

infections in AIDS patients. Thus, mortality rates from these infectious diseases have started to increase again in this manner.

HIV / AIDS

According to the HIV sentinel surveillance carried out by the MOPH every six months, Phayao and Chiangmai in the North are the most critical provinces in the HIV epidemic. This data provides valuable indication of the levels of HIV infection among five different groups in all 76 provinces in Thailand. The results of the sentinel surveillance for June 1995 showing the top five provinces in three groups are included in the following table, which indicates that some provinces in the project area have very high infection levels. The country medians of each group are 17.79% for prostitute, 8.08% for male STD patients, and 2.29% for pregnant women.

Top Five Provinces in HIV Infection in Specific Groups²

	<u>Prostitutes</u>	<u>Male STD³ patients</u>	<u>Pregnant women</u>
1	Kanchanaburi (49.33%)	Phayao (42.86%)	Phrae (9.86%)
2	Phayao (44.58%)	Petchaburi (25.00%)	Phayao (8.38%)
3	Nan (44.00%)	Chiangmai (24.47%)	Maehongsorn (7.98%)
4	Ratchaburi (34.71%)	Pathumtani (23.53%)	Rayong (7.82%)
5	Lampang (34.21%)	Nakonratcasema (23.1%)	Chiangmai (6.95%)

Data on the number of AIDS patients per population indicates that the project area ranks as the region with the third highest prevalence of the disease.

No of AIDS Patients per Population by Region (as of Apr. 1996)

Rank	Region	No. of AIDS Patients per population
1	North	1.17
2	East	0.83
3	West	0.72
4	BMR	0.46
5	South	0.33
6	Northeast	0.21
	Whole Kingdom Average	0.58

² Sentinel Surveillance, June 1995

³ Sexually Transmitted Disease

As the above data shows, the north region (which includes the project area) is the most critical region for AIDS/HIV.

Health Services and Manpower

(I) Health Personnel

Provinces in the project area lack health personnel, especially doctors, in comparison with other regions.

Doctors per population by province and region

Province	Doctors per population	Region	Doctors per population
Kanchanaburi	1:9,615	Northeast	1:10,740
Ratchaburi	1:3,804	West	1:7,441
Phayao	1:10,127	North	1:6,318
Petchaburi	1:9,209	South	1:5,968
Prachuap Khirikhan	1:7,050	Central	1:5,548
Chumphon	1:8,655	Bangkok	1: 915
		Thailand Average	1:4,295

The number of hospitals in the project area is already sufficient because almost all districts have one community hospital. However, as the table above shows, the study area has significant lower levels of health personnel in comparison with other regions. The shortage of physicians in the project area is critical.

The new graduates from public medical schools are now obligated by MOPH to work in rural public hospitals for three years. However, after working for three years, they tend to move to urban areas like Bangkok or to private hospitals. The project area has no medical schools and three public nursing colleges. The distance from Bangkok is another obstacle to attracting doctors, particularly in the southern part of the project area.

(3) Eighth Plan for Public Health Development

In 1995 MOPH put emphasis on the following health issues :

- universal coverage of health security ;
- improvement of quality of health services ;
- healthcare workforce development ;
- promotion of health education and public relations; and
- consumer protection concerning foods and drugs.

The 8th National Health Development Plan (1997-2001), which will be implemented by MOPH, focuses on human development as well. Since the high rate of economic development in recent years has caused serious health problems, the development of human potential will be the main target of the 8th plan. The primary seven policies of the 8th Health Development Plan are as follows:

- improve the efficiency of health administration, management and financing;
- improve the quality and efficiency of health services at all levels including the private sector;
- upgrade health promotion and communicable disease control, including AIDS and occupational health;
- improve consumer protection;
- develop health personnel to be sufficient in number and capability;
- improve community participation in PHC (primary health care) and health behavior; and
- upgrade medical technology

2.3.4.2 Overview of Macroeconomic Conditions

(1) National economic conditions

Over the past three decades, Thailand's economic growth has averaged about 7.25 percent annually, while inflation averaged below 5 percent during the period—resulting in a five-fold increase in per capita income. This is an extraordinary record and a testimony to the enterprise of the Thai people and the quality of the authorities' economic management. This rapid economic expansion has also transformed the economy from one largely dependant upon a narrow agricultural base to one with significant modern manufacturing and service sectors. For example, in 1965 agriculture accounted for 35 percent of Gross Provincial Product (GPP), while industry and services contributed 24 percent and 41 percent respectively. By 1995, agriculture's share of output dropped to 11 percent, while the shares of industry and services had increased to 40 percent and 49 percent respectively.

Thailand's most difficult period for macroeconomic management occurred from 1980 to 1986 when the economy was adjusting to severe external shocks: the second oil price shock, the surge in US interest rates and the appreciation of the dollar, and depressed commodity prices. The major problems were deterioration in the balance of payments, falling external reserves, and rising foreign debt. Stabilization measures included restrictive monetary and fiscal policies, tax system restructuring, and devaluation of the baht in 1981 and 1984 and the pegging of the baht to a currency basket. The measures put in place proved to be instrumental to the resumption of rapid economic growth as the external environment improved after 1986. The following table records average annual economic growth during recent Plan periods:

GDP Growth by Plan Period

Plan	Period	Real Average GDP Growth
5th Plan	1982-86	5.2%
6th Plan	1987-91	11.3%
7th Plan	1992-96	8.4% (estimate)
8th Plan	1997-2001	8.0% (target)

Since 1986, economic growth in Thailand has averaged 9.4 percent a year—high both in absolute terms and in comparison with other countries. Economic growth reached a peak of 13.3 percent in 1988 and since 1991 has been relatively stable in the range of 8.0 to 8.8 percent. Thailand has experienced this extraordinary economic boom over the past 10 years owing largely to a rapid expansion of exports and

investment expenditure (see Table 2.3.4.16). The driving force propelling the 23 percent annual expansion in exports was a surge in manufacturing exports, which accounted for 80 percent of the total exports by 1995. This expansion in investment came largely from the private sector, especially in the export-oriented manufacturing sector. Particularly after 1988, Thailand also benefited from a surge in foreign direct investment, much of which came in the form of industrial relocation from Japan and newly industrialized countries (NICs) of Asia in response to concurrent economic restructuring in these countries. Reflecting this surge and the growing general attractiveness of Thailand as an investment destination, non-monetary capital net inflows—almost entirely private capital—increased from US\$700 million in 1986 to US\$22 billion in 1995.

The sustainability of Thailand's economic boom has been enhanced by its strong domestic actions in the area of macroeconomic and structural policies. Among the policies of importance were:

1. achieving and maintaining an overall surplus in the central government budget by strict control over current expenditure (while also providing for somewhat higher rates of infrastructure investment after 1990/91);
2. a reformed tax system and rate structure that is incentive-oriented and broadly comparable with that of competitive regional countries;
3. efficient and profitable operation of the public sector enterprises (largely confined to provision of public utility services) that underpinned the maintenance of an overall public sector surplus;
4. deregulation of interest rate and exchange controls;
5. liberalization and institutional strengthening measures in the banking and capital markets;
6. the establishment and rapid development of the Bangkok International Banking Facility (BIBF);
7. a reformed and lowered structure of tariff rates and liberalization of capital account transactions and certain trade restrictions; and
8. the revision of the BOI investment incentive framework.

Thailand will face challenges to sustaining its ongoing rapid economic expansion. It must be careful to not overheat the economy, but at the same time deal with the remaining structural constraints to growth. As such, microeconomic tasks include managing financial policies to achieve rapid economic growth with relative price and exchange rate stability, avoiding destabilizing short-term capital flows, and raising the domestic savings rate to lessen the present reliance on large current account deficits. Structural issues largely relate to overcoming implementation delays in building up the economic and social

Table 2.3.4.16. Key Economic and Financial Indicators, 1985-1995

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Growth and Inflation (% change)											
Real GDP	4.60	5.50	9.50	13.30	12.20	11.20	8.50	8.10	8.30	8.80	8.70
Real fixed investment	-3.70	-0.70	18.40	21.90	22.50	29.60	12.70	6.80	10.60	12.40	12.60
CPI (annual average change)	2.50	1.80	2.50	3.80	5.40	5.90	5.70	4.10	3.40	5.10	5.80
Investment and savings (% of GDP)											
Gross domestic investment	28.20	25.90	27.90	32.60	35.10	41.30	42.70	40.00	40.40	41.20	43.10
Gross national savings	23.10	24.40	27.50	32.00	34.10	33.20	34.00	33.90	33.50	34.50	34.40
Statistical discrepancy	-1.30	-2.00	0.20	2.00	2.50	0.40	-0.40	-0.50	-1.10	-1.10	-0.60
Foreign savings	3.80	-0.60	0.50	2.60	3.50	8.50	8.30	5.60	5.90	5.60	8.10
Employment rate(%)		5.60	5.90	4.30	3.60	3.90	3.10	3.00	2.60	2.60	2.60
Trade(% change)	-5.60	10.70	-1.00	-1.80	-4.90	-2.80	-1.10	0.70	0.00	1.40	-3.50
Central government budget											
(% of GDP, fiscal year basis)											
Revenue and grants	15.80	15.40	15.90	17.00	17.90	19.20	19.40	18.30	18.30	18.90	19.00
Expenditure and net lending	21.00	20.00	18.10	16.30	14.70	14.60	14.70	15.50	16.20	17.10	16.40
Overall surplus/deficit	-5.20	-4.60	-2.20	0.70	3.20	4.60	4.70	2.70	2.10	1.70	2.60
Public sector overall balance											
(% of GDP, fiscal year basis)	-6.00	-4.80	-1.60	1.30	4.10	4.70	4.00	1.60	0.90	1.60	2.50
Balance of payments (US\$ billions)											
Exports (F.O.B)	7.10	8.80	11.60	15.90	19.90	22.90	28.30	32.20	35.60	44.60	56.00
Imports (C.I.F)	-9.30	-9.30	-13.20	-19.80	-25.30	-32.70	-37.80	-40.10	-45.10	-53.40	-70.90
Current account	-1.50	0.30	-0.30	-1.50	-2.40	-7.10	-7.40	-6.10	-6.10	-7.80	-13.10
(% of GDP)	-4.00	0.70	-0.70	-2.60	-3.50	-8.80	-7.50	-5.50	-5.40	-5.60	-8.10
Nonmonetary capital											
Medium and long-term capital	1.50	0.70	0.80	2.80	5.90	8.10	11.30	9.70	10.50	12.20	22.00
Private sector	0.40	0.10	0.50	1.50	4.50	4.80	4.10	4.00	6.60	4.60	8.40
Direct investment (equity)	0.20	0.20	0.20	0.90	1.40	1.50	1.20	1.50	1.20	0.80	1.10
Public sector	1.00	0.20	0.20	-0.30	-0.20	-1.30	0.60	0.30	0.70	0.00	1.00
Short-term capital	0.10	0.40	0.20	1.60	1.70	4.70	6.60	5.40	3.10	7.60	12.60
Overall balance	0.50	1.30	0.70	1.60	4.30	2.20	4.20	3.00	3.90	4.20	7.20
Official reserves and external debt											
(In US dollars billions)											
Gross official reserves	3.00	3.80	5.20	7.10	10.50	14.30	18.40	21.20	25.40	30.30	37.00
External debt (short and long term)	17.40	18.20	19.90	20.90	22.70	29.20	37.90	43.60	52.10	64.90	82.60
(% of GDP)	43.90	42.00	38.40	33.80	31.40	33.80	38.60	39.40	41.30	45.40	49.40
Debt service ratio (%)	27.50	24.80	19.80	14.60	12.70	10.50	10.60	11.30	11.20	11.70	11.40
Exchange rate (Baht/US dollar)											
End year	26.65	26.13	25.07	25.24	25.69	25.29	25.52	25.54	25.09	25.19	24.92
Year average	27.16	26.30	25.72	25.29	25.70	25.59	25.52	25.40	25.32	25.15	24.92

Source: Bank of Thailand

infrastructure, dealing with environmental problems, and boosting the educational attainment of the population to facilitate the transition from low-wage, labor-intensive manufacturing to the more remunerative higher-technology, skill-intensive industries. Moreover, measures to address unequal income distribution and the uneven pattern of regional income levels and economic growth rates will be crucial to ensuring the sustainability of the development effort over the longer term.

(2) Existing Economic Condition in the Project Area

This section describes and assesses recent economic trends in the project area. At present, regional economic data are less complete and timely than are national economic data. The most comprehensive economic indicators are the provincial national income account estimates that are generated on a Kingdom-wide basis. These are summarized in the table below and presented in more detail in the other tables referred to in the following discussion. The NESDB estimates GDP by industrial sector for each of the 76 provinces, which are grouped into seven regional areas.⁴ As it is not presently possible to make estimates of the expenditure or income side of the accounts at the provincial level, the lack of information on investment expenditure and other components of aggregate demand necessarily limits the full understanding of evolving economic developments and trends in growth at the provincial and regional level of the Thai economy.

(3) Overview

The project area roughly conforms to the Northeastern region of provinces as indicated in the table below. The agricultural sector accounts for about 19 percent of GPP and industry 20 percent. The economic strength of the project area is very small relative to that of the entire Thai economy and the other provincial regions as it accounts for only about 1.3 percent of national GDP, 3.8 percent of population, and about 5.5 percent of land area. Per capita GPP in the project area, however, has traditionally been relatively low. Real economic growth in the project area has also lagged behind the BMR and other provincial regions in recent years. This characterization, however, is significantly influenced by the strong performance of the Eastern region (10.4%)

⁴ Bangkok and Vicinity (abbreviated here as BMR), Central, Eastern, Western, Southern, Northern, and Northeastern

Summary of Regional Economic Indicators

	Project Area	Other Provincial Regions	Bangkok Region (BMR)	Whole Kingdom
Agriculture	19.31	18.80	2.20	10.20
Industry ⁵	20.33	32.60	45.40	39.30
(Manufacturing)	3.00	19.70	35.90	28.20
Services	60.36	48.60	52.40	50.40
Total	100.00	100.00	100.00	100.00
GPP (mn. Baht)	B 46.70	B 1,604.20	B 1,855.90	B 3,600.90
Share in total GDP	1.3%	44.6%	51.5%	100%
Per capita GDP	B20,857	B 34,993	B 186,167	B 61,335
Growth in real GDP, 1981 to 1994 (p.a.)	8.2%	7.3%	9.1%	8.2%

Table 2.3.4.17 compares the economic structure of the project area with each of the other provincial regions and includes data on area, population, per capita income, and growth in real GPP in the 1981 to 1994 period (the longest, most recent period for which comparable data are available). The table indicates that the GPP of the project area is considerably smaller than that of the BMR—about 2.5% of the BMR value. The agricultural sector in the project area (19.31 percent of GPP) is relatively comparable in size to that of the Northeastern regions, while the Southern region is larger (36 percent of GPP) and the Central and Eastern regions are smaller (about 10 percent of GPP). Notably, fisheries are relatively important in the Southern region (12 percent of GPP, raising the size of the agricultural sector) followed at some distance by the project area (0.19 percent of GPP) and Eastern (2.8 percent of GPP) regions. The manufacturing sector in the Eastern and Central regions accounts for about 40 percent of GPP, compared with about 3.6 percent of GPP in the project area, and only 5 percent of GPP in the Southern and 10-13 percent of GPP in the Northeast and Northern regions. The service sector generally accounts for about 60 percent of GPP in the provincial regions, except for the Eastern and Central regions, where it accounts for 55 percent. Variations in GPP per capita across regions are extreme and largely reflect the relative importance of manufacturing and certain service industries where output per worker is much higher than in the other sectors. As detailed in Table 2.3.4.4, per capita GPP in 1993 varied from a low of B20,000 in the Northeastern region to a (non BMR) high of B100,000 in the Eastern region, while the BMR level was B186,000.

⁵ Includes mining and quarrying, construction, electricity and water, and manufacturing.

**TABLE 2.3.4.4 GROSS PROVINCIAL PRODUCT AT CURRENT MARKET PRICES BY
PROVINCE WHOLE KINGDOM 1993**

Changwat (Province)	Gross Provincial Product (GPP) (Thousand Baht)	Percapita GPP (Baht)	Percapita priority Region priority	Country priority
Central				
Samut Prakan	194,031,371	226,672	1	1
Chon Buri	154,427,506	168,589	2	2
Pathum Thani	70,918,754	148,366	3	3
Samut Sakhon	41,055,055	113,726	4	4
Rayong	48,040,891	108,936	5	5
Nonthaburi	64,747,620	94,384	6	6
Saraburi	43,771,870	79,011	7	8
Chachoengsao	31,017,268	53,294	8	10
Nakhon Pathon	34,227,237	51,162	9	11
Trat	9,091,455	45,916	10	12
Phra Nakhon Si Ayutthaya	31,555,326	45,403	11	13
Kanchanaburi	31,191,497	43,994	12	14
Prachuap Khiri Khan	17,312,724	39,169	13	17
Ratchaburi	29,622,859	38,824	14	18
Phetchaburi	16,589,280	38,580	15	19
Chanthaburi	16,045,722	35,816	16	22
Sing Buri	6,690,706	30,138	17	26
Chai Nat	10,284,889	29,811	18	27
Nakhon	6,755,777	29,761	19	29
Samut Songkhram	5,604,128	27,743	20	33
Lop Buri	20,396,165	27,600	21	34
Suphan Buri	22,424,082	27,480	22	35
Ang Thong	7,640,368	26,808	23	38
Prachin Buri	20,738,860	23,540	24	47
Northern				
Chiang Mai	55,085,085	37,781	1	20
Lampang	25,492,967	34,173	2	24
Lamphun	11,319,186	29,787	3	28
Uthai Thani	8,229,528	27,250	4	36
Nakhon Sawan	27,902,905	26,701	5	39
Phitsanulok	21,081,181	26,451	6	41
Kamphaeng Phet	18,644,669	26,446	7	42
Uttaradit	11,894,997	26,375	8	43
Tak	9,935,867	24,533	9	44
Mae Hong Son	4,708,899	23,903	10	45

Changwat (Province)	Gross Provincial Product (GPP) (Thousand Baht)	Percapita GPP (Baht)	Percapita priority Region priority	Country priority
Sukhothai	13,659,578	23,632	11	46
Phrae	10,096,815	21,621	12	50
Phichit	11,765,310	21,085	13	51
Nan	8,950,070	20,575	14	52
Chiang Rai	22,784,038	19,440	15	55
Phayao	9,398,473	19,378	16	56
Phetchabun	17,923,364	18,593	17	58
Northeastern				
Khon Kaen	38,687,977	23,519	1	48
Nakhon Ratchasima	50,033,935	20,489	2	53
Nong Khai	16,591,672	19,705	3	54
Loei	11,012,590	18,263	4	59
Maha Sarakham	14,818,638	17,072	5	60
Chaiyaphum	18,326,216	16,922	6	61
Udon Thani	30,286,402	16,424	7	62
Ubon Ratchathani	30,477,527	15,479	8	63
Kalasin	14,096,880	15,323	9	64
Roi Et	18,860,519	15,173	10	65
Mukdahan	4,561,122	15,053	11	66
Yasothon	7,848,020	14,949	12	67
Buri Ram	21,086,294	14,870	13	68
Sakon Nakhon	15,079,565	14,857	14	69
Nakhon Phanom	9,737,672	14,732	15	70
Surin	18,635,081	14,064	16	71
Si Sa Ket	17,096,439	12,702	17	72
Southern				
Phuket	19,226,961	93,335	1	7
Ranong	9,628,403	67,806	2	9
Phangnga	9,778,654	41,789	3	15
Songkhla	49,279,380	40,828	4	16
Krabi	12,102,332	36,126	5	21
Surat Thani	29,241,357	34,281	6	23
Chumphon	14,062,998	32,596	7	25
Yala	11,855,282	29,272	8	30
Trang	16,915,204	29,114	9	31
Satun	7,250,927	29,004	10	32
Narathiwat	17,073,140	27,230	11	37
Pattani	15,549,334	26,489	12	40
Nakhon Si Thammarat	36,900,789	23,325	13	49
Phatthalung	9,939,153	19,299	14	57

Source : Office of The National Economic and Social Development Board

Growth in real GPP has been marked by appreciable regional differences in the 1981 to 1994 period. Four regions exceeded the Kingdom average growth rate of 8.2 percent per annum—Eastern (10.4 percent), BMR (9.1 percent), Central (8.3 percent) and the project area (8.2%). The high growth in the Eastern region, of course, reflects the build up in infrastructure under the ESB Development Project and the spillover of investment from the BMR in an era of significantly increased private investment expenditure—both foreign and domestic. Growth in the other regions was about 6 percent per annum, except in the Southern region which recorded a 7 percent rate. This trend of disparate economic growth and the extreme variations in income levels across the regions prompted the adoption of new regional policies in 1993 that included a revision of BOI incentives to emphasize a regional zone approach and the introduction of other supporting measures fostering faster regional economic development. Moreover, the Eighth Plan (1997 to 2001) places renewed emphasis on policies to promote regional and human development. The effects of these policies, will of course, only be apparent in the provincial GPP data in the years ahead.

(4) The Project Area's Provinces

Chiang Rai province has traditionally dominated the economy of the project area, and now accounts for somewhat more than one half of the area's GPP (see Table 2.3.4.18). In addition, economic growth in Chiang Rai province has been the highest in the project area economy while Phayao's growth has been the lowest. The population of the project area is generally proportional to the economic shares. The industrial structure of GPP by province is varied. The share of agriculture ranges from a high of 24.1 percent in Phayao to a low of 16.78 percent in Chiang Rai. The share of manufacturing in total output ranges from a low of 1.72 percent in Nan to a high of 4.14 percent in Phayao. Value added in the services sector ranged more narrowly between provinces and remained within 4.39 percentage points of the project area average of 61.37 percent of GPP. A relatively large wholesale and retail trade sector in Nan and Phayao explains much of this variation in provincial service sector shares.

(5) Sources of Growth in the Project Area

Over the 1989 to 1994 period, economic growth in the project area averaged 8.2 percent per annum. Growth varied markedly over the individual provinces (Table 2.3.4.19). However, this variation appeared not to be associated in a direct way with the province's initial industrial structure—whether it was more or less agriculturally oriented—but depended instead on whether new industrial activity was introduced in the province. Above average output growth was recorded by Chiang Rai (8.6%), Phayao (7.87%), and Nan (8.13%).

Table 2.3.4.18 Provincial and project area structure of GPP in 1994

	Chiang Rai	Share in total GPP (%)	Phayao	Share in total GPP (%)	Nan	Share in total GPP (%)	Project area	Share in total GPP (%)
Agriculture	4,647,402	16.78	2,275,215	24.21	2,089,792	21.82	9,012,409	19.31
Crops	3,356,368	12.12	1,530,839	16.29	1,489,265	15.55	6,376,472	13.66
Livestock	630,990	2.28	332,175	3.53	323,800	3.38	1,286,965	2.76
Fisheries	38,187	0.14	34,860	0.37	15,611	0.16	88,658	0.19
Forestry	442	0.00					442	0.00
Agricultural services	183,714	0.66	100,929	1.07	75,542	0.79	360,185	0.77
Simple agri. processing products	437,701	1.58	276,412	2.91	185,574	1.94	899,687	1.93
Mining and quarrying	124,884	0.45	36,170	0.38	36,797	0.38	197,851	0.42
Manufacturing	1,127,529	4.07	388,684	4.14	165,166	1.72	1,681,379	3.60
Construction	5,115,472	18.47	617,603	6.57	1,209,108	12.62	6,942,183	14.87
Electricity and water supply	410,071	1.48	146,932	1.56	115,499	1.21	672,502	1.44
Transportation and communication	1,785,904	6.46	383,758	4.08	314,742	3.29	2,487,404	5.33
Wholesale and retail trade	5,420,754	19.57	1,977,136	21.04	2,179,030	22.75	9,576,920	20.52
Banking, insurance and real estate	1,776,505	6.41	384,299	4.09	356,380	3.72	2,517,184	5.39
Ownership of dwelling	1,753,039	6.33	684,905	7.29	581,781	6.07	3,019,725	6.47
Public administration and defence	1,536,005	5.54	878,942	9.35	954,718	9.97	3,369,665	7.22
Services	4,000,414	14.44	1,624,829	17.29	1,575,081	16.44	7,200,324	15.43
Gross Provincial Product (GPP)	27,700,979		9,398,473		9,578,094		46,677,546	
(As a percent of project area total)	59.35		20.13		20.52			
Per capita GDP	22,125		18,321		20,250		20,857	
(As a percent of regional average)								
(As a percent of Kingdom average)								
(As a percent of BMR)								
Population (1,000 persons)	1,252		513		473		2,238	
(As a person of regional population)	55.94		22.92		21.13			
(As a person of Kingdom's population)								
Area (sq km)	11,678.37		6,344.06		11,472.07		29,494.50	
% of project area	39.60		21.51		38.90			
Population density	107.21		80.86		41.23		75.88	
Secondary structure(%)								
Agriculture	16.78		24.21		21.82		19.31	
Industry	24.47		12.65		15.93		20.33	
(Manufacturing)	4.00		4.14		1.72		3.6	
Service	58.75		63.14		62.24		60.36	
Total	100.00		100.00		100.00		100	
Real GDP growth 1989-1994(% p a)	8.60		7.87		8.13			

Table 2.3.4.19 Gross Provincial Product by Provinces and Project Area, 1989 - 1994
(in current market prices)

	1989	1990	1991	1992	1993	1994	Share in GPP	
							1989	1994
Phayao								
Agriculture	2,007,751	2,271,762	2,523,952	1,953,768	2,275,215		31.19	24.21
Industry	843,530	880,994	966,113	1,109,861	1,189,389		13.10	12.66
(Manufacturing)	325,281	312,312	317,292	311,804	388,684		5.05	4.14
Services	3,585,872	4,182,640	4,599,271	5,229,882	5,933,869		55.71	63.14
GPP	6,438,153	7,335,396	8,089,336	8,293,511	9,398,473			
Chiang Rai								
Agriculture	4,561,006	4,788,960	5,081,375	3,932,632	4,472,744	4,647,402	28.96	16.78
Industry	2,341,519	3,615,274	4,305,019	5,493,429	6,119,177	6,777,956	14.87	24.47
(Manufacturing)	679,242	669,173	694,666	606,513	856,471	1,127,529	4.31	4.07
Services	8,846,835	9,939,582	11,330,152	12,891,597	14,777,206	16,275,621	56.17	58.75
GPP	15,749,360	18,343,816	20,716,546	22,317,658	25,369,127	27,700,979		
Nan								
Agriculture		1,945,319	2,103,192	202,977	1,914,608	2,089,936	30.10	21.82
Industry		796,695	913,380	1,050,271	1,224,627	1,526,570	12.33	15.94
(Manufacturing)		117,284	113,570	110,081	145,090	165,166	1.81	1.72
Services		3,720,235	4,143,210	4,781,633	5,474,030	5,961,732	57.57	62.24
GPP		6,462,250	7,159,782	6,034,881	8,613,265	9,578,238		
Project Area								
Agriculture	6,568,757	9,006,041	9,708,519	6,089,377	8,662,567	6,737,338	29.61	18.07
Industry	3,185,049	5,292,964	6,184,512	7,653,561	8,533,193	8,304,526	14.36	22.28
(Manufacturing)	1,004,523	1,098,769	1,125,528	1,028,398	1,391,245	1,292,695	4.53	3.47
Services	12,433,707	17,842,457	20,072,633	22,903,112	26,185,105	22,237,353	56.04	59.65
GPP	22,187,513	32,141,462	35,965,664	36,646,050	43,380,865	37,279,217		

Source: Statistical Report of Chiang Mai, 1995

The service sector was the main source of growth in the project area during the 1989 to 1994 period, while the share of the agricultural sector declined considerably. The construction and the electricity and water supply sectors also grew rapidly, while value added in mining and quarrying remained effectively unchanged over the period. The agricultural sector, which currently accounts for about 45.9% of the project area employment, fell from 29.61% to 18.07% of GPP over the period. The crop sector accounted for 70 percent and the fisheries sector accounted for 0.98 percent of the total one third of the agricultural value added in 1994. Fisheries were the most rapidly growing subsector in agriculture, recording a 11 percent annual gain. However, this performance mainly reflected a sharp jump in output in 1991 with only small subsequent gains. Regardless, resource constraints preclude sustained expansion of fishing output at this rate. Forestry output has varied from year to year but has been on a declining trend due to resource constraints. Growth in manufacturing output over the 1989 to 1994 period averaged about 7 percent per annum.

(6) Employment and Output per Worker

Data on employment for the project area are only available for 1994. These employment data and project area GPP data have been used to calculate output per worker estimates in Table 2.3.4.20. These statistics attempt to identify trends in employment and output per worker by economic sector in the project area. As a reference, identical calculations were made for the Kingdom as a whole using the same data sources. These overall productivity calculations for the Kingdom also agree with the results of a Ministry of Labor and Welfare study on national productivity, providing a check on the validity of the analysis (see Table 2.3.4.21). While project area output per worker varies considerably by sector, the pattern of variation by sectors is broadly in accord with reported national data.

For the agricultural sector, the data suggest that the output per worker is very low compared with the other industry, though the share of the employment is nearly half: 42.9% in Chiang Rai province; 45.6% in Phayao province; and 53.9% in Nan province. On the other hand, the transport sector indicates high productivity in each project area province: 131 in Chiang Rai; 100 in Phayao; and 163 in Nan. The employment share of the transport sector is very low, though: 2.4% in Chiang Rai; 1.9% in Phayao; and 0.9% in Nan. The employment share in the manufacturing sector is about 10 percent in each project area province. However, the productivity in this sector is the lowest overall in all but Chiang Rai province. This indicates one reason why the project area may be unattractive for manufacturing investment.

Table. 2.3.4.20 Productivity at each Province

	1994			
	GPP	Employment		Output / Worker
Chiang Rai				
Agriculture	4,647,402	240,887	42.99	19.29
Mining and Quarring	124,884	0		
Manufacturing	1,127,529	53,382	9.53	21.12
Construction	5,115,472	87,302	15.58	58.60
Electricity, gas, water and sanitary services	410,071	6,486	1.16	63.22
Commerce	8,950,298	105,397	18.81	84.92
Transport, storage and communication	1,788,904	13,607	2.43	131.47
Services	5,536,419	53,234	9.50	104.00
Total	27,700,979	560,295		49.44
Phayao				
Agriculture	2,275,215	91,786	45.61	24.79
Mining and Quarring	36,170	18	0.01	2009.44
Manufacturing	388,684	27,633	13.73	14.07
Construction	617,603	29,606	14.71	20.86
Electricity, gas, water and sanitary services	146,932	519	0.26	283.11
Commerce	3,046,340	23,593	11.72	129.12
Transport, storage and communication	383,758	3,807	1.89	100.80
Services	2,503,771	24,294	12.07	103.06
Total	9,398,473	201,256		46.70
Nan				
Agriculture	2,089,792	114,949	54.00	18.18
Mining and Quarring	36,797	0		
Manufacturing	165,166	16,411	7.71	10.06
Construction	1,209,108	22,018	10.34	54.91
Electricity, gas, water and sanitary services	115,499	261	0.12	442.52
Commerce	3,117,191	35,618	16.73	87.52
Transport, storage, and communication	314,742	1,920	0.90	163.93
Services	2,529,799	21,709	10.20	116.53
Total	9,578,094	212,886		44.99
Project Area				
Agriculture	9,012,409	447,622	45.94	20.13
Mining and Quarring	197,851	18	0.00	10991.72
Manufacturing	1,681,379	97,426	10.00	17.26
Construction	6,942,183	138,926	14.26	49.97
Electricity, gas, water and sanitary services	672,502	7,266	0.75	92.55
Commerce	15,113,829	164,608	16.89	91.82
Transport, storage and communication	2,487,404	19,334	1.98	128.65
Services	10,569,989	99,237	10.18	106.51
Total	46,677,546	974,437		47.90

Source: Report of the Labor Survey Round 1, National Statistical Office

Table 2.3.4.21 Labor Productivity Index by Industries for the Kingdom, 1984-1994

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Avg. Growth	
																1984-94	1990-94
Agriculture					97.70	101.80	97.70	100.40	100.00	112.00	93.00	124.50	126.90	122.20	148.50	4.30	12.40
Mining and Quarrying					29.80	57.90	86.10	98.90	100.00	144.00	136.70	135.30	148.70	166.10	200.90	21.00	10.10
Manufacturing					80.50	76.20	83.00	80.80	100.00	97.60	112.20	103.70	108.20	117.10	121.70	4.20	2.10
Construction					94.70	97.00	96.40	87.80	100.00	109.50	123.30	92.00	85.80	101.40	85.80	-1.00	-8.70
Electricity, gas and water					686.60	84.70	87.10	88.20	100.00	121.50	144.80	142.40	153.70	145.00	130.40	6.60	-2.60
Transport and communication					81.90	85.10	88.90	84.90	100.00	104.80	113.90	104.30	114.50	117.20	126.90	4.50	2.70
Commerce					91.00	86.00	85.80	84.70	100.00	111.10	133.90	118.70	127.80	134.20	146.90	4.90	2.30
Public administration and other					92.00	99.00	100.10	96.00	100.00	104.10	110.00	108.00	105.60	104.10	101.30	1.00	-2.00
Total					85.00	87.40	88.60	93.50	100.00	110.90	112.60	130.50	135.90	143.20	160.50	6.60	9.30
Percentage change																	
Agriculture						4.20	-4.00	2.80	-0.40	12.00	-17.00	33.90	1.90	-3.70	21.50		
Mining and Quarrying						94.30	48.70	14.90	1.10	44.00	-5.10	-1.00	9.90	11.70	21.00		
Manufacturing						-5.30	8.90	-2.70	23.80	-2.40	15.00	-7.60	4.30	8.20	3.90		
Construction						2.40	-0.60	-9.00	14.00	9.50	12.60	-25.40	-6.70	18.20	-15.40		
Electricity, gas and water						23.50	2.80	1.30	13.40	21.50	19.20	-1.70	7.90	-5.70	-10.10		
Transport and communication						3.90	4.50	-4.50	17.80	4.80	8.70	-8.40	9.80	2.40	8.30		
Commerce						-5.50	-0.20	-1.30	18.10	11.10	20.50	-11.40	7.70	5.00	9.50		
Public administration and other						7.60	1.10	-4.10	4.20	4.10	5.70	-1.80	-2.20	-1.40	-2.70		
Total						2.80	1.40	5.50	7.00	10.90	1.50	15.90	4.10	5.40	12.10		
Overall Index (All industries)																	
GDP Index	58.60	62.00	65.40	69.00	73.00	76.40	80.60	88.30	100.00	112.30	125.30	135.80	146.50	158.50	172.20	9.00	8.00
Labor Index	81.20	75.30	77.90	82.60	85.90	87.40	91.00	94.40	100.00	101.20	111.20	104.10	107.80	110.70	107.30	2.20	2.00
Labor Productivity Index	72.10	82.40	83.90	83.50	85.00	87.40	88.60	93.50	100.00	110.90	112.60	130.50	135.90	143.20	160.50	6.60	5.90

Source: Labor Studies and Planning Division, Department of Labor Protection and Welfare

2.3.5 Rural Development

(1) Existing Situation:

(1) Overview and Prospects of Rural Development in the Project Area⁶

The project area is predominantly rural with a limited number of urban centers that are all relatively small. The rural population in the region accounted for 96.1 % of the total project area's population in 1995.

Present levels of various social services in the project area are generally comparable to their respective national averages. At present, they seem reasonable as far as average levels are concerned, but some serious problems do exist in spots (e.g. poverty pockets). Provision of social services is expected to be consistently improved in keeping with economic development.

In the project area, many social problems are associated with jobs. In particular, job opportunities largely determine incomes, and low incomes are at the root of most social problems, including weakening ties among family members due to out-migration of individual family members in search of jobs.

A particularly important related problem is the gender issue. The poverty of women-headed households is just one of several gender-related social problems, though. Other concerns include possible social constraints to increased participation of women in the labor force, limited education opportunities for women (especially at higher levels), and lack of social recognition for women as main actors in the participatory provision of social services.

(2) Existing Socio-Economic Conditions at Village Level

Existing socioeconomic conditions in rural portions of the project area are summarized by province in Table 2.3.5.1. In the table, villages in each province are classified using 33 indicators selected from the National Rural Development Survey. The three classes include: those facing serious problems, those having moderate problems, and the remaining provinces. The following may be observed.

⁶ In this section, project area means Chiang Rai, Phayao, and Nan provinces.

Table 2.3.5.1. Existing Socio-Economic Conditions in Villages of the project area.

Indicator	Degree of the problems in Villages							
	Serious Number	%	Medium Number	%	Low Number	%	Total number	%
1. General village profile								
(1) Land documents								
Chiang Rai	362	32.55	248	22.30	502	45.14	1,112	100.00
Phayao	119	22.28	151	28.28	264	49.44	534	100.00
Nan	405	55.40	198	27.09	128	17.51	731	100.00
Total	886	37.27	597	25.12	894	37.61	2,377	100.00
(2) Electricity								
Chiang Rai	61	5.28	36	3.12	1,058	91.60	1,155	100.00
Phayao	12	2.18	9	1.63	530	96.19	551	100.00
Nan	78	10.36	18	2.39	657	87.25	753	100.00
Total	151	6.14	63	2.56	2,245	91.30	2,459	100.00
(3) Transportation network								
Chiang Rai	100	8.65	267	23.10	789	68.25	1,156	100.00
Phayao	21	3.77	128	22.98	408	73.25	557	100.00
Nan	99	13.29	152	20.40	494	66.31	745	100.00
Total	220	8.95	547	22.25	1,691	68.80	2,458	100.00
(4) Petty trade								
Chiang Rai	317	27.09	420	35.90	433	37.01	1,170	100.00
Phayao	160	28.57	204	36.43	196	35.00	560	100.00
Nan	229	30.53	283	37.73	238	31.73	750	100.00
Total	706	28.47	907	36.57	867	34.96	2,480	100.00
(5) Source of firewood and fuel supply								
Chiang Rai	611	72.65	26	3.09	204	24.26	841	100.00
Phayao	359	86.09	14	3.36	44	10.55	417	100.00
Nan	472	68.41	29	4.20	189	27.39	690	100.00
Total	1,442	74.02	69	3.54	437	22.43	1,948	100.00
(6) Draft animals								
Chiang Rai	23	15.86	4	2.76	118	81.38	145	100.00
Phayao	31	20.81	9	6.04	109	73.15	149	100.00
Nan	73	17.76	44	10.71	294	71.53	411	100.00
Total	127	18.01	57	8.09	521	73.90	705	100.00
(7) Land rights								
Chiang Rai	553	47.26	314	26.84	303	25.90	1,170	100.00
Phayao	218	38.93	171	30.54	171	30.54	560	100.00
Nan	162	21.60	118	15.73	470	62.67	750	100.00
Total	933	37.62	603	24.31	944	38.06	2,480	100.00

Table 2.3.5.1 Existing Socio-Economic Conditions in Villages of the project area. (cont'd)

Indicator	Degree of the problems in Villages							
	Serious Number	%	Medium Number	%	Low Number	%	Total number	%
2. Production & Employment								
(8) Occupation and employment								
Chiang Rai	303	25.90	137	11.71	730	62.39	1,170	100.00
Phayao	144	25.71	61	10.89	355	63.39	560	100.00
Nan	88	11.73	34	4.53	628	83.73	750	100.00
Total	535	21.37	232	9.35	1,713	69.07	2,480	100.00
(9) Wage rate								
Chiang Rai	19	1.65	5	0.43	1,130	97.92	1,154	100.00
Phayao	5	0.92	0	0.00	539	99.08	544	100.00
Nan	136	18.18	34	4.55	578	77.27	748	100.00
Total	160	6.54	39	1.59	2,247	91.86	2,446	100.00
(10) Output from paddy								
Chiang Rai	173	16.73	297	28.72	564	54.55	1,034	100.00
Phayao	111	21.22	177	33.84	235	44.93	523	100.00
Nan	182	34.87	152	29.12	188	36.02	522	100.00
Total	466	22.41	626	30.11	987	47.47	2,079	100.00
(11) Output from planting products								
Chiang Rai	463	62.48	108	14.57	170	22.94	741	100.00
Phayao	116	33.43	42	12.10	189	54.47	347	100.00
Nan	485	68.12	124	17.42	103	14.47	712	100.00
Total	1,064	59.11	274	15.22	462	25.67	1,800	100.00
(12) Other types of occupation								
Chiang Rai	332	74.44	40	8.97	74	16.59	446	100.00
Phayao	191	84.89	13	5.78	21	9.33	225	100.00
Nan	471	90.75	20	3.85	28	5.39	519	100.00
Total	994	83.53	73	6.13	123	10.34	1,190	100.00
(13) Labor out-migration								
Chiang Rai	719	62.69	103	8.98	325	28.33	1,147	100.00
Phayao	364	65.94	93	16.85	95	17.21	552	100.00
Nan	499	66.80	144	19.28	104	13.92	747	100.00
Total	1,582	64.68	340	13.90	524	21.42	2,446	100.00
(14) Farmer's organization								
Chiang Rai	135	11.54	188	16.07	847	72.39	1,170	100.00
Phayao	52	9.29	134	23.93	374	66.79	560	100.00
Nan	64	8.53	145	19.33	541	72.13	750	100.00
Total	251	10.12	467	18.83	1,762	71.05	2,480	100.00

Table 2.3.5.1. Existing Socio-Economic Conditions in Villages of the project area. (Cont'd)

Indicator	Degree of the problems in Villages							
	Serious Number	%	Medium Number	%	Low Number	%	Total number	%
2. Production & Employment								
(15) Use of production credit								
Chiang Rai	23	12.92	155	87.08			178	100.00
Phayao	3	0.55	148	27.01	397	72.45	548	100.00
Nan	15	2.24	112	16.74	542	81.02	669	100.00
Total	41	2.94	415	29.75	939	67.31	1,395	100.00
(16) Dry season cultivation								
Chiang Rai	612	56.46	281	25.92	191	17.62	1,084	100.00
Phayao	308	56.31	166	30.35	73	13.35	547	100.00
Nan	363	51.42	184	26.06	159	22.52	706	100.00
Total	1,283	54.90	631	27.00	423	18.10	2,337	100.00
3. Health Profile & Basic Health								
(17) Basic health care services								
Chiang Rai	436	39.49	155	14.04	513	46.47	1,104	100.00
Phayao	74	13.65	75	13.84	393	72.51	542	100.00
Nan	225	30.65	91	12.40	418	56.95	734	100.00
Total	735	30.88	321	13.49	1,324	55.63	2,380	100.00
(18) Health coverage								
Chiang Rai	986	84.27	125	10.68	59	5.04	1,170	100.00
Phayao	349	62.32	114	20.36	97	17.32	560	100.00
Nan	195	26.00	132	17.60	423	56.40	750	100.00
Total	1,530	61.69	371	14.96	579	23.35	2,480	100.00
(19) Household sanitation								
Chiang Rai	560	47.86	373	31.88	237	20.26	1,170	100.00
Phayao	192	34.29	179	31.96	189	33.75	560	100.00
Nan	390	52.00	171	22.80	189	25.20	750	100.00
Total	1,142	46.05	723	29.15	615	24.80	2,480	100.00
(20) General health care								
Chiang Rai	29	2.48	782	66.84	359	30.68	1,170	100.00
Phayao	23	4.11	457	81.61	80	14.29	560	100.00
Nan	13	1.73	618	82.40	119	15.87	750	100.00
Total	65	2.62	1,857	74.88	558	22.50	2,480	100.00
(21) Weight of newborn infants								
Chiang Rai	326	28.03	135	11.61	702	60.36	1,163	100.00
Phayao	82	14.64	67	11.96	411	73.39	560	100.00
Nan	271	36.33	84	11.26	391	52.41	746	100.00
Total	679	27.50	286	11.58	1,504	60.92	2,469	100.00

Table 2.3.5.1. Existing Socio-Economic Conditions in Villages of the project area. (Cont'd)

Indicator	Degree of the problems in Villages							
	Serious Number	%	Medium Number	%	Low Number	%	Total number	%
(22) Malnutrition among new born to 5 years infants								
Chiang Rai	23	12.92	155	87.08			178	100.00
Phayao	3	0.55	148	27.01	397	72.45	548	100.00
Nan	15	2.24	112	16.74	542	81.02	669	100.00
Total	41	2.94	415	29.75	939	67.31	1,395	100.00
(23) Family planning								
Chiang Rai	121	10.34	152	12.99	897	76.67	1,170	100.00
Phayao	32	5.78	23	4.15	499	90.07	554	100.00
Nan	52	6.93	58	7.73	640	85.33	750	100.00
Total	205	8.29	233	9.42	2,036	82.30	2,474	100.00
4. Water Resource								
(24) High quality for drinking								
Chiang Rai	643	54.96	232	19.83	295	25.21	1,170	100.00
Phayao	221	39.46	125	22.32	214	38.21	560	100.00
Nan	432	57.60	132	17.60	186	24.80	750	100.00
Total	1,296	52.26	489	19.72	695	28.02	2,480	100.00
(25) Low quality for drinking								
Chiang Rai	354	30.26	122	10.43	694	59.32	1,170	100.00
Phayao	101	18.04	39	6.96	420	75.00	560	100.00
Nan	283	37.73	92	12.27	375	50.00	750	100.00
Total	738	29.76	253	10.20	1,489	60.04	2,480	100.00
(26) Water Supply								
Chiang Rai	347	60.88	148	25.96	75	13.16	570	100.00
Phayao	109	19.46	47	8.39	404	72.14	560	100.00
Nan	238	31.73	66	8.80	446	59.47	750	100.00
Total	694	36.91	261	13.88	925	49.20	1,880	100.00
(27) Irrigation								
Chiang Rai	556	50.00	103	9.26	453	40.74	1,112	100.00
Phayao	201	37.50	81	15.11	254	47.39	536	100.00
Nan	311	43.80	61	8.59	338	47.61	710	100.00
Total	1,068	45.29	245	10.39	1,045	44.32	2,358	100.00
5. Education and Culture								
(28) Level of study								
Chiang Rai	291	24.87	384	32.82	495	42.31	1,170	100.00
Phayao	99	17.68	220	39.29	241	43.04	560	100.00
Nan	225	30.00	223	29.73	302	40.27	750	100.00
Total	615	24.80	827	33.35	1,038	41.85	2,480	100.00

Table 2.3.5.1. Existing Socio-Economic Conditions in Villages of the project area. (Cont'd)

Indicator	Degree of the problems in Villages							
	Serious Number	%	Medium Number	%	Low Number	%	Total number	%
(19) Education by government								
Chiang Rai	361	30.85	362	30.94	447	38.21	1,170	100.00
Phayao	131	23.39	146	26.07	283	50.54	560	100.00
Nan	168	22.40	194	25.87	388	51.73	750	100.00
Total	660	26.61	702	28.31	1,118	45.08	2,480	100.00
(30) Religion, Culture, and sport activity								
Chiang Rai	338	28.89	255	21.79	577	49.32	1,170	100.00
Phayao	102	18.21	94	16.79	364	65.00	560	100.00
Nan	215	28.67	106	14.13	429	57.20	750	100.00
Total	655	26.41	455	18.35	1,370	55.24	2,480	100.00
6. Natural Resource and Environment								
(31) Forest								
Chiang Rai	405	34.62	607	51.83	158	13.50	1,170	100.00
Phayao	101	18.04	389	69.46	70	12.50	560	100.00
Nan	348	46.40	215	28.67	187	24.93	750	100.00
Total	854	34.44	1,211	48.83	415	16.73	2,480	100.00
(32) Soil								
Chiang Rai	382	33.30	607	52.92	158	13.78	1,147	100.00
Phayao	143	32.43	231	52.38	67	15.19	441	100.00
Nan	184	58.97	107	34.29	21	6.73	312	100.00
Total	709	37.32	945	49.74	246	12.95	1,900	100.00
(33) Water								
Chiang Rai	149	14.22	485	46.28	414	39.50	1,048	100.00
Phayao	53	10.88	263	54.00	171	35.11	487	100.00
Nan	30	4.21	244	34.22	439	61.57	713	100.00
Total	232	10.32	992	44.13	1,024	45.55	2,248	100.00

In terms of the percentage of villages facing serious or moderate problems related to land documents, the land ownership issue seems to be of greatest concern in the villages of Nan province followed by Chiang Rai province. Land rights problems are comparatively more serious in Chiang Rai province. In the project area as a whole, some 75 percent of villages face land ownership related problems.

The availability of electricity is generally good in the project area with 91 percent of villages facing little or no problem. However, the problem of water supply is more serious than electricity in project areas. Chiang Rai province in particular shows a serious rate of 60.88%.

The seriousness of problems related to the transportation network varies more widely among the provinces. The percentage of project area villages facing serious problems with their transport network ranges from 3.77 percent in Phayao province to 13.29 percent in Nan province.

Health care services are perceived as unsatisfactory by a large number of villages in the project area. Problems with basic health care are perceived as serious by 31 percent of villages, while 62 percent of villages perceive serious problems with health coverage. Meanwhile, only 46 percent of villages are reported to face little or no problem with household sanitation.

Among economic indicators which exhibit a uniform pattern for all provinces, a large percentage of villages face serious problems related to output from planting products, labor out-migration, and dry season cultivation. These problems are all directly related to the income of farmers in the project area.

(3) Existing National Policies for Rural Development

The national development policies stipulated in the Eighth National Economic and Social Development Plan pertinent to rural development fall into six areas of concern.

a. Development of human resources potential:

This concern is to enhance the development potential of human resources by ensuring personal well-being in terms of health, access to knowledge, and exposure to a learning process that can lead to the development of self-reliance. This process should increase the potential for rural dwellers to participate in the development process of the country.

b. Development of social environment:

This concern addresses the need to develop the social environment by strengthening social institutions such as families and communities, as well as by initiating and maintaining a vital cultural environment.

c. Increase of development potentials in regions and rural areas:

This measure strives to disperse the development opportunities, economic activities, and development benefits as well as improved social services to regions. This strategy also promotes the development of participatory processes through strengthening community organizations, supports the learning process and learning networks for the benefit of the community, and recognizes the need to strengthen the roles of private business and non-government organizations. Due recognition is also given to the need to address problems of the urban environment, and to adopt a multi-disciplinary approach to addressing general and area-specific development activities.

d. Economic adjustments:

This concern seeks to adjust production structures so as to strengthen and the ability of the Thai economy to confront changes in the world market. The strategy promotes the development of science and technology in order to provide a sound base for sustainable development, and to ensure development of physical infrastructure.

e. Management of environment and natural resources:

The strategy incorporates management approaches for effective rehabilitation and conservation of natural resources as well as principles to ensure equitable allocation of resources for maximum benefit to society and to rural communities.

f. Strengthening the public sector:

This concerns strengthening the public sector to ensure its ability to assume an effective role in enhancing the development potential and capacity of human resources, and to ensure the development of a partnership between the public sector and the civil society to induce public participation in activities that

involve delivery of public services. This strategy also recognizes the need to ensure the improvement of the operational efficiency of the public sector, and to ensure continuity in management of public affairs.

Instrumental to substantiating these six concerns is the need for competent management to ensure effective translation of the plan into concrete actions. This will include approaches towards translating plans into actions at the local and at the operational level by ensuring involvement of all concerned agencies and the general public. This will also involve developing the structure of the public sector as well as adjusting legal systems to support desirable directions of change. This may also involve introducing measures to increase the capacity of other institutions outside of the public sector to ensure their effective contribution.

(2) Objectives and Strategy for Project Area's Rural Development

The present rural development efforts in the project area aim to solve social problems dominant in rural areas through implementing the Kok-Ing-Nan water diversion project. Given the existing social conditions and limited resources in the project area as outlined above, a more focused approach appears necessary to ensure the successful rural development of the project area.

First, most job- and wage-related social problems should be addressed most effectively through economic development. The proposed project area development attempts to create a wide range of job and wage opportunities in various fields including manufacturing and specialized service jobs. These should improve the macro-economic environment and change the social structure in terms of the socio-economic backgrounds of residents.

Second, gender issues (with the exception of poverty in women-headed households) would be treated best within the context of broader socio-economic development. One important condition for project area development is therefore to mainstream women through socio-economic development: i.e. as more significant contributors to the labor force or as main actors in participatory social services.

Third, as the above two items make clear, the poverty issue should be the focus of attention in the project area's rural development. Poverty in rural areas is after all primarily an outcome of various socio-economic factors inherent in traditional rural communities.

Fourth, an issue-oriented approach may be taken to rural development corresponding to emerging opportunities for new economic activities. Rather than trying to solve or alleviate existing social problems

associated with poverty, this approach would anticipate future problems that may be associated with new economic activities and try to minimize their social costs.

In general, two distinct approaches may be taken to address poverty issues dominant in rural areas: a target group approach and a focused area approach. The target group approach attempts to solve problems faced by a particular segment of the society such as women-headed households, subsistence fishers, or plantation workers. This approach may lead to formulation of a program to cover the target group in an extensive area, while not effectively solving a complex set of problems in any small area.

The focused area approach, however, may be more applicable to the project area's rural development, since most social problems in the region are related to job and wage opportunities and these issues may be addressed rather effectively through economic development initiatives. Considering the expansive nature of the project area, problem areas must be broadly identified as representing typical problem complexes existing in the region. Then pilot projects may be formulated, one for each of the typical problem complexes so that they may be effectively replicated in other areas having similar problem complexes.

(3) Focused Area Approach to the Project Area Rural Development

If a focused area approach is to be taken to rural development in the project area, a framework must first be set to clarify broad areas and measures to be focused on in project formulation. A social interview survey conducted as part of the study was used for this purpose in combination with basic socio-economic statistics and field observation and interviews. Second, a limited number of Amphoes that face typical poverty and related social problems or emerging economic opportunities may be selected, and pilot rural development projects are formulated for implementation in the nearest future. Lessons can be learned through the pilot project implementation, which may then be reflected in the formulation and implementation of subsequent rural successful development.

(1) Problem Amphoes

Selection of Problem Amphoes

The project area encompasses 36 Amphoes and 290 tambons in three provinces. Amphoes directly related to the project are Muang Chiang Rai, Thoeng, Winang Chai, and Phayamenrai in Chiang Rai province between the Kok and Ing Rivers. Between the Ing and Nan Rivers, Amphoe Thoeng in

Chiang Rai province and Amphoe Chiang Kum in Phayao province are also related directly. Updated socio-economic data for population, household income, education, health conditions, and various social infrastructure and services are available on the Amphoe level (1995 statistics). Updated data on the tambon level are available only for population statistics. Selected Amphoe data are provided in Tables 2.3.5.2-1 to 2.3.5.2-10.

Comparison of the Amphoe data reveals that there is some correlation between Amphoe by different indices. In particular, ranking of Amphoe by household income has a high correlation with ranking by indices related to the land use rate, especially in arid season. Also, Amphoe classifications by emmigration rate, working place and land use rate in the dry season are understandably highly correlated.

Problem Amphoes have been selected by using two broad categories of indices: income / land use and land use / emmigration rate at the project site. Specifically included in each broad category are the average annual household incomes, the land use rate in the arid season, and the ratio of emmigration and land use rate. Classification of Amphoes by each index.

As indicated above, a degenerative cycle tends to afflict the problem Amphoes as follows:

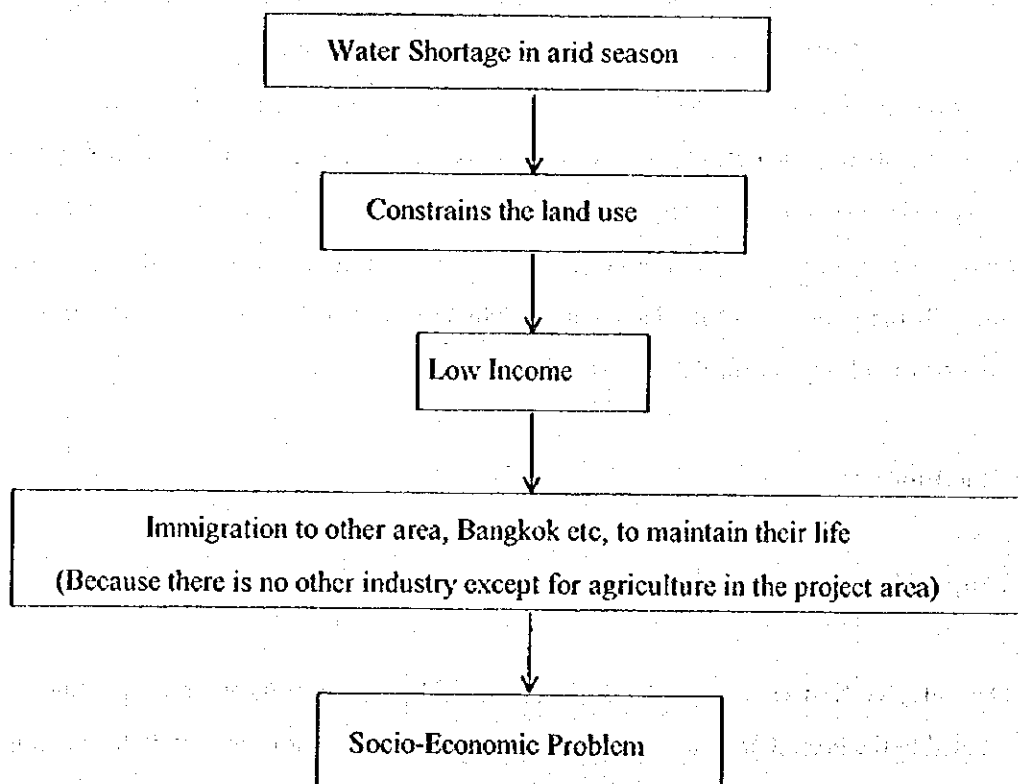


Table 2. 3.5.2-1 Population and Household of the Amphoes along the project route, 1994

Changwat / Amphoe	Male		Female		Total Population	Total Household	Farmer household		Size of Household
	Number	%	Number	%			Number	%	
Kok-Ing									
Chiang Rai									
Amphoe Muang	5,668	48.82	5,943	51.18	11,611	2,940	388	13.20	3.95
Thoeng	14,384	50.75	13,958	49.25	28,342	6,963	1,662	23.87	4.07
Wiang Chai	13,730	51.18	13,098	48.82	26,828	6,821	894	13.11	3.93
Phayamenrai	5,419	50.74	5,260	49.26	10,679	2,480	239	9.64	4.31
Total	39,201	50.61	38,259	49.39	77,460	19,204	3,183	16.57	4.03
Ing-Nan									
Chiang Rai									
Thoeng	4,947	50.28	4,891	49.72	9,838	2,391	1,134	47.43	4.11
Phayao									
Chiangkum	16,478	50.47	16,169	49.53	32,647	7,275	2,906	39.95	4.49
Total	21,425	50.43	21,060	49.57	42,485	9,666	4,040	41.80	4.40
Grand Total	60,626	50.54	59,319	49.46	119,945	28,870	7,223	25.02	4.15

Source: Provincial statistical Office

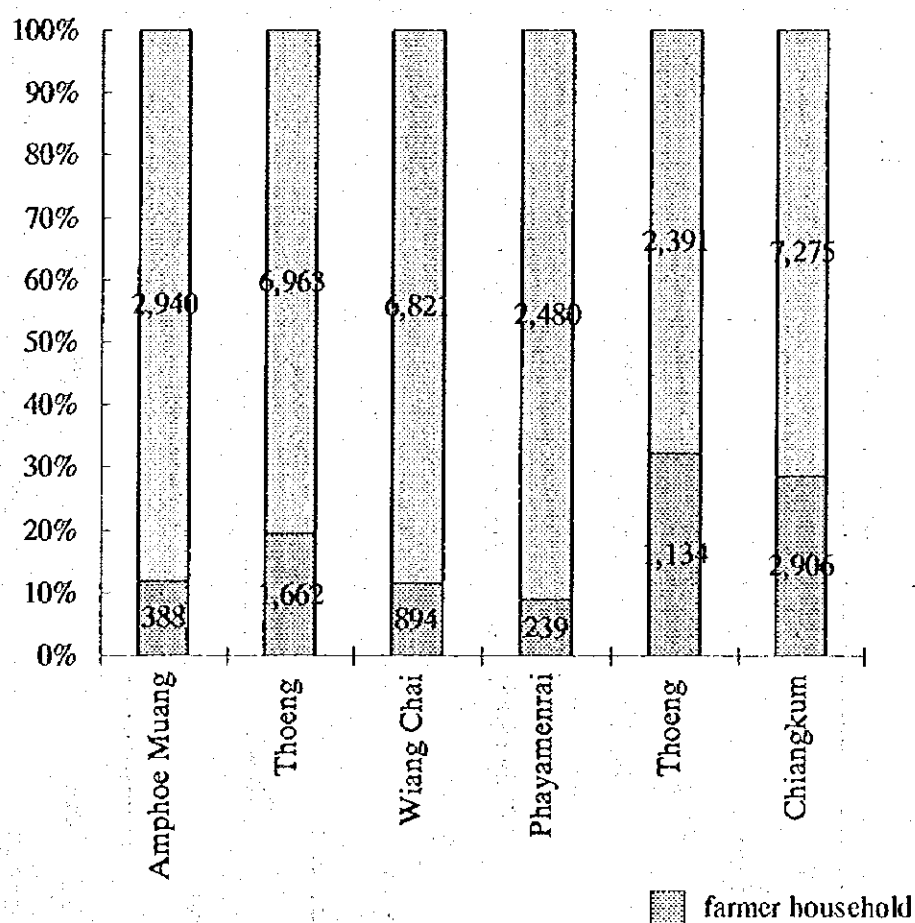


Table 2.3.5.2-3 Annual average Income distribution, 1994

Changwat/Amphoe	Average Income								
	fruit	rice	Upperland Crop	vegetable	Feeding animal	Feeding fish	Freshwater fishery	Others	Industry & Handicraft
Kok-Ing									
Chiang Rai									
Amphoe Muang	438	9,039	19	1,952	1,601	340	0	50	232
Thoeng	452	7,003	20,218	38	2,345	77	33	0	667
Wiang Chai	1,342	6,230	57,026	169	3,678	955	875	12	385
Phayamengrai	6,176	5,531	36,149	134	7,218	0	0	0	405
Total	8,408	27,803	113,412	2,293	14,842	1,372	908	62	474
Ing-Nan									
Chiang Rai									
Thoeng	98	903	5,376	6,528	2,461	0	0	0	0
Phayao									
Chiangkum	603	3,791	14,037	644	2,133	0	0	0	102
Total	701	4,694	19,413	7,172	4,594	0	0	0	102
Grand total	9,109	32,497	132,825	9,465	19,436	1,372	908	62	576

Source: Provincial statistical Office

Table 2.3.5.2- 4 Water supply condition, 1994

Changwa/Amphoe	Water Resource Total groundwater & Shallow pool	Ground water pool (%)	Shallow pool (%)	Total (%)	No. of household	Rate of Household	
						Drinking water (%)	Using water (%)
Kok-Ing							
Chiang Rai							
Amphoe Muang	2,631	42.80	57.20	100.00	2,940	61.19	79.29
Thoeng	3,792	2.43	97.57	100.00	6,963	47.71	88.57
Wiang Chai	4,505	6.79	93.21	100.00	6,821	50.49	88.21
Payamengrai	1,857	1.08	98.92	100.00	2,480	86.90	95.52
Total	12,785	12.08	87.92	100.00	19,204	55.82	87.92
Ing-Nan							
Chiang Rai							
Thoeng	1,226	2.61	97.39	100.00	2,391	18.19	97.99
Phayao							
Chiangkum	3,116	2.50	97.50	100.00	7,275	31.64	73.58
Total	4,342	2.53	97.47	100.00	9,666	28.32	79.62
Grand total	17,127	7.31	92.69	100.00	28,870	42.07	83.77

Source: Provincial statistical Office

Table 2.3.5.2-5 Planting rate and water resource during the dry season, 1994

Changwat/Amphoe	Farming family	Planting in the dry season (%)	Source of water supply			
			Surface water	Ground water	Rain	Total
Kok-Ing						
Chiang Rai						
Amphoe Muang	388	42.01	75.00	25.00	0.00	100.00
Thoeng	1,662	21.54	60.00	40.00	0.00	100.00
Wiang Chai	894	71.36	81.82	9.09	9.09	100.00
Phayamenrai	239	26.36	50.00	50.00	0.00	100.00
Total	3,183	38.39	67.65	29.41	2.94	100.00
Ing-Nan						
Chiang Rai						
Thoeng	1,134	66.05	100.00	0.00	0.00	100.00
Phayao						
Chiangkum	2,906	69.51	97.14	0.00	2.86	100.00
Total	4,040	68.54	97.67	0.00	2.33	100.00
Grand total	7,223	55.25	82.66	14.71	2.63	100.00

Source: Provincial statistical Office

Table 2.3.5.2-6 Land Use classification, 1994

Changwat/Amphoe	Land use				Factor of non-use Land								
	> 90%	76 - 90%	51 - 74%	< 50%	Total	Soil	Labor	Economic	Knowledge	Water supply	Flooding	Others	Total
Kok-Ing													
Chiang Rai													
Amphoe Muang	46.15	7.69	0.00	46.15	100.00	21.43	0.00	0.00	0.00	28.57	7.14	42.86	100.00
Thoeng	20.00	57.14	17.14	5.71	100.00	5.88	2.94	2.94	2.94	73.53	5.88	5.88	100.00
Wiang Chai	10.00	53.33	33.33	3.33	100.00	3.33	0.00	46.67	3.33	40.00	0.00	6.67	100.00
Phayamenrai	25.00	75.00	0.00	0.00	100.00	16.67	0.00	8.33	0.00	75.00	0.00	0.00	100.00
Total	21.11	51.11	17.78	10.00	100.00	8.89	1.11	17.78	2.22	55.56	3.33	11.11	100.00
Ing-Nan													
Chiang Rai													
Thoeng	0.00	80.00	20.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	100.00
Phayao													
Chiangkum	37.74	52.83	7.55	1.89	100.00	9.26	1.85	12.96	3.70	66.67	0.00	5.56	100.00
Total	29.41	58.82	10.29	1.47	100.00	7.25	1.45	10.14	2.90	73.91	0.00	4.35	100.00
Grand total	25.26	54.97	14.04	5.74	100.00	8.07	1.28	13.96	2.56	64.73	1.67	7.73	100.00

Source: Provincial statistical Office

Table 2. 3.5.2-7 Education Level, 1994

Changwat/Amphoe	Elementary school	Secondary school (Grammar school)	Secondary school (High school)	> Secondary school	Total
Kok-Ing					
Chiang Rai					
Amphoe Muang	85.48	5.75	4.81	3.96	100.00
Thoeng	89.99	6.33	2.74	0.94	100.00
Wiang Chai	94.04	4.26	1.15	0.54	100.00
Phayamengrai	82.37	9.16	5.54	2.93	100.00
Total	89.70	5.80	2.89	1.62	100.00
Ing-Nan					
Chiang Rai					
Thoeng	86.98	8.64	3.45	0.93	100.00
Phayao					
Chiangkum	93.75	3.73	1.63	0.89	100.00
Total	91.31	5.50	2.29	0.91	100.00
Ground total	90.50	5.65	2.59	1.26	100.00

Source: Provincial statistical Office

Table 2.3.5.2-8 Sanitary situation, 1994

Changwat / Amphoe	No. of Household	Type of toilet Modern style	Primitive style	None
Kok-Ing				
Chiang Rai				
Amphoe Muang	2,940	96.53	3.40	0.07
Thoeng	6,963	88.01	8.59	0.53
Wiang Chai	6,821	94.58	5.26	0.16
Phayamengrai	2,480	99.76	0.00	0.24
Total	19,204	93.16	5.50	0.29
Ing-Nan				
Chiang Rai				
Thoeng	2,391	95.32	4.68	0
Phayao				
Chiangkum	7,275	97.18	0.43	0.84
Total	9,666	96.72	1.48	0.63

Source: Provincial statistical Office

Table 2.3.5.2-9 Working location and period, 1994

Changwat/Amphoe	Location						Daily	out of farming	Period	
	Amphoe	Changwat	Norther area	Others	Bangkok	Abroad	Total		< 3 months	> 3 months
Kok-Ing										
Chiang Rai										
Amphoe Muang	50.00	50.00	0.00	0.00	0.00	0.00	100.00	12.50	0.00	6.25
Thoeng	0.00	0.00	8.57	2.86	85.71	2.86	100.00	31.43	5.71	62.86
Wiang Chai	0.00	75.00	3.57	3.57	17.86	0.00	100.00	28.57	7.14	7.14
Phayamengrai	0.00	25.00	0.00	0.00	75.00	0.00	100.00	75.00	8.33	16.67
Total	8.79	35.16	4.40	2.20	48.35	1.10	100.00	32.97	5.49	29.67
Ing-Nan										
Chiang Rai										
Thoeng	0.00	0.00	0.00	26.67	73.33	0.00	100.00	0.00	0.00	0.00
Phayao										
Chiangkum	3.45	3.45	34.48	17.24	41.38	0.00	100.00	37.04	7.41	55.56
Total	2.27	2.27	22.73	20.45	52.27	0.00	100.00	23.81	4.76	71.43
Grand total	5.53	18.72	13.56	11.33	50.31	0.55	100.00	28.39	5.13	50.55

Source: Provincial statistical Office

Table 2.3.5.2-10 Emigration rate and type of work around diversion routes in project area in 1994

unit : percentage

Changwat/Amphoe	No. of Household	No. of Household work outside	Total Population		Emmigration		Type of work					Total
			Male	Female	Male	Female	Industry	Agriculture & Fisher	Service	Handicraft	Others	
Kok-Ing												
Chiang Rai												
Amphoe Muang	2,940	52.82	5,668	5,943	28.49	26.45	6.25	0.00	6.25	18.75	68.75	100.00
Thoeng	6,963	22.69	14,384	13,958	8.85	7.35	11.43	8.57	42.86	34.29	2.86	100.00
Wiang Chai	6,821	20.17	13,730	13,098	8.32	5.62	7.14	0.00	21.43	53.57	17.86	100.00
Phaya Mengrai	2,480	19.48	5,419	5,260	8.77	7.76	0.00	0.00	33.33	66.67	0.00	100.00
Total	19,204	25.99	39,201	38,259	11.49	9.78	7.69	3.30	28.57	41.76	18.68	100.00
Ing-Nan												
Chaing Rai												
Amphoe Thoeng	2,391	18.70	4,947	4,891	4.37	5.60	6.67	0.00	93.33	0.00	0.00	100.00
Phayao												
Amphoe Chiang Kharn	7,275	26.27	16,478	16,169	10.43	8.08	16.33	6.12	30.61	34.69	12.24	100.00
Total	9,666	24.39	21,425	21,060	9.03	7.50	14.06	4.69	45.31	26.56	9.38	100.00
Grandtotal	14,435	25.19	30,313	29,660	10.26	8.64	10.88	3.99	36.94	34.16	14.03	100.00

Source : Provincial statistical Office

In short, all of the problems in the project area result from water shortages in the arid season, as Tables 2.3.5.2-5 and 2.3.5.2-6 show. Water supply for agricultural use during the arid season is crucial to solving these problems.

The following three Amphoes have been selected for further analysis:

1. Amphoe Thoeng in Chiang Rai province
2. Amphoe Muang Chiang Rai in Chiang Rai province
3. Amphoe Chiangkum in Phayao province

Preliminary survey of problem Amphoes

A preliminary social survey was conducted to the selected Amphoes. The main objectives were to find out existing microeconomic conditions in less developed communities and to develop a better understanding of the livelihoods in those communities.

The survey was based on field observation and interviews. Field observations were limited to areas around respective amphoe capitals and along access routes to the capitals. Interviews were also limited due to time constraints. Amphoe officers were interviewed in Thoeng. Results naturally contain the biases of respective interviewees, but nevertheless provide useful insight into characteristic conditions of the communities surveyed.

(II) Amphoes Facing Emerging Economic Opportunities

Various new economic opportunities are emerging in different parts of the project area, which may usher social problems or conflicts. Typical potential problems include conflicts over land being used for urban/industrial and rural/agricultural activities as well as social conflicts between immigrant workers and local people.

Some problems, especially those associated with intensification of agricultural land use, may have more extensive effects. For example, enhanced productivity of irrigated farms in Amphoe Thoeng and intensification of fruit cultivation in Amphoe Muang need to be carefully planned so that they will provide maximum benefit to local people with minimum social costs.

(4) Pilot Projects for Rural Development

Rural development projects are usually small and complement large scale infrastructure and economic development projects that would transform the socio-economic and spatial structure of any region. They are implemented for many communities, usually one after another. Lessons learned from early implementations can thereby be reflected in the formulation and implementation of subsequent projects. The earliest projects should serve as pilot projects, which can be replicable to varying degrees, in other communities.

Three Amphoes have been selected in the project area for early implementation of rural development projects. These selected Amphoes are expected to undergo significant social and economic changes as a result of the planned water diversion project. Pilot projects for these Amphoes should therefore help indicate how similar projects might be formulated and implemented in other communities facing similar problems or opportunities.

Existing and potential land uses in the three Amphoes are summarized in Tables 2.3.5-5 and 2.3.5-6. Socio-economic data on these Amphoes are extracted from the Village Level Basic Data Survey of 1994.

(I) Pilot projects for problem Amphoes

Pilot projects have been formulated for the three selected Amphoes facing poverty and other typical social problems. They are Muang Chiang Rai, Thoeng, and Chiangkum. A common objective of these projects is to improve the livelihood of people in tambons of the respective Amphoes by introducing new and diversified economic activities.

Characteristic activities that may hold promise for these Amphoes make use of water supply and irrigation facilities. Different combinations of cash crops such as fruits, vegetables, flowers, and upland crops will be provided. In addition, institutional supports will be provided for farmer organizing, agricultural extension, and community rights for resource use.

(II) Pilot projects for Amphoes facing emerging economic opportunities

Pilot projects have been formulated for two selected Amphoes, Thoeng and Chiangkum. Emerging economic opportunities in these two Amphoes are not only related to the new water supply during the arid season for paddies but also for vegetables, flowers, and other upland and tree crops, as well

as diversification of crops in favor of high value-added crops and those which may be processed locally. Keys for the success of the project include improved water use and management and land consolidation. Farmer organizing is a prerequisite for these pilot projects as well as joint procurement of various materials and marketing.

Emerging economic opportunities in Thoeng relate primarily to expansion and intensification of fruit production. Thoeng has an extensive area which is well suited to fruits and other tree crops partly under irrigation. Intensive fruit production under supplemental irrigation is a relatively new farming practice. Farmers may need to adopt themselves to the new system with support from extension services, provision of seedlings/saplings, and the joint procurement of materials and marketing, hence the pilot project before full scale implementation

(5) Institutional Measures for Rural Development

While the pilot projects formulated through the Conceptual Study are implemented, more rural development projects are expected to be formulated with local participation. Existing institutional arrangements need to be streamlined for more effective planning and implementation of rural development projects with more active local participation.

In Thailand, both top-down and bottom-up planning mechanisms exist for rural development. Future directions for improved rural development planning and implementation should be based on (1) further decentralization of development administration, and (2) the newly instituted status of Tambon Administrative Organization. Rural development institutions need to be strengthened at the tambon level with broad guidance from the national institution for rural development and more active participation of local people and communities.

At present, the Tambon Council formulates and proposes tambon development plans, while a development committee of the Council supports project development through technical assistance. Mostly, however, the Tambon Council undertakes coordination, cooperation and information dissemination for government projects.

Project initiation and development at the tambon level should be strengthened with active local participation. It should start with participatory rural appraisal (PRA). Through PRA, villagers themselves assess existing conditions of livelihood and resource potentials. Critical problems facing villagers and their needs are thus identified. The PRA should be followed by a project development

workshop. The workshop may be organized at the tambon level with the participation of villagers, stakeholders, officials of local administrations, and NGOs active in the locality.

Based on the PRA and the workshop, a tambon rural development plan should be prepared along with a tambon land use plan. Preparation of the tambon land use plan would require substantive input again from villagers as to areas to be allocated to particular crops and locations of key infrastructure facilities. The tambon rural development plan would also clarify arrangements for implementing formulated projects, including roles to be played by NGOs.



Chapter 3 IEE for the Route Recommended by JICA Study Team

3.1 Reviews and Comments for TEAM J/V Report

The diversion routes proposed by TEAM J/V are shown on Figure 3.1.1.

3.1.1 Surface Water and Aquatic Ecology

3.1.1.1 Water quality

The construction of the open canal / culvert and tunnel system will certainly create impacts on the water quality both during the construction and operation phase. The erosion during the construction caused by rainfall at the open construction site, will increase the turbidity and suspended materials into the water sources. During the operation phase, the diversion of water from one watershed to other watershed may change characteristics of the receiving water.

(1) Methodology of the study

Site investigation was made in mid - March, 1996.

Water samplings of ten stations were carried out in the following schedule:

The first water sampling was taken between May 27 - 29, 1996.

Water samples were collected from 10 stations shown in Figure 3.1.1.1

The first two stations of station 1 and 2 were in the Kok River.

From station number 3 to 7, samples were taken from the Ing Watershed.

From station number 8 to 10, samples were from the Nan Watershed.

The following items are analyzed :

- physical parameter :
transparency, flow rate, water temperature, velocity, depth, pH, conductivity,
- chemical parameter :
total hardness, dissolved oxygen, COD, BOD, nitrate, phosphate, ammonium,
total solid, dissolved solid, suspended solid, chlorinate, sulfate
- biological parameter :
total coliform bacteria, fecal coliform bacteria
- heavy metals :
Pb, Cd, Cr, Hg, As, Ca, Mg, Fe, Mn
- organochlorine :
dieldrin, aldrin, BHC, heptachlor, endrin, DDT

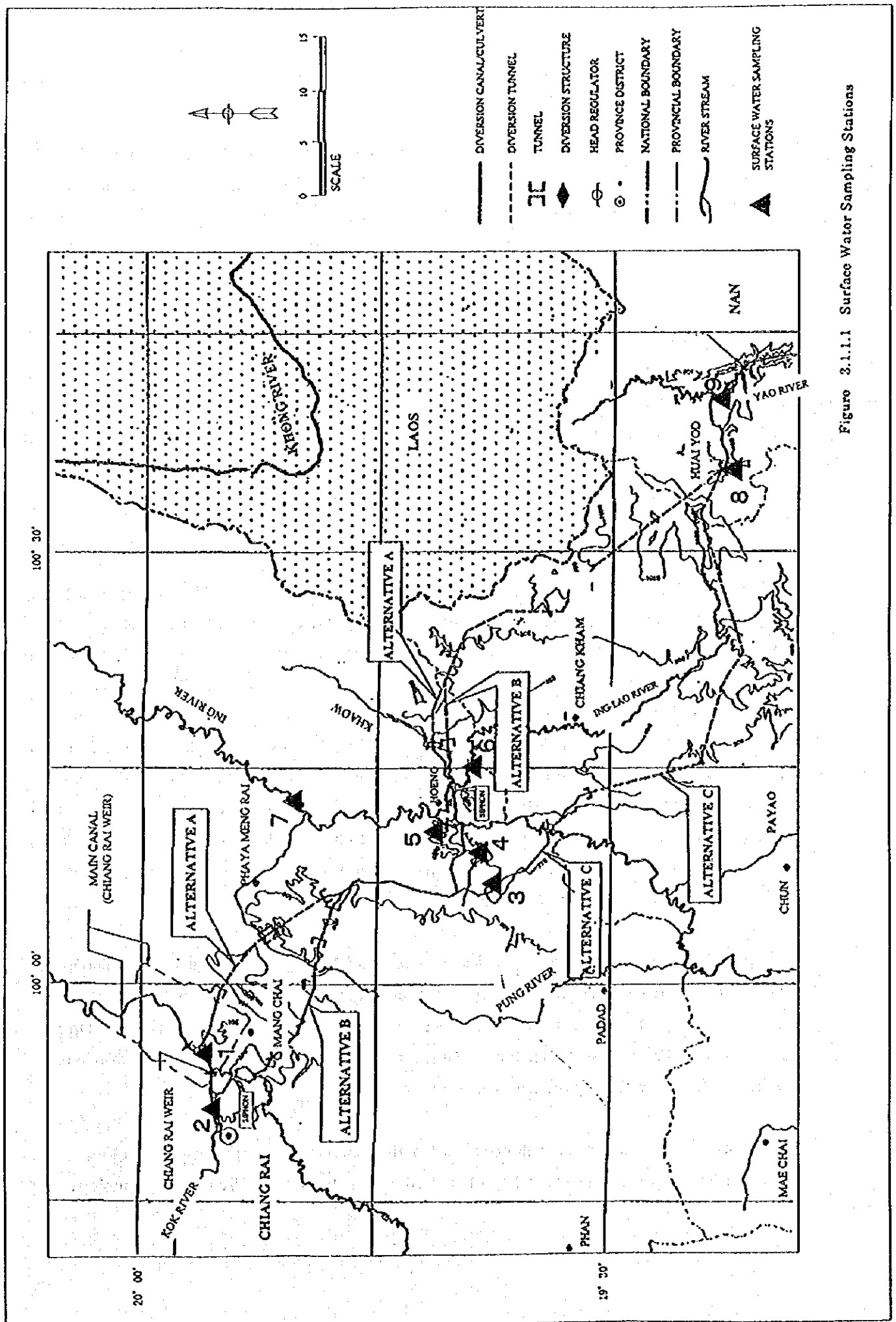


Figure 3.1.1.1 Surface Water Sampling Stations

2) Result of preliminary study

The characteristics of water samples analyzed in the study are shown in Tables 3.1.1.1 to 3.1.1.3. Table 3.1.1.1 shows ordinary water characteristics while Table 3.1.1.2 and 3.1.1.3 reveal the level of the heavy metal and pesticide in the water samples respectively. The water characteristics of samples are as follows :

The water in Kok River (station 1 and 2) was rather turbid with the suspended solid.

The hardness of water samples were also slightly alkaline and rather soft.

DO (dissolved oxygen) levels were also high.

BOD (biochemical oxygen demand) levels were very low.

Inorganic nutrients in terms of total phosphate and ammonium were also low.

Coliform bacteria level was rather high especially at the station downstream of Chiangrai municipality.

Heavy metals were also low except iron which was rather high.

Pesticides in terms of organochlorine can not be detected.

In the Ing Watershed, water samples were taken from Mae Nam Loi, Huai Plong, Ing - Loa River and Ing River. It was noticeable that during sampling period there was almost no flow in Huai Plong and Mae Nam Loi since both streams are small and villagers constructed their own weirs along the streams, which caused stagnant water in the streams. In the case of Ing - Loa River and Ing River, water flows were higher than in Kok River. In this watershed water characteristics are quite similar to each other except turbidity. Small streams seem to be less turbid than big rivers. Water was also quite soft. DO levels were high. BOD levels were quite low in big rivers but rather high in case of Huai Plong and Mae Nam Loi. Both streams run close to many small communities from which wastewater from villagers activities flow directly into the streams. pH levels were quite neutral. Both of the total and fecal coliform levels were rather high. Heavy metal were rather low in all stations. Pesticides cannot be detected from the samples.

Unlike other watershed, water samples from the Nan Watershed were rather clear during the sampling period. Suspended solid level were in the lower range because of no rain during that period. Water was also slightly alkaline and the hardness was higher than in other watersheds. Organic substances in terms of BOD were also low. Nutrients and coliform bacterial were lower than in other watershed. Heavy metal and pesticide were also very low.

Results from the first water sampling show that the characteristics of the water in the Kok - Ing Rivers and Nan River are in class 2 as classified by the Ministry of Science, Technology and

Table 3.1.1.1
Quality of Water in Kok-Ing-Nan (May 1996)

Parameters	Unit	Station									
		Kok		Ing					Nan		
		1	2	3	4	5	6	7	8	9	10
Transparency	cm	14	15	38	19	12	30	22	>27	-	49
Flow rate	m ³ /s	-	50.8	-	-	-	8.39	15.2	0.88	2.67	-
Air Temperature	°C	29.4	27.6	-	-	-	-	-	31.3	30.3	31.0
Water Temperature	°C	30.3	28.4	34	33	33	32	31	26.5	28.9	27.8
Velocity	m/s	0.64	0.71	-	-	4.9	0.23	0.5	0.83	0.28	-
Depth	m	0.95	0.85	-	-	1.26	-	0.88	0.19	0.69	1.29
pH		8.0	8.2	7.5	7.6	7.7	7.8	7.6	7.9	8.1	8.2
Conductivity	μs/cm	154	158	174	124	146	153	146	224	230	257
TH	mg/l CaCO ₃	54	50	58	36	36	58	52	92	96	98
DO	mg/l	6.0	6.8	6.7	6.0	6.3	6.2	6.2	7.4	7.0	6.6
COD	mg/l	12	35	13	25	10	8.7	6.1	1.7	23	4.0
BOD	mg/l	1.0	0.8	2.7	4.9	1.9	0.9	0.2	0.7	1.0	0.7
NO ₃ -N	mg/l	0.23	0.23	0.53	0.26	0.21	0.03	0.19	0.15	0.2	0.09
TP	mg/l	0.36	0.20	0.09	0.33	0.51	0.16	0.04	0.01	0.03	0.06
NH ³ -N	mg/l	0.22	0.20	0.04	0.32	0.27	0.11	0.08	0.03	0.04	0.07
TS	mg/l	188	309	131	160	252	142	148	118	112	133
DS	mg/l	88	70	99	110	147	87	79	113	103	115
SS	mg/l	100	239	32	50	105	55	69	5	9	18
Cl-	mg/l	1.6	1.6	2.6	2.6	4.1	1.6	1.0	0.5	1.0	2.6
SO ₄ ²⁻	mg/l	8.4	7.9	6.2	8.8	10.8	6.9	6.6	5.1	5.2	5.8
Total Coliform	MPN/100 vel	700	1,700	500	1,100	260	3,000	170	90	90	90
Fecal Coliform	MPN/100 vel	500	800	500	1,100	80	2,400	170	60	40	90

Table 3.1.1.2
Heavy Metal Level In Kok-Ing-Nan (May 1996)

(Unit: mg/l)

Station	Items								
	Pb	Cd	Cr	Hg	As	Ca	Mg	Fe	Mn
1	0.007	0.003	0.002	<0.002	0.003	8.61	3.94	1.54	0.14
2	0.006	0.002	<0.002	<0.002	0.002	8.73	4.09	2.39	0.28
3	0.006	<0.002	<0.002	<0.002	<0.002	8.18	4.4	0.19	0.22
4	0.004	0.002	0.002	<0.002	0.002	5.21	2.37	1.00	0.42
5	0.004	<0.002	<0.002	<0.002	<0.002	6.48	2.4	2.54	0.41
6	0.005	<0.002	0.002	<0.002	0.002	11.88	2.8	0.92	0.11
7	0.004	0.003	<0.002	<0.002	0.003	10.61	2.8	0.86	0.06
8	0.003	<0.002	<0.002	<0.002	<0.002	19.09	3.54	0.35	0.08
9	0.004	0.002	<0.002	<0.002	<0.002	19.94	4.06	0.39	0.05
10	0.004	<0.002	<0.002	<0.002	<0.002	18.79	4.62	0.35	0.08

Table 3.1.1.3
Organochlorine In Kok-Ing-Nan (May 1996)

(Unit: μ g)

Station Chemicals	Sampling Station									
	1	2	3	4	5	6	7	8	9	10
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
DDT	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Environment. In the case of all streams such as Huai Plong and Mae Nan Loi, the water qualities were classified in class 4 due to higher BOD levels. However, since the flows in these streams are quite small in quantity, when they reach the Ing River, they cannot change its water quality so much.

(3) Comparison of preliminary impact assessment among the three alternatives

It was preliminary assessed on the impact of the three alternatives of A, B and C in the present Kok - Ing - Nan Project as follows. During the construction phase, there will be a construction on the open canal on the alternative A less than the alternative B and C within the Kok Watershed. And the length of tunnel on the alternative A will be longer than the length of tunnel on the alternatives B and C. This means that during construction, the open surface of construction site of the alternative B and C will be larger and during rainy season, rain water can wash down sediment from the construction site into the streams and later into Kok River much more than the alternative A. Apart from this, the impacts on the Ing and Nan River water quality are not so much different between the alternative A and B. During the operation phase, since the diversion site and the receiving water bodies are quite far from each other. Therefore, the impact of on water quality of both will be similar.

3.1.1.2 Aquatic biology / Fishery

The development of natural water resources can cause some impacts on the aquatic ecology and fishery resources. With the high demand of water for domestic use, irrigation, industries, power plants and also for the new project to increase the national production, many water resources are exploited to serve for its purpose. Some probably adverse effect can be solved or minimized as the activities of water resource development are on the same watershed. Water transfer and link with other watersheds may cause some impacts to the species composition and the abundance of aquatic organisms existing in the watershed. The purpose of the present survey is to evaluate the existing environment within the project sites in regard to the aquatic biology and fishery resources.

(1) Methodology of the study

The secondary data and information were collected and reviewed. Site investigation was carried out during March, 1996. During 26-29 May 1996, the field trip was conducted to the project site for the collection of aquatic organisms. During the sampling period, fishing activities were observed to make interviews with local fishermen. The characteristics of aquatic organisms identified are the species composition in population, predominant species, frequency of occurrence, their abundance and also species size, weight and numbers.

(2) Result of preliminary study

1) Sapling site characteristics

Kok River (Station 1 and 2) :

0.8 - 3.0 m depth, 100 - 120 m width, with high flow and turbid water.

Mae Loi River (Station 3 and 4) :

1 - 2 m. depth, 8 - 12 m. width, stagnated turbid water.

Ing River (Station 5 and 7) :

1 - 1.5 . depth, 30 m width, stagnated and turbid water.

Laos River (Station 6) :

2 m. depth, 20 m. width, low flow and turbid water.

Yod River (Station 8) :

0.5 m. depth, 15 m. width, clear water and flow.

Yao River (Station 9) :

35 m. width, low flow and turbid.

Nan River (Station 10) :

0.6 m. depth, 50 m. width, low flow and turbid water.

2) Fish

Total of forty two (42) fish species were found in five (5) sampling stations including twelve (12) families as shown in Table 3.1.1.4. The family Cyprinidae was the most abundant with 12 species followed by cobitidae of 11 species, Bagridae and Mastacembelidae of each 3 species. Number of species and total weight of fish at each sampling station are as follow

River	family	species	size range (cm)	tails	total weight (grams)
Kok	4	7	1.5 - 17.5	281	302
Laos	7	20	166	288	
Ing	5	16	2.2 - 17.0	726	823
Yod	6	14	1.5 - 13.0	302	270
Nan	8	12	1.5 - 21.0	158	522

3) Plankton organisms

Plankton organisms collected from 10 stations consisted of 5 of phytoplankton and 4 phylum of zooplankton. Phytoplankton are Bacillariophyta, 13 species and Chlorophyta 12 species, Cyanophyta 6 species, Euglenophyta 1 species and Pyrrophyta 2 species. Zooplankton groups are Rotifera 10 species , Protozoa 4 species, Arthropoda 8 species and Nematoda 1 species.

4) Benthic animals

Three phyla of benthic animal are found. Number of families and species found in each phyla were Annelida; 2 families, 2 species, 13 families with 12 species of Arthropoda, and 6 families with 10 species of Mollusca.

5) Aquatic plant

There are 12 families of aquatic plants found with in the total of 15 species. Floating plants 2 species, Submerged plants 5 species, Emerged plants 2 species and Marginal plants 6 species.

(3) Preliminary impact on aquatic ecology / fishery

From the preliminary study on the aquatic ecology and fishery, the initial impacts due to the present Kok - Ing - Nan Project are as follows:

- The impact on distribution of fish population from one watershed to other watersheds is expected to be low because the preliminary result of the study revealed the same groups of fish with no violent behavior, and the same of foliage and carnivore fish ratio.
- The aquatic ecosystem in the diversion tunnel may be changed in high level, i.e. the decrease of water temperature, oxygen consumption and light will affect to the living organism in the water. The impact levels of Alternative A, B and C will not be different.
- The distribution of aquatic plants, especially Giant Minosa, will be affected in moderate level.
- Other impacts will be occurred during the construction period, namely, increase of sediment in surface water near the construction site.

Table 3.1.1.4 (1/2)
Species of Fish Found in the Samples Collected from
Kok-Ing-Nan Rivers during May 27-28, 1996

Family /Scientific Name	Thai Name	Sampling Station				
		2	6	7	8	10
1. Cyprinidae (17=40.49%)						
<i>Barilius quttatus</i>	Nang oar	X	-	-	-	-
<i>Epalzeorhynchos coatesi</i>	Soi dok yang	X	-	-	-	-
<i>Barilius nanensis</i>	Nam muk	-	X	-	-	X
<i>Cirrhinus jullieni</i>	Soi kao	-	X	X	-	-
<i>Cyclocheilichthys armatus</i>	Pak lium	-	X	X	-	-
<i>Epalzeorhynchos siamensis</i>	Leb mue nang	-	X	-	-	-
<i>Esomus metallicus</i>	Siew nuard yao	-	X	X	-	-
<i>Labeo erythrurus</i>	Gar dang	-	X	X	-	-
<i>Labiobarbus lineatus</i>	Sar	-	X	X	-	-
<i>Mystacoleucus marginatus</i>	Hang luang	-	X	X	-	X
<i>Osteochilus vittatus</i>	Rong mai tub	-	X	X	-	-
<i>Puntius ticto</i>	Tum	-	X	-	X	X
<i>Rasbora palustris</i>	Siew	-	X	X	-	-
<i>Morulius chrysophekadion</i>	Ga dum	-	-	X	-	-
<i>Garra teaniaia</i>	Lia hin	-	-	-	X	-
<i>Rasbora borapetensis</i>	Siew hang dang	-	-	-	X	-
<i>Hampala macrolepidota</i>	Kar sub ked	-	-	-	-	X
2. Cobitidae (11=26.19%)						
<i>Acanthopsis choirohynchus</i>	Rark kluay	X	X	X	-	-
<i>Botia cos</i>	Mum	-	X	-	-	-
<i>Cobitophis anquillaris</i>	Ard	-	X	X	-	-
<i>Botia hymenophysa</i>	Mum	-	-	X	-	-
<i>Nemacheilus binotatus</i>	Khor	-	-	-	X	X
<i>N. menanensis</i>	Khor	-	-	-	X	-
<i>N. nicholsi</i>	Khor	-	-	-	X	-
<i>N. redei</i>	Khor	-	-	-	X	-
<i>N. pallidus</i>	Khor	-	-	-	X	-
<i>N. multifasciatus</i>	Khor	-	-	-	X	-
<i>N. poculi</i>	Khor	-	-	-	X	-

Table 3.1.1.4 (2/2)
Species of Fish Found in the Samples Collected from
Kok-Ing-Nan Rivers during May 27-28, 1996

Family /Scientific Name	Thai Name	Sampling Station				
		2	6	7	8	10
3. Baqridae (3=7.14%)						
Mystus nemurus	Kod luang	X	-	X	-	-
Leiocassis siamensis	Kayaeng hin	X	X	-	-	-
Mystus cavasius	Kayaeng bai kwai	-	X	X	-	-
4. Channidae (1=2.38%)						
Channa striata	Chon	X	-	X	-	-
5. Centropomidae (1=2.38%)						
Chanda siamensis	Pan khaew	-	X	X	-	X
6. Pristolepididae (1=2.38%)						
Pristolepis fasciatus	Mom chang yeab	-	X	-	X	X
7. Anabantidae (1=2.38%)						
Trichopsis vittatus	Krim	-	X	-	-	-
8. Mastacembelidae (3=7.14%)						
Macrognathus siamensis	Load	-	X	-	-	X
Mastacembelus maculatus	Khar thing	-	-	-	X	-
Mastacembelus armatus	Khar thing	-	-	-	-	X
9. Belonidae (1=2.38%)						
Xenentodon cancila	Khar thunghae	-	-	-	X	X
10. Gobiidae (1=2.38%)						
Pseudoqobiopsis siamensis	Bou	-	-	-	X	-
11. Notopteridae (1=2.38%)						
Notopterus notopterus	Salad	-	-	-	-	X
12. Tetraodontidae (1=2.38%)						
Tetraodon leiurus	Pukpao jud	-	-	-	-	X
Total 12 Families 42 species		6	20	16	14	12

Note : Sampling stations are shown in Figure 3.1.1.1

3.1.1.3 Review and comments

A. Surface water quality

Method

Additional descriptions are needed for the following items;

- sampling location mentioned with the river name, longitude and latitude
- frequency of the sampling in each station
- sampling apparatus of all kinds used during the survey
- storage condition of samples after the sampling
- criteria to select analyzed items

Additional sampling items are needed for the following items;

- mud samples in each station to compare the water samples
- specific gravity of water
- particulate organic matter in terms of carbon

Items to be analyzed

Items to be analyzed are for the followings;

- matrix analysis among the analyzed items
- sinking rate of silt in the stagnant condition
- spectrum of silt particles in water samples
- specific gravity of water samples
- particulate organic matter in terms of carbon in water samples
- chlorophyll and phaeophytin contents in water samples
- total count of bacteria and aggregates in water samples
- viable count of general type of bacteria on the plates in water samples
- pesticides/herbicide in mud samples
- inorganic N and P in mud samples
- ignition loss in mud samples
- heavy metals in mud samples
- Eh in mud samples
- hydrogen sulfide in mud samples
- viable count of bacteria on the plate in mud samples

B. Aquatic ecology/ Fishery

Method

Additional description are needed for the followings;

Fish

- sampling location mentioned with the river name, longitude and latitude
- definition of the fish size of the total, standard or fork length
- types, mesh size and length of fish sampling net
- examination of the sampling accuracy among the samples

Plankton

- sampling location mentioned with the longitude and latitude
- mesh size and mouth size of plankton net
- water volume of the haul in the sampling
- examination of the sampling accuracy among the samples
- type of the fixative and its final concentration in the samples
- dividing method of the samples before observation under the microscope
- number of the fields of observation under the microscope
- light intensity on the bottom

Benthos

- sampling location with longitude and latitude
- sampling device with the specification
- diversity index in each sampling station
- examination of the sampling accuracy among the samples

Aquatic plant

- sampling location with longitude and latitude
- sampling device with the specification

Items to be analyzed

Items to be analyzed are as follows :

Fish

- classification based on the indigenous and exotic species
- classification based on the feeding habit
- clear definition of difference between production and productivity
- diversity index in each sampling station to characterize the location

Plankton

- microplankton with the size less than 100 or 200 micrometers
- estimate of biomass in terms of dry weight
- diversity index in each sampling station to characterize the location

Benthos

- size classification by phyla and/or classes
- estimate of biomass in terms of weight in dry or wet
- classification based on the feeding habit

- diversity index in each sampling station to characterize the location

Aquatic plant

- vegetation or density based on the ecological category or species of the plants
- estimate of the biomass in terms of dry weight by the random sampling
- estimate of detritus quantity in dry weight to estimate the potential food supply to water bodies
- diversity index in each sampling station to characterize the location

C. Route selection

Any difference among the alternatives is not identified before the project implementation for surface water quality and aquatic ecology/fishery.

(1) Surface water quality

Diversion structure in Kok River

- 1) Water quality near the Diversion structure
It is clear that coliform bacteria, inorganic nitrogen and phosphorus, ammonia, total solid, suspended solid are higher in some extent compared to other stations.
- 2) Communities located upstream
Approximate number of community households are required to be described.
- 3) Water use of communities upstream/downstream
The purpose of water use and supply in this area is not so clear.

Diversion structure in Ing River

- 1) Water quality near the Diversion structure
It is clear that BOD value of 2.7 and 4.9 are higher than other sampling station. But coliform bacteria, organic nitrogen and ammonia are not so low level.
- 2) Communities located upstream
Approximate number of community households are required to be described.
- 3) Water use of communities upstream/downstream
Water usage from the main stream or river are required to be mentioned

Diversion canals/ culverts and tunnels from Kok River to Ing River

- 1) Obstruction on the natural flow direction
Velocity of the stream will be accelerated due to the straight structure and steep slope in the facilities.
- 2) Sediment increase during construction period
By river bed dredging will be done for 1.5 kilometers of length, sediment increase in the river will be occurred in some extent during the construction. But those will be disappeared in a while due to the rapid flow of the river

Diversion canals/culverts and tunnels from Ing River to Nan River (Yod)

- 1) Obstruction on the natural flow direction
Velocity of the stream will be accelerated due to the straight structure and steep slope in the facilities.
- 2) Sediment increase during construction period
By river bed dredging will be done for 1.5 kilometers of length, sediment increase in the river will be occurred in some extent during the construction. But those will be disappeared in a while due to the rapid flow of the river

(2) Aquatic ecology/ Fishery in Alternative A

Diversion structure in Kok River

- 1) Type and abundance of fish
Without diversity index and biomass, location characteristics are not clear so that the distribution patterns cannot be easily compared to other points.
- 2) Abundance of aquatic weed
It is not clear the degree of the density which surveyed to be carried out of the length ,width by which can be estimated its biomass, and the function of them whether it contribute to strengthen the banks or to be a kind of obstacles
- 3) Abundance of plankton and benthos
Without diversity index and biomass, location characteristics are not clear so that the distribution patterns cannot be easily compared to other points.
- 4) Fisheries
Needed to confirm the existence of the ponds and artisanal fishing of the villagers

Diversion structure in Ing River

- 1) Type and abundance of fish
Without diversity index and biomass, location characteristics are not clear so that the distribution patterns cannot be easily compared to other points.
- 2) Abundance of aquatic weed
It is not clear the degree of the density which surveyed to be carried out of the length ,width by which can be estimated its biomass, and the function of them whether it contribute to strengthen the banks or to be a kind of obstacles
- 3) Abundance of plankton and benthos
Without diversity index and biomass, location characteristics are not clear so that the distribution patterns cannot be easily compared to other points.
- 4) Fisheries
Needed to confirm the existence of the ponds and artisanal fishing of the villagers

Diversion canals/culverts and tunnels from Kok River to Ing River

- 1) Distribution of aquatic organisms

Without diversity index and biomass, location characteristics are not clear so that the distribution patterns cannot be easily compared to other points.

2) Change of aquatic ecological condition

Impacts themselves affect the organisms but through the change of the physical factors.

Diversion canals/ culverts and tunnels from Ing River to Nan River (Yod)

1) Distribution of aquatic organisms

Without diversity index and biomass, location characteristics are not clear so that the distribution patterns cannot be easily compared to other points.

2) Change of aquatic ecological condition

Impacts themselves affect the organisms but through the change of the physical factors.

3.1.2 Forest Resources

3.1.2.1 Forest resources along the diversion route

Forest resources along the diversion route are shown at Table 3.1.2.1

Table 3.1.2.1 Forest resources along the KIN-diversion route

Location	Forest resources
Kok Diversion Dam	- none forest
Kok - Ing Diversion Canal	<ul style="list-style-type: none"> - there are some small hill areas - most of hill areas are covered by degraded forest - most of forest areas are constituted for National Forest Reserve (c)
Ing Diversion Dam	- none forest
Ing Diversion Canal to Ing - Yot Tunnel	<ul style="list-style-type: none"> - there are some small hill areas - most of hill areas are covered by degraded forest - most of forest areas are constituted for National Forest Reserve (c) - some head watershed areas are constituted for Watershed classification (1A)
Ing River Training	- none forest
Ing - Yot Tunnel	<ul style="list-style-type: none"> - most of this area are mountainous areas covered by degraded/secondary forests - main forest type is the Hill Evergreen Forests (source ; RFD office) - most of the mountain's foot areas are encroached for cultivation , the forests are deforested ; fields , bush , bamboo . - most of this area are Doi Phu San National Park under establishment - most of this area are Watershed Classification (1A) zone - most of this areas are National Forest Reserve (C) zone <p>* No data about the vegetation around the Phu Sang Waterfall (only one warm waterfall in the Thailand)</p>
Flood Control Dam	<ul style="list-style-type: none"> - most of this area are mountainous areas covered by degraded/secondary forests - most of the mountain's foot areas are encroached for cultivation , the forests are deforested ; fields , bush , bamboo - some areas are Watershed Classification (1A) zone - some areas are National Forest Reserve (C) zone
Yao river Training	- few trees

3.1.2.2 Environmental Resources and Aspects at each Construction site

Most of the area that the water diversion canals of alternatives A, B and C, will pass through are the agricultural land such as rice field, corn, cane and the shifting cultivation. For the areas of inlet/outlet and inclined shaft, they are covered with the degraded forest which have been disturbed by the local people for agricultural purpose. The diversion tunnel section will pass under the conservation areas such as the natural forest reserves, the forest conservation zone and watershed class 1 (WSC1) but the forest community will not be disturbed because the diversion tunnel will pass underground with more than 500-1,000 m. depth. In association with the tunnel construction, tunnel shafts are planned to be located at seven places along the route. In order to avoid the environmental impact, the entrance, exit and all the inlet portions of shafts are located outside of the Watershed Classification (1A).

(1) Around the Diversion Structure Site in Kok River

Environmental Resources	Alternative A	Alternative B/C
Ecosystem Condition around the Diversion Structure Site	Mainly agricultural areas, especially rice paddy and maize. No forest area.	Mainly agricultural areas, near Huai Mae Gorn which flows to Nam Mae Kok. No forest area.
Natural Forest Tree Covering the Construction Area	Area on both sides of Nam Kok at this site is covered with Giant mimosa. No forest tree species	No forest trees in this area, there are only Giant mimosa along both sides of the river.

(2) Around the Diversion Structure Site in Ing River

Environmental Resources	Alternative A	Alternative B/C
Ecosystem Condition around the Diversion Structure Site	Mainly agricultural areas, especially rice field and maize, in the vicinity of the site, degraded Mixed Deciduous and Dry Dipterocarp forest were found.	Mainly agriculture areas i.e., paddy field.
Natural Forest Tree Covering the Construction Area	<i>Shorea siamensis</i> (Rung), <i>Shorea obtusa</i> (Teng), <i>Azelia xylocarpa</i> (Makka), <i>Pterocarpus macrocarpus</i> (Pradu), <i>Xylia xylocarpa</i> (Daeng), <i>Spondias pinnata</i> (Makok) are the natural tree species in this area.	No forest trees in the area adjacent to the proposed dam site.

(3) Along the Diversion Canal/Culverts and Tunnels from Nam Kok to Nam Ing

Environmental Aspects	Alternative A	Alternative B	Alternative C
Disturbance to the Forest Reserves	The diversion canal and tunnel from Mae Kok to Mae Ing will pass 5 national forest reserves in zone C about 12 km, and zone E for 4 km, most of these sections pass underneath the mountain.	The diversion canal and tunnel from Mae Kok to Mae Ing will pass 5 national forest reserves in zone C for 4 km and zone A for 2.5 km. National forest would be slightly disturbed because the diversion structure at those sections mostly pass underground, not lower than 500-1,000 m. from ground surface.	Not differ from alternative B.
Disturbance to Watershed Class 1 areas	Tunnel will pass underneath watershed class 1 areas, with distance about 2 km.	Both canal and tunnel will not pass through watershed class 1 area.	Both canal and tunnel will not pass through watershed class 1 area.
Forest Conditions	The canal mainly passes through the rice field and upland crops areas. Mixed Deciduous and Dry Dipterocarps Forests were scattering and Bamboos were found near the tunnel inlet.	Mostly areas which will be destroy are agriculture. The area at the tunnel inlet and outlet was slope hillside or slope hillfoot covered mostly with upland crop. Remaining forest areas are in a few.	Almost affected areas area are the same areas as alternative B.
Size forest of areas to be disturbed	About 100-200 rai of degraded forest will be disturbed.	Forest area \approx 100 rais will be disturbed.	About 100 rai of degraded forest will be disturbed.

(4) Along the Diversion Canal/Culverts and Tunnels From Nam Ing to Nam Nan(Yod)

Environmental Aspects	Alternative A	Alternative B	Alternative C
Disturbance to the Forest Reserves	Most of alternative A are tunnel which will pass beneath 3 national forest reserves in the forest conservation zone (C) about 56.61 km and the economic forest zone (E) about 0.54 km.	The diversion tunnel of alternative B will pass beneath 3 national forest reserves in the forest conservation zone (C) about 56.61 km and the economic forest zone (E) about 0.54 km.	The tunnel will pass beneath 9 national forest reserves in the forest conservation zone (C) about 34.46 km, the economic forest zone (E) about 3.39 km and the forest land suitable for agriculture about 3.57 km
Disturbance to Watershed Class 1 areas	The diversion tunnel of alternative A will pass underneath WC1 about 29.70 km.	The diversion tunnel of alternative B will pass underneath WC 1 about 27.0 km.	The diversion tunnel of alternative C will pass underneath WC 1 about 16.30 km.
Forest Conditions	The alternative A will pass through agricultural land and degraded forest.	The alternative B will pass through agricultural land and degraded forest.	As same as Alternative A and B.
Size of forest areas to be disturbed	About 700-800 rai of degraded forest will be disturbed.	About 400-500 rai of degraded forest will be disturbed.	About 300-400 rai of degraded forest will be disturbed.

3.1.2.3 Summary of TEAM J/V Report

The impacts of each Alternative route are examined based on the length of the route into/under the forest areas .

Preliminary Impacts Assessment on Forest Resources is shown as follows ;

(IEE)

- 1 . The expected impact on forest resource is of low level .
- 2 . There are regulation about watershed classification. The route, especially in the 50 km tunnel portion, is in the watershed class 1, so the EIA report submission to the National Environmental Board (NEB) is necessary.
- 3 . After the EIA report has been approved by the NEB, the project will be further addressed to the cabinet for approval.

(Reason)

- 1 . The water diversion canals of alternatives A, B and C, will pass mostly through the agricultural land such as rice field, corn, cane and the shifting cultivation.
- 2 . For the areas of inlet/outlet and vertical shaft, they are covered with the degraded forest which have been encroached by the local people for agricultural purpose.
- 3 . The diversion tunnel section will pass under the conservation areas such as the National Forest Reserves, the forest conservation zone and watershed class 1 (WSC1), but the forest community will not be disturbed because the diversion tunnel will pass underground with more than 500-1,000 m. depth.
- 4 . Tunnel shafts are planned to be located at seven places along the route. In order to avoid the environmental impact, the entrance, exit and all the inlet portions of shafts are located outside of the Watershed Classification (IA).

Problems / Important Impacts	Recommended Mitigation Measures
<ul style="list-style-type: none"> - Loss of forest area to the construction of canal/culvert and tunnel for water diversion - Disturbance of the Watershed Class I area (WSC1) - Forest land adjacent to the construction site being illegally occupied by project's workers/officials and local villagers. 	<ul style="list-style-type: none"> - The construction should not be done in forest reserve area; if it cannot be avoided, cut as few trees as possible and reforestation should be done properly. - In case the construction has to be done in reserved forest area, permission has to be secured from the Royal Forestry Department in accordance with law and regulations; a plan to compensate for forest land lost because the construction has to be prepared and approved by RFD. - No activities to be allowed in WSC1 area; if this cannot be avoided, the activities has to follow laws and regulations strictly and EIA needs to be prepared for the approval of the National Environmental Board , and the project will be further submitted to the cabinet for approval resolution. - Don't build worker's camp or community close to forest area. - Do not allow project's workers/officials and villagers to encroach forest area. No hunting be allowed by issuing regulations and enforcing them strictly.

3.1.2.4 Review and Comments for TEAM J/V Report

Although the expected impact on forest resource is of low level but there are regulation about watershed classification, according to which no development activities are allowed in the forest areas classified as A1 watershed. On this matter, it will be quite indispensable for RID to discuss with RFD and OEPP, focusing on the necessity of the development, the conservation of the forest, and the subsequent environmental impacts of the development. Then, the submission of EIA report to the National Environmental Board is necessary. After the EIA report has been approved by the NEB, the project will be further submitted to the cabinet for approval.

From the viewpoint of Forest Resources , the impact examined at this phase on the routes proposed by TEAM J/V are also expected to be low. However, the following additional investigation will be required to strengthen the IEE (TEAM J/V) before proceeding to the EIA

- the Preliminary Impact Assessment on the Nan watershed area ,
 - ; some impact are expected from the Flood Control Dam and Yao River Training
- the Preliminary Impact Assessment on the vegetation around the Phu Sang Waterfall ,
 - ; this waterfall is a warm waterfall only present in Thailand
- the investigation about each forest type in Kok , Ing and Nan basins ,
 - ; for natural forest , secondary forest , degraded/deforested area ,recovering forest area
 - ; distribution
 - ; vegetation type , biological characteristics , biodiversity , ecosystem
 - ; forest production
 - ; utilization of the forest
 - ; management plan for using and conservation of the forest
- the investigation about the condition of the each forest type in Kok , Ing , Nan basins
 - ; for natural forest , secondly forest , degraded/deforested area , recovering forest area
 - ; meteorological condition
 - ; soil conditons

3.1.3 Wildlife

3.1.3.1 Wildlife Environment

An outline of environmental condition in the project area are as shown in Table 3.1.3.1.

Table 3.1.3.1 Outline of environmental condition of the project area

Area	Alternative	Environment and Wildlife
Kok-Ing Diversion Canal/Culvert	A	Mostly agriculture area and village community. Only small size wildlife (rat, snake, lizard , frog etc.) found.
	B	Mostly plain and cultivation area. Only small size wildlife (rat snake lizard , Frog etc.) found.
	C	Mostly rainfed rice field. Only small size wildlife with active movement especially birds, found.
Tunnel Inlet/Outlet	A	Mixed deciduous forest and crop cultivation area, mostly corn. Only small size wildlife found.
	B/C	Crop cultivation, mostly corn. Only small size wildlife found.
Ing-Nan Diversion Canal/Culvert Tunnel Inlet	A/B/C	Crop cultivation, mostly corn. Only small size wildlife found.
	A/B	Mostly corn cultivation area. Only small size wildlife
	C	Mostly rice field. Only small size wildlife found.
Outlet	A/B/C	Crop cultivation, mostly corn. Fruit orchard (lychee) Only small size wildlife found.
Shaft	A/B/C	in the National Park (Phu-Sang) Mostly crop cultivation. Only small size wildlife found. Medium size mammals were reported by local people. They however, already immigrated to the mountainous forest area.

3.1.3.2 Summary of TEAM J/V Study

A summary of environmental condition for wildlife in the TEAM J/V Study are shown on Table 3.1.3.2.

(1) Wildlife Diversity

Alternative A

4 groups(amphibian, reptilia, aves and mamalia) of wildlife were found, the majority of which were birds and small size animals. They are able to adapt themselves to the affected area.

Alternative B

Wildlife species found in Alternative B were small size animals, same kinds as these of Alternative A whcih are able to adapt themselves to the affected area.

Alternative C

Most of them were similar to those found in Alternative B.

(2) Disturbance on Food Source

Disturbance on food source and wildlife route are almost of the same level among Alternative A, B and C.

Alternative A, B and C will pass mostly through agricultural area which has been continuously disturbed. Wildlife living in this area would be able to adapt themselves to the changes of environment due to the project implementation or move to adjacent areas.

(3) Comment

According to the TEAM J/V Study, there is almost no difference among the alternative A, B and C in terms of impact on wildlife. Either alternative A, B or C will generate only low level of impacts. This finding is judged to be reasonable.

Table 3.1.3.2 Summary of Environmental Resources around the Diversion Route in Kok-Ing-Nan River

Environmental Aspects	Alternative
<ul style="list-style-type: none"> - Wildlife Diversity 	<p><u>Alternative A</u> Wildlife found is of small size and able to adapt themselves to disturbed area. Most of them are in bird group. Siamese hare and Common civet were the biggest mammals found.</p> <p><u>Alternative B</u> Most wildlife species found were similar to those found in alternative A. Bird is the majority group.</p> <p><u>Alternative C</u> Wildlife in the area of alternative C was similar to those found in Alternative B</p>
<ul style="list-style-type: none"> - Disturbance on Food Source and wildlife Route 	<p><u>Alternative A, B, C</u> Areas to be affected by 3 alternatives are agricultural areas which have been continuously disturbed. Wildlife living in this area would be able to adapt themselves to the ecological changes. It is expected that wildlife could use the adjacent area instead of the disturbed area.</p>