No. 3

THE KINGDOM OF THAILAND

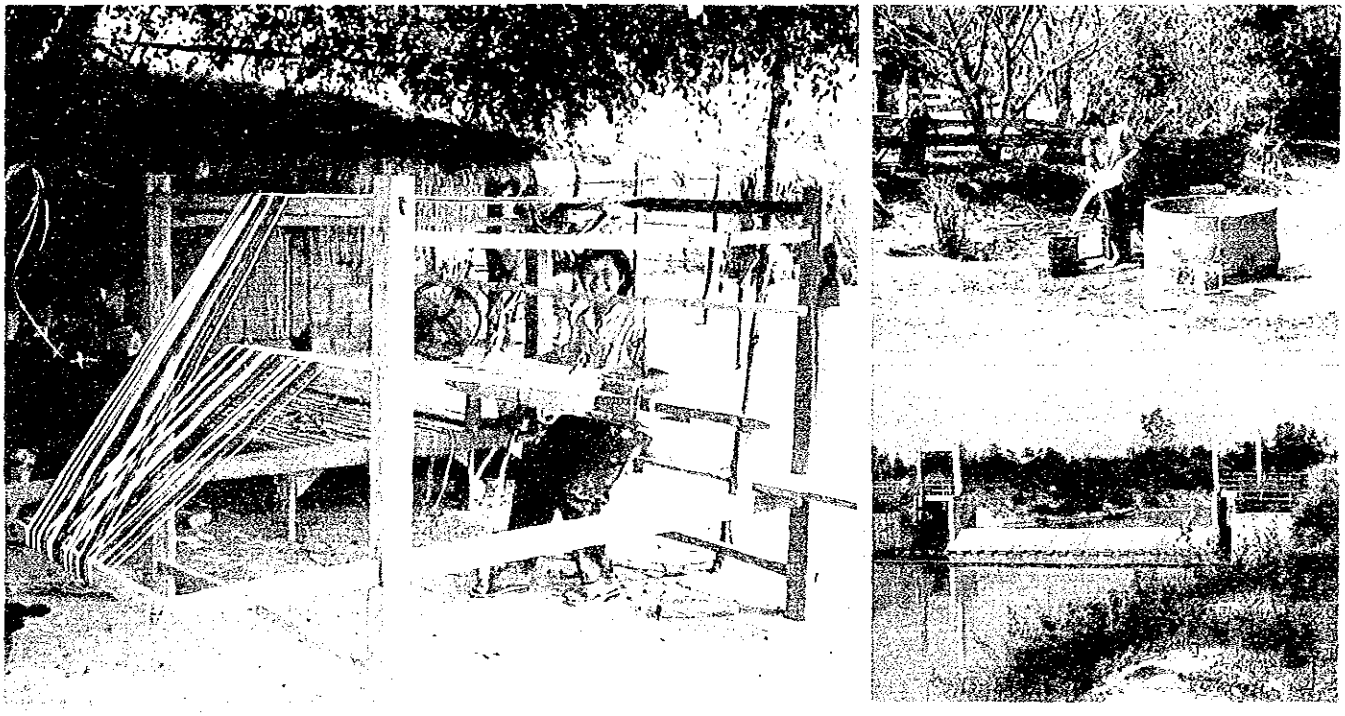
THE OFFICE OF ACCELERATED RURAL DEVELOPMENT

THE FEASIBILITY STUDY ON

THE INTEGRATED RURAL DEVELOPMENT PROJECT

AT LOWER NORTH THAILAND

MAIN REPORT



OCTOBER, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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FINAL REPORT

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a feasibility study on the Integrated Rural Development Project at Lower North Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr.Kunio Ohta, Sanyu Consultants Inc., from July 1990 to August 1991.

The team held discussions with the officials concerned of the Government of Thailand and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

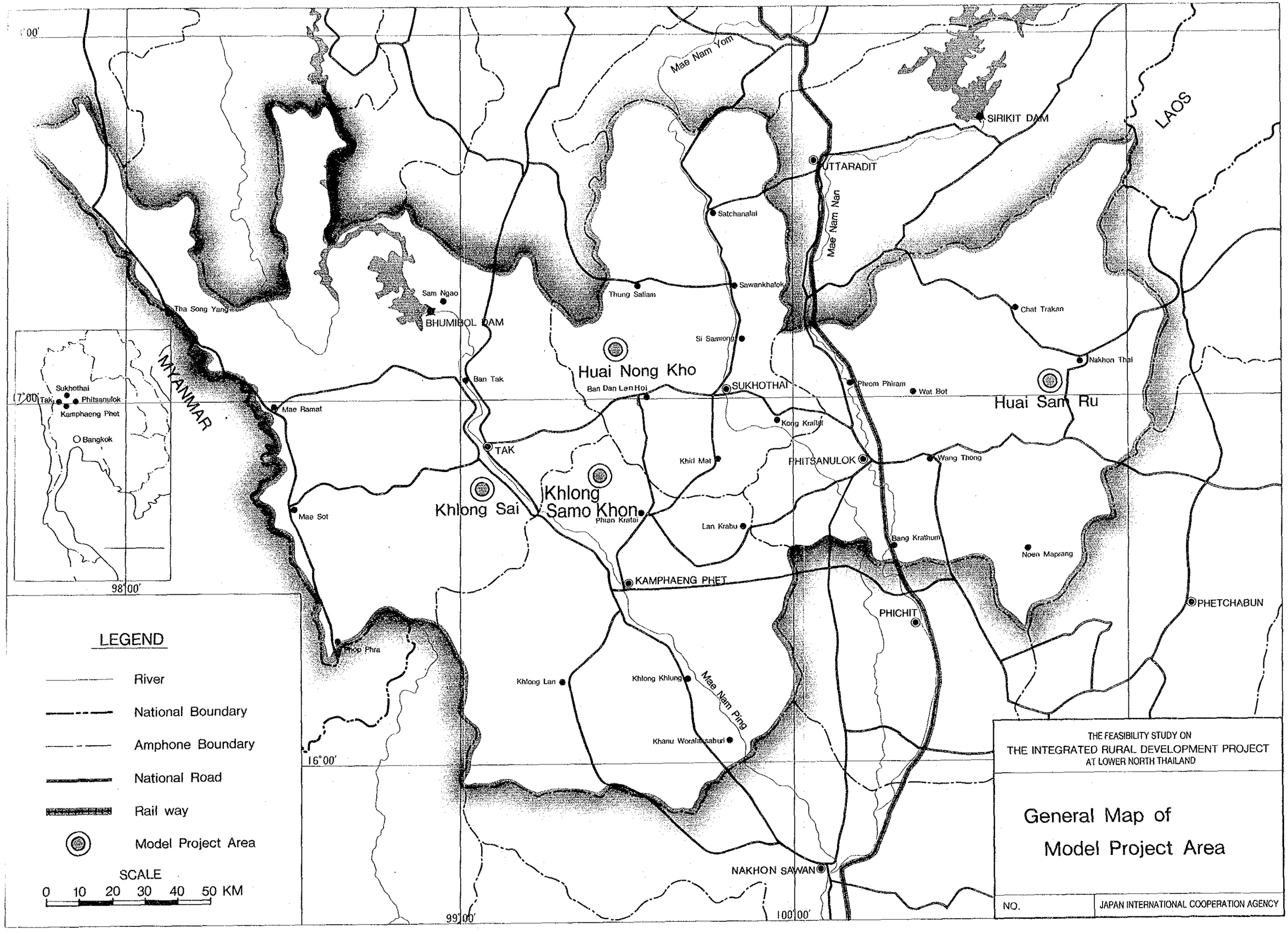
October, 1991

Kensuke Yanagiya

Kensuke Yanagiya

President

Japan International Cooperation Agency



LEGEND

- River
- National Boundary
- Amphone Boundary
- National Road
- Rail way
- Model Project Area

SCALE
0 10 20 30 40 50 KM

THE FEASIBILITY STUDY ON
THE INTEGRATED RURAL DEVELOPMENT PROJECT
AT LOWER NORTH THAILAND

General Map of Model Project Area

NO.

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

CHAPTER III SURVEY ON BACKWARD VILLAGES

CHAPTER IV DEVELOPMENT PROPOSAL

CHAPTER V OVERALL 5-YEAR DEVELOPMENT PLAN

CHAPTER VI MODEL PROJECT AREA

CHAPTER VII PLAN OF MODEL PROJECT

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS, GLOSSARY AND UNIT

Abbreviations

ARD	:	Office of Accelerated Rural Development, MOI
DLD	:	Department of Land Development, MOAC
DOAE	:	Department of Agricultural Extension, MOAC
DOF	:	Department of Fisheries, MOAC
JICA	:	Japan International Cooperation Agency
MOAC	:	Ministry of Agriculture and Cooperatives
MOI	:	Ministry of Interior
NESDB	:	National Economic and Social Development Board, Prime Ministers Office
RFD	:	Royal Forest Department, MOAC
RID	:	Royal Irrigation Department, MOAC
HYV	:	High Yielding Varieties
O & M	:	Operation and Maintenance
SSIP	:	Small Scale Irrigation Program
SSIFP	:	Small Swamp Inland Fisheries Project
OECF	:	Overage Economic Cooperation Founol

Glossary

Changwat	:	Province
Muang	:	Capital of Province
Amphoe	:	District
Tambon	:	Sub-district
Muban	:	Village
Mae Nam	:	Larger river
Nam	:	Medium river
Huai	:	Small river

Unit

Rai	:	Unit of land measurement	0.16 ha
Baht	:	Unit of Thai currency	
mm	:	Millimeter	
cm	:	Centimeter	
m	:	Meter	
km	:	Kilometer	
m^3	:	Cubic meter	
m^3/sec	:	Cubic meter per second	
km^2	:	Square kilometer	
ha	:	Hectare	
°C	:	Degree centigrade	
MCM	:	Million cubic meter	

SUMMARY AND RECOMMENDATION

SUMMARY AND RECOMMENDATION

I. INTRODUCTION

(Background of Study)

01 The Government of Thailand has set forth the rural development program, one of the most important polices of the Sixth National Economic and Social Development implemented in 1987, placing an emphasis on rural poverty alleviation, improvement of quality of life and rectification of intra-regional economic imbalances. In accordance with the scope of work agreed upon between the Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Office of Accelerated Rural Development of the Government of Thailand (hereinafter referred to as "ARD") on February 20, 1990, JICA sent the feasibility study team to Thailand in July, 1990 to conduct the study on the integrated rural development at the Lower North Thailand. The study was carried out over a two year period between 1991 and 1992. This final report was prepared in October, 1991. It presents the results of the study conducted in close cooperation with ARD and other government agencies concerned.

(Objective and Scope of Study)

02 The objective is to formulate the integrated rural development plan (overall 5-year plan) for backward villages in four provinces of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak at the Lower North Thailand, and to conduct the feasibility study for the integrated rural development of the four model areas selected.

The study was implemented in two phases. Phase I included ① preparation of inventories of backward villages, ② collection and analysis of existing data and information, ③ formulation of an overall 5-year development plan, and ④ selection of four model areas. Phase II included ① feasibility study of four model projects, ② project implementation planning, ③ an estimate of project costs and benefits, ④ project evaluation, and ⑤ recommendations.

II. GENERAL DESCRIPTION OF STUDY AREA

(Area and Population)

03 The study area comprises 33 Amphoe (district), 235 Tambon (sub-district) and 2,617 villages (Muban) with a total area of 42,427 sq.km, or equivalent to 8.3 percent of the country. The population of the study area increased from 2,078 thousand in 1981 to 2,331 thousand in 1988 at an annual rate of 1.7 percent.

(Rainfall and River Runoff)

04 The average annual rainfall through the study area amounts to around 1,000 to 1,500 mm; it shows a tendency to increase in both the western and eastern area and to decrease in the central area. In the northwest of the Doi Musoc mountains, ranging from north to south through Tak province, it reaches more than 1,800 mm. The study area can be divided into six river basins; 74 percent of the study area is covered by the basins of three big rivers, Ping, Nan and Yom. The average annual river runoff ranges from five to 15 ℓ/sec/sq.km. The annual runoff coefficients of annual rainfalls are estimated at 14 to 17 percent for the province of Sukhothai and east Tak, and 20 to 30 percent for other areas.

(Land Use)

05 Of the total area of four provinces, 1,492 thousand hectares of lands, or 35 percent, is farm land : 61 percent in Kamphaeng Phet province, 51 percent in Sukhothai province, 41 percent in Phitsanulok province, and nine percent in Tak province. 49 percent of the farm lands are shared by paddy fields and 41 percent by upland crop fields. The study area has a forest area of 2,013 thousand hectares, corresponding to 14 percent of the total forest in Thailand. The share of forest in the total study area decreased from 61 percent in 1973 to 47 percent in 1988. There are 63 reserve areas in the study area ; they include 49 national forest reserve areas, 10 national parks and four wild life conservation areas.

(Agriculture)

06 The total irrigation area of the study area amounts to 216 thousand hectares (or equivalent to 14 percent of the farm lands), a bit less than the national average irrigation efficiency of 17 percent. The highest irrigation efficiency is 20 percent in Phitsanulok province where the large scale irrigation

projects are in operation, while the least efficiency is 10 percent in Tak province.

07 Paddy is a major product in the study area. With the implementation of the irrigation projects in the lowlying areas along three large rivers, the cropping of dry season paddy has increased spreading to 14 percent of all paddy fields. Major upland crops prevailing in the study area are maize, soybean, mungbean and sugarcane. Upland paddy is grown in two provinces of Phitsanulok and Tak.

08 Under the supervision of the Department of Agricultural Extension, 315 provincial and local agricultural extension officers are in service. One extension officer is responsible for extension activity in nine villages with 1,100 to 1,400 farm families, except Tak province where one extension officer covers six villages with 626 farm families. The Department established three seed centers in the study area to produce and deliver recommended varieties of paddy, soybean, mungbean and sesame. The Tak sericulture center was established in 1989. The Sukhothai forage research center and the fisheries stations in Phitsanulok and Tak, are extending their services to rural people.

(Present Rural Development Project)

09 ARD provincial offices have actively promoted the implementation of rural development projects, and 32 irrigation projects, rural trunkroads amounting to 1,045 km and many wells and ponds have been constructed. In parallel with the construction of major infrastructures, ARD provincial offices are promoting the improvement of socio-economic conditions of rural people under the three programs of: ① rural youth training, ② occupation and income promotion, and ③ agri-business promotion.

10 In the study area, 101 thousand hectares of farm lands are irrigated with 266 small scale irrigation projects on a village basis, being constructed under the small scale irrigation program of the Royal Irrigation Department. The Department of Fisheries has formulated the small swamp inland fisheries project for the purpose of providing fish protein to rural people, and the project has been completed for the rehabilitation of 52 small swamps, three fish seed centers and two equipment centers in the study area.

III. SURVEY ON BACKWARD VILLAGES

(Backward Villages)

11 The inventory of backward villages on the present development levels have been made based on data in 1988 surveyed by the information system for rural development developed by the National Economic and Social Development Board (NESDB). According to the information system, NESDB divides all villages into three categories of backward, middle level and progressive according to their development levels of their socio-economic disposition. In the study area there are 994 backward villages that are in need of urgent development. Of 33 Amphoe, only Amphoe Si Satchanalai in Sukhothai province has no backward village. The distribution of the backward villages is summarized as follows:

BACKWARD VILLAGES

Province	Nos. of Amphoe	Nos. of Tambon	Nos. of Villages	Nos. of Backward Villages	(%)
Phitsanulok	9	67	825	282	(34)
Sukhothai	9	61	654	209	(32)
Kamphaeng Phet	7	61	695	288	(41)
Tak	8	46	443	215	(49)
Total	33	235	2,617	994	(38)

(Contents of Inventory)

12 Since 1982, the stored data in the information system for rural development has been updated every two years. The updated data in 1988, on which this study is based, is composed of 97 socio-economic items and 34 items regarding the development levels of the villages. The listings of socio-economic items provide general information about households, population, water use, social infrastructure and public services, farm economy, education, public health, labor, and quality of life, and for the present development level, they include infrastructure, productivity, public health, water use and educations.

(Analysis of Inventory)

13 The data contained in the inventory has been analyzed in order to clarify the problems confronting rural people, formulate a plan of approach to solve the problems, and select four model areas. The inventory data has been rearranged so that the present economic development level and the social

development level are explained quantitatively by employing two indicators : the income indicator expressed in terms of the average annual income per capita, and the quality of life indicator expressed in percentage in terms of dissatisfaction according to the 34 items regarding the quality of life set by NESDB.

(Priority Amphoe for Development)

14 The indicators of income and quality of life are assessed for all the backward villages, Tambon, Amphoe and the provinces. The priority of this development is ranked in order of low income for the income indicator, and in order of high dissatisfaction percentage for the quality of life indicator, and the average of both rankings present the overall priority for development of the villages, Tambon, Amphoe and the provinces. The present development levels and their priorities for the development of the four provinces are given below:

DEVELOPMENT LEVEL BY PROVINCE

Province	Income Indicator		Quality of Life Indicator		Average	Nos. of
	Baht/Person	Rank	%	Rank	Rank	Backward Villages
Phitsanulok	8,034	3	44.1	3	3	282
Sukhothai	7,898	2	45.6	2	2	209
Kamphaeng Phet	9,665	4	41.8	4	4	288
Tak	2,704	1	55.9	1	1	215

The present development level of provinces is low beginning with Tak, Sukhothai, Phitsanulok and ending with Kamphaeng Phet, among which Tak province is ranked exceptionally low compared to other provinces. The highest priority Amphoe which ranks from 1st to 5th on a provincial basis is given below:

PRIORITY AMPHOE BY PROVINCE

Phitsanulok Province		Sukhothai Province		Kamphaeng Phet Province		Tak Province	
Rank	Amphoe	Rank	Amphoe	Rank	Amphoe	Rank	Amphoe
1.	Nakhon Thai	1.	Ban Dan Lan Hoi	1.	Phran Kratai	1.	Tha Song Yang
2.	Noen Maprang	2.	Muang	2.	Khlong Lan	1.	Mae Ramat
3.	Muang	3.	Thung Saliam	3.	Muang	3.	Umphang
3.	Chat Trakan	4.	Khri Mat	3.	Khanuworalak Buri	4.	Sam Ngao
5.	Wat Bot	4.	Sawan Khalok	5.	Khlong Khlung	5.	Mae Sot

(Income Indicator)

15. The annual average income per capita, as the income indicator, is calculated based on the inventory data. The rates of diffusion of the backward villages whose annual average income per capita is less than 4,000 Baht, deemed as the absolute poverty line, are 80 percent in Tak province, 23 percent in Phitsanulok province, 22 percent in Sukhothai province and 16 percent in Kamphaeng Phet province, with the average of 33 percent in the four provinces. The economy of the backward villages depends mostly on agricultural income, and more than 90 percent of the annual income is derived from the rainy season cropping, monoculture relying on rainfed cropping.

(Social Infrastructure and Public Services)

16. The evaluation of the present development levels of social infrastructure, public health and education, which are closely related to the quality of life, is also based on the inventory data. The ratios of households with electrification are 52.0 percent, 33.4 percent and 38.2 percent in Phitsanulok province, Sukhothai province and Kamphaeng Phet province respectively, but, the ratio in Tak province is only 20.1 percent. The rates of backward villages utilizating pavement, including laterite paved roads of Amphoe roads and market roads, are more than 90 percent, thus exceeding Tak province where the rate is between 56 to 62 percent.

(Public Health)

17. The backward villages with a hospital or clinic account for only four to five percent of the total backward villages in the three provinces, not including Kamphaeng Phet province which has a rate of eight percent. On the other hand, child nutritional centers have been established in more than 85 percent of all backward villages. The ratio of nutrition survey services for one to five years old children is 94 percent in Kamphaeng Phet province, 85 percent in Sukhothai province, 84 percent in Phitsanulok province and 65 percent in Tak province. This directly affects the malnutrition rate, thus the rate ranks from lowest to highest in the following order : Kamphaeng Phet province, Sukhothai province, Phitsanulok province and Tak province.

(Education)

18. Education is closely connected with the quality of life, as well as indirectly connected with the improvement of agricultural productivity through agricultural technique extension, improvement of public health

through public health knowledge, and increase in job opportunities through technical training. In Tak province, the ratio of finishing primary education is as low as 23.1 percent, which appears low when compared to three different provinces having a ratio of 62 to 66 percent. The literacy ratio is more than 90 percent, including Tak province ; yet, the average frequency of training is less than once a year.

(Rural Road)

19. Rural roads are important infrastructures for rural people ; they provide access to public services as well as markets. The rural road networks in Tak province are so underdeveloped that 30 percent and 38 percent of the backward villages are not respectively linked with Amphoe roads and market roads, while in another three provinces only one to two percent of the villages are not linked; however, many rural roads are impassable during the rainy season.

(Rural Water Supply)

20. Rural water supplies are closely related to the quality of life. As far as the rural water supply is concerned, Tak province is distinguished from the other three provinces by the relatively high spread of water pipelines ; 21 percent of backward villages have pipelines and 14 percent of households are equipped with pipelines. About 70 percent of the households replied that they are satisfied with the present water supply for drinking.

IV DEVELOPMENT PROPOSAL

(Objective of Rural Development)

21. The social and economical problems, that confront the people of 994 backward villages, have been revealed by the analysis of the NESDB data base survey. Based on the outcome of the analysis, the problems to be solved for the development of the backward villages have been identified as: ① low agricultural productivity leading to inadequate income, ② shortage of water to meet the people's basic needs, ③ inconvenient road systems covering villages with Amphoe and markets, ④ poor health and sanitation, and ⑤ lack of knowledge of developing the quality of life and income increase.

Economic depression may be responsible for disease, poor health and the lack of knowledge and education. For stimulating economic growth, in addition to investment in agricultural development, the provision of infrastructure-roads, water, electricity, schools, etc.- are essential for enhancing farm productivity and the quality of life. From this point of view, development objectives of the Integrated Rural Development at the Lower North Thailand have been set forth as follows:

① To increase the income level of the people in the backward villages through the improvement of agricultural productivity and production, the major economic activity in the areas, and

② To improve the access of the peoples in the backward villages to social infrastructures and public services.

(Agricultural Development)

22. So far, the increase in agricultural production, attained in the study area, is mainly attributed to farm land expansion. There is little scope for the supply of unused arable land as forest is to be reserved. Cropping is being practiced in the backward areas without irrigation, hence, they are relying on rainfall that fluctuates seasonally and yearly. Under such circumstances, the project emphasizes the improvement of agricultural production on the existing farm lands, particularly rice, an important staple food. Initially, the aim is to achieve self-sufficiency in food production, then it will shift to commercial agriculture to increase farm income and job opportunities.

Agricultural development involves development of irrigation and production support such as extension services, and supply of input (i.e., seeds, fertilizers, etc., institutional credit, and so on). Irrigation development shall be promoted where physical conditions allow the development of water resources. Guidelines for agricultural development are summarized as follows : ① improvement of paddy cropping system, ② crop diversification, ③ improvement of rainfed agriculture, and ④ introduction of mixed farming.

(Orchard, Sericulture, Cattle Raising and Fisheries)

23. Fruit and tree crops suitable for the study areas include mangos, tamarinds, bananas of Khloh Khwai species and bamboo shoots. Through the application of fertilizers and chemicals and the introduction of irrigation and

group work, the productivity of fruit and tree crops will be improve as well as quality. Farmers' groups will be organized for the undertaking of group works. Bamboo shoots are in great demand, and are considered to be one of the promising crops in the study area where there are many highlands and inter mountain areas.

The Department of Agriculture established the Tak sericulture center in 1990 as the base for the development of sericulture in the North Thailand, and one of the biggest four silk reeling factories, located in Phetchabun province which is adjacent to the study area, is in operation This factory supplies silkworm eggs to farmers and it purchases cocoons from the farmers. The project proposes to promote sericulture in the study area making better use of the above situation.

The demand for meat is increasing. Generally, cattle in the study area are raised in natural grasslands through extensive pastoral farming, resulting in low capacities for carrying and breeding. With the improvement of pasture lands and bathing places, as well as provisions of supplemental feed during the dry season, cattle raising will be promoted, for which farmer groups will be established.

In the Lower North Thailand, so called flood fisheries were ever extensively practiced with abundant supplies of flood water from big rivers that run through the area; however, inland fisheries are on the decline due to the sedimentation of swamps and decrease in flooding after the completion of large scale water resources development projects. Swamps will be rehabilitated with the construction of dikes, spillways and outlet works so as to maintain water surface area with a moderate water depth for fisheries.

(Irrigation Development)

24. About 90 percent of the annual rainfalls concentrate in six months of the rainy season, or 50 percent in a three month period. Agriculture in the backward villages is operated under the influence of the rainfall which fluctuates in annual and seasonal patterns. Water resources developments, in the study area, requires some form of artificial storage and regulation of free-flowing water resources. High priorities are given to storage schemes, and run-of-river schemes to divert free-flowing water with a diversion weir will be proposed for river sites that have no potential for dam construction.

(Social Infrastructure)

25. This project will provide ① the ARD standard road networks as rural trunkroads to connect isolated Tambon with market centers, towns and government facilities and services, and ② service road networks to connect the backward villages with existing all-weather roads or proposed ARD road networks. With respect to the present road networks, the problem to be pointed out is that many roads are impassable during the rainy season due to poor maintenance of roads and in some cases malfunction of drainage facilities. Amphoe roads and market roads are impassable during the rainy season for 20 to 40 percent of the backward villages within the four provinces.

Accordingly, the improvement and maintenance of the existing roads will be strengthened. Provisions of rural roads will enable farmers to go to markets, and traders, middlemen and service officials to visit the villages. As a result of the construction of rural roads, electrification will be easily promoted.

26. The goal of rural domestic water supplies, under the direction of the government, is to upgrade service levels to level 3 as specified by the NESDB that at least 70 percent of households in a village should enjoy fresh drinking water throughout the year in terms of both quantity of two ℓ/person/day and quality. In the study area, 442 backward villages do not attain this level of service.

The project proposes to provide deep wells in the backward villages, where groundwater yields more than 20 gpm, in order to supply water for drinking and daily use at the ARD rate of 60 ℓ/person/day. Deep wells will be provided for backward villages, but no distribution system. Groundwater, which requires no treatment, is preferable to surface water as a low-cost technology to rural development.

27. According to the NESDB data base on rural electrification, the number of Amphoe, where more than 50 percent of the households are not electrified, is three in Phitsanulok province, seven in Kamphaeng Phet province, seven in Sukhothai province and eight in Tak province, totaling 25 Amphoe. As rural electrification is a basic minimum need and plays an important role in the improvement of agricultural production and quality of life, the project proposes to promote the rural electrification development to raise the electrification ratio to over 50 percent for all backward villages. The

implementation of rural road development projects will accelerate electrification work.

(Rural Infrastructure)

28. In the integrated rural development, in addition to the agriculture and social infrastructure development including irrigation facilities, roads, and water supplies, the arrangement of rural infrastructure plays an important role in agricultural extension, enhancing the value addition to agricultural products, and creating employment opportunities. In this view, ARD is promoting the arrangement of rural infrastructure under the programme of rural youth training, employment promotion and income increase and agri-business promotion. The rural infrastructure development programmes are formulated, in coordination with the ARD policies; the actual situation of the project area can be grasped by inventory and field surveys.

In this integrated rural development project, agricultural extension will be performed for the selected young farmers as well as for female farmers in the project areas. The obtained agricultural technique shall be transferred to other regional farmers, thereby improving the agricultural technique of all farmers shortly and efficiently in conjunction with extension services by the Department of Agricultural Extension. In addition to agricultural extension, technical training for cottage industries, fishery, sericulture, and livestock raising, participation in the planning of integrated rural development, operation and maintenance of projects and job training for rural youth and women shall be carried out. To this end, the project will provide the rural youth and agricultural technology training centers on the Amphoe basis.

29. The purpose of employment promotion and income enhancement programme is to absorb the surplus of labor during the dry season, to create job opportunities for practical use of abilities of women, and to increase the cash income by improving the value of agricultural products. Taking into account the accessibility to raw materials and skills, the cottage industries to be promoted include silk weaving, bamboo craft art, and jewelry polishing. These products shall be marketed through the Government-assisted Narayana hand-craft products center; jewelry shall be also marketed through the Government-assisted Asian jewelry science center.

30. Part of the infrastructure network, which assumes increasing importance in farm surplus growth, is the postharvest system for collecting, storing, transporting, processing, and retailing those surpluses. The lack of marketing opportunity acts as disincentive to farmers. This integrated rural development project will promote provisions for rice mills, grain storage facilities, vegetable and fruit collecting houses and village shops that are closely related to increasing the value added to farm products.

V. OVERALL 5-YEAR DEVELOPMENT PLAN

(Project Components)

31. To attain the objective of rural development aiming to raise income through the improvement of productivity and production of agriculture, main economic activities in the area, and to improve access to social infrastructure and public services, the integrated rural development project for 994 backward villages in four provinces of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak has been proposed to cover the fields of agriculture, irrigation, rural roads, rural water supplies, rural infrastructure, rural electrification, public health and education.

Among several project components deemed necessary to solve the problems confronting rural populations in the backward villages, four project components of irrigated agriculture development, rural road development, rural water supply development and rural infrastructure development, which are practicable under the responsibility of the Office of Accelerated Rural Development with the close cooperation of other government agencies concerned, have been incorporated into the integrated rural development, as given below:

① Irrigated Agriculture Development
- Water resources development for irrigation by constructing dams and weirs,
- Construction of irrigation canal systems,
- Construction of on-farm facilities,
- Water management on farm level by water users' group, and
- Strengthening of agricultural supporting services.

② Rural Road Development
- Construction of rural trunkroads to connect main villages with markets and centers of public services,
- Construction of service roads to connect backward villages with rural trunkroads, and
- Improvement of existing roads.

③ Rural Water Supply Development
- Construction of deep wells for water supply of drinking and daily use.

④ Rural Infrastructure Development
- Establishment of rural youth and agricultural technology training centers, and
- Promotion of cottage industries.

32. Projects for the development of rural electrification, public health and education, which closely relate to the improvement of the quality of life, shall be implemented by other government agencies than the Office of Accelerated Rural Development, through the coordination by the National Rural Development Coordinating Centre, in line with the proposed implementation schedule for this integrated rural development project.

Efficient marketing for the surplus of small farmers demands rapid responses to varied and quickly changing local requirements, a task not suited for farmers nor centrally administrated agencies. Therefore, the project expects these projects to be invested and managed by the private sector. The construction of primary infrastructure consisting of irrigation facilities, roads, and electricity under the integrated rural development plan shall create the incentives for private sector to participate in the project.

(Overall 5-Year Development Plan)

33. Implementation and operation of the integrated rural development projects involve many government agencies and villagers concerned, and need agricultural supporting services such as extension of improved farming management, prompt supplies of farm input materials, proper water management and so on. There is a financial conflict with other development projects and limitation of engineering capacities when the integrated rural

development project at Lower North Thailand is proposed to function on a short-term program.

Based on the development proposal, potential projects were identified. The priority projects that are in need of urgent development, or have high project impacts on rural areas have been incorporated into the overall 5-year development project plan which is to be implemented in the next national plan period from 1992 to 1996.

(Model Areas)

34. At the initial stage of the implementation of the integrated rural development project, the project should be started on a model project basis in a few selected areas. This is necessary in order to : ① formulate a development plan that concentrates on actual problems confronting rural people in different backward villages scattered amongst the four provinces with different natural, socio-economic conditions, and ② assess the benefits to be generated from different project components through monitoring and evaluating of implementing problems, obstacles in project areas and changes in rural people's standards of living. The experience and the achievement help in planning long-term schemes on the integrated rural development project.

The model areas were selected on the basis of the following criterion: ① areas in need of urgent development because of their present low development levels with respect to economy and the quality of life, ② areas which make effective model projects and represent the general situation in the study region. These area will have better access. ③ areas with bordering areas which possess potentiality to develop water resources for irrigation of dry season crops, the key industries in the study area, and ④ areas with villagers willing to join the project.

35. As a result of selection, four Amphoe have been selected as model areas: Amphoe Nakhon Thai in Phitsanulok province, Amphoe Ban Dan Lan Hoi in Sukhothai province, Amphoe Phran Kratai in Kamphaeng Phet province and Muang Tak in Tak province. Three Amphoe, except Muang Tak, are given top priority for development as discussed in III-Backward Villages and these areas have potentialities to construct dams and reservoirs as well as better access to the areas.

In Tak province, though given high priority for development, three Amphoe of Tha Song Yang, Mae Ramat and Umphang are screened out from the selection of the model area because the physical and socio-economic conditions do not represent the general situation of Tak province, thus Muang Tak has been selected. The area could be characterized as an economically and socially stagnated area, yet it is located in the relatively developed Amphoe where the provincial capital is seated.

(Irrigation Development)

36. The initial selection of possible damsites was based on the topographic maps with a scale of 1 : 50,000 and contour intervals of 20 m on which all the information of the existing irrigation projects and locations of the backward villages were shown. The damsites that cause villages or considerably wide farm lands to be submerged, or that may conflict with existing irrigation projects were excepted from the list of possible damsites. As a result, 43 possible damsites have been listed.

The reconnaissance field investigation was made into the possible damsites, beneficial areas and backward villages. Such damsites as have existing farm lands and A1 reserved forest within the proposed submerged areas, and have potentiality of large scale water resources development were excluded, thus leading to the selection of 12 potential damsites. The overall 5-year development plan has proposed to construct four dams, all of which are included in the model projects.

37. According to topographic maps with a scale of 1 : 50,000, the locations of proposed diversion weirs are confined to areas that are located just upstream of the backward villages within a several hundred meters. The project excluded sites with a catchment area of more than 100 sq.km, which needs high investment costs for spillways, and less than five sq.km. As a result of the selection of construction sites for diversion weirs, 55 potential construction sites have been screened as potential sites.

In the selection of the priority projects for the overall 5-year development plan, first priority is given to projects which are connected with the existing and/or proposed rural trunkroads, and second priority to projects which cover the backward villages with high priority for development, resulting in selection of 26 irrigation projects of run-of-river scheme.

The overall 5-year development plan will provide the following irrigation projects:

PROPOSED IRRIGATION PROJECT

Province	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
Nos. of Irrigation Project					
- Storage Scheme	1	1	1	1	4
- Run-of-River Scheme	5	4	9	8	26
Total	6	5	10	9	30
Irrigation Area (ha)					
- Paddy Fields	1,267	1,565	2,711	2,373	7,916
- Upland Crop Fields	647	119	26	143	935
- Orchards	188	100	22	144	454
Total	2,102	1,784	2,759	2,660	9,305

(Sericulture, Cattle Raining and Fisheries)

39. In line with the regional agricultural development plan prepared on an Amphoe basis, the overall 5-year development plan has proposed to promote sericulture in nine Amphoe and cattle raising in 10 Amphoe. For sericulture promotion, farmers' groups shall be organized; each group consisting of 20 farmers with 16 ha of mulberry fields. Farmers' groups shall also be organized for the promotion of cattle raising; each standard group shall be composed of 50 farmers with 50 ha of pasturelands. For the development of inland fisheries, the rehabilitation of 52 small scale swamps has been proposed. Numbers and sizes of the selected swamps, other than model projects, are assumed to be based on the experience of the small swamp inland fisheries projects in the study area. Outlines of the proposed projects are given below:

DEVELOPMENT OF SERICULTURE, CATTLE RAISING AND FISHERIES

- Unit: Nos. of Project -

Project	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
Sericulture	12	8	12	4	36
Cattle Raising	4	4	6	6	20
Inland Fisheries	14	17	14	7	52
Water Area (ha)	149	272	241	42	704

(Rural Road Development)

40 The plan to develop rural road networks to connect the backward villages with Amphoe and market centers are based on the topographic maps with a scale of 1 : 50,000. To select priority roads to be implemented under the overall 5-year development plan, first priority is given to the completion of the on-going ARD road projects, and to the construction of service roads to connect the backward villages with the proposed first priority roads. Second priority is given to the construction of service roads to connect the backward villages with the existing national, provincial and rural trunkroads, and to the pavement of the sections within villages of ARD roads.

As a result of the selection of priority rural roads development projects, as mentioned above, the following roads have been proposed to be implemented with the overall 5-year development plan.

SUMMARY OF PROPOSED RURAL ROAD PROJECT

Province	Rural Trunkroads		Service Roads (km)	Pavement of Existing Road (km)	Nos.of Backward Village
	Nos.of Roads	Length(km)			
Phitsanulok	11	235.9	127.7	27.8	148
Sukhothai	5	105.6	135.5	10.5	97
Kamphaeng Phet	7	89.0	252.0	16.0	178
Tak	3	23.0	91.0	5.5	119
Total	26	453.5	606.2	59.8	542

(Rural Water Supply Development)

41. According to the inventory, 442 backward villages are not satisfied with the present supply, of which 411 backward villages are located in areas where the development of groundwater of more than 20 gpm (or 75.7 ℓ/minute) is expected. Since water for domestic use is a basic human need, the project has proposed to provide deep wells to the above 411 backward villages for supplies for of drinking and daily use during the overall 5-year development period. Summaries of the rural water supply development projects are as follows:

OUTLINE OF RURAL WATER SUPPLY PROJECTS

Province	Objective Backward Village	Proposed Backward Villages	Nos.of Deep Wells
Phitsanulok	126	126	176
Sukhothai	85	85	118
Kamphaeng Phet	157	150	211
Tak	74	50	69
Total	442	411	574

(Rural Infrastructure Development)

42. The training center for rural youth and agricultural technology will be established on an Amphoe basis. The overall 5-year development plan will provide four centres; one center for each model project. The center will be stationed in the center of Amphoe for better access and maintenance of facilities.

Due to increasing demand, the overall 5-year development plan has proposed to promote three kinds of cottage industries: silk weaving, bamboo art craft and jewelry polishing; these are in practice in the study area. To promote cottage industry, farmer's groups will be organized with group working facilities: five farm households for a silk weaving group, 20 farm households for a bamboo art craft group and 20 farm households for a jewelry polishing group. The following group working facilities will be constructed on a pilot basis for the promotion of cottage industries.

GROUP WORKING FACILITIES FOR COTTAGE INDUSTRIES

Province	Silk Weaving		Bamboo Art Craft		Jewel Polishing	
	Nos.of Amphoe	Nos.of Facilities	Nos.of Amphoe	Nos.of Facilities	Nos.of Amphoe	Nos.of Facilities
Phitsanulok	1	1	2	4	2	2
Sukhothai	1	1	3	6	2	2
Kamphaeng Phet	1	1	2	4	2	2
Tak	1	1	5	10	2	2
Total	4	4	12	24	8	8

VI. PLAN OF MODEL PROJECTS

(Present Situation)

43. Four areas are selected as model project areas to be implemented under the overall 5-year development plan on the integrated rural development at the Lower North Thailand, and a feasibility study has been conducted for these four model projects. Locations of the model project area are given below:

LOCATION OF MODEL PROJECT AREAS

Name of Areas	Province	Amphoe	Nos. of Villages
Huai Sam Ru	Phitsanulok	Nakhon Thai	3
Huai Nong Kho	Sukhothai	Ban Dan Lan Hoi	4
Khlong Samo Khon	Kamphaeng Phet	Phran Kratai	2
Khlong Sai	Tak	Muang Tak	4

The irrigable lands are selected among the existing farm lands of the backward villages, and the farm lands of other villages than the backward located just downstream of the proposed reservoirs are also included in the project area as far as water resources allow to do so. The gross project areas of four model projects amount to 2,950 ha including villages, forest lands, rivers and others, as summarized below;

GROSS PROJECT AREAS

- Unit: ha -

Model Area	Farm Land	Villages	Forest and Others	Total
Huai Sam Ru	1,130	53	207	1,390
Huai Nong Kho	624	11	75	710
Khlong Samo Khon	200	12	28	240
Khlong Sai	489	57	64	610
Total	2,443	133	374	2,950

The total population of the four model project areas in 1988 was 10,145 people with 2,272 households, which is equivalent to an average of 4.47 people per family unit.

44. The land use survey is based on map analysis of the model areas, aerial photographs and field reconnaissance. Out of the total project area of

2,950 ha, 2,443 ha, or equivalent to 83 percent of the total project area, are classified as farm lands. Present farm land use is given as follows:

PRESENT FARM LAND USE

Farm Land	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total	%
Paddy Field	107	353	144	57	661	(27)
Upland Crop Field	727	202	30	238	1,197	(49)
Orchard	50	39	5	30	124	(5)
Fallow Land	246	30	21	164	461	(19)
Total	1,130	624	200	489	2,443	(100)

Major crops prevailing in the areas include rainy season paddy in paddy fields, but no second cropping, and maize, mungbean, soybean and groundnut in upland crop fields. Cassava and sugarcane are cropped in the Sam Ru area and the Khlong Samo Khon area, respectively. Vegetables are grown on a small scale around villages. Mango and banana are the main fruits grown in the areas.

(Backward Villages)

45. Of 13 villages involved in the model projects, eight villages are classified as backward villages. The present development levels of the backward villages are grasped from the NESDB data base which clarify the problems confronting villagers and needs for development. The backward villages are listed as follows:

LIST OF BACKWARD VILLAGES

Model Area	Tambon	Village	NESDB Code
Huai Sam Ru	Nong Katoa	Kaeng Wa	030708
	-do-	Kaeng Hai	030711
	Bang Yaeng	Sam Ru	030610
Huai Nong Kho	Wang Nam Khaw	Wang Phong	050408
	-do-	Lan Thong	070406
Khlong Samo Khon	Tha Mai	Samo Khon	040501
	-do-	Nam Dip Ma Praw	040506
Khlong Sai	Chung Thong	Wang Tamlung	010509

All villages involved in the two model projects of Huai Sam Ru and Khlong Samo Khon are backward villages; 73 percent of the households in Huai Nong Kho area and nine percent of the households in Khlong Sai area make a living in the backward villages. All villages, totaling a population of 6,376 people, or 1,357 households, would enjoy the benefits to be generated from the implementation of the model projects. The quality of life indicator expressed in percentage in terms of dissatisfaction ratio exceeds 50 percent in all the backward villages, being higher than the provincial average. In three backward villages in Huai Sam Ru area, the dissatisfaction ratios are as high as 67.6 to 70.6 percent, while the provincial average of Phitsanulok is 44.1 percent.

(Irrigated Agriculture Development)

46. This project has proposed to convert farm lands suitable for paddy cultivation into paddy fields. In accordance with the land classification study, 180 ha of upland crop fields will be converted into paddy fields: 98 ha in Huai Sam Ru area, 31 ha in Huai Nong Kho area and 51 ha in Khlong Sai area.

By introducing irrigation, fallow lands will be used as orchard or upland crop fields, depending on their suitability for cropping. The proposed land use of the model areas is given as follows:

PROPOSED LAND USE

- Unit: ha -

Land	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Paddy Field	187	355	131	103	776
Upland Crop Field	647	119	26	143	935
Orchard	188	100	22	144	454
Sub-total	1,022	574	179	390	2,165
Villages	53	11	12	57	133
Forest and Others	315	125	49	163	607
Sub-total	368	136	61	220	785
Total	1,390	710	240	610	2,950

47. The proposed storage of water will be firstly used to stabilize paddy cropping during the rainy season, and upland cropping during the dry

season.Cash crops, such as vegetables will be introduced to about 40 percent of the project area. Leguminous crops are recommended for the fundamentals of increasing soil fertility. Crop selection is based on the policy of provincial DAE offices, marketability and farming practice found in and around the model areas. Main crops, second to paddy crops, include groundnut, soybean and mungbean; upland field crops include maize, groundnut, soybean, mungbean, redbeans, vegetables, sugarcane, and asparagus. Orchards include mangos, tamarinds, mulberries and bamboo shoots.

Target yields are estimated with the consideration of agricultural statistics available in and around the project areas, yields attained in irrigation areas and survey results of sample farmers. The scale of the model projects is as small as 179 to 1,022 ha. The rural youth and agricultural technology training center will be established through the implementation of the project. This implementation may be highly efficient for producing agricultural extension services. Under the situations, the following target yields are projected:

TARGET YIELDS

- Unit : kg/ha -

Crop	Yield	Crop	Yield
Paddy	4,000	Sugarcane	62,500
Maize	2,500	Vegetable	15,160
Soybean	1,875	Asparagus	6,000
Mungbean	1,125	Mango	15,625
Redbean	1,500	Bamboo Shoots	8,200
Groundnut	1,875	Cocoon	300

(Sericulture, Cattle Raising and Fisheries)

48. According to the classification study concerning fallow land use, 128 ha of land will be converted into mulberry fields and 130 ha of lands will be converted into pasture. Site selection of small swamps with a moderate catchment area and water depths of two to three m is based on the topographic maps of the project areas; as a result, four small swamps are proposed to be rehabilitated for inland fisheries development purpose with the construction of dikes and water control facilities. Outlines of the proposed project are presented as below:

SERICULTURE, CATTLE RAISING FISHERIES AND FISHERIES

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Cattle Raising					
- Nos. of Groups	2	1	-	1	4
- Nos. of Members	76	36	-	16	128
- Pasture Land (ha)	77	37	-	16	130
- Nos. of Cattle	190	90	-	40	320
Sericulture					
- Nos. of Groups	2	1	1	3	7
- Nos. of Members	40	30	20	70	160
- Mulberry Field (ha)	32	24	16	56	128
- Group Work House	2	1	1	3	7
Inland Fisheries					
- Nos. of Group	1	1	1	1	4
- Water Area (ha)	3.70	1.88	3.13	5.30	14.01

(Irrigation Development)

49. To determine reasonable irrigation areas, with the proposed calendars and the given reservoir storage capacities, reservoir operations are examined on a monthly basis for a two year period on the condition that the first year is the dry year and the second year is the wet year, both with a return period of 10 years. The simulation of reservoir operation are run by substituting variable dry season irrigation areas into the balance equation to obtain a maximum irrigation area that reservoir water contents recover to full contents at the end of the October of the second year. In the simulation, irrigation efficiency is estimated at 58 percent, and water losses from evaporation of the reservoir surface and percolation through the reservoirs are accounted. As a result, with a combined storage of 15 - 31 million cu.m, 2,165 ha and 1,140 ha of farm lands will be irrigated during the rainy season and dry season as follows:

PROPOSED IRRIGATION AREA

- Unit ha -

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Effective Storage (MCM)	3.98	6.79	2.40	2.14	15.31
Rainy Season Irrigation	1,022	574	179	390	2,165
Dry Season Irrigation	518	290	85	247	1,140
Total	1,540	864	264	637	3,305

(Irrigation Facilities)

50 Judging from the topographical and geological conditions of damsites, as well as the quality and quantity of construction materials available at the sites, earth-fill dams are recommended. Major features of the proposed dams and reservoirs are as follows:

PROPOSED DAM AND RESERVOIR

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Dam Length (m)	260	935	1,380	1,345
Dam Height (m)	23.9	19.4	11.0	12.1
Embankment (1,000 cu.m)	122	398	138	181
Design Flood (cu.m/sec)	170	55	45	187
Catchment Area (ha)	2,800	3,400	1,300	4,700
Reservoir Area (ha)	79	203	143	145
Gross Storage (MCM)	4.30	7.30	2.60	2.85
Flood Level (El.m)	310.4	139.5	141.0	171.1

Main and lateral canals are designed to be trapezoid channels with concrete lining with a conveyance capacity of 1.62 ℓ/sec/ha. Canals will be constructed to command an irrigation area down to a terminal irrigation block of 16 ha (or, 100 rai). Regulators with measuring devices, check structures, drops and so on will be provided for efficient water control. Tails of irrigation canals are connected with existing rivers to drain excess water in the canals. Major features of the canal systems are summarized as follows:

PROPOSED IRRIGATION SYSTEMS

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
① Main Canals				
- Irrigation Area (ha)	1,022	574	179	390
- Canal Length (km)	13.50	7.20	8.95	9.90
- Max. Discharge(cu.m/sec)	1.66	0.52	0.29	0.53
② Lateral Canals				
- Nos. of Canals	15	2	2	6
- Canal Length (km)	23.40	1.80	3.10	9.63

(Rural Road Development)

51. Two existing roads to link the project areas to national highways will be improved as the ARD standard road. The improvement of service roads is proposed to connect villages with existing rural trunkroads. Road sections within villages will be paved with concrete I blocks. Outlines of the proposal for rural road are given below:

PROPOSED RURAL ROAD DEVELOPMENT

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
ARD Standard Road					
- Nos. of Routes	1	1	-	-	2
- Length (km)	13.5	22.0	-	-	35.5
Service Road					
- Nos. of Routes	2	2	1	1	6
- Length (km)	2.0	13.0	1.0	0.9	16.9
Total Length (km)	15.5	35.0	1.0	0.9	52.4
of which, Pavement (km)	1.0	5.0	1.0	-	7.0

(Rural Water Supply Development)

52. The model projects will provide deep wells with a four-inch bores and hand pumps for water supplies for drinking and daily use. The minimum space between deep wells shall be 1,000 m as deep wells are assumed to have a 500 m radius of the circle of influence. Yields for deep wells are estimated to be at

least 20 gpm (or, 75.7 ℓ/minute). The average depth of wells is assumed to be 50 m from the experience of ARD projects. The number of proposed deep wells is based on the standard water demand of 60 ℓ/day per capita, as given below;

OUTLINE OF RURAL WATER SUPPLY DEVELOPMENT

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Nos. of Villages	3	4	2	4	13
Nos. of Deep Wells	3	7	4	6	20

(Rural Infrastructure Development)

53. The model projects will provide four rural youth and agricultural technology training centers: one center for each project. The centers will be established in the seat of Amphoe office namely, Nakhon Thai, Ban Dan Lan Hoi, Phran Kratai, and Muang Tak. The center with a floor space of 144 sq.m have an administration office, meeting rooms and training rooms for the use of rural youth and villagers for training of vocational skills and improved agricultural technology. Furthermore, the center will be utilized for exhibitions of agricultural products and cottage industry product, thus functioning as the center of the integrated rural development project. The center will be equipped with equipment for office and extension service uses. The Office of Accelerated Rural Development will be responsible for the management of the centers.

The model projects will provide the group working houses for the promotion of silk weaving and bamboo art crafting in the model areas where materials are available. The group working houses will be managed by farmers' groups: five farmers for a silk weaving group and 20 farmers for a bamboo art craft group. Jewelry polishing, one of the most flourishing cottage industries in Thailand, will be promoted in the Khlong Sai area in Tak province, as a pilot project. A farmers' group composed of 20 members will be organized to manage the group working house for jewelry polishing; they will work on a contract basis with jewelers. The number of group working houses for the cottage industries are given as follows:

GROUP WORKING HOUSES FOR COTTAGE INDUSTRY

Type of Work	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Silk Weaving	1	1	1	4
Bamboo Art Craft	1	1	-	2
Jewel Polishing	-	-	-	1
Total	2	2	1	7

VII. PROJECT IMPLEMENTATION AND PROJECT COST

(Project Implementation)

54. The implementation of the integrated rural development project at the Lower North Thailand involves many ministries, government agencies and private sectors. These offices include the five principal ministries: Interior, Agriculture and Cooperatives, Public Health, Education and Industry, which are responsible for rural development activities, local governments, provincial electricity authority, and private sectors on cottage industries and agribussines. In order to implement the rural development project in time in integrated manner, at a national level, the National Rural Development Coordination Center will be responsible for coordinating plans and project implementation for the various agencies concerned.

The rural development program should be prepared on a village or Tambon basis with participation of rural people to solve actual problems faced by the rural people of each area. In this context, the establishment of a project coordinating committee, on an Amphoe basis, is proposed with the emphasis to give localities of areas careful consideration. The representative of the provincial government concerned will preside over the committee; the chief of Amphoe will be the secretary of the committee and the chief of ARD provincial office will be the deputy secretary.

The Office of Accelerated Rural Development will be the executive agency responsible for implementing the integrated rural development project at the Lower North Thailand. Out of several project components, these four project components of irrigated agriculture development. rural road development, rural water supply development, and rural infrastructure

development including rural youth and agricultural technology training program and cottage industry development, will be implemented under the direct responsibility of the Office of Accelerated Rural Development with the assistance and cooperation by other government agencies concerned.

(Kamphaeng Phet Field Operation Center)

55. The Kamphaeng Phet field operation center was established in 1990. Staff and office space of the center are being boosted to meet the increasing demand of the implementation of rural development projects. The center has a plan to procure a fleet of construction equipment by 1992. This equipment would be used for the early completion of the on-going projects in seven provinces which will be covered by the center. Therefore, this integrated rural development project has proposed to support the implementation of the model projects by providing the following types of construction equipment: one set of reservoir construction equipment, three sets of large size percussion drilling equipment and one set of road maintenance equipment.

(Implementation Schedule)

56. The project will be implemented over a five year period from 1992 to 1996. The detail design of model projects will be completed in two years, from 1992 to 1993, by employing consultants. As presented in the attached table, all of the construction work for this five year project will be completed in 1966.

(Project Cost)

57. In addition to the construction costs for irrigated agriculture development, rural road development, rural water supply development, rural youth and agricultural technology training center and cottage industry promotion, the costs of the overall 5-year development project include costs for procurement of equipment, land acquisition, survey and investigation, administration and consulting services. 10 percent of the physical contingencies are added to the costs of the model projects and 20 percent are added to the costs of other projects. Price escalation contingencies are calculated at a rate of 4.5 percent per year for local currency component and for foreign currency component, escalation rates are based on World Bank's data. The project costs are estimated at a price level of March, 1991, and the foreign exchange rate of US$1.00 = Baht 25.5 is applied.

The total project cost of the overall 5-year development project, including the model projects, amounts to 2,942.9 million Baht, of which 1,465.7 million Baht (or, equivalent to 50 percent of the total) are in foreign currency components. The cost for model projects are estimated at 655.6 million Baht, corresponding to 22 percent of the total costs for the overall 5-year development project (refer to the attached table).

VIII. PROJECT EVALUATION

(Economic Evaluation)

58. Quantitative benefits in monetary terms from the project would be generated from irrigated agriculture development, rural road development, rural water supply development and inland fisheries development. The economic internal rates of return (EIRR) have been computed in consideration of the analysis period of 50 years and the gestation period of four-year attaining full benefits in the component of irrigated agriculture. The results are summarized in the following:

ECONOMIC INTERNAL RATES OF RETURN

-Unit: %-

Model Project	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	
EIRR	7.0	4.9	3.1	5.5	
Overall Plan	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
EIRR	8.0	7.5	9.5	8.2	7.8

In the above analysis, any case of EIRR, both the model projects and the overall plan, is lower than the marginal productivity (opportunity cost) of capital in Thailand, which is ranging from 10 to 12 percent; to merely judge the appropriateness of the implementation of the proposed projects by the low economic feasibility is not reasonable. The proposed integrated rural development plan put more emphasis on backward villages so as to contribute to primary objectives of the 7th National Plan, "to smooth out regional income differential" and "to eradicate poverty", for which efficient allocation from limited resources is usually not provided.

(Financial Evaluation)

59. In order to evaluate the financial impact on beneficiary farmers through the implementation of the proposed model projects, a farm budget analysis for typical farms has been made for cases of "without" and "with" project.

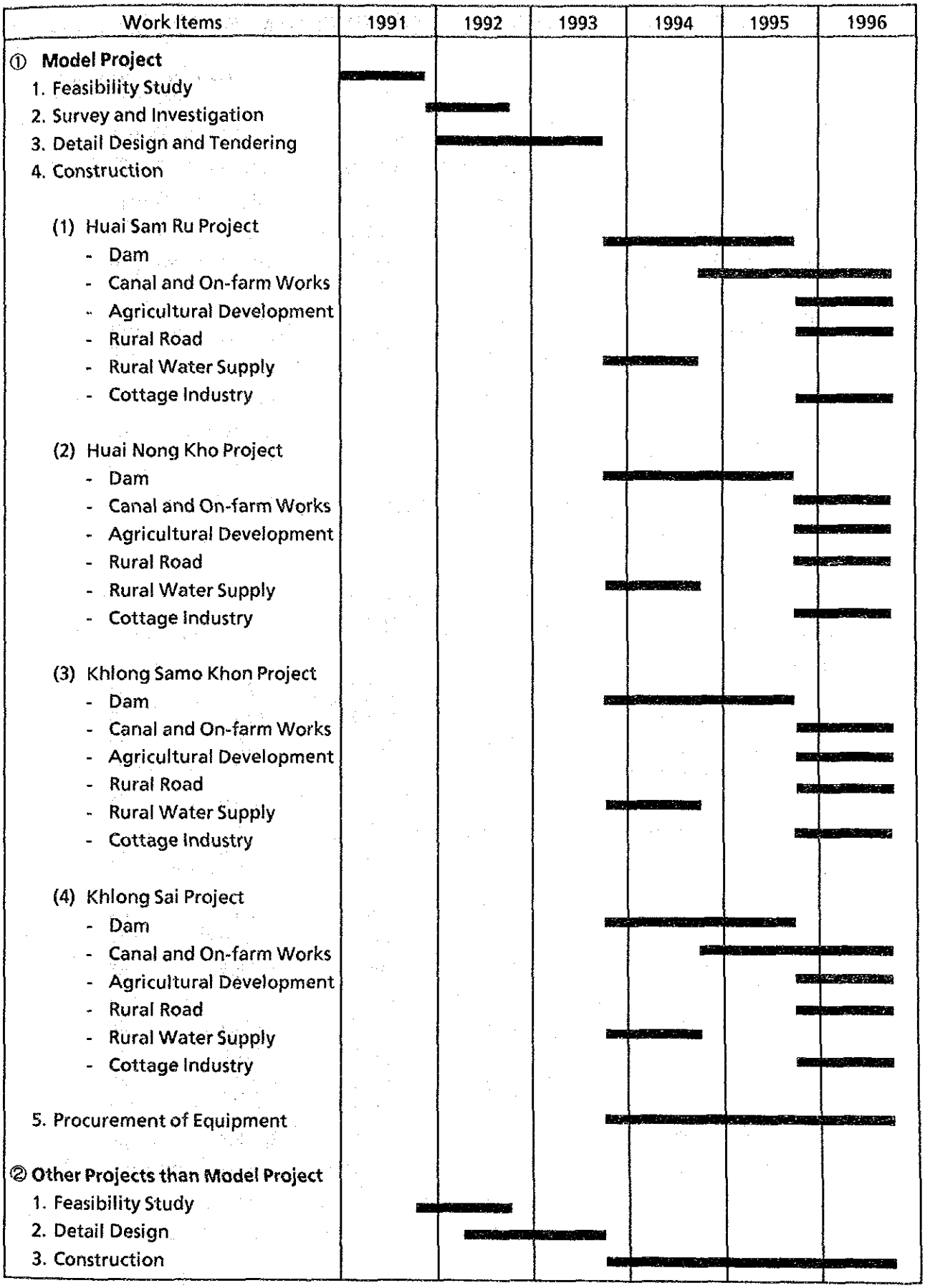
The farm budget analysis of the representative farm households that have an average farm size and operate farming with an average crop intensity within the model area has been worked out; off-farm income was considered only for the Khlong Samo Khon area because the farm size is as small as 1.75 ha when compared to other areas and the representative farmer has workable capacities for off-farm labor. The representative farmers will enjoy the incremental surplus, the difference of surplus between cases without and with project. They range from 11,525 to 26,073 Baht as summarized below;

FARM BUDGET ANALYSIS

- Unit: Baht -

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Farm Size (ha)	3.62	3.49	1.75	3.04
Crop Intensity (%)	121	145	121	110
Income				
- Farm income	69,462	73,417	36,284	75,127
- Off-farm income	-	-	6,768	-
Total	69,462	73,417	43,052	75,127
Expenditure	39,353	41,543	24,771	45,681
Surplus	30,109	31,874	18,281	39,446
Increment	26,073	22.371	11,525	25,442

TABLE VIII - 1 PROPOSED IMPLEMENTATION SCHEDULE OF OVERALL 5-YEAR DEVELOPMENT PROJECT



PROJECT COSTS FOR OVERALL 5-YEAR DEVELOPMENT PROJECT

- Unit: Baht Million -

Sub Prject	Local Currency	Foreign Currency	Total	Foreign (%)
Phitsanulok Province	468.9	409.7	878.6	47
Sukhothai Province	332.8	325.0	657.8	49
Kamphaeng Phet Province	382.2	355.7	737.9	48
Tak Province	241.9	233.8	475.7	49
Filed Operation Center	51.4	141.5	192.9	73
Total	1,477.2	1,465.7	2,942.9	50

BREAKDOWN OF PROJECT COSTS

- Unit : Baht Million -

Sub Prject	Local Currency	Foreign Currency	Total	Foreign (%)
Phitsanulok Province				
- Model Project	92.4	106.5	198.9	54
- Other Projects	376.5	303.2	679.7	45
Total	468.9	409.7	878.6	47
Sukhothai Province				
- Model Project	104.3	111.7	216.0	52
- Other Projects	228.5	213.3	441.8	48
Total	332.8	325.0	657.8	49
Kamphaeng Phet Province				
- Model Project	46.3	49.7	96.0	52
- Other Projects	335.9	306.0	641.9	48
Total	382.2	355.7	737.9	48
Tak Province				
- Model Project	71.8	72.9	144.7	50
- Other Projects	170.1	160.9	331.0	49
Total	241.9	233.8	475.7	49
Field Operation Center	51.4	141.5	192.9	73
Grand Total	1,477.2	1,465.7	2,942.9	50

RECOMMENDATION

① It is recommended that the overall 5-year development project on the integrated rural development at the Lower North Thailand with the aim to improve stagnated socio-economic conditions in the backward villages should be accomplished according to the proposed implementation schedule as a package project on the provincial basis of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak.

The development plans are formulated toward solving the actual problems confronted by rural people, through the analyses of the data available in the information system for rural development of Thai Government. The economic internal rate of 7.8 percent, based on primary benefits only, shows that the project will contribute significantly to the development of the economy of the backward villages in need of immediate development as defined in the National Plan.

Of the overall 5-year development projects, detail design of the four model projects are to succeed this feasibility study, and detail project planning and engineering design for other projects than the model projects are to be carried out.

② It is recommended to implement the development projects of rural electrification, public health and education, in conformity with the proposed implementation schedule, under the coordination of the National Rural Development Coordinating Center.

The implementation of the projects regarding the irrigated agriculture development, rural road development and rural water supply development, for which the Office of Accelerated Rural Development is the executive agency, will create the incentives to rural peoples participating in the above three development projects: rural electrification, public health and education.

③ To give active support to the plan formulation and management of the integrated rural development project, the establishment of project coordination committees on the Amphoe basis is recommended.

The implementation of the rural development project must be based on rural community action with participation of rural people under the leadership of local government. The representative of the provincial government would preside over the committee, and the chief of Amphoe would be the secretary of the committee. He or she performs the duties to promote better communication between provincial offices, local governments and rural people, in association with the chief of the ARD provincial office to be appointed as the deputy secretary of the committee, thus giving localities of each area careful consideration.

④ It is recommended that the Office of Accelerated Rural Development should prepare guidelines of development for land use, water resources and irrigation to promote the small scale irrigation projects at backward areas scattered over the four provinces.

The plan formulation of the overall 5-year development project is based on the topographic maps with a scale of 1 : 50,000, which is prepared by the Royal Thai Survey Department, except for the model projects. According to the field surveys, there is a possibility to develop small scale water resources for irrigation use; however, data on topography and river runoff is lacking. In order to promote the small scale irrigation projects, efforts should be made to analyze local information and data to be collected by rural people. This may encourage rural people to participate in the project.

⑤ It is recommended that prior to initiation of detail design and construction of the model projects, additional investigation in the fields of topography, geology, soil engineering and hydrology must be carried out.

The feasibility study was based on the topographic maps with a scale of 1: 5,000. Further topographic surveys are necessary for the proposed damsites, borrow areas and construction sites of heavy structure. Additional geological investigation includes drilling, test pits and soil tests. Hydrological observations should be done at the proposed damsites in terms of rainfall, river runoff and sedimentation.

CHAPTER I INTRODUCTION

CHAPTER I. INTRODUCTION

I-1 BACKGROUND OF THE STUDY

The Government of Thailand has set forth the rural development program, one of the most important policies of the Sixth National Economic and Social Development Plan implemented in 1987, placing an emphasis on rural poverty alleviation, improvement of quality of life and rectification of intra-regional economic imbalances.

The Office of Accelerated Rural Development (hereinafter referred to as "ARD") of the Ministry of Interior, leading agency for rural development, is expanding its activities to promote the rural development in the Lower North Thailand consisting of four provinces of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak. To this end, Kamphaeng Phet field operation center was established in 1990 as a base for the implementation of the rural development in the Lower North.

Under the above circumstances, the Government of Thailand requested the Government of Japan in March, 1988 to extend technical aid for the implementation of a feasibility study on the Integrated Rural Development Project at the Lower North Thailand. In response to the request of the Government of Thailand, Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched to Thailand a preliminary survey team in February, 1990.

In accordance with the scope of work agreed upon between the preliminary survey team and ARD on February 20, 1990, JICA sent the feasibility study team to Thailand in July, 1990 to conduct the study. The study was carried out for a period of 2 years. This final report presents the results of study made in close cooperation with ARD and other government agencies concerned.

I-2 OBJECTIVE AND SCOPE OF WORK

The objective of the study is to formulate the integrated rural development plan (5-year overall plan) for backward villages in four provinces of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak at the Lower North Thailand, and to conduct the feasibility study for the integrated rural development of selected four model projects. The study was implemented in two phases as follows ;

(Phase I Study)

① Preparation of inventory of backward villages

② Collection and analyses of existing data and information, and field surveys, including:

- Natural conditions
- Social conditions
- Agriculture
- Agricultural infrastructure
- Agro-economy
- Social infrastructure
- Others related to the study

③ Formulation of the overall plan for the integrated rural development project, including:

- Formulation of the basic plan for the development
- Preliminary cost estimate
- Identification of the development priority projets taking into consideration such components as agriculture development, irrigation development, rural road and farm road, domestic water, and others
- Identification of the development priority areas

④ Selection of four model areas

(Phase II Study)

① Feasibility study of the selected model areas
② Revision of the overall plan based on the results of the feasibility study on the model areas
③ Preparation of implementation schedule
④ Estimate of the project costs and benefits
⑤ Project evaluation
⑥ Recommendation

I-3 NATIONAL POLICY ON THE RURAL DEVELOPMENT

I-3-1 Development Objective and Target Area

The rural development is implemented on an uninterrupted and continuous basis. The rural poverty alleviation program adopted in the Fifth Plan period attained satisfactory results. Nevertheless, previous operations may be considered successful in solving rural poverty problems to a limited extent only and in rather limited target areas.

The program for rural development in the Sixth Plan period adopts a change in strategy and a new operational plan that will concentrate on actual problems confronted by the rural population in different areas, and the nature of these problems determines the areas and priorities for implementation. The target areas will be determined in accordance with the problems and needs of particular areas as follows:

① Backward areas in need of immediate development are defined as areas in which most of the people are economically deprived and which face four or five of the following problems: inconvenient communications, low production or incomes, poor health, shortage of water, and lack of knowledge concerning methods of self-improvement.

② Middle-level areas, the second priority in development, are areas in which most people are economically deprived and which are affected by one to three of the preceding problems.

③ Progressive areas are those in which most of the people have high production potential; such areas enjoy reasonably favorable economic conditions and suffer from few of the problems mentioned above.

I-3-2 Development Guidelines

The Government formulated development guidelines to ensure that rural development proceeds according to the development objective and contributes to development targets in regard to economic growth, income distribution, social services and improvement of the quality of life. Development guidelines focus on creating opportunities to increase production which will help solve the problems of rural livehood and occupations. Development guidelines are summarized as follows:

① Develop the basic factors in rural production and marketing.

- Development of the quality of the population and labor force
- Development of land resources
- Development of water resources
- Development of science and technology for rural development
- Support for the creation and strengthening of farmers' institutions.

② Increase the efficiency and capability of government agencies in solving rural problems.

③ Improve administrative mechanisms by consolidating efforts in an integrated rural development system.

④ Increase participation by people's organizations and the private sector, especially in operation in backward and middle-level areas.

I-3-3 Administrative Organizations and System of Rural Development

At the national level, the committee on national rural development chaired by the prime minister is the highest policy-making body. The responsibility for solving rural problems lies with the ministry of interior, ministry of agriculture and cooperatives, ministry of education, ministry of public health and ministry of industry, and the ministries concerned have prepared work plans with respect to ① development of rural infrastructure, ② improvement of productivity, income and employment, ③ water resources

development, ④ improvement of rural health, and ⑤ promotion of education of rural people to gain sufficient knowledge to improve their quality of life.

The plans have been integrated under the program for rural development within the administrative system of the committee on national rural development. There are a large number of agencies involved in rural development activities. In order to avoid duplication of projects and delay in project implementation, at the national level, the national rural development coordinating center was established, and at the provincial and Amphoe (district) level, coordinating organizations were restructured. Each rural development project shall be implemented according to the following procedures:

① Project may be directly requested by the people in line with the procedures for preparing provincial rural development plans.

② Project may be jointly requested by government agencies and the people: for instance, by Amphoe development committees in conjunction with Tambon (sub-district) councils or by Tambon working groups on development in conjunction with Tambon councils or village committees.

③ Project may be requested by provincial authorities in agreement with Amphoe, Tambon and villages.

I-4 THE OFFICE OF ACCELERATED RURAL DEVELOPMENT

The Office of Accelerated Rural Development (ARD) was organized in 1966. Through long years field experiences, ARD has established the following agency objectives for rural development: ① to improve the living conditions of rural people through a balanced approach involving both physical infrastructure development and socio-economic development, and ② to solve the rural security problems using development activities. To achieve the above objective, ARD has formulated four major programs, that is, ① infrastructure construction including rural roads and water resources development for both human consumption and supplementary irrigation, ② rural youth training, ③ occupation and income promotion, and ④ agri-business promotion.

ARD with the headquarter in Bangkok operates rural development projects in 72 provinces, being divided into 10 regions, under the control of 10 field operation centers. The budget of ARD for rural development has been increasing year by year, and it amounts to about 7,750 million Baht in 1990, or equivalent 3.8 times of 2,020 million Baht in 1986.

In order to cope with the increasing demand for implementation of rural development projects in the Lower North Thailand, ARD has established four field operation centers in 1990 including Kamphaeng Phet field operation center that covers seven provinces in the Lower North Thailand. The responsibility of Kamphaeng Phet field operation center is ① to provide assistance to ARD provincial offices in survey, design and construction of engineering works that are beyond the technical capacities of ARD provincial offices, ② to supply heavy equipment for construction, and ③ to train staff of ARD provincial offices. In the fiscal year of 1991, about 518.2 million Baht were earmarked for implementation of rural development projects in the study area.

CHAPTER II THE STUDY AREA

CHAPTER II. THE STUDY AREA

II-1 AREA AND POPULATION

The study area covers four provinces of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak, comprising 33 Amphoe, 235 Tambon and 2,617 villages. The study area is situated 330 km north of Bangkok with a total area of 42,427 sq.km, or equivalent to 8.3 percent of the whole country.

The study area had a population of 2,331 thousand in 1988. There was steady increase in population from 2,078 thousand population in 1981 at an annual rate of 1.7 percent, a little less than the national average of 2.0 percent. The population density in 1988 was 55 persons per sq.km corresponding to about half of the national average of 105 persons per sq.km.

AREA AND POPULATION

Province	Area (sq.km)	Area (%)	Population (1,000)	Population (%)	Density (Person/sq.km)	Rate of Increase (%: 1981-'88)
Phitsanulok	10,816	(25)	767	(33)	71	1.2
Sukhothai	6,596	(16)	583	(25)	88	1.3
Kamphaeng Phet	8,608	(20)	644	(28)	75	2.0
Tak	16,407	(39)	337	(14)	21	2.7
Total	42,427	(100)	2,331	(100)	55	1.7

II-2 REGIONAL ECONOMY

The gross regional product (GRP) in the study area increased from 21,010 million Baht in 1981 to 32,045 million Baht in 1987, which is equivalent to 2.8 percent and 2.6 percent of the gross national domestic product in the respective year, indicating that both land and labor productivity in the study area are quite low in comparison to the national average. The per capita GRP in the study area was 10,111 Baht in 1981 and 14,086 Baht in 1987, which is 63

percent and 61 percent of the national average and 21 percent and 20 percent of that in Bangkok and its vicinities, showing the increased income gaps.

The aggregate GRP of the study area in 1987 was about 32,045 million Baht, of which 31 percent or 9,902 million Baht was produced in Kamphaeng Phet, followed by 28 percent in Phitsanulok and about 20 percent in both Sukhothai and Tak. The average real economic growth over the period from 1981 to 1987 was 5.1 percent per annum in the study area, showing the highest growth rate of 10.2 percent in Tak, followed by 6.8 percent in kamphaeng Phet and 3.7 percent in Phitsanulok. The high economic growth in Tak was mainly contributed by the mining sector.

The per capita GRP was estimated at 14,086 Baht on the average in the study area, showing the highest figure of about 20,000 Baht in Tak, followed by 16,000 Baht in Kamphaeng Phet and about 12,000 in both Phitsanulok and Sukhothai.

II-3 TOPOGRAPHY AND GEOLOGY

II-3-1 Topography

The topography of Thailand may be classified into six regions: central plain, central highlands, northeast plateau, north and west continental highlands, southeast coast and peninsular Thailand. The study area lies over four topographic regions of central plain, central highlands, and north and west continental highlands.

Being located in the lower central part of Thailand, the central plain is bordered by hilly areas on the east, north and west and by the gulf of Thailand on the south. In the study area, the central plain covers about half of Phitsanulok province and the most part of both provinces of Sukhothai and Kamphaeng Phet, being occupied by alluvial terraces of three large rivers of Nan, Yom and Ping. The landform is composed of flat plains, natural levees, back swamps and isolated hills.

The central highlands are subdivided into three portions of the north, middle and southeast, and about half of Phitsanulok province belongs to the

northern part of the central highlands which is mainly composed of hills and more or less strongly incised plateaus or peneplains at elevations of 300 m to 1,200 m above the mean sea level. There are steep intervening hills and very steep craggy limestone buttes.

The north and west continental highlands may be subdivided into two portions of the western mountains and northern hills and valleys. Most parts of Tak province and a part of both provinces of Sukhothai and Kamphaeng Phet are located on the western mountains which consist of parts of the rugged central cordillera along the Thai-Myanmar border. Several narrow, deep valleys are developed at sub-parallel ridges. The valleys are flat and sedimentary plains composed of small scale terraces and former river courses.

II-3-2 Geology

① Phitsanulok Province

The Khorat group sedimentary rocks range on the eastern part of the province in the direction from northeast to southwest with a coverage of around 60 percent of the province. Many faults and folds are found in the Khorat group sedimentary rocks. The remaining area is formed of the Quaternary sedimentary rocks.

② Sukhothai Province

About 60 percent of the province are formed with the Quaternary sedimentary rocks, and the rest with the Lampang group sedimentary rocks, the Permian-Carboniferous sedimentary rocks, the Carboniferous sedimentary rocks and the Devonian-Silurian metamorphic rocks. The Lampang group sedimentary rocks are situated at the western part of the north mountain region with faults and folds. The Permian-Carboniferous sedimentary rocks are mainly found at the north mountain region covering about 20 percent of the province. The Carboniferous sedimentary rocks are found only at the southwestern part.

③ Kamphaeng Phet Province

The Quaternary sedimentary rocks occupy about 70 percent of the province, most of which is the diluvium sedimentary rocks. The rest is made up of several kinds of rocks such as sedimentary rocks and metamorphic rocks in the Triassic, the Carboniferous, the Devonian-Silurian, the Precambrian and the igneous rocks.

The Triassic sedimentary rocks are found along the great tectonic line at the southwest of the province. The Carboniferous sedimentary rocks are at the northern part. The Devonian-Silurian metamorphic rocks lie scattered over the province except the eastern part of the province. The Precambrian metamorphic rocks are situated at the west side of the great tectonic line, covering about 20 percent of the province. The igneous rocks (the granite complexes and the volcanic complexes) scatter at the north and west part of the province.

④ Tak Province

The rocks of the province are mainly composed of the Quaternary, the Triassic, the Permian-Carboniferous, the Carboniferous, the Devonian, the Ordovician, the Carbonian, the Precambrian and the igneous. At the north of the great tectonic line, the Ordovician sedimentary rocks and granitic rocks (complexes) are dominant, and other sedimentary rocks and metamorphic rocks are scattered. The Quaternary sedimentary rocks are found only along the Nan river. The granitic complexes occupy about 70 percent of the northern part of the great tectonic line, and the Ordovician sedimentary rocks are found at 20 percent area.

At the southern part of the great tectonic line, the rocks are composed of the Quaternary, the Triassic, the Permian-Carboniferous, the Devonian-Silurian and the Cambrian, covering about 60 percent of the southern part of the tectonic line. The Quaternary sedimentary rocks are found at two places: along the Thai-Myanmar border and valley plains located at the middle point of the great tectonic line.

II-4 GROUNDWATER

① Phitsanulok Province

There are 11 aquifers in the province, of which only two aquifers are productive with yields of 500 to 1,000 gallon per minutes (gpm) covering about 15 percent of the province, while three moderate productive aquifers with yields ranging from 200 to 500 gpm cover about 10 percent of the province. The Chiang Rai aquifer, low productive with a yield of about 50 gpm, occupies 10 percent of the province. The above-mentioned aquifers are found at the central plain. At the central highlands, there are three aquifers: the lower Khorat aquifer and the Carbonate acquire with yields of 20 to 100 gpm and the middle Khorat aquifer yielding very few to 20 gpm.

② Sukhothai Province

The aquifers in the province totaled to 10, of which the Chao Phraya aquifer is highly productive with yields of 200 to 500 gpm, three moderate productive aquifers yield 100 to 200 gpm, and the Chiang Rai aquifer is low productive yielding about 50 gpm. These five aquifers occupy around 50 percent of the province. Other five aquifers are found at the highlands, yielding very few to 50 gpm.

③ Kamphaeng Phet Province

Among nine aquifers in the province, three aquifers are classified as high productive having yields of 100 to 500 gpm, and cover 40 percent of the province. The Chiang Rai aquifer is found at the 40 percent area of the province. The remaining five aquifers at the highlands yield only few to 50 gpm.

④ Tak Province

13 aquifers are identified in the province. Three aquifers of metamorphic sediment aquifer, metamorphic aquifer and granitic aquifer are dominant, covering about 80 percent of the province with yields of few to 20 gpm. Two aquifers of Rat Buri and Thung Song, as high productive aquifer, cover 15 percent of the province with yields of 20 to 100 gpm.

II-5 METEOROLOGY AND HYDROLOGY

II-5-1 Meteorology

The study area belongs to the tropical monsoon zone with clear dry and rainy seasons. During the southwest monsoon season (May to October), which corresponds to the rainy season, 90 percent of annual rainfall are concentrated. The northeast monsoon season (November to April) is distinctly dry with low temperature.

(1) Rainfall

The average annual rainfall, throughout the study area, is approximately 1,000 to 1,500 mm. In the central zone, the amount of rainfall is less than that of the eastern and western areas of the study area. In the northwest of Sukhothai and the northeast of Tak, annual rainfalls are less than 1,000 mm, whereas in the mountain zone located east of Phitsanulok and west of Tak, an annual rainfall over 1,500 mm is recorded; especially, it is over 1,800 mm in the northwest mountain zone of Tak. It rains for more than 140 days in a year in western Tak but about 110 to 120 days in other areas. Table II-2 and Figure II-1 show an annual and monthly rainfall information.

(2) Temperature

The average temperature is approximately 27°C in the study area except western Tak in which it is 25°C. The mean temperature is 25 to 27°C in the dry season, while it is 27 to 30°C in the rainy season. The annual mean maximum temperature is 33°C and the monthly one rises to 37°C in March through May, which is transitional season between the dry and rainy seasons. On the other hand, the mean minimum temperature falls to 16°C in December. During the dry season, the daily temperature range is as large as 13°C on the average, comparing with 7 to 10°C during the rainy season.

(3) Other Climate Information

The annual evaporation amounts to approximately 1,500 to 1,700 mm in the study area, except the eastern Tak where it is over 1,900 mm. The minimum evaporation occurs during November - January and the maximum in

April. The relative humidity is about 50 percent in February and 70 to 85 percent in the rest of the year. General meteorological information is given in Table II-3 and Figure II-2.

II-5-2 Hydrology

(1) River Basin

In the central part of the study area, there are three large rivers that run through from north to south; these are Ping river (including Wong river, a branch of Ping river), Nan river and Yom river. In the western part of study area, Moei river runs to the north and Nam Mae Klong runs to the south. These two rivers constitute a western boundary of the study area as well as the national boundary with Myanmar.

The study area can be divided into six river basins; 74 percent of the study area is covered by the three large river basins, 12 and 10 percent by the basins of Moei river and Nam Mae Klong, and the remaining four percent by other river basins.

(2) River Run-Off

The average unit run-off (specific discharge) falls between 5.0 and 15.0 l/s/sq.km, which is equivalent to 160 and 500 mm/year. The distribution by area is almost the same as that of rainfall; it is less in the central zone than that in eastern and western zone. In the northeast of Tak and in the east of Kamphaeng Phet, unit run-off is less than five l/s/sq.km. And, in the northeast of Sukhothai and in the northwest of Tak, it exceeds 15 l/s/sq.km. The annual ratio between run-off and rainfall (run-off percentage) is about 17 percent in Sukhothai and eastern Tak. But in other parts of the study area, it is 20 to 30 percent. Table II-4 and Figure II-3 show monthly run-off and areal distribution of run-off.

II-6 SOILS AND LAND USE

II-6-1 Soils

According to the general soil map of Thailand prepared by the Department of Land Development (DLD), soils in the study area are classified into five major orders: Entisols, Inceptisols, Alfisols, Ultisols and Histosols. Out of 21 kinds of soils in the study area, 12 kinds of soils are distributed at the central plain alluvium, and are mainly used for growing paddy. Nine kinds of soils are seen at the central highlands and the north and west continental highlands, being used for growing upland crops, orchards and grasses.

DISTRIBUTION OF SOIL ORDERS

- Unit: percent -

Soil Order	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak
Entisols	-	-	1	-
Inceptisols	1	5	1	-
Alfisols	25	40	30	1
Ultisols	45	30	50	30
Histisols	25	20	15	60
Others	4	5	3	9

Soil maps of four provinces prepared by DLD reveal that there are 152 soil series in Phitsanulok province, 62 soil series in Sukhothai province, 119 soil series in Kamphaeng Phet province and 69 soils series in Tak province. Soils are generally characterized as shallow soils in the plain, and rocks are jutting out with mountain soils due to the soil surface being washed away by heavy rain.

II-6-2 Land Use

The total area of four provinces amounts to 4,243 thousand ha (26,516 thousand rai), of which 1,492 thousand ha (equivalent to 35 percent) are used for agriculture (refer to Table II-5). Paddy fields occupy 49 percent of total farm land and field crop land 41 percent (refer to Table II-6).

FARM LAND USE

- Unit: 1,000 ha -

Province	Paddy Field	Field Crop Land	Orchard	Flower and Vegetable	Others	Total
Phitsanulok	273.9	139.0	12.5	0.5	22.2	448.1
Sukhothai	162.0	162.5	11.8	1.4	29.0	366.7
Kamphaeng Phet	241.3	237.4	13.2	0.8	30.3	523.0
Tak	48.0	64.8	10.4	2.3	28.3	153.8
Total	725.2	603.7	47.9	5.0	109.8	1,491.6
(percent)	(48.6)	(40.5)	(3.2)	(0.3)	(7.4)	(100.0)

One of the characteristics of land use prevailing in the study area is higher percentage of field crop land than the national average of 24 percent. According to the data on land use by Amphoe prepared by the provincial agricultural extension offices, the following 20 Amphoe have field crop lands larger than paddy fields:

Phitsanulok	:	Chat Trakan, Nakhon Thai, Wang Thong, Wat Bot, Noem Maprang
Sukhothai	:	Thung Saliam, Ban Dan Lan Hoi, Si Satchanalai, Sawan Khlok
Kamphaeng Phet	:	Muang, Khanuworalak Buri, Khlong Lan
Tak	:	Tha Song Yang, Ban Tak, Mae Ramat, Mae Sot, Sam Ngao, Umphang, Phop Phra, Muang

II-6-3 Forest

The data on forest land prepared by the Royal Forest Department (RFD) shows that the total area of forest in Thailand was 143,803 sq.km in 1988, of which 20,131 sq.km, or equivalent to 14 percent, are occupied by the study area.

FOREST LAND

- Unit: sq.km -

Province	Total Area	Forest Area	%
Phitsanulok	10,816	2,882	27
Sukhothai	6,596	2,524	38
Kamphaeng Phet	8,608	2,243	26
Tak	16,407	12,482	76
Total	42,427	20,131	47
Whole Kingdom	513.115	143,803	28

The share of forest land to the total country land was decreased from 43 percent in 1973 to 28 percent in 1988. The same is observed in the study area: from 43 percent to 27 percent in Phitsanulok, from 55 percent to 38 percent in Kamphaeng Phet and from 87 percent to 76 percent in Tak, respectively.

There are 63 reserve areas of which 49 areas are the national forest reserve area, 10 areas are the national park and four areas are the wild life conservation area. The Government of Thailand has applied strict regulations to development works in the reserve area and no development project is allowed in the national park area and wildlife conservation area.

II-7 AGRICULTURE

II-7-1 Irrigation

The total irrigation area of the study area amounts to 216,000 ha (or, 1,349,000 rai), corresponding to 14 percent of the total farm lands, a bit less than the national average irrigation efficiency of 17 percent, as summarized below:

IRRIGATION AREA

- Unit: 1,000 ha -

Item	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
Farm Land	4448.1	366.7	523.0	153.8	1,419.6
Irrigation Area	88.0	38.1	66.9	22.9	215.9
Irrigation Efficiency (%)	20	10	13	15	14

Phitsanulok province has the highest irrigation efficiency of 20 percent among four provinces. Nan river, one of the biggest tributaries of Chao Phraya river, runs southward through the province. Flows of the river are controlled with the Sirikit dam and reservoir, and are diverted with the Naresuan diversion works for use of the Phitsanulok irrigation project.

In addition to several medium scale irrigation projects constructed in Sukhothai province, irrigation projects by exploiting groundwater have been

promoted at the northern part of the province since 1977, and the beneficial area covers about 50 percent of the total irrigation area in the province.

In Kamphaeng Phet province, many small scale irrigation projects have been constructed, and at present 82 small scale irrigation projects, largest among four provinces, are in operation covering 75 percent of the total irrigation area in the province.

With the combined storage water of 11 million cubic meter of four reservoirs, about 16,000 ha (or, equivalent to 70 percent of the total irrigation area) of cultivated lands are irrigated in Tak Province. Furthermore, 10 pump irrigation projects were constructed to irrigate 6,900 ha of paddy fields along Pin river by lifting regulated flows to be released from the Bhumbol reservoir.

II-7-2 Agriculture Production

Paddy is a major product in the study area; paddy has been planted at the highest rate in Phitsanulok, Sukhothai and Kamphaeng Phet province, except Tak province where maize for livestock has been grown at the highest rate. In the low-lying areas along the rivers of Nan, Yom and Ping, crop intensities of dry season paddy are as high as 15 percent in Kamphaeng Phet province and 13 percent in Phitsanulok province, while the national average is about nine percent. The field crops with planting area of more than 1,600 ha (10,000 rai) are given below :

Phitsanulok	:	Maize, cassava, soybean, blackgram, sugarcane, mungbean, upland paddy, sesame
Sukhothai	:	Soybean, sugarcane, maize, cotton, mungbean, sesame
Kamphaeng Phet	:	Maize, sugarcane, cassava, soybean mungbean
Tak	:	Maize, soybean, upland paddy, mungbean

Based on the data of cropping area in Phitsanulok for last nine years (1981 - 1990), special features on field crop plantation are summarized below:

- Paddy is increasing constantly,
- Soybean is increasing at high rate,
- Maize as the cash crop was turned up in 1989,

- Mungbean and blackgram are rapidly decreasing due to recent export stagnation,
- Cassava and sugarcane as contract farming are increasing respectively to meet increasing export demand, and
- Oil seed crops such as sesame, groundnut, cotton, castor bean seeds, etc. are gradually increasing.

The growing fruit and perennial crops include bananas, coconuts, Jack-fruit, tamarinds, mangos, longans, lemons, coffee, cashew-nuts, kapok etc., and Kamphaeng Phet is popular as a growing area of a kind of banana, Krul Khai specie.

The current average three years (1987 - 1989) crop yields are summarized based on the agricultural statistics of Thailand for the crop year of 1988/89 as follows:

YIELDS OF MAJOR CROPS

- unit : kg/ha -

Crop	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Whole Country
Rainy Season Paddy	2,360	1,730	2,460	2,410	1,930
Dry Season Paddy	4,080	3,490	3,600	3,060	3,790
Maize	2,160	1,750	2,210	2,320	2,350
Soybean	1,180	1,290	1,210	1,140	1,230
Mungbean	706	663	706	663	650
Groundnut	1,480	1,230	1,520	1,530	1,370
Sugarcane (ton/ha)	49.9	49.5	54.9	52.0	50.1
Cassava (ton/ha)	15.0	14.4	14.6	14.0	14.6

II-7-3 Sericulture

The research and development of Thai modern sericulture was assisted by the JICA sericulture development program implemented during the period of eight years from 1969 to 1977. According to information of the sericulture research institute, DOAE, there were 332,808 sericulture farmers, 44,100 ha of mulberry fields and 1,022 ton of weft silk production in 1988 in the country, of which the study area shared 1,069 farmers, 170 ha of mulberry fields and 3,278 kg of production.

The Tak sericulture center was established in 1989. The center has a training course to farmers on technical guidance of mulberry cultivation and silk worm breeding. Among four provinces, sericulture in Kamphaeng Phet province has been well developed through organizing farmer's and women's groups on sericulture as one of cottage industries.

II-7-4 Livestock

According to the data of the Department of Livestock, there were 127,120 buffaloes, 276,333 cattles and 222,174 swines as of 1988 in the study area, and the data indicates that the number of buffaloes has been remarkably decreasing, while the number of cattle and swine has not been decreasing. This may be owing to the development of farm mechanization and on the contrary the increasing demand of animal meat. There can be seen many grass lands and pastures in Tak and Sukhothai province. The forage research center in Tak releases seeds to farmers for improvement of pastures: Hamata and Napier as legume variety and Guinea, Ruzi and Cemil as grass variety.

II-7-5 Agricultural Extension Services

The Department of Agricultural Extension (DOAE) has established 21 seed centers in the major crop growing areas of Thailand for supply of improved seed varieties. Three seed centers are in operation in the study area: the 1st seed center in Phitsanulok province, the 9th seed center in Kamphaeng Phet province and the 21th seed center in Sukhothai province. The improved seed varieties to be distributed to farmers in the study area as follows:

Paddy	:	RD 23, Khao Dok Mali 105, Lueng Pra Thew 123, Phitsanulok 60-2, RD6
Soybean	:	Sukhothai-1, SJ-4, SJ-5, Chiang Mai-60
Mungbean	:	Suwan-1, Nakhon Sawan-1
Sesame	:	Black sesame, white sesame 60

According to the seed production plan by three seed centers in the study area, the improved seeds to be distributed to farmers in 1990 are 2,440 ton (1,250 ton for paddy, 770 ton for soybean and mungbean, 400 ton for maize and 20 ton for sesame) in the Phitsanulok center, 1,730 ton (700 ton for paddy, 1,000 ton for soybean and mungbean, 30 ton for sesame) in the Kamphaeng

Phet center and 350 ton (70 ton for paddy and 280 ton for soybean and mungbean) in the Sukhothai center, totaling to 4,520 ton.

Under the control of DOAE, provincial and local agricultural extension officers are in service. One extension officer is responsible for extension activity in nine villages with 1,100 to 1,400 farm families, except Tak province where one extension officer covers six villages with 626 farm families.

II-8 RURAL DEVELOPMENT PROJECTS

II-8-1 ARD Projects

ARD provincial offices have actively promoted the implementation of rural development projects through water resources development and rural road development. The main projects constructed and under construction by 1990 were summarized below:

MAJOR CONSTRUCTION WORKS

Project	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
Irrigation: Nos.	9	6	8	9	32
Rural Road: Km	403	191	211	240	1,045

In parallel with the implementation of construction works, in order to improve the socio-economic conditions of rural people, ARD provincial offices extend the following services:

Rural Youth Training : to organize youth groups for training of skills, such as fruit farming, rubber sandals, concrete I block, brick, water jar.

Occupation and Income Promotion : to train farmers for improved farming and income increase, including upland grop farming, livestock breeding, fish culture, fruit farming, pasture improvement, etc.

Agribusiness Promotion	:	to organize farmers' groups for extension of agri-business under the institutional support, such as sericulture, bamboo craft and the like.

Kamphaeng Phet field operation center was established in 1990 covering seven provinces including four provinces of the Lower North region. The responsibility of the center is to provide engineering services in the construction of the major works such as rural roads, reservoirs, ponds, irrigation facilities and wells, which may be beyond engineering capabilities of ARD provincial offices, supply and maintain heavy equipment for construction, and train staff of ARD provincial offices.

II-8-2 Projects Implemented by Other Government Agencies

(1) Small Scale Irrigation Program by RID

The Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperatives has long been executing the major irrigation projects in this country although several government agencies have been engaged in the irrigation projects. The details of the medium and large scale irrigation projects executed by RID are described in Appendix E.

RID has also promoted implementation of the Small Scale Irrigation Program (SSIP) at the village level in order to provide water for irrigation, domestic use and animal drinking to the farmers suffering from water shortage since 1977. The construction cost of an individual project of SSIP was restricted to four million Baht at first, so that the scale of the projects was accordingly limited to village unit as a spot type development. After years of implementation, the ceiling amount of SSIP has been raised to 10 million Baht since FY 1988. Many types of project facilities such as reservoir, weir, pond, regulator, etc. are included except for distribution canal, which is to be constructed by farmers themselves. The summary of SSIP is given as follows:

SUMMARY OF SSIP

Project	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak
1. Nos. of Project	70	59	82	55
- Canal	5	7	6	4
- Gate	10	16	62	2
- Weir	22	23	13	35
- Reservoir	33	13	1	14
2. Storage (MCM)	4,658	5,219	12,735	2,210
3. Irrigation Area (ha)	19,357	18,194	50,560	12,912
(rai)	120,977	113,710	316,000	80,700

(2) Small Swamp Inland Fisheries Project

The Department of Fisheries (DOF) formulated in 1982 the small swamp inland fisheries project (SSIFP) for the purpose of providing animal protein to rural people in 18 provinces in the regions of North and East Thailand. The phase I project of SSIFP was commenced in 1985 with the 5-year period, and 100 swamps were rehabilitated, and eight fish seed centers (FSC) and four equipment centers (EC) were established. The phase II project is scheduled to complete in 1991 for the rehabilitation of another 100 swamps and establishment of six fish seed centers. In the study area, the following facilities are included in SSIFP:

SUMMARY OF SSIFP

	Phase I			Phase II	
Province	FSC	EC	Swamp	FSC	Swamp
Phitsanulok	1	-	5	-	9
Sukhothai	-	-	11	1	6
Kamphaeng Phet	-	-	8	-	6
Tak	1	1	3	-	4
Total	2	1	27	1	25

TABLE II - 1 TAMBON AND VILLAGES

Amphoe	Nos. of Tambon	Nos. of Villages	
		Total	Backward Villages
(Phitsanulok Province)			
- Muang Phitsanulok	10	141	26
- Chat Trakan	5	53	35
- Nakhon Thai	6	114	33
- Bang Krathum	5	85	11
- Bang Rakam	8	103	24
- Phrom Phiram	10	99	25
- Wang Thong	10	118	52
- Wat Bot	6	53	34
- Noen Maprang	7	59	42
Total : 9 Amphoe	67	825	282
(Sukhothai Province)			
- Muang Sukhothai	8	71	27
- Kong Krailat	9	96	31
- Khiri Mat	9	88	52
- Thung Saliam	4	40	6
- Bang Dan Lan Hoi	5	44	25
- Si Satchanalai	7	80	20
- Si Samrong	8	106	29
- Sawan Khalok	8	103	19
- Si Nakhon	3	26	-
Total : 9 Amphoe	61	654	209
(Kamphaeng Phet Province)			
- Muang Kamphaeng Phet	13	170	68
- Khanuworalak Buri	12	143	62
- Khlong Khlung	14	140	59
- Phran Kratai	7	89	36
- Sai Ngam	7	58	20
- Kholng Lan	3	40	26
- Lan Krabu	5	55	17
Total : 7 Amphoe	61	695	288
(Tak Province)			
- Muang Tak	11	99	35
- Tha Song Yang	4	55	50
- Ban Tak	5	64	9
- Mae Ramat	4	48	27
- Sae Sot	9	73	29
- Sam Ngao	4	41	11
- Umphang	5	37	35
- Phop Phra	4	26	19
Total : 8 Amphoe	46	443	215
Grand Total : 33 Amphoe	235	2,617	994

TABLE II - 2 RAINFALL

— Unit : mm —

Month	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak East	Tak West	Average
4	52.7	49.8	53.2	42.3	46.5	48.9
5	165.9	162.0	160.7	155.2	180.8	164.9
6	178.9	139.1	144.8	97.0	259.6	163.9
7	190.9	137.9	142.5	80.4	305.9	171.5
8	237.3	180.5	172.9	101.8	311.9	200.9
9	253.6	251.6	262.4	215.3	243.7	245.3
10	117.8	141.2	156.1	168.9	148.1	146.4
11	26.7	25.0	36.7	49.9	40.7	35.8
12	3.6	4.9	3.0	4.4	4.2	4.0
1	6.8	6.2	7.8	4.9	5.0	6.1
2	14.8	8.6	15.9	5.6	7.5	10.5
3	26.1	19.3	22.8	13.8	13.3	19.1
Total	1,275.1	1,126.1	1,178.8	939.5	1,567.2	1,217.3

TABLE II - 3 METEOROLOGICAL INFORMATION

Month	Pressure (mbr)	Relative Humidity (%)	Evapo-ration (mm)	Wind Speed (km / hr)	Rainy Days (day)	Temperature (°C)		
						Mean	Max.	Min.
1	1,013	67.1	116.0	2.45	0.5	23.4	31.6	16.6
2	1,011	58.6	146.1	3.75	1.3	26.8	34.8	19.6
3	1,009	54.5	201.0	5.22	2.0	29.2	36.6	22.4
4	1,007	57.8	217.0	6.22	4.9	30.8	37.8	24.9
5	1,006	70.5	183.7	5.15	13.5	29.5	35.4	25.0
6	1,006	79.1	124.5	4.04	19.6	27.7	32.4	24.4
7	1,006	77.3	136.4	4.99	17.3	27.7	32.2	24.3
8	1,006	79.5	125.3	4.82	19.2	27.4	31.4	24.2
9	1,008	81.6	122.5	3.12	17.5	27.3	32.3	23.7
10	1,010	82.8	115.5	2.37	15.0	26.7	31.8	23.0
11	1,013	79.1	102.2	2.26	5.5	25.2	30.8	20.7
12	1,015	72.4	105.9	2.28	0.7	22.4	30.0	16.2
Annual	1,009	71.7	1,696.1	3.89	117.0	27.0	33.1	22.1

TABLE II-4 AVERAGE MONTHLY RUNOFF

- Unit : ℓ / s /sq.km -

Month	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak East	Tak West	Average
4	3.70	0.29	3.03	3.81	2.81	2.73
5	5.21	2.65	6.95	4.28	4.69	4.76
6	8.60	5.12	8.02	4.55	6.78	6.61
7	13.89	5.22	7.80	4.07	8.73	7.94
8	24.96	13.78	9.48	5.13	16.07	13.88
9	32.75	22.65	26.82	9.88	21.24	22.67
10	18.89	15.26	37.68	10.69	20.71	20.65
11	8.03	4.85	19.69	5.30	12.17	10.01
12	3.90	1.43	6.10	2.46	6.87	4.15
1	2.78	0.64	3.37	2.24	5.05	2.82
2	2.99	0.32	2.89	3.17	3.87	2.65
3	3.24	0.19	2.88	4.05	3.03	2.68
Average	10.90	6.05	10.71	4.95	9.56	8.43
Annual (mm)	344	191	338	156	302	266
Coefficiency (%)	27	17	29	17	19	22

TABLE II-5 LAND USE IN 1988

Item		Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
Forest	(rai)	1,801,250	1,577,344	1,401,563	7,801,250	12,581,407
	(%)	26.7	38.3	26.0	76.1	47.4
Farm Land	(rai)	2,800,562	2,292,127	3,268,853	961,291	9,322,833
	(%)	41.4	55.6	60.8	9.4	35.2
Others	(rai)	2,158,097	253,086	709,265	1,491,615	4,612,063
	(%)	(31.9)	6.1	13.2	14.5	17.4
Total	(rai)	6,759,909	4,122,557	5,379,681	10,254,156	26,516,303
	(%)	100.0	100.0	100.0	100.0	100.0

(Note : 1.0rai = 0.16ha)

TABLE II - 6 CROPPED AREA IN 1989/90

- Unit: rai -

Crop	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total
Paddy Field	1,638,313	1,089,109	1,698,587	254,850	4,680,859
(1) Rainy Season Paddy	1,615,192	1,012,068	1,518,546	291,849	4,437,655
(2) Dry Season Paddy	219,235	44,795	248,943	10,535	523,508
(3) Dry Season Intensity (%)	13	4	15	4	11
Upland Crop Field	1,113,406	869,057	1,574,036	500,549	4,057,048
Upland Paddy	23,125	-	-	49,178	72,303
Maize	413,314	126,769	409,155	672,886	1,622,124
Soybean	144,364	903,345	229,895	150,803	1,428,407
Mungbean	66,665	86,972	210,162	16,903	380,702
Black Gram	83,977	-	18,915	-	102,892
Groundnut	9,838	4,104	1,786	7,992	23,720
Sesame	20,871	36,037	2,650	-	59,558
Castorbean	3,650	-	-	4,463	8,113
Cotton	7,017	88,848	7,850	6,075	109,790
Cassava	306,483	-	379,279	-	685,762
Sugarcane	75,774	137,782	384,401	3,589	601,546
Tobacco	-	34,623	-	-	34,623
Kenaf	-	2,268	-	-	2,268
Banana	-	-	30,176	-	30,176
Total	1,155,078	1,420,748	1,674,269	911,889	5,161,984
(4) Crop Intensity	104	163	106	182	127

FIGURE II-1 MEAN ANNUAL RAINFALL (1952 – 1985)

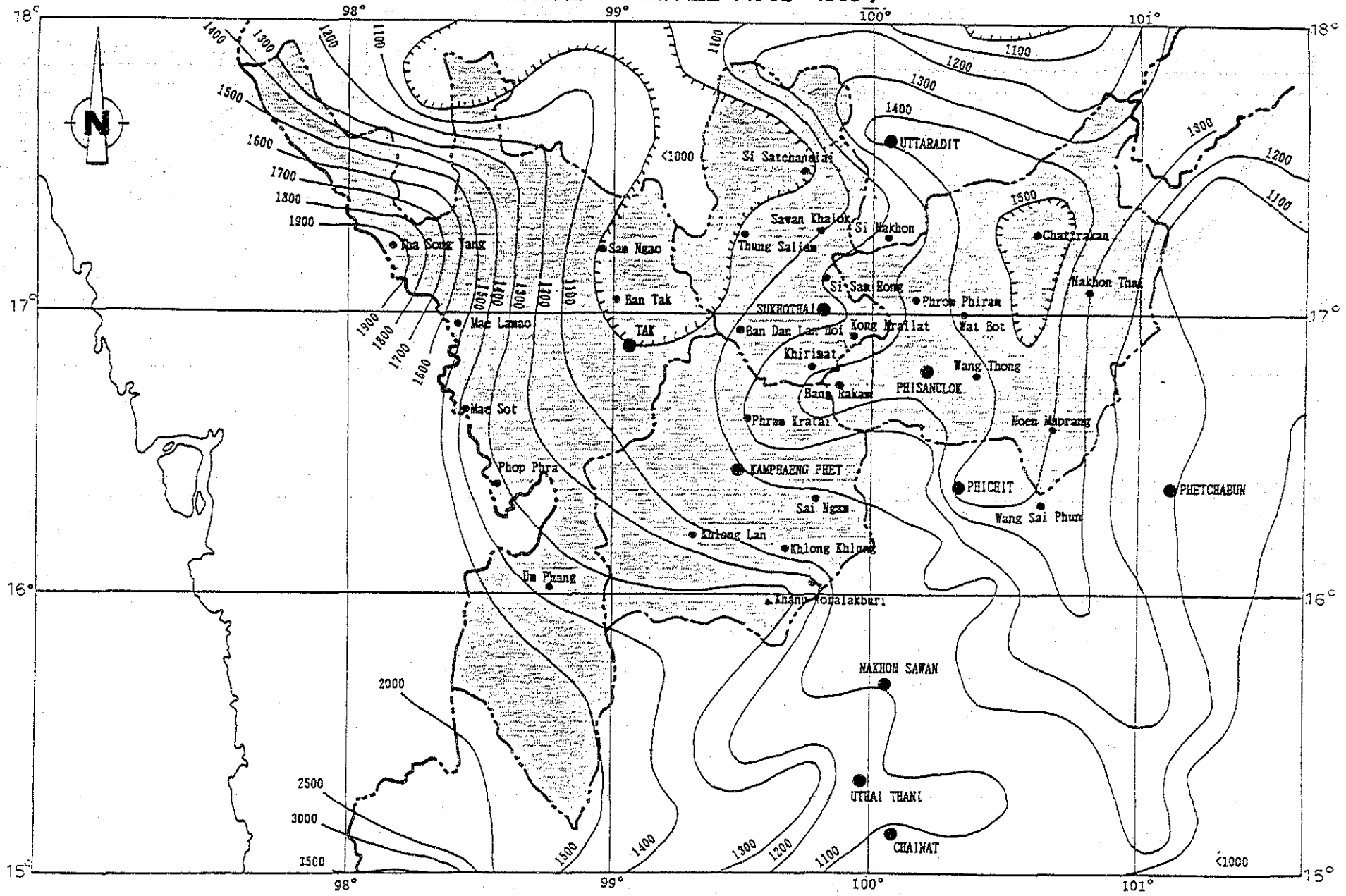
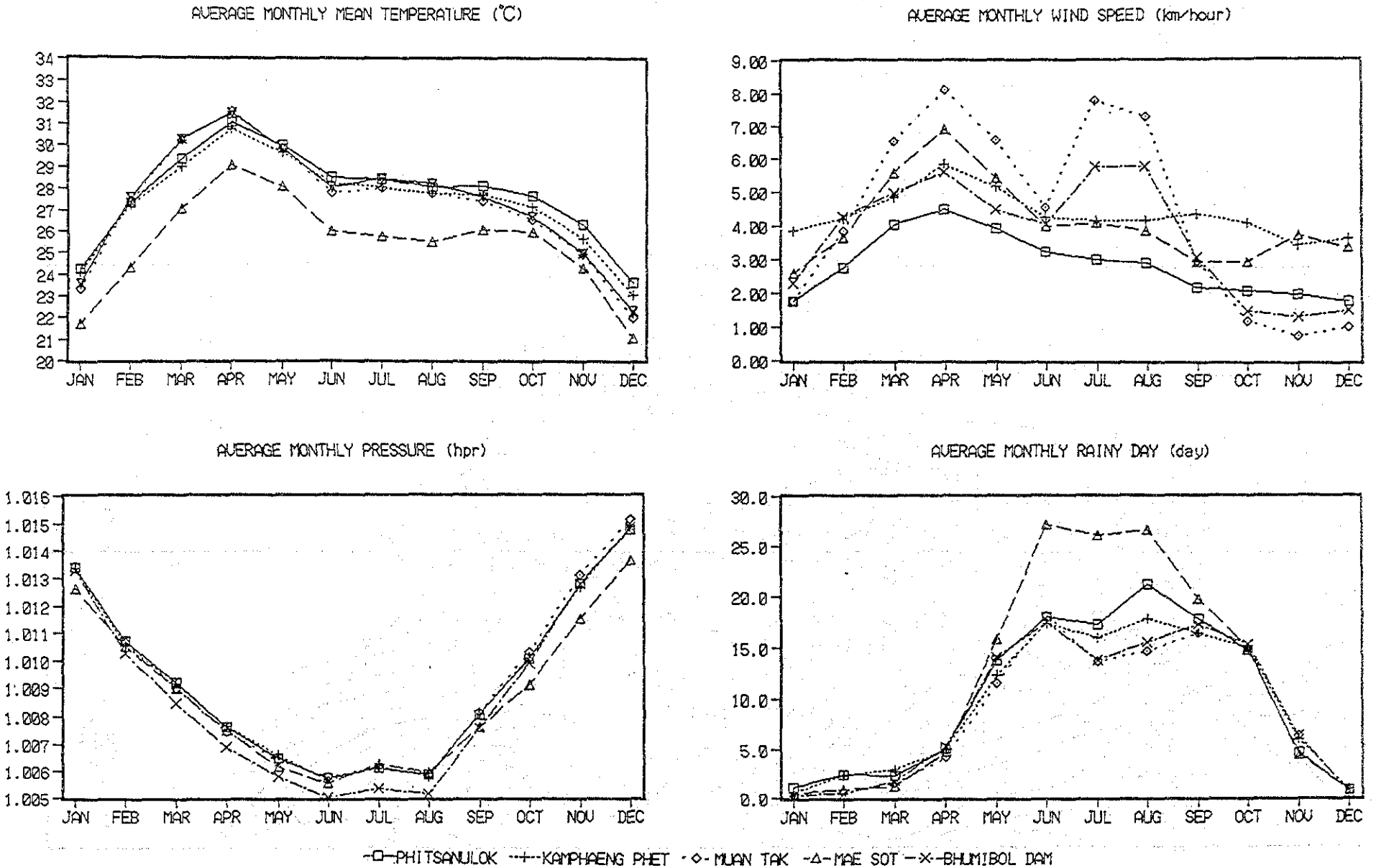
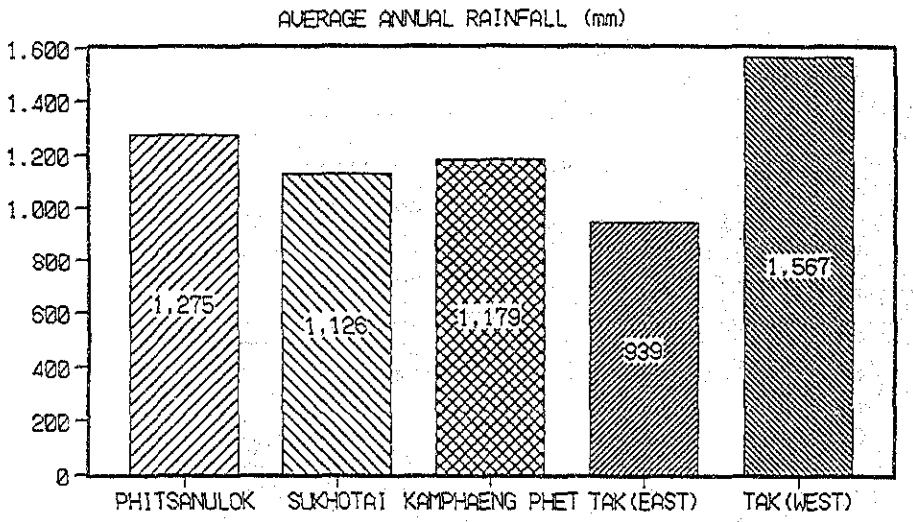
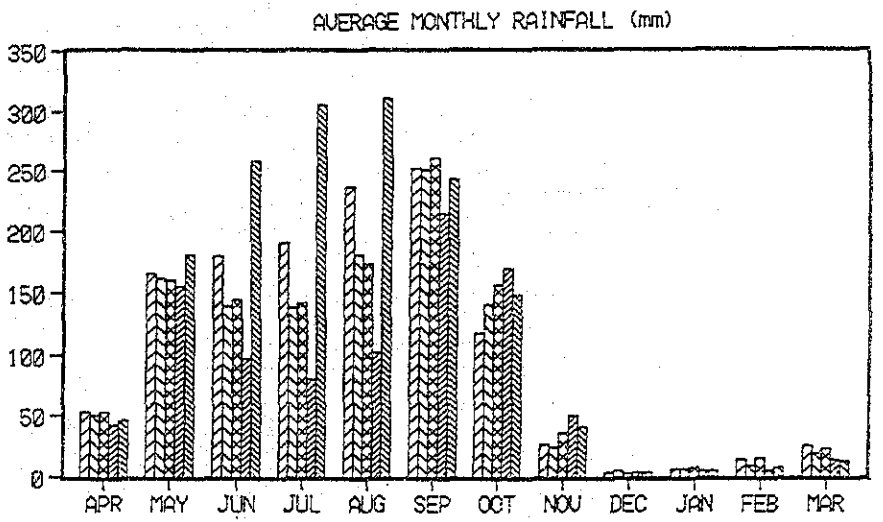


FIGURE II-2 General Meteorology (1/2)



General Meteorology (2/2)





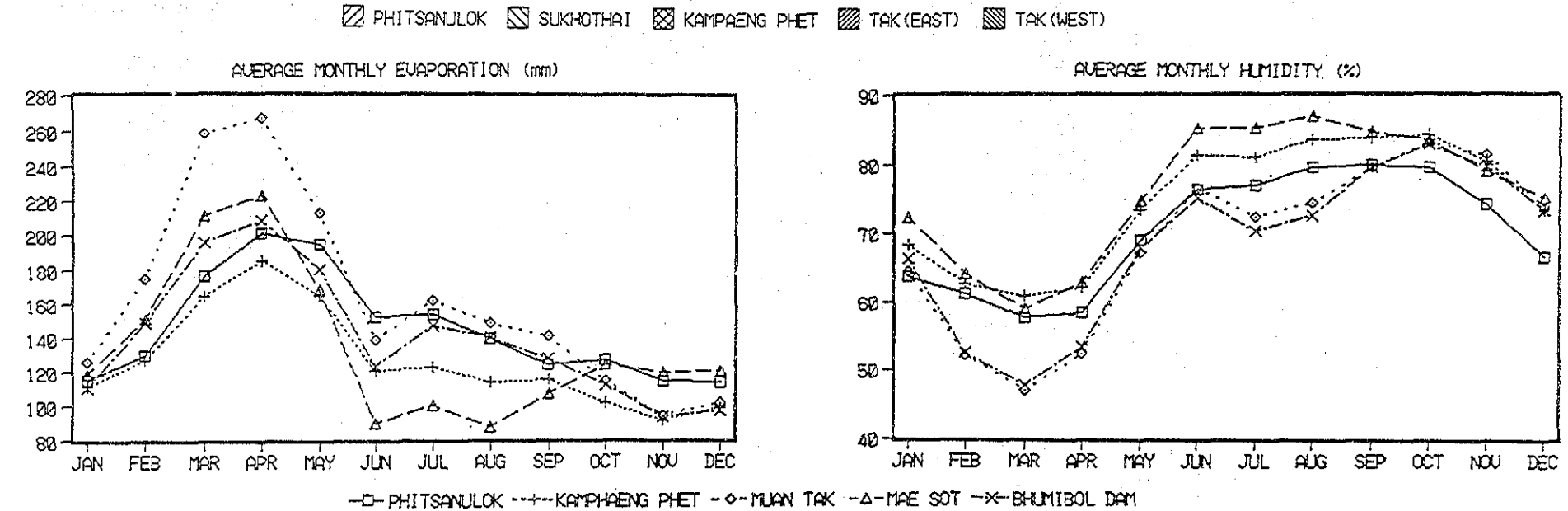


FIGURE II-3 RIVER BASIN

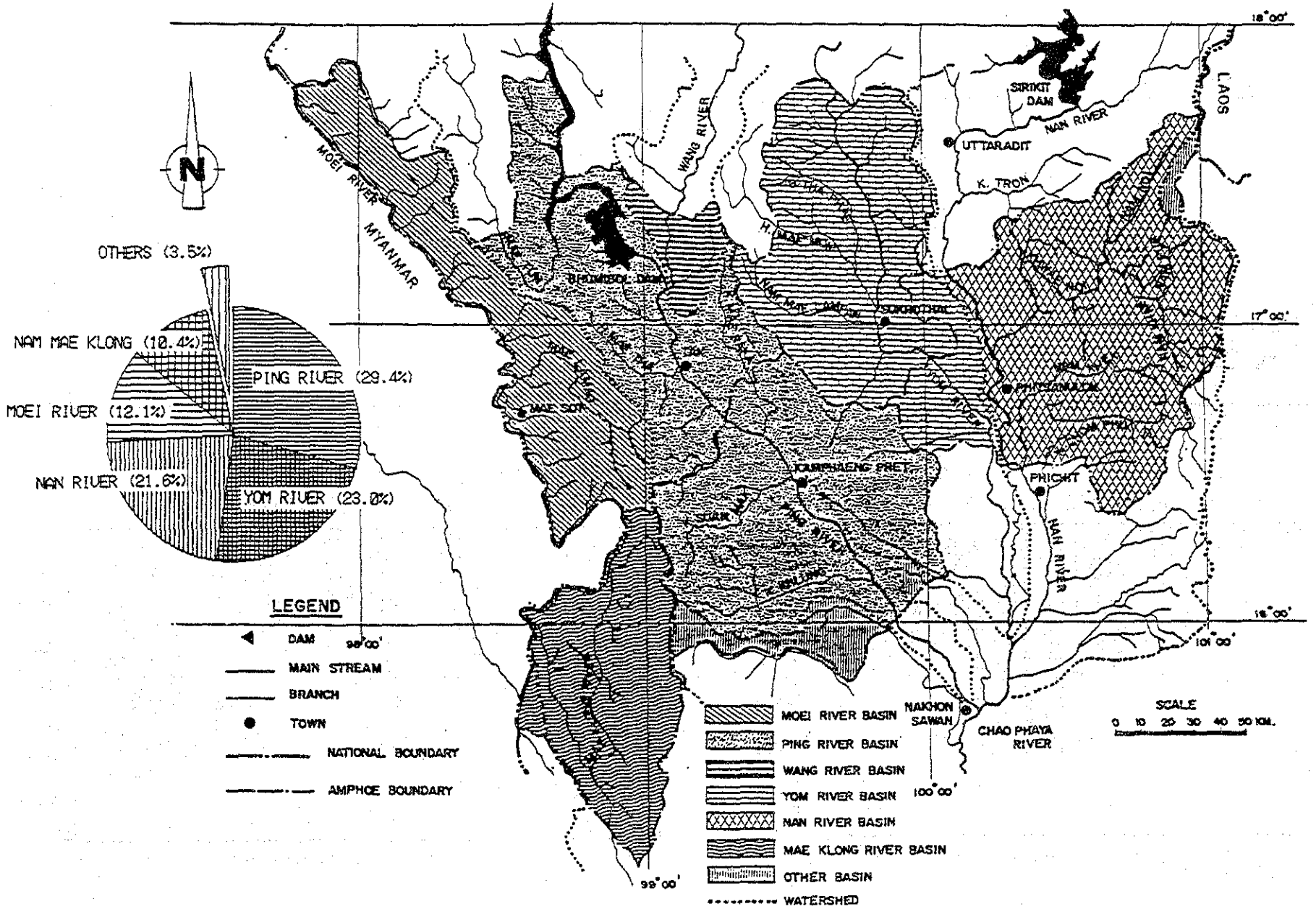


FIGURE II-4 AVERAG YIELD OF RUNOFF UNIT (l/sec / km.^{2})