Roleang Chrey Regulator
(downstream view)

Andong Sla Intake
(downstream view)

Vat Krouch Intake
(downstream view)

North Main Canal

South Main Canal

Socio-economic Survey in Kampong Speu

| | |
|---|---|
| **Sub-project Name:** | **Roleang Chrey Headworks Rehabilitation Sub-project** |
| **Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia** | **JICA Survey Team** |

Intake gate on Tumnup Lok Reservoir

Diversion structure on Tumnup Lok Reservoir

Spillway of Kpob Trobek Reservoir

Diversion canal

Rainy season rice
(Supplying water from tertiary canal)

Socio-economic survey in Takeo

| | |
|---|---|
| **Sub-project Name:** | **Upper Slakou Irrigation System Rehabilitation Sub-project** |
| **Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia** | **JICA Survey Team** |

Daeum Ruse Regulator on connection canal between Prek Thnot River and Stung Touch River


Existing intake and pump station at Tonle Bati Lake (intake gates are heavily deteriorated and pump capacity is much less than required one)

Abandoned "incomplete connection canal of NS-78" and rainfed paddy fields on both bank

Tertiary canal in priority area of Kandal Stung

House on canal bank (MR-1, Sta. 0.7 km)

Upland crop field irrigated by watering pot

| **Sub-project Name:** | **Kandal Stung - Bati Irrigation System Rehabilitation Sub-project** |
|---|---|
| **Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia** | **JICA Survey Team** |

Intake of Khpob Krous Reservoir

Main Canal 35
(near Khpob Krous Reservoir)

Main Canal 35
(3 km downstream of Khpob Krous Reservoir)

Main Canal 35
(Downstream area)

Rice field (Early rainy season)
(near Khpob Krous Reservoir)

Rice trading company in Basedth District

| | |
|---|---|
| **Sub-project Name:** | **Main Canal 35 Rehabilitation Sub-project** |
| **Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia** | **JICA Survey Team** |

Srass Prambai Reservoir Dike (already rehabilitated)

Srass Prambai Reservoir Dike (to be rehabilitated)

Intake culvert on reservoir dike

Main canal after recession

Rice field under recession cultivation

Interview with villagers on
Sub-project implementation

| | |
|---|---|
| **Sub-project Name:** | **Srass Prambai Water Recession Rehabilitation Sub-project** |
| **Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia** | **JICA Survey Team** |

Temporary weir for Daun Pue Intake made with sand bags and wooden material

Main canal and culvert

Stung Chieb River

Pipe culvert on main canal (to be replaced)

Rice field in dry season

Private rice milling company
in Kampong Chhnang Province

| | |
|---|---|
| **Sub-project Name:** | **Daun Pue Irrigation System Rehabilitation Sub-project** |
| **Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in The Kingdom of Cambodia** | **JICA Survey Team** |

PREPARATORY SURVEY
FOR
IRRIGATION AND DRAINAGE SYSTEM
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

# SUMMARY

## PART I GENERAL INFORMATION

### CHAPTER I-1 INTRODUCTION

***General***

(1) This final report has been prepared in accordance with the Minutes of Discussion on Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project (the Survey) between the Japan International Cooperation Agency (JICA) and the Royal Government of Cambodia (RGC) signed on February 25, 2011. (*P I-1-1*)

(2) The report shows the works executed from June 2011 to April 2012 such as the results of the study on scope, implementation organization, implementation plan, economic evaluation, environmental and social consideration, and preliminary water balance on Prek Thnot River Basin of the Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project (SPPIDRIP) consisting of the Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP), Upper Slakou Irrigation System Rehabilitation Sub-project (USISRSP), Kandal Stung-Bati Irrigation System Rehabilitation Sub-project (KSBISRSP), Main Canal 35 Rehabilitation Sub-project (MC35RSP), Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) and Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP), which were part of the Irrigation and Drainage System Rehabilitation and Improvement Project (the Project). (*P I-1-1*)

***Background of the Project***

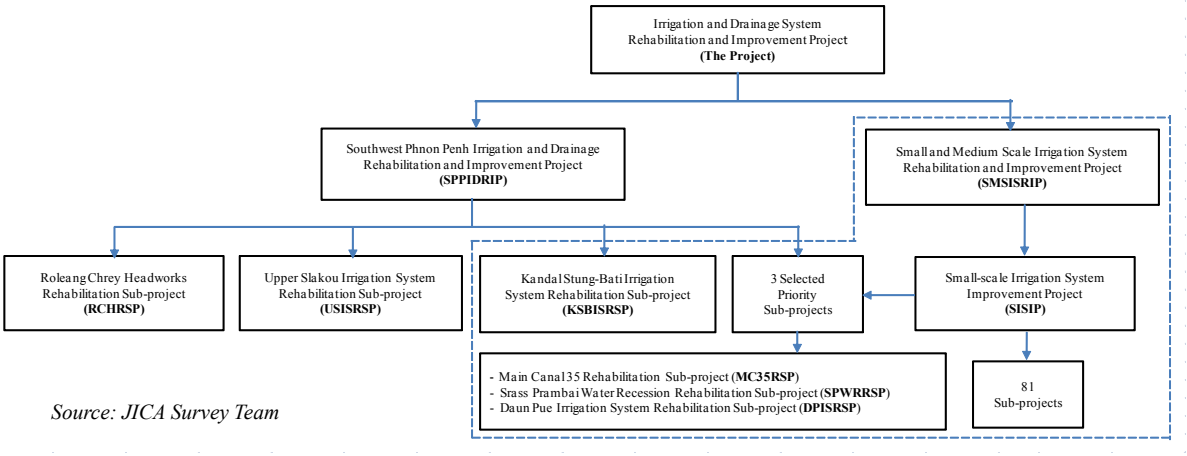
(3) The agriculture sector in Cambodia, a major component of its economy, contributed 36% to the gross domestic product (GDP) or around US$4,047 million in 2010. About 80% of the country's population dwells in the rural area, where about 90% of them live in poverty. Based on these figures, agricultural development in the country plays an important role for poverty reduction as well as economic development. The main crop in the country is paddy. The paddy field was estimated to be approximately 2,547,000 ha in 2009. Out of this, about 773,000 ha (30%) is irrigated during the rainy season and about 347,000 ha (14%) is irrigated during the dry season. (*P I-1-1*)

(4) This implies that rainfed cultivation is dominant in the country, which results to low and unstable agricultural production. Under such situation in agriculture, RGC requested the Government of Japan (GOJ) to provide development support to high potential areas for agricultural production. In reply to the request, JICA executed a series of technical assistance in these said areas.

Thereafter, RGC requested GOJ to provide further assistance for the implementation of projects where feasibility study (F/S) was executed to identify priority studies in the surrounding areas. In answer to this further request and consideration from the previous request of RGC for small-scale irrigation project, JICA decided to carry out the Survey aiming to prepare for possible loan application. (*P I-1-2*)

***Components of the Project***

(5) The following figure shows the components of the Project. (*P I-1-2*)




*Source: JICA Survey Team*

***Objective of the Survey***

(6) The objective of the Survey is to scrutinize the project cost for the rehabilitation of irrigation and drainage facilities through confirmation of the suitable project scope and construction method. This work is undertaken by collecting and analyzing the necessary information for project preparation as repayable aid of loans, and by reviewing the existing F/S or M/P relevant to the Project and the project proposal on SISIP. (*P I-1-2*)

## CHAPTER I-2 NATIONAL AND SECTORAL POLICIES RELATED TO THE PROJECT

(7) There are 8 national and sectoral policies related to the Project. These are the (i) *Rectangular Strategy-Phase II*, (ii) *National Strategic Development Plan Update 2009-2013*, (iii) *Strategy for Agriculture and Water Program 2010-2013*, (iv) *Agriculture Strategic Development Plan 2009-2013*, (v) *Action Plan on Water Resources and Meteorology Management and Development 2009-2013*, (vi) *Policy Paper for Promotion of Paddy Production and Rice Export*, (vii) *Action Plan for Implementing Government Policy on Promotion of Paddy Production and Rice Export*, and (viii) *National Water Resources Policy for the Kingdom of Cambodia*.(*P I-2-1 to I-2-6)*

(8) Of these 8 policies, the *Rectangular Strategy-Phase II* is the most fundamental policy for RGC. Other policies are therefore formulated by referring to the said strategy. *Rectangular Strategy-Phase II* accords top priority for the enhancement of the agriculture sector as *Rectangle 1*, and adopted the *Improvement of Agricultural Productivity and Diversification* as the crucial strategy in *Rectangle 1*. In the *Strategy for Agriculture and Water Program 2010-2013*, the following quantifiable indicators are closely related to the Project: (*P I-2-1 to I-2-3*)

- Agriculture output will be increased by 20% over the four-year period from 2010-2013 or there will be an estimated increase of 1.5 million ton for rice;

- Beneficiary income will be increased by 20% over the 4-year period from 2010-2013 or there will be an estimated increase of about US$30/month/household in rural areas; and
- The area of cropping land with access to irrigated service will be increased by 100,000 ha over the 4-year period from 2010-2013.

## CHAPTER I-3 RELEVANT ORGANIZATIONS

### *Ministry of Water Resources and Meteorology*

(9) The Ministry of Water Resources and Meteorology (MOWRAM) became an independent ministry of the Ministry of Agriculture, Forestry, and Fisheries **(**MAFF) in 1999 with the mission of an effective, equitable, and sustainable development and management of water resources of the country. MOWRAM is composed of 7 technical departments, 3 administrative departments, the Technical Service Center (TSC) for Irrigation and Meteorology and 24 Provincial Departments of Water Resources and Meteorology (PDOWRAM). There are 5 categories in staff qualification, i.e., (i) engineer, (ii) technician, (iii) vocational, (iv) qualified, and (v) non-qualified. There is a total staff of 666 at the central level and 623 at the provincial level as of March 2011. (*P I-3-1*)

(10) The annual budget and actual expenditure of MOWRAM are summarized below:

**Summary of Budget and Expenditure of MOWRAM** (Unit: million Riel)

| Item | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Budget | 13,210 | 14,327 | 18,756 | 90,366* | 149,894* | 141,356 |
| (US$ 1,000)** | 3,235 | 3,508 | 4,593 | 22,127 | 36,703 | 34,612 |
| Actual Expenditure | 12,392 | 15,650 | 17,268 | 88,316* | 146,090 | Not available |
| (US$ 1,000)** | 3,034 | 3,832 | 4,228 | 21,625 | 35,771 | Not available |

*Source: Department of Finance, MOWRAM*
**: Including investment for irrigation system (70 million Riel in 2010 and 90 million Riel in 2011)*
***: US$1=4,084 Riel*

As seen in the above table, the budget excluding investment for irrigation system has increased steadily. (*P I-3-2*)

### *Ministry of Agriculture, Forestry, and Fisheries*

(11) MAFF has a mission to support the economic growth of Cambodia by providing high quality services to agriculture, fishery, and forestry-based sectors in order to secure food supply and increase agricultural output with added-value in a sustainable and cost-effective manner. MAFF consists of 19 departments, namely, the Fisheries Administration, the Forestry Administration, the National Agricultural Laboratory, the Agricultural Information and Documentation Center, the Financial Control Unit, the public institutions, and 24 provincial and municipal departments of agriculture and forestry. The total number of staff of the central and local offices is 7103 as of June 30, 2011. (*P I-3-2*)

(12) The summary of the annual budget and actual expenditure of MAFF is as follows:

**Summary of Budget and Expenditure of MAFF** (Unit: million Riel)

| Item | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Budget | 39,274 | 42,873 | 48,758 | 54,779 | 64,048 | 87,695 |
| (US$1,000)* | 9,617 | 10,498 | 11,939 | 13,413 | 15,683 | 21,473 |
| Actual Expenditure | 36,896 | 49,132 | 52,257 | 54,525 | 57,878 | Not available |
| (US$1,000)* | 9,034 | 12,030 | 12,796 | 13,351 | 14,172 | Not available |

*Source: Department of Finance, MAFF*
**: US$1 =4,084Riel*

The growth rate of the annual budget ranges from 9.2% to 36.9%, and has increased every year. (*P I-3-3*)

***Provincial Department of Water Resources and Meteorology***

(13) PDOWRAM is placed in each province as a sub-ordinate agency of MOWRAM. It consists of 5 offices, namely; (i) Administration and Personnel Office, (ii) Irrigated Agriculture Office, (iii) Water Resources Management and Conservation Office, (iv) Water Supply and Sanitation Office, and (v) Hydro-meteorological Office. Under PDOWRAM, there are district offices, of which there are a total of 183 district offices in the whole country. (*P I-3-3*)

***Provincial Department of Agriculture***

(14) The Provincial Department of Agriculture (PDA) is established in each province as a sub-ordinate agency of MAFF. PDA has several technical offices such as (i) Agricutural Extension, (ii) Veterinary & Animal Production, (iii) Agricultural Machinery, (iv) Agricultural Legislation, (v) Agro-industry, (vi) Agronomy & Land Improvement, and (vii) Administrative Offices, which subordinated some district agriculture offices (DAO). Extension workers assigned in DAO are directly controlled by the deputy director of PDA. Agricultural support services are provided by DAO, of which the major activity is the demonstration of improved rice farming practices. (*P I-3-3 and I-3-4*)

***Farmer Water Users Community***

(15) In 1999, RGC issued Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems. Circular No.1 indicates that Farmer Water Users Community (FWUC) shall be responsible for O&M of irrigation systems, payment of irrigation service fee (ISF) for O&M, and water distribution to paddy fields under the support of MOWRAM. Prakas 306 issued in July 2000 shows the structure and functions of FWUC including collection of ISF. Presently, MOWRAM is finalizing the sub-decree on establishing FWUC by following Circular No.1 and Prakas 306. The sub-decree will relate the organizational structure, statute, establishment procedures, and roles and responsibility of FWUC. (*P I-3-4*)

(16) According to MOWRAM, there are some 350 FWUCs established nationwide, as of 2011. Out of 350 FWUCs, 150 FWUCs are registered to MOWRAM. Depending on the source of project support, some FWUCs are registered at PDOWRAM level only. (*P I-3-5*)

## CHAPTER I-4 DONOR'S ASSISTANCE

***Irrigation Projects Completed in Ten-year Period from 2001 to 2010***

(17) The irrigation projects completed in the 10-year period from 2001 to 2010 are listed as follows: (*P I-4-1*)

**List of Irrigation Projects Completed in 10 Years by 2010**

| Project | Donor | Completed Year | Amount (US$ $10^6$) | Province |
|---|---|---|---|---|
| Colmatage Irrigation Rehabilitation Project (2,122 ha) | Japan | 2002 | 8.7 | Kandal |
| Stung Chinit Irrigation and Rural Infrastructure Project (3,000 ha) | ADB+AFD | 2008 | 25.6 | Kampong Thom |
| Integrated Development in Battambang Province (1,950 ha) | FAO | 2008 | 3.3 | Battambang |
| Batheay Irrigation Construction Project (8,000 ha) | Korea | 2010 | 4.3 | Kampong Cham |
| Tamouk Reservoir Dike Rehabilitation Project (4,051 ha) | Korea | 2004 | 1.4 | Kandal |
| Bassac Dam Rehabilitation Project in Battambang Province (20,000 ha) | Japan | 2006 | 2.0 | Battambang |
| Rehabilitation of the Kandal Stung Irrigation System in the Lower Prek Thnot River Basin | Japan | 2007 | 16.3 | Kandal |
| Grant Assistance for Grass-Roots Human Security Project (11 Sub-projects, 11 River basin, 12,200 ha) | Japan | 2005-2009 | | |
| Study on the Comprehensive Agricultural Development of Prek Thnot River Basin | Japan | 2008 | 4.0 | Kampong Speu |
| River Basin and Water Use Study for Northwest Irrigation Sector Project (NWISP) | ADB+AFD | 2006 | 30.9 | Pursat, Battambang, Banteay Measchey, Siem Reap |
| M/P on Water Resources Development in Cambodia | Korea | 2008 | 1.5 | Whole Country |
| The Basin-Wide Basic Irrigation and Drainage M/P Study | Japan | 2009 | 4.0 | Kampong Chhnang, Pursat, Battambang |
| Technical Cooperation for TSC-Phase 2 | Japan | 2009 | 7.2 | Kandal, Pursat, Takeo |

*Source: Irrigation Development in Cambodia, as of March 2011*

### *On-going Projects*

(18) The following are the on-going projects as of March 2011: (*P I-4-2 and I-4-3*)

**List of On-going Irrigation Projects**

| Project | External Support | | Implementation | | Province | Project Cost (US$' 000) | Fund Resource (US$ '000) | | Status as of March 15, 2011 |
|---|---|---|---|---|---|---|---|---|---|
| | Donor | Fund Type | From | To | | | External | Local | |
| North West Irrigation Sector Project | ADB+ AFD | Loan+ Grant | 2005 | 2012 | Pursat, Battambang, Banteay Measchey, Siem Reap | 30,870 | 21,740 | 9,130 | On-going |
| Eastern Rural Irrigation Development Project | IMF | MDRI | 2007 | 2013 | Kampong Cham, Prey Veng, Svay Rieng, Kratie, Stung Treng, Rotanak Kiri, Mondul, Kiri | 33,380 | 32,763 | 617 | On-going |
| Krang Ponley Multipurpose Water Resources Project | Korea | Loan | 2008 | 2012 | Kampong Spue | 29,505 | 26,098 | 3,407 | On-going |
| Tonle Sap Lowlands Rural Development Project (TSLRDP) | ADB | Loan+ Grant | 2008 | 2015 | Kampong Chhnang, Pursat, Kampong Thom | 24,000 | 20,000 | 4,000 | On-going |
| Water Resources Management Sector Development Program (WRMSDP) | ADB + OPEC +AFD | Loan+ Grant | 2011 | 2018 | Kampong Thom, Siem Reap, Banteay Meanchey | 31,900 | 24,800 | 7,100 | On-going |
| Kampong Trabek River Flood Control Project | China | Loan | 2010 | 2014 | Prey Veng | 31,010 | 31,010 | 0 | On-going |
| Stung Sreng Irrigation Development Project | China | Loan | 2011 | 2015 | Preah Vihear, Kampong Thom | 65,000 | 54,780 | 10,220 | Loan Processing |
| Mongkol Borey Dam Development Project | Korea | Loan | 2009 | 2013 | Battambang | 24,301 | 18,700 | 5,601 | On-going |
| Kong Hort Irrigation Development Project | China | Loan | 2010 | 2014 | Battambang | 61,000 | 49,900 | 11,100 | On-going |
| Dauntri Multipurpose Dam Development Project | Korea | Loan | 2009 | 2013 | Battambang | 45,958 | 40,283 | 5,675 | Loan Processing |
| Stung Pursat Dam No.3 and No.5 Development Project | China | Loan | 2011 | 2014 | Pursat | 80,000 | 66,460 | 13,540 | On-going |
| Stung Tasal Storage Reservoir Development Project | India | Loan | 2011 | 2013 | Kampong Spue | 19,000 | 19,000 | 0 | On-going |
| Surrounding Bayong Kouv Reservoir Improvement Project | Korea | Grant | 2010 | 2013 | Takeo | 3,012 | 3,012 | 0 | Committed |
| Prek Stung Kev Water Resources Development Project | China | Loan | 2011 | 2015 | Kampot | 52,000 | 42,620 | 9,380 | On-going |
| Technical Cooperation for TSC-Phase 3 | Japan | Grant | 2009 | 2014 | Battambang, Pursat, Kampong Chhnang | 4,625 (¥370 x $10^6$) | 4,625 | 0 | On-going |

*Source: Irrigation Development in Cambodia, as of March 2011*
**: Loan processing as of March 2011*

### *Work Progress on Stung Tasal Storage Reservoir Development Project*

(19) The contract agreement for the design and construction of the project was signed among MOWRAM, WAPCOS Ltd, and Angelique International Limited on January 12, 2011. The contract agreement includes (i) infrastructure development works, (ii) civil works including dam with instrumentation, (iii) hydro-mechanical work, and (iv) engineering works such as geo-technical survey, detailed design, and preparation of construction drawings.(*P I-4-5*)

(20) The time for completion of the entire scope of work is 18 months from the date the contract comes into full force and effect. According to MOWRAM, Angelique International Limited mobilized the team in the site on May 19, 2011, and has started the topographic survey and finalization of land for colony and access road. The third quarterly progress report (November 2011 to February 2012) shows that excavation of the dam foundation and spillway has been 80% completed at the end of February 2012. (*P I-4-5*)

### *Current Situation on Other Dam Projects Located Upstream of Prek Thnot River*

(21) There are 3 dam development plans prepared by the Korea International Cooperation Agency (KOICA), which are located upstream of Prek Thnot River. Out of them identified, 2 dams, namely, Peam Levear Dam and O Tang Dam are planned to be rehabilitated, while the other one is planned for dam construction. Presently, F/S has been completed for these dam projects. However, there are no definite plans for their implementation so far. (*P I-4-5 and I-1-4-6*)

(22) MOWRAM planned 2 dam construction projects on the tributaries of Prek Thnot River, i.e., Stung Sva Slab Water Resources Development Project and Stung Khleach Water Resources Development Project. MOWRAM prepared and submitted the proposals for these projects to

MEF in September 2010. Thereafter, RGC requested financial assistance from the Prime Minister of India when he made an official visit to Cambodia. Currently, MOWRAM expects that F/S for these projects will be carried out in 2012, however no plans yet are carried out at the moment. (*P I-4-6*)

## CHAPTER I-5 OTHER RELEVANT INFORMATION

***Information on Mines and Unexploded Bombs in the Project Area***

(23) For RCHRSP, the project area is not contaminated with mines and unexploded ordinances (UXOs) although considerable bombs had been dropped in its command area. For USISRSP, according to the results of a hearing survey conducted by Cambodian Mine Action Center (CMAC) in 2000, suspected areas with mines and bombs would be located along about 4 km upstream of the diversion canal from the Tumnup Lok Reservoir and around the proposed borrow pit area. In addition, around the southern part of Main Canal 33, where the battle was once conducted, the possibility of buried UXOs might exist. On the other hand, there are suspected areas in the southern and central parts of Kandal Stung Area of KSBSRSP although these areas are small in size. It is thus deemed necessary for CMAC to carry out the detailed technical ground survey prior to the commencement of the detailed design. (*P I-5-6*)

## CHAPTER I-6 OUTLINE OF PREVIOUS STUDIES

(24) As for SPPIDRIP, the following studies were conducted so far:

**List of Previous Studies/Proposal**

| Sub-project | Study/Proposal | Period | Finance |
|---|---|---|---|
| RCHRSP | The Study on Comprehensive Agricultural Development of Prek Thnot River Basin (Master Plan Study) | 2005-2008 | JICA |
| | Roleang Chrey Regulator and Intakes Improvement Project (Feasibility Study) | 2006 | JICA |
| | Roleang Chrey Regulator Improvement Project (Grant Aid) | 2007-2008 | JICA |
| USISRSP | The Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin (Master Plan Study) | 2001-2002 | JICA |
| | Upper Slakou River Irrigation Reconstruction Plan (Feasibility Study) | 2002 | JICA |
| KSBISRSP | Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh | 1993-1994 | JICA |
| SISIP | Project Proposal Document to Small Scale Infrastructure Project | 2009 | MOWRAM |

*Source: JICA Survey Team*

Immediately after the commencement of the Survey, these studies/proposals were reviewed to examine the appropriateness of the project scope proposed by MOWRAM by scrutinizing the development concept and features of the project and relevant information. (*P I-6-1 to I-6-32*)

(25) The Project also includes SISIP consisting of 84 sub-projects. The project proposals were prepared by PDOWRAM under the direction of MOWRAM and TSC-2. Based on the results of the review, problems on the studies/proposals were identified as follows: (i) no observation on the definition of small scale, (ii) lack of technical information on water resources, (iii) overestimation of targeted irrigation area, (iv) less understanding/appreciation on the project area in project evaluation, (v) incomplete rehabilitation plan proposed, (vi) insufficient back-up data and breakdown, and (vii) insufficient data storage system in PDOWRAM. Under such poor situations, the priority sub-projects were barely selected through first screening and priority ranking by backbreaking data collection and analysis. The items for priority ranking are

as follows: (i) availability of data, design and cost estimate, and satellite image, (ii) social conditions, (iii) scale of irrigation area, (iv) effect of sub-project, and (v) PDOWRAMS's intension. (*P I-6-26 to I-6-31*)

(26) The selected sub-projects were accepted by MOWRAM too. Thus, the following were decided as priority sub-projects in the Survey: (*P I-6-32*)

**Decided Priority Sub-projects**

| Sub-project | Water Source | Province |
|---|---|---|
| Main Canal 35 Rehabilitation Sub-project (MC35RSP) | River/Reservoir | Kampong Speu |
| Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) | River/Flood Water | Kandal |
| Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP) | River/Headworks | Kampong Chhnang |

*Source: JICA Survey Team*

# PART II SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

## CHAPTER II-1 PROJECT AREA

***Roleang Chrey Headworks Rehabilitation Sub-project***

### *Socio-economy*

(27) According to the Commune Database managed by the National Committee for Democracy Development (NCDD), the poverty rate of Kampong Speu Province was 30.1% in 2010 which was higher than the average of the whole country estimated around 25.8% in 2010. Therefore, RCHRSP is located in a poverty-stricken area.(*P II-1-7)*

### *Agriculture*

(28) Agricultural situation in the command area of RCHRSP has no drastic change from the previous study period. Therefore, it is deemed that the rice production in the area could be characterized as low and unstable. The cropping calendar in the area is diversified depending on locations and seasons affected by the availability of irrigation water. Since this situation has not been improved so far, it is concluded that there are no changes in the prevailing cropping calendar and patterns in the area. Compared with rice production, production of other crops such as upland crops, vegetables, and fruits are extremely limited in the area. This situation is likely the same with the previous study. (*P II-1-9 to II-1-11)*

### *Roleang Chrey Headworks*

(29) The Roleang Chrey Headworks consist of (i) Roleang Chrey Regulator, (ii) Andong Sla Intake, and (iii) Vat Krouch Intake and their approach channels. Based on the results of the review of previous studies, site visit with drawings at hand and hearing survey from Kampong Speu PDOWRAM, it was confirmed that there were no remarkable changes in the conditions of the headworks from the time of detailed design preparation. (*P II-1-12 to II-1-14)*

### *Irrigation and Drainage*

(30) MOWRAM already executed some rehabilitation works for the Roleang Chrey Irrigation Canal System as per request of Kampong Speu PDOWRAM for 4 years from 2006 to 2009 after the M/P study had been substantially completed. The total cost was Riel 24,035 million. These rehabilitated works were examined whether it is included in the upstream 10 km of NMC and SMC which were requested by MOWRAM. Consequently, it was clarified that these works were out of the scope of RCHRSP. (*P II-1-14 to II-1-18)*

***Upper Slakou Irrigation System Rehabilitation Sub-project***

***Socio-economy***

(31) The commune database indicated that poverty rate in Takeo Province was 23.4% in 2010, which was slightly better than the poverty rate (25.8%) of the whole country, therefore, Takeo Province does not show serious poverty. (*P II-1-22)*

***Agriculture***

(32) Rice is the major crop in the USISRSP Area. Diversified crops are few although their profitability is higher than paddy. Further, it is not easy to cultivate them in paddy field due to unsuitable condition with high soil moisture content, soil structure, water management, etc. It was confirmed that these crops were planted less in the farmlands of the USISRSP Area. In parts of the USISRSP Area, double cropping paddy combined with early maturing varieties of high yielding varieties (HYVs) is being undertaken since irrigation water becomes available after the rehabilitation of the Kpob Trobek Reservoir in 2005. (*P II-1-24 and II-1-25)*

***Irrigation and Drainage***

(33) The review on the irrigation and drainage development plan was carried out by (i) field reconnaissance including interviews and discussions with concerned agencies and farmers, and (ii) inventory survey of the existing canals for 69 km and related structures of 412 nos. on the canals. Based on the results of the review, it was confirmed that rehabilitation should be urgently provided for water resource facilities such as Tumnup Lok Reservoir, Kpob Trobek Reservoir, Diversion Canal, and other canal systems. On the other hand, it was also confirmed that some rehabilitation works were already conducted for Kpob Trobek Reservoir in 2005 by MOWRAM, following the preliminary design in F/S, so minor rehabilitation works such as repair of erosion of dike and improvement of flap gates are only required. (*P II-1-25 to II-1-30)*

***Kandal Stung-Bati Irrigation System Rehabilitation Sub-project***

***Socio-economy***

(34) Based on the results of the socio-economic survey conducted by the JICA Survey Team, the sampled population of the KSBISRSP Area showed higher per capita daily expenditure than the poverty line. This is equivalent to a per capita daily expenditure of US$0.58 set for Cambodia rural areas by the *Achieving Cambodia's Millennium Development Goals 2010*, which ranges from US$0.63 to US$1.12. From this, it is deemed that the KSBISRSP Area is not seemingly below the poverty line.(*P II-1-34)*

***Agriculture***

(35) The main crop in the KSBISRSP Area is also rice similar to other irrigated agriculture projects in Cambodia. The cropping calendar of paddy is diversified depending on locations and seasons affected by the availability of irrigation water. Since this situation has not improved so far, it is deemed that there is no big difference between the previous and present cropping patterns in the area from the previous study time.(*P II-1-35 to II-1-37)*

***Irrigation and Drainage (Kandal Stung Area)***

(36) The present irrigation canal system was constructed during 1975 to 1979 (Pol Pot Regime). Canals were constructed following the latitude and longitudinal gridlines regardless of the topographic conditions. In addition to such technical problem, due to absence of substantial

improvement or rehabilitation work for the canals and related structures for more than 30 years, the degree of deterioration of irrigation facilities is severe, thus these do not function well. (*P II-1-37 and II-1-38)*

(37) In consideration of such severe condition of the existing canal system, completion of construction works for Kandal Stung New Diversion Weir on the Prek Thnot River was done in 2007 and the completion of the Stung Tasal Dam is expected in 2012 MOWRAM prepared an official proposal to rehabilitate the existing irrigation canal system covering 1750 ha by utilizing the original flow of the Stung Touch River and supplemental water from the Prek Thnot River. (*P II-1-37)*

***Irrigation and Drainage (Bati Area)***

(38) The present irrigation canal system in the Bati Area as well as the Kandal Stung Area was constructed at the same time. The canals were constructed following the latitude and longitudinal grid lines regardless of the topographic conditions as applied to the Kandal Stung Area. During the period of 1987 to 1992, rehabilitation of some irrigation canals and related structures were carried out by the World Council of Churches (WCC) and the Mekong Secretariat with the financial assistance of United Nations Development Program (UNDP). (*P II-1-38)*

(39) However, after rehabilitation in 1992, no substantial rehabilitation and improvement has been executed so far, except for ad-hoc works such as dredging of canal bed and construction of regulators (check structures). Through inventory survey for this existing irrigation canal system, it was confirmed that canals were heavily deteriorated and the number of structures for water management of irrigation was still short. (*P II-1-38 and II-1-39)*

***Main Canal 35 Rehabilitation Sub-project***

***Socio-economy***

(40) MC35RSP is located at Kampong Speu Province. As mentioned in RCHRSP, the poverty rate of Kampong Speu Province was 30.1% in 2010 which was largely higher than the average of the whole country estimated around 25.8% in 2010, therefore serious poverty situation is experienced in Kampong Speu Province. (*P II-1-41)*

***Agriculture***

(41) The total area of MC35RSP is estimated to be around 900 ha. The whole area is categorized as paddy field. Out of 900 ha, 850 ha is rainfed paddy fields, and double cropping is carried out in limited area. Harvested paddy is normally threshed at the farmers' backyard, and thus sold to traders at farm gate. Meanwhile rice millers are not available in and around the area although mobile rice miller is popular. (*P II-1-42 and II-1-43)*

***Irrigation and Drainage***

(42) The existing Main Canal 35 Irrigation System, consisting of 3 reservoirs and main and secondary canals, was originally constructed during the Pol Pot regime (1975-1977) targeting to irrigate more than 3,000 ha of the paddy field. Since then 2 reservoirs upstream located were rehabilitated by MOWRAM in 2009/10, but the remaining facilities have remained as they are. Thus, the system does not function well now. (*P II-1-43)*

***Srass Prambai Water Recession Rehabilitation Sub-project***

***Socio-economy***

(43) The SPWRRSP Area is administratively situated in Po Ti Ban Commune, Kaoh Thum District, Kandal Province. Poverty rate in Kandal Province was 15.9% in 2010, which was better than the average (25.8%) poverty rate of the whole country. Poverty situation in this province is not a serious condition as far as this rate is concerned. (*P II-1-48)*

***Agriculture***

(44) During the rainy season, the SPWRRSP Area is flooded due to the increased water level of the Bassac River. Water level becomes lower from the beginning of November, and then rice cultivation starts in the area, depending on the decrease of water level. Early rice varieties are common in this area. (*P II-1-49 and II-1-50)*

***Irrigation and Drainage***

(45) The Srass Prambai Irrigation System, consisting of the Srass Prambai Reservoir and main and secondary canals was originally constructed during the Pol Pot regime aiming to irrigate the flood recession cultivation area in the flood plain between the Tonle Basac and Mekong Rivers. The system was sufficiently operated until 2000 when the reservoir dike was damaged by flood. The recession cultivation lands have been facing shortage of irrigation water since then. (*P II-1-50)*

***Daun Pue Irrigation System Rehabilitation Sub-project***

***Socio-economy***

(46) The DPISRSP Area lies in Chieb, Khlong Porpork, and Aphivath Communes in Teuk Phos District, Kampong Chhnang Province. Poverty rate in Kampong Chhnang Province was 30.4% in 2010, which was higher than the average (25.8%) poverty rate of the whole country, so serious poverty situation is still seen in the province. (*P II-1-56)*

***Agriculture***

(47) The total area of DPISRSP is estimated at around 1,210 ha. The whole area is categorized as rice field. Out of 1,210 ha, 1,060 ha is rainfed rice field, and the remaining area is an irrigated rice field with supplemental irrigation. Harvested rice is normally threshed at farmers' back yards, and then sold to traders, while some farmers directly sell their products to rice millers in Kampong Chhnang, the capital of the province. (*P II-1-58 and II-1-59)*

***Irrigation and Drainage***

(48) The Daun Pue Irrigation System was constructed in the Pol Pot regime (1975-1977) for targeting water supply from the Stung Chieb River to its command area of about 1400 ha. The existing Daun Pue Irrigation System is seriously deteriorated at present, and only limited parts near the main canal are currently provided with supplemental irrigation during the rainy season. (*P II-1-58)*

***Institutions Concerned for Project Implementation***

(49) Four PDOWRAMs are closely related to SPPIDRIP. These are Kampong Speu, Kandal, Takeo, and Kampong Chhnang PDOWRAMs. These PDOWRAMs have 5 offices under the director. Major common missions of PDOWRAM are to: (i) prepare development plans, (ii) research and

observe natural disasters, (iii) collect meteorological and hydrological data, (iv) implement operation and maintenance of irrigation systems, (v) organize and train FWUC, and (vi) study, plan, design, and construct small-scale projects. When SPPIDRIP starts its implementation, these PDOWRAMs should play an important role for the smooth implementation although strengthening them is needed especially for O&M. (*P II-1-60 to II-1-63)*

(50) Four PDAs of Kampong Speu, Kandal, Takeo, and Kampong Chhnang are related to SPPIDRIP. PDA is responsible for the agricultural development and provision of agricultural support services at the provincial, district, commune, and village levels. The major duties related to the functions of the Agronomy Office of PDA include technology development, seed production and plant protection, and the major duties related to the functions of the Extension Office which are provision of extension services and human resources development. Presently, PDAs' activities are not executed very well mainly due to limited budget. (*P II-1-63 to II-1-66)*

(51) For the Roleang Chrey Irrigation System, 6 FWUCs were established in 2011. Whereas for USISRSP, Kpob Trobek FWUC was established at Ou Saray commune in 2005 when the Kpob Trobek Reservoir was rehabilitated. Most of FWUCs are generally inactive mainly due to the lack of functional irrigation systems and weak organization and management. The remaining 4 Sub-projects have no FWUCs at present. (*P II-1-66 and II-1-70)*

## CHAPTER II-2 EXAMINATION OF PROJECT SCOPE

***Necessity and Justification***

***National and Sectoral Policies***

(52) In the Rectangular Strategy-Phase-II, which is the most fundamental policy in Cambodia, the *Improving Agricultural Productivity and Diversification* and *Water Resources and Irrigation Management* strategies were taken up and given high priority in the implementation of the projects. The respective sectoral policies exactly follow the policy. The objective of SPPIDRIP is to provide timely and stable irrigation water to fields and finally increase the agricultural production through the integrated approach of hardware and software components. Thus, it can be said that SPPIDRIP duly contributes to attaining the goals specified in the said national and sectoral policies. (*P II-2-1)*

***Policy of Official Development Assistance of Japan to Cambodia***

(53) JICA announced a new vision: *Promotion of Dynamic Development Granting Benefits to All People* in 2008. In order to realize this vision, JICA decided to draw 4 missions such as (i) addressing global agenda, (ii) reducing poverty through equitable growth, (iii) improving governance, and (iv) achieving human security. In Cambodia, the most important mission to be realized is reducing poverty through equitable growth. As mentioned in Rectangular Strategy-Phase II, agricultural development is the most effective means to realize this mission. JICA also recognizes that agriculture is one of the important sectors for sustaining economic growth and reducing poverty in Cambodia. The proposed SPPIDRIP will duly contribute to the above mentioned mission through increase of agricultural production by applying the integrated approach of hardware and software components. (*P II-2-1 and II-2-2)*

***Necessity and Justification***

(54) Poverty reduction or improvement of the living standard is a crucial subject to be urgently

solved in Cambodia. The percentage of people living below poverty line accounted for 25.8% for the whole country in 2010, although the situation has been gradually improving yearly. Of the total number of poor, more than 90% live in rural areas. This implies that Cambodia's poverty is rooted in agriculture which is characterized by low and unstable productivity caused by unreliable rainfed cultivation. RGC promulgates the policy paper on the promotion of paddy production. According to this paper, RGC is planning to increase paddy production annually by 2.6% to 6.1% from 2010 to 2015, and 2.6% after 2016 focusing on at least catching up with the domestic consumption. (*P II-2-2 and II-2-3)*

(55) SPPIDRIP is composed of 6 Sub-projects: RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP, and DPISRSP. Presently, the facilities involved in RCHRSP are mostly deteriorated and nonfunctional. In particular, the Roleang Chrey Regulator is seriously deteriorated. In case the regulator will malfunction completely, its large command area could not be irrigated and will rely on erratic rainfed cultivation. This would result in low and unstable productivity. Similarly, USISRSP and KSBISRSP are presently envisaged with incomplete existing irrigation and drainage system because of the absence of substantial rehabilitation works and inappropriate O&M works. Consequently, these systems could not properly convey irrigation water to fields and thus, hardly contributes to the increase in agricultural production. (*P II-2-2 and II-2-3)*

(56) The remaining 3 Sub-projects, namely, MC35RSP, SPWRRSP, and DPISRSP which were selected as priority sub-projects from SISIP, were already provided with irrigation canal systems. However, these irrigation canal systems are mostly deteriorated or damaged at present. To increase agricultural production, it is necessary to execute, not only the rehabilitation and improvement works for these systems, but also strengthening of agricultural extension services and establishment of FWUC, which was the same concept with RCHRSP, USISRSP, and KSBISRSP. (*P II-2-3)*

(57) SPPIDRIP aims to increase agricultural production especially on paddy through the rehabilitation and improvement of existing irrigation and drainage facilities, and also strengthening of agriculture support services and establishing/strengthening of FWUCs. It is certain that SPPIDRIP will contribute to poverty reduction or improvement of the living standards in rural areas by increasing agricultural production, which is the ultimate goal of Cambodia. In addition, if the increased rate pattern of rice production from 2010 to 2015, and after 2016 specified in the rice policy paper materializes, Kampong Speu, Kandal, Takeo, and Kampong Chhnang Provinces surrounding Phnom Penh will be required to play their regional roles as paddy producers in the country, especially for Phnom Penh, a big consuming city. It is positive that SPPIDRIP will contribute to some extent to the implementation of this political goal. (*P II-2-3)*

***Roleang Chrey Headworks Rehabilitation Sub-project***

***Basic Concept***

(58) The examination of the scope of RCHRSP proposed by MOWRAM was carried out using the basic concepts of (i) application of integrated approach of hard and soft aspects, (ii) improvement of Roleang Chrey Headworks from appropriate permanent treatment viewpoint, (iii) priority ranking on scope of Sub-project as loan project, and (iv) reflection of

lessons learnt from Japan's grant aid program. (*P II-2-3 and II-2-4)*

***Agricultural Development Plan***

(59) The following proposed cropping pattern and intensity in the M/P study could be applied after being confirmed through the water balance study since there were no changes in national policies and social conditions in the RCHRSP area since the M/P Study time: (*P II-2-4)*

**Confirmed Cropping Patterns and Intensity in the Survey**

| Zone | Confirmed Cropping Pattern | Intensity | Definition of Zone |
|---|---|---|---|
| 1 | Early Rice (18%)- Medium Rice (91%)- Upland Crops (5%) | 114% | 80% Dependability Irrigation |
| 2 | Early Rice (14%)- Medium Rice (91%)- Upland Crops (5%) | 110% | 50% Dependability Irrigation |
| 3 | Medium Rice (100%) - Upland Crops (5%) | 105% | Water Harvesting |
| 4 | Medium Rice (100%) - Upland Crops (1%) | 101% | Rainfed Cultivation |

*Source: Final Report for the Study on Comprehensive Agricultural Development Prek Thnot River Basin*

(60) The current unit yield of crops was reviewed based on the latest agricultural statistics as well as the results of field inspection. Based on the result, it was found that the current unit yield was better than that in the M/P stage. Based on this finding, it was also found that the target unit yield of paddy could be estimated by referring to the *Verification Study on Paddy Cultivation* conducted in the latter stage of M/P Study, which showed the crop yield of paddy ranging from 3.3 ton/ha to 5.2 ton/ha. (*P II-2-4 and II-2-5)*

***Water Balance Study***

(61) Based on the results of water balance calculation, the 80% dependable area was estimated at 6,500 ha as against 5,660 ha recorded in M/P, and the 50% dependable area was estimated at 18,100 ha as against 16,700 ha stated in M/P. For both cases, the review results were about 10% higher than those in M/P. Taking into consideration the calculation method and reliability of meteo-hydrological data, it could be considered that the difference in both cases would be rather positioned within allowable extent. From the reasons mentioned above and the conservative viewpoint, it was concluded that the 80% and 50% dependable areas stated in M/P, as shown in the right table, was acceptable. (*P II-2-5 to II-2-7)*

**Probable Irrigation Area**

| Dependability | Early Rice | Medium Rice |
|---|---|---|
| 80% | 500 ha | 5,660 ha |
| 50% | 2,100 ha | 16,700ha |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin*

***Scope of Sub-project***

(62) The proposed scope of RCHRSP was examined through review of the previous studies and site investigation with detailed drawings at hand and discussions with MOWRAM and PDOWRAM. In the course of the Survey, MOWRAM/PDOWRAM strongly requested to include some works in the scope related to the upstream 10 km of NMC and SMC. Considering this request, the examined scope of RCHRSP is shown in the following table. (*P II-2-17 and II-2-18)*

**Examined Scope of RCHRSP**

| Scope Proposed by MOWRAM in M/D[*1] | Examined Scope of RCHRSP |
|---|---|
| a) Project Area<br>Not specified | a) Project Area<br>350 ha excluding 220 ha to be implemented by TSC-3, but influence to 16,910 ha for project evaluation |
| b) Cropping Pattern and Intensity<br>- Rice-based cropping system with upland crops<br>- Crop intensity:101% - 114% | b) Cropping Pattern and Intensity<br>- Rice-based cropping system with upland crops<br>- Crop intensity:101% - 114% |

| Scope Proposed by MOWRAM in M/D[*1] | Examined Scope of RCHRSP |
|---|---|
| c) Hardware Components | |
| - Rehabilitation of Roleang Chrey Headworks | The rehabilitation works of the regulator gates are urgently required as the top priority of RCHRSP, aiming at restoration of the appropriate function of the gates so as to maintain or increase the present production level by preventing further deterioration of the function. Based on the Survey, the following work items are highly required;<br>a) Renewal/construction of regulator gates such as<br>- Renewal of all gate leaves,<br>- Renewal of all hoist system with local control panels,<br>- Renewal of all host decks with staircase, and<br>- New construction of remote control panel,<br>b) New construction of river outlet structure gate with guide frames and manually operated hoists,<br>c) New construction of inlet and outlet fixed trash racks,<br>d) New provision of downstream protection works,<br>e) New provision of retaining wall, and<br>f) New construction of by-pass for releasing low water to the downstream reach. |
| - Rehabilitation of Andong Sla Intake including Replacement of Radial Gate | The results of the review showed the urgent necessity of reconstruction of gates and related facilities. The proposed works are:<br>a) Renewal/provision of intake gates,<br>- Renewal of gate leaves,<br>- Renewal of guide frames,<br>- Renewal of electrically driven hoists,<br>- New provision of gate remote control operation,<br>- Renewal of manually driven hoists,<br>b) New construction of gate piers,<br>c) New construction of downstream protection, and<br>d) Partial rehabilitation of approach channel. |
| - Rehabilitation of Vat Krouch Intake Structure | Through the review, it was confirmed that the following are needed urgently:<br>a) Renewal of intake gates,<br>- Renewal of gate leaves,<br>- Renewal of guide frames,<br>- Renewal of electrically-driven hoists,<br>- Provision of gate remote control operation, and<br>- Renewal of manually driven hoists,<br>b) Partial improvement of supply canals*[2], and<br>c) New construction of structures on supply canals*[2]. |
| - Rehabilitation of NMC and SMC with related structures, of which the length is 10.0 km, respectively | After site investigation, length of NMC and SMC to be rehabilitated are determined at 9.1 km and 9.8 km, respectively. Required rehabilitation works on NMC and SMC are identified in the Survey, most of which need urgent improvement to ensure the water supply to the downstream part of the irrigation system. The works required under RCHRSP are:<br>a) Partial improvement of canal embankment,<br>b) Partial enlargement of canal section,<br>c) Partial improvement of bank of canal crossing reservoir,<br>d) Replacement or partial improvement of structures on main canals, and<br>e) Additional construction of structures on main canals. |
| - Rehabilitation of secondary canals with related structures related to NMC and SMC of which the length is 10.0 km respectively | In connection with the rehabilitation for upstream 9.1 km of NMC and 9.8 km of SMC, MOWRAM, and PDOWRAM requested to include improvement of relevant secondary canals and their related structures in the scope because of urgent and higher necessity and also accruing the benefits from the irrigated fields. It is deemed that this request is appropriate from technical viewpoint<br>The works to be additionally requested consist of<br>a) Partial rehabilitation, improvement, and repair of canals section, and<br>b) Partial rehabilitation and new construction of related structures. |
| - Development of Tertiary Canal System in Model Area | MOWRAM requested to include the model area development proposed in M/P in the area of upstream part (up to 7.8 km) of SMC.<br>a) Partial rehabilitation and improvement tertiary canal system. |

| Scope Proposed by MOWRAM in M/D*1 | Examined Scope of RCHRSP |
|---|---|
| d) Software Components | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M | In order to keep the sustainability of RCHRSP, these are indispensable thus be included in the scope of RCHRSP. |
| - Strengthening of FWUC not proposed | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential thus be included in scope of RCHRSP. |
| - Strengthening of agricultural extension services | In order to attain the improvement of agricultural productivity, this is needed, thus be included in scope of RCHRSP. |

**1; Minutes of Discussions on Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project, signed on February 25, 2011*
**2; Supply canal; canals directly branched from approach channels between the regulator and intakes*
*Source: JICA Survey Team*

***Upper Slakou Irrigation System Rehabilitation Sub-project***

***Basic Concept***

(63) The scope of USISRSP proposed by MOWRAM was examined using the basic concepts such as (i) harmonization of hardware and software components, (ii) determination of Sub-project scale through water balance study using updated relevant data, (iii) full utilization of existing facilities, and (iv) priority ranking of each work included in USISRSP scope.(*P II-2-19 and II-2-20 )*

***Agricultural Development Plan***

(64) It was found through site visits that double cropping of paddy has been applied to about 150 ha because certain irrigation water becomes available due to the rehabilitation of Kpob Trobek Reservoir by MOWRAM in 2005. It was also found that in spite of the proposal for the introduction of diversified crops in F/S, the planted area is still inadequate. Taking into consideration such current cropping pattern, the double cropping of paddy was proposed. The target yields of paddy proposed in F/S were re-estimated based on the current statistical data and also by referring to the results of the verification study executed in the *Study on Comprehensive Agricultural Development of Prek Thnot River Basin* (*P II-2-20 and II-2-21)*

***Water Balance Study***

(65) In the review, the water balance calculation was made for 30 years by adding 10 years more from 2001 to 2010. As for water resources, 2 reservoirs of Tumnup Lok on the Slakou River and Kpob Trobek on the Don Phe River were considered and these reservoirs are connected by the diversion canal. Possible irrigation area was estimated using the irrigation water demand, river maintenance flow, river runoffs, and storage effects of reservoirs. Based on the result, the following extent of crops could be realized with 80% dependability. (*P II-2-21 and II-2-22)*

**Results of Water Balance Study**

| Stage | Medium Paddy (RS) | HYV-1 Paddy (RS) | HYV-2 Paddy (Early RS) | Diversified Crop-1 (Early RS) | Diversified Crop-2 (Early RS) | Crop Intensity Per Year |
|---|---|---|---|---|---|---|
| F/S in 2002 | 2,400 | 1,100 | - | 500 | 550 | 130% |
| Review in 2011 | 2,400 | 1,100 | 200 | - | 200 | 111% |

*Source: JICA Survey Team*
*Note: RS means Rainy Season.*

***Scope of Sub-project***

(66) The works proposed by MOWRAM and F/S were examined from technical and economical viewpoints and also considering the application for Japanese loan, through the review of M/P

and F/S, site visits, consultations with farmers, and a series of discussions with MOWRAM and PDOWRAM. The results of the examination compared with the works proposed by MOWRAM are shown in the following table, (*P II-2-30 and II-2-31)*

**Examined Scope of USISRSP**

| Scope Proposed by MOWRAM in M/D* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| a) Irrigation Development Area | | |
| - 3,500 ha | - 3,500 ha | Justified through water balance study. |
| b) Cropping Pattern and Crop Intensity | | |
| - Paddy-based cropping system with upland crops.<br>- Crop intensity: 130% | - Rice-based cropping system with upland crops.<br>- Crop intensity: 111% | Application of double cropping of paddy in view of present cropping pattern. |
| c) Hardware Components | | |
| - Rehabilitation of two reservoirs including spillway, outlet structures, and a diversion canal between the two reservoirs with related structures<br>Tumnup Lok Reservoir<br>Kpob Trobek Reservoir | - Tumnup Lok Reservoir<br>Partial rehabilitation of the existing dike (2.3 km), and new construction of the reservoir facilities including over-flow type spillway of 230 m, one maintenance gate, and two intakes for diversion canal.<br>- Kpob Trobek Reservoir<br>Partial minor repairs of flap gates on spillway (6 nos.) and new provision of slope protection for dike (3.3 km). | - Construction of tertiary canals for 15 ha is not included in scope of USISRSP. |
| - Rehabilitation of diversion canal | - Full reshaping and lining of existing canal section (9.4 km), including new construction of two bridges, one cross drain and one siphon (75 m long) crossing the Krouch River. | |
| - Rehabilitation of main canal with related structures | - Partial rehabilitation of Main Canal 33 (7.3 km) including new construction of related structures. | |
| - Rehabilitation of secondary canals with related structures | - Partial rehabilitation of seven secondary canals (44.7 km in total) including new construction of related structures. | |
| - Construction of tertiary canals and related structures | - New construction of tertiary canals for 110 km and related structures with condition that MOWRAM will provide special arrangement for acquiring land for tertiary canals. | Development plan and design for tertiary canals and related structures will be made by employing national consultants. Construction of tertiary canals and related structures will be carried out by local contractors to be selected through LCB. All of the works will be under the responsibility of PMU Japan Support Fund. |
| | - New provision of O&M facility and equipment. | FWUC office is included, while heavy construction equipment is not included. |
| d) Software Components | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M. | In order to keep the sustainability of USISRSP, these are indispensable, thus should be included in scope of USISRSP. | |
| - Strengthening of FWUC not proposed. | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus should be included in scope of USISRSP. | |
| - Strengthening of agricultural extension services. | In order to attain the improvement of agricultural productivity, this is needed, thus should be included in scope of USISRSP. | |

**: Minutes of Discussion dated February 25, 2011*
*Source: JICA Survey Team*

***Kandal Stung-Bati Irrigation System Rehabilitation Sub-project***

***Basic Concept***

(67) The Sub-project works planned in M/P and F/S in 1995 were reviewed using basic concepts such as (i) integrated approach of hardware and software components, (ii) consideration of new water source, (iii) determination of project scale through water balance study, (iv) full utilization of existing canal system, (v) application of concrete lining to main canals, (vi) use of part of Pol Pot canals as main drains, and (vii) priority ranking on Sub-project scope by criteria. (*P II-2-32 and II-2-33)*

***Agricultural Development Plan***

(68) Through site visits and discussions with PDA, it was found that some areas in the KSBISRSP Area were already cultivated with double cropping or triple cropping of paddy and most farmers preferred to cultivate paddy instead of diversified crops if water is available. Taking into consideration the present cropping pattern, it was proposed to introduce double cropping of paddy into the KSBISRSP Area. Target yield of paddy was set at 4.0 ton/ha for early rice and 3.5 ton/ha for medium rice based on the current statistics data and also by referring to the promising results of the verification study executed in the *Study on Comprehensive Agricultural Development of Prek Thnot River Basin*. (*P II-2-33)*

***Water Balance Study***

(69) Water balance study was carried out for 2 cases, namely, *without dams* and *with dams*. In case of *without dams*, which was conducted in the previous studies, the Prek Thnot River system, without any artificial flow control, is a water source for irrigation. Based on the results of the water balance study, the following crop intensity and dependability were confirmed: (*P II-2-36)*

**Results of Water Balance Simulation *Without Dams***

| Item | Roleang Chrey (Zone-I) | Roleang Chrey (Zone-II) | Dangkor System | Kandal Stung (Grant) | KSBISRSP Area | |
|---|---|---|---|---|---|---|
| | | | | | Kandal Stung (Extension) | Bati Area |
| Total Irrigation Area (ha) | 5,660 | 11,040 | 300 | 1,950 | 0 | 1,600 |
| Early Rice-1 | 500 | 975 | 42 | 975 | 0 | 800 |
| Medium Rice | 5,162 | 10,069 | 258 | 975 | 0 | 800 |
| Early Rice-2 | 500 | 975 | 42 | 900 | 0 | 800 |
| Upland Crop | 280 | 546 | 0 | 540 | 0 | 480 |
| Crop Intensity | 114% | 114% | 114% | 174% | 0% | 180% |
| Dependability | 80% | 57% | 80% | 83% | | 100% |

*Source: JICA Survey Team*

As can be seen in the above table, the Kandal Stung (extension) Area could not be irrigated without any new water source. On the other hand, in case of *with dams*, the water balance study was carried out for the following 5 cases: (*P II-2-34 to II-2-36)*

**Results of Water Balance Simulation *With Dams***

| Case | Combination of Proposed Dams |
|---|---|
| Case-1 | with Stung Tasal Dam only |
| Case-2 | with Stung Tasal Dam + K-water 3 Dams |
| Case-3 | with Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam |
| Case-4 | with Stung Tasal Dam + K-water 3 Dams + Stung Khleach Dam |
| Case-5 | with Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam + Stung Khleach Dam |

*Source: JICA Survey Team*

The results of water balance study for these five cases are shown in the following table.

**Summary of Case Study of Water Balance Simulation with Dams** (Unit of area: ha)

| Case No. | Kandal Stung Area (Grant) | | | Kandal Stung Area (Extension) | | | Tonle Bati Area | | | Total Area |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area | Crop Intensity | Depend-ability | Total Area | Crop Intensity | Depend-Ability | Total Area | Crop Intensity | Depend-ability | |
| Case-1 | 1,950 | 180% | 97% | 1,800 | 180% | 93% | 4,200 | 180% | 80% | 7,950 |
| Case-2 | 1,950 | 180% | 97% | 1,750 | 180% | 93% | 4,200 | 180% | 80% | 7,900 |
| Case-3 | 1,950 | 180% | 100% | 4,200 | 180% | 93% | 6,000 | 180% | 83% | 12,150 |
| Case-4 | 1,950 | 180% | 100% | 2,940 | 180% | 93% | 6,000 | 180% | 80% | 10,890 |
| Case-5 | 1,950 | 200% | 100% | 4,200 | 200% | 93% | 6,000 | 200% | 80% | 12,150 |

*Source: JICA Survey Team*

As can be seen in the above table, it was clarified that the Kandal Stung Area (Extension: 1750 ha) could be irrigated with crop intensity of 180% for any case at least. (*P II-2-36 and II-2-37)*

***Scope of Sub-project***

(70) The works proposed in MOWRAM and F/S were examined from technical and economical viewpoints and also considering the application of Japanese loan, through the review of previous studies such as M/P and F/S, site visits, consultations with the farmers, and a series of discussions with MOWRAM and PDOWRAM. The following table shows the results of the examination. (*P II-2-46)*

**Examined Scope of KSBISRSP**

| Scope Proposed by MOWRAM in M/D* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| a) Irrigation Development Area | | |
| Not specified | 3,350 ha in total, consisting of 1,750 ha in the Kandal Stung Area and 1,600 ha in the Bati Area. | The extent of irrigation area is confirmed through basin wide water balance study on Prek Thnot River although Stung Tasal Dam should be implemented as planned. |
| b) Cropping Pattern and Crop Intensity | | |
| Not specified | - Paddy-based cropping system with upland crops.<br>- Crop intensity: 180% | Application of double cropping of paddy considering present cropping pattern |
| c) Hardware Components | | |
| Rehabilitation of main canals and secondary canals including related structures. | Kandal Stung Area: Full rehabilitation of two main canals of 11.3 km and two secondary canals of 5.0 km long<br>Bati Area: Full rehabilitation of two main canals of 7.6 km and six secondary canals of 8.6 km long. | Concrete lining of 75 mm thick with wire mesh of D 10 mm @ 25 cm grid is provided for the main irrigation canals of 18.9 km. |
| Rehabilitation of third canals including related structures. | New construction of tertiary irrigation canals of 53 km for the Kandal Stung (1,750 ha) and 48 km for the Bati Area (1,600 ha). | No tertiary drainage canal is planned due to difficulty in land acquisition. |
| Gate installation for diversion works, intakes, and checks | New construction of one new diversion weir and rehabilitation of one gated weir, and replacement of three intakes on the Stung Touch River.<br>New construction of check and turnout structures on main and secondary canals<br>replacement of Daeum Rues Regulator on the Prek Thnot River for supplying water to the Stung Touch River. | Three intakes for EW-60, EW-58 and NS-82 |
| Rehabilitation of intake, pumping station, spillway, embankment etc. around Lake Tonle Bati | Full replacement of intake structure and pump station for the Bati Area on Lake Tonle Bati, Kampong Daungkar spillway, and heightening of flood dike for 2.7 km. | |
| Rehabilitation of Stung Touch Gate and NS-78*Canal<br><br>**: NS87 in MD is clerical error.* | Full enlargement of NS-82 as a connection canal for future development of the Bati Area, and construction of new diversion weir on the Stung Touch River | Through comparative study between NS-78 and NS-82, NS-82 was selected due to less construction cost; same diversion weir for the main canal EW-58 can be used. |

| Scope Proposed by MOWRAM in M/D* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| d) Software Components | | |
| - Capacity development for MOWRAM and PDOWRAM's staff on O&M. | In order to realize the sustainability of KSBISRSP, these are indispensable, thus be included in scope of KSBISRSP. | |
| - Formation and strengthening of FWUC<br>not proposed | To execute appropriate water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus be included in the scope of KSBISRSP. | |
| - Strengthening of agricultural extension services | In order to fulfill the improvement of agricultural productivity, this is needed, thus be included in the scope of KSBISRSP. | |

**: Minutes of Discussion dated February 25, 2011*
*Source: JICA Survey Team*

## ***Main Canal 35 Rehabilitation Sub-project***

### *Basic Concept*

(71) The Sub-project works proposed were reviewed using the basic concepts paying attention to the following current conditions of MC35RSP; (i) integrated approach of hardware and software components, (ii) priority area proposed by MOWRAM/PDWORAM, (iii) determination of sub-project scale through water balance study, (iv) utilization of existing canal system, and (v) priority ranking on Sub-project scope by criteria. (*P II-2-47 and II-4-48)*

### *Agriculture Development Plan*

(72) The agricultural development plan proposed in 2009 was reviewed through site visits, analysis of collected latest data and information from the relevant institutes, and discussion with PDA and DAO staff to determine the water demand for the water balance study, and also to contribute in the preparation of the appropriate scope of MC35RSP. In particular, it is noted that the proposed area of 3,018 ha was changed into 1,935 ha (Zone-A) through discussion with MOWRAM/PDOWRAM. As for the cropping calendar, it was proposed to introduce early rice and medium rice based on the results of the review mentioned above if water is available. (*P II-2-48 and II-2-49)*

### *Water Balance Study*

(73) The water balance simulation was conducted for the MC35RSP Area, say Zone-A (1,935 ha) using estimated discharge of 20 years from 1992 to 2011 and irrigation water requirement at each command area by half monthly steps. Based on the result of the water balance simulations, it was confirmed that 850 ha out of 1,935 ha with average crop intensity of 115% can be irrigated with 80% dependability. (*P II-2-50 and II-2-51)*

**Results of Water Balance Study of MC35RSP Area**

| Zone | Max. Irr. Area | Total Irr. Area | Early Rice (Early Rainy) | Mid Paddy | Early Rice (Early Dry) | Crop Intensity | Dependability | Deficit Year (times) |
|---|---|---|---|---|---|---|---|---|
| A | 1,935 ha | 850 ha | 125 ha | 850 ha | 0 ha | 115% | 80% | 4 |

*Source: JICA Survey Team*

### *Scope of Sub-project*

(74) Based on the investigation, the proposed works and scope of the rehabilitation works under MC35RSP were examined as shown in the following table. (*P II-2-56 and II-2-57)*

**Examined Scope of MC35RSP**

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **a) Irrigation Development Area** | | |
| - 2,648 ha in the rainy season<br>- 120 ha in the early rainy season<br>- 250 ha in the dry season<br>(with three reservoirs) | - 850 ha in the rainy season<br>- 130 ha in the early rainy season<br>(with one reservoir only) | Justified through water balance study |
| **b) Cropping Pattern and Crop Intensity** | | |
| - Rice Cropping System<br>- Crop Intensity: 116% | - Rice Cropping System<br>- Crop Intensity: 115% | Determined based on the present cropping pattern |
| **c) Hardware Component** | | |
| 1) Khpob Krous Reservoir<br>- Dike, spillway, intake<br>not proposed | 1) Khpob Krous Reservoir<br>- Dike, spillway, intake<br>not proposed | Reservoir related to MC35RSP has been rehabilitated in 2009. |
| 2) Main Canal 35 and related structures<br>- Main canal<br>Reshaping of existing canal section for whole main canal (25,299 m) | 2) Main Canal 35 and related structures<br>- Main canal<br>Rehabilitation of existing canal for Zone-A (12,800 m out of 25,299 m) and construction of new canal (1,200 m) | It is judged that the rehabilitation of the whole main canal section is unsuitable for SISIP. |
| - Related structures<br>(New Construction)<br>Check structure: 19 nos.<br>Culvert: 1 no.<br>Spillway: 1no.<br>Water gate: 7 nos. | - Related structures<br>Check structure: 9 nos.<br>Turnout: 16 nos.<br>Culvert: 8 nos.<br>Drain inlet: 10 nos.<br>Drop: 5 nos.<br>Cross Drain: 1 no.<br>Road Bridge: 1 no.<br>Footpath Bridge: 9 nos. | |
| 3) Secondary canals and related structures<br>not proposed | 3) Secondary canals and related structures<br>- Secondary canals<br>Rehabilitation of existing secondary canals (5 nos., 9,250 m) and construction of a new canal<br>(1 no., 2,150 m)<br>- Related structures<br>Check Structure: 20 nos.<br>Turnout: 35 nos.<br>Culvert: 26 nos.<br>Drop: 1 no. | Rehabilitation of only the main canal is insufficient to realize efficient irrigation system. |
| 4) Drainage system<br>not proposed | 4) Drainage system (included above scopes of main/secondary canals) | Rehabilitation/ construction of drain is not proposed |
| 5) Tertiary canals<br>not proposed | 5) Tertiary canals<br>- Tertiary system development: 26 km (850 ha) | MOWRAM will provide special arrangement for land acquisition for tertiary canals.<br>Tertiary canals will be constructed by local contractors to be selected through LCB |
| 6) Construction of Project Office<br>not proposed | 6) Construction of Project Office<br>- Office building (300 $m^2$)<br>- Parking shed, gate, and fencing<br>- Well drilling and electric works | |
| **d) Software Component** | | |
| 1) Capacity development for MOWRAM and PDOWRAM staff on O&M<br>not proposed. | In order to realize the sustainability of MC35RSP, these are indispensable, thus should be included in the scope of MC35RSP | |
| 2 Formation and strengthening of FWUC<br>not proposed. | To execute appropriate water management and O&M at tertiary canal system level, formation and strengthening of FWUC is essential, thus should be included in the scope of MC35RSP | |
| 3) Strengthening of agricultural extension services<br>not proposed. | In order to fulfill the improvement of agricultural productivity, this is needed, thus should be included in scope of MC35RSP | |

*Source *: Project Proposal Document prepared by PDOWRAM (2009)*
***: JICA Survey Team*

***Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP)***

***Basic Concept***

(75) The SPWRRSP works proposed by PDOWRAM/MOWRAM were reviewed using the basic concepts paying attention to the following current conditions of SPWRRSP; (i) integrated approach of hardware and software components, (ii) appreciating present irrigation system under the recession cultivation, (iii) determination of the sub-project scale through water balance study, and (iv) priority ranking on Sub-project scope by criteria. (*P II-2-57and II-2-58)*

***Agriculture Development Plan***

(76) The agricultural development plan proposed in 2009 was reviewed through site visit, analysis on collected latest data and information from relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute to the preparation of the appropriate scope of SPWRRSP. As for the proposed cropping pattern, early rice in the dry and rainy seasons was introduced considering the results of the above activities. (*P II-2-58 and II-2-59)*

***Water Balance Study***

(77) SPWRRSP is planted with recession irrigation crop during the dry season. Water balance study was conducted by considering the flood water level of the Tonle Bassac River. During the flood season, river water from the Tonle Bassac River is channeled to the Srass Prambai Reservoir. After the flood season, inundation area will dry, and then will be cultivated with recession rice crop. The water in the Srass Prambai Reservoir will be used for irrigation. Water balance simulation was conducted using storage capacity curve of the Srass Prambai Reservoir and the estimated irrigation water requirement for the proposed cropping patterns. According to the water balance simulations of 20 years from 1991 to 2011 for SPWRRSP, a total 1200 ha with crop intensity of 106% can be irrigated with 80% dependability. (*P II-2-59 to II-2-61)*

**Results of Water Balance Study SPWRRSP Area**

| Max. Command Area (ha) | Available Total Irrigation Area | Early Rice (Dry) | Early Rice (Recession) | Crop Intensity |
|---|---|---|---|---|
| 2,500 ha | 1,200 ha | 70 ha | 1,200 ha | 106% |

| Dependability | Deficit Year (times/20years) |
|---|---|
| 80% | 4 |

*Source: JICA Survey Team*

***Scope of Sub-project***

(78) Based on the basic concept for irrigation rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under SPWRRSP are shown in the following table: (*P II-2-63 and II-2-64)*

**Examined Scope of SPWRRSP**

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **a) Irrigation Development Area** | | |
| - 2,500 ha in the dry season | - 1,200 ha in the dry season | Justified through water balance study |
| **b) Cropping Pattern and Crop Intensity** | | |
| - Rice Cropping System<br>- Crop Intensity: 100% | - Rice Cropping System<br>- Crop Intensity: 106% | Application of double cropping of rice considering present cropping pattern |
| **c) Hardware Component** | | |
| 1) Reservoir dike<br>- Rehabilitation of the existing dike (5.0 km) | 1) Reservoir dike<br>- Rehabilitation of the existing dike (9.1 km). | Northern part of the dike was recently rehabilitated in 2008. |
| 2) Replacement of intake | 2) Replacement of intake culverts on | i. Removing existing structures; |

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| culverts on reservoir dike | reservoir dike.<br>- Replacement of seven intake culverts with provision of new slide gates | ii. Construction of new structures maintaining original capacity;<br>iii. Installation gate and screen; and<br>iv. Protection on both sides |
| 3) Construction of Project Office<br>not proposed | 3) Construction of Project Office<br>- Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electrical works | |
| **d) Software Component** | | |
| 1) Capacity development for MOWRAM and PDOWRAM staff on O&M<br>not proposed | In order to realize the sustainability of SPWRRSP, these are indispensable, thus should be included in the scope of SPWRRSP | |
| 2) Formation and strengthening of FWUC<br>not proposed | To execute appropriate water management and O&M at tertiary canal system level, formation and strengthening of FWUC is essential, thus be included in scope of SPWRRSP | |
| 3) Strengthening of agricultural extension services<br>not proposed | In order to fulfill the improvement of agricultural productivity, this is needed, thus should be included in scope of SPWRRSP | |

*Source: JICA Survey Team*

***Daun Pue Irrigation System Rehabilitation Sub-project***

***Basic Concept***

(79) The Sub-project works proposed by PDOWRAM/MOWRAM will be reviewed using the basic concepts paying attention to the following current conditions of DPISRSP: (i) integrated approach of hardware and software components, (ii) determination of Sub-project scale through water balance study, (iii) utilization of existing canal system, and (iv) priority ranking on Sub-project scope by criteria.(*P II-2-64 and II-2-65)*

***Agriculture Development Plan***

(80) The agricultural development plan proposed in 2009 was reviewed through site visit, analysis on collected latest data and information from relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute in the preparation of the appropriate scope of DPISRSP. As a result, medium rice was cultivated only in the rainy season due to availability of water source for irrigation.(*P II-2-65 and II-2-66)*

***Water Balance Study***

(81) There is no existing reservoir in the DPISRSP Area and relevant river basin. Therefore, simplified water balance study was conducted for the DPISRSP Area. According to the water balance simulations, a total 1150 ha of command area with crop intensity of 100% will be able to be irrigated with 80% dependability.(*P II-2-66 to II-2-68)*

***Scope of Sub-project***

(82) Based on the basic concept for irrigation rehabilitation plan mentioned above, the scope of DPISRSP was examined and compared with the proposal made by MOWRAM, as follows: (*P II-2-73 and II-2-74)*

**Examined Scope of DPISRSP**

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **a) Irrigation Development Area** | | |
| - 1,150 ha | - 1,150 ha in the rainy season | Justified through water |

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| | | balance study |
| **b) Cropping Pattern and Crop Intensity** | | |
| - Rice cropping system<br>- Crop intensity: 100% | - Rice cropping system<br>- Crop intensity: 100% | |
| **c) Hardware Component** | | |
| 1) Construction of headworks<br>a) Protection with stone pitching;<br>b) Fixed weir with and flood gate;<br>Flood gates:<br>1.5 m (H) x 1.5 m (W), 13 spans<br>Stoplog section:<br>0.7 m (H) x 1.8 m (W), 8 spans each on both sides<br>c) Construction of intake structure not proposed | 1) Construction of headworks<br>a) River training of up and down stream of proposed headworks<br>b) Construction of regulator (2 m x 10 m x 4 sets)<br>c) Construction of intake structure | |
| 2) Rehabilitation of Daun Pue Main Canal<br>a) Improvement of canal (6.0 km, only upper reach) on the existing route<br>- New construction of canal-related structures;<br>- Check structure 7 nos.<br>- Culvert 3 nos.<br>- Spillway 1 no. | 2) Rehabilitation of Daun Pue Main Canal<br>a) Improvement of canal (6.2 km from BP to P6+200, raising of embankment and/or enlargement of canal section),<br>b) Changing route of main canal (4.9 km from P6+200 to EP, upgrading of secondary to main canal)<br>c) Construction of canal inspection road<br>d) Replacement or new construction of canal-related structures;<br>- Check structure 14 nos.<br>- Turnout 34 nos.<br>- Culverts 13 nos. | - Section and profile of canal are designed in accordance with the designed diversion water requirement and topographic condition.<br>- All existing structures are to be demolished and new structures. |
| 3) Rehabilitation of secondary canals not proposed. | 3) Rehabilitation of secondary canals.<br>a) Improvement of canal (3.4 km in total);<br>b) Construction of new secondary canal from main canal to existing secondary canal (1.2 km);<br>c) Construction of canal inspection road; and<br>d) Replacement or new construction of canal-related structures;<br>- Check structure 9 nos.<br>- Turnout 15 nos.<br>- Culverts 8 nos. | - Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition.<br>- All existing structures are to be demolished and new structures. |
| 4) Rehabilitation of drains not proposed. | 4) Rehabilitation of drains.<br>-Improvement and reshaping of drains | Improvement and reshaping of existing canal sections |
| 5) Development of tertiary canal system not proposed. | 5) Development of tertiary canal system.<br>-Development of tertiary canal system: 35 km (1150 ha). | |
| 6) Construction of Project Office not proposed. | 6) Construction of Project Office<br>- Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works | |
| **d) Software Component** | | |
| 1) Capacity development for MOWRAM and PDOWRAM's staff on O&M not proposed. | In order to realize the sustainability of SPWRRSP, these are indispensable, thus be included in scope of SPWRRSP | |
| 2) Formation and strengthening of FWUC not proposed. | To execute appropriate water management and O&M at tertiary canal system level, formation and strengthening of FWUC is essential, thus be included in scope of SPWRRSP | |
| 3) Strengthening of agricultural extension services not proposed. | In order to fulfill the improvement of agricultural productivity, this is needed, thus be included in scope of SPWRRSP | |

*Source: JICA Survey Team*

# CHAPTER II-3 SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

## ***Scope and Objective of South Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project*** *(SPPIDRIP)*

### *Overall Goal, Objective, and Expected Output and Outcome*

(83) Summary of SPPIDRIP design is tabulated as follows: (*P II-3-2 and II-3-3)*

**Summary of SPPIDRIP Design**

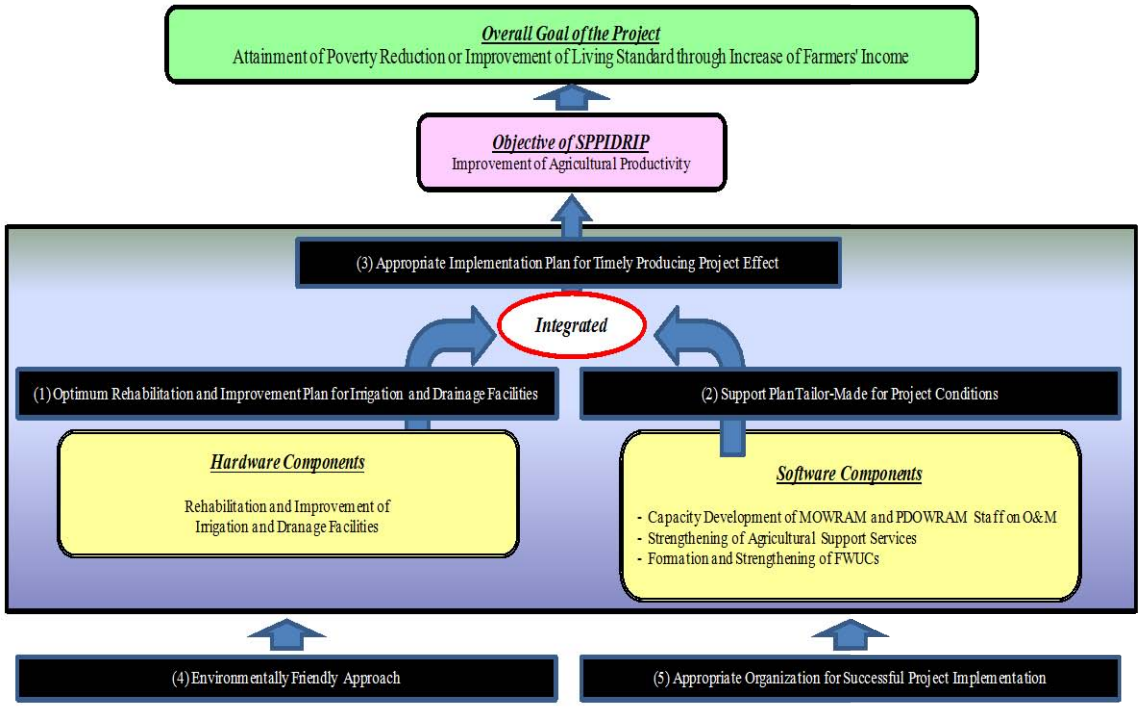
| Description |
|---|
| **Overall Goal**<br>To attain poverty reduction or improve the living standard through increase of farmers' income |
| **Objective**<br>To improve agricultural productivity by rehabilitating and improving the existing irrigation and drainage facilities, executing capacity development for MOWRAM and PDOWRAM staff on O&M, strengthening agricultural extension services, and forming and strengthening of FWUCs |
| **Expected Output and Outcome**<br>1) RCHRSP<br>- Stable water abstraction from the Prek Thnot River for irrigation to the related command area<br>- Appropriate and timely gate control of Roleang Chrey regulator at normal and flood times<br>- Proper water supply to SMC and NMC through the rehabilitated intake structures<br>- Realized smooth water flow to the downstream portions on SMC and NMC<br>- Improved agricultural productivity contributing to the improvement of farmers' income.<br>- Established O&M system by strengthening Kampong Speu PDOWRAM and FWUC<br>2) USISRSP<br>- Ensured water resources for irrigation to command area;<br>- Realized smooth water conveyance to command area by rehabilitating and improving the connection canal, main canal, secondary canals, tertiary canals, and related structures;<br>- Developed command area of 3,500ha<br>- Improvement of agricultural productivity contributing to the improvement of farmers' income, especially by provision of agricultural extension services<br>- Established O&M system by strengthening Takeo PDOWRAM and FWUC<br>3) KSBISRSP<br>- Ensured water resources for irrigation to command area of 3350 ha consisting of 1750 ha for the Kandal Stung Area and 1600 ha for the Bati Area;<br>- Realized smooth and effective water convey to command area by rehabilitating and improving the existing irrigation canal system;<br>- Established irrigation canal system in consideration of further development in the future;<br>- Improved agricultural productivity to contribute to the improvement of farmers' income, especially through the provision of agricultural extension services; and<br>- Established O&M system by strengthening Kandal PDOWRAM, and organizing and strengthening FWUC.<br>4) MC35RSP<br>- Ensured water resources for irrigation to command area of 850 ha;<br>- Realized smooth water convey to command area by rehabilitating and improving the existing reservoir and irrigation canal system;<br>- Improved agricultural productivity to contribute to the improvement of farmers' income, especially through the provision of agricultural extension services;<br>- Established O&M system by strengthening Kampong Spue PDOWRAM, and organizing and strengthening FWUC.<br>5) SPWRRSP<br>- Ensured water resources for irrigation to command area of 1200 ha by rehabilitating the existing reservoir;<br>- Improved agricultural productivity to contribute to the improvement of farmers' income, especially through the provision of agricultural extension services; and<br>- Established O&M system by strengthening Kandal PDOWRAM, and organizing and strengthening FWUC.<br>6) DPISRSP<br>- Ensured water resources for irrigation to command area of 1150 ha by newly constructing headworks;<br>- Smooth water convey to command area by rehabilitating and improving the existing irrigation canal system;<br>- Improved agricultural productivity to contribute to the improvement of farmers' income, especially through the provision of agricultural extension services; and<br>- Established O&M system by strengthening Kampong Chhnang PDOWRAM, and organizing and strengthening FWUC. |

*Source: JICA Survey Team*

## ***Approach and Strategy***

(84) SPPIDRIP will be implemented under the basic concept of *integrated approach of hardware and software components*, to successfully accomplish its objective mentioned above, and eventually to attain its overall goal, *attainment of poverty reduction or improvement of living*

*standard through increase of farmers' income*. The approach and strategy of SPPIDRIP are illustrated as follows: (*P II-3-3 to II-3-7)*




*Source: JICA Survey Team*

**Approach and Strategy of SPPIDRIP**

## ***Preparatory Works***

(85) In order to successfully execute the implementation of SPPIDRIP, it is crucial to carry out the preparatory works effectively prior to its commencement. The required preparatory works for the implementation of SPPIDRIP are (i) explanation of SPPIDRIP to the National Steering Committee, (ii) timely budget arrangement for smooth implementation of SPPIDRIP, (iii) prior establishment of implementation organization, (iv) land acquisition for construction of canals, and (v) execution of detailed technical ground survey for mines and UXOs. (*P II-3-7 and II-3-8)*

## ***Hardware Components***

### *Roleang Chrey Headworks Rehabilitation Sub-project*

(86) The Roleang Chrey Headworks are located in the Prek Thnot River, about 100 km upstream from its confluence with Bassac River, in Samraong Tong District, Kampong Speu Province. The RCHRSP Area lies in Kampong Speu Province. RCHRSP is the top priority project in the comprehensive agricultural development scenario of the Prek Thnot River basin formulated in the M/P Study. The relation of the whole Roleang Chrey Irrigation System Area and RCHRSP Area is tabulated as follows: (*P II-3-8)*

**Relation of Whole Roleang Chrey Irrigation System Area and RCHRSP Area**

| Description | Area |
|---|---|
| Roleang Chrey Irrigation System | 16,910 ha for project evaluation |
| RCHRSP Area<br>South Upstream area directly benefited from the rehabilitation of upstream parts of SMC (9.8 km) and secondary canals | 350 ha excluding 220 ha to be implemented by TSC-3 |

*Source: JICA Survey Team*

(87) Paddy production under without- and with-project conditions for IAIMP prepared in the M/P Study and the command area except IAIMP are shown below: (*P II-3-9 and II-3-10)*

**Production under Without- and With-Project Conditions**

**IAIMP**

| Paddy | Without-project Condition*1 | | | With-project Condition*1 | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*2 | Production (Ton) | Area (ha) | Unit Yield (ton/ha)*3 | Production (Ton) | |
| Early Rainy Season | | | | | | | |
| Early Rice | - | - | - | 285 | 4.00 | 1,140 | 1,140 |
| Rainy Season | | | | | | | |
| Early Rice | - | - | - | 285 | 4.00 | 1,140 | 1,140 |
| Medium Rice (irrigated) | - | - | - | - | - | - | - |
| Medium Rice (rainfed) | 580 | 2.12 | 1,230 | 285 | 3.50 | 998 | -232 |
| Total | 580 | - | 1,230 | 855 | - | 3,278 | 2,048 |

*Note*

**1: No supply of irrigation water due to malfunction of the regulator under without-project condition, while tertiary canal system development as well as soft component activities is carried out under with-project condition. The target area for development is 570 ha (285 ha + 285ha).*

**2: Unit yield under without project condition is settled, considering the results of the socio-economic survey.*

**3: Unit yield under with-project condition is settled, considering the results of the verification trial, which was conducted in F/S time.*

*Source: JICA F/S (2002) and JICA Survey Team*

**Command Area except IAIMP**

| Paddy | Without-project Condition*1 | | | With-project Condition*1 | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| Early Rainy Season | | | | | | | |
| Early Rice | - | - | - | 930 | 2.79 | 2,595 | 2,595 |
| Rainy Season | | | | | | | |
| Early Rice | - | - | - | | | | |
| Medium Rice (irrigated) | - | - | - | 8,570 | 2.31 | 19,797 | 19,797 |
| Medium Rice (rainfed) | 16,340 | 2.12 | 34,640 | 7,770 | 2.12 | 16,472 | -18,168 |
| Total | 16,340 | | 34,640 | 17,270 | | 38,864 | 4,224 |

*Note*

**1: No supply of irrigation water due to malfunction of the regulator under without-condition, while water supply condition could be recovered up to the current situation under with-project condition. The target area for development is 16,340 ha (8,570 ha + 7,770 ha).*

**2: Unit yield is settled, considering the result of socio-economic survey.*

*Source: JICA F/S (2002) and JICA Survey Team*

Thus, the target area for "without-project condition" and "with-project condition" become 16, 920 ha (580 ha + 16,340 ha) and 16,910 ha (570 ha + 16,340 ha) respectively.

(88) Irrigation water requirement based on the cropping pattern of early rice and medium rice, and upland crop in a year with overall cropping intensity of 114% with 80% dependability, which was the same with F/S, is as follows: (*P II-3-11)*

**Irrigation Water Requirement and Design Discharge for RCHRSP**

| Description | Design Value |
|---|---|
| Irrigation water requirement | |
| - Main canals | 1.60 lit/sec/ha |
| - Secondary canals | 1.41 lit/sec/ha (=1.60 x 0.88)*[1] |
| - Tertiary canals | 2.10 lit/sec/ha (15.7 mm/day x 10,000 / 86,400 / 0.85)*[2] |
| Design discharge | |
| - NMC | 10.4 $m^3$/sec (1.60 lit/sec/ha x 6,500 ha) |
| - SMC | 16.3 $m^3$/sec (1.60 lit/sec/ha x10,200 ha) |
| - River outlet structure | 5.0 $m^3$/sec*[3] |

*Remarks: 1;Irrigation efficiencies for paddy are assumed at 66% for overall and 88% for main and secondary canals.*

*2;Design discharge for tertiary canal should be determined at land preparation time when more water is required for 20 days for one tertiary block.*

*3:Basic Design Report of Japan's Grant Aid Project 2009.*

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008.*

(89) Basic design values such as design flood discharge and water levels for the rehabilitation of the headworks are referred in D/D of the Japanese Grant Aid project, as summarized below. (*P II-3-11)*

**Design Flood Discharge and Water Level of Roleang Chrey Headworks**

| Description | Design Value |
|---|---|
| Design flood discharge for headworks | 1,600 $m^3$/sec (1 in 50 years) |
| Water level at headworks<br>- High water level<br>- Low water level at intakes | <br>36.00 m<br>35.70 m |

*Source: Basic Deign Report of Japan's Grant Aid Project, 2008.*

(90) Facilities to be rehabilitated and/or reconstructed under RCHRSP are tabulated below. (*P II-3-12)*

**List of Facilities to be Rehabilitated under RCHRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 350 ha excluding 220 ha for TSC-3 pilot area, but influences 16,920 ha for project evaluation |
| 2) | Roleang Chrey Headworks | |
| | - Roleang Chrey Regulator | Regulator gates<br>- Fixed wheel gates, five sets, 12.5 m (W) x 6.7 m (H).<br>Civil works<br>- Construction of the downstream river bed protection<br>- Rehabilitation of the downstream river bank protection. |
| | - Andong Sla Intake | Intake gates<br>- Radial gates, 2 sets, 4.0 m (W) x 2.7 m (H).<br>Civil works<br>- Construction of curtain walls and operation deck,<br>- Protection of up & downstream of intake<br>- Rehabilitation of approach channel. |
| | - Vat Krouch Intake | Intake gates<br>- Radial gates, two sets, 4.0 m (W) x 2.7 m (H)<br>Civil works<br>- Construction of upstream & downstream transitions<br>- Construction of gate pier, box culvert and protection of canal beds,<br>- Rehabilitation of approach channel |
| | - River outlet structure | Inlet gates<br>- Slide gates, 4 sets, 1.0 m (W) x 1.0 m (H).<br>Outlet gates<br>- Slide gates, 2 sets, 1.25 m (W) x 1.4 m (H). |
| 3) | NMC and SMC | 2 nos.<br>Design discharge: NMC 10.4 $m^3$/sec at beginning point<br>SMC 16.3 $m^3$/sec at beginning point |
| | - Total length | 18.9 km (NMC = 9.1 km and SMC =9.8 km) |
| | - Structures to be rehabilitated/ reconstructed | Check structures : 3 nos.<br>Turnout : 18 nos.<br>Bridge : 7 nos.<br>Spillway : 3 nos.<br>Drainage gate : 11 nos. |
| 4) | Secondary canals to be rehabilitated | 12 nos. |
| | - Total length | 16.9 km |
| | - Structures to be rehabilitated/ reconstructed | Check structures : 45 nos.<br>Turnout : 53 nos.<br>Culvert : 32 nos.<br>Drain inlet : 4 nos. |
| 5) | Tertiary Canal System | |
| | - Area (length) | 350 ha (11 km) |

*Source: JICA Survey Team*

***Upper Slakou Irrigation System Rehabilitation Sub-project***

(91) USISRSP is located at about 70 km southwest from Phnom Penh and extends mainly on the right bank of the Slakou River and in Tram Kak District of Takeo Province. The development area for USISRSP was estimated at 3,500 ha through water balance study between the available water with 80% dependability and water demand for crop cultivation. (*P II-3-12)*

(92) Incremental production of paddy under without- and with-project conditions is shown as follows: (*P II-3-13)*

**Incremental Production of Paddy under Without- and With-Project Conditions**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| Early Rice | 470 | 2.13 | 1,001 | 1,300 | 4.00 | 5,200 | 4,199 |
| Medium Rice | 2,800 | 2.09 | 5,852 | 2,400 | 3.50 | 8,400 | 2,548 |
| Total | 3,270 | | 6,853 | 3,700 | | 13,600 | 6,747 |

*Note*
**1: Unit yield under present / without project conditions is settled, considering the results of the socio-economic survey.*
**2: Unit yield under with-project condition is settled, considering the results of the verification trial in the Study on Comprehensive Agricultural Development of Prek Thnot River Basin.*
*Source: JICA Survey Team*

(93) Unit irrigation water requirement for canal design was proposed to apply 110% of the average irrigation requirement of 1.0 lit/sec/ha, considering rather long calculation step of 15 days. Thus, the unit irrigation water requirement was calculated at 1.1 lit/sec/ha. Based on this unit water requirement, the diversion irrigation water requirement was estimated at 3.5 $m^3$/sec, with irrigation efficiency of 60% for paddy field. Unit drainage requirement for paddy field was estimated at 1.6 lit/sec/ha based on (i) allowable inundation depth of 150 mm, (ii) allowable inundation period of 3 days, (iii) design rainfall of 173 mm at Takeo with 1 in 10 year 3-day rainstorm, and (iv) initial water depth in the paddy field of 50 mm. (*P II-3-14)*

(94) The list of facilities to be rehabilitated under USISRSP area is as follows: (*P II-3-15)*

**List of Facilities to be Rehabilitated under USISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 3,500 ha |
| 2) | Water resource facilities | |
| | - Reservoir-1 | Tumnup Lok Reservoir in the Slakou River (CA=332 $km^2$), Ve= 1.0 MCM, Re-construction of dike, spillway, intake, and maintenance facilities. |
| | - Reservoir-2 | Kpob Trobek Reservoir in the Don Phe River (CA=137 $km^2$), Ve= 2.6 MCM Supplemental improvement and repair of dike and spillway gates were rehabilitated by MOWRAM in 2005. |
| | - Diversion canal | Connecting the above two reservoirs, 9.4 km, design discharge: 3.5 $m^3$/sec. |
| 3) | Main canal | 1 no. design discharge: 3.2 $m^3$/sec. |
| | - Length | 7.3 km |
| | - Off-takes | 6 nos. |
| | -Diversion structure | 5 nos. |
| 4) | Secondary canals | 7 nos. |
| | - Total length | 44.7 km |
| | - Off-takes | 102 nos. |
| | -Diversion structure | 66 nos. |
| 5) | Tertiary canals | |
| | - Total length | 110 km |

*Source: JICA Survey Team*

***Kandal Stung-Bati Irrigation System Rehabilitation Sub-project***

(95) The Sub-project Area of 3,550 ha in total consists of 2 irrigation areas, namely the Kandal Stung Area of 1,750 ha and the Bati Area of 1,600 ha. The Kandal Stung Area is situated in Kandal Stung District of Kandal Province about 20 km south of Phnom Penh. And, the Bati Area of 1,600 ha is situated in Bati District of Takeo Province about 30 km south of Phnom Penh. (*P II-3-15)*

(96) Paddy production under without- and with-project conditions in KSBISRSP is shown as follows: (*P II-3-17)*

**Incremental production of Paddy under Without- and With-Project Conditions**

| Paddy | Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| 1) Early Rainy Season | | | | | | | |
| - Early rice | 140 | 2.58 | 362 | 2,680 | 4.00 | 10,720 | 10,358 |
| 2) Rainy Season | | | | | | | |
| - Early rice (irrigated) | 500 | 2.58 | 1,290 | - | - | - | - 1,290 |
| - Medium rice (irrigated) | - | - | - | 3,350 | 3.50 | 11,725 | 11,725 |
| - Medium rice (rainfed) | 2,850 | 2.09 | 5,957 | - | - | - | - 5,957 |
| Total | 3,490 | | 7,609 | 6,030 | | 22,445 | 14,836 |

*Note*
**1: Unit yield under present / without project conditions is settled, considering the result of socio-economic survey.*
**2: Unit yield under with-project condition is settled, considering the result of verification trial conducted in F/S time of RCISRSP.*
*Source: JICA Survey Team*

(97) Based on the revised cropping pattern, the irrigation water requirement was re-calculated for 30 years. Result for the peak water requirement of the revised cropping pattern having 80% dependability became 1.4 lit/sec/ha that was the same in F/S. On the other hand, the unit drainage water requirement for paddy field was also estimated at 1.6 lit/sec/ha provided that 1 in 10 year 3-day rainstorm or around 165 mm is eliminated within 3 days. (*P II-3-17 and II-3-18)*

(98) The list of facilities to be rehabilitated under KSBISRSP is shown in the following table. (*P II-3-19)*

**List of Irrigation and Drainage Facilities to be Rehabilitated under KSBISRSP**

| No | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 3,350 ha in total consisting of 1,750 ha in Kandal Stung and 1,600 ha in Bati |
| 2) | Water resource facilities | |
| | - Diversion weir on Stung Touch River | 2 nos. on the Stung Touch River;<br>(one is new headworks and the other is partial improvement of spillway) |
| | - Intakes on Stung Touch River | 3 nos. on the Stung Touch River;<br>(full replacement for EW-60, EW-58 and NS-82) |
| | - Pump Station on Lake Tonle Bati | 1 no. at Lake Tonle Bati<br>(Full replacement of the existing one, four sets of 45 $m^3$/min each) |
| | - Regulator on Prek Thnot River for Stung Touch River | 1 no.<br>(Full replacement of Daeum Rues Regulator on the Prek Thnot River) |
| 3) | Main irrigation canal | 4 canals, Q= 5.88 – 0.91 $m^3$/sec |
| | - Length | 18.9 km in total, rehabilitation of the full stretch of the canal sections consisting 11.3 km for Kandal Stung and 7.6 km in the Bati Area |
| | - Off-takes | 71 nos. |
| | - Diversion structures | 17 nos. |
| | - Road crossing | 29 nos. |
| 4) | Secondary irrigation canals | 8 canals, Q=0.45 – 0.21$m^3$/sec |
| | - Length | 13.6 km in total, rehabilitation of the full stretch of the canal sections consisting of 5.0 km for Kandal Stung and 8.6 km in the Bati Area. |
| | - Off-takes | 36 nos. |
| | - Diversion structures | 9 nos. |
| 5) | Main drainage canals | 4 canals, Q=2.24 – 0.88 $m^3$/sec |
| | - Length | 18.8 km in total, rehabilitation of the full stretch of the canal sections consisting of 12.1 km for Kandal Stung and 6.7 km in the Bati Area |
| | - Structures | 73 nos. |
| 6) | Other facilities | |
| | - Connection canal | 3.5 km<br>(Upgrading of NS-82 to Lake Tonle Bati, Q=5.6 $m^3$/sec) |
| | - Spillway of Lake Tonle Bati | 1 no.<br>(Full replacement of Kampong Daungkar spillway, Q=197 $m^3$/sec) |
| | - Flood protection dike | Heightening of the existing dike of 2.7 km and replacement of one bridge |
| 7) | Tertiary canal system | |
| | - Length | 101 km in total, new construction and rehabilitation of the canal system consisting of 53 km for Kandal Stung Area and 48 km in the Bati Area |

*Source: JICA Survey Team*

### *Main Canal 35 Rehabilitation Sub-project*

(99) MS35RSP is located in the upstream of Slakou River basin, west of Phnom Penh. The command area of the Sub-project lies in the left bank of the Chraloy River along the provincial road, having long and narrow shape extending from west to east with gentle slope. The area is

administratively situated mainly in Basedth District, Kampong Speu Province bordering the National Road No.4, and partly extending in the western part of Takeo Province. The MS35RSP area is determined to be 850 ha based on the water balance study in Zone-A, the first priority rehabilitation area proposed by PDOWRAM/MOWRAM. (*P II-3-20)*

(100) Paddy production under without- and with-project conditions is shown as follows: (*P II-3-20 and II-3-21)*

**Production under Without- and With-Project Conditions for MC35RSP**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield*1 (ton/ha) | Production (ton) | Area (ha) | Unit Yield*2 (ton/ha) | Production (ton) | |
| a) Early Rainy Season | | | | | | | |
| - Early Rice (irrigated) | | | | 130 | 4.0 | 520 | 520 |
| b) Rainy Season | | | | | | | |
| - Medium Rice (irrigated) | 50 | 2.13 | 107 | 850 | 3.5 | 2,975 | 2,868 |
| - Medium Rice (rainfed) | 850 | 2.09 | 1,777 | | | | -1,777 |
| Total | 900 | | 1,884 | 980 | | 3,495 | 1,611 |

*Note:*
**1: Considered the results of the socio-economic survey in USISRSP as well as field investigation including interviews to farmers*
**2: Applied the result of verification trial, which was conducted in F/S time of RCISRSP*
*Source: JICA Survey Team*

(101) Irrigation water requirement was calculated based on the water balance study. As a result, unit water requirement of the main and secondary canals is set at 2.5 l/sec/ha, applying overall irrigation efficiency of 42% consisting of conveyance efficiency of 70% and application efficiency of 60%. Based on the unit water requirement, the peak diversion water requirement from the Khpob Krous Reservoir is estimated at 2.1 $m^3$/sec. (*P II-3-21)*

(102) Based on the basic concept for the rehabilitation plan, facilities to be rehabilitated, and/or reconstructed under MC35RSP are shown in the following table. (*P II-3-22and II-3-23)*

**List of Irrigation and Drainage Facilities to be Rehabilitated under MC35RSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area. | - 850 ha in priority area (Zone-A) |
| 2) | Main Canal 35 and related structures.<br>- Main Canal 35<br><br><br>- Related structures | <br>- Main canal<br>Rehabilitation of existing canal section for Zone-A<br>(12.8 km out of 25.3 km) and construction of new canal (1.2 km)<br>- Related structures<br>Check structure: 9 nos.<br>Turnout: 16 nos.<br>Culvert: 8 nos.<br>Drain inlet: 10 nos.<br>Drop: 5 nos.<br>Cross Drain: 1 no.<br>Road Bridge: 1 no.<br>Footpath Bridge: 9 nos. |
| 3) | Secondary canals and related structures. | Secondary canals and related structures<br>- Secondary canals<br>Rehabilitation of existing secondary canals (5 nos., 9.2 km) and construction of a new canal<br>(1 no., 2.2 km)<br>- Related structures<br>Check Structure: 20 nos.<br>Turnout: 35 nos.<br>Culvert: 26 nos.<br>Drop: 1 no. |
| 4) | Drainage system. | Drainage system<br>- Drain inlet: 10 nos. on main canal.<br>- Cross drain: 2 nos. (One is on main canal and the other is on a secondary canal).<br>- Shaping of existing drain sections. |
| 5) | Tertiary canals. | Tertiary system development : 26 km (850 ha) |
| 6) | Construction of the project office. | - Office building (300 $m^2$);<br>- Parking shed, gate, and fencing;<br>- Well drilling and electric works, etc. |

*Source: JICA Survey Team*

### *Srass Prambai Water Recession Rehabilitation Sub-project*

(103) The SPWRRSP Area is located in the flood plain between the Bassac and the Mekong Rivers. The area lies at the left side of the Bassac River in its lower reach, about 20 km from the national border of Vietnam. The area is administratively situated in Po Ti Ban Commune, Kaoh Thum District, Kandal Province. (*P II-3-22)*

(104) Paddy production under without- and with-project conditions is shown as follows: (*P II-3-23)*

**Production under Without- and With-Project Conditions for SPWRRSP**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield*1 (ton/ha) | Production (ton) | Area (ha) | Unit Yield*2 (ton/ha) | Production (ton) | |
| 1) Dry Season | | | | | | | |
| - Early rice (irrigated) | 700 | 3.5 | 2,450 | 1,200 | 5.0 | 6,000 | 3,550 |
| 2) Early Rainy Season | | | | | | | |
| - Early rice (irrigated) | - | - | - | 70 | 5.0 | 350 | 350 |
| Total | 700 | | 2,450 | 1,270 | | 6,350 | 3,900 |

*Note*
**1: Considered the results of the socio-economic survey in USISRSP as well as field investigation including interviews to farmers*
**2: Applied the results of the verification trial, which was conducted in F/S time of RCISRSP*
*Source: JICA Survey Team*

(105) Irrigation water requirement was calculated based on the water balance study. As a result, unit water requirement at the main and secondary canal levels is set at 2.4 l/sec/ha, applying overall irrigation efficiency of 70%. Based on the unit water requirement, the peak diversion water requirement from the Srass Prambai Reservoir was estimated at 2.8 $m^3$/sec. (*P II-3-23)*

(106) The facilities to be rehabilitated and/or reconstructed under SPWRRSP are listed in the following table. (*P II-3-24)*

**List of Irrigation Facilities to be Rehabilitated under SPWRRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 1,200 ha |
| 2) | Partial rehabilitation of reservoirs dike. | Rehabilitation of the existing dike (9.1 km). |
| 3) | Full replacement of intake culverts on reservoir dike. | Replacement of seven intake culverts with provision of new slide gates. |
| 4) | New construction of the project office. | a) Office building (300 $m^2$);<br>b) Parking shed, gate, and fencing; and<br>c) Well drilling and electric works, etc. |

*Source: JICA Survey Team*

### *Daun Pue Irrigation System Rehabilitation Sub-project*

(107) DPISRSP is located in the upstream of the Chieb River basin, about 40 km from its confluence of Tonle Sap River. The irrigation command area of DPISRSP lies in the left bank of the Chieb River and along the provincial road, having long and narrow shape extending from west to east. Administratively, the area lies in Chieb, Khlong Porpork and Aphivath Communes in Teuk Phos District. (*P II-3-24)*

(108) Paddy production under without- and with-project conditions is shown as follows: (*P II-3-25)*

**Production under Without- and With-Project Conditions for DPISRSP**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield*1 (ton/ha) | Production (ton) | Area (ha) | Unit Yield*2 (ton/ha) | Production (ton) | |
| Rainy Season | | | | | | | |
| - Medium Rice (irrigated) | | | | 1,150 | 3.50 | 4,025 | 4,025 |
| - Medium Rice (rainfed) | 1,060 | 2.09 | 2,215 | - | | | -2,215 |
| Total | 1,060 | | 2,215 | 1,150 | | 4,025 | 1,810 |

*Note*
**1: Considered the results of the socio-economic survey in USISRSP as well as field investigation including interviews to farmers.*
**2: Applied the results of the verification trial, which was conducted in F/S time of RCISRSP.*
*Source: JICA Survey Team*

(109) The list of facilities to be rehabilitated and/or reconstructed under DPISRSP is shown in the following table: (*P II-3-26)*

**List of Irrigation and Drainage Facilities to be Rehabilitated under DPISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 1,150 ha |
| 2) | New construction of headworks | a) River training of up and down stream of proposed headworks<br>b) Construction of regulator (2 m x 10 m x 4 sets)<br>c) Construction of intake structure |
| 3) | Full rehabilitation of Daun Pue Main Canal. | a) Improvement of canal (6.2 km from BP to P6+200, raising of embankment and/or enlargement of canal section),<br>c) Changing route of main canal (4.9 km from P6+200 to EP, upgrading of secondary to main canal)<br>d) Construction of canal inspection road<br>e) Replacement or new construction of canal related structures<br>- Check structure 14 nos.<br>- Turnout 34 nos.<br>- Culverts 13 nos. |
| 4) | Full rehabilitation of secondary canals. | a) Improvement of canal (3.4 km in total)<br>b) Construction of new secondary canal from main canal to existing secondary canal (1.2 km)<br>c) Construction of canal inspection road |
| | | d) Replacement or new construction of canal related structures:<br>- Check structure 9 nos.<br>- Turnout 15 nos.<br>- Culverts 8 nos. |
| 5) | Full rehabilitation of drains. | a) Improvement and reshaping of drains. |
| 6) | Development of tertiary system. | a) New construction of tertiary canals (35 km) |
| 7) | New construction of project office. | a) Office building (300 $m^2$);<br>b) Parking shed, gate, and fencing; and<br>c) Well drilling and electric works, etc. |

*Source: JICA Survey Team*

## ***Software Component***

### *General*

(110) Three activities are proposed under the soft component of SPPIDRIP to establish organizational set-up in order to effectively utilize rehabilitated irrigation facilities as follows: (i) capacity development of MOWRAM and PDOWRAM staff on O&M, (ii) strengthening of FWUC, and (iii) strengthening of agricultural extension services. (*P II-3-27)*

(111) Software component under SPPIDRIP will be conducted based on the following principles such as (i) follow-up of output of TSC-3 supported area in both Roleang Chrey and Slakou Irrigation Systems, (ii) integration of output of TSC-3 supported area and the extension area in both RCHRSP and USISRSP so as to demonstrate proper water management and increase rice production in the Model Area (570 ha) under RCHRSP and command area extending 3,500 ha under USISRSP, and (iii) extension to other Sub-projects such as KSBISRSP, SPWRRSP and DPISRSP. General framework of soft component is tabulated as follows: (*P II-3-27and II-3-28)*

**General Framework Software Component under SPPIDRIP**

| No. | Title | Activities | Implemented by | Main Target Group |
|---|---|---|---|---|
| 1) | Capacity Development of MOWRAM and PDOWRAM Staff on O&M | - Preparation of practical O&M guidelines for rehabilitated facilities<br>- Dissemination and training workshop<br>- Training management<br>- Periodical monitoring and evaluation<br>- Follow-up workshop | Technical consultant (short- term foreign consultant) for work plan preparation and trial training.<br><br>Training programs and M&E by PMU Japan Support Fund with Technical Service Center | MOWRAM and PDOWRAM Staff |

| No. | Title | Activities | Implemented by | Main Target Group |
|---|---|---|---|---|
| 2) | Formation and Strengthening of FWUC | - Support to awareness raising<br>- Support to establishment of FWUC<br>- Implementation of training programs (organizational management, water management & O&M of tertiary canal systems)<br>- Support and monitoring of water management and O&M of irrigation facilities) | MOWRAM and PDOWRAM staff by employing national consultants | FWUCs in six sub-project irrigation systems |
| 3) | Strengthening of Agricultural Extension Services[1] | - TOT for capacity development of group leaders to act as extension facilitator<br>- Soil fertility diagnosis program<br>- Pre-harvest technology improvement<br>- Post-harvest technology improvement<br>- Demonstration plots | Technical consultant (short-term foreign consultant) for work plan preparation and trial training<br><br>PDA staff and national consultants under the control of PMU Japan Support Fund | FWUCs in six sub-project irrigation systems |

*Source; JICA Survey Team*

(112) It is proposed that software component will be generally carried out through training of trainers (TOT) approach, where trainees at one level become trainers at the other level as having been widely carried out by the previous irrigation projects with development partners and TSC of MOWRAM. (*P II-3-27 and II-3-28)*

***Technical Assistance***

***Demarcation of Services***

(113) The technical services consist of 2 types. One is the services of technical consultant consisting of foreign consultant and national consultant, and the other is the services of MOWRAM. The demarcation of these services is tabulated below: (*P II-3-51)*

**Demarcation of Services of Technical Consultant and MOWRAM**

| Services of Technical Consultant | Services of MOWRAM |
|---|---|
| - Review of previous studies<br>- Preparation of definitive development plan<br>- Execution of additional survey<br>- Detailed design for large scale structures and major canal system<br>- Preparation of prequalification documents and tender documents for construction<br>- Execution of prequalification and tender evaluations for construction<br>- Construction supervision for large scale structures and major canal system<br>- Capacity development of MOWRAM and PDOWRAM staff on O&M<br>- Training of PDA staff on agricultural extension services<br>- Preparation of relevant reports | - Development of tertiary canal system by employing national consultants<br>- Formation and Strengthening of FWUCs by PDOWRAM trained under TOT system<br>- Strengthening of agricultural extension services by PDA trained under coordination by MOWRAM |

*Source: JICA Survey Team*

***Outline of Consulting Services***

(114) The outline of consulting services under task and assistance concepts is tabulated below: (*P II-3-52)*

[1] *Out of 3 components proposed, "Strengthening of Agricultural Extension Services" is explained in details in Annex C: Agriculture.*

**Outline of Consulting Services**

| Concept | Description | |
|---|---|---|
| Task concept | All Stages | - Overall project management, monitoring and coordination among MOWRAM, PDOWRAM, PDA, and other agencies concerned |
| | Detailed Design Stage | - Review of previous studies<br>- Preparation of definitive development plan<br>- Detailed design<br>- Preparation of prequalification and tender documents<br>- Preparation of reports concerned |
| | Construction Stage | - Quality control<br>- Progress control<br>- Quantity control<br>- Safety control<br>- Capacity development for MOWRAM and PDOWRAM staff on O&M<br>- Training of PDA staff on agricultural extension services<br>- Preparation of reports concerned |
| Assistance Concept | All Stages | - To assist and advise PMU and PIUs in preparation of implementation schedule |
| | Detailed Design Stage | - To assist and advise PMU and PIUs in holding public consultation meeting |
| | Construction Stage | - To assist and advise PMU in prequalification and tender evaluation works<br>- To assist and advise PMU in issuing variation order<br>- To assist and advise PMU in settling contractors' claims. |

*Source: JICA Survey Team*

### *Necessary Inputs of Consulting Services*

(115) Technical consultants, consisting of foreign consultant and national consultant, are necessary for different special fields for the smooth implementation of the SPPIDRIP through support to PMU Japan Support Fund. Approximate man-months necessary for the implementation of SPPIDRIP are (i) 188 M/M for foreign consultant and (ii) 1,030 M/M for national consultant as detailed below: (*P II-3-54)*

**Approximate Man-Months Required for Consulting Services**

| No. | Item | Foreign Consultant (M/M) | National Consultant (M/M) |
|---|---|---|---|
| **1)** | **Hardware Components** | | |
| | Detailed Design for Major Structures | 75.0 | 130.0 |
| | Construction Supervision for Major Structures | 102.0 | 428.0 |
| | Development of Tertiary Canal System | - | 258.0 |
| | Sub-total | 177.0 | 816.0 |
| **2)** | **Software Component** | | |
| | Capacity Development for MOWRAM and PDOWRAM Staff on O&M | 9.0 | 36.0 |
| | Formation and Strengthening of FWUCs | - | 126.0 |
| | Strengthening of Agricultural Extension Services | 2.0 | 24.0 |
| | Financial Management | - | 28.0 |
| | Sub-total | 11.0 | 214.0 |
| 3) | Grand Total | 188.0 | 1,030.0 |

*Source: JICA Survey Team*

## CHAPTER II-4 PROJECT IMPLEMENTATION AND O&M PLAN

### ***Project Implementation Plan***

### *Implementation Organization*

(116) Three implementation organizations applied and/or proposed for recent major irrigation projects under MOWRAM were studied during the Survey: (i) NWISP (ADB), (ii) WRMSDP (ADB), and (iii) WTSIDRIP (JICA). Based on the results of the study as well as discussion with MOWRAM, the proposed implementation organization for SPPIDRIP is designed on the basis of that for WTSIDRIP. Some modifications to be applied for SPPIDRIP are (i) clear positioning of JICA in the implementation, (ii) assignment of a provincial level project manager, (iii) clear relation between PIU and PDA, and (iv) establishment of PIU Coordination Committee in case the sub-project area extends over rural provinces. (*P II-4-1 and II-4-2*)

***Staff Required for the Design and Construction Works***

(117) Smooth project implementation requires full-time professional staff from MOWRAM and PDOWRAM at the central and provincial levels, which will be directly and indirectly supported by relevant technical departments, as shown in the right table: (*P II-4-3*)

**Staff Required for the Design and Construction Works for SPPIDRIP**

| Central/Province | Organization | nos. |
|---|---|---|
| Central Level | PMU Japan Support Fund (=1) | 13 |
| Provincial Level | PIU at Kampong Speu Province | 5 |
| | PIU at Takeo Province | 16 |
| | PIU at Kandal Province | 6 |
| | PIU at Kampong Chhnang | 8 |
| | Sub-total (Provincial Level) (=2) | 35 |
| **Grand Total (1+2)** | | **48** |

*Source: JICA Survey Team*

***Construction Package***

(118) As for ICB works, 6 sub-projects are divided into 2 construction packages in consideration of the scattered location of working sites, shortening of construction period, similar works and provision of more chances to tenderers. On the other hand, LCB works like the construction of tertiary canals and related structures for 5 Sub-projects are proposed to be carried out by dividing them into 12 packages in view of the procurement thresholds mentioned above. (*P II-4-9*)

**Packaging for the Works of Hardware Component**

| Sub-project | Province | Nos. of Packages | | | |
|---|---|---|---|---|---|
| | | International Competitive Bidding (ICB) | | Local Competitive Bidding (LCB) | |
| RCHRSP | Kampong Speu | 1 | - Partial rehabilitation of headworks including 2 intakes<br>- Partial rehabilitation of main and secondary canals (36 km in total)<br>- Construction of structures (176 nos.). | 1 | Construction of tertiary canal (350 ha: 11km) |
| DPISRSP | Kampong Chhnang | | - New construction of headworks,<br>- Partial rehabilitation of main and secondary canals (16.3 km), and<br>- Construction of structures (93 nos.). | 2 | Construction of tertiary canal (15 km-18 km) |
| USISRSP | Takeo and partly in Kampong Speu (right bank of Tumnup Lok Reservoir) | 1 | - Partial rehabilitation of water resource facilities (two reservoirs and diversion canal)<br>- Partial rehabilitation of main and secondary canals (52 km in total)<br>- Construction of structures (179 nos.) | 4 | Construction of tertiary canal (15 km-18 km) |
| KSBISRSP | Kandal and Takeo | | - New construction of diversion weirs Full replacement pumps and pump house<br>Full replacement of regulator<br>- Full upgrading of connection canal<br>- New construction of spillway<br>- Partial rehabilitation of main and secondary canals (32.5km)<br>- Partial rehabilitation of drainage canal system (18.8 km). | 4 | Construction of tertiary canal (24km -27 km) |
| MC35RSP | Kampong Speu | | - Partial rehabilitation of Khpob Krous Reservoir<br>- Partial rehabilitation of main canal and secondary canal (25.4 km)<br>- New construction of structures (151 nos.) | 1 | Construction of tertiary canal (26 km) |
| SPWRRSP | Kandal | | - Partial rehabilitation of Srass Prambai Reservoir<br>- New construction of intakes (7 nos.) | - | - |
| Total | | ICB: 2 Packages | | LCB: 12 Packages | |

*Source: JICA Survey Team*

***Implementation Schedule***

(119) Hardware components are proposed to be implemented from the beginning of 2013 after the loan agreement (L/A) until the middle of 2020, out of which the period from the beginning of D/D to the completion of construction would continue for 6.5 years. The overall schedule is illustrated as follows: As can be seen in this figure, construction works of SPPIDRIP will be

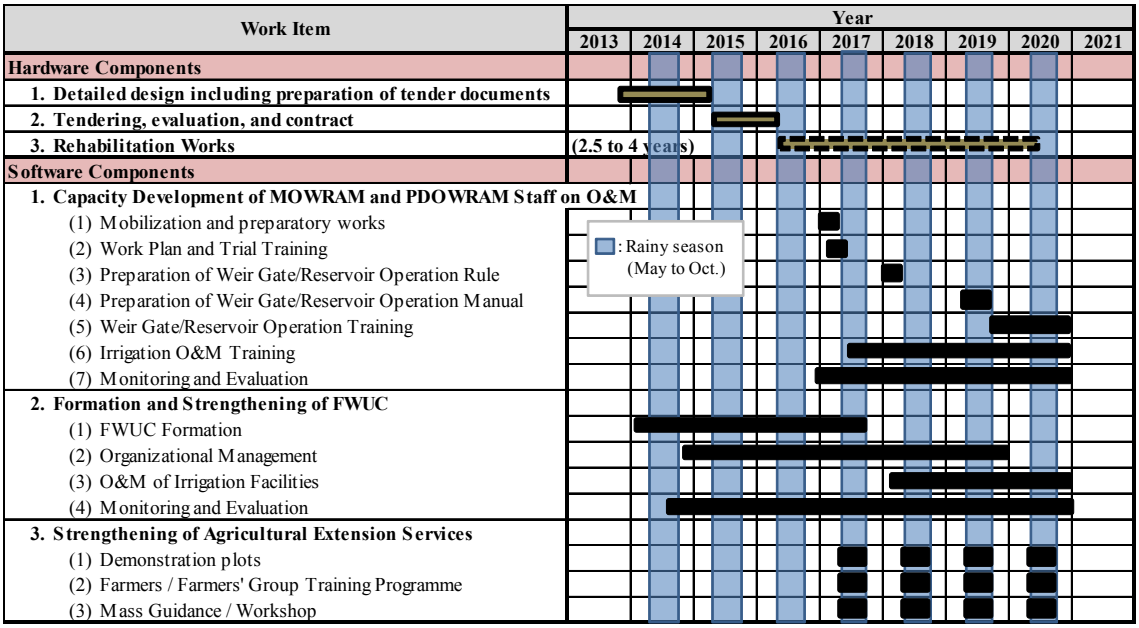
started in mid. 2016 and be completed by mid. 2020 although SPWRRSP will be completed in end of 2017. However, since the partial operation can be applied sub-project by sub-project, the project effect is expected to occur earlier, say mid. 2019 for RCHRSP, mid. 2018 for USISRSP, mid. 2018 for KSBISRSP, mid. 2019 for MC35RSP, mid. 2019 for DPISRSP (*P II-4-10 to II-4-20*).

| Work Item | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **1. Loan Agreement (L/A)** | | | | | | | | | | |
| **2. Procurement of Consultant** | | | | | | | | | | |
| **3. Clearance of Mines and UXOs** | | | | | | | | | | |
| **4. Land Acquistion** | | | | | | | | | | |
| **5. Consulting Services** | | | | | | | | | | |
| **5-1 Detailed design for water resources facilities and main and secondary canal system** | | | | | | | | | | |
| **5-2 Assistance for procurement of ICB Contractor** | | | | | | | | | | |
| **5-3 Construction supervision** | | | | | | | | | | |
| **6. Rehabilitation and Construction of Roleang Chrey Headworks Rehabilitation Sub-project** | | | | | | Contract for ICB works except tertiary canal system | | | | |
| **6-1 Preparatory works** | | | | | | | | | | |
| **6-2 Temporary works** | | | | | | | | | | |
| **6-3 Construction works** | | | | | | | | | | |
| (1) Roleang Chrey Headworks Improvement Works | | | | | | | | | | |
| (a) Design, approval, fabrication and transportation of gates | | | | | | | | | | |
| (b) Full improvement of hydro-mechanical works, intakes, and others | | | | | | | | | | |
| (2) Rehabilitation works for North and South Main Canals | | | | | | | | | | |
| (a) Partial rehabilitation works for North Main and Secondary Canals (28.35km) | | | | | | | | | | |
| (b) Partial rehabilitation works for South Main and Secondary Canals (28.50 km) | | | | | | | | | | |
| (c) Partial rehabilitation of drainage canals (3 km in total) | | | | | | | | | | |
| (3) New construction of tertiary canal system in model area (350 ha) | | | | | | | | | | |
| (4) New construction of Sub-project office | | | | | | | | | | |
| **6-4 Start of partial operation (Apperance of project effect)** | | | | | | | | | | |
| **7. Rehabilitation and Construction of Upper Slakou Irrigation System Rehabilitation Sub-project** | | | | | | Contract for ICB works except tertiary canal system | | | | |
| **7-1 Preparatory works** | | | | | | | | | | |
| **7-2 Rehabilitation and construction works** | | | | | | | | | | |
| (1) Partial rehabilitation of Tumnup Lok Reservoir | | | | | | | | | | |
| (2) Partial rehabilitation of diversion canal (9.4km) | | | | | | | | | | |
| (3) Partial rehabilitation of Kpob Trobek Reservoir | | | | | | | | | | |
| (4) Full rehabilitatan of Main Canal 33 system (7.3km) | | | | | | | | | | |
| (5) Partial rehabilitation of secondary canal system (44.7km) | | | | | | | | | | |
| (6) Partial rehabilitation and new construction of tertiary canal system. (3,500 ha) | | | | | | | | | | |
| (7) New construction of Sub-project office | | | | | | | | | | |
| **7-3 Start of partial operation (Apperance of project effect)** | | | | | | | | | | |
| **8. Rehabilitation and Construction of Kandal Stung-Bati Irrigation System Rehabilitation Sub-project** | | | | | | Contract for ICB works except tertiary canal system | | | | |
| **8-1 Preparatory works** | | | | | | | | | | |
| **8-2 Rehabilitation and construction works** | | | | | | | | | | |
| (1) New construction and partial improvement of diversion weirs | | | | | | | | | | |
| (2) Full replacement of pumps and house | | | | | | | | | | |
| (3) Full replacement of regulator for Stung Touch | | | | | | | | | | |
| (4) Full upgrading of connection canal | | | | | | | | | | |
| (5) New construction of Kampong Duagkar spillway | | | | | | | | | | |
| (6) Partial rehabilitation of main canal system (18.9 km) | | | | | | | | | | |
| (7) Partial rehabilitation of seconadary canal system (13.6 km) | | | | | | | | | | |
| (8) Partial rehabilitation of main drainage canal system (18.8 km) | | | | | | | | | | |
| (9) New construction of tertiary canal system (3,350 ha) | | | | | | | | | | |
| (10) New construction of Sub-project office | | | | | | | | | | |
| **8-3 Start of partial operation (Apperance of project effect)** | | | | | | | | | | |
| **9. Rehabilitation and Construction of Main Canal 35 Rehabilitation Sub-project** | | | | | | Contract for ICB works except tertiary canal system | | | | |
| **9-1 Preparatory works** | | | | | | | | | | |
| **9-2 Rehabilitation construction works** | | | | | | | | | | |
| (1) Partial rehabilitation of Khpob Krous Reservoir and intake structure | | | | | | | | | | |
| (2) Partial rehabilitation of main canal system (14.0 km) | | | | | | | | | | |
| (3) Partial rehabilitation and new construction of secondary canal system (14.5 km) | | | | | | | | | | |
| (4) New construction of tertiary canal system (850 ha) | | | | | | | | | | |
| (5) New construction of Sub-project office | | | | | | | | | | |
| **9-3 Start of partial operation (Apperance of project effect)** | | | | | | | | | | |
| **10. Rehabilitation and Construction of Srass Prambai Water Recession Rehabilitation Sub-project** | | | | | | Contract for ICB works | | | | |
| **10-1 Preparatory works** | | | | | | | | | | |
| **10-2 Rehabilitation and construction works** | | | | | | | | | | |
| (1) Partial rehabilitation of Srass Prambai Reservoir | | | | | | | | | | |
| (2) New construction of intake structures (7 nos.) | | | | | | | | | | |
| (3) New construction of Sub-project office | | | | | | | | | | |
| **10-3 Start of operation (Apperance of project effect)** | | | | | | | | | | |
| **11. Rehabilitation and Construction of Daun Pue Irrigation System Rehabilitation Sub-project** | | | | | | Contract for ICB works except tertiary canal system | | | | |
| **11-1 Preparatory works** | | | | | | | | | | |
| **11-2 Temporary works** | | | | | | | | | | |
| **11-3 Rehabilitation and new construction works** | | | | | | | | | | |
| (1) Daun Pue Headworks Construction Works | | | | | | | | | | |
| (a) Design, approval, fabrication and transportation of gates | | | | | | | | | | |
| (b) Nerw construction of hydro-mechanical works and intake structure | | | | | | | | | | |
| (2) Partial rehabilitation of main canal system (11.7 km) | | | | | | | | | | |
| (3) Partial rehabilitation and construction of secondary canal system (5.2 km) | | | | | | | | | | |
| (4) New construction of tertiary canal system (1,150 ha) | | | | | | | | | | |
| (5) New construction of Sub-project office | | | | | | | | | | |
| **11-4 Start of partial operation (Apperance of project effect)** | | | | | | | | | | |

*Source: JICA Survey Team*

**Overall Implementation Schedule of Hardware Components under SPPIDRIP**

(120) Although beneficiary farmers will be provided with necessary information about SPPIDRIP in each area by means of workshops and meetings as soon as detailed design starts, substantial activities on software components are planned to be implemented from 2017 to 2020 over the four-year period in concurrence with the progress of hardware components. The overall implementation time schedule is illustrated as follows: (*P II-4-20 and II-4-21*)




*Source: JICA Survey Team*

**Overall Implementation Schedule of Software Components under SPPIDRIP**

## ***O&M Plan***

### *Demarcation of O&M Responsibility*

(121) After completion of the rehabilitation works, the O&M responsibility for the secondary and tertiary level facilities is proposed to be transferred to FWUC in the SPPIDRIP area respectively, in accordance with Circular No. 1 on the Implementation Policy for Sustainable Irrigation Systems by gradually reducing subsidy from MOWRAM. The O&M responsibility among stakeholders for SPPIDRIP is as follows: (*P II-4-22*)

**O&M Responsibility among Stakeholders for SPPIDRIP**

| Level of Facilities / O&M Activities | Reservoir/ Headworks | Main Canals | Secondary Canals | Tertiary Canals and Below |
|---|---|---|---|---|
| Annual O&M Planning | PDOWRAM | PDOWRAM | PDOWRAM/ FWUC | Sub-FWUG |
| Cropping Schedule Preparation | - | - | FWUC/FWUG | Sub-FWUG |
| Operation | PDOWRAM | PDOWRAM | FWUC/FWUG | Sub-FWUG |
| Maintenance | PDOWRAM | PDOWRAM | FWUC/FWUG | Sub-FWUG |

*Source: JICA Survey Team*

### *Staff Required for O&M of Rehabilitated Irrigation Systems*

(122) Number of staff required for the operation and maintenance of SPPIDRIP is estimated at 21 in total as shown in the right table: (*P II-4-24*)

**Number of Staff Required for O&M of SPPIDRIP**

| Organization | No. |
|---|---|
| **Central Level** | |
| - PMU Japan Support Fund (=1) | 2 |
| **Provincial Level** | |
| Project Implementation Unit (PIU) | |
| - Kampong Speu Province | 6 |
| - Takeo Province | 6 |
| - Kandal Province | 5 |
| - Kampong Chhnang Province | 2 |
| Sub-total of Provincial Level (=2) | 19 |
| **Grand Total (=1+2)** | **21** |

*Source: JICA Survey Team*

### *O&M Plan*

(123) Tasks in O&M among stakeholders for irrigation facilities for SPPIDRIP are tabulated as follows:

(*P II-4-25 to II-4-27*)

**Job Demarcation of O&M among MOWRAM, PDOWRAM, and FWUC**

| Organization | Department/ Position | Job Description |
|---|---|---|
| **Central Level** | | |
| MOWRAM | PMU Japan Support Fund<br><br>Department of Engineering | - Overall coordination with relevant technical department in MOWRAM and external organization for O&M, and monitoring and evaluation and capacity development of PDOWRAM<br>- In coordination with PMU Japan Support Fund, in charge of engineering advice and instruction |
| | Department of FWUC | - In coordination with PMU Japan Support Fund, in charge of establishment and strengthening of FWUC |
| | Department of Irrigated Agriculture | - In coordination with PMU Japan Support Fund, relevant organizations within MOWRAM, MAFF, and PDA, in charge of promotion of irrigated agriculture in the command area using rehabilitated irrigation facilities |
| **Provincial Level** | | |
| PDOWRAM | Project Manager | - Overall coordination at the provincial level<br>- Approval of annual O&M plan prepared by engineer and district staff<br>- Report of provincial and field level activities to MOWRAM<br>- Budget request to MOWRAM for major repairing works based on inspection by engineers/district staff<br>- Contract management of sublet work of local contractors |
| | Engineer/District Staff | - Preparation of annual O&M plan including budgetary plan<br>- Regular monitoring and evaluation of FWUC at the field level<br>- Instruction to FWUC based on annual O&M plan<br>- Technical advice to FWUC<br>- Regular inspection of irrigation facilities at the main canal level<br>- Report preparation of facilities' conditions based on regular inspection<br>- Report preparation of O&M activities<br>- Operation of major facilities such as reservoir/headworks |
| **Commune and Village Level** | | |
| FWUC | Board of FWUC | - Overall coordination of FWUC activities<br>- Coordination with external organizations such as CCs and VDCs<br>- Approval of annual plan prepared by FWUC<br>- Conflict management among the group |
| | FWUGs | - Established for approximately 200 ha per group in charge of O&M of secondary block<br>- Operation of turnout gate on the main canal in consultation with PDOWRAM |
| | Sub-FWUG | - Established for approximately 50 ha per group in charge of O&M of tertiary block<br>- Operation of turnout gate on the secondary canal in consultation with PDOWRAM |
| | WUGs | - Established for approximately 5 ha per group in charge of O&M of quarterly block<br>- Operation of division box on the tertiary canals |
| Others | General Meeting | - It is proposed that this organization be newly established to facilitate coordination at the community level, members of which would consist of (i) FWUC representative, (ii) CC members, and (iii). VDC members.<br>- In charge of broad-based conflict management in the community including irrigation water management<br>- O&M of community infrastructure such as village roads<br>- Coordination of land acquisition within the community |

*Source: JICA Survey Team*

## CHAPTER II-5 PROJECT COST ESTIMATE

### ***Initial Investment Cost***

(124) The initial investment cost for SPPIDRIP is estimated at US$ 94 million, of which F/C and L/C portions are shown in the following table: (*P II-5-1*)

**F/C and L/C Portions of Initial Investment Cost for SPPIDRIP**

| No. | Item | Total Investment Cost (US$1,000) | F/C (JPY million) | L/C (US$1,000) |
|---|---|---|---|---|
| 1) | Construction Cost | 45,936 | 2,470 | 13.782 |
| 2) | Tertiary Development Cost | 3,294 | 149 | 1,347 |
| 3) | Procurement Cost | 1,603 | 105 | 235 |
| 4) | Consulting Services Cost | 7,068 | 201 | 4,452 |
| 5) | UXO/Mine Survey Cost | 1,200 | 0 | 1,200 |
| 6) | Soft Component Activities Cost | 2,712 | 32 | 2,301 |
| 7) | Land Acquisition Cost | 942 | 0 | 942 |
| 8) | Project Administration Cost | 1,378 | 0 | 1,378 |

| No. | Item | Total Investment Cost (US$1,000) | F/C (JPY million) | L/C (US$1,000) |
|---|---|---|---|---|
| 9) | Tax & Duty | 5,910 | 0 | 5,910 |
| 10) | Price Escalation | 16,483 | 553 | 9,402 |
| 11) | Physical Contingencies | 7,4,94 | 339 | 3,075 |
| 12) | Interest during Construction | 25 | 0 | 25 |
| | **Total** | **94,045** | **3,839** | **44,049** |

*Source: JICA Survey Team*

***O&M Cost***

(125) Annual O&M cost includes: (i) salary and wages for staff personnel of PDOWRAM and FWUC consisting of board members of FWUC and FWUGs and (ii) direct cost for minimum office expenses and repair works. The annual O&M cost is estimated at 0.05% of direct construction cost for each sub-project. Major repairs, including replacements, will be executed every 10 years after the completion of the construction works and the cost is assumed to be 5% of the construction costs (*P II-5-4 and II-5-5*)

## CHAPTER II-6 PROJECT EVALUATION

***Economic Evaluation***

(126) The economic evaluation was made in terms of net present value (NPV), benefit-cost (B/C) ratio and economic internal rate of return (EIRR) of the proposed rehabilitation plan. In addition, sensitivity analyses are done for cases such as cost increase of 10% and 20%, benefit reduction by 10% and 20%, and combination of each case. The results of the economic evaluation are summarized below. (*P II-6-1 to II-6-3*)

**Results of Economic Evaluation**

| Evaluation Item | Evaluation Results | | | |
|---|---|---|---|---|
| NPV at 12% discount rate | NPV of benefit (US$) | 41,028,255 | NPV (US$) | 6,642,769 |
| | NPV of cost (US$) | 34,385,486 | | |
| B/C ratio and EIRR | B/C ratio | 1.19 | EIRR (%) | 14.3 |
| Sensitivity analysis (%) | | Cost normal | Cost 10% up | Cost 20% up |
| | Benefit normal | 14.3 | 12.7 | 11.9 |
| | Benefit 10% down | 12.9 | 11.4 | 10.7 |
| | Benefit 20% down | 11.5 | 10.1 | 9.5 |

*Source: JICA Survey Team*

As shown in the above table, it was confirmed that SPPIDRIP would be economically viable with an EIRR of 14.3%. Besides, EIRR of SPPIDRIP was calculated at 17.7% provided that the released flow from the Stung Tasal dam is supplied to RCHRSP. (*P II-6-2 and II-6-3*)

***Financial Evaluation***

(127) The average planted area of paddy per 1-ha paddy field in the whole SPPIDRIP Area is anticipated to be 0.96 ha under the present/without project condition and 1.25 ha under the with-project condition. Based on such conditions, it is estimated that the annual net return per farm household growing paddy will increase by US$825 from US$418 to US$1,243 on the weighted average base. According to the proposed plan, the required annual O&M cost of secondary and tertiary canal systems are estimated at US$7.2/ha to a maximum extent. Adding an annual charge of management cost for FWUC and FWUG, every beneficiary farmer needs to pay about US$10/ha annually. Compared with the predicted increase in farmer's capacity to pay, this allocated annual O&M cost is affordable to the respective beneficiaries. (*P II-6-3 and II-6-4*)

***Indirect Benefits and Socio-economic Impact***

(128) Indirect benefits and socio-economic impact to be expected from SPPIDRIP are as follows: (i) to generate opportunities for extra cash income by temporary employment opportunities in and around the SPPIDRIP Area of about 1.3 million person-days (unskilled labor) during the four-year construction period, (ii) to enable the farmers to improve nutritionally balanced diet and primary health care conditions of their family members, (iii) to ensure the farmers' children will complete primary schooling, have access to higher education, and participate in the early childhood education program; and (iv) to enable the farmers to buy goods and services as well as luxuries for meeting family needs contributing to rural economy with positive effects. (*P II-6-4*)

## CHAPTER II-7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

(129) Preliminary environmental impact assessment of SPPIDRIP was carried out from the view point of 6 categories which are stipulated in the JICA guidelines for environmental and social considerations (April 2010): (i) permits and explanation, (ii) pollution control, (iii) natural environment, (iv) social environment, (v) others, and (vi) note. As the result of the assessment, no significant impact will be expected if proposed mitigation measures in the Survey are appropriately carried out. The following are summary of conclusions of examination on SPPIDRIP. (*P II-7-3 to II-7-14*)

**Summary of Conclusion of Assessment for SPPIDRIP**

| Sub-project | Summary of Conclusion of Examination |
|---|---|
| (a)RCHRSP | |
| 1) Land use and utilization of local resources | Land acquisition process should be conducted carefully from the design phase. The impact of temporary land acquisition also would be a sensitive issue to local people. Therefore, this matter may have a high risk of social problem for project implementation if proper measures are not carried out. |
| 2) Water usage or water rights and rights of common | Due consideration shall be given to this issue, especially on the current use of river water during the dry season, since approximately 12,000 people are expected to be affected by the rehabilitation works of SMC as reported in the feasibility study on RCHRSP. |
| (b) USISRSP | |
| 1) Land use and utilization of local resources | The process of land acquisition should be carefully and properly conducted from the design phase as USISRSP might affect more than 200 buildings/facilities, such as houses, shops, fences, and canal crossings (small bridges and landfills) on canals. Although the Land Law (2001) provides MOWRAM with legal bases for evicting encroachers without compensation or reimbursement for losses of immovable property in state lands, the JICA guidelines strongly require the recipient countries (i.e., MOWRAM) to give compensation or reimbursement to any affected families/people |
| 2) Misdistribution of benefit and damage/local conflict of interests. | To minimize a feeling of unfairness and the potential for social conflict among community members, MOWRAM shall conduct a series of meetings with all the stakeholders, especially those affected by the sub-project, to facilitate their understanding on the positive and negative impacts of the project. |
| (c) KSBISRSP | |
| 1) Involuntary resettlement | MOWRAM shall prepare an abbreviated RAP or another document similar to a simplified RAP based on the detailed socio-economic survey and stakeholder meetings. |
| (d) MC35RSP | |
| 1) Land use and utilization of local resources | Land acquisition process should be conducted carefully from the design phase even though area to be acquired is small, it might not be small impact to the affected people. Therefore, MOWRAM should explain MC35RSP's benefits and anticipated negative impacts to affected people. |
| (d) SPWRRSP | |
| 1) Local economy such as employment and livelihood | Official land acquisition process is not necessary to SPWRRSP since the entire reservoir area belongs to the government. However, MOWRAM should conduct a detailed socio-economic survey of local people who do farming inside the reservoir and prepare the compensation policy to avoid having critical impact to local farmers, especially vulnerable groups. |
| 2) Land use and utilization of local resources/socially vulnerable groups | MOWRAM should conduct socio-economic survey and inventory surveys to grasp the status of vulnerable groups such as number, income, livelihood, and others. Also, MOWRAM should prepare the compensation policy through these survey results and public consultation meeting among local people. |
| (d) DPISRSP | |
| 1) Flora, fauna, and biodiversity | Construction of new headworks would change downstream river water volume and affect the downstream biodiversity. However, the impact is limited in surrounding area of the headworks because another river is joining together near downstream. |

| | |
|---|---|
| 2) Land use and utilization of local resources/socially vulnerable groups | The land acquisition process should be conducted carefully from the design phase, especially in the residential area. Because some affected people already have been full of doubt and fears regarding RGC projects from their previous experience. MOWRAM must conduct a detailed socio-economic survey to identify all losses from land acquisition and hold public consultation meetings at the earliest possible date. |

*Source: JICA Survey Team*

(130) Main contents of Environmental Management Plan (EMP) for SPPIDRIP are: i) Water pollution, ii) Flora fauna and biodiversity, and iii) Land use and utilization of local resources. Contents of Environmental Monitoring Plan (EMoP) for SPPIDRIP are: i) Resettlement and land acquisition, ii) Water quality, iii) Soil erosion, and iv) Noise, vibration, water quality and waste during construction phase. Especially, resettlement and land acquisition will be a critical issue for SPPIDRIP. MOWRAM are thus requested to timely prepare appropriate abbreviation Resettlement Action Plan for 5 Sub-projects except USISRSP, which are RCHRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. (*P II-7-15 to II-7-17*)

# CHAPTER II-8 PRELIMINARY STUDY ON INFLUENCE OF ROLEANG CHREY COMMAND AREA WITH DAM PLAN

## ***Dam Plans in Basin Area of Prek Thnot River***

(131) There are 6 dam development projects in the upstream basin area of Prek Thnot River. The present situation of these dam development projects is shown below:(*P II-8-1 to II-8-8*)

**Present Situation of 6 Dam Development Projects**

| Dam Name | River Name | Catchment Area | Present Stage | Planned by | Expected Stage |
|---|---|---|---|---|---|
| Stung Tasal | Stung Tasal | 495 $km^2$ | Under construction | WAPCOS | - |
| Stung Sva Srab | Stung Sva Srab | 188 $km^2$ | Proposal | MOWRAM | F/S |
| Stung Khleach | Stung Khleach | 125 $km^2$ | Proposal | MOWRAM | F/S |
| New dam | Stung Aveang | 156 $km^2$ | F/S completed | K-water | D/D and C/W |
| Peam Levear | Stung Aveang | 238 $km^2$ | F/S completed | K-water | D/D and C/W |
| O Tang | Ou Khlong | 54 $km^2$ | F/S completed | K-water | D/D and C/W |

*Note:*
*F/S=Feasibility study, D/D=Detailed design, C/W=Construction works, WAPCOS=Indian Consultant*
*K-water=Korea Water Resources Corporation*
*Source: JICA Survey Team*

## ***Study Cases***

(132) In order to clarify the influence to the Roleang Chrey command area, the following 6 cases are studied: (*P II-8-10*)

| Case | Combination of Proposed Dams |
|---|---|
| Case-0 | Without dam (Present Condition) |
| Case-1 | With Stung Tasal Dam only |
| Case-2 | With Stung Tasal Dam + K-water 3 Dams |
| Case-3 | With Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam |
| Case-4 | With Stung Tasal Dam + K-water 3 Dams + Stung Khleach Dam |
| Case-5 | With Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam + Stung Khleach Dam |

*Source: JICA Survey Team*

## ***Results of Water Balance Study of "With- and Without-" Dam Cases***

(133) The summary of case studies of water balance simulation of “with-/without-” dam scenarios is shown in the following table. (*P II-8-10*)

**Summary of Case Study of Water Balance Simulation of “With/Without” Dam Scenarios**

(Unit of area: ha)

| Case No. | Dangkor Irrigation Area | | | Roleang Chrey-I (80% Zone-I) | | | Roleang Chrey-II (50% Zone-II) | | | RC |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area | Crop Intensity | Depend-ability | Total Area | Crop Intensity | Depend-ability | Total Area | Crop Intensity | Depend-ability | Total Area |
| Case-0 | 300 | 114% | 80% | 5,660 | 114% | 80% | 11,040 | 114% | 57% | 16,700 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Case-1 | 300 | 180% | 90% | 16,000 | 180% | 80% | 700 | 130% | 77% | 16,700 |
| Case-2 | 300 | 180% | 93% | 15,400 | 180% | 80% | 1,300 | 130% | 80% | 16,700 |
| Case-3 | 300 | 180% | 93% | 16,700 | 180% | 80% | 0 | - | - | 16,700 |
| Case-4 | 300 | 180% | 93% | 16,700 | 180% | 80% | 0 | - | - | 16,700 |
| Case-5 | 300 | 180% | 93% | 16,700 | 200% | 80% | 0 | - | - | 16,700 |

| Case No. | Kandal Stung (Grant) | | | Kandal Stung (Extension) | | | Tonle Bati (Priority Area) | | | KSB |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area | Crop Intensity | Depend-ability | Total Area | Crop Intensity | Depend-ability | Total Area | Crop Intensity | Depend-ability | Total Area |
| Case-0 | 1,950 | 174% | 83% | 0 | - | - | 1,600 | 180% | 100% | 3,550 |
| Case-1 | 1,950 | 180% | 97% | 1,800 | 180% | 93% | 4,200 | 180% | 80% | 7,950 |
| Case-2 | 1,950 | 180% | 97% | 1,750 | 180% | 93% | 4,200 | 180% | 80% | 7,900 |
| Case-3 | 1,950 | 180% | 100% | 4,200 | 180% | 93% | 6,000 | 180% | 83% | 12,150 |
| Case-4 | 1,950 | 180% | 100% | 2,940 | 180% | 93% | 6,000 | 180% | 80% | 10,890 |
| Case-5 | 1,950 | 200% | 100% | 4,200 | 200% | 93% | 6,000 | 200% | 80% | 12,150 |

*Source: JICA Survey Team*

For Case-2, this is after implementation of the Stung Tasal Dam and the K-water's 3 Dam Projects case, total irrigable area of the Roleang Chrey Zone-I (80% dependable area) will be able to increase from 5,660 ha (with crop intensity of 114%) to 15,400 ha (with crop intensity of 180%). Also, the Kandal Stung (grant) Area, the crop intensity and the dependability will be increased. The Kandal Stung (extension) Area will be able to irrigate "with dam" condition. The total irrigable area of the Bati Area will be increased from 1,600 ha to 4,200 ha with crop intensity of 180% and dependability of 80%. (*P II-8-10*)

## CHAPTER II-9 CONCLUSION AND RECOMMENDATIONS

### ***Conclusion***

(134) In the Rectangular Strategy-Phase II, RGC emphasized the improvement of agricultural productivity for economic growth as well as accelerating poverty reduction. Also, RGC focuses on water resources and irrigation management to ensure irrigation water for agricultural productivity improvement. SPPIDRIP giving focal point on development of irrigated agriculture is duly conducive to the implementation of this policy. According to the Policy Paper on the Promotion of Paddy Production and Rice Export, paddy production is planned to be increased annually from 2.6% to 6.1% for 2010 to 2015, and it is deemed that annual increasing rate would be 2.6% after 2016. Implementation of SPPIDRIP would quantitatively, to a certain extent, contribute to the implementation of the policy paper. The calculated EIRR was 14.3% for SPPIDRIP. As far as this evaluation result is concerned, it could be said that SPPIDRIP would be economically feasible. Besides, SPPIDRIP would not only contribute to the implementation of super-ordinate policies mentioned above, but also bring about socio-economic benefits such as creation of job opportunities and improvement of farm income. From the above, it is concluded that SPPIDRIP should be urgently implemented for Cambodia. (*P II-9-1*)

### ***Recommendations***

(135) The following items are recommended for the smooth and effective implementation of SPPIDRIP: (i) explanation of SPPIDRIP to National Steering Committee, (ii) timely budget arrangement, (iii) prior establishment of implementation organization, (iv) land acquisition for construction of tertiary canals, (v) careful gate control at Roleang Chrey Regulator, (vi) arrangement toward post evaluation to clarify project effect, (vii) execution of detailed water balance study for Prek Thnot River basin, (viii) establishment of Prek Thnot River Basin

Management Unit in MOWRAM, and (ix) execution of detailed survey for mines and UXOs. (*P II-9-1 to II-9-3*)

# PART III SMALL-SCALE IRRIGATION SYSTEM IMPROVEMENT PROJECT

## CHAPTER III-1 PROJECT INFORMATION

(136) SISIP consisted of 84 sub-projects as of March 2012. The project proposals for these sub-projects were prepared by PDOWRAM under the direction of MOWRAM, assisted by TSC-2 in October 2009. Based on the results of the examination of current progress conditions, it was found that 17 out of the total sub-projects were already rehabilitated or committed. Thus, 67 sub-projects remained in the long list of sub-projects. (*P III-1-1*)

## CHAPTER III-2 PREPARATION OF SHORT LIST

(137) The 67 sub-projects were prioritized using the criteria such as (i) river basin priority, (ii) suitable scale of irrigation area, (iii) effect of the sub-project, (iv) available water resource, (v) farmers' consensus, (vi) risk of land mine, and (vii) land acquisition. After prioritization, 20 sub-projects were in the short list, of which the total irrigation area came to about 19,000 ha. (*P III-2-1and III-2-2)*

## CHAPTER III-3 EXECUTION OF PRELIMINARY FEASIBILITY STUDY

(138) Proceeding to the next step for implementation of the sub-projects in the short list, it is expected that PDOWRAM will carry out the preliminary feasibility study under the direction of MOWRAM for implementation in the future. In order to assist PDOWRAM in the execution of the preliminary feasibility study, a manual was prepared by the JICA Survey Team. The manual briefly and practically mentions the procedure of execution of preliminary feasibility study for small-scale irrigation projects, which reflected the experiences obtained in the course of the preliminary feasibility study for the 3 selected Sub-projects. (*P III-3-1*)

## CHAPTER III-4 RECOMMENDATIONS

(139) For smooth and effective implementation of the small-scale irrigation project, it is recommended that MOWRAM should observe the definition of small-scale irrigation project and carry out the arrangement of budget and staff for the execution of preliminary feasibility study, and to timely update the short list of sub-projects. (*P III-4-1*)

PREPARATORY SURVEY
FOR
IRRIGATION AND DRAINAGE SYSTEM
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

# FINAL REPORT

Table of Contents

## List of Tables

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## Attachments

Abbreviations

**[A]**

| | |
|---|---|
| ADB | Asian Development Bank |
| AFD | Agence Française de Développement |
| AH | Affected Household |
| AMO | Agricultural Marketing Officer |
| AP | Affected People |
| AQIP | Agricultural Quality Improvement Project |
| ASDP | Agricultural Strategic Development Plan |
| ASEAN | Association of South East Asian Nations |
| AusAID | Australian Aid |

**[B]**

| | |
|---|---|
| B/C | Benefit-Cost Ratio |
| B/D | Basic Design |
| B/S | Breeder Seed |

**[C]**

| | |
|---|---|
| CARDI | Cambodian Agricultural Research and Development Institute |
| CAVAC | Cambodian Agricultural Value Chain Program |
| CC | Commune Council |
| CCAM | Central Company of Agricultural Management |
| CDB | Commune Data Base |
| CDC | Council for Development of Cambodia |
| CEDAC | Centre d'Etude de et Dévelopment Agricole Cambodgien |
| Ce/S | Certified Seed |
| CIF | Cost, Insurance and Freight |
| CMAA | Cambodian Mine Action Authority |
| CMAC | Cambodia Mine Action Center |
| Co/S | Commercial Seed |
| C/P | Counter Part |
| CRIC | Chinit Reservoir Irrigation Committee |
| CSF | Commune Sangkat Fund |

**[D]**

| | |
|---|---|
| DAALI | Department of Agronomy and Agricultural Land Improvement |
| DAE | Department of Agriculture Extension |
| DAFF | Department of Agriculture, Forestry and Fisheries |
| DAO | District Agricultural Office |
| DAP | Diammonium Phosphate (Ammonium Phosphate dibasic) |
| D/D | Detailed Design |
| DEIA | Department of Environmental Impact Assessment |
| DP | Development Partner |
| DPISRSP | Daun Pue Irrigation System Rehabilitation Sub-project |
| DRD | Department of Rural Development |
| DRF | Draft Resettlement Framework |

**[E]**

| | |
|---|---|
| EIA | Environmental Impact Assessment |
| EIRR | Economic Internal Rate of Return |
| EMP | Environmental Management Plan |
| EMoP | Environment Monitoring Plan |

| | |
|---|---|
| EMU | Environment Management Unit |
| E/N | Exchange of Notes |
| EU | European Union |

**[F]**

| | |
|---|---|
| FAO | Food and Agriculture Organization of the United Nations |
| F/C | Foreign Currency portion |
| FFS | Farmer Field School |
| FG | Farmers' Group |
| FO | Farmers' Organization |
| FOB | Free on Board |
| F/S | Feasibility Study |
| Fo/S | Foundation Seed |
| FWL | Flood Water Level |
| FWUC | Farmer Water Users Community |
| FWUG | Farmer Water Users Group |

**[G]**

| | |
|---|---|
| G/A | Grant Agreement |
| GDP | Gross Domestic Product |
| GIS | Geographic Information System |
| GOJ | Government of Japan |
| GRM | Grievance Redress Mechanism |

**[H]**

| | |
|---|---|
| H.E. | His Excellency |
| HH | Household |
| HRD | Human Resource Development |
| HWL | High Water Level |
| HYV | High Yielding Variety |

**[I]**

| | |
|---|---|
| IAIMP | Irrigated Agriculture Improvement Model Project |
| ICB | International Competitive Bidding |
| IEE | Initial Environmental Examination |
| IEIA | Initial Environmental Impact Assessment |
| IFAD | International Fund for Agricultural Development |
| IMF | International Monetary Fund |
| IMT | Irrigation Management Transfer |
| IOL | Inventory of Losses |
| IPM | Integrated Pest Management |
| IRC | Inter-Ministerial Resettlement Committee |
| IRS method | Method recommended in Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat) |
| IR variety | Improved early variety |
| ISF | Irrigation Service Fee |
| ISPU | Irrigation Services Program Unit |
| IUCN | International Union for Conservation of Nature and Natural Resources |
| IWRM | Integrated Water Resources Management |

**[J]**

| | |
|---|---|
| JICA | Japan International Cooperation Agency |

**[K]**

| | |
|---|---|
| KOICA | Korea International Cooperation Agency |

| | |
|---|---|
| KSBISRSP | Kandal Stung-Bati Irrigation System Rehabilitation Sub-project |
| K-Water | Korea Water Resources Corporation |

**[L]**

| | |
|---|---|
| L/C | Local Currency portion |
| LCB | Local Competitive Bidding |
| LNMC | Lower North Main Canal |
| LNMCP | Lower North Main Canal Irrigated Agriculture Improvement Project |
| LSMC | Lower South Main Canal |
| LSMCP | Lower South Main Canal Irrigated Agriculture Improvement Project |
| LWL | Low Water Level |

**[M]**

| | |
|---|---|
| MAFF | Ministry of Agriculture, Forestry and Fisheries |
| MC35RSP | Main Canal 35 Rehabilitation Sub-project |
| MCC | Mennonite Central Committee |
| M/D | Minutes of Discussion |
| MDG | Millennium Development Goal |
| MDRI | Multilateral Debt Relief Initiative |
| M&E | Monitoring and Evaluation activities |
| MEF | Ministry of Economy and Finance |
| MIME | Ministry of Mines and Energy |
| MLMUPC | Ministry of Land Management, Urban Planning and Construction |
| M/M | Men-months |
| MOC | Ministry of Commerce |
| MOE | Ministry of Environment |
| MOH | Ministry of Health |
| MOP | Ministry of Planning |
| MOWA | Ministry of Women's Affairs |
| MOWRAM | Ministry of Water Resources and Meteorology |
| MOWRAM-RU | Ministry of Water Resources and Meteorology Resettlement Unit |
| M/P | Master Plan |
| MPWT | Ministry of Public Works and Transport |
| MRD | Ministry of Rural Development |
| MSL | Mean Sea Level |

**[N]**

| | |
|---|---|
| NCDD | National Committee for Democracy Development |
| NDMC | National Disaster Management Committee |
| NGO | Non Government Organization |
| NMC | North Main Canal |
| NPMO | National Project Management Office |
| NPV | Net Present Value |
| NSDP | National Strategic Development Plan |
| NWISP | Northwest Irrigation Sector Project |

**[O]**

| | |
|---|---|
| OKAIAIP | Ou Krang Ambel Irrigated Agriculture Improvement Project |
| O&M | Operation and Maintenance |
| OPEC | Organization of the Petroleum Exporting Countries |

**[P]**

| | |
|---|---|
| PAP | Project Affected People |
| PDA | Provincial Department of Agriculture |

| | |
|---|---|
| PDLMUPC | Provincial Department of Land Management, Urban Planning and Construction |
| PDOE | Provincial Department of Environment |
| PDOWRAM | Provincial Department of Water Resources and Meteorology |
| PDP | Small Pond Development Project |
| PGRC | Provincial Grievance Redress Committee |
| PMO | Project Management Office |
| PIF | Provincial Investment Fund |
| PIMD | Participatory Irrigation Management and Development |
| PIU | Project Implementation Unit |
| PMED | Provincial and Municipal Environmental Department |
| PMIMU | Project Management and Implementation Monitoring Unit |
| PMO | Project Management Office |
| PMU | Project Management Unit |
| PO | Project Owner |
| POC | Priority Operation Cost |
| P/Q | Prequalification |
| PPCC | Provincial Project Coordination Committee |
| PRDC | Provincial Rural Development Committee |
| PRA | Participatory Rural Appraisal |
| PRDC | Provincial Rural Development Committee |
| PSC | Project Steering Committee |
| PSU | Project Support Unit |

**[R]**

| | |
|---|---|
| RAP | Resettlement Action Plan |
| RD | Resettlement Department |
| RCHRSP | Roleang Chrey Headworks Rehabilitation Sub-project |
| RCP | Roleang Chrey Headworks and Intake Improvement Project |
| RGC | Royal Government of Cambodia |
| RIP | Rural Road Improvement Program |
| ROW | Right of Way |
| RU | Resettlement Unit |

**[S]**

| | |
|---|---|
| SAW | Strategy for Agriculture and Water |
| SCF | Standard Conversion Factor |
| SDP | Sector Development Program |
| 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. (The Program ended in 2007) |
| SEU | Social and Environmental Unit |
| SISIP | Small-scale Irrigation System Improvement Project |
| SMC | South Main Canal |
| SME | Small and Medium Enterprise |
| SMS | Short Message Service |
| SMSISRIP | Small and Medium Scale Irrigation System Rehabilitation and Improvement Project |
| SPPIDRIP | Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project |
| SPWRRSP | Srass Prambai Water Recession Rehabilitation Sub-project |
| SRI | System of Rice Intensification |

| | |
|---|---|
| SRP | Small Reservoir Rehabilitation Plan |
| SWRF | Shadow wage rate factor |

**[T]**

| | |
|---|---|
| the Project | Irrigation and Drainage System Rehabilitation and Improvement Project |
| the Survey | Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project |
| TOT | Training-of-Trainers |
| TSAU | Technical Supervision and Assistance Unit |
| TSC | Technical Service Center |
| TSLRDP | Tonle Sap Lowlands Rural Development Project |
| TWGAW | Technical Working Group on Agriculture and Water |

**[U]**

| | |
|---|---|
| UNDP | United Nations Development Programme |
| UNMC | Upper North Main Canal |
| UNMCP | Upper North Main Canal Irrigated Agriculture Improvement Project |
| USISRSP | Upper Slakou Irrigation System Rehabilitation Sub-project |
| USMC | Upper South Main Canal |
| USMCP | Upper South Main Canal Irrigated Agriculture Improvement Project |
| USP | Upper Slakou River Irrigation Reconstruction Plan |
| UXO | Unexploded Ordnance |

**[V]**

| | |
|---|---|
| VAEW | Village Agricultural Extension Worker |
| VAHW | Village Animal Health Worker |
| VAT | Value Added Tax |
| VDC | Village Development Committee |
| VEW | Village Extension Worker |
| VLAS | Village Livestock Agents |

**[W]**

| | |
|---|---|
| WCC | World Council of Churches |
| WHO | World Health Organization |
| WHP | Water Harvesting Irrigated Agriculture Improvement Project |
| WPPIDCP | Western Phnom Penh Integrated Development Center Project |
| WRMSDP | Water Resource Management Sector Development Program |
| WRPU | Water Resources Program Unit |
| WTSIDRIP | West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project |
| WUG | Water Users Group |

## Measurement Units

**Extent**

$cm^2$ = square centimeter(s) (1.0 cm × 1.0 cm)
$m^2$ = square meter(s) (1.0 m × 1.0 m)
$km^2$ = square-kilometer(s) (1.0 km × 1.0 km)
ha = hectare(s) (10,000 $m^2$)

**Length**

mm = millimeter(s)
cm = centimeter(s) (cm = 10 mm)
m = meter(s) (m = 100 cm)
km = kilometer(s) (km = 1,000 m)

**Power and Energy**

A = ampere
V = volt
W = watt
kWh = kilowatt hour
HP = horse power

**Currency**

US$ 1.0 = JPY 76.8 = 4,084 Riel
(As instructed by JICA for Japanese ODA Appraisal as of November 2011)
US$ = United State dollar(s)
JPY = Japanese yen(s)
R, Riel = Cambodian Riel(s)

**Volume**

$cm^3$ = cubic centimeter(s) (1.0 cm × 1.0 cm × 1.0 cm or 1.0 ml)
$m^3$ = cubic meter(s) (1.0 m × 1.0 m × 1.0 m or 1.0 kl)
lit l = liter (1,000 $cm^3$)
MCM = million cubic meter(s)

**Weight**

g = gram(s)
kg = kilogram(s) (1,000 grams)
ton = metric ton(s) (1,000 kg)

**Others**

ppm = parts per million
°C = degrees Celsius
% = percent

**Time**

sec = second(s)
min = minute(s)
hr = hour(s)

# *PART I*

*GENERAL INFORMATION*

# PART I GENERAL INFORMATION

## CHAPTER I-1 INTRODUCTION

### I-1.1 General

This final report has been prepared in accordance with the Minutes of Discussion (M/D) on Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project (the Survey) between the Japan International Cooperation Agency (JICA) and the Royal Government of Cambodia (RGC) signed on February 25, 2011.This report shows the results of study on scope, implementation organization and plan, project cost and project evaluation of the Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project (SPPIDRIP) consisting of Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP), Upper Slakou Irrigation System Rehabilitation Sub-project (USISRSP), Kandal Stung-Bati Irrigation System Rehabilitation Sub-project (KSBISRSP), Main Canal 35 Rehabilitation Sub-project (MC35RSP), Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) and Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP) which are part of the Irrigation and Drainage System Rehabilitation and Improvement Project (the Project). This report also presents the prioritization of remaining sub-projects of Small-scale Irrigation System Improvement Project (SISIP) and the results of preliminary study on influence of Roleang Chrey command area with dam plan.

### I-1.2 Background of the Project

Cambodia has a territorial area of 181,035 km$^2$, of which 17% is used as agricultural land in 2009[1]. GDP was estimated at US$ 4,047 million in 2010[2]. The agriculture sector in Cambodia is a major component of its economy, contributing to 36% of GDP[3]. On the other hand, about 80% of population of the country dwells in the rural area, where about 90% of people under poverty line, too. From this fact, it is said that the agricultural development in the country plays an important role for the poverty reduction as well as the economic development. In consideration of such situations, RGC gives a high priority to the implementation of agricultural project by considering that the agricultural development is indispensable for attaining at the economic growth and poverty reduction targeted in the National Strategic Development Plan Update 2009-2013.

The main crop in the country is paddy. The paddy field was estimated to be approximately 2,547,000 ha in 2009[4]. Out of this, irrigation water was supplied only for about 773,000 ha (30%) in the rainy season and about 347,000 ha (14%) in the dry season[5]. This implies that the rainfed cultivation is dominant in the country, so that agricultural production is low and unstable. According to the statistic data on yield and production of paddy during 28 years from 1980 to 2007 (Statistical Yearbook of Cambodia 2008), it was deemed that the paddy production from 1980 to 1994 was increased in proportion to expansion of paddy field in area, but it was increased by improving the crop yield after 1995. From this tendency, it can be said that the promotion of irrigation development leading to increase in yield of paddy is a vital subject for agriculture in the country, to increase in paddy production.

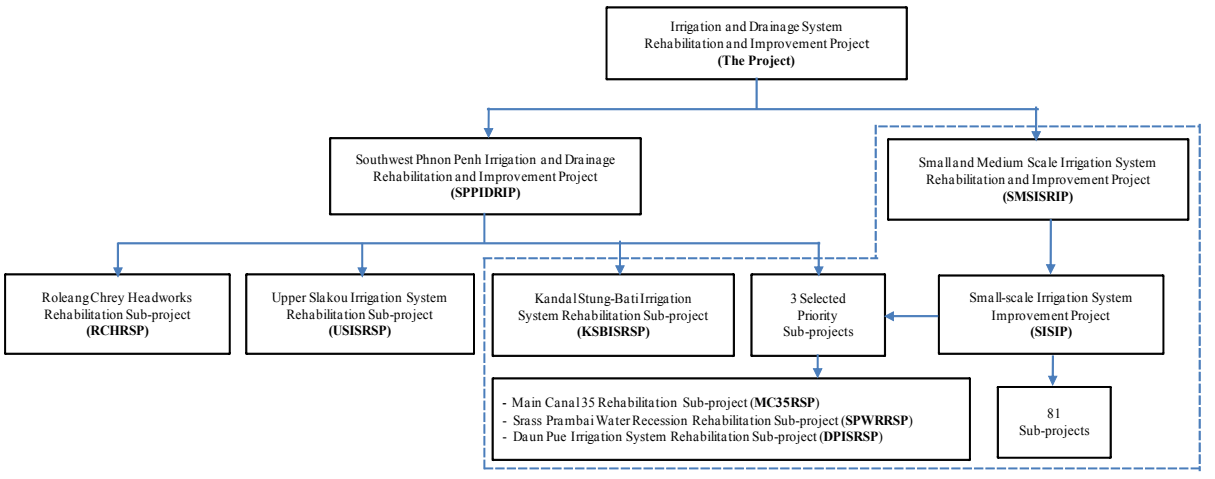
Under such situation in agriculture, RGC requested the Government of Japan (GOJ) to provide the

*1 Cambodia Socio-Economic Survey 2009*
*2 http://data.worldbank.org/*
*3 http://data.worldbank.org/*
*4 Internal data of MOWRAM, 2012*
*5 Internal data of MOWRAM, 2012*

development support to high potential areas of agricultural production. In reply to this request, JICA executed the technical assistances such as "Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh" (1993-1994), "The Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin" (2001-2002), and "The Study on Comprehensive Agricultural Development of Prek Thnot River Basin" (2005-2008). Thereafter, RGC requested GOJ to provide further assistance for the areas where Feasibility Study (F/S) was executed as priority ones in these studies, and their surrounding areas. In answer to this further request and considering the small-scale irrigation project separately requested by RGC, JICA decided to conduct the Survey aiming at preparation of the Project to apply Japanese Yen Loan.

## I-1.3 Components of the Project

Figure I-1.3.1 shows the components of the Project.




*Source: JICA Survey Team*

**Figure I-1.3.1 Components of the Project**

The 3 selected priority Sub-projects mentioned above, namely MC35RSP, SPWRRSP and DPISRSP, are explained how to select them from SISIP in Clause I-6.9.4 in Part-I.

## I-1.4 Objective of the Survey

The objective of the Survey is to scrutinize the project cost for rehabilitation of irrigation and drainage facilities through confirming the suitable project scope and construction method by collecting and analyzing the necessary information for project preparation as repayable aid of loans, and by reviewing the existing F/S or Master Plan (M/P) relevant to the Project and the proposal on SISIP.

## I-1.5 Scope of the Survey

The scope of the Survey is given in the following table.

**Table I-1.5.1 Scope of the Survey**

| Survey Items | Scope of the Survey |
|---|---|
| Confirmation and appropriateness of the Project and preparation of suitable scope of the Project | (a) Confirmation of subjects in agricultural policy and irrigation policy<br>(b) Confirmation of scope of rehabilitation of irrigation facilities as Japanese Yen's loan<br>(c) Review of agricultural information for each survey area<br>(d) Grasping of preliminary conditions on each survey area<br>(e) Confirmation of policies, development plans and laws on the Project<br>(f) Confirmation of importance and appropriateness of the Project<br>(g) Preparation of the suitable scope of project in consideration of the above |

| Survey Items | Scope of the Survey |
|---|---|
| Preparation of basic design and strengthening plan of executing and Operation and Maintenance (O&M) organizations, and estimate of project cost | (a) Review of basic design prepared in the "Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh", "Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin", and "Study on Comprehensive Agricultural Development Prek Thnot River Basin", and proposal on suitable construction method. In particular, as for the Roleang Chrey Regulator, review on the basic and detailed design executed under grant aid. Regarding SISIP, study on project proposal prepared by Ministry of Water Resources and Meteorology (MOWRAM)<br>(b) Study on yearly basis construction plan and construction cost<br>(c) Estimate on total project cost and project cost for Japanese Yen loan<br>(d) Confirmation of setting method of unit prices<br>(e) Preparation of financial arrangement plan<br>(f) Study on consulting services<br>(g) Preparation of procurement packages<br>(h) Confirmation of project implementation organization<br>(i) Study on O&M organization |
| Confirmation of environmental and social considerations | (a) Preparation of checklist based on the "JICA Environmental and Social Consideration Guidelines (April 2010)"<br>(b) Study on Social consideration |
| Confirmation of project effects | (a) Proposal on indicators of operation and effect (setting of standard indicators and target indicators and proposal of methods of data inputs and evaluation)<br>(b) Confirmation of qualitative effects (proposal of suitable method for confirming qualitative effects by project)<br>(c) Estimate of Economic Internal Rate of Return (EIRR) |

*Source: JICA Survey Team*

## I-1.6 Work Schedule of the Survey

The Survey will be carried out in the following schedule:

**Table I-1.6.1 Work Schedule of the Survey**

| Works and Period | Major Activities in the Survey |
|---|---|
| Preparatory Work in Japan<br>(from late May to early June 2011) | - Discussion on scope of works of the Survey with JICA<br>- Preparation of inception report |
| First Field Work<br>(from early June to early August 2011) | - Explanation of inception report to Steering Committee<br>- Confirmation of policies and validity of project implementation<br>- Execution of preparatory work for sub-contract work<br>- Study on scope of RCHRSP and USISRSP<br>- Study on implementation organization<br>- Collection of data and information on Stung Tasal Dam Project<br>- Preparation of progress report (1) |
| Second Field Work<br>(from early August to early October 2011) | - Study on project components of RCHRSP and USISRSP<br>- Plan and design of project components (hardware and software)<br>- Cost estimate and project evaluation<br>- Confirmation of project impact as well as environmental and social consideration |
| First Home Work in Japan<br>(from early October to middle October 2011) | - Preparation of progress report (2) by compiling the results obtained until early October 2011 |
| Third Field Work<br>(from end November 2011 to mid April 2012) | - Study on scope of KSBISRSP, MC35RSP, SPWRRSP and DPISRSP<br>- Study on project components of KSBISRSP, MC35RSP, SPWRRSP and DPISRSP<br>- Plan and design of project components (hardware and software)<br>- Cost estimate and project evaluation<br>- Confirmation of project impact as well as environmental and social consideration<br>- Preparation of Manual Execution of Preliminary Feasibility Study for Small-scale Irrigation Project |
| Second Home Work in Japan<br>(end April 2012) | - Preparation of draft final report showing overall work progress and the results of the Survey |
| Fourth Field Work (middle June 2012) | - Discussion on draft final report with Steering Committee |
| Third Home Work in Japan<br>(from early July to beginning August 2012) | - Preparation of final report reflecting comments from Steering Committee and JICA if any |

*Source: JICA Survey Team*

## I-1.7 Steering Committee Meetings

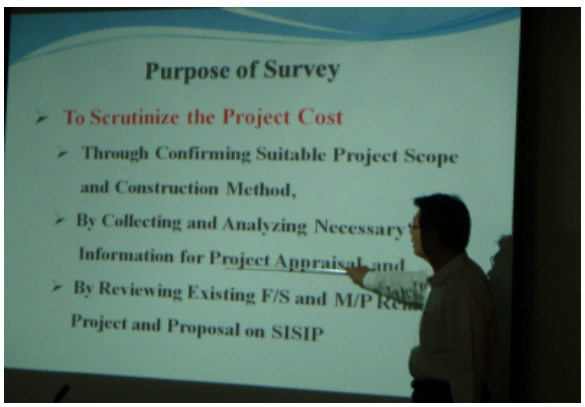
(1) Steering Committee Meeting for Inception Report

The Steering Committee Meeting for the inception report was held at the conference room of MOWRAM on June 29, 2011. The meeting was attended by representatives of MOWRAM, Ministry of Economy and Finance (MEF), Ministry of Agriculture, Forestry and Fisheries (MAFF) and JICA Cambodia Office. After the opening address by H. E. Mr. Pich Veasna, Deputy Director General of Administration Affairs, MOWRAM, the JICA Survey Team briefly explained the contents of Inception Report, highlighting the basic approaches and outputs of the Survey. Thereafter, lots of discussions were made among the participants. Consequently, the Steering Committee accepted the inception report (Attachment-3: Minutes of Meeting on Inception Report for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project).

| | |
|---|---|
|  |  |
| **Opening Address by H. E. Mr. Pich Veasna** | **Presentation by JICA Survey Team** |

(2) Steering Committee Meeting for Progress Report (1)

The Steering Committee Meeting for the progress report (1) was held at the conference room of MOWRAM on August 30, 2011. The participants were representatives of MOWRAM, MEF, MAFF and JICA Cambodia Office. After the opening address by H. E. Mr. Pich Veasna, Deputy Director General of Administration Affairs, MOWRAM, the JICA Survey Team briefly explained the contents of progress report (1), highlighting the results of examination of project scope and study on implementation organization. Thereafter, many discussions were made among the participants. Consequently, the Steering Committee accepted the progress report (1) (Attachment-4: Minutes of Meeting on Progress Report (1) for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project).

| | |
|---|---|
|  |  |
| **Chaired by H. E. Mr. Pich Veasna** | **Presentation by JICA Survey Team** |

(3) Steering Committee Meeting for Progress Report (2)

On December 13, 2011, the Steering Committee Meeting for the progress report (2) was held at the conference room of MOWRAM. The meeting was attended by representatives of MOWRAM, MEF, MAFF and JICA Cambodia Office. Firstly H. E. Mr. Pich Veasna, Deputy Director General of Administration Affairs, MOWRAM, conducted the opening address. Thereafter, the JICA Survey Team briefly explained the contents of progress report (2), highlighting the results of project evaluation as well as the examination of project scope and study on implementation plan. After the brief explanation, discussions were thoroughly made among the participants. Consequently, the Steering Committee accepted the progress report (2) (Attachment-5: Minutes of Meeting on Progress Report (2) for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project).

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| **Participants** | **Presentation by JICA Survey Team** |

(4) Steering Committee Meeting for Draft Final Report

Thirty copies of draft final report were submitted to MOWRAM on May 21, 2012. In order to discuss the contents of the report, the Steering Committee Meeting was held on June 7, 2012 at the conference room of MOWRAM. The meeting was attended by representatives of MOWRAM, MEF, MAFF and JICA. JICA mission from JICA Headquarters also attended the meeting. The meeting was chaired by H.E.Mr.Pich Veasna, Deputy Director General of Administration Affairs, MOWRAM. After opening address by him, the JICA Survey Team briefly explained the contents of the Report. After this, discussion was made among participants. As a result, the report was in principle accepted by the Steering Committee (Attchment-6: Minutes of Meeting on Draft Final Report for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project).

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| **Participants** | **Presentation by JICA Survey Team** |

# CHAPTER I-2 NATIONAL AND SECTORAL POLICIES RELATED TO THE PROJECT

## I-2.1 Rectangular Strategy for Growth, Employment, Equity and Efficiency-Phase II

In succession to the first Rectangular Strategy set out in the First Cabinet Meeting of the Third Legislature of the National Assembly held on July 16, 2004, the Rectangular Strategy for Growth, Employment, Equity and Efficiency-Phase II was proclaimed in the first Cabinet Meeting of the Fourth Legislature of the National Assembly held on September 26, 2008.

The Rectangular Strategy-Phase II maintains the earlier structure and fine-tunes and sharpens the prioritized policies in responding to the current conditions. The Rectangular Strategy-Phase II has 4 components for its implementation, out of which the 4 strategic growth rectangles have 4 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, and (iv) Rectangle 4: Capacity Building and Human Resource Development. These Rectangles cover the following strategic sides:

**Table I-2.1.1 Rectangular Strategy**

| Rectangle | Strategic Sides |
|---|---|
| **Rectangle 1:** Enhancement of the Agriculture Sector | **(1) Improving agricultural productivity and diversification** |
| | (2) Land reform and clearing of mines |
| | (3) Fisheries reform |
| | (4) Forestry reform |
| **Rectangle 2:** Further Rehabilitation and Construction of Physical Infrastructure | (1) Further restoration and construction of transport infrastructure |
| | **(2) Water resources and irrigation system management** |
| | (3) Development of the energy sector |
| | (4) Development of information and communication technology |
| **Rectangle 3:** Private Sector Development and Employment | (1) Strengthening private sector and attracting investments |
| | (2) Creation of jobs and ensuring improved working conditions |
| | (3) Promotion of SMEs |
| | (4) Creation of social safety nets for civil servants, employees and workers |
| **Rectangle 4:** Capacity Building and Human Resource Development | (1) Strengthening quality of education |
| | (2) Enhancing health services |
| | (3) Implementation of gender equity |
| | (4) Implementation of national 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-Phase II*

In Side 1: Improving Agricultural Productivity and Diversification, of the Rectangle 1, it is reported that Cambodia has already achieved 2.5 tons/ha of rice yield during the period of 2005 to 2007, due to increased investments in irrigation network, improvement in water management, increase in credit made available by commercial banks and microfinance institutions, and increasing use of better farming practice. RGC still continues to place priority on improving agricultural productivity and diversification. RGC will also continue to pay further attention to increased production, employment, and rural income, and ensure food security as well as to increase export of agricultural products. This will be achieved through an integrated approach including increased proper use of improved agricultural inputs, agricultural extension, research and development, construction and maintenance of rural infrastructures, especially irrigation network. In Side 2: Water Resources and Irrigation System Management, of the Rectangle 2, RGC has rehabilitated existing and constructed more irrigation network and has taken other measures to maximize its full potential in order to solve the water needs

of the agriculture sector. As a result, the capacity of water reservoirs has expanded and the ability to provide water for cultivation has increased. RGC will continue to accord priority to the rehabilitation, construction, maintenance and efficient management of irrigation infrastructure, water reservoir, canals, pipes, drainages, flood, and water pumping stations to increase irrigated areas and boost agricultural production.

### I-2.2 National Strategic Development Plan Update 2009-2013

As mentioned above, RGC proclaimed the Rectangular Strategy-Phase II in the first Cabinet Meeting of the Fourth Legislature of the National Assembly held on September 26, 2008. In this context, the National Strategic Development Plan (NSDP) 2006-2010 needed to be updated. Thus, the National Strategic Development Plan Update (NSDP Update) 2009-2013 has been prepared, mainly to accomplish 2 primary goals; first, to synchronize the time period covered by NSDP Update with the term of the Fourth Legislature of RGC in order to ensure that the actions, programs, and projects of all ministries and agencies are aligned to implement the prioritized policies that are outlined in the Rectangular Strategy-Phase II; second, to ensure that the actions to be laid out by line ministries and agencies to implement these prioritized policies are formulated taking into account the potential impact of the global economic downturn on the country economy.

NSDP Update mentions that although the significant progress has been made in increasing the land area for crops, paddy cultivation area, yield per ha, etc., further challenges are needed especially for (i) increase of productivity in rice and other crops, (ii) increase and improvement of access to extension services, credit and inputs, (iii) increase of irrigation, (iv) ensuring of better benefits for farmers through marketing, (v) improvement of farmers' knowledge in using agricultural inputs, techniques and soil management. As for irrigation system management, NSDP Update suggests a need to strengthen irrigation infrastructure management to (i) select priority locations for rehabilitation and construction within the irrigation infrastructure that have high potential for generating incomes in rural communities, (ii) engage commune councils in managing commune irrigation infrastructure, (iii) take action to encourage water resources management in order to contribute to the maximization of the increase in agricultural production, (iv) increase participation of farmers and farming communities in matters dealing with the use and maintenance of irrigation system, and (v) cost the financial sources for maintenance of irrigation system.

### I-2.3 Strategy for Agriculture and Water Program 2010-2013

The Strategy for Agriculture and Water (SAW) Program 2010-2013 was prepared by Task Management Support Group with financial support from Agence Française de Développement (AFD) and Technical Working Group on Agriculture and Water (TWGAW) in April 2010, to achieve an over-arching goal: "to contribute to poverty reduction, food security and economic growth through enhancing agricultural productivity and diversification and improving water resources development and management". To achieve this goal, the formulated programs are (i) Program-1: Institutional capacity building and management support programs for agriculture and water, (ii) Program-2: Food security support programs, (iii) Programe-3: Agriculture and agri-business (value chain) support programs, (iv) Water resources, irrigation management and land programs, and (v) Agricultural and water resource research, education and extension programs.

SAW is a rolling medium to long term program to guide the implementation of individual projects and

actions aimed at improving food security and economic growth through (i) enhancing agricultural productivity and diversification and (ii) improving water resources development and management. SAW comprises 24 components arranged over 6 strategic pillars; (i) Policy and Regulations, (ii) Institutional Capacity Building and Human Resources Development, (iii) Research and Education, (iv) Food Security, (v) Water Resource Management and Agricultural Land Management, and (vi) Agricultural Business and Marketing.

The achievement of the SAW goal will be realized by the following quantifiable indicators which will be attained over 4 years from 2010 to 2013:

- Agriculture output increased by 20% (say estimated increase of about 1.5 million ton for rice[1])
- Beneficiary income increased by 20% (say estimated increase of about US$ 30/month/household in rural area[2])
- Employment in agri-business and agro-industrial sector increased by 20%
- Area planted to cash crops increased by 20%
- Value of agricultural exports increased by 30%
- Value of formal bank loans for capital investment in agriculture increased by 25%
- Volume of imported processed agri-foods decreased by 20%
- Number of agri-business SME's increased by 10%
- The area of cropping land with access to irrigation service increased by 100,000 ha
- The incidence of drought or flood affected farmland reduced by 20%

In order to achieve the SAW goal mentioned above, the required budget is estimated at US$ 501.295 million. The goal closely related to the Project is that "agriculture output increased by 20%", "beneficiary income increased by 20%", and "the area of cropping land with access to irrigate service is increased by 100,000 ha".

### I-2.4 Agricultural Strategic Development Plan 2009-2013

The Agricultural Strategic Development Plan (ASDP) 2009-2013 has been prepared based on the Rectangular Strategy-Phase II and NSDP Update 2009-2013. ASDP 2009-2013 defined its long term vision which is to "ensure enough and safe food availability for all people, reduce poverty, increase GDP per capita and sustainable natural resource management and conservation". To achieve the long term vision, MAFF decided the major sectoral goals to contribute the national economic development and accelerate the poverty reduction through enhancement of agricultural productivity and diversification and commercialization with sound environmental protection and considered also food safety. To achieve this sectoral goals, MAFF defined its specific policy goals for the development of agriculture sector, such as (i) Policy Goal-1: Food security, productivity and diversification, (ii) Policy Goal-2: Market access for agricultural products, (iii) Policy Goal-3: Improving institutional capacity and legislative framework, and (iv) Policy Goal-4: Forestry reform. And then, the 5 priority programs which are parts of the Public Financial Reform Program of RGC, are formulated to achieve these specific goals. These priority programs are (i) Program-1: Enhancement of agricultural productivity and diversification, (ii) Program-2: Increase of market access for agricultural products, (iii) Program-3: Strengthening of institutional, legislative framework and human resource development (HRD), (iv) Program-4: Sustainable fisheries resources management and (v) Program-5:

[1] *Annual Report for Agriculture Forestry and Fisheries, 2010-2011, MAFF See Table AC-1.1.1.1*
[2] *Cambodia Socio-Economic Survey 2009, Table 9.1b*

Sustainable forestry resource management. Out of these 5 priority programs, the strategic approach which is closely related to the Project is that "more focuses should put on the strengthening and expanding the Agricultural Extension Services by increasing technical capacity to the extension staff at grass-root level (especially district agriculture offices and commune agricultural centers) and transferring the know-how to the specific target groups, farmers/members of agricultural cooperatives". The services will include the village agricultural extension workers (VAEWs) and more efforts will be provided to transform the existing village animal health workers (VAHWs) to be as VAEWs.

### I-2.5 Action Plan on Water Resources and Meteorology Management and Development 2009-2013

MOWRAM prepared and issued the Action Plan on Water Resources and Meteorology Management and Development based on the Rectangular Strategy-Phase II 2009-2013. The Action Plan aims at clarifying the actions to be taken during 5 years from 2009 to 2013 in the irrigation sector, which are worked out based on the results of review on the lessons learnt and the achievement in the past 5 years from 2004 to 2008, to conduce to the stabilization and increase of food production in the country. The primary matters mentioned in the Action Plan are (i) the achievement in water resources and meteorology implemented in 5 years from 2004 to 2008, (ii) the strategy and the action plan for implementing water resources and meteorology in the subsequent 5 years from 2009 to 2013, (iii) the list of on-going and future priority projects.

Based on the achievement in the past 5 years, the strategy for the Action Plan elaborated by MOWRAM for 2009 to 2013 is to "effectively manage and develop water resources with fairness, and sustainability to ensure the eco-system to reduce the dangers caused by natural disasters: flood, drought on daily living and public property".

In the Action Plan, the required budget for its implementation is estimated at US$ 735 million consisting of US$ 99 million for RGC and US$ 636 million for the foreign aid and development partners. Annual budget required is as shown in the following table:

**Table I-2.5.1 Required Budget for Implementation of Action Plan** (Unit: US$ 1,000)

| Year | Government Budget | Foreign Aids and Development Partners | | Total |
|---|---|---|---|---|
| | | Committed | Not Committed | |
| 2009 | 13,902 | 31,200 | 0 | 45,102 |
| 2010 | 23,942 | 38,700 | 86,885 | 149,527 |
| 2011 | 22,625 | 50,300 | 98,863 | 171,788 |
| 2012 | 17,980 | 46,500 | 114,496 | 178,976 |
| 2013 | 20,791 | 39,500 | 129,730 | 190,201 |
| Total | 99,420 | 206,200 | 429,974 | 735,594 |

*Source: MOWRAM*

### I-2.6 Policy Paper for Promotion of Paddy Production and Rice Export

The Policy Paper on "the Promotion of Paddy Production and Rice Export" was promulgated on August 17, 2010 by Samdech Akka Moha Sena Padei Techo Hun Sen, Prime Minister of RGC. The Policy Paper on "the Promotion of Paddy Production and Rice Export" clearly defined the critical policy measures in 4 main approaches: (i) policy measures relating to enhance rice productivity, (ii) policy measures focusing on paddy collection and processing, (iii) policy measures for export facilitation and (iv) policy measures for marketing.

### I-2.7 Action Plan for Implementing Policy Paper on Promotion of Paddy Production and Rice Export

MAFF has prepared its detail action plan for further implementation to realize the policy measures and actions which defined in this policy paper.

In order to achieve this policy goal and direction, the "Enhancement of the Productivity", especially "Rice Intensification" and "Diversification" are the key successful approaches to be taken into account. These will be focused on the increase of effective supporting services and other necessary interventions to increase rice production through agricultural research and technology transfer, developing best rice seed varieties which are suitable to weather and soil condition and especially defining the important rice seed varieties that market required.

The actions for implementation prepared by MAFF are focused on (i) Measures related to paddy production, (ii) Measures related to paddy rice collection and processing, (iii) Measures related to rice export facilitation system and (iv) Measures related to marketing. In (i) Measures related to paddy production, a stress is put on review on framework for agricultural extension services, expanding of agricultural extension services at commune level, preparation of plan to support the establishment of farmers' organizations (FOs), strengthening of capability of farmers and agricultural cooperatives, and efficient use of agricultural land.

### I-2.8 National Water Resources Policy for the Kingdom of Cambodia

RGC mapped out vision for water to ensure the effective, sustainable, wise and equitable use of water resource as follows:

- Access for all to safe, adequate, and affordable drinking water, hygiene, and appropriate price,
- Provide sufficient water for agriculture, industry and economic activities,
- Tackle and minimize for all from the threat of loss of life and livelihood as the results of water related hazards, and
- Manage the water resource environment with unpolluted .

In order to realize the vision, MOWRAM prepared the National Water Resources Policy for the Kingdom of Cambodia in January 2004, taking it into consideration that population growth and economic development will place rapidly increasing demands on water resources and national environment in future. To ensure the effective and sustainable water resources management, the following fundamental principles were taken up in the National Water Resources Policy:

- Water and water resources management are the competence of RGC.
- Ware resources projects shall be prepared based on the data and information resulting from the water resources inventory, in accordance with the national water resources plan, the economic development plan and the national and regional environmental plans, and by maintaining the balance between water availability and present and foreseeable demands.
- Everyone has the right to use water resources for drinking, washing, bathing and other domestic purposes, the watering of domestic animals and buffaloes, fishing and the irrigation of gardens and orchards, in an amount not exceeding that necessary to satisfy the individual and family needs of user.
- The water resources utilization and development must ensure the effectiveness, sustainability and does not harm to environment.

In addition, the National Water Policy refers to the need of river basin management and development. One of policies related to river basin management and development, is to promote the study and the preparation of short-, medium- and long-term development plans for river basin by taking comprehensive account of modifications to the hydrological system, particular river flows and aquifer levels, to ensure that utilization of water resources at present and in future is sustainable. Furthermore, the policy states that water distribution need to balance the requirements of all relevant sectors, so that water is used to the greatest total national benefit.

In connection with this National Water Policy, Law on Water Resources Management was promulgated in 2010 by introducing basic concept of integrated water resources management (IWRM), aiming to foster the effective and sustainable management of the water resources, to attain socio-economic development and welfare of the people. The Law determines (i) the right and obligations of water users, (ii) the fundamental principles of water resources management, and (iii) the participation of water users associations in the sustainable development of water resources.

# CHAPTER I-3 RELEVANT ORGANIZATIONS

## I-3.1 Ministry of Water Resources and Meteorology

(1) History and Organization Structure

MOWRAM was independently of MAFF in 1999 under the Sub-degree 58 with the mission of development and management of water resources of the country in an effective, equitable and sustainable manner by integration of river basin water management, pro-poor management of water resources, water management facilities, water-related hazards and land resources. Figure I-3.1.1 shows the organization structure of MOWRAM as of June 2011. MOWRAM is composed of 7 technical departments, 3 administrative departments, Technical Service Center for Irrigation and Meteorology (TSC) and 24 Provincial Departments of Water Resources and Meteorology (PDOWRAMs). There are 5 categories in staff qualification; (i) engineer, (ii) technician, (iii) vocational staff, (iv) qualified staff and (v) non-qualified staff. Total number of staff is 666 at central level and 623 at provincial level as of March 2011.

**Table I-3.1.1 Number of Categorized Staff in MOWRAM**

| Level | Engineer | Technician | Vocational | Qualified | Non-qualified | Total |
|---|---|---|---|---|---|---|
| Central | 330 | 160 | 29 | 11 | 136 | 666 |
| Provincial | 97 | 120 | 69 | 23 | 314 | 623 |

*Source: Government Officer Statistic, MOWRAM March 31, 2011*

(2) Duties and Responsibilities

The duties and responsibilities imposed on MOWRAM are quoted from MOWRAM's guide paper:

- Identify policy and strategy development of water resources, to business development, maintenance and preservation in accordance with the RGC's policies.
- Study and research potential water resources including surface water, ground water and weather, to confirm technical field fitting to national frame work.
- Develop the short, medium and long term plan for business development and preservation on water resources and meteorology to serve national economic for alternative livelihood of urban and rural people.
- Manage and control all business making on water resources directly and indirectly, and minimize the disaster.
- Develop the regulation, legislation and other documents to ensure the management and monitoring on the implementation of water resources.
- Collect and document information on meteorology and hydrology, and use them to serve national and international related sectors for national benefits.
- If necessary, provide support and technical advice to stakeholders such as private sector, NGOs, community and people to appropriately correct/better balance on water resources business making.
- Widen and introduce more model technology in order to better train and propagate widely it.
- Participate in executing all works related to Mekong River Basin in accordance with duties and responsibilities of MOWRAM.
- Strengthen and promote national and international cooperation on water resources and meteorology.

(3) Budget and Expenditures of MOWRAM

The annual budgets and actual expenditures of MOWRAM are shown in Table I-3.1.2.

**Table I-3.1.2 Summary of Budget and Expenditures of MOWRAM** (Unit: million Riel)

| Item | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Budget | 13,210 | 14,327 | 18,756 | 90,366* | 149,894* | 141,356 |
| (US$ 1,000)** | 3,235 | 3,508 | 4,593 | 22,127 | 36,703 | 34,612 |
| Actual Expenditure | 12,392 | 15,650 | 17,268 | 88,316* | 146,090 | Not available |
| (US$ 1,000)** | 3,034 | 3,832 | 4,228 | 21,625 | 35,771 | Not available |

*Source: Department of Finance, MOWRAM*

**: including investment budget for irrigation system (70million Riel in 2010 and 90 million Riel in 2011)*

***: US$ 1=4,084Riel*

As can be seen in the above table, the budget even excluding investment budget for irrigation system has been increased with considerable high rate.

## I-3.2 Ministry of Agriculture, Forestry and Fisheries

(1) Organization Structure

The organization structure of MAFF is shown in Figure I-3.2.1. MAFF has a mission to support the economic growth of Cambodia by providing high quality services which result in a secure safe food supply, increased agricultural output and add value on a sustainable and cost effective basis to agricultural, fishery and forestry based sectors. MAFF consists of 19 departments, the fisheries administration, the forestry administration, the national agricultural laboratory, the agricultural information and documentation center, the financial control unit, the public institutions and 24 provincial and municipal departments of agriculture and forestry. The number of central staff is reported to be 4,269 as of June 2011.

Among the many departments of MAFF, the Department of Agriculture Extension supervises the Provincial Department of Agriculture (PDA) in execution of the agricultural support services particularly in the dissemination of farming technology at the field level through extension workers belonging to the District Agriculture Office (DAO).

(2) Functions

According to the mission statement, MAFF has the following functions:

- Organize and operate the development policies in agriculture sectors which aim at the improvement of the living standards of the population;
- Participate in the establishment of pricing policies and search out the markets for agricultural products;
- Direct and establish the agriculture sector development plans;
- Coordinate, monitor and evaluate the implementation of policies and activities for development of agriculture;
- Monitor and manage natural resources of agriculture sector and facilitate activities of exploitation on these resources to meet domestic demands with respect to the stability of ecology system;
- Enact legislation and regulations on the management, maintain and protect the natural resources of agriculture sector and monitor on implementation;
- Evaluate and develop human resources for participation in the development of agriculture with promoting the technical skills and knowledge and make an effective use of these human resources;
- Necessarily support and advise the farmers on technologies to improve production and increase productivity;

- Set up principles and monitor on implementation to enhance and improve the process of concerned professional organizations, associations involved in agriculture sector;
- Conduct research, study and extension on agricultural technology, science and economics for all sub-sectors;
- Advise on agricultural land development, soil quality improvement and appropriate utilization of land, seed, breeds, fertilizer, chemicals, to the conditions of geographic manner and regional climate and this leads to ensure the increasing high yield and maintain the balancing of natural environment;
- Coordinate and cooperate with internal and external organizations, non-governmental organizations for the development of agriculture sector;
- Participate in enhancing and acceleration of investment, export of food and agricultural products;
- Participate and implement the activities related to Mekong Basin in accordance with the roles and functions of the Ministry;
- Participate in the establishment of pricing policies and search out the markets for agricultural products;
- Collect revenue to the national budget or collaborate with MEF for revenue collection; and
- Implement other activities to be given by RGC;

(3) Budget and Expenditures of Ministry of Agriculture, Forestry and Fisheries

The annual budgets and actual expenditures of MAFF are shown in Table I-3.2.1.

**Table I-3.2.1 Summary of Budget and Expenditures of MAFF** (Unit: million Riel)

| Item | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Budget | 39,274 | 42,873 | 48,758 | 54,779 | 64,048 | 87,695 |
| (US$ 1,000)* | 9,617 | 10,498 | 11,939 | 13,413 | 15,683 | 21,473 |
| Actual Expenditure | 36,896 | 49,132 | 52,257 | 54,525 | 57,878 | Not available |
| (US$ 1,000)* | 9,034 | 12,030 | 12,796 | 13,351 | 14,172 | Not available |

*Source: Department of Finance, MAFF*
**: US$ 1 =4,084 Riel*

The growth rate of annual budgets ranges from 9.2% to 16.9%, and has been increased year by year.

### I-3.3 Provincial Department of Water Resources and Meteorology

PDOWRAM is placed at each province as sub-ordinate agency of MOWRAM. PDOWRAM generally consists of 5 offices such as (i) administration and personnel office, (ii) irrigated agriculture office, (iii) water resources management and conservation office, (iv) water supply and sanitation office and (v) hydro-meteorological office. Each PDOWRAM subordinates a district office, of which the total number is 183 in the whole country.

### I-3.4 Provincial Department of Agriculture

PDA is established at each province as sub-ordinate agency of MAFF. PDA generally has several technical offices such as (i) agricutural extension, (ii) veterinary & animal production, (iii) agricultural machinery, (iv) agricultural legislation, (v) agro-industry and (vi) agronomy & land improvement and administrative offices, subordinating some DAO. The total numbers of PDA staff including DAO are reported to be 2,834 as of June 2011, and that of each PDA including DAO range from 100 to 300. It is also noted that the number of staff of 4 PDAs which are Kampong Spue, Takeo, Kandal and Kampong Chhnang are 248, 192, 170 and 107 respectibvely as of June 2011.

Extension workers are assigned to DAO directly contrlloed by deputy director of PDA. Agricultural

support services are provided through DAO, of which the major activity is demonstration of improved rice farming practice. Agricultural extension is sometimes carried out in collaboration with NGOs such as World Vision, Centre d'Etude de et Développement Agricole Cambodgien (CEDAC) and New Human.

### I-3.5 Farmer Water Users Community

In 1999, RGC issued Circular No.1 on Implementation Policy for Sustainable Irrigation Systems. The Circular promulgates the following 6 principles of reform:

- Farmer water users community (FWUC) will be a formal legal entity recognized by the government and civil society.
- Irrigation system development will be done only at the request of FWUC, and FWUC will participate in all aspects of scheme development.
- Water users will be obligated to pay for the cost of routine O&M and develop a fund to pay for emergency repairs.
- Irrigation systems will be maintained and improved over time, in partnership between FWUC and the government.
- Water delivery will be arranged by FWUC in an equitable and reliable manner.
- MOWRAM will be responsible to provide technical and managerial support, monitoring and evaluation and other supports as needed.

In June 2000, MOWRAM issued Prakas 306, which promotes the Policy for Sustainability of O&M of Irrigation Systems, elaborating the new Participatory Irrigation Management and Development (PIMD) policy to be implemented by MOWRAM. The Policy describes the structure and functions of FWUC and lower-level farmer water users group (FWUG), the basis for calculating the irrigation service fee (ISF) and the responsibility of the government to provide training and extension, monitoring and evaluation, environmental assessment and agency human resource development. MOWRAM also issued a brief document that explains 8 steps for organizing and establishing FWUC. MOWRAM is currently finalizing a sub-degree on establishing FWUC. This FWUC sub-degree follows deeply Circular No.1 and Prakas 306, especially for the organization and structure, FWUC Statute, establishment procedures and also roles and responsibilities, and financial support from the government. The main objective of the sub-degree is to provide FWUC with legal status. PIMD specifies the essential rights and obligations of FWUC as follows:

**Table I-3.5.1 Rights and Obligations of FWUC**

| Item | Description |
|---|---|
| Rights | - Clear water use rights that are consistent with government regulations, FWUC interests and capacity of local water control structures<br>- Protection of FWUC against irrigation land use conversion within FWUC area<br>- Right to federate up to the main scheme level<br>- Authority to require water users to become members of FWUC or pay for water service<br>- Right to make and enforce rules<br>- Right to choose Irrigation Service Providers and hire or release O&M staff<br>- Right to make and implement the Irrigation Service Plan and budget<br>- Right to set, collect and use funds from an ISF<br>- Right to make legal contracts and own property<br>- Right to determine cropping patterns by consensus among water users |
| Obligations | - Obligation to comply with government policy and regulations for the water and agriculture sectors<br>- Obligation to use and preserve irrigation system infrastructure consistent with transfer agreements<br>- Obligation to function according to agreed principles of democratic participation, transparency, honesty and interest in the public welfare<br>- Obligation to protect the environment |

*Source: Module 2 on Participatory Irrigation Management and Development: Policy, Legal and Institutional Framework*

According to MOWRAM, there are some 350 FWUCs established nationwide, as of 2011, of which total of 150 are registered to MOWRAM[1]. Depending upon the source of project support, some FWUCs are registered at provincial level only. In general, FWUC is composed of one chief, 2 vice chiefs, one accountant and all leaders of FWUGs. FWUG consists of one group leader and one assistant.

[1] *Information from MOWRAM*

# CHAPTER I-4 DONORS' ASSISTANCE

## I-4.1 Irrigation Projects Completed in 10-year Period from 2001 to 2010

The irrigation projects completed in the 10-year period from 2001 to 2010 are listed as follows:

**Table I-4.1.1 List of Irrigation Projects Completed in 10 years by 2010**

| Project | Donor | Completed Year | Amount (US$ Million) | Province |
|---|---|---|---|---|
| Colmatage Irrigation Rehabilitation Project (2,122 ha) | Japan | 2002 | 8.7 | Kandal |
| Stung Chinit Irrigation and Rural Infrastructure Project (3,000 ha) | ADB+AFD | 2008 | 25.6 | Kampong Thom |
| Integrated Development in Battambang Province (1,950 ha) | FAO | 2008 | 3.3 | Battambang |
| Batheay Irrigation Construction Project (8,000 ha) | Korea | 2010 | 4.3 | Kampong Cham |
| Tamouk Reservoir Dike Rehabilitation Project (4,051 ha) | Korea | 2004 | 1.4 | Kandal |
| Bassac Dam Rehabilitation Project in Battambang Province (20,000 ha) | Japan | 2006 | 2.0 | Battambang |
| Rehabilitation of the Kandal Stung Irrigation System in the lower Prek Thnot River Basin | Japan | 2007 | 16.3 | Kandal |
| Grant Assistance for Grass-Roots Human Security Project (11 Sub-projects, 11 River basin, 12,200 ha) | Japan | 2005-2009 | | |
| Study on Comprehensive Agricultural Development of Prek Thnot River Basin | Japan | 2008 | 4.0 | Kampong Speu |
| River Basin and Water Use Study for Northwest Irrigation Sector Project (NWISP) | ADB+AFD | 2006 | 30.9 | Pursat, Battambang, Banteay Measchey, Siem Reap |
| M/P on Water Resources Development in Cambodia | Korea | 2008 | 1.5 | Whole Country |
| The Basin-Wide Basic Irrigation and Drainage M/P Study | Japan | 2009 | 4.0 | Kampong Chang, Pursat, Battambang |
| Technical Cooperation for TSC-Phase 2 | Japan | 2009 | 7.2 | Kandal, Pursat, Takeo |

*Source: Irrigation Development in Cambodia, Status as of March 2011*

Out of the completed projects mentioned above, a brief outline of some projects is given as follows:

(1) Kandal Stung Irrigation Development Project

The Kandal Stung Irrigation Development Project (1,950 ha) was taken up as priority project in the M/P Study on the Integrated Agricultural and Rural Development Project in the suburbs of Phnom Penn which was executed from 1994 to 1995, aiming to establish a model area as a technical and implementing base which would be used as a core to demonstrate the effects of the integrated agricultural and rural development and to be a base for future expansion of the whole area.

On this basis, GOJ decided to implement the Kandal Stung Irrigation System under the Japan's Grant Assistance in reply to the request of RGC. The Basic Design (B/D) Study for the Kandal Stung Irrigation System was carried out from 2002 to 2004, and then its construction/rehabilitation was set out in 2006 and completed in 2007. The major facilities constructed/rehabilitated are as follows:

- Construction of new headworks : 1 no.
- Rehabilitation of regulators and 7$^{th}$ January dam : 2 nos.
- Demolish of existing regulator : 1 no.
- Construction of new intake : 1 no.
- Rehabilitation of main canal and related structures : 5.3 km
- Rehabilitation of O&M road : 9.3 km

After completion of the system mentioned above, there have found some damages on the concrete block lining provided on the side slope of main canal, which occur due to dispersive and swelling soils. In particular, the serious damages by dispersive soil are observed place to place in the canals constructed in the country. In this Survey, therefore, such phenomenon due to soil characteristics will be taken into consideration in the planning and designing of canal facilities of the project as lessons learnt from this implementation.

(2) Technical Cooperation for Technical Service Center for Irrigation and Meteorology Phase-2

TSC was established as an ad hoc organization in January 2001, with a mission to make capacity building of staff of MOWRAM, PDOWRAM and farmers on proper water management and operation

and maintenance of irrigation systems. TSC plays roles of (i) preparation of capacity building program, (ii) implementation of technical training program, (iii) preparation of technical manuals for training, (iv) establishment of information management system, (v) study and research on irrigation management, and (vi) assistance in engineers/farmers on technical matters. GOJ /JICA has continued to provide technical cooperation for TSC from its start in 2001. TSC Phase-2 (TSC-2) was carried out from 2006 to 2009. During this period, the executed activities are (i) implementation of 38 training courses, (ii) preparation of 9 technical manuals, (iii) provision of on-site training course and technical assistance to 3 Provincial C/Ps and farmers groups for water management, (iv) preparation of B/D documents for 3 irrigation system rehabilitation projects, and (v) technical information management (establishment of technical library). These activities were conducted at Model Site: 260 ha at Kandal Stung in Kandal Province, Pilot Site A: 1,700 ha at Kandal in Kandal Province, Pilot Site B: 100 ha at Thlea Maom in Pursat Province, and Pilot Site C: 300 ha at Thomney in Takeo Province. TSC-2 was completed in July 2009. In connection with the completion of TSC-2, the joint assessment by MOWRAM and the JICA Evaluation Study Team was carried out from the viewpoints of relevance, effectiveness, efficiency, impact and sustainability. The results are summarized as follows:

**Table I-4.1.2 Results of Joint Assessment by MOWRAM and JICA Evaluation Team**

| No. | Indicator | Result |
|---|---|---|
| (a) | Relevance | - The project is consistent with the policies of Cambodian Government such as the Rectangular Strategy and the National Strategic Development Plan (2006-2010) stressing the need of irrigation development to enhance agricultural productivity.<br>- Consistency with the ODA policies of GOJ was confirmed as Japanese ODA policy put priority on sustainable economic growth and social security for the support to Cambodia, and agriculture and rural development as well as improvement of agriculture productivity is considered as vital cooperation strategy in the assistance program. |
| (b) | Effectiveness | - Both achievement of the curriculum target and satisfaction are judged to be high.<br>- Improvement of technical capability of MOWRAM and PDOWRAM staffs as well as training management of TSC has been achieved through the Project. |
| (c) | Efficiency | - Appropriateness of input from both Japanese and Cambodian side is judged sufficient in timing, duration and quantity. |
| (d) | Impact | - Not only the enhancement of capability of MOWRAM and PDOWRAM staffs, but also positive impacts have been observed such as increase of cropping intensity at the pilot sites. |
| (e) | Sustainability | - Sustainability aspect is judged to be fair in general.<br>- Allocation of budget toward TSC after the project would be smaller, so that organizational sustainability of TSC system would be jeopardized.<br>- Regular technical update and upgrade needs to be carried out through further assistance.<br>- Technical capability needs to be expanded from tertiary level facilities to river basin and main facilities. |

*Source: Project Formation for West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project*

## I-4.2 On-going Irrigation Projects

The list of on-going irrigation projects as of March 2011 is given as follows:

**Table I-4.2.1 List of On-going Irrigation Projects**

| Project | External Support | | Implementation | | Province | Project Cost (US$ 1,000) | Fund Resource (US$ 1,000) | | Status as of March 15, 2011 |
|---|---|---|---|---|---|---|---|---|---|
| | Donor | Fund Type | From | To | | | External | Local | |
| North West Irrigation Sector Project (NWISP) | ADB+ AFD | Loan+ Grant | 2005 | 2012 | Pursat, Battambang, Banteay Measchey, Siem Reap | 30,870 | 21,740 | 9,130 | On-going |
| Eastern Rural Irrigation Development Project | IMF | MDRI | 2007 | 2013 | Kampong Cham, Prey Veng, Svay Rieng, Kratie, Stung Treng, Rotanak Kiri, Mondul Kiri | 33,380 | 32,763 | 617 | On-going |
| Krang Ponley Multipurpose Water Resources Project | Korea | Loan | 2008 | 2012 | Kampong Speu | 29,505 | 26,098 | 3,407 | On-going |
| Tonle Sap Lowlands Rural Development Project (TSLRDP) | ADB | Loan+ Grant | 2008 | 2015 | Kampong Chhnang, Pursat, Kampong Thom | 24,000 | 20,000 | 4,000 | On-going |
| Water Resources Management Sector Development Program (WRMSDP) | ADB+ OPEC +AFD | Loan+ Grant | 2011 | 2018 | Kampong Thom, Siem Reap, Banteay Meanchey | 31,900 | 24,800 | 7,100 | On-going |

| Project | External Support | | Implementation | | Province | Project Cost (US$ 1,000) | Fund Resource (US$ 1,000) | | Status as of March 15, 2011 |
|---|---|---|---|---|---|---|---|---|---|
| | Donor | Fund Type | From | To | | | External | Local | |
| Kampong Trabek River Flood Control Project | China | Loan | 2010 | 2014 | Prey Veng | 31,010 | 31,010 | 0 | On-going |
| Stung Sreng Irrigation Development Project | China | Loan | 2011 | 2015 | Preah Vihear, Kampong Thom | 65,000 | 54,780 | 10,220 | Loan Processing |
| Mongkol Borey Dam Development Project | Korea | Loan | 2009 | 2013 | Battambang | 24,301 | 18,700 | 5,601 | On-going |
| Kong Hort Irrigation Development Project | China | Loan | 2010 | 2014 | Battambang | 61,000 | 49,900 | 11,100 | On-going |
| Dauntri Multipurpose Dam Development Project | Korea | Loan | 2009 | 2013 | Battambang | 45,958 | 40,283 | 5,675 | Loan Processing |
| Stung Pursat Dam No.3 and No.5 Development Project | China | Loan | 2011 | 2014 | Pursat | 80,000 | 66,460 | 13,540 | On-going |
| Stung Tasal Storage Reservoir Development Project | India | Loan | 2011 | 2013 | Kampong Speu | 19,000 | 19,000 | 0 | On-going |
| Surrounding Bayong Kouv Reservoir Improvement Project | Korea | Grant | 2010 | 2013 | Takeo | 3,012 | 3,012 | 0 | Committed |
| Prek Stung Kev Water Resources Development Project | China | Loan | 2011 | 2015 | Kampot | 52,000 | 42,620 | 9,380 | On-going |
| Technical Cooperation for TSC-Phase 3 (TSC-3) | Japan | Grant | 2009 | 2014 | Battambang, Pursat, Kampong Chhnang | 4,625 (¥370 million) | 4,625 | 0 | On-going |

*Source: Irrigation Development in Cambodia, Status as of March 2011*

Out of the on-going irrigation projects mentioned above, a brief outline of some projects is given as follows:

(1) Northwest Irrigation Sector Project

NWISP aims to achieve better use of water resources and promotion of irrigated agriculture through: (i) a comprehensive policy and strategic framework to be applied in the development of water resources, (ii) a better understanding knowledge and application of the integrated water resources management approach in a river basin context, (iii) improvement of water resources management through rehabilitated/upgraded small to medium-scale irrigation schemes and other water control infrastructure, (iv) a strengthened capacity of communities and institutions in planning, implementing, managing and maintain such infrastructure, and (v) improved agricultural support services to the beneficially water users. To meet the aims mentioned above, NWISP has 3 components: (i) institutional strengthening, (ii) irrigation infrastructure development and management, and (iii) support to irrigated agriculture development.

NWISP implemented 11 sub-projects located at 4 provinces; Pursat Province, Battambang Province, Banteay Measchey Province and Siem Reap Province, and have completed the actual physical works by the end of 2011. In the component of "Support to Irrigated Agriculture Development", the project planned the execution of cooperative woks of PDOWRAM and PDA to achieve the project objective. The required finance for PDA was provided by MOWRAM through PDOWRAM. However, this financial flow could not realize the effective agricultural support service due to delay in payment. As the lesson leant from this, it was reported that the financial flow should be made from MOWRAM to PDA directly without any intervention of PDOWRAM.

(2) Tonle Sap Lowlands Rural Development Project

The Tonle Sap Lowlands Rural Development Project (TSLRDP) consists of 3 components. Component 1 is that it will support 40 communes in development and upgrading of rural infrastructure through a combination of community led and executed activities and government agency implemented infrastructure development in the provinces of Kampong Chhnang, Kampong Thom and Pursat in the Tonle Sap Basin. Component 2 is to also assist in the creation of new and improved livelihood opportunities in these communes. Component 3 is to strengthen the institutional capacity of commune, provincial and national organizations.

The outputs expected by TSLRDP are (i) Improvement of Rural Infrastructure, (ii) Rural livelihoods Improvement and Employment Options Enhancement, and (iii) Project Management. In the "Improvement of Rural Infrastructure", the further expected outputs are (i) Improvement and Development of Social Infrastructure, (ii) Improvement of Agricultural Water Management

Infrastructure, and (iii) Improvement of Rural Roads. As mentioned in the above, TSLRDP takes the integrated approach of infrastructure development and strengthening of support services to the community development.

(3) Water Resources Management Sector Development Program

The Water Resources Management Sector Development Program (WRMSDP) is proposed as a sector development program (SDP) comprising a program component to address national water resources management and irrigation policy issues in Cambodia, and an investment component to assist MOWRAM to rehabilitate small- to medium-scale irrigation systems and delivery irrigation services within the Tonle Sap Basin. WRMSDP aims to achieve 2 key outcomes: (i) improved management of water resources in Cambodia and (ii) more efficient and sustainable irrigation systems in the proposed project area in 4 river basins such as (i) Stung Sreng, (ii) Stung Staung, (iii) Stung Chikreng and Stung Sen administratively located in Siem Ream Province, Kampong Thom Province and Banteay Meanchey. WRMSDP expects the following outputs and activities:

**Table I-4.2.2 Expected Outputs and Activities under WRMSDP**

| SDP | Expected Outputs | Activities |
|---|---|---|
| Output A | Enhanced Capacity of the Government to Manage Water Resources | - Support the Government's strategy, policy and legal framework for IWRM.<br>- Improve coordination and cooperation framework for IWRM.<br>- Strengthen capacity of MOWRAM to promote IWRM.<br>- Execute human resources capacity development to promote IWRM. |
| Output B | Enhanced Capacity of MOWRAM to Manage and Delivery Irrigation Services | - Support to implement SAW.<br>- Strengthen organizational structures and administrative and technical capacity of MOWRAM, PDOWRAMs and district offices.<br>- Provide adequate budget for O&M of irrigation systems.<br>- Develop human resources capacity to manage, operate and maintain irrigation systems (Government and FWUCs). |
| Output C | Sustainable Rehabilitation of Existing Small- and Medium-scale Irrigation Schemes in the Tonle Sap Basin | - Strengthen provincial and district level administrative capacity.<br>- Rehabilitate and improve irrigation infrastructures.<br>- Enhance technical skills, livelihood opportunities and capacity for FWUCs and farmers within rehabilitated irrigation schemes.<br>- Execute project management. |

*Source: Memorandum of Understanding between the Government of Cambodia and Asian Development Bank for WRMSDP*

WRMSDP will be implemented over 8 years. The 8-year timeframe of the project loan is to provide for a 5-year implementation period for the completion of irrigation system rehabilitation works and a subsequent period of 3 years to allow for consolidation of agricultural benefits and continued support to FWUCs.

(4) Technical Cooperation for Technical Service Center for Irrigation and Meteorology Phase-3

In succession to TSC-2, TSC-3 is under operation with a period from 2009 to 2014. The programs to be implemented in TSC-3 are to (i) strengthen capacity of TSC, (ii) promote donor cooperation on capacity under SAW, (iii) establish comprehensive technical assistance system for twenty four PDOWRAMs, (iv) increase capacity for implementation of training course and technical support by MOWRAM counterparts management, (v) develop farmers facilitation for participation on water management activities, and (vi) develop and promote the PDA and PDOWRAM joint partnership model at field level. The pilot sites are 6 in number, which are located in Battambang, Pursat and Kampong Chhnang Provinces.

## I-4.3 Work Progress on Stung Tasal Storage Reservoir Development Project Assisted by Indian Government

As shown in Table I-4.2.1, it is reported that the Stung Tasal Storage Reservoir Development Project is on-going under the Indian Government loan. The JICA Survey Team collected from MOWRAM the contract agreement which was signed among MOWRAM, WAPCOS Ltd and Angelique International Limited on January 12, 2011. The contract includes Part A: Infrastructure development works (approach road embankment, office & residential buildings with all facilities), Part B: Civil works (diversion works, dam with instrumentation and spillway for irrigation and power intake blocks and other items), and Part C: Hydro-mechanical works (irrigation sluices and power intake). This contract also includes the engineering services consisting of survey, geo-technical investigation, detailed design (D/D), preparation of construction drawings along with D/D calculations and construction material survey, the network design for rain gauge stations in the catchment of the Stung Tasal, and the operational training to engineering officers and staff of MOWRAM of the Project after commission. The time for completion of the entire scope of work is eighteen months from the date which the contract comes into full force and effect (i.e. upon signing of the contract agreement and its approval by MEF, RGC and Exim Bank of India). According to MOWRAM, Angelique International Limited already mobilized the team in site on May 19, 2011 and has started the topographic survey and finalization of land for colony and access road. In addition, MOWRAM reported in his letter dated August 24, 2011 to the Embassy of India that dam site was cleared by Ministry of Environment (MOE) and forest was also cleared along the dam axis.

According to the third quarterly progress report, the following works have been done by end of February 2012:

- Infrastructure development works
  - All columns for foundation have been erected.
  - Compaction of sub-grade has been done.
- Dam works
  - Dam foundation of left and right has been completed up to 95% and 80%, respectively.
  - Spillway excavation gas been completed up to 75%, say 13,000 $m^3$ in volume.
  - Extraction of rock has been done up to 60,000 $m^3$.
  - Sand has been collected up to 150,000 $m^3$.
  - Aggregate has been collected up to 150,000 $m^3$.

## I-4.4 Current Situation on Other Dam Projects Located Upstream of Prek Thnot River

(1) Three Dam Development Plans Prepared by Korea International Cooperation Agency

There are 3 dam development plans prepared by Korea International Cooperation Agency (KOICA), which are located upstream of Prek Thnot River. Out of them, 2 dams, say Peam Levear Dam and O Tang Dam are planned to be rehabilitated, and the remaining is a newly constructed dam. The basin characteristics at respective dam sites are as follows:

**Table I-4.4.1 Basin Characteristics of Three Dams Located Upstream of Prek Thnot River**

| Item | Basin Area ($km^2$) | Longest Flow (m) | Beginning Elevation (m) | End Elevation (m) | Slope | Average Elevation (m) |
|---|---|---|---|---|---|---|
| New Dam | 155.8 | 18,925 | 1,698 | 170 | 0.0807 | 632 |
| Peam Levear | 237.5 | 29,911 | 1,698 | 129 | 0.0525 | 512 |
| O Tang | 53.6 | 14,679 | 744 | 129 | 0.0419 | 208 |

*Source: F/S on Water Resources Development Project for The Prek Thnot River Basin*

F/S was carried out for these dam projects in February 2010. According to the study, these dams will have multipurpose of flood control, power generation and supply of irrigation water. Irrigation water will be supplied to the farm land close the dam sites. Main features of these dams are shown below:

**Table I-4.4.2 Features of Three Dams Located Upstream of Prek Thnot River**

| Item | Dam Type | Effective Storage ($10^6m^3$) | Water Supply for Irrigation ($10^6m^3$/yr) | Flood Control Storage ($10^6m^3$/sec) | Power Generation (kW) |
|---|---|---|---|---|---|
| New Dam | Earth dam | 25.9 | 73 (4,432 ha × 2 times) | 5.3 | 330 |
| Peam Levear | Earth dam | 7.8 | | 2.4 | 70 |
| O Tang | Earth dam | 5.6 | | 2.1 | - |

*Source: F/S on Water Resources Development Project for The Prek Thnot River Basin*

Presently, F/S has been completed for these dam projects. However, there is no definite plan for their implementation so far.

(2) Two Dam Development Plans Requested by MOWRAM to Government of India

MOWRAM planned 2 dam construction projects on the tributaries of Prek Thnot River. These are: (i) Stung Sva Slab Water Resources Development Project and (ii) Stung Khleach Water Resources Development Project. The preliminary features of these dam projects are given below:

**Table I-4.4.3 Preliminary Features of Two Dams Located Upstream of Prek Thnot River**

| Item | Stung Sva Slab Dam | Stung Khleach Dam |
|---|---|---|
| (a) Location | About 40 km upstream of Peam Khley in Srae Ambel and Kampong Speu Seila District, Kos Kong Province | About 45 km upstream of Peam Khley in Ambel District, Kampong Speu Province |
| (b) River Name | Stung Sva Slab River | Stung Khleach River |
| (c) Catchment Area | 660 $km^2$ | 125 $km^2$ |
| (d) Dam Type | Rockfill Dam | Rockfill Dam |
| (e) Length of Dam | 1,000 m | 570 m |
| (f) Height of Dam | 25 m | 40 m |
| (g) Deepest Bed Level | EL. 120 m | EL. 100 m |
| (h) Expected Irrigation Area | 15,000 ha in the rainy season and 5,000 ha in the dry season | 13,000 ha in the rainy season and 3,000 ha in the dry season |
| (i) Construction Cost | US$ 43 million | US$ 34 million |

*Source: MOWRAM*

MOWRAM prepared the proposals for these projects and submitted to MEF in September 2010. Thereafter, RGC requested the financial assistance to the Prime Minister of India when he made the official visit to Cambodia. Now, MOWRAM expects that F/S for these projects will be carried out in 2012, but it is not sure at present.

# CHAPTER I-5 OTHER RELEVANT INFORMATION

## I-5.1 Prices of Agricultural Production

Seasonal fluctuations in market prices of paddy as well as upland crops including vegetables are a common phenomenon in the Project Area and Phnom Penh. In case of paddy, cultivation of photosensitive varieties is common, but there is so limited paddy cultivation during the period of dry season due to insufficient irrigation facilities. Therefore, paddy prices are the lowest from January to February just after the peak harvesting season and the highest from September to October before the harvesting season. Further, price differences between local medium/late varieties (mixed) and improved early varieties (IR varieties) are also reported in the Project Area. Meanwhile seasonal fluctuation of vegetable prices in the Project Area is generally identified. Monthly wholesale prices of rice and vegetables are shown in Table I-5.1.1.

**Table I-5.1.1 Monthly Wholesale Prices of Rice and Vegetables in Phnom Penh, 2010** (Unit: Riel/kg)

| Crops | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rice (Mixed) | 1,900 | 1,900 | 1,900 | 1,900 | 1,900 | - | 1,900 | 1,717 | 1,700 | 1,700 | 1,750 | 1,800 |
| Rice (Neang Minh) | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | - | 2,000 | 1,900 | 1,900 | 1,900 | 1,900 | 2,000 |
| Rice (Phka Kanhey) | 2,150 | 2,150 | 2,175 | 2,175 | 2,200 | - | 2,200 | 2,450 | 2,450 | 2,450 | 2,450 | 2,450 |
| Rice (Somaly) | 2,700 | 2,700 | 2,775 | 2,775 | 2,850 | - | 2,850 | 2,988 | 3,000 | 3,000 | 3,000 | 2,600 |
| Ground Nut | 7,000 | 7,000 | 7,000 | 7,000 | 7,000 | 6,071 | 6,000 | 6,189 | 6,733 | 7,000 | 7,433 | 7,511 |
| Mung bean | 6,000 | 5,956 | 5,911 | 6,000 | 6,000 | 6,917 | 7,000 | 7,000 | 6,771 | 6,500 | 5,983 | 5,500 |
| Sesame (white) | 6,500 | 6,644 | 7,000 | 7,000 | 7,000 | 7,000 | 6,952 | 7,000 | 7,000 | 7,000 | 7,000 | 7,000 |
| Soybean | 2,989 | 2,956 | 2,811 | 2,800 | 2,800 | 2,971 | 3,000 | 3,000 | 2,890 | 2,733 | 2,600 | 2,689 |
| Maize (Yellow) | 1,000 | 1,056 | 1,197 | 1,200 | 1,200 | 1,388 | 1,400 | 1,361 | 1,300 | 1,300 | 1,350 | 1,400 |
| Beet | 950 | 1,435 | 1,057 | 1,271 | 1,360 | 1,655 | 1,356 | 1,410 | 1,210 | 1,575 | 1,591 | 1,007 |
| Bitter Gourd | 1,540 | 1,530 | 1,504 | 1,559 | 1,650 | 1,700 | 1,378 | 1,200 | 1,120 | 1,838 | 1,717 | 1,831 |
| Cabbage | 1,120 | 1,215 | 1,571 | 1,786 | 1,773 | 1,845 | 1,694 | 1,890 | 1,690 | 1,750 | 1,667 | 1,469 |
| Chinese Kale | 1,780 | 2,120 | 1,664 | 1,591 | 1,836 | 2,991 | 4,589 | 2,770 | 2,570 | 5,338 | 4,650 | 1,738 |
| Cucumber | 1,465 | 1,455 | 1,347 | 1,591 | 1,482 | 1,645 | 1,278 | 1,290 | 1,210 | 1,425 | 1,533 | 1,292 |
| Lettuce | 1,975 | 915 | 1,061 | 1,727 | 2,400 | 5,905 | 2,889 | 1,240 | 1,630 | 4,757 | 3,125 | 1,554 |
| Tomato | 1,335 | 1,360 | 1,729 | 2,391 | 2,300 | 2,218 | 1,950 | 2,160 | 1,930 | 1,863 | 2,217 | 2,025 |
| Long Bean | 2,140 | 1,480 | 1,429 | 1,759 | 1,968 | 1,418 | 1,189 | 1,370 | 1,220 | 1,550 | 2,117 | 1,923 |
| Mustard Green | 1,465 | 945 | 1,075 | 1,395 | 1,168 | 1,255 | 1,233 | 1,020 | 1,080 | 2,325 | 1,317 | 1,031 |
| Petsai | 2,075 | 1,460 | 1,319 | 1,577 | 1,927 | 1,840 | 1,722 | 1,450 | 1,690 | 3,363 | 2,308 | 1,408 |
| Cauliflower | 3,000 | 2,610 | 3,693 | 3,991 | 4,400 | 6,020 | 6,083 | 5,820 | 5,910 | 7,188 | 6,542 | 3,992 |
| Soiu Sum | 1,905 | 765 | 1,257 | 1,309 | 1,495 | 1,400 | 1,244 | 1,140 | 1,420 | 2,738 | 1,525 | 1,346 |
| Pok joy | 2,005 | 1,270 | 1,425 | 1,805 | 2,090 | 2,688 | 1,856 | 1,350 | 2,130 | 4,438 | 2,125 | 1,531 |

*Source: Department of Planning and Statistics, MAFF*

## I-5.2 Demand and Supply of Rice

RGC prepared the Policy Paper on the Promotion of Paddy Production and Rice Export, July 2010. This Policy Paper shows the current and future demand and supply of rice as follows:

**Table I-5.2.1 Projection of Rice Production and Rice Export in Cambodia 2010 - 2015**

| Items | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Cultivated area in wet season (million ha) | 2.34 | 2.35 | 2.36 | 2.37 | 2.38 | 2.39 |
| Cultivated area in dry season (million ha) | 0.38 | 0.38 | 0.41 | 0.42 | 0.45 | 0.48 |
| Total Production (million ton) | 7.30 | 7.62 | 8.09 | 8.44 | 8.85 | 9.08 |
| Seed and Post-harvest loss (million ton) | 0.95 | 0.99 | 1.05 | 1.10 | 1.15 | 1.18 |
| Consumable amount (million ton) | 6.35 | 6.63 | 7.04 | 7.34 | 7.70 | 7.90 |
| Population (million) | 14.05 | 14.26 | 14.47 | 14.69 | 14.91 | 15.13 |
| Domestic consumption (million ton) | 3.14 | 3.19 | 3.23 | 3.28 | 3.33 | 3.38 |
| Paddy for export (million ton) | 3.32 | 3.44 | 3.80 | 4.06 | 4.37 | 4.51 |
| Milled rice for export (million ton) | 2.06 | 2.20 | 2.43 | 2.60 | 2.80 | 2.89 |

*Note: 2008 and 2009: actual figures*
*Source: Policy Paper on the Promotion of Paddy Production and Rice Export, July 2010, the RGC*

As can be seen in the above table, total consumable amount of paddy ({total production} – {seed and post-harvest loss}) is increased by about 24% from 2010 to 2015, while domestic consumption will be increased by about 8% for the same period which is mostly similar to population increase for the same period. Meanwhile, the growth rate of paddy for export is projected to be high, say about 36% from 2010 to 2015. For this, RGC stresses the promotion of paddy production as mentioned above.

Current demand and supply of rice in 3 provinces that is Kampong Speu, Kandal, and Takeo Provinces is shown as follows:

**Table I-5.2.2 Current Food Balance in Four Provinces**

| Items | Kampong Speu | Kandal | Takeo | Kampong Chhnang |
|---|---|---|---|---|
| Total Production, 2011 – 2012 (ton) | 356,372 | 382,412 | 1,023,072 | 401,255 |
| Seed and Post-harvest loss (ton) | 46,328 | 49,712 | 132,999 | 52,164 |
| Remaining milled rice (64% of paddy) | 198,428 | 212,927 | 569,646 | 223,418 |
| Population | 775,704 | 1,383,298 | 879,328 | 520,398 |
| Domestic consumption (ton) | 110,926 | 197,811 | 125,743 | 74,416 |
| Surplus of milled rice | 87,502 | 15,116 | 443,903 | 149,002 |

*Source: Food Balance 2011/12, PDAs Kampong Speu, Kandal, Takeo, and Kampong Chhnang Provinces*

Although there is some surplus of milled rice in 4 provinces as shown in the above table, some districts, such as Chbar Mon District in Kampong Speu Province and Ang Snoul District in Kandal Province, have certain deficit. This implies that it is necessary to improve productivity of paddy as well as farmers' income. Furthermore, surplus from these provinces is marketed to big consuming region, say Phnom Penh. Especially, Takeo and Kampong Chhnang Provinces are positioned as granary for Phnom Penh City and other large towns.

## I-5.3 Regulations and Laws on Land Use and Water Use

The RGC's strategy and policy related with land and water use are elaborated in a number of regulations and laws and continuously updated. Major regulations and laws are tabulated as follows:

**Table I-5.3.1 Regulations and Laws related with Land Use and Water Use**

| Title | Issued in | Provisions |
|---|---|---|
| **Water Resources Policy** | | |
| National Water Resources Policy for the Kingdom of Cambodia | 2004 | - It is a basic policy for using water resources in Cambodia. It is aim to ensure the effective, sustainable, wise and equitable use of water resources referring to all over the aspect for water use and consists of 4 chapters: (i) Introduction, (ii) Vision for water in Cambodia, (iii) Fundamental principles, (iv) The national water resources policy and (v) Implementation of the national water resources policy, (vi) Conclusion. |
| Law on Water Resources Management | 2007 | - The law, giving the framework to effective utilize water resources in an integrated manner, is comprised of 11 chapters and 41 articles such as: (i) property, (ii) necessity of integrated management approach, (iii) responsibility of MOWRAM, (iv) licensing of water use etc. |
| **Land Management** | | |
| Land Law | 2001 (under approval process) | - Land law (2001) was drafted by revising previous Land Law 1992. It consists of following contents: (i) Article 1, Private and Public Ownership, (ii) Article 2, Acquisition of Ownership, (iii) Article 3, The Regime of Private Ownership, (iv) Article 4, the Forms of Ownership, (v) Article 5, Immovable Property Used as Surety, (vi) Cadastre, (vii) Penalty Provisions and (viii) Final Provisions.<br>- The Law deals with ownership, property rights and compensation which are needs to be considered for irrigation and drainage development. |
| Sub-decree on Addressing Socio-economic Impacts caused by Development Projects | Draft | - It was originally drafted in 2004 and currently under approval process. The purpose of the sub-decree is to minimize social impact caused by development projects including land acquisition and resettlement issues.<br>- The sub-decree consists of 10 chapters: (i) Chapter 1, General Provisions, (ii) Chapter 2, General Public Interest and National Interest, (iii) General Principles and Requirements, (iv) Procedures for Determining specific Nature of a Proposed Project, (v) Planning to Address Project Social Impacts, (vi) Compensation and Rehabilitation Assistance, (vii) Complaints and Judicial Review, (viii) Budget, (ix) Institutional Arrangements and (x) Final Provisions. |

| Title | Issued in | Provisions |
|---|---|---|
| **Basin Management** | | |
| Sub-decree on Basin Management | Draft | - It aims to begin the implementation of water management plans and the creation of basin organizations to matches the IWRM principles in Cambodia. |
| **Water management** | | |
| Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems | 1999 | - MOWRAM defines the role of FWUC in the policy for Sustainability of O&M Irrigation Systems. Circular No.1 defines organizational flame of FWUC and is attached The Statute of The FWUC. The statute defines the objectives, criteria, organization, finance management, rules and punishment of FWUC, and enhances the establishment of FWUC. |
| Policy for Sustainability of O&M Irrigation Systems | 2000 | - It defines the ways of O&M of irrigation system. In this policy, the management responsibility and water allocation transfer to FWUC. The functions and roles of FWUC, the system of ISF and supporting system for maintenance activity of FWUC, Monitoring and Evaluation system are mentioned.<br>- It consists of 5 chapters, (i) Introduction, (ii) O&M Irrigation System, (iii) Environment, (iv) HRD, (v) Miscellaneous. |
| Steps in the Formation of a FWUC | 2000 | - FWUC has the responsibility for O&M of irrigation system. MOWRAM enhance to establish FWUC and shows steps in the formation of FWUC in this document. FWUC finally will be registered by MOWRAM. |
| Training Manual for PIMD | 2003 | - The manual was prepared with the aim of promoting PIMD based on decentralization and Irrigation Management Transfer policy of the Government.<br>- It consists of 7 modules as follows: (i) Module 1: General concept of PIMD and lesson and learnt of PIMD around the world, (ii) Module 2: Policy, legal and institutional framework of PIMD, (iii) Module 3: Planning and implementing PIMD at the national level, (iv) Module 4: Implementation of PIMD at provincial and irrigation system level, (v) Module 5: Functions of FWUC support team in order to establish FWUC and develop their capacity, (vi) Module 6: Monitoring and evaluation system to support implementation and further development of PIMD and (vii) Module 7: Technical guide for irrigation water management targeted FWUC leaders and members. |
| Sub-decree on FWUC | Draft | - The objective of this Sub-decree is to manage and use the irrigation systems in effective and sustainable manner by establishing and strengthening FWUCs. This sub-decree consists of 12 chapters and is to define the basic principles and process, function and supporting system etc.<br>- The sub-decree also fosters farmers' participation in the O&M of irrigation system through FWUC based on PIMD and IMT. |
| Sub-decree on Water Allocation and Licensing | Draft | - It is with the purpose of beginning an activity of water licensing by MOWRAM. |

*Source: JICA Survey Team based on MOWRAM and REVIEW on Nationwide Irrigation Development in Cambodia, 2010, JICA*

## I-5.4 Opinion of Relevant Agencies on Land Development and Water Use

(1) Ministry of Agriculture, Forestry and Fisheries

The Cambodia's 2001 Land Law built the foundation for governing the uses and management of land resources and strengthening land tenure security to facilitate the country's fast growing economy with heavily demand for land uses and development. In addition to this Law, RGC has legislated and enacted a number of legal documents to support and strengthening the development of agricultural sector which included the sub-decrees on social and economic land concessions, strategy of land policy framework and state land management, and the rectangular strategies. The enforcement and implementation of these legislations in most cases requires a strong coordination among related RGC's institutions, but such coordination has been reported to be weak. The governance of the use and management of agricultural lands has been poorly taken into account because much of the research has been in favor of technology development and adoption to increase crop production. Under such situation, the agricultural lands have been facing the challenge of "Conversion of land to other use, and the unused farmlands being kept for speculative purpose". In this case, the lands are poorly protected, conserved, and enhanced for productivity. Thus, there is an urgent need to develop policy framework for protection, conservation and productivity-enhancement of agricultural lands. The current problems facing to agricultural lands are summarized as follows:

**Table I-5.4.1 Summary of Current Problems on Agricultural Lands**

| Item | Problem |
|---|---|
| (1) Agricultural Land Legal Status | - A poor legal framework to protect, conserve, and enhance the use of agricultural lands for productivity and sustainability. |
| (2) Land Resource Assessment | - Lack of comprehension of people who make policy and land use decisions.<br>- Lack of continuation to update land resource information for the whole country.<br>- Insufficient data on land capability classification.<br>- Not well managed data of land resource information. |
| (3) Small Holder Land Tenure Security | - Increase of agricultural lands being purchased for speculation.<br>- Selling of agricultural lands of poorest land owners due to debts and health care.<br>- Coerced land transactions.<br>- Little application of social land concession mechanism.<br>- Ineffective communal land rights of indigenous communities on field. |
| (4) State Land Resources | - Implementation and enforcement of economic land concessions which do not follow the spirit and letter of the law and sub-degree.<br>- Lack of clear definition of forest.<br>- Lack of clearly demarcated boundaries concerning the jurisdictions of various government agencies. |
| (5) Monitoring of Land Tenure Policies | - Lack of a well-organized and reliable land use and land tenure database system.<br>- Need of agricultural census every 10 years.<br>- Need of specific research (rural-rural migration, its impact on land use and land tenure and land change, gender aspects of rural land tenure, land tenure and land disputes and resolution mechanisms) for support of policies. |

*Source: Program Design Document for Strategy for Agriculture and Water 2010-2013 (Draft)*

(2) Ministry of Water Resources and Meteorology

As for water resources management at national level, RGC has recently progressed steadily in establishing a legal and policy framework for the water sector. In this framework, the National Water Resources Policy was approved in early 2004. It consists of 4 sections: Section 1 Introduction, Section 2 A Vision for Water in Cambodia, Section 3 Fundamental Principles Related to Water, and Section 4 Water Resources Policy. In the agricultural scope, the policy can be summed up as follows:

- Improve the monitoring of the water resources.
- Promote river basin management and development.
- Provide enough water for agricultural production.
- Improve the legal and institutional framework.
- Increase public information and participation.
- Mitigate flood hazards.
- Protect aquatic system.
- Increase financial means through private management, fees collection and requests to the donors.
- Collaborate with neighboring countries in order to achieve the aims of the Mekong agreement.

The Law on Water Resources Management is comprised of 11 Chapters and 41 Articles. Major contents of text are mentioned below:

- Water resources are the property of the State.
- Water resources shall be managed following an integrated approach.
- MOWRAM is responsible for leading the implantation of this law.
- MOWRAM is responsible for managing an inventory of the water resources.
- Everyone has the right to use water resources for basic needs without license.
- Use of water for other purpose than basic needs are subject to a license.
- MOWRAM is responsible for establishment of FWUC.
- Farmers using water from the same irrigation system have a right to establish FWUC.
- Disposal of polluting substances shall be subject to a license.

- MOWRAM can establish a protected zone when a water body is seriously threatened by human activities.
- MOWRAM can establish flood protection areas in which a flood protection plan is to be prepared and implemented and in which some activities can be prohibited.
- MOWRAM shall take into account the Mekong River Agreement.

Table I-5.4.2 shows the summary of problems in the water resources sector:

**Table I-5.4.2 Summary of Problems Identified in Water Resources Sector**

| Item | Problem |
|---|---|
| Water Data Management | - Very limited collection of water data stored in poor conditions<br>- Less dense and unsustainable observatory systems which do not cover the whole country<br>- Lack of skill of MORWAM Staff on data management<br>- Lack of data for water resources assessment which is a strong constraint<br>- Undeveloped systematic activity of water assessment in MOWRAM<br>- No capitalization of water resources assessment produced by different project<br>- No availability of water resources assessment for agricultural planning purpose<br>- Incomplete flood and drought forecasting system |
| Integrated Water Resources Management | - Weak institutional framework of MOWRAM<br>- Incomplete national legal framework<br>- Insufficient financial and human means of MOWRAM to enforce the legal framework<br>- Difficult coordination with many agencies by MOWRAM<br>- No capitalization of projects by MOWRAM, which have been already studied at several basins<br>- No existence of basin committees and basin management plan |

*Source: Program Design Document for Strategy for Agriculture and Water 2010-2013 (Draft)*

(3) Ministry of Land Management, Urban Planning and Construction

Cambodia's Land Law was firstly prepared in 1991 and updated in 2001 by the Ministry of Land Management, Urban Planning and Construction (MLMUPC). This law aims to determine the regime of ownership for immovable properties in Cambodia for the purpose of guaranteeing the rights of ownership and other rights related to immovable property in accordance with the provisions of the 1993 Constitution of Cambodia.

On the basis of this Land Law, the following 3 Circulars were promulgated so far:

**Table I-5.4.3 Issued Year and Major Contents of Circulars**

| Circular | Issued Year | Major Contents |
|---|---|---|
| Circular 01 | 2011 | Protection of natural resources and fishery area around Tonle Sap |
| Circular 02 | 2007 | Illegal occupation of state land in rural area |
| Circular 03 | 2010 | Resolution of temporary settlement on land illegally occupied in capital, municipal and urban areas |

*Source: Interview with Director General of MLMUPC*

As can be seen in the above table, Circular 02 is closely related to the Project, especially the cultivation within the reservoir area and houses built along canal in USISRSP and KSBISRSP. There are 3 authorities on land development. These are (i) Provincial State and Management Committee, (ii) Provincial Land Use and Land Distribution Committee, and (iii) Provincial Committee in charge of M/P. As for Circular 02, Provincial State and Management Committee is in charge. The current problems on land development are as follows:

- Land use conflict due to delay by the complicated approval system at provincial level
- Insufficient number of skilled staff at provincial and district level
- Lack of office equipment and transportation for smooth execution of the works
- Poor dissemination of legal and technical measures and regulation matters

## I-5.5 Information on Mines and Unexploded Bombs in Project Areas

In order to grasp the current conditions on mines and unexploded ordnances (UXOs) in the project areas, a contact was made to the Cambodia Mine Action Center (CMAC) through the JICA Cambodia Office. As far as the information from CMAC is concerned, RCHRSP area would not be contaminated with mines and UXOs although considerable bombs had been dropped in its command area. While, in USISRSP, suspected area would be found along about 4 km upstream of Diversion Canal from the Tumnup Lok Reservoir and around the proposed borrow pit area, which are the results of hearing survey conducted by CMAC in 2000. In addition, it is said that around southern part of Main Canal 33, where the battle was once conducted, would have a possibility of buried UXOs. On the other hand, the southern and central parts of Kandal Stung Area of KSBISRSP would be suspected areas according to the said survey. It is thus deemed necessary to carry out the detailed technical ground survey by CMAC, prior to commencement of D/D. Figures I-5.5.1 to I-5.5.6 show the conditions of mines and/or UXOs in 6 Sub-projects which were prepared by CMAC based on the results of hearing survey.

## I-5.6 Capability of National Contractors

(1) Capability of Civil Contractors

In Cambodia, there is no registration system with classification, qualification and ranking of civil contractors, except legal registration system under the Cambodian law. With reference to previous and on-going projects including national and externally financed projects, there are national contractors available for simple earthworks and concrete works. However, they don't have sufficient experiences and capability for large-scale construction projects that require efficient construction management including strict control of quality, schedule, safety and financial matters. Heavy equipment operators and skilled laborers can be sourced from Phnom Penh, while common laborers are widely available within the vicinity of the each sub-project site. Therefore, the national contractors can be employed as sub-contractor(s), if they are determined as qualified in terms of construction and financial capacity, subject to the supervision and control of the contractor selected through international competitive bidding (ICB). However, the national contractors might be possible to undertake the small-scale works like construction of tertiary canal system.

(2) Capability of Gate Manufacturers

According to the information of MOWRAM, there is only one gate manufacture in Cambodia who has experiences of manufacturing and installation of several automatic flap gates under the MOWRAM's projects. In order to evaluate his capability for design, manufacturing and installation of hydro-mechanical equipment for the rehabilitation of the Roleang Chrey Headworks, the shop inspection was made by the JICA Survey Team in July 2011. The shop inspection report and details of the evaluation are shown in ANNEX D. The required equipment and manpower for manufacturing of large-scale gates in comparison of the available ones of the national manufacturer are summarized as below.

**Table I-5.6.1 Comparison of Required and Present Capability of National Gate Manufacturer**

(a) Equipment

| Equipment | Specifications | Required Q'ty | Available Q'ty |
|---|---|---|---|
| Gantry type automatic gas cutting machine | 3.5 m (W) x 15 m (L),<br>up to 30 mm thickness | 2 | 1 |
| Gantry type drilling machine | 5 m (W) x 15 m (H) | 1 | 5 |
| Hydraulic press | 100 ton | 1 | 1 |
| Beveling machine | Up to 30 mm(T) | 1 | - |
| Automatic welding machine | 1.000 A | 1 | 1 |

| Equipment | Specifications | Required Q'ty | Available Q'ty |
|---|---|---|---|
| Semi-automatic welding machine | 500 A | 1 | - |
| AC welding machine | 500 A | 12 | - |
| Gauging machine | 600 A | 2 | - |
| Facing machine | 2 m (W) x 6 m (L) | 1 | - |
| Air compressor | 10 kW to 22 kW | 4 | - |
| Airless painting machine | - | 4 | - |
| Shot blasting facilities | 6 m (W) x 15 m (L) | 1 | - |
| Lath | φ600 x 3 m (L) | 4 | 6 |
| Assembly frame with level blocks | 8 m (W) x 15 m (L) | 3 | - |
| Overhead traveling crane | 20 tons | 1 | 1 |
| Full size drawing facilities | 10 m (W) x 20 m (W) | 1 | - |
| Testing facilities for hoist | - | 1 | - |
| Diesel engine generator | 200 kVA | 1 | - |
| Factory space | 20 m (W) x 60 m (L) | 1 | - |
| Stock yard space | 20 m (W) x 50 m (L) | 1 | - |
| Gantry crane or truck crane | 20 tons | 1 | - |

*Remarks: (H); Height. (W); Width, (T) ; Thickness*

(b) Manpower

| Classification | Qualification | Required Number | Available Number |
|---|---|---|---|
| Chief design engineer | Deign of roller gates & radial gates: more than 15 years and 10 types of those gates | 1 | - |
| Sr. design engineer | Deign of roller gates & radial gates: more than 10 years and 5 types of those gates | 2 | - |
| Design engineer | Deign of roller gates & radial gates: more than 7 years and 4 types of those gates | 5 | 2 |
| Chief procurement engineer | Work experience: more than 10 years | 1 | - |
| Chief manufacturing engineer | Work experience: more than 10 years | 1 | - |
| Chief quality control engineer | Work experience: more than 10 years | 1 | - |
| Jr. engineer | Work experience: more than 5 years | 9 | - |
| Welders | Qualified welders | 10 | 10 |
| Mechanic | | 20 | 4 |
| Fitters & rigger | | 20 | 3 |
| Electrician | | 10 | |
| Common labor | | 20 | 6 |

*Source: JICA Survey Team*

As the results of the above inspection and the obtained information, it is judged that this national gate manufacturer has no enough capability to fulfill the design, manufacturing and installation of large size gates and all the related hydro-mechanical equipment required for the Roleang Chrey Headworks in terms of the shop facilities and manpower. In addition, it was confirmed that he has no experience in design, manufacturing and installation of: (i) electrically driven wire rope type hoist, (ii) electrically driven spindle type hoist and (iii) fixed wheel, although having many experiences in manufacturing and installation of flap gates. Judging from the results of the above investigation, it is proposed that the international gate manufacture be employed as a sub-contractor.

(3) Capability of Civil Engineers

Qualified civil engineers are available in Cambodia, some of which have sufficient experiences in working in the externally financed construction projects. While, authorized design criteria, standard, and tools for design and quality control of the construction works are quite limited in the country. Therefore, it is proposed to employ working manner which the national qualified engineers should work in line with the design criteria, construction supervision and other tools prepared by foreign consultants and also in cooperation with foreign consultants.

# CHAPTER I-6 OUTLINES OF PREVIOUS STUDIES

## I-6.1 General

As mentioned in Section I-1.3, SPPIDRIP is composed of 6 Sub-projects such as RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. The outlines of previous studies related to these Sub-projects are briefly given hereinafter.

## I-6.2 The Study on Comprehensive Agricultural Development of Prek Thnot River Basin (Master Plan Study)

### I-6.2.1 Background

Agriculture as the major economic activity in the basin of the Prek Thnot River, relies on erratic rainfall due to limited irrigation system. This results in low and unstable production of crops with some farmers still unable to harvest enough for their self-consumption of rice. RGC therefore requested GOJ to extend technical assistance aiming at improvement of agricultural productivity in the basin. In reply to the request, GOJ decided to execute the Study on Comprehensive Agricultural Development of Prek Thnot River Basin. The study included formulation of M/P, F/S on the priority projects selected in M/P and verification study at pilot projects.

### I-6.2.2 Project Components

In order to attain the "***Improvement of Agricultural Productivity centering on Rice***" and in a concept of "***Well-harmonized Development of Irrigation and Drainage, Agriculture and Institutions***", the project components consisting of 27 projects/studies for scheme-wise improvement plan and subject-wise improvement plan were worked out. Out of them, 10 projects aim at the rehabilitation and improvement of existing irrigation facilities although Roleang Chrey Regulator Gates Urgent Improvement Project was completed during the M/P Study.

### I-6.2.3 Agricultural Development Plan

In the M/P Study, the target area was divided into the 4 zones[1]: (i) Zone-1(5,660 ha), (ii) Zone-2 (11,040 ha), (iii) Zone-3 (1,200 ha), and (iv) Zone-4 (23,380 ha), considering water availability and land use as well[2]. The agricultural development plan consisting of objectives, plan and strategies was elaborated for 4 zones. The proposed cropping pattern, cropping area and intensity for respective zones are as follows:

**Table I-6.2.3.1 Proposed Cropping Patterns, Cropping Area and Intensity**

| Zone | Proposed Cropping Pattern in M/P Study | Crop Intensity | Area |
|---|---|---|---|
| 1 | Early Rice (18%)- Medium Rice (91%)- Upland Crops (5%) | 114% | 5,660 ha |
| 2 | Early Rice (14%)- Medium Rice (91%)- Upland Crops (5%) | 110% | 11,040 ha |
| 3 | Medium Rice (100%) - Upland Crops (5%) | 105% | 1,200 ha |
| 4 | Medium Rice (100%) - Upland Crops (1%) | 101% | 23,380 ha |

*Note: In F/S, the total area for Zone-1 and Zone-2 was revised into 16,920ha (refer Appendix-IIC, Vol.-VII of the source).*
*Source: Final Report for the Study on Comprehensive Agricultural Development Prek Thnot River Basin*

[1] *Zone-1: Irrigable area with 80 % dependability, Zone-2: Irrigable area with 50% dependability, Zone-3: Water harvesting area, Zone-4: Rainfed area*
[2] *Appendix-D, The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

### I-6.2.4 Irrigation and Drainage Development Plan

(1) Water Resources and Irrigation Area

In the target area of M/P, the largest water source is the Prek Thnot River, and the existing facilities are (i) Roleang Chrey Headworks and (ii) North Main Canal (NMC) and South Main Canal (SMC). The available water sources for irrigation were evaluated based on a water balance study with 5-day dependable discharges and the irrigation water demand. As a result, the following probable irrigation areas were estimated:

**Table I-6.2.4.1 Irrigation Area by Different Dependability of Prek Thnot River Basin**

| Zone | Definition | Net irrigable Area |
|---|---|---|
| 1 | Irrigated by Prek Thnot River with 80% dependability | 5,660 ha |
| | (Upper North Main Canal(UNMC) Area) | (2,210 ha) |
| | (Upper South Main Canal(USMC) Area) | (3,450 ha) |
| 2 | Irrigated by Prek Thnot and Ou Krang Ambel Rivers with 50% dependability | 11,040 ha |
| | (Lower North Main Canal(LNMC)Area) | ( 4,290 ha) |
| | (Lower South Main Canal(LSMC) Area) | (6,750 ha) |
| 3 | Irrigated by Water Harvesting Pond with 50% dependability | 1,200 ha |
| 4 | Rainfed area | - |
| | Total of Zone-1 to Zone-4 = 41,280 ha | Total:17,900 ha |

*Source：The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

(2) Irrigation Development Plan

The irrigation development plan was designed for 2 types: (i) irrigated agriculture model project and (ii) zone-wise irrigated agriculture improvement projects in 5 areas (UNMC and USMC in Zone-1, LNMC and LSMC Areas and Ou Krang Ambel Area in Zone-2) as summarized below.

**Table I-6.2.4.2 Irrigation Improvement Plans in M/P**

| ***Improvement Plan*** | |
|---|---|
| **Irrigated Agriculture Improvement Model Project** | |
| - Construction works | Rehabilitation of SMC from Vat Krouch Intake Gate for a length of 7 km, including construction of related structures |
| | Rehabilitation of existing secondary canals (6.1 km), construction of new secondary canals (1.0 km), and rehabilitation of tertiary canal systems for 570 ha, including related structures and drainage canals |
| | Rehabilitation of 4 water harvesting facilities (ponds) including intake structures and irrigation canal systems |
| - Procurement of O&M equipment | |
| - Formation and strengthening of FWUCs/FWUGs/Water Users Groups (WUGs) | |
| **Irrigated Agriculture Improvement Projects** | |
| - Construction works | Rehabilitation of NMC, SMC and Ou Krang Ambel Canal from intake gates to the end of the canals including construction of related structures |
| | Rehabilitation of existing secondary canals construction of new secondary canals, and rehabilitation of tertiary canal systems, including related structures such as turnouts, checks, culverts and drainage canals |
| | Rehabilitation of water harvesting facilities (reservoirs) including intake structures and irrigation canal systems |
| - Procurement of O&M equipment | |
| - Formation and strengthening of FWUCs/FWUGs/WUGs | |
| - Engineering Services | Survey, design, preparation of tender documents, and construction supervision |
| | Prepare operation rules and an operation manual for the facilities |
| | Reinforce organization for O&M of the facility |

*Source：The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

(3) Improvement of Roleang Chrey Headworks

The Roleang Chrey Headworks are key facilities for irrigation development for this area, consisting of Roleang Chrey Regulator, Andong Sla Intake, Vat Krouch Intake and Approach Channels. The proposed works were divided into 2 projects in the M/P Study, such as a temporary treatment (Roleang Chrey Regulator Gates Urgent Improvement Project) and permanent measures (Roleang Chrey Regulator and Intakes Improvement Project) as below.

**Table I-6.2.4.3 Improvement Plans of Roleang Chrey Headworks in M/P**

| *Improvement Plan* | |
|---|---|
| **Roleang Chrey Regulator Gates Urgent Improvement Project** | |
| - Temporary treatment | Replacement of the counter weight wire rope in all 5 gates |
| | Installation of one additional diesel generator of 75 kVA |
| | Provision of spare parts |
| | Provision of standard maintenance tools |
| **Roleang Chrey Regulator and Intakes Improvement Project** | |
| - Rehabilitation and Improvement of Roleang Chrey Regulator | Rehabilitation of all gates and hoist systems of the regulator |
| | Improvement of the downstream apron and river side slope protection |
| | Construction of a river outlet structure at the right side of the regulator |
| | Construction of an operators hut |
| - Reconstruction of the Intake Gates | Reconstruction of Andong Sla Intake Gate and Vat Krouch Intake Gate |
| | Rehabilitation of the approach channels to the intake gates |
| | Construction of a power transmission line from the regulator and intake gates |
| - Engineering Support Services | Survey, design, preparation of tender documents, and construction supervision |
| | Prepare operation rules and an operation manual for the facilities |
| | Reinforce the organization for the O&M of the project facility |

*Source：The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

## I-6.2.5 Agricultural Support Plan

The agricultural support services require for the promotion of adoption of the proposed farming practices and for attaining the project target cropping patterns, cropping intensity and crop yields at the earliest possible stage are as follows:

**Table I-6.2.5.1 Required Agricultural Support Services**

| Activity | Program Required |
|---|---|
| Field Extension Programs | Rice: Plot & area demonstration, adaptability test, seed multiplication<br>Upland crops: Plot demonstration and adaptability test |
| Farmer/Farmer's Group (FG) Training Programs | Training programs, farmer field schools (FFSs), study tours, village extension agent training & deployment |
| Mass Guidance/Workshops | Mass guidance/workshops |
| Farmer-to-farmer Extension Support | Farmer-to-farmer extension support |
| Staff Empowerment | Staff training, study tours |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

## I-6.2.6 FWUC Formation and Strengthening

In order to execute properly water management and O&M at minor canal level, the proposed formation and strengthening plan for FWUC include: (i) precise structure and responsibilities, (ii) formation of FWUC, FWUG and WUG considering tragic history, (iii) clear sharing of roles of FWUC, FWUG and WUG, (iv) timely participation of beneficial farmers, (v) participation of beneficial farmers at construction stage, and (vi) collection of ISF.

## I-6.2.7 Results of Verification Study on Paddy Cultivation

Verification tests were carried out in 2 years of 2006/2007 to 2007/2008, in order to confirm whether the target yields and cropping pattern proposed in M/P are achievable by introducing improved farming practices or not. Small-scale adaptability tests were also arranged to confirm effect of the promising varieties, proper on-farm water management, seeding rate, and planting method on the target yield. As the results of these tests, crop yield of early rice ranged from 3.8 ton/ha to 4.7 ton/ha and that of medium rice from 3.2 ton/ha to 5.7 ton/ha, which are higher than the target yield of 3.3 ton/ha for early rice and 3.0 ton/ha for medium rice, respectively.

## I-6.3 Roleang Chrey Regulator and Intakes Improvement Project (Feasibility Study)

### I-6.3.1 Background

The Roleang Chrey Regulator and the Andong Sla Intake, which were constructed in 1974, have been severely deteriorated and are not functioning efficiently at present. The Vat Krouch Intake, which was constructed in 2002, has also faced various operational deficiencies. If these conditions are left unattended, the water supply for each related command area would become a serious concern due to malfunctioning facilities. Consequently, the strategic target for M/P aiming at improvement of agricultural productivity centering on rice, would not be materialized by 2015. Thus, to ensure stable water supply and to achieve the strategic goal, it is essential to execute related urgent improvement works.

Based on the results in the M/P Study, F/S was executed for the selected 2 priority/urgent projects till August 2008 in order to delineate appropriate development plans, which were (i) Roleang Chrey Regulator and Intakes Improvement Project and (ii) Irrigated Agriculture Improvement Model Project.

### I-6.3.2 Project Works

The construction works were divided into (i) Roleang Chrey Regulator, (ii) Andong Sla Intake and (iii) Vat Krouch Intake. The components of these works for improvement of the Roleang Chrey Headworks are summarized in the table below.

**Table I-6.3.2.1 Summary of Proposed Project Works in F/S**

| Facility | Proposed Project Works |
|---|---|
| Roleang Chrey Regulator | |
| Civil Works | - Provision of downstream apron<br>- Provision of retaining wall<br>- Construction of by-pass for releasing low water to the downstream reach |
| Hydro-mechanical Works | - Closing of sluiceway<br>- Improvement of gate leaves (repair of wheels, painting and repair of rubber seals)<br>- Replacement of hoists<br>- Improvement of the operation system |
| **Andong Sla Intake** | |
| Civil Works | - Construction of gate piers<br>- to install two of the four gates<br>- to provide a concrete wall for the remaining two gates, so as to enable the installation of a gate in each in the future<br>construction of downstream apron |
| Hydro-mechanical Works | - Installation of gates (4 guide frames, 2 gate leafs and hoists)<br>- Installation of stoplog (4 guide frames for stoplog and 1 stoplog leaf) |
| **Vat Krouch Intake** | |
| Civil Works | - Construction of upstream and downstream transitions<br>- Construction of gate pier and box culvert<br>- Protection of upstream and downstream canal beds<br>- Rehabilitation of approach channel |
| Hydro-mechanical Works | - Installation of gates (2 guide frames, 2 gate leafs and hoists) |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

### I-6.3.3 Project Design

Table I-6.3.3.1 shows summary of design of the proposed project facilities.

**Table I-6.3.3.1 Summary of Design of Proposed Project Works in F/S**

| Works | Designed Details |
|---|---|
| **Roleang Chrey Regulator** | |
| Civil Works | |
| - Provision of downstream apron | Design flood: 1,600 $m^3$/sec (1/50 probable flood)<br>Type: Apron with baffle blocks and end sill<br>Length: 23.48 m<br>Backfill concrete and riprap protection |
| - Provision of retaining wall | Type : Inverted T-shape retaining wall<br>Length : 23.48 m length<br>Height : 11~12 m<br>Embankment supported by retaining wall and riprap protection |
| Hydro-mechanical Works | |
| - Construction of by-pass | Capacity: 10 $m^3$/sec<br>Type: by-pass with inlet, pipe conduit and stilling basin<br>Inlet: equipped with 2 slide gates of four sealing edges<br>Pipe conduit : 2 pipes (Dia=1.0 m. L= 92.42 m)<br>Stilling basin : box type with end sill and broad-crest weir |
| - Provision of stop log facility | Type : floating gate type |
| - Repair of gates | Repair of wheels :<br>- replacement of bearing metals by oil less bearings<br>- wheel shafts by corrosion resisting steel shafts<br>Painting of gate leaves<br>Replacement of rubber seals<br>Renewal of hoist |
| **Andong Sla Intake** | |
| Civil Works | |
| - Intake gate | Capacity : 10.4 $m^3$/sec (6,500 ha)<br>25.1 $m^3$/sec (15,680 ha)<br>- To install two of the four gates to ensure the discharge of 10.4 $m^3$/sec in this study<br>- To provide a concrete wall for the remaining two gates, so as to enable the installation of a gate in each in the future |
| - Retaining wall | Type : Reinforced concrete<br>6.4 m (H) × 7.5 m (W) × 1 set |
| - Gate Piers | Reinforced concrete<br>L= 10.2 m<br>H=5.4 m<br>t=1.2 m |
| - Downstream apron | Reinforced-concrete apron provided with baffle block and end sill |
| - Construction method | Partially closing with sheet pile |
| Hydro-mechanical Works | |
| - Provision of new gates | Gate type : Vertical lift fixed wheel type |
| | Clear span 4.00 m<br>Height 4.80 m<br>Design head 4.50 m<br>Hoist Electric driven wire rope winding hoist, one motor two drums<br>Control system Local and remote control from Roleang Chrey Regulator |
| **Vat Krouch Intake** | |
| Civil Works | |
| - Intake gate | Capacity : 17.4 $m^3$/sec (10,850 ha)<br>gates are required of H=5.0 m, W=4.0 m |
| - Upstream and downstream transitions | Type : Reinforced concrete transition protected with gabion mattresses |
| - Gate pier and box culvert | Reinforced concrete with baffle block and end sill<br>Double box type: H=4.6 m, W=4.0 m<br>Gate pier: H=5.3 m, W=1.3 m |
| - Protection of upstream and downstream canal | Gabion mattresses |
| - Rehabilitation of approach channel | Enlargement of canal section and sod-facing on side slopes |
| - Construction method | Partially closing with coffer dam and by-pass channel |
| Hydro-mechanical works | |
| - Provision of new gates | Type: Vertical lift fixed wheel gate<br>Quantity: Gate and hoist: 2<br>Guide frame for stoplog; 2<br>Stoplog leaf: 1<br>Clear span: 4.000 m<br>Height: 5.000 m<br>Design head: 4.720 m<br>Hoist Electric driven wire rope winding hoist, one motor two drums<br>Control system<br>Local and remote control from Roleang Chrey Regulator |

*Remarks; W: Width, H: Height, L: Length, Dia: Diameter*
*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

### I-6.3.4 Implementation, Operation and Maintenance

The project works are composed of 4 parts; (i) survey and design including preparation of tender documents, (ii) tendering, (iii) construction, and (iv) environmental monitoring. The duration for the project implementation was planned to be 45 months from August 2007 to April 2011, including of 11 months for survey and design, and 4 months for tendering. Upon completion of construction works, Kampong Speu PDOWRAM, under the support of the Department of Irrigated Agriculture, would be directly in charge of O&M for the improved facilities. In this connection, an O&M office for the project facilities was proposed to be established in Kampong Speu PDOWRAM, to strengthen the overall O&M activities.

### I-6.3.5 Project Cost and Evaluation

The project cost was estimated at US$ 4,991 thousand equivalent to Riel 20,263 million. EIRR for the project was estimated at 14.8%. B-C and B/C at 7% discount rate were estimated as Riel 7,646 million and 1.6, respectively. These economic indicators show that the project is economically feasible.

## I-6.4 Roleang Chrey Regulator Improvement Project (Grant Aid)

### I-6.4.1 Background

Based on the results of F/S for Roleang Chrey Regulator and Intakes Improvement Project, RGC requested GOJ to extend the grant aid assistance for the project in July 2006. GOJ, through JICA dispatched the B/D Study Team twice from November, 2007 to June, 2008. Base on the results of the B/D Study, the grant agreement (G/A) was exchanged on February 10, 2009 between RGC and JICA to conduct the D/D works for the project. After completion of D/D, G/A was exchanged for the project implementation between RGC and JICA on June 15, 2009.

### I-6.4.2 Project Works

Through the review on F/S, site visit and discussion with MOWRAM, the project works under the grant were determined as follows:

**Table I-6.4.2.1 Project Works Grant Aid Scheme**

| Project Works Proposed by MOWRAM | Evaluation in Japan's Grant Aid Scheme |
|---|---|
| **Rehabilitation of Roleang Chrey Regulator** | |
| - Rehabilitation of all gates and hoist systems | Grant aid scheme |
| - Improvement of the downstream river bank protection (river side slope protection) | Grant aid scheme |
| - Rehabilitation of the downstream river bed protection (river apron protection) | Grant aid scheme |
| - Construction of a river outlet structure at the right side of the regulator | Grant aid scheme |
| - Construction of an operator's hut | <Excluded><br>The existing operator's hut still function and there was enough space for a new control panel. |
| **Reconstruction of Intakes with Gates** | |
| - Rehabilitation of the north approach channel to Andong Sla Intake | <Excluded><br>The north approach channel had enough flow capacity and necessity of urgent rehabilitation was not observed. |
| - Reconstruction of Andong Sla Intake with gates | Grant aid scheme |
| - Rehabilitation of the south approach channel to Vat Krouch Intake with gates | <Excluded><br>The south approach channel has enough flow capacity to serve the present irrigation area. Even though it is rehabilitated, its benefit will not be appreciated since there are no secondary canals and tertiary canals in the downstream area. |

| Project Works Proposed by MOWRAM | Evaluation in Japan's Grant Aid Scheme |
|---|---|
| - Reconstruction of Vat Krouch Intake with gates<br>- Construction of a power transmission line from the regulator to intakes | <Excluded><br>At present, a gate operator operates gates manually without any serious problems. Necessity of urgent rehabilitation has been not observed. |
| **Engineering Supporting Services** | |
| To prepare operation rules and operation manual for the facilities | Grant aid scheme |

*Source：Basic Design Study Report on the Project for Improvement of Roleang Chrey Headworks in the Kingdom of Cambodia, JICA, 2008*

### I-6.4.3 Project Design

The rehabilitation works under the grant aid scheme were designed with the following basic concepts.

- To maintain present agricultural productivity and farmers' income in the beneficial area of about 10,000 ha by stable irrigation water supply
- To supply irrigation water to the Kandal Stung Irrigation Area of about 1,950 ha located about 40 km downstream
- To mitigate inundation and flood damage in the upstream and downstream areas of the regulator

The design of the rehabilitation works of the Roleang Chrey Headworks are summarized in the following table.

**Table I-6.4.3.1 Design of Improvement Works under Grant Aid Project**

| Subject | Design of the Facilities |
|---|---|
| **Rehabilitation of Roleang Chrey Regulator** | |
| - Rehabilitation of all gates and hoist system<br>Gate type : Steel roller gate<br>Clear span: 12.5 m<br>Gate high: 6.7 m<br>Gate nos.: 5 sets | Replacement of wheel bushings and pins : 40 sets<br>(8 sets/gate × 5 gates)<br>Rust removal and re-painting of gate leaf : 5 sets of gates<br>Replacement of rubber seals : 5 sets of gates<br>Replacement of all hoist systems : 5 sets<br>(electric wire-rope winch type with counter weight)<br>Replacement of local control panels : 5 sets<br>Installation of new remote control panels at O&M office : 1 set<br>(including main distribution panels, distribution panels for room lighting connection cables between control panels and hoist system)<br>Installation of lightning arrestors: 3 sets<br>Installation of staff gauge: 5 sets<br>Core-drilling and recovery work on gate piers: 10 locations<br>(Dia. 40 cm × L 50 cm) |
| - Construction of the downstream river bed protection | Additional ground sill consolidation work :<br>W 72.5 m × L 8 m × H 1.25 m<br>Grouted riprap work : W 40 m × L 42 m × Thickness 0.5 m |
| - Rehabilitation of the downstream river bank protection | Toe foundation work :<br>W 2 m × H 2 m × L 110 m (right bank), L 90 m (left bank)<br>Riprap work : H 6 m × L 89 m (right bank), L 78 m (left bank) |
| - Construction of river outlet structure | Inlet : W 4.6 ~ 2.6m × H 6.0 ~ 8.0 m × L 13.9 m<br>Outlet : W 4.0 m × H 4.7 ~ 6.0 m × L 10.9 m<br>Culvert : Double lane concrete pipes Dia. 1.0 m × L 83 m<br>Manufacturing and Installation of new steel slide gates: 4 sets (total)<br>(Clear span 1.0 m × H 1.0 m, 4 edge-rubber seal, manual operation hoist system with rack pinion/ screw spindle type.<br>Discharge regulation gate: 2 sets, Maintenance gate: 2 sets) |
| **Reconstruction of Andong Sla Intake** | |
| - Reconstruction of the intake | Curtain walls:<br>W 4.0 m × H 2.5 m × 2 nos. (w/new gate sections)<br>W 4.0 m × H 5.2 m × 2 nos. (gate-dismantled sections)<br>Operation deck: W 2.0 m × Clear span 4.0 m × 4 nos.<br>Upstream Transition work: W 18.6~43 m × H 5.2 m × L 5 m<br>Downstream river bed protection work: W 18.6 ~ 33.8 m × Thickness 0.5 m |
| - Replacement of gates<br>Gate type : Steel radial gate<br>Clear span: 4.0m<br>Gate high: 2.7m | Removal of existing steel radial gates : 4 sets<br>Manufacturing and Installation of new steel radial gates: 2 sets<br>(4 edge-rubber seal, swing type manual operation hoist system with rack pinion/screw spindle) |

*Remarks ; W: Width, H: Height, L= Length, Dia. : Diameter*
*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

As for the existing reinforced concrete facilities for Roleang Chrey Regulator and Andong Sla Intake, the compression strength was examined using Schmidt hammer. The results shows that the existing reinforced concrete had enough compression strengthen as shown in Table I-1.6.5.3.2. Thus, it was determined that the existing reinforced concrete facilities mentioned above could be used without any treatment.

### I-6.4.4 Construction Method

(1) Roleang Chrey Regulator

(a) Temporary Diversion Work

As the work method of temporary diversion, the temporary coffer dam plan was selected through the comparative study. In the temporary coffer dam plan, the existing north approach channel with flow capacity of about 70 $m^3$/sec will be utilized instead of the newly constructed temporary diversion channel. For the protection of said approach channel, a temporary spillway with related facilities with flow capacity of 40 $m^3$/sec was planned to be newly constructed on the north approach channel.

(b) Hydro-mechanical Works

All the pins and bushing (40 sets) of the regulator's gate were to be replaced with new ones, of which the standard work sequence was planned to be (i) drilling 10 holes (diameter 40 cm and length 50 cm) in the concrete piers of the regulator, (ii) removal of wheels, bushings and pins through the drilled holes, (iii) measurement of bushings and pins, (iv) manufacturing of new bushings and pins from makers after size measurement, (v) rust removal and repainting of gate leaves and replacement of rubber seals, (vi) insertion of new bushings into the existing wheels and (vii) installation of existing wheel with new bushings and pins on the gate leaf.

(2) Andong Sla Intake

Since design discharge of the intake gates is 10.4 $m^3$/sec, 4 sets of the existing gates should be dismantled and 2 sets of new radial gates should be installed at the center of the intake. The work method planned in B/D are (i) provision of a temporary diversion channel and temporary coffer dams, (ii) construction of the side wall, guide wall and base slab after dismantling the four sets of the existing gates and vertical wall, (iii) replacement of 2 sets of new radial gates, (iv) construction of reinforced concrete curtain walls at the right and left spaces, reinforced concrete curtain walls, and (v) repair of downstream canal bed with grouted riprap.

### I-6.4.5 Project Cost and Evaluation

(1) Project Cost

Project cost estimate for the Japan's grant aid scheme is not officially available. According to the information obtained from Ministry of Foreign Affairs in Japan, the total amount of the grant was Yen 819 million in the E/N on June 15, 2009.

(2) Evaluation

The direct effects by the improvement of the Roleang Chrey Headworks are that (i) the present agricultural productivity of irrigated rainy season paddy of 2.3 to 2.4 tons/ha and gross farmers' income of US$ 450 to US$ 590 /household will be maintained due to a stable water supply to about 10,000 ha, (ii) the stable irrigation water supply with a discharge of about 5 $m^3$/sec will become possible to Kandal Stung irrigation area of about 1,950 ha, (iii) flood entrance to the north approach channel will be

prevented, and adequate irrigation water regulation, based on an irrigation water supply schedule, will become possible through the reconstruction of the Andong Sla intake, (iv) flood damage in the downstream area of the regulator will be mitigated since communication network among the related gate facilities located in the downstream area will be formulated and (v) the inundation risk to the upstream area of the regulator will be prevented since flood will more timely flow down owing to the smooth opening of the regulator's rehabilitated gates.

### I-6.4.6 Tendering and Results

Based on D/D, G/A was exchanged on June 15, 2009, and tendering schedule was determined. Prequalification (P/Q) was announced on August 3, 2009. In P/Q notice, tendering schedule was announced as follows.

- Closing of P/Q application; August 10, 2009
- Delivery of tender document; around 25th of August, 2009
- Closing of submission of tender; around middle of October, 2009

Submission of P/Q application was closed on August 10, 2009, however no applicant submitted the application by the date, and therefore the tendering for construction was failed. As one of reasons of failing in tendering was the work scope. In the results of technical study in F/S and the subsequent B/D and D/D, it concluded that there found no technical problem on gate body, but needs of (i) replacement of gate wheels, (ii) re-painting, (iii) replacement of sealers and (iv) replacement of hoist system. This rehabilitation work is technically possible, but if considering the construction period, merit and risk of contractor, relation between civil contractor and gate maker, it could seem that this work scope might be not attractive for the Japanese contractor.

## I-6.5 The Study on the Rehabilitation and Reconstruction of Agriculture Production System in the Slakou River Basin (Master Plan Study)

### I-6.5.1 Background

The Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin was executed based on the agreement between MOWRAM, RGC and JICA on October 9, 2000. The study including F/S on the priority projects was conducted from January 2001 to March 2002.

The study area of about 650 $km^2$ in total is located about 70 km southwest from Phnom Penh and extends mainly on the right bank of the Slakou River. It is administratively extending mainly in Takeo Province and partly in Kampong Speu Province, bordering on the Slakou River in the north, Kampot Province in the south and the west, and on the national road No.2 and the railway in the east.

Objective of the study was to prepare M/P for agricultural reconstruction/development in the upper to middle basin of the Slakou River as a model for the reconstruction/ development of shallow and small-scale reservoir irrigation systems in Cambodia.

### I-6.5.2 Project Components

The project aims at: (i) rehabilitating the existing facilities, and (ii) improving self-sustainable organization for O&M to increase agricultural productivities and (iii) a model project for reconstruction of small and medium scale irrigation system. The project components studied in M/P

are (i) agricultural production program including agriculture support program, (ii) irrigation-based development consisting of rehabilitation and reconstruction of irrigation and drainage infrastructures, rural road improvement program and institutional development program, and (iii) environmental conservation program.

### I-6.5.3 Agricultural Development Plan

(1) Crop Selection for Irrigated Agriculture

Proposed crops for the 3 irrigation development plans are selected on the basis of the following principles. These are to: (i) adopt paddy-based farming system in order to attain food sufficiency of the residents in the study area, (ii) introduce crop diversification before or after paddy cropping within the extent of available irrigation water in order to increase on-farm income, and (iii) select suitable diversified crops by examination of suitability for natural conditions, profitability, marketability of products and present level of farmers farming technique.

**Table I-6.5.3.1 Selected Crops for Irrigation Development Plans**

| Plans | Paddy | Diversified Crops |
|---|---|---|
| 1) Upper Slakou River Irrigation Reconstruction (3,500 ha) | High Yielding Varieties (HYVs) (early maturing paddy of IR-series) and Improved local varieties (medium maturing varieties) | Maize, Beans (Mung-bean, Soybean), Groundnut, Sesame, and Vegetables (Cucumber, Tomato, Eggplant, String-bean, Watermelon, Pumpkin, Mustard green, Chili, etc.) |
| 2) Small Reservoir Rehabilitation (280 ha) | | |
| 3) Small Pond Development (2,100 ha out of 39,220 ha) | HYVs or Improved local varieties (medium maturing varieties) under rain-fed condition | Beans (Mung-bean, Soybean), Groundnut, Sesame, and Vegetables (Cucumber, Tomato, Eggplant, String-bean, Watermelon, Pumpkin, Mustard green, Chili, etc.) |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System*

(2) Cropping Pattern and Crop Production

The target yields are estimated as shown below, taking into due consideration low soil fertility, cropping under lower sunlight conditions in the rainy season, and application of water saving irrigation method.

**Table I-6.5.3.2 Anticipated Unit Yield under Irrigated Condition**

| Crop | Yield (ton/ha) | | Crop | Yield (ton/ha) | |
|---|---|---|---|---|---|
| | Average | Range | | Average | Range |
| Rice (medium) | 2.8 | 2.5 - 3.0 | Average of vegetables *2 | 8.3 *1 | |
| Rice (early) | 3.3 | 3.0 - 3.5 | | | |
| Maize | 2.0 | 1.8 - 2.2 | Cucumber | 10.0 | 8.0 -12.0 |
| Groundnut *2 | 0.85 | 0.8 - 0.9 | String-bean | 6.0 | 5.0 - 7.0 |
| Soybean *2 | 1.0 | 0.9 - 1.1 | Tomato | 9.0 | 8.0 -10.0 |
| Sesame *2 | 0.8 | 0.6 - 0.85 | | | |

**1: Average of three kinds of vegetables: Cucumber, string bean and tomato*
**2: Yields of PDP area were estimated at 80% of the above yields for manual irrigation.*
*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System*

The proposed cropping area and production in the future is shown in the following table. It is expected that paddy production will increase to nearly twice that of the present condition, and diversified crops including vegetables will be major crops in the irrigated area.

**Table I-6.5.3.3 Cropped Area, Production and Production Increase in Irrigation Area**

| Crop | Cropping Area (ha) | Production (ton) | Increment (ton) |
|---|---|---|---|
| Rice | 3,780 | 11,178 | 6,654 |
| Maize | 86 | 173 | 143 |
| Groundnut | 520 | 378 | 346 |
| Soybean/Mung-bean | 1,058 | 906 | 823 |
| Sesame | 520 | 356 | 356 |
| Vegetables | 1,980 | 13,970 | 12,640 |
| Total | 7,944 | | |

*Source: Table II-4.5.1, Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System*

### I-6.5.4 Irrigation and Drainage Development Plan

The fundamental constraint for rehabilitation and reconstruction of agricultural production system in the Slakou River Basin is the limited water resources to improve productivity and promote product diversification. Based on the present availability of water resources, the three development approaches were studied: (i) Upper Slakou River Irrigation Reconstruction Plan (USP in M/P and F/S), (ii) Small Reservoir Rehabilitation Plan (SRP), and (iii) Small Pond Development Plan (PDP).

Out of them, USP was taken up in the Survey. According to M/S, 12 development alternatives for combination of water resources were examined in terms of cost and development scale, technical soundness, negative impact as shown as follows:

**Table I-6.5.4.1 Development Alternatives in Master Plan**

| Alternative | Combination of Reservoirs and Dike Top Elevation | | | Irrigation area (ha) | Contribution of O Saray reservoir* | Evaluation for dike raising** | Construction cost (US$ /ha) | Remarks |
|---|---|---|---|---|---|---|---|---|
| | Kpob Trobek | O Saray | Tumnup Lok | | | | | |
| Alt 1-1 | 39m | - | - | 800 | | | 5,190 | |
| Alt 1-2 | 40m | - | - | 950 | | Excluded for flood risk | | Not applicable |
| Alt 2-1 | 39m | 40.5m | - | 1,100 | Irrigation area is significantly increased (300 ha or 38%) | | 6,119 | |
| Alt 2-2 | 40m | 40.5m | - | 1,350 | Irrigation area is significantly increased (400 ha or 42%) | Excluded for flood risk | | Not applicable |
| **Alt 3-1** | **39m** | **-** | **43m** | **3,500** | | | **3,483** | **Selected alternative** |
| Alt 3-2 | 39m | - | 44m | 4,000 | | Excluded for negative impacts | | Not applicable |
| Alt 3-3 | 40m | - | 43m | 4,000 | No significant increase in irrigation area (200 ha or 6%) | Excluded for flood risk | | Not applicable |
| Alt 3-4 | 40m | - | 44m | 4,500 | No significant increase in irrigation area (100 ha or 2%) | Excluded for flood risk and negative impacts | | Not applicable |
| Alt 4-1 | 39m | 40.5m | 43m | 3,700 | No significant increase in irrigation area (100 ha or 2%) | | | Not applicable |
| Alt 4-2 | 39m | 40.5m | 44m | 4,100 | No significant increase in irrigation area (100 ha or 2%) | Excluded for negative impacts | | Not applicable |
| Alt 4-3 | 40m | 40.5m | 43m | 4,100 | Irrigation area is significantly increased (300 ha or 38%) | Excluded for flood risk | | Not applicable |
| Alt 4-4 | 40m | 40.5m | 44m | 4,600 | Irrigation area is significantly increased (400 ha or 42%) | Excluded for flood risk and negative impacts | | Not applicable |

*-: not included in the alternative*
**: The results show that O Saray Reservoir contributes to an increase in irrigable area in Alternative series 2, but little in Alternative series 4.*
***: Dike raising plans by 1.0 m (high dike plan) were excluded from the risk of floods damage to the village downstream the Kpob Trobek reservoir and negative impacts such as compensatory work for the village road and increment of submergence area for the Tumnup Lok reservoir*
*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System*

The benefit area of USP would be fed with irrigation water by 2 main canals (Main Canal 33 and Koh Kaek Canal) and Secondary Canal 24 (C24) starting at the Kpob Trobek Reservoir and their secondary canals. Finally, Alternative 3-1 (Kpob Trobek- 39 m + Tumnup Lok- 43 m) was selected as the most appropriate development alternative, which is the largest development scale of 3,500 ha with the lowest development cost per ha, and less risk against flood damages and adverse impacts to the environment.

### I-6.5.5 Agricultural Support Plan

The study was made for (i) FGs at Village Level, (ii) Extension Service of Agriculture and Animal Husbandry, (iii) Credit Service, and (iv) Agro-processing and Marketing. Out of them, "extension service of agriculture" which is closely related to the project, is summarized as follows:

**Table I-6.5.5.1 Summary of Improvement of Extension Services**

| Components | Activities / Required inputs |
|---|---|
| Improvement of extension service | Activities<br>- Implementation of FFSs<br>- Preparation and distribution of technical booklet<br>- Periodical training and guidance for extension workers by research institutes<br>- Training for leader farmers for village level extension activities through FFS<br>- Organization of a extension FG under Village Development Committee (VDC)<br>- Setting- up of demonstration plots in the village<br>- Assignment of field staff (field extension specialists) for technical service<br>- Training of leader farmers<br>- Field level extension specialists (to be recruited from local consultants or NGOs)<br>- Senior extension specialist / Trainer for field level extension specialists<br>- Extension facilities and equipment including transportation and communication facilities |
| Promotion of paddy seed multiplication | Activities<br>- Multiplication and distribution of improved paddy seeds<br>Required inputs:<br>- Importing improved breeder seeds<br>- Training of seed growing farmers |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

### I-6.5.6 Project Cost and Evaluation

(1) Project Cost

The project cost for USP was estimated at Riel 71,461 million, and that for SRP and PDP was estimated at Riel 1,036 million and Riel 381 million, respectively.

(2) Project Evaluation

The economic cost and benefit stream comprising (i) the cost for project investment, O&M and replacement, and (ii) irrigation and drainage, and negative benefit was prepared for the economic life of the respective projects for USP, SRP and PDP. EIRR and other indicators were calculated and summarized as follows:

**Table I-6.5.6.1 Economic Efficiencies of Projects**

| Item | USP | SRP | | | PDP (Per 5ha) | | |
|---|---|---|---|---|---|---|---|
| | | Kim Sei | Ang 160 | Trapeang Lean | Pond (Group) | Canal Pond | Pond (individual) |
| EIRR (%) | 10.0 | 9.4 | 9.8 | 6.6 | 10.5 | 14.4 | 7.7 |
| NPV (Riel Million) | | | | | | | |
| (6.5% discount rate) | | | | | | | |
| Benefit | 59,380 | 417 | 417 | 199 | 102 | 107 | 98 |
| Cost | 40,780 | 302 | 291 | 197 | 72 | 59 | 88 |
| B – C | 18,600 | 115 | 126 | 2 | 30 | 48 | 10 |
| B / C | 1.5 | 1.4 | 1.4 | 1.0 | 1.4 | 1.8 | 1.1 |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

## I-6.6 Upper Slakou River Irrigation Reconstruction Plan (Feasibility Study)

### I-6.6.1 Project Works

The project works proposed based on the irrigated agricultural development plan for the area are (i) rehabilitation and reconstruction of the existing irrigation and drainage facilities covering irrigation

area of 3,500 ha, (ii) procurement of O&M equipment including marketing assistance facilities, and (iii) institutional development.

### I-6.6.2 Agricultural Development Plan

(1) Proposed Cropping Pattern and Planted Area

Paddy-based cropping system is applied for the improvement of food security in the project area. Crop diversification is also encouraged within the availability of irrigation water to increase farmers' income in USP. USP distributes irrigation water to 3,500 ha of paddy field. The rainy season paddy of the whole area is irrigated and water additionally irrigates 500 ha and 550 ha of diversified crops before and after the paddy cultivation, respectively.

(2) Target Unit Yields

Target unit yield of paddy was estimated at 2.8 ton/ha for local variety, 3.3 ton /ha for HYV through examination of the yields in existing irrigation areas in and around the project area.

(3) Prospective Crop Production

The paddy production is planned to be 10,350 ton in the USP Area. The incremental production is estimated at 6,050 ton. The diversified crops, especially, vegetables in the USP Area, are expected to become a major cash crop income source for the beneficiaries.

### I-6.6.3 Irrigation and Drainage Development Plan

(1) Development Concept

Most of the existing irrigation facilities were constructed in the mid 1970's during the Pol Pot regime, and these now require significant rehabilitation and/or reconstruction. The major development concept for irrigation and drainage system are that (i) both initial construction cost and O&M cost are to be as low as possible with due consideration to maintain sufficient function, safety and durability, (ii) reliability level is set at 80% dependability, (iii) lining would not be considered except for the new canal or unless the minimum allowable flow velocity could be maintained, (iv) related structures of the canal, both in terms of structure and materials, would be designed to conform with those that PDOWRAM and Department of Rural Development (DRD) generally design and construct in Takeo Province and (v) the basic concept of drainage in USISRSP is "maintenance of the status quo".

(2) Proposed Facility Plan

USP, which was selected as a high priority project in M/P, would divert irrigation water from Tumnup Lok Reservoir on the Slakou River, through the Diversion Canal. The diverted water will be stored and regulated at Kpob Trobek Reservoir and will irrigate 3,500 ha through Main Canal 33 and C24, as shown in Figure AD-2.2.1.1.2 in ANNEX D. The basic features of the proposed irrigation facilities are listed below.

**Table I-6.6.3.1 Basic Features of Proposed Irrigation Facilities for Upper Slakou River Irrigation Reconstruction Plan**

| Item | Description |
|---|---|
| Net irrigation area | 3,500 ha |
| Beneficiaries: | 4,020 Households (HHs) of 32 villages in 5 communes in Tram Kak District |
| Reconstruction of Tumnup Lok reservoir including spillways | Catchment area = 332 $km^2$, Effective storage volume = 1.0 MCM,<br>Dike top EL. = 43.3 m, Flood discharge (100 years) = 420 $m^3$/sec, HWL = EL.41.3 m,<br>LWL = EL.40.4 m, L = 2.5 km) |
| Reconstruction of Kpob Trobek reservoir including intakes and spillways | Catchment area = 137 $km^2$, Effective storage volume = 2.63 MCM,<br>Dike top EL. =39.0 m, Flood Discharge (100 years) = 195 $m^3$/sec, HWL = EL.37.3 m,<br>LWL = EL.34.2 m, L = 3.3 km |

| Item | Description |
|---|---|
| Reconstruction of Diversion Canal | Q = 3.5 $m^3$/sec, L = 9.4 km running between the above two reservoirs |
| Rehabilitation of Main Canal 33 | Q = 3.2 $m^3$/sec, L = 7.3 km |
| Rehabilitation of C24 | Q = 0.6 $m^3$/sec, L = 5.7 km |
| Rehabilitation of other 6 secondary canals | L=39 km |
| On-farm development including tertiary canals and watercourses | Tertiary canal: 33 ha per block on average<br>Watercourse: 5 ha per quaternary block on average |
| Others | Construction of project office at Angk Roka, Ta Phem Commune |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

(3) Institutional Development and Capacity Building Program

Institutional development and capacity building programs were proposed, in order to (i) smoothly organize FWUC, (ii) conduct financially and technically sustainable operation of FWUCs, and (iii) ultimately increase farm income. It was proposed that MOWRAM would deploy experts of institutional development and capacity building for 6 years. Two steps are proposed for the implementation of the program. Firstly, the deployed experts will provide training for the project office staff. Secondly, the trained project office staff will give training to farmers and FWUC staff.

For the institutional development and capacity building for project office staff, deployment of 8 experts such as FWUC Expert, Irrigation O&M Expert, Participatory On-farm Development Expert, were proposed. The proposed training programs to farmers and FWUC staff are as follows:

**Table I-6.6.3.2 Proposed Training Programs to Farmers and FWUC staff**

| Program | Participants |
|---|---|
| FWUC and its formation to farmers | about 4,020 HHs |
| On-farm development to FWUC staff | 72 persons in total |
| Management of FWUC to FWUC staff | 22 persons in total |
| O&M irrigation facilities to FWUC staff | 82 persons in total |
| Marketing to FWUC staff | 10 persons in total |
| Farming practice | 120 leader-farmers |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

(4) Operation and Maintenance Equipment

It was assumed in F/S that the project office would be curtailed to a small advisory unit, so-called as "the Technical Supervision & Assistance Unit (TSAU)", upon the completion of the formation of FWUC and the project works. And, FWUC of USP would work under TSAU for the first 4 years as joint management. After the joint management, FWUC should manage all the O&M work itself. Based on the above assumptions, the following facilities and equipment were proposed to be provided for both project office and FWUC:

- An Apex Committee office, 6 secondary canals FWUC offices, and 2 gate keepers' huts
- Computers and ordinary office equipments such as desks, chairs, and cabinets
- One four-wheel drive vehicle, 8 motorcycles, 3 walky-talkies, 1 generator

### I-6.6.4 Agricultural Support Plan

Four agricultural support plans are proposed in F/S. These are (i) Organization of FGs, (ii) Extension Services, (iii) Credit Services and (iv) Marketing Assistance Program. Out of them, "Extension Services" are highly related to the project.

The proposed agricultural extension plan consists of 3 components, i.e. (i) strengthening plan of extension service, (ii) paddy seed production plan, and (iii) distribution plan of farm inputs as follows:

**Table I-6.6.4.1 Summary of Strengthening Plan of Agricultural Extension Services**

| Components | Contents |
|---|---|
| FFS | Objective: Training of leader farmers who disseminate the trained farming practice to farmers in their villages as Village Extension Workers (VEWs)<br>Period: One day every week during 16 weeks according to the cropping season of the target crop<br>Curriculum of FFS: All farming practices from land preparation to post-harvesting, and Integrated Pest Management (IPM)<br>FFS course: Paddy and diversified crops including vegetables<br>Participants: Around 30 farmers |
| Demo-plots in Farmers' Field | Objective: Demonstration of improved farming technology and improved varieties for beneficiaries in the field<br>Size: 0.1 ha per plot of farmer's field<br>Farm inputs: Free supply of seeds and fertilizer<br>Activities: Eight Demo-plots to each secondary canal FWUC<br>Two plots each for: (i) local paddy, (ii) HYV paddy, (iii) rainy season diversified crops, and (iv) dry season diversified crops |
| Extension Activities of VEWs | Activities: VEWs will have to effectively use Demo-plots for dissemination of improved technology<br>Extension officers and Takeo PDA will support and monitor the VEW activities |

*Source: Tables IV-5.2.1 and IV-5.2.2, Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

**Table I-6.6.4.2 Summary of Rice Seed Production Plan**

| Components | Contents |
|---|---|
| Rice seed production | Requirement: About 50 - 60 ton per year to 3,500 ha<br>Sowing rate is 50 - 60 kg/ha.<br>Renewal is done every 4 cropping seasons.<br>Seed production in 25 - 30 ha of paddy field<br>Seed growers: About 30 farm HHs<br>Inspection: Takeo PDA |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

**Table I-6.6.4.3 Summary of Distribution Plan of Farm Inputs**

| Components | Contents |
|---|---|
| Distribution plan of farm inputs | Situation: Transportation cost is high from market, (Ang Roka, or Angk Ta Saom) to village. The farm-gate price of fertilizer is generally 5 - 7% higher than that in Takeo and Angk Ta Saom market.<br>Activity: Extension FGs take a few percent as a handling charge from farmers to fund for activities such as VEWs work and Demo-plots. |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

## I-6.6.5 Project Cost and Evaluation

(1) Estimated Project Cost

Total amount of the project cost of the plan is Riel 76,625 million as summarized below. The estimated total cost was equivalent to US$ 19.1 million or unit development cost of US$ 5,433 /ha.

**Table I-6.6.5.1 Project Cost of USP Estimated in F/S** (Unit: million Riel)

| Work Item | F/C | L/C | Total |
|---|---|---|---|
| Preparatory Work | 2,484.9 | 846.3 | 3,331.2 |
| Direct Construction Cost | 30,633.5 | 14,238.0 | 44,871.5 |
| O&M Equipment | 156.7 | 10.3 | 167.0 |
| Institutional Development | 666.9 | 1,760.8 | 2,427.7 |
| Relocation and Land Compensation Cost | 3.3 | 197.0 | 200.3 |
| Administration Cost | 155.7 | 824.3 | 980.0 |
| Consulting Service | 11,921.7 | 623.5 | 12,545.2 |
| Contingencies | 8,358.0 | 3,743.7 | 12,101.7 |
| Total | 54,380.7 | 22,243.9 | 76,624.6 |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

(2) Evaluation

The economic cost and benefit stream comprising (i) the cost of project investment, O&M and replacement, and (ii) irrigation and drainage, road improvement, and negative benefit was prepared for the economic project life. EIRR and other indicators were calculated as follows:

**Table I-6.6.5.2 Economic Efficiency of Project**

| EIRR (%) | NPV at 6.5% discount rate | | | |
|---|---|---|---|---|
| | Benefit | Cost | B - C | B / C |
| 10.2 | Riel 73,660 million | Riel 47,535 million | Riel 26,125 million | 1.5 |

*Source: Volume I Main Report, the Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin*

## I-6.7 Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study)

### I-6.7.1 Background

The construction works of the dam for storing capacity of 1,120 MCM and power station of the Prek Thnot Multipurpose Project were started in 1969 and have been suspended since 1974 due to the civil wars. A re-appraisal of the project was carried out in 1991, and it was identified that about 4,200 ha under "without-dam" conditions, 34,000 ha under "with-dam" conditions if irrigation priority is given, and 27,000 ha if hydropower generation is given priority, would be respectively irrigable.

The M/P Study was executed from 1993 to 1995 in accordance with the Scope of Work agreed upon between MAFF of the Kingdom of Cambodia and JICA in January 1993. The objectives of the M/P Study were to formulate an integrated agricultural and rural development plan to achieve substantial and sustainable improvement in the living conditions of the inhabitants in the area. Focus was put on the water resources in the Prek Thnot River basin, agricultural resources, social and agricultural infrastructures, and rural living improvement.

### I-6.7.2 Basic Development Plan for Integrated Agricultural and Rural Development

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

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

To achieve the objectives mentioned above and solve the present problem, the following plans were prepared and proposed:

- Improvement of irrigation and drainage facilities,
- Agricultural development,
- Strengthening of agricultural supporting services including fanners' organization,
- Development of rural infrastructure,
- Improvement of rural life,
- Establishment of model area, and
- Landscape improvement.

The stage-wise integrated development plan for agricultural and rural components covering for 8,400 ha was proposed in consideration of the availability of irrigation water source in the Prek Thnot River as explained below:

(1) First Stage Development (without Prek Thnot Reservoir)

Irrigated agricultural development of 3,550 ha consisting of 1,950 ha in the Kandal Stung area and 1,600 ha in the Tonle Bati area was selected as priority development areas, where reliable irrigation water could be ensured under "without Prek Thnot Reservoir" conditions. The first stage development includes;

- Urgent improvement of the Tuk Thla and Kampong Tuol regulators on the Prek Thnot River,
- Rehabilitation of irrigation and drainage systems
- Rural infrastructures development,
- Measures for rural life improvement,
- Support services to women's group, and
- Measures for environment problems.

(2) Second Stage Development (with Prek Thnot Reservoir)

The remaining development of 4,850 ha, consisting of 2,250 ha in Kandal Stung area and 2,600 ha in Tonle Bati area, was covered under the second stage development under "with Prek Thnot Reservoir" condition. The commencement of the irrigation works was expected to be coincided with the implementation time schedule of the Prek Thnot Multipurpose Dam.

### I-6.7.3 Agricultural Development Plan

(1) Crop Selection for Irrigated Agriculture

The most promising crops were selected based on the results of investigations on the natural and social condition in the project area. Paddy was a base of farming and economic activities and supply of staple food. Farmers in the area had long experience in paddy cultivation. Rice varieties to be introduced were high-yielding varieties with early to medium maturing period or 120 to 150 days. Meanwhile maize and soybeans were selected for the secondary crops in the dry season, in connection with the promotion of livestock production especially pig and poultry. Since vegetables such as Chinese cabbage, cabbage, string beans and kale, were planned to be introduced as cash crops in the dry season. Green grams, groundnuts, sesame and sweet potato were also considered to be introduced in the dry season.

(2) Cropping Pattern and Crop Production

The main aim of the proposed irrigated agricultural development was to stabilize cultivation of the rainy season rice, and then to introduce the early rainy season rice in about 50% of the irrigated area. Meanwhile it was planned to introduce upland crops especially for promotion of livestock raising. The area of mixed cultivation of maize and soybeans were about 38% of the irrigated area together with about 12% of vegetables under with Prek Thnot Reservoir condition. Under without Prek Thnot Reservoir condition, mixed cultivation of soybeans/maize and vegetables were about 15%, respectively. As a result, cropping intensity for each alternative were 200% for 8,400 ha and 180% for 3,850 ha, respectively as shown in below tables:

**Table I-6.7.3.1 Proposed Cropping Pattern, Cropping Intensity, and Area to be Cultivated**

(a) With Prek Thnot Reservoir

| Scheme | Crop | Rainy Season | | Dry Season | | Total | |
|---|---|---|---|---|---|---|---|
| | | Cropping Intensity (%) | Area (ha) | Cropping Intensity (%) | Area (ha) | Cropping Intensity (%) | Area (ha) |
| Kandal Stung (4,200 ha) | Rice | 100 | 4,200 | 50 | 2,100 | 150 | 6,300 |
| | Maize / Soybeans | - | - | 38 | 1,596 | 38 | 1,596 |
| | Vegetables | - | - | 12 | 504 | 12 | 504 |
| | Total | 100 | 4,200 | 100 | 4,200 | 200 | 8,400 |
| Tonle Bati (4,200 ha) | Rice | 100 | 4,200 | 50 | 2,100 | 150 | 6,300 |
| | Maize / Soybeans | - | - | 38 | 1,596 | 38 | 1,596 |
| | Vegetables | - | - | 12 | 504 | 12 | 504 |
| | Total | 100 | 4,200 | 100 | 4,200 | 200 | 8,400 |

*Source: Fig. IV-10 (1/3). Annex IV, Vol. 3, Master Plan Study*

(b) Without Prek Thnot Reservoir

| Scheme | Crop | Rainy Season | | Dry Season | | Total | |
|---|---|---|---|---|---|---|---|
| | | Cropping Intensity (%) | Area (ha) | Cropping Intensity (%) | Area (ha) | Cropping Intensity (%) | Area (ha) |
| Kandal Stung (1,950 ha) | Rice | 100 | 1,950 | 46 | 900 | 146 | 2,850 |
| | Maize / Soybeans | - | - | 14 | 270 | 14 | 270 |
| | Vegetables | - | - | 14 | 270 | 14 | 270 |
| | Total | 100 | 1,950 | 74 | 1,440 | 174 | 3,390 |
| Tonle Bati (1,600 ha) | Rice | 100 | 1,600 | 50 | 800 | 150 | 2,400 |
| | Maize / Soybeans | - | - | 15 | 240 | 15 | 240 |
| | Vegetables | - | - | 15 | 240 | 15 | 240 |
| | Total | 100 | 1,600 | 100 | 4,200 | 180 | 2,880 |

*Source: Fig. IV-10 (2/3 and 3/3). Annex IV, Vol. 3, Master Plan Study*

Present yield of crops in the project area was rather low mainly due to lack of irrigation water, shortage of farm inputs, and low level of supporting services to supply farming techniques and inputs. After implementation of the project, the yield of crops would have been substantially increased and stabilized through getting accustomed to irrigation farming practices accompanied by agricultural support services. The target yield of crops at the full development stage was assumed as shown below:

**Table I-6.7.3.2 Anticipated Unit Yield under Irrigated Condition**

| Crop | Present | Without Irrigation | With Irrigation |
|---|---|---|---|
| Rice | | | |
| Local varieties | 1.2 | 2.5 | 3.0 |
| High Yielding Varieties | - | - | 4.0 |
| Maize & beans (mixed) | | | |
| Maize | 1.2 | 1.5 | 3.0 |
| Soybeans | 1.0 | 1.0 | 2.0 |
| Groundnut | 0.7 | 0.7 | 1.5 |
| Mungbeans | 0.6 | 0.6 | 1.0 |
| Sesame | 0.5 | 0.5 | 1.2 |

*Note:*
*1. Yield of rice is in dried paddy, maize and groundnuts for shelled grain. Maize and beans are grown as mixed crop.*
*2. Yield of without irrigation condition is assumed under the condition covered by agricultural support service.*
*Source: Page IV-43, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995*

## I-6.7.4 Irrigation and Drainage Development Plan

(1) Development Concept

The following were basic concept/consideration applied for preparing the proposed irrigation and drainage development plan:

- Realization of solid headwork (intakes on the Prek Thnot River), which was repeatedly damaged by floods to ensure the irrigation water supply to the project area, especially for the Kandal Stung area

- Full utilization of the existing canal system which was constructed in the Pol Pot regime in late 1970's
- Concrete lining is planned for main and lateral canals to ensure the slope protection of them
- Drainage canal system are separately provided from the irrigation canal system
- Additional construction of related structures and improvement of the existing ones
- Tertiary canal system covering about 50 ha and quaternary canal block of 7-10 ha are planned for efficient water management

(2) Application of Stage-wise Development

The maximum area suitable for irrigation development in Kandal Stung area was estimated at 4,200 ha based on the assessment of soil and topographic conditions as well as the result of the water balance study. 1,950 ha of the Kandal Stung Area will be served by the unregulated river flow (run-of-river water) of the Prek Thnot River through Kampong Tuol Headworks (Intake), with an irrigation dependable level of 4 out of 5 years. Remaining area of 2,250 ha (4,200 ha less 1,950 ha) could be implemented only after the realization of the Prek Thnot Reservoir.

The area suitable for irrigation development in the Tonle Bati area was also estimated at 4,200 ha at the maximum based on the water balance simulation. It is proposed to develop 1,600 ha based on the available water resources of the original flow of the Tonle Bati River and the storage of Lake Tonle Bati, since the implementation schedule of the Prek Thnot Multipurpose Dam Project was not formulated at the time, and it was not clear whether the Prek Thnot Reservoir would become operational.

(3) Proposed Works of Irrigation and Drainage Canal System

The proposed project works of the irrigation and drainage canal system are tabulated as below.

**Table I-6.7.4.1 Principal Features of Irrigation Development Plan Formulated in Master Plan Study**

| Description | Unit | Overall | Kandal Stung area | | Tonle Bati area | |
|---|---|---|---|---|---|---|
| | | Stage-1 (8,400 ha) | Stage-1 (1,950 ha) | Stage-2* (2,250 ha) | Stage-1 (1,600 ha) | Stage-2 (2,600 ha) |
| (a) Improvement of Tuk Thla and Kampong Tuol Headworks (Intakes) | (set) | 1 | | | | |
| (b) Main canal | | | | | | |
| - Improvement of main canals | (km) | | 5.3 | 0.0 | 8.3 | 0.0 |
| (c) Laterals | | | | | | |
| - Improvement of existing laterals | (km) | | 8.2 | 0.0 | 6.9 | 0.0 |
| - Construction of laterals | (km) | | 4.0 | 18.3 | 3.1 | 6.3 |
| (d) Tertiary canals | | | | | | |
| - Improvement/constriction of canals | (km) | | 56.8 | 65.5 | 48.1 | 78.2 |
| (e) Quaternary canals | (ha) | | 1,950 | 1,750 | 1,600 | 2,600 |
| (f) Drainage works | | | | | | |
| - Main Drain | (km) | | 18.1 | 20.9 | 10.4 | 16.9 |
| - Secondary drain | (km) | | 64.6 | 74.5 | 13.7 | 22.3 |
| (g) Improvement of Lake Tonle Bati Related Structures | | | | | | |
| - Intake | (nos.) | | - | - | 1 | - |
| - Pumping station | (nos.) | | - | - | 1 | - |
| - Spillway of the lake | (nos.) | | - | - | 1 | - |
| - Lake dike | (km) | | - | - | LS | - |
| (h) Improvement of Connection Canal | | | | | | |
| - Connection canal | (km) | | | | 4.6 | |
| - Stung Touch Regulator | (nos.) | | | | 1 | |
| - Stung Touch Dike | (km) | | | | 1.0 | |
| - Kandal Stung Regulator | (nos.) | | | | 1 | |

**: Although under Stage-2 of Kandal Stung area, Saba Scheme of 500 ha is included, the Master Plan Study gave lower priority due to high cost of dam construction against its commanding area of 500 ha*

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

### I-6.7.5 Agricultural Support Plan

The supporting services proposed in M/P comprise (i) the agricultural technical extension, (ii) agricultural inputs and equipment supply, rural credit supply and agricultural insurance system, and (iii) operation and maintenance of irrigation and drainage system and provided rural infrastructures such as road and domestic water supply. Furthermore, it was proposed that all of the proposed agricultural support services be extended through 3 proposed agricultural development centers.

The most important activities in agricultural support plan is to carry out agricultural extension services, which should be provided mainly for food (rice), some other secondary crops, and livestock raising mainly pig, poultry, and cattle for draft power, through provision of trained extension personnel, vehicles and equipment and office buildings to be constructed as follows:

**Table I-6.7.5.1 Summary of Improvement of Extension Services**

| Components | Activities / Required inputs |
|---|---|
| Improvement of extension service | Activities<br>- Introduction of improved varieties<br>- Supply of planting materials<br>- Demonstration and guidance on cultivation techniques<br>- Extension on livestock production<br>- Strengthening of vaccination service<br>- Monitoring and evaluation |
| Staff recruitment for agricultural development centre | Kandal Stung No. 1 (existing): 5,600 ha 7 persons<br>Kandal Stung No. 2 (proposed): 5,700 ha 10 persons<br>Tonle Bati (existing): 6,900 ha 10 persons |
| Facilities and Equipment | 1. for Agricultural Development Center<br>- Office Space for subject matter specialists — 3 specialists in each centre<br>- 4WD vehicle — 3 for each centre<br>- Minibus(20persons) — 1 for each centre<br>- Mobile extension unit vehicle(4WD)with audio visual equipment and veterinary service — 1 in each centre<br>- Cold storage for Vaccine(Solar energy) — 1 in each centre<br>- Copy/Printing machine — 1 in each centre<br>- Personal computer with printer — 1 set in each centre<br>- Residence — 1 residence for each specialist<br>- Trial cum demonstration farm — 1 ha for each centre<br>- Electricity supply — 1 in each centre<br>- Portable generator for community hall — 2 for each centre<br>- Farm machinery for demonstration machinery for each centre — 1 set of mechanized rice farming |
| | 2. In Community Hall<br>- Office Space for field worker — 1 to 3 persons<br>- Motor cycle — 1 for each worker<br>- Residence — 1 for each worker<br>- Store space for equipment — 1 space in each hall<br>Trial farm — 0.1 ha<br>- Life improvement training facilities — 1 set |

*Source: Page IV-51, Annex IV, Vol. III, Master Plan Study*

### I-6.7.6 Selection of Priority Development Area

The priority development area of 3,550 ha (total irrigation area of Stage-1 of Kandal Stung and Tonle Bati areas) were selected from the suitable irrigation development area of 8,400 ha, by the availability of water resource (with irrigation dependency of 4 out of 5 years) under the condition of the "without the Prek Thnot Multipurpose Dam", considering uncertainness of implementation of the Prek Thnot Multipurpose Dam Project. Priority development area of 3,550 ha consists of 1,950 ha in the Kandal Stung Area and 1,600 ha in the Bati Area.

### I-6.7.7 Preliminary Project Cost and Evaluation

(1) Project Cost

The project cost consists of construction cost, procurement of machinery, land acquisition cost, engineering and administration cost and contingency. The total project cost was estimated at US$ 101.3 million and the cost required for the first stage works was estimated at US$ 67 million as shown below.

**Table I-6.7.7.1 Financial Project Cost Estimated in M/P Stage**

(Unit: US$ million)

| Description | Total (8,400 ha) | Stage-1 (3,550 ha) |
|---|---|---|
| (a) Construction cost | | |
| 1) Irrigation and drainage | 51.35 | 38.48 |
| 2) Rural development centre | 5.29 | 2.59 |
| 3) Rural road network | 9.21 | 6.53 |
| 4) Rural water supply system | 3.88 | 1.07 |
| 5) Village clinic | 0.38 | 0.14 |
| 6) School building | 1.37 | 0.92 |
| 7) Community hall | 3.23 | 1.26 |
| 8) On-farm development | 5.30 | 2.20 |
| Sub-total | 80.02 | 53.20 |
| (b) Procurement of O&M equipment | 2.00 | 1.00 |
| (c) Engineering service and administration | 9.84 | 6.50 |
| (d) Land acquisition | 0.23 | 0.03 |
| (e) Contingencies | 9.21 | 6.07 |
| **Total** | **101.30** | **66.81** |

*Rate in 1994: US$ 1.0 = Riel 2,200 = Yen 100*

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

(2) Project Evaluation

The economic incremental agricultural benefit for the irrigation development area under "without Prek Thnot Reservoir" conditions, was estimated at US$ 2.1 million and US$ 1.8 million for the Kandal Stung and the Tonle Bati Areas, respectively, totaling about US$ 3.9 million. EIRR of the proposed agricultural development plan under the "without Prek Thnot Reservoir" condition (priority development area of 3,550 ha) was estimated at 12 %.

## I-6.8 Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Feasibility Study)

### I-6.8.1 Background

F/S was carried out for the priority development area of 3,550 ha consisting of 1,950 ha of the Kandal Stung Area and 1,600 ha of the Bati Area from 1993 to 1995. The priority area was selected in the Master Plan Study from the suitable irrigation development area of 8,400 ha, and mainly by the availability of water resource (with 80% dependability) under the condition of the “without Prek Thnot Reservoir”, considering uncertainness of implementation of the Prek Thnot Multipurpose Dam Project.

### I-6.8.2 Project Components

Proposed components for the priority development area of 3,550 ha are tabulated as below.

**Table I-6.8.2.1 Proposed Project Components for Priority Development Area of 3,550 ha in F/S**

| Components | Description |
|---|---|
| (a) Agricultura1 development | - Improvement and strengthening of agricultural support services, |
| | - Establishment of a Rural Development Centre, including a demonstration farm |
| (b) Irrigation and drainage development | - Improvement of the Tuk Thla and Kampong Tuol headworks (regulators) on the Prek Thnot River |
| | - Improvement of irrigation and drainage facilities of the Kandal Stung area of 1,950 ha and Tonle Bati area of 1,600 ha |
| (c) Development of rural infrastructures- | - Improvement of rural road network, |
| | - Construction of rural water supply facilities, |
| | - Improvement of village clinics, |
| | - Improvement of school buildings, and |
| | - Construction of community halls |
| (d) Measures for rural life improvement | |
| (e) Support services to Women's group | |
| (f) Measures for environment problems | |

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

## I-6.8.3 Agricultural Development Plan

(1) Proposed Cropping Pattern and Planted Area

The proposed cropping patterns, under "without Prek Thnot Reservoir" condition, were prepared on the basis of the following basic principles which govern the selection of crops and cropping seasons to be introduced under the project conditions:

- In the rainy season, 100% of irrigable land would be cultivated with paddy
- In the dry season, 50% of land is allocated for paddy, while 30% of land is allocated for upland crops such as maize, soybeans and vegetables.

The proposed cropping pattern for the Kandal Stung Area (1,950 ha) and the Tonle Bati Area (1,600 ha) were elaborated based on the above mentioned concepts and summarized as follows:

**Table I-6.8.3.1 Planted Area**

| Crops | Kandal Stung Area (1,950ha) | | | | Tonle Bati Area (1,600ha) | | | |
|---|---|---|---|---|---|---|---|---|
| | Rainy Season | | Dry Season | | Rainy Season | | Dry Season | |
| | (%) | (ha) | (%) | (ha) | (%) | (ha) | (%) | (ha) |
| Rice | 100 | 1,950 | 46 | 900 | 100 | 1,600 | 50 | 800 |
| Early dry season rice | 0 | 0 | 46 | 900 | 0 | 0 | 50 | 800 |
| Early rainy season rice | 50 | 975 | 0 | 0 | 50 | 800 | 0 | 0 |
| Medium rainy season rice | 30 | 585 | 0 | 0 | 30 | 480 | 0 | 0 |
| Medium local variety of rice | 20 | 390 | 0 | 0 | 20 | 320 | 0 | 0 |
| Maize & soybeans | 0 | 0 | 14 | 270 | 0 | 0 | 15 | 240 |
| Vegetables | 0 | 0 | 14 | 270 | 0 | 0 | 15 | 240 |
| Total Crop Intensity/ area | 100 | 1,950 | 74 | 1,440 | 100 | 1,600 | 80 | 1,280 |

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

(2) Target Unit Yields

The present yield of crops in the priority development area was rather in low level mainly due to lack of irrigation water, flooding and poor drainage, shortage of farm inputs, and low level of supporting services to supply farming techniques and materials. After implementation of the project, the yield of crops would have been substantially increased and stabilized through getting accustomed to irrigation farming practices accompanied by agricultural support services. The target yield of crops at the full development stage was assumed as shown below:

**Table I-6.8.3.2 Target Crop Yields** (Unit: ton/ha)

| Crop | Present | Without Irrigation | With Irrigation |
|---|---|---|---|
| Rice | | | |
| Local varieties | 1.2 | 2.5 | 3.0 |
| High Yielding varieties | - | - | 4.0 |
| Maize & beans (mixed) | | | |
| Maize | 1.2 | 1.5 | 3.0 |
| Soybeans | 1.0 | 1.0 | 2.0 |
| Groundnut | 0.7- | 0.7 | 1.5 |
| Mungbeans | 0.6 | 0.6 | 1.0 |
| Sesame | 0.5 | 0.5 | 1.2 |

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

(3) Prospective Crop Production

The anticipated annual paddy production at the full target level in the area was summarized as follows:

**Table I-6.8.3.3 Anticipated Crop Production in Priority Development Area**

| Section | Kandal Stung | | | Tonle Bati | | |
|---|---|---|---|---|---|---|
| | ha | ton/ha | ton | ha | ton/ha | ton |
| Rice: | | | | | | |
| Local varieties | 390 | 3.0 | 1,170 | 320 | 3.0 | 960 |
| High Yielding varieties | 2,460 | 4.0 | 9,840 | 2,080 | 4.0 | 8,320 |
| Total | 2,850 | | 11,010 | 2,400 | | 9,280 |
| Maize & beans (mixed) | | | | | | |
| Maize | 270 | 3.0 | 810 | 240 | 3.0 | 720 |
| Soybeans | 270 | 1.5 | 405 | 240 | 1.5 | 360 |
| Vegetables | 270 | 10.0 | 2,700 | 240 | 10.0 | 2,400 |

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

Vegetables were expected to become a major cash crop income source for the beneficiaries.

## I-6.8.4 Irrigation and Drainage Development Plan

(1) Development Concept

The following were basic concept/consideration applied for preparing the proposed irrigation and drainage development plan:

- Realization of solid headwork (intakes on the Prek Thnot river), which was repeatedly damaged by floods to ensure the irrigation water supply to the project area, especially for the Kandal Stung Area
- Full utilization of the existing canal system which was constructed in the Pol Pot regime in late 1970's
- Plan of concrete lining for main and lateral canals to ensure the slope protection of the canal
- Separate provision of drainage canals system from the irrigation system
- Additional construction of related structures and improvement of the existing ones
- Plan of tertiary canal system covering about 50 ha and quaternary canal block of 7-10 ha for efficient water management

(2) Proposed Facility Plans

The following structures were proposed for both Kandal Stung and Bati Areas:

**Table I-6.8.4.1 Proposed Irrigation and Drainage System Improvement under Stage-1 in F/S**

| Description | Unit | Kandal Stung (1,950 ha) | Bati (1,600 ha) | Total (3,550 ha) |
|---|---|---|---|---|
| (a) Headworks on the Prek Thnot river | | | | |
| 1) Improvement of Tuk Thla and Kampong Tuol Regulators, etc. | LS | - | - | 1 |
| (b) Irrigation and Drainage System | | | | |
| 1) Irrigation Canals | | | | |
| - Main canal | (km) | 5.3 | 8.3 | 13.6 |
| - Laterals | (km) | 12.0 | 10.0 | 22.0 |
| - Tertiary canals | (km) | 56.8 | 48.1 | 104.9 |

| Description | Unit | Kandal Stung (1,950 ha) | Bati (1,600 ha) | Total (3,550 ha) |
|---|---|---|---|---|
| 2) Drainage Canals | | | | |
| - Main Drain | (km) | 18.1 | 24.1 | 42.2 |
| - Secondary/ tertiary drain | (km) | 64.6 | 41.8 | 106.4 |
| 3) Improvement of Lake Tonle Bati Related Structures | | | | |
| - Intake | (nos.) | - | 1 | 1 |
| - Pumping station | (nos.) | - | 1 | 1 |
| - Spillway of the lake | (nos.) | - | 1 | 1 |
| - Lake dike | LS | - | 1 | 1 |
| 4) Improvement of Connection Canal | | | | |
| - Connection canal | (km) | - | 4.6 | 4.6 |
| - Stung Touch Intake | (nos.) | - | 1 | 1 |

*Note: Work quantities above are quoted from the main text of the Feasibility Study Report (page 78 and 81)*
*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

(3) Operation and Maintenance Plan

F/S envisaged that the overall water management of the Prek Thnot River would be carried out by MAFF at then time. The responsibility of O&M of the irrigation and drainage systems would be divided into 2 types of administrative entities, i.e., a project operation body, responsible for the head regulator (headworks) to the lateral systems, and water users group responsible for tertiary irrigation and drainage canal system.

The Water Management Division in Department of Agricultural Hydraulics and Hydro-meteorology of MAFF would be responsible for the operation, maintenance, and management of the head regulators (headworks) and localized reservoirs in order to ensure the equitable water management and safe operation of the large facilities. The local governments concerned would be responsible for the operation, maintenance and management of the main canals up to the lateral systems. To co-ordinate smooth operation and maintenance of the irrigation system and water management, the provincial and district irrigation committees would be organized at provincial and district government levels, respectively. It was proposed that these were made up of representatives of the provincial or district government offices, including the agriculture office, the public works office, the rural development office, and the police/military office.

### I-6.8.5 Agricultural Support Plan

The proposed supporting services covered (i) the agricultural technical extension, (ii) agricultural inputs and equipment supply, rural credit supply and agricultural insurance system, (iii) operation and maintenance of irrigation and drainage system, and (iv) provision of rural infrastructures such as road and domestic water supply. It was proposed that the agricultural development centers would be operated directly under the management of the Department of Extension of MAFF. And operation of the agricultural development centers with sufficient qualified extension workers and facilities was proposed to be transferred to each district office. The most important activities in agricultural support plan are to execute agricultural extension services summarized as follows:

**Table I-1.6.8.5.1 Summary of Improvement of Extension Services**

| Components | Activities / Required inputs |
|---|---|
| Improvement of extension service | Activities<br>- Introduction of improved varieties<br>- Supply of planting materials<br>- Demonstration and guidance on cultivation techniques<br>- Extension on livestock production<br>- Strengthening of vaccination service<br>- Monitoring and evaluation |

| Components | Activities / Required inputs |
|---|---|
| Staff recruitment for agricultural development centre | Kandal Stung No. 2 (proposed): 2,400 ha 10 persons<br>Bati (existing): 1,830 ha 3 persons |
| Facilities and Equipment | 1. for Agricultural Development Center<br>- Office Space for subject matter specialists 3 specialists in each centre<br>- 4WD vehicle 3 for each centre<br>- Minibus(20persons) 1 for each centre<br>- Mobile extension unit vehicle (4WD) with audio visual equipment and veterinary service 1 in each centre<br>- Cold storage for Vaccine(Solar energy) 1 in each centre<br>- Copy/Printing machine 1 in each centre |
| | - Personal computer with printer 1 set in each centre<br>- Residence 1 residence for each specialist<br>- Trial cum demonstration farm 1 ha for each centre<br>- Electricity supply 1 in each centre<br>- Portable generator for community hall 2 for each centre<br>- Farm machinery for demonstration 1 set of mechanized rice farming machinery for each centre |
| | 2. In Community Hall<br>- Office Space for field worker 1 to 3 persons<br>- Motor cycle 1 for each worker<br>- Residence 1 for each worker<br>- Store space for equipment 1 space in each hall<br>Trial farm 0.1 ha |

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

### I-6.8.6 Project Cost and Evaluation

(1) Estimated Project Cost

Project cost for the priority development of 3,550 ha, including improvement of (i) Thuk Thla and Kampong Tuol Regulators on the Prek Thnot River and (ii) social infrastructures, was estimated at US$ 66.8 million in total as shown below. Unit development costs for the total development and irrigation and drainage systems per ha are calculated at US$ 18,820 /ha and US$ 6,120 /ha, respectively. Cost for improvement of the Tuk Thla and Kampong Tuol Regulators (headworks) on the Prek Thnot River of US$ 16.8 million accounts for 44% of the irrigation and drainage work cost of US$ 38.5 million.

**Table I-6.8.6.1 Cost Estimated for Priority Development of 3,500 ha in F/S Stage**

(Unit: US$ million)

| Description | Total (3,550 ha) | Kandal Stung (1,950 ha) | Bati (1,600 ha) |
|---|---|---|---|
| (a) Construction cost | | | |
| 1) Irrigation and drainage | 38.49 | 24.51 | 13.98 |
| (1)Tuk Thla and Kampong Tuol Regulators | (16.76) | (16.76) | |
| (2)Irrigation and drainage systems | **(21.73)** | **(7.75)** | **(13.98)** |
| 2) Rural development centre | 2.59 | 2.59 | 0.00 |
| 3) Rural road network | 6.53 | 5.53 | 1.01 |
| 4) Rural water supply system | 1.07 | 0.60 | 0.47 |
| 5) Village clinic | 0.14 | 0.07 | 0.07 |
| 6) School building | 0.92 | 0.46 | 0.46 |
| 7) Community hall | 1.26 | 0.63 | 0.63 |
| 8) On-farm development | 2.20 | 1.30 | 0.90 |
| **Sub-total** | **53.20** | **35.68** | **17.52** |
| (b) Procurement of O&M equipment | 1.00 | 0.55 | 0.45 |
| (c) Engineering service and administration | 6.50 | 3.57 | 2.93 |
| (d) Land acquisition | 0.03 | 0.02 | 0.01 |
| (e) Contingencies | 6.07 | 3.34 | 2.73 |
| **Total** | **66.80** | **43.16** | **23.64** |
| (US$/ha for total cost)* | (18,817) | (22,132) | (14,773) |
| (US$/ha for irrigation and drainage systems)* | (6,121) | (3,975) | (8,733) |

*Rate in 1994: US$ 1.0 = Riel 2,200 = Yen 100*

*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

*JICA Survey Team*

Breakdown of irrigation and drainage system improvement cost is summarized below. Costs for improvement of the pumping station and connection canal from the Stung Touch River to the Lake Tonle Bati are additionally needed for development of the Bati system. Lining cost of main and lateral canals and connection canal accounts for 40 to 80% of these work costs.

**Table I-6.8.6.2 Breakdown of Estimated Cost for Irrigation and Drainage System Improvement**

(Unit: US$ 1,000)

| Description | Unit | Kandal Stung Area (1,950 ha) | | Bati Area (1,600 ha) | |
|---|---|---|---|---|---|
| | | Q'ty | Amount | Q'ty | Amount |
| (a) Irrigation Canals | | | | | |
| - Main canal | km | 5.3 | 2,073 | 8.3 | 2,878 |
| - Laterals | km | 14.2 | 1,877 | 10.0 | 1,373 |
| - Tertiary canals | km | 56.8 | 1,934 | 48.1 | 1,737 |
| (b) Drainage works | | | | | |
| - Main Drain | km | 18.1 | 510 | 24.1 | 233 |
| - Secondary/ tertiary drain | km | 64.6 | 485 | 41.8 | 350 |
| (c) Improvement of Lake Tonle Bati Related Structures | | | | | |
| - Intake | nos. | - | | 1 | 149 |
| - Pumping station | nos. | - | | 1 | 2,222 |
| - Spillway of the lake | nos. | - | | 1 | 319 |
| - Lake dike | km | - | | LS | 109 |
| (d) Improvement of Connection Canal | | | | | |
| - Connection canal | km | - | | 4.6 | 3,330 |
| - Stung Touch Intake | nos. | - | | 1 | 677 |
| (e) Others | | | | | |
| - Preparatory works | nos. | LS | 43 | LS | 56 |
| - On-farm works for demo farm | ha | 265 | 517 | 259 | 373 |
| - O&M Road (laterite pavement) | km | 28.5 | 313 | 18 | 166 |
| **Total** | | | **7,752** | | **13,973** |
| Unit cost per ha | | | 3,975 | | 8,733 |

*Note: Rate in 1994: US$ 1.0 = Riel 2,200 = Yen 100*
*No cost for (i) improvement of Tuk Thla and Kampong Tuol Regulators, and (ii) on-farm works is included*
*Source: Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Master Plan Study, JICA, February 1995)*

(2) Evaluation

The cost for civil works, O&M equipment, engineering services, administration and O&M and replacement cost were considered for the economic evaluation. But cost for the social and rural infrastructures was not counted, since these benefits were intangibly counted in the study. Thus, total economic investment cost was set at US$ 24.8 million. Economic benefit accrued from the irrigation development was estimated at US$ 3.9 million per year based on the expected increase of crops and livestock production with the project condition.

Economic viability of the priority project for 3,550 ha was evaluated by EIRR. F/S concluded that the priority development (Stage-1) was economically viable since the EIRR was calculated at 11.7%. Financial analysis also showed that the net income of the typical farmers was expected to increase by 3.1 to 4.6 times (from US$ 480-520 /year to US$ 1,477-2,407 /year).

## I-6.9 Small-scale Irrigation System Improvement Project

### I-6.9.1 Background

According to the updated irrigation inventory by MOWRAM in 2004, there are 2,403 irrigation systems extending 1.05 million ha (total cultivation area in rainy and dry seasons). Out of this, 59% (1,415 systems) are reported small-scale irrigation system having irrigation area of less than 200 ha, and 40% (955 systems) are categorized into medium scale having irrigation area of more than 200 ha

and less than 5,000 ha. However, only some 10% of irrigation scheme were fully operational and up to 70% of the agricultural area was not readily irrigable[3]. The MOWRAM's Action Plan[4] aims to elaborate necessary actions to be taken during 2009-2013 based on the review of the lessons learnt and achievement in the past 5 years (2004-2008), which focuses on the rehabilitation of existing irrigation infrastructure.

Under such situation, RGC requested to JICA for rehabilitation of 84 small-scale irrigation systems in 23 provinces all over the country as well as the other Sub-projects such as RCHRSP, USISRSP and KSBISRSP. In response, the original scope of this JICA Preparatory Survey for Small-scale Irrigation System Improvement Project (SISIP) included (i) preparation of selection criteria for high priority area, (ii) revision of the long list of sub-projects, (iii) classification of all the proposed sub-projects into categories, (iv) F/S for one site from each category and (v) estimate and evaluation of the overall cost, (vi) preparation of implementation schedule of the project, and (vii) preparation of manuals for conducting F/S and procedures for appraisal by MOWRAM, etc, which envisaged the project implementation under the Japanese ODA sector loan. During the survey period, however JICA revised the scopes as below.

- Regarding SISIP, from 2 to 3 viable projects would be selected from the 84 sub-projects based on the criteria, combining those viable projects with other 3 Sub-projects of RCHRSP, USISRSP and KSBISRSP. Therefore, the project package for the loan project will be composed of the said 3 Sub-projects and 2 to 3 Sub-projects selected from SISIP.
- With regard to the rest of the sub-projects in SISIP except for the above 2-3 viable Sub-projects, the prioritized Sub-project list based on the criteria and manual for MOWRAM to conduct pre-F/S, would be prepared as originally agreed.

### I-6.9.2 Composition of Sub-projects

Total of 84 sub-projects in the long list were nominated from 23 provinces, the whole country except Phnom Penh. Table I-6.9.2.1 summarizes the nominated sub-projects by provinces. Original list prepared by MOWRAM and location map of 84 proposed sub-projects are attached in ANNEX D.

**Table I-6.9.2.1 Summary of Long Listed Sub-projects by Province**

| Code | Province | Nos. | Total Area (ha) | Code | Province | Nos. | Total Area (ha) |
|---|---|---|---|---|---|---|---|
| 01 | Banteay Mean Chey | 3 | 5,166 | 13 | Siem Reap | 3 | 2,996 |
| 02 | Mondul Kiri | 2 | 1,440 | 14 | Pailin | 1 | 4,000 |
| 03 | Kampong Chhnang | 3 | 2,647 | 15 | Ratanakkrir | 1 | 90 |
| 04 | Kampong Speu | 3 | 7,668 | 16 | Kampong Cham | 5 | 2,856 |
| 05 | Battambang | 2 | 5,460 | 17 | Prey Veng | 6 | 9,373 |
| 06 | Takeo | 5 | 5,715 | 18 | Svay Rieng | 11 | 7,251 |
| 07 | Sihanuk Ville | 2 | 646 | 19 | Kampong Thom | 2 | 1,250 |
| 08 | Pursat | 7 | 5,275 | 20 | Kratie | 3 | 1,311 |
| 09 | Kandal | 5 | 6,965 | 21 | Koh Kong | 2 | 583 |
| 10 | Stung Treng | 3 | 4,121 | 22 | Preah Vihear | 2 | 760 |
| 11 | Kep | 4 | 1,231 | 23 | Odar Mean Chey | 2 | 2993 |
| 12 | Kampot | 7 | 5,268 | | Total | 84 | 85,065 |

*Source: MOWRAM*

[3] *Reported in NWISP in 2003*
[4] *Action Plan on Water Resources and Meteorology Management and Development (2009-2013)*

### I-6.9.3 Outline of Sub-projects

(1) Project Proposal

Project proposal documents for the rehabilitation of the 84 sub-projects were submitted to MOWRAM in October 2009 prior to the JICA Survey. These proposals were prepared by PDOWRAM by filling up standard proposal forms that were given by MOWRAM under assistance of TSC-2. The proposal consisted of an application form and annexes including the following descriptions, in principle,

**Table I-6.9.3.1 Components of Project Proposal Document**

| Application form | Annexes |
|---|---|
| (a) Applicant's information (PDOWRAM)<br>- Name and address of responsible person<br>- Number of staff and annual budget<br>- Project implementation system<br>- Experiences of project implementation<br>(b) Project information<br>- Project site<br>- Background of project<br>- Purpose of project<br>- Outline of project<br>- Project cost with breakdown cost estimation<br>- Beneficiaries<br>- O&M cost<br>- FWUC establishment<br>- Expected project effect/impact<br>- Economic evaluation (IRR) | (a) Map<br>- Location map<br>- Layout map<br>- Command area map (before project)<br>- Command area map (after project)<br>(b) Photo<br>(c) Project work plan<br>(d) Project cost estimation<br>(e) Design documents<br>(f) Answer to questionnaire on :<br>- FWUC,<br>- Land mine,<br>- Consensus of villagers,<br>- Necessary land acquisition, etc |

*Source: MOWRAM*

(2) Problems of Proposals

These documents indicated various information necessary for the project appreciation, however the following problems are observed on the existing project proposals and its preparation process through scrutiny of them, discussion with PDOWRAM and confirmation at the representing project sites.

(a) Definition of Small-Scale Irrigation Project

According to MOWRAM's criteria, the small-scale irrigation project is defined with its irrigation area less than 200 ha. However, the proposed sub-projects did not follow such definition, and included medium-scale ones, which were totaled more than 95% of all the proposed sub-projects.

(b) Lack of Technical Information on Water Resources

Though one of the most important issues is water resource for the project evaluation of the technical soundness, the proposal documents do not describe any information of the water source, such as name and type of water source, catchment area, observed and/or estimated discharge, capacity of reservoirs, etc, causing difficult to evaluate the suitable size of irrigation area. In addition, the proposals were prepared without consideration of the other irrigation systems located in the same river basin taking water from the same river in up and down stream of the basin.

(c) Overestimate of Targeted Irrigation Area

Most of the proposed sub-projects have their origin in Pol Pot regime, in which the canals (Pol Pot Canals) had targeted maximum extent of their command area without water balance study, and hence they did not guarantee the amount of irrigation water supply with certain dependability. The rehabilitation works were proposed to cover the area commanded by the existing Pol Pot Canals networks, which are mostly overestimate of the irrigation area.

(d) Less Understanding on Project Area in Project Evaluation

Distribution of land use is not clear and the project area is misunderstood in project evaluation to compare before and after the project, such as irrigated and rainfed paddy, upland field, fallow area and non-agricultural land. The project area totaled of each land use shall be the same in the project area before and after the rehabilitation. The project area shall include the existing fallow area and non-agricultural land before rehabilitation, in case these area will be irrigated after the project. The project area in the proposal is not the same before and after the rehabilitation in most cases. In addition, the area is not clearly categorized, such as the actually irrigated, irrigable, and rainfed area.

(e) Incomplete Rehabilitation Plan Proposed

In many cases, the proposed rehabilitation works does not include all necessary works for the complete irrigation system. For example in some cases, the rehabilitation is limited to main canal and structures, while secondary canals and other facilities are not considered. In other cases, rehabilitation of only upper reach of main canal are proposed, but project benefit was considered for the whole area including lower reach of main canal.

(f) Insufficient Back Data and Breakdown

Some items of the unit cost and benefit estimate were referred to uniform standard values given by MOWRAM assisted by TSC-2, for instance (i) agricultural extension service, (ii) increase of agricultural input for existing cultivated area, (iii) increase of agricultural input for newly cultivated area, and (iv) O&M cost, etc. As there is no breakdown and source for IRR calculation in the application form, it is difficult to review and update the result.

(g) Insufficient Data Storage System in PDOWRAM

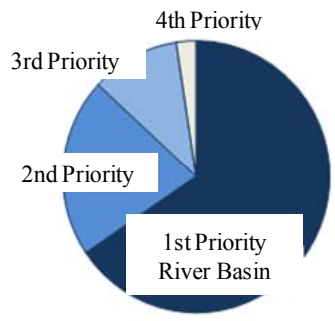
The proposal was prepared in 2009 and more than 2 years have passed before the Survey, in which some of the technical data including topographic survey data, design calculation, drawings and work quantity and cost estimate have been lost or misplaced. This also causes difficulty in review and updating.

(3) Distribution of Long Listed Sub-projects

Based on 84 proposals submitted by each PDOWRAM, the JICA Survey Team examined the summary of the outline of the Sub-projects scatted in whole country.

(a) Distribution of Candidates by River Basin Priority

Previous study[5] has prioritized all 42 river basins in the country using criteria of natural and human resource and social conditions and so on, determining from the 1st to 4th priority river basins in turn. The location of 84 proposed sub-projects in theses river basin are shown in ANNEX D. As shown in Figure I-6.9.3.1, 55 sub-projects (66% of total 84 Sub-projects) are located in the first priority river basins, 18 Sub-projects (21%) are in the second priority river basins, and 11 sub-projects (13%) are located in 3rd and 4th river basins.




*Source: JICA Survey Team*

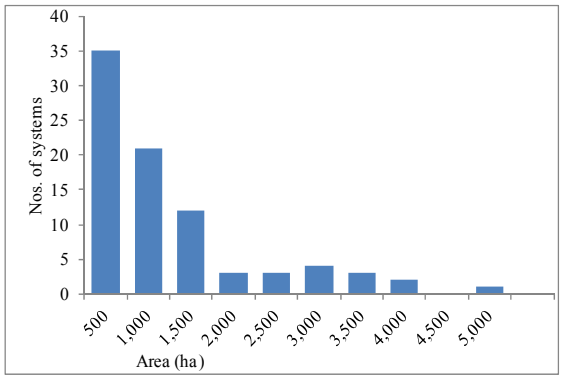
**Figure I-6.9.3.1 Distribution of Candidates by River Basin Priority**

[5] *Review on Nationwide Irrigation Development, March 2010*

(c) Distribution by Irrigation Area

The irrigation area of 84 proposed sub-projects are varied as shown in Figure I-6.9.3.2.

Irrigation systems of which irrigation areas are less than 500 ha occupy more than 40% in number, and those having the area of less than 1,000 ha accounts for about two-third. Irrigation systems of more than 2,000 ha are totaled about 15%.




*Source: JICA Survey*

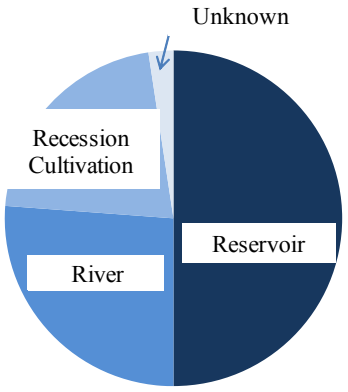
**Figure I-6.9.3.2 Distribution of Candidates by Irrigation Area**

(d) Distribution by Irrigation Type

All candidate sub-projects are categorized as gravity type and neither lift irrigation nor groundwater irrigation project was proposed. The water sources for the proposed sub-projects are further categorized into 3 types, which area (i) river run-off without reservoir, (ii) reservoir, and (iii) flood recession water. Distribution of irrigation type is therefore classified by these types of water resources.

Distribution by water resources are shown in ANNEX D and summarized below and in Figure I-6.9.3.3.

- Reservoir irrigation system (50%);
- River irrigation without reservoir (26%);
- Recession cultivation (21%)




*Source: JICA Survey*

**Figure I-6.9.3.3 Distribution of Candidates by Irrigation Type**

## I-6.9.4 Selection of Priority Sub-projects

### I-6.9.4.1 Selection Procedure and Criteria

The purposes of pre-F/S are: (i) to confirm the technical and economical viability of the selected sub-project to be implemented, and (ii) to feed-back to the remaining sub-projects in the long list, and hence the sub-projects to be selected should be representing as a model case of the other sub-projects in the long list. Under this understanding, the following steps and criteria were considered to select representative pre-F/S area as viable Sub-projects under SPPIDRIP, and as models for other small-scale irrigation projects. The flow chart of the selection process is illustrated in Figure I-6.9.4.1.1. A detailed description of the 2-stage is provided below.

**Screening**

| | |
|---|---|
| (1) | Sub-projects located inside the first priority river basins |
| (2) | Sub-projects located in 4 provinces near Phnom Penh |
| (3) | Completed, started or committed Sub-projects excluded |

**Priority Ranking**

Ranking by point scoring method for 10 items

**Final Selection**

| | |
|---|---|
| (1) | One Sub-project for each irrigation category |
| (2) | One Sub-project at maximum in one province |

*Source: JICA Survey Team*

**Figure I-6.9.4.1.1 Flowchart for Selection of Pre-F/S Sites**

(1) First Screening

At first, prior to priority ranking, the candidate projects were screened by the following criteria.

- Only the sub-projects located inside the first priority river basins were considered.

- Only the sub-projects located in 4 provinces of Kampong Chhnang, Kampong Speu, Kandal and Takeo Provinces were considered.
- Sub-projects that has been completed, started or committed to start already by the government budget and/or other donor's fund were omitted

(2) Priority Ranking

The priority ranking was carried out by use of the following 10 ranking criteria on the basis of the proposed existing irrigation schemes from the selected 4 provinces in south-west Phnom Penh, which are the target area of SPPIDRIP. Point score in ranking is set up in the items, such as data availability, social conditions, and so on, which are 10 points each and 100 points in total, and priority Sub-projects are ranked according to the total score.

**Table I-6.9.4.1.1 Point Score for Priority Ranking**

| Item | Conditions | Point |
|---|---|---|
| Data availability | | |
| (1) Survey data | Partly available | 10 |
| | Not available | 0 |
| (2) Design and cost estimate | Partly available | 10 |
| | Not available | 0 |
| (3) Satellite image | Available | 10 |
| | Not Available | 0 |
| (4) Social conditions (Farmers' consensus) | 100% Concurred | 10 |
| | More than 80% concurred | 5 |
| | Less than 80% concurred | 0 |
| (5) Social conditions (Risk of land mine) | No risk | 10 |
| | Risk or not known | 0 |
| (6) Social conditions (Land acquisition) | All government land | 10 |
| | All government land with illegal occupation | 5 |
| | Land acquisition required | 0 |
| (7) Scale of irrigation area | More than 500 ha and less than 1,500 ha | 10 |
| | Less than 500 ha | 5 |
| | More than 1,500 ha | 0 |
| (8) Effect of Sub-project (Incremental irrigation area) | More than 100% increased | 10 |
| | More than 50% and less than 100% increased | 5 |
| | Less than 50% increased | 0 |
| (9) Access for packaging | Near Phnom Penh | 10 |
| | Far from Phnom Penh | 0 |
| (10) PDOWRAM's priority | 1st priority | 10 |
| | 2nd priority | 5 |
| | Others | 0 |

*Source: JICA Survey Team*

Based on the above point scouring, total scour of each sub-project are summarized in Table I-6.9.4.1.2.below.

**Table I-6.9.4.1.2 Summary of Priority Ranking**

| Code*[1] | Province | Name of Sub-project | Area (ha) | Point Score | | | | | | | | | | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total | |
| 3 – 2 | Kampong Chhnang | Daun Pue | 1,151 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 100 | River |
| 4 - 1 | Kampong Speu | Main Canal 35 | 800[*2] | 10 | 10 | 10 | 10 | 10 | 5 | 10 | 10 | 10 | 10 | 95 | Reservoir |
| 9 - 1 | Kandal | Srass Prambai | 1,200[*3] | 0 | 10 | 10 | 5 | 10 | 0 | 10 | 5 | 10 | 10 | 70 | Recession |
| 4 - 2 | Kampong Speu | O Kontorom | 500 | 0 | 10 | 10 | 10 | 10 | 5 | 10 | 10 | 0 | 5 | 70 | Reservoir |
| 4 - 3 | Kampong Speu | O Ta Peen | 1,400 | 0 | 10 | 10 | 10 | 10 | 5 | 10 | 10 | 0 | 0 | 65 | Reservoir |
| 9 - 2 | Kandal | Tom Or | 247 | 0 | 10 | 10 | 5 | 10 | 0 | 5 | 10 | 10 | 5 | 65 | Recession |
| 6 - 3 | Takeo | Sen Priem | 567 | 0 | 0 | 10 | 10 | 10 | 0 | 10 | 0 | 10 | 5 | 55 | Recession |
| 6 - 4 | Takeo | Potatsu | 1,756 | 0 | 0 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 10 | 50 | Reservoir |
| 6 - 5 | Takeo | Potawa | 2,872 | 0 | 0 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 40 | Reservoir |
| 3 - 3 | Kampong Chhnang | Canal Steung Sdach | 1,046 | Under construction by PDOWRAM | | | | | | | | | | | |
| 6 - 1 | Takeo | Chroy Samrong | 300 | Under construction by PDOWRAM | | | | | | | | | | | |
| 6 - 2 | Takeo | Chroy Veng | 220 | Committed under World Bank Project (2012) | | | | | | | | | | | |
| 9 - 4 | Kandal | Chak Khaek | 226 | Completed by PDOWRAM | | | | | | | | | | | |
| 9 - 5 | Kandal | Mlech | 3,820 | Under construction by PDOWRAM | | | | | | | | | | | |

*Remarks; [*1]: Code No. is referred to the original long list prepared by MOWRAM.*
*[*2]: PDOWRAM proposed only upstream part (800 - 1,000 ha) out of the entire system of more than 3,000 ha as a first stage.*
*[*3]: Original proposal showing 2.400 ha was revised according to confirmation with PDOWRAM.*

*Source: JICA Survey Team*

(3) Final Selection

Based on the results of priority ranking, the representing pre-F/S areas were selected with the following selection conditions.

- One sub-project for each irrigation (water resource) category
- One sub-project at maximum in one province

### I-6.9.4.2 Selected Priority Sub-projects

As a result of the above screening and priority ranking, draft list of the pre-F/S sites were prepared, based on which selection criteria and results were discussed with MOWRAM and concurred on December 19, 2011 upon confirmation to respective PDOWRAM.

The selected 3 sub-project sites consists of (i) irrigation system with reservoir in Kampong Speu Province, (ii) irrigation system under recession cultivation in Kandal Province and (iii) River irrigation system without reservoir in Kampong Chhnang Province and general features are summarized in Table I-6.9.4.2.1. Pre-F/S for the above selected sites was commenced in the third field work period from December 2011 through March 2012.

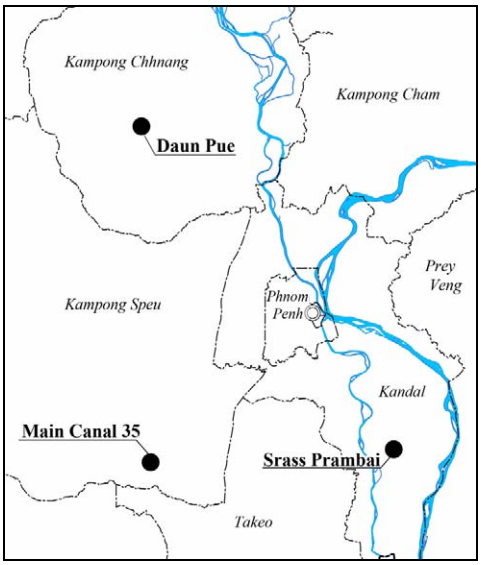



**Figure I-6.9.4.2.1 Location of Pre-F/S Sites**

**Table I-6.9.4.2.1 Summary of Selected Sub-projects**

| Sub-project Name | Main Canal 35 | Srass Prambai | Daun Pue |
|---|---|---|---|
| Commune | Katplug | Chue Khmao | Chiep |
| District | Basedth | Kaoh Thum | Teuk Phos |
| Province | Kampong Speu | Kandal | Kampong Chhnang |
| River basin priority | 1 | 1 | 1 |
| Water source | Stung Kat Phluk River and Ou Kat Srov River | Flood recession water from Basac and Mekong Rivers | Stung Oukhley River |
| Irrigation type | Reservoir | Recession | River |
| Proposed irrigation area | 800 - 1,000 ha | 1,200 ha | 1,150 ha |
| Proposed crop intensity | Paddy in rainy & early rainy seasons | Paddy in dry & early rainy seasons | Paddy in rainy & early rainy seasons |
| Proposed project works | Canal and related structures | Reservoir dike and related structures | Headworks, canals and related structures |

*Source: Prepared by the Survey Team based on the proposal documents submitted by PDOWRAM*

# *PART II*

*SOUTHWEST PHNOM PENH*

*IRRIGATION AND DRAINAGE*

*REHABILITATION AND IMPROVEMENT*

*PROJECT*

# PART II SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

## CHAPTER II-1 PROJECT AREA

### II-1.1 General

As can be seen in Figure I-1.3.1, SPPIDRIP consists of 6 Sub-projects such as RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. Natural conditions, socio-economic conditions, and current conditions of agriculture, irrigation and drainage for these Sub-projects are mentioned hereunder.

### II-1.2 Roleang Chrey Headworks Rehabilitation Sub-project

#### II-1.2.1 Location and Administration

The regulators in RCHRSP are located on the Prek Thnot River, about 100 km upstream from its confluence with the Bassac River. The Andong Sla and Vat Krouch Intakes are respectively provided at the heads of NMC and SMC branched off from the Prek Thnot River upstream from the regulators. The regulators are located in Tumpung Village, Kahaeng Commune, Samraong Tong District, Kampong Speu Province.

The right bank of the Roleang Chrey Regulator is at EL. 39.651 m. The longitudinal survey shows that the longitudinal slope of the upstream of Prek Thnot River where the Roleang Chrey Regulator is located midway, is 1/2,720, which is slightly steeper than 1/3,000 of the average one from the confluence with the Bassac River to Peam Khley (113.4 km in distance).

According to the tender drawings for the Roleang Chrey Regulator which were prepared in 1968, it was constructed on fresh tuff after removal of the weathered tuff. In fact, it is observed that the tuff crops out after the downstream apron of the Roleang Chrey Regulator. The fresh tuff has sufficient bearing capacity to act as a foundation for the Roleang Chrey Regulator.

#### II-1.2.2 Meteorology and Hydrology

##### II-1.2.2.1 Meteorology

There is only one meteorological observation station in the Prek Thnot River Basin at Pochentong, Phnom Penh. Rainfall has been recorded from 1901 to 2010, however, the other data, such as temperature, relative humidity, etc., have been recorded from 1991 to 2010 at Pochentong station.

According to the meteorological data at the station, average annual rainfall from 1991 to 2010 is estimated at 1,384 mm. The seasonal distribution is divided into the rainy season from May to October and the dry season from November to April. The rainy season accounts for about 80% (1,104 mm) of the average annual rainfall mentioned above.

Monthly mean temperature ranges from 26.2°C in December to 30.6°C in April. Monthly maximum temperature higher than 31°C is common and it rises to higher than 35°C during the period from March to May. Monthly minimum temperature rarely falls below 21°C. Monthly mean relative humidity ranges from 70% in March to 84% in September.

The following table shows averages of monthly data at Pochentong station.

**Table II-1.2.2.1.1 Summary of Meteorological Data at Pochentong Station (1991 – 2010)**

| Item | Unit | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Average or Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | °C | | | | | | | | | | | | | |
| Mean | | 26.6 | 28.0 | 29.5 | 30.6 | 30.4 | 29.6 | 28.8 | 29.2 | 28.4 | 27.7 | 27.0 | 26.2 | 28.5 |
| Maximum | | 32.3 | 33.9 | 35.6 | 36.4 | 35.6 | 34.7 | 33.4 | 33.2 | 32.9 | 32.0 | 31.7 | 31.5 | 33.6 |
| Minimum | | 20.9 | 22.1 | 23.5 | 24.8 | 25.1 | 24.4 | 24.2 | 25.2 | 23.8 | 23.5 | 22.4 | 21.0 | 23.3 |
| Rainfall* | mm | 8.0 | 8.0 | 27.4 | 70.4 | 141.3 | 147.4 | 147.9 | 165.6 | 242.9 | 258.5 | 129.8 | 36.6 | 1383.8 |
| Humidity | % | 72.0 | 70.4 | 69.7 | 71.4 | 75.9 | 77.8 | 80.3 | 81.3 | 84.1 | 84.1 | 78.5 | 74.0 | 76.6 |
| Wind Speed | m/sec | 3.2 | 3.8 | 4.1 | 3.9 | 4.3 | 4.9 | 4.3 | 5.4 | 4.4 | 3.1 | 3.9 | 3.9 | 4.0 |
| Evaporation | mm/day | 4.4 | 5.4 | 6.2 | 5.8 | 4.8 | 4.6 | 4.1 | 4.0 | 3.5 | 3.1 | 3.6 | 4.1 | 4.4 |
| Sunshine | hr/day | 8.5 | 8.6 | 8.3 | 8.0 | 7.3 | 6.6 | 5.9 | 5.9 | 5.7 | 6.1 | 7.5 | 8.2 | 7.2 |

*Note: Wind Speed data during the period from September 2005 to December 2010 were unavailable.*
*Source: Pochentong Observatory, Department of Meteorology(Temperature, Humidity, Wind speed , Evaporation and Sunshine)*
**: Reappraisal Report of the Prek Thnot Multipurpose Project, Australian Catholic Relief in December 1991 (Rainfall data in the period from 1901 to 1991)*

### II-1.2.2.2 Hydrology

The hydrological conditions in the RCHRSP Area by 2005 are already mentioned in Section I-6.2. In this Sub-clause, the hydrological data in the period from 2006 to 2010 is studied for updating the information of hydrological conditions.

(1) Prek Thnot River Condition

The Prek Thnot River originates from the Elephant mountain region and flows between southeast and east from the region. The average elevation of the Prek Thnot River Basin is EL. 1,543 m above the mean sea water level. The Prek Thnot River system consists of 11 sub-basins as shown in Table II-1.2.2.2.1 and Figure II-1.2.2.2.1. According to the longitudinal survey from the Peam Khley 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 survey shows the discharge carrying capacity of the Prek Thnot River as given in Table II-1.2.2.2.2.

**Table II-1.2.2.2.1 Area of Sub-basin**

| Sub-basin | Area ($km^2$) |
|---|---|
| Trang Krang | 294 |
| Ta Sal | 674 |
| Aveaeng | 431 |
| Phleah | 235 |
| Aoral | 502 |
| Ou Krang Ambel | 455 |
| Tang Haong | 1,435 |
| Anlong Ramilch | 228 |
| Bat Kmeng | 300 |
| Kandal | 78 |
| Residual | 18 |
| Total | 4,650 |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

**Table II-1.2.2.2.2 Discharge Carrying Capacity of Prek Thnot River**

| Chainage(m) | Discharge Carrying Capacity ($m^3$/sec) |
|---|---|
| 0 – 33,446 (Kandal Steung Weir) | 200 – 500 |
| 33,446 – 50,000 | 300 – 800 |
| 50,000 – 73,587 (Ou Krang Ambel River) | 500 – 800 |
| 73,587 – 90,038 (Thnuous Luong Station) | 800 – 1,200 |
| 90,738 – 98,431 (Roleang Chrey Regulator) | 1,200 – 1,300 |
| 98,431 – 113,411 (Peam Khley) | 1,300 – 1,500 |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

(2) Average Depth of Rainfall over Area

For the purpose of estimate of water balance in the RCHRSP Area, the discharges of the Prek Thnot River at the Roleang Chrey Regulator and at the Ou Krang Ambel Reservoir should be calculated. In order to calculate the discharge at those points, average depths of rainfall over area are calculated as shown below:

According to the rainfall data in/around the Prek Thnot River Basin shown in Table II-1.2.2.2.3 and

Figure II-1.2.2.2.2, average rainfall in upstream basin of the Peam Khley station and basin of the Ou Krang Ambel Reservoir are calculated by the Thiessen method. Results of calculation are shown in the following tables.

**Table II-1.2.2.2.3 Rainfall Station**

| No. | Rainfall Station | Observation Period | No. | Rainfall Station | Observation Period |
|---|---|---|---|---|---|
| 1 | Chbar Mon / Kampong Speu | 1966 ~ 1969, 1982 ~ 2010 | 10 | Aoral | 1997 ~ 2010 |
| 2 | Phnom Srouch | 1966 ~ 1969, 1988 ~ 2010 | 11 | Ou Taroth | 2000 ~ 2010 |
| 3 | Odong | 1987 ~ 2003, 2005 ~ 2009 | 12 | Prey Pdou | 1997 ~ 2007 |
| 4 | Srae Klang | 2000 ~ 2009 | 13 | Prey Dob | 1983 ~ 1990, 2000 ~ 2010 |
| 5 | Krang Ampil | 2000 ~ 2010 | 14 | Sdok | 2000 ~ 2010 |
| 6 | Kirirom | 1966 ~ 1969, 2000 ~ 2005 | 15 | Trapeang Chor | 2000 ~ 2010 |
| 7 | Thnal Toteung | 1983 ~ 2009 | 16 | Thpong | 1987 ~ 2010 |
| 8 | Basedth | 1987 ~ 2010 | 17 | Peam Khley | 2000 ~ 2010 |
| 9 | Kong Pisey | 1984 ~ 2010 | | | |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

**Table II-1.2.2.2.4 Annual Rainfall in each Station and Average Rainfall in Upstream Basin of Peam Khley**

(Unit: mm)

| Rainfall Station | Trapeang Chor | Aoral | Kirirom | Srae Klong | Peam Khley | Total / Average |
|---|---|---|---|---|---|---|
| Catchment Area ($km^2$) | 893 | 113 | 680 | 700 | 246 | 3,654 |
| Thiessen Coefficient | 24.5% | 31.0% | 18.6% | 19.2% | 6.7% | 100% |
| 2001 | 1,243 | 1,443 | 2,275 | 1,490 | 1,283 | 1,547 |
| 2002 | 1,197 | 896 | 1,158 | 1,231 | 1,161 | 1,100 |
| 2003 | 1,230 | 1,535 | 1,343 | 1,316 | 1,329 | 1,369 |
| 2004 | 1,062 | 1,056 | 1,203 | 917 | 808 | 1,041 |
| 2005 | 817 | 939 | 1,359 | 1,053 | 838 | 1,002 |
| 2006 | 1,377 | 1,024 | 1,095 | 923 | 966 | 1,100 |
| 2007 | 797 | 1,297 | 1,646 | 1,361 | 1,339 | 1,255 |
| 2008 | 1,132 | 1,237 | 1,684 | 1,387 | 1,060 | 1,311 |
| 2009 | 1,392 | 1,074 | 1,138 | 1,231 | 922 | 1,183 |
| 2010 | 1,371 | 1,466 | 1,320 | 1,178 | 829 | 1,317 |
| Average | 1,162 | 1,197 | 1,422 | 1,209 | 1,054 | 1,223 |

*Source: JICA Survey Team*

**Table II-1.2.2.2.5 Annual Rainfall in each Station and Average Rainfall in Basin of Ou Krang Ambel Reservoir**

(Unit: mm)

| Rainfall Station | Aoral/ Oral | Thpong | Ou Taroth | Kampong Speu | Prey Pdau | Area Rainfall |
|---|---|---|---|---|---|---|
| Catchment Area ($km^2$) | 13 | 184 | 193 | 20 | 43 | 453 |
| Thiessen Coefficient | 2.9% | 40.6% | 42.6% | 4.4% | 9.5% | 100.0% |
| 2001 | 1,444 | 1,616 | 1,458 | 1,723 | 1,639 | 1,551 |
| 2002 | 896 | 1,036 | 1,015 | 937 | 882 | 1,004 |
| 2003 | 1,535 | 1,421 | 1,208 | 883 | 1,096 | 1,279 |
| 2004 | 1,056 | 1,078 | 785 | 949 | 882 | 928 |
| 2005 | 939 | 967 | 907 | 1,114 | 1,019 | 952 |
| 2006 | 1023.5 | 1,277 | 1,287 | 1,178 | 1,086 | 1,251 |
| 2007 | 1296.8 | 1,112 | 1,013 | 1,650 | 998 | 1,088 |
| 2008 | 1236.8 | 1,448 | 798 | 1,444 | 1,357 | 1,156 |
| 2009 | 1074.1 | 1,366 | 1,023 | 1,405 | 1,330 | 1,210 |
| 2010 | 1465.8 | 1,534 | 815 | 1,281 | 1,336 | 1,195 |
| Average | 1,197 | 1,285 | 1,031 | 1,256 | 1,162 | 1,161 |

*Source: JICA Survey Team*

(3) Hydrological Analysis

(a) Low Flow Analysis

1) Probable Drought Discharge at Peam Khley

The observation period of daily discharge at the Peam Khley gauging station is 14 years from January 1997 to December 2010. Long term monthly mean runoff at Peam Khley is available for the period of

1901 to 1972 and 1997 to 2010. Based on these monthly data during 85 years, the probability analysis was made to determine the drought discharge at 20% non-exceedance probability and 50% non-exceedance probability.

The estimated monthly discharges with 20% non-exceedance probability and 50% non-exceedance probability are shown below:

**Water Gauging Station at Peam Khley**

**Table II-1.2.2.2.6 Summary of Monthly Discharge at Peam Khley** (Unit: MCM)

| Discharge | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 11.6 | 5.2 | 6.1 | 12.9 | 45.5 | 51.6 | 130.2 | 175.7 | 252.6 | 431.9 | 158.7 | 38.0 | 1,320.1 |
| Maximum | 63.5 | 34.1 | 26.6 | 85.2 | 566.2 | 276.3 | 545.3 | 747.6 | 684.9 | 1407.4 | 788.4 | 391.5 | 4,126.5 |
| Minimum | 1.6 | 0.5 | 0.4 | 1.5 | 3.7 | 3.2 | 5.3 | 12.7 | 69.8 | 45.6 | 12.2 | 2.4 | 452.9 |
| 20%* | 9.1 | 3.1 | 4.2 | 12.2 | 35.6 | 44.8 | 117.1 | 160.8 | 265.2 | 277.5 | 42.1 | 23.0 | 994.7 |
| 50%* | 9.0 | 3.0 | 4.2 | 14.7 | 35.9 | 43.3 | 115.8 | 160.2 | 347.6 | 338.0 | 123.2 | 22.9 | 1,217.8 |

*Remarks: Non-exceedance probability*
*Source: JICA Survey Team*

2) 5-day Discharge at Peam Khley

The 5-day discharge of the Prek Thnot River at Peam Khley was estimated to determine the 5-day discharge available for irrigation for 20% non-exceedance probability and 50% non-exceedance probability. The 5-day discharges for 20% non-exceedance probability and 50% non-exceedance probability are calculated by the distribution from dependable monthly discharge for the period from 1901 to 1972 and from 1997 to 2010 in proportion to the actual 5-day runoff distribution pattern for every month for 14 years from 1997 to 2010. The calculation results for both cases are shown below:

**Table II-1.2.2.2.7 5-day Discharge for 20% Non-exceedance Probability at Peam Khley** (Unit: $m^3$/sec)

| Days | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-05 | 3.8 | 1.4 | 1.4 | 2.2 | 10.0 | 12.8 | 32.6 | 57.5 | 87.8 | 90.9 | 33.2 | 15.4 |
| 06-10 | 3.8 | 1.3 | 1.4 | 3.6 | 8.0 | 24.0 | 62.5 | 83.3 | 84.1 | 107.4 | 23.3 | 16.3 |
| 11-15 | 4.2 | 1.3 | 1.6 | 3.5 | 13.9 | 11.0 | 29.5 | 45.2 | 73.1 | 132.4 | 14.2 | 5.4 |
| 16-20 | 3.8 | 1.2 | 1.7 | 4.8 | 21.0 | 12.8 | 38.0 | 72.0 | 86.1 | 130.8 | 12.4 | 4.5 |
| 21-25 | 2.6 | 1.2 | 1.6 | 6.9 | 20.3 | 21.0 | 38.6 | 48.1 | 121.7 | 78.6 | 8.7 | 5.9 |
| 26-end | 2.1 | 1.4 | 1.7 | 7.2 | 6.5 | 22.1 | 61.1 | 54.1 | 161.2 | 81.4 | 5.5 | 4.0 |

*Source: JICA Survey Team*

**Table II-1.2.2.2.8 5-day Discharge for 50% Non-exceedance Probability at Peam Khley** (Unit: $m^3$/sec)

| Days | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-05 | 3.8 | 1.3 | 1.4 | 2.6 | 10.1 | 12.4 | 32.2 | 57.3 | 115.0 | 110.8 | 97.2 | 15.3 |
| 06-10 | 3.8 | 1.3 | 1.4 | 4.3 | 8.1 | 23.2 | 61.8 | 83.0 | 110.2 | 130.8 | 68.3 | 16.2 |
| 11-15 | 4.2 | 1.2 | 1.6 | 4.2 | 14.1 | 10.6 | 29.2 | 45.1 | 95.8 | 161.3 | 41.7 | 5.4 |
| 16-20 | 3.7 | 1.1 | 1.7 | 5.8 | 21.1 | 12.4 | 37.6 | 71.7 | 112.8 | 159.4 | 36.4 | 4.5 |
| 21-25 | 2.6 | 1.1 | 1.6 | 8.3 | 20.5 | 20.3 | 38.2 | 48.0 | 159.5 | 95.7 | 25.6 | 5.8 |
| 26-end | 2.1 | 1.3 | 1.7 | 8.7 | 6.6 | 21.4 | 60.4 | 53.9 | 211.3 | 99.2 | 16.1 | 4.0 |

*Source: JICA Survey Team*

3) 5-day Discharge at Roleang Chrey Regulator

The 5-day discharge 20% non-exceedance probability and 50% non-exceedance probability at the Roleang Chrey Regulator is calculated from that at Peam Khley in proportion of the catchment area. The equation for conversion from the discharge at Peam Khley to the discharge at the Roleang Chrey Regulator is as follows:

$$Qr = Qp \times Ar / Ap$$

*Where, Qr: discharge at Roleang Chrey Regulator ($m^3$/sec)*

*Qp: discharge at Peam Khley ($m^3$/sec)*
*Ar: upstream area of Roleang Chrey Regulator ($km^2$),*
*Ap: upstream area of Peam Khley ($km^2$)*

**Table II-1.2.2.2.9 5-day Discharge for 20% Non-exceedance Probability at Roleang Chrey Regulator**

(Unit: $m^3$/sec)

| Days | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-05 | 4.1 | 1.5 | 1.5 | 2.3 | 10.7 | 13.7 | 34.9 | 61.5 | 93.9 | 97.3 | 35.5 | 16.5 |
| 06-10 | 4.1 | 1.4 | 1.5 | 3.8 | 8.6 | 25.7 | 66.8 | 89.1 | 90.0 | 114.9 | 25.0 | 17.5 |
| 11-15 | 4.5 | 1.4 | 1.7 | 3.8 | 14.9 | 11.7 | 31.6 | 48.4 | 78.2 | 141.7 | 15.2 | 5.8 |
| 16-20 | 4.0 | 1.2 | 1.8 | 5.2 | 22.4 | 13.7 | 40.7 | 77.0 | 92.1 | 140.0 | 13.3 | 4.9 |
| 21-25 | 2.8 | 1.3 | 1.7 | 7.4 | 21.8 | 22.4 | 41.3 | 51.5 | 130.2 | 84.1 | 9.3 | 6.3 |
| 26-end | 2.3 | 1.5 | 1.8 | 7.7 | 7.0 | 23.6 | 65.4 | 57.8 | 172.5 | 87.1 | 5.9 | 4.3 |

*Source: JICA Survey Team*

**Table II-1.2.2.2.10 5-day Discharge for 50% Non-exceedance Probability at Roleang Chrey Regulator**

(Unit: $m^3$/sec)

| Days | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-05 | 4.0 | 1.4 | 1.5 | 2.8 | 10.8 | 13.3 | 34.5 | 61.3 | 123.1 | 118.5 | 104.0 | 16.4 |
| 06-10 | 4.0 | 1.4 | 1.5 | 4.6 | 8.6 | 24.8 | 66.1 | 88.8 | 117.9 | 140.0 | 73.0 | 17.4 |
| 11-15 | 4.5 | 1.3 | 1.7 | 4.5 | 15.0 | 11.3 | 31.2 | 48.2 | 102.5 | 172.6 | 44.6 | 5.8 |
| 16-20 | 4.0 | 1.2 | 1.8 | 6.2 | 22.6 | 13.3 | 40.2 | 76.7 | 120.7 | 170.5 | 38.9 | 4.8 |
| 21-25 | 2.8 | 1.2 | 1.7 | 8.9 | 21.9 | 21.7 | 40.9 | 51.3 | 170.6 | 102.4 | 27.4 | 6.2 |
| 26-end | 2.3 | 1.4 | 1.8 | 9.3 | 7.0 | 22.8 | 64.7 | 57.6 | 226.1 | 106.1 | 17.3 | 4.3 |

*Source: JICA Survey Team*

4) 5-day Discharge at Ou Krang Ambel Reservoir

The 5-day discharge of the Ou Krang Ambel Reservoir is estimated from the data collected at Peam Khley in proportion to catchment area and rainfall amount. The equation for conversion from the discharge at Peam Khley to that at Ou Krang Ambel Reservoir is as follows:

$$Qo = Qp \times Ao / Ap \times Ro / Rp$$

*Where, Qo: discharge at Ou Krang Ambel Reservoir ($m^3$/sec)*
*Ao: upstream area of Ou Krang Ambel Reservoir ($km^2$)*
*Ro: average depth of rainfall in Ou Krang Ambel River basin (mm)*
*Rp: average depth of rainfall in upstream basin of Peam Khley (mm)*

**Table II-1.2.2.2.11 5-day Discharge for 20% Non-exceedance Probability at Ou Krang Ambel Reservoir**

(Unit: $m^3$/sec)

| Days | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-05 | 0.4 | 0.2 | 0.2 | 0.3 | 1.2 | 1.5 | 3.8 | 6.7 | 10.3 | 10.6 | 3.9 | 1.8 |
| 06-10 | 0.4 | 0.2 | 0.2 | 0.4 | 0.9 | 2.8 | 7.3 | 9.7 | 9.8 | 12.6 | 2.7 | 1.9 |
| 11-15 | 0.5 | 0.1 | 0.2 | 0.4 | 1.6 | 1.3 | 3.5 | 5.3 | 8.6 | 15.5 | 1.7 | 0.6 |
| 16-20 | 0.4 | 0.1 | 0.2 | 0.6 | 2.5 | 1.5 | 4.4 | 8.4 | 10.1 | 15.3 | 1.5 | 0.5 |
| 21-25 | 0.3 | 0.1 | 0.2 | 0.8 | 2.4 | 2.5 | 4.5 | 5.6 | 14.2 | 9.2 | 1.0 | 0.7 |
| 26-end | 0.2 | 0.2 | 0.2 | 0.8 | 0.8 | 2.6 | 7.2 | 6.3 | 18.9 | 9.5 | 0.6 | 0.5 |

*Source: JICA Survey Team*

**Table II-1.2.2.2.12 5-day Discharge for 50% Non-exceedance Probability at Ou Krang Ambel Reservoir**

(Unit: $m^3$/sec)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-05 | 0.4 | 0.2 | 0.2 | 0.3 | 1.2 | 1.5 | 3.8 | 6.7 | 13.5 | 13.0 | 11.4 | 1.8 |
| 06-10 | 0.4 | 0.2 | 0.2 | 0.5 | 0.9 | 2.7 | 7.2 | 9.7 | 12.9 | 15.3 | 8.0 | 1.9 |
| 11-15 | 0.5 | 0.1 | 0.2 | 0.5 | 1.6 | 1.2 | 3.4 | 5.3 | 11.2 | 18.9 | 4.9 | 0.6 |
| 16-20 | 0.4 | 0.1 | 0.2 | 0.7 | 2.5 | 1.5 | 4.4 | 8.4 | 13.2 | 18.6 | 4.3 | 0.5 |
| 21-25 | 0.3 | 0.1 | 0.2 | 1.0 | 2.4 | 2.4 | 4.5 | 5.6 | 18.7 | 11.2 | 3.0 | 0.7 |
| 26-end | 0.2 | 0.2 | 0.2 | 1.0 | 0.8 | 2.5 | 7.1 | 6.3 | 24.7 | 11.6 | 1.9 | 0.5 |

*Source: JICA Survey Team*

5) Probable Flood at Roleang Chrey Regulator

According to F/S and the water level data collected in this Survey, the past annual peak discharge of the Prek Thnot River is estimated as shown in Table II-1.2.2.2.13.

**Table II-1.2.2.2.13 Annual Peak Discharge of Prek Thnot River at Roleang Chrey Regulator.**

| Year | Peak Discharge at Roleang Chrey Regulator ($m^3$/sec) | Peak Discharge at Peam Khley Station ($m^3$/sec) |
|---|---|---|
| 1991 | 1371 | |
| 1996 | | 801 |
| 1997 | | 826 |
| 1998 | | 507 |
| 1999 | | 798 |
| 2000 | 1276 | 1276 |
| 2001 | | 866 |
| 2002 | | 132 |
| 2003 | | 926 |
| 2004 | | 214 |
| 2005 | | 302 |
| 2006 | 1191 | 1125 |
| 2007 | | 525 |
| 2008 | | 318 |
| 2009 | | 432 |
| 2010 | | 725 |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*
*MOWRAM and data additionally collected in this Survey*

MOWRAM has observed the daily-basis peak discharge since 1991 at the Roleang Chrey Regulator and since 1996 at the Peam Khley station. The data of flood peak discharge is not enough to conduct the numerical probability analysis for the exceedance probability of more than 20 years, therefore, the long-term flood peak discharge is estimated based on the available data, field survey and interview to gate keeper for the Roleang Chrey Regulator. The flood peak discharge of the Prek Thnot River in the past 20 years is 1,371 $m^3$/sec according to the data tabulated above. The accuracy of this observational data is endorsed by the comments from the gate keeper for the Roleang Chrey Regulator revealing that the flood occurred in 1991 was the maximum in his experiences since 1969. On the basis of data and comments from the gate keeper, it could be said that the probable flood peak discharge would be around 1,400 $m^3$/sec for the exceedance probability of about 40 years. On the other hand, the flow capacity of the Prek Thnot River in the upstream reaches of the Roleang Chrey Regulator is estimated to be 1,300-1,500 $m^3$/sec as previously discussed in Clause I-6.3.3, which would correspond to the past flood peak discharge at the regulator site of 1,371 $m^3$/sec in 1991. From the discussion above, in the M/P Study, the design flood discharge for rehabilitating the Roleang Chrey Regulator was conservatively determined to be 1,600 $m^3$/sec. Additional data of the peak discharge at Peam Khley station for 3 years from 2008 to 2010 collected in this Survey, does not indicate any tendency to change this design flood discharge.

### II-1.2.3 Socio-economy

(1) Ethnicity

It is said that more than 90% of the entire population are ethnic Khmers, while minor ethnic groups are being isolated in highlands, coastal area, etc. In the RCHRSP Area, majority is Khmers, thus there do not find any remarkable difference of manners and customs, food culture, religions and ethnic makeup, etc. in the RCHRSP Area.

(2) Poverty

Poverty estimates for three regions (Phnom Penh, other urban areas, and rural areas) identify the concentration of the poor in specific locality and help to target development activities as follows:

**Table II-1.2.3.1 Changes in Poverty Rates, 2004 and 2007**

| Region | Headcount Index (%) | | % of All Poor | |
|---|---|---|---|---|
| | 2004 | 2007 | 2004 | 2007 |
| Total poverty line | | | | |
| Phnom Penh | 4.6 | 0.8 | 1.1 | 0.3 |
| Other urban areas | 25.8 | 21.9 | 7.2 | 7.5 |
| Rural areas | 39.1 | 34.7 | 91.7 | 92.3 |
| Cambodia | 34.8 | 30.1 | 100.0 | 100.0 |
| Food poverty line | | | | |
| Phnom Penh | 2.6 | 0.1 | 1.1 | 0.1 |
| Other urban areas | 14.8 | 12.7 | 7.2 | 7.3 |
| Rural areas | 22.1 | 20.8 | 91.6 | 92.7 |
| Cambodia | 19.7 | 18.0 | 100.0 | 100.0 |

*Source: Table 11, Poverty Profile and Trends in Cambodia, 2007 and World Bank, 2009*

The above table shows a decline in Cambodia's headcount index from 34.8% in 2004 to 30.1% in 2007. There is a decline of about 4% over the period, that is, an average of 1% decline yearly. Further it is necessary to accelerate farm and non-farm activities in order to sustain poverty reduction. Table II-1.2.3.2 shows a continuing downward trend in poverty[1], based on the Commune Data Base (CDB) managed by National Committee for Democracy Development (NCDD).

**Table II-1.2.3.2 Poverty Rate by Regions (RCHRSP)** (Unit: %)

| Region | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Phnom Penh | 6.8 | 6.9 | 5.8 | 0.5 | 0.3 | 0.2 | 0.1 |
| Kampong Speu | 41.4 | 40.3 | 39.5 | 37.3 | 35.2 | 32.2 | 30.1 |
| Kandal | 27.6 | 26.2 | 24.1 | 21.2 | 19.7 | 17.6 | 15.9 |
| Cambodia | 35.1 | 34.2 | 32.9 | 30.7 | 29.3 | 27.4 | 25.8 |

*Source: Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

As shown in the above table, the poverty rate for the whole country was reduced from 35.1% in 2004 to 25.8% in 2010[2]. Meanwhile the poverty rate of Kampong Speu Province is 30.1% in 2010, which is higher than that of Kandal as well as whole Cambodia. Poverty is defined as the percentage of population with daily per capita consumption below the national poverty line. The poverty line in 2007 was calculated as follows. Also, Achieving Cambodia's Millennium Development Goals 2010, Ministry of Planning (MOP) shows the updated national poverty line as follows:

**Table II-1.2.3.3 National Poverty Lines by Region (2004 and 2007)** (Unit: Riel per capita per day)

| Region | Category | 2004 | 2007 |
|---|---|---|---|
| Phnom Penh | Food | 1,782 | 2,445 |
| | Non-food | 569 | 647 |
| | Total | 2,351 | 3,092 (US$ 0.76) |
| Other Urban Area | Food | 1,568 | 2,274 |
| | Non-food | 384 | 430 |
| | Total | 1,826 | 2,704 (US$ 0.67) |
| Rural Area | Food | 1,398 | 1,965 |
| | Non-food | 364 | 402 |
| | Total | 1,826 | 2,367 (US$ 0.58) |
| National | Food | 1,442 | 2,042 |
| | Non-food | 384 | 428 |
| | Total | 1,825 | 2,471 (US$ 0.61) |

*Note: US$ 1 = 4,062 Riel in 2007*
*Source: Achieving Cambodia's Millennium Development Goals 2010, MOP*

[1] *Page 10, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*
[2] *Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

As mentioned in the above table, the resulting average poverty line in rural area for 2007 is Riel 2,367 per capita per day, or US$ 0.58. Adopting this poverty line, the current situation on poverty status in the RCHRSP Area was confirmed based on the results by the socio-economic survey, which was conducted in this Survey.

(3) Gender Issue

It is judged through some interview with farmers in the RCHRSP Area that current situation on gender issue has not been changed, compared with the results obtained from the socio-economic survey in the previous study period. Namely there are no serious gender problems. Females' access and control over the resources such as water, residential and farm land, and livestock, are not constrained.

(4) Results of Socio-economic Survey[3]

(a) Demographic Condition

General characteristics of farm HHs in RCHRSP are shown below. Zoning in this table follows those in the M/P Study.

**Table II-1.2.3.4 General Characteristics of Farmers Households in RCHRSP**

| Item | Zone 1* | Zone 2** | Whole |
|---|---|---|---|
| Average Family Size (persons) | 5.34 | 5.48 | 5.41 |
| Balance of Male and Female (%) | 48 : 52 | 50 : 50 | 49 : 51 |
| Working-age Population (persons) | 3.86 | 3.91 | 3.88 |
| Literacy Rate (%) | 75 | 74 | 74 |
| Education (from primary school) (%) | 77 | 79 | 78 |

*Source: Socio-economic survey, 2011*
**: Area to be irrigated with 80% dependability which is classified in the M/P study*
***: Area to be irrigated with 50% dependability which is classified in the M/P study*

In the RCHRSP Area, average family size is 5.41persons/HH. Meanwhile a balance of male and female of the sampled HH members shows that female outweighs male with 51% and 49% respectively. Average age of heads of farm HHs is 49 years old. Average number of working-age population (between 15 to 64 years old) per farm HH is 3.88persons/HH. Further the literacy rate of sampled HH members is 74% for total samples.

(b) Household Income and Expenditure

The proportional income volumes from various income sources are calculated for each source and zones as shown below

**Table II-1.2.3.5 Proportional Income Volumes from Different Sources in RCHRSP** (Unit: %)

| No | Type of Income | Zone 1 (Kampong Speu) | Zone 2 (Kampong Speu) | Zone 2 (Kandal) |
|---|---|---|---|---|
| 1) | Selling rice | 18.2 | 16.5 | 12.3 |
| 2) | Selling vegetables (red pepper/ tobacco/ water melon/ others) | 0.6 | 2.6 | 0.1 |
| 3) | Selling fruits (mango/ papaya, banana/ hairly fruit/ orange/ others) | 0.8 | 1.8 | 0.2 |
| 4) | Selling palm sugar | 2.3 | 2.2 | 11.5 |
| 5) | Selling livestock/ poultry products | 6.1 | 7.2 | 8.1 |
| 6) | Selling fishes | 2.3 | 4.8 | 0.1 |
| | Sub-total of Agricultural Income | 30.3 | 35.1 | 32.3 |
| 7) | Salary from permanent job | 24.1 | 25.3 | 21.3 |
| 8) | Wage from temporary on-farm job | 10.6 | 3.9 | 1.9 |
| 9) | Wage from temporary off-farm job | 11.9 | 11.4 | 11.3 |
| 10) | Private business (transportation, trading, shop, etc.) | 7.2 | 1.0 | 13.3 |
| 11) | Remittance from family members | 5.5 | 11.1 | 1.5 |
| 12) | Selling firewood/charcoal | 3.5 | 0.3 | - |
| 13) | Selling handicraft/ cottage industry products | - | 1.5 | 1.8 |

[3] *Socio-economic survey was conducted in July and August, 2011 by the JICA Survey Team. Detailed data is shown in ATTACHMENTs 1 and 2 of ANNEX C.*

| No | Type of Income | Zone 1 (Kampong Speu) | Zone 2 (Kampong Speu) | Zone 2 (Kandal) |
|---|---|---|---|---|
| 14) | Selling forest vegetable/ crop | 0.0 | 0.3 | 5.0 |
| 15) | Others | 6.9 | 10.1 | 11.6 |
| | Sub-total of Non-Agricultural Income | 69.7 | 64.9 | 67.7 |
| 16) | Total | 100.0 | 100.0 | 100.0 |

*Source: Socio-economic survey, 2011*

From above table, it is clear that the agricultural income is less than 40% for each zone. It is less than the non-agricultural income. Further "Salary from permanent job" is bearing especially high proportion of zone-wide total income. Furthermore, data on income and expenditure was processed to work out the daily income and expenditure per capita among sampled HH population.

**Table II-1.2.3.6 Daily Income and Expenditure Per Capita of Sampled Population in RCHRSP**

| Income Strata | Average HH Income (US$/Year) | Average HH Expenditure (US$/Year) | Average HH Pop. (nos.) | Per Capita Daily Income (US$) | Per Capita Daily Expenditure (US$) |
|---|---|---|---|---|---|
| **Zone 1 (Kampong Speu)** | | | | | |
| 1st | 2,879 | 2,280 | 6.20 | 1.29 | 1.02 |
| 2nd | 1,670 | 1,314 | 5.60 | 0.83 | 0.65 |
| 3rd | 1,310 | 991 | 5.40 | 0.67 | 0.51 |
| 4th | 920 | 726 | 4.40 | 0.58 | 0.46 |
| **Zone 2 (Kampong Speu)** | | | | | |
| 1st | 2,671 | 1,829 | 5.80 | 1.28 | 0.88 |
| 2nd | 1,531 | 1,370 | 5.80 | 0.73 | 0.66 |
| 3rd | 1,179 | 1,053 | 5.50 | 0.60 | 0.53 |
| 4th | 774 | 768 | 4.73 | 0.45 | 0.45 |
| **Zone 2 (Kandal)** | | | | | |
| 1st | 2,619 | 2,289 | 6.70 | 1.09 | 0.95 |
| 2nd | 2,351 | 1,548 | 6.20 | 1.05 | 0.69 |
| 3rd | 1,448 | 1,032 | 5.10 | 0.79 | 0.56 |
| 4th | 906 | 681 | 4.40 | 0.57 | 0.43 |

*Source: Socio-economic survey, July 2011*

In the above table, the area was divided into 3 categories that is Zone 1, Kampong Speu area in Zone 2, and Kandal area in Zone 2, considering water availability and province according to the M/P Study. In Zone 1, the sample HHs were divided into 20 HH intervals, while 10 HH intervals in Zone 2. In this interval, the sample HHs were arranged from the highest income HH to the lowest, in order to form 1st to 4th income strata. The figures obtained in Cambodian Riel were converted into US Dollars with the current effective exchange rate that is US$ 1 = Riel 4,084 in November 2011.

Applying the poverty line (equal to per capita daily expenditure of US$ 0.58, setting for Cambodia rural area by the Achieving Cambodia's Millennium Development Goals 2010) shown in Table II-1.2.3.3, it is judged that 4th strata and 3rd strata fall below the poverty line provisionally. Accordingly around 50% of farm HHs in the RCHRSP Area are supposed to be still under the poverty line.

### II-1.2.4 Agriculture

The Roleang Chrey Headworks were planned to command 24,000 ha under the Western Phnom Penh Integrated Development Center Project started in 2001 by the Government own finance. The command area covers mostly Kampong Speu Province and also small part of Kandal Province and Take Province which are included in the target area (62,100 ha) of the Study on Comprehensive Agricultural Development of the Prek Thnot River basin.

(1) Agro-demography and Land Tenure & Holding

In the said study, 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 as follows:

**Table II-1.2.4.1 Agro-demographic Features of Project Communes in Target Area**

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

*Source: Table 4.7.1, Volume II M/P, Final Report for the Study on Comprehensive Agricultural Development of Prek Thnot River Basin*

(2) Paddy Production

Agricultural situation in the command area of RCHRSP has no changes from the previous study period up to now. Therefore, it is judged that the paddy production in the area could be generally characterized as low and unstable productivity with a prolonged rice cultivation season continuing form May to January with the cultivation of rice varieties of different growth durations of early to late as the same as the M/P Study time. Further, traditional farming practice adapted to the agro-climatic conditions in the area is another characteristic of the rice production.

Cropping seasons in the area are generally defined into 2 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. Actually, 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 March in irrigated areas. The cropping calendar in the area is diversified depending on locations affected by the seasonal availability of irrigation water. Since this situation has not been improved so far, it is judged that there are no changes in the prevailing cropping calendar and patterns in the area.

Current situation of paddy production in 2 provinces based on the latest provincial statistics is shown below:

**Table II-1.2.4.2 Area, Unit Yield, and Production of Paddy in Kampong Speu Province**

| No. | District | Rainy Season 2010 | | | Dry Season 2011 | | | Total 2010-2011 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) |
| (a) | Basedth | 22,323 | 2.67 | 59,481 | 91 | 3.13 | 285 | 22,414 | 2.67 | 59,765 |
| (b) | Chbar Mon | 3,126 | 2.85 | 8,970 | 241 | 3.20 | 772 | 3,367 | 2.89 | 9,742 |
| (c) | Kong Pisei | 14,948 | 2.66 | 39,825 | 18 | 3.21 | 58 | 14,966 | 2.67 | 39,882 |
| (d) | Oral | 5,935 | 3.12 | 18,517 | 0 | - | 0 | 5,935 | 3.12 | 18,517 |
| (e) | Udong | 15,522 | 2.48 | 38,541 | 40 | 3.00 | 120 | 15,562 | 2.48 | 38,661 |
| (f) | Phnom Srouch | 16,040 | 2.85 | 45,720 | 39 | 3.45 | 135 | 16,079 | 2.85 | 45,854 |
| (g) | Samraong Tong | 23,484 | 2.61 | 61,228 | 175 | 3.20 | 561 | 23,659 | 2.61 | 61,789 |
| (h) | Tpong | 9,581 | 2.73 | 26,156 | 0 | - | 0 | 9,581 | 2.73 | 26,156 |
| Total | | 110,959 | 2.69 | 298,437 | 604 | 3.19 | 1,929 | 111,563 | 2.69 | 300,366 |

*Note: Districts Chbar Mon, Kong Pisei, and Samaraong Tong are related with the Survey Area.*
*Source: Agricultural Statistics 2010 – 2011, Provincial Department of Agriculture, Kampong Speu Province*

**Table II-1.2.4.3 Area, Unit Yield, and Production of Paddy in Kandal Province**

| No | District | Rainy Season 2010 | | | Dry Season 2011 | | | Total 2010-2011 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) |
| (a) | Kandal Stung | 12,453 | 2.95 | 36,794 | 600 | 3.60 | 2,160 | 13,053 | 2.98 | 38,954 |
| (b) | Kean Svay | 930 | 3.50 | 3,255 | 5,964 | 4.20 | 25,049 | 6,894 | 4.11 | 28,304 |
| (c) | Ksach Kandal | 6,231 | 2.68 | 16,684 | 5,500 | 3.60 | 19,800 | 11,731 | 3.11 | 36,484 |

| No | District | Rainy Season 2010 | | | Dry Season 2011 | | | Total 2010-2011 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) |
| (d) | Koh Tom | 2,864 | 3.29 | 9,416 | 14,506 | 4.25 | 61,651 | 17,370 | 4.09 | 71,067 |
| (e) | Laek Duck | 1,232 | 4.15 | 5,112 | 4,750 | 4.30 | 20,425 | 5,982 | 4.27 | 25,537 |
| (f) | Lvea Em | 739 | 4.40 | 3,251 | 6,653 | 4.20 | 27,943 | 7,392 | 4.22 | 31,194 |
| (g) | Muk Kompoul | 462 | 4.08 | 1,885 | 6,600 | 4.10 | 27,060 | 7,062 | 4.10 | 28,945 |
| (h) | Sang Snuol | 9,276 | 2.77 | 25,731 | | - | | 9,276 | 2.77 | 25,731 |
| (i) | Pongea Loe | 4,384 | 2.78 | 12,173 | 6,957 | 4.29 | 29,846 | 11,341 | 3.71 | 42,019 |
| (j) | Saang | 5,276 | 2.85 | 15,037 | 10,443 | 4.25 | 44,383 | 15,719 | 3.78 | 59,420 |
| (k) | Ta Kmao | 54 | 2.96 | 160 | 17 | 3.82 | 65 | 71 | 3.17 | 225 |
| Total | | 43,901 | 2.95 | 129,498 | 61,990 | 4.17 | 258,382 | 105,891 | 3.66 | 387,880 |

*Note: Districts Kandal Stung and Sang Snuol are related with the Survey Area.*
*Source Agricultural Statistics 2010 – 2011, Provincial Department of Agriculture, Kandal Province*

(3) Production of Other Crops

Compared with paddy production, productions of other crops such as upland crops, vegetables and fruits are extremely limited in the area. Major upland crops and vegetables are maize, mung bean, sweet potato, sesame, sugarcane, water melon, cucumber, string bean, etc. Major fruit trees found in the area are banana, mango and coconut, although the planted area as a whole is limited. It is judged that this situation has not been changed yet, compared with the M/P Stage.

(4) Land Holding of Farm Households (only for farm land)

Agricultural land holding Size, which was obtained from the socio-economic survey, is shown as follows:

**Table II-1.2.4.4 Farm Land Holding Size of Farm Households in RCHRSP**

(Unit: ha)

| Item | Zone 1 | Zone 2 | Whole Area |
|---|---|---|---|
| (a) Owned Land | | | |
| 1) Paddy field | | | |
| -Irrigated Paddy Field | 0.51 | 0.23 | 0.37 |
| -Rainfed Paddy Field | 0.43 | 0.51 | 0.47 |
| Sub-Total | 0.94 | 0.74 | 0.84 |
| 2) Upland Field | 0.13 | 0.04 | 0.08 |
| Total (a) | 1.07 | 0.78 | 0.92 |
| (b) Operated Land | | | |
| 1) Paddy field | | | |
| -Irrigated Paddy Field | 0.57 | 0.34 | 0.46 |
| -Rainfed Paddy Field | 0.46 | 0.53 | 0.49 |
| Sub-total | 1.03 | 0.87 | 0.95 |
| 2) Upland Field | 0.13 | 0.04 | 0.08 |
| Total (b) | 1.16 | 0.91 | 1.03 |

*Source: Socio-economic survey, 2011*

(5) Holding Situation of Livestock

Holding situation of livestock, which was obtained through the socio-economic survey, is shown as follows:

**Table II-1.2.4.5 Holding of Adult Livestock in RCHRSP**

| Item | Zone 1 | | | Zone 2 | | | Whole | | |
|---|---|---|---|---|---|---|---|---|---|
| | Respondent | | Number of adult | Respondent | | Number of adult | Respondent | | Number of adult |
| | no./nos. | % | Average | no./nos. | % | Average | no./nos. | % | Average |
| Cows / Oxen | 60 | 71 | 2 | 69 | 81 | 3 | 129 | 76 | 2 |
| Water buffalo | - | - | - | - | - | - | - | - | - |
| Goat / Sheep | - | - | - | - | - | - | - | - | - |
| Swine | 11 | 13 | 4 | 5 | 6 | 3 | 16 | 9 | 4 |
| Chicken | 42 | 49 | 6 | 47 | 55 | 6 | 89 | 52 | 6 |
| Duck | 16 | 19 | 8 | 8 | 9 | 6 | 24 | 14 | 7 |

*Note: n means number of responses*
*Source: Socio-economic survey, 2011*

### II-1.2.5 Roleang Chrey Headworks

The Roleang Chrey Headworks are the most important key structures for the Roleang Chrey Irrigation System, which were constructed on the Prek Thnot River about 100 km upstream from its confluence with the Bassac River. The headworks consist of (i) Roleang Chrey Regulator, (ii) Andong Sla Intake and (iii) Vat Krouch Intake and (vi) their approach channels, of which the locations are shown in the layout map in Figure II-1.2.5.1. The major features of the hydro-mechanical facilities are summarized in Table II-1.2.5.1.

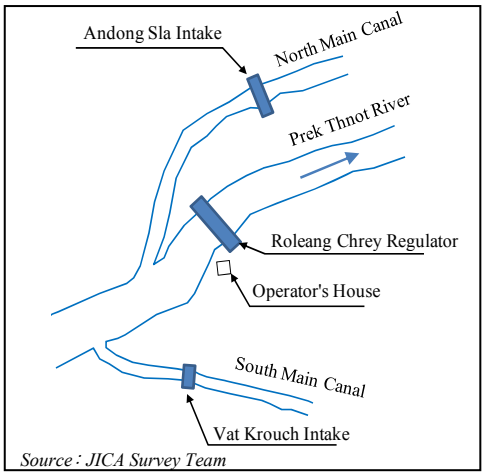



**Figure II-1.2.5.1 General Layout of Roleang Chrey Headworks**

**Table II-1.2.5.1 General Information on Hydro-mechanical Facilities for Roleang Chrey Headworks**

| Structure | Items | General Information |
|---|---|---|
| **Roleang Chrey Regulator** | Type | Fixed wheel gate |
| | Number | 5 nos. |
| | Clear span | 12.5 m |
| | Height | 6.7 m |
| | Hoist | Electric driven, wire rope winding, one motor two drum, with counter weight |
| **Andong Sla Intake** | Type | Steel radial gate, four sealing edges |
| | Number | 4 nos. |
| | Clear span | 4.0 m |
| | Height | 2.7 m |
| | Hoist | Electric driven, wire rope winding, one motor two drum |
| **Vat Krouch Intake** | Type | Steel radial gate, four sealing edges |
| | Number | 1 no. |
| | Clear span | 4.00 m |
| | Height | 2.54 m |
| | Hoist | Manually operated wire rope hoist |

*Source： The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

The present conditions of these structures were reviewed through field reconnaissance, review of previous studies and hearing from Kampong Speu PDOWRAM, and confirmed that there were no changes from the D/D Time. The review results are summarized below.

(1) Roleang Chrey Regulator

**Roleang Chrey Regulator**

Though the Roleang Chrey Regulator was constructed in 1974, its structural components remain stable, such as the retaining walls, gate piers, operation deck and bridge. However, its downstream apron and river side are severely eroded, for which protection works need to be improved to protect the regulator. The regulator gates have not been well maintained since it was constructed, therefore almost all the gate wheels could not rotate due to rusting of shafts causing overload to the hoist mechanism, which makes it difficult to operate precisely. A lot of water leakage was observed due to deterioration and cracks in the rubber seal. In 2006, replacement of wire ropes connecting with counter-weight and installation of diesel generator for the Roleang Chrey Regulator were made as emergency treatment under financial assistance of JICA.

For the hydro-mechanical works, electric motors, speed reducers, counter shafts and winding drums of the hoists are still in running condition in spite of the fact that those are quite old. None of the brakes, position indicators or limit switches functions 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. Rehabilitation of the severely deteriorated rollers equipped with gate leaves should be thus urgently required since there would be high possibility to bring about sudden malfunction.

(2) Andong Sla Intake

The Andong Sla Intake was constructed for supplying water to NMC in 1974 together with the Roleang Chrey Regulator. The related facilities such as gate piers, operation deck and bridge do not exhibit severe conditions. Its downstream protection works however are severely damaged. The approach channel does not require any improvement since it has adequate flow capacity and show no indications of serious erosion.

**Andong Sla Intake**

The intake has not been well maintained since it was constructed, and a very large amount of leakage is observed from the gates. The existing steel radial gate leaks excessively through the seal and wire rope holes. In addition, the hoist wires are also damaged, and currently temporally repaired using steel wires connected with the arm of the gate leaf. The steel radial gate also exhibit structural deficiencies such as instability due to the extremely slender gate leaf, susceptibility to corrosion of the structural components, difficulty of maintenance due to being constantly submerged, and perennial difficulty in sealing. 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.

(3) Vat Krouch Intake

The Vat Krouch Intake was constructed in 2002 as an intake facility for SMC. Though the approach channel from the Prek Thnot River to the Vat Krouch Intake is not large enough to accommodate the design discharge, no serious erosion is observed on its side slopes. The Vat Krouch Intake appears structurally stable, but, its downstream portion is severely eroded. The intake is equipped with one steel radial gate with four sealing edges. This induces large head loss, which is one of the constraints of gravity irrigation.

**Vat Krouch Intake**

One radial gate is currently in working condition although the wire ropes are repaired in a temporary fashion. This radial gate produces a great deal of head loss to abstract 16.3 $m^3$/sec of the design discharge from the river, which would create difficulty in introduction of a gravity irrigation system.

(4) O&M

(a) Operation

At present, Kampong Speu PDOWRAM is responsible for O&M for gates and accessories for the Roleang Chrey Regulator, Andong Sla and Vat Krouch Intakes. O&M for them has not been properly

conducted by PDOWRAM mainly due to financial constraint. Even O&M manual is not available. It is practically executed by one aged person who has been working since 1970.

As for the gate operation for the Roleang Chrey Regulator, generally, the gates for the regulator are kept closed, and at flood time, are opened by observing the upstream water level in front of the gates. At flood time, the gates are opened one by one from center when the upstream water level becomes over EL. 35.7 m. This is a sole rule for gate operation for the Roleang Chrey Regulator.

The gate operation of the Andong Sla and the Vat Krouch Intakes is carried out on the demand basis, but not based on the irrigation schedule. The intake gates are operated customarily based on the request from farmers of NMC and SMC. Although the gates are operated by skillful operator, such operation results in much loss of water source as well as high risk of damages of facilities. The gates have to be rehabilitated as soon as possible including communication system among the gate operators, PDOWRAM offices and MOWRAM.

(b) Maintenance

Regular maintenance for the Roleang Chrey Regulator, the Andong Sla Intake and the Vat Krouch Intake are hardly made by the Kampong Speu PDOWRAM. Emergency repair such as replacement of wire is made not permanently but temporally. Minor repairs such as replacement of magnetic conductor and switch, are conducted at own budget of PDOWRAM, while major serious problems have not been repaired after the urgent repair by JICA in 2006. In addition, severe erosion around structures has not been repaired.

### II-1.2.6 Irrigation and Drainage

(1) Irrigation System

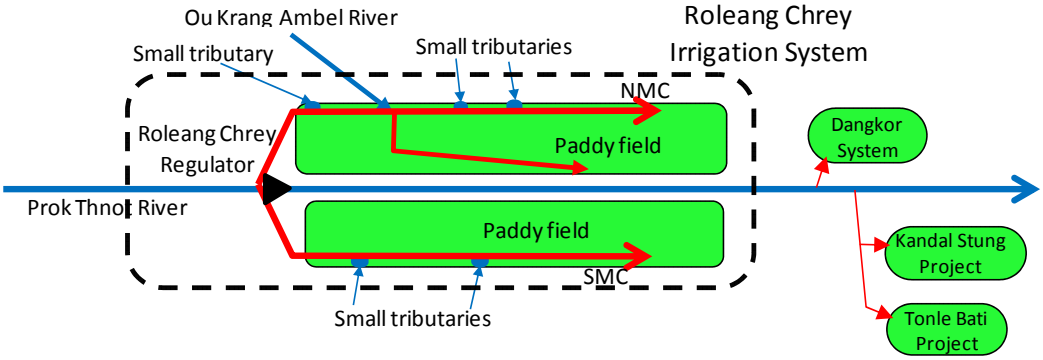
The construction of the Roleang Chrey Regulator, Andong Sla Intake, and NMC was planned in late 1960s and started early 1970s as a part of the Prek Thnot Multi Purpose Dam Project, aiming to irrigate 35,000 ha. This project was however discontinued due to the civil war and political change, and the Government started the Western Phnom Penh Integrated Development Center Project (WPPIDCP) in 2001 using its own budget. Under WPPIDCP, NMC after the Andong Sla Intake was constructed aiming to irrigate 13,470 ha of the downstream area, provided that new water resources would be developed. The Vat Krouch Intake was constructed in 2002, and SMC was planned to irrigate 2,320 ha under WPPIDCP. The major features of the Roleang Chrey Irrigation System under WPPIDCP are summarized below, and the layout of the irrigation system is illustrated in Figure II-1.2.6.1.

**Table II-1.2.6.1 Outline of Roleang Chrey Irrigation System**

| Item | Outline |
|---|---|
| - Water source | Prek Thnot River:<br>- Roleang Chrey Regulator<br>- Intakes<br>- Pump stations (1) |
| - Command area | 24,000 ha* in Kampong Speu, Kandal, and Takeo Provinces |
| - Main canals | NMC:<br>- Command area: 8,670 ha*<br>- Design capacity 15 $m^3$/sec<br>Lum Hack Canal :<br>- Command area: 4,800 ha*, starts from Ou Krang Ambel reservoir,<br>SMC:<br>- Command area: 2,320 ha*,<br>- Design capacity: 15 $m^3$/sec<br>Ou Speandek canal:<br>- Command area: 3,360 ha*<br>Chrey Ou Phnoy Canal:<br>- Command area: 4,850 ha* |

| Item | Outline |
|---|---|
| - Secondary canals | 19 nos.*: 62 km in total |
| - Tertiary canals | 50 nos.*: 192 km in total |
| - Drainage canals | 26 nos.*: 95 km in total |
| - Major structures | Spillways, Turnouts , Inlets, Bridges, Culverts |

**: Original plan as WPPIDCP*
*Source : The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*




*Source : JICA Survey Team*

**Figure II-1.2.6.1 General Layout of Roleang Chrey Irrigation System**

(2) Irrigation Canals and Related Facilities

(a) North Main Canal and Ou Krang Ambel System

In downstream of NMC at about 800 m from the Roleang Chrey Regulator, Andong Sla Intake was constructed to control irrigation water taking from the river to the northern area of the Prek Thnot River. The construction of NMC was ceased completely because of war activities. After 1979, the construction was resumed by the Government under the own budget. The most downstream part of NMC has been recently constructed by MOWRAM. A total length of NMC is about 32 km from the Roleang Chrey Regulator to the end point in Angk Snuol District in Kandal Province.

**North Main Canal**

Ou Krang Ambel Irrigation System is also located in the geographic area of NMC. It has a reservoir in the Ou Krang Ambel River, which is a tributary of the Prek Thnot River in this irrigation system, and its catchment area is estimated at 453 km$^2$ at the reservoir located along the National Road No.4 near Kampong Speu town. However, 2 reservoirs were further constructed for the irrigation development in the upstream of the Ou Krang Ambel River. Accordingly available water source to the downstream area remarkably decreased, and the system therefore mainly receives water from NMC.

**South Main Canal**

(b) South Main Canal

Vat Krouch Intake Gate was constructed for 1.5 km south from the Roleang Chrey Regulator to divert water from the Regulator to southern area of the Prek Thnot River. Since then, the Government has continued construction of SMC, and completed it by 2002. A total length of SMC is about 38.5 km from the

Roleang Chrey Regulator to the end point i.e. crossing point with the National Road No.3 in Kong Pisei in Kampong Speu Province. There are 18 irrigation systems branched off from SMC.

(c) Reservoirs

There are 3 and 8 reservoirs on NMC and SMC respectively, which are level crossing of local rivers with single band along the main canals, collecting the runoff of the small tributaries and supplementing the discharge into the main canals. Most of reservoirs have intake gates on the main canals to supply water to the adjacent secondary or minor canals and spillways to evacuate the excess water in flood season. The embankment of 3 systems was once seriously or partly damaged by flood, but is now functioning due to recent repairs by MOWRAM.

(d) Pump Systems

Pumps were installed by the Government to take water from the main canals or directly from the Prek Thnot River. On NMC, there is one existing pump station at 5.3 km point and planed one at 10.2 km point from the Andong Sla Intake, while there is no pump station operating on SMC.

In addition, PDOWRAM is managing 14 mobile pumps, which are transported and operated according to the request from FWUCs or village chief. There are 3 types of pumps being operated by the beneficiaries, which are fixed, mobile, and floating type. Due to shortage of operation cost, these pumps are operated for limited time only. The condition of pumps is fairly good.

(e) Secondary and Tertiary Canals

Subordinate canals such as secondary and tertiary canals are not sufficiently constructed in number and in length, causing difficulty to distribute water properly from main canals to paddy fields. To solve this problem, farmers excavated canal and bury pipes in many places. In the secondary and tertiary canals, related structures such as turnouts, checks, and culverts are also not sufficiently constructed in number due to lack of budget. This obstructs proper water management, and needs high pumping cost and blocking of canal by soil for crossing.

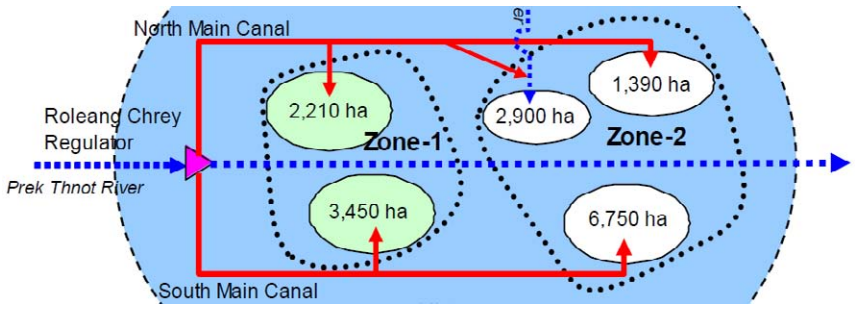
(2) Irrigation Area

WPPIDCP was planned aiming to irrigate about 24,000 ha, which extend over Kampong Speu Province, Kandal Province, Phnom Penh Metropolitan Area, and Takeo Province. However, the water resources are not enough at all the planned area, because the system was designed without rationale water balance study. In the previous JICA M/P Study in 2006, it was proposed to classify the beneficiary area into 2 dependability, namely with 80% dependability (4 in 5 years, categorized as Zone-1), and with 50% dependability (3 in 6 years, categorized as Zone-2) taking into consideration the available water from the Prek Thnot River.

**Table II-1.2.6.2 Irrigation Area by Different Dependability of Roleang Chrey Irrigation System**

| Dependability | Area | Area | Total |
|---|---|---|---|
| 80% (Zone-1) | NMC Area, Upstream | 2,210 ha | 5,660 ha |
| | SMC Area, Upstream | 3,450 ha | |
| 50% (Zone-2) | NMC Area, Downstream | 1,390 ha | 11,040 ha |
| | Ou Krang Ambel Area | 2,900 ha | |
| | SMC Area, Downstream | 6,750 ha | |
| Total (Zone-1+Zone-2) | All area commanded by NMC | 6,500 ha | 16,700 ha |
| | All area commanded by SMC | 10,200 ha | |

**: Ou Krang Ambel System is mainly supplied by NMC.*
*Source：The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*




*Source : The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

**Figure II-1.2.6.2 Irrigation Area by Different Dependability**

(3) Drainage Conditions

In the field survey and the experiences in the pilot projects in the previous JICA Study from 2005 to 2008, it was observed that on-farm drains were not available in irrigated areas, and the small rivers and/or natural streams are utilized as drains to evacuate the excess water from the area.

According to the inventory survey during the JICA Study in 2005, about 13% of the inventory area affected or damaged by flood every year or once in a few years suffered from flood or poor drainage. These are scattered in the western and central parts in the Roleang Chrey Irrigation Area, and the flood or drainage damage seemed to occur only in the depressed area in which insufficient drain was provided in the irrigation systems concerned. Thus, drainage is not serious for farmers in the Roleang Chrey Irrigation Area. Through site visit and interview with farmers, it was confirmed that these situation are not changed from the M/P Time.

(4) Operation, Maintenance and Water Management

(a) O&M

There is no written O&M manual of main canal facilities. Operation of the irrigation facilities of the main system (Roleang Chrey Headworks, NMC, SMC, secondary canals and pumps on the Prek Thnot River) is carried by the Government (MOWRAM and Kampong Speu PDOWRAM), while the tertiary canal systems are managed by FWUC.

There is no clear boundary of their responsibilities between MOWRAM and PDOWRAM, but generally relatively large works are being carried out by MOWRAM, while small works are done by PDOWRAM. Whenever needed, PDOWRAM requests MOWRAM for execution of rehabilitation works, based on which MOWRAM executes necessary works after approval of MEF on budgetary arrangement. The works including rehabilitation and construction of additional facilities, the contractor is selected through local bidding. The rehabilitation works carried out by MOWRAM during the period from 2006 to 2010 are summarized in the table below.

**Table II-1.2.6.3 Rehabilitation Works of Roleang Chrey Irrigation System Carried Out by MOWRAM from 2006 to 2010**

| Year | Rehabilitation Works | Rehabilitated Facilities | Cost (Million Riel) |
|---|---|---|---|
| 2006 | Repair of canal system and construction of structures on SMC | 4 check structures | 1,865 |
| | | 3 check structures | |
| | | 6 drain structures | |
| | | 2 spillways | |
| | | Repair of Main Canal (29 km) | |
| | Repair of Roleang Chrey Regulator | Repair of Roleang Chrey Regulator | 512 |
| | Repair of canal system and construction of structures on NMC | Repair of 1 gate structures | 471 |
| | | 2 spillways | |

| Year | Rehabilitation Works | Rehabilitated Facilities | Cost (Million Riel) |
|---|---|---|---|
| 2008 | Construction of canals on SMC | Construction of canal (2.9 km) | 2,533 |
| | | Construction of Say canal (1 km) | |
| | Repair of canal system and construction of structures on SMC | 3 gate structures | 2,207 |
| | | 1 gate structure | |
| | | 5 culvert and drain structures | |
| | | 1 spillway | |
| | | Repair of main canal (29 km) | |
| | Repair of canal system and construction of structure on NMC | 3 gate structure | 4,810 |
| | | 5 culvert structures | |
| | | Repair of canal (18.9 km) | |
| 2009 | Repair of canal system and structures on Main Canal | 7 check structures | 5,777 |
| | | 14 culvert structures | |
| | | 3 stone bridges | |
| | | 3 check structures | |
| | | 3 culvert structures | |
| | | Repair of main canal dike (700 m) | |
| | Repair of canal system and structures on SMC | 4 check structures | 5,860 |
| | | Repair of secondary canal (5.6 km) | |
| | | Rehabilitation of 3 secondary canals (12 km) | |

*Source: Engineering Department, MOWRAM*

(b) Water Management

Six FWUCs in total have been established in NMC and SMC irrigation areas, and registered to the Government, which are however presently not yet activated. There is no written irrigation service plan and no water management guidelines for the irrigation system recommended by the Government. Farmers in the irrigation system do not have sufficient experience in exercising water management, so that they do not enjoy effect of executing water management activity. The conditions of structures are poor due to lack of maintenance, which results in much water loss, discourage of stakeholders to participate in water management activity and less collection of ISF.

### II-1.3 Upper Slakou Irrigation System Rehabilitation Sub-project

#### II-1.3.1 Location and Administration

The USISRSP Area (3,500 ha) is located on the right bank of the Slakou River between 104°30' to 104°40' east longitude, and 11°00' to 11°05' north latitude. The elevation of the area ranges from 15 m to 35 m with a slope of 1/200 to 1/1000 from west to east. The approximate distance to Takeo town from the area is about 15 to 35 km. The USISRSP Area administratively belongs to Basedth District of Kampong Speu and Tram Kak District of Takeo Province. Five communes and 32 villages are included in the area.

#### II-1.3.2 Meteorology and Hydrology

##### II-1.3.2.1 Meteorology

There are no meteorological stations in the USISRSP Area. Thus, the meteorological data recorded at Pochentong, Phnom Penh, which is shown in Table II-1.2.2.1.1, is used for estimate of crop water requirement.

##### II-1.3.2.2 Hydrology

As mentioned in Section I-6.2, there is no available data of water level and discharge in the Slakou River basin. Hydrological analysis is carried out based on the hydrological data of the Prek Thnot River basin neighboring the Slakou River basin.

(1) Condition of Slakou River, Tumnup Lok Reservoir and Kpob Trobek Reservoir

The Slakou River, called Tras Stream at upstream, is perennial, although the flow becomes negligibly small in the mid dry season. The Tumnup Lok Reservoir is located on the Slakou River. The Kpob Trobek Reservoir exists on the Don Phe Stream, which is a perennial stream, however dries up several months in the dry season at reservoir site, because of water abstraction for irrigation about 8 km upstream of the Kpob Trobek Reservoir. These reservoir systems are shown in Figure II-1.3.2.2.1.

(2) Average Depth of Rainfall over Area

Based on the rainfall data at each station, the average rainfall over area at each reservoir in the Slakou River Basin were calculated by the Thiessen method. The average rainfall over area ranges from 1,000 mm to 1,200 mm.

**Table II-1.3.2.2.1 Annual Rainfall at each Station and Average Rainfall in Tumnup Lok Reservoir Basin**

| Reservoir | Rainfall Station | Catchment Area ($km^2$) | Ratio to Area | Annual Rainfall* (mm) |
|---|---|---|---|---|
| Tumnup Lok | Srae Klong | 122 | 37% | 1,144 |
| | Prey Dob | 60 | 18% | 1,008 |
| | Basedth | 150 | 45% | 1,198 |
| | All | 332 | 100% | 1,144 |
| Kpob Trobek | Basedth | 137 | 100% | 1,198 |
| Don Phe | Basedth | 70 | 100% | 1,198 |

*Note: Average in the period from 1966 to 1969 and from 1983 to 2010*
*Source: JICA Survey Team*

(3) Hydrological Analysis

(a) Concept of Calculations

As mentioned above, there was no water gauge station in the Slakou River Basin in 2002. On the other hand, a water gauge observation at Peam Khley station on the Prek Thnot River, neighboring the Slakou River Basin, has been continuously carried out. This observation condition has not changed and also there is still no water gauge station in the Slakou River Basin. Therefore, the runoff analysis model constructed in the previous study could be adopted in this Survey.

At first, the runoff analysis model was validated with updated discharge data at Peam Khley station. Then the flow discharge of the Slakou River and Don Phe Stream was calculated using the model with the rainfall data at each basin.

(b) Runoff Analysis

The outline of this runoff analysis model constructed in the previous survey is given below.

Monthly rainfall is partly consumed by evapo-transpiration. If rainfall mount is very small, almost all the rainfall water evaporates and no or little rainwater contributes to runoff and groundwater. If rainfall water is not small but not much, most of the rainfall evaporates and a little amount of rainfall contributes to runoff and groundwater. If rainfall is much, large amount of rainfall contributes to runoff. Even if rainfall increases more, evaporation little increases and becomes almost constant, while runoff continuously increases as rainfall does. Considering such phenomena, the following equations in relation between monthly rainfall and monthly effective rainfall which contribute to runoff, were arranged in this analysis:

$$ER = R - L$$

$$L = \alpha \times ETo \times (1 - exp^{-\beta \times R})$$

*In case of $L > R$ in the above equation, $L = R$*
*Where, ER: effective rainfall, which contributes to runoff (mm)*

*R:* *monthly rainfall (mm)*
*L:* *loss (mm)*
*α, β:* *coefficient*
*ETo:* *potential evapotranspiration (mm)*

Large percentage of effective rainfall contributes to runoff within the same month when the rainfall occurs. Some of the effective rainfall flows out in the next month. Further the small percentage flows out 2 months, 3 months, and several months later. Conversely speaking, monthly runoff (Q) is composed of runoff elements caused by rainfall in the same month, last month, 2 month ago, 3 months ago, and several months ago as presented by the following equation.

$$Q = A \times ER_0 + B \times ER_1 + C \times ER_2 + D \times ER_3 + E \times ER_4 + F \times ER_5$$

*Where, Q: monthly runoff (mm),*
*Attached figures 0, 1, 2, 3, 4 and 5 indicate this month, last month, two months ago, three months and four months ago, respectively.*
*A, B, C, D, E and F: contribution rates of effective rainfall to runoff for the same month when runoff (Q) is estimated, last month, 2 months ago, 3 months ago, 4 months ago and 5 months ago from the month that runoff (Q) is estimated, respectively.*

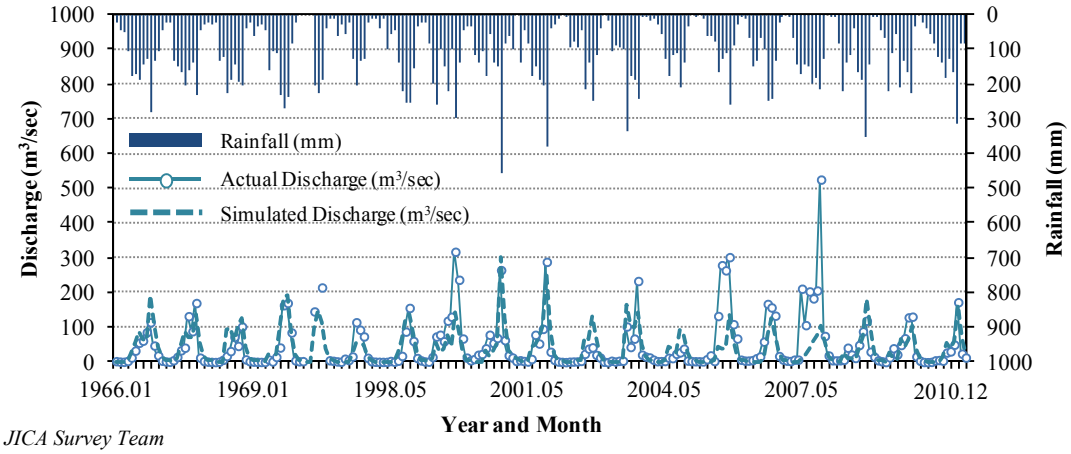
These coefficients of α, β, A, B, C, D, E and F are estimated so that the simulated runoff meets to actual runoff as much as possible.

(c) Validation of Runoff Analysis Model

The rainfall data calculated as the average rainfall over area in Item (2) of Sub-clause II-1.3.2.2 is applied to the runoff analysis model. The applied coefficients of this model are the same as previous study, as shown below:

*α = 1.23 and β = 0.006*
*A = 0.68, B =0.23, C = 0.08, D = 0.015, E = 0.01, and F = 0.005*

The result of the simulation is shown below:




*Source: JICA Survey Team*

**Figure II-1.3.2.2.2 Validity of Runoff Analysis Model at Peam Khley Station on Prek Thnot River**

As shown above, actual and simulated discharges are almost fitted, except for several periods in the rainy season when the simulated discharge is smaller than the actual discharge. Therefore, this runoff analysis model and these coefficients applied in the previous survey are considered to be highly repeatable. Consequently, the runoff analysis model and these coefficients could be applied to this Survey.

(4) Calculation of Runoff

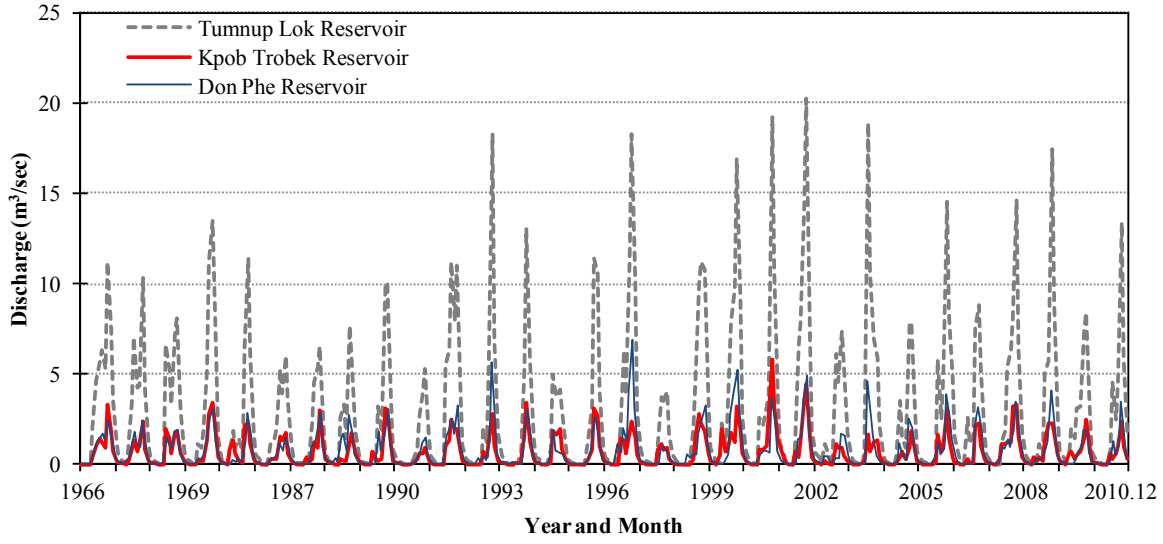
The discharge in each reservoir basin is calculated by the runoff analysis model as explained above. The rainfall data input to the model are the average rainfall over area calculated in Item (2) of Sub-clause II-1.3.2.2 so as to reflect the rainfall condition in each basin.

**Table II-1.3.2.2.2 Results of Runoff Calculation**

| Reservoir | C.A. ($km^2$) | Monthly Discharge (MCM) |
|---|---|---|
| Tumnup Lok | 332 | 7.83 |
| Kpob Trobek | 67 | 1.78 |
| Don Phe | 70 | 2.02 |

*Source: JICA Survey Team*

The results of the runoff calculation are as below:




*Source: JICA Survey Team*

**Figure II-1.3.2.2.3 Discharge of each Reservoir Basin**

**Table II-1.3.2.2.3 Monthly Discharge in each Reservoir (30 years of 1966 to 2010)**

(Unit: $m^3$/sec)

| Reservoir | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tumnup Lok | | | | | | | | | | | | | |
| Mean | 0.51 | 0.25 | 0.10 | 0.10 | 0.59 | 1.49 | 3.55 | 4.11 | 7.02 | 10.80 | 5.51 | 1.73 | 2.98 |
| Maximum | 1.49 | 0.59 | 0.24 | 1.12 | 2.58 | 6.65 | 18.84 | 11.17 | 14.45 | 20.24 | 10.78 | 4.72 | 20.24 |
| Minimum | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.04 | 0.12 | 2.53 | 2.97 | 1.01 | 0.28 | 0.01 |
| Kpob Trobek | | | | | | | | | | | | | |
| Mean | 0.12 | 0.06 | 0.02 | 0.09 | 0.24 | 0.46 | 0.68 | 0.89 | 1.78 | 2.34 | 1.20 | 0.36 | 0.69 |
| Maximum | 1.02 | 0.42 | 0.12 | 0.79 | 1.99 | 1.94 | 1.85 | 2.50 | 3.55 | 5.80 | 3.15 | 1.32 | 5.80 |
| Minimum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.61 | 0.59 | 0.25 | 0.08 | 0.00 |
| Don Phe | | | | | | | | | | | | | |
| Mean | 0.14 | 0.07 | 0.03 | 0.05 | 0.20 | 0.42 | 0.97 | 1.00 | 1.74 | 2.75 | 1.50 | 0.49 | 0.78 |
| Maximum | 0.44 | 0.16 | 0.07 | 0.41 | 1.04 | 1.56 | 4.61 | 2.70 | 4.09 | 6.88 | 3.29 | 1.40 | 6.88 |
| Minimum | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.39 | 0.49 | 0.18 | 0.06 | 0.01 |

*Source: JICA Survey Team*

(5) Flood Discharge at Reservoirs

No additional flood data are available for the Slakou River after completion of F/S. In F/S, flood discharges of the Kpob Trobek and the Tumnup Lok Reservoirs were estimated using 3 methods: (i) method recommended in Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat) (hereinafter called as the IRS method), (ii) unit hydrograph method and (iii) non-uniform calculation method. Among others, non-uniform calculation was executed only for Tumnup Lok Reservoir, but the result was not adopted. In the Survey, flood discharges of the Tumnup Lok Reservoir and the Kpob Trobek Reservoir are calculated by the remaining 2 methods except for the non-uniform calculation method with additionally collected rainfall data. The calculation results are summarized in Table II-1.3.2.2.4. Although the result shows that flood discharges of both 2 reservoirs are slightly

larger than those obtained in F/S, it is proposed to apply the re-estimated flood discharges for design of rehabilitation of the Kpob Trobek Reservoir and the Tumnup Lok Reservoir from safety side viewpoint.

**Table II-1.3.2.2.4 Flood Discharges for each Reservoir in F/S and USISRSP**

| Reservoir | | Catchment Area ($km^2$) | Flood Discharge ($m^3$/sec) | | | |
|---|---|---|---|---|---|---|
| | | | 100 years | 80 years | 50 years | 20 years |
| USISRSP | Kpob Trobek | 137 | 203 | 195 | 177 | - |
| | Tumnup Lok | 332 | 450 | 433 | 392 | - |
| F/S | Kpob Trobek | 137 | 190 | - | 166 | 135 |
| | Tumnup Lok | 332 | 408 | - | 359 | 289 |

*Source: JICA Survey Team*

### II-1.3.3 Socio-economy

(1) Ethnicity

It is said that more than 90% of the entire population were ethnic Khmers, while minor ethnic groups are being isolated in highlands, coastal area, etc. In the USISRSP Area, majority is Khmers, thus there are any remarkable difference of manners and customs, food culture, religions and ethnic makeup, etc.

(2) Poverty

Poverty estimates for three regions (Phnom Penh, other urban areas, and rural areas) identify the concentration of the poor in specific locality and help to target development activities as shown in Table II-1.2.3.1. The table shows a decline in Cambodia's headcount index from 34.8% in 2004 to 30.1% in 2007. There is a decline of about 4% over the period, that is, an average of 1% decline yearly. Further it is necessary to accelerate farm and non-farm activities in order to sustain poverty reduction.

Table II-1.3.3.1 shows a continuing downward trend in poverty[4], based on CDB managed by NCCD.

**Table II-1.3.3.1 Poverty Rate by Regions (USISRSP)** (Unit:%)

| Province | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Phnom Penh | 6.8 | 6.9 | 5.8 | 0.5 | 0.3 | 0.2 | 0.1 |
| Takeo | 31.6 | 30.7 | 29.2 | 28.1 | 26.8 | 25.2 | 23.4 |
| Cambodia | 35.1 | 34.2 | 32.9 | 30.7 | 29.3 | 27.4 | 25.8 |

*Source: Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

As shown in the above table, the poverty index in Takeo Province is 23.4% in 2010, which is slightly better than the average (25.8%) of the whole country, so that it can be said that Takeo Province does not show serious poverty.

(3) Gender Issue

It is judged that current situation on gender issue has not been changed, compared with the results obtained from the socio-economic survey in the previous study period, through interview with farmers in the USISRSP Area. Thus there are no serious gender problems. Females' access and control over the resources such as water, residential and farm land, and livestock, are not constrained.

(4) Results of Socio-economic Survey[5]

(a) Demographic Condition

1) Head of household — The survey respondents are mostly the male and female heads of HHs (62.5% and 37.5% respectively) with their average age 49 years old.

2) Family member — Average family member is 5.33persons/HH in USISRSP.

[4] *Page 10, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

[5] *Socio-economic survey was conducted in July and August, 2011 by the JICA survey team. Detailed data is shown in ATTACHMENTs 1 and 2 of ANNEX C.*

| | |
|---|---|
| 3) Male-Female balance | Male-Female balance of the sampled HH members is 51% for male and 49% for female for the average of all samples |
| 4) Age composition | An outstanding feature of HH members' age composition in the survey area is that the proportion of 11 – 20 years age groups is prominent (23%) compared to other age groups. |
| 5) Education / Literacy | More than 80% of population has received education more than primary school level. Literacy rate is over 80%. |

(b) Household income and expenditure

The proportional values from various income sources are calculated for each source as shown below.

**Table II-1.3.3.2 Proportional Income Volumes from Different Sources in USISRSP** (Unit: %)

| No | Type of Income | Proportional Value |
|---|---|---|
| 1) | Selling rice | 23.2 |
| 2) | Selling vegetables (red pepper/ tobacco/ water melon/ others) | 2.8 |
| 3) | Selling fruits (mango/ papaya, banana/ hairy fruit/ orange/ others) | 2.9 |
| 4) | Selling palm sugar | 0.4 |
| 5) | Selling livestock/ poultry products | 16.0 |
| 6) | Selling fishes | 2.1 |
| | Sub-total of Agricultural Income | *47.4* |
| 7) | Salary from permanent job | 10.5 |
| 8) | Wage from temporary on-farm job | 3.4 |
| 9) | Wage from temporary off-farm job | 10.6 |
| 10) | Private business (transportation, trading, shop, etc.) | 10.8 |
| 11) | Remittance from family members | 6.5 |
| 12) | Selling firewood/charcoal | 3.5 |
| 13) | Selling handicraft/ cottage industry products | - |
| 14) | Selling forest vegetable/ crop | 0.4 |
| 15) | Others | 6.9 |
| | Sub-total of Non-Agricultural Income | *52.6* |
| 16) | Total | 100.0 |

*Source: Socio-economic survey, 2011*

From above table, it is clear that proportion of agricultural income is slightly less than non-agricultural income. Further "private business" is bearing especially high proportion income source, following "selling rice" and "selling livestock/poultry products".

Furthermore, data on income and expenditure was processed to work out the daily income and expenditure per capita among sampled HH population.

**Table II-1.3.3.3 Daily Income and Expenditure Per Capita of Sampled Population in USISRSP**

| Income Strata | Average HH Income (US&/Year) | Average HH Expenditure (US$/Year) | Average HH Population (nos.) | Per Capita Daily Income (US$) | Per Capita Daily Expenditure (US$) |
|---|---|---|---|---|---|
| 1st | 2,212 | 1,484 | 5.8 | 1.06 | 0.71 |
| 2nd | 1,556 | 1,097 | 4.8 | 0.90 | 0.63 |
| 3rd | 1,083 | 1,020 | 6.5 | 0.46 | 0.44 |
| 4th | 662 | 611 | 4.2 | 0.44 | 0.40 |

*Source: Socio-economic survey, 2011*

In the above table, the sample HHs were divided into 10 HH intervals. In this interval, the same HHs were arranged from the highest income HH to the lowest, in order to form 1st to 4th income strata. The figures obtained in Cambodian Riel were converted into US Dollars with the current effective exchange rate that is US$ 1=Riel 4,084 in November 2011.

Applying the poverty line (equal to per capita daily expenditure of US$ 0.58, setting for Cambodia rural area by the Achieving Cambodia's Millennium Development Goals 2010) to the above tables, it is judged that 4th strata and 3rd strata fall below the poverty line. It is assumed that around 50% of farm HHs in the USISRSP Area are supposed to be still under the poverty line.

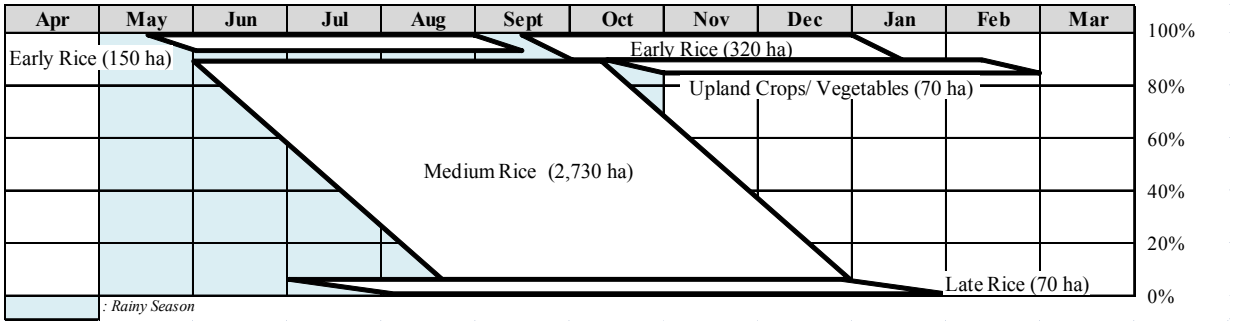
### II-1.3.4 Agriculture

(1) Land Tenure and Landholding

Tenant and landless farmers are very limited in the USISRSP Area, and tenant/landless farmer ratio to the whole farm HHs is estimated at less than 3%. It was confirmed that this situation has not been changed drastically in this survey period. Furthermore it was confirmed that land registration of land-use right has not been implemented in the USISRSP Area.

(2) Paddy Production

Paddy is the major crop in the USISRSP Area. Diversified crops are few although their profitability is higher than paddy. Further, it is not easy to cultivate them in paddy field due to unsuitable condition with high soil moisture content, soil structure, water management, etc. It was confirmed that these crops were planted less in the farmland of the USISRSP Area. In parts of the USISRSP Area, double cropping rice combined with early maturing varieties of HYVs is being undertaken since irrigation water becomes available after the rehabilitation of Kpob Trobek Reservoir in 2005. Hence it is judged that double cropping of paddy in the USISRSP Area has increased to some extent, and double cropping of paddy extends over about 150 ha during the period of early rainy season through the site investigation and interview with farmers. The present cropping pattern is shown as follows:




*Source: JICA Survey Team*

**Figure II-1.3.4.1 Present Cropping Patterns for USISRSP Area**

Current situation of paddy cultivation in Takeo Province is shown as follows:

**Table II-1.3.4.1 Area, Unit Yield, and Production of Paddy in Takeo Province**

| No. | District | Rainy Season 2010 | | | Dry Season 2011 | | | Total 2010-2011 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) | Harvested Area (ha) | Yield (ton/ha) | Production (ton) |
| 1) | Angkorborey | 5,372 | 3.46 | 18,564 | 17,219 | 4.65 | 80,068 | 22,591 | 4.37 | 98,632 |
| 2) | Bati | 20,120 | 3.16 | 63,601 | 2,257 | 3.90 | 8,802 | 22,377 | 3.24 | 72,403 |
| 3) | Bareychulsa | 4,942 | 3.37 | 16,631 | 15,870 | 4.90 | 77,763 | 20,812 | 4.54 | 94,394 |
| 4) | Kirivong | 27,971 | 3.23 | 90,391 | 10,590 | 4.60 | 48,714 | 38,561 | 3.61 | 139,105 |
| 5) | Kos Ondaet | 16,137 | 3.13 | 50,476 | 14,921 | 4.70 | 70,129 | 31,058 | 3.88 | 120,605 |
| 6) | Preykabas | 16,847 | 3.17 | 53,426 | 6,310 | 4.60 | 29,026 | 23,157 | 3.56 | 82,452 |
| 7) | Samraong | 20,685 | 3.22 | 66,625 | 5,418 | 4.10 | 22,214 | 26,103 | 3.40 | 88,839 |
| 8) | Doun Kaev | 3,568 | 3.32 | 11,861 | 3,169 | 4.20 | 13,310 | 6,737 | 3.74 | 25,171 |
| 9) | Tram Kak | 39,156 | 3.32 | 129,888 | 35 | 3.20 | 112 | 39,191 | 3.32 | 130,000 |
| 10) | Treang | 29,006 | 3.27 | 94,976 | 5,115 | 4.10 | 20,972 | 34,121 | 3.40 | 115,948 |
| Total | | 183,804 | 3.24 | 596,439 | 80,904 | 4.59 | 371,110 | 264,708 | 3.66 | 967,549 |

*Note: The Survey Area is in District Tram Kak.*
*Source: Agricultural Statistics 2010 – 2011, Provincial Department of Agriculture, Takeo Province*

(3) Land holding of Farm Households (only for farm land)

Agricultural land holding size, which was obtained from the socio-economic survey, is shown as follows:

**Table II-1.3.4.2 Farm Land Holding Size of Farm Households in USISRSP** (Unit: ha)

| Land Holding (Land Owned) (ha) | | | | | | | | Land Holding Land Use (Land Operated/) (ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paddy Field | | | | | Upland for field crop | Upland for field crop | Total Farm Land | Paddy Field | | | | | Upland for field crop | Upland for field crop | Total Farm Land |
| Irrigated paddy field | supplementary Irrigated paddy field | Irrigated field Total | Rainfed paddy field | Total Paddy field | | | | Irrigated paddy field | supplementary Irrigated paddy field | Irrigated field Total | Rainfed paddy field | Total Paddy field | | | |
| 0.23 | 0.23 | 0.45 | 1.32 | 1.77 | 0.17 | - | 1.94 | 0.24 | 0.23 | 0.47 | 0.62 | 1.08 | 0.17 | - | 1.25 |

*Source: Socio-economic survey, 2011*

Average holding size is around 1.94 ha, which is larger than farmers in RCHRSP, however they don't use the whole area for agricultural activities. Especially, some paddy fields have been fallow without any activities.

(4) Holding Situation of Livestock

Holding situation of livestock, which was obtained through the socio-economic survey, is shown as follows:

**Table II-1.3.4.3 Holding of Livestock in USISRSP**

| Item | Adult | | | Young | | |
|---|---|---|---|---|---|---|
| | Respondent | | Average | Respondent | | |
| | no./nos. | % | | no./nos. | % | Average |
| Cows / Oxen | 39 | 40 | 2 | 18 | 40 | 1 |
| Water buffalo | 1 | 1 | 2 | - | - | - |
| Goat / Sheep | - | - | - | - | - | - |
| Swine | 12 | 12 | 3 | - | - | - |
| Chicken | 34 | 35 | 23 | 24 | 53 | 28 |
| Duck | 12 | 12 | 8 | 3 | 7 | 10 |

*Source: Socio-economic survey, 2011*

## II-1.3.5 Irrigation and Drainage

(1) General

Water resources and diversion facilities of the USISRSP Area are the Tumnup Lok Reservoir on the upstream of the Slakou River (Tras Stream), the Kpob Trobek Reservoir on the Don Phe Stream, which is a tributary of the Slakou River, and the Diversion Canal from the Tumnup Lok Reservoir to the Kpob Trobek Reservoir. The USISRSP Area consists of (i) 3,485 ha commanded by the Main Canal 33 (7.3 km), the Canal 24 and 6 secondary canals which originate from Main Canal 33 (44.7 km in total of secondary canals), and (ii) 15 ha commanded directly by the Tumnup Lok Reservoir. The existing irrigation facilities, major roads and the proposed irrigation area are shown in Figure AD-2.2.1.1.2 in ANNEX D.

The review on the irrigation and drainage development plan was executed by (i) field reconnaissance including interviews to and discussions with concerned agencies and farmers, and (ii) inventory survey of the existing canals for 69 km and related structures of 412 nos. on the canals. The inventory survey was conducted for examining the conditions of canal at every 500 m and one of every structure as well as all obstructions such as buildings and private bridges. Details of the inventory survey are presented in Attachment-4 of ANNEX D.

(2) Tumnup Lok Reservoir

The Tumnup Lok Reservoir on the Slakou River was constructed in 1976 under the Pol Pot regime. The main dike runs north-to-south about 1.3 km across the Slakou River, along which 3 gate-type spillways

existed and an intake facility to the diversion canal existed on the right bank at 600 m from the existing river course. The dike was damaged by floods that occurred in 1980s and at the beginning of the 1990s, then was finally flushed away for about 180 m in length beside the northern-most spillway on the left. Since then, the reservoir has lost its function as a reservoir and also as a diversion facility. The existing river bed level is about EL. 36 m, while the dike top level lies about EL. 43.5 m. The spillways and the intake facilities are not being used at all. About 120 m of the main dike were also flushed away at about 480 m on the left bank from the river course.

**Slakou river and Breached Dike of Tumnup Lok Reservoir**

The geological formation inside the reservoir below 2 to 7 m from the ground surface is silty sand, and sandy silt and has N value of 10 to 37 (rather dense). The geological formation below such layer is clay layer with a thickness of 3 to 4 m, and its N value is 10 to 50. Below this layer, weathered rock (silty stone) exists, of which the N value is more than 50. The clay layer and weathered rock have a high enough bearing capacity for 5-7 m high embankment and ordinary concrete irrigation structure.

The dike made by clayey sand and silty sand would be safe against slope failure, but it has a possibility of piping by water seepage and erosion by rainfall and waves in the reservoir that could result in collapse of dike. Therefore, the existing dike was proposed to be protected by suitable soil on the inner surface of the dike and filter material on the toe of the outer surface. River bed materials near the proposed reservoir will be collected and utilized as the filter material.

(3) Diversion Canal

The existing Diversion Canal starting at the Tumnup Lok Reservoir runs southward for about 5 km into the O Saray River. Then, another canal starts at the O Saray Reservoir and runs for about 5 km toward Kpob Trobek Reservoir. Even having slight sedimentation, the canal section has been maintained and the canals could be utilized with certain rehabilitation works. However, for a stretch of 3 km on the O Saray River, a new canal connecting the Diversion Canals should be constructed to make a detour around the river. The Diversion Canal does not currently have the function of "diversion from the Slakou River", but a part of it functions as a drain to catch the surface water from the western part of the area and to drain it to the Slakou River via the O Saray Reservoir and the Ou Krouch Stream.

**Canal condition of the Diversion Canal**

According to the inventory survey conducted in this Survey, 4 bridges are on the canal route, and one place near the temple was embanked for road crossing. Erosion of canal slopes would progress due to sandy soils and inflows of rain water, and no maintenance. Detailed information of the survey points are presented in ANNEX D.

(4) Kpob Trobek Reservoir

The Kpob Trobek Reservoir is located on the Don Phe Stream, a tributary of the Slakou River. The main dike runs from west to east for 2.9 km, and 2 sub-dikes about 600 m in length were constructed

southward on both ends of the main dike. The Diversion Canal was connected at the west-side sub-dike, and 2 gate-type spillways were constructed along the main dike. An intake structure with a pipe culvert to the Canal 24 was constructed at 350 m from the east end of the main dike. Another intake structure for Main Canal 33 exists at the eastern end of the main dike, while another intake for Koh Kaek Main Canal is located 150 m along the eastern sub-dike. The geological formation inside the reservoir is alternating layers of silty sand, and sandy clay with a thickness of 6 to 10 m and N value of 10 on average. Below such layers, a firm sandy clay exists which has N value of more than 50. The material of the existing dike is silty sand and sandy clay which have N value of 20 to 50. The material of existing dike has the same soil mechanical nature as that of the Tumnup Lok Reservoir dike.


**Gated spillway and bridge on Kpob Trobek Reservoir**

The dike was breached at the center of the main dike and flushed away for about 180 m by a flood that occurred in the 1990s. The gates of all intake structures were damaged and did not function. The damaged portion of the dike was repaired but the dike top elevation remains lower by 2 m than that of the adjacent part of the main dike. Under the urgent rehabilitation work of MOWRAM in 2005, the following structures were rehabilitated and/or re-constructed:

- Dike at breached portion of 180 m,
- Flood spillway with automatic gates (6 nos.) at the breached section,
- Bridge of 80 m on national road 130A at the above spillway,
- Two intake structures for the Main Canal 33 and secondary canal (C24), and
- Two maintenance gate structures (west and east gates)

According to Takeo PDOWRAM, only one automatic spillway gate is functional, but other 5 gates are not due to some mechanical problems. The risk against floods is high at the present and urgent repair is expected if this situation is true. Seepage and erosion are also reported on the repaired dike. The dike is used as a part of the National Road No.130A and paved by asphalt in 2008.

(5) Automatic Spillway Gates on Kpob Trobek Reservoir

(a) Present Condition of Spillway Gates

Six sets of flap type spillway gates having 8.0 m wide by 1.8 m high provided on the Kpob Trobek Reservoir were completed in 2005. The conditions of these spillway gates were examined through site inspection and hearing from Takeo PDOWRAM early in July 201, to confirm the said PDOWRAM's information. As the result of hearing, the operation record of 6 gates is as shown below.

**Table II-1.3.5.1 Gate Operation Record at Kpob Trobek Reservoir**

| Gate No. | Gate Operation Record* |
|---|---|
| 1, 2 ,6 | These gates have never been opened since they were completed |
| 3 | This gate was opened 3 times per the past year. |
| 4 | This gate was opened 1 time per the past year. |
| 5 | This gate was opened only one time after completion. |

**: Water levels when the gates were opened were unknown.*

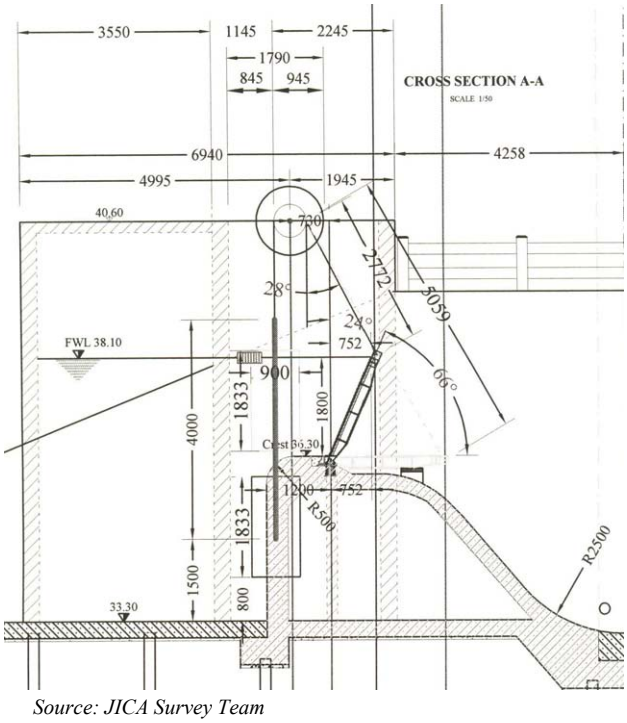
Further, the following defects were observed from the visual inspection.

- Any lubricant is not applied to all bearing blocks since all grease nipples are removed from all bearing blocks of hoists. Therefore, all bearings of hoists are contaminated by rust and dust.

- Painting material is peeled off from some surfaces of all gates and hoists and such areas become rusty.
- Some counter weight chambers are contaminated by trash and rubble of concrete.

(b) Design Concept of Automatic Gates

The flap gates are operated automatically by the counter weight provided in the chambers of both sides of piers as shown in Figure II-1.3.5.1.




*Source: JICA Survey Team*

**Figure II-1.3.5.1 Profile of Spillway Gates**

The automatic operation of gates is designed by the following design concept.

- The gates are kept in closed position by the dead weight of counter weight until the reservoir water level reaches around FWL. 38.1 m since the load to open the gate due to rotation moment by the water pressure load, dead weight of gate and other friction forces are lower than the dead weight of counter weight.
- When the reservoir water level reaches FWL. 38.1 m, firstly No.3 gate is opened fully because the load to open the gate at such water level overcomes the dead weight of counter weight.
- In order to avoid simultaneous opening operation for all gates, it is designed that the dead weight of counter weights for other gates is heavier than that for No.3 gate and the other gates are opened in order when the reservoir water level reaches above FWL. 38.1 m.
- All gates are closed again when the dead weight of counter weight overcomes the load to open the gate at a certain water level.

(6) Main Canal 33

Main Canal 33 starts at the Kpob Trobek Reservoir, and runs eastward along the National Roads No.130A and No.132 for about 16 km to National Road No.3 of 16 km, a 7.3 km stretch of the canal is used for USISRSP from the beginning point to Ta Phem Commune.

According to the inventory survey made in 2011, shape of the most canal sections still remains enough to flow the irrigation water as well as drainage water from the southern high lands. Most of the canal sections have a capacity of 5.0 $m^3$/sec or more. These sections could be utilized by re-shaping of section as proposed in F/S. Many structures are found on the canal as tabulated below. All related structures have malfunctioned due to deterioration or loss of gates, erosion of surrounding slopes, etc., which requires reconstruction. It is noted that many facilities were constructed on the canal. Removal of these facilities might be needed prior to commencement of implementation of USISRSP by MOWRAM.

**Table II-1.3.5.2 Number of Structures on Main Canal 33**

| Canal | Survey Length (m) | Division Structure | Culvert with Grooves (Intake)** | Public Bridge/ Culvert | Private Bridge /Culvert | Buildings within ROW | Total |
|---|---|---|---|---|---|---|---|
| Main Canal 33* | 7,730 | 4 | 7 | 7 | 45 | 25 | 88 |

**: Since the Main Canal 33 runs along National Road 130A, many buildings were constructed.*
***: Grooves are provided at inlet of culverts to place planks, but no gate is placed.*
*Source: JICA Survey Team*

(7) Secondary Canals

Seven existing secondary canals would be rehabilitated under USISRSP. One secondary canal, C24, starts at the Kpob Trobek Reservoir, but other 6 canals are branched off from the Main Canal 33. The intake structure of C24 commanding 561 ha in net was reconstructed in 2005 under the urgent rehabilitation of MOWRAM. First 1 km section is functional as an irrigation canal, but downstream sections are not used as an irrigation canal, but for the drainage canal.

**Canal 24 and Deteriorated Division Structure**

Six existing secondary canals along C24 would also be rehabilitated under USISRSP: C23 (net command area is 774 ha), C22 (609 ha), C21(490 ha), C20 (619 ha) and C3U and C3D (432 ha, opposite side of the Main Canal 33). These canals run eastward at an interval of 1 km from north to south. The width of the canals ranges from 5 to 10 m. Most of the related structures such as diversion and off-take structures have deteriorated and should be replaced.

According to the inventory survey made in 2011, shape of the most canal sections still remain to flow irrigation water as well as drainage water from the southern high lands. Due to no supply of irrigation water for more than 30 years and no substantial maintenance work for flow sections by Takeo PDOWRAM and beneficiaries, canal section has become flat and widened. Re-shaping of canal sections would be needed taking into account the capacity of drainage requirement as proposed by F/S. Many structures were found on the canal as tabulated below. It was found that no water control structure such as gated regulator and turnout were designed and constructed, though water conveyance structure such as bridge and culverts were only constructed. All related structures except culverts on public roads have malfunctioned due to deterioration, erosion of surrounding slopes, etc., which require reconstruction. All necessary water control structures needed to be replaced and additionally new ones be constructed.

It is noted that many structures were constructed within right of way (ROW), especially on the secondary canals of 3U and 3D which run along the National Road 130A. Removal of these structures would be needed prior to start of the implementation by MOWRAM.

**Table II-1.3.5.3 Number of Structures on Secondary Canals in USISRSP**

| Secondary Canal | Survey Length (m) | Division Structure | Culvert with Grooves (Regulator)** | Public Bridge/Culvert | Private Bridge/Culvert | Buildings within ROW | Total |
|---|---|---|---|---|---|---|---|
| C20 | 8,920 | 0 | 2 | 10 | 28 | 4 | 52 |
| C21 | 8,280 | 0 | 6 | 9 | 26 | 0 | 41 |
| C22 | 9,850 | 0 | 2 | 8 | 26 | 1 | 37 |
| C23 | 10,700 | 0 | 4 | 14 | 40 | 1 | 59 |
| C24 | 6,050 | 1 | 0 | 6 | 12 | 0 | 19 |
| 3U* | 1,510 | 0 | 2 | 1 | 7 | 5 | 15 |
| 3D* | 8,530 | 0 | 5 | 10 | 65 | 48 | 128 |
| Total | 53,840 | 1 | 21 | 58 | 212 | 25 | 351 |

**: Since secondary canals 3U and 3D run along National Road 130A, many buildings were constructed.*
***: Grooves are provided at inlet of culverts to place planks, but no gate is installed.*
*Source: JICA Survey Team*

(8) Tertiary Canals

There are no systematic tertiary canal systems, though some small-scale canals are branched off from secondary canals. It seems that area of about 100 ha surrounded by secondary canals is irrigated by field-to-field (plot-to-plot) irrigation. Such irrigation practice requires longer time for irrigating the tail-end than irrigation through tertiary canal system, and makes irrigation efficiency lower. Formation of systematic tertiary canal system would be required to utilize the irrigation water efficiently and timely.

(9) Drainage Facilities

In the USISRSP Area, most of the existing canals are used for both irrigation and drainage. The irrigation canal has the same cross-section (capacity) from the beginning to the tail end, for draining inflow from the surrounding field to the downstream area. The drained water is re-used as "return flow" in the downstream areas. Considering the present drainage condition and difficulty in securing land for drainage canals, it is judged that that drainage of the area should be maintained as it is as proposed in F/S. In other word, neither construction of new drainage canal nor drainage improvement is planned, but the improvement of the irrigation condition would be focused.

## II-1.4 Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

### II-1.4.1 Location and Administration

(1) General

Suitable irrigation area identified by M/P was 8,400 ha in total from the total study area of 18,000 ha, in accordance with soils and topographic conditions and the availability of irrigation water source in the Prek Thnot River. Selected area of 8,400 ha consists of 4,200 ha in the whole Kandal Stung area and 4,200 ha in the Tonle Bati area with the augmentation of irrigation water source by the Prek Thnot Reservoir (storage capacity of about 1,120 MCM). M/P selected priority development area of 1,950 ha (later called as "Kandal Stung Area") in the whole Kandal Stung area and 1,600 ha (later called as "Bati Area") in the Tonle Bati area which could be developed without construction of the Prek Thnot reservoir, and F/S was made for 2 priority areas in 1994-95.

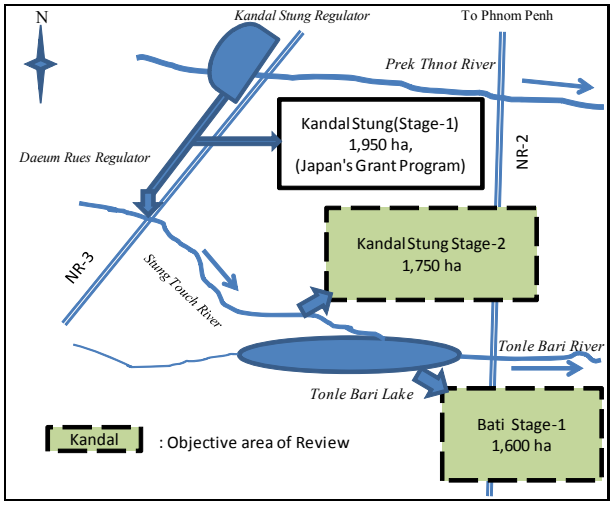



**Figure II-1.4.1.1 Schematic Diagram of KSBISRSP**

**Table II-1.4.1.1 Suitable Irrigation Area Identified in M/P in 1995** (Unit: ha)

| Item | Kandal Stung | Tonle Bati | Remarks |
|---|---|---|---|
| Study area of M/P | 11,000 | 7,000 | |
| Suitable area for irrigation development | 4,200 | 4,200 | With Prek Thnot reservoir |
| Priority development area | 1,950 | 1,600 | Without Prek Thnot Reservoir |

*Source: Master Plan Study on the integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, JICA, 1995*

Development of main canal system for the first priority area of 1,950 ha in Kandal Stung area including headworks on the Prek Thnot River was completed in 2007 under the Japan's grant aid program, and MOWRAM has continued further development in the area.

Objective area of this Survey in KSBISRSP is (i) southern part of the first priority area of 1,750 ha in the whole Kandal Stung Area as proposed by MOWRAM with condition that a supplemental water would be supplied by the Stung Tasal Reservoir which is under construction by MOWRAM, and (ii) the first priority area of 1,600 ha in Tonle Bati Area, where substantial rehabilitation has not been carried out.

(2) Kandal Stung Area

The objective area is situated in Kandal Stung District of Kandal Province about 20 km south of Phnom Penh. It is broadly bounded by Notional Road No.2 in the east, Notional Road No.3 in the west, the priority development area of 1,950 ha completed in 2007 by Japan's Grant Aid program in the north, and the Tonle Bati River in the south. The area covers about 2,400 ha in gross which is mostly agricultural and residential land. The Stung Touch River flows from northwest to southeast direction. The land is generally sloping toward the southeast with the average slope of 1:2,000 to 1:3,000, and drained to the Lake Tuk Chou and the Lake Tonle Bati.

(3) Bati Area

The priority area of 1,600 ha is situated in Bati District of Takeo Province about 30 km south of Phnom Penh. The National Road No.2 crosses the western part of the area. The area covers about 2,100 ha in gross, which is mostly agricultural and residential land. The ground elevation varies from 7.5 m to 5.8 m, sloping toward Lake Chenug Loung. There is slightly elevated flat land in the central part where numbers of villages are located.

(4) Numbers of beneficiaries

Numbers of beneficiary farm HHs and beneficiaries of the Sub-project of 3,350 ha is roughly estimated at 3,400 nos. and 19,000 persons respectively, based on the socio-economic survey made in 2012 as shown below.

**Table II-1.4.1.2 Estimate of Number of Beneficiaries in KSBISRSP**

| Item | Kandal Stung Area | Bati Area | Total |
|---|---|---|---|
| (a) Net irrigation area (ha) | 1,750 | 1,600 | 3,350 |
| (b) Average farm land size* (ha) | 0.92 | 1.07 | |
| **(c) Nos. of beneficiary HHs (nos.)** | **1,910** | **1,500** | **3,410** |
| (d) Average family size (persons)* | 5.45 | 5.75 | |
| **(e) Nos. of beneficiaries (persons)** | **10,410** | **8,630** | **19,040** |

*Note: *: figures obtained through Socio-economic survey, 2012*
*Source: JICA Survey Team*

## II-1.4.2 Meteorology and Hydrology

### II-1.4.2.1 Meteorology

There are no meteorological stations in the KSBISRSP Area. Thus, the meteorological data recorded at Pochentong in Phnom Penh, which is shown in Table II-1.2.2.1.1, is used for estimate of crop water requirement.

### II-1.4.2.2 Hydrology

There is no available data of water level and discharge in the Stung Touch River and the Tonle Bati River Basin. Hydrological analysis is carried out based on the hydrological data of the Prek Thnot River Basin neighboring the KSBISRSP Area.

(1) Condition of Stung Touch River and Lake Tonle Bati

The Stung Touch River and the Stung Tonle Bati River are predominantly in the low flat areas. The area on the right bank of the Prek Thnot River downstream of the O Krang Ambel River confluence

drains primarily to the Stung Touch River. A further large area to south drains to the Stung Tonle Bati. The discussion of the geomorphology of the area suggests that the Stung Touch River was formerly an old course of the Prek Thnot River. When the Prek Thnot River migrated northwards, perhaps in response to regional tilting of the land surface, the present Stung Touch River retained this part of the former Prek Thnot River drainage area. SMEC reports that the Stung Touch River acts as a distributary of the Prek Thnot River during major floods. Part of the flood crossing into the Stung Touch and thereafter follows the course of the Stung Touch towards Boeng Cheung Luong. Most of the low flat land contains numerous ponds and some lakes that are marked as seasonal storage on the 1:50,000 scale maps. The Lake Tonle Bati exists on the Tonle Bati River which is largest reservoir in the KSBISRSP Area.

(2) Average Depth of Rainfall over Area

Based on the rainfall data at each station, the average rainfall over area at Duam Ruese (under the National Road No.3) of the Stung Touch River and the Lake Tonle Bati were calculated by Thiessen method. The average rainfall over area ranges from 700 mm to 1,500 mm.

**Table II-1.4.2.2.1 Estimated Basin Mean Rainfall at Stung Touch and Tonle Bati River Basin**

(Unit: mm)

| Site | Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stung Touch | Average | 9.8 | 5.6 | 24.2 | 85.8 | 114.3 | 109.5 | 118.1 | 124.7 | 198.1 | 218.9 | 76.3 | 17.3 | 1,102.6 |
| | Maximum | 122.8 | 59.4 | 102.7 | 240.6 | 301.7 | 196.7 | 276.9 | 251.2 | 335.9 | 382.7 | 206.6 | 137.2 | 1,502.4 |
| | Minimum | 0.0 | 0.0 | 0.0 | 1.8 | 51.6 | 58.7 | 25.0 | 31.9 | 112.4 | 54.8 | 6.5 | 0.0 | 715.3 |
| Tonle Bati | Average | 10.6 | 4.3 | 21.2 | 79.0 | 112.9 | 106.0 | 116.1 | 122.6 | 195.5 | 228.8 | 76.0 | 17.5 | 1,090.6 |
| | Maximum | 84.5 | 31.7 | 78.2 | 173.2 | 250.1 | 208.2 | 289.5 | 270.6 | 320.9 | 404.7 | 165.8 | 88.1 | 1,564.1 |
| | Minimum | 0.0 | 0.0 | 0.0 | 4.5 | 44.0 | 61.4 | 41.2 | 48.2 | 113.3 | 49.8 | 8.8 | 0.0 | 783.3 |

*Note: Average in the period from 1982 to 2010*
*Source: JICA Survey Team (based on Rainfall Data from MOWRAM)*

(3) Hydrological Analysis

(a) Concept of Calculations

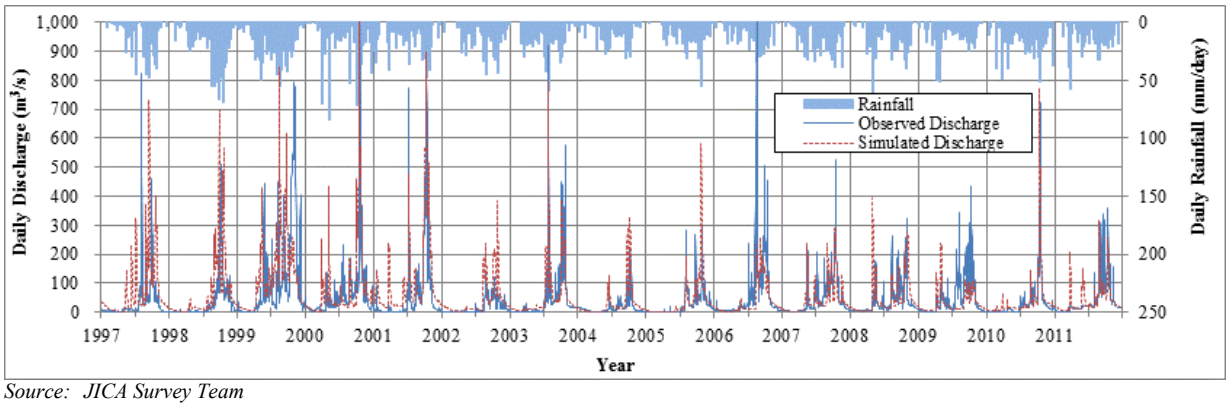
As mentioned above, there was no water gauge station in the Stung Touch River and the Tonle Bati River Basin. On the other hand, a water gauge observation at Peam Khley station on the Prek Thnot River, neighboring the KSBISRSP Area, has been continuously carried out. This observation condition has not changed and also there is still no water gauge station in the Stung Touch River and the Tonle Bati River Basin.

Therefore, the runoff analysis model in the Survey was constructed for estimation of long-term discharge at the Stung Touch River and the Tonle Bati River for water balance study.

At first, the Daily Tank Model was validated with discharge data at the Peam Khley station. Then the flow discharge of the Stung Touch River and the Tonle Bati was calculated using the estimated discharge by Tank Model from 1982 to 1996 and observed discharge from 1997 to 2011 with ratio of the annual basin rainfall and ratio of catchment area at each basin.

(b) Runoff Analysis

The daily Tank Model was validated with discharge data at the Peam Khley station of the Prek Thnot River. The model parameters were calibrated using observed daily discharge from 1997 to 2011. The result of the simulation is shown below:




*Source: JICA Survey Team*

**Figure II-1.4.2.2.1 Validity of Runoff Analysis Model at Peam Khley Station on Prek Thnot River**

As shown above, observed and simulated discharges are almost fitted, except for several periods in the rainy season. Therefore, this runoff analysis daily Tank Model could be applied to this Survey.

(4) Calculation of Runoff

Using observed daily discharge at Peam Khley from 1997 to 2011 and simulated daily discharge from 1982 to 1986, the discharge in each site is calculated by ratio of catchment and annul basin rainfall. The results of the runoff calculation are as below:

**Table II-1.4.2.2.2 Monthly Discharge at each Site in KSBISRSP Area (30 years of 1982 to 2011)**

(Unit: $m^3$/sec)

| Reservoir | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Duam Ruese of Stung Touch River (C.A.=148.2 $km^2$) | | | | | | | | | | | | | |
| Mean | 0.43 | 0.21 | 0.22 | 0.51 | 1.42 | 1.48 | 2.77 | 3.27 | 5.78 | 8.73 | 3.02 | 1.07 | 2.41 |
| Maximum | 1.09 | 0.60 | 2.23 | 5.25 | 8.21 | 5.14 | 9.59 | 11.91 | 12.96 | 18.10 | 14.14 | 5.05 | 18.10 |
| Minimum | 0.05 | 0.02 | 0.03 | 0.03 | 0.07 | 0.05 | 0.13 | 0.13 | 0.71 | 2.27 | 0.24 | 0.17 | 0.02 |
| Lake Tonle Bati of Stung Tonle Bati River (C.A.=240.2 $km^2$) | | | | | | | | | | | | | |
| Mean | 0.71 | 0.33 | 0.37 | 0.89 | 2.43 | 2.46 | 4.67 | 5.37 | 9.62 | 14.34 | 4.93 | 1.76 | 3.99 |
| Maximum | 1.61 | 0.99 | 3.92 | 10.38 | 16.24 | 8.40 | 18.60 | 18.65 | 21.19 | 29.49 | 22.57 | 8.06 | 29.49 |
| Minimum | 0.08 | 0.02 | 0.04 | 0.05 | 0.12 | 0.09 | 0.21 | 0.22 | 1.17 | 2.76 | 0.35 | 0.24 | 0.02 |

*Source: JICA Survey Team*

(5) Flood Discharge

No observe flood data are available for the KSBISRSP Area, flood discharges of the Stung Touch River and the Lake Tonle Bati were estimated using 3 methods: (i) IRS method, (ii) unit hydrograph method and (iii) rational formula method. Among these methods, the unit hydrograph method was selected for estimation of flood of the Stung Touch River and the Lake Tonle Bati in this Survey. The calculation results are summarized in Table II-1.4.2.2.3. Although the result shows that flood discharges of both 2 sites are slightly larger than those obtained in Euroconsult (1992), it is proposed to apply the re-estimated flood discharges for design of rehabilitation of the Stung Touch and the Lake Tonle Bati from safety side viewpoint.

**Table II-1.4.2.2.3 Estimated Flood Discharge by Unit Hydrograph Method and Euroconsult (1992)**

| River/Site | Catchment Area ($km^2$) | Flood Peak Discharge ($m^3$/sec) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10 years | 20 years | 25 years | 50 years | 100 years | 200 years |
| Stung Touch / Duam Ruese | | | | | | | |
| This Survey (2012) | 148.2 | 103 | 103 | 108 | 123 | 137 | 151 |
| Euroconsult (1992) | | | | 54 | | 121 | |
| Tonle Bati / Bati Lake | | | | | | | |
| This Survey (2012) | 240.2 | 161 | 189 | 198 | 224 | 249 | 273 |
| Euroconsult (1992) | | | | 103 | | 231 | |

*Estimates for Stung Toch and Tonle Bati are those delivered by Euroconsult (1992)*
*Estimates for Stung Toch refer only to floods deriving from own area*
*Source: Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, JICA, Nippon Koei, 1995, Volume-III Annexes, p.I-43.*
*JICA Survey Team*

### II-1.4.3 Socio-economy

(1) Ethnicity

It is said that more than 90% of the entire population in Cambodia are ethnic Khmers, while minor ethnic groups are being isolated in highlands, coastal area, etc. In the KSBISRSP Area, majority is Khmers, thus there do not find any remarkable difference of manners and customs, food culture, religions and ethnic makeup, etc. in this area.

(2) Poverty

As shown in the following table, poverty rates in Kandal and Takeo Provinces are 15.9% and 23.4% in 2010 respectively, which are better than the average (25.8%) of the whole country, so that serious poverty situation is not shown in Kandal and Takeo Provinces. Furthermore the table also shows a continuing downward trend in poverty.

**Table II-1.4.3.1 Poverty Rate by Regions (KSBISRSP)** (Unit:%)

| Region | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Phnom Penh | 6.8 | 6.9 | 5.8 | 0.5 | 0.3 | 0.2 | 0.1 |
| Kandal | 27.6 | 26.2 | 24.1 | 21.2 | 19.7 | 17.6 | 15.9 |
| Takeo | 31.6 | 30.7 | 29.2 | 28.1 | 26.8 | 25.2 | 23.4 |
| Cambodia | 35.1 | 34.2 | 32.9 | 30.7 | 29.3 | 27.4 | 25.8 |

*Source: Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

(3) Gender Issue

It is judged that current situation on gender issue has not been changed, compared with the results obtained from the socio-economic survey in the previous study period, through some interview with farmers in the KSBISRSP Area. Namely there are no serious gender problems. Females' access and control over the resources such as water, residential and farm land, and livestock, are not constrained.

(4) Results of Socio-economic Survey[6]

(a) Demographic Condition

General characteristics of farm HHs in KSBISRSP are shown below.

**Table II-1.4.3.2 General Characteristics of Farm Households in KSBISRSP**

| Items | Kandal Stung Area | Bati Area |
|---|---|---|
| Average Family Size (persons) | 5.45 | 5.75 |
| Balance of Male and Female (%) | 48 : 52 | 52 : 48 |
| Working-age Population (persons) | 3.70 | 3.70 |
| Literacy Rate (%) | 71 | 71 |
| Education (from primary school) (%) | 85 | 83 |

*Note: refer Attachment-3 in ANNEX-C for details*
*Source: Socio-economic survey, 2012*

As shown in the above table, demographic conditions in both Kandal Stung and Bati Areas are almost similar.

(b) Household Income and Expenditure

The proportional values from various income sources are calculated for each source as shown below.

**Table II-1.4.3.3 Proportional Income Volumes from Different Sources in KSBISRSP** (Unit: %)

| No. | Type of Income | Kandal Stung | Bati |
|---|---|---|---|
| 1) | Selling rice | 14.4 | 30.5 |
| 2) | Selling vegetables (red pepper/ tobacco/ water melon/ others) | 0.7 | - |
| 3) | Selling fruits (mango/ papaya, banana/ hairly fruit/ orange/ others) | 0.1 | 0.8 |

[6] *Socio-economic survey was conducted in July and August, 2011 by the JICA Survey Team. Detailed data is shown in ATTACHMENT 3 of ANNEX C.*

| No. | Type of Income | Kandal Stung | Bati |
|---|---|---|---|
| 4) | Selling palm sugar | - | - |
| 5) | Selling livestock/ poultry products | 5.5 | 18.7 |
| 6) | Selling fishes | 0.0 | 0.6 |
| | Sub-total of Agricultural Income | 20.8 | 50.5 |
| 7) | Salary from permanent job | 21.3 | 20.2 |
| 8) | Wage from temporary on-farm job | 2.2 | 0.2 |
| 9) | Wage from temporary off-farm job | 14.5 | 3.7 |
| 10) | Private business (transportation, trading, shop, etc.) | 19.1 | 8.5 |
| 11) | Remittance from family members | 12.7 | 12.1 |
| 12) | Selling firewood/charcoal | - | - |
| 13) | Selling handicraft/ cottage industry products | 3.2 | 2.2 |
| 14) | Selling forest vegetable/ crop | - | - |
| 15) | Others | 6.3 | 2.6 |
| | Sub-total of Non-Agricultural Income | 79.2 | 49.5 |
| | Total | 100.0 | 100.0 |

*Note: Refer Attachment-3 in ANNEX-C for details*
*Source: Socio-economic survey, 2012*

From above table, the following characteristics are observed.

1) Agricultural income of is less than non-agricultural income at Kandal Stung but agricultural income is higher than non-agricultural income at the Bati Area.
2) The income sources of sampled HHs are diversified not only in variety but also in proportional volume.
3) Among agricultural income sources, the "selling rice" is the most viable cash income source in both Kandal Stung and Bati Areas.
4) Among non-agricultural income sources, the "salary from permanent job" is the most viable cash income source in both Kandal Stung and Bati Areas. This income is mostly obtained from garment factory by young girl.

**Table II-1.4.3.4 Daily Income and Expenditure Per Capita of Sampled Population in KSBISRSP**

| Income Strata | Average HH Income (US$/Year) | Average HH Expenditure (US$/Year) | Average HH Pop. (Nos.) | Per Capita Daily Income (US$) | Per Capita Daily Expenditure (US$) |
|---|---|---|---|---|---|
| **Kandal Stung Area** | | | | | |
| 1st | 2,822 | 2,576 | 6.40 | 1.22 | 1.12 |
| 2nd | 1,432 | 1,205 | 4.50 | 0.88 | 0.74 |
| **Bati Area** | | | | | |
| 1st | 2,796 | 2,179 | 5.60 | 1.39 | 1.08 |
| 2nd | 1,616 | 1,335 | 5.90 | 0.76 | 0.63 |

*Note: Refer Attachment-3 in ANNEX-C for details*
*Source: Socio-economic survey, 2012*

The sampled HHs were arranged from the highest income HH to the lowest, in order to form 1st and 2nd income strata. The figures obtained in Riel were converted into US Dollars with the current effective exchange rate that is US$ 1 = Riel 4,032[7] in February 2012.

If applying the poverty line (equal to per capita daily expenditure of US$ 0.58, setting for Cambodia rural area by the Achieving Cambodia's Millennium Development Goals 2010) shown in Table II-1.2.3.3, it is deemed that they are not seemingly below the poverty line.

### II-1.4.4 Agriculture

(1) Paddy Cultivation and Production in KSBISRSP Area

Agricultural situation in the Kandal Stung Area has not mostly changed from the previous study time up to now. Main cropping season of paddy is the rainy season, and cropping intensity is around 100% as shown in Tables II-1.4.4.1 and II-1.4.4.2, and summarized as follows:

[7] *Official exchange rate in JICA (February 2012)*

**Table II-1.4.4.1 Paddy Cultivation in Kandal Stung Area**

| No. | Related Commune | Cultivated Area in 2010/11 (ha) | | | | Cropping Intensity (%) |
|---|---|---|---|---|---|---|
| | | Early Rice | Medium Rice | Late Rice | Total | |
| 1) | Along Romiet | 12 | 280 | 39 | 331 | 104 |
| 2) | Thmei | 20 | 276 | 75 | 371 | 106 |
| 3) | Kouk Trab | 88 | 404 | 123 | 615 | 117 |
| 4) | Preaek Roka | 9 | 337 | 292 | 638 | 101 |
| 5) | Tbaeng | 0 | 626 | 77 | 703 | 100 |
| 6) | Trapeang Veaeng | 0 | 556 | 164 | 720 | 100 |
| 7) | Trea | 30 | 497 | 49 | 576 | 105 |
| Total | | 159 | 2,976 | 819 | 3,954 | 104 |

*Source: Kandal Stung District Agricultural Office 2012*

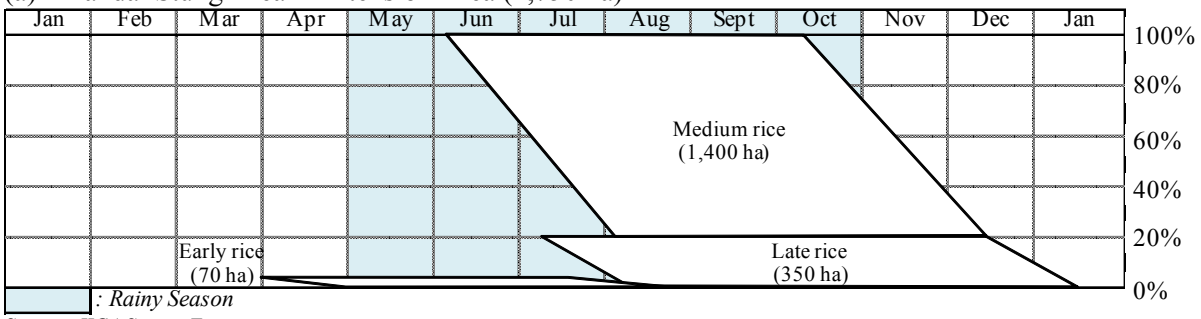
**Table II-1.4.4.2 Paddy Cultivation in Bati Area**

| No. | Related Commune | 2010 | | 2011 | |
|---|---|---|---|---|---|
| | | Harvested Area (ha) | Cropping Intensity (%) | Harvested Area (ha) | Cropping Intensity (%) |
| 1) | Champei | 1,751 | 115 | 1,789 | 118 |
| 2) | Pot Sar | 2,525 | 128 | 2,696 | 137 |
| 3) | Krang thnong | 1,615 | 106 | 1,664 | 110 |
| 4) | Kandoeng | 1,196 | 116 | 1,235 | 120 |
| 5) | Trapeang Sab | 1,144 | 108 | 1,153 | 107 |
| Total | | 8,231 | 116 | 8,537 | 120 |

*Source: Bati District Agricultural Office 2012*

Cropping seasons in the area are generally defined into 2 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. Actually, rice cropping seasons could be better differentiated into (i) the early rainy season which paddy is cultivated from March to June in irrigated areas, (ii) the rainy season which paddy is cultivated from July to October both in rainfed and irrigated areas, and (iii) the dry season rice planted from November to February in irrigated areas. The cropping calendar in the area is diversified depending on locations affected by the seasonal availability of irrigation water. Since this situation has not been improved so far, it is deemed that there is no big difference between previous and present cropping patterns in the area from the previous study time as shown in the following cropping pattern.

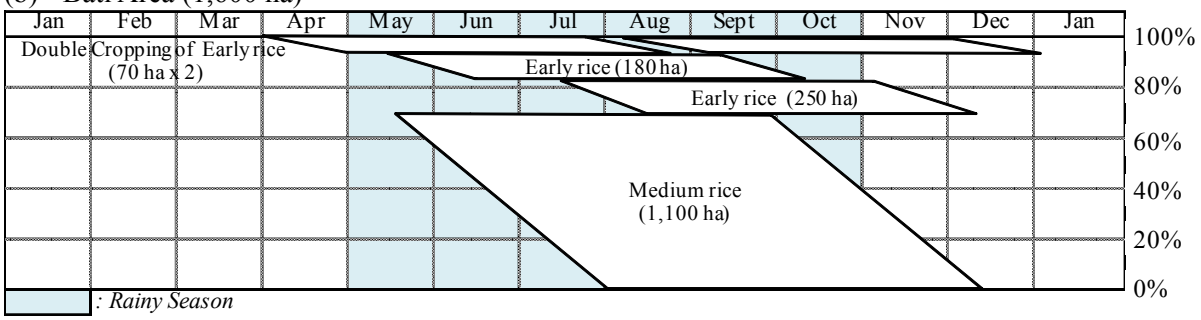
(a) Kandal Stung Area – Extension Area (1,750 ha)




*Source: JICA Survey Team*

**Figure II-1.4.4.1 Present Cropping Pattern for Kandal Stung Area**

(b) Bati Area (1,600 ha)




*Source: JICA Survey Team*

**Figure II-1.4.4.2 Present Cropping Pattern for Bati Area**

(2) Land Holding of Farm Households (only for farm land)

Agricultural land holding Size, which was obtained from the socio-economic survey, is shown as follows:

**Table II-1.4.4.3 Farm Land Holding Size of Farm Households in KSBISRSP** (Unit: ha)

| Category | Kandal Stung Area | Bati Area |
|---|---|---|
| (a) Owned Land | | |
| 1) Paddy field | | |
| -Irrigated Paddy Field | 0.45 | 0.87 |
| -Rainfed Paddy Field | 0.38 | 0.18 |
| Sub-Total | 0.83 | 1.05 |
| 2) Upland Field | 0.09 | 0.02 |
| Total | 0.92 | 1.07 |
| (b) Operated Land | | |
| 1) Paddy field | | |
| -Irrigated Paddy Field | 0.50 | 1.10 |
| -Rainfed Paddy Field | 0.33 | 0.20 |
| Sub-total | 0.83 | 1.31 |
| 2) Upland Field | 0.05 | 0.02 |
| Total | 0.88 | 1.33 |

*Note: Refer Attachment-3 in ANNEX-C for details*
*Source: Socio-economic survey, 2012*

(3) Holding Situation of Livestock

Holding situation of livestock, which was obtained through the socio-economic survey, is shown as follows:

**Table II-1.4.4.4 Holding of Adult Livestock in KSBISRSP** (Unit: no./ nos.)

| Livestock | Kandal Stung Area | | Bati Area | |
|---|---|---|---|---|
| | Holders | Livestock* | Holders | Livestock* |
| Cows / Oxen | 12 | 4 | 20 | 2 |
| Water buffalo | 0 | 0 | 0 | 0 |
| Goat / Sheep | 0 | 0 | 0 | 0 |
| Swine | 0 | 0 | 2 | 2 |
| Chicken | 17 | 5 | 11 | 4 |
| Duck | 4 | 5 | 5 | 6 |

*Note: - Nos. means number of responses*
*- Nos. means number of responses*
*- Refer Attachment-3 in ANNEX-C for details*
*- Average per respondent on each livestock*
*Source: Socio-economic survey, February 2012*

### II-1.4.5 Irrigation and Drainage

(1) Kandal Stung Area

In 1975 to 1979 (Pol Pot regime), the present irrigation canal system was constructed, including the Tuk Thla and the Kampong Tuol regulators (headworks) on the Prek Thnot River. Canals were constructed following latitude and longitudinal grid lines regardless of the topographic conditions. Major canals are located approximately 1 km by 1 km grids. Drain water in the area discharges to Lake Heung Loung through Pol Pot canals.

Upon completion of construction works for Kandal Stung new diversion weir on the Prek Thnot in 2007 and promising the completion of the Stung Tasal Dam very soon, MOWRAM prepared the official proposal to develop the objective area of 1,750 ha by utilizing the original flow of the Stung Touch River and supplemental water from the Prek Thnot River.

Due to absence of substantial improvement or rehabilitation work for the canals and related structures for more than 30 years, not like northern part of the area where some rehabilitation works were done in 1987 and 1991 as well as 2005-2007, deterioration degree of irrigation facilities is rather severe than one of northern part.

The inventory survey was carried out by the JICA Survey Team in 2011-12 for 8 Pol Pot canals for about 29 km in total. Most of canal sections are considerably eroded due to lack of proper maintenance for long time. Some canal sections are checked by earth bund and small size culverts, private simple check structures and fish fence. Downstream sections of some canals are obstructed by heavy sediments, water plants (water hyacinth) and bush. Inspection/ farm road along the canals are narrowed by erosion, growing of plants and less maintenance. Out of 5 existing intakes on the Stung Touch River, one intake is equipped with control gates, but other 4 are not. Irrigation as well as flood waters have flowed into canals without control. This situation caused sedimentation, erosion of canal bank and damages of slopes. Related structures for water management are few, but bridges/culverts counts at 45 nos. No houses and huts on the canal bank are observed. Summary of inventory survey is tabulated as below and details are presented in ANNEX D.

**Table II-1.4.5.1 Summary of Inventory Survey Results of Existing Canals in Kandal Stung Area**

(Unit: no. / nos.)

| Canals | Survey length (m) | Off take | Intake* | Public bridge/ culvert | Private bridge/ culvert | Huts and houses ** | Total |
|---|---|---|---|---|---|---|---|
| Total | 29,130 | 14 | 13 | 29 | 16 | 0 | 72 |

**: including culvert with bridge*
***: buildings on the banks on the canals*
*Source: JICA Survey Team*

(2) Bati Area

In 1975 to 1979, the present irrigation canal system was constructed depended on the water source of the Lake Tonle Bati (gross storage of 16.7 MCM). The canals were constructed following latitude and longitudinal grid lines, but regardless of the topographic conditions as applied to Kandal Stung Area. The intake and pump station were constructed at the head of North-South Canal 84 (NS-84 canal). A spillway for the Lake Tonle Bati was constructed without gate but with stoplogs at the outlet of the lake. In 1985, the World Council of Churches (WCC), prepared a plan of the integrated agricultural development plan. It consisted of the rehabilitation of irrigation canal system for about 6,000 ha including pump station, setting up of an agricultural development center, and the provision of some agricultural extension services. During period of 1987 to 1990, the rehabilitation of irrigation system for 900 ha was executed with the assistance of WCC. In August 1991, the irrigation facilities were damaged by flood. In February 1992, rehabilitation of some parts of the damaged canal embankment was executed by the Mekong Secretariat with the financial assistance of UNDP. Improvement of the spillway was also made in 1992 with provision of 4 slide gates in front of the previous outlet of stoplogs.

Due to higher elevation of irrigation area comparing with water level of the lake, lifting irrigation is needed especially in the dry season. After rehabilitation in 1992, no substantial rehabilitation and improvement has been executed, except ad-hoc works such as dredging of canal bed and construction of intakes (check structures). Generally, canals are heavily deteriorated, and the number of structures for proper water management of irrigation is short.


**Intake and Pump Station at Lake Tonle Bati**

The inventory survey was made for 9 existing canals and one dike/road along the Lake Tonle Bati for about

30 km by the JICA Survey Team in 2011-12. According to the survey, most of canal sections except MR-3 are heavily eroded and considerable sediments are seen on the canal beds. Most of stretch for MR-3 was dredged by MOWRAM in 2011, but excavated materials remains along the canal. Among the canals, MR-3 was provided with water management structures such as off-takes (turnouts) and regulators which were constructed by NGOs. Bridges and culverts to across the canals are counted at 61 nos. Many culverts on laterals for house and farm access by farmers have insufficient flow area. Summary of inventory survey is tabulated as below and details are presented in ANNEX D.

**Table II-1.4.5.2 Summary of Inventory Survey Results of Existing Canals and Dike in Bati Area**

(Unit: nos.)

| Canals | "Survey length (m)" | Off-take | Regulator* | Public bridge/ culvert | Private bridge/ culvert | Huts and houses** | Total |
|---|---|---|---|---|---|---|---|
| Total | 29,890 | 11 | 7 | 31 | 30 | 13 | 93 |

**: including culvert with bridge*
***: buildings on the bank s within priority area of 1,600 ha*
*Source: JICA Survey Team*

Due to small difference between water level of the lake and elevations of irrigation area, intake discharge has been suffered by draw down of the lake water level especially in the dry season. The existing intake gates at the head of the main canal with 3 gates are heavily deteriorated and nearly mal-functioned. Three diesel engine driven pumps of 18 $m^3$/min in total are still functioning, and are operated based on the request of district chief for 2-3 months in a year, but no written record of operation is available. According to Takeo PDOWRAM, the amount of lifting water was much insufficient to demands due to less capacity of the existing pumps. The operation cost has not been collected from the beneficiaries, and fully born by MOWRAM accordingly.

## II-1.5 Main Canal 35 Rehabilitation Sub-project

### II-1.5.1 Location and Administration

The Main Canal 35 Irrigation System is located in the upstream of the Slakou River Basin, and situated in the plateau and mountainous region, west of Phnom Penh. The irrigation command area lies in the left bank of the Stung Kat Phluk River along the provincial road, having long and narrow shape extending from west to east with gentle slope. The area is administratively situated mainly in Basedth District, Kampong Speu Province bordering to the National Road No.3, and partly extending in the western part of Takeo Province.

The expected irrigable area of whole irrigation system with 3 reservoirs are too large (3,018 ha, reported by PDOWRAM) to deal with MC35RSP as a small-scale irrigation system rehabilitation project. The command area of MC35RSP can be divided into 3 areas by reservoirs, namely Zone-A (1,935 ha) with the Khpob Krous Reservoir, Zone-B (705 ha) with the O Kbear Reservoir and Zone-C (378 ha) with the Ka Ek Tom Reservoir. In consideration of the scale of Sub-project area and irrigation water availability, the upstream area (Zone-A) from the intake of the Khpob Krous Reservoir to the confluence of the Main Canal 35 with the connection canal from the O Kbear Reservoir was given priority by PDOWRAM/MOWRAM of rehabilitation works to be implemented under MC35RSP, while in the downstream areas (Zone-B and Zone-C), from the confluence to downward is not given high priority.

### II-1.5.2 Meteorology and Hydrology

#### II-1.5.2.1 Meteorology

There are no meteorological stations in the MC35RSP Area. Thus, the meteorological data recorded at Pochentong, Phnom Penh, which is shown in Table II-1.2.2.1.1, is used for estimate of crop water requirement.

#### II-1.5.2.2 Hydrology

(1) Condition of Area

The MC35RSP Area is located in the Slakou River Basin. There is no available data of water level and discharge in the Slakou River Basin. Hydrological analysis is carried out based on the hydrological data of the Prek Thnot River Basin neighboring to the MC35RSP Area.

(2) Condition of Reservoirs

The Slakou River, called Tras Stream at upstream, is perennial, although the flow becomes negligibly small in the mid dry season. The Khpob Krous Reservoir is located on the Ou Chraloy River that is tributary of the Slakou River. The O Kbear Reservoir is located on the Ou Doun Angir Stream. The Ka Ek Tom Reservoir is located on the Ou Boeng Toap Stream.

(3) Average Depth of Rainfall over Area

Based on the rainfall data at each station, the average rainfall over area at the Khpob Krous Reservoir, the O Kbear Reservoir and Ka Ek Tom Reservoir were calculated by Thiessen method. The average rainfall over area ranges from 670 mm to 1,600 mm.

**Table II-1.5.2.2.1 Estimated Basin Mean Rainfall in MC35RSP Area** (Unit: mm)

| Reservoir | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Khpob Krous | | | | | | | | | | | | | |
| Mean | 7.7 | 7.3 | 21.4 | 71.7 | 106.6 | 101.0 | 111.7 | 123.6 | 184.2 | 206.5 | 69.8 | 15.0 | 1,027 |
| Maximum | 135.2 | 43.0 | 90.7 | 245.9 | 261.6 | 189.2 | 424.9 | 248.5 | 348.9 | 384.8 | 202.5 | 78.2 | 1,608 |
| Minimum | 0.0 | 0.0 | 0.0 | 0.0 | 34.3 | 18.3 | 27.0 | 45.4 | 34.1 | 70.9 | 0.0 | 0.0 | 703 |
| O Kbear | | | | | | | | | | | | | |
| Mean | 7.4 | 6.5 | 19.1 | 72.8 | 112.3 | 101.7 | 112.8 | 119.6 | 189.4 | 207.9 | 69.2 | 14.8 | 1,034 |
| Maximum | 128.6 | 49.9 | 96.5 | 230.9 | 283.0 | 220.8 | 414.9 | 245.1 | 368.3 | 398.2 | 218.3 | 87.5 | 1,573 |
| Minimum | 0.0 | 0.0 | 0.0 | 0.0 | 31.0 | 28.1 | 33.5 | 42.9 | 20.5 | 63.5 | 0.0 | 0.0 | 718 |
| Ka Ek Tom | | | | | | | | | | | | | |
| Mean | 7.1 | 4.0 | 20.0 | 85.9 | 120.6 | 104.0 | 119.4 | 121.1 | 193.1 | 215.1 | 73.7 | 17.5 | 1,082 |
| Maximum | 104.5 | 44.3 | 106.1 | 303.8 | 298.4 | 206.9 | 349.4 | 247.5 | 323.6 | 401.9 | 217.4 | 138.8 | 1,434 |
| Minimum | 0.0 | 0.0 | 0.0 | 0.0 | 36.9 | 38.4 | 32.7 | 30.4 | 19.7 | 64.2 | 0.0 | 0.0 | 671 |

*Note: Average in the period from 1982 to 2010*
*Source: JICA Survey Team (based on Rainfall Data from MOWRAM)*

(4) Hydrological Analysis

As mentioned above, there was no water gauge station in the Slakou River basin. On the other hand, a water gauge observation at Peam Khley station on the Prek Thnot River, neighboring to the MC35RSP Area, has been continuously carried out.

Therefore, the daily tank model for the Peam Khley of the Prek Thnot River constructed in Item (3) of Sub-clause II-1.4.2.2 was adopted to estimate of runoff at each reservoir in the MC35RSP Area. The outline of this runoff analysis model was described in Item (3) of Sub-clause II-1.4.2.2.

The discharge in each reservoir basin is calculated by the result of tank model for the Peam Khley. Parameters of tank model are used the same as for the Peam Khley. The rainfall data input to the model are the average rainfall over area calculated in Item (3) of Sub-clause II-1.5.2.2 so as to reflect the rainfall condition in each basin. The results of the runoff calculation are as follows:

**Table II-1.5.2.2.2 Monthly Discharge in each Reservoir in MC35RSP Area (30 years of 1982 to 2011)**

(Unit: $m^3$/sec)

| Reservoir | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Khpob Krous | | | | | | | | | | | | | |
| Mean | 0.47 | 0.21 | 0.20 | 0.72 | 1.03 | 0.74 | 1.49 | 1.67 | 2.79 | 4.64 | 1.78 | 0.73 | 1.38 |
| Maximum | 2.71 | 0.87 | 1.39 | 3.84 | 3.53 | 3.18 | 8.46 | 3.51 | 7.40 | 14.43 | 6.23 | 1.87 | 3.65 |
| Minimum | 0.16 | 0.07 | 0.03 | 0.02 | 0.01 | 0.03 | 0.05 | 0.12 | 0.32 | 0.50 | 0.66 | 0.36 | 0.48 |
| O Kbear | | | | | | | | | | | | | |
| Mean | 0.40 | 0.17 | 0.15 | 0.42 | 0.89 | 0.81 | 1.39 | 1.42 | 2.71 | 4.00 | 1.36 | 0.63 | 1.20 |
| Maximum | 2.29 | 0.78 | 1.30 | 2.62 | 4.34 | 4.22 | 6.64 | 4.57 | 7.65 | 11.06 | 5.28 | 1.58 | 2.94 |
| Minimum | 0.13 | 0.06 | 0.03 | 0.02 | 0.01 | 0.03 | 0.14 | 0.12 | 0.26 | 0.60 | 0.55 | 0.28 | 0.38 |
| Ka Ek Tom | | | | | | | | | | | | | |
| Mean | 0.06 | 0.03 | 0.03 | 0.11 | 0.15 | 0.15 | 0.22 | 0.23 | 0.43 | 0.69 | 0.25 | 0.11 | 0.21 |
| Maximum | 0.29 | 0.11 | 0.23 | 0.74 | 0.65 | 0.61 | 0.81 | 0.70 | 1.22 | 1.54 | 0.85 | 0.28 | 0.41 |
| Minimum | 0.02 | 0.01 | 0.00 | 0.01 | 0.01 | 0.03 | 0.03 | 0.02 | 0.06 | 0.05 | 0.08 | 0.04 | 0.07 |

*Source: JICA Survey Team*

(5) Flood Discharge at Reservoirs

Flood discharges at each reservoir in the MC35RSP Area were estimated using 3 methods: (i) IRS method, (ii) unit hydrograph method and (iii) rational formula method. Among these methods, the unit hydrograph method was selected for estimation of flood of the MC35RSP Area in the Survey. The calculation results are summarized in Table II-1.5.2.2.3.

**Table II-1.5.2.2.3 Estimated Flood Discharge by Unit Hydrograph Method (MC35RSP)**

| Reservoir | Catchment Area ($km^2$) | Flood Peak Discharge ($m^3$/sec) | | | | |
|---|---|---|---|---|---|---|
| | | 10 years | 20 years | 50 years | 100 years | 200 years |
| Khpob Krous | 97.7 | 109.2 | 124.5 | 143.4 | 157.0 | 170.3 |
| O Kbear | 92.6 | 111.3 | 126.5 | 145.3 | 158.8 | 172.0 |
| Ka Ek Tom | 9.8 | 12.7 | 14.4 | 16.5 | 18.0 | 19.5 |

*Source: JICA Survey Team*

## II-1.5.3 Socio-economy

(1) Poverty

As shown in the following table, poverty rate in Kampong Speu Province is 30.1% in 2010, which is higher than the average (25.8%) of the whole country. Furthermore the table also indicates a continuing downward trend in poverty.

**Table II-1.5.3.1 Poverty Rate by Regions (MC35RSP)** (Unit: %)

| Region | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Phnom Penh | 6.8 | 6.9 | 5.8 | 0.5 | 0.3 | 0.2 | 0.1 |
| Kampong Speu | 41.4 | 40.3 | 39.5 | 37.3 | 35.2 | 32.2 | 30.1 |
| Cambodia | 35.1 | 34.2 | 32.9 | 30.7 | 29.3 | 27.4 | 25.8 |

*Source: Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

(2) Demographic Conditions

General characteristics of farm HHs in the related communes are shown below.

**Table II-1.5.3.2 General Characteristics of Farm Households in MC35RSP**

| Related Communes | Total Population (person) | Total No of HH (nos.) | Average Family Size (person) | Working-age Population (person) | Literacy Rate (%) |
|---|---|---|---|---|---|
| (a) Basedth | 10,737 | 2,565 | 4.2 | 6,418 | 71.3 |
| (b) Pheari Mean Chey | 7,639 | 1,690 | 4.5 | 4,404 | 67.9 |
| (c) Pou Mreal | 9,203 | 2,187 | 4.2 | 3,969 | 74.9 |
| (d) Tuol Ampil | 9,464 | 2,059 | 4.6 | 5,336 | 67.3 |
| (e) Kak | 5,173 | 1,258 | 4.1 | 2,812 | 66.8 |
| (f) Preah Khae | 5,541 | 1,289 | 4.3 | 3,035 | 57.8 |
| (g) Kat Phluk | 7,647 | 1,663 | 4.6 | 4,325 | 64.4 |
| (h) Niteam | 7,070 | 1,661 | 4.3 | 3,776 | 76.3 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(3) Living Conditions

(a) Water for Drinking

Actual situation on sources and locations on drinking water in the related communes is shown as follows:

**Table II-1.5.3.3 Sources of Drinking Water in MC35RSP** (Unit: HH)

| Related Communes | Type of Sources | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PW | TPW | DW | Rain | Sp/Ri | Bought | Others | Total |
| 1) Basedth | 20 | 433 | 1,441 | 7 | 633 | 5 | 26 | 2,565 |
| 2) Pheari Mean Chey | 27 | 410 | 300 | 4 | 882 | 46 | 21 | 1,690 |
| 3) Pou Mreal | 10 | 404 | 830 | 7 | 925 | 6 | 5 | 2,187 |
| 4) Tuol Ampil | 86 | 463 | 236 | 98 | 1,162 | 1 | 13 | 2,059 |
| 5) Kak | 15 | 449 | 161 | 0 | 624 | 6 | 3 | 1,258 |
| 6) Preah Khae | 13 | 509 | 417 | 0 | 328 | 21 | 1 | 1,289 |
| 7) Kat Phluk | 30 | 828 | 196 | 3 | 599 | 5 | 2 | 1,663 |
| 8) Niteam | 7 | 103 | 582 | 7 | 960 | 1 | 1 | 1,661 |

*Note: PW: Piped water , TPW: Tube pile well, DW: Dug well, SP/Ri: Spring/River*
*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

As shown in the above table, major sources for drinking water are wells including tube well and dug well and spring/river as well.

(b) Type of Fuel for Cooking

Major fuel for cooking is firewood. Firewood is available in market, while gathering firewood from surrounding area of farmers' houses is also common as follows:

**Table II-1.5.3.4 Sources of Fuel for Cooking in MC35RSP** (Unit: HH)

| Related Communes | Type of Sources | | | | | |
|---|---|---|---|---|---|---|
| | Firewood | Charcoal | Gas Cylinder | Electricity | Others | Total |
| 1) Basedth | 2,512 | 14 | 20 | 0 | 20 | 2,565 |
| 2) Pheari Mean Chey | 1,566 | 4 | 4 | 0 | 116 | 1,690 |
| 3) Pou Mreal | 2,119 | 2 | 53 | 1 | 12 | 2,187 |
| 4)Tuol Ampil | 2,016 | 9 | 25 | 1 | 8 | 2,059 |
| 5) Kak | 1,243 | 2 | 3 | 2 | 8 | 1,258 |
| 6) Preah Khae | 1,267 | 8 | 10 | 0 | 4 | 1,289 |
| 7) Kat Phluk | 1,642 | 1 | 8 | 0 | 12 | 1,663 |
| 8) Niteam | 1,639 | 1 | 14 | 0 | 1 | 1,661 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(c) Type of Sources for Lighting

Major sources of lighting are Kerosene and battery in the related communes. Sources of lighting are shown as below.

**Table II-1.5.3.5 Sources of Lighting in MC35RSP** (Unit: HH)

| Related Communes | Type of Source of Lighting | | | | | | |
|---|---|---|---|---|---|---|---|
| | City Power | Generator | Kerosene | Candle | Battery | Others | Total |
| 1) Basedth | 47 | 7 | 988 | 1 | 1,516 | 6 | 2,565 |
| 2) Pheari Mean Chey | 82 | 17 | 975 | 3 | 610 | 3 | 1,690 |
| 3) Pou Mreal | 20 | 5 | 955 | 6 | 1,195 | 6 | 2,187 |
| 4)Tuol Ampil | 120 | 37 | 963 | 5 | 930 | 4 | 2,059 |
| 5) Kak | 14 | 1 | 637 | 2 | 601 | 3 | 1,258 |
| 6) Preah Khae | 9 | 19 | 507 | 0 | 753 | 1 | 1,289 |
| 7) Kat Phluk | 82 | 3 | 800 | 15 | 761 | 2 | 1,663 |
| 8) Niteam | 14 | 5 | 930 | 2 | 709 | 1 | 1,661 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

### II-1.5.4 Agriculture

(1) Land Use in MC35RSP Area

Total area of the Sub-project Area is estimated to be around 900 ha according to the water balance study discussed in Clause II-2.6.3. The whole area is categorized as paddy filed. Out of 900 ha, 850 ha

is rainfed paddy fields, while the remaining area of 50 ha is irrigated paddy fields, in which double cropping is carried out.

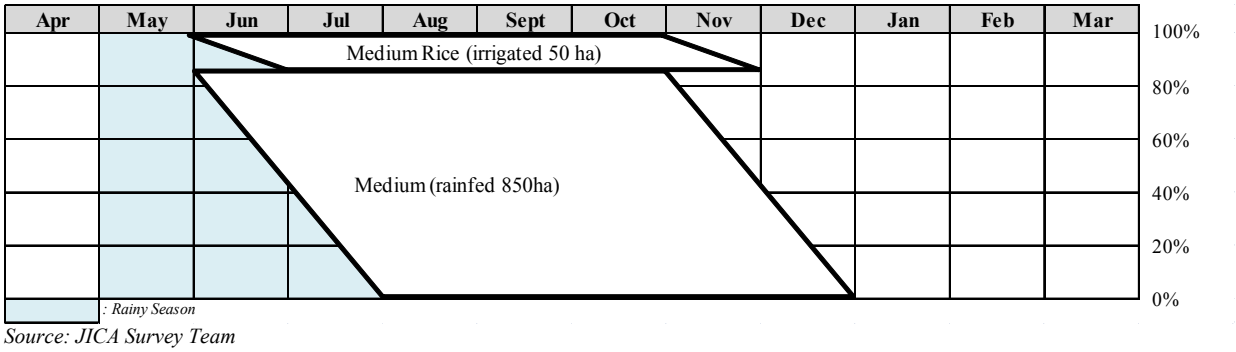
**Table II-1.5.4.1 Land Use in MC35RSP** (Unit: ha)

| Land Use | | Before Rehabilitation | | | | | | After Rehabilitation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Physical Land | Cultivated Area | | | | | Physical Land | Cultivated Area | | | | |
| | | | Paddy by Seasons | | | Upland Crops | Total | | Paddy by Seasons | | | Upland Crops | Total |
| | | | Dry | Early Rainy | Rainy | | | | Dry | Early Rainy | Rainy | | |
| Irrigated Paddy Field | Low Land | 50 | - | 50 | 50 | - | 100 | 850 | - | 130 | 850 | - | 980 |
| | Recession Area | - | - | - | - | - | 0 | | | | | | 0 |
| Rainfed Paddy Field | | 850 | - | - | 850 | - | 850 | - | - | - | - | - | 0 |
| Upland Field | | - | - | - | - | - | 0 | - | - | - | - | - | 0 |
| Non-agricultural Land | | - | - | - | - | - | 0 | - | - | - | - | - | 0 |
| Right of Way | | - | - | - | - | - | 0 | 50 | - | - | - | - | 0 |
| Total | | 900 | 0 | 50 | 900 | 0 | 950 | 900 | 0 | 130 | 850 | 0 | 980 |
| Cropping Intensity (%) | | | | | | | 106 | | | | | | 115 |

*Source: JICA Survey Team*

(2) Paddy Cultivation in MC35RSP Area

Rainy season cropping is mainly from July to December. Medium rice and late rice are cultivated under rainfed condition, while double cropping (early rainy season – rainy season) of paddy cultivation with early rice is also carried out, but it is in so limited area near the reservoir. Main canal has been blocked and broken everywhere, hence it is difficult to use it for irrigation to the downstream area. Water management is not conducted properly. Sometimes the gate of the reservoir is opened depending on urgent requests from farmers. Present cropping pattern is shown as follows:




*Source: JICA Survey Team*

**Figure II-1.5.4.1 Present Cropping Pattern for MC35RSP**

Harvested paddy is normally threshed at farmers' home yard, and thus sold to traders at farm gate. Meanwhile rice millers are not available in and around this Sub-project Area, although mobile rice miller is popular here.

## II-1.5.5 Irrigation and Drainage

(1) General

The existing Main Canal 35 Irrigation System, consisting of 3 reservoirs and main and secondary canals, was originally constructed during Pol Pot regime (1975-1977) targeting to irrigate more than 3,000 ha of the paddy field. This system is facing to insufficient irrigation water supply since long time due to damage of the reservoir dike by flood and deterioration of irrigation facilities. The latest rehabilitation works were conducted by MOWRAM in 2009 and 2010, which however only covered the dikes of 2 upstream reservoirs and new construction of spillways and intakes, while the other facilities such as main and secondary canals remained as they were. Therefore rehabilitation of canals has been proposed by PDOWRAM in order to maximum utilize the water source impounded in the rehabilitated reservoirs.

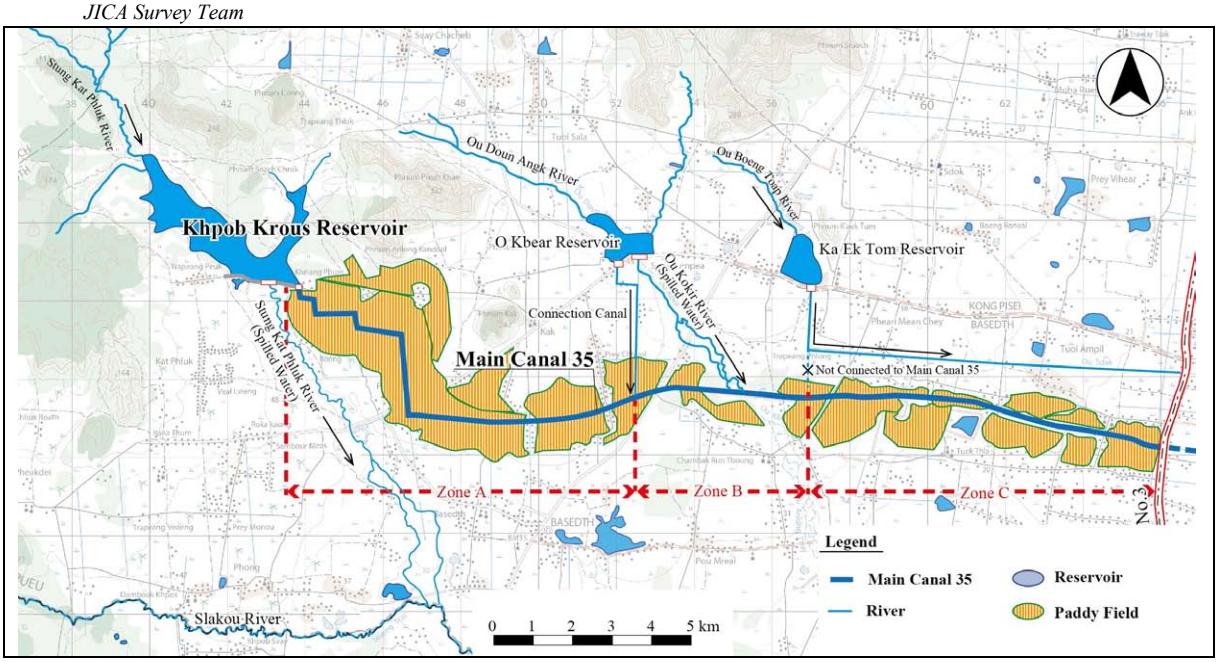
(2) Existing Irrigation System

Major components of the entire irrigation system consist of 3 reservoirs and main and secondary canals, of which the general features are summarized as below.

**Table II-1.5.5.1 General Features of Main Canal 35 Irrigation System**

| Item | Features |
|---|---|
| Water source | Stung Kat Phluk River and Ou Kat Srov River: Khpob Krous Reservoir<br>Doun Angk River: O Kbear Reservoir<br>Boeng Toap River: Ka Ek Tom Reservoir |
| Command area* | Whole system : 3,018 ha in Basedth district, Kampong Speu Province<br>Zone-A: 850 ha (examined by water balance (refer to Sub-clause II-2.6.3.2) ) |
| Reservoirs | 1) Khpob Krous Reservoir<br>2) O Kbear Reservoir<br>3) Ka Ek Tom Reservoir |
| Main Canal 35 | Length in whole system : 25 km<br>Length in Zone-A : 14 km<br>Design capacity: No data |
| Secondary canals | Whole system : 27 secondary canals: 36km<br>Zone-A : 22 secondary canals; 26 km |

*Remarks *: Proposed by MOWRAM*
*Source: Main Canal 35 Rehabilitation Project in Basedth District, Kampong Speu Province, Project Proposal Document To Small Scale Infrastructure Project (2009)*
*JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-1.5.5.1 General Layout of Main Canal 35 Irrigation System**

(3) Present Condition of Irrigation and Drainage

(a) Reservoirs

1) Outline of Khpob Krous and O Kbear Reservoirs after last rehabilitation in 2009/10

The Khpob Krous and the O Kbear Reservoirs are located in Khnang Phum Village, Preah Khe Commune, and Kbear Village, Savay Rumpea Commune, respectively in Basedth District, Kampong Speu Province. Both reservoirs were rehabilitated in 2009 and 2010. The works for the Khpob Krous Reservoir consisted of (i) rehabilitation of the dike of 1,300 m in length, (ii) new construction of a spillway with provision of automatic flap gates and (iii) construction of an intake (outlet structure to the main canal). On the other hand, the

**Intake of Khpob Krous Reservoir (View from Downstream)**

works for the O Kbear Reservoir consisted of (i) new construction of a spillway with provision of automatic flap gates and (ii) new construction of intakes of pipe culverts. The outline of the rehabilitated facilities and their present conditions are summarized below.

**Table II-1.5.5.2 Present Conditions of Khpob Krous Reservoir and O Kbear Reservoir**

| Reservoir | Item | Conditions |
|---|---|---|
| Khpob Krous Reservoir | (i) Dike | (i) Length: 1,300 m<br>Crest Elevation: EL. 55.5 m |
| | (ii) Spillway | (ii) Gate Type (nos.): Automatic Flap Gate (4 nos.)<br>Gate Height: 2.2 m<br>Gate Width: 8.0 m |
| | (iii)Intake | (iii)Gate Type (nos.): Slide Gate (3 nos.)<br>Gate Height: 3.0 m<br>Gate Width: 1.5 m |
| O Kbear Reservoir | (i) Spillway | (i) Gate Type (nos.): Automatic Flap Gate (2 nos.)<br>Gate Height: 2.3 m<br>Gate Width: 8.0 n |
| | (ii) Intake | (ii) Type (nos.): Pipe Culvert with slide gate (2 nos.)<br>Culvert Diameter: 0.8 m<br>Culvert Length: 9.6 m<br>Gate Height: 1.06 m<br>Gate Width: 1.10 m |

*Source: Project Proposal for Khpob Krous Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, 2008*
*Project Proposal for O Kbear Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, 2008*

2) Intakes (Outlet Structures) at Khpob Krous and O Kbear Reservoirs

As mentioned above, one intake was constructed at the Khpob Krous Reservoir in 2010, while another intake of pipe culvert had been installed at the O Kbear Reservoir before the rehabilitation was conducted in 2009. Although there are 3 intakes in total on the O Kbear Reservoir, only one intake rehabilitated in 2009 can supply water from the reservoir to the main canal through connection canal as shown in Figure II-1.5.5.1. According to chiefs of the villages around the Main Canal 35, gate operation of each reservoir intake is entrusted to some of them, and operation rules are based on farmers' water request.

**Culvert of O Kbear Reservoir (View from Downstream)**

3) Ka Ek Tom Reservoir

The Ka Ek Tom Reservoir is located at 4.5 km east from the O Kbear Reservoir and 3 km north from the Main Canal 35.

An intake is installed on the reservoir without any gate. As of March 2012, rehabilitation works were not done on this reservoir and any information related to the reservoir is not available.

**Intake of Ka Ek Tom Reservoir (View from Upstream)**

4) Connection Canals from Reservoirs to Main Canal 35

a) O Kbear Reservoir

The connection canal starting at one of 3 intakes on the O Kbear Reservoir runs southward for about 4 km into the Main Canal 35. The other 2 intakes are not connected to the Main Canal 35. Existing related structures on the connection canal are partially broken, however they still have functional roles. Using these structures, farmers around the connection canal draw water from the canal to their paddy fields. According to some villagers, check structures are controlled by commune leaders based on farmers' requests for irrigation water.

On the other hand, spilled water from the O Kbear Reservoir also flows into the Main Canal 35 via the Kokir River. Villagers say that the spillway gates rehabilitated in 2009 would open every rainy season. The spilled water flows to Takeo Province through culvert under the National Road No.3 and reaches a reservoir in Samraong District, which is the end point of the Main Canal 35. According to some farmers in Takeo Province, they can use water for irrigation during the limited period when Main Canal 35 is suffused with spilled water from O Kbear Reservoir.

b) Ka Ek Tom Reservoir

According to the staff of Kampong Speu PDOWRAM, the Ka Ek Tom Reservoir and Main Canal 35 were originally connected by a canal. Due to the partial sedimentation and erosion, the canal sections nearby the Main Canal 35 have become flat and finally lost a function to convey water from Ka Ek Tom Reservoir to the main canal. The canal currently runs south at first and then turns east at just 500 m north from the Main Canal 35. Consequently, the canal from Ka Ek Tom Reservoir would never be confluent with the Main Canal 35.

(b) Main Canal 35 and Related Structures

The Main Canal 35 runs in Basedth District, Kampong Speu Province. The canal starts at the Khpob Krous Reservoir and runs eastward firstly, then turns southward and finally turns eastward again, which crosses the National Road No.3 and reaches to a reservoir in Takeo Province.

**Main Canal 35 (Downstream of Kokir River Confluence)**

The Main Canal 35 was damaged totally and lost a functional role to convey water from the Khpob Krous Reservoir and the O Kbear Reservoir to paddy fields because of the reason mentioned as below. Generally, canals constructed in Pol Pot regime commonly have some problems, that is (i) canal route was determined without considering topological conditions, so that most of canals were so constructed as to have reverse longitudinal slope, which prevent water flow and accelerate sedimentation, and (ii) farmer had to apply pumps to abstract water from the canal to their paddy because the canal was of excavated type, so that elevation of canal bed as well as the designed water level was relatively lower than neighboring paddy field. Furthermore, the Main Canal 35 was constructed in inappropriate design because spilled water from the O Kbear Reservoir flows into the canal without control, so that severe erosion occurs at the confluence of both. Actually, water from the Khpob Krous Reservoir flow only about 1 km upstream of the canal because of severe sedimentation in the canal.

There exist canal related structures, mostly constructed in upstream area, as shown in Table II-1.5.5.3. In the rainy season, rain water is pooled in lower parts in Main Canal 35 and used for irrigation by the farmers with these structures and small portable pumps.

(c) Secondary Canals and Related Structures

Twenty seven secondary canals are branched off from the Main Canal 35 toward south. Due to the malfunction of Main Canal 35, water is not distributed to secondary canals. Some secondary canals are filled with soil and cultivated as paddy field.

There are some structures on secondary canals, such as pipe culverts for crossing canals at entrance of houses, diversion structures to tertiary canals. Rain water is stored in secondary canals and supplied to neighboring paddy fields in the rainy season.

(d) Tertiary Canals

There is no systematic tertiary canal system, while some small canals are extended from the secondary canals or the Main Canal 35. In the upstream area where the Main Canal 35 functions to flow water from the Khpob Krous Reservoir, some tertiary canals are directly branched off from the Main Canal 35 and deliver water to the paddy fields. Even these working tertiary canals could not deliver sufficient water to paddy fields due to so long length.

(e) Drainage System

In the Sub-project Area, irrigation canals could function as drains concurrently because elevation of canal bed is generally lower than surrounding paddy field. Considering the present conditions and difficulty in acquiring land for drainage canals, it is judged that drainage should be maintained in the same manner with the present situation.

## II-1.6 Srass Prambai Water Recession Rehabilitation Sub-project

### II-1.6.1 Location and Administration

The Srass Prambai Irrigation System, consisting of the Srass Prambai Reservoir and main and secondary canals was originally constructed during Pol Pot regime targeting to irrigate the flood recession cultivation area in the flood plain between the Bassac and the Mekong Rivers. The area lies at the left side of the Bassac River in its lower reach, about 20 km from the national border with Vietnam, as shown in the location map. The area is administratively situated in Po Ti Ban Commune, Kaoh Thum District, Kandal Province.

Agricultural production system in this area is characterized by the flooding cycle of the Mekong and the Bassac Rivers in the category of colmatage, lowland irrigation and rainfed agriculture. Flood recession cultivation of paddy is prevailing in the flood plain along these rivers as well as the Tonle Sap River.

### II-1.6.2 Meteorology and Hydrology

#### II-1.6.2.1 Meteorology

There are no meteorological stations in the SPWRRSP Area. Thus, the meteorological data recorded at Pochentong, Phnom Penh, which is shown in Table II-1.2.2.1.1, is used for estimate of crop water requirement.

#### II-1.6.2.2 Hydrology

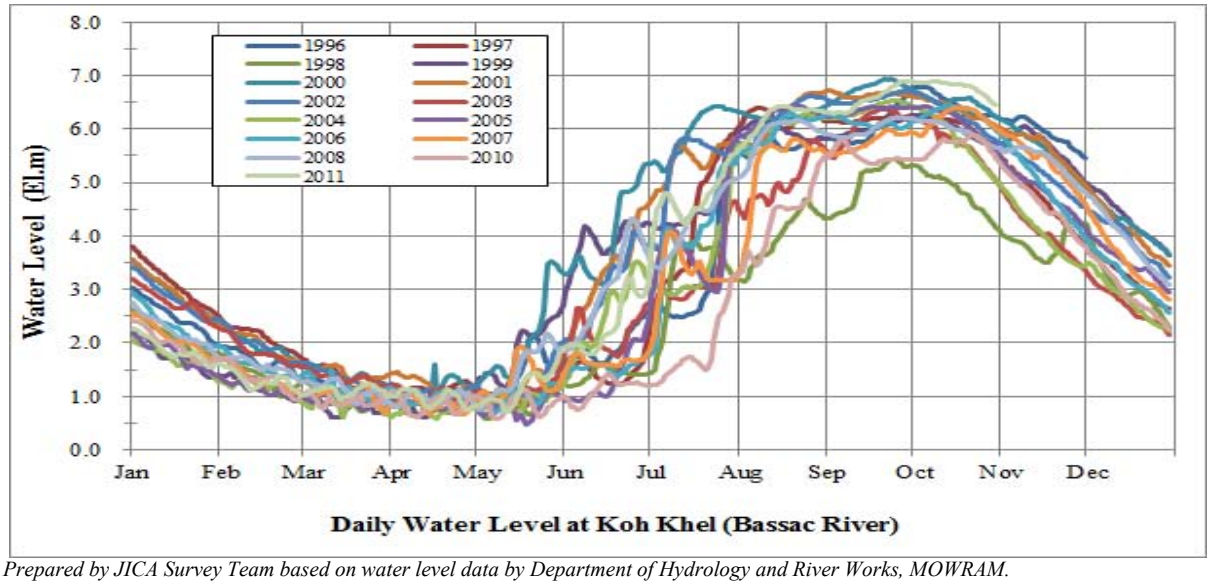
(1) Condition of Area

The SPWRRSP Area is located in flood plain between the Tonle Bassac River and the Mekong River in the Kandal Province. In the flood season from July to November, the SPWRRSP Area is inundated by flood from the Tonle Bassac River. After the flood season, recession dry season rice cropping was started using the inundated water in the area.

(2) Water Level Data of Bassac River and Mekong River

Figure II-1.6.2.2.1 shows the daily water level data in elevation at the Bassac River at Koh Khel station that is converted from daily gauge height and the zero gauge height of above MSL -1.000 m. From September to October, the water level of the Tonle Bassac River at Koh Khel is raised between EL. 5 m and EL. 7 m. The maximum water level of the observed period from 1996 to 2011 was

occurred in year 2000 at EL. 6.94 m. 50% non-exceedance (or return period of 1/2 years) is about EL. 6.42 m and 84% non-exceedance (or return period of 1.2 years) is about EL. 6.22 m.




*Prepared by JICA Survey Team based on water level data by Department of Hydrology and River Works, MOWRAM.*

**Figure II-1.6.2.2.1 Daily Water Level of Tonle Bassac River at Koh Khel**

(3) Hydrological Analysis

The Srass Prambai Reservoir water is supplied by flood of the Tonle Bassac River. In the Survey, it was assumed that if the water level of the Tonle Bassac River is higher than EL. 5.0 m, the flood water from the Tonle Bassac River flow into the Srass Prambai Reservoir. Inflow discharge was assumed that 4.0 $m^3$/sec, if water level of the Tonle Bassac River is higher than EL. 5.0 m in the water balance study.

### II-1.6.3 Socio-economy

(1) Poverty

As shown in the following table, poverty rate in Kandal Province is 15.9% in 2010, which is better than the average (25.8%) of the whole country, so that serious poverty situation is not shown in Kandal Province. Furthermore the table also shows a continuing downward trend in poverty.

**Table II-1.6.3.1 Poverty Rate by Regions (SPWRRSP)** (Unit:%)

| Region | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Phnom Penh | 6.8 | 6.9 | 5.8 | 0.5 | 0.3 | 0.2 | 0.1 |
| Kandal | 27.6 | 26.2 | 24.1 | 21.2 | 19.7 | 17.6 | 15.9 |
| Cambodia | 35.1 | 34.2 | 32.9 | 30.7 | 29.3 | 27.4 | 25.8 |

*Source: Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

(2) Demographic Conditions

General characteristics of farm HHs in the related communes are shown below.

**Table II-1.6.3.2 General Characteristics of Farm Households in SPWRRSP**

| Related Communes | Total Population (person) | Total No of HH (nos.) | Average Family Size (person) | Working-age Population (person) | Literacy Rate (%) |
|---|---|---|---|---|---|
| (a) Kampong Kong | 11,450 | 2,430 | 4.7 | 6,945 | 79.3 |
| (b) Kaoh Thum Ka | 5,424 | 1,255 | 4.4 | 3,224 | 80.4 |
| (c) Kaoh Thum Kha | 6,784 | 1,545 | 4.4 | 4,466 | 92.0 |
| (d) Leuk Daek | 13,176 | 2,818 | 4.6 | 7,856 | 76.8 |
| (e) Porthi Ban | 11,129 | 2,396 | 4.6 | 6,893 | 73.1 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(3) Living Conditions

(a) Water for Drinking

Major source of drinking water in the related communes is spring, river and stream as follows:

**Table II-1.6.3.3 Sources of Drinking Water in SPWRRSP**

| Related Communes | Type of Sources | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PW | TPW | DW | Rain | Sp/Ri | Bought | Others | Total |
| 1) Kampong Kong | 232 | 794 | 372 | 33 | 565 | 421 | 13 | 2,430 |
| 2) Kaoh Thum Ka | 3 | 424 | 11 | 5 | 809 | 1 | 2 | 1,255 |
| 3) Kaoh Thum Kha | 782 | 155 | 153 | 32 | 299 | 122 | 2 | 1,545 |
| 4) Leuk Daek | 23 | 76 | 79 | 1 | 2,533 | 3 | 103 | 2,818 |
| 5) Porthi Ban | 34 | 112 | 12 | 3 | 2,158 | 71 | 6 | 2,396 |

*Note: PW: Piped water, TPW: Tube pile well, DW: Dug well, SP/Ri: Spring/River*
*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(b) Type of Fuel for Cooking

Major fuel for cooking is firewood. Firewood is available in market, while gathering firewood from surrounding area of farmers' houses is also common as follows:

**Table II-1.6.3.4 Sources of Fuel for Cooking in SPWRRSP**

| Related Communes | Type of Sources | | | | | |
|---|---|---|---|---|---|---|
| | Firewood | Charcoal | Gas Cylinder | Electricity | Others | Total |
| 1) Kampong Kong | 2,388 | 7 | 11 | 2 | 22 | 2,430 |
| 2) Kaoh Thum Ka | 1,238 | 10 | 3 | 0 | 4 | 1,255 |
| 3) Kaoh Thum Kha | 1,360 | 58 | 76 | 27 | 24 | 1,545 |
| 4) Leuk Daek | 2,768 | 10 | 14 | 1 | 25 | 2,818 |
| 5) Porthi Ban | 2,348 | 20 | 9 | 0 | 19 | 2,396 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(c) Type of Sources for Lighting

Recently city power has become common in Kaoh Thum Kha, however battery and kerosene are still common in the related commune as shown in the following table:

**Table II-1.6.3.5 Sources of Lighting in SPWRRSP**

| Related Communes | Sources of Lighting | | | | | | |
|---|---|---|---|---|---|---|---|
| | City Power | Generator | Kerosene | Candle | Battery | Others | Total |
| 1. Kampong Kong | 36 | 57 | 457 | 2 | 1,871 | 7 | 2,430 |
| 2. Kaoh Thum Ka | 8 | 5 | 286 | 3 | 951 | 2 | 1,255 |
| 3. Kaoh Thum Kha | 1,103 | 14 | 303 | 13 | 110 | 2 | 1,545 |
| 4. Leuk Daek | 63 | 65 | 438 | 8 | 2,234 | 10 | 2,818 |
| 5. Porthi Ban | 55 | 29 | 390 | 4 | 1,912 | 6 | 2,396 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

## II-1.6.4 Agriculture

(1) Land Use in Sub-project Area

Total area of the Sub-project Area is estimated at around 1,200 ha. Out of that area, around 700 ha is currently utilized for paddy cultivation, while the remaining area of 500 ha is categorized as fallow area as shown in the following table.

**Table II-1.6.4.1 Land Use in SPWRRSP** (Unit: ha)

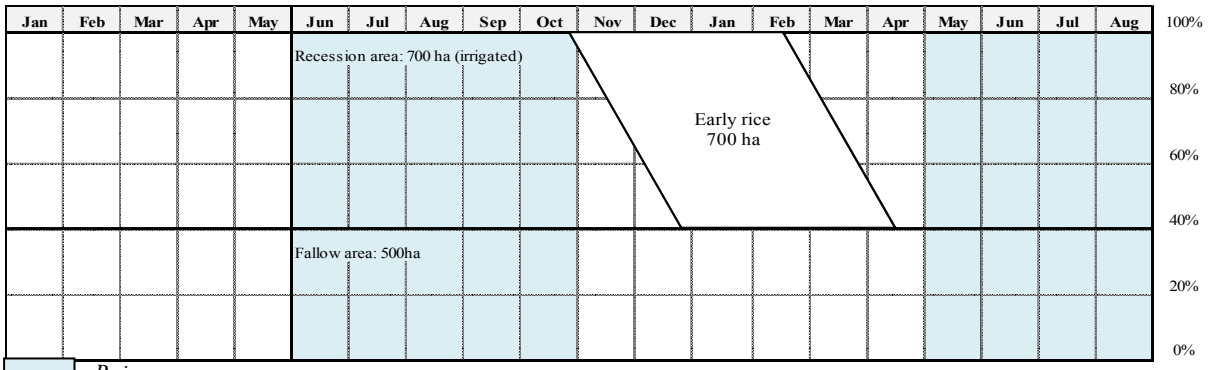
| Land Use | | Physical Land | Cultivated Area | | | | |
|---|---|---|---|---|---|---|---|
| | | | Paddy by Seasons | | | Upland Crops | Total |
| | | | Dry | Early Rainy | Rainy | | |
| Irrigated Rice Field | Low Land | - | - | - | - | - | 0 |
| | Recession Area | 700 | 700 | - | - | - | 700 |
| Rainfed Rice Field | | - | - | - | - | - | 0 |
| Upland Field | | - | - | - | - | - | 0 |
| Non-agricultural Land | | - | - | - | - | - | 0 |
| Fallow Area | | 500 | - | - | - | - | 500 |
| Total | | 1,200 | 700 | 0 | 0 | 0 | 1,200 |
| Cropping Intensity (%) | | | | | | | 58 |

*Source: JICA Survey Team*

(2) Paddy Cultivation and Production in SPWRRSP Area

During the rainy season, the area is flooded by the increased water from the Bassac River. Water level reduces from the beginning of November, thus paddy cultivation starts in the area, depending on reduction of water level. Early rice varieties are common in this area.

Paddy cultivation in this recession area is carried out under fully irrigated condition with pumping up flooded water from the existing canals. Currently it is difficult to control the water level of flooded water in the existing canals as well as reservoir due to poor function of irrigation facilities. Cropping pattern in the recession area is shown as follows:




*Source/: JICA Survey Team*

**Figure II-1.6.4.1 Present Cropping Pattern for SPWRRSP**

## II-1.6.5 Irrigation and Drainage

(1) General

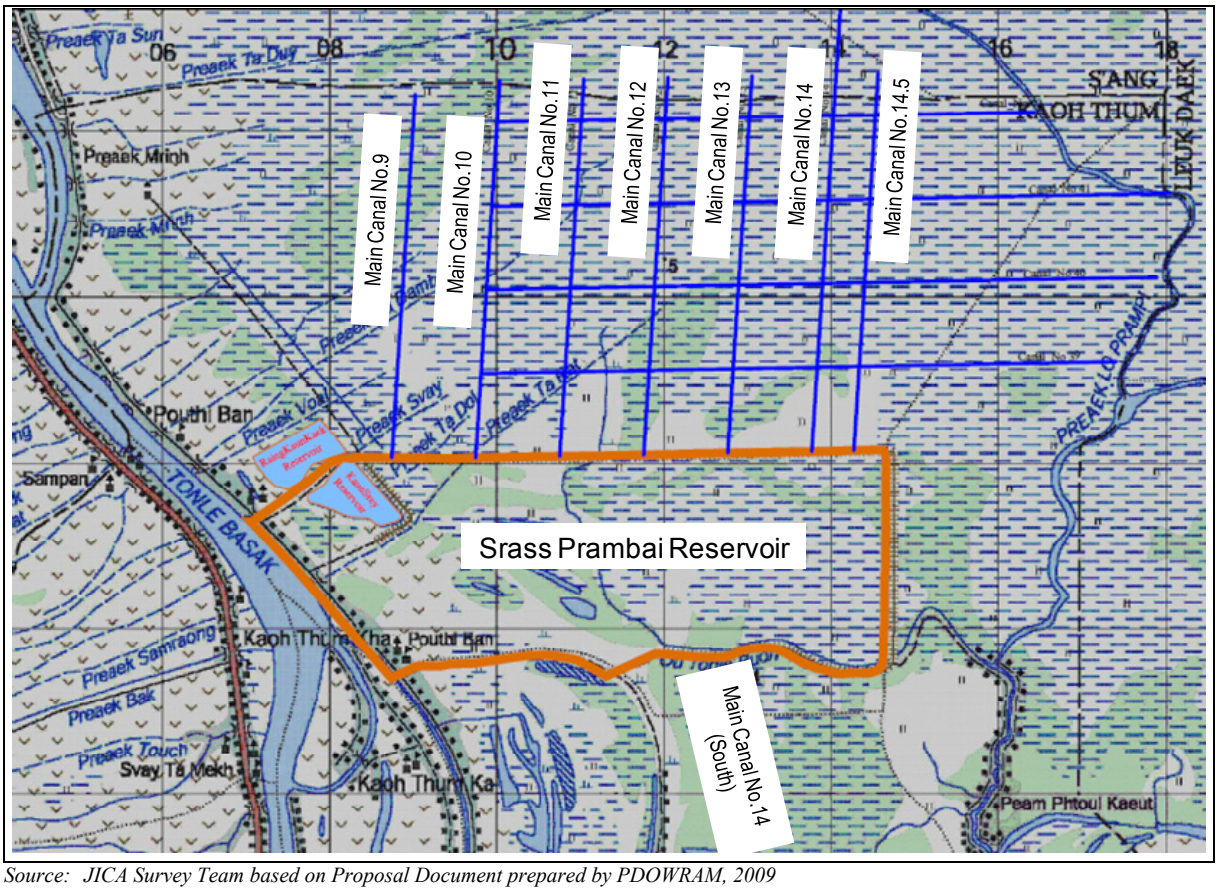
The Srass Prambai Irrigation System, consisting of the Srass Prambai Reservoir and main and secondary canals was originally constructed during Pol Pot regime targeting to irrigate the flood recession cultivation area in the flood plain between the Tonle Bassac and the Mekong Rivers. The system was sufficiently operated until 2000 when the reservoir dike was damaged by flood. The recession cultivation lands have been facing the shortage of irrigation water since then, and the lowland paddy areas were abandoned. Therefore, the farmers and PDOWRAM requested to MOWRAM for urgent rehabilitation. Previously, rehabilitation works of the reservoir dike with about 7 km were executed by the local religious party under the assistance of PDOWRAM, while the rest of the dike remains untreated.

(2) Flood Recession Cultivation in Srass Prambai Irrigation System

Agricultural production system in this area is characterized by the flooding cycle of the Mekong and the Bassac Rivers in the category of colmatage, lowland irrigation and rain fed agriculture. Flood recession cultivation of paddy is prevailing in the flood plain along these rivers as well as the Tonle Sap River. Water from the preceding flood flows into the lands directly or through the colmatage canals, spreading and submerges the paddy field, and also flows into the reservoir through the intake culverts constructed on the reservoir dike. After the flood season, inundated water level on the paddy fields decreases gradually from the higher to the lower lands, according to which paddy cultivation starts from November in higher lands to February in lower lands. Supplementary irrigation water is then conveyed by gravity from the reservoir in the rainy season into the Pol Pot canal system. The farmers use their own small portable pumps to lift the water in the canal system to their lands. The recession cultivation is locally and traditionally developed without water balance study, and the available water is fully depending on the natural flood conditions.

(3) Existing Irrigation System

The components of the irrigation system consist of the Srass Prambai Reservoir and main and secondary canals. The canals, having the function as a creek, are called as Pol Pot Grid Canals, which were excavated at 500 m interval as shown in Figure II-1.6.5.1.




*Source: JICA Survey Team based on Proposal Document prepared by PDOWRAM, 2009*

**Figure II-1.6.5.1 General Layout of Srass Prambai Irrigation System**

The general features of the existing irrigation system are summarized as below.

**Table II-1.6.5.1 General Features of Srass Prambai Irrigation System**

| Item | Features |
|---|---|
| Water source | Mekong River and Bassac River |
| Command area* | Total potential land resources : 2,500 ha (reported by PDOWRAM)<br>Existing irrigated area : 700 ha<br>Target area for rehabilitation : 1,200 ha[1] |
| Reservoirs | Srass Prambai Reservoir |
| Main canals | Nos. : 12 nos.<br>Length in total : 66 km |
| Secondary canals | Nos. : 9 nos.<br>Length in total : 57 km |

*Remarks *: Proposed by MOWRAM*
*Source: Project Proposal Document To Small Scale Infrastructure Project(2009)*
*JICA Survey Team*

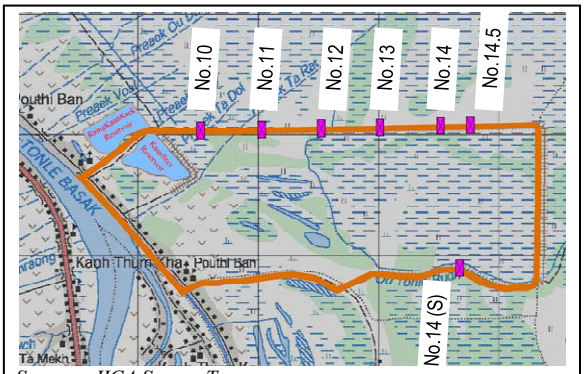
(a) Srass Prambai Reservoir

The Srass Prambai Reservoir was constructed in Pol Pot regime. The reservoir is surrounded by the dike at the northern, western and southern sides and the road at eastern side as shown in Figure II-1.6.5.2. The total length of dike is 12.3 km, and 7 m in height at maximum with top width of 5 m. The reservoir dike was eroded at many places and damaged. The northern part of the dike was rehabilitated by a religious party under assistance of MOWRAM in 2008. However the eastern and

southern parts of the dike of around 9 km remain un-rehabilitated.

(b) Intake Culverts at Srass Prambai Reservoirs

There are 7 existing culverts on the reservoir dike as shown in Figure II-1.6.5.2, which were originally constructed during Pol Pot regime. These culverts have 2 flow directions. The flooded water in the low land flows into the reservoir according to the increase of water level outside in the rainy season, and the opposite direction from the reservoir to outside after peak flood water level according to the water recession on the lands.




*Source : JICA Survey Team*

**Figure II-1.6.5.2 Layout of Intake Culverts on Reservoir Dike**

These culverts were equipped with wooden stop logs inner side the reservoir, however all of them are malfunctioning at present, so that the reservoir is not able to store the water. The existing 7 culverts are listed in Table II-1.6.5.2.

**Dike of Srass Prambai Reservoir**

Though Kandal PDOWRAM is responsible for O&M for this irrigation system, no activities are required because all of the control facilities are malfunctioning, while water management is executed by the farmers themselves at on-farm level. There was no written operation rule and guidelines of reservoir operation including stop log of the culverts, but they were operated by their rules given traditionally through their experiences. When the stoplogs of culvert were operational, the farmers group themselves was responsible for day-to-day operation, which was adjusting the stop log opening height, etc.

**Existing Intake Culvert**

**Table II-1.6.5.2 List of Intake Culverts at Srass Prambai Reservoir**

| No, | Name of Off-taking Canal | Culvert | | Length (m) | Base EL. (m) | Water control facility |
|---|---|---|---|---|---|---|
| | | Box | Pipe | | | |
| 1) | Main Canal 10 | - | Ø 1.2m x 1 | 9.0 | 4.46 | Stoplog |
| 2) | Main Canal 11 | - | Ø 1.2m x 1 | 9.0 | 4.49 | Stoplog |
| 3) | Main Canal 12 | - | Ø 1.2m x 1 | 9.0 | 4.59 | Stoplog |
| 4) | Main Canal 13 | - | Ø 1.2m x 1 | 9.0 | 4.04 | Stoplog |
| 5) | Main Canal 14 | - | Ø 0.6m x 2 | 9.0 | 4.00 | Stoplog |
| 6) | Main Canal 14.5 | - | Ø 0.6m x 2 | 9.0 | 4.03 | Stoplog |
| 7) | Main Canal 12(South) | 1.0 m x 1.5 m | - | 5.0 | 4.60 | Stoplog |

*Remarks : Elevation is surveyed from local bench mark*

*Source: JICA Survey Team based on the inventory survey in January 2012*

(c) Main and Secondary Canals

The Pol Pot grid canal system was constructed according to latitude and longitude direction, with the concept that their access to water was shortened, and the gravity irrigation was not premised. Most of farm lands are irrigated subject to the operation of small portable pumps owned by the farmers themselves. The main and secondary canals in the system are summarized in Table II-1.6.5.3 below.

**Main canal**

**Table II-1.6.5.3 List of Canals in Srass Prambai Irrigation System**

| Name of Canal | Length (km) | Structure and Remarks |
|---|---|---|
| Main Canal 9 | 4.47 | - No structure |
| Main Canal 10 | 4.36 | - Intake culvert Ø 1.2m at reservoir dike<br>- Pipe culvert at 500 m from intake |
| Main Canal 11 | 4.21 | - Intake culvert Ø 1.2m at reservoir dike |
| Main Canal 12 | 4.28 | - Intake culvert Ø 1.2m at reservoir dike |
| Main Canal 13 | 4.30 | - Intake culvert Ø 1.2m at reservoir dike |
| Main Canal 14 | 4.28 | - Intake culvert (Double line) Ø 0.6m at reservoir dike |
| Main Canal 14.5 | 4.27 | - Intake culvert (Double line) Ø 0.6m at reservoir dike |
| Main Canal 39 | 8.64 | - No structure |
| Main Canal 40 | 8.67 | - No structure |
| Main Canal 41 | 8.89 | - No structure |
| Main Canal 42 | 8.97 | - No structure |
| Main Canal 12(South) | 1.0 | - Intake culvert ( Box culvert ) at reservoir dike |
| Secondary Canal 9.5 | 4.52 | - No structure |
| Secondary Canal 10.5 | 4.43 | - No structure |
| Secondary Canal 11.5 | 4.25 | - No structure |
| Secondary Canal 12.5 | 4.26 | - No structure |
| Secondary Canal 13.5 | 4.3 | - No structure |
| Secondary Canal 38.5 | 8.6 | - No structure |
| Secondary Canal 39.5 | 8.88 | - No structure |
| Secondary Canal 40.5 | 9.12 | - No structure |
| Secondary Canal 941.5 | 8.84 | - No structure |

*Source: JICA Survey Team based on the inventory survey in January 2012*

In principle, no structure was constructed on the Pol Pot Gird Canal system. At present, only one structure on the canal system is observed, which is a pipe culvert with a diameter of 0.5 m on Main Canal No.10 at 500 meters from the beginning point, installed by farmers themselves.

The canal grid, as well as the reservoir, is also utilized for fishery activities and transportation by water for the local peoples

(d) Tertiary Canal System and Drainage

In this system, drainage conditions are fully depending on the flood inundation from the Bassac and the Mekong Rivers and its recession water level. In the dry season, the water level is gradually reduced and the lands are dried accordingly, although the some areas remain wet and swampy.

## II-1.7 Daun Pue Irrigation System Rehabilitation Sub-project

### II-1.7.1 Location and Administration

The Daun Pue Irrigation System is located in the upstream of the Stung Chieb River Basin, about 40 km from its confluence with the Tonle Sap River. The irrigation command area lies in the left bank of the Chieb River and along the provincial road, having long and narrow shape extending from west to east as shown in the location map. Administratively, the area lies in Chieb, Khlong Porpork and Aphivath Communes in Teuk Phos District.

### II-1.7.2 Meteorology and Hydrology

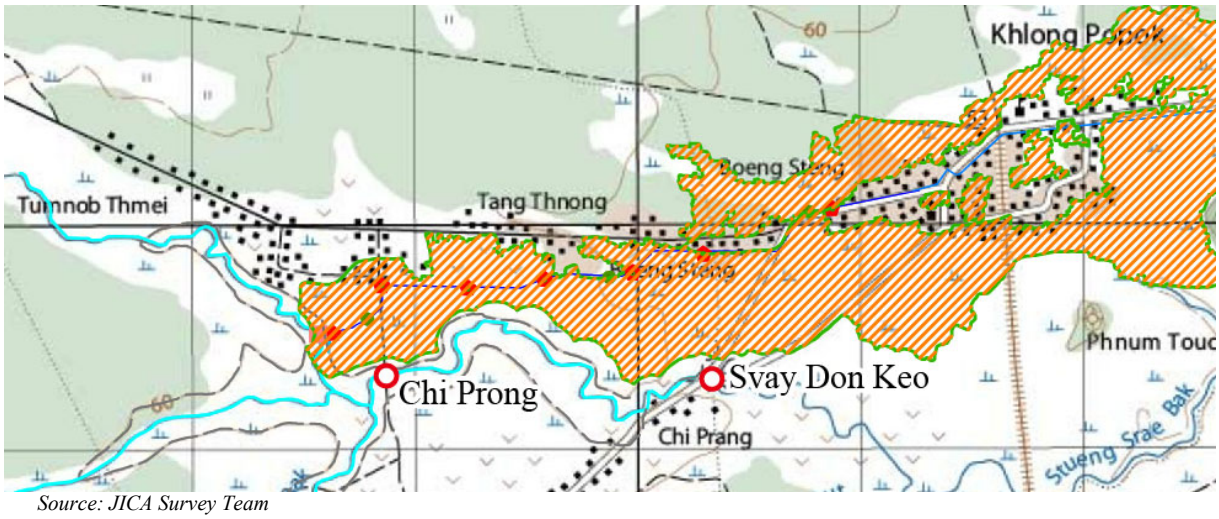
#### II-1.7.2.1 Meteorology

There are no meteorological stations in the DPISRSP Area. Thus, the meteorological data recorded at Pochentong, Phnom Penh, which is shown in Table II-1.2.2.1.1, is used for estimate of crop water requirement.

### II-1.7.2.2 Hydrology

(1) Water Level and Discharge Observation

The DPISRSP Area belongs in the Stung Srae Bak River Basin. There are 2 water level and discharge gauging stations in the Stung Srae Bak River as shown in Figure II-1.7.2.2.1. The Chi Prong water level gauging station is located near the proposed intake site of DPISRSP and the water level observation period is available from March, 2007 to December, 2009.




*Source: JICA Survey Team*

**Figure II-1.7.2.2.1 Location of Water Level Gauging Station at Stung Srae Bak River**

(2) River Systems

The Stung Srae Bak River has a tributary named the Stung Chieb River, and these rivers to join at just upstream of Chi Prong water level gauging station. The proposed intake site of DPISRSP is located at just upstream of this confluence point. The catchment area of the Stung Srae Bak River and the Stung Chieb River is 118.8 $km^2$ and 225.1 $km^2$, respectively. Total catchment area at Chi Prong water level gauging station is 344 $km^2$.

The Stung Chieb River (north river) flows from west to east and the peak of basin is Mount Phnum Chry Miu at elevation of 1,597 m. Western part of the Stung Chieb River basin is steep, but most of middle to downstream part of slope is comparatively flat. In this reason, most floods will was inundated at near the confluence. Total length of the Stung Chieb River up to confluence point is 53.2 km.

The Stung Srae Bak River (south river) flows from southwest to northeast and the peak of basin is Mount Phnum Chrey Miu at elevation of 1,129 m. Western part of the Srae Bak River Basin is also steep, but most of middle to downstream part of slope is comparatively flat. Total length of the Stung Srae Bak River up to confluence point is 33.1 km.

(2) Average Depth of Rainfall over Area

Long-term daily basin rainfall from 1982 to 2011 (30 years) was estimated using the Thiessen coefficients and observed and interpolated daily rainfall data. Estimated monthly basin mean rainfall at Chi Prong water level gauging station is shown in Table II-1.7.2.2.1. The average rainfall over area ranges from 911 mm/year to 1,760 mm/year.

**Table II-1.7.2.2.1 Estimated Basin Mean Rainfall at Chi Prong Water Level Station**

(Unit: mm)

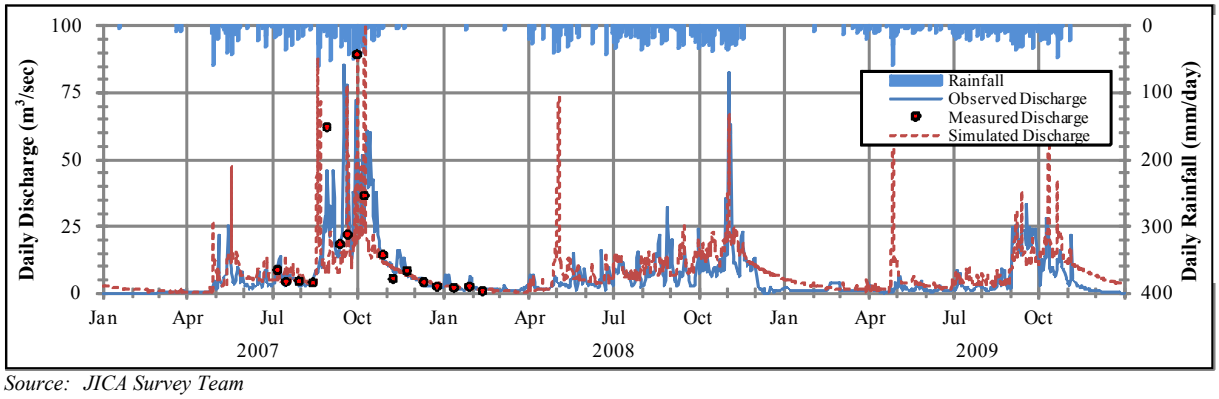
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 5.1 | 5.8 | 30.8 | 75.7 | 136.7 | 125.7 | 157.0 | 189.1 | 269.8 | 219.8 | 84.4 | 18.3 | 1,318 |
| Maximum | 40.3 | 63.7 | 172.5 | 182.1 | 293.9 | 244.4 | 309.3 | 302.2 | 405.2 | 417.5 | 229.7 | 148.0 | 1,760 |
| Minimum | 0.0 | 0.0 | 0.0 | 0.0 | 33.9 | 41.5 | 70.6 | 80.5 | 151.5 | 38.3 | 1.6 | 0.0 | 911 |

*Source: JICA Survey Team (based on Rainfall Data from MOWRAM)*
*Note: Average in the period from 1982 to 2010*

(3) Hydrological Analysis

As described above, daily observed water level at Chi Prong gauging station is available only 3 years from March 2007 to December 2009. Thus, in this Survey, using the observed daily water level and H-Q rating curve at Chi Prong gauging station, long-term discharge was estimated by Tank Model for analysis of water balance study.

For water balance study, long-term daily discharge for 20 years from 1992 to 2011 was prepared. Missing periods from January 1992 to February 2006 and from January 2010 to December 2011 are estimated using the tank model. The model parameters of the daily tank model are calibrated using observed daily discharge at Chi Prong from 2007 to 2009. Figure II-1.7.2.2.2 shows comparison of observed daily discharge and estimated daily discharge by the tank model at Chi Prong. There are some differences between observed and estimated discharge by the tank model, however, most of trends of hydrographs are well fitted to the observed and estimated discharge.




*Source: JICA Survey Team*

**Figure II-1.7.2.2.2 Validity of Runoff Analysis Model at Chi Prong on Stung Srae Bak River**

After estimation of daily discharge at Chi Prong by the tank model, 5 days mean discharge was prepared for water balance study. With estimated and observed 5days mean discharge at Chi Prong, 5 days mean discharge at proposed intake site at the Stung Chieb River are estimated using catchment area and annual rainfall as shown in below.

**Table II-1.7.2.2.2 Monthly Discharge at Chi Prong on Stung Srae Bak River (20 years of 1992 to 2011)**

(Unit: $m^3$/sec)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 2.64 | 1.57 | 1.66 | 1.92 | 4.60 | 4.56 | 6.30 | 8.80 | 15.25 | 16.77 | 9.47 | 4.58 | 6.45 |
| Maximum | 6.39 | 4.70 | 9.44 | 7.96 | 18.40 | 9.50 | 29.44 | 17.95 | 41.43 | 46.20 | 26.81 | 11.23 | 9.20 |
| Minimum | 0.56 | 0.39 | 0.00 | 0.16 | 0.39 | 0.23 | 1.36 | 1.58 | 6.71 | 4.09 | 1.53 | 0.32 | 3.70 |

*Source: JICA Survey Team*

(4) Flood Discharge at Reservoirs

No observe flood data are available for the DPISRSP Area, flood discharges at proposed intake sites were estimated using 3 methods: (i) IRS method, (ii) unit hydrograph method and (iii) rational formula method. Among these methods, the unit hydrograph method was selected for estimation of flood of the DPISRSP Area in the Survey. The calculation results are summarized in Table II-1.7.2.2.3.

**Table II-1.7.2.2.3 Estimated Flood Discharge by Unit Hydrograph Method (DPISRSP)**

| Proposed Intake Site | Catchment Area ($km^2$) | Flood Peak Discharge ($m^3$/sec) | | | | |
|---|---|---|---|---|---|---|
| | | 10 years | 20 years | 50 years | 100 years | 200 years |
| Stung Chieb (Stung Oukhley) | 255.1 | 129 | 173 | 236 | 287 | 342 |
| Confluence of St. Chieb & St. Srae Bak River | 92.6 | 209 | 279 | 377 | 456 | 540 |

*Source: JICA Survey Team*

## II-1.7.3 Socio-economy

(1) Poverty

As shown in the following table, poverty rate in Kampong Chhnang Province is 30.4% in 2010, which is higher than the average (25.8%) of the whole country, so serious poverty situation is still shown in the province. Furthermore the table also illustrates a continuing downward trend in poverty.

**Table II-1.7.3.1 Poverty Rate by Regions (DPISRSP)** (Unit:%)

| Region | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Phnom Penh | 6.8 | 6.9 | 5.8 | 0.5 | 0.3 | 0.2 | 0.1 |
| Kampong Chhnang | 37.9 | 37.2 | 36.7 | 35.6 | 34.2 | 32.3 | 30.4 |
| Cambodia | 35.1 | 34.2 | 32.9 | 30.7 | 29.3 | 27.4 | 25.8 |

*Source: Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

(2) Demographic Conditions

General characteristics of farm HHs in the related communes are shown below.

**Table II-1.7.3.2 General Characteristics of Farm Households in DPISRSP**

| Related Communes | Total Population (person) | Total No of HH (nos.) | Average Family Size (person) | Working-age Population (person) | Literacy Rate (%) |
|---|---|---|---|---|---|
| (a) Chaong Maong | 6,083 | 1,309 | 4.7 | 3,695 | 72.8 |
| (b) Chieb | 6,706 | 1,419 | 4.7 | 3,728 | 70.9 |
| (c) Khlong Popok | 5,459 | 1,247 | 4.4 | 3,383 | 78.4 |
| (d) Akohivoadth | 8,703 | 1,829 | 4.7 | 5,253 | 68.4 |
| (e) Tang Krasang | 8,080 | 1,970 | 4.1 | 4,857 | 67.8 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(3) Living Conditions

(a) Water for Drinking

Major sources for drinking water are wells including tube well and dug well and spring/river as well.

**Table II-1.7.3.3 Sources of Drinking Water in DPISRSP**

| Related Communes | Type of Sources | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PW | TPW | DW | Rain | Sp/Ri | Bought | Others | Total |
| (a) Chaong Maong | 24 | 628 | 544 | 0 | 111 | 0 | 2 | 1,309 |
| (b) Chieb | 40 | 837 | 328 | 11 | 200 | 0 | 3 | 1,419 |
| (c) Khlong Popok | 11 | 1,063 | 131 | 1 | 39 | 0 | 2 | 1,247 |
| (d) Akohivoadth | 25 | 1,129 | 498 | 53 | 38 | 14 | 72 | 1,829 |
| (e) Tang Krasang | 21 | 1,222 | 368 | 1 | 253 | 0 | 105 | 1,970 |

*Note: PW: Piped water , TPW: Tube pipe well, DW: Dug well, SP/Ri: Spring/River*
*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(b) Type of Fuel for Cooking

Major fuel for cooking is firewood. Firewood is available in market, while gathering firewood from surrounding area of farmers' houses is also common.

**Table II-1.7.3.4 Sources of Fuel for Cooking in DPISRSP**

| Related Communes | Type of Sources | | | | | |
|---|---|---|---|---|---|---|
| | Firewood | Charcoal | Gas Cylinder | Electricity | Others | Total |
| (a) Chaong Maong | 1,301 | 2 | 2 | 0 | 4 | 1,309 |
| (b) Chieb | 1,403 | 3 | 3 | 0 | 10 | 1,419 |
| (c) Khlong Popok | 1,228 | 12 | 6 | 0 | 1 | 1,247 |
| (d) Akohivoadth | 1,652 | 146 | 15 | 0 | 16 | 1,829 |
| (e) Tang Krasang | 1,953 | 4 | 7 | 0 | 6 | 1,970 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

(c) Type of Sources for Lighting

As shown in the following table, source of lighting in and around the Sub-project Area is obviously kerosene.

**Table II-1.7.3.5 Sources of Lighting in DPISRSP**

| Related Communes | Sources of Lighting | | | | | | |
|---|---|---|---|---|---|---|---|
| | City Power | Generator | Kerosene | Candle | Battery | Others | Total |
| (a) Chaong Maong | 4 | 7 | 1,152 | 0 | 144 | 2 | 1,309 |
| (b) Chieb | 17 | 5 | 1,021 | 1 | 372 | 3 | 1,419 |
| (c) Khlong Popok | 11 | 7 | 918 | 0 | 310 | 1 | 1,247 |
| (d) Akohivoadth | 24 | 425 | 1,190 | 1 | 182 | 7 | 1,829 |
| (e) Tang Krasang | 50 | 6 | 1,551 | 0 | 361 | 2 | 1,970 |

*Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning*

## II-1.7.4 Agriculture

(1) Land Use in Sub-project Area

Total area of the Sub-project Area is estimated at around 1,210 ha. The whole area is categorized as paddy filed. Out of 1,210 ha, 1,060 ha is rainfed paddy fields, while the remaining area of 150 ha is irrigated paddy fields with supplementary irrigation.

**Table II-1.7.4.1 Land Use in DPISRSP** (Unit: ha)

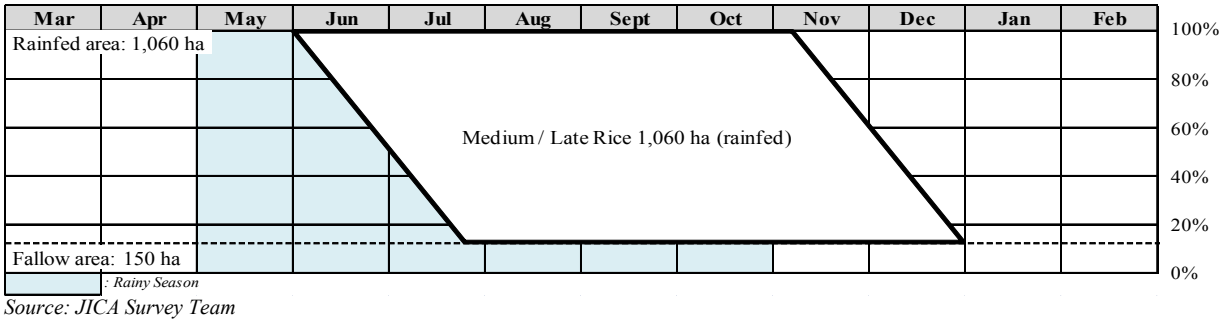
| Land Use | | Physical Land | Cultivated Area | | | | |
|---|---|---|---|---|---|---|---|
| | | | Paddy by Seasons | | | Upland Crops | Total |
| | | | Dry | Early Rainy | Rainy | | |
| Irrigated Paddy Field | Low Land | 150 | - | - | 150 | - | 150 |
| | Recession Area | - | - | - | - | - | 0 |
| Rainfed Paddy Field | | 1,060 | - | - | 1,060 | - | 1,060 |
| Upland Field | | - | - | - | - | - | 0 |
| Non-agricultural Land | | - | - | - | - | - | 0 |
| Total | | 1,210 | 0 | 0 | 1,210 | 0 | 1,210 |
| Cropping Intensity (%) | | | | | | | 100 |

*Source: JICA Survey Team*

(2) Paddy Cultivation in Sub-project Area

Paddy cultivation in this Sub-project is carried out only during rainy season due to shortage of river water as well as rainfall.

Rainy season cropping is mainly from June to December. Medium rice is mainly cultivated under rainfed condition, while paddy cultivation with supplementary irrigation is also carried out in the so limited area near the temporary river intake. However double cropping of paddy is not available due to shortage of river water. Present cropping pattern is shown as follows:




*Source: JICA Survey Team*

**Figure II-1.7.4.1 Present Cropping Pattern for DPISRSP**

Harvested paddy is normally threshed at farmers' home yard, and then sold to traders, while some farmers directly sell their products to rice millers at Kampong Chhnang, which is the capital of the province. Rice millers are selling milled rice at Kampong Chhnang as well as Phnom Penh.

### II-1.7.5 Irrigation and Drainage

(1) General

The Daun Pue Irrigation System was constructed in the Pol Pot regime (1975-1977) for targeting water supply from the Stung Chieb River to its command area of about 1,400 ha in Teuk Phos District in Kampong Chhnang Province. The intake of the system was constructed in the upstream of the Stung Chieb River basin, about 40 km upstream from its confluence with the Tonle Sap River. The irrigation command area lies in the left bank of the Stung Chieb River and along the provincial road, having long and narrow shape extending from west to east with gentle slope as shown in the location map in Figure II-1.7.5.1.

When it was originally constructed in Pol Pot regime, this irrigation area consisted of 2 systems: one was commanded by the existing intake and the other was irrigated by the headworks constructed at Chiprong Village. The Chiprong headworks was however totally damaged by flood and hence no more used. The area that was irrigated by the Chiprong headworks have been included in the existing Daun Pue Irrigation System by additional canals and using natural stream connecting with Daun Pue canal network. The existing Daun Pue Irrigation System has been seriously deteriorated, and only limited parts near the main canal are currently provided with supplementary irrigation in the rainy season.

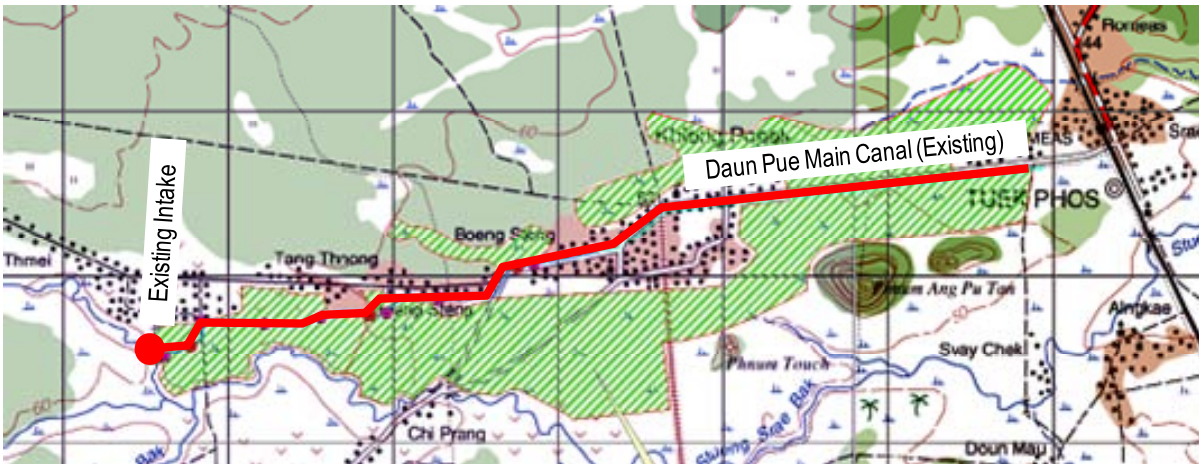



**Figure II-1.7.5.1 General Layout of Daun Pue Irrigation System**

(2) Existing Irrigation System

The command area of Daun Pue Irrigation System is reported by PDOWRAM to be 1,151 ha in total, extending on the left bank of the Chieb River. The sole water source is the Chieb River, having catchment area of 225 km$^2$ at the existing intake site.

**Existing Temporary Headworks**

The Daun Pue Iirrigation System consists of temporary headworks and main and secondary canals, which has originally poorly designed and constructed facilities. The intake has no permanent structure, and a temporary low diversion weir was constructed manually by the farmers with wooden material and sand bags. The general features of Daun Pue Irrigation System are summarized as below.

**Table II-1.7.5.1 General Features of Daun Pue Irrigation System**

| Item | Features |
|---|---|
| Water source | Chieb River |
| Command area | 1,150 ha |
| Headworks | Temporary weir constructed by farmers with wooden material and sand bags.<br>Length : 45 m, approx<br>Height : 0.5 - 1.0 m, approx<br>Intake has no permanent structure |
| Main and secondary canals | Main canal: 1 no. Length : 11.5 km<br>Secondary canal:14 nos. Length : 22.9 km |
| Tertiary canal system and drainage | No tertiary canal system and no drainage system |

*Source: JICA Survey Team*

(3) Main and Secondary Canals

The Daun Pue Main Canal starts at the intake site on the left bank of the river and runs eastward to the end point near Tuek Phos Village. In the lower part of the main canal, the Pol Pot grid canal system is found, which is however not functioning due to the wrong selection of canal route and poor hydraulic designs of the canal system. The canals are generally shallow, eroded and buried with the sediment deposit transported from the intake during the flood regime at many parts of the canals.

**Existing Main Canal and Culvert**

On the main canal, check structures and off-taking structures are quite limited, and most off-taking canals are diverted without permanent facilities. Only a few water control structures are found on the canal. All related structures have malfunctioning due to deterioration or loss of gates, erosion of surrounding slopes, etc., which mostly requires reconstruction. Pipe culverts were provided to cross the roads, and additionally constructed by the villagers for crossing the canal to approach their residential place, which are uncontrolled by PDOWRAM. According to the inventory and topographic survey by the JICA Survey Team in 2012, the most canal sections are not sufficiently designed, constructed and maintained causing much less capacity enough to flow the irrigation water to the fields. Furthermore, sample topographic survey of secondary canals by the JICA Survey Team indicated that some secondary canals run to inverse draft from lower to higher lands, especially secondary canals in the right bank in the downstream reach of the main canal. Some canal routes in the left bank of the main canal might be utilized by re-excavation of the canal sections and/or raising of the canal banks.

**Existing Secondary Canal**

**Table II-1.7.5.2 Summary of Canals and Structures on Main and Secondary Canals in DPISRSP**

| Item | Quantity | Item | Quantity |
|---|---|---|---|
| (a) Main canal<br>Nos. and total length | 1 no.<br>11.5 km | Secondary canals<br>Total length | 14 nos.<br>22.9 km |
| Main canal related structures | | Secondary canal related structures | |
| (a) Check structure | 2 nos. | (a) Pipe culvert | 7 nos. |
| (b) Box culvert | 7 nos. | | |
| (c) Pipe culvert | 6 nos. | | |
| (d) Pipe culvert (for access to house) | 34 nos. | | |
| (e) Bridge | 6 nos. | | |

*Source: Inventory Survey by JICA Survey Team*

The canals in this system, originally developed during Pol Pot regime, have the following fundamental problems and issues.

(a) The target area was demarcated without water balance study, and therefore the canal network covered the existing land resource more than the irrigable area with certain dependability (80%) that should be determined based on the available water source.
(b) The Pol Pot grid canal system was constructed according to latitude and longitude direction, with the concept that their access to water was shortened, and the gravity irrigation was not premised. Most of farm lands are irrigated subject to the operation of small portable pumps owned by the farmers themselves. In many cases, the canal runs to inverse draft causing water not flowing.
(c) The canal route was determined without considering topological situations therefore canals were excavated inverse draft in many cases, which prevents water flow.
(d) The canals and related structures were not adequately designed in engineering sense based on hydraulic and structural calculations, which caused malfunction of facilities in many cases, such as submerged overflow, insufficient capacity of pipe, insufficient protective works at the structures, and so on, causing easy destruction.
(e) The facilities have not been maintained and rehabilitated due to the social ferment in and after the civil war, and hence they have been seriously deteriorated or damaged.

(4) Tertiary Canal and Drainage System

There is neither systematic tertiary irrigation canal nor drain. It seems that only limited area surrounded by the secondary canal grid is irrigated supplementally by field-to-field irrigation only in case that sufficient water head is available by gravity. Otherwise, the water is taken from the main or secondary canals into the fields using small portable pump owned by the farmers. Formation of the tertiary canal system is required to utilize the irrigation water efficiently and timely. Most of the existing canals constructed in Pol Pot regime have double functions of irrigation and drainage.

The small rivers and/or natural streams are utilized as drains to evacuate the excess water from the area. According to the interview to the local people, the upstream areas near the Chieb River are frequently affected or inundated by flood once in a few years.

## II-1.8 Institutions Concerned for Project Implementation

### II-1.8.1 Ministry of Water Resources and Meteorology

(1) Demarcation of role and responsibility of Ministry of Water Resources and Meteorology and Provincial Department of Water Resources and Meteorology

Basic demarcation of role and responsibility of MOWRAM and PDOWRAM for irrigation development and O&M as well as organization for FWUC s is as shown below.

**Table II-1.8.1.1 Demarcation of Roles and Responsibilities**

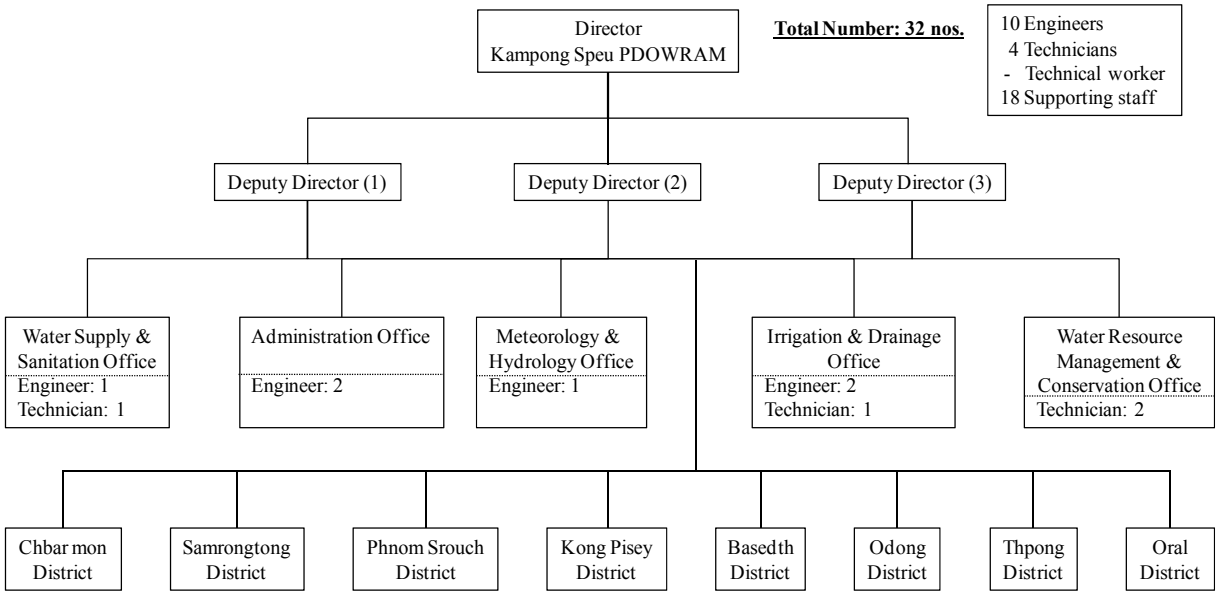
| Activity | Small scale (up to 200 ha) | Medium scale (200 ha to 5,000 ha) | Large scale (Above 5,000 ha) |
|---|---|---|---|
| Planning and Survey | PDOWRAM | MOWRAM & PDOWRAM | MOWRAM & PDOWRAM |
| Construction and Repair | FWUC | MOWRAM & PDOWRAM | MOWRAM |
| O&M | FWUC | PDOWRAM & FWUC | MOWRAM & FUWC |
| Formation of FWUCs | PDOWRAM | MOWRAM & PDOWRAM | MOWRAM |

*Source: JICA Survey Team*

MOWRAM involves development and rehabilitation as well as formation of FWUCs in medium or large-scale development program, while PDOWRAM deals mainly small-scale schemes and minor repairs, as well as O&M of medium of major facilities in medium-scale schemes.

(2) Kampong Speu Provincial Department of Water Resources and Meteorology

Kampong Speu PDOWRAM is located in almost center of the upstream part of the Roleang Chrey Irrigation System, about 10 km from the Roleang Chrey Regulator. PDWORAM has 5 sections of (i) administration and personal, (ii) meteorology and hydrology, (iii) irrigated agriculture, (iv) water resources protection management, and (v) water supply and sanitation, and manages 8 district offices. The staff of the PDOWRAM as of 2011 consists of 1 Chief of Department (Director), 3 Vice-chiefs of Department, 9 technical staff and 19 administrative staff, the total of which are 29 males and 3 females. Organizational structure of Kampong Speu PDOWRAM is illustrated as follows:



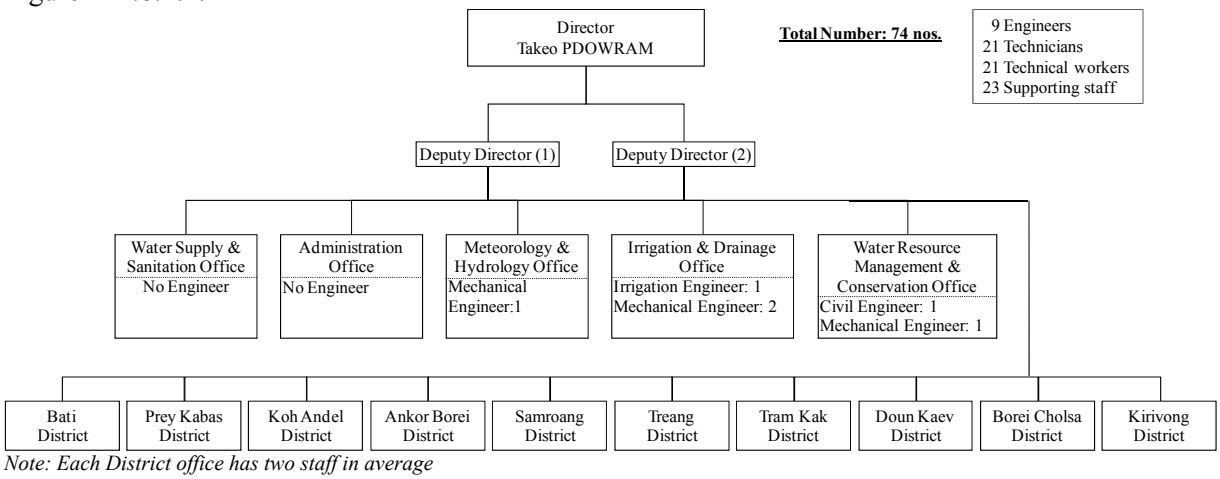

*Source: Kampong Speu PDOWRAM*

**Figure II-1.8.1.1 Organization Structure of Kampong Speu PDOWRAM**

Major technical missions of the provincial department are to (i) prepare development plans, (ii) research and observe natural disasters, (iii) collect meteorological and hydrological data, (iv) implement O&M of irrigation systems, (v) organize and train FWUC, and (vi) study, plan, design and construct small scale projects.

(3) Takeo Provincial Department of Water Resources and Meteorology

Takeo PDOWRAM headed by the Director, has 5 sectional offices and 10 district offices as shown in Figure II-1.8.1.2.




*Note: Each District office has two staff in average*
*Source: Takeo PDOWRAM*

**Figure II-1.8.1.2 Organization Structure of Takeo PDOWRAM**

Five offices are (i) Irrigation and drainage office mainly for maintenance of the existing irrigation facilities, (ii) Water supply office for checking water quality and resources for domestic water supply, (iii) Hydrology and meteorology office for observing and recording the concerned data, (iv) Water resources management office for solving conflicts about water and (v) Administration sections.

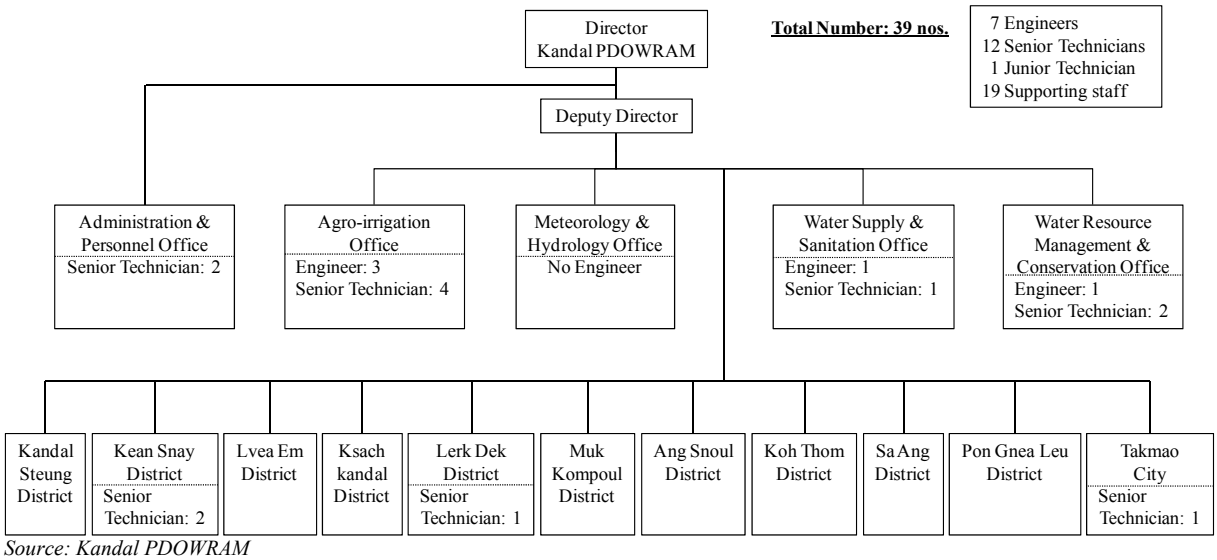
Due to lack of fund for rehabilitation and construction of irrigation facilities, the maintenance works have been stagnated. According to the information from PDOWRAM, the annual work budge has been provided by the provincial government.

Ninety four reservoirs exist in Takeo Province, which are to be maintained by Takeo PDOWRAM, only half of them are functional at present. Available equipment for O&M is one excavator and one operation vehicle (one set of heavy equipment such as bulldozer, backhoe, grader, roller will become available in August 2011 through grant of Japan). Only one full set of meteorological equipment is available at Takeo, and 10 rainfall stations at the district offices are operational. Takeo PDOWRAM has the development plan to increase the irrigation area within the province from 85,000 ha in the rainy season (50% of total potential area of 170,000 ha) to 136,000 ha (to 80%). However, due to lack of fund and implementation capacity, it is hard to set the clear schedule and program to implement it. Strengthening of capacity on planning, design and construction management as well as support services to FWUCs are urgently needed.

Under such conditions, Takeo PDOWRAM has keen intention to second his staff to the implementation organization of USISRSP in design, construction and strengthening of FWUCs, for grading up his implementation capability. It is noted that Takeo PDOWRAM is confident of clearing the temporary buildings (houses, storages and shops) as well as private bridges /culverts on the canal routes, but this should be confirmed through RAP to be prepared by the Resettlement Unit of MOWRAM. According to the inventory survey made in 2011, there are about 43 buildings within ROW of the canals.

(4) Kandal Provincial Department of Water Resources and Meteorology

Kandal PDOWRAM consists of 5 sections as similar to that in Kampong Speu PDOWRAM: (i) administration & personnel, (ii) irrigated-agriculture, (iii) meteorology and hydrology, (iv) water supply and sanitation and (v) water resource management and conservation, under which, in addition, there are 11 district offices. Organizational structure of Kandal PDOWRAM is depicted as follows:



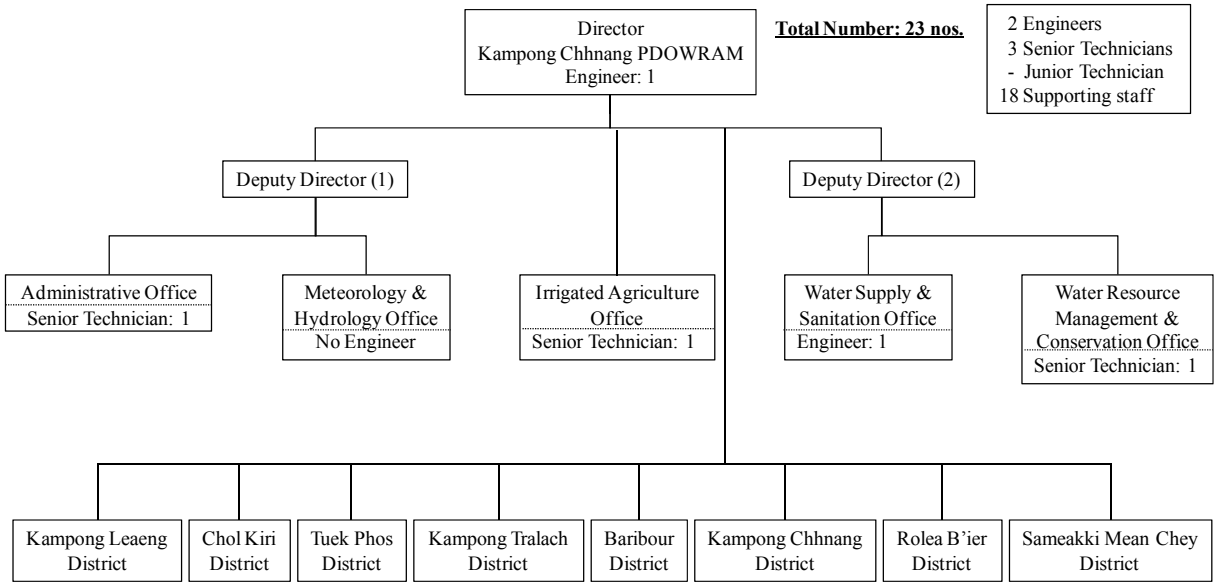

*Source: Kandal PDOWRAM*

**Figure II-1.8.1.3 Organization Structure of Kandal PDOWRAM**

There are 40 numbers of staff, out of which 7 staff are categorized as engineer. Insufficiency of district level staff would be one of the issues as there are no staff allocated to Pon Gnea Leu District.

(5) Kampong Chhnang Provincial Department of Water Resources and Meteorology

Kampong Chhnang PDOWRAM has also 5 technical and administrative sections consisting of: (i) administration, (ii) meteorology & hydrology, (iii) irrigated agriculture, (iv) water supply & sanitation and (v) water resource management & conservation, under which there are 8 district offices to carry out field level irrigation system support. The number of staff of PDOWRAM as of January 2012 is 23 headed by: (i) one Chief of Department (Director) and 3 Deputy Directors. Its organizational structure is depicted as follows:




*Source: Kampong Chhnang PDOWRAM*

**Figure II-1.8.1.4 Organization Structure of Kampong Chhnang PDOWRAM**

(6) Annual Budget for Related 4 POWRAMs

The total number of each PDOWRAM including district office ranges from 3 to 74 as of March 2011. The annual budgets of PDOWRAMs relevant to SPPIDRIP consisting of: (i) Kampong Speu, (ii) Kandal, (iii) Takeo and (iv) Kampong Chhnang are tabulated as follows:

**Table II-1.8.1.2 Annual Budgets of 4 PDOWRAMs**

| PDOWRAM | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ |
| Kampong Speu | 278 | 68 | 575 | 140 | 501 | 122 | 553 | 135 | 509 | 124 |
| Kandal | 323 | 79 | 346 | 84 | 458 | 111 | 522 | 127 | 484 | 118 |
| Takeo | 395 | 96 | 529 | 129 | 770 | 187 | 918 | 223 | 904 | 220 |
| Kampong Chhnang | 327 | 80 | 199 | 48 | 215 | 52 | 416 | 101 | 409 | 100 |

**: 1US$= 4,109 Riel*

*Source: each PDOWRAM*

As can be seen in the above table, there is no definite tendency in budget amount change. It might depend upon the implementation of new project (s).

### II-1.8.2 Ministry of Agriculture, Forestry and Fisheries

Among a number of the departments of MAFF (see Figure I-3.2.1), Departments of Agriculture Extension (DAE) and Department of Rice Crops are the agencies responsible for agricultural support services related with the implementation of SPPIDRIP. In practical, DAE is a central agency mandated

for extension services, farming system development and FOs. The Cambodian Agricultural Research and Development Institute (CARDI) is placed under the jurisdiction of MAFF as one of the public institutions. The provincial level agricultural agency of PDA is technically and financially under the jurisdiction of MAFF.

PDA is a provincial level agricultural agency belonging to MAFF and is responsible for agricultural development and provision of agricultural support services at the provincial, district, commune and village levels. Organization structures of 4 PDAs of Kampong Speu, Kandal, Takeo, and Kampong Chhnang are shown in Figures II-1.8.2.1 to 4 respectively. The number of staff including district level staffs in 3 PDAs of Kampong Speu, Kandal, Takeo, and Kampong Chhnang Provinces are 248, 192, 170, and 107, respectively.

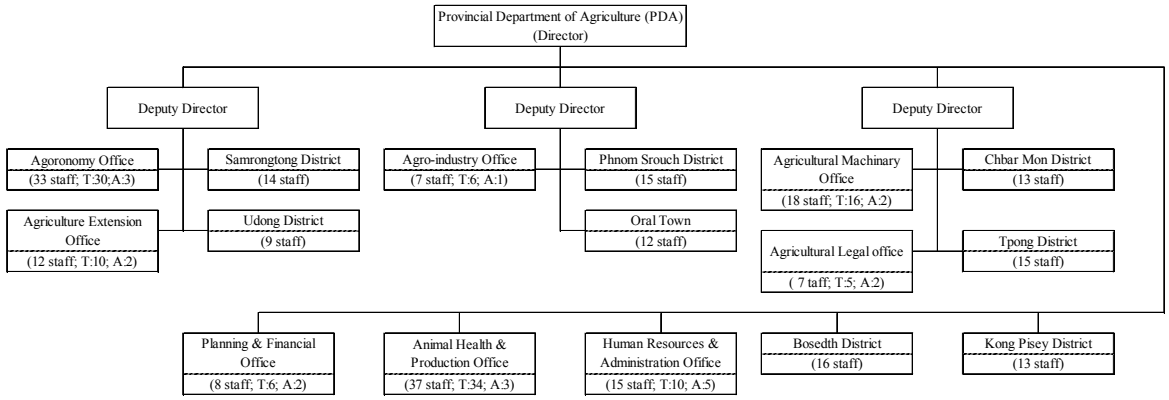
The major duties related functions of the Agronomy Office of PDA include technology development, seed production and plant protection and the major duties related functions of the Extension Office are provision of extension services and human resources development. Presently, PDA activities are not well mainly because of limited budget.

The following DAOs, branch offices of each PDA, are deployed in the Sub-project Area.

**Table II-1.8.2.1 Related DAOs in Sub-project Area**

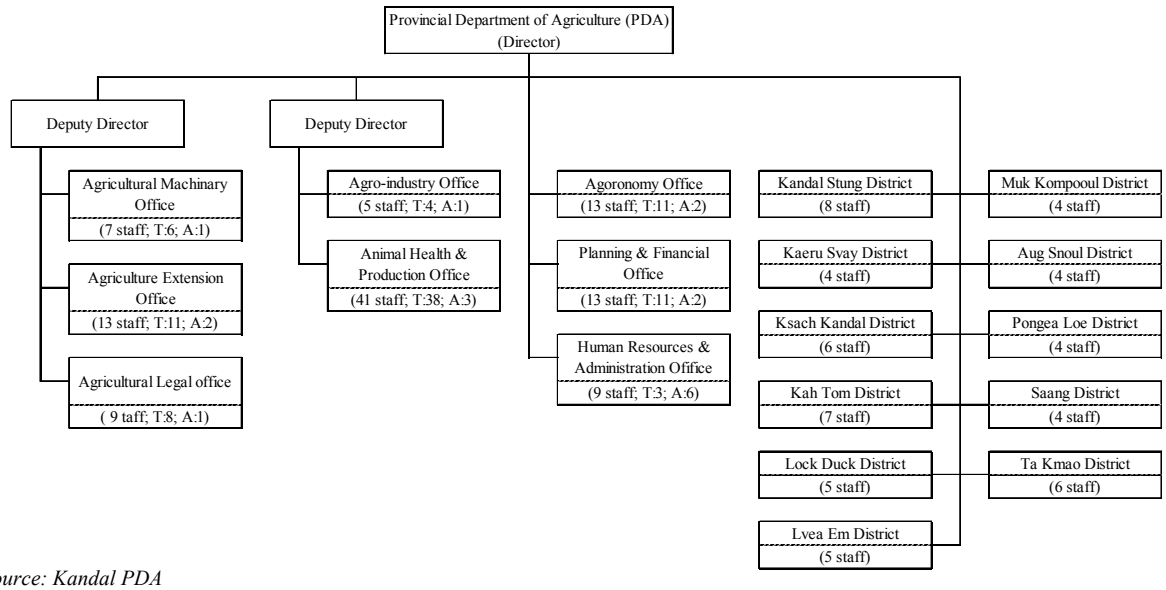
| Kampong Speu | | | Kandal | | | Takeo | | | Kampong Chhnang | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DAO | Nos. of Staffs | | DAO | Nos. of Staffs | | DAO | Nos. of Staffs | | DAO | Nos. of Staffs | |
| | Before* | Now** | | Before* | Now** | | Before* | Now** | | Before* | Now** |
| Chbar Mon | 10 | 13 | Kandal Stung | 10 | 8 | Tram Kak | No data | 8 | Tuek Phos | No data | 2 |
| Samraong Tong | 11 | 14 | Angk Snuol | 11 | 4 | Bati | No data | 7 | | | |
| Kong Pisei | 11 | 13 | Khao Thum | No data | 7 | | | | | | |
| Basedth | No data | 16 | | | | | | | | | |

*Before: At the time of the previous study
**Now: As of February 2012
Source: each PDA



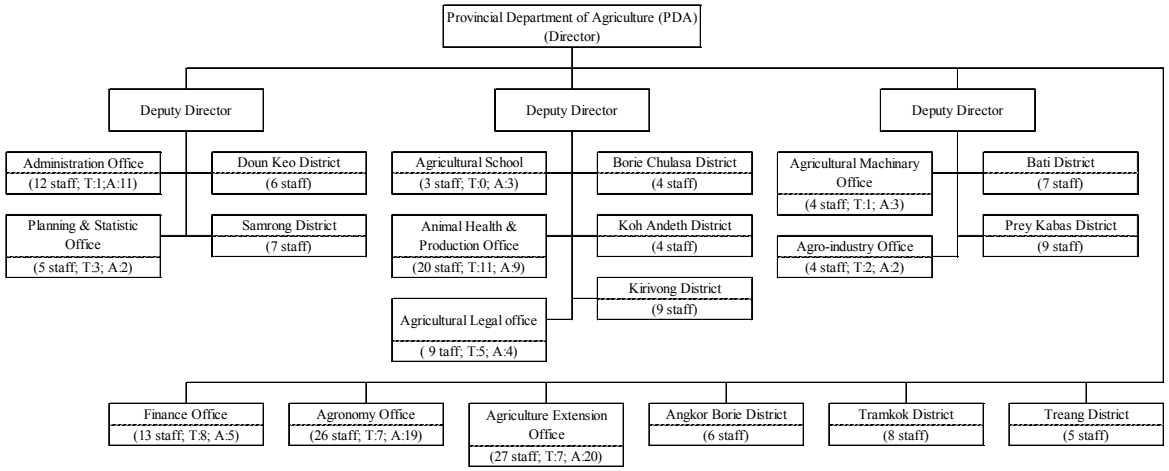

Source: Kampong Speu PDA

**Figure II-1.8.2.1 Organization Structure of Kampong Speu PDA**



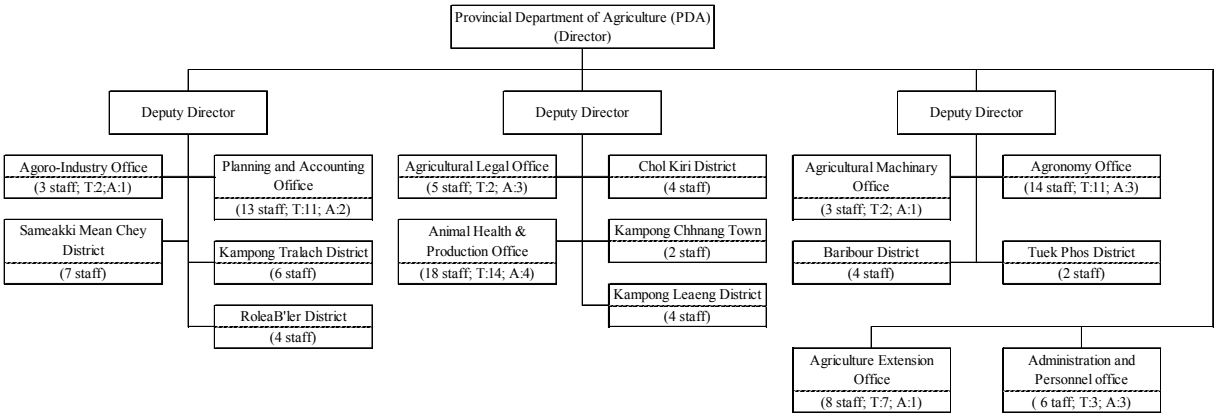

*Source: Kandal PDA*

**Figure II-1.8.2.2 Organization Structure of Kandal PDA**




*Source: Takeo PDA*

**Figure II-1.8.2.3 Organization Structure of Takeo PDA**




*Source: Kampong Chhnang PDA*

**Figure II-1.8.2.4 Organization Structure of Kampong Chhnang PDA**

The annual budgets of Kampong Speu, Kandal, Takeo and Kampong Chhnang PDAs are as follows:

**Table II-1.8.2.2 Annual Budgets of 4 PDAs**

| PDA | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ | $10^6$ Riel | $10^3$US$ |
| Kampong Speu | 1,135 | 278 | 1,367 | 335 | 1,776 | 435 | 2,077 | 509 | 2,228 | 546 |
| Takeo | 1,012 | 248 | 1,033 | 253 | 1,220 | 299 | 1,436 | 352 | 1,407 | 345 |
| Kandal | 1,225 | 300 | 1,283 | 314 | 1,488 | 364 | 1,767 | 433 | 1,812 | 444 |
| Kampong Chhnang | 945 | 231 | 997 | 244 | 1,211 | 297 | 1,235 | 302 | 1,168 | 286 |

*Note: *: 1US$=4,084Riel (November 2011)*
*Source: Department of Accounting and Finance, MAFF, 2012*

### II-1.8.3 Farmer Water Users Community

(1) Roleang Chrey Headworks Rehabilitation Sub-project

FWUC was established in accordance with the FWUC statute issued in June 2000. In Kampong Speu and Kandal Provinces, it was reported that 25 FWUCs were established in the area of M/P, but none of them are officially registered. Most of FWUCs are generally inactive, mainly due to lack of functional irrigation systems. This situation has not been changed since the M/P Stage in 2008. In the Roleang Chrey Irrigation System, 6 FWUCs exist as of 2011 as shown in the table below.

**Table II-1.8.3.1 FWUC in Roleang Chrey Irrigation System**

| No. | Community Name | Location | | Nos. of Village | Participated Family No. | Member | | Irrigated Area (ha) |
|---|---|---|---|---|---|---|---|---|
| | | Commune | District | | | Total | Female | |
| 1) | N-6 | Tropaeng Korng | Samraong Tong | 8 | 427 | 2,259 | 1,310 | 148.29 |
| 2) | North Roleang Chrey Main Canal | Tang Kroch, Chbar Mon, Rokarthom,Vor Sor, Tropaeng Korng, Sambo | Chbar Mon and Samraong Tong | 52 | 3,222 | 16,625 | 7,305 | 1,639.00 |
| 3) | South Roleang Chrey main canal | Karheng, Kandorl Dom, Svay Krovan, Roleang Chek, Rolaeng Kreul Sen Dey, Rokar Koh, Veal | Samraong Tong and Kong Pisey | 22 | 2.262 | 10,068 | 8,086 | 1,036.51 |
| 4) | Beung Arch Ka Ek | Rolaeng Chork | Samraong Tong | 12 | 570 | 3,015 | 2,045 | 245.20 |
| 5) | Phum Roung | Svay Kror Van | Chbar Mon | 11 | 439 | 2,402 | 1,329 | 211.19 |
| 6) | O'veng | Ka Heng | Samraong Tong | 23 | 2,432 | 7,036 | 4,382 | 976.00 |
| | Total | | 8 districts | 128 | 9,352 | 41,405 | 24,457 | 4,256.00 |

*Source: Kampong Speu PDOWRAM*

MOWRAM is currently undertaking the nationwide program for formation of FWUC under the FAO EU Food Facility Project[8], in line with the government policy and strategy on FUWC. Under this project, the first stage was completed and the guidelines were prepared, of which the second stage is planned to be implemented by Kampong Speu PDOWRAM.

Meanwhile FO was 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 (VAHWs). According to the report from Kampong Speu and Kandal PDAs, there are 3 agricultural cooperatives in the target area of the M/P Study. One is in Preah Nipean Commune, one is in Prey Nheat Commune, and the last is in Roleang Kruel Commune of Kampong Speu Province. This situation has not been changed since the M/P Stage in 2008. Constraints and needs recognized by FWUCs are summarized as follows:

*8 Refer to FAO EU Food Facility Project, Organization of farmer Water User Communities, June 2011 (in Khmer language)*

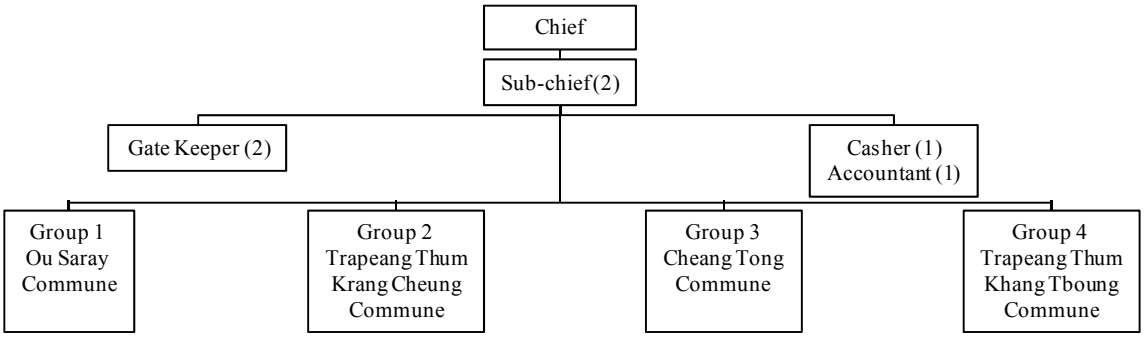
**Table II-1.8.3.2 Constraints and Needs recognized by FWUCs in Kampong Speu Province**

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Hardware Aspect | - Insufficient tertiary canals and those related structures<br>- Deterioration of secondary and tertiary canals and those related structures | - Rehabilitation of secondary canals and those related structures<br>- New development of tertiary canals and those related structures<br>- Construction of FWUC office | - O&M of irrigation facilities<br>- Water management<br>- Administrative management for the group<br>- Conflict management among group members<br>- Awareness raising of the group members<br>- Leadership training<br>- Farming techniques (rice and other crops) |
| Software Aspect | - Difficulty in water management due to conflict among member farmers<br>- Insufficient awareness among farmers for the importance of irrigation water<br>- Insufficient farmers' participation in O&M of facilities and water management<br>- Conflict among FWUC members and non-members | - Strengthen organizational capacity as well as individual farmers in O&M of facilities and irrigation water management<br>- Encouragement of farmers to participate in group work<br>- Awareness raising on the importance of irrigation water and O&M of irrigation facilities<br>- Establishment of new group by younger generation | |

*Source: JICA Survey Team based on Field Interview*

(2) Upper Slakou Irrigation System Rehabilitation Sub-project

There were no FWUCs in the USISRSP Area in 2002. However, Kpob Trobek FWUC was established at Ou Saray commune in 2005. Member farmers of this FWUC are counted for around 3,340 HHs, who stay in 4 communes as shown in Figure II-1.8.3.1. In the same year, the Kpob Trobek Reservoir was rehabilitated, hence, in collaboration with Takeo PDOWRAM, this FWUC has carried out management of abstracted water from the reservoir for paddy cultivation. Meanwhile, the F/S Report mentioned that there were no FOs in the USISRSP Area. This situation has not been changed since the F/S Stage in 2002.




*Source: Kpob Trobek FWUC*

**Figure II-1.8.3.1 Organization Structure of Kpob Trobek FWUC**

Major constraints and needs recognized by FWUC are tabulated as follows, which needs to be considered for the implementation of the software components for USISRSP:

**Table II-1.8.3.3 Constraints and Needs recognized by Kpob Trobek FWUC**

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Hardware Aspect | - Deterioration of main and secondary canal systems<br>- Insufficient development of tertiary irrigation systems<br>- Automatic regulating gates (4 nos.) on Kpob Trobek Reservoir not functioning properly | - Rehabilitation of secondary canals and those related structures<br>- New development of tertiary canals and those related structures | - Water management<br>- Administrative management for the group<br>- Financial management<br>- Conflict management |

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Software Aspect | - Insufficient awareness among farmers for the importance of irrigation water and O&M of irrigation system<br>- Difficulty in ISF collection due to insufficient understanding among farmers | - Encouragement of farmers to participate in group work<br>- Awareness raising on the importance of irrigation water and O&M of irrigation | |

*Source: JICA Survey Team based on Field Interview*

(3) Kandal Stung-Bati Irrigation System Rehabilitation Sub-Project

FWUC has not been established in both Kandal Stung Extension Area and Kandal Stung-Bati Area. Instead, farmers have been collaboratively working together for irrigation system O&M through unofficial FG headed by relevant commune chiefs (13 nos.), under which 84 village chiefs are working together, intensively supported by Kandal PDOWRAM after 2 main pumps were installed in 1993. Five numbers of portable pumps, together with diesel for operation, are provided to communes for secondary level water management from MOWRAM.

In fact, however, FG activities are still limited and largely depending upon technical and administrative support from MOWRAM and PDOWRAM in water management and O&M of facilities. Assessments and reviews of farmers' group (FG) activities from the view point of group administration, water management and O&M of irrigation facilities identify the following issues affecting irrigation service and management performance in KSBISRSP.

- Payment of ISF is completely not carried out by farmers at present due to such regulations unprepared as well as insufficient awareness among farmers in importance of irrigation system O&M.
- Member list of farmers of the group would remain incomplete to understand overall activities of the groups.
- FGs in both areas do not clearly understand demarcation of O&M responsibility among MOWRAM, PDOWRAM and FG.
- Members complain of sometimes insufficient and irregular water supply by the operation of main pumps resulting poor agricultural production.
- Canals and facilities maintenance and upkeep are less than the required level, therefore, it is difficult for farmers to be organized and mobilized as groups.

In such conditions, only Chambei commune under Kandal Stung Bati Extension Area is planning to start collection of ISF from the rainy season cropping of 2012.

**Table II-1.8.3.4 Constraints and Needs recognized by Farmers' Groups in KSBISRSP**

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Hardware Aspect | - Deterioration of main and secondary canal systems (e.g. main canal: canal No.59 and 60, and secondary canal: No.81, 83 and 85 particularly pointed out in Kandal Stung Bati Extension Area)<br>- Insufficient development of main canal system (such as: no weir constructed on Stung Touch River to carry out irrigated-agriculture in the extension area)<br>- Insufficient development of tertiary canal systems for all the area | - Rehabilitation of main & secondary canals and those related structures<br>- Development of main canal system in technically feasible manner<br>- New development of tertiary canals and those related structures to carry out effective on-farm level water management | - Group formation support<br>- Basic group management skills<br>- Water management<br>- Administrative management for the group<br>- Financial management<br>- Conflict management including facilitation of collaborative relationship with non-farmer stakeholders |

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Software Aspect | - Insufficient awareness among farmers to carry out water management and O&M of irrigation facilities by themselves at secondary and tertiary canal levels<br>- No group maturity in collection of ISF (not yet collected)<br>- Conflict among farmers and/or between farmers and fishermen on irrigation system O&M | - Encouragement of farmers to participate in group work<br>- Awareness raising on the importance of irrigation water and O&M of irrigation | |

*Source: JICA Survey Team based on Field Interview*

(4) Main Canal 35 Rehabilitation Sub-project

As similar to KSBISRSP, FWUC has not been established in the MC35RSP Area yet while FG is formulated in November 2009 to carry out water management and O&M of irrigation facilities supported by Kampong Speu PDOWRAM. The organization is headed by 1 chairman and 3 vice chairmen (commune chiefs), under which there are 9 villages' chiefs as representative of each village under irrigation system. Since the main canal is highly deteriorated with insufficient permanent water management structures, secondary canal systems have not been developed and FG activities are still limited at present.

Constraints and needs recognized by FG in MC35RSP are summarized as follows, which needs to be considered for the implementation of the software components programs under SPPIDRIP.

**Table II-1.8.3.5 Constraints and Needs recognized by Farmers' Group in MC35RSP**

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Hardware Aspect | - Highly deteriorated facilities overall due to flooding in every rainy season<br>- No permanent water management structures<br>- Insufficient water availability in dry season<br>- Insufficient development of secondary and tertiary canal systems for all the area | - Rehabilitation of appurtenant structures on main reservoir of the system<br>- Rehabilitation of main & secondary canals and those related structures<br>- Development of new reservoir under Main Canal 35 irrigation system<br>- New development of tertiary canals and those related structures for on-farm level water management | - Group formation support<br>- Basic group management skills<br>- Water management<br>- Administrative management for the group<br>- Financial management<br>- Conflict management including facilitation of collaborative relationship with non-farmer stakeholders |
| Software Aspect | - Conflict between up and downstream farmers over water use<br>- No group maturity in collection of ISF (not yet collected) | - Encouragement of farmers to participate in group work<br>- Awareness raising on the importance of irrigation water and O&M of irrigation | |

*Source: JICA Survey Team based on Field Interview*

(5) Srass Prambai Water Recession Rehabilitation Sub-project

FWUC has not been established in the SPWRRSP Area. Instead FG is formulated to be in charge of water management and minor maintenance of reservoir dike and canals with the support of Kandal PDOWRAM. The group is headed by chief (1 no.) and vice-chiefs (2 nos.), under which there are 32 persons as village representatives from villages under irrigation system. According to Kandal PDOWRAM, although no equipment is owned by the group, portable pumps are provided from PDOWRAM to carry out supplemental irrigation on the basis of farmers' request. Fishermen in the reservoir would be also one of the important stakeholders for Srass Prambai System as they regularly pay communes fee of 5,000 - 10,000 Riel/fisherman/year, part of which are utilized for reservoir maintenance.

**Table II-1.8.3.6 Constraints and Needs recognized by Farmers' Group in SPWRRSP**

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Hardware Aspect | - Deterioration of reservoir dyke and appurtenant structures to manage water<br>- Highly deteriorated facilities due to flooding in every wet season<br>- No permanent structures on canal system<br>- Insufficient development of secondary and tertiary canal systems for all the area | - Rehabilitation of reservoir dyke and appurtenant structures including sluice gates as top priority<br>- Rehabilitation of main & secondary canals and those related structures | - Group formation support<br>- Basic group management skills<br>- Water management<br>- Administrative management for the group<br>- Financial management<br>- Conflict management including facilitation of collaborative relationship with non-farmer stakeholders |
| Software Aspect | - Conflict between up and downstream farmers over water use<br>- No group maturity in collection of ISF (not yet collected) | - Encouragement of farmers to participate in group work<br>- Awareness raising on the importance of irrigation water and O&M of irrigation<br>- Development of collaborative relationship between farmers and fishermen | |

*Source: JICA Survey Team based on Field Interview*

(6) Daun Pue Irrigation Rehabilitation Sub-project

FWUC has not been established in the area of DPISRSP while informal FG was established in 2007 headed by the chief of Chieb Commune. Under the chief of the group, one vice chairman and 13 village representatives together carry out group works necessary for O&M of irrigation system with the support of Kampong Chhnang PDOWRAM including provision of materials for rehabilitation. No permanent weir is available and canals are highly deteriorated, therefore, regular maintenance and/or repair of makeshift wooden weir and de-silting of canals are presently considerable burdens for the groups according to the interview.

**Table II-1.8.3.7 Constraints and Needs recognized by Farmers' Group in DPISRSP**

| Item | Constraints | Needs | Training Programs in which Group is interested |
|---|---|---|---|
| Hardware Aspect | - No permanent intake weir available<br>- Highly deteriorated and sedimented main canal<br>- Lack of water management structures on main canal<br>- Insufficient secondary and tertiary canals | - Construction of permanent weir on the main water source<br>- Rehabilitation of main canals and construction of appurtenant water management structures on main canal<br>- Construction of secondary canals and those related structures | - Group formation support<br>- Basic group management skills<br>- Water management<br>- Administrative management for the group<br>- Financial management<br>- Conflict management over water and land including facilitation of collaborative relationship with non-farmer stakeholders |
| Software Aspect | - Insufficient materials for O&M (such as sand bags/plastic sheets, wood, bamboo etc.)<br>- Conflict among upstream and downstream farmers over water and land<br>- Weak organizational capability of the group in collection of ISF (not yet collected) | - Encouragement of farmers to participate in group work<br>- Awareness raising on the importance of irrigation water and O&M of irrigation<br>- Development of collaborative relationship among stakeholders | |

*Source: JICA Survey Team based on Field Interview*

# CHAPTER II-2 EXAMINATION OF PROJECT SCOPE

## II-2.1 Project Component

In connection with the implementation of SPPIDRIP, important issues to be considered are that (i) SPPIDRIP should be completed within scheduled period, (ii) the SPPIDRIP's effect should occur as planned, and (iii) the project sustainability should be ensured through the independent and proper management and O&M by the relevant entities. The indispensable approaches to these issues to be realized are to execute the good designing, good planning and good implementation of the required project facilities (hardware component) and to apply the empowerment and strengthening of the relevant government organization and FO (software component), which would materialize the effective use of the project facilities. Thus, SPPIDRIP is characterized by composition of hardware components and software components, and then is worked out from the viewpoint of integrated approach of them.

## II-2.2 Necessity and Justification

### II-2.2.1 National and Sectoral Policies

The Rectangular Strategy-Phase II is the most influential policy for every political activity in Cambodia. In Rectangle 1 of the Rectangular Strategy-Phase-II, the "Improving Agricultural Productivity and Diversification" is first of all taken up as Side 1 since the agriculture sector which is regarded as the core of rural economy, has highly contributed toward sustaining the economic growth as well as accelerating poverty reduction in the previous Rectangular Strategy time. Thus, RGC decided to continue to place priority to increasing agricultural productivity. In order to increase agricultural productivity, irrigation is the most effective way, so that the "Water Resources and Irrigation Management" is adopted as Side 2 of Rectangle 2, to solve the water needs of the agriculture sector. To this end, RGC continues to accord priority to the rehabilitation, construction, maintenance and efficient management of irrigation infrastructures.

With such influential policy background, the Agricultural Strategic Development Plan 2009-2013 defines the sectoral goal which is to contribute the national economic development and accelerate the poverty reduction through enhancement of agricultural productivity and diversification and commercialization with sound environmental protection. On the other hand, the Program Design Document for Strategy for Agriculture and Water 2010-2013, indicates the quantifiable indicators which are the increase of the agricultural output by 20% and the increase of the area of cropping land with access to irrigate service by 100,000 ha over 4 years from 2010 to 2013 as mentioned in Section I-2.4.

SPPIDRIP will realize timely and stable supply of irrigation water to fields, and aims to improve the agricultural productivity through the integrated approach of hardware and software components. Thus, it can be said that SPPIDRIP duly conduces to attaining the goals specified in the said national and sectoral policies.

### II-2.2.2 Policy of Official Development Assistance of Japan to Cambodia

The Japan's country assistance policy to Cambodia was worked out in February 2002, in consideration of achieving the Millennium Development Goals (MDGs) formulated in 2000, which consist of 8 targets. The policy indicates the four assistance piers: (i) continuation of support to reconstruction

effort, (ii) assistance based on economic trend, (iii) assistance toward balanced development of urban and rural areas, and (iv) assistance toward rectification of regional gap within ASEAN countries. Based on these assistance piers, GOJ has been assisting Cambodia in: (i) realization of sustainable economic growth and safe society, (ii) assistance to socially vulnerable groups, (iii) global issue and (iv) alleviation of economic gap with other ASEAN countries.

JICA announced a new vision[1]: "*Promotion of Dynamic Development Granting Benefits to All People*" in 2008. In order to realize this vision, JICA decided to draw 4 missions. These are (i) addressing global agenda, (ii) reducing poverty through equitable growth, (iii) improving governance and (iv) achieving human security. And to execute these missions, the 4 strategies are elaborated. These are (i) comprehensive assistance, (ii) continuous assistance, (iii) promotion of development partnership, and (iv) strengthening of research function and message to external entities. In Cambodia, the most important mission to be realized in the above is "reducing poverty through equitable growth", in a board sense, "improvement of living standard". As mentioned in Rectangular Strategy-Phase II, agricultural development is the most effective mean to realize this mission. JICA also recognizes that agriculture is one of important sectors for sustaining economic growth and reducing poverty in Cambodia. The proposed SPPIDRIP will duly contribute to the above mentioned mission through the increase of agricultural production by applying the integrated approach of hardware components (rehabilitation and improvement of irrigation facilities) and software components (strengthening of agriculture support services and relevant organizations).

### II-2.2.3 Necessity and Justification

The poverty reduction or improvement of living standard is the crucial subject to be urgently solved in Cambodia. CDB in NCDD shows a continuing downward trend in poverty[2]. For instance, the poverty rate for the whole country was reduced from 35.1% in 2004 to 25.8% in 2010[3], although the situation has been gradually improving yearly. Of the total number of the poor, more than 90% live in the rural areas. This implies that Cambodia's poverty is rooted in the agriculture sector which is characterized by low and unstable productivity caused by unreliable rainfed cultivation.

Rice is a staple food in Cambodia. As mentioned in Section I-2.6, RGC promulgates the policy paper on promotion of paddy production and rice export. According to this paper, RGC is planning to increase paddy production annually by 2.6% to 6.1% for 2010 to 2015, and 2.6% after 2016 not only to catch up with domestic consumption but also to promote export. Therefore, MAFF comes out with a positive position on strengthening of agricultural extension services, support of establishment of FOs and efficient use of agricultural land.

SPPIDRIP is composed of 6 Sub-projects: RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. RCHRSP covers the Roleang Chrey Regulator, Andong Sla Intake and Approach Channel, Vat Krouch Intake and Approach Channel, and SMC (9.8 km) and NMC (9.1 km). Most of these irrigation facilities are deteriorated and do not function well now. In particular, the Roleang Chrey Regulator which was constructed in 1974 is seriously deteriorated rather than damaged. If this Regulator becomes to malfunction completely, large presently irrigated area, say 9,150 ha could not be irrigated and is obliged to rely on rainfed cultivation. This would undesirably result in low and unstable productivity, and eventually decline of living standard through decrease of farm income. The

[1] *JICA Home Page: http://www.jica.go.jp/about/vision/index.html#vision*
[2] *Page 10, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*
[3] *Table 1, Achieving Cambodia's Millennium Development Goals, Ministry of Planning, 2010*

rehabilitation and improvement of these facilities are therefore essential for the relevant regional society. On the other hand, USISRSP and KSBISRSP are presently envisaged with the incomplete irrigation and drainage system because of no substantial rehabilitation works and no appropriate O&M works. Consequently, these systems could not properly convey irrigation water to fields and hardly contributes to increase of agricultural production accordingly. Thus urgent rehabilitation and improvement of the system are keenly requested by beneficiary famers as well as MOWRAM. USISRSP and KSBISRSP also aim at improvement of agricultural productivity, especially paddy through the rehabilitation and improvement of existing irrigation and drainage facilities and also strengthening of agriculture extension services and relevant organizations.

The remaining 3 Sub-projects, namely MC35RSP, SPWRRSP and DPISRSP which were selected as priority Sub-projects from SISIP, are already provided with irrigation canal systems. However, these irrigation canal systems are poor in quality and insufficient in number, and are mostly deteriorated or damaged presently. Thus, these Sub-projects need not only the rehabilitation and improvement works but also strengthening of agriculture extension services and FO, which is the same concept with RCHRSP, USISRSP and KSBISRSP, to increase the agricultural production, mainly paddy.

It is convinced that SPPIDRIP will conduce to poverty reduction or improvement of living standard in rural area by improvement of agricultural productivity, which is the ultimate goal for Cambodia as explained above. In addition, if materializing the increase rate of rice production from 2010 to 2015, and after 2016 in the rice policy paper as explained above, Kampong Speu, Kandal, Takeo and Kampong Chhnang Provinces surrounding Phnom Penh, would be highly required to play their regional roles as paddy producers in the country, especially for Phnom Penh, a big consuming city. Rehabilitation of irrigation facilities under SPPIDRIP will contribute to some extent to implementation of this political goal.

### II-2.3 Roleang Chrey Headworks Rehabilitation Sub-project

#### II-2.3.1 Basic Concept

(1) Application of Integrated Approach of Hardware and Software Components

The JICA M/P Study[4] has formulated the mid-term comprehensive agricultural development plan of the Prek Thnot River Basin, covering 10 years from 2006 through 2015, in which the top priority has been given to the Roleang Chrey Headworks Improvement, followed by various projects including both hardware and software components. The comprehensive agricultural development depends on the suitable planning and implementation of project facilities in hardware components and also the empowerment and strengthening of the government organization and FO under software components. In consideration of the above, the Sub-project scope should be discussed with the basic concept of "integrated approach of hardware components and software components to ensure the smooth implementation and the sustainability of Sub-project".

(2) Improvement of Roleang Chrey Headworks from Appropriate Permanent Treatment Viewpoint

The current conditions of the Roleang Chrey Headworks are judged quite serious because of very high possibility which the gates will become inoperable before long. If left as they are, it is sure that the water supply to the Roleang Chrey command area would be difficult, or rather impossible. To ensure a stable water supply, improvement of these facilities is needed urgently. The highest priority of the

*4 The Study on Comprehensive Agricultural Development of Prek Thnot River Basin, JICA, 2008, in which M/P was formulated in 2006.*

objective is given to ensure proper gate operation for irrigation water supply and flood water, in order to maintain the present production level at least in all the connected command areas by preventing the deterioration of the irrigation water supply. Based on the findings through review on the relevant reports and the site investigation, the countermeasures for those malfunctioned water gates are to be studied from the viewpoints of the appropriate permanent treatment, to renovate them so as to realize the proper function being of an extent and quality that will provide for another 50 years of service life.

(3) Priority Ranking on Scope of Sub-project as Loan Project

The Japanese loan projects require that the project should be implemented as planned, the project effect should be realized as planned, and the project sustainability should be ensured as planned. The main objective of RCHRSP is to ensure water resource for irrigation by proper water abstraction and water supply through rehabilitation of the headworks and major irrigation facilities. In accordance with this concept, the scope of the project works should be carefully studied and determined. Meanwhile, the Roleang Chrey Irrigation System presently requires various types of the improvement works including new construction, large scale improvement, simple rehabilitation, minor repairing works, and so on listed in the proposal by Kampong Speu PDOWRAM. To meet with the requirements of the loan project mentioned above, these proposed improvement works will be categorized and evaluated with priority ranking by the proper criteria, such as (i) objectives of the works, (ii) urgent necessity, (iii) scale of the works, and (iv) maturity of the plan, taking into due consideration technical and economical viewpoints.

(4) Reflection of Lessons Learnt from Japan's Grant Aid Project

As mentioned in Section II-1.2, the tendering for the last grant aid project of Roleang Chrey Headworks Improvement was failed. One of the reasons for this failing was the harsh work scope including construction schedule. The rehabilitation work planned in the project was confirmed to be technically possible through B/D and D/D. But if considering the scope of the construction works, cost and period, merit and risk of contractor, relation between civil contractor and gate manufacturer, it is deemed that this work scope must be so severe for the Japanese contractor. In this Survey, therefore the work scope will be elaborated based on not only technical and economical viewpoints, but also the work scale, the time schedule and the contract amount suitable for the ICB contractors.

### II-2.3.2 Agricultural Development Plan

(1) Cropping Pattern and Intensity

The M/P Study proposed the following cropping pattern for each Zone:

**Table II-2.3.2.1 Proposed Cropping Patterns and Intensities in M/P Study**

| Zone | Proposed Cropping Pattern in M/P Study | Intensity | Remarks |
|---|---|---|---|
| 1 | Early Rice (18%)- Medium Rice (91%)- Upland Crops (5%) | 114% | 80% Dependability Irrigation |
| 2 | Early Rice (14%)- Medium Rice (91%)- Upland Crops (5%) | 110% | 50% Dependability Irrigation |
| 3 | Medium Rice (100%) - Upland Crops (5%) | 105% | Water Harvesting |
| 4 | Medium Rice (100%) - Upland Crops (1%) | 101% | Rainfed Cultivation |

*Source: Final Report for the Study on Comprehensive Agricultural Development Prek Thnot River Basin*

There are no changes on promotion of paddy production in national policies and social-conditions in the Roleang Chrey command area since the M/P Study has been conducted, therefore these cropping pattern and intensity could be applied if being confirmed through water balance study.

(2) Farming Practices for Paddy Cultivation

Current farming practices are almost the same with the situation in the M/P Stage. In other words

constraints which were pointed out in the M/P Stage have not been improved yet. Accordingly, the farming practices proposed in the M/P Study are employed as they are in this Survey.

(3) Crop Yields

Current unit yield of crops is reviewed based on the latest agricultural statistics as well as the results of field inspection. As a result, it was found that current unit yield was better than that in the M/P Stage. On the other hand, it was found that target unit yield of paddy could be estimated by referring to the Verification Study on Paddy Cultivation conducted in the M/P Study. According to the Verification Study as mentioned in Clause II-1.3.7, the crop yield of paddy ranged from 3.3 ton/ha to 5.2 ton/ha. Thus, the target unit yield of crops is determined by referring to these data.

(4) Agricultural Extension Service

In the scope of RCHRSP, not only rehabilitation of the Roleang Chrey Headworks, but also the rehabilitation of major canals is included. This means that the command area development is also needed in RCHRSP toward improvement of agricultural productivity. Thus, agricultural extension services shall be considered to be included in RCHRSP.

### II-2.3.3 Water Balance Study

#### II-2.3.3.1 Water Demand

(1) General

The water balance study was reviewed and updated in the Survey in order to examine the possible extent of the irrigable area estimated in M/P. Water demand in M/P was estimated using statistically estimated monthly rainfall for both 80% and 50% dependability. The water demand consists of irrigation water requirement in the Roleang Chrey Irrigation System and obligatory discharge for river maintenance flow and release for the irrigation demand in downstream irrigation projects.

(2) Irrigation Water Requirement

Irrigation water requirement was calculated based on the proposed cropping pattern consisting of early variety and medium variety of paddy and upland crop in a year with overall cropping intensity of 114% with 80% dependability. The water requirement was calculated by almost the same procedure with M/P although some modifications were made, which is summarized in the following table for comparison with those in M/P.

**Table II-2.3.3.1.1 Conditions for Estimate of Irrigation Water Requirement**

| Item | M/P Study | This Survey |
|---|---|---|
| Calculation interval | 5-day basis | Remain unchanged |
| Method for estimating potential evapo-transpiration | Penman-Montieth method | Remain unchanged |
| Meteorological data | Pochentong Station (Phnom Penh) | Remain unchanged |
| Rainfall data | Kampong Speu Station<br>(Base year statistically estimated) | Pochentong Station (Phnom Penh)<br>year 1911 (80% dependable)<br>year 1948 (50% dependable) |
| Percolation rate | 8 mm/day<br>With introduction of water saving irrigation Method | Remain unchanged |
| Irrigation efficiency | Paddy; 66%<br>Upland crop; 53% | Remain unchanged |

*Source: JICA Survey Team*

The diversion water requirements at the Roleang Chrey Headworks estimated in the Survey is summarized below;

**Table II-2.3.3.1.2 Summary of Estimated Diversion Water Requirement for Roleang Chrey Irrigation System with 80% and 50% Dependability**

(Unit: $m^3$/sec)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80% Dependability (Reference Year : 1911) | | | | | | | | | | | | |
| 1 - 5 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 0.5 | 1.0 | 7.0 | 2.0 | 6.3 | 10.6 | 2.9 |
| 6 - 10 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 0.5 | 2.0 | 7.6 | 1.8 | 6.5 | 9.2 | 1.7 |
| 11 - 15 | 0.0 | 0.0 | 0.0 | 0.3 | 0.6 | 0.5 | 3.3 | 8.1 | 1.5 | 6.6 | 8.1 | 0.8 |
| 16 - 20 | 0.0 | 0.0 | 0.0 | 0.4 | 0.7 | 0.5 | 4.9 | 8.0 | 1.9 | 7.1 | 6.9 | 0.0 |
| 21 - 25 | 0.0 | 0.0 | 0.0 | 0.5 | 0.7 | 0.6 | 5.3 | 7.5 | 2.4 | 7.6 | 5.8 | 0.0 |
| 26 - end | 0.0 | 0.0 | 0.0 | 0.5 | 0.6 | 0.6 | 5.7 | 6.8 | 2.5 | 7.7 | 4.6 | 0.0 |
| 50% Dependability (Reference Year : 1948) | | | | | | | | | | | | |
| 1 - 5 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 0.5 | 1.3 | 7.1 | 0.4 | 4.1 | 7.0 | 3.2 |
| 6 - 10 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 0.5 | 2.3 | 7.7 | 0.3 | 4.3 | 6.0 | 1.9 |
| 11 - 15 | 0.0 | 0.0 | 0.0 | 0.3 | 0.7 | 0.5 | 3.6 | 8.3 | 0.2 | 4.5 | 5.3 | 1.0 |
| 16 - 20 | 0.0 | 0.0 | 0.0 | 0.4 | 0.7 | 0.6 | 5.1 | 8.3 | 0.3 | 4.9 | 4.5 | 0.0 |
| 21 - 25 | 0.0 | 0.0 | 0.0 | 0.5 | 0.8 | 0.6 | 5.9 | 7.8 | 0.6 | 5.4 | 3.8 | 0.0 |
| 26 - end | 0.0 | 0.0 | 0.0 | 0.5 | 0.7 | 0.6 | 6.8 | 7.2 | 0.6 | 5.5 | 3.1 | 0.0 |

*Source: JICA Survey Team*

(3) River Maintenance Flow and Obligatory Discharge to Downstream

The river maintenance flow to downstream from the Roleang Chrey Regulator was estimated at 0.6 $m^3$/sec throughout a year by referring to the guidelines of Japan[5]. Minimum obligatory discharge from the Roleang Chrey Regulator to downstream was estimated by summing the following water requirement of 3 irrigation systems located downstream: Kandal Stung, Dangkor and Tonle Bati Irrigation Systems, in the same way as mentioned in M/P.

**Table II-2.3.3.1.3 Summary of Monthly Water Requirement of Downstream Irrigation Projects**

(Unit: $m^3$/sec)

| Irrigation System | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kandal Stung | | 0.80 | 0.70 | 0.00 | 0.10 | 0.80 | 1.30 | 2.33 | 1.00 | 0.30 | 0.60 | 1.30 | 1.50 |
| Dangkor | | 0.00 | 0.00 | 0.00 | 0.20 | 0.05 | 0.05 | 0.16 | 0.30 | 0.18 | 0.21 | 0.23 | 0.03 |
| Tonle Bati | 1 - 15 | 0.95 | 0.66 | 0.00 | 0.02 | 0.40 | 0.91 | 1.66 | 1.14 | 0.34 | 0.82 | 0.75 | 0.98 |
| | 16 - end | 0.57 | 0.64 | 0.00 | 0.05 | 0.84 | 0.99 | 1.42 | 0.68 | 0.50 | 0.64 | 0.82 | 1.21 |

*Source : The Study on Comprehensive Agricultural Development of Prek Thnot River Basin In the Kingdom of Cambodia, JICA, 2008*

### II-2.3.3.2 Water Balance Study

(1) Calculation Method and Conditions

In M/P, the water balance was simulated applying the probable river run off and water demand estimated for 80% dependability and 50% dependability. The water balance simulation applied in M/P and the Survey is compared as follows:

**Table II-2.3.3.2.1 Comparison of Water Balance Simulation in M/P and the Survey**

| Item | M/P Study | This Survey |
|---|---|---|
| Calculation interval | 5-day basis | Remain unchanged |
| Method for estimating potential evapo-transpiration | Penman-Montieth method | Remain unchanged |
| Runoff data | Data at Peam Khley station | Remain unchanged |
| Water balance in Ou Krang Amble system | Consideration of storage effect of 2 upstream reservoirs | Remain unchanged |
| Simulation model | Refer to Figure II-2.3.3.2.1 | Remain unchanged |
| Reference year | Kampong Speu Station<br>(Reference year statistically estimated) | Kampong Speu Station<br>year 1911 (80% dependability)<br>year 1948 (50% dependability) |
| Irrigation fail | Continuous deficit in 10 days | Remain unchanged |

*Source: JICA Survey Team*

*5 River maintenance flow; between mean annual draught runoff and 1/10 dependable draught runoff*

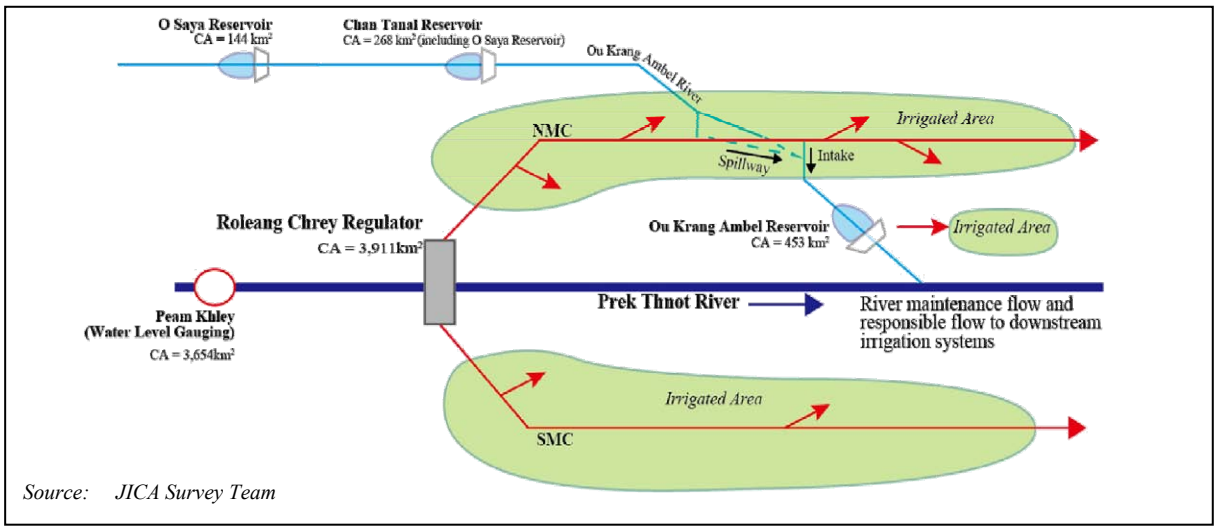



**Figure II-2.3.3.2.1 Simulation Model for Water Balance**

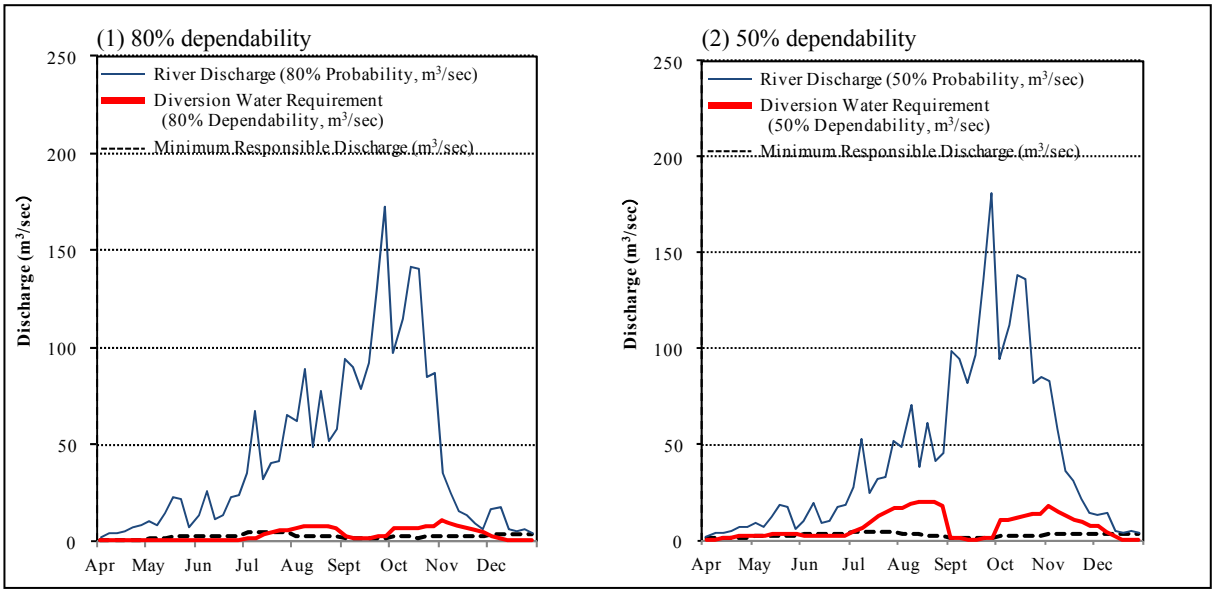
(2) Result of Water Balance Calculation

As the results of water balance calculation with supplemented rainfall data of recent 5 years, the 80% dependable area was estimated at 6,500 ha against 5,660 ha recorded in M/P, and 50% dependable area at 18,100 ha against 16,700 ha stated in M/P. For both cases, the review results showed about 10% higher than those in M/P due to modifications of operation simulation of the Ou Krang Ambel Reservoir. Taking into consideration the calculation method and reliability of meteo-hydrological data, it could be considered that the difference in both cases would be rather positioned within allowable extent. From the reasons mentioned above and the conservative viewpoint, it is acceptable to use the 80% and 50% dependable areas estimated in the M/P Study. The probable irrigation area estimated for each crop is shown in the right table:

**Table II-2.3.3.2.2 Probable Irrigation Area**

| Dependability | Early Rainy | Rainy Season |
|---|---|---|
| 80% | 500 ha | 5,660 ha |
| 50% | 2,100 ha | 16,700 ha |

*Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin*




*Source: JICA Survey Team*

**Figure II-2.3.3.2.2 Result of Water Balance Study for Roleang Chrey Irrigation System**

### II-2.3.4 Hardware Components

#### II-2.3.4.1 Roleang Chrey Headworks Rehabilitation Works

(1) Rehabilitation Works for Hydro-mechanical Works

(a) Present Condition of Hydro-mechanical Equipment

All hydro-mechanical equipments provided in the Roleang Chrey Regulator were examined through site investigation and interview to Kampong Speu PDOWRAM early in July 2011. As the results of examination, it was confirmed that present condition of all hydro-mechanical equipment remains unchanged as compared with the D/D Stage of Grant Aid. In general, it was found that these were in so serious condition as described in Table II-2.3.4.1.1.

**Table II-2.3.4.1.1 Present Condition of Hydro-mechanical Equipment**

| Equipment | Present Condition |
|---|---|
| Regulator Gates | - It is very difficult to operate all 5 gates; the gate leaf can be opened with difficulty, however, the gate cannot be lowered without lowing upstream water level until approximately EL. 30.0 m (1 m higher from gate sill).<br>- Large amount of water leakage is observed.<br>- Almost all of paint materials on all gate leaves are peeled off and all surfaces rust.<br>- Wire ropes for counter weight for some gates are deteriorated and some fuses of electrical panel are blown out. |
| Andong Sla Intake Gates | - Three out of 4 gates cannot be operated completely.<br>- One operable hoist system is damaged and the gate operation is very difficult.<br>- Large amount of water leakage is observed.<br>- Almost all of paint materials on all gate leaves are peeled off and all surfaces rust. |
| Vat Krouch Intake Gate | - The gate operation is so difficult since the gate leaf and hoist are damaged.<br>- Large amount of water leakage is observed.<br>- Almost all of paint materials on gate leaf are peeled off and all surfaces rust. |

*Source: JICA Survey Team*

It was confirmed again that it was necessary to urgently rehabilitate all hydro-mechanical equipment for Roleang Chrey Regulator.

(b) Scope of Rehabilitation Works

1) General Concept for Rehabilitation Work

The rehabilitation work for the hydro-mechanical equipment shall be planed taking into account (i) easiness for O&M system, (ii) results of review for the function and structure so as to resolve the problem on O&M so far, and (iii) elapsed years of the equipment, wear, durability and aging of the parts, technology obsolescence and frequency in use should also be considered.

2) Equipment to be Rehabilitated

A discussion was made between MOWRAM and the JICA Survey Team in middle July 2011 to determine the scope of rehabilitation works based on the rehabilitation plan prepared at the B/D Stage and the D/D Stages in 2008 and 2009, respectively. As the result of discussion, it was proposed that the following equipment should be rehabilitated in line with the general concept mentioned above.

a) Roleang Chrey Regulator Gates

- Renewal of 5 sets of fixed wheel gate leaves, wire rope wound hoists with steel hoist decks and staircase including remote control operation covering each gate opening of 12.5 m in width and 6.7 m in height

b) River Outlet Structure

- Construction of 4 sets of river outlet slide gates with each guide frame and spindle screw or rack type hoist covering each opening of 1.0 m in width and 1.0 m in height

- Construction of 4 sets of fixed trash racks for the river outlet gates covering each opening of 1.0 m in width and 3.0 m in vertical height
- Construction of 2 sets of trash racks for end structure of river outlet covering each opening of 1.0m in diameter

c) Andong Sla Intake

- Reconstruction of 2 sets of Andong Sla Intake radial gates with each guide frame, spindle screw or rack type hoist and hoist deck covering each opening of 4.0 m in width and 2.7 m in height

d) Vat Krouch Intake

- Reconstruction of 1 set of intake fixed wheel gates with each guide frame, spindle screw or rack type hoist and hoist deck covering each opening of 4.0 m in width and 5.0 m in height

3) Renewal of Gate Leaves for Regulator Gates

The scope of works for rehabilitation of regulator gate leaves under JICA Grant Aid was as follows.

- Replacement of total 40 sets of bushings and pins of main wheels for all gate leaves with new ones,
- Repair painting of all gate leaves upon performing sand blasting of all gate leaves, and
- Replacement of rubber seals provided on all gate leaves.

Such partial rehabilitation works of gate leaves are technically acceptable through the field investigation and study performed at the B/D Stage in 2008 and the D/D Stages in 2009 as follows.

- Enough strengthening for the main gate structure such as main girders and skin plate at the present stage even though it was observed that some auxiliary members like bracings were deteriorated.
- No observation on the main structure although the painting material on them is peeled off and all surfaces rusted.

However, it is proposed that all gate leaves should be renewed with complete new ones instead of such replacement and repainting mentioned in the above. The necessity of renewal of gate leaves is explained hereinafter.

a) Changing Wheel Assembly Type

The wheel assembly should be designed that its bushing shall be replaced with new one easily without any modification of civil structure since the standard renewal interval of bushing under the proper maintenance is 23 years as shown below.

**Table II-2.3.4.1.2 Standard Renewal or Replacement Interval of Hydro-mechanical Equipment**

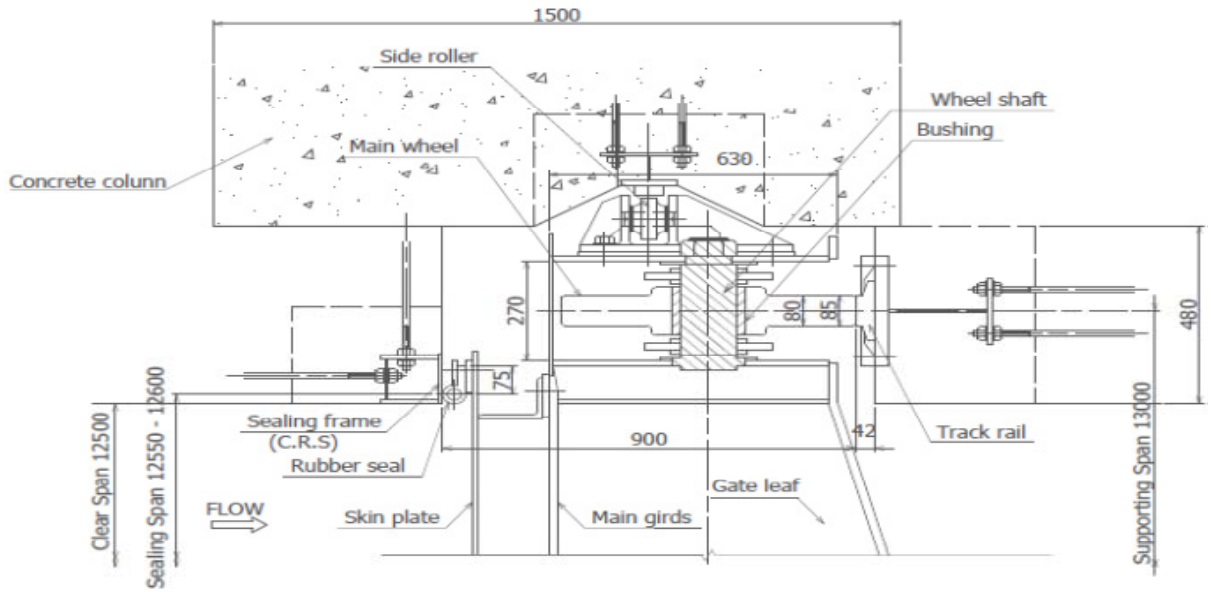
| Facility/Equipment/Part | | | Kind | Standard Renewal or Replacement Intervals (years) |
|---|---|---|---|---|
| Gate leaf | Structure member | | Renewal | 56 |
| | Main wheel assembly | Wheel | Replacement | 50 |
| | | Shaft | Replacement | 53 |
| | | Bushing | Replacement | 23 |
| | Auxiliary roller | | Replacement | 55 |
| | Wire sheave assembly | | Replacement | 50 |
| | Rubber seal | | Replacement | Not set replacement interval since unexpected damage often happens. |

| Facility/Equipment/Part | | | Kind | Standard Renewal or Replacement Intervals (years) |
|---|---|---|---|---|
| Wire rope winch type hoist | Electric motor | | Replacement | 38 |
| | Electromagnet brake | | Replacement | 30 |
| | Hydraulic lift brake | | Replacement | 27 |
| | Changeover device | | Replacement | 29 |
| | Gear reducer | | Replacement | 29 |
| | Open gears | | Replacement | 44 |
| | Wire rope sheave assembly | | Replacement | 45 |
| | Bearings | | Replacement | 29 |
| | Shaft couplings | | Replacement | 29 |
| | Wire ropes | | Replacement | 14 |
| | Wire rope end | | Replacement | 27 |
| Hydraulic hoist | Hydraulic cylinder | | Replacement | 16 |
| | Hydraulic unit | | Replacement | 16 |
| Rack type hoist | Main structure (Actuator and rack) | | Renewal | 19 |
| Spindle type hoist | Main structure (Actuator and spindle) | | Renewal | 25 |
| Control cabinet | Limit switch | | Replacement | 24 |
| | Gate position indicator | | Replacement | 25 |
| | Local control cabinet | Panel | Replacement | 19 |
| | | Relays | Replacement | 15 |
| | | Circuit breaker | Replacement | 19 |
| | | Switches | Replacement | 19 |

*Source: Inspection, Maintenance and Replacement Manual for River Gates issued by Ministry of Land, Infrastructure and Transport, Japan 2008.*

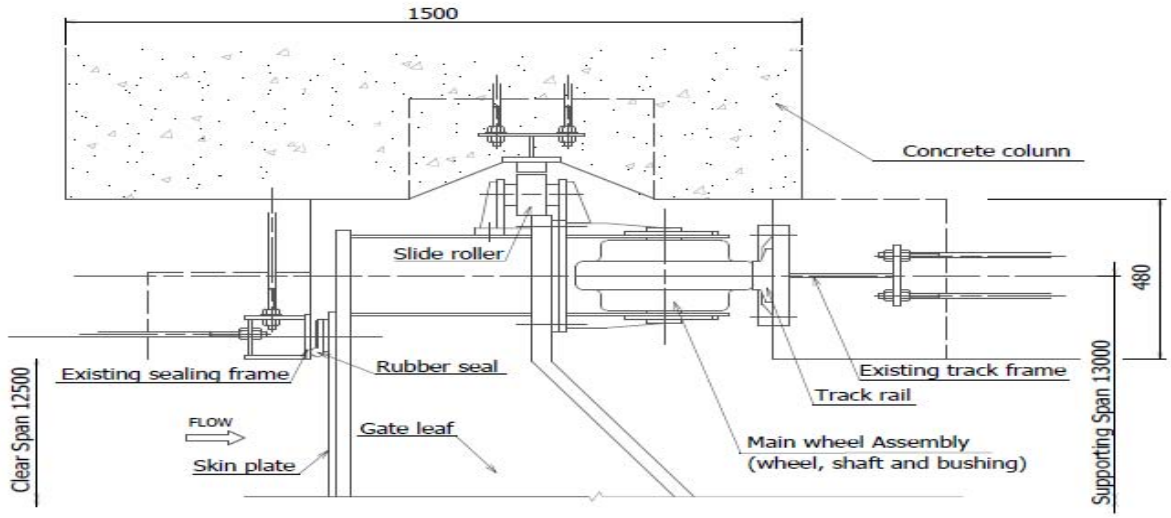
The existing wheel assembly is as shown in Figure II-2.3.4.1.1. It has a disadvantage that the wheels assembly cannot be disassembled and bushing replaced with new one if the hole is provided in the concrete columns of hoist deck. Considering the above renewal interval of bushing, the bushings shall be replaced with new ones again after 23 years reckoned from the year of finishing such replacement.

To replace with new bushing, it is necessary to make the large scale of replacement work again by providing the cofferdam. In order to replace the bushing easily within the short period without any modification of the concrete column, it is proposed that the wheel assemblies should be provided at the downstream side of the end beams as shown in Figure II-2.3.4.1.2. It is necessary to renew the gate leaf completely to accommodate the wheel assemblies at the downstream side of gate leaf since existing gate leaves cannot be modified to do so.




*Source: JICA Survey Team*

**Figure II-2.3.4.1.1 Wheel Assembly of Existing Regulator Gate**




*Source: JICA Survey Team*

**Figure II-2.3.4.1.2 Proposed Wheel Assembly of Regulator Gate**

b) Renewal Interval of Gate Leaf

The regulator was completed in 1974 and 37 years have elapsed until now. It is necessary to renew the gate leaf within the lifetime of the Roleang Chrey Regulator as explained below.

In general, the lifetime of civil structures such as regulator is about 80 years subject to provision of regular maintenance. On the other hand, the renewal interval of gate structure is 56 years as shown in Table II-2.3.4.1.2. The gate leaves are to be renewed approximately in 2030 which is within the lifetime of the Roleang Chrey Regulator if proper maintenance is conducted. Such renewal of gate leaves needs the large scale of construction works and the long term construction period again. Judging from the total costs for maintenance and rehabilitation works, it is economically better that the gate leaf should be renewed with the proposed type at one time.

c) Work Volume of Rehabilitation Work of Regulator Gates

The notice of P/Q for Tender for the Project for Improvement of the Roleang Chrey Headworks under JICA Grant Aid and the issue of P/Q Documents were made on August 3, 2009 upon preparing Tender Documents in July 2009. However, any applicant did not submit his P/Q Documents by closing date of August 10, 2009 and the tender was discontinued accordingly.

The main causes of such situation are deemed as follows:

- Small work volume of gate rehabilitation
- Very difficult and complicated replacement work for bushings and shafts of main wheels of regulator gates
- Severely tight work period, say only 4.3 months for disassembly, procurement and installation of bushings and shafts of main wheels of regulator gates

It is assured that work volume to be increased by the renewal of all gate leaves of regulator gates becomes adequate work scale to be implemented under ICB, so that there is a possibility which a number of the gate manufacturers participate actively in the tender as a sub-contractor. Table II-2.3.4.1.3 shows the summary of review results in the table below in comparison with the previous studies.

**Table II-2.3.4.1.3 Review on Proposed Hydro-mechanical Works**

| Item | Proposal of Grant Aid Project | Review in 2011 |
|---|---|---|
| **Roleang Chrey Regulator** | | |
| (i) Regulator gates<br>- Type: Fixed wheel gates<br>- Quantity: 5sets<br>- Clear span: 12.5 m<br>- Gate height: 6.7 m | (i) Rehabilitation of all regulator gates and hoists:<br>- Renewal of bushings and shafts of main wheels of all gate leaves<br>- Repainting of all gates leaves after rust removal<br>- Replacement of rubber seals of all gate leaves<br>- Renewal of all hoist with local control panels upon modifying hoist deck<br>- Construction of remote control panel | Based on the review study, the following works are proposed.<br>(i) Rehabilitation of all regulator gates and hoists:<br>- Renewal of all gate leaves<br>- Renewal of all hoist system with local control panels<br>- Renewal of all host decks with staircase<br>- Construction of remote control panel |
| (ii) River outlet structure<br>Type: Slide gates<br>Quantity: 4 sets<br>Clear span: 1.0 m<br>Clear height: 1.0 m | (ii) Construction of river outlet facilities<br>- Construction of gates with guide frames and manually operated hoists | Based on the review study, construction of remote control panel is proposed in addition to construction of gates with guide frames and electrically driven hoists |
| - Inlet fixed trashrack<br>Quantity: 4 sets<br>Clear span: 1.0 m<br>Vertical height: 3.0 m | - Construction of inlet trashracks | According to the review study, the following proposed works remain unchanged.<br>- Construction of inlet trash racks |
| Outlet fixed trashrack<br>Quantity: 2 sets<br>Clear span: 1.25 m<br>Vertical height: 1.4 m | - Construction of outlet trashracks | - Construction of outlet trash racks |
| **Andong Sla Intake** | | |
| - Intake gates<br>Type: Radial gates<br>Quantity: 2 sets<br>Clear span: 4.0 m<br>Gate height: 2.7 m | Reconstruction of gates with guide frames and manually operated hoists | Based on the review study, proposed works are ;<br>- Reconstruction of gates with guide frames and electrically driven hoists<br>- Construction of remote control panel |
| **Vat Krouch Intake** | | |
| - Intake gates<br>Type: Fixed wheel gates<br>Quantity: 2 sets<br>Clear span: 4.0 m<br>Gate height: 5.0 m | - Construction of gates with guide frames and manually operated hoists* | Based on the review study, proposed works are ;<br>- Construction of gates with guide frames and electrically driven hoists<br>Type: Radial gates<br>Quantity: 2 sets<br>Clear span: 4.0 m<br>Gate height: 2.7 m<br>- Construction of remote control panel |

**: Proposal in F/S (Proposal in F/S was not adopted in grant aid project)*
*Source: JICA Survey Team*

4) Priority of Rehabilitation Works

The proposed rehabilitation works for the hydro-mechanical equipment is prioritized as follows:

- 1st priority: the works should be carried out urgently to recover and/or maintain the function of the equipment with reliability and durability.
- 2nd priority: the works should be carried out to improve convenience for gate operation.

The result of prioritization is shown in Clause II-2.3.6.

(2) Civil Works for Improvement of Roleang Chrey Headworks

(a) Roleang Chrey Regulator

The facilities of the Roleang Chrey Regulator, except for the downstream slope protection, are presently in stable condition although small-scale scouring is observed immediately after the downstream apron. In the previous F/S in 2008 and subsequent B/D in 2009, it was proposed to conduct the improvement works to keep or rather further strengthen such stable condition and to ensure the reliable release to downstream reach. In the review, it was confirmed that there were no

remarkable change in the above conditions, and thus the proposed improvement works in B/D is referred to in principle. The proposed works are (i) provision of downstream apron, (ii) provision of retaining wall, and (iii) construction of by-pass river outlet.

(b) Andong Sla Intake

The required discharge for improvement of Andong Sla Intake and its approach channel is referred to F/S and subsequent B/D, as (i) 10.4 $m^3$/sec without consideration of new water resource development, and (ii) 25.1 $m^3$/sec in future. Taking this condition into consideration, the proposed improvement works were confirmed to apply the improvement plan to (i) design the 4 gates portions, (ii) install 2 gates out of 4 gates to ensure the discharge of 10.4 $m^3$/sec, and (iii) provide a concrete wall for the remaining 2 gates, so as to enable the installation of a gate in each in the future. In addition, retaining walls and downstream apron will be provided to protect the downstream of the structures, while rehabilitation work for the upstream approach channel is not touched at all.

(c) Vat Krouch Intake

According to the design discharge for SMC estimated in F/S and the review in this Survey, gate capacity should be determined using the discharge of 17.4 $m^3$/sec. Consequently, 2 gates are required of 5.0 m high and 4.0 m wide. To smoothly connect the gated box culvert with the upstream and downstream canal of trapezoidal section, a reinforced concrete transition is to be provided for both side slopes of the canals. The canal bed at the transition is protected with gabion mattresses from scouring.

A gate pier combined with a box culvert was proposed to save construction cost. On the bottom slab of the box culvert, a baffle block and end sill are provided to dissipate the hydraulic energy. Gabion mattresses are to be provided on the canal bed before and after the transition, to protect the canal bed from scouring.

The present flow capacity of the approach channel is only 13.6 $m^3$/sec, and this is too small to carry the design discharge of 16.3 $m^3$/sec, according to F/S. The existing section needs to be enlarged, which was also pointed out by Kampong Speu PDOWRAM during the joint inspection at this time.

The review results of the proposed improvement on the civil works of Roleang Chrey Headworks are summarized below.

**Table II-2.3.4.1.4 Review of Proposed Civil Works**

| Item | Proposal of Grant Aid Project | Review in 2011 |
|---|---|---|
| **Roleang Chrey Regulator** | | |
| | - Construction of the downstream river bed protection<br>- Rehabilitation of the downstream river bank protection<br>- Construction of river outlet structure | As no remarkable change in the present condition and design values in the review study, proposed works in B/D remain unchanged. |
| **Andong Sla Intake** | | |
| | - Curtain walls:<br>W 4.0 m × H 2.5 m × 2 nos.<br>(w/ new gate sections)<br>W 4.0 m × H 5.2 m × 2 nos.<br>(gate-dismantled sections)<br>- Operation deck:<br>W 2.0 m × L 4.0 m × 4 nos.<br>- Protection of up & downstream of intake and rehabilitation of approach channel | As no remarkable change in the present condition and design values in the review study, proposed works in B/D remain unchanged. |

| Item | Proposal of Grant Aid Project | Review in 2011 |
|---|---|---|
| **Vat Krouch Intake** | | |
| | - Not included | Based on the review and investigation in this Survey, the following works are included in the Sub-project.<br>- Construction of upstream and downstream transitions*<br>- Replacement of gate pier and box culvert*<br>- Protection of upstream and downstream canal beds<br>- Rehabilitation of approach channel* |

**: Proposal in F/S (Proposal of grant aid project is )*
*Remarks; W: Width, H: Height, L= Length*
*Source: JICA Survey Team*

### II-2.3.4.2 Rehabilitation Works for North Main Canal, South Main Canal and Related Structures

(1) General

In M/P, RCHRSP was formulated to solely cover the improvement of the headworks consisting of the Roleang Chrey Regulator, Andong Sla Intake, Vat Krouch Intakes and their approach channels, while improvement of the irrigation system was separately formulated as UNMC and USMC Irrigated Agriculture Improvement Projects, and Irrigated Agriculture Improvement Model Project. During the discussion between MOWRAM and the JICA Mission on implementation program of the Survey in February 2011, MOWRAM proposed to JICA Mission to include the improvement of Main Canals into the RCHRSP scope in addition to the rehabilitation of the Headworks. As a result, it was mutually agreed that the rehabilitation of upstream of NMC and SMC with length of 10 km each with related structures was included in the Scope of RCHRSP, as concluded on February 25, 2011. The following table summarizes the comparison of components of improvement works of the Roleang Chrey Headworks in the past and present studies.

**Table II-2.3.4.2.1 Comparison of Project Components of Headworks Improvement Works in Past and Present Studies**

| M/P | F/S | Japan's Grant Aid Project | This Survey |
|---|---|---|---|
| Improvement of Roleang Chrey Headworks | Improvement of Roleang Chrey Headworks | Improvement of Roleang Chrey Headworks | Improvement of Roleang Chrey Headworks |
| Improvement of Andong Sla Intake | Improvement of Andong Sla Intake | Improvement of Andong Sla Intake | Improvement of Andong Sla Intake |
| Improvement of Vat Krouch Intake | Improvement of Vat Krouch Intake | | Improvement of Vat Krouch Intake |
| NMC and SMC Improvement projects formulated separately. | Improvement of upper SMC in Model Project (7.8 km) | | Improvement of upper NMC and SMC (approximately 10 km each) |

*Source: JICA Survey Team*

(2) Improvement Works Proposed by PDOWRAM

The NMC and SMC rehabilitation works have been proposed by MOWRAM to be included in the scope of RCHRSP works during the visit of JICA Mission to Cambodia in February 2011, however the details of proposed plan is not available. Kampong Speu PDOWRAM has a keen intention to execute the improvement works of NMC, SMC and also improvement of secondary canals and related structures even including new construction of additional facilities with general and rough idea, on which basic data, technical investigation results, topographic survey results, and design have not been studied.

During the period of the first filed works of the Survey, Kampong Speu PDOWRAM prepared the list of their proposed improvement works to be included in RCHRSP with their priority ranking. Based on

the list, PDOWRAM, MOWRAM and the JICA Survey Team jointly inspected them in order to clarify the present conditions and possibility to be included in the Scope of RCHRSP.

The proposed works for NMC and SMC are summarized in the following table:

**Table II-2.3.4.2.2 Summary of Improvement Works on NMC and SMC of Roleang Chrey Irrigation System Proposed by PDOWRAM**

(Unit: no. / nos.)

| Proposed Works | NMC | | | SMC | | | Total |
|---|---|---|---|---|---|---|---|
| | Approach Channel*1 | NMC | NMC Total | Approach Channel*1 | SMC | SMC Total | |
| Improvement of canal embankment | 2 | 0 | 2 | 1 | 1 | 2 | 4 |
| Enlargement of canal section | 0 | 1 | 1 | 1 | 0 | 1 | 2 |
| Improvement of bank of canal crossing reservoir | 0 | 1 | 1 | 0 | 2 | 2 | 3 |
| Replacement or improvement of structures | 2 | 11 | 13 | 3 | 9 | 12 | 25 |
| Construction of pump station | 0 | 1*2 | 1 | 0 | 0 | 0 | 1 |
| Construction of structures | 0 | 2 | 2 | 1 | 7 | 8 | 10 |
| Rehabilitation of secondary canals | | 9 | 12 | 1 | 7 | 8 | 20 |
| Total | 7 | 25 | 32 | 7 | 26 | 33 | 65 |

**1: Approach channel from the Prek Thnot River to Intakes*
**2: Proposed pump station on NMC to supply water to the existing secondary canal that was already constructed by MOWRAM*
*Source: JICA Survey Team*

## II-2.3.5 Software Components

### II-2.3.5.1 Capacity Development of MOWRAM and PDOWRAM on O&M

Capacity Development of MOWRAM and PDOWRAM on O&M mainly consists of the following 2 aspects: (i) preparation of operation rules and an operation manual for the facilities, and (ii) enhancement of relevant of the organization for O&M of the project facilities.

At the final stage of construction, technical assistance to O&M of the rehabilitated and constructed facilities at the Roleang Chrey Headworks will be rendered to gate operators as software component plan in order to sustain the functions for stable irrigation water supply. The objectives of the software component plan are as follows:

- The gate operation of the regulator and intakes will be conducted smoothly and properly.
- A communication network among the Roleang Chrey Regulator and the gate structures in the downstream of the regulator will be formulated for closely coordinated gate operation.
- Closely coordinated gate operation of the Roleang Chrey Regulator and Andong Sla and Vat Krouch Intakes will possibly prevent flood entrance to the north approach channel and regulate irrigation water to NMC in accordance with irrigation water supply schedule.
- The gate operators will recognize importance and necessity of O&M of the facilities.

The activities of the software component plan for strengthening of the government agency concerned, such as MOWRAM and PDOWRAM are as follows:

- Preparation of O&M guidelines of the improved facilities, such as irrigation water supply schedule and gate operation manual of the Roleang Chrey Regulator, and the Andong Sla and Vat Krouch Intakes
- Technical guidance on gate operation for normal conditions for irrigation water supply based on the irrigation schedule
- Technical guidance on gate operation against flood, utilizing the communication network of the Roleang Chrey Headworks, meteorological and discharge measurement stations and PDOWRAM office

For the software component plan, an O&M expert will be assigned at the final stage of the construction. The participating trainees will consist of gate operators who are or will be involved in O&M of irrigation facilities and gates, such as those from Kampong Speu PDOWRAM and Kandal PDOWRAM.

#### II-2.3.5.2 Strengthening of Farmer Water Users Community

The command area of RCHRSP is located on the upstream side of NMC and SMC, and is comparatively blessed with irrigation water. However, the activities of FWUC, such as water management and O&M at the minor canal level, do not reach a satisfactory level. In the framework of M/P, various projects were proposed in order to strength FWUC, such as Irrigated Agriculture Improvement Model Project, UNMC and USMC Irrigated Agriculture Improvement Projects, and Irrigated Agriculture On-farm Technology Improvement Pilot Project. To attain the objectives of strengthening FWUC, these projects should be implemented for FWUC formation and strengthening in the target area of RCHRSP following strategies in M/P.

In addition, MOWRAM is currently undertaking the nationwide program for organization of FWUC under the FAO EU Food Facility Project, in accordance with the government policy and strategy of FUWC. The formation and strengthening of FWUC in the RCHRSP target area are expected to be expedited by this program in line with the government policy on the tertiary canal system and on-farm development.

In RCHRSP, FWUC strengthening program will be proposed targeting the existing FWUC in the upstream of the Roleang Chrey Irrigation System as the Model Area in the first step of overall program. Training-of-Trainers (TOT) approach will be applied for RCHRSP. In the program, capacity development program for concerned PDOWRAM staff will be carried out by relevant technical units under Project Management Unit (PMU) Japan Support Fund. Then, the trained PDOWRAM staff will train the FWUC member taking into account the sustainable strengthening of FWUC.

#### II-2.3.5.3 Strengthening of Agricultural Extension Services

The objective of RCHRSP is to improve agricultural productivity, especially irrigated paddy. To tackle development constraints faced in the RCHRSP Area, strengthening of agricultural extension services will be essential in order to ensure the attainment of project targets at an early stage. This strengthening of agricultural extension services shall be implemented in the Model Area by PDA in coordination and collaboration with MOWRAM, MAFF and PDOWRAM.

The services shall be implemented in the Model Area with 570 ha along SMC. Meanwhile TSC-3 will carry out technical support services including agricultural extension activities up to 2014 in the target area of 220 ha which occupies a part of the Model Area included in the Roleang Chrey command area. Accordingly it is proposed that the extension service of RCHRSP in the Model Area be carried out, considering the result as well as experience of the extension service to be carried out by TSC-3.

The strengthening activities are proposed with the objectives of (i) development and extension of improved and sustainable farming technologies on rice production to enhance productivity of the primary agricultural activity in the RCHRSP Area, and (ii) promotion of farmer to farmer technology transfer. The agricultural extension services to be required for the promotion of adoption of the proposed farming practices and for attaining the target cropping patterns, cropping intensity and crop yields at an earlier stage are as shown in the following table.

**Table II-2.3.5.3.1 Proposed Agricultural Extension Services**

| Activity | Program Required |
|---|---|
| Field Extension Programs | Plot & area demonstrations, adaptability tests, seed propagation |
| Farmer/Farmer Group Training Programs | Training programs, farmer field schools, study tours |
| Mass Guidance/Workshops | Mass guidance/workshops |
| Farmer-to-farmer Extension Support | Farmer-to-farmer extension support |

*Source: JICA Survey Team*

### II-2.3.6 Scope of Sub-project

(1) Objective of RCHRSP

M/P in 2008 formulated the overall rehabilitation scenario in the Prek Thnot River basin, in which the highest priority was given to RCHRSP consisting of rehabilitation of the Roleang Chrey Regulator and the intakes with the condition that the other projects, such as rehabilitation of upper and lower reach of NMC and SMC, will follow in future. The objective of RCHRSP is to maintain the present production level at least in all the command area by preventing the deterioration of the irrigation water supply due to malfunctioning of the Roleang Chrey Regulator and Andong Sla and Vat Krouch Intakes in near future and to make command area development of 1,320 ha.

(2) Examination of Scope of Roleang Chrey Headworks Rehabilitation Sub-project Proposed by Ministry of Water Resources and Meteorology

As for NMC and SMC, it was confirmed that rehabilitation works were executed by MOWRAM for the middle to lower reach (from 8 km point of NMC in 2003-2005 and from 7 km point of SMC in 2005-2007), while the upper reaches of these canals have not yet been rehabilitated so far. Through the inventory and topographic survey for the upper reaches, there find canal sections and structures that require large scale improvement works. Also it is confirmed that MOWRAM has a strong intention to implement the Model Area development proposed in M/P under RCHRSP, which is covered by the upstream part (up to 7.8 km) of SMC.

The examined scope of RCHRSP is shown in the following table.

**Table II-2.3.6.1 Examined Scope of RCHRSP**

| Scope Proposed by MOWRAM in M/D[*1] | Examined Scope of RCHRSP |
|---|---|
| (a) Project Area<br>Not specified | (a) Project Area<br>350 ha excluding 220 ha to be implemented by TSC-3, but influences to 16,910 ha for project evaluation |
| (b) Cropping Pattern and Intensity<br>- Rice-based cropping system with upland crops<br>- Crop intensity:101% - 114% | (b) Cropping Pattern and Intensity<br>- Rice-based cropping system with upland crops<br>- Crop intensity:101% - 114% |
| (c) Hardware Components | |
| - Rehabilitation of Roleang Chrey Headworks | The rehabilitation works of the regulator gates are urgently required with the top priority of RCHRSP, aiming at restoration of the appropriate function of the gates so as to maintaining or increasing the present production level by preventing the deterioration of the function. Based on the Survey, the following works are highly required.<br>(a) Renewal/Construction of regulator gates,<br>- Renewal of all gate leaves<br>- Renewal of all hoist system with local control panels<br>- Renewal of all host decks with staircase<br>- New construction of remote control panel<br>(b) New construction of river outlet structure gate with guide frames and manually operated hoists<br>(c) Introduction of remote control system<br>(d) New construction of inlet and outlet fixed trash racks<br>(e) New provision of downstream protection works<br>(f) New provision of retaining wall<br>(g) New construction of by-pass for releasing low water to the downstream reach |

| Scope Proposed by MOWRAM in M/D[*1] | Examined Scope of RCHRSP |
|---|---|
| - Rehabilitation of Andong Sla Intake including Replacement of Radial Gate | The results of review showed the urgent necessity of reconstruction of gates and related facilities. The proposed works are;<br>(a) Renewal/Provision of intake gates,<br>- Renewal of gate leaves<br>- Renewal of guide frames<br>- Renewal of electrically driven hoists<br>- New provision of gate remote control operation<br>- Renewal of manually driven hoists<br>(b) New construction of gate piers,<br>(c) New construction of downstream protection, and<br>(d) Partial rehabilitation of approach channel |
| - Rehabilitation of Vat Krouch Intake Structure | Through the review, it was confirmed that the following are needed urgently:<br>(a) Renewal of intake gates,<br>- Renewal of gate leaves<br>- Renewal of guide frames<br>- Renewal of electrically driven hoists<br>- Provision of gate remote control operation<br>- Renewal of manually driven hoists<br>(b) Partial improvement of supply canals*[2], and<br>(c) New construction of structures on supply canals*[2] |
| - Rehabilitation of NMC and SMC with Related Structures, of which the length are 10.0 km respectively | After the site investigation, Length of NMC and SMC to be rehabilitated were determined as 9.1 km and 9.8 km, respectively. Required rehabilitation works on NMC and SMC are identified in the Survey, most of which need urgent improvement to ensure the water supply to the downstream part of the irrigation system. The works required under RCHRSP are;<br>(a) Partial improvement of canal embankment,<br>(b) Partial enlargement of canal section,<br>(c) Partial improvement of bank of canal crossing reservoir,<br>(d) Replacement or partial improvement of structures on Main Canals,<br>(e) Additional construction of structures on Main Canals. |
| - Rehabilitation of Secondary Canals with Related Structures related to the NMC and SMC of 10.0 km respectively. | In connection with rehabilitation for upstream 9.1 km of NMC and 9.8 km of SMC, MOWRAM and PDOWRAM requested to include improvement of relevant secondary canals and their related structures the scope because of urgent and higher necessity of them and also accruing the benefits from the irrigated fields. It is deemed that this request is appropriate from technical viewpoint<br>The works to be additionally requested consist of;<br>(a) Partial rehabilitation, improvement and repair of canals section, and<br>(b) Partial rehabilitation and new construction of related structures |
| - Development of tertiary system in Model Area | MOWRAM requested to include the model area development proposed in M/P in the area of upstream part (upto 7.8 km) of SMC<br>(a) Partial rehabilitation and improvement tertiary irrigation canals, and<br>(b) Partial rehabilitation and improvement of tertiary drains |
| (d) Software Components | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M<br>Not proposed | In order to keep the sustainability of RCHRSP, these are indispensable, thus be included in scope of RCHRSP |
| - Strengthening of FWUC<br>Not proposed | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus be included in scope of RCHRSP |
| - Strengthening of agricultural extension services<br>Not proposed | In order to attain the improvement of agricultural productivity, this is needed, thus be included in scope of RCHRSP |

**1; Minutes of Discussions on Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project, signed on February 25, 2011*

**2; Supply canal; Canals directly branched from approach channels between the Regulator and Intakes*

*Source: JICA Survey Team*

(3) Priority Ranking for Works included in Scope of RCHRSP

As mentioned above, the works originally included in scope of RCHRSP are increased as per the request of MOWRAM and PDOWRAM in connection with the rehabilitation of upstream 10 km of NMC and SMC. It is not sure presently that all of these works could be implemented at the same time in the available loan amount. Thus, as mentioned in Clause II-2.3.1, these examined works are given priority ranking based on the following criteria:

- The works indispensable for attaining at the objective of RCHRSP (rehabilitation of the regulator and the intakes at Roleang Chrey Headworks) are given high priority.

- Urgently required works for proper operation of irrigation system are given priority.
- The facilities which need large scale rehabilitation to convey irrigation water are given priority.
- The facilities which require only minor rehabilitation like maintenance works, are accorded to not high priority.
- The facilities for which the basic data/information on survey, plan and design is available, are given high priority.

**Table II-2.3.6.2 Priority Ranking of Each Work**

| Examined Scope by JICA Survey Team | | Priority |
|---|---|---|
| (a) Hardware Components | | |
| 1) Rehabilitation of Roleang Chrey Headworks | a) Renewal/Construction of regulator gates, | ◎ |
| | b) New construction of river outlet structure gate with guide frames and manually operated hoists | ○ |
| | c) Introduction of remote control system | ◎ |
| | d) New construction of inlet and outlet fixed trash racks | ◎ |
| | e) New provision of downstream protection works | ◎ |
| | f) New provision of retaining wall | ◎ |
| | g) New construction of by-pass for releasing low water to the downstream reach | ◎ |
| 2) Rehabilitation of Andong Sla Intake including Replacement of Radial Gate | a) Renewal/Provision of intake gates | ◎ |
| | b) New construction of gate piers | ◎ |
| | c) New construction of downstream protection | ◎ |
| | d) Partial rehabilitation of approach channel | ◎ |
| 3) Rehabilitation of Vat Krouch Intake Structure | a) Renewal/Provision of intake gates | ◎ |
| | b) Partial improvement of supply canal | △ |
| | c) New construction of structures on supply canal | △ |
| 4) Rehabilitation of NMC and SMC with Length of 9.1 km and 9.8 km respectively, with Related Structures | a) Partial improvement of canal embankment | ○ |
| | b) Partial enlargement of canal section | ○ |
| | c) Partial improvement of bank of canal crossing reservoir | ○ |
| | d) Replacement or improvement of structures on Main Canal | ○ |
| | e) New construction of structures on Main Canal | ○ |
| 5) Rehabilitation of secondary canals and Related Structures | a) Partial rehabilitation, improvement and repair of canals section | △ |
| | b) Partial rehabilitation and new construction of related structures | △ |
| 6) Development of Tertiary Canal System in Model Area | a) Partial rehabilitation and improvement Tertiary Canals | △ |
| | b) Partial rehabilitation and improvement of Tertiary Drains | △ |
| (b) Software Components | | |
| 1) Capacity Development for MOWRAM and PDOWRAM Staff on O&M | Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 2) Strengthening of FWUC | Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC | ◎ |
| 3) Strengthening of Agricultural Extension Service | Executed by PDA under the control of PMU Japan Support Fund of MOWRAM with the support of foreign consultant | ◎ |

**: High Priority: ◎, Medium Priority: ○, Low Priority: △*
*Source: JICA Survey Team*

## II-2.4 Upper Slakou Irrigation System Rehabilitation Sub-project

### II-2.4.1 Basic Concept

The project works proposed in F/S and also by MOWRAM will be reviewed in the following basic concept.

(1) Harmonization of Hardware and Software Components

Low and unstable agricultural production under the mono culture of rain-fed paddy has caused mainly by (i) non-availability of irrigation water due to serious damages of water resource facilities as well as

deteriorated and mal-designed irrigation system, and (ii) less knowledge on and poor experience in improved farming technologies. Since the aim of USISRSP is to improve agricultural productivity through timely and stable water supply to fields and provision of agricultural extension services in the area, the review on the project scope proposed by MOWRAM is carried out under the basic concept of "integrated approach of hardware and software components to ensure the smooth implementation and the sustainability of project".

(2) Determination of Project Scale through Water Balance Study using Updated Relevant Data

Irrigation development should be planned based on available water, available land and the water demand by crops. The irrigation area proposed in F/S will be confirmed through a water balance study using the updated relevant data.

(3) Full Utilization of Existing Facilities

There are the existing irrigation facilities in the USISRSP Area. In order to save construction cost and lighten the burden for land acquisition, these existing irrigation facilities are used as much as possible.

(4) Priority Ranking on Sub-project Scope by Criteria

In order to maximize USISRSP effect using limited budget, proposed items are prioritized based on the set of criteria giving high priority to (i) the works indispensable for attaining at the aim of USISRSP, (ii) Urgently required works for proper operation of irrigation system, (iii) the facilities related to ensuring water resources, and (iv) the facilities which need large scale rehabilitation to convey irrigation water.

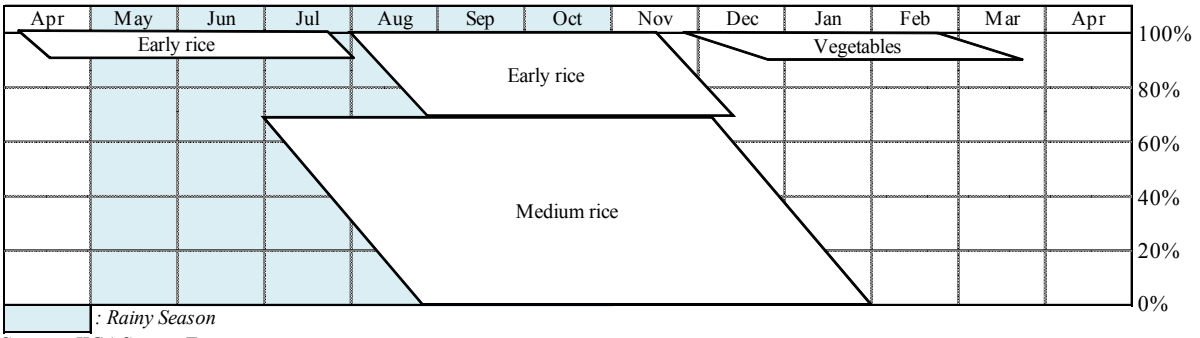
### II-2.4.2 Agricultural Development Plan

The agricultural development plan proposed in F/S (2002) was reviewed through the site visit, analysis on collected latest data and information, discussion with PDA staff, to determine the water demand for water balance study and to contribute to preparation of the appropriate scope of USISRSP. The review results are given in the following table:

**Table II-2.4.2.1 Review on Agricultural Development Plan**

| Item | F/S | Review in 2011 |
|---|---|---|
| 1) Cropping Pattern | Paddy-based cropping system is proposed for improvement of food security. Diversified Crops are also incorporated in the cropping pattern in order to increase farmers' income. | Site visit found that double cropping of paddy has been applied to about 150 ha because the certain irrigation water becomes available due to rehabilitation of Kpob Trobek Reservoir in 2005. In spite of proposal of introduction of diversified crops in F/S, the planted area is less as shown in Figure II-2.4.2.1. Taking into consideration of current cropping pattern, the double cropping of paddy is proposed as shown in Figure II-2.4.2.1 |
| 2) Farming Practices | Three to four times of the fertilizer application volume at the F/S stage are proposed. In addition, improved seed of paddy for both local varieties and HYVs is proposed to produce by the seed production farmers group. | Current farming practices are almost the same with the situation at the F/S Time. Thus, the proposed farming practices in F/S are to be applied. |
| 3) Unit Yield of Paddy | Target unit yield of paddy was estimated at 2.8 ton/ha for local variety, 3.3 ton/ha for HYV. | Based on the current statistic data and also by referring to the promising results of Verification Study executed in the Study on Comprehensive Agricultural Development of Prek Thnot River Basin, target yield can be set at 4.0 ton/ha (early rice) and 3.3 ton/ha (medium rice) which is higher than the yields estimated during the F/S Stage. |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-2.4.2.1 Proposed Cropping Calendar for USISRSP**

## II-2.4.3 Water Balance Study

### II-2.4.3.1 Water Demand

(1) General

The water demand consists of (i) irrigation water requirement for the irrigation area, and (ii) river maintenance flow for the Slakou River to conserve the riverine environment downstream of the Tumnup Lok Reservoir. The maintenance flow was not considered in F/S in 2002. According to Takeo PDOWRAM, no downstream users exist at present.

(2) Irrigation Requirement

Based on the revised cropping pattern consisting of double cropping of rice and one diversified crop in a year as mentioned in Clause II-2.4.2, the irrigation water requirement was re-calculated on half-monthly basis in the same manner with F/S, using updated potential evapo-transpiration rate at Pochentong Observatory, and rainfall data at Basedth instead of that at Takeo. Because rainfall station at Basedth is located at 11 km northwest from the irrigation area while Takeo station used in F/S is at 25 km west. Other conditions such as water saving irrigation method, percolation rate, and irrigation efficiency are not changed from those applied in F/S. As a result, peak irrigation water requirement based on the revised cropping pattern for 3,500 ha with 80% dependability was estimated at 3.5 $m^3$/sec, which is the same value estimated in F/S.

(3) River Maintenance Flow

The river maintenance flow is considered for the Slakou River too. The maintenance flow at the Tumnup Lok Reservoir having catchment area of 332 $km^2$ is determined at 0.051 $m^3$/sec through-out a year. The flow is estimated based on that applied for the Roleang Chrey Headworks on the Prek Thnot River. Namely maintenance flow at the Roleang Chrey Headworks having catchment area of 3,911 $km^2$ is estimated at 0.6 $m^3$/sec as explained in Clause II-2.3.3, then that for the Slakou river is estimated in proportion to the catchment area.

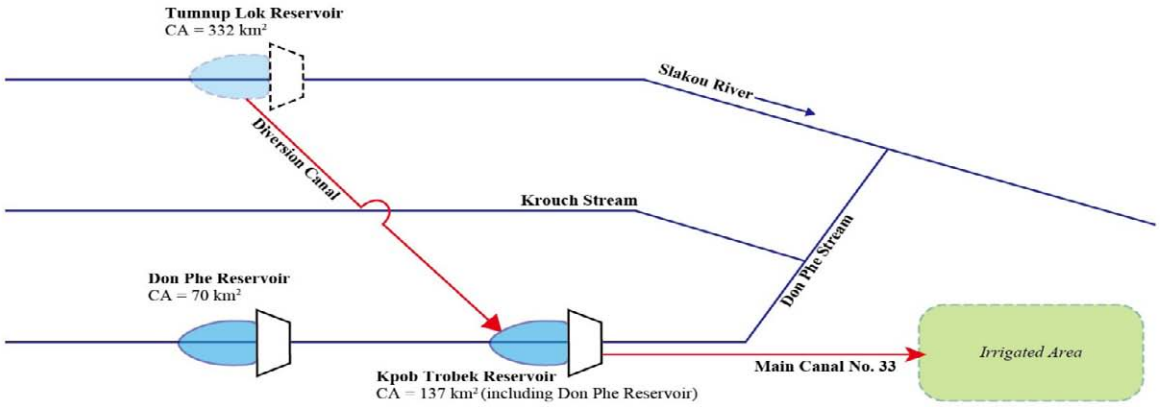
### II-2.4.3.2 Water Balance Study

(1) Calculation Method and Conditions

Water balance study was executed for 20 years from 1966 to 2000 in F/S. In the review, the water balance calculation is made for 30 years by adding 10 years more from 2001 to 2010. The water balance is calculated on the half-monthly basis as applied in F/S. The system has 2 reservoirs, Tumnup Lok on the Slakou River and Kpob Trobek on the Don Phe River. Two reservoirs are connected by the Diversion Canal as shown in Figure II-2.4.3.2.1. The effect of Don Phe Reservoir, located 13 km

upstream of the Kpob Trobek Reservoir with irrigation area of 700 ha, is also taken into account in the same manner with F/S.

On the other hand, as for irrigation area by Don Phe Reservoir, Kampot PDOWRAM planed that irrigation area after rehabilitation by International Fund for Agricultural Development (IFAD) in 2006 would be 2,000 ha in the rainy season and 500 ha in the dry season. However, this irrigation plan of Kampot PDOWRAM, say 2,000 ha in the rainy season and 500 ha in the dry season would be so large as compared with the specific irrigable area per catchment area related to the USISRSP Area, say 9 ha/km$^2$ (3,500 ha/ (332 km$^2$ of Tumnup Lok Reservoir + 67 km$^2$ of Kpob Trobek Reservoir) = 9 ha/km$^2$). Assuming this specific irrigable area per catchment area and 70 km$^2$ of catchment area of Don Phe Reservoir, the irrigation area by Don Phe Reservoir would be roughly calculated to be approximately 630 ha. Considering the result of this review and accuracy of calculation, it can be said that 700 ha of the assumed irrigation area in F/S as mentioned above is applicable for the water balance study.




*Source: JICA Survey Team*

**Figure II-2.4.3.2.1 Schematic Diagram of Water Resources**

As explained in Sub-clause II-1.3.2.2, runoffs for these streams are estimated on a monthly basis at the Kpob Trobek Reservoir and the Tumnup Lok Reservoir. The dimensions of concerned reservoirs applied for the water balance calculation are tabulated below.

**Table II-2.4.3.2.1 Storage Capacity Applied for Water Balance Study**

| Item | Unit | Tumnup Lok | Kpob Trobek | Don Phe |
|---|---|---|---|---|
| Effective Storage Volume | (MCM) | 1.00 | 2.63 | 2.50 |
| Catchment Area | (km$^2$) | 332 | 137 | 70 |

*Source: JICA Survey Team*

(2) Result of Water Balance Calculation

Possible irrigation area is estimated using irrigation water demand per 1,000 ha of each crop proposed, the river maintenance flow, river runoffs, and storage effects of reservoirs. As a result, the following cultivation areas of crops could be realized with 80% dependability.

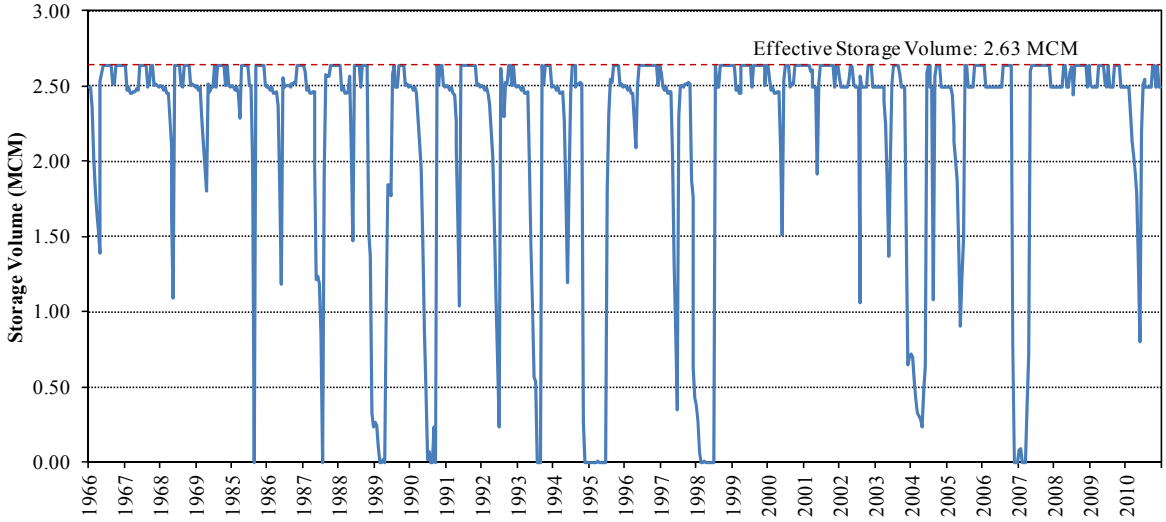
**Table II-2.4.3.2.2 Results of Water Balance Study** (Unit: ha)

| Stage | Medium Rice (RS) | HYV-1 Rice (RS) | HYV-2 Rice (Early RS) | Diversified Crop-1 (Early RS) | Diversified Crop-2 (Early RS) | Cropping Intensity |
|---|---|---|---|---|---|---|
| F/S in 2002 | 2,400 | 1,100 | - | 500 | 550 | 130% |
| Review in 2011 | 2,400 | 1,100 | 200 | - | 200 | 111% |

*Note: RS means "Rainy Season".*
*Source: JICA Survey Team*

Cultivation area of rainy season paddy is 3,500 ha in total as estimated in F/S. Paddy field in the early rainy season and diversified crops in the late rainy season are limited to 200 ha, respectively. Cropping intensity comes to 111%. USISRSP provides supplemental irrigation water for the rainy season, but not for the dry season due to lack of water resources.

The changes of storage volumes of the Kpob Trobek Reservoir under the above cropping pattern for 30 years are shown below.




*Source: JICA Survey Team*

**Figure II-2.4.3.2.2 Changes of Storage Volumes of Kpob Trobek Reservoir**

Serious deficits more than half month occur 6 times in 1989, 1990, 1993, 1994 to 1995, 1998, 2006, 2007, and short time deficits for a half month occur in years of 1985 and 1987.

## II-2.4.4 Hardware Components

### II-2.4.4.1 Reservoir Rehabilitation Works

(1) Tumnup Lok Reservoir

No rehabilitation/reconstruction work has been implemented for the reservoir since the F/S Stage. So, there is no significant change of the existing conditions and facilities. Although some 20 houses have been constructed inside the reservoir since 2007, these will not be influenced by stored water due to topographically high place.

The flood discharge with return period of 1 in 100 years is revised at 450 $m^3$/sec through the review in 2011. Revised discharge is increased by 7% from 420 $m^3$/sec estimated in F/S in 2002. Consequently, the width of weir-type spillway is to be lengthened to 230 m from the proposed length of 215 m in F/S.

The review results of the proposed work in F/S are tabulated below and the general layout plan of the reservoir is given in Figure AD-2.2.1.3.3 in ANNEX D.

**Table II-2.4.4.1.1 Review of Tumnup Lok Reservoir**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Compensation for submergence of the existing farm land | Since 1990's, farmers have been using the reservoir area as cultivated land, mainly paddy fields. The estimated area of affected land would be 130 ha (220 ha at FWL).<br>Compensatory work for the land use is to be provided by MOWRAM. | MOWRAM is confident of successful implementation of the compensation for the land within the reservoir area and has started part of compensation work. |

| Item | F/S | Review in 2011 |
|---|---|---|
| (b) Dike | Bearing capacity of the foundation is suitable for concrete structures and /or constructing dike of about 5-7 m high.<br>Re-shaping of the existing dike, protection of the slope on the reservoir side with impervious materials such as laterite, and laying filter materials on the opposite slope of the dike would be required. | The proposed work is acceptable with condition that further investigations about the foundation and embankment materials will be made in the design stage. |
| (c) Spillway | An overflow-type fixed weir of 215 m long is proposed for preventing damage to the dike due to operational failure. | Considering remote location of the site and future maintenance of the spillway, over-flow type is suitable. Width of spillway would be lengthened to 230 m due to change of flood discharge. |
| | Design flood discharge of 420 $m^3$/sec, which is 1-in-100-year recurrence period, is adopted. | Design Manual of MOWRAM proposes to take 50-200 years return period. Updated design flood discharge is estimated at 450 $m^3$/sec (107% of 420 $m^3$/sec) |
| | No bridge over the spillway is proposed for the spillway portion, but the crest width of 4 m for access during dry season is provided | Access to the right bank from the left bank is available via Basedth town. No provision of bridge is suitable for saving construction cost. |
| (d) Maintenance gate | Sand flushing gate is needed to reduce the sediment in the reservoir. Provision of one maintenance gate structure with two manual gates of 1.5 m × 1.5 m | The gate would also be used for releasing river maintenance flow to the downstream |
| (e) Intake structures | Three intake structures were planned: one is for the diversion canal and other two are for two tertiary blocks of 15 ha in total downstream the reservoir | Two intake structures for tertiary blocks might be integrated into one. These two structures are located within 200 m. |

*Source: JICA Survey Team*

(2) Kpob Trobek Reservoir

Based on the results of the M/P Study and F/S in 2002, MOWRAM implemented a part of the proposed works, namely urgent rehabilitation work for the Kpob Trobek Reservoir in 2005. The urgent work implemented by MOWRAM consists of (i) re-construction of breached dike for 180 m and raising dike elevation for full length of 3.3 km, (ii) construction of gated spillway with bridge, (iii) replacement of intake structures for the Main Canal 33 and the Canal 24, and (iv) replacement of 2 maintenance gate structures on the dike. Above works of MOWRAM for the Kpob Trobek Reservoir is examined as tabulated below, based on the design drawings of gated spillway and updated flood discharge of the Don Phe River at the reservoir site.

**Table II-2.4.4.1.2 Comparison of Design Values of Spillway on Kpob Trobek Reservoir**

| Item | F/S | Existing Spillway Constructed by MOWRAM* | Remarks |
|---|---|---|---|
| | (2002) | (2005) | |
| FWL | EL. 38.1 m | EL. 38.1 m | No change |
| HWL | EL. 37.3 m | EL. 37.3 m | No change |
| LWL | EL. 34.2 m | EL. 34.2 m | No change |
| Length of spillway | 160 m | 48 m | about 1/3 of one proposed in F/S |
| Nos. of gates | 0 | 6 | F/S proposed non-gated spillway considering future O&M |
| Type and size of gate | - | Automatic flap gate with counter weight,<br>8 m wide × 1.8 m high | |
| Crest EL. of fixed weir | EL. 37.3 m | EL. 36.3 m | 1 m below than one proposed in F/S |
| Road (dike) surface elevation | EL. 39.0 - 39.3 m | EL. 39.0 - 39.3 m | No change |
| Bridge on the spillway | Causeway was proposed | Road bridge of 80 m long for national road No.130A | The road surface was paved by asphalt in 2008 |
| Design flood discharge | 195 $m^3$/sec<br>Return period of 100 year | 203 $m^3$/sec<br>Updated flood discharge with 100 years return period | Design Manual of MOWRAM recommends to take 50-200 years return period |
| Flow capacity of spillway | 196 $m^3$/sec<br>OK | 209 $m^3$/sec<br>OK | Gated spillway has C value of 1.8 (narrow weir) |

*Source: JICA Survey Team*

As the result of the above examination, it was judged that the new spillway and dike have been constructed as proposed in F/S and new spillway has enough capacity even for updated flood discharge. Intakes and maintenance gates are also in good condition. The current problem is some seepage from the eroded dike.

(3) Proposed Improvement Work for Automatic Spillway Gates on Kpob Trobek Reservoir

Judging from the present condition, operation record and design concept, it could be said that all gates function. However, it is proposed that the following improvement work on flap gates should be carried out to operate the gate surely and safely.

- The existing concrete made of counter weights of all gates should be replaced with steel made counter weights which should be divided into several pieces to easy adjust their weight in order to open the designated water levels of each gate.
- The designated water levels and weight of counter weight of each gate should be decided in the coming D/D Stage after due consideration of the reservoir operation.
- All bearings of hoists should be renewed with new ones since it is deemed that the sticking of such bearing due to rust and no lubricant increases friction force for the rotation of wire drums. It is noted that such necessity of replacement was confirmed by the joint inspection of the mechanical engineer of MOWRAM and the JICA Survey Team on July 25, 2011.
- The repair painting should be applied to the damaged area of all gate leaves.

### II-2.4.4.2 Diversion Canal Rehabilitation Works

Proposed alignment of the Diversion Canal in F/S for 9.4 km was planned to utilize the existing canal route, except detour route near passing point with the Krouch River by a siphon structure, then connects the existing Diversion Canal to the Kpob Trobek Reservoir (Figure AD-2.2.1.3.5 in ANNEX D). The designed longitudinal gradient of the canal was set at 1 in 4,400, and canal bed width of 2.0 m. The water depth is 1.4 m for the designed discharge of 3.5 $m^3$/sec. The canal will be constructed with borrowed material suitable for embankment.

Review results of the Diversion Canal based on the observation in the fields are tabulated as below.

**Table II-2.4.4.2.1 Review of Diversion Canal**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Canal route | Utilizing the existing canal except crossing point with Krouch River | No serious obstruction is found, the proposed route in F/S is applicable to minimize land acquisition. |
| (b) Canal Cross section and lining | Due to low degree of erosion resistance of existing canal bank materials, the canal bank is to be lined by laterite | Serious erosion of side slopes of the canal is observed. Erosion of side slopes has progressed. Earth lining of 0.5 m thick is to be planned as proposed in F/S. The advantage of earth lining is confirmed through cost comparison among lining methods by soil cement, and geo- synthetic sand bag etc. Earth lining will be carried out using borrowed material suitable for embankment. |
| (c) Siphon across the Krouch River | 75 m long with double barrel of 1.3 × 1.3 m each was proposed through comparison with aqueduct. | Topography is flat and no suitable site to construct aqueduct is available; according to the study in M/P, construction of O Saray Reservoir is not economical. The siphon plan is reasonable. |
| (d) Excavation of sediments on the canal bed | Excavate the canal bed for 1-1.5 m | After Sta. 0+700 m, sedimentation on the bottom of the canal has been increased due to erosion of slopes and inflows from adjacent areas |
| (e) Road bridge | Three road bridges were proposed at crossing point with National Road 130A and commune road near temple and O Saray River | Since one bridge near O Saray River was constructed in 2006, road bridge to be constructed would be two only |
| (f) Slope protection for outer bend portion | Not included | Serious erosion is found at the bend portion near the Temple (Sta. 2+800) |

*Source: JICA Survey Team*

As the result of review, minor adjustment of proposed plan of F/S for nos. of road bridge (refer to Figure II-2.4.4.2.1), and additional work for slope protection by solid material would be needed.

### II-2.4.4.3 Irrigation and Drainage Canal Facility Rehabilitation Works

(1) Main Canal 33

According to F/S, the design discharge of the Main Canal 33 at the beginning point is 3.2 $m^3$/sec, and reduces to 1.0 $m^3$/sec by the end point (diversion point to C20). However, the canal would also have function as a drain. The existing canal section has the capacity to serve as a drain at the bottom part of the section. Using the unit drainage requirement of 1.6 lit/sec/ha, the drainage capacity of 2.0 $m^3$/sec for a catchment of 12 $km^2$ would be needed as the minimum capacity of the Main Canal 33.

The following are the review results of the Main Canal 33 based on the observation in the fields:

**Table II-2.4.4.3.1 Review of Main Canal 33**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Canal route | Utilizing the existing canal | The concept of full utilization of the existing canal is acceptable. |
| (b) Canal Cross section and lining | Proposed canal dimensions are: bed width of 2.0 m, design water depth of 1.2-1.6 m with flow velocity of 0.4 - 0.6 m/sec.<br>No lining is proposed | The present canal is used for dual purpose of irrigation and drainage. So the section is much larger than the proposed section, namely bottom width of more than 5 m and height of 2 - 3 m. Canal sections remain as proposed in F/S as the minimum section. |
| (c) Off-takes with regulating structures | Six off-takes with regulating structures were proposed. | All the existing off-takes and regulating structures are found not functional and new structures are needed.<br>No change from the proposal in F/S |
| (d) Drop structures | Four nos. of drops were proposed to keep allowable velocity in the canal | All the existing drops are found not functional and new structures are needed.<br>No change from the proposal in F/S |
| (e) Private access over the canal | No description | Several private access structures across the canal are found, other than road culverts identified in F/S. Integration of these access would be needed |

*Source: JICA Survey Team*

Significant change from development plan prepared during F/S would not be required, except for the treatment of private accesses over the canal.

(2) Secondary Canals

Seven secondary canals of 44.7 km in total were planned to distribute irrigation water to farm land through tertiary canals and watercourses. Although the design capacity from the irrigation requirement varies from 0.2 to 0.85 $m^3$/sec, the capacity of the existing secondary canals would also be maintained to drain the excess water flowing from the surrounding fields. Assuming that the area of tertiary blocks along a stretch of secondary canal is 120 ha, a capacity of about 200 lit/sec (120 ha × 1.6 lit/sec/ha ≈ 200 lit/sec) would be maintained for the stretch. The drained water (200 lit/sec) would be discharged through a side spillway constructed at the end of the stretch into a lateral drain. The following are review results of secondary canals based on the observation in the fields:

**Table II-2.4.4.3.2 Review of Secondary Canals**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Canal route | Utilizing the existing canal | No serious obstruction is found , except secondary canals of C3U, and C3D along National Road 130A<br>Removal of obstructions would be needed. |
| (b) Canal section and lining | Most of canals are proposed to be unlined canal, but 10.3 km (or 23%) out of 44.7 km is proposed to be lined by earth or soil cement, to maintain the minimum permissible velocity. | Canal lining would not be required for maintaining the minimum velocity, but for preventing leakage and grass growth.<br>5 km or about 10% of total length is planned for the canal lining for the permeable sections. |

| Item | F/S | Review in 2011 |
|---|---|---|
| (c) Related structures | Diversion structures, off-takes, regulators, drops, road crossing structures and cross drains are proposed. | All existing structures are seriously deteriorated and not functional, except some culverts and bridges on commune and village roads.<br>So, all the required structures shall be newly constructed. |

*Source: JICA Survey Team*

Treatment of obstructions on the canal routes especially for 3D and 3U, such as private access constructed by backfilling the canal, concrete access and temporary huts, would be needed by MOWRAM. Lining could be reduced to 10% of the total length of secondary canals.

(3) Tertiary blocks

As stated previously, there is no systematic tertiary canal system at present. The irrigation area was planned to be divided into 106 tertiary blocks with average area of 33 ha in F/S. Assuming 1,000 m long of tertiary canal per 33 ha, its total length would be estimated at 110 km. In each tertiary block, watercourses are proposed for commanding 5 ha per watercourse. Length of the watercourse may be 1,200 m per 5 ha, or 1,260 km for whole area of 3,500 ha. Construction of tertiary canal was considered to be contracted to local contractors, while the watercourses would be constructed by beneficiary farmers. Alignment of tertiary canals as well as size of tertiary canal blocks would be determined by FWUC under support of PDOWRAM. Land required for tertiary canals and watercourses would be provided by beneficiary farmers according to the government regulation. The following are review results of the tertiary blocks:

**Table II-2.4.4.3.3 Review of Tertiary Blocks**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Tertiary blocks | Irrigation area of 3,500 ha is divided into 106 tertiary blocks with average extent of 33 ha | Although the "Design Manual of MOWRAM" in 2004 recommended the maximum extent of block of 25 ha, the layout of blocks seems to meet the actual filed conditions.<br>Layout plan of tertiary blocks would be finalized based on the manual and intensions of concerned beneficiary farmers |
| (b) Provision of land for canals | Land for tertiary canals is assumed to be provided by the beneficiary farmers. | According to the experience of TSC, it took very long time to provide the land for Tertiary Canal.<br>The work for the tertiary canal system development would be carried out under the responsibility of MOWRAM and PDOWRAM. |

*Source: JICA Survey Team*

Although the necessity of the development for tertiary canal system is well recognized, it might take long time to acquire the land for tertiary canals and watercourses. It is therefore proposed that the tertiary canal system development would be implemented under the responsibility of MOWRAM.

(4) Embankment Materials for Rehabilitation

The soils of the irrigation areas are mainly silty sand, clayey sand, sandy clay, and clay. The embankment materials of rehabilitation of dikes and canals should be borrowed material suitable for embankment, clayey gravel, excavated material of the existing dikes, and excavated materials in the area inside the reservoirs and USISRSP areas. It is confirmed that the suitable materials are available at the borrow area adjacent to Prey Kdouch village located about 4 km westward from Trapeang Kranhung. Such materials suitable for embankment should be used for slope and surface protection of dike and canals, and surface pavement of roads.

(5) Provision of O&M Equipment

O&M of the irrigation facilities was proposed to be conducted substantially by FWUC after completion of the construction works and taking over of the facilities. A site office was planned to be constructed independently for the construction management and future O&M for PDOWRAM. As for office and

operational equipment, the following were planned to be procured under USISRSP, while no provision of heavy construction equipment for the maintenance works was proposed considering heavy burden for maintaining these heavy equipment:

**Table II-2.4.4.3.4 Review of O&M Equipment**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Vehicle | A four-wheel drive vehicle: 1 no. | This matter is discussed in Section II-4.3. |
| (b) Motorcycle | Motorcycles: 8 nos. | This matter is discussed in Section II-4.3. |
| (c) Communication Equipment | Walky-talkies: 3 nos. | Since cell phones are widely utilized in USISRSP area, communication equipment is not additionally required. |
| (d) Generator | Generator: 1 no. | This matter is discussed in Section II-4.3. |
| (e) Office Equipment for O&M Office | Photo copy machines and computers and furniture | This matter is discussed in Section II-4.3. |
| (f) Office Equipment for FWUC Office | Photo copy machines and computers and furniture | This matter is discussed in Section II-4.3. |

*Source: JICA Survey Team*

(6) Facilities for FWUC

ISF collection would be one of the fundamental activities for FWUGs that will be organized by respective secondary canal command areas. It was considered in F/S that ISF was usually collected as in-kind paddy and sold to buyers or at markets to provide funds for O&M activities. In the area, there was no suitable place and facility for ISF collection and storage. So F/S proposed to construct and provide the followings:

**Table II-2.4.4.3.5 Review of Facilities for FWUC**

| Item | F/S | Review in 2011 |
|---|---|---|
| (a) Office | Community office with storage (500 $m^2$): 6 nos. for each FWUG | This matter is discussed in Section II-4.3. |
| (b) Drying yard | Drying yard (108 $m^2$): 6 nos. | According to the information from FWUC Kpob Trobek, ISF has been collected in cash at Riel 30,000 /ha/year and collection by in-kind is not conducted at present. Therefore, it is not necessary to provide any drying yards and platform scale under USISRSP. |
| (c) Platform scale | Platform scale (200 kg) : 6 nos. | |

*Source: JICA Survey Team*

## II-2.4.5 Software Components

### II-2.4.5.1 Strengthening of MOWRAM and PDOWRAM Staff on O&M

Implementation of USISRSP consists of 3 stages: (i) design stage, (ii) construction stage and (iii) O&M stage. In particular, the staff of MOWRAM and Takeo PDOWRAM will be required to take initiatives in O&M of rehabilitated irrigation facilities so as to maintain overall sustainability of the system. It is, therefore, necessary to enhance capability of MOWRAM and PDOWRAM staff focusing on O&M skills through the software components activities.

**Table II-2.4.5.1.1 Review on Strengthening of Government Agencies Concerned**

| Item | F/S | Review in 2011 |
|---|---|---|
| Capacity building of Staff of MOWRAM and Takeo PDOWRAM | F/S proposed the following methods on the capacity building of staff of MOWRAM and Takeo PDOWRAM:<br>- Strengthening capacity of planning, design, and construction management<br>- Assignment of additional engineering staff for planning, design, and construction management<br>- Training of staff concerned of PDOWRAM as well as MOWRAM | Focus is given on ensuring sustainability of rehabilitated facilities. Therefore, the enhancement of MOWRAM and PDOWRAM staff's capability on O&M of irrigation system is proposed activities for the software components of USISRSP. Foreign consultant will be employed at the initial stage of the program to prepare work plan and to conduct trial trainings. Then, PMU Japan Support Fund will continuously carry out overall management by assigning technical staff of MOWRAM, employing national consultants and through utilizing accumulated know-how within MOWRAM like useful training curricula in TSC. |

*Source: JICA Survey Team*

### II-2.4.5.2 Strengthening of Farmer Water Users Community

FWUC will be responsible for O&M of minor canals. However, FWUC is presently inactive and could not execute the proper O&M of minor canals. In order to improve such situation, it is indispensable to strengthen FWUC timely.

**Table II.2.4.5.2.1 Review on Strengthening of FWUC**

| Item | F/S | Review in 2011 |
|---|---|---|
| Formation of FWUC | F/S proposes to take the following activities to organize FWUC smoothly<br>- Creation of farmers' awareness<br>- Establishment of FWUG<br>- Formation of Apex committee and preparation of statute<br>- Registration of FWUC | According to the relevant government policy, FWUC should be established for each irrigation system. These proposed activities will be conducted by PDOWRAM to be trained by technical units under PUM Japan Support Fund, relevant technical departments of MOWRAM and TSC. |
| Enhancement of activities of FWUC | F/S proposes the following strengthening measures for FWUC:<br>- Preparation of irrigation schedule, operation program, O&M program<br>- Enhancement of O&M of irrigation facilities | PIMD specifies the procedure and methodology for these measures. Thus, in line with PIMD, these measures shall be provided for FWUC by PDOWRAM to be trained by technical units under PUM Japan Support Fund, relevant technical departments of MOWRAM and TSC. |

*Source: JICA Survey Team*

As proposed in RCHRSP, TOT will be similarly applied for USISRSP. In the program, capacity development program for concerned PDOWRAM staff will be carried out by relevant technical units under PMU Japan Support Fund. Then, the trained PDOWRAM staff will train the FWUC member taking into account the sustainable strengthening of FWUC.

### II-2.4.5.3 Strengthening of Agricultural Extension Services

Agricultural extension services are indispensable for attaining the targeted crop yield and crop production as well as the sustainability of USISRSP. Considering the existing situation surrounding rice production and export in Cambodia, review was carried out for them proposed in F/S focusing on the extension services. The results of review are mentioned in Table II-2.4.5.3.1.

**Table II-2.4.5.3.1 Review on Agricultural Support Services**

| Item | F/S | Review in 2011 |
|---|---|---|
| 1) Strengthening Plan for Agricultural Extension Services | The extension plan basically conforms to the present framework of the PDA extension system, and is proposed to strengthen the present system, especially on activities in the field of VEWs. For this purpose, F/S proposes as the agriculture support program, that extension FGs including VEWs should be organized under VDCs, and farmers' leaders. Further demonstration plot (Demo-plots) should be set up in farmers' fields. | Currently number of extension workers is limited, and extension services have been carried out, depending on the budget, which is available. Currently FGs have been formulated by village chief, according to the schedule of extension activities. Thus, this strengthening plan should be incorporated in the scope of USISRSP, although further detailed study might be required at the next stage in the light of the latest policy. Especially, FFS and short-term trainings are considered as major extension activities. |
| 2) Establishment of Extension Farmers' Group | F/S proposes to consider the following principles and lessons learnt from the past projects supported by NGOs and development partners for formation of Extension FGs:<br>- All FGs should produce benefit for members of FGs.<br>- Member fee of FGs should be minimized.<br>- Well-organized and -operated VDC's know-how should be utilized.<br>- Training should be provided to members of FGs in order to create a sense of solidarity and mutual aid, and avoid violation of rules.<br>- Management persons of FGs should get a reasonable allowance in proportion to the profits of their FG activity. | The proposal on formation of FGs in F/S should be taken into consideration.<br>Basically, it is proposed that FGs be members of FWUC. This subject is discussed in Sub-clause II-2.4.5.3. |

| Item | F/S | Review in 2011 |
|---|---|---|
| 3) Seed Production Plan | F/S recommends the promotion of seed multiplication and seed distribution However its cost for investment as well as operation is not considered in the project cost. | In order to increase the unit yield of crop, it is important to apply quality seeds.<br>Regarding rice production, MAFF has promoted rice production, and proposed to use the recommendable 10 varieties to each province<br>In principle, the system of seed production and seed distribution should be managed by MAFF in cooperation with CARDI and the Agricultural Quality Improvement Project (AQIP) seeds company. Furthermore, PDA has carried out promotion plan for seed multiplication and distribution, based on the national policy. Therefore, this plan should not be included in the scope of USISRSP. |
| (4) Distribution plan of farm inputs | It is proposed that FGs manage purchase and distribution of farm inputs as a small business of FGs. | Farmers are not really facing to the serious situation on procurement of farm inputs. It is expected that group purchase could be required in the future. Therefore this plan should not be considered in the scope of USISRSP. |

*Source: JICA Survey Team*

### II-2.4.6 Scope of Sub-project

(1) Examination of Scope of Upper Slakou Irrigation System Rehabilitation Sub-project Proposed by Ministry of Water Resources and Meteorology

In the previous Sections and Clauses, the works proposed by MOWRAM were examined from technical and economical viewpoints and also considering application of Japan loan, through review on previous studies like M/P and F/S, site visits, hearing from farmers and a series of discussions with MOWRAM and PDOWRAM. The results of examination are shown in the following table, comparing with the works proposed by MOWRAM:

**Table II-2.4.6.1 Examined Scope of USISRSP**

| Scope Proposed by MOWRAM in M/D* and F/S | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| (a) Irrigation Development Area | | |
| - 3,500 ha | - 3,500 ha | Justified through water balance study |
| (b) Cropping Pattern and Crop Intensity | | |
| - Paddy-based cropping system with upland crops<br>- Crop intensity: 130% | - Paddy-based cropping system with upland crops<br>- Crop intensity: 111% | Application of paddy double cropping system considering present cropping pattern |
| (c) Hardware Components | | |
| - Rehabilitation of 2 reservoirs including spillway, outlet structures and a diversion canal between the 2 reservoirs with related structures<br>Tumnup Lok Reservoir<br>Kpob Trobek Reservoir | - Tumnup Lok Reservoir<br>Partial rehabilitation of the existing dike (2.3 km), and new construction of the reservoir facilities including over-flow type spillway of 230m, one maintenance gate, and 2 intakes for diversion canal.<br>- Kpob Trobek Reservoir<br>Partial minor repairs of flap gates on spillway (6 nos.) and new provision of slope protection for dike (3.3 km). | - Construction of tertiary canal for 15 ha is not included in scope of USISRSP |
| - Diversion canal | - Full reshaping and lining of existing canal section (9.4 km), including new construction of 2 bridges, one cross drain and one siphon (75 m long) crossing the Krouch River. | |
| - Main canal with related structures | - Partial rehabilitation of Main Canal 33 (7.3 km) including new construction of related structures | |
| - Secondary canals with related structures | - Partial rehabilitation of 7 secondary canals (44.7 km in total) including new construction of related structures | |

| Scope Proposed by MOWRAM in M/D* and F/S | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| - Tertiary canals and related structures | - New construction of tertiary canals for 110 km and related structures with condition that MOWRAM will provide special arrangement for acquiring land for tertiary canals | Development plan and design for tertiary canals and related structures will be made by employing national consultant. Construction of tertiary canals and related structures will be carried out by local contractors to be selected through LCB. All of the works will be under the responsibility of PMU Japan Support Fund. |
| - | - New provision of O&M facility and equipment | FWUC office is included. But heavy construction equipment is not included. |
| (d) Software Components | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M<br>Not proposed | In order to keep the sustainability of USISRSP, these are indispensable, thus should be included in scope of USISRSP | |
| - Strengthening of FWUC<br>Not proposed | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus should be included in scope of USISRSP | |
| - Strengthening of agricultural extension services<br>Not proposed | In order to attain the improvement of agricultural productivity, this is needed, thus should be included in scope of USISRSP | |

**: Minutes of Discussion dated February 25, 2011*
*Source: JICA Survey Team*

(2) Priority Ranking for Works included in Scope of Upper Slakou Irrigation System Rehabilitation Sub-project

There are many works in hardware and software components in the examined scope of USISRSP. It is not sure presently that all of these works could be simultaneously implemented in the available loan amount. Thus, as mention in Clause II-2.4.1, these examined works are given priority ranking based on the following criteria

- The works indispensable for attaining at the aim of USISRSP mentioned above are given high priority.
- Urgently required works for proper operation of irrigation system are given high priority.
- The facilities related to ensuring water resources should be given high priority since USISRSP severely suffers from shortage of irrigation water.
- The facilities which need large scale rehabilitation to convey irrigation water are given high priority.
- The facilities which require only minor rehabilitation like maintenance works, are accorded to not high priority.

**Table II-2.4.6.2 Priority Ranking for Each Work**

| Examined Scope by JICA Survey Team | | Priority* |
|---|---|---|
| (a) Hardware Components | | |
| - Tumnup Lok Reservoir | - Partial rehabilitation of the existing dike (2.3 km) | ◎ |
| | - New construction of the reservoir facilities including over-flow type spillway of 230 m, one maintenance gate, and 2 intakes for diversion canal. | ◎ |
| - Kpob Trobek Reservoir | - Partial minor repairs of flap gates on spillway (6 nos.) | ○ |
| | - New provision of slope protection for dike (3.3 km) | ○ |
| - Diversion canal with related structures | - Full reshaping and lining of existing canal section (9.4 km) | ◎ |
| | - New construction of 2 bridges, one cross drain and one siphon (75 m long) crossing the Krouch River | ◎ |

| Examined Scope by JICA Survey Team | | Priority* |
|---|---|---|
| - Main canal with related structures | - Partial rehabilitation of Main Canal 33 (7.3 km) | ◎ |
| | - New construction of related structures | ◎ |
| - Secondary canals with related structures | - Partial rehabilitation of 7 secondary canals (44.7 km in total) | ○ |
| | - New construction of related structures | ○ |
| - Tertiary canals and related structures | - New construction of tertiary canals (110 km in total). MOWRAM will make special arrangement for acquiring land for tertiary canals timely | △ |
| | - New construction of related structures | △ |
| - Provision of O&M facility and equipment | - New procurement of O&M equipment (vehicle and motor cycles excluding heavy construction equipment, and FWUC office) | △ |
| (b) Software Components | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M | Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| - Strengthening of FWUC | Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| - Strengthening of agricultural extension services | Executed by PDA under the control of PMU Japan Support Fund of MOWRAM with the support of foreign consultant | ◎ |

*Source: JICA Survey Team*

**: High Priority: ◎, Medium Priority: ○, Low Priority: △*

## II-2.5 Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

### II-2.5.1 Basic Concept

The project works planned in M/P and F/S in 1995 will be reviewed in the following basic concept paying attention upon the current conditions of the KSBISRSP Area.

(1) Integrated Approach of Hardware and Software Components

Irrigated agriculture development for KSBISRSP is planned in the concept of integrated approach of hardware and software components which is the same with USISRSP, in order to heighten the project effect and to maintain the project sustainability.

(2) Consideration of New Water Source

Irrigation development for KSBISRSP, especially for Kandal Stung area, is planned taking into consideration the released water from the Stung Tasal dam located upstream of Prek Thnot River.

(3) Determination of Project Scale through Water Balance Study

Irrigation development should be planned mainly based on available water, available land and the water demand by crops. Since KSBISRSP has enough farm land for irrigation, its project size will be determined through a water balance study.

(4) Full Utilization of Existing Canal System

There are the existing irrigation canals which were constructed in Pol Pot regime, in the KSBISRSP area. In order to save construction cost and lighten the burden for land acquisition, these existing irrigation canals are used as much as possible.

(5) Application of Concrete Lining to Canals

In the priority area (1,950 ha) in the Kandal Stung, main canal was provided with concrete lining, which was financed by JICA. Considering gradual expansion of advanced/modern irrigation system in Cambodia and easy O&M, MOWRAM strongly desires to apply the same system to KSBISRSP. Thus, concrete lining will be applied only for main canals in due consideration of saving the project cost, taking into account such MOWRAM's desire.

(6) Use of Part of Pol Pot Canals as Main Drains

In order to eliminate the excess water from field smoothly and considering easy water management, part of the existing Pol Pot canals will be used as main drainage canals with reshaping work, but no other drains are planned considering difficulty in land acquisition and saving construction cost.

(7) Priority Ranking on Sub-project Scope by Criteria

As KSBISRSP requires many project works, these will be prioritized so as to use the limited budget. High priority should be given to (i) the works indispensable for attaining at the aim of USISRSP, (ii) Urgently required works for proper operation of irrigation system, (iii) the facilities related to ensuring water resources, and (iv) the facilities which need large scale rehabilitation to convey irrigation water.

### II-2.5.2 Agricultural Development Plan

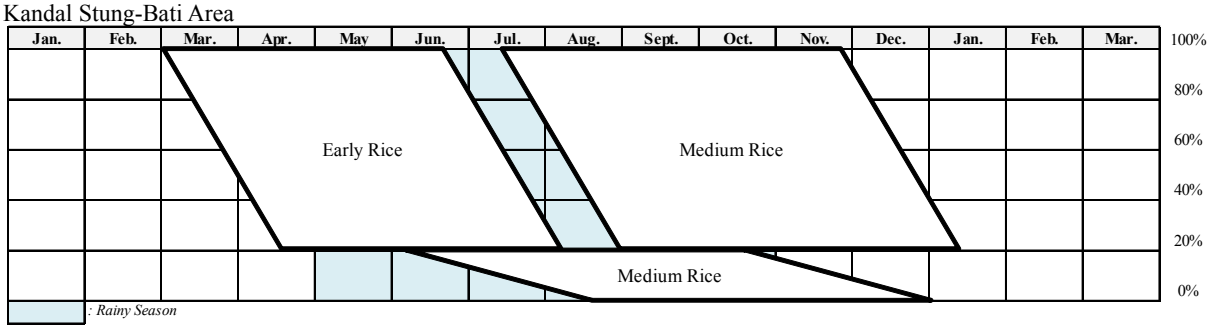
The agricultural development plan proposed in F/S (1995) was reviewed through the site visit, analysis on collected latest data and information from the relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute to preparation of the appropriate scope of KSBISRSP. The review results are given in the following table:

**Table II-2.5.2.1 Review on Agricultural Development Plan**

| Item | F/S | Review in 2011 |
|---|---|---|
| 1) Cropping Pattern | (a) Paddy-based cropping system is proposed for improvement of food security. Diversified crops are also incorporated in the cropping pattern in order to increase farmers' income.<br>(b) Proposed cropping intensity is around 180%, that is 150% of double cropping of paddy and 30% of single cropping of upland crops during dry season. | (a) It is understandable that double cropping of paddy is applied in some area. Further triple cropping of paddy is also applied in this area, although its area is so limited. In spite of proposal of introduction of diversified crops in F/S, most farmers prefer to cultivate paddy double cropping and triple cropping as well. Taking into consideration current cropping pattern, just double cropping of paddy is proposed as shown in Figure II-2.5.2.1.<br>(b) 180% of cropping intensity is proposed considering the present cultivation condition, if the water is available. |
| 2) Farming Practices | Three to four times of the fertilizer application volume at the F/S Stage are proposed. In addition, improved seed of paddy for both local varieties and HYVs is proposed to produce by the seed production farmers group. | Current farming practices are almost the same with the situation at the F/S Time. Thus, the proposed farming practices in F/S are to be applied. Dosage amount of fertilizer could be reviewed. |
| 3) Unit Yield of Paddy | Target unit yield of paddy was estimated at 3.0 ton/ha for local variety, 4.0 ton/ha for HYV. | Based on the current statistic data and also by referring to the promising results of Verification Study executed in the Study on Comprehensive Agricultural Development of Prek Thnot River Basin, target yield can be set at 4.0 ton/ha (early rice) and 3.5 ton/ha (medium rice) which is slightly higher than the yields estimated during the F/S Stage. |

*Source: JICA Survey Team*

Kandal Stung-Bati Area




*Source: JICA Survey Team*

**Figure II-2.5.2.1 Proposed Cropping Calendar for KSBISRSP**

### II-2.5.3 Water Balance Study

#### II-2.5.3.1 Water Demand

(1) General

The water balance study was reviewed and updated in the Survey in order to confirm the possible extent of the irrigable area estimated in M/P. In M/P, water demand was estimated using statistically estimated monthly rainfall both with 80% and 50% dependability. The water demand consists of irrigation water requirement in the Roleang Chrey Irrigation System and responsible discharge both for river maintenance flow and responsible release for the irrigation demand in downstream irrigation projects which is as the Kandal Stung Area, the Tonle Bati Area, the Dangkor System and the Kampong Damrey Area. In this Survey, the water balance simulation was conducted for RCHRSP and KSBISRSP using long-term (30 years) discharge and irrigation water requirement at each command area by 5-day steps.

(2) Irrigation Water Requirement

Irrigation water requirement was calculated based on the proposed cropping pattern consisting of early variety and medium variety of paddy and upland crop in a year with overall cropping intensity of 114% with 80% dependability for the Roleang Chrey Irrigation System, cropping intensity of 174%-180% with 80% dependability for the KSBISRSP Area. The water requirement was calculated by almost the same procedure with M/P although some modifications were made, which is summarized in the following table with comparison to those in M/P.

**Table II-2.5.3.1.1 Conditions for Estimate of Irrigation Water Requirement for KSBISRSP**

| Item | M/P Study | This Survey |
|---|---|---|
| Calculation interval | 5-day basis | Remain unchanged |
| Method for estimating potential evapo-transpiration | Penman-Montieth method | Remain unchanged |
| Meteorological data | Pochentong Station (Phnom Penh) | Remain unchanged |
| Rainfall data | Kampong Speu Station (Base year statistically estimated) | Roleang Chrey: Pochentong Station (Phnom Penh); 1982-2011<br>KSBT: Bari Station; 1982-2011 |
| Percolation rate | 8 mm/day<br>With introduction of water saving irrigation Method | Remain unchanged |
| Irrigation efficiency | Paddy; 66%<br>Upland crop; 53% | Remain unchanged |

*Source: JICA Survey Team*

The average diversion water requirements at the Roleang Chrey Irrigation System estimated in this Survey is summarized Table II-2.5.3.1.2. Also, average diversion water requirement for the Kandal Stung-Bari Irrigation System estimated in this Survey is shown in Table II-2.5.3.1.3.

**Table II-2.5.3.1.2 Summary of Estimated Average Diversion Water Requirement for Roleang Chrey Irrigation System (Average of 30 years; 1982-2011)** (Unit: $m^3$/sec)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roleang Chrey Zone-I; 80% Dependability Area (5,660 ha) | | | | | | | | | | | | |
| 1-5 | 0.0 | 0.0 | 0.0 | 0.1 | 0.8 | 0.7 | 1.2 | 5.4 | 3.2 | 3.5 | 8.3 | 2.9 |
| 6-10 | 0.0 | 0.0 | 0.0 | 0.2 | 0.8 | 0.8 | 1.8 | 6.0 | 3.0 | 3.6 | 7.1 | 1.7 |
| 11-15 | 0.0 | 0.0 | 0.0 | 0.4 | 0.7 | 0.8 | 2.8 | 6.6 | 2.7 | 3.8 | 6.3 | 0.9 |
| 16-20 | 0.0 | 0.0 | 0.0 | 0.6 | 0.7 | 0.8 | 4.1 | 6.9 | 3.1 | 4.2 | 5.4 | 0.0 |
| 21-25 | 0.0 | 0.0 | 0.0 | 0.8 | 0.7 | 0.8 | 4.6 | 6.8 | 3.6 | 4.6 | 4.5 | 0.0 |
| 26-end | 0.0 | 0.0 | 0.0 | 1.0 | 0.7 | 0.8 | 5.2 | 6.3 | 3.7 | 4.7 | 3.6 | 0.0 |
| Roleang Chrey Zone-II; 50% Dependability Area (11,040 ha) | | | | | | | | | | | | |
| 1-5 | 0.0 | 0.0 | 0.0 | 0.2 | 1.6 | 1.4 | 2.3 | 10.5 | 6.2 | 6.8 | 16.3 | 5.7 |
| 6-10 | 0.0 | 0.0 | 0.0 | 0.4 | 1.6 | 1.5 | 3.6 | 11.6 | 5.8 | 7.1 | 13.9 | 3.4 |
| 11-15 | 0.0 | 0.0 | 0.0 | 0.8 | 1.4 | 1.5 | 5.5 | 12.9 | 5.3 | 7.3 | 12.3 | 1.7 |
| 16-20 | 0.0 | 0.0 | 0.0 | 1.2 | 1.3 | 1.5 | 8.0 | 13.5 | 6.1 | 8.2 | 10.5 | 0.0 |
| 21-25 | 0.0 | 0.0 | 0.0 | 1.6 | 1.4 | 1.5 | 9.0 | 13.2 | 7.0 | 9.0 | 8.7 | 0.0 |
| 26-end | 0.0 | 0.0 | 0.0 | 1.9 | 1.4 | 1.5 | 10.2 | 12.3 | 7.3 | 9.2 | 7.1 | 0.0 |

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roleang Chrey Irrigation System Total | | | | | | | | | | | | |
| 1-5 | 0.0 | 0.0 | 0.0 | 0.2 | 2.4 | 2.1 | 3.5 | 15.8 | 9.4 | 10.3 | 24.6 | 8.7 |
| 6-10 | 0.0 | 0.0 | 0.0 | 0.6 | 2.4 | 2.2 | 5.4 | 17.6 | 8.8 | 10.7 | 21.1 | 5.2 |
| 11-15 | 0.0 | 0.0 | 0.0 | 1.2 | 2.2 | 2.3 | 8.3 | 19.5 | 8.0 | 11.1 | 18.6 | 2.6 |
| 16-20 | 0.0 | 0.0 | 0.0 | 1.9 | 2.0 | 2.3 | 12.1 | 20.4 | 9.2 | 12.4 | 15.9 | 0.0 |
| 21-25 | 0.0 | 0.0 | 0.0 | 2.4 | 2.1 | 2.3 | 13.7 | 20.0 | 10.6 | 13.6 | 13.2 | 0.0 |
| 26-end | 0.0 | 0.0 | 0.0 | 2.8 | 2.1 | 2.3 | 15.4 | 18.6 | 11.0 | 13.9 | 10.7 | 0.0 |

*Source: JICA Survey Team*

**Table II-2.5.3.1.3 Summary of Estimated Average Diversion Water Requirement for Kandal Stung-Bati Irrigation System (Average of 30 years; 1982-2011)**

(Unit: $m^3$/sec)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kandal Stung (Grant) Irrigation System | | | | | | | | | | | | |
| 1-5 | 0.8 | 0.7 | 0.0 | 0.0 | 0.9 | 0.9 | 1.8 | 1.0 | 0.3 | 1.0 | 0.7 | 1.2 |
| 6-10 | 0.7 | 0.7 | 0.0 | 0.0 | 1.1 | 0.9 | 1.9 | 0.9 | 0.3 | 1.0 | 0.7 | 1.2 |
| 11-15 | 0.6 | 0.7 | 0.0 | 0.1 | 1.1 | 1.7 | 1.2 | 0.8 | 1.1 | 0.2 | 0.7 | 1.2 |
| 16-20 | 0.7 | 0.5 | 0.0 | 0.1 | 1.3 | 1.7 | 1.3 | 0.7 | 1.1 | 0.2 | 0.8 | 1.1 |
| 21-25 | 0.6 | 0.2 | 0.0 | 0.1 | 1.4 | 1.9 | 1.2 | 0.7 | 1.1 | 0.2 | 0.8 | 1.0 |
| 26-end | 0.8 | 0.1 | 0.0 | 0.9 | 0.7 | 1.9 | 1.1 | 0.7 | 1.1 | 0.2 | 0.8 | 1.0 |
| Tonle Bati Irrigation System | | | | | | | | | | | | |
| 1-5 | 0.7 | 0.6 | 0.0 | 0.0 | 0.8 | 0.7 | 1.5 | 0.8 | 0.2 | 0.9 | 0.6 | 1.0 |
| 6-10 | 0.6 | 0.6 | 0.0 | 0.0 | 0.9 | 0.7 | 1.6 | 0.7 | 0.2 | 0.9 | 0.6 | 1.1 |
| 11-15 | 0.5 | 0.6 | 0.0 | 0.0 | 0.9 | 1.4 | 1.0 | 0.7 | 0.9 | 0.2 | 0.6 | 1.1 |
| 16-20 | 0.6 | 0.4 | 0.0 | 0.0 | 1.1 | 1.4 | 1.0 | 0.6 | 0.9 | 0.2 | 0.7 | 1.0 |
| 21-25 | 0.5 | 0.2 | 0.0 | 0.0 | 1.2 | 1.5 | 1.0 | 0.5 | 1.0 | 0.2 | 0.7 | 0.9 |
| 26-end | 0.7 | 0.0 | 0.0 | 0.8 | 0.6 | 1.6 | 0.9 | 0.6 | 0.9 | 0.1 | 0.7 | 0.9 |
| Total | | | | | | | | | | | | |
| 1-5 | 1.6 | 1.4 | 0.0 | 0.0 | 1.7 | 1.6 | 3.3 | 1.8 | 0.5 | 1.9 | 1.4 | 2.2 |
| 6-10 | 1.4 | 1.3 | 0.0 | 0.0 | 1.9 | 1.6 | 3.5 | 1.6 | 0.5 | 1.9 | 1.3 | 2.2 |
| 11-15 | 1.2 | 1.3 | 0.0 | 0.1 | 2.1 | 3.1 | 2.1 | 1.5 | 2.0 | 0.4 | 1.3 | 2.3 |
| 16-20 | 1.3 | 0.9 | 0.0 | 0.1 | 2.4 | 3.1 | 2.3 | 1.3 | 2.0 | 0.4 | 1.4 | 2.1 |
| 21-25 | 1.2 | 0.5 | 0.0 | 0.1 | 2.6 | 3.4 | 2.2 | 1.2 | 2.1 | 0.4 | 1.5 | 1.9 |
| 26-end | 1.4 | 0.1 | 0.0 | 1.7 | 1.3 | 3.5 | 2.1 | 1.3 | 2.0 | 0.3 | 1.6 | 1.8 |

*Source: JICA Survey Team*

(3) River Maintenance Flow and Obligatory Discharge to Downstream

The river maintenance flow to downstream from the Roleang Chrey Headworks was estimated at 0.6 $m^3$/sec throughout a year by referring to the guidelines of Japan[6]. Irrigation water requirement for the Dangkor Irrigation Systems was given the same value as mentioned in M/P.

**Table II-2.5.3.1.4 Monthly Water Requirement of Dangkor Irrigation System**

(Unit: $m^3$/sec)

| Irrigation System | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dangkor | 0.0 | 0.0 | 0.0 | 0.2 | 0.05 | 0.05 | 0.16 | 0.3 | 0.18 | 0.21 | 0.23 | 0.03 |

*Source : The Study on Comprehensive Agricultural Development of Prek Thnot River Basin In the Kingdom of Cambodia, JICA, 2008*

### II-2.5.3.2 Water Balance Study without Dams

(1) Calculation Method and Conditions

In M/P, the water balance was simulated applying the probable river run off and water demand estimated with statistically analyzed for 80% dependability and 50% dependability. In this Survey, long-term water balance simulation method was applied. The water balance simulation in the review in this Survey is summarized as below with comparison to those in the previous the M/P Study.

**Table II-2.5.3.2.1 Comparison of Water Balance Simulation between M/P and this Survey for Roleang Chrey and Kandal Stung-Bati Irrigation Systems**

| Item | M/P Study | This Survey |
|---|---|---|
| Calculation interval | 5-day basis | Remain unchanged |
| Method for estimating potential evapo-transpiration | Penman-Montieth method | Remain unchanged |
| Runoff data | Estimated from the data at Peam Khley station | Remain unchanged |
| Water balance in Ou Krang Amble System | Storage effect of 2 upstream reservoirs are considered | Remain unchanged |

[6] *River maintenance flow; between mean annual draught runoff and 1/10 dependable draught runoff*

| Item | M/P Study | This Survey |
|---|---|---|
| Simulation model | Refer to Figure AD-2.1.1.3.2 | Roleang Chrey + Kandal Stung-Bati Irrigation System + Dangkor System |
| Reference year | Kampong Speu Station (Reference year statistically estimated) | By the long-term (1982-2011; 30years) simulation |
| Irrigation fail | Continuous deficit in 10 days | Continuous deficit in 15 days |

*Source: JICA Survey Team*

(2) Result of Water Balance Calculation

Results of water balance calculation are summarized in Table II-2.5.3.2.2. As the results of water balance calculation, the 80% dependable area was estimated at 5,660 ha against 5,660 ha in M/P for the Roleang Chrey Zone-I. In the Kandal Stung Grant Area, total 1,950 ha with crop intensity of 174% was shown for 83% dependability. While in the Tonle Bati Irrigation Area, total 1,600 ha with crop intensity of 180% was shown for 100% dependability. As mentioned above and the conservative viewpoint, it is proposed to use the 80% and 50% dependable areas planned in M/P.

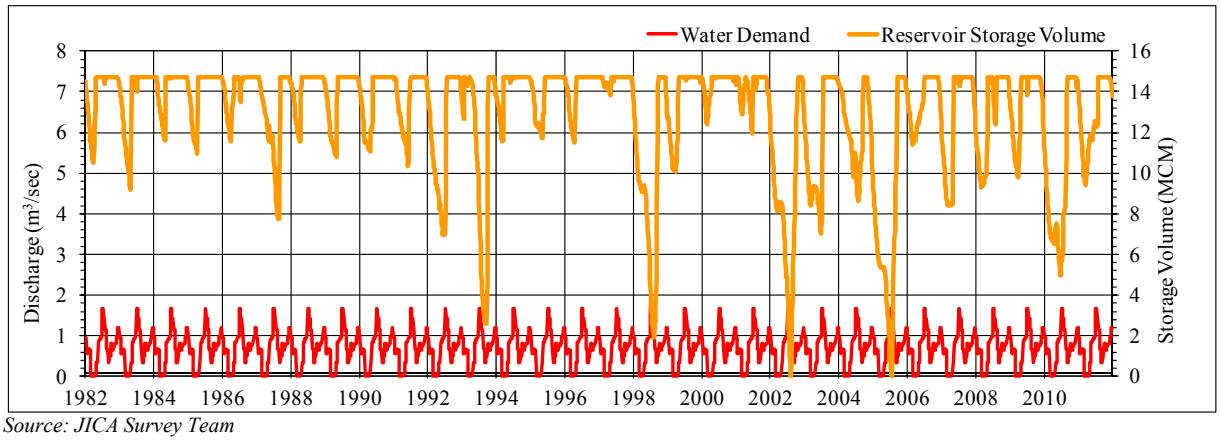
**Table II-2.5.3.2.2 Results of Water Balance Simulation for Roleang Chrey and Kandal Stung-Bati Irrigation Area**

| Item | Roleang Chrey (Zone-I) | Roleang Chrey (Zone-II) | Dangkor System | Kandal Stung (Grant) | Kandal Stung (Extension) | Bati Area |
|---|---|---|---|---|---|---|
| Total Irrigation Area (ha) | 5,660 | 11,040 | 300 | 1,950 | 0 | 1,600 |
| Early Rice-1 | 500 | 975 | 42 | 975 | 0 | 800 |
| Medium Rice | 5,162 | 10,069 | 258 | 975 | 0 | 800 |
| Early Rice-2 | 500 | 975 | 42 | 900 | 0 | 800 |
| Upland Crop | 280 | 546 | 0 | 540 | 0 | 480 |
| Crop Intensity | 114% | 114% | 114% | 174% | 0% | 180% |
| Dependability | 80% | 57% | 80% | 83% | | 100% |

*Source: JICA Survey Team*

The changes of storage volumes of the Lake Tonle Bati under the above cropping pattern for 30 years are shown below.

Serious deficits more than half month occur six times in 2002, 2005, and short time deficits occur in years of 1993, 1998 and 2010.




*Source: JICA Survey Team*

**Figure II-2.5.3.2.1 Changes of Storage Volumes of Lake Tonle Bati**

### II-2.5.3.3 Water Balance Study with Dams

(1) General

The water balance study with dams is discussed in Chapter II-8, so that details of study are described there. Summary of study is mentioned hereunder.

(2) Case Study

The water balance study with dams is carried out for the following 5 cases:

**Table II-2.5.3.3.1 Study Case of Water Balance Study for Proposed Dam Plans**

| Case | Combination of Proposed Dams |
|---|---|
| Case-1 | with Stung Tasal Dam only |
| Case-2 | with Stung Tasal Dam + K-water 3 Dams |
| Case-3 | with Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam |
| Case-4 | with Stung Tasal Dam + K-water 3 Dams + Stung Khleach Dam |
| Case-5 | with Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam + Stung Khleach Dam |

*Source: JICA Survey Team*

(3) Results of Water Balance Study with Dams

Table II-2.5.3.3.2 shows the results of water balance study for 5 cases:

**Table II-2.5.3.3.2 Summary of Case Study of Water Balance Simulation with Dams**

(Unit of Area: ha)

| Case No. | Dangkor Irrigation Area | | | Roleang Chrey-I (80% Zone-I) | | | Roleang Chrey-II (50% Zone-II) | | | RC |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area | Crop Intensity | Dependability | Total Area | Crop Intensity | Dependability | Total Area | Crop Intensity | Dependability | Total Area |
| Case-1 | 300 | 180% | 90% | 16,000 | 180% | 80% | 700 | 130% | 77% | 16,700 |
| Case-2 | 300 | 180% | 93% | 15,400 | 180% | 80% | 1,300 | 130% | 80% | 16,700 |
| Case-3 | 300 | 180% | 93% | 16,700 | 180% | 80% | 0 | - | - | 16,700 |
| Case-4 | 300 | 180% | 93% | 16,700 | 180% | 80% | 0 | - | - | 16,700 |
| Case-5 | 300 | 180% | 93% | 16,700 | 200% | 80% | 0 | - | - | 16,700 |

| Case No. | Kandal Stung (Grant) | | | Kandal Stung (Extension) | | | Tonle Bati (Priority Area) | | | KSBT |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area | Crop Intensity | Dependability | Total Area | Crop Intensity | Dependability | Total Area | Crop Intensity | Dependability | Total Area |
| Case-1 | 1,950 | 180% | 97% | 1,800 | 180% | 93% | 4,200 | 180% | 80% | 7,950 |
| Case-2 | 1,950 | 180% | 97% | 1,750 | 180% | 93% | 4,200 | 180% | 80% | 7,900 |
| Case-3 | 1,950 | 180% | 100% | 4,200 | 180% | 93% | 6,000 | 180% | 83% | 12,150 |
| Case-4 | 1,950 | 180% | 100% | 2,940 | 180% | 93% | 6,000 | 180% | 80% | 10,890 |
| Case-5 | 1,950 | 200% | 100% | 4,200 | 200% | 93% | 6,000 | 200% | 80% | 12,150 |

*Source: JICA Survey Team*

As can be seen in the above table, it is clarified that the Kandal Stung Area (Extension: 1,750 ha) could be irrigated with crop intensity of 180 % for any case.

## II-2.5.4 Hardware Components

### II-2.5.4.1 Rehabilitation of Water Resource Facilities

(1) Diversion Weir (headworks) on Stung Touch River for Kandal Stung Area

In M/P, no diversion weir was planned on the Stung Touch River, but supplied from the main canal of priority area. Considering prior completion of Priority Area of 1,950 ha in 2007, provision of 2 diversion weirs on the Stung Touch River was proposed by MOWRAM. One is upgrading the existing weir at Thmei commune and the other is construction of new headworks just downstream of crossing point between EW-58 and NS-82 (near Lake Saba).

As for the former existing weir at Thmei commune, taking it into consideration the existing gated weir at Thmei commune is rather new structure of passing 6 years only and also in view of token of friendship of goodwill, the existing one shall be remained as it is. However, it is obvious that flow capacity of the existing gated portion is much less than the design flood of 57 $m^3$/sec (probable flood with 100 years). It is thus proposed to construct overflow type spillway at the site. The latter new headworks would be needed to divert the water to KC-31 (EW-58) and NS-82 (connection canal to Tonle Bati).

(2) Intake and Pumping station for Tonle Bati Area

The following are the review results based on the observation in the field and results of water balance study:

**Table II-2.5.4.1.1 Review of Pump Station at Lake Tonle Bati**

| Item | F/S in 1995 | Review in2012 |
|---|---|---|
| Existing condition | Three sets of diesel engine driven pumps with capacity of 8 $m^3$/min (one set) and 5 $m^3$/min (other two sets); Total capacity is 18 $m^3$/min (or 0.3 $m^3$/sec);<br>The pump capacity is not sufficient to supply irrigation water to the whole project area;<br>The pumps are used for providing supplemental water in low water level season of the Lake Tonle Bati | Three same pump sets are still functioning, with minor maintenance such as replacement of a diesel engine in 2011;<br>Pump operation and water level of Lake Tonle Bati has not been recorded by PDOWRAM and no operation cost is charged to beneficiaries;<br>Pumps have been operated depending on the request of District Governor, and for 2-3 month per year only |
| Basic consideration for the improvement | Water level of the Lake Tonle Bati will be lowered in dry season even after augmentation from the Prek Thnot River through connection canal. | Water level of the lake will vary from EL. 5.5 m and HWL of 7.8 m for full use of effective water in the lake. |
| Capacity of pumps | Four sets (including one spare set) of horizontal volute type pump with capacity of 45 $m^3$/min and 30kW per set; total head is 4.5 m ;<br>(Total capacity of 3 sets of pumps is 2.25 $m^3$/sec) | Assuming the pumps will be operated between HWL (EL. 7.8 m) and LWL (EL. 5.5 m), the required pump up discharge is estimated at 2.0 $m^3$/sec.<br>The proposed capacity of F/S is confirmed. |
| Conclusion | Replacement of pump station with 4 pump units including one stand-by set | No change is needed and apply as proposed in F/S, with condition that water users community will be organized for sustainable use of the pumps |

*Source: JICA Survey Team*

Assuming fuel consumption rate of 0.4 lit/kWh, operation period of 3 month with 30 kW and diesel oil price of US$ 1.25/lit, total cost of fuel is calculated at US$ 32,400 for 1,600 ha, or US$ 20 /ha. Sustainable O&M of pumps shall be realized through organization of FWUC with strong assistance of MOWRAM.

(3) Daeum Rues Regulator on the Prek Thnot River

To supply irrigation water from the Prek Thnot River to the Stung Touch River, Daeum Rues Regulator was provided at the end of supply channel from the Kandal Stung Regulator on the Prek Thnot River. MOWRAM proposes to replace the existing Deum Russ Regulator due to lack of flow capacity and difficulty in operation. According to MOWRAM, difficulty in operation of gates is caused by present layout of gates which are set with flow direction diagonally. The gates of the regulator were heightened to meet the intake water level of new Kandal Stung Regulator on the Prek Thnot River constructed under the Japan's Grant Aid program in 2005-2007.

Present flow capacity is estimated at 10 -15 $m^3$/sec based on the flow area and assumed flow velocity, which is more than the requirement of 9 $m^3$/s, equivalent to the irrigation requirement of 6,000 ha (=4,200 ha in Tonle Bati + 1,750 ha in Kandal Extension). Considering frequent operation of gates would be required after completion of the Stung Tasal Reservoir and importance of the structure for about 6,000 ha, it is planned to replace the said regulator as proposed by MOWRAM. Major points of new regulator would be (i) provision of easy lifting gear for gates, (ii) setting of the gate surface to be right angle to the flow direction, (iii) installation of water level gauge for discharge measuring, and (iv) downstream protection.

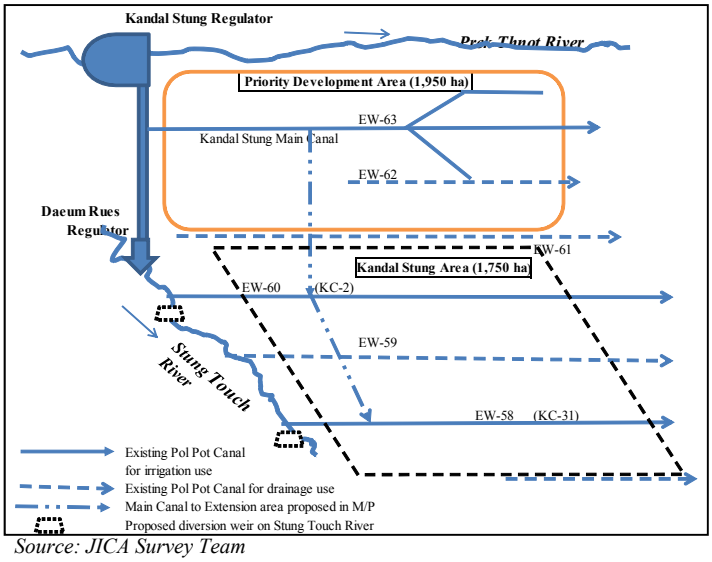
### II-2.5.4.2 Irrigation and Drainage Canal Facility Rehabilitation Works

(1) Main and Secondary Canals

Main irrigation canal system consisting of main and secondary canals is formulated by full use of the existing Pol Pot canals. In case of Kandal Stung Area of 1,750 ha, M/P showed that irrigation water was planned to be supplied to the Kandal Stung Area through main canal for the priority area (EW-63

canal). However, EW-63 canal was already improved for the priority area of 1,950 ha only, and there is no capacity for further development of the Kandal Stung Area. Then, MOWRAM proposed to supply water to the Extension Area of 1,750 ha through the Stung Touch River by constructing new diversion weirs (headworks) and improvement of Daeum Rues Regulator.

The Bati Area has 2 existing main irrigation canals of MR-1 and MR-3 and 6 laterals. Theses canals cover all area of 1,600 ha. One drainage canal of MC-2 (or MD-1) runs along the western edge of the irrigation area.




*Source: JICA Survey Team*

**Figure II-2.5.4.2.1 Schematic Diagram of Kandal Stung Area of 1,750 ha**

Most of the existing canals were constructed by excavating the ground surface, and dikes and roads along canals which were formed by excavated soils. Main purposes of the canals were just conveyance of the irrigation water as near as possible to the fields, and drainage of excessive water from the paddy fields. Gravity irrigation was not aimed. Deterioration and eroded condition of the existing canals is mainly caused by (i) dual use of canals for irrigation and drainage purposes, (ii) erosive soils used for canals, and (iii) lack of periodic maintenance. Lack of maintenance by beneficiaries was mainly caused by insufficient water supplies to the canals. M/P and F/S proposed to reshape canal sections and place a concrete lining of 150 mm thickness for canal slopes of the main and secondary (lateral) canals. Cost of lining work accounted for about 60% of the total rehabilitation cost of main canal and 40% of laterals. Assuming that the unit direct construction cost for rehabilitation work is desired to be lower than US$ 3,000 per ha from the economic view point (by MEF), concrete lining as proposed in M/P and F/S is to be limited. However, the following are to be considered to rehabilitate and upgrading the existing irrigation canals which were originally constructed in Pol Pot regime in late 1970':

- Main canal for the priority area of 1,950 ha, which was rehabilitated and upgraded with Japan's assistance, has been lined by concrete as a model development;
- The above development is expected to contribute toward developing the advanced/ modern irrigation system;
- Objective areas of Kandal Stung Area of 1,750 ha and Bati Area of 1,600 ha are located just adjacent to the model area above;
- Expansion of the model area is strongly desired by MOWRAM as a model for modernization of Pol Pot canals
- Lightening the budgetary burden of O&M activities is strongly desired due to limited budget for maintenance works of canals
- Lining cost should be reasonable range of total project cost, but not excessively like one proposed in F/S.

It is, therefore, decided to apply Portland cement concrete lining of 75 mm thickness with wire mesh of D10mm@25cm grid, for main canals only (EW-60 and EW-58 in Kandal Stung area, and MR-1 and

MR-3 of Tonle Bati Area), and just apply re-shaping of cross sections and longitudinal profiles for secondary (lateral) canals. From lessons learnt in the construction of lining canal for the main canal of the model area using the swellability soils, the lining work shall be realized based on the careful study on the soil mechanics on the embankment materials.

**Table II-2.5.4.2.1 Review of Main and Secondary Canals**

| Item | M/P and F/S in 1995 | Review in 2012 |
|---|---|---|
| (a) Improvement of main and secondary canals | Kandal Stung Area: 0 km and 18.3 km<br><br>Bati Area: Main canal of 8.3 km (rehabilitation) and secondary canals of 10 km (rehabilitation of 6.9 km and new of 3.1 km) | Kandal Stung area: 2 main canals of 11.3 km (rehabilitation) from Stung Touch River and 2 secondary canals of 5.0 km (rehabilitation and new)<br>Bati area: 2 main canals of 7.6 km (rehabilitation) and 6 secondary canals of 8.6 km (rehabilitation) |
| (b) Lining of canals | Two phased concrete lining (lining of 150 mm thickness for slopes) and sod facing for main and secondary (lateral) canals: Total length of 36.6 km | Concrete lining of 75 mm thick is limited to main canals of 18.9 km only, for saving construction cost and extending the advanced or modern irrigation system |

*Source: JICA Survey Team*

(2) Drainage canals

F/S proposed to improve the main and secondary drains of about 21 km long in the Kandal Stung Area and 24 km long in the Bati Area for realizing complete drainage system. Considering difficulty in (i) land acquisition for construction of new drains, and (ii) no report about serious drainage problems except caused by large floods, no substantial drainage improvement is considered except main drainage canals as applied to the priority development area in the Kandal Stung Area. Main drainage canals will be improved through re-shaping of the existing Pol Pot canal sections and provision of drain inlets and bridges/ culverts.

**Table II-2.5.4.2.2 Review of Main Drainage Canal**

| Item | M/P and F/S in 1995 | Review in 2012 |
|---|---|---|
| (a) Main drainage system | Kandal Stung Area: 21 km, and<br>Bati area: 24 km | Re-shaping of the existing Pol Pot canals as main drains only is planned; Kandal Stung Area of 12.1 km and Bati are of 6.7 km, considering difficulty in land acquisition and resistance to inundation of paddy |
| (b) Related structures | Bridges, culverts, and closing bunds | In addition to ones proposed in M/P and F/S, drainage inlets are to be included. |

*Source: JICA Survey Team*

### II-2.5.4.3 Other Related Facility Rehabilitation Works

(1) Connection Canal to Lake Tonle Bati from Stung Touch River

For conveying water from the Prek Thnot River to Lake Tonle Bati through the Stung Touch River for further development of 2,600 ha (= 4,200 ha-1,600 ha), activation of NS-78 canal with construction of diversion weir on the Stung Touch River was proposed in F/S. The flow capacity of connection canal was set at 7 $m^3$/sec for full development of 4,200 ha. Considering augmentation of irrigation water source by construction of the Stung Tasal Reservoir on the Prek Thnot River by MOWRAM, and high demand of irrigation development in the area, construction of connection canal from the Stung Touch River to the Lake Tonle Bati is now highly desirable. It is proposed to include the connection canal in the Sub-project with condition that MOWRAM will start necessary arrangement for the further development of remaining area of 2,600 ha. The proposed route of NS-78 (4.8 km), however, has a problem, namely, high cost of concrete lining due to dispersive soils, necessity of construction of diversion weir and intake newly.

The connection canal of NS-87 of 4.6 km long (Original Route) was originally constructed in Pol Pot regime. MOWRAM has tried to activate it in early 1990, but canal section has excavated halfway only and no diversion weir has been constructed due to difficulty in provision of construction fund. In F/S the construction cost was estimated at US$ 4.0 million consisting of US$ 3.3 million for connection canal and US$ 0.7 million for diversion weir with intake (headworks). This amount of US$ 4.0 million accounts for about 30% of total construction cost for irrigation and drainage work under Stage 1 for 1,600 ha. It is noted that the cost for lining work of the NS-78 account for about 80% of the total construction cost for treatment against dispersive soils along the route by self-retaining 2 phased reinforced concrete canal lining. Unit rehabilitation cost for the Tonle Bati Area including the cost for connection canal (US$ 4.0 million) and pump station (US$ 2.2 million) was thus estimated at US$ 8,700 /ha in F/S. For saving the cost of connection canal, an alternative route is worked out. The alternative (Alternative Route) is a route by enlarging the existing canal of NS-82 which was also constructed in Pol Pot regime. The intake site of the Alternative Route is set at about 9 km downstream from one for NS-78 canal and length to the Lake Tonle Bati is 3.5 km long.

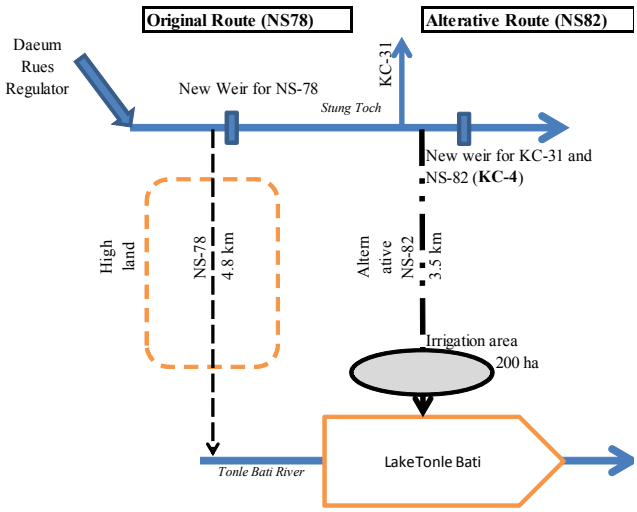



**Figure II-2.5.4.3.1 Alternative Route of Connection Canal**

It is proposed to alter the canal route to NS-82 of 3.5 km due to less construction cost, though soil mechanics investigation would be needed in design stage. In addition, NS-82 could supply the irrigation water to the area near the Tonle Bati Area of about 200 ha. Further, one headworks could contribute to KC-31 (EW-58), and the connection canal (NS-82). Comparison of 2 alternative routes is summarized as below.

**Table II-2.5.4.3.1 Study on Alternative Route for Connection Canal from Stung Touch to Lake Tonle Bati**

| Item | NS-78 (Original Route in F/S (1995)) | NS-82 (KC-4) Alternative Route |
|---|---|---|
| (a) Existing condition | Canal runs in high elevated area. The canal is so deep and the canal berm encounters dispersive clay layers and many eroded soils deposit on the existing canal bed. Canal bed rises from EL. 10.3 m at Sta.500 m to EL. 13.2 m at Sta. 1,600 m and then goes down gradually to the Tonle Bati River. | The canal is partially used as pond and canal, but side slope of canal bank remains rather in good condition. This canal is also incomplete canal. The canal bed raises from EL. 8.2 m at Sta. 600 m to EL. 10.5 m till Sta. 2,600 m, and then goes down gradually to the lake. |
| (b) Soil mechanics condition | Huge and serious erosion is observed due to dispersive soils and easy to eroded away soils | No serious erosion is observed except some short stretch, though additional investigation will be required |
| (c) Possible irrigation area on the way to Lake Tonle Bati | Rainfed rice field spread on the both sides, but elevation of these fields are higher than EL. 16 m; lifting of 5-6 m high is needed for irrigation: lifting irrigation is not realistic | Irrigation area of 200 ha located near Lake Tonle Bati is expected, though some lifting arrangement for 2-3 m high is needed. |
| (d) Diversion weir | Construction of new diversion weir with intake is proposed for NS-78 | Construction of a new diversion weir is proposed for the main irrigation canal of EW-58 (KC-31) and NS-82 (KC-4) |
| (e) Canal section | Self-retaining 2 phase canal lining (1.8 m high, reinforced concrete) for full stretch, considering dispersive soils | Canal lining by reinforced thin concrete (75 mm thick) could be assumed for full stretch, though soil mechanics investigation would be needed |

| Item | NS-78 (Original Route in F/S (1995)) | NS-82 (KC-4) Alternative Route |
|---|---|---|
| (f) Earth work quantity | Cut volume of about 250,000 $m^3$ is additionally required | Additional excavation volume is estimated at about 230,000 $m^3$, which is similar to one for NS-78 |
| (g) Estimated construction cost<br>Total<br>Lining<br>Earth work<br>Weir | About 80% of total cost is account of lining cost against dispersive soils<br>(Quoted from F/S report)<br>US$ 4.0 million)<br>US$ 2.6 million (79%)<br>US$ 0.7 million (21%)<br>US$ 0.7 million | It is expected to reduce the cost by nearly 50% due to less need of lining (rough estimate based on F/S cost only)<br>US$ 2.1 million<br>Assuming 40% of NS-78: US$ 1.0 million<br>90% of NS-78 * US$ 0.7 million<br>Half of F/S for dual use: US$ 0.4 million |
| (h) Conclusion | Proposed to construct NS-78 with intake structure and diversion weir as originally planned by MOWRAM, though possibility for implementation of the Prek Thnot Multipurpose Dam Project was expected to be low. | Although further soil mechanics investigation would be needed, Alternative Route (NS-82) has more advantage than NS-87.<br>It is thus proposed to change the route to NS-82 mainly for saving construction cost |

*Source: JICA Survey Team*

(2) Flood Protection Facilities of Lake Tonle Bati

(a) Flood protection dike

1) Flood water level of the lake

F/S set the HWL of the lake at 7.8 m and crest of flood protection dike at EL. 8.7 m, considering the effects to the Tonle Bati Pagoda and recreation center. Based on the study on Kampong Dangkor Spillway against flood taking into account the retardation effect of the lake, FWL is set at EL. 8.4 m, which has a freeboard of 0.3 m against 1 in 100 year flood. Bank crest of 8.7 m, HWL of 7.8 m and LWL of 5.5 m as proposed in F/S remains unchanged, considering the effective use of stored water in the lake and existence of the Tonle Bati Pagoda and recreation facilities as pointed out in F/S.

2) Flood protection dike

According to the topographic survey for northern dike of 5.9 km made by the JICA Survey Team in 2012, elevation of almost portion of the dike is higher than EL. 9 m, except section from Sta. 0.5 to Sta. 1.0 km and from Sta. 5.1 km to EP (Sta. 5.9 km). The northern dike needs some additional embankment of 0.3 to 0.5 m high on average for 1.5 km long. In addition, supplemental flood dike for the Pagoda will be needed as proposed in F/S, though it is reported that some additional embankment of about 0.5 m was made by the Pagoda's fund in 2008-09. Results of the review are tabulated below.

**Table II-2.5.4.3.2 Flood Protection Dike along Lake Tonle Bati**

| Item | F/S in 1995 | Review in 2012 |
|---|---|---|
| Crest elevation of dike | EL. 8.7 m | Do as left |
| Length to the heightening section (for north dike) | 2.1 km | 1.5 km |
| (for Pagoda and south dike) | 1.2 km | Do as left |
| Replacement of one bridge on the western edge on the Tonle Bati river | 1 no. | Do as left |

*Source: JICA Survey Team*

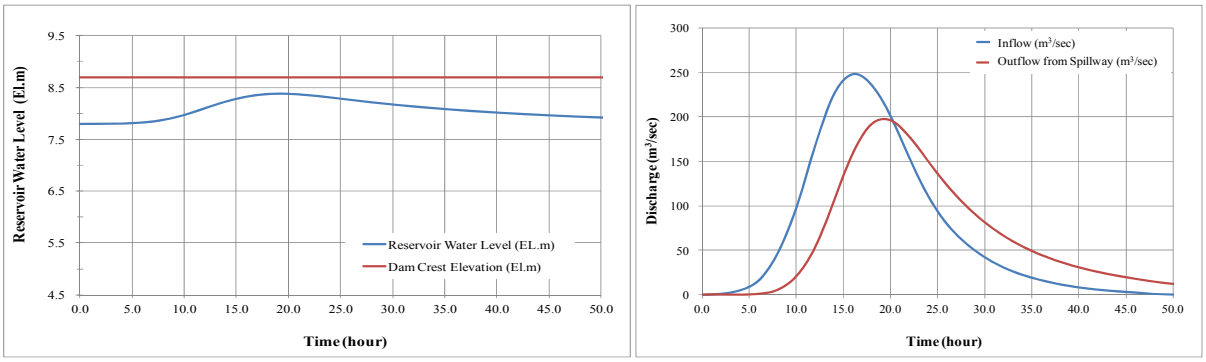
(b) Kampong Dangkor Spillway (Spillway at Outlet of Lake Tonle Bati)

In 1992, 4 manual operation wooden slide gates were constructed by the Department of Hydrology (predecessor of MOWRAM) for the spillway instead of stop-logs provided in Pol Pot regime. Gate size is 1.1-1.2 m wide and 3 m high each, and crest elevation of gate is about EL. 7.5 m. In November 2011, the wooden-made slide gates were replaced by NGO, since the gate leaves were nearly collapsed. A review result of the structure is tabulated as below, and its details are presented in ANEEX B.

**Table II-2.5.4.3.3 Kampong Dangkor Spillway at Outlet of Lake Tonle Bati**

| Item | F/S in 1995 | Review in 2012 |
|---|---|---|
| Existing condition | There are some operation conflicts among farmers in the Tonle Bati irrigation system and one benefited by the Kampong Damrei Reservoir. Supply of the lake water to Kampong Damrei Reservoir would be needed. | No operation rule is prepared for the spillway gates by Takeo PDOWRAM. According to the request of downstream users, gates are partially opened for 5-7 days per month in dry season.<br>For mitigating the conflicts, duty flow for rice cultivation of 200 ha in wet and dry season is considered in water balance study. |
| Flow capacity of the existing spillway | No description | According to the flood routine study, the existing spillway can only manage 20 year probable flood of 189 $m^3$/s at FLW of EL. 8.7 m, though design flood discharge with 100 year probability is 249 $m^3$/sec. |
| Proposed work | No improvement plan for the spillway is proposed, since it was newly constructed by MOWRAM in 1992<br><br>The bridge on the National Road No. 2, which is located immediately downstream of the spillway and is severely damaged, will be replaced. | Construction of new spillway with 4 nos. of 4 m wide gates and 16 m overflow weir. With this structure, regulated peak outflow of 197 $m^3$/sec at the lake water level of EL. 8.37 m (considering freeboard of 0.3 m to EL. 8.7 m) will be spilled out safely. (refer to figure below)<br>The proposed steel bridge in F/S was already constructed, but span is only 6 m long.<br>Although no detailed condition of the Tonle Bati River downstream of the spillway is available at present, enlargement of the existing bridge span (more than 20 m long) will be needed to evacuate the design regulated flood flow of 197 $m^3$/sec. |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-2.5.4.3.2 Flood Flow and Lake Water Level with Proposed Spillway**

### II-2.5.4.4 Tertiary Canal System Development

There is no systematic tertiary canal system at present, although some canals were constructed in the past. The irrigation command area of the tertiary block was planned to be about 50 ha in F/S. Assuming the canal density of 30 m per ha, its total length is estimated at 53 km in the Kandal Stung Area and 48 km in the Bati Area. In each tertiary block, watercourses (or quaternary canal) were proposed for commanding 7-10 ha. Length of the watercourse was estimated at 1,200 m per 7-10 ha. Construction of tertiary canal was considered to be conducted by local contractors, while watercourses would be constructed by beneficiary farmers. Alignment of tertiary canals as well as size of tertiary blocks would be determined by FWUC under support of concerned PDOWRAM. Land required for tertiary canals and watercourses would be provided by beneficiary farmers. The following are review results of the tertiary blocks:

**Table II-2.5.4.4.1 Review of Tertiary Blocks**

| Item | M/P and F/S in 1995 | Review in 2012 |
|---|---|---|
| (a) Existing canals | Tertiary canals for 900 ha in Bati area have been developed although these presently do not function. In case of Kandal Stung area, no description is found | No functional tertiary canal is observed, although some traces of canals are found in both areas |

| Item | M/P and F/S in 1995 | Review in 2012 |
|---|---|---|
| (b) Average size of tertiary block | 47-50 ha in average varying from 30-100 ha | Although the "Design Manual of MOWRAM" in 2004 recommended the maximum extent of block of 25 ha, the layout of blocks seems to meet the actual filed conditions.<br>Layout plan of tertiary blocks would be finalized based on the manual and intensions of concerned beneficiaries |
| (c) Tertiary irrigation canals | Kandal Stung area (1,750 ha) of 66 km and Bati area (1,600 ha) of 48 km | Assuming 30 m/ha,<br>Kandal Stung area (1,750 ha) of 53 km and Bati area (1,600 ha) of 48 km |
| (d) Tertiary drainage canals | Kandal Stung area (1,750 ha) of 75 km and Bati area (1,600 ha) of 67 km | No tertiary drainage canal is planned considering difficulty in land acquisition and resistance to inundation of paddy |
| (e) Related structures | Division boxes, measuring devices, culverts, etc. | Plan for provision of a measuring device is not realistic, considering available hydraulic heads |

*Source: JICA Survey Team*

Although the necessity of the development for tertiary canal system is well recognized, it would take long time to secure the land for tertiary canals and watercourses. MOWRAM is therefore requested to take timely actions for land acquisition for constructing them smoothly.

### II-2.5.5 Software Components

#### II-2.5.5.1 Strengthening of MOWRAM and PDOWRAM Staff on O&M

Implementation of KSBISRSP consists of 3 stages: (i) design stage, (ii) construction stage and (iii) O&M stage. KSBISRSP extends to 2 provinces: Kandal and Takeo. The staff of MOWRAM, Kandal and Takeo PDOWRAM are expected to take charge of O&M of rehabilitated irrigation facilities in order to maintain overall sustainability of the system. In order to execute O&M of them effectively, it is necessary to enhance capability of MOWRAM and PDOWRAM staff focusing on O&M skills through the software components activities.

**Table II-2.5.5.1.1 Review on Strengthening of Government Agencies Concerned**

| Item | F/S | Review in 2011 |
|---|---|---|
| Capacity building of Staff of MOWRAM, Kandal and Takeo PDOWRAM | F/S elaborated the importance of timely O&M by relevant government staff. O&M plan for rehabilitated facilities was also prepared. Capacity building of relevant staff would be expected through OJT. In addition, O&M support was partially expected by the establishment of Kandal Stung Center and Tonle Bati Center proposed in F/S. | As similarly proposed for RCHRSP and USISRSP, capacity development program for MOWRAM and PDOWRAM for O&M is proposed in order to ensure sustainability of rehabilitated facilities. Overall implementation program and preparatory arrangement will be carried out by employing international consultant while substantial implementation and monitoring will be by PMU Japan Support Fund with national consultant. Accumulated know-how in TSC will be effectively utilized in this process.. |

*Source: JICA Survey Team*

#### II-2.5.5.2 Formation and Strengthening of Farmer Water Users Community

FWUC will be responsible for O&M of minor canals including tertiary canal level facilities. However, FWUC has not been established in KSBISRSP, so that there is no situation to conduct proper O&M at minor canal level. In order to improve such situation, it is indispensable to formulate and strengthen FWUC in timely manner.

**Table II.2.5.5.2.1 Review on Strengthening of FWUC**

| Item | F/S | Review in 2012 |
|---|---|---|
| Formation and strengthening of FWUC | Since previously proposed project involved comprehensive components, F/S proposed the following activities in organization of farmers' group in charge of multiple activities.<br><br>- Water users' supply association (irrigation)<br>- Drinking water supply group (wells)<br>- Small farmers' credit group<br>- Cultivation techniques study group<br>- Life Improvement leading group | As KSBISRSP focuses on improvement of rural livelihood by rehabilitation of irrigation facilities, among several groups proposed in F/S, activities will focus on FWUC establishment and strengthening.<br>Evidently, it is backed by government policy such as PIMD policy. Such proposed activities will be conducted by PDOWRAM to be trained by technical units under PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC. |

*Source: JICA Survey Team*

### II-2.5.5.3 Strengthening of Agricultural Extension Services

In KSBISRSP, agricultural supporting services development plan was proposed to raise crop production in order to increase farm household income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under the project. Considering the existing situation surrounding rice production and export in Cambodia, review was carried out for them proposed in F/S focusing on the extension services. The results of review are mentioned in Table II-2.5.5.1.1.

**Table II-2.5.5.3.1 Review on Agricultural Support Services**

| Item | F/S | Review in 2011 |
|---|---|---|
| (1) Strengthening Plan for Agricultural Extension Services | - It was proposed that the agricultural supporting services at the initial stage in the project area be carried out by the agricultural development centers to be operated directly under the management of the Department of Extension. Afterward, it was expected that operation of the centre with sufficient qualified extension workers and facilities be transferred to the management under each district office.<br>- It was proposed that the agricultural extension services cover not only paddy but also secondary crops and livestock. | - In the F/S stage, 2 agricultural development centers were active, while one centre was newly proposed. Currently the existing centers have been mainly operated as research station, although they have some function on demonstration activities on advanced farming practices of paddy cultivation.<br>- There is no clear relationship between PDA/DAO and these agricultural development centers, regarding extension activities.<br>- Farmers have sufficient intension to cultivate paddy, if water is available. Therefore, it is clear that major crop is paddy, and extension activities be conducted for paddy and secondary crops except livestock. |
| (2) Establishment of Agricultural Development Center | In the F/S, it was proposed that existing agricultural development center be rehabilitated, while one center be newly constructed. | As mentioned in (1), there is currently no relationship between PDA / DAO and the center, regarding agricultural extension activities, although they have some cooperative activities. Accordingly, establishment of the center is excluded for the development plan. |
| (3) Distribution plan of farm inputs | It was proposed that those centers have function to distribute farm inputs. | Farmers are not really facing to the serious situation on procurement of farm inputs. It is expected that group purchase could be required in the future. Therefore this plan should not be considered in the scope of KSBISRSP. |

*Source: JICA Survey Team*

### II-2.5.6 Scope of Sub-project

In the previous sections and clauses, the works proposed by MOWRAM were examined from technical and economical viewpoints and also considering application of Japan Yen's loan, through review on previous studies like M/P and F/S, site visits, hearing from farmers and a series of

discussions with MOWRAM and PDOWRAM. The results of examination are shown in the following table, comparing with the works proposed by MOWRAM:

**Table II-2.5.6.1 Examined Scope of KSBISRSP**

| Scope Proposed by MOWRAM in M/D* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **(1) Irrigation Development Area** | | |
| Not specified | 3,350 ha in total,<br>consisting of 1,750 ha in Kandal Stung area and 1,600 ha in Bati Area | The extent of irrigation area is confirmed through basin wide water balance study on the Prek Thnot River |
| **(2) Cropping Pattern and Crop Intensity** | | |
| Not specified | - Rice-based cropping system with cropping intensity of 180% per year | Application of double cropping of rice considering present cropping pattern |
| **(3) Hardware Components** | | |
| Rehabilitation of main canals and secondary canals including related structures | Kandal Stung Area: Full rehabilitation of two main canals of 11.3 km and two secondary canals of 5.0 km long<br>Bati Area: Full rehabilitation of two main canals of 7.6 km and 6 secondary canals of 8.6 km long | Concrete lining of 75 mm thick is provided for main irrigation canals of 18.9 km |
| Rehabilitation of third canals including related structures | Tertiary irrigation canals of 53 km for Kandal Stung Area (1,750 ha) and<br>48 km for Bati Area (1,600 ha) | No tertiary drainage canal is planned considering difficulty in land acquisition |
| Gate installation for diversion works, intakes and checks, | Construction of one new diversion weir and rehabilitation of one gated weir, and replacement of 3 intakes on the Stung Touch river.<br>New construction of check and turnout structures on main and secondary canals<br>Replacement of Daeum Rues Regulator on the Prek Thnot River for supplying water to the Stung Touch River | Three intakes are; for EW-60, EW-58 and NS82 |
| Rehabilitation of intake, pumping station, spillway, embankment etc. around Lake Tonle Bati | Replacement of intake structure and pump station for Bati Area on the Lake Tonle Bati, Kampong Daungkar spillway and heightening of flood dike for 2.7 km | |
| Rehabilitation of Stung Touch Gate and NS78*Canal<br><br>**: NS87 in MD is clerical error* | Enlargement of NS-82 as a connection canal for future development of Bati Area, and construction of new diversion weir on the Stung Touch River | Through comparative study between NS-78 and NS-82, NS-82 was selected due to less construction cost; the same diversion weir for the main canal EW-58 could be used |
| **(4) Software components** | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M<br>Not proposed | Capacity development for MOWRAM and PDOWRAM staff on O&M | Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant |
| - Formation and Strengthening of FWUC<br>Not proposed | Formation and Strengthening of FWUC | Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC |
| - Strengthening of agricultural extension services<br>Not proposed | Strengthening of agricultural extension services | Executed by PDA under the control of PMU Japan Support Fund of MOWRAM |

**: Minutes of Discussion dated February 25, 2011*
*Source: JICA Survey Team*

(2) Priority Ranking

The examined Sub-project scope consists of many works. It is not sure presently that all of these works could be simultaneously implemented in the available loan amount. Thus, these examined works are given priority ranking based on the following criteria

- The works indispensable for attaining at the aim of KSBISRSP mentioned above are given high priority.
- Urgently required works for proper operation of irrigation system are given high priority.
- The facilities related to ensuring water resources should be given high priority since KSBISRSP severely suffers from shortage of irrigation water.
- The facilities which need large scale rehabilitation to convey irrigation water are given high priority.
- The facilities which require only minor rehabilitation like maintenance works, are accorded to not high priority.

**Table II-2.5.6.2 Priority Ranking for Each Work**

| Examined Scope by JICA Survey Team | | Priority* |
|---|---|---|
| **(a) Hardware Components** | | |
| Rehabilitation of Main Canals including related structures | Full rehabilitation of 2 main irrigation canals of 11.3 km in Kandal Stung Area and 2 main canal of 7.6 km in Bati Area (total; 18.9 km) | ◎ |
| Rehabilitation of secondary canals including related structures | Construction and rehabilitation of secondary canals of 5.0 km in Kandal Stung area and full rehabilitation of the existing canals for 8.6 km in Bati Area (total; 13.6 km) | ○ |
| Gate installation for diversion works, intakes and checks, | Construction of one new diversion weir and rehabilitation of one existing weir, and replacement of 3 intakes on the Stung Touch river.<br>Replacement of Daeum Rues Regulator on the Prek Thnot River | ◎ |
| Rehabilitation of intake, pumping station, spillway, embankment etc. around Lake Tonle Bati | Replacement of intake structure and pump station on Lake Tonle Bati, Kampong Daungkar spillway and heightening of flood dike for 2.7 km | ◎ |
| Construction of Connection Canal through rehabilitation of NS82 | Rehabilitation of NS-82 of 3.5 km as a connection canal for future development of Bati Area (the canal is not needed for the first stage development of 1,600 ha, but strongly desired it for future development by MOWRAM) | △ |
| Tertiary canals including related structures | Tertiary irrigation canals of 53 km for Kandal Stung Area (1,750 ha) and 48 km for Bati Area (1,600 ha) | △ |
| **(b) Software Components** | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M | Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| - Formation and Strengthening of FWUC | Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| - Strengthening of agricultural extension services | Executed by PDA under the control of PMU Japan Support Fund of MOWRAM with support of foreign consultant | ◎ |

*Source: JICA Survey Team*
**: High Priority: ◎, Medium Priority: ○, Low Priority: △*

Regarding the "Connection Canal", it is recommendable to include it into the Sub-project in case of that the economic viability is confirmed and construction fund is available, since MOWRAM has strong intension to develop remaining are of 2,600 ha in the Tonle Bati Area by himself as Stage 2.

## II-2.6 Main Canal 35 Rehabilitation Sub-project

### II-2.6.1 Basic Concept

The project works proposed by PDOWRAM/MOWRAM are reviewed in the following basic concept paying attention upon the current conditions of MC35RSP.

(1) Integrated Approach of Hardware and Software Components

Irrigated agriculture development for MC35RSP is planned in the concept of integrated approach of hardware and software components which is the same as the other sub-projects, in order to heighten the project effect and to maintain the project sustainability.

(2) Priority Area for Rehabilitation under the Project proposed by PDWORAM/MOWRAM

All the area of the Main Canal 35 Irrigation System totaled more than 3,000 ha commanded by 3 existing reservoirs, as reported by PDOWRAM, which is too large to deal with as a small-scale irrigation system rehabilitation project. In consideration of the scale of sub-project area and irrigation water availability, the upstream area (Zone-A) out of 3 zones is only considered to be implemented under MC35RSP, as concurred with PDOWRAM/MOWRAM

(3) Determination of Project Scale through Water Balance Study

Irrigation development should be planned mainly based on available water, available land and the water demand by crops. Since MC35RSP has reservoirs and enough farm to be served by the existing reservoirs, its project size will be determined through a water balance study.

(4) Utilization of Existing Canal System

There are the existing irrigation canals which were constructed in Pol Pot regime. In order to save construction cost and lighten the burden for land acquisition, these existing irrigation canals are used as much as possible.

(5) Priority Ranking on Sub-project Scope by Criteria

As MC35RSP requires many project works, these will be prioritized so as to use the limited budget. High priority should be given to (i) the works indispensable for attaining at the aim of MC35RSP, (ii) urgently required works for proper operation of irrigation system, (iii) the facilities related to ensuring water resources, and (iv) the facilities which need large scale rehabilitation to convey irrigation water.

### II-2.6.2 Agricultural Development Plan

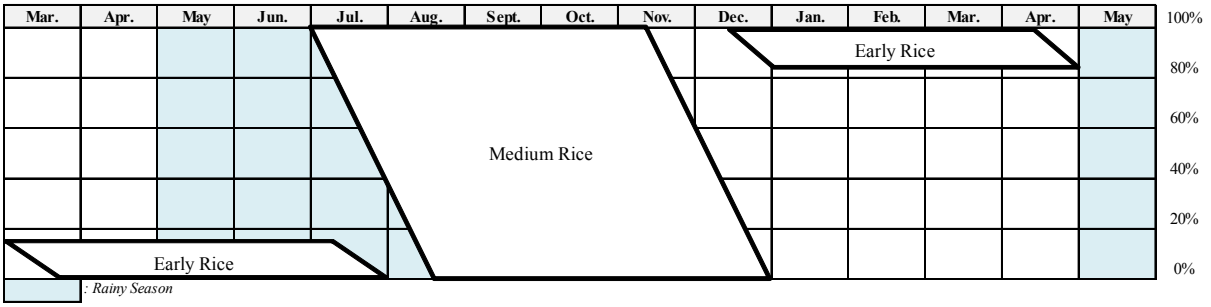
The agricultural development plan proposed in 2009 was reviewed through the site visit, analysis on collected latest data and information from the relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute to preparation of the appropriate scope of MC35RSP. The review results are given in the following table:

**Table II-2.6.2.1 Review on Agricultural Development Plan**

| Item | Proposal in 2009 | Review in 2011 |
|---|---|---|
| 1) Irrigation Development Area | (a) Sub-project area of 3,018 ha was estimated in the proposal. | (a) The proposed area of 3,018 ha was changed into 1,935 ha (Zone-A) through discussion with MOWRAM/PDOWRAM |
| 2) Cropping Pattern and Cultivated Area | (a) No cropping pattern<br>(b) Unit cost on increase of agricultural input for existing cultivated area: US$ 50/ha<br>(c) Cultivated area is shown as follows:<br>Before rehabilitation<br>- Rainy season: 3,018 ha<br>After rehabilitation<br>- Early rainy season 120 ha<br>- Rainy season 2,648 ha<br>- Dry season 250 ha<br>(d) Cropping intensity: 112% | (a) Based on some interview to PDOWRAM, PDA, DAO, and farmers, proposed cropping pattern was prepared.<br>(b) Breakdown on unit cost of US$50/ha is not available. Therefore, prevailing and proposed production costs of paddy should be estimated as shown in based on production costs in RCHRSP, USISRSP and KSBISRSP, and interview to DAO and farmers.<br>(c) Proposed areas for early rainy and dry seasons or 120ha and 250 ha are not confirmed. It is necessary to do water balance study.<br>(d) It is necessary to confirm them by executing water balance study, in order to confirm the proposed area. First priority consideration for the confirmation is to secure maximum area to be irrigated during rainy season. Hence if irrigation water is still available, increase of cropping intensity should be considered. |

| Item | Proposal in 2009 | Review in 2011 |
|---|---|---|
| 3) Beneficiaries | In the proposal, the related communes, number of villages, and number of beneficiaries are specified. | Estimated number of beneficiaries by village should be tentatively identified |
| 4) Unit Yield of Paddy | (a) Target unit yield of paddy was estimated as follows:<br>Before rehabilitation<br>- Rainy season: 1.8 ton/ha<br>After rehabilitation<br>- Early rainy season: 3.0 ton/ha<br>- Rainy season: 2.5 ton/ha<br>- Dry season: 3.0 ton/ha<br>(b) These yields are estimated, based on the interview to farmers, but not from PDA and DAO. | (a) Proposed target unit yield of paddy is relatively reasonable. However, proposed yield with project condition is slightly lower. It is necessary to review them, based on the latest statistical data as well as farmers' interview. |
| 5) Agricultural Extension Services | In the proposal, cost for implementation of agricultural extension services was estimated as unit cost per ha of US$ 10 /ha. | In the proposal, there is no breakdown for US$ 10/ha. JICA Survey Team estimated at US$ 12/ha. Namely US$ 10 /ha is reasonable. |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-2.6.2.1 Proposed Cropping Calendar for MC35RSP**

### II-2.6.3 Water Balance Study

#### II-2.6.3.1 Water Demand

(1) General

In this Survey, the water balance simulation was conducted for the MC35RSP Area using estimated discharge of 20 years from 1992 to 2011 and irrigation water requirement at each command area by half monthly steps. Operations of existing 3 reservoirs are also considered for water balance study. Water deficit of continuous 2 times of half month (more than 15 days) is judged as deficit year. Inflow discharge at each reservoir was estimated by the daily base Tank Model that was calibrated for observed discharge at the Peam Khley of the Prek Thnot as described in Item (3) of Sub-clause II-1.4.2.2.

(2) Irrigation Water Requirement

Irrigation water requirement for the MC35RSP Area was calculated based on the proposed cropping calendar mentioned in Figure II-2.6.2.1, which consists of early variety and medium variety. Estimated unit irrigation water requirement for Early Rice (Early Rainy Season and Dry Season) and Medium Rice in the MC35RSP Area is shown in Table II-2.6.3.1.1.

**Table II-2.6.3.1.1 Estimated Unit Irrigation Water Requirement for MC35RSP Area** (Unit: $m^3$/sec/ha)

| Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Early Rice (Early Rainy Season) | | | | | | | | | | | | |
| 1-15 | 0.00 | 0.71 | 2.35 | 2.73 | 1.98 | 0.66 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16-end | 0.00 | 1.43 | 2.73 | 2.69 | 1.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| (2) Medium Rice (Early Rainy Season) | | | | | | | | | | | | |
| 1-15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.71 | 0.56 | 0.84 | 1.44 | 0.56 |
| 16-end | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.53 | 1.03 | 0.60 | 0.80 | 0.94 | 0.00 |

| Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (3) Early Rice (Dry Season) | | | | | | | | | | | | |
| 1-15 | 2.53 | 3.11 | 2.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.43 |
| 16-end | 2.74 | 3.06 | 0.95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.57 | 2.29 |

*Source: JICA Survey Team*

### II-2.6.3.2 Water Balance Study

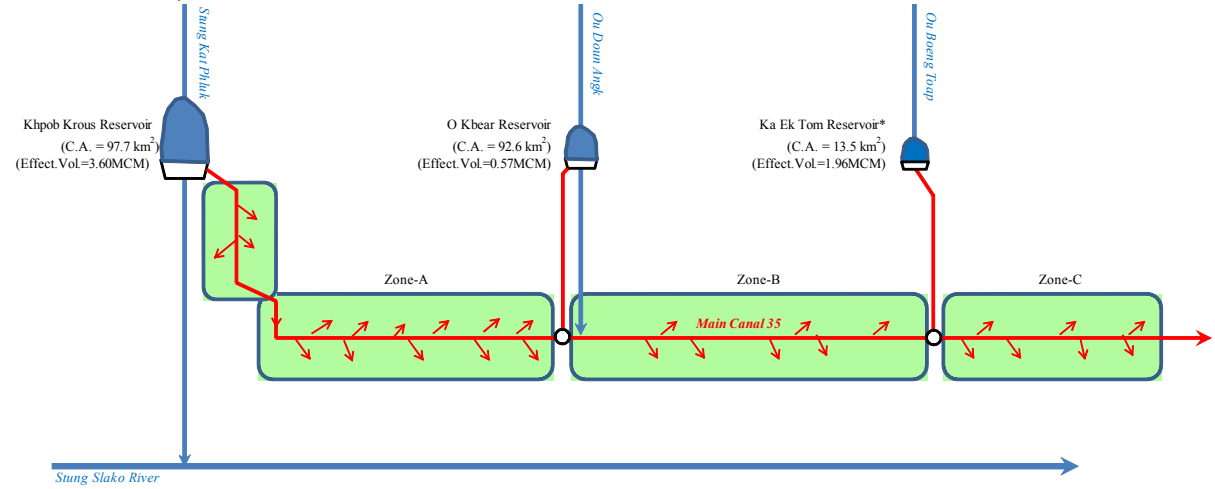
(1) Calculation Method and Conditions

In the Survey, long-term water balance simulation method was applied. The water balance simulation in the Survey is summarized in Table II-2.6.3.2.1 and the water balance model is schematically described in Figure II-2.6.3.2.1, respectively.

**Table II-2.6.3.2.1 Condition of Water Balance Simulation for MC35RSP Area**

| Item | This Survey |
|---|---|
| Calculation interval | Half-monthly basis |
| Method for estimating potential evapo-transpiration | Penman-Montieth method |
| Runoff data | Estimated from the data at Peam Khley station |
| Reservoir Operation | Storage effect of 3 reservoirs are considered |
| Simulation model | By the long-term (1992-2011; 20years) simulation |
| Irrigation fail | Continuous deficit in 15 days |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-2.6.3.2.1 Schematic Layout of Water Balance Model for MC35RSP**

(2) Reservoir Operation

(a) Khpob Krous Reservoir

Main features and reservoir storage curve (H-V-A curve) of the Khpob Krous Reservoir on the Ou Chraloy River are shown in ANNEX B. The reservoir storage curve (H-V-A curve) of the Khpob Krous Reservoir was prepared by bathymetry survey by the JICA Survey Team in January 2012.

The reservoir operation and the design outflow from the Khpob Krous Reservoir were assumed to achieve for irrigation demand of "Zone-A" of MC35RSP Area as shown in Figure II-2.6.3.2.1.

(b) O Kbear Reservoir

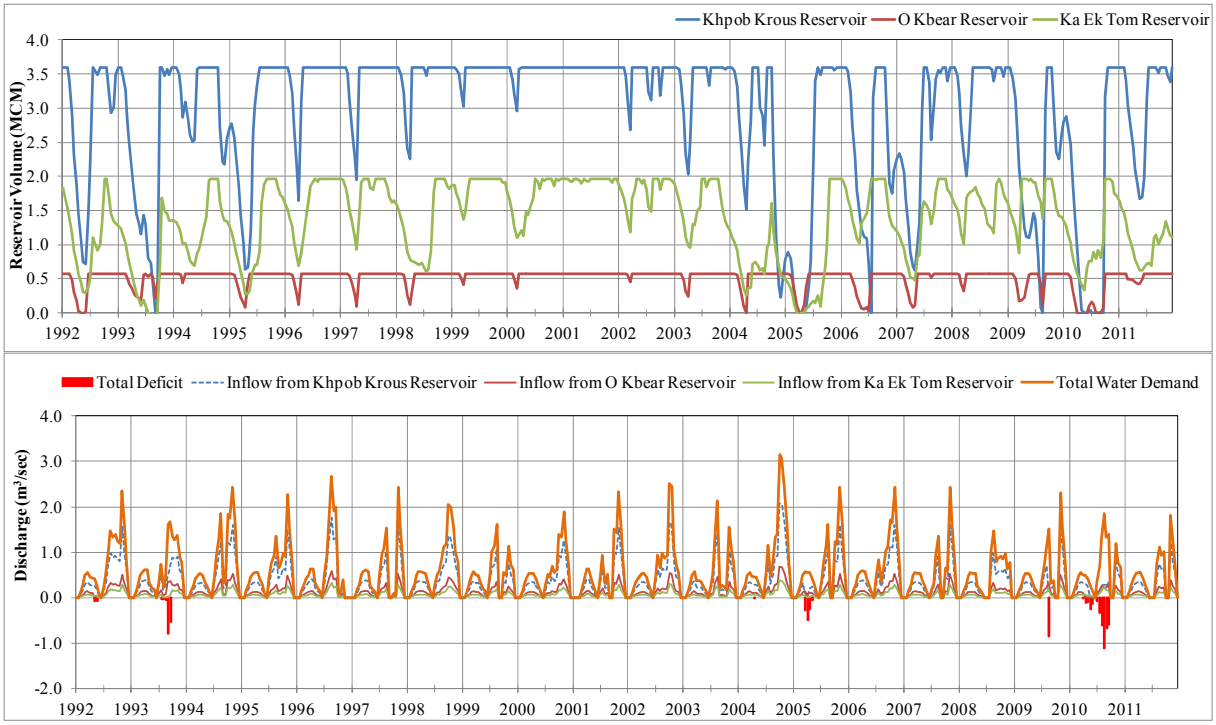
Main features and assumed reservoir storage curve (H-V-A curve) of the O Kbear Reservoir on the Ou Doun Angir River are shown in ANNEX B. The reservoir storage curve (H-V-A curve) of the O Kbear Reservoir was assumed using ratio of both reservoir areas by aerial photo of same date and the assumed ratio of H-V-A curve.

The reservoir operation and the design outflow from O Kbear Reservoir were assumed to achieve irrigation demand of "Zone-B" and "Zone-C" of the MC35RSP Area.

(c) Ka Ek Tom Reservoir

Main features and assumed reservoir storage curve (H-V-A curve) of the Ka Ek Tom Reservoir are mentioned in ANNEX B. The reservoir storage curve (H-V-A curve) of the Ka Ek Tom Reservoir was assumed using ratio of both reservoir areas by aerial photo of same date and the assumed ratio of H-V-A curve.

Result of reservoir operation of above 3 reservoirs is shown in below:




*Source: JICA Survey Team*

**Figure II-2.6.3.2.2 Results of Reservoir Operation of MC35RSP**

(3) Result of Water Balance Calculation

Results of water balance simulations of MC35RSP are summarized in Table II-2.6.3.2.5 and Figure II-2.6.3.2.3. According to the water balance simulations, total 1,280 ha of command area with average crop intensity of 116% will be able to irrigate for 80% dependability.

**Table II-2.6.3.2.5 Results of Water Balance Study of MC35RSP**

| Zone | Max. Irr. Area | Total Irr. Area | Early Paddy (Early Rainy) | Mid Paddy | Early Paddy (Dry Rainy) | Crop Intensity | Dependability | Deficit Year (times) |
|---|---|---|---|---|---|---|---|---|
| A | 1,935 ha | 850 ha | 130 ha | 850 ha | 0 ha | 115% | 80% | 4 |
| B | 705 ha | 280 ha | 45 ha | 280 ha | 0 ha | 116% | 80% | 4 |
| C | 378 ha | 150 ha | 25 ha | 150 ha | 0 ha | 117% | 80% | 4 |
| Total | 3,018 ha | 1,280 ha | 200 ha | 1,280 ha | 0 ha | 116% | | |

*Source: JICA Survey Team*

Although water balance study is conducted for 3 zones, the target area of MC35RSP is only Zone-A as mentioned in Section II-6.1. Thus, the irrigation area for MC35RSP comes to 850 ha out of 1,935 ha according to the results of water balance study.

### II-2.6.4 Hardware Components

(1) Examination of Present Capacity of Existing Spillway

The spillways of the Khpob Krous Reservoir and O Kbear Reservoir were constructed in 2009/10. They have been functioning and floods overflowing the top of dike have not occurred during the period from 2009 to 2011. In MC35RSP, the present flow capacity of these spillways is examined by

comparing the capacity and probable flood discharge on each reservoir. The results of examination are summarized in the following table and details of the examination are presented in ANNEX B. In conclusion, the maximum reservoir water level will not be over the dike crest elevation by the flood with the return period of 200 years at each reservoir, and hence the rehabilitation and/or improvement of the reservoir including the existing spillway with hydro-mechanical works are not considered under MC35RSP.

**Table II-2.6.4.1 Results of Examination of Spillways on Khpob Krous and O Kbear Reservoirs**

| Reservoir | C.A. ($km^2$) | Elevation of Dike Crest (EL. m) | Probable Peak Discharge* ($m^3$/sec) | Peak Water Level (EL. m) |
|---|---|---|---|---|
| Khpob Krous | 97.7 | 55.50 | 170.3 | 55.31 |
| O Kbear | 92.6 | 47.80 | 172.0 | 46.47 |

**: Return Period is 200 years.*
*Source: JICA Survey Team*

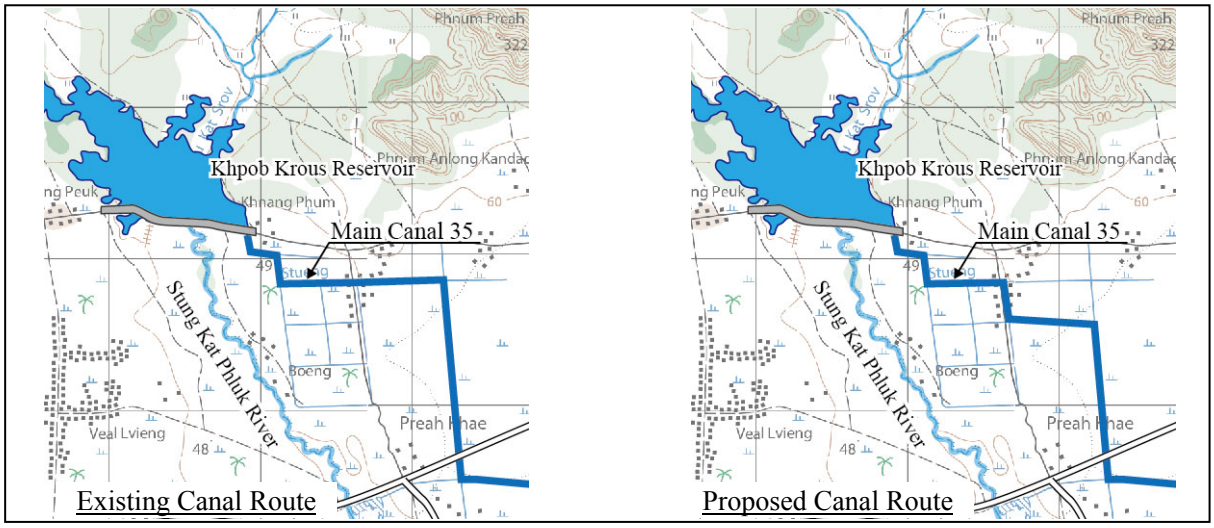
(2) Proposed Rehabilitation works

(a) Intake of Khpob Krous Reservoir

According to the topographic survey along the Main Canal 35 conducted by Kampong Speu PDOWRAM in 2008, the elevation of paddy field along the main canal is higher than the low water level of the Khpob Krous Reservoir (EL. 52.0 m). That is, some area near the reservoir would not be irrigable when water level in the reservoir is almost the lowest water level around the end of the dry season. However, these areas can be irrigated when water level is enough high above the low water level during the other seasons keeping the present cropping pattern. On the other hand, raising low water level will cause the decrease of effective volume of the reservoir, which brings about reduction of total irrigable area. In order to conserve the irrigable area, excavation of reservoir area or raising dike would be necessary, which will be a drastic construction. Furthermore, the intake was constructed in 2009 and functioned without significant hitch. Considering these conditions, it is judged that the intake of the Khpob Krous Reservoir should not be rehabilitated or reconstructed in MC35RSP.

(b) Main Canal 35 and Related Structures

As mentioned in previous Sub-clause, Main Canal 35 is not functioning at all and the present canal route is deemed inadequate due to the inverse draft section. According to the topographic survey executed in 2012, the route of Main Canal 35 is proposed to change partly as shown in Figure II-2.6.4.1, which leads to shorten about 300 m of the canal length.




*Source: JICA Survey Team*

**Figure II-2.6.4.1 Existing and Proposed Route of Main Canal 35**

The location and feature of related structures on the main canal are figured out through the inventory survey conducted by the JICA Survey Team in 2012. The existing structures in Zone-A should be basically demolished because the canal earthworks will be executed for whole sections of the Main Canal 35 in Zone-A. The proposed scopes for the Main Canal 35 is summarized below:

**Table II-2.6.4.1 Scope of Main Canal and Related Structures in MC35RSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Canal length | 25.3 km (whole Main Canal 35) | 14.0 km (Zone-A) out of 25.3 km |
| 2) Canal route | Not proposed | Serious inverse draft is found at 2.0 km downstream from Khpob Krous Reservoir.<br>Canal route should be changed, which is utilizing existing secondary canal. |
| 3) Canal section | - Reshaping canal cross section with one basic design<br>- Design canal gradient: 0.0001 ~ 0.0005 | Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition. |
| 4) Related Structures | Check structures, water gates, a culvert and a spillway are proposed. | All existing structures are to be demolished and new structures, i.e. check structures, drain inlets, turnouts, culverts, drops, bridges and a cross drain are proposed |

*Source: Main Canal 35 Rehabilitation Project in Basedth District, Kampong Speu Province, Project Proposal Document To Small Scale Infrastructure Project (2009)*
*JICA Survey Team*

(c) Secondary Canals and Related Structures

Due to the catastrophic situation of Main Canal 35, secondary canals and related structures are not in service as canal system. According to the sample inventory survey, there are a few structures on secondary canals. Though rehabilitation works for secondary canals and related structures are not proposed by MOWRAM, 6 secondary canals and related structures are proposed by JICA Survey Team so as to make effective use of the limited water resources. Scopes of works for the secondary canals and the related structures are shown in the following table:

**Table II-2.6.4.2 Scope of Secondary Canal and Related Structures in MC35RSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Canal quantity and length | Not Proposed | Six secondary canals, 11.4 km in total<br>(Rehabilitation: 5 nos., 9.3 km in total<br>New construction: 1 no., 2.2 km) |
| 2) Canal route | | Serious inverse draft is found at 2.0 km of main canal downstream from the Khpob Krous Reservoir. A secondary canal route also should be changed. |
| 3) Canal section | | Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition. |
| 4) Related Structures | | All existing structures are to be demolished and new structures, i.e. check structures, drain inlets, Turnouts, culverts, drops, bridges and a cross drain are proposed |

*Source: Main Canal 35 Rehabilitation Project in Basedth District, Kampong Speu Province, Project Proposal Document To Small Scale Infrastructure Project (2009)*
*JICA Survey Team*

(d) Drainage System

Canals constructed in Pol Pot regime are relatively lower than surrounding land and, therefore, they are used as not only irrigation but also drainage canal in general. In the MC35RSP Area, the main and the secondary canals are used in the same concept, and some of them have drainage inlets to convey water from drains to the main canal. In order to realize smooth drainage and also to avoid canal erosion, it is proposed to make not only replacement of drainage inlets but also new construction of cross drain. The proposed works for drainage system are shown below.

**Table II-2.6.4.3 Scope of Drainage System in MC35RSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) New Drain | Not proposed. | The same with left |
| 2) Drainage inlet | | Drainage inlet is proposed at every confluence of main canal and drain, even there are not any structures existing at the point. |
| 3) Cross Drain | | Two cross drains, one for main canal and the other for secondary canal, are proposed. |

*Source: Main Canal 35 Rehabilitation Project in Basedth District, Kampong Speu Province, Project Proposal Document To Small Scale Infrastructure Project (2009)*
*JICA Survey Team*

(e) Tertiary Canals

Currently, there is no systematic tertiary canal system in the MC35RSP Area. The irrigable area in this Sub-project is proposed to be divided into 42 tertiary blocks. Alignment of tertiary blocks and design of the canal route should be prepared under the consensus of the related FWUC with assistance of Kampong Speu PDOWRAM. Land required for the tertiary canals and watercourses should be offered by beneficial farmers.

**Table II-2.6.4.4 Scope of Tertiary Blocks in MC35RSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Tertiary Canals | Not proposed | In MC35RSP, the blocks are divided on the basis of aerial photographs. Layout plan of tertiary canals should be finalized in accordance with the "Design Manual of MOWRAM", actual field conditions and intensions of beneficiaries. |

*Source: Main Canal 35 Rehabilitation Project in Basedth District, Kampong Speu Province, Project Proposal Document To Small Scale Infrastructure Project (2009)*
*JICA Survey Team*

### II-2.6.5 Software Components

#### II-2.6.5.1 Strengthening of MOWRAM and PDOWRAM Staff on O&M

MC35RSP will be implemented through 3 stages such as (i) design stage, (ii) construction stage and (iii) O&M stage. During O&M stage, the staff of MOWRAM and Kampong Speu PDOWRAM is highly expected to carry out O&M of rehabilitated irrigation facilities in order to keep overall sustainability of the system. It is, therefore, proposed to elevate capability of MOWRAM and PDOWRAM staff focusing on O&M skills through the software components activities.

**Table II-2.6.5.1.1 Review on Strengthening of Government Agencies Concerned**

| Item | Project Proposal | Review in 2011 |
|---|---|---|
| Capacity building of Staff of MOWRAM and Kampong Speu PDOWRAM | The proposal was originally prepared by Kampong Speu PDOWRAM under support of MOWRAM assisted by TSC. It generally focused on rehabilitation of irrigation facilities and capacity building program for government, and capacity building for government is expected to be carried out through OJT and OFF-JT particularly organized by TSC under MOWRAM. | In order to establish O&M set-up for sustainable irrigation system management in Main Canal 35 Irrigation, relevant staff capability strengthening is of critical importance. Therefore, in concurrence with facilities' rehabilitation and development and OJT, budget needs to be allocated to organized training program. As similar to KSBISRSP, international consultant will be assigned at the initial stage of the program to prepare overall schedule and arrangement. TSC together with national consultant is expected to perform as trainers for the program. |

*Source: JICA Survey Team*

#### II-2.6.5.2 Formation and Strengthening of Farmer Water Users Community

FWUC will be responsible for O&M of minor canals including tertiary canal level facilities. However, FWUC has not yet been established in MC35RSP. Therefore, it is indispensable to organize and strengthen FWUC in timely manner in order to conduct proper O&M for rehabilitated facilities.

**Table II-2.6.5.2.1 Review on Strengthening of FWUC**

| Item | Project Proposal | Review in 2011 |
|---|---|---|
| Formation and strengthening of FWUC | In the original proposal of SISIP, formation and strengthening of FWUC was not included as project component. Such activities were expected to be conducted through MOWRAM routine task particularly with the initiatives of Department of FWUC and Kampong Speu PDOWRAM. In addition, villagers and farmers have agreed to establish FWUC for O&M purpose. | Due to insufficient budget pointed out by Kampong Speu PDOWRAM, it is highly recommended that formation and strengthening of FWUC be included as one of MC35RSP components with appropriate budgetary arrangement.<br>Evidently, it is backed by government policy such as PIMD policy. Such proposed activities will be conducted by PDOWRAM to be trained by technical units under PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC. |

*Source: JICA Survey Team*

### II-2.6.5.3 Strengthening of Agricultural Extension Services

In MC35RSP, it is expected that strengthening of agricultural supporting services be promoted to raise paddy production in order to increase farm household income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under MC35RSP. However, the proposal has no details of activities on strengthening of agricultural extension services, but only unit cost or US$10/ha.

Through interview and discussion with PDA, DAO, and farmers, constraints on implementation of agricultural extension activities are clarified as follows:

- Purpose and target of implementation of extension services are not clear. Further there are no monitoring activities after completion of demonstration activities.
- There are various constraints on irrigation water for paddy cultivation such as shortage of water, no proper operation on water management by farmers' water users groups, no sufficient organizations for water management, poor irrigation facilities, etc.
- Training materials including guideline, pamphlet, handout, poster, etc. are available[7]. It is understandable that PDA and DAO have enough experience and knowledge for implementation of demonstration activities as well as farmers' field schools. Actually training materials are prepared by PDA or DAO staff, based on those materials, However, there are no proper action plan for implementation of extension services, and further no filing system for materials and experience in District Agricultural Office.

Considering the current constraints mentioned above, the following training activities are proposed for smooth implementation of demonstration activities:

- Preparation of action plan for demonstration activities based on the needs and requirement of beneficiaries,
- Preparation of training materials,
- Preparation of guideline on demonstration activities, based on the existing materials,
- Filing of training materials, and
- Implementation of monitoring and evaluation

Furthermore, it is proposed that exchange of materials and information as well as cooperation among PDAs and DAOs be facilitated periodically.

[7] *Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF.*

### II-2.6.6 Scope of Sub-project

(1) Examination of Scope of Main Canal 35 Rehabilitation Sub-project Proposed by MOWRAM

In project proposal document, MOWRAM proposed the rehabilitation works as listed in Table II-2.6.6.1, which include earthworks and construction/rehabilitation works of related structures on only the main canal. Based on the investigation, the proposed works and scopes of the rehabilitation works under MC35RSP are examined as shown in the following table.

**Table II-2.6.6.1 Examined Scope of MC35RSP**

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **(a) Irrigation Development Area** | | |
| - 2,648 ha in rainy season<br>- 120 ha in early rainy season<br>- 250 ha in dry season<br>(with 3 reservoirs) | - 850 ha in rainy season<br>- 130 ha in early rainy season<br>(with 1 reservoir) | Justified through water balance study |
| **(b) Cropping Pattern and Crop Intensity** | | |
| - Rice Cropping System<br>- Crop Intensity: 116% | - Rice Cropping System<br>- Crop Intensity: 115% | Application of double cropping of rice considering present cropping pattern |
| **(c) Hardware Components** | | |
| 1) Reservoir<br>- Dike, Spillway, Intake<br>Not proposed | 1) Reservoir<br>- Dike, Spillway, Intake<br>Not proposed | Reservoir related to MC35RSP has been rehabilitated in 2009 |
| 2) Main Canal 35 and Related Structures<br>- Main canal<br>Reshaping of existing canal section for whole main canal (25,299 m)<br><br>- Related structures<br>(New Construction)<br>Check structure: 19 nos.<br>Culvert: 1 no.<br>Spillway: 1no.<br>Water gate: 7 no. | 2) Main Canal 35 and Related Structures<br>- Main canal<br>Rehabilitation of existing canal section for Zone-A (12,800 m out of 25,299 m) and construction of new canal (1,200m)<br><br>- Related structures<br>Check structure: 9 nos.<br>Turnout: 16 nos.<br>Culvert: 8 nos.<br>Drain inlet: 10 nos.<br>Drop: 5 nos.<br>Cross Drain: 1 no.<br>Road Bridge: 1 no.<br>Footpath Bridge: 9 nos. | It is judged that rehabilitation of whole main canal section is unsuitable for SISIP. |
| 3) Secondary canals and related structures<br>Not Proposed | 3) Secondary canals and related structures<br>- Secondary canals<br>Rehabilitation of existing secondary canals (5 nos., 9,250 m) and construction of a new canal (1 no., 2,150 m)<br>- Related structures<br>Check Structure: 20 nos.<br>Turnout: 35 nos.<br>Culvert: 26 nos.<br>Drop: 1 no. | Rehabilitation of only main canal is insufficient to realize efficient irrigation system. |
| 4) Drainage system<br>Not proposed | 4) Drainage system<br>- Construction of drain structures | Rehabilitation/ construction of drain is not proposed |
| 5) Tertiary canals<br>Not proposed | 5) Tertiary canals<br>- Tertiary system development: 26 km (850 ha) | MOWRAM will provide special arrangement for land acquisition for tertiary canals.<br>Tertiary canals will be constructed by local contractors to be selected through LCB |
| 6) Construction of Project Office<br>Not Proposed | 6) Construction of Project Office<br>- Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works | |

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **(d) Software Components** | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M<br>Not proposed | In order to keep the sustainability of MC35RSP, these are indispensable, thus should be included in scope of MC35RSP | |
| - Formation and Strengthening of FWUC<br>Not proposed | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus should be included in scope of MC35RSP | |
| - Strengthening of agricultural extension services<br>Not proposed | In order to attain the improvement of agricultural productivity, this is needed, thus should be included in scope of MC35RSP | |

*Source* *: *Main Canal 35 Rehabilitation Project in Basedth District, Kampong Speu Province, Project Proposal Document To Small Scale Infrastructure Project (2009)*
**: *JICA Survey Team*

(2) Priority Ranking

There are many works in hardware and software components in the examined scope of MC35RSP. It is not sure presently that all of these works could be simultaneously implemented in the available loan amount. Thus, as mentioned in Clause II-2.6.1, these examined works are given priority ranking based on the following criteria

- The works indispensable for attaining at the purpose of MC35RSP are given high priority
- Urgently required works for adequate operation of irrigation system are given high priority
- The rehabilitation works for facilities needed to recover their functions are given high priority

The priority ranking of each work based on the criteria is summarized in the following table.

**Table II-2.6.6.2 Priority Ranking of Each Work**

| Scope Examined by JICA Survey Team | | Priority* |
|---|---|---|
| **(a) Hardware Components** | | |
| - Rehabilitation of Main Canal 35 and related structures | - Reshaping canal section (12,800 m) and construction of new canal (1,200 m)<br>- Replacement and new construction of related structures | ◎ |
| - Rehabilitation of secondary canals and related structures | - Reshaping canal section (5 nos., 9,250 m) and construction of new canal (1 no., 1.250 m)<br>- Replacement and new construction of related structures | ◎ |
| - Tertiary development | - Construction of tertiary canals | ○ |
| - Construction of project office | - Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works | ○ |
| **(b) Software Components** | | |
| 1) Capacity development for MOWRAM and PDOWRAM staff on O&M | - Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 2) Formation and Strengthening of FWUC | - Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 3) Strengthening of agricultural extension services | - Executed by PDA under the control of PMU Japan Support Fund of MOWRAM with the support of foreign consultant | ◎ |

**: High priority: ◎ , Medium priority: ○ , Low priority: △*
*Source: JICA Survey Team*

## II-2.7 Srass Prambai Water Recession Rehabilitation Sub-project

### II-2.7.1 Basic Concept

The project works proposed by PDOWRAM/MOWRAM are reviewed in the following basic concept paying attention upon the current conditions of SPWRRSP.

(1) Integrated Approach of Hardware and Software Components

Irrigated agriculture development for SPWRRSP is planned in the concept of integrated approach of hardware and software components which is the same as the other sub-projects, in order to heighten the project effect and to maintain the project sustainability.

(2) Appreciating Present Irrigation System under Recession Cultivation

There is the existing irrigation canal system constructed in Pol Pot regime, which are currently well functioning and suitable locally and traditionally under the present water management practices for the recession cultivation in this area. Therefore, accepting the present conditions, this canal system is to be utilized without rehabilitation in order to save construction cost and lighten the burden for land acquisition.

(3) Determination of Project Scale through Water Balance Study

Rehabilitation plan should be planned mainly based on available water, available land and the water demand by crops. Since SPWRRSP has reservoir and enough farm land to be served by the existing reservoir, its project size will be determined through a water balance study.

(4) Priority Ranking on Sub-project Scope by Criteria

As SPWRRSP requires many project works, these will be prioritized so as to use the limited budget. High priority should be given to (i) the works indispensable for attaining at the aim of SPWRRSP, (ii) Urgently required works for proper operation of irrigation system, (iii) the facilities related to ensuring water resources, and (iv) the facilities which need large scale rehabilitation to convey irrigation water.

### II-2.7.2 Agricultural Development Plan

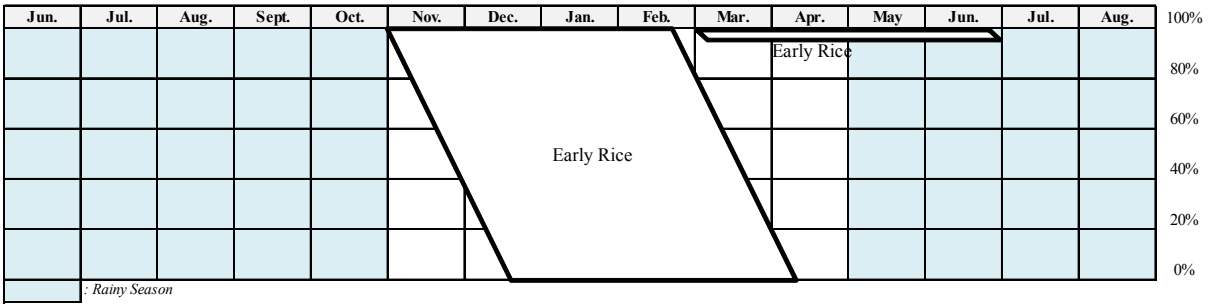
The agricultural development plan proposed in 2009 was reviewed through the site visit, analysis on collected latest data and information from the relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute to preparation of the appropriate scope of this Sub-project. The review results are given in the following table:

**Table II-2.7.2.1 Review on Agricultural Development Plan**

| Item | Proposal in 2009 | Review in 2011 |
|---|---|---|
| 1) Irrigation Development Area | Sub-project areas:<br>Before rehabilitation<br>- Dry season: 700 ha<br>After rehabilitation<br>- Dry season 1,200 ha | (a) Sub-project area should be fixed.<br>(b) Sub-project areas before and after rehabilitation should be same. Namely balance before and after rehabilitation is 500 ha. Its current situation of land use is not clear. JICA survey team judged that the remaining area of 500 ha is fallow land. |
| 2) Cropping Pattern and Cultivated Area | (a) No cropping pattern<br>(b) In the proposal, there is no mention about unit cost on increase of agricultural input for existing cultivated area.<br>(c) Cultivated area: There are no clear reasons for settlement of the proposed area for paddy cultivation. | (a) Based on some interview to PDOWRAM, PDA, DAO, and farmers, proposed cropping pattern should be prepared.<br>(b) Breakdown on unit cost on increase of agricultural input for existing cultivated area is not available. Therefore, prevailing and proposed production costs of paddy is estimated, based on production cost in RCHRSP, USISRSP, and KSBISRSP, and interview to DAO and farmers. |
| | | (c) It is necessary to do water balance study, in order to confirm the proposed area. It is understandable that the most important point for agricultural development is ensured dry season paddy with 100% cropping intensity at least. |
| 2) Beneficiaries | In the proposal, the related communes, number of villages, and number of beneficiaries are not specified obviously. | Estimated number of beneficiaries by village should be tentatively identified |
| 3) Unit Yield of Paddy | (a) Target unit yield of paddy was estimated at 3.2 ton/ha before rehabilitation, while 3.5 ton/ha after rehabilitation.<br>(b) This is estimated, based on the interview to farmers, but not from PDA and DAO. | Paddy productivity in recession area is relatively high. Proposed yield for current situation or 3.2 ton/ha is reasonable. Meanwhile proposed yield could be lower side. Actual yield level must be more than the proposed level. |

*Source: JICA Survey Team*

Based on the results of review, the following cropping calendar is proposed for water balance study.




*Source: JICA Survey Team*

**Figure II-2.7.2.1 Proposed Cropping Calendar for SPWRRSP**

## II-2.7.3 Water Balance Study

### II-2.7.3.1 Water Demand

(1) General

Due to SPWRRSP is recession crop irrigation in the dry season, the water balance study was conducted by considering of flood water level of the Tonle Bassac River. During flood season from September to November, river water from the Tonle Bassac River into the Srass Prambai Reservoir. After the flood season, inundation area dries up, and then those areas are cultivated with recession rice crop. The water in the Srass Prambai Reservoir will be used for irrigation. Water balance simulation was conducted using storage capacity curve of the Srass Prambai Reservoir and the estimated irrigation water requirement for proposed cropping patterns. In this water balance study, irrigation water for the command area was assumed to supply from only the Srass Prambai Reservoir.

(2) Irrigation Water Requirement

Irrigation water requirement for the SPWRRSP Area was calculated based on the proposed cropping calendar mentioned in Sub-clause II-2.7.2 (Figure II-2.7.2.1), which consists of early medium variety of early rice (recession) and early medium variety of early rice (2nd dry). Estimated irrigation water requirement in the SPWRRSP Area is shown in Table II-2.7.3.1.1.

**Table II-2.7.3.1.1 Estimated Unit Irrigation Water Requirement for SPWRRSP (Average of 20 years; 1992-2011)**

(Unit: $m^3$/sec/ha)

| Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Early Rice (Recession) | | | | | | | | | | | | |
| 1-15 | 2.28 | 1.99 | 0.99 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.36 | 1.28 |
| 16-end | 2.26 | 1.50 | 0.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 1.74 |
| (2) Early Rice (2nd Dry Season) | | | | | | | | | | | | |
| 1-15 | 0.00 | 0.00 | 2.82 | 2.28 | 2.13 | 0.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16-end | 0.00 | 1.65 | 2.46 | 2.36 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Source: JICA Survey Team*

### II-2.7.3.2 Water Balance Study

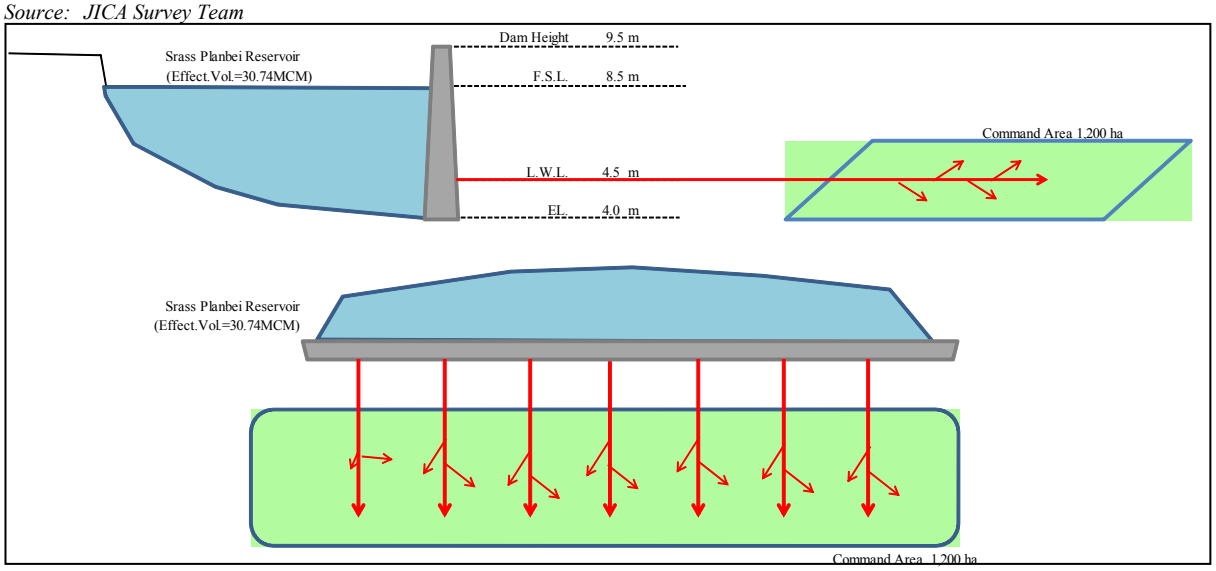
(1) Calculation Method and Conditions

In this Survey, long-term water balance simulation method was applied. The water balance simulation model in this Survey is summarized as below:

**Table II-2.7.3.2.1 Condition of Water Balance Simulation for SPWRRSP**

| Item | This Survey |
|---|---|
| Calculation interval | Half-monthly basis |
| Method for estimating potential evapo-transpiration | Penman-Montieth method |
| Runoff data | Estimated from the data at Peam Koh Khel |
| Reservoir Operation | Storage effect of Srass Prambai reservoirs are considered |
| Simulation model | By the long-term (1992-2011; 20years) simulation |
| Irrigation fail | Continuous deficit in 15 days |

*Source: JICA Survey Team*



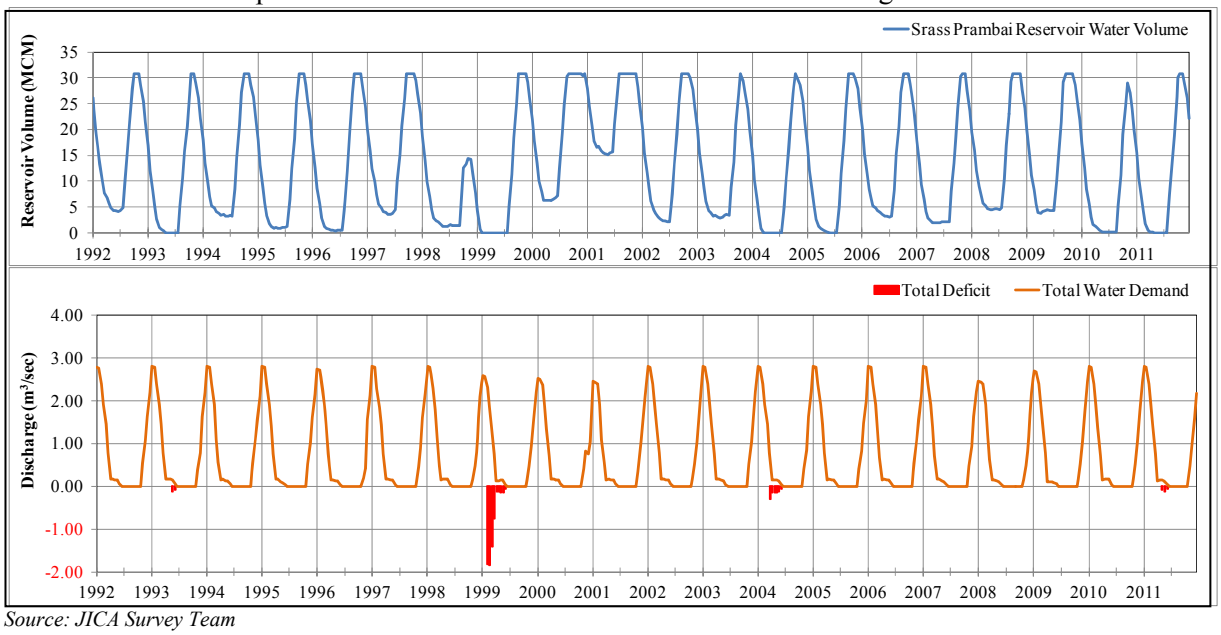

*Source: JICA Survey Team*

**Figure II-2.7.3.2.2 Schematic Layout of Water Balance Model for SPWRRSP**

(2) Reservoir Operation

Reservoir storage curve (H-V-A curve) of the Srass Prambai Reservoir was prepared by based on results of topographic survey by the JICA Survey Team as shown in ANNEX B. The reservoir operation and the design outflow from the Srass Prambai Reservoir were decided to achieve for irrigation water demand of SPWRRSP Area. In this simulation, when the water level of the Tonle Bassac River is over EL.5.0 m, river water from the Tonle Bassac River was assumed to flow into the Srass Prambai Reservoir at 4.0 $m^3$/sec.

Results of reservoir operation for Srass Prambai Reservoir are shown in Figure II-2.7.3.2.1.




*Source: JICA Survey Team*

**Figure II-2.7.3.2.1 Results of Reservoir Operation Simulations of Srass Prambai Reservoir**

(3) Result of Water Balance Calculation

Results of water balance simulations of 20 years from 1991 to 2011 for SPWRRSP are shown in Table II-2.7.3.2.2. According to the water balance simulations, total 1,200 ha with crop intensity of 106% (early rice recession: 1,200 ha + early rice 2nd dry: 70 ha) can be irrigated by 80% dependability.

**Table II-2.7.3.2.2 Results of Water Balance Study of SPWRRSP**

| Max. Command Area (ha) | Available Total Irrigation Area | Early Rice (Dry) | Early Rice (Recession) | Crop Intensity | Dependability | Deficit Year (times/20years) |
|---|---|---|---|---|---|---|
| 2,500 ha | 1,200 ha | 70 ha | 1,200 ha | 106% | 80% | 4 |

*Source: JICA Survey Team*

## II-2.7.4 Hardware Components

(1) Dike of Srass Prambai Reservoir

The Srass Prambai Reservoir that was constructed in Pol Pot regime is surrounded by the dike at the northern, western and southern sides and the road at eastern side. The dike is 12.3 km long in total and 7 m in height at maximum with top width of 5 m. The reservoir dike was eroded at many places and damaged. The northern part of the dike was recently rehabilitated in 2008, while the eastern and southern parts of the dike remain untreated. PDOWRAM proposed the rehabilitation of the embankment of the dike of 5.0 km, which are examined by the JICA Survey Team with topographic survey for confirmation of the present conditions of longitudinal and cross sections of the dike. As a result, the rehabilitated sections in the northern part are still sufficient for height, width and side slopes. Therefore, the remaining parts are proposed to be rehabilitated in the Sub-project in order to enlarge the embankment section to meet the same height of the rehabilitated sections. The length of the proposed rehabilitation is estimated at 9.1 km based on the topographic survey.

(2) Intake Culvert on Reservoir Dike

There are 7 existing culverts on the reservoir dike originally constructed during Pol Pot regime. These culverts were equipped with wooden stop logs inner side of the reservoir however all of them are malfunctioning at present. Though Kandal PDOWRAM proposed new construction of 2 culverts in the proposal document, the JICA Survey Team and PDOWRAM concluded that the existing intake culverts should be replaced with new provision of steel gates based on the investigation of the conditions. The required works include (i) removing existing structures, (ii) construction of new structures maintaining original capacity, (iii) installation gate and screen, and (iv) protection at both sides. Proposed intake culverts are listed as below.

**Table II-2.7.4.1 List of Proposed Intake Culverts at Srass Prambai Reservoir**

| No, | Name of Off-taking Canal | Culvert | | Length (m) | Gate |
|---|---|---|---|---|---|
| | | Box | Pipe | | |
| 1) | Main Canal 10 | - | Ø 1.2 m x 1 | 10.0 | 1.2 m x 1. 2 m (4-edge sealing) |
| 2) | Main Canal 11 | - | Ø 1.2 m x 1 | 10.0 | 1.2 m x 1. 2 m (4-edge sealing) |
| 3) | Main Canal 12 | - | Ø 1.2 m x 1 | 10.0 | 1.2 m x 1. 2 m (4-edge sealing) |
| 4) | Main Canal 13 | - | Ø 1.2 m x 1 | 10.0 | 1.2 m x 1. 2 m (4-edge sealing) |
| 5) | Main Canal 14 | - | Ø 1.0 m x 1 | 10.0 | 1.0 m x 1. 0 m (4-edge sealing) |
| 6) | Main Canal 14.5 | - | Ø 1.0 m x 1 | 10.0 | 1.0 m x 1. 0 m (4-edge sealing) |
| 7) | Main Canal 12(South) | 1.0 m x 1.5 m | - | 6.0 | 1.0 m x 1. 5 m (4-edge sealing) |

*Source: JICA Survey Team based on the inventory survey in January 2012*

(3) Other Facilities

As mentioned in Clause II.1.6.5, the present conditions of canal system are operational and well matching to the recession cultivation in this area, so that the rehabilitation of the canal system is not proposed in this Survey according to the basic concept described on Clause II-2.7.1.

### II-2.7.5 Software Components

#### II-2.7.5.1 Strengthening of MOWRAM and PDOWRAM Staff on O&M

After completion of rehabilitation works for irrigation facilities, the staff of MOWRAM and Kandal PDOWRAM is highly expected to take charge of O&M of them. In order to maintain overall sustainability of the system, it is proposed to heighten capability of MOWRAM and PDOWRAM staff focusing on O&M skills through the software components activities.

**Table II-2.7.5.1.1 Review on Strengthening of Government Agencies Concerned**

| Item | Project Proposal | Review in 2011 |
|---|---|---|
| Capacity building of Staff of MOWRAM and Kandal PDOWRAM | The proposal was prepared by Kandal PDOWRAM under direction of MOWRAM assisted by TSC. It generally focused on improvement of irrigation facilities, however, capacity building program for government is not included. Instead capacity building was expected to be carried out through OJT and OFF-JT particularly organized by TSC under MOWRAM. In addition, villagers and farmers have agreed to establish FWUC for O&M purpose. | In order to establish O&M set-up for sustainable irrigation system management in Main Canal 35 Irrigation, relevant staff capability strengthening is of critical importance. In concurrence with facilities' rehabilitation and development and OJT of Kandal PDOWRAM staff, budget needs to be allocated to organized training program as OFF-JT program. As similar to KSBISRSP, international consultant will be assigned at the initial stage of the program to prepare overall schedule and arrangement. TSC together with national consultant is expected to perform as trainers for the program. |

*Source: JICA Survey Team*

#### II-2.7.5.2 Formation and Strengthening of Farmer Water Users Community

FWUC will be generally responsible for O&M of minor canals including tertiary canal level facilities. However, FWUC has not been established so far. In order to conduct proper O&M at minor canal level, it is essential to organize and strengthen FWUC in timely manner.

**Table II-2.7.5.2.1 Review on Strengthening of FWUC**

| Item | Project Proposal | Review in 2011 |
|---|---|---|
| Formation and strengthening of FWUC | In the original proposal of SISIP, formation and strengthening of FWUC was not included as project component in SPWRRSP. Such activities were expected to be conducted through MOWRAM routine task particularly with the initiatives of Department of FWUC and Kandal PDOWRAM. | Considering insufficient budget indicated by Kandal PDOWRAM, it is recommended that FWUC be organized and strengthened under SPWRRSP with appropriate budgetary arrangement. The program would be particularly establishment of joint operation set-up of main reservoir among Kandal PDOWRAM and FWUC and O&M of canal systems.<br>Evidently, it is backed by government policy such as PIMD policy. Such proposed activities will be conducted by PDOWRAM to be trained by technical units under PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC. |

*Source: JICA Survey Team*

#### II-2.7.5.3 Strengthening of Agricultural Extension Services

In SPWRRSP, it is expected that strengthening of agricultural supporting services be promoted to raise paddy production in order to increase farm household income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under SPWRRSP. However, the proposal has no details of activities on strengthening of agricultural extension services.

Through interview and discussion with PDA, DAO, and farmers, constraints on implementation of agricultural extension activities are clarified as follows:

- In the Sub-project area, demonstration for paddy cultivation has been done often. The purpose and target of implementation of extension services are clear. Extension services have been carried out, considering current situation of recession area. However, it seems that there are no monitoring activities after completion of demonstration activities. Lessons learnt have not been put to good account for the next demonstration activities.
- Paddy cultivation in this Sub-project area has been done under irrigated condition. The existing facilities of the reservoir have no function, thus water from the reservoir is not controlled. It is strongly required to manage water by water users groups after rehabilitation of the reservoir.
- Training materials including guideline, pamphlet, handout, poster, etc. are available[8]. It is understandable that PDA and DAO have enough experience and knowledge for implementation of demonstration activities as well as farmers' field schools. Actually training materials are prepared by PDA or DAO staff, based on those materials, However, there are no proper action plan for implementation of extension services, and further no filing system for materials and experience in District Agricultural Office.

Considering the current situation mentioned above, the following training activities would be proposed for smooth implementation of demonstration activities:

- Preparation of action plan for demonstration activities based on the needs and requirement of beneficiaries,
- Preparation of training materials,
- Preparation of guideline on demonstration activities, based on the existing materials,
- Filing of training materials, and
- Implementation of monitoring and evaluation

Furthermore, it is proposed that exchange of materials and information as well as cooperation among PDAs and DAOs be facilitated periodically.

### II-2.7.6 Scope of Sub-project

(1) Examination of Scope of Srass Prambai Water Recession Rehabilitation Sub-project Proposed by MOWRAM

Based on the basic concept for irrigation rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under SPWRRSP are shown in the following table:

**Table II-2.7.6.1 Examined Scope of SPWRRSP**

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **(a) Irrigation Development Area** | | |
| - 2,500 ha in the dry season | - 1,200 ha in the dry season | Justified through water balance study |
| **(b) Cropping Pattern and Crop Intensity** | | |
| - Rice Cropping System<br>- Crop Intensity: 100% | - Rice Cropping System<br>- Crop Intensity: 106% | Application of double cropping of rice considering present cropping pattern |
| **(c) Hardware Components** | | |
| 1) Reservoir dike<br>- Rehabilitation of the existing dike (5.0 km) | 1) Reservoir dike<br>- Rehabilitation of the existing dike (9.1 km) | Northern part of the dike was recently rehabilitated in 2008. |
| 2) Replacement of intake culverts on reservoir dike | 2) Replacement of intake culverts on reservoir dike<br>- Replacement of 7 intake culverts with provision of new slide gates | (i) Removing existing structures<br>(ii) Construction of new structures maintaining original capacity<br>(iii)Installation gate and screen<br>(iv)Protection at both sides |

[8] *Refer to Attachment-5 for master textbook and guidelines, which are prepared by MAFF.*

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| 6) Construction of Project Office<br>Not Proposed | 6) Construction of Project Office<br>- Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works | |
| **(d) Software Components** | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M<br>Not proposed | In order to keep the sustainability of SPWRRSP, these are indispensable, thus should be included in scope of SPWRRSP | |
| - Formation and Strengthening of FWUC<br>Not proposed | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus should be included in scope of SPWRRSP | |
| - Strengthening of agricultural extension services<br>Not proposed | In order to attain the improvement of agricultural productivity, this is needed, thus should be included in scope of SPWRRSP | |

*Source: JICA Survey Team*

(2) Priority Ranking

There are many works in hardware and software components in the examined scope of SPWRRSP. It is not sure presently that all of these works could be simultaneously implemented in the available loan amount. Thus, as mention in Clause II-2.7.1, these examined works are given priority ranking based on the following criteria

- The works indispensable for attaining at the purpose of SPWRRSP are given high priority
- Urgently required works for adequate operation of irrigation system are given high priority
- The rehabilitation works for facilities needed to recover their functions are given high priority

The priority ranking of each work based on the criteria is summarized in the following table.

**Table II-2.7.6.2 Priority Ranking of Each Work**

| Scope Examined by JICA Survey Team | | Priority* |
|---|---|---|
| **(a) Hardware Components** | | |
| - Rehabilitation of reservoir dike | - Rehabilitation of dike (9.1 km) | ◎ |
| - Replacement of intake culverts on reservoir dike | - Replacement of intake culverts (7 nos.) with slide gates | ◎ |
| - Construction of project office | - Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works | ○ |
| **(b) Software Components** | | |
| 1) Capacity development for MOWRAM and PDOWRAM staff on O&M | - Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 2) Formation and strengthening of FWUC | - Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 3) Strengthening of agricultural extension services | - Executed by PDA under the control of PMU Japan Support Fund of MOWRAM | ◎ |

**: High priority: ◎ , Medium priority: ○ , Low priority: △*
*Source: JICA Survey Team*

## II-2.8 Daun Pue Irrigation System Rehabilitation Sub-project

### II-2.8.1 Basic Concept

The project works proposed by PDOWRAM/MOWRAM will be reviewed in the following basic concept paying attention upon the current conditions of DPISRSP.

(1) Integrated Approach of Hardware and Software Components

Irrigated agriculture development for DPISRSP is planned in the concept of integrated approach of hardware and software components which is the same as the other Sub-projects, in order to heighten the project effect and to maintain the project sustainability.

(2) Determination of Project Scale through Water Balance Study

Irrigation development should be planned mainly based on available water, available land and the water demand by crops. Since DPISRSP has enough farm land to be served by the proposed headworks, its project size should be determined through a water balance study, taking into account other irrigation systems located upstream and downstream in the same river basin.

(3) Utilization of Existing Canal System

There are the existing irrigation canals which were constructed in Pol Pot regime. In order to save construction cost and lighten the burden for land acquisition, these existing irrigation canals are used as much as possible.

(4) Priority Ranking on Sub-project Scope by Criteria

As DPISRSP requires many project works, these will be prioritized so as to use the limited budget. High priority should be given to (i) the works indispensable for attaining at the aim of DPISRSP, (ii) Urgently required works for proper operation of irrigation system, (iii) the facilities related to ensuring water resources, and (iv) the facilities which need large scale rehabilitation to convey irrigation water.

### II-2.8.2 Agricultural Development Plan

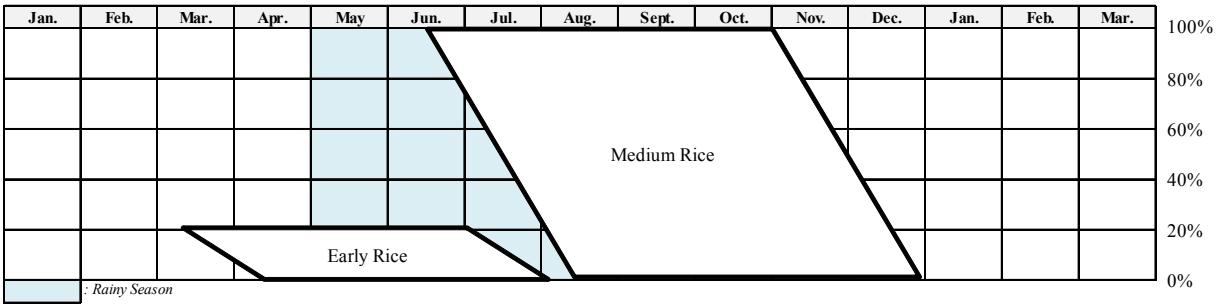
The agricultural development plan proposed in 2009 was reviewed through the site visit, analysis on collected latest data and information from the relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute to preparation of the appropriate scope of DPISRSP. The review results are given in the following table:

**Table II-2.8.2.1 Review on Agricultural Development Plan**

| Item | F/S | Review in 2011 |
|---|---|---|
| 1) Irrigation Development Area | (a) Sub-project area of 1,151 ha was estimated in the proposal. | (a) The proposed area of 1,151 ha was roughly confirmed on the topographic map.<br>(b) Sub-project area should be the same area before and after rehabilitation. |
| 2) Cropping Pattern and Cultivated Area | (a) No cropping pattern<br>(b) Unit cost on increase of agricultural input for existing cultivated area: US$ 50/ha<br>(c) Unit cost on increase of agricultural input for newly cultivated area: US$ 150/ha<br>(d) Cultivated area is shown as follows:<br>Before rehabilitation<br>- Rainy season: 150 ha<br>- Rainy season (rainfed): 1,001 ha<br>After rehabilitation<br>- Rainy season 1,151 ha<br>(e) Cropping intensity: 100% | (a) Based on some interview to PDOWRAM, PDA, DAO, and farmers, proposed cropping pattern should be prepared.<br>(b) Breakdown on unit cost of US$50/ha and US$150/ha is not available. Therefore, prevailing and proposed production costs of paddy were estimated based on production costs in RCHRSP, USISRSP and KSBISRSP, and interview to DAO and farmers.<br>(c) It is necessary to make water balance study, in order to confirm the proposed area. It is understandable that the most important point for agricultural development is ensured the rainy season paddy with 100% cropping intensity at least. |
| 3) Beneficiaries | In the proposal, the related communes, number of villages, and number of beneficiaries are specified. | Estimated number of beneficiaries by village should be tentatively identified |
| 4) Unit Yield of Paddy | (a) Target unit yield of paddy was estimated as follows:<br>Before rehabilitation<br>- Rainy season: 1.2 ton/ha<br>- Rainy season(rainfed): 0.8 ton/ha<br>After rehabilitation<br>- Rainy season: 2.0 ton/ha<br>(b) These yields are estimated, based on the interview to farmers, but not from PDA and DAO. | (a) Proposed target unit yield of paddy is relatively reasonable. However, proposed yield with project condition is slightly lower. It is necessary to review them, based on the latest statistical data as well as farmers' interview. |

| Item | F/S | Review in 2011 |
|---|---|---|
| 5) Agricultural Extension Services | In the proposal, cost for implementation of agricultural extension services was estimated as unit cost per ha of US$ 10/ha. | - In the proposal, there is no breakdown for US$10/ha. JICA survey estimated at around USD12/ha. Namely USD10/ha is reasonable. |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-2.8.2.1 Proposed Cropping Calendar for DPISRSP**

### II-2.8.3 Water Balance Study

#### II-2.8.3.1 Water Demand

(1) General

There is no existing reservoir in the DPISRSP Area and the basin. Therefore, simplified water balance study was conducted for the DPISRSP Area.

As described in Sub-clause II-1.7.2.2, daily observed water level at Chi Prong gauging station is available only 3 years from March 2007 to December 2009. Thus, in this Survey, using the observed daily water level and H-Q rating curve at Chi Prong gauging station, long-term discharge was estimated by tank model for analysis of water balance study. For water balance study, long-term daily discharge for 20 years from 1992 to 2011 was prepared. After estimation of daily discharge at Chi Prong by tank model, 5-day mean discharge was prepared. With estimated and observed 5-day mean discharge at Chi Prong, 5-day mean discharge at proposed intake site at the Stung Chieb River are estimated using catchment area and annual basin mean rainfall.

(2) Irrigation Water Requirement

Irrigation water requirement for the DPISRSP Area was calculated based on the proposed cropping calendar mentioned in Figure II-2.8.2.1. Estimated irrigation water requirement in the DPISRSP Area is shown in Table II-2.8.3.1.1.

**Table II-2.8.3.1.1 Estimated Unit Irrigation Water Requirement for DPISRSP Area (Average of 20 years; 1992-2011)**

(Unit: lit/sec/ha)

| Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Early Rice (Early Rainy Season) | | | | | | | | | | | | |
| 1-15 | 0.00 | 0.00 | 0.68 | 2.03 | 1.96 | 1.77 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16-end | 0.00 | 0.00 | 1.36 | 2.37 | 1.93 | 1.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| (2) Medium Rice (Rainy Season) | | | | | | | | | | | | |
| 1-15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 | 0.83 | 0.55 | 0.79 | 1.15 | 0.44 |
| 16-end | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.72 | 1.05 | 0.58 | 0.63 | 0.76 | 0.00 |

*Source: JICA Survey Team*

#### II-2.8.3.2 Water Balance Study

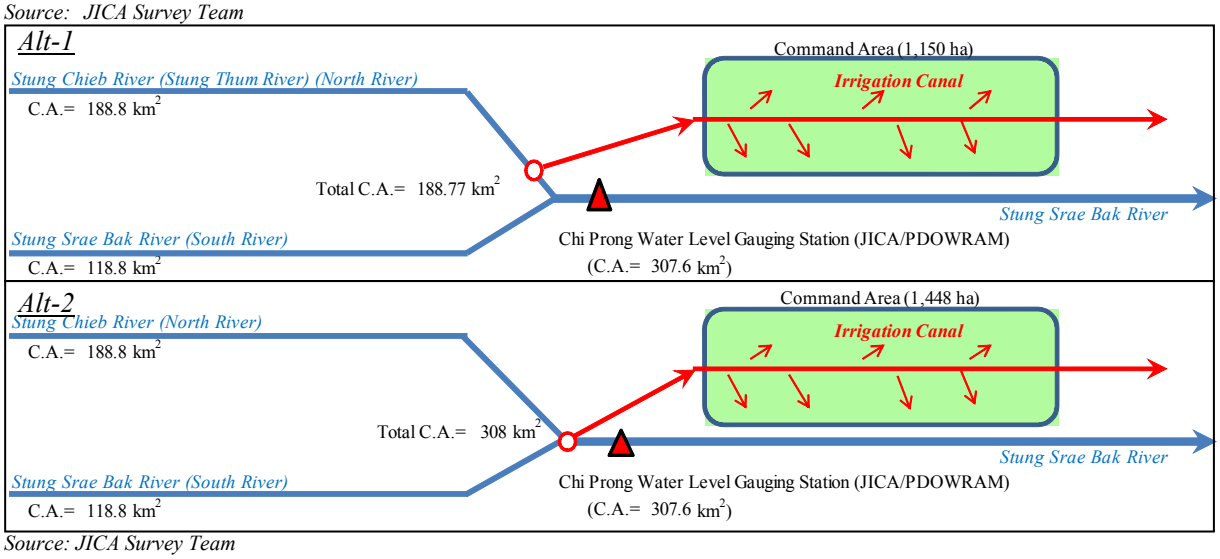
(1) Calculation Method and Conditions

In the Survey, long-term water balance simulation method was applied. The water balance simulation in the Survey is summarized as below:

**Table II-2.8.3.2.1 Condition of Water Balance Simulation for DPISRSP**

| Item | This Survey |
|---|---|
| Calculation interval | Half-monthly basis |
| Method for estimating potential evapo-transpiration | Penman-Montieth method |
| Runoff data | Estimated from the data at Peam Khley station |
| Reservoir Operation | no reservoir in the area |
| Simulation model | By the long-term (1992-2011; 20years) simulation |
| Irrigation fail | Continuous deficit in 15 days |

*Source: JICA Survey Team*




*Source: JICA Survey Team*

**Figure II-2.8.3.2.1 Schematic Layout of Water Balance Model for DPISRSP**

(2) Result of Water Balance Calculation

Water demand and river discharge during simulated term are shown in Figure II-2.8.3.2.2. The deficit in the figure describes water shortage. Results of water balance simulations of DPISRSP are shown in Table II-2.8.3.2.2. Two alternatives of intake sites, which are (i) only the Stung Chieb River before confluence and (ii) the Stung Chieb River + the Stung Srea Bak River after confluence, were simulated for water balance study for DPISRSP Area. According to the water balance simulations, total 1,150 ha of command area with crop intensity of 100% will be able to be irrigated with 80% dependability in Alt-1. If intake site is located at downstream of confluence point (Alt-2), available irrigation area will be increased. Schematic results of 80% dependability are shown in Figure II-2.8.3.2.3.

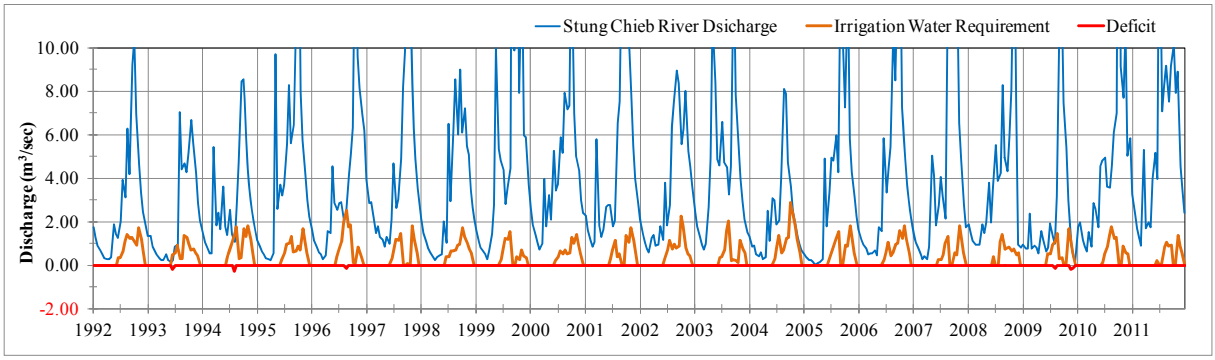



**Figure II-2.8.3.2.2 Results of Water Balance Study for DPISRSP (Alt-1)**

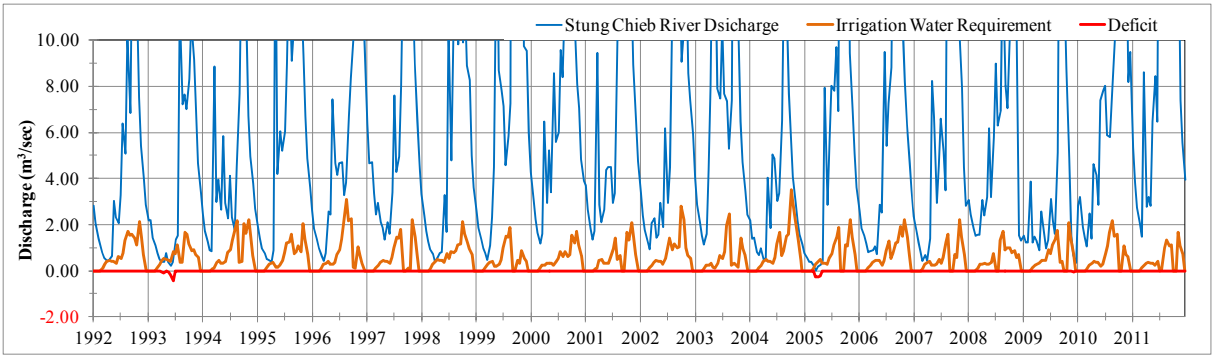



**Figure II-2.8.3.2.3 Results of Water Balance Study for DPISRSP (Alt-2)**

**Table II-2.8.3.2.2 Results of Water Balance Study of DPISRSP (80% Dependability)**

| Study Case | Total Area | Early Rice (Early Rainy) | Mid Rice | Crop Intensity | Dependability | Deficit Year (times/20years) |
|---|---|---|---|---|---|---|
| Alt-1: Only Stung Chieb River | 1,150 ha | 0 ha | 1,150 ha | 100% | 80% | 4 |
| Alt-2: Stung Chieb River + Stung Srae Bak River | 1,448 ha | 174 ha | 1,448 ha | 112% | 80% | 4 |

*Source: JICA Survey Team*

## II-2.8.4 Hardware Components

### II-2.8.4.1 Headworks Rehabilitation

(1) Alternative Sites of Proposed Headworks

As mentioned in Clause II-2.8.3, there are 2 alternative intake sites, one is the existing intake site (Alt-1) on the Stung Chieb River and the other is about 1 km downstream from the existing intake (Alt-2), where the Stung Chieb River confluents into the Stung Srae Bak River. Based on the result of water balance study, the proposed intake at existing intake site has sufficient water source for irrigating the proposed target area of 1,150 ha in the rainy season.

In addition, the following conditions are considered to determine the proposed intake site.

(a) Designed flood discharges are estimated for both sites in Clause AB-2.6.2.6 in ANNEX B, in which the results shows 236 $m^3$/sec for Alt-1 and 377 $m^3$/sec for Alt-2 with return period of 50 years. In order to reduce the construction cost, Alt-1 site is advantageous to Alt-2.

(b) There exists another irrigation system named Canal Steung Sdach Irrigation System, which is also one of the proposed rehabilitation Sub-projects for the Survey. This system lies in downstream of DPISRSP, of which intake is located about 16 km downstream of the confluence of 2 rivers; Stung Chieb River and the Stung Srae Bak River. In order to ensure the water source for this system, it is proposed that the water source in the Stung Srae Bak River basin be allocated for the system in downstream.

Taking the above situations into consideration, the intake for DPISRSP is proposed to be constructed at Alt-1.

(2) Proposed Works for Headworks

In the project proposal prepared by PDOWRAM, construction of diversion weir (called as spillway in the proposal) is proposed at the existing intake site, which consists of 2 sections of (i) flood gate section (1.5 m (H) x 1.5 m (W), 13 spans) and (ii) stoplog section (1.8 m x 0.7 m, 18 spans each in both sides). Based on the investigation taking the above conditions into consideration, the proposed works of the headworks is summarized as below.

**Table II-2.8.4.1.1 Scope of Headworks**

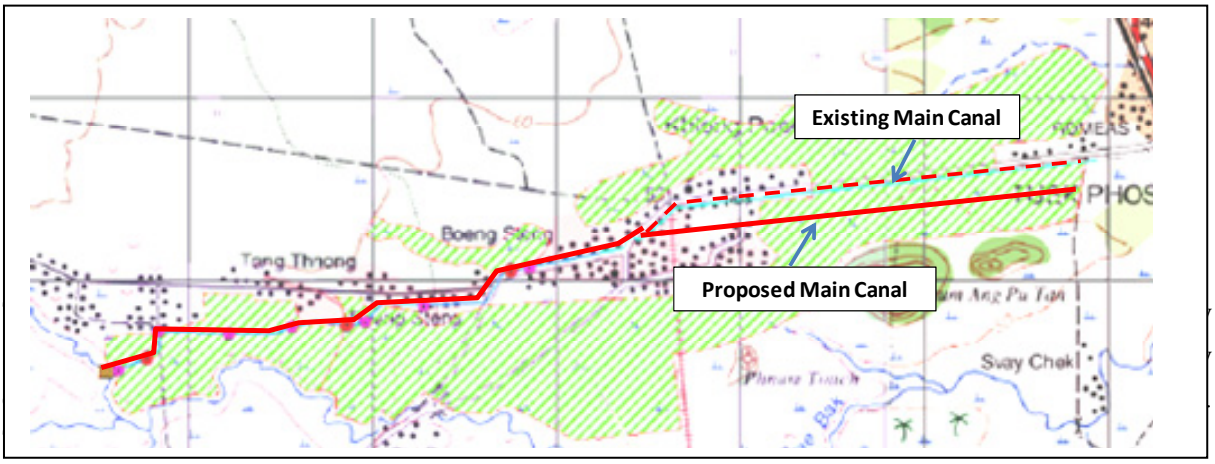
| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| (a) Weir and hydro-mechanical works | - Fixed weir with and flood gate stoplog section<br>Flood gates :<br>1.5 m (H) x 1.5 m (W), 13 spans<br>Stoplog section<br>0.7 m (H) x 1.8 m (W), 8 spans each in both sides | - Movable weir<br>Flood gates (Wheel gate)<br>2 m (H) x 10 m (W) x 4 span |
| (b) Intake | Not proposed | - Intake gates (Slide gate)<br>1.5 m (H) x 1.5 m (W) x 2 span |
| (c) River training and protection | Protection with stone pitching | - Up and downstream, 1 km approx.<br>- Protection with gabion |

*Source: JICA Survey Team*

### II-2.8.4.2 Irrigation Facilities Rehabilitation

(1) Main Canal

As mentioned in previous Sub-clauses, the main canal is not functioning due to the deterioration and originally poor hydraulic designs. The present canal route is deemed inadequate especially downstream reach of the area. In the right bank of the main canal from P6+200 (6.2 km from the intake) to the end, secondary canals taking-off from the main canal runs inverse draft from north to south. Based on the sample topographic survey on the secondary canals, the route of main canal is proposed to change as shown in Figure II-2.8.4.2.1.




*Source: JICA Survey Team*

**Figure II-2.8.4.2.1 Proposed Route of Main Canal in DPISRSP**

The proposed scopes for the main canal are summarized below:

**Table II-2.8.4.2.1 Scope of Main Canal and Related Structures**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Canal length | 6.0 km (only upper reach) | 11.1 km |
| 2) Canal route | On the existing route | Canal route is proposed to change from 6.2 km point to end. |
| 3) Canal section | Design discharge : not mentioned<br>Canal gradient: 0.0001 ~ 0.0005 | Design discharge ; 2.8 $m^3$/sec - 0.2 $m^3$/sec<br>Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition. |
| 4) Related Structures | Check structures, water gates, a culvert and a spillway are proposed. | All existing structures are to be demolished and new structures, i.e. check structures, turnouts, culverts, drops, bridges and a cross drain are proposed |

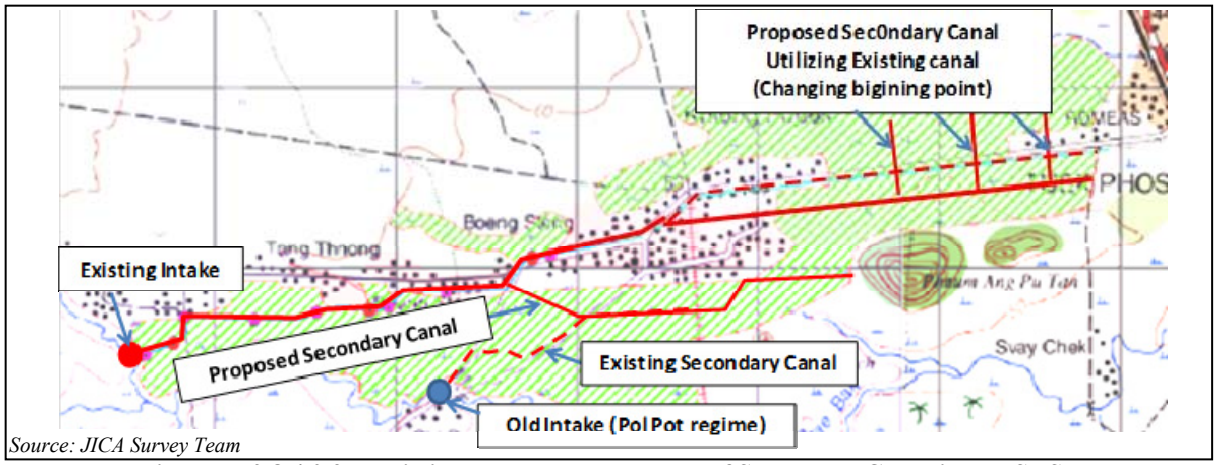
*Source: JICA Survey Team*

(2) Secondary Canals

Due to the route change of the main canal mentioned above, alignment of the secondary canals is also changed in the downstream part of the area. Their routes however remain unchanged, while taking-off

point from the main canal will be shifted according to the changed route of the main canal as shown in Figure II-2.8.4.3.

In addition, the route of one secondary canal named No.2 will be changed, because it starts from the old intake constructed in Pol Pot regime, which are totally damaged at present, and hence this system is to be included in DPISRSP. In the Survey, the canal is proposed to connect the main canal directly and the other secondary canal as shown in Figure II-2.8.4.2.2.




*Source: JICA Survey Team*

**Figure II-2.8.4.2.2 Existing and Proposed Route of Secondary Canal in DPISRSP**

The location and feature of related structures on the main canal are figured out through the inventory survey conducted by JICA Survey Team in 2012. The existing structures should be basically demolished because the canal earthworks will be executed whole section of the main canal.

The proposed scopes for the secondary canals are summarized below

**Table II-2.8.4.2.2 Scope of Secondary Canal and Related Structures in DPISRSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Canal quantity and length | Not Proposed | Four secondary canals, 4.6 km long in total |
| 2) Canal route | | Changed as shown in Figure II-2.8.4.3.3 |
| 3) Canal section | | Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition. |
| 4) Related Structures | | All existing structures are to be demolished and new structures, i.e. check structures, drain inlets, Turnouts, culverts, drops, bridges and a cross drain are proposed |

*Source: JICA Survey Team*

(3) Drainage System

In the DPISRSP Area, the existing canals are seems to have double functions of irrigation and drainage. Some of the existing canals will be rehabilitated as irrigation canals with raising designed water level and subsequent embankment, while the other canals will remain as it is which will be utilized as drains after shaping of canal sections. Natural streams are also functioning as drains. Under such situation, construction of new drainage canal is not proposed, because land acquisition for drains is difficult and no serious drainage problem is observed in the area, except some areas near the river affected by the flood inundation due to the high backwater from the river within only a few days. The proposed works for drainage system are shown as below.

**Table II-2.8.4.3 Scope of Drainage System in DPISRSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Drainage canal | Not proposed. | Improvement and reshaping of existing canal sections |

*Source: JICA Survey Team*

(4) Tertiary Canals

Currently, there is no systematic tertiary canal system in the DPISRSP Area. The irrigable area in this Sub-project is proposed to be divided into 30 tertiary blocks. Alignment of tertiary blocks and layout plan of the canals would be prepared under the consensus of the related FWUC with assistance of Kampong Speu PDOWRAM. Land for the tertiary canals and watercourses would be offered by beneficiary farmers.

**Table II-2.8.4.4 Scope of Tertiary Blocks in DPISRSP**

| Item | Scope Proposed by MOWRAM | Scope Examined by JICA Survey Team |
|---|---|---|
| 1) Tertiary Canals | Not proposed | In DPISRSP, the blocks are divided on the basis of aerial photographs. Layout plan of tertiary canals would be finalized based on the manual and intensions of concerned beneficiary farmers |

*Source: JICA Survey Team*

## II-2.8.5 Software Components

### II-2.8.5.1 Strengthening of MOWRAM and PDOWRAM Staff on O&M

During O&M stage of DP, the staff of MOWRAM and Kampong Chhnang PDOWRAM is highly expected to be in charge of O&M of rehabilitated irrigation facilities. In order to execute O&M effectively and eventually to ensure overall sustainability of the system, it is proposed to raise capability of MOWRAM and PDOWRAM staff focusing on O&M skills through the application of software components.

**Table II-2.8.5.1.1 Review on Strengthening of Government Agencies Concerned**

| Item | Project Proposal | Review in 2011 |
|---|---|---|
| Capacity building of Staff of MOWRAM and Kampong Chhnang PDOWRAM | The proposal was prepared by Kampong Chhnang PDOWRAM under support of MOWRAM assisted by TSC. It generally focused on improvement of irrigation facilities, however, capacity building program for government is not included. Instead capacity building was expected to be carried out through OJT and OFF-JT particularly organized by TSC under MOWRAM. | In order to establish O&M set-up for sustainable irrigation system management in DPISRSP, relevant staff capability strengthening is of critical importance. In concurrence with facilities' rehabilitation and development and OJT of Kampong Chhnang PDOWRAM staff, budget needs to be allocated to organized training program as OFF-JT program. International consultant will be employed at the initial stage of the program to prepare overall schedule and arrangement. TSC together with national consultant is expected to serve as trainers for the program. |

*Source: JICA Survey Team*

### II-2.8.5.2 Formation and Strengthening of Farmer Water Users Community

FWUC will be generally responsible for O&M of minor canals including tertiary canal level facilities of Daun Pue Irrigation System. However, there does not exist FWUC in DPISRSP at present. In order to conduct proper O&M at minor canal level, it is indispensable to organize and strengthen FWUC in timely manner.

**Table II.2.8.5.2.1 Review on Strengthening of FWUC**

| Item | Project Proposal | Review in 2011 |
|---|---|---|
| Formation and strengthening of FWUC | In the original proposal of SISIP, formation and strengthening of FWUC was not included as project component in DPISRSP. Such activities were expected to be conducted through MOWRAM routine task particularly with the initiatives of Department of FWUC and Kandal PDOWRAM. | As the result of discussion with Kampong Chhnang PDOWRAM, it is highly recommended that formation and strengthening of FWUC be included as one of DPISRSP components with appropriate budgetary arrangement.<br>Evidently, it is backed by government policy such as PIMD policy. Such proposed activities will be conducted by PDOWRAM to be trained by technical units under PMU Japan Support Fund, related technical departments of MOWRAM and TSC. |

*Source: JICA Survey Team*

### II-2.8.5.3 Strengthening of Agricultural Extension Services

In DPISRSP, it is expected that strengthening of agricultural supporting services be promoted to raise paddy production in order to increase farm household income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under the Sub-project. However, the proposal has no details of activities on strengthening of agricultural extension services, but only unit cost or US$ 10/ha. Through interview and discussion with PDA, DAO, and farmers, constraints on implementation of agricultural extension activities are clarified as follows:

- Extension services have been carried out by Tuek Phos DAO. However, there are only 2 staff in this DAO. It means that it is difficult to conduct extension services properly. Accordingly the most important subject in this DAO is to deploy more extension staff.
- Budget of PDA Kampong Chhnang is not sufficient. There are no demonstration and training activities in this area during the last 2 years.
- There are various constraints on irrigation water for paddy cultivation such as shortage of water, no proper operation on water management by farmers, no sufficient organizations for water management, poor irrigation facilities, etc.
- Training materials including guidelines, pamphlet, handout, poster, etc. are available[9]. It is understandable that PDA and DAO have enough experience and knowledge in implementation of demonstration activities as well as farmers' field schools. Actually training materials are prepared by PDA or DAO staff, based on those materials. However, there are no proper action plan for implementation of extension services, and further no filing system for materials and experience in DAO.

Considering the current constraints mentioned above, the following training activities are proposed for smooth implementation of demonstration activities:

- Preparation of action plan for demonstration activities based on the needs and requirement of beneficiaries,
- Preparation of training materials,
- Preparation of guidelines on demonstration activities, based on the existing materials,
- Filing of training materials, and
- Implementation of monitoring and evaluation

Furthermore, it is proposed that exchange of materials and information as well as cooperation among PDAs and DAOs be facilitated periodically.

### II-2.8.6 Scope of Sub-project

(1) Examination of Scope of Daun Pue Irrigation System Rehabilitation Sub-project Proposed by MOWRAM

Based on the basic concept for irrigation rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under DPISRSP are shown in the following table:

**Table II-2.8.6.1 Examined Scope of DPISRSP**

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **(a) Irrigation Development Area** | | |
| - 1,150 ha | - 1,150 ha in the rainy | Justified through water balance study |

[9] *Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF.*

| Proposed by MOWRAM* | Examined Scope by JICA Survey Team | Remarks |
|---|---|---|
| **(b) Cropping Pattern and Crop Intensity** | | |
| - Rice Cropping System<br>- Crop Intensity: 100% | - Rice Cropping System<br>- Crop Intensity: 100% | |
| **(c) Hardware Components** | | |
| 1) Construction of headworks<br>a) Protection with stone pitching<br>b) Fixed weir with and flood gate<br>Flood gates:<br>1.5 m (H) x 1.5 m (W), 13 spans<br>Stoplog section:<br>0.7 m (H) x 1.8 m (W), 8 spans each in both sides<br>c) Construction of intake structure<br>Not Proposed | 1) Construction of headworks<br>a) River training of up and down stream of proposed headworks<br>b) Construction of headworks with provision of flood gates (2 m x 10 m x 4 sets)<br>c) Construction of intake structure | |
| 2) Rehabilitation of Daun Pue Main Canal<br>a) Improvement of canal (6.0 km, only upper reach) on the existing route<br>- New construction of canal related structures; | 2) Rehabilitation of Daun Pue Main Canal<br>a) Improvement of canal (6.2 km from BP to P6+200, raising of embankment and/or enlargement of canal section),<br>b) Changing route of main canal (4.9 km from P6+200 to EP, Upgrading of secondary to main canal) | - Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition. |
| - Check structure 7 nos.<br>- Culvert 3 nos.<br>- Spillway 1 no. | c) Construction of canal inspection road<br>d) Replacement or new construction of canal related structures;<br>- Check structure 14 nos.<br>- Turnout 34 nos.<br>- Culverts 13 nos. | - All existing structures are to be demolished and new structures. |
| 3) Rehabilitation of secondary canals<br>Not Proposed | 3) Rehabilitation of secondary canals<br>a) Improvement of canal (3.4 km in total)<br>b) Construction of new secondary canal from main canal to existing secondary canal (1.2 km)<br>c) Construction of canal inspection road<br>d) Replacement or new construction of canal related structures;<br>- Check structure 9 nos.<br>- Turnout 15 nos.<br>- Culverts 8 nos. | - Section and profile of canal are designed in accordance with designed diversion water requirement and topographic condition.<br><br>- All existing structures are to be demolished and new structures. |
| 4) Rehabilitation of drains<br>Not Proposed | 4) Rehabilitation of drains<br>a) Improvement and reshaping of drains | Improvement and reshaping of existing canal sections |
| 5) Development of tertiary system<br>Not Proposed | 5) Development of tertiary system<br>a) Development of tertiary canal system: 35 km (1,150 ha) | |
| 6) Construction of Project Office<br>Not Proposed | 6) Construction of Project Office<br>- Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works | |
| **(d) Software Components** | | |
| - Capacity development for MOWRAM and PDOWRAM staff on O&M<br>Not proposed | In order to keep the sustainability of DPISRSP, these are indispensable, thus should be included in scope of DPISRSP | |
| - Formation and Strengthening of FWUC<br>Not proposed | To execute proper water management and O&M at tertiary canal system level, strengthening of FWUC is essential, thus should be included in scope of DPISRSP | |
| - Strengthening of agricultural extension services<br>Not proposed | In order to attain the improvement of agricultural productivity, this is needed, thus should be included in scope of DPISRSP | |

*Source: JICA Survey Team*

(2) Priority Ranking

There are many works in hardware and software components in the examined scope of DPISRSP. It is not sure presently that all of these works could be simultaneously implemented in the available loan amount. Thus, as mention in Clause II-2.8.1, these examined works are given priority ranking based on the following criteria

- The works indispensable for attaining at the purpose of DPISRSP are given high priority
- Urgently required works for adequate operation of irrigation system are given high priority
- The rehabilitation works for facilities needed to recover their functions are given high priority

The priority ranking of each work based on the criteria is summarized in the following table.

**Table II-2.8.6.2 Priority Ranking of Each Work**

| Scope Examined by JICA Survey Team | | Priority* |
|---|---|---|
| **(a) Hardware Components** | | |
| - Construction of headworks | 1) River training of up and down stream of proposed headworks<br>2) Construction of headworks with provision of flood gates (2 m x 10 m x 4 sets)<br>3) Construction of intake structure | ◎ |
| - Rehabilitation of Daun Pue Main Canal | 1) Improvement of canal (6.2 km from BP to P6+200, raising of embankment and/or enlargement of canal section),<br>2) Construction of canal inspection road<br>3) Replacement or new construction of canal related structures | ◎ |
| - Rehabilitation of secondary canals | 1) Improvement of canal (3.4 km in total)<br>2) Construction of new secondary canal from main canal to existing secondary canal (1.2 km)<br>3) Construction of canal inspection road<br>4) Replacement or new construction of canal related structures; | ◎ |
| - Tertiary canal system development | - Construction of tertiary canals (35 km) | ○ |
| - Construction of project office | 1) Office building (300 $m^2$)<br>2) Parking shed, gate and fencing<br>3) Well drilling and electric works | ○ |
| **(b) Software Components** | | |
| 1) Capacity development for MOWRAM and PDOWRAM staff on O&M | - Executed by technical units of PMU Japan Support Fund, relevant technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 2) Formation and strengthening of FWUC | - Executed by PDOWRAM staff to be trained by PMU Japan Support Fund, technical departments of MOWRAM and TSC with the support of foreign consultant | ◎ |
| 3) Strengthening of agricultural extension services | - Executed by PDA under the control of PMU Japan Support Fund of MOWRAM | ◎ |

**: High priority: ◎ , Medium priority: ○ , Low priority: △*
*Source: JICA Survey Team*

# CHAPTER II-3 SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

## II-3.1 Scope and Objective of Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project

### II-3.1.1 Scope

SPPIDRIP consists of 6 Sub-projects: RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. The examined scope of SPPIDRIP is summarized in the following table:

**Table II-3.1.1.1 Summary of Project Scope**

| Area | | | Scope of the Project |
|---|---|---|---|
| **Sub-project** | **Water Source** | **Province** | |
| RCHRSP | Prek Thnot River | Kampong Speu | (a) Hardware Components<br>- Partial Rehabilitation of Roleang Chrey Regulator<br>- Full Rehabilitation of Andong Sla Intake<br>- Full Rehabilitation of Vat Krouch Intake<br>- Partial Rehabilitation of North and South Main Canal system<br>- Partial Rehabilitation of secondary canal system<br>- Partial Rehabilitation and Construction of tertiary canal system<br>(b) Software Components<br>- Capacity Development of MOWRAM and PDOWRAM staff on O&M<br>- Strengthening of FWUC<br>- Strengthening of Agricultural Extension Services |
| USISRSP | Slakou River (Tumnup Lok Reservoir, Kpob Trobek Reservoir) | Takeo, Kampong Speu | (a) Hardware Components<br>- Partial Rehabilitation of Tumnup Lok Reservoir<br>- Partial Rehabilitation of Kpob Trobek Reservoir<br>- Partial Rehabilitation of Diversion canal system<br>- Partial Rehabilitation of Main canal system<br>- Partial Rehabilitation of secondary canal system<br>- New Construction of tertiary canal system<br>- New Procurement of O&M Facility and Equipment<br>(b) Software Components<br>- Capacity Development of MOWRAM and PDOWRAM staff on O&M<br>- Formation and Strengthening of FWUC<br>- Strengthening of Agricultural Extension Services |
| KSBISRSP | Prek Thnot River, Stung Touch River, Tonle Bati River (Lake Tonle Bati) | Kandal, Takeo | (a) Hardware Components<br>- Partial Rehabilitation of Diversion Weirs<br>- Full Replacement of Pump and Pump Station<br>- Full Replacement of Regulator for Stung Touch River<br>- Full Upgrading of Connection canal<br>- New Construction of Spillway<br>- Partial Rehabilitation of Main canal system<br>- Partial Rehabilitation of secondary canal system<br>- Partial Rehabilitation Drainage canal system<br>- New Construction of tertiary canal system<br>- New Procurement of O&M Facility and Equipment<br>(b) Software Components<br>- Capacity Development of MOWRAM and PDOWRAM staff on O&M<br>- Formation and Strengthening of FWUC<br>- Strengthening of Agricultural Extension Services |
| MC35RSP | Stung Kat Phluk River, Ou Kat Srov River (Khpob Krous Reservoir) | Kampong Speu | (a) Hardware Components<br>- Partial Rehabilitation of Main canal system<br>- Partial Rehabilitation of secondary canal system<br>- New Construction of tertiary canal system<br>(b) Software Components<br>- Capacity Development of MOWRAM and PDOWRAM staff on O&M<br>- Formation and Strengthening of FWUC<br>- Strengthening of Agricultural Extension Services |

| Area | | | Scope of the Project |
|---|---|---|---|
| Sub-project | Water Source | Province | |
| SPWRRSP | Mekong River, Bassac River (Srass Prambai Reservoir) | Kandal | (a) Hardware Components<br>- Partial Rehabilitation of Srass Prambai Reservoir<br>- New Construction of Intake Structures<br>(b) Software Components<br>- Capacity Development of MOWRAM and PDOWRAM staff on O&M<br>- Formation and Strengthening of FWUC<br>- Strengthening of Agricultural Extension Services |
| DPISRSP | Stung Chieb River | Kampong Chhnang | (a) Hardware Components<br>- New Construction of Daun Pue Headworks<br>- Partial rehabilitation of Main canal system<br>- Partial Rehabilitation of secondary canal system<br>- New construction of tertiary canal system<br>(b) Software Components<br>- Capacity Development of MOWRAM and PDOWRAM staff on O&M<br>- Formation and Strengthening of FWUC<br>- Strengthening of Agricultural Extension Services |

*Source: JICA Survey Team*

### II-3.1.2 Overall Goal

Overall goal of SPPIDRIP is to attain poverty reduction or improve living standard through increase of farmers' income.

### II-3.1.3 Objective

In order to attain the overall goal mentioned above, SPPIDRIP aims to improve the agricultural productivity by rehabilitating and improving the existing irrigation and drainage facilities, executing the capacity development of MOWRAM and PDOWRAM staff on O&M, and strengthening the agricultural extension services, and formation and strengthening of FWUCs.

### II-3.1.4 Expected Outputs and Outcomes

Six Sub-projects included in SPPIDRIP are expected to bear the following outputs and outcomes:

(1) RCHRSP

- Stable water abstraction from the Prek Thnot River for irrigation to the related command area
- Appropriate and timely gate control of Roleang Chrey regulator at normal and flood times
- Proper water supply to SMC and NMC through the rehabilitated intake structures
- Realized smooth water flow to the downstream portions on SMC and NMC
- Improved agricultural productivity contributing to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kampong Speu PDOWRAM and FWUC

(2) USISRSP

- Ensured water resources for irrigation to command area
- Realized smooth water convey to command area by rehabilitating and improving the diversion canal, main canal, minor canals and related structures
- Developed command area of 3,500 ha
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Takeo PDOWRAM and FWUC

(3) KSBISRSP

- Ensured water resources for irrigation to command area of 3,350 ha consisting of 1,750 ha for the Kandal Stung Area and 1,600 ha for the Bati Area
- Realized smooth and effective water convey to command area by rehabilitating and improving the existing irrigation canal system
- Established irrigation canal system in consideration of further development in the future
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kandal PDOWRAM, and organizing and strengthening FWUC

(4) MC35RSP

- Ensured water resources for irrigation to command area of 850 ha
- Realized smooth water convey to command area by rehabilitating and improving the existing reservoir and irrigation canal system
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kampong Speu PDOWRAM, and organizing and strengthening FWUC

(5) SPWRRSP

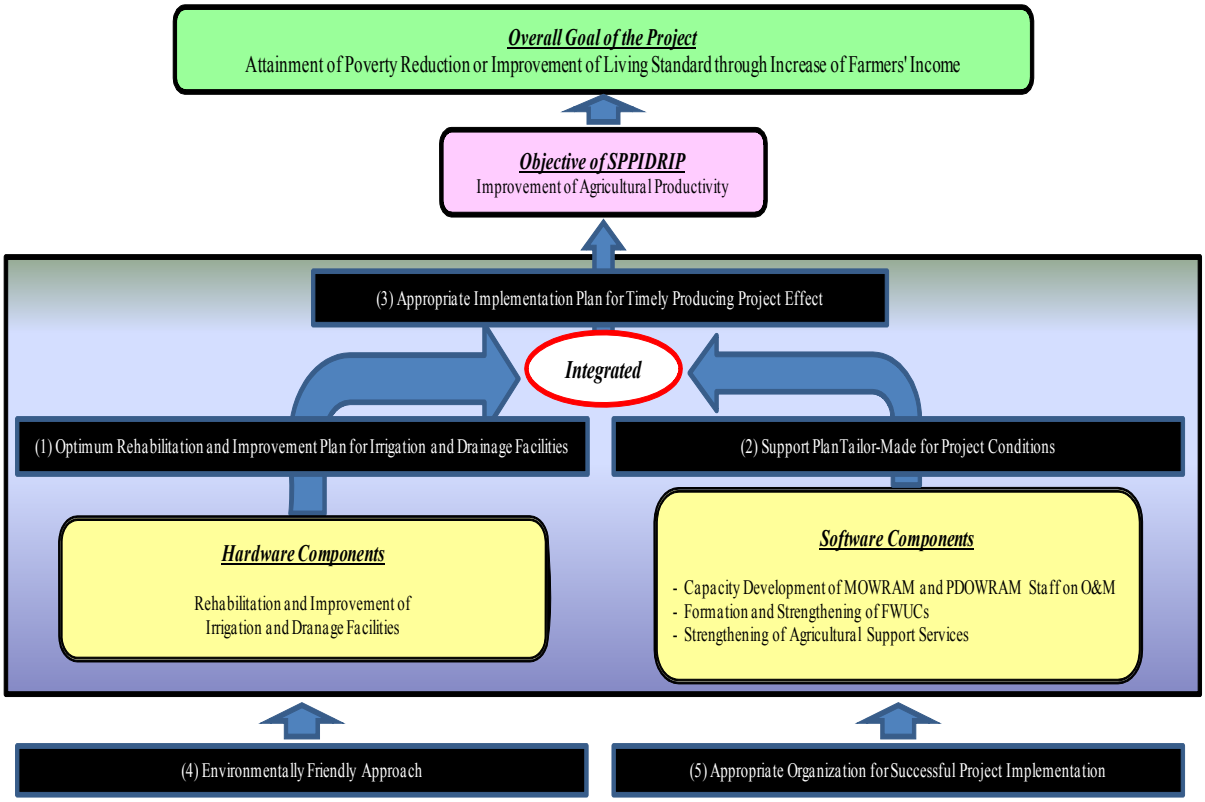
- Ensured water resources for irrigation to command area of 1,200 ha by rehabilitating the existing reservoir
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kandal PDOWRAM, and organizing and strengthening FWUC

(6) DPISRSP

- Ensuring of water resources for irrigation to command area of 1,150 ha by newly constructing headworks
- Smooth water convey to command area by rehabilitating and improving the existing irrigation canal system
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kampong Chhnang PDOWRAM, and organizing and strengthening FWUC

### II-3.2 Approach and Strategy

SPPIDRIP will be implemented under the basic concept of "*Integrated Approach of Hardware and Software Components*", to successfully accomplish its objective mentioned above, and eventually to attain its overall goal, say "*Attainment of Poverty Reduction or Improvement of Living Standard through Increase of Farmers' Income*". The approach and strategy of SPPIDRIP are illustrated as follows:




*Source: JICA Survey Team*

**Figure II-3.2.1 Approach and Strategy of SPPIDRIP**

(1) Optimum Rehabilitation and Improvement Plan for Irrigation and Drainage Facilities

The optimum rehabilitation and improvement plan for irrigation and drainage facilities is essential for effective use of the limited water resources and land resources. The plan is therefore elaborated taking into due consideration the following points:

(a) Effective Use of Water Resources

The water resources for RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP composing SPPIDRIP need to be used effectively since these are limited. Thus, the rehabilitation and improvement plan for the headworks/reservoir/intake structures should be prepared focusing on how to use such river or reservoir water effectively through water balance study based on the results of analysis on hydrological data.

(b) Maximum Use of Existing Facilities

There are many existing facilities in SPPIDRIP although most of them are presently in poor conditions. SPPIDRIP provides rehabilitation and improvement for these existing facilities. The conditions of these facilities should be checked through inventory survey, and then be used as much as possible, to save cost and to minimize the additional land acquisition.

(c) Consideration of Additional Facilities

As mentioned above, lots of existing facilities are provided in SPPIDRIP. However, these are not enough to make proper water distribution to the fields. In the rehabilitation and improvement plan, additional facilities will be considered, but should be minimized in number and length.

(d) Construction of Tertiary Canal System

In order to deliver irrigation water to respective fields timely, the tertiary canal system is indispensable. In the SPPIDRIP Area, some tertiary canals are observed, but these are absolutely insufficient in

number and length. According to the Design Manual for Small and Medium Scale Irrigation System Planning prepared by MOWRAM in 2004, a command area by one tertiary canal is regulated to be 25 to 50 ha. Following this criteria and taking into consideration the current conditions of existing tertiary canals, tertiary canal system is designed and is planned to be constructed in local competitive bidding (LCB).

(e) Consideration of Dispersive Soil

There find place to place severe damages in the canal embankment due to dispersive soil in Cambodia. In order to avoid such damages due to dispersive soil, care should be put on use of suitable soil for canal embankment, which will be procured from the borrow pit areas nearby. In addition, the swelling soil also provides the trouble for canal embankment, especially solid lining canal. Therefore, this matter will be also given care to such solid lining canal if any.

(f) Execution of Alternative Study on Canal Embankment

In order to seek for proper treatment against erosion of canal embankment, consideration will be given to some alternative ideas such as earth lining using borrowed materials, soil cement and soil bags. After the comparison study from technical and economical viewpoints, the suitable treatment will be taken up and applied for the plan.

(2) Support Plan Tailor-Made for Project Conditions

SPPIDRIP proposes the software components consisting of (i) capacity development of MOWRAM and PDOWRAM staff on O&M, (ii) strengthening of agricultural extension services and (iii) strengthening of FWUC as the software components is absolutely necessary for withdrawing properly the project effect, especially improving agricultural productivity, from the following viewpoints:

(a) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

SPPIDRIP will implement the rehabilitation and improvement of irrigation and drainage facilities, to create the fundamental situation so as to make proper water supply to field. The rehabilitation and improvement of irrigation and drainage facilities would be comparatively easy if the appropriate plan is available and the competent contractor is selected, which could be done using the outsourcing. The most important issue is how to operate and maintain the rehabilitated and improved facilities properly over the project life. Needless to say, this is closely linked with the sustainability of SPPIDRIP. In order to execute the proper O&M, there are many factors such as availability of able staff in number, enough budget, suitable O&M structure. Although all these factors are crucial for O&M, availability of able staff in number is the most important issue, especially for O&M of comparatively large-scale structures such as Roleang Chrey Regulator, Tumnup Lok Reservoir, Kpob Trobek Reservoir, Srass Prambai Reservoir and Daun Pue Headworks. Presently, MOWRAM and PDOWRAM staff has less experiences and knowledge in O&M for them, so that the capacity development for them is required. With this viewpoint, capacity development of MOWRAM and PDOWRAM staff on O&M is included in SPPIDRIP.

(b) Strengthening of Agricultural Extension Services

The rehabilitation and improvement of irrigation and drainage facilities are merely the means to surely supply water to fields although the proper O&M is essential. However, the objective of SPPIDRIP is to improve the agricultural productivity, especially for rice as mentioned previously. In order to attain

this objective, it is indispensable to provide the agricultural extension services. The improvement of agricultural productivity becomes the most attractive incentive for the beneficiary farmers concerned to increase their income, which would lead to proper O&M for tertiary canal system by the beneficiary farmers. Thus, the agricultural extension services are included in SPPIDRIP. It is planned in SPPIDRIP that the agricultural extension services will be carried out by PDA based on the well-conceived plan to be prepared by international consultant.

(c) Strengthening of Farmer Water Users Community

The Policy on PIMD stresses the promotion of co-administration in irrigation system among the Government and FWUCs. The subsequently promulgated "Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems" and "Policy for Sustainability of Operation and Maintenance Irrigation Systems", also focus on the importance of FWUC in successful irrigation development. In fact, FWUC is responsible for O&M for minor canal system according to the said policies. It can be said that the satisfactory effect of SPPIDRIP, say stable agricultural production would not occur unless O&M for minor canal system are conducted by FWUC. Presently the existing FWUCs in SPPIDRIP are institutionally weak and do not conduct their duties satisfactorily. To this end, the strengthening of FWUC is included in SPPIDRIP.

(3) Appropriate Implementation Plan for Timely Producing Project Effect

SPPIDRIP is composed of 6 Sub-projects mentioned above. These Sub-projects involve many works under the category of hardware components and software components as mentioned in Chapter II-2. In order to realize the SPPIDRIP effect timely and effectively, it is essential these works should be implemented in systematic order. For instance, the works involved in software components should be started in consideration of progress of works involved in hardware components. The works involved in hardware components, will be arranged in a form of construction package, and should be constructed so that the water supply to fields could be made as shorter as possible. Accordingly, the preparation of appropriate implementation plan is taken up as one of notable strategies toward timely producing project effect.

(4) Environmentally Friendly Approach

SPPIDRIP is of rehabilitation and improvement of existing irrigation and drainage facilities. Namely, RCHRSP provides rehabilitation and improvement of headworks although the command area development less than 1,000 ha is included. USISRSP targets the rehabilitation of irrigation and drainage facilities covering 3, 500 ha. KSBISRSP aims at rehabilitation and improvement of existing irrigation system covering 3,350 ha consisting of 1,750 ha for Kandal Stung Area and 1,600 ha for Bati Area. Three small-scale sub-projects such as MC35RSP, SPWRRSP and DPISRSP also aim to rehabilitate and improvement of existing irrigation system commanding 850 ha, 1,200 ha and 1,150 ha, respectively. If considering these conditions, neither the Environmental Impact Assessment (EIA) nor the Initial Environmental Impact Assessment (IEIA) is required because the Sub-decree on Environmental Impact Assessment Process relates that irrigation development with more than 5,000 ha is required to execute EIA or IEIA for approval of MOE prior to the implementation. However, in USISRSP, the site investigation has found that there are some houses build on the canals and in the right of way to canals, and also the cultivated lands in the reservoir area. As these might be interfered with smooth rehabilitation and improvement of canals and reservoirs, resettlement might be required. In KSBISRSP, there find some houses along the canal, too. Thus, the environmental study should be

carefully carried out in an environmentally friendly manner taking into consideration the illegally occupied inhabitants by referring to the relevant Cambodian laws and JICA Guidelines on Social Environmental Consideration and also in consultation with MOWRAM and MOE,

(5) Appropriate Organization for Successful Project Implementation

The appropriate implementation organization is crucial for effective management toward successful implementation of SPPIDRIP. In the Survey, the implementation organization is determined by reviewing that for the similar project/program which MOWRAM is an executing agency. The proposed implementation organization is prepared centering on PMU Japan Support Fund established in 2008 within MOWRAM. In determination of implementation organization, careful attention is paid to the objective, scope and conditions of SPPIDRIP. In addition, consideration is given to demarcation of duties of MOWRAM and PDOWRAM to avoid any mis-management, and also to close communication between PDOWRAM and PDA to fulfill the strengthening of agricultural extension services toward improvement of agricultural productivity. With the viewpoints mentioned above, the appropriate organization is taken into account as a strategy for successful project implementation.

### II-3.3 Preparatory Works

In order to successfully execute the implementation of SPPIDRIP, it is essential to carry out the preparatory works effectively. The required preparatory works for the implementation of SPPIDRIP are as follows:

(1) Explanation of SPPIDRIP to National Steering Committee

In WTSIDRIP of which the implementation will be started earlier than SPPIDRIP, a National Steering Committee will be established mainly for provision of the necessary political coordination and supports from the relevant ministries. This National Steering Committee will also be in charge of the implementation of SPPIDRIP with the same purpose. Thus, PMU will explain the objective and scope of SPPIDRIP to the National Steering Committee prior to the commencement of implementation of SPPIDRIP so as to enable the Committee to deepen its understanding on significance of SPPIDRIP.

(2) Timely Budget Arrangement for Smooth Implementation of SPPIDRIP

Timely budget arrangement is essential for smooth implementation of SPPIDRIP. Immediately after the loan agreement is made, MOWRAM will set out to prepare the budget plan necessary for the implementation of SPPIDRIP in the light of the implementation plan. In preparation of budget plan, consideration shall be given to budget for administration and software components.

(3) Prior Establishment of Implementation Organization

As mentioned previously, the implementation organization will play a crucial role for successful implementation of SPPIDRIP. In general, it would take certain time to reach the implementation organization in full swing. Therefore the implementation organization will be established in appropriate timing prior to commencement of implementation of SPPIDRIP.

(4) Land Acquisition for Construction of Canals

In the SPPIDRIP Area, there are existing canals, but their number and length are not enough to execute the timely and effective water distribution to fields. Thus, it is necessary to construct the new canals, especially tertiary canals. According to the Government policy, the land required for construction of tertiary canals should be offered by the beneficiary farmers without compensation. Due to this, land

acquisition for construction of tertiary canals has often faced a problem with them, which would lead to large delay in construction of tertiary canals, and eventually in accruing from project benefit. In order to avoid such unexpected situation, PMU will preferentially take a necessary action for land acquisition for tertiary canals in advance.

(5) Execution of Detailed Technical Ground Survey for Mines and UXOs

As mentioned in Section I-5.5, CMAC indicates as the result of hearing survey in 2000, that there are suspected areas along about 4 km upstream of Diversion Canal from the Tumnup Lok Reservoir and around the proposed borrow pit area in USISRSP. Besides, it is said that there is a possibility of buried UXOs around southern part of the Main Canal 33. On the other hand, KSBISRSP and DPISRSP also have suspected areas although their areas are small in scale. It is thus necessary to carry out the detailed technical ground survey for these areas by CMAC, prior to commencement of D/D. In this connection, it is expected that MOWRAM should make the necessary budget arrangement and contract with CMAC timely.

## II-3.4 Hardware Components

### II-3.4.1 Roleang Chrey Headworks Rehabilitation Sub-project

#### II-3.4.1.1 Location and Development Area

The Roleang Chrey Headworks are located on the Prek Thnot River, about 100 km upstream from its confluence with the Bassac River, in Samraong Tong District, Kampong Speu Province. The RCHRSP Area lies in Kampong Speu Province. RCHRSP is the top priority project in the comprehensive agricultural development scenario of the Prek Thnot River basin formulated in the M/P Study. RCHRSP aims at securing stable water distribution to whole Roleang Chrey Irrigation System through (i) rehabilitation of the key irrigation facilities, consisting of the headworks and upper reaches of NMC and SMC and (ii) demonstration of proper O&M of rehabilitated tertiary canal system in the Model Area. The total area covering whole Roleang Chrey Irrigation System is estimated at 16,910 ha of existing physically cultivated area in this irrigation system, which will be used for project evaluation of RCHRSP.

**Table II-3.4.1.1.1 Relation of Whole Roleang Chrey Irrigation System Area and RCHRSP Area**

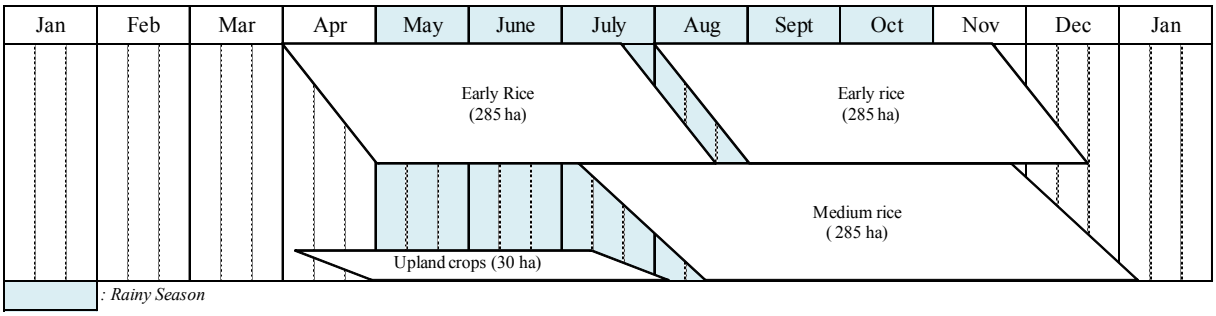
| Description | Area |
|---|---|
| Roleang Chrey Irrigation System | 16,910 ha for project evaluation |
| RCHRSP Area<br>South Upstream area directly benefited from the rehabilitation of upstream parts of SMC (9.8 km) and secondary canals | 350 ha excluding 220 ha to be implemented by TSC-3 |

*Source: JICA Survey Team*

#### II-3.4.1.2 Crop Production Plan

(1) Model Area

In the area of 570 ha for Irrigated Agriculture Improvement Model Project (IAIMP) which was preferentially proposed in the M/P Study, on-farm development as well as software components activities are considered for improvement of productivity of paddy. Therefore it is expected that intensive farming practice such as double cropping of paddy will be applied as shown in Figure II-3.4.1.2.1.

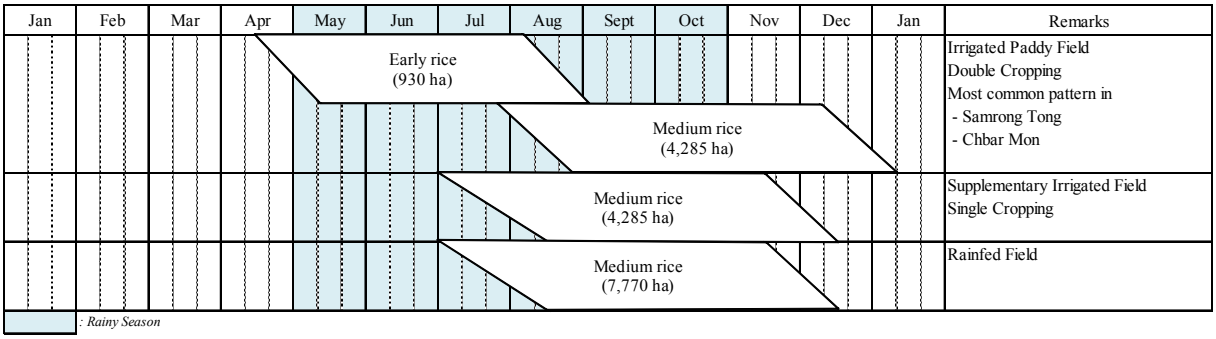



*Source: Original cropping pattern in Appendix D, Volume IV, Comprehensive Agricultural Development of Prek Thnot River Basin 2008 was referred and reviewed in 2011*

**Figure II-3.4.1.2.1 Proposed Cropping Pattern for IAIMP in M/P Study**

(2) Command Area except IAIMP

RCHRSP will maintain the present production level in all connected command areas by ensuring water source for irrigation through rehabilitating irrigation facilities. After completion of RCHRSP, the prevailing cropping pattern could be adopted without any changing as shown in Figure II-3.4.1.2.2.




*Source: Original cropping pattern in Appendix D, Volume IV, Comprehensive Agricultural Development of Prek Thnot River Basin 2008 was referred and reviewed in 2011*

**Figure II-3.4.1.2.2 Proposed Cropping Pattern except IAIMP**

As for farming practices, the current ones are almost the same with the situation at the M/P Time. It means that beneficiary farmers are still facing to the similar constraints, which were revealed at the M/P Time. In this Survey, thus it is not necessary to modify the proposed farming practices in M/P.

(3) Predicted Paddy Production

Paddy production under without- and with-project conditions for IAIMP and command area except IAIMP is shown in TableII-3.4.1.2.1.

**Table II-3.4.1.2.1 Production under Without- and With-Project Conditions**

(a) IAIMP

| Paddy | Without-project Condition*1 | | | With-project Condition*1 | | | Increment |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*3 | Production (ton) | Production (ton) |
| Early Rainy Season | | | | | | | |
| Early Rice | - | - | - | 285 | 4.00 | 1,140 | 1,140 |
| Rainy Season | | | | | | | |
| Early Rice | - | - | - | 285 | 4.00 | 1,140 | 1,140 |
| Medium Rice (irrigated) | - | - | - | - | - | - | - |
| Medium Rice (rainfed) | 580 | 2.12 | 1,230 | 285 | 3.50 | 998 | -232 |
| Total | 580 | - | 1,230 | 855 | - | 3,278 | 2,048 |

*Note*

**1: -No supply of irrigation water due to malfunction of the regulator under without-project condition, while on-farm development as well as software component activities is carried out under with-project condition.*

**2: Unit yield under without project condition is settled, considering the result of socio-economic survey.*

**3: Unit yield under with-project condition is settled, considering the result of verification trial, which was conducted in F/S time.*

*Source: JICA Survey Team*

(b) Command Area except IAIMP

| Paddy | Without-project Condition*1 | | | With-project Condition*1 | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*2 | Production (Ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (Ton) | |
| Early Rainy Season | | | | | | | |
| Early Rice | - | - | - | 930 | 2.79 | 2,595 | 2,595 |
| Rainy Season | | | | | | | |
| Early Rice | - | - | - | | | | |
| Medium Rice (irrigated) | - | - | - | 8,570 | 2.31 | 19,797 | 19,797 |
| Medium Rice (rainfed) | 16,340 | 2.12 | 34,640 | 7,770 | 2.12 | 16,472 | - 18,168 |
| Total | 16,340 | | 34,640 | 17,270 | | 38,864 | 4,224 |

*Note*
**1: No supply of irrigation water due to malfunction of the regulator under without-condition, while water supply condition could be recovered up to the current situation under with-project condition.*
**2: Unit yield is settled, considering the result of socio-economic survey.*
*Source: JICA Survey Team*

### II-3.4.1.3 Irrigation and Drainage Plan

(1) Basic Concept of Rehabilitation

(a) Headworks

The current conditions of the headworks show so highly negative possibility which the regulator gates will become inoperable before long. To ensure a stable water supply, the rehabilitation should be executed to renovate them so as to realize the proper function being of an extent and quality that will provide for other 50 years of service life.

(b) NMC, SMC and Secondary canals

Upper reaches of NMC and SMC are left unattended from the recent rehabilitation by MOWRAM and require urgent rehabilitation works such as enlargement of narrow and/or shallow canal sections, raising of low canal bank, repair/replacement of deteriorated structures and so on. The proposed rehabilitation works are planned with the following basic concepts.

- Gravity irrigation systems are proposed as much as possible by raising the water level in the canals, except physically difficult (high) land
- Existing canal sections and structures would be utilized as much as possible.
- Necessary rehabilitation works are justified and designed by referring to the observation and proposal by PDOWRAM.
- Design conditions such as design discharge and design water level of the irrigation and drainage facilities, which were used in the previous studies of F/S and the Japan's Grant Aid project, are applied with minimum modifications through review.
- Construction of new drainage canal is not considered, except downstream area of spillway that will be rehabilitated and the drains in the Model Area.

(c) Tertiary Canal System Development in Model Area

Tertiary canal system is designed for 350 ha out of the Model Area proposed in F/S, which excludes the on-going TSC-3 pilot area (220 ha), based on the following basic concepts.

- Existing tertiary canals should be incorporated in the new system as much as possible to save construction cost and to avoid unnecessary troubles on land acquisition with beneficial farmers.
- In order to supply irrigation water to each field from canals smoothly and effectively, the density of the tertiary canals should be heightened, say 30 m/ha.
- Some existing canals have double functions of irrigation and drainage. From the proper water management and smooth drain, the drainage system should be designed independently. In this

connection, use of natural small streams and degraded area are to be used as natural drains to minimize cost.

(2) Irrigation and Drainage Water Requirements

Irrigation water requirement estimated in the previous F/S was reviewed based on the proposed cropping pattern, which consists of early variety and medium variety of rice and upland crop in a year with overall cropping intensity of 114% with 80% dependability. The design discharges for respective canals are estimated as shown in Table II-3.4.1.3.1. Since there are no modifications on the said cropping pattern, these design discharges are applied in the Survey.

**Table II-3.4.1.3.1 Irrigation Water Requirement and Design Discharge for RCHRSP**

| Description | Design Value |
|---|---|
| Irrigation water requirement | |
| - Main canals | 1.60 lit/sec/ha |
| - Secondary canals | 1.41 lit/sec/ha (=1.60 × 0.88)*1 |
| - Tertiary canals | 2.10 lit/sec/ha (15.7 mm/day × 10,000 / 86,400 / 0.85)*2 |
| Design discharge | |
| - NMC | 10.4 $m^3$/sec (1.60 lit/sec/ha × 6,500 ha) |
| - SMC | 16.3 $m^3$/sec (1.60 lit/sec/ha ×10,200 ha) |
| - River outlet structure | 5.0 $m^3$/sec*3 |

*Remarks: 1; Irrigation efficiencies for paddy are assumed at 66% for overall and 88% for main and secondary canal*
*2; Design discharge for tertiary canal should be determined at land preparation time when more water is required for 20 days for one tertiary block*
*3: Basic Design Report of Japan's Grant Aid Project. 2009*

*Source：The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

In F/S, drainage water requirement was estimated at 5.0 lit/sec/ha using the maximum 3-day rainfall data in Kampong Speu from 2001 to 2006 under condition that this 3-day continuous rainfall should be drained within 3 days. This drainage water requirement is used in the Survey too because no significant changes on conditions do not occur and/or are not made since the F/S time.

(3) Design Flood Discharge and Water Level at Headworks

Basic design values such as design flood discharge and water levels for the rehabilitation of the headworks are referred to those in D/D of the Japan's Grand Aid project, as summarized below.

**Table II-3.4.1.3.2 Design Flood Discharge and Water Level of Roleang Chrey Headworks**

| Description | Design Value |
|---|---|
| Design flood discharge for headworks | 1,600 $m^3$/sec (1 in 50 years) |
| Water level at headworks | |
| - High water level | EL.36.00 m |
| - Low water level at intakes | EL.35.70 m |

*Source: Basic Deign Report of Japan's Grant Aid Project, 2008*

(4) Rehabilitation of Irrigation and Drainage Facilities

Based on the basic concept for irrigation and drainage rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under RCHRSP are shown in the following table.

**Table II-3.4.1.3.3 Main Features of Rehabilitation of Roleang Chrey Headworks**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 350 ha excluding 220ha to be developed by TSC-3, but influences to 16,910 ha for project evaluation |
| 2) | Roleang Chrey Headworks | |
| | - Roleang Chrey Regulator | Regulator gates<br>- Fixed wheel gates, 5 sets, 12.5 m (W) × 6.7 m (H)<br>Civil works<br>- Construction of the downstream river bed protection<br>- Rehabilitation of the downstream river bank protection<br>- Construction of river outlet structure |

| No. | Description | Quantity |
|---|---|---|
| | - Andong Sla Intake | Intake gates<br>- Radial gates, 2 sets, 4.0 m (W) × 2.7 m (H)<br>Civil works<br>- Curtain walls and operation deck,<br>- Protection of up & downstream of intake<br>- Rehabilitation of approach channel |
| | - Vat Krouch Intake | Intake gates<br>- Radial gates, 2 sets, 4.0 m (W) × 2.7 m (H)<br>Civil works<br>- Upstream & downstream transitions<br>- Gate pier and box culvert and protection of canal beds,<br>- Rehabilitation of approach channel |
| | - River outlet structure | Inlet gates<br>- Slide gates, 4 sets, 1.0 m (W) × 1.0 m (H)<br>Outlet gates<br>- Slide gates, 2 sets, 1.25 m (W) × 1.4 m (H) |
| 3) | NMC and SMC | Design discharge: NMC 10.4 $m^3$/sec at beginning point<br>SMC 16.3 $m^3$/sec at beginning point |
| | - Total length | 18.9 km (NMC = 9.1 km and SMC =9.8 km) |
| | - Structures to be rehabilitated/reconstructed | Check structures : 3 nos.<br>Turnout : 18 nos.<br>Bridge : 7 nos.<br>Spillway : 3 nos.<br>Drainage gate : 11 nos. |
| 4) | Secondary canals to be rehabilitated | 12 nos. |
| | - Total length | 16.9 km |
| | - Structures to be rehabilitated/reconstructed | Check structures : 45 nos.<br>Turnout : 53 nos.<br>Culvert : 32 nos.<br>Drain inlet : 4 nos. |
| 5) | Tertiary canal system | |
| | - Area | 350 ha (11 km) |

*Source: JICA Survey Team*

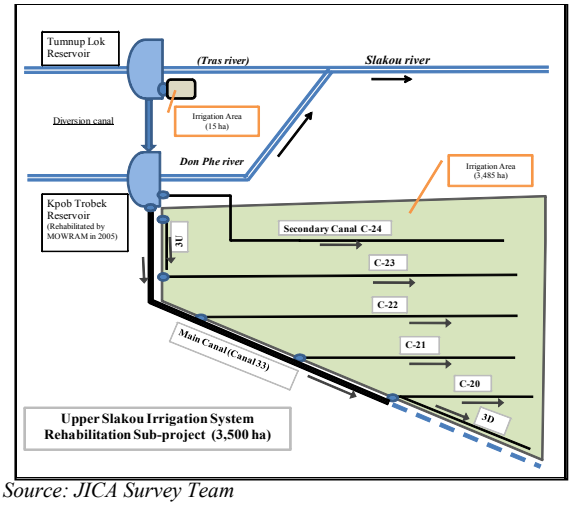
(5) Expected Output

- Stable water abstraction from the Prek Thnot River for irrigation to the related command area
- Appropriate and timely gate control of Roleang Chrey regulator at normal and flood times
- Proper water supply to SMC and NMC through the rehabilitated intake structures
- Realized smooth water flow to the downstream portions on SMC and NMC
- Improved agricultural productivity contributing to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kampong Speu PDOWRAM and FWUC

### II-3.4.2 Upper Slakou Irrigation System Rehabilitation Sub-project

#### II-3.4.2.1 Location and Development Area

USISRSP is located at about 70 km southwest from Phnom Penh and extends mainly[1] on the right bank of the Slakou River and in Tram Kak District of Takeo Province. The net development area for USISRSP was estimated at 3.500 ha through water balance study between the available water with 80% dependability and water demand for crop cultivation.




*Source: JICA Survey Team*

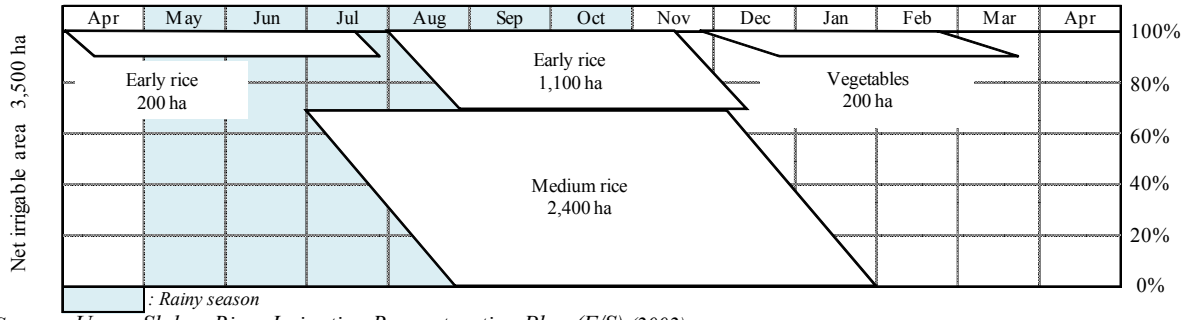
**Figure II-3.4.2.1.1 Schematic Layout of USISRSP**

[1] *Right bank of the Tumnup Lok reservoir is located in Basedth District of Kampong Speuu Province.*

### II-3.4.2.2 Crop Production Plan

(1) Proposed Cropping Pattern

In spite of introduction of diversified crops during the early rainy season in F/S, beneficiary farmers are eager to cultivate paddy instead of upland crops as well as vegetables. Taking into consideration the current cropping pattern, beneficiary farmers' intension and the results of water balance study, the double cropping of paddy is proposed as shown in Figure II-3.4.2.2.1.




*Source: Upper Slakou River Irrigation Reconstruction Plan (F/S) (2002)*
*JICA Survey Team*

**Figure II-3.4.2.2.1 Proposed Cropping Pattern for USISRSP**

As for farming practices, the current ones are almost the same with the situation at the F/S Time. It means that beneficiary farmers are still facing to the similar constraints, which were revealed at the F/S Time. Thus it is not necessary to modify the proposed farming practices in F/S.

(2) Predicted Paddy Production

Paddy production under without- and with-project conditions is shown in Table II-3.4.2.2.1.

**Table II-3.4.2.2.1 Production under Without- and With-Project Conditions**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| Early Rice | 470 | 2.13 | 1,001 | 1,300 | 4.00 | 5,200 | 4,199 |
| Medium Rice | 2,800 | 2.09 | 5,852 | 2,400 | 3.50 | 8,400 | 2,548 |
| Total | 3,270 | | 6,853 | 3,700 | | 13,600 | 6,747 |

*Note*
**1: Unit yield under present / without project conditions is settled, considering the result of socio-economic survey.*
**2: Unit yield under with-project condition is settled, considering the result of verification trial, which was conducted in the F/S Time.*
*Source: Upper Slakou River Irrigation Reconstruction Plan (F/S) (2002)*

### II-3.4.2.3 Irrigation and Drainage Plan

(1) Basic Concept

Most of the existing irrigation facilities were constructed in the mid 1970s during Pol Pot regime, and these now require significant rehabilitation to ensure stable irrigation farming. The basic policy of rehabilitation of these facilities is to make both initial construction cost and O&M cost as low as possible in due consideration of maintaining sufficient function, safety and durability. To meet these, the purpose of the plan would not be to seek for the “perfect” outcome, but to provide the minimum function required for ensuring water resources for irrigation.

Considering the above, the required rehabilitation works will be planned in the following basic concept:

- Reliability level of irrigation supply is set at 4 in 5 years or 80%
- Design flood discharge of 1-in-100-year recurrence period is adopted for rehabilitation of reservoirs

- 24-hour water conveyance will be applied for diversion, main and secondary systems
- Existing dikes of the reservoirs would be utilized as much as possible
- Existing canal section would be utilized and canal lining would not be considered in principal
- Related structures of the canal, both in terms of structure and materials, would be designed to conform with those that PDOWRAM generally design and construct in Takeo Province
- No substantial improvement is considered for drainage system

(2) Irrigation Water Requirement

As for the unit irrigation water requirement for canal design, it is proposed to apply 110% of averaged irrigation requirement of 1.0 lit/sec/ha, considering rather long calculation step of 15 days. Thus, the unit irrigation water requirement is calculated at 1.1 lit/sec/ha, which is equivalent to the peak unit requirement of HYV-2 paddy. Based on this unit water requirement, the diversion irrigation water requirement is estimated at 3.5 $m^3$/sec, with irrigation efficiency of 60% for paddy.

(3) Drainage Water Requirement

Unit drainage requirement for paddy was estimated at 1.6 lit/sec/ha based on the following conditions and assumptions:

- Allowable inundation depth : 150 mm
- Allowable inundation period : 3 days
- Design rainfall : 173 mm at Takeo with 1-in-10-year 3-day rainstorm
- Initial water depth in the paddy field : 50 mm

(4) Rehabilitation of Irrigation and Drainage Facilities

(a) Study on Canal Lining

In order to select the suitable type of canal lining well-fitted to local conditions, a comparative study was carried out for 3 types such as earth lining by borrowed materials, soil cement and soil bag. Direct costs for constructing the both lining alternatives estimated in F/S as well as assumed durable year of lining method are tabulated as below. It is assumed that 0.5% of each direct cost of linings and 5% for periodical repairing cost in every following year of the durable year. Taking into account this assumption coupled with discount rate of 12% and 60-year span of project life, unit annual equivalent cost is estimated for the respective alternatives.

**Table II-3.4.2.3.1 Comparison of Direct Construction Cost and Unit Annual Equivalent Cost**

| Lining | Direct Cost (US$ 1,000) | Unit Cost (US$/ m) | Assumed Durable Year | Unit Annual Equivalent Cost (US$/ m) | Remarks |
|---|---|---|---|---|---|
| Earth lining by borrowed material | 1,770 | 188 | 10 years | 2.94 | Updated cost used in F/S |
| Soil cement | 2,169 | 231 | 12 years | 3.56 | |
| Sand bag | | 1,248 | 20 years | 19.13 | Geosynthetic bags filled by mortar (US$ 130 /$m^2$) |

*Source: Upper Slakou River Irrigation Reconstruction Plan (F/S) (2002)*
*JICA Survey Team*

As can be seen in the above table, the earth lining by borrowed material shows the lowest annual equivalent cost among them. Taking into consideration this result and easy availability of material at site, it is proposed to use earth lining by borrowed material. Detailed explanation is given in Sub-clause AD-2.2.2.3 of ANNEX D.

(b) Facilities to be Rehabilitated under USISRSP

Based on the basic concept for irrigation and drainage development plan mentioned above, facilities to be rehabilitated under USISRSP are shown in the following table:

**Table II-3.4.2.3.2 List of Irrigation and Drainage Facilities to be Rehabilitated under USISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 3,500 ha |
| 2) | Water resource facilities | |
| | - Reservoir-1 | Tumnup Lok Reservoir on the Slakou River (CA=332 $km^2$), Ve = 1.0 MCM, Re-construction of dike, spillway, intake and maintenance facilities |
| | - Reservoir-2 | Kpob Trobek Reservoir on the Don Phe River (CA=137 $km^2$), Ve = 2.6 MCM Supplemental improvement and repair of dike and spillway gates which were rehabilitated by MOWRAM in 2005 |
| | - Diversion canal | Connecting the above two reservoirs, 9.4 km, Design discharge: 3.5 $m^3$/sec |
| 3) | Main canal system | 1 no. Design discharge: 3.2 $m^3$/sec |
| | - Length | 7.3 km |
| | - Off-takes | 6 nos. |
| | - Diversion structure | 5 nos. |
| 4) | Secondary canal system | 7 nos. |
| | - Total length | 44.7 km |
| | - Off-takes | 102 nos. |
| | - Diversion structure | 66 nos. |
| 5) | Tertiary canal system | |
| | - Total length | 110 km |

*Source: JICA Survey Team*

(5) Expected Output

Expected output of USISRSP is listed below.

- Ensured water resources for irrigation to command area
- Realized smooth water convey to command area by rehabilitating and improving the diversion canal, main canal, minor canals and related structures
- Developed command area of 3,500 ha
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Takeo PDOWRAM and FWUC

### II-3.4.3 Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

#### II-3.4.3.1 Location and Development Area

The Sub-project area of 3,550 ha in total consists of 2 irrigation areas, namely Kandal Stung Area of 1,750 ha and the Bati Area of 1,600 ha. The Kandal Stung Area is situated in Kandal Stung District of Kandal Province about 20 km south of Phnom Penh. And, the Bati Area of 1,600 ha is situated in Bati District of Takeo Province about 30 km south of Phnom Penh. Water resources of irrigation development are (i) the Prek Thnot River regulated by the Stung Tasal dam under construction, (ii) original flow of the Stung Touch River, and (iii) regulated flow of the Tonle Bati River by the Lake Tonle Bati.

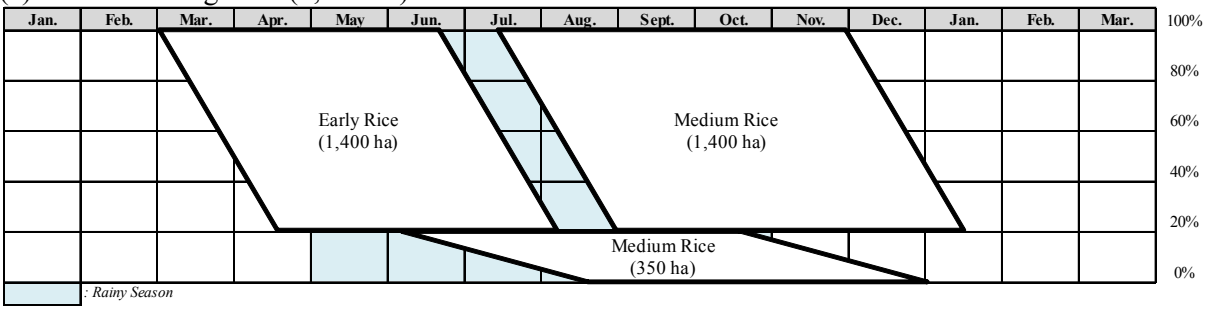
#### II-3.4.3.2 Crop Production Plan

(1) Proposed Cropping Pattern

It is understandable that double cropping of paddy is applied in some area. Further triple cropping of paddy is also available. In spite of proposal of introduction of diversified crops in F/S, major farmers prefer to cultivate paddy double cropping and triple cropping as well. Taking into consideration current

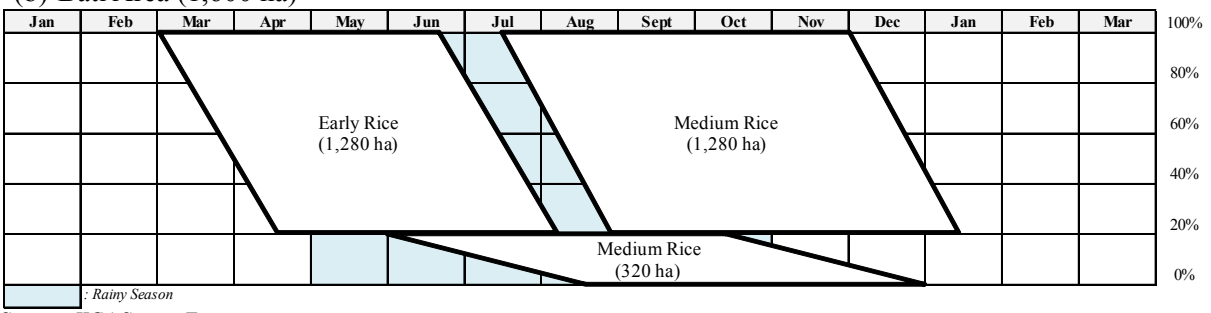
cropping pattern and the results of water balance study, double cropping of paddy is proposed as shown in Figure II-3.4.3.2.1.

(a) Kandal Stung Area (1,750 ha)




*Source: JICA Survey Team*

(b) Bati Area (1,600 ha)




*Source: JICA Survey Team*

**Figure II-3.4.3.2.1 Proposed Cropping Pattern for KSBISRSP**

Through the Survey, the present and proposed farming practices as well as farm input requirement were reviewed. In principle, it is almost not necessary to change present situations although minor adjustment on input requirement was done.

(2) Predicted Paddy Production

Paddy production under without- and with-project conditions in the Kandal Stung and Bati Areas is shown as follows:

**Table II-3.4.3.2.1 Production under Without- and With-Project Conditions**

(a) Kandal Stung Area (1,750 ha)

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| 1) Early Rainy Season | | | | | | | |
| - Early rice | 70 | 2.58 | 181 | 1,400 | 4.00 | 5,600 | 5,419 |
| 2) Rainy Season | | | | | | | |
| - Medium rice (irrigated) | - | - | - | 1,750 | 3.50 | 6,125 | 6,125 |
| - Medium rice (rainfed) | 1,750 | 2.09 | 3,658 | - | - | - | - 3,658 |
| Total | 1,820 | | 3,839 | 3,150 | | 11,725 | 7,886 |

(b) Bati Area (1,600 ha)

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| 1) Early Rainy Season | | | | | | | |
| - Early rice | 70 | 2.58 | 181 | 1,280 | 4.00 | 5,120 | 4,939 |
| 2) Rainy Season | | | | | | | |
| - Early rice (irrigated) | 500 | 2.58 | 1,290 | - | - | - | - 1,290 |

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| - Medium rice (irrigated) | - | - | - | 1,600 | 3.50 | 5,600 | 5,600 |
| - Medium rice (rainfed) | 1,100 | 2.09 | 2.299 | - | - | - | - 2,299 |
| Total | 1,670 | | 3,770 | 2,880 | | 10,720 | 6,950 |

(c) Whole Area (3,350 ha)

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield (ton/ha)*1 | Production (ton) | Area (ha) | Unit Yield (ton/ha)*2 | Production (ton) | |
| 1) Early Rainy Season | | | | | | | |
| - Early rice | 140 | 2.58 | 362 | 2,680 | 4.00 | 10,720 | 10,358 |
| 2) Rainy Season | | | | | | | |
| - Early rice (irrigated) | 500 | 2.58 | 1,290 | - | - | - | - 1,290 |
| - Medium rice (irrigated) | - | - | - | 3,350 | 3.50 | 11,725 | 11,725 |
| - Medium rice (rainfed) | 2,850 | 2.09 | 5,957 | - | - | - | - 5,957 |
| Total | 3,490 | | 7,609 | 6,030 | | 22,445 | 14,836 |

*Note*
**1: Unit yield under present / without project conditions is settled, considering the result of socio-economic survey.*
**2: Unit yield under with-project condition is settled, considering the result of verification trial, which was conducted in F/S time of RCISRSP*
*Source: JICA Survey Team*

### II-3.4.3.3 Irrigation and Drainage Plan

(1) Basic Concept

Most of the existing irrigation facilities were constructed in the late 1970's during Pol Pot regime, and these facilities now require significant rehabilitation and/or reconstruction to realize stable irrigation farming. The basic concept of rehabilitation of these facilities is to make both initial construction cost and O&M cost as low as possible with due consideration to maintain sufficient function, durability, and economic viability. Considering the above, the target level of the works is set as listed below.

- Reliability level of irrigation supply is set at 4 in 5 years or 80%
- Existing canals would be utilized as much as possible for irrigation and drainage purposes
- Canal lining is considered to step forward the advanced irrigation level in the country, but within the reasonable investment cost
- Water resource structures to realize efficient use of three water resources are provided, based on the assumption that basin wide water management system including the Stung Tasal Dam will be established
- Emphasis of development is put on the irrigation, but no substantial improvement of drainage system is considered

(2) Irrigation Water Requirement

Based on the revised cropping pattern, which consists of double cropping of paddy per year as mentioned in Sub-clause II-3.4.3.2, the irrigation water requirement is re-calculated for 30 years. The calculation is made for 5-day basis and using updated potential evapo-transpiration rate at Pochentong Observatory, and rainfall data at Tonle Bati instead of that at Phnom Penh. Rainfall station at Tonle Bati has been operated since 2003. Other conditions such as percolation rate, irrigation efficiency are not changed from those applied in F/S. As a result, peak water requirement of the revised cropping pattern having 80% dependability is estimated at 1.4 lit/sec/ha, which is the same value estimated in F/S.

(3) Drainage Water Requirement

Considering difficulty in land acquisition for drainage canals and main crop of paddy, which has strong resistance against inundation, some inundation depth and period is allowed. Unit drainage requirement for paddy is thus estimated at 1.6 lit/sec/ha based on the following conditions and assumptions:

- Allowable inundation depth 150 mm
- Allowable inundation period 3 days
- Design rainfall 165 mm at Tonle Bati with 1-in-10-year 3-day rainstorm
- Initial water 50 mm

For the upland crops, F/S recommended to grow them on the raised ridge of more than 150 mm, considering difficulty in provision of perfect drainage system and less extent of upland crop in the rainy season.

(4) Rehabilitation of Irrigation and Drainages Facilities

(a) Study on Canal Lining

M/P and F/S proposed to reshape canal sections and place a concrete lining of 150 mm thickness for canal slopes of main and secondary (lateral) canals. Cost of lining work accounted for about 60% of the total rehabilitation cost of main canal and 40% of secondary canals. Assuming that the unit direct construction cost for rehabilitation work is desired to be lower than US$ 3,000 per ha from the government policy, concrete lining as proposed in M/P and F/S is to be limited. However, the followings are to be considered to rehabilitate and upgrading the existing irrigation canals which were originally constructed in Pol Pot regime in late 1970':

- Main canal for priority are of 1,950 ha, which was rehabilitated and upgraded with Japan's assistance, has been lined by concrete as a model development;
- The above development is expected to contribute toward developing the advanced/ modern irrigation system
- The Kandal Stung Area of 1,750 ha and the Bati Area of 1,600 ha are located just adjacent to the priority area of 1,950 ha above;
- Expansion of model area is strongly desired by MOWRAM as a model case for modernization of Pol Pot canals
- Lightening the budgetary burden of O&M activities is strongly expected due to limited budget for maintenance works of canals
- Lining cost should be reasonable range of total project cost.

Through discussion with MOWRAM, it is finally decided to apply Portland cement concrete lining of 75 mm thickness with iron bar mesh of D10mm @25cm grid, for the main canals (EW-60 and EW-58 in Kandal Stung Area, and MR-1 and MR-3 of Bati Area) of 18.9 km in total, but just apply re-shaping of cross sections and longitudinal profiles for secondary (lateral) canals.

(b) Connection canal to Lake Tonle Bati

According to the water balance study, Stage 1 development of 1,600 ha in Bati Area could be realized without supplemental water from the Prek Thnot River. Considering realization of the Stung Tasal dam very soon and MOWRAM's strong intension to develop remaining are of 2,600 ha as Stage 2, it is proposed to be included into the Sub-project in case the economic viability is confirmed and construction fund is available.

(c) Facilities to be Rehabilitated

Based on the basic concept for irrigation and drainage development plan, facilities to be rehabilitated under KSBISRSP are shown in the following table.

**Table II-3.4.3.3.1 List of Irrigation and Drainage Facilities to be Rehabilitated under KSBISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Sub-project area | 3,350 ha in total,<br>consisting of 1,750 ha in the Kandal Stung and 1,600 ha in Bati Areas |
| 2) | Water resource facilities | |
| | - Diversion weir on Stung Touch River | 2 nos. on the Stung Touch river;<br>(one is new headworks and the other is partial improvement of spillway) |
| | - Replacement of intakes on Stung Touch River | 3 nos. on the Stung Touch river;<br>(full replacement for EW-60, EW-58 and NS-82) |
| | - Pump Station on Lake Tonle Bati | 1 no. at Lake Tonle Bati<br>(Full replacement of the existing one, 4 sets of 45 $m^3$/min each) |
| | - Regulator on Prek Thnot River for Stung Touch river | 1 no.<br>(Full replacement of Daeum Rues Regulator on the Prek Thnot River) |
| 3) | Main irrigation canal | 4 canals, Q= 5.88 – 0.91 $m^3$/sec |
| | - Length | 18.9 km in total, Rehabilitation of canal sections for full stretch<br>consisting 11.3 km for Kandal Stung and 7.6 km in Bati Area |
| | - Off-takes | 71 nos. |
| | - Diversion structures | 17 nos. |
| | - Road crossing | 29 nos. |
| 4) | Secondary irrigation canals | 8 canals, Q=0.45 – 0.21$m^3$/sec |
| | - Length | 13.6 km in total, Rehabilitation of canal sections for full stretch<br>consisting 5.0 km for Kandal Stung and 8.6 km in Bati Area |
| | - Off-takes | 36 nos. |
| | - Diversion structures | 9 nos. |
| 5) | Main drainage canals | 4 canals, Q=2.24 – 0.88 $m^3$/sec |
| | - Length | 18.8 km in total, Rehabilitation of canal sections for full stretch<br>consisting 12.1 km for Kandal Stung and 6.7 km in Bati Area |
| | - Structures | 73 nos. |
| 6) | Other facilities | |
| | - Connection canal | 3.5 km<br>(Upgrading of NS-82 to Lake Tonle Bati, Q=5.6 $m^3$/sec) |
| | - Spillway of Lake Tonle Bati | 1 no.<br>(Full replacement of Kampong Dangkor spillway, Q=197 $m^3$/sec) |
| | - Flood protection dike | Heightening of the existing dike of 2.7 km and replacement of one bridge |
| 7) | Tertiary canal system | |
| | - Length | 101 km in total, new construction and rehabilitation<br>consisting 53 km for Kandal Stung and 48 km in Bati Area |

*Source: JICA Survey Team*

(5) Expected Output

Below mentioned is expected output of KSBISRSP.

- Ensured water resources for irrigation to command area of 3,350 ha consisting of 1,750 ha for the Kandal Stung Area and 1,600 ha for the Bati Area
- Realized smooth and effective water convey to command area by rehabilitating and improving the existing irrigation canal system
- Established irrigation canal system in consideration of further development in the future
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kandal PDOWRAM, and organizing and strengthening FWUC

### II-3.4.4 Main Canal 35 Rehabilitation Sub-project

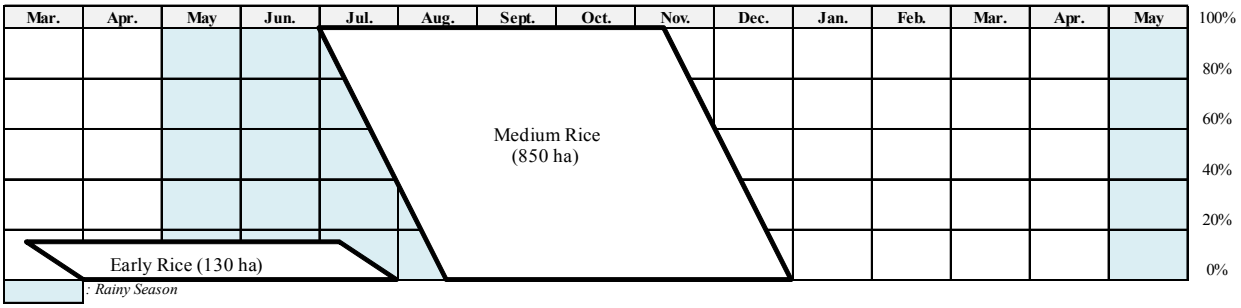
#### II-3.4.4.1 Location and Development Area

MS35RSP is located in the upstream of the Slakou River basin, west of Phnom Penh. The command area of the Sub-project lies in the left bank of the Chraloy River along the provincial road, having long and narrow shape extending from west to east with gentle slope. The area is administratively situated mainly in Basedth District, Kampong Speu Province bordering to the National Road No.4, and partly extending in the western part of Takeo Province. The Sub-project area of MS35RSP is determined to be 850 ha based on the water balance study in Zone-A, the first priority rehabilitation area proposed by PDOWRAM/MOWRAM, which is commanded by the Khpob Krous Reservoir.

#### II-3.4.4.2 Crop Production Plan

(1) Proposed Cropping Pattern

Based on some interview to PDOWRAM, PDA, DAO, farmers and the results of water balance study, the proposed cropping pattern was prepared as shown in Figure II-3.4.4.2.1.




*Source: JICA Survey Team*

**Figure II-3.4.4.2.1 Proposed Cropping Pattern for MC35RSP**

(2) Predicted Paddy Production

Paddy production under without- and with-project conditions is shown as follows:

**Table II-3.4.4.2.1 Production under Without- and With-Project Conditions for MC35RSP**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield*1 (ton/ha) | Production (ton) | Area (ha) | Unit Yield*2 (ton/ha) | Production (ton) | |
| (a) Early Rainy Season | | | | | | | |
| - Early rice (irrigated) | - | - | - | 130 | 4.0 | 520 | 520 |
| (b) Rainy Season | | | | | | | |
| - Medium rice (irrigated) | 50 | 2.13 | 107 | 850 | 3.5 | 2,975 | 2,868 |
| - Medium rice (rainfed) | 850 | 2.09 | 1,777 | - | - | - | -1,777 |
| Total | 900 | | 1,884 | 980 | | 3,495 | 1,611 |

*Note:*
**1: considered the result of socio-economic survey in USISRSP as well as field investigation including interviews to farmers*
**2: applied the result of verification trial, which was conducted in F/S time of RCISRSP*
*Source: JICA Survey Team*

#### II-3.4.4.3 Irrigation and Drainage Plan

(1) Basic Concept of Rehabilitation

Khpob Krous Reservoir was recently rehabilitated and well functioning including hydro-mechanical works, and therefore no significant rehabilitation work is required. In contrast, most of the existing irrigation canal and related facilities were constructed in Pol Pot regime, and these now require significant rehabilitation and/or reconstruction to ensure stable irrigation farming.

The basic concept of rehabilitation of these facilities is to make both initial construction cost and O&M cost as low as possible in due consideration of maintaining sufficient function, safety and durability. To meet these, the purpose of the plan would not be to seek for the "perfect" outcome, but to provide the minimum function required for ensuring water resources for irrigation.

Considering the above, the required rehabilitation works will be planned in the following concepts:

- Rehabilitation of the Khpob Krous Reservoir including hydro-mechanical works is not included under MC35RSP, based on the observation and examination including the existing capacity of the spillway in this Survey.
- Irrigation facilities are planned with conditions that (i) reliability level of irrigation supply is set at 4 in 5 years or 80%, (ii) gravity irrigation systems are proposed as much as possible by raising the water level in the canals, except physically difficult (high) land, and (iii) 24-hour water conveyance will be applied for diversion, main and secondary system.
- Most of existing canal routes would be utilized and canal lining would not be considered. In case that the existing canal route is not topographically suitable for rehabilitation, the canal route would be modified based on the topographic situations.
- No construction of new drainage canal would be proposed, because land acquisition for drains is difficult and no serious drainage problem is observed
- Canal and related structures are designed preliminarily at pre-F/S level in this Survey, because no topographic map with large scale and detailed counter line are available. The facilities should be designed in detail at next stage after preparation of topographic map.

(2) Irrigation Water Requirement

Irrigation water requirement was calculated based on the water balance study as discussed in Section II-2.6.3.2. As a result, unit water requirement of the main and the secondary canals is set at 2.5 l/sec/ha, applying overall irrigation efficiency of 42% consisting of conveyance efficiency of 70% and application efficiency of 60%. Based on the unit water requirement, the peak diversion water requirement from the Khpob Krous Reservoir is estimated at 2.1 $m^3$/sec.

(3) Rehabilitation of Irrigation and Drainage Facilities

Based on the basic concept for the rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under MC35RSP are shown in the following table.

**Table II-3.4.4.3.1 List of Irrigation and Drainage Facilities to be Rehabilitated under MC35RSP**

| No. | Description | Quantity |
|---|---|---|
| (a) | Irrigation Development Area | - 850 ha in priority area (Zone-A) |
| (b) | Main Canal 35 and Related Structures<br>- Main Canal 35 | - Main canal<br>Rehabilitation of existing canal section for Zone-A<br>(12.8 km out of 25.3 km) and construction of new canal (1.2 km) |
| (c) | - Related structures | - Related structures<br>Check structure: 9 nos.<br>Turnout: 16 nos.<br>Culvert: 8 nos.<br>Drain inlet: 10 nos.<br>Drop: 5 nos.<br>Cross Drain: 1 no.<br>Road Bridge: 1 no.<br>Footpath Bridge: 9 nos. |

| No. | Description | Quantity |
|---|---|---|
| (d) | Secondary canals and related structures | Secondary canals and related structures<br>- Secondary canals<br>Rehabilitation of existing secondary canals (5 nos., 9.2 km) and construction of a new canal (1 no., 2.2 km)<br>- Related structures<br>Check Structure: 20 nos.<br>Turnout: 35 nos.<br>Culvert: 26 nos.<br>Drop: 1 no. |
| (d) | Drainage system | Drainage system<br>- Construction of drain structures<br>- Shaping of existing drain |
| (e) | Tertiary canals | Tertiary system development : 26 km (850 ha) |
| (f) | Construction of project office | - Office building (300 $m^2$)<br>- Parking shed, gate and fencing<br>- Well drilling and electric works, etc. |

*Source JICA Survey Team*

(4) Expected Output

Expected output of MC35RSP is listed below.

- Ensured water resources for irrigation to command area of 850 ha
- Realized smooth water convey to command area by rehabilitating and improving the existing reservoir and irrigation canal system
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kampong Speu PDOWRAM, and organizing and strengthening FWUC

### II-3.4.5 Srass Prambai Water Recession Rehabilitation Sub-project

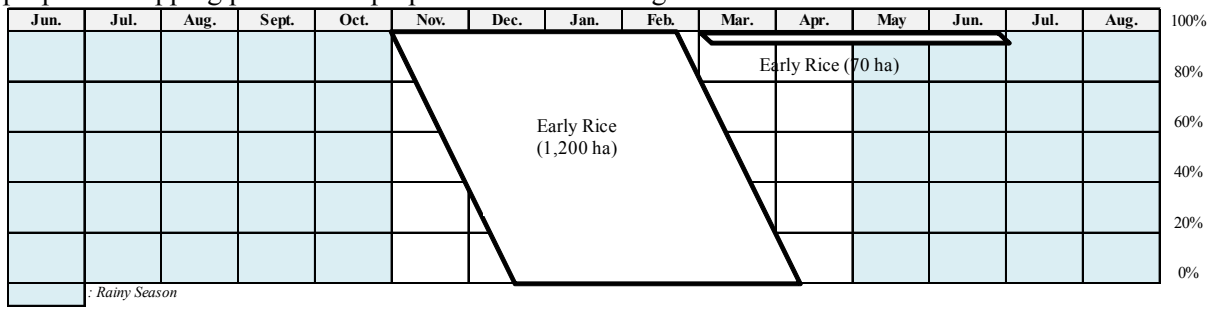
#### II-3.4.5.1 Location and Development Area

SPWRRSP Area is located in the flood plain between the Bassac and the Mekong Rivers. The area lies at the left side of the Bassac River in its lower reach, about 20 km from the national border with Vietnam. The area is administratively situated in Po Ti Ban Commune, Kaoh Thum District, Kandal Province. SPWRRSP aims at stable irrigation water supply to the recession cultivation area of 1,200 ha by rehabilitation of the Srass Prambi Reservoir including dike and related intake culverts on the dike.

#### II-3.4.5.2 Crop Production Plan

(1) Proposed Cropping Pattern

Based on some interview to PDOWRAM, PDA, DAO, farmers and the results of water balance study, proposed cropping pattern was prepared as shown in Figure II-3.4.5.2.1.




*Source: JICA Survey Team*

**Figure II-3.4.5.2.1 Proposed Cropping Pattern for SPWRRSP**

(2) Predicted PaddyProduction

Paddy production under without- and with-project conditions is shown as follows:

**Table II-3.4.5.2.1 Production under Without- and With-Project Conditions for SPWRRSP**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield*1 (ton/ha) | Production (ton) | Area (ha) | Unit Yield*2 (ton/ha) | Production (ton) | |
| 1) Dry Season | | | | | | | |
| - Early rice (irrigated) | 700 | 3.5 | 2,450 | 1,200 | 5.0 | 6,000 | 3,550 |
| 2) Early Rainy Season | | | | | | | |
| - Early rice (irrigated) | - | - | - | 70 | 5.0 | 350 | 350 |
| Total | 700 | | 2,450 | 1,270 | | 6,350 | 3,900 |

*Note*
**1: considered the result of socio-economic survey in USISRSP as well as field investigation including interviews to farmers*
**2: applied the result of verification trial, which was conducted in F/S time of RCISRSP*
*Source: JICA Survey Team*

### II-3.4.5.3 Irrigation and Drainage Plan

(1) Basic Concept of Rehabilitation

The existing Srass Prambai Reservoir requires urgent and significant rehabilitation and improvement to ensure stable irrigation farming in the recession cultivation area. The basic concept of rehabilitation of these facilities is to make both initial construction cost and O&M cost as low as possible in due consideration of maintaining sufficient function, safety and durability, accepting current irrigation practices using portable small pump at on-farm level under the existing Pol Pot canal grid system. Considering the above, the required rehabilitation works will be planned in the following basic concept:

- Rehabilitation of the Srass Prambai Reservoir is given the highest priority both for the reservoir dike and related intake culverts.
- Existing Pol Pot canal grid would be utilized as it is without rehabilitation.
- Irrigation facilities is planned with conditions that (i) reliability level of irrigation supply is set at 4 in 5 years or 80%, and (ii) 24-hour water conveyance will be applied for diversion, main and secondary systems
- Tertiary canal system is not considered because current irrigation practice seems to be suitable for the recession cultivation in this area.
- Rehabilitation of dike and related structures are designed preliminarily at pre-F/S level in this Survey. The facilities should be designed in detail at next stage after preparation of topographic map.

(2) Irrigation Water Requirement

Irrigation water requirement is calculated based on the water balance study as discussed in Section II-2.7.3.2. As a result, unit water requirement at a main and secondary canal level is set at 2.4 l/sec/ha, applying overall irrigation efficiency of 70%. Based on the unit water requirement, the peak diversion water requirement from the Srass Prambai Reservoir is estimated at 2.8 $m^3$/sec.

(3) Design Inflow Discharge at Reservoir

In order to determine the capacity of the intake culverts on the reservoir, designed inflow discharge from the Tonle Bassac River into the reservoir is assumed to be 4.0 $m^3$/sec through the water balance simulation study as discussed in ANNEX B-2.5.2.4.

(4) Rehabilitation of Irrigation and Drainage Facilities

Based on the basic concept for the rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under SPWRRSP are shown in the following table.

**Table II-3.4.5.4.1 List of Irrigation Facilities to be Rehabilitated under SPWRRSP**

| No. | Description | Quantities |
|---|---|---|
| 1) | Irrigation Development Area | 1,200 ha |
| 2) | Rehabilitation of reservoirs dike | Rehabilitation of the existing dike (9.1 km) |
| 3) | Replacement of intake culverts on reservoir dike | Replacement of 7 intake culverts with provision of new slide gates |
| 4) | Construction of project office | (a) Office building (300 $m^2$)<br>(b) Parking shed, gate and fencing<br>(c) Well drilling and electric works, etc. |

*Source: JICA Survey Team*

(5) Expected Output

Expected output of SPWRRSP is as follows.

- Ensured water resources for irrigation to command area of 1,200 ha by rehabilitating the existing reservoir
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kandal PDOWRAM, and organizing and strengthening FWUC

### II-3.4.6 Daun Pue Irrigation System Rehabilitation Sub-project

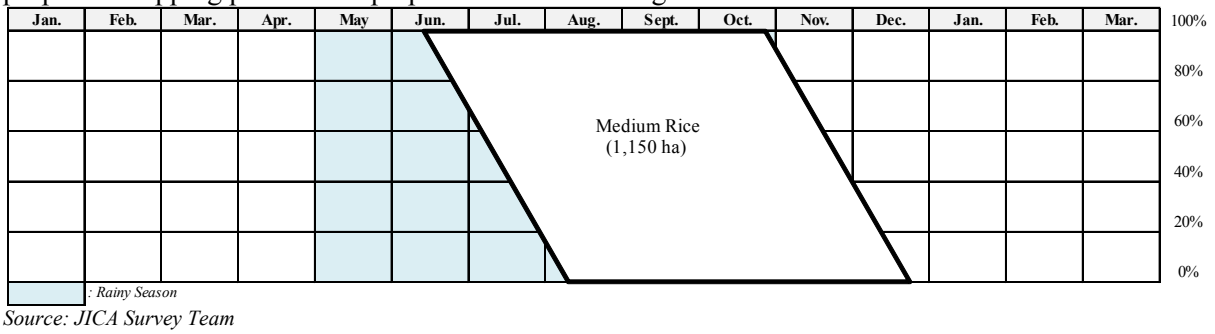
#### II-3.4.6.1 Location and Development Area

DPISRSP is located in the upstream of the Chieb River Basin, about 40 km from its confluence with the Tonle Sap River. The irrigation command area of DPISRSP lies in the left bank of the Chieb River and along the provincial road, having long and narrow shape extending from west to east. Administratively, the area lies in Chieb, Khlong Porpork and Aphivath Communes in Teuk Phos District. The DPISRSP Area is determined to be 1,150 ha based on the water balance study.

#### II-3.4.6.2 Crop Production Plan

(1) Proposed Cropping Pattern

Based on some interview to PDOWRAM, PDA, DAO, farmers and through water balance study, proposed cropping pattern was prepared as shown in Figure II-3.4.6.2.1.




*Source: JICA Survey Team*

**Figure II-3.4.6.2.1 Proposed Cropping Pattern for DPISRSP**

(2) Predicted Paddy Production

Paddy production under without- and with-project conditions is shown as follows:

**Table II-3.4.6.2.1 Production under Without- and With-Project Conditions for DPISRSP**

| Paddy | Present / Without-project Condition | | | With-project Condition | | | Increment Production (ton) |
|---|---|---|---|---|---|---|---|
| | Area (ha) | Unit Yield*1 (ton/ha) | Production (ton) | Area (ha) | Unit Yield*2 (ton/ha) | Production (ton) | |
| 1) Rainy Season | | | | | | | |
| - Medium rice (irrigated) | - | - | - | 1,150 | 3.50 | 4,025 | 4,025 |
| - Medium rice (rainfed) | 1,060 | 2.09 | 2,215 | - | | | -2,215 |
| Total | 1,060 | | 2,215 | 1,150 | | 4,025 | 1,810 |

*Note*
**1: considered the result of socio-economic survey in USISRSP as well as field investigation including interviews to farmers*
**2: applied the result of verification trial, which was conducted in F/S time of RCISRSP*
*Source: JICA Survey Team*

### II-3.4.6.3 Irrigation and Drainage Plan

(1) Basic Concept of Rehabilitation

At present, irrigation water is diverted from the river by temporary weir without permanent facilities, which causes difficulty and low efficiency of sufficient water diversion. Therefore, new construction of headworks is indispensable for DPISRSP. In addition, most of the existing irrigation facilities were constructed in the Pol Pot regime, and they now require significant rehabilitation and/or reconstruction to ensure stable irrigation farming. The basic concept of rehabilitation of these facilities is to make both initial construction cost and O&M cost as low as possible in due consideration of maintaining sufficient function, safety and durability. To meet these, the purpose of the plan would not be to seek for the "perfect" outcome, but to provide the minimum function required for ensuring water resources for irrigation.

Considering the above, the required rehabilitation works will be planned in the following concepts:

- New construction of the headworks instead of the existing temporary weir including gated intake structure is indispensable for the Sub-project.
- Irrigation facilities is planned with conditions that (i) reliability level of irrigation supply is set at 4 in 5 years or 80%, (ii) gravity irrigation systems are proposed as much as possible by raising the water level in the canals, except physically difficult (high) land, and (iii) 24-hour water conveyance will be applied for diversion, main and secondary system.
- Most of existing canal routes would be utilized and canal lining would not be considered. In case that the existing canal route is not topographically suitable for rehabilitation, the canal route would be modified based on the topographic situations.
- No construction of new drainage canal would be proposed, because land acquisition for drains is difficult and no serious drainage problem is observed.
- Canal and related structures are designed preliminarily at pre-F/S level in this Survey, because no topographic map with large-scale and detailed counter line is available. The facilities should be designed in detail at next stage after preparation of topographic map.

(2) Irrigation Water Requirement

Irrigation water requirement is calculated based on the water balance study as discussed in Section II-2.8.3.2. As a result, unit water requirement of main canal and secondary canals is set at 2.4 l/sec/ha, applying overall irrigation efficiency of 42% consisting of conveyance efficiency of 70% and application efficiency of 60%. Based on the unit water requirement, the peak diversion water requirement is estimated at 2.8 $m^3$/sec.

(3) Design Flood Discharge for Headworks

Design flood discharge is estimated at 129 $m^3$/sec and 236 $m^3$/sec for the return period of 10 and 50 years, respectively.

(4) Rehabilitation of Irrigation and Drainage Facilities

Based on the basic concept for the rehabilitation plan mentioned above, facilities to be rehabilitated and/or reconstructed under DPISRSP are shown in the following table:

**Table II-3.4.6.3.1 List of Irrigation and Drainage Facilities to be Rehabilitated under DPISRSP**

| Descriptions | Quantities |
|---|---|
| 1) Irrigation Development Area | (a) Sub-project Area<br>1,150 ha |
| 2) Hardware Components | |
| - New construction of headworks | (a) River training of up and down stream of proposed headworks<br>(b) Construction of headworks with provision of flood gates<br>(2 m x 10 m x 4 sets)<br>(c) Construction of intake structure |
| - Full rehabilitation of Daun Pue Main Canal | (a) Improvement of canal (6.2 km from BP to P6+200, raising of embankment and/or enlargement of canal section),<br>(c) Changing route of main canal (4.9 km from P6+200 to EP, Upgrading of secondary to main canal)<br>(d) Construction of canal inspection road<br>(e) Replacement or new construction of canal related structures;<br>- Check structure 14 nos.<br>- Turnout 34 nos.<br>- Culverts 13 nos. |
| - Full rehabilitation of secondary canals | (a) Improvement of canal (3.4 km in total)<br>(b) Construction of new secondary canal from main canal to existing secondary canal (1.2 km)<br>(c) Construction of canal inspection road<br>(d) Replacement or new construction of canal related structures;<br>- Check structure 9 nos.<br>- Turnout 15 nos.<br>- Culverts 8 nos. |
| - Full rehabilitation of drains | (a) Improvement and reshaping of drains |
| - Development of tertiary canal system | (a) Rehabilitation and improvement of tertiary irrigation canals (35 km) |
| - New Construction of project office | (a) Office building (300 $m^2$)<br>(b) Parking shed, gate and fencing<br>(c) Well drilling and electric works, etc. |

*Source: JICA Survey Team*

(5) Expected Outputs

Expected output of DPISRSP is as follows.

- Ensuring of water resources for irrigation to command area of 1,150 ha by newly constructing headworks
- Smooth water convey to command area by rehabilitating and improving the existing irrigation canal system
- Improved agricultural productivity to contribute to improvement of farmers' income, especially by provision of agricultural extension services
- Established O&M system by strengthening Kampong Chhnang PDOWRAM, and organizing and strengthening FWUC

## II-3.5 Software Components

### II-3.5.1 General

(1) Proposed Activities

On the basis of approach and strategy of SPPIDRIP stressing integration of hardware and software components to successfully accomplish its objective, the following 3 activities are proposed under the

software components of SPPIDRIP to establish organizational set-up in order to effectively utilize rehabilitated irrigation facilities:

- Capacity Development of MOWRAM and PDOWRAM Staff on O&M
- Formation and Strengthening of FWUC
- Strengthening of Agricultural Extension Services

(2) General Framework

Software components under SPPIDRIP will be conducted based on such principles as (i) follow-up of output of TSC-3 supported area in both Roleang Chrey and Slakou Irrigation Systems, (ii) extension to other Sub-projects such as KSBISRSP, MC35RSP, SPWRRSP and DPISRSP and (iii) integration of output of TSC-3 supported area and the extension area in both RCHRSP and USISRSP so as to demonstrate proper water management and increase rice production in the Model Area (570 ha) under RCHRSP and command area extending 3,500 ha under USISRSP. General framework of software components is tabulated as follows:

**Table II-3.5.1.1 General Framework Software Components under SPPIDRIP**

| No. | Title | Activities | Implemented by | Main Target Group |
|---|---|---|---|---|
| 1) | Capacity Development of MOWRAM and PDOWRAM Staff on O&M | - Preparation of practical O&M guidelines for rehabilitated facilities<br>- Dissemination and training workshop<br>- Training management<br>- Periodical monitoring and evaluation<br>- Follow-up workshop | Technical consultant (short-term foreign consultant) for work plan preparation and trial training<br>Training programs and M&E by PMU Japan Support Fund with Technical Service Center | MOWRAM and PDOWRAM Staff |
| 2) | Formation and Strengthening of FWUC | - Support to awareness raising<br>- Support to establishment of FWUC<br>- Implementation of training programs (organizational management, water management & O&M of tertiary canal systems)<br>- Support and monitoring of water management and O&M of irrigation facilities | MOWRAM and PDOWRAM staff by employing national consultants | FWUCs in 6 Sub-project irrigation systems |
| 3) | Strengthening of Agricultural Extension Services[2] | - TOT for capacity development of group leaders to act as extension facilitator<br>- Soil fertility diagnosis program<br>- Pre-harvest technology improvement<br>- Post-harvest technology improvement<br>- Demonstration Plots | Technical Consultant (Short-term foreign consultant) for work plan preparation and trial training<br>Training programs execution and M&E by PDA staff and national consultants under the control of PMU Japan Support Fund | FWUCs in 6 Sub-project irrigation systems |

*Source; JICA Survey Team*

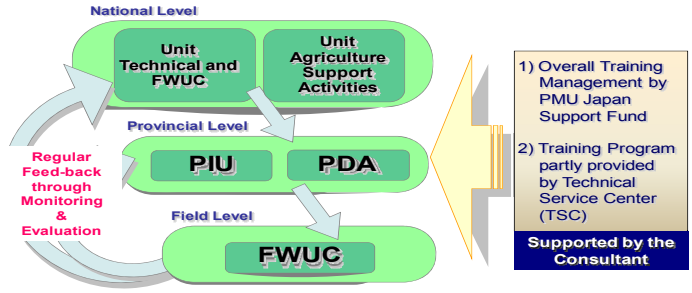
As explained in the above table, technical consultants will be employed to support MOWRAM for the implementation of software components from planning to overall monitoring. In the next section, necessary consultant inputs are proposed for each subproject separately. It would be effective if such style as same technical consultants consistently carry out planning and implementation support of software components in the course of the program in 6 Sub-projects so that accumulated know-how and output from the software components can be effectively shared among sub-projects.

(3) Capacity Development through Training-of-Trainers

It is proposed that software components will be generally carried out through TOT (or cascading system of training) approach, where trainees at one level become trainers at the other level. This method

[2] *Out of 3 components proposed, "Strengthening of Agricultural Extension Services" is explained in details in Annex C: Agriculture.*

will facilitate the mechanism of information flows and feedback from training programs among lower to higher levels of stakeholders. Such approach has been widely carried out by the previous irrigation projects with development partners and TSC of MOWRAM, images of which are illustrated in Figure II-3.5.1.1. In practice, national level units: (i) technical and FWUC and (ii) agriculture extension activities under PMU Japan Support Fund will train staff of Project Implementation Unit (PIU) at the provincial level, in coordination with relevant technical departments in MOWRAM, and trained PIU staff will train the members of FWUC at the field level. As already explained, there are useful accumulated training curricula in TSC of MOWRAM, having been supported by the technical cooperation project by JICA. In this process, therefore, such know-how is expected to be effectively disseminated and utilized.




*Source; JICA Survey Team*

**Figure II-3.5.1.1 General Image of TOT to be Applied for SPPIDRIP**

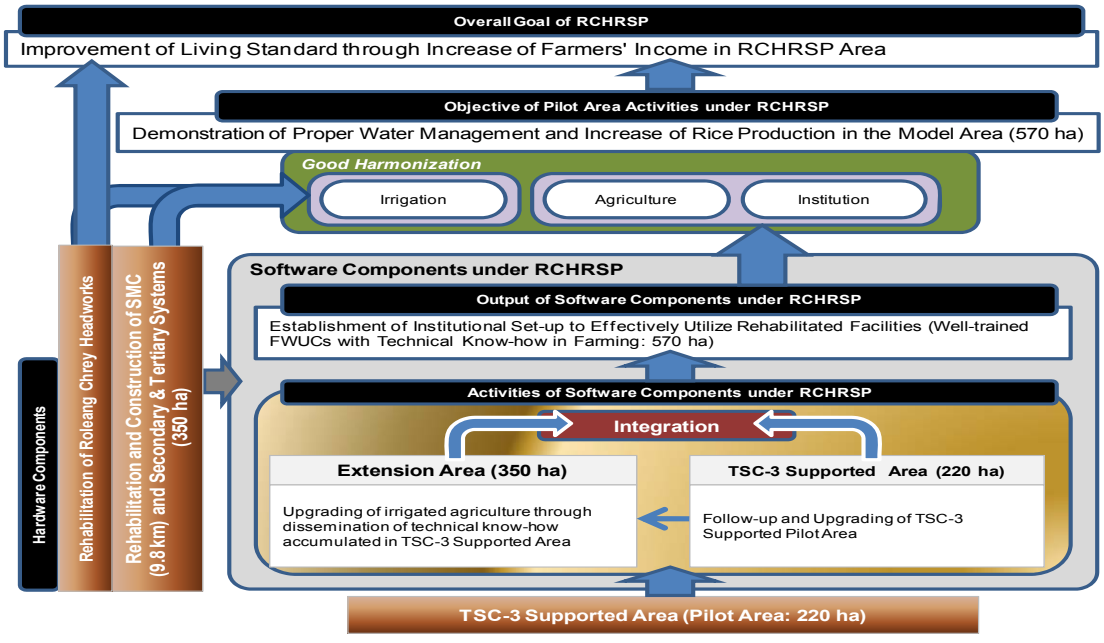
(4) Employment of Financial Management Consultant

Two programs, Formation and Strengthening of FWUC and Strengthening of Agricultural Extension Services software components are proposed to be implemented with the initiatives of MOWRAM using special account for the activities. In order to expedite its implementation through maintaining transparency of their disbursement, national financial management consultant will be employed to be in charge of necessary administrative works for software components under special account. The required M/M for national financial management consultants is estimated at 28 M/M.

## II-3.5.2 Software Components under Roleang Chrey Headworks Rehabilitation Sub-project

### II-3.5.2.1 Approach

On the basis of proposed framework mentioned in the previous section, proposed approach of software components under RCHRSP is illustrated as follows:




*Source; JICA Survey Team*

**Figure II-3.5.2.1.1 Approach of Software Components under RCHRSP**

SMC is 26 km in total recently constructed by MOWRAM, out of which the target area of software components under RCHRSP is extended to 570 ha located under upper reach of SMC originally proposed as "Irrigated Agriculture Improvement Model Project" in the M/P Study. Since JICA's technical cooperation, TSC-3 is preparing to commence their pilot project in the upstream of this area, software components of RCHRSP is proposed for: (i) follow-up of TSC-3 supported area (220 ha) and (ii) extension of technical know-how to remaining area (350 ha). RCHRSP's objective will be accomplished by integrating the results from both areas.

(1) Overall Goal of RCHRSP

Overall goal of RCHRSP is "poverty reduction on improvement of living standard through increase of farmers' income in RCHRSP Area.

(2) Objective of Pilot Area Activities under RCHRSP

Objective of pilot area activities under RCHRSP is, with the support of hardware components by rehabilitation of the Roleang Chrey Headworks, SMC and construction of secondary and tertiary canal system, demonstration of proper water management and increase of rice production in the Model Area (570 ha) in the command area of the Roleang Chrey Headworks through good harmonization of irrigation, agriculture and institution. Output of software components under RCHRSP is "establishment of institutional set-up to effectively utilize rehabilitated facilities (well-trained FWUCs with technical know-how in farming: 570 ha).

### II-3.5.2.2 Activities

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

Focal point of proposed activities for capacity development of MOWRAM and PDOWRAM staff under RCHRSP is given to O&M of Roleang Chrey Headworks including coordination among irrigation systems under the Headworks through Prek Thnot River Basin Management Unit summarized in the following table:

**Table II-3.5.2.2.1 Proposed Activities for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (RCHRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Institutional set-up for O&M within MOWRAM and PDOWRAM is established to effectively utilize irrigation facilities at the main canal level. | |
| **Output**<br>(a) Improvement of technical capability on O&M of MOWRAM and PDOWRAM Staff<br>1) Capability of relevant MOWRAM staff is enhanced in instructing and supporting field level O&M activities of irrigation facilities by PDOWRAM staff<br>2) Capability of PDOWRAM staff is improved in O&M skills for irrigation facilities.<br>(b) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for field activities at Roleang Chrey Irrigation System.<br>1) Support and instruction for PDOWRAM Staff's field activities is carried out timely by MOWRAM.<br>2) Monitoring and instruction to district staff activities are timely carried out by PDOWRAM staff. | |
| **Activity** (4 years)<br>(a) O&M Training (Roleang Chrey Headworks and Irrigation System in the model area: 570 ha)<br>1) Water management training for MOWRAM staff: 4 nos. (1 time/year)<br>2) Water management training for PDOWRAM staff: 8 nos. (2 times/year)<br>3) Maintenance training for MOWRAM staff: 4 nos. (1 time/year)<br>4) Maintenance training for PDOWRAM staff: 8 nos. (2 times/year)<br>(b) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- Foreign consultant: 1.5 M/M (O&M Expert)<br>- National consultant: 6 M/M (Irrigation Expert 3 M/M and O&M Expert 3 M/M)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel etc.) |

| Narrative Summary of Proposed Activities | |
|---|---|
| **Training Subject**<br>(a) Overall Training Management<br>- Outline of O&M and strengthening of FWUCs<br>- Outline of agriculture support services<br>- O&M of major and minor facilities<br>- FWUC's participation in irrigation system management<br>- Facilitation skills of FWUCs<br>- Coordination among relevant agencies<br>(b) Roleang Chrey Headworks Gate O&M<br>- Gate operation rule including coordination among relevant organizations (Kampong Speu, Takeo, Kandal Provinces and Phnom Penh Municipality through Prek Thnot River Basin Management Unit)<br>- Gate maintenance including emergency repair<br>(c) Irrigation O&M<br>- Irrigation planning at the Model Area (570 ha)<br>- Water management at Main and secondary canal level<br>- Maintenance work including repairing at Main and secondary canals level<br>(d) Monitoring and evaluation<br>- Meteo-hydrological data including rainfall, temperature, evaporation, humidity etc. at RCHRSP Area<br>- River water level and runoff for the water source<br>- Monitoring and evaluation of O&M works at main and secondary canals level<br>- Monitoring and evaluation of O&M works at secondary and tertiary canals level by FWUC<br>- Monitoring and evaluation of FWUC activities | |

*Source; JICA Survey Team*

(2) Formation and Strengthening of FWUC

Formation and strengthening of FWUC under RCHRSP will be implemented for model area extending 570 ha based on the organization to be established through the support of TSC-3 as being planned. The proposed activities for are tabulated as follows:

**Table II-3.5.2.2.2 Proposed Activities for Formation and Strengthening of FWUC (RCHRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- FWUC is established and strengthened in the model area of Roleang Chrey Irrigation System to properly carry out O&M of secondary and tertiary level facilities. | |
| **Output**<br>(a) Improvement of technical capability on training management of PDOWRAM staff<br>1) Training management through TOT is understood by PDOWRAM staff.<br>(b) FWUC establishment and strengthening (FWUC: 1 no., FWUG: 3 nos., Sub-FWUG: 22 nos.)<br>1) FWUC is established and registered to cover Model Area (570 ha).<br>2) Member of FWUC in Model Area of Roleang Chrey Irrigation System understand irrigation O&M skills and necessary activities.<br>(c) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for FWUC activities at Roleang Chrey Irrigation System.<br>1) Support and instruction for PDOWRAM Staff's support activities to FWUC is carried out timely by MOWRAM.<br>2) Monitoring and instruction to FWUC activities are timely carried out by PDOWRAM staff. | |
| **Activity** (7 years)<br>(a) TOT for PDOWRAM staff<br>1) Training to PDOWRAM staff: 7 nos. (1 time/year)<br>(b) Training to FWUC<br>1) Organizational strengthening (awareness raising, organizational management, financial management, conflict resolution etc.): 8 nos. (2 times/year)<br>2) O&M (irrigation plan, water management, maintenance of facilities etc.): 14 nos. (2 times/year)<br>(c) Monitoring and evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff<br>**Training Subject**<br>Target<br>FWUC: 1 no., FWUG: 3 nos., Sub-FWUG: 22 nos.<br>(a) FWUC and its formation | **Input**<br>- National consultant: 10.5 M/M (Institutional Expert: 1.5 M/M / year × 7 years)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel, registration etc.) |

| Narrative Summary of Proposed Activities | |
|---|---|
| - Irrigation plan<br>- FWUC and its objectives and organization<br>- FWUC formation process<br>- Responsibility/duty and right etc.<br>(b) FWUC management<br>- FWUC and formation process of FWUC<br>- Organizational management<br>- Financial management including bank account, cash book, accounting book, ISF, revenue and expense of FWUC - Conflict management<br>- Budgeting<br>(c) O&M of irrigation facilities<br>- Irrigation plan for model area<br>- Water management at secondary, tertiary and water course level<br>- Maintenance work including repair work<br>- Preparation of annual water management schedule<br>- ISF and cost for O&M | |

*Source; JICA Survey Team*

## (3) Strengthening of Agricultural Extension Services

Proposed activities for strengthening of Agricultural Extension Services are shown as follows:

**Table II-3.5.2.2.3 Proposed Activities for Strengthening of Agricultural Extension Services (RCHRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Farmers get better yield of paddy. | |
| **Output**<br>(a) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>(b)Training of Farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>(c) Periodical Checking and Analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season | |
| **Activity** (Period: 4 years, refer Table AC-2.1.6.3.5 in ANNEX C)<br>(a) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: foreign consultant in collaboration with national consultant<br>1) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>2) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed.<br>(b) Training of Farmers<br>Target: 3 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant<br>1) Field programs<br>- Demonstration plots (Rice): 9 plots<br>- Demonstration plots (Upland Crops): 3 plots<br>- Demonstration plots (Vegetables): 3 plots<br>- Water management: 6 courses<br>2) Farmer/Farmer Group Training Programs<br>- Short-term training course (by topics): 3 courses<br>- FFS/ IPM: 3 courses<br>- Study tour: 3 courses<br>3) Mass guidance / Workshop: 6 courses<br>(c) Periodical Checking and Analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>1) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO | **Input**<br>(a) 1 Foreign consultant: 0.30 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>(b) 1 National consultant: 0.86 MM /year (3.44 MM / 4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>(c) Other direct costs (refer Tables AC-2.1.6.3.4 and AC-2.1.6.3.5 in ANNEX C)<br>(d) Training materials (refer Attachment-5 in ANNEX C) |

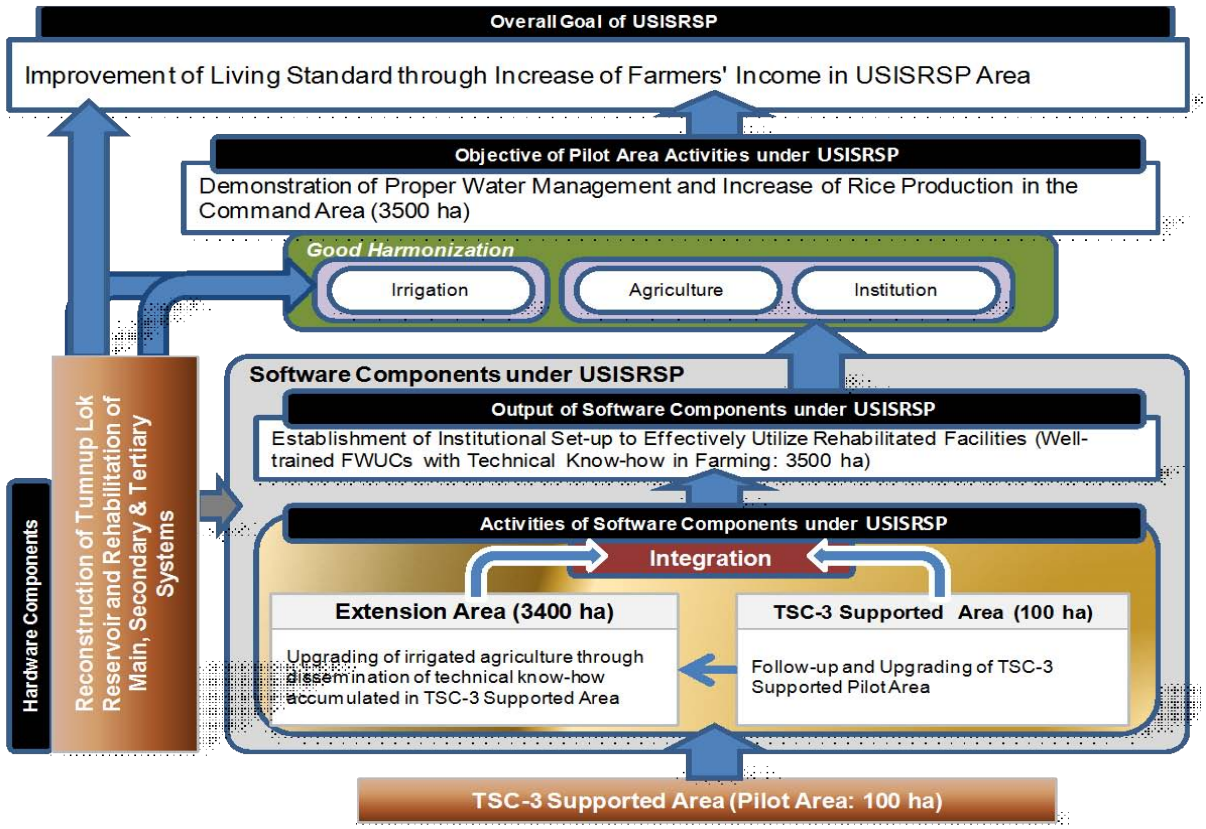
| Narrative Summary of Proposed Activities | |
|---|---|
| **Training Subject**<br>(a) Training of Trainers<br>- Capacity building on preparation of action plan,<br>(b) Training of Farmers<br>1) Field programs<br>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG<br>2) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>3) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>(c) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation | |

*Source; JICA Survey Team*

### II-3.5.3 Software Components under Upper Slakou Irrigation System Rehabilitation Sub-project

#### II-3.5.3.1 Approach

In general, similar approach as RCHRSP will be applied for the implementation of software components of USISRSP as depicted as follows:




*Source; JICA Survey Team*

**Figure II-3.5.3.1.1 Approach of Software Components under USISRSP**

In the command area of USISRSP as well, JICA's technical cooperation, TSC-3 is under preparation to start pilot project covering 100 ha under secondary canal blocks. Therefore, maximum utilization of output from TSC-3 pilot area will be useful to achieve overall improvement of O&M in the command area of USISRSP. Software components under USISRSP are similarly proposed for: (i) follow-up of TSC-3 supported area (100 ha) and (ii) extension of technical know-how to remaining area (3,400 ha). USISRSP's objective will be attained by integrating the results from both areas.

(1) Overall Goal of USISRSP

USISRSP's overall goal is "improvement of living standard through increase of farmers' income" in the USISRSP Area.

(2) Objective of Software Components under USISRSP

Objective of software components under USISRSP is, with the support of hardware components by construction of the Tumnup Lok Reservoir, rehabilitation of main and secondary canal systems and new construction of tertiary canal system, demonstration of proper water management and increase of rice production in the USISRSP Area (3,500 ha) through good harmonization of irrigation, agriculture and institution. Output of software components under USISRSP is "establishment of institutional set-up to effectively utilize rehabilitated facilities (well-trained FWUC with technical know-how in farming: 3,400 ha except 100ha of the TSC-3 support area).

### II-3.5.3.2 Activities

Among 3 activities proposed for software components, 2 activities: (i) Capacity Development of MOWRAM and PDOWRAM Staff on O&M and (ii) Formation and Strengthening of FWUC of USISRSP are described as follows:

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

In order to establish institutional set-up for effective O&M of rehabilitated facilities, proposed activities for capacity development of MOWRAM and PDOWRAM staff on O&M under USISRSP are tabulated as follows:

**Table II-3.5.3.2.1 Proposed Activities for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (USISRSP)**

<table>
<tr><th colspan="2">Narrative Summary of Proposed Activities</th></tr>
<tr><td colspan="2">Objective<br>- Institutional set-up for O&M within MOWRAM and PDOWRAM is established to effectively utilize irrigation facilities at the main level.</td></tr>
<tr><td colspan="2">Output<br>(a) Improvement of technical capability on O&M of MOWRAM and PDOWRAM staff<br>1) Capability of relevant MOWRAM staff is enhanced in instructing and supporting field level O&M activities of irrigation facilities by PDOWRAM staff<br>2) Capability of PDOWRAM staff is improved in O&M skills for irrigation facilities.<br>(b) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for field activities at Slakou Irrigation System.<br>1) Support and instruction for PDOWRAM Staff's field activities is carried out timely by MOWRAM.<br>2) Monitoring and instruction to district staff activities are timely carried out by PDOWRAM staff.</td></tr>
<tr><td>Activity (4 years)<br>(a) O&M training (Slakou Irrigation System: 3,500 ha)<br>1) Water management training for MOWRAM staff: 4 nos. (1 time/year)<br>2) Water management training for PDOWRAM staff: 8 nos. (2 times/year)<br>3) Maintenance training for MOWRAM staff: 4 nos. (1 time/year)<br>4) Maintenance training for PDOWRAM staff: 8 nos.(2 times/year)<br>(b) Monitoring and evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff<br>Training Subject<br>(a) Overall training management<br>- Outline of O&M and strengthening of FWUCs<br>- Outline of agriculture support services<br>- O&M of major and minor facilities<br>- FWUC's participation in irrigation system management<br>- Facilitation skills of FWUCs<br>- Coordination among relevant agencies</td><td>Input<br>- Foreign consultant: 1.5 M/M (O&M Expert)<br>- National consultant: 6 M/M (Irrigation Expert 3 M/M and O&M Expert 3 M/M)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel etc.)</td></tr>
</table>

| Narrative Summary of Proposed Activities | |
|---|---|
| (b) Tumnup Lok and Kpob Trobek Reservoirs gate O&M<br>- Gate operation rule including coordination among relevant organizations<br>- Water management of Tumnup Lok and Kpob Trobek Reservoirs<br>- Gate maintenance including emergency repair<br>(c) Irrigation O&M<br>- Irrigation planning in the Slakou Irrigation System (3,500 ha)<br>- Water management at diversion, main and secondary canal level<br>- Maintenance work including repairing at diversion, main and secondary canals level<br>(d) Monitoring and evaluation<br>- Meteo-hydrological data including rainfall, temperature, evaporation, humidity etc. at RCHRSP Area<br>- River water level and runoff for the water source<br>- Monitoring and evaluation of O&M works at diversion, main and secondary canals level<br>- Monitoring and evaluation of O&M works at secondary and tertiary canals level by FWUC<br>- Monitoring and evaluation of FWUC activities | |

*Source; JICA Survey Team*

## (2) Formation and Strengthening of FWUC

Proposed activities for strengthening of FWUC under USISRSP are tabulated as follows:

**Table II-3.5.3.2.2 Proposed Activities for Formation and Strengthening of FWUC (USISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- FWUC is established and strengthened in the command area of USISRP to properly carry out O&M of secondary and tertiary level facilities. | |
| **Output**<br>(a) Improvement of technical capability on Training Management of PDOWRAM staff<br>1) Training management through TOT is understood by PDOWRAM staff.<br>(b) FWUC establishment and strengthening (FWUC: 1 no., FWUG: 14 nos., Sub-FWUG: 106 nos.)<br>1) FWUC is established and registered to cover Slakou Irrigation area (3,500 ha).<br>2) Member of FWUC in Slakou Irrigation System understand irrigation O&M skills and necessary activities.<br>(c) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for FWUC activities at Slakou Irrigation System.<br>1) Support and instruction for PDOWRAM Staff's support activities to FWUC is carried out timely by MOWRAM.<br>2) Monitoring and instruction to FWUC activities are timely carried out by PDOWRAM staff. | |
| **Activity** (7 years)<br>(a) TOT for PDOWRAM staff<br>1) Training to PDOWRAM staff: 7 nos. (1 time/year)<br>(b) Training to FWUC<br>1) Organizational strengthening (awareness raising, organizational management, financial management, conflict resolution etc.): 14 nos. (2 times/year)<br>2) O&M (irrigation plan, water management, maintenance of facilities etc.): 8 nos. (2 times/year)<br>(c) Monitoring and evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- National consultant: 21 M/M (Institutional Expert: 3 M/M / year × 7 years)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel, registration etc.) |
| **Training Subject**<br>Target<br>FWUC: 1 no., FWUG: 14 nos., Sub-FWUG: 106 nos.<br>(a) FWUC and its formation<br>- Irrigation plan<br>- FWUC and its objectives and organization<br>- FWUC formation process<br>- Responsibility/duty and right etc.<br>(b) FWUC management<br>- FWUC and formation process of FWUC<br>- Organizational management<br>- Financial management including bank account, cash book, accounting book, ISF, revenue and expense of FWUC<br>- Conflict management<br>- Budgeting | |

| Narrative Summary of Proposed Activities | |
|---|---|
| (c) O&M of irrigation facilities<br>- Irrigation plan for Model Area<br>- Water management at secondary, tertiary and watercourse level<br>- Maintenance work including repair work<br>- Preparation of annual water management schedule<br>- ISF and cost for O&M | |

*Source; JICA Survey Team*

Based on the results of the verification study at pilot projects carried out during the Study on Comprehensive Agricultural Development of Prek Thnot River Basin by JICA (2005-2008), the following issues are recommended for the process of establishment and strengthening of FWUC:

- Preparation of the cadastre and cadastral map through the Participatory Rural Appraisal (PRA) and a participatory mapping,
- Training programs staring from how to organize and facilitate meeting,
- Construction of office building,
- Intensive training on financial management
- Information dissemination in the community through, such as FWUC magazines,
- Management transfer by the initiative of the government staffs with the assistance of FWUC,
- Training on simple feasibility study, and
- Continuous support services by MOWRAM

Such recommendations need to be fully considered for the implementation of software components under SPPIDRIP.

(3) Strengthening of Agricultural Extension Services

Proposed activities for strengthening of Agricultural Extension Services are shown as follows:

**Table II-3.5.3.2.3 Proposed Activities for Strengthening of Agricultural Extension Services (USISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Farmers get better yield of paddy. | |
| **Output**<br>(a) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>- Monitoring and evaluation are carried out by PDA and DAO.<br>- Conclusions obtained from monitoring and evaluation are affected to the action plan for the following cropping season.<br>(b)Training of farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>(c) Periodical checking and analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season. | |
| **Activity** (Period: 4 years, refer Table AC-2.2.6.3.3 in ANNEX C)<br>(a) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: Foreign consultant in collaboration with national consultant<br>1) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>2) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed.<br>(b) Training of farmers<br>Target: 18 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant | **Input**<br>(a) 1 Foreign consultant: 0.30 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>(b) 1 National consultant: 0.86 MM /year (3.44 MM/4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>(c) Direct costs (refer Tables AC-2.1.6.3.4 and AC-2.2.6.3.3 in ANNEX C)<br>(d) Training materials (refer Attachment-5 in ANNEX C) |

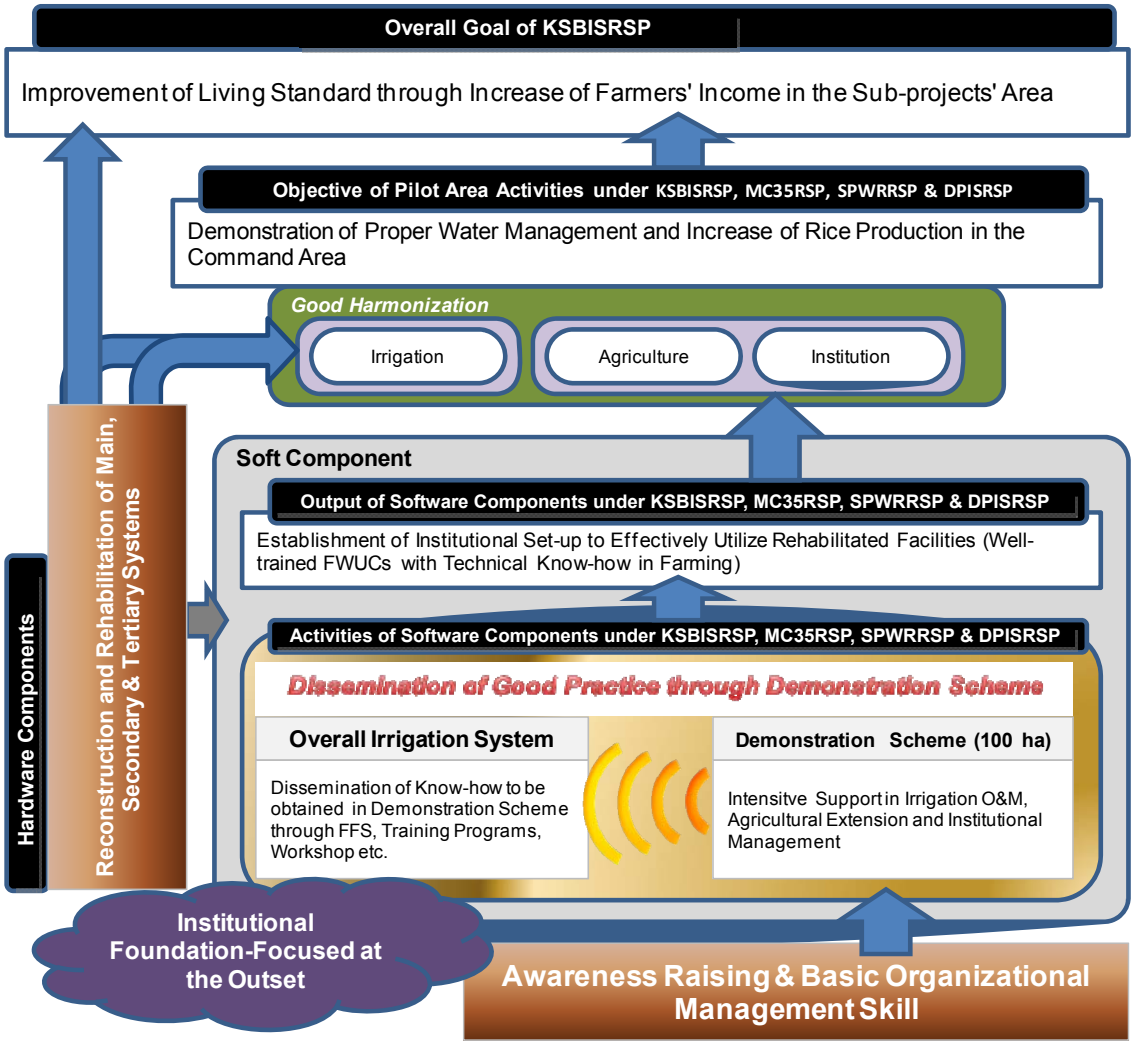
| Narrative Summary of Proposed Activities | |
|---|---|
| 1) Field programs<br>- Demonstration plots (Rice): 36 plots<br>- Demonstration plots (Upland Crops): 18 plots<br>- Demonstration plots (Vegetables): 18 plots<br>- Water management: 36 courses<br>2) Farmer/Farmer group training programs<br>- Short-term training course (by topics): 18 courses<br>- FFS/ IPM: 18 courses<br>- Study tour: 18 courses<br>3) Mass guidance / workshop: 36 courses<br>(c) Periodical checking and analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>1) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO | |
| **Training Subject**<br>(a) Training of Trainers<br>- Capacity building on preparation of action plan<br>(b) Training of Farmers<br>1) Field programs<br>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG<br>2) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>3) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>(c) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation | |

*Source; JICA Survey Team*

### II-3.5.4 Software Components under Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

#### II-3.5.4.1 Approach

FWUC has not been established in the command area of KSBISRSP so that software components needs to be more intensive and institutional foundation-focused in the supporting process attention to be given to awareness raising and basic organizational management skill at the beginning. Proposed approach of software components under KSBISRSP is illustrated as follows:




*Source; JICA Survey Team*

**Figure II-3.5.4.1.1 Approach of Software Components under KSBISRSP**

As for the institutional maturity, conditions of 4 Sub-projects consisting of: (i) KSBISRSP, (ii) MC35RSP, (iii) SPWRRSP and (iv) DPISRSP are similar as:

- No FWUC has been established while informal farmers' groups are formulated headed by commune chief,
- Existing irrigation facilities are highly deteriorated and activities of farmers' group are quite limited in water management and facilities' O&M, and
- Institutional support programs have not been actively carried out by MOWRAM, PDOWRAM and/or other relevant supporting partners.

Above-illustrated approach is, therefore, proposed to be applied for KSBISRSP, MC35RSP, SPWRRSP and DPISRSP in common.

(1) Overall Goal of KSBISRSP

Overall goal of KSBISRSP is "improvement of living standard through increase of farmers' income in KSBISRSP Area."

(2) Objective of Software Components under KSBISRSP

Software components under KSBISRSP aim to, with the support of hardware components by construction and rehabilitation of main and secondary irrigation canal systems and new construction of

tertiary canal system, demonstrate proper water management and to increase rice production in the Kandal Stung Area (1,750 ha) and the Bati Area (1,600 ha) through good harmonization of irrigation, agriculture and institution. Output of software components under KSBISRSP is "establishment of institutional set-up to effectively utilize rehabilitated facilities (well-trained FWUCs with technical know-how in farming at the Kandal Stung and Bati Areas amounting to 3,350 ha in total)."

### II-3.5.4.2 Activities

Out of 3 activities proposed for software components, 2 activities: (i) Capacity Development of MOWRAM hand PDOWRAM Staff on O&M and (ii) Formation and Strengthening of FWUC of KSBISRSP are described as follows:

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

The activities for capacity development of MOWRAM and PDOWRAM staff on O&M under KSBISRSP are proposed as shown in the following table:

**Table II-3.5.4.2.1 Proposed Activities for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (KSBISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Institutional set-up for O&M within MOWRAM and PDOWRAM is established to effectively utilize irrigation facilities at the main level. | |
| **Output**<br>(a) Improvement of technical capability on O&M of MOWRAM and PDOWRAM Staff<br>1) Capability of relevant MOWRAM staff is enhanced in instructing and supporting field level O&M activities of irrigation facilities by PDOWRAM staff<br>2) Capability of PDOWRAM staff is improved in O&M skills for irrigation facilities.<br>(b) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for field activities at the Kandal Stung Area and the Bati Area.<br>1) Support and instruction for PDOWRAM Staff's field activities is carried out timely by MOWRAM.<br>2) Monitoring and instruction to district staff activities are timely carried out by PDOWRAM staff. | |
| **Activity** (4 years)<br>(a) O&M Training (Kandal Stung and Bati Irrigation System: 3,350 ha)<br>1) Water management training for MOWRAM staff: 4 nos. (1 time/year)<br>2) Water management training for PDOWRAM staff: 8 nos. (2 times/year)<br>3) Maintenance training for MOWRAM staff: 4 nos. (1 time/year)<br>4) Maintenance training for PDOWRAM staff: 8 nos. (2 times/year)<br>(b) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- Foreign consultant: 1.5 M/M (O&M Expert)<br>- National consultant: 6 M/M (Irrigation Expert 3 M/M and O&M Expert 3 M/M)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel etc.) |
| **Training Subject**<br>(a) Overall Training Management<br>- Outline of O&M and strengthening of FWUCs<br>- Outline of agriculture support services<br>- O&M of major and minor facilities<br>- FWUC's participation in irrigation system management<br>- Facilitation skills of FWUCs<br>- Coordination among irrigation systems in the basins<br>- Coordination among relevant agencies<br>(b) Major Intake Weir Gate O&M<br>- Gate operation rule including coordination among relevant organizations<br>- Water management of Intake Weirs<br>- Gate maintenance including emergency repair<br>(c) Irrigation O&M<br>- Irrigation planning in the Kandal Stung Extension Area and Bati Area (3,350 ha)<br>- Water management at main and secondary canal level<br>- Maintenance work including repairing at main and secondary level<br>(d) Monitoring and evaluation<br>- Meteo-hydrological data including rainfall, temperature, evaporation, humidity etc. at the KSBISRSP Area<br>- River water level and runoff for the water source | |

| Narrative Summary of Proposed Activities | |
|---|---|
| - Monitoring and evaluation of O&M works at main and secondary level<br>- Monitoring and evaluation of O&M works at secondary and tertiary level by FWUC<br>- Monitoring and evaluation of FWUC activities | |

*Source; JICA Survey Team*

(2) Formation and Strengthening of FWUC

Proposed activities for formation and strengthening of FWUC under KSBISRSP are tabulated as follows:

**Table II-3.5.4.2.2 Proposed Activities for Formation and Strengthening of FWUC (KSBISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- FWUC is established and strengthened in the command area of KSBISRSP to properly carry out O&M of secondary and tertiary level facilities. | |
| **Output**<br>(a) Improvement of technical capability on training management of PDOWRAM staff<br>1) Training management through TOT is understood by PDOWRAM staff.<br>(b) FWUC establishment and strengthening (FWUC: 1 no., FWUG: 17 nos., Sub-FWUG: 67 nos.)<br>1) FWUC is established and registered to cover the Kandal Stung and Bati Areas (3,350 ha).<br>2) Member of FWUC in the Kandal Stung and Bati Areas understand irrigation O&M skills and necessary activities.<br>(c) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for FWUC activities at the Kandal Stung and Bati Areas.<br>1) Support and instruction for PDOWRAM Staff's support activities to FWUC is carried out timely by MOWRAM.<br>2) Monitoring and instruction to FWUC activities are timely carried out by PDOWRAM staff. | |
| **Activity** (7 years)<br>(a) TOT for PDOWRAM staff<br>1) Training to PDOWRAM staff: 7 nos. (1 time/year)<br>(b) Training to FWUC<br>1) Organizational strengthening (awareness raising, organizational management, financial management, conflict resolution etc.): 14 nos. (2 times/year)<br>2) O&M (irrigation plan, water management, maintenance of facilities etc.): 8 nos. (2 times/year)<br>(c) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- National consultant: 42 M/M (Institutional Expert: 6 M/M / year × 7 years)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel, registration etc.) |
| **Training Subject**<br>Target<br>FWUC: 1 no., FWUG: 17 nos., Sub-FWUG: 67 nos.<br>(a) FWUC and its formation<br>- Irrigation plan<br>- FWUC and its objectives and organization<br>- FWUC formation process<br>- Responsibility/duty and right etc. | |
| (b) FWUC management<br>- Formation process of FWUC<br>- Organizational management<br>- Financial management including bank account, cash book, accounting book, ISF, revenue and expense of FWUC<br>- Conflict management<br>- Budgeting<br>(c) O&M of irrigation facilities<br>- Irrigation plan for model area<br>- Water management at secondary, tertiary and water course level<br>- Maintenance work including repair work<br>- Preparation of annual water management schedule<br>- ISF and cost for O&M | |

*Source; JICA Survey Team*

(3) Strengthening of Agricultural Extension Services

Proposed activities for strengthening of Agricultural Extension Services are shown as follows:

**Table II-3.5.4.2.3 Proposed Activities for Strengthening of Agricultural Extension Services (KSBISRSP)**

(a) Kandal Stung Area

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Farmers get better yield of paddy. | |
| **Output**<br>1) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>- Monitoring and evaluation are carried out by PDA and DAO.<br>- Conclusions obtained from monitoring and evaluation are affected to the action plan for the following cropping season.<br>2)Training of farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>3) Periodical Checking and Analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season. | |
| **Activity** (Period: 4 years, refer Table AC-2.3.6.3.3 in ANNEX C)<br>1) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: Foreign consultant in collaboration with national consultant<br>a) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>b) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed.<br>2) Training of Farmers<br>Target: 9 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant<br>c) Field programs<br>- Demonstration plots (Rice): 18 plots<br>- Demonstration plots (Upland Crops): 9 plots<br>- Demonstration plots (Vegetables): 9 plots<br>- Water management: 18 courses<br>d) Farmer/Farmer Group Training Programs<br>- Short-term training course (by topics): 9 courses<br>- FFS/ IPM: 9 courses<br>- Study tour: 9 courses<br>e) Mass guidance / Workshop: 18 courses<br>3) Periodical Checking and Analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>a) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO | **Input**<br>1) 1 Foreign Consultant: 0.25 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>2) 1 National Consultant: 0.85 MM /year (3.40 MM/4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>3) Direct costs (refer Tables AC-2.1.6.3.4 and AC-2.3.6.3.3 in ANNEX C)<br>4) Training materials (refer Attachment-5 in ANNEX C) |
| **Training Subject**<br>1) Training of Trainers<br>- Capacity building on preparation of action plan<br>2) Training of Farmers<br>a) Field programs<br>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG<br>b) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>c) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>3) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation | |

*Source; JICA Survey Team*

(b) Bati Area

| Narrative Summary of Proposed Activities |
|---|
| **Objective**<br>- Farmers get better yield of paddy. |

<table>
<tr><th colspan="2">Narrative Summary of Proposed Activities</th></tr>
<tr><td colspan="2">Output<br>1) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>- Monitoring and evaluation are carried out by PDA and DAO.<br>- Conclusions obtained from monitoring and evaluation are affected to the action plan for the following cropping season.<br>2)Training of farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>3) Periodical Checking and Analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season.</td></tr>
<tr><td>Activity (Period: 4 years, refer Table AC-2.3.6.3.3 in ANNEX C)<br>1) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: Foreign consultant in collaboration with national consultant<br>a) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>b) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed.<br>2) Training of Farmers<br>Target: 8 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant<br>c) Field programs<br>- Demonstration plots (Rice): 16 plots<br>- Demonstration plots (Upland Crops): 8 plots<br>- Demonstration plots (Vegetables): 8 plots<br>- Water management: 16 courses<br>d) Farmer/Farmer Group Training Programs<br>- Short-term training course (by topics): 8 courses<br>- FFS/ IPM: 8 courses<br>- Study tour: 8 courses<br>e) Mass guidance / Workshop: 16 courses<br>3) Periodical Checking and Analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>a) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO</td><td rowspan="4">Input<br>1) 1 Foreign Consultant: 0.25 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>2) 1 National Consultant: 0.85 MM /year (3.40 MM/4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>3) Direct costs (refer Tables AC-2.1.6.3.4 and AC-2.3.6.3.3 in ANNEX C)<br>4) Training materials (refer Attachment-5 in ANNEX C)</td></tr>
<tr><td>Training Subject<br>1) Training of Trainers<br>- Capacity building on preparation of action plan<br>2) Training of Farmers<br>a) Field programs</td></tr>
<tr><td>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG<br>b) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>c) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>3) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation</td></tr>
</table>

*Source; JICA Survey Team*

## II-3.5.5 Software Components under Main Canal 35 Rehabilitation Sub-project

### II-3.5.5.1 Approach

The approach for software components to be applied for MC35RSP is the same as that described in KSBISRSP.

(1) Overall Goal of MC35RSP

Overall goal MC35RSP is "improvement of living standard through increase of farmers' income in MC35RSP Area."

(2) Objective of Software Components under MC35RSP

Objective of software components under MC35RSP is, with the support of hardware components by construction and rehabilitation of main and secondary irrigation systems and new construction of tertiary system, demonstration of proper water management and increase of rice production in the Main Canal 35 System through good harmonization of irrigation, agriculture and institution. Output of software components under MC35RSP is "establishment of institutional set-up to effectively utilize rehabilitated facilities (well-trained FWUCs with technical know-how in farming: 850 ha)."

### II-3.5.5.2 Activities

Among 3 activities proposed for software components, 2 activities: (i) Capacity Development of MOWRAM hand PDOWRAM Staff on O&M and (ii) Formation and Strengthening of FWUC of MC35RSP are described as follows:

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

O&M of rehabilitated reservoir, main and secondary irrigation canal systems and support to FWUC for O&M of tertiary canal systems are the integral tasks by MOWRAM and PDOWRAM. Proposed activities for capacity development of MOWRAM and PDOWRAM staff on O&M under MC35RSP are tabulated as follows:

**Table II-3.5.5.2.1 Proposed Activities for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (MC35RSP)**

<table>
<tr><th colspan="2">Narrative Summary of Proposed Activities</th></tr>
<tr><td colspan="2">Objective<br>- Institutional set-up for O&M within MOWRAM and PDOWRAM is established to effectively utilize irrigation facilities at the main level.</td></tr>
<tr><td colspan="2">Output<br>(a) Improvement of technical capability on O&M of MOWRAM and PDOWRAM Staff<br>1) Capability of relevant MOWRAM staff is enhanced in instructing and supporting field level O&M activities of irrigation facilities by PDOWRAM staff<br>2) Capability of PDOWRAM staff is improved in O&M skills for irrigation facilities.<br>(b) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for field activities at Main Canal 35 System.<br>1) Support and instruction for PDOWRAM Staff's field activities is carried out timely by MOWRAM.<br>2) Monitoring and instruction to district staff activities are timely carried out by PDOWRAM staff.</td></tr>
<tr><td>Activity (4 years)<br>(a) O&M Training (Main Canal 35 System: 850 ha)<br>1) Water management training for MOWRAM staff: 4 nos. (1 time/year)<br>2) Water management training for PDOWRAM staff: 8 nos. (2 times/year)<br>3) Maintenance training for MOWRAM staff: 4 nos. (1 time/year)<br>4) Maintenance training for PDOWRAM staff: 8 nos. (2 times/year)<br>(b) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff<br><br>Training Subject<br>(a) Overall training management<br>- Outline of O&M and strengthening of FWUCs<br>- Outline of agriculture support services<br>- O&M of major and minor facilities<br>- FWUC's participation in irrigation system management<br>- Facilitation skills of FWUCs<br>- Coordination among relevant agencies<br>(b) Major reservoir O&M<br>- Reservoir operation rule including coordination among relevant organizations<br>- Reservoir maintenance including emergency repair</td><td>Input<br>- Foreign consultant: 1.5 M/M (O&M Expert)<br>- National consultant: 6 M/M (Irrigation Expert 3 M/M and O&M Expert 3 M/M)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel etc.)<br>(These inputs cover Kampong Speu, Kandal, Takeo and Kampong Chhnang PDOWRAMs.)</td></tr>
</table>

| Narrative Summary of Proposed Activities | |
|---|---|
| (c) Irrigation O&M<br>- Irrigation planning in Main Canal 35 System (850 ha)<br>- Water management at main and secondary canal level<br>- Maintenance work including repairing at main and secondary canal level<br>(d) Monitoring and evaluation<br>- Meteo-hydrological data including rainfall, temperature, evaporation, humidity etc. at MC35RSP Area<br>- River water level and runoff for the water source<br>- Monitoring and evaluation of O&M works at main and secondary canal level<br>- Monitoring and evaluation of O&M works at secondary and tertiary canal level by FWUC<br>- Monitoring and evaluation of FWUC activities | |

*Source; JICA Survey Team*

(2) Formation and Strengthening of FWUC

As similarly proposed in KSBISRSP, FWUC has not been established under the area of MC35RSP. In order to establish effective O&M set-up at farmers' level, proposed activities for formation and strengthening of FWUC under MC35RSP are tabulated as follows:

**Table II-3.5.5.2.2 Proposed Activities for Formation and Strengthening of FWUC (MC35RSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- FWUC is established and strengthened in the command area of MC35RSP to properly carry out O&M of secondary and tertiary level facilities. | |
| **Output**<br>(a) Improvement of technical capability on Training Management of PDOWRAM staff<br>1) Training management through TOT is understood by PDOWRAM staff.<br>(b) FWUC establishment and strengthening (FWUC: 1 no., FWUG: 6 nos., Sub-FWUG: 20 nos.)<br>1) FWUC is established and registered to cover MC35RSP (850 ha).<br>2) Member of FWUC in Main Canal 35 System Area understand irrigation O&M skills and necessary activities.<br>(c) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for FWUC activities at Main Canal 35 System Area.<br>1) Support and instruction for PDOWRAM Staff's support activities to FWUC is carried out timely by MOWRAM.<br>2) Monitoring and instruction to FWUC activities are timely carried out by PDOWRAM staff. | |
| **Activity** (7 years)<br>(a) TOT for PDOWRAM Staff<br>1) Training to PDOWRAM staff: 7 nos. (1 time/year)<br>(b) Training to FWUC<br>1) Organizational strengthening (awareness raising, organizational management, financial management, conflict resolution etc.): 14 nos. (2 times/year)<br>2) O&M (irrigation plan, water management, maintenance of facilities etc.): 8 nos. (2 times/year)<br>(c) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- National consultant: 21 M/M (Institutional Expert: 3 M/M / year × 7 years)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel, registration etc.) |
| **Training Subject**<br>Target<br>FWUC: 1 no., FWUG: 6 nos., Sub-FWUG: 20 nos.<br>(a) FWUC and its formation<br>- Irrigation plan<br>- FWUC and its objectives and organization<br>- FWUC formation process<br>- Responsibility/duty and right etc.<br>(b) FWUC management<br>- Formation process of FWUC<br>- Organizational management<br>- Financial management including bank account, cash book, accounting book, ISF, revenue and expense of FWUC<br>- Conflict management<br>- Budgeting<br>(c) O&M of irrigation facilities<br>- Irrigation plan for model area<br>- Water management at secondary, tertiary and water course level<br>- Maintenance work including repair work<br>- Preparation of annual water management schedule<br>- ISF and cost for O&M | |

*Source; JICA Survey Team*

(3) Strengthening of Agricultural Extension Services

Proposed activities for strengthening of Agricultural Extension Services are shown as follows:

**Table II-3.5.5.2.3 Proposed Activities for Strengthening of Agricultural Extension Services (MC35RSP)**

<table>
<tr><th colspan="2">Narrative Summary of Proposed Activities</th></tr>
<tr><td colspan="2">Objective<br>- Farmers get better yield of paddy.</td></tr>
<tr><td colspan="2">Output<br>(a) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>- Monitoring and evaluation are carried out by PDA and DAO.<br>- Conclusions obtained from monitoring and evaluation are affected to the action plan for the following cropping season.<br>(b)Training of farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>(c) Periodical Checking and Analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season.</td></tr>
<tr><td>Activity (Period: 4 years, refer Table AC-2.4.6.3.3 in ANNEX C)<br>(a) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: Foreign consultant in collaboration with national consultant<br>1) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>2) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed.<br>(b) Training of Farmers<br>Target: 4 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant<br>1) Field programs<br>- Demonstration plots (Rice): 8 plots<br>- Demonstration plots (Upland Crops): 4 plots<br>- Demonstration plots (Vegetables): 4 plots<br>- Water management: 8 courses<br>2) Farmer/Farmer Group Training Programs<br>- Short-term training course (by topics): 4 courses<br>- FFS/ IPM: 4 courses<br>- Study tour: 4 courses<br>3) Mass guidance / Workshop: 8 courses<br>(c) Periodical Checking and Analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>1) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO</td><td rowspan="2">Input<br>(a) 1 Foreign Consultant: 0.30 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>(b) 1 National Consultant: 0.86 MM /year (3.44 MM/4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>(c) Direct costs (refer Tables AC-2.1.6.3.4 and AC-2.4.6.3.3 in ANNEX C)<br>(d) Training materials (refer Attachment-5 in ANNEX C)</td></tr>
<tr><td>Training Subject<br>(a) Training of Trainers<br>- Capacity building on preparation of action plan<br>(b) Training of Farmers<br>1) Field programs<br>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG<br>2) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>3) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>(c) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation</td></tr>
</table>

*Source; JICA Survey Team*

### II-3.5.6 Software Components under Srass Prambai Water Recession System Rehabilitation Sub-project

#### II-3.5.6.1 Approach

The approach for software components under SPWRRSP is the same as that described in KSBISRSP.

(1) Overall Goal of SPWRRSP

Overall goal SPWRRSP is “improvement of living standard through increase of farmers’ income" in the SPWRRSP Area.”

(2) Objective of Software Components under SPWRRSP

Objective of software components under SPWRRSP is, with the support of hardware components by construction and rehabilitation of reservoir dyke and canal systems, demonstration of proper water management and increase of rice production in Srass Prambai System through good harmonization of irrigation, agriculture and institution. Output of software components under SPWRRSP is “establishment of institutional set-up to effectively utilize rehabilitated facilities (well-trained FWUCs with technical know-how in farming: 1,200 ha).”

#### II-3.5.6.2 Activities

Three activities are proposed for software components under SPPIDRIP, out of which 2 activities: (i) Capacity Development of MOWRAM hand PDOWRAM Staff on O&M and (ii) Formation and Strengthening of FWUC of SPWRRSP are described as follows:

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

Enhancement of relevant government staff is indispensable for effective O&M of SPWRRSP particularly joint operation of rehabilitated reservoir with FWUC. To do so, proposed activities for capacity development of MOWRAM and PDOWRAM staff on O&M under SPWRRSP are tabulated as follows:

**Table II-3.5.6.2.1 Proposed Activities for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (SPWRRSP)**

<table>
<tr><th colspan="2">Narrative Summary of Proposed Activities</th></tr>
<tr><td colspan="2">Objective<br>- Institutional set-up for O&M within MOWRAM and PDOWRAM is established to effectively utilize irrigation facilities at the main level.</td></tr>
<tr><td colspan="2">Output<br>(a) Improvement of technical capability on O&M of MOWRAM and PDOWRAM Staff<br>1) Capability of relevant MOWRAM staff is enhanced in instructing and supporting field level O&M activities of irrigation facilities by PDOWRAM staff<br>2) Capability of PDOWRAM staff is improved in O&M skills for irrigation facilities.<br>(b) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for field activities at Srass Prambai System.<br>1) Support and instruction for PDOWRAM Staff’s field activities is carried out timely by MOWRAM.<br>2) Monitoring and instruction to district staff activities are timely carried out by PDOWRAM staff.</td></tr>
<tr><td>Activity (4 years)<br>(a) O&M Training (Srass Prambai System: 1,200 ha)<br>1) Water management training for MOWRAM staff: 4 nos. (1 time/year)<br>2) Water management training for PDOWRAM staff: 8 nos. (2 times/year)<br>3) Maintenance training for MOWRAM staff: 4 nos. (1 time/year)<br>4) Maintenance training for PDOWRAM staff: 8 nos. (2 times/year)<br>(b) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff<br>Training Subject<br>(a) Overall Training Management<br>- Outline of O&M and strengthening of FWUCs<br>- Outline of agriculture support services</td><td>Input<br>- Foreign consultant: 1.5 M/M (O&M Expert)<br>- National consultant: 6 M/M (Irrigation Expert 3 M/M and O&M Expert 3 M/M)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel etc.)</td></tr>
</table>

| Narrative Summary of Proposed Activities | |
|---|---|
| - O&M of major and minor facilities<br>- FWUC's participation in irrigation system management<br>- Facilitation skills of FWUCs<br>- Coordination among relevant agencies<br>(b) Reservoir O&M<br>- Gate operation rule including coordination among relevant organizations<br>- Water management of Reservoir<br>- Gate maintenance including emergency repair<br>(c) Irrigation O&M<br>- Irrigation planning in Srass Prambai System (1,200 ha)<br>- Water management at canal systems<br>(d) Monitoring and evaluation<br>- Meteo-hydrological data including rainfall, temperature, evaporation, humidity etc.<br>- Reservoir water level and runoff for the water source<br>- Monitoring and evaluation of O&M works at canal systems<br>- Monitoring and evaluation of FWUC activities | |

*Source; JICA Survey Team*

(2) Formation and Strengthening of FWUC

Until now, FWUC has not been organized in SPWRRSP and informal farmers group is in place for executing limited O&M activities. Since SPWRRSP is a water recession system, major activities of FWUC will be focused on reservoir O&M. Proposed activities for formation and strengthening of FWUC under SPWRRSP are tabulated as follows:

**Table II-3.5.6.2.2 Proposed Activities for Formation and Strengthening of FWUC (SPWRRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- FWUC is established and strengthened in the command area of Srass Prambai System to properly carry out O&M of main reservoir and canal systems together with PDOWRAM. | |
| **Output**<br>(a) Improvement of technical capability on Training Management of PDOWRAM staff<br>1) Training management through TOT is understood by PDOWRAM staff.<br>(b) FWUC establishment and strengthening (FWUC: 1 no., FWUG: 5 nos.)<br>1) FWUC is established and registered to cover SPWRRSP Area (1,200 ha).<br>2) Member of FWUC in the SPWRRSP Area understand irrigation O&M skills and necessary activities.<br>(c) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for FWUC activities at the SPWRRSP Area.<br>1) Support and instruction for PDOWRAM Staff's support activities to FWUC is carried out timely by MOWRAM.<br>2) Monitoring and instruction to FWUC activities are timely carried out by PDOWRAM staff. | |
| **Activity** (7 years)<br>(a) TOT for PDOWRAM Staff<br>1) Training to PDOWRAM staff: 7 nos. (1 time/year)<br>(b) Training to FWUC<br>1) Organizational strengthening (awareness raising, organizational management, financial management, conflict resolution etc.): 14 nos. (2 times/year)<br>2) O&M (irrigation plan, water management, maintenance of facilities etc.): 8 nos. (2 times/year)<br>(c) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- National consultant: 21 M/M (Institutional Expert: 3 M/M / year × 7 years)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel, registration etc.) |
| **Training Subject**<br>Target<br>FWUC: 1 no., FWUG: 5 nos. (no sub-FWUG will be developed.)<br>(a) FWUC and its formation<br>- Irrigation plan<br>- FWUC and its objectives and organization<br>- FWUC formation process<br>- Responsibility/duty and right etc.<br>(b) FWUC management<br>- Formation process of FWUC<br>- Organizational management<br>- Financial management including bank account, cash book, accounting book, ISF, revenue and expense of FWUC<br>- Conflict management<br>- Budgeting | |

| Narrative Summary of Proposed Activities | |
|---|---|
| (c) O&M of irrigation facilities<br>- Irrigation plan for model area<br>- Water management at main reservoir with the support of PDOWRAM<br>- Water management at canal systems<br>- Maintenance work including repair work<br>- Preparation of annual water management schedule<br>- ISF and cost for O&M | |

*Source; JICA Survey Team*

## (3) Strengthening of Agricultural Extension Services

Proposed activities for strengthening of Agricultural Extension Services are shown as follows:

**Table II-3.5.6.2.3 Proposed Activities for Strengthening of Agricultural Extension Services (SPWRRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Farmers get better yield of paddy. | |
| **Output**<br>(a) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>- Monitoring and evaluation are carried out by PDA and DAO.<br>- Conclusions obtained from monitoring and evaluation are affected to the action plan for the following cropping season.<br>(b)Training of farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>(c) Periodical Checking and Analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season. | |
| **Activity** (Period: 4 years, refer Table AC-2.5.6.3.3 in ANNEX C)<br>(a) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: Foreign consultant in collaboration with national consultant<br>1) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>2) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed. | **Input**<br>(a) 1 Foreign Consultant: 0.30 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>(b) 1 National Consultant: 0.86 MM /year (3.44 MM/4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>(c) Direct costs (refer Tables AC-2.1.6.3.4 and AC-2.5.6.3.3 in ANNEX C)<br>(d) Training materials (refer Attachment-5 in ANNEX C) |
| (b) Training of Farmers<br>Target: 6 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant<br>1) Field programs<br>- Demonstration plots (Rice): 12 plots<br>- Demonstration plots (Upland Crops): 6 plots<br>- Demonstration plots (Vegetables): 6 plots<br>- Water management: 12 courses<br>2) Farmer/Farmer Group Training Programs<br>- Short-term training course (by topics): 6 courses<br>- FFS/ IPM: 6 courses<br>- Study tour: 6 courses<br>3) Mass guidance / Workshop: 12 courses<br>(c) Periodical Checking and Analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>1) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO | |
| **Training Subject**<br>(a) Training of Trainers<br>- Capacity building on preparation of action plan<br>(b) Training of Farmers<br>1) Field programs<br>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG | |

| Narrative Summary of Proposed Activities | |
|---|---|
| 2) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>3) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>(c) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation | |

*Source; JICA Survey Team*

### II-3.5.7 Software Components under Daun Pue Irrigation System Rehabilitation Sub-project

#### II-3.5.7.1 Approach

The approach for software components to be applied for DPISRSP is the same as that described in KSBISRSP.

(1) Overall Goal of DPISRSP

Overall goal DPISRSP is "improvement of living standard through increase of farmers' income in DPISRSP Area."

(2) Objective of Software Components under DPISRSP

Software components under DPISRSP aim to, with the support of hardware components by construction and rehabilitation of weir, main & secondary systems and new construction of tertiary system, demonstrate proper water management and increase rice production in Daun Pue Irrigation System through good harmonization of irrigation, agriculture and institution. Output of software components under DPISRSP is "establishment of institutional set-up to effectively utilize rehabilitated facilities (well-trained FWUCs with technical know-how in farming: 1,150 ha)."

#### II-3.5.7.2 Activities

In SPPIDRIP, among 3 activities proposed for software components, 2 activities: (i) Capacity Development of MOWRAM hand PDOWRAM Staff on O&M and (ii) Formation and Strengthening of FWUC of DPISRSP are described as follows:

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

Major activities of MOWRAM and PDOWRAM are O&M of rehabilitated facilities consisting of headworks, main and secondary canal systems of Daun Pue Irrigation system. In order for relevant staff to perform such important tasks, proposed activities for capacity development of MOWRAM and PDOWRAM staff on O&M under DPISRSP are tabulated as follows:

**Table II-3.5.7.2.1 Proposed Activities for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (DPISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Institutional set-up for O&M within MOWRAM and PDOWRAM is established to effectively utilize irrigation facilities at the main canal level. | |
| **Output**<br>(a) Improvement of technical capability on O&M of MOWRAM and PDOWRAM Staff<br>1) Capability of relevant MOWRAM staff is enhanced in instructing and supporting field level O&M activities of irrigation facilities by PDOWRAM staff<br>2) Capability of PDOWRAM staff is improved in O&M skills for irrigation facilities.<br>(b) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for field activities at Daun Pue Irrigation System.<br>1) Support and instruction for PDOWRAM Staff's field activities is carried out timely by MOWRAM.<br>2) Monitoring and instruction to district staff activities are timely carried out by PDOWRAM staff. | |
| **Activity** (4 years)<br>(a) O&M Training (Daun Pue Irrigation System: 1,150 ha)<br>1) Water management training for MOWRAM staff: 4 nos. (1 time/year) | **Input**<br>- Foreign consultant: 1.5 M/M (O&M |

| Narrative Summary of Proposed Activities | |
|---|---|
| | Expert)<br>- National consultant: 6 M/M (Irrigation Expert 3 M/M and O&M Expert 3 M/M)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel etc.) |
| 2) Water management training for PDOWRAM staff: 8 nos. (2 times/year)<br>3) Maintenance training for MOWRAM staff: 4 nos. (1 time/year)<br>4) Maintenance training for PDOWRAM staff: 8 nos. (2 times/year)<br>(b) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | |
| **Training Subject**<br>(a) Overall Training Management<br>- Outline of O&M and strengthening of FWUCs<br>- Outline of agriculture support services<br>- O&M of major and minor facilities<br>- FWUC's participation in irrigation system management<br>- Facilitation skills of FWUCs<br>- Coordination among relevant agencies<br>(b) Major Intake Weir Gate O&M<br>- Gate operation rule including coordination among relevant organizations<br>- Water management of Intake Weirs<br>- Gate maintenance including emergency repair<br>(c) Irrigation O&M<br>- Irrigation planning in Daun Pue System (1,150 ha)<br>- Water management at main and secondary canal level<br>- Maintenance work including repairing at main and secondary level<br>(d) Monitoring and evaluation<br>- Meteo-hydrological data including rainfall, temperature, evaporation, humidity etc.<br>- River water level and runoff for the water source<br>- Monitoring and evaluation of O&M works at main and secondary level<br>- Monitoring and evaluation of O&M works at secondary and tertiary level by FWUC<br>- Monitoring and evaluation of FWUC activities | |

*Source; JICA Survey Team*

(2) Formation and Strengthening of FWUC

No FWUC has been established instead informal farmers' group is currently organized. However, their activities for O&M of irrigation facilities are quite limited. Proposed activities for formation and strengthening of FWUC under DPISRSP are tabulated as follows:

**Table II-3.5.7.2.2 Proposed Activities for Formation and Strengthening of FWUC (DPISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- FWUC is established and strengthened in the command area of Daun Pue Irrigation System to properly carry out O&M of secondary and tertiary level facilities. | |
| **Output**<br>(a) Improvement of technical capability on Training Management of PDOWRAM staff<br>1) Training management through TOT is understood by PDOWRAM staff.<br>(b) FWUC establishment and strengthening (FWUC: 1 no., FWUG: 4 nos., Sub-FWUG: 23 nos.)<br>1) FWUC is established and registered to cover the DPISRSP Area (1,150 ha).<br>2) Member of FWUC in the DPISRSP Area understands irrigation O&M skills and necessary activities.<br>(c) Monitoring and evaluation is properly carried out by MOWRAM and PDOWRAM staff for FWUC activities at Daun Pue Irrigation System Area.<br>1) Support and instruction for PDOWRAM Staff's support activities to FWUC is carried out timely by MOWRAM.<br>2) Monitoring and instruction to FWUC activities are timely carried out by PDOWRAM staff. | |
| **Activity** (7 years)<br>(a) TOT for PDOWRAM Staff<br>1) Training to PDOWRAM staff: 7 nos. (1 time/year)<br>(b) Training to FWUC<br>1) Organizational strengthening (awareness raising, organizational management, financial management, conflict resolution etc.): 14 nos. (2 times/year)<br>2) O&M (irrigation plan, water management, maintenance of facilities etc.): 8 nos. (2 times/year)<br>(c) Monitoring and Evaluation<br>1) Monitoring and evaluation of field activities by MOWRAM staff<br>2) Monitoring and evaluation of field activities by PDOWRAM staff | **Input**<br>- National consultant: 21 M/M (Institutional Expert: 3 M/M / year × 7 years)<br>- Vehicle<br>- Training materials<br>- Monitoring cost<br>- Other direct cost (allowance for participants, fuel, registration etc.) |

| Narrative Summary of Proposed Activities | |
|---|---|
| **Training Subject**<br>Target<br>FWUC: 1 no., FWUG: 4 nos., Sub-FWUG: 23 nos.<br>(a) FWUC and its formation<br>- Irrigation plan<br>- FWUC and its objectives and organization<br>- FWUC formation process<br>- Responsibility/duty and right etc.<br>(b) FWUC management<br>- Formation process of FWUC<br>- Organizational management<br>- Financial management including bank account, cash book, accounting book, ISF, revenue and expense of FWUC<br>- Conflict management<br>- Budgeting<br>(c) O&M of irrigation facilities<br>- Irrigation plan for model area<br>- Water management at secondary, tertiary and water course level<br>- Maintenance work including repair work<br>- Preparation of annual water management schedule<br>- ISF and cost for O&M | |

*Source; JICA Survey Team*

## (3) Strengthening of Agricultural Extension Services

Proposed activities for strengthening of Agricultural Extension Services are shown as follows:

**Table II-3.5.7.2.3 Proposed Activities for Strengthening of Agricultural Extension Services (DPISRSP)**

| Narrative Summary of Proposed Activities | |
|---|---|
| **Objective**<br>- Farmers get better yield of paddy. | |
| **Output**<br>(a) Training of Trainers<br>- Action plan is prepared by staff of PDA and DAO.<br>- Monitoring and evaluation are carried out by PDA and DAO.<br>- Conclusions obtained from monitoring and evaluation are affected to the action plan for the following cropping season.<br>(b)Training of farmers<br>- Farmers understand promising farming practices for paddy, upland crops, and vegetables.<br>- Farmers try to improve their own practices.<br>- Proper water management is carried out by FWUGs.<br>(c) Periodical Checking and Analysis<br>- Checking and analysis are carried out by PDA and DAO themselves.<br>- Conclusions to be obtained from checking and analysis are fed back to the action plan for the following cropping season. | |
| **Activity** (Period: 4 years, refer Table AC-2.6.6.3.3 in ANNEX C)<br>(a) Training of Trainers<br>Target: Extension staff of PDA and DAO<br>Executed by: Foreign consultant in collaboration with national consultant<br>1) Training on preparatory work by foreign and national consultants (1 time per year, 4 times per 4 years)<br>- Preparation of annual action plan<br>- Preparation of hand-outs, guidelines, etc., based on the previous materials<br>2) Periodical assistance by national consultant<br>- Assistance work for training of farmers could be done.<br>- Activities of PDA and DAO could be checked and analyzed.<br>(b) Training of Farmers<br>Target: 6 FWUGs<br>Executed by: Staff of PDA and DAO<br>Assisted by: National consultant<br>1) Field programs<br>- Demonstration plots (Rice): 12 plots<br>- Demonstration plots (Upland Crops): 6 plots<br>- Demonstration plots (Vegetables): 6 plots<br>- Water management: 12 courses<br>2) Farmer/Farmer Group Training Programs<br>- Short-term training course (by topics): 6 courses<br>- FFS/ IPM: 6 courses<br>- Study tour: 6 courses<br>3) Mass guidance / Workshop: 12 courses | **Input**<br>(a) 1 Foreign Consultant: 0.30 MM<br>- Training of trainers on preparation of annual action plan in the 1st year<br>(b) 1 National Consultant: 0.86 MM /year (3.44 MM/4 years)<br>- Training of trainers for 4 years<br>- Assistance on training of farmers for 4 years<br>- Periodical checking and analysis<br>(c) Direct costs (refer Tables AC-2.1.6.3.4 and AC-2.6.6.3.3 in ANNEX C)<br>(d) Training materials (refer Attachment-5 in ANNEX C) |

| Narrative Summary of Proposed Activities | |
|---|---|
| (c) Periodical Checking and Analysis<br>Target: Extension staff of PDA and DAO<br>Executed by: National consultant<br>1) Checking and analysis of work progress and performance on training of farmers to be carried out by extension staff of PDA and DAO | |
| **Training Subject**<br>(a) Training of Trainers<br>- Capacity building on preparation of action plan,<br>(b) Training of Farmers<br>1) Field programs<br>- Implementation of demonstration plots and dissemination of proposed farming practices<br>- Daily water control and strengthening community in each FWUG<br>2) Farmer/Farmer Group Training Programs<br>- Introduction of proposed farming practices as well as useful information<br>3) Mass guidance / Workshop<br>- Motivation on improvement of agricultural activity<br>(c) Periodical Checking and Analysis<br>- Capacity building on monitoring and evaluation | |

*Source; JICA Survey Team*

## II-3.6 Technical Assistance

### II-3.6.1 Demarcation of Services

The technical assistance consists of 2 services. One is the services by technical consultant consisting of foreign consultant and national consultant and the other is the services by MOWRAM. The demarcation of these services is tabulated below:

**Table II-3.6.1.1 Demarcation of Services by Foreign Consultant and MOWRAM**

| Services by Technical Consultant | Services by MOWRAM |
|---|---|
| - Review of previous studies<br>- Preparation of definitive development plan<br>- Execution of additional survey<br>- Detailed design for large scale structures and major canal system<br>- Preparation of prequalification documents and tender documents for construction<br>- Execution of prequalification and tender evaluations for construction | - Development of tertiary canal system by employing national consultants<br>- Formation and strengthening of FWUCs by PDOWRAM trained under TOT system<br>- Strengthening of agricultural extension services by PDA trained under coordination by MOWRAM |
| - Construction supervision for large scale structures and major canal system<br>- Capacity development of MOWRAM and PDOWRAM staff on O&M<br>- Capacity development of PDA staff on agricultural extension services<br>- Preparation of relevant reports | |

*Nate: As mentioned above, Technical Consultant consists of foreign consultant and national consultant to be in charge of D/D and C/S of large scale structures and major canal systems and capacity development of MOWRAM and PDOWRAM staff on O&M.*

*Source: JICA Survey Team*

### II-3.6.2 Purpose

The technical assistance is divided into 2 concepts; task concept and assistance concept. The technical assistance has therefore different purpose for respective concepts so as to accomplish the project object. Under task concept, the purpose of technical assistance is to execute the works for PMU Japan Support Fund. On the other hand, that under assistant concept is to advise and support PMU Japan Support Fund, an overall project management organization, in construction supervision and software components.

### II-3.6.3 Outline of Consulting Services

Outline of consulting services under task concept and assistant concept is tabulated below:

**Table II-3.6.3.1 Outline of Consulting Services**

| Concept | Description | |
|---|---|---|
| Task concept | All Stages | - Overall project management, monitoring and coordination among MOWRAM, PDOWRAM. PDA and other agencies concerned |
| | Detailed Design Stage | - Review of previous studies<br>- Preparation of definitive development plan<br>- Detailed design<br>- Prequalification and tender documents<br>- Preparation of reports |
| | Construction Stage | - Quality control<br>- Progress control<br>- Quantity control<br>- Safety control<br>- Capacity development for MOWRAM and PDOWRAM staff on O&M<br>- Preparation of reports |
| Assistant Concept | All Stages | - To assist and advise PMU and PIUs in preparation of implementation schedule |
| | Detailed Design Stage | - To assist and advise PMU and PIUs in holding public consultation meeting |
| | Construction Stage | - To assist and advise PMU in prequalification and tender evaluation works<br>- To assist and advise PMU in issuing variation order<br>- To assist and advise PMU in settling contractors' claims |

*Source: JICA Survey Team*

## II-3.6.4 Scope of Consulting Services

Scope of consulting services is shown based on a kind of works as follows;

**Table II-3.6.4.1 Scope of Consulting Services**

| Works | Task Concept | Assistant Concept |
|---|---|---|
| Overall Project Management | - To execute overall project management, monitoring and coordination among MOWRAM, PDOWRAM, JICA, and other agencies concerned for the purpose of smooth implementation of the Project,<br>- To monitor, evaluate and individually authorize tender process, contracts, physical and financial progress, and to prepare a regular progress report, and<br>- To monitor and individually authorize the disbursement of fund and collate those data. | - To assist and advise project director and national project manager at PMU and provincial project manager at PIUs of each Province in preparation of implementation schedule of Sub-projects and annual budget arrangement, ,<br>- To assist and advise PMUs in preparation of implementation schedule of sub-projects and annual budget arrangement,<br>- To assist and advise PMU and PIUs in organizing and operating PIU Coordination Committee, and<br>- To assist and advise PMU and PIUs in coordination with PDA on strengthening of agricultural extension services. |
| Detailed Design | - To review the previous studies,<br>- To prepare definitive development plan,<br>- To prepare design criteria,<br>- To prepare detailed topographic maps for large-scaled structure sites,<br>- To execute additional soil mechanical survey,<br>- To make route survey for major canals,<br>- To make construction material survey,<br>- To make detailed design of irrigation and drainage facilities including preparation of detailed drawings,<br>- To review the existing environmental studies,<br>- To estimate work quantities, unit cost and construction cost,<br>- To prepare construction schedule including construction packages,<br>- To prepare prequalification and tender documents<br>- To prepare the reports including progress report, design report and service completion report | - To assist and advise PMU and PIUs in holding public consultation meeting for project implementation and O&M |

| Works | Task Concept | Assistant Concept |
|---|---|---|
| Construction | - To carry out construction supervision of construction works for the Sub-projects for the following items to the extent of such powers that will be delegated to the Consultant by the national project manager of PMU:<br>- To prepare the quality control manuals for earth works, concrete works, stone works and other important construction works and to apply such manual for quality control in the field,<br>- To check and approve construction drawings and shop drawings to be prepared by the contractor,<br>- To check and approve the setting-out lines and levels, and control points established by the contractor,<br>- To check and approve the construction plan proposed by the contractor which includes construction materials, equipment arrangement, construction method, labor arrangement and other related matters required for the works,<br>- To supervise field tests, sampling and laboratory tests to be carried out by the contractor,<br>- To inspect the construction method, equipment use, workmanship at the site, and to attend shop inspection and manufacturing test in accordance with the technical specifications,<br>- To issue a site instruction or other instruction to the contractor, as the necessity arises, on the way of clarification of construction drawings and technical specifications, and the construction supervision,<br>- To attend the regular meetings to check and confirm the construction method, work performance, work progress, status of equipment and materials, work schedule, and problems to be solved,<br>- To survey and measure the work output performed by the contractor,<br>- To check and certify the advance payment and progress payment claimed by the contractor for approval of the project manager of sub-project,<br>- To keep proper records necessary for preparation of the project completion report,<br>- To check as-built drawings prepared by the contractor,<br>- To perform the final inspection of the works together with the sub-project office and recommend to issue the completion certificate, and<br>- To prepare O&M manual for each Sub-project. | - To assist and advise PMU in pre-qualification of construction firms,<br>- To assist and advise PMU in tendering of construction firms,<br>- To assist and advise in modifying original detailed designs, technical specifications and drawings, related calculation and cost estimate as the necessity arises in accordance with the actual site condition,<br>- To assist and advise in issuing variation order, and<br>- To assist and advise in settlement of the contractor's claim and disputes on the basis of the analysis of the Consultant hereof in accordance with the civil work contract. |
| Capacity Development of MOWRAM and PDOWRAM on O&M | - To prepare working plan for each Sub-project<br>- To make training and lecture to MOWRAM and PDOWRAM staff based on O&M Manual for each Sub-project<br>- Arrangement of attendance as seminar and/or lecture to be executed by TSC | - To assist MOWRAM and PDOWRAM in execution of working plan on O&M<br>- To assist MOWRAM and PDOWRAM in M&E works |
| Establishment and Strengthening of FWUCs | | - To assist MOWRAM and PDOWRAM in establishment and strengthening of FWUCs |
| Strengthening of Agricultural Extension Services | | - To assist PDA in execution of agricultural extension services |
| Financial Management | | - To assist in PMU Japan Support Fund in necessary administrative works for software components under special account. |

*Source: JICA Survey Team*

### II-3.6.5 Necessary Inputs of Consulting Services

Technical Consultant consists of foreign consultant and national consultant in different special fields for smooth implementation of SPPIDRIP through support to PMU Japan Support Fund. Approximate man-months necessary for the implementation of SPPIDRIP are (i) 188 M/M for foreign consultant and (ii) 1,030 M/M for national consultant as mentioned in Table II-3.6.5.1. In Figure II-3.6.5.1, these inputs of consulting services are worked out taking due into consideration (i) maximum use of national consultants, (ii) scattered location of 6 Sub-projects, and (iii) scope of project works, and in the light of implementation plan of SPPIDRIP.

**Table II-3.6.5.1 Approximate Man-Months Required for Consulting Services**

| No. | Item | Foreign Consultant (M/M) | National Consultant (M/M) |
|---|---|---|---|
| (1) | Hardware Components | | |
| | Detailed Design for Major Structures | 75.0 | 130.0 |
| | Construction Supervision for Major Structures | 102.0 | 428.0 |
| | Development of tertiary canal system | - | 258.0 |
| | Sub-total | 177.0 | 816.0 |
| (2) | Software Components | | |
| | Capacity Development for MOWRAM and PDOWRAM Staff on O&M | 9.0 | 36.0 |
| | Establishment and Strengthening of FWUCs | - | 126.0 |
| | Strengthening of Agricultural Extension Services | 2.0 | 24.0 |
| | Financial Management | - | 28.0 |
| | Sub-total | 11.0 | 214.0 |
| (3) | Total | 188.0 | 1,030.0 |

*Source: JICA Survey Team*

The man-months of foreign consultant and national consultants mentioned above are further discussed as follows:

(1) Detailed Design Stage

The services period for D/D would be 1.5 years including mapping, topographic survey for main and secondary canals and major related structures and geological investigation for headworks. The assignment of foreign consultant and national consultant in design works is in principle determined based on the following considerations:

- Team Leader is periodically assigned only.
- Foreign Senior Design Engineer 1 will be in charge of control of all design works, especially 2 headworks together with 2 National Design Engineers.
- Foreign Senior Design Engineer 2 will be in charge of design works for 3 Sub-projects such as USISRSP, KSBISRSP and MC35RSP, together with 5 National Design Engineers.
- Foreign Senior Design Engineer 3 will be engaging in design works for 3 Sub-projects such as RCHRSP, SPWRRSP and DPISRSP together with 3 National Design Engineers.
- One National Design Engineer will be in charge of design works for SPWRRSP and MC35RSP.
- Other foreign consultants assigned for specific fields will execute their duties independently.

Terms of reference for respective experts assigned are as follows:

**Table II-3.6.5.2 Terms of Reference of Consultant Staff for Detailed Design**

| Position | M/M | Terms of Reference |
|---|---|---|
| **Foreign Consultant** | | |
| (a) Team Leader | 6 | Three times visiting (2 M/M for each) is planned, say beginning time, middle time and end time for the following duties:<br>- Preparation of working plan and execution of administrative works<br>- Check of work progress and modification of work plan if necessary<br>- Check of products and administrative works |

| Position | M/M | Terms of Reference |
|---|---|---|
| | | - Preparation of service completion report |
| (b) Hydrologist | 2 | - Investigate of water sources and clarification of current progress of each project<br>- Execute of water balance study for Prek Thnot River Basin<br>- Preparation of technical report |
| (c) Senior Design Engineer 1 | 18 | - Overall control of detailed design works<br>- Preparation of design criteria<br>- Site investigation for headworks (RCHRSP and DPISRSP)<br>- Detailed design of headworks (RCHRSP and DPISRSP) including hydraulic calculation and structural calculation<br>- Control of Design Engineers 1 and 2<br>- Preparation of progress report<br>- Preparation of design report<br>- Preparation of tender drawings for headworks (RCHRSP and DPISRSP) |
| (d) Senior Design Engineer 2 | 16 | - Detailed design of main and secondary canal systems for USISRSP, KSBISRSP and MC35RSP including hydraulic calculation and structural calculation<br>- Control of Design Engineers 3,4, 5, 6 and 9<br>- Preparation of progress report<br>- Preparation of design report<br>- Preparation of tender drawings for main and secondary canal systems for USISRSP, KSBISRSP and MC35RSP |
| (e) Senior Design Engineer 3 | 12 | - Detailed design of main and secondary canal systems for RCHRSP, SPWRRSP and DPISRSP including hydraulic calculation and structural calculation<br>- Control of Design Engineers 7, 8 and 9<br>- Preparation of progress report<br>- Preparation of design report<br>- Preparation of tender drawings for main and secondary canal systems for RCHRSP, SPWRRSP and DPISRSP |
| (f) Geodetic Engineer | 4 | - Preparation of contract documents for mapping and topographic survey for 6 Sub-projects<br>- Supervision of mapping and topographic survey for 6 Sub-projects<br>- Check of products for 6 Sub-projects |
| (g) Gate Engineer | 3 | - Preparation of pro-to-type drawings for large gates for RCHRSP and DPISRSP<br>- Preparation of pro-to-type drawings for small gates for 6 Sub-projects<br>- Preparation of technical specifications for gates<br>- Preparation of technical report<br>- Preparation of progress report |
| (h) Soil Mechanical Engineer | 2 | - Investigation of soil conditions for 6 Sub-projects<br>- Supervision of soil mechanical test<br>- Determination of borrowed areas for 6 Sub-projects<br>- Preparation of technical report<br>- Preparation of progress report |
| (i) Pump Engineer | 1 | - Preparation of pro-to-type drawings for pumps for KSBISRSP<br>- Preparation of detailed drawing for pump house<br>- Preparation of technical specifications for pumps<br>- Preparation of technical report<br>- Preparation of progress report |
| (j) Cost Estimator | 2 | - Arrangement of work quantities for 6 Sub-projects<br>- Execution of unit price analysis<br>- Cost estimate for 6 Sub-projects<br>- Preparation of technical report<br>- Preparation of progress report |
| (k) Specification Writer | 2 | - Preparation of tender documents for 2 construction packages |
| **National Consultant** | | |
| (a) Design Engineer 1 | 6 | - Site investigation with Senior Design Engineer 1<br>- Design of headworks for RCHRSP including hydraulic calculation and structural calculation under control of Senior Design Engineer 1<br>- Work volume estimate<br>- Preparation of tender drawings for headworks for RCHRSP |
| (b) Design Engineer 2 | 6 | - Site investigation with Senior Design Engineer 1<br>- Design of headworks for DPISRSP including hydraulic calculation and structural calculation under control of Senior Design Engineer 1<br>- Work volume estimate<br>- Preparation of tender drawings for headworks for DPISRSP |
| (c) Design Engineer 3 | 16 | - Site investigation with Senior Design Engineer 2<br>- Detailed design of main and secondary canal systems for USISRSP including hydraulic calculation and structural calculation<br>- Work volume estimate |

| Position | M/M | Terms of Reference |
|---|---|---|
| | | - Preparation of tender drawings for headworks for USISRSP |
| (d) Design Engineer 4 | 16 | - Site investigation with Senior Design Engineer 2<br>- Detailed design of main and secondary canal systems for USISRSP including hydraulic calculation and structural calculation<br>- Work volume estimate<br>- Preparation of tender drawings for main and secondary canal systems for USISRSP |
| (e) Design Engineer 5 | 16 | - Site investigation with Senior Design Engineer 2<br>- Detailed design of main and secondary canal systems for KSBISRSP including hydraulic calculation and structural calculation<br>- Work volume estimate<br>- Preparation of tender drawings for main and secondary canal systems for KSBISRSP |
| (f) Design Engineer 6 | 16 | - Site investigation with Senior Design Engineer 2<br>- Detailed design of main and secondary canal systems for KSBISRSP including hydraulic calculation and structural calculation<br>- Work volume estimate<br>- Preparation of tender drawings for main and secondary canal systems for KSBISRSP |
| (g) Design Engineer 7 | 16 | - Site investigation with Senior Design Engineer 2<br>- Detailed design of main and secondary canal systems for RCHRSP including hydraulic calculation and structural calculation<br>- Work volume estimate<br>- Preparation of tender drawings for main and secondary canal systems for RCHRSP |
| (h) Design Engineer 8 | 16 | - Site investigation with Senior Design Engineer 2<br>- Detailed design of main and secondary canal systems for DPISRSP including hydraulic calculation and structural calculation<br>- Work volume estimate<br>- Preparation of tender drawings for main and secondary canal systems for DPISRSP |
| (i) Design Engineer 9 | 16 | - Site investigation with Senior Design Engineer 2 and 3<br>- Detailed design of main and secondary canal systems for MC35RSP and reservoir for SPWRRSP including hydraulic calculation and structural calculation<br>- Work volume estimate<br>- Preparation of tender drawings for main and secondary canal systems for MC35RSP and reservoir for SPWRRSP |

*Source: JICA Survey Team*

(2) Construction Stage

The services period for construction supervision would be 4.0 years from mid.2016 to mid. 2020. The assignment of foreign consultant and national consultant in construction supervision is decided based on the following considerations:

- One foreign consultant should be at least assigned during construction supervision time to sign the monthly itemized statement.
- Team Leader is periodically assigned only.
- Foreign Senior Construction Engineer 1 is in charge of control of construction supervision works, especially headworks together with one National Construction Engineer and 2 National Construction Assistants.
- Foreign Construction Engineer who is assigned for the dry season only, supervise constriction works for main and secondary canal system for 6 Sub-project, together with 3 National Construction Engineers and 5 National Construction Assistants.
- Foreign Senior Design Engineer will be periodically assigned to cope with design modification during construction time.
- Other Foreign Consultants for specific fields such as gates, pumps and soil mechanics are assigned as short term experts

Terms of reference for respective experts assigned are as follows:

**Table II-3.6.5.3 Terms of Reference of Consultant Staff for Construction Supervision**

| Position | M/M | Terms of Reference |
|---|---|---|
| **Foreign Consultant** | | |
| (a) Team Leader | 10 | Eight times visiting is planned, including tender evaluation work.<br>- Execution of evaluation of ICB tendering<br>- Preparation of tender evaluation report<br>- Determination of administrative staff<br>- Establishment of consultant office<br>- Settlement of problems encountered if any<br>- Preparation of service completion report<br>- Preparation of completion report |
| (b) Senior Construction Engineer | 43 | - Management of all foreign and national consultants<br>- Supervision of all construction works, especially headworks together with one National Construction Engineer and 2 National Construction Assistants<br>- Check of working drawings to be prepared by contractors<br>- Attendance at tripartite progress meeting among MOWRAM, Consultant and Contractors<br>- Assistance in management of claims from contractor<br>- Check and sign of itemized statement<br>- Preparation of official letters related to construction works<br>- Preparation of progress report<br>- Preparation of completion report |
| (c) Construction Engineer | 24 | - Supervision of construction works for especially main and secondary canal systems of 6 Sub-projects together with 3National Construction Engineer and 5 National Construction Assistants<br>- Check of related working drawings to be prepared by contractors<br>- Attendance at tripartite progress meeting among MOWRAM, Consultant and Contractors<br>- Preparation of official letters related to construction works<br>- Preparation of progress report |
| (d) Senior Design Engineer 1 | 24 | - Modification of detailed drawings during construction time<br>- Check of working drawings to be prepared by contractors<br>- Preparation of progress report |
| (e) Gate Engineer | 12 | - Inspection of gate factory<br>- Check of shop drawings<br>- Inspection of gates delivered<br>- Supervision of installation of gates<br>- Execution of test run<br>- Preparation of operation manual of gates |
| (f) Pump Engineer | 2 | - Inspection of gate factory<br>- Check of shop drawings<br>- Inspection of gates delivered<br>- Supervision of installation of gates<br>- Execution of test run<br>- Preparation of operation manual of gates |
| **National Consultant** | | |
| (a) Design Engineer 1 | 18 | - Modification of detailed drawings for headworks during construction time under direction of Senior Construction Engineer and Senior Design Engineer<br>- Check of working drawings to be prepared by contractors under direction of Senior Construction Engineer and Senior Design Engineer |
| (b) Design Engineer 3 | 56 | - Modification of detailed drawings for main and secondary canal systems for RCHRSP, DPISRSP, MC35RSP during construction time under direction of Senior Construction Engineer and Senior Design Engineer<br>- Check of working drawings to be prepared by contractors under direction of Senior Construction Engineer and Senior Design Engineer |
| (c) Design Engineer 4 | 56 | - Modification of detailed drawings for main and secondary canal systems for USISRSP, KSBISRSP and SPWRRSP during construction time under direction of Senior Construction Engineer and Senior Design Engineer<br>- Check of working drawings to be prepared by contractors under direction of Senior Construction Engineer and Senior Design Engineer |
| (d) Construction Engineer 1 | 30 | - Supervision of construction for headworks for RCHRSP and DPISRSP under direction of Foreign Senior Construction Engineer<br>- Record of quality control, progress control and quantity control by supervising 2 National Construction Assistants<br>- Attendance at tripartite progress meeting among MOWRAM, Consultant and Contractors |

| Position | M/M | Terms of Reference |
|---|---|---|
| (e) Construction Engineer 2 | 34 | - Supervision of construction for main and secondary canal systems for RCHRSP and DPISRSP under direction of Foreign Senior Construction Engineer<br>- Record of quality control, progress control and quantity control by supervising 2 National Construction Assistants<br>- Attendance at tripartite progress meeting among MOWRAM, Consultant and Contractors |
| (f) Construction Engineer 3 | 34 | - Supervision of construction for main and secondary canal systems for USISRSP and reservoir for SPWRRSP under direction of Foreign Senior Construction Engineer<br>- Record of quality control, progress control and quantity control by supervising 2 National Construction Assistants<br>- Attendance at tripartite progress meeting among MOWRAM, Consultant and Contractors |
| (g) Construction Engineer 4 | 34 | - Supervision of construction for main and secondary canal systems for KSBISRSP and MC35RSP under direction of Foreign Senior Construction Engineer<br>- Record of quality control, progress control and quantity control by supervising 2 National Construction Assistants<br>- Attendance at tripartite progress meeting among MOWRAM, Consultant and Contractors |
| (h) Construction Assistant 1 | 18 | - Execution of quality control for Headworks for RCHRSP under direction of National Construction Engineer 1<br>- Execution of quantity control for Headworks for RCHRSP under direction of National Construction Engineer 1<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |
| (i) Construction Assistant 2 | 18 | - Execution of quality control for Headworks for DPISRSP under direction of National Construction Engineer 1<br>- Execution of quantity control for Headworks for DPISRSP under direction of National Construction Engineer 1<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |
| (h) Construction Assistant 3 | 30 | - Execution of quality control for main and secondary canal systems for RCRSP under direction of National Construction Engineer 2<br>- Execution of quantity control for main and secondary canal systems for RCRSP under direction of National Construction Engineer 2<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |
| (i) Construction Assistant 4 | 30 | - Execution of quality control for main and secondary canal systems for USISRSP under direction of National Construction Engineer 3<br>- Execution of quantity control for main and secondary canal systems for USISRSP under direction of National Construction Engineer 3<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |
| (j) Construction Assistant 5 | 30 | - Execution of quality control for main and secondary canal systems for KSBISRSP under direction of National Construction Engineer 4<br>- Execution of quantity control for main and secondary canal systems for KSBISRSP under direction of National Construction Engineer 4<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |
| (k) Construction Assistant 6 | 30 | - Execution of quality control for main and secondary canal systems for DPISRSP under direction of National Construction Engineer 2<br>- Execution of quantity control for main and secondary canal systems for DPISRSP under direction of National Construction Engineer 2<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |
| (l) Construction Assistant 7 | 30 | - Execution of quality control for reservoir SPWRRSP and main and secondary canal systems for MC35RSP under direction of National Construction Engineer 3 and 4, respectively<br>- Execution of quantity control for reservoir SPWRRSP and main and secondary canal systems for MC35RSP under direction of National Construction Engineer 3 and 4, respectively<br>- Check and Record of construction consumables such cements, aggregates, fuel and iron bars and labors |

*Source: JICA Survey Team*

(3) Software Components

The services period for software components, consisting of capacity development of MOWRAM and PDOWRAM staff on O&M, formation and strengthening of FWUC and strengthening of agricultural extension services, would be 7 years from 2014 to 2020. The assignment of foreign consultant and national consultant in the implementation of software components is prepared according to the following considerations.

(a) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

- One Foreign Consultant (O&M Specialist) is assigned for each subproject at the beginning of the program to prepare overall work plan (1.0 M/M) and to conduct trial training (0.5 M/M).
- Two National Consultants consisting of irrigation expert (3.0 M/M) and O&M expert (3.0 M/M) are assigned for each subproject at the initial stage of the program to support MOWRAM and PDOWRAM in the preparation of training materials and establishment of monitoring and evaluation procedure for O&M activities.

(b) Formation and Strengthening of FWUC

- Institutional expert of National Consultant (3.0 M/M) annually for each subproject will be assigned to support MOWRAM and PDOWRAM in preparation of training materials, organization of workshop and training programs etc.

(c) Strengthening of Agricultural Extension Services

- Foreign Consultant (Agronomist/Agricultural Extension Expert) will be assigned for the preparatory work of the program.
- National Consultant (Agronomist/Agricultural Extension Expert) will be assigned to support PDA in the implementation of training program and demonstration farm including monitoring and evaluation.

(d) Financial Management

- National Consultant (Financial Management Expert) will be assigned to support PMU Japan Support Fund in necessary administrative works for software components under special account.

Terms of reference for respective experts assigned are as follows:

**Table II-3.6.5.4 Terms of Reference of Consultant Staff for Capacity Development of MOWRAM and PDOWRAM Staff on O&M (Software Components)**

| Position | M/M | Terms of Reference |
|---|---|---|
| **Foreign Consultant** | | |
| 1) O&M Expert | 9 | - Review of existing training materials in MOWRAM<br>- Preparation of overall work plan<br>- Preparation of sample training materials<br>- Conduct of trial training program<br>- Preparation of training report |
| **National Consultant** | | |
| 1) Irrigation Expert | 18 | - Review of existing irrigation training materials in MOWRAM<br>- Support preparation of improved training materials for irrigation<br>- Support MOWRAM and PDOWRAM in the execution of irrigation training programs based on overall work plan<br>- Preparation of training report<br>- Support MOWRAM and PDOWRAM in monitoring and evaluation of irrigation activities in each irrigation system |

| Position | M/M | Terms of Reference |
|---|---|---|
| 2) O&M Expert | 18 | - Review of existing O&M training materials in MOWRAM<br>- Support preparation of improved training materials for O&M<br>- Support MOWRAM and PDOWRAM in the execution of O&M training programs based on overall work plan<br>- Preparation of training report<br>- Support MOWRAM and PDOWRAM in monitoring and evaluation of O&M activities in each irrigation system |

*Source: JICA Survey Team*

**Table II-3.6.5.5 Terms of Reference of Formation and Strengthening of FWUC (Software Components)**

| Position | M/M | Terms of Reference |
|---|---|---|
| **National Consultant** | | |
| 1) Institutional Expert | 126 | - Review of existing FWUC organizational development training materials in MOWRAM<br>- Support preparation of improved training materials for institutional development of FWUC<br>- Support MOWRAM and PDOWRAM in the execution of FWUC formation and registration in each irrigation system<br>- Support MOWRAM and PDOWRAM in the execution of FWUC training programs<br>- Preparation of training report<br>- Support MOWRAM and PDOWRAM in monitoring and evaluation of FWUC activities in each irrigation system |

*Source: JICA Survey Team*

**Table II-3.6.5.6 Terms of Reference of Strengthening of Agricultural Extension Services (Software Components)**

| Position | M/M | Terms of Reference |
|---|---|---|
| **Foreign Consultant** | | |
| 1) Agronomist/Agricultural Extension Expert | 2 | - Preparation of guideline for annual action plan<br>- Preparation of guideline for monitoring and evaluation of extension activities<br>- Preparation of annual action plan<br>- Preparation of handouts and other materials to be required<br>- Preparation of guideline for monitoring and evaluation of extension activities |
| **National Consultant** | | |
| 1) Agronomist/Agricultural Extension Expert | 24 | - Preparation of guideline for annual action plan<br>- Preparation of guideline for monitoring and evaluation of extension activities<br>- Preparation of annual action plan<br>- Preparation of handouts and other materials to be required<br>- Preparation of guideline for monitoring and evaluation of extension activities<br>- Support in field programs<br>- Support in farmer/farmer Group Training Programs<br>- Support in mass guidance / Workshop: 12 courses<br>- Periodical checking and analysis on work progress and performance of extension activities to be carried out by extension staff of PDA and DAO |

*Source: JICA Survey Team*

**Table II-3.6.5.7 Terms of Reference of Financial Management**

| Position | M/M | Terms of Reference |
|---|---|---|
| **National Consultant** | | |
| 1) Financial Management Expert | 28 | - Support PMU Japan Support Fund to train technical staff in charge of software component to prepare accounting report<br>- Check of accounting report for software component activities to be prepared by technical staff of PDOWRAM<br>- Support PMU Japan Support Fund in preparation of periodical accounting report according to MEF's regulation<br>- Support PMU Japan Support Fund in coordination between MOWRAM and MEF for budgetary arrangement for software component |

*Source: JICA Survey Team*

# CHAPTER II-4 PROJECT IMPLEMNETATION AND O&M PLAN

## II-4.1 Project Implementation Plan

### II-4.1.1 Implementation Organization

(1) Implementation Organization

Three implementation organizations applied and/or proposed for recent major irrigation projects under MOWRAM were studied during the Survey: (i) NWISP (ADB), (ii) WRMSDP (ADB) and (iii) West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project (WTSIDRIP:JICA). As the results of the study and also discussion with MOWRAM, the proposed implementation organization for SPPIDRIP is designed on the basis of that for WTSIDRIP taking into due consideration the following matters:

- The implementation organization for WTSIDRIP has been already accepted by MOWRAM and JICA.
- Major purpose of SPPIDRIP is to increase of agricultural production by applying the integrated approach of hardware components (rehabilitation and improvement of existing irrigation and drainage facilities) and software components (strengthening of agricultural support and relevant organizations), which is just the same development concept with WTSIDRIP.
- Implementation organization for WRMSDP is designed focusing on the capacity building of relevant agencies to water resources development, which is rather deviated from the purpose of SPPIDRIP.
- In case of WTSIDRIP, it is possible to use the existing units such as Project Steering Committee (PSC), Resettlement Unit (RU) and Environmental Management Unit (EMU) established in NWISP.
- There is no overlap in PIU at provincial level between WTSIDRIP and SPPIDRIP.
- It was further confirmed that MOWRAM could arrange the implementation organization proposed for WTSIDRIP.

For the implementation organization proposed for WTSIDRIP, however it is proposed to make some modifications as stated below:

- Positioning of JICA will be clarified in the implementation organization.
- Provincial Level Project Manager will be precisely assigned as responsible person for management of PIU, aiming at smooth and efficient implementation of SPPIDRIP.
- Relation between PIU and PDA will be clearly indicated in the implementation organization.
- In case the Sub-project area extends over plural provinces, a PIU Coordination Committee will be established to keep close communication between the relevant PDOWRAMs toward smooth implementation of Sub-project. The key staff of each PDOWRAM concerned will be appointed as members of PIU Coordination Committee.

Figure II-4.1.1.1 shows the proposed implementation organization for SPPIDRIP. The major tasks of each organization are tabulated below:

**Table II-4.1.1.1 Major Tasks of Each Organization**

| Organizations | Major Tasks |
|---|---|
| National Steering Committee | - Operation of National Steering Committee chaired by the Minister of MOWRAM with the secretary of State of MOWRAM assigned as permanent vice chair, including high level representatives of MAFF, MEF, MOE,MRD,MOH,MPWT, MIME, MLMUPC, MOP, MOWA and NDMC<br>- Provision of the necessary political coordination and supports from the relevant Ministries to MOWRAM to carry out the Project in effective and efficient manner<br>- Assisting for the arrangement of necessary technical support and supplemental budget to be required for the Project<br>- Advice to Provincial Coordination Committee<br>- Monitoring of project progress and provision of advices when necessary |
| PMU Japan Support Fund headed by Project Director subordinating National Level Project Manager | - Operation of PMU Japan Support Fund by Project Director<br>- Overall management of the Project<br>- Preparation of annual disbursement plan of the Project<br>- Coordination with four Units within MOWRAM<br>- Procurement of the consultant<br>- Procurement of contractors for hardware components<br>- Overall supervision and guidance to the consultant and the contractors to be engaged in the Project<br>- Supervision of land acquisition, necessary for the Project, by RU<br>- Monitoring and evaluation as well as reporting of project progress to relevant Ministries and the Steering Committee |
| TSC | - Advice to PMU Japan Support Fund in accordance with TSC's missions |
| JICA | - Assistance and advice to PMU Japan Support Fund for smooth implementation of the Project under Japan's Loan |
| Provincial PIU headed by Provincial Level Project Manager | - Supervision of construction works for the Sub-project at the field level supported by MOWRAM<br>- Preparation of annual work plan in collaboration with PMU Japan Support Fund<br>- Coordination with relevant rural administration including provincial government and Commune Councils (CCs)<br>- Provision of advice to the technical consultant including available data and information related with each sub-project<br>- Provision of supervision and guidance to the local contractors<br>- Progress monitoring and evaluation of the Project and regular report to PMU Japan Support Fund<br>- Performing any other tasks necessary to support PMU Japan Support Fund |
| Provincial Coordination Committee | - Assistance and advice to CCs for smooth implementation of Sub-project at provincial level |
| PIU Coordination Committee | - Coordination of relevant PIUs toward smooth implementation of Sub-project |
| CCs | - Coordination with MOWRAM, PDOWRAM and farmers for the implementation of the Project at the commune level<br>- Support of FWUC establishment and strengthening<br>- Coordination with FWUC for irrigation system O&M<br>- Internal monitoring at the commune level |

*Source: JICA Survey Team*

(2) Application of Priority Operation Cost

According to the information from ADB, ADB has applied the Priority Operation Cost (POC) to MOWRAM staff in his projects for smooth implementation of the project. It was informed that this POC would be covered with a part of loan or grant. In the said NWISP and WRMSDP, POC has been applied or might be applied respectively which is highly appreciated for MOWRAM staff. It is deemed that POC is one of unignored factors from the viewpoint of whether the project is successfully implemented or not, especially under conditions of the limited budget for outsourcing. In the near future, implementation of SPPIDRIP and WTSIDRIP under Japan's loan might be started in parallel to WRMSDP by ADB. Even in this case, it is expected that any confusion would not bring about in MOWRAM staff.

As explained in the previous section, during the survey, shortage of operation cost was pointed out by relevant PDOWRAM staff as one of the serious constraints in project implementation and O&M of irrigation facilities. In order to minimize such problems, budgetary arrangement for the field works for the staff of MOWRAM and PDOWRAM would be highly required for SPPIDRIP.

### II-4.1.2 Staff Required for Detailed Design and Construction Works

Smooth project implementation requires full-time professional staff from MOWRAM and PDOWRAM at the central and the provincial level, which will be directly and indirectly supported by relevant technical department. During D/D and construction stage of SPPIDRIP, necessary number of staff is tabulated as follows:

**Table II-4.1.2.1 Staff Required for Design and Construction Works for SPPIDRIP**

| Organizations | Position | Nos. |
|---|---|---|
| **Central Level** | | |
| PMU Japan Support Fund | Project Director | 1 |
| | Project Manager | 1 |
| | National Level Project Manager | 1 |
| | Administration & Finance | 2 |
| | Procurement | 2 |
| | Resettlement & Environment | 2 |
| | Technical and FWUC | 2 |
| | Agriculture (to be dispatched from MAFF) | 2 |
| Sub-total (Central Level) (=1) | | 13 |
| **Provincial Level** | | |
| Project Implementation Unit (PIU) | | |
| - Kampong Speu Province<br>*Roleang Chrey Irrigation System*<br>*&*<br>*Main Canal 35 System* | Provincial Level Project Manager/Technical | 3 |
| | Agriculture (to be dispatched from PDA) | 2 |
| Sub-Total of kampong Speu (=2) | | 5 |
| - Takeo Province<br>*Upper Slakou Irrigation System*<br>*&*<br>*Kandal-Stung Bati Irrigation System* | Provincial Level Project Manager/Technical | 5 |
| | Agriculture (to be dispatched from PDA) | 11 |
| Sub-Total of Takeo (=3) | | 16 |
| - Kandal Province<br>*Kandal Stung Extension Irrigation System*<br>*&*<br>*Srass Prambai Water Recession System* | Provincial Level Project Manager/Technical | 2 |
| | Agriculture(to be dispatched from PDA) | 4 |
| Sub-Total of Kandal (=4) | | 6 |
| - Kampong Chhnang Province<br>*Daun Pue Irrigation System* | Provincial Level Project Manager/Technical | 3 |
| | Agriculture (to be dispatched from PDA) | 5 |
| Sub-Total of Kampong Chhnang (=5) | | 8 |
| Sub-total (Provincial Level) | | 35 |
| **Grand Total** | | **48** |

*Source: JICA Survey Team*

### II-4.1.3 Decision and Instruction Flow

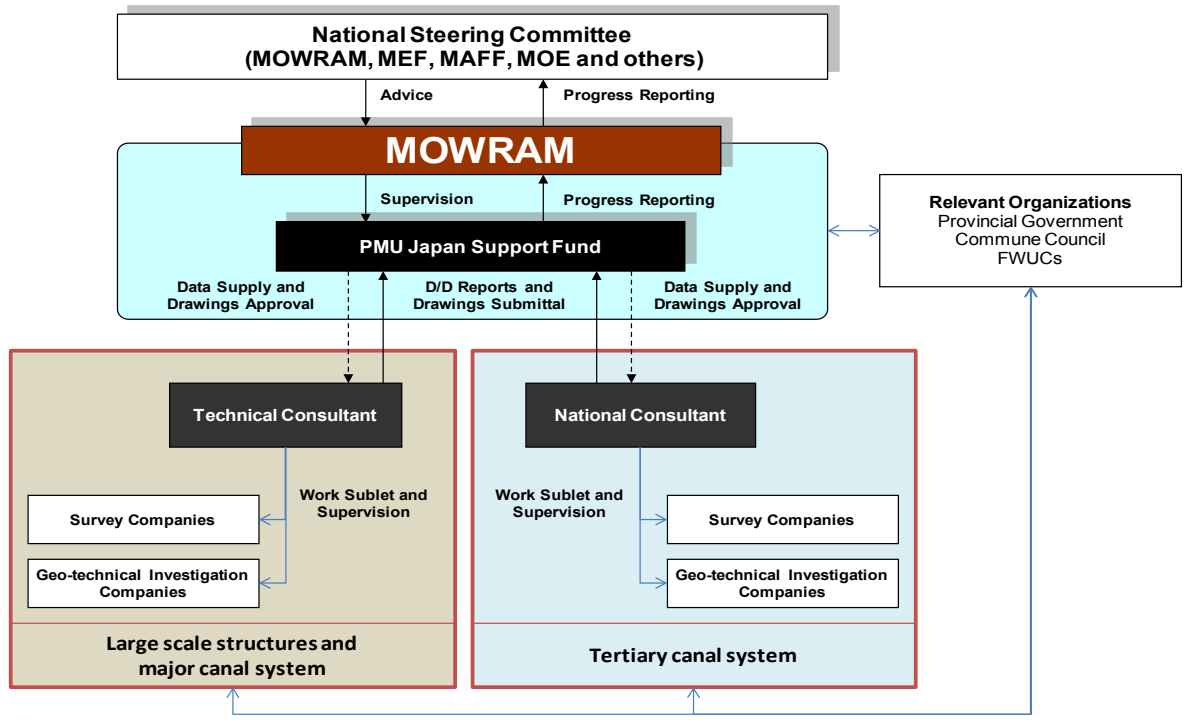
(1) During Detailed Design

In accordance with proposed implementation organization for SPPIDRIP, decision and instruction flow is proposed on the basis of following conditions in order to smoothly manage the project.

- Construction works will be carried out through ICB for main and secondary canal systems, and LCB for tertiary canal systems.
- MOWRAM and technical consultant are required to perform their services according to the demarcation of services explained in the previous section and also attached in ANNEX I.
- In general, technical consultant consisting of: (i) foreign consultant and (ii) national consultant is in charge of providing services for D/D, P/Q and tender document preparation, P/Q and tender evaluation, construction supervision for ***large-scale structures and major canal system*** under the contract with MOWRAM.
- Under the overall supervision by PMU Japan Support Fund, MOWRAM will take charge of ***tertiary canal system*** development including plan, survey, design and construction supervision,

execution of tendering and evaluation for all the construction works by employing national consultant.

- Land acquisition and/or voluntary donation necessary for SPPIDRP will be managed by Resettlement and Environment Unit under PMU Japan Support Fund. At the central level, this unit coordinates with Inter-Ministerial Resettlement Committee (IRC) while at the provincial level, PIU communicate with sub-committee of IRC headed by the provincial governor to smoothen the land acquisition and/or voluntary donation.
- Project implementing system during detail design for: (i) large-scale structures and major canal system and (ii) tertiary canal system is similar as that proposed in the formulation study of WTSIDRIP as shown in Figure II-4.1.3.1.



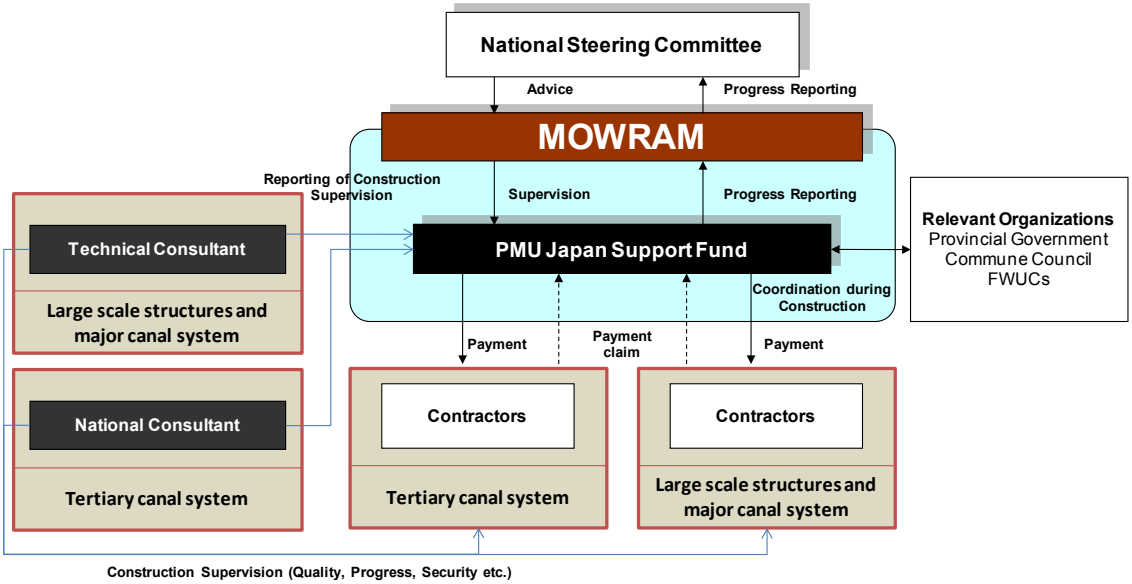

*Source: JICA Survey Team*

**Figure II-4.1.3.1 Project Implementing System during Detailed Design**

As similarly proposed in WTSIDRIP, technical consultant will make contract with MOWRAM for large-scale structures and major canal system. Separately, PMU Japan Support Fund will employ national consultant for tertiary canal system works. For large-scale structures and major canal system, technical consultant prepares plan, design report, drawings, P/Q document, tender documents and submit to PMU Japan Support Fund. PMU Japan Support Fund will check the documents and issue approval. Technical survey such as topographic survey and geotechnical investigation will be sublet to survey companies and/or geo-technical investigation companies, under the supervision of technical consultant. Necessary data during the design will be provided from PMU Japan Support Fund to the technical consultant. Such works for tertiary canal system will be supervised by the national consultant.

(2) During Construction

The implementing system during construction supervision for irrigation facilities is depicted in the following figure.



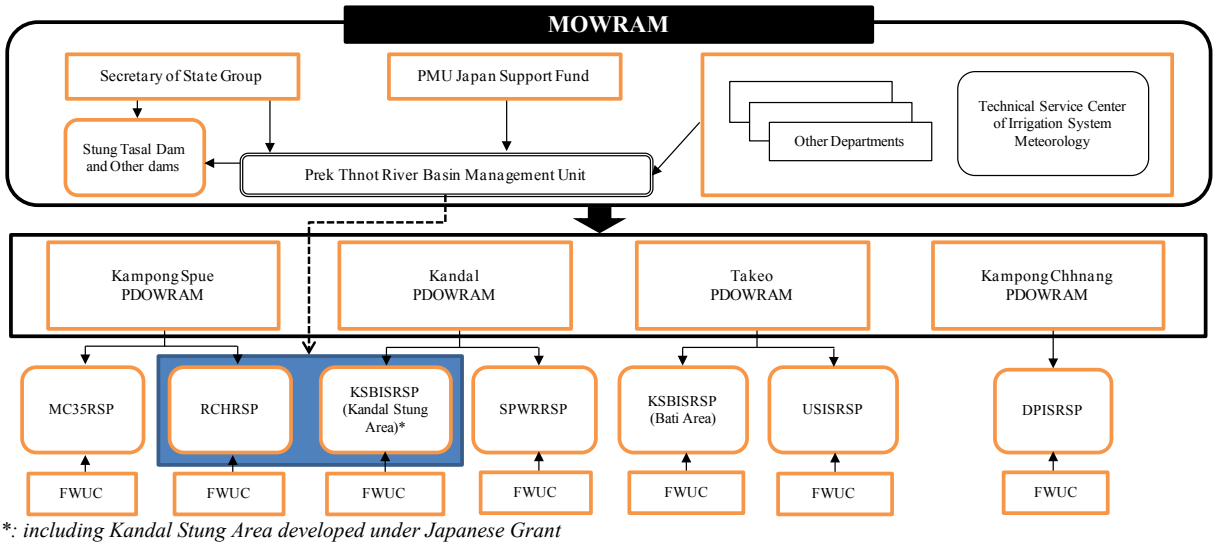

*Source: JICA Survey Team*

**Figure II-4.1.3.2 Project Implementing System during Construction**

The contractor for large-scale structures and major canal system, and those of tertiary canal system will make contract with MOWRAM and will be supervised by PMU Japan Support Fund. As the same as the system during D/D, the works for large-scale structures and major canal system will be technically supervised by the technical consultant while those of tertiary canal system will be managed by the national consultant.

(3) During O&M

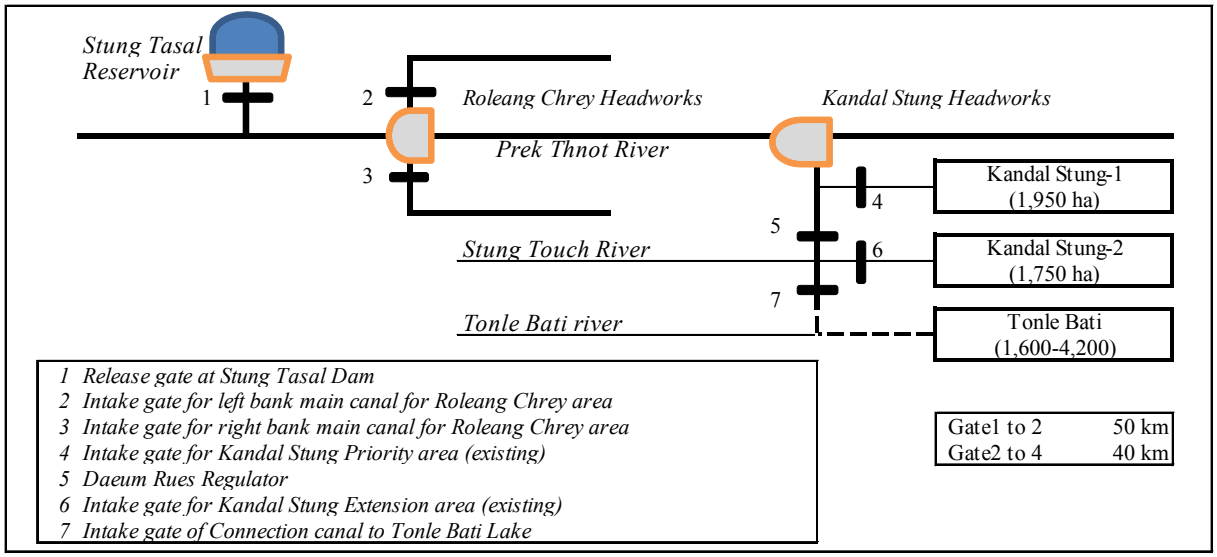
After completion of construction works for SPPIDRIP, O&M will be started mainly by relevant PDOWRAMs and FWUCs under support of MOWRAM. The proposed organization of O&M is shown in Figure II-4.1.3.3.




**: including Kandal Stung Area developed under Japanese Grant*
*Source: JICA Survey Team*

**Figure II-4.1.3.3 Organization of O&M**

The demarcation of O&M responsibilities between PDOWRAM and FWUC is discussed in Clause II-4.2.2. In O&M for SPPIDRIP, attention should be paid to operation of Stung Tasal dam, RCHRSP and KSBISRSP (Kandal Stung Area) including the Kandal Stung grant area developed under Japanese grant since water sources for these Sub-projects are the same, namely the discharge of the Prek Thnot River and the released discharge from Stung Tasal dam shown in Figure II-4.1.3.4.




*Source: JICA Survey Team*

**Figure II-4.1.3.4 Related Project/Sub-projects located in Prek Thnot River Basin**

If the released discharge from Stung Tasal dam is not properly controlled, the planned discharge not be allocated to RCHRSP and KSBISRSP (Kandal Stung Area). In addition, if more water is taken at the Roleang Chrey command area, the expected water could not arrive at KSBISRSP (Kandal Stung Area) located downstream. Thus, it is crucial to make careful operation among Stung Tasal dam, RCHRSP and KSBISRSP (Kandal Stung Area). In order to do so, it is proposed to establish a Prek Thnot River Basin Management Unit in MOWRAM. The member of unit will be assigned from the relevant department such as Department of Hydrology and River Works and Department of Water Resources Management Conservation. The necessary equipment such as vehicle and communication system will be procured under SPPIDRIP.

## II-4.1.4 Construction Package

### II-4.1.4.1 Proposed Project Components

Objectives of the proposed project components of two Sub-projects are tabulated as follows:

**Table II-4.1.4.1.1 Principal Features of RCHRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 350 ha excluding 220 ha to be developed by TSC-3, but influences to 16,910 ha for project evaluation |
| 2) | Roleang Chrey Headworks | |
| | - Roleang Chrey Regulator | Regulator gates<br>- Fixed wheel gates, 5 sets, 12.5 m (W) × 6.7 m (H)<br>Civil works<br>- Construction of the downstream river bed protection<br>- Rehabilitation of the downstream river bank protection<br>- Construction of river outlet structure |
| | - Andong Sla Intake | Intake gates<br>- Radial gates, 2 sets, 4.0 m (W) × 2.7 m (H)<br>Civil works<br>- Curtain walls and operation deck,<br>- Protection of up & downstream of intake<br>- Rehabilitation of approach channel |
| | - Vat Krouch Intake | Intake gates<br>- Radial gates, 2 sets, 4.0 m (W) × 2.7 m (H)<br>Civil works<br>- Upstream & downstream transitions<br>- Gate pier and box culvert and protection of canal beds,<br>- Rehabilitation of approach channel |

| No. | Description | Quantity |
|---|---|---|
| | - River outlet structure | Inlet gates<br>- Slide gates, 4 sets, 1.0 m (W) × 1.0 m (H)<br>Outlet gates<br>- Slide gates, 2 sets, 1.25 m (W) × 1.4 m (H) |
| 3) | NMC and SMC | 2 nos.<br>Design discharge: NMC 10.4 $m^3$/sec at beginning point<br>SMC 16.3 $m^3$/sec at beginning point |
| | - Total length | 18.9 km (NMC = 9.1 km and SMC = 9.8 km) |
| | - Structures to be rehabilitated/reconstructed | Check structures : 3 nos.<br>Turnout : 18 nos.<br>Bridge : 7 nos.<br>Spillway : 3 nos.<br>Drainage gate : 11 nos. |
| 4) | Secondary canals | 12 nos. |
| | - Total length | 16.9 km |
| | - Structures to be rehabilitated/reconstructed | Check structures : 45 nos.<br>Turnout : 53 nos.<br>Culvert : 32 nos.<br>Drain inlet : 4 nos. |
| 5) | Tertiary canal system | |
| | - Area | 350 ha |

*Source: JICA Survey Team*

**Table II-4.1.4.1.2 Principal Features of USISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 3,500 ha |
| 2) | Water resource facilities | |
| | - Reservoir-1 | Tumnup Lok reservoir on the Slakou River (CA=332 $km^2$), Ve= 1.0 MCM,<br>Re-construction of dike, spillway, intake and maintenance facilities |
| | - Reservoir-2 | Kpob Trobek reservoir on the Don Phe river (CA=137 $km^2$), Ve= 2.6 MCM<br>Supplemental improvement and repair of dike and spillway gates which were rehabilitated by MOWRAM in 2005 |
| | - Diversion canal | Connecting the above two reservoirs, 9.4 km, Design discharge: 3.5 $m^3$/sec |
| 3) | Main canal | 1 no. Design discharge: 3.2 $m^3$/sec |
| | - Length | 7.3 km |
| | - Off-takes | 6 nos. |
| | - Diversion structure | 5 nos. |
| 4) | Secondary canals | 7 nos. |
| | - Total length | 44.7 km |
| | - Off-takes | 102 nos. |
| | - Diversion structure | 66 nos. |
| 5) | Tertiary canal system | |
| | - Total length | 110 km |

*Source: JICA Survey Team*

**Table II-4.1.4.1.3 Principal Features of KSBISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 3,350 ha in total,<br>consisting of 1,750 ha for Kandal Stung Area and 1,600 ha for Tonle Bati Area |
| 2) | Water resource facilities | |
| | - Diversion weir | 2 nos. on the Stung Touch Rivera;<br>(one is new headworks and the other is improvement of spillway) |
| | - Pump station | 1 no. at Lake Tonle Bati<br>(Replacement of the existing one, 4 sets of 45 $m^3$/min) |
| | - Regulator for Stung Touch Rivera | 1 no.<br>(Replacement of Daeum Rues Regulator on the Prek Thnot River) |
| | - Connection canal | 3.5 km<br>(Upgrading of NS-82 r to Tonle Bati Lake, Q=5.6 $m^3$/sec) |
| | - Spillway of Tonle Bati Lake | 1 no.<br>(Kampong Dangkor spillway, Q=197 $m^3$/sec) |
| 3) | Main irrigation canal | 4 canals, Q= 5.88 – 0.91 $m^3$/sec |
| | - Length | 18.9 km in total,<br>consisting 11.4 km for Kandal Stung and 8.3 km in Tonle Bati Area |
| | - Off-takes | 61 nos. |
| | - Diversion structures | 17 nos. |

| No. | Description | Quantity |
|---|---|---|
| 4) | Secondary irrigation canals | 8 canals, Q=0.45 – 0.21$m^3$/sec |
| | - Length | 13.6 km in total,<br>consisting 5.0 km for the Kandal Stung and 8.6 km in Tonle Bati Area |
| | - Off-takes | 46 nos. |
| | - Diversion structures | 9 nos. |
| 5) | Main drainage canals | 4 canals, Q=2.24 – 0.88 $m^3$/sec |
| | - Length | 18.8 km in total,<br>consisting 12.1 km for the Kandal Stung and 6.3 km in the Tonle Bati Area |
| | - Structures | 49 nos. |
| 6) | Tertiary canal system | |
| | - Length | 101 km in total,<br>consisting 53 km for the Kandal Stung and 48 km in the Tonle Bati Area |

*Source: JICA Survey Team*

**Table II-4.1.4.1.4 Principal Features of MC35RSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 850 ha |
| 2) | Water resource facilities | Khpob Krous reservoir on the Ou Chraloy and the Ou Kat Srov Rivers<br>(CA=78 $km^2$), Ve=3.6 MCM |
| 3) | Main canal | 1 no. Design discharge: 2.3 $m^3$/sec |
| | - Length | 14.0 km |
| | - Check structure | 19 nos. |
| | - Turnout | 16nos. |
| | - Culvert | 8 nos. |
| | - Drain inlet | 10 nos. |
| | - Drop | 5 nos. |
| | - Cross drain | 1 no. |
| | - Road bridge | 1 no. |
| | - Footpath bridge | 9 nos. |
| 4) | Secondary canals | 6 nos. |
| | - Total length | 11.4 km |
| | - Check structure | 20 nos. |
| | -Turnout | 35 nos. |
| | - Culvert | 26 nos. |
| | - Drop | 1 no. |
| 5) | Tertiary canal system | |
| | - Total length | 26 km |

*Source: JICA Survey Team*

**Table II-4.1.4.1.5 Principal Features of SPWRRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 1,200 ha |
| 2) | Water resource facilities | Srass Prambai reservoir connecting with Bassac River Ve=30.7 MCM |
| | | Rehabilitation of dike (9.1 km) |
| | | New construction of 7 intake structures |
| 3) | Canal system | No rehabilitation |

*Source: JICA Survey Team*

**Table II-4.1.4.1.6 Principal Features of DPISRSP**

| No. | Description | Quantity |
|---|---|---|
| 1) | Irrigation Development Area | 1,150 ha |
| 2) | Water resource facilities | Daun Pue Headworks on the Stung Chieb River |
| 3) | Main canal | 1 no. Design discharge: 3.2 $m^3$/sec |
| | - Length | 11.7 km |
| | - Check structure | 14 nos. |
| | - Turnout | 34 nos. |
| | - Culvert | 13 nos. |
| 4) | Secondary canals | 3 nos. |
| | - Total length | 4.6 km |
| | - Check structure | 9 nos. |
| | - Turnout | 15 nos. |
| | - Culvert | 8 nos. |
| 5) | Tertiary canal system | |
| | - Total length | 35 km |

*Source: JICA Survey Team*

### II-4.1.4.2 Construction Package

According to the "Procurement Manual for Externally Financed Project/ Programs in Cambodia, September 2005" issued by MEF, the procurement thresholds are defined as follows:

- International competitive bidding : all procurement above US$ 300,000
- Local competitive bidding : all procurement above US$ 40,000 and below US$ 300,000

In the light of this procurement thresholds and taking it into account that it would take rather longer time to secure the land for tertiary canals than for main and secondary canals, the construction works of Sub-projects are divided into two groups: one is construction work for main and secondary canals and related structures, and the other is for tertiary canals and related structures. The former is planned to be executed by ICB and the latter by LCB.

As for ICB works, 6 Sub-projects are divided into 2 construction packages in consideration of scattered location of working site, shortening of construction period, similar works and provision of more chances to tenderers. On the other hand, ICB works, say construction of tertiary canals and related structures for 5 Sub-projects, are proposed to be carried out by dividing them into 12 packages in view of the procurement thresholds mentioned above.

The conceivable construction packages are tabulated as follows.

**Table II-4.1.4.2.1 Packaging for Construction Works of Hardware Components**

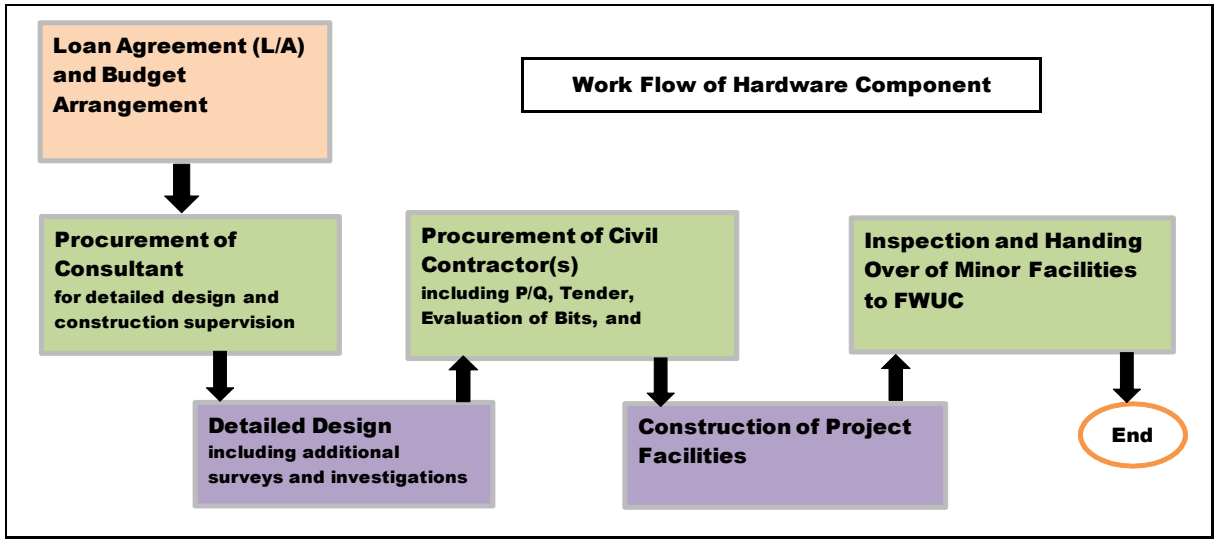
| Sub-project | Province | Nos. of Package | | | |
|---|---|---|---|---|---|
| | | International Competitive Bidding (ICB) | | Local Competitive Bidding (LCB) | |
| RCHRSP | Kampong Speu | 1 | - Partial rehabilitation of headworks including 2 intakes<br>- Partial rehabilitation of main and secondary canals (36 km in total)<br>- Construction of structures (176 nos.) | 1 | Construction of tertiary canal (350 ha: 11km) |
| DPISRSP | Kampong Chhnang | | - Full rehabilitation of headworks<br>- Partial rehabilitation of main and secondary canals (16.3 km)<br>- Construction of structures (93 nos.) | 2 | Construction of tertiary canal (15 km-18 km) |
| USISRSP | Takeo and partly in Kampong Speu (right bank of Tumnup Lok Reservoir) | 1 | - Partial rehabilitation of water resource facilities (2 reservoirs and diversion canal)<br>- Partial rehabilitation of main and secondary canals (52 km in total)<br>- Construction of structures (179 nos.) | 4 | Construction of tertiary canal (15 km-18 km) |
| KSBISRSP | Kandal and Takeo | | - New Construction of diversion weirs<br>- Full replacement pumps and pump house<br>- Full replacement of regulator<br>- Full upgrading of connection canal<br>- New construction of spillway<br>- Partial rehabilitation of main and secondary canals (32.5km)<br>- Partial Rehabilitation of drainage canal system (18.8 km) | 4 | Construction of tertiary canal (24km -27 km) |
| MC35RSP | Kampong Speu | | - Partial rehabilitation of main canal and secondary canal (25.4 km)<br>- New construction of structures (151 nos.) | 1 | Construction of tertiary canal (26 km) |
| SPWRRSP | Kandal | | - Partial rehabilitation of Srass Prambai reservoir<br>- New construction of intakes (7 nos.) | - | - |
| Total | | ICB: 2 Packages | | LCB: 12 Packages | |

*Source: JICA Survey Team*

### II-4.1.5 Implementation Schedule

#### II-4.1.5.1 Overall Schedule

Overall schedule for implementing the hardware components would be as follows:




*Source: JICA Survey Team*

**Figure II-4.1.5.1.1 Work Flow of Hardware Components**

The actions to be taken by the implementation agency (MOWRAM) are illustrated in Figure II-4.1.5.1.1 and actual works for design and construction would be made by the employed consultant and contractor(s), respectively. Implementation time schedule of RCHRSP and USISRSP is described in following Sub-clause.

#### II-4.1.5.2 Roleang Chrey Headworks Rehabilitation Sub-project

(1) Rehabilitation of Headworks and Main and Secondary Canals

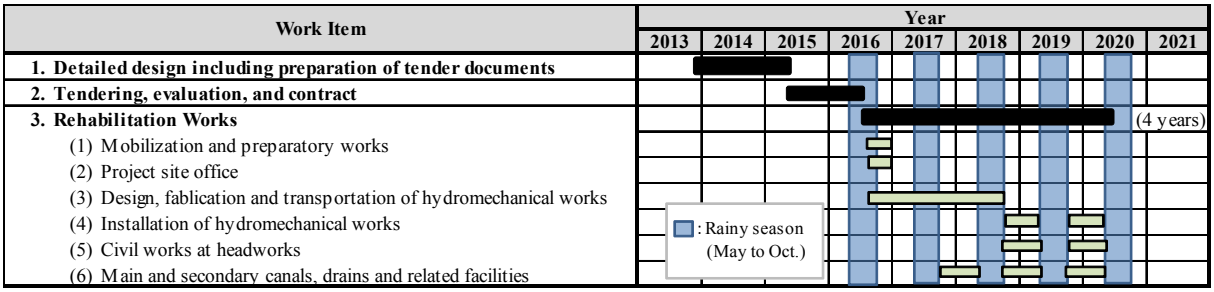
RCHRSP consists of 3 major rehabilitation works, which are (i) headworks, (ii) main and secondary canal system and (iii) tertiary canal system in model area. The rehabilitation works at the headworks are further divided into (i) hydro-mechanical works of the regulator and 2 intakes and (ii) related civil works. Rehabilitation of main and secondary canal system is divided into upstream NMC and SMC and secondary canals branched off from each main canal.

Total construction period of rehabilitation works will require 4 years after procurement procedure of the contractor. It is assumed D/D including preparation of tender documents would be completed within one year. Critical path of the rehabilitation works of RCHRSP will be the hydro-mechanical works, requiring 4 years in total, which is broken down as shown below:

- Site survey and design by gate manufacture : 5 months
- Approval of the Project Engineer (foreign consultant) : 3 months (1 month overwrap with above)
- Material procurement : 10 months (3 month overwrap with above)
- Fabrication : 8 months (4 month overwrap with above)
- Transportation to site : 2 months (1 month overwrap with above)
- Demolishing of existing gates and installation of new gates
  : 8 months in total in 2 dry seasons

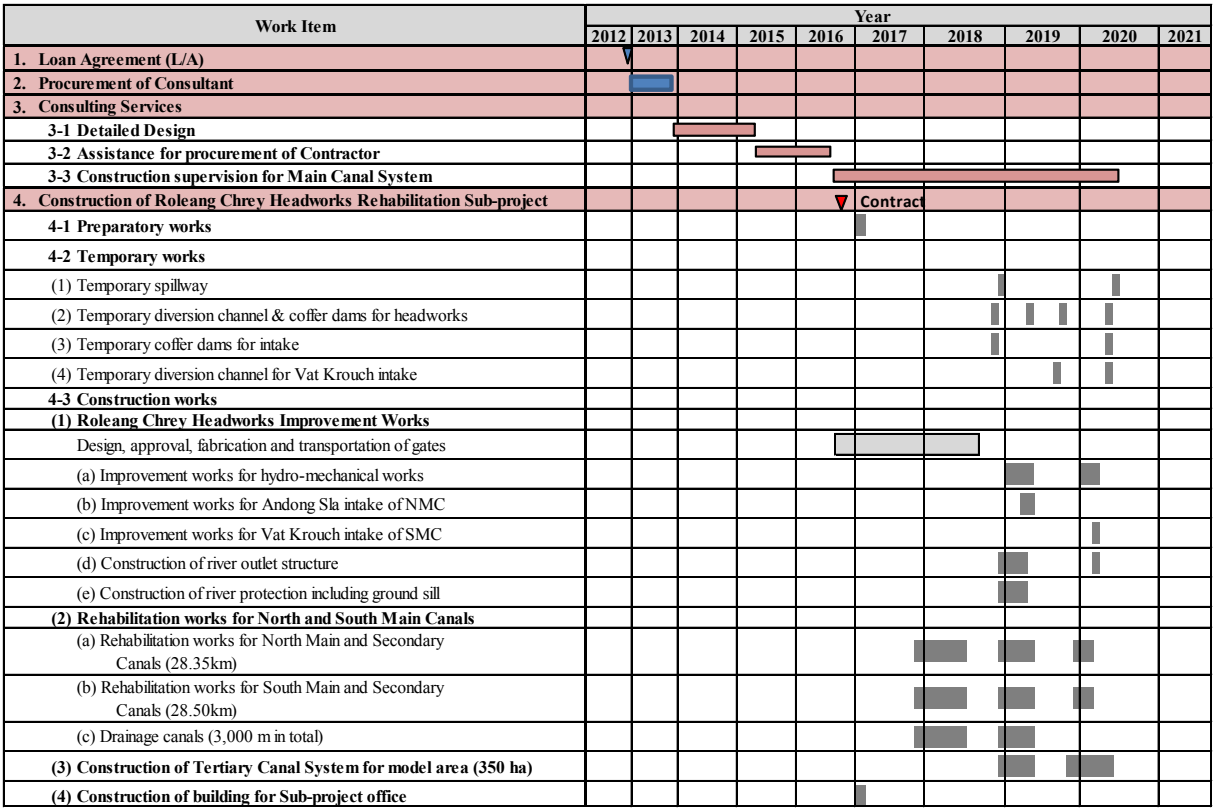
Main and secondary canals with related structures will also be completed within the dry season in 3 years. Contractor for the work will be selected through ICB, while tertiary development will be

executed by the national contractor selected through LCB. Period required from the commencement of D/D to the end of rehabilitation work would be 6 years as shown below. Overall construction schedule of RCHRSP is attached in Figure II-4.1.5.2.2.




*Source: JICA Survey Team*

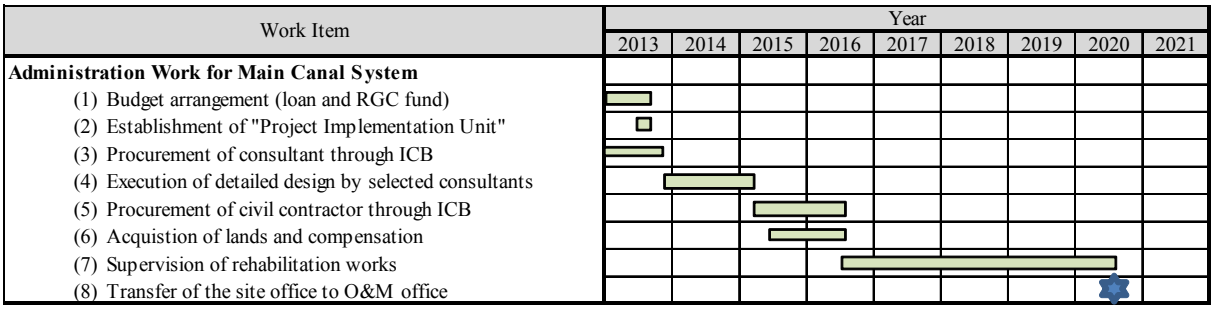
**Figure II-4.1.5.2.1 Implementation Time Schedule for Main Canal System of RCHRSP**




*Source: JICA Survey Team*

**Figure II-4.1.5.2.2 Overall Construction Schedule of RCHRSP**

For realizing the above activities, required administration works of MOWRAM and PDOWRAM would be as follows:




*Source: JICA Survey Team*

**Figure II-4.1.5.2.3 Administrative Activities for RCHRSP**

It is assumed that the budget arrangement would be completed within one year and procurement of the international consultant for 12 months. The construction management office of Sub-project would be transferred to PDOWRAM. It is expected the secondary and tertiary canal systems will be handed over to the FWUC for joint operation with PDOWRAM while O&M for the Roleang Chrey Headworks and will remain under the administration of PDOWRAM for O&M purpose.

(2) Construction of Tertiary Canal System in Model Area

Tertiary Canal System development in Model Area of 350 ha consisting of construction and rehabilitation of tertiary canals and drains will be implemented following the rehabilitation work for headworks and main and secondary canals. D/D for tertiary canal system development would be prepared by the national consultant with close coordination with PDOWRAM, FWUC and TSC-3, and based on the D/D for the main canal system. The delineation of tertiary block and alignment of tertiary canals are to be agreed by FWUC and land owners. Period of D/D is estimated at one year and construction period is estimated at set at 2 years depending on land acquisition process as shown below:

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Construction of Tertiary Canal System** | | | | | | | | | |
| (1) Detailed design | | | | | | | | | |
| (2) Tendering, evaluation, and contract | | | | | | | | | |
| (3) Construction work for tertiary canal system | | | | | | | | | |

*Source: JICA Survey Team*

**Figure II-4.1.5.2.4 Implementation Schedule for Tertiary Canal System in Model Area of RCHRSP**

For realizing the above activities, the required administration works of MOWRAM and PDOWRAM are as shown below:

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Administration for Tertiary Canal System** | | | | | | | | | |
| (1) Budget arrangement | | | | | | | | | |
| (2) Procurement of consultant through LCB | | | | | | | | | |
| (3) Execution of detailed design with selected consultants | | | | | | | | | |
| (4) Acquring lands thru obtaining the consents of land owners | | | | | | | | | |
| (5) Procurement of civil contractor through LCB | | | | | | | | | |
| (6) Supervision of rehabilitation works | | | | | | | | | |
| (7) Handing over of tertiary canal system to FWUC | | | | | | | | | |

Revision of design will be done by Project staff

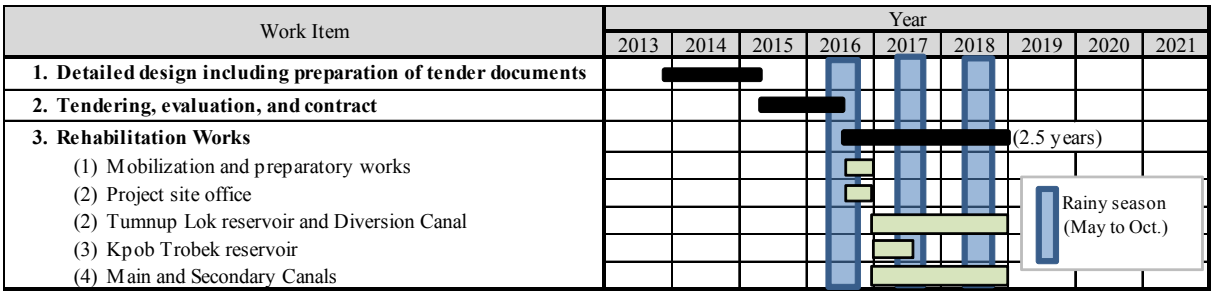
*Source: JICA Survey Team*

**Figure II-4.1.5.2.5 Administrative Activities for Construction of Tertiary Canal System in Model Area of RCHRSP**

### II-4.1.5.3 Upper Slakou Irrigation System Rehabilitation Sub-project

(1) Rehabilitation of Main and Secondary Canal System

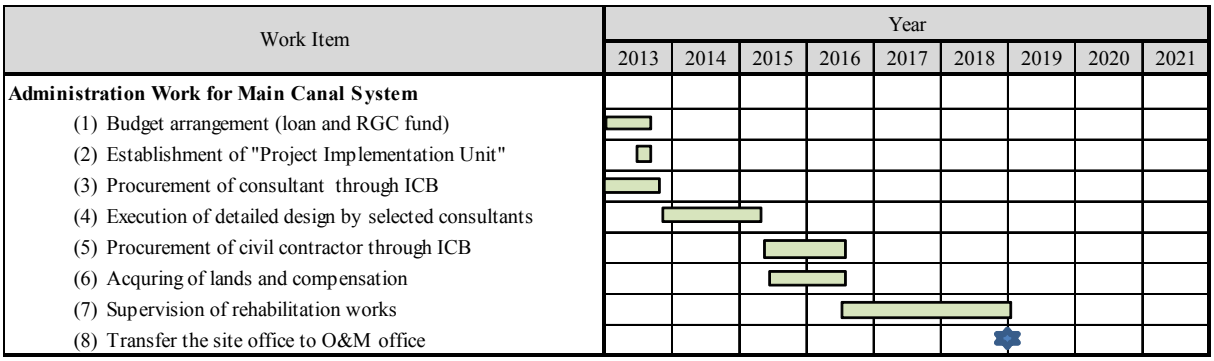
Main canal system of USISRSP consists of 2 reservoirs, a diversion canal and main/secondary canals and related structures. The rehabilitation works of the main canal system will require a period of 2.5 years or 2 dry seasons after procurement procedure of the construction contractor based on D/D prepared by the employed consultant. It is assumed D/D including preparation of tender documents would be completed within one year. Rehabilitation of the Kpob Trobek Reservoir, diversion and main canals will be completed in the first year, but the Tumnup Lok Reservoir and secondary canals will be rehabilitated for the whole construction period. Contractor for the work will be selected through ICB, while ones for tertiary canals will be selected through LCB. Time required from the commencement of D/D including mapping to the end of rehabilitation work would be 5 years as shown below:




*Source: JICA Survey Team*

**Figure II-4.1.5.3.1 Implementation Time Schedule for Main Canal System of USISRSP**

For realizing the above activities, required administration works of MOWRAM and PDOWRAM would be as follows:



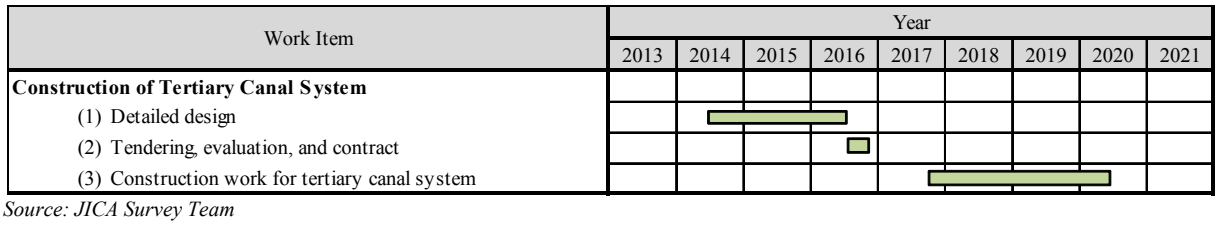

*Source: JICA Survey Team*

**Figure II-4.1.5.3.2 Administrative Activities for Main Canal System of USISRSP**

It is assumed that the budget arrangement would be completed within one year and procurement of the foreign consultant for one year. It is noted that treatment of obstructions on the canals would be completed within one year prior to starting the rehabilitation work by MOWRAM. After completion of rehabilitation work, the construction management office of USISRSP would be transferred to PDOWRAM for O&M purpose.

(2) Construction of Tertiary Canal System

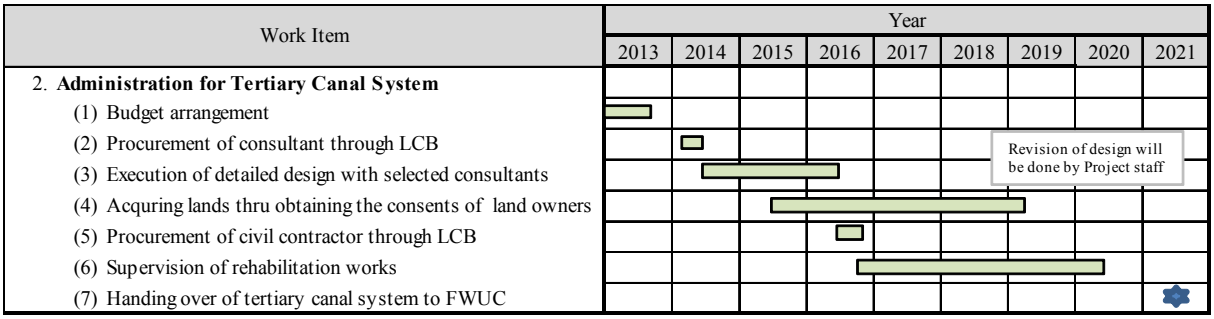
Construction and rehabilitation of tertiary canals covering 3,500 ha will be implemented following the rehabilitation work for main canal system. D/D for tertiary canal would be prepared by the national consultant with close coordination with PDOWRAM and FWUC, and based on the design for the main and secondary canal system. The delineation of tertiary block and alignment of tertiary canals are to be agreed by FWUC and land owners. It would take rather longer period, since private lands should be provided for tertiary canals by land owners free of charge. Therefore, period of D/D is estimated at 2 years including confirmation of alignment of tertiary canals. Assuming the progress rate of work at about 1,000 ha per year, construction period is set at 3.5 years (4 dry seasons) as shown below. It is expected the tertiary canal system will be handed over to FWUC after 1-year maintenance period of construction.




*Source: JICA Survey Team*

**Figure II-4.1.5.3.3 Implementation Time Schedule for Tertiary Canal System of USISRSP**

For realizing the above activities, the required administration works of MOWRAM and PDOWRAM are as shown below:




*Source: JICA Survey Team*

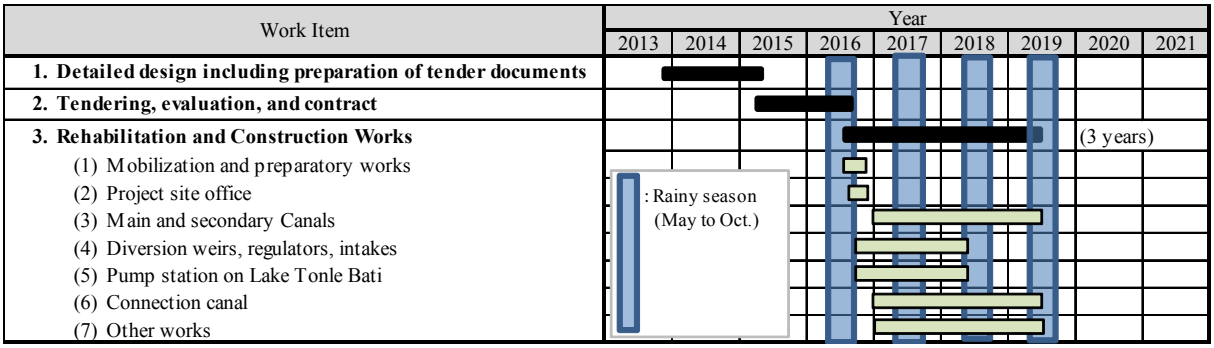
**Figure II-4.1.5.3.4 Administrative Activities for Construction of Tertiary Canal System of USISRSP**

It is assumed that the budget arrangement would be completed about 10 months and procurement of the national consultant for 3 months. After completion of tertiary canal system, it would be handed over to FWUC after one-year maintenance period.

### II-4.1.5.4 Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

(1) Rehabilitation of Water Resource Facilities and Main and Secondary Canal System

Facilities of the main system of KSBISRSP consists of 2 diversion weirs (headworks) and 3 intake gates on the Stung Touch River, a connection canal from the Stung Touch River to the Lake Tonle Bati, a pumping station at the Lake Tonle Bati, flood protection dike and a spillway of the Lake Tonle Bati, and main and secondary canals with related structures. The rehabilitation works of the main system will require a period of 2.5 years or 2 dry seasons after procurement procedure of the construction contractor based on D/D prepared by the employed consultant. It is assumed that D/D including preparation of tender documents would be completed within 1.5 years. Rehabilitation of the main canals, flood dike and spillway, diversion weir and intakes will be completed in the first year, but the pump station and the connection canal will be for the whole construction period due to rather long procurement time of pumps and huge amount of excavation volume of about 200,000 $m^3$. Contractor for the work will be selected through ICB, while ones for tertiary canals will be selected through LCB. Time required from the commencement of D/D including mapping to the end of rehabilitation work would be 5.5 years as shown below:




*Source: JICA Survey Team*

**Figure II-4.1.5.4.1 Implementation Time Schedule for Main Canal System of KSBISRSP**

For fulfilling the activities mentioned above, required administration works of MOWRAM and PDOWRAM would be as follows:

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Administration Work for Main Canal System** | | | | | | | | | |
| (1) Budget arrangement (loan and RGC fund) | | | | | | | | | |
| (2) Establishment of "Project Implementation Unit" | | | | | | | | | |
| (3) Procurement of consultant (1) through ICB | | | | | | | | | |
| (4) Execution of detailed design by selected consultants | | | | | | | | | |
| (5) Procurement of civil contractor through ICB | | | | | | | | | |
| (6) Supervision of rehabilitation and construction works | | | | | | | | | |

**Figure II-4.1.5.4.2 Administrative Activities for Main Canal System of KSBISRSP**

(2) Construction of Tertiary Canal System

Construction and rehabilitation of tertiary canals covering 3,350 ha will be implemented following the rehabilitation work for main canal system. D/D for tertiary canal would be prepared by the national consultant with close coordination with PDOWRAMs and FWUCs, and based on the design for the main canal system. The delineation of tertiary block and alignment of tertiary canals are to be agreed by FWUCs and land owners. It would take rather longer period, since private lands should be provided for tertiary canals by land owners free of charge. Therefore, period of D/D is estimated at 2 years including confirmation of alignment of tertiary canals. Assuming the progress rate of work at about 800-1,000ha per year, construction period is set at 3 years (3 dry seasons) as shown below. It is expected the tertiary canal system will be handed over to FWUC after 1-year maintenance period.

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Construction of Tertiary Canal System** | | | | | | | | | |
| (1) Detailed design | | | | | | | | | |
| (2) Tendering, evaluation, and contract | | | | | | | | | |
| (3) Construction work for tertiary canal system | | | | | | | | | |

*Source: JICA Survey Team*

**Figure II-4.1.5.4.3 Implementation Time Schedule for Tertiary Canal System of KSBISRSP**

In order to execute the above activities successfully, the required administration works of MOWRAM and PDOWRAM are as shown below:

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 2. **Administration for Tertiary Canal System** | | | | | | | | | |
| (1) Budget arrangement | | | | | | | | | |
| (2) Procurement of consultant through LCB | | | | | | | | | |
| (3) Execution of detailed design with selected consultants | | | | | | | | | |
| (4) Acquring lands thru obtaining the consents of land owners | | | | | | | | | |
| (5) Procurement of civil contractor through LCB | | | | | | | | | |
| (6) Supervision of rehabilitation works | | | | | | | | | |
| (7) Handing over of tertiary canal system to FWUC | | | | | | | | | |

Revision of design will

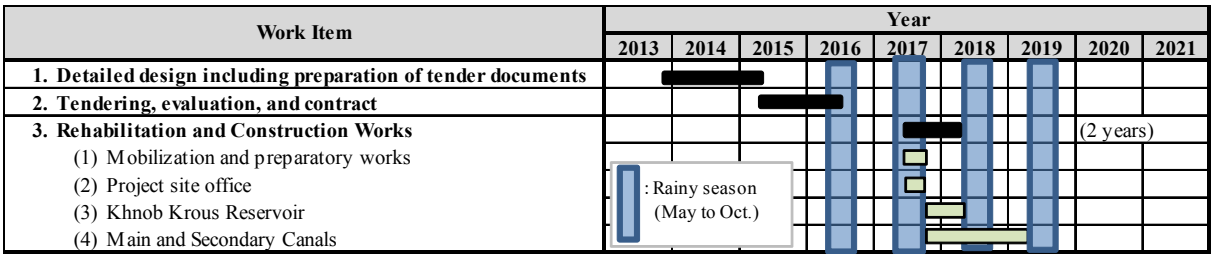
*Source: JICA Survey Team*

**Figure II-4.1.5.4.4 Administrative Activities for Construction of Tertiary Canal System of KSBISRSP**

### II-4.1.5.5 Main Canal 35 Rehabilitation Sub-project

(1) Rehabilitation of Reservoir and Main and Secondary Canal System

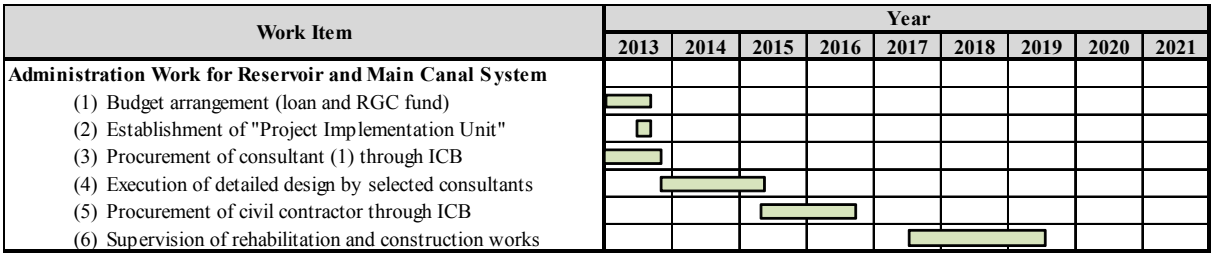
Major facilities included in MC35RSP are the Khpob Krous Reservoir, main canal and secondary canals and related structures. These are required to rehabilitate one main canal and 6 secondary canals. Besides, one secondary canal is newly constructed. In these systems, new construction is made for 141 structures in total. As for construction of them, ICB is applied. Time required from the commencement of D/D including mapping to the end of rehabilitation work would be 5 years as shown below:




*Source: JICA Survey Team*

**Figure II-4.1.5.5.1 Implementation Time Schedule for Reservoir and Main Canal System of MC35RSP**

For fulfilling the activities mentioned above, required administration works of MOWRAM and PDOWRAM would be as follows:



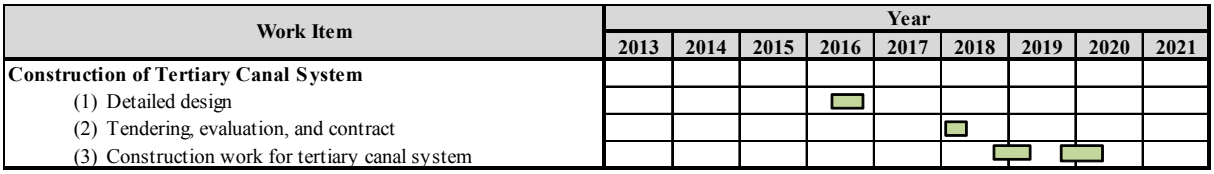

*Source: JICA Survey Team*

**Figure II-4.1.5.5.2 Administrative Activities for Reservoir and Main Canal System of MC35RSP**

The budget arrangement and procurement of the foreign consultant are assumed to be completed within one year respectively. Out of 6 secondary canals, one secondary canal will be newly constructed therefore MOWRAM and PDOWRAM are requested to execute land acquisition for it on time. After completion of rehabilitation work, the construction management office of MCS35RSP would be handed over to PDOWRAM for O&M purpose.

(2) Construction of Tertiary Canal System

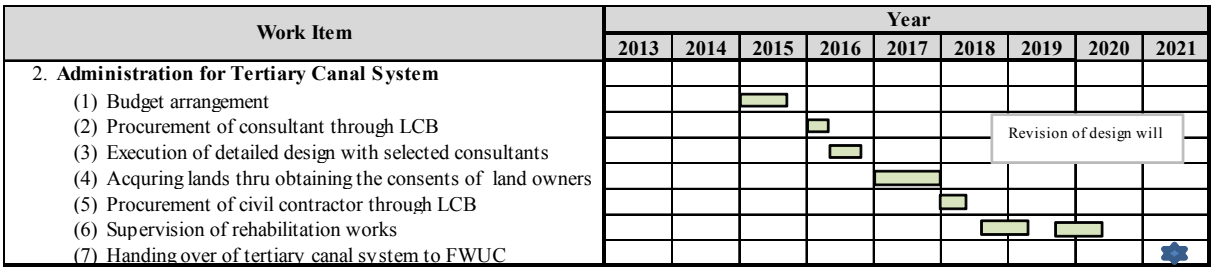
Tertiary canals covering 850 ha, of which the length is 26 km in total, will be constructed following the rehabilitation work for main and secondary canal system. D/D for tertiary canal would be prepared by the national consultant in close coordination with PDOWRAM and FWUC, and based on the design for the main and secondary canal system. The delineation of tertiary block and alignment of tertiary canals are to be agreed by FWUC and land owners. It would take rather longer period, since private lands should be provided for tertiary canals by land owners free of charge. Therefore, period of D/D is estimated at 6 months including confirmation of alignment of tertiary canals. Assuming the progress rate of work at about 1,000 ha per year, construction period is set at 9 months (1 dry season) as shown below. It is expected the tertiary canal system will be handed over to FWUC after 1-year maintenance period of construction.




*Source: JICA Survey Team*

**Figure II-4.1.5.5.3 Implementation Time Schedule for Tertiary Canal System of MC35RSP**

For realizing the above activities, MOWRAM and PDOWRAM are requested to conduct the following administration works:



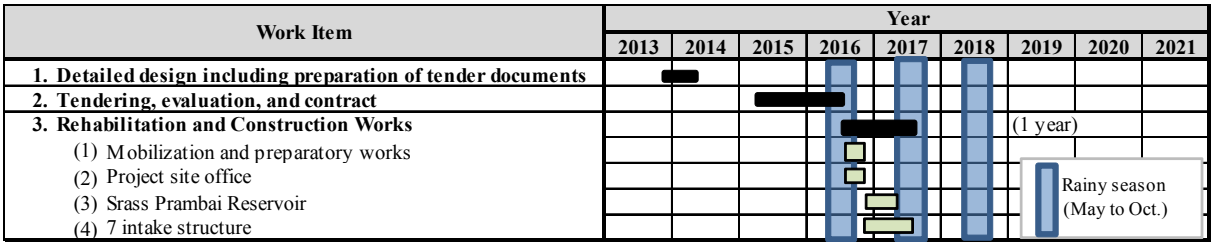

*Source: JICA Survey Team*

**Figure II-4.1.5.5.4 Administrative Activities for Construction of Tertiary Canal System of MC35RSP**

It is expected that the budget arrangement would be completed about 10 months and procurement of the national consultant for 3 months. Land acquisition for tertiary canal would require about one year. After completion of tertiary canal system, it would be handed over to FWUC after 1-year maintenance period.

### II-4.1.5.6 Srass Prambai Water Recession Rehabilitation Sub-project

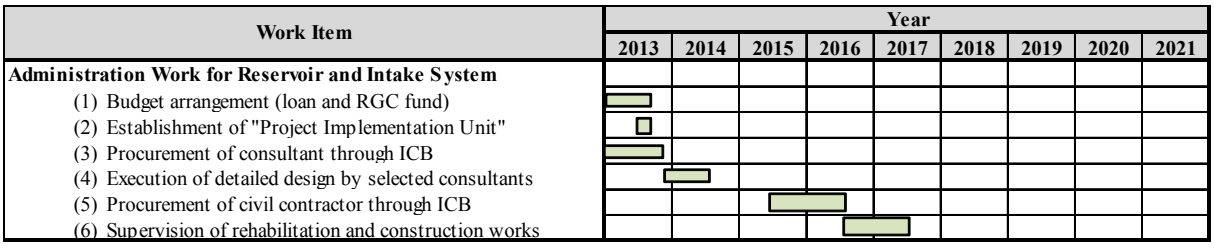
In SPWRRSP, the required works are to rehabilitate of the existing reservoir and to construct 7 intake structures at the reservoir. Command area development is not included in SPWRRSP since the existing irrigation canal system could be used as they are. If the existing irrigation canal system is damaged, it will be repaired by FWUC as one of maintenance works as usual because it is submerged in the rainy season every year. D/D of them including topographic survey and preparation of tender documents will be started immediately after selection of consultant and be completed within 6 months. The rehabilitation of the existing reservoir and construction of 7 intake structures will be completed within the first year after selection of contractor through ICB since the work volume is not large. Period required from the commencement of D/D to the end of rehabilitation work would total to 3 years as shown below:




*Source: JICA Survey Team*

**Figure II-4.1.5.6.1 Implementation Time Schedule for Main Canal System of SPWRRSP**

In order to materialize the above activities, MOWRAM and PDOWARM are required to fulfill the following administration works:




*Source: JICA Survey Team*

**Figure II-4.1.5.6.2 Administrative Activities for Reservoir and Intake System of SPWRRSP**

It is expected that the required budget arrangement would be completed within one year and procurement of foreign consultant for one year. As one of careful approaches, attention should be paid so as not to cause the conflict between farmers and fishermen.

### II-4.1.5.7 Daun Pue Irrigation System Rehabilitation Sub-project

(1) Construction of Headworks and Rehabilitation of Main and Secondary Canal System

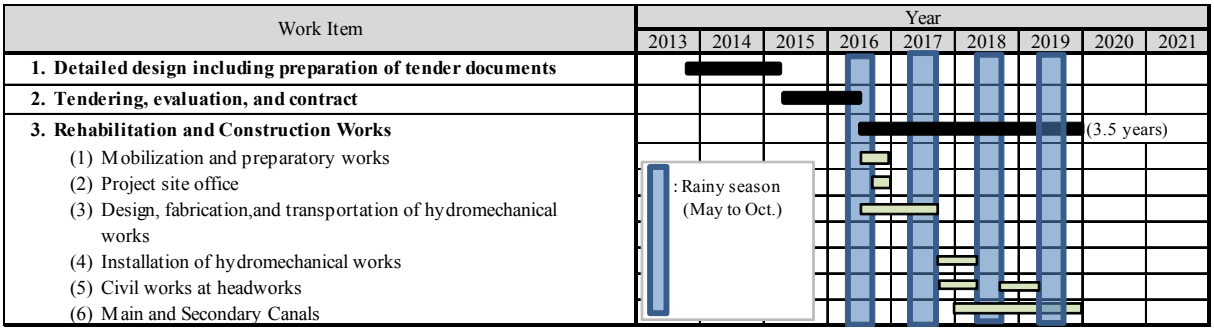
DPISRSP needs construction of headworks and rehabilitation of main and secondary canals to abstract and deliver irrigation water for command area of 1,150 ha. The headworks to be newly constructed are of barrage type to cope with flood. The partially rehabilitated main and secondary canals are 11.7 km and 5.2 km, respectively.

Total construction period of construction and rehabilitation works will require 3.5 years after procurement procedure of the contractor. It is expected that D/D including mapping and preparation of tender documents would be completed within 1.5 years.

Critical path of the rehabilitation works of DPISRSP will be the hydro-mechanical works, requiring 21 months in total, which is broken down as shown below.

- Site survey and design by gate manufacture : 4 months
- Approval of the Project Engineer (foreign consultant) : 2 months (1 month overwrap with above)
- Material procurement : 8 months (2 month overwrap with above)
- Fabrication : 6 months (3 month overwrap with above)
- Transportation to site : 2 months (1 month overwrap with above)
- Installation of new gates : 6 months

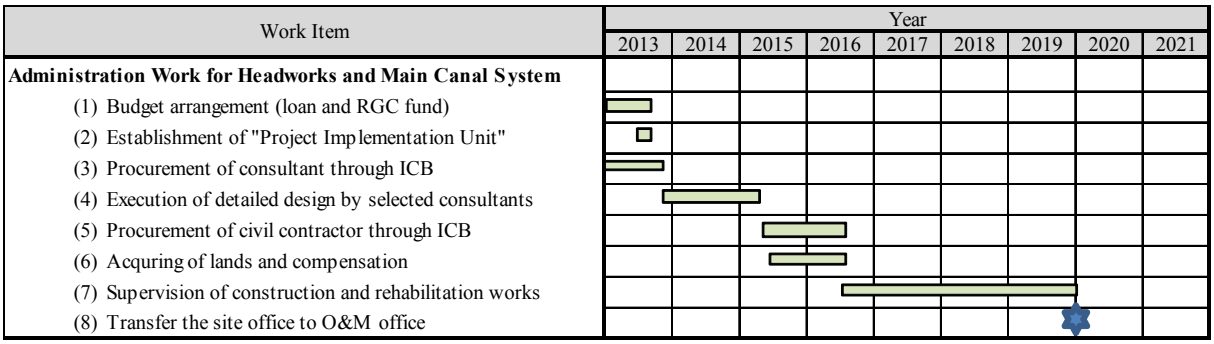
Main and secondary canals and related structures will be completed in 2 years from 2018 to 2019. Contractor for rehabilitation and construction will be selected through ICB. Period required for rehabilitation and construction works from the beginning of D/D including orthographic mapping to the end of all construction/rehabilitation works would be 6 years as shown below.




*Source: JICA Survey Team*

**Figure II-4.1.5.7.1 Implementation Time Schedule for Headworks and Main Canal System of DPISRSP**

For realizing the above activities, MOWRAM and PDOWRAM are requested to conduct the following administration works.




*Source: JICA Survey Team*

**Figure II-4.1.5.7.2 Administrative Activities for Headworks and Main Canal System of DPISRSP**

(2) Construction of Tertiary Canal System

Tertiary canal system of DPISRSP covers 1,150 ha, of which the length is about 35 km in total. It will be newly constructed following the rehabilitation work for main and secondary canal system. D/D for tertiary canal system would be prepared by the national consultant in close communication with PDOWRAM and FWUC, and based on the design for the main and secondary canal system. The tertiary block and alignment of tertiary canals should be delineated with consent of FWUC and land owners. It would take rather longer period, since private lands should be voluntarily provided for tertiary canals by land owners. Therefore, period of D/D is estimated at 6 months including confirmation of alignment of tertiary canals. Assuming the progress rate of work at about 1,000 ha per year, construction period is set at 9 months (1 dry season) as shown below. It is expected the tertiary canal system will be handed over to FWUC after 1-year maintenance period of construction.

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Construction of Tertiary Canal System** | | | | | | | | | |
| (1) Detailed design | | | | | | | | | |
| (2) Tendering, evaluation, and contract | | | | | | | | | |
| (3) Construction work for tertiary canal system | | | | | | | | | |

*Source: JICA Survey Team*

**Figure II-4.1.5.7.3 Implementation Time Schedule for Tertiary Canal System of DPISRSP**

For realizing the above activities, MOWRAM and PDOWRAM are requested to conduct the following administration works.

| Work Item | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 2. **Administration for Tertiary Canal System** | | | | | | | | | |
| (1) Budget arrangement | | | | | | | | | |
| (2) Procurement of consultant through LCB | | | | | | | | | |
| (3) Execution of detailed design with selected consultants | | | | | | | | | |
| (4) Acquring lands thru obtaining the consents of land owners | | | | | | | | | |
| (5) Procurement of civil contractor through LCB | | | | | | | | | |
| (6) Supervision of rehabilitation works | | | | | | | | | |
| (7) Handing over of tertiary canal system to FWUC | | | | | | | | | |

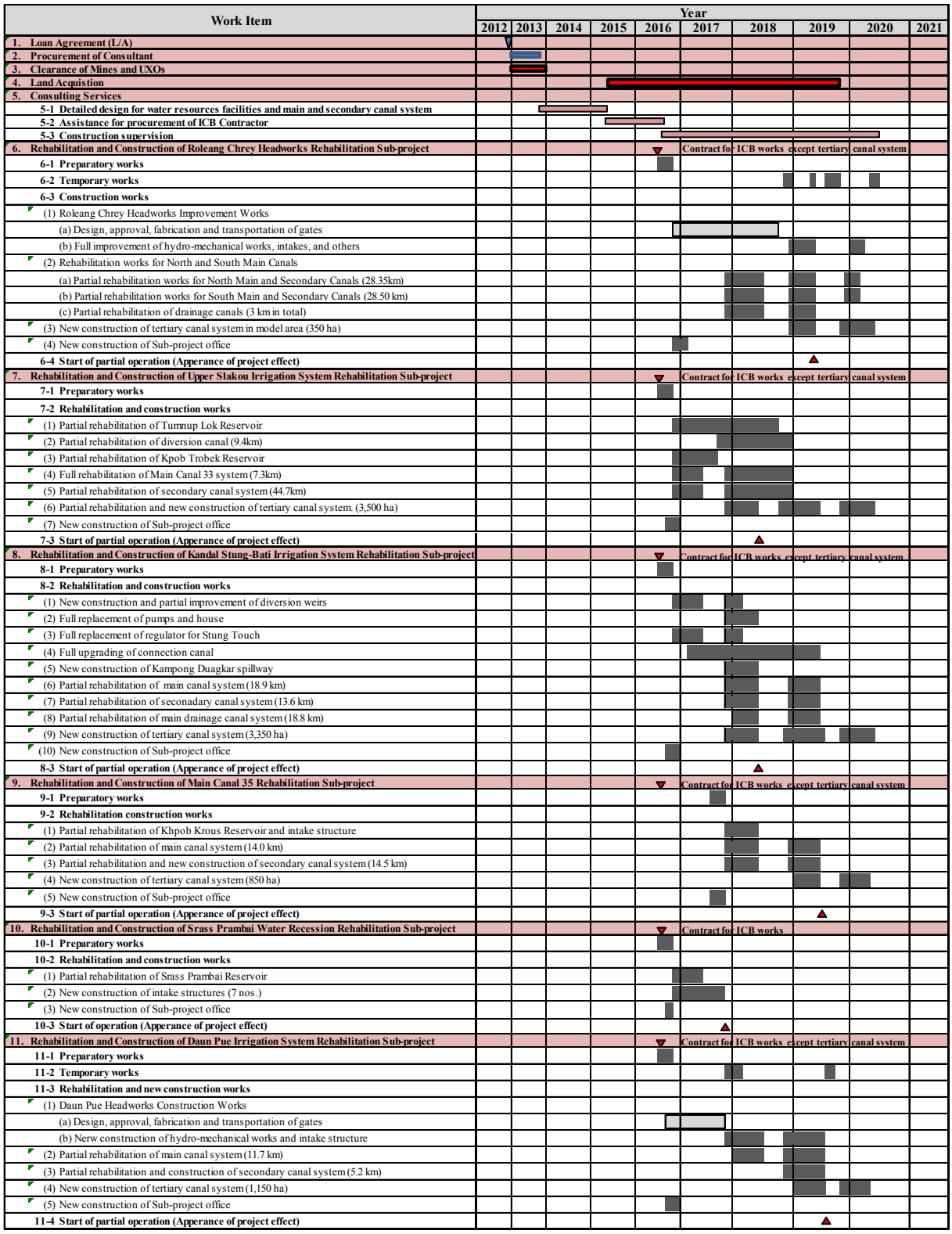
Revision of design will be done by Project staff

**Figure II-4.1.5.7.4 Administrative Activities for Construction of Tertiary Canal System of DPISRSP**

The budget arrangement and procurement of the national consultant area assumed to be completed for 10 months and 3 months respectively. Land acquisition for tertiary canal would require about 1.5 years. After completion of tertiary canal system, it would be handed over to FWUC after 1-year maintenance period.

### II-4.1.5.8 Overall Construction Schedule of Southwest Phnom Penh Irrigation and Drainage Rehabilitation Project

Overall construction schedule of SPPIDRIP is attached in Figure II-4.1.5.4.1 including RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. As can be seen in this figure, construction works of SPPIDRIP will be started in mid. 2016 and be completed by mid. 2020 although SPWRRSP will be completed in end of 2017. However, since the partial operation can be applied sub-project by sub-project, the project effect is expected to occur earlier, say mid. 2019 for RCHRSP, mid. 2018 for USISRSP, mid. 2018 for KSBISRSP, mid. 2019 for MC35RSP, mid. 2019 for DPISRSP.



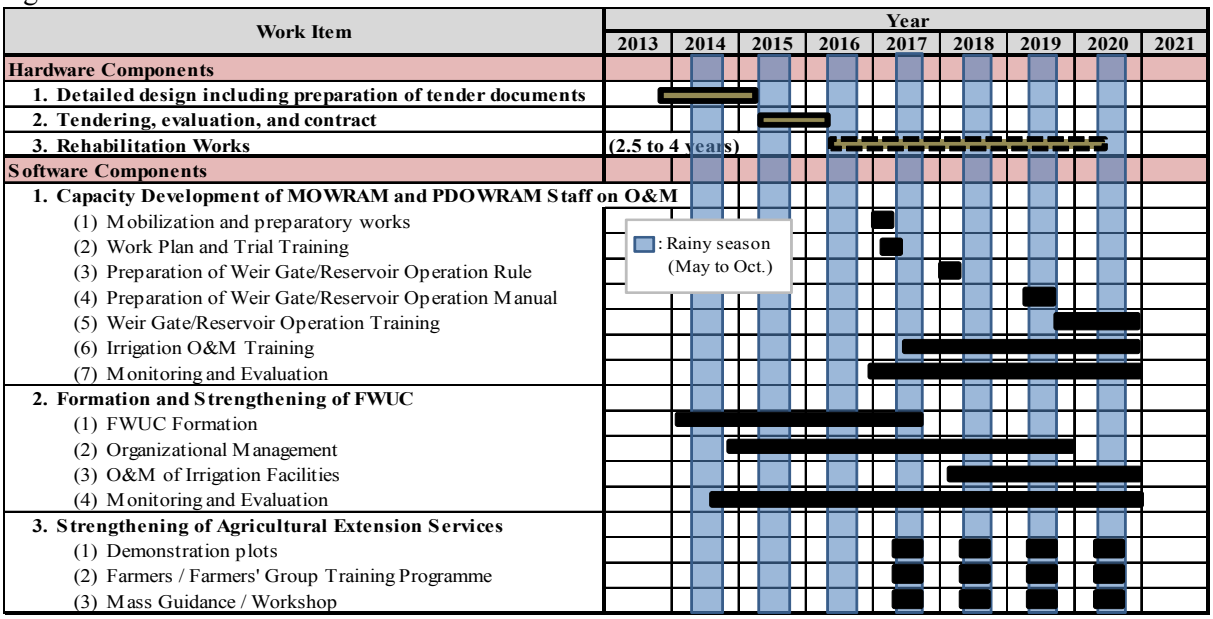

*Source: JICA Survey Team*

**Figure II-4.1.5.8.1 Overall Construction Schedule of SPPIDRIP**

## II-4.1.5.9 Software Components

Software components consist of three activities: (i) capacity development of MOWRAM and PDOWRAM staff on O&M, (ii) strengthening of FWUC and (iii) strengthening of agricultural extension services. Although beneficiary farmers should be provided with the necessary information

about RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP in each area by means of workshops and meetings as soon as D/D starts, substantial activities on software components are planned to be implemented from 2017 to 2020 over 4 years in concurrence with the progress of hardware components. Overall implementation time schedule of software components is illustrated in Figure II-4.1.5.9.1.




*Source: JICA Survey Team*

**Figure II-4.1.5.9.1 Overall Implementation Schedule of Software Components under SPPIDRIP**

(1) Capacity Development of MOWRAM and PDOWRAM Staff on O&M

The program will be implemented based on existing organizational set-up within MOWRAM and PDOWRAM. Foreign consultant will be assigned at the initial stage of the program to prepare work plan and conduct training needs assessment and trial trainings in the early 2017. In succession, PMU Japan Support Fund will manage overall activities with employing national consultants and utilizing technical curricula accumulated in TSC over 4 years until 2020.

(2) Strengthening of FWUC

This program also will be implemented from 2017 for 2020 commencing with FWUC formation activities followed by organizational management and O&M of irrigation facilities. Overall activities will be monitored and evaluated by PMU Japan Support Fund for regular feed-back to improve activities. Although FWUCs have been already established in RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP areas, their activities and areal coverage are limited. Therefore, adequate time needs to be given for formation and/or restructuring of existing FWUCs.

(3) Strengthening of Agricultural Extension Services

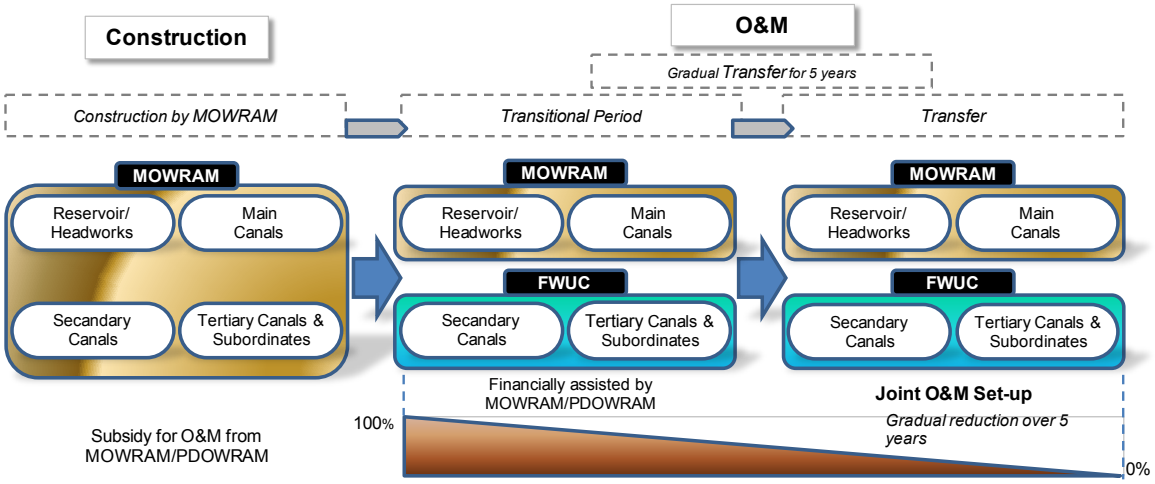
The program will focus on improvement of agricultural productivity (rice and vegetables such as cucumber, string bean, tomato, mung bean etc.) in early rainy season and rainy season cropping over 4 years from 2017 to 2020. Intensive training will be carried out through trial farming in demonstration plots in the RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP Areas, FFS and mass guidance/workshop, particularly during early rainy and rainy season, to be managed by PDA based on the strengthening plan to be prepared by international consultant under the control of technical unit of PMU Japan Support Fund.

## II-4.2 O&M Plan

### II-4.2.1 Basic Consideration

Important principles on the establishment of O&M system of rehabilitated irrigation facilities are as follows:

- Existing FWUC will be re-formulated and/or restructured in each area covering: (i) 570 ha for model area of RCHRSP including 220 ha to be developed by TSC-3 and (ii) 3,500 ha for USISRSP.
- New FWUC will be established and strengthened utilizing existing farmers' group as foundations in 4 Sub-projects: KSBISRSP (3,350 ha), MC35RSP (850 ha), SPWRRSP (1,200 ha) and DPISRSP (1,150 ha).
- Responsibility of O&M on rehabilitated facilities will be transferred to FWUC to be established. Level of facilities to be transferred are not clearly stated in the policy paper, therefore, demarcation of responsibility among the Government and FWUC depends upon the capability of FWUC.
- On the basis of the policy, in reality, it would be proposed that main facilities such as reservoir/headworks and main canals will be managed by PDOWRAM with the support and supervision by MOWRAM while management of secondary and tertiary level of facilities will be carried out by FWUC.
- Transfer of facilities (secondary level facilities in case of SPPIDRIP) to FWUC will be gradually carried out in conformity with Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems showing that step-by-step reduction of government subsidy for the irrigation facilities over 5 years after completion of the construction works. This concept is illustrated in the right figure:
- In this process, involvement of FWUCs from D/D to operation stage is of necessity in order to raise awareness and sense of ownership for irrigation facilities.
- Agreement and/or MOU needs to be prepared between MOWRAM/PDOWRAM, FWUC and local authorities for implementation of joint management as well as transfer of management responsibility of designated facilities.
- Although O&M responsibility of secondary and tertiary canals will be transferred to FWUC, periodical monitoring and technical advice on O&M are required by PDOWRAM at the field level. In this connection, appropriate information management system is required such as record of O&M of facilities, water management, meetings etc. for both PDOWRAM and FWUCs.
- Comparatively large scale maintenance works for major facilities are the responsibility of MOWRAM. Employment of contractors needs to be considered to carry out such works.




*Source: JICA Survey Team*

**Figure II-4.2.1.1 Transfer of O&M of Rehabilitated Facilities**

## II-4.2.2 Demarcation of O&M Responsibility

Regarding the transfer of the management responsibility to FWUC for irrigation facilities and water allocation, the Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems describes as follows:

***Based on the capacity of the farmer organizations, the irrigation schemes shall be transferred to the FWUCs for their sustainable operation and maintenance and for the promotion of irrigated agriculture. Irrigation systems not fully transferred shall be jointly managed by the FWUC and the government.***[1]

According to this explanation, level of facilities to be transferred to FWUC would be determined depending upon the capability of FWUC. In the case of SPPIDRIP, it would be realistic that responsibility on O&M of secondary and tertiary systems and below can be gradually transferred to FWUCs, through 5 years, in line with transfer policy while such major facilities as the Roleang Chrey Headworks, Tumnup Lok Reservoir, Kpob Trobek Reservoir, Daun Pue Headworks, Khpob Krous Reservoir and Srass Prambai Reservoir, to be rehabilitated by SPPIDRIP, will be continuously managed by MOWRAM and PDOWRAM. O&M responsibility of 6 Sub-projects among stakeholders for rehabilitated facilities is proposed in the following table:

**Table II-4.2.2.1 O&M Responsibility among Stakeholders for 6 Sub-projects**

| Level of Facilities / O&M Activities | Reservoir/ Headworks | Main Canals | Secondary Canals | Tertiary Canals and Below |
|---|---|---|---|---|
| Annual O&M Planning | PDOWRAM | PDOWRAM | PDOWRAM/ FWUC | Sub-FWUG |
| Cropping Schedule Preparation | - | - | FWUC/FWUG | Sub-FWUG |
| Operation | PDOWRAM | PDOWRAM | FWUC/FWUG | Sub-FWUG |
| Maintenance | PDOWRAM | PDOWRAM | FWUC/FWUG | Sub-FWUG |

*Source: JICA Survey Team*

Circular No. 1 also described that transfer of O&M responsibility requires: (i) registration of FWUC and (ii) conclusion of agreement between the Department of Irrigated Agriculture of MOWRAM and FWUC. Such arrangement will be considered in the activities of software components on the basis of discussion and consultation with FWUC.

[1] *Page 4 of Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems, MOWRAM*

### II-4.2.3 Staff Required for O&M of Rehabilitated Irrigation Systems

Number of staff to be required for O&M of Sub-project irrigation systems are tabulated as follows:

**Table II-4.2.3.1 Number of Staff Required for O&M of 6 Sub-project Irrigation Systems**

| Organization | Position | No(s). | General Task |
|---|---|---|---|
| **Central Level** | | | |
| PMU Japan Support Fund | Project Director | 1 | - Overall management of O&M |
| | Manager | 1 | - Coordination with relevant departments |
| Sub-total of Central Level (=1) | | **2** | |
| **Provincial Level** | | | |
| Project Implementation Unit (PIU) | | | |
| - Kampong Speu Province<br><br>*Roleang Chrey Irrigation System*<br>*&*<br>*Main Canal 35 System* | Project Manager | 2 | Roleang Chrey Irrigation System (1 no.)<br>- Overall management of O&M at provincial level<br>- Coordination with central level<br>Main Canal 35 System (1 no.)<br>- Overall management of O&M at provincial level<br>- Coordination with central level |
| | Irrigation/O&M | 2 | Roleang Chrey Irrigation System (1 no.)<br>- Water management and O&M at Model Area extending 570 ha<br>Main Canal 35 System (1 no.)<br>- Water management and O&M at Main Canal 35 System (1,200 ha) |
| | Gate Keeper | 2 | Roleang Chrey Irrigation System (1 no.)<br>- Gate operation of Roleang Chrey Headworks<br>Main Canal 35 System (1 no.)<br>- Gate operation of Reservoir |
| Sub-total of Kampong Speu Province (=2) | | **6** | |
| - Takeo Province<br><br>*Upper Slakou Irrigation System*<br>*&*<br>*Kandal-Stung Bati Irrigation System* | Project Manager | 2 | Upper Slakou Irrigation System (1 no.)<br>- Overall management of O&M at provincial level<br>- Coordination with central level<br>Kandal-Stung Bati Irrigation System (1 no.)<br>- Overall management of O&M at provincial level<br>- Coordination with central level |
| | Irrigation/O&M | 3 | Upper Slakou Irrigation System (2 nos.)<br>- Water management and O&M of the system in 3,400ha<br>Kandal-Stung Bati Irrigation System (1 no.)<br>- Water management and O&M of the system (1,600 ha) |
| | Gate Keeper | 1 | Upper Slakou Irrigation System (1 no.)<br>- Gate operation of Tumnup Lok and Kpob Trobek Reservoirs |
| Sub-total of Takeo Province (=3) | | **6** | |
| - Kandal Province<br><br>*Kandal Stung Extension Irrigation System*<br>*&*<br>*Srass Prambai Water Recession System* | Project Manager | 2 | Kandal Stung Extension Irrigation System (1 no.)<br>- Overall management of O&M at provincial level<br>- Coordination with central level<br>Srass Prambai Water Recession System (1 no.)<br>- Overall management of O&M at provincial level<br>- Coordination with central level |
| | Irrigation/O&M | 3 | Kandal Stung Extension Irrigation System (2 no.)<br>- Water management and O&M of the system (1,750ha)<br>Srass Prambai Water Recession System (1 no.)<br>- Water management (gate operation of the reservoir) and O&M of the system (1,200 ha) |
| Sub-total of Kandal Province (=4) | | **5** | |
| - Kampong Chhnang Province<br><br>*Daun Pue Irrigation System* | Project Manager | 1 | - Overall management of O&M at provincial level<br>- Coordination with central level |
| | Irrigation/O&M | 1 | - Water management and O&M of the system (1,200 ha) |
| Sub-total of Kampong Chhnang Province (=5) | | **2** | |
| Sub-total of Provincial Level (=6=1+2+3+4+5) | | **19** | |
| Grand Total (=1+6) | | **21** | |

*Source: JICA Survey Team*

### II-4.2.4 Operation Plan

Out of 6 Sub-projects, USISRSP, MC35RSP and SPWRRSP have a reservoir as water source for irrigation to their command areas. Therefore, operation of intake gates installed at the reservoir should be carefully controlled by observing the water level of reservoir and irrigation calendar. Prior to operation of intake gate, it is essential to prepare a H-V curve and also install the gauging staff in the reservoir. As for DPISRSP, headworks will be newly constructed in order to abstract the river water and to supply it to subsequent main canal. The headworks are of barrage type like Roleang Chrey Regulator, therefore gate operation should be made in the same manner with Roleang Chrey Regulator, especially for flood. In particular, attention should be paid to operation of RCHRSP and KSBISRSP (Kandal Stung Area) since water source for them is the Prek Thnot River and Stung Tasal dam (refer to Figure II-8.4.2.1.1). Also, as shown in this figure, there is an on-going Stung Tasal dam project located upstream of Prek Thnot River, and high cropping intensity of these Sub-projects are realized due to released discharge from the Stung Tasal dam according to the water balance study. Thus, careful operation should be required for the Stung Tasal dam, RCHRSP and KSBISRSP (Kandal Stung Area). In order to make appropriate operation of them, it is proposed to establish the Prek Thnot River Basin Management Unit in MOWRAM and to procure the necessary inputs such as manpower, transportation equipment, computers, and wireless communication equipment under SPPIDRIP as mentioned in Item (3) of Clause II-4.1.3.

### II-4.2.5 Maintenance Plan

(1) Maintenance Activities

Maintenance aims at restoring the system to its full functional performance. It is imperative that in order to remain engaged in agricultural development and consolidation continuously, the irrigation facilities shall always be kept in serviceable condition. Maintenance works can be classified into four categories:

- Regular maintenance works to regularly maintain and improve facilities rehabilitated and constructed under SPPIDRIP
- Periodic and time-bound Maintenance & Repairs including repair of damage portions of facilities
- Emergency maintenance consisting of repair and rehabilitation of occasional damage of the facilities caused by natural disaster such as flood, heavy rainfall and any other causes, and
- Annual maintenance such like the works requiring large volumes and/or special technical skill and know-how.

Regular maintenance or routine maintenance is carried out on a day to day basis, as and where and when required. It is essentially a low-cost activity carried out on local basis, but it is very effective for preventing further damages the repair of which might involve large funding.

Periodic and time-bound maintenance is a planned activity and its aim is to prepare the irrigation system for specific services related to cropping calendar and its requirement. Desilting of canals and restoring their conveyance capacity before the start of cropping season, strengthening and raising of banks after rainy season, restoring the farm roads after rains etc., fall in this category.

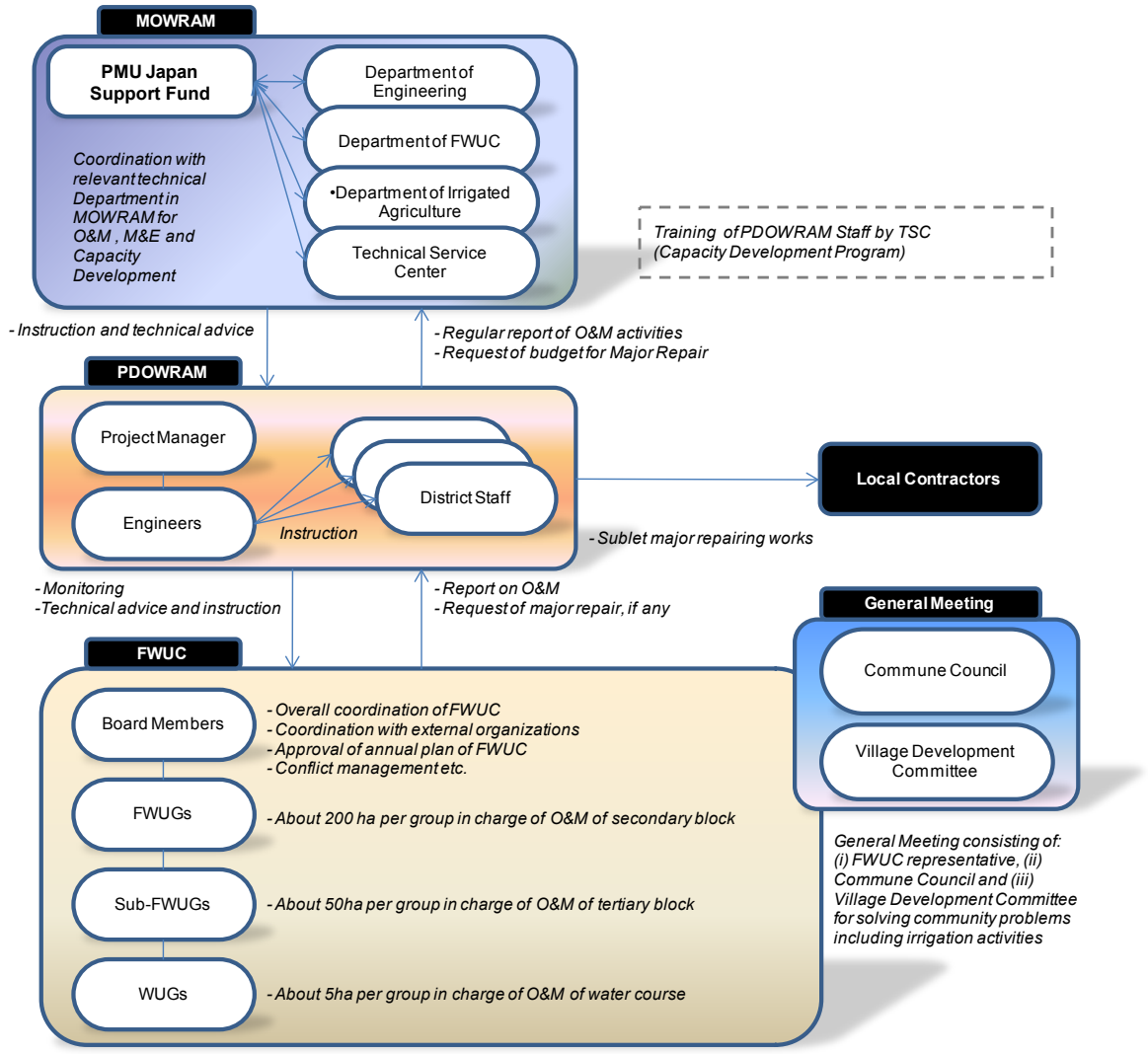
Emergency maintenance and repairs are carried out to restore a sudden and/or serious damage which has caused, or may cause, interruption to irrigation. Canal breaches or damages to regulatory structures come under such calamities which call for emergency maintenance and repairs. It requires quick yet

decisive measures, which first aim to contain the damage by temporary repairs and then consolidating it by permanent repairs followed by its maintenance.

Annual maintenance requires comparatively large volumes and/or special skills such as re-fill of embankment for reservoir and canals, concrete structure repair so forth. As mentioned above, to carry out such works, it would be realistic to employ contractors in contract-basis.

(2) Organizational Set-up

Proposed organizational set-up from the central level to field levels for O&M of irrigation facilities under SPPIDRIP is illustrated in the following figure.




*Source: JICA Survey Team*

**Figure II-4.2.5.1 Proposed Organizational Set-up for O&M of Irrigation Facilities under SPPIDRIP**

Tasks in O&M among stakeholders for irrigation facilities for RCHRSP and USISRSP are tabulated as follows:

**Table II-4.2.5.1 Job Demarcation of O&M among MOWRAM, PDOWRAM and FWUC**

| Organization | Department/ Position | Job Description |
|---|---|---|
| **Central Level** | | |
| MOWRAM | PMU Japan Support Fund | - Overall coordination with relevant technical Department in MOWRAM and external organization for O&M, monitoring and evaluation and capacity development of PDOWRAM |

| Organization | Department/ Position | Job Description |
|---|---|---|
| | Department of Engineering | - In coordination with PMU Japan Support Fund, in charge of engineering advice and instruction |
| | Department of FWUC | - In coordination with PMU Japan Support Fund, in charge of establishment and strengthening of FWUC |
| | Department of Irrigated Agriculture | - In coordination with PMU Japan Support Fund, relevant organizations within MOWRAM, MAFF and PDA, in charge of promotion of irrigated agriculture in the command area using rehabilitated irrigation facilities |
| **Provincial Level** | | |
| PDOWRAM | Project Manager | - Overall coordination at the provincial level<br>- Approval of annual O&M plan prepared by engineer and district staff<br>- Report of provincial and field level activities to MOWRAM<br>- Budget request to MOWRAM for major repairing works based on inspection by Engineers/District Staff<br>- Contract management of sublet work of local contractors |
| | Engineer/District Staff | - Preparation of annual O&M including budgetary plan<br>- Regular monitoring and evaluation of FWUC at the field level<br>- Instruction to FWUC based on annual O&M plan<br>- Technical advice to FWUC<br>- Regular inspection of irrigation facilities at the main level<br>- Report preparation of facilities' conditions based on regular inspection<br>- Report preparation of O&M activities<br>- Operation of major facilities such as reservoir/headworks |
| **Commune and Village Level** | | |
| FWUC | Board of FWUC | - Overall coordination of FWUC activities<br>- Coordination with external organizations such as CCs and VDCs<br>- Approval of annual plan prepared by FWUC<br>- Conflict management among the group |
| | FWUGs | - Established for approximately 200 ha per group in charge of O&M of secondary block<br>- Operation of turnout gate on the main canal in consultation with PDOWRAM |
| | Sub-FWUG | - Established for approximately 50 ha per group in charge of O&M of tertiary block<br>- Operation of turnout gate on the secondary canal in consultation with PDOWRAM |
| | WUGs | - Established for approximately 5 ha per group in charge of O&M of tertiary block<br>- Operation of division box on the tertiary canals |
| Others | General Meeting | - It is proposed that this organization be newly established to facilitate coordination at the community level, members of which would consist of: (i) FWUC representative, (ii) CC members and (iii) VDC members.<br>- In charge of broad-based conflict management in the community including irrigation water management<br>- O&M of community infrastructure such as village roads<br>- Coordination of land acquisition within the community |

*Source: JICA Survey Team*

## II-4.3 Procurement of Office Equipment for O&M

Equipment necessary for SPPIDRIP will be procured for central and provincial levels including Prek Thnot River Basin Management Unit, FWUCs and the Consultant such as vehicles, computers, photocopy machines, stationery etc. as tabulated as follows:

**Table II-4.3.1 List of Office and Equipment for O&M**

| Organization/Irrigation System | Equipment | No(s). |
|---|---|---|
| **Central Level** | | |
| PMU Japan Support Fund | Vehicle | 5 |
| | Motor cycle | 10 |
| **Provincial Level** | | |
| Kampong Speu PDOWRAM | Vehicle | 1 |
| | Motor cycle | 5 |
| | Photocopy machine | 1 |
| | Office furniture | 1 (set) |
| | Computer | 1 (set) |

| Organization/Irrigation System | Equipment | No(s). |
|---|---|---|
| Kandal PDOWRAM | Vehicle | 1 |
| | Motor cycle | 5 |
| | Photocopy machine | 1 |
| | Office furniture | 1 (set) |
| Takeo PDOWRAM | Vehicle | 1 |
| | Motor cycle | 5 |
| | Photocopy machine | 1 |
| | Office furniture | 1 (set) |
| Kampong Chhnang PDOWRAM | Vehicle | 1 |
| | Motor cycle | 5 |
| | Photocopy machine | 1 |
| | Office furniture | 1 (set) |
| **FWUC** | | |
| RCHRSP | Office | 1 |
| | Office furniture | 1 (set) |
| | Photocopy machine | 1 |
| USISRSP | Office | 1 |
| | Office furniture | 1 (set) |
| | Photocopy machine | 1 |
| KSBISRSP | Office | 1 |
| | Office furniture | 1 (set) |
| | Photocopy machine | 1 |
| MC35RSP | Office | 1 |
| | Office furniture | 1 (set) |
| | Photocopy machine | 1 |
| SPWRRSP | Office | 1 |
| | Office furniture | 1 (set) |
| | Photocopy machine | 1 |
| DPISRSP | Office | 1 |
| | Office furniture | 1 (set) |
| | Photocopy machine | 1 |
| **River Basin Management Unit** | | |
| Prek Thnot River Basin Management Unit | Photocopy machine | 1 |
| | Office furniture | 1 (set) |
| | Vehicle | 1 |
| | Motor cycle | 4 |
| | Wireless communication system | 1 (set) |
| **Consultant** | | |
| Consultant for D/D and C/S | Vehicle | 5 |
| | Motor cycle | 10 |
| **Total** | | |
| Transportation equipment | Vehicle | 15 |
| | Motor cycle | 44 |
| Office equipment | Photocopy machine | 11 |
| | Office furniture | 11 (set) |
| Office Building | Office for FWUC | 6 |
| Telecommunication system | Wireless communication system | 1 (set) |

*Source: JICA Survey Team*

# CHAPTER II-5 PROJECT COST ESTIMATE

## II-5.1 Basic Conditions for Cost Estimate

The basic conditions and assumptions employed for the project cost estimate are as follows:

( 1 ) Cost estimate refers to the prices as of November 2011.

( 2 ) The following exchange rates applied for the cost estimate:

1 US Dollar (US$) = 4,084 Riel

= JPY 76.8

( 3 ) Unit prices of labor, construction materials, engineering works, etc., are collected from MOWRAM, PDOWRAMs, and NCDD of the concerned provinces and market.

( 4 ) Project costs are divided into foreign currency portion (F/C) and local currency portion (L/C). Ratios of F/C and L/C are estimated based on the each unit price analysis and by referring to similar types of the projects in Cambodia.

( 5 ) Construction cost is estimated using US Dollars according to the Procurement Manual Volume II for externally financed project/program in Cambodia.

( 6 ) Price escalation rates are assumed to be 1.6%/annum for F/C and 6.7%/annum for L/C.

( 7 ) Physical contingency is 10.0% except for that for consulting services of 5.0%.

( 8 ) Tax (VAT) is 10% according to the Government regulation.

( 9 ) Project administration cost is 3.0% of construction cost.

(10) Interest during construction is 0.01% of accumulated loan portion.

## II-5.2 Project Cost Estimate

### II-5.2.1 Initial Investment Cost for Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project

The initial investment cost for SPPIDRIP which consists of 6 Sub-projects, i.e. RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP, is estimated at US$ 94,045 thousands consisting of JPY 3,839 million for F/C portion and US$ 44,049 thousands for L/C portion as shown in ANNEX F and summarized in the following table:

**Table II-5.2.1.1 Initial Investment Cost for SPPIDRIP**

| No. | Item | Total Investment Cost (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|---|
| (1) | Construction Cost | 45,936 | 2,470 | 13.782 |
| (2) | Tertiary Development Cost | 3,294 | 149 | 1,347 |
| (3) | Procurement Cost | 1,603 | 105 | 235 |
| (4) | Consulting Services Cost | 7,068 | 201 | 4,452 |
| (5) | UXO/Mine Survey Cost | 1,200 | 0 | 1,200 |
| (6) | Software components Activities Cost | 2,712 | 32 | 2,301 |
| (7) | Land Acquisition Cost | 942 | 0 | 942 |
| (8) | Project Administration Cost | 1,378 | 0 | 1,378 |
| (9) | Tax & Duty | 5,910 | 0 | 5,910 |
| (10) | Price Escalation | 16,483 | 553 | 9,402 |
| (11) | Physical Contingencies | 7,494 | 339 | 3,075 |
| (12) | Interest during Construction | 25 | 0 | 25 |
| | **Total** | **94,045** | **3,839** | **44,049** |

*Source: JICA Survey Team*

The initial investment cost is also divided into Loan and MOWRAM portions as follows:

**Table II-5.2.1.2 Loan and MOWRAM Portions of Initial Investment Cost for SPPIDRIP**

| No | Item | Total Investment Cost (US$ 1,000) | Loan portion | | | MOWRAM portion |
|---|---|---|---|---|---|---|
| | | | Total (F/C+L/C) (JPY million) | F/C (JPY million) | L/C (US$ 1,000) | L/C (US$ 1,000) |
| (1) | Construction Cost | 45,936 | 3,527 | 2,469 | 13,782 | 0 |
| (2) | Tertiary Development Cost | 3,294 | 253 | 149 | 1,347 | 0 |
| (3) | Procurement Cost | 1,603 | 123 | 105 | 235 | 0 |
| (4) | Consulting Services Cost | 7,068 | 543 | 201 | 4,452 | 0 |
| (5) | UXO/Mine Survey Cost | 1,200 | 0 | 0 | 0 | 1,200 |
| (6) | Software components Activities Cost | 2,712 | 208 | 32 | 2,301 | 0 |
| (7) | Land Acquisition Cost | 942 | 0 | 0 | 0 | 942 |
| (8) | Project Administration Cost | 1,378 | 0 | 0 | 0 | 1,378 |
| (9) | Tax & Duty | 5,910 | 0 | 0 | 0 | 5,910 |
| (10) | Price Escalation | 16,483 | 1,248 | 544 | 9,179 | 225 |
| (11) | Physical Contingencies | 7,4,94 | 557 | 339 | 2,838 | 237 |
| (12) | Interest during Construction | 25 | 0 | 0 | 0 | 25 |
| | **Total** | **94,045** | **6,461** | **3,839** | **34,132** | **9,917** |

*Source: JICA Survey Team*

(1) Construction Cost

The construction cost for SPPIDRIP includes direct construction costs and costs for general items, miscellaneous works and contractor's expenses and is estimated for the following components of each Sub-project:

Item 1-1: Temporary works and general items

Item 1-2: Headworks, reservoir, regulator, intake structures, pump station and/or other important major structures.

Item 1-3: Diversion canal, main and secondary irrigation and drainage canals and related structures.

Item 1-4: Sub-project office and relevant facilities.

The construction cost for each Sub-project is estimated as shown in AF-2.2 to AF-2.7 of ANNEX F and summarized in the following table:

**Table II-5.2.1.3 Construction Cost for Sub-projects**

| Item and Sub-project | Total (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|
| (a) Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP) | 15,036 | 858 | 3,862 |
| (b) Upper Slakou Irrigation System Rehabilitation Sub-project (USISRSP) | 8,871 | 473 | 2,716 |
| (c) Kandal Stung-Bati Irrigation System Rehabilitation Sub-project (KSBIRSP) | 11,203 | 549 | 4,060 |
| (d) Main Canal 35 Rehabilitation Sub-project (MC35RSP) | 2,728 | 148 | 799 |
| (e) Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) | 2,926 | 175 | 653 |
| (f) Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP) | 5,172 | 267 | 1,692 |
| **Total** | **45,936** | **2,470** | **13,782** |

*Source: JICA Survey Team*

(2) Tertiary Canal System Development Cost

Tertiary canal system development cost includes: (i) national consulting services cost of detailed design and construction supervision and (ii) construction cost for tertiary canal system. The target areas for the tertiary canal system development are a model area of 350 ha in RCHRSP and whole area of 3,500 ha in USISRSP, 3,350 ha in KSBISRSP, 850 ha in MC35RSP and 1,150 ha in DPISRSP, 9,200 ha in total. The construction cost for tertiary canal system of each Sub-project is shown in AF-2.2 to AF-2.7 of ANNEX F. The total land acquisition area required for construction of tertiary canals is

estimated at 100 ha for 5 Sub-projects mentioned above, provided that the average width of canal section including canal bank is 3.5 m and the canal density is around 30 m/ha.

**Table II-5.2.1.4 Tertiary Development Cost for SPPIDRIP**

| Sub-project | Total (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|
| (a) National consulting services for D/D and C/S | 654 | 0 | 654 |
| (b) Construction | | | |
| 1) Model tertiary canal system construction for the Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP) | 114 | 6 | 33 |
| 2) Tertiary canal system construction for the Upper Slakou Irrigation System Rehabilitation Sub-project (USISRSP) | 900 | 52 | 223 |
| 3) Tertiary canal system construction for the Kandal Stung-Bati Irrigation System Rehabilitation Sub-project (KSBISRSP) | 1,016 | 57 | 273 |
| 4) Tertiary canal system construction for the Main Canal 35 Rehabilitation Sub-project (MC35RSP) | 260 | 15 | 70 |
| 5) Tertiary canal system construction for the Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) | 0 | 0 | 0 |
| 6) Tertiary canal system construction for the Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP) | 350 | 20 | 94 |
| **Total** | **3,294** | **150** | **1,347** |

*Source: JICA Survey Team*

(3) Procurement Cost

Procurement cost for SPPIDRIP includes: (i) procurement cost of vehicles, (ii) procurement cost of motorcycles, (iii) procurement cost of office equipment and furniture and (iv) wireless communication system. In addition, office for FWUC of every Sub-project is also procured. The procurement cost is estimated as follows:

**Table II-5.2.1.5 Procurement Cost for SPPIDRIP**

| Item | Total (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|
| (a) 4WD vehicle | 789 | 61 | 0 |
| (b) Motorcycle | 258 | 20 | 0 |
| (c) Office equipment & furniture | 170 | 9 | 55 |
| (d) Wireless communication system | 12 | 1 | 0 |
| (e) Office for FWUC | 375 | 15 | 180 |
| **Total** | **1,603** | **105** | **235** |

*Source: JICA Survey Team*

(4) Consulting Services Cost

The consulting services cost consists of remuneration for necessary foreign and national consultants and direct costs such as office running cost, communication, survey and investigations costs, etc to cover a detailed design and construction supervision for all the Sub-projects. The foreign consultants are consisting of Japanese and non-Japanese. The consulting services cost is estimated as shown in AF-2.1 of ANNEX F and summarized in the following table:

**Table II-5.2.1.6 Consulting Services Cost for SPPIDRIP**

| Component | Total (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|
| (a) Remuneration for foreign and national consultants and office staff | 5,249 | 214 | 2,463 |
| (b) Direct cost | 1,819 | 3 | 1,781 |
| **Total** | **7,068** | **217** | **4,244** |

*Source: JICA Survey Team*

(5) UXO/Mine Survey

The construction sites of SPPIDRIP are located in Takeo, Kampong Speu, Kandal and Kampong Chhnang Provinces and a part of some areas of USISRSP, KSBISRSP and DPISRSP are categorized

as risky "Level 1 Survey Area which defines that the area have some risks with mines surveyed by Cambodian Mine Action Authority (CMAA)" by CMAC. Therefore, prior to the survey and/or the construction, areas to be in construction operation shall be surveyed for clearance of mines. The clearance operation will be entrusted to CMAC and the required cost is estimated as follows:

**Table II-5.2.1.7 UXO/Mine Survey Cost for SPPIDRIP**

| Item | Total (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|
| (a) Roleang Chrey Headworks Rehabilitation Sub-project | 0 | 0 | 0 |
| (b) Upper Slakou Irrigation System Rehabilitation Sub-project | 600 | 0 | 600 |
| (c) Kandal Stung-Bati Irrigation System Rehabilitation Sub-project | 400 | 0 | 400 |
| (d) Main Canal 35 Rehabilitation Sub-project | 0 | 0 | 0 |
| (e) Srass Prambai Water Recession Rehabilitation Sub-project | 0 | 0 | 0 |
| (f) Daun Pue Irrigation System Rehabilitation Sub-project | 200 | 0 | 200 |
| **Total** | **1,200** | **0** | **1,200** |

*Source: JICA Survey Team*

(6) Software Components Activities

The cost for software components activities to cover SPPIDRIP is estimated as shown in AF-2.2 to AF-2.7 of ANNEX F and summarized in the following table:

**Table II-5.2.1.8 Software Component Activities Cost for SPPIDRIP**

| Component | Total (US$ 1,000) | F/C (JPY million) | L/C (US$ 1,000) |
|---|---|---|---|
| (a) Capacity development of MOWRAM & PDOWRAM staff | 628 | 25 | 299 |
| (b) FWUC formation and strengthening | 1,192 | 0 | 1,192 |
| (c) Agricultural support service | 724 | 6 | 642 |
| (d) Financial management | 168 | 0 | 168 |
| **Total** | **2,712** | **31** | **2,301** |

*Source: JICA Survey Team*

(7) Land Acquisition Cost

Land acquisition cost for SPPIDRIP is estimated based on the actual anticipated area for each Sub-project. The land acquisition cost is divided into 2 categories, i.e. (i) land purchase with compensation and (ii) land lease for temporary works, and estimated as shown in the following table:

**Table II-5.2.1.9 Land Acquisition Cost for SPPIDRIP**

| Component | Area (ha) | | Amount (US$ 1,000) | | |
|---|---|---|---|---|---|
| | Acquisition* | Lease ** | Acquisition | Lease | Total |
| (a) Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP) | 15.0 | 9.7 | 300 | 0 | 300 |
| (b) Upper Slakou Irrigation System Rehabilitation Sub-project (USISRSP) | 0.5 | 0.0 | 10 | 0 | 10 |
| (c) Kandal Stung-Bati Irrigation System Rehabilitation Sub-project (KSBISRSP) | 5.0 | 0.0 | 100 | 0 | 100 |
| (d) Main Canal 35 Rehabilitation Sub-project | 16.0 | 0.0 | 320 | 0 | 320 |
| (e) Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) | 0 | 0.0 | 0 | 0 | 0 |
| (f) Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP) | 10.6 | 1.0 | 212 | 0 | 212 |
| **Total** | **47.1** | **10.7** | **942** | **0** | **942** |

** For the project office and main and secondary systems only*
***Temporary works for Roleang Chrey Headwork s and Daun Pue Headworks for 3 years and cost for lease is counted in construction cost*
*Source: JICA Survey Team*

## II-5.2.2 O&M Cost

(1) Annual O&M Cost

Annual O&M cost includes: (i) salary and wages for staff personnel of PDOWRAM and FWUC which consists of board members of FWUC and FWUGs and (ii) direct cost for minimum office expenses and

repairing works. The annual O&M cost is estimated at 0.05% of direct construction cost for each Sub-project.

(2) Major Repair Cost

Major repair including replacement will be executed every 10 years after the completion of the construction works and the cost is assumed to be 5% of the construction costs, by referring to similar types of projects in Cambodia.

## II-5.3 Disbursement Schedule

The annual disbursement schedule is prepared based on the Project implementation schedule shown in Figure II-4.1.5.8.1. The annual disbursement schedule is shown in Attachment-1 of ANNEX F and summarized in the following table:

**Table II-5.3.1 Annual Disbursement Schedule for SPPIDRIP**

| Year | Total (US$ 1,000) | F/C (US$ 1,000) | L/C (US$ 1,000) |
|---|---|---|---|
| 2013 | 2,402 | 752 | 1,649 |
| 2014 | 1,514 | 486 | 1,029 |
| 2015 | 1,697 | 457 | 1,240 |
| 2016 | 4,483 | 1,818 | 2,665 |
| 2017 | 20,469 | 10,404 | 10,064 |
| 2018 | 28,613 | 15,292 | 13,321 |
| 2019 | 26,830 | 16,160 | 10,670 |
| 2020 | 8,036 | 4,646 | 3,390 |
| 2021 | 0 | 0 | 0 |
| **Total** | **94,045** | **50,016** | **44,029** |

*Source: JICA Survey Team*

# CHAPTER II-6 PROJECT EVALUATION

## II-6.1 Evaluation Conditions

The economic evaluation is made aiming to justify the economic viability of SPPIDRIP, comprising 6 Sub-projects such as RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP, in due consideration of the assumptions as listed up below:

- The evaluation period is 50 years from 2013;
- Exchange rate is US$ 1.0 = Riel 4,084 = JPY 76.8 as of November 2011;
- Economic project cost covers direct cost of civil works, procurement cost of equipment and consulting services, implementation cost of software-component programs, O&M cost of project facilities, and physical contingency for the respective cost items. The financial cost estimated is converted to the economic cost by applying the standard conversion factor (SCF) of 1.000 to foreign currency portion and 0.978 to local currency portion of each cost item, and also the shadow wage rate factor of 0.601 to skilled labor cost and 0.363 to unskilled labor cost, both included in local currency portion of the direct cost of civil works and O&M cost. Since the estimated project costs of KSBISRSP and MC35RSP include pre-investment cost for the future project components, the concerned cost is excluded from the economic project cost for the economic evaluation purpose;
- Project benefits are composed of imputed loss of profits borne if the existing the Roleang Chrey Headworks are totally malfunctioned and incremental net return generated by implementing 5 Sub-projects under SPPIDRIP and the Model Area development in RCHRSP. Financial project benefits estimated on the basis of crop budgets are converted to economic project benefits by referring to FOB or CIF forecasted price data[1] as export or import goods. The project benefit is to be produced from the first year or 2017 after partly completing civil works and reach to the target level in 2024; and
- The economic viability of project is expressed in the form of NPV, B/C and EIRR, while the financial viability of SPPIDRIP is to be examined focusing on beneficial farmers' perspective in terms of their capacity to pay.

## II-6.2 Economic Evaluation

Considering specific features of the respective Sub-projects under SPPIDRIP, the expected project benefits are to be categorized into 3 types:

- The first type is defined as an incremental net benefit that is attributable to the anticipated increase in the total net return from crop production by securing irrigation water supply to paddy cultivation for the both early rainy and rainy seasons in Sub-project Areas such as USISRSP, KSBISRSP, MC35RSP and DPISRSP as well as the Model Area of RCHRSP where irrigation and drainage facilities will be newly constructed or rehabilitated under the Sub-project. In the MC35RSP Area, irrigated paddy cultivation for early wet season is practiced at the downstream of exiting reservoir, but its coverage is negligible small so that its production output is not counted in the project evaluation;

*1 Projections as of January 17, 2012 by the World Bank Economic Policy and Prospects Group*

- The second type is defined as an incremental net benefit that is attributable to the anticipated increase in the total net return from crop production by creating a new stable water resource facility for supporting the prevailing pump irrigation system in the SPWRRSP Area; and
- The third type is defined as an imputed loss of profits that are attributable to the surplus of net returns earned from crop production in the RCHRSP Area between under the existing partially irrigated condition and under the fully rain-fed condition.

Based on the basic assumptions set up in ANNEX G, the economic project benefits for the above 3 types are predicted and the economic project cost is computed by converting the financial project cost. The annual disbursement of initial investment cost, O&M cost and increment net benefit of the proposed SPPIDRIP Plan for the initial 12-year period up to 2024 is summarized in the form of cash flow of economic cost and benefit as presented in Table II-6.2.1.

**Table II-6.2.1 Cash Flow of Economic Cost and Benefit**

(Unit: US$ 1,000)

| Item | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment cost | 2,170 | 1,325 | 1,405 | 3,072 | 13,590 | 20,028 | 14,800 | 5,542 | - | - | - | - |
| O&M cost | - | - | - | - | 11 | 68 | 157 | 216 | 239 | 239 | 239 | 239 |
| Increment benefit | - | - | - | - | - | 3,036 | 5,569 | 7,402 | 9,641 | 10,039 | 10,164 | 10,288 |

*Source: JICA Survey Team*

From the above cash flow of economic cost and benefit, the economic evaluation is made in terms of NPV, B/C ratio and EIRR of the proposed rehabilitation plan. In addition, sensitivity analyses are done for such cases as cost increase of 10% and 20%, benefit reduction of 10% and 20%, and combination of each case. The results of the economic evaluation are summarized in Table II-6.2.2.

**Table II-6.2.2 Results of Economic Evaluation**

| Evaluation Item | Evaluation Results | | | |
|---|---|---|---|---|
| NPV at 12 % discount rate | NPV of benefit (US$) | 41,028,255 | NPV (US$) | 6,642,769 |
| | NPV of cost (US$) | 34,385,486 | | |
| B/C ratio and EIRR | B/C ratio | 1.19 | EIRR (%) | 14.3 |
| Sensitivity analysis (%) | | Cost normal | Cost 10% up | Cost 20% up |
| | Benefit normal | 14.3 | 13.0 | 11.9 |
| | Benefit 10% down | 12.9 | 11.7 | 10.7 |
| | Benefit 20% down | 11.5 | 10.4 | 9.5 |

*Source: JICA Survey Team*

## II-6.3 Economic Evaluation on Alternative Case

Considering the current situation to create a new regulated irrigation water source by constructing the Stung Tasal Dam on upper reach of the Prek Thnot River System, the water balance study for RCHRSP was made through the Survey. Its result reveals that the command area of RCHRSP will be able to be irrigated up to 12,600 ha during the early rainy season and 16,000 ha during the rainy season with 80% dependability from hydrological point of view. In this regard, the impact of sustainable irrigation water source creation on predicted increase in irrigated paddy cultivation areas of the RCHRSP command area is evaluated focusing on the capacity of irrigation canal system coupled with cropping intensity as well as the expected yield level of irrigated paddy cultivation.

As development of tertiary canal system and provision of intensive farming guidance are limited to the 570-ha model area of RCHRSP in this Survey, the impact is conservatively quantified in the following manner:

- In terms of irrigation facility condition, the capacity of main and secondary canal systems will be the same as it is, although necessary cost for rehabilitation works are appropriated. As a

result, the expected irrigation water supply condition will be upgraded to only the existing level of model area without tertiary canal system;

- As for cropping pattern, irrigated paddy cultivation will be expected to be practiced fully in 16,000 ha paddy fields during the rainy season and 5,600 ha during the early rainy season, corresponding to the present cropping intensity of 135% in the model area; and
- Concerning paddy yield, the rainy season paddy will be 2.31 ton/ha and the early rainy season paddy will be 2.79 ton/ha which are the same as the current yield level in the model area under the condition of without provision of intensive farming guidance.

Taking the above conditions into account, the economic project benefit is calculated, while the same economic project cost is appropriated. The annual disbursement of initial investment cost, O&M cost and increment net benefit of the proposed SPPIDRIP Plan for the initial 12-year period up to 2024 is summarized in the form of cash flow of economic cost and benefit as presented in Table II-63.1.

**Table II-6.3.1 Cash Flow of Economic Cost and Benefit for Alternative Case**

(Unit: US$ 1,000)

| Item | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment cost | 2,170 | 1,325 | 1,405 | 3,072 | 13,590 | 20,028 | 14,800 | 5,542 | - | - | - | - |
| O&M cost | - | - | - | - | 11 | 68 | 157 | 216 | 239 | 239 | 239 | 239 |
| Increment benefit | - | - | - | - | - | 3,036 | 5,569 | 7,402 | 13,099 | 13,498 | 13,662 | 13,747 |

*Source: JICA Survey Team*

From the above cash flow of economic cost and benefit, the economic evaluation is made in terms of NPV, B/C ratio and EIRR of the proposed rehabilitation plan. In addition, sensitivity analyses are done for such cases as cost increase of 10% and 20%, benefit reduction of 10% and 20%, and combination of each case. The results of the economic evaluation are summarized in Table II-6.3.2.

**Table II-6.3.2 Results of Economic Evaluation for Alternative Case**

| Evaluation Item | Evaluation Results | | | |
|---|---|---|---|---|
| NPV at 12 % discount rate | NPV of benefit (US$) | 52,568,465 | NPV (US$) | 18,182,978 |
| | NPV of cost (US$) | 34,385,486 | | |
| B/C ratio and EIRR | B/C ratio | 1.53 | EIRR (%) | 17.7 |
| Sensitivity analysis (%) | | Cost normal | Cost 10% up | Cost 20% up |
| | Benefit normal | 17.7 | 16.3 | 15.0 |
| | Benefit 10% down | 16.1 | 14.8 | 13.7 |
| | Benefit 20% down | 14.5 | 13.3 | 12.2 |

*Source: JICA Survey Team*

## II-6.4 Financial Evaluation

Financial evaluation aims to examine how much beneficiary farmer's capacity to pay will increase and also presume how much an individual beneficiary farmer will be able to share annual O&M cost of irrigation system after the implementation of proposed rehabilitation plan in the SPPIDRIP Area. The average planted area of paddy per 1-ha paddy field in the whole SPPIDRIP Area is anticipated to be 0.96 ha under the present/without project condition and 1.25 ha under the with-project condition. Based on such conditions, it is estimated that the annual net return per farm household growing paddy and vegetables on paddy field will increase by US$ 825 from US$ 418 to US$ 1,243 on the weighted average base. According to the proposed plan, the required annual O&M cost of secondary and tertiary canal systems are estimated at US$ 7.2/ha to a maximum extent. Adding annual charge of management cost for FWUC and FWUG, every beneficiary farmer needs to pay about US$ 10/ha annually. Compared with the predicted increase in farmer's capacity to pay by US$ 825/ha, this allocated annual O&M cost is affordable to the respective beneficiaries.

Another aim of financial evaluation is to grasp the impact of increased crop production in paddy field on farm economy of beneficiary farmers. Since the average holding size of paddy field in the SPPIDRIP Area is 0.98 ha per farm household, it can be expected to increase gross income by US$ 881 or 117% and net return defined as disposable income by US$ 631 or 136% through implementation of SPPIDRIP. Although the average holding size of paddy field differs sub-project by sub-project ranging between 0.39 ha and 1.77 ha, beneficiary farmer's disposable income attributable to increased paddy production can be expected to become at least more than two times before implementation of the project.

### II-6.5 Indirect Benefits and Socio-economic Impacts

As a typical case of indirect benefits generated through implementation of the proposed construction and rehabilitation works, temporary employment opportunities will be generated in and around the 6 Sub-project Areas of SPPIDRIP. It is predicted that the total requirement of unskilled labors is around 1.3 million person-days during the 4-year construction period. Except for peak time of farm operation like transplanting and harvesting, therefore, local residents will be able to earn additional cash income if they intend to utilize such temporary job opportunities. The total households in 82 Communes where 6 Sub-projects are located are estimated at around 104,000, of which about 40% is engaged in farming activities according to the result of Socio-Economic Survey conducted by the JICA Survey Team in August 2011. Thus, it is expected that extra cash income per farm household can be earned by taking advantages of such temporary job opportunity for 31 person-days on an average.

Concerning socio-economic impacts when implemented, the proposed project would create various impacts on the direct beneficiaries attributable to an increase in their net household income are expected:

- To enable them to improve nutritionally balanced diet and primary health care conditions of their family members;
- To ensure their children complete primary schooling, have access higher education and participate in the early childhood education program; and;
- To enable them to buy goods and services as well as luxuries for meeting families' needs contributing to rural economy with positive effects.

Additional socio-economic impacts expected through adding funds amounting to US$ 1,200,000 for de-mining to the project cost for USISRSP, KSBISRSP and DPISRSP is to contribute to reduction of casualties from landmines and explosive remnants of war, as the period for landmine clearance was officially decided by the government to extend until 2019 and to clear another 47,000 ha for the coming 10-year period.

### II-6.6 Operation and Effect Indicators

#### II-6.6.1 Operation Indicators

Operation indicators proposed for monitoring SPPIDRIP are listed in Table II-6.5.1.1.

The project benefit is to be borne from the next year after the completion of civil works and reach to the target yield in the third year. For the case of RCHRSP, operation indicators need to be selected from hydrological viewpoints in order to confirm whether the design capacities of diversion systems will be maintained at the original level aiming to ensure satisfaction of irrigation water demand in command areas.

**Table II-6.6.1.1 Operation Indicators for SPPIDRIP**

| Indicator / Sub-project | Unit | RCHRSP | USISRSP | KSBISRSP | MC35RSP | SPWRRSP | DPISRSP |
|---|---|---|---|---|---|---|---|
| Net irrigation area | ha | 570 | 2,400 | 3,350 | 850 | 1,200 | 1,150 |
| Planted area of paddy | ha | 855 | 3,700 | 6,030 | 980 | 1,270 | 1,150 |
| Cropping intensity of paddy | % | 150 | 154 | 189 | 115 | 106 | 100 |
| Establishment of FWUC | | | | | | | |
| - FWUC | nos. | 1 | 1 | 1 | 1 | 1 | 1 |
| - FWUG | nos. | 3 | 14 | 18 | 6 | 5 | 4 |
| - Sub-FWUG | nos. | 22 | 106 | 67 | 20 | - | 23 |
| Collection rate of water charge | % | 90 | 80 | 80 | 80 | 80 | 80 |
| Design discharge | | | | | | | |
| - Roleang Chrey Regulator* | $m^3$/sec | 5.0 | - | - | - | - | - |
| - Andong Sla Intake Gate | $m^3$/sec | 10.3 | - | - | - | - | - |
| - Vat Krouch Intake Gate | $m^3$/sec | 16.3 | - | - | - | - | - |

*Note: *; Discharge consists of river maintenance flow and responsible discharge for downstream irrigation areas.*
*Source: JICA Survey Team*

## II-6.6.2 Effect Indicators

Effect indicators selected for monitoring the first type of predicted benefits to be born through the proposed development or rehabilitation of irrigation and drainage systems are paddy yield and production at the end of build-up period that is the fourth year after practicing improved farming method. These indicators are to be applied to 4 Sub-projects, USISRSP, KSBISRSP, MC35RSP and DPISRSP as well as the Model Area of RCHRSP. As for the second type of predicted benefits attributable to creation of the proposed water source facility, paddy yield and production for the dry season are taken up as effective indicators taking the access condition to the SPWRRSP site into account. Concerning the third type of predicted project benefits, recovery condition of irrigation water supply area is to be provisionally selected as a qualitative indicator until improvement works of main and secondary canal systems as well as tertiary system development works will be undertaken. At that time, it will be required to carry out a baseline survey aiming at collection of relevant data to the both operation and effect indicators. The effective indicators selected are summarized in Table II-6.5.2.1.

**Table II-6.6.2.1 Effect Indicators for SPPIDRIP**

| Type of Project Benefit | Unit | 1st & 3rd | 1st | | | | 2nd |
|---|---|---|---|---|---|---|---|
| Sub-project | | RCHRSP | USISRSP | KSBISRSP | MC35RSP | DPISRSP | SPWRRSP |
| Paddy yield for early rainy season | | | | | | | |
| - Early rice | ton/ha | 4.00 | 4.00 | 4.00 | 4.00 | - | - |
| Paddy yield for rainy season | | | | | | | |
| - Medium rice | ton/ha | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | - |
| Paddy yield for dry season | | | | | | | |
| - Early rice | ton/ha | - | - | - | - | - | 5.00 |
| Paddy production (annual) | | | | | | | |
| - Annual | ton | 3,278 | 13,600 | 23,445 | 3,495 | 4,025 | - |
| - Dry season | ton | - | - | - | - | - | 6,000 |
| Irrigation water supply area | ha | 10,270 | - | - | - | - | - |

*Source: JICA Survey Team*

## II-6.6.3 Procedures for Monitoring Operation and Effect Indicators

The operation and effect indicators above mentioned will be collected by the persons concerned who will carry out baseline survey and M&E. Based on the collected data, monthly, quarterly and annual report will be prepared by them. After finishing SPPIDRIP, M&E activity will be handed over to MOWRAM.

# CHAPTER II-7 ENVIRONMENTAL AND SOCIAL CONSIDERATION

## II-7.1 List of Laws and Regulations

The main legislations related to natural and social environment in Cambodia are tabulated as follows:

**Table II-7.1.1 List of Major Legislations for Environment**

| Category | Title |
|---|---|
| Basic Law | Law on Environmental Protection and Natural Resources Management (1996) |
| Institution | Sub-decree on Organization and Functions of Ministry of Environment (1997) |
| | Declaration on the Organization of the Provincial and Municipal Environment Department (1999) |
| Environmental Impact Assessment | Sub-decree on the Environmental Impact Assessment Process (1999) |
| | (Draft) Guideline for conducting Environmental Impact Assessment Report |
| Pollution Control | Sub-decree on Water Pollution Control (1999) |
| | Sub-decree on Solid Waste Management (1999) |
| | Sub-decree on Air and Noise Pollution Control (2000) |
| Resettlement and Land acquisition | Constitution (1993) |
| | Land Law (2001) |
| | Expropriation Law (2010) |
| | Sub-Decree on Social Land Concession (2003) |
| | (draft) Sub-Decree on Addressing Socio-Economic Impacts caused by Development Projects (2007) |
| Protected Area | Decree on Creation and Designation of Protected Areas (1993) |
| | Declaration No.1033 on Protected Areas (1994) |

*Prepared by JICA Survey Team*

## II-7.2 JICA Guidelines for Environmental and Social Consideration, April 2010

### II-7.2.1 General

JICA proclaimed anew "JICA guidelines for environmental and social considerations" (hereinafter "the new Guidelines") on April, 1st, 2010 by consolidating the guidelines for environmental and social considerations previously used by former JBIC and JICA into a single set of guidelines along the merger of 2 agencies. The new Guidelines have come into effect since July 1st, 2010, and have been applied to the projects which were obliged to apply the guidelines by project proponents and funding institutions, on after the effective date (July 1st, 2010) of the guidelines.

For the preparation of guidelines, JICA established a committee, members of which consisted of academics, NGOs, the private sector and relevant ministries, and all the meetings of the committee were open to the public. In addition, the guidelines were prepared through public comments and consultation process to ensure transparency and accountability.

Main points of the new Guidelines are: (i) consolidation of procedures for technical cooperation, loan and grant aid projects, (ii) enhancement of information disclosure, (iii) enhancement of involvement of advisory committee and (iv) strengthening of the requirements for environmental review

### II-7.2.2 Contents of Environmental Checklist for Irrigation Project

The contents of the JICA environmental checklist of irrigation projects elaborated in the new Guidelines are shown below. Accordingly, the environmental review for irrigation project needs to be carried out from the view point of six categories: (i) permits and explanation, (ii) pollution control, (iii) natural environment, (iv) social environment, (v) others and (vi) note.

**Table II-7.2.2.1 Summary of Environmental Checklist 16 Agriculture, Irrigation and Livestock Industry**

| Category | Environmental Item |
|---|---|
| 1) Permits and Explanation | (a) EIA and Environmental Permits |
| | (b) Explanation to the local Stakeholders |
| | (c) Examination of Alternative |
| 2) Pollution Control | (a) Water Quality |
| | (b) Wastes |
| | (c) Soil Contamination |
| | (d) Subsidence |
| | (e) Odor |
| 3) Natural Environment | (a) Protected Areas |
| | (b) Ecosystem |
| 4) Social Environment | (a) Resettlement |
| | (b) Living and Livelihood |
| | (c) Heritage |
| | (d) Landscape |
| | (e) Ethnic Minorities and Indigenous Peoples |
| | (f) Working Conditions |
| 5) Others | (a) Impacts during Construction |
| | (b) Monitoring |
| 6) Note | (a) Reference to Checklist of Other Sectors |
| | (b) Note on Using Environment Checklist |

*Source : JICA Survey Team*

## II-7.3 Environmental and Social Impacts Anticipated

### II-7.3.1 Permits and Explanation on Official EIA Process

An EIA or IEIA is required for an irrigation development project with more than 5,000 ha of the development area under the Cambodian environmental legislation system. Even though the development area is less than 5,000 ha, IEIA is required if MOE concludes that the project may cause significant adverse impacts and IEIA is necessary.

All the Sub-projects handled in the survey target the rehabilitation and improvement of the existing facilities of the systems, and their command areas are less than 5,000 ha as shown in Table II-7.3.1.2. Considering the natures of the Sub-projects, the EIA section of MOE judged and suggested that the all Sub-projects require IEIA prior to the implementation.

In order to facilitate the process that MOWRM needs to go through for acquisition of the environmental approval, the preparatory survey team carried out an assessment survey equivalent to an IEIA and prepared an IEIA report as shown in ANNEX H.

**Table II-7.3.1.1 List of Projects Required for IEIA or EIA (Agriculture)**

| Type and activities of the projects | Size/Capacity |
|---|---|
| 1) Concession forest | ≧10,000ha |
| 2) Logging | ≧500ha |
| 3) Land covered by forest | ≧500ha |
| 4) Agriculture and agro industrial land | ≧10,000ha |
| 5) Flooded and coastal forests | All sizes |
| 6) **Irrigation systems** | **≧5,000ha** |
| 7) Drainage systems | ≧5,000ha |
| 8) Fishing ports | All sizes |

*Source : JICA Survey Team*

**Table II-7.3.1.2 Scale of each Command Area**

| Scale of Command Area | Size |
|---|---|
| RCHRSP | Less than 1,000ha |
| USISRSP | 3,500 ha |
| KSBISRSP | 3,350 ha |
| MC35RSP | 850 ha |
| SPWRRSP | 700 ha |
| DPISRSP | 1,151 ha |

*Source : JICA Survey Team*

### II-7.3.2 Results of Examination by Impacts Matrix

Environmental scoping matrix for each 6 Sub-project is undertaken to identify anticipated positive/negative environmental impacts to be examined. The summary of the scoping is shown in Table II-7.3.2.1.

### II-7.3.3 Anticipated Negative Impacts by Each Project

The IEIA by the JICA Survey Team reveals that there would be no severe environmental impacts caused by the Sub-projects as long as the proper mitigation measures proposed by the JICA Survey Team are appropriately taken. The results of the assessment including potential impacts as well as mitigation measures associated with the respective impacts are shown in ANNEX H, and summarized in Tables II-7.3.3.1 - II-7.3.3.6. The following sub-sections further describe some highlights of the results of the assessments.

#### II-7.3.3.1 Roleang Chrey Headworks Rehabilitation Sub-project

The implementation of the Sub-project may cause some adverse social impacts during the planning/designing and construction phases and the pollution of river water during the construction phase. Among other things, the following 2 issues need to be particularly considered in the implementation of RCHRSP.

(1) Land Use and Utilization of Local Resources (Construction Phase)

(a) Activity

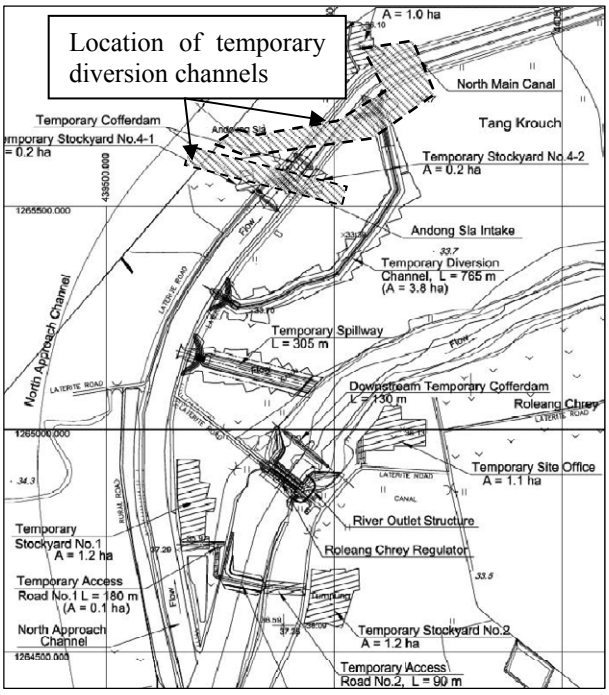
- Rehabilitation works of regulator, canals/drainages and other related facilities

(b) Affected Area

- Areas surrounding the Roleang Chrey Regulator

(c) Expected Potential Impacts

The lands for the temporary diversion channels, construction office and other related facilities need to be temporarily acquired for about 2 years in the construction stage. Further land acquisition is required for the 3 km extension of the existing drainage canal. However, there is no land acquisition expected for rehabilitation of NMC and SMC since its related works are only rehabilitation of existing structures.




*Source; JICA Survey Team*

**Figure II-7.3.3.1.1 Location of Required Temporary Land Acquisition**

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To design temporary diversion channels, other temporary related facilities and drainage canals by minimizing land acquisition as much as possible during D/D;
- To conduct a detailed socio-economic survey of potentially-affected families/persons in the project preparatory stage to assess all losses that would result from the land acquisition;
- To fairly compensate all affected families/persons, including those without a title to land, for all their losses at reasonable rates or replacement rates, if any; and
- To properly restore the affected area after construction works.

(e) Conclusion of Examination

Land acquisition process should be conducted carefully from design phase. Average holding size of agricultural land is only 0.84 ha per HH in the RCHRSP Area. Even through area to be acquired is small, it might not be small impacts to the affected people. The impacts of temporary land acquisition also would be sensitive issues to local people. Therefore, this matter may have a high risk of social problem for project implementation if proper measures are not carried out.

(2) Water Usage or Water Rights and Rights of Common (Construction Phase)

(a) Activity

- Rehabilitation works of regulator, canals/drainages and other related facilities

(b) Affected Area

- Areas surrounding the Roleang Chrey Regulator

(c) Expected Potential Impacts

The water flow of the river will be stopped for rehabilitation of SMC and secondary canals during the construction phase. The stoppage of the flow will be done in the dry season in principle to lessen the impacts on farm production in the area. Nevertheless, it would affect a total of about 12,000 people who have used the river water for domestic purposes during the dry season. Furthermore, some rehabilitation works may be conducted even during the rainy season, which is the main cropping season in the area. In such cases, agricultural production in some areas might be adversely affected by RCHRSP.

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To set a work schedule to complete construction works during the dry season so as not to impacts farm production;
- To intensively manage the construction works and keep to the schedule to complete the works during the fallow period;
- To hold a series of stakeholder meetings when preparing a detailed schedule for the construction works to build consensus among stakeholders including affected people;
- To examine the possibility of developing an alternative water source like a pump well for drinking and domestic purposes for those who would be affected by the stoppage of the river to avoid their additional burden; and
- To distribute water for drinking and domestic use by water tanker for the affected people during construction phase

(e) Conclusion of Examination

Due consideration shall be given to this issue, especially the current use of river water during the dry season, since approximately 12,000 people are expected to be affected by the rehabilitation works of SMC as reported by the feasibility study on the Sub-project. The proposed mitigation measures shall be approximately taken even in the planning/designing phase as specified above.

#### II-7.3.3.2 Upper Slakou Irrigation System Rehabilitation Sub-project

USISRSP may cause similar adverse impacts as outlined below:

(1) Land Use and Utilization of Local Resources (Planning /Design Phase)

(a) Activity

- Rehabilitation canals/drainages and other related facilities
- Rehabilitation of the existing dike of Tumnup Lok Reservoir)

(b) Affected Area

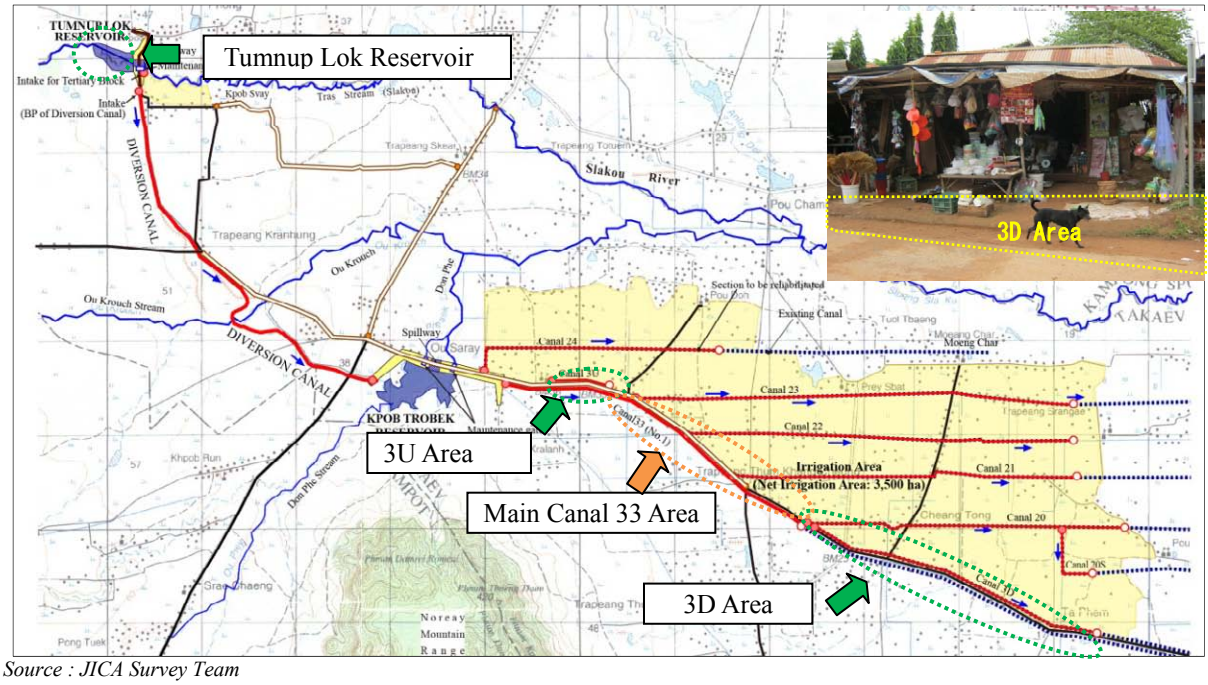
- Areas along canals/drainages,
- Area of the Tumnup Lok Reservoir

(c) Expected Potential Impacts

Expected potential impacts by each proposed canal alignment is shown below. The number of affected house, related facilities and area are just in round number from the field visit. Socio-economic and inventory of losses survey reveal the exact number.

Secondary Canal 3D Area (3D)

There are permanent and temporary houses, shops and other buildings located along 3D as shown below.




*Source : JICA Survey Team*

**Figure II-7.3.3.2.1 Location Map of Social Environmental Issues on USISRSP**

**Table II-7.3.3.2.1 Number of Affected Buildings and Other Facilities on 3D**

| Objectives | | Number | Total | Remarks |
|---|---|---|---|---|
| Shop | Permanent | 7 | 33 | - |
| | Temporary | 26 | | |
| House (not residential) | Permanent | 4 | 15 | - |
| | Temporary | 11 | | |
| Other facilities | | | 40 | Fences, Gates |
| Canal crossing | | | 122 | Constructed for crossing canals |
| Total | | | 210 | - |

*Source: JICA Survey Team*

All the canal crossings and part of some buildings are currently located in the proposed alignment of 3D and its right of way. They need to be removed and/or relocated when the rehabilitation works start.

Secondary Canal 3U Area and Main Canal 33 Area (3U & Main Canal 33)

The rehabilitation of 3U and Main Canal 33 would face a similar situation to that 3D would. A preliminary site investigation carried out by the JICA Survey Team reveals that about eight houses and about 20 houses might be affected by the rehabilitation of 3U and Main Canal 33, respectively, and all the houses are not for residential use.

Tumnup Lok Reservoir

At present, there are about 20 houses residing within the potential inundation area of the proposed reservoir using about 130 ha of the area as paddy fields. Such paddy fields will be totally submerged by the construction of Tumnup Lok Reservoir, although their houses are located in the areas topographically higher than the designed water level of the proposed reservoir. Regarding paddy field inside the reservoir area, the following issues have been confirmed during F/S. In the F/S report, the characteristics of such HHs and paddy fields were analyzed as follows:

- No farmer had legitimate right to use the reservoir area for paddy production since the areas were registered as the state property in accordance with the regulations. All the 20 families were aware of their illegality;
- MOWRAM had already explained this matter to those staying inside the reservoir area;
- The families showed their willingness to continue farming in the reservoir area at their own risk if MOWRAM allowed them to do so; and
- MOWRAM should prepare a land acquisition policy in consideration of the above-mentioned issues.

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To conduct a detailed socio-economic survey of the affected families/people in the beginning of the project preparation stage to estimate all the potential losses resulting from land acquisition;
- To establish a joint committee, composed of the executing agency, other related/relevant agencies, and local authorities, as a decision making body to launch and facilitate the process of land acquisition;
- To hold stakeholder meetings with local families/people including those affected by USISRSP;
- To develop a land acquisition and compensation policy through mutual discussions among/between the joint committee and the affected c/people; and
- To prepare a realistic schedule of land acquisition and inform the affected families/people of the schedule well in advance.

(e) Conclusion of Examination

The process of land acquisition should be carefully and properly conducted from the design phase as USISRSP might affect more than 200 buildings/facilities, such as houses, shops, fences, and canal crossings (small bridges and landfills) on canals, as described above. Although the Land Law (2001) provides MOWRAM with legal bases for evicting encroachers without compensation or reimbursement for losses of immovable property in the state lands, the new Guidelines strongly require the recipient countries (i.e., MOWRAM) to give any affected families/people, including non-title holders, the right to claim compensation for any losses or expenses for restoration/maintenance of their property.

The Resettlement Unit of MOWRAM (MOWRAM-RU), with the assistance of the JICA Survey Team, conducted a socio-economic and inventory of losses survey and finalized the draft resettlement

framework (DRF) in March 2012, survey result summary of DRF is shown Table-II-7.3.3.2.2. DRF defines non-title holders as a target group for compensation and incorporates special consideration for voluntary groups into the framework. It also proposes examining the new alignment of some parts of the main canals to minimize the potential negative impacts on local people as a result of public consultations. DRF is shown in ANNEX J.

**Table II-7.3.3.2.2 Number of Affected Buildings and Other Facilities**

| Asset / Area | Land | | Number of Assets | | | | | | Affected HHs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rice Land ($m^2$) | Residential Land ($m^2$) | House | Stall/ Shop | Other facilities* | Economic Tree | Concrete Fence (m) | Steel Fence (m) | Number of Aps (HHs) | Vulnerable Group (HHs) |
| Area along canals | 42,200 | 31,368 | 23 | 51 | 125 | 5,410 | 402 | 217 | 1,951 (368) | 63 |
| Tumnup Lok Reservoir | 1,470,314 | 27,025 | - | - | - | 338 | - | - | 193 | 46 |

**Other facilities: Latrine, Grange, Dug well, Hand pump Well, Pond, Culvert, Concrete bridge, Wooden bridge, Place of concrete slab, Cemetery, Wooden stair, Concrete stair, Balcony, Fuel station*

*Source: Upper Slakou Irrigation System Rehabilitation Sub-project in Takeo Province of Cambodia Draft resettlement framework (2012)*

(2) Misdistribution of Benefit and Damage /Local Conflict of Interests (Planning / Design Phase)

(a) Activity

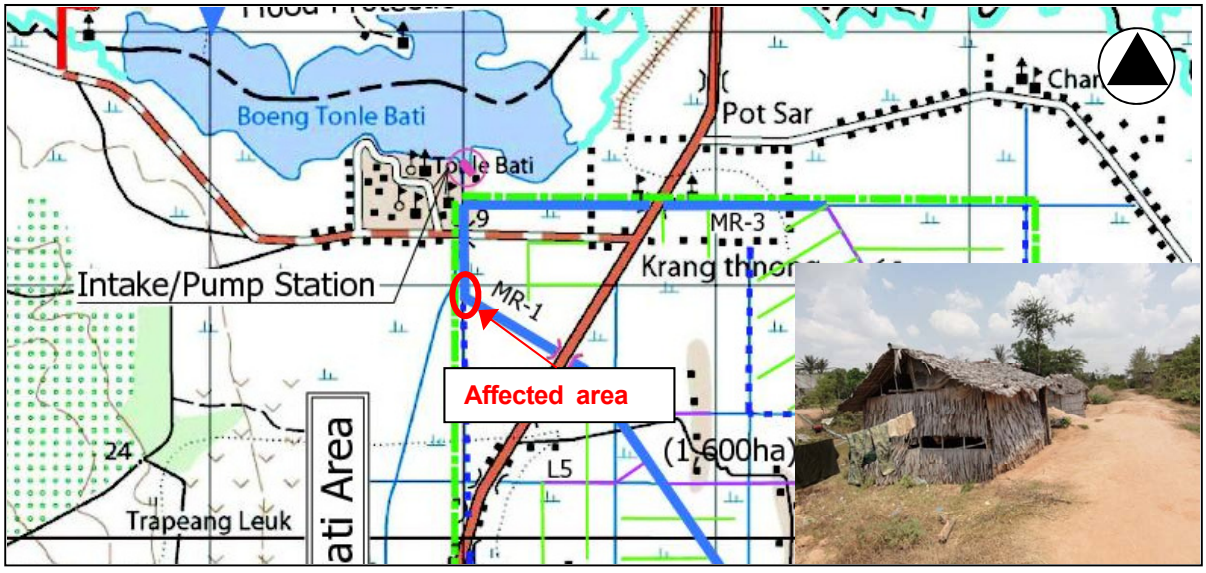
- Rehabilitation main and secondary canals/drainages and other related facilities
- Rehabilitation of the existing dikes of Tumnup Lok Reservoir

(b) Affected Area

- Areas in and around the construction sites of the above-mentioned facilities, especially along Main Canal 33, 3D and 3U

(c) Expected Potential Impacts

USISRSP will contribute to the stabilization of agricultural production in the command area by providing stable irrigation water, while the Sub-project will force farmers who illegally stay and use the construction sites, particularly the areas along Main Canal 33, 3D and 3U, need to give up their farms following the land acquisition process. Different results among local families/people, where on the one hand some families are benefited by the Sub-project but at the same time some other families lose their farm lands, would course social conflict among/between community members.




*Source: JICA Survey Team*

**Figure II-7.3.3.3.1 Affected Area by KSBISRSP**

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To conduct a detailed socio-economic survey of the affected families/people in the beginning of the planning/design stage to identify all losses resulting from land acquisition;
- To organize/hold stakeholder meetings with local families/people including affected ones to explain and discuss the project outlines and expected impacts;
- To develop a compensation policy through consultation among the joint committee together with affected families/people; and
- To prepare a realistic schedule of land acquisition and inform the affected families/people of the schedule well in advance.

(e) Conclusion of Examination

To minimize a feeling of unfairness and potential for social conflict among community members, MOWRAM shall conduct a series of meetings with all the stakeholders, especially those affected by the Sub-project, to facilitate their understandings about both positive and negative impacts on them. In particular, the compensation policy shall be clearly explained to those who would be negatively affected by KSBISRSP, so that they would have a sense of unfairness as well as a sense of distrust of the Sub-project.

#### II-7.3.3.3 Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

Involuntary resettlement is the major potential negative impacts caused by KSBISRSP as outlined below.

(1) Involuntary Resettlement (Planning/Design Phase)

(a) Activity

- Construction of the main/secondary canals, drainage canals and other water resource facilities

(b) Affected Area

- Areas along MD-canal near Tonle Bati village

(c) Expected Potential Impacts

It is expected that KSBISRSP will cause a small-scale involuntary resettlement, probably resettlement of 5 houses (5 HHs (25 people)) in total, along with the construction of the main canals. Even though the alignment of the main canals were planned and designed to avoid the involuntary resettlement, 5 families whose houses are located on the dike of the MC-1 canal (near Tonle Bati village) in Bati Area need to be relocated.

In order to clarify socio-economic conditions of the 5 HHs, the JICA Survey Team carried out an interview survey as shown in Table 7.3.3.3.1. All of them have no legal land title and are already aware of KSBISRSP since village chiefs briefed them on the Sub-project. They also show their willingness to relocate their houses along with the Sub-project on the condition that they would get official support for their relocation as they are conscious of their illegal occupation.

**Table II-7.3.3.3.1 Results of Interview Survey to Affected Households**

| Affected house / Contents | No.1 | No.2 | No.3 | No.4 | No.5 |
|---|---|---|---|---|---|
| Head of affected households (AHs) (age) | Male (43) | Male(35) | Female(71) | Male (27) | Male(48) |
| Number of HHs | 5 | 5 | 1 | 4 | 10 |
| Ethnic Group | Khmer | Khmer | Khmer | Khmer | Khmer |

| Contents \ Affected house | No.1 | No.2 | No.3 | No.4 | No.5 |
|---|---|---|---|---|---|
| Type of settlement | Temporary living | Permanent living | Permanent living | Temporary living | Permanent living |
| Year of construction | 2009 | 2010 | 3-4years ago | 2008 | 2002 |
| Livelihood (Head of AHs) | Construction worker (Motor tax) | Construction worker | No income (Half-paralyzed patient) | Construction worker (Lay off) | Construction worker (Lay off) |
| Monthly income (US$) | 90 | 30-80 | No income | 50-100 | 0-100 |
| Agreement of the relocation | Agree (with official support) | Agree (with official support) | Agree (with official support) | Agree (with official support) | Agree (with official support) |

*Source: JICA Survey Team*

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To conduct a detailed socio-economic survey of the affected families/people before the D/D Stage;
- To conduct a series of meetings with the affected families/people and village chiefs to build consensus on: (i) project purpose, (ii) compensation measures, and (iii) support programs among them;
- To prepare the abbreviated resettlement action plan (RAP) based on the results of the survey and meetings described above;
- To compensate for all the losses at an adequate rate;
- To prepare realistic schedule of land acquisition and inform the affected families/people of the schedule well in advance; and
- To monitor the process of recovery of living/livelihood conditions of the affected families/people.

(e) Conclusion of Examination

MOWRAM shall prepare an abbreviated RAP or another document similar to a simplified RAP based on the detailed socio-economic survey and stakeholder meetings. The abbreviated RAP shall include a compensation policy for resettlement with a resettlement schedule and other necessary processes of and procedures for resettlement. .

### II-7.3.3.4 Main Canal 35 Rehabilitation Sub-project

(1) Land Use and Utilization of Local Resources (Planning/Design Phase, Construction Phase)

(a) Activity

- Rehabilitation of existing canals/drainages and other facilities

(b) Affected Area

- Area along canals / drainages

(c) Expected Potential Impacts


**Affected House along existing Main Canal**

Lands along the existing canal as well as the proposed alignment should be acquired prior to the implementation of the Sub-project. Most of the lands to be acquired are currently used as paddy or other agricultural fields. Some parts of the proposed alignment will run through the residential area; therefore, some backyard gardens or fences would also be affected by MC35RSP, although no involuntary resettlement would be required. In addition, temporary land acquisition might be required in and around the construction site during the

construction stage. Village leaders of the related communes shows their willingness to cooperate with the Sub-project for smooth land acquisition since the stable supply of t irrigation water by MC35RSP is crucial to their livelihoods.

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To design the canals/drainages to minimize the possible adverse effects by land acquisition in the D/D Phase;
- To conduct a detailed socio-economic survey of affected families/persons to identify all the losses from land acquisition before the D/D Phase;
- To fairly compensate all affected families/persons, including those without a legal title to land, for all their losses at reasonable rates or replacement rates, if any;
- To establish a IRC as a decision making body to carry out the land acquisition process;
- To hold stakeholder meetings with affected families/people;
- To prepare a realistic schedule of land acquisition and inform affected families/ of the schedule well in advance; and
- To properly restore the affected area after the construction works.

(e) Conclusion of Examination

Due consideration should be given to the process of land acquisition from the design phase. Even though the total area of land acquisition might be small, the potential impacts on the respective affected families/people must not be negligible. It is, therefore, crucially important for MOWRAM in coordination with village leaders to explain the possible benefit from MC35RSP and its potential negative impacts on affected families/people, especially those living along the existing canal, in the planning/design stage, to build consensus on the project design and the proposed compensation measures for affected families/people to avoid a potential social problem in the future.

#### II-7.3.3.5 Srass Prambai Water Recession Rehabilitation Sub-project

Local people living in and around the proposed reservoir area have relied on the area for their livelihoods in both the dry and the rainy seasons. They have used the area for producing rice and other agricultural crops in the dry season, while it has been used for fishing throughout a year. SPWRRSP which aims to restorete the functions of the reservoir by rehabilitation will make it impossible for them to use the area for farming during the dry season. It is therefore expected that the implementation of SPWRRSP would change the land use and affect the income/livelihood of local people in and around the reservoir.

(1) Local Economy such as Employment and Livelihood, etc. (Planning/Design phase)

(a) Activity

- Rehabilitation of reservoir

(b) Affected Area

- Area in the Srass Prambai Reservoir

(c) Expected Potential Impacts

Many local people have been using the area in the reservoir for producing paddy and other agricultural crops during the dry season, although the area is the government land. It will be difficult for them to

use the area when SPWRRSP rehabilitates the reservoir. It is however expected that the impacts might be less significant as they could expand the fishing activities in the dry season and the expected income from fishing would be larger than that from paddy production. Furthermore, most of them have another land to cultivate outside the reservoir area according to village chiefs.

**Fisheries in SPWRRSP**

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To conduct a detailed socio-economic survey of affected families/people in the beginning of the project preparatory stage to estimate the extent of the impacts on their HH economy;
- To conduct stakeholder meetings with affected families/people and village chiefs to explain and discuss: (i) project purpose, (ii) compensation measures, and (iii) support programs, so as to build consensus on the Sub-project and compensation for their losses; and
- To fairly compensate all affected families /people including those without a legal title to land.

(e) Conclusion of Examination

MOWRAM should conduct a detailed socio-economic survey of local people who have used/are using the reservoir area for farming and prepare a compensation policy to reconstruct their livelihoods and avoid any social problems in the future. On the other hand, fisherman might remain nearly unaffected by SPWRRSP because they become available to use the reservoir throughout the year after the Sub-project.

(2) Land Use and Utilization of Local Resources (Operation Phase)/ Socially Vulnerable Groups such as the Poor and Indigenous People (including Gender matter)

(a) Activity

- Rehabilitation of reservoir

(b) Affected Area

- Area in the Srass Prambai reservoir

**Paddy Field inside Proposed Reservoir Area**

(c) Expected Potential Impacts

According to villagers, there are some Vietnamese who have lived along the dike since they migrated there few years ago and used the reservoir area for farming. They seem not to have any other lands to cultivate outside the reservoir, although they have also engaged in fishing mainly during the rainy season. It's highly likely that their livelihoods would be significantly affected by the Sub-project. There is a need to conduct a detailed socio economic survey as the existing socio-economic status of the SPWRRSP Area does not clearly describe their socio-economic status.

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To conduct a detailed socio-economic survey of affected families/persons to clarify their socio-economic conditions and estimate the potential impacts before the D/D Phase;
- To fairly compensate all affected families/persons, including those without a title to land, for all their losses at replacement rates, if any;
- To establish a joint committee as a decision making body to carry out the land acquisition process
- To hold stakeholder meetings with affected families/people
- To prepare a realistic schedule of land acquisition and inform affected families/people of the schedule well in advance; and
- To monitor the living conditions of the affected families/people during the Sub-project as well as in the post-project period.

(e) Conclusion of examination

MOWRAM should conduct a socio-economic survey and inventory survey to grasp status of the vulnerable group, such as the number of families, their income level, major livelihoods, and other important matters. MOWRAM should prepare a compensation policy based on the results of the said survey and also comments/suggestions given in the public consultation meetings with local people.

#### II-7.3.3.6 Daun Pue Irrigation System Rehabilitation Sub-project

DPISRSP plans to construct new head works on the upper stream of the Stung Chieb River. The headworks will dam up the river for a certain period of time during the wet season and might cause a negative impact on the downstream ecosystem as the river flow during the dry season will be reduced by the head works.

DPISRSP also includes the rehabilitation of its canal system along with new construction of the headworks. Like in the other Sub-projects, the acquisition of lands is inevitable for such construction works.

(1) Flora, Fauna and Biodiversity

(a) Activity

- New construction of headworks, canal and other facilitates

(b) Affected Area

- Downstream ecosystem on the Stung Chieb River

(c) Expected Potential Impacts

Damming up the river or water intake is done only during the rainy season to support the paddy production in the downstream area; therefore, the river flow in the dry season will be maintained as it is. Even during the wet season, the river maintenance flow will be kept to maintain the functions of the river. Furthermore, the flow of the Stung Srae Bak River, which meets the Stung Chieb River at 200 m below the head works, will supplement the flow volume of the Stung Chieb River.

As long as the operations of the head works will be done properly in both seasons, the expected impacts on the downstream ecosystem would be minimal.

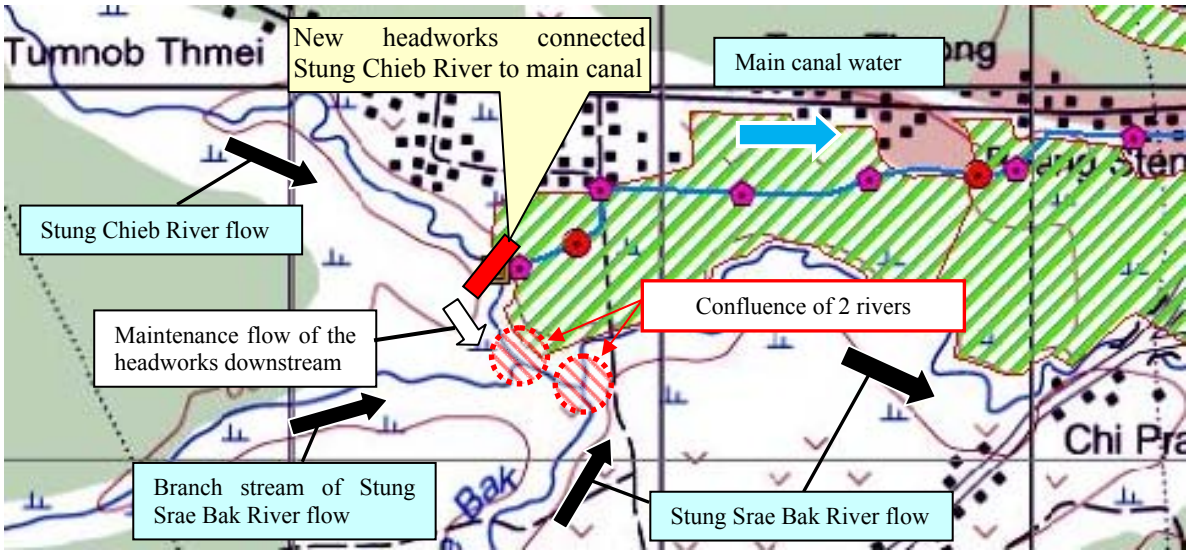
(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To ensure the river maintenance flow to keep a certain level of water in the wet season;
- To restrict water intake from the river during the dry season; and
- To ensure adequate and proper operation and maintenance of the new head works by FWUC.

(e) Conclusion of Examination

The construction of new head works would change the downstream flow of the river and might affect the downstream ecosystem. However, the impact is expected to be limited as long as the aforementioned mitigation measures are properly taken.




*Source: JICA Survey Team*

**Figure II-7.3.3.6.1 New Headworks Location of DPISRSP**

(2) Land Use and Utilization of Local Resources (Planning/Detailed Design phase, Construction phase)

(a) Activity

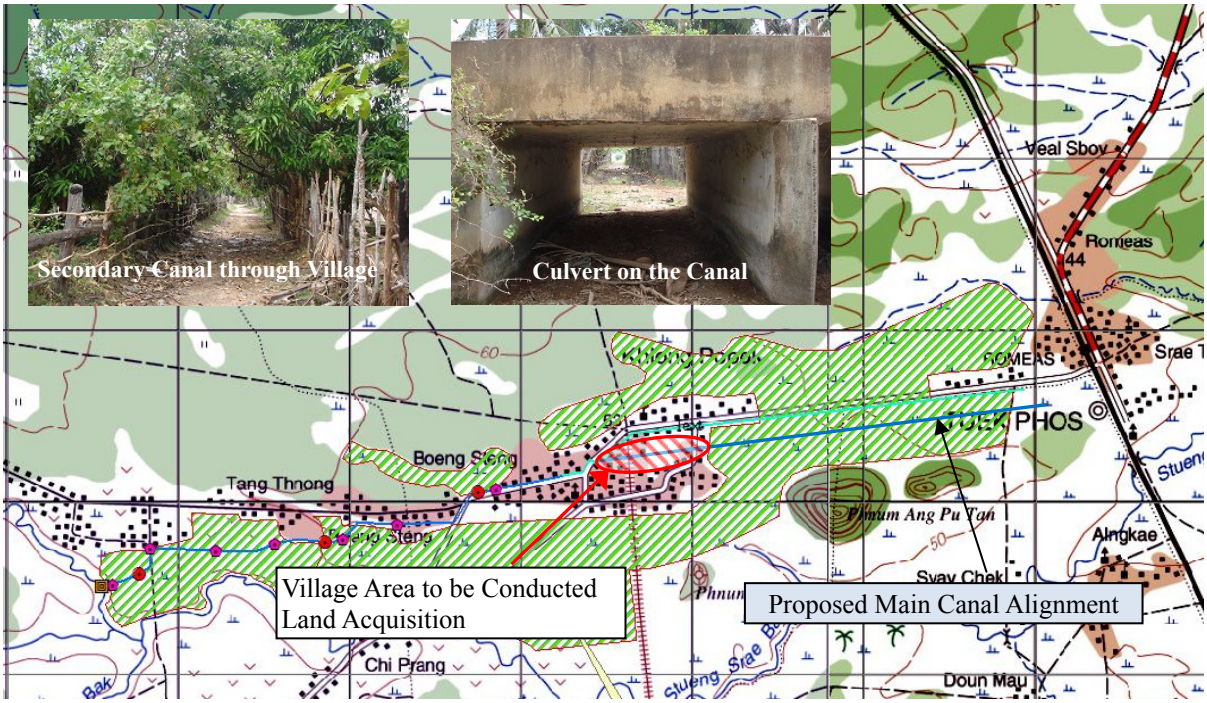
- Rehabilitation of existing main/secondary canals and other facilities
- Construction of new headworks and its related facilities

(b) Affected Area

- Areas along the main canals/secondary canals and around the proposed site for the new headworks

(c) Expected Potential Impacts

The rehabilitation of the existing canals, which include the widening of canals, will need to acquire lands and existing immovable assets along the canals. Almost all the canals are located in paddy fields, but about 1km of the secondary canal passes through four villages: Trapaeng Chhrey; Khlong Popok; Takab; and Trapaeng Krabao. It is therefore necessary to acquire existing structures and property, such as private fences, culverts and trees planted by local people along the canal, which belong to about 40 HHs in the villages according to village leaders. The areas to be acquired are categorized as the state land and those living in the areas are regarded as illegal occupants under the current government system. However, local people in the villages claimed that they had lived in the areas before the construction of the canal in the Pol Pot regime.




*Source: JICA Survey Team*

**Figure II-7.3.3.6.2 Land Acquisition Area in Village Area of DPISRSP**

(d) Mitigation Measures

The following measures need to be taken to mitigate the potential impacts.

- To realign and design the irrigation and drainage canals to minimize the scale of land acquisition caused by the Sub-project during the D/D Phase;
- To conduct a detailed socio-economic survey of affected families/people to identify/estimate all the potential losses from land acquisition before the D/D Phase;
- To fairly compensate all affected families/persons, including those without a title to land, for all their losses at replacement rates, if any;
- To establish a joint committee as a decision making body to carry out the land acquisition process;
- To conduct stakeholder meetings with affected families/people;
- To prepare a realistic schedule of land acquisition and inform affected families/people of the schedule well in advance; and
- To properly restore the affected area after the construction works.

(e) Conclusion of Examination

Land acquisition should be conducted carefully from the D/D Phase. In particular, due consideration should be given to consultations with local people in the affected vilalges, as some families/people have already doubted if DPISRSP would treat their losses properly based on their past experiences. Hence, MOWRAM must conduct a detailed socio-economic survey to estimate all losses from land acquisition and hold a series of public consultation meetings with them at the earliest stage. Furthermore, the part of canal alignment should be re-considered/re-examined based on the results of public consultation meetings withaffected families/peopleto minimize the possible effect in the D/D Phase.

## II-7.4 Environmental Management Plan and Monitoring Plan

### II-7.4.1 Environmental Management Plan

Based on the results of IEIA as described above, the following Environmental Management Plan (EMP) is proposed for each Sub-project. Main EMP are shown in TableII-7.4.1.1. EMP of each Sub-project is shown in ANNEX-H.

**Table II-7.4.1.1 Main Environmental Management Plan of SPPIDRIP**

| Impact | Activity | Mitigation/Management Measures | Planning and Implementation | |
|---|---|---|---|---|
| | | | Planning and Implementation | Supervision and Responsible |
| **Pollution Control** | | | | |
| Water pollution by construction works (Construction phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To stipulate environmental consideration measures in the technical specification of the construction works | Design consultant and Contractor | MOWRAM and Contractor |
| Water pollution (Operation phase) | - Utilization of irrigation water | - To conduct support programs regarding appropriate agricultural management<br>- To introduce composting activity to the farmers<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To monitor water quality and agricultural activities regularly<br>- To stipulate environmental consideration measures in the technical specification of the construction works | MOWRAM, and FWUC | MOWRAM, and FWUC |
| **Natural Environment** | | | | |
| Flora, fauna and biodiversity | - Rehabilitation of the existing dike and construction of the reservoir<br>- Construction of new intake | - To ensure the amount of river maintenance water particularly in the dry season | MOWRAM, PDOWRAM and FWUC | MOWRAM and FWUC |
| **Social Environment** | | | | |
| Local economy such as employment and livelihood, etc.<br>Land use and utilization of local resources | - Rehabilitation of main, secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir | - To design canals to minimize negative impact as much as possible in D/D<br>- To conduct detailed socio-economic survey of affected people during early stage of project preparation to identify all losses from land adjustment.<br>- To establish joint committee as IRC to implement land adjustment process, members of which consist of: (i) executing agencies (MOWRAM, PDOWRAM, PDA), (ii) related agencies (Provincial Department of Land Management, Urban Planning and Construction (PDLMUPC) etc.) and (iii) local authorities (commune council, village chief, etc)<br>- To conduct stakeholder meetings with farmers including affected people on: (i) project purpose, (ii) compensation measures, (iii) support programs to build consensus among the people especially the affected people through involvement of village chief<br>- To compensate affected persons, including those without title to land.<br>- To prepare adequate and realistic schedule of land adjustment through joint committee and inform affected people early<br>- To monitor the life condition of the affected people and the community | Design consultant, MOWRAM, PDOWRAM, Local authorities, and IRC | MOWRAM, MEF and IRC |
| Sanitation<br>Hazardous (risk) infectious diseases such as HIV/AIDS<br>Accident | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages | - To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction works | Contractor | MOWRAM |

| Impact | Activity | Mitigation/Management Measures | Planning and Implementation | |
|---|---|---|---|---|
| | | | Planning and Implementation | Supervision and Responsible |
| | and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule.<br>- To stipulate environmental consideration measures in the technical specification of the construction works | | |

*Source: JICA Survey Team*

### II-7.4.2 Environmental Monitoring Plan

Pollution and Natural Environmental impact/mitigation monitoring shall be conducted to determine the actual impacts. Summary of Environmental Monitoring Plan (EMoP) for impact and mitigation monitoring is shown in Table II-7.4.2.1. Details and proposed monitoring forms are shown in ANNEX-H.

**Table II-7.4.2.1 Summary of Environmental Monitoring Plan for SPPIDRIP**

| Environment Component | Parameters | Monitoring Location | Duration /Frequency | Institutional Responsibility | Sub-project | Unit Cost |
|---|---|---|---|---|---|---|
| Design Phase | | | | | | |
| Resettlement<br>Land acquisition | - Progress of resettlement / land acquisition (Detailed measurement survey, PCMs, negotiation and payments, and etc)<br>- Number of grievance | Land acquisition area | -Every day | IRC, MOWRAM | RCHRSP, USISRSP, KSBISRSP, MC35RSP, DPISRSP (SPWRRSP)* | N/A |
| Construction Phase | | | | | | |
| Noise and Vibration | - Noise level in dB (A)<br>- Vibration in dB | The nearest village where construction sites | Hourly records, for 8hr/1time during the largest construction periods | Construction contractor | All | KHR. 600,000 /1location |
| Water quality monitoring | - pH<br>- TSS<br>- Water temperature<br>- Odor<br>- Appearance | Surface water at two points for (upstream and downstream of construction area) canals and rivers | - Weekly | Construction contractor | All | KHR. 20,000 /1location |
| Construction Vehicle and machine (for Air pollution) | - Number of construction vehicle and machine,<br>- Working time | Roads in construction sites | - Every day | Construction contractor | All | N/A |
| Construction Waste | Adequate construction waste management | In construction sites | - Every day | Construction contractor | All | N/A |
| Resettlement<br>Land Acquisition | - Progress of resettlement / land acquisition (Negotiation and payments, and etc)<br>- Number of grievance | Land acquisition area | - Weekly | IRC, MOWRAM | RCHRSP, USISRSP, KSBISRSP, MC35RSP, DPISRSP | N/A |
| Operation Phase | | | | | | |
| Water Monitoring | - Temperature of air/water<br>- Flow rate, color, odor, appearance<br>- Transparency (turbidity)<br>- Physico-chemical properties (pH, EC, TSS, BOD, DO)<br>- Total Nitrogen<br>- Total Phosphorus<br>- Micro-organisms (bacteria, coliform group) | - Surface water at two points for (upstream and downstream of construction area) canals and rivers<br>- Rivers where are intaked by the project | - Quarterly (Rainy season and dry season) | MOWRAM and FWUC | All | KHR. 502,000 /1location |
| Soil Erosion | - Canal | - All canals (except concrete lining canal) | -Monthly | FWUC | RCHRSP, USISRSP, KSBISRSP, MC35RSP, DPISRSP | N/A |

| Environment Component | Parameters | Monitoring Location | Duration /Frequency | Institutional Responsibility | Sub-project | Unit Cost |
|---|---|---|---|---|---|---|
| Resettlement<br>Land Acquisition | - Recovery of livelihoods,<br>- Number of grievance | Land acquisition area | -Monthly | IRC, MOWRAM | RCHRSP, USISRSP, KSBISRSP, MC35RSP, DPISRSP | N/A |

*Note: *1 SPWRRSP doesn't include land acquisition because all affected area by the sub-project is government land. However, the sub-project is required to explain project description and social impact to surrounding people through PCMs.*
*Source: JICA Survey Team*

## II-7.5 Recommendations

### II-7.5.1 Preparation of Policies and Framework on Resettlement/Land Acquisition

- No large-scale involuntary resettlement is foreseen along with the implementation of 6 Sub-projects, but KSBIRSP and USISRSP might cause the small-scale one. Moreover, all the Sub-projects need to acquire lands for rehabilitation/construction of the irrigation facilities, such as main and secondary canals, drainage canals, head works, and other related facilities. In particular, a number of families/people might be negatively affected by the implementation of USISRSP and SPWRRSP, although they are regarded as illegal occupants.

Considering such potential impacts on social environment, it is strongly recommended that MOWRAM prepare the policies on resettlement and land acquisition based on the results of field surveys and stakeholder meetings with affected families/people in the earliest stage of the Sub-projects. The affected families/people shall also be fully informed of the developed policies through the stakeholder meetings.

MOWRAM-RU prepare the said policies in a proper and timely manner, the JICA Survey Team has assisted MOWRAM-RU in the preparation of DRF for USISRSP in March 2012 as shown in ANNEX J. DFR can be used as a framework of the policies, therefore it is crucial for MOWRAM-RU to develop the policy on land acquisition using DRF in the course of the detail design of USISRSP.

Furthermore, MOWRAM-RU is also responsible for the preparation of similar documents/policies for the other 5 Sub-projects based on the field surveys and full consultations with affected families/people in the early stage of the Sub-projects. As a first step, MOWRAM-RU shall prepare DRF for each Sub-project prior to the D/D Stage of the Sub-projects.

### II-7.5.2 Establishment of Monitoring System for Resettlement and Land Acquisition Implementation

Resettlement and land acquisition are one of the critical issues of SPISRRSP, and if not implemented adequately, could cause significant delays in the implementation of the Sub-project. MOWRAM as responsibility agency must implement monitoring in collaboration with IRC. It is therefore crucially important for MOWRAM to monitor resettlement and land acquisition activities in a systematic manner. Timely and effective monitoring can identify any problem/difficulty before it becomes serious and keep the activities in the right track.

The monitoring will comprise both internal monitoring (by the project administration) and external monitoring (by an independent body) activities. The following 4 aspects shall be assessed by both types of monitoring:

- Procurement and physical delivery of goods, structures and services related to resettlement and land acquisition, and the costs incurred;

- Utilization of the structures and services provided for the resettled families/people, and their initial reactions to the structures and services provided;
- Reasons (social, environmental or economic) for any unexpected reactions by the resettled families/people; and
- Measurement of output indicators (such as productivity gains) to the extent that these can be measured during resettlement and land acquisition implementation.

The basis of most internal monitoring will be the collection and review of data which is, in any case, needed for regular management reporting within the project. The progress of resettlement actions should be reported against the time-bound resettlement and land acquisition implementation schedule. Quantitative indicators of achievement are preferred for the monitoring of resettlement performance, but in the case of socioeconomic issues supplementary qualitative assessment will be necessary.

The monitoring of project affected peoples (PAPs) themselves is an important part of resettlement monitoring. It is essential to develop a direct channel for PAPs to voice their concerns, perceptions, and acceptance or rejection of project interventions. PAP contact and monitoring should be linked to the overall project strategy for communication. Periodic meetings, focus-group discussions, and other forms of participation will be included. Resettlement and land acquisition interview responses will depend both on the questions asked and on who is asking the questions. External consultants will therefore be engaged to work with PAPs to verify the results of internal monitoring. The minutes of meetings with PAPs should be recorded, and major issues communicated to project management as part of the regular internal reporting process.

### II-7.5.3 Reinforcement of MOWRAM-Resettlement Unit

MOWRAM-RU has experiences in the preparation of RAP and conduct of land acquisition for similar irrigation projects in Cambodia. Although MOWRAM-RU is expected to play a major role in resolving the problems facing in the course of land acquisition, it has only three permanent staffs, and all of them are so busy in other works in parallel with those for SPPIDRIP. In addition, there is no field surveyor for a/an socio-economic survey and/or an inventory survey in the unit.

Reinforcement of MOWRAM-RU is essential to the successful and smooth implementation of SPPIDRIP. In fact, land acquisition is very sensitive issue, which might cause delays in the Sub-project implementation, and a deliberated policy on RAP/land acquisition shall be prepared in the beginning of the Sub-project. In the concrete, the full-time professional workers with field surveyors necessary for the 6 Sub-projects should be added to the unit.

### II-7.5.4 Confirmation of Need of Official Environmental Impact Assessment Process

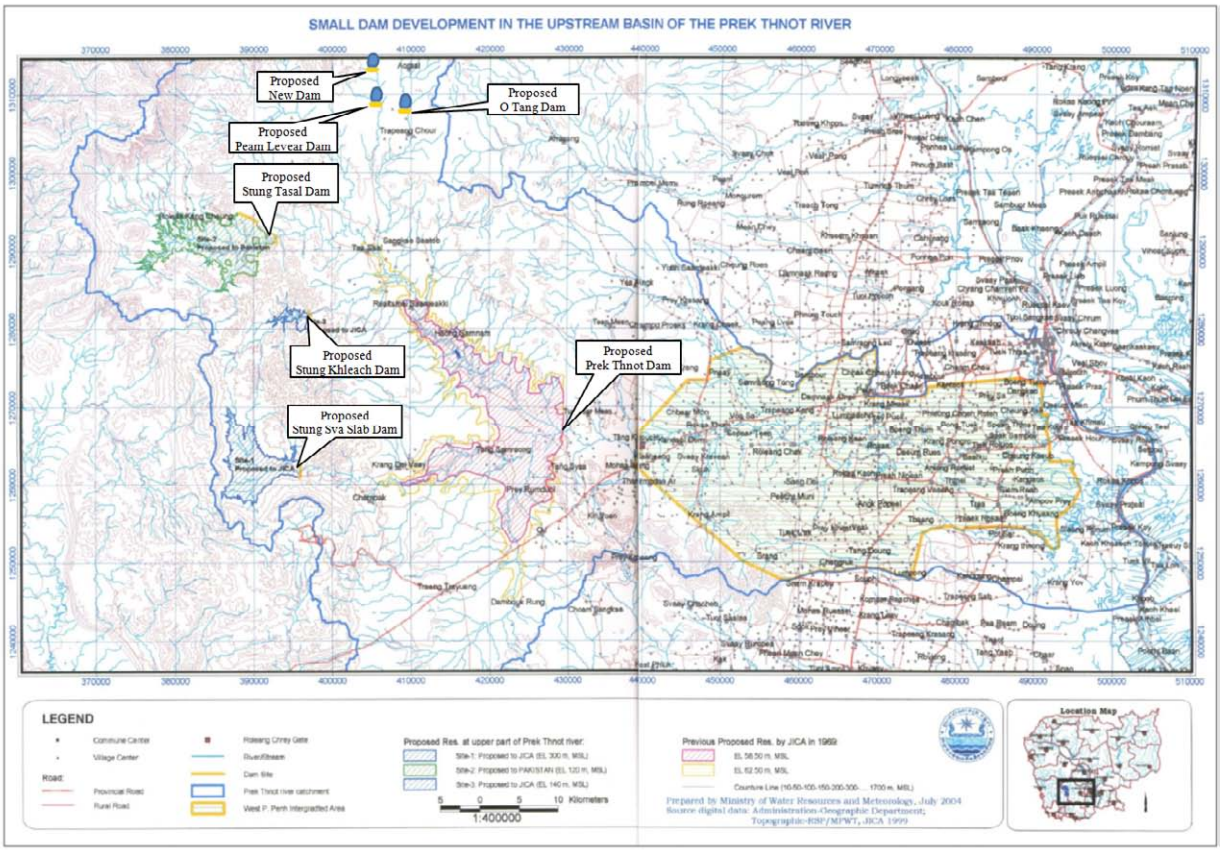
MOWRAM came with official letter; Confirmation of Need of EIA and IEIA for RCHRSP and USISRSP on October 20, 2011. The letter mentioned that MOWRAM has an honor to inform that based on the Sub-decree on EIA process dated 11tt August 1999 of RGC, 2 Sub-projects; RCHRSP and USISRSP, are not required to conduct the EIA or IEIA as their command area is less than 5,000 ha and they area existing irrigation systems.

According to IEIA mentioned above, significant adverse environmental impacts will not be expected if the proposed mitigation measures are carried out. MOWRAM should confirm the necessity of EIA or IEIA for the Sub-projects except RCHRSP and USISRSP, which were judged by MOE.

# CHAPTER II-8 PRELIMINARY STUDY ON INFLUENCE OF ROLEANG CHREY COMMAND AREA WITH DAM PLANS

## II-8.1 General

There are several dam plans or projects in the Prek Thnot River basin as shown in Figure II-8.1.1 Purpose of preliminary study in this section is to evaluate the influence of these proposed dam projects for the Roleang Chrey Command Area. Among these proposed dam projects, the Stung Tasal dam project which is high priority and a higher possibility according to MOWRAM, is under construction now.




*Source: MOWRAM*

**Figure II-8.1.1 Location Map of Proposed Dam Projects in Prek Thnot River Basin**

## II-8.2 Dam Plans in Basin Area of Prek Thnot River

### II-8.2.1 Prek Thnot Multipurpose Dam

In this preliminary study, the “Prek Thnot Multipurpose Dam Project" is not considered because the implementation schedule of the Prek Thnot Multipurpose Dam Project is not formulated at present, and it is not clear when the Prek Thnot Multipurpose Dam becomes operational.

Study on the Prek Thnot Multipurpose Dam Project was made in the period 1960-1967 (Prek Thnot Investigation Team, 1962; WRD-Tahal, 1965; Mekong Secretariat, 1966; SMEC, 1968) and construction of the first phase started in 1969 but was halted a few years later due to the civil war.

The Project Preparation Study of the Prek Thnot Pioneer Agricultural Project in 1975 concluded that a reservoir with a maximum capacity of 1,120 MCM could irrigate up to 50,000 ha, and as much as

66,000 ha if the dam was raised a further 3 m. Reappraisal concluded that 34,000 ha can be double cropped if irrigation is given priority, but this is reduced to 27,000 ha double cropped if power is the priority.

The Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh in 1995 (JICA) conducted irrigation simulation of "with and without" Prek Thnot Multipurpose Dam conditions. In order to confirm the irrigation potential under the "with" Prek Thnot Multipurpose Dam condition referred to in the Master Plan for the Study Area, a rural simulation of reservoir was carried out by use of the 10-year reservoir inflow series defined in the study and the original irrigation requirements. The irrigable area will be in the range of 25,000 ha (maximum firm power) to 35,000 ha (irrigation priority) based on the double cropping plan.

### II-8.2.2 Proposed 3 Dams

#### II-8.2.2.1 Features of 3 Dams

There are 3 dam development plans prepared by Korea Water Resources Corporation (K-water) and Komho Engineering & Construction in February 2010, which are located at the Stung Aveang River and the Ou Khlong River that is upstream of the Prek Thnot River. Out of them, 2 dams, say the Peam Levear Dam and the O Tang Dam are planned to be rehabilitated, and the remaining is a newly constructed dam. The basin characteristics at respective dam sites are as follows:

**Table II-8.2.2.1.1 Basin Characteristics of 3 Dams Located Upstream of Prek Thnot River**

| Item | Basin Area ($km^2$) | Longest Flow (m) | Beginning Elevation (m) | End Elevation (m) | Slope | Average Elevation (m) |
|---|---|---|---|---|---|---|
| New Dam | 155.8 | 18,925 | 1,698 | 170 | 0.0807 | 632 |
| Peam Levear | 237.5 | 29,911 | 1,698 | 129 | 0.0525 | 512 |
| O Tang | 53.6 | 14,679 | 744 | 129 | 0.0419 | 208 |

*Source: F/S on Water Resources Development Project for The Prek Thnot River Basin*

F/S was carried out for these dam projects in February 2010. According to the study, these dams will have multipurpose of flood control, power generation and supply of irrigation water. Irrigation water will be supplied to the farm land close the dam sites of downstream. Main features of these dams are shown in Table II-8.2.2.1.2.

**Table II-8.2.2.1.2 Features of 3 Dams Located Upstream of Prek Thnot River**

| Item | Dam Type | Effective Storage ($10^6m^3$) | Water Supply for Irrigation ($10^6m^3$/yr) | Flood Control Storage ($10^6m^3$/sec) | Power Generation (kW) |
|---|---|---|---|---|---|
| New Dam | Earth dam | 25.9 | 73 (4,432 ha × 2 times) | 5.3 | 330 |
| Peam Levear | Earth dam | 7.8 | | 2.4 | 70 |
| O Tang | Earth dam | 5.6 | | 2.1 | - |

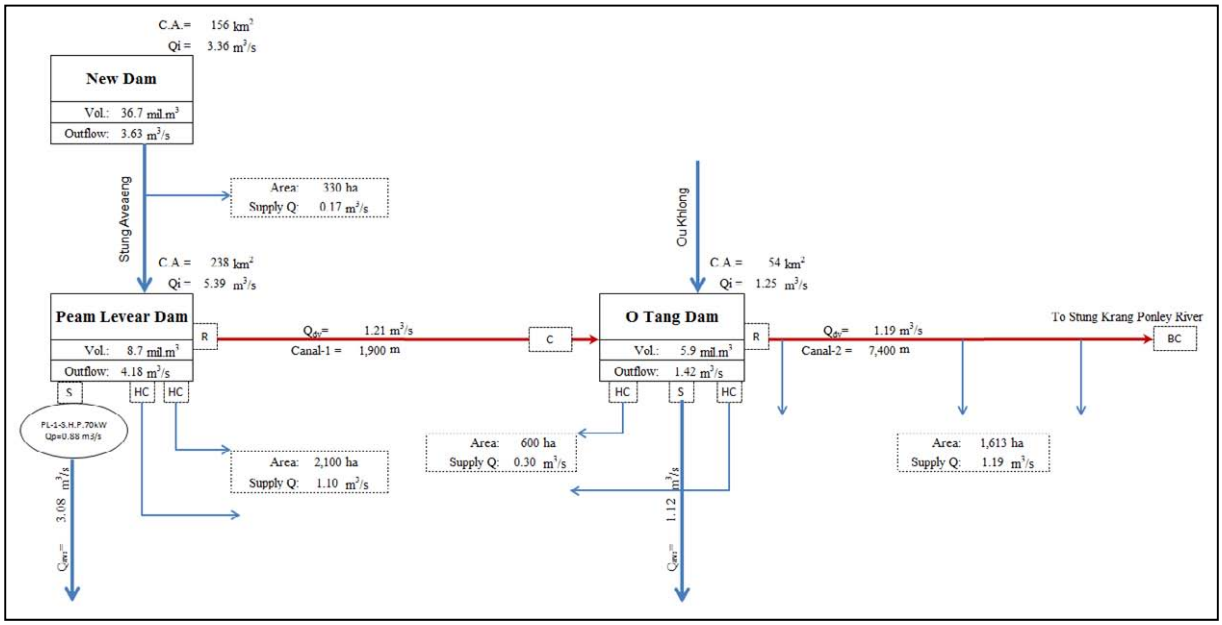
*Source: F/S on Water Resources Development Project for The Prek Thnot River Basin*

Presently, F/S has been completed for these dam projects. However, there is no definite plan for their implementation so far.

#### II-8.2.2.2 Conjunctional Operation System

Figure II-8.2.2.2.1 below shows the schematic diagram for water supply of conjunctional operation of current 2 dams and new dam. These 3 dams are planned as combined operation. Reservoir water of the New Dam will supply irrigation own area of 330 ha at downstream and surplus water include spill outflow will be flow into the Peam Levear Dam. The reservoir water of the Peam Levear Dam will supply irrigation area of 2,100 ha at downstream and spill-outflow will flow into downstream, but the

surplus water flows into the O Tang Dam. The O Tang Dam has 2 irrigation areas of 600 ha and 1,613 ha. The reservoir water of the O Tang Dam will supply to those 2 areas and surplus water will flow into another river basin named the Stung Krang Ponley River. Thus, if these proposed 3 dams are constructed, only spill-outflow and river maintenance flow will flow into the Prek Thnot River Basin including few return flows from agricultural areas. Water supply plan for current 2 dams was based on the previous Krang Ponley Water Resources Development Project, so that such water supplied may be used in those basins which are not in the Prek Thnot River Basin. In this situation, available river water for the Roleang Chrey command area will be decreased after construction of these 3 dams.




*Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water*

**Figure II-8.2.2.2.1 Schematic Diagram for Water Supply of 3 Dams by K-Water**

### II-8.2.2.3 Irrigation Water Requirement

Water demands for rural areas in the project area were estimated in F/S. As a result, total water demands required were estimated at 88.0 MCM/year, including 78 MCM/year (agricultural water demand) and 10 MCM/year (river maintenance flow) for downstream of the Prek Thnot River Basin as shown in Table II-8.2.2.3.1.

**Table II-8.2.2.3.1 Water Demand for Rural Areas in 3 Dam Projects by K-Water**

(Unit: MCM)

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural Water Demand | 12.16 | 8.73 | 0.00 | 0.00 | 0.00 | 0.34 | 9.38 | 10.15 | 1.80 | 2.48 | 12.66 | 20.54 | 78.24 |
| Maintenance Flow | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 9.78 |
| Total | 12.97 | 9.54 | 0.81 | 0.81 | 0.81 | 1.15 | 10.19 | 10.96 | 2.61 | 3.29 | 13.47 | 21.35 | 87.96 |

(Unit: $m^3$/sec)

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural Water Demand | 4.54 | 3.61 | 0.00 | 0.00 | 0.00 | 0.13 | 3.50 | 3.79 | 0.70 | 0.93 | 4.88 | 7.67 | 2.48 |
| Maintenance Flow | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| Total | 4.84 | 3.94 | 0.30 | 0.31 | 0.30 | 0.44 | 3.81 | 4.09 | 1.01 | 1.23 | 5.19 | 7.97 | 2.79 |

*Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water*

### II-8.2.2.4 River Maintenance Flow

River maintenance flow (instream flow) for downstream of the Prek Thnot River Basin was decided as the average value of firm yield ($Q_{355}$) in 355 days of the year in the F/S conducted by K-water. Average drought flow at the New Dam, the Peam Levear Dam and the O Tang Dam sites, which was

obtained from flow duration analysis, was applied for river maintenance flow in F/S as shown in Table II-8.2.2.4.1.

**Table II-8.2.2.4.1 Flow Duration and River Maintenance Flow ($Q_{355}$) at 3 Dams** (Unit: $m^3$/sec)

| Dam Site | Abundant flow ($Q_{95}$) | Average flow ($Q_{185}$) | Low flow ($Q_{275}$) | Drought flow ($Q_{355}$) |
|---|---|---|---|---|
| New Dam | 3.45 | 0.98 | 0.41 | 0.16 |
| Peam Levear Dam | 5.25 | 1.50 | 0.63 | 0.25 |
| O Tang Dam | 1.19 | 0.34 | 0.14 | 0.06 |
| **Total (Peam Levear & O Tang)** | **6.44** | **1.84** | **0.77** | **0.31** |

*Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water*

### II-8.2.2.5 Stage-Area-Capacity Curve

Stage-Area-Capacity (H-V-A) curves at 3 dams are shown in Table II-8.2.2.5.1. In F/S, storage area and capacity was prepared using digital map of project site by results of topographic survey.

**Table II-8.2.2.5.1 Stage-Area-Capacity Curves at 3 Dams**

| New Dam | | |
|---|---|---|
| Stage (EL. m) | Area ($km^2$) | Capacity ($10^6m^3$) |
| 153 | 0.354 | 0.000 |
| 154 | 0.503 | 0.428 |
| 155 | 0.581 | 0.970 |
| 156 | 0.652 | 1.587 |
| 157 | 0.727 | 2.277 |
| 158 | 0.982 | 3.131 |
| 159 | 1.158 | 4.201 |
| 160 | 1.276 | 5.418 |
| 161 | 1.396 | 6.754 |
| 162 | 1.522 | 8.213 |
| 163 | 2.292 | 10.120 |
| 164 | 2.743 | 12.638 |
| 165 | 3.084 | 15.551 |
| 166 | 3.415 | 18.800 |
| 167 | 3.743 | 22.379 |
| 168 | 4.516 | 26.508 |
| 169 | 5.127 | 31.330 |
| 170 | 5.540 | 36.663 |
| 171 | 5.967 | 42.417 |
| 172 | 6.416 | 48.608 |

| Peam Levear Dam | | |
|---|---|---|
| Stage (EL. m) | Area ($km^2$) | Capacity ($10^6m^3$) |
| 126 | 0.008 | 0.000 |
| 127 | 0.034 | 0.021 |
| 128 | 0.154 | 0.115 |
| 129 | 0.353 | 0.369 |
| 130 | 0.592 | 0.842 |
| 131 | 0.887 | 1.581 |
| 132 | 1.361 | 2.705 |
| 133 | 1.746 | 4.259 |
| 134 | 2.209 | 6.236 |
| 135 | 2.679 | 8.680 |
| 136 | 3.107 | 11.033 |

| O Tang Dam | | |
|---|---|---|
| Stage (EL. m) | Area ($km^2$) | Capacity ($10^6m^3$) |
| 128 | 0.024 | 0.000 |
| 129 | 0.104 | 0.064 |
| 130 | 0.374 | 0.303 |
| 131 | 0.623 | 0.801 |
| 132 | 0.928 | 1.577 |
| 133 | 1.336 | 2.709 |
| 134 | 1.729 | 4.241 |
| 135 | 2.218 | 5.948 |
| 136 | 2.851 | 8.021 |

*Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water*

### II-8.2.2.6 Reservoir Operation Study

Using given condition of proposed irrigation areas and feature of these 3 dams, preliminary reservoir operation simulation was conducted by the JICA Survey Team for confirmation of plan. In this reservoir operation study, estimated discharge at each site of the total 30-years that was prepared by observed discharge at the Peam Khley water level gauging station from 1997 to 2011 and simulated discharge by the tank model from 1982 to 1996, which was described in Item (3) of Sub-clause II-1.4.2.2, ratio of catchment area and annual basin mean rainfall was used.

The results of our simulation of reservoir operations are shown in Table II-8.2.2.6.1. According to results of reservoir operation of 30-years by the JICA Survey Team, Case-2 of proposed by F/S is difficult to irrigate with high dependability. Case-3 that is proposed by F/S as an optimum scale, is able to irrigate with almost 80% dependability. Case-1 is irrigation area that is shown in Figure II-8.2.2.2.1 above. In this condition, if 80% dependability of irrigation is required, irrigation areas of Case-4 are recommendable.

**Table II-8.2.2.6.1 Results of Reservoir Operations of Proposed 3 Dams**

| Proposed Dam | Case-1 | Dependability | Case-2 | Dependability | Case-3 | Dependability | Case-4 | Dependability |
|---|---|---|---|---|---|---|---|---|
| New Dam | 330 ha | 67% | 376 ha | 57% | 330 ha | 73% | 330 ha | 80% |
| Peam Levear Dam | 2,313 ha | 70% | 2,398 ha | 10% | 2,100 ha | 77% | 1,740 ha | 80% |
| O Tang Dam | 704 ha | 77% | 1,926 ha | 3% | 600 ha | 87% | 620 ha | 80% |
| Total | 3,347 ha | | 4,700 ha | | 3,030 ha | | 2,060 ha | |

*Source: JICA Survey Team*

## II-8.2.3 Proposed Stung Tasal Dam

### II-8.2.3.1 Status of Project

It is reported that the Stung Tasal Dam Development Project is on-going under the Indian Government loan. The JICA Survey Team collected from MOWRAM the contract agreement which was signed among MOWRAM, WAPCOS Ltd and Angelique International Limited on January 12, 2011. The contract includes Part A: Infrastructure development works (approach road embankment, office & residential buildings with all facilities), Part B: Civil works (diversion works, dam with instrumentation and spillway for irrigation and power intake blocks and other items), and Part C: Hydro-mechanical works (irrigation sluices and power intake). This contract also includes the engineering services consisting of survey, geo-technical investigation, D/D, preparation of construction drawings along with D/D calculations and construction material survey, the network design for rain gauge stations in the catchment of the Stung Tasal River, and the operational training to engineering officers and staff of MOWRAM of the project after commission. The time for completion of the entire scope of work is 18 months from the date which the contract comes into full force and effect (i.e. upon signing of the contract agreement and its approval by MEF, RGC and Exim Bank of India). According to MOWRAM, Angelique International Limited mobilized a team at site on May 19, 2011 and has started the topographic survey and finalization of land for colony and access road. In addition, MOWRAM reported in his letter dated August 24, 2011 to the Embassy of India that dam site was cleared by MOE and forest was also cleared along the dam axis.

### II-8.2.3.2 Main Features

Main features of proposed the Stung Tasal Dam are shown in Table II-8.2.3.2.1. Stage-area-capacity curve of proposed the Stung Tasal Dam is shown in Table II-8.2.3.2.2.

It is proposed to construct a 21 m high and 650 m long rock-fill dam across the Stung Tasal River primarily to provide assured irrigation to an area of about 10,000 ha. About 8,000 ha of the command under the 2 canal systems of downstream of the Roleang Chrey Headworks and 2,000 ha of the area upstream of the Roleang Chrey Headworks would benefit from the project. Besides, a hydropower station with an installed capacity of 750 kW at 60% load factor would also be constructed about 70 m downstream of the dam.

An un-gated ogee spillway of total length 90.5 m would be provided with a 6 m wide road above it. The inlet for the irrigation sluices would be provided in a 20 m long concrete non-overflow section on the right side of the spillway. Another concrete non-overflow section of 20 m in length would be provided on the left side of the spillway for the intakes of the penstocks for the powerhouse.

Since irrigation is given the top priority, the hydropower station has been designed to utilize only the releases for irrigation. Thus with 75% dependable water availability for irrigation, about 4 million units of electrical energy would be available in a year.

**Table II-8.2.3.2.1 Salient Features of Proposed Stung Tasal Dam**

| Sl. No | | |
|---|---|---|
| 1) | Province/ District | Kampong Speu / Aoral |
| 2) | River | Stung Tasal |
| 3) | Catchment area upto dam site | 495 $km^2$ |
| 4) | Average annual rainfall | 1,210 mm |
| 5) | Reservoir data | |
| | Average River Bed Level | 89.2 EL. m |
| | Maximum water level | 108.7 EL. m |
| | Full reservoir level | 107.2 EL. m |
| | Outlet elevation | 95.0 EL. m |
| | Dead Storage level | 94.2 EL. m |
| | Gross storage at Full reservoir level | 147.627 MCM |
| | Dead storage | 8.01 MCM |
| | Live storage | 139.61 MCM |
| 6) | Estimate of Cost | 13.4 US$ Million |

*Source: "Stung Tasal Dam Project" Volume-I, Design Engineering Report, WAPCOS Limited, December 2008.*

**Table II-8.2.3.2.2 Stage-Area-Capacity Curve of Proposed Stung Tasal Dam**

| Sl. No. | Elevation (EL. m) | Surface Area ($km^2$) | Capacity (MCM) |
|---|---|---|---|
| 1) | 90 | 0.494 | 0.000 |
| 2) | 95 | 3.123 | 8.099 |
| 3) | 100 | 5.753 | 29.957 |
| 4) | 105 | 14.830 | 79.657 |
| 5) | 110 | 31.520 | 192.941 |
| 6) | 115 | 49.680 | 394.227 |
| 7) | 120 | 69.620 | 691.079 |

*Source: "Stung Tasal Dam Project" Volume-I, Design Engineering Report, WAPCOS Limited, December 2008.*

### II-8.2.3.3 Cost Estimate

The total estimated construction cost of the project is US$ 13.40 million of which the cost of civil works is US$ 13.08 million and that of electrical and mechanical works US$ 0.32 million.

### II-8.2.3.4 Benefits

(1) Irrigation

- Canal irrigation (gravity flow) below Roleang Chrey Headworks = 8,000 ha
- Lift irrigation upstream of Roleang Chrey Headworks = 2,000 ha

(2) Power

Electrical energy per year = 4.00 million units

(3) Flood Moderation

Because of its large area the reservoir would absorb all normal floods, thereby providing considerable relief from annual floods in the lower reaches of Stung Tasal up to its conference with the Prek Thnot River. The design flood of 2,029 $m^3$/sec would be moderated to 304 $m^3$/sec.

### II-8.2.3.5 Economic Evaluation

The B/C ratio for the project is estimated at 1.77 and EIRR at 13%.

### II-8.2.3.6 Irrigation Plan

At the present situation, lift irrigation system is the only option. But this system of irrigation is costly. So, such irrigation system has been considered to be limited. After completion of the proposed multipurpose dam, the remaining areas would be covered. The river water cannot be simply used for irrigation by gravity since the cultivated lands are at levels higher than that of the watercourse. This would be possible when the multipurpose dam development plan is implemented.

There is the Roleang Chrey Headworks constructed in 1974 to command an area of 16,910 ha. The irrigation releases from the Stung Tasal Reservoir also strengthen the irrigation in an area of about 8,000 ha in the command of 2 canals off taking from the Headworks.

#### II-8.2.3.7 Reservoir Operation Study

According to the design engineering report by WAPCOS, the simulation study of the Stung Tasal Reservoir considering the outlet at EL. 95.00 m has been undertaken from 1983 to 2007 by monthly base. It can be seen from the simulation study, the reservoir would successfully meet the demand. Thus the proposed project would be able to meet the irrigation demand of proposed command area of 10,000 ha.

### II-8.2.4 Proposed Stung Sva Srab Dam and Stung Khleach Dam

#### II-8.2.4.1 General

MOWRAM planned 2 dam construction projects on the tributaries of the Prek Thnot River. These are (i) Stung Sva Slab Water Resources Development Project and (ii) Stung Khleach Water Resources Development Project. The preliminary features of these dam projects are given in Table II-8.2.4.1.1.

MOWRAM prepared the proposals for F/S of these projects and submitted to MEF in September 2010. Thereafter, RGC requested the financial assistance to the Prime Minister of India when he made the official visit to Cambodia. Now, MOWRAM expects that F/S for these projects will be carried out in 2012, but it is not sure at present.

**Table II-8.2.4.1.1 Preliminary Features of Stung Sva Srab Dam and Stung Khleach Dam**

| Item | Stung Sva Slab Dam | Stung Khleach Dam |
|---|---|---|
| (1) Location | About 40 km upstream of Peam Khley in Srae Ambel and Kampong Speu Seila District, Kaoh Kong Province | About 45 km upstream of Peam Khley in Ambel District, Kampong Speu Province |
| (2) River Name | Stung Sva Slab River | Stung Khleach River |
| (3) Catchment Area | ~~660 km$^2$~~ => 188 km$^2$ | 125 km$^2$ |
| (4) Dam Type | Rockfill Dam | Rockfill Dam |
| (5) Length of Dam | 1,000 m | 570 m |
| (6) Height of Dam | 25 m | 40 m |
| (7) Deepest Bed Level | ~~EL. 120 m~~ => EL. 240 m | EL. 100 m |
| (8) Expected Irrigation Area | 15,000 ha in the rainy season and 5,000 ha in the dry season | 13,000 ha in the rainy season and 3,000 ha in the dry season |
| (9) Construction Cost | US$ 43 million | US$ 34 million |

*Source: MOWRAM*

#### II-8.2.4.2 Stage-Area-Capacity Curve

Since there is no study for proposed the Stung Sva Srab Dam and the Stung Khleach Dam, the stage-area-capacity curve of each dam is prepared using 1/50,000 scale topographic map. Main features and prepared stage-area-capacity curves of proposed Stung Sva Srab Dam and Stung Khleach Dam are shown in Table II-8.2.4.2.1 and Table II-8.4.2.2, respectively.

**Table II-8.2.4.2.1 Preliminary Features of Stung Sva Srab Dam**

| Dam site | Stueng Sva Slab Dam | |
|---|---|---|
| River | Stueng Sva Slab | |
| C.A. | 215.6 | $km^2$ |

(1) Reservoir Storage Curve

| Elevation (EL. m) | Volume ($x10^6$ $m^3$) | Area ($km^2$) |
|---|---|---|
| 240 | 0.000 | 0.170 |
| 250 | 33.350 | 6.500 |
| 260 | 131.800 | 13.190 |
| 270 | 297.650 | 19.980 |
| 280 | 547.400 | 29.970 |
| 290 | 899.700 | 40.490 |
| 300 | 1,355.550 | 50.680 |

(2) Input Data

| | | |
|---|---|---|
| Full Supply Level (FSL) (EL. m) | 260.0 | m |
| Riverbed Elevation (EL. m) | 240.0 | m |
| Dead Wter Level (EL. m) | 242.3 | m |
| Freeboard | 3.00 | m |
| Dam Height (m) | 23.0 | m |
| Gross Storage Vol.($x10^6$ $m^3$) | 131.80 | MCM |
| Dead Storage ($x10^6$ $m^3$) | 7.76 | MCM |
| Effective Storage Vol.($x10^6$ $m^3$) | 124.04 | MCM |

| | | |
|---|---|---|
| Annual Sediment Inflow Rate | 0.036 | $ham/km^2/yr$ |
| Annual Sediment Inflow Rate | 360 | $m^3/km^2/yr$ |
| Sediment Volume for 50years | 3.8808 | x $10^6$ $m^3$ |
| Sediment Level for 50 years (EL. m) | 241.16 | m |
| Sediment Volume for 100years | 7.7616 | x $10^6$ $m^3$ |
| Sediment Level for 100 years (EL. m) | 242.33 | m |

*Source: JICA Survey Team*

**Table II-8.2.4.2.2 Preliminary Features of Stung Khleach Dam**

| Dam site | Stueng Khleach Dam | |
|---|---|---|
| River | Stueng Khleach | |
| C.A. | 109.8 | $km^2$ |

(1) Reservoir Storage Curve

| Elevation (EL. m) | Volume ($x10^6$ $m^3$) | Area ($km^2$) |
|---|---|---|
| 100 | 0.000 | 0.080 |
| 110 | 2.150 | 0.350 |
| 120 | 12.650 | 1.750 |
| 140 | 86.050 | 5.590 |
| 160 | 268.450 | 12.650 |

(2) Input Data

| | | |
|---|---|---|
| Full Supply Level (FSL) (EL. m) | 137.0 | m |
| Riverbed Elevation (EL. m) | 100.0 | m |
| Dead Wter Level (EL. m) | 111.7 | m |
| Freeboard | 3.00 | m |
| Dam Height (m) | 40.0 | m |
| Gross Storage Vol.($x10^6$ $m^3$) | 75.04 | MCM |
| Dead Storage ($x10^6$ $m^3$) | 3.95 | MCM |
| Effective Storage Vol.($x10^6$ $m^3$) | 71.09 | MCM |

| | | |
|---|---|---|
| Annual Sediment Inflow Rate | 0.036 | $ham/km^2/yr$ |
| Annual Sediment Inflow Rate | 360 | $m^3/km^2/yr$ |
| Sediment Volume for 50years | 1.9764 | $x10^{\wedge 6}$ $m^3$ |
| Sediment Level for 50 years (EL. m) | 109.19 | m |
| Sediment Volume for 100years | 3.9528 | $x10^{\wedge 6}$ $m^3$ |
| Sediment Level for 100 years (EL. m) | 111.72 | m |

*Source: JICA Survey Team*

## II-8.3 Preliminary Water Balance Study

### II-8.3.1 Conditions of Preliminary Water Balance Study

The effect of these proposed dams for the irrigation in the RCHRSP and KSBISRSP Areas was evaluated using available information of these dam projects except the "Prek Thnot Multipurpose Dam Project". The simulation of water balance between water supply from dams and the estimated irrigation water requirement was conducted. In M/P, the water balance was simulated applying the probable river run off and water demand estimated with statistically analyzed for 80% dependability and 50% dependability. In this Survey, long-term water balance simulation method was applied. Conditions for this study are summarized in Table below.

**Table II-8.3.1.1 Conditions of Preliminary Study on Influence of Roleang Chrey Command Area with Dam Plan**

| Item | This Survey |
|---|---|
| Calculation interval | 5-day basis |
| Method for estimating potential evapo-transpiration | Penman-Montieth method |
| Meteorological data | Pochentong Station (Phnom Penh) |
| Rainfall data for estimation of irrigation water requirement | Roleang Chrey: Pochentong Station (Phnom Penh); 1982-2011<br>Kandal Stung-Bati: Bati Station; 1982-2011 |
| Percolation rate for estimation of irrigation water requirement | 8 mm/day<br>(With introduction of water saving irrigation Method) |
| Irrigation efficiency | Paddy; 66%, Upland crop; 53% |

| Item | This Survey |
|---|---|
| Runoff data | Observed daily discharge data at Peam Khley station from 1997-2011, and estimated daily discharge data by Tank Model from 1982-1996, total 30-years |
| Water balance in Ou Krang Amble | Storage effect of 2 upstream reservoirs are considered |
| Water balance simulation model | Roleang Chrey + Kandal Stung-Bati + Dangkor Irrigation Systems |
| Method of water balance simulation | Not by reference year method. By the long-term (1982-2011; 30years) simulation |
| Irrigation fail | Continuous deficit in 15 days |
| Evaporation from reservoir | using pan evaporation data at Pochentong |
| Percolation rate from reservoir | 2 mm/day for Ou Krang Amble's reservoirs, Lake Tonle Bari<br>0 mm/day (not considered for proposed dam) |

*Source: JICA Survey Team*

### II-8.3.2 Basin Rainfall

Basin mean rainfall at each proposed dam site was estimated for the period of 1982-2011 by interpolated daily rainfall and the Thiessen coefficient (refer to ANNEX B).

### II-8.3.3 Inflow Discharge at Proposed Dam Sites

As described in Sub-clause II-1.4.2.2, inflow discharge at each proposed dam site was estimated for the period of 1982-2011 using ratio of catchment area, ratio of annual basin mean rainfall and observed or simulated daily discharge by the tank model at the Peam Khley water level gauging station. For the water balance study, 5-day mean discharge at each dam site was prepared.

### II-8.3.4 Irrigation Water Demand of Roleang Chrey Command Area

Irrigation water requirements at the Roleang Chrey Command Area, the KSBISRSP Area, the Dangkor Irrigation Area, the Kampong Damrey Irrigation Area and the Ou Krang Ambel Irrigation Area were estimated based on the proposed cropping patterns and conditions that are described in Sub-clause II-2.3.3.1 and II-2.5.3.1. The area of each command area was changed as a parameter for trial and error method by each case of "with and without" of proposed dams on the water balance study.

### II-8.3.5 Reservoir Operation of Proposed Dams

(1) Evaporation from Reservoir Water Surface

Evaporation from reservoir water surface at each proposed dam was used observed pan evaporation data at Pochentong meteorological station in Phnom Penh.

(2) Percolation from Reservoir Bed

Percolation from reservoir bad at each proposed dam site was not considered in this water balance study due to this is unknown factor at present.

(3) Design Outflow

Design outflow from proposed 3 dams (New Dam, Peam Levear Dam and O Tang Dam) were decided using irrigation water requirement that is presented in the F/S report by the K-Water

Meanwhile, design outflow for proposed the Stung Tasal Dam, the Stung Sva Srab Dam and the Stung Khleach Dam was decided to achieve the deficit of irrigation water demand in command area of the downstream of the Roleang Chrey Headworks. In case of combination of dams, design outflow from each dam was divided for each dam by ratio of reservoir capacity volume. Water demand of lift irrigation at upstream of the Roleang Chrey Headworks by the proposed Stung Tasal Dam was not considered in this moment.

## II-8.4 Influence to Roleang Chrey Command Area

### II-8.4.1 Study Cases

The following cases are evaluated for water balance simulation for preliminary study on influence of the Roleang Chrey command area with dam plans.

**Table II-8.4.1.1 Study Case of Water Balance Study for Proposed Dam Plans**

| Case | Combination of Proposed Dams |
|---|---|
| Case-0 | without dam (Present Condition) |
| Case-1 | with Stung Tasal Dam only |
| Case-2 | with Stung Tasal Dam + K-water 3 Dams |
| Case-3 | with Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam |
| Case-4 | with Stung Tasal Dam + K-water 3 Dams + Stung Khleach Dam |
| Case-5 | with Stung Tasal Dam + K-water 3 Dams + Stung Sva Slab Dam + Stung Khleach Dam |

*Source: JICA Survey Team*

### II-8.4.2 Results of Water Balance Study of "With and Without" Dams

Summary of case study of water balance simulation of "with/without" dam is shown in Table II-8.4.2.1.

In case of "Case-2", this is after implementation of the Stung Tasal Dam and the K-water's 3 Dam Projects case, total irrigable area of the Roleang Chrey Zone-I (80% dependable area) will be able to be increased from 5,660 ha (with crop intensity at 114%) to 15,400 ha (with crop intensity at 180%). Also, in the Kandal Stung (grant) Area, the crop intensity and the dependability will be increased, and the Kandal Stung (extension) Area will be able to be irrigated "with dam" condition. In the Bati Area total irrigable area will be increased from 1,600 ha to 4,200 ha with crop intensity of 180% and the dependability at 80%.

Schematic diagram of results of water balance study "with and without" dam condition of Case-2 is shown in Figure II-8.4.2.1.1. Result of reservoir operation of the Stung Tasal Dam of Case-2 is shown in Figure II-8.4.2.1.2.

**Table II-8.4.2.1 Summary of Case Study of Water Balance Simulation of "With/Without" Dams**

| Case No. | Dangkor Irrigation Area | | | Roleang Chrey-I (80% Zone-I) | | | Roleang Chrey-II (50% Zone-II) | | | RC |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area (ha) | Crop Intensity | Dependability | Total Area (ha) | Crop Intensity | Dependability | Total Area (ha) | Crop Intensity | Dependability | Total Area (ha) |
| Case-0 | 300 | 114% | 80% | 5,660 | 114% | 80% | 11,040 | 114% | 57% | 16,700 |
| Case-1 | 300 | 180% | 90% | 16,000 | 180% | 80% | 700 | 130% | 77% | 16,700 |
| Case-2 | 300 | 180% | 93% | 15,400 | 180% | 80% | 1,300 | 130% | 80% | 16,700 |
| Case-3 | 300 | 180% | 93% | 16,700 | 180% | 80% | 0 | - | - | 16,700 |
| Case-4 | 300 | 180% | 93% | 16,700 | 180% | 80% | 0 | - | - | 16,700 |
| Case-5 | 300 | 180% | 93% | 16,700 | 200% | 80% | 0 | - | - | 16,700 |

| Case No. | Kandal Stung (Grant) | | | Kandal Stung (Extension) | | | Tonle Bati (Priority Area) | | | KSBT |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Area (ha) | Crop Intensity | Dependability | Total Area (ha) | Crop Intensity | Dependability | Total Area (ha) | Crop Intensity | Dependability | Total Area (ha) |
| Case-0 | 1,950 | 174% | 83% | 0 | - | - | 1,600 | 180% | 100% | 3,550 |
| Case-1 | 1,950 | 180% | 97% | 1,800 | 180% | 93% | 4,200 | 180% | 80% | 7,950 |
| Case-2 | 1,950 | 180% | 97% | 1,750 | 180% | 93% | 4,200 | 180% | 80% | 7,900 |
| Case-3 | 1,950 | 180% | 100% | 4,200 | 180% | 93% | 6,000 | 180% | 83% | 12,150 |
| Case-4 | 1,950 | 180% | 100% | 2,940 | 180% | 93% | 6,000 | 180% | 80% | 10,890 |
| Case-5 | 1,950 | 200% | 100% | 4,200 | 200% | 93% | 6,000 | 200% | 80% | 12,150 |

*Source: JICA Survey Team*

## II-8.5 Recommendation

As described above, the Stung Tasal Dam affects a large benefit for the Roleang Chrey command area. In addition, implementation of the Stung Tasal Dam Project highly benefits the Kandal Stung (extension) Area. Stung Khleach Dam is larger effect than Stung Sva Slab Dam as shown in table above Case-3 and Case-4. These dam projects also have large effect to benefit of the Roleang Chrey command area. F/S of the Stung Khleach Dam and the Stung Sva Slab Dam will be recommended too.

# CHAPTER II-9 CONCLUSION AND RECOMMENDATIONS

## II-9.1 Conclusion

In the Rectangular Strategy-Phase II which is the most influential policy for every activity in Cambodia, RGC emphasizes the improvement of agricultural productivity since the agriculture sector is regarded as the core of rural economy and has highly contributed toward sustaining the economic growth as well as accelerating poverty reduction. Also, RGC focuses on the water resources and irrigation management to ensure the irrigation water necessary for attaining the said improvement of agricultural productivity. SPPIDRIP which is irrigated agriculture project is duly conducive to implementation of this policy.

According to the Policy Paper on the Promotion of Paddy Production and Rice Export, paddy production is planned to be increased by annually 2.6% to 6.1% for 2010 to 2015, and it is deemed that annual increasing rate would be 2.6% after 2016. In case of following this increase rate pattern, rice production in 4 provinces, namely Kampong Speu, Kandal, Takeo and Kampong Chhnang Provinces which are related to SPPIDRIP, would be increased by 1,158,789 tons[1] in 2024 when full benefit of SPPIDRIP occurs. If 6 Sub-projects are implemented under SPPIDRIP as planned, rice production would be increased by 30,978 tons which correspond to 2.7% of 1,158,789 tons. From this analysis, it can be said that SPPIDRIP would to a certain extent contribute to implementation of the Policy Paper mentioned above.

The economic evaluation was conducted for SPPIDRIP, RCHRSP, USISRSP, KSBISRSP, MC35RSP, SPWRRSP and DPISRSP. The calculated EIRR are 14.3% for SPPIDRIP, 8.6% for RCHRSP, 14.5% for USISRSP, 20.0% for KSBISRSP, 11.3% for MC35RSP, 21.0% for SPWRRSP and 6.2% for DPISRS. As far as this evaluation result concerned, it could be said that SPPIDRIP would be economically feasible. Besides SPPIDRIP would not only contribute to the implementation of super-ordinate policies mentioned above, but also bring about the socio-economic benefits such as creation of job opportunity (1.3 million person-days during construction time) and improvement of farm income (increase of US$ 825 in annual net return for household).

## II-9.2 Recommendations

(1) Explanation of the Project to National Steering Committee

In WTSIDRIP of which the implementation will be started earlier than SPPIDRIP, a National Steering Committee will be established mainly for provision of the necessary political coordination and supports from the relevant ministries. This National Steering Committee will be in charge of the implementation of SPPIDRIP with the same purpose. It is therefore recommended that PMU shall explain the objective and scope of SPPIDRIP to the National Steering Committee prior to the commencement of implementation of SPPIDRIP so as to enable the Committee to deepen its understanding on contents and significance of SPPIDRIP.

[1] *Annual Report for Agriculture Forestry and Fisheries 2010-2011, MAFF*
*Rice production to be increased for 4 provinces : 3.200,926(2024) – 2,042,137 (2010)=1,158,789*

(2) Timely Budget Arrangement for Smooth Implementation of SPPIDRIP

Timely budget arrangement is essential for smooth implementation of SPPIDRIP. Immediately after the loan agreement is made, MOWRAM should set out to prepare the budget plan necessary for the implementation of SPPIDRIP t in the light of the implementation plan. In preparation of budget plan, consideration shall be given to budget arrangement for administration and software component.

(3) Prior Establishment of Implementation Organization

As mentioned previously, the implementation organization will play a crucial role for successful implementation of SPPIDRIP. In general, it would take certain time to reach the implementation organization in full swing. It is therefore recommended that the implementation organization should be established in appropriate timing prior to commencement of implementation of SPPIDRIP.

(4) Land Acquisition for Construction of Tertiary Canals

In the Sub-project Areas there exist tertiary canals, but their number and length are not enough to execute the timely and effective water distribution to fields. Thus, it is necessary to construct the tertiary canals additionally. According to the government policy, the land required for construction of tertiary canals should be offered by the beneficiary farmers without compensation. Due to this, land acquisition for construction canals has often faced a problem with them, which would lead to delay in construction of tertiary canals. In order to avoid such unexpected situation, it is recommended that PMU shall preferentially take a necessary action for land acquisition for tertiary canals in advance.

(5) Careful Gate Control at Roleang Chrey Regulator

In the upstream area of the Prek Thnot River, the implementation of the Stung Tasal Dam has been started since January 2011 under financial cooperation of the Government of India. After completion of the Stung Tasal Dam construction, the stored water could be supplied to the downstream irrigation area, say Kandal Stung Area, through the Roleang Chrey Regulator. Thus, the gate control of Roleang Chrey Regulator is so important to supply irrigation water to the downstream area properly. In RCHRSP, the Roleang Chrey Regulator will be so improved as to enable to release small discharge to downstream area. Even under such situation, it is recommended that careful attention shall be paid to the control of gate to be installed newly, in order to surely release the required irrigation water to the downstream area.

(6) Arrangement toward Post Evaluation to Clarify Project Effect

It is crucial to clarify whether the project effect is revealed as planned or not, for the subsequent formulation of similar project. In the Survey, the socio-economic survey was already carried out for RCHRSP, USISRSP and KSBISRSP, of which the reports have been submitted to MOWRAM. The results of this socio economic survey could become the benchmarks for monitoring the project effect. MOWRAM is thus recommended that the necessary arrangement toward post evaluation should be taken into consideration in advance, in order to grasp the project effect accurately.

(7) Need of Detailed Water Balance Study for Prek Thnot River Basin

In the Survey, a preliminary water balance study was carried out for the Prek Thnot River basin taking into consideration the 5 dam projects located in upstream basin of Prek Thnot River. As a result, it was found that the released discharge from these dams would play an important role of irrigation projects located downstream. Thus, it is recommended that the further detailed study should be carried out at the beginning time of detailed design in order to clarify the definite irrigable area located downstream and also to contribute to proper dam operation, especially for the on-going Stung Tasal Dam.

(8) Establishment of Prek Thnot River Basin Management Unit in MOWRAM

As mentioned above, dam projects located in the upstream basin of the Prek Thnot River basin would highly influence the irrigation condition of irrigation projects located downstream. This means that it is necessary to make careful approach to the water allocation of Prek Thnot River including the released discharge from the Stung Tasal Dam. In order to realize this careful approach, it is recommended that the Prek Thnot Basin Management Unit in MOWRAM prior to completion of SPPIDRIP.

(9) Execution of Detailed Survey for Mines and UXOs

According to the information from CMAC, there exist some suspected areas in USISRSP Area and KSBISRSP Area. Prior to commencement of D/D for these Sub-projects, say during period of selection of consultant, detailed survey should be conducted by CMAC. In this connection, it is recommended that MOWRAM should arrange the necessary budget for the survey and also take necessary actions toward smooth execution of the survey by CMAC.

# *PART III*

*SMALL-SCALE IRRIGATION SYSTEM IMPROVEMENT PROJECT*

# PART III SMALL-SCALE IRRIGATION SYSTEM IMPROVEMENT PROJECT

## CHAPTER III-1 PROJECT INFORMATION

### III-1.1 General

Project proposal documents for the rehabilitation of 84 sub-projects in SISIP were submitted to MOWRAM in October 2009 prior to the Survey. These proposals were prepared by PDOWRAM by filling up standard proposal forms that were given by MOWRAM under assistance of TSC-2. Out of 84 sub-projects, 3 Sub-projects consisting of (i) MC35RSP, (ii) SSPWRRSP and (iii) DPISRSP are selected for pre-F/S in the Survey after screening and priority ranking as mentioned previously.

The original long list was prepared in 2009 and almost 3 years have already passed. Situations have been changed since then, hence it is needed to update the future possible implementation by RGC or other donors. The original list prepared by MOWRAM and location map of 84 proposed sub-projects is shown in ANNEX D. This Chapter describes the updated long list and the proposed short list based on the proposed screening and ranking criteria by the JICA Survey Team.

### III-1.2 Updated Long List

As mentioned above, the original long list was prepared in 2009, after when some projects have already been completed, commenced or committed to start by the other financial source like RGC or international organizations. According to MOWRAM, the following 17 irrigation sub-projects are to be excluded from the long list, the sub-project area of which totaled 15,700 ha as of March, 2012.

**Table III-1.2.1 Sub-projects Excluded from Long List**

| Province | Name of Sub-projects | Area (ha) | Remarks |
|---|---|---|---|
| Kampong Chhnang | Daun Pue | 1,151*1 | Under the Survey |
| Kampong Speu | Main Canal 35 | 3,018*1 | Under the Survey |
| Takeo | Chroy Samrong | 300 | Study completed to be funded by RGC |
| Takeo | Thra Peng Veng | 200 | Study completed to be funded by World Bank |
| Takeo | Sen Presh Ream | 567 | Study completed to be funded by RGC |
| Pursat | Kompeang Reservoir | 380 | Will be signed with MOWRAM to be funded by Grass Root |
| Pursat | Wat Leap | 600 | Under study with assistance of World bank |
| Kandal | Ta Tray | 172 | Under rehabilitation (50%) by RGC |
| Kandal | Chak Kaek | 226 | Study completed to be funded by RGC |
| Kandal | Srass Prambai | 2,500*1 | Under the Survey |
| Kep | Dem Pring | 160 | Started to Rehabilitation commenced by RGC |
| Kompot | Ou Chranieng Reservoir | 310 | Rehabilitation completed by World Bank |
| Pailin | Thnal Bot | 4,000 | Rehabilitation completed by World Bank |
| Prey Veng | Char | 888 | Study completed to be funded by RGC |
| Svay Rieng | Krang Leav | 642 | Rehabilitation completed by RGC |
| Koh Kong | Saray Polder | 342 | Rehabilitation completed by RGC |
| Koh Kong | Tanni Polder | 241 | Rehabilitation completed by RGC |
| **Total** | 17 sub-projects | **15,697** | |

*Remarks 1; Project area is referred to the original list prepapred by MOWRAM*
*Source: Prepared by JICA Team based on the data of MOWRAM*

After dropping out of the above sub-projects, 67 sub-projects in total remain in the updated long list, which are nominated from 21 provinces, the whole country except Phnom Penh, Pailin and Kaoh Kong. Table III-1.2.2 summarizes comparison between the original and updated sub-projects by

provinces. The updated long list and location map of 67 proposed sub-projects are shown in Figure AD-2.4.5.1.1 in ANNEX D.

**Table III-1.2.2 Summary of Original and Updated Long List by Province**

| Code | Province | Original Long List (2009) | | Updated Long List (2012) | | Remarks |
|---|---|---|---|---|---|---|
| | | No/Nos. | Total Area (ha) | No/Nos. | Total Area (ha) | |
| 01 | Banteay Mean Chey | 3 | 5,166 | 3 | 5,166 | |
| 02 | Mondul Kiri | 2 | 1,440 | 2 | 1,440 | |
| 03 | Kampong Chhnang | 3 | 2,647 | 2 | 1,496 | 1 sub-project has been dropped out |
| 04 | Kampong Speu | 3 | 7,668 | 2 | 4,650 | 1 sub-project has been dropped out |
| 05 | Battambang | 2 | 5,460 | 2 | 5,460 | |
| 06 | Takeo | 5 | 5,715 | 2 | 4,628 | 3 sub-projects have been dropped out |
| 07 | Sihanuk Ville | 2 | 646 | 2 | 646 | |
| 08 | Pursat | 7 | 5,275 | 5 | 4,295 | 2 sub-projects have been dropped out |
| 09 | Kandal | 5 | 6,965 | 2 | 4,067 | 3 sub-projects have been dropped out |
| 10 | Stung Treng | 3 | 4,121 | 3 | 4,121 | |
| 11 | Kep | 4 | 1,231 | 3 | 1,071 | 1 sub-project has been dropped out |
| 12 | Kampot | 7 | 5,268 | 6 | 4,958 | 1 sub-project has been dropped out |
| 13 | Siem Reap | 3 | 2,996 | 3 | 2,996 | |
| 14 | Pailin | 1 | 4,000 | 0 | 0 | 1 sub-project has been dropped out |
| 15 | Ratanakkrir | 1 | 90 | 1 | 90 | |
| 16 | Kampong Cham | 5 | 2,856 | 5 | 2,856 | |
| 17 | Prey Veng | 6 | 9,373 | 5 | 7,497 | 1 sub-project has been dropped out |
| 18 | Svay Rieng | 11 | 7,251 | 10 | 6,609 | 1 sub-project has been dropped out |
| 19 | Kampong Thom | 2 | 1,250 | 2 | 1,250 | |
| 20 | Kratie | 3 | 1,311 | 3 | 1,311 | |
| 21 | Koh Kong | 2 | 583 | 0 | 0 | 2 sub-projects have been dropped out |
| 22 | Preah Vihear | 2 | 760 | 2 | 690 | |
| 23 | Odar Mean Chey | 2 | 2993 | 2 | 2,993 | |
| | **Total** | **84** | **85,065** | **67** | **68,290** | |

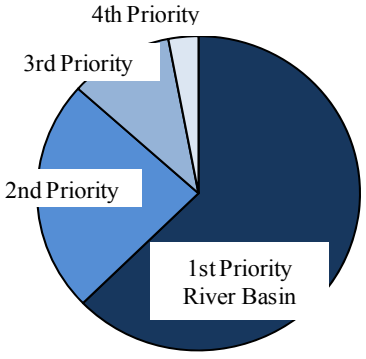
*Source: MOWRAM*

## III-1.3 Outline of Sub-projects in Updated Long List

Based on the remaining 67 proposals submitted by each PDOWRAM, which are scattered in whole country, the JICA Survey Team examined the summary of the outline of the sub-projects.

(1) Distribution of Candidates by River Basin Priority

Previous study[1] has prioritized all 42 river basins in the country using criteria of natural and human resource and social conditions and so on, determining from the 1st to 4th priority river basins in turn. As shown in Figure III-1.3.1, 42 sub-projects (63% of total 67 sub-projects) are located in the 1st priority river basins, 16 sub-projects (24%) are in the 2nd priority river basins, and 9 sub-projects (13%) are located in 3rd and 4th river basins.




*Source: JICA Survey Team*

**Figure III-1.3.1 Distribution of Candidates by River Basin Priority**

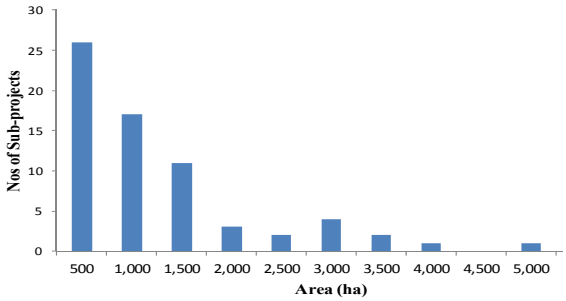
(2) Distribution by Irrigation Area

The irrigation area of 67 proposed sub-projects are varied as shown in Figure III-1.3.2.

Irrigation systems of which irrigation areas are less than 500 ha occupy about 40% in number, and

[1] *Review on Nationwide Irrigation Development, March 2010*

those having the area of less than 1,000 ha accounts about two-third. Irrigation systems of more than 2,000 ha totaled to about 15%.




*Source : JICA Survey Team*

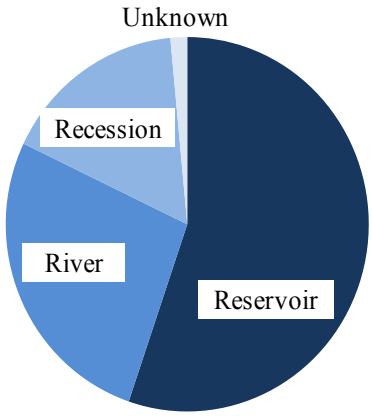
**Figure III-1.3.2 Distribution of Candidates by Irrigation Area**

(3) Distribution by Irrigation Type

All candidate projects are categorized as gravity type and neither lift irrigation nor groundwater irrigation project was proposed. The water sources for the proposed projects are further categorized into 3 types, which area (i) reservoir, (ii) river run-off without reservoir, and (iii) flood recession water. Distribution of irrigation type is therefore classified by these types of water resources.

Distribution by water resources are summarized below and in Figure III-1.3.3.

- Reservoir irrigation system (55%)
- River irrigation without reservoir (27%)
- Recession cultivation (16%)




*Source : JICA Survey Team*

**Figure III-1.3.3 Distribution of Candidates by Irrigation Type**

# CHAPTER III-2 PREPARATION OF SHORT LIST

## III-2.1 General

As mentioned in Section III-1-3, SISIP covering the whole country is proposed to be implemented in near future by RGC or other possible donors, based on the experiences to be obtained through the Survey and the expected Japan's loan project. Therefore, short list is prepared in the Survey for necessary action and arrangement by MOWRAM.

The purposes of preparation of the short list are: (i) to confirm the potential projects for future implementation and (ii) to indicate the sample flowchart and criteria.

## III-2.2 Criteria for Preparation of Short List

(1) Updated long list

In Section III-1.2, the original long list prepared by MOWRAM in 2009 is updated based on the information of the completed, on-going and committed sub-projects during the period from 2009 through March 2012.

(2) Priority Ranking

The priority ranking is carried out based on the following 7 ranking criteria. These criteria are almost similar to the selection criteria for the pre-F/S sites in this Survey, however, those are modified based on the experience obtained through the Survey.

As experienced in the Survey, one of the most important technical information is the available water resource, which is however not clearly explained in PDOWRAM's proposal documents. Available water resource is estimated based on the catchment area on the available topographic map and evaluated by the ratio of the proposed irrigation area and the catchment area, of which the point score is given double to the other items.

Other point score in ranking is set up in the items, such as the river basin priority, project scale, effects of sub-project, social conditions, and so on, which are 10 points each and 80 points in total including the above points on water source. Priority projects to be nominated in the short list are ranked according to the total score. Based on the score, the short list includes the sub-projects which have more than 50 points as a 1st priority group.

**Table III-2.2.1 Point Score for Priority Ranking**

| Item | Conditions | Point |
|---|---|---|
| (a) River basin priority | First priority river basin | 10 points |
| | Second priority river basin | 5 points |
| | Other river basin | 0 points |
| (b) Suitable scale of irrigation area | More than 500 ha and less than 1,500 ha | 10 points |
| | Less than 500 ha | 5 points |
| | More than 1,500 ha | 0 points |
| (c) Effect of sub- project (Incremental irrigation area) | More than 100% increased | 10 points |
| | More than 50% and less than 100% increased | 5 points |
| | Less than 50% increased | 0 points |
| (d) Available water resource | Catchment area / Irrigation area > 20 | 20 points |
| | 20 > Catchment area / Irrigation area > 10 | 10 points |
| | Catchment area / Irrigation area < 10 | 0 points |
| (e) Social conditions (Farmers' consensus) | 100% Concurred | 10 points |
| | More than 80% concurred | 5 points |
| | Less than 80% concurred | 0 points |

| Item | Conditions | Point |
|---|---|---|
| (f) Social conditions (Risk of land mine) | No risk | 10 points |
| | Risk or not known | 0 points |
| (g) Social conditions (Land acquisition) | All government land | 10 points |
| | All government land with illegal occupation | 5 points |
| | Land acquisition required | 0 points |

*Source : JICA Survey Team*

## III-2.3 Sub-projects Selected in Short List

Based on the above point scoring, total score of each sub-project are shown in Table AD-2.4.5.3.1 in ANNEX D, and the sub-projects selected in the short list are 20 nos. in number and 19,000 ha in total area out of the long listed 67 sub-projects as summarized in Table III-2.3.1.

**Table III-2.3.1 Summary of Short Listed Sub-projects**

| Code | Province | Name of Project | Type of Irrigation (Water source) | Irrigation Area (ha) |
|---|---|---|---|---|
| 1-1 | Banteay Mean Chey | Mongkolborey Main Canal | River without Reservoir | 1,116 |
| 1-3 | Banteay Mean Chey | An longrot Reservoir | Reservoir | 1,350 |
| 3-1 | Kampong Chhnang | Khla Krap | Recession cultivation | 450 |
| 3-3 | Kampong Chhnang | Canal Stung Sdatch | River without Reservoir | 1,046 |
| 6-4 | Takeo | Portasu | Reservoir | 1,756 |
| 8-4 | Pursat | Kab Kralanh | River without Reservoir | 550 |
| 8-6 | Pursat | Tram Canal | Reservoir | 350 |
| 8-7 | Pursat | Ken Seng | River without Reservoir | 235 |
| 9-2 | Kandal | Torn Or | Recession cultivation | 247 |
| 9-5 | Kandal | Mlech Krabai Kon | Recession cultivation | 3,820 |
| 11-1 | Kep | Rones | Reservoir | 621 |
| 11-3 | Kep | Prek Tanen | Reservoir | 75 |
| 11-4 | Kep | Veal Vong | Reservoir | 375 |
| 13-1 | Siem Reap | Neary Canal | River without Reservoir | 611 |
| 13-2 | Siem Reap | Louk Canal | River without Reservoir | 1,085 |
| 13-3 | Siem Reap | Trabek Canal | River without Reservoir | 1,300 |
| 16-4 | Kampong Cham | Bay Dei Reservoir | Reservoir | 894 |
| 17-5 | Prey Veng | Anlong Cha Canal | Recession cultivation | 2,226 |
| 18-10 | Svay Rieng | So Pha | Recession cultivation | 650 |
| 18-11 | Svay Rieng | Svay Year | Recession cultivation | 350 |
| | Total | 20 sub-projects | Reservoir : 7<br>River without Reservoir : 7<br>Recession cultivation : 6 | 19,107 |

*Source: JICA Survey Team*

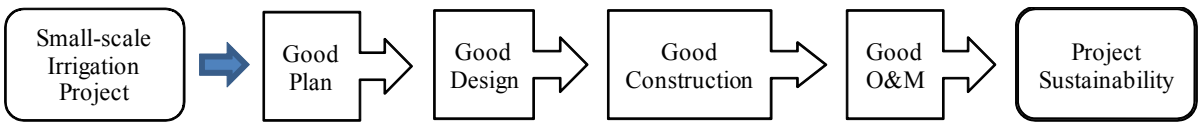
# CHAPTER III-3 EXECUTION OF PRELIMINARY FEASIBILITY STUDY

## III-3.1 General

As for proceeding to next step for the implementation of sub-projects in the short list and updating the short list as well, it is expected that PDOWRAM will carry out the preliminary F/S under direction of MOWRAM for implementation in future. As far as the project proposals on them prepared by PDOWRAM are concerned, however unfortunately, these would not attain at the satisfactory level from the technical and economical viewpoints. Thus, it is essential to take necessary arrangement for enabling PDOWRAM to carry out the preliminary F/S in a proper way.

## III-3.2 Need of Preliminary Feasibility Study

The purpose of the preliminary F/S is to prove that the project is technically sound and economically viable. The project is always requited to be sustainable. To realize this requirement, the project needs to follow the flow of "good plan", "good design", "good construction" and "good O&M". The project sustainability could not be attained even if one of them is lacked.



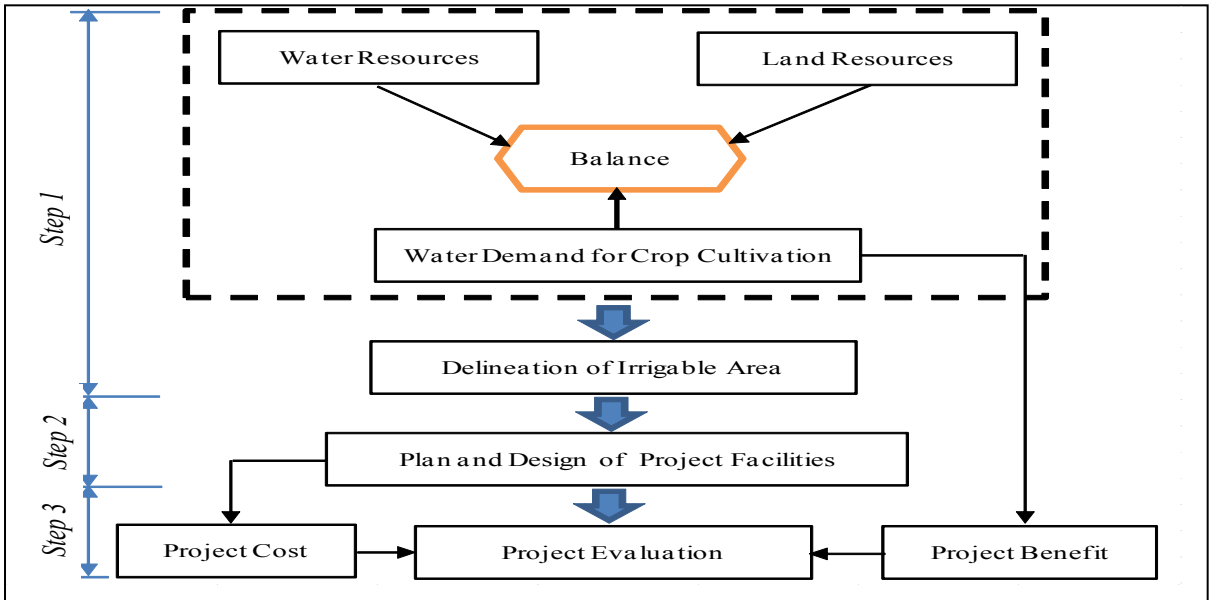

*Source: JICA Survey Team*

**Figure III-3.2.1 Flow of Appropriate Procedure to Project Formulation**

In this flow, F/S plays a role of seeking for the "good plan" of the project. The meaning of "good plan" is nothing other than satisfying both technical and economical requirements.

## III-3.3 Manual on Execution of Preliminary Feasibility Study

For the purpose mentioned above, the manual is prepared in this Survey to strengthen the PDOWRAM capability for execution and examination of preliminary F/S. The objective of the manual is to provide




*Source: JICA Survey Team*

**Figure III-3.3.1 Outline of Work Procedure**

the PDOWRAM staff with the procedure of execution of preliminary F/S for the small-scale irrigation projects, which is worked out mainly by reflecting the experiences obtained through the preliminary F/S for the selected 3 Sub-projects. On the other hand, even the preliminary F/S covers many fields such as hydrology, agronomy, irrigation, drainage, economy and environment. In order to cope with such complicated situations, the manual should be therefore elaborated in a more simple and practical manner, so that the PDOWRAM staff can bear mind to easily use it.

In general, the preliminary F/S should be carried out by the limited staff within the limited time. In order to effectively and smoothly execute the preliminary F/S, it is imperative to know the whole works in advance, and then to take the necessary steps on time to complete it as scheduled.

The preliminary F/S is largely divided into the following 3 steps (See Figure III-3.3.1):

***Step 1: Delineation of Irrigable Area***

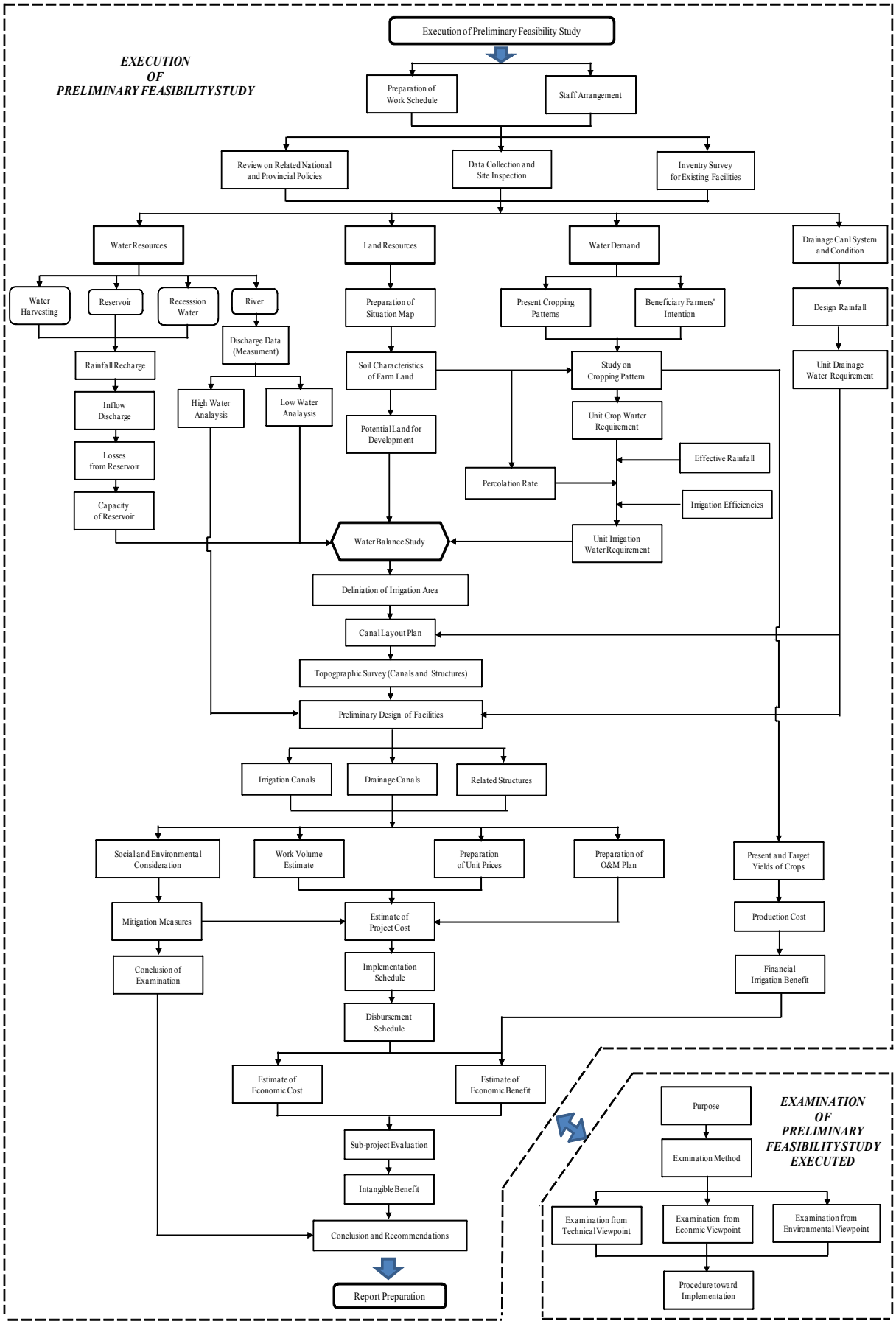
Balance of water resource, land resource and water demand for crop cultivation

***Step 2: Plan and Design of Project Facilities***

Execution of good plan and good design for project facilities to effectively distribute irrigation water to field

***Step3: Project Evaluation***

Execution of appropriate project evaluation using project cost, project benefit by crop production and project implementation plan. Detailed work flow for preliminary F/S is shown in Figure III-3.3.2




*Source: JICA Survey Team*

**Figure III-3.3.2 Detailed Work Flow for Preliminary Feasibility Study**

# CHAPTER III-4 RECOMMENDATIONS

## III-4.1 Observing of Definition of Small-scale Irrigation Project

According to the MOWRAM's criteria, the small-scale irrigation project is defined with its irrigation area less than 200 ha, however the irrigation area for the sub-projects in the updated lists and the short lists largely fluctuates and mostly they are larger than 200 ha as discussed in Section III-1. Therefore, it is recommended that the suitable scale of the small-scale irrigation project should be defined for the future process and implementation of the packaged project.

## III-4.2 Arrangement of Budget and Staff for Execution of Preliminary Feasibility Study

Timely arrangement of budget and staff for execution of preliminary F/S is essential for smooth process to the future small-scale irrigation project. After completion of this Survey, it is recommended that MOWRAM should prepare the action plan for the preparatory works for the project including execution as soon as possible and updating pre-F/S, and subsequently set out to prepare the budget plan necessary for the continuous pre-F/S of small-scale irrigation project in the light of the implementation plan.

## III-4.3 Timely Updating of Short List

As mentioned in the previous Sections, the situation of the candidate projects in the list might change from time to time. Therefore, the data and information on the short list should be updated periodically and the list should be refreshed at least once a year.

# *Tables*

**Table II-7.3.2.1 Environmental Scoping Result by each Sub-project**

| | | Impact | RCHRSP | USISRSP | KBISRSP | MC35RSP | SPWRRSP | DPISRSP |
|---|---|---|---|---|---|---|---|---|
| Pollution Control | 1 | Air pollution | B- | B- | B- | B- | B- | B- |
| | 2 | Water pollution | B- | B- | B- | B- | B- | B- |
| | 3 | Soil contamination | - | - | - | - | - | - |
| | 4 | Waste | B- | B- | B- | B- | B- | B- |
| | 5 | Noise and vibration | B- | B- | B- | B- | B- | B- |
| | 6 | Ground subsidence | - | - | - | - | - | - |
| | 7 | Offensive odor | - | - | - | - | - | - |
| | 8 | Bottom sediment | - | - | - | - | - | - |
| | 9 | Disaster | - | - | - | - | - | - |
| Natural Environment | 10 | Topography and geographical features | - | - | - | - | - | - |
| | 11 | Soil erosion | B- | B- | B- | B- | - | B- |
| | 12 | Groundwater | - | - | - | - | - | - |
| | 13 | Hydrological situation | C- | C- | C- | C- | C- | B- |
| | 14 | Coastal zone | - | - | - | - | - | - |
| | 15 | Flora, fauna and biodiversity | - | B- | B- | - | B- | B- |
| | 16 | Meteorology | - | - | - | - | - | - |
| | 17 | Landscape | - | - | - | - | - | - |
| | 18 | Global warming | - | - | - | - | - | - |
| Social Environment | 19 | Involuntary resettlement | - | - | B- | - | - | B- |
| | 20 | Local economy such as employment and livelihood, etc. | A+ | B-/A+ | A+ | A+ | A-/A+ | A+ |
| | 21 | Land use and utilization of local resources | B-/B+ | B-/B+ | B-/A+ | B-/A+ | A-/A+ | B-/A+ |
| | 22 | Social institutions (including regional severance) | - | - | - | - | - | - |
| | 23 | Existing social infrastructures and services | B- | B- | B- | B- | B-/A+ | B- |
| | 24 | Socially vulnerable groups such as the poor, indigenous and ethnic people (including gender matter) | B+ | B+ | B-/B+ | B+ | C-/B+ | - |
| | 25 | Misdistribution of benefit and damage | - | B- | - | - | B- | - |
| | 26 | Historical and cultural heritage (including religious matters) | - | - | - | - | - | - |
| | 27 | Water usage or water rights and rights of common | A+ | A+ | A+ | A+ | A+ | A+ |
| | 28 | Local conflict of interests | - | B- | B+ | - | B- | B- |
| | 29 | Sanitation | B- | B- | B- | B- | B- | B- |
| | 30 | Hazardous (risk) infectious diseases such as HIV/AIDS | B- | B- | B- | B- | B- | B- |
| | 31 | Accident | B- | B- | B- | B- | B- | B- |

*Source: JICA Survey Team*

*<Rating>*

*A-: Serious impact is expected, if any measure is not implemented to the impact.*

*B-: Some impact is expected, if any measure is not implemented to the impact.*

*C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)*

*-: No impact is expected.*

*A+:Remarkable effect is expected due to the project implementation itself and environmental improvement caused by the project.*

*B+:Some effect is expected due to the project implementation itself and environmental improvement caused by the project.*

*Overall rating: Highest rate will be the overall rating among the rating of relevant project-related activities for negative and positive ratings, respectively. (e.g. Even only one "A-" is included in an environmental item, overall rating of the environmental item becomes "A-".)*

**Table II-7.3.3.1 Consideration of Negative Environment/Social Impact and Mitigation Measures (RCHRSP)**

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| **Pollution Control** | | | | | |
| 1 | Air pollution and Noise and Vibration (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation works of regulator, canals/drainages and other related facilities | - In and around construction area | - Air pollution caused by construction works<br>- Noise and vibration caused by construction works | - To educate construction workers for minimizing idling of construction machinery<br>- To limit construction time. e.g. during daytime only<br>- To hold stakeholder meetings to build consensus about the construction time<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 2 | Water Pollution by Construction Works | - Operation of construction equipment and vehicles<br>- Rehabilitation works of regulator, canals/drainages and other related facilities | - Downstream of Prek Thnot River, NMC and SMC | - Water pollution caused by construction works | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 3 | Waste Management by Construction Works | - Operation of construction equipment and vehicles<br>- Rehabilitation works of regulator, canals/drainages and other related facilities | - In and around construction area | - Construction waste caused by construction works | - To comply with relevant laws pertaining to the management and disposal of solid waste, hazardous waste and re-waste.<br>- To arrange suitable sites for disposal of solid waste prior to the construction works,<br>- To avoid dumping in the area of private property without written consent of the owner<br>- To carry out recycle use of disposed soil as much as possible<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 4 | Water Pollution (Operation Phase) | - Utilization of irrigation water | - Downstream of Prek Thnot River, NMC and SMC | - Chemical contamination in drainage water by increase of farm inputs | - To conduct support programs regarding appropriate agricultural management<br>- To introduce composting activity to the farmers<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To monitor water quality and agricultural activities regularly<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| **Natural Environment** | | | | | |
| 5 | Soil Erosion | - Operation and maintenance of regulator and canals/drainage | - NMC and SMC | - Possibility of soil erosion in rehabilitation canals/drainage | - To implement maintenance of canals by adequate methods and appropriate timing<br>- To design main canal and its structures to consider alleviation of soil erosion |
| **Social Environment** | | | | | |
| 6 | Land use and utilization of local resources | - Rehabilitation works of regulator, canals/drainages and other related facilities | - Surrounding the Roleang Chrey Regulator | - Land acquisition (for temporary diversion channel and drainage) | - To design temporary diversion channels, other temporary related facilities and drainage canals by minimizing land acquisition as much as possible during D/D<br>- To conduct detailed socio-economic survey for affected persons during preparatory stage of RCHRSP to identify all losses from land acquisition<br>- To fairly compensate to all affected persons, including those without title to land, for all their losses at replacement rates, if any.<br>- To properly restore the affected area after construction works |
| 7 | Existing social infrastructures and services | - Operation of construction equipment and vehicles<br>- Rehabilitation works of regulator, canals/drainages and other related facilities | - Roleang Chrey Regulator and its surrounding | - Limitation of accessibility on bridges of Roleang Chrey regulator | - To establish a temporary bridge during rehabilitation work<br>- To hold a series of public consultation meetings for surrounding people in order to explain, discuss and find the way of passage restriction<br>- To educate construction workers for adequate traffic rule of construction vehicles<br>- To post a bill to inform impassable duration to commune council, village chief by means of, such like, social facilities including schools, pagodas and hospitals, after the work schedule is fixed with people's consensus. |
| 8 | Water usage or water rights and rights of common | - Rehabilitation works of regulator, canals/drainages and other related facilities | - Surrounding Area Roleang Chrey Regulator | - Limitation of water usage around rehabilitation works of Roleang Chrey regulator and canals | - To conduct construction works in fallow period intensively as much as possible<br>- To hold a series of stakeholder meetings when detailed construction works schedule is prepared in order to build consensus among stakeholders including affected people.<br>- To consider alternative water source like pump well for drinking and domestic use for those who have to visit far away for collecting water to avoid increase of women's burden,<br>- To train stakeholders in order to share the work among men and women for water collection<br>- To distribute water for drinking and domestic use by water tanker for the affected people during construction phase |
| 9 | Sanitation | - Operation of construction equipment and vehicles<br>- Rehabilitation works of regulator, canals/drainages and other related facilities | - In and around construction area | - Degradation of sanitation condition and security due to inflow of construction workers from outside<br>- Risk of infectious diseases by construction workers from outside<br>- Risk of accident by construction works | - To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction works<br>- To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule.<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 10 | Hazardous (risk) infectious diseases such as HIV/AIDS | | | | |
| 11 | Accident | | | | |

*Source: JICA Survey Team*

**Table II-7.3.3.2 Consideration of Negative Environment/Social Impact and Mitigation Measures (USISRSP)**

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| **Pollution Control** | | | | | |
| 1 | Air pollution and Noise and Vibration | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - In and around construction area | - Air pollution caused by construction works<br>- Noise and vibration caused by construction works | - To educate construction workers for minimizing idling of construction machinery<br>- To limit construction time. e.g. during daytime only<br>- To hold stakeholder meetings to build consensus about the construction time<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 2 | Water Pollution by Construction Works (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - Downstream of Slakou River, Main and Secondary Canals | - Water pollution caused by construction works | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 3 | Waste Management by Construction Works | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - In and around construction area | - Construction waste caused by construction works | - To comply with relevant laws pertaining to the management and disposal of solid waste, hazardous waste and re-waste.<br>- To arrange suitable sites for disposal of solid waste prior to the construction works,<br>- To avoid dumping in the area of private property without written consent of the owner<br>- To carry out recycle use of disposed soil as much as possible<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 4 | Water Pollution (Operation Phase) | - Utilization of irrigation water | - Downstream of the Slakou River and Main Canal | - Chemical contamination in drainage water by increase of farm inputs | - To conduct support programs regarding appropriate agricultural management<br>- To introduce composting activity to the farmers<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To monitor water quality and agricultural activities regularly<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| **Natural Environment** | | | | | |
| 5 | Soil Erosion | - Control of Maintenance Canals/Drainages | - Command area of the USISRSP | - Possibility of soil erosion in rehabilitation canals/drainage | - To implement maintenance of canals by adequate methods and appropriate timing<br>- To design main canal and its structures to consider alleviation of soil erosion |
| 6 | Flora, fauna and biodiversity | - Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - Downstream of Slakou River | - Decrease in amount of flowing in the downstream Slakou River by irrigation water | - To ensure the amount of river maintenance water particularly in the dry season |
| **Social Environment** | | | | | |
| 7 | Local economy such as employment and livelihood, etc. | - Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - Area along Main Canal33 and Secondary Canal 3D and 3U<br>- Area of Tumnup Lok Reservoir | - Loss of paddy field (illegal use) on Tumnup Lok Reservoir<br>- Loss of structure (house, shop and other facilities) along main and secondary canals (illegal use) | - To design canals to minimize negative impact as much as possible in D/D<br>- To conduct detailed socio-economic survey of affected people during early stage of project preparation to identify all losses from land adjustment.<br>- To establish joint committee as decision making body to implement land adjustment process, members of which consist of: (i) executing agencies (MOWRAM, MAFF, PDOWRAM, PDA), (ii) related agencies (Provincial Department of Land Management, Urban Planning and Construction PDLMUPC etc.) and (iii) local authorities (commune council, village chief, etc)<br>- To conduct stakeholder meetings with farmers including affected people on: (i) project purpose, (ii) compensation measures, (iii) support programs to build consensus among the people especially the affected people through involvement of village chief<br>- To compensate affected persons, including those without title to land.<br>- To prepare adequate and realistic schedule of land adjustment through joint committee and inform affected people early<br>- To monitor the life condition of the affected people and the community |
| 8 | Land use and utilization of local resources | - Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - Area along Main Canal 33 and Secondary Canal 3D and 3U<br>- Area of Tumnup Lok Reservoir | - Loss of accessibility from road to residential houses and shops along main and secondary canals | - To conduct detailed socio-economic survey of affected people during early stage of project preparation to identify all losses from land adjustment<br>- To establish joint committee as decision making body to implement land adjustment process, consisting of executing agencies, related agencies and local authorities.<br>- To conduct stakeholder meetings with local people including affected people by USISRSP<br>- To decide compensation policy among joint committee and affected people<br>- To prepare adequate and realistic schedule of land adjustment through joint committee and inform affected people early |
| 9 | Existing social infrastructures and services | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and | - In and around construction area, especially along Main Canal 33, Secondary Canal 3U and 3D | - Objection of traffic by construction work<br>- Loss of easy accessibility from road to residential houses and shops | - To educate construction workers for adequate traffic rules of construction vehicles<br>- To limit construction time. e.g. at daytime only<br>- To conduct stakeholder meetings to obtain consensus about the construction time with surrounding people.<br>- To design and re-construct canal crossing to minimize negative impact as much as possible<br>- To enact the local rules to construct new canal crossings by themselves |

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| | | construction of the reservoir (Tumnup Lok Reservoir) | | | |
| 10 | Misdistribution of benefit and damage | - Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | - In and around construction area, especially along Main Canal 33, Secondary Canal 3U and 3D | - Misdistribution of benefit and damage between farmers and non-farmers<br>- Conflicts of interest between farmers and non-farmers | - To conduct detailed socio-economic survey of affected people during early stage of project preparation to identify all losses from land adjustment<br>- To conduct stakeholder meetings with local people including affected people on project contents<br>- To decide compensation policy among joint committee and affected people<br>- To prepare adequate and realistic schedule of land adjustment through joint committee and inform affected people early |
| 11 | Local conflict of interests | | | | |
| 12 | Sanitation | - Operation of construction equipment and vehicles<br>- Rehabilitation of Main and Secondary canals/drainages and other related facilities<br>- Rehabilitation of the existing dike and construction of the reservoir (Tumnup Lok Reservoir) | In and around the USISRSP Area | - Degradation of sanitation condition and security due to inflow of construction workers from outside<br>- Risk of infectious diseases by construction workers from outside<br>- Risk of accident by construction works | - To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction works<br>- To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule.<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 13 | Hazardous (risk) infectious diseases such as HIV/AIDS | | | | |
| 14 | Accident | | | | |

*Source : JICA Survey Team*

**Table II-7.3.3.3 Consideration of Negative Environment/Social Impact and Mitigation Measures (KSBISRSP)**

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| **Pollution Control** | | | | | |
| 1 | Air pollution and Noise and Vibration | - Operation of construction equipment and vehicles<br>- Rehabilitation works of canals/drainages and other related facilities | -In and around construction area | - Air pollution caused by construction works<br>- Noise and vibration caused by construction works | - To educate construction workers for minimizing idling of construction machinery<br>- To limit construction time. e.g. during daytime only<br>- To hold stakeholder meetings to build consensus about the construction time<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 2 | Water Pollution by Construction Works (Construction Phase) | Operation of construction equipment and vehicles<br>- Rehabilitation works of canals/drainages and other related facilities | -Downstream of construction area | - Water pollution caused by construction works | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 3 | Waste Management by Construction Works | Operation of construction equipment and vehicles<br>- Rehabilitation works of canals/drainages and other related facilities | -In and around construction area | - Construction waste caused by construction works | - To comply with relevant laws pertaining to the management and disposal of solid waste, hazardous waste and re-waste.<br>- To arrange suitable sites for disposal of solid waste prior to the construction works,<br>- To avoid dumping in the area of private property without written consent of the owner<br>- To carry out recycle use of disposed soil as much as possible |
| 4 | Water Pollution (Operation Phase) | - Utilization of irrigation water | -Downstream of KSBISRSP command area | - Chemical contamination in drainage water by increase of farm inputs | - To conduct support programs regarding appropriate agricultural management<br>- To control the amount of fertilizer and pesticide through the training farmers<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To monitor water quality and agricultural activities regularly |
| **Natural Environment** | | | | | |
| 5 | Soil Erosion | - Operation and maintenance of water resource facilities and canals/drainage | -Main/secondary canals and drainages | - Possibility of soil erosion in rehabilitation canals/drainage | - To implement maintenance of canals by adequate methods and appropriate timing<br>- To design main canal and related structures to consider alleviation of soil erosion<br>- To adopt concrete lining to main canals |
| 6 | Flora, fauna and biodiversity | - Rehabilitation works of canals/drainages and other related facilities | -Main canals (Kandal Stung :11.3km, Bati : 7.6 km) and around area | - Obstruction of amphibian animal to access between canals and fields by concrete lining,<br>- Increase of flow rate of existing canal by concrete lining<br>- Deterioration of habitat condition of aquatic plants in canals | - To make choice environmentally friendly design for main canals<br>- To consider aquatic ecosystem by maintenance and operation measures |
| **Social Environment** | | | | | |
| 7 | Involuntary Resettlement | - Rehabilitation works of canals/drainages and other related facilities | -Area along MD-canal near Tonle Bati village | - Land acquisition of area along the canal | - To conduct a detailed socio-economic survey of the affected families/people before the D/D stage;<br>- To conduct a series of meetings with the affected families/people and village chiefs to build consensus on: (i) project purpose, (ii) compensation measures, (iii) support programs, among them;<br>- To prepare the abbreviated RAP based on the results of the survey and meetings described above;.<br>- To compensate for all the losses at an adequate rate ;<br>- To prepare realistic schedule of land acquisition and inform the affected families/people of the schedule well in advance; and<br>- To monitor the process of recovery of living/livelihood conditions of the affected families/people. |
| 8 | Land use and utilization of local resources | - Rehabilitation works of canals/drainages and other related facilities<br>- Design of main/secondary canals, drainages and other water resource facilities | -Area along the main / secondary canals and drainages | - Land acquisition of area along the canal | - To design canals/drainage by minimizing land acquisition as much as possible during D/D<br>- To conduct detailed socio-economic survey for affected persons to identify all losses from land acquisition before D/D phase<br>- To fairly compensate to all affected persons, including those without title to land, for all their losses at replacement rates, if any<br>- To establish joint committee as decision making body to implement land acquisition process, members of which consist of (i) executing agencies (MOWRAM, MAFF, PDOWRAM, PDA), (ii) related agencies (Provincial Department of Land Management, Urban Planning and Construction PDLMUPC etc.) and (iii) local authorities (commune council, village chief, etc)<br>- To conduct stakeholder meetings with affected people on: (i) project purpose, (ii) compensation measures, (iii) support programs to build consensus among the people especially the affected people through involvement of village chief<br>- To prepare adequate and realistic schedule of land acquisition through joint committee and inform affected people early<br>- To prepare Abbreviation RAP based on above surveys and meeting results.<br>- To monitor recovery condition of the affected people and the community<br>- To properly restore the affected area after construction works |
| 9 | Existing social infrastructures and services | - Operation of construction equipment and vehicles | -Local roads in and around KSBISRSP area | - Objection of traffic by construction work | - To hold a series of public consultation meetings for surrounding people in order to explain, discuss and find the way of passage restriction<br>- To educate construction workers for adequate traffic rule of construction vehicles<br>- To post a bill to inform impassable duration to commune council, village chief by means of, such like, social facilities including schools, pagodas and hospitals, after the work schedule is fixed with people's consensus |

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| 10 | Socially Vulnerable Groups such as the Poor, Indigenous and Ethnic People | - Rehabilitation works of canals/drainages and other related facilities<br>- Design of main/secondary canals, drainages and other water resource facilities | -Area along MD-canal near Tonle Bati village | - Land acquisition of area along the canal | - To fairly compensate to all affected persons, including those without title to land, for all their losses at replacement rates, if any<br>- To conduct stakeholder meetings with affected people to hear their opinion<br>- To prepare adequate and realistic schedule of land acquisition through joint committee and inform affected people<br>- To monitor recovery life condition of the affected people and the community<br>- To pay special attention to vulnerable groups by operation phase |
| 11 | Sanitation | - Operation of construction equipment and vehicles<br>- Rehabilitation works of canals/drainages and other related facilities | - In and around the KSBISRSP area | - Degradation of sanitation condition and security due to inflow of construction workers from outside<br>- Risk of infectious diseases by construction workers from outside<br>- Risk of accident by construction works | To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction works<br>- To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule.<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 12 | Hazardous (risk) infectious diseases such as HIV/AIDS | | | | |
| 13 | Accident | | | | |

*Source : JICA Survey Team*

**Table II-7.3.3.4 Consideration of Negative Environment/Social Impact and Mitigation Measures (MC35RSP)**

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| **Pollution Control** | | | | | |
| 1 | Air pollution and Noise and Vibration (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new main/secondary canals and other related facilities | -In and around construction area | - Air pollution caused by construction works<br>- Noise and vibration caused by construction works | - To educate construction workers on minimizing idling of construction machinery<br>- To restricted construction time. e.g. during daytime only<br>- To hold stakeholder meetings to build consensus about the construction time<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 2 | Water Pollution by Construction Works (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new main/secondary canals and other related facilities | -Downstream of construction area | - Water pollution caused by construction works | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To avoid implementation of earthwork during rainy season<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 3 | Waste Management by Construction Works (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new main/secondary canals and other related facilities | -In and around construction area | - Construction waste caused by construction works | - To comply with relevant laws pertaining to the management and disposal of solid waste, hazardous waste and re-waste.<br>- To arrange suitable sites for disposal of solid waste prior to the construction works,<br>- To avoid dumping in the area of private property without written consent of the owner<br>- To carry out recycle use of disposed soil as much as possible |
| 4 | Water Pollution (Operation Phase) | - Utilization of irrigation water | -Downstream of MC35RSP command area | - Chemical contamination in drainage water by increase of farm inputs | - To conduct support programs regarding appropriate agricultural management<br>- To control the amount of fertilizer and pesticide through the training farmers<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To monitor water quality and agricultural activities regularly |
| **Natural Environment** | | | | | |
| 5 | Soil Erosion | - Operation and maintenance of main/secondary canals and dranaiges | -Main/secondary canals and drainages | - Possibility of soil erosion in rehabilitation canals/drainage | - To implement maintenance of canals by adequate methods and appropriate timing<br>- To design main canal and related structures to consider alleviation of soil erosion |
| **Social Environment** | | | | | |
| 6 | Land use and utilization of local resources | - Rehabilitation of existing main/secondary canals and other facilities | -Area along the main / secondary canals and drainages | - Land acquisition of area along the canal | - To design the canals/drainages to minimize the possible adverse effects by land acquisition in the D/D phase<br>- To conduct a detailed socio-economic survey of affected families/persons to identify all the losses from land acquisition before the D/D phase<br>- To fairly compensate all affected families/persons, including those without a legal title to land, for all their losses at reasonable rates or replacement rates, if any;- To establish a IRC as a decision making body to carry out the land acquisition process<br>- To hold stakeholder meetings with affected families/people;<br>- To prepare a realistic schedule of land acquisition and inform affected families/ of the schedule well in advance<br>- To properly restore the affected area after the construction works. |
| 7 | Existing social infrastructures and services | - Operation of construction equipment and vehicles | -Local roads in and around MC35RSP area | - Objection of traffic by construction work | - To hold a series of public consultation meetings for surrounding people in order to explain, discuss and find the way of passage restriction<br>- To educate construction workers for adequate traffic rule of construction vehicles<br>- To post a bill to inform impassable duration to commune council, village chief by means of, such like, social facilities including schools, pagodas and hospitals, after the work schedule is fixed with people's consensus |
| 8 | Sanitation | - Operation of construction equipment and vehicles<br>- Rehabilitation works of canals/drainages and other related facilities | - In and around the MC35RSP area | - Degradation of sanitation condition and security due to inflow of construction workers from outside<br>- Risk of infectious diseases by construction workers from outside<br>- Risk of accident by construction works | - To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction workers<br>- To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule.<br>- To stipulate environmental consideration measures in the technical specifications of the construction works |
| 9 | Hazardous (risk) infectious diseases such as HIV/AIDS | | | | |
| 10 | Accident | | | | |

*Source: JICA Survey Team*

**Table II-7.3.3.5 Consideration of Negative Environment/Social Impact and Mitigation Measures (SPWRRSP)**

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| **Pollution Control** | | | | | |
| 1 | Air pollution and Noise and Vibration (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of reservoir | -In and around construction area | - Air pollution caused by construction works<br>- Noise and vibration caused by construction works | - To educate construction workers on minimizing idling of construction machinery<br>- To restricted construction time. e.g. during daytime only<br>- To hold stakeholder meetings to build consensus about the construction time<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 2 | Water Pollution by Construction Works (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of reservoir | -Downstream of construction area | - Water pollution caused by construction works | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To stipulate environmental consideration measures in the technical specification of the construction works |
| 3 | Waste Management by Construction Works (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of reservoir | -In and around construction area | - Construction waste caused by construction works | - To comply with relevant laws pertaining to the management and disposal of solid waste, hazardous waste and re-waste<br>- To arrange suitable sites for disposal of solid waste prior to the construction works<br>- To avoid dumping in the area of private property without written consent of the owner<br>- To carry out recycle use of disposed soil as much as possible |
| 4 | Water Pollution (Operation Phase) | - Rehabilitation of reservoir | -Downstream of SPWRRSP command area | - Chemical contamination in drainage water by increase of farm inputs | - To conduct support programs regarding appropriate agricultural management<br>- To introduce composting activity to the farmers<br>- To control the amount of fertilizer and pesticide through the training farmers<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To monitor water quality and agricultural activities regularly<br>- To control the amount of fertilizer and pesticide through the training farmers<br>- To conduct environmental education about waste management program to local people |
| **Natural Environment** | | | | | |
| 5 | Flora, fauna and biodiversity | - Rehabilitation of reservoir | - Area in the Srass Prambai reservoir | - Loss of existing natural environment in the Srass Prambai reservoir | - To maintain surrounding natural environment |
| **Social Environment** | | | | | |
| 6 | Local Economy such as Employment and Livelihood, etc. | - Rehabilitation of reservoir | - Area in the Srass Prambai reservoir | - Loss of paddy field (illegal use) in Srass Prambai Reservoir<br>- Alteration of fishery usage in Srass Prambai Reservoir | - To conduct a detailed socio-economic survey of affected families/people in the beginning of the project preparatory stage to estimate the extent of the impact on their household economy<br>- To conduct stakeholder meetings with affected families/people and village chiefs to explain and discuss: (i) project purpose, (ii) compensation measures, and (iii) support programs, so as to build consensus on the sub-project and compensation for their losses<br>- To fairly compensate all affected families / people including those without a legal title to land. |
| 7 | Land use and utilization of local resources | - Rehabilitation of reservoir | - Area in the Srass Prambai reservoir | - Loss of paddy field (illegal use) in Srass Prambai Reservoir<br>- Alteration of fishery usage in Srass Prambai Reservoir<br>- Conflicts of interest between farmers and non-farmers | - To conduct a detailed socio-economic survey of affected families/persons to clarify their socio-economic conditions and estimate the potential impact before the D/D phase<br>- To fairly compensate all affected families/persons, including those without a title to land, for all their losses at replacement rates, if any<br>- To establish a joint committee as a decision making body to carry out the land acquisition process<br>- To hold stakeholder meetings with affected families/people<br>- To prepare a realistic schedule of land acquisition and inform affected families/people of the schedule well in advance<br>- To monitor the living conditions of the affected families/people during the sub-project as well as in the post-project period<br>- To properly restore the affected area after construction works |
| 8 | Socially Vulnerable Groups such as the Poor, Indigenous and Ethnic People (including Gender matter) | | | | |
| 9 | Local Conflict of interests | | | | |
| 10 | Existing social infrastructures and services | - Operation of construction equipment and vehicles | - Local road on the dike | - Objection of traffic by construction work | - To hold a series of public consultation meetings for surrounding people in order to explain, discuss and find the way of passage restriction<br>- To educate construction workers for adequate traffic rule of construction vehicles<br>- To post a bill to inform impassable duration to commune council, village chief by means of, such like, social facilities including schools, pagodas and hospitals, after the work schedule is fixed with people's consensus |
| 11 | Misdistribution of Benefit and Damage | - Rehabilitation of reservoir | - Area in the Srass Prambai reservoir | - Misdistribution of benefit and damage between almost farmers and affected people who use the existing reservoir area | - To conduct detailed socio-economic survey of affected people during early stage of project preparation to identify all losses from land acquisition<br>- To conduct stakeholder meetings with local people including affected people on project contents<br>- To compensate affected persons, including those without title to land. |
| 12 | Sanitation | - Operation of construction equipment and vehicles<br>- Rehabilitation of reservoir | - In and around the SPWRRSP area | - Degradation of sanitation condition and security due to inflow of construction workers from outside<br>- Risk of infectious diseases by construction workers from outside<br>- Risk of accident by construction works | - To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction workers<br>- To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule<br>- To stipulate environmental consideration measures in the technical specifications of the construction works. |
| 13 | Hazardous (risk) infectious diseases such as HIV/AIDS | | | | |
| 14 | Accident | | | | |

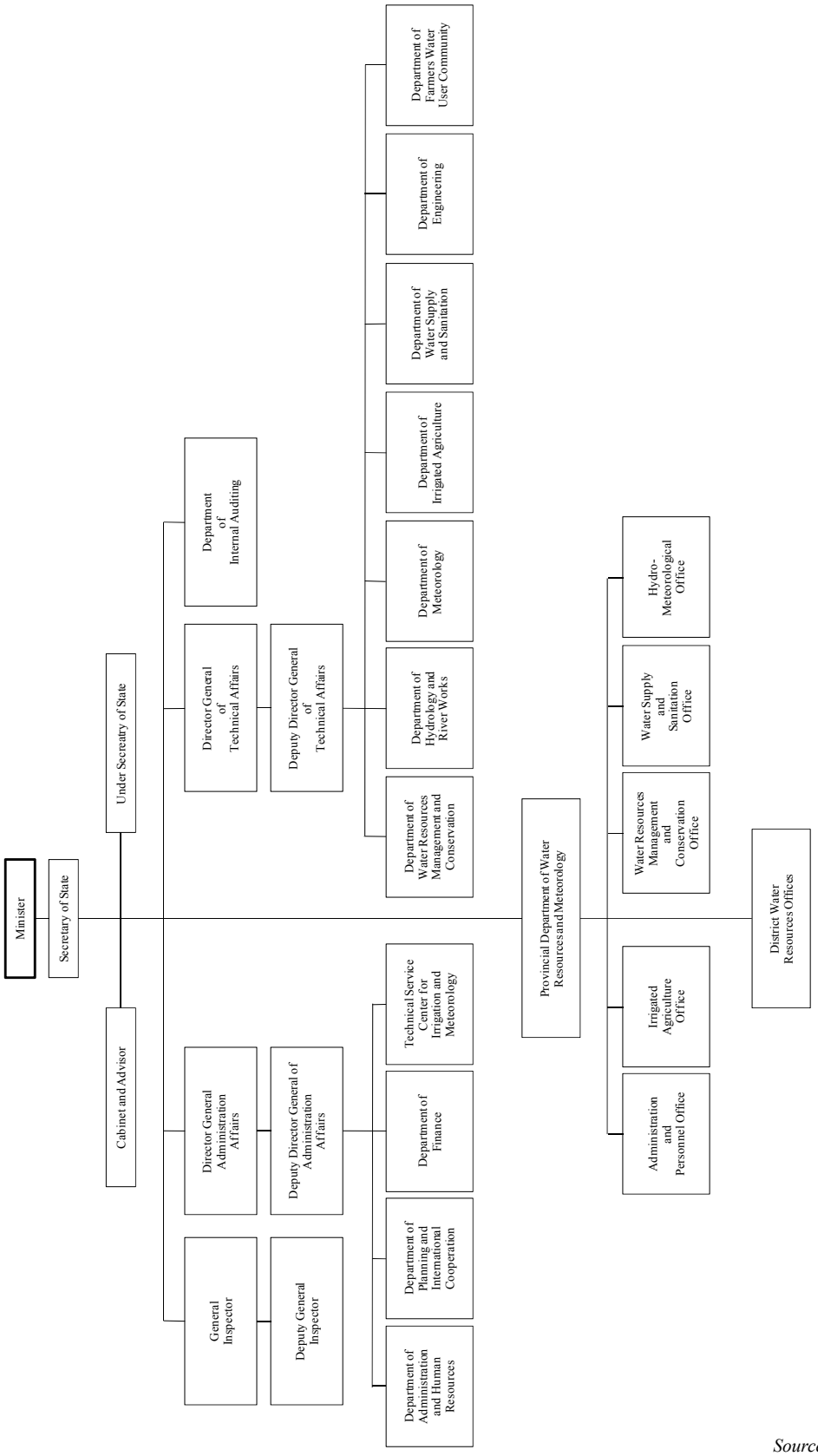
*Source: JICA Survey Team*

**Table II-7.3.3.6 Consideration of Negative Environment/Social Impact and Mitigation Measures (DPISRSP)**

| Positive Impact | | Activity | Affected Area | Project Impact | Mitigation Measures |
|---|---|---|---|---|---|
| **Pollution Control** | | | | | |
| 1 | Air pollution and Noise and Vibration | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new headworks and its related facilitates | - In and around construction area | - Air pollution caused by construction works<br>- Noise and vibration caused by construction works | - To educate construction workers on minimizing idling of construction machinery<br>- To restricted construction time. e.g. during daytime only<br>- To hold stakeholder meetings to build consensus about the construction time<br>- To stipulate environmental consideration measures in the technical specification of the construction works. |
| 2 | Water Pollution by Construction Works (Construction Phase) | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new headworks and its related facilitates | - Downstream of construction area | - Water pollution caused by construction works | - To dilute or neutralize alkalified water from concrete mixer trucks by pooling in regulating pond before discharging<br>- To pool discharging water from the concrete plant for dilution or neutralization<br>- To install adequate treatment system for muddy and alkalified water in construction site such as installation of water tank to collect water from concrete works for neutralization<br>- To stipulate environmental consideration measures in the technical specification of the construction works. |
| 3 | Waste Management by Construction Works | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new headworks and its related facilitates | - In and around construction area | - Construction waste caused by construction works | - To comply with relevant laws pertaining to the management and disposal of solid waste, hazardous waste and re-waste<br>- To arrange suitable sites for disposal of solid waste prior to the construction works<br>- To avoid dumping in the area of private property without written consent of the owner<br>- To carry out recycle use of disposed soil as much as possible. |
| 4 | Water Pollution (Operation Phase) | - Utilization of irrigation water | - Downstream of DPISRSP command area | - Chemical contamination in drainage water by increase of farm inputs | - To conduct support programs regarding appropriate agricultural management<br>- To introduce check system among the FWUC members regarding agricultural management<br>- To control the amount of fertilizer and pesticide through the training farmers<br>- To monitor water quality and agricultural activities regularly |
| **Natural Environment** | | | | | |
| 5 | Soil Erosion | - Operation and maintenance of main / secondary canals | - Main canals, secondary canals area | - Possibility of soil erosion in rehabilitation canals/drainage | - To implement maintenance of canals by adequate methods and appropriate timing<br>- To design main canal and related structures to consider alleviation of soil erosion |
| 6 | Flora, fauna and biodiversity | - Construction of new headworks and its related facilitates | - Downstream ecosystem on the Stung Chieb River | - Decrease in amount of flowing in the downstream the Stung Chieb River by irrigation water | - To ensure the river maintenance flow to keep a certain level of water in the wet season<br>- To restrict water intake from the river during the dry season<br>- To ensure adequate and proper operation and maintenance of the new head works by FWUC |
| **Social Environment** | | | | | |
| 7 | Land use and utilization of local resources | - Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new headworks and its related facilitates | - Areas along the main canals/secondary canals and around the proposed site for the new head works | | - To realign and design the irrigation and drainage canals to minimize the scale of land acquisition caused by the sub-project during the D/D phase<br>- To conduct a detailed socio-economic survey of affected families/people to identify/estimate all the potential losses from land acquisition before the D/D phase<br>- To fairly compensate all affected families/persons, including those without a title to land, for all their losses at replacement rates, if any<br>- To establish a joint committee as a decision making body to carry out the land acquisition process;<br>- To conduct stakeholder meetings with affected families/people<br>- To prepare a realistic schedule of land acquisition and inform affected families/people of the schedule well in advance<br>- To properly restore the affected area after the construction works. |
| 8 | Local conflict of interests | | | | |
| 9 | Existing social infrastructures and services | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities | - Local roads in and around DPISRSP area | - Objection of traffic by construction work<br>- Limitation of usage of local walking pass during construction phase | - To hold a series of public consultation meetings for surrounding people in order to explain, discuss and find the way of passage restriction;<br>- To educate construction workers for adequate traffic rule of construction vehicles; and<br>- To post a bill to inform impassable duration to commune council, village chief by means of, such like, social facilities including schools, pagodas and hospitals, after the work schedule is fixed with people's consensus |
| 10 | Sanitation | - Operation of construction equipment and vehicles<br>- Rehabilitation of existing main/secondary canals and other facilities<br>- Construction of new headworks and its related facilitates | - In and around DPISRSP area | - Degradation of sanitation condition and security due to inflow of construction workers from outside<br>- Risk of infectious diseases by construction workers from outside<br>- Risk of accident by construction works | - To improve sanitary condition of workers by proper arrangement of accommodation, installation of toilets and proper water supply<br>- To implement education programs for workers about sanitation, security and rules/discipline of daily activities<br>- To implement safety education and training for construction workers<br>- To implement periodical patrol of workers in order to avoid both occurrence of local conflict and epidemics of diseases<br>- To hold a series of stakeholder meetings for surrounding people in order to explain construction works and its schedule.<br>- To stipulate environmental consideration measures in the technical specifications of the construction works |
| 11 | Hazardous (risk) infectious diseases such as HIV/AIDS | | | | |
| 12 | Accident | | | | |

*Source : JICA Survey Team*

# *Figures*

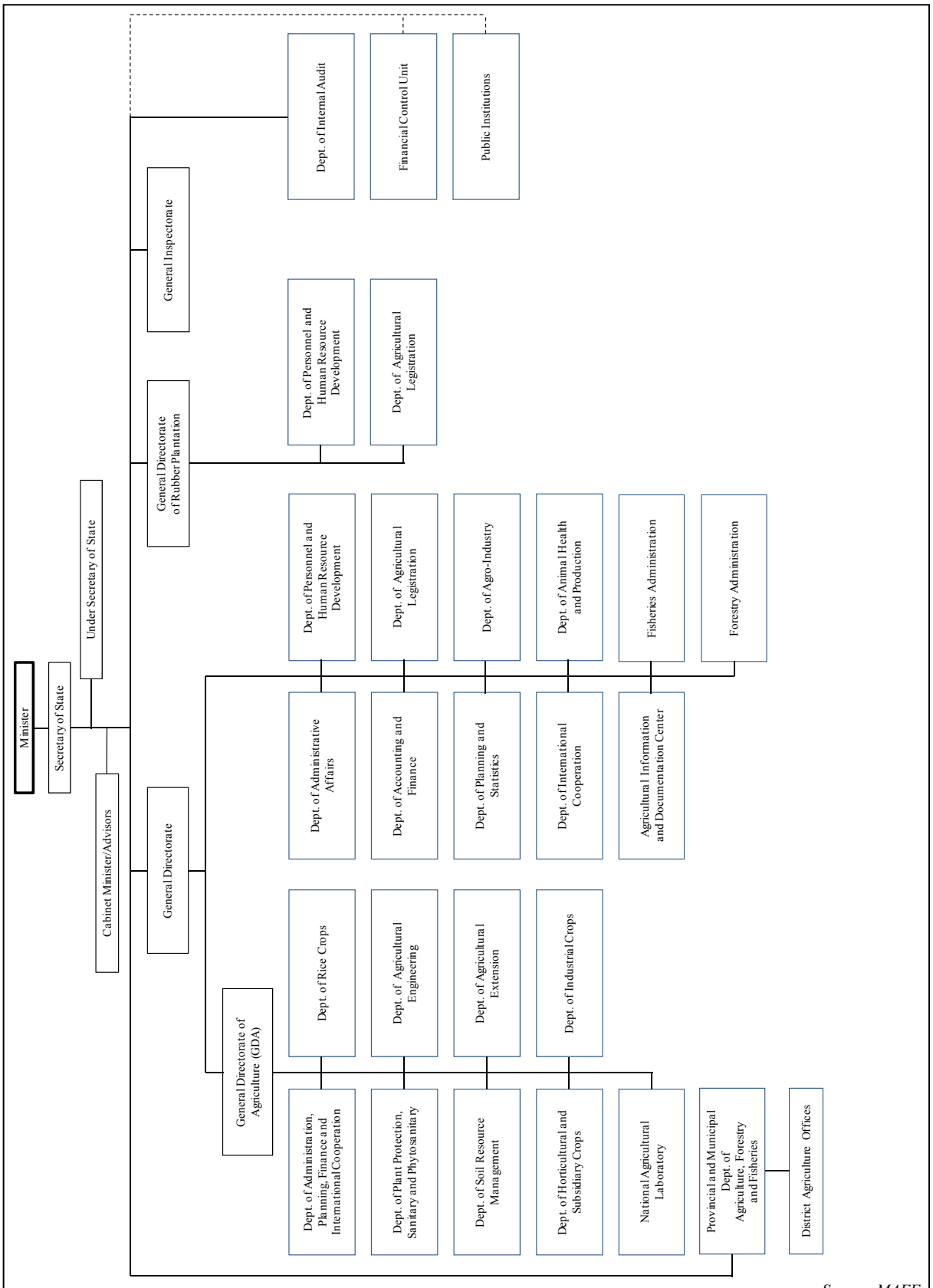



*Source: MOWRAM*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure I-3.1.1**
**Organization Structure of Ministry of Water Resources and Meteorology (MOWRAM)**

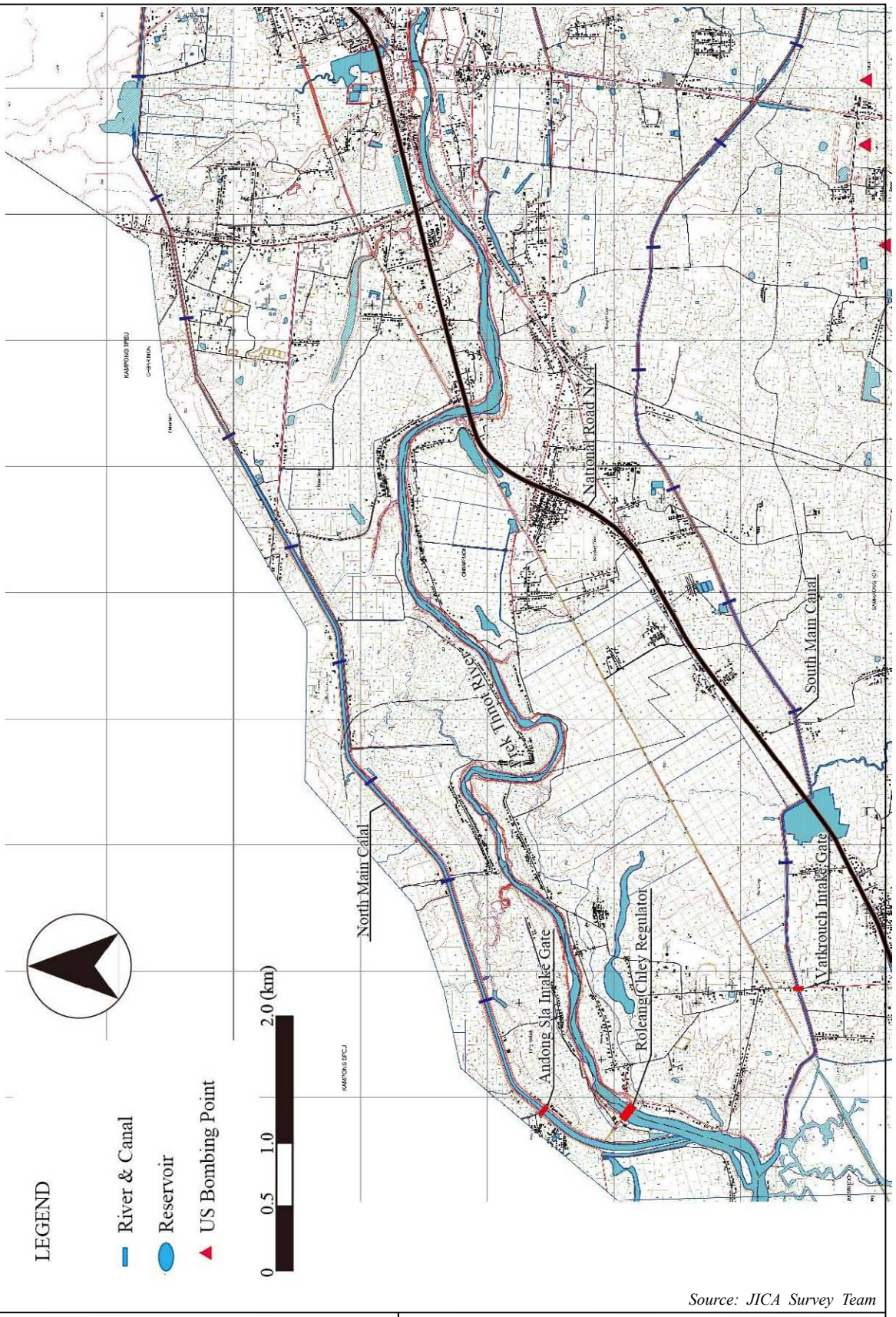



*Source: MAFF*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure I-3.2.1**
**Organization Structure of Ministry of Agriculture, Forestry and Fisheries (MAFF)**



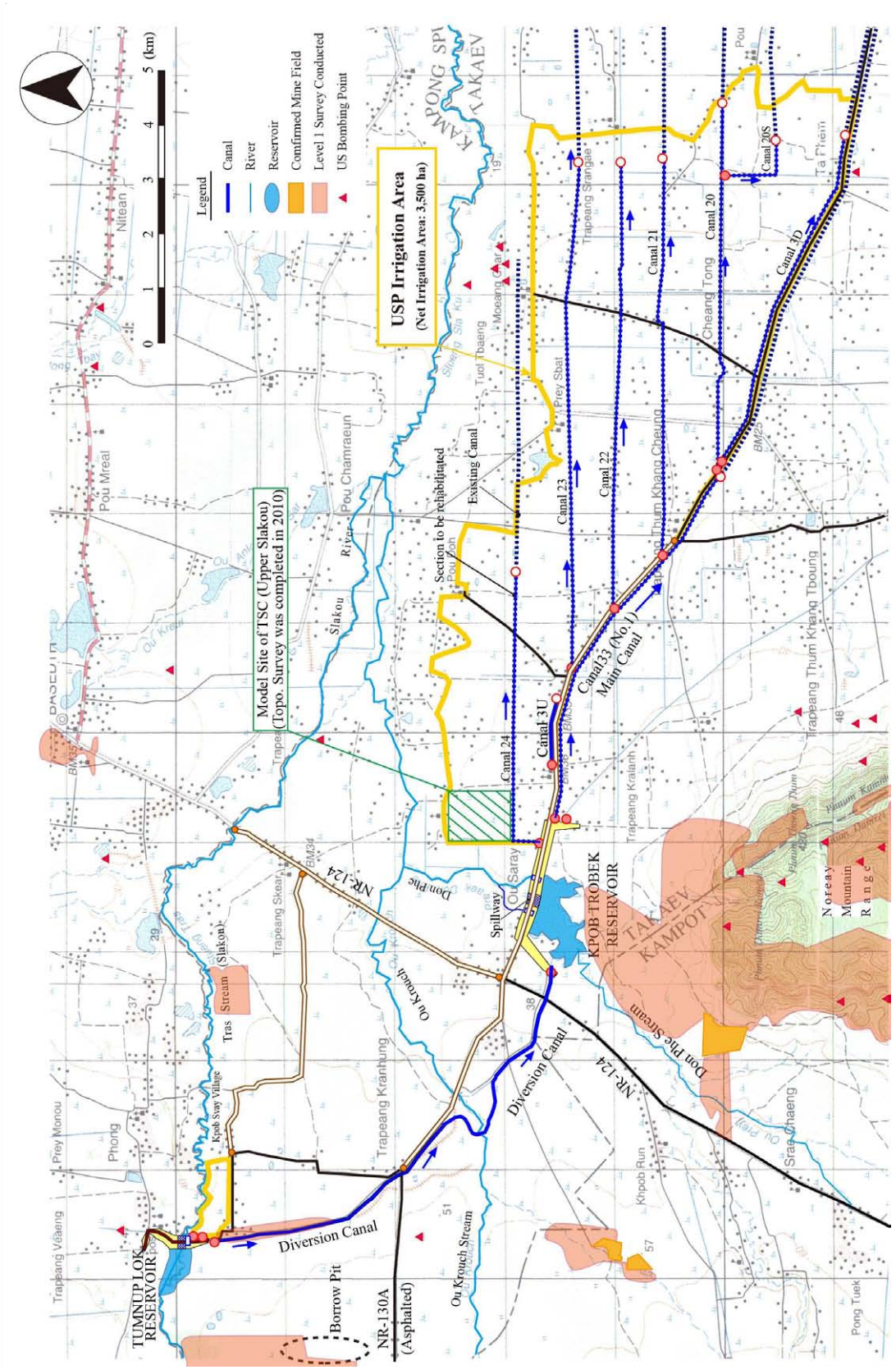

*Source: JICA Survey Team*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure I-5.5.1**

**Mine/UXO Condition at RCHRSP Area**




*Source: JICA Survey Team*

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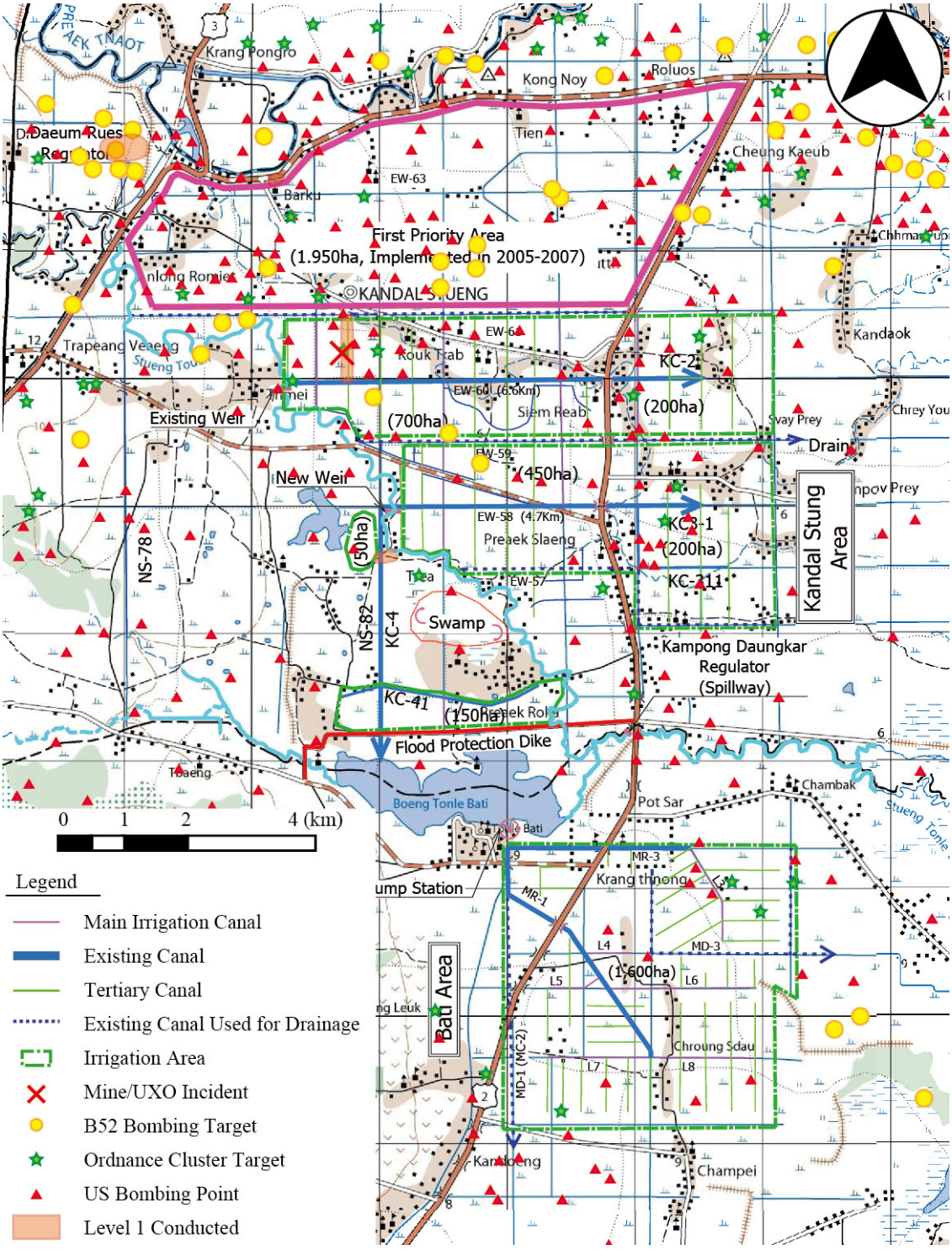
| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure I-5.5.2** |
| Japan International Cooperation Agency | **Mine/UXO Condition at USISRSP Area** |




*Source: JICA Survey Team*

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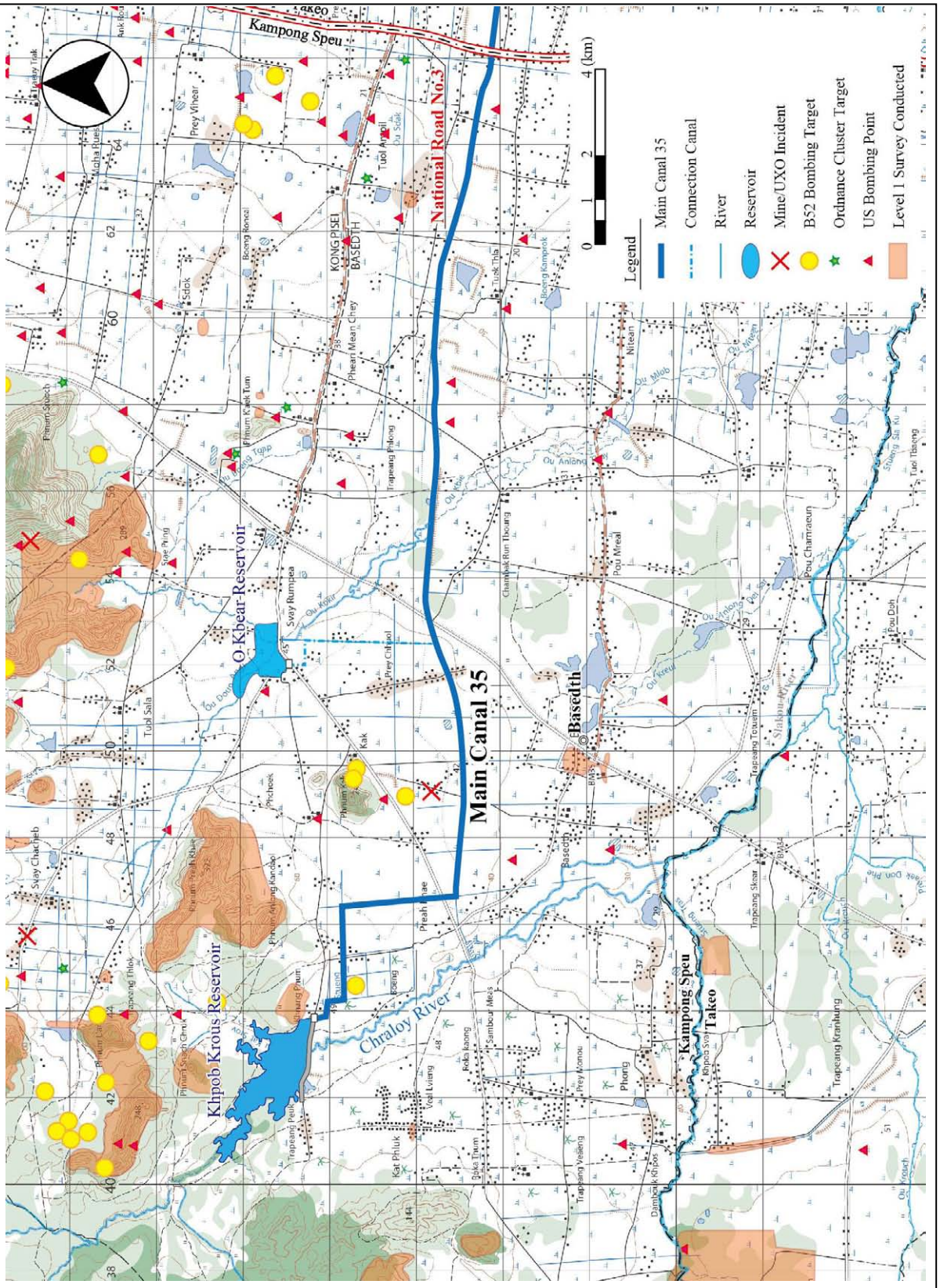
| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure I-5.5.3** |
| Japan International Cooperation Agency | **Mine/UXO Condition at KSBISRSP Area** |




*Source: JICA Survey Team*

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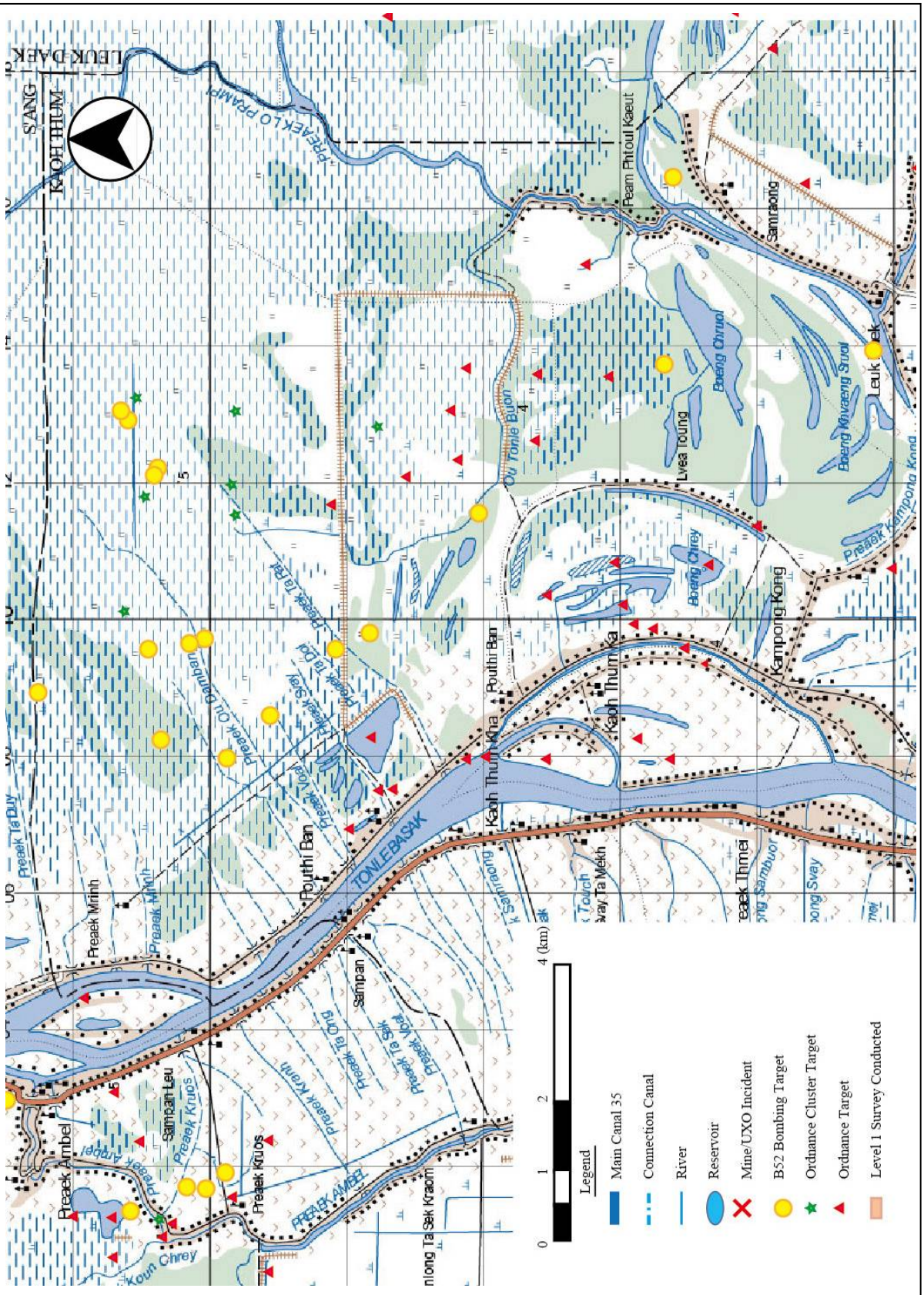
| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure I-5.5.4** |
| Japan International Cooperation Agency | **Mine/UXO Condition at MC35RSP Area** |




*Source: JICA Survey Team*

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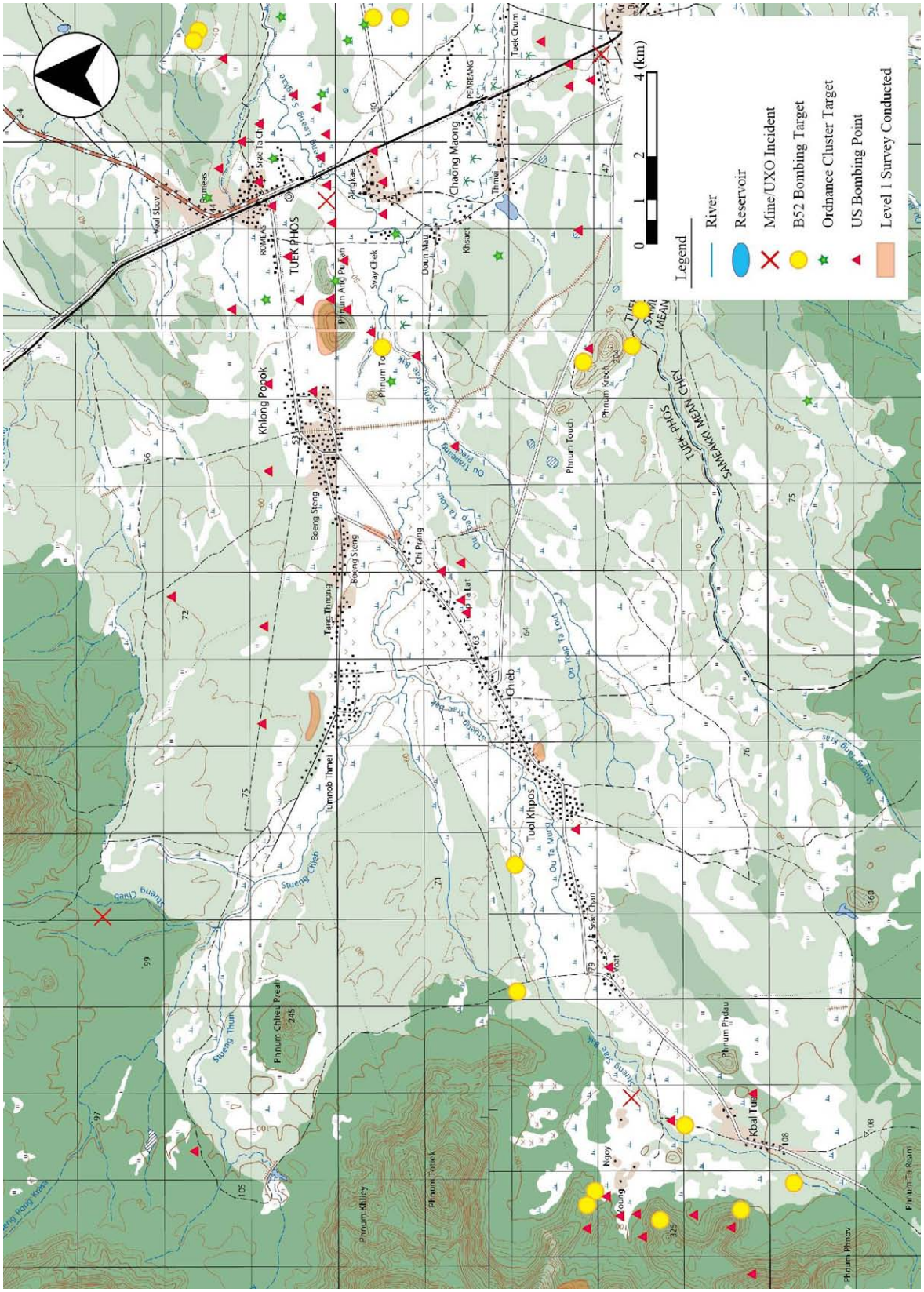
| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure I-5.5.5** |
| Japan International Cooperation Agency | **Mine/UXO Condition at SPWRRSP Area** |




*Source: JICA Survey Team*

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| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure I-5.5.6** |
| Japan International Cooperation Agency | **Mine/UXO Condition at DPISRSP Area** |

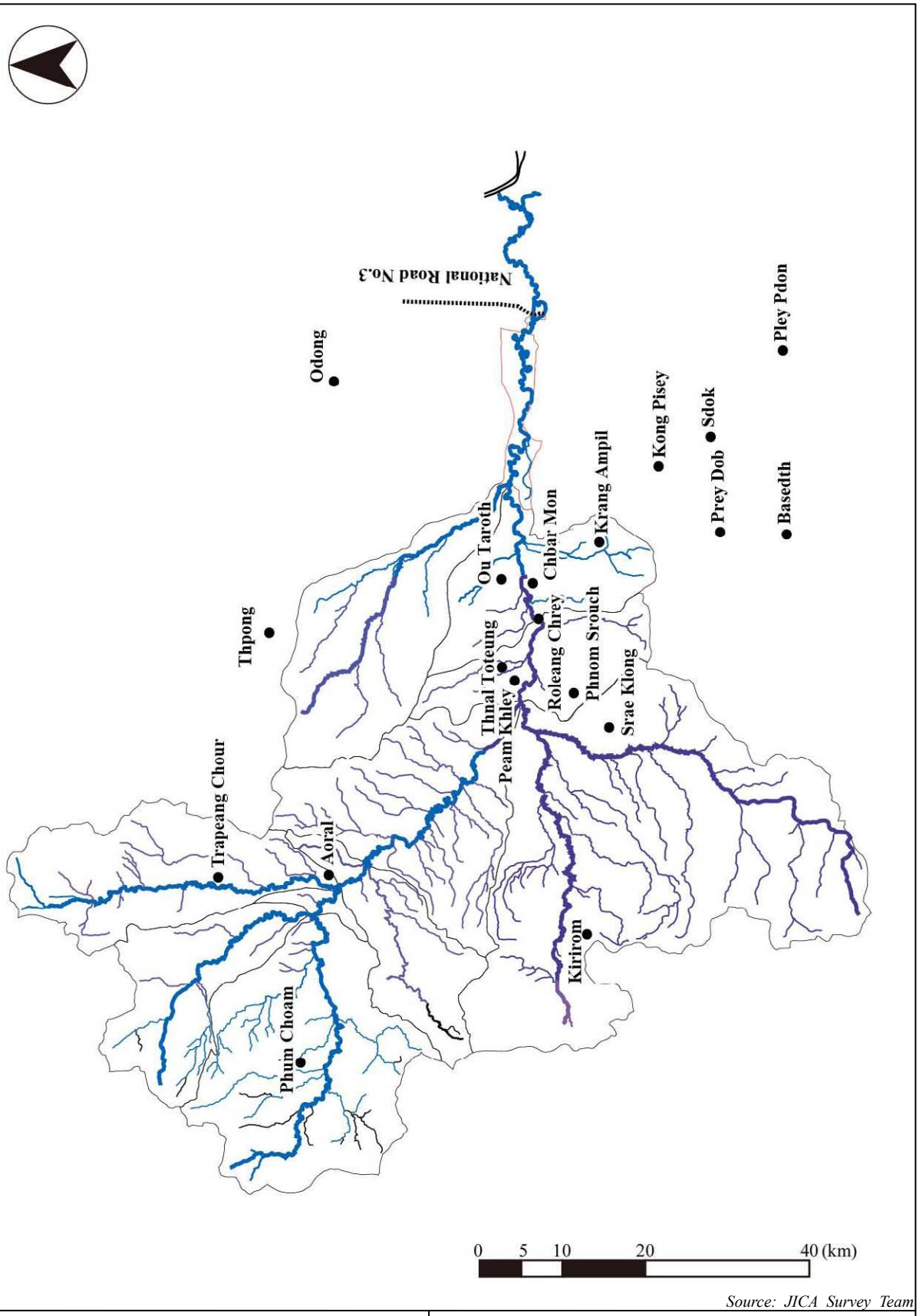
*Source: JICA Survey Team*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure II-1.2.2.2.1**

**Sub-basins of Prek Thnot River**




*Source: JICA Survey Team*

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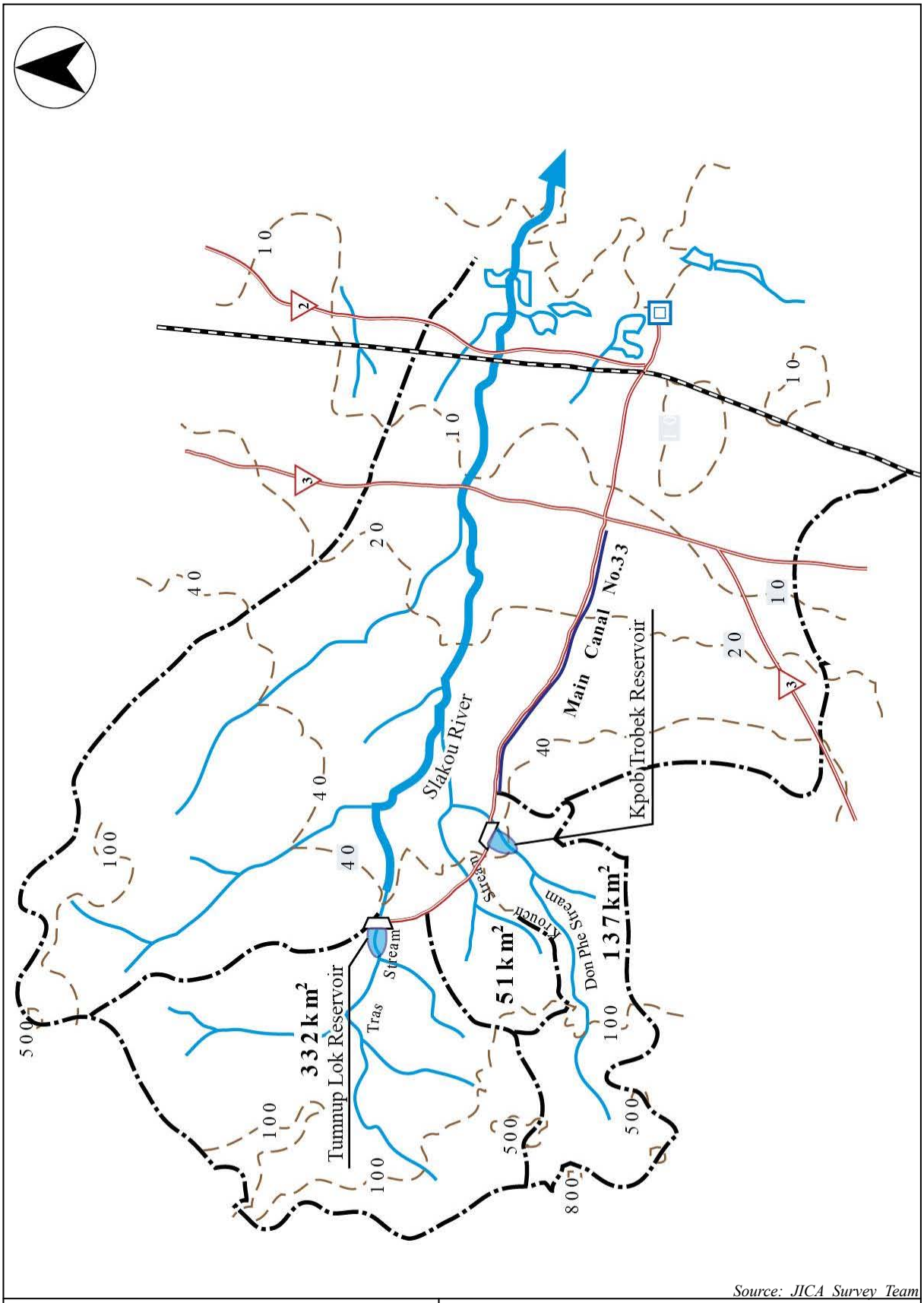
| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure II-1.2.2.2.2** |
| Japan International Cooperation Agency | **Location Map of Rainfall Station** |




Source: JICA Survey Team

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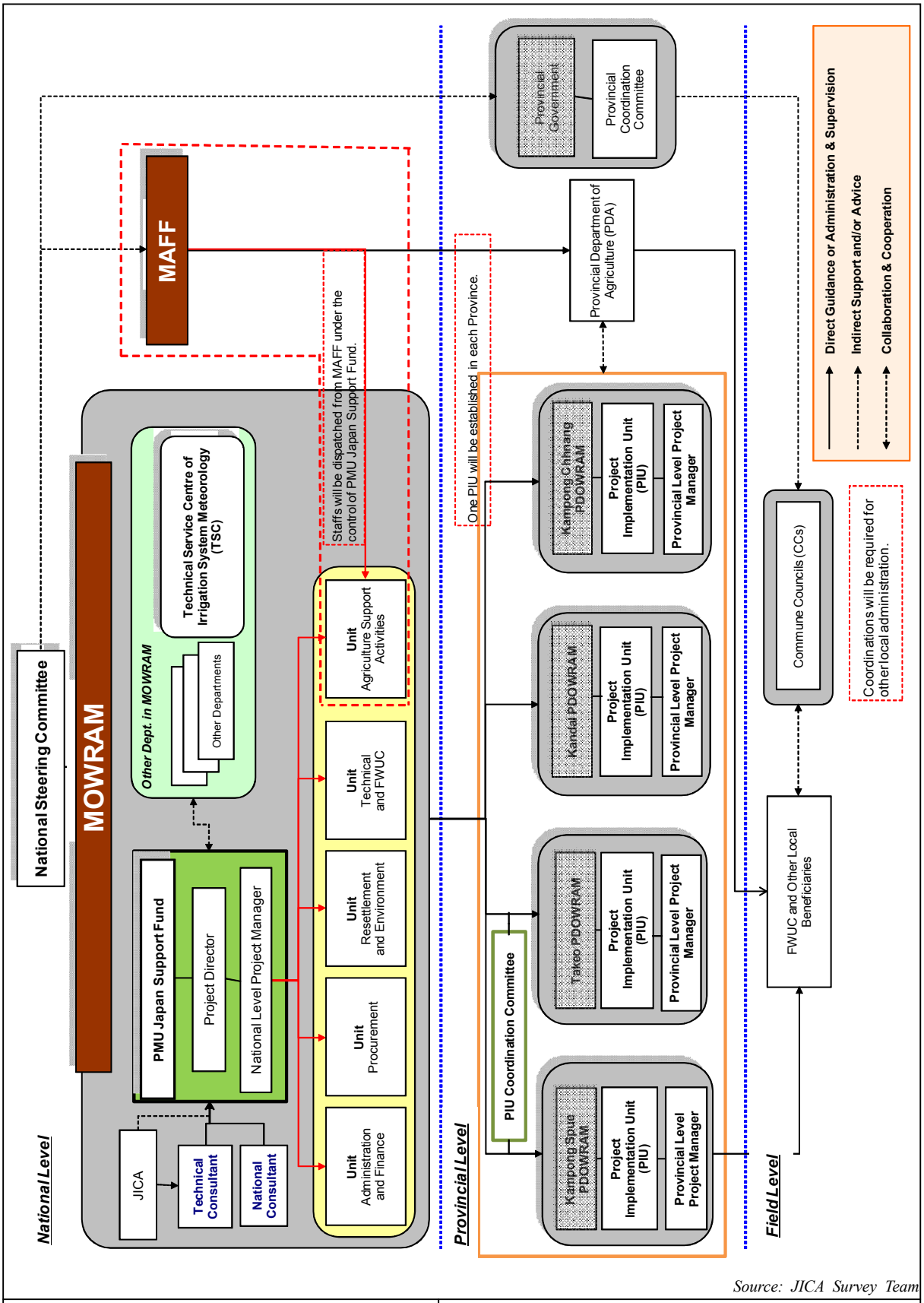
| PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT | **Figure II-1.3.2.2.1** |
| Japan International Cooperation Agency | **Location Map of Slakou River, Tumnup Lok Reservoir, and Kpob Trobek Reservoir** |

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure II-3.6.5.1**

**Proposed Consulting Services**



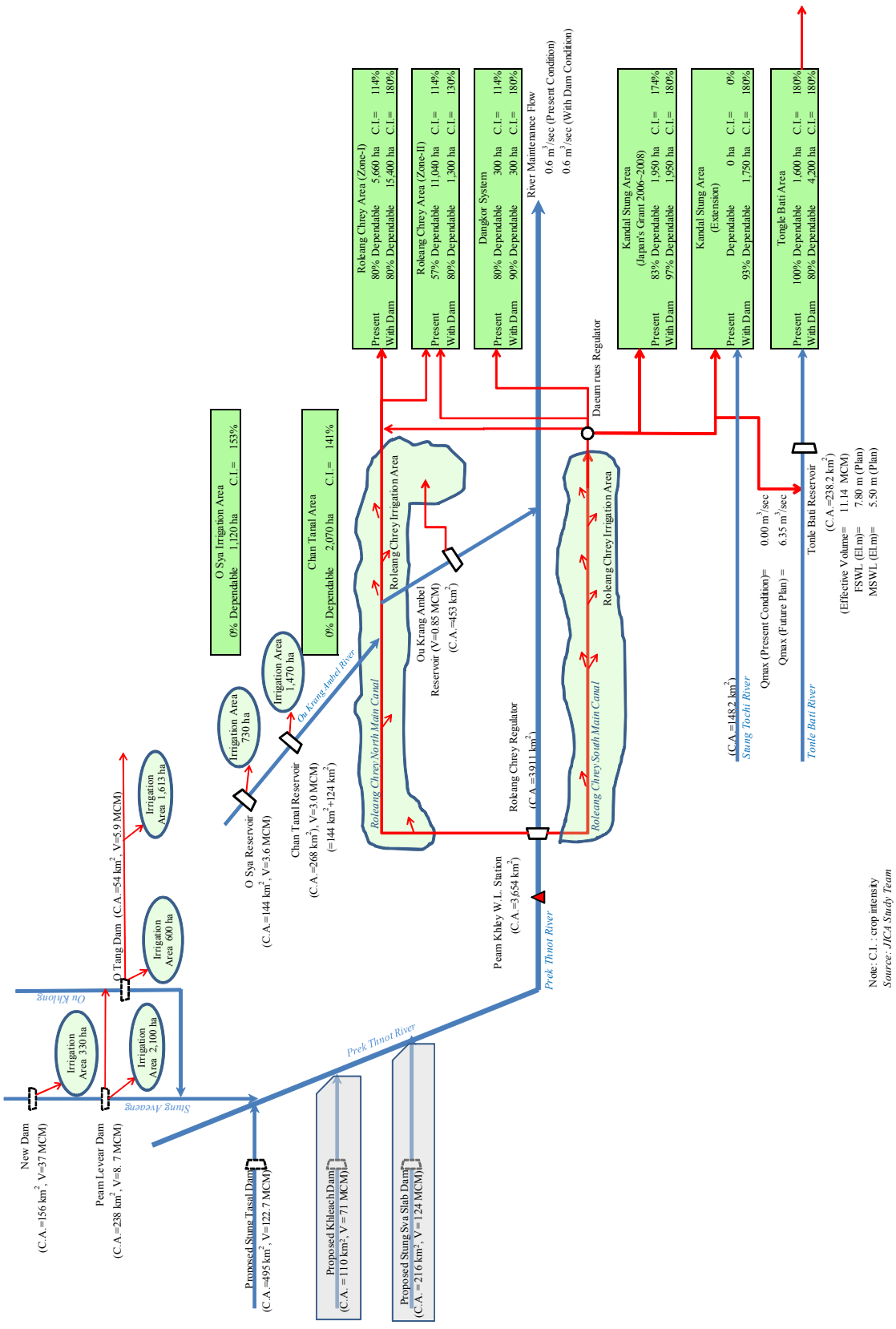

*Source: JICA Survey Team*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure II-4.1.1.1**

**Proposed Implementing Organization for SPPIDRIP**



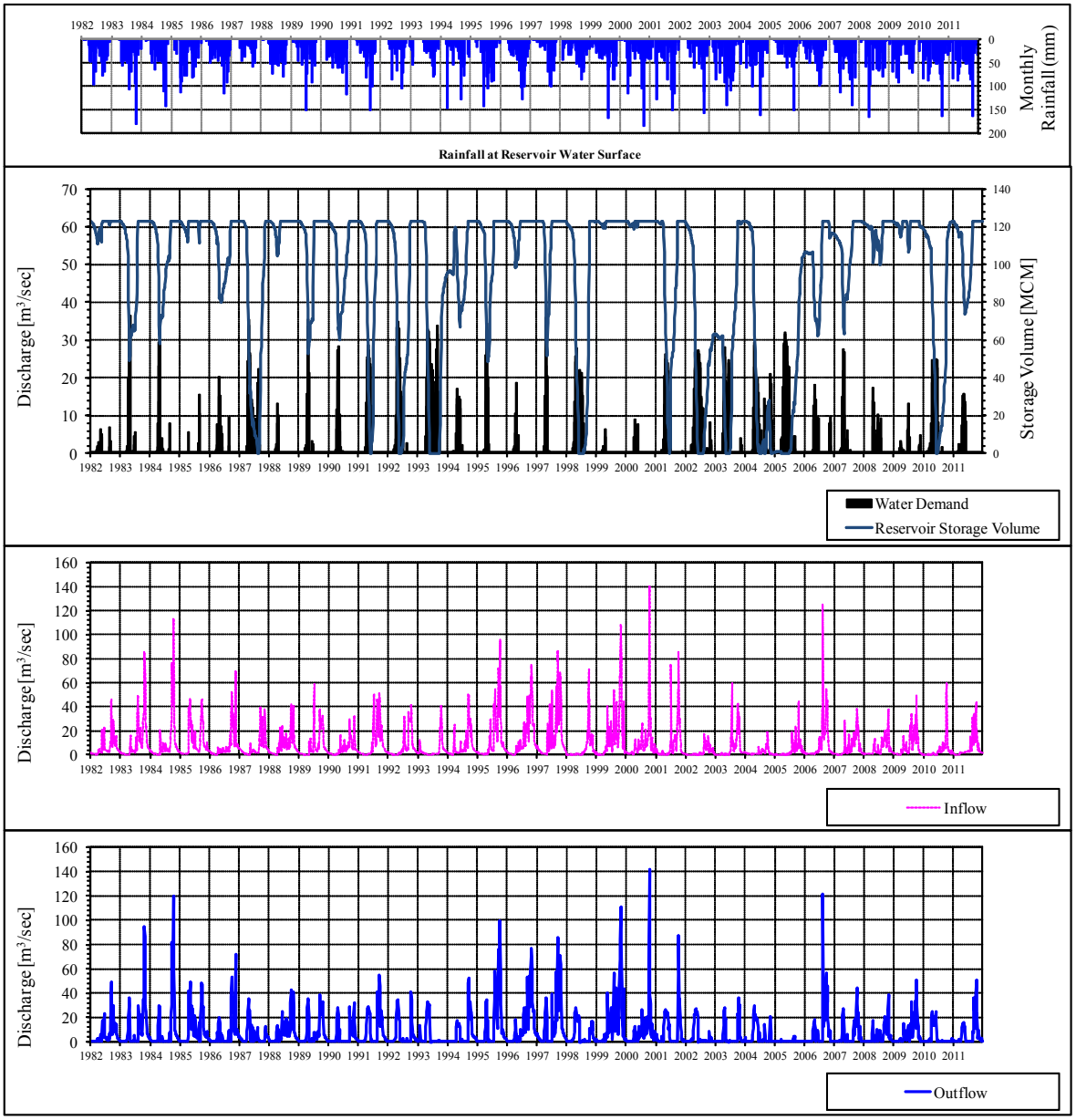

*Source: JICA Survey Team*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure II-8.4.2.1.1**

**Results of Water Balance Study "with/without" Tasal Dam (Case-2)**




PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

**Figure II-8.4.2.1.2**

**Result of Reservoir Operation of Stung Tasal Dam (Case-2)**

# *Attachments*

# *Attachment 1*

*Minutes of Discussion on Preparatory Survey*
*for Irrigation and Drainage System*
*Rehabilitation and Improvement Project*
*between Japan International Cooperation Agency*
*and the Royal Government of Cambodia*
*(February 25, 2011)*

# MINUTES OF DISCUSSION
# ON
# PREPARATORY SURVEY
# FOR
# IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT
# BETWEEN
# JAPAN INTERNATIONAL COOPERATION AGENCY
# AND
# THE ROYAL GOVERNMENT OF CAMBODIA

DATE: February 25, 2011
PLACE: Phnom Penh, Cambodia

1. The Japan International Cooperation Agency (hereinafter referred to as "JICA") Mission visited Cambodia from February 21st to 25th, 2011 and had discussions on the draft Implementation Program of Preparatory Survey (hereinafter referred to as "the Survey") for Irrigation and Drainage System Rehabilitation and Improvement Project (hereinafter referred to as "the Project") with officials of Ministry of Economy and Finance, and Ministry of Water Resources and Meteorology (hereinafter referred to as "MEF" and " MOWRAM" ).

2. JICA Mission, MEF and MOWRAM hereby agreed upon the draft Implementation Program of the Survey for the Project as per Annex-1, subject to the approval by the competent higher authorities of both sides. It should be noted that implementation of the Survey does not imply any decision or commitment by JICA to extend its loan for the Project at this stage.

3. JICA Mission, MEF and MOWRAM made the record of main points discussed as per Annex-2.

**For**
**Ministry of Economy and Finance**

Chan Sothy
Director
Department of Investment and Cooperation
Ministry of Economy and Finance

**For**
**Japan International Cooperation Agency**

Kenichiro Kobayashi
Director
Paddy Field Based Farming Area Division 1
Rural Development Department
JICA

**For**
**Ministry of Water Resources and Meteorology**

H.E. Mr. Pich Veasna
Deputy Director General of Administration Affairs
Ministry of Water Resources and Meteorology

cc:
- JICA Cambodia Office

Annex-1

# IMPLEMENTATION PROGRAM
# ON
# PREPARATORY SURVEY
# FOR
# IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

## 1. Background

(1) The development of the agriculture sector has been an important element of the Royal Government of Cambodia's strategy to reduce poverty in rural communities and sustainable economic growth because over 80% of the population lives in rural communities and 75% of the poor are farmers. The Cambodian economy depends on products from agriculture (mainly rice). In spite of rapid growth of the industrial sector, agriculture sector continues to be the main source of employment accounting for nearly 80% of the labor force.

(2) Lack of water control and management constrain agricultural production although Cambodian government has put all effort to investment in construction and rehabilitation of irrigation and drainage system. The total cultivated area for rice production is 2,615,741 ha but irrigated area is only 245,288 ha for dry season and 582,085 ha for rainy season, which accounts for 31.6% in total of the cultivated land.

(3) To expand irrigation and drainage system in potential production area is urgent need in Cambodia. Although there are numerous canals and facilities which were constructed nationwide in 1970s, it is needed to restore and improve them in order to enhance agricultural production by managing water use effectively.

Based on the above understanding, the Royal Government of Cambodia (RGC) has requested some projects for rehabilitation of irrigation and drainage facilities to the Government of Japan (GOJ). In response to the requests of RGC, GOJ conducted "Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh" (1994-1995), "Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin" (2001-2002) and "Study on Comprehensive Agricultural Development of Prek Thnot River Basin" (2005-2008) as a part of assistance in irrigation and water management sector in Cambodia. As a result of the studies, "Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project" (Upper Slakou, Kandal Stung-Bati and Roleang Chrey) was selected from above studies as the top priority project.

RGC also requested "Small Scale Irrigation System Improvement Project" for rehabilitation of small scale irrigation system all over the country.

## 2. Outline of the Projects subject to review by the Survey

(1) Objectives

To increase agricultural production through the rehabilitation and improvement of irrigation

and drainage systems, hereby contributing to economic development and poverty reduction of the Kingdom of Cambodia.

(2) Project Names and Sites

| No | Project | Province |
|---|---|---|
| 1 | Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project | Takeo, Kandal and Kampong Speu |
| 2 | Small Scale Irrigation System Improvement Project | Nationwide |

(3) Scopes of the projects

The feasibility of the proposed projects would be examined within the Survey and the scopes of the projects listed below would be revised or added as the result of the Survey.

1) Reconstruction and rehabilitation of irrigation and drainage system of Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project

<Kandal Stung-Bati Irrigation System Rehabilitation Sub-Project>

- Rehabilitation of main canals, secondary canals, third canals including related structures; gate installation for division works, intakes and checks, rehabilitation of cross section of canals, etc,

-Rehabilitation of intake, pumping station, spillway, embankment etc around Tonle Bati Lake,

-Rehabilitation of Stung Toch Gate and NS87 Canal.

<Upper Slakou Irrigation System Rehabilitation Sub-Project>

-Rehabilitation of two reservoirs; Tumnup Lok Reservoir and Kpob Trobek Reservoir including spillway, outlet structures and a diversion canal between the two reservoirs with related structures,

-Rehabilitation of main canals, secondary canals and third canals with related structures.

<Roleang Chrey Headworks Rehabilitation Sub-Project>

-Rehabilitation of Roleang Chrey Headworks,

-Rehabilitation of Andong Sla Intake including replacement of radial gates,

-Rehabilitation of Wat Kroach Intake structures,

-Rehabilitation of north and south main canals with length of 10km each with related structures.

2) Reconstruction and rehabilitation of irrigation and drainage system of Small Scale Irrigation System Improvement Project

-Confirmation of the feasibility of selected Sub-Projects,

-Reconstruction or rehabilitation of irrigation and drainage facilities.

3) Consulting services

- Detail design, procurement assistance of civil works and equipment / facilities, supervision and monitoring of the civil works,

-Capacity development for operation and maintenance (O&M),

-Capacity development for agricultural extension service.

(4) Implementation structure

Executing Agency:

Ministry of Water Resources and Meteorology (MOWRAM)

**3. Terms of Reference of the Survey**

TOR1: Review of policy and current situation

1-1 Review the latest agricultural policy and strategy in irrigation and water management sector,

1-2 Examine the current and future balance of supply and demand for rice and fluctuations in prices of agricultural products in Cambodia,

1-3 Review data and information of agricultural and economic activities in the target area including information of landmines clearance,

1-4 Review related on-going and committed projects supported by other donors in irrigation and water management sector and propose conceivable collaboration with the Project.

TOR2: Examination of the environmental and social consideration

2-1 Examine environmental and social considerations in accordance with relevant laws and rules in Cambodia, as well as the requirements of "JICA Guidelines for Environmental and Social Considerations" (April 2010) (hereinafter referred to as "JICA Guidelines"), identify any additional required procedures, and prepare an environmental checklist based on JICA Guidelines,

2-2 Support MOWRAM to prepare Environmental Impact Assessment Report (EIA) or other required environmental documents, if necessary,

2-3 Examine social consideration components (gender, assistance of the socially vulnerable, etc),

2-4 Propose monitoring form for environmental and social consideration including monitoring indicators and monitoring system,

2-5 Examine Cambodian laws, regulations and procedures of resettlement and land

acquisition, study social and economic impact of local residents in the area of resettlement, and support MOWRAM to prepare Resettlement Action Plan (RAP) in accordance with the requirements of JICA guidelines in case that the residents to resettle are specified,

2-6 Examine the impact on cultural heritage and natural environment in the target area as well as relevant laws and regulations for protection of cultural heritage and natural environment.

TOR3: Examination of the details of Small Scale Irrigation System Improvement Project

3-1 Prepare a criteria for selection of high-priority area and sites,

3-2 Revise the long list of sub-projects based on the criteria,

3-3 Classify all the proposed sub-projects into categories such as new construction or rehabilitation, with or without headworks, with or without dams, and so on,

3-4 Implement Feasibility Study (F/S) for one site from each category,

3-5 Prepare manuals for conducting F/S and procedures for appraisal by MOWRAM,

3-6 Estimate and evaluate the overall cost and the cost which is included in Japanese ODA loan,

3-7 Prepare annual fund requirement,

3-8 Study consulting services necessary for the Project,

3-9 Propose implementation arrangements for the project,

3-10 Confirm technical and financial abilities of implementing agencies (MOWRAM, MAFF, PDWRAM and PDA), and identify relevant organizations/groups/departments other than listed above as well as their responsibilities, if any,

3-11 Propose procurement plan,

3-12 Study additional technical assistance or possibility of collaboration with technical cooperation projects and implementing agencies,

3-13 Prepare implementation schedule of the Project,

3-14 Confirm technical abilities of design and construction of local enterprises,

3-15 Collect information on irrigation/drainage-related projects using Sector Loan Scheme financed by other donor agencies/organizations,

3-16 Review the baseline and target of qualitative and quantitative data for monitoring and identify operation and effect indicators,

3-18 Estimate Economic Internal Rate of Return (EIRR).

TOR4: Examination of the details of Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project

4-1 Review the exiting F/S in terms of reexamination of project scope, recalculation of

water balance, etc,

4-2 Estimate and evaluate the overall cost and the cost which is included in Japanese ODA loan,

4-3 Confirm a standard for setting up unit cost,

4-4 Prepare annual fund requirement,

4-5 Study consulting services necessary for the Project,

4-6 Propose implementation arrangements for the project,

4-7 Confirm technical and financial abilities of implementing agencies (MOWRAM, MAFF, PDWRAM and PDA) and identify relevant organizations/groups/departments other than listed above as well as their responsibilities, if any,

4-8 Prepare procurement plan,

4-9 Study additional technical assistance or possibility of collaboration with technical cooperation projects and implementing agencies,

4-10 Prepare implementation schedule of the Project,

4-11 Confirm technical abilities for design and construction of local enterprises,

4-12 Review the baseline and target of qualitative and quantitative data for monitoring and identify operation and effect indicators,

4-13 Estimate Economic Internal Rate of Return (EIRR).

**4. Implementation Framework of the Survey**

(1) Survey team

JICA will select and dispatch a survey team (hereinafter referred to as "the Team") to carry out the Survey.

The Team will include the following experts:

- Team Leader
- Irrigation and Drainage Civil Engineer and Planning Specialist
- Irrigation and Drainage Planning and Management Specialist
- Farming Specialist
- Economic and Financial Analysis Specialist
- Environmental and Social Consideration Specialist

The Team may engage local consultants, NGOs, and/or other supporting staff

(2) Implementation Schedule

February 2011 - Discussion and confirmation of the Survey Implementation Program (including TOR), Signing of Minutes and Discussions,

| | | |
|---|---|---|
| April 2011 | - | Selection of consultants by JICA, |
| May 2011 to October 2012 | - | Mobilization of the Team, commencement of the Survey, submission of Inception Report, |
| | - | Submission of Progress Report (1) and (2), |
| | - | Submission of Draft Final Report, |
| | - | Draft Final Report Mission, |
| October 2012 | - | Submission of Final Report, |

(3) Reports

(a) Reports to be prepared

The Team will prepare and present the following reports in English.

(Following number of copies will be shared by JICA and the Cambodian side.)

| | | |
|---|---|---|
| Inception Report | : | 40 copies (English) |
| Progress Report (1) | : | 40 copies (English) |
| Progress Report (2) | : | 40 copies (English) |
| Draft Final Report | : | 40 copies (English) |
| Final Report (full version) | : | 40 copies (English) |
| Final Report (Summary) | : | 40 copies (English) |

※ The Final Report may be disclosed to the public on request based on Japan's Law concerning Access to Information held by administrative Organization. JICA will consult with RGC and MOWRAM as to the contents and sections to be disclosed.

(4) Monitoring

The Team's work will be subject to periodic review by JICA staff. JICA staff will attend meetings between the Team and MOWRAM, and/or other organizations concerned during the implementation of the Survey as necessary.

**5. Undertaking by MOWRAM and other organizations concerned**

MOWRAM and other relevant organizations such as MEF, will undertake to provide the followings in order to assist the implementation of the study services on schedule, through close co-operation with the authorities concerned within RGC:

(1) To provide the Team with all available and relevant data, information and

documents requested by the Team,

(2) To assign counterpart personnel,

(3) To provide the Team with appropriate office space with necessary equipment and secretariat service, etc,

(4) To ensure issuance of entry permits necessary for the team members to conduct field survey,

(5) To ensure safety of the team members, if and when required,

(6) To assist the Team in making transportation arrangements,

(7) To assist the Team in medical services as needed,

(8) To assist the Team in customs clearance, exempt from any duties with respect to equipment, instruments, tools and other articles to be brought into and out of the Kingdom of Cambodia in connection with the implementation of the Survey,

(9) To assist the Team to obtain other privileges and benefits if necessary.

- Exemption from prosecution: RGC shall bear claims, if any arises, against the members of the Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in implementation of the Survey, except when such claims arise from gross negligence or willful misconduct on the part of the member of the Team.

**6. Others**

The nature of the services to be rendered by the Team shall be exclusively advisory, with all decisions as to whether to accept or implement any recommendation(s) made or instruction(s) given in the course of the implementation of the Survey shall be the responsibility of RGC and other concerned agencies.

RGC through relevant agencies shall take, with their own responsibility, all the necessary measures for the utilization of the recommendations and outcomes of the Survey in JICA finance projects.

Annex-2

# MAIN POINTS DISCUSSED

## 1. Project Title

Both sides agreed that the titles of the projects subject to review by the Survey would be decided as follows;

1) "Kandal Stung-Bati Irrigation System Rehabilitation Project", "Upper Slakou Irrigation System Rehabilitation Project" and "Roleang Chrey Headworks Rehabilitation Project" shall be hereinafter collectively referred to as, "Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project".
2) "Small Scale Infrastructure Project" shall be hereinafter referred to as "Small Scale Irrigation System Improvement Project" in order to clarify the scope of the Project.

## 2. Project Request

1) MOWRAM proposed that order of priority for the projects and sub-projects is as follows;

   1st: Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project which consists of following three sub-projects;

   1st Kandal Stung-Bati Irrigation System Rehabilitation Sub-Project
   2nd Upper Slakou Irrigation System Rehabilitation Sub-Project
   3rd Roleang Chrey Headworks Rehabilitation Sub-Project

   2nd: Small Scale Irrigation System Improvement Project

   JICA mission team suggested that implementation schedule and combination of the sub-projects listed above would be subject to feasibility examined in the Survey.

2) Both sides confirmed that the Royal Government of Cambodia (RGC) had already dispatched a loan request to the Government of Japan for "Small Scale Infrastructure" on July 24, 2009 as an official request. Both sides confirmed that Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project ("Kandal Stung-Bati Irrigation System Rehabilitation Project", "Roleang Chrey Headworks Rehabilitation Project" and "Upper Slakou Irrigation System Rehabilitation Project") are considered as the prioritized projects for Japanese ODA Yen Loan within RGC.

## 3. Implementation Structure for the Survey

1) Both sides confirmed that MOWRAM would be the Project owner and be the main counterpart to the Team.
2) Both sides agreed that the Cambodian side would make the following arrangements for the Team:
   i) MOWRAM will coordinate to assist the Team to acquire necessary information from other relevant authorities,
   ii) MOWRAM will assign appropriate counterpart personnel to assist and work with the Team.

## 4. Detailed Outline of the Survey

1) Review and examination of preliminary design of the Project

   As for the three potential sub-projects, Kandal Stung-Bati Irrigation System Rehabilitation Project, Upper Slakou Irrigation System Rehabilitation Project and Roleang Chrey Headworks Rehabilitation Project of Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project, both sides confirmed that "Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh", "Study on the Rehabilitation and Reconstruction of Agricultural Production System in the Slakou River Basin" and "Study on Comprehensive Agricultural Development of Prek Thnot River Basin" which RGC requested were defined as Feasibility Study (F/S) of the Project, and it would be reviewed by the Team.

   As for Small Scale Irrigation System Improvement Project, both sides agreed that the Team would design the criteria for selecting high-priority sites and implement F/S for some of the selected sites.

2) Scope of the Project

   Both sides agreed that the Team estimate the total project cost and the cost to be financed by JICA and consider the proper consulting service.

3) Implementation structure

   Both sides confirmed that the Team would review the organization structure for the project implementation at headquarter (Project Management Unit: PMU) and at Provincial level (Project Implementation Unit: PIU) for Irrigation and Drainage System Rehabilitation and Improvement Project and collaboration mechanism with other concerned ministries.

4) Consulting Service

   Both sides confirmed that preparation of detailed Terms of Reference (TOR) of the projects consultants would be proposed within the survey.

5) Environmental and Social Consideration

Both sides recognized the importance of considering the environmental and social issues such as gender, assistance of the socially vulnerable, and so on. JICA mission explained that

a) JICA Guidelines would be applied to the survey, and

b) JICA mission explained that draft scoping of the survey, draft final report and final report shall be disclosed to the public according to the procedure of "JICA Guidelines" if needed, and MOWRAM agreed.

6) Office space and equipment for the Team

MOWRAM informed JICA mission that they would provide the Team with office space including necessary equipments (e.g. electricity, room, chairs and so on).

## 5. Environmental Impact Assessment (EIA)

1) Both sides confirmed that EIA report would not be required.

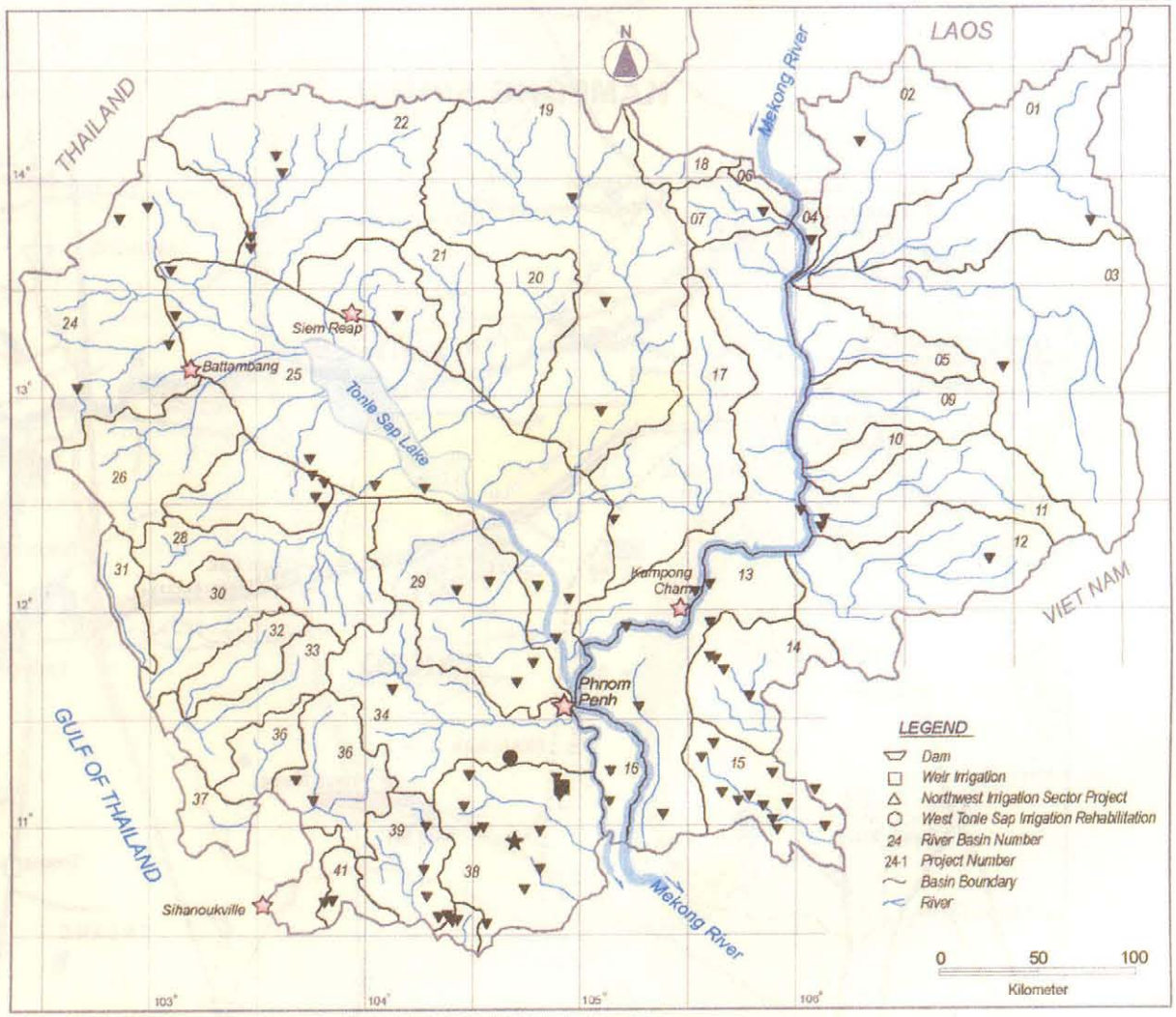
2) Both sides confirmed that the Team would prepare an environmental checklist based on JICA Environmental Guidelines and MOWRAM would fill in the checklist.

## 6. Landmine Clearance

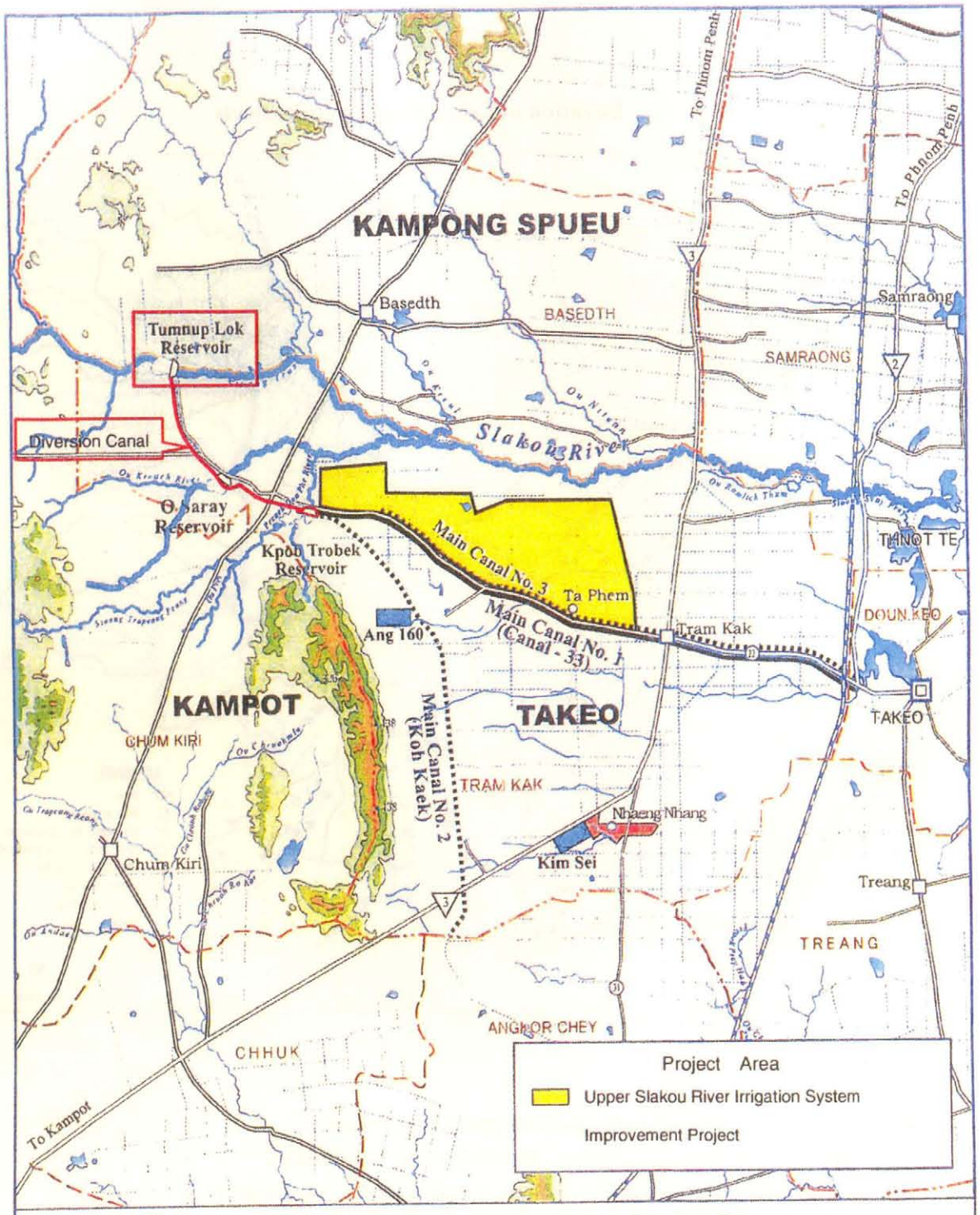
Both sides confirmed that the RGC shall take responsibility for the detection and the removal of unexploded ordnances (hereinafter referred to as "UXOs") and mines within the Project area. In case the removal of UXOs and mines becomes necessary, the RGC shall remove them as soon as practical following the detections prior to and during the preparatory survey in and around the proposed sites.

**Annex-3**

## Location of Projects and Sub-Projects




- ● Roleang Chrey Headworks Rehabilitation Sub-Project
- ★ Upper Slakou Irrigation System Rehabilitation Sub-Project
- ■ Kandal Stung-Bati Irrigation System Rehabilitation Sub-Project
- ▼ Small Scale Irrigation System Improvement Project



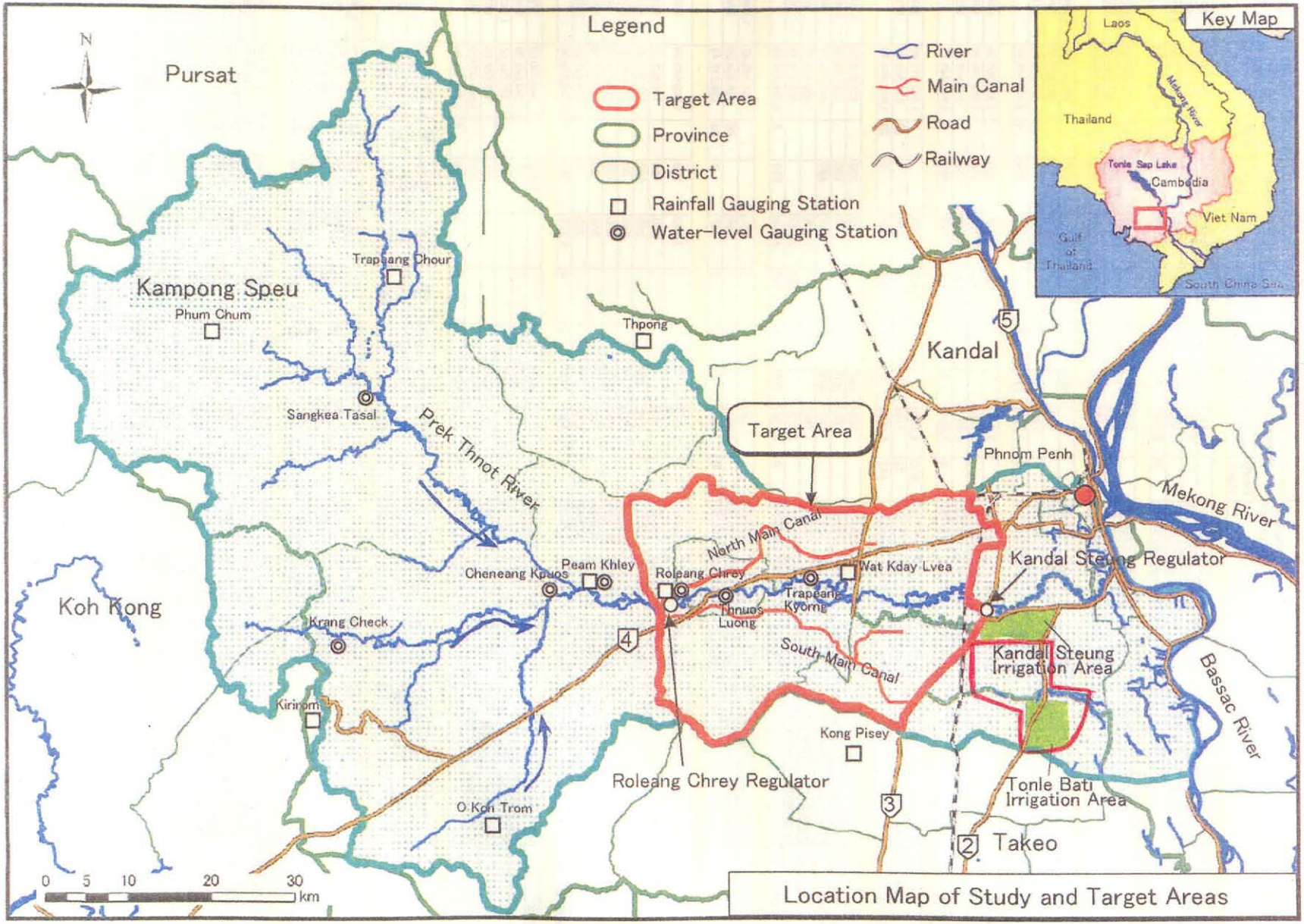

# LOCATION MAP OF THE PROJECT


LEGEND

| | | | |
|---|---|---|---|
| | Study Area | | River |
| PROVINCE | Province | | Canal |
| DISTRICT | District | 3 | National Road |
| | Provincial Border | 31 | Road / Dike |
| | District Border | | Railway |
| | Provincial Capital | | Reservoir |
| | District Capital | | |

N

0 5km


Legend
Target Area
Province
District
Rainfall Gauging Station
Water-level Gauging Station
River
Main Canal
Road
Railway
Key Map
Laos
Thailand
Mekong River
Tonle Sap Lake
Cambodia
Viet Nam
Gulf of Thailand
South China Sea
N
Pursat
Kampong Speu
Phum Chum
Trapeang Chour
Thpong
Sangkea Tasal
Prek Thnot River
Kandal
Target Area
Phnom Penh
Mekong River
North Main Canal
Kandal Steung Regulator
Cheneang Kpuos
Peam Khley
Roleang Chrey
Wat Kday Lvea
Trapeang Kyorng
Thnuos Luong
Koh Kong
Krang Check
South Main Canal
Kandal Steung Irrigation Area
Bassac River
Kirirom
Kong Pisey
Roleang Chrey Regulator
Tonle Bati Irrigation Area
O Koh Trom
Takeo
0 5 10 20 30 km
Location Map of Study and Target Areas

# *Attachment 2*

*Minutes of Discussion on Preparatory Survey for*
*Irrigation and Drainage System*
*Rehabilitation and Improvement Project*
*between Japan International Cooperation Agency*
*and the Royal Government of Cambodia*
*(June 13, 2011)*

# MINUTES OF DISCUSSION
# ON
# PREPARATORY SURVEY
# FOR
# IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT
# BETWEEN
# JAPAN INTERNATIONAL COOPERATION AGENCY
# AND
# THE ROYAL GOVERNMENT OF CAMBODIA

DATE: June 13, 2011
PLACE: Phnom Penh, Cambodia

1. The Japan International Cooperation Agency (hereinafter referred to as "JICA") Mission visited Cambodia from June 7th to 13th, 2011 and had discussions on the Implementation Program of Preparatory Survey (hereinafter referred to as "the Survey") for Irrigation and Drainage System Rehabilitation and Improvement Project (hereinafter referred to as "the Project") based on the Inception Report with officials of Ministry of Water Resources and Meteorology (hereinafter referred to as "MOWRAM") and members of the team of the Survey (hereinafter referred to as "JICA Survey Team").

2. JICA mission and JICA Survey Team presented the Inception Report of the Survey and MOWRAM accepted its contents. It should be noted that implementation of the Survey does not imply any decision or commitment by JICA to extend its loan for these projects at this stage, and the timing of the implementation of these projects will be depending on the feasibility of the Survey.

3. JICA mission, JICA Survey Team and MOWRAM made the record of main points as shown in Annex-1.

**For**
**Ministry of Water Resources and Meteorology**

Pich Veasna
Deputy Director General of
Administration Affairs
Ministry of Water Resources and
Meteorology

**For**
**Japan International Cooperation Agency**

Kenichiro Kobayashi
Director
Paddy Field Based Farming Area
Division 1
Rural Development Department
JICA

**For**
**JICA Survey Team**

Hitoshi Shimazaki
Leader
Deputy Director/ Chief Engineer
Irrigation and Drainage Engineer
Nippon Koei Co., Ltd.

cc:
- JICA Cambodia Office
- Ministry of Economy and Finance

**Annex-1**

# MAIN POINTS DISCUSSED

## 1. Change of Project Titles

Both sides agreed that the project titles which were agreed in the Minutes of Discussions on February 26, 2011 will be changed as follows;

(1) "Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project"
This project is composed of "Upper Slakou Irrigation System Rehabilitation Sub-Project" and "Roleang Chrey Headworks Rehabilitation Sub-Project".

(2) "Small and Medium Scale Irrigation System Rehabilitation and Improvement Project"
This project is composed of "Kandal Stung-Bati Irrigation System Rehabilitation Sub-Project" and "Small-scale Irrigation System Improvement Project".

The project formation would be examined within the Survey and the project titles above would be revised according to the project formation as the results of the Survey.

## 2. Project Formation Schedule of Expected Japanese Yen Loan Projects

As described in the Inception Report, the first project, which is to be studied in the first batch of the Survey (from early June to late October 2011), is the above-mentioned project in 1- (1). The second project, which is to be studied in the second batch of the Survey (from early December 2011 to late June 2012), is the above-mentioned project in 1- (2).

## 3. Scope of the Survey

The Roleang Chrey Headworks Rehabilitation Sub-project and the Kandal Stung- Bati Irrigation System Rehabilitation Sub-project are located in the basin of the Prek Thnot River whose runoff is greatly influenced by an operation plan of Stung Tasal Dam, which is planned to be supported by the Indian government. However, the detail information such as inflow to and released discharge from the dam reservoir, construction schedule, etc. was not clarified during the stay of JICA Mission.

Taking it into due consideration that Roleang Chrey Headworks Rehabilitation Sub-project is not so affected by runoff of the Prek Thnot River while the Kandal Stung-Bati Irrigation System Rehabilitation Sub-project is largely affected, both sides agreed as follows:

- As for the Roleang Chrey Headworks Rehabilitation Sub-project, it will be planned

without consideration of mitigation of flood by the Stung Tasal Dam.

- Although JICA Survey Team will collect information of the progress of Stung Tasal Dam project from the relevant agencies during the first batch, MOWRAM will extend the cooperation to the JICA Survey Team for smooth collection of the necessary information.
- As for the Kandal Stung-Bati Irrigation System Rehabilitation Sub-Project, both sides will discuss in the process of the Survey before the second batch of the Survey starts whether those should be planned based on the results of water balance calculation with or without the Stung Tasal Dam, on the grounds of the information collected during the first batch.

**4. Establishment of Steering Committee**

Both sides agreed to establish the Steering Committee. The members of the Steering Committee are as follows;

(1) Ministry of Water Resources and Meteorology
(2) Ministry of Economy and Finance
(3) Ministry of Agriculture, Forestry and Fisheries

# *Attachment 3*

*Minutes of Meeting on Inception Report for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia (June 30, 2011)*

MINUTES OF MEETING
ON
INCEPTION REPORT
FOR
PREPARATORY SURVEY
FOR
IRRIGATION AND DRAINAGE SYSTEM
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

The JICA Survey Team arrived in Cambodia on June 6, 2011, to set out to commence the 1st field work for the Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project (hereinafter referred to as "the Survey"). Prior to the commencement of the Survey, the JICA Survey Team sent the Inception Report to the Ministry of Water Resources and Meteorology (hereinafter referred to as "MOWRAM") by e-mail on June 2, 2011 and also submitted thirty (30) copies of the Inception Report, to MOWRAM on June 7, 2011 in accordance with the Minutes of Discussion on the Survey signed by representatives of MOWRAM, MEF and JICA on February 25, 2011.

A meeting on the Report was held with the Steering Committee at the conference room of MOWRAM on June 29, 2011. In the meeting, the JICA Survey Team explained the contents of the Report, highlighting basic approaches and outputs of the Survey. Thereafter, a series of fruitful discussions was made among them. As the result of the discussions, the Report was in principle accepted by the Steering Committee. The main issues discussed in the meeting and the list of participants is shown in ANNEXES attached hereto.

June 30, 2011

H.E. Mr. Pich Veasna
Deputy Director General of
Administration Affairs
Ministry of Water Resources and
Meteorology,
The Kingdom of Cambodia

Mr.Hitoshi SHIMAZAKI
Leader
The JICA Survey Team

*(ANNEX I)*

**Main Issues Confirmed and Agreed at the Meeting**

1. Use of Effective Storage Water exploited by Stung Tasal Dam

   According to the Engineering Report, the Stung Tasal Dam which would exploit the effective storage of approximately 140 million $m^3$, could irrigate farm land of some 10,000 ha. In this connection, the JICA Survey Team requested the Steering Committee to discuss how to use this storage water because the Master Plan Study carried out in 1993-94 concluded that it would be necessary to seek for another water resource like the Prek Thnot Multipurpose Dam, to irrigate the Kandal Stung Area located at the downstream area of the Prek Thnot river, which is one of target areas in the Survey. After the thorough discussion, the Steering Committee concluded that the storage water by the Stung Tasal Dam should be preferentially used for irrigation to the Kandal Stung Area.

2. Cultivated Lands in Reservoir Area and Houses along Canals in Upper Slakou Sub-Project

   The JICA Survey Team explained that in the Upper Slakou Sub-project, there found many paddy fields in the reservoir area and many houses along the canal, and these would be impeded for rehabilitation of reservoirs and canal. The Steering Committee replied that MOWRAM had many experiences in land acquisition and resettlement in the past, so that MOWRAM and the Governor could jointly solve these problems in accordance with the Cambodian policy and law.

3. Need of Further Dams Upstream of Prek Thnot River

   The Steering Committee explained that there was a need of implementation of two dam projects located upstream of Prek Thnot River since the Stung Tasal Dam only could not supply enough water to irrigate all farm lands in its river basin. The JICA Survey Team replied that progress on these dam projects would be checked.

4. Need of Clarification of Water Demand in Downstream Area

   The Steering Committee explained that the water demand in downstream area of Prek Thnot River should be clarified for proper operation of Roleang Chrey Regulator. The JICA Survey Team replied that water demand in its downstream area was already clarified in the Master Plan carried out in 2005-2008, however further review would be made based on the additional data and considering water supply to the Kandal Stung Area and Bati Area.

5. Need of Implementation Organization Well-fitted to local Conditions

   The JICA Survey Team explained that there were some sub-projects extending over plural provinces, thus it was necessary to consider the establishment of efficient implementation organization. The Steering Committee understood this explanation and agreed to discuss this matter among the persons in charge.

6. Need of Urgent Implementation of Upper Slakou Sub-project

   The Steering Committee appealed the need of urgent implementation of Upper Slakou Sub-project

because the beneficial farmers concerned have long waited for its implementation since 2002 when the Master Plan was formulated. The JICA Survey Team answered that Upper Slakou Sub-project was taken up as a proposed one to apply Japanese Yen loan as mentioned in the Inception Report.

7. Inspection of Water Resources for Kandal Stung Area

   The Steering Committee requested the JICA Survey Team to inspect the condition of water resources for Kandal Stung Area in the rainy season. The JICA Survey Team accepted this request.

8. Prioritization of Sub-projects in Small-scale Irrigation System Improvement Project

   The Steering Committee requested the JICA Survey Team that the prioritization of sub-projects in Small-scale Irrigation System Improvement Project should be carefully made based on the definite prioritization criteria. The JICA Survey Team accepted this request.

9. Change of Grouping of Target Sub-projects

   The Steering Committee explained that there was a change of grouping of target sub-projects through discussion with JICA Mission on June 13, 2011, and this matter would be officially informed from MOWRAM to MEF.

10. Procedure of Loan Project

    It was confirmed that MOWRAM should feed back the experiences in the West Tonle Sap Project for smooth and effective project management since the procedure of loan project is much different from that of grant-aide project.

11. Need of Close Coordination with All Stakeholders

    It was confirmed that MOWRAM should keep the close coordination with all stakeholders concerned for good communication among them.

12. Need of Clarification of Water Balance Study

    The Steering Committee requested the JICA Survey Team that water resources are the most important issue for the irrigation development, therefore the balance of water demand and supply should be carefully studied. The JICA Survey Team recognized this request.

13. Need of On-farm Development

    The Steering Committee explained that the on-farm development which is responsibility of FWUCs, is important for proper water distribution to fields, however it was difficult for FWUCs to execute it. The JICA Survey Team understood this explanation and would discuss with MOWRAM on this matter in the light of the MOWRAM's policy.

14. Need of Share of Information

    It was confirmed that it was important to coordinate and share the information between irrigation sector and agriculture sector, and also between Central office and Provincial Offices.

# *Attachment 4*

*Minutes of Meeting on Progress Report (1) for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia*

*(August 31, 2011)*

MINUTES OF MEETING
ON
PROGRESS REPORT (1)
FOR
PREPARATORY SURVEY
FOR
IRRIGATION AND DRAINAGE SYSTEM
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

The JICA Survey Team submitted thirty (30) copies of the Progress Report (1) to the Ministry of Water Resources and Meteorology (hereinafter referred to as "MOWRAM") on August 23, 2011 in accordance with the Minutes of Discussion on the Survey signed by representatives of MOWRAM, MAFF, MEF and JICA on February 25, 2011.

A meeting on the Report was held with the Steering Committee at the conference room of MOWRAM on August 30, 2011. In the meeting, the JICA Survey Team briefly explained the contents of the Report, highlighting the results of examination of project scope and study on implementation organization. Thereafter, a series of fruitful discussions was made among them. As the result of the discussions, the Report was in principle accepted by the Steering Committee. The main issues discussed in the meeting and the list of participants is shown in ANNEXES attached hereto.

August 31, 2011

H.E. Mr. Pich Veasna
Deputy Director General of
Administration Affairs
Ministry of Water Resources and
Meteorology,
The Kingdom of Cambodia

Mr.Hitoshi SHIMAZAKI
Leader
The JICA Survey Team

## Main Issues Confirmed and Agreed at the Meeting

1. Data on Released Discharge by Stung Tasal Dam

   Stung Tasal Dam Project financially supported by the Government of India is one of the biggest issues in terms of analysis on water resources availability for downstream irrigation system development, particularly Kandal Stung-Bati Irrigation System Rehabilitation Sub-project (KSBISRSP). In this regard, the Steering Committee firstly mentioned in the meeting that the plan on released discharge by Stung Tasal Dam will be provided by WAPCOS within today.

2. Progress of Dam Construction Plans by KOICA

   Although Feasibility Studies were completed, the Steering Committee added that the implementation of three dam construction plans: (i) New Dam, (ii) Peam Levear and (iii) O Tang have not been committed yet.

3. Dependability applied for Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP)

   Slide in page 5 shows two dependability, 80 % and 50 %, utilized in water balance study to confirm irrigable area during M/P stage. The Steering Committee inquired about which dependability is applied for the present survey. The JICA Survey Team replied that 80 % of dependability was applied for the survey as recognized as worldwide standard in irrigation planning.

4. Inclusion of Tertiary Development in the JICA Loan

   The JICA Survey Team inquired about whether the tertiary development for the Project will be included in the JICA loan. The tertiary canals are the properties of farmers in accordance with the regulation of MOWRAM. No physical compensation will be made to them so that consensus building among stakeholders usually takes longer period of time, which is not suitable for loan project component. The JICA Survey Team, therefore, recommended that the tertiary development will be excluded from the JICA loan instead it would be implemented using the budget of MOWRAM. The Steering Committee replied that the Project by JICA loan will be an opportunity for MOWRAM to develop advanced irrigation system having main, secondary to tertiary facilities. Such complete system will be expected also to promote establishment and strengthening of FWUC. The Steering Committee requested that the tertiary development will be included in the JICA loan for USISRSP under the conditions that the necessary land acquisition would be carried out timely by MOWRAM responsibility as similarly arranged in the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project (WTSIDRIP). The JICA Survey Team again stressed that the smooth land acquisition will be a determinant factor for the success of tertiary development. Therefore, the JICA Survey Team will deliver the comments from the Steering Committee to JICA Headquarters that the tertiary development will be included as one of the sub-project components under the conditions that "the necessary arrangement for land acquisition and resettlement will be timely made by MOWRAM."

5. Need of Justification of Proposed Length of North and South Main Canals under RCHRSP

Rehabilitation of North Main Canal (NMC) and South Main Canal (SMC) with the length of 10 km each with those related structures are proposed by MOWRAM as in the Minutes of Discussion on Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project, signed on February 25th, 2011. In this regard, the JICA Survey Team stressed that the project scope under JICA loan needs clear justification and the length of NMC and SMC to be rehabilitated are not left out. At present, no structures exist at 10 km locations on both NMC and SMC so that above-proposed length is not necessarily justified. In this regard, the JICA Survey Team suggested that the Team would prepare alternative plans for the rehabilitation of NMC and SMC based on the survey result and the discussion in today's meeting to determine, together with MOWRAM, the proposed scope for JICA loan. The Steering Committee has agreed to this suggestion.

6. Confirmation on Work Schedule

The JICA Survey Team reported that the Progress Report (2) would be issued around October 2011 after discussion with JICA Headquarters, the contents of which would primarily consist of (i) background, (ii) project scope, (iii) implementation organization, as having been already prepared in Progress Report (1), and (iv) project plan, (v) implementation schedule, (vi) cost, (vii) economic and financial evaluation and (viii) environmental assessment.

MINUTES OF MEETING
ON
PROGRESS REPORT (2)
FOR
PREPARATORY SURVEY
FOR
IRRIGATION AND DRAINAGE SYSTEM
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

The JICA Survey Team submitted thirty (30) copies of the Progress Report (2) to the Ministry of Water Resources and Meteorology (hereinafter referred to as "MOWRAM") on December 2, 2011 in accordance with the Minutes of Discussion on the Survey signed by representatives of MOWRAM, MAFF, MEF and JICA on February 25, 2011.

A meeting on the Progress Report (2) was held with the Steering Committee at the conference room of MOWRAM on December 13, 2011. In the meeting, the JICA Survey Team briefly explained the contents of the Report, highlighting the results of examination of project scope, study on implementation organization, cost estimate, project evaluation and environmental issues. Thereafter, a series of fruitful discussions was made among them. As the result of the discussions, the Progress Report (2) was in principle accepted by the Steering Committee. The main issues discussed in the meeting and the list of participants is shown in ANNEXES attached hereto.

December 14, 2011

H.E. Mr. Pich Veasna
Deputy Director General of
Administration Affairs
Ministry of Water Resources and
Meteorology,
The Kingdom of Cambodia

Mr.Hitoshi SHIMAZAKI
Leader
The JICA Survey Team

*(ANNEX I)*

## Main Issues Confirmed and Agreed at the Meeting

1. Comparison Study for Renewal of Regulator and Construction of Stoplog

   The Steering Committee requested to quantify the construction cost, construction period and maintenance cost mentioned in the comparison table for easier clarification. The JICA Survey Team responded that this request would be tried as much as possible in the Draft Final Report although a detailed study would be made in the detailed design stage.

2. Implementation Plan of Software Component

   The Steering Committee asked the JICA Survey Team whether the implementation plan for software component was prepared or not in the Progress Report (2). The JICA Survey Team replied that the implementation plan for software component was mentioned in AE-4.6.4 and Figure AE-4.6.4.1 of ANNEX E.

3. Need of Collaboration between MOWRAM and MAFF for Software Component

   In the meeting, the Steering Committee stressed that the collaboration between MOWRAM and MAFF was essential for successful execution of software component, and further requested the JICA Survey Team to coordinate with TSC-3 and APPP. The JICA Survey Team agreed to this request.

4. Establishment Nos. of FWUG per Year

   The Steering Committee asked the JICA Study Team whether the number of establishment of FWUG per year would be reasonable or not because it seemed to be so large. The JICA Survey Team replied that Table II-4.5.3.2.2 showed how to establish 120 FWUGs/Sub-FWUGs during 7 years since one FWUC has been already established, although further study would be made for reality of this number through confirmation on the past achievements in other projects.

5. Implementation Period for RCHRSP

   The Steering Committee asked the JICA Study Team whether it was possible to shorten the implementation period for RCHRSP because it seemed to be long. The JICA Study Team answered that the implementation period was worked out taking into consideration two years required for gate assembling and the pre-construction period in conformity with the JICA Guidelines.

6. Tertiary Canal Development

   The Steering Committee asked the JICA Study Team why the project works from headworks to main and secondary canals would be undertaken by international consultant, while tertiary canal development by national consultant to be employed by MOWRAM. The JICA Study Team replied that the tertiary canal development would be largely influenced by the progress of land acquisition to be offered from farmers without compensation, which would bring about the difficulty in control by international consultant. The Steering Committee requested MEF to consider the compensation for land acquisition to tertiary canal for its smooth implementation.

7. Estimated EIRR

The Steering Committee indicated that the estimated EIRR, say 10.3 % was low, and might not be accepted by MEF. The JICA Survey Team explained that the low EIRR was due to RCHRSP, but the higher EIRR would be expected if including the Kandal Stung-Bati Sub-project and 3 to 4 small-scale irrigation projects in SPPIDRIP.

8. Consulting Service Cost

The Steering Committee stated that the consulting service cost should not exceed 10% of construction cost. The JICA Survey Team explained that the consulting service cost mentioned in the Progress Report (2) was on the estimated basis, which was made as the result of discussion with JICA.

9. UXO Mine Survey and Clearance Cost

The Steering Committee explained that the UXO mine survey cost of US$ 60,000 remained, but the UXO mine clearance cost of US$600,000 should be additionally included in RGC portion.

10. Urgent Commencement of Abbreviated RAP Preparation

The JICA Survey Team requested the Steering Committee to urgently commence the preparation of abbreviated RAP for USISRSP by Resettlement Unit. The Steering Committee accepted this request and promised to take necessary action immediately.

# *Attachment 6*

*Minutes of Meeting on Draft Final Report for Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia*

*(June 7, 2012)*

MINUTES OF MEETING
ON
DRAFT FINAL REPORT
FOR
PREPARATORY SURVEY
FOR
IRRIGATION AND DRAINAGE SYSTEM
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

The JICA Survey Team submitted thirty (30) copies of the Draft Final Report to the Ministry of Water Resources and Meteorology (hereinafter referred to as "MOWRAM") on May 21, 2012 by DHL in accordance with the Minutes of Discussion on the Survey signed by representatives of MOWRAM, MAFF, MEF and JICA on February 25, 2011.

A meeting on the Draft Final Report was held with the Steering Committee at the conference room of MOWRAM on June 7, 2012. In the meeting, the JICA Survey Team briefly explained the contents of the Report, highlighting the results of examination of project scope, study on implementation organization, cost estimate, project evaluation, environmental issues, preliminary study on influence to Roleang Chrey command area with dam plans and small-scale irrigation projects. Thereafter, a series of fruitful discussions was made among them. As the result of the discussions, the Draft Final Report was in principle accepted by the Steering Committee. The main issues discussed in the meeting and the list of participants is shown in ANNEXES attached hereto.

June 8, 2012

H.E. Mr. Pich Veasna
Deputy Director General of
Administration Affairs
Ministry of Water Resources and
Meteorology,
The Kingdom of Cambodia

Mr. Hitoshi SHIMAZAKI
Leader
The JICA Survey Team

*(ANNEX I)*

## Main Issues Confirmed and Agreed at the Meeting

1. General Layout Map and Structure Drawings

   The Steering Committee requested that the general layout map and structure drawings for each Sub-project would be expected to be prepared in A3 size sheet from clear viewpoint. The JICA Survey Team replied that printing and binding of mixing of A4 and A3 size sheets would be difficult within the limited time, but would consider how to improve them in the final report.

2. Implementation Schedule

   The Steering Committee asked the JICA Survey Team to shorten the implementation period because it seemed to be too long. The JICA Survey Team answered that the implementation schedule was worked out in conformity with the JICA Guidelines, and then explained the required period for each stage which are that the procurement of consultant, detailed design and procurement of contractor would require 1 year, 1.5 years and 1 year respectively, and the construction of 6 Sub-projects would require 4 years although construction of RCHRSP would become a critical path. In addition, the Steering Committee related that the completion of SPPIDRIP was too late because the current rice policy targets export of 1 million tons of rice by 2015. The JICA Survey Team replied that SPPIDRIP should be implemented as scheduled, to some extents so as to contribute the target described in the said rice policy.

3. Monitoring of Water Allocation in Prek Thnot River Basin

   The Steering Committee suggested that the control of water allocation to each irrigation system in the Prek Thnot River basin and its monitoring would be required. The JICA Survey Team explained that it was therefore essential to establish the Prek Thnot River Basin Management Unit aiming to properly allocate irrigation water to all the related irrigation systems based on irrigation schedule and operation rule of gates, and also to execute monitoring work.

4. Cropping Intensity of DPISRSP

   The Steering Committee indicated that cropping intensity for DPISRSP was too low in the dry season. The JICA Survey Team explained that the cropping intensity was estimated through the water balance study with 80% dependability, but farmers might be able to cultivate more if water is available in river. In this connection, the JICA Survey Team requested that hydrological observation including river discharge should be carried out to grasp more accurate water availability because it is so limited or nothing now.

5. Government Budget Arrangement for the Project

   The Steering Committee requested the JICA Survey Team to make the detailed explanation about the government budget required for SPPISDRIP. The JICA Survey Team answered that the cost for SPPIDRIP was estimated for both the loan portion and the Government portion in the Report.

6. EIRR for RCHRSP and DPISRSP

The Steering Committee pointed out that EIRR of RCHRSP and DPISRSP was lower than 10%, which might not be accepted by MEF. The JICA Survey Team explained that EIRR of SPPIDRIP is 14.3% which is high enough, therefore requested the Steering Committee to confirm with MEF whether either overall EIRR or EIRR for each Sub-project would be used for selection of loan object Sub-project. The JICA Survey Team also requested the Steering Committee to discuss with MEF in line with the MOWRAM's irrigation policy.

7. Mines and UXOs

The JICA representative stated that the Report showed that the contaminated Sub-projects with mines and UXOs were only USISRSP and KSBISRSP, and then asked how about other Sub-projects. The JICA Survey Team replied that USISRSP and KSBISRSP were surely contaminated with mines and UXOs, but other Sub-projects would not be contaminated with them although further confirmation would be made in preparation of final report.

8. Progress of Dam Projects in Prek Thnot River Basin

The JICA Mission asked the Steering Committee about the progress of the dam projects located in the Prek Thnot River basin. The Steering Committee answered that the Stung Tasal Dam was under construction, F/S for three dams was completed by KOICA, and other two dams have no progress as mentioned in the Report.

9. Command Area of RCHRSP

The JICA Expert indicated that there was a difference in the command area of RCHRSP mentioned in the Report. The JICA Survey Team replied that it should be checked and corrected if necessary.

10. Soft Data of Water Balance Study

The Steering Committee asked the JICA Survey Team to provide the soft data on water balance study for Prek Thnot River basin because it was so useful for the Pursat River basin management. The JICA Survey Team answered that the soft data on water balance study could be provided if there was no problem judging from royalty point.

11. Consulting Service Cost

The JICA Mission explained that the estimated consulting service cost was over 10% of construction cost in the Report, but according to the government policy, the consulting cost should be less than 10% of construction cost. In this connection, the JICA Mission requested the Steering Committee to search for proper solution.

12. Abbreviated Resettlement Action Plan (ARAP)

The JICA Mission explained that ARAP for not only voluntary resettlement but also land acquisition should be prepared before JICA appraisal in September 2012. The Steering Committee replied that it was difficult to arrange the budget for preparation of ARAP although the required experts are available, and requested JICA the financial cooperation for preparation of ARAP. The JICA Mission replied that

this request would be conveyed to JICA Headquarters.

13. EIRR for all cases in Preliminary Water Balance Study

JICA Expert asked the JICA Survey Team about availability of EIRR of all the cases of the preliminary water balance study. The JICA Survey Team replied that the preliminarily study aimed at only water balance in the river basin, thus EIRR calculation for each case was not made.

14. Further Comments

The Steering Committee determined that any further comments on the Report if any should be submitted to the JICA Survey Team through JICA within three weeks, say by June 28, 2012.