham Tia	Klon Do	0
	Sub-Total		562
Total			892

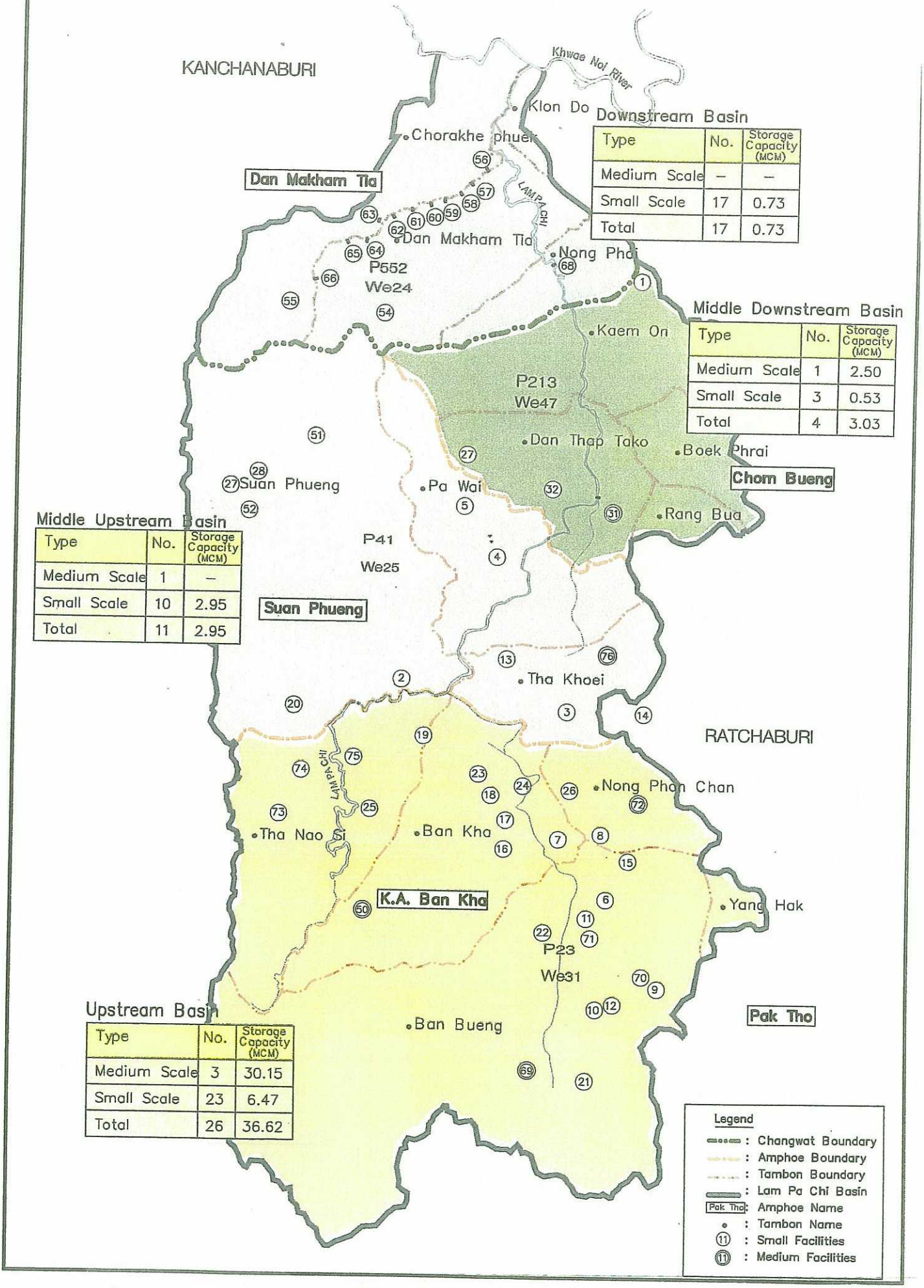
Sourced by each Tambon Development Plan, Well data is adopted by Khor Chor Chor

(3) Estimation of the Irrigation Area

Table below shows the estimated current irrigable area at each sub basin. According to the table, irrigation area at upstream basin might be too large, because the Study Team could not find the irrigation activity during the field survey period in this area. Due to the deteriorated conveyance system or brought about by other factors, the actual irrigable area might be smaller than that of the RID' data. As for weirs and ponds, based on the storage capacity of each facility, irrigation area was estimated to be using 3,000 m^3/ha/vegetable. Total irrigation area is currently estimated at about 90,130 rai or 14,420 ha which is about 14 % of the whole cultivated land in the Study Area (see table 4.4.1).

Table 4.5.8 Estimated Current Irrigation Area at Each Sub Basin

Sub Basin	Dams and Weirs by RID (rai)					DEDP Pump (rai)	TAO (rai)		Total	
	Small Scale		Medium Scale		Total of RID		Weirs	Pond	rai	ha
	Irrigation	Planned	Irrigation	Planned						
Upstream	4,200	12,070	8,400	10,000	34,670	n.a.	230	110	35,010	5,600
Mid. Upstream	5,800	7,220	0	1,200	14,220	n.a.	85	150	14,455	2,310
Mid.Down stream	0	6,480	10,000	0	16,480	n.a.	15	1,390	17,885	2,860
Downstream	0	6,300	0	0	6,300	13,640	30	2,810	22,780	3,650
Total	10,000	32,070	18,400	11,200	71,670	13,640	360	4,460	90,130	14,420



Downstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	–	–
Small Scale	17	0.73
Total	17	0.73

Middle Downstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	1	2.50
Small Scale	3	0.53
Total	4	3.03

Middle Upstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	1	–
Small Scale	10	2.95
Total	11	2.95

Upstream Basin

Type	No.	Storage Capacity (MCM)
Medium Scale	3	30.15
Small Scale	23	6.47
Total	26	36.62

Figure 4.5.1 Location Map for Existing Dams Constructed by RID

4.6 Organizations

4.6.1 Public Organization

(1) General Flows of Water Resource Development

According to the regional and provincial irrigation offices, the general flow of water resource development is as follows:

1) A request for water resource development is brought to the RID offices by the districts or Tambons.
2) Based on the request, the RID provincial office conducts a reconnaissance survey and prepares a report.
3) The request is conveyed to the regional office for further consideration, if judged positively by the provincial office.
4) The regional office conducts a detailed survey and prepares an analysis report. In the report, the office assesses the request whether it is feasible to implement or not, and if feasible, whether medium or small scale.
5) If the scale of a project is judged as small, the regional office designs and implements the project (dam and weir construction projects are designed by the central office regardless of the scale). If a project is medium scale, the request is conveyed to the RID central office for further study. The regional office however is responsible for designing and implementation.

The requests of water resource development have been brought to the RID regional or provincial offices originated from the districts, Tambons, villages or individuals. There is no standard procedure of making a request. In principle, the agencies prefer that the requests would come through Tambon offices because (1) the people are expected to make a request after they have discussed and reached to a consensus, and (2) the land acquisition for the project can be done much easier, particularly for a small scale project in which the government cannot compensate the lands. The requests brought directly to the RID regional office are sent to the provincial offices for initial assessment.

The RID Kanchanaburi and Ratchaburi Provincial Offices receive 30 to 50 requests a year, and the office staffs sometimes conduct one-day survey for all the requests. At present, the requests that have been judged feasible have reached to 70, but not yet financed. The criteria of project scale are defined as follows:

Table 4.6.1 Criteria of Project Scale

Items	Conditions	Scale
Implementation Costs	Less than 50 million Bt	Small
	Less than 200 million Bt	Medium
	Others	Large
Implementation Periods	Within 1 year	Small
	Others	medium or large

Note: Land compensation can be made only for large and medium scale projects.

The RID regional and provincial offices meet and ask the farmers to form a water users' group when a water resource development project was decided for implementation. The RID offices assist the farmers in the selection of the group's leaders.

(2) Regional Office 13, RID

As a result of 2002's government reform, the regional office 10, to which the Study Area belongs, has become the regional office 13. By the reforms, the regional office has to assume the responsibility both for (1) the construction of irrigation projects, which used to be under the regional construction offices, and (2) the implementation of medium scale projects, which used to be under the RID central office. For project planning and implementation on water resource development, the regional office conducts a detailed survey after received the reconnaissance survey report from the provincial office. In the office, the project consideration section of engineering administration division is in charge for the survey.

The staffs check the conditions of the proposed sites and assesses whether the project is feasible or not, and whether it will be medium or small scale. Under the regional office, the operation and maintenance project section is responsible for water users' organization. The organizational chart is shown in Figure 4.6.2.

(3) Kanchanaburi Provincial Office of RID

The total number of the office's staff is 44, consisted of 7 bachelors and 2 technical college graduates. The operation and maintenance (O&M) sections are divided according to the districts, and the Lam Pa Chi area is under the jurisdiction of the O&M section 1. This section is also responsible for O&M of Thalor Pump-Irrigation Project in Taman district. The organizational chart of Kanchanaburi Provincial Office of RID is shown in Figure 4.6.3. The office engineer branch is responsible for the reconnaissance surveys on water resource development, if requested by Tambons or villages. The O&M sections take part of the reconnaissance surveys, being responsible for non-engineering aspects such as land use, water users' groups, etc. The number of staff in the office engineer branch is 6, consisted of 3 engineers, 1 typist, 1 secretary and 1 clerk. The number of staff in the O&M section 1 is 8, consisted of 1 engineer, 2 graduates of technical college for construction, 3 gate operators and 2 labors for Thalor Project.

(4) Ratchaburi Provincial Office of RID

Ratchaburi Provincial Office of RID has 46 staff, consisted of 9 officers and 37 temporary employees. There are 1 master, 6 bachelors and 2 technical college graduates. The office receives 30-40 requests every year for water resource development. The office then meets the Tambon officials and conducts one-day reconnaissance survey for all the requests. In the office, there are already 70 small-scale projects approved but waiting for budget.

(5) Provincial Agricultural and Cooperative Office in Kanchanaburi

The organizational structure of the provincial and district agriculture offices are shown in Figure 4.6.4. The provincial office is responsible for supervising the Technology Transfer Centers (TTCs), with the promotion & production division of the district agriculture offices. The provincial office provides the annual budget of 20,000 Bt to every TTC for its operation.

The community's crop production groups, such as rice, upland crops, orchard, etc. should register with this office to be recognized as the legal entities. The office then provides those groups with the budgets for agricultural inputs, and make sure the inputs are purchased and distributed to the farmers. In Lam Pa Chi area, asparagus production is promoted for export by the provincial agricultural and cooperative office. There are many asparagus growers' groups in the area introduced originally by a Japanese company (see 4.6.2). According to the agriculture officers interviewed, this office receives much more attention by the governor than the RID does, as a result of the currently on-going decentralization. It seems for them that the RID still has the decision to plan and implement most of projects by itself. The office has no collaborated activities with the provincial RID. The possible form of collaboration would be to discuss and fix the cropping patterns of the areas.

(6) Provincial Agricultural and Cooperative Office in Ratchaburi

There are 11 staffs in the office; 1 director, 5 for agricultural development planning and 5 for administration. The office is responsible for planning agricultural development at the provincial level, preparing budget plans, coordinating the related agencies for project implementation, etc. The office supports the TTCs financially, providing 20,000 Bt annually to every TTC. It also sends technical experts to the TTCs when requested.

(7) Tambon Administration Offices (TAOs)

The TAO is composed of the board and the executive committee. The board has the chairperson and the vice-chairperson to be elected from the members (except Kamnan), and the secretary to be elected from the board members. The organizational structure of the TAO is shown as follows:

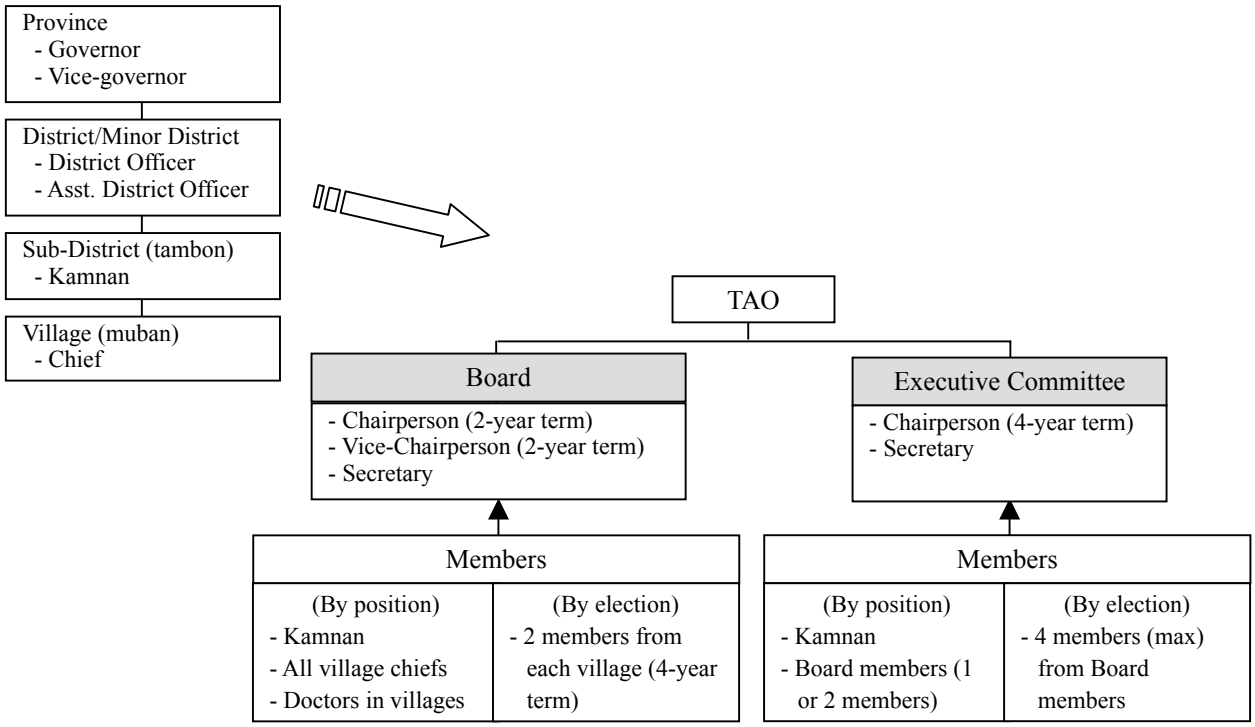


Figure 4.6.1 Organizational Structure of TAO

a) Tambon Dan Makham Tia has the 5-year development plan for 2001 to 2006, in which 36 projects are included. This Tambon consists of 12 villages, and each village has proposed 3 projects for the plan. To prioritize the projects, site conditions and necessary costs are mainly taken into account. The Tambon has various financial sources for annual budgets. Last year, it received 2 MBt from the central government (Ministry of Interior), 50 MBt from various public agencies, and 3 MBt from tax revenue of the Tambon.

b) In Tambon Chorak Puek, there are 9 staffs working for the TAO. The main activities of the TAO are (i) construction/rehabilitation of infrastructures such as irrigation, electricity, roads, etc., (ii) provision of loans (no interest) to the farmers groups' for agricultural activities, and (iii) training the people on drug protection. The main expenditure items last year were 2 MBt for infrastructures and 2 MBt for staff salary.

The process of project planning and implementation is as follows:

1) To discuss the problems with the people in each village
2) To prioritize them by the TAO through site observation. One problem is taken into account from every village.
3) To submit the results to the board of the Tambon for approval (every February and August). The board has 22 members, two from every village.
4) To submit the results to the district office for approval
5) To implement the projects

c) Tambon Boek Phrai, received the annual budgets of 1.7 MBt from the central government (Ministry of Interior), 4-5 MBt from various public agencies, and 150,000 Bt from tax revenue. The main expenditures were 2 MBt for infrastructures and 2 MBt for salary. The process of project planning and implementation is the same as Tambon Chorak Puek.

(8) Technology Transfer Centers (TTCs)

The TTCs have been established in every Tambon in the process of the MOAC's new challenge, which intends to change the procedures of agricultural development by putting the farmers at the center of stage. The TTCs shall therefore be the place to develop the capacity of the farmers, by facilitating participatory development, and providing the necessary services to the farmers at one place (so-called "one stop service" center). The following is the common steps when the TTC starts its activities in a community:

1) To discuss with the farmers on participatory development and motivate them to participate in the activities conducted by TTC
2) To prepare the database and maps of the area
3) To formulate the tambon development plan
4) To transfer necessary knowledge and technologies to the farmers

According to the MOAC officer interviewed, the main purpose of establishing TTCs is to coordinate agriculture staff, NGOs and local people in facilitating grass-root development. The TTCs shall discuss agriculture-related problems with farmers, collect the necessary data on the areas, and prepare Tambon's development plans. It will also facilitate development by the integrated manners, where various subjects are considered in problem identification, planning and implementation. This is one of the indications the MOAC had realized that the farmers' problems are complicated and requires multi-dimensional approaches.

The MOAC had encountered the following problems on the TTCs:

- The number of extension officers, who should be the key officials of the TTC, is not enough.
- The budget is not adequately distributed to the local government.
- The field workers are not strongly motivated to promote grass-root development.

The MOAC has then decided to take some countermeasures against those problems. The followings are examples:

- Per-diem for extension officers is increased from 500 to 1,500 Bt.
- Field workers can be promoted to the officers.
- The MOAC has ordered all TTCs to be functional from March 2003 up to present. To make it sure, the MOAC will accept free-call from the farmers if they have any complaint to TTC staff.

According to the provincial agricultural and cooperative office in Kanchanaburi, the district agriculture officer was used to be the chairperson of the TTC, and some farmers (must be the TAO members or leaders of village committee4) were its members. One officer was assigned to one Tambon. After the government reform in 2002, the farmer representative of the community shall be the chairperson, and the district or sub-district (Tambon) agriculture officer shall become the secretary. The secretary shall assist the farmers by connecting them with agriculture-related public agencies. At the same time, one officer can become responsible for a couple of Tambons due to the budget constraint of the agencies.

The problem mentioned is lack of the number of the district officers who work for the TTC. An officer can usually stay only two days a week at maximum, since he/she goes to the district office three days a week for communication.

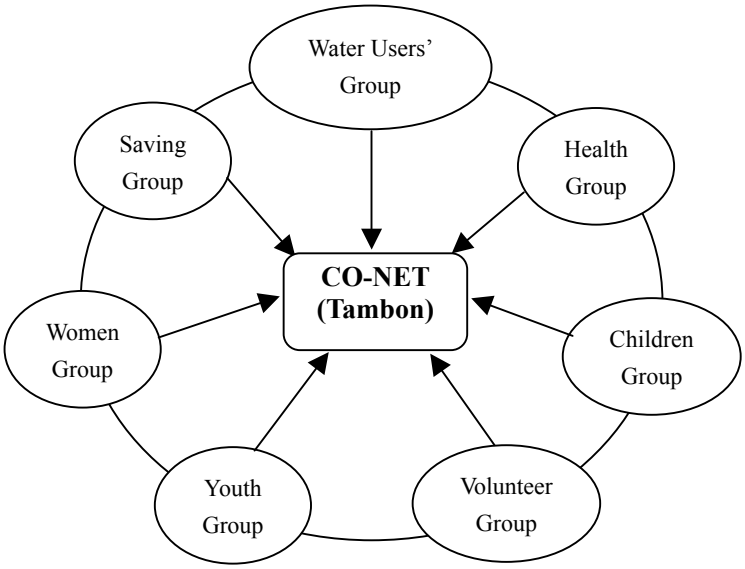
(9) Land Development Station in Kanchanaburi

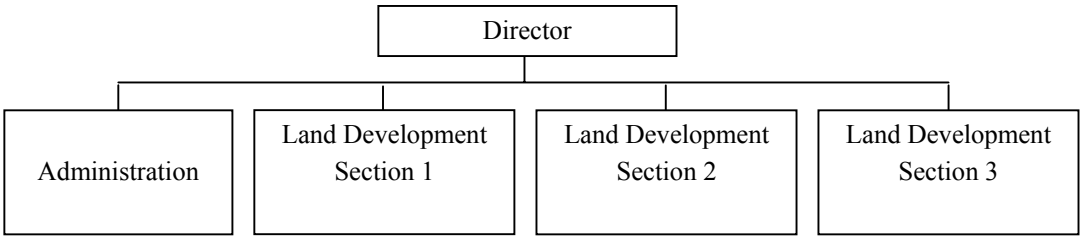
This station is operated under the Regional Office 10 of the Department of Land Development. The main responsibility[5] of the station is to develop the potentials of land resources for agricultural

[4] For example, the village committee in Pongko Phailomrak village in Tambon Chorak Puek has 15 members; one chief, 4 assistant chiefs, one secretary, and other members.

[5] According to the official statement, Land Development Department is responsible for soil survey and classification, soil

purposes. For example, the station surveys and analyzes soils in the area and recommends the farmers suitable cropping patterns. For the area with steep slope, the station provides protection measures against erosion, such as ponds, contour-line ditches, etc. The station also promotes the use of natural fertilizer and assists the farmers to make it by themselves. The staff of the station work for the TTCs, when the farmers request technical assistance. The station covers the whole province with 9 officers and 9 supporting staff. Six (6) Officers are stationed in the land development sections 1 to 3 and responsible for the different districts as shown in the organizational structure below:





The problems mentioned are (i) farmers are not interested in advanced technologies, (ii) the officers have limited means to visit the villages, and (iii) the budget necessary for transferring technologies to farmers is not enough.

(10) Community Development Office in Kanchanaburi

The main responsibilities of the office are to raise the potentials and strengths of communities, and facilitate participation of the people in every activity in the communities. The office responds to the villagers' requests on the formation and strengthening of groups, such as saving groups, water users' groups, housewives groups, etc. by coordinating them with the relevant agencies.

According to the office, the community organization network (co-net) has been established in every Tambon since 2002, to link various kinds of the existing community organizations and groups for solving problems of the villagers. The members of the co-net are the leaders of each organizations or groups, and the leaders of the co-net shall be elected through votation.

The community development workers at the district shall coordinate the groups at the field level, and assist the leaders how they should logically think and solve the problems. One community development worker is usually responsible for two Tambons.

analysis, land use planning, conduct experiments and carry various aspects of land development, assist farmers in soil and water conservation practices and soil improvement, seed production for cover crops and soil improvement materials, transfer technology from its research of soil development and soil science for multiple purpose use.

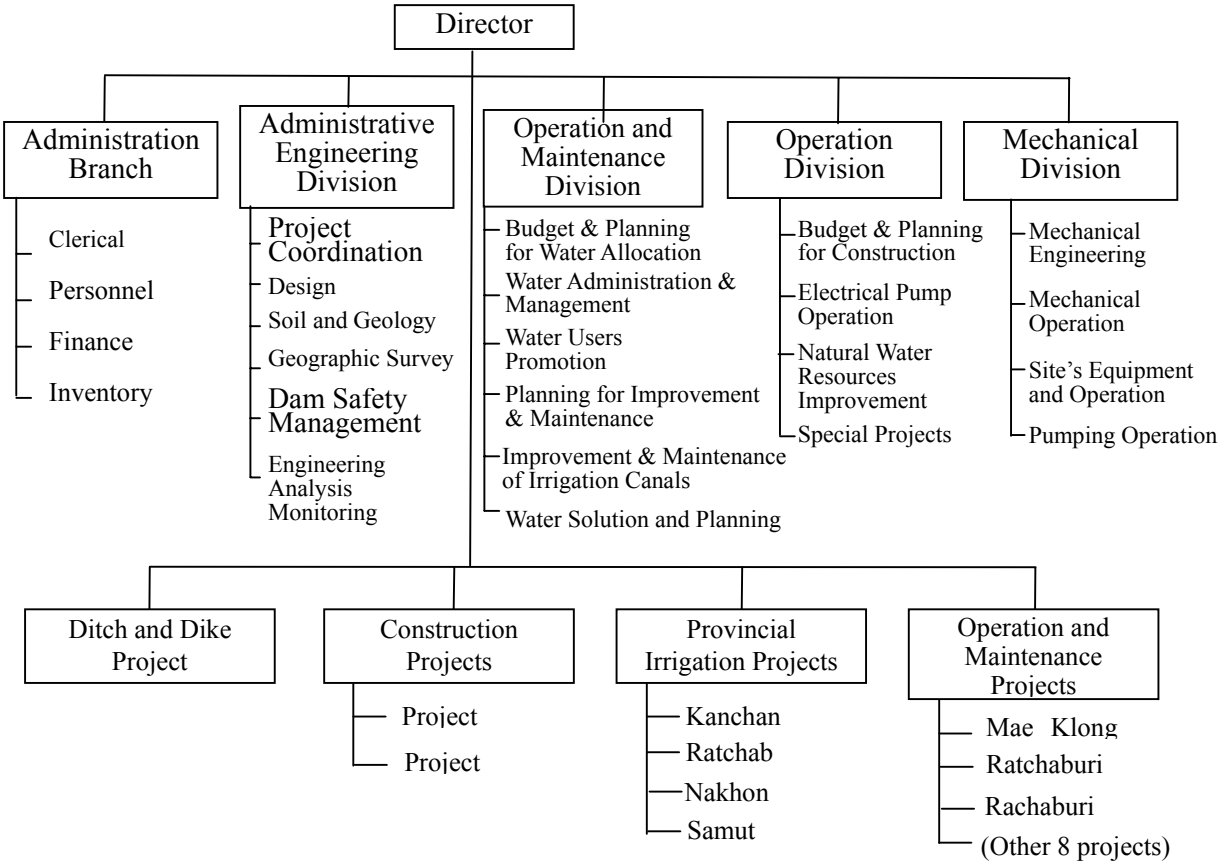


Figure 4.6.2 Organizational Structures <Regional Office 13 of RID>

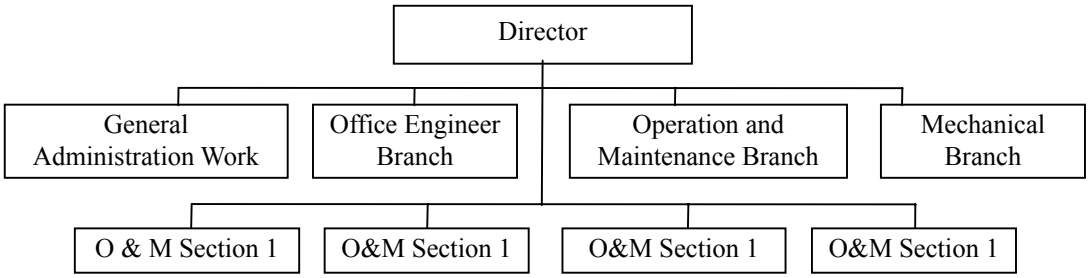


Figure 4.6.3 Organizational Structures < Kanchanaburi Provincial Office of RID>

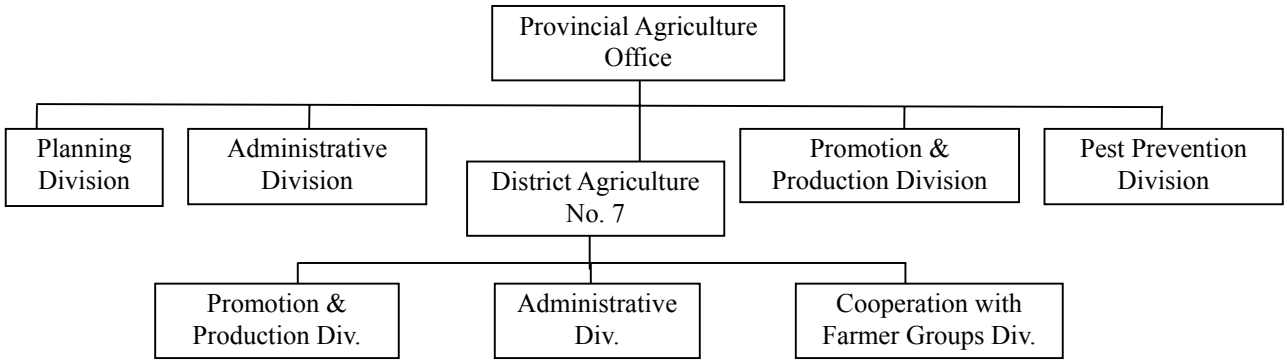


Figure 4.6.4 Organizational Structures < Kanchanaburi Provincial Agriculture Office >

4.6.2 Community Organizations

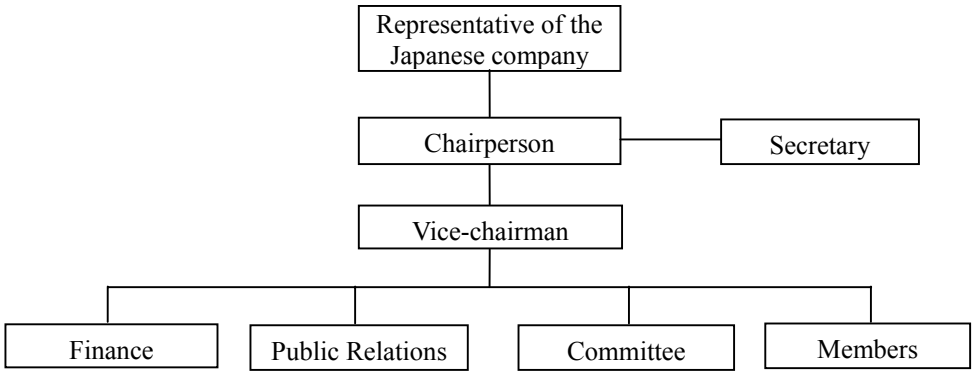
(a) Asparagus Growers' Organizations

A number of asparagus growers' organizations can be seen in the Study Area. Through the organizations, the farmers make a contract with asparagus processing factories owned by a Japanese company (a buyer of the products). The organizations are classified into two types; Types I and II. Type I is headed by the representative of the Japanese company, while Type II is managed by asparagus growers. An idea of establishing the organizations came from the company, and two types were established in the different ways.

1) Type I

When the company visited the area more than 20 years ago, asparagus was thought to be one of the exportable crops to Japan. Since there was no asparagus grower in the area, the company explained to the farmers the profitability of growing and selling it to them. The farmers then started growing asparagus, and the asparagus growers' organization was established. The purpose of forming the organization was to provide technical support to the farmers by assuring the quality of their products. The group has been growing, and currently has 300 members.

The organizational structure is as follows:



In the organization, the members share the information from the company concerning the cropping methods necessary to meet the company's standards. All the positions under the representative are filled with the Thai. The members negotiate and set a price with the company individually and not as a group. One of the benefits for the members is that they can get loans from the company to buy fertilizer. However, some members complained that the chairperson does not fairly judge the quality of their products.

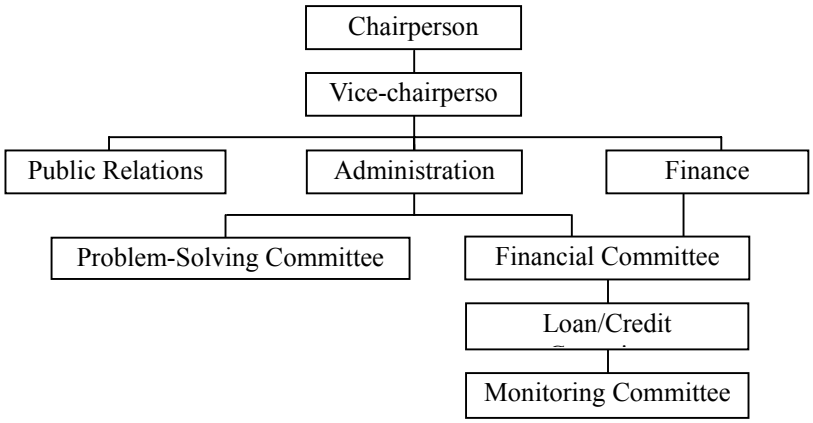
2) Type II

Some farmers grew asparagus on trial and brought them to the company. The company then agreed to make a contract with those farmers and suggested that they form a group. This was the origin of Type II organization and spread in numbers to the area. One of the organizations in Tambon Dan Makham Tia consists of 13 sub-groups, and has 450 members in total. The objectives of Type II organizations are not only to obtain the information from the company, but also to have better negotiation power on the price against the factories. The members make either one or three-year contract with the processing factories. The organizations intend to set the selling price to be satisfactory to the members. In

principle, the representatives of all sub-groups discuss and decide the selling price, and then negotiate with the factories to set the final price. The members have to pay 1 % of their annual income to the group, and receive the following benefits:

- The members can get loans to buy fertilizer with 1 % interest rate (have to repay the whole amount within three months; otherwise the borrowers will be fined.)
- The members' family can receive 3,000 Bt in case of member's death
- The members can receive 1,000 Bt in case of a family member's death
- The members can get refund of his hospital bills less than 5,000 Bt

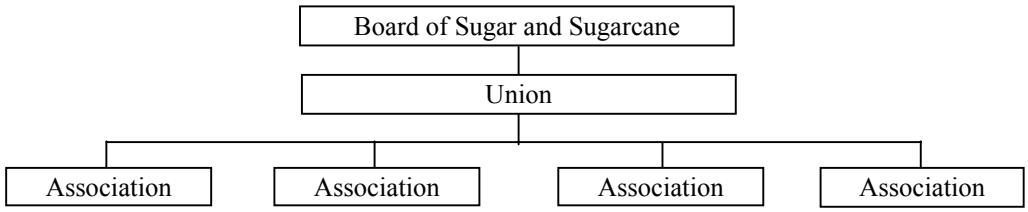
Below is the structure of the sub-group of the organization. The upper five positions are selected by votation every year. The chairperson of the group receives 1,000 Bt as a monthly salary.



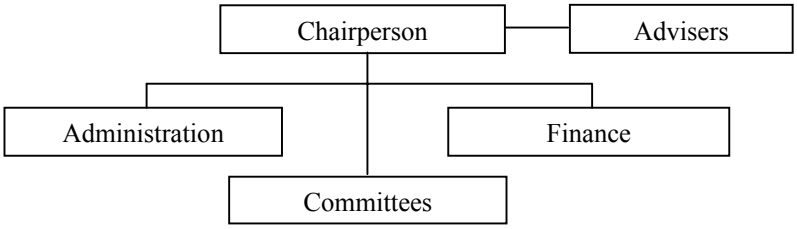
According to the representatives of the organizations, the members are satisfied with the organizations' benefits and their selling prices. There was a case however that the organization in Tambon Dan Makham Tia was split into two because of conflicts among members concerning the ways how the organization should be financially managed. Several government agencies have supported the organizations. For example, Agricultural Extension Department facilitated the negotiations of price setting between the growers and the factory every year. Land Development Department provided free fertilizers to the organizations. Internal Trade Department supported them during the signing of the contracts with the factories.

(b) Sugarcane Association

Sugarcane associations were established by sugarcane growers in 1971. There are four sugarcane associations in the country, and each association represents their own regions. Kanchanaburi belongs to the association of the central region. Sugarcane price is decided nationally by the board of sugar and sugarcane, and all the sugarcane growers have to accept that price. The sugarcane associations form the union to serve as part of the board of sugar and sugarcane as shown in the chart below:



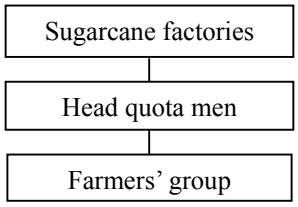
The intention of forming the associations is for sugarcane growers to negotiate in better ways the product prices with the factories. The growers therefore participate in the board meeting to set the prices with other board members. The Ministry of Finance compensates the price gap to the growers when the association fails to keep the growers' desired prices in negotiation with the sugarcane factories. 92% of the board members are government officers, while the farmers consist of 6% and the factory owners 2%. There are 87,000 members in the association for the central region. 99% of the members are farmers, and the rest are consisted of export merchants and lawyers providing advices to the association. Below is an organizational structure of the sugarcane association.



There are twenty-four committees. Each committee has 30 members to represents 85 farmers. Some farmers interviewed said that they are not satisfied with the association's performance because the price of sugarcane has always been set lower than their desired price.

(c) Sugarcane Groups under the Head Quota Men

Under the sugarcane factories, there are the head quota men who bought sugarcane from the growers and sold it to the factories. The head quota men organize 7 to 8 growers into a group. This type of groups under the head quota men can be seen in many parts of the Study Area. Right figure is an illustration structure of the head quota system.



The farmers who have the land to grow sugarcane can be part of the quota system. Under this system, they can rent tractors or other vehicles to deliver their products. They can get loans to buy fertilizer and pesticide with 3% interest rate per 10 months. Within the group, the status of all the farmers is equal. There is no particular group activity. The members have to sell all of their harvests to the head quota men. A member has to work with the same head quota men at least 3 years unless the member repays the whole amount of loan to them. Sugarcane growers are not necessarily obliged to work under the quota system, but if they will not, they cannot receive the above-mentioned benefits, and therefore the majority of them prefer the system. A member interviewed said there is no problem within the group, but unsatisfied with high costs of renting tractor and other vehicles which the head quota men charge.

(d) Agricultural Cooperatives

Agricultural cooperative is one of the sources of loans for the farmers to purchase their agricultural inputs. The cooperatives' members can also receive technical assistance from public agencies. Moreover, even in case of bankruptcy, the government guarantees the investment of the members. These are the main reasons that small groups of farmers have been shifting to cooperatives. The

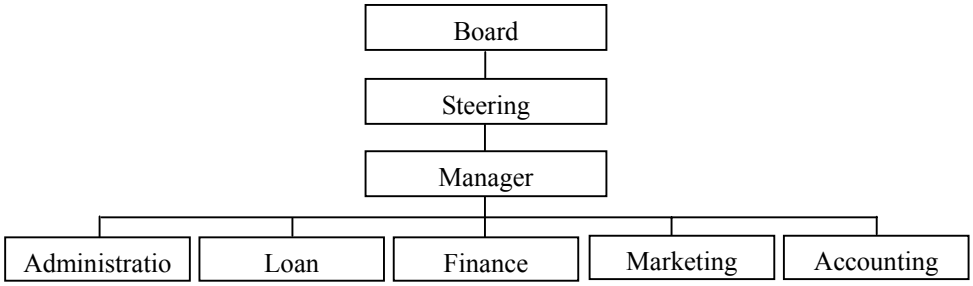
agricultural cooperative in Tambon Dan Makham Tia is an example. The members used to organize a livestock group in which they exchange information on cattle raising. The members wanted to have the government support to expand their activities, thus changed the group to cooperative in 1993. Any farmer who meets the criteria stated below can become a member.

- Over 20 years old
- Have no unpaid loan
- Live in the Tambon permanently

Each member has to purchase at least one share of the cooperative every month. Followings are the benefits that the members can receive from the cooperative.

- Get loans with 12% interest rate to buy fertilizer, pesticide and others
- Save money with 6% interest rate

The upper limit of loans for each member depends on the number of share they own and the amount of saving. The chart below is the organizational structure of the cooperative.



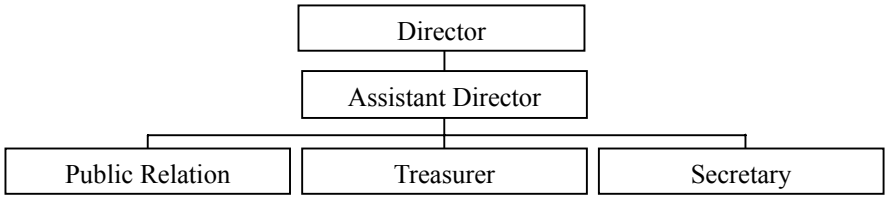
The representatives from various Tambons serve as the members of the steering committee. The cooperative holds monthly meetings in which those representatives participate. Decisions are mainly made by votation in the meetings. According to the assistant manager, the problem of the cooperative is the lack of active members. The number of the active members is only about 400 out of the total 900 members. This has caused the decrease of the cooperative's revenues, which eventually limits the amount of loans the members can borrow. This also limits the number of the administrative staff, which makes the committee members work voluntarily for the office administration.

(e) Water Users' Groups

There are several water users' groups in the Study Area. It is usually suggested to the farmers by the government agencies such as the Royal Irrigation Department (RID) to form the water users' group when an irrigation project is to be implemented. The main purpose of the group is to assure its members equal and adequate distribution of irrigation water. The members of one group are usually consisted of the farmers in several villages, and each village is responsible for the maintenance of different parts of canals.

The water users' groups set the regulations of O&M by themselves. For example, a group in Tambon Dan Makham Tia regularly charges its members a certain amount of fees for electricity and

maintenance of canals. On the other hand, a group in Tambon Dan Thap Tako does not charge its members at all unless it needs to repair some facilities. In general, the groups pay the costs of pumping. The groups also require their members to provide free labor once a year for the maintenance of the irrigation facilities. The members usually make decisions by votation. They can basically solve problems by consensus when conflict arises. The organizational structure varies from one group to another group. The following is one of the typical forms:



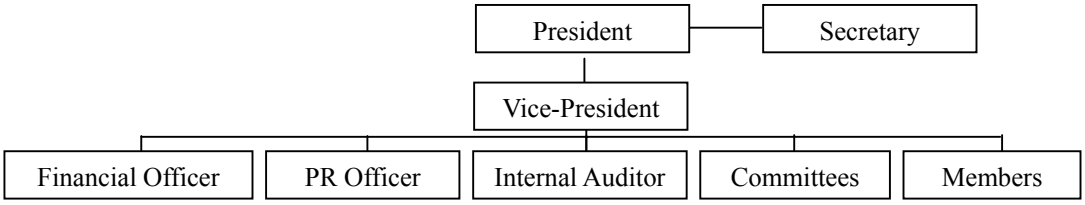
The water users' group in Tambon Chorakhe Phuek has changed to the water users' cooperative by the effort of the Tambon chief. The intention was to increase the opportunities for the members to obtain funds from the government. This cooperative pays for electricity and other pumping costs, and the costs for repairing damages are shared by the cooperative and the Department of Energy and Promotion. A farmer has to pay 50 Bt as an initial membership fee and buy 200-Bt share to become a member. Below are the benefits that the members can obtain from the cooperative.

- Get loans with 12% interest rate to buy fertilizer and others
- Save money with 6% interest rate

One problem of the cooperative is related to loan repayment. When a member wants to get loans from the cooperative, that member has to make a group with other two members as the guarantors. Even with this system, however, there are several members who do not pay back their loans on time. It has lowered the cooperative's capital, which has resulted in the decrease of the total available loan amount for the members. The other problem is that the chairperson does not follow the rule of sharing water with other members. He sometimes takes all the water. No one can complain to him because he is the chairperson in the group and the chief of the Tambon.

(f) Herbal Groups

The herbal group in Tambon Dan Thap Tako was established by the herbal growers in 2000. The President of the herbal group mentioned that there are a few number of herbal groups around the Area. The purpose of forming the herbal group is to mutually share technical information among the herbal growers. The group can also make it easier to receive financial supports from the government than individuals. The group then received 15,000 Bt from the provincial office to facilitate its activities. The group functions as just like the cooperatives. Currently, about 100 members belong to the group. There are five sub-groups, each of which has at least 15 members. The group holds meetings once a month to discuss their issues. To become a member, one has to buy one share which costs 100 Bt. The member can get loans with 5% interest rate. The organizational structure is shown as follows.



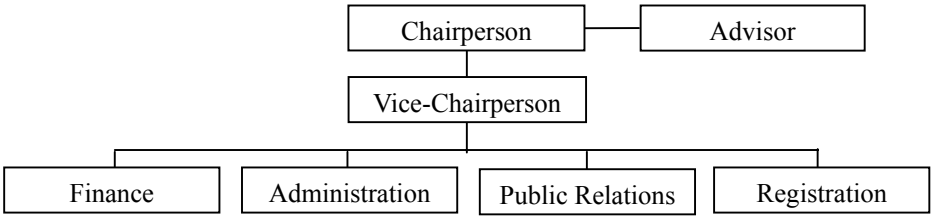
At least one person from each sub-group has to serve as the committee member. Decisions are made by votation. Their main problem is the lack of capital. The members can get loans, but the available amount is not enough to buy other inputs except for seedlings.

(2) Village Level Groups

(a) Saving Groups

Many villages have these saving groups. The main goal of the group is to encourage people to save money for increasing business opportunities as well as securing their lives. The membership of the saving groups is limited within the same villages. The main activities are to collect money from the members for deposit and provide loans to them. In case of Tambon Kaem On, one village received 20,000 Bt from the Petroleum Authority of Thailand (PTT) to initiate the saving group in 2000. At that time, the PTT was implementing the underground pipeline project to bring petroleum from Myanmar to Ratchaburi province. The villagers however were uncomfortable with the project, and therefore the PTT provided compensation to them. They decided to start the saving group with this money.

Each member has to deposit 100 Bt a month to the group's account. The members can borrow the amount as three times large as the amount they deposit. The interest rate is 12% per annum, and the loan period is six months. The interest rates vary group by group. When the interest rate is lowered, the loan period needs to be shortened as well. For the saving group in Kaem On village, the loans have to be used for agriculture or other small scale business. Below is one of the typical organizational structures of the saving group.



The group holds a formal meeting once a year and an informal meeting every month. Decisions are made by votation. Each member can have one vote, except for the chairperson who can vote twice when the counting tally on the same number as a result of votation and needs to be splitted. One of the PTT staff has participated in the meeting as an advisor. The number of the members had been increasing, and the total amount of saving had grown from 20,000 to 200,000 Bt from year 2000 to 2002. There had been no unpaid loan. One of the reasons for this result is attributable to the lending conditions. When a member needs money from the group, that person has to borrow with two other members. Those three members are mutually responsible for the repayments.

(b) Women's Groups

Not all but only some of the women's groups are active for generating incomes. A chili paste group in Tambon Boek Phrai has interesting activities. The PTT provided 28,000 Bt to the village in 1999. The villagers then discussed how they should spend this money. The PTT suggested that they should form a group for earning income by selling some products at the shop in the PTT's H/Q. Some housewives had an idea to produce and sell chili paste, investing this money to buy the necessary equipment and ingredients. Other villagers agreed them and chili paste making was started.

The group was formed only by the housewives. The objective of the group was to support the family members' by supplementing their incomes. The group sells their products at the PTT's shop twice a month. Anyone interested in the activities can join the group without any membership fee. The number of the members has been 15 since its establishment. The group sells 30 kilograms of chili products a month and earns 3,000 Bt in average. A part of profits is used to buy ingredients for the next production. 200 Bt has been saved to buy equipment in the future. The rest of the profits have been shared by the members equally. The group holds a meeting every month and decisions are made through votation. The chairperson of the group says that the group has met its objective and there has been no serious problem. The minor problem they could think is that sometimes there is not enough money to buy ingredients for the next production.

(c) Livestock Groups

There are many groups of livestock such as chicken, cow, etc. in the Study Area. In the case of the group in Tambon Boek Phrai, the district extension officer as well as the livestock officer encouraged livestock owners to form groups since it becomes easier for them to receive technical support from the government. When the livestock officer comes to the village, the group members get together to receive his technical guidance for raising their livestock. The prices of livestock are determined individually between the farmer and middleman. There is no group negotiation. There is neither group activity nor collaboration among the groups since they have been formed in the small scales.

(d) Cremation Groups

A lot of cremation groups exist in the Study Area. The cremation group is to mutually support funeral expenses when any member of the group dies. In general, the group has the limited membership within their own village. The group collects the membership fee on a monthly basis. For example, there are 100 members in the cremation group of Kaem On Village, and the members have to deposit 100 Bt a month. There is no other activity.

(e) Bank of the Agriculture and Agricultural Cooperatives (BAAC) group

The BAAC provides loans to farmers, either individually or in groups. Individual loans are made if a farmer has the land title. If none, the farmers should form a group to mutually guarantee their loan payments. The interest rate of loan is 1.5 % per annum, and the repayment period is at maximum of 15 years.

4.7 Environmental Survey

(1) Environment Evaluation System in Thailand

Enhancement and Conservation of National Environmental Quality Act was promulgated in Thailand in 1975, due to environment deteriorations such as water pollution or deforestation. The National Environment Board was established in order to oversee, preserve and prescribe the policy for environmental management. As a result of amendment in 1978 and 1979, the board was transferred to be under the supervision of the Ministry of Science, Technology and Energy.

In 1992 the role and the authority of the Board was restructured and upgraded by the Enhancement and Conservation of National Environmental Quality Act of 1992. The name of the Ministry has been changed to the Ministry of Science, Technology and Environment. Another organizational reform has been done in October 2002 and the name of the ministry was changed to the Ministry of Natural Resources and Environment (MNRE).

Office of Environment and Natural Resources Planning and Policy of MNRE has authority to carry out Environment Impact Assessment (EIA) from a project or activities, likely to have environmental impact, of any government agency or individual, which are tendentious to damage the environmental quality. It is depends on the scale, cost, manner, location, etc. of projects whether implementation of EIA and Initial Environment Examination (IEE) is required or not. Type and size of projects concerning water resource development and irrigation, which require Environmental Study, are as follows:

Table 4.7.1 Type and Size of Projects That Require Environmental Study

Items	Projects that require EIA	Projects that require IEE	Projects that require environmental data
1.Dam or reservoir 1.1 Storage volume	>100MCM	-	-
1.2 Reservoir storage area	>15 km^2	-	-
1.3 Construction cost	>200MBt	50-200MBt	<50MBt
1.4 Construction period	>1 year	>1 year	<1 year
2. Irrigation			
2.1 Irrigated area	>80,000rais	Unnecessary	Unnecessary
2.2 Construction cost	>200MBt	50-200MBt	50MBt
3. All projects in watershed class 1B* require EIA	Any projects	-	-
4. Small hydropower project with reservoir or weir type	Construction cost >200MBt	Construction cost 50-200MBt	Construction cost <50MBt
5. Construction projects** which pass through reserved forest	-	Length >5km	Length <5km
6. Diversion weir for irrigation purpose	-	The project corresponds	-
7. Forestation projects for community forest, forestry village and forest garden	-	The project corresponds	-
8. All other water resources projects and hydropower project	-	-	The project corresponds

Reference: "Environment Impact Assessment System of Thailand" Environment Impact Evaluation Division, Office of Environmental Policy and Planning, 1997

*Watershed Class 1B is explained at (3) (b)

**Projects such as a road, high voltage transmission line, conveyance pipeline and so on.

(2) Existing Environment Conservation Activities in the Study Area

(a) Activities of Environment Office in the Study Area

The Ratchaburi Environment Office (Environment Office No.8) is under the Permanent Secretary Office of MNRE and serves 5 provinces, namely, Kanchanaburi, Ratchaburi, Petchaburi, Prachuap Khirikhan and Samut Songkharam. The office is in charge of air pollution, water pollution and soil erosion in these provinces. Any severe problems concerning these pollutions are not properly reported except for soil erosion. Water quality check of Lam Pa Chi River was done in 2002 and the result is shown below. The water quality is categorized into class 2 and 3 based on the 1992 Surface Water Quality Standard, which categorizes water quality into 5 classes. The data shows the river water quality is not so deteriorated.

Table 4.7.2 Water qualities of Lam Pa Chi River in 2002

Sampling points (Bridge across the river)	Parameter	Value	Class*
Chorakhe Phuek	Total Coliform Bacteria Fecal Coliform Bacteria	5,133 MPN/100ml 1,183MPN/100ml	3
Dan Thap Tako	DO BOD Total Coliform Bacteria Fecal Coliform Bacteria	6.3 mg/l 1.0 mg/l 887MPN/100ml 343MPN/100ml	2
Suan Phueng	Total Coliform Bacteria Fecal Coliform Bacteria	17,967MPN/100ml 1,200MPN/100ml	3
Ta Nao Si	DO	5.9mg/l	3

Resource: Environmental office No.4, Ratchaburi province

1) Class and Description

Class 2: Very clean surface water with some pollution contamination, suitable for (1) consumption and use, requiring customary water treatment and disinfection, (2) aquatic organism conservation, (3) fisheries, (4) swimming and water sports

Class 3: medium clean surface water with some pollution contamination, suitable for (1) consumption and use, requiring customary water treatment and disinfection, (2) agriculture

There are some processing factories of agricultural products such as sugarcane in the Study Area, they have obligation to control the effluent water quality. They have to submit monthly reports of the water quality to Government of Provincial Office. After checking by the Government, the reports are presented to Ministry of Natural Resources and Environment, and finally to Regional Environment Office. If the water quality is beyond the standard, operation of the factories would be suspended. In addition to that, the Government monitors the water quality through inspection.

2) Activities of Conservation Forest Management Office

Area of about 240-320 ha is burned out due to the annual forest fire mostly in the dry season from December to May which is mainly caused by people. The responsible agency concerning forest conservation in Lam Pa Chi River basin is the Conservation Forest Management Office No.5 under the National Park, Wildlife and Botanic Breeding Department, MNRE. The office also takes care of 7 forest fire control offices, which have the duties to control and protect the forest fire.

3) Reforestation by Queen's Project

A reforestation project funded by the Queen started at Tha Nao Si Tambon in 1989, since forest conservation was deteriorated due to cutting of treess by the people. In the ranges of 480 ha forestation area (finally extended to 74,400 ha), 219 local tree species were planted. At present 30 people including Ka rieng people are employed and worked for the management and conservation of the forest at 120 Bt allowance per day. In addition to this main project, two sub-projects are performed. One is forestation training for the villagers in the forestation area of 21,760 ha at Yang Hak Tambon, which started in 1991, and the other is agricultural demonstration which was established in 2002 August. The agricultural demonstration area is 64 ha, planted with mango, banana, broccolis, mushroom, etc. and fish culture of Tilapia, are practiced. 100 people of Ka rieng were employed as laborers at 100 Bt allowance per day.

(3) Current Environment Situation to be Considered

(a) National Forest Reserve Area (NFRA) in Lam Pa Chi River Basin

The Government specified 23 million ha, 45.9% of the total land area of the country, as National Forest Reserve Area (NFRA) in 1992, due to rapid deforestation resulting in flood devastation. There is NFRA of 110,644 ha in Lam Pa Chi River basin. The NFRA is categorized into Conservation forest (Zone C), Economic forest (Zone E) and Agriculture forest (Zone A). The areas are 62,801ha, 38,012ha and 9,831ha for Zone C, Zone E and Zone A respectively. It was found that about a quarter of the Study Area is occupied by Zone C, for which special consideration for environment conservation is required.

Table 4.7.3 National Forest Reserve Area in Lam Pa Chi River basin

Item	Zone C	Zone E	Zone A	Total
Area	62,801ha	38,012ha	9,831ha	110,644ha

Source: Land Use Plan for Lam Pa Chi River basin, 1999

The C-Zone, Conservation Forest was laid out in the existing protected forest area and natural forest relatively less influenced by human activities. Some areas are still occupied illegally by agriculture. This zone corresponds to national park and wildlife sanctuary. Some areas were and still are occupied by agriculture by shifting cultivation etc.

Lam Pa Chi Wildlife Sanctuary: There is one wildlife sanctuary in Suan Phung Tambon, namely, the Lam Pa Chi wildlife sanctuary, which has 48,931 ha area. This evergreen forest has abundant water resources and food sources for wildlife, so that various species of animals such as Capricornis Siematransis, Tarpium Indicus, Muniacus Feai range in the forest. This forest was promulgated as wildlife sanctuary in 1978 to maintain its good condition for wildlife preservation as well as protection of the watershed. One head office and six-branch offices are responsible to monitor and protect wild animals. They conduct trainings and seminars for villagers twice a year to help them understand the importance of wildlife protection. The E-Zone, Economical Forest was laid out and planned for commercial plantations for landless farmers. Forests are often bared, scarce and/or poor in the area; land is used for some kind of silvo-agri-pastoral occupation.

The A-Zone, Agricultural Uses was laid out in areas suitable for agriculture and to be allocated to landless farmers by means of the agricultural land reform process. In these areas, forest is often absent, scarce and/or poor; land is often used for some kind of silvo-agri-pastoral occupation.

(b) Watershed Classes in Lam Pa Chi River Basin

Watershed is categorized into 5 classes in terms of its physical characteristics, hydrological potential and environmental management. All of watershed classes, ranging from class 1 to class 5 are in the Study Area. The Class 1 area is approximately 110,000ha, about 45% of the Study Area. Class 1 and Class 2 are specified unsuitable area for farming; therefore, they must not be included for development project.

Watershed Class 1: This class should be particularly preserved as watershed because the area, when changed, leads tremendous effects on the environment. Class 1 is divided into two sub-watersheds as follows:

Class 1A is the watershed consisting of plentiful forests. According to the cabinet resolution, changing forest by any means is restricted in order to protect watershed. Only once Watershed Class 1A was used as in the cabinet resolution dated December 12th, 1989. There was a strict compliance with the use of Class 1A for security reason of the army. Three roads were constructed and from that moment on, no other actions were allowed again to this class.

Class 1B is the watershed, in which its forest is destroyed, or changed for development or other types of land use. If ever road construction or mining are to be conducted in Class 1B, the organizations in charge for this activity must control soil erosion. In case the use of land by any governmental organizations is inevitable, the organizations are subject to report the analysis of its environmental impact to the National Environmental Committee to be considered.

- Watershed Class 2: the secondary class to Class 1. This class can be used for some certain activities such as mining. The area is allowed to be used for timber industry and mining under restrictive control. Agricultural activities should be avoided.
- Watershed Class 3: cultivation, mining and plantation are allowed. The area is for timber industry, farming and other activities, which has to be under restrictive controls.
- Watershed Class 4: the class that its forests cleared mostly for farming. All activities are permitted in this area. Nevertheless, agriculture is restricted to be done on the slope of no more than 28% and has to be planned out by using the land and water conservation principles.
- Watershed Class 5: its surface is plain or small slope in general. The majority of the forest in this class is cleared for agriculture especially rice's farming. All activities are permitted.

(c) Minority Groups

The Lam Pa Chi River basin is located in the border area between Thai and Myanmar, having the minority group of people living in five Tambons in the Study Area. Most of them are Burmese, Ka rieng tribe and Peguan tribe. Especially there is migration center in Suan Phueng Tambon, which accommodates 4,000 people. The distribution in each Tambon is as follows;

Table 4.7.4 Population of the Minority groups in each Tambon

Tambon name	Minority Groups
Yang Hak	Peguan and Burmese about 100 household
Ban Kha	Ka rieng
Kaem On	Burmese and Ka rieng come to be workers at cassava mill and the mill owner provide their accommodation.
Suan Phueng	Burmese and Ka rieng stay in every villages about 10-20 people except Ban Pa Pok (MU.3), which accommodate 4,000 people in the migration center. Ban Tum Hin has asylum center which contain 200 people and Ban Tako Lang (MU.8) admit 300 people.
Ta Nao Si	Ka rieng, Peguan and Burmese about 1,600 people with 700 people who are Thai nationality and Ka rieng citizenship

Source: Baseline survey done by JICA Team, October 2002.

The Study Team had an interview to Ka rieng village chief of Banbowi, where almost all the people living in that area are Ka rieng minorities, in Tambon Ta Nao Si. Farmland in the village is only 13% of the village area. The people make their living by weaving bamboo baskets; their income from this works is about 3,000Bt/person/month. They get bamboo materials by rotational cutting for the purpose of resource preservation. About 10 % of the people often go to Ratchaburi town for emigration.

Most of the households have been served of electricity. The chief cited that there was non occurrence of any severe problems except shortage of domestic water in the village. The relationship between Thai people and the Ka rieng people are amicable. Some Ka rieng persons teach Ka rieng language to Thai. The chief joined the workshop conducted by the Study Team and the people have the opportunities to give their opinions. Judging from that situation, it can be said that special consideration for this group is not necessary.

(d) Small Scale and Medium Dams Proposed by RID

The RID has proposed small scale and medium dams in the Study Area. Details are described in Section 4.3. Based on the Criteria Table 4.7.5, if constructions of dams are planned, Checklist/IEE for medium scale dams should be essential.

Table 4.7.5 Classification of the Dams (Reservoirs)

Scale	Storage Capacity	Construction Cost	Irrigation Area	Construction Period	Remarks
Small	Less10 MCM	Less 10 MBt	4,000 rai	<1 year	Checklist
Medium	10-100 MCM	10-20 MBt	< 8,000rai	> 1 year	Checklist

(4) Environment Evaluation in the Study Area

Although components of the Pilot Project are still under discussion, the project scale is considered not so big with construction cost less than 50MBt and construction period is less than one year. Therefore, with regards to the environmental guideline, the Project probably doesn't need EIA or IEE, and only checklist description is required. After deciding the project components, it is necessary to fill up the checklist of Thai standard format.

4.8 Constraints

During the course of site survey, problems and constrains for development at each field have been identified and summarized below.

(1) Surface Water Resources

- Limited water resources development, which have resulted to frequent flood and/or drought.
- Shortage of irrigation water and lack of knowledge for water control system.
- Quality of water. The downstream portion of the Lam Pa Chi River basin has recently been facing with a problem of polluted water, due to the release of certain poisonous chemicals by the upstream farmers for fishing purpose and heavy use of pesticides and insecticides that their residues penetrates the underground that could cause another problem. Further study on these aspects should perhaps be required to avoid a serious problem and constrain to socio-economic and agricultural development in the basin.

(2) Underground Water

- Almost all of the shallow wells are difficult to use for irrigation water in the dry season because the groundwater level in wells dropped tremendously.
- Making a construction plan of wells in the Study Area becomes difficult because many governmental agencies such as DMR, PWD, ALRO, DH, etc. are engaged in the construction of wells with their own way.
- Without cooperation among the above mentioned agencies resulted to non availability of data base of wells and also items of inventory for wells are not uniform.
- There are no past records where we can observe and monitored the groundwater level of wells.

(3) Agriculture

Based on the RRA survey, PCM workshops and field survey undertaken, some of constrains are cleared out, which had been in the minds of the farmers for a long time. Followings are the main constraints on agriculture as pointed out from by the farmers.

- Low Productivity
  - Poor soil fertility
  - Damages form diseases and insects
- High cost for agricultural input comparing with product price
- Low price of product
  - ・Inappropriate relationship with middleman
- Lack of knowledge on farming
  - ・Unreliable extension service from government
- Mono-crop plantation
- Lack of fund for agricultural investment
- Lack of basic infrastructure such as the village/rural farm roads, collection points, market places and related information

(4) Irrigation

- Cost-effective irrigation system. Presently the farmers have a tendency to develop irrigation water for their own uses but, with limited resources, accordingly the facilities may not be highly efficient or effective. Furthermore, as rice is not a major crop, which uses much water in the basin, appropriate irrigation systems that are suited to the different kind of crops should be identified and/or developed.
- Farmers have suffered from lack of funds to purchase small scale irrigation facilities (small scale pump with piped systems), especially at upstream and middle upstream basin.
- Due to shortage of water in dry season, farmers are not able to practice irrigation farming.
- Ponds less than 1 rai of size are not enough to use water through a year for irrigation purpose.
- There were no regulations/rules to use water from ponds, weirs, etc. for irrigation purpose.

(5) Related Public Organizations

Decentralization

- With the current decentralization policies, the provincial governors have been given more authority for the development of the areas. The relationships between the RID and the provincial office are therefore changing, and it is not yet clear in what way or another it will influence on agricultural development. It is not clearly indicated what agencies take what responsibilities for the development.
- The TAOs have been given the responsibilities of planning and implementing small scale projects, including the management of its budgets. Most of them are however not yet capable for it.
- The newly established Ministry of Natural Resources and Environment has been tasked for the formulation of water resource development plans over the country. The ministry also becomes responsible for the construction and operation of small scale projects while RID is responsible for that of medium and large scale projects. This gives the question of whether the planning of water resource development is not regarded as the task of RID any more.

TTC

- Many TTCs are not active because the capacities and number of extension officers and workers, who are the key players for the TTC, are not yet adequately equipped.
- Extension workers are not keen in promoting participatory or grass-root development.

Participatory Development

- The participatory development is still at the conceptual stage. The public agencies at the central as well as the local levels are not much aware what their tasks are, which resulted to unclear roles and responsibilities of these agencies.
- The officers and field workers are not skilled for implementing participatory development.
- Participatory development requires changes of development process, which eventually requires organizational changes. It will generally encounter a lot of resistance in and outside of the organization and be easy to hit a setback. In our study, it largely depends on the leadership within RID to what extent RID can incorporate the concept and approach of participatory development in its tasks; however, it is still doubtful whether the leaders of RID have strong commitment for it.

(6) Community Organizations

- There is not much collaboration among the members within an organization. The reasons would be (i) most of the community organizations have been established by the government agencies but not by the people, and (ii) group work is not traditionally exercised.
- The number of active members in an organization is very much limited.
- The negotiation power of the organizations against middlemen or agents of factories is still weak.
- There are various kinds of community organizations in a village. Some of them have been established by different agencies, but have similar activities. In most cases, they are not linked or coordinated well.

CHAPTER 5 MASTER PLAN

5.1 Needs from Inhabitants

(1) Problem, Needs and Direction of the Development at Tambons

(a) Problems or Needs

The problems, which people faced in the area was revealed during the course of PCM at sixteen Tambons and solutions against these problems were identified. This section shows the integrated outputs from the Problems Trees of each Tambon in order to show the essence of what the people thought is the problem. The result of the PCM workshops reached to one perception that all of Tambon in the Study Area share the same type of issue as a core of Problems Trees as "**High expenditure compare to income**" that caused by following 4 main problems:

1) High cost for agricultural inputs
2) Low productivities
3) Damage on the products
4) Low market prices

Each Tambon identified at least three of the above mentioned problems for their communities, although natural conditions such as topography, water resources, soil type as well as agricultural practices varies among the Study Area. The chart below describes structural relationship between Top Problem, Main Problems and Main Causes in each Tambon. The Main Problems and its direct causes, namely Main Causes, suggested in each Tambon are indicated at Table 5.1.1.

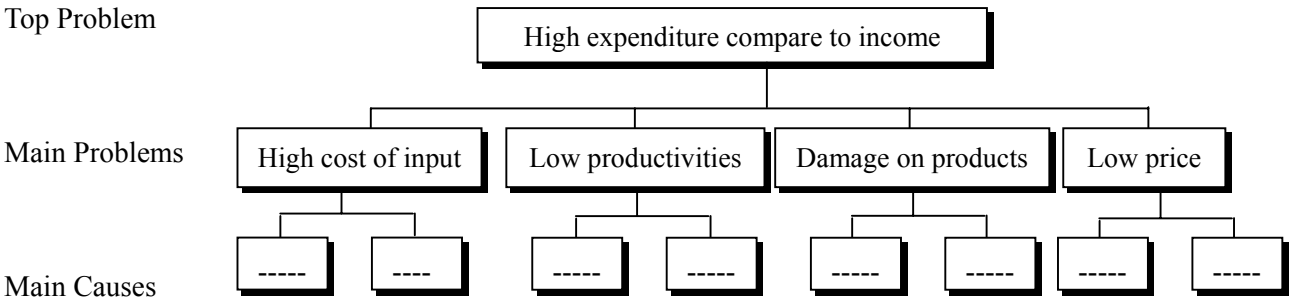


Table 5.1.1 Main Problems in Each Tambon

Sub-Basin	Tambon		A	B	C	D	E	F
Upstream	1	Ban Bueng	✓	✓	✓	✓		
	2	Ban Kha	✓	✓		✓		
	3	Tha Nao Si	✓		✓	✓		
	4	Nong Phan Chan	✓	✓		✓		
	5	Yang Hak	✓	✓		✓		
Middle-Upstream	6	Suan Phueng	✓	✓	✓			
	7	Tha Khoei	✓	✓		✓		
	8	Pa Wai	✓	✓		✓		
Middle-Downstream	9	Dan Thap Tako	✓	✓		✓		
	10	Rang Bua	✓	✓		✓		
	11	Kaem On	✓	✓		✓		
	12	Boek Phrai	✓	✓		✓		
Downstream	13	Nong Phai	✓	✓	✓	✓		
	14	Dan Makham Tia	✓	✓		✓		
	15	Chorakhe Phuek	✓	✓		✓	✓	
	16	Klon Do	✓	✓	✓	✓		✓
Total			16	15	5	15	1	1

Remarks:
A: High production costs
B: Low productivities
C: Damaged on products
D: Low market price
E: Limited credit for investment
F: Sub-standard products

Note: Problems each Tambon suggested as a direct causes of the "Top Problem"

From among the above listed main problems in each Tambon, high production costs, low productivities and low marketing price are outstanding as more than fifteen Tambon have indicated. Particularly, high production costs and low marketing prices are highly related to each other to lead top problem of "High expenditure compare to income" directly. Furthermore, the direct causes of four Main Problems are concluded at Table 5.1.2 respectively. Outstanding causes of each Main Problem, which are the most popular in the Study Area, are as follows:

1) High cost for agricultural inputs

As causes of high cost for agriculture, a total of twenty-five Main Causes are suggested in whole basin. Some issues are quite common in the whole river basin as follows:

(a) ***Transportation***---All the Tambons in Upstream Basin and Middle Upstream Basin pointed out many causes for transportation problem, while only one Tambon out of Middle down and Downstream Basin mentioned about transportation problem. Long distance on marketing crops could be one of the main reasons. While pineapple is the main crop of Upstream Basin, there is no pineapple factory. Middlemen have to bring the products to factory in Kanchanaburi which may cause high transportation cost.

(b) ***Insufficient labors***---Half or more than half of Tambons proposed problems on insufficient labors in Upstream Basin and Downstream Basin. Considering the main crop of each sub basin, it appears that all of main crops in each basin such as pineapple and sugarcane as well as cassava, requires quite intensive works especially during harvesting season. Cropping area of pineapple is the highest in Upstream Basin and of sugarcane is in Downstream Basin. Appropriate number of labors is needed at appropriate timing in these areas.

(c) ***High Interest***---Four out of five Tambons in Upstream Basin suggested problems on high interest, while only one Tambon indicated in the other sub basin. It doesn't mean about interests of official organizations such as BAAC but purely on individuals such as "merchants." Although size of land and low productivity could be the causes, only about the "land titling" as well as inappropriate loan system was suggested as a cause of high interest.

2) Low productivities

As causes of high cost for agriculture, a total of nineteen Main Causes are suggested in whole river basin. Some issues are quite common in the whole river basin as follows:

(a) ***Disease/pest***---A total of ten Tambons out of sixteen Tambons in the whole basin raised an issue of disease and pest as same as water shortage. Although quantitative aspect is not cleared out in PCM workshops, most of Tambon think it is a problem.

(b) ***Water shortage***---Although water shortage could be the main problem since it is the greatest in Downstream Basin, but all the Tambons pointed it out as a Main Cause of low productivities. Irrigation facilities are highly maintained in Downstream Basin and many advanced farmers demonstrated high yield with irrigation facility. This fact becomes the key in enhancing the farmers' awareness toward the water resource.

(c) ***Deteriorated soil***--- This is most common in Upstream Basin. It depends mainly upon manners of agricultural practice as well as geographical condition. Pineapple farmers tend to use considerable amount of agro-chemicals such as fertilizer, pesticide and herbicide and it deteriorates the quality of soil. In addition, these areas are quite hilly and could be eroded much more than the other area.

3) Low market price

(a) ***Exploitation from middleman***---it is most common in both Upstream Basin and Downstream Basin. Limited market channel and low negotiation power due to no colaboration are suggested as the cause of this Main Cause. According to the RRA survey, farmers in Downstream Basin complained a lot about their less competitiveness on vegetable marketing. Regarding the Upstream Basin, this cause might be caused by highly fluctuated market price of pineapple.

(b) ***Low quality of products***---this is a common problem except in Downstream Basin. One of the reasons they raised is lack of knowledge. Why it is not a big problem in Downstream Basin? It is because there are appropriate organizations for each product that provides extension services and support to farmers.

(c) ***Surplus products to requirement***---All the Tambon in Upstream Basin proposed it. This must be about pineapple, since market price of pineapple is quite fluctuated rather than that of sugarcane. In the year of 1998 to 1999 was the biggest harvest of pineapple and many pineapples were seen to be thrown away here and there.

4) Damage on the products

Most of the Main Causes are suggested in Upstream Basin. Actually, a total of eleven Main Causes are suggested in Upstream Basin, while only two Main Causes are suggested in Middle Upstream Basin and Downstream Basin. Therefore, this Main Problem could be complicated in Upstream Basin. Several constraints are suggested as Main Causes of the "damage of the products" such as disease/pest, flood, drought and others. However, nothing is outstanding.

Table 5.1.2 (1) Main Causes of "High Cost for Input"

Sub-basin		Tambon	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
Upstream Basin	1	Ban Bueng	✓		✓	✓	✓			✓	✓				✓	✓											
	2	Ban Kha	✓	✓								✓															
	3	Tha Nao Si	✓		✓	✓	✓				✓				✓												
	4	Nong Phan Chan	✓	✓	✓					✓																	
	5	Yang Hak	✓	✓	✓			✓																			
		Sub-Total	5	3	4	2	2	1	0	2	2	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0
Middle Upstream Basin	6	Suan Phueng	✓										✓				✓	✓	✓								
	7	Tha Khoei	✓		✓											✓											
	8	Pa Wai	✓	✓					✓	✓										✓							
		Sub-Total	3	1	1	0	0	0	1	1	0	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0
Middle Downstream Basin	9	Dan Thap Tako			✓	✓			✓																		
	10	Rang Bua					✓				✓	✓	✓	✓							✓						
	11	Kaem On				✓		✓	✓																		
	12	Boek Phrai		✓						✓												✓					
		Sub-Total	0	1	1	2	1	1	2	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0
Downstream Basin	13	Nong Phai		✓			✓	✓															✓				
	14	Dan Makham Tia			✓	✓			✓																		
	15	Chorakhe Phuek						✓						✓										✓	✓		✓
	16	Klon Do	✓	✓			✓				✓															✓	
		Sub-Total	1	2	1	1	2	2	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1
Total			9	7	7	5	5	4	4	4	4	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1

Source: Result of PCM workshops in sixteen Tambons

Remarks:

a : High cost of transportation
b : Insufficient labor
c : High interest
d : High cost of labor
e : High cost of seedling
f : Lack of agricultural knowledge
g : Unable to produce own product's input
h : Insufficient equipment / machinery
i : High cost of medical / fertilizer
j : High cost of animal breeding
k : Expensive animal feed
l : Insufficient grass
m : High cost of plough
n : High cost of gas
o : Product price is set by middle man
p : Unable to store seedling for own use
q : Some farmers have no own land
r : Inadequate land
s : No support on semen artificial breeding from government
t : Insufficient management system
u : Dealer take advantage on price
v : Disease / Pest
w : Deteriorated soil
x : High cost of electrical pump
y : Improper soil for cultivation

Table 5.1.2 (2) Main Causes of "Low Productivities"

Sub-basin		Tambon	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
Upstream Basin	1	Ban Bueng	✓		✓		✓														
	2	Ban Kha	✓		✓					✓	✓			✓							
	3	Tha Nao Si																			
	4	Nong Phan Chan	✓	✓	✓	✓		✓				✓	✓		✓						
	5	Yang Hak		✓	✓			✓				✓									
		Sub-Total	3	2	4	1	1	2	0	1	1	2	1	1	1	0	0	0	0	0	0
Middle Upstream Basin	6	Suan Phueng	✓	✓	✓	✓										✓					
	7	Tha Khoei	✓	✓		✓	✓		✓								✓				
	8	Pa Wai	✓		✓	✓					✓		✓								
		Sub-Total	3	2	2	3	1	0	1	0	1	0	1	0	0	1	1	0	0	0	0
Middle Downstream Basin	9	Dan Thap Tako	✓	✓		✓		✓	✓												
	10	Rang Bua	✓			✓				✓								✓			
	11	Kaem On																	✓	✓	
	12	Boek Phrai		✓	✓			✓													
		Sub-Total	2	2	1	2	0	2	1	1	0	0	0	0	0	0	0	1	1	1	0
Downstream Basin	13	Nong Phai	✓	✓		✓	✓														✓
	14	Dan Makham Tia		✓			✓		✓												
	15	Chorakhe Phuck		✓																	
	16	Klon Do	✓	✓	✓					✓											
		Sub-Total	2	4	1	1	2	0	1	1	0	0	0	0	0	0	0	0	0	0	1
Total			10	10	8	7	4	4	3	3	2	2	2	1	1	1	1	1	1	1	1

Source: Result of PCM workshops in sixteen Tambons

Remarks:
a : Disease / Pest
b : Water shortage
c : Deteriorated soil
d : Lack of knowledge
e : Drought
f : Low quality of seedling
g : Flooded
h : Animal disease
i : Insufficient water resource
j : Damaged crop
k : No seasonal rainfall
l : Insufficient grass for animal feed
m : Upland area
n : Insufficient / low quality of labor
o : Fired forest
p : Product do not meet with quality
q : Low quality of fertilizer
r : Effect of residual herbicide in sugar ca field on nearby vegetable field
s : No quality of water farm well

Table 5.1.2 (3) Main Causes of "Low Market Price"

Sub-basin		Tambon	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
Upstream Basin	1	Ban Bueng	✓		✓														
	2	Ban Kha		✓	✓	✓			✓			✓	✓						
	3	Tha Nao Si	✓	✓	✓														
	4	Nong Phan Chan	✓	✓	✓	✓	✓		✓	✓				✓	✓				
	5	Yang Hak	✓	✓	✓		✓												
		Sub-Total	4	4	5	2	2	0	2	1	0	1	1	1	1	0	0	0	0
Middle Upstream Basin	6	Suan Phueng																	
	7	Tha Khoei	✓	✓	✓														
	8	Pa Wai		✓		✓					✓								
		Sub-Total	1	2	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Middle Downstream Basin	9	Dan Thap Tako		✓			✓	✓											
	10	Rang Bua				✓				✓	✓								
	11	Kaem On		✓	✓		✓	✓	✓								✓	✓	✓
	12	Boek Phrai	✓	✓	✓														
		Sub-Total	1	3	2	1	2	2	1	1	1	0	0	0	0	0	1	1	1
Downstream Basin	13	Nong Phai	✓		✓											✓			
	14	Dan Makham Tia	✓	✓				✓											
	15	Chorakhe Phuek	✓																
	16	Klon Do	✓																
		Sub-Total	4	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Total			10	10	9	4	4	3	3	2	2	1	1	1	1	1	1	1	1

Source: Result of PCM workshops in sixteen Tambons

Remarks:
a : Exploitation from middle man
b : Products do not meet the quality
c : Excess product
d : No price guarantee
e : No negotiation power
f : Damaged crop
g : No cooperation among farmers
h : No market demand
i : Farmers unable to fix own price
j : Lack of marketing knowledge
k : Unable to deliver products on time
l : Excess chemical in products
m : No product processing
n : No support attentively from sugarcane growers group
o : High interest loan from quota man
p : Limited market channel
q : Fluctuation price

Table 5.1.2 (4) Main Causes of "Damage on Products"

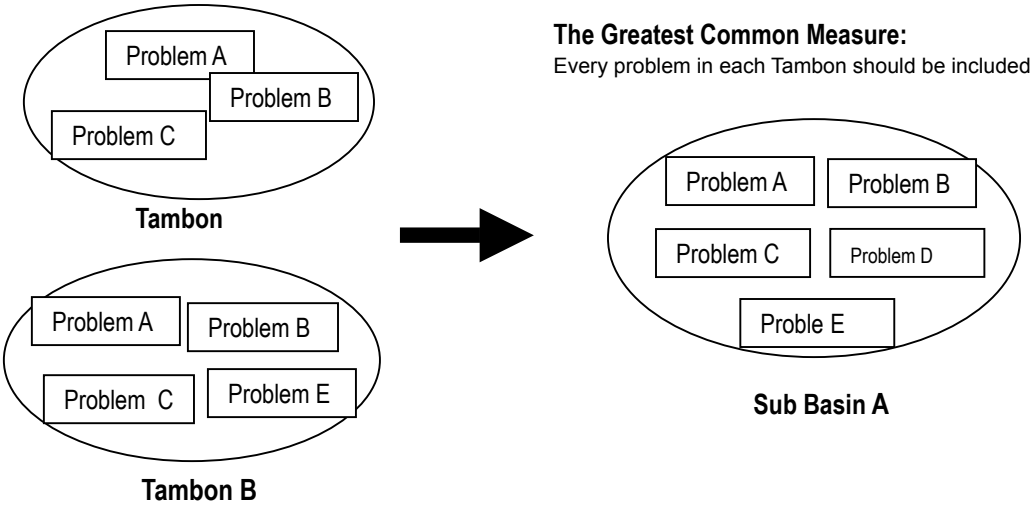
Sub-basin		Tambon	a	b	c	d	e	f	g	h	i	j	k	l	m
Upstream Basin	1	Ban Bueng	✓		✓	✓	✓	✓	✓	✓					
	2	Ban Kha													
	3	Tha Nao Si	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
	4	Nong Phan Chan													
	5	Yang Hak													
		Sub-Total	2	1	2	2	2	2	2	1	1	1	1	0	0
Middle Upstream Basin	6	Suan Phueng												✓	✓
	7	Tha Khoei													
	8	Pa Wai													
		Sub-Total	0	0	0	0	0	0	0	0	0	0	0	1	1
Middle Downstream Basin	9	Dan Thap Tako													
	10	Rang Bua													
	11	Kaem On													
	12	Boek Phrai													
		Sub-Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Downstream Basin	13	Nong Phai	✓	✓											
	14	Dan Makham Tia													
	15	Chorakhe Phuek													
	16	Klon Do		✓											
		Sub-Total	1	2	0	0	0	0	0	0	0	0	0	0	0
Total			3	3	2	2	2	2	2	1	1	1	1	1	1

Source: Result of PCM workshops in sixteen Tambons

Remarks:
a : Disease / Pest
b : Flooded
c : Drought
d : Soil surface erosion
e : Variable weathered condition
f : Underflow water damaging crop
g : Insufficient water resource
h : Forest fire
i : Lack of knowledge
j : No quality of water for agriculture
k : Deteriorated soil
l : No buyer in th area
m : Inconvinient transportation

(2) Problem, Needs and Direction of the Development at Sub Basins

After the PCM workshops in sixteen Tambons, the Study Team combined the Problem Trees and the PAM of the Tambons in each Sub Basin so that it could represent the problems and directions in the whole Sub Basin. Technically, Problems Tree in each Sub Basin contain every problem, which participants suggested in each Tambon in the Sub Basin as with the manner stated below. PAM is also combined by the same manner as the greatest common measure.



According to the newly established Problem Trees and PAM in each Sub Basin, Stage 3, Discussion Session, has taken place in each Sub Basin as shown below, to make consensuses of "**what is the problems**" and "**what is the direction**" of each Sub Basin.

In the discussion, such objectives are displayed as follows:

1. To confirm Problem Trees and PAM in sub basin that the Study Team prepared.
2. To gives priorities on each activities in PAM with regard to the urgency

In cooperation with RID counterparts and local consultants, representatives of each Tambon had discussed enthusiastically on their development issues. They added some amendments and new ideas at Problem Tree and PAM as well as decided priority activities by their own criteria.

Furthermore, discussions at each Sub Basin as well as the Whole River Basin with technical advices from the Study Team, TSG and other related agencies took place again to discuss more about possibilities of the activities and to set up development plan of each Sub Basin.

Completed Problem Trees and PAM as well as the priority activities are shown in following table.

Table 5.1.3 Priority Activities in Each Sub Basin Confirmed by the Participants

Items	Upstream	Mid-Upstream	Mid-Downstream	Downstream
Funds/credit	Establish fund for agricultural rotation	The state issues the land document of right	The state issues the land document of right	The state issues the land document of right
Water	Transmission Pipeline for irrigation	Transmission Pipeline for irrigation Pumping Station for irrigation	Weir/Ladder weir Dredging in natural pond/canal	Reservoir
Soils	Expert gives advice/knowledge	Raise the awareness of requirement the soil quality for farmers	Expert gives advice monitoring and analyzing soil quality	• Expert gives advice & knowledge • Training for soil improvement
Disease/ insects	Expert gives advice	Responsible agencies should support	Expert gives advice and provide training	Expert gives advice and provide training
Animal Disease	Expert gives advice	Providing training for farmers		Expert gives advice and provide training
Farm Input	Expert gives advice	Expert gives advice	Expert gives advice	• Seedling storage • Appropriate uses of fertilizer and chemicals • Establish farmers groups
Production Price & Market	Government has fix price guarantee	Search for the central markets	Setting up groups to do joint market	• Search for the central markets • Information network on marketing and new markets
Knowledge	Coordinate with Government agencies to provide support	• Expert gives advice the new plan for agriculture • Raise responsibility consciousness		Establish farmers groups
Production	Government have a policy designate the cultivation area	Processing technology/knowledge Establish information networks	Processing for value added	Expert gives advice for planting, seedling, insecticide, pesticide
Flood	Dredging sediment/load Consciousness-raising on forest protection	Dredging in creek Raise forest preservation consciousness		Construction of concrete river protection
River Bank Erosion			Dredging sediment/load	

Problem Tree - Upstream (Ban Bueng, Ban Kha, Tha Nao Si, Nong Phan Chan, Yang Hak)

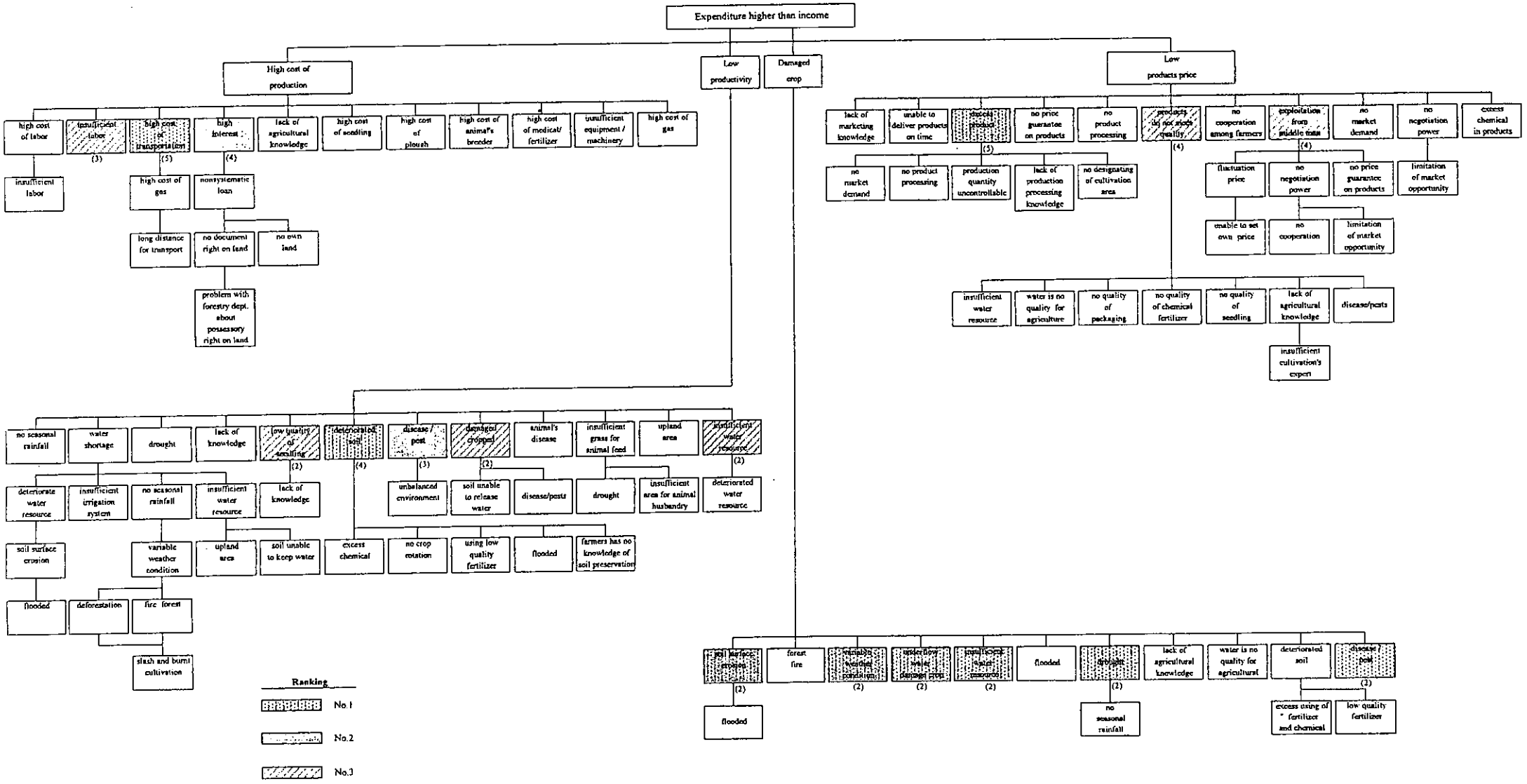


Figure 5.1.1 Problem Tree at Upstream Basin

Problem Tree - Middle Upstream (Suan Phueng, Tha Khoei, Pa Wai)

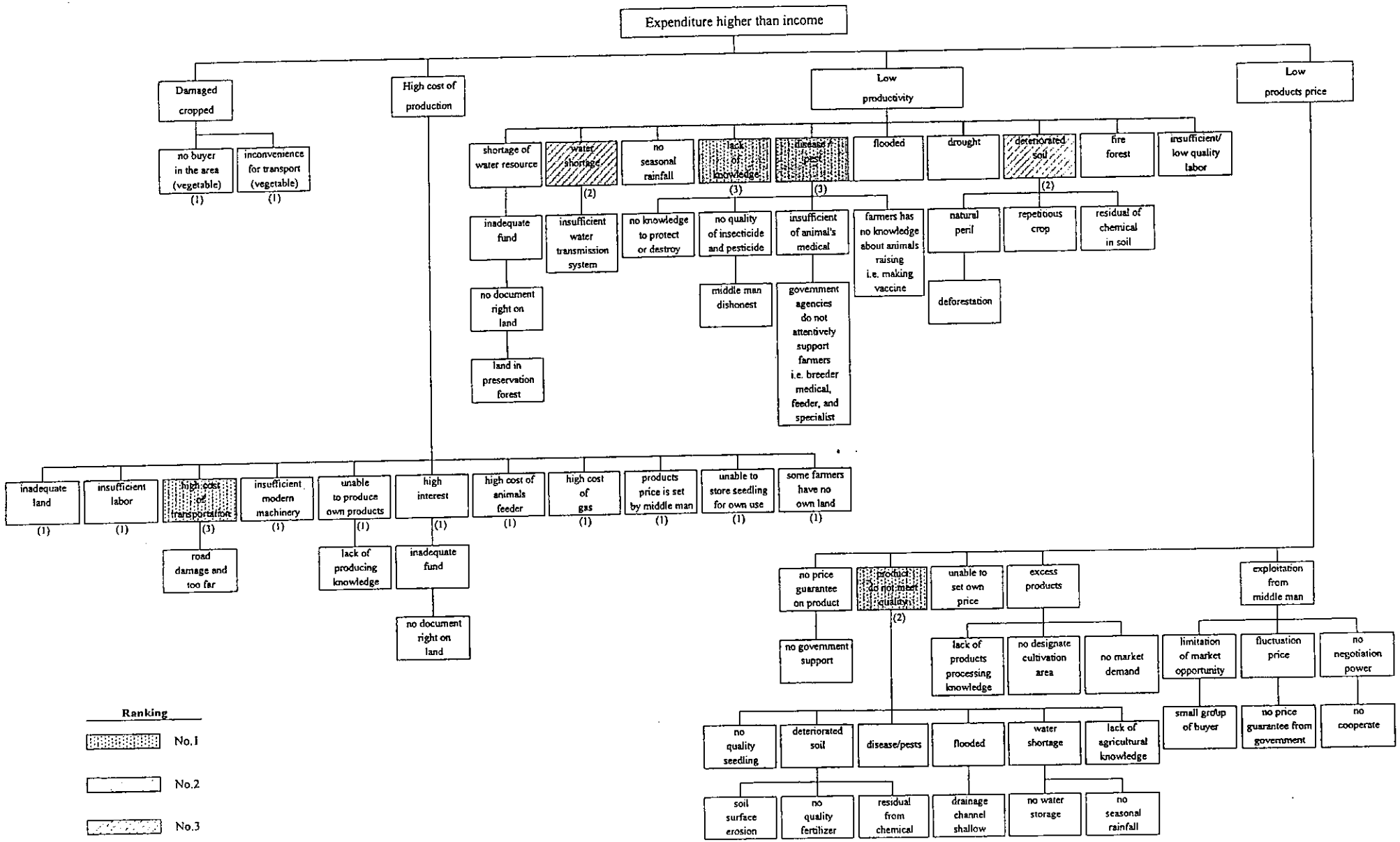


Figure 5.1.2 Problem Tree at Middle Upstream Basin

Problem Tree - Middle Downstream (Boek Phrai, Rang Bua, Dan Thap Tako, Kaem On)

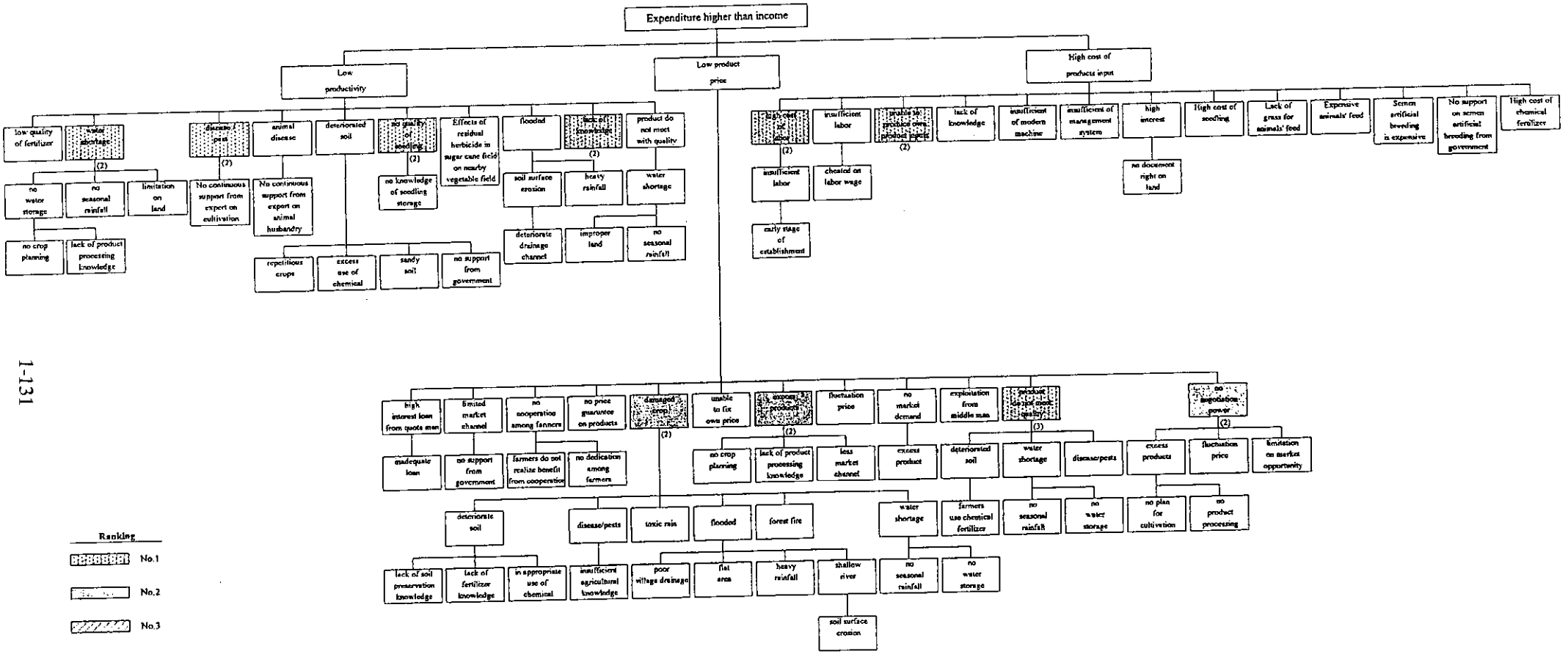


Figure 5.1.3 Problem Tree at Middle Downstream Basin

Problem Tree - Downstream (Nong Phai, Dan Makham Tia, Chorakhe Phuek, Klon Do)

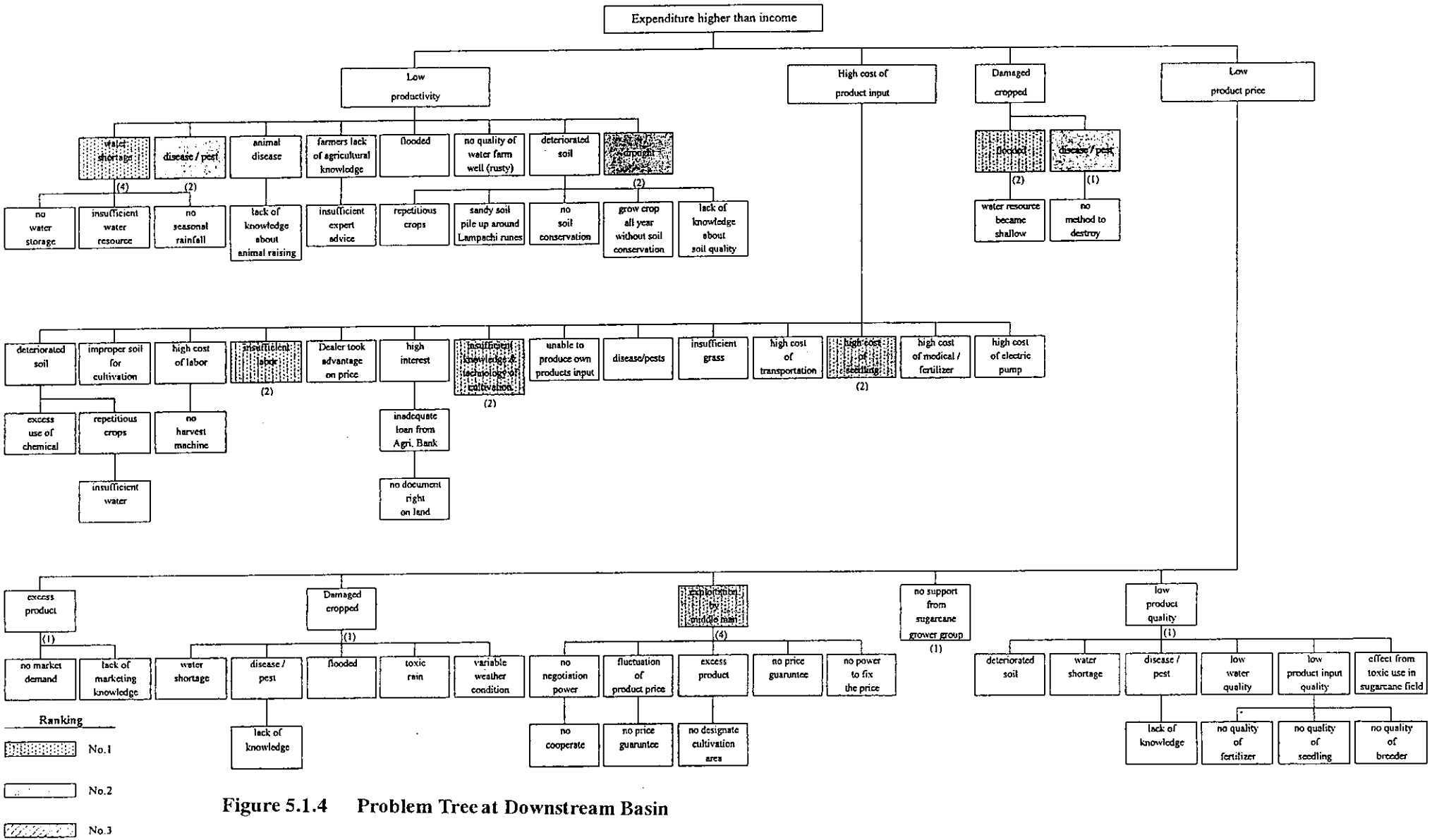


Figure 5.1.4 Problem Tree at Downstream Basin

Table 5.1.5 Project Activities Matrix in Upstream Basin

Project Approaches	Urgent (within 2-3 years)	Within 5 years	Less urgent After 5 years
ๆ Investmant funds/credit	- The state issues the land document of right - Expert gives guidance on establishment of cooperatives and demonstrate the work performance - Establishing the saving money group - Establishing Community/ Agriculture Bank - Establishing agricultural rotation fund - Procuring loan with low interest	- Grouping - Cooperatives establishment	
ๆ Water	- Small reservoir (in Ta Nao Si sub-district) - Spillway - Pond - Transmission pipelines - Well - Dredging sediment in reservoir - Dredging in natural creek	- Small reservoir - Medium reservoir - Shallow well - Reforestration - Transmission pipeline - Dredging sediment and riprap - Weir	- Well - Transmission pipe system - Reservoir
ๆ Soil	- Expert gives advice/knowledge - Using quality fertilizer appropriately - Responsible government agencies attentively make improvement - Using bio-fertilizer instead of chemical fertilize - Growing leguminous crop (crop rotation) - Growing elephant grass - Digging more channel aroud underflow area	- Growing leguminous crop (crop rotation)	- Soil conservation
ๆ Disease/ insects animal disease	- Expert gives advice - Responsible government agencies attentively make improvement - Crop rotation - Promoting organic extract to eliminate disease/pests - Promoting non- toxic chemical residual - Using quality fertilizer appropriately - Using bio-fertilizer	- Setting up medical fund (for livestock)	
ๆ Farm Input	- Experts gives advice - Procuring quality seeds - Promoting on animals research - Producing home-made insecticide/pesticide - Establishing Market information center - Establishment Groups to joint working - Joint grouping to procure modern machine for production - Improve management of cooperatives - Provide training on making living from agricultural - Joint grouping to procure and produce farm input by each crop	- Group joining in asking for supportatives on farmer's equipment - Promoting in growing grass for animals feed - Provide demonstration plot about fertilizer/ chemical	

Project Approaches	Urgent (within 2-3 years)	Within 5 years	Less urgent After 5 years
๗ Production prices marketing	- Setting up banking for fertilizer and medical within the village - Joining as a group to purchase - breeder to use among the group - PR on marketing - Expert give advice about crop planning - Government has fix price guarantee - Making contract in advance of trading - Training in appropriate uses of chemicals and fertilizers - Registering as farmer under agricultural category - Setting up group growing toxicant free crops	- Price guarantee - Set the proper area for cultivation	- Setting up central market (District level)
๗ Knowledge	- Coordinate with Government agencies to provide support - Study visit to successful case in administrative and management - Training in soil improvement - Training appropriate uses of chemical-fertilize - Expert gives advice and plan for cultivation		
๗ Production	- Produce good quality products - Government agencies have a policy designate the cultivation area - The government provides support for agricultural product processing - Growing plants in consistent with market condition - Expert gives advice on high quality plants - Procuring in appropriate seedling with geography and climate - Expert gives advice about seedling storage		
๗ Flood preventatior	- Dredging sediment/load - Concoulsness-raising on forest protection - Spillway - All construction building must not to obstruct to the river/stream	- Growing elephant grass to relieve flood problem	

1st priority

2nd priority

3rd priority

4th priority

Table 5.1.6 Project Activities Matrix in Mid-Upstream Basin

Project Approaches	Urgent (within 2-3 years)	Within 5 years	Less urgent After 5 years
· Investmant funds/credit	- The state issued the land document of right - Setting up farmer's group - Procuring loan with low interest	- Cooperatives establishment	
· Water	- Weir - Distribute system - Pond - Shallow well/ Well - Dredging sediment - Transmission pipe - Electrical Pumping Station	- Transmission pipeline system	- Medium Reservoir
· Soil	- Raise the awareness and understanding about requirement the soil quality for the farmers - Expert gives advice/knowledge - Responsible agencies make attentively support - Using compost and organic fertilizer - Growing legumenous crop (crop rotation) - Forming a group for distribute knowledge about soil	- Soil conservation	
· Disease and insects	- Making the demonstration plot in consistent with giving knowledge to every village - Crops rotation - Responsibility agencies make attentively support - Using in appropriate and quality fertilizer	- Promote the growing of herbs to produce insecticide/pesticide	
· Animals disease	- Providing training for farmers - Dissiminating information of wide spread disease - Establishing vaccine center within district		
· Farm Input	- Expert gives advice on the method of seedling storage, producing insecticide/ pesticide and appropriate uses of fertilizers and chemicals - Producing own bio-fertilizer - Forming a group for modern machinery procurement for the production system - Promoting on animals research - Procuring quality and low price seed, animals and medical	- Producing home made ferterizer and insecticide/pesticide - The government to set up the agricultural machinery rental center	- Cooperative establishment
· Production prices marketing	- Establishing marketing network center - Government has fix price guarantee - Search for the central market - Making trading contract in advance - Forming goup to sell products		
· Knowledge	- Expert gives advice about the new plan for agriculture - Study visit to successful case - Prepaing demonstration plot of medical and fertilizer - Forming farmers group - Raise responsibility consciousness	- Information sources - Establishing the animal and plant diseases research center of the sub-district - Increasing personnel of the TTC	
	----------Evaluation follow up after training----------		
· Production	- Producing quality products - Grows crop in consistent with market demand - Government provide support for products processing in technology/knowledge and establish information network center on agriculture production (emphasize on cultivated areas) - Government agencies has policy about designation on cultivation area		
· Flood preventation	- Dredging sediment in creek - Construct drainage channel - Raise forest preservation consciousness	- Grows elephant grass - Afforestation	

Table 5.1.7 Project Activities Matrix in Mid-Downstream Basin

Project Approaches	Urgent (within 2-3 years)	Within 5 years	Less urgent After 5 years
• Investman funds/credit	- The state issues the land document of right	- Money saving - Cooperatives establishment or improve the operation system for the exist one	- Revoliving fund - Procuring loan with low interest
• Soil	- Expert gives advice - Responsible government agencies attentively make improvement - Producing green manure for own use - Growing leguminous crop (crop rotation) - Monitoring and analyzing soil quality	- Soil conserve for agriculture	
• Disease and insects	- Expert gives advice and provide training - Responsible Government agencies attentively make improvement - Provide demonstration plot - Using quality and disease resistance seedling - Using organic fertilizer	- Crop rotation	
• Water	- Small reservoir - Weir/ Ladder weir - Irrigation canal - Digging a small pond (5-10 rai) - Shallow well - Dredging sedimen in natural pond/ canal - Construct a distribution system for existing weir/river	- Small reservoir - Digging a large pond in the deteriorated area of approximately 1,200 rai - Setting up pumping station along with irriation system - Transmission system - Stream dredging	- Medium reservoir
• Farm Input	- Expert gives advice - Promoting cultivation of plants that are both cash crops and feed crops - Study visit to successful area in cost reduction - Provide demonstration procedure and method of cost reduction - ----------Producing insecticide/ pesticide for own uses----------	- Forming a group for modern machinery procurement for the production system - Producing organic-fertilizer for own uses	
• Production prices and marketing	- Producing only quality products - Govrnment agencies have a policy designate the cultivation area in appropriate with land condition - Provide knowledge and requirement to the farmer about the growing plants system and trainning in agricultural planning - Appoint representative or coordinator to monitor on marketing data both in retail and wholesale - Price guarantee - Government agencies provide assistance on monitoring market - Setting up groups to do joint market	- Selling through farmer group - Guranteered price by buyers - Production of standardized agricultural products - Crop planning by farmers	- Designate cultivation area
• Knowledge			
• Production			
• Bank erosion preventation	- Spillway - Dredging sediment/load - Growing elephant grass	- Grass/tree planting for slope protection - More drainage channel	- River dredging
• Cooperation in group formation	- Expert gives advice - Study visit to successful area - Setting up Farmer's group - Create/ build a vision amongst farmers		
• Product processing	- Promote the product processing for value added and solving oversupply for fresh product		

Table 5.1.8 Project Activities Matrix in Downstream Basin

Project Approache	Urgent (within 2-3 years)	Within 5 years	Less urgent After 5 years
· Investmant funds/credit	- The state issue the land document of right - PR and provision of knowledge on banking at Tambon level	- Cooperatives establishment - Government support in establishing the bank/ saving group	- Procuring loan with low interest - Establishing the bank at Tambon level
· Water	- Reservoir - Weir - Irrigation system and electric pumping station - Distribution system - Shallow well - Pond - Dredging	- Small reservoir - Weir - Transmission canal	- Medium Reservoir - Large reservoir - Reatforestration
· Soil	- Crop rotation (i.e. leguminous crop) - Farmers produce own bio-fertilizer instead of chemical ferterlizr - Responsible government agencies provide supporting - Training for volunteer about soil preservation - Demonstration Plot		
· Disease/insects and livestock disease	- Using quality seed free of germs - Responsible Government agencies attentively make improvement - Expert gives advice and provide training - Farmers produce own insecticide/pesticide - Crop rotation - Using of other technologies of pollution-free nature		
· Farm Input	- Expert gives advice about seedling storage appropriate uses of fertilizers and chemicals - Government agencies perform as coordinator for both public and private production input seller - Farmers group to procure modern machinery for production - Producing own insecticide/pesticide made from natural herbs - Establishments group of farmers	- Using machine instead of labor (save production cost)	
· Knowledge	- Expert give advice in crop planning, farm budget, making green manure and marketing - Setting up Farmers group - Study visit to other successful areas		
· Production prices and marketing	- Price guarantee - Government agencies designate the cultivation area - Government agencies provide support for product processing - Search for the market - Growing plants in consistency with market - Gathering all sale products - Trading with contract - Establishing information network on marketing and new markets - Producing quality product		
· Production	- Expert gives advice about plants categories - Expert gives advice about using quality of seeding, breeder, insecticide and pesticide - Using quality fertilizer appropriately		
· Flood / Bank erosion prevention	- Construction of concrete embankment (especially at the river curve) - Spillway - ------Growing grass, elephant grass, bamboo to relieve flood problem------ - ----------Dredging Sediment----------	- Reservoir - Concrete wall with barrage at proper area (convenience for water to flow in and out)	
· Negotiation power	- Crop planning		

5.2 Direction of the Development Planning

(1) Targets and Development Components

Under the 9th NESDB plan, average net farm income increment/household target in the agriculture sector has been set up at 2.0% per annum. Agricultural Development Strategy for Ratchaburi and Kanchanaburi Provinces under the 9th Plan has been set "to increase the sugarcane product" and "to reduce the chemicals use for livestock and agriculture." On the other hand, under the present study, the participatory development planning has been made from Tambon level to the whole Lam Pa Chi River Basin to reveal the prevailing problems and needs raised by farmers. In line with the results of participatory development planning and with taking due consideration of the government policies, the goal of the Master Plan is defined as "**Agricultural incomes meet its cost**." To achieve the goal, therefore, Master Plan was formulated in such a way to produce the following outputs;

1. Cost of agricultural inputs should be lowered,
2. Productivities should be raised,
3. Farm gate prices for markets should be raised, and
4. Damages on products should be lessened.

To attain the above outputs, the Master Plan will apply the following components and objectives which have been finalized through a series of participatory development planning stages under the Study.

Table 5.2.1 Development Components and Objectives

Components	Objectives
1.Water Resources	To ensure sufficient water for production
2. Flood	To reduce damage on crops by flood.
3.Production System	To improve knowledge on farm account, farming technology, cropping plan, to obtain good seed & seedling, to produce good quality products, to introduce crop diversifications, and to promote farm processing
4.Soil	To improve soil conditions
5.Farm Inputs	To produce farm inputs by farmers
6.Pest and Disease	To reduce damage on crops caused by pest and disease
7.Credit	To easy the access to credit with low interest rates
8.Marketing System	To lower the purchase costs and reduce the use of inputs, and ensure or raise the selling prices

(2) Target Periods for Master Plan

Target periods of the Master Plan including short-term (Urgent): within 3 years, mid-term: within 8 years, and long-term: within 20 years are proposed. The short-term covers a period of not more than 3 years and should take a procedure for selection of projects, planning, design and implementation. The mid-term covers next 5 years consisting of review of the implemented projects and follows the same procedure as in the short-term. The long-term for 20 years duration should be in line with the focus of the next 20 years considering the National Development Vision of the 9th National Economic and Social Development Plan (2002-2006).

5.3 Feedback from the Pilot Project

Through the implementation of the Pilot Project from October 2003 to November 2004, a number of lessons are learnd. Lessons learnd through the Pilot Project are integrated into three items such as:

1) Implementation Structure: roles of each agency concerned
2) Development Component: effectiveness, feasibility and farmers' needs on the components
3) Participatory Approach: process from planning to evaluation

Lessons on the "Implementation Structure" are summarized into "Chapter 6," and the lessons on "Development Components" are fed back to each item in "Chapter 5.4." On the other hand, lessons on "Participatory Approach" are concluded in the separate volume "Pilot Project." The following as shown below are the primary lessons on implementation structure and development components.

Table 5.3.1 Lessons on Implementation Structure learnt from the Pilot Project

Agencies	Roles expected	Achievement/ lessons	Roles in Future
TSG	- Technical support at field level	- It is difficult to function as a working group at field level	- Coordinate among several agencies at province level - Screen and prioritize the development components for the provincial development plan
TAO	- Coordinate to absorb the needs from farmers in the process of development plan	- Technical level for implementation is not high enough - Possible to support the farmers as a coordinator - Possible to possess and maintain small scale irrigation facilities	- Be start point of the bottom up approach for participatory approach - Coordinate between farmers and government agencies - Implement the small scale project
TTC	- Support the farmers on agricultural field	- Technical capacity is limited - Budget is insufficient for the extension services	- Activate the service by securing sufficient budget and permanent staff - Utilize out sources
WUG	- Undertake O&M and collection of water fee of the irrigation facilities - Be core of the farmers groups	- Possible to collect the water fee appropriately - WUG performed as a core of the farmers groups at satisfactory level	- O&M of the irrigation facilities - Coordinate among the farmers groups - Invest and manage the revolving fund
RID	- Conduct design, cost estimation and implementation of the irrigation schemes - Establish and implement water resource development plan - Instruct water management - Calculate appropriate water fee	- Maintain enough capability for implementation of the water resource development - Not always explain enough about the detail to the farmers - Not appropriate as a main planner of the integrated agricultural and rural development plan	- Give advice and instruct the TAO for small scale development plan - Conduct design, cost estimation, implementation and O&M of the water resource development - Instruction of the water management
Overall	-	- TSG's support for TAO and TTC is not enough - Relationship among WUG, TAO and farmers group are cultivated	- Role of the TSG should be focused on provincial level - TAO should lead the implementation of the development activities

Table 5.3.2 Lessons learnt on Development Components

Component	Achievement/ lessons
Compost making	A facility for compost making was constructed with the financial support from JICA. It was confirmed that compost making activity can generate profit through marketing in and around the village. Also it appeared that main ingredients of the compost are possible in Kanchanaburi at reasonable price. Moreover, it was found that compost contributes to the improvement of the soil composition and reduction of the utilization of chemical fertilizers, which in turn to reduce input cost.
Artificial breeding center	Artificial breeding center was established in TAO Nong Pai by DOL's own budget. Farmers appreciate that the center can provide artificial insemination at reasonable price cheaper than mean price. One center can cover only several Tambons, therefore, this activity should be expanded to other area.
Revolving fund	Revolving fund was established thorough the activities of compost making and group purchase of the chemical fertilizer. It was revealed that, if managing group functions well, any kind of profitable activities can be a source of the revolving fund. On the other hand, for more expansion, it is also a challenge to secure a budget for initial cost. To this end, Village Fund can be one of the good sources.
Irrigation	In the irrigation system of BTPW, it became possible to apply agricultural chemicals through the pipeline. Due to the high pumping pressure, irrigation time was saved, which enabled to reduce labor work. Also, in the process of the Pilot Project, floor level of the pumping station was heightened according to the farmers' opinion, which enabled to avoid the damage from flood. In addition, ownerships of the irrigation facilities were transferred from RID to TAO. Furthermore, beneficial farmers in BTPW are afraid of the price of water fee due to the insufficient explanation by RID, and be passive to install tertiary pipeline. On the other hand, beneficial farmers in UHMR easily optimistically agreed to pay the water fee, because the cost of gravity irrigation is relatively low. Thereof, in the case of pumping irrigation, collection of the water fee is the challenge.
Improvement of water and soil qualities	As a part of activities for improvement of water and soil quality, quality test was conducted. Through the process, it was confirmed that it is necessary and important to identify the specific condition of the soil and water, before the actual countermeasure is done. LDD provides the services of quality check and it should take a role of testing in other areas in the future.
Study tour	Mutual visiting between both pilot project sites and Study Tour to advanced farmers are conducted. In the case of former, both farmers enlightened each other, and farmers in one site had learnt unknown activity and started it by themselves. Note that, through the exchange of information, relationship between two sites was cultivated very well. In the case of later, farmers were able to learn details of the ingredients for compost making, which became a cornerstone to promote compost as a One Tambon One Product. Accordingly, it was revealed that Study Tour provides participants a good opportunity for getting new ideas as well as contribute to establish a link between the participants. In the future, more and more opportunity of the Study Tour should be provided.
Cost sharing	Cost sharing was properly done on the cost of O&M of the irrigation facilities, installation of the tertiary pipeline and land acquisition for installation of main pipeline. Principle of the cost sharing is possible only when stakeholders participated in the planning stage of the project. Thus, it should be abided in the future's projects. In the Pilot Project, it was it was not successful to get a cost sharing from private sector such as sugar factory. This is because the scale of the Pilot Project was small and the advantage for the sugar factory was expected to be insufficient. In order to get cost sharing from the private sectors, it is required to scale up the project through coordination at TAO levels as well as to get involved the private sectors in the planning stage of the projects.

5.4 Development Plans

5.4.1 Land Use Plan

Table below shows the comparison between the existing and the planning of land use in the area as studied by the LDD. The forest area has been decreased continuously and upstream basins in main rivers, lakes and marshes have been seriously damaged by destruction of forests. In 1961 the forest area was 27.36 million ha or 53%, but the area was lowered to 17.12 million ha or 33% in 2000 in the whole country. Compared with the current situation of deforestation in the country, the Lam Pa Chi river basin shows 56.9% in the planning and has been conserved as the forest area to date. Miscellaneous areas such as vast wilderness, bush, and abundant mines will be changed into the forest zone. Table 5.4.1 shows the land use plan in Lam Pa Chi river basin as prepared by the LDD.

Table 5.4.1 Land Use Plan in the Study Area

Land use	Existing		Planning		Balance	
	ha	Ratio (%)	ha	Ratio (%)	ha	Ratio (%)
Forest zone	134,216	53.1	143,014	56.9	8,798	3.8
Agricultural zone	104,937	41.5	100,882	40.2	▲ 4,055	▲1.3
Water resource zone	949	0.4	1,060	0.4	111	0
Community zone	3,466	1.4	1,296	0.5	2,733	1.1
Industrial zone			4,903	2.0		
Miscellaneous	9,126	3.6	0	0	▲ 9,126	▲3.6
Total	252,694	100.0	251,155	100.0	▲ 1,539	

Source: Survey and land use analysis in Lam Pa Chi River Basin Report, LDD

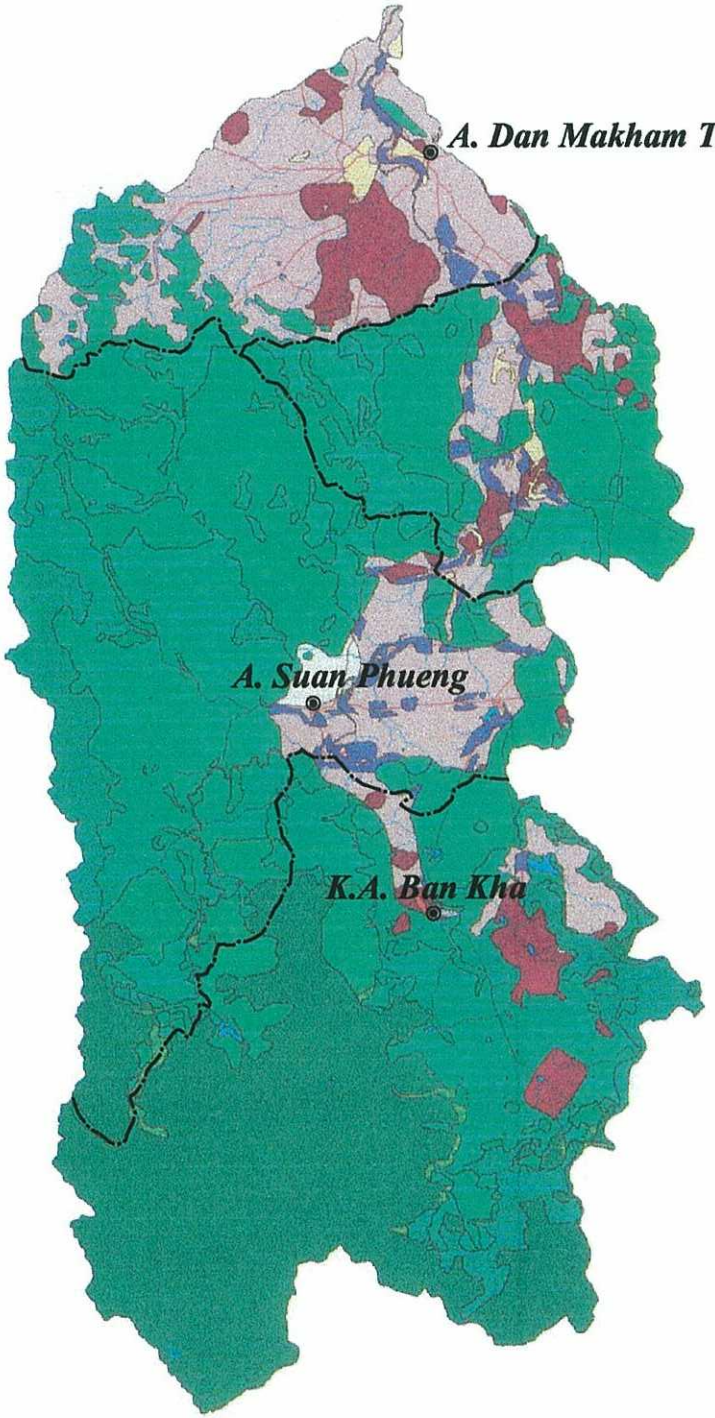
As for the agricultural zone, land use in sugarcane, pineapple and cassava which are the main crops in the Study Area is proposed to rotate with three-year term followed by other upland crops such as leguminous in order to prevent land degradation or disease/pest and to avail the soil fertility. Soils of the Study Area are broadly divided into 4 categories as tabulated below based on the data prepared by the LDD in 1999. Planting plan should be determined according to the suitability of the soil. For the planning, theLDD is responsible to provide the information of soil classification.

Table 5.4.2 Soil Categories in the Study Area

Category	Characteristic	Location	Suitability
1. Clayey Soils (Soils with large quantity of clay)	Heavy to very heavy texture; very weak coarse subangular blocky to moderate medium subangular blocky structure; slightly firm moist to firm moist consistency; pH range 4.5 to 6.0; water table depth about 1.5 meter.	These soils occur in lowland areas with slope 0 to 1%.	Rice and sugarcane can be successfully grown in these soils.
2. Silty Soils (Soils with large quantity of silt)	Medium to heavy texture; weak fine subangular blocky to moderate fine subangular block structure; friable moist consistency; pH range 5.0 to 8.5; water table depth 1.5 to 2.0 m; slight erosion.	These soils occur in lowland areas with slope 0 to 1%.	Suitable for growing sugarcane, cassava, rice and legumes.
3. Loamy Soils (Soils containing some amount of clay and silt, and large quantity of sand	Medium to heavy texture; weak coarse subangular block to moderate medium subangular block structure; friable moist to firm moist consistency; pH range 5.0 to 8.0; water table depth 1.2 to 2.0 m; slight sheet and rill erosion.	These Soils are usually distributed in plateau and upper terraces having slope 0 to 12%.	Suitable for growing fodder crops and be used as pasture, as well as for growing some cereal crops.

Category	Characteristic	Location	Suitability
4. Sandy Soils (Soils with large amount of sand)	Light to medium texture; moderate fine granular to gravelly structure; friable moist consistency; pH range 5.0 to 6.0; water table depth more than 3 meter.	Soils are distributed in areas with slope of 0 to 5%.	Suitable for growing root and leafy crops, and high potential for irrigated agriculture.

Land Use Plan in Lam Pa Chi River Basin



- Forest protection zone
- Forest rehabilitation as natural zone
- Forest plantation for compensation zone
- Forest maintenance zone
- Economic forest plantation zone
- Agricultural forestry zone
- Special eco-agriculture zone for specific eco-crop
- Advance eco-agriculture zone for upland crop/perennial tree
- Paddy development acceleration area
- Upland crop/perennial tree development acceleration area
- Community zone
- Factory industrial zone
- Water resource zone

- Amphoe
- Amphoe Boundary

Figure 5.4.1 Land Use Plan in Lam Pa Chi River Basin

5.4.2 Water Resources Development Plan

Water resources development is one of the most important factors for the development of agriculture as well as the reduction of sedimentation in the rivers, creeks and mitigation of flood in the Study Area. Water resources development, therefore, has proceeded centering on development by medium to small-scale dams and weirs in the Study Area.

Water resources facilities are to be developed taking long term crops, orchards and vegetables irrigation into consideration due to soil conditions and topographic characteristics, etc. Therefore, such facilities like a weir, pond and well which have no enough storage function will not be effective for irrigation during dry season. Consequently, medium to small-scale dams will be much more preferred.

On the other hand, reservoir development is rather difficult from environmental and social point of view. Most land for reservoirs are located in conservation forests protected from development activities in the forest. Therefore, it is difficult to get the agreement among related agencies concerned for reservoir development. Accordingly, construction of medium scale dams and weirs will only proceed with careful attention on social and environmental aspects.

(1) Small to Medium Dam/Weir

An average surface runoff in Thailand is about 209,251 MCM. And only 20% or 41,850 MCM of water is controlled/utilized by large to medium scale reservoirs. The total agricultural land area of Thailand is about 21 million hectares or 41% of the whole country and a total area with irrigation is estimated at about 5.1 million hectares or 24.3% of the total agricultural area in 2002. On the contrary, in the Study Area, the following table shows that controlled/utilized water is estimated at 47.35 MCM or 13.2% in total mean annual discharge of 357.3 MCM as well as irrigation area as 13,280 ha or 7.9% in total farm land of 104,937 ha and found that development for water resources still remains at lower level in the Study Area.

Table 5.4.2 Comparison of Controlled/utilized Water Ratio

Item	Whole Country		Lam Pa Chi River Basin	
Controlled/utilized Water	41,850 MCM	20 %	47.35 MCM	13.2 %
Irrigation Area	5.1 million ha	24.3%	13,280 ha	7.9%

* Refer to Table 4.3.6

Based on the 1:50,000 map, potential development sites in "Chapter 4, 4.3, (e) Water Resources Development Plan" has been reviewed by RID Regional Irrigation office 13, and 18 sites have been selected for water resources development. The following tables show the results of water development study. According to the tables, development plan for small-scale dams/weirs is given with urgent priority and for medium-scale dams/weirs in Middle-Upstream to Upstream basin is given second priority due to the amount of construction cost, length of construction period and environmental aspects. More details are shown in Table 4.3.7.

Table 5.4.3 Construction Plan for Small Scale Dams/weirs proposed by RID

Item	Unit	Upstream	Mid-up	Mid-Down	Down	Total
Number	Nos.	0	2	3(1)	4(1)	9(2)
Storage Capacity	MCM	0	2.29	4.79	1.60	8.68
Beneficiaries Area	rai	0	4,000	6,000	6,800	16,800
	ha	0	640	960	1,088	2,688
Const. Schedule	year	-	2005-6	2004-5	2004-6	

Note: (1) shows a number of weir's construction)

Table 5.4.4 Construction Plan for Medium Scale Dam proposed by RID

Item	Unit	Upstream	Mid-up	Mid-Down	Down	Total
Number	Nos.	4	4	0	1	9
Storage Capacity	MCM	154.3	122.7	0	8.5	285.5
Beneficiaries Area	rai	247,720	113,320	0		361,040
	ha	39,636	18,132	0		57,768
Const. Schedule	year	2008-2017	2007-2018	0	2004	

(2) Other Water Resources

Table 4.4.8 shows the ratio of no water source implying that farmers do not have access to any surface water and groundwater, currently water resources availability in all facilities, water resources development probability in medium to small scale and proposed water development priority need at each sub-basin. According to the table, Middle-Down and Downstream basins have no potential to get the benefit from medium size dams in comparison with the other basins. Especially, in Middle-Down Basin, 71 % of farmers are not able to access to the surface water and groundwater. Details are shown in Table 5.4.8. On the contrary, in Upstream and Middle-Upstream, potentiality for water resources is much abundant. Based on mentioned the above, water development strategy for the basins and small scale water resources are decided as stated below;

(a) Upstream to Middle Upstream Basin

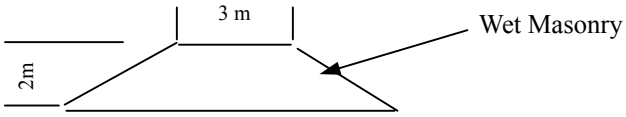
Potentiality of the groundwater is not highly expected a part of Nong Phan Chan, Ban Kha and Ban Bueng. Also, introduction of farm pond will be expensive choice due to sandy soil condition which could not prevent occurrence of high seepage from the bottom. Taking these conditions into consideration, construction of weirs, therefore, will be recommendable and given the first priority to develop in the basins. After construction of the proposed medium to small reservoirs in the future, these water conveyance systems will be easy to access to the weirs.

(b) Middle Downstream to Downstream Basin

Potentiality of medium to small reservoirs will no longer be expected in the future. Facilities such as small scale weir, farm pond will be developed as much as possible as well as the underground water should be utilized due to sufficient potentiality in the basins.

(c) Weirs

Small scale weirs will be used mainly during rainy season's as irrigation water supplementary supply. Due to the topography condition in the beneficiary area, pump or gravity pipeline system will be applied. Taking into account the budget allocation, construction of weir is limited. According to the TAO data, 48 numbers of weirs in Ratchaburi (Upstream to Mid-downstream) and 47 numbers in Kanchanaburi (Downstream) have been proposed. Standard section of weir is shown as below



Typical Section of Small Scale Weir

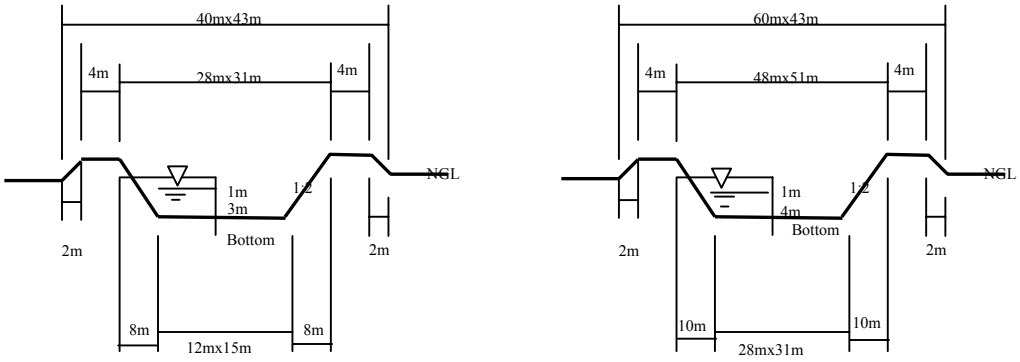
(d) Farm Ponds

Development for rain fed agriculture should be considered not only for improvement methods of crop production but also for introducing the farm ponds which are useful for dry season's farming. Farm pond development has been applied for 2 typical cases namely A) Farm pond 1,200 m^3 which is necessary in land spacing 1 rai and B) Farm pond 6,000 m^3 be necessary in land spacing 5 rai.

The general condition of location and characteristics of farm pond was considered following several criteria as follows; farm pond size, location, topography, catchment area, type of soil, present condition of water, water quality, purpose of farm pond, main crop, how many rai of crop, duration of cultivation and most especially of farmer's need. However, some farmers have recognized that some farm ponds leak water and others were broken down by the floods. Almost all of farm ponds are rectangular-shaped which averages to 4 meters depth and varies in length and width depending on each farm pond. Main purpose of farm pond is multiple in nature including irrigation, fishery and for domestic use.

Table 5.4.5 Dimensions of Farm Ponds

Item	Type A (Size 6,000 m3)	Type B (Size 1,200 m3)
Bottom of Pond	28.0m x 31.0 m	12.0 x 15.0 m
Top of Pond	48.0 x 51.00 m	28.0 x 31.0 m
Depth of Pond	5.00 m	4.00 m
Slope	1:2	1:2
Width of Pond Crest	4.00 m	4.00 m
Water Depth	4.00 m	3.00 m
Height of Embankment	1.00 m	1.00 m
Seepage Control	Should be carried out if necessary	Not specific
Compaction Criteria	85% Standard Proctor Compaction	Not specific



Farm Pond 1,200 m^3 Farm Pond 6,000 m^3

Figure 5.4.2 Typical Cross Section of Farm Pond

Estimation of proposed farm pond will be based on proportion of the existing farm ponds as well as the limitation of budgetary allocation in each sub-basin taking into consideration what has been mentioned above. According to the TAO data, 520 and 135 numbers of pond Type A have been proposed for implementation in Upstream to Middle Downstream Basin, and in the Downstream basin, respectively. As for Type B pond which should be constructed in the farmland by individual farmers, it is not included in as TAO plan.

(e) Shallow wells and Deep wells

1) Shallow wells

For development of shallow well in the Study Area, it can be divided into 2 cases based on diameter and construction material namely Type A (shallow well dia.1.00 m with concrete ring) and Type B (shallow well dia.0.10 m (4”) with PVC). Villager can implement both wells but it’s still risky of fail drilling in case of dry well.

2) Deep wells

The deep well is proposed to utilize groundwater in deep confined aquifer, which can be available for long period of dry season. In Lam Pa Chi basin, it is rather difficult to develop the groundwater resources at Upstream basin (especially in western part) with limited budget. The deep well will be implemented in only one case by borehole dia.0.10 m (4”) with steel casing. It is recommended to consider the casing and well screen type to protect for iron contamination.

3) Implementation

Table 5.4.6 shows the density of the existing wells at each sub basin. According to the Table, almost all of the wells are concentrated in Middle-Down to Downstream basins and it was found that there is a lot of underground water potentiality in these basins.

Table 5.4.6 Density of the wells in the Study Area

Basin	House-Hold No.	Shallow Well		Deep Well		Total		Potential
		Nos	Density	Nos	Density	Nos	Density	
Upstream	4,706	302	16	106	44	408	12	Low
Mid-up	2,736	309	9	65	42	374	7	Lowest
Mid-down	4,540	1,183	4	657	7	1,840	2	Highest
Down	3,891	827	5	1,073	4	1,900	2	High
Total	15,873	2,621	6	1,901	8	4,522	4	

Note: HH; Household, density; HH/No.

According to the Table 5.4.7, surface water development by dams will be difficult anymore in the feature but groundwater development by shallow wells will be possible in middle-down to downstream basins. As for the deep wells, it will be possible to develop at central to eastern areas in upstream and middle down basins. Taking into due consideration of these conditions, construction of shallow wells are proposed with 70 numbers in Ratchaburi and 45 numbers in Kanchanaburi and 110 deep well is proposed in Ratchaburi. Construction of deep weel in Kanchanaburi is not much due to almost all of the area is developed.

(3) Potentiality for Water Resources Development in the Whole River Basin

The Table below summarizes the proposed development plans for water resources by the TAO and RID in the Study Area. According to the table, it is clear that water resources potentiality of the medium dams is much bigger than that of other facilities. Based on the RID Regional 13 office's plan, a total of 9 medium dams have been proposed, which consists of 2 numbers in short term, 6 numbers in medium term, and 1 number in long term, respectively. It will be able to store about 285.MCM, which is about 4.6 times bigger than the current water storage volume of 32.65 MCM. As mentioned in the preceding section, in order to mitigate flood or drought damages, construction of the medium scale dams are essential and should be given with the first priority taking into consideration of the community's consensus as well as the environmental aspects carefully.

On the other hand, so many numbers of small scale facilities, such as farm ponds, weirs and dams have been proposed by TAO. Because the construction cost is low, effectiveness appears immediately and O&M of facilities are easy compared to the medium scale facilities thus, construction of these facilities should be promoted actively for the time being.

Table 5.4.7 Water Resources Development Potentiality at each sub basin

Basin	**Upstream**		**Mid-up**		**Mid-down**		**Down**		**Total**	
Ratio of no water sources in dry season*	32%		44 %		71 %		39 %		49 %	
Existing										
	MCM	Nos.	MCM	Nos.	MCM	Nos.	MCM	Nos.	MCM	Nos.
Medium Reservoir/Weir	30.15	3	2.50	1	0	1	0.00	0	32.65	5
Small Reservoir	8.19	20	3.10	8	0.53	3	0.74	2	12.56	33
Small Weir	-	34	-	27	-	38		37	-	136

Basin	Upstream		Mid-up		Mid-down		Down		Total	
Farm Pond	0.05	22	0.07	29	0.67	279	1.35	562	2.14	892
Shallow Well		302		309		1,183		827	0.00	2,621
Deep Well		408		65		657		1,073	0.00	2,203
Total	38.39		5.67		1.20		2.09		47.35	
Planning										
Medium Reservoir/Weir	154.3	4	122.70	4	0.00	0	8.50	1	285.50	9
Small Reservoir	0	0	2.29	2	4.79	3	1.60	4	8.68	9
Small Weir		17		20		11		47		95
Farm Pond	1.3	210	0.8	130	1.1	180	0.8	135	4.00	655
Shallow Well		30		0		40		45		115
Deep Well		40		35		35		0		110
Total	155.6		125.79		5.89		10.9		298.18	

Source: RID 13 Regional Office and each TAO

(4) Irrigation

Development of water resources for irrigation purpose within Lam Pa Chi basin is mainly under the responsibility of the RID, consisting of medium to small-scale Irrigation Projects. In addition, other relevant offices as ALRO, WRD and TAO have a responsibility to develop small-scale projects, such as farm ponds, shallow wells and underground wells for irrigation water or domestic use. Thus, the water sources development of each agency will depend largely on individual work plan with its own budget. Due to the decentralization on resources management, TAO has a responsibility or is in the position to make plans and facilitate their implementation at the earliest.

(a) Irrigation Development Plan by RID

There are 2 medium scale and 3 small-scale irrigation projects, which have been proposed by RID in 2003. Among them, Tha Khoei Reservoir constructed in 2002 is the biggest one with the storage capacity of 23.40 MCM and irrigation development plan has been proposed. After the completion of the Medium to Small Scale reservoir to date, about 60% of these irrigation development plans has not been established yet due to insufficient budgetary allocation.

Table 5.4.8 Irrigation Project Proposed by RID in 2003

No	Project Name	Location			Project Component	Irrigable Area (ha)	Budget Million Bt
		Basin	Amphoe	Tambon			
M-1	Huai Tha Koei Irrigation System in Ratchaburi	Up	K.A. Ban Ka	Ban Bueng	Gravity Pipe system	1,600 (160)	172.0
M-2	Huai Klum Weir Irrigation System in Ratchaburi, King's Project	M-Up	Suan Phueng	Suan Phueng	Gravity Open Canal	384 (160)	94.8
S-1	Pipe Syatem for Ban Ta Ko Lang Reservoir	M-Up	Suan Phueng	Suan Phueng	Gravity Pipe system	144	3.5
S-2	Pipe Syatem Improvement for Nong Pak Chad Reservoir	M-D	Chom Bueng	Kaem On	-ditto-	160	4.5
S-3	Construction of Small Scale Irrigation System Huai Lam Khlung Weirs	Down	D.M.Tia	D.M.Tia	Rehabilitation of weirs, etc.		7.7
	Total					**2,288**	**282.5**

Note: 384 (160) means Irrigable area in wet season (dry season)

According to the table below, RID has proposed 34 numbers of small scale and 2 numbers of medium scale irrigation development systems in the master plan which will be able to irrigate about 6,500 ha, which is about 2.6% of the whole cultivated area of 252,694 ha in the Study Area. Also, 56 numbers of pump irrigation systems has been planed. Know How in Ban Tha Phyom Weir pilot project for organization of the WUIG, O&M as well as collection of electricity fee, etc will be useful for these facilities. In order to use water effectively in the existing water resources facilities, dredging for the swamp, ponds and canals are proposed actively.

Table 5.4.9 Irrigation Project Proposed by RID

Item	Upstream		Mid-Up		Mid-Down		Down		Total	
	No.	Irri. Area	No.	Irri. Area	No.	Irr. Area	Nos	Irri. Area	Nos	Irri. Area
SSIS	15	1,931	4	1,155	4	1,037	11	640	34	4,763
MSIS	1	1,600	1	192	0		0		2	1,792
Pump Irrigt.	18		12		16		8		54	
Dredging	64		21		20		43		148	
Total		3,531		1,347		1,037		640		6,555

Note: SSIS, Small Scale Irrigation System, MSIS, Medium Scale Irrigation System

(b) Small Scale Irrigation Scheme

From Cor Chor Chor's data, the condition of water use in the Study Area was found that the village with sufficient water for growing crops shares only 20-30 % of total number of villagers, while the village data indicates that about 50% of villages have surface water or groundwater sources. This is due to the fact that the existing water sources are small and the potential is limited, not covering fully the demand for irrigation purpose. The target for developing the water sources for irrigation purposes are as follows;

- To enable the farmers, whose cultivation areas are far from natural water sources, to have opportunity to use the water from existing water sources
- To enable the farmers to have the chance of using the water for agricultural purpose and consumption use
- To increase opportunity of farmers to grow crops both in rainy and dry season using small scale irrigation facilities such as farm ponds, weirs and wells as many as possible.
- To enable the farmer to realize the necessity of maintaining the existing water sources and the use of water in conservative manner in order to get highest benefit

(5) Water Users' Group

The objectives for establishing the water users group are;

- To enable the farmers to use water jointly in a justifiable way and in equitable manner
- To enable the farmers to learn how to utilize the water in a conservative manner and in order to get highest benefit
- To enable the farmers who are jointly using the water to help in maintaining the water distribution system
- To enable a development and to find guideline for performing agriculture by preparing cultivation

plan suitable with topography, climate condition and market demand

Responsibility of water users' group comprises of administrative work and management on water allocation, operation and maintenance of water distribution system. The expense on implementation, water fee, cost of electricity including maintenance cost, is to be in compliance with the resolution of the water users' group that has been established. As the establishment of the water users' group in the area within Lam Pa Chi basin may be a new issue for the farmers, this may enable the implementation to be unsuccessful complying with the objectives of the Project, therefore, the MOAC has to support the group. Based on the results of the implementation of the pilot project, the officers that have the role of supporting the water user groups are cleared as follows;

1) RID: to make plans for survey the alignment of canals, design, cost estimate, and construction schedule and also necessary to get mutual consensus with beneficiaries for decision of the canal alignment through the site survey, based on the request from community/TAO.
2) RID: to help in giving training to the water users to be able to handle water allocation aspect, water distribution and maintenance work as well as helping to coordinate work with other relevant offices and after that to transfer irrigation facilities to TAO immediately.
3) TAO: to collect the water fee from farmers beneficiary for O&M of irrigation facilities and to secure the budget allocation according to the regulation, if necessary.
4) DOAE: to help in promoting and developing the production in agricultural aspect
5) Department of Cooperative Promotion (DOCP): to help in establishing water user groups especially pump irrigation system, agricultural cooperatives and also access to credit/financial source.
6) The Community Development Department (CDD): to help in promoting the administration of the Organization, strengthening the farmer's group/ organizations, including the promotion and development of livelihoods to the members
7) The Companies and factories which are buyers of agricultural products, to help in preparing the production plan, the purchasing/sales agreement on produce, to promote and give advice to the group for quality control
8) BAAC: to help the water user group in giving loans for investment on production system and establishment of the organization

5.4.3 Mitigation of Flood Plan

Flood disaster often occurs in the area along the Lam Pa Chi river. Inundation is also caused on the lower part of the river basin by heavy runoff from the upper to middle sub basins. Flood conditions in the basin should be improved to secure rural life of inhabitants as well as their agricultural activities. To restore the affected area and to prevent recurrence of flood disaster, infrastructure measures should be taken into consideration. For infrastructure planning, it is essential to conduct feasibility study on the specified sub-basin along the tributaries taking into consideration the present soil condition, agricultural land use and watershed characteristics as well as new reservoirs proposed by RID in

future.

(1) Protection of River Bank

According to the site investigation result, 9 places were eroded seriously by flood and found that the right banks of the river are damaged heavier than the left banks due to characteristic of flood discharge. Detail is shown in Table 5.4.10. To protect such heavily eroded riverbanks, concrete framework with wet masonry should be applied. Accordingly, construction cost will be high and its period takes too much. RID will have a responsibility to implement these protection work.

Table 5.4.10 Length of the Riverbanks Eroded Seriously by Flood

No.	Amphoe	Tambon	Length in Severe Erosion (m)		
			Left Bank	Right Bank	Total
1	K.A.Ban Kha	Ban Kha	-	1,000	1,000
2.	Suan Phung	Tha Khoei	-	400	400
3..		Pa Wai	900	900	1,800
4.	Chom Bueng	Dan T. Tako	-	1,000	1,000
5.		Kaem On	-	2,200	2,200
6.	Dan M. Tia	Nong Phai	800	800	1,600
7.		Dan M. Tia	700	700	1,400
8.		Ch. Phuek	1,000	-	1,000
9.		Klon Do	-	1,500	1,500
Total			3,400	8,500	11,900

According to the RID13Regional Office, riverbanks in mid-down to down stream including the pilot project area of Ban Tha Phyaom has been given a first priority project for flood damages protection. Stonemasonry method for riverbank protection of 14.6km on the right bank and 11.8km on the left bank has been proposed and about 653.2 Million Bt has been estimated. The period of construction will be about 3 years in the medium term plan. The river bank protection plan is shown below.

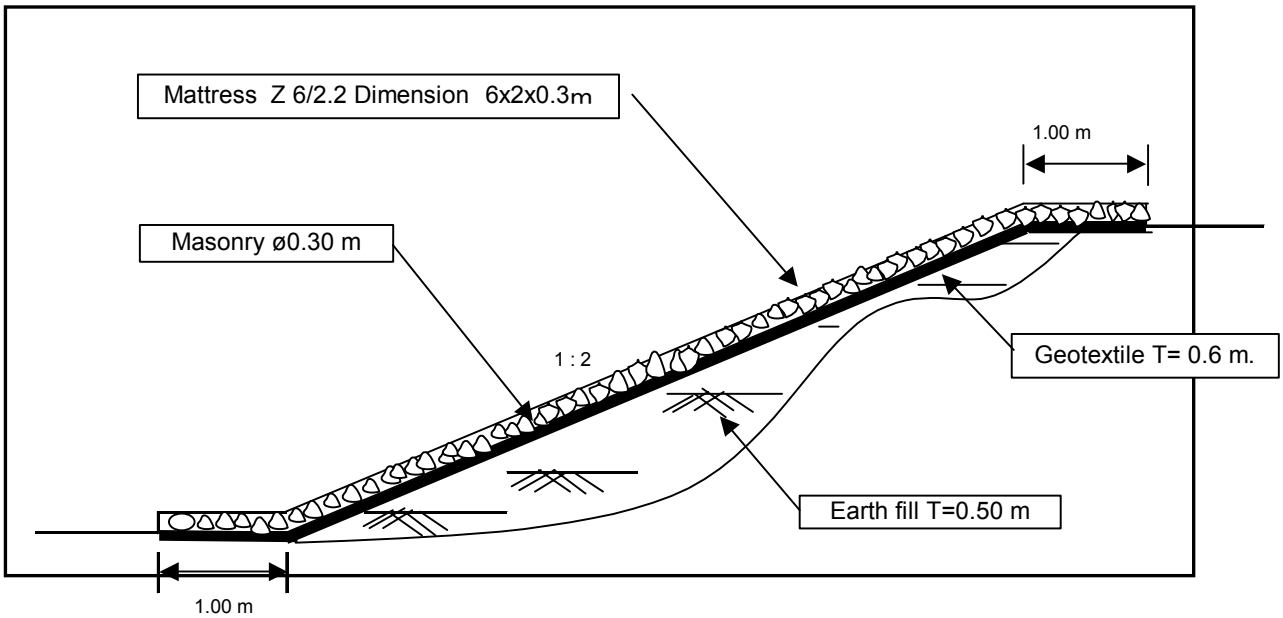


Figure 5.4.3 Plan of Riverbank Protection by Stone Masonry in Lam Pa Chi River

(2) Sodding on River Bank

To protect soil erosion at the river bank as well as area of surface soil runoff, planting of elephant grass or bamboo will be applied. These planting activities will not be so expensive but areas to be planted are vast and it will take a long time to cover these areas. Glass root level's continuous activity therefore will be necessary so that villager should take in charge of the activities.

5.4.4 Agricultural Production Improvement Plan

Based on farmers' interview and official personnel interview, especially provincial DOAE staff, it is obvious that farmers in the Study Area are of two categories. The first category is of progressive farmers who perform farming practices with innovative technology, having cash flow and/or access to credit sources and having secured market channel, while the farmers of the second category are subsistence farmers who are left behind with shortage of all sorts of production inputs. With all these information, plan for agricultural improvement in the Study Area must be based on this fact.

Farmers farming in flat land of upstream basin in Ratchaburi and downstream basin in Kanchanaburi are mostly progressive farmers. Those farmers who make living on low lying area of Amphoe Suan Phueng, Chom Bueng, Ban Kha and Pak Tho of Ratchaburi and Amphoe Dan Makham Tia of Kanchanaburi can grow crops with secured marketing opportunity. They grow sugarcane with government guaranteed price under quota system, and vegetables such as asparagus, baby corn, sweet corn, string bean and peanut as well as some kinds of flowers such as marigold on contract basis. For asparagus, the price of farm produce is agreed before harvesting between the processing factories operated by Japanese or Taiwanese firms and growers' organization or individual farmers. Considering those farmers who grow vegetables and flowers, some of them practice on their own will and capital, while the majority, especially in Dan Makham Tia, receives advanced credit from merchants from town. The credit is used for the expenses of land preparation, seeds, fertilizer and pesticides. The credit is eventually deducted from the price of the farm products at the end. The fact is that price of the product fluctuates every season, and the credit is charge with high interest rate. This is one of the crucial points that need to be alleviated. Moreover, there is few farmers' organization of these crops growers formed in the area. In the process of development plan preparation, this issue should, therefore, receive a high consideration.

Aside from sugarcane production where the farm produce has a secured market channel with government guaranteed price, asparagus farming system is best organized as far as marketing opportunity is concerned. Asparagus growers' organizations are established to take care of the benefit of the members. However, the organization is of two types. Type I has been under Japanese company initiative on the matter of production technology and product quality control. The members can borrow money to purchase farm inputs; however, price of the product is negotiated between the company and individual farmers. In type II, the organization is solely managed by its members and the benefit seems to be more than that of type I. Members can get loan for input procurement with

relatively low interest rate; members and their family member are entitled to receive assistance partly on their hospital bill and certain amount of money in case of death. It was mentioned that the Taiwanese company buys various grades of the products from the farmers while Japanese company buys only the first class quality. Negotiation of the price with the company is carried out by the organization management. Nevertheless, in most cases, negotiation power generally falls on the company side and the growers are eventually compelled to take the agreement eventhough that is always below the line of being reasonable. Therefore, problem of price negotiation is another point to be solved in the process of planning for the area development.

Irrigation is possible in the areas discussed above. Sources of water may be medium and small irrigation schemes, large and medium farm ponds, from which water is made available throughout the year. Small farm ponds with the sizes of 1,200 – 2,000 m^3 are also existed, but water can only last for a few months after the rain ceases. Some farmers in these areas who are well to do or can borrow money from lending sources are able to have ground water system. The cost for drilling, electric and pumping components is approximately 100,000 Bt for a depth of 60 m.

As for subsistence farmers, their farming practices deal with high lying and/or hilly lands having small area of low productive cassava and pineapple and other cash crops under rain fed condition. Although marketing opportunity is available for their crops, price fluctuates somehow. Furthermore, application of farm inputs to this class of farms is generally limited. Fertilizer may be used in some plots, but utilization is of low rate. So, quality of the produce is difficult to generate; starch content of cassava root is usually low, size and sugar and acidity content of pineapple are out of control and are often could not pass the processing factory grade.

Given the information discussed above, concept and methodology of development shall be aimed at the two target beneficiaries – progressive farmers and subsistence farmers.

(1) Improvement of Agricultural Production System

In order to attain successful goal of rural and agriculture development in the Study Area, following elements should be of prime importance in the planning concept.

a. *Provision of Irrigation Sources*: This is to sustain farm activities.
b. *Promotion and Encouragement of Establishing Strong Production groups*: This is to create negotiating power of the farmers when dealing with input distributors and/or farm product purchasers.
c. *Provision of Credit Sources*: Credit is one of the essential needs of the farmers if they wish to rise up their income and life standard: Borrowed money is necessary for farm inputs and household expenditure before they can stand on their own.
d. *Provision of Market Channel*: Market is the last but important component of agricultural production system: Without a reasonable market, development fails. Governmental organizations

should offer a strong hand to play an important role to create a good market channel to absorb farm products.

e. *Provision of Training Program*: In any development project, training of relevant personnel is of prime importance and is generally placed on the top priorities. For agricultural production system improvement, two basic trainings are needed, i.e. training for extension agencies and related officials who will later serve as trainers for the farmers, and training for farmers to transfer innovative technology and know-how in order that they can eventually raise their farming quality.

However, as discussed earlier, the plan for agriculture development in the Study Area should be based on two categories of farming levels being practiced in the area, i.e. progressive farming and subsistence farming. The planning concepts proposed above are for both levels of farming. The following proposals are some points of development for progressive farming and subsistence farming that should received high attention in the planning formulation to develop each type of farming.

Progressive Farming

i) Irrigation should be allowed at medium and large scales to guarantee stable availability of water for high productivity maintenance.
ii) Inputs should be at optimum to generate optimum productivity.
iii) Chemical fertilizer and pesticide utilization should be allowed to maintain high yield and marketing quality. However, recommended doses and timing of application must be carefully followed to obtain safe products.

Subsistence Farming

i) Development concept should be toward self sufficiency and self reliability, at least in the early stage of the development.
ii) Encouraging practices of sustainable agriculture, such as integrated farming including Royal Initiative New Theory Integrated Farming System. Agro-forestry farming should also be planned to conserve environment.
iii) Water sources can be small scale, such as small scale irrigation scheme, various sized-farm ponds and community ground water well.
iv) Promotion of the use of organic fertilizers and organic pesticides. Utilization of chemical products should be limited.

(2) Soil Improvement

In a broad sense, soil improvement is soil conservation which is important where soil surface degradation is at high rate due to high speed run-off of soil surface water, especially in the rolling and hilly areas. In preparing planning guidelines, the following items should be emphasized.

i) Collection of information on the situation of soil problems in the area.
ii) Identification of agencies and their roles involving the implementation of soil conservation. In general, responsible agencies are LDD and DOAE.
iii) Provision of encouragement of farmers and local people in the community to play an active

role in soil conservation program.

iv) Provision of farmer's training and public relation campaign to raise the public awareness of the importance of soil conservation.

v) Promotion of soil conservation demonstration plot in the farmer's land in collaboration with landowner to promote the dissemination of techniques of soil conservation.

For soil conservation in term of soil improvement suitable for good cultural practices in individual farms, some key activities should be planned as follows.

1) Soil Surface Protection.

Soil surface degradation that may be caused by run-off water or wind may be reduced to a minimum by following means.

i) Use of mulching, cover cropping and inter-cropping to protect soil surface.

ii) Use of contour ridges, contour farming, strip cropping to control surface run-off.

iii) Use of such structural measures as terracing, drainage channel system and farm road network to reduce speed and incline direction of run-off water.

iv) Use of appropriate amount of irrigating water. Excessive use of irrigating water may cause soil surface run-off.

2) Soil Fertility Improvement

At present there is innovative knowledge regarding soil fertility improvement generated by several institutions, such as LDD, DOA and universities having faculty of agriculture. The knowledge shall be incorporated and must be part of the plan for developing the Study Area. The mentioned knowledge includes the following items.

i) Use of green manure: Plant used as green manure is generally legume such as crotalaria and many species of bean and pea. The plants are ploughed over and incorporated into the soil at blooming stage.

ii) Use of animal manure: Excrement of every species of animal can be used as manure. However, it should be left for a certain period of time for a complete decomposition.

iii) Use of compost: Compost can be made by fermenting mixture of plant, animal manure and soil. Activator can be used to accelerate the decomposition of the mixture.

Three types of fertilizers discussed above are organic fertilizers used to improve physical property of the soil in such a way to increase water holding capacity of the soil and also activate release of plant nutrient elements from the soil. They, however, provide the nutrients at a small amount. To be useful, organic fertilizers should be used in large amount and be incorporated into the soil.

3) Utilization and Production of Organic Fertilizer by Farmers.

In the plan for rural and agriculture development, utilization and production of organic fertilizer should be promoted. In the plan, following criteria should be emphasized.

i) Educating the farmers of the usefulness of organic fertilizer by means of public campaign and training program.
ii) Encouraging the use of organic fertilizer, especially in the area practicing subsistence farming.
iii) Encouraging the farmers to produce organic fertilizer by themselves. Dissemination of know-how of fertilizer making can be simply carried out in the training program and by instruction brochures distribution.
iv) Establishing demonstration activities for organic fertilizer production and application in the farmer land. This is a rapid way of disseminating method and technique of the production and utilization of organic fertilizer.

In the area of progressive farming, demonstration plot and the fertilizer making should be at a large scale, while these can be smaller in subsistence farming area. However, organic fertilizer making at community level should be encouraged as a way to promote group participation. The needs and usefulness of the compost making was confirmed through the Pilot Project, hence, dissemination should be actively carried out in broad wide areas.

4) Appropriate Utilization of Chemical Fertilizers

In the area of progressive farming where high productivity is necessary to stabilize required production volume for the factory, chemical fertilizers are still needed. However, for optimum yield, cost minimizing, and environment conservation, appropriate application of this type of input must be exercised. Appropriate use includes the followings.

i) *Use of right kind and right formula*: There are various kinds and formulae of chemical fertilizers; different kinds and formula are needed according to the species of crops and stage of growth. Therefore, to attain optimum return from the fertilizers, this instruction must be followed.
ii) *Use of right amount*: Excessive use of chemical fertilizers may be harmful to the growth of the crop. Furthermore, too much fertilization than the plants requirements may be washed out from the soil into water sources, and hence, the environment will be harmed. Farmers should be advised to apply with recommended rate.
iii) *Use at right time*: Fertilizer may not pay off, if it is used at the wrong period. Too close interval of the application may hamper the growth of the crop and too far interval may delay the growth. Therefore, the farmers should be advised to apply chemical at right time as recommended.

(3) Alleviation of Plant Pests

One of the complaints of the farmers in their crop production is an outbreak of plant disease and insect pests. To alleviate this problem, following measures should be exercised.

1) Insect and Disease Outbreak Surveillance Program

This program has been initiated by DOA and later jointly executed by the DOA and DOAE. In the program, farmers are alerted in advance to be aware of the plant pests outbreak in order that they can prevent the cropping failure through recommended means. The warning is usually carried out through newspaper, radio and agricultural TV program.

It is envisaged that this program will be helpful in the Study Area, especially in such areas having large plantation of sugarcane. Aside from the alerting method discussed above, the news can be transmitted to the farmers by broadcasting system that is usually located at the village chief or chairman of the production group residence.

To alleviate plant pest problem, other means can be also carried out by following ways:

i) *Community public campaign*: Concerned organizations hold meetings in the community. Farmers learn about importance and danger of plant disease and insect pests as well as the means of their control. The campaign organizer should be the Mobile Unit (MU), now being executed by MOAE, who can visit from village to village.

ii) *Instruction brochures*: Concerned organizations, such as DOAE and DOA should be responsible in making brochure containing introduction to the key plant pests and their control, and also safe use of chemical pesticides. The brochures should be free of charge and readily available to the farmers at the offices of TAO, TTC and village chief residence.

iii) *Training class*: The training class should contain subject on plant pests and means of pest control. In the class, farmers should have an opportunity to view specimen of plant disease and insect pest and the symptom of their outbreak so that they will be confident to handle the problem. Details will be discussed later as a part of training program.

2) Utilization and Production of Organic Pesticides by Farmers

In Thailand, organic pesticide making has been initiated by local wisdoms that include community scholars and progressive farmers. Now, they are widely accepted and used, especially by small farmland holders and subsistence farmers. The use of organic pesticides is friendly to environment. It is, therefore, reasonable to promote the use of these substances in the Study Area. Procedure on making organic pesticides is simple and any farmer can do with a little effort. There are many formulae, but the main ingredients are of those strong smell plants such as neem, lemmon grass and molasses.

3) Appropriate Utilization of Chemical Pesticides

Chemical pesticides are under the same situation as chemical fertilizers that they are still needed in the area of progressive farming where the large plantations are to maintain large production for the factory. To stabilize high productivity, plant pests must be under full control. However, a safe utilization must be exercised. Safe measure covers the farmers, farm products and environment. To be safe, the chemical pesticides should be applied with following procedures.

i) *Apply with the right chemical*: With the wrong chemical, the plant pests will be tolerant.
ii) *Apply with right doses*: The wrong doses of application will cause unthorough fatality to the pests, and excessive application may be harmful to the environment.
iii) *Apply at right interval*: Application with long interval pest control may not be successful. However, short interval application is not just uneconomical but also dangerous to both consumers and environment. Intervals should be long enough to allow the chemical residue to be exterminated.

(4) Promotion of Livestock and Fishery

Livestock and fishery are already existed in the Study Area. However, from farmers' interview and field observation of the Study Team, it was revealed that raising farm animal, especially in the area of subsistence farming, seems to be limited. To promote a fruitful program of raising animal, some levels of recommended technologies must be followed. For example, supplementary feeds and health care regarding disease control should be provided.

1) Livestock

In the hilly and rolling land of the Study Area lying on the left bank near the borderline, where public grazing land is available, beef cattle raising should be encouraged. Each household, even the subsistence farmers, should at least keep 2 to 3 heads for fattening and/or calf production. On the average, one fattened cattle can make a profit of 1,000 Bt/month.

Domestic animals such as swine and poultry should be also promoted at a limited scale for home consumption as a source of protein, and also for additional income. Farm yard feeding and farm by-product with little supplement feeds are adequate for this scale. Animal manure is an excellent organic fertilizer and a good source for home organic fertilizer production. In addition, artificial breeding center, which is verified through the Pilot Project, should be also expanded throughout the Study Area so that those who have experience and tried the technology can work as counselors on livestock raising.

2) Fishery

With existing and newly provided farm pond, fish culture should be promoted for household consumption and additional income. In the public reservoirs where water is not used for community waterworks, fish culture by means of basket-culture should be allowed and encouraged.

(5) Training Program

In any area development program, training program is a prime necessity. The training simultaneously facilitates steps of the development. The training program of the MP should cover the following activities.

1) Training for Concerned Official Personnel

This activity is so-called 'training of trainer (TOT)'; the trainer who will take part in community development in the Project Area. Prior to emersion in the field, the personnel who will serve as field working group should be armed with innovative knowledge for each step of rural development.

2) Training for Farmers

To hasten the speed of rural development, farmers and concerned villagers should be trained at the beginning stage of the Project and along with the stage of project implementation. However, before the project implementation, public relation campaign should be conducted to introduce development criteria and project structure to the community people and hear their opinion in order that the project components can be possibly revised.

3) Training Components

For a fruitful training program that the trainees gain maximum knowledge and experiences, following activities should be conducted.

i) *Classroom training*: This is a formal training that the trainees sit in a designated place for a fix period of time with assigned instructors giving lectures or transmitting essential knowledge for development project. Curriculum should mainly consist of the subjects relevant to the project. This type of training is suitable for leading farmers in the project area. It should be planned that after the training, the trained farmers will be able to teach their fellow farmers innovative technology of what they learnd in the training courses.

ii) *On-site training*: This is an informal training that can be conducted at any place ranging from village temple ground to school field. Main purpose of this type of training is to demonstrate specific farm practices, farm equipment and their use. This type of training can be a study tour for trainees of the classroom training. In the study tour, farmers will have an opportunity to visit successful farms, government experiment stations and Royal initiative project farms. Knowledge and experiences gained from those places should enable them to to improve their farming practices.

5.4.5 Micro Credit

Credit is not only vitally important for big business and large investment. It also plays an important role in all steps of human life; even the grassroots people sometimes need credit for their household expenditures including farming practices and development activities.

(1) Importance of Capital for Rural Development

From the past four decades until now, agricultural practices have been changed from so called labor-oriented to capital-oriented. The more the agricultural technology developed, the higher the need for the capital funds. Capital requirements of the farmers are usually for investment costs such as farm pond construction, machinery and cattle buying, and for seasonal operating expenses such as land preparation, seeds and fertilizer costs.

Capital funds are also essential element for other aspects of rural development such as job creation for income generation, group participation for specific purposes, village infrastructure construction carried out by the villagers. In the rural area, cash flow is commonly scarce. Credit or loan is, therefore, important to carry on activities of development strongly.

(2) Government Policy on Credit for Rural Development

Up to present, the Government has provided a series of credit sources for rural development. Some sources are bank loans, while the others are development funds provided by various Ministries. Followings are the examples of those funds.

1) Poverty Alleviation Fund

The Poverty Alleviation Fund is in line with the Government policy to improve quality of life of the poor people in 40,000 villages. The amount of fund per village is 280,000 Baht. This fund was started in 1993 and still revolving with very low unpaid rate under good management of the village fund committee. The department in-charge is CDD.

Purposes of this fund are:

i) To provide an opportunity to the poor of these occupations: farmer, craftsmen, household industry and trading business.
ii) To increase annual income up to more than 15,000 Baht per capita in the village.
iii) To develop life standard to meet the standard criteria.

Target groups of the fund are families having capita income less than 15,000 Baht in the villages. However, since the year 2002, the 'One Million Baht Village Fund' has been implemented, in which each village receives one million Bt; almost four times larger than that of the Poverty Alleviation Fund. The One Million Baht Village fund provides money to all residents of the villages and not only the poor ones. As a result of this new development, the Poverty Alleviation Fund has been suspended, and the management of the village fund committee has applied for the One Million Baht Village Fund.

2) One Million Baht Village Fund

This is a large scale revolving fund aiming at generation of "One Tambon One Product (OTOP)" activity. It was started in 2002, in which all the villages, amount to 74,872, are targeted. The organization in-charge is the Prime Minister Office. Purposes of the One Million Baht Village Fund are:

i) To develop career and create job opportunity for income generation.
ii) To build up self sustainable system in the community, regarding education, job creation and business initiation.
iii) To improve capability and to strengthen economy and society of local people.
iv) To stimulate economy of the grassroots people.

3) Economic Development Fund

This fund was started in 2002 and the organization in-charge is the Prime Minister Office.
Target areas of this fund are in 8,435 places. Purposes of the Economic Development Fund are:

i) To generate employment and to increase income of local people.
ii) To strengthen grassroots economy and to solve poverty problem in the long run.
iii) To support development process and participation of the people in the community

4) Credit Program for Rural Development

This fund was started in 1995 and the organization in-charge is the Government Savings Bank, Ministry of Finance. Purposes of the Credit Program for Rural Development are:

i) To strengthen saving-and-credit activity of villager's groups in the community including savings groups, village banks and credit unions
ii) To encourage self-reliance and continuation of mutual support among individual group members
iii) To extend credit to the community organizations to help implement efficiently and successfully the schemes for development.

The community organizations eligible for the loans must be formed under the Credit Program criteria set up by the Government Savings Bank.

Besides the sources of credit discussed above, there are another three sources from which loans are available to local people. These are BAAC and Agricultural Land Reform Fund.

5) BAAC

The BAAC plays a vital role in lending money to the farmers. Even though objective of the loans is more or less limited for agriculture development, in the near future BAAC is likely to be transformed to Rural Development Bank. After the transformation, objective of the loans can cover more activities of rural development. At present, basic types of BAAC loans are summarized as follows.

i) Short term loans for agricultural production with repayment period of 12 months.
ii) Medium term loans for investment in agricultural asset, such as purchase of farm machinery

and investment in raising livestock, with repayment period of three years.

iii) Long term loans for refinancing old debts and for investment in agriculture with repayment period of 15 years.

iv) Cash credit loans; it is a short term credit lines which are very convenient for BAAC client farmers.

Agricultural credit from BAAC is popular at short term loans, in which one farm borrows 15,000 to 30,000 Baht on average. The Bank lends not exceeding 30,000 Baht at a basic interest rate of 12% and 9% to individual farmer and farmers' organizationsrespectively.

6) Agricultural Land Reform Fund

This fund is provided only to the farmers in the land reform areas in both short and long term period. The loans cover purchase of physical inputs for agricultural development as well as working capital such as construction cost of farm pond.

7) Internal Trade Department Loans

Internal Trade Department also lends money for establishment of community shops that can be convenient stores or shops selling specific products. The loans are of two steps-beginning loans to start up the shop and the loans for shop improvement.

(3) Promotion Plan for Credit Sources in the Community

Plan for credit sources in the community can be proposed as follows.

i) Encouraging establishment of new organizations having one activity at least concerning savings and giving loans to the members. The new groups can be savings group, credit union, cooperatives, and other production groups initiated by people having the same interest, such as village cattle raising group, community shop managing group.

ii) Strengthening local organizations which are already lending money to members. Activity covering credit of these existing organizations should be extended.

iii) Seeking new credit sources from related agencies, such as DOAE, CDD, CPD. These agencies usually implement special projects by giving revolving fund to farmers as one component to invest in agriculture development or generate off-farm income. For example, DOAE has one project to promote utilization of organic fertilizer and lends money up to 25,000 Baht as a revolving fund to one village to make compost.

iv) Effective utilization of the One Million Baht Village Fund that each village allots to its individual or group members. At the initial stage of this fund the money was mostly spent for household daily expenses, though projects for career development were submitted to the village fund committee.

5.4.6 Marketing Plan

(1) Strengthening Plan for Market Channel

Market channel for agricultural products in the Study Area must be developed and strengthened. However, to facilitate the formulation of market development plan, strategies and responsibility of the Internal Trade Department, Ministry of Commerce, should be carefully studied. At present, Office of Provincial Internal Trade is designated to every province so that relevant information, guidance, assistance and cooperation can be acquired.

Roles of the Internal Trade Department related to the purpose of the marketing plan for the Study Area are:

i) Stabilizing prices of agricultural goods.
ii) Promoting establishment of community shops.
iii) Developing and promoting market for agricultural goods, such as central market, market fair, market for collective trade.
iv) Disseminating price information and commercial news to provincial offices, private sector and common civilians at provincial level. However, dissemination of price information is most of the time not prompt, and information received by the recipients is not up to date, although the mean is through radio and TV transmission. This activity needs more improvement.

For a successful market channel strengthening, the plan should cover the following core activities.

1) Improvement of Public Relation on Market Information

There are two schemes to fulfill this activity.

i) Provision of the trend of price of each crop grown in the area. Responsible agencies should be DOAE and relevant offices of Ministry of Commerce who have an access to the trend of the world demand and supply. However, this measure should be emphasized on short duration cash crops that the farmers can turn about and adjust their crop pattern if the forecast goes wrong.
ii) Strengthening price information dissemination of the Internal Trade Department. The change can be undertaken by:

- Updating the price of each commodity on day-to-day basis.
- Establishing a network between the central office of the Internal Trade Department and rural offices by connecting the price disseminating system on line with TAO and TTC, so that the farmers in the remote areas can have accessed to fresh information. However, TAO and TCC operational management must be strengthened.
- Each day chairmen of various production groups and village chief receive the news from TAO and TCC and transmit it to their respective members/villagers.

Transmission of market information through radio and TV still going on for the benefit of progressive

farmers who possess either radio or TV set or both.

2) Strengthening Existing Wholesale Market

In both provinces of the Study Area, there are wholesale markets to absorbed agricultural products and their activities are quite effective. However, on the farmer side there still some big problems exist. The two major and very important problems are:

i) The markets are located in the city, far away from the site of agricultural production and hence costs of transportation add to the cost of production. Consequently, the farmers cannot add the transportation cost to the price of their goods.

ii) The price of the farm produce in the markets is usually unfair to the farmers. The middlemen and retailers always earn much more money than farmers do.

With this evidence, marketing plan for this specific phenomenon is called for.

i) Meeting points for the farmers and the market middlemen should be extensively located thoroughly in the production areas, so that the two sides can share the cost of transportation. The farmers canl take advantage of this system, eventhough it is envisaged that the retailed price for the consumers will be higher.

ii) The price information dissemination system of the Internal Trade Department should be made fully effective reinforcing the pricing system in the wholesale markets. Or, the Provincial Internal Trade Office shall control the price of the wholesale market.

3) Strengthening Farmers' Organization

Farmers' organization is a loosed term for any type of farmers' group eventhough they unite together for a specific purpose in rural communities. However, for the sense of marketing plan, the meaning of farmers' organization should cover only crop production group and marketing group wishing to organize community shop. Again, the term strengthening should include both strengthening existing organization and establishing new and essential ones with strengthening efforts.

In the Study Area existing groups engaged with marketing are Asparagus Growers' Organization, Sugarcane Association, Sugarcane Quota Group, Pineapple Growers' Group, Women's Group and Livestock Group. So it is evident that more production groups are needed especially vegetables growers as of baby corn, sweet corn and string bean who are mostly doing their farming on credit from the trader and their negotiating power for crop price is almost nil.

Specific advantages of strengthening existing and establishing new production groups are to create a power for:

1) Producing accepted quality farm products.

2) Creating negotiation and bargaining power to purchase farm inputs and selling farm products.

Another means of creating marketing opportunity is community shop. In this regard, community marketing group can be formed under the guidance and assistance from the Internal Trade Department.

However, groups under other names, such as farmers' housewives group, farmers' cooperatives or others, can plan and operate community shop. The group who will manage community shop can request credit assistance from the Internal Trade Department, under its rules and regulations, with free interest. The loanable amount for setting up the shop is 50,000 Baht and later on 100,000Baht for improving the shop. The credit can be obtained from the Provincial Internal Trade Office.

4) Establishment of Small Scale Agro-Processing Plant

Small scale agro-processing plant is needed by the farmers in the Study Area to create value added products in the community. A basic idea to establish processing industry in rural area is that the business should be undertaken by the village members with participatory approach other than looking for outsiders to invest. The investors have an instinct of making maximum profit. The farmers with natural low negotiating power will eventually have no advantage. So, with the above direction, a few criteria can be planned to fulfill the need of the farmers in the Study Area as follows.

i) The farmers establish production group for this purpose.
ii) Raw materials in the area are identified for processing.
iii) With assistance of TSG and other concerned organizations guidance and assistance from DOAE, CDD and Internal Trade Department in regard to technical training, credit for initial investment and regulations for overall management are acquired.
iv) The scale of the agro-processing activity should be first aimed at home made product and cottage industry. Preserved foods and handicrafts should be the initial main products. With strong cooperation among the group members, continues assistance from the organizations concerned and continuous quality improvement of the products, it is envisioned that the processing activity will be progressive until small scale agro-processing plant operated by rural members is established.
v) The government is now promoting OTOP (One Tambon One Product) policy. The activity of homemade processing and cottage industry should be in line with this policy. However, distinctive traits of the products must be identified to prevent repetition with products of other areas.

5) Provision of Agricultural Product Price Guarantee

The Government occasionally undertakes price intervening policy for agricultural products when the price of the products is below the reasonable level due to the world demand-supply situation. However, the policy is usually used with the price of paddy which is not the important crop in the Study Area.

However, there is an alternative to help the farmers to be satisfied with the price of their products. The Internal Trade Department has undertaking two measures for advanced price demarcation, which are contract farming or contract market system and agricultural future marketing system.

i) Contract Farming System

In reality, contract farming system has been practiced in the Study Area for sugarcane, pineapple, asparagus and some other vegetables. However, except for sugarcane price of which is guaranteed by the government, the system is loose with many weak points and disadvantageous for the farmers. If the measures stipulated by the Internal Trade Department are strictly followed, it can be foreseen that the system will render the benefit to both sides-the farmers and purchasers.

The principles of the contract farming system are of many points. For the important points, the farmers have a secured market channel, processing plants have stable quantity of raw materials and the exporters have quality products to deliver at determined time. These conducts contribute mutual benefit to all parties concerned, leading to having new alternative to minimize risk of price fluctuation and production quantity. The farmers and the businessmen, processors or exporters, can make an effective plan for production and marketing.

The contract may emphasize on marketing issues that cover price, quantity, quality of crops and time of delivery. However, some contract may emphasize provision of inputs for crop production. Agricultural products suitable for adapting contract farming are perishable crops such as vegetables and fruits that need a prompt delivery to consumers or processing plants.

ii) Agricultural Future Market System

Agricultural future market is a place where buyers and sellers openly meet to bid or bargain and make a contract to deliver in the future of the products of predetermined kind, quantity, quality, place and time of delivery, under the rules and regulations of the market.

Justifications of establishing future market are:

- Uncertainness of quantity and price of agricultural products due to erratic rainfall and weather. Farmers lack information on what and how much to produce for the market.
- A surplus of production at harvesting time leading to over supply and price reduction.
- Without signed contract, marketing system usually falls into only few businessmen's hands, and trade agreements are not uncommon to be repudiated.
- Information transmission system is not thorough and usually inaccurate. Center for marketing information distribution is lacking.

With the above reasons, there is a need to establish future market for the benefit of both parties-businessmen and farmers. Goods suitable for negotiating in the future market are:

- The goods that can be classified according to quality levels and must be stipulated in the contract.
- Supply and demand of the goods should be large enough to prevent price decision by the buyers' will.
- The goods should have a long shelf life.
- Bargaining and price demarcation should be free from the government control.

5.4.7 Strengthening Plan for Relevant Organizations

Members of relevant organizations which are designated to implement the Project in cooperation with rural people are the core element for the success of the project implementation. Strengthening the organizations to be responsible for the project implementation in the Study Area is a task of human resource development. Only strong organizations with motivated inspiration and well trained personnel can drive the project to a success. In the Study Area, relevant organizations are both of Government and private sector.

(1) Strengthening of Related Government Organizations

1) Tambon Administration Office (TAO)

TAO is the lowest level of local administration, originated by the decentralization policy recently. There are five classes of TAO; the first class is those earning revenue more than 10 million Baht, and the fifth class earning less than 5 million Baht.

Structure and designated role and responsibility of TAO seem to be effective; however, its performance so far is not fully in line with its function. TAO in any province has been criticized that its members are interested mainly in constructing local infrastructure from which they gain profit. TAO's role in community development in term of well-being of the people has not been fully throttled up. This is one of several weak points of TAO, and for that reason, the Government possibly will transform some of it to municipality.

However, the Study Team sees that in the remote areas, TAO is still important and necessary for rural development if its performance and work coverage are improved. Plan for strengthening to improve performance of TAO is proposed as follows.

i) Educate the community people to let them realize the importance of TAO to their life. The people should be taught to study policy and plan for community development so as to encourage them to become the candidates for TAO members. Only devoted candidates should be elected.
ii) Develop intensive training course for TAO members to inspire them to be conscious of the true duties of TAO and the importance and necessity of overall community development.
iii) Tambon Development Plan with multidisciplinary and integrated sectors must be encouraged, both in the preparation stage and implementation stage.

However, TAO is only functioned recently. Any improvement for it to perform as planned and expected needs more time, and it may not be possible that every TAO can do the same rate of improvement in the due period of time.

2) Technology Transfer Center

In the 9th Plan, MOAC has demarcated several action plans. Among them are Human Resource and Organization Development in agriculture sector, strategy of which is to strengthen learning process and participatory procedure of the farmers and farmers' organizations as a continuous system. In approaching this goal the role of TTC will be utilized to develop the quality and capability of the farmers and farmers' organizations for agriculture and natural resource development.

The MOAC strongly intends to use TTC as its outreach unit for agriculture development at Tambon level as sustainable learning center for the rural community, and for providing One Stop Service regarding the know-how for agriculture development. The TTC has been planned to work closely with the farmers to motivate participatory process, to prepare data of agriculture status of the area, to prepare Tambon's agriculture development plan, and to transfer innovative technologies to the farmers.

Regardless of well plan, TCC still encounters with many problems and constraints. The key problems are inadequacy of staff and budget, and unmotivated field workers. Although MOAC has undertaken a few solutions, TTC is still not fully functioning.

In September 2003, the Permanent Secretary of MOAC called a meeting to readjust the structure of TTC and one direction has been proposed. The approach is to let the community take part in the process of planning as to what and how much to produce in accordance with demand and supply and market opportunity of each commodity. The TTC staff participation is that of a moderator.

The Study Team agrees with this solution. However, it sees that some more solutions can be added to make the TTC a fruitful unit for rural agriculture development.
So, the plan for strengthening the TTC is proposed, including the outcome of the MOAC meeting, as follows.

i) Accept the role of the community in the management of the TTC, in which key persons, village scholars should serve as members of the unit. In the long run, the TTC will be the brain unit for agriculture development in each Tambon, responsible for making production and marketing plans, and calls for a periodic meeting to exchange idea and solve the problems that may arise. The TTC in-charge serves as the moderator of all periodic meeting, however, he can share idea.
ii) Provide adequate budget and equipment necessary for operating the office.
iii) In the meantime, invite technical personnel from TSG, district extension office and MU (mobile unit) members to participate in the TTC meeting to provide advices relevant to the topic being discussed. The MU is newly established under a new policy of MOAC to assist the farmers with multidisciplinary approach. Its members are recruited from DOA, DOAE, DOF, LDD and DLD.

iv) The role of representatives from DOA experiment stations cannot be ignored. There are experiment stations located in Kanchanaburi, Ratchaburi and Petchaburi, activities of which concern with horticulture and rice research. Their expertise can be helpful in making the plan.

v) Last but vitally important is that TCC in-charge must be well motivated and well trained. If necessary, incentive should be given.

3) Technical Support Group (TSG)

The TSG was established, each in Kanchanaburi and Ratchaburi, to give technical support to the farmers in the Study Area. Members of the TSG are representatives from provincial offices of Permanent Secretary Office, RID, DOAE, DOF, DRF (Department of Royal Forestry), ALRO, DLD, CPP (Cooperative Promotion Department), LDD, district secretary and local NGO. The TSG was set up by Sub-Steering Committee of each province, and planned to play an important role in project formulation in cooperation with local people, in providing technical advices and solution to unsolved problems.

However, considering performance of the TSG in both provinces, it can be frankly said that it has not been functioning reasonably. The main problems of the TSG that can be discussed here are:

i) The group is oversized. Some members rarely attended the meeting.

ii) Some members of the group are already heavily loaded with other regular assignment; the JICA's Study is an additional assignment without full authorization. Most of the time those members assign their representatives to attend the meeting. The representatives who have no background and experience about the project consequently cannot share idea or make decision.

To plan for TSG strengthening, serious and thorough consideration must be undertaken. The points to be considered are that 1) should it be the original group to be strengthened, 2) is there a need to establish a new group of appropriate size, 3) when considering 'technical support', are the organizations not responsible for technical works needed in the TSG, 4) are representatives from TAO and experiment stations needed in the TSG, and 5) should full authorization given to the duty of the TSG.

Considering the above points of view, the Study Team has come to a conclusion for TSG strengthening plan as follows.

i) TSG should be regarded as the group of technical advisers at higher level. They can be contacted by the farmers or TTC when necessity arises. The efforts however should first be made at the farmers, Tambon or district levels.

ii) Components of the TSG should be revised, and it should be compact so that calling for a meeting is convenient.

iii) Members of the Group should be mainly representatives from organizations having function on technical aspect. In this regard nominees from nearby experiment stations should be welcomed. For organizations not related to technical issue, cooperation or assistance can be requested from time to time without being a member of the Group.
iv) TAO should take part in the Group since it is the main stakeholder.
v) At present, the provincial governor is regarded as Chief Executive Officer (CEO) of the province having absolute power of authority over all governmental organizations. The project should be known to the governor and the TSG should be authorized by him.

(2) Strengthening of Existing Farmers' Organization

In any type of development, people are the fundamental and very important element. For agricultural development, farmers are the final deciding factor in assuring the success of development programs. In modern agriculture development, therefore, the programs are designed in a fashion that rural people or farmers are the nucleus of the program implementation.

Farmers' organization is a link among farmers and also between farmers and government agencies. A strong farmers' organization can create a negotiating power for their occupational management. Therefore, the role of active farmers' organization is considered an important part of the program implementation.

In the past, establishment of farmers' organization was promoted by various government agencies involved in agriculture development, such as DOAE, RID, CDD and CPD. The organizations are of many models, namely farmers' housewives group, savings group, agricultural cooperatives, water users' group, and production groups of specific activities, such as vegetables farmers' group, fruit growers' group and livestock raising group.

Even though many farmers' organizations still exist, however, only few organizations are efficient and successful, including in the Study Area. The main reasons are that 1) establishment of the organization is motivated by government agencies and the people lack inspiration to participate, 2) active and devoted leaders are lacking, and 3) farmers have little self reliance and consider that agriculture is no longer their main source of income.

In order to strengthen existing farmers' organization, following action plans are proposed.

1) Provision of Training Program

To freshen up the activities of farmers' organization and inspired its members, training is necessary. The training program can be formal or informal and also study tour to successful organization will be included. The training subjects should include the followings.

i) Advantage of farmers' organization
ii) Role and responsibility of the members

iii) Relevant aspects of agriculture development including environment and natural resource conservation.
iv) Occupational skills aiming at giving optional know-how for non-agricultural employment

2) Promotion of Active Agricultural Extension Services

Agricultural extension services serve as a bridge between research outcomes and the farmers who ultimately are the main producers. In general, DOAE is a major agency for transfering innovative technology to the farmers. However, efforts of extension agents from DOAE alone may not be adequate. To enhance the accomplishment of the project, representatives of agencies dealing with agriculture development are also important.

Regarding extension services, emphasis should be placed on intensive consultation and public campaign for improvement of farming practices and performance of farmers' organization. Village public relation service should be made use to broadcast agricultural news. Periodic visits by extension workers and encouragement for on-site visits to a successful farms or agricultural restructuring projects and off-farm activities implemented by farmers are also important.

3) Institutional Development

For institutional development aspect for farmers' organization, achievement can be obtained by the following activities.

i) Reviewing the operation performance of existing farmers' organizations and relevant local organizations, both formal and informal.
ii) Promoting systematic and effective collaboration among various farmers' organizations at village level to formulate a network for exchange of information and experiences.
iii) Providing training in administration and management capability to the staff members of the organizations with focus on managerial skill, marketing, finance and general administration. Motivation of inspiration and leadership should be considered.

(3) Promotion of New Farmers' Organization Establishment

There is a need to establish new farmers' organizations in the Study Area to strengthen farming improvement in the zones farmers' organization which do not exists at present. However, since this is a new establishment, there is a good opportunity to conduct in a way without strong intervention from government agencies. Institutional planning for new organization must be initiated with the will of the farmers in order to raise their awareness of group collaboration. However, at the formation stage agency concerned, such as extension agent or well trained representative from TTC or TAO, should participate as a moderator or stimulator in the discussion.

Steps to be conducted for farmers' organization establishment should cover the followings.

i) Conducting village forum attended by farmers having common interest to establish new organization for specific purpose.

ii) Identifying the objective of the new organization.
iii) In the meeting leadership and key persons are identified, so that the organization committee can be formed.
iv) Collecting data as to size of the production area and number of households involved.
v) Stipulating rules and regulations of the organization, including responsibility of the member and member fee for group management.

After a period of time an evaluation of the organization may be necessary. If performance of the organization is not progressive, the shortcomings must be sought and carefully solved. If the members are unable to retrieve the situation, assistance from agencies concerned, especially extension agents, should be acquired. In order to revive unsuccessful organization management, measures for strengthening farmers' organization discussed earlier should be applied.

5.4.8 Environmental Conservation Plan

(1) Forest Conservation Plan

RFD in principle has a responsibility for forest conservation. However extensive agriculture is the main reason for the expansion of illegal farmland into the forest as well as the increase in population, the lack of social responsibility and awareness and environmental knowledge. The forest conservation plan, therefore, should be based on environmental education, leadership training and regular meetings with villagers by ALRO, RFD, MONRE and NGOs. The support by RFD mainly will carry out following items to the inhabitants for economic forest plantation zone and agricultural forest zone including community forest.

a) Meeting with villagers to enlighten them about the importance of forest conservation
b) Environmental education for both adults and children
c) Meeting with villagers for the planning of community forests and afforestation
d) Provision of seeds and seedling
e) Leadership training for the management of community forests and the conservation of environment including a) and d)

To conserve the forest, by participatory approach, community forest development and afforestation plan should be essential.

1) Community Forest Conservation Plan

To improve communal forest by the community for soil and water conservation, and to guard the annual forest fire, following activities should be formulated by villagers.

a) Regulations to prohibit private logging and farming
b) Seeding and planting of seedling
c) Protection of seedling from livestock
d) Collection of firewood, vegetables, mushrooms, etc.
e) To establish superintendent group for watching forest fire through volunteerism from

inhabitants

2) Afforestation Plan

To reduce pressure on forest conservation, improvement of soil fertility by fallen leaves and income from forestry, following activities should be carried out by villagers.

a) Plantation of seedlings around/in farm plots
b) Protection of seedlings from livestock
c) Logging and replanting trees at the proper time

(2) Monitoring Plan for surface water and groundwater quality

At present the water quality in Lam Pa Chi River is categorized into class 2 and 3 based on the Surface Quality Standard in 1992 and is not so deteriorated. As for groundwater quality, the results of field water quality check at 10 villages in the Study Area were found mostly good enough for drinking. But the downstream of the Lam Pa Chi River basin has recently facing with a problems of polluted water due to heavy use of pesticides and insecticides in the upstream that their residues underground could cause problems. In this connection, 3 or 4 times per year Monitoring for river discharge by LDD or Ratchaburi Environmental Office in MONRE and groundwater by Department of Groundwater Resources (DGR) in MONRE should be planned.

5.4.9 Plan of Monitoring and Evaluations

(a) Monitoring Plan

After the decision of the project site by TAO, TTC will start its monitoring. It is recommended that TTC members in cooperation with TSG members are required to conduct site visition once a month to monitor progress of the construction, farmers' organization established by beneficiaries, problems, people's activities as well as provide guidance on implementation methods and technology etc.

(b) Evaluation Process

Evaluation will be carried out for three times, namely initial, interim and final stages as shown below.

Table 5.4.11 Schedule of the Evaluation

Stages	Schedule	Purposes of Evaluation
1) Initial	After the decision of the project area	-Contents of the project component -Verification of the cost sharing by beneficiaries -Progress of setting up of farmer's organization
2) Interim	After the completion of the facilities	-Activity of Agricultural Extension services -Land use, cropping pattern, water control -Condition of facilities, etc.
3) Final	One year after the completion of the facilities	-Activity of Agricultural Extension services -Land use, cropping pattern, water control -Condition of facilities, etc. -Production and yields

(c) Evaluation Index

Evaluation will be carried out in accordance with the following five (5) evaluation items shown in Table 5.4.12 below. Taking into consideration of sustainability of evaluation activities, evaluation items should be simplified as easier as possible. TTC members will work with initiative in collaboration with TSG in the form of group discussion method and workshop. Evaluation will be carried out three times as mentioned above and it takes one day for one project.

Table 5.4.12 Five Evaluation Items

Items	Contents
1. Relevance	-Adequacy based on beneficiary's needs -With or without of feeling of inequality and opponents
2. Efficiency	-Problems on construction schedule, project costs and implementing agencies -Suitability for quality and quantity of input (human, material & cost) -Adequacy for procurement
3. Effectiveness	-Accomplishment to the target -Factor on success and constraints, countermeasures to constraints
4. Impact	-Direct and indirect benefits on economy, society and environment -Unpredicted Effects -Positive and negative impacts on environment and society, and countermeasures to the negative impacts
5. Sustainability	-O & M organization (organization, budget and technology) -O & M activities (ratio of people's participation) -Correspondence of the supporting agencies and their intention to continuation of the project -Beneficiary's intention to continuation of the project

CHAPTER 6 IMPLEMENTAITON PLAN

6.1 Implementation Organization

Proposed development plan covers so many components, i.e. such as water development, irrigation development, flood mitigations, agricultural development with necessary support services for farmers. RID, therefore, cannot handle all the components by itself. Hence the project goal can be achieved only through the coordination of these activities with those of other agencies involved in the project. In order to assure smooth and successful implementation of the project, several levels of coordination are necessary for project implementation, namely TAO level coordination and action plan, provincial level coordination of local government agencies and central level coordination of budgets.

It is recommended that three levels of coordination committee and Field Working Group will be established as follows:

a) Field Working Group (TTC/District Officer)
b) Technical Support Group (TSG)
c) Sub Steering Committee
d) Steering Committee

The Field Working Group consists of TTC members and District officers. The group plays a major role in implementation of the projects and coordination among the agencies concerned at the field level. A Filed Working Group should be established and the TTC member should act as chairman of this Group. But judging from the involvement of TTC to the pilot project, it is difficult for present form of TTC to function as one stop service center. The main reason would be that the members but the district agricultural officer are not paid, which might lessen their commitments to their responsibilities. They are also really not knowledgeable of agriculture and therefore have difficulties to provide technical supports to the farmers. The function of the TTC at present therefore would be coordinator to link the farmers groups with TAO and TSG. Function and organization of the TTC should be expected to be improved in the near future.

TSG has been established at early stage of the Study consisting of the representative from the department of each sector in Province and districts. TSG member is expected to play more important roles in formulating the activities jointly with the local peoples by providing technical advices as well as formulating solutions to the problems. The representative of agricultural sector should act as chairman of TSG. TSG has played important role when meetings were held at the provincial level to discuss the project plans, monitoring and evaluation results, and problems and solutions at each stage of the pilot project.

The Sub Steering Committee would function as provincial level coordination. This committee should be chaired by the Deputy Governor, while members of the Committee are composed of provincial and district officials of the agencies involved in the project. The Steering Committee will

be the top executive body and will assume leadership of external coordination among the agencies concerned, which should be chaired by the Deputy Permanent Secretary of MOAC. This committee will set policies, resolve any problems and difficulties in project implementation, and budgetary matters. Members of the committee would be the Director of the involved offices and departments.

Project Implementation Organization is shown in Figure 6.1.1.

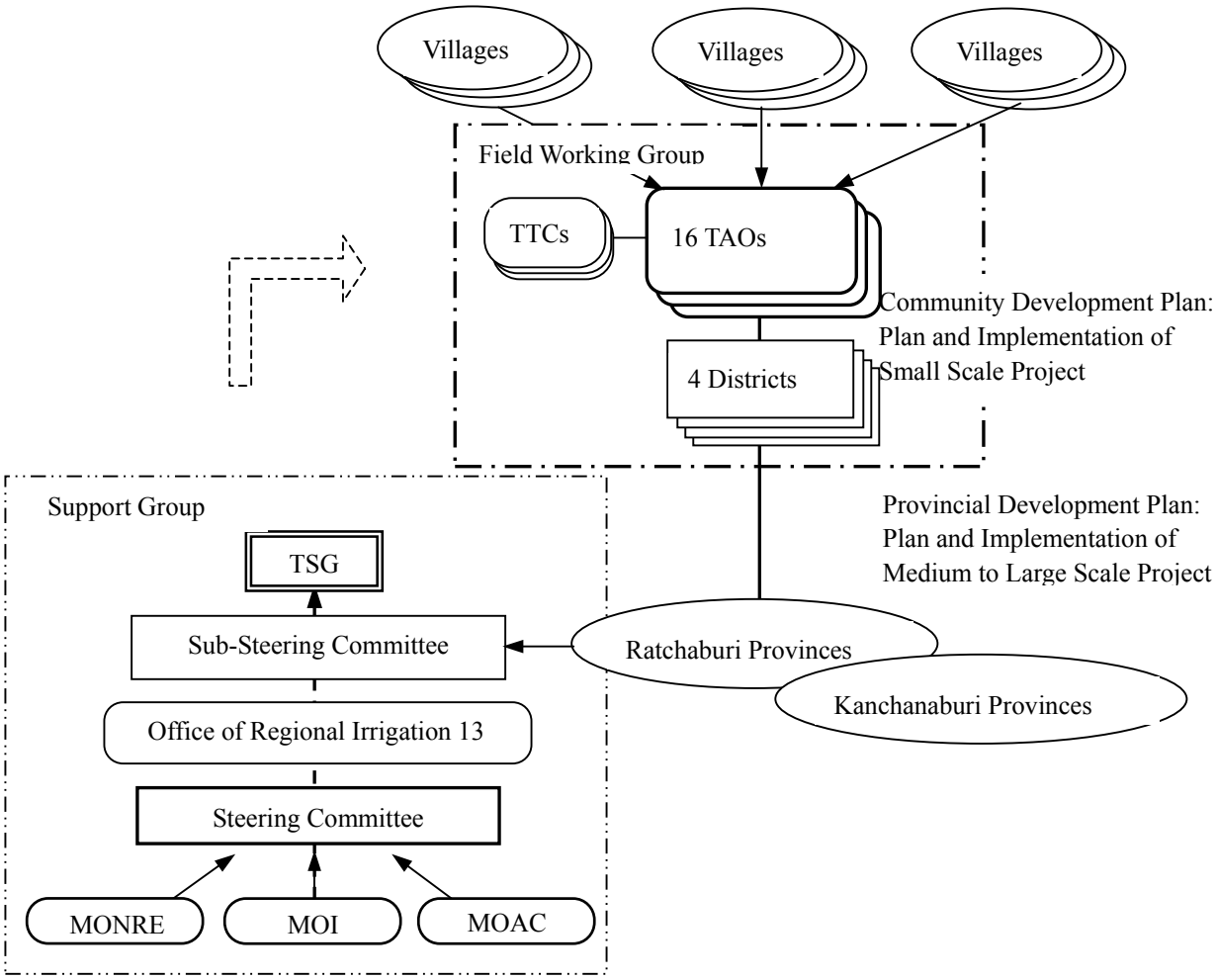


Figure 6.1.1 Project Implementation Organization

6.2 Implementation Schedule and Cost

(1) Implementation Schedule

Based on the results of the PCM workshops and discussions in sub-basin and whole river basin, 8 development components have been proposed and details of sub component plans at each development component have been proposed in the implementation schedule. Sub-components whose implementation cost is cheap and effects of implementation become fast are given the first priority as the short term plan (3years). On the contrary, the projects that are highly public and high cost such as medium scale dams and weirs and bank protection work for preventing flood are applied for medium to long term plan (4 to 20 years). And also policy issues for price stabilization of the agricultural

products, soil improvement, and quality improvement for agricultural products that have been studied continuously are also involved in the medium to long term plan. The project implementation plan is shown in Figure 6.2.1 and the details are shown in Table 6.2.2 to 6.2.9 and Figure 6.2.2 to 6.2.9 respectively.

(2) Project Cost

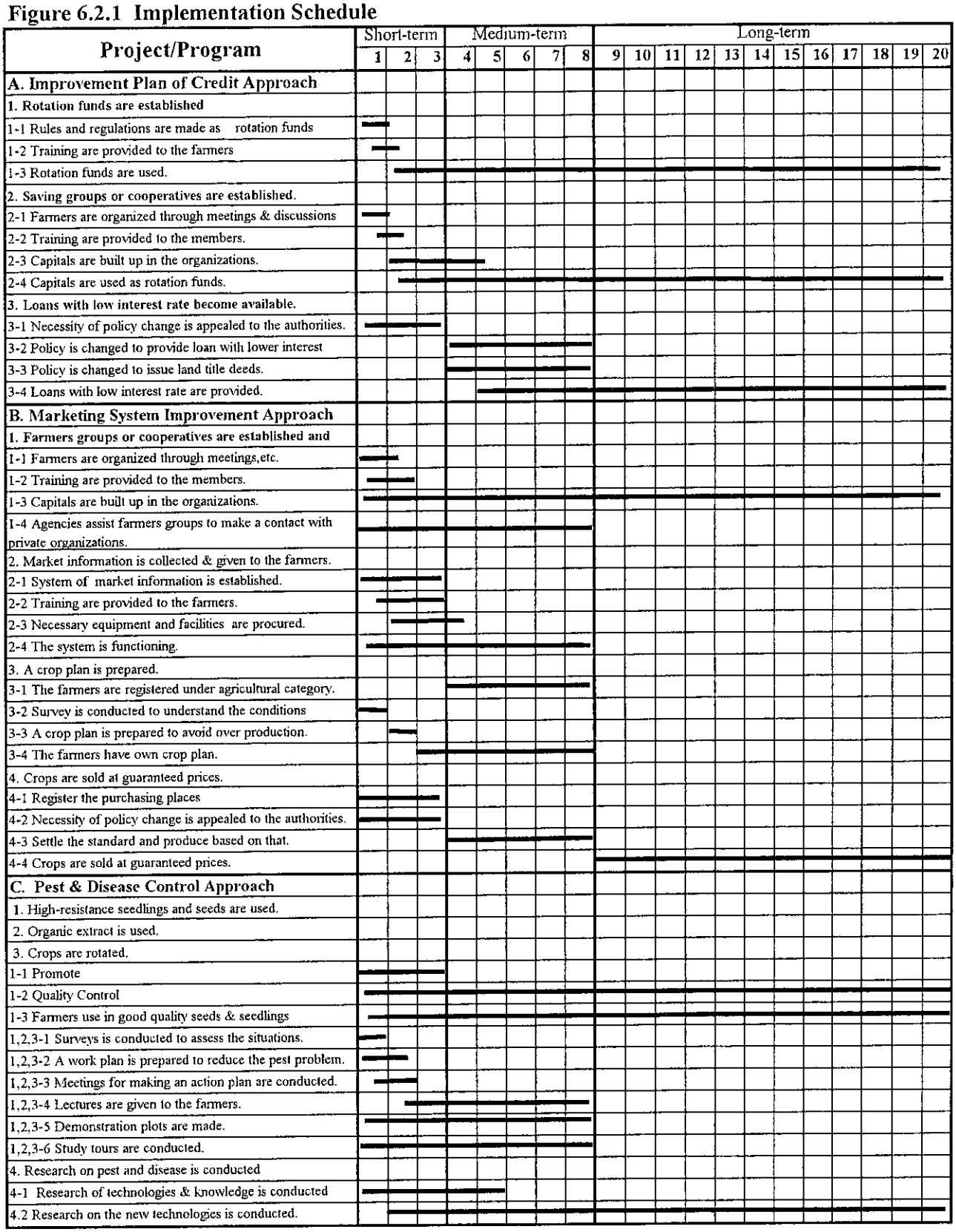
In cooperation with the RID and TAO, the project costs in hard components of water resources development and irrigation systems are estimated but it is rather difficult to estimate the soft components project cost at present. It is because the soft components plan will be prepared with hard components in one united body or the plan shall be prepared independently. Accordingly in order to have a good estimate of the soft components project cost, the value of 12% which is the actual ratio for the soft components cost against the hard components in the pilot project will be applied. According to the table below, total cost is estimated at about 4,514 million Bt, which consists of 1,608 million Bt in short term, 1,825 million Bt in medium term and 1,083 million Bt in long term respectively. Detail of project cost at each component is shown in Table 6.2.1.

Summary of the Project Cost

Project Component	S.T. (3 year)	M.T. (5 years)	L.T. (12 years)	Total
Soft Components Approach	164.2	175.2	97.7	437.1
Water Resources Approach	1,441.2	1,584.1	985.8	4,011.1
Flood Mitigations Approach	0	65.7	0	65.7
Total (Million Bt)	1,605.4	1,825.0	1083.5	4,513.9
Investment Amount（Bt/person）	22,930	26,020	15,440	64,360

(Unit: million Bt)

Figure 6.2.1 Implementation Schedule



Project/Program	Short-term			Medium-term					Long-term											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
D. Soil Improvement Approach																				
1. Compost or green manure are used.																				
2. Leguminous crops are grown.																				
3. Quality seeds are used with the support of the government.																				
4. Elephant grass are grown																				
1,2,3,4-1 Surveys and analysis are conducted to assess.																				
1,2,3,4-2 A work plan is prepared..																				
1,2,3,4-3 Meetings for making an action plan are conducted																				
1,2,3,4-4 Lectures are given to the farmers.																				
1,2,3,4-5 Demonstration plots are made.																				
1,2,3,4-6 Study tours are conducted.																				
5. Research on soil improvement is conducted																				
5-1 Research on technologies and knowledge is conducted.																				
5-2 Research on the new technologies is conducted.																				
E. Farm Input Improvement Approach																				
1. Fertilizers and/or Pesticides are produced by farmers.																				
1-1 Lectures and demonstrations are given to the farmers.																				
2. Animal Breeding is promoted																				
2-1 Technology transfer																				
2-2 Study tour																				
2-3 Farm demonstration																				
3. Biological fertilizer and/or pestcides are produced.																				
3-1 Lectures & demonstration are given to the farmers																				
3-2 Promotion																				
3-3 Monitoring																				
F. Production Improvement Approach																				
1. Products are produced in good quality.																				
2. A crop production plan is prepared.																				
1,2-1 Survey is conducted to assess f the areas.																				
1,2-2 Market information is collected.																				
1,2-3 A crop production plan is prepared.																				
1,2-4 Meetings for making an action plan are conducted .																				
1,2-5 Lectures are given to the farmers.																				
1,2-6 Demonstration plots are made.																				
1,2-7 Study tours are conducted.																				
3. Farmers are organized and strengthened by each crop.																				
3-1 Farmers are organized through meetings and discussions.																				
3-2 Training are provided to the members .																				
4. Seeds and seedlings are stored properly.																				
4-1 Lectures are given to the farmers.																				
4-2 Study tours are conducted.																				
4-3 Storages are built.																				
G. Water Resource Development Approach																				
1. Medium scale reservoirs& weirs																				
2. Small scale reservoirs & weirs																				
3. Weirs by TAO																				
4. Ponds by TAO																				
5. Irrigation system and Transmission pipeline system																				
6. Dredging for reservoirs, ponds, natural creeks & canals																				
7. Electric pump stations																				
8. Well																				
8-1 Shallow wells by TAO																				
8-2 Deep wells by TAO																				
H. Flood Protection Approach																				
1. Construction of concrete embankment																				
1-1 Feasibility study																				
1-2 Implementation																				
2. Elephant grass/bamboo are grown																				

Table 6.2.1 Project Cost

(unit: million Bt)

Project/Program	Short-term (1-3 years)	Medium-term (4-8 years)	Long-term (9-20 years)	Total
A. Improvement Plan of Credit Approach				
1. Rotation funds are established				
2. Saving groups or cooperatives are established.				
3. Loans with low interest rate become available.				
B. Marketing System Improvement Approach				
1. Farmers groups or cooperatives are established and				
2. Market information is collected & given to the farmers.				
3. A crop plan is prepared.				
4. Crops are sold at guaranteed prices.				
C. Pest & Disease Control Approach				
1. High-resistance seedlings and seeds are used.				
2. Organic extract is used.				
3. Crops are rotated.				
4. Research on pest and disease is conducted				
D. Soil Improvement Approach				
1. Compost or green manure are used.				
2. Leguminous crops are grown.				
3. Quality seeds are used with the support of the government.				
4. Elephant grass are grown				
5. Research on soil improvement is conducted				
E. Farm Input Improvement Approach				
1. Fertilizers and/or Pesticides are produced by farmers.				
2. Animal Breeding is promoted				
3. Biological fertilizer and/or pestcides are produced.				
F. Production Improvement Approach				
1. Products are produced in good quality.				
2. A crop production plan is prepared.				
3. Farmers are organized and strengthened by each crop.				
4. Seeds and seedlings are stored properly.				
Sub-Total	164.2	175.2	97.7	437.1
G. Water Resource Development Approach				
1. Medium scale reservoirs& weirs	147.1	329.4	63.0	539.5
2. Small scale reservoirs & weirs	42.6	6.8	0.0	49.4
3. Weirs by TAO	507.0	831.0	330.0	1,668.0
4. Ponds by TAO	203.3	63.5	0.0	266.8
5. Irrigation system and Transmission pipeline system				
5-1 Small Scale Reservoirs & Weirs	61.2	49.5	26.0	136.7
5-2 Medium Scale Reservoirs & Weirs	266.8	0.0	0.0	266.8
6.. Electric pump stations	140.0	180.0	395.0	715.0
Sub-Total	1,368.0	1,460.2	814.0	3,642.2
7. Dredging for reservoirs, ponds, natural creeks & canals	53.4	121.9	171.8	347.1
8. Well				0.0
8-1 Shallow wells by TAO	6.6	1.2	0.0	7.8
8-2 Deep wells by TAO	13.2	0.8	0.0	14.0
Total	1,441.2	1,584.1	985.8	4,011.1
H. Flood Protection Approach				0.0
1. Construction of concrete embankment				0.0
1-1 Feasibility study	0.0	0.4	0.0	0.4
1-2 Implementation	0.0	65.3	0.0	65.3
2. Elephant grass/bamboo are grown	0.0	0.0	0.0	0.0
Sub-Total	0.0	65.7	0.0	65.7
Grand-Total	1,605.4	1,825.0	1,083.5	4,513.9

6.3 Cost Sharing

In case of a small scale irrigation project, cost allocation consisted of initial investment cost and O&M cost for facilities. In general the government will subsidize a part of initial cost and the remaining cost will be beard by the farmer beneficiary. This is not only to enhance farmer's ownership but also the fact that it is very difficult for Thai government to cover the O&M cost due to financial difficulty.

On the other hand it is the trend in the world that the operation and maintenance cost as water fee will be collected from farmer beneficiaries. This will led to enhancing ownership and the main body for the operation and maintenance for small scale irrigation facilities will be farmers themselves
According to the regulation of the RID, the small scale irrigation systems have been transferred to the TAO after completion of the works and the pilot projects implemented by the Study were already transferred to the TAO in November 2004. Accordingly TAO and WUG have a responsibility to maintain and operate the systems. Pump irrigation projects by ASPL (Agricultural Sector Project Loan) have already decided that farmer beneficiary has to pay water fees themselves as O&M cost.

In the Study Area, sugarcane factories have much interest in improving the quality and quantity of sugarcane by supporting the technology transfer to the farmers such as introducing good variety, improvement of harvesting, fertilizer application and farming, etc. In the pilot project, cost sharing from the sugarcane or pineapple factories had been tried but due to the limited small scale irrigation area, farmers have not recieved their support. In the near future, it will be expected to improve quality and quantity for sugarcane, pineapple as well as vegetables introducing the soil improvement, quality improvement for agricultural products and pest & disease control, etc as well as increase of planting area prepared the planting plan by TAO level. It is therefore cost sharing from the sugarcane or pineapple factories that should be tried actively.

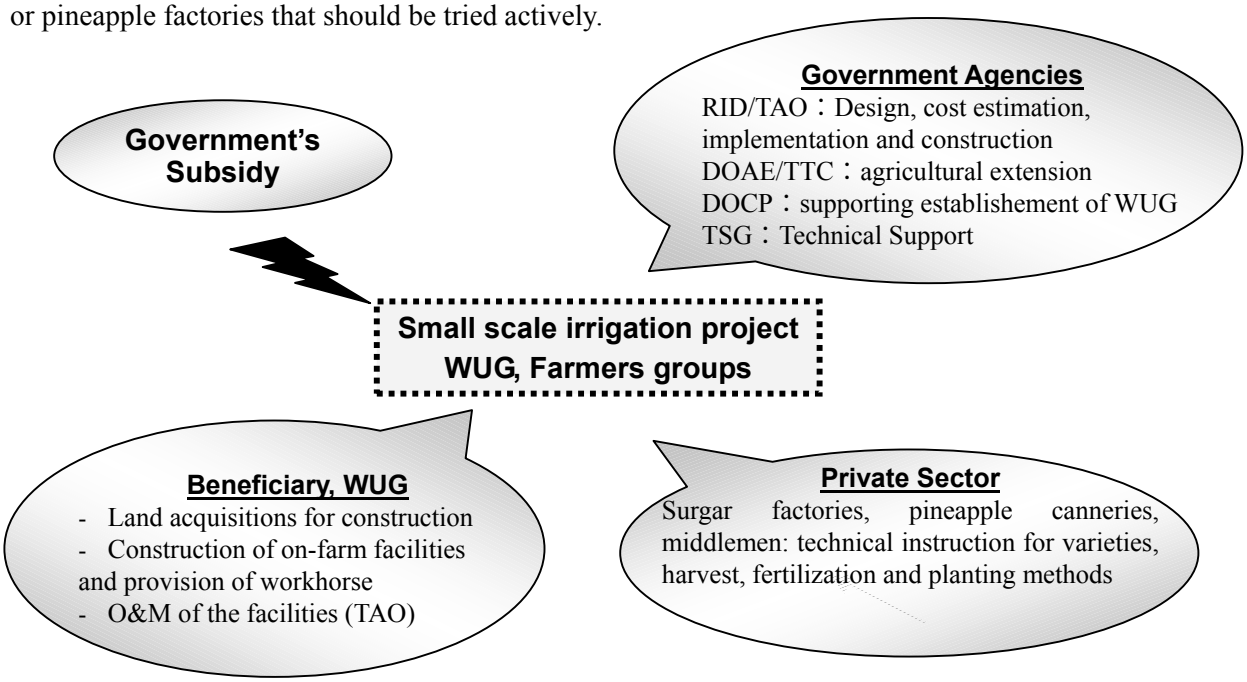


Figure 6.3.1 Concept of Cost Sharing