

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES
KINGDOM OF CAMBODIA

THE AGRICULTURAL DEVELOPMENT STUDY
OF
THE MEKONG FLOODED AREA
IN
CAMBODIA

FINAL REPORT

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MARCH, 1998

SANYU CONSULTANTS INC.

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PREFACE

In response to a request from the Government of Cambodia, the Government of Japan decided to conduct the Agricultural Development Study of the Mekong Flooded Area in Cambodia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a study team headed by Mr. Takanori TAKATSUKA, Sanyu Consultants Inc., four times between April 1996 and December 1997.

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

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

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

March, 1998



Kimio FUJITA

President

Japan International Cooperation Agency

March, 1998

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

Letter of Transmittal

Dear Mr. Fujita,

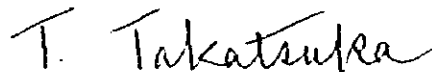
We are pleased to submit to you the Final Report of the Agricultural Development Study of the Mekong Flooded Area in Cambodia. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency, as well as the formulation of development plan. The comments made by the officials concerned of the Government of Cambodia during the discussions on the draft final report held in Phnom Penh and Tokyo are also reflected in this report.

The Study aimed to formulate agricultural development plan to contribute to the growth of agricultural economy, the stabilization of rural community and the harmonization with the conservation of fishery resources and farming. As the results of the study, we proposed three types of agricultural development plans; Colmatage Farming Improvement Plan, Agricultural Development Plan Harmonized with Fisheries and Rainfed Agricultural Development Plan. The development objectives of the plans are in line with the National Socio-Economic Development Plan aiming at rehabilitation and reconstruction in Cambodia.

The proposed projects are feasible and will produce many economic and social benefits, and environmental conservation effects. Furthermore, the implementation of the projects will contribute greatly to the stabilization of living of the farmers and fishermen in the area. We recommend that the Government of Cambodia should implement these projects as a top priority.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Agriculture, Forestry and Fisheries and the Embassy of Japan in Cambodia. We also wish to express our deep gratitude to officials concerned of the Government of Cambodia for the close cooperation and assistance extended to us during our study.

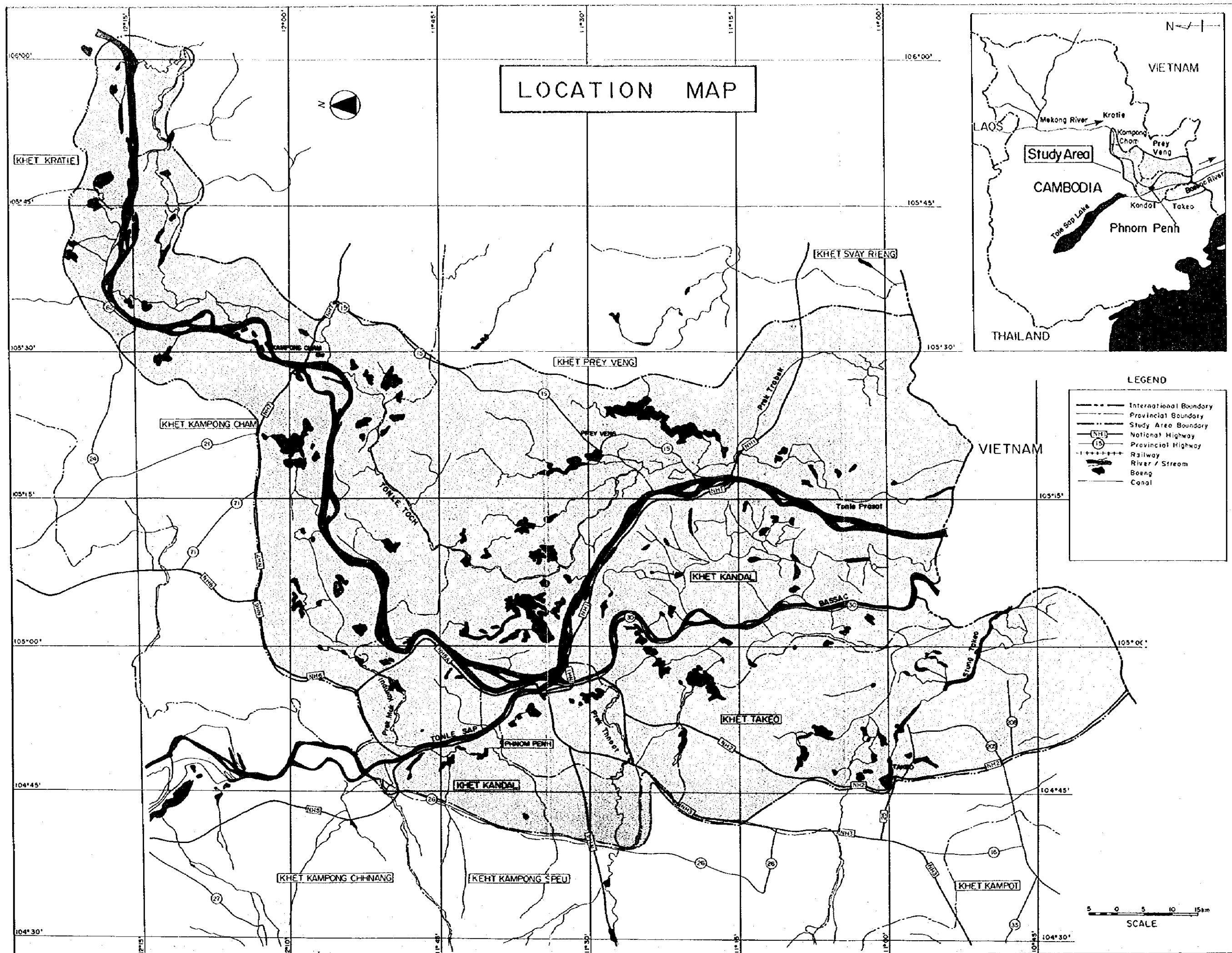
Very truly yours,



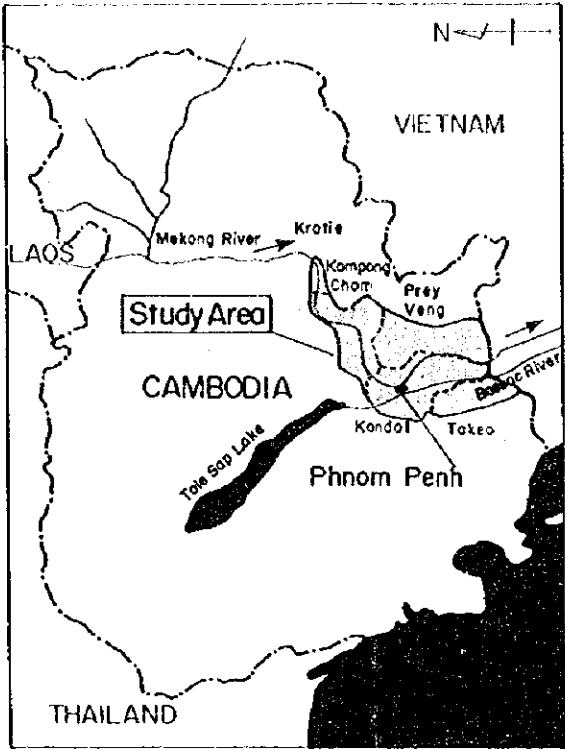
Takanori TAKATSUKA

Team Leader

The Agricultural Development Study
of the Mekong Flooded area in Cambodia
Sanyu Consultants Inc.



LOCATION MAP

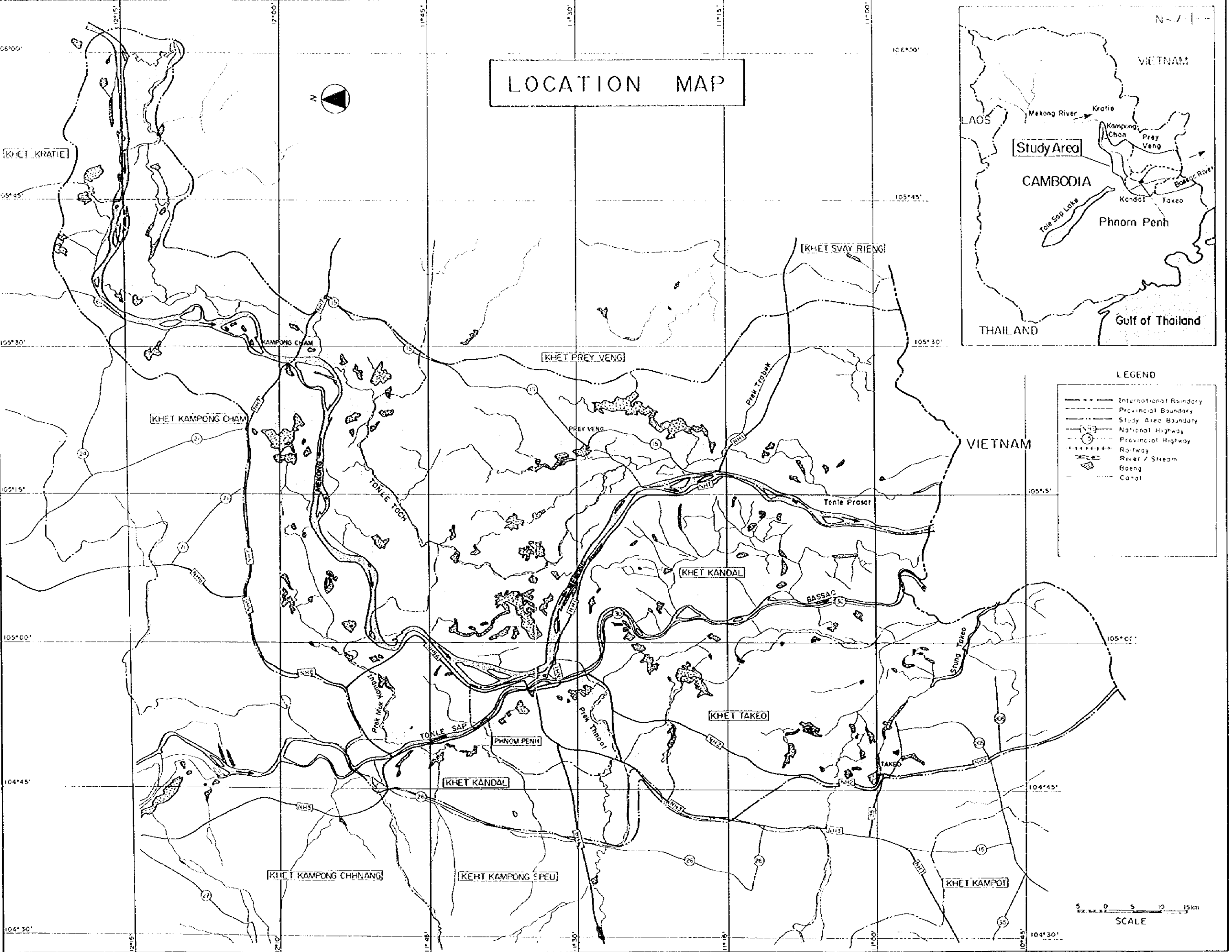
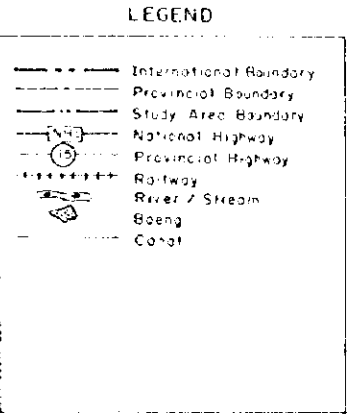
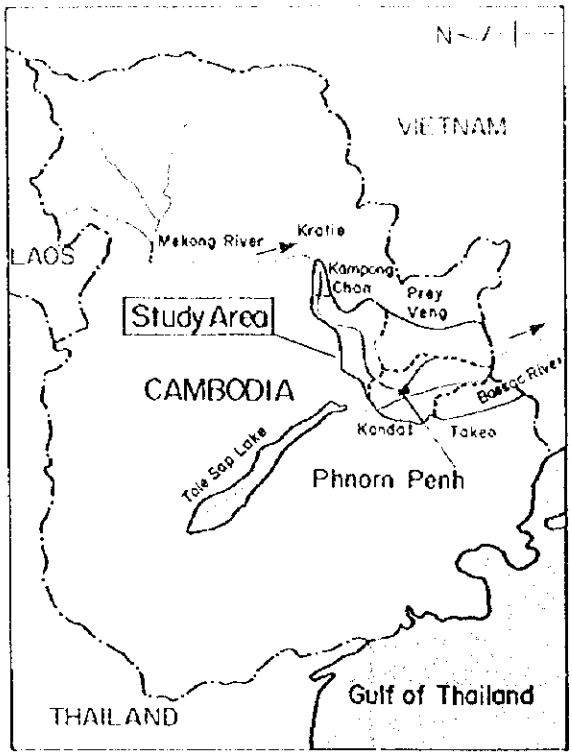


LEGEND

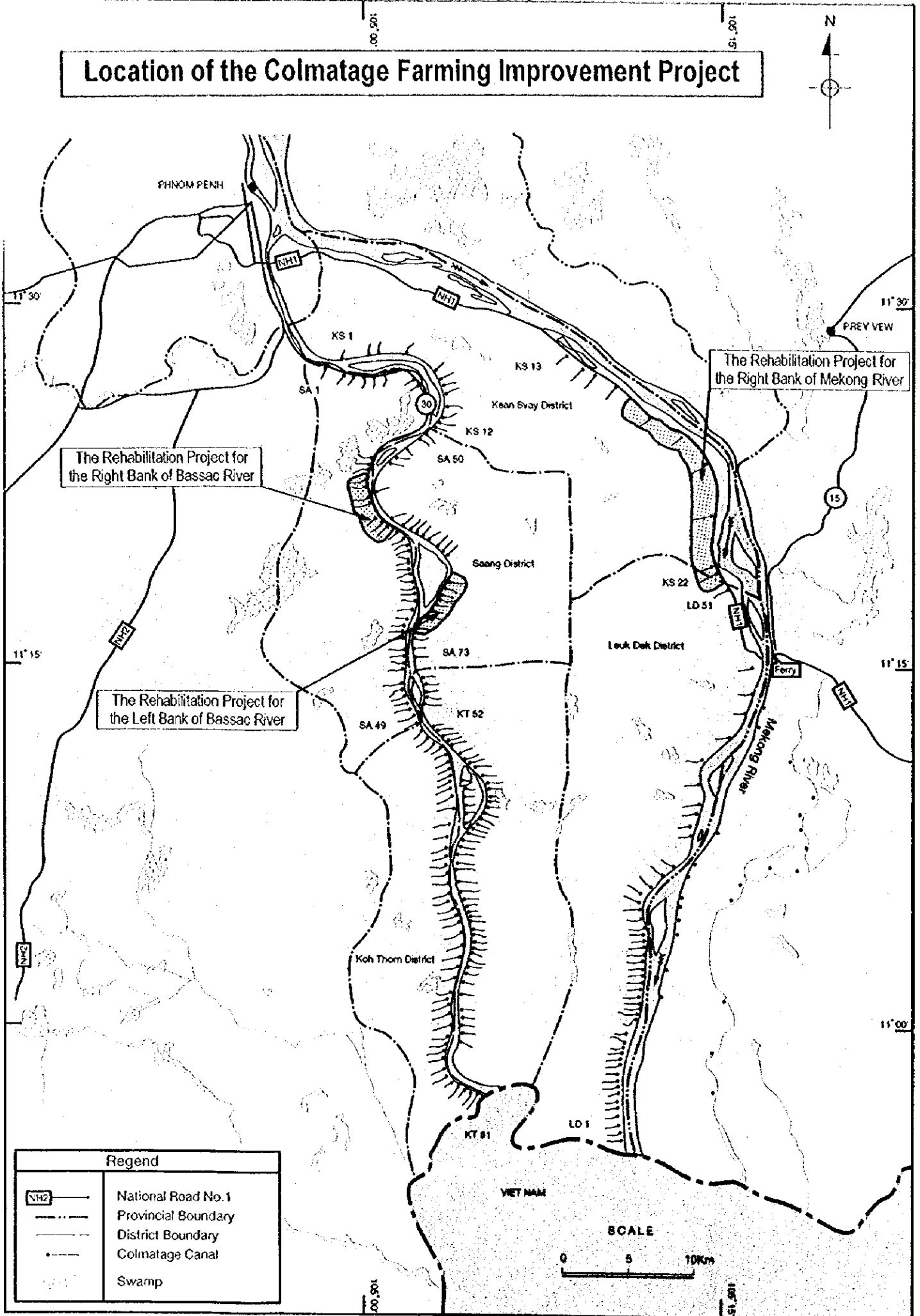
- International Boundary
- - - Provincial Boundary
- ▨ Study Area Boundary
- ⦶ National Highway
- ⦶ Provincial Highway
- ⦶ Railway
- River / Stream
- ⦶ Boeng
- - - Canal

0 5 10 15 km
SCALE

LOCATION MAP



Location of the Colmatage Farming Improvement Project



The Rehabilitation Project for the Right Bank of Bassac River

The Rehabilitation Project for the Left Bank of Bassac River

The Rehabilitation Project for the Right Bank of Mekong River

Legend	
	National Road No. 1
	Provincial Boundary
	District Boundary
	Colmatage Canal
	Swamp

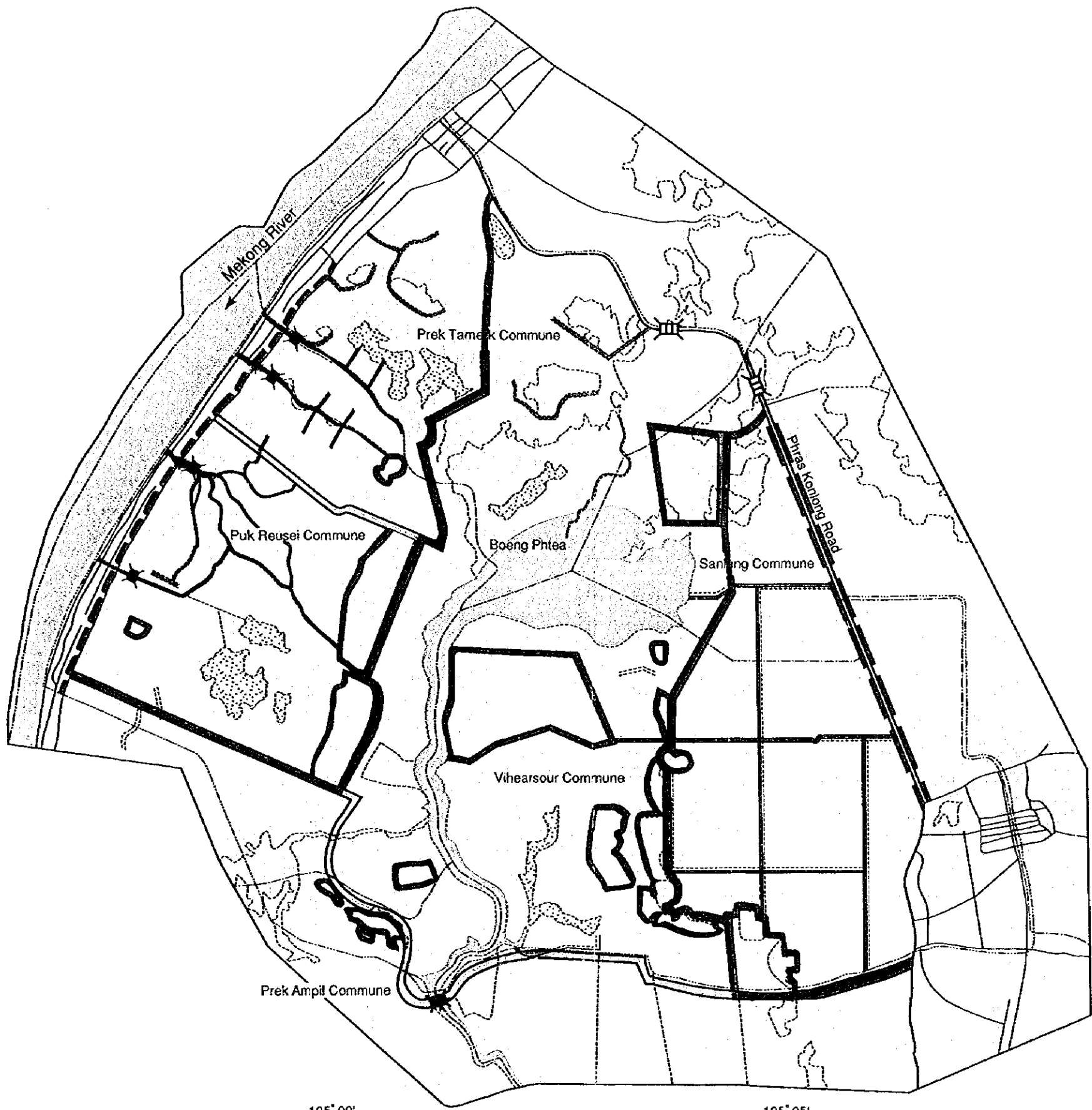


General Plan of the Boeng Phtea Area



11° 45'

11° 45' -

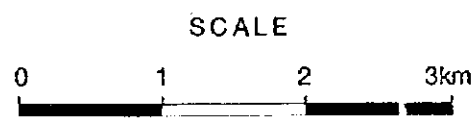


Component of the Project	
Stage I 	Rehabilitation of the District Road Construction of the Farm Road Construction of the Weir at Boeng Phtea Rehabilitation of the Reservoirs Rehabilitation of the Canals
Stage II 	Rehabilitation / Expansion of the Colmatage Canals Installation of the Intake Gates
Stage III 	Construction of the Flood Control Gates Construction of the Road

Legend	
	Boundary of Study Area
	Boundary of District
	Boundary of Commune
	Dike of Reservoir
	Colmatage
	Rural Road
	Lake / Swamp
	Existing Canal

11° 40'

11° 40' -



105° 00'

105° 05'

SUMMARY

1. MASTER PLAN STUDY

A.1 INTRODUCTION

- (1) The Cambodian national economy is still stagnant under the meager social infrastructure devastated by the civil war. The level of GDP per capita is as low as 289 US dollars (1994) and the restoration of socio-economy is an urgent problem.
- (2) The Mekong River flooded area, where Phnom Penh, the capital city is located, is the central region for agricultural and socio-economic activities in the country. Traditional agriculture depending on flood water has been developed in this area. However, its productivity is very low as compared with neighboring countries because of the damaged agricultural and rural infrastructures brought about by the civil war.
- (3) Under such circumstances, the Government of Cambodia requested "the Agricultural Development Study of the Mekong Flooded Area in Cambodia" to the Government of Japan. In compliance with the request, the Japanese Government initiated a preliminary survey in October 1995, and the Scope of Works (S/W) for the study was affirmed. Considering the S/W, the Japan International Cooperation Agency (JICA) dispatched a study team in April 1996. The result of the study is summarized in this report.

A.2 PRESENT CONDITIONS

- (1) The Study Area, covering an area of 1,188,000 ha, is located in the Mekong Flood Area in southern Cambodia. It includes the five provinces of Kratie, Kampong Cham, Prey Veng, Kandal and Takeo.
- (2) Average annual rainfall in the area is about 1,000 mm in the south and 1,600 in the north. Mean monthly temperature ranges from 25 to 30°C. The climate, distinctively marked by dry and wet seasons, is dominated by tropical monsoons. The three main rivers of Mekong, Tonle Sap and Bassac flow in the area. Water level in the river starts to rise in May, reaches its peak in September and October, then gradually decreases until April. Mean annual discharge of Mekong river is estimated to be 431.4 billion tons at Kampong Cham. During flood season, some water in the river flows into Tonle Sap Lake while some overflows into the delta through the canals along the banks, tributaries and natural runoff. The water forms a temporary extensive inundated area. Also, some water goes back to rivers that flows down to the Vietnam delta, while some (estimated about 64 billion tons) remains in the lowland area, lakes and swamps. The total amount of over-bank flow into the delta is estimated to be 170.7 billion tons. Although large parts of the delta are submerged in the rainy season, fertile silt-bearing flood water is a vital source of agriculture. It also brings about migration of fish, enriching fishing resources in the lakes and swamps. Rice-oriented agriculture and inland fishery in this area are run under such hydrological conditions.
- (3) Local administration in Cambodia consists of Province (Khet), District (Srok), Commune (Khum), and Village (Phum). Each province has 5-16 districts, a district 6-23 communes, a commune 23-30 villages. A village has more than 100 households.

- (4) Population and population density in the Study Area are about 3,440,000 and 289 people/km², respectively. The average number of the family per household is 5.4. Cultivated land is approximately 679,000 ha. Paddy production is about 1.04 million tons, corresponding to the share of 47% of the whole country. However, it is unstable depending on flood water and rainfall occurrences.
- (5) Agricultural production system in the area is characterized by the flooding cycle of the Mekong River, in the category of colmatage, lowland irrigation and rainfed agriculture.

Colmatage agriculture: In the area along the natural levees, farmers introduce fertile silt-bearing flood water to farmland through colmatage canals along the levees. Upland crops and fruit trees are planted in/around higher residential places safe from flood, while dry season paddy is grown in the lower land as flood water recedes. There exists 386 colmatage farming systems in the area consisting of 18,500 ha of upland crops, 6,972 ha of wet season paddy and 52,972 ha of dry season paddy. Kandal province has the largest 254 canal systems in the four provinces. Most canals have problems such as collapse of side-slope, soil sedimentation and deterioration of water control gates.

Lowland irrigation agriculture: Though lowland area around the lakes and swamps submerges during the flood season, paddy is planted at the end of rainy season by utilizing receding flood water and supplemental irrigation water. The sources of water for irrigation are small scale reservoir with traditional man-powered irrigation facilities called "snaich" or "rohat." This type of irrigation areas have a total number of 292 occupying 33,650 ha during rainy season and 75,789 ha during the dry season. About 173 were constructed during the Pol Pot Regime. Though some of them are still working, many are giving negative impact on hydrological environment because of inadequate planning, design and construction. Many irrigation facilities are out of use due to lack of proper maintenance work.

Rainfed agriculture: In higher land where farmers have no access to lakes and swamps, wet season paddy is grown depending solely on rainwater. Total rainfed agricultural area in the Study Area comes up to 491,200 ha.

- (6) According to the Rural Socio-economic Survey conducted by the Study Team on 1,000 farm households, land ownership is about 1.2 ha on the average. Most of wet season paddy (61 species) is traditional and medium/late maturity species. IR varieties (IR 66, IR 36 and IR 42) are common in dry season paddy. Rice growing farmers mostly keep the seed individually by themselves. Farm labor basically depends on manual works and draught animals. Average yield is relatively at low level, at 1.47 ton/ha for wet season paddy and 2.77 for dry season paddy.
- (7) Construction, operation and maintenance works of the irrigation and drainage facilities are to be managed and controlled under the following three categories: (1) small scale project (beneficial area is less than 200 ha), (2) medium scale project (200 to 5,000 ha), and (3) large scale project (more than 5,000 ha). This is under the guidance of the General Directorate of Irrigation Meteorology and Hydrology (GDIMH), Ministry of Agriculture, Forestry and Fisheries (MAFF). However, the GDIMH is hampered by lack of

experienced engineers, financial limitation and worn-out equipment/machines, etc.

- (8) Agricultural technology research works are undertaken by 18 national institutions (6 research stations, 5 agricultural development centers, 3 rural development centers and 4 state farms) under the supervision of the Department of Agronomy, MAFF. Much weight is put on rice, but not active. Officially, agriculture technology extension service is to be managed by the Department of Technique, Economy and Extension, MAFF. The Australian Government has started official assistance for agricultural technology extension services since May 1996, the project name of which is "Cambodia Australia Agricultural Extension Project (CAALP)". Several agricultural processing factories in and around Phnom Penh, are not in operation at present. Small-scale private-owned rice-mills are available in almost all villages. Also, medium scale commercial rice-mills are also found along national highways. However, most these facilities are for farmhouse consumption rather than commercial use. Only two provinces, Prey Veng and Takeo meet the demand of rice. Flow of agricultural products are not systematic.
- (9) Though there are 31 commercial banks in Phnom Penh, none of them offers loan for farm households. Some 30% of farm households in the Study Area are in debt from relatives, neighbors or money lenders. Many NGOs support campaigns to introduce agricultural credit system into rural society.
- (10) Rural development works are supposed to be promoted by Rural Development Committees in each administrative level under the Ministry of Rural Development (MRD). However, their development activities are presently not active due to lack of manpower and budget. On the other hand, more than 100 NGOs have been working in Cambodia since 1979. Many NGOs are endeavoring to support rural development in the area.
- (11) Most farmers are reluctant to participate in any organizations since they have bitter experience on a group work in the past. Although there are several farmers' organizations such as water users' groups and others for lending rice, money and cows, most of them are small in scale with a single objective. Women's activities in rural area are diverse, from household chores to field works. However, they hardly have opportunities to give their opinions in public. Female headed households are often poorer than male headed households. Women in agricultural works generally do not use cattle to plow the field and tend to have rather light works.
- (12) There is no electricity for more than half of whole farm households in the area. Firewood is usually used for domestic fuel. Therefore, gathering firewood is an indispensable activity in the rural areas. However, decreasing forest once seen widely in the area is an impending social problem.
- (13) Construction and maintenance of national and provincial artery highways are under the supervision of the Ministry of Public Works and Transport (MPWT), while that of rural roads under the MRD. However, all highways and roads were damaged during the prolonged civil war and are deteriorated due to lack of proper maintenance work. Rural water supply is under the control of the MRD. However, international assisting agencies and NGOs are actually contributing very much to the digging of wells for safe drinking

water.

- (14) Flooded area around lakes and swamps is not only for agriculture, but for fish habitat and inland fishery. Inland fishery is designed depending on migration and life cycle of fish along with the flood regime of Mekong river.
- (15) According to the statistics of 1995 on commercial fishing in Cambodia, the amount of inland fish capture is 72,000 ton or 60% of the national amount of whole fishery of 120,000 ton. As seen in the yearly change of the amount of inland fish capture, it gradually increased before 1990 owing to the improved fishing techniques as fishing net and movable fishing gears. However, the figure remained at almost the same level in the recent years (1990-1995). The fact suggests that exploitation of fishery resources has already reached its limit.
- (16) Institutional legal framework of inland fishery in the flood area is based on the Law on Fishery Management and Administration of 1987. According to the law, inland fishery zones are classified into; (1) designated fishing lots to be awarded by public auction every two years, and (2) sanctuaries. Benefit from the auction goes to Government's revenue (It occupied 67% of total fishery income in 1994.).
- (17) The areas of 450,356 ha with 72 fishing lots and one sanctuary have been proclaimed in the Study Area. Kandal province has the largest area of 178,907 ha. According to the trend of inland fish capture, with decline of high-grade fish capture, small and low-grade fish are increasing. Exhaustion of fishery resources is being apprehended.
- (18) Conflicts between farmers and fishermen or among fishermen themselves are found occasionally around the fishing lots in the high demand of decreasing natural resources such as land, water, fish and firewood. Licensees of fishing lot are generally inclined to monopolize the benefit from fishing lot. Concept of natural resources conservation has to be seriously taken into consideration in the land use planning.
- (19) The Ministry of Environment (MOE) is establishing a framework for environment preservation and a guideline for Environmental Impact Assessment (EIA) with the assistance of concerned institutes and agencies. Part of marsh and swamp area between Mekong and Bassac rivers is considered to be a candidate area for environment conservation, but it has not been prescribed as of 1996.

A.3 BASIC DEVELOPMENT PLAN

A.3.1 Basic Approach to Agricultural Development

- (1) In Cambodia, the First Socio-Economic Development Plan (1996-2000) is presently being prepared. In the agricultural sector, the basic objectives are 1) to achieve food security, 2) to contribute to the growth of national economy with increase of production and 3) to improve income opportunities for farm households. In order to achieve these objectives, agricultural and rural developments in the Study Area are necessary.

- (2) In consideration of importance of agricultural and rural development in national policy, the target for agricultural development in the Study Area was set up as follows;
- To contribute to the growth of agricultural economy through expansion of rice production, promotion of crop diversification and achievement of self-sufficiency.
 - To stabilize rural community through agriculture development by improving rural infrastructures.
 - To harmonize the conservation of fishery resources with farming.
- (3) The short-term, medium-term and long-term targets in this agricultural development, considering the need for food security in relation to both of population growth in the Study Area and contribution to the national agro-economic growth, was set to the years 2000, 2005 and 2010, respectively. Agricultural production is considered as a index of development target. In the national plan, the average annual growth rate in the agricultural sector is set at 5.2% for whole production and 6% for paddy production. Assuming that 6% is applied to the Study Area, the target of paddy production for each target year is set 1.3 million tons (2000), 1.8 million tons (2005) and 2.4 million tons (2010).
- (4) Agriculture in the Study Area is linked with the annual flood cycle of Mekong river. Its traditional production system is considered sustainable and suitable for regional environment. However, development plans that would require construction of modern large-scale facilities for control of water flow in Mekong river which would bring remarkable increase of production with advanced agricultural technology might cause comprehensive change in the social and natural environment. It would also take longer period of time to materialize. The basic development concept in this master plan study, therefore, should be put to maintain, conserve and improve the existing traditional agricultural system that has been well adapted to the flood cycle.
- (5) To achieve the target of agricultural development in the Study Area, the following three types of development plan were drawn, considering the above-mentioned concept.

Colmatage Farming Improvement Plan

This plan is to promote crop diversification and increase of land productivity by introducing upland crops in the colmatage farming area around the colmatage canals along the natural levees on the Mekong and Bassac rivers. The covered area is 25,500 ha in wet season and 52,900 ha in dry season with the existing 386 canals.

Agricultural Development Plan Harmonized with Fisheries

This plan is to expand irrigation farming, to stabilize and expand the production system of dry season paddy and to conserve fishery resources in the lowland irrigation areas dispersed around the lakes and swamps as well as the areas for inland fishery. The covered area is 33,700 ha in wet season and 75,800 ha in dry season with the existing 292 lowland irrigation areas.

Rainfed Agriculture Development Plan of the Inundated Area

This plan is to develop new farm land and to stabilize and expand wet season paddy

production system through improvement of rainfed farming in the surrounding above two (2) areas. The covered area is estimated 491,200 ha in the Study Area.

A.3.2 Colmatage Farming Improvement Plan

- (1) Colmatage farming is based on upland crop farming with silt-bearing flood water along natural levees and canals. Its basic development policy is to increase land productivity by means of maintaining and improving the existing land use pattern. On upland crop fields, various crops such as maize, sesame, sugarcane, mungbean, etc., while on natural levees, fruit trees such as banana, mango, longan, etc. are being grown. Higher elevation lands around the residential area are utilized as vegetable fields for home consumption. This farming area is densely populated and comparatively convenient to the marketing of agricultural products. Intensive market-oriented farming could be developed by improving present farming system.
- (2) In order to improve the present farming system, the colmatage canals, one of the basic infrastructure, have to be rehabilitated. The canals function as conservation of ecosystem in the back swamp area, keeping migration routes for fish, supply of silt-bearing water to farm land, and source of irrigation water during the dry season cropping. The rehabilitation of these canals will therefore have wide and effective impact.
- (3) Canal facilities to be rehabilitated include water control gates, bridges, canals and maintenance roads. For planning purpose, they can be categorized into several groups by type of facilities. Related to the rehabilitation of water control gates, 80 canals are planned to install them, considering the present conditions of existing ones and farmers' capability to operate and maintain them, as well as preservation of migration routes of fish. Rehabilitation works should be carried out in the following steps; 1) to classify the existing canals into several groups at the level of local administration in the provinces and districts, 2) to evaluate each group by some factors of intensity of farming, development potentials to generate agricultural benefit, farmers' capability to manage the facilities and degree of deterioration of the existing canal facilities, 3) to set up priority for rehabilitation, and 4) to promote rehabilitation works on the canal basis.
- (4) According to the guidelines mentioned in (7), A.2, rehabilitation of individual colmatage canal is regarded as a small-scale project. The operation and maintenance (O&M) should be undertaken by beneficiaries of each canal under the supervision of the Provincial Bureau of Irrigation Meteorology and Hydrology (PBIMH) and the District Office of Irrigation, Meteorology and Hydrology (DOIMH). With the execution of rehabilitation works, the beneficiaries are requested to organize a water users' association (WUA) with the attendance of DOIMH and commune office under the supervision of PBIMH. After the completion of rehabilitation, management and control of the rehabilitated facilities shall be transferred from DOIMH to the established WUA that will thereafter be in charge of O&M. Main works of O&M, such as, dredging canals, opening and closing gates, repairing maintenance roads should be conducted basically by supply of labors from beneficiaries themselves.
- (5) To promote crop diversification and expand agricultural productivity, it is imperative to

strengthen research works on the selection of suitable variety for major upland crops and multiplication of selected seeds, and the establishment of distribution system of seeds. Technical assistance by well-versed experts in this field is necessary.

- (6) Under the present conditions, rice bran (for extraction of oil), maize (for fodder), mungbean (for noodles), sesame (for extraction of oil), etc. have high potential for commercial agro-processing and marketing. Some farmers could export products from a long term development point of view, if low-interest credit system can be made available to them or farmers' organizations.
- (7) Located along national highways and provincial roads, the area is comparatively easy access to the agricultural activities. However, road density has to be improved for more effective farming. Supply of safe drinking water with appropriate hygienic control is also indispensable to rural people in the area.

A.3.3 Agricultural Development Plan Harmonized with Fishery

- (1) The way of present land use is controlled by the seasonal flooding. The farm land practicing until flood comes, becomes a fishing ground as flooding water is intruding, and is used for farming again as the water is receding. Since fishing right has been prescribed in many lots in the inundated area, basic development concept for land use would be different depending on the existence of fishing lot in the area. Outside of the fishing lots, land use for farming is comparatively easy. In the fishing lot, however, availability of swamps, grasslands and marshes has to be carefully developed from the viewpoint of conservation of fishery resources.
- (2) Cropping patterns are limited because farming is possible only during non-inundated period. In the areas where irrigation water is secured in dry season, paddy (dry season irrigation paddy and flood recession paddy) and upland crops can be grown during the time from the receding of inundated water to the beginning of rainy season. Dry season irrigation paddy, which relies entirely on irrigation water, needs much water through the irrigation facilities. Therefore, its area is not easily expandable. On the other hand, flood recession paddy to be grown in receding inundated water is rather easily expandable as it needs only additional irrigation water through the small-scale facilities. Its paddy yield is much better with higher farm-gate prices than that of wet season paddy.
- (3) Rehabilitation and extension of existing irrigation and drainage facilities in 292 areas are a essential matter to stabilize and boost the increase of production. Facilities such as polder dikes, small scale reservoirs, canals and pumping stations are necessary. The polder dike is a multi-purpose facility that serves as reservoir, flood protection and road. Small scale reservoirs are useful for conservation of fishery resources. Rehabilitation of large and medium scale pumping stations may not be programmed at present due to higher construction and O&M cost as well as requirement of operation and maintenance organizations by beneficial farmers/groups. Priority should be placed on the introduction of small mobile pumps for supplementary irrigation. As a first step towards the promotion of common use mobile pumps, one effective way is to establish a loan system for pumps and a farmers' organization aimed at the common use of them.

- (4) The source of irrigation is inundated water stored at the end of rainy season in lowlands, lakes and swamps. Results of an approximate water balance study between the amount of water necessary for dry season irrigation paddy and the amount of water available from stored water, shows that there is sufficient amount of water source for the implementation of this plan.
- (5) Various works of rehabilitation, expansion and O&M of the irrigation facilities are supposed to be carried out under the supervision of PBIMH. Technical assistance from the concerned institutional agencies is indispensable for smooth execution and appropriate management of such works. The main problems to be assisted are 1) providing machinery for O&M, 2) establishing guidelines for use of water in harmony with fishery resources and for O&M of irrigation and drainage facilities, 3) organizing and supporting water users' associations.
- (6) Since the inundated area is also the place for inland fishery, basic concept for agricultural development in the fishing area should be put to conduct sustainable fishing in harmony with farming by effective use of natural resources. The basis of development planning should be consisted of appropriate institutional approach, infrastructural planning for conservation of natural resources, and aquaculture.
- (7) With the view to conserve resources and control fish capture, the institutional approach is composed of 1) strengthening of Department of Fisheries (DOFi) and related research institutions, 2) modification of legal framework for inland fishery, and 3) establishment of fishermen's cooperatives and introduction of credit system for fishing business. Existing laws and regulations, as they are, may lead to unfair distribution of resources and cause social conflicts. Modification of related laws and regulations and its strict enforcement is required for re-establishment of public fishing zones for family fishing, vegetation zones for conservation of natural resources and sanctuaries for sustainable fishing.
- (8) The infrastructural planning, the construction of facilities, can contribute directly to the conservation of natural resources in the inundated area. The annual fish capture of around 125 kg/ha is expected with the conservation of fishing ground in lakes and swamps. One particular activity that can be undertaken is the construction of embankment to store water during dry season.
- (9) Aquaculture can be introduced as a part of farm management. Raising fish in ponds, canals and paddy fields provides animal protein for village people. It also brings additional income besides farming.
- (10) For increase in production of IR varieties, popularly practiced in the flooded area, establishment of proper cropping system and its diffusion are necessary. Since most of paddy growing farmers use self-keeping rice seed, the yield tends to decrease as its variety deteriorates. Therefore, seed multiplication and its distribution system have to be improved. The activities of the Cambodia-IRRI-Australia Project (CIAP) are expected to be effective in this field.
- (11) With the implementation of the plan, it is expected to bring about improvement of production and distribution systems of rice. Together with this, post harvest facilities such

as, rice-mill, warehouse and drying yard for paddy, has to be improved to upgrade the quality of rice and to increase its productivity.

- (12) Since many of the irrigation facilities are easily damaged due to submerged condition during flood season, appropriate maintenance after flood receded is indispensable. Water users' association should be established by each irrigation facility to operate and maintain their facilities. For this purpose, it is more realistic to organize farmers' into the association by getting support from related assistance agencies including NGOs under the leadership of organizer assigned from relevant government offices. As a first step, training and rearing organizers is urgently needed. After this, farmers could be trained and educated on many subjects related to agriculture, fishery and rural life, under the organizer.
- (13) As for road improvement, priority is given to roads with multi-functions/roles such as flood control and water storage, etc. Wells should be constructed with participation of rural people. These wells are expected to be operated and maintained by beneficiaries themselves.

A.3.4 Rainfed Agricultural Development Plan

- (1) Flood control and water resource development are the key components to initiate a development plan in the rainfed area. Since there is no construction plan of large-scale irrigation and drainage facilities on Mekong river, land use depending on the cropping of wet season paddy is compelled to introduce in this area.
- (2) From a viewpoint of water resource development, the plan is categorized into 1) lowland small scale agricultural development plan and 2) tributaries agricultural development plan.
- (3) The former plan is applied in areas where irrigation water is not available. It enables the area to introduce small-scale irrigation agriculture in village or individual farm level by improving the existing irrigation facilities constructed during the Pol Pot Regime and small ponds as water sources. The latter plan helps farmers to introduce irrigation agriculture along the tributaries by taking irrigation water from them.
- (4) Farmers in this area are generally poorer than the ones in other two development areas. To mitigate this gap, rural infrastructures such as roads, rural water supply, public health, education, medical care, etc. have to be improved in addition to the agricultural infrastructure.
- (5) To accomplish main development objectives to stabilize wet season paddy production, it is required, for planning purpose, to classify the present paddy fields based on the degree of draught and inundation. According to the characteristics of classified fields, appropriate rice practicing technique with suitable variety can be introduced into each paddy field. It is also important to secure irrigation water at the beginning of rainy season and to shift present variety from medium/late photoperiod sensitive native ones to early photoperiod insensitive native or improved ones.
- (6) There are many small or poor farmers in the area. Public agricultural credit system should

be introduced for sustainable agriculture taking the NGO's experience into consideration.

A.3.5 Zoning and Agricultural Development Plan

- (1) For planning purpose, the Study Area is divided into 13 zones based on the socio and agro-economic conditions such as population, crops and agricultural production, and the natural conditions such as topography, inundation intensity and roads. The three types of agricultural development plans previously mentioned would be implemented by each zone considering their characteristics.
- (2) By evaluating each zone, agricultural practice in the zones along Mekong and Bassac rivers where are densely populated and severely inundated is more active than that in the other zones. Since marketing system in these zones is also more accessible, it is considered that development potentials are greater.
- (3) Single cropping or double cropping of paddy and upland crops is proposed to be applied by zone. The target yield for short/medium term development plan may be set at 3.4-4.3 ton/ha (partly 3.0 ton/ha) for dry season paddy and 1.85 ton/ha for wet season paddy. For long term target, the yield of wet season paddy would be raised to as close as that of dry season paddy.
- (4) The road improvement by each zone is planned 404 km and 343 km for rehabilitation and new construction, respectively. For rural water supply, the target number of tube-wells to be constructed is planned 9,872 in all zones. Coordination between related organizations and agencies is required to implement these plans.

A.3.6 Proposal of Agricultural Development Projects

- (1) The agricultural development projects should be formulated and materialized through the Feasibility Study (F/S) undertaken by each area selected from zones. As a development strategy, some of the areas with high development potentials were selected from the covered areas of Colmatage Agricultural Improvement Plan and Agricultural Development Plan Harmonized with Fishery. The development plan for selected areas should be promoted as the priority projects.

Colmatage Farming Improvement Project

The Study Area stretches along the rivers. Though agriculture is practiced actively in all zones, the two zones along Mekong and Bassac rivers in Kandal province were proposed to be the priority areas since development potentials are the highest in the zones. The canals to be rehabilitated are 250 in their zones. Rehabilitation of these canals is likely to be feasible with their agricultural production benefits. The areas or canals are prioritized based on the agricultural characteristics of the zones and the degree of deterioration of the canal facilities. The project might be implemented on a canal basis according to the priority.

Agricultural Development Project Harmonized with Fishery

The Study Area is dispersed around lakes and swamps. Though viability of the project has to be assessed through some comprehensive feasibility studies, 20 areas were selected from the existing lowland irrigation areas as the priority development areas, considering anticipated project scale and development effect. The projects for the selected areas are likely to be viable. It is desirable to undertake the feasibility study immediately for project implementation.

A.3.7 Implementation Plan

Short and Medium Term Plan

In order to achieve the agricultural production target within a short and medium term, some development plans with fastest effect on agricultural production should be promoted. Therefore, both of Colmatage Farming Improvement Plan and Agricultural Development Plan Harmonized with Fishery, which aim at rehabilitation and extension of the present traditional agricultural production system, is set as a short/medium term plan.

To reach the target, as a first step, the proposed two types projects, Colmatage Farming Improvement Project in Kandal province and Agricultural Development Project Harmonized with Fisheries at 20 areas have to be developed. These projects, however, will be difficult to implement quickly due to financial limitation and poor capability of the implementation body. Under this circumstance, priority areas from the both projects will be selected to be implemented as the pilot projects (refer to A.5). Considering the outcomes of the pilot projects, the projects for remaining areas will be materialized and implemented one by one. The pilot projects have to be implemented urgently as a part of the short term plan.

Medium and Long Term Plan

The rainfed Agricultural Development Plan aimed at stabilization and increment of agricultural productivity should be promoted as a medium and long term plan. Though periodic flooding brings a lot of benefits to agricultural and fishery activities, it also is the biggest constraint for more commercial and productive agriculture development. Unexpected heavy floods have to be prevented to some extent in order to achieve long-term agricultural and rural development targets. Though some of the inundated water is used for agriculture, it is not enough to cover the whole rainfed agricultural area. Agricultural development plan including the tributaries development linked with the flood mitigation plan of the Mekong river, has to be conducted for medium and long term plan. For successful planning, coordination between related organizations and agencies is required.

A.3.8 Environmental Impact

- (1) It can be considered that the implementation of the proposed development plan will not bring about generally negative impacts on the present social life and natural environment in and around the Study Area. However, implementation of some specified projects in the limited areas may bring some environmental impacts in and around those areas directly or

indirectly. Accordingly, it is necessary to carry out an Environmental Impact Assessment (EIA) for these projects.

A.3.9 Impact of the Agricultural Development Plan

- (1) Implementation of the Colmatage Farming Improvement Plan will bring about improvement of the cropping intensity in the beneficial area (52,900 ha in rainy season, 25,500 ha in wet season). As for the Agricultural Development Plan Harmonized with Fishery, irrigable area will be expanded to 22,700 ha for wet season and 47,500 ha for dry season. Present total cultivated area will expand from 679,100 ha to 739,200 ha. Paddy production as a quantitative benefit with and without plans is summarized as follows, and medium term target will be achieved with the implementation of proposed projects/plans.

Without Project/Plan				With Project/Plan			
Irrigated Area (ha)		Rainfed Area (ha)	Paddy Production (Mil. ton)	Irrigated Area (ha)		Rainfed Area (ha)	Paddy Production (Mil. ton)
Wet	Dry			Wet	Dry		
59,200	128,800	491,100	1.04	81,900	176,300	481,000	1.83

- (2) Non-quantitative benefits such as increment of farm household income, stable rural life, land supply for landless farmers, preservation of fishery resources, etc. will also be generated.

A.4 COLMATAGE FARMING IMPROVEMENT PROJECT IN KANDAL PROVINCE

A.4.1 Present Condition

- (1) Most of the people in Kandal province are engaged in diversified agriculture which is combined with the periodic flooding of Mekong and Bassac rivers. The Ministry of Environment (MOE) is considering the lowland backswamp area of the natural levee as a candidate of environmental conservation area.
- (2) The function of colmatage canals has been deteriorating due to deposited sedimentation, soil erosion and non-functional water gates. If this situation would continue without any remedial measures, traditional farming and fishing system and natural environment of the backswamp area would deteriorate. Rehabilitation works should be implemented urgently.
- (3) 250 of colmatage canals is distributed in the project area. The colmatage farming area is divided into five (5) zones on the basis of district. In the Koh Thom district, many canals, the number of which is 103 are located along the Bassac river.
- (4) Related to the agricultural land use, dry season cropping area comprises about half of the total cropping area. During the wet season, both paddy and upland crop areas have almost the same areas. Maize is planted in more than 80 % of upland crop area during the wet season. About five (5) % of the whole cropping area is utilized as orchard.

A.4.2 Agricultural Development Plan

- (1) It is possible to control flood water intrusion during the wet season and to retain irrigation water during the dry season with the rehabilitation of the colmatage canals. The present cropping system, dry and wet season paddies, upland crops/vegetable could be intensified.
- (2) With the project implementation, cropping area and agricultural production will be increased from the present area of 8,576 ha and crop intensity of 100% to 30,446 ha and 107%, and from 74,537 ton to 96,586 ton, respectively.

A.4.3 Colmatage Canal Rehabilitation Plan

- (1) Idle/uncultivated lands are distributed widely between the colmatage canals. These lands could be reclaimed as new cultivation land by conveying silt-bearing water into the lands in a long-term farming practice.
- (2) Based on the degree of deterioration of canals and farming activities inside the project area, rehabilitation of priority zone/district is determined. According, the priority is given to Kean Svay, Saang, Leuk Dek and Kho Thom, in that order.
- (3) For planning purposes, the colmatage canal is divided into five (5) types. Rehabilitation is applied by type, based on the present capacity and function of canals. Water control gate is planned to be installed at 50 canals.
- (4) Operation and maintenance works of the canals should be undertaken by water users association organized by each canal under the management of GDMH and related commune offices.
- (5) The project cost is estimated at 37.91 million US\$. The project should be implemented by GDMH, MAFF, as the responsible agency. It should be implemented as a short and medium term plan.

A.4.4 Project Justification

- (1) Quantitative benefits that will be derived with the implementation of the project are increase in crop yield, cropping intensity and planting area. Economic internal rate of return (EIRR) based on the agricultural quantitative benefits and the project cost is accounted at 12.3%, indicating that the project is economically feasible.
- (2) Based on the financial analysis for typical farm household with 0.6 ha of farm size, the farm economy will be improved and disposable income will be generated with the project implementation.

A.4.5 Environment Impact

- (1) The natural and social environment of the backswamp area has been maintained by periodic annual flood through the colmatage canals. The present environmental situation will not

change, unless the hydrological condition of Mekong river is drastically changed.

- (2) The main project component is the rehabilitation of canals to restore its original function. Therefore, no negative impact on the present rural life and social activities, and the present water use system among villagers may take place with the project implementation. The project may not also cause negative effects on the present ecosystem in and around the project area.
- (3) Silt-sedimentation will gradually intrude into the backswamp area in a long-term period. For the conservation of ecosystem in the backswamp area, concept for land use should be introduced. Accordingly, zoning for environmental conservation should be delineated institutionally and technically.

A.4.6 Overall Evaluation

- (1) Based on the agricultural production benefit, the project is concluded to be economically feasible. In addition, the project implementation will contribute to the conservation of fishing resources and ecosystem in the backswamp area. Therefore, it is recommended to implement the project.
- (2) To materialize the project, priority areas/canals should be selected based on the rehabilitation priority, anticipated project scale and fund available for the project. The project may be implemented on the basis of canal.
- (3) For smooth implementation of the project, active participation of the beneficiaries in the project is necessary.

A.5 SELECTION OF PRIORITY PROJECTS AND PRIORITY PROJECT AREAS

- (1) Priority projects and areas were selected from the proposed development projects as the pilot projects. The outcome of the pilot projects will be reflected to the same type of development projects. As a result, considering the possibility of quick development effect, predicted project scale and recent movement of financial assistance by international development agency, the following two (2) areas were selected; 1) colmatage farming area (the area has about 20 colmatage canals) in Kean Svay and Saang districts in Kandal province as a Colmatage Farming Improvement Project Area, and 2) the area around lakes and swamps (Boeng Phitca) in Ksach Kandal district in Kandal province as an Agricultural Development Project Harmonized with Fishery Area.

2. FEASIBILITY STUDY

B. COLMATAGE FARMING IMPROVEMENT PROJECT IN THE PRIORITY AREA

B.1 PRESENT CONDITIONS

B.1.1 Study Area

- (1) The Study Area consist of three (3) areas, located at the right bank of Mekong river in the Kean Svay district (an area of about 2,640 ha) at the left bank of Bassac river in the Saang district (720 ha) and at the right bank of Bassac river in the Saang district (1,500 ha). The Study Area has a total area of about 4,900 ha.

B.1.2 Colmatage Canals

- (1) Six (6) canals are distributed along the right bank of Mekong river. Water control gates had been installed except in the Prek Chrey canal. However, the gate facilities has deteriorated and not functional at present. (The rehabilitation project of the canals was requested to the Japanese Government in 1994.) The Cambodia Government has launched the National Road No.1 improvement project with a loan from ADB, assigned the Ministry of Public Works and Transport (MPWT) as the responsible agency.
- (2) There are eight (8) canals at the left bank of Bassac river. The average length, width and depth of the canals are calculated at 1.7 km, 12.4 m and 2.0 m, respectively. No water control gates have been installed. Farming in the areas along the Prek Thmei, Prek Ta Pe and Kranh canals is relatively more active than that of the other canals.
- (3) There are seven (7) canals at the right bank of Bassac river. The average canal length, width and depth are 2.0 km, 11.6 m, and 2.9 m, respectively. Gates were not installed.

B.1.3 Agriculture

- (1) A Rural Socio-economic Survey was carried out to grasp the social and agricultural conditions in the Study Area. The farmers interviewed were 100 selected at random from the different areas in the Study Area.
- (2) According to the survey, average farm size is estimated at 1.73 ha at Kean Svay, 0.81 ha at the left bank of Bassac and 0.66 ha at the right bank of Bassac. The overall average farm size is about 1.1 ha.
- (3) Most of interviewed farmers cultivate either wet or dry season paddy, however, one-third of these farmers can not meet their home consumption. Agricultural income is mainly derived from the sale of upland crops.
- (4) The most popular upland crop in the wet season is maize. Sugarcane, peanut and mungbean are next in that order. In the dry season, though many crops are planted,

mungbean is most popular. Farming is generally conducted by draft animal.

- (5) There are no farmer's organizations in the Study Area. According to the Survey, most of farmers are willing to join water users' association if established. On the average, one farmer is willing to pay about 90,000 Riels/year for water charge. Most of the farmers have actively participated in the repairing works of canal and road.

B.1.4 Farm Economy

- (1) The Study Area consist of total 10 villages, 23,160 population, 4,343 households with an average family size of 5.33 per household. According to the Survey, the total annual income is estimated at about 1.2 million Riels per household. The main source of the income is mainly from farming.

B.2 PROJECT FORMULATION

B.2.1 Agricultural Production Plan

- (1) Agricultural production is expected to increase by the implementation of the project. The present cropping intensity of 107% will be increased to 114% with project, though the agricultural land use will not changed broadly. Production of cash crops of upland crops/vegetable will be increased.
- (2) The target of crop yield was set based on the statistical data in Kandal province. With the project implementation, total production is expected to increase by 29%.

B.2.2 Colmatage Canal Rehabilitation Plan

- (1) The number of the canals is 20, with a total length of 36 km. Water control gate is planned to be installed at five (5) canals while 10 bridges will be rehabilitated (not including the bridges along the National Road No.1).
- (2) Project cost is estimated at 3.95 million US\$ for the right bank of Mekong, 1.25 million US\$ for the left bank of Bassac and 1.36 million US\$ for the right bank of Bassac. Total project cost comes to 6.56 million US\$.
- (3) The project should be implemented by the GDMH. The GDMH shall secure the necessary land for canal rehabilitation through discussion with related farmers and communes before project implementation.

B.3 PROJECT JUSTIFICATION

- (1) Method of evaluation is the same as in the Colmatage Farming Improvement Project in Kandal Province.
- (2) Agricultural benefit expected is the increase of crop production of paddy, vegetables and

upland crops. The value of EIRR based on the project cost and the benefit is estimated at 13.9%. This indicates that the project is considered to be economically feasible.

- (3) According to the financial analysis for typical farm household in the Study Area, farm household incomes will be raised and disposable income will be also generated with the project implementation.

B.4 CONCLUSION AND RECOMMENDATION

- (1) The proposed Colmatage Farming Improvement Project in the Priority Area is concluded to be feasible. Since the project is recognized as a pilot project for the said project in Kandal province (refer to A.4), it is recommended to implement urgently.

C. AGRICULTURAL DEVELOPMENT PROJECT HARMONIZED WITH FISHERIES IN THE PRIORITY AREA

C.1 PRESENT CONDITIONS

C.1.1 Natural Conditions

- (1) The Phtea lake area, about 25km northeast of Phnom Penh, is located in Srok Ksach Kandal in Kandal province. The Study Area covers an area of 6,130ha in the left bank of Mekong river. The area has a concave topography with the lake of Phtea. The land descends and gradates southward toward the Phtea lake. The area elevation is from EL 5.0 to 9.0 m.
- (2) The climate of the Study Area is dominated by the tropical monsoons. Annual rainfall ranges from 1,095mm (1992) to 1,552mm (1987), with an average of 1,279mm. Over 90% of rainfall occurs in the wet season. Mean monthly temperature ranges from 25.0 (December) to 29.7 (April). Mean relative humidity is high throughout the year, over 67%. Evapo-transpiration by modified penman varies between 4.8 mm/day (September) to 7.3mm/day (March). The peak flooded water level in the Study Area is assumed to be 9.33 m for 1/2 return period (average year) and 10.47 m for 1/10 return period. In the past 1/2 year, 88% of the Study Area was inundated in September when inundation is at its peak.
- (3) The Study Area comprises three major soil units, namely Brown Alluvial, Alluvial and Cultural Hydromorphics. These three (3) soil units are not major constraints to agricultural production.
- (4) Land use in the Study Area is classified into the following six categories; farmland, reservoir/inundated forest, waste/grass/bush land, river/lake, residential land and road/canal. Farmland has the largest area of 3,565 ha, about 58% of the Study Area. Second largest area is the waste/grass/bush land comprising 1,127 ha (18%).
- (5) The natural vegetation in the reservoir/inundated forest is abundant. The stored floodwater in the reservoir is usually utilized for irrigation of dry season recession paddy. The vegetation supplies firewood to the village people. It also provides fish habitat during inundated period. Recently, vegetation appear to be decreasing gradually due to the cutting for firewood and clearing and reclamation of new farmland.

C.1.2 Socio and Agro-Economy

- (1) The study Area consist administratively of five (5) communes which are composed of 20 villages. It comprise about 20% of Ksach Kandal district. The population is estimated at 27,033 with 4,992 households and average family size of 5.42. Population density per km² is 552 persons.
- (2) Paddy production in the five (5) communes are not sufficient and does not meet self-sufficiency requirement (WFP/FAO, 1996/97). According to the Rural Socio-economic Survey (refer to C.1.6 (1)), only 43% of farm households meet family demand.

- (3) In the Study Area, farmlands were allocated to farmers in 1987. Farm size per family was decided from 0.3 to 0.5 ha for farmers along the Mekong river and from 0.5 to 2.5 ha for inland farmers, as the result of equitable allocation based on such conditions as water availability, access to the farm plot and family size.
- (4) It is observed that most farmers in the Study Area live on the incomes below the poverty line of 2.2 million Riels (820 US\$) per year per family in Cambodia. Average annual family income including off-farm incomes is 1,347,000 Riels (480US\$).

C.1.3 Agriculture

- (1) From the relation between agricultural land use and land elevation in the Study Area, land use pattern is classified into four categories; orchard and upland crops located above EL 9.0 m, upland crops and irrigation paddy from EL 9.0 to 8.0 m, rainfed paddy and recession paddy from EL 8.0 to 6.0 m, and recession paddy below EL 6.0 m. The agricultural land use area consists of 1,622 ha of recession paddy, 1,052 ha of rainfed paddy, 817 ha of irrigation paddy and upland crops, and 74 ha of orchard.
- (2) According to the Rural Socio-economic Survey, 491 farmers out of 500 have paddy field with an average paddy field area of 0.92 ha. Upland crops farming is also practiced. In the dry season, mat grass is the most popular crop. This is followed by mungbean, tomato, watermelon and chili in that order. In the wet season, sesame is the most popular crop followed by cassava and maize.
- (3) Based on the Survey, self-keeping paddy seed is customarily used for nursery. Farmers who renew paddy seed are very few, only less than 10%. Urea is the commonly used fertilizer in both the wet and dry season. Agricultural chemicals are not commonly used. About one fourth of the farmers use chemicals in the wet season. But the number of farmer users increases to 50% in the dry season.
- (4) For wet season paddy, farmers usually conduct land preparation between June to July and transplant seedlings between July and August. Harvesting season varies from October to December since the growth period depends on the planted variety. On the other hand, each farming practice for dry season paddy is generally conducted in accordance with the recession of floodwater. Generally, land preparation is conducted between October to December, transplanting is between November to January, and harvesting is between February to April.
- (5) Paddy yield is estimated based on the statistics of planted and damaged areas by commune, district average yield and communal harvested area. In wet season paddy of 1995, the district average paddy yields of early, medium and late variety are 3.0, 2.5 and 2.7 tons/ha, respectively. The yield of 1994/95 dry season paddy varies from 3.51 to 3.84 tons/ha by variety type.
- (6) According to the Rural Socio-economic Survey, agricultural machine is not commonly used in the area. Fifty-five of farmers have draft animal. The average draft head ranges from 2.1 to 2.4 heads. Pigs are important sub-income sources for rural people. About 90% of

interviewed farmers also breed chickens for eggs and meat supply and for home consumption.

C.1.4 Agricultural Supporting Service

- (1) The Agronomy Section and Animal Production & Health Section, under the District Agriculture Office, are the related office providing agricultural extension services in the Study Area. At present, the office conducts meeting/seminar for commune staff. Due to limited budget, however, there is no training material for attendants such as brochure/textbooks. Only oral lecture is given. The office provides injection and medicines for prevention of spread of diseases of cattle, buffaloes and pigs. They also control the slaughterhouses in the district by monitoring the number of slaughtered animals and collecting tax.
- (2) Commercial basis post-harvest activities are not available in the area. However, small-scale village-based rice mills counting 43 are found in the area. Milling charge is 250 Riels per 10 kg of paddy. Mat manufacturing is commonly practiced, particularly in the villages along the Mekong river. There are three (3) local markets in the Study Area.

C.1.5 Agricultural Infrastructures

- (1) There are eight (8) colmatage canals in the Study Area. All the canals are shallow. The side slopes are eroded due to rainfall and flood water. Rehabilitation such as dredging, reshaping of canal slopes and maintenance roads are required.
- (2) A total of 37 reservoirs exist in the Study Area, divided into semi-closed type and closed-type. The number of semi-closed type is counted at 12, located at above EL 9.0 m along the Mekong river. Full surface water area and its stored water are estimated at 116 ha, 0.8 MCM, respectively. On the other hand, the closed-type counted at 25 are distributed in the inundated area below EL 7.0 m. Full surface water area and its stored water are estimated at 530 ha and 4.7 MCM, respectively. The canals are mostly small and earth type.
- (3) Farm roads are poor, unpaved and non-functional during the flooding season. The road density is also low for farming activities.
- (4) No organizations carry out operation and maintenance of the infrastructure facilities in the Study Area. A chief of commune has the responsibility to organize farmer to maintain the facilities. However, maintenance work is not active.

C.1.6 Rural Sociology

- (1) A Rural Socio-economic Survey was done by interviewing 500 households which is about 10% of the total households of 4,992 in the Study Area.
- (2) The Survey result shows that provision of irrigation facilities is recognized as the urgent requirement for farmers. The second need mentioned is flood protection.

- (3) Public institutions for agricultural and rural development are the following sections under the district office, Agriculture, Rural Development, Public Works, Women's Affairs, Health and Education. However, development works are limited due to financial difficulties. Rural development committees are set up at each administrative level.
- (4) No farmers' organizations exist in the Study Area. However, two rice banks exist at present. For the maintenance works of reservoir, one manager is nominated or selected under the supervision of the commune. The manager usually organizes farmers to rehabilitate the reservoir. Reinforcement of reservoir dike and water gates are generally supposed to be conducted by the organized farmers under the supervision of the manager.
- (5) There are several NGOs working in the Study Area, but no NGOs working for agricultural development. SHARE for health, SAO for fish culture, and GRET for rural credit and drinking water supply are the major ones in the Area.
- (6) According to the Rural Socio-economic Survey, 51% of total population are women, its percentage is the almost same as that of country's average. According to the Women's Affairs section, out of the total 18,994 households in Ksach Kandal district, 3,994 households (21%) are the female headed household. The female headed households are generally poorer than the male headed households.

C.1.7 Rural Infrastructure

- (1) The total length of district and village roads in the Study Area is 18.80 km and 73.27 km, respectively. Although the roads are supposed to be maintained by the district office, maintenance work is generally not active due to financial constraints.
- (2) Simple rural water supply system consisted of lifting pump at the waterside of Mekong river, storage tank, gravity pipeline and house tap with meter, has been provided for the area along the Mekong river. However, the present system has no treatment facility. In the far area of the Mekong river, 90 of total households has tube-well as drinking water source. Water quality of the tube-well is safe for drinking.
- (3) In the area, sanitary facilities and public electric supply service have not been developed.

C.1.8 Fisheries

- (1) Inland fishery is active during flooding season in the Phtea lake and its vicinity. Fishing ground is varied depending on the hydrological seasons. At the water level of EL 4.0 m, the total area of the Phtea lake is about 312 ha. Together with its outlet of about 120 ha, about 432 ha are used for fishing during the dry season.
- (2) Most of the fishes caught in the area are Sheatfish, Catfish, Silver Barb, Smith Barb, Soldier River Barb and Glassfish. It should be noted that a part of the Fishing Lot No. 17 of Kandal Province is overlapped with the Study Area. The No 17 Fishing Lot area is 8,828 ha while its overlapped area is about 1,100 ha. Aquaculture is not active.

- (3) Fish production in the area for more than three (3) months of flood period (5,330 ha, EL. 9.0 m and below) is estimated at about 320 ton/year or 640 ton equivalent to one leasing period of Fishing Lot. Based on the past study on fish grade composition, production of three (3) grades, first, second and third are assumed at 19, 43 and 258 ton/year, respectively.
- (4) Fishing activities in Lot 12, 13, 16 and 17 have been controlled by the Kandal Provincial Fishery Inspection Unit. The Provincial Fishery Inspection Unit has designated the Muk Kampul district as the sub-ordinate authority. From 1996-1997, the tendered price of Lot 17 was 33.4 million Riels.

C.1.9 Environment

- (1) The Study Area is recognized as a typical rural area along the Mekong river. Its social environment will not be changed rapidly as long as hydrological patterns of the river remain unchanged.
- (2) The O&M works of the reservoirs are not active except for small repair work of bank. However, since communes and villages have capability to arbitrate the interest among the beneficiaries, there is no serious conflict of water allocation between villagers or villages at present.
- (3) Available land for new agricultural development is very limited. Though excessive input of agrochemical to expand productivity is one of the harmful environmental factors, no negative impact has been found.
- (4) There is no serious conflict of farming and fishing activities between farmers and fishermen in No.17 fishing lot. However, over-cut of branches or vegetation in the reservoirs and waterside may bring some negative impacts on fishery resources.
- (5) Hygiene, medical and drinking water conditions are still at low levels as in other rural areas. There is scarce case of crucial infectious or endemic disease except popular parasites. There is no place of historical and cultural importance to preserve, except for temples in the area.
- (6) Most of the trees in the flooded area belong to the species of Lecythidaceae and Combretum. Their seed and seedling are easily spread by flooding water and grow rapidly. Their appropriate management is indispensable for stable supply of firewood and conservation of ecosystem in the area.
- (7) There exist many kinds of flora and fauna in and around the Phtea lake. Their nationwide inventory including invaluable species has been prepared by the related agencies, but the data on the Study Area is very limited.

C.2 DEVELOPMENT PLAN

C.2.1 Basic Approach

- (1) The development objectives for the Study Area are 1) to secure self-sufficiency in the area by increasing rice production, 2) to stabilize rural life through enhancement of agricultural based rural development, and 3) to conserve fishery resources for sustainable inland fishery.
- (2) To achieve the objectives, the following measures should be considered; 1) construction/rehabilitation of reservoirs, 2) construction/rehabilitation of canal systems, 3) construction of multi-purpose roads, and 4) construction of small scale weir for water conservation, as infrastructure measures, and 1) strengthening of agricultural supporting services, 2) establishment of farmers' organization, and 3) provision of operation and maintenance supporting office, as non-infrastructure measures.
- (3) Allowing for many constraints and unknown factors for project implementation, especially limited implementation capability of related agencies and farmers' organization and financial difficulties, the concept of stage development should be introduced for plan formulation. In this staged development, some benefits may be generated in each stage.

Stage-1

The lowland area where recession rice and rainfed rice are grown are developed as first stage. As infrastructure measures, reservoirs and multi-purposed roads/dikes will be rehabilitated/constructed to stabilize and expand production of recession paddy and rainfed agriculture. Water conservation weir will be constructed to conserve fishery resources and to increase fishery production. The development plan in this stage is the minimum requirement to attain the development objectives.

Stage-2

Colmatage canals will be rehabilitated to control flood intrusion from Mekong river. With the canals and the multi-purpose roads/dikes rehabilitated/constructed in stage-1, intensive farming could be introduced in colmatage farming and lowland areas.

Stage-3

Flood intrusion should be controlled to some extent to promote intensive agriculture in the area. For this purpose, this stage involves the concept of enclosed dikes to block the area by adding some roads and structures to the stage-2 development.

- (4) Although requirement of non-infrastructure measures differs by each agricultural pattern of each stage, supporting service activities for agricultural and fishery activities should be strengthened by the proposed operation and maintenance supporting office (refer to B.2.8), in accordance with various levels of farming practices and farmers' participation.

C.2.2 Land Use Plan

- (1) Although land use in the area is limited by the flood cycle of Mekong river even after the completion of stage development, flooding period can be somewhat controlled by provision

of the multi-purpose roads. Consequently, flood damage on rainfed paddy, upland crops and orchard will be mitigated, and farmers could extend farming period.

- (2) The development of new farmland is limited only in waste/grass/bush lands. The vegetation and inundated forest should be conserved as the source of firewood and the habitat and spawn area of fish.
- (3) Land use in each stage is planned at 1,792 ha of recession paddy and 1,117 ha rainfed paddy in stage-1, 817 ha upland crops in stage-2, and 324 ha upland crops in stage-3.

C.2.3 Proposed Cropping System

- (1) Photoperiod insensitive early/medium duration varieties such as IR66 and IR42 will be grown in the areas of recession paddy. In the future, some improved varieties, IR72, Kru and IR Kesar, released by the Cambodia-IRRI-Australia Project (CIAP) are recommended.
- (2) Present cropping patterns and farming technique will be strengthened. As for fertilizer input, manure, green manure, plant waste and ash should be mainly utilized. However, application of inorganic fertilizers will be more popular since improved varieties are usually reactive to them and high yield is expected. Therefore, application of input materials should be properly managed.
- (3) Though photoperiod sensitive medium/late duration traditional varieties such as Sar Thungun and Bonla Phdau are presently planted in the area of rainfed paddy, they should be shifted to improved medium duration varieties (Santepheap-1, Santepheap-2, and Santepheap-3) developed by the IRRI, or photoperiod sensitive medium duration varieties and photoperiod sensitive late duration varieties suited for rainfed paddy of wet season.
- (4) Sesame, cassava, maize, green bean, tomato, watermelon, etc. will continually be grown in the upland crop areas. The cropping of vegetable will be increased gradually considering geographical conditions in the area.
- (5) Based on the Rural Socio-economic Survey, typical farm sizes are classified into three types; 0.5-1.0 ha for recession paddy plus upland crops, 1.0-2.0 ha for recession paddy plus rainfed paddy and 0.7-1.4 ha for rainfed paddy plus animal husbandry. Though in the proposed cropping system, labor requirement are at the maximum in December, farmers in the area can afford to supply the required labor force.

C.2.4 Agricultural Infrastructures

- (1) Existing reservoirs will be rehabilitated to supply irrigation water into the recession paddy area. Semi-closed type reservoirs are not be expected to increase the capacity since heightening dike is difficult due to the topographic condition. However, reinforcement of top and side slopes of dikes is planned to retain the original capacity. On the other hand, closed type reservoirs will be expected to increase the capacity by heightening their dikes. Necessary height of dike is estimated based on the water requirement of recession paddy. In order to prevent trespassing on inundated forest and grassland inside the reservoirs,

construction of ditch/canal is planned along the dike. Some parts of the reservoir dikes may be used as farm roads. Water control and intake gates are planned to be installed. These facilities should be prepared in stage-1 development.

- (2) The present colmatage canals will be rehabilitated to secure irrigation water and control flood intrusion. Rehabilitation components are dredging of bed, reshaping of side slopes, construction of maintenance road and bridges, and installation of water control gates. These rehabilitation is planned to be done in stage-2 development.
- (3) Parallel with the rehabilitation of the reservoirs, the irrigation canals will be constructed/rehabilitated. Scale of the canals should be small, earth type, therefore, existing canals may be re-shaped by some rehabilitation works. Though gravity irrigation from the reservoirs is basically the best way, small mobile pumps may be required due to topographical condition. Existing Pol Pot canals may be used with some rehabilitation works to supply supplement irrigation water source for rainfed paddy.
- (4) Since farm roads function not only as transportation network of agricultural products, but also as flood protection dike, each route should be planned considering the location of reservoirs and performance of flood control and water conservation. Surface elevation of farm roads that will also function as flood protection dike is planned at EL 9.5 m, taking into account the surface elevation of Phras Konlong road which is equivalent to 1/2 return period of flood water level.
- (5) By utilization farm roads as a reservoir dike, some parts of waste/swamp areas will become water conservation areas. New agricultural land for recession paddy and upland crops might be reclaimed around their areas if irrigation water could be stored in the area.
- (6) Operation and maintenance (O&M) of agricultural infrastructures should be conducted by beneficiary farmers. The O&M works consists of bush clearing, dredging, leveling, reshaping and reinforcement of the infrastructures. These works should be carried out during agricultural off-season in May or June.

C.2.5 Inland Fisheries

- (1) The objectives of inland fishery development in the area are to conserve fishing resources for sustainable fishing and farming through effective use of resources and to conduct productive fishing in and around the Phtea lake. In the development planning, therefore, physical measures related to the rehabilitation of facilities, and institutional approach related to the administrative and institutional system, are required to achieve the objectives.
- (2) Reservoirs, inundated forest and vegetation areas in and around the Phtea lake are being disturbed and deteriorated by uncontrolled farming, fishing and firewood collection activities at present. Fishing and farming in these areas should be exclusively prohibited to conserve resources. For this, institutional approach is that the reservoirs of Son Say, Tanon, Pleuv Tuk and Promok are planned to be preserved at its natural conditions in the form of proclaimed sanctuary with clear demarcation. Control and management of land use in these reservoirs should be authorized by the Department of Fisheries (DOFi), MAFF,

in line with the present regulation or law related to the fishery management.

- (3) As the physical measures, it is recommended to construct a weir at the downstream of the Phtea lake. The scale of weir should be designed as a small structure that would not restrict the present recession paddy farming. Retention water depth would be planned at about 2.0 m. The weir will be submerged during flood season as inundated water level rises above BL 5 m. During dry season, the top of weir could be used as a farm road.
- (4) With the construction of the weir, water level of the Phtea lake during dry season would be retained for longer period than the present. Consequently, waterside vegetation around the lake could be preserved. Though agricultural activities repeated during dry season in the waterside might be limited to some extent, fishing area during dry season would be extended. Expected increment of fish production is approximately 90 ton/year. Besides fish production, aquaculture in the Phtea lake will be developed. Retained water may also be used as a supplemental irrigation water for recession paddy in the periphery of the lake.
- (5) Benefits are expected in the Fishing Lot. Since agricultural and fishing activities in the Lot are controlled by DOFi and lot licensees, their consent to the development are needed before construction of the weir.
- (6) The operation and maintenance supporting office (refer to B.2.8) provides farmers and fishermen with various supporting activities including training and diffusion of fishing technology to conserve and manage fishing resources in and around the area. Concretely, introduction of fishery credit system, seed production, promotion of aquaculture with farming practice, etc. have to be provided.
- (7) Compound management with farming and fishing by introducing aquaculture is one of the effective way to provide additional income of farmers. The aquaculture with farming practice consists of rice cum fish culture, livestock cum fish/cash crop culture and semi-intensive fish pond culture. The operation and maintenance supporting office will construct the facilities of seed production to promote aquacultural-farming system in the fields and aquaculture in the Phtea lake. Assuming fishing production of the compound management, 330 ton could be achieved after 3-4 months of growing period. Furthermore, the production of 200 ton/year could be expected if aquaculture would be practiced in the Phtea lake.

C.2.6 Agricultural Supporting Services

- (1) Agricultural extension services have been providing through the Cambodia Australia Agricultural Extension Project (CAAEP). To assist and strengthen the present agricultural extension activities, it is necessary to continue the present periodical seminars and meetings organized by the district agricultural office, in addition to the CAAEP.
- (2) Research activity in Cambodia remains traditional and even the national research institutes do not work efficiently at present. It is difficult to conduct research activity only for the Study Area, but useful research information applicable to the area should be given to farmers through the extension service.

- (3) Establishment of agricultural credit system is necessary to support farmers not only for production of rice but also for purchase of rice for home consumption. The Cambodia government established a Credit Committee for Rural Development (CCRD) in February 1995, to improve financial condition of agriculture. It suggests that central financial institute should be established to provide credit service for all classes of farm households. Agricultural credit system should be introduced in the Study Area, under the management and coordination of CCRD and by making full use of the experiences of NGOs such as GRET.
- (4) At present, agro-processing such as mat weaving, processing of noodle and smoked fish has been practiced in small scale in the area. These small home industries should be encouraged and extended to improve income of farm household. Rice mills are the major post-harvest facilities since rice-centered agriculture is practiced in the area. The capacity of existing rice mills can still meet future demands.

C.2.7 Strengthening of Farmers' Organization

- (1) The Rural Socio-economic Survey reveals that most farmers in the area want to join the organizations such as agricultural cooperative and water users' association (WUA) in the future.
- (2) Agricultural cooperatives are useful to produce and sell agricultural products and purchase materials and machinery. At present, possible cooperatives to be established in the area are grass mat producers' cooperative or lotus seed producers' cooperative. Women's association will be useful to help women to make them participate in rural development and improve living conditions.
- (3) Taking the present condition of the area into consideration, establishment of WUA, to manage and operate irrigation facilities by farmers themselves, is the most urgent step. Allowing for the scale of existing facilities in the area, the district agricultural office would be responsible for organizing the WUA.
- (4) The following steps are proposed to organize the WUA; 1) organizer is selected from the hydrology section of the agricultural office, 2) the organizer explain the advantages of organization to the manager of each reservoir, and 3) each manager explain and request the endorsement to beneficiary farmers on the establishment of WUA. The organizer should be well experienced in organizing.
- (5) Each WUA has to organize a committee through a democratic procedure. Next, the committee should prepare own regulation on operation. The regulations can be formulated actually with the assistance of the organizer, the operation and maintenance supporting office and the district agricultural office, if necessary. The WUA is expected to operate and manage facilities under the guidance prepared by the committee.
- (6) Financial source was the biggest constraint to operate and maintain the irrigation facilities in the past. With appropriate management of reservoir, beneficiary farmers could benefit more than the present. Therefore, it is indispensable to collect water charge (paid in cash

or rice). Collected charge can be used by WUA for O&M.

C.2.8 Operation and Maintenance Supporting Office

- (1) It is necessary to provide technical assistance to farmers for establishment of the WUAs. In addition, supporting services such as, farming technique, agricultural credit and fishery management is required to achieve development target by farmers themselves. Therefore, the operation and maintenance supporting office should be established aiming at provision of technical assistance to the farmers who are the core of O&M activities. The supporting office should be managed by the agricultural section of district agricultural office. The staff of agricultural section concurrently hold its work, however, they may request some assistance from other agencies concerned when necessary. The agricultural section can tap necessary services on other related agencies in the undertaking of the supporting services activities.
- (2) The supporting office will require building, such as meeting hall, office and storehouse, etc., and machine/equipment such as portable pump, tractor, bulldozer, vehicles, etc. The office equipped with these facilities can provide technical advice to farmers' organizations and space to hold meetings and various training. The office may also rent out portable pumps, agricultural and O&M machinery to farmers and WUAs' members.
- (3) The proposed development project is considered as a model project for other similar areas. Since human resources of the district agricultural office to operate and manage the services is limited, it is recommended to ask for some assistance from related agencies or NGOs at the beginning stage of establishment of supporting office.

C.2.9 Rural Infrastructure

- (1) In the planning, farm roads will be connected to the district roads for easy transportation and distribution of agricultural products in and around the area. Since some parts of the district roads are dilapidated due to no maintenance provided, rehabilitation work is required.
- (2) To improve the facilities of rural water supply, simple treatment facility by means of gravel or sand should be added to the existing water storage tanks in the areas along Mekong river. In the far areas from the Mekong, it is necessary to increase the use of tube wells as drinking water source together with diffusion of sanitation program by hospitals and schools.
- (3) It is expected that sanitary environment in and around the area will be changed together with improvement of living conditions of rural people. Therefore, sanitary improvement should be undertaken, in which provision of toilet is the basic requirement. It should be proceeded through public assistance agencies and NGOs.

C.3 FACILITY PLAN AND PROJECT IMPLEMENTATION PROGRAM

C.3.1 Facility Design and Planning

- (1) Dam body of closed type is designed to be elevated from 1.0 to 2.0 m. For semi-closed type, the top of body is reinforced and reshaped.
- (2) The width of farm road is planned at 3.0 m and 2.0 m. The number of colmatage canals to be rehabilitated is five (5). The canals are equipped with water control gate. Wooden bridges will be replaced at required places across the extended canal. As the appurtenant facilities, intake gate and culvert are also planned.
- (3) The concrete-built weir is planned to be installed for water conservation. The key dimensions are crest width of 2.5 m, weir length of 70 m and downstream apron length of 9.6 m. As the appurtenances, fish way, navigation way and two sand sluices are also planned.
- (4) The facilities and equipment for the operation and maintenance supporting office will be provided. As a center, a building for office and meeting spaces is proposed. Some machinery and equipment such as portable pump and tractor will also be provided. Seed production facilities for fish culture, reservoir, brood stock pond and nursery pond will be constructed.

C.3.2 Project Cost

- (1) Based on the facility plan, project cost was estimated by development stage at 6.66 million US\$ for stage-1, 2.93 million US\$ for stage-2 and 1.69 million US\$ for stage-3 with a total cost of 11.28 million US\$.

C.3.3 Project Implementation

- (1) The proposed project shall be implemented in close cooperation with the government agencies such as MAFF, MOE, MPWT and MRC. The leading agency is the MAFF. Related department in the MAFF is GDIMH, DOA, DOFi, DTEE, etc. In order to promote the positive participation of farmers, local governmental institutions of Kandal province, Ksack Kandal district and the related six (6) communes, and NGOs should be involved in the project implementation. Considering the present conditions of these agencies and institutions, it is recommended to establish a project executive committee at related ministry levels, project coordinate committee at related department and local government level, and project unit task force at site level for smooth and successful implementation of the project.
- (2) It will be difficult for the Government of Cambodia to fully provide financial requirement for the project due to domestic financial limitation. It is desirable that whole project cost should be secured by foreign government fund or international development fund.
- (3) The agricultural infrastructures should be operated and maintained by farmers' organization

under the operation and maintenance supporting office and the district office. Related to the maintenance works of the reservoir dikes, some farmers' organizations should manage the inundated forest in their reservoirs to prevent over-cutting for firewood.

C.4 PROJECT JUSTIFICATION

C.4.1 Basic Concept for Project Evaluation

- (1) The project is the agricultural development project for about 27,000 beneficiaries of about 5,000 households living in the Phtea lake area. The project aims to increase agricultural production, fishing resources conservation and improvement of farm economy and living standard through structural and non-structural development. These are in line with the objectives of the First Socio-Economic Development Plan (1996-2000) of Cambodia aiming at attainment of food security and poverty alleviation. The project consists of three stages and benefit will be generated by stage.

C.4.2 Project Benefits

- (1) As to quantitative benefit, agricultural benefit from paddy production will be generated by each stage. In stage-1, increase of planting area for recession rice and its yield, expansion of inland fishery, land reclamation of waste land, prevention of flood damage will be expected. Increase of planting area for upland crops and dry season paddy in stage-2 and double cropping of paddy and upland farming in stage-3 will be generated.
- (2) As to non-quantitative benefit, improvement of farming technology, development of marketing system, improvement of rural life and increase of employment opportunity through the construction works of the project and expansion of farming activities will be expected.
- (3) The planning and implementation of this project is a model case for areas being developed in the future. In particular, development method in the fields required harmony with agriculture and fishery, designing based on the O&M by farmers and institutional development planning will be give better suggestion for future development plan.

C.4.3 Economic Analysis

- (1) Economic internal rate of return (EIRR) estimated by discounted economic cost and benefit estimated are 8.6% (stage-1), 10.9% (stage-1+2) and 11.0% (stage-1+2+3).
- (2) The value of the stage-1 is relatively low, since this stage involves many indirect benefits such as conservation of fishery resources and inundated forest/vegetation, stable rural life through establishment of farmers' organization. It also includes the social impact of setting up of the operation and maintenance supporting office and strengthening of agricultural supporting services which are the basic requirement for all stage developments.
- (3) Based on the values of EIRR of whole stages, the project implementation is considered

economically feasible.

C.4.4 Financial Analysis

- (1) Based on the financial analysis for typical farm households in the colmatage farming area, the recession farming area and the rainfed area, annual farm household incomes which are currently below the poverty line, will be improved with the project implementation. Farm economy will be improved by earning disposable income, indicating that beneficial farmers will bear the O&M cost needed for the infrastructures.

C.4.5 Comprehensive Evaluation

- (1) As the result of economic analysis, EIRR was estimated at 11.0, which shows the economic feasibility of the project. Farm economy of some typical farmers will also be improved by the project implementation. Consequently, the project is evaluated to be economically viable.

C.5 ENVIRONMENTAL IMPACT ASSESSMENT

C.5.1 Environmental Impact

- (1) The most effective impacts on the rural society to be caused by the project implementation will be the expansion and activation of agricultural and socio-economic activities in and around the area. In this impact, no negative one will not be expected. Proposed rehabilitation plan of existing reservoirs and their utilization is considered not to disorder the present water allocation manner among beneficiary farmers.
- (2) Appropriate management of the vegetation area will induce conservation of inundated forest and mitigation of conflict between farmers and fishermen. It will not infringe upon the vested rights of No.17 Fishing Lot.
- (3) Natural ecosystems in the area is directly influenced by seasonal flooding of Mekong river. Since proposed plan is for agricultural and fishery activities utilizing the flood cycle, there is no disturbance on hydrological condition in the area. Therefore, proposed plan hardly brings any negative impact on present ecosystem.
- (4) The hydro-cycle of flood intrusion, inundation and recession observed in the area will not be changed drastically by the development of stage-1 and 2. On the other hand, flood intrusion from the northern part will be controlled in stage-3. Though they seem not to lead immense change of flood cycle of Mekong, it is required to coordinate with relevant development projects on flood control in and around the area.
- (5) The project implementation will not give negative impact on the life-cycle of fish of spawning, growth and migration which suits to natural environment in the area. Construction of weir and establishment of sanctuary will lead the conservation of habitat environment of fish.

- (6) Most of the seeds of plants in the flooded area are spread by flood water. They grow easily and rapidly. Some of them grow as trees and are used as firewood by rural people. The living environment of these plants will not be changed by the project implementation.
- (7) Inhabiting and migratory waterfowl species and other wildlife are seen in the area. Their habitat environment will not be disturbed by the project implementation except the period of construction of facilities.

C.5.2 Environment Conservation Plan

- (1) Since intensive farming is practiced with the use of agrochemical and chemical fertilizer, fishery resources are easily devastated and people may be harmed by their inappropriate utilization. Therefore, the Department of Agronomy (DOA) should provide proper guidance and monitoring.
- (2) It is important to accumulate observation data on hydrological condition to manage and conserve natural environment in the middle and long term period. Since change of water quality affects fishery resources, the GDMH should collect water samples regularly to monitor their changes. The DOFi should conduct periodic survey on fishing production and should apply the results into the planning of resource conservation and sustainable production.
- (3) The MOE is expected to increase awareness of villagers on hygiene improvement and conservation of natural resources. Especially, negative effect on over-consumption of firewood and provision of toilet should be propagated to the rural people.
- (4) Regional inventory data on plants and animals and their living environment have to be collected and arranged since they become a fundamental data for preservation of natural environment.

C.6 CONCLUSION AND RECOMMENDATION

C.6.1 Conclusion

- (1) In this Agricultural Development Study of the Mekong Flooded area in Cambodia, three types of Colmatage Farming Improvement Plan, Agricultural Development Plan Harmonized with Fisheries and Rainfed Agricultural Development Plan were formulated. These plans are based on the advantage of traditional farming practice with annual ecological cycle of the Mekong river. The development objectives of the plans are in line with the National Socio-Economic Development Plan aiming at rehabilitation and reconstruction in Cambodia.
- (2) From the three (3) types of development plan, the priority project, two projects of Colmatage Farming Improvement Project and Agricultural Development Project Harmonized with Fishery were selected as the pilot project to materialize the proposed development component. In this part of the Study, the Agricultural Development Project

Harmonized with Fisheries in the Priority Area were formulated.

- (3) The proposed project was concluded to be feasible based on the economic evaluation and the other social impacts.
- (4) The project implementation will also contribute to the national agro-economic growth through the increase of agricultural production and the stabilization of rural life. It is recommended to implement urgently.

C.6.2 Recommendation

- (1) For smooth and successful implementation of the project, it is necessary that farmer's participation is considered. It is therefore required to establish and strengthen the farmers' organization at the initial implementation stage. To ensure sustainable farming and fishing, training and propagation activities aiming at successful harmonized agriculture and fishery should be undertaken and supported. For the development in the Fishing Lot, setting of sanctuaries and construction of weir should be sought for permission from the DOFi and the lot licensee.

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GLOSSARY

Abbreviations and Acronyms

ACLEDA	Association of Cambodia Local Economic Development Agencies
ACR	Australian Catholic Relief
ADB	Asian Development Bank
CA	College of Agriculture
CAAEP	Cambodia Australia Agricultural Extension Project
CCC	Cooperation Committee of Cambodia
CIAP	Cambodia IRRI Australia Project
CMAC	Cambodia Mine Action Center
COCMA	Central Company of Agricultural Materials
CWS	Church World Service
DOA	Department of Agronomy
DOFo	Department of Forestry
DOFi	Department of Fisheries
DOIMH	District Office of Irrigation, Meteorology and Hydrology
DRDC	District Rural Development Committee
DRWS	Department of Rural Water Supply, MRD
DTEE	Department of Technique, Economy and Extension
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
GCPV	Gross Crop Production Value
GD	Geographic Department, Ministry of Council
GDIMH	General Directorate of Irrigation, Meteorology and Hydrology
GDP	Gross Domestic Product
GRET	Groupe De Recherche Et d'Echanges Technologiques Project Credit Rural
IEE	Initial Environment Examination
IRRI	International Rice Research Institute
JVC	Japan International Volunteer Center
LTD	Land Title Department
LUMO	Land Use Mapping Office, MAFF
MAFF	Ministry of Agriculture, Forestry and Fisheries
MBIMH	Municipal Bureau of Irrigation, Meteorology and Hydrology
MCC	Mennonite Central Committee
MOE	Ministry of Environment

MOH	Ministry of Health
MOP	Ministry of Planning
MPWT	Ministry of Public Works and Transport
MRC	Mekong River Commission
MRD	Ministry of Rural Development
NGO	Non Governmental Organization
NPRD	National Program to Rehabilitate and Develop Cambodia
O&M	Operation and Maintenance
PADEK	Partnership for Development in Kampuchea
PBIMH	Provincial Bureau of Irrigation, Meteorology and Hydrology
PRASAC	Programme de Réhabilitation et d'Appui au Secteur Agricole du Cambodge
PRDC	Provincial Rural Development Committee
RUA	Royal University of Agriculture
SFU	Swamp Fisheries Unit
TSS	Total Suspended Solids
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 Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNTAC	United Nations Transitional Authority in Cambodia
USAID	United States Agency for International Development
VDC	Village Development Committee
WFP	World Food Program, United Nations
WUA	Water Users Association

Khmer Words Used in the Report

Khet	Province
Srok	District
Khum	Commune
Phum	Village
Krom	Group or Sub-Village
Krom Samak	Solidarity Group
Provasdai	Mutual Help
Ang	Reservoir
Boeng	Lake
Tonle	Major River (Bassac and Mekong)
Prek	Minor River
Stung	Stream

Units and Measures

Length

mm	millimeter
cm	centimeter
m	meter
Km	kilometer

Area

m ²	square meter
km ²	square kilometer

Volume

MT	metric ton
kg	kilogram
m ³	cubic meter
MCM	million cubic meter

Density

ppm	parts per million
-----	-------------------

Currency

\$, US\$	United States Currency(Dollar)	(\$1.00 ≙ ¥115)
¥	Japanese Currency(Yen)	(¥1.00 ≙ 24 Riel)
Riel, R	Cambodian Currency	(\$1.00 ≙ 2,700 Riel)