

Emerging plants are concentrated within the littoral zone, and are replaced with each other as the depth of the water changes either in space or in time. Typical plants are *Nymphaea stellata* (water lily), *Nelumbo nucifera* (lotus), *Scirpus articulatus* (bulrush), *Cyperus difformis* , *C. rotundus* , *C. procerus* , *Nymphoides indica*

Submerging plants place most of their body under the water surface to provide the shelter and nursery for smaller invertebrates in the fragile stage of its life cycle. Typical plants are *Potamogeton* spp. (pond weed), *Najas gaminea* (naiad), *Ceratophyllum demersum* (coontail), *Hydrilla verticillata* , *Leesia alexandra* , *Blyxa lancifolia*, *Utricularia aurea*,

Floating plants are mostly wandering on the surface water to follow the water current. They easily form periphyton (Aufwuchs) to provide the shelter and nursery where abundant microbes and smaller invertebrates build the microcosms for their convenience. Typical plants are as follows : *Eichornia crassipes* (water hyacinth), *Pistia stratiotes* (water lettuce)

Dominant invertebrates beneath the periphyton are gastropoda of *Lynceus* spp., *Pila* spp., oligochaeta of *Tubefis* spp., insecta of *Macromia* spp., decapoda of *Macrobrachium canchesteri*

2.3.1.3 Environmental impact

Description of major environmental impacts in the project site focuses on five subjects consisting of water level, silt, eutrophication, pollution and weed. These subjects less interfere the present project although they often limit the structure and growth of organisms present in the project site.

(1) . Water level

The water level fluctuation affects the following matter :

- inundation of tributary stream
- reduction in riparian habitat, vegetation in wetlands, avian nest
- poor stability of bank and bed
- loss of aquatic habitat
- decreased quality of aquatic habitat
- decreased primary and secondary aquatic production
- altered sedimentation pattern
- stranding of fish and benthic invertebrates
- loss of fish nursery grounds

- decreased fish spawning and incubation
- alteration of food chains
- disruption of fish migration
- changes in relative volumes of epilimnion and hypolimnion
- flushing of plankton from reservoir

The freshwater marsh are held in an early succession stage by the seasonal fluctuations in water levels. The drawdown in dry season speeds up aerobic decomposition of accumulated organic matter, releasing nutrients that, in flooding, support a wet season bloom in productivity. The life histories of many organisms are intimately coupled to this periodicity. Without periodic drawdowns, the shallow basins would be filled up with organic matter and succession would proceed from the present pond and preirie condition toward a scrub or swamp forest.

Drawdown zone between the highest and lowest water level provides the space for fish population of recruitment from the nursery and spawning ground.

(2) Siltation

Deforestation is recognized as a major environmental impact in the North of Thailand, with estimates in 1985 indicating that only 29% of the country's total area remained under forest cover,. This represents a reduction in forest cover of around 45% between 1961 and 1985. In the North, forest cover has decreased from 73 million rai to 53 million rai over the same period (42% to 14 % of land area). This deforestation has caused siltation because of increased soil erosion and has exacerbated water supply problems, with the loss of forest leading to extremes of drought and flooding. In addition to the loss of forest cover, replacement of forest with agricultural crops has led to further environmental impacts, with increased use of fertilizers and pesticides required to maintain soil productivity, causing further degradation of the forest.

Sedimentation linked to deforestation and increased erosion due to poor land management practice is recognized as a severe impact in Northern Thailand, leading to siltation of water courses and swamps and ponds. Some studies in the upper Chao Phraya catchment show a sediment yield from a full cover of evergreen forest of 40 tones/square kilometers/year, compared to 1,114 tons/kilometers/year from an area settled by hill tribes.

In the two provinces of Northern Thailand which lie within the Mekong Basin, Chiang Rai and Phayao, cultivation of maize on steep slopes is badly damaging ecological stability and may be affecting water availability in the lowlands.

Sediment load is to be considered, as sedimentation can restrict water resource development potential and affect fisheries, through sedimentation of spawning and feeding migration routes, light limitations causing reductions in primary productivity, and silting up of spawning and feeding areas. The sediment load is generally small compared to other major rivers, with loads decreasing from upstream to downstream stations. Sediment loads is generally related to discharges with sediment content in the main river in the basin usually 5 - 10 times higher than during the low flow season, when the sediment content is 50 - 100 mg/liter.

Silt distribution of river water prevent the fish population from excess reacting to the ultraviolet radiation which stimulate their optic nervous system as stronger solar radiation in the tropical zone.

Due to oligotrophic water bodies, less in organic matter, and turbulent of the water body, the oxygen depletion seldom occurs. As organic particles aggregate microbes on their surface, the oxygen consumption of ambient water is promoted by microbial growth during the degradation of organic substrates.

In the geology, the silt is identified as the particle size of

4 62.5 micro-meters in Udden - Wentworth scale.

And in the pedology, the diameters of them are identified as follows:

0.2 to 0.02 micro-meters, International system

0.02 to 0.05 micro-meters, USDA system

(3) Eutrophication

Some of the tributaries and canals are known to be significantly eutrophicated by agricultural run-off and domestic waste water.

Phosphorus and nitrogen nutrients are generally low in the mainstream, but increase as they are washed into the mainstream during the rainy season. Increased nutrient concentrations and enhanced daytime oxygen concentrations have been noted in some tributaries.

(4) Pollution

In chapter 3.2.3 of The Seventh National Economic and Social Development Plan (1992 - 96), the authorities state as follows:

Encourage correct use of chemical products and reduce their uses in the future so that they will not pose hazards to consumers of agricultural produce and to agricultural workers, through the following measures.

Consumption of agriculture chemicals are recently increased mainly for the vegetable culture. In 1991, whole Thailand of farmers consumed 37 thousand tons of herbicides and 14 thousand of insecticides.

There is a trend towards increasing use of agro-chemicals including fertilizers, pesticides and herbicides in North Thailand, particularly in irrigated areas. Some organochlorines are detectable in fish tissues, with highest concentrations of DDT in the mainstream. There was some tendency for higher concentrations in carnivorous fish due to the food chain accumulation. Water quality in irrigated and rainfed areas showed higher levels of organochlorine pesticides in water draining irrigated areas. Intensification of agriculture will result in a loss of fish production and contamination of fishery products, and undoubtedly in some area aquaculture and fisheries may be incompatible with agriculture because of heavy pesticide use, e.g. double rice cropping areas, industrial crops. These problems seem most likely to arise in irrigated areas and less so in the rainfed paddy areas.

Typical herbicides utilized in the country are as follows: alachlor, butachlor, bromacil, 2-4-D, fluazifop-buthyl, glyphosate, haloxyfop-methyl, imazapyr, oxadiazon, oxyfluorfen, paraquat, pretilachlor, propanil, triclopyr, butachlor + 2-4-D, molonate + propanil

Typical insecticides are as follows: bifenthrin, buprofezin, carbaryl, carbofuran, carbosulfan, cartap, chlordane, chlorfluazuron, cyfluthrin, cyhalothrin L, fenitrothion, formothion, methomyl, MIPC, omethoate, pirimiphos-methyl, quinalphos, sulprofos, thiodicarb, thiometon, triazophos, chlorpyrifos + BPMC, cypermethrin + phosalone, alphacypermethrin + BPMC, alphacypermethrin + PBO, monocrotophos + cypermethrin, fenitrothion + BPMC, fenitrothion + fenvalerate.

Typical fungicides are as follows: chlorothalonil, dinocap, etridiazol, fosetyl-aluminium, pyrazophos, quintozone, thiabendazole, triadimefon, dicloran + captan, carbendazim + mancozeb, metalaxyl + mancozeb.

Typical rat poisons are as follows: brodifacoum, bromadiolone, coumatetralyl, flucoumafen, zinc phosphide.

(5) Weed

The thorny *Mimosa pigra* L. (*Mimosaceae*) or giant mimosa (*ton mayarap* in Thai) grows in dry areas but thrives in water margins, especially in areas exposed to bright sunlight. It can grow in water up to 1 meter deep and to reach height of 7 meters so that it can extend a considerable distance into most waterways. It also chokes river banks and invades fields, its extensive root system resisting all efforts to extirpate it. In 1947, the mimosa was introduced into Northern Thailand from Indonesia as a green manure and cover crop in tobacco plantations. It was later planted to help control ditch bank erosion around Chiang Mai. After 1975, it quickly spread upriver into Chiang Rai and Chiangsaen, its seeds carried in road construction sand dredged and transported from the lower river. After infesting northern provinces, it moved downstream, reaching Bangkok by 1980'. The weed is particularly noxious along canals where it blocks the passage of sediment and, ultimately, of irrigation water. Growing primarily on the inside bends of rivers, its roots and stems increase sediment deposition by estimated 75 %, causing the more rapid erosion of the opposite bend. Efforts to eradicate it have been fruitless. It is extremely prolific with a single plant producing between 40 thousands and 100 thousands seeds a year after 6 or 8 months. The seeds are drought resistant and can remain submerged for at least 1 month before dying. Seed pods submerged for more than 2.5 years will still germinate. The leaves are tried to control by two methods of mechanical and chemical. The former is done by the way of cutting, digging or burning, and latter by herbicides especially aerial spraying just before the rainy season. The herbicides cause the foliage and thorns to drop off, making easier for farmers to harvest the stem, but neither method is viable for large scale eradication programs. Two new techniques to control the mimosa are being field tested in the National Biological Research Center at Kasetsart University. Two species of seed eating beetles of *Acanthoscelides puniceus* and *A. quadridentatus* (Coleoptera: Bruchidae) were imported from South America after extensive testing in Australia. They curtail the mimosa's proliferation by eating its seeds before they mature. The beetles only diminish seed production, they can control the mimosa's spread but cannot eliminate existing plants. Their benefit is that they are host-specific so will not damage other plants. The Center is also experimenting with a species of Diabole fungus which attack the plant, causing die back but it works only in dry areas. In the end of 1986, the meeting on the giant Mimosa was held at

Chiang Mai University entitled as “ Workshop on Uses and Losses due to *Mimosa pigra* “ This was followed to the international symposium on the Mimosa management held in the same place in early 1982. The water hyacinth is an imported weed during the time of King Chulalongkorn from Indonesia because of the beauty of its flowers for decorative in ponds. They eventually found their way into the canals and from thence into the rivers where they have become a hazard to navigation, entirely clogging canals or floating in enormous clusters down rivers during the monsoon season. In the 1930s, a Water Hyacinth Control Act was passed but it has had little effect in controlling its spread.

2.3.1.4 Fishery

Agriculture, including fisheries sector, accounts for approximate 12 % of the national gross domestic product (GDP). The estimated value of the commercial inland fisheries of Thailand in 1993 was 8.6 billion Baht, contributing 11.0% to the total value of fisheries of 78.41 billion Baht. Compared to GDP of Thailand in 1993 of 3,164 billion Baht, the fisheries sector in total contributed 2.5% and inland fisheries only 0.27%

DOF has recently prepared a comprehensive policy document for the development of the fisheries sector as a contribution to the Seventh National Economic and Social Development Plan (1992 - 96).

The fishery occurs in a range of different systems, each with their characteristics: reservoirs, natural lakes and swamps, main rivers, large tributaries, small rivers and canals, flooded rice fields and ditches. Some of these fisheries represent a mixture between aquaculture and capture fishing such as the stocking of reservoirs and the release of fingerlings into rice fields and communal ponds.

The seasonal pattern of the fisheries is governed by a combination of the migratory cycle of the fish which is coupled to the hydrological cycle, and the sequence of the needs for labor in agriculture.

The average amount of freshwater fish consumed per capita in the urban and rural area is presented as follows :

| | | |
|------------|----------------|--------------|
| Urban area | Municipality | 22.3 kg/year |
| | Urban district | 18.9 |
| Rural area | Water rich | 36.4 kg/year |
| | Water medium | 25.1 |
| | Water poor | 13.3 |

| | |
|-----------------|--------------|
| Average | 21.5 kg/year |
| Overall average | 21.3 kg/year |

The fish production in three provinces of Chiang Rai, Phayao and Nan are shown in Tables 2.3.1.1 to 2.3.1.3 and species of fish production in Table 2.3.1.4.

Summary of fish production in three province of the project site is presented as follows:

| province | Chiang Rai | Phayao | Nan |
|--------------------------------|------------|-----------|-----------|
| total production (kgs) | 2,218,835 | 1,382,886 | 1,383,425 |
| average in amphoe | 158,488 | 197,555 | 106,417 |
| total reservoir (rai) | 166,633 | 4,410 | 19,700 |
| average in amphoe | 9,802 | 630 | 1,515 |
| total pond (rai) | 10,112 | 2,329 | 1,482 |
| average in amphoe | 595 | 333 | 114 |
| average productivity (kgs/rai) | 33.1 | 214.0 | 452.0 |

Summary of fish production along the planning course in amphoe is presented as follows:

| amphoe | Muang Chian Rai | Thoeng | K.A. Kwae |
|------------------|-----------------|----------------|---------------|
| province | Chiang Rai | Chiang Rai | Nan |
| facility | open canal | canal / tunnel | tunnel |
| point | inlet | inlet / outlet | outlet |
| production | 418,000 kgs | 148,000 kgs | 17,500 kg |
| reservoir + pond | 60,989 rai | 9,817 rai | 33 rai |
| productivity | 6.9 kgs/rai | 15.1 kgs/rai | 530.3 kgs/rai |

(1) Fishing

The freshwater section of the policy framework focuses, where the capture fisheries are concerned, on :

- 1) the need for conservation and rehabilitation of natural water resources as suitable habitats for fish, including the development and re-excavation of small village water bodies and ponds, prevention of excessive vegetation growth, protection of spawning grounds and fry feeding area, and construction of facilities to improve fish habitats and facilitate fish migration;
- 2) the need to protect particularly the economically valuable species by preventing misuse of the resources, to involve closed seasons and the banning of harmful fishing gear and methods;

- 3) the need to control pollution of natural water bodies through the specification of minimum levels of toxicity; and
- 4) the breeding of economically valuable and endangered species and the production of fry to the necessary levels.

A wide range of species are exploited although the majority of the catches are constituted by some 20 species. These include:

- a) Small profile species such as *Corica* sp., *Chandra* sp. And to some degree *Cirrhinus jullienni*, which seasonally may be abundant in swamps and reservoirs;
- b) the major indigenous cyprinids such as *Puntius gonionotus*, *Hampala macrolepidota* and *H. dispar*;
- c) the predators such as the snakehead (*Channa* spp.) and catfishes (*Clarias* spp.);
- d) the river catfishes (*Pangasius* spp.); and
- e) various introduced species which have been stocked in reservoirs, a group which includes tilapia (*Oreochromis niloticus*), rohu (*Labeo rohita*) and bighead carp (*Aristichthys nobilis*).

The peak fishing periods are April - June in upstream migration, and September - November in downstream migration.

Typical fishing areas and gears are listed that in the mainstream and tributaries, they use gill nets (set and drifting), dip net, lift net, long lines, traps, haul seines, and in the reservoir, they use gill nets, dip net, lift net.

During the time without fishing activities, village workings are as follows:

- rice seed bed, plough, harrow, transportation, harvest,
- cane harvest, cone harvest, plant garden, harvest garden, field foraging, wage labor, land cleaning,
- mat weaving, bamboo weaving, cloth weaving, charcoal making, house repair,
- snail collection, indigo collection, cotton dyeing,

(2) Aquaculture

The policy of freshwater aquaculture aims at:

- 1) an increase in production for local consumption and for export;
- 2) improving the culture techniques, the production environment and prevention of fish

- diseases;
- 3) improving the use of suitable water bodies for cage and pen cultures;
 - 4) establishing extension programs and information dissemination through training and demonstration,
focusing on culture techniques as well as on product quality;
 - 5) providing credit facilities for small-scale investors; and
 - 6) establishment of central fish marketing facilities.

It has been recognized that small scale aquaculture in Northern Thailand offers excellent potential for farmers to generate income and improve their diet. Fish farming can help diversify farming activities because of its natural complementary activity to general agriculture. A fish pond can be used to store water which can be used for livestock and crop irrigation in the dry season.

Most farmers have enhanced the natural fishery by modifying their rice fields, by raising the height of the dikes, and/or deepening a small area in the field to form a trap pond. Wild fish were concentrated in the trap pond when flood waters receded at the end of the rainy season, which facilitated their capture. The trap pond is often the starting point for the farmers' entry into fish culture as trenches are often dug connecting with it, and/or the trap pond itself may be widened and deepened.

Fish culture is largely based on the use of agricultural by-products as pond input, such as buffalo manure, rice bran, cassava leaves and roots, and other organic matter sources collected on and near the farm such as termites, water spinach, and duck weed. Most of these are generally in short supply and rice bran has to be purchased. Yields of most ponds are low, probably only about 60 - 80 kg/rai (about 0.3 - 0.5 tones/ha).

A total of 16 species are cultured by farmers in Northern Thailand, 5 indigenous and 11 exotic species which are listed as follows:

| <u>Species name</u> | <u>English name</u> | <u>Thai name</u> |
|--|------------------------|--------------------|
| <u>Indigenous species</u> | | |
| Carp group | | |
| <i>Puntius gonionotus</i> | silver barb | pla tapian khao |
| Catfish group | | |
| <i>Clarias batrachus</i> | walking catfish | pla duk dan |
| <i>C. macrocephalus</i> | | pla duk oui |
| Goby group | | |
| <i>Oxyeleotris marmorata</i> | sand goby | pla boo |
| Snake head group | | |
| <i>Channa striata</i> | snake head | pla chon |
| <u>Exotic species</u> | | |
| Carp group | | |
| <i>Aristichthys nobilis</i> | silver carp | pla kled ngerm |
| <i>Cirrhinus mrigala</i> | mrigal | pla nuan chan tade |
| <i>Ctenopharingodon idella</i> | grass carp | pla kin ya |
| <i>Cyprinus carpio</i> | common carp | pla nai |
| <i>Hypophthalmichthys molitrix</i> | bighead carp | pla nua to |
| <i>Labeo rohita</i> | rohu | pla yeesok tate |
| Catfish group | | |
| <i>Clarias gariepinus</i> | African catfish | pla duc tate |
| <i>C. gariepinus</i> x <i>C. macrocephalus</i> | | pla duc oui tate |
| Tilapia group | | |
| <i>Orreochromis nilotica</i> | | pla nin |
| <i>O. mossambicus</i> | | pla mor tate |
| Prawn group | | |
| <i>Macrobrachium rosenbergii</i> | giant freshwater prawn | koong kaam kaam |

Table 2.3.1.1 Fish Production (Chiang Rai Province)

| Amphoe | Production kgs | Reservoir rais | Pond rais | Productivity kgs/rai |
|-------------------|-------------------|-------------------|--------------|-------------------------|
| Muang Chiang Rai | 418,000 | 59,027 | 1,962 | 6.9 |
| Mae Chan | 123,300 | 24,597 | 412 | 4.9 |
| Mae Sai | 107,900 | 1,026 | 950 | 113.5 |
| Chiang Saen | 155,350 | 31,877 | 667 | 4.8 |
| Wiang Chai | 288,000 | 15,259 | 1,105 | 17.6 |
| Thoeng | 148,000 | 9,261 | 556 | 15.1 |
| Mae Suai | 75,200 | 1,846 | 246 | 35.9 |
| Wiang Pa Pao | 24,450 | 1,027 | 103 | 21.6 |
| Chiang Khong | 22,045 | 12,667 | 314 | 1.7 |
| Phan | 719,500 | 3,610 | 1,619 | 137.6 |
| Pa Daet | 48,690 | 583 | 556 | 42.7 |
| Phaya Mengrai | 44,900 | 1,064 | 198 | 35.6 |
| K.A. Mae Fa Luang | | 1,805 | 58 | |
| K.A. Mae Lao | 18,800 | 1,557 | 152 | 11.0 |
| K.A. Khun Tan | 24,700 | 1,463 | 182 | 15.0 |
| K.A. Chiang Rung | | 597 | 1,012 | |
| K.A. Wiang Kaen | | 392 | 20 | |
| Total | 2,218,835 | 166,633 | 10,112 | |
| Average | 158,488 | 9,802 | 595 | 33.1 |

Table 2.3.1.2 Fish Production (Phayao Province)

| Amphoe | Production kgs | Reservoir rais | Pond rais | Productivity kgs/rai |
|----------------|-------------------|-------------------|--------------|-------------------------|
| Muang Phayao | 823,000 | 805 | 584 | 592.5 |
| Chun | 18,700 | 351 | 361 | 26.3 |
| Chiang Kham | 136,820 | 591 | 545 | 120.4 |
| Chiang Muan | 11,150 | 230 | 98 | 34.0 |
| Dok Kham Thai | 83,940 | 1,980 | 337 | 36.2 |
| Pong | 59,691 | 201 | 194 | 151.1 |
| Mae Chai | 249,585 | 252 | 210 | 540.2 |
| Total | 1,382,886 | 4,410 | 2,329 | |
| Average | 197,555 | 630 | 333 | 214.0 |

Table 2.3.1.3 Fish Production (Nan Province)

| Amphoe | Production kgs | Reservoir rais | Pond rais | Productivity kgs/rai |
|--------------|-------------------|-------------------|--------------|-------------------------|
| Muang Nan | 246,000 | 1,335 | 299 | 150.6 |
| Waiang Sa | 420,050 | 9,500 | 472 | 42.1 |
| Na Noi | 101,555 | 1,450 | 96 | 65.7 |
| Tha Wang Pha | 53,030 | 515 | 176 | 76.7 |
| Pua | 165,000 | 5,000 | 173 | 31.9 |
| Chiang Klang | 56,400 | 553 | 54 | 92.9 |
| Thung Chang | 59,540 | 380 | 128 | 117.2 |
| Mae Charim | 51,450 | 140 | 20 | 321.6 |
| Ban Luang | 51,200 | 400 | 13 | 124.0 |
| Santisuk | 51,100 | 370 | 23 | 130.0 |
| Na Muh | 76,600 | 30 | 5 | 2188.6 |
| Bo Kua | 34,000 | 7 | 10 | 2000.0 |
| K.A. Kwae | 17,500 | 20 | 13 | 530.3 |
| Total | 1,383,425 | 19,700 | 1,482 | |
| Average | 106,417 | 1,515 | 114 | 452.0 |

Table 2.3.1.4 Production of Fish by Species by Province

| English name | Thai name | Chiang Rai kgs | Phayao kgs | Nan kgs | Total kgs |
|-----------------|-------------|-------------------|---------------|------------|--------------|
| Snake head | Pla Chon | 189,050 | 111,556 | 97,245 | 397,851 |
| Catfish | Pla Duk | 209,850 | 122,629 | 177,400 | 509,879 |
| Climbing perch | Pla Mo Thai | 24,520 | 78,892 | 18,720 | 122,132 |
| Local carp | Pla Tapian | 300,300 | 132,427 | 138,480 | 571,207 |
| Tilapia | Pla Nil | 690,800 | 522,376 | 224,200 | 1,437,376 |
| Common carp | Pla Nai | 406,700 | 248,351 | 134,600 | 789,651 |
| Sepat siam | Pla Salid | 10,400 | 22,870 | 19,050 | 52,320 |
| Catfish | Pla Swai | 15,600 | 10,015 | 62,300 | 87,915 |
| Swamp eel | Pla Lai | 15,550 | 5,236 | 12,430 | 33,216 |
| Other food fish | | 260,565 | 90,529 | 483,150 | 834,244 |
| Macrobrachium | Kun Kam Kam | | 5,000 | | 5,000 |
| Shrimp | Kun Phoi | | 21,642 | 10,040 | 31,682 |
| Others | | 95,500 | 11,363 | 5,810 | 112,673 |
| Grand total | | 2,218,835 | 1,382,886 | 1,383,425 | 4,985,146 |

2.3.2 Forest Resources

This study has been conducted for the following items.

- forest resources
- forest condition ; deforestation , soil erosion

2.3.2.1 Forest resources in Thailand including the Study area

The Study area consists of Chiang Rai, Phayao and Nan in the Northern region and Uttaradit in the Central region. Most forest land in the Study area spread in the Northern region .

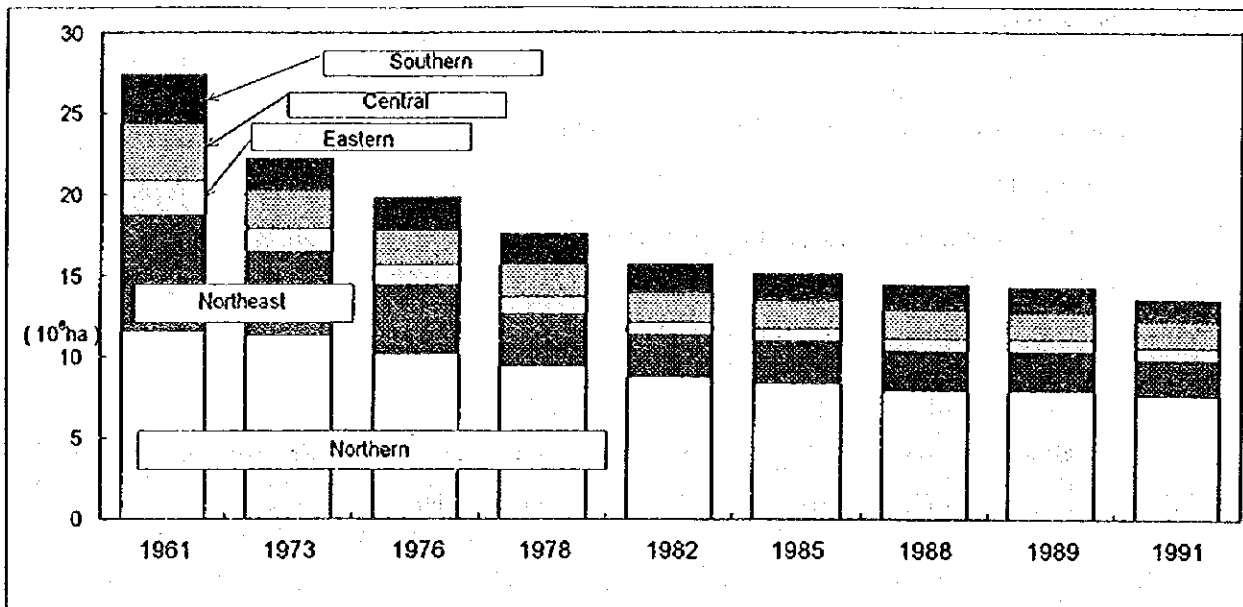
(1) Forest resources

According to the Thailand Forest Inventory conducted between 1982-1985 by the Royal Forest Department with an aid of aerial photographs and remote sensing, average depletion of the forest area was 1,572,242 rai per year. The rates of depletion by region are:-

- | | | |
|-----|-------------------------|-----------------------|
| 1st | ; 0.71 percent per year | - Northern region |
| 2nd | ; 0.64 percent per year | - Central region |
| 3rd | ; 0.45 percent per year | - Southern region |
| 4th | ; 0.33 percent per year | - Northeastern region |
| 5th | ; 0.01 percent per year | - Eastern region |

The historical change of forest land between 1961 - 1991 is shown in figure 2.3.2.1.

The forest area in Thailand has been decreasing , the area in 1961 was over 27 million ha ; 53% of Thailand , the area in 1991 was under 14 million ha ; 27% of Thailand . The forest area in the Northern region has been the largest among all regions, the area in 1961 was about 11.6 million ha ; 69% of the Northern region , in 1991 the area decreased down to about 7.7 million ha ; 45% of the Northern region .



Source : Forestry Statistics of Thailand (1985 and 1991 version) , The Royal Forest Department , Bangkok , Thailand

Figure 2.3.2.1 Change of Forest areas in the Thailand

(2) Soil erosion

With decrease of the forest area , it has caused the severe soil erosion in whole Thailand .

a) Classification of soil erosion degree

Degree of soil erosion is related to several factors such as land form , soil type, land use and others . In order to identify the degree of soil erosion , 5 categories have been adopted and validated as shown below.

The “ very severe “ area is more than 10% of the eroded area in Thailand . The “ very severe ” is over 625 t/ha/yr. ; more than 100 times of the soil erosion in the “very slight ” area .

| Categories | Soil erosion (ton / ha / year) | areas (million ha) | land use |
|-------------|-------------------------------------|-------------------------|--|
| very slight | 0.06 - 6.25 | 19.00 | forest , paddy |
| slight | 6.25 - 31.25 | 14.44 | forest , rubber , orchards , paddy |
| moderate | 31.25 - 125.0 | 4.15 | rubber , orchards , field crop , forest + field crop |
| severe | 125.0 - 625.0 | 6.82 | rubber , orchards , field crop , forest + field crop , shifting cultivation |
| very severe | > 625.0 | 6.27 | field crop , forest + shifting cultivation |
| others | - | 0.73 | coastal area , mangrove forest , shrimp farm etc . |
| Total | - | 51.41 | - |

Source ; 1991, Department of Land Development , Soil erosion in Thailand .

b) Soil conservation measures

Soil is the primary resource for the production . The deterioration of this resource may cause socio-economic damage . Therefore , soil conservation and reforestation should be urgently needed.

The measures to conserve the forest in a long-term and to maximize the benefit from proper land use are as follows ;

- acceleration of the national land use plan.
- systematic investigation to solve the soil erosion problems and prevent the soil erosion.
- acceleration of soil and water conservation by government agencies , private sectors and farmers .
- utilization of the legal measures for supporting conservation program .

c) Erosion of each region

Degree of soil erosion in each region of Thailand is presented as follows ;

| | |
|---------------------|--|
| Northern region | There was very high degree of soil erosion in the western and eastern parts because forests area had been destructed for agricultural purpose . |
| Northeastern region | There was very high degree of soil erosion in the northeastern and southern part . In the central part , moderate degree of erosion was identified in the upland area . |
| Central region | In Chao Phaya River plain , there was very slight degree of soil erosion by their intensive farming on flat terrain . |
| Eastern region | Cultivation of field crops on hill slope and mountain has reflected the severe degree of erosion due to not only according to slope factor but also soil erodibility . |
| Western region | There was very high degree of erosion in the mountainous area of the upper river basin . In the undulating and hilly topography where grows sugar cane , degree of erosion is high . |
| Southern region | Soil erosion was very severe in an upper part of the region . In the lower part , forest , rubber and orchard could bring about low to moderate degree of erosion . |

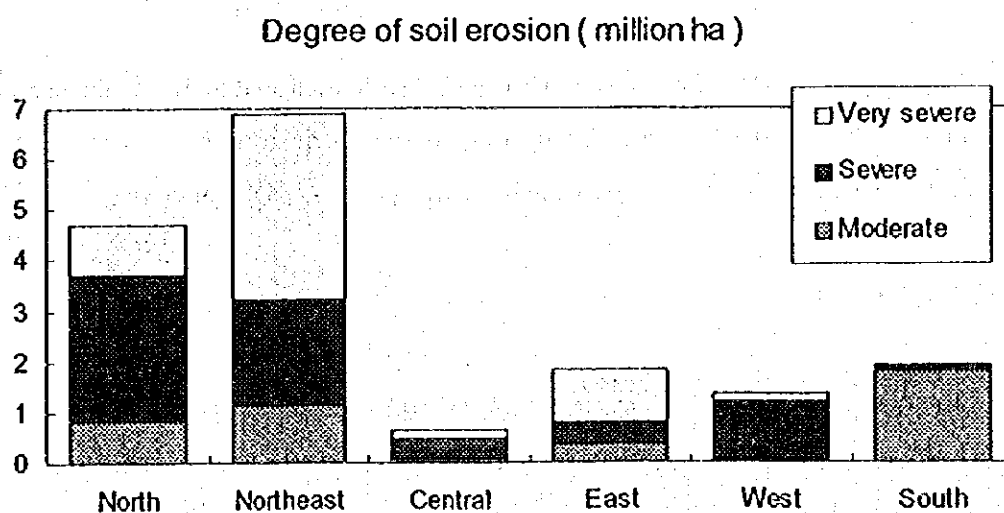
Source ; 1991, Department of Land Development , Soil erosion in Thailand .

From the viewpoint of the degree of soil erosion , soil erosion is very severe especially in Northeastern and Northern regions. The Northeastern region is ranked as No.1 with the 6.87 million ha ; 39.6% of whole Thailand and the Northern region ranked as No.2 with 4.68 million ha ; 27.0 % of whole Thailand .

In the Northeastern region , about half of the eroded areas are very severe and in the Northern region ,over half of the eroded areas are severe . For the Northern region , it is necessary to take the effective soil conservation measures as soon as possible before the degree of soil erosion be as high as the Northeastern region.

| Region | Degree of soil erosion | | | (million ha) |
|-----------|------------------------|--------|-------------|----------------|
| | Moderate | Severe | Very severe | Total |
| North | 0.82 | 2.88 | 0.98 | 4.68 |
| Northeast | 1.17 | 2.04 | 3.66 | 6.87 |
| Central | 0.06 | 0.42 | 0.14 | 0.62 |
| East | 0.35 | 0.43 | 1.06 | 1.84 |
| West | 0.03 | 1.16 | 0.18 | 1.42 |
| South | 1.77 | 0.08 | 0.06 | 1.91 |
| Total | 4.25 | 7.01 | 6.08 | 17.34 |

Source ; 1991, Department of Land Development , Soil Erosion in Thailand .



2.3.2.2 Forest resources in Kok , Ing , Nan basins including the Project area

(1) Forest land

a) The Kok basin

The Kok basin area covers about 10,875 sq.km in 8 Amphoe and 2 King-Amphoe of Changwat Chiang Mai and Chiang Rai. There are 3 National Forest Reserves out of 23 under Changwat Chiang Mai, with an area of 1,012,031 rai covering the Kok basin. The basin was also under the Chiang Rai National Forest Reserves in 12 forests out of 30, with an area of 2,169,354 rai or 69 percent of the Kok basin. The names and areas of National Forest Reserves in the Kok basin are shown in Table 2.3.2.2-1.

Duangchan Charoenmuang (1992) reported that the forest resources of Chiang Rai had a tendency to decline, but in 1961 and 1973 the forest area increased from 52.4 percent to 65 percent because of the promulgation of the Forest Reserves Act 1964. From 1973 to 1989, the forest areas were continuously encroached, so that the forest areas decreased from 7,316,252 rai in 1973 to 3,842,500 rai in 1976 and down to 2,694,130 rai in 1989 as shown in Table 2.3.2.2-2.

b) The Ing basin

The total area of the Ing Basin is approximately 7,388 sq.km covering Changwat Phayao and Amphoe Chiang Khong, Changwat Chiang Rai. The Basin lies under 29 National Forest Reserves with an area of 2,560,281 rai or 55 percent of the Ing basin. The names and areas of National Forest Reserves are shown in Table 2.3.2.2-3.

It was reported that the forest area of Changwat Phayao decreased from 2.4 million rai in 1976 to 1.92 million rai in 1991 whilst reforestation during 1982 to 1991 could achieve only 10,042 rai. The main problems of deforestation are supposed to be caused by land acquisition and illegal logging.

c) The Nan basin

The Nan Basin covers the area about 34,300 sq.km. in Changwat Nan, Uthradit, Petchabun, Pitsanulok, Pichit and Nakhonsawan. There are 66 National Forest Reserves with the total area of 19.3 million rai of which 13.7 million rai are conservation forests, 5.0 million rai are economic forest and only 0.6 million rai

are classified as area suitable for agriculture. The names and areas of National Forest Reserves in provinces are shown in Table 2.3.2.2-4

CUSRI (1987) reported that in the Nan watershed above the Sirikit Dam, the forest area in 1984 was 11,066 sq.km or 82.89 percent of the Nan basin above Sirikit Dam as shown in Table 2.3.2.2-5. The land use for the forest are also classified according to the forest conditions of this basin.

Table 2.3.2.2-1 National Forest Reserves of the Kok Basin

| No. | Name of the Forest | Amphoe | Area (Rai) |
|-------------------|--|----------------------|---------------|
| Chiang Mai | | | |
| 1. | Mae Fang Forest | Fang | 1,000,000 |
| 2. | Mae Lak Muen Forest | Fang | 8,125 |
| 3. | Mae Soon Forest | Fang | 3,906 |
| Chiang Rai | | | |
| 1. | Pong Salee Forest | Muang | 668 |
| 2. | Mae Khao Tom and Huai Luk Forest | Muang-Mae Chan | 15,362 |
| 3. | Huai Sak-Right Bang of Mae Kok Forest | Muang-Wiang Chai | 191,250 |
| 4. | Left Bank of Mae Lao Forest | Mae Suay | 710,937 |
| 5. | Right Bank of Mae Lao Forest | Wiang Pa Pao | 124,375 |
| 6. | Doi Bo Forest | Muang-Mae Chan | 149,185 |
| 7. | Right Bank of Sob Kok Forest | Mae Chan-Chiang Saen | 265,725 |
| 8. | Right Bank of Mae Lao Forest | Mae Suay | 169,437 |
| 9. | Left Bank of Mae Lao and Right Bank of Mae Kok Forest | Muang | 203,125 |
| 10. | Doi Pui Forest | Muang | 91,875 |
| 11. | Nam Ma and Sob Ruak Forest | Chiang Saen | 12,028 |
| 12. | Mae Poon Noi, Mae Poon Luang & Huai Pong | Wiang Pa Pao | 398,750 |
| 13. | Men Forest Nam Mae Kam, Nam Mae Salong & Left | Mae Chan | 353,750 |

| | | | |
|-----|--|-------|---------|
| 14. | Bank | Muang | 132,100 |
| 15. | of Nam Mae Chan Forest Doi Nang Lae, Doi Yao & Doi Prabat Forest Doi Thum Pha Tong, Doi San Pakoi & Nam Ngam Forest | Muang | 38,475 |

Source : Chiang Rai and Chiang Mai Forest Regional Office

Table 2.3.2.2-2 The Change of Forest areas in Chiang Rai province

| Year | Area (Rai) | % of Provincial Area | % of Change | Note |
|------|------------|----------------------|-------------|---|
| 1971 | 5,901,785 | 52.42 | +23.96 | Declaration of new national forest reserves |
| 1973 | 7,316,252 | 64.98 | -47.40 | |
| 1976 | 3,842,500 | 52.64 | -9.99 | |
| 1978 | 3,458,750 | 47.39 | -9.58 | |
| 1981 | 3,127,566 | 42.83 | -3.30 | |
| 1982 | 3,024,375 | 41.83 | -1.83 | |
| 1983 | 2,968,992 | 40.68 | -1.83 | |
| 1984 | 2,914,623 | 39.93 | -1.83 | |
| 1985 | 2,861,250 | 39.20 | -1.83 | |
| 1986 | 2,808,854 | 38.48 | -1.83 | |
| 1988 | 2,715,250 | 37.20 | -3.33 | |
| 1989 | 2,694,130 | 36.91 | -0.79 | |

Note : Total area of the province is approximately 7,298,980 rai since 1977

Source : Duangchan (Apavacharut) Charoenmuang

Table 2.3.2.2-3 National Forest Reserves of the Ing Basin

| Name of Forest | Area (Rai) | Percent |
|--|------------|---------|
| 1. Right Bank of Mae Khong Forest | 9,113 | 0.36 |
| 2. Right Bank of Mae Sob Kok Forest | 40,341 | 1.58 |
| 3. Nam Maa and Nam Chang Forest | 54,453 | 2.13 |
| 4. Doi Khamin & Nam Yaeng Forest | 6,392 | 0.25 |
| 5. Huai Sak & Right Bank of Nam Kok Forest | 131,038 | 5.12 |
| 6. Doi Luang, Nam Yao & Nam Sor Forest | 132,038 | 5.19 |
| 7. Khun Huai Ngiw, Chiang Kian & Khun Huai Pong Forest | 298,828 | 11.67 |
| 8. Right Bank of Mae Ing & Mae Hgao Forest | 64,350 | 2.52 |
| 9. Huai Pa Daeng, Huai Pa Tann & Huai Krai Forest | 124,743 | 4.87 |
| 10. Left Bank of Nam Ngao Forest | 106,250 | 4.15 |
| 11. Doi Taa & Doi Bo Som Forest | 20,000 | 0.78 |
| 12. Doi Pui Forest | 28,008 | 1.09 |
| 13. Huai Ton Yaang & Huai Kaew Forest | 50,000 | 1.95 |
| 14. Right Bank of Mae Lao, Mae Saan & Mai Chai Forest | 170,625 | 6.66 |
| 15. Mae Pum & Mae Poong Forest | 169,087 | 6.60 |
| 16. Mae Pum & Dong Pradu Forest | 31,000 | 1.21 |
| 17. Huai Bong Po, Huai Kian Forest | 34,737 | 1.36 |
| 18. Mae Hong Po, Huai Kaew & Left Bank of Mae Ing Forest | 75,450 | 2.95 |
| 19. Mae Loi Rai, Sak Lo & Nam Poong Forest | 93,750 | 3.66 |
| 20. Doi Bo Som & doi Pong Nok Forest | 28,125 | 1.10 |
| 21. Doi Bo som & Doi Pong Nok Forest | 269,022 | 10.51 |
| 22. Nam Van & Huai Krai Forest | 86,250 | 3.37 |
| 23. Mae Choon Forest | 104,063 | 4.06 |
| 24. Dok Khem & Right Bank of Ing Forest | 98,750 | 3.86 |
| 25. Mae Yom Forest | 9,802 | 0.38 |
| 26. Mae Rong Sui Forest | 71,614 | 2.80 |
| 27. Mae Tum Forest | 99,551 | 3.89 |
| 28. Mae Tum and Mae Na Rua Forest | 148,407 | 5.80 |
| 29. Doi Muan Poo Mao & Muan Hin Yao Forest | 3,502 | 0.14 |
| Total | 2,560,281 | 100.00 |

Table 2.3.2.2-4 The National Forest Reserves of Nan Basin And Some Parts of Adjacent basin

| Province | Conservation Zone | | Economic Zone | | Area Suitable for Agriculture | | Total | |
|---------------|-------------------|-------|---------------|-------|-------------------------------|------|------------|--------|
| | Area(rais) | % | Area(rais) | % | Area(rais) | % | Area(rais) | % |
| Nan | 5,998,450 | 87.50 | 812,133 | 11.88 | 25,150 | 0.37 | 6,835,733 | 100.00 |
| Uttaradit | 2,681,325 | 81.19 | 621,250 | 18.81 | 0 | 0.00 | 3,302,575 | 100.00 |
| Pitsanulod | 1,953,492 | 61.40 | 1,228,053 | 38.6 | 0 | 0.00 | 3,181,545 | 100.00 |
| Pichit | 0 | 0.00 | 137,235 | 95.49 | 6,475 | 4.51 | 143,710 | 100.00 |
| Petchabun | 2,613,740 | 56.49 | 1,749,018 | 37.80 | 263,875 | 5.70 | 4,626,633 | 100.00 |
| Nakhorn Sawan | 460,175 | 9.95 | 508,550 | 10.99 | 257,175 | 5.56 | 1,225,900 | 100.00 |
| Total | 13,707,182 | 70.96 | 5,056,239 | 26.18 | 552,675 | 2.86 | 19,316,096 | 100.00 |

Source ; Master Plan and Implementation Plan for Environment and Watershed Rehabilitation , Environmental Policy and Planning Office , 1995

Table 2.3.2.2-5 Forest Classification of Nan Watershed above Sirikit Dam

| Land Use | Area ^{1/} (Sq.Km) | Percentage of Watershed area |
|--|-------------------------------|---------------------------------|
| 1. Forest Area | 11,033 | 82.89 |
| 1.1 Hill Evergreen Forest | 2,338 | 17.52 |
| 1.2 Dry Evergreen Forest | 3,746 | 28.06 |
| 1.3 Mixed Deciduous Forest | 477 | 3.57 |
| 1.4 Dry Dipterocarps Forest | 230 | 1.72 |
| 1.5 Degraded Forest | 4,275 | 32.02 |
| 2. Agricultural Land and Settlement area | 2,024 | 15.16 |
| 3. Water Body | 260 | 1.95 |
| Total | 13,350 | 100.00 |

Source : Chulalongkorn Social Reserch Institute, 1987

Remark : ^{1/} Remote Sesging (December, 1974)

(2) Forest Type

The main Forest Types in this region are as follows ;

(Hill Evergreen Forest)

; dominates the high mountain above 1,000 m above msl.

(Pine Forest)

; Usually found between 200-1,300 m above msl. with two native pines, *Pinus kesiya* and *Pinus merkusi*.

(Moist Evergreen Forest)

; Usually found along the river banks and the gorges with high soil moisture.

(Mixed Deciduous Forest)

; The most valuable forest in this region because of the richness of high quality timber species, such as Teak, Daeng, Prude, Makamong, etc.

(Dry Dipterocarps Forest)

; Common in the sandy and lateritic soils where many valuable timber species such as Teng, Rang, Hiang, Pluang etc are present .

a) The Kok basin

The main forest type in this basin is of Evergreen forest , because most of mountainous area is higher than 1000m above msl .

b) The Ing basin

The forests spread in the middle area and on the border of this basin .

The main forest type at the middle area of the basin is Deciduous forest . The main forest type on the border with the Nan basin is Evergreen forest .

c) The Nan basin

Most of the upper Nan basin is a mountainous area . The main forest type is Evergreen forest in western and eastern part of the upper Nan basin , and Deciduous forest in the northern part of the upper Nan basin .

(3) Forest tree species

The main Forest tree species in this region are as follows ;

Teak (*Tectona grandis*), Ta Kian (*Hopea odovata*), Teng (*Shovea obtuse*), Rang (*Shovea siamensis*), Prudu (*Pterocarpus macrocarpus*), Daeng (*Xylia xylocarpa*), Hiang (*Dipterocarpus obtusifolius*), Taback (*Lagerstroemia calyculata*), Yom Hin (*Chukrasia velutina*), Ked Dum (*Dalbergia assamica*), Ked Daeng (*Dalbergia spp*), Ma Ka Mong (*Azelia xylocarpa*).

Teak is the most important species in the Thailand for forest production ; material and furniture .
Teng , Rang and Ma Ka Mong are also important species for forest production .

Teng and Rang are main species of the Deciduous Dipterocarpus Forests .

(4) Forest products

The Forest product from the forest in this region are as follows ;

honey , honey wax , oak bark , medicinal plants , charcoal , fuelwood , and orchids , etc .

The Northern region is expected to be an important area for production of variable forest products because of moderate rain and warm climate.

These forest products must be more valuable for the local promotion as forest conservation be managed effectively . It is also important that consideration and creation to the new method for improvement of value added on the forest product .

(5) Deforestation

a) Deforested areas

The forest in Kok , Ing , Nan basins have been continuously encroached . Most of the forest areas are secondary/degraded forest and the virgin forest areas appear to be rare . Therefore, the following areas are deforested .

- most of the forests at the foot of the Hill suitable for cultivation have been changed to fields.
- most of the forests at the foot of the Hill not suitable for cultivation have been changed to bush, for instance, degraded Evergreen Forest to bamboo .
- Some areas where the impact on the forest was significant , have been not yet recovered to the forest and have been still grass land .

For these areas , the protection program for soil erosion has to be implemented as soon as possible. These areas spread to the boundary area between the head of Lao watershed and the head of Yot watershed , about 600m - 800m above the sea level over 1sq.km .

The cause of Deforestation are as follows ;

- Land acquisition and slash-and-burning
- Fire , especially Deciduous forest in the dry season

b) Problems due to deforestation

The problems due to deforestation are as follows (ESCAP , 1991) ;

The deforestation has caused siltation because of increased soil erosion and has deteriorated the water supply situation with the decrease of forest, leading to extremes of drought and flooding . In addition to the decrease of forest cover, replacement of forest with agricultural crops has led to further environmental problems, with increased use of fertilizers and pesticides required to maintain soil productivity .

The problem of soil erosion is particularly severe in the Northern region, where deforestation on steep sided slopes gives rise to a rapid and severe loss of topsoil. For example, studies in the upper Chao

Phaya catchment show that a sediment yield from a full cover is evergreen forest of 40tonnes/km²/year , compared to 1,114tonns/km²/year from an area settled by hill tribes .

According to "SPC/UNDP/FAO , 1989 " , the problem of soil erosion in Chiang Rai and Phayao provinces is probably more serious than in the Northeastern region, because of upland cropping . In these provinces, cultivation of maize on steep slopes is badly damaging ecological stability and may be affecting water availability in the lowland . Such processes have naturally an adverse effect on fisheries . This is most pronounced in the Northeastern region where many traditional village fishponds have silted up over time to deprive local populations of their traditional protein sources .

Sedimentation has also been related to reservoir construction . In the Northeastern region, deforestation have led to increased erosion in the reservoir catchment area , leading to a shortening of the lifetime of the reservoir .

The preliminary analysis of sedimentation in Kok , Ing and Nan basin is shown at table 2.3.2.2-7. The average erosion rate in Kok basin is 0.100 - 0.104 mm./year , in the Ing basin 0.100 - 0.102 mm./year , in the Nan basin is 0.088 - 0.219 mm./year .

Table 2.3.2.2-6 Preliminary Analysis of Sedimentation in Kok , Ing , Nan Basin

| Location point | River Basin | Area sq.km. | Average suspende d load Ton/year | Bed load Ton/year | Total Ton/year | Total cu.m./year | Average erosion rate mm./year |
|---|--------------|----------------|---|----------------------|-------------------|---------------------|--|
| Intake of diversion canal alignment B | Kok River | 6,220.00 | 464,300 | 139,290 | 603,590 | 622,899 | 0.100 |
| Intake of diversion canal alignment A | Kok River | 9,430.00 | 700,699 | 210,210 | 910,909 | 940,051 | 0.100 |
| Lao basin | Lao River | 3,180.00 | 239,133 | 71,740 | 310,873 | 320,819 | 0.101 |
| Nong Luang | Lao River | 138.00 | 10,742 | 3,223 | 13,964 | 14,411 | 0.104 |
| Amphoe Thoeng's bridge | Ing River | 5,370.00 | 401,499 | 120,450 | 521,948 | 538,647 | 0.100 |
| Ing river at weir site | Ing River | 3,993.00 | 299,519 | 89,856 | 389,375 | 401,832 | 0.101 |
| Lao basin | Lao River | 1,377.00 | 104,507 | 31,352 | 135,859 | 140,205 | 0.102 |
| Downstream of diversion tunnel | Huai Yot | 32.26 | 5,278 | 1,583 | 6,861 | 7,080 | 0.219 |
| Conjunction of Huai Yot & Huai Nam Yao | Huai Yot | 120.16 | 16,012 | 4,804 | 20,815 | 21,481 | 0.179 |
| Conjunction of Huai Nam Yao & Huai Yot | Huai Nam Yao | 254.09 | 30,125 | 9,038 | 39,163 | 40,416 | 0.159 |
| Nam Yao dam site | Huai Nam Yao | 372.00 | 41,559 | 12,468 | 54,026 | 55,755 | 0.150 |
| Huai Nam Yao | Huai Nam Yao | 521.70 | 55,287 | 16,586 | 71,874 | 74,173 | 0.142 |
| Station N51 | Huai Nam Yao | 774.00 | 77,130 | 23,139 | 100,268 | 103,476 | 0.134 |
| Conjunction of Huai Nam Yao & Nan River | Huai Nam Yao | 882.79 | 86,184 | 25,855 | 112,039 | 115,624 | 0.131 |
| Station N17 | Nan River | 1,156.00 | 108,208 | 32,462 | 140,671 | 145,171 | 0.126 |
| Conjunction of Nan River & Huai Nam Yao | Nan River | 2,214.24 | 187,281 | 56,184 | 243,465 | 251,254 | 0.113 |
| Conjunction of Nan River & Nam Yao | Nan River | 3,687.96 | 288,065 | 86,420 | 374,485 | 386,465 | 0.105 |
| Station N49 | Nam Yao | 155.00 | 19,850 | 5,955 | 25,805 | 26,631 | 0.172 |
| Conjunction of Nam Yao & Nan River | Nam Yao | 598.35 | 62,069 | 18,621 | 80,690 | 83,271 | 0.139 |

| | | | | | | | |
|--------------------------------------|-----------|----------|---------|---------|---------|-----------|-------|
| Station N1 | Nan River | 4,609.00 | 347,702 | 104,311 | 452,013 | 466,474 | 0.101 |
| Conjunction of Nan River & Nam Samun | Nan River | 4,733.83 | 355,634 | 106,690 | 462,324 | 477,114 | 0.101 |
| Conjunction of Nam Samun & Nan River | Nam Samun | 590.93 | 61,419 | 17,426 | 79,844 | 82,399 | 0.139 |
| Conjunction of Nam Sa & Nan River | Nam Sa | 749.18 | 75,037 | 22,511 | 97,548 | 100,669 | 0.134 |
| Conjunction of Nan River & Nam Wa | Nan River | 6,533.83 | 466,794 | 140,038 | 606,832 | 626,246 | 0.096 |
| Station N42 | Nam Wa | 2,107.00 | 179,596 | 53,879 | 233,475 | 240,944 | 0.114 |
| Conjunction of Nam Wa & Nan River | Nam Wa | 2,153.57 | 182,940 | 54,882 | 237,823 | 245,431 | 0.114 |
| Conjunction of Nan River & Nam Hang | Nan River | 8,912.40 | 606,623 | 181,987 | 786,610 | 813,839 | 0.091 |
| Station N63 | Nam Hang | 788.00 | 78,305 | 23,492 | 101,797 | 105,054 | 0.133 |
| Conjunction of Nam Hang & Nan River | Nam Hang | 1,030.30 | 98,189 | 29,457 | 127,646 | 131,730 | 0.128 |
| Station N35 | Nan River | 10,335.0 | 687,387 | 206,216 | 893,603 | 922,191 | 0.089 |
| Downstream of Sinkit Dam | Nan River | 11,600.9 | 757,801 | 227,340 | 985,142 | 1,016,658 | 0.088 |

(6) National Forest Reserves and Watershed Management

National Forest Reserves

In the Kok , Ing , Nan basins, there are National Forest Reserves , National Parks, Wildlife Sanctuaries and Areas classified as watershed classification 1A areas shown at Table 2.3.2.2-7 and in Database map.

Table 2.3.2.2-7 Constituted area in the Kok , Ing , Nan basin

| Basin | Kok Basin | Ing Basin | Nan Basin |
|--|--|--|--|
| National Forest Reserve | - 18 forests - 2.2 million rai - 69 % of the basin | - 29 forests - 2.6 million rai - 55 % of the basin | - 66 forests - 19.3 million rai - 90 % of the basin |
| Most of the forest areas are constituted for the conservation area . | | | |
| National Park | - 2 parks ; Doi Luang (e*) ; Khun Ja (u**) | - 1 park - Doi Phu Sang (u**) | - 6 parks ; Doi Phu Ka (u**) ; Chat Ta Kan (e*) ; Phu Hin Rong Ka (e*) ; Na Haeo (e*) ; Thung Sa Lang Wang (e*) ; Sri Nan (u**) |
| Wildlife Sanctuary | - none | - 1 Sanctuary ; Wang Lo (e**) | - 1 Sanctuary ; Phu Miang |
| Watershed classification | The head watershed areas in most mountaineous areas are constituted for A1 . | | |

- e* ; existing , u** ; under establishment

- Source ; The office of Socio and Economic Development Board (1995)

- Forest areas are classified into 3 zones

; Conservation Forest (C)

; Economic Forest (E)

; Land Suitable for Agriculture (A)

Watershed Classification

Watershed Classification Project was accomplished by the Thai government to formulate land-use plans for the conservation of natural resources, particular water resources from the viewpoint of their sustainable use. In October 1979, a Committee on Watershed Classification was officially formed. The National Economic and Social Development Board (NESDB) provided fund for Kasetsart University through the Office of Environmental Policy and Planning (formerly Office of the National Environment Board) for conducting the project. The classification takes into consideration physical characteristics, including stable features such as landform, geology, soil, elevation and slope. Forest cover and environmental features of landscape units, which are less stable and interact with climatic trends and human uses are also considered. It was firstly enforced for the Ping-Wang River Basin in 1985, and finally finished in 1995 as follows;

Cabinet Resolution on the Watershed Classification

| Bsin | Date |
|---|--------------|
| PING-WANG | My 28, 1985 |
| YOM-NAN | Oct 21, 1986 |
| MUN-CHI | Jly 12, 1988 |
| SOUTHERN REGION | Nov 7, 1989 |
| EASTERN REGION | Nov 7, 1989 |
| WESTERN, CENTRAL, INTER-TRIBUTARIES, PASAK | Feb 21, 1995 |

Brief descriptions of Watershed Classification (WSC) are as follows;

WSC 1: Protected or Conservation Forest and Headwater Source :

This class is divided into 2 sub-classes;

WSC 1A: includes areas of protected forest and headwater source area, usually located at high elevation on very steep slopes. These areas must be protected permanently.

WSC 1B: denotes similar physical and environmental features as WSC 1A, but some parts of this area have already been cleared for agricultural use by villagers. These areas require special soil conservation and protection measures and should be reforested.

WSC 2: **Commercial Forest:**
This class comprises areas of protected and/or commercial (mainly commercial) forest. These areas are mostly located at higher elevation on steep slopes. Landform is less erosive than WSC 1. Areas may be used for agroforestry.

WSC 3: **Fruit-tree Plantation:**
This class covers upland areas with steep slopes and less erosive landform. These areas are usually used for fruit tree plantation or certain agriculture crops, and may be used for commercial forest, agroforestry, and grazing. However, soil conservation measures are required for their uses.

WSC 4: **Upland farming:**
This class has land with gentle slopes covered with crops, fruit trees, and grazing, but it requires soil conservation measures.

WSC 5: **Lowland Farming:**
This class lies between gentle slopes and flat areas, used for paddy field or other agricultural uses with few restriction.

2.3.3 Wildlife

(1) Wildlife

According to the TEAM J/V Study (RID Study), 210 species of wildlife were confirmed during the survey period. Out of these, 44 species will be adversely affected by the project implementation. The names of these wildlife are shown in Table 2.3.3.1. The number of species to be affected will be larger in diversion tunnel area than in diversion canal area, since diversion tunnel passes under forest where many wildlife live.

The survey did not specify any rare or endangered species in the project area. The TEAM J/V Study (RID Study) reports that "Big-headed turtle" is classified as in "vulnerable status" according to the IUCN Standard, 1990. Big-headed turtles live in small creeks with relatively low flow and are found throughout Northern Thailand. A certain level of impacts will be felt by encroachment of workers into their habitat during construction and an increase in river flow in the Yod River disturbing their habitat and food resources. Change in the status of other 43 species by the project needs further analysis.

(2) Division of Habitat

The constructed canal will divide the wildlife habitat, making it difficult for mammals and reptiles to cross the canal. The impact of the project, however, is judged to be minimal considering high adaptability of wildlife found in the project area, mostly small ones, and short radius of their activity area, estimated to be less than 50 meters. No small animals are likely to cross the canal.

(3) Wetland

The planned canal routes pass not only paddy field but also wetland where weeds grow. Wetland is the feeding ground for birds and other wildlife as well as breeding and living ground. Food chain is maintained well. Birds appearing in wet lands are mostly seasonal water birds. They fly to Thailand during autumn or winter season. These waterbirds are winter visitor and divided into passage migrant and breeding visitor.

Wetland is an important area for birds and other wildlife as well as for human activities such as rice cultivation and fishing. Wetlands, therefore, should be presented as an area where wildlife and human activities can coexist. Non-hunting area, for example, will provide fishing and bird watching ground for visitors. Appropriate measures need to be taken to realize the coexistence of wildlife and human activities in the event that canals pass through wetland.

Table 2.3.3.1 Wildlife Observed in Preliminary Survey

| Class | Common names and Scientific names | Note |
|------------|--|---------------------------------|
| Amphibian | Common grown (<i>Rana nigrovittata</i>) | C Mi |
| 4 Species | Aquatic frog (<i>Rana Kuhlic</i>) | C Mi |
| | Common stream frog (<i>Rana pileate</i>) | C Mi |
| | Truncate snout(<i>Glyphoglossus molossus</i>) | C Mi |
| Reptilia | Big-headed turtle (<i>Ptylasteron megasephalum</i>) | Δ |
| 4 Species | Elogate yurthouse (<i>Indotestudo elongata</i>) | Δ Mi |
| | Oreng-e-winged flying lizard (<i>Dorco maculatus</i>) | Δ Mi |
| | Forest lizard (<i>Calotesemma</i>) | Δ Mi |
| Aves | Crested serpent eagle (<i>Spilornis cheela</i>) | C Mi |
| 26 Species | Crested gosshawk(<i>Accipiter trivigatus</i>) | C Mi |
| | Collar falconet (<i>Microhierax caerulecens</i>) | C Mo |
| | Red jungle fowl(<i>Gallus gallus</i>) | Mi |
| | Red breasted parakeet(<i>Psitacula alexandri</i>) | Δ Mo |
| | Vernal hanging lorikeet(<i>Lariculus vernalis</i>) | Mo |
| | Brown-fish owl(<i>Ketupa zeylonensis</i>) | Mo |
| | Green-eared barbet(<i>Megalaima faiostrica</i>) | C Mo |
| | Dollarbird (<i>Eurystomus orientalis</i>) | Δ Mo (winter visitor) |
| | Great barbet(<i>Mygalaima virens</i>) | Δ Mo |
| | Spekled pinculet(<i>Picumnus innominatus</i>) | C Mo |
| | Large cuckoo-shrike(<i>Coracina macet</i>) | C Mi |
| | Bar-winged Flycatchert-shrike(<i>Hemipus picatus</i>) | C Mi |
| | Scarlet Minivet(<i>Pericrocotus flammeus</i>) | C Mi |
| | Golden fronted leafbird(<i>Chloropsis aurifrons</i>) | C Mi |
| | Blue-winged leafbird(<i>Chloropsis cochinensis</i>) | C Mi |
| | Velvet-fronted nuthatch(<i>Sitta frontalis</i>) | C Mi |
| | Long-tailed sibia(<i>Heteroohasia picaoides</i>) | C Mi |
| | Black-headed bulbul(<i>Pycnontos atriceps</i>) | C Mi |
| | White-crested laughingthrush (<i>Gerrulax lencolophus</i>) | C Mi |
| | White -rumped shama(<i>Copsychus malabaricus</i>) | C Mi (passage in winter) |
| | Gray-headed fly catcher(<i>Culcipapa ceylonensis</i>) | C Mi |
| | Tickell's blue flycatcher(<i>Cyornis tickelliae</i>) | C Mi (winter visitor) |
| | Verditer flycatcher (<i>Eumyias thalassina</i>) | C Mi |
| | Black-naped monarch(<i>Hypothumis azurea</i>) | C Δ Mo(much reduced by capture) |
| | Hill Myna(<i>Gracula religiosa</i>) | |

| Class | Common names and Scientific names | Note |
|-----------------------|---|----------------------|
| Mamalia 10 Species | Siamese hare (<i>Lepus peguensis</i>) | C Mi |
| | Noisy rat (<i>Leopoldamys sabanus</i>) | C Mi |
| | Malayan porcupine (<i>Hystrix brachyura</i>) | C Mi (not evidenced) |
| | Bamboo rat (<i>Canomys badius</i>) | C Mi |
| | Large bamboo rat (<i>Rhizomys sumatrensis</i>) | C Mi |
| | Common-palm civet (<i>Paradoxurus hermaphroditus</i>) | C Mi |
| | Small Indian civet (<i>Viverricula malaccensis</i>) | Δ Mi |
| | Large Indian civet (<i>Viverra zibetha</i>) | Δ Mi |
| | Common wild pig (<i>Sus scrofa</i>) | C Mi |
| | Common barking deer (<i>Mutiacus muntjak</i>) | C Mi |

Note C: Common species
Δ: species to be protected
Mo: Modelate Affected
Mi: Minor Impact

(4) Conservation areas of Wildlife

In 1962, the first national park in Thailand "Khao Yai" was established. Since then, 77 national parks, 36 wildlife sanctuaries and 40 non-hunting areas have been created. Most non-hunting areas are wetlands, where fishing and water weeds harvesting are made by local people.

The total area of all these areas covers about 13 percent of the total land area of Thailand. Out of 111 national parks and wildlife sanctuaries, forty areas are small, whereas 20 areas are over 1,000 square kilometers.

Table 2.3.3.2 shows national parks and wildlife sanctuaries in the Kok-Ing-Nang watershed area. Their location is shown in Database Map.

Table 2.3.3.2
Wildlife Sanctuary, National Park in KOK-ING-NAN Watershed

| Watershed | Wildlife Sanctuary | | National Park | |
|-----------|--------------------|---------------------|--|--|
| | Name | Status | Name | Status |
| 1. Kok | - | - | 1. Doi Luang 2. Khun Ja | Existing Under establishment |
| 2. Ing | 1. Wang Lo | Under establishment | 1. Phu Sang | Under establishment |
| 3. Nan | 1. Phu Miang | existing | 1. Doi Phu Ka 2. Chat Ta Kan 3. Phu Hin Pong Ka 4. Na Haeo 5. Thung Sa Lang Wang 6. Sri Nan | Under establishment existing existing existing existing under establishment |

The following sites may be more or less, affected by the Project in the course of project implementation, so that more precise survey will be required to be made in the next detailed study.

- Phu Sang National Park

A project tunnel will pass under Phu Sang National Park with an area of 285 km² in Chang Kham (Phayao Province) and Thoeng (Chiang Rai Province) districts. Though the national park status was declared in September, 1995, official designation has not been made yet. The Phu Sang National Park shares 30 km of border with Laos in rugged mountainous area.

• Nongbongkai Wildlife Restriction Area(NWRA) (Chiang San Basin)

- Location : 20° 10' - 20° 18' N, 99° 57'-100° 11'E; The area extends from the Golden Triangle to 10 km north of Chiang Saen as shown in Database map.
- Area : 10,000 ha
- Altitude : 350 ~ 400m
- Wetland type : rivers, streams, oxbow lakes, river line marshes, freshwater lakes, freshwater ponds, swamps, seasonally flooded grassland, rice paddies.
- Climate condition : Tropical monsoonal climate
- Principal vegetation : Patches of *Sacharum arundinaceum* along rivers. Many areas along the river banks are overgrown with dense scrub.
- Land tenure : The areas of open water are state owned.
- Conservation measures taken : Nong Bong Khai was declared as a non hunting area in 1985.
- Land use : fishing, irrigation corn cultivation.
- Possible changes in land use : Increased tourism, Cultivation of cash crops such as coffee.

• Wetland Nong Luang

- Location : 19° 47'-19° 52'N, 99° 57'E; 17km southeast of Chiang Rai town as shown in Database map.
- Area : 2,000ha
- Altitude : 400m
- Wetland type : rivers, streams, oxbow lakes, riverline marshes, freshwater ponds, swamps, seasonally flooded grassland, savanna, rice paddies.
- Climatic conditions : Tropical monsoonal climate.
- Principal vegetation : Extensive beds of *Saccharum arundinaceum*. Floating vegetation includes *Eichhornia crassipes*.
- Land tenure : Marshes and openwater areas are under public ownership.
- Conservation measures taken : none
- Conservation measures proposed : The establish went of a non-hunting Area is proposed.
- Land use : Fishing, cattle grazing and cultivation of lotus and rice
- Research and facilities : A fisheries station of the Inland Fisheries Division, Department of Fisheries, is situated at Nong Luang.

2.3.4 Socio-economic Environment

2.3.4.1 Socio Environment

(1) Introduction

The Eighth Economic and Social Development Master Plan Study for Thailand speaks a good deal about social values and the need to maintain them in the face of pending economic development. This report on social policy concerns addresses how social values in the Chiang Rai, Phayao, and Nan provinces of Thailand may be altered in the future as a result of planned economic development activities. It does not necessarily address concerns about the current social structure in this region.

One of the first issues addressed in this report has to do with the scope and content of social policy. Considered in broad terms, social policy would be seen to encompass the sum of activities which impact on individual well-being. In this manner, economic, educational, legal, and political systems would all be seen as subsets of the broader social system. A more restrictive definition would define social policy, in bureaucratic terms, as what social policy makers do. Under this approach, social policy would be defined as those activities engaged in by Ministries of Public Health, Labor and Social Welfare, Education, and so on. Clearly a balance must be found between inclusiveness and practicability.

Social policy is the amalgam of programs designed to internalize what are perceived to be external or social costs. The existence of poverty or illiteracy is generally felt to impact negatively on the collective well-being since the associated costs extend beyond the impoverished or the undereducated to society-at-large. In structuring income-transfer or remedial-education programs, the intent is to minimize these social costs through pooling, to transfer costs to public budgets rather than leaving a perceived unfair burden to be concentrated among less fortunate individuals. Basically, social policy comprises what might be called the "human services", health, housing, day care, nutrition, income support, counseling. It is the individual, rather than the system within which that individual operates, which is the focus of social policy. While economic policy is largely concerned with the production of goods or services, social policy is largely concerned with providing equitable access to goods and services. Although the primary focus of social policy is distribution, as opposed to allocation, most programs in practice mix more than one function. Human capital investments such as education and health are made partially to improve the distribution of income opportunities but they are also undertaken to increase economic growth prospects.

One possible distinction between a "standard" economic development plan and one which is "socially-oriented" has to do with objectives. Under the "standard" approach, a region would be developed primarily in an effort to maximize potential national economic growth rates. Here, targeted regions would largely be seen as agents of nation-wide growth, and investment resources would be allocated on the basis of expected contribution to GDP acceleration (comparative regional advantage). With a "socially-oriented" development plan, the objective would be to raise the living standards of residents within the target area (Gross Regional Product), with little attention paid to possible spillovers to other regions of the country. Moreover, a "socially-oriented" development plan would address dual objectives: incomes, and other social amenities (family values, health and income distribution targets, etc.). The remainder of this volume emphasizes the planning objective of maximizing income opportunities for residents of the project area, subject to constraints on other social objectives and concerns.

(2) Existing Social Conditions in the project area

Demography

The following Table 2.3.4.1 provides information on the population of the project area for 1990, and 1994. The data are derived from Human Resources Planning Division, National Economic and Social Development Board (HRPD, NESDB) statistics. The total population of the project area was 2.0 million in 1994. The population in the region has been growing more slowly than that in other areas of Thailand outside of Bangkok (0.625% versus 1.1%), and lower than the average rate of increase for the Kingdom as a whole (1.225%). The primary reason for these differential growth rates has been migration: the project area has been a net population loser and Bangkok, which grew at 2.125% per annum from 1990 - 1994, was a net population gainer over the years covered. Differential migration propensities are due primarily to perceptions of differential employment and earning opportunities, as well as to differentials in such amenities as schools.

Table 2.3.4.1 Population in the Project Area, whole Kingdom, Bangkok, and Outside Bangkok 1990, and 1994 (in thousand)

| | Chiang Rai | Phayao | Nan | Project area | Whole Kingdom | Bangkok | Non-Bangkok |
|--------------------------|------------|--------|-----|--------------|---------------|---------|-------------|
| 1990 Population | 1,071 | 483 | 424 | 1,978 | 55,839 | 6,198 | 49,641 |
| 1994 Population | 1,099 | 496 | 435 | 2,030 | 58,713 | 6,778 | 51,935 |
| Growth Rates 1990 - 1994 | | | | 0.63 | 1.23 | 2.13 | 1.10 |

Source: HUMAN RESOURCES PLANNING DIVISION NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD, March 1995

Table 2.3.4.2 provides estimates of population growth in the project area and in other areas of Thailand up to the year 2005. The data reflect trend rates of increase as estimated by HRPD, NESDB. Provincial-level projections are available only up to the year 2005, so trend rates had to be extrapolated one year forward. Naturally, these trend rates assume no increase in the relative economic growth of the project area.

Table 2.3.4.2 Population Projection for Project Area (2000 - 2005)

| Year | Chiang Rai | Phayao | Nan | Project area | Whole Kingdom | Bangkok (BMA) | Non- Bangkok |
|---------------------------|------------|---------|---------|--------------|---------------|---------------|--------------|
| 2000 | 1,117,378 | 504,858 | 442,873 | 2,065,109 | 62,405,000 | 7,637,000 | 54,768,000 |
| 2001 | 1,118,120 | 505,255 | 443,221 | 2,066,596 | 62,914,000 | 7,775,000 | 55,139,000 |
| 2002 | 1,119,021 | 505,724 | 443,633 | 2,068,378 | 63,430,000 | 7,917,000 | 55,513,000 |
| 2003 | 1,119,894 | 506,181 | 444,033 | 2,070,108 | 63,959,000 | 8,066,000 | 55,893,000 |
| 2004 | 1,120,022 | 506,239 | 444,084 | 2,070,345 | 64,492,000 | 8,218,000 | 56,274,000 |
| 2005 | 1,120,474 | 506,443 | 444,263 | 2,071,180 | 65,034,000 | 8,375,000 | 56,659,000 |
| Growth Rate (% per annum) | 0.056 | 0.062 | 0.062 | 0.058 | 0.808 | 1.762 | 0.666 |

Source: HUMAN RESOURCES PLANNING DIVISION NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD, March 1995

Table 2.3.4.3 shows the year 2011 population projection disaggregated by gender, age and province. The projections indicate an aging of the population; those over 60 years accounted for 5.7% of the total in 1990 in the project area, but are expected to increase to 12.7% by 2005 in the project area.

Table 2.3.4.3 also shows the expected population distribution by province for the year 2011, under the assumption of continuation of current trends. Indeed, many of the proposals could not be implemented unless population (labor force) and productivity are increased.

Ethnicity

Chiang Rai, Phayao, and Nan provinces are among a few of Thailand's 76 provinces that have a large variety of different ethnic groups. In addition to the Lanna native group there are more than 8 minor groups and many who have migrated from different areas including ethnic Chinese, Burmese, Laotians, Indians, Japanese, and Westerners who work and live in the project area. The Thai Yuan group is credited with building the first cities and developing the civilization of Lanna. They call themselves "Khon Muang," and they demonstrate the major culture of the region and have mixed together with other groups.

The 8 primary minority groups include the Mong, Yao or Mien, Lisu, Lahu, Akha, Karen, Lua, and Kamu who all live in the high elevations. In case of Chiang Rai province, according to 1994 statistics, there is a total hill tribe (minority) population of 147,322 or 11.23% of the total provincial population.

Table 2.3.4.3 Population Projections By Gender, Age, 2011

| | Chiang Rai | Phayao | Nan | Project area | Whole Kingdom | Bangkok (BMA) | Non-Bangkok |
|--------------------|------------------|----------------|----------------|------------------|-------------------|------------------|-------------------|
| Females | | | | | | | |
| 0-14 | 114,695 | 50,342 | 48,723 | 213,760 | 7,311,000 | 809,117 | 6,501,883 |
| 15-24 | 90,549 | 40,019 | 35,820 | 166,388 | 5,262,000 | 830,809 | 4,431,191 |
| 25-29 | 45,938 | 19,577 | 17,611 | 83,126 | 2,740,000 | 520,611 | 2,219,389 |
| 30-44 | 126,111 | 57,279 | 46,546 | 229,936 | 8,015,000 | 1,259,228 | 6,755,772 |
| 45-59 | 99,140 | 48,052 | 40,791 | 187,983 | 6,396,000 | 925,002 | 5,470,998 |
| 60-64 | 20,627 | 9,698 | 7,413 | 37,738 | 1,390,000 | 187,637 | 1,202,363 |
| 65+ | 42,582 | 20,265 | 19,090 | 81,937 | 2,897,000 | 366,597 | 2,530,403 |
| Total | 539,642 | 245,232 | 215,994 | 1,000,868 | 34,011,000 | 4,899,000 | 29,112,000 |
| Male | | | | | | | |
| 0-14 | 114,848 | 52,110 | 49,796 | 216,754 | 7,552,000 | 761,000 | 6,791,000 |
| 15-24 | 98,626 | 44,672 | 38,472 | 181,770 | 5,382,000 | 683,000 | 4,699,000 |
| 25-29 | 53,794 | 24,315 | 20,143 | 98,252 | 2,817,000 | 432,000 | 2,385,000 |
| 30-44 | 141,953 | 64,325 | 52,544 | 258,822 | 8,270,000 | 1,239,000 | 7,031,000 |
| 45-59 | 102,727 | 47,987 | 39,963 | 190,677 | 6,109,000 | 863,000 | 5,246,000 |
| 60-64 | 20,886 | 9,305 | 6,896 | 37,087 | 1,250,000 | 153,000 | 1,097,000 |
| 65+ | 41,849 | 18,197 | 16,649 | 76,695 | 2,321,000 | 257,000 | 2,064,000 |
| Total | 574,683 | 260,911 | 224,463 | 1,060,057 | 33,701,000 | 4,388,000 | 29,313,000 |
| Total | | | | | | | |
| 0-14 | 229,543 | 102,452 | 98,519 | 430,514 | 14,863,000 | 1,570,117 | 13,292,883 |
| 15-24 | 189,175 | 84,691 | 74,292 | 348,158 | 10,644,000 | 1,513,809 | 9,130,191 |
| 25-29 | 99,732 | 43,892 | 37,754 | 181,378 | 5,557,000 | 952,611 | 4,604,389 |
| 30-44 | 268,064 | 121,604 | 99,090 | 488,758 | 16,285,000 | 2,498,228 | 13,786,389 |
| 45-59 | 201,867 | 96,039 | 40,791 | 338,697 | 12,505,000 | 1,788,002 | 10,716,998 |
| 60-64 | 41,513 | 19,003 | 14,309 | 74,825 | 2,640,000 | 340,637 | 2,299,363 |
| 65+ | 84,431 | 38,462 | 35,739 | 158,632 | 5,218,000 | 623,597 | 4,594,403 |
| Grand total | 1,114,325 | 506,143 | 215,994 | 1,836,462 | 67,712,000 | 9,287,000 | 58,425,000 |

Source: Human Resources Planning Division, National Economic and Social Development Board,

Population Projections for Thailand, 1990 - 2020, March 1995

This population includes 27,870 families living in 517 different villages, the majority of which cultivate high land. At 43,414 people, the Akha group has the largest minority population, followed by the Lahu with 34,125 people. Currently only 35% of the hill tribe population has obtained Thai nationality, and each group has its own language and culture. This makes the project area one of great ethnic diversity, and a very interesting place to visit. Figure 7.2 of "Database map" details the distribution of major tribal village settlements in Thailand.

Other Statistical Indicators

By most statistical indicators, the project area ranks in the bottom half compared with other areas in Thailand, but exhibits few extreme scores. Table 2.3.4.4 shows that Gross Provincial Product (GPP) per capita rank between 52nd and 56th among Thailand's 72 provinces. The level of Chiang Rai, Phayao and Nan of per capita GPP shows the lower level. (Figure 7.1 of "Database map")

Maximum temperatures in the project area (Chiang Rai, Phayao and Nan provinces), are higher than in the Bangkok and Phuket areas, while minimum temperatures in the project area are much lower than in Bangkok and Phuket (see Table 2.3.4.5). Annual rainfall in the project area is much less than in Phuket.

Table 2.3.4.5 Rainfall, Temperature and Relative Humidity: 1994

| | Total rainfall (mm). | Temperature (C) | |
|------------|-------------------------|-------------------|--------------|
| | | Extreme min. | Extreme max. |
| Chiang Rai | 2,160.30 | 8.90 | 38.20 |
| Phayao | 1,544.50 | 7.00 | 38.10 |
| Nan | 1,476.20 | 9.20 | 41.10 |
| Bangkok | 1,543.60 | 24.20 | 33.00 |
| Phuket | 2,544.20 | 25.00 | 32.30 |

Source: Meteorological Station

Migration

The provinces of the project area form a corridor linking Myanmar and Laos. They have experienced a great deal of change due to migration patterns—from South to North, or to Bangkok, or more often from Laos or Myanmar. The major travel corridor cuts through most of the region, bringing a steady flow of trucks, supplies, and temporary residents. These visitors are accommodated with typical

**Table 2.3.4.4 Gross Provincial Product at Current Market Prices by
Province Whole Kingdom 1993**

| Changvat (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) | Per capita GPP (Baht) | Per capita 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 |
| Chumpon | 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

Thai adaptability and compassion. Of those families which remain in the area, most seem at least reasonably content. They like their neighbors and the quality of their lives. Families are stable, and concerns about the environment are only now emerging. Some would like to see greater prosperity (i.e. jobs and incomes), and others are concerned about the potential social consequences of too-rapid or uncontrolled development. A number of families would like to see greater development in their areas so that they could share concomitant increasing prosperity.

Young people have been leaving the project area for better education or career opportunities in more urbanized settings. There are no public universities in the project area. The rate of employment increase has been modest in relation to the national average, while agricultural employment, traditionally a mainstay of the regional economy, has been declining. From the perspective of a young person wishing to better his/her family's life, there are few professional challenges, or social amenities to offset the generally deteriorating labor market conditions.

Income Distribution

Table 2.3.4.6 presents estimates of the distribution of annual household incomes in the project area for 1994¹. It may be noted that nearly 4% of the surveyed households reported annual incomes of over B 50,000. There are nearly eight times as many of these households as there are households whose income lie under B 6,000; in other words, there are relatively more "low-income" households in the project area than there are "well-off" households.

Table 2.3.4.6 Distribution of Annual Household Income in the Project Area (1994)

| Income per annum | Annual household income | | | | | | | |
|---------------------|-------------------------|--------|---------|--------|--------|--------|---------|--------|
| | Chiang Rai | % | Phayao | % | Nan | % | Total | % |
| Under 6000 | 58,657 | 24.36 | 31,385 | 28.67 | 42,044 | 43.72 | 132,086 | 29.59 |
| 6000 - 9999 | 54,833 | 22.77 | 27,391 | 25.03 | 20,813 | 21.64 | 103,037 | 23.08 |
| 10000 - 19999 | 45,966 | 19.09 | 23,350 | 21.33 | 13,965 | 14.52 | 83,281 | 18.65 |
| 20000 - 29999 | 31,002 | 12.87 | 11,248 | 10.28 | 6,672 | 6.94 | 48,922 | 10.96 |
| 30000 - 49999 | 19,668 | 8.17 | 5,183 | 4.74 | 4,159 | 4.32 | 29,010 | 6.50 |
| Over 50000 | 9,705 | 4.03 | 4,189 | 3.83 | 3,338 | 3.47 | 17,232 | 3.86 |
| Unknown | 20,986 | 8.71 | 6,706 | 6.13 | 5,184 | 5.39 | 32,876 | 7.36 |
| Number of household | 240,817 | 100.00 | 109,452 | 100.00 | 96,175 | 100.00 | 446,444 | 100.00 |

Source: 1994 Village Survey, National Statistical Office

From Table 2.3.4.7, it presents the situation of , on average, households monthly income distribution of region. This reaffirms an observation that non-farming incomes are greater than are

¹ This is the first time the National Statistical Office's bi-annual Survey of Income was carried out at the regional level.

Table 2.3.4.7 Average monthly income per household by source of income on region : 1994

| Source of income | Region | | | | | | | | | | | |
|----------------------------|---------------|--------|-----------------|--------|---------|--------|-------|--------|-----------|--------|-------|--------|
| | Whole Kingdom | | Greater Bangkok | | Central | | North | | Northeast | | South | |
| | Baht | % | Baht | % | Baht | % | Baht | % | Baht | % | Baht | % |
| Percent of households | | 100.00 | | 16.50 | | 19.10 | | 20.30 | | 31.50 | | 12.60 |
| Total income | 8,326 | 100.00 | 16,543 | 100.00 | 8,776 | 100.00 | 6,267 | 100.00 | 5,685 | 100.00 | 8,065 | 100.00 |
| Wages and salaries | 3,501 | 42.10 | 9,160 | 55.40 | 3,625 | 41.30 | 2,185 | 34.90 | 1,883 | 33.10 | 2,952 | 36.60 |
| Profits, non-farm | 1,649 | 19.80 | 3,723 | 22.50 | 1,945 | 22.20 | 1,057 | 16.90 | 903 | 15.90 | 1,618 | 20.10 |
| Profits from farming | 802 | 9.60 | 142 | 0.90 | 1,040 | 11.90 | 712 | 11.30 | 645 | 11.30 | 1,709 | 21.20 |
| Property income | 97 | 1.20 | 202 | 1.20 | 82 | 0.90 | 74 | 1.20 | 83 | 1.50 | 71 | 0.90 |
| Current transfer | 550 | 6.60 | 624 | 3.80 | 581 | 6.60 | 519 | 8.30 | 618 | 10.90 | 302 | 3.70 |
| Non-money income | 820 | 9.80 | 1,017 | 6.10 | 580 | 6.60 | 867 | 13.80 | 903 | 15.90 | 681 | 8.40 |
| Other money receipts | 104 | 1.30 | 87 | 0.50 | 89 | 1.00 | 172 | 2.70 | 91 | 1.60 | 72 | 0.90 |
| Rental value of owned home | 803 | 9.60 | 1,588 | 9.60 | 834 | 9.50 | 681 | 10.90 | 559 | 9.80 | 660 | 8.20 |
| Average household size | 3.8 | | 3.3 | | 3.7 | | 3.5 | | 4.1 | | 4.1 | |

Note: Greater Bangkok: includes Nonthaburi, Pathum Thani and Samut Prakan

Central: excludes Bangkok Metropolis, Nonthaburi, Pathum Thani and Samut Prakan

Profits, non-farm: includes profits from roomers

Non-money income: excludes rentals value of owned home

Source: Preliminary Report of the 1994 Household Socio-Economic Survey, National Statistical Office.

differences in household incomes across region. Comparing all households across the region, the variance in incomes across the various socio-economic categories is approximately three times as large as is the income-variance across provinces.

It would appear that household income is influenced more by the occupation of the household than by any other factor, with farm operators showing the lowest average monthly incomes.

It is not possible to calculate the incidence of poverty within or among the provinces in the project area, because poverty lines for each of the provinces have not yet been stipulated. Poverty standards must be adjusted for geographic cost-of-living differentials, as well as for alternative family sizes. A simple examination of incidence of low household incomes is not adequate justification for public-sector intervention; analysis of incomes in relation to basic needs is required as well.

Current conditions of Education

(I) Problems with Thailand's Education System

There are a great number of problems and challenges facing the educational system in Thailand. The more important ones are detailed in the following subsections.

Low transition rates

There has historically been an exceedingly low rate of transition from grade six to higher levels of education. According to one source, the transition rate beyond grade six was less than 40% five years ago. Last year, it was alleged to be above 90%. Still, the work force does not yet have high levels of education. In 1994, 54.3% of the employed population had six years of education or less.

Within the provinces of the project area, fully 67% of those employed in 1994 had less than seventh grade education (see Table 2.3.4.8). Improvements in the level of educational attainment have been initiated by expanding primary facilities, especially in rural areas, to include higher levels of schooling. Under consideration by the Parliament is a proposal to increase the level of compulsory education from six to nine years. It will, however, take many years for these improvements to translate into broad-based improvements in human capital among job seekers.

Table 2.3.4.8 Employed persons by Levels of Educational Attainment
in the project area, Whole Kingdom, Bangkok, and Non-Bangkok regions, 1994

| Level of Educational Attainment | Chiang Rai | % | Phayao | % | Nan | % | Project area | % | Whole Kingdom | % | Bangkok (BMA) | % | Non-Bangkok | % |
|---------------------------------|------------|-------|---------|--------|---------|--------|--------------|--------|---------------|--------|---------------|--------|-------------|-------|
| Total | 560,484 | 100 | 201,292 | 100.00 | 212,886 | 100.00 | 974,662 | 100.00 | 30,164,293 | 100.00 | 3,339,753 | 100.00 | 26,824,540 | |
| None | 66,541 | 11.87 | 21,527 | 10.69 | 21,047 | 9.89 | 109,115 | 11.20 | 1,261,888 | 4.18 | 62,933 | 1.88 | 1,198,955 | 4.47 |
| Less than Pratom 4 | 36,481 | 6.51 | 7,259 | 3.61 | 10,574 | 4.97 | 54,314 | 5.57 | 807,063 | 2.68 | 51,359 | 1.54 | 755,704 | 2.82 |
| Lower Elementary | 277,231 | 49.46 | 108,896 | 54.10 | 107,152 | 50.33 | 493,279 | 50.61 | 14,322,200 | 47.48 | 1,028,770 | 30.80 | 13,293,431 | 49.56 |
| Upper Elementary | 96,451 | 17.21 | 34,521 | 17.15 | 36,415 | 17.11 | 167,387 | 17.17 | 7,333,656 | 24.31 | 566,770 | 16.97 | 6,766,953 | 25.23 |
| Lower Secondary | 36,682 | 6.54 | 11,767 | 5.85 | 19,708 | 9.26 | 68,157 | 6.99 | 2,449,541 | 8.12 | 407,231 | 12.19 | 2,042,310 | 7.61 |
| Upper Secondary | 17,184 | 3.07 | 7,558 | 3.75 | 5,639 | 2.65 | 30,381 | 3.12 | 925,077 | 3.07 | 196,487 | 5.88 | 728,590 | 2.72 |
| Vocational | 5,951 | 1.06 | 1,577 | 0.78 | 2,678 | 1.26 | 10,206 | 1.05 | 886,894 | 2.94 | 309,846 | 9.28 | 577,049 | 2.15 |
| University: | | | | | | | | | | | | | | |
| - Academic | 8,534 | 1.52 | 2,069 | 1.03 | 2,524 | 1.19 | 13,127 | 1.35 | 936,059 | 3.10 | 463,608 | 13.88 | 472,451 | 1.76 |
| - Tech/Vocational | 7,606 | 1.36 | 2,494 | 1.24 | 3,385 | 1.59 | 13,485 | 1.38 | 592,713 | 1.96 | 162,970 | 4.88 | 429,743 | 1.60 |
| Teacher Training | 7,766 | 1.39 | 3,583 | 1.78 | 3,765 | 1.77 | 15,114 | 1.55 | 626,699 | 2.08 | 79,355 | 2.38 | 547,344 | 2.04 |
| Short-course Vocational | | | | | | | | | 6,255 | 0.02 | 2,220 | 0.07 | 4,035 | 0.02 |
| Others | 57 | 0.01 | 40 | 0.02 | | | 97 | 0.01 | 15,502 | 0.05 | 7,710 | 0.23 | 7,792 | 0.03 |
| Unknown | | | | | | | | | 748 | 0.00 | 561 | 0.02 | 187 | 0.00 |

Source: National Statistical Office, 1994 Labour Force Survey

Need for improvements in teachers

There is an apparent "brain-drain" among teachers who are being hired away from schools by private industry. This is a natural consequence of skill scarcity and will eventually have to be addressed through improved compensation systems and career-development paths within the educational profession. Some form of performance-based compensation might be considered as an option to address this problem. In March 1996 the cabinet approved in principle the allocation of 5% of teacher salaries (which amounts to 5 billion Baht annually) to support programs for the advanced education of teachers through training institutes. The coordinating agency for this effort is the National Education Commission, although the project director does not have a teaching background.

Students' orientation for degrees

Generally speaking, Thai students seem far more concerned with the credentials they receive than with what they are taught in the classroom—a phenomenon known as "credentialism." It will likely persist as long as labor markets are permitted to reward degrees over knowledge. The expansion of non-formal education should be a welcome alternative to the current practice, however, many young people choose not to pursue this alternative and many others are not even aware of it. As the majority of the work force in the project area still have formal education through only primary school or less, careful design of non-formal education, based upon a comprehensive local labor market analysis, is necessary.

Gender bias

As in many other societies, women tend to track through the educational system differently than men. Illiteracy rates among females are double those for men, and there appears to be traditional disinclination among females to pursue science and mathematics. Industrial and occupational segregation of women has resulted in women's earnings being around 20 per cent lower than those for men.

Inadequate curricula

There is a dearth of graduates in the scientific, technical, and management fields. The Ministry of Education is well aware of this problem and is actively working it at the university level, focusing on women. A rather large World Bank loan (\$112 million) to the education sector (primarily secondary and technical education) will also attempt to address this problem. To achieve the objective of increasing scientific skills and knowledge among graduates and adults of varying levels of educational attainment,

complementary steps will likely be required, such as science museums, science exhibition centers, scholarships, etc. Such ancillary activities could be promoted in the project area.

Inadequate teaching methods

Teaching methods are felt to be antiquated—based upon rote-lecture methods rather than on problem-solving techniques. This makes the transition from school to work difficult for school completors as well as for their eventual employers. Future labor market requirements will place less emphasis on what is known and more on how to learn to confront and resolve new problems. Thailand has already made the transitions from a subsistence to a monetary economy, and is well on its way to upgrading to higher forms of technology. The next step will require an improvement in the skills of the work force to support the new technology which will inevitably be introduced, and a generally flexible work force which may adapt to rapidly changing international market conditions. This, in turn, will require input from the local labor market. Continued reliance on the government budget is not likely sustainable, due to lack of funds and accountability.

Administrative problems

An additional problem, which applies to educational systems at the provincial level, involves unclear lines of authority. School teachers fall under the general authority of the Ministry of Education. Certain personnel decisions, however, can be made by the Governor's Office, meaning that the Ministry of the Interior is also involved in the educational system. This sort of dual authority makes it difficult for local staff to know which policies they should be and have support in implementing.

(II) Existing Status of Education in the Project Area

As mentioned, the problems detailed above are under active discussion at the national policy level. All of these problems apply equally to the project area. However, most of the preceeding discussion relates to students or school-age persons—i.e., the rather young. This leaves an important gap concerning adults and adult education. From international studies, it is well known that on-the-job training for employed adults is the most economical and effective form of training. Moreover, it is logical to expect that skill upgrading of the existing labor force will have a more immediate and effective impact on national (or regional) productivity than will enhanced job preparation for first-time job-seekers alone.

Data on schools and other educational institutions in the project area are provided in Table 2.3.4.9. Also included are estimates of the number of students, classes, and teachers. There are two important messages contained in the data. First, the educational structure is pluralistic, in the sense that there are many different sources of and types of schools. Second, the distribution of resources appears to be generally away from the project area. The reported number of students per teacher in the project area is telling of the educational situation: the typical teacher in Chiang Rai province must take responsibility for more students than teachers in any other province.

Table 2.3.4.9 School facilities, Students, Classes, and Teachers in the project area, 1994

| | Chiang Rai | Phayao | Nan | Project Area | % |
|---------------------------------------|------------|--------|--------|--------------|--------|
| Number of Schools (Facilities) | | | | | |
| Preprimary-Elementary | 244 | 118 | 136 | 498 | 70.34 |
| Elementary | 58 | 28 | 18 | 104 | 14.69 |
| Secondary | 50 | 24 | 32 | 106 | 14.97 |
| Total | 352 | 170 | 186 | 708 | 100.00 |
| Number of Students | | | | | |
| Preprimary -Elementary | 29,724 | 12,626 | 15,237 | 57,587 | 15.51 |
| Elementary | 110,772 | 47,260 | 49,423 | 207,455 | 55.86 |
| Secondary | 51,922 | 24,711 | 29,700 | 106,333 | 28.63 |
| Total | 192,418 | 84,597 | 94,360 | 371,375 | 100.00 |
| Number of Classes | | | | | |
| Preprimary-Elementary | 1,355 | 578 | 751 | 2,684 | 16.90 |
| Elementary | 5,254 | 2,213 | 2,714 | 10,181 | 64.12 |
| Secondary | 1,419 | 719 | 876 | 3,014 | 18.98 |
| Total | 8,028 | 3,510 | 4,341 | 15,879 | 100.00 |
| Number of Teachers | | | | | |
| Preprimary - Elementary | 1,238 | 458 | 665 | 2,361 | 12.08 |
| Elementary | 5,930 | 3,041 | 3,383 | 12,354 | 63.20 |
| Secondary | 2,301 | 1,171 | 1,360 | 4,832 | 24.72 |
| Total | 9,469 | 4,670 | 5,408 | 19,547 | 100.00 |

Source : Phayao Provincial Education Office

The educational problems in the project area are not as much quantitative as they are qualitative, however. Teachers can be found, but they are not especially committed, nor are they especially qualified. Very often, teaching vacancies are filled from the pool of recent graduates, few of whom have undertaken

any pedagogical courses, and none of whom have any experience in the world of work. Standards have to be adjusted downward to permit unfilled vacancies to be filled.

The good ones want to stay around Bangkok, where salary supplements are available through consulting, or part-time work in private schools."

Labor Force and Employment

Table 2.3.4.10 provides data on the 1994 labor force, including the working age population and labor force participation rates by gender. Labor force participation rates range from a low of 50.74% in Nan province to a high of 54.86% in Chiang Rai province. Taken as a whole, labor force participation rates in the project area are significantly lower than the national average, Bangkok, and areas outside the BMA. This may be due to the low degree of employment in agriculture in the project area compared with the other areas. However, relatively low (by international standards) unemployment rates are also noted: with the exception of Phayao, which recorded a 3.88% unemployment rate, all the rest of the provinces in the project area had rates less than 2.5%—well below the national average and below the average for areas outside the BMA.

Table 2.3.4.10 Population of Working Age, Labor Force, and Participation Rates, By Gender Employment, and Unemployment, Project Areas, Kingdom, Bangkok, and Non-Bangkok, 1994

| | Chiang Rai | Phayao | Nan | Project Area | Whole Kingdom | Bangkok (BMA) | Non-Bangkok |
|---------------------------------|------------|---------|---------|--------------|---------------|---------------|-------------|
| Population | | | | | | | |
| 13 and older | 1,101,586 | 480,689 | 434,789 | 2,017,064 | 43,939,418 | 5,113,563 | 38,825,856 |
| Male | 452,494 | 247,095 | 222,495 | 922,084 | 21,680,309 | 2,431,533 | 19,248,776 |
| Female | 417,193 | 233,594 | 212,294 | 863,081 | 22,259,109 | 2,682,030 | 19,577,080 |
| Labor Force | | | | | | | |
| Male | 604,350 | 263,259 | 220,620 | 1,088,229 | 30,997,940 | 3,395,358 | 27,602,583 |
| Female | 350,413 | 147,225 | 131,967 | 629,605 | 17,125,940 | 1,860,766 | 15,265,174 |
| Female | 253,935 | 116,033 | 88,653 | 458,621 | 13,872,000 | 1,534,592 | 12,337,409 |
| Labor Force Participation Rates | | | | | | | |
| Male | 54.86 | 54.77 | 50.74 | 53.95 | 70.55 | 66.40 | 71.09 |
| Female | 77.44 | 59.58 | 59.31 | 68.28 | 78.99 | 76.53 | 79.30 |
| Female | 60.87 | 49.67 | 41.76 | 53.14 | 62.32 | 57.22 | 63.02 |
| Employment | 560,484 | 201,292 | 212,886 | 974,662 | 30,164,294 | 3,339,653 | 26,824,541 |
| Unemployment | 11,856 | 7,804 | 4,139 | 23,799 | 833,647 | 55,605 | 778,042 |
| Unemployment Rate | 2.12 | 3.88 | 1.94 | 2.44 | 2.76 | 1.66 | 2.90 |

Source: National Statistical Office, 1994 Labour Force Survey.

Table 2.3.4.11 shows the distribution of employment by industry in 1994 for the provinces of the project area, the Whole Kingdom, Bangkok, and the rest of Thailand. Unfortunately, 1994 is at present the only year in which the Labor Force Survey was carried out at the provincial level, so it is not possible to perform time-series analyses of labor market indicators, nor make projections based on trend analysis.

Only two interesting conditions are apparent in this data: a lower proportion of project area residents are employed in Agriculture/Fishing than is the case for the nation as a whole (45.93% versus 50.3%); and the proportion of project area wage-earners employed in manufacturing is lower than the national average (10.0% compared with 13.9%).

Table 2.3.4.12 indicates the occupational distributions of employment for the project area and the Whole Kingdom. The relative numbers of professional, technical, and related workers are different (2.89% for the project area versus 4.7% for the Whole Kingdom), although when the BMA is excluded from the comparisons, differences are less pronounced. Only the proportions of agricultural workers (farmers, fishermen, hunters, loggers, and related workers) are considerably different between the project area and the rest of the Kingdom, excluding Bangkok (46.22% versus 56.4%)—the project area has a relatively low proportion of employment in agriculture.

Table 2.3.4.8 provides information on the educational levels of employed persons in the project area, the Whole Kingdom, Bangkok, and non-Bangkok. Here, differences between the project area and the rest of the country are more pronounced: fully 67% of those employed in the project area had only completed lower elementary education, compared with 54.4% in the Kingdom as a whole, or 56.9% for areas outside of Bangkok. Likewise, university-educated persons are under-represented among the employed in the project area (2.7% versus 5.1% for the Whole Kingdom or 3.4% for areas outside of Bangkok). In part, these differences reflect the fact that there are relatively few institutions of higher learning in the project area. It is generally known that young persons seeking higher education often migrate to more prestigious schools in Bangkok or elsewhere in the country, where there are more schools in general.

Public Health

Existing Conditions of Public Health in Thailand

Health Status

(I) Basic Health Indicators

Thailand is in a period of epidemiological transition. While poverty-related maladies such as infectious diseases and malnutrition have decreased dramatically, injuries and non-communicable diseases have been increasing. Due to rapid economic growth during the past decades, a rise in income levels and changes in life-style have had a great impact on disease patterns. At present, the three leading causes of

Table 2.3.4.11 Employed Persons by industry, project area, Whole Kingdom, Bangkok and Non-Bangkok Regions, 1994

| Industry | Chiang Rai | Phayao | Nan | Project Area | Percent Distribution | Whole Kingdom | Percent Distribution | Bangkok (BMA) | Percent Distribution | Non-Bangkok | Percent Distribution |
|--|------------|---------|---------|--------------|----------------------|---------------|----------------------|---------------|----------------------|-------------|----------------------|
| Total | 560,484 | 201,292 | 212,886 | 974,662 | 100.00 | 30,164,293 | 100.00 | 3,339,753 | 100.00 | 26,824,540 | |
| Agriculture, forestry, hunting and fishing | 240,887 | 91,786 | 114,949 | 447,622 | 45.93 | 15,180,501 | 50.30 | 96,425 | 2.89 | 15,084,077 | 56.23 |
| Mining and quarrying | | 18 | | 18 | 0.00 | 57,838 | 0.20 | 3,476 | 0.10 | 54,362 | 0.20 |
| Manufacturing | 53,382 | 27,633 | 16,411 | 97,426 | 10.00 | 4,190,856 | 13.90 | 910,076 | 27.25 | 3,280,781 | 12.23 |
| Construction, repair, and demolition | 87,302 | 29,606 | 22,018 | 138,926 | 14.25 | 1,996,777 | 6.60 | 203,119 | 6.08 | 1,793,659 | 6.69 |
| Electricity, gas, water, and sanitary services | 6,486 | 519 | 261 | 7,266 | 0.75 | 183,958 | 0.60 | 59,987 | 1.80 | 123,971 | 0.46 |
| Commerce | 105,397 | 23,593 | 35,618 | 164,608 | 16.89 | 3,765,876 | 12.50 | 873,365 | 26.15 | 2,892,512 | 10.78 |
| Transport, storage, and communications | 13,607 | 3,807 | 1,920 | 19,334 | 1.98 | 894,904 | 3.00 | 276,969 | 8.29 | 617,936 | 2.30 |
| Services | 53,234 | 24,294 | 21,709 | 99,237 | 10.18 | 3,882,019 | 12.90 | 911,788 | 27.30 | 2,970,231 | 11.07 |
| Activities not adequately described | 188 | 35 | | 223 | 0.02 | 11,564 | 0.00 | 4,551 | 0.14 | 7,014 | 0.03 |

Source: National Statistical Office, Labour Force Survey, 1994

Table 2.3.4.12 Distribution of Employment, By Occupation, Project Area, Whole Kingdom, Bangkok, and Non-Bangkok Regions

| Occupations | Chiang Rai | Phayao | Nan | Project Area | % distribution | Whole Kingdom | % distribution | Bangkok | % distribution | Non-Bangkok | % distribution |
|--|------------|---------|---------|--------------|----------------|---------------|----------------|-----------|----------------|-------------|----------------|
| Total | 560,484 | 201,292 | 212,886 | 974,662 | 100.00 | 30,164,293 | 100.00 | 3,339,753 | 100.00 | 26,824,540 | 100.00 |
| Professional, technical and related workers | 13,809 | 7,688 | 6,688 | 28,185 | 2.89 | 1,428,164 | 4.70 | 422,594 | 12.65 | 1,005,570 | 3.75 |
| Administrative, executive and managerial workers | 5,860 | 3,272 | 3,362 | 12,494 | 1.28 | 684,381 | 2.30 | 269,348 | 8.06 | 415,033 | 1.55 |
| Clerical workers | 17,157 | 2,526 | 3,174 | 22,857 | 2.35 | 1,149,127 | 3.80 | 441,136 | 13.21 | 707,991 | 2.64 |
| Sales workers | 90,417 | 20,968 | 32,951 | 144,336 | 14.81 | 3,308,384 | 11.00 | 559,984 | 16.77 | 2,748,400 | 10.25 |
| Farmers, fishermen, hunters, loggers, and related workers | 242,592 | 92,614 | 115,314 | 450,520 | 46.22 | 15,234,628 | 50.50 | 102,209 | 3.06 | 15,132,419 | 56.41 |
| Workers in transport and communications | 14,837 | 4,136 | 1,229 | 20,202 | 2.07 | 1,088,745 | 3.60 | 273,576 | 8.19 | 815,169 | 3.04 |
| Craftsmen, production, process workers, and laborers, nec. | 153,907 | 62,195 | 42,332 | 258,434 | 26.52 | 5,906,954 | 19.60 | 891,533 | 26.69 | 5,015,421 | 18.70 |
| Service, sport, and recreation workers | 21,904 | 7,894 | 7,836 | 37,634 | 3.86 | 1,356,300 | 4.50 | 375,451 | 11.24 | 980,849 | 3.66 |
| Workers not classifiable by occupation | 0 | 0 | 0 | 0 | | 7,610 | 0.00 | 3,922 | 0.12 | 3,688 | 0.01 |

Source: National Statistical Office, Labour Force Survey, 1994

death in Thailand are: (1) heart disease, (2) accident and poisoning, and (3) cancer. As Thailand moves toward more rapid industrialization, chronic disease and accidents are likely to become increasingly prevalent.

Table 2.3.4.13 shows the major health indicators in Thailand. Table 2.3.4.13 Statistics such as life expectancy, infant mortality rate (IMR), crude birth rate, and maternal mortality rate indicate improved public health in recent decades. Achievements in population policy have resulted in an increase in the elderly population and decrease in the labor force. At the same time, changes in social values such as consumption behavior, working competition, and the transition from an extended family to a nuclear family, have contributed to an increase in social problems related to mental health, drugs, and crime. Accidents, suicide, murder, drug addiction, mental health disorders, occupational health, and AIDS will be high-priority health problems in the near future.

Table 2.3.4.13 Trends in Major Health Indicators in Thailand

| Indicator | Unit | 1988 | 1995 |
|-------------------------------------|-------------------------|-------|-------|
| Life Expectancy | Male | 63.00 | 66.60 |
| | Female | 68.00 | 71.70 |
| Infant Mortality | per 1,000 live births | 35.00 | 25.90 |
| Crude Birth rate | per 1,000 population | 17.00 | 16.50 |
| Crude Death rate | per 1,000 population | 4.20 | 6.10 |
| Maternal Mortality | per 1,000 live births | 0.40 | 0.14 |
| Population over 60 years | in total population (%) | 6.10 | 6.80 |
| Family Planning rate | receiving (%) | 70.50 | 74.00 |
| Vaccination BCG | receiving (%) | 96.00 | 98.90 |
| measles vaccine | receiving (%) | 80.00 | 83.60 |
| Households with safe drinking water | % | 74.00 | 87.80 |

Source: Health in Thailand, Ministry of Public Health

Comparison of Health Status and Financing in Selected Asia Countries (1992)

| Country | GNP per capita | % of Government Health Budget | IMR | Life Expectancy | Population per Hospital Bed |
|------------|----------------------|-------------------------------------|-----|--------------------|-----------------------------------|
| Malaysia | 2,790 | 6.8% | 14 | 71 | 435 |
| Thailand | 1,840 | 5.7% | 26 | 69 | 738 |
| Philippine | 770 | 3.3% | 40 | 65 | 647 |
| Sri Lanka | 540 | 4.5% | 18 | 72 | 368 |
| China | 470 | 4.2% | 31 | 69 | 465 |

Although health indicators have improved rapidly in Thailand, the rates indicated in the above table are still worse than those of many other Asian developing countries. Countries such as Sri Lanka and China have devoted a lower proportion of their budgets to the health sector yet maintain better health than Thailand, based upon these statistics.

(II) HIV/AIDS

Thailand has the largest number of reported AIDS patients in Southeast Asia as the following table indicates. AIDS was first reported in Thailand in 1984 among the homosexual male population. From that time, a total of 36,629 cases has been reported (by the end of March 1996). Estimated HIV infections in Thailand were 700,000 in 1995 according to official data, and will be 1.3 million by 2000 and 2.2 million by 2010 according to a projection by NESDB.

AIDS and HIV Infections in Selected Southeast Asian Countries (as of Dec. 1995)

| Country | Reported AIDS Cases | Estimated HIV Infections |
|-------------|---------------------|--------------------------|
| Thailand | 29,090 | 700,000 |
| India | 2,095 | 1,500,000 |
| Myanmar | 570 | 400,000 |
| Vietnam | 233 | 200,000 |
| Singapore | 145 | 1,000 |
| Philippines | 220 | 19,000 |

Although the predominant modes of HIV transmission in the late 1980's were homosexuality and intravenous drug use, today it is clear that HIV has spread rapidly from the high-risk population into the general population. In 1995, 42.6% of total AIDS patients were general workers, including factory workers and construction workers. A dramatic increase of HIV infection among wives and girlfriends of men who visit commercial sex workers is a major focus of concern. Its growing magnitude is tragically reflected by the fact that 2.2% of pregnant women attending pre-natal care clinics in June 1995 tested HIV positive. The number of AIDS widows and the number of vertical HIV transmissions from mothers to their infants have been increasing. Also, abandonment of orphans related to HIV/AIDS is a critical social problem.

In 1991 the Thai government launched a national AIDS campaign through all kinds of media. A national survey in 1995 showed that around 80% of the population know about AIDS, its transmission, and how to prevent HIV. However, there is still a wide gap between knowledge of risk and the practice of safer sexual behavior.

Health Resources

(I) Health Services

The health services in Thailand can be simply categorized into three types: (1) the Government sector which includes the Ministry of Public Health (MOPH) and other government agencies, (2) non-governmental organization, (3) the private sector. Public hospitals accounted for 76.7% of the total number of beds and 67.3% of the total number of hospitals in 1993.

Referral System of MOPH Hospitals in Thailand (1994)

| Hospital Type | No. of hosp. | No. of beds | No. of doctors | Population Coverage |
|---------------------|--------------|-------------|----------------|----------------------|
| Regional Hospital | 17 | 500 to 1000 | - | 300,000 to 1,000,000 |
| Provincial Hospital | 75 | 150 to 500 | - | 300,000 to 1,000,000 |
| Community Hosp. | 706 | 10 to 120 | 1 to 11 | 50,000 to 100,000 |
| Health Center | 8,699 | 0 to 3 | none | 5,000 to 10,000 |

In the public sector, the MOPH hospitals provide services through a three-tiered health delivery system as indicated above. In each of the 7,159 tambons (subdistricts), there is at least one health center which is staffed by technical nurse, midwife, and junior sanitarian. They provide primary care such as emergency treatment, immunization, essential drugs, delivery, and dental health. They also support community development and the Primary Health Care program, which is operated by village health volunteers, village committees, and housewife groups in each village. In 1994, 572,172 people served as health volunteers. There are several Village Funds such as Revolving Drug Funds, Sanitation Funds, Nutrition Funds, and Health Card Funds that are managed at the village level.

Almost 92% of the nation's districts have a community hospital which is responsible for providing comprehensive curative care, health promotion, prevention and rehabilitation. Most of the provincial hospitals, located in each province, have specialists, are fully equipped, and have all kinds of medical

personnel available. Complicated and severe cases are generally referred to a regional hospital or university hospital in the region, but are often referred to large special hospitals in Bangkok or private hospitals in the region at the request of patients.

In the private sector, the number of hospital beds and clinics has nearly doubled during the past decades. Increasing demands for high quality medical services have stimulated the growth of private hospitals in proportion to increases in the income level. Private hospitals and clinics are concentrated in urban areas, especially in the BMA.

Distribution of Health Resources in Thailand (1991)

| Region | No. of physicians | % of total | No. of hospital beds | % of total |
|------------------|-------------------|------------|----------------------|------------|
| Bangkok | 5,832 | 45.6 | 18,804 | 23.8 |
| Bangkok Vicinity | 609 | 4.8 | 3,154 | 4.0 |
| Central | 421 | 3.3 | 4,916 | 6.2 |
| Eastern | 682 | 5.3 | 6,252 | 7.9 |
| Western | 515 | 4.0 | 5,470 | 6.9 |
| Northeastern | 1,818 | 14.2 | 15,668 | 19.8 |
| Northern | 1,747 | 13.6 | 14,787 | 18.7 |
| Southern | 1,179 | 9.2 | 10,105 | 12.8 |

(II) Healthcare Workforce

Thailand has 12 public medical schools and one private school which graduate a total of 1,000 doctors annually. There are 50 public nursing schools and 9 private schools which produce 5,000 nurses every year. The number of doctors and nurses in Thailand has been increasing at a greater rate than the population, as the following table shows.

Thai Population per Healthcare Professional

| | 1988 | 1989 | 1990 | 1991 | 1992 |
|-----------|--------|--------|--------|--------|--------|
| Physician | 4,832 | 4,361 | 4,500 | 4,425 | 4,282 |
| Dentist | 32,585 | 26,316 | 24,656 | 23,530 | 21,497 |
| Nurse | 1,065 | 962 | 929 | 885 | 828 |

However, there is a wide gap in distribution of healthcare workers between urban and rural areas. In addition, due to the wide income differential between public and private hospitals, an unprecedented number of doctors, dentists, and other health personnel have moved from the public to the private sector. Salaries in private hospitals are at least double those of the public hospitals. The percentage of dentists working in the private sector has recently been estimated at 50 to 60%. It is believed that the official figures in the table below underrepresent this trend due to underreporting.

Percent of Health Personnel in the Private Sector

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|------------|--------|--------|--------|--------|--------|--------|
| Physicians | 9.45% | 14.12% | 15.47% | 18.01% | 19.04% | 18.62% |
| Dentists | 13.59% | 19.45% | 20.08% | 22.59% | 24.20% | 23.54% |
| Nurses | 6.35% | 8.36% | 8.62% | 9.58% | 10.19% | 10.40% |

This "brain-drain" from the public to the private sector is an urgent concern because private hospitals are not presently regulated by or accountable to the MOPH.

Existing Public Health Conditions in the Project Area

Basic Health Indicators in the Project Area

(I) Population and Family Planning

Due to the achievements of family planning programs, population growth rates in the project area have already decreased to below 1%, while the national average was 1.1% in 1995 (see Table 2.3.4.14). Table 2.3.4.14 Nationally, 74% of married women of childbearing age presently use contraception. In the project area, though, the contraception rate is somewhat lower than the national average, ranging from 58.3% in Nan province to 60.3% in Phayao and 67.3% in Chiang Rai province. Popular family planning methods in these provinces include the birth control pill, injection, tubectomy, and condoms.

Table 2.3.4.14 Basic Health Indicators in the Project Area in 1994

| Indicators | Chiang Rai | Phayao | Nan | Whole Kingdom |
|-------------------------------|------------|---------|---------|---------------|
| Population | 1,251,581 | 513,471 | 473,115 | 59,396,000 |
| Population density | 107.171 | 81 | 41.24 | 115.8 |
| Population growth rate | 0.78 | 0.52 | 0.63 | 1.1 |
| % of Population over 60 | 9.53 | 8.669 | 12.4 | 6.8 |
| Contraception method coverage | 67.30% | 60.30% | 58.30% | 74.00% |
| Maternal mortality rate * | 0 | 0 | 0 | 0.1 |
| Crude birth rate** | 12.8 | 13 | 13 | 16.5 |
| Crude death rate** | 6.7 | 9 | 4.7 | 4.9 |

Source: Provincial Health Offices

Note: * per 1,000 live births, ** per 1,000 populations

(II) Migration

The reduction of the population growth rate has affected the age structure in the project area. Working-age persons in the project area often move to urban areas like Bangkok. The percentage of the population over 60 years old varies from 8.7% in Phayao to 9.53% in Chiang Rai and 12.4% in Nan—all of which are higher than the national average (7.3%). Although the rate of natural population increase in the project area has decreased rapidly, migration from this project area to Bangkok (BMR) area is still remarkable, especially during the dry season.

Mortality and Morbidity

Table 2.3.4.15 presents top seven leading causes of death officially reported in the project area. In all provinces, heart disease, malignant neoplasms, and respiratory system disease are leading causes of death.

(I) Communicable Diseases

Major communicable diseases, especially those that could be prevented by vaccines, continue to cause less mortality and morbidity in Thailand. However, some of these diseases can still be found on the list of leading causes of death and morbidity. Table 15 indicates the leading causes of morbidity in the project area.

(II) Opportunistic Infections in AIDS Patients

The incidence of infectious disease has generally fallen in Thailand, but mortality and morbidity from tuberculosis and other infectious diseases are increasing in the project area because of opportunistic

Table 2.3.4.15 Top 7 Leading Causes of Death in the Project Area (1994)

| | Number | Phayao Rate 100,000 persons |
|--|--------|--------------------------------|
| 1. Disease of Hear | 804 | 157.4 |
| 2. Malignant neoplasms | 342 | 66.95 |
| 3. Respiratory disease | 304 | 59.51 |
| 4. Transport accidents | 183 | 35.82 |
| 5. Nephritis, nephrotic syndrome | 143 | 27.99 |
| 6. Pyrexia of unknown origin | 134 | 26.23 |
| 7. Hypertension and cerebrovascular disease | 120 | 23.49 |
| | | Chiang Rai |
| 1. Respiratory disease | 1,020 | 94.19 |
| 2. Malignant neoplasms | 859 | 79.32 |
| 3. Disease of Hear | 753 | 60.54 |
| 4. Transport accident | 363 | 33.52 |
| 5. Nephritis, nephrotic syndrome | 360 | 33.24 |
| 6. Hypertension and cerebrovascular disease | 238 | 21.98 |
| 7. Other acidents | 189 | 17.45 |
| | | Nam |
| 1. Disease of hear | 332 | |
| 2. Pneumonia and other disease of lung | 289 | |
| 3. Accident and poisoning | 244 | |
| 4. Malignant neoplasms | 222 | |
| 5. Nephritis, nephrotic syndrome and nephrosis | 126 | |
| 6. Hypertension and cerebrovascular disease | 96 | |
| 7. Suicide, homicide and other injury | 65 | |
| 8. Disease of liver and pancrease | 29 | |

Source: Provincial Health Office, 1994