

H. ENVIRONMENT

APPENDIX II. ENVIRONMENT

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1. Socio-Economic Condition

Table H-1 Condition of Sanitation, Education, etc.

(%)

Items	Target for 1996 - 2000	Khon Kaen	Maha Sarakham	Mukdahan	Sakon Nakhon
Malnutrition level of children from birth to 5 years,					
Malnutrition level 1	Not over level 3	32.3	53.2	40.5	29.7
Malnutrition level 2		14.7	18.2	17.7	13.8
Malnutrition level 3		1.5	1.0	1.8	1.8
Children to 14 years receive all necessary nutrients	93	79.5	82.7	81.2	82.6
Houses are kept clean	90	48.6	54.6	83.2	63.8
Family uses sanitary latrine	95	60.3	89.1	83.2	63.8
Family has safe drinking water	95	35.9	41.1	33.0	39.8
People between 14 to 50 years are literate	99	72.7	72.6	73.5	50.8
Children finish complete compulsory education and attend secondary school	73	85.7	94.8	66.6	85.8
Children who do not attend secondary school receive occupation training	80	12.8	13.4	14.4	23.4
People are safe from harm and theft	100	88.7	93.1	87.2	86.8
People have income no less than 15,000 Baths/year	70	9.6	10.2	6.9	8.0
Couples have family planning	77	87.2	83.7	83.9	85.5
Couples have no more than 2 children and are able to choose birth control	75	39.3	48.1	20.6	31.4
People use their right to vote	90	41.3	65.0	79.9	52.6
Absence of addiction to alcohol	90	95.8	97.5	98.2	97.5
Absence of addiction to cigarette	90	36.3	57.7	31.2	32.3
Old people have receive take care	90	96.3	96.4	92.5	96.4

: Rate achieved to the target

Source: Department of Rural Community Development, Ministry of Interior, as of 1995

Table H-2 Labor Force Participation Rates by Age Group, Sex and Region

(%)

Age (Years)	Whole Kingdom		Central		Northern		Northeastern		Southern	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
13-14	18.1	17.8	12.3	10.9	10.3	12.2	32.4	30.4	8.1	7.3
15-19	52.7	50.5	49.3	49.3	51.5	45.6	64.3	61.6	41.6	36.9
20-24	88.1	76.6	88.3	76.2	87.2	79.7	92.3	80.5	86.5	69.6
25-29	96.5	81.2	97.2	80.2	97.3	81.1	96.8	84.6	96.1	75.2
30-34	97.9	84.4	97.3	82.9	98.0	86.1	98.3	89.0	98.7	82.9
35-39	98.2	85.8	98.4	84.0	98.6	90.3	99.0	91.1	97.4	83.6
40-49	97.7	82.7	96.7	81.0	97.3	86.9	98.2	88.4	98.2	86.1
50-59	92.4	69.9	91.6	66.8	92.9	70.7	95.9	80.6	92.4	77.0
60 ≤	49.3	25.1	45.5	23.8	49.6	25.7	57.6	30.1	52.0	29.9
Total	80.8	67.2	79.8	65.3	68.3	68.3	84.3	73.3	76.7	62.8
Total	73.9		72.4		74.8		78.8		69.7	

Source: Report of the Labor Force Survey (August 1994)

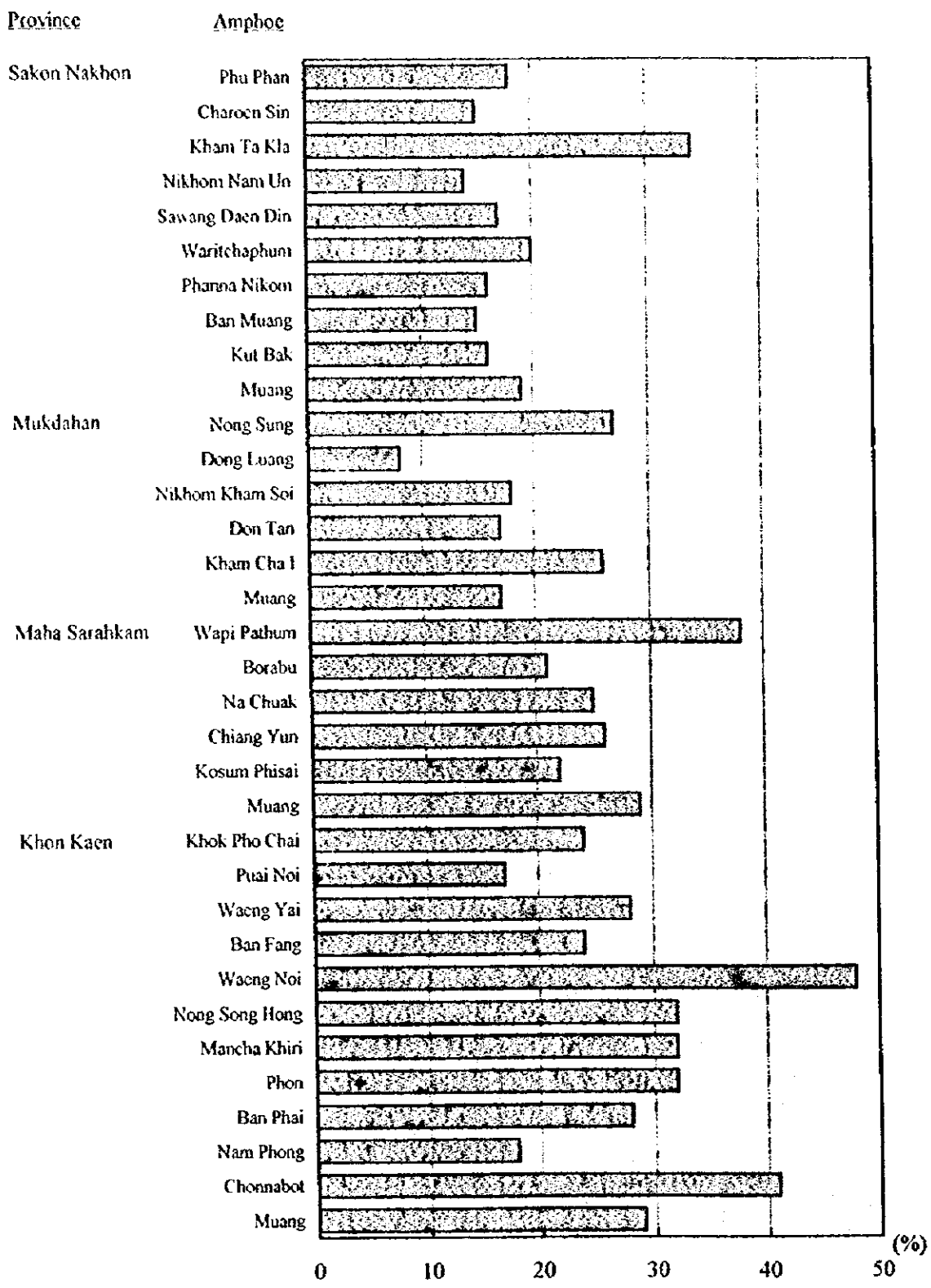


Figure H-1 Work Outside the Tambon

Table H-3 Health Condition

Health Information	Khon Kaen	Maha Sarakham	Mukdahan	Sakon Nakhon
Birth Rate (per 1,000)	15.34	12.30	17.20	16.36
Death Rate (per 1,000)	5.24	5.25	4.49	5.01
Population Growth Rate (%)	1.01	0.71	1.27	1.14
Maternal Death Rate (%)	0.08	0.00	0.36	0.00
Infant Death Rate (%)	8.83	13.59	6.62	4.03
Life Expectancy at Birth - Male	66.6			
- Female	71.7			

Source: Provincial Health Offices, as of 1996

Table H-4 Leading Causes of Out-Patients and Deaths

Province	Leading Causes of Out-Patients	Leading Causes of Deaths
Khon Kaen	<ol style="list-style-type: none"> 1. Diseases of the respiratory system 2. Diseases of the digestive system 3. Symptoms, signs, not elsewhere classified 4. Certain infectious and parasitic diseases 5. Mental and behavioral disorders 	<ol style="list-style-type: none"> 1. Cancer 2. Heart diseases 3. Traffic accidents 4. Diseases of the liver and pancreas 5. Diseases of respiratory system except upper respiratory system
Maha Sarakham	<ol style="list-style-type: none"> 1. Diseases of the respiratory system 2. Diseases of the digestive system 3. Certain infectious and parasitic diseases 4. Diseases of the musculoskeletal system and connective tissue 5. Endocrine, nutritional and metabolic diseases 	<ol style="list-style-type: none"> 1. Cancer 2. Heart diseases 3. Traffic accident 4. Diseases of the liver and pancreas 5. Symptoms, signs, not elsewhere classified
Mukdahan	<ol style="list-style-type: none"> 1. Diseases of the respiratory system 2. Diseases of the digestive system 3. Diseases of the musculoskeletal system and connective tissue 4. Diseases of the skin and subcutaneous tissues 5. Symptoms, signs, not elsewhere classified 	<ol style="list-style-type: none"> 1. Cancer 2. Heart diseases 3. Traffic accident 4. Symptoms, signs, not elsewhere classified 5. Diseases of the liver and pancreas
Sakon Nakhon	<ol style="list-style-type: none"> 1. Diseases of the respiratory system 2. Diseases of the digestive system 3. Diseases of the musculoskeletal system and connective tissue 4. Other external cause 5. Symptoms, signs, not elsewhere classified 	<ol style="list-style-type: none"> 1. Cancer 2. Heart diseases 3. Diseases of the liver and pancreas 4. Diseases of respiratory system 5. Traffic accidents

Source: Provincial Health Offices, as of 1996

Table H-5 Water Quality of Fresh Water and Water Supply from Bung Kut-Khao and Mancha Keri in Khon Kaen

Parameter	Unit	NEB Standard for Natural Stream	Standard for Drinking Water		November 1995		March 1996		September 1996	
			WHO	DOH in Thailand	Fresh water	Water supply	Fresh water	Water supply	Fresh water	Water supply
Color	Pt.Cob	-	-	15	28	5	28	5	50	2
Turbidity (濁度)	NTU	-	-	5	16	2.2	7.3	4.5	41	6.5
TDS	mg/l	-	-	1,000						
pH		5 - 9	6.5 - 9.2	6.5 - 8.5	7.07	7.57	6.89	6.71	7.37	6.73
EC	μ mho/cm at 25°C	750	-	-	294	327	852	872	442	639
Hardness CaCO ₃	mg/l	300	500	500	56	58	94	102	90	76
Alkalinity CaCO ₃	mg/l	>20	-	-	50	32	48	36	48	22
Ca	mg/l	-	75	-	14	18	22	23	26	19
Mg	mg/l	-	50	-	4.9	-	9.7	11	6.5	6.6
Cl ⁻	mg/l	-	200	250	60	60	238	-	106	-
Fe	mg/l	-	0.3	0.3	2.2	0.6	2.0	0.9	2.3	-
Mn	mg/l		0.5	0.1	0.06	0.10	0.08	0.10	0.15	-
SO ₄	mg/l	-	200	400	4.8	22	6.6	15	nil	17
F	mg/l	-	-	1.5	0.3	0.1	0.3	0.2	0.3	0.1

Source: Provincial Waterworks Authority (Water Quality Control Div. PWA, Khon Kaen)

Table H-6 Result of Water Analysis

Province	Study Area No.	Village	Drinking water				Other water			Remarks
			Coli	Bac.	pH	EC (μ s/cm)	EC (%)	pH	EC (μ s/cm)	
Khon Kaen	6	Sua Tao	+	>100	8.6	181	0.00			Rainjar Hand pump, brown water Pond Reservoir for tap water constructed by RID in 1988
	*6	Nong Wang Nang Pao								
	1	Lao Nua	- ++	0 <100	8.8	91	0.00	7.1	2,800	0.15 Rainjar Pond
	1	Kum Din	+	<100	9.1	121	0.00	8.5	320	0.01 Pond
								8.6	3,500	0.18 Pond
								7.3	1,750	0.09 Concrete tank with a faucet for rain water From the faucet of water supply facilities
Maha Sarakham	*3	Ban Non Ngarm						8.0	138	0.00 Pond by DLD, 15 rai, depth 4m (not in the study list)
	*3	Huai Kho						8.6	240	0.01 Pond
								8.3	210	0.01 Pond, green color
	*4	Kham Hua Chang						7.8	186	0.00 Private pond by SPK, 12m x 15m, depth 3m
	6	Hua Nong	+	<100				7.2	1,840	0.09 From the faucet of water supply facilities
	6	Bung Sanakkee	++ ++	>100 >100	9.3 7.6	200 210	0.01 0.01			Rainjar Rainjar Pond
Mukdahan	6	Na Chareon	++	>100	8.1	138	0.00			Rainjar
	6	Lao Jan						7.3	193	0.00 Pond
								7.7	130	0.00 Pond
								8.5	49	0.00 Huai Kee Lek Reservoir
	3	Phu Phang Ma	-	0	6.8	68	0.00			From the faucet of water supply facilities
	3	Na Than	+	<10	4.6	30	0.00	7.8	460	0.02 Water is put in a jar from water supply facilities by MOH Handpump (There is a public well by ARD containing oxidized iron.) Pond for fishery Broken shallow well, Water level 0
								5.3	29	0.00
								5.9	78	0.0

Province	Study Area No.	Village	Drinking water				Other water			Remarks		
			Coli	Bac.	pH	EC (μ s/cm)	EC (%)	pH	EC (μ s/cm)		EC (%)	
Mukdahan	3	Huai Sai	+	<50	9.0	109	0.00		8.6	65	0.00	Rainjar (There is a public well by DPW for washing.) Dammed up natural pond
Sakon Nakhon	5	Lat Somboon							6.6	240	0.01	Handpump, depth of 25 m (By ARD, DPW and villagers themselves. Some include oxidized iron.) From the faucet of water supply facilities, depth of 45 m by MOH (Water tower is under construction by ALRO.)
	5	Ton	-	0	5.7	260	0.01					Motor pump, depth of 15 m (There is a public well, depth of 60 m by ARD, supply is not enough.) Handpump, depth of 6 m Dammed up river by King Project. No flow in the dry season
Khon Kaen	4	Phon Ngam	++	<100					6.7	510	0.02	Water is put in a jar from the well, depth of 10 m
	4	Na Kam	+	<100	7.0	149	0.00		5.3	32	0.00	Rainjar (There are three broken wells by ARD and private wells in all households.)
			+	<20	8.3	120	0.00		8.3	139	0.00	Pond of the project site by DLD Pond of the Forest Village Project site
		* Poilder Project Site							6.7	8,400	0.46	
		* Nonchard Dongkeng							8.8	8,000	0.43	

Measurement: from Feb. 21, 1997 to March 4, 1997 (*: from June 30, 1997 to July 5, 1997)

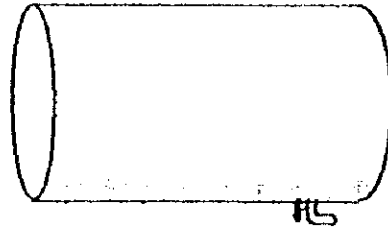
Coliform count : KYORITSU TPA-CG

Bacteria count : KYORITSU TPA-BG

pH : TRNS Pal pH Meter

EC : HORIBA Conductivity Meter B-173

Remarks: FAO Guide Line for the irrigation water: less than 500ppm (=350 μ s/cm) is no problem.



Concrete tank for rain water
(10,000 liters)



Rainjar
(1,000 liters)

Table H-7 Consumption of Chemical Fertilizer in Thailand

Thai-year	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524
Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
TOTAL	247,103	282,851	273,685	280,279	261,479	407,990	418,396	390,332	506,428	664,391	792,024	785,433	827,204	786,841	894,542
N	41,855	47,921	46,358	47,475	44,290	59,107	70,870	55,115	85,781	112,537	134,156	133,040	140,115	133,194	151,140
P ₂ O ₅	31,936	36,557	35,371	36,223	33,794	52,729	54,074	50,447	65,451	85,866	102,361	101,510	106,908	101,627	116,265
K ₂ O	12,678	14,513	14,042	14,380	13,416	20,933	21,467	20,027	25,983	34,088	40,637	40,298	42,448	40,348	45,763

(Unit: ton)

Thai-year	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538
Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TOTAL	1,042,503	1,272,041	1,246,688	1,250,000	1,400,000	1,548,765	1,992,633	2,297,733	2,648,910	2,487,082	2,806,784	3,195,576	3,387,804	3,313,313
N	174,765	233,388	227,712	252,900	319,927	342,784	439,720	494,923	576,517	525,825	600,176	769,095	720,211	663,345
P ₂ O ₅	134,229	154,044	142,623	124,999	137,409	148,344	200,833	188,823	318,337	272,318	325,713	430,253	412,273	412,155
K ₂ O	57,643	83,701	67,916	65,660	72,930	95,245	137,456	117,793	148,937	164,016	191,858	250,147	263,434	288,949

Source: Agricultural Economic Office

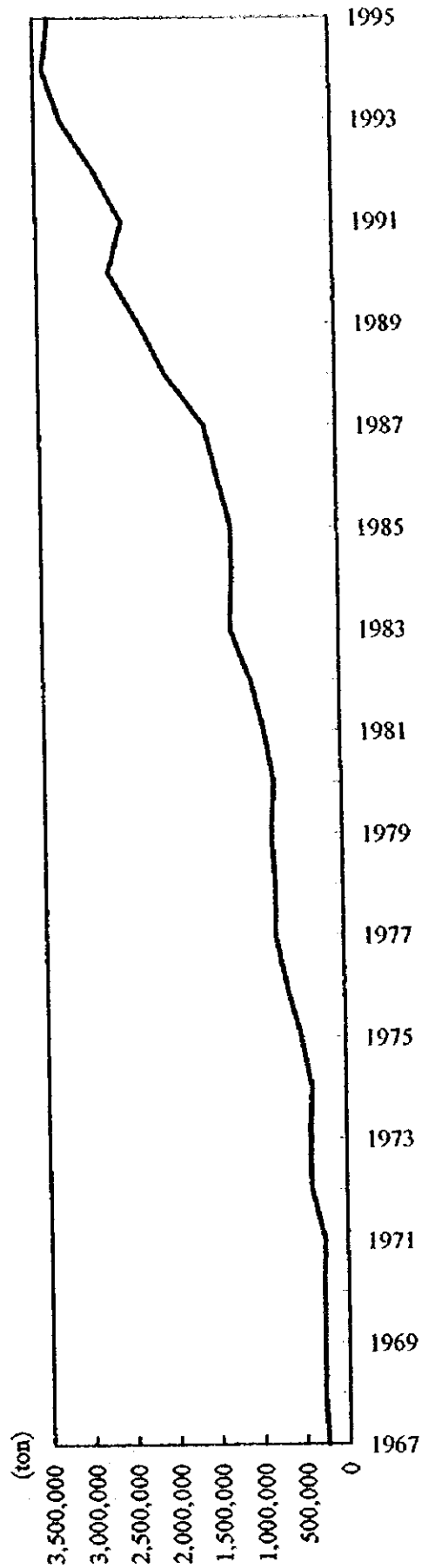


Figure H-2 Consumption of Chemical Fertilizer in Thailand

2. Natural Environment

Table II-8 Endangered Species in the National Parks

Phu Kao - Phu Phan Kha National Park, Khon Kaen

<u>Species</u>	<u>Scientific Name</u>	<u>English Name</u>
BIRD	Tyto Alba	Barn Owl
	Ichthyophaga Humilis	Lesser Fish Eagle
	Accipiter Gentilis	Northern Goshawk
	Treron Phoenicoptera	Yellow Footed Pigeon
	Picoides Hyperythrus	Rufous-bellied Hoodp
MAMMAL	Rhinolophus Macrotis	Large Eared Horse Shoe
	Mustela Sibirica	Siberian Measel
	Viverricula Indica	Small Indian Civet
	Felis Viverrina	Fishing Cat
	Neofelis Nebulosa	Clouded Leopard
	Panthera Tigris	Tiger
	Cervus Porcinus	Hog Deer
	Mus Caroli	Ryukyu Mouse

Mukdahan National Park

<u>Species</u>	<u>Scientific Name</u>	<u>English Name</u>
BIRD	Ceoptilos Dubius	Greater Adjutant
MAMMAL	Panthera Tigris	Tiger
	Cervus Procinus	Hog Deer
	Bos Javanicus	Banteng
	Mus Caroli	Ryukyu Mouse

Huai Huad National Park, Mukdahan and Sakon Nakhon

<u>Species</u>	<u>Scientific Name</u>	<u>English Name</u>
BIRD	Cairina Scutulata	White Winged Duck
	Picoides Hyperythrus	Rufous-bellied Hoodp
	Ceoptilos Dubius	Greater Adjutant
MAMMAL	Rhinolophus Macrotis	Large Eared Horse Shoe
	Mustela Sibirica	Siberian Measel
	Mustela Strigidorsa	Back Striped Measel
	Viverricula Indica	Small Indian Civet
	Felis Viverrina	Fishing Cat
	Neofelis Nebulosa	Clouded Leopard
	Panthera Tigris	Tiger
	Dicerorhinus Sumatrensis	Sumatran Rhinoceros

	Cervus Porcinus	Hog Deer
	Bos Javanicus	Banteng
	Mus Caroli	Ryukyu Mouse
REPTILE	Eumeces Quadrilineatus	Blue Tailed Skink
	Lygosoma Haroldyoungi	Banded Supple Skink
	Sphnomorphus Stellatus	Cambodian Hill Skink
	Typhlops Diardi	Indochinese Blined Sn
	Pareas Hamptoni	Hampton's Slug Snake
	Oligodon Dorsalis	Gray's Keekri Snake
	Amphiesma Stolata	White Striped Kellba
AMPHIBIANS	Microphyla Annamensis	Annamese Proglot

Phu Phan National Park, Sakon Nakhon

<u>Species</u>	<u>Scientific Name</u>	<u>English Name</u>
BIRD	Cairina Scutulata	White Winged Duck
	Ichthyophaga Ichthyaetus	Grey Headed Fish Eagle
	Columba Punicea	Pale Capped Pigeon
	Tyto Alba	Barn Owl
MAMMAL	Rhinolophus Macrotis	Large Eared Horse Shoe
	Mustela Sibrica	Siberian Measel
	Mustela Strigidorsa	Back Striped Measel
	Viverricula Indica	Small Indian Civet
	Felis Viverrina	Fishing Cat
	Neofelis Nebulosa	Clouded Leopard
	Panthera Tigris	Tiger
	Dicerorhinus Sumatrensis	Sumatran Rhinoceros
	Cervus Porcinus	Hog Deer
	Mus Caroli	Rykyu Mouse
REPTILES	Pareas Hamptoni	Hampton's Slug Snake
	Oligodon Dorsalis	Gray's Keekri Snake
	Gekko Petricolus	Sandstone Gecko
	Eumeces Quadrilineatus	Blue Tailed Skink
	Lygosoma Haroldyoungi	Banded Supple Skink
	Typhlops Diardi	Indochinese Blind Sn
	Amphiesma Stolata	White Striped Keelba
AMPHIBIANS	Microphyla Annamensis	Annamese Proglot

Source: Study of Potential Development of Water Resources in the Mae Khong River Basin, NESDB by AIT, 1994

Table H-9 Legal Situation and Policy Setting in Relation to Protected Areas and Land Reform Area

Legal Land Status	Relevant Act	Allowed by Law	Prohibited by Law
Wild Life Sanctuary	Wildlife Preservation and Protection Act 1960 (Amended 1992)	The entry of visitors with permission of authorized officials.	Removal of all flora and fauna. Hunting and fishing. Modification of natural features. Mining.
National Park	National Park Act 1964	Entry of visitors. Educational or technical research. Any activities for NP maintenance or to promote tourism.	Land ownership. Clearing & burning. Cattle raising. Removal of flora & fauna. Alter waterways.
Reserve Forest	National Reserved Forests Act 1964	Mining. Cattle raising. Collection of forest products (restricted). Unrestricted entry of visitors.	Logging. Occupation. Use of fire. Collection of materials in a way that would harm the forest.
Agricultural Land Reform Area	Agricultural Land Reform Act 1975. (Amended 1976 and 1989)	Occupation and land use for agricultural purposes. Inheritance on death to surviving family. Resale to ALRO at assessed value. Extraction of timber by RFD and FIO.	Sale to individuals. Renting or leasing land to others. Allowing the land to stand idle. Extraction of timber by the occupier.

Source: Huaikha Khaeng Complex - Integrated Conservation and Development Project, Ministry of Environment & Energy / DANCED, 1996

3. Forest Resources

Table H-10 Ratio of the Forest Area

Province	Forest area (%)												
	1961	1967	1972	1976	1978	1982	1985	1988	1989	1991	1993	1995	
Name	Area (km ²)	1961	1967	1972	1976	1978	1982	1985	1988	1989	1991	1993	1995
Whole country	513,115	53.32	48.25	44.02	38.67	34.15	30.52	29.40	28.03	27.95	26.64	26.02	25.62
Khon Kaen	10,886			16.80	14.28	10.88	10.30	8.56	8.56	8.42	7.75	7.65	7.49
Mukdahan	4,340			4.97	4.21	2.99	1.55	0.96	0.96	0.93	0.72	0.66	0.64
Maha Sarakham	5,292			30.07	19.60	18.60	18.26	16.42	16.32	14.96	14.75	14.50	14.50
Sakon Nakhon	9,608												

Source: Remote Sensing Sub-Division, Forest Management Division, Royal Forest Department

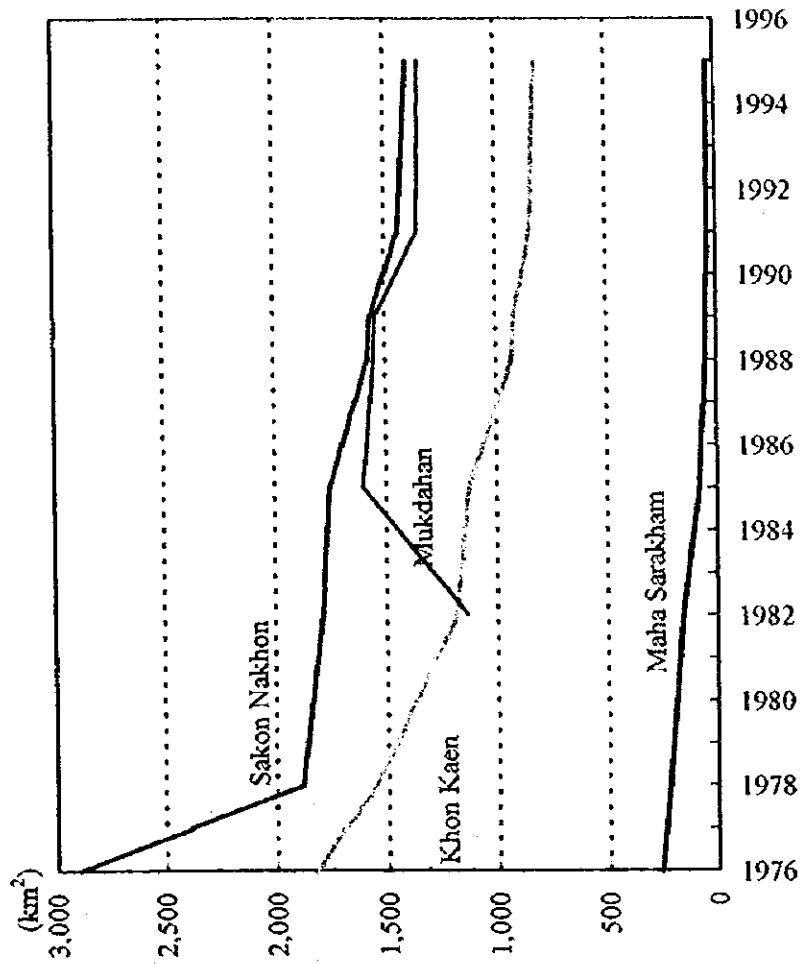


Figure H-3 Forest Area in Four Provinces

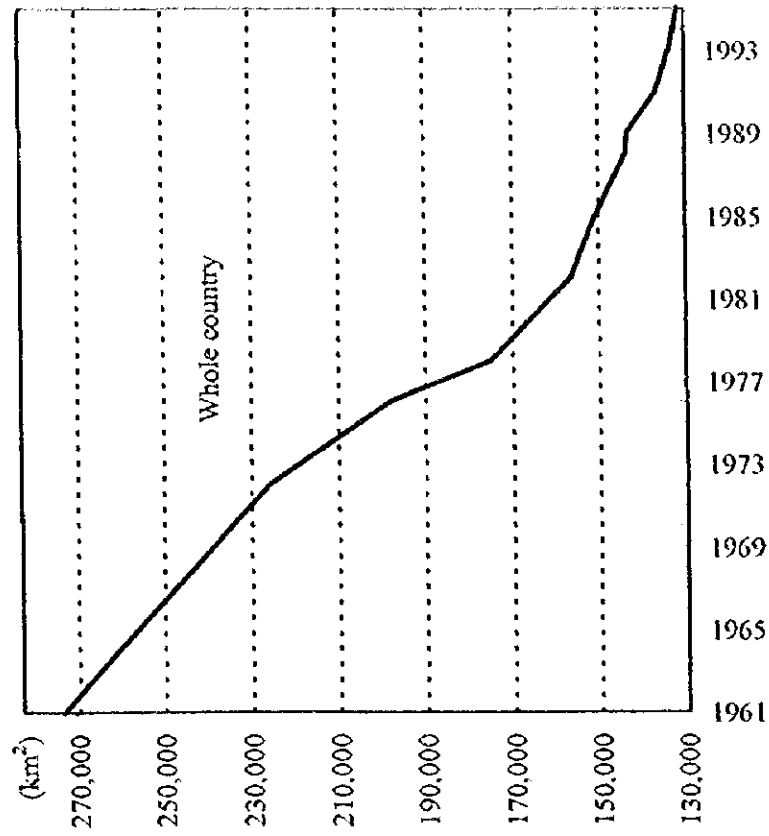


Figure H-4 Forest Area in Thailand

Table H-11 Total Number and Volume of Trees in the Forest

Species	Thai Name	Khon Kaen		Maha Sarakham		Muekdaan		TOTAL					
		No. of Trees	Volume (m ³)	Volume (%)	No. of Trees	Volume (m ³)	Volume (%)	No. of Trees	Volume (m ³)	Volume (%)			
<i>Pterocarpus macrocarpus</i> Kurz	Pradu	1,566,928	228,589	6.4	12,205	1,909	1.2	3,508,014	608,974	8.7	5,087,147	839,472	7.8
<i>Xylocarpus xylocarpa</i> Taub		1,974,069	247,779	6.9	38,357	5,971	3.9	3,657,299	530,526	7.6	5,669,725	784,276	7.3
<i>Large lagerstroemia calyculata</i> Kurz		710,543	149,891	4.2	56,664	5,849	3.8	2,800,122	612,930	8.8	3,567,329	768,670	7.2
<i>Shorea obtusa</i> Wall	Tengnung	2,330,861	308,468	8.6	189,605	29,504	19.2	1,087,534	205,927	3.0	3,608,000	543,899	5.1
<i>Irungia Malayana</i> Oliv				0.0	34,870	8,116	5.3	1,499,512	383,361	5.5	1,534,382	391,477	3.7
<i>Lagerstroemia calyculata</i>	Tabagyai	692,313	160,690	4.5			0.0	605,121	151,847	2.2	1,297,434	312,537	2.9
<i>Dipterocarpus tuberculatus</i>	Pluang	1,273,508	180,027	5.0	88,919	12,693	8.3	388,944	76,074	1.1	1,751,371	268,794	2.5
<i>Dipterocarpus obrusifolius</i> Teijsm.	Hiang	1,121,157	161,871	4.5	129,455	19,457	12.7	416,408	70,891	1.0	1,667,020	252,219	2.4
<i>Shorea stamensis</i> Mia		1,817,376	205,367	5.7	91,970	10,766	7.0			0.0	1,909,346	216,133	2.0
<i>Canarium subulatum</i> Gull		329,879	63,524	1.8			0.0	774,784	145,712	2.1	1,104,663	209,236	2.0
<i>Milletia leucantha</i> Kurz	Sae	59,465	7,683	0.2			0.0	1,087,535	185,505	2.7	1,147,000	193,188	1.8
<i>Vitex pinnata</i> Linn.				0.0			0.0	894,391	156,237	2.2	894,391	156,237	1.5
Wild almond		751,343	147,369	4.1			0.0			0.0	751,343	147,369	1.4
<i>Terminalia alata</i>	Rokfah	396,290	82,392	2.3	10,462	1,726	1.1	262,691	63,219	0.9	669,443	147,337	1.4
<i>Mitragyna diversifolia</i> (Rubraeae)				0.0			0.0	926,288	146,172	2.1	926,288	146,172	1.4
Yellow poincana				0.0			0.0	666,253	139,125	2.0	666,253	139,125	1.3
<i>Cratogeomys pronomiflorum</i> (hyperaceae)	Tew	203,570	34,850	1.0	26,153	4,934	3.2	641,445	87,707	1.3	871,168	127,491	1.2
<i>Careya arborea</i>				0.0			0.0	804,464	124,280	1.8	804,464	124,280	1.2
<i>Garuga pinnata</i>	Takram	264,339	64,869	1.8			0.0	475,768	111,163	1.6	475,768	111,163	1.0
<i>Schleichera oleosa</i>	Takroh	11,017,983	1,533,487	43.0	324,730	52,392	34.2	20,023,044	3,169,580	45.5	31,365,757	4,755,459	44.4
Others		24,509,624	3,576,856	100	1,003,390	153,317	100	40,519,617	6,969,230	100	66,032,631	10,699,403	100
TOTAL													

Source: Forest Survey Report, 1995, Royal Forest Department

Table II-12 Area of the Community Forest

Province	Forest	Study Area		Community Forest	
		No.	Area (rai)	Zone	Area (rai)
Khon Kaen	Phu Ra-ngam Forest	1	68,125		N.A.
	Sawathi Forest	2	15,375	A	1,489
	Sawathi Forest			E	14,000
	Kok Luang Forest (Plot 3)	3	19,700	A&E	615
	Kok Talat Yai Forest	4	11,450	A&E	0
	Dong Sam Forest	5	6,525	A	0
	Non Nam Baeng Forest	6	152,343	A&E	3,125
Maha Sarakham	Khok Khao Forest	1	1,613		0
	Din Daeng and Wang Kung Forest	2	69,747		N.A.
	Khok Hin Lard Forest	3	2,275		N.A.
	Khok Kham Poom Forest	4	10,625	E	0
	Khok Phuk Kut and Pong Daeng Forest	5	12,050	A	0
	Khok Phuk Kut and Pong Daeng Forest			E	2,450
	Nong Khu and Na Dun Forest	6	20,065	A	86
	Don Ken and Nong Ya Prong Forest	7	10,937	E	0
	Kut Rang Forest	8	80,402	A	0
	Kut Rang Forest		388	E	357
Khok Sum Rong and Pro Pan Forest	9			1,840	
Khok Rai Forest	10	5,762	E	0	
Mukdahan	Dong Bung-I (Plot 1) Forest	1	109,055		N.A.
	Dong Bung-I (Plot 2) Forest	2	56,292		N.A.
	Dong Bung-I (Plot 3) Forest	3	103,958		N.A.
	Dong Bung-I (Plot 4) Forest	4	1,387		N.A.
	Dong Bung-I (Plot 5) Forest	5	6,450		N.A.
	Dong Bung-I (Plot 7) Forest	6	700		N.A.
	Dong Phu Si Than Forest	7	47,150		N.A.
	Dong Phu Phan Forest	8	64,800		N.A.
	Dong Mu Forest	9	43,529		2,000
	Dong Mu (Plot 1) Forest	10	1,281		N.A.
	Dong Mu (Plot 2) Forest	11	11,394		N.A.
	Dong Mu (Plot 3) Forest	12	12,237		N.A.
Sakhon Nakhon	Dong Mo Thong Forest	1	24,600	E	0
	Dong Pha Lat Forest	2	36,775		N.A.
	Kut Hai, Na - Nai, Non Udom Forest	3	139,813	A&E	18,551
	Khok Phu and Na Mong Forest	4	87,700	A&E	4,972
	Dong Chomphu Phan and Dong Kachoe Forest	5	69,350	E	2,000
	Dong Chomphu Phan and Dong Kachoe Forest (Pa Mai 2-village)			E	1,181
	Phu Wong Forest	6	40,956	E	0
Dong I - Bang, Dong Kham Phlu and Dong Kham Kang Forest	7	16,950		N.A.	

Source: Land Reform Operation Division, Agricultural Land Reform Office, 1997

A: Agricultural Zone
E: Economic Zone

Table H-13 Afforestation Area in Thailand

Item of afforestation	(Unit: km ²)									
	before 1986	1987	1988	1989	1990	1991	Total			
Government budget	4,239.53	240.00	240.00	207.76	320.00	258.99	5,486.28			
Concessionaire	1,243.26	91.74	97.03	31.11	47.39	6.81	1,517.34			
Forest Industry Organization	245.88	5.14	4.21	3.42	45.18	6.41	310.24			
Royal Forest Department	1.16	23.28	28.20	34.17	9.27	11.87	107.95			
Budget for concessionaire	-	-	-	-	28.13	56.99	85.12			
Total	5,729.83	2347.16	2357.44	2265.46	2439.97	2312.07	7,506.93			

Source: Royal Forest Department

Table H-14 Potential of Using Wood

Species	Pillar	Small structural wood: shaft, purling, latch	Pole for supporting electric cable	Furniture	Bond wood	Frame-work of door, window	Panel	Tongued and grooved floors	Turnery and carving tools	Parquet-mosaic	Total potential
<i>Tectona grandis</i>	3	0	2	2	2	3	3	3	3	3	24
<i>Acacia auriculiformis</i>	0	0	1	3	2	2	2	3	3	3	19
<i>Toxicodendron succedanea</i>	2	0	0	3	3	3	3	1	3	1	19
<i>Gmelina arborea</i>	0	0	0	3	3	2	2	2	3	3	18
<i>Swietenia macrophylla</i> King	0	0	0	3	3	2	2	2	3	3	18
<i>Casuarina equisetifolia</i>	3	2	2	0	1	1	1	2	0	2	14
<i>Pinus kesiya</i>	0	0	0	3	2	2	2	1	2	1	13
<i>Casuarina junghuhiana</i>	2	1	2	1	1	1	0	2	0	2	12
<i>Eucalyptus camaldulensis</i>	1	1	2	0	0	1	1	1	0	1	8
<i>Melia azedarach</i>	0	0	0	2	2	0	1	0	2	0	7
<i>Anthocephalus chinensis</i>	0	0	0	2	0	0	1	0	3	0	6
<i>Ailanthus fauveliana</i> Pierre	0	0	0	2	0	0	1	0	2	0	5
<i>Leucaena leucocephala</i>	0	0	0	1	1	0	0	1	1	1	5
<i>Terameles nudiflora</i>	0	0	0	1	1	0	0	0	0	0	2

3 = Excellent 2 = Good 1 = Fair 0 = Bad

Source: Forestry and Forest Soil Survey in Thailand, RFD, 1987 (by Mr. Kazuhiro ISHIZUKA)

Table II-15 Production of Major Forest Products

Item	Unit	(Unit: m ³)						
		1989	1990	1991	1992	1993	1994	1995
Fire wood	1,000 m ³	426.0	390.1	409.4	289.0	267.9	173.1	151.2
Wood charcoal	1,000 m ³	325.5	274.5	225.2	145.2	128.9	122.0	90.4
Wood Tar	1,000 l	639.5	292.6	254.5	43.6	56.4	14.2	2.8
Barks	ton	55.6	42.7	23.8	0	0	0	0
Rattans	ton	1,234.9	1,097.6	867.9	417.1	329.5	544.7	58.8
Palm-leaf	1,000 sheets	302.2	9.9	155.0	250.0	48.8	175.0	442.0
Bamboos	million pieces	15.6	7.0	13.6	15.2	11.1	0.9	1.3
Bamboo stalks	million pieces	38.7	41.3	38.2	41.3	26.0	13.3	5.3

Source: Forestry Statistics of Thailand 1995

Table II-16 Production and Confiscation of Timber, Fuelwood and Wood Charcoal in 1995

Province	Teak		Others		Fuelwood		Wood charcoal	
	Product	Confiscate	Product	Confiscate	Product	Confiscate	Product	Confiscate
Whole country	2,154	2,016	32,730	6,370	151,220	7	90,362	3
Khon Kaen	0	0	219	219	0	0	0	0
Maha Sarakham	-	-	-	-	-	-	-	-
Mukdahan	0	0	87	82	0	0	0	0
Sakon Nakhon	0	0	280	280	0	0	0	0

Source: Forestry Statistics of Thailand 1995

Table II-17 Exports of Logs and Sawntimber by species in 1995

Item	Quantity (m ³)	Amount (baht)
Teak	6,168	410,874,446
Confier	4,111	121,049,215
Pra-du	5,057	221,678,152
Ching-chan	Less than 1.0 m ³	6,623
Ma-ka	3	341,867
Teng and Rang	Less than 1.0 m ³	2,851
Yang	10	121,926
Para-rubber wood	24,931	736,816,556
Eucalyptus	26,027	31,624,567
Dark red meranti, etc.	9	33,779
Sleepers	2	201,427
Others	14,215	693,381,517

Source: Forestry Statistics of Thailand 1995

4. Reforestation and Extension Project (REX)

Table II-18 Number of Seedling Receiver of REX (1991 - 1996)

	Maharakham N.C.	Udonthani N.C.	Total	%
1. Villager or Farmer	24,446	24,512	48,958	91
2. Government and State Enterprise	846	911	1,757	3
3. Temple	647	630	1,277	2
4. School and Educational Institute	743	877	1,620	3
5. Other projects	200	150	350	1
Total	26,882	27,080	53,962	100

N.C.: Nursery Center

Source: Plan and Result of The Reforestation and Extension Project in the Northeast of Thailand, March 1997

Table II-19 Number of Seedlings Production by Nursery Centers (1996)

Species	Maharakham N.C.	Udonthani N.C.	Total	%
1 <i>Pterocarpus macrocarpus</i>	2,301,423	2,030,230	4,331,653	43.3
2 <i>Azelia xylocarpa</i>	159,620	657,880	817,500	8.2
3 <i>Dalbergia cochinchinensis</i>	330,247	329,520	659,767	6.6
4 <i>Peltophorum dasyrachis</i>	291,740	151,300	443,040	4.4
5 <i>Xylia Kerrii</i>	249,270	65,000	314,270	3.1
6 <i>Cassia fistula</i>	213,930	91,920	305,850	3.1
7 <i>Acacia mangium</i>	156,500	128,200	284,700	2.8
8 <i>Shorea talura</i>	162,600	22,650	185,250	1.9
9 <i>Lagerstroemia speciosa</i>	77,000	81,780	158,780	1.6
10 <i>Cassia siamea</i>	50,350	89,280	139,630	1.4
11 <i>Tectona grandis</i>	99,058	23,050	122,108	1.2
12 Others	908,262	1,329,190	2,237,452	22.4
Total	5,000,000	5,000,000	10,000,000	100

N.C.: Nursery Center

Source: Plan and Result of The Reforestation and Extension Project in the Northeast of Thailand, March 1997

Table II-20 Community Forest Establishment by REX (1996)

Province	Location			Type of Land	Area (rai)	Planted Tree Species
	Muban	Tumbol	Amphur			
Khon Kaen	Nong Toa	Kok sri	Muang	Temple Land	34	5
Maharakham	Wang Kung	Khawn rai	Kosumpishai	Public Land	92	6
	Nong Bua	Loa Bua Ban	Chieng Yuan	School Land	20	2
	Nong Boon cho	Ku Thong	Chieng Yuan	Public Land	33	4
Sakon Nakhon	-	-	-	-	-	-
Mukdahan	-	-	-	-	-	-

Source: Plan and Result of The Reforestation and Extension Project in the Northeast of Thailand, March 1997

5. Eucalyptus Plantation in Khon Kaen

5.1 Process of Eucalyptus Plantation

RFD Khon Kaen encourages Eucalyptus plantation for the following reasons:

- Responsibility for the Plantation Target of the Government (40% of the land)
- Fast growing tree
- Durability of dryness and infertile soil
- Needless of management after plantation
- Useful as a cash crop by logging 7 times every 5 years

The pulp factory, Phoenix Pulp & Paper Public Co., Ltd. is situated in Khon Kaen since 1981. It supplies the seedlings and fertilizer for the first year with free to the farmers within 150 km. Eucalyptus is logged after 5 years and carried to the pulp factory by traders and there is no hard work for farmers. The minimum guarantee price of Eucalyptus is 700 B/MT by fresh weight. The customers are Japanese trading companies for 50% and domestic for 50%. The business crops by the pulp factory is as follows:

Table H-21 Business Crops by the Phoenix Pulp & Paper Public Co., Ltd. (1997)

Crops	Business in a Year	Min. Guarantee Price	Purchasing Price
Kenaf	30,000 M/T	2,000 B/MT dry weight	2,000 B/MT
Bamboo	400,000 M/T	700 B/MT fresh weight	810 B/MT
Eucalyptus	500,000 M/T	700 B/MT fresh weight	765 B/MT

5.2 Problems of Eucalyptus Plantation

5.2.1 Degradation of Natural Environment

Eucalyptus is planted with few fertilizer and can be a cash crop for 35 years. As it has a characteristics of fast growing by the strong absorbing power of soil nourishment, soil degradation will be increased. Any other plants can not grow and wild animals can not live in the forest of Eucalyptus monoculture. And it is reported that the function to prevent the erosion is low because of small crown.

5.2.2 Degradation of Social Environment

The net income of Eucalyptus plantation is 2,400 - 5,400 B/rai (= Income - Cost : B3,600) with the yield of 10 - 15 ton/rai and it means 480 - 1,080 B/rai/year. According to the information from the pulp factory, the price will be down next year by the request of trading companies.

Any other plant can not grow in the forest of Eucalyptus monoculture. While the positive impact of the forest by indigenous species is great for the local residents; collection of fuelwood, vegetables, mushrooms and medical

Table H-22 Forest Products in the Market in Khon Kaen

Product	Price (B/kg)
Brittle Mushroom	140 - 150
Blepharis Mushroom	50
Boletus Mushroom	150
Bamboo Shoot	20
Indian Laburnum (Cassia fistula)	40
Charcoal	5

Field survey, June 30, 1997

plants, hunting of birds and animals, etc. If they had natural forest, their food life would be rich with forest resources and they could save money for food and fuel.

Table II-23 Wood Price in Khon Kaen

Wood	Price
Selling Price of a Tree Market	
- Eucalyptus ϕ 5cm (1 year)	5 B/tree
- Eucalyptus ϕ 10cm (3 years)	17 B/tree
- Eucalyptus ϕ 15cm (5 years)	50 B/tree
- Bamboo	15 B/tree
Purchase Price of a Furniture Factory	
- <i>Tectona grandis</i> (Teak)	1,500 B/ft ³ (=16,700 B/m ³)
- <i>Lagerstroemia</i>	500 B/m ³
- <i>Dipterocarpus</i> (Rubber tree)	400 B/m ³

Field survey, June 30, 1997

5.3 Farmers' Ideas for Tree Plantation

The interview with farmers who had no forest was carried out and their ideas for tree plantation were as follows;

**Table H-24 Answer to the Question:
"If you have a land for tree plantation, what kind of trees do you want to plant?"**

Answerer	Tree Species	Reason
4 persons	Eucalyptus	Fast growing, good price, less maintenance, easy to sell. For charcoal making.
3 persons	Teak	Very high price.
1 person	Fruit tree	For family consumption
1 person	Mango	For family consumption
2 persons	Sugarcane	Not tree but sugarcane because it is cash crop. Long growing plant.
2 persons	Cassava	Only cassava planting because it is a cash crop and easy to plant. Long growing plant.
1 person	Nim	Fast growing, wider use.
1 person	Others	For charcoal making.

As the result of interview, 4 persons answered that they wanted to plant Eucalyptus. However, Eucalyptus is not high price (480 - 1,080 B/rai/year) and a farmer who has a Eucalyptus forest thinks to change it to sugarcane field because of its high price (4,000 B/rai/year). The information about price as same as market and growing method of crops including trees should be given to farmers.

6. Result of the Questionnaire in Villages

Table H-25 Result of the Questionnaire to the Village Leaders (Khon Kaen and Maha Sarakham), June 1997

Province	Forest No.	Village Name	Fuel Consumption in village			Condition	Community Forest		Private Forest		Major Crops (Rice is a major crop in all villages)	
			Wood	Char-coal	Price (B)		Cans	Price (B/15kg)	Indige-nous	Teak		Indige-nous
KK	1	Nong Phavom	35%	5%	180	60%	180	70	0	0	cassava, sugarcane, vegetable	
KK	1	Nong Tao	30%	30%	160/50kg	40%	170	80	0	0	cassava, sugarcane, vegetable, foxtail, bamboosugarcane	
KK	2	Lad Na Piang	100%	100%	180/bag	30%	250	80	0	0	cassava, sugarcane, vegetable, foxtail, bamboosugarcane	
KK	3	Jang Tub Ma	90%	90%		10%		80	0	0	Sugarcane, Krnaf	
KK	3	Ban Non Ngarm*	40%	60%	150/60kg	60%	180	80	0	0	sugarcane, cotton, eucalyptus	
KK	4	Hing Khong	100%	100%	160	5%	200	60	Teak 5	2	1	Sugarcane, vegetable
KK	4	Non Khong*	100%	20%	150kg	85%	160	240	0	12		Sugarcane
KK	4	Kham Hua Chang*	70%	20%	190/50kg	80%	180	32	7	0	50	cassava, sugarcane, vegetable
KK	5	Lao Yai (No.82)	10%	60%	200	30%	155	0	0	0	30	cassava, sugarcane, pine
KK	5	Lao Yai (No.85)	40%	40%	200/50kg	20%	170	0	0	0	30	cassava, sugarcane, eucalyptus
KK	5	Sam Rong	60%	20%	180	20%	200	200	6	200	5	cassava, sugarcane, corn, krnaf, fruit
KK	6	Chot Nong Khae	10%	60%	170kg	30%	160	35	25	0	0	sugarcane, vegetable, eucalyptus
KK	6	Ban Huan Kho	20%	10%	170	70%	160	40	0	0	10	cassava, sugarcane, vegetable, fruit, eucalyptus
KK	6	Phai Kho Noi	50%	75%	200/bag	15%	170	330	0	0	500	cassava, sugarcane, vegetable, fruit, eucalyptus
KK	6	Ban Sok Nuk	55%	30%	150	15%	170	40	0	0	10	cassava, sugarcane, vegetable, fruit, eucalyptus
KK	6	Marp Ta Kla	100%	30%	180/50kg	50%	170					cassava, sugarcane, vegetable, eucalyptus, teak
KK	6	Nong Nam Khum Nua	0%	70%	200/bag	30%						cassava
KK	6	Ban Hua Rae	93%	2%	150/bag	5%	150	50	0	0	20	cassava, sugarcane, eucalyptus
KK	6	Ban Nong Wang Nong	0%	30%	200/bag	70%	175	80	0	0	20	cassava, sugarcane, vegetable, eucalyptus, teak
KK	6	Par Por	10%	10%		80%	165					cassava
MHS	1	Na Kham Noi	0%	95%		5%	170					cassava, sugarcane, eucalyptus
MHS	2	Hun Hae	60%	60%	150/bag	40%	160	50	0	0	20	cassava, sugarcane, eucalyptus
MHS	3	Non Khu	38%	60%	160	2%		80	0	0	20	cassava, sugarcane, eucalyptus
MHS	3	Sivlan	30%	70%		0%						cassava, sugarcane, vegetable
MHS	4	Nong Ngua Noi	95%	95%		5%	175					cassava, sugarcane, vegetable
MHS	5	Khok Lam	70%	25%	130	5%	170					cassava, sugarcane, vegetable
MHS	5	Sala	40%	50%	150	10%	160					cassava, sugarcane, vegetable
MHS	7	Dong Keng	40%	40%		20%	175					cassava, sugarcane, vegetable
MHS	8	Sam Rong	90%	90%	180/bag	5%	180					cassava, sugarcane, vegetable
MHS	10	Non Hin Hae	50%	30%		20%						cassava

*: It means that the answers of the leader and women were difference, and the women's answer was recorded.

Table H-26 Result of the Questionnaire to the Village Leaders (Mukdahan and Sakhon Nakhon), June 1997

Province	Forest No.	Village Name	Fuel Consumption in village			Conservation Forest		Community Forest		Community Forest (rai)	Private Forest (rai)	Major Crops	Condition of Buffer Zone (rai)					Remarks		
			Wood	Char-coal	Price (B)	Gas	Price (B) / (1.5kg)	Condition	Activities				Condition	Activities	Indigo-nous	Eucalyptus	Rice field		Sugar-cane	Upland crop
MKD	1	Na Sok	50%	30%	140 /25kg	20%	140	good afforestation	None	300	0	200	(Rice is a major crop in all villages)	0	0	0	100	0	0	Enough water
MKD	2	Na Yo	85%	85%	120 /bag	15%		1500 rai					cassava, sugarcane, cotton, rubber							
MKD	2	Khok Tabeng	100%	100%		3	house	None					cassava, sugarcane, vegetable, bean							
MKD	3	Khun Lai	45%	50%	120 /bag	5%		Not exist					cassava, sugarcane, vegetable							
MKD	3	Na Charoen	15%	20%	200 /bag	15%		300 rai					cassava, sugarcane, vegetable, eucalyptus							
MKD	4	Ban Nong Mok	98%	97%	130 /bag	3%		20 rai												
MKD	5	Ban Loop Ping	10%	80%	170 /40kg	10%	180	desolated natural	cattle raising, collection of fuelwood, mushroom, plant for eat, lossing, cattle raising, collection of mushroom, plant for eat, lossing, cattle raising,	250	0	150	cassava, sugarcane	Yes	Yes	Yes	Yes	Yes	Yes	
MKD	5	Ban Wang	0%	80%	180 /40kg	20%	180	desolated natural	collection of fuelwood, mushroom, plant for eat, lossing, cattle raising,	130	0	100	cassava, sugarcane, kenaf	Yes	Yes	Yes	Yes	Yes	Yes	
MKD	7	Khun Phok	70%	20%	160 /40kg	10%	180	good natural	collection of fuelwood, mushroom, plant for eat, lossing,	2	0	800	cassava, sugarcane	Yes	Yes	Yes	Yes	Yes	Yes	
MKD	8	Kaeng Nang	1%	99%	100 /20kg	10	house	Not exist												
MKD	8	Park Chong	70%	30%	150 /50kg	0%	150	good, natural	Collection of fuelwood, mushroom, etc.	20	0	60	cassava (2000 rai), eucalyptus (200 rai)	0	0	750	0	0	0	0
MKD	8	Phon Hai	70%	30%	150 /50kg	0		good, natural	Collection of fuelwood, mushroom, etc.	200	0	200	cassava, vegetable, papaya	800	100	100	0	9	9	0
MKD	8	Tiu	100%	100%		2	house	desolated natural	Collection of fuelwood	3-4	1		cassava, vegetable, eucalyptus							

Province	Forest No.	Village Name	Fuel Consumption in village				Conservation Forest		Community Forest		Community Forest (ha)			Private Forest (ha)		Major Crops (Rice is a major crop in all villages)	Condition of Buffer Zone (ha)						Remarks
			Wood	Char-coal	Price (B)	Gas	Price (B /15kg)	Condition	Activities	Condition	Activities	Indigenous	Eucalyptus	Indigenous	Eucalyptus		Indigenous	Rice field	Sugar-cane	Cas-sava	Fuca-hyphus	Upland crop	
MKD	9	Ban Pa Wai	69%	30%	150 /50kg	0%	150			good, problem with villagers	cattle raising, collection of fuelwood, mushroom	2000	0	1500	0	cassava, sugarcane	0	500	1000	0	0	0	
MKD	10	Ban Cha Nod Noi	70%	25%	150 /40kg	5%	180	good natural	cattle raising, collection of fuelwood, mushroom, etc.	god natural	collection of fuelwood, mushroom, etc.	100	0	2500	0	cassava, sugarcane	Yes	Yes	Yes				
MKD	11	Nong Bua	50%	40%	120 /50kg	10%		under afforestation, problem with villagers	Collection of fuelwood, mushroom, etc.	under afforestation, problem with villagers	Collection of fuelwood, mushroom, etc.	465	0	2000 - 3000	50	cassava, sugarcane, vegetable	1000	0	1000	2000	0	1000	
SKN	1	Dong Mo Thong	10%	60%	120 /50kg	30%	150	-	-	flooding	Collection of fuelwood	252	0	0	150	cassava, sugarcane, onion	-	-	-	-	-	-	
SKN	2	Kham Chareon	85%	0%		15%	160	-	-	Not exist		-	-	200	cassava, sugarcane, eucalyptus	-	-	-	-	-	-		
SKN	3	Kut Bak	30%	30%	150 /bag	40%	150			good natural					cassava, sugarcane, vegetable, eucalyptus						foods		
SKN	4	Phon Ngam	95%	95%	140 /50kg	5%	180			Not exist		-	-		acacia, cassava, vegetable, teak, acacia						river bank erosion		
SKN	6	Bang Phu Wong	75%	75%	120 /bag		165			Under afforestation, problem with villagers		25	0	0	cassava, sugarcane, eucalyptus	0	300	600	300	4470	0	0	
SKN	7	Bang Fang	70%	30%	170 /50kg	0%				good natural		50	0	10	onion, chili, etc.	-	-	-	-	-	-	Reservoir	

Table II-27 Result of the Questionnaire to the villagers in Khon Kaen (July 1997)

Study Area	Village Name (*: not in the list)	Answerer	Male / Female	Family		Land (rai)	Forest		Annual Fuel Consumption			Reason not to Use the Gas		Fuelwood Collection		Family Budget		Land Owner	
				Work in Bangkok	Work in Khon Kaen City		Rental	Indigenous species	Eucalyptus	Area (rai)	Gas (tank)	Charcoal (bag)	Fuelwood (bag)	Expensive	Difficult to buy (km)	Difficult to use	Dangerous		Man
1	Bang Nong Tao		M	4	0	0	23	10	0	10	5	0			x				M
1	Bang Nong Tao		M	6	0	0	16	13	0	60	6	0			x				M
1	Non Khong	village leader	M	5	4	0	8	12	2	10	2	12							M
1	Non Khong	charcoal maker	F	5	0	0	7	14	2	12	3	0	10	x					F
1	Non Khong	general shop	F	9	0	0	37	15	14	x	x	2	0						M
3	Ban Non Ngarm*		M	3	0	1		30	9	x	36	5	0	x					F
3	Ban Non Ngarm*		M	7	0	0	26	8	26	x	36	4	18						M
3	Ban Non Ngarm*		M	6	0	2	1	92	100	x	12	24	12						M
4	Kham Hua Chang	village leader	M	5		+	5	10	0	0	0	0	8						M
4	Kham Hua Chang	village leader	F	4	3	0		4	6	0	48	0	0	x					F
6	Chot Nong Khae	village leader	M	4	0	1	3	25	0	0	4	6							M
6	Chot Nong Khae	general/gas shop	M	4	0	2		19	0	0	2	4							M
6	Chot Nong Khae	charcoal maker	M	3	0	0	0	5	11	0	0	36	0	x					F
6	Huai Kho	village leader	M	5	0	2	10	10	0	1	2	12							M
6	Huai Kho	general/gas shop	M	4	0	2	7	43	0	0	0	7							M
6	Huai Kho		M	5	0	0	10	10	0	48	0	0	x						F
6	Huai Kho Nai	food shop	F	3	0	0		4	0	0	0	12							F
6	Huai Kho Nai		F	9	0	1	20		0	6	6	12							M
6	Huai Rae	family of leader	M	9	0	3	30		0	36	0	0	x						M
6	Huai Rae		F	3	0	0	1		0	0	48	0	x	40					F
6	Huai Rae		F	12	4		35	42	0	0	6	5							M
6	Marp Ta Kla	village leader	M	7	0	2	100		40	x	48	12	16						M
6	Marp Ta Kla		F	4	0	1	20		4	x	0	36	0	x					M
6	Marp Ta Kla	general/gas shop	M	6	0	3	32	15	0	0	0	12							F
6	Nong Wang Nang Pao	village leader	M	4	0	2	37	21	21	x	0	2	10						F
6	Nong Wang Nang Pao	gas shop	M	4	0	0	8	20	15	x	0	0	10						M
6	Nong Wang Nang Pao	charcoal maker	M	6	0	0		11	0	0	24	0	x						F
6	Nong Wang Nang Pao	general/silk shop	F	7	0	4	58		11	x	10	5	6						M
6	Sok Nak	village leader	M	4	0	0		1	0	0	48	6							M
6	Sok Nak		F	2	0	0	4		0	0	48	1	0	x					F
6	Sok Nak	food/gas shop	F	2	0	0	1		0	0	12	6							F

Remarks: The answers were mainly got from village leaders, gas shops and villagers who use only fuelwood and charcoal.

7. Environmental Activities

7.1 Royal Forest Department (RFD)

Table H-28 Forest Village Project in the Four Provinces

Project name	Tambon	Amphoe	Total area (rai)	Reforest area (rai)
Khon Kaen				
Huay Bong-Phrabath	Whathong	Phuwiang	681	
Khokluang	Suangmon	Mungchakir	12,000	
Nonchard Dongkeng *	Dongkeng	Nongsonghong	1,179	
Mukdahan				
Pa Dong Moo	Pone Sai	Muang	20,000	900
Pa Dong Phupan	Ban Lao	Kunchae	66,500	2,370
Pa Dong Moo - Pa Dong Phuphan	Koktoon	Dong Luang	78,041	3,350
Sakon Nakhon				
Dong Chomphuphan- Don Ka Chur		Kut Bak	418,125	55,200

***: Nonchard Dongkeng Project**

A officer of RFD stays in a village as a teacher of mathematics since 3 years ago. He is a specialist of forestry and works as a leader of this King's project. Collection of medical plants and animals are prohibited and collection of firewood and mushrooms are permitted by the rules of this Project. Villagers understand the benefits of natural forest and join the forest plantation activities.

Other Activities of RFD are as follows:

Khon Kaen:	Afforestation:	225,314 rai	(1954 - 1996)
Maha Sarakham:	-		
Mukdahan:	Plantation of roadside trees:	1,000,000 trees	
	Support of farmers for afforestation:	8,003 rai	(1996)
Sakon Nakhon:	Seedling production:	25 species, total 580,700 trees	(1996)

7.2 North-Eastern Region Environmental Office Khon Kaen (Tel: 236-499)

Documents concerning environment are opened and able to read.

7.3 Regional Community Forestry Training Center, Kasetsart University Bangkok (Tel: 579-0108)

Training courses and workshops for departmental personnel, NGOs and community leaders for the sustainable management of forest resources.

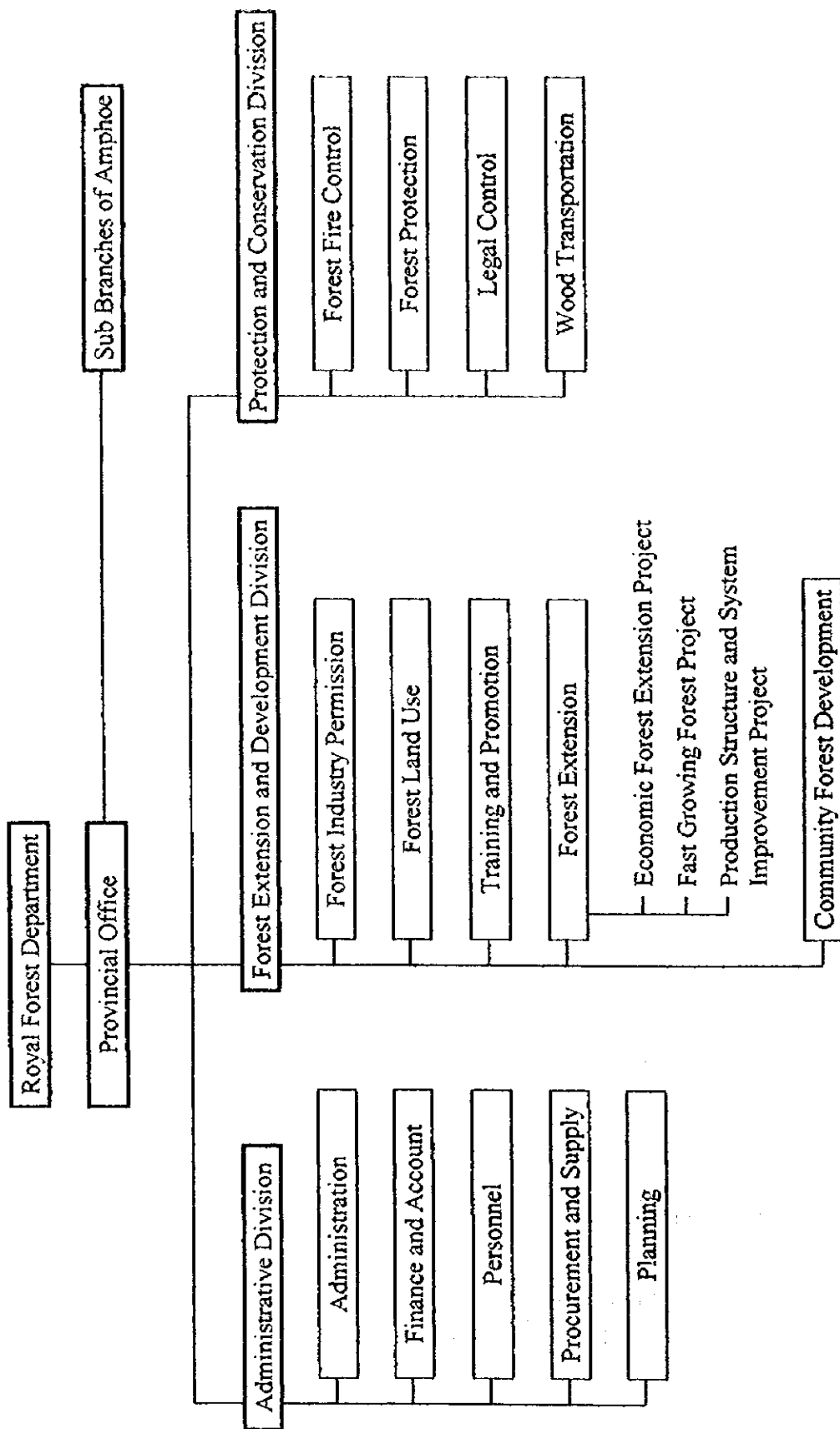


Figure H-5 Organization of Royal Forest Department, Provincial Office

Table H-29 Forestry Projects in the Northeastern Region

Project name	Executing agency	Year	Method	Result and problem
Forest Village Program	RFD	1976 -	Provision of farmland (2.3 ha), land for house (0.8 ha), electric, water supply to farmers in the national forest to promote the afforestation.	Completion of 77 forest villages and 32,000 ha was provided to 23,000 households in 144 villages until 1984. Selling of the land by settlers, difficulty of making a living in the decreased farm land.
Village Woodlot Project	RFD, USAID	1981 - 1985	Afforestation and seedling production.	6,000 rai of model forest, provision of 10 million seedling. Invasion of farmers in the forest.
STK (Sit Thi Thamkin) Project	RFD	1982 -	Provision of land, free of charge within 2.4 ha and rental within 8 ha.	Provision of 400,000 ha to 250,000 households in 574 forests until 1985.
Green Esaan Project	MOAC, Military Service	1987 - 1992	Forced settlement from national forest, and afforestation.	Strong critique by the public opinion. The project was stopped.
Khon Kaen University - Ford Foundation Social Forestry Research Project (in TUSFP Project)	RFD, KKU, Ford Foundation	1988 -	Community organizer of RFD stays in village to promote the afforestation.	

KKU: Khon Kaen University
 MOAC: Ministry of Agriculture and Cooperatives
 TUSFP Project: Thailand Upland Social Forestry Pilot Project (1982 -)

Remarks: Cause of deforestation in Thailand; 1. Lumbering on a large scale lawfully and illegally
 2. Invasion of farmers to get a farmland
 3. Increase of swidden cultivation by mountainous ethnic
 4. Development of dam, road, house, industry, mineral resources, etc.
 5. Military strategy against communist
 6. Decrease of interest since the lumbering was prohibited by law

7.4 NGOs concerning Reforestation in Thailand

1) Asia Children's Education Center (ACEC) Khon Kaen (Tel: 043-342-890)

One of the main activities of ACEC in 1997 is as follows;

Project Name: Fruit Tree Development Project in Northeast

Researchers: Assoc. Prof. Dr. Yuphin Tacchamance, Khon Kaen University
Assoc. Prof. Taweekiat Yimsawadi, Khon Kaen University

Study Area: 2 elementary schools in Kalasin Province

Objectives:

1. Increase of trees
2. Agricultural training for the teachers and students
3. Fruit consumption supporting for students
(Lack of potassium is one of causes of death.)
4. Increase of fruit trees and getting the budget for school
by the stock sales

Methods:

1. Selection of the schools for the Project
2. Preparation of sites for fruit growing
3. Training of staffs for the fruit growing
4. Visiting of the sites for support
5. Training for fruit growing propagation

Budget:

1. Fuel for transport	3,000 B
2. Car driver salary	2,000 B
3. Foods for staffs	4,000 B
4. Plant stock (15,000 trees/school)	30,000 B
5. Insecticides and fertilizers	3,000 B
6. Other necessary factors	7,000 B
7. Weed controls	4,000 B
Total	53,000 B

2) North East Rural Development Association (NERDA)

Khon Kaen (Tel: 043-241-788)

Number of Staffs: 22 in the Northeast

Support: 400 families in Khon Kaen (19 villages)
3,200 families in the Northeast (273 villages)

Activities:

1. Education and training of children;
Importance of village life, agricultural practice and food processing
2. Health care (visit of traditional doctor)
3. Community forest training (including ALRO Area);
 - Farmers' leader training
 - Seedling of 200 species/6 rai/family

4. Promotion of women's association; production of cotton, silk, cloth, etc.
5. Cultural exchange with Japanese NGO, Daichi-wo-Mamoru-Kai

3) Population and Community Development Association (PDA)

Khon Kaen (Tel: 043-242-032)

Number of staffs: 55

Activities:

1. Birth control project by the government in Khon Kaen
2. Development of rural life
3. Sanitation
4. Reforestation for the Forest Plantation Target by RFD in the government forest;
 - 3,000 rai by IFCT and Sahaunion-Groups (private company)
 - 1,500 rai by RFD; plantation of Eucalyptus
 - 4,000 rai by PDA (1995 - 1998); plantation of indigenous species: 1995 - 1996
management: 1997 - 1998
5. Forestation of community forest;
 - Meeting in over 100 villages in Khon Kaen
 - Provision of seedling
 - Visiting villages for the support 2 times/year
6. Water resource development; community tap water, underground water and river for irrigation, big tank for rainwater (budget from German Agro Action)

4) OISCA-International

(Tel: Japan 03-3322-5161)

Children Forest Program: Afforestation in 21 schools, and environmental and forestry education for the development of community forest in the northern region.

7.5 Other NGOs in the North Eastern Region

5) Plan International

Khon Kaen (Tel: 043-237-763)

Approximately 92 % of total income represents Foster Parent sponsorship funds; Netherlands (44.8 %), Japan (13.7 %), USA (11.7 %), Canada (10 %) and so on. In the Fiscal Year 1995, Plan Thailand had the following program;

- Khon Kaen (Tel: 043-237-763): Basic needs (health, education, water, hygiene, housing), Occupational skills, Community development, HIV/AIDS
- Maha Sarakham (Tel: 043-721-492): Integrated village development (economic development, health, educational support, leadership training), HIV/AIDS

6) Pink Project Khon Kaen

(Tel: 043-224-605, 224-659)

Encouragement of people for the community development and support the community to have revolving fund for the village development and be able to manage the fund by themselves.

7) Cooperative Committee of Esaan Private Development Organization

Khon Kaen (Tel: 043-226-542)

Supporting strength of the members and branches in the north eastern region. Cooperation with teacher's college and university for the conservation of natural resource.

8) Esaan Farmer Assembly for approving Land Holding and Improving Natural Resource

Khon Kaen (Tel & Fax: 043-220-895)

Promotion of public and private organizations, and education for the improvement and management of natural resource.

9) Community Base Integrated Rural Development Khon Kaen (Tel: 043-242-032)

Support of people to involve with rural development, education and service of family planning.

10) World Vision Foundation of Thailand, Khon Kaen (Tel: 043-222-870)

Promotion of education by scholarship, career training, use of water jars to keep rain water and toilet for the control of diarrhea and parasite, vaccination, and provision of clean water.

11) Un-Chu-That-Esaan Club Mahasarakham

Training of agriculture and conservation of natural and environmental resource.

12) Village Volunteer Organization for Rural Development

Mahasarakham (Tel: 043-241-917)

Integrated community development; rice bank, bank of medicine, co-operation, training center and publicize of developing baby center, construction of deep well, weave cloth, silk worm farming, local doctor, fish farm in paddy field, training of youth, agricultural training, training of leader, and bank of cow and buffalo.

8. Initial Environmental Examination

Project: Integrated Agriculture Development in the Agricultural Land Reform Areas
(including construction of ponds, reservoirs, roads and irrigation facilities, change of cropping pattern, and formation of farmers' organizations)

Table II-30 Initial Environmental Examination (based on JICA Environmental Guidelines)
Comparison of two cases: No problem and Problem

××× : Serious negative impact expected ●●● : Important positive impact expected
 ×× : Some negative impact expected ●● : Some positive impact expected
 × : Extent of negative impact not known ● : Extent of positive impact not known
 □ : No impact

1/3

Environmental Item	In case of no problem in the project		In case of problem in the project	
	Evaluation	Hypothetical items for the evaluation basis	Evaluation	Hypothetical items for the evaluation basis
1. Settlement	××	Possibility of settlement and decrease of farm land by the construction of pond, reservoir and road.	××	Possibility of settlement and decrease of farm land by the construction of pond, reservoir and road.
2. Involuntary resettlement	□		××	For the dam construction.
3. Substantial changes in the way of life	●●	Increase of farm income.	□	No change because of the failure of participation in the Project.
4. Conflict among people	●●	Good relation among ALRO, RFD and villagers.	××	Conflict between RFD and villagers about the conservation forest, among villagers for irrigation water.
5. Impact on native people	●●	Project includes the area of ethnic minorities.	××	Project includes the area of ethnic minorities.
6. Population increase	××	Increase of job opportunities will bring it	××	Increase of job opportunities will bring it
7. Drastic change in population composition	□		□	
8. Changes in bases of economic activities	●●	Economic activities will be good by the income increase.	□	No change because of the failure of participation in the Project.
9. Occupational change and loss of job opportunities	●●	Construction of pond and irrigation farming will make job opportunities.	□	
10. Increase in income disparities	●●●	Income of low income farmers will be increased.	××	Expenses for seeds, fertilizer, etc. will be a heavy burden for low income farmers.
11. Adjustment of water or fishing rights	●●●	Foundation of water and fishing committees will contribute the rural development.	×××	Irrigation facilities won't be used efficiently and impartially. Benefits of downstream villages will be decrease.
12. Changes in social and institutional structures	●●●	Strengthen of rural organizations.	□	
13. Changes in existing institutions and customs	●●●	Formation of the conception for forest conservation.	□	
14. Increased use of agrochemicals	××	Use of chemical fertilizer will increase.	××	Use of chemical fertilizer will increase.
15. Outbreak of endemic diseases	□	No serious disease because of small-scale farming.	□	

Environmental Item	In case of no problem in the project		In case of problem in the project	
	Evaluation	Hypothetical items for the evaluation basis	Evaluation	Hypothetical items for the evaluation basis
16. Spreading of endemic diseases	<input type="checkbox"/>	No serious disease because of small-scale farming.	<input type="checkbox"/>	
17. Residual toxicity of agrochemicals	<input type="checkbox"/>	MOAC will support farmers for the appropriate use of insecticides.	×	Use of high toxic agrochemicals may increase a little.
18. Increase in domestic and other human wastes	× ×	Increase of population will bring it.	× ×	Increase of population will bring it.
19. Impairment of cultural assets	<input type="checkbox"/>	No cultural assets in the Project area	<input type="checkbox"/>	
20. Damage to aesthetic sites	●●	Project is expected the impact for the conservation of forest.	× × ×	Encroachment of the conservation forest won't be stopped. Some dams are planned in the conservation forest.
21. Impairment of buried assets	<input type="checkbox"/>	No buried assets.	<input type="checkbox"/>	
22. Changes in vegetation	●●●	Monoculture will be changed to the integrated farming. Afforestation will be promoted.	× × ×	Encroachment of the conservation forest won't be stopped.
23. Negative impact on important or indigenous fauna and flora	●	Conservation of forest where important species may exist will be promoted.	×	Encroachment of the forest will bring the negative impact if there are important species.
24. Degradation of ecosystems with biological diversity	●●	Conservation of forest where various species exist will be promoted.	× ×	Encroachment of the forest will bring the degradation of ecosystems.
25. Proliferation of exotic and/or hazardous species	<input type="checkbox"/>	Project objectives include sustainable agriculture that won't bring hazardous species.	<input type="checkbox"/>	There won't be a serious change in the style of agriculture to bring them.
26. Destruction of wetlands and peat lands	<input type="checkbox"/>	No wetland and peat land.	<input type="checkbox"/>	
27. Decrease of tropical rain forests and wild lands	× × ×	Construction of dams in the conservation forest.	× × ×	Construction of dams in the conservation forest.
28. Destruction of mangrove forests	<input type="checkbox"/>	No mangrove forest.	<input type="checkbox"/>	
29. Degradation of coral reefs	<input type="checkbox"/>	No coral reef.	<input type="checkbox"/>	
30. Soil erosion	●●●	Project objectives include soil conservation.	× × ×	Action for soil conservation won't be done and soil erosion won't be stopped.
31. Soil salinization	<input type="checkbox"/>	Ground water and some ponds which have a high salinity won't be used in the Project. Water management will be well done.	× ×	There may be some areas of high saline groundwater and the lack of irrigation management may bring soil salinization in the study area and the lowland area.
32. Deterioration of soil fertility	●●●	Project objectives include soil conservation.	× × ×	Action for soil conservation won't be done and the deterioration of soil fertility will be serious.
33. Soil contamination by agrochemicals and others	<input type="checkbox"/>	MOAC will support farmers for the appropriate use of agrochemicals.	× ×	Use of agrochemicals will increase according to the increase of crop production.
34. Devastation or desertification of land	●●●	Project objectives include soil conservation.	× ×	Devastation of land by crops of high fertilizer absorption power.

Environmental Item	In case of no problem in the project		In case of problem in the project	
	Evaluation	Hypothetical items for the evaluation basis	Evaluation	Hypothetical items for the evaluation basis
35. Devastation of hinterland	●●●	Project will bring the conservation of forest around the project area.	××	Devastation of forest will be contented to cut trees or to get farmland.
36. Ground subsidence	<input type="checkbox"/>	No excessive exploitation of groundwater.	<input type="checkbox"/>	
37. Change in surface water hydrology	××	Because of the construction of reservoir.	××	Failure of management of reservoir will bring some problems.
38. Change in ground water hydrology	×	Because of the development of ground water.	×	
39. Inundation	●	Afforestation and construction of dam will decrease the victim of inundation in the lowland.	●	Construction of dam will decrease the victim of inundation in the lowland.
40. Sedimentation	××	Sedimentation in reservoir.	××	Sedimentation in reservoir.
41. Riverbed degradation	×	At the downstream of reservoir.	×	At the downstream of reservoir.
42. Impediment of inland navigation	<input type="checkbox"/>	No inland navigation.	<input type="checkbox"/>	
43. Deterioration of water quality	×		×	
44. Water eutrophication	<input type="checkbox"/>	No possibility.	<input type="checkbox"/>	
45. Sea water intrusion	<input type="checkbox"/>	No relation.	<input type="checkbox"/>	
46. Change in temperature of water	<input type="checkbox"/>	No possibility.	<input type="checkbox"/>	
47. Air pollution	<input type="checkbox"/>	No relation.	<input type="checkbox"/>	

Table H-31 Mitigation for the Hypothetical Problem

Environmental Item	In case of problem		Mitigation
	Evaluation	Evaluation basis	
1. Settlement	<input type="checkbox"/>	Possibility of settlement and decrease of farm land by the construction of pond, reservoir and road.	Good communication of ALRO and people is required in advance.
2. Involuntary resettlement	××	For the dam construction.	Good communication of ALRO and people is required in advance and appropriate compensation estimate is necessary.
3. Substantial changes in the way of life	<input type="checkbox"/>	No change because of the failure of participation in the Project.	Continuous encouragement activities of MOAC in villages is required.
4. Conflict among people	××	Conflict between RFD and villagers about the conservation forest, among villagers for irrigation water.	Encouragement activities of RFD in villages is required.
5. Impact on native people	××	Project includes the area of ethnic minorities	
6. Population increase	××		Enlightenment of family planning is required by DOH.
8. Changes in bases of economic activities	<input type="checkbox"/>	No change because of the failure of participation in the Project.	Encouragement activities of MOAC in villages is required.

Environmental Item	In case of problem		Mitigation
	Evaluation	Evaluation basis	
9. Occupational change and loss of job opportunities		No change because of the failure of participation in the Project.	Encouragement activities of MOAC in villages is required.
10. Increase in income disparities	× ×	Expenses for seeds, fertilizer, etc. will be a heavy burden for low income farmers.	Improvement of agricultural cooperative to help them.
11. Adjustment of water or fishing rights	× × ×	Irrigation facilities won't be used efficiently and impartially. Benefits of downstream villages will be decrease.	Hydrological study around the project area is required. Continuous supervision of MOAC is required.
14. Increased use of agrochemicals	× ×	Use of chemical fertilizer will increase.	Proper guidance for farmers about the treatment of agrochemicals is required.
18. Increase in domestic and other human wastes	× ×	Increase of population will bring it.	Recycle system of resources should be developed in Thailand.
20. Damage to aesthetic sites	× ×	Encroachment of the conservation forest won't be stopped. Some dams are planned in the conservation forest.	Encouragement activities of MOAC for the efficient land use and the conservation of forests is required. Special care during the construction, plantation and its management is required around the dam site.
22. Changes in vegetation	× × ×	Encroachment of the conservation forest won't be stopped.	Encouragement activities of MOAC in villages is required.
24. Degradation of ecosystems with biological diversity	× ×	Encroachment of the forest will bring the degradation of ecosystems.	
27. Decrease of tropical rain forests and wild lands	× × ×	Construction of dams in the conservation forest	Special care during the construction, plantation and its management is required around the dam site.
30. Soil erosion	× × ×	Action for soil conservation won't be done and soil erosion won't be stopped.	Encouragement activities of MOAC in villages is required.
31. Soil salinization	× ×	There may be some areas of high saline groundwater and the lack of irrigation management may bring soil salinization in the study area and the lowland area.	Hydrological study is required and irrigation system should not constructed in this area.
32. Deterioration of soil fertility	× × ×	Action for soil conservation won't be done and the deterioration of soil fertility will be stopped.	Organic fertilizer should be provided by MOAC. Encouragement activities of MOAC in villages is required.
33. Soil contamination by agrochemicals and others	× ×	Use of agrochemicals will be increased according to the increase of crop production.	Proper guidance for farmers about the treatment of agrochemicals is required.
34. Devastation or desertification of land	× ×	Devastation of land by crops of high fertilizer absorption power.	Encouragement activities of MOAC in villages are required.
35. Devastation of hinterland	× ×	Devastation of forest will be contented to cut trees or to get farmland.	
37. Change in surface water hydrology	× ×	Failure of management of reservoir will bring some problems.	
40. Sedimentation	× ×	Sedimentation in reservoir.	Conservation of natural forest in the upperstream is required.

**Table II-32 Proclamation for Types and Sizes of Projects
Required Environmental Impact Assessment (No. 1)**

<i>Types of Project or Activities</i>	<i>Sizes</i>
1. Dam or reservoir	Storage volume of 100 MCM or more storage surface area of 15 km ² or more
2. Irrigation	Irrigated area of 80,000 rai (12,800 ha) or more
3. Commercial airport	All sizes
4. Hotel or resort facilities in the environmentally sensitive areas such as areas adjacent to rivers, coastal areas, lakes or beaches or in the vicinity of national parks or historical parks	80 rooms or more
5. Mass transit system and expressway as defined by the Mass Transit System and Expressway Act or projects similar to expressway or rail type of mass transit system	All sizes
6. Mining as defined by the Mineral Act	All sizes
7. Industrial Estate as defined by the Industrial Estate Authority of Thailand Act, or project similar to Industrial Estate	All sizes
8. Commercial port and harbor	With capacity for vessels of 500 ton-gross or more
9. Thermal power plant	Capacity of 10 MW or more
10. Industries	
(1) Petrochemical industry	Using raw materials which is produced from oil refinery and/or natural gas separation with production capacity of 100 tons/day or more
(2) Oil refinery	All sizes
(3) Natural gas separation of processing	All sizes
(4) Chlor-alkaline industry requiring NaCl as raw material for production, Na ₂ CO ₂ , NaOH, HCl, Cl ₂ , NaOCl and bleaching power	Production capacity of each or combined products of 100 tons/day or more
(5) Irons and/or steel industry	Production capacity of 100 tons/day or more (production capacity calculated by using production capacity of furnace in ton/hour multiply by 24 hours)
(6) Cement industry	All sizes
(7) Smelting industry other than iron and steel	Production capacity of 50 tons/day or more
(8) Pulp industry	Production capacity of 50 tons/day or more
11. All projects in watershed classified as 1 B by the Cabinet Resolution	All sizes

**Table II-33 Proclamation for Types and Sizes of Projects
Required Environmental Impact Assessment (No. 2)**

<i>Types of Project or Activities</i>	<i>Sizes</i>
1. Coastal reclamation	All sizes
2. Building in areas adjacent to rivers, coastal areas, lakes or beaches or in the vicinity of national parks or historical parks	Building: 1. 23.0 meter height or more 2. Total area of all floors or area of any floor in the same building is 10,000 m ² or more
3. Residential condominium as defined by Condominium Act	80 units or more
4. Land appropriate (or housing development)	Number of land plot is 500 plots or more or total land area is more than 100 rai (16 ha)
5. Hospital which located: (1) In area adjacent to rivers, coastal areas, lakes, beaches (2) In area other than (1)	5.1 30 beds or more 5.2 60 beds or more
6. Pesticide industry or industry producing active ingredient by chemical process	All sizes
7. Chemical fertilizer industry using chemical process in production	All sizes
8. Highway or road defined by Highway Act passing through following area (1) Wildlife sanctuaries and wildlife non-hunting areas as defined by Wildlife Conservation and Protect Regulation (2) National parks as defined by National Park Act (3) Watershed class 2 as approved by the cabinet (4) Mangrove forests designated as the National Forest Preserves (5) Coastal area within 50 meters from the maximum sea level	All projects which equivalent to or above the minimum standard of rural highway including roadbed expansion.

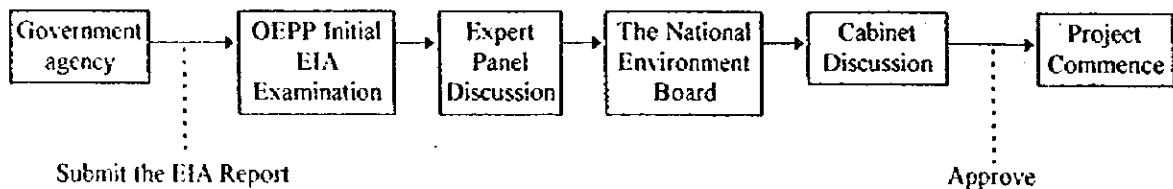


Figure H-6 Procedure for EIA for Government Project

9. Forest Related Regulation and Condition of Illegal Farming in the Forest

Table II-34 Legal Permission for the Use of Forest Zone and Land Reform Area

Item	Conservation Zone			Economic Zone	Agricultural Land Reform Area
	Wild Life Sanctuary	National Park	Other C Zone		
Responsible Agency	RFD				ALRO
Construction of reservoir and pond					
- Public use			O	O	O
- Private use					O
Mining				O	O
Logging of natural indigenous tree					
Logging of artificial indigenous tree (registration when it was planted)				O	O
Logging of exotic tree without registration				O	O
Cattle raising				O	O
Hunting and fishing				O	O
Collection of vegetable and firewood				O	O
Land use as a community forest				O	O
Land ownership					
Lease from the responsible agency				O	O
Land use for agricultural purpose					O
Lease or sale to others					

O : Allowed by Law

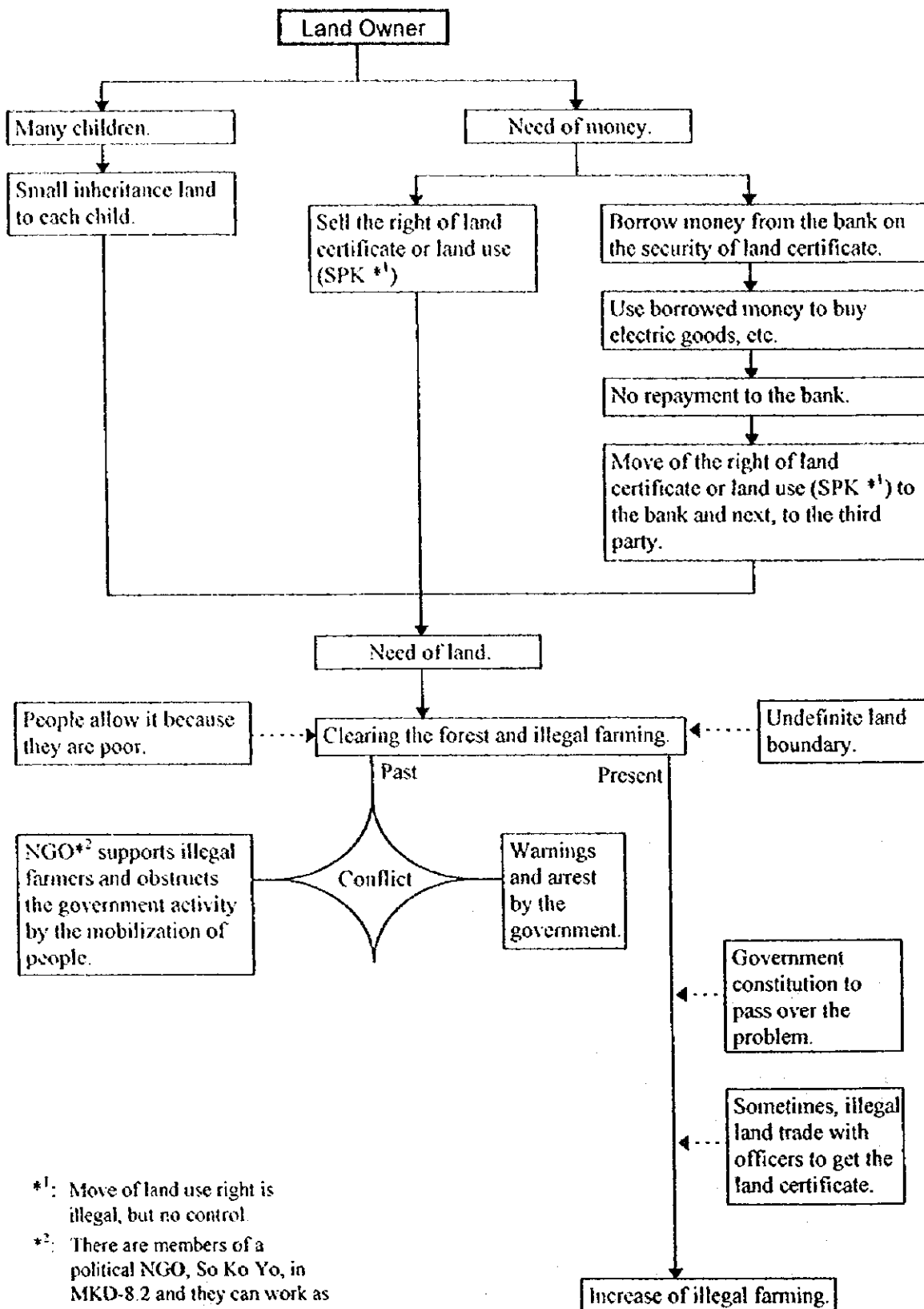
Source: RFD and REX, January 1998

Table H-35 Extract from the Draft Community Forest Act

Extract from the Draft Community Forest Act	Section No.
"Community Forest" means the forest which has been approved to established as community forest by receiving management in accordance with this Act.	3
"Preservation Area" means National Park Area, National Conservation Forest Area, Wild Animals Protection Area, Wild Animals Prohibited Area and other areas as specified in the Ministerial Regulations.	3
Objectives of the Community Forest: (1) Use of natural resource in a sustainable manner. (2) Promote variety of culture/custom of the community in preservation, revival, development, control/care-taking and use of natural resource.	5
Permission to the establishment Community Forest in the preservation area.	5
Permission to reside within the community forest.	17, 18, 27
Prohibition of wood forestry which exist by nature.	33
Permission to the cattle raising, hunting and cultivation of annual crops among big trees.	41 (6)

Source: RFD, January 1998

Figure II-7 Condition of Illegal Farming in the Forest



*1: Move of land use right is illegal, but no control.
 *2: There are members of a political NGO, So Ko Yo, in MKD-8.2 and they can work as a representative of villages for the legal problem against the government.

10. Community Forest in the Priority Area

Table II-36 Population and Land Use in the Priority Area and some of Study Areas

Study Area No.	Priority Area	Village Name	Population (1)	Number of H.H. (2)	Av. H.H. Member (1)/(2)	Popula- tion/ agri. area (1)/(4)	Whole land (rai) (3)	Agri. Area (rai) (4)	Other Area (rai) (3)-(4)	Community Forest (rai)		
										Data 1	Data 2	
KK-6	x	Nong Nam Khun Nua	1,080	165	6.5	0.31	3,984	3,460	524	0	330	
	xx	Nong Nam Khun Tai	470	100	4.7	0.21	2,460	2,210	250	0		
	x	Nong Waeng	300	78	3.8		610			N.A.		
	x	Don Puai	540	93	5.8	0.43	1,510	1,260	250	0		
	x	Huai Sua Thao	1,130	180	6.3		4,510				10	
	x	Wang Hin	456	96	4.8		3,161				19	
	x	Lak Dan	561	101	5.6	0.23	2,512	2,460	52	52		
		Average or Total			5.4	0.30	18,747	9,390				
		Nong Sala	558	113	4.9	0.18	3,232	3,182	50	0		
		Kud Luang	145	33	4.4	0.60	280	240	40	0		
		Nong Yang					610	480	130	0		
		Nong Yang Noi					2,745	2,457	288	0		
		Marp Ta Kla									60	
		Sok Nak									206	
		Huai Rae									40	
	Huai Kho									0		
	Huai Kho Noi									0		
	Chot Nong Khae									32		
MHS -5	x	Sala	864	171	5.1	0.26	3,981	3,321	660	0		
	x	Non Thong	662	124	5.3	0.28	2,613	2,400	213	0		
	x	Non Sa-at	313	67	4.7	0.28	1,300	1,100	200	0		
	x	Nong Khan	414	77	5.4		2,500			N.A.		
	xx	Ta-lat Muang	717	142	5.0	0.26	3,433	2,800	633	633	1,270	
	x	Nong Bo	465	92	5.1	0.39	1,627	1,200	427	400	3)	
	x	Hua Kao Tack	259	73	3.5	0.27	1,328	950	378	378		
		Average or Total			4.9	0.29	16,782					
	Khok Lam									45		
SKN -3.1	x	Kut Bak	1,695	428	4.0		5,280			N.A.		
	x	Nong Song Hang	827	190	4.4		2,355			N.A.		
	x	Kut Hai (No.1 & 6)	2,589	457	5.7	1.21	3,600	2,131	1,469	569		
	xx	Bua	1,450	270	5.4	0.41	3,825	3,500	325	exist	1)	
	x	Sai Kaeo	1,208	277	4.4	0.32	4,000	3,800	200	150		
	x	Ngiu	458	87	5.3	0.22	2,732	2,037	695	17		
	x	Kho Yai	1,250	168	7.4	0.45	3,940	2,750	1,190	0		
	x	Kho Noi	1,666	376	4.4	0.52	4,300	3,210	1,090	779	2)	
		Average or Total			5.1	0.52	30,032					
	Kut Kaet	2,639	450	5.9	0.09	8,920	4,910	4,010	50			
MKD -8.2	xx	Phang Daeng	970	177	5.5	0.49	2,540	2,000	540	0		
	x	Tiu	731	163	4.5		948			0		
	x	Na Lak	389	65	6.0	0.65	1,000	600	400	0		
	x	Nong Mu	570	96	5.9	0.57	1,600	1,000	600	0		
	x	Huai Lao	349	53	6.6		1,400			0		
	x	Nong Klong	495	117	4.2	0.62	1,860	800	1,060	0		
		Average or Total			5.5	0.58	9,348					
	Non Sawang	404	76	5.3	0.67	1,100	600		10			

xx: Meeting among villagers, ALRO and Study Team was held.

- 1): Managing by monk. Fence construction by villagers in 1997. No use for cattle raising at present.
- 2): Managing by monk. Fence construction by donation of villagers 15 years ago. Road preparation by army. Good natural forest.
- 3): For surrounding villages. No big tree. Mushroom and vegetable collection, cattle raising. RFD officer visits sometimes. Cooperation of ALRO, RFD and villagers is good.

Source: Kor Chor Chor 2 Khor (Data 1), Field Survey by the Study Team in 1997/1998 (Data 2)

11. Procedure for Huai Lak Reservoir Construction

11.1 According to RFD Mukdahan, the procedure and necessary documents to get the permission of RRD for the reservoir construction in the reserved forest is as follows:

- (1) Project Name, objective, capacity of the reservoir
- (2) Reservoir construction plan
- (3) Location of the reservoir area (scale 1:50,000)
- (4) Report of the environmental impact survey
- (5) Letter from the Secretary General
- (6) Letter of permission for the land use to the director of the defend. (By the commission of the Prime Minister declared on July 14, 1977, this area is a restricted zone where any person is not allowed to enter or reside.)
- (7) Submission of the application by Po Sor 17 Form to Dong Luang District Office
- (8) Importance of reservoir construction from economic and agricultural aspect

11.2 In addition, the result of EIA shall be respected for the following items.

- (1) Compensation with the propriety rate for the farmland in the site by the sufficient discussion with villagers including village committee
- (2) Reforestation in the same size with the reservoir area

12. Environmental Impact Assessment

Environmental Impact Assessment was carried out by TESCO Ltd. and the EIA report was submitted in February 1998 during the Phase II field study, based on the provisional development plan, though some components of the plan has been changed on the last stage.

EIA Report consists of following contents:

Chapter 1	Introduction	(Omitted)	
Chapter 2	Project Description	(Omitted)	Page
Chapter 3	Existing Environment	(Extract)	H-39
Chapter 4	Impact Assessment	(Extract)	H-73
Chapter 5	Mitigation and Monitoring	(Extract)	H-81

CHAPTER 3

EXISTING ENVIRONMENT

The existing environment will be emphasized on reservoir project of Huai Lak. Nevertheless, the current condition of Huai Kha Na, even avoided, will also be described as data collection had been undertaken.

3.1 NATURAL PHYSICAL CONDITION

3.1.1 Topography and Geology

The study area is located on undulating ranges of Phu Phan Range which runs along the southwestern edge of Mukdahan Province. The proposed reservoir areas of Huai Lak and Huai Kha Na are located on the higher ranges at elevations about 200 and 180 mMSL respectively; whereas their downstream irrigation villages in ALR area are mostly situated on the lower ranges at elevations between approximately 140-160 mMSL.

Slope complex topography is found at Ban Na Lak, Ban Nong Mu and Ban Phang Daeng while the areas in Ban Huai Lao and Ban Tui are respectively characterised as highland and upland plains. Further, the areas in Ban Nong Khlong and Ban Phon Swang are respectively characterised as silty sand highland and upland. The study areas, especially those of which in Ban Na Lak and Ban Phon Swang, are dominated by Mesozoic sedimentary rocks (Korat Group) of Phu Phan Formation, composing of scattered rock outcrops.

3.1.2 Soils

The purpose of describing soils in the inundation area of Huai Lak Reservoir is to display the loss value of the impounding soils.

3.1.2.1 Soil Characteristics in the Huai Lak Reservoir Area

Largely, soils in the Huai Lak reservoir area are classified into an association of Korat/Warin/Satuk : Kt/Wn/Suk.

Korat series (Kt) is a member of fine-loamy, siliceous family of Oxic Palenstults. They are formed from old alluvium and occur on middle terraces and moderately well drained soils. Originally dry dipterocarp forest and mixed deciduous forest.

Warin series (Wn) is a member of fine-loamy siliceous family of Oxic Paleustults. they are formed from old alluvium and occur on the middle and high terraces and well drained soils. Originally mixed deciduous forest and dipterocarp forest. Parts are cleared for upland crops such as corn, cotton, sugar cane, kenaf, water melon, and some fruit crops such as pineapple, castard apple etc.

Satuk series is member of fine-loamy, siliceous family of Oxic Paleustults. They are formed from old alluvium and occur on the middle and high terraces and well drained soils. Mainly dipterocarp and mixed deciduous forest with parts cleared for the cultivation of upland crops such as kenaf, water melon, beans, corn, etc.

The soil association covers an area of approximately 600 rai or 0.96 sq.km. which is 87.27% of the total area of the reservoir. Soil in the other 87.5 rai or about 0.14 sq.km, which is 12.73% of the total area of the reservoir, can be classified as Slope Complex or Sc. Slope complex generally occurs on colluvial slope and residual hill complex.

3.1.2.2 Soils Characteristics in the Huai Kha Na Reservoir Area

Soils in the Huai Kha Na reservoir area can be classified as Korat/Warin/Satuk association : Kt/Wn/Suk. Each soil series was previously described in item 3.1.2.1. The soil association mostly occupies 237.2 rai of the reservoir area.

3.1.2.3 Soil Sampling

1) Soil Erosion Quantity

The average soil losses of proposed reservoirs in Huai Lak and Huai Kha Na are respectively estimated at 20.58 ton/rai/yr and 7.68 ton/rai/year as shown in Table 3.1-5.

Table 3.1-5 Soil Erosion Estimate of Proposed Reservoir Areas

USLE Parameter (USLE : Universal Soil Loss Equation)		Huai Lak Reservoir	Huai Kha Na Reservoir
• R (Rainfall erosion index)		996.0	996.0
• K (Soil erodibility factor)		0.35	0.35
• LS (Topographic factor)		1.19	2.87
• C (Cropping management factor)		0.31	0.048
• P (Erosion control practice)		1.0	1.0
A = RKLSCP (A : Average Soil Loss)		ton/rai/yr	ton/rai/yr
• very slight	0.01-1.00	-	-
• slight	1.01-5.00	-	-
• moderate	5.01-20.00	-	7.68
• severe	20.01-100.00	20.58	-
• very severe	100.01-966.65	-	-

2) Soil Property Quality

The result of soil analysis is shown in Table 3.1-6.

- 1. Orchard plantation :** the soils should have the same fertility levels at low and very low. Nevertheless, due to fertilizer application at Ban Nong Khlong, there are more nutrient residues and high organic matter with very high CEC than such of Ban Phang Daeng and Ban Phone Swang where fertilization should be minimal.
- 2. Sugarcane plantation :** no fertilization is undertaken for upland cropping. Therefore, all soil samples consist of low fertility. They are also excessive acidic. The essential nutrients are typically low whereas the other nutrients are generally moderate. Organic matter contents are low with low CEC.

Table 3.1-6 Laboratory Analysis of Soil Sampling Survey

Soil Property Quality	ORCHARD PLANTATION			SUGARCANE PLANTATION			CASSAVA PLANTATION			RICEFIELD PLANTATION			EUCALYPTUS PLANTATION		
	B. Phang Daeng	B. Nong Khlong	B. Phone Swang	B. Phang Daeng	B. Phang Daeng	B. Phone Swang	B. Phang Daeng	B. Nong Khlong	B. Nong Mu	B. Phang Daeng	B. Nong Khlong	B. Nong Mu	B. Phang Daeng	B. Phone Swang	B. Phone Swang
	5.2	7.1	5	5.6	4.9	5.1	5.1	5.1	5.5	4.6	5	7	4.6	5.5	4.5
• pH	7.2	60	80	70	70	68	66	70	44	77	66	64	80	78	76
• Soil Texture	21	31	17	23	23	23	25	25	49	23	25	25	17	19	15
- % Sand	7	9	3	7	7	9	9	5	7	5	9	11	3	3	3
- % Silt	SL	SL	ls	SL	SL	SL	SL	SL	L	SL	SL	SL	ls	ls	SL
- % Clay	1.5	8.6	0.5	0.8	1.1	0.7	1	0.9	2.4	0.5	0.6	1.4	1.1	1.3	1.2
• Organic Matter	L	H	VL	VL	L	VL	L	VL	M	VL	VL	L	L	L	L
- % Content	6	265	9	5	3	3	2	9	8	4	2	68	3	8	4
• Phosphorus (P)	L	VH	L	L	L	L	L	L	L	L	L	VH	L	L	L
- ppm	80	650	20	20	25	30	40	50	140	20	25	50	20	260	10
- Quality Rating	H	VH	L	L	L	L	M	M	VH	L	L	M	L	VH	L
• Potassium (K)	480	2400	4000	520	960	440	480	400	920	188	400	2880	128	400	144
- ppm	M	H	H	M	H	M	M	M	H	L	M	H	L	M	L
- Quality Rating	54	550	26	48	46	90	56	55	170	26	46	34	30	100	50
• Magnesium (Mg)	M	H	L	M	M	M	M	M	H	L	M	L	L	H	M
- ppm	80	80	60	60	60	60	70	70	60	70	70	70	60	80	70
- Quality Rating	75	183	28	25	27	13.	16	27	13	16	13	27	16	56	27
• Sodium (Na), ppm	26	60	26	20	20	26	20	20	33	20	23	17	20	55	20
• Sulphate (SO ₄), ppm	2.2	15.4	0.6	1.2	1.6	2.8	2.0	2.0	3.4	1.0	2.2	0.8	3.4	1.4	2.0
• Chloride (Cl), ppm	12.00	12.32	9.08	13.29	12.07	8.85	10.38	10.68	14.24	11.65	8.94	10.57	25.58	14.26	13.16
• CEC, meq/100 g															
• C/N Ratio															

Source : Sampling by Tesco & Analysis by Kasetsart University, 1997

3. **Cassava plantation** : due to soil texture, silty soil at Ban Nong Mu is rather of more fertility than sandy silt soils of the others.

4. **Ricefield plantation** : due also to soil texture, silty soil at Ban Nong Mu is rather of more fertility than sandy silty soils of the others. Both ricefield soils at Ban Phang Daeng and Ban Nong Khlong are excessively acidic.

5. **Eucalyptus plantation** : There are only eucalyptus plantation at Ban Phone Swang. Thus, the soils are of the same property with low fertility, excessive acidity and of sandy silt texture.

In general, the soil sampling is surface soils which characterize the substrate to upland crop and ricefield. They are all of rather low fertility and having acid soil problem in some villages especially Ban Phang Daeng and Ban Phone Swang. For orchard plantation, subsurface soil at root depth level should be considered on fertility and texture. Subsurface soil may consist of gravel or rock which limit perennial tree growing.

3.1.3 Soil Conservation Techniques

Deterioration of soil fertility, soil erosion and soil salinity are major problems of soil conservation in the Northeastern Thailand. However, soil salinity which mainly affects lowland paddy field, is not found in the study area.

For controlling soil erosion, there are 8 principal techniques in present use in Thailand indicated as follows:

1) Mulching

Spreading of plant residues up to 60-70% of ground area. In Thailand, for instance, a spreading of 9.92 t/ha of bagasse could help reducing soil loss on a sandy loam up to 78%.

2) Minimum tillage or reduced tillage

Minimum-, reduced- or no-tillage, in combination with mulching, is effective especially on both upland and highland in rainfed areas under rain shadow or areas with erratic rainfall such as Northeastern Thailand.

3) Contour cultivation

Plowing land and planting crops along the contour line such as on a sandy loam soil for roselle cultivation in Northeastern Thailand could help reducing soil loss up to 1.7 t/ha/yr instead of 3.9 t/ha/yr by conventional practice. The technique also helps reducing NPK and organic matter losses up to 7.0 and 26.6 kg/ha/yr instead of 10.7 and 45.5 kg/ha/yr respectively.

4) Strip cropping

Alternate strips of narrow planted spacing crops such as rice or beans could trap soil eroded from the alternate strips of wide planted spacing crops such as corn or

sorghum. In Northeastern Thailand a sustainable cropping by growing rice alternated with corn and leguminous crops in rotation manner could improve in soil fertility management; as corn is a short duration crop and legumes can be rotationally planted after corn harvest without tillage, but employing corn stalks as mulch.

5) Contour trash lines

Placing available plant residues along the contour lines, 4-10 meters apart, and planting crash crops in the alleys between the trash lines such as in Northern Thailand can reduce soil erosion on a 45 percent-slope land up to 98.8% and 99.5% with conventional tillage and reduced tillage respectively.

6) Grass strips

Planting a 1-2 meters width strip along the contour and planting crops in the areas between the grass strips such as in Northern Thailand can reduce soil erosion as much as 97%. Grass species such as vetiver (*Vetiveria zizanioides*), napier (*Pennisetum purpureum*), staria grass (*Setaria anceps*), or guinea (*Panicum maximum*) are selected because they grow straight having roots growing down straight in order to avoid competition for the air, sunlight, water and nutrients with the main crops.

7) Contour hedgerows

A double row of leguminous shrubs or trees in a hedgerow along the contour line is planted alternately to food crops. The hedgerows are cut back at planting and kept being pruned as green manure or mulch. Suitable leguminous species for Thailand include leucaena (*Leucaena leucocephala*), gliricidia (*Gliricidia sepium*), pigeon peas (*Cajanus cajan*), flemingia (*Flemingia congesta*), tephrosia (*Tephrosia candida*), etc. Leucaena hedgerows (four years old) in one hectare in a year in Thailand could return 15.22 tons of stems and leafless branches and 18.75 tons (5.22 tons dry weight) of fresh leaves which become decomposed as organic fertilizer having 173.3 kg N, 10.44 kg P and 107.53 kg K.

8) Agroforestry

Trees planting and growing cash crops between them can act in impeding to reverse the soil erosion process. Tree species include cashgenerating crops for producing either food, fibers, tannins, dyes, gums, rasins, firewood or timber; up to 50 agroforestry models in Thailand.

3.1.4 Soil Conservation Survey

As shown in Table 3.1-7, the KAP (knowledge, attitude, and practice) survey was conducted through questionaired meeting with 70 respondents in 7 villages. The 8 main soil erosion control techniques are key questions to the villagers in this study.

Amongst all surveyed villagers, only those of which in Ban Nong Mu have no knowledge on all types of soil erosion control technique, and thus never practise them. Nevertheless, it was observed that all the surveyed villagers intend to do so, if trained. On

Table 3.1-7 Soil Conservation Knowledge, Practice and Attitude of Survey Villages

(Unit : %)

Village	Erosion Prone Locality	I. Mulching			II. Minimum/Reduced Tillage			III. Contour Cultivation			IV. Strip Cropping		
		Know	Practice	Willing	Know	Practice	Willing	Know	Practice	Willing	Know	Practice	Willing
Ban Na Lak	Slope Complex & Silty Sand with Rock Outcrops	50.00	20.00	80.00	40.00	30.00	80.00	20.00	-	80.00	20.00	-	70.00
Ban Nong Mu	Slope Complex & Silty Sand	-	-	90.00	20.00	40.00	100.00	-	10.00	100.00	-	-	100.00
Ban Phang Daeng	Slope Complex	40.00	30.00	90.00	40.00	30.00	90.00	10.00	-	20.00	10.00	-	20.00
Ban Phon Swang	Rock Outcrops & Silty Sand Upland	40.00	40.00	100.00	40.00	40.00	100.00	30.00	30.00	100.00	50.00	20.00	70.00
Ban Nong Khlong	Silty Sand Highland	10.00	10.00	100.00	20.00	30.00	80.00	10.00	10.00	70.00	20.00	10.00	70.00
Ban Huai Lao	Highland Plain	40.00	20.00	90.00	20.00	20.00	90.00	30.00	10.00	70.00	20.00	-	70.00
Ban Tiu	Upland Plain	20.00	10.00	80.00	40.00	30.00	70.00	20.00	-	70.00	10.00	-	80.00
Average		28.57	18.57	90.00	31.43	31.43	87.14	17.14	8.57	72.86	18.57	4.29	68.57
Village	Erosion Prone Locality	V. Contour Trash Lines			VI. Grass Strips			VII. Contour Hedgerows			VIII. Agroforestry		
		Know	Practice	Willing	Know	Practice	Willing	Know	Practice	Willing	Know	Practice	Willing
Ban Na Lak	Slope Complex & Silty Sand with Rock Outcrops	30.00	10.00	80.00	30.00	20.00	80.00	20.00	-	80.00	20.00	10.00	90.00
Ban Nong Mu	Slope Complex & Silty Sand	-	-	100.00	-	-	90.00	-	-	90.00	10.00	10.00	100.00
Ban Phang Daeng	Slope Complex	10.00	-	50.00	10.00	-	40.00	10.00	-	40.00	30.00	10.00	60.00
Ban Phon Swang	Rock Outcrops & Silty Sand Upland	60.00	40.00	90.00	50.00	30.00	90.00	50.00	30.00	90.00	50.00	30.00	100.00
Ban Nong Khlong	Silty Sand Highland	10.00	10.00	90.00	-	-	80.00	-	-	80.00	-	-	80.00
Ban Huai Lao	Highland Plain	20.00	10.00	90.00	10.00	10.00	80.00	10.00	-	70.00	20.00	-	60.00
Ban Tiu	Upland Plain	20.00	-	70.00	10.00	-	60.00	10.00	-	70.00	20.00	-	70.00
Average		21.43	10.00	81.43	15.71	8.57	74.29	14.29	4.29	74.29	21.43	8.57	80.00

Source : Soil Conservation Survey (October, 1997), Tesco Ltd.

the other hand, it was observed that amongst those who have a knowledge on the techniques; Ban Phon Swang is the most practised village. At present, several techniques being employed by large number of villagers are mulching, minimum/reduced tillage, contour cultivation, contour trash line, grass strip and agroforestry.

At villages of slope complex prone to soil erosion such as Ban Na Lak, Ban Nong Mu and Ban Phang Daeng, the most practised techniques include minimum/reduced tillages, agroforestry and mulching. The techniques of less practised are contour cultivation, contour trash lines and grass strips. Whereas, two techniques never been practised, are strip cropping and contour hedgerows.

Based on the results of survey, it was found if a training provided, the most interesting techniques to be carried on by the villagers are mulching, contour cultivation and grass strips.

3.1.5 Soil Management Techniques

Deterioration of soil fertility is a problem found in the study areas. In practice, there are 3 principal soil management techniques to improve soil fertility in Thailand, which are described as follows:-

1) Crop rotation

Crop rotation is cultivation of various crops, in rotation, in the same agricultural land. Based on time of rotation, it can be separated into 1) short rotation and 2) long rotation which respectively lasts less than 3 years and more than 3 years. Based on effect on soil, there are 2 types of crop rotation which is 1) destructive crop rotation and 2) constructive crop rotation. However only constructive crop rotation is known as a technique help to improve soil fertility or help reducing deterioration of soil fertility, and type of crops used for construction crop rotation should comprise soil protecting crops such as soil covering crops, soil building crop such as beans which can increase nitrogen in soil by *Rhizobium sp.* on roots, and soil consuming crop such as grain crops (e.g. rice, barley etc), and cultivated crops (e.g., oil crops, cassava, sugar cane, croton, cotton, vegetables etc.). In addition to help improving soil fertility, the technique supports farmers capable of cultivating crops throughout the year, thus also helps increasing farmer's income.

2) Fertilization

In order to improve soil fertility and thus obtain increased yields from high yielding varieties of various crops, fertilizer is one of the most vital component of package of practices for agriculture in Thailand. Generally, fertilizer used in Thailand comprise organic fertilizers such as green manure, manure and chemical fertilizers which can be easily found in markets. In addition, mixed fertilizer which is a combination of organic and chemical fertilizers can be economically used as well. However, type of fertilizer used is dependent on type of cultivated crops, soil and environment. In Thailand, for example, recommended formula of chemical fertilizer used when grow cassava on sandy loam, is 20-10-20 (N-P₂O₅-K₂O) at the rate of 30-60 kg/rai, or when grow sugar care on loam, is 20-10-10 (N-P-K) at the rate of 50 kg/rai, or when grow corn on black clay, is 20-20-20 (N-P-K) at the rate of 25 kg/rai, or when grow soybean on red clay, is 0-45-0 (N-P-K) at the rate of 15 kg/rai

etc. On the other hand, for horticultural crops recommended formula of chemical fertilizer used when grow tomato on loam, is 15-10-10 (N-P-K) at the rate of 100 kg/rai, or when grow vegetables on loam, is 20-10-10 (N-P-K) at the rate of 60 kg/rai. etc.

There are several methods of fertilizer application which are broadcasting, band placement, in-the-row application, top dressing or side dressing and foliar application.

3) Weed control

Weed is unwanted and unuseful plants, having an affect on reducing of soil nutrients, thus, results in product losses.

Methods of weed control are 1) mechanical methods 2) cropping and competition methods 3) biological methods and 4) chemical methods. Firstly, mechanical methods comprise hand pulling, hand hoeing, mowing, tillage, burning, flooding and smothering with non living materials. Secondly, cropping and competition methods consists of a) crop rotation method using row crops, grain crops and competitive crops or smother crops such as sudan grass, millet, sunflower, alfalfa, barley, rye, sorghum, soybean, ensilage corn etc. b) competition method which creates suitable environment for crops grow, so they are able to compete with weeds for soil nutrients, light and moisture. Thirdly, biological methods using insects as natural predators and also inoculation of plant diseases as effective tools to control weeds. Lastly, chemical methods using selective herbicides which are broadly sold in Thailand, such as atrazine, and nonselective herbicides such as sodium arsenite. Furthermore, based on type of crops, herbicides used are firstly foliage applied herbicides such as paraquat, propanil, dalapon, glyphosate, and secondly soil applied or residual herbicides such as simazine, atrazine, diuron, EPTC, DCPA etc. Based on time of application, herbicides can be applied, dependent on type of herbicides and crops, during pre-planting or pre-sowing or pre-emergence or post-emergence period. Preplanting herbicides are such as trifluralin. Pre-emergence herbicides are such as atrazine, alachlor etc.

3.1.6 Soil Management Survey

Assumably, farmers in Thailand have knowledge of the techniques to improve soil fertility. However, the problem is on whether the farmers usually practise or intend to practise. In this study, the survey on practices and attitudes on soil management was conducted through questionnaire meeting with 70 respondents in 7 villages and results of the survey are shown in Table 3.1-8.

Based on results of the survey, it was found that the rotational cropping is hardly practised in the study area due to water shortage. Chemical or organic fertilization as well as manual and chemical use for weed control are presently practised. A small number of respondents used to practise the slash and burn cultivation which known to deteriorate the soil fertility.

Most of respondents in villages having soils of poor fertility such as Ban Huai Lao and Ban Phong Daeng, never do rotational cropping; but some used to do slash and burn. In

Table 3.1-8 Soil Management Practice and Attitude of Survey Villages

(Unit : %)

Village	Soil Problematic Locality	Rotational Cropping				Fertilization					
		Practice		Willing		Practice		Willing			
		Never	Presently	Used to	None	Chemical	Organic	Mixed	None	Chemical	Organic
Ban Huai Lao	Low Nutrients	100.00	-	-	80.00	20.00	60.00	10.00	10.00	10.00	80.00
Ban Phang Daeng	Low Nutrients with Gravels	90.00	-	10.00	60.00	50.00	30.00	20.00	-	-	90.00
Ban Na Lak	Gravels & Rock Outcrops	80.00	10.00	10.00	80.00	60.00	10.00	20.00	10.00	10.00	60.00
Ban Nong Mu	Gravels	90.00	-	10.00	20.00	30.00	30.00	10.00	30.00	30.00	90.00
Ban Phon Swang	Rock Outcrops	70.00	20.00	10.00	80.00	40.00	40.00	10.00	10.00	10.00	70.00
Ban Nong Khlong	No Problems	70.00	10.00	20.00	80.00	70.00	10.00	20.00	-	-	60.00
Ban Tiu	No Problems	80.00	10.00	10.00	80.00	10.00	10.00	80.00	-	-	100.00
	Average	82.86	7.14	10.00	68.57	40.00	27.14	24.29	8.57	8.57	78.57

Village	Soil Problematic Locality	Weed Control				Slash and Burn					
		Practice		Willing		Practice		Willing			
		None	Chemical	Manual	Mixed	Used to	Presently	Never	None	Presently	Never
Ban Huai Lao	Low Nutrients	-	18.18	81.82	-	100.00	30.00	-	70.00	-	-
Ban Phang Daeng	Low Nutrients with Gravels	20.00	20.00	60.00	-	100.00	-	-	100.0	0	10.00
Ban Na Lak	Gravels & Rock Outcrops	30.00	20.00	50.00	-	90.00	-	-	100.0	0	10.00
Ban Nong Mu	Gravels	-	-	100.00	-	90.00	10.00	10.00	80.00	-	-
Ban Phon Swang	Rock Outcrops	30.00	20.00	50.00	-	90.00	10.00	-	90.00	10.00	10.00
Ban Nong Khlong	No Problems	-	-	100.00	-	100.00	30.00	-	70.00	-	-
Ban Tiu	No Problems	-	9.09	90.91	-	100.00	-	-	100.0	0	-
	Average	95.71	12.47	76.10	-	95.71	11.43	1.43	87.14	4.29	4.29

Source : Soil Management Survey (October, 1997), Tesco Ltd.

order to overcome a problem on soil fertility deterioration, the farmers prefer the use of fertilizers to weed control techniques. Further, it was found that the surveyed villagers are mostly willing to continue practising on weed control, fertilization, and crop rotation after trained. Most of them intend to give up slash and burn cultivation.

3.1.7 Hydrology and Hydrogeology

Huai Lak is approximately 5 m. in width and with steep banks. Its cross section is slightly a U-shape; containing mostly sandy streambed. Whereas, Huai Kha Na streambed comprises rocky boulders. Huai Kha Na is irregularly wider than Huai Lak, but the banks are not so steep. Both Huai Lak and Huai Kha Na (including Hua Lao) are tributaries of Huai Bang Sai.

There are about 40% of the groundwater aquifer of yield less than 2 cub.m./hr and the remaining 60% with 2-10 cub.m./hr in the study area. Therefore groundwater is not adequately supplied to the villagers. Phu Kam Phra is a recharge area of the two proposed reservoir aquifer, having proximately flow direction from the south toward the north.

3.1.8 Surface Water Quality

Upstream, damsite and downstream sampling sites of each reservoir area : Huai Lak and Huai Kha Na were mapped in Figure 3.1-5 and the results of water analysis shown in Table 3.1-9.

Huai Lak upstream is diluted downstream by a tributary stream at the confluence which is its damsite. After passing Ban Nong Mu where the flow mixed with domestic discharges, the water quality is still of less contaminated. The overall water quality standard of Huai Lak is classified as class 3 regarding Thailand surface water standard. The water quality standard of class 3 can be defined as medium clean fresh surface water resource which can be used for consumption, if treated with an ordinary treatment process and can also be used for agriculture.

Due to the tributary confluences, the dissolved oxygen (DO) is increasing along its downstream, while the Biochemical Oxygen Demand (BOD) and Suspended Solid (SS) are decreasing. The water type can be classified as a soft water. Coliform bacteria found in water might be from cow dung. Only traces of pesticides were found; and possibly because of pesticide contamination. traces of arsenic and mercury were also found on the other hand, Huai Kha Na has an overall water quality standard classified as class 2 Thailand surface water standard. It is defined as very clean fresh surface water resource, can be used for consumption, if treated with an ordinary treatment process and also be used for aquatic organism conservation, for living and assisting, to fishery and recreation. This is due that the dissolved oxygen is considerably high due to reeration by rock outcrops and boulders along the streambed. Based on the results of water analysis, BOD, suspended solid, coliform bacteria, pesticide, and heavy metal (only arsenic) are less than those in Huai Lak.

3.1.9 Groundwater Quality

Samples of groundwater are collected from 2 sampling stations in Ban Nong Mu which are 1) a shallow well of 6 m. depth and 2) deep well of 60 m. depth. Based on the drinking water standard shown in Table 3.1-10, water from the shallow well can be used for

Table 3.1-9 Water Quality Analysis from Proposed Dam Site and Vicinity in Mukdahan

Parameters	Unit	Surface Water						Surface Water Standard for Class				
		Huai Lak			Huai Kha Na			1	2	3	4	5
		Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6					
Physical												
Temp.	°C	28.0	28.0	28.0	27.5	27.5	NA	n	n'	n'	n'	-
pH	-	6.68	6.58	6.81	6.80	6.48	NA	n	5-9	5-9	5-9	-
DO	mg/l	6.60	6.95	8.05	7.35	7.55	NA	n	6	4	2	-
SS	mg/l	40.0	44.0	29.0	23.0	58.0	NA					
TDS	mg/l	83.0	65.0	75.0	73.0	48.0	NA					
Turbidity	NTU	38.79	39.40	30.30	25.48	53.94	NA					
Conductivity	u mho/cm	61.5	67.3	66.7	26.8	25.5	NA					
Chemical												
BOD	mg/l	1.16	2.10	2.31	1.57	2.08	NA	n	1.5	2.0	4.0	-
COD	mg/l	11.16	11.18	11.50	11.17	5.58	NA					
Bicarbonate	mg/l as CaCO ₃	38.74	40.00	40.64	15.24	15.24	NA					
Sulphate	mg/l as SO ₄ ²⁻	0.30	0.70	0.70	0.50	0.70	NA					
Nitrate	mg/l as NO ₃	1.99	1.02	1.00	0.78	0.36	NA	n	5.0	5.0	5.0	-
Manganese	mg/l as Mn	0.099	0.091	0.098	0.023	0.030	NA	n	1.0	1.0	1.0	-
Iron	mg/l as Fe	1.796	1.898	1.857	1.075	1.491	NA					
Calcium	mg/l as Ca	10.0	9.8	9.8	4.0	4.7	NA					
Magnesium	mg/l as Mg	1.4	1.4	1.4	0.7	0.7	NA					
Sodium	mg/l as Na	6.04	4.84	7.26	5.98	7.31	NA					
Potassium	mg/l as K	2.11	1.75	2.13	1.68	2.00	NA					
Cadmium	mg/l as Cd	ND	ND	ND	ND	ND	NA	n	0.005*/ 0.05**	0.005*/ 0.05**	0.005*/ 0.05**	-
Lead	mg/l as Pb	ND	ND	ND	ND	ND	NA	n	0.05	0.05	0.05	-
Mercury	mg/l as Hg	0.0007	ND	0.0023	ND	ND	NA	n	0.05	0.05	0.05	-
Arsenic	mg/l as As	0.0004	0.0004	0.0006	0.0007	0.0007	NA	n	0.01	0.01	0.01	-
Bacteriological												
Coliform	MPN/100ml	16,000	5,400	350	920	1,700	NA	n	5,000	20,000	-	-
Fecal Coliform	MPN/100ml	2,800	2,200	79	240	490	NA	n	1,000	4,000	-	-
Pesticides												
A-BHC	ug/l	ND	ND	ND	ND	ND	NA	n	0.02	0.02	0.02	-
B-BHC	ug/l	ND	ND	0.003	0.001	ND	NA					
G-BHC	ug/l	ND	ND	ND	ND	ND	NA					
D-BHC	ug/l	ND	ND	ND	ND	ND	NA					
Heptachlor	ug/l	ND	ND	0.001	ND	ND	NA	n	0.2	0.2	0.2	-
Heptachlor Epoxide	ug/l	ND	ND	ND	ND	ND	NA					
Aldrin	ug/l	ND	ND	ND	ND	ND	NA	n	0.1	0.1	0.1	-
Dieldrin	ug/l	ND	ND	ND	ND	ND	NA	n	0.1	0.1	0.1	-
Endrin	ug/l	ND	ND	ND	ND	ND	NA	n	none	none	none	-
Endrin Aldehyde	ug/l	ND	ND	ND	ND	ND	NA					
Endosulfan I	ug/l	ND	ND	ND	ND	ND	NA					
Endosulfan II	ug/l	ND	ND	ND	ND	ND	NA					
Endosulfan Sulfate	ug/l	ND	ND	ND	ND	ND	NA					
p,p-DDE	ug/l	ND	ND	ND	ND	ND	NA					
p,p-DDD	ug/l	ND	ND	ND	ND	ND	NA					
p,p-DDT	ug/l	ND	ND	ND	ND	ND	NA	n	1.0	1.0	1.0	-

Note: ND = Not Detectable
NA = Not Available.

n = Naturally

n' = Naturally but changing not more than 30C

* = When water hardness not more than 100mg/l as CaCO₃

** = When water hardness more than 100mg/l as CaCO₃

Table 3.1-10 Groundwater Quality Analysis for Vicinity of Dam Site in Mukdahan

Parameters	Unit	Groundwater		Water Quality Standard for Rural Water Supply (Drinking Water) Dept. of Health	Drinking Water Quality (WHO)	Groundwater Quality Standard (Thailand/US*)
		Shallow	Deep			
		Sta. 7	Sta. 8			
Physical						
Temp.	°C	28.0	28.0			
pH	-	5.48	6.24	6.5 - 8.5		7.0 - 8.5
DO	mg/l	3.20	7.50			
SS	mg/l	10.0	33.0			750
TDS	mg/l	152.0	107.0			
Turbidity	NTU	4.24	106.67	5 JTU		5 JTU
Conductivity	u mho/cm	143.2	176.7			
Chemical						
BOD	mg/l	2.66	2.52			
COD	mg/l	18.60	74.40			
Bicarbonate	mg/l as CaCO ₃	20.38	107.32			
Sulphate	mg/l as SO ₄ ²⁻	0.30	0.30	400		200
Nitrate	mg/l as NO ₃	8.90	0.69	10	50	45
Manganese	mg/l as Mn	0.044	0.132	0.1	0.5	0.3
Iron	mg/l as Fe	0.272	16.41	0.3		0.5
Calcium	mg/l as Ca	10.9	21.0			
Magnesium	mg/l as Mg	2.6	1.1			
Sodium	mg/l as Na	15.25	10.43			
Potassium	mg/l as K	1.99	1.01			
Cadmium	mg/l as Cd	ND	ND	0.005	0.003	0.01
Lead	mg/l as Pb	ND	ND	0.05	0.01	0.05
Mercury	mg/l as Hg	ND	0.0021	0.001	0.001	0.001
Arsenic	mg/l as As	0.0004	0.0004	0.05	0.01	0.05
Bacteriological						
Coliform	MPN/100ml	2,800	2	0	ND	<2.2
Fecal Coliform	MPN/100ml	2,800	<2	0		none
Pesticides						
A-BHC	ug/l	ND	ND			
B-BHC	ug/l	ND	ND			
G-BHC	ug/l	ND	ND		2.0	
D-BHC	ug/l	ND	ND			
Heptachlor	ug/l	ND	ND		0.03	none
Heptachlor Epoxide	ug/l	ND	ND			
Aldrin	ug/l	ND	ND		0.03	none
Dieldrin	ug/l	ND	ND			none
Endrin	ug/l	ND	ND			no data
Endrin Aldehyde	ug/l	ND	ND			
Endosulfan I	ug/l	ND	ND			
Endosulfan II	ug/l	ND	ND			
Endosulfan Sulfate	ug/l	ND	ND			
p,p-DDE	ug/l	ND	ND			
p,p-DDD	ug/l	ND	ND			
p,p-DDT	ug/l	ND	ND		2.0	none

Note: ND = Not Detectable

* = GWQS (Class GA) from US being used for pesticides only.

domestic purpose such as washing, cooking and cleaning, without treatment due to low turbidity, low manganese and iron. However, the water is not suitable for drinking due to the high fecal coliform. On the other hand, water from the deep well can be used neither for drinking nor domestic purpose due to high turbidity, high manganese, and mercury. Nevertheless, both wells are not contaminated by any pesticide.

3.2 NATURAL ECOLOGICAL CONDITION

3.2.1 Forest Condition

The legal conditions of the forest around the study area as shown in Figure 3.2-1 are divided into three major legislative types:-

- Conservation zone of Huai Huad National Park outside of the proposed reservoir,
- Additional conservation zone of Phu Phan Reserve Forest where the proposed reservoir situate; and
- Land Reform Areas

Nevertheless, by ecological conditions, the three forest types abovementioned are interconnected as the same ecosystem having the same natural forest types of mixed deciduous and dry dipterocarp forests. Accordingly, there are mixed deciduous forest along the streamside of Huai Lak and Huai Kha Na; and dry dipterocarp forest are found as an ecotone to the common hilly watershed of the two streams especially Phu Kam Phra. The existing natural condition of the proposed Huai Lak reservoir area is shown in Figure 3.2-2.

1) Huai Lak

As the impoundment area is classified as watershed forest class 4 of undulating plain topography, there have been illegal conversion of the original mixed deciduous forest into rice and cassava fields. The remainy clusters of mixed deciduous forest are found scatteredly along the stream. Also, there are some remaining dry deciduous forest existed at the ecotone foothill of Phu Kam Phra.

1.1) Mixed deciduous forest

Dominant species comprise of Takian Hin (*Hopea ferra*), Ket Daeng (*Dalbergia dongnaiensis*), Ka Jor (*Milletia leucantha*), Ma-ka Tae (*Sandoricum indicum*), Takian Nu (*Anogeissus acuminata*), etc. as tree. There are seedlings and saplings undergrowth of the tree; including Daeng (*Xylia xylocarpa*), Takian Nu (*Anogeissus acuminata*), Tao Rang (*Didymospermum candata*), Chaphlu Pa (*Piper aurantiacum*), Ngac Pa (*Bombax aucepa*), etc. At least 25 species of mixed deciduous forest species are found in the inundation area.

The remaining clusters of mixed deciduous forest tree consist of three vertical canopies of community structure:-

- Canopy 1 : more than 20 m. height of tree such as Takian Hin (*Hopea ferra*), Takian Nu (*Anogeissus acuminata*), Pra-du (*Pterocarpus macrocarpus*), Rok Fa

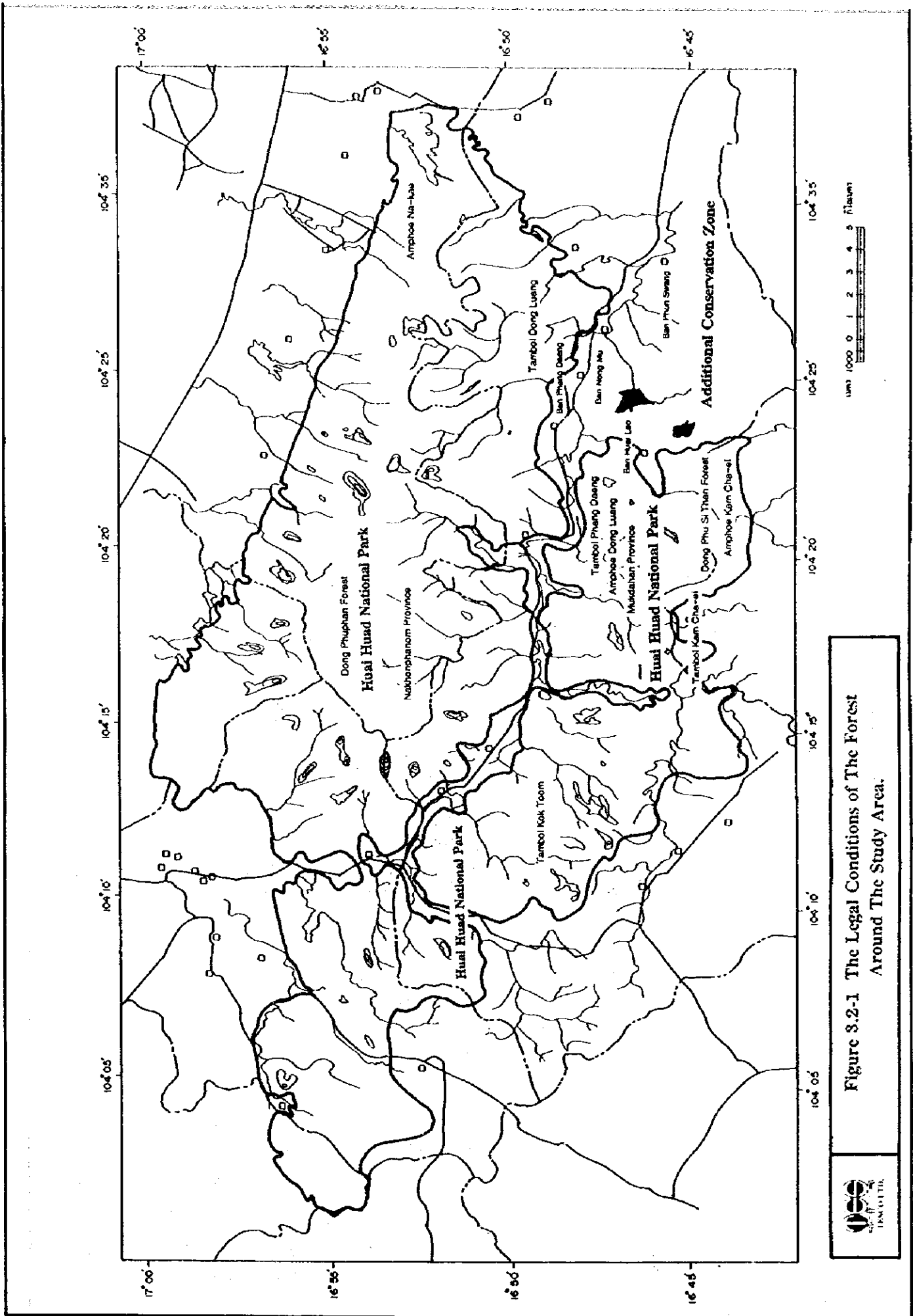


Figure 8.2-1 The Legal Conditions of The Forest Around The Study Area.

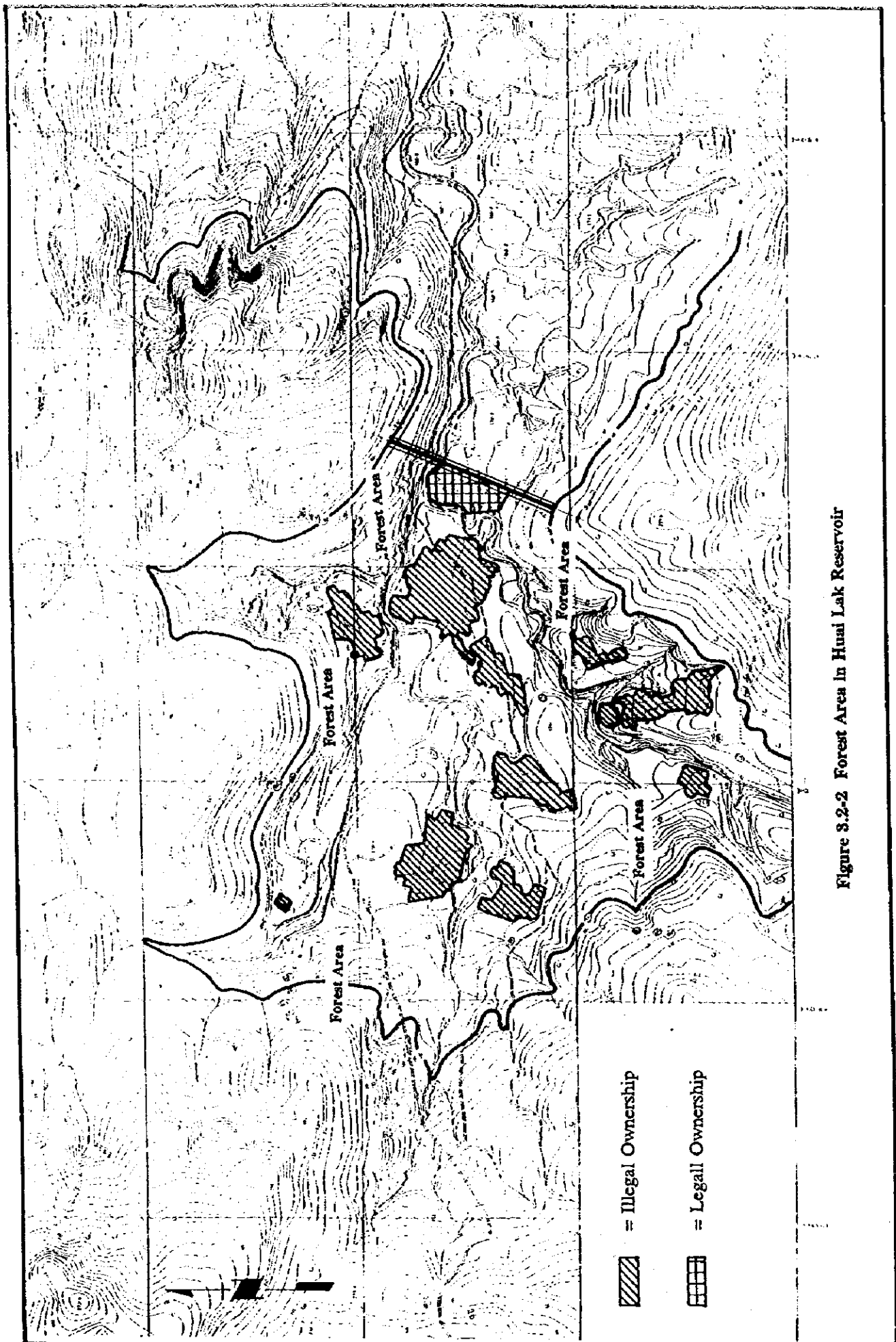


Figure 3.2-2 Forest Area in Hual Lak Reservoir

(*Terminalia alata*), Kra Bok (*Ivingia malayana*), Ma-ka Tac (*Sandoricum indicum*), etc.

- **Canopy 2** : between 15-20 m. height of tree such as Saem Sarn (*Cassia garrettiana*), Ta-kor (*Schleichera oleosa*), Makok (*Spondias pinnata*), Tiu (*Cartoxylum spp.*), etc.
- **Canopy 3** : less than 15 m. height of tree such as Daeng (*Xylia xylocarpus*), Ta-back Yai (*Largestroemia spp.*), etc.

The economic tree illegally cutting found during field survey include Daeng (*Xylia xylocarpus*), Takian (*Anogeissus spp.*), and Ta-back (*Largestroemia spp.*).

1.2) Dry Dipterocarp Forest

Dominant species include Taeng (*Shorea obtusa*) and Rang (*Shorea saimensis*). Particularly at rock outcrop and shallow soil surface, Taeng (*Shorea obtusa*) will become the only dominant species. Nevertheless, since the dry dipterocarp forest in the proposed reservoir area is an ecotone to the hilly forest of Phu Kam Phra, there are also some mixed deciduous forest species spread over this dry dipterocarp one. Dominant species thus additionally consist of Rok Fa (*Terminalia alata*), Teen Nok (*Vitex pinnata*), Pra-du (*Pterocarpus macrocarpus*) and Daeng (*Xylia xylocarpus*). Up to 41 species of dry dipterocarp forest species are found in the impoundment area.

The three canopies of community structure of the ecotone forest tree comprise of both mixed deciduous and dry dipterocarp forest species:-

- **Canopy 1** : more than 20 m. height of tree such as Taeng (*Shorea obtusa*) and Rang (*Shorea saimensis*).
- **Canopy 2** : between 15-20 m. height of tree such as Rok Fa (*Terminalia alata*), Ta-back (*Largestroemia spp.*), Daeng (*Xylia xylocarpa*), and Pra-du (*Pterocarpus macrocarpus*), etc.
- **Canopy 3** : less than 15 m. height of tree such as Kook (*Lannea coromandelica*), Som Thai (*Terminalia chebula*), Teen Nok (*Vitex pinnata*), Kam Mog Luang (*Gardenia sootepensis*), Ma-muang Hua Mang-wan (*Buchanania latifolia*), etc.

Undergrowth of dry dipterocarpic tree are mainly shrub and saplings. Seedlings include Sa-laeng Chai (*Strychnos nuxvomica*), Mhuad (*Aporosa spp.*), Kra Chiew (*Curcuma spp.*), etc.

2) Huai Kha Na

The impoundment area is also classified as watershed forest class 4 having undulating plain topography. There are small clusters of mixed deciduous forest scatteredly along the stream; which is an ecotone of the dry dipterocarp forest at foothill of Phu Kam Phra. The remaining dry dipterocarp forest are excessively destroyed due to illegal logging; and then upland cropping especially cassava.

2.1) Mixed deciduous forest

Dominant species consist of Yang Na (*Dipterocarpus alatus*), Krai Nam (*Homononia rapania*), and Takian Hin (*Hopea ferrea*). Other species include Chomphu Nam (*Euginia jambos*), Man Pla (*Adinandra laotica*), Khaeng Kwang (*Wendlandia tinetoria*), etc. At least 21 species of mixed deciduous forest species are found in the inundation area.

The ecotone of mixed deciduous forest clusters along the stream have the community structure with the following two vertical canopies:-

- **Canopy 1** : more than 15 m. height of tree such as Takian Hin (*Hopea ferra*), Yang Na (*Dipterocarpus alatus*), etc.
- **Canopy 2** : less than 15 m. height of tree such as Krai Nam (*Homononia rapania*), Chom-phu Nam (*Euginia jambos*), Man Pla (*Adinandra laotica*), and Khaeng Kwang (*Wendlandia tinetoria*), etc.

2.2) Dry dipterocarp forest

Dominant species are Teng (*Shorea obtusa*) and Rang (*Shorea siamensis*). There are also mixed deciduous forest species including Rok Fa (*Terminalia alata*), Pra-du (*Pterocarpus macrocarpus*), Sarn (*Dillenia ovata*), and Daeng (*Xylia xylocarp*). At least 45 species of dry dipterocarp forest species are found in the inundation area.

There are two canopies of community structure as follows:-

- **Capopy 1** : more than 15 m. height of tree such as Taeng (*Shorea obtusa*), Rang (*Shorea siamensis*), Rok Fa (*Terminalia alata*), Ta-back (*Largestroemia spp.*), Daeng (*Xylia xylocarpa*), and Pra-du (*Pterocarpus macrocarpus*), etc.
- **Canopy 2** : less than 15 m. height of tree such as Ngew Pa (*Bombax ancep*), Kra-done (*Careya arborea*), Tab-tao Ton (*Diospyros chretioides*), Tiu (*Cartoxylum spp.*), etc.

The undergrowth are mainly shrub, saplings, and seedlings of Taeng (*Shorea obtusa*), Rang (*Shorea siamensis*), Sarn (*Dillenia ovata*), Sa-laeng Chai (*Strychnos nuxvomica*), Mhuad (*Aporosa spp.*), Kra Chiew (*Circuma spp.*), and Prong (*Cycas spp.*).

There are also edible mushrooms including Hed Phao (*Astraeus hygrometrions*), Hed Pluak/Hed Khone (*Termitomyces tyleramus*), etc.

3.2.2 Wildlife Condition

The wildlife habitats of mixed deciduous and dry dipterocarp ecotone forests in the Phu Phan Reserve Forest are legally less protected from poaching than those of nearby connecting ecosystem of the Huai Huad National Park. Therefore, there is only an endangered Small Indian Civet or Cha-Mod Ched (*Viverricula indica*) of Huai Huad National Park which might be found at less abundance within both reservoir areas. The other

remaining 21 endangered species of Huai Huad National Park are not found in the impoundment areas.

The same ecotone forests altogether interconnected by Phu^{*} Kam Phra provide the same wildlife habitats of the two proposed reservoirs. Types of animal species are therefore similar; but their abundances are dependent on sizes of survey areas and, certainly, poaching. The Thai So are basically poachers by nature; their ancestor resided along the Phu Phan Range and poaching for subsistence. Table 3.2-6 show the wildlife species, abundance, and status of Huai Lak and Huai Kha Na Reservoir Areas basing on this survey.

Totally, there are at least about 132 wildlife species of 22 orders, 58 families, and 98 genus. Most of them are birds at about 74 species (14 orders, 34 families, and 54 genus); which could inhabitate widely along the Phu Phan Range. Because the habitats are clusters of mixed deciduous forest beside the two streams, there are approximately 22 species of reptiles (1 order, 10 families, and 19 genus) and 19 species of amphibians (1 order, 4 families, and 9 genus); which favour moisture of water retention. Due to poaching pressure, mammals are found at about 17 species (6 orders, 10 families, and 16 genus).

1) Huai Lak

There are about 119 wildlife species found in the proposed reservoir area; representing 90.15% of the total species richness in the study area. Of which, they are 16 mammals, 65 birds, 21 reptiles, and 17 amphibians.

Most of the mammals are less abundant (11 species), with some moderate abundance (4 species). Only one highly abundant species is Nu-Na Tong-Kao or Roof Rat (*Rattus rattus*) which is rat pest of ricefield.

The birds are mainly local species (44) with some migratory (21). They are also mostly less abundant (45 species); with some moderate abundance (18 species). Only two highly abundant species are Nok-Kum Ud-Yai or Yellow-legged Buttonquail (*Turnix tanki*) which reside along grass and rice fields; and Nok-Nang-An Ta-Pok-Daeng or Red-rumped Swallow (*Hirundo daurica*) which are migratory birds found in dry seasons. The proposed reservoir area is not suitable for permanent habitats for these birds due to human activities; and thus presently acts as only a feeding habitat during crop harvesting seasons. Farmers often shoot the birds in the rice field; whereas poachers usually trap the baby birds for sales.

Reptiles are mostly less abundant (12 species), with some moderate abundance (6 species). There are only three highly abundant species which are mostly adaptive to various types of ecosystem, including Ching-Chok Hang-Nam or Tokay gecko (*Hemidactylus frenatus*), King-Ka Hua-Daeng or Indian garden lizard (*Calotes versicolor*), and Ching-Len Ban or Indian brown-sided glass shink (*Mabuya macularia*).

The proposed reservoir area is the confluence of two nearly perennial streams having rice field habitat; which is most suitable for amphibians. Therefore, there are more-or-less equal abundance at all levels comprising 6 less abundant species, 5

* : Phu = mountain (north-eastern dialect)

Table 3.2-6 Abundance and Status of the Mammal Species Found Occurring in the Project Areas

Order/Family/Species	Abundance		Present Status	
	Huai Lak	Huai Kha Na	Legal Protection	Threatened Animal
Order Scandentia				
Family Tupaiidae				
1. Common Treeshrew (<i>Tupaia glis</i>)	3	3	-	-
Order Pholidota				
Family Manidae				
2. Pangolin (<i>Manis</i> sp.)	-	3	P	T
Order Rodentia				
Family Sciuridae				
3. Cambodian Striped Tree Squirrel (<i>Tamiops rodolphei</i>)	2	2	-	-
4. Variable Squirrel (<i>Callosciurus finlaysoni</i>)	3	3	-	-
5. Red-checked Flying Squirrel (<i>Hylopetes lepidus</i>)	3	-	P	-
Family Muridae				
6. Roof Rat (<i>Rattus rattus</i>)	1	2	-	-
7. Lesser Ricefield Rat (<i>R. losea</i>)	2	2	-	-
8. Bay Bamboo Rat (<i>Cannomys badius</i>)	3	3	-	-
9. Great Bandicoot (<i>Bandicota indica</i>)	3	-	-	-
Family Hystricidae				
10. Malayan Porcupine (<i>Hystrix brachyura</i>)	3	-	P	-
Order Carnivora				
Family Viverridae				
11. Small Indian Civet (<i>Viverricula indica</i>)	2	3	-	-
12. Spotted Palm Civet (<i>Paradoxurus hermaphroditus</i>)	3	3	-	-
13. Masked Palm Civet (<i>Arctogalidia trivirgata</i>)	3	-	-	-
Family Herpestidae				
14. Javan Mongoose (<i>Herpestes javanicus</i>)	3	2	P	-
Order Artiodactyla				
Family Suidae				
15. Common Wild Boar (<i>Sus scrofa</i>)	3	3	-	-
Family Cervidae				
16. Common Barking Deer (<i>Muntiacus muntjak</i>)	3	3	P	-
Order Lagomorpha				
Family Leporidae				
17. Burmese Hare (<i>Lepus pequiensis</i>)	2	3	P	-

Abundance : 1 = very common 2 = Common 3 = less common

Present Status : Legal Protection

R = Reserved animal

P = Protected animal

- = Unprotected animal

T = Threatened animal (Humphry and Bain, 1990)

- = Unthreatened animal

moderate abundant species, and 6 high abundant species. Most of amphibians are highly adaptive to the future impoundment area. Some of them are not preferably edible.

Majority of the wildlife species are commonly found throughout the country including Huai Huad National Park and Phu Phan Reserve Forest. There is only one threaten species of Ta-Kuad or Common monitor or Bangal monitor (*Varanus nebulosus*) due to hunting for food; and two endangered species of Nok-Kaew-Mong or Alexandrine Parakeet (*Psittacula eupatria*) and Cha-Mod Ched or Small Indian Civet (*Viverricula indica*) due to hunting for sale.

2) Huai Kha Na

Even the general ecological condition of Huai Kha Na is naturally suitable to wildlife habitat than such of Huai Lak, because of its less size of only 11.33% of the proposed reservoir of Huai Lak, there are less species richness in Huai Kha Na. Nevertheless, due to its locality closer to Huai Huad National Park, there are at least about 94 species comprising birds 51 species, reptiles 17 species, amphibians 13 species, and mammals 13 species.

There is no highly abundant mammal. They are 9 species of less abundance and 4 species of moderate abundance. Mammals mostly enter the proposed reservoir area for drinking water in the stream during dry seasons. Also, there is no rice field habitat for mices.

Birds are mainly of less abundance (34 species), having some moderate and high abundancy (13 and 4 species respectively). They mostly inhabitate in the Huai Huad National Park and enter the proposed reservoir area for feeding. There are also three species locally inhabited in the future impound area including Nok Ta-Karb-Thung or Indian Roller (*Caracias benghalensis*), Nok Pho-Ra-Dok Hu-Keow or Green-eared Barbet (*Megalaima faiostricta*), and Nok Kra-Jip Kor-Dam or Dark-necked Tailorbird (*Orthotomus atrogularis*). They are not endemic species so that they could be prevailed throughout the country including Huai Huad National Park.

Reptiles are of 9 less abundant species, 5 moderate abundant species, and 4 high abundant species. The highly abundancy include Ching-Chok Hang-Nam or Tokay gecko (*Hemidactylus frenatus*), King-Ka Hua-Daeng or Indian garden lizard (*Calotes versicolor*), and Ching-Len Ban or Indian brown sided glass shink (*Mabuya macularia*) which are the same as Huai Lak.

The amphibians found in Huai Kha Na are also similar to Huai Lak. They are highly adaptable to changing habitat including such from running water to standing water. There are 5 less abundant species, 4 moderate abundant species, and 4 high abundant species.

There are two threatening species due to hunting for food including Nim or Pangolin (*Mammis spp.*) and Ta-Kuad or Common Monitor or Bangal Monitor (*Veranus nebulosus*). One endangered species is Cha-Mod-Ched or Small Indian Civet (*Viverricula indica*) due to hunting for sale.