

**Ministry of Water Resources and Meteorology,  
Ministry of Agriculture, Forestry and Fisheries,  
The Kingdom of Cambodia**

**THE STUDY  
ON  
COMPREHENSIVE AGRICULTURAL DEVELOPMENT  
OF PREK THNOT RIVER BASIN  
IN  
THE KINGDOM OF CAMBODIA**

**FINAL REPORT**

**Volume - II  
Master Plan**

**August 2008**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

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**NIPPON KOEI CO., LTD.**

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## PREFACE

In response to a request from Cambodia, the Government of Japan decided to conduct a study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Hitoshi SHIMAZAKI of NIPPON KOEI Co., LTD. between July 2005 and August 2008.

The team held discussions with the officials concerned of the Government of Cambodia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

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

August 2008

MATSUMOTO Ariyuki,  
Vice-President  
Japan International Cooperation Agency

Mr. Ariyuki MATSUMOTO  
Vice President  
Japan International Cooperation Agency  
Tokyo, JAPAN

## Letter of Transmittal

Dear Sir,

We are pleased to submit you herewith the Report on the Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia. This Report presents the results of all works performed in both Cambodia and Japan during a total period of 38 months from July 2005 to August 2008.

The objectives of the Study are to i) formulate the Master Plan aiming at improvement of agricultural productivity in the Target Area, ii) execute the Feasibility Study on the selected priority/urgent projects, iii) prepare the flood forecasting and warning plan to mitigate the flood damage in the Target Area and iv) transfer technologies to the counterpart personnel on planning, environmental consideration, etc.

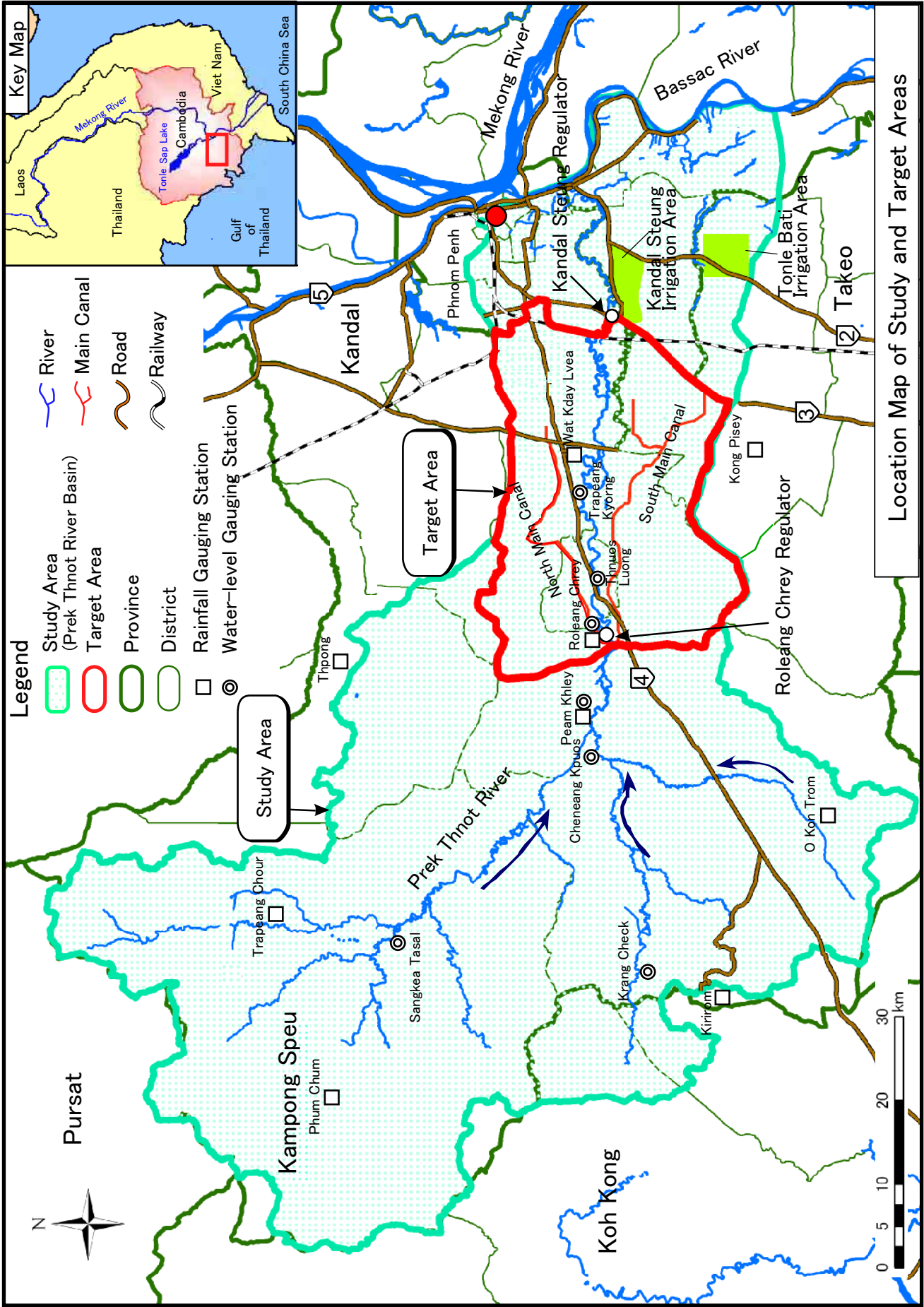
In the first year of the Study, the Master Plan was formulated with the aim of the improvement of agricultural productivity centering on rice in the Target Area. In the Master Plan, 27 projects/studies are proposed in a concept of well-harmonized development of irrigation and drainage, agriculture and institution. In the second year, the Feasibility Study was conducted for the priority/urgent projects selected in the Master Plan. In addition, the Pilot Projects were implemented for the second and third years, to verify the sustainability and replicability of the countermeasures for the subjects identified. In this parallel, the flood forecasting and warning plan was prepared to mitigate the damage of frequent floods from the Prek Thnot river, and also environmental management basic capacity strengthening was conducted for the counterpart personnel concerned of MOWRAM and MAFF about the environmental management items necessary for planning the new water resources development. Major lessons learned from these activities were reflected upon the Master Plan, which is a part of the Report.

The Feasibility Study on the priority/urgent projects, the Pilot Projects for the identified subjects, the flood forecasting and warning plan to mitigate flood damages and the environmental management basic capacity strengthening of counterpart personnel concerned are of the proposed 27 projects/studies in the Master Plan. This means that the Master Plan has been already undertaken in the course of the Study. Thus, it is highly expected that the Government of Cambodia will continuously implement the remaining projects/studies proposed in the Master Plan, to attain the improvement of agricultural productivity centering rice.

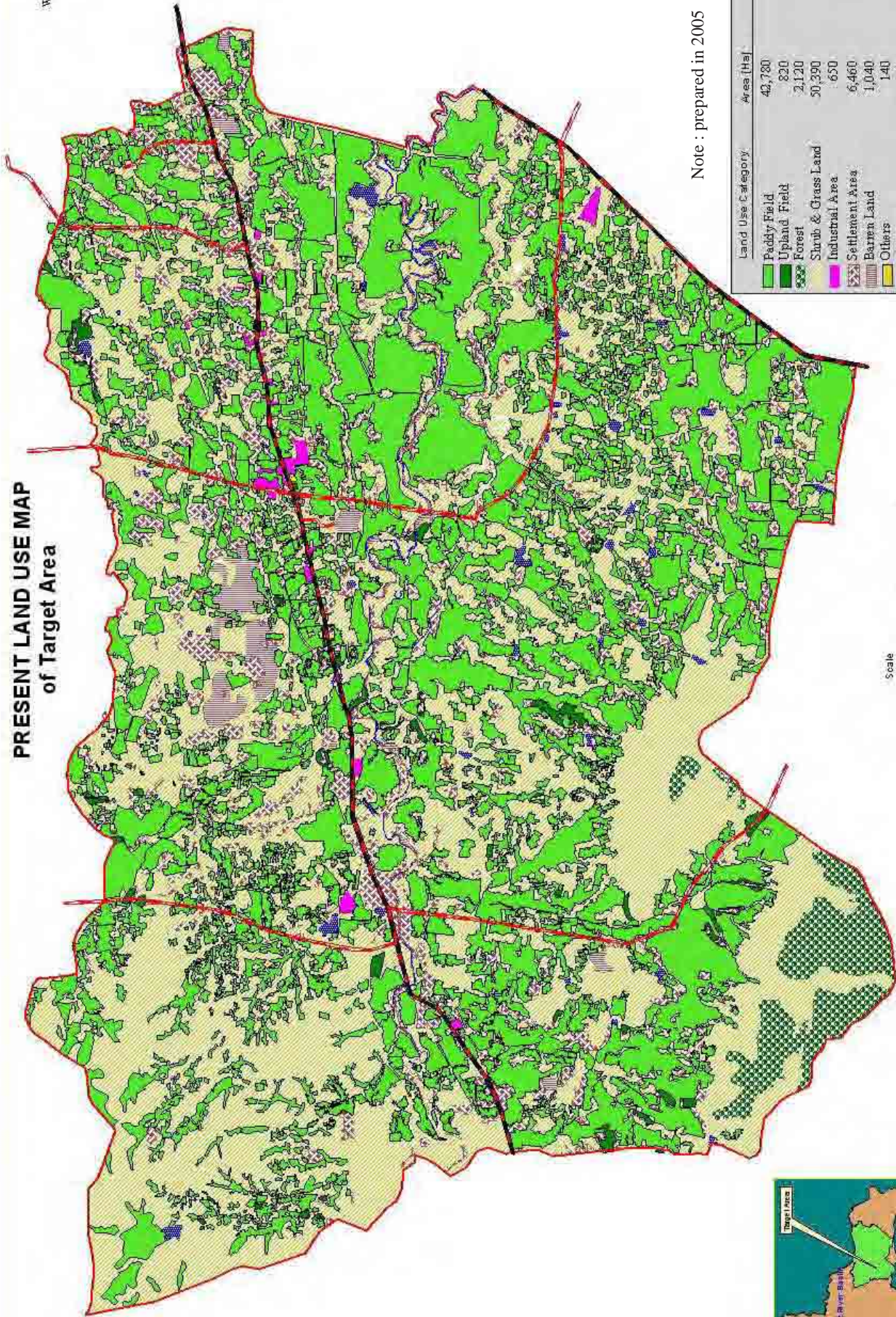
We wish to express our deep appreciation and sincere gratitude to the officials concerned of your Agency, the Ministry of Foreign Affairs, the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan for the courtesies and cooperation kindly extended to our team. We also wish to express our hearty appreciation and gratitude to the officials concerned of Cambodia Office of your Agency, the Embassy of Japan in Cambodia, the Ministry of Water Resources and Meteorology, Ministry of Agriculture, Forestry and Fisheries, Ministry of Economics and Finance, Ministry of Environment, the Cambodian National Mekong Committee and other relevant authorities for close cooperation and assistance extended to our team during field investigations and studies in Cambodia.

Very truly yours,

Hitoshi SHIMAZAKI  
Team Leader of  
the Study on Comprehensive Agricultural Development  
of the Prek Thnot River Basin in the Kingdom of Cambodia



# PRESENT LAND USE MAP of Target Area

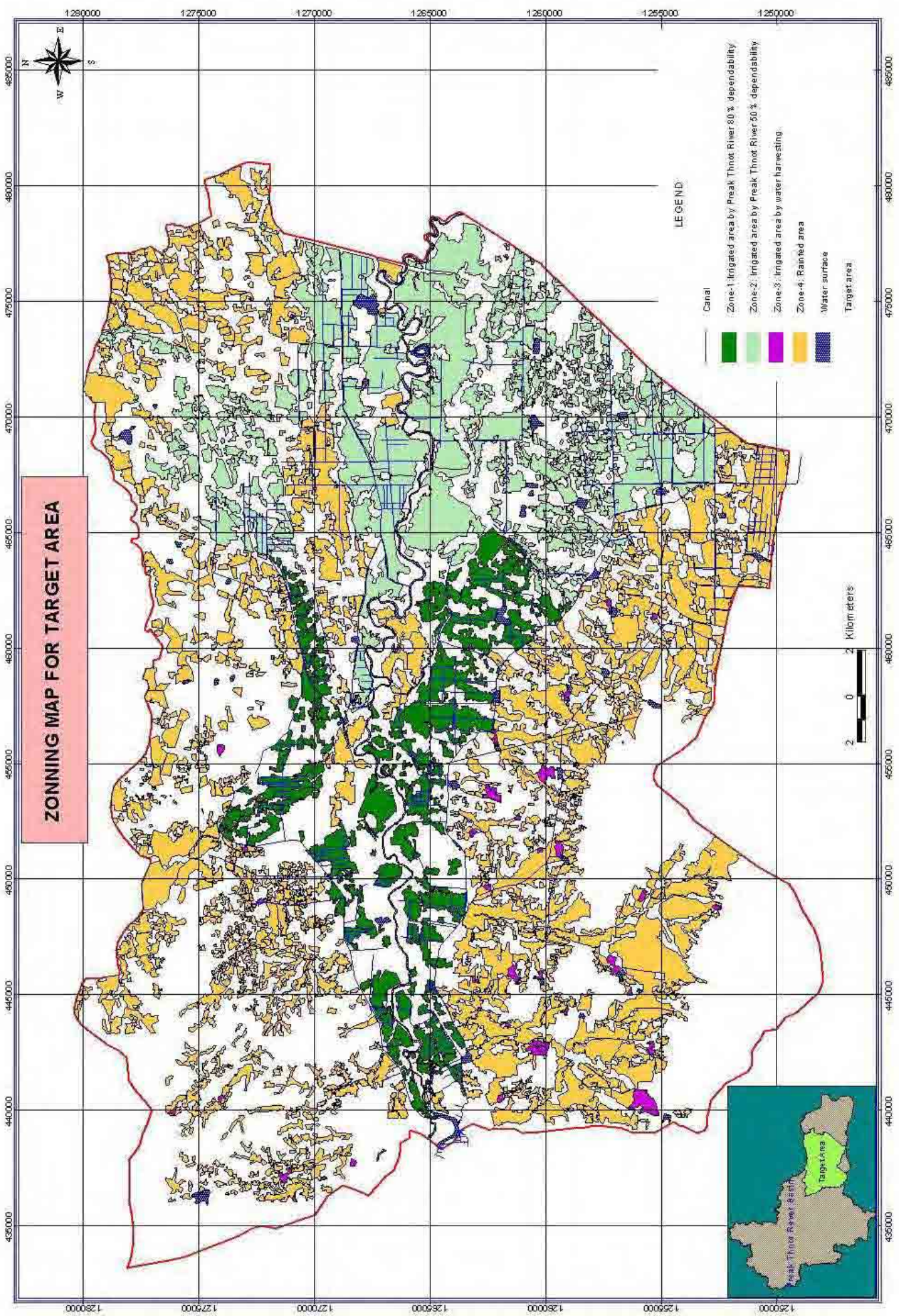


Note : prepared in 2005

Land Use Category	Area (Ha)	%
Paddy Field	42,780	40.7
Upland Field	820	0.8
Forest	2,120	2.0
Shrub & Grass Land	50,390	47.9
Industrial Area	650	0.6
Settlement Area	6,460	6.1
Barren Land	1,040	1.0
Others	140	0.1
Water Surface	800	0.8
<b>Total</b>	<b>105,200</b>	<b>100</b>



# ZONNING MAP FOR TARGET AREA



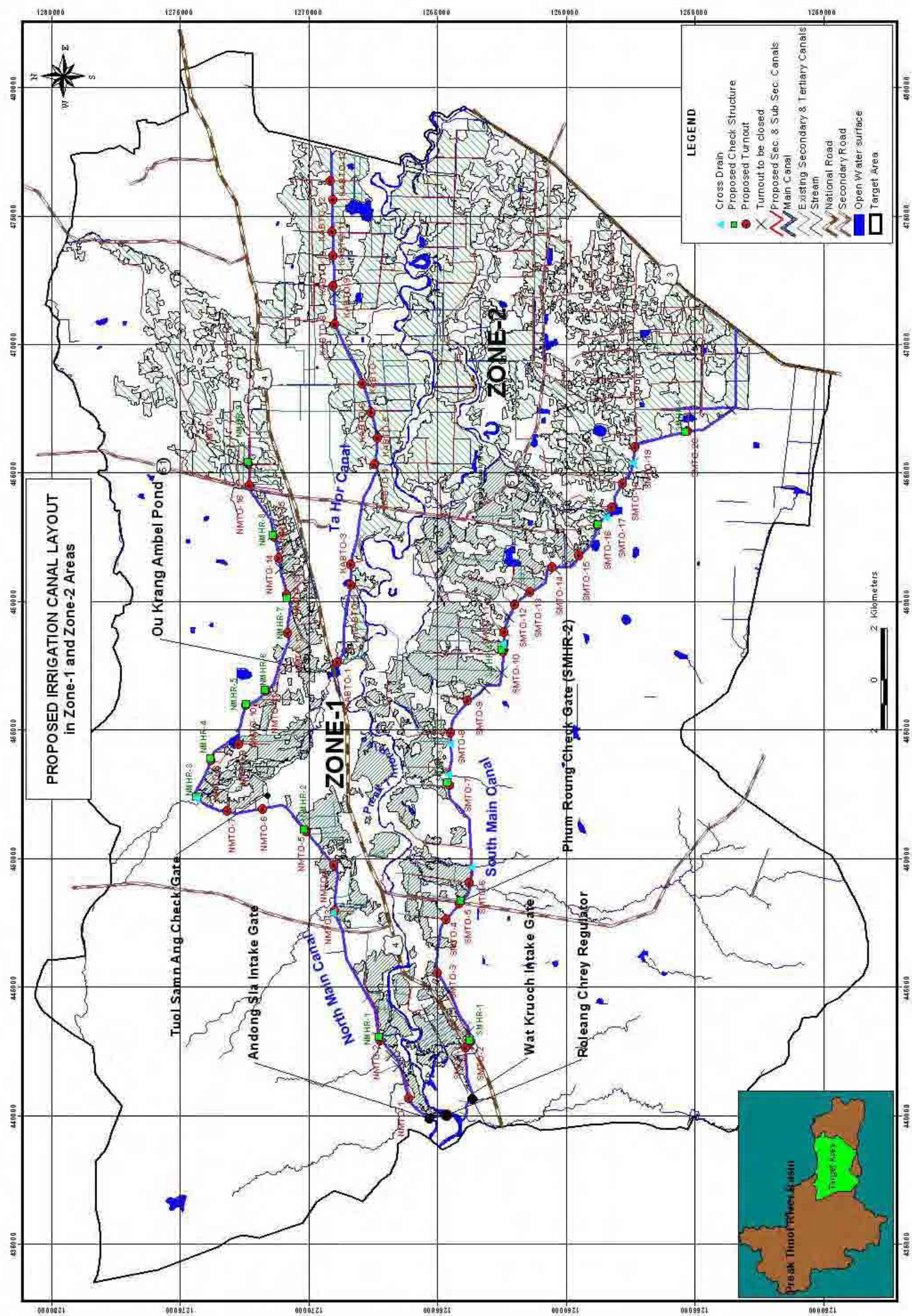
## LEGEND

- Canal
- Zone-1: Irrigated area by Peak Thnot River 80 % dependability
- Zone-2: Irrigated area by Peak Thnot River 50 % dependability
- Zone-3: Irrigated area by water harvesting
- Zone-4: Rainfed area
- Water surface
- Target area

0 2 Kilometers







**PROPOSED IRRIGATION CANAL LAYOUT  
in Zone-1 and Zone-2 Areas**

**LEGEND**

- Cross Drain
- Proposed Check Structure
- Proposed Turnout
- Turnout to be closed
- Proposed Sec. & Sub Sec. Canals
- Main Canal
- Existing Secondary & Tertiary Canals
- Stream
- National Road
- Secondary Road
- Open Water surface
- Target Area



480000 470000 460000 450000 440000 430000 420000 410000 400000

1280000 1270000 1260000 1250000 1240000 1230000 1220000 1210000 1200000

0 2 Kilometers

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Volume-II: Master Plan**

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## Abbreviations

ADB	Asian Development Bank
AEA	Agro-Ecosystems Analysis
AEO	Agricultural Extension Offices
AEWs	Agricultural Extension Workers
AMIS	Agricultural Market Information System Project
AQIP	Agricultural Quality Improvement Project
AusAID	Australian Agency for International Development
CAAEP	Cambodia Australia Agricultural Extension Project
CARDI	Cambodian Agricultural Research and Development Institute
CAP	Commune Agricultural Plan
CC	Community Council
CCF	Construction Conversion Factor
CDC	Council for Development of Cambodia
CEA	Cambodian Environment Association
CEC	Cation Exchange Capacity
CEDAC	Centre d'Etude de Development Agricole Cambodgien
CMAC	Cambodia Mine Action Center
CNMC	Cambodian National Mekong Committee
DAALI	Department of Agronomy and Agricultural Land Improvement
DAFF	Department of Agriculture, Forestry and Fisheries, MAFF
DAE	Department of Agriculture Extension
DAO	District Agricultural Office
DDFC	District Development Facility Committee
DHRW	Department of Hydrology and River Works
DO	Dissolved Oxygen
DTR	Department of Training and Research, MRD
EEA	Environmental Examination Application
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EOJ	Embassy of Japan
ETo	Crop Evapotranspiration
EU	European Union
EXCOM	Executing Committee of SEILA
FAIEX	Freshwater Aquaculture Improvement Extension Project
FAO	Food and Agriculture Organization of the United Nations
FG	Farmers Group
FLD	Farmer Livelihood Development
FMI	Micro Finance Institution
FO	Farmers Organization
F/S	Feasibility Study
FWUC	Farmer Water User Community
FWUG	Farmer Water User Group
GDP	Gross Domestic Product
GIS	Geographic Information System
GOC	Government of Cambodia
GOJ	Government of Japan
HH	Household
HYV	High Yielding Variety
IAIMP	Irrigated Agriculture Improvement Model Project
IBRD	International Bank for Reconstruction and Development
IEIA	Initial Environmental Impact Assessment
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development

IFFS	Integrated Farmer Field Schools
IMF	International Monetary Fund
IO	International Organization
IRC	Inter-Ministerial Resettlement Committee
ISF	Irrigation Service Fee
JICA	Japan International Cooperation Agency
LEPNRM	Law on Environmental Protection and Natural Resources Management
LNMC	Lower North Main Canal Irrigated Agriculture Improvement Project
LSMC	Lower South Main Canal Irrigated Agriculture Improvement Project
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economics and Finance
M&E	Monitoring and Evaluation
MIS	Market Information System
MOE	Ministry of Environment
MOWRAM	Ministry of Water Resources and Meteorology
M/P	Master Plan Study
MRD	Ministry of Rural Development
NPRS	National Poverty Reduction Strategy
NGO	Non Government Organization
NMC	North Main Canal
O&M	Operation and Maintenance
OPM	JICA Open Paddy Market Project
PCM	Project Cycle Management
PDA	Provincial Department of Agriculture
PDE	Provincial Department of Environment
PDM	Project Design Matrix
PDOWRAM	Provincial Department of Water Resources and Meteorology, MOWRAM
PNKS	Ponlen Ney Kdey Sangkum (Light of Hope)
PRASAC	Support Program for the Agricultural Sector in Cambodia
RC	Roleang Chrey Regulator and Intakes Improvement Project
RGC	Royal Government of Cambodia
RRA	Rapid Rural Appraisal
SCF	Standard Conversion Factor
SEILA	Foundation Stone in Khmer: This word is used as national rural development program to 1- alleviate poverty and 2- Strengthen local governance and ownership of local government.
SPFS	Special Program for Food Security
SRI	System of Rice Intensification
SLPP	Smallholder Livestock Production Program
SMC	South Main Canal
SMS	Subject Matter Specialist
SWR	Shadow Wage Rate
SWOT	Strengths, Weaknesses, Opportunities and Threats
TOT	Training of Trainers
UN	United Nations
UNESCO	United Nations Educational Scientific and Cultural Organization
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNMC	Upper North Main Canal Irrigated Agriculture Improvement Project
USAID	United States Agency for International Development
USMC	Upper South Main Canal Irrigated Agriculture Improvement Project
VAHW	Village Animal Health Worker Associations
VDC	Village Development Committee
VEW	Village Extension Worker
VLA	Village Livestock Agent

WFP	World Food Program
WMO	World Meteorological Organization
WUG	Water User Group
DHRW	Department of Hydrology and River Works
TSC	Technical Service Center
TSS	Total Suspended Solids
PDOWRAM	Provincial Department of Water Resources and Meteorology

### **Khmer Words Used in the Report**

Khet	Province
Srok	District
Khum	Commune
Phum	Village
Krom	Group or Sub-Group
Krom Samak	Solidarity Group
Provasdai	Mutual Help

### **Measurement Units**

<b>Extent</b>	<b>Volume</b>
cm <sup>2</sup> = Square-centimeters (1.0 cm x 1.0 cm)	cm <sup>3</sup> = Cubic-centimeters (1.0 cm x 1.0 cm x 1.0 cm or 1.0 m-lit.)
m <sup>2</sup> = Square-meters (1.0 m x 1.0 m)	
km <sup>2</sup> = Square-kilometers (1.0 km x 1.0 km)	m <sup>3</sup> = Cubic-meters (1.0 m x 1.0 m x 1.0 m or 1.0 k-lit.)
a = Are(100 m <sup>2</sup> or 0.01 ha.)	lit 1 = Liter (1,000 cm <sup>3</sup> )
ha = Hectares (10,000 m <sup>2</sup> )	MCM = Million Cubic Meter
ac = Acres (4,046.8 m <sup>2</sup> or 0.40468 ha.)	
<b>Length</b>	<b>Weight</b>
mm = Millimeters	gr = Grams
cm = Centimeters (cm = 10 mm)	kg = Kilograms (1,000 gr.)
m = Meters (m = 100 cm)	ton = Metric ton (1,000 kg)
km = Kilometers (km = 1,000 m)	
<b>Power and Energy</b>	<b>Others</b>
A = Ampere	ppm = parts per million
V = Volt	°C = degree centigrade
W = Watt	% = percent
kWh = Kilowatt hour	
HP = Horse power	
<b>Currency</b>	<b>Time</b>
US\$ 1.0 = ¥ 118.311 = 4,070 Riel (Internal Bank Rate as of Jan. 31, 2006)	sec = Seconds
US\$ = United State Dollars	min = Minutes (60 sec.)
¥ = Japanese Yen	hr = Hours (60 min.)
R, Riel = Cambodian Riel	

**THE STUDY  
ON  
COMPREHENSIVE AGRICULTURAL DEVELOPMENT  
OF  
PREK THNOT RIVER BASIN  
IN  
THE KINGDOM OF CAMBODIA  
  
FINAL REPORT  
  
VOLUME-I: MASTER PLAN**

**Chapter 1 Introduction**

**1.1 Authority**

This master plan is a part of final report which was prepared in accordance with the Scope of Work for the Study on Comprehensive Agricultural Development of Prek Thnot River Basin agreed between the Ministry of Water Resources and Meteorology, the Kingdom of Cambodia (MOWRAM) and the Japan International Cooperation Agency (JICA) on April 11, 2005.

**1.2 Composition of Final Report**

The final report consists of the following volumes:

- Volume-I: Summary
- Volume-II: Master Plan
- Volume-III: Feasibility Study for Priority/Urgent Projects
- Volume-IV: Pilot Projects
- Volume-V: Hydrological Study and Environmental Management Basic Capacity Strengthening
- Volume-VI: Appendixes for master plan
- Volume-VII: Appendixes for Feasibility Study for Priority/Urgent Projects

This report is VOLUME-II: MASTER PLAN, and presents the results of master plan study conducted from July 2005 to February 2006, to which some results obtained through the execution of pilot project activities are also fed back.

**1.3 Background and Objectives of the Study**

**1.3.1 Background**

The basin of the Prek Thnot River, which flows around Phnom Penh, is one of the major paddy cultivation areas in Cambodia. However, agriculture in this basin, as well as in other areas, necessarily depends on erratic rainfall due to a limited irrigation system. This results in low and unstable crop production with some farmers in the basin not even able to cover their own consumption of rice. The Royal Government of Cambodia (RGC) therefore requested the Government of Japan (GOJ) to extend technical assistance for the Study on Comprehensive Agricultural Development of Prek Thnot River Basin. In reply to this request, GOJ dispatched a preparatory study team in January 2005 and finally agreed the said Scope of Work for the Study with RGC (Attachment-1).

### 1.3.2 Objectives

The objectives of the Study are:

- To formulate the master plan on Comprehensive Agricultural Development (M/P) in order to improve agricultural productivity in the Prek Thnot River Basin;
- To implement the Feasibility Study (F/S) on the rehabilitation of existing irrigation and drainage facilities with high priority/urgency being primarily associated with improvement of rice cultivation;
- To prepare a flood forecasting and warning plan; and
- To transfer technologies to the counterpart personnel through on-the-job training during the course of the Study.

### 1.4 Target and Study Areas

The Target Area of the M/P will cover agricultural land comprising mainly paddy fields in the Prek Thnot River Basin. The Target Area is located in Chabar Mon District, which is part of the Samraong Tong and Kong Pisei Districts in Kampong Speu Province and part of the Ang Snuol and Kandal Stueng Districts in Kandal Province, and extends from the Roleang Chrey Regulator to the west of National Road No. 3.

The Study Area includes both the upstream and downstream sections of the basin from the viewpoint of the collection of hydrological data necessary for the analyses.

### 1.5 Flow Chart of the Study

The flow chart of the Study executed is shown on the next page.

### 1.6 Technology Transfer

The counterpart personnel assigned for the master plan formulation are as follows:

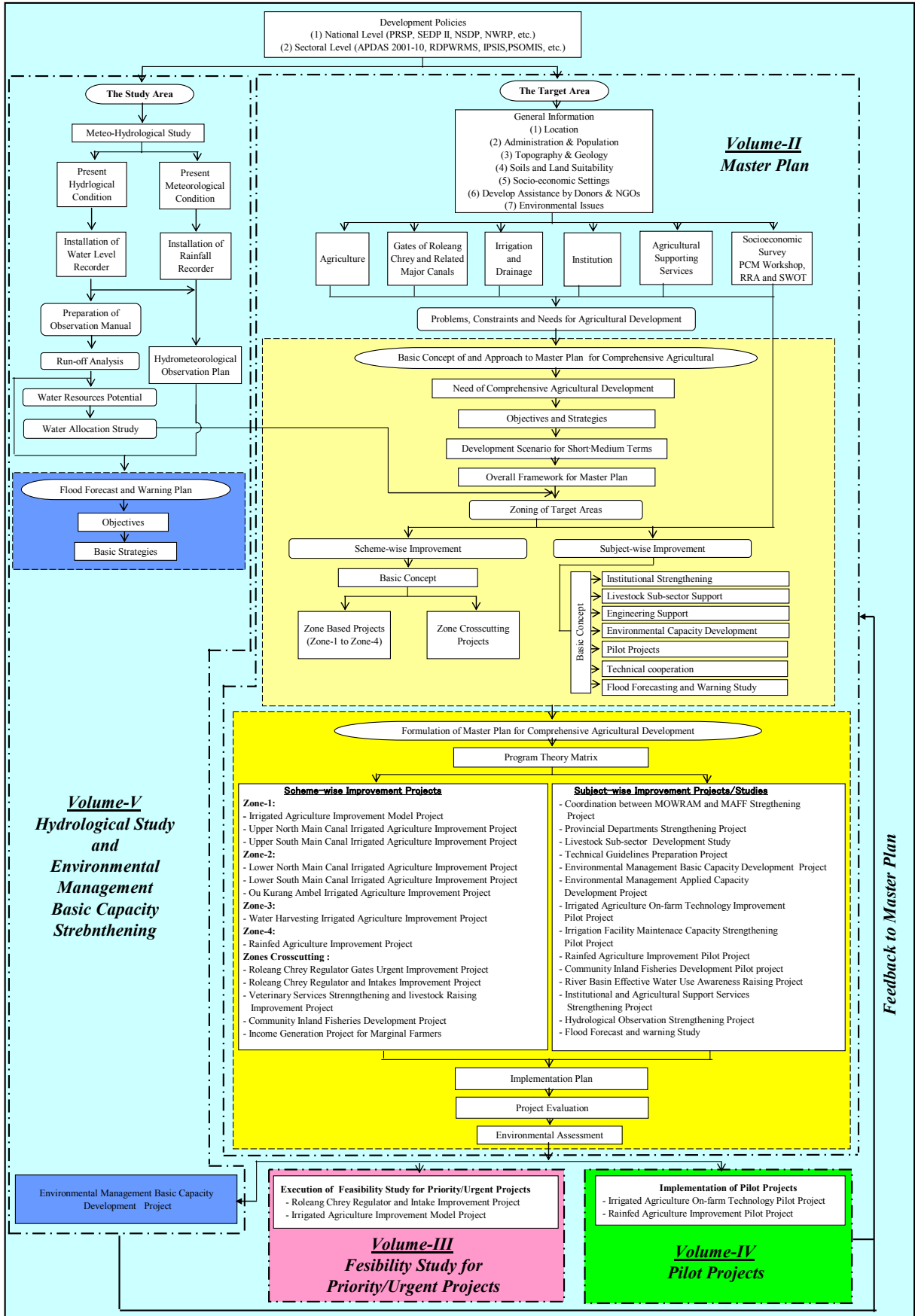
**Counterpart Personnel Assigned**

Study Team	Position	Counterpart Personnel
Mr. H. Shimazaki	Team Leader/Agriculture Development Plan	Mr. Pich Veasna <sup>1/</sup>
Mr. M. Kodama	Irrigation & Drainage Plan/Water Management (1)	Mr. Chhear Bunrith
Mr. J. Tsurui	Irrigation & Drainage Plan/Water Management (2)	Mr. Khieu Visith
Mr. T. Shiraki	Agronomy	Mr. Am Phirum
	Extension Services	Mr. Khean Sovannara
	Marketing	Mr. Thong Aun
Mr. Y. Oyama	Hydrology/Flood Forecast and Warning (1)	Mr. Long Saravuth
Mr. T. Kameyama/ Mr. T. Imai	Hydrology/Flood Forecast and Warning (2)	Mr. Tong Seng
Ms. A. Ishikawa	Socio-economy	Mr. Soun Sam Aun
		Mr. Chea Sivuta
Mr. T. Sugiyama	Project Evaluation	Mr. Sarun Sambath
Ms. S. Suwa	Environment	Mr. Koch Savath
		Mr. Tith Bone
		Ms. Pheng Sophada
Mr. S. Yakushiji	Facility Plan/Design. Cost Estimate	Mr. Koeut Kitimeath
Mr. R. Shimoda	Gate Facility/Operation	Mr. Ung Phaly
		Mr. Phiv Phalkun

<sup>1/</sup> : Chief Counterpart Personnel

Prior to commencement of the Study, the Study Team submitted the Plan of Technology Transfer to the MOWRAM on August 6, 2005. In line with this plan, the technology transfer was carried out mainly through on-the-job training.

## FLOW CHART OF ENTIRE STUDY



Note:

Volume-I: Summary, Volume-VI: Appendixes for Master Plan, Volume-VII: Appendixes for Feasibility Study for Priority/Urgent/ Projects



## 1.7 Steering Committee Meetings

As for the Study, the following six Steering Committee Meetings were held at the conference room of MOWRAM

Steering Committee Meeting	Discussed Reports	Date
1	Inception Report	August 02, 2005
2	Progress Report (1)	February 22, 2006
3	Interim Report (1)	June 16, 2006
4	Progress Report (2)	February 22, 2007
5	Interim Report (2)	June 14, 2007
6	Progress Report (3)	February 20, 2008
7	Draft Final Report	May 28, 2008

These meetings were started by the opening-address by H.E. Veng Sakhon, Secretary of State, MOWRAM and then the JICA study team briefly explained the contents of the reports. This was followed by brisk discussions on the contents of the reports among the participants from MOWRAM, MAFF, MOE, MEF, CNMC, EOJ and JICA Cambodia Office. As the result of the discussions, the contents of these reports were accepted by the Steering Committee (Attachments-2 to -8).



*Steering Committee Meeting*

## 1.8 Seminars for the Inception Report and Master Plan

On September 21, 2005, a seminar was held at the conference room of the Sunway Hotel, aiming to explain the study contents and plan of operation which were mentioned in the Inception Report. The seminar was chaired by H. E. Mr. Veng Sakhon, Secretary of MOWRAM, under attendance of staff of MOWRAM, MAFF, MOE, CNMC, NISP (ADB Project) and JICA Cambodia Office. After the presentation of the study contents and plan of operation by Mr. Pich Veasna Deputy Director General/Chief counterpart personnel, discussion among the participants followed. The seminar was successfully operated and closed with the closing address by H. E. Mr. Veng Sakhon, Secretary of MOWRAM.

On February 23, 2006, a seminar was conducted for the master plan at the conference room of the Sunway Hotel. The seminar was attended by H.E. Veng Sakhon, Secretary of State, MOWRAM, H.E. Ith Nody, Under Secretary of State, MAFF, and Mr. H.Ukai, Deputy Resident Representative, JICA Cambodia Office. The presentation and subsequent responses to questions of participants were well given by the counterpart personnel despatched from MOWRAM and MAFF.



*Seminar on Inception Report*



*Seminar on Master Plan*

## **1.9 Issuance of News Letters**

The JICA study team has prepared and issued News Letters through the study period, to relevant agencies and stakeholders, aiming to create an enabling environment to disseminate the results of the study and exchange of opinions with the stakeholders.

## **Chapter 2 Background**

### **2.1 Natural and Socio-economic Conditions**

Cambodia has a territorial area of 181,035 km<sup>2</sup>, of which 20% is used for agricultural land use. It is bound on the west by Thailand, on the north by Thailand and Laos, on the east by Vietnam and to the south by the Gulf of Thailand. It is geographically divided into four regions; the plain region, the Tonle Sap lake region, the plateau and mountain region, and the coastal region. Administratively, it consists of 24 provinces, 183 districts, 1,603 communes and 13,364 villages.

The climate of Cambodia is divided into pronounced dry and rainy seasons which are caused by two monsoons, i.e., northeastern monsoon from November to April, and southwestern monsoon from May to October. The northeastern monsoon is cool and dry, but the southwestern monsoon brings high humidity and heavy rains. The annual rainfall in the flood plain along the Mekong River and the Tonle Sap Lake ranges 1,200 mm to 1,400 mm, and about 90 % of the rain concentrates in the rainy season.

The population of Cambodia is estimated at 14.0 million (2006)<sup>1</sup>, consisting of 6.8 million males and 7.2 million females. The estimated percentage of rural population is 84 % of the population. Density of population is 82 persons/km<sup>2</sup>. The average family size is 5.1 persons/household. About 95 % of the population is Khmer and most of them are Buddhist. The annual population growth rate is estimated at 2.0%.

GDP per capita of Cambodia is at a very low level and was approximately US\$ 385 in 2005<sup>2</sup>. Poverty in Cambodia is presently widespread with some 36 % of the population living below the poverty line of US\$ 0.46-0.63/day at the current exchange rate<sup>3</sup>. The majority of the poor (79 %) are those with household heads employed in the agricultural sector.

Nevertheless, the agricultural sector in Cambodia is a major component of the economy, contributing approximately 30 % of the GDP and accounting for 71% of the working population<sup>4</sup>. Rice is a principal agricultural crop and attaining food security through increased rice production is a priority theme in the agricultural sector. The area of paddy cultivation is estimated to be approximately 2 million ha, but double cropping occurs on only 16% of this area. As rainfed cultivation prevails in Cambodia, crop production is generally low and unstable. Currently, the potential for expansion of agricultural land is limited and increases in crop production must rely on improvements in crop yield. To improve the agricultural productivity in Cambodia, it is thus essential to expand the irrigated area through provision of proper irrigation systems and to extend suitable farming technology.

Socio-economic indicators of Cambodia are shown in Table 2.1.1.

### **2.2 National Development Policies**

#### **2.2.1 Rectangular Strategy for Growth, Employment, Equity and Efficiency**

In the First Cabinet Meeting of the Third Legislature of the National Assembly held on July 16, 2004, the Rectangular Strategy, which is the successor of the Triangular Strategy of the RGC in the Second Legislature of the National Assembly, was set out aiming to attain poverty reduction, development, progress, prosperity, national harmony and the happiness of the Cambodian people. The Rectangular Strategy is thus a compass of

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<sup>1</sup> *Statistical Yearbook 2006, National Institute of Statistic, Ministry of Planning*

<sup>2</sup> *Statistical Yearbook 2006, National Institute of Statistic, Ministry of Planning*

<sup>3</sup> *National Poverty Reduction Strategy 2003-2005*

<sup>4</sup> *Economic Institute in Cambodia*

government policies to be prepared by various ministries.

Good governance is selected as the core of the Rectangular Strategy. The Rectangular Strategy has four elements for its implementation and four strategic growth rectangles. Each strategic growth rectangle has four sides such as (i) Rectangle 1: Enhancement of the Agriculture Sector, (ii) Rectangle 2: Further Rehabilitation and Construction of Physical Infrastructure, (iii) Rectangle 3: Private Sector Development and Employment Generation, and (iv) Rectangle 4: Capacity Building and Human Resource Development. These Rectangles cover the following strategic sides:

Rectangle 1:	<b>(1) Improved productivity and diversification of agriculture</b>
	(2) Land reform and clearing of mines
	(3) Fisheries reform
	(4) Forestry reform
Rectangle 2:	(1) Further restoration and construction of transport infrastructure
	<b>(2) Management of water resources and irrigation</b>
	(3) Development of energy and power grids
	(4) Development of information and communication technology
Rectangle 3:	<b>(1) Strengthened private sector and attraction of investments</b>
	(2) Promotion of SMEs
	(3) Creation of jobs and ensuring improved working conditions
	(4) Establishment of social safety nets for civil servants, employees and workers
Rectangle 4:	(1) Enhanced quality of education
	(2) Improvement of health services
	(3) Fostering gender equity
	(4) Implementation of population policy

*Source: Address by Samdech HUN SEN Prime Minister of the Royal Government of Cambodia on Rectangular Strategy for Growth, Employment, Equity and Efficiency*

In Side (1) Improved Productivity and Diversification of Agriculture, RGC states that the government policy for agriculture is to improve agricultural productivity and diversification, thereby enabling the agricultural sector to serve as the dynamic driving force for economic growth and poverty reduction. To improve the agricultural productivity, RGC stresses the need for development of irrigation facilities and water resource management by improving efficiency of existing irrigation systems, further creating and enhancing quality of Farmer Water User Communities (FWUCs) and as well as reducing vulnerability to natural disasters.

RGC again emphasizes in Side 2: Water Resources and Irrigation System Management, the development and expansion of irrigated land and effective water resources management by improving the efficiency of the existing irrigation systems, further developing and enhancing the effectiveness of FWUCs and reducing the vulnerability of the population to natural disasters and its total dependence on natural conditions.

## 2.2.2 National Poverty Reduction Strategy 2003-2005 (NPRS)

The National Poverty Reduction Strategy 2003-2005 (NPRS) was elaborated by RGC in December 2002, aiming at reducing poverty and inequality, and improving the quality of life of the rapidly increasing number of poor. NPRS was formulated through a participatory process with frequent national workshops.

NPRS proposes eight priority actions for poverty reduction. These are (i) maintaining macroeconomic stability, (ii) improving rural livelihoods, (iii) expanding job opportunities, (iv) improving capabilities, (v) strengthening institutions and improving governance, (vi) reducing vulnerability and strengthening social inclusions, (vii) promoting gender equality, and (viii) priority focus on population.

The smooth implementation of these priority actions requires adequate budget allocations

and their appropriate execution and management, so that RGC has launched revenue mobilization to achieve the targeted increase in revenue ratio from 9 % of GDP in 1998 to 14% by 2005. Monitoring and evaluation processes and capacity building activities are also essential for successful implementation of the actions. RGC established the poverty monitoring and analysis institutional framework early in 2002. The selected indicators for monitoring and evaluating NPRS are (i) resources from the RGC sources and donors, (ii) delivery capacity of institutions, (iii) timeframe of NPRS, (iv) measurable and monitorable characteristics, (v) poverty-sensitivity of the indicators, (vi) baseline information, and (vii) capacity of the line agencies in collecting, maintaining and analyzing relevant information.

NPRS was launched in March 2003. The Annual Progress Report was prepared in August 2004. The report stated that the activities executed by RGC were (i) preparation of costed and prioritized programs in the annual budget, (ii) strengthening of budget management, (iii) governance improvement and corruption reduction, (iv) building of national capacity for poverty monitoring and evaluation of key programs and policies, and (v) focus on strategies for elaborating and implementing pro-poor rural and infrastructure development. As for sectoral priorities, the report relates that the growth of the agricultural sector is still given a high priority as an effective measure to alleviate the poverty in Cambodia. Rice is a staple food in Cambodia. Paddy production in 2003 increased by 23% from 3.8 million tons in 2002 to 4.7 million tons in 2003, well beyond the population growth of 2.3%. However, the current average yield level in rice is still low, at approximately 2 tons/ha, compared with that of neighboring countries. There is considerable potential to improve the yield further, especially by introducing proper water management and farming practice.

### 2.2.3 Second Five Year Socioeconomic Development Plan 2001-2005 (SEDP II)

RGC formulated the Second Five-year Socioeconomic Development Plan (2001-2005), enfolding NPRS. The poverty reduction is thus a principal target of SEDP II. To achieve this target, a focus is put on three development objectives; (i) broad-based, sustainable economic growth with equality at a rate of 6-7% per year, (ii) social and cultural development, and (iii) sustainable management and use of natural resources and the environment. The specific strategies of these development objectives are as follows:

#### Development Objectives and their Specific Strategies

Development Objectives	Specific Strategies
1. Broad-based, sustainable economic growth with equality at a rate of 6-7% per year	1. Implementation of fiscal reforms and maintenance of a stable macroeconomic environment
	2. Improvement of the efficiency and effectiveness of the public sector through civil service reform, reform of the judiciary, and public enterprise reform
	3. Enhancement of the private sector while protecting public interests by: (i) improving physical infrastructure, (ii) developing the legal and regulatory frameworks within which business enterprises operate, (iii) liberalizing trade and investment policies, and (iv) supporting banking system reform and financial sector development
	4. Promotion of agricultural development and on-farm employment creation, and additionally boosting manufacturing development and sustainable tourism development that is based on Cambodia's natural and cultural assets
	5. Empowerment of the poor to participate in, and thus benefit from, the growth process by improving their access to natural assets (especially land), health and education services, appropriate technology, and credit.

<b>Development Objectives</b>	<b>Specific Strategies</b>
2. Social and cultural development	1. Increase of the quantity and quality of investment in education and health
	2. Improvement of access to health and education services, especially for females
	3. Increase of participation and empowerment of the poor
	4. Strengthening of Cambodian culture
	5. Extension of provision of a social safety net for disadvantaged and vulnerable groups
3. sustainable management and use of natural resources and the environment	1. Prevention of environmental and resource degradation caused by policy distortions and market failures
	2. Establishment and implementation of the legal frameworks for natural resource management
	3. Enhancement of the human resources capacity for natural resource management
	4. Design and implementation of a land management framework that makes adequate provision for the poor, including local community access to common property resources.

SEDP II points out that the agriculture sector, among many sectors, has great potential, not only to lead the national economy, but also to reduce poverty, and improvement of productivity is one of the means of generating agricultural growth. As the specific strategies, the following are proposed:

- Substantial increase in yield and cropping intensity through improvement in irrigation systems and management of water.
- Increase of productivity by introducing good quality seeds on a timely basis into farming communities and developing markets for rice exports.
- Increase of competitiveness in production of other crops by applying irrigation and improved technologies.

These strategies will be reflected in the M/P of the Comprehensive Agricultural Development of Prek Thnot River Basin.

#### **2.2.4 National Strategic Development Plan 2006-2010 (NSDP)**

Following the Second Five-year Socioeconomic Development Plan (2001-2005), RGC prepared the National Strategic Development Plan (NSDP: 2006 – 2010) in January 2006, describing the Rectangular Strategy for Growth, Employment, Equity and efficiency, which provides the framework for the country's socioeconomic development. The NSDP aims at the economic growth and poverty reduction through achievement of the Cambodian Millennium Development Goals (CMDGs) having 9 goals, 25 strategic targets and 106 specific targets.

To achieve the CMDGs, especially the poverty reduction, the NSDP emphasizes the attainment of significant and steady progress in several socio-economic spheres. One of them is the marked increase in agricultural production and productivity, since these are crucial to improving incomes, particularly of the poor, in rural areas. The proposed indicative targets by 2010 regarding agricultural production and productivity are to realize (1) 3,500,000 ha of land under crops, (2) 650,000 ha of irrigated area, (3) 2,500,000 ha of paddy-cultivated area, and (4) 2.40 tons/ha of paddy crop yield. As for the physical infrastructure related to irrigation, the NSDP places a priority on the rehabilitation of existing irrigation facilities to realize the effective use of the limited water resources in the country.

#### **2.2.5 National Water Resources Policy (NWRP)**

RGC worked out the visions for water to ensure the effective, sustainable, wise and

equitable use of water resources. These are to (i) provide access for all to safe, adequate, and affordable drinking water, hygiene, at an appropriate price, (ii) provide sufficient water for agriculture, industry and economic activities, (iii) minimize the threat of loss of life and livelihood as a result of water related hazards, and (iv) manage the water resource environment in an ecologically sound manner.

To actualize these visions, the National Water Resources Policy (NWRP) was prepared in January 2004 highlighting the policies for the eight subjects such as (i) Cambodia's surface water and groundwater, (ii) appropriate development and management of freshwater resources, (iii) equitable water sharing and allocation, (iv) mitigation of water-related hazards, (v) maintenance, protection and sustainability of the aquatic systems, (vi) international aspects of water, (vii) water resource management along the border with neighboring countries, and (viii) management of coastal and marine waters.

Out of these, the subject of appropriate development and management of freshwater resources addresses the issue of provision of sufficient water for agricultural production. The proposed policies are to (i) provide farmers with the quantity of water they need, when and where they need it, and within the limits of available water resources and technology, (ii) promote the rehabilitation and construction of irrigation, drainage, and flood management infrastructure in order to provide sufficient water for agricultural production and to alleviate the adverse consequences of excess water, (iii) promote the development and extension of appropriate water management technologies that are particularly suited to rainfed agricultural areas, such as water harvesting, improvement to the moisture-holding capacities of soils and use of farm ponds, (iv) strengthen and expand the Farmer Water User Communities (FWUC), to enable them to participate in water management and allocation and to maintain irrigation infrastructure with effectiveness and sustainability, and (v) minimize the impact on the water resources caused by the use of chemical substances in the agricultural production by encouraging people to implement diversified agriculture.

## **2.3 Sectoral Development Policies**

### **2.3.1 Agriculture Development Plan for Short, Medium and Long Term 2001-2010**

Agriculture is the key sector of the Cambodian economy. In parallel with the national policies, RGC set up clear objectives for development of agriculture, which are to ensure food security and natural resources conservation. To achieve this objective by 2010, RGC has launched seventeen agricultural development policies. Of these policies, the major policies related to the Study are as follows:

- To continue the implementation of irrigated-water policies.
- To expand the irrigated areas from 16% to 20% of the total cultivated areas.
- To expand the cultivated areas, increase crop yield and improve the quality of agricultural products.
- To ensure secure land occupation, ownership and utilization and prevent anarchy and violent occupation of the land.
- To promote private sector developments and their investment programmes.
- To prepare rural financial systems for providing credit to the farmers.
- To direct public and private investments toward the agriculture sector.
- To strengthen agricultural extension activities in the use and management of natural resources and technology applications to meet the requirements of local markets and demand and for export.

### 2.3.2 Action Program for Development of Agricultural Sector 2001-2010

MAFF elaborated the Action Program for Development of the Agricultural Sector 2001-2010. The action program was prepared in consideration of the background of national agricultural resources, institutional framework for development and assessment of performance of the agricultural sector in the last ten years. The action program still stresses the possibility of development of this sector mainly from the following viewpoints:

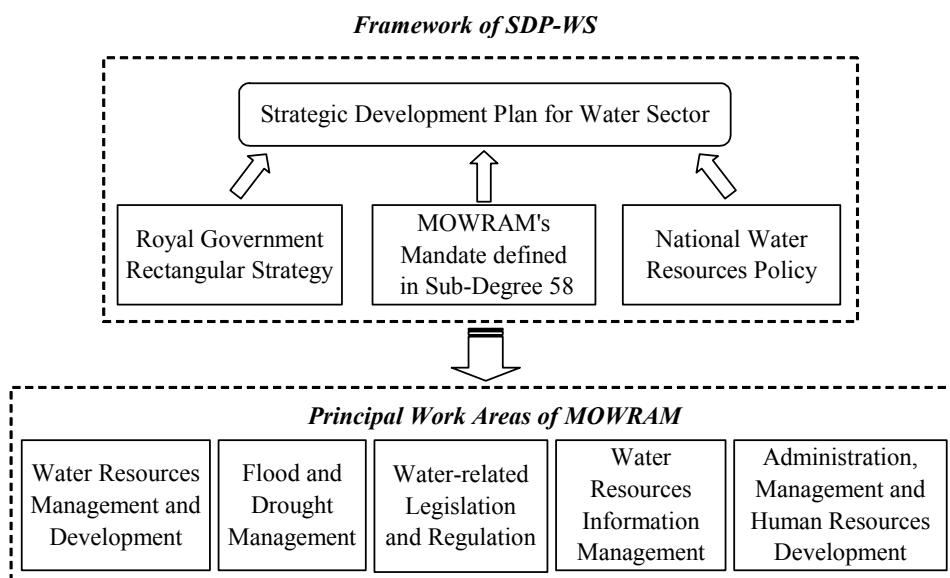
- Geographically and topographically suitable location of land for agriculture
- Eighty five percent of the population is engaged in agriculture
- Provision of high priority from the government to the agricultural sector in the national economy
- Higher responsibility of government employees
- Participation of farmers and private investors
- Good relationships and co-operation between other concerned authorities

The action program proposes that the development of the agricultural sector should be promoted by determining the priority areas for action. These are (i) farmers' education (extension), (ii) research and agricultural technology, (iii) agricultural marketing service, (iv) rural finance, (v) monitoring and evaluation and (vi) environmental protection and resource management for sustainable agriculture.

As for the agriculture development, the action program focuses on ensuring food security, poverty alleviation and job creation by increasing rice cultivated area and rice yield up to 2.45 t/ha. It also suggests that the cultivated areas of the crops other than rice would be created through family and private investment.

### 2.3.3 Strategic Development Plan for Water Sector 2006-2010

MOWRAM prepared the Strategic Development Plan for the Water Sector (SDP-WS) in May 2005, which presents the objectives, outputs and activities of MOWRAM during 2006 to 2010, although it is still in a draft version. SDP-WS aims to contribute to achieving the national priority goals as a part of the Rectangular Strategy. The framework of SDP-WS is as follows:



For these five principal work areas, the respective over-arching goals for 2006 -2010 are



worked out. In addition, to achieve the over-arching goals, the MOWRAM's priority goals were drawn up. The principal work areas, over-arching goals for 2006-2010 and national priority goals are outlined as follows:

**Principal Work Areas, Over-arching Goals for 2006-2010 and National Priority Goals**

Principal Work Area	Over-Arching Goal for 2006-2010	National Priority/Institutional Goals
1. Water resources management and development	Management and development of Cambodia's water resources in an effective, equitable and sustainable manner	1. Development of a National Irrigation Drainage Strategy in selected key basins in collaboration with MAFF, MRD and MOE
		2. Better water management of irrigable cropland by farmers, and development of hardware and software in a fully complementary way
		3. Better water management of rainfed cropland by farmers, and development of hardware and software in a fully complementary way
		4. Application of integrated approach to water resources management and development.
2. Flood and drought management	Minimization of the impacts of water-related hazards, particularly floods and droughts on the lives, property and livelihoods of the Cambodian people and on public property	1. Provide MOWRAM with a nationwide capability for short-, medium- and long-term monitoring and forecasting of droughts and floods, and for issuing timely warnings and situation reports to public
		2. Operation of a properly maintained network of flood management embankments and drainage channels
		3. Availability of the capacity in high-risk provinces to provide emergency response to extreme events, particularly emergency pumping equipment to mitigate drought impacts and heavy construction machinery to carry out emergency repairs to channels and embankments
		4. Implementation of a comprehensive non-structural strategy for the mitigation of floods and droughts in cooperation with the Cambodian Natural Disaster Management Committee
3. Water-related legislation and regulations	Effective and fair implementation of a sound legal foundation for water resources management and development	1. Establishment and maintenance of the legal-regulatory framework required by MOWRAM for the discharge of its mandate
		2. Provide MOWRAM with the capacity required to enforce the body of Law for which it is responsible at the same time that the Law is enacted
		3. Provide MOWRAM with a comprehensive capacity to develop and apply procedures for social and environmental impact assessment and mitigation
		4. Establishment and maintenance of the comprehensive formal basis required to establish and support PIMD, IMT and FWUCs
4. Water resources information management	Confident and wise development and management of Cambodia's water resources on the basis of adequate information	1. Collect, archive and disseminate hydrological and related water quality data and information by a nationwide hydrological observing system
		2. Provision of real-time weather information for public forecasting purposes, and archives of historical data for agro-meteorological research, design of infrastructure, etc. by a nationwide hydrological observing system

		3. Availability of basic information, in a readily accessible, usable and consistently maintained form, that describes the nation's water resources and hydrological systems
		4. Availability of an authoritative National Flood and Drought Hazard Map for planning, design and regulatory purposes
5 Administration, management and human resources development	Efficient and effective execution of water resources management-related functions by means of administrative and management systems, technical capacities, facilities and human resources of MOWRAM, Provincial DWRAMs, related sub-provincial institutions, and community-based organizations	1. Adequate institutional and staff capacity in MOWRAM in administration and management that enables it to carry out its mandate efficiently at national, provincial and district levels. 2. Adequate institutional and staff capacity at national, provincial and district levels of MOWRAM and in community-based organizations to plan and carry out effective and sustainable management and use of water resources and aquatic ecosystems, and to enable active participation therein 3. Adequate sub-national capacity to manage I&D systems sustainably, through PIMD and FWUCs 4. Provision of equal opportunity for women and men, to be equipped and participate in water resources management and development at all levels of governance within MOWRAM's area of influence

As can be seen in the above table, these goals should be duly taken into consideration in preparation of the comprehensive agricultural development plan of the Prek Thnot river basin. The achievement of these goals will be monitored by MOWRAM at the years of 2008 and 2010, using the performance indicators.

#### 2.3.4 Rehabilitation and Development Plan for Water Resources and Meteorology Sector for Second Five Years 2001-2005

In compliance with SEDP II, MOWRAM mapped out the Rehabilitation and Development Plan for Water Resources and the Meteorology Sector for the Second Five Years 2001-2005, which covers (i) meteorological works, (ii) hydrological works, (iii) river works, (iv) surface and groundwater potential management, (v) irrigation works, (vi) water supply and wastewater, (vii) providing appropriate human resources training for the water resources and meteorology sector, and (viii) establishment of water resources management legislation.

The Water Resources and Meteorology Sector plays an important role for the present and future development of the economy and society. The major objectives of the sector development related to the Study are (i) expansion of the irrigated areas from 16.62% to 20%, (ii) rehabilitation and construction of emergent irrigation systems, (iii) the existing operation and maintenance process to be made effective and sustainable, (iv) better management of hydrological data for research purposes and evaluation of surface and groundwater potential and monitoring of the variation of groundwater and wet lands suitable for the agricultural sector, and (v) regular forecasts timely dissemination of weather warnings prior to natural disasters.

To attain these objectives, the strategic plans proposed are (i) rehabilitation of irrigation systems and flood dikes, (ii) installation of pumping stations, water pumps, materials and measures to provide water to crops, (iii) formulation of FWUCs for effective and sustainable O&M of irrigation systems, (iv) selection and prioritization of suitable irrigation systems and flood dikes, (v) improvement and installation of hydrological stations, (vi) expansion of monitoring networks for flood forecasting, (vii) dissemination of hydrological information through mass media for early warning before the disasters

happened, (viii) improvement and installation of meteorological stations and rain gauges, and (iv) research, analysis and evaluation of meteorological data for increasing its accuracy.

### **2.3.5 Policy for Sustainability of Operation and Maintenance of Irrigation Systems**

MOWRAM prepared and issued the Policy for Sustainability of Operation and Maintenance of Irrigation Systems in consideration that FWUC is a main actor for operation and maintenance of irrigation systems.

The policy touches on (i) policy provisions for irrigation development and management, (ii) transfer of management responsibility and water allocation to FWUC, (iii) formation of FWUC, (iv) irrigation service fees (ISF), (v) linkage and accountability of various agencies, (vi) farm water management and action training, (vii) monitoring and evaluation, and (viii) environmental assessment and human resource development and research.

The policy states that the crucial issues for sustainability of operation and maintenance of irrigation systems are to (i) establish efficient, sustainable, reliable and environmentally friendly irrigation systems, (ii) promote irrigated agriculture ensuring food security and growth of the national economy, (iii) gradually increase the role and responsibility of organized participating farmers in every stage of the implementation program to reduce the government's responsibility in irrigation development, (iv) enhance the capability of FWUC in managing and safeguarding the irrigation systems, (v) promote awareness of the participating farmers in taking over the management responsibility of the government managed irrigation schemes and expedite the transfer process to FWUC, (vi) encourage the donor agencies to increase funding in developing and managing the irrigation systems with active involvement of the participating farmers, and (vii) bring about uniformity in the selection and implementation process of irrigation development and management among the government institutions and supporting national and international agencies involved in irrigation extension.

## Chapter 3 Hydro-meteorological Analysis of the Study Area

### 3.1 Present Meteorological Conditions

There is only one meteorological observation station in the Prek Thnot River Basin at Pochentong in Phnom Penh managed by the Department of Meteorology (DOM) under MOWRAM. The observation records for temperature, relative humidity, wind speed, sunshine hours and evaporation at this observation station go back more than 15 years, however hourly/daily data except evaporation and rainfall are available only for about the most recent 5 years.

The climatic classification of Cambodia is a tropical monsoon climate with definite rainy and dry seasons. According to the data at Pochentong, the meteorological situations are as follows:

Mean temperature has small seasonal variation from 26.1°C in December to 30.5°C in April. Monthly maximum temperatures higher than 31°C are common and, just prior to the rainy season, rise to above 35.8°C. Monthly minimum temperature rarely falls below 21°C. Relative humidity ranges from 66% to 77% in February and March and 80% to 90% in September and October.

### 3.2 Present Hydrological Conditions

#### 3.2.1 Prek Thnot River Condition

The Prek Thnot River flows between southeast and east from the Elephant mountain region, which is its origin. The elevation of the Prek Thnot River basin is El. 1,543 m above mean sea level. The Prek Thnot River system consists of 11 sub-basins. The area of each sub-basin is shown in the table to the right. According to the longitudinal survey from the Peam Khley, about 15 km upstream from the Roleang Chrey Regulator to the confluence with the Bassac River, slope of the Prek Thnot River ranges from 1/2,720 for the upstream reaches to 1/5,100 for the downstream reaches. The non-uniform calculation based on the results of the longitudinal survey, shows the following discharge carrying capacity of the Prek Thnot River:

Area of Sub-basin

Sub-basin	Area (km <sup>2</sup> )
Trang Krang	294
Ta Sal	674
Aveaeng	431
Phleah	235
Aoral	502
Krang Ambel	455
Tang Haong	1,435
Anlong Ramlich	228
Bat Kmeng	300
Kandal	78
Residual	18
Total	4,650

Discharge Carrying Capacity of Prek Thnot River

Chainage (m)	Discharge Carrying Capacity
0 – Kandal Steung Weir (33,446)	200 m <sup>3</sup> /s – 500 m <sup>3</sup> /s
Kandal Steung Weir – 50,000	300 m <sup>3</sup> /s – 800 m <sup>3</sup> /s
50,000 – Krang Ambel River (73,587)	500 m <sup>3</sup> /s – 800 m <sup>3</sup> /s
73,587 – Thnuous Luong Station (90,038)	800 m <sup>3</sup> /s – 1200 m <sup>3</sup> /s
Thnuous Luong Station – Roleang Chrey Regulator (98,431)	1200 m <sup>3</sup> /s – 1300 m <sup>3</sup> /s
Roleang Chrey Regulator – Peam Khley (113,411)	1300 m <sup>3</sup> /s – 1500 m <sup>3</sup> /s

#### 3.2.2 Rainfall

There are one automatic and 17 ordinary rainfall gauging stations in and around the Prek Thnot River basin. The automatic gauging station has been located at Kampong Speu PDOWRAM office since 2000. The rainfall data availability period is more than 23 years for daily data at some locations, but only 5 years at other locations. Other than these, long term monthly rainfall records from 1901 to 1990 at Phnom Penh are available in the Reappraisal Report of the Prek Thnot Multipurpose Project, Volume 5.2 - Annex I for the Australian Catholic Relief in December 1991.

According to those rainfall data, the rainfall conditions in the basin are as follows:

Average annual rainfall in the basin is 1,225 mm. The seasonal distribution is divided into the rainy season from May to November and the dry season from December to April. The rainy season accounts for 90% of the annual rainfall. Most rain is showery and the hyetal region is small and the heaviest annual rainfall falls in the southwest of the Prek Thnot River Basin.

### 3.2.3 Water Level and Discharge

There were 3 water level gauging stations along the Prek Thnot River as of 2005. The gauging stations at Peam Khley and Thnuos Luong were installed by DHRW in 1996. The gauging station at Roleang Chrey Regulator was installed in 1999.

Discharge at these gauging stations is computed from the rating curve developed by DHRW. Data of discharge measurements, data logs, rating curves, daily water stage and discharge at Peam Khley, Thnuos Luong and Roleang Chrey Regulator are available. The periods of data available vary from 5 years to 9 years by station.

Daily discharge at Peam Khley gauging station is available for the period from 1997 to 2005. Tabulated below are monthly discharges summarized from the daily discharge.

**Summary of Monthly Discharge at Peam Khley** Unit: 10<sup>6</sup>m<sup>3</sup>

Discharge	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mean	11.3	5.0	5.7	11.6	36.1	48.2	116.6	155.7	238.2	408.1	158.6	35.0	1,232.2
Max	63.5	34.1	53.3	54.7	345.6	221.6	354.5	373.9	505.8	851.0	614.7	391.5	2,931.2
Min.	2.4	0.4	0.4	1.5	3.7	3.0	5.3	12.7	69.8	45.6	12.0	2.4	398.4

### 3.2.4 Flooding Conditions

The past annual peak discharges of the Prek Thnot River are estimated as follows:

**Past Annual Peak Discharge of Prek Thnot River**

Year	Peak Discharge at Roleang Chrey	Peak Discharge at Peam Kley
1991	1,369 m <sup>3</sup> /s	
1996		801 m <sup>3</sup> /s
1997		826 m <sup>3</sup> /s
1998		507 m <sup>3</sup> /s
1999		798 m <sup>3</sup> /s
2000	1,276 m <sup>3</sup> /s	1,276 m <sup>3</sup> /s
2001		788 m <sup>3</sup> /s
2002		
2003		974 m <sup>3</sup> /s
2004		
2005		
2006	1,192 m <sup>3</sup> /s	

According to the operator of the Roleang Chrey Regulator, the flood peak in 1991 was the maximum in his career as the gate caretaker since 1969. Accordingly the flood peak discharge in 1991 was the maximum in the most recent 38 years. This means that the probable flood peak discharge of the Prek Thnot River would be around 1400 m<sup>3</sup>/s for the probability of about 1/40 even though this may need to be studied more in the future since the caretaker did not work as the caretaker in the period of 1975 to 1978 due to the social and political situations in Cambodia.

On the other hand, the discharge carrying capacity of the Prek Thnot River in the upstream reaches of the Roleang Chrey Regulator site is estimated at 1300 m<sup>3</sup>/s ~ 1500 m<sup>3</sup>/s as discussed in Sub-section 3.2.1. This corresponds to the past flood peak discharge of the Prek Thnot River at the Roleang Chrey Regulator site, which was 1369 m<sup>3</sup>/s.

The available flood peak discharge data of the Prek Thnot River in the past is too limited to conduct a reliable numerical probability analysis for return periods of more than 20 years.

Accordingly, the probable flood peak discharge to be used as the design discharge of the Roleang Chrey Regulator for its improvement would be between 1300 m<sup>3</sup>/s and 1500 m<sup>3</sup>/s, or between 1400 m<sup>3</sup>/s and 1600 m<sup>3</sup>/s from a conservative view point on the condition that any river improvement works in the upstream reaches of the weir site would not increase the river discharge carrying capacity of the said reaches.

### 3.3 Current Observation Structures

DOM is a principal agency to collect meteorological data in Cambodia. The Department of Hydrology and River Works (DHRW) under MOWRAM undertakes hydrological observations all over the country, but mainly the work is concentrated into data collection in the Mekong River Basin for flood forecasting in collaboration with the Mekong River Commission. Hydrological data are stored in the PC-based HYMOS database.

Rainfall for each station is observed manually by a villager under a contract with Kampong Speu PDOWRAM. The observed rainfall data are sent to PDOWRAM through the district office and kept in the Meteorology Section of PDOWRAM office. The rainfall data recorded by automatic recorder with data logger is collected by both PDOWRAM and DHRW. The water level records of at Peam Khley, Thnuos Luong and Roleang Chrey are collected by DHRW. Discharge measurement at these stations is carried out by DHRW.

### 3.4 Establishment of New Rainfall and Water Level Gauging Stations

For some time now, there have been 18 rainfall and 3 water level gauging stations in the Prek Thnot River basin. These stations were mainly ordinary gauging stations except for the rainfall gauging station at Kampong Speu PDOWRAM. New automatic gauging stations have been established at locations among these sites in consideration of the spatial distribution and data continuation. The newly established automatic gauging stations under the Study are as follows:

**New Rainfall Gauging Stations**

No.	Station Name	Equipment	District/Village	Location (UTM)		Remarks
				Northing	Easting	
1	Kirirom	Automatic	Phnom Sruoch	1252931	396882	Replaced
2	Wat Kdey Lvea	Automatic	Samrongtong	1268598	462114	Newly installed
3	Kong Pisey	Automatic	Kong Pisey	1247922	459627	Newly installed
4	Trapeang Chour	Automatic	Aoral	1306348	405995	Replaced
5	Thpong	Automatic	Thpong	1299115	438559	Replaced
6	Peam Khley	Automatic	Phnom Sruoch	1267566	430740	Replaced
7	Phum Chum	Automatic	Aoral	1294020	383194	Newly installed
8	Roleang Chrey	Automatic	Samrongtong	1264829	439962	Newly installed
9	Prey Kaniech	Automatic	Phnom Sruoch	1262000	409200	Newly installed
10	O Kon Trom	Automatic	Phnom Sruoch	1238125	417515	Newly installed

### New Water Level Gauging Stations

No.	Station Name	Equipment	District/Village	Location (UTM)		Remarks
				Northing	Easting	
1	Peam Khley Bridge	S.G.	Phnom Sruoch	1266500	430871	Newly installed
2	Thnuos Luong	Logger & S.G.	Chbr Mon	1266357	446561	Replaced
3	Krang Chek	Logger & S.G.	Phnom Sruoch	1261082	402458	Newly installed
4	Cheneang Kpuos	Logger & S.G.	Phnom Sruoch	1265906	427244	Newly installed
5	Sangkea Tasal	Logger & S.G.	Aoral	1290500	405000	Replaced
6	Trapeang Kchon	Logger & S.G.	Samrongtong	1267436	458215	Newly installed
7	Roleang Chrey	S.G.	Samrongtong	1265095	440236	Newly installed
8	Prey Mean	S.G.	Aoral	1285872	406818	Newly installed

S.G. : Staff Gauge

## 3.5 Hydrological Analysis

### 3.5.1 Low Flow Analysis

#### (1) Runoff Ratio

The basin rainfall at Peam Khley is estimated from point rainfall at Pochentong with the least square method although the only data available for the least square method is samples from four different years beginning in 1928. The runoff ratio varies from 0.51 (in 1999) to 0.09 (in 1928) and the mean runoff ratio is 0.26.

#### (2) Dependable Discharge at Peam Khley

The record period of daily discharge at the Peam Khley gauging station is 9 years from January 1997 to September 2005. Long term monthly mean runoff at Peam Khley is available for the period of 1901 to 1972 and 1997 to 2004. A monthly summary with 80% and 50% dependable discharge amount is shown below:

**Summary of Monthly Discharge at Peam Khley (MCM)**

Discharge	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean	11.3	5.0	5.7	11.6	36.1	48.2	116.6	155.7	238.2	408.1	158.6	35.0	1,232.2
Max	63.5	34.1	53.3	54.7	345.6	221.6	354.5	373.9	505.8	851.0	614.7	391.5	2,931.2
Min.	2.4	0.4	0.4	1.5	3.7	3.0	5.3	12.7	69.8	45.6	12.0	2.4	398.4
80%dependable	8.8	3.0	4.2	7.8	16.6	24.3	71.3	133.2	193.7	274.2	55.7	22.9	
50%dependable	8.9	3.2	4.2	10.3	35.3	44.3	116.7	160.0	229.1	383.6	110.7	22.9	

#### (3) Dependable 5-day Discharge at Peam Khley

Dependable 5-day discharge of the Prek Thnot River at Peam Khley was estimated to determine the dependable 5-day discharge available for irrigation. A record period of more than 10 years is generally necessary to estimate reliable discharge for statistical analysis. The runoff data for non-recording periods at Peam Khley are produced from the runoff data at Thnuos Luong based on the runoff relationship between both sites.

The 80% and 50% dependable 5-day discharges are estimated by the distribution from dependable monthly discharge for the period from 1901-1972 and 1997-2004 in proportion to the actual 5-day runoff distribution pattern for every month for the 8 years from 1997 to 2004. The result is shown in Table 3.5.1.

#### (4) Dependable 5-day Discharge at Roleang Chrey Regulator

Dependable 5-day discharge at the Roleang Chrey Regulator can be estimated from those at Peam Khley by making an adjustment proportional to the catchment areas. As the catchment areas at Peam Khley and Roleang Chrey Regulator are calculated in this Study at 3,654 km<sup>2</sup> and 3,911 km<sup>2</sup> respectively, the equation for conversion is as follows:

$$Q_r = 3911/3654 \times Q_p = 1.07 \times Q_p$$

Where,

$Q_r$ : discharge at Roleang Chrey,  $Q_p$ : discharge at Peam Khley

Dependable 5-day discharge at the Roleang Chrey Regulator is shown in Table 3.5.2.

#### (5) Dependable 5-day Discharge of the Ou Krang Ambel

Dependable 5-day discharge of the Ou Krang Ambel River at the confluence with the Prek Thnot River is estimated from the data collected at Peam Khley in proportion to catchment area and rainfall amount. The catchment area of the Ou Krang Ambel River is 453 km<sup>2</sup>. The ratio of annual rainfall amount of Ou Krang Ambel to that of Peam Khley is estimated based on the data from 2001 to 2004 as shown below.

Year	Peam Khley	Ou Krang Ambel River Basin	Ratio
2001	1,547	1,551	1.00
2002	1,100	1,004	0.91
2003	1,369	1,279	0.93
2004	1,041	928	0.89
Mean			0.93

The equation for conversion is as follows:

$$Q_k = 453/3654 \times Q_p \times R_k/R_p = 0.124 \times Q_p \times R_k/R_p$$

Where,

$Q_k$ : discharge of Ou Krang Ambel River Basin

$Q_p$ : discharge at Peam Khley

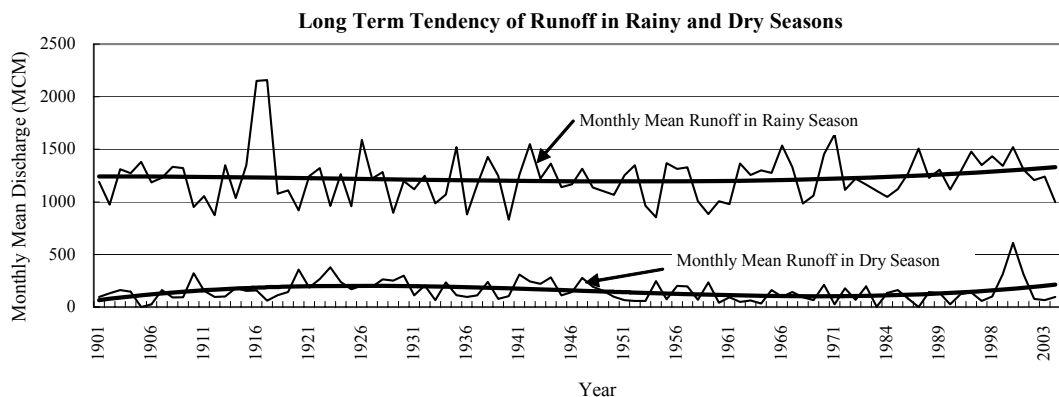
$R_k$ : area rainfall of Ou Krang Ambel River Basin

$R_p$ : area rainfall at Peam Khley

$R_k$ : area rainfall of the Ou Krang Ambel River

### 3.5.2 Long Term Runoff Tendency

Long term runoff is studied in the present Study to see if any long term runoff tendency can be found in the runoff patterns. In general, if deforestation progresses in the basin, runoff in the rainy season becomes larger, while that in the dry season becomes smaller due to decline of reservation capacity in the basin. The figure below shows the long term tendency in the rainy and dry seasons from 1901 to 2005 although 12 years of data are not available:





According to the above figure, long term tendency of runoff seems to be stable and no definite influence from deforestation in the basin can be found.

### **3.6 Hydrometeorological Observation Plan**

#### **3.6.1 Proposed Observation Structure**

The rainfall observation in the Prek Thnot River basin has been conducted by use of an ordinary rainfall gauge. The water level observation has been conducted by reading the water level on the staff gauge twice a day at 7:00 a.m. and 7:00 p.m. These works have been conducted by a caretaker at each gauging site and the data have been reported to PDOWRAM through the district office.

Now that the new rainfall and water level gauging stations with data loggers have been established in the basin, the present practice of observation and reporting can not be applied anymore for the immediate future. The recorded data should be downloaded using a laptop type computer and the data file shall be analyzed to prepare the hourly rainfall and water level data. The present provisional practice is that downloading the data and the analysis of the downloaded file are being conducted by the pivotal staff of DHRW. This system should be continued for the immediate future in consideration of the operation system of downloading and the data file analyzing. Then the collated rainfall and water level data should be sent to PDOWRAM in reverse. But this system should not be continued indefinitely.

But data collection and data processing should be gradually shifted to PDOWRAM in view of the budget preparation and capacity building in PDOWRAM in the long view.

But for the real time data collection during floods for flood forecasting and warning, the observation structure should be a different one to be studied later in the present Study and based on the water law in Cambodia to be enacted soon.

Regarding the discharge measurement at the water level gauging station sites, the activities are presently being conducted under sub-contract with the Study Team for the period of the Study. But this activity of discharge measurement should be conducted by PDOWRAM in the future.

#### **3.6.2 Observation Method, Procedure and Manual**

The operation methods and procedure for configuration of the data loggers and downloading the recorded data from the data loggers on rainfall and water level are provided by the equipment maker. The operation and procedure for arrangement of the downloaded files on rainfall are presented in the manual which has been submitted to MOWRAM. The operation and procedure for discharge measurement are presented in the manual on discharge measurement. Regarding downloading the rainfall and water level data, it is suggested that the frequency of downloading be conducted at least once in 3 months in consideration of data file size in the logger and the arrangement procedure. During the rainy season, it is suggested that the downloading be conducted at least once in two months since the rainfall amount is expected to be more than 100mm per day in some cases. It should be kept in mind that the downloading can not be done in the field during rain and/or thunderstorms. Accordingly the planning of data downloading should be prepared deliberately.

## **Chapter 4 The Target Area**

### **4.1 Location**

Cambodia has a territorial area of 181,035km<sup>2</sup> and is located between latitude 12 and 15 degrees North and longitudes 102 and 108 degrees East. It is bordered by Thailand to the west, Lao PDR to the North, Vietnam to the east and southeast, and the Thai Gulf to the southeast.

The Target Area of the M/P is located about 40km west of Phnom Penh, the capital of Cambodia, extending over both sides of National Road No.4. It presents an almost rectangular shape of approximately 25 km by 40 km.

### **4.2 Administration and Population**

The Target Area is administratively related to 2 provinces, 5 districts, 44 communes and 761 villages. Chabar Mon District and part of Samraong Tong and Kong Pisei Districts in Kampong Speu Province are included in the Target Area. Additionally, Kandal Stueng District and part of Angk Snuol District in Kandal Province are included in the Target Area.

According to the SEILA Commune Database, 2004, the population of the Target Area is 340,784 consisting of 243,944 in Kampong Speu Province and 96,840 in Kandal Province. Out of the population, the working population, which means the population of 15 to 65 years old, corresponds to 198,176 in total.

Detailed Administrative information on the Target Area is given in Table 4.2.1.

### **4.3 Topography and Geology**

The Target Area, with elevations ranging from 20 m to 70 m except some small mountains, is divided into the northern part and southern part by the Prek Thnot River flowing from west to the east. Both parts slope toward the Prek Thnot River and the entire area inclines to the east along the flow direction of the river.

The western part of the area presents different topography than the eastern part. The western part is further divided into the northwestern part and the southwestern part topographically. The northwestern part is covered with gentle slopes of 1 to 500 on average. In the southwestern part, there exist some mountains 400 to 600 m high. On the other hand, the eastern part presents comparatively smooth slope topography.

The geology of the Target Area is characterized by the Quaternary and the Mesozoic deposits. But the Quaternary is predominant in the area, and the Mesozoic is only located in the southwestern part of the area. In the Quaternary, the alluvial fans are developed in the riparian area of the Prek Thnot River. An alluvial terrace forms the northern part, and the alluvial fans extend to the southern part although alluvial terrace exists in places, especially the southwestern part. The Mesozoic is surrounded by pediments, and formed by sand stone, silt stone, and marls.

### **4.4 Soils and Land Suitability**

#### **(1) Soils**

The soils distributed in the Target Area are classified into six soil types, Gleyic Acrisol Medium Textured Phase, Gleyic Acrisols Medium to Fine Textured Phase, Gleyic Acrisol Coarse Textured Phase, Plinthic Acrisols and Dystric Leptosol as shown in Figure.4.4.1 and in the following table.

### Soil Distribution in Target Area

Soil Type	Soil Taxonomy	Distribution	
		(ha)	(%)
Gleyic Acrisol Medium Textured Phase (GAm)	Ultisols	55,410	53
Gleyic Acrisol Medium to Fine Textured Phase (GAf)	Ultisols	10,750	10
Gleyic Acrisol Coarse Textured Phase (GAc)	Ultisols	1,460	1
Plinthic Acrisols (PA)	Ultisols	28,580	27
Dystric Leptosol (DL)	Entisols	9,000	9
Total		105,200	100

Soils found in the Target Area are almost exclusively medium textured (SL) at the surface layers underlain with finer textured sub-soils, however, the distribution of a limited extent of surface soils with fine or coarse textured are also identified.

#### (2) Land Suitability

The land suitability classification of the Target Area for annual crop production has been made by applying the system proposed in the Framework for Land Evaluation (FAO, 1976). The results of the land suitability classification of the soils in the Target Area are presented in the following table.

#### Results of Land Suitability Classification for Crop Production

Soil Type	Mapping Symbol	Land Suitability Class					Total
			S2	S3	S3C	N	
Gleyic Acrisols Medium Textured Phase	GAm	Area (ha)		55,410			55,410
		%		100			53
Gleyic Acrisols Medium to Fine Textured Phase	GAf	Area (ha)	10,750				10,750
		%	100				10
Gleyic Acrisols Coarse Textured Phase	GAc	Area (ha)			1,460		1,460
		%			100		1
Plinthic Acrisols	PA	Area (ha)		28,580			28,580
		%		100			27
Dystric Leptosol	DL	Area (ha)					9,000
		%					9
Total		Area (ha)	10,750	83,990	1,460	9,000	105,200
		%	10	80	1	9	100

As shown in the table, 10% of the Target Area (Gleyic Acrisol Fine to Medium Textured Phase) are classified as moderately suitable (S2) for crop production, 80% of the Area (Gleyic Acrisol Medium Textured Phase and Plinthic Acrisols) as marginally suitable (S3), 1% of the Area (Gleyic Acrisol Coarse Textured Phase) as critical (S3C) and 9% of the Area (Dystric Letosol) as non-suitable (N).

## 4.5 Socio-economic Settings

### 4.5.1 Income, Expenditure and Employment

According to the Socio-Economic Survey conducted with 200 household samples in the Target Zone, the household income level of the sampled households is in average 3,600,000 Riels/HH/year, with a median 2,900,000 Riels/HH/year. However, among the 200 samples, the household income ranges from a minimum of 360,000 Riels up to a maximum of 25,370,000 Riels.

Income sources of the sampled households consist of various activities. In occupation, the farmer is the most predominant (73.5%) among all working-aged individuals belonging to the sampled households, followed by salaried workers (15.1%) and non-farm labor (2.0%), while the unemployment figure is quite low at 3.9% of all working aged individuals.

In value, farming activity (including livestock/poultry) generates 43.6% of all cash

incomes of sampled households, followed by salaries from permanent jobs (22.5%), private businesses (12.3%), and remittance from family members (6.5%), etc.

The expenditure level of sampled households is on average 2,058,000 Riels/year, while the median is 1,585,000 Riels/year. The proportion (%) of expenditures for major consumption items consist of other food (47.4%), rice (11.4%), education (10.6%), health (10.5%), and others.

#### 4.5.2 Food Deficit

According to the food balance analysis conducted by the Study, there exists roughly a 38% deficit of paddy against the consumption requirements of the Communes in the Target Area. The Socio-Economic Survey also indicated that 11.4% of total expenditure of all survey respondents is used to buy rice, while 47.4% is used for buying other foods, including vegetables. While the proportions (%) of expenditure that the different income strata spend for buying rice do not differ, the values (Riel) differ about 4.5 times between the bottom strata and top strata. Taking into consideration the fact that selling the paddy/rice is one of the major income sources of the bottom strata, the poorer households are reducing the level of expenditures for rice by consuming their own products.

#### 4.5.3 Poverty Status

The data gathered by the Socio-Economic Survey was processed to work out the daily income and expenditure per capita among sampled households. As a result, the following figures were obtained.

**Daily Income and Expenditure Per Capita of Sampled Population**  
(Unit: '000 Riel)

Income Strata	Average Income/ HH/Year	Average HH Pop.	Per Capita Daily Income	Per Capita Daily Expenditure
1st	7,795	6.8	3.2	1.3
2nd	4,124	6.5	1.7	1.0
3rd	2,943	5.8	1.4	0.9
4th	1,939	5.9	0.9	0.6
5th	974	5.7	0.5	0.5

*Source: Socio-Economic Survey Results, October 2005*

In the above table, 200 sampled households were divided into 40 household intervals from the highest income household to the lowest, in order to form the 1st to 5th income strata.

The per capita daily incomes in US dollars for these income strata converted with the current exchange rate (Riel 4,070 = US\$ 1) will be US\$ 0.80 for the 1st stratum, 0.42 for 2nd, 0.34 for 3rd, 0.22 for 4th, and 0.12 for 5th, respectively. As far as the sampled households' average pictures are concerned, all except the 1st strata will fall below the poverty line (US\$ 0.46/day/per capita).

#### 4.5.4 Gender Issues

The Socio-economic Survey indicated that there exist no serious gender problems, as far as the sampled households are concerned. Females' access and control over the resources such as water, residential and farm land, and livestock, are not constrained.

As a matter of course, there are differences between males and females over their roles in society. When looking at the main activities of both sexes the respondents consider, after farming which was the top activity for both sexes, housekeeping, cooking and care of children/elders were the second to fourth most common activities that females were undertaking, while for males only income generating activities, such as making palm sugar, care of livestock, and handicraft were prevalent.

However, when looking at the actual cash income sources, an outstanding difference came to surface which is that the income from the garments factory was mainly earned by females, while for other cash income sources, no major difference found between the sexes.

#### 4.6 Development Assistance by Donors and NGOs in Agriculture and Water Sectors

##### 4.6.1 Donors

Lots of donors are extending technical and financial assistance to the RGC in various sectors. Table 4.6.1 shows the donors' names, their on-going projects/programmes, cost, objectives/scopes and relationship to the Target Area in the agriculture and water sectors. These include CAAEP II, AQIP and CARDI which are assisted by AusAID and are closely connected with the Study. Therefore, the Study will be carried out in concert with these projects. FAO is presently assisting the MAFF and MOWRAM in extension of the Special Programme for Food Security (SPFS) for 5 provinces to improve food security and income generation for poor farmers which are not directly related to the Target Area. The government and FAO intend that SPFS will be extended over the whole country.

##### 4.6.2 NGOs

Many NGOs are working in various fields in the Target Area. The following table shows the NGOs and their projects/major activities related to the agriculture sector.

**NGOs and Their Projects/Activities related to Agricultural Sector**

NGOs	Working Site	Projects/Major Activities
<b>(1) Kampong Speu Province</b>		
IPM	Whole Province	- Implementation of integrated agricultural development
		- Dissemination of rice production techniques
		- Extension of fish culture
		- Organization of farmers' association
CAP	Samroang Tong	- Establishment of environmental network
	Kong Pisei	- Farmers' capacity building - Demonstration of animal raising and vegetable cultivation
World Vision	Samroang Tong	- Community development (Farmers agriculture school)
CEDAC	Samroang Tong	- Organization of farmers' association
	Kong Pisei	- Dissemination of System for Rice Intensification (SRI)
		- Dissemination of ecological farming vegetable cultivation - Community development
Asia URB	Samroang Tong Chbar Mon	- Community development (pig bank, credit & saving, fish culture, home garden, SRI)
		- Introduction of foreign vegetables to farmers
		- Marketing arrangements for foreign vegetables
Enfant & Development	Kong Pisei	- Implementation of rural development including micro-credit, cow bank, animal raising, and home gardens in close communication the Community Council
NAPA	Samroang Tong Kong Pisei	- Farmer Livelihood Development consisting of animal raising, SRI, home gardens, organization of farmers' association, credit and introduction of organic farming.
FLD	Kong Pisei	- Farmer Livelihood Development including SRI, micro-credit, animal raising, organization of farmers' association, and introduction organic farming
<b>(2) Kandal Province</b>		
JVC	Angk Snuol	- Implementation of sustainable agriculture & rural development
CEDAC	Angk Snuol	- Execution of SLS Project covering organic farming, SRI, animal raising, organization of farmers' association.

NGOs	Working Site	Projects/Major Activities
Sre Khmer	Kandal Stung	- Introduction of organic farming
		- Organization of farmers association
		- Experiment with wood vinegar for protecting vegetables from pests
		- Seed selection
World Vision	Kandal Stung	- Increase of family income
		- Construction of small dam
IPM	Whole province	- Implementation of integrated agricultural development consisting of improvement of rice production techniques, introduction of fish culture, and organization of farmers' association
FLD	Kandal Stung	- Farmer Livelihood Development including SRI, micro-credit, animal raising, organization of farmers' association, and introduction of organic farming

Source: Interview survey and Directory of International Development Assistance 2003-04 and Directory of Cambodian NGOs 2004-05

As can be seen in the above table, the NGOs main target is to increase income as a core of community development. In the coming Verification Study (Pilot Projects), the experienced NGO(s) might be employed as assistant(s) to implement the pilot projects.

## 4.7 Agriculture

### 4.7.1 Agro-demography and Land Tenure & Holding

#### (1) Agro-demographic Features

The agro-demographic features of the project communes in the Target Area were identified based on the Commune Survey on Crops & Livestock, 2003, MAFF and village-wise data from the SEILA Commune Data Base 2004 are presented in Table 4.7.1 and summarized in the following table.

**Agro-demographic Features of Project Communes in Target Area**

Items	Features
Nos. of Households (total)	62,100
Nos. of Farm Households (No. of crop producing households)	55,847
% of Farm Households of Total Households	90 %
%. Of Non-Farm Households (No. of none crop producing households)	10 %
% of Farm Households Producing Rice	100 %
Total Population in nos.	340,784
Average Family Size	5.4
Working Population (15 ~ 64 years old)	198,176
Working Population/ Household (15 ~ 64 years old)	3.1

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2004

When assuming that the number of farm households is equal to the number of crop producing households, farm households in the Target Area account for 90% of the total households and non-farm households are estimated at 10% of the total. One hundred percent of farm households (crop producing households) are producing rice. Average family size is 5.4 members and working population is estimated at 3.1 persons/household.

#### (2) Land Tenure and Land Holding

##### (a) Land Issues in Cambodia<sup>1</sup>

In Cambodia, land tenure and administration structures have changed several times and

<sup>1</sup> This section was prepared based on "Land Issue Study in Cambodia, CEDAC & JVC, 2005"

all the farm lands operated collectively by villagers during the previous political regime were allocated to individual villagers in 1989 with the policy moving toward a free market system. The government reintroduced land ownership rights are as follows;

Land for domicile:	To be provided for ownership by the provincial committee or municipality; size up to 2,000m <sup>2</sup>
Possession land:	State land allocated to farmers to manage and for use for exploitation; size up to 5 ha
Concession land:	Right to occupy land for large scale crop production that would contribute to the national economy; size greater than 5 ha

However, because of the increasing trend of illegal occupation of larger land areas, land concentration and land disputes, the government issued a new land law in 2001, in which maximum land size for ownership is no longer limited and land concessions for large scale crop production could be provided for up to 10,000 ha.

The number of landless citizens is increasing at an alarming rate due primarily to the population growth, health problems, indebtedness and land grabbing. Although the estimates on the proportion of households that have no agricultural land vary depending on the sources of the estimates, it was estimated at 10 % of the total households in the Target Area in the Commune Crop & Livestock Survey, 2003, MAFF.

#### (b) Land Tenure and Land Holding

The access to data/information on land tenure was rather limited in the present Study. However, the Commune Survey on Crops & Livestock, 2003, MAFF and SEILA Data Base, 2004 provides some information on the land tenure and holding status as shown in Table 4.7.1 and summarized in the following table.

#### **Land Tenure & Holding Features of the Project Communes in the Target Area**

Indicator	Features
No. of Households (total)	62,100
No. of Farm Households (No. of crop producing households)	55,847
No. of Non-Farm Households (No. of non-crop producing households)	6,253 <sup>1/</sup>
No. of Landless Households	
Total Paddy Field in Project Communes	39,688 ha
Average Paddy Field Holding Size per Farm Household	0.71 ha
% of Farm Households with Holding Size Less Than 0.1ha	4 %
% of Farm Households with Holding Size More Than 3ha	2 %
% of Landless Households	10%

<sup>1/</sup>: A total of 41 % area in Chbar Mon District, which is categorized as urban area in SEILA Data Base

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Data Base 2004

As shown in the table, all the farm households in the Target Area appear to have some farmland and average holding size of paddy field per farm household is estimated at 0.71ha, when assuming that the number of farm households is equal to the number of crop producing households. The proportion of land holding farm households having less than 0.1ha is calculated at 4% and those holding more than 3ha is 2%, which might indicate that evenly distributed land holding still exists in the Area after the land allocation in 1989.

The number of landless households (No. of none crop producing households) reported in the Commune Survey on Crops & Livestock, 2003, MAFF was calculated at 10% of the total households. This figure, however, appears to include non-farm households in urban areas and the actual number of landless farmers can not be estimated. Holding size of upland fields is rather limited in the Target Area and estimated based on the results of the Socio-economic Survey conducted by the Study Team as follows;

### Upland Field Holding Status of Sample Farmers

Land Type	Nos. of Respondents		Total Area (ha)	Average per	
	Nos.	%		Respondent	Sample
Upland Field for Field Crop Prod.	83	42%	28.8	0.35	0.14
Upland Field for Fruit Production	41	21%	9.7	0.24	0.05
Total	-	-	38.5	-	0.19

<sup>1/</sup>: Socio-economic Survey by the JICA Study team, 2005; sample No. 200

The result also indicates that 99% of the sample farmers in the Target Area are owner operators and a tenancy arrangement is seldom practiced on the farm land.

#### 4.7.2 Present Land Use

The present land use of the Target Area was studied by applying 1:50,000 topographic maps as base maps and by updating information presented in the maps with the interpretation of 1:40,000 air-photographs taken in 2004, ground verification surveys and the irrigation inventory survey made by the JICA Study Team. The land use in the Target Area was categorized into seven categories: i) paddy field, ii) upland field, iii) forest, iv) shrub & grass land, v) settlement/industrial land, vi) others and vii) water surface.

The present land use map is presented in the opening page and the area extents of individual categories of lands are estimated as shown in the following table.

#### Present Land Use of the Target Area

Land Use Category	Area (ha)	%	Land Use Category	Area (ha)	%
Paddy Field <sup>1/</sup>	42,780	40.7	Settlement/Industrial Land	7,110	6.8
Upland Field	820	0.8	Others	1,180	1.1
Forest	2,120	2.0	Water Surface	800	0.8
Shrub & Grass Land	50,390	47.9	Total	105,200	100

<sup>1/</sup>: Gross area

As shown in the table, the area extent of the project target land use category of paddy field is 42,780 ha consisting of irrigated field and rainfed field. The descriptions of major land use categories are as follows;

##### (1) Paddy Field

This category of land is the primary target area of the present study and accounts for 42,780 ha in gross or 41 % of the Target Area and includes irrigated paddy field and rainfed paddy field. The distribution of irrigated paddy field depends on surface water resources available and is mainly located close to the Roleang Chery Regulator and along the North and South Main Canals. The gross area of paddy field includes paddy field, right of ways and some other categories of land such as settlement and shrub/grass land because of the limitation in mapping of scattered small scale distributions of such land uses. The net area of paddy field in the Area is estimated at 41,500 ha, 97% of gross area<sup>2</sup>, in the present study. The present agricultural development plans are to be formulated on this paddy field area, although there exist some differences in paddy field areas between the result of the land use study and the statistical data.

The irrigated fields are located within the command area of an irrigation system capable of supplying irrigation water. However, irrigable area in the dry season is extremely limited and the majority of the fields are sufficiently irrigated only in the rainy season, so called supplementary irrigated paddy fields. The irrigated paddy fields in the Area are almost exclusively used for rice cultivation and upland crop cultivation is extremely limited.

Rainfed paddy fields is the largest land use type within the paddy fields in the Target Area

<sup>2</sup> With the use of GIS system and recent air-photographs, paddy field area was measured precisely.



and extensive distributions of the same are found in the northern and southern parts of the Target Area located away from the Prek Thnot River. Rainfed paddy fields are used for a single cropping of rice, which is grown in the rainy season; however, because of unstable rainfall distribution and cultivation of traditional varieties, productivities are limited.

(2) Upland Fields (820 ha or 0.8 % of the Target Area)

The distribution of upland fields is basically limited to the areas surrounding settlements and their extent is limited to 820 ha or 0.8% of the Area. The land is primarily used for limited cultivation of upland crops. Major crops grown are vegetables and mungbeans.

(3) Shrub and Grass Land

Shrub land and grass land with scattered shrub is the largest land use category in the Area and is extensively distributed in the north eastern part, the northern part and the low mountainous portions of the Target Area. The extent is 50,390 ha or 48% of the Target Area. The shrub land in the northeastern part is controlled by the Kampung Speu Provincial Department of Forestry for watershed conservation purposes.

(4) Settlement/Industrial Land

This category of land includes villages, urban settlement areas and industrial land and accounts for 7,110 ha or 6.8% of the Target Area. Located close to the capital, land use conversion from farmland (paddy field) to industrial or settlement area was substantial in the past and such conversion will continue in the future. Especially, the expansion of industrial area is remarkable along national roads No. 3, 4, 42 and 51. The current extent of industrial area in the Target Area is estimated at 650 ha.

### 4.7.3 Rice Production

(1) General

Rice production is the most important agricultural activity in the Target Area and nearly 100% of farm households are engaging in the rainy season rice cultivation. However, those producing dry season rice are rather limited and according to the SEILA Data Base the extent of dry season rice is only about 3% of the total paddy field reflecting water supply constraints in the dry season in the Target Area. The rice production in the Target Area could be characterized as low and unstable productivity in rainfed fields with a prolonged rice cultivation season continuing from May to January with the cultivation of rice varieties of different growth durations of early to late. Further, traditional farming practices adapted to the agro-climatic conditions in the Target Area is another characteristic of the rice production in the Target Area.

(2) Cropping Seasons and Variety

Cropping seasons in the Target Area are generally defined into two seasons, the rainy season and the dry season. The rainy season, the predominant cropping season, lasts from May to October and the dry season is from November to April. Statistically, the rainy season rice is defined as rice planted from May to October and dry season rice is planted from November to April. However, from the actual practice, rice cropping seasons could be better differentiated into: i) early rainy season rice planted from April/May to June in irrigated areas, ii) rainy season rice planted from July to September both in rainfed and irrigated areas and iii) dry season rice planted from January to February in irrigated areas.

Rice varieties in Cambodia are classified into photosensitive early rice, medium rice and late rice cultivated in the rainy season and non-photo sensitive rice cultivated both in the dry and rainy seasons. Current predominant rice varieties grown in the Target Area are medium rice in the rainy season and non-photosensitive early rice in the dry or early rainy season. Traditional local varieties appear to have been selected by farmers in the past and have some characteristics suited to local agro-climatic conditions such as drought

tolerance and tolerance to inundation.

Rice breeding in Cambodia was initiated by CIAP (Cambodia-IRRI-Australian Project) and followed by CARDI. Under the breeding program, a number of rice varieties were released through pure line selections of local varieties in the country. Major varieties released by CARDI with their characteristics and varieties grown commonly in the Area and are listed in Table 4.7.2.

### (3) Cropping Calendar and Pattern

The cropping calendar and patterns in the paddy fields in the Target Area were studied by categorizing the fields based on irrigation water supply conditions into three categories: (i) irrigated paddy field, (ii) supplementary irrigated paddy field in rainy season and (iii) rainfed paddy field.

#### (a) Irrigated Paddy Fields

In the irrigated paddy fields, double cropping of rice is practiced to a limited extent under irrigation. Rainy season rice cultivation under supplemental irrigation is practiced in the entire area and dry or early rainy season rice cultivation in a limited part of the field because of the limited irrigation water supply. The cropping calendar in the area is diversified depending on locations affected by the seasonal availability of irrigation water. The prevailing cropping calendar and patterns in the field are shown in Figure 4.7.1.

Cultivation of upland crops and vegetables in the paddy fields is extremely limited and is mostly practiced from June to August in the early rainy season before cultivation of rainy season rice. Vegetable cultivation under irrigation is also practiced to a limited extent, mostly in the dry season from November to April.

#### (b) Supplementary Irrigated Paddy Field

Single cropping of rainy season rice under insufficient irrigation water supply is the exclusive cropping pattern in the supplementary irrigated paddy fields and the prevailing cropping calendar is May ~ July/August to November ~ January as shown in Figure 4.7.1. The prevailing variety in the field is a medium variety, while an early variety is also grown in case the start of cultivation is delayed due to irrigation water supply and rainfall distribution. Cultivation of upland crops and vegetables are practiced to only a negligible extent in the early rainy season from May to July.

#### (c) Rainfed Paddy Fields

Similar to the supplementary irrigated area, single cropping of a medium or late variety of rice is a cropping pattern in the rainfed field in the Area. The prevailing cropping calendar is June/July ~ December/January as shown in Figure 4.7.1. The predominant variety is a medium variety and cultivation of late variety becomes less common except in areas suffering from seasonal inundation in December during the early dry season.

### (4) Cropped Area and Production in the Project Communes

Aiming at obtaining basic reference data on rice production in the Target Area, rice production features in the project communes<sup>3</sup> have been examined based on the SEILA Commune Data Base and crop statistics of MAFF and PDAs.

#### (a) Cropped Area and Cropping Intensity

Cropped area and cropping intensity of rice in the project communes are estimated based on the SEILA Commune Data Base from 2002 to 2004 as shown in Table 4.7.3 and as summarized in the following table.

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<sup>3</sup> *Communes wholly or partly located in the Target Area*

### Cropped Area & Cropping Intensity in Project Communes

Item	Cropped Area	Cropping Intensity <sup>1/</sup>
Cropped Area and Cropping Intensity in the Rainy Season	38,705 ha	100 %
Cropped Area in the Dry Season	1,139 ha	3 %
Annual Cropped Area & Cropping Intensity	39,865 ha	103 %

<sup>1/</sup>: Total paddy field: 38,881 ha

Source: Shown in Table 4.7.3

As shown in the table, the overall cropping intensity of rice in the rice fields in the project communes is estimated at 100% in the wet season, but at only 3% in the dry season and 103 % annually. However, it was found from the water balance study made by the Study Team that the cultivation of dry or early wet season rice in the Area might be practiced under strict water shortage conditions.

#### (b) Paddy Yield and Production

Yield and production of paddy in the project communes are estimated on the basis of the statistic data of MAFF and PDAs as shown in Table 4.7.4 and as summarized in the following table.

### Paddy Yield & Production in Project Communes

Communes	Average Paddy Yield (ton/ha)				Production (1000ton)
	To Cropped Area		To Harvested Area		
	Rainy Season	Dry Season	Rainy Season	Dry Season	
Kampong. Speu <sup>1/</sup>	1.4	2.4	1.7	2.6	38.0
Kandal <sup>2/</sup>	1.8	2.8	1.9	2.8	17.2
All Project Communes <sup>3/</sup>	1.6	2.4	1.7	2.4	62.7

<sup>1/</sup>: Average of 2003/04 – 2004/05; <sup>2/</sup>: 2000/01 – 2003/04; <sup>3/</sup>: 2003/04 Source: Shown in Table 4.7.4

#### (5) Crop Losses

Because of unstable rainfall distribution and limited water resources for irrigation, rice production in the Target Area remains unstable and serious crop losses occurred in the rainy season 2004/05 due mainly to severe drought are reported as shown in Table 4.7.5 and as summarized below.

### Rice Crop Losses in 2004/05 and Normal Years in the Project Communes

Causes	2004/05 Rainy Season		2003/04 Rainy Season (Normal Year)	
	Area Completely Destroyed	Proportion to Cropped Area	Area Completely Destroyed	Proportion to Cropped Area
Drought	12,396 ha	36 %	295 ha	1 %
Flood	0 ha	-	710 ha	2 %
Pest & Disease	0 ha	-	148 ha	0.4 %
Total	12,396 ha	36 %	1,153 ha	3 %

As shown in the table, loss of rice plants caused by drought in the 2004/05 rainy season was very serious and reportedly about 36% of cropped areas suffered complete losses.

#### (6) Prevailing Farming Practices

##### (a) Prevailing Farming Practices

Prevailing farming practices in the Target Area by cropping season and land use category are presented in Table 4.7.6.

##### (b) SRI in and around the Target Area

Modified SRI (System of Rice Intensification) was initially introduced in the Target Area in Kampong Speu Province under the guidance of CEDAC (Centre d'Etude de Développement Agricole). Basic farming practices specific to the modified SRI are: i) use of raised beds for nurseries, ii) transplanting of a single seedling, iii) regular or line planting and iv) keeping rice field under nearly upland conditions up to flowering

(currently seldom applied in irrigated fields in the country).

In 2005, the areas in which the modified SRI in rainfed paddy fields was applied in Kampong Speu Province expanded greatly through the joint guidance of PDA and CEDAC. The extent of rainfed rice cultivation applying a part of SRI practices in the province is as follows;

**Area Introduced Modified SRI in Kampong Speu in 2005/06 Cropping Season**

District	No. of Villages	No. of Farmers	Cropped Area	Land Use
Chbar Mon	2	25	5 ha	Irrigated field
Samraong Tong	27	178	35 ha	Mostly irrigated
Kong Pisei	36	925	486 ha	Rainfed paddy field
Other Districts (2)	116	1,672	814 ha	Rainfed paddy field

*Source: Kampong Speu PDA*

In most cases, the SRI practices applied in the cultivation were transplanting of young seedlings, a single plant per hill and regular or line planting, but the SRI water management system was not practiced.

(7) Post-harvest and Processing

(a) Post-harvest and Processing

As described in the prevailing farming practices, manual operation of harvesting and threshing after sun drying in the field is common practice, although mechanical threshing employing an engine thresher is being introduced. After sun drying in home yards, paddy is stored in the home for family consumption or marketing. Storage of rice in farm households before consumption or marketing and the marketing of rice are almost exclusively in the form of paddy (dry unhusked rice).

Rice milling for family consumption is carried out at a small rice mill operated in a village. Prevailing arrangement of rice milling in the Target Area is free milling in stead of surrendering rice bran to a rice miller.

Rice milling facilities in the Target Area are mostly small scale rice milling units and are operated at the village level mainly for milling rice for family consumption. The number of such rice mills in the project communes is 1,427 in total. Rice milling capacities of such rice mills are mostly in the range of 200 to 500 kg of paddy/hour. Current rice milling capacity in the Target Area is far larger than the milling demand for family consumption in the Target Area.

In addition to such small scale rice mills, medium to large scale rice mills in the project communes are reported to be 67 in total. In such rice mills, commercial operation of procurement and processing is practiced. Among such millers, large scale commercial rice procurement and processing (milling) is operated by several large scale rice millers. Such large scale rice millers include Kasekam Angkhor and a rice mill at Prey Roka village in Angk Snuol District, Kandal and a rice mill in Chbar Mon, Kampong Speu. Kasekam Angkhor has a large scale rice mill factory with factory space of 3,840m<sup>2</sup>. The firm is procuring specified varieties of organic rice under a contract growing arrangement with farmers in Kandal, Kandal, Takeo and Kompot provinces. Rice milling capacity of the rice mill in Prey Roka village is 3.3 – 3.5 ton/hour and they are solely procuring and processing IR varieties of rice for supply to the military and police sector.

(b) Post-harvest Losses

Substantial post-harvest losses in rice production in the Target Area occur in many instances including: i) at harvesting, ii) after harvesting during field drying and transport from the fields to home yards for threshing, iii) at threshing and iv) at storage. In the food balance study on rice of the food security office, 13% of paddy productions are estimated as post-harvest losses and seed requirements for food security analysis.

#### (8) Problems and Constraints in Rice Production in the Target Area

Problems and constraints on rice production in the Target Area, which should duly be addressed in the present development plan, are enumerated in the following.

- Unstable and low productivity of rice primarily attributed to limited and unstable availability of water because of the limitation of available water resources and unstable rainfall distribution,
- With the limited availability of water resources, rainfed rice cultivation with poor and unstable productivity remains as a mainstay in farming activities,
- Prevailing farming practices characterized by use of traditional varieties, continuous use of self produced seeds, aged seedlings, random planting, limited application of fertilizer, inadequate post-harvest practices, etc., present serious problems attributing to low productivity,
- Single cropping of rice resulting in low annual land use intensity of around 100% and extremely limited production of upland crops,
- Farmers preference for medium or late traditional varieties resulting in a prolonged cropping season, higher water requirements and a single cropping of rice for almost all the paddy fields. Release of promising early and medium varieties by CARDI provide chances to improve such situations, but achieving shortening of the cropping season is still limited; and
- Substantial extent of land conversion from rice fields to industrial or settlement areas mainly along the National Roads.

#### 4.7.4 Food Balance

The food balance of rice in the project communes in the past 3 years was studied applying the method adopted in the food balance study of MAFF to obtain a rough idea of the food supply conditions in the communes. The results of the food balance study in the project communes are presented in Table 4.7.7 and the summary is shown in the following table.

**Food Balance of Rice in Project Communes**

Crop Year	Milled Rice Production (ton)	Milled Rice Requirement (ton)	Food Balance of Milled Rice (ton)	Proportion (%) <sup>1/</sup>
2002 – 2003	25,145	45,659	- 20,514	45
2003 – 2004	34,925	46,436	- 11,512	25
2004 – 2005	26,140	47,141	- 21,001	45
Average	28,736	46,412	- 17,676	38

<sup>1/</sup>: Proportion of deficits to requirements

Source: Shown in Table 4.7.7

As shown in the table, it is estimated that production is roughly 38% less than the requirements of the communes on average. The average deficit of some 17,680 tons of rice corresponds to about 32,000 tons of paddy, which is about 62% of the average annual production volume of 51,610 tons.

#### 4.7.5 Production of Other Crops

Compared with rice production, productions of other crops such as upland crops, vegetables and fruits are extremely limited in the Target Area. Cropped areas of upland crops and vegetables are extremely limited to about 4 % of an average annual rice cropped area of 39,900 ha. Major upland crops are mungbeans followed by groundnuts. Major vegetables include water melon, cucumber, string beans and morning glory. Major fruit trees found in the Area are banana, mango and coconut, although the planted area as a whole is limited.

Cultivation of upland crops, especially of mungbeans, is mainly practiced in the rainy

season. Mungbean cultivation in paddy fields is carried out under a non-tillage system. A local variety is planted and cultivation is extensive with very limited farm inputs (fertilizer) application. Productivity of upland crops in the Area is low and the yield level of mungbeans is estimated at less than 0.5 ton/ha.

Vegetable cultivation is mainly practiced in home gardens, upland & irrigated paddy fields close to Roleang Chrey Regulator, Krang Ampil Commune, which has a spring water supply and along the natural levee of the Prek Thnot River.

#### 4.7.6 Livestock

##### (1) Livestock Population and Holding

The livestock sub-sector is an important agricultural activity for farm economy and a substantial number of animals and poultry are raised in the project communes as shown in Table 4.7.8 and as summarized below.

**Livestock Population & Holding Status in Project Communes**

Item	Cattle	Cows	Draft Cattle	Pigs
Population	123,436	40,405	48,713	51,406
Holding Size/Farm (ha)	2.3	0.7	0.9	1.0
% of Households <sup>1/</sup>	63 %	-	-	26 %

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Data Base, 2004

<sup>1/</sup>: Percentage of households holding a subject animal

From the table, an average holding size of cattle, cows, draft cattle and pigs is calculated at 2.3, 0.7, 0.9 and 1.0 heads per farm household, respectively, equivalent to animal units of 4.2 in total. The holding size of poultry is calculated at 8.1 per farm. However, as the statistics include livestock & poultry held by commercial farms, the actual holding size per farm is lower than the said estimates. Farm households having livestock are rather limited and cattle/buffalos and pigs are raised by 63% and 26% of farm households, respectively. Commercial pig and poultry farms are operated to a substantial extent in and around the Target Area of Kampong Speu Province. The number and scale of such farms are as shown in the table to the right.

**Nos. of Commercial Livestock Farms in Kampong Speu**

Farm	Number	Farming Size (head)
Pig Farms	22	200 ~ 2,000
Poultry Farms	47	3,000 ~ 100,000

Source: PDA Kampong Speu

Land preparation for paddy cultivation is mostly done by draft animals in the Area and as a whole; the number of draft animals currently available appears to be adequate to carry out such work.

##### (2) Problems and Constraints in the Livestock Sub-sector

The livestock sub-sector is the second most important economic activity of farm households in the Target Area. In addition, draft cattle are primary sources of power for land preparation and transport of farm products. However, livestock husbandry in the Area is still in the stage of being rather less intensive and the sub-sector faces unstable and low productivity. Major constraints for the development of the livestock sub-sector, which should be duly addressed in the present development plan, are enumerated in the following:

- The primary constraint reported by PDAs is animal/poultry loss cause by disease due to insufficient veterinary service coverage,
- Less intensive or poor livestock raising practices are also current serious constraints to be addressed immediately in the sub-sector; and
- Other constraints are the lack of a comprehensive study on livestock development

potential in the environment of the Target Area including investigations on improvement of genetic resources and feed supply conditions as well as animal health issues.

#### 4.7.7 Inland Fishery

##### (1) Fish Production

In the Target Area, inland fisheries are the 3<sup>rd</sup> most important sub-sector (within the agriculture sector) following the crop and livestock sub-sectors in the rural economy, although figures on the production volume were not available because the majority of freshwater fish harvested in the Area is from capture fisheries. However, the role of aquaculture in fish production appears to be increasing.

Fishing activities in natural water bodies in the Area are allowed from October to June and the closed period is from July to September. However, the main fishing season is October to November. Most fish catches are consumed domestically either as fresh fish or processed products such as dried fish, fish paste (prahok) and fish sauce (tuk tery). Common species of fish caught include common carp, silver carp, silver barb, snake head, *Hypsibarbus pierrei* and *Trichogaster pectoralis*. Fishing lots are not established in the Target Area.

##### (2) Freshwater Fish Culture

The Fisheries Office of PDA Kampong Speu has fish breeding facilities and efforts to introduce freshwater fish culture in the Target Area have been made although they are still at the threshold level. Freshwater culture in the Area is carried out both in small ponds or ponds and rice fields. The PDA reported the existence of 150 small fish ponds in Vosai District (outside of the Target Area) in 2006 and the development of 40 small fish ponds in Kong Pisei in Kampong Speu Province. Kinds and number of breeding facilities of the Offices and those owned privately are shown in the following table.

**Fish Breeding Facilities in & around Target Area**

Project Province	Hatcheries	Breeding Ponds	Fingerling Production
Kampong Speu	3 (PDA)	8 (6PDA & 2 private)	± 2.0 million in 2005
Kandal	1 (project)	0	-

Source: Kampong Speu & Kandal PDA

Fish fingerling production capacities of the breeding facilities in Kampong Speu are reported to be 3 to 4 million.

In the Target Area, JICA lunched the Freshwater Aquaculture Improvement & Extension Project (FAIEX) in 2005 in 4 provinces including Kampong Speu and started cooperative efforts with the Fisheries Office of the province. Further, a commercial fish farm was recently constructed close to the Roleang Chrey Regulator.

Needs for diversification of income sources as well as improvement of nutrition could be addressed through the introduction of freshwater fish culture in the Target Area, especially directed to marginal status farmers. The main freshwater aquaculture strategies in Cambodia include: (i) fattening juvenile fish for market, (ii) stocking surplus fish in order to speculate on market prices, (iii) small-scale, low input fish-raising for food security purposes.

##### (3) Problems and Constraints in the Inland Fisheries Sub-sector

In the Target Area, inland fisheries are the 3<sup>rd</sup> most important sub-sector (within the agriculture sector) in the rural economy and needs for diversification of income sources as well as improvement of the farmers' nutrition could be addressed through the expansion of freshwater fish culture in the Target Area, especially for those marginal status farmers. However, freshwater fish culture appears to be still in an initial stage in the

Target Area, which appears to be the primary constraint for the development of an inland fisheries sub-sector in the Area. The approaches to be introduced in the present Study will be to initiate efficient use of water bodies/ponds and to diversify income sources through the introduction of freshwater culture.

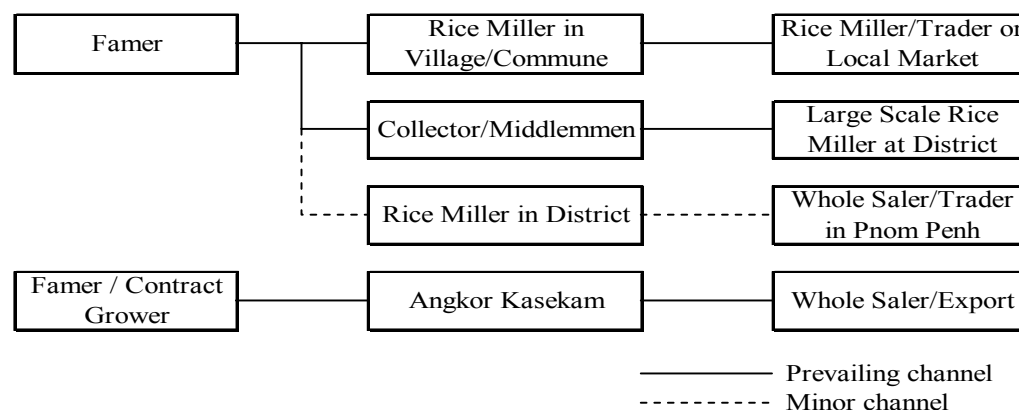
#### 4.7.8 Marketing

##### (1) Rice Marketing

##### (a) Marketing Volume and Channels

As the Target Area as a whole runs a rice deficit and the size of rice fields is estimated to be around 0.7 ha per farm, the volumes of rice that will be available for market are estimated to be small. The Socio-economic Survey presented in Table 4.7.9 indicates that an average amount of paddy marketed is 1,180 kg per those marketed and 670 kg per a sample farmer. However, the same survey also indicates that the amount of paddy marketed account for 34% of total products sold and 55% of the respondents (184 farmers) reported that they were marketing paddy. Marketing of rice in the Target Area is carried out almost exclusively in the form of paddy (dry unmilled rice). The farmers' timing of taking rice to market appears to depend on the individual farmer. However, the most common time for the farmer to sell rice is when cash is needed urgently followed by when he feels that the current price is high.

The prevailing marketing channels for paddy in the Target Area identified through the Socio-economic Survey, information provided by PDAs and rice millers and field surveys by the JICA Study Team are illustrated in the following figure:



**Prevailing Marketing Channel of Paddy**

As shown in the figure, the area specific marketing channel is the marketing under the contract growing with Angkor Kasekam Roongroeng Co., Ltd. located in Angk Snuol.

Another notable marketing system reported in the Target Area is a paddy mortgage system between farmers and rice millers. In the system, a farmer can deposit his products (paddy) at the warehouse of a rice miller without paying storage charges under the condition that he shall sell his products to the miller and that he is free to choose the timing of selling of his products. Such a system appears to be quite an advantage to farmers, however, according to agricultural agencies; there appear to be unfair practices involved in measuring and other stages by a miller. The JICA Open Paddy Market (OPM) Project has been introducing OPM Paddy Mortgage System in the pilot projects.

##### (b) Market Prices

Seasonal fluctuations in market prices of paddy are a common phenomenon in the Target Area and in Cambodia as well since cultivation of photosensitive varieties of rice prevail.



Generally, paddy prices are lowest from January to February just after the peak harvesting season and highest from September to October before the harvesting season. Further, price differences of about 50~100 Riel/kg between local medium/late varieties and improved early varieties (IR varieties) are also reported in the Target Area. Seasonal and varietal differences of paddy prices in the Target Area are reported as follows:

**Differences of Paddy Prices in Target Area in 2004/2005 (unit: riel/kg) <sup>1/</sup>**

Variety	(a) January ~ February	(b) September	Differences (b – a)
Local (medium/late)	590	700	110
Early Variety (IR)	550	620	70

<sup>1/</sup>: Farm gate prices of local varieties of paddy Source: Rice millers in the Target Area

Such price differences between varieties reflect consumers' preference for local varieties over improved varieties because of the preferred taste and aroma of the former compared with the later. As a common practice in irrigated areas, farmers grow local varieties in the rainy season for family consumption and improved varieties for marketing in the early rainy or dry season.

Farmers have little bargaining power in setting the price at which they sell their rice because of the small quantities sold by individual farmers and also the fact that prices of paddy are determined by buyers (rice millers or their agents or middlemen) on the basis of the wholesale market in Phnom Penh.

Major constraints for paddy marketing identified in the present Study through the Socio-economic Survey are the low and unstable market price of paddy followed by the limited market for paddy.

#### (2) Marketing of Other Agricultural Products

Both production and, therefore, marketing volumes of other crops are rather limited in the Target Area. Common marketing destinations of upland crops are local markets followed by middlemen and the usual destinations for vegetables are local markets followed by markets in district centers.

In contrast, a substantial number of animals and poultry are marketed as estimated from the population of those in the Area. Common market destinations for animals and poultry are middlemen followed by village markets and markets in district centers. There are 4 slaughter houses in and around the Target Area.

#### (3) Agro-processing

A notable agro-processing product in the Target Area is palm sugar, which is produced at the household level. Although, no data on production volumes was accessible, palm sugar production is an important income source in the Target Area.

#### (4) Marketing Facilities

The distribution of 17 village markets, 15 commune level markets and 4 district level markets are reported. Among such markets, the 4 district level markets are important marketing places for purchasing farm inputs and vegetables distributed from wholesale markets in Phnom Penh. The local level markets, village and commune markets are destination markets for agricultural products.

#### (5) Problems and Constraints in Marketing

Major paddy marketing constraints identified in the present Study are the low and unstable market price. The approaches to mitigate such constraints will be: (i) production of quality products through improvement of farming practices, (ii) formation of farmer groups and seeking possibilities to introduce contract growing or partnership arrangements as a group economic activity and (iii) provision of marketing information to farmer groups as an activity of the extension services; although chances to intervene in

marketing issues under the present Study will be limited because of the spatial limits of the Target Area.

#### 4.7.9 Agro-economic and Farm Economic Problems and Constraints

Problems in the captioned issues are closely related to low and unstable productivity of the crop sub-sectors and, therefore, to agronomic or technical issues.

Because of limited land holding size and irrigation water resources availability, the economic situation of the majority of farm households are at a marginal level. The approaches to be taken to mitigate such situations will be intervention for productivity improvement in agronomic or technical issues. However, such situations might be most serious with landless households, women headed households and farm households with land holding size of less than 0.1 ha. The approaches to be taken targeted to those households will be income generating approaches based on assistance from the farmer groups.

#### 4.8 Gates of Roleang Chrey Regulator and Other Structures

##### 4.8.1 General

The Roleang Chrey Regulator is the key structure for the irrigation system in the Target Area. The Roleang Chrey Regulator was constructed in 1974, and it is presently observed that some portions are deteriorated rather than damaged. In particular, the water gates, which are indispensable for proper water abstraction and flood control, are in such a crucially severe condition that they do not function properly.

Some water gates recently installed at the major canals connecting with the Regulator, also present poor situations such as leakage, unnecessarily long spindles and corrosion which might be due to improper design and/or lack of maintenance.

##### 4.8.2 Roleang Chrey Regulator

###### (1) General Information regarding the Gates

Item	General Information
Type	Fixed wheel gate
Number	5
Clear span	12.50 m
Height	6.70 m
Hoist	Electric driven, wire rope winding, one motor two drum, with counter weight
Construction year	1974

###### (2) Present Condition and Findings

###### (a) Gate Leaves

- Almost none of the main wheels are able to rotate because of resistance due to rusting of the shafts. The gates, therefore, cannot be closed fully when the upstream water level is high. The hoist mechanisms are overloaded while the gate is opening, which leads to the frequent burning of fuses.
- A lot of water leakage was observed due to aging and cracks in the rubber seal.
- The paint on the gate leaves has peeled off.
- The four wheels installed in a side girder could not smoothly rotate, which obstructs gate movement.

###### (b) Guide Frame

The entire guide frame could not be investigated in detail since it is partially submerged.

But its exposed parts seem to be sound.

(c) Hoist

- Electric motors, speed reducers, counter shafts and winding drums are still in running condition in spite of the fact that they are quite old.
- None of the brakes, position indicators or limit switches function at all. The operation of the hoist is carried out only by means of the experience and sense of the operator.
- The hoist wire ropes are aged but in service.
- As for the wire rope for the counterweight, a connection with the weight has been repaired using wire clips. Use of wire sockets is recommended.
- The number of spare parts held in stock, such as fuses and contacts for the magnetic switches are not sufficient.

(d) Diesel Generator

- A diesel generator of 23.9 kVA is aged, but still in working condition.
- As the output of this generator is small, no more than two gates can be operated simultaneously.

**4.8.3 Other Structures**

**4.8.3.1 Andong Sla Intake Gates (L1)**

(1) General Information regarding the Gates

General information of the Andong Sla intake gates (L1) is given below:

Item	General Information
Type	Steel radial gate, four sealing edges
Number	4
Clear span	4.00 m
Height	2.70 m
Hoist	Electric driven, wire rope winding, one motor two drum
Construction year	1974

(2) Present Condition and Findings

(a) Gate leaves

1) Corrosion

Although almost all parts are presently submerged and surface conditions were not observed, no heavy corrosion was found on the visible parts.

2) Leakage

Water is leaking through seals due to damage of the seal rubber and the wire rope holes of the gate leaf.



*Leakage through Gate Top Seal*

(b) Guide frame

The present condition of the guide frame is not clear because it was submerged.

(c) Hoist

1) Hoists for gates No.1 and No.2

The electric parts, such as motors and control cabinets for gates No.3 and No.4 were removed. This removal obliges us to operate these gates by manual cranking in limited openings. The hoisting wire ropes are damaged and now temporarily repaired using steel wires connected with the arm of the gate leaf.

2) Transmission line

At the time of construction in 1974, electric power was sent from the Roleang Chrey Regulator to the intake gates by a transmission line of about one kilometer. The cables have been removed and only a few poles remain.

**4.8.3.2 Tousamn Ang Check Gates**

(1) General Information regarding the Gates

General information regarding the Tousamn Ang check gates is given below:

Item	General Information
Type	Steel slide gate
Number	2
Clear span	2.0 m
Height	3.0 m
Hoist	Manually operated spindle hoist
Construction year	2003

(2) Present Condition and Findings

(a) Gate leaves, guide frame and hoist

No problems were found at the facility, and no countermeasures are required.

(b) Downstream side slope

Parts of the downstream side slope are severely eroded and could become unstable without warning, therefore, repair works are urgently required.

(c) Improper design

Some farmers claimed that ox-drawn carriages and motorbikes cannot pass smoothly over the culvert due to the steep slope of the approach.

**4.8.3.3 Ou Krang Ambel Intake Gates**

(1) General Information regarding the Gates

General information regarding the Ou Krang Ambel intake gates is given below:

Item	General Information
Type	Steel slide gate
Number	4
Clear span	3.5 m
Height	3.0 m
Hoist	Manually operated spindle hoist
Construction year	1987

(2) Present Condition and Findings

(a) Gate leaves

1) Paint

The paint is damaged and thus corrosion is proceeding.

2) Leakage

Leakage was observed through damaged rubber seals.

(b) Guide frame

The gates were originally designed as radial gates, but slide gates were installed using the guide frames for stoplogs. Due to this change, the guide frames were not equipped with stainless steel seal seats. This is one of the reasons for the severe leakage.

(c) Hoist

No problems are found with the hoist.



*Corrosion and Leakage*

**4.8.3.4 Vatkrouch Intake Gate**

(1) General Information regarding the Gate

General information regarding the Vatkrouch intake gate is given below:

Item	General Information
Type	Steel slide gate
Number	1
Clear span	4.00 m
Height	2.54 m
Hoist	Manually operated spindle hoist
Construction year	2002

(2) Present Condition and Findings

(a) Gate leaf

1) Corrosion

Corrosion was not observed although the paint is damaged.

2) Rubber seal

Condition of the rubber seal can not be observed since both sides of the gate leaf are submerged.

(b) Guide frame

Condition of the guide frame could not be observed due to its submergence.

(c) Hoist

There is no problem with the hoist itself but its ropes were temporarily repaired using steel wire.



*Temporary Measure for Wire*

**4.8.3.5 Phum Rong Intake and Check Gates**

(1) General Information regarding the Gates

General information regarding the Phum Rong intake and check gates is given below:

Item	General Information		
	Steel radial gate	Steel slide gate	Steel slide gate
Type	Steel radial gate	Steel slide gate	Steel slide gate
Number	1	3	1
Clear span	4.00 m	1.15 m	1.0 m
Height	2.54 m	2.0 m	1.0 m
Hoist	Manual wire rope winding	Manual spindle	Manual spindle
Construction year	2004	2004	2004

(2) Present Condition and Findings

	Steel radial gate	Steel slide gate
Gate leaf	Corrosion is not observed although the paint is damaged. Rubber seal can not be observed since both sides of the gate leaf are submerged.	No problem on the gate leaf was found
Guide frame	Condition of guide frame could not be clarified due to its submergence	No metal seal seat has been provided. The rubber seal touches and slides on the uneven concrete surface. Clearance between the concrete surface and the rubber seal is a cause of leakage. One of the operators strongly wants to stop the leakage.
Hoist	There were no problems with the hoist itself but the hoisting wire ropes were temporarily repaired using steel wire and chain	Maintenance is insufficient. Some debris and no lubricant were found in the spindle screw. A spindle cover pipe on the top and a bellows on the bottom are sometimes used as protectors for the spindle. Since fitting of the protector is not easy after installation of the hoist, those are not included in the scope.

#### 4.9 Irrigation and Drainage

##### 4.9.1 Inventory Survey for Irrigation Systems

###### 4.9.1.1 Objective and Scope

An inventory survey was conducted and completed by MOWRAM in Kampong Speu in March 2005. As the survey area contained the Target Area, the result could be utilized in the Study, although an additional inventory survey was required in Kampong Speu PDOWRAM. The supplemental items are (i) O&M responsibility for the irrigation facility, (ii) collection of water fees, (iii) flatness of paddy fields, (iv) water borne disease, (v) soil erosion, and (vi) problems in operation and maintenance, and so on.

In addition, the Study Team carried out inventory surveys in Angk Snuol District and Kandal Stung District, which are contained in the Target Area, to understand the current situation of the irrigation and drainage condition.

The questionnaire used in Kampong Speu by MOWRAM was presented and explained to Kandal PDOWRAM by the Study Team. To identify the irrigation area, the Study Team requested that a village chief or inhabitant show the boundary of the irrigation area in the field. The main points of the boundaries so indicated were identified by handheld GPS, and plotted on a topographic map with a scale of 1 to 50,000.

###### 4.9.1.2 Major Findings through Inventory Survey

The following are the major findings from the Inventory Survey and field inspection by the Study Team.

- There are 85 irrigation systems in the Target Area

- Out of them, 67 irrigation systems each have an individual small reservoir
- Each irrigation system is an independent system operated by PDOWRAM or the farmers even though some of them currently receive supplementary irrigation water from the two Main Canals from the Roleang Chrey Regulator.

#### 4.9.1.3 Classification of Inventoried Irrigation Systems

Based on the Inventory Survey by MOWRAM and the Study Team, irrigation systems were classified by water source and irrigation method.

##### (1) Classification by water source

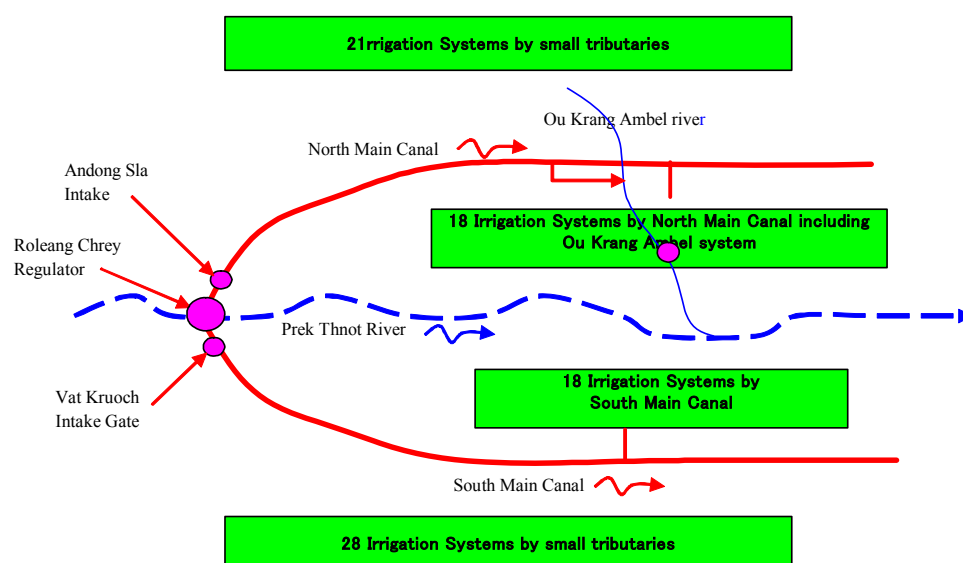
The irrigation systems in the Target Area were classified into 2 types by water source.

**Irrigation Systems Classified by Geographic Condition and Water Source**

Category	Type of Water Source	No of Systems	Inventory Area <sup>1/</sup>	No. of Systems with Ponds
1	Prek Thnot River	35	15,207	17
2	Ou Krang Ambel River	1	498	1
3	Small Tributaries	49	1,796	49
	Total	85	17,501	67

<sup>1/</sup>: Reported by farmers or PDOWRAM, Source: Study Team

The inventory area mentioned above is estimated without applying probability concept for water supply which is generally used for delineation of irrigable area, and includes even the area which is irrigated only a few days in each crop season or the areas which are only irrigated once every few years. Thus, the inventory area does not mean the proposed irrigation area.



##### (2) Classification by irrigation method

The irrigation systems in the Target Area are classified into 3 types by irrigation method currently being applied.

**Irrigation Systems Classified by Irrigation Method**

Category	Type of Irrigation Method	No. of System	Inventory Area (ha) <sup>1/</sup>
1	Gravity	1	180
2	Gravity and Small pump by farmers	80	15,325
3	Pump by PDOWRAM	4	1,996
	Total in the Target Area	85	17,501

<sup>1/</sup>: Reported by farmers or PDOWRAM, Source: Study Team

In the above table, gravity and small pump systems operated by farmers are predominant in the Target Area. This means farmers have to pump irrigation water from an adjacent canal because the water level in the canal is lower than in the paddy field. The reasons are that:

- Canal route was decided without paying careful attention to operation of a gravity system, and
- The check structures are insufficient in number to maintain a high enough water level

Only one gravity irrigation system is located in Kandal Province, but even this does not function presently because its pond is damaged.

#### 4.9.1.4 Definition of Irrigation Area

(1) Inventory Area obtained by Inventory Survey

The area obtained by the inventory survey is quite large as follows:

**Inventory Area by Farmers and PDOWRAM (Unit: ha)**

Name of District	Inventory Area in Rainy Season	Inventory Area in Dry Season
Chbar Mon	325	243
Samraong Tong	10,875	711
Kong Pisei	206	17
Angk Snuol	4,139	0
Kandal Stung	1,956	10
Total	17,501	981

*Source: Study Team*

The above figures were carefully studied in the present Study as described hereunder.

(2) Definition of Irrigation in Cambodia

Irrigation generally means artificial water supply to the crops to cover a deficit between crop evapotranspiration and various water losses which inevitably occur between water sources to the crop field and the effective rainfall in order to secure healthy growth and yield of the crops. However, in the Target Area, as well as Cambodia in general, the volume of water given to the crop can not be considered to be adequate. People call this “Supplemental Irrigation” when whatever available amount of water is given to crops whether it is sufficient for healthy growing and reasonable yield of crop or not.

(3) Present Irrigation Area Assumed

Due to idea of “Supplemental Irrigation”, identification of irrigation areas is also different from that generally accepted. During the inventory survey, the inventory area boundary indicated by the farmers contained the area which is irrigated only a few days in each crop season or the areas which are only irrigated once every few years.

The result of the Inventory Survey was compared with available water in the Target Area as described in the following Chapter. Eventually, the present irrigation area is assumed to be about 6,000 ha in the rainy season, which is about 30 % of the development area obtained through the inventory survey.

#### 4.9.2 On-going or Proposed Irrigation Projects in and around the Target Area

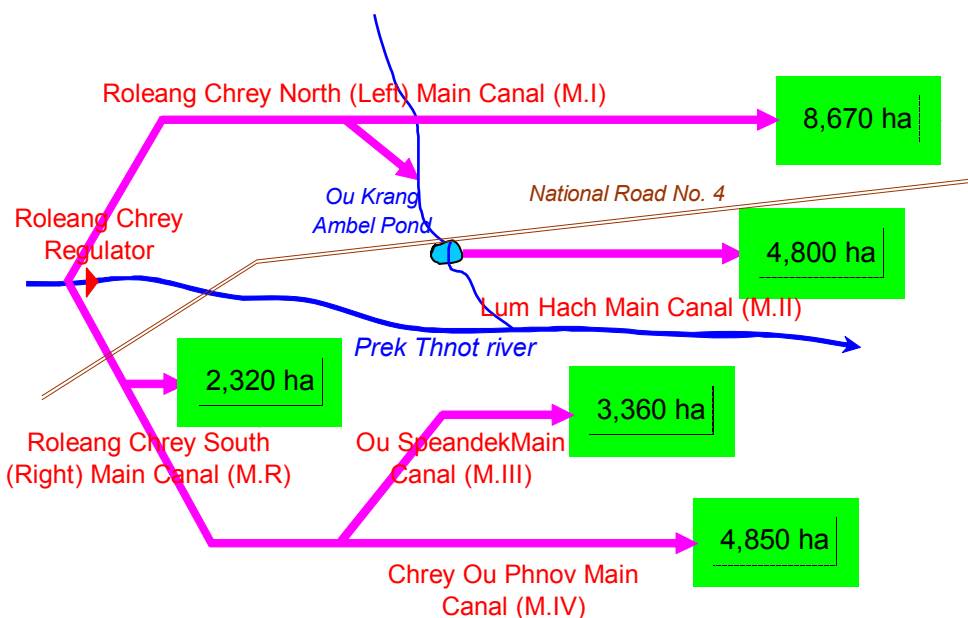
(1) Western Phnom Penh Integrated Development Center Project

The project was started in 2001 using government budget. The project aims to irrigate about 24,000 ha which are spread over Kampong Speu Province, Kandal Province, Phnom Penh Metropolitan Area, and Takev Province. The project’s main facilities area includes Roleang Chrey Regulator and Intakes, the North and South Main Canals, and secondary canals. Outline of the project is summarized as follows:



- Total project cost:	US\$7,900,000 (about 7% has been invested up to 2005)
- Water source:	Prek Thnot River: Roleang Chrey Regulator and Intakes, Pump stations (4 new, 1 rehabilitation)
- Service area:	24,000 ha
- Main canals:	North Main Canal 8,670 ha, Design capacity 15 m3/sec, Lum Hach canal (M.I) 4,800 ha, starts from Ou Krang Ambel Pond, South Main Canal (MR) 2,320 ha, Design capacity 15 m3/sec Ou Speandek canal (M.III) 3,360 ha, Chrey Ou Phnoy canal 4,850 ha
- Secondary canals:	19 secondary canals 62 km,
- Tertiary canals:	50 tertiary canals 192 km
- Drainage canals:	26 drains 95 km
- Major structures:	Spillways 2, Turnouts 40, Inlets 14, Bridges 24, Culverts 72, Maintenance roads 79 km,
- Formation of FWUC	Not specified in number

### Western Phnom Penh Integrated Development Center Project



As shown in the above figure, most parts of the project service area are located in the Target Area. The irrigation water is supplied to the area through the Roleang Chrey Regulator and Main Canals which were constructed in the 1970s but not used effectively until the early 2000s. The project contains all irrigation areas in the Target Area. The major problems envisaged with this project, which have been obtained from the Inventory Survey and field inspection by the Study Team means, are as follows.

- The size of the planned service area is very large due to no rational water balance study between available water resources and water demand.
- Water level is planned to be lower than paddy fields, however, the number of check structures is insufficient.
- Quality of construction work is low.

The problems and current situation of the project are analyzed in the following section in detail.

#### (2) Other On-going and Proposed Irrigation Projects and Systems

- Kandal Stung Irrigation Project

- Dangkor Irrigation Project
- Tonle Bati Irrigation Project

These project and systems are located outside of the Target Area but downstream of Prek Thnot River, and are planned to take irrigation water from Prek Thnot River. So, their irrigation water requirements are to be taken into account in the water balance study (refer to Chapter 6).

### 4.9.3 Irrigation Systems Supplied from the Prek Thnot River

- (1) Roleang Chrey Regulator, Andong Sla Intake Gate, and North Main Canal

Roleang Chrey Regulator is located in the Prek Thnot River in Roleang Chrey Village, Taing Kruoch Commune, Samraong Tong District in Kampong Speu Province.

The construction of the Roleang Chrey Regulator, Andong Sla Intake, and North Main Canal (NMC) was planned in the late 1960s and started in the early 1970s as a part of the Prek Thnot Multi Purpose Project. Roleang Chrey Regulator was constructed to control the water level in the Prek Thnot River. Andong Sla Intake was constructed about 800 m downstream from the Regulator of NMC to control water taken from the River and to send it to the northern area of the Prek Thnot River. The construction of the North Main Canal ceased completely because of internal disturbances. After 1979, the construction was resumed by the government under assistance by donor countries. The most downstream part of NMC has been recently constructed by MOWRAM. The total length of NMC from Roleang Chrey Regulator to the end point in Angk Snuol District in Kandal Province is about 32 km.

#### Irrigation Systems fed by NMC

Nos. of system	Inventory Area <sup>1/</sup> (ha)	Wet season irrigated area <sup>2/</sup> (ha)	Nos. of systems having reservoirs
18	5,445	3,100	10

<sup>1/</sup>: Reported by farmers or PDOWRAM

<sup>2/</sup>: Assumed by the Study Team

There are 18 irrigation systems branching off from NMC at the present. The present supplemental irrigation area is assumed to be about 3,100 ha. Most of them were constructed in the late 1970s by farmers.

The Ou Krang Ambel irrigation system is located close to NMC, and is currently receiving water from it.

The design of NMC has continued, but has deviated considerably from the original design in 1960s. At present, the following problems are reported by farmers and were observed by the Study Team.

#### NMC and Related Structures

- (a) The water level in the canal is generally lower than the paddy fields because of lack of check structures. So, the water level in the secondary or tertiary canals is lower than the paddy fields. This forces farmers to use pumps in many places.
- (b) The excavated sandy soil is being deposited on both sides of the canal without compaction due to lack of construction budget. The soil, therefore, severely erodes and flows into the canal, which results in decreasing flow capacity.
- (c) The number of turnouts which divert water from the main canal to the secondary and tertiary canals are not sufficient. This makes it difficult for farmers to take water from the main canal. To solve this problem, farmers excavate the canal embankment and bury pipes in many places (so called Farmers' Intakes). They do not properly backfill these places, which causes collapse of the canal.
- (d) Culverts are not provided in sufficient numbers in the canal, which makes it difficult

for people to cross the canal for daily activities. To settle this problem, people block the canal with soil, which results in a decrease of flow capacity in the canal.

#### Secondary canals and related structures

- (a) The water level is lower than the paddy fields so that pumping of water is required.
- (b) In the secondary and tertiary canals, the number of related structures, such as turnouts, checks, and culverts is not sufficient due to lack of budget. This obstructs proper water management such as timely irrigation and smooth water distribution.
- (c) The number and length of secondary canals are not sufficient for smooth water supply.

#### Ponds

Not all 9 ponds have gates on the intake structure. Out of the 9, only 3 ponds presently function. The embankments of three of the systems are partly damaged but function. The remaining three systems have serious damage.

#### (2) Vat Kruoch Intake Gate and South Main Canal

Vat Kruoch Intake Gate was constructed about 1.5 km south from Roleang Chrey Regulator to divert water from the Regulator to the southern area of the Prek Thnot River. Since then, MOWRAM continued construction of the South Main Canal (SMC), and it was completed by 2002. The total length of SMC from Roleang Chrey Regulator to the end point i.e. crossing point with National Road No.3 in Kong Pisei in Kampong Speu Province is about 38.5 km.

#### **Irrigation Systems fed by South Main Canal**

<b>Nos. of system</b>	<b>Inventory Area <sup>1/</sup></b>	<b>Wet season irrigate area <sup>2/</sup></b>	<b>Nos. of system w/pond</b>
18	10,260 ha	2,100 ha	9

<sup>1/</sup>: Reported by farmers or PDOWRAM

<sup>2/</sup>: Assumed by the Study Team

There are 18 irrigation systems located in the SMC area at present. The present supplemental irrigation area is assumed to be about 2,100 ha. Most of them were constructed in the late 1970s by farmers.

At present, the following problems are reported by farmers and observed by the Study Team.

#### SMC and related structures

- (a) The water level in SMC is generally lower than the paddy fields because of lack of check structures. So, the water level in the secondary or tertiary canals is also lower than the paddy fields. This forces farmers to use pumps in many places.
- (b) The route of SMC was selected along the contour line at EL. 30m. Accordingly, the top of canal bank is almost constant at about 30 m, but the canal base was designed to have a downward slope resulting in high freeboard, which leads to a high pumping head.
- (c) Permanent turnouts, which divert water from SMC to secondary and tertiary canals, were not constructed in sufficient number. It makes it difficult for farmers to take water from the main canal. To solve this problem, farmers have excavated the canal embankment and buried pipes. They do not properly backfill these places, so that collapse of canal causes major problems.
- (d) There are not enough culverts provided in the canal, therefore people face difficulty in crossing the canal for daily activities. To cope with this problem, people block the canal with soil, but these results in decreasing flow capacity in the canal.

### Secondary canals and related structures

- (a) The water level is lower than the paddy fields requiring pumping by the farmers.
- (b) In the secondary and tertiary canals, related structures such as turnouts, checks, and culverts were not constructed in sufficient numbers due to lack of budget. This obstructs proper water management, such as timely irrigation and results in high pumping cost, blocking the canals with soil for crossing and so on.
- (c) The number and length of secondary canals are not sufficient for proper irrigation.

### Reservoirs

Not all 9 reservoirs have gates on the intake structure. Out of the 9, only one reservoir dike is in fairly good condition. The embankments of seven of the reservoirs are seriously damaged. One reservoir embankment is partly damaged but functions.

### Pumps in Prek Thnot River

Three systems take water from the Prek Thnot River by pumps which were installed by the government. All systems are located in Kandal Stung District in Kandal Province, and geographically included in the SMC command area. Pumps of 500 mm diameter have been installed. Due to shortage of operation funds, these pumps are operated for only limited times, such as severe drought periods. The condition of the pumps is fairly good.

## **4.9.4 Irrigation Systems Supplied by Water Harvesting from the Tributaries**

There are 49 irrigation systems outside of the NMC and SMC command areas. All systems have reservoirs. Water sources for these systems are small tributaries of the Prek Thnot River, of which, the catchment areas vary from more than 100 km<sup>2</sup> to less than 10 ha. Average catchment area is 2 km<sup>2</sup>, and the most frequent size is about 1.0 km<sup>2</sup>. Not all tributaries have perennial flow. These reservoirs collect only rainfall in the catchment, which is thus called “Water Harvesting” in this Study. Since the catchment is small, the reservoirs are usually dry from January to May.

### Irrigation Systems by Water Harvesting Facilities

No. of Systems	Inventory Area <sup>1/</sup> (ha)	Inventory Area in Rainy Season <sup>2/</sup> (ha)	No. of Systems with Reservoir
49	1,796	800	49

<sup>1/</sup>: Reported by farmers or PDOWRAM

<sup>2/</sup>: Assumed by the Study Team

The total inventory area is reported to be 1,796 ha. Out of 49 systems, only 13 systems function fairly well. The embankments of 21 reservoirs are partly damaged but function anyhow. Those of 15 reservoirs are seriously damaged, so that do not function well or do not function at all.

## **4.9.5 Operation and Maintenance**

### (1) Responsible Organization

Based on the Inventory Survey and information collected from PDOWRAM, the organization responsible for operation and maintenance of irrigation facilities in the Target Area are classified as follows.

### Responsibility for Operation and Maintenance of Irrigation Facilities

Facility	Organization		
	PDOWRAM	Farmer Water User Community	Individual farmer
Roleang Chrey Regulator and 2 Intakes	○	X	X
NMC and SMC	○	X	X
Pumps on Prek Thnot River	○	X	X
Secondary canals	○	X	X
Tertiary canals	X	○	X
Reservoirs	X	○	X
Small pumps	X	X	○

According to the inventory survey, Farmer Water User Communities (FWUCs) have been established for 25 irrigation systems so far, but are not yet registered to MOWRAM.

#### (2) Operation and Maintenance of Roleang Chrey Regulator and Intake Gates

The operation and maintenance of Roleang Chrey Regulator and Andong Sla Intake Gate and Vat Kruoch Intake Gate are the responsibility of Kampong Speu PDOWRAM. But it has been executed by one aged person who has been working since the 1970s.

There is no operation manual for the Regulator and Intake Gates. Regulator gates are opened in the rainy season when the upstream water level reaches the critical level of the upstream embankment, which is about EL. 35.8 m. However, due to mechanical problems with the gate hoist system and the large size of the gates, the gates can not be operated smoothly as required. To cope with this, the gate operator opens the gate more than is required and then closes it after the water level goes down. This causes remarkable fluctuation in the water level in the downstream intake sites such as Tuk Thla and Kampong Tuol located about 50 km downstream in Kandal Province. In the dry season, when the river flow decreases remarkably, a gate has to be opened to release a small amount to the downstream. However, due to the same problem, it is difficult to constantly release only a small amount.

Intake gates are customarily operated based on requests from the farmers of NMC and SMC. The intake gates of NMC and SMC are opened alternately.

Although the gates are operated by a skillful operator, such operation results in much loss of water sources as well as presenting a high risk of damage to the facilities. The gate facilities, including a system for communication among the gate operator, the PDOWRAM office and MOWRAM, have to be improved urgently.

#### (3) Operation and Maintenance of NMC and SMC

There is no written operation manual for the main canal facilities. Opening of turnout gates in the main canal is executed by FWUC concerned.

In SMC, an inspection road was recently repaired. The condition of the canal structures, however, is still poor due to lack of proper maintenance. These results in much water loss and discourage stakeholders to participate in water management activities.

#### (4) Operation and Maintenance of Water Harvesting Reservoirs

A reservoir irrigation system is operated by FWUC concerned. The operation rules are presently determined by FWUC. The existing embankments, reservoirs, and canal structures are mostly in very poor condition. MOWRAM is allocating budget for rehabilitation of reservoirs. But many reservoirs are left unrepaired due to limited budget.

#### 4.9.6 Water Management

##### (1) Irrigation Service Plan

No written Irrigation Service Plan has been prepared by PDOWRAM or FWUC although it has been recommended by MOWRAM.

##### (2) Present Activity

At present, water management activity seems to be left to FWUC. The reasons are as follows:

- (a) There is no systematic approach to implement water management activity. The reasons are:
- Poor irrigation canal system,
  - No O&M manual for the facilities,
  - No guidelines or tools to rationally predict a base flow in the Prek Thnot River,
  - Lack of government budget for O&M, and
  - Not enough human resources
- (b) Farmers in the Target Area do not have adequate experience in planning and exercising water management plans, so that they do not enjoy the benefits obtained by executing proper water management activities.
- (c) The main structures in the Prek Thnot River and canals are deteriorated and hard to control smoothly.
- (d) FWUCs are not yet well organized or activated

#### 4.10 Institution

##### 4.10.1 MOWRAM

###### 4.10.1.1 National Level

##### (1) Mission, Organization and Staff Number

MOWRAM is a relatively new government agency which was established in 1999. The National Water Resources Policy states that the long-term mission of MOWRAM is to manage and develop water resources in an effective, sustainable and equitable manner, to protect ecosystems, and to reduce the effects of water related hazards such as floods and droughts on people's lives and public property. To fulfill this mission, MOWRAM had 9 departments and 707 staff in total as of November 2004, out of which 195 are engineers. Figure 4.10.1 shows the organizational chart of MOWRAM.

##### (2) Budgets for the Central Office

Approved annual budgets for the central office from 2001 to 2005 is given below:

**Approved Annual Budgets for Central Office (Unit: Riel unless noted)**

Category	2001	2002	2003	2004	2005 <sup>1/</sup>
Administration	7,511,616,000	10,503,500,000	10,739,000,000	11,652,000,000	12,330,000,000
Development	1,076,231,050	363,000,000	500,000,000	3,510,315,100	19,766,520,000
	US\$5,809,930	US\$5,266,439	US\$4,850	-	-
Total	8,587,847,050	10,866,500,000	11,239,000,000	15,162,315,100	32,096,520,000
	US\$5,809,930	US\$5,266,439	US\$4,850	-	-

Source: MOWRAM

<sup>1/</sup>: Estimated

As can be seen in the table, development budget fluctuates largely every year, which is due to varying financial assistance from donors.

#### 4.10.1.2 Local Level

##### (1) Mission, Organization and Staff Number

MOWRAM has 24 provincial departments, which manage 183 district offices. Figure 4.10.2 shows the organizational chart of the Provincial Department of Water Resources and Meteorology (PDOWRAM). Major technical missions of the provincial department are to (a) prepare short, medium and long term development plans, (b) research and observe natural disasters, (c) collect meteorological and hydrological data, (d) implement operation and maintenance of irrigation systems, (e) organize and train FWUC, and (f) study, plan, design and construct small scale projects.

##### (2) Budget for PDOWRAM

Annual budgets for PDOWRAMs from 2001 to 2005 are shown below:

Category	2001	2002	2003	2004	2005 <sup>1/</sup>
Administration	2,408,600,000	2,726,300,000	3,755,131,000	3,698,000,000	3,030,000,000

<sup>1/</sup>: Estimated

Annual budget for provincial and district offices has increased year by year. This increase in budget might be due to the decentralization policy.

#### 4.10.2 MAFF

##### 4.10.2.1 National Level

MAFF is a huge government ministry. The primary mission of MAFF is to ensure the food security for the people and generate higher incomes for their better living standards, education and welfare, and to increase agricultural production from year to year, for supporting local industries and for promoting exporting, from which the commercial balance is to be maintained. To accomplish this mission, MAFF is operating 13 departments and 24 provincial departments. Figure 4.10.3 shows the current organizational structure of MAFF. The budgets for 2004 and 2005 were Riel 29,600 million (US\$ 7.4 million equivalent) and Riel 53,135 million (US\$ 12.5 million equivalent), respectively. The breakdown of these budgets is given below:

Items	2004		2005	
	Riel 1,000	US\$	Riel 1,000	US\$
Salary and Bonus	4,530,000	1,132,500	12,523,000	3,130,750
Administrative Work, Material & Minor Maintenance	7,550,000	1,887,500	17,622,000	4,405,500
Duty Allowance	6,200,000	1,550,000	7,900,000	1,975,000
Program Cost	10,000,000	2,500,000	7,500,000	1,875,000
Interest Repayment for Loan \$ Debt	0	0	0	0
Economic Intervention	740,000	185,000	3,700,000	925,000
Social & Cultural Intervention	80,000	20,000	490,000	122,500
International Intervention	500,000	125,000	400,000	100,000
Total	29,600,000	7,400,000	50,135,000	12,533,750

Out of these items, program cost means the development cost, and its amount increased largely in 2005.

##### 4.10.2.2 Local Level

The Provincial Department of Agriculture (PDA) is a provincial agency of MAFF.

Figures 4.10.4 and 4.10.5 show the organizational structure of PDA Kampong Speu and Kandal, respectively. PDA has 6 technical offices and 2 administration offices. District offices belong to PDA. The total number of staff, including district offices, is 269 in Kampong Speu and 331 in Kandal, respectively.

#### 4.10.3 Commune Councils

The Commune is the smallest administrative unit under the Ministry of the Interior. A Commune is governed by a Commune Council (CC). CC is headed by a Commune Chief, who is selected by the Commune Council Election every 5 years. The members of CC are also elected at the same time. The roles, duties and functions are stipulated in the “Law on the Administration and Management of the Commune”. CC serves as a contact between the villages and donors.

#### 4.10.4 Village Development Committees

Village Development Committees (VDC) are established according to the guidelines approved by RGC in 1999. VDC members are elected through secret ballot by the villagers, and thus the villagers rely on the VDC and regard it as their representative. The Ministry of Rural Development (MRD) has been working to strengthen or organize the VDC, but the VDC are independent organizations. Therefore, the VDC does not have any political, religious, or racial influences. Usually, the VDC cooperates with the Village Chief when the donors come to the village for development and/or support. It is remarkable that the VDC members do not receive any salary or allowance, but continue their activities none the less. Their incentives are that they have better opportunities to join training courses and study tours than the ordinary villagers, and that the villagers rely on them. Currently, 70% of the villages in the Target Area have established a VDC and the rest are preparing to do so.

#### 4.10.5 Farmers’ Water Users Community

Forming of FWUC and its subordinate organization, Farmers’ Water Users Group (FWUG) has been promoted by MOWRAM. They have been established based on the FWUC statute issued in June 2000. The main objectives of FWUC are to supply adequate water for irrigation to the members, and to acquire knowledge of management, operation and maintenance of the irrigation system as well as financial affairs. The table below presents the inventory data on FWUC in the Target Area. As shown in the table, 25 FWUCs have been established in the Target Area but none of them are officially registered. Most of the FWUCs are generally inactive, mainly due to lack of functional irrigation systems.

**Inventory Data on FWUC**

Name of Irrigation System	Area		
	Commune	District	Province
Ou Kam Pis	Roka Thum	Chbar Mon	Kampong Speu
Prey Sya	Roleang Chak	Samraong Tong	Kampong Speu
Prey Svay	Roleang Chak	Samraong Tong	Kampong Speu
Prey Robang	Roleang Chak	Samraong Tong	Kampong Speu
Prey Ronggeang	Skuh	Samraong Tong	Kampong Speu
Anlong Por	Roleang Chak	Samraong Tong	Kampong Speu
Bak Thmenh	Roleang Chak	Samraong Tong	Kampong Speu
Ou Veang	Kahaeng	Samraong Tong	Kampong Speu
Daun Try	Roleang Kreul	Samraong Tong	Kampong Speu
Rong Kor	Rong Kor	Samraong Tong	Kampong Speu
Prey Rumduol	Saen Dei	Samraong Tong	Kampong Speu
Roleang Chrey	Tang Krouch	Samraong Tong	Kampong Speu
Thmor Pouk	Thommada Ar	Samraong Tong	Kampong Speu



Name of Irrigation System	Area		
	Commune	District	Province
Ou Krang Ambel	Trapeang Kong	Samraong Tong	Kampong Speu
Sala Kruos	Preah Nipean	Kong Pisei	Kampong Speu
Boeng Chram Khang Cheung	Preah Nipean	Kong Pisei	Kampong Speu
Pring Tuek	Roka Kaoh	Kong Pisei	Kampong Speu
O Ta Pung	Roka Kaoh	Kong Pisei	Kampong Speu
Day Krohorm	Roka Kaoh	Kong Pisei	Kampong Speu
Samdech Sang Choun Nath	Roka Kaoh	Kong Pisei	Kampong Speu
Domnak Ampil main canal	Damnak Ampil	Angk Snuol	Kandal
Ta Hor Canal	Prey Puok	Angk Snuol	Kandal
Ta Hor Canal	Krang Mkaka	Angk Snuol	Kandal
Ta Hor Canal	Boeng Thum	Angk Snuol	Kandal
Ta Hor Canal	Lom Hach	Angk Snuol	Kandal

Source: Inventory List of FWUCs of Cambodia, MOWRAM, Socioeconomic Survey by the Study Team

#### 4.10.6 Farmers Organization

A Farmers Organization (FO) is defined in the Status of FOs in Cambodia, MAFF 1999 as; “An organization which is a collective entity of farmers in a village or in a number of contiguous villages who have come together for an economic activity related to agriculture”. Under the coordination of MAFF, there are 4 FOs; Agricultural Cooperatives, Community Forestry Communities, Fishery Communities, and Village Animal Health Worker Associations (VAHW). According to the reports from PDA Kampong Speu and Kandal Provinces, there are 3 agricultural cooperatives in the Target Area. One is in Preah Nipean Commune, one is in Prey Nheat Commune, and the last is in Roleang Kruek Commune of Kampong Speu Province.

#### 4.10.7 SWOT for Institutional Analysis

##### (1) Background

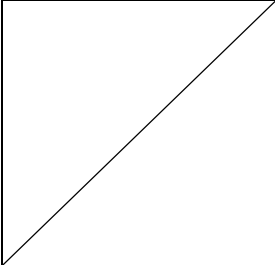
Participatory workshops applying SWOT (Abbreviation of Strengths, Weaknesses, Opportunities and Threats) analysis were held to understand the present condition of the governmental agencies concerned with the Study; MOWRAM, MAFF, PDOWRAMs and PDAs in Kandal and Kampong Speu Provinces. The final goal of the workshops was to formulate the strategies for strengthening and developing the agencies from the viewpoint of officers working for the agencies respectively. The workshop also aimed at seeking of the means for implementing cooperation and collaboration between the governmental agencies mentioned above and the Study Team.

##### (2) Results of SWOT Workshops and Findings

###### (a) MOWRAM

“Managing and developing the water resources and taking the data on meteorology constantly” is regarded as the “Mission” of MOWRAM among the participants. SWOT and the 4 types of strategies to achieve the mission mentioned above are as follows.

### WOT Matrix for MOWRAM

	<b>Opportunities</b> <b>1<sup>st</sup>:</b> RGC is interested in irrigation systems. <b>2<sup>nd</sup>:</b> There is the water management policy. <b>3<sup>rd</sup>:</b> There is the support from JICA. <b>4<sup>th</sup>:</b> Farmers cooperate with MOWRAM in repairing irrigation systems.	<b>Threats</b> <b>1<sup>st</sup>:</b> Cambodian people face flood and drought almost every year. <b>2<sup>nd</sup>:</b> The budget to develop water resources is not sufficient. <b>3<sup>rd</sup>:</b> MOWRAM doesn't receive enough budget for constructing irrigation facilities.
<b>Strengths</b> <b>1<sup>st</sup>:</b> MOWRAM has good planning skill. <b>2<sup>nd</sup>:</b> Managers have leadership ability and manage the works properly based on their technical skills. <b>3<sup>rd</sup>:</b> Most staffs are capable.	<b>Growth Strategy</b> <ul style="list-style-type: none"> <li>• Submitting plans and projects to the National Assembly and requesting support from JICA for the development.</li> <li>• Making a good master plan about the irrigation system that would last for a long time with support from JICA.</li> <li>• Controlling of information on hydrology and meteorology.</li> <li>• Controlling and developing the water resources.</li> <li>• Requesting the farmers' participation in maintaining the irrigation systems.</li> <li>• Establishing laws and regulations about sustainable water use and practicing them.</li> </ul>	<b>Avoidance Strategy</b> <ul style="list-style-type: none"> <li>• Requesting enough budget from the National Assembly or other organizations for construction of irrigation systems in order to fight drought.</li> <li>• Establishing flood control plans.</li> <li>• Building levees to prevent flooding and reservoirs to store water to fight drought.</li> <li>• Preparing the request for budget in order to improve and build more sufficient irrigation systems led by capable officers.</li> </ul>
<b>Weaknesses</b> <b>1<sup>st</sup>:</b> Staffs' salary is low. <b>2<sup>nd</sup>:</b> Distribution of the work assignment is not proper. <b>3<sup>rd</sup>:</b> There is no training program to modernize the knowledge within MOWRAM.	<b>Improvement Strategy</b> <ul style="list-style-type: none"> <li>• Improve the management and the administration to develop the human resources through requesting help from RGC.</li> <li>• Requesting higher allowances, bonuses, and salaries.</li> <li>• Requesting more cooperation from the officers of the other organizations.</li> <li>• Improving the human resources through asking for help from JICA.</li> <li>• Creating more training programs for officers and farmers.</li> <li>• Increasing the salary and allowances of the staffs that perform well.</li> <li>• Improving technical skills to work more effectively and to receive more pay.</li> <li>• Improving the staffs' capacity to apply for the natural disaster related jobs.</li> </ul> <p>(The job assignments are not based on the hierarchy status, and staffs' salary is low. Is this the reason that we cannot cooperate and work properly?)</p>	<b>Withdrawal Strategy</b> <ul style="list-style-type: none"> <li>• Expecting more state budget allocation to MOWRAM.</li> </ul>

(b) MAFF

“Improving agricultural productivity for enhancing food security and promoting export to boost national economy” was regarded as the “Mission” of MAFF among the participants.

The participants believed this mission plays an important role to reduce poverty. SWOT and 4 types of the strategies to achieve the mission mentioned above are as follows.

**SWOT Matrix for MAFF**

	<p style="text-align: center;"><b>Opportunities</b></p> <p>1<sup>st</sup>: MAFF can get the support from RGC to build irrigation systems.          2<sup>nd</sup>: MAFF can get the support from donors for agricultural development.          3<sup>rd</sup>: MAFF can get participation from farmers, who represent 80% of the population.</p>	<p style="text-align: center;"><b>Threats</b></p> <p>1<sup>st</sup>: Due to low salary, the experts cannot help the farmers.          2<sup>nd</sup>: There is corruption.          3<sup>rd</sup>: Forests are destroyed everyday and fish are endangered.</p>
<p style="text-align: center;"><b>Strengths</b></p> <p>1<sup>st</sup>: Some departments of MAFF have adequate expertise.          2<sup>nd</sup>: Some staffs have strong motivation to work.          3<sup>rd</sup>: All departments have an action plan for development.</p>	<p style="text-align: center;"><b>Growth Strategy</b></p> <ul style="list-style-type: none"> <li>• Encouraging farmers to increase their agricultural production through training, providing production means, and guaranteeing a market for their products.</li> <li>• Providing new technologies to the farmers to promote intensive agriculture and grow more varieties of crops.</li> <li>• Strengthening the monitoring system for agricultural land, and promoting the reclamation of cultivatable land.</li> <li>• Increasing agricultural production yield.</li> <li>• With the encouragement and support of RGC and available MAFF development action plans, improving agricultural productivity through farmers' participation promoted by the motivated experts of MAFF.</li> </ul>	<p style="text-align: center;"><b>Avoidance Strategy</b></p> <ul style="list-style-type: none"> <li>• Reducing corruption</li> <li>• Improving the national resource management (by using the staffs that have strong motivation).</li> </ul>
<p style="text-align: center;"><b>Weaknesses</b></p> <p>1<sup>st</sup>: There are no incentives in the departments.          2<sup>nd</sup>: MAFF lacks physical and financial resources to implement its good plans and law.          3<sup>rd</sup>: Level of staffs' expertise is still low.</p>	<p style="text-align: center;"><b>Improvement Strategy</b></p> <ul style="list-style-type: none"> <li>• Encouraging the staffs, who perform the work well.</li> <li>• Providing more new technology and skills to the staffs through training.</li> <li>• Encouraging the staffs to go for the training in new technology, and in the meantime, asking for support from foreign countries.</li> <li>• Encouraging farmers to grow crops, and raise animals in the uncultivated land.</li> <li>• Encouraging the experts through giving them the opportunities to work in their specialized fields and using their expertise.</li> <li>• Increasing the salary of the staffs</li> <li>• Prioritizing the staffs' capacity building and improving their living standard.</li> <li>• Dispatching agricultural experts throughout the country.</li> </ul>	<p style="text-align: center;"><b>Withdrawal Strategy</b></p> <ul style="list-style-type: none"> <li>• Reducing the number of staffs who do not have an educational background related to agriculture, and encouraging the agricultural experts.</li> </ul>

The workshop was conducted with a small number of highly efficient and selected staffs. The discussion during the workshop was not limited to SWOT and expanded to the framework of Japanese ODA as a whole. More specifically, the discussion on the

structure of MAFF and the relation between MAFF and the National Assembly was remarkably interesting. The participants had a deep interest in the activities of the Study Team and JICA. They were seeking/seizing the “Opportunities” provided through the Study Team and JICA. This is a good sign to promote cooperation with MAFF and the Study Team.

(c) Kampong Speu PDOWRAM

“To supply enough water for agricultural and industrial uses and also for the daily living to people” is regarded as the “Mission” of Kampong Speu PDOWRAM among the participants. SWOT and the 4 types of strategies to achieve the mission mentioned above are as follows.

**SWOT Matrix for Kampong Speu PDOWRAM**

<b>Opportunities</b> 1 <sup>st</sup> : Kampong Speu PDOWRAM can get support from JICA. 2 <sup>nd</sup> : RGC is interested in water resources. 3 <sup>rd</sup> : Kampong Speu PDOWRAM can get participation from farmers.	<b>Threats</b> 1 <sup>st</sup> : Staffs’ salary is low. 2 <sup>nd</sup> : Kampong Speu PDOWRAM lacks the budget for rehabilitation works. 3 <sup>rd</sup> : Existing irrigation systems do not guarantee water for farmers.
<b>Strengths</b> 1 <sup>st</sup> : Leaders are capable. 2 <sup>nd</sup> : Kampong Speu PDOWRAM can make plans. 3 <sup>rd</sup> : Kampong Speu PDOWRAM has good relationships with farmers.	<b>Growth Strategy</b> • Utilizing the good relation with farmers and proposing rehabilitation projects for irrigation systems through seeking support from RGC and funds from JICA.
<b>Weaknesses</b> 1 <sup>st</sup> : The capacity of accounting, administration, and planning is limited. 2 <sup>nd</sup> : There are not enough Study tours to foreign countries and in Cambodia. 3 <sup>rd</sup> : Kampong Speu PDOWRAM lacks the means to work.	<b>Improvement Strategy</b> • Making the training program and planning a long-term study tour in the country or foreign countries through seeking the support from RGC and funds from JICA. • Asking for help and funds from JICA and RGC in order to purchase the working means and equipment such as cars, and motorcycles.
<b>Avoidance Strategy</b> • Leaders’ creating jobs such as the programs and the projects prepared by IOs or NGOs and RGC. • Making the program for repairing the irrigation system step by step, and at the same time trying to seek support from donors.	<b>Withdrawal Strategy</b> N.A.

The staffs of PDOWRAM were competent enough to identify SWOT and to classify them into internal and external factors. They see the problems in their working environment and performance. It took time for them to understand how to formulate the strategies, but they were eager to conceive the strategies. The director also had a keen interest in a participatory SWOT analysis and joined the discussion enthusiastically. It was observed that they have high motivation for their works but face financial and physical difficulties.

(d) Kandal PDOWRAM

“To supply enough water for agricultural, industrial and daily/domestic uses and to tell the people how to maintain the irrigation systems by themselves” is regarded as the “Mission” of Kandal PDOWRAM among the participants. SWOT and the 4 types of strategies to achieve the mission mentioned above are as follows.

### SWOT Matrix for Kandal PDOWRAM

<b>Opportunities</b>	<p>1<sup>st</sup>: Cambodia is politically stable.</p> <p>2<sup>nd</sup>: RGC named it the “Irrigation Government.”</p> <p>3<sup>rd</sup>: JICA helped Kandal PDOWRAM to study the irrigation facilities.</p>	<b>Threats</b>	<p>1<sup>st</sup>: Natural disasters have struck Kandal Province.</p> <p>2<sup>nd</sup>: Kandal PDOWRAM lacks the budget for construction works.</p> <p>3<sup>rd</sup>: Water Law doesn’t exist.</p>
<b>Strengths</b>	<p>1<sup>st</sup>: Officers enjoy good health condition.</p> <p>2<sup>nd</sup>: Kandal PDOWRAM has good management.</p> <p>3<sup>rd</sup>: Kandal PDOWRAM can get active participation in the works of the PDOWRAM.</p>	<b>Growth Strategy</b>	<ul style="list-style-type: none"> <li>• Seeking help from JICA in order to study the development project about the irrigation systems.</li> <li>• Establishing good relations and information exchange with JICA.</li> <li>• Collecting the data on the water shortage area and proposing the projects to JICA for help</li> </ul>
<b>Weaknesses</b>	<p>1<sup>st</sup>: The officers’ salary is low.</p> <p>2<sup>nd</sup>: Kandal PDOWRAM lacks transportation means.</p> <p>3<sup>rd</sup>: The office is too small.</p> <p>4<sup>th</sup>: Kandal PDOWRAM lacks the funds to study projects.</p>	<b>Improvement Strategy</b>	<ul style="list-style-type: none"> <li>• Renting the transportation means in order to search for budgetary assistance for the projects.</li> <li>• Seeking kind people or supporting agencies in the country or abroad.</li> <li>• Seeking partners to construct the irrigation systems.</li> </ul>
	<b>Withdrawal Strategy</b>		<ul style="list-style-type: none"> <li>• Contacting NGOs and JICA for salary support.</li> <li>• Requesting JICA for help with transportation means.</li> <li>• Requesting budget from JICA in order to study and improve the irrigation systems.</li> <li>• Requesting JICA for help with constructing the office.</li> <li>• Requesting JICA for the budget to study the projects.</li> <li>• Requesting JICA for the budget to construct the irrigation systems.</li> <li>• Renting a truck for study tours in the areas with developed irrigation systems.</li> </ul>

At the beginning of the workshop, its earlier methods provoked great discussion among the participants. This was proof that they had an interest in SWOT analysis. It was a little hard for them to classify the factors into external and internal ones, but the classification gradually became smooth. They thoroughly understood how to formulate “Growth” and “Improvement” strategies. The director organized the workshop very well. This proved the high capability in management of Kandal PDOWRAM.

(e) Kampong Speu PDA

“To increase farmers’ income by improving agricultural production activities” is regarded as the “Mission” of Kampong Speu PDA among the participants. SWOT and the 4 types of strategies to achieve the mission mentioned above are as follows.

### SWOT Matrix for Kampong Speu PDA

<b>Opportunities</b>	<p>1<sup>st</sup>: JICA implements the project in Speu Province Kampong.</p> <p>2<sup>nd</sup>: RGC puts the 1<sup>st</sup> priority on agriculture.</p> <p>3<sup>rd</sup>: There is farmers’ participation.</p>	<b>Threats</b>	<p>1<sup>st</sup>: There are not enough irrigation systems in Kampong Speu Province.</p> <p>2<sup>nd</sup>: Kampong Speu PDA lacks the budget for development.</p> <p>3<sup>rd</sup>: Technical knowledge of farmers is still low.</p>
<b>Strengths</b>	<p>1<sup>st</sup>: There are capable leaders.</p> <p>2<sup>nd</sup>: Knowledge, the</p>	<b>Growth Strategy</b>	<ul style="list-style-type: none"> <li>• Managing of the planning activities and proposing the projects to JICA for the</li> </ul>
	<b>Avoidance Strategy</b>		<ul style="list-style-type: none"> <li>• Trying to repair the irrigation systems through requesting supporting projects from JICA.</li> </ul>

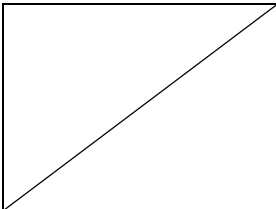
number and capability of the staffs are medium. <b>3<sup>rd</sup></b> : There is a clear plan. <b>4<sup>th</sup></b> : There are enough experienced staffs to apply to the project.	budgetary assistance for the agricultural works. <ul style="list-style-type: none"> <li>Assigning skillful staffs to cooperate with the farmers.</li> <li>Seeking support from JICA and providing the training program to the farmers.</li> </ul>	<ul style="list-style-type: none"> <li>Increasing the relationship with PDOWRAM in order to construct the irrigation systems and control the water resources effectively and efficiently.</li> </ul>
<b>Weaknesses</b> <b>1<sup>st</sup></b> : Skills of some staffs are limited. <b>2<sup>nd</sup></b> : Allowance for the staffs is limited. <b>3<sup>rd</sup></b> : Kampong Speu PDA staffs lack transportation means.	<b>Improvement Strategy</b> <ul style="list-style-type: none"> <li>Trying to find documents or books in libraries related to agriculture.</li> <li>Strengthening the abilities of the staffs and farmers through training programs and study tours.</li> </ul>	<b>Withdrawal Strategy</b> <ul style="list-style-type: none"> <li>Expecting the investment of private companies in agriculture.</li> <li>Giving permission to the private companies to develop water resources.</li> </ul>

The participants said they had knowledge of SWOT and had experienced other SWOT workshops. Nevertheless, it was tough for them to classify the factors into external and internal ones. Most of them lacked the motivation to participate in the workshop. This might be because there have been so many opportunities to attend the workshops organized by various types of donors, and the donors have not required their involvement much in the discussion. The participants did not tend to see any problems with their performance and focused on the general but not the specific issues to them. Moreover, one third of the participants left the workshop after the break in the morning because of joining a wedding ceremony. A ray of hope in this agency is the existence of a few qualified and eager chief class staff.

(f) Kandal PDA

“To enhance the agricultural development in order to guarantee food security and increase the income of the farmers” is regarded as the “Mission” of Kandal PDA among the participants. SWOT and the 4 types of strategies to achieve the mission mentioned above are as follows.

**SWOT Matrix for Kandal PDA**

	<b>Opportunities</b> <b>1<sup>st</sup></b> : Kandal PDA can get support from JICA. <b>2<sup>nd</sup></b> : Kandal PDA can expect participation from the farmers. <b>3<sup>rd</sup></b> : RGC has a clear and good policy.	<b>Threats</b> <b>1<sup>st</sup></b> : Kandal Province has faced drought and flood. <b>2<sup>nd</sup></b> : Farmers do not incorporate the new techniques. <b>3<sup>rd</sup></b> : Irrigation systems are insufficient and improper.
<b>Strengths</b> <b>1<sup>st</sup></b> : Staffs are highly responsible. <b>2<sup>nd</sup></b> : Organizational structure of Kandal PDA is proper. <b>3<sup>rd</sup></b> : Chiefs have good management and leading skill.	<b>Growth Strategy</b> <ul style="list-style-type: none"> <li>Trying to make the farmers understand farming knowledge by themselves.</li> <li>Extending the knowledge to the farmers through the staffs who had received technical training.</li> <li>Organizing farmers' associations.</li> <li>Giving TOT (Training of Trainers).</li> <li>Providing the extension service to farming leaders.</li> <li>Transferring the crop planting technique to the farmers.</li> <li>Sending the staffs to study appropriate technologies.</li> <li>Providing more knowledge to the farmers for agricultural development.</li> </ul>	<b>Avoidance Strategy</b> <ul style="list-style-type: none"> <li>Managing and controlling the existing or new irrigation systems for proper water use and distribution.</li> <li>Trying to forecast natural disasters and to make good plans for preparing for drought/ flood.</li> <li>Dispatching the experienced officers to train the farmers.</li> </ul>

	<ul style="list-style-type: none"> <li>• Training the staffs in order to extend the knowledge to the farmers.</li> <li>• Establishing a good relationship with JICA in order to ask for help to manage irrigation systems and to fight drought.</li> </ul>	
<p><b>Weaknesses</b></p> <p>1<sup>st</sup>: Staffs' salary is low</p> <p>2<sup>nd</sup>: Working means are insufficient.</p> <p>3<sup>rd</sup>: There are not enough human resources in rural areas.</p>	<p><b>Improvement Strategy</b></p> <ul style="list-style-type: none"> <li>• Proposing a specific project for supporting the insufficient part of Kandal PDA</li> <li>• Proposing a project to seek support from JICA in order to organize the village livestock agency (VLA).</li> <li>• Improving the capacity of the staffs in order to get the support from IOs and NGOs</li> <li>• Creating a program for providing seeds to the farmers in the rural areas through proposing the project to JICA.</li> <li>• Requesting the help of NGOs or the other donors in order to construct reservoirs and to repair irrigation systems.</li> <li>• Requesting budget for a study tour for the farmers.</li> <li>• Searching for help from the donors in order to act on time.</li> <li>• Requesting the help of JICA to establish an "Animal Bank."</li> <li>• Requesting the help of JICA for emergency assistance in the provision of animal foods in preparation for flood/ drought.</li> <li>• Proposing a project to JICA for rehabilitating the small irrigation systems.</li> <li>• Extending the techniques to the farmers through rural development groups.</li> <li>• Trying to extend and introduce new seeds suitable for each area.</li> <li>• Organizing and strengthening the FWUC in each area.</li> <li>• Seeking help from donor agencies in order to provide extension programs to the farmers for early rice planting.</li> </ul>	<p><b>Withdrawal Strategy</b></p> <ul style="list-style-type: none"> <li>• Stopping some activities which cannot avoid the effects of natural disasters and/or which require complex techniques.</li> </ul>

The participants said they had the knowledge of SWOT and had experienced other SWOT workshops. Except for a few participants, they lacked the motivation to participate in the workshop. Two thirds of the participants walked out and the remainder abandoned themselves to chatting or reading documents not related to the workshop. This meant most of the participants did not have any interest in improving their working environment and/or performance. A ray of hope for this agency is that a senior officer has the opinion; it is ashamed of depending on the donors for all PDA works.

In conclusion, the motivation/incentive to work is very crucial to achieve the missions and to cooperate with the other agencies; specifically, MOWRAM and MAFF, and PDOWRAM and PDA in each Province. Improving their motivation surely contributes to

executing the pilot projects in the Master Plan for comprehensive agricultural development in the Prek Thnot river basin and the Master Plan itself. It is comprehensible that most of the participants/officers lack strong motivation to work due to low salary. Nevertheless, the incentives should not be limited to money. It is noticeable that staff motivation can be boosted by the awareness of the necessity for the works or. Acknowledgement from somebody of authority; especially, the bosses and probably external agencies concerned would be a strong incentive for the officers.

#### **4.11 Agricultural Support Services**

##### **4.11.1 Agricultural Support Institutions**

###### **(1) Government Institutions**

The government institutions involved in agricultural support services include MAFF at the central level and the Provincial Department of Agriculture (PDA) in Kampong Speu and Kandal Province at the provincial level. Because of the decentralization policy in the country, government sector providers of such services at the field level are the PDA of the individual provinces.

###### **(a) MAFF**

Among a number of the departments of MAFF, the Department of Agronomy & Agricultural Land Improvement (DAALI), Agricultural Extension (DAE), Fisheries and Animal Health & Production are the agencies responsible for agricultural support services related with the present Study. DAALI is a technical agency responsible for crop sub-sector technology development, seed production, plant protection and soil management & improvement. DAE is a central agency mandated to extension services, farming system development and farmer organizations. Agricultural marketing issues are handled by the Agricultural Marketing Office of the Department of Planning & Statistics. The Central Agricultural Research and Development Institute (CARDI) is placed under the jurisdiction of the Ministry as one of the public institutions. The provincial level agricultural agency of PDA is technically under the jurisdiction of the Ministry.

The most serious technical weakness of the related departments appears to be the limited accessibility to information on actual agricultural and agro-economic conditions at provincial, district and field levels.

###### **(b) PDA**

PDA is a provincial level agricultural agency under the provincial government and is an agency responsible for agricultural development and provision of agricultural support services at the provincial, district, commune and village levels. As shown in Figure 4.10.4 and Figure 4.10.5, Kampong Speu PDA is composed of six technical offices and two planning/administrative offices and Kandal PDA is of six technical offices and three planning/administrative offices. Total number of staffs, including district level staffs, is 269 and 331, respectively in Kampong Speu and Kandal.

The major project related functions of the Agronomy Office of PDA include technology development, seed production and plant protection and the major project related functions of the Extension Office are provision of extension services and human resources development. The Animal Health & Production Office has functions of provision of veterinary services, technology development and extension services and the functions of the Fishery Office are fish fry and fingerling production (only in Kampong Speu), technology development and extension services. The major functions of the technical offices of PDAs are explained in Table 4.11.1 Current major project activities of the Agronomy Offices are as follows;



### Current Major Project Activities of Agronomy Offices

Agronomy Office	Project	Extension Activities
Kampong Speu	APIP/LWF	IPM (3 non- project districts)
	WVC	IPM (1 non-project district)
	CIDA	RFV (rice-fish-vegetable system) (Kong Pisei & 4 non-project districts)
Kandal	APIP	IPM (Kandal Stung, Angk Snuol, etc.)
	FAO	IPM (Kandal Stung, etc.)

*Source: Kampong Speu & Kandal PDA*

PDA has its branch offices at district level called District Agricultural Office (DAO). In the Target Area of the present Study, 3 DAOs in Kampong Speu and 2 DAOs in Kandal are deployed as shown below.

### DAOs & Their Staffs in the Target Area

Kampong Speu		Kandal	
DAO	Nos. of Staffs	DAO	Nos. of Staffs
Chbar Mon	10	Kandal Stung	10
Samraong Tong	11	Angk Snuol	11
Kong Pisei	11		

*Source: Kampong Speu & Kandal PDA*

The amount and sources of development budget in 2005 for Kampong Speu PDA were US\$ 293,000 in total with 38% of that total being allocated from MAFF.

#### (2) International Organizations and NGOs

A number of international and bilateral cooperation organizations are involved in agricultural sector support activities in and around the Target Area. Similarly, a number of NGOs are involved in the same. Some of important activities or programs closely related with the present study are discussed in Sub-section 4.11.7.

#### 4.11.2 Agricultural Research

The institutional set-up for agricultural research and technology development activities in Cambodia is composed of the central institute for crop sector research (Cambodian Agricultural Research and Development Institute/CARDI) and the state farms and experimental stations belonging to DAALI of MAFF as illustrated in Figure 4.10.3.

##### (1) CARDI

CARDI is a semi-autonomous, leading agricultural research and technology development public institute under the jurisdiction of MAFF and its core purpose is to improve the living standards of Cambodian farmers through agricultural research, technology development and technology transfer. The institute is located close to the Target Area along National Road No.3.

To meet the national mandates, CARDI currently is running six research programs or units of: (i) plant breeding, (ii) agronomy & farming system, (iii) soil & water sciences, (iv) plant protection, and (v) agricultural engineering. In addition, the institute has a Training & Information Center for training and technology transfer purposes.

One of the important functions of CARDI has been rice seed development and production and the Institute has been established as a national provider of rice genetic resources, breeder seed and foundation seed. A number of quality rice seeds developed or selected by CARDI have been released by the Varietal Recommendation Committee of Cambodia. Among the same, promising rice varieties of Sen Pidao (non-photo sensitive early rice) and Phka Rumduol & Rieng Chey (photo sensitive medium variety) for the Target Area are included.

The institute should be considered as a technical resource agency for the pilot project

under the present study and close collaboration and cooperation should be sought during the pilot project operation.

(2) Other Research and Technology Development Institutions

Other agricultural research and technology development institutes under DAALI of MAFF include Prey Pdao and Kbal Koh Experimental Stations and Toul Samroang Rice Seed Farm and Chamkaleu Seed Production Farms. The major mandate of the Stations and Farms are adaptive technology development and seed production.

The Prey Pdao Experimental Stations is located in Angk Snuol District of the Target Area. The organizational set-up of the Station is composed of Production, Research and Administration Sections and major functions are rice seed production, adaptive research and demonstration activities as stated earlier. The staffing and facilities of the Station are shown in the following table.

**Staffing and Major Facilities of Prey Pdao Station**

Position	No(s).	Facilities	No./Area
Staff		Facilities/land	
Director (acting)	1	Irrigated rice field	7 ha
Deputy Director	1	Office	1
Section Chief	2	Accommodation	1
Staffs	4	Storehouse	1
Total	8	Tractor	1

Source: Prey Pdao Station

The Station could be nominated as a technical support institute for the operation of the pilot project under the present Study.

**4.11.3 Agricultural Extension**

(1) Institutional Set-up for Agricultural Extension

The national mandate for agricultural extension in Cambodia is placed with Department of Agricultural Extension (DAE) and Agricultural Extension Offices (AEO) of PDA in the provinces. Although extension staffs in provinces and districts and Agricultural Offices (DAO) at the district level for extension have been deployed and financial and reporting systems are in place to an insufficient degree, the establishment of the extension system is yet to be envisaged and the provision of extension services to farming communities are limited due, primarily, to the financial constraints of the agents.

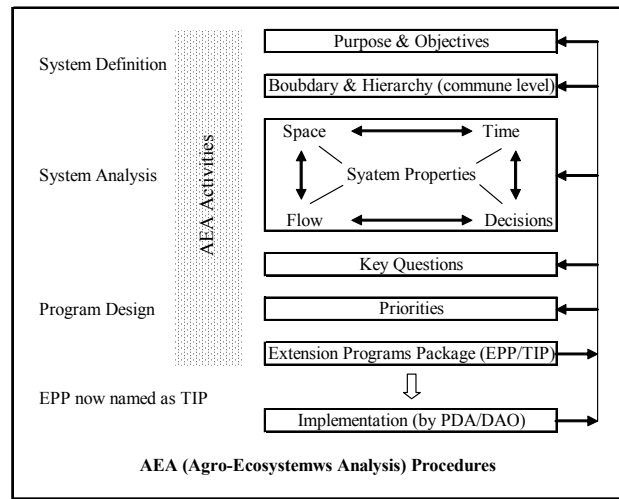
The establishment of the national agricultural extension system was envisaged under CAAEP I (1998-2000) and the institutional set-up for the agricultural extension system to be established in the country was designed as shown in Figure 4.11.1.

The target provinces of the present Study, Kampong Speu and Kandal, are among 14 provinces where CAAEP II activities are being introduced, however, the envisaged extension system has not been fully introduced or applied yet in the target provinces. In the proposed extension system, district level staffs will have essential functions on field level extension activities as shown in the technology transfer role of the district level agriculture staffs<sup>4</sup> as illustrated in Figure 4.11.2.

<sup>4</sup> Source: Guidelines for Agricultural Extension in Cambodia, August 2000, CAAEP

(2) Extension Method

The approaches for the provision of agricultural extension services or the extension method envisaged in the extension system include AEA at the commune level as a participatory needs assessment methodology for planning agricultural extension and development programs for implementation under the Commune Agricultural Plan (CAP) with SEILA funding. AEA has been implemented in over 200 communes in 14 provinces, and its use is now endorsed under the current MAFF policy. The procedures for AEA are illustrated in the figure on the right<sup>5</sup>.



(3) Provincial Extension Agencies

Within the agencies mandated to provide agricultural extension services, those actually involved in such services are PDAs, their district level offices of DAOs and their staffs. Those practical extension agencies are weakly established in various meanings

(a) Staffing and Deployment of Agricultural Extension Workers

Staffing of the Agricultural Extension Office (AEO) of PDA and deployment of Agricultural Extension Workers (AEWs) in the project provinces are as follows;

**Staffing & Deployment of AEWs**

Office	Kampong Speu		Office	Kandal	
	AEW	SMS		AEW	SMS
AEO	7	2	AEO	6	2
Chbar Mon DAO	5		Kandal Stung DAO	5	
Kong Pisei DAO	5		Angk Snuol DAO	5	
Samraong Tong DAO	5		Other DAOs	30	
Other DAOs	23				
Total	45	2	Total	41	2

Source: Kampong Speu & Kandal PDA

Among the said AEWs, those involved in fulltime project activities are 16 for CAAEP II and 12 for SEILA in Kampong Speu and 16 for CAAEP II in Kandal.

(b) Activities of Project AEOs

The envisaged extension activities of AEOs are reported to be;

- Implementation of AEA under CAAEP II,
- Demonstration activities on crops & livestock, and
- Farmer training through meetings/courses, field days & field visits.

However, because of constraints on operational funds for extension activities, the provision of extension services through the implementation of projects of donors and NGOs are primary activities of AEOs. Currently, such extension activities of AEOs carried out under project supports are as follows;

<sup>5</sup> Source: IEA for Irrigation System Development (ISAEA), 2005, CAAEP II

### Current Major Project Extension Activities of AEO

AEO	Project	Extension Activities
Kampong Speu	CAAEP II	AEA in 20 communes Staff training and formation of agriculture cooperatives
	SEILA	Farmer training and demonstration (all districts)
Kandal	CAAEP II	AEA in 30 communes Farmer training, demonstration and study tours
	SEILA	Village livestock agent training
		Cow bank

#### (c) Village Livestock Agent (VLA)

In the Target Area, farmer veterinary & extension service providers called Village Livestock Agents (VLA) are deployed as shown in the following table.

#### VLAs Deployed in Target Area

Kampong Speu				Kandal		
Chbar Mon	Samraong Tong	Kong Pisei	Province	Angk Snuol	Kandal Stung	Province
20	57	37	400	20	66	338

Source: Kampong Speu & Kandal PDA

Those VLAs were trained for about a month before qualification under support programs of donors/NGOs and SEILA. The proportion of VLAs still engaging in such services in Kampong Speu is reported to be around 70 to 80% by PDA.

#### 4.11.4 Seed Production and Supply

The current predominant rice seed production and supply system in Cambodia is illustrated in Figure 4.11.3. As shown in the figure, the main rice seed production system consists of: (i) production of breeder seed by CARDI, (ii) production of foundation seed by State Farms, CARDI and Agricultural Experimental Station and (iii) commercial seed (certified seed) production by seed producers and seed growers. However, due to lack of a national seed policy and seed production and certification system, seed inspection and certification is implemented arbitrarily by individual seed producers and quality seeds produced are usually called commercial seed.

As indicated in the figure, the major quality seed producers in the country include: (i) CARDI, (ii) State Farms and Agricultural Experimental Stations of DAALI, (iii) 4 seed companies established under AQIP (Agricultural Quality Improvement Project) and (iv) seed growers/seed growers groups. In and around the Target Area, Prey Pdao Agricultural Experimental Station in Angk Snuol District, to a limited extent, and Super Seed Company in Kandal Stung, to a large extent, are producing certified seed for distribution to dealers, farmers or others. Certified seed production of the Station in 2004 was about 20 tons and the same of the Company was about 400 tons. Commercial or certified seed prices of CARDI and Seed Companies are Riel 1,500/kg irrespective of varieties (retail price of Seed Companies is Riel 1,600/kg).

Common channels for supply of quality seed in and around the Target Area are from seed grown under contract by Kasekam Angkor and also from support programs of donors or others. Commercial seed suppliers in the Area are farm input suppliers in district centers but their supply volumes are limited.

The predominant rice seed source is from self-propagated seeds (products of the previous season) followed by seeds exchanged with other farmers in the Target Area. Further, seed replacement frequency is low and demand for quality seeds is low at present.

In upland crops production, quality seeds are seldom used and major seed sources are: (i) seeds procured at local markets and (ii) own products. Prevailing seed sources vegetables are also seeds procured at local markets and home grown seed. However, vegetable seeds imported from Thailand and Vietnam are commonly used for intensive

vegetable production under irrigation.

Production of upland crops and vegetables in Cambodia is still limited. However, upland crop seed production is carried out by the Chamkaleu Seed Production Farm and CARDI has started to produce upland crops seed. The main upland crop seed produced by the farm is beans and the same of CARDI is beans and maize.

#### 4.11.5 Farm Inputs Supply

Supply sources for chemical fertilizers and agro-chemicals in Cambodia solely depend on import commodities since no fertilizer or agro-chemical industries have been established. Since the introduction of privatization of farm input import, the major role in the same is undertaken by the private sector. The most common origins of such commodities are Thailand and Vietnam. Serious problems in farm input supply in the country are distribution (marketing) of chemical fertilizers and agro-chemicals of poor quality.

Farm input supplies in the Target Area are mostly carried by dealers in district centers and local markets at the commune or district level. Group purchasing of fertilizer is seldom practiced in the Area, however, introduction of such purchasing arrangement by 2 farmer cooperatives in the Area is reported.

The results of the Socio-economic Survey indicate that no serious constraints exist for procurement of fertilizer except for price as follows;

##### Fertilizer Supply Conditions in Target Area

Enquiry	Responses (200 sample farmers)
Purchase of Fertilizer	Easy: 90%; difficult: 10%
Delivery of Fertilizer	On time: 87%; delayed: 13%
Fertilizer Price	Too expensive: 81%; acceptable: 19%

Source: Socio-economic Survey by the Study Team, 2005

#### 4.11.6 Farm Credit

Formal banking systems for farm credit are limited in Cambodia and some institutions called, "Micro Finance Institution (FMI)", having credit services are offering farm credit services to farmers or rural people. Such institutions operating in and around the Target Area include ACLEDA Bank (NGO involved in rural credit established as a bank), PRASAC and Vision Fund. Further, several NGOs providing micro credit services in the project provinces including FLD (Farmer Livelihood Development), PNKS (Ponlen Ney Kdey Sangkum/Light of Hope) and Infant & Development. However, non-institutional credit providers such as rice millers, farm input suppliers and relatives or friends might be the mainstay in financing in the Area. The results of the Socio-economic Survey on farm credit are as follows;

##### Results of Socio-economic Survey on Farm Credit

Enquiry	Responses (200 sample farmers)
Access to Farm Credit	Easy: 45%; difficult: 36%, not received: 19%
Amount of Credit	Sufficient: 59%; not sufficient: 22%; not received: 19%

Source: Socio-economic Survey by the Study Team, 2005

#### 4.11.7 Major On-going Agricultural Support Programs/Schemes

Current on-going major agricultural support programs or schemes operated in the Target Area and their main activities are as follows;

##### (1) CAAEP II

Project Title	Cambodia Australia Agriculture Extension Project II
Financing Agency	AusAID
Executing Agency	MAFF & PDA of 14 provinces (Kampong Speu, Kandal, others)
Project Period	2001 ~ 2006
Project Cost	AUS\$ 18.9 million (≈ US\$ 10 million)

CAAEP II is the second phase of the CAAEP project which was implemented aiming at the establishment of an agricultural extension system in Cambodia and the primary objective of the phase II project is the development of an extension method to be introduced under the system and practical introduction of the method at the province, district and commune levels. The proposed extension method is the formulation of TIP (Technical Implementation Procedures; formally called EPP/Extension Programs Package) through AEA as discussed earlier in Sub-section 4.11.3.

In the Target Area, AEAs were conducted in 17 of the 44 project communes. The current stage of AEA in most of the target communes is the formulation of agricultural extension programs for the identified priority needs. Such extension programs are to be implemented in 2006 in 6 provinces (not yet decided). However, some of extension programs have been executed as pilot operations as follows;

#### **Pilot Extension Programs Implemented under CAAEP II**

Program	Target Province
Vegetable Production	Kandal,
FWUC Empowerment	Bateman, Modndolkiri
Early Wet & Dry Season Rice Production	Kandal, Modndolkiri, Kampong Cham

*Source: CAAEP II*

#### (2) CEDAC (Centre d'Etude de Development Agricole)

CEDAC is a research and development NGO specialized in the field of ecological agriculture and rural development. The Center was set up in 1997 by Cambodians with initial support from GRET (a French NGO). The mission of the Center is to work towards “the improvement of the well being of small farmers and consumers by promoting ecological agriculture and building up capacity of farmer organizations and other stakeholders”. Current staff number of CEDAC is around 130 consisting of full-time staff and field-based staff. It is operating in 14 provinces from the central and 7 field offices.

The major development activities of the Center include the dissemination of SRI (System of Rice Intensification) and formation and empowerment of farmer & community-based organizations, especially FWUC.

SRI has been introduced in 20 provinces including the project provinces of Kampong Speu and Kandal and total the number of farmers applying SRI for their rice production is roughly estimated at 50,000 by the Center. In Cambodia, SRI is practiced both in irrigated and rainfed paddy fields and area extent is larger in the latter. In Kampong Speu, rainfed rice cultivation applying a part of SRI practices expanded largely in 2005 as discussed in Sub-section 4.7.3.

Another CEDAC activity closely related to the present Study is the formation and empowerment of FWUC. Such activities are currently operated in the project areas of the ADB financed North Western Irrigation Project. Further, the Center is providing agricultural extension activities under the financial support of NGOs. For example, the Center is providing technical (consultancy) services in Stung Chinta Irrigation and Rural Infrastructure Project implemented under ADB financing by MOWRAM/PDOWRAM. The agricultural extension and FWUC formation/empowerment components of the project are financed by AFD with GRET (French NGO) and CEDAC involved as implementing organizations of such support services.

#### (3) Smallholder Livestock Production Program (SLPP)

Project Title	Smallholder Livestock Production Program
Financing Agency	European Union
Executing Agency	Department of Animal Health & Production, MAFF
Target Provinces	Kampong Speu, Takeo, Kampong Chang, Pursat
Project Period	April 2005 ~ March 2010 (5 years)
Project Cost	€ 5.0 million

SLPP is a newly commenced livestock sub-sector project covering the project province of Kampong Speu. The overall project objective is to reduce poverty and food insecurity in rural areas by increasing the rate of growth of livestock GDP. The project envisages solving the problems contributing to low productivity and returns from livestock production in Cambodia; poor animal health, poor technical capacity in local communities and inequitable and inefficient markets. Smallholder livestock producers represent the primary beneficiaries of the project. Other key stakeholders include Village Livestock Agents, Department and Office of Animal Health and Production, commune councils, private sector traders and other intermediaries, and local NGOs. Major project activities include:

- Institutional capacity building for the Department of Animal Health & Production,
- Improvement of rural animal health services through training, certification and expansion of Village Livestock Agents (VLA),
- Introduction and implementation of a national system of animal disease surveillance and monitoring,
- Improvement of animal health through demonstrations and extension services,
- Improvement of livestock feed regimes,
- Linking producers with local markets, and
- Improvement of meat processing, storage and marketing.

(4) Freshwater Aquaculture Improvement Extension Project (FAIEX)

Project Title	Freshwater Aquaculture Improvement & Extension Project
Financing Agency	JICA
Executing Agency	Department of Fisheries, MAFF
Target Provinces	Kampong Speu, Takeo, Kampong Chang, Pursat
Project Period	February 2005 ~ February 2010 (5 years)
Project Cost	JPY 550 million (≒US\$ 5 million)

FAIEX was recently started with the objective of improvement of freshwater fish culture in the target provinces. The objectives of the project are the improvement of small-scale freshwater fish culture technologies and extension of the technologies to rural communities and development of a fish culture extension network in rural areas.

Major project activities envisaged are:

- Trainings of staffs of the Fisheries Office of PDA, farmers and small-scale fish fingerling producers,
- Farmer assistance by provision of guidance, fingerlings & equipment,
- On-station & on-farm trials, and
- Enhancement of community pond management through participatory management of fish-refuge ponds by promoting formation of “fish-refuge communities” in villages.

The activities of FAIEX commenced in February 2005 and the small-scale aquaculture extension program and the community pond management program are being implemented in Kampong Speu and other 3 provinces. In the Target Area, a small-scale aquaculture extension program was introduced in Veal Commune of Kong Pisei District.

**4.11.8 Problems and Constraints**

Major constraints in Agricultural Support Services appear to be financial constraints, implementation of support activities in an uncoordinated manner and lack of ownership by PDAs of activities carried out by donors and NGOs such as the following:

- In the Target Area, agricultural support activities have been implemented by a number

of donor agencies and NGOs or through their support. For efficient use of such resources and to serve the beneficiaries actual needs, implementation of such activities needs to be well coordinated,

- Because of the financial constraints of PDAs for development activities, current agricultural extension or support services are basically limited to those supported by donor agencies. Possibly, such situation might have resulted in the lack of program ownership by PDAs and formulation and implementation of programs poorly reflecting area specific or target group specific needs or the needs identified by PDAs;
- Because of the limited finances available to PDAs and the limited amount of support being offered by donor agencies, efficient utilization of those limited resources has not yet been seriously pursued, and
- The strengthening of agricultural support services introduced in a well integrated manner and implemented in a farmer participatory manner (because of financial constraints of government institutions) should be sought.

#### 4.12 Environmental Issues

This section describes current environmental conditions of the Target Area from the view points of social environment, natural environment and pollution.

These environmental conditions have been examined through site reconnaissance and a series of interviews with the related government agencies, including the Ministry of Environment (MOE) and the Provincial Department of Environment (PDE) of Kampong Speu and Kandal. The results of the socio-economic survey and RRA survey have been also taken into consideration.

##### 4.12.1 Social Environment

###### 4.12.1.1 People/Community

The characteristics of the people and community are summarized in the following table.

**Characteristics of People and Community**

Items	Contents
Population	The population in the target communes was approximately 340,000 consisting of 245,000 in Kampong Speu Province and 95,000 in Kandal Province in 2004. Average population density is estimated about 3 persons/ha in the Target Area. The annual growth rate of population ranges from 1.5% to 2.4%.
Ethnic Group and Religion	The major ethnic group is Kumer in and around the Target Area. Most of them are Buddhist. Buddhist Pagodas are common. Meanwhile, only a small number of Cham families live in villages of Kampong Speu Province. Cham are Muslims and around 200,000 are estimated to live in other areas in Cambodia. No social conflict between Kumer and Cham is reported.
Local Community	There are several local groups like VDC, FWUC and FO, including Agricultural Cooperatives. They have different objectives and are supported by different agencies. No specific relationships or collaboration between them were observed in the Area.
Social Conflict caused by Water Use	According to PDEs of Kampong Speu and Kandal, there are social conflicts over water among the people. Inequitable water allocation sometimes leads to strife between upstream and downstream people. Even though FWUC was organized, there are water conflicts among the members due to inappropriate management of its committee. As water for crop cultivation, especially paddy, is important for their livelihood, special attention should be paid to this issue.
Gender Issues	It is implicated that there are very few specific problems about gender discrimination in the Target Area. The socio-economic survey shows that housekeeping and cooking are the female's main activities, while other activities, including farming, are undertaken by both sexes. Palm sugar production is male's activity. Females are apt to work at the sewing factory, while males are employed as security guards or other kind of ancillary works.

Source: Study Team



#### 4.12.1.2 Land Use

Land use in the Target Area is shown in the table below. As can be seen in this table, paddy fields account for about 40% of the Target Area.

**Land Use in the Target Area**

Category	Paddy Field	Upland Field	Forest	Grass, Shrub Land	Industrial Zone	Resettlement Area	Barren Land	Others	Water Surface	Total
Area (ha)	42,775	821	2,116	50,391	650	6,459	1,038	136	801	105,187
(%)	41	1	2	48	1	6	1	0	1	100

Source: Study Team

#### 4.12.1.3 Public Facilities

##### (1) Water Source for Domestic Use

According to the Socio-economic Survey, more than 70% of the people use wells for both drinking and domestic use purposes in the dry season, while around 40% use rain water in the rainy season. People living near the river and/or canals utilize water from them in both the dry and rainy seasons. More than 30% of the people experience a shortage of water in the dry season.

##### (2) Water Rights and Water Management

In Cambodia, water rights have not been officially issued because the water law has not been enacted so far. Instead, customary water rights are prevailing. In the Target Area, water allocation is made by these customary water rights, especially for the flow adjustment between the upstream and downstream segments of the river.

##### (3) Current Water Management of Canals

In the Target Area, MOWRAM conducts the water management and O&M for major canals such as the main and secondary canals. FWUC and its subordinate organizations, FWUG are in charge of tertiary canals and watercourses, respectively.

The main objectives of FWUC/FWUG are to affect timely supply of adequate water to each field, and also to collect the irrigation service fees necessary for O&M activities. Most of them do not fulfill these objectives, mainly due to insufficient canal water and weak FWUC/FWUG. Such a situation causes the water conflicts mentioned previously. In the Target Area, 25 FWUCs have been established but none are officially registered to MOWRAM yet.

##### (4) Energy

According to the socio-economic survey, 99% of households rely on firewood for cooking fuel, while 1% rely on charcoal. Approximately 80% of households feel that it is easy to obtain firewood from the surrounding shrub land. Approximately half of the people use kerosene for lighting. Nevertheless, there are no data or information regarding the amount of firewood consumed in the Target Area.

##### (5) Lack of Canal Crossing Structures

The RRA Survey indicates that people have complained about the insufficient number of bridges over the existing canals. This problem causes difficulty in access to schools, markets, pagodas, water resources and hospitals.

#### **4.12.1.4 Economy**

##### **(1) Local Economy**

Most of the people living in the Target Area are farmers. They are earning money from both agricultural income and non-agricultural income. Agricultural income includes sale of paddy, vegetables, fruits, palm sugar, livestock and fishes. Non-agricultural income includes permanent based salary, on-farm labor, handicraft/cottage industry products, and so on. The annual income ranges from Riel 350,000 to Riel 25,000,000, with the median at Riel 3,000,000 according to the Socio-economic Survey.

Both the amount and composition of income, which are highly varied among the people, seem to be largely concerned with water availability for agriculture. Water availability for agriculture has a positive impact on the number of agricultural-income-only households and agricultural income itself. Moreover, farmers who have difficulty with water availability are obliged to get a permanent job for income.

As for expenditures, food expense occupies more than 50% of total expenditures on average, followed by health, clothes, education and transportation in turn.

Moreover, the Socio-economic Survey indicates that almost all people have some savings which is mostly in the form of livestock holdings, followed by land and cash. On the other hand, around 40% of the people have loans or debts from an NGO or friends/relatives. Popular purposes for loans/debts are agricultural inputs and purchase of food, which represent 50% and 15% of borrowing respectively.

##### **(2) Usage of Fertilizer**

No data regarding agrochemical input in and around the Target Area are available. According to the Socio-economic Survey, 2005, most farmers answered that the reason for limited agricultural productivity is inadequate application of fertilizers, followed by drought in both the rainy and dry seasons. This means that negative impacts due to over application of fertilizer are probably not occurring at present.

#### **4.12.1.5 NGO's Activities in Environment**

MLUP BAITONG established in 1998 with support from British NGO, Global Witness, is mainly working for environmental awareness and conservation through education, training and advocacy for sustainable and equitable use of natural resources for the benefit of Cambodia. In Kampong Speu Province, they have conducted two kinds of activities, namely, i) a School Environmental Project and ii) Buddhism and the Environment Project.

#### **4.12.2 Natural Environment**

##### **4.12.2.1 Fauna and Flora, and Their Habitats**

###### **(1) Protected Areas**

The "Decree on Creation and Designation of Protected Areas" issued in 1993 designates the country's protected areas under 4 categories, which correspond to international classifications. These are National Parks, Wildlife Sanctuaries, Protected Landscapes, and Multiple Use Management Areas.

In the Target Area, there are no protected areas. The nearest protected areas around the Target Area are Kiririom National Park located around 35 km from the east boundary of the Target Area. Aural Wildlife Sanctuaries is located upstream of Prek Thnot River. The following table shows characteristics of these two areas.

### National Protected Areas located around Target Area

Protected Area	Location			Area (ha)	Characteristics
	Province	Distance from the Target Area	Relevance to the Target Area		
Kirirom National Park	Koh Kong Province	35 km (east)	—	35,000	High elevation pine forest with large mammals including elephants.
Aural Wildlife Sanctuaries	Koh Kong, Pursat, Kompong Chhnang and Kampong Speu Province	35 km (northeast)	Upstream of Prek Thnot River	253,750	Highest mountain (1,743m) in Cambodia with a wide diversity of vegetation ranging from dry Dipterocarpus/Podocarpus forest to medium altitude evergreen forest.

Source: Decree on Creation and Designation of Protected Areas, State of Environment Report, MOE, 2004

#### (2) Forests

The forest area is very limited in and around the Target Area. Only 2% of the Target Area is covered by forests, which are located in the south mountainous area.

#### (3) Fish and their habitats

The major water resources for fishing in and around the Target Area are many ponds, Prek Thnot River, Ou Krang Ambel River and the canals. A total of 800 ha of water surface is in the Target Area as habitat of fish. According to the local people, in the past there were many fishes both in the rainy season and the dry season, however, the amount and variety of fish are decreasing presently. The one reason is that people started using electric fishing gear, which has wiped out the fish. In addition, exotic species that have been discharged are changing the aquatic-diversity.

Species of fish raised by relevant people, including the Department of Fishery, and MAFF in and around the Target Area are shown below.

#### Existing Fish in Prek Thnot River

	Khmer Name	English name	Scientific Name	indigenous/exotic
1	Tilapia	Nile tilapia	<i>Oreochromis niloticus</i>	Exotic
2	Kranh Srai	Climbing perch	<i>Anabas testudineus</i>	Indigenous
3	Phtuok/Rous	Snakehead	<i>Channa striata</i>	Indigenous
4	Trey Andaing Roueng	Walking catfish	<i>Clarias batrachus</i>	Indigenous
5	Andaing Tonle	Gray eel-catfish	<i>Plotosus canius</i>	Indigenous
6	Kanhtor	Snake-skin gourami	<i>Trichogaster pectoralis</i>	Indigenous
7	Chhpin	--	<i>Hypsibarbus pierrei</i>	Indigenous
8	Trey Raw	Snakehead murrel	<i>Channa striata</i>	Indigenous
9	Trey chhpin	Silver barb	<i>Barbodes gonionotus</i>	Indigenous
10	Trey chhlonh chhnoht	Peacock eel	<i>Macrogathussiamensis</i>	Indigenous
11	Trey kormorm	Butter catfish	<i>Ompok bimaculatus</i>	Indigenous
12	Carp sor	Silver carp	<i>Hypophthalmichthys molitrix</i>	Exotic
13	Carp samanh	Common carp	<i>Cyprinus carpio</i>	Exotic
14	Kulriang	Giant barb	<i>Catlocapio siamensis</i>	Exotic
15	Klia	Finescale tigerfish	<i>Danioides microlepis</i>	Indigenous
16	Crobey	Crocodile catfish	<i>Bagarius suchus</i>	Indigenous

Source; Interview to Provincial Office of Fishery, PDE of Kampong Speu Province, the local people, 2006

#### (4) Wildlife

Though there is no specific data or records about wildlife in and around the Target Area, the bio-diversity in the Target Area seems poor because of its limited habitat. People expressed that the wildlife was more diversified and plentiful in the past, but the number

of varieties of wildlife has been reduced, and wildlife and its habitat are very scarce in and around the Target Area.

#### 4.12.2.2 River Systems

The Prek Thnot River flows from the southeast to the east from its origin in the Elephant mountain region and joins the Bassac River in Kandal Province. The total catchment area of the Prek Thnot River is 4,650 km<sup>2</sup> at the confluence with the Bassac River.

Locals that were interviewed stated that watershed degradation has occurred in the Target Area. The watershed degradation is one of the main factors for lack of stability of river flow, such as seasonal flooding in the rainy season and extreme drying in the dry season. It is also reported that at the bank of the river, both in Kampong Speu and in Kandal, sand factories have pumped sand from the river channel and river bank and those activities have caused riverbed degradation.

#### 4.12.2.3 Landscape

The Target Area is almost all flat plain and there is no landscape resource to be preserved.

#### 4.12.3 Pollution

##### 4.12.3.1 Water Quality/ Pollution

There is no analyzable data regarding the Prek Thnot River in and around the Target Area except for the area around Kampong Toul in Kandal Province. PDOWRAM had monitored the water quality of the Prek Thnot River at Kampong Toul station located at its crossing of National Road No.3 since 1996. The results of the analysis of 2003 are presented in the following table.

**Water Quality Monitoring Data in 2003**

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Standard <sup>1</sup>
pH	7.28	6.57	7.30	7.03	7.03	7.15	6.90	6.41	6.50	6.52	6.67	6.72	6.5-8.5
TSS <sup>2</sup> (mg/L)	43	55	25	60	150	93	303	172	119	175	21	32	25-100
DO <sup>3</sup> (mg/L)	8.25	6.33	7.74	7.58	6.34	7.64	6.20	7.38	6.50	6.20	6.72	7.40	2.0-7.5

Note: 1 Under the sub-decree on water pollution control, water quality standard in river for bio-diversity conservation is defined.

2 TSS: Total Suspended Solids,

3 DO: Dissolved Oxygen

Source: PDOWRAM of Kandal Province, 2003

In the four months from July to October, the Total Suspended Solids is beyond the standard acceptable quantity in rivers for bio-diversity conservation. The values for Ph met the standards in every month except August. The DO level was outside the standard limits in January and March.

##### 4.12.3.2 Offensive Odors

According to the PDE of Kampong Speu, people have complained about bad smells from pig farms. In reply to this complaint, PDE has made an agreement with the owner of the pig farm to urgently mitigate the offensive odors. In addition, PDE has started to monitor the offensive odors from the livestock farms.

##### 4.12.3.3 Other Pollution

There are no available records about other pollution conditions in the Target Area. As far as the site inspection was concerned, no serious problems of air pollution, noise or vibration have been observed since no pollution source can be found in or around the Target Area.

## Chapter 5 PCM Workshops and RRA

### 5.1 General

Project Cycle Management (PCM) workshops and Rapid Rural Appraisal (RRA) workshops were conducted as a part of the rural socioeconomic survey. The details, including backgrounds, method/methodology, and outputs of both workshops are mentioned hereinafter. Common characteristics of both workshops are the application of the participatory approach.

### 5.2 PCM Workshops

#### 5.2.1 Background

PCM Workshops were held for MOWRAM, MAFF, PDOWRAM, PDA and the farmers who live in the villages located in the Target Area. The goals of the PCM workshops were (i) to understand the present condition of the farmers who live in the villages and if they have access to sufficient or insufficient irrigation water. (ii) to find their problems and solutions, and (iii) to determine the depth of understanding that the governmental agencies concerned have regarding the Target Area and its associated problems.

#### 5.2.2 Contents and Results of PCM Workshops

##### 5.2.2.1 PCM Workshop for MOWRAM and MAFF

The Target Group was the “Farmers.” The analysis began with an investigation of the Core Problem that the “Farmer’s income is low” as (a starting point of Problem Analysis) and 2 Direct Causes (the problems that directly cause the Core Problem), (i) Agricultural income is low and (ii) It’s hard to increase agricultural income. The “Core Objective” was “Increasing Farmer’s income.” The concept of “Agricultural income is to be improved” was prioritized as a main means to achieve this objective. It is interesting to note that improvement of the coordination between MOWRAM and MAFF was mentioned in the Stakeholder Analysis as a crucial objective for MAFF.

##### 5.2.2.2 PCM Workshop for PDOWRAM and PDA of Kampong Speu and Kandal Provinces

Originally, a Stakeholder Analysis and Problems Analysis was planned to be carried out jointly by 4 provincial agencies because “Farmers” was thought to be their common Target Group. However, the Analysis was carried out by the officers of PDOWRAM and PDA Kampong Speu and those Kandal Provinces, respectively as the officers insisted that the characteristics and problems of the farmers were different in each province. It was noteworthy that they insisted that Pol Pot Canals and Hun Sen Canals should be discussed separately. The Target Group of both groups was “Farmers.” The results of their Analysis are given below:

#### Results of PCM Workshop for PDOWRAM and PDA of Kampong Speu and Kandal Provinces

	PDOWRAM and PDA Kampong Speu	PDOWRAM and PDA Kandal
Target Group	Farmers in Kampong Speu Province	Farmers in Kandal Province
Core Problem	Agricultural production is low	Lack of water for agricultural use
Direct Causes	(1) Irrigation systems are insufficient (2) Drought (3) There are not good plans for planting (4) Unfertile land (5) Farmers use indigenous knowledge (6) Lack of quality seeds	(1) Lack of water for agricultural use (2) Insufficient irrigation systems (3) No one maintains irrigation systems (4) Natural disaster
Core Objective	Agricultural production is to be increased	Sufficient water is to be made available for farmers
Direct Means	(1) Sufficient irrigation systems	(1) Extension of water management

	(2) Making specific crop planting plans (3) Making the land fertile (4) Changing of indigenous practices (5) Quality seeds are to be made available	methods (2) Studying of how to make the plans (3) Repairing/ rehabilitating of the existing irrigation systems (4) Helping farmers to get enough food (5) Formation of FWUC (6) Preparing for natural disaster
<b>Prioritized alternative means</b>	1 <sup>st</sup> : Direct Means (1) Sufficient irrigation systems 2 <sup>nd</sup> : Direct Means (4) Changing of indigenous practices 3 <sup>rd</sup> : Combination of Direct Means (4) and (5) to achieve Core Objective	1 <sup>st</sup> : Direct Means (3) Repairing/ rehabilitating of the existing irrigation systems with Direct Means (4) Helping farmers to get enough food 2 <sup>nd</sup> : Direct Means (1) Extension of water management methods to achieve Core Objective

### 5.2.2.3 PCM Workshop for Farmers

The Group Categorization in the Stakeholder Analysis describes the huge presence of NGOs (such as World Vision) and International Organizations (such as WFP) as the supporting agencies for the farmers. The PCM Workshops for farmers were held for the farmers who live in the villages where there is access to sufficient irrigation water (herein after “the farmers with sufficient water”) and those who live in the villages where there is not access to irrigation water (herein after “the farmers with insufficient water”). The participants came from 21 out of the 44 Communes in the Target Area. The table below shows the name of Communes and the results of the workshops. Three Communes (Samraong Tong, Saen Dei, and Sayav Kravan,) are listed more than once. It can be assumed that accessibility to irrigation of water varies within the same Commune.

#### Results of PCM Workshop on Farmers

	Farmers with Sufficient Water	Farmers with Insufficient Water
Target Group	Farmers with Sufficient Water	Farmers with Insufficient Water
Name of Commune	Samraong Tong, Saen Dei, Sayav Kravan, Skuh, Pneyay, Sopoar Tep, Trapeang Kong, Kahaeng, Tang Krouch, Roleang Kreul, Roleang Chak, Veal (13)	Samraong Tong, Saen Dei, Sayav Kravan,, Roka Thum, Sambour, Trapeang Chour, Prey Nheat, Veal (8)
Core Problem	Agricultural production is low	Low rice production yield
Direct Causes	(1) Lack of technique for rice growing (2) Lack of pesticides (3) Unequal social structure (4) Lack of draft animals (5) Farmers use indigenous knowledge (6) Unfertile soil (7) Disaster (8) Lack of high yield varieties (HYV) seeds	(1) Inappropriate location of rice fields (2) Poor soil management (3) Farmers cannot use water effectively (4) Unfertile soil (5) Pests/diseases of domestic animals (6) Lack of quality rice seed (7) Insufficient knowledge of rice growing
Core Objective	Agricultural production increases	Agricultural production increases
Direct Means	(1) The proper technique for rice growing is taught (2) Pesticide is available (3) More equal social structure (4) Soil is made fertile (5) Seeds of high yield variety (HYV) are made available	(1) Expansion of land for rice cultivation (2) Good soil management (3) Land is re-fertilized (4) Pest/disease damage to domestic animals is reduced (5) Quality rice seed is made available (6) Sufficient knowledge of rice growing is taught
Prioritized alternative means	1 <sup>st</sup> : Combination of all Direct Means 2 <sup>nd</sup> : Combination of Direct Means (1), (2) and (3) 3 <sup>rd</sup> : Combination of Direct Means (4),	1 <sup>st</sup> : Sufficient water for agricultural use 2 <sup>nd</sup> : Combination of Direct Means (5) and (6) 3 <sup>rd</sup> : Combination of Direct Means (4) and

	(5) and (6) to achieve Core Objective	(5) to achieve Core Objective
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### 5.2.2.4 Problems, Objectives, and Needs Identified

All stakeholders remarked that the crucial farmers' problems are that the farmers' income is low and the agricultural production is low. As the necessary measures to solve these problems, agricultural extension service teaching how to improve the present farming methods and ineffective water management are required. Both the farmers with sufficient and insufficient water focused their discussion points on improving the farming practice through improving the agricultural inputs. The farmers with insufficient water are eager to obtain sufficient irrigation water. They suffer from not only a shortage of irrigation water, but also the lack of subsistence food. Accordingly, it can be said that the farmers with insufficient water are worse off than those with sufficient water. The needs of those latter farmers are mainly construction or rehabilitation of irrigation facilities such as canals, and farm roads. The depth of understanding of MOWRAM, MAFF, PDOWRAMs, PDAs and the farmers themselves of the Target Area farmers' present condition and problems is of great importance. Increasing this understanding can likely bring a bright future for the comprehensive agricultural development in the Prek Thnot river basin.

## 5.3 Rapid Rural Appraisal

### 5.3.1 Background

RRA workshops were conducted aiming at grasping the socioeconomic condition of the farmers in the Target Area by the Zone Areas which are specified in Section 8.4. More specifically, conducting of RRA intends to identify rural socioeconomic characteristics, the problems, the needs and their backgrounds qualitatively and with deep insight from the viewpoint of the farmers.

### 5.3.2 Selection of Venues and Participants

The Communes where the RRA workshops were conducted were determined based on 2 maps prepared in the Preparatory Study for the Study on Comprehensive Agricultural Development of Prek Thnot River Basin; (1) the Drought Report Reference Map showing the location of the Prek Thnot river, Roleang Chrey Regulator, and the North and South Main Canals and the table summarizing SEILA Commune Data Base 2004, including the names of the Provinces, Districts, Communes, number of villages, and rice cropped areas in the rainy and dry seasons in the Target Area. Three villages from each Zone Area were selected from among the chosen Communes through discussion with PDOWRAM Kampong Speu and Kandal Provinces. The criteria for classifying the Target Area into the Zone Areas are as follows:

**Criteria for Classifying the Target Area into Zone Areas**

Zone Area	Selection Criteria
Zone -1	Area where irrigation water is available with 80% dependability
Zone -2	Area where irrigation water is available with 50% dependability
Zone -3	Area that has small reservoirs for irrigation with 50% dependability
Zone-4	Area where rainfed cultivation is carried out

The participants were picked by village authorities according to the following criterion; the farmers who can provide the village information. Thus, the participants' group consisted of farmers' representatives, Village Chiefs, Group Leaders, and the members of FWUC and VDC when they were available. Gender balance was also considered. The venue and participants are shown in the following table:

**Venue and Participants on RRA Workshops**

Item	Zone-1	Zone-2	Zone-3	Zone-4
Venue				
Name of Village	i) Ou Veang ii) Tumpung iii) Kahaeng	i) Sala Kruos ii) Boeng Chram Tboung iii) Sayav	i) Beng ii) Angkor Chea iii) Sampov Ngo	i) Chamkar Trach ii) Tuol Tnaot iii) Angk Samnang
Name of Commune	Kahaeng	Preah Nipean	Pneay	
Name of District	Samraong Tong	Kong Pisei	Samraong Tong	Peuk
Name of Province	Kampong Speu	Kampong Speu	Kampong Speu	Angk Snuol Kandal
Nos. of villages in the Commune	15	27	19	19
Participants	i) 16 (10:6)	i) 15 (10:5)	i) 15 (8:7)	i) 13 (10:3)
Nos. (Male: Female)	ii) 15 (10:5) iii) 16 (10:6)	ii) 13 (8:5) iii) 15 (11:4)	ii) 15 (12:3) iii) 15 (9:6)	ii) 12 (4:8) iii) 15 (8:7)
Occupation/ Position	Village Chief, Group Leaders, VDC members, FWUC Chief and Deputy Chief, farmers	Village Chief, Group Leaders, VDC members, FWUC members, farmers	Village Chief, Group Leaders, VDC members, FWUC members, farmers	Commune Chief, Village Chief, Deputy Village Chief, Group Leaders, VDC members, farmers

### 5.3.3 Major Outputs of RRA

#### 5.3.3.1 Natural and Social Resources

The Natural and Social Resource Map provides basic information of the determined venues. The information identified through making the Maps is summarized in Tables 5.3.1 to 5.3.4 by Zone Area. The tendency is that the population of the villages is relatively large in the upstream areas. Landless farm households, those who have involuntarily lost land, possess no skills other than in farming and face uncertain livelihood because of the loss of land but have only residential lands are commonly observed. Female-headed households are not rare. Both households are relatively vulnerable in the villages. Vulnerability is also brought by illness and too many children (5-6 children). Herein after, it is defined that “household” or *kruosar* in Khmer, means a small unit which generates livelihood together. It is noticeable that the villagers classify ponds into natural (*trapeang*) and artificial ones (*sras*). When they say “a big pond” it means a natural pond (*trapeang*). More detailed information on the rural socio-economy follows.

#### 5.3.3.2 Economic Condition

##### (1) Income Source

More than 95% of the villagers are farmers. Therefore, the main income sources are (i) selling surplus rice, (ii) selling surplus vegetables, (iii) selling pigs and chickens, and (iv) making palm sugar. Busy farming seasons are; transplanting of rice seedlings normally from July to August and harvesting of rice, normally from December to January. In these seasons, the poorer farmers work as a farm laborer. Farm laborers are required for plowing, pulling rice seedlings, transplanting of rice seedlings, and harvesting. The main non-farm income source is remittance/ salary from children working for a garment factory. Common subsidiary occupations are (i) a motorbike taxi driver, (ii) a traditional wedding music player, (iii) a craftsman (weaving palm leaves), and (iv) a construction worker. Two out of 28 sample households did not earn any income in 2004. Both of them live in Boeng Chram Tboung Village of Zone Area-2 and survived through borrowing.



## (2) Expenditures

The main items of expense are roughly divided into two categories; agricultural inputs and living expenses. In the past, the villagers were nearly self-sufficient. They grew rice and vegetables and caught fish for self-consumption. Now they need much cash for food, seasonings, clothes, children's education, recharging of batteries for lightening and watching TV, kerosene for lamps, gasoline for motorbikes, and modern medical care. They also need cash for contributions to a pagoda/wat and various types of ceremonies. Consequently, 21 out of 28 sample households were in debt in 2004. Minimum and maximum debts were R 39,500 (about US\$ 10) and R 9,957,800 (about US\$ 2,500) respectively. To satisfy their debts they sold cows, pigs, chickens, gold, jewelry and a motorbike, and still owed debt. The main lenders were relatives who didn't charge interest. Seven out of 28 sample households were in the black in 2004. Minimum and maximum surpluses were R 47,200 (about US\$ 12) and R 2,369,200 (about US\$ 600) respectively. The surplus was saved as gold, cows, pigs, and/or additional paddy field, if it was available. Some of them spent it for purchasing farm equipment such as ploughs and harrows.

## (3) Accessibility to Rural Micro Finance

Rural credit has been largely provided by NGOs, a bank named ACLEDA and IOs concerned primarily with poverty reduction. Village Saving Associations are also available in Kahaeng and Tumpung Villages. Accordingly, the access to rural micro finance is good in the villages of all Zone Areas. It can be said that the accumulation of capital in the form of cash, equipment or real estate is very large, relatively speaking, and it could lead to inflation in the near future.

## (4) Economic Stratification

Economic stratification was identified through the group discussions. The main indicators of economic stratification are (i) the material of a house, (ii) farmland holding size (for paddy and vegetables), (iii) the number of livestock cattle/cows, pigs, chickens, and ducks, and (iv) surplus of rice for selling. A large number of children negatively influence the economic condition of the household. Around 50% of the villagers think that they are in the middle class. The standards of "the middle class" households are; (i) living in a zinc roofed house, (ii) holding 1ha of paddy field and 0.2-0.5ha of vegetable field, (iii) keeping 1 or 2 cows/oxen, 1 or 2 pigs and poultry, and (iv) having a surplus of rice for selling. It is noteworthy that the standard of the indicators is somewhat higher in Zone Area-1 than in the other Zone Areas.

### **5.3.3.3 Agriculture**

Due to the nature of agriculture, climate and weather directly influence crop production, the type of livestock, and the style of fishery. The climatic zone of Cambodia is classified as tropical monsoon. It is governed by 2 monsoons. The cool, dry, northeastern one carries little rain and the southwestern one brings strong winds, high humidity and heavy rains. The season is roughly divided into the rainy and dry seasons. The rainy season ordinarily starts from the end of May and continues until the end of October. In the strict sense, the dry season is classified into the cool dry from the beginning of November to the end of January and the hot dry seasons from the beginning of February to the middle of May.

#### (1) Crop Production

The staple crop is rice in all Zone Areas. The villagers intend to mitigate the risk of growing rice through using many varieties of seeds. According to them, rice variety is classified into 4 categories; early rice, medium rice, late rice and IR. They grow a variety of vegetables depending on water availability and soil condition. Some of the vegetables

grown are cabbage, sponge gourd, wax gourd, pumpkin, tomatoes, lettuce, leeks, cucumbers, watermelon, mung beans and string beans for self-consumption and sale. Cauliflower is grown for sale only in Sala Kruos Village, Zone Area-2. Both chemical and natural fertilizers are commonly used for rice and vegetable growing. Chemical pesticide is also commonly used for solving the main problems of farming; the damage of pests (red caterpillars and worms), birds and mice. As a result, the expense for agricultural inputs is large against the revenue. Kahaeng Village in Zone Area-1 quit using chemical fertilizer and uses compost instead, because chemicals result in the loss of rice fragrance. It would be possible to reduce the expense for agricultural inputs by use of the compost and natural pesticides.

## (2) Animal Husbandry

Animal husbandry is practiced in all Zone Areas. The breeds of typical livestock are cattle (cows and oxen), pigs, chickens, and ducks. Ou Veang Village in Zone Area-1 keeps geese for self-consumption and sale, and dogs as guard dogs and for self-consumption. The intended use of livestock by breed is summarized as follows.

**Intended Use of Livestock by Breed**

Breed	Intended Use/ Objectives	
Cattle	<ul style="list-style-type: none"> <li>• Draft animal</li> <li>• For sale</li> <li>• Dung for fertilizer</li> <li>• Breeding</li> </ul>	<ul style="list-style-type: none"> <li>• Exchange</li> <li>• Energy source</li> <li>• Traditional identity</li> </ul>
Pigs	<ul style="list-style-type: none"> <li>• For sale</li> <li>• Dung for fertilizer</li> <li>• Breeding</li> </ul>	<ul style="list-style-type: none"> <li>• Exchange</li> <li>• Feast for ceremonies</li> <li>• Self-consumption</li> </ul>
Chickens	<ul style="list-style-type: none"> <li>• For sale (meat and eggs)</li> <li>• Excrements for fertilizer</li> <li>• Breeding</li> </ul>	<ul style="list-style-type: none"> <li>• Feast for ceremonies</li> <li>• Self-consumption (meats and eggs)</li> </ul>
Ducks	<ul style="list-style-type: none"> <li>• For sale (meat and eggs)</li> <li>• Breeding</li> <li>• Feast for ceremonies</li> </ul>	<ul style="list-style-type: none"> <li>• Self-consumption (meat and eggs)</li> <li>• A present for relatives</li> </ul>

## (3) Fishery

Fish is a staple food as well as rice. Fish catch has been decreasing in both the rainy and dry seasons in all Zone Areas. In the past, there were more fish in the dry season compared with the rainy season. The reason was that fish gathered in specific places due to the reduced size of the water bodies in the villages. The amount of fish caught was enough to feed the villagers and leave a surplus that could be sold for cash income. On the other hand, in the present, the villagers ordinarily need to buy fish from January to April for daily self-consumption and making *prahock* (fermented fish paste). The price of fish ranges between Riel 1,000-8,000/kg in the villages and Riel 1,500-7,000/kg at the markets according to the location of the villages, season and weather. The most serious problem is the extinction of fish due to the current use of electrical fishing tools. The expense for purchasing fish brings heavy pressure on the villagers' living standards.

## (4) Marketplaces

Markets, rice millers, and small vending shops are available with a 60 minutes walk in all Zone Areas. The villagers can buy daily necessities and simultaneously sell their agricultural produce in the markets in the villages and the neighboring markets. Dealers/Middlemen come to villages to buy rice, vegetables, chickens, ducks, cows/oxen, and pigs in front of the gates. In many of the sample villages, their purchase price is lower than the market price. When the villagers in Kampong Speu Province (Zone Area-1, -2 and -3) want to sell large quantities of produce, they go to the Kampong Speu Province Market by motorbike, motorbike taxi, *remorque-moto*, or pickup truck. The villagers of Kandal Province (Zone Area -4) go to Angk Snuol District Market by the same

transportation means. Transportation fees depend on the distance from the village to the market, and the type of transportation. Motorbike taxi fare ranges between R 120/km and R 500/km, and *remorque-moto* fare is R 500/km. At present, the marketplaces are sufficient for the villagers. Nevertheless, the price of agricultural products is not favorable to the villagers.

#### **5.3.3.4 Institutions and Organizations**

##### **(1) Local Authorities**

The commune is the smallest administrative unit under the Ministry of Interior. Each commune has a Commune Council and the head of the Commune Council is the Commune Chief who is selected by a Commune Council Election. Each commune consists of natural villages, and the settlers have a sense of belonging in their villages. In the villages there are Village Chiefs and Deputy Village Chiefs appointed by the Commune Chiefs. Moreover, the village consists of from two to five Groups depending on the number of the households in the village. Each Group consists of 10-18 households and is represented by a Group Chief/Leader. Villagers regard a line of authority starting from the Commune and ending up at the Group as the local administrative authority.

##### **(2) FWUC**

Water distribution has been practiced in a customary manner. As for intermediation of water conflicts, 10 out of 12 sample villages do not have any records. In 2 villages, conflict occurred among the farmers when external entities such as NGOs and donors provided motor pumps and some members did not obey the rules. MOWRAM has promoted organizing FWUC and its subordinate organization, FWUG since the late 1990s. FWUC and FWUG take care of the irrigation systems at the farmers' level. They are in charge of repairing irrigation facilities, distributing water, and collecting water charges. There are members of FWUC in all villages in Zone Area-1,-2, and -3 and Tuol Thnaot Village in Zone Area-4; however, some of the members are titular. In Ou Veang Village, where FWUC functions well, the farmers appreciate the FWUC because of its advantage on effective water management and O & M of irrigation facilities. The condition of FWUC/ FWUG as of September 2005 is summarized in Table 5.3.5. Condition of FWUC/ FWUG by village.

##### **(3) Village Development Committee (VDC)**

A VDC has been established in all but 2 of the 12 sample villages. Those 2 villages; Tuol Thnaot Village and Angk Samnang Village of Zone Area -4 are preparing to establish a VDC. VDC members know the natural and social conditions of their villages very well. Because of the nature of a VDC, the VDC plays an important role to unite villagers.

##### **(4) Village Savings Associations**

Village Savings Associations has been organized and promoted by CEDAC in Kahaeng and Tumpung Villages. The purpose of these associations is to alleviate poverty and share and save money for agricultural inputs as a group. In the case of the Tumpung Village Savings Association, initial funds of Riel 7,600,000 were collected from the members. After contributing to the initial funds, the members have to save Riel 1,300 every month. The villagers can borrow money from the fund at an interest of 3%/ month.

##### **(5) International Organizations**

UNICEF widely covers the Zone Areas with digging of hand pumped wells and providing non-formal education projects as mentioned above. PRASAC continues the activity of providing a large amount of loans to the villagers with an interest rate of 3-4%/month.

(6) NGOs

Except for Ou Veaeng Village in Zone Area-1, all villages have had support from a variety of NGOs. The activities mainly focus on providing finance (cash and in kind such as rice and cows) and agricultural training. The presence of the Children's Right Program is remarkably large due to its great efforts in supporting children but and it contributes a great deal to the villages.

### 5.3.3.5 Culture

The villagers spend their lives dominated by religious events/ceremonies and farming. The religious events, ceremonies, festivals, and farming activities commonly follow the lunar calendar in the villages.

The majority of the villagers are followers of Theravada Buddhism. The Pagoda/Wat is the core of their religion and the welfare oriented activities in the villages. Monks take care of the moral, spiritual and religious needs of the villagers. In turn, the villagers take care of the monks' physical and material needs, the so-called, four contributions; robes, food, residence and medicine. The connecting line between the monks and the villagers is a temple volunteer, an *achar*. The role of the *achar* is to initiate Theravada Buddhism and manage the religious events and ceremonies in the pagoda/wat.

Animism has also taken root in rural society in all Zone Areas. All villages have their own *Neak Ta* or holly and sacred spirit around the villages. *Neak Ta* can be described as a Mother Earth concept, an energy force uniting a rural society with its earth and water. Accordingly, all villages have a sacred place/land in the villages. The villagers pray to *Neak Ta* for plenty of rainfall, high production, and protection from disasters. Christianity is also establishing a presence but its popularity is still low.

Consequently, the events, ceremonies, and festivals deeply related to Theravada Buddhism and the *Neak Ta* faith are common in the villages of all Zone Areas. For example, Bon Dalien, the festival expressing gratitude to *Neak Ta* of land and water for cultivation, is held in the 1<sup>st</sup> lunar month in all villages. The other examples of the common and enormous events are the Khmer New Year celebration in the 1<sup>st</sup> lunar month and Pchum Ben, the ceremony commemorating deceased persons in the 5<sup>th</sup> lunar month. The villagers enjoy these events through taking time out from their busy farming schedule.

### 5.3.3.6 Gender and Development

It is generally said, while Cambodian political and religious policies do not directly discriminate against women, females are rarely afforded the same opportunities as males. In the sample villages, "Day Time Line" informed by male aged between 20s' and 60s' is dissimilar with that of female. Nevertheless, neither gender discrimination nor inequality is obviously practiced in any of the sample villages. In addition, the following issues are in similar in all sample villages of all Zone Areas.

(1) Income Generating Activities

The main income generating activities are farming and animal husbandry in all sample villages. Because climate influences farming and animal husbandry activities considerably, the villagers' daily activities in the rainy season are different from those in the dry season.

Traditionally, there are separate roles for males and females in farming activities. Transplanting of rice seedlings used to be a typical farming activity of the females; however, recently it's being done by both genders in some sample villages.

Both males and females engage in animal husbandry activities such as taking cattle to the grasslands, feeding and watering cattle, pigs, chickens and ducks. Only making fires for

protecting cattle from mosquitoes in the rainy season is specific to males.

Other income generating activities are clearly different between males and females. The table below shows the details of income generating activities by gender.

**Income Generating Activities by Gender**

Type of Income Generating Activity	Male	Female
Farming	<ul style="list-style-type: none"> <li>• Plowing</li> <li>• Burying manure</li> <li>• Building banks for paddy fields</li> <li>• Pulling rice seedlings</li> <li>• Transplanting of rice seedlings</li> <li>• Weeding</li> <li>• Harvesting</li> <li>• Taking care of vegetables</li> </ul>	<ul style="list-style-type: none"> <li>• Transplanting of rice seedlings</li> <li>• Pulling rice seedlings</li> <li>• Collecting vegetables</li> <li>• Harvesting rice</li> <li>• Controlling water in paddy fields</li> <li>• Land preparation for cultivating vegetables</li> <li>• Cultivating vegetables</li> <li>• Weeding</li> <li>• Taking care of vegetables and fruit trees in the backyards</li> <li>• Making compost</li> <li>• (Preparing meals for hired laborers)</li> </ul>
Animal husbandry	<ul style="list-style-type: none"> <li>• Taking care of animals and birds</li> <li>• Bringing cattle to grasslands</li> <li>• Making fires for cattle</li> <li>• Collecting cattle and pig dung</li> <li>• Feeding and watering</li> </ul>	<ul style="list-style-type: none"> <li>• Taking care of animals and birds</li> <li>• Bringing cattle to grasslands</li> <li>• Collecting cattle and pig dung</li> <li>• Feeding and watering</li> </ul>
The others	<ul style="list-style-type: none"> <li>• Charcoal sale</li> <li>• Climbing palm trees to collect palm juice</li> <li>• Making palm sugar</li> <li>• Driving a motorbike taxi/ a taxi/ a truck/ <i>remorque-moto</i></li> <li>• Construction worker</li> </ul>	<ul style="list-style-type: none"> <li>• Working for a garment factory</li> <li>• Teacher</li> <li>• Health worker</li> <li>• Sewing clothes</li> </ul>

(2) Roles in the Community

Administrative community leaders are usually men in all sample villages. Females are rare as VDC members as well, but females participate in the VDC member elections and meetings. Both genders have fair opportunities to participate in the meetings on the irrigation systems at the village level. The opportunities for attending training courses/extension services provided by governmental agencies, IOs, and NGOs are also fair between males and females. The contents of the training courses/extension services are varied; rice growing, animal husbandry, income generation, education, health care, HIV/AIDS awareness, preservation of traditional culture, human rights, and Domestic Violence awareness. As for construction works such as rehabilitation of canals and roads for village development, usually only males have engaged in it.

(3) Roles in the Home

Division of roles by gender at home has been changing. Specially, males in their 20s' and 30s' help a wife with cooking, housekeeping, and taking care of children. In many cases, these phenomena emerge when a wife works for a garment factory and she is also an important breadwinner for the family.

### Roles in the Home by Gender

Male	Female
<ul style="list-style-type: none"> <li>• Head of family</li> <li>• Breadwinner</li> <li>• Catching fish, crabs, and snails for self-consumption</li> <li>• Collecting and chopping firewood</li> <li>• Helping wife with cooking/Cooking</li> <li>• Taking care of/teaching children</li> <li>• Cleaning the house</li> </ul>	<ul style="list-style-type: none"> <li>• Cooking/Boiling water</li> <li>• Washing and putting dishes in order</li> <li>• Cleaning the house</li> <li>• Laundry</li> <li>• Collecting firewood and grasses</li> <li>• Taking care of/teaching children</li> <li>• Buying food at a market</li> <li>• Breadwinner/Head of family</li> </ul>

Participation in decision making in the family depends to some extent on who earns the income. Generally, the ratios of decision making between males and females are moving toward 50:50 or 60:40 in the sample villages.

#### (4) Political Participation

Ninety percent of sample villagers have voted 4 times since 1993. They had the 1<sup>st</sup> General Election for the National Assembly in 1993, the 2<sup>nd</sup> General Election for the National Assembly in 1998, the Commune Chief Election in 2002 and the 3<sup>rd</sup> General Election for the National Assembly in 2003.

#### 5.3.4 Problems and Needs Identified

The following table describes the problems identified by the villagers and an analysis on their causes.

#### Problems Identified by the Villagers and Cause Analysis

Area	Causes of the Problems	Problems
Zone -1	<ul style="list-style-type: none"> <li>• Water shortage in the dry season</li> <li>• Rainfall has decreasing since 2003</li> </ul>	<ul style="list-style-type: none"> <li>◆ Lack of rice for self-consumption</li> <li>◆ Paying lot of money to buy water for cultivation and daily use</li> </ul>
	<ul style="list-style-type: none"> <li>• Fertilizer is expensive</li> <li>• Food is expensive</li> <li>• Annual income fluctuates year by year due to rainfall</li> </ul>	<ul style="list-style-type: none"> <li>◆ It's financially hard for the villagers to buy food</li> </ul>
	<ul style="list-style-type: none"> <li>• Design of the irrigation system is improper</li> </ul>	<ul style="list-style-type: none"> <li>◆ There is no bridge across canals to go to schools or pagodas/wats</li> </ul>
Zone -2	<ul style="list-style-type: none"> <li>• Rainfall has been decreasing since 2003</li> <li>• Water sources have not been fully developed</li> <li>• Irrigation systems do not function sufficiently</li> </ul>	<ul style="list-style-type: none"> <li>◆ Drinking water is not sufficient</li> <li>◆ Production of rainfed paddy field is not stable</li> </ul>
	<ul style="list-style-type: none"> <li>• Rainfall has been decreasing since 2003</li> <li>• Irrigation facilities that existed in the past were removed by the government</li> <li>• Although there are irrigation facilities, there is no water in the dry season</li> </ul>	<ul style="list-style-type: none"> <li>◆ Water for cultivation decreased compared with the past</li> <li>◆ Too many expenses compared with income</li> </ul>
	<ul style="list-style-type: none"> <li>• Change of water flow due to newly constructed houses</li> </ul>	<ul style="list-style-type: none"> <li>◆ Flood damage</li> </ul>
	<ul style="list-style-type: none"> <li>• It's not affordable for the villagers to purchase toilet facilities</li> </ul>	<ul style="list-style-type: none"> <li>◆ Shortage of latrines</li> </ul>
Zone -3	<ul style="list-style-type: none"> <li>• Water sources are not fully developed</li> <li>• Rainfall has been decreasing since 2003</li> </ul>	<ul style="list-style-type: none"> <li>◆ Water for drinking, domestic, and agricultural use is not sufficient</li> </ul>

	<ul style="list-style-type: none"> <li>• Harvest depends on rainfall</li> <li>• Irrigation systems are not efficient</li> <li>• Water management is not properly carried out</li> <li>• Water resources are limited</li> </ul>	<ul style="list-style-type: none"> <li>◆ Insufficient water for growing rice for subsistence in a drought-stricken year</li> <li>◆ Not being able to cultivate rice 2 times/year</li> </ul>
	<ul style="list-style-type: none"> <li>• Marketable products are limited</li> <li>• Income fluctuates</li> </ul>	<ul style="list-style-type: none"> <li>◆ It is impossible to calculate yearly income and expenditures (1 village)</li> </ul>
Zone -4	<ul style="list-style-type: none"> <li>• Water sources are limited</li> <li>• FWUC/ FWUG doesn't function fully</li> <li>• Rainfall has been decreasing since 2003</li> </ul>	<ul style="list-style-type: none"> <li>◆ Water conflicts regarding agricultural water in the rainy season</li> </ul>
	<ul style="list-style-type: none"> <li>• Droughts in 2003 and 2004</li> <li>• Extension services on rice growing are not sufficient</li> </ul>	<ul style="list-style-type: none"> <li>◆ 90% of rice production was damaged → Low standard of living</li> </ul>
	<ul style="list-style-type: none"> <li>• It is difficult to raise pigs</li> <li>• Extension services on pig raising are not sufficient</li> </ul>	<ul style="list-style-type: none"> <li>◆ It is tough to produce high output from pig raising</li> </ul>