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THE KINGDOM OF CAMBODIA
MINISTRY OF AGRICULTURE,
FORESTRY AND FISHERIES

JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)

**MASTER PLAN STUDY ON
THE INTEGRATED AGRICULTURAL AND RURAL
DEVELOPMENT PROJECT
IN THE SUBURBS OF PHNOM PENH**

MAIN REPORT

VOLUME-II

FEASIBILITY STUDY

February, 1995

NIPPON KOEI CO., LTD.

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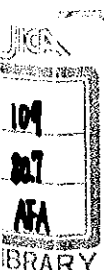
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PREFACE

In response to a request from the Royal Government of the Kingdom of Cambodia, the Government of Japan decided to conduct a Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Cambodia a study team headed by Mr. Shinichi Yano, Nippon Koei Co., Ltd., three times from October 1993 to December 1994.

The team held discussions with the officials concerned of the Royal Government of the Kingdom of Cambodia, 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 Royal Government of the Kingdom of Cambodia for their close cooperation extended to the team.

February, 1995

A handwritten signature in black ink, appearing to read 'Kimio Fujita', written in a cursive style.

Kimio Fujita
President

Japan International Cooperation Agency

February, 1995

Mr. Kimio Fujita
President,
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We have the pleasure of submitting the study report for the Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, in accordance with the Scope of Work agreed upon between the Ministry of Agriculture and the Japan International Cooperation Agency (JICA).

The study was carried out for a total period of 17 months from October 1993 to February 1995. The master plan for the integrated agricultural and rural development was basically formulated with principal aim of increase of agricultural production and improvement of rural life conditions, paying attention to environment conservation in the study area which consists of Kandal Stung Area in Kandal Province and Tonle Bati Area in Takeo Province, totalled 16,000 ha.

The basic development plans of the project consist of six aspects ; (1) protection from flood damage, (2) irrigation and drainage improvement, (3) agricultural production promotion, (4) improvement of rural life condition, (5) agricultural and rural infrastructure development, and (6) strengthening of the agricultural support institute and service systems, and these aspects are interlinked each other to achieve the main targets of the plan. We would recommend that the project will be soon implemented in line with the conclusions presented in this report.

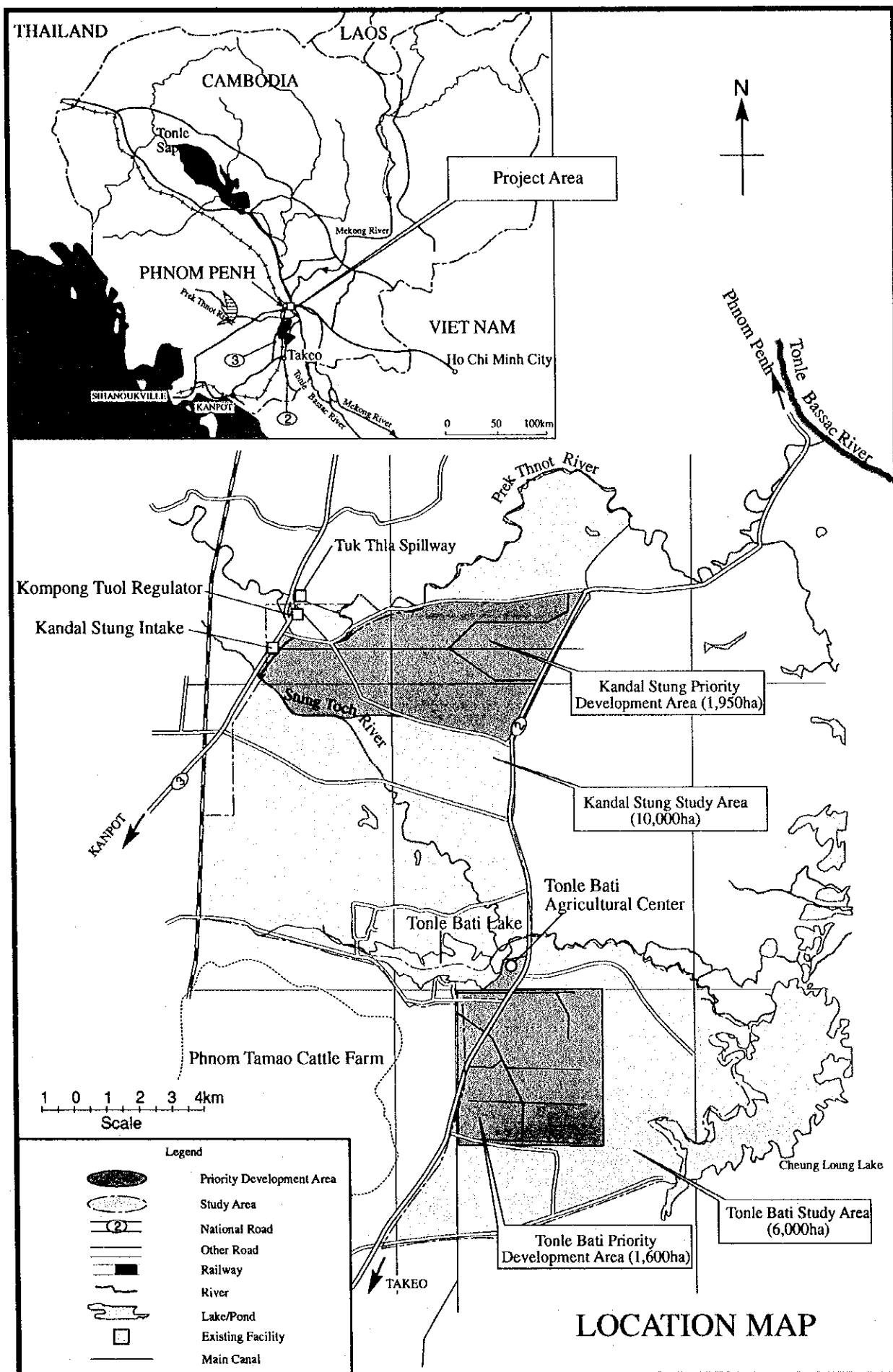
We wish to express our deep appreciation and gratitude to the personnel concerned of your and other Agencies, your Cambodia Office, the Embassy of Japan in the Kingdom of Cambodia, and the Authorities concerned of the Royal Government of the Kingdom of Cambodia as well as various NGOs for the courtesies and cooperation extended to us during our field surveys and studies.

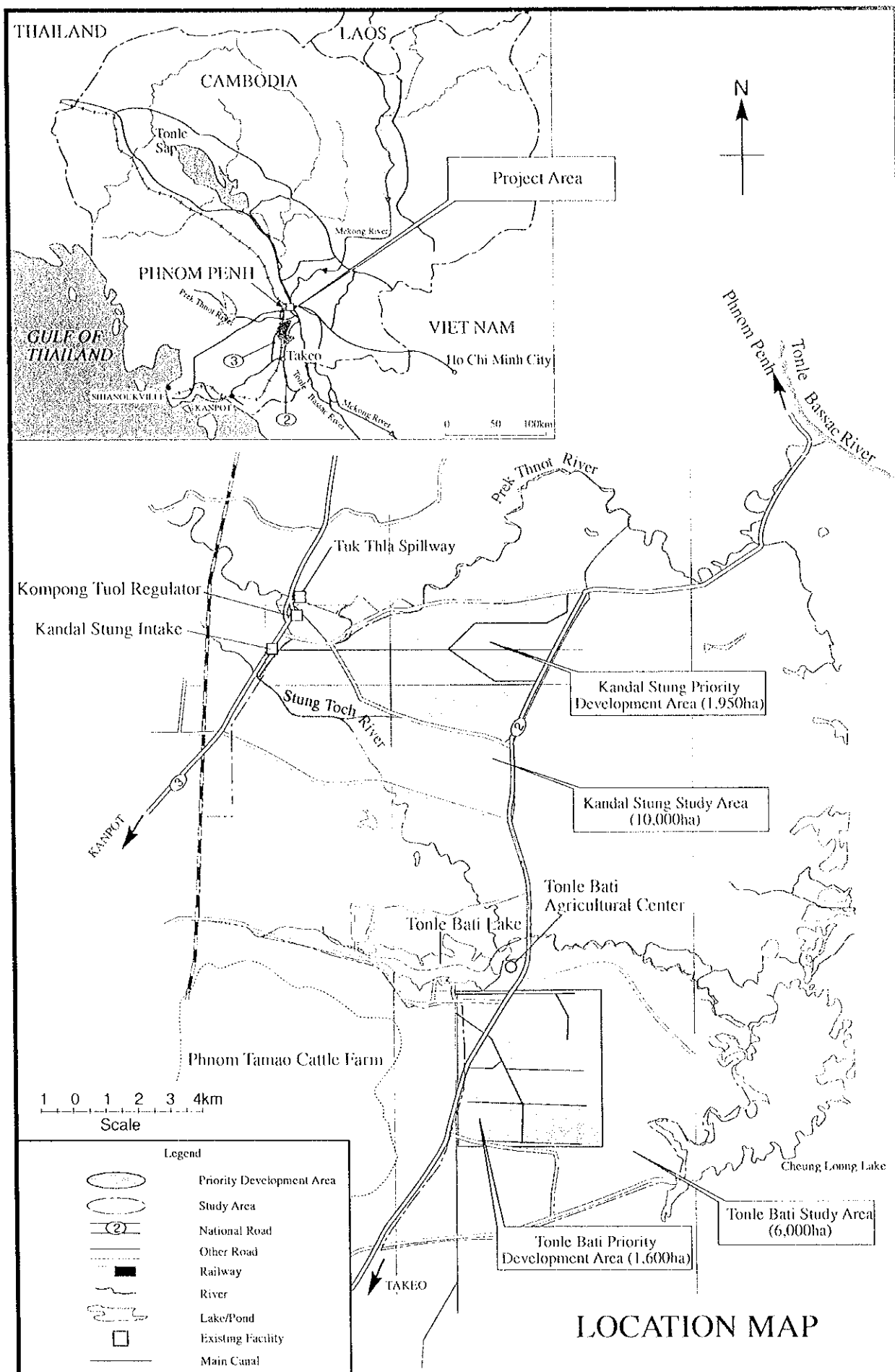
Very truly yours,



Shinichi YANO

Team leader of the Study Team for the Master Plan Study on
the Integrated Agricultural and Rural Development Project in
the Suburbs of Phnom Penh





SUMMARY

1. This report presents the results of the Feasibility Study on the Integrated Agricultural and Rural Development in the priority development area identified through the Master Plan Study carried out during a period from October 1993 through February 1995, describing the present conditions of the Study Area, basic development concept and plan, and a development schedule.
2. The priority development area for the model integrated agricultural development has been selected based on the physical, agricultural and socio-economic conditions taking into account the following points:
 - Benefit will accrue quickly after its implementation.
 - The priority area will function extensively as a model exhibition to the surrounding area.
 - Project components will be easily applied to other areas extensively.
 - Land productivity is relatively high.
 - The area is located near a water source and it is possible to introduce double cropping and crop diversification.
 - Accessibility of farm products to market is fairly good.
 - Security condition is good.

As a result, 1,950 ha in the Kandal Stung area and 1,600 ha in the Tonle Bati area were selected as a priority development area. The Irrigation system, exist but do not function properly at present, and reliable gravity irrigation could be ensured without using the Prek Thnot reservoir after the rehabilitation of the headworks.

3. Cambodia has an area of about 181,000 km². Forests cover about 12,300,000 ha or 68 % and are located mainly in the northeastern part and between the Tonle Sap Lake and the Dongrek mountains in the north. Farmlands occupy about 3,800,000 ha or 21 %, comprising 2,700,000 ha of paddy fields, 1,000,000 ha of upland fields, and 85,000 ha of the rubber plantations. The cultivated areas are mainly concentrated in the lowland around the Tonle Sap Lake and on both sides of the Mekong River in the south of the country.

The population in 1991 was about 8.8 million and the annual growth rate was 2.8 %. About 88 % of the total population lived in the rural areas, and female, totalled about 54 %. The population density was 49 persons/km² in the whole country and 1,840 persons/km² in Phnom Penh. The total labour force was 3.7 million and adult literacy rate was about 30 %.

4. Since the independence declaration in 1959, political instability caused by civil wars has retarded the social and economic development process, and continued to maintain a delicate political situation. At the 1991 Paris Conference of Cambodia, the Agreement on a Comprehensive Political Settlement of the Cambodia Conflict was signed. General elections were held from April to May 1993, and the new Royal Government was formulated in September 1993.

The Gross Domestic Product (GDP) in 1991 was 280 billion Riels (US\$ 127 million), and the agriculture sector occupied 46.9 % of real GDP. Rice accounted for 17.6 %, other crops and rubber 11.7 %, livestock 11.2 %, fishing 4.8 %, and forestry 1.5 %. GDP per capita was US\$ 223 equivalent and its recent annual growth rate was 19 %. Exports amounted to US\$ 51.3 million in 1991 and the principal exports were timber, rubber, soybeans, maize and fish/fish products. Imports totalled US\$ 345.7 million in 1991 and the main imports were food, fuel, fertilizers, raw materials, equipment and consumer goods.

5. The agricultural sector is recognized as the top priority sector in the national reconstruction program. For the purpose of increasing agricultural productivity and thus improving living standards, the Government has been taking effective measures such as granting land ownership, introduction of a free market, and the decontrol of product prices in order to provide more incentives to producers. The supporting infrastructure including irrigation and drainage facilities, and rural roads needs to be improved and expanded and the delivery of basic support services needs to be strengthened.
6. The Ministry of Agriculture, Forestry and Fisheries (MAFF) has overall responsibility for coordinating agricultural development activities. The most relevant departments in MAFF for agriculture and rural development are the Department of Agricultural Hydraulics and Hydro-meteorology (DOAHH), the Department of Agronomy (DOA), the Central Company of Agricultural Materials (CCAM), and the Land Titling Department (LTD). The Secretariat of Rural Development is responsible for the supervision and management of rural development, having a target of achieving at the same socio-economic level as that of other Southeast Asian countries by the year 2000.
7. Construction of the dam and power station under the Prek Thnot Multipurpose Project was started in 1969 and the works have been suspended due to past civil wars. A re-appraisal of the Project was carried out in 1991, and the irrigable area according to the appraisal result is 4,200 ha under the "without dam" conditions, 34,000 ha if irrigation is given priority, and 27,000 ha if hydropower generation is given priority.
8. The alternating monsoon system controls the climate in the Study Area. The wet season, the Southwest monsoon, is from May to November when about 90 % of total rainfall occurs. The remaining months, the Northeast monsoon, are hot, dry and less humid with a potential of particularly high transpiration demands in March and April. Annual mean rainfall is 1,365 mm and the monthly temperatures range from 21 °C to 35 °C.

Runoff from December to April forms a small part of the annual total. From May through the remaining months of the wet season, floods can occur at any time in response to intense rainfall, but the highest floods tend to occur towards the end of the wet season, usually in September or October. The hydrograph declines rapidly at the end of the wet season and this is similar for all years. The annual runoff of the Prek Thnot River is 1,130 - 1,620 MCM. Probable flooding at the Prek Thnot dam site is 1,900 m³/sec in a 100-year return period and 3,900 m³/sec in a 1000-year return period. The annual sediment transported at the dam site is estimated to be 0.37 to 0.31 MCM.

9. The two areas sandwiched between the Stung Toch and Prek Thnot rivers and extending immediately south of the Tonle Bati River consist of active alluvial flood plains with recent and silty soils. The lands extending south of the Stung Toch River and southwest of the Tonle Bati River are older terraces where natural flooding no longer occurs. The proposed new dike and existing Kompong Tuol regulator site is located on an underlaid high permeable recent alluvium sand layer. These soils are loose and susceptible to piping. However, the less pervious layer having 3 to 5 m thickness extends between the recent alluvium sand and the old alluvium sand.
10. The main soils in the Study Area were classified into seven (7) soil units in accordance with the FAO system (FAO-UNESCO, 1974) and thirteen (13) land units were identified based on their formation on location, land form, soils, native vegetation and land use. Land suitability is assessed in terms of the ability to support three particular forms of land use - wet season lowland rice, dry season (irrigated) rice, and dry season (irrigated) upland crops, and classified into "Suitable: S1-S3", "Suitable with Conditions: N1" and "Non-suitable: N2" in accordance with the FAO (1985) system.

The majority of farmland is devoted to wet season rice cultivation: about 1,950 ha or 81 % of the gross Kandal Stung and about 1,600 ha or 87 % of the Tonle Bati area. As a result, most of Kandal Stung area is suitable for wet and dry season rice, and for dry season upland crops, and more than 90 % of the land in the Tonle Bati area is suitable for wet and dry season rice and upland crops.

11. The Study Area is under the jurisdiction of the Kandal Stung District of Kandal Province (the Kandal Stung area) and the Tonle Bati District of Takeo Province (the Tonle Bati area). The Kandal Stung area includes 24 villages belonging to 13 of the 23 communes of the district, and the Tonle Bati area includes 9 villages belonging to 5 of the 11 communes of the district. The Kandal Stung area covers about 2,404 ha and the Tonle Bati area about 1,828 ha in gross.

The population of the Study Area in 1993 was estimated at about 8,924 (5.6 person/family) for the Kandal Stung area and about 5,814 (5.5 person/family) persons for the Tonle Bati area. The proportion of the female population is about 53 % in the Study Area. The Study Area seems to be relatively homogeneous in terms of the socio-economic position of the families and no great differences have been discovered, either in size of land holdings, assets, income, or type of house owned by the families. A quite vulnerable group in the area would be the Female Headed Households (FHHs) without adult male members, which account for about 28 % of families in the Study Area. The most problematic points of FHHs are the lack of manpower for ploughing fields and a shortage of funds. Another problem for FHHs is the lack of child care centres in the district.

Both districts in the Study Area have a similar curative public health services structure, headed by a district hospital of about 100 beds, and each village (khum) has an infirmary or khum clinic assisted by a khum Health Committee. Public health services in both districts are supported by foreign NGOs; 24 Hr TV supports the District Hospital while WVI has a Primary Health Care Program in the Kandal Stung district. In the Bati district JOCS provides support to the District Hospital and to Primary Health Care. However it can be concluded that the public health services in the Study Area, even with the assistance of NGOs, have got a long way to go in providing adequate services to the people, due to a shortage of staff such as nurses and midwives in a number of khum clinics. Some clinics have been damaged by war and are not functioning properly. There are several primary schools and some lower and higher secondary schools. The socio-economic survey results of the Study Area show that more than 80 % of children between 6-16 go to school. There does not seem to be a significant difference between girls and boys attending school. Classrooms are not sufficient to cope with the enrolled pupils.

Farming activities are either performed by males, females or both. Ploughing and threshing/pounding is traditionally done by men, and mostly in groups or with hired labour. Transplanting and harvesting are women's jobs. Manuring/fertilizing is mostly done by the female members of the family while seeding and weeding are activities performed by both male and female family members. Both districts are largely similar in relation to the traditionally female activities such as cooking, washing the dishes, cleaning the house and going to the market for shopping. But, while water carrying, firewood collection and caring for ill family members are very much shared activities in Kandal Stung District, the respondents in Bati District claim that the first two activities are predominantly done by males, and the third is predominantly a female activity.

12. Private land ownership has been granted and the registration of land titles in the Study Area is being prepared by MAFF. The average land holding size by household is 0.9 ha for Kandal Stung and 1.4 ha for the Tonle Bati areas. The agriculture in the Study Area is dominated by rice cultivation and most of the farm land is rainfed lowland rice fields with a rather low average unit yield of about 1.4 ton/ha. A typical pattern is rain-fed single cropping in the wet season, however, annual double cropping using irrigation is

done in a very limited area. The early rice, medium rice and late rice cultivated during the rainy season is 120 ha, 1,170 ha, and 780 ha in the Kandal Stung area, and 130 ha, 1,120 ha and 480 ha in the Tonle Bati area, respectively. In addition to rice cultivation, farmers grow other crops including vegetables, bananas, mangoes, and guava in limited areas in home gardens. Livestock raising is also very important in the Study Area. Most farmers keep pigs and poultry. Cattle is raised for ploughing and haulage.

Transplanting, using the wet nursery methods is a common practice for growing rice in the area. The farmers use farmyard manure as a basal dose and use chemical fertilizers such as Urea, averaging 20 kg/ha, and Compound (16:20:0) averaging of 80 kg/ha. Plant protection is usually not required because of low damages by insects and disease. Farmers rarely use chemicals, especially for brown plant hoppers in March to April. Harvesting and threshing is done manually. The threshed paddy is well dried under the sun and stored in a granary at each farm household. At half the number of villages, privately owned rice mills are providing services for the surrounding villages. At present, almost all the villagers use a rice mill for milling rice for their own consumption, instead of the pounding method. At present, the marketing of farm products in the area is under a free marketing system and no government control is observed, except for farm inputs supplied by the government (mainly fertilizers and chemicals). Usually farmers sell their products, especially paddy, pigs and poultry, whenever cash is required, to middlemen visiting each individual farmer. No organization has been established for the marketing of farm products, and the farmer has less power to negotiate with the middleman on the prices of their products.

13. The total production of rice, palm sugar and the number of livestock raised by the Study Area in 1993 are shown below:

Items	Kandal Stung Area	Tonle Bati Area
Paddy (ton)	2,900	2,400
Sugar (ton)	100	10
Cattle (head)	3,000	3,400
Pig (head)	1,100	1,400
Poultry (head)	9,100	8,900

The Study Area's main economy base is rice cultivation, but the production is not sufficiently high due mainly to an irrigation water deficit and a shortage of inputs and improved techniques. The farmers are at present earning income basically from rice cultivation, but the majority of farmers maintain their living supplemented by other incomes, livestock, sugar, wages, etc. The gross income of farm households in the Kandal Stung area is estimated at about 370 US\$ for farming and 160 US\$ for off-farm activities, totalling 530 US\$. Farm household income in the Tonle Bati area is estimated at about 570 US\$ for farming and 30 US\$ for off-farm activities. About 30 % of the gross income in the Kandal Stung area is derived from off-farm income, while more than 95 % of the gross farm income is derived from rice production in the Tonle Bati area. The average annual living expenditures in the Kandal Stung and the Tonle Bati areas is estimated at about 480 and 520 US\$, respectively. The study on farm budgets makes it clear that the farm economy for typical farmers in both Kandal Stung and Tonle Bati areas remains at a subsistence level.

14. Agricultural support services are offered by MAFF at the central level, the Provincial Agricultural Office at the provincial level, and the District Agricultural Office at the district level. DOA in MAFF is responsible for the formulation of an experimental plan at the national level and for the monitoring of food production in the country through provincial agricultural offices. There are seven (7) agricultural/rural development centres under DOA, and most of them are receiving support from NGOs. Each centre provides

services for irrigation water management and farm input supplies for rice cultivation. However, most of the centres are forced to scale down their activities mainly due to shortages of manpower and budget. CCAM distributes agricultural inputs, mainly fertilizers, chemicals, and some agricultural tools such as sprayers through the agricultural development centres, and provincial and district offices at fixed Government prices. Timely distribution of the inputs is not always carried out mainly due to a shortage of manpower and facilities. A small amount of fertilizers is often sold through private channels at rather high prices and some small farmers, especially the poorest, are unable to obtain the necessary inputs.

Agricultural extension work in the Study Area has been carried out under DOA, by the Tonle Bati Agricultural Development Centre (TBADC) in the Tonle Bati area and by the Kandal Stung Rural Development Centre (KSRDC) in the Kandal Stung area. The area covered for the agricultural extension by KSRDC is about 375 families in 12 villages belonging to 3 communes. Most of the activities concentrate on community development through small scale agricultural credit. But service is not provided for the priority development area in Kandal Stung. On the other hand, TBADC substantially provides agricultural support services in cooperation with the District Agricultural Office. These services include irrigation water supply, agro-input supply and extension works such as rural credit, operation of a demonstration plot to show farming techniques for fertilizer application and improved varieties, and community development such as repairing of rural roads, digging wells, and education of teachers for primary schools. The activities of the centres and agricultural offices are very limited due mainly to a lack of qualified manpower, budget and facilities.

The area and families covered by the small scale rural credit scheme are still very limited due mainly to a shortage of funds and qualified manpower. The items of activities covered by the credit are mostly vegetable gardens, pig raising, and the operation of small shops in the villages. There are no large differences between men and women's roles in the credit. The Family Food Programme (FFP), sponsored by UNICEF and implemented with the assistance of the World Food Programme (WFP) and the Khmer Women Association, specifically targets poor families with children under five, FHHs, widows, etc. At the more general level of the overall the health status of the population in the Study Area, it should be noted that, apart from government services provided through a district hospital and several khum health clinics, NGOs in both districts are active in the Primary Health Care (PHC) field (:WVI and 24 Hour TV in Kandal Stung District; JOCS in Bati District). This includes such activities as the improvement of the domestic water supply, sanitation, vegetable gardening, and vaccination.

15. During the Pol Pot regime 1975-79, an irrigation canal system was constructed in the Kandal Stung area. At first, the Prek Thnot By-pass Channel with the Tuk Thla Regulator was constructed at the National Road No. 3 crossing, together with a road dike, the Kompong Tuol Regulator, and a flood dike. Irrigation canals and their related structures were then constructed in the Kandal Stung area, following latitudinal and longitudinal grid lines, regardless of the topographic conditions.

The irrigation area envisaged in the Kandal Stung area is 3,100 ha, for which water is diverted from the left bank of the Prek Thnot River about 1 km south of the Kompong Tuol regulator. In 1987 to 1991, the rehabilitation of the irrigation facilities was executed by the Department of Hydrology and the joint effort of the Kandal Stung District and Kandal Province, under the assistance of MCC (Mennonite Central Committee). However the National Road No. 3 dike was washed out by the August 1991 flood. In February 1992, rehabilitation of some parts of the damaged canal embankment and structures of the Kandal Stung Project was executed by the Mekong Secretariat (executing agency). But in October 1992, the road dike was washed out again by flood, and rehabilitated again in December 1993. However, the dike was destroyed again in August 1994 by flood. Therefore, the water supply to the Kandal Stung area has not been ensured since then.

16. During the period of 1975 - 1979, the canal system of the Tonle Bati Project, for the planned area of 6,000 ha was constructed, of which water was diverted from the Tonle Bati Lake. During 1987 - 1990, the irrigation system was rehabilitated by the Department of Hydrology with the assistance of WCC for an area of about 900 ha. However, irrigation facilities are presently not functioning well due to insufficient rehabilitation, insufficient water level/storage of the Tonle Bati Lake, and the lack of an effective O&M system. At the head of the main canal, an intake and pumping station were installed. The pumping station is used for supplying water in the dry season. The operation and maintenance of the facilities is made by the Bati District office.
17. In the Study Area, there are about 6.5 km of national roads(NR No.2 and No. 3) and about 16.4 km of provincial roads. The National Road is mostly paved with asphalt. The provincial road is asphalt-paved but is severely damaged, so that only four wheel driven car, can pass in the rainy season. District roads remain unpaved and are affected by erosion. The district road of Kandal Stung is impassable due to damage to a bridge on the irrigation canal. Farm road networks are insufficient for the efficient transport of farm inputs and outputs. In the rainy season, these roads are barely passable by car due to mud or serious erosion.

Ground water is the main source for drinking and domestic purposes. In most of these wells, water is drawn with a well bucket. Tubewells are equipped with manual operated pumps. River water or pond water is also used for domestic purposes. In the dry season many wells are dry forcing villagers to take water from other water sources such as lakes, canals or ponds. Generally they are faced with a severe shortage of domestic water.

Basically, a commune clinic is provided for each commune. The existing conditions of five clinic buildings are : 3 in good condition, and 2 in marginal condition. School facilities such as building, books and science equipment, are inadequate. Some wooden buildings are in such bad conditions that replacement or additional buildings are indispensable in improving the quality of education. There is no community centre, in the Kandal Stung and the Tonle Bati areas.

Market Facilities in the Study Area are satisfactory, however, their facilities and access to the market areas need to be improved. Rice mill facilities at present, are mostly sufficient in quantity and quality.

18. The most striking feature in the Study Area is the absence of natural systems such as undisturbed forests or wetlands. Consequently, biological diversity is poor and larger animals are not evident. Water is plenty in the wet season but dries up in the dry season, resulting in severe shortages for domestic use. River and canal banks are eroding and riverine vegetation, which provides natural stability to river banks, has disappeared in many places. Although livestock are reared extensively, the integration of crops and livestock husbandry has not taken place with any seriousness. Often manure goes to waste. Pigs and poultry are free range, thereby making the excreta unavailable.

Firewood is in short supply throughout the Study Area. Part of the domestic needs are supplied by home gardens and from nearby wet lands. In the Tonle Bati district, part of the firewood demand is met by the Phnum Thamao forest reserve which is nearly denuded.

The Ta Prohm Temple at Tonle Bati is a place of archaeological interest. It is near the Tonle Bati Lake, which is also a recreation area, very popular during holidays. The recreation area is in poor condition, with evidence of large scale erosion.

19. The major physical and socio-economic constraints in the Study Area are summarized below.

- | | |
|----------------------------------|---|
| (1) Soil Mechanical condition | - Embankment materials surrounding the proposed dike site are considered to be undesirable due to their dispersive property. |
| (2) Soils | - Soils in the older terrace geomorphic province, lying South-west of the Study Area, have low fertility, requiring a large amount of farm inputs for effective production. |
| (3) Water Resources | <ul style="list-style-type: none"> - Inadequate timely water resources available in the dry season and through the early months of the wet season, and - High potential for severe flooding both in terms of damage to irrigation facilities and by the inundation of cropped areas later in the wet season. |
| (4) Irrigation and Drainage | <ul style="list-style-type: none"> - Shortage of experienced engineers and technical staff in planning, design and implementation, and a lack of funds for rehabilitation / reconstruction and operation and maintenance - Inadequate design and implementation due to a lack of design standards and construction specifications, and - Lack of a systematic operation of the irrigation system including O&M organization. |
| (5) Rural Infrastructures | <ul style="list-style-type: none"> - Insufficient number of rural water supply facilities and the drying-up of water sources in the dry season, - Muddy rural roads in the rainy season making it difficult to maintain daily transportation access, and - Inadequate provision of facilities for community organization development, and health care services. |
| (6) Agriculture and agro-economy | <ul style="list-style-type: none"> - Insufficient supply of certified seeds, and agricultural inputs such as fertilizers and chemicals and - Lack of supporting services and improved techniques. |
| (7) Socio-economic conditions | <ul style="list-style-type: none"> - No sufficient extension services to FHH families, - Lack of sufficiently skilled Government staff, and - Lack of credit opportunities at reasonable cost/interest rates. |
| (8) Environment | <ul style="list-style-type: none"> - River and canal bank erosion, and - Shortage of firewood supply. |

The farmer's needs and expectation, for agricultural and rural development are summarized below :

Major expectations in the dry season

- 1) Supply of irrigation water
- 2) Supply of domestic water
- 3) Sufficient health services

Major expectations for production

- 1) Sufficient supply service of fertilizers and agro-chemicals
- 2) Need of drought animals
- 3) Supply of improved paddy seeds

Major expectations for living conditions

- 1) Increase of food for home consumption
- 2) Sufficient school facilities
- 3) Increase in living expenses
- 4) Convenience of medical services
- 5) Sufficient program for FHH

20. In due consideration of the Government policy applied to the agricultural and rural development as well as the present socio-economic conditions of the Study Area, it is presumed that the following are regarded as the ultimate objectives and development strategies of the integrated agricultural and rural development of the Study Area:

- (1) The objectives of the integrated rural development plan are to achieve substantial and sustainable improvement in the living conditions of the inhabitants of the Study Area.
- (2) To achieve the objectives of development, the strategy adopted is to increase farming output in the area through improvement and development of irrigation, drainage and rural infrastructure, together with suitable supporting services and schemes.

According to the development needs and the national development policy, the objectives for development of the whole area are described as follows :

- (1) To raise farmer's income level through the enhancement of agriculture, especially rice and livestock production, and by the effective utilization of land and water resources in the Study Area.
- (2) To contribute to regional and national needs to increase rice production with the aim of achieving self-sufficiency.
- (3) To raise the living standard and to improve rural people's life through increasing farm income and extending services.

The practical targets set up for the above objectives are as follows.

- (i) **Production and self-sufficiency in rice**
To supply 310 kg of paddy for consumption per capita per year on the basis of a production target of 400 kg per capita.
- (ii) **Income generation**
To increase the present level of total annual farm household income of about 1.12 million Riels (US\$ 509) to more than 3.0 million (US\$ 1,364) or more than 2.5 times the present level, with an annual increase rate of 10%
- (iii) **Living cost and meal cost**
To reduce the ratio of the meal cost (Engel's coefficient) to less than 50% of the total living cost, and to reserve about 10% of annual income.

To achieve the objective mentioned above and solve the present problem, the following plan will be executed:

- (1) Irrigation and drainage facilities improvement,
- (2) Agricultural development,
- (3) Agricultural supporting services,
- (4) Farmers' organization development,
- (5) Rural infrastructure development,
- (6) Living standard improvement plan, and

- (7) Establishment of a model area.
- (8) Land scope improvement regarding environmental aspect.

21. The available amount of water of the Prek Thnot River for irrigation development of the Study Area is as follows:

(1) Run-of-River Water

The flow available for the Study Area is estimated to be the residual flow after sharing the gross irrigation demands of the irrigation schemes located/envisaged upstream of the Tuk Thla and Kompong Tuol regulators. The average monthly flow derived from the 10-year series of residual flow at Tuk Thla is shown below:

Average residual flow at Tuk Thla for the 10-year design period (MCM)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuk Thla	8.0	5.3	4.5	6.4	33.0	79.0	140.9	199.0	318.6	433.7	147.9	69.2
	1446											

(2) With Prek Thnot Reservoir

The irrigation potential "with dam condition" is estimated at the range of 25,000 ha (maximum firm power) to 35,000 ha (irrigation priority) based on the double cropping plan.

22. The proposed cropping patterns are formulated for the "with and without Prek Thnot Reservoir conditions" as shown below, on the basis of the following basic principles:

- a. 100 % of wet season rice under irrigation of which about 20 % would be local varieties.
- b. 50 % of improved varieties of dry season rice, 30 % of upland crops such as maize and soybeans and the remaining 20 % for fallow.
- c. The cropping period varies according to farm labour availability in the farming season, particularly for transplanting and harvesting, and the availability of irrigation water during the planting season.

Crops	Kandal Stung Area				Tonle Bati Area			
	Wet season		Dry season		Wet season		Dry season	
	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)
Rice:	100	1,950	46	900	100	1,600	50	800
Early dry season rice			46	900			50	800
Early wet season rice	50	975			50	800		
Medium wet season rice	30	585			30	480		
Local varieties	20	390			20	320		
Maize & soybeans			14	270			15	240
Vegetables			14	270			15	240
Crop intensity/total area	100	1,950	74	1,440	100	1,600	80	1,280

23. It is necessary to introduce new high-yielding varieties or hybrid seeds with the appropriate use of fertilizers and agro-chemicals (minimum use and environmentally sound chemicals such as Fenitrothion, Buprofezin, Dithiocarbamate, Benomyl) along with the provision of irrigation facilities and institutional support services. The present farming practices prevailing in the project area are basically applied including animal power for soil preparation and transportation, manual operation for transplanting and harvesting, wet nursery system, and ordinary transplanting method. Taking into consideration the present circumstances, rapid introduction of full mechanization is not practicable in the area, but some mechanization is necessary, especially for chemical application, threshing rice, and shelling maize and groundnut.

Regarding plant protection, farmers should choose the chemicals through consultation with the Agricultural Development Centres and their services and it is recommended to apply these under the guidance of the agricultural extension worker. It is recommended to organize an integrated pest management system for the protection the crops as well as the environmental conservation of the area. To promote livestock production, it is recommended to produce secondary crops for feed and to construct proper shelters to manage feeding effectively and for the better health condition of the animals. It is also essential to promote disease control by the extension of veterinary services such as vaccination and the breeding of healthy animals.

24. The target yield of crops at the full development stage is expected to be as follows :

crop	HYV rice	maize	soybeans	groundnuts	mungbeans	sesame.
yield	4.0	3.0	2.0	1.5	1.0	1.2

The anticipated annual rice production in the Kandal Stung and Tonle Bati areas, at the full target stage, is estimated at 11,010 tons and 9,280 tons, respectively. The present rice production is estimated at about 2,900 tons and 2,400 tons, therefore the increment of rice production by the project is expected to be about 8,100 and 6,400 tons, respectively.

The anticipated incremental production of upland crops and livestock in both the Kandal Stung and the Tonle Bati areas is estimated as follows:

Crops	Kandal Stung		Tonle Bati	
	Planted area (ha)	Production (ton)	Planted area (ha)	Production (ton)
Maize	270	810	240	720
Soybeans	270	405	240	360
Vegetables	270	2,700	240	2,400
Livestock(head)		1,440		1280

25. The area is located in the suburbs of Phnom Penh and is densely populated with a high increase rate. It is anticipated that rice demand will considerably increase under these circumstances, and livestock production will also increase, especially for the markets of Phnom Penh, due to a rise in consumption brought on by a change of diet for protein.

The anticipated agricultural benefit after the implementation of the project is estimated to be about US\$ 2.5 million for the Kandal Stung area, and US\$ 2.1 million for the Tonle Bati area. From the viewpoint of the individual farmer's economy, a typical farm budget was evaluated under "with project" conditions. As a result, the net income obtained by each farmer would be sufficient to pay more than 3 million Riel(US\$ 1,364) for annual living expenses including foods, welfare, and education, and to earn a certain net reserve.

The economic incremental agricultural benefit evaluated for the priority areas is estimated at US\$ 2.1 million and 1.8 million for Kandal Stung and Tonle Bati area respectively.

26. The strengthening of the support services in the priority area includes the activation of the existing Agricultural Development Centre in the Tonle Bati area and the establishment of a new agricultural development centre in the Kandal Stung area. The majority of services including agricultural extensions, agricultural input supply, credit services, water management of the irrigation system, management of the rural infrastructure, and rural life improvement activities will be made through the Agricultural Development Centres.

The operation plan of the centre is formulated taking into consideration the close cooperation and coordination between each district office, the relevant research stations, development centres, other projects such as the IRRI-Cambodia Project, and various activities regarding the life improvement extension. It is proposed that the agricultural supporting services at the initial stage in the project area will be carried out by the Agricultural Development Centres, which will be operated directly under the management of the Department of Extension. And afterward, operation of the Agricultural Development Centres with sufficient qualified extension workers and facilities will be transferred to the management of each district office. The supporting services extended by the centres are as follows:

- Extension of agricultural techniques,
- Agricultural inputs and equipment supply, rural credit supply and agricultural insurance system,
- Assistance and guidance for operation and maintenance of irrigation and drainage, and provided rural infrastructures, and
- Life improvement extension services

The proposed agricultural extension services will be provided mainly for food (rice) and other secondary crops, and livestock raising, mainly pigs, poultry, and cattle for draft power, through the provision of trained extension personnel, vehicles and equipment, and office buildings to be constructed. The key points of emphasis in the agricultural extension are as follows:

- Introduction of improved varieties,
- Supply of planting materials,
- Demonstration and guidance of cultivation techniques,
- Extension of livestock production,
- Introduction of a vaccination service, and
- Monitoring and evaluation.

27. There is not an effective farmers' organization for the various support services through the agricultural development centre in the priority development area at present. The following are the anticipated groups to be established:

- a. Water users' association(irrigation water),
- b. Drinking water supply group(wells),
- c. Small farmers' credit group,
- e. Cultivation techniques study group,
- d. Life improvement leading group, and
- f. FHH/women's' group

28. The Kandal Stung area will be served by 1,950 ha which is estimated on the water balance simulation with an irrigation dependency of 4 out of 5 years. The following table shows the salient features of the irrigation facilities:

Description	Unit	Quantity
Main canal:		
- Improvement	(km)	5.3
Lateral:		
- Improvement	(km)	8.2
- Construction	(km)	4.0
Tertiary canal:		
- Improvement/construction	(km)	56.8
Quaternary canal:	(ha)	1,950
Drainage facilities:		
- Main canal	(km)	18.1
- Tertiary canal	(km)	64.6

29. The Tonle Bati area will be served by about 1,600 ha based on the water balance simulation as mentioned above, and the irrigation facilities are provided from the following design considerations:

- 1) Available river discharge of the project area from upstream,
- 2) Tonle Bati lake water level at 7.8 m,
- 3) Pump irrigation during the low water period of the Tonle Bati Lake,
- 4) Priority pump irrigation in the elevated area during the dry season,
- 5) Separate irrigation and drainage system, and
- 6) Future development

The following are principal features of the irrigation and drainage facilities:

Description	Unit	Quantity
Main Canal		
- Improvement of main canal	(km)	8.3
- Construction of main canal	(km)	-
Lateral		
- Improvement of existing Lateral	(km)	6.9
- Construction of Lateral	(km)	3.1
Tertiary Canal		
- Improvement of existing tertiary canal	(km)	15.0
- Construction of tertiary canal	(km)	33.1
Quaternary canal system	(ha)	1,600
Improvement of Tonle Bati Lake Related Structures		
- Intake	(nos)	1
- Pumping Station	(nos)	1
- Spillway of Lake	(nos)	1
- Lake Dike	(km)	L.S.
Improvement of Connection Canal		
- Connection canal	(km)	4.6
- Stung Toch Regulator	(nos)	1
- Stung Toch Dike	(km)	1.0
- Kandal Stung Regulator	(nos)	1
Improvement of Drainage canals and structures		
- Main Drain	(km)	10.4
- Secondary Drain	(km)	13.7
- Tertiary	(km)	41.8

30. Improvement of the Tuk Thla and Kompong Tuol regulators are a prerequisite in the development of the Kandal Stung and Tonle Bati areas. The improvement plan is described below.

- a) Design flood without the dam : 1,900 m³/sec (100-year return period)
- b) Required intake water level : EL 11.50 m for water intake
- c) Allowable maximum flood water level : EL 13.00 m

The following five alternative cases are studied for the determination of the proposed plan:

- Case-1 Improvement of the Existing Regulators and Construction of an Additional Overflow Type Spillway.
- Case-2 Improvement of the Existing Tuk Thla Regulator and Construction of an Additional Overflow Type Spillway.

- Case-3 Improvement of the Existing Tuk Thla Regulator, Replacement of the Existing Kompong Tuol Regulator, and Construction of a New Overflow Type Spillway.
- Case-4 Improvement of the Existing Tuk Thla Regulator and Replacement of the Existing Kompong Tuol Regulator with a New Regulator consisting of a Rubber-made Dam and Bridge.
- Case-5 Construction of a new regulator at Kompong Tram which is located about 25 km upstream of the existing Kompong Tuol Irrigation Intake.

In Case-1 and Case-2, the proposed works require more than 650 m of over flow spillway along the National Road No. 3. It will be necessary to remove existing houses and a by-pass road. In regard to the rural people living around the site, these two cases will not be proposed.

According to a preliminary cost estimate for Case-3, Case-4 and Case-5, Case-4 is more costly than Case-3 due mainly to the high cost of bridges inherently required by rubber type weirs. Case-5 is also not economical due to the expensive cost for a division weir, bridge, and a headreach canal for about 25 km long to Kompong Tuol. Accordingly, it is proposed to adopt the improvement plan given in Case-3.

The proposed improvement works are summarized as follows :

- Tuk Thla Regulator: Replacement of gates, (6m x 3m x 5 sets)
- Kompong Tuol Regulator: Replacement of existing regulator,
(Gate: 6m x 8.0m x 5 sets, bridge: width = 15 m)
- Spillway: Overflow type, 400 m in length
- Route National No. 3: Total width 15 m, asphalt pavement and width 9 m
- Flood Dike on Upstream: Length about 5 km, top dike width 4 m
- Tele-communication system: Main, branch and two site stations

31. The overall water management of Prek Thnot river will be carried out by the Ministry of Agriculture and Forestry. The responsibility of operation and maintenance of the irrigation and drainage systems will be divided into two types of administrative bodies, i.e., a project operation body, responsible for the head regulator to the lateral systems, and water users group responsible for tertiary irrigation and the drainage system.

The Water Management Division in DOAHH will be responsible for the operation, maintenance, and management of the head regulators and localized reservoirs in order to ensure the equitable water management and safe operation of the large facilities. The local governments concerned will be responsible for the operation, maintenance and management of the main canal up to the lateral systems. To co-ordinate smooth operation and maintenance of the irrigation system and water management of the Project, the provincial and district irrigation committees will be organized at provincial and district government levels. They are made up of representatives of the provincial or district government offices, including the agriculture office, the public works office, the rural development office, and the police/ military office.

The O&M section will prepare a seasonal water distribution schedule including rotational blocks for dry and rainy season cropping, respectively. It will submit the prepared irrigation schedule to the chairman of the Irrigation Committee for its approval. After the approval, the irrigation schedule will be announced to the water user's association before starting crop cultivation.

32. The improvement of provincial, district and farm roads will made using asphalt or gravel-metall. In order to stabilize the supply of domestic water, additional tubewells are proposed to be provided where existing wells are insufficient. Regarding health services

facilities, it is proposed to improve the existing Khum clinics whose facilities have severely deteriorated and to construct new clinics in place of those destroyed during the Pol Pot regime. Since the present primary school facilities are very poor and substantially short of classrooms, 58 additional classrooms are proposed to be provided in the respective Khums, to be used as multi-purpose facilities for rural social structure improvement.

Facilities		Unit	Quantity	
Road	Provincial	(km)	14.9	Asphalt pave.
	Farm or rural	(km)	22.6	Gravel pave.
Tubewell	Depth more than 50 m	(Nos)	2	
	Depth less than 50 m	(No.)	74	
Khum clinic	Kandal Stung	(No.)	2	384 m2
	Tonle Bati	(No.)	1	384 m2
School class room		(No.)	38	
Community hall		(No.)	7	

33. The proposed measures to improve food and nutrition for the people are categorized into (i) attainment of food and balanced nutrition by intensification and increase of the staple food crop (rice), secondary crops, livestock raising and vegetables for home consumption and (ii) educational life improvement extension work including the improvement in knowledge of nutrition, hygiene and health management, the improvement of the effective cooking methods covering the modernization of cooking facilities and the saving of energy, the improvement in knowledge of safety and hygiene in food and domestic water, and improvement of the living environment, consisting of the construction of rural infrastructure wells for the domestic water supply, and the application of improved methods of livestock raising, especially relating to their living conditions.

The measures proposed within this element are mostly the promotion of agricultural production by diversifying to cash crops, and vocational training on such activities as handicraft, weaving, and sewing. The key point envisaged to carry out these measures is to formulate leading groups to initiate the practices of these activities.

To improve support services for life improvement is need to strengthen the support services by reactivating and improving the Agricultural Development Centres and to carry out most of the relevant services and programmes in cooperation with the agricultural support services. To improve household management is need to educate and also offer practical training on the importance of clothing for safety and health, and offer training on basic accounts and record keeping of income and expenses.

Community development is the most important for improving the conditions of the people in the area. The proposed measures for this development are the promotion of people's participation at the planning stage of programs, and organizing grass root communities including water users' associations, small farmers' credit groups, life improvement leading groups, and FHH /women's group.

34. Special consideration should be paid to health and sanitation among the environmental issues envisaged along with agricultural development in the Study Area. The rural people at present depend on fish and small aquatic animals in the rivers, canals and ponds for their protein supply. In order to minimize the adverse impacts to the environment and to enjoy sustainable improved agricultural production, special attention should be paid to chemical application for pest control, and environmental conservation pest control techniques such as an integrated pest management system should be established.
35. The project cost consists of construction cost, procurement of machinery, land acquisition cost, engineering and administration cost and contingency. The total cost is estimated to be US\$ 67 million comprising US\$ 43.6 million of foreign currency and

US\$ 23.2 million of local currency. The construction time required for the Project is estimated at about 41 months, including the time necessary of preparatory works totalling about 9 months for definite design, contract administration and mobilization. The construction of irrigation and drainage works which comprise 3 major works, the Improvement of Kompong Toul Intake, the Kandal Stung Irrigation Scheme and the Tonle Bati Irrigation Scheme will take about 28 months, including preparatory works. Rural infrastructure will be implemented in stage, parallel to the irrigation works.

36. The implementation of the priority development will be concentrated in the Kandal Stung area of 1,950 ha and the Tonle Bati area of 1,600 ha. The implementation program will include the following:
 - (1) Agricultural development
 - Improvement and strengthening of agricultural support services, and
 - Establishment of a Rural Development Centre, including a demonstration farm
 - (2) Development of irrigation and drainage development
 - Urgent work for the improvement of the Tuk Thla and Kompong Tuol regulators,
 - Improvement of irrigation and drainage facilities of the Kandal Stung Irrigation Project of 1,950 ha,
 - Improvement of irrigation and drainage facilities of the Tonle Bati Irrigation, Project of 1,600 ha
 - (3) Development of rural infrastructures
 - Improvement of rural road network,
 - Construction of rural water supply facilities,
 - Improvement of village clinics,
 - Improvement of school buildings, and
 - Construction of community halls
 - (4) Measures for rural life improvement
 - (5) Support services to Women's group
 - (6) Measures for environment problems
37. The main agricultural impact will be the increase in agricultural production through improved irrigation, inputs and extension services. These crop production increases will bring about not only the upgrading of rural living standards in the Study Area but also the improvement of nutrition in and around Phnom Penh.

Livestock production will also increase after the proposed development. A certain portion of incremental coarse grains could be fed to livestock, which can be regarded as a form of value-added farm activities. The increased livestock production will contribute not only to the increase in farmers' cash income but also to the improvement of nutrition in and around the Project area.

Farmers in the Study Area as well as in other agricultural areas, especially in the suburbs of Phnom Penh, will become familiar with modern irrigation farming practices and value-added livestock raising. The incentive for adopting improved irrigation farming practices will be greatly enhanced. Enthusiasm generated from this success may even shorten the development period of other projects.

The improvement of the rural water supply, roads, community facilities, clinics, etc., will contribute to the development of the project area, and the living standard of the people will be greatly improved.

The increase of the net farm income will provide motives for improving the living standards of the farmers as well as the rural economic development. In addition, the farmers' increased purchasing power will activate the stagnated rural markets.

Employment opportunities for unskilled labourers will be generated during the construction period. Employees will be able to gain more experience and skills in the various working fields. The accumulation of experience and skills will be very useful for the O&M work of the farmers.

The need is increasing to adjust the land use system and to improve the efficiency of land use, so that natural resources may be managed to provide benefit for successive generations. From this point of view, the proposed integrated agricultural and rural development by this master plan will enable to bring about suitable, economical and sustainable land use which will be expected to definitely produce sustainable benefit.

A preliminary evaluation of the proposed agricultural development plan under "without-dam" conditions has been made in order to confirm the viability of the plans. The calculated EIRR is 12 %, proving that the proposed plan will be highly viable from an economic point of view. As a result of the evaluation in terms of the farmer's economy, the net income of a typical farmer is expected to increase, by 3.1 to 4.6 times, from US\$ 480 and US\$ 520 under without project condition up to US\$ 1,500 and US\$ 2,400 under "with project" conditions, for Kandal Stung and Tonle Bati area respectively. Accordingly, the incremental net income of the farmers is substantially increased which proves the farmer could pay water charges and additional costs easily.

38. It is concluded that the priority project is justified, because the project will significantly contribute to the economic development of the priority area as well as to rural life improvement, in addition to the numerous direct and indirect benefits already described. It is strongly recommended to implement the project as early as possible.
39. The integrated rural development herein conceived includes various components ranging widely in both soft and hard-ware technologies. It is therefore suggested that the Government of Cambodia particularly MAFF shall organize the project implementing agency together with a coordinating system for its efficient implementation. In this context, it is proposed to establish a Project Steering Committee, a Project Development Office, etc. The operation and management of the Agricultural Development Centre are recommended to be carried out in close contact and cooperation with other Government organizations and NGOs.
40. Along with the development of the priority area, it is strongly proposed to carry out a feasibility study and the subsequent implementation of the remaining development area when the Prek Thnot Multipurpose Dam Development Project is sure to be implemented. In this context, the following points are particularly recommended to be taken into account for the smooth implementation of the project.
 - 1) The early improvement of the Kompong Toul and Tuk Thla regulators.
 - 2) Farmers' participation in the project, particularly strengthening the farmer's beneficiaries intention for agricultural development.
 - 3) The establishment of an irrigation association and sufficient technical guidance on irrigation water management and O&M by the Government organization in order to smoothly manage operation and maintenance of the existing irrigation facilities.
 - 4) The early establishment of a telecommunication system on river basin water management in order to minimize flood damage and for the effective irrigation water use of the Prek Thnot River.
 - 5) The establishment of a demonstration farm which would exhibit modernized irrigation farming and demonstrate to the surrounding areas for extension.

- 6) **Training of the Government staff related to the Project and the leading farmers on technical and management of improved farming in Cambodia and abroad.**

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**MASTER PLAN STUDY ON
THE INTEGRATED AGRICULTURAL AND RURAL
DEVELOPMENT PROJECT
IN THE SUBURBS OF PHNOM PENH**

**FEASIBILITY STUDY FOR THE SELECTED PRIORITY SCHEMES
MAIN REPORT**

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LOCATION MAP

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LIST OF ABBREVIATIONS

24HRTV	24 Hour Television
ACR	Australian Catholic Relief
ADB	Asian Development Bank
ADRA	Adventist Development and Relief Agency
AIDAB	Australian International Development Assistance Bureau
ANS	Action Nord Sud
ASEAN	Association of Southeast Asian Nations
BOD	Biological Oxygen Demand
IBRD	International Bank of Reconstruction and Development
CAA	Community Aid Abroad
CCAM	Central Company of Agricultural Materials
CCC	Cooperation Committee of Cambodia
CDAI	Chamcar Daugn Agricultural Material
CIDSE	Cooperation International Pour le Developement et la Solidarite
CIRP	Cambodia IRRI Rice Project
CMEA	Council for Mutual Economic Assistance
CNMC	Cambodia National Mekong Committee
CWS	Church World Service
DO	Dissolved Oxygen
DOA	Department of Agronomy
DOF	Department of Forestry
DOH	Department of Hydrology
DOL	Department of Livestock
EIA	Environmental Impact Assessment
IERR	Internal Economic Rate of Return
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agricultural Organization of the United Nations
FD	Fisheries Department
FFP	Family Food Production Programme
FHH	Female Headed Household
FX	Foreign Exchange
GDP	Gross Domestic Product
GO	Government Organization
GPV	Gross Production Value
HEKS	Hilfswerk der Evangelischen Kirchen der Schweiz (Swiss Interchurch Aid)
HSP	Hydrology Support Programme

HYV	High Yielding Variety
ICO	Irrigation Community Organizer
ICORC	International Committee for the Reconstruction of Cambodia
ILO	International Labour Organization
IMF	International Monetary Fund
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ISF	Irrigation Service Fee
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
JOCS	Japan Overseas Christian Medical Cooperative Service
JSF	Japan Special Fund
KWA	Khmer Women Association
LTD	Land Titling Department
LUMO	Land Use Mapping Office, MAFF
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCC	Mennonite Central Committee
MOE	Ministry of Education
MOP	Ministry of Planning
MRD	Ministry of Rural Development
MTCP	Ministry of Transport, Communication and Posts
NGO	Non Governmental Organization
NPV	Net Production Value
O&M	Operation and Maintenance
ODA	Overseas Development Administration
OECD	Organization for Economic Cooperation and Development
PADEK	Partnership for Development in Kampuchea
PHC	Primary Health Care
PIU	Project Implementation Unit
PMCU	Project Monitoring and Coordination Unit
PSC	Project Steering Committee
PTMP	Prek Thnot Multipurpose Project
RBD	Roads and Bridges Department
RLR	Rainfed Lowland Rice
SIDA	Swedish International Development Agency
SNC	Supreme National Council of Cambodia
TAC	Technical Advisory Committee
TB	Tuberculosis
TBA	Traditional Birth Attendant

UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Educational Fund
UNTAC	United Nations Transitional Authority in Cambodia
USAID	United States Agency for International Development
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
VSO	Voluntary Service Overseas
WCC	World Council of Churches
WFP	World Food Programme
WHO	World Health Organization
WPO	Wildlife Protection Organization
WUO	Water Users Organization
WVI	World Vision International

KHMER WORDS USED IN THE TEXT

Khet	Province
Srok	District
Khum	Sub-District or commune
Phum	Village
Krom	Sub-Village
Krom Samakki	Solidarity Group
Provasday	Mutual Help
Riel	Cambodian Currency

MEASUREMENT

Length

mm	millimeter
cm	centimeter
m	meter
km	kilometer

Area

m ²	square meter
km ²	square kilometer
ha	hectare

Weight

kg	kilogram
ton	ton (= 1,000 kg)

Volume

cc	milliliter
l, lit	litter
m ³	cubic meter
mcm	million cubic meter

Time

s, sec	second
min.	minute
hr	hour

Temperature

°C	degree Celsius (centigrade)
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Currency

\$, US\$	United States Currency (Dollar)
¥	Japanese Currency (Yen)
Riel	Cambodian Currency

Others

HP	horsepower
W	watt
kW	kilowatt
MW	megawatt
kVA	kilo-volt-ampere
no(s).	numbers

I. INTRODUCTION

1.1 Authority

This Report on the Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh (the Study) was prepared in accordance with the Scope of Work agreed upon between the Ministry of Agriculture of the Kingdom of Cambodia and the Japan International Cooperation Agency (JICA) on January 26, 1993.

The Study was completed in two steps: Phase I and Phase II. During the Phase I Study from October 1993 to March 1994, the Master Plan Study on the whole Study Area was carried out, and the Kandal Stung and Tonle Bati areas were selected as the priority development areas. During the Phase II Study from May 1994 to February 1995, a Feasibility Study was carried out for the selected priority development areas.

The Final Report consists of the Master Plan Report, Feasibility Report, Annexes, Drawings and Executive Summary. This Feasibility Study Report briefly explains the development plan of the integrated agricultural and rural development project for the selected priority development areas and verifies the technical and economic and financial viability of the subject development. The Master Plan Report in a separate volume describes the overall development plan of the Study Area, and the selection of the priority development area. The Annexes provide a detailed report on the study including and assessment of the present situation of the Study Area, and all the development components with their alternative case studies. The Drawings were prepared as an essential reference for the development plan.

1.2 Background of the Study

The agriculture sector has been recognized as the top priority sector in the national reconstruction program. The productivity of the sector, on which about 85% of the national population rely, is still low due to the lack of rural infrastructure and agricultural production technology. Agriculture in Cambodia is mostly dominated by rainfed paddy cultivation. Although irrigation development can greatly increase the cropping intensity and agricultural production, lack of capital has limited expansion of the irrigated area. Since irrigation development requires a rather large investment and accrue of its benefit is often delayed, it would be more effective to scale the development.

In order to formulate a basic approach for the assistance of agricultural development in the Kingdom of Cambodia, the Government of Japan sent a mission for the Project Formation Study of the Agriculture Sector, in March 1992. After investigation of the sector, discussions with Government officials, and identification of individual projects, the mission concluded that the highest priority is to be given to an integrated rural development project which centered on irrigation improvement in the suburbs of Phnom Penh. Implementation of such a project near the capital would have high extension and dissemination effects. In September 1992 JICA dispatched a preparatory study mission to define the scope of the Study. The Government of the Kingdom of Cambodia requested the Government of Japan to extend technical assistance for the master plan and feasibility studies on the project. In response to the request, JICA sent a preparatory study team again in January 1993 and agreed on the Scope of Work for the "Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh" according to which this Study was undertaken.

1.3 Scope of the Study

The Scope of Work for the Study is summarized as follows:

(1) Objectives of the Study

The objectives of the Study are :

- i) to prepare an overall Master Plan for the Study Area focusing on water resources, agricultural resources, social and agricultural infrastructures, rural living improvement, etc.;
- ii) to conduct a Feasibility Study for the selected project area identified through the Master Plan in order to formulate an integrated agricultural and rural development plan;
- iii) to carry out technology transfer to the Cambodian counterpart personnel during the Study.

(2) Study Area

The Study Area consists of the Tonle Bati area (6,000 ha) and the Kandal Stung area (10,000 ha) which administratively belong to Takeo Province and Kandal Province, respectively. The areas lie about 30 km south of the capital city, Phnom Penh.

(3) Scope of the Study

The Study has been carried out in two phases in accordance with the Scope of Work. The Study period is 18 months from October 1993 to March 1995. The Scope of the Study is summarized below:

i) Phase-I Study

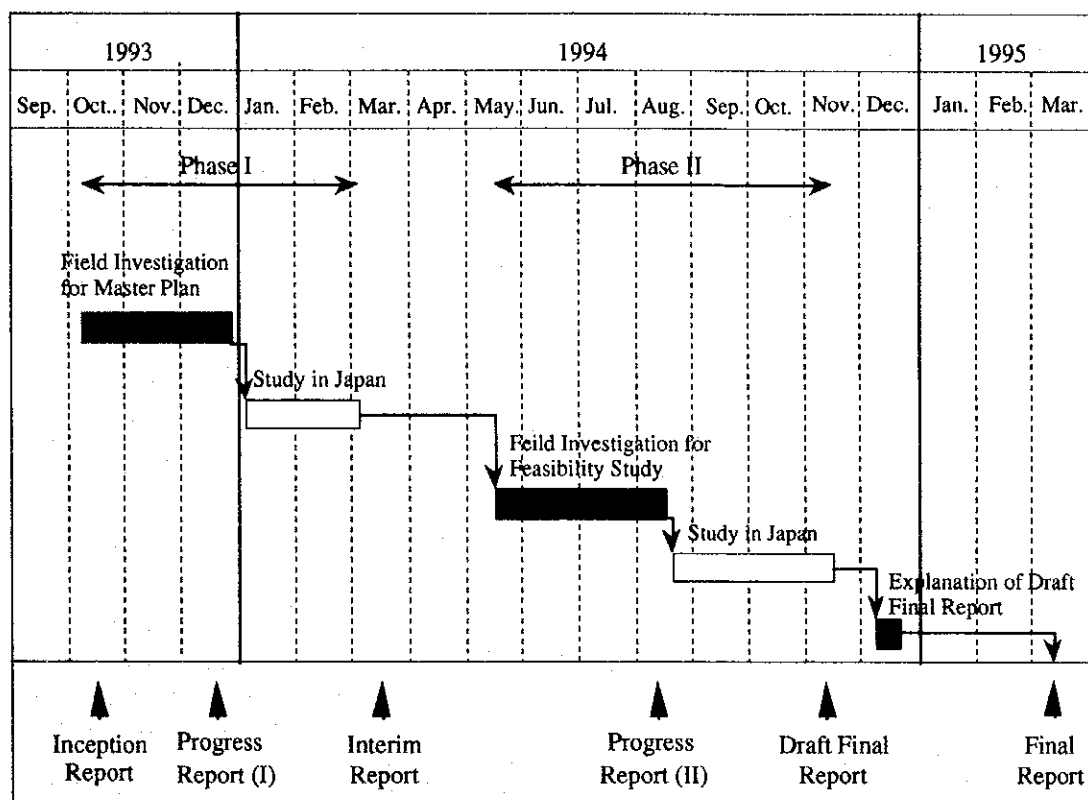
A Master Plan for integrated agricultural and rural development is formulated for the Study Area in the Phase-I Study. This is composed of field works in Cambodia and home office works in Japan.

ii) Phase-II Study

The Phase-II Study is composed of a Feasibility Study which is carried out for the priority project selected in the Phase-I Study. The Study also consists of field works in Cambodia and home office works.

The Study has been carried out in accordance with the following schedule :

Schedule of Study



II. NATIONAL BACKGROUND

2.1 Land and Population

2.1.1 Land

Cambodia covers about 181,000 km² of land and its use categories are summarized below:

Present Land Use of Cambodia			
		Area (1,000 km ²)	Share (%)
I	Natural Areas	138	76
	A. Forest	123	68
	a. Dense evergreen forest	63	35
	b. Deciduous forest	60	33
	B. Other Vegetation	15	8
II	Cultivated Areas	38	21
III	Other Land Usage	5	3
Total		181	100

The total forest area is about 12.3 million ha, or 68 % of the country, of which 6.3 million ha (51 %) are dense evergreen forest. The deciduous forest is mainly located in the north-eastern part between the Tonle Sap Lake and Dongrek mountains in the north. About 1.5 million ha (8 %) are covered with other vegetation, consisting of thickets, scrub, brushwood, grass savannah and grassland susceptible to flooding, and swampy vegetation is distributed all over the country. The cultivated area covers about 3.8 million ha or 21 % of the total area. This includes 2.7 million ha of paddy field, 1.0 million ha of upland crops, and 85 thousand ha of rubber plantations. This also includes settlement areas and other infrastructure. Other land use categories such as bare land, sandy banks, open water areas, and rivers account for about 0.5 million ha or 3 % of the total land of Cambodia.

The cultivated areas are mainly concentrated in the lowland around Tonle Sap Lake and on both sides of the Mekong River, in the south of the country. The upland crops are distributed all over the country, while the field crops and fruit gardens are mainly located along the banks of the main rivers.

2.1.2 Population

According to the Ministry of Planning Statistics Book (1980-1991), the population of Cambodia in 1991 was about 8.8 million and the annual growth rate was 2.8 %. About 88 % of the total population live in the rural areas. The population density is 49 persons/km² on the national average and 1,840 persons/km² in Phnom Penh. Females totalled about 54 % of the total population.

The labour force population (males from 16 to 60 years old and females from 16 to 55 years old) was 47.2% in 1980 and the demographic dependency ratio (non-labour force population to labour force population) was 1.11. The total labour force in the country was estimated at 3.7 million and the agricultural labour force was estimated at about 2.6 million or 70.4 % of the total population (Selected Indicators , 1991, FAO). The adult literacy rate is about 30 %.

2.2 Current Situation of National Economy

2.2.1 Government Administration

Since Cambodia declared its independence in November 1959, the country has consistently experienced political power upheavals due to numerous civil wars. The political instability caused by civil wars has retarded the social and economic development process, and maintained a delicate political situation. In 1991, at the final meeting of the Paris Conference of Cambodia, the Agreement on a Comprehensive Political Settlement of the Cambodia Conflict was signed by Cambodia and 18 other nations in the presence of the UN Secretary General. The general election was held from April to May 1993.

During 1980 to 1990, Cambodia was administrated by 14 Ministries, 23 governmental supervisory administrative offices, and about 49,000 state cadre personnel. However, reform of the administrative structure was made by the Royal Government of the newly formulated Kingdom of Cambodia in September, 1993. The newly formulated Royal Government of Cambodia comprises 19 Ministries and 4 Secretariats of state.

2.2.2 National Economy

(1) GDP

The industrial Gross Domestic Product (GDP) at constant prices (million of Riels) from 1987 to 1991, is summarized in the following table. GDP in terms of constant 1989 prices has experienced uneven growth in recent years, advancing by 16.2 % in 1988, 2.4 % in 1989, and 13.5 % in 1991, and falling by 0.1 % in 1990.

	Item	1987	1988	1989	1990	1991
1.	GDP (million of Riels in Constant 1989 Prices)	207,873	241,534	247,300	247,015	280,304
2.	Real Growth Rates of GDP (%)	-	16.2	2.4	-0.1	13.5
3.	Share of Real GDP (%)					
	Agriculture	51.4	44.0	45.8	45.4	46.9
	Industry	15.3	16.9	16.7	16.3	15.6
	Services	33.3	39.1	37.5	38.3	37.5

Paddy accounts for 17.6 %, other crops and rubber 11.7 %, livestock 11.2 %, fishing 4.8 % and forestry 1.5 %. Per capita GDP from 1987 to 1991 was estimated at US\$ 127, 170, 153, 171 and 223, respectively. The average annual growth rate of per capita GDP was estimated at about 19 % for the period.

(2) Trade

Export amounted to US\$ 34.7 million in 1990, and US\$ 51.3 million in 1991. The principal exports were timber, rubber, soybeans, maize and fish products, while imports amounted to US\$ 115.3 million in 1990 and US\$ 345.7 million in 1991. The main imports were food, fuel, fertilizers, raw materials, equipment, and consumer goods. A huge influx of personal transport equipment and materials was observed in 1990 and 1991.

2.3 Agriculture and Agricultural Economy

2.3.1 Agricultural Situation

(1) General

In spite of the importance of agriculture in Cambodia at the end of the 1970's, Cambodia's agricultural sector was virtually destroyed. Rice production was down to 0.5 million tons in 1979, compared with 3.2 million tons in 1968. Rubber production totalling 53,000 tons in 1967 drastically declined to almost nil in 1979. The number of animals recorded in 1969 decreased to about one third in 1979. The fish catch fell to 20,000 tons in 1979 from the pre-war level of 100,000-125,000 tons.

Since 1980, the agricultural sector has recovered steadily. The cultivated area and the production of rice in 1991 were about 1.8 million ha and 2.5 million tons, respectively. Fish production in 1991 increased six times from its 1980 level. Rubber production rose to about 30,000 tons in 1989 from practically zero in 1979. The number of cattle in 1991 recovered to the level at the end of 1960s, 2.3 million heads, pigs increased to 1.6 million heads in 1991 from 50 thousand heads in 1979, and poultry increased to 8.4 million in 1991 from 870 thousand in 1979. Despite these increase, agricultural economy in the country, still remains at subsistence levels.

(2) Rice Production

Rice is the most important crop in the country, accounting for 23 % of agricultural sector's GDP. Some 85-90 % of agricultural fields are under rice cultivation. The rice production area is widely divided into four regions;

- i) Plain region,
- ii) Tonle Sap Lake region,
- iii) Coastal region,
- iv) Plateau and mountain region.

Among these regions, about 85 % of rice area is concentrated in the plains along the Mekong and Bassac rivers and the Tonle Sap Lake region.

Rice ecosystems in Cambodia are broadly classified into four systems depending on the condition of water availability, rainfed upland, rainfed lowland, deepwater land and dry season irrigated crop. More than 90 % of rice cultivation is dependent on rain in the wet season while the irrigated dry season rice accounts for less than 10 % of the total cultivated area. In 1990, the average unit yield of rice was still stagnating at low levels of 1.5 t/ha, mainly due to the dependancy of wet season rains and the cultivation of low quality of rice. In other words, there exists a great potential for increasing rice production by stabilizing the water supply and by applying improved varieties and farming practices.

(3) Other Crops

The other crops grown in the country include rubber, maize, mungbeans, soybean, sesame, tobacco, groundnuts, coconuts, sugar palm, vegetables, jute and sugar cane. The total planted area for these crops in 1967 was about 250 thousand ha, decreasing to 120 thousand ha in 1979, and recovering to 150 thousand ha in 1991. In recent years, soybean, mungbeans and maize (yellow) were exported, but in small quantities. The cultivated area of maize was about 120 thousand ha in 1967 and decreased to about 75 thousand ha in 1979, and 46 thousand ha in 1991. This was mainly due to reduced markets and storage problems. Vegetables grown mainly along the river banks, accounted for about 27,000 ha in 1991.

Rubber is cultivated on plantation farms and is one of main agricultural exports. Exports reached 33 thousand tons in 1989.

(4) Livestock

Livestock husbandry is mainly characterized by small scale units, mostly occurring in small subsistence farms. Most farm families keep a few cows as draught animals, and pigs, chickens and ducks mainly for cash income. The number of draught animals is still insufficient for crop cultivation, although substantial increases occurred after the liberalization of the economy in 1980. These livestock animals are frequently affected by diseases. Their efficiency could be greatly increased if their nutrition and health conditions are improved.

(5) Fisheries

Fisheries provide important protein for the people of Cambodia. The main fishery resources are inland fisheries at the Tonle Sap and the Mekong rivers, lakes and marshes alongside rivers, farm ponds and marine fisheries. The inland water bodies in Cambodia are useful fish resources. Fishery production has substantially recovered to about 117,000 tons in 1991 from 73,600 tons in 1986 (1.6 times). Out of 117,000 tons of product, 75,000 tons were from fresh water which increased from 64,200 tons in 1986 (1.2 times). 1991 per capita fish consumption in Cambodia was estimated at 13 kg/year.

(6) Forestry

Cambodia still has a substantial proportion of forest coverage totalling about 60 % in the late 1980s. There is rapid forest depletion, particularly in the Southeast, where population density and therefore increased timber and fuel wood consumption is higher. Commercial logging has officially been between 200,000 and 300,000 m³ per year over the past five years, while unofficial logging, which is not controlled by the present administration, is roughly estimated at two to three times that figure. Reforestation occurred in only 2,100 ha from 1986 to 1990 with 70 % of the seed surviving. The Forest Department's annual target for reforestation is 5,000 ha from 1991 to 1995, and 7,500 ha from 1996 to 2,000. Timber exports were about 18,000 m³ in 1980, and increased to about 260,000 to 300,000 m³ in 1991 and 1992. The new government intends to promote forest conservation in connection with environmental protection.

2.3.2 National Agricultural and Rural Development Policy and Plans

(1) Agricultural and Rural Development Policy

The agricultural sector is recognized as a top priority sector in the national reconstruction program. The productivity of the sector, which about 85 % (7.5 million) of the national population rely on, is still low, however, there is considerable potential to increase and diversify agricultural production. For the purpose of increasing productivity and thus improving living standards, the Government has taken effective measures including the granting of land ownership rights, the introduction of free markets, and deregulation of product prices in order to provide more incentives to producers.

In order to quickly realize the sector's potential, improvement is necessary in farmer's access to agricultural inputs, such as fertilizers, pesticides, seeds and agricultural credit. The sector should also be improved and expanded in the supporting infrastructures such as irrigation, flood control and drainage facilities, and rural roads, and to have the delivery of basic support services, such as research and extension services strengthened, to promote production and to improve rural living standards.

Agriculture in Cambodia is mostly dominated by rainfed rice cultivation. Although irrigation development can greatly increase the cropping intensity and agricultural production, a lack of capital has limited expansion of the irrigated area. Since irrigation development requires large investments and accrualment of its benefit is often delayed, the Government intends in the beginning to promote cost-effective and quick-responding small scale developments as model schemes in which sustainable and self-reliant agriculture can be achieved. The model schemes can work as show-cases to display the effects of agricultural and rural infrastructure development, strengthened agriculture support services, and rural life improvement and community development.

The Secretariat of Rural Development (SRD) recently published the 'Programme for Rural Development'. The SRD's target is to achieve by the year 2000, the same level of social and economic well-being in Cambodia's rural population as is prevalent in other South East Asian countries. To achieve this, a number of measures are envisaged, including the creation of pilot and model villages; the strengthening of rural credit institutions to assist the population in rural areas and to increase production capacity; the training of a rural development cadre, and assistance to promote small scale on and off-farm rural industries.

Rural development is to be formulated in line with the SRD's programme to ensure the development of rural communities in becoming self-sufficient, and to contribute to overcoming the rural-urban disparity currently existing in the country.

(2) Agricultural Development Plans

i) Five Year Plan

Cambodia First Five Year Plan (FFYP) was inaugurated in 1985 as an accomplishment for the nation's economic development covering the period of 1985 to 1990. The Second Five Year Plan (SFYP) covers 1991 to 1995, which is a milestone in the transition of Cambodia's economic development. The plan notes concern for the capacity of the state in guiding economic development, and identifies key sectors for emphasis as follows :

Sector	Total Investment (million Riels/1984 Price)	Distribution (%)
Agriculture	3,318.90	30
Communication	2,765.75	25
Industry	1,106.30	10
Electrical Energy	1,659.45	15
Tourism	553.15	5
Others	1,659.45	5
Total	11,063.00	100

The SFYP strives to move towards a market-oriented economy. In the plan, increase in food grain production is projected as per capita production and the total paddy food grain production for 1991 was 340 kg/year, and 3,030 thousand tons for maize.

ii) Five Year and Two Year Agricultural Development Plan

MAFF prepared the Five Year Agricultural Development Plan titled " Situation and Objectives of Agricultural Development Policies " to follow the SFYP (1991-1995), and under the new government MAFF drafted up the Two Year Agricultural Development Plan for 1994-1995. The objective of the Two Year Plan is to identify the urgent need of national economic strengthening included in the program of the SFYP. It is targeted in the Two Year Plan by strengthening the national economy based on the improvements of rural infrastructures. Funds will be mostly donated by the

international communities to the economic development priorities. The development policies incorporated in the SFYP are followed basically in the development.

2.3.3 Agricultural Supporting System at National Level

(1) Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF has the overall responsibility for coordinating the agricultural sector development activities at the central level. In addition each province has a Provincial Agriculture Department which is responsible for coordinating agricultural activities at the provincial level through the Agricultural Office of each district. Although MAFF is the key institution in the sector, there are a number of relevant authorities, in particular the Secretariats of State for Rural Development, the Environment, and Women's Affairs.

The government organization is still at a transitional stage, and at present the Government is improving the organization of the Ministry, as shown in Fig. 1.

(2) Technical Departments of MAFF

Among the 16 departments of the Ministry, the technical departments which are relevant for agriculture and rural development are, the Department of Agricultural Hydraulic and Hydro-Meteorology (ex-Department of Hydrology), the Agronomy Department, the Central Company of Agricultural Materials (ex-Department of Agricultural Materials), Department of Animal Production and Health, and the Department of Land Titles.

The Department of Agricultural Hydraulic and Hydro-Meteorology (DOH) is responsible for the planning, design, construction and maintenance of all water conservation, flood control, irrigation and drainage works, and is also responsible for water management. Technical aspects relating to large-scale (larger than 1,000 ha) and multipurpose projects are dealt centrally by the DOH, while small and medium scale projects are handled at the provincial level.

The implementation of the Government's policies and programmes for livestock production and health is the responsibility of the Department of Animal Production and Health (DAPH). The Department is currently divided into 5 sections, Animal Production, Animal Health, Finance, Planning and Administration. The Animal Health Section consists of the National Veterinary Diagnostic Laboratory, the Veterinary Vaccine Laboratory, the Veterinary Clinic, and the Vaccination Services. The Animal Production Section includes 3 breeding stations, the Phnom Tamao Cattle Breeding Station (Takeo Province), the Pig Breeding Station (KM 11), and the Poultry Breeding Station (Prek Samron).

The Department of Agronomy (DOA) is responsible for formulating experimental plans at the national level and, to monitor food production in the country through the provincial agricultural offices. The Department also manages a network of agricultural research stations and state farms, including three rice seed production farms, two rice experimental stations, a vegetable research station, a plant protection research station, two cotton farms, and a pepper farm. In addition to these 10 stations, MAFF has operated the International Rice Research Institute (IRRI) -Cambodia Project since 1989 in collaboration with the IRRI. The main activities are to carry out various studies and experiments on improving rice cultivation in Cambodia.

There are seven (7) agricultural/rural development centres operated under DOA. Each development centre has a target area to provide services for cultivation. The agricultural development centres were established under the control of the Department of Agronomy, with most receiving support from NGOs. The centres provide services for irrigation water

and farm input supplies for rice cultivation. However, most of the activities have been scaled due to a shortage of manpower and budget.

(3) Agricultural Extension and Input Supply

i) Agricultural Extension

At the national level, the Department of Agronomy and the Department of Extensions under MAFF, provide agricultural extension services, which have limited impact at field level in small areas. Each department in MAFF has its own extension unit and executes extension works through the provincial and district agricultural offices. The Department of Extension (consists of Offices of Technical Extension and Rural Credit), established under MAFF, is training the extension workers at the Prek Leap Agricultural College. It aims to dispatch Community Extension Workers at a commune level to each province with the support from the District Extension Leaders. But the present extension work covers a very limited area mainly due to a shortage of qualified manpower and budget.

ii) Input Supply

There are two channels to supply inputs to the farmers, a Government operated Central Company of Agricultural Materials (formerly the Department of Agricultural Materials), and the private market. The Company under MAFF is responsible for the distribution of agricultural inputs, mainly fertilizers, chemicals, and some agricultural tools such as sprayers, through government channels. The Company distributes at fixed Government prices to the agricultural development centres, provincial and district offices upon request. The farmers can receive the fixed prices by paying in cash. A small amount of fertilizers are often sold through private channels at rather high prices, and the poorest are unable to obtain the necessary inputs. Timely distribution of the inputs is not always carried out, when the farmers need them for the cultivation of rice. Credit sales of fertilizers are not practised at present.

2.4 Socio-economy

The overall socio-economic situation has changed dramatically during the last few years, particularly following the May 1993 elections which resulted in a democratic system of government. But despite these changes, Cambodia still has got a long to go before it recovers from decades of turmoil and human disaster. The prolonged war and unrest in the country during the seventies and eighties has caused considerable damage to the social and physical infrastructure. Today's per capita income is around US \$ 220 (amongst the lowest in the world) while life expectancy at birth is below 50 % and the literacy rate is less than 30 %. The current situation is further aggravated by continued unrest in parts of the country and the legacy of millions of uncleared mines rendering large parts of fertile agricultural land inaccessible for cultivation.

Apart from these physical constraints, human resources have also been depleted. Millions of lives were lost during the turmoil and large contingents of skilled people fled the country. About half the population is below 15 years of age and growing at 2.5-3 % annually. This, combined with inadequate health and education services, and continuing problems with law and order, makes it extremely difficult for the country to recover quickly.

At the micro level, and particularly in the rural areas, the lack of social and physical infrastructure has resulted in low production figures and poor household hygiene, causing a situation which, for most families, is difficult to endure. Agriculture, employing approximately 80 % of the 9 million population, lacks important support and extension services while education facilities are limited, inadequate and/or non-existent. Chronic malnutrition and preventable diseases are major concerns with less than 50 % of the population having access to

(inadequate) health services. Rehabilitation, reconstruction and (further) development of Cambodia therefore requires a comprehensive long term strategy, focusing on improving the physical and social infrastructure while stimulating and enabling the population to actively participate in this process leading to structural, sustainable and equitable progress.

2.5 Environmental Organization and Policy

2.5.1 Institutional Organization

Cambodia has an abundance of important natural resources, including land, forests, fishery and water. These can, if rationally harnessed, serve the needs of the current relatively small population and the future generations. In the past two decades, any pretensions to good management had to be put aside due to the unsettled conditions, when institutional capability, administrative ability, and jurisdiction of the central governments, were either seriously challenged or were subject to extraordinary political influence. This does not, however, mean that there was rampant over-exploitation of the country's resources. In fact, the opposite occurred, except in certain provinces where government control was totally absent.

The extensive bombing in the first half of the 1970s killed many people and caused the destruction of forests, and animal life. A bleaker period in history was during 1975-79, when all institutional capability broke down and thousands of people were murdered. Education was also affected forcing schools and the only university to close.

It was a case of starting from nothing when the government changed in 1979. More important than resource conservation, was the priority to get the administrative machinery in place. It was only after the Paris Peace Accord in 1991, and the nationwide election which followed in 1993, that the pieces began to fall into place. However, a long, difficult road lies ahead.

Having recognised the importance of the environment as a key factor in the economic development process, the present government created the Ministry of Environment in July 1993. In November 1993, the Ministry was transformed into the State Secretariat for the Environment, with a clear mandate for formulating environmental policy, instituting environmental legislation and regulatory requirements, undertaking environmental planning, initiating environmental impact assessments, supervising environmental education, and taking responsibility for the overall coordination of environmental protection and management. Daunting tasks for a fledgling institution. However, the Secretariat has gathered a nucleus staff and has initially embarked on a programme of capability building, with the assistance of the donor community. Other programme components including the preparation of draft legislation for pesticide control and the preparation of environmental assessment procedures are being currently pursued. With the new political order, the government believes that greater investment opportunities will be available in the field of natural resources and that these resources, if managed wisely, can benefit the current rehabilitation effort. However, this requires a strong executing and guiding capability within the confines of the State Secretariat for the Environment, and this is yet to be developed.

The Secretariat is headed by a Secretary of State, and an Under-Secretary and three Directors make up the senior executive staff. The following five main technical departments are under a single Director, while a second Director is responsible for administration.

- a. Environmental Planning, Water Management and Land Use,
- b. Nature Conservation and Protection,
- c. Pollution Control, Reduction and Prevention,
- d. Legal Affairs, and,
- e. Education and Communications.

The Secretary of State for the Environment is an *ex. officio* member of the following national committees:

- a. Land Use and Urbanization for Phnom Penh and the Provinces;
- b. Investment;
- c. Rehabilitation and Development; and,
- d. the National Mekong Committee.

Participation at these committees at such a senior level provides opportunities for the submission and safeguarding of environmental concerns by consultation, compromise and consensus, whenever development objectives cut across narrow sectoral and departmental boundaries, as they often do. This also will hopefully ensure that parochial sectoral interests are not pursued at the expense of long-term sustainability of the resource base.

Another useful step has been the creation of the Environmental Assessment Commission, comprising senior officials representing the following ministries:

- a. Agriculture, Forestry and Fisheries;
- b. Industries, Mines and Energy;
- c. Public Works and Transport;
- d. Culture and Fine Arts;
- e. Education;
- f. Health;
- g. Tourism; and,
- h. Secretariat of Rural Development.

The Commission is chaired by the Prime Minister and the vice-chairman is the State Secretary for the Environment. It is expected to pave the way for inter-ministerial co-ordination.

2.5.2 National Policy

At present, the country lacks an environmental policy. It also has not defined sectoral policies for the major natural resource fields. The damage and inaction of the past two decades demands a concerted rehabilitation effort with priority in setting up an institutional framework encompassing provincial and sectoral matters. One of the key policy goals of the government is to integrate a policy for environmental protection and management. In the present context, preparation of such a policy is not easy. However, the beginnings have been made, shortcomings recognised, and efforts are underway to face new challenges. Policies, legislation, education, guidelines, and controls are all part of a package of initiatives currently being worked upon.

In the current efforts in formulating an integrated environmental policy, emphasis is being placed on four areas, considered to be of importance in the current development climate. These include:

i) **Environmental Legislation:**

There are no laws, regulations or standards to manage either the environment or the exploitation of natural resources;

ii) **Environmental Impact Assessment:**

With a likelihood of rapid investment in the near future, the The Government finds itself lacking the capability to screen proposals for their environmental stability, and impact assessment is seen as one of the tools available to ensure balanced development;

iii) **Environmental Education:**

The Government acknowledges the importance of education to achieve desired goals, particularly as there is little appreciation of the need to use resources rationally; and,

iv) **Inter-Agency Coordinating Mechanisms:**

To avoid conflict among users of resources and to ensure that ecological principles are honoured by those competing for scarce resources, the Government sees the urgent need for consultation, compromise and consensus.

III. PRESENT CONDITIONS OF THE PRIORITY DEVELOPMENT AREA

3.1 General

The Priority Development Areas are characterized by their high population density, low fertile land for agricultural production, and limited water resources in the dry season. The present socio-economic conditions and infrastructure are still at a minimum, although infrastructure improvement such as irrigation and drainage works has been carried out in the past. Further, the agricultural supporting services are not functioning adequately. Therefore, agricultural production in the Priority Development Areas is still low, at the subsistence levels.

In due consideration of the Government policy applied to the agricultural and rural development and the present socio-economic situation of the Study area, the Master Plan on the integrated agricultural and rural development was formulated with the following ultimate objective and development strategies:

- (1) The ultimate objective of the Integrated Agricultural and Rural Development Project is to achieve a substantial and sustainable improvement in the living conditions of the population in the Priority Development Areas.
- (2) The strategy adopted is to increase farming output in the area through the improvement and development of irrigation, drainage and the rural infrastructure, combined with appropriate support services and structures.

Reflecting the need and the national development policy, the objectives for the agricultural development plan in the Master Plan are :

- a. To raise farmer's income level through the enhancement of agriculture, especially rice and livestock productions, by the efficient utilization of the land and water development potential in the area,
- b. To contribute to regional and national needs to increase rice production with the aim of achieving self-sufficiency in rice, and
- c. To raise living standard and improve rural life by generating farm income and extending living techniques.

To attain the above-mentioned development targets and dissolve the present constraints prevailing in the Priority Development Areas, the following development strategies were proposed in the Master Plan.

- a. Irrigation and drainage improvement/development
- b. Agricultural development
- c. Agricultural supporting services
- d. Farmers' organization development
- e. Improvement of rural infrastructure
- f. Life improvement plan
- g. Establishment of Model Area

3.2 Natural Resources

3.2.1 Topography and Geology

(1) Topography

The Kandal Stung Priority Development Area is located in the Kandal District of Kandal Province about 20 km southwest of Phnom Penh. It is bounded by the National Road No. 2 in the east and the National Road No.3 in the west. The area covers about 2,400 ha which is mostly agricultural and residential. Old river trails cross the area in the south and north, which create a slight undulating topography. The land is generally sloping toward the east with an average ground slope of 1:2,000, and is drained to the Tuk Chou Lake.

The Tonle Bati Priority Development Area is situated in the Bati District of Takeo Province about 25 km south of Phnom Penh. The National Road No.2 crosses the western part of the area. The area covers about 1,800 ha which is also mostly agricultural and residential. The area lies in ground elevations of 8 m to 5.5 m, sloping toward the Cheung Loun Lake. There is a slightly elevated flat land in the central part where numbers of villages are located.

(2) Geology

Kandal Stung and Tonle Bati Priority Development Areas are underlain by Quaternary unconsolidated deposits subdivided into the three alluvium units ; (1) Old Alluvium, (2) Young Alluvium, and (3) Recent Alluvium, in ascending order, with each unit unconforming to the other. These units are observed sub-horizontally. Old alluvium deposits predominantly consist of sand inter-fingering with fine-grained soil. Below approximately El.-20m, the Kandal Stung Area is underlain by a gravel layer which is an aquifer for the wells. The shallow area of the Kandal Stung Area is underlain by fine-grained Young Alluvium soil, with a thickness of a several meters.

The proposed dike and the existing Kompong Tuol Regulator site are underlain by a high permeable recent alluvium sand layer. This layer is loose and susceptible to piping. Hence it is considered that failures occurred in the past partially because the hydraulic gradient and the velocity of seepage in this area might have been greater than the critical level. However at the proposed dike site, the less pervious layer – the old alluvium fine grained soil, 3 to 5 m thick is located between the recent and old alluvium sand strata. On the other hand, at the proposed Kompong Tuol Regulator site, the less pervious old alluvium fine grained soil is not thick enough (2 m approximately). Taking into account the above geological condition, cut-off works such as one or two rows of sheet piles will be needed in the recent alluvium sand to the old alluvium fine-grained soil areas located between the existing Kompong Tuol regulator site and the proposed Kompong Tuol regulator site. At the proposed Kompong Tuol regulator site and Tuk Thla Regulator site, the similar type of cut-off works will be carried out to the required depths, which will be determined according to the empirical theory of creep ratio.

For the dike embankment materials, borrow sites were selected based on the results of geological surface survey and test pitting followed by laboratory test. Due to its physical and mechanical properties, the fine-grained soil near the new dike site is not suitable as embankment material but a mixture of fine-grained soil and either laterite or gravel is considered desirable. On the other hand, the in-situ fine-grained soil itself and the mixture are not suitable according to the dispersion test by a double hydrometer. Therefore neither the in-situ fine-grained material alone nor the mixture with laterite or gravel can be used as embankment materials.

To cope with problems of embankment materials, the following two alternatives are recommended: (1) dispersion may be decreased by adding hydrate lime, alum or gypsum to

the dispersive fine-grained soil near the proposed dike site; (2) a large quantity of laterite is available around Ph. Prin and Ph. Con Don Pha Cum, about 28 km to 30 km along the road from Ph Kompong Tuol. The thickness of the laterite ranges from 70 cm to 110 cm, and a fine-grained soil layer underlies the laterite. According to the observation of this fine-grained soil soaked with distilled water, the fine-grained soil is considered non dispersive. Therefore mixed materials of fine-grained soil and laterite with a mix-proportion of 3:7 (fines: laterite) may be desirable in view of their mechanical property, resistance against leakage and dispersion.

3.2.2 Meteorology and Hydrology

(1) Meteorology

The alternating monsoon system controls the climate in Cambodia. The wet season, the southwest monsoon, is from May to November when about 90% of total rainfall occurs. The remaining months, the northeast monsoon, are hot, dry and less humid with a potential of particularly high transpiration demands in March and April. The table below summarises the main features of the climate using data from Phnom Penh. This record is typical of the lowland region and represents the Project area. The potential transpiration figures are derived by the Penman equation from the meteorological information.

Average meteorological data for Phnom Penh

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall	mm	6	9	28	71	139	143	150	160	236	256	130	37	1,365
Minimum rainfall	mm	0	0	0	0	25	27	37	44	93	63	2	0	935
Maximum rainfall	mm	57	127	193	359	395	393	359	380	474	650	324	186	2,310
Number of raindays		2	1	1	4	14	18	17	18	20	21	10	4	129
Maximum temperature	deg C	30.7	32.6	34.5	35.2	34.1	33.2	32.6	32.1	31.7	30.6	30.1	30.2	
Minimum temperature	deg C	21.2	22.7	24.2	25.4	25.3	25.0	24.7	24.7	24.4	24.2	23.6	21.7	
Sunshine	hours	8.6	9.0	9.0	8.0	7.3	6.3	6.3	5.6	5.8	6.8	7.6	8.5	
Humidity	%	67.4	65.3	62.5	67.0	75.4	77.0	78.7	79.3	82.4	81.9	76.6	71.2	
Wind speed	m/s	2.4	2.2	2.7	2.2	2.1	2.4	2.7	2.6	2.1	1.8	2.3	2.4	
Potential transpiration	mm	145	161	206	188	165	149	150	147	132	136	135	142	1,857

The Chaine de l'Elephant mountains to the west of the project area causes rain shadow over the lowland area to the east. Annual rainfall of 3000 to 5000 mm is recorded to the west of the watershed, whereas 1300 mm is more typical in the lowlands. All the upper basin of Prek Thnot lies on the eastern facing slopes. Average runoff from the upper basin is just over 300 mm. With actual transpiration losses of about 1200 to 1500 mm per year, the average rainfall on the upper basin must be in the range 1500 to 1800 mm. The annual rainfall is similar to the lowland average of about 1300 mm on most of the lower tributaries and on the smaller rivers including the Stung Toch and Stung Tonle Bati rivers.

The average seasonal distribution of rainfall and the number of raindays does not vary significantly across the lowland area. Also, the average rainfall per rainday is roughly constant between months and between stations. In other words, some months are wetter than others only because it rains more often not because it rains more intensely. The exceedance probability of daily rainfall on raindays is found to be the same across the

lowland region. Thus for drainage design, the past records for Phnom Penh are used to describe the statistics of short-term rainfall in the Project area.

Estimated maximum short period rainfall at Phnom Penh (mm)

	1 day	2 day	3 day	4 day	5 day
Mean annual maxima	80	103	120	137	151
10-year return period maxima	100	142	169	196	212
20-year return period maxima	118	165	184	220	236

Rainfall is poorly correlated between the stations, even over an annual time scale. Over shorter time scales the correlation is insignificant. This means that rain storms are highly localised and that average rainfall over a river basin or even a large irrigation area is less variable than the records from an individual station would suggest. The time series of annual and wet season rainfalls for Phnom Penh and Kompong Speu show few unusual features. The two years 1916 and 1917 had unusually high rainfall from July to November. Rainfall in March 1922 was unusually heavy in some stations, and caused the highest floods this century.

The potential transpiration estimates, based on 20 years of meteorological data, show very little variation from year to year. The average figures shown in the table above are used for the calculation of crop water requirements. Effective rainfall for rice cultivation is estimated from the results of model trials using daily rainfall data. The model simulates the irrigation regime of a cascade of paddy fields. About 60% of rainfall is effective on average, and there is little variation on the average through the cropping season.

(2) Hydrology

The only runoff records for the region comprise of about ten years of measurements at the Prek Thnot river from two stations between Kompong Speu and the proposed dam site, and some older records from a third station in Kompong Speu. These records represent runoff from the upper mountainous basin of Prek Thnot. No records exist for the lowland tributaries or the smaller rivers. The records are reviewed as to their rating curves and general consistency, and may be regarded as fairly good. They suggest an average runoff of about 335 mm from a basin area of about 3650km².

The runoff from December to April forms a small part of the annual total. From May through to the remaining months of the wet season, floods can occur at any time in response to intense rainfall, but the highest floods tend to occur towards the end of the wet season, usually in September or October. Rarely, high floods have occurred unseasonably. The hydrograph declines rapidly at the end of the wet season and this recession is similar for all years.

In the Prek Thnot River, the excess flow for 80 % of the time is a little more than 1 m³/s. But, the Roleng Chrey regulator and associated canal offtakes have the capacity to withdraw up to 50 m³/s from the river. Thus, the low-flow regime in the lower river is now controlled by the irrigation operations upstream.

Specific runoff from the lower tributaries of Prek Thnot, and the smaller rivers, should be less than from the headwater basin. Rainfall is lower, losses are higher, and there is greater potential for retaining water in the bunded fields and other natural storage areas. Runoff is not perennial. Flow ceases soon after the end of the wet season and after the river valleys are cultivated.

Runoff from these smaller rivers is estimated using a monthly rainfall-runoff model calibrated on the headwaters basin above Anlong Touk. As rainfall intensities in the upper basin and in the lower areas are similar, the model can be used to provide estimates of runoff in the lowlands. The model is modified to allow for the increased storage potential of paddy fields and natural depressions.

The table below summarises the estimates of runoff from the tributaries and the smaller rivers, which are described in detail in Annexe I.

Average river flows for the 10-year design period (mcm)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Dam site	9.3	5.2	4.5	9.5	38.0	78.9	130.0	187.2	292.2	383.2	131.3	64.0	1,334.0
Tributaries	0.9	0.1	0.0	0.0	0.0	2.7	13.5	15.3	31.0	52.5	19.6	9.6	145.2
Stung Toch	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.8	7.0	2.5	1.2	14.6
Stung Tonle Bati	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.4	3.9	9.6	3.5	1.6	20.1

Runoff from all but the upper basin is severely curtailed in the dry season, the majority concentrated in the months of September and October. The rapid decline of flow during December and January accords with field observations that flow ceases during the dry season in all the rivers except Prek Thnot.

(3) Flood estimation

Estimates of flood discharge are required for the rehabilitation of the Tuk Thla and Kompong Tuol regulators and their associated embankments that enable the diversion of water to Kandal Stung and Tonle Bati. The embankment south of Tuk Thla including the Kompong Tuol regulator, was constructed during the Pol Pot era. It was breached by the flood of August 1991 with a peak level approximately 0.1 m above the embankment level. Following repair work, the embankment was breached again in October 1992, although it was not overtopped. This, and the flooding in March 1994, was due to piping through the embankment material because of large head differences across the embankment. The flood of August 1994 again breached the structure.

Flood estimation is extremely difficult due to the poor records. There was no severe flood in Prek Thnot when flows were recorded, primarily in the 1960s, and there is no systematic surveying of flood levels or general flow conditions. Most information refers to the upper river between the proposed dam site and Kompong Speu. There are no data for the lower reaches down to Tuk Thla.

High floods exceed the conveyance capacity of the main river channel and cause widespread inundation. The total width of flow on the flood plain can reach several kilometres. Little is known of the flow conditions on the flood plain; there are many obstructions to flow such as dikes carrying roads and a railway. Some of these dikes cross the flood plain; others run parallel to the general direction of flow.

Each succeeding flood analysis appears to increase the estimate of the floods that can be expected. In 1965 SMHEA estimated the 100-year flood peak at the dam site at 1000 m³/s. In 1992 SMEC increased this estimate to 1800 m³/s. More recently SMEC have suggested a 100-year flood of 8000 m³/s, based largely on a review of the August 1991 flood. This wide range of estimates is a measure of the uncertainty in predicting rare and intermediate floods, and not the result of more significant flood data.

A regional flood frequency analysis is used to estimate flood discharges, based on published regional curves for Thailand and Malaysia. In this method only the shape of the

frequency curve is transferred. The curve is scaled by an estimate of the mean annual flood derived from data at Prek Thnot.

The 100-year flood is estimated to be 1900 m³/s, and the 1000-year flood 3900m³/s. These figures compare well with those presented by SMEC in 1992 and the shape of the frequency curve is similar. They bear no comparison to the more recent and much higher estimates which cannot be supported. The higher estimates imply a mean annual flood of about 2000m³/s which would result in out-of-river floods in most years, and are difficult to reconcile with the history of the Kompong Tuol embankment. The necessary simplifications made in the SMEC (1993) analyses could well result in exaggerated estimates of peak flows and the data are insufficient to support stronger analytical techniques.

Euroconsult estimated tributary floods using empirical equations derived from flood data from eastern Thailand. These equations are accepted as reasonable as they imply growth factors for different return periods that are consistent with the regional flood frequency curve discussed above. However, the balance between flood attenuation and the additional flood flows from the tributaries downstream of the dam site cannot be defined accurately, and also flood water from Prek Thnot crosses into the Stung Toch during high floods. However, the assumption that floods at Tuk Thla will not exceed flood flows at the dam site, as proposed by Euroconsult, is accepted as conservative.

The recommended design floods for Tuk Thla are summarised in the following table.

	Estimates of Flood Discharge (m ³ /s)						
	Return Period (years)						
	10	20	25	50	100	500	1000
Prek Thnot at Tuk Thla	860	1,100		1,500	1,900	3,200	3,900
Stung Toch			54		121		
Stung Tonle Bati			103		231		

Estimates for Stung Toch and Stung Tonle Bati are derived by Euroconsult (1992)

Estimates for Stung Toch refer only to floods from its own basin area

More comprehensive flood data, including flood levels, topography, and the dimensions and capacity of man-made structures throughout the basin, are essential to interpreting historical floods. Routine data collection procedures must be strengthened and special efforts urgently made to survey evidence of the 1991 and 1994 floods. Until this information is available, the estimates of extreme floods remain uncertain.

(4) Sediment Load

In the lower Prek Thnot, downstream of Kompong Speu, the river channel meanders across the flood plain, with the low flow channel located within the wide sand bed of the river. Typically, the river section is 80-100 m wide and the bank-full depth is about 8 m. The river channel incises into the flood plain and the banks are near vertical cliffs of 2-4 m high. There are shallow levees on both sides of the river.

The main channel bed is predominantly coarse sand, which is exploited for construction work, primarily in the river reaches from Kompong Tram down to Kompong Tuol. The banks are comprised of unstable and friable materials with a wide distribution of grain size. Floods deposit layers of a much finer silt on the lower parts of the banks and on the shoals in the river bed.

Sediment samples were analysed to provide particle size distribution for samples typical of the coarse sand that forms the river bed in the lower reaches of the river, below Kompong Speu, and the finer material that is deposited on the banks. It is reasonable to assume that the

former is carried as bed load during periods of flood discharge and the latter is carried in suspension over a wider range of discharge.

In the absence of any direct measurements of sediment load, it is necessary to estimate the sediment rating curves by empirical methods using a range of widely used equations. The ranges can be integrated with the flow duration curve to provide estimates of the total sediment transport. The Shields and Einstein-Brown bed load equations give estimates of average annual sediment load of 0.37 and 0.31 mcm/year respectively for a typical median grain size of 1.4 mm.

3.2.3 Soil, Land Use and Land Suitability

(1) Soils

Soil classification and description are carried out according to the FAO system (FAO-UNESCO, 1974). Chemical and physical analysis were conducted in the Department of Agriculture Laboratories in Phnom Penh.

A summary of the soil classification of both priority areas is given in the following table.

Soil Unit (FAO)	Summary Description	Appearing Area	
Acrisols:	Gleyic Acrisols	Old, strongly mottled, sticky sandy loams over heavy clays with rounded sand grains and very poor drainage.	Both
Cambisols:	Dystric/Ferralic Cambisols	Slightly elevated, poorly drained, dense, mottled heavy clay on old river levees.	Tonle
	Eutric Cambisols	Shallow, yellowish brown, silty clay on recent alluvium of low permeability.	Both
	Vertic Cambisols	Deep, yellowish brown, weakly structured, mottled silty medium clay on recent alluvium.	Both
Fluvisols:	Eutric Fluvisols	Brown, massive, hard-setting silty clay on recent layered alluvium.	Both

(2) Land Units

Since soil formation mainly coincides with the geomorphological condition and vegetation in the study area, land classification and mapping is conducted based on the geomorphological land unit. Soils maps for each priority area are presented in Figs. 2 and 3. A brief description of each land unit is described as follows, and the details are in Annex II.

i) Kandal Stung Priority Development Area

The river levees and levee remnants of mapping unit L have weakly differentiated, generally silty soils with moderate consistency. The active levees are flooded to shallow depth at irregular intervals but the older levees remnants are flood free.

On the slightly elevated plains (P1) soil texture varies. The soils with sandier B horizons have a high pH - often 8.5 or 9. It is not known why this is so but it may be caused by the upward movement of saline soil water by capillarity during the dry season, evaporation of the water, and precipitation of soluble salts.

Amongst the almost flat plain soils, one has a distinctly paler- coloured topsoil, visible from aerial photographs and in the field (P21). This soil appears to have a recent silty overlay of 20 to 30 cm depth overlying older, more mature clay.

The most extensive soil in the Kandal Stung Priority Development Area is Vertic Cambisols. It occurs on almost flat plains and is mapped as P22. This is the best irrigation soil in the area. Drainage is imperfect to poor and soil permeability is low, which is good for rice. Soil analysis results indicate that these soils are of high short term fertility and moderate long term fertility.

Only one area of old, very flat clay plains (P3) occurs in the Kandal Stung Priority Development Area, in the mid-north along the link road between Highways 2 and 3, near Rolous Village. This soil is strongly differentiated and very poorly drained. Soil analysis results indicate saline topsoils, and very low fertility.

Soil unit D in the Kandal Stung Priority Development Area is located in depressed, partially infilled, seasonally inundated, former river channels and oxbows. These soils have very silty and fine sandy, very poorly drained, layered profiles with hydromorphic features and are flooded to 50-100 cm several times a year.

Land units in the Kandal Stung Priority Development Area and the soil units they occur in are shown below:

Land Unit Types	Mapping Unit	Dominant Soils Unit	Area (ha)*1	%
Levee (L)				
Old levee remnant	L	Eutric Fluvisols	339	14
Plain (P)				
Slightly elevated plain	P1	Eutric Cambisols	389	16
Almost flat plain	(P2)			
pale surface	P21	Eutric Cambisols	218	9
the others	P22	Vertic Cambisols	1,229	51
Old flat plain	P3	Gleyic Acrisols	18	1
Depressional terrain (D)	D	Eutric Fluvisols	194	8
Low-lying land (S)	S	-	12	1
Hillock (H)	H	-	5	0
Total			2,404	100

ii) Tonle Bati Priority Development Area

The Tonle Bati Priority Development Area is a complex alluvial terrace which is no longer flooded and the soils formed upon it are generally old. However, some soils (in mapping units T1 and T2) are relatively young as they are formed upon the most recently deposited alluvial materials.

The old levee remnants (L) have strongly differentiated soils with dark yellowish brown sticky sandy loams including an eluvial horizon abruptly overlying very hard, strongly mottled medium to heavy clays.

The lower flanks of the old levees (Lf) have younger soils with fine sandy loam to sandy clay loam A horizons over firm, medium textured, mottled B horizons, and a pH in the slightly acid range.

The soils of the plains fall into three distinct groups. The highest of them (T1) forms on gently sloping terrain, with common low terracing and a contour alignment of the fields in the sharply sloping areas. Drainage is imperfect to poor. This soil also occurs in mapping unit T2.

The second plains soil (T2 & P2) forms on very gently sloping (T2) to an almost flat terrain (P2). Only very minor terracing has been undertaken in these areas. Drainage is poor to very poor. This soil is most common in the east of the Tonle Bati area.

The third plains soil (P3) is old. It forms almost exclusively in the west of the area along highway number 2, on apparently flat terrain. This soil is strongly differentiated and very poorly drained.

Land unit D in the Tonle Bati Priority Development Area is located in depressed, partially infilled, seasonally inundated, low lying areas. These soils have very silty and fine sandy, very poorly drained layered profiles with hydromorphic features, and are seasonally flooded to 50-100 cm, several times a year.

The area of each land unit of the Tonle Bati Priority Development Area is summarized as follow:

Land Unit Types	Mapping Unit	Dominant Soils Unit	Area (ha)*1	%
Levee (L)				
Old levee remnant	L	Gleyic Acrisols	55	3
Levee flank	Lf	Ferralic Cambisols	36	2
Terrace & Plain (T&P)				
Gently sloping plain with terrace (common)	T1	Vertic Cambisols	449	25
Very gently sloping plain with terrace (some)	T2	Eutric Cambisols	767	42
Almost flat plain	P2	Vertic Cambisols	344	19
Old flat plain	P3	Gleyic Acrisols	120	7
Depressional terrain (D)	D	Eutric Fluvisols	2	0
Hillock (H)	H	-	20	1
Low, man-made rise (M)	M	-	36	2
Total			1,828	100

(3) Land use

The land use types of the Priority Development Areas are classified into four types of paddy fields, two types of uplands (but three types of upland in Tonle Bati), swampy areas and hillocks. The details are described below.

i) Rice field

Rice (wet season rice) fields are broadly extended in the Priority Development Area. However, only one crop can be grown per year in most areas because of a shortage of irrigation water in the dry season. Most of the rice fields are located in the gently sloping and flat terrain. The rice field in the gently sloping terrain (Up) is medium to small in size and often irregular in shape, and may be aligned relative to the contour. The rice field in the flat terrain is divided into two land use types by the field size and shape, small to medium and irregular (Ps) and medium to large and square or rectangular (Pl).

Some areas of depressional terrain (Pd), mainly old river channels, are designated for small size rice fields. These areas have good wet season water supplies and occasionally there is a chance of double cropping in the dry season by using retained water, but seasonal inundations are a limiting factor.

ii) Upland and others

Uplands are slightly elevated flood free areas. These lands are generally less suitable for rice because of their higher soil permeability, and would not be commandable by gravity.

In the Kandal Stung Priority Development Area, about half of the uplands are used for villages and gardens etc (V), and the other half for grazing cattle and some wet season upland crops (U). The village areas (V) may be densely packed with houses or have only scattered buildings. Sugar palm, coconuts, mangoes, cassava, sweet potatoes, mungbeans and other crops are grown amongst the buildings. Some rice may be grown if sufficient wet season rainwater can be impounded for the crop. In the grazing and upland crops field (U), mungbeans, maize, bananas and other crops are planted, or grasses and shrubs are growing.

The elevated land in Tonle Bati Priority Development Area is fully occupied by villages, and upland crops grow in the flank of the elevated land. The elevated land in Kandal Stung is shared by villages, upland crop fields and/or grazing land.

Other land includes swampy areas and hillock grazing land, which are not used for agricultural purpose.

Land use maps of each Priority Development Area are shown in Figs. 4 and 5, and the distribution of each land use type is summarized below:

Land Use Types		Mapping Unit	Kandal Stung		Tonle Bati	
			Area (ha)*	%	Area (ha)*	%
1.	Rice field	(P)	(2,048)	(85)	(1,680)	(92)
	1-1 Rice field in gently sloping terrain	Up	389	16	449	25
	1-2 Rice field in almost flat terrain					
	(1)small to medium (irregular) size (very gently sloping)	Ps	460	19	767	42
	(2)medium to large (square or rectangular) size	Pl	1,005	42	464	25
	1-3 Rice field in depression terrain	Pd	194	8	0	0
2.	Upland and others		(356)	(15)	(148)	(8)
	2-1 Upland crops field	U	130	5	36	2
	2-2 Villages and others (house garden, orchard, road, etc.)	V	214	9	91	5
	2-3 Grazing land on hillocks	H	0	0	20	1
	2-4 Swamps	S	13	1	2	0
Total			2,404	100	1,828	100

Remark: *1 ; Area of each land use type is the gross area, including canals, foot paths, field bunds, etc. Especially for each paddy field, it is supposed that the area of canals, foot paths, roads etc. are estimated at 5% of the net area

(4) Land Suitability

In this Feasibility Study land suitability is assessed in relation to the requirements of the specific forms of land use; i.e. based on the degree to which the characteristics of the land can satisfy the environmental requirements of the four specific crops. These are wet season paddy rice (with supplementary irrigation), dry season (irrigated) paddy rice, dry season (irrigated) upland 'cash' crops, and variously irrigated pastures for cattle or fuelwood production.

The land suitability data are presented according to the FAO (1985) system for the evaluation of land for irrigated agriculture. This system uses five classes of suitability for use:

- a. S1, S2, S3 : Suitable (highly, moderately, marginally)
- b. N1, N2 : Non suitable (currently, permanently)

Suitability for the crops concerned was determined by matching the environmental requirements of the crops with the characteristics of the soils, to determine the degree to which they were compatible. If the land can supply all the needs of a particular crop it would be rated class S1 for that crop; but if there are limiting factors it may be class S2 or S3 or worse, depending upon the degree of severity of the limiting factor(s).

The important environmental factors for the crop production are the soil physical condition, the soil chemical condition, landscape complexity, drainability, and commandability, in which the factors of water supply and serious floods are excluded, because the flood dike and canal system will be constructed in the future overcoming these factors.

The results of the land suitability assessment for the four (4) crops are summarized in the following tables. Land suitability maps for each crop are presented in Figs 6 and 7.

Kandal Stung Priority Development Area								
Land unit	Wet season rice		Dry season rice		Upland crops		Pasture and fodder	
	(ha)	%	(ha)	%	(ha)	%	(ha)	%
S1	1,447	60	1,641	68	339	14	922	38
S2	357	15	357	15	1,618	67	1,229	51
S3	583	24	389	16	236	10	236	10
N1	0	0	0	0	194	8	0	0
N2	0	0	0	0	0	0	0	0
swamp etc.	17	1	17	1	17	1	17	1
Total	2,404	100	2,404	100	2,404	100	2,404	100

Tonle Bati Priority Development Area								
Land unit	Wet season rice		Dry season rice		Upland crops		Pasture and fodder	
	(ha)	%	(ha)	%	(ha)	%	(ha)	%
S1	1,560	85	986	54	91	5	1,077	59
S2	211	12	665	36	986	54	694	38
S3	2	0	120	7	574	31	0	0
N1	0	0	0	0	150	7	2	0
N2	0	0	0	0	2	0	0	0
swamp etc.	55	33	55	3	55	3	55	3
Total	1,828	100	1,828	100	1,828	100	1,828	100

Over 90% of the Priority Development Areas are suitable for irrigation farming; All of the priority areas have good soils and land conditions suitable for rice cropping. About 60% of the Kandal Stung priority area and over 50% of Tonle Bati area are highly suitable for double cropping of rice.

3.3 Socio-economy

3.3.1 Population

(1) Statistics

The population statistics used here originate from the data base prepared by UNTAC which conducted an extensive count of the population for election purposes in May 1993. The population statistics of the Master Plan Study Area were calculated as shown below:

Population Statistics Master Plan Study Area						
(Source: calculations based on AEPU, UNTAC - 1993)						
Study Area	Number of villages (phum)	Number of villages covered by Master Plan	Total population	% Total Females	Number of Households	Average Size of Households
Kandal Stung	78	72	26,123	56.2	5,698	4.6
Tonle Bati	49	25	15,503	53.9	2,828	5.5
Study Area Total	127	97	41,626	55.3	8,526	4.9

The population statistics of the priority areas were estimated on UNTAC's data base, as shown below:

Population Statistics Priority Development Areas								
(Source: calculations based on AEPU, UNTAC - 1993)								
Priority Development Area	Number of villages (phum)	Total Population	% Total Females	% Total 18years olds	% Total 18years old Females	% 18years old Females in Female Population	Number of Households	Size of Households
Kandal Stung	24	8,924	55.8	54.2	57.6	57.6	1,962	4.6
Tonle Bati	9	5,814	49.0	48.9	57.5	57.9	1,053	5.5
Priority Area Total	33	1,478	53.1	52.1	57.6	57.7	3,015	4.9

During both phases of the Master Plan Study, a socio-economic household survey (including some questions relating to population) was undertaken as part of the field work in Cambodia. The results are summarised below:

Population Statistics of Household Survey Phase I
MASTER PLAN STUDY AREA

(Source: socio-economic survey of 113 households, December 1993)

Master Plan Study Area	Total Population	% Total Females	% Total 16years olds	% Total 16years old Females	% 16years old Females in Female Population	Number of Households	Size of Households
KSN	205	53.2	48.3	56.6	51.4	35	5.9
KSS	179	54.2	45.3	62.9	52.6	30	6.0
BATI	311	54.0	45.0	52.9	44.0	48	6.5
Totals	695	53.9	46.0	56.6	48.4	113	6.2

Notes:

KSN: Kandal Stung District, Northern Part (Study Area only)

KSS: Kandal Stung District, Southern Part (Study Area only)

BATI: Bati District (Study Area only)

Population Statistics of Household Survey Phase II
PRIORITY DEVELOPMENT AREAS

(Source: socio-economic survey of 164 households, June/July 1994)

Priority development Areas	Total Population	% Total Females	% Total 16years olds	% Total 16years old Females	% 16years old Females in Female Population	Number of Households	Size of Households
KS	661	56.6	50.8	60.7	54.5	119	5.6
BATI	270	48.9	49.3	54.1	54.5	45	6.0
Totals	931	54.4	50.4	58.8	54.5	164	5.7

Notes:

KS: Kandal Stung District, Priority Development Area only

BATI: Bati District, Priority Development Area only

(2) Analysis

i) Composition, Family Size and Density

The population, divided into two age groups, shows that the Kandal Stung priority project area has a larger proportion of 18 year olds (54.2 %) than the Tonle Bati priority project area (48.9 %). The average family size in the Kandal Stung District (4.6) is generally smaller than in the Bati District (5.5), and the average number of families per village is also smaller than in the Bati District. 79 against 113 in the Master Plan Study area, and 82 against 117 in the priority project areas. If related to the total area of land under the Master Plan Study one finds that, in the Kandal Stung District, the average population per ha. is 2.61 (261/km²) while in the Bati District it is 2.58 person/ha (average total study area: 2.60/ha). The average population per ha in the priority project areas of Kandal Stung is 4.96 as against 2.61 while in Bati District this figure is 3.63 persons/ha as against 2.58 (average total priority project areas: 4.33/ha). This indicates that, although the population density in both districts is almost identical, the priority project areas cover the more densely populated areas of the Master Plan Study.

ii) Females in the Study Area

The percentage of females in the Master Plan Study area is 56.2 in the Kandal Stung area and 53.9 in the Tonle Bati area. A further breakdown at village level and into age groups in the priority project areas and household surveys shows a more significant difference between the areas: the percentage of females in the Kandal Stung area

remains more or less the same as for the Master Plan Study level, but Bati's percentage drops from 53.9 to 49.0. If we, however, calculate the percentage of females in the adult population (based on UNTAC data), and also if we calculate the proportion of adult females in the female population, it appears that both district areas are almost identical at 57.6 %. The household surveys confirm these trends but the percentages vary. It is nevertheless clear that the current overall population figures are biased in favour of women as a result of Cambodia's recent violent history. But there are also signs that this is gradually changing as the sex ratio (i.e. number of females/number of males) in the under 18 population in the priority project area of the Kandal Stung District now stands at 1.07 while in the Bati District this figure is .71. The trends observed here are similar to those found in the total population of Cambodia where the sex ratio stands at 1.13 for the total population, and at 1.01 for the under 18 years of age population.

Sex ratios in Study Areas and Cambodia
(Source: calculations based on AEPU, UNTAC - 1993)

	Kandal Stung District	Bati District	Cambodia
under 18 years of age	1.07	0.71	1.01
total population	1.26	0.96	1.13

iii) Female Headed Households (FHHs)

In both socio-economic surveys special attention was paid to the results in relation to FHHs. It was found that, from the 113 households surveyed in December 1993, 20 (18%) were headed by females. It needs to be noted that 18 of those were in Kandal Stung District where a total of 65 households were surveyed (equivalent to 28 %), and only 2 out of 48 households surveyed in Bati District (4 %). A detailed analysis showed that 4 households (3.5 %) do not include any other adult, and that 5 (4.5 %) include one or more female adults. The remaining 11 households (10 %) all include one or more male adults (and female adults). Another interesting observation here is, in the 4 households without additional adults, all the children (ranging from 6-15 years old) go to school. Except in one case, all the children are 6 years of age and mostly in school. The FHHs with one or more adult male members usually live with their married daughter or son. The younger children in these households are, in most cases, grand-children. In the second household survey in June/July 1994 it appeared that 50 of the 164 households (30.5 %) were headed by women. Of these, 44 are widows (70 % of which were widowed more than 10 years ago), 4 are (recent) divorcees, 1 is unmarried, and 1 widow has recently remarried. A further analysis of the 49 single women reveals that about 15 (including 3 divorcees) are women living alone with small dependent children.

Although it is obvious that most women who lost their husbands in the seventies and eighties encountered great difficulties, at present the most problematic FHHs are those who have recently lost their husbands (either through death or divorce), and are left alone to provide for their small children.

iv) Population Structure

The violent history of Cambodia in the seventies and early eighties is reflected in the demographic data of the study area. The population is relatively young (48 % younger than 18 years of age) and the proportions of males to females by age groups differ significantly, as is shown in the following table:

Age and Sex Groups of Study Area
(Source: calculations based on AEPU, UNTAC - 1993)

Age groups	Male (%)	Female (%)
≥18 years old	42.4	57.6
<18 years old	51.8	48.2
All ages	46.9	53.1

The above figure shows the proportion of males to females is equalizing. It also indicates that, with the passing of time, the problem of single women with dependent young children, is slowly decreasing. Most women who were widowed in the seventies and early eighties have found to help for their immense problems from relatives and, at a later stage, from their adult children.

3.3.2 Socio-economic Conditions

(1) Services in the Study Area

i) Health

According to the Ministry of Health the population growth rate for Cambodia is estimated to be between 2.5-3 %, with the crude birth rate around 45 per 1,000 and the crude death rate approximately 15-20 per 1,000. Child mortality (<5 years of age) is amongst the highest in Asia (>200 per 1000) while maternal mortality is estimated to be between 900-1,500 per 100,000 deliveries. Both child and maternal mortality are related to a lack of a preventative (primary) health care system, difficulties in having deliveries supervised by adequately trained medical personnel, hard work performed by pregnant women, inadequate diets, repeated and close pregnancies, and illegal abortions.

Both districts have similar curative public health services, including a district hospital with usually 100 beds. The District Health Officer is in charge of the District Hospital, and the health services delivery system in the district. At the next level, each khum is supposed to have an infirmary or khum clinic, staffed by a nurse and a midwife, and assisted by a khum Health Committee. At the phum or village level there is a traditional birth attendant (TBA) and health activists, supposed to provide and maintain a link with the khum level services. Public health services are free in Cambodia. The study area includes the district hospital of Kandal Stung while the Bati District Hospital is situated outside the study area, close to the District Headquarters.

The district hospitals in both areas are full due to the number of TB in-patients. In the khum clinics, daily out-patient attendance is rather low mainly due to deteriorated facilities and equipment. The staff of the clinics frequently provide health services including vaccination, infant care, maternity consultation, and birth control in the patients homes.

Public health services in both districts are supported by foreign NGOs. In the Kandal Stung District 24HRTV supports the District Hospital while WVI has a Primary Health Care programme covering the whole district. In the Bati District JOCS provides support to the District Hospital and has started a Primary Health Care programme. In summary it can be concluded that the public health services in both districts - even with the assistance of NGOs - have a long way to go in providing adequate services to the population.

ii) Education

It is generally observed that the quality of education is of a low standard in the country. Agencies like UNICEF are providing assistance in this area but the quality and quantity of education, at all levels, will take a very long time to improve.

According to the information obtained from the Kandal Stung District Office, total enrollment is 85 % for primary schools, 9 % for lower secondary schools, and 6 % for higher secondary schools. In general, it appears that the percentage of female students gradually decreases in the higher grades, totalling 45 % for primary schools, 43 % for lower secondary, and 34.5 % for higher secondary schools. The buildings and facilities in primary schools are deteriorated and there is a shortage of school rooms. Improvement of those facilities is essential. The following table shows the total number of schools and students enrolled in the Study Area and Priority Development Area.

District		Master Plan Area		Priority Develop. Area	
		Primary	L. & H. Secondary	Primary	L. & H. Secondary
Kandal Stung	School	19	2	8	2
	Student	6,700	1,100	3,100	1,100
Tonle Bati	School	13	1	3	1
	Student	4,100	400	1,500	400

iii) Credit and Savings Schemes

No data were available from the District Offices on these subjects. Apart from small credit schemes run under the Tonle Bati Development Centre, the WVI development centre in Kandal Stung, and the FFP programme of the KWA/UNICEF, there are no institutions in the area providing rural credit. Savings schemes were not evident, nor did any family state they actually had any savings.

(2) Families in the Study Area

i) Occupation and Production

Most people claim to be farmers, owning on average 1.0 ha of land and predominantly engaged in wet season rice cultivation which, for about 80 % of the families, produces insufficient food. Almost 70 % of families collect additional food from rivers, wetlands, paddy fields and forest areas, in particular, fish, crabs, frogs, snails and, to a lesser extent, fruits. Raising livestock and growing vegetables are largely perceived as a means to earn additional cash income rather than an additional source of protein and vitamins, resulting in a certain degree of chronic malnutrition. Apart from these income generating activities, small businesses and salary/wage labour are important activities. It appears that about 70 % of all families interviewed have at least one member engaged in non-farming activities to earn extra cash income.

ii) Constraints on Production and Life

The needs of families and villages are predominantly related to the inability to grow sufficient rice for their own consumption due to a variety of reasons, including the lack of a reliable and sufficient water supply, oxen for ploughing, agricultural inputs, availability of land, and the low quality of available land. Simultaneously, the lack of cash to invest in agricultural inputs, vegetable seeds, and livestock for commercial production purposes is the main stumbling block to fulfilling other needs such as a housing and medical. No appropriate credit facilities exist in the area but nearly 65 % of the families report to be indebted, and can pay upto 60 % interest per month.

iii) Community Organization

Families appear to be quite self-centred and inward looking. This is largely due to Cambodia's recent history which has led to severe disruptions in family life, a considerable fragmentation of society, and feelings of insecurity, causing a sense of mistrust to prevail. Having said that, it also appears that, rather than being organized 'from the top' (such as the *krom sammakis* and KWA), people do actually join hands on their own terms and conditions if the purpose and result benefits all involved in a reasonably equal way. The (wide spread) illustration of this phenomenon is the exchange of labour on the basis of reciprocity (*provasdaya*) or daily wages payment observed during the process of rice production. A large majority of families are included in this arrangement.

iv) Division of Job by Gender

The division of labour and authority in most households is gender specific for matters related to the process of rice production, budget control and cooking and dish washing. At the same time, a considerable number of activities are undertaken and decided jointly by men and women.

(3) Conclusions

- i) Health and education services in the area are either weak or non-existent. Generally, there is a lack of resources (manpower, money and material), sufficient and adequate physical structures, knowledge, appropriate concepts and approaches, proper planning and management, and institutional capacity. In the health field NGOs seem to produce reasonable results but their coverage is confined to a few villages. Inter-NGO co-ordination is limited or absent, occasionally resulting in overlaps leading to waste of resources and confusion with the population. Competition between NGOs occurs and there is a lack of clear and sound long term development concepts. In the field of education UNICEF provides some material assistance but the problem is also one of quality.
- ii) Socio-economic conditions for most families in the area are largely the same. FHHs with dependent small children and no other adult(s) in the household presumably face the same or worse hardships as the poorest families.
- iii) Most families in the area produce insufficient rice to feed themselves year round, and only a small proportion grows vegetables or owns livestock, resulting in poor diet which in turn causes a certain degree of chronic malnutrition. This, combined with deplorable domestic hygiene, sanitation and a lack of safe drinking water as well as poor health services, contributes to a high frequency of preventable diseases and, subsequently, to an unnecessary waste of human and material resources.
- iv) The needs of families and villages in the area are predominantly defined in terms of their inability to grow sufficient rice for their own consumption, to have limited or no access to credit facilities, and to suffer ill health.
- v) Formalised organisational structures such as the *krom sammakkis* and the KWA, instituted by previous regimes, have lost their momentum. It has been observed though that informal structures of *provasdaya* (mutual help) continue to exist. These structures could possibly be used as a mechanism for project and development activities.
- vi) The division of labour and authority of decision making in the household warrants a careful consideration of gender specific strategies, particularly in relation to agricultural