MINISTRY OF WATER RESOURCES
AND METEOROLOGY,
THE KINGDOM OF CAMBODIA

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

FINAL REPORT

VOLUME - II

ANNEXES (1/3)

SEPTEMBER 2012

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

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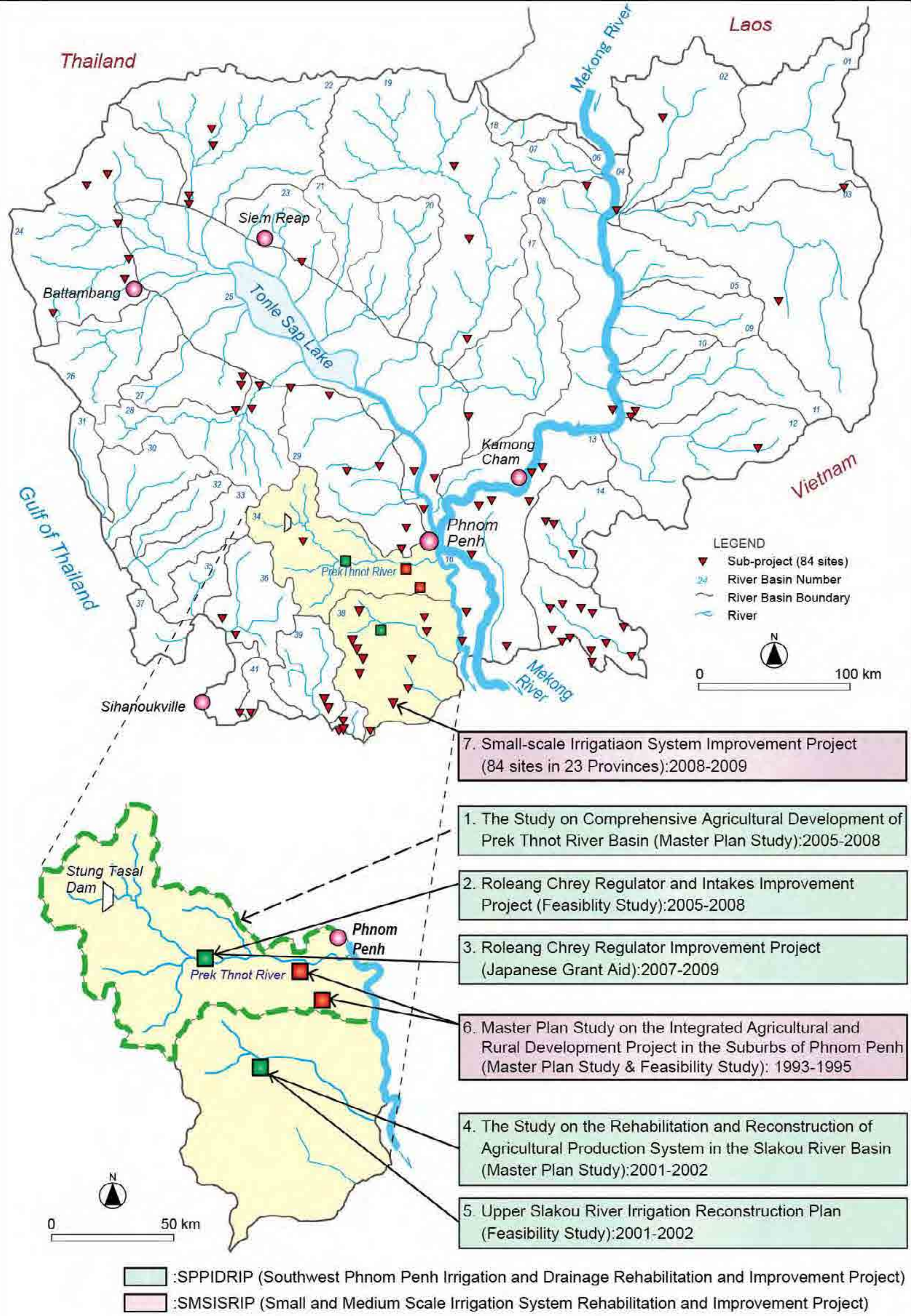
LIST OF REPORTS

ANNEX A

Outlines of Previous Studies



Previous Studies Relevant to the Project

PREPARATORY SURVEY
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ANNEX A
OUTLINES OF PREVIOUS STUDIES

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ANNEX A

OUTLINES OF PREVIOUS STUDIES

CHAPTER AA-1 GENERAL INFORMATION

AA-1.1 Objective of the Survey

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project in the Kingdom of Cambodia is carried out in accordance with the Minutes of Discussion (M/D) between the Japan International Agency (JICA) and the Royal Government of Cambodia (RGC) signed on February 25, 2011.

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 appraisal 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.

AA-1.2 Scope of the Survey

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

Table AA-1.2.1 Scope of the Survey

Survey Items	Scope of the Survey
Confirmation and appropriateness of the Project and preparation of suitable scope of the Project	(1) Confirmation of subjects in agricultural policy and irrigation policy (2) Confirmation of scope of rehabilitation of irrigation facilities as Japanese Yen loan (3) Review of agricultural information for each survey area (4) Grasping of preliminary conditions on each survey area (5) Confirmation of policies, development plans and laws on the Project (6) Confirmation of importance and appropriateness of the Project (7) Preparation of the suitable scope of project in consideration of the above
Preparation of basic design and strengthening plan of executing and Operation and Maintenance (O&M) organizations, and estimate of project cost	(1) 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) (2) Study on yearly basis construction plan and construction cost (3) Estimate on total project cost and project cost for Japanese Yen loan (4) Confirmation of setting method of unit prices (5) Preparation of financial arrangement plan (6) Study on consulting services (7) Preparation of procurement packages (8) Confirmation of project implementation organization (9) Study on O&M organization

Survey Items	Scope of the Survey
Confirmation of environmental and social considerations	(1) Preparation of checklist based on the "JICA Environmental and Social Consideration Guidelines (April 2010)" (2) Study on Social consideration
Confirmation of project effects	(1) Proposal on indicators of operation and effect (setting of standard indicators and target indicators and proposal of methods of data inputs and evaluation) (2) Confirmation of qualitative effects (proposal of suitable method for confirming qualitative effects by project) (3) Estimate of Economic Internal Rate of Return (EIRR)

Source: JICA Survey Team

AA-1.3 List of Previous Studies

The existing F/S or M/P relevant to the Project were prepared as follows and summarized in this Annex.

Table AA-1.3.1 List of Existing Studies relevant to the Project

Project	Relevant Study	Implemented by	Period
Southwest Phnom Penh Irrigation and Drainage Rehabilitation and Improvement Project (SPPIDRIP)	The Study on Comprehensive Agricultural Development of Prek Thnot River Basin (Master Plan Study)	JICA	2005-2008
	Roleang Chrey Regulator and Intakes Improvement Project (Feasibility Study)	JICA	2005-2008
	Roleang Chrey Regulator Improvement Project (Japanese Grant Aid)	GOJ/JICA	2007-2009
	The Study on the Rehabilitation and Reconstruction of Agriculture Production System in the Slakou River Basin (Master Plan Study)	JICA	2001-2002
	Upper Slakou River Irrigation Reconstruction Plan (Feasibility Study)	JICA	2001-2002
Small and Medium Scale Irrigation System Rehabilitation and Improvement Project (SMSISRIP)	Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh	JICA	1994-1995
	Small Scale Irrigation System Improvement Project	MOWRAM	2008-2009

Source: JICA Survey Team

CHAPTER AA-2 SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

AA-2.1 General

SPPIDRIP is composed of RCHRSP and USISRSP. As for RCHRSP, the M/P Study, F/S, B/D and D/D have been carried out so far. On the other hand, USISRSP has been worked out through the M/P Study and F/S. The results of these previous studies are summarized hereinafter.

AA-2.2 Climate

There was only one meteorological observation station in the RCHRSP Area and the USISRSP Area at Pochentong in Phnom Penh managed by MOWRAM. The observation recorded for temperature, rainfall, relative humidity, wind speed, sunshine hours and evaporation at this observation station. According to the previous studies, the meteorological situations in the period from 1991 to 2005, except for rainfall data collected during the period from 1901 to 1990, are as follows:

The climate classification of Cambodia is a tropical monsoon climate with definite rainy and dry season. Monthly mean temperature at the Pochentong station in Phnom Penh city shows seasonal variation from 26.2°C in December to 30.5°C in April. Monthly maximum temperature higher than 31°C is common. Monthly minimum temperature never falls below 21°C. Monthly mean relative humidity ranges from 70% in March to 85% in September and October. The relative humidity is high at night and low at daytime throughout the year. The following table shows monthly data at Pochentong station.

Table AA-2.2.1 Summary of Meteorological Data at Pochentong Station (1991 - 2005)

Item	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average or Total
Temperature	°C													
Mean		26.4	27.8	29.4	30.5	30.2	29.3	28.7	29.3	28.1	27.5	26.9	26.2	28.3
Maximum		31.6	33.2	34.9	35.7	35.0	33.8	32.7	32.6	32.2	31.3	31.1	30.9	32.9
Minimum		21.2	22.4	23.8	25.3	25.4	24.9	24.6	26.0	24.0	23.7	22.7	21.5	23.8
Rainfall*	mm	7.5	8.4	26.8	70.3	140.8	144.5	148.7	160.3	241.3	259.8	131.9	37.6	1,377
Humidity	%	73.2	70.7	69.7	71.0	75.8	77.8	81.1	81.7	84.6	84.6	79.0	74.9	77.0
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	4.4	5.5	6.3	5.9	4.8	4.5	4.0	3.9	3.3	2.9	3.5	4.1	53.1
Sunshine	hr/day	8.7	8.6	8.3	8.0	7.2	6.3	5.7	5.8	5.5	6.0	7.5	8.3	7.1

Note: Wind Speed data during the period from September 2005 to December 2005 are unavailable.
Source: 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)*

AA-2.3 The Study on Comprehensive Agricultural Development of Prek Thnot River Basin (Master Plan Study)

AA-2.3.1 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. Responding 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 and F/S on the priority projects selected in M/P, and Verification Study at pilot projects which are of project components mentioned in Clause AA-2.3.2.

AA-2.3.2 Project Components

The objective of M/P is to present and elaborate strategies of improving the agricultural productivity in the target area by the specific year, considering the existing water resources. Based on the survey and study results, the "***Improvement of Agricultural Productivity centering on Rice***" is selected as the strategic target of M/P, which will be attained through "***program approach***", in a concept of "***Well-harmonized Development of Irrigation and Drainage, Agriculture and Institutions***". In order to attain this strategic target and in the above mentioned concept, the project component consisting of twenty seven projects/studies for scheme-wise improvement plan and subject-wise improvement plan was worked out as follows:

Table AA-2.3.2.1 Project Component

Scheme-wise Improvement Plan		
	Zone Based Projects (Zone-1)	
1	A.1(1)	Irrigated Agriculture Improvement Model Project
2	A.1(2)	Upper North Main Canal (UNMC) Irrigated Agriculture Improvement Project
3	A.1(3)	Upper South Main Canal (USMC) Irrigated Agriculture Improvement Project
	Zone Based Projects (Zone-2)	
4	A.2(1)	Lower North Main Canal (LNMC) Irrigated Agriculture Improvement Project
5	A.2(2)	Lower South Main Canal (LSMC) Irrigated Agriculture Improvement Project
6	A.2(3)	Ou Krang Ambel Irrigated Agriculture Improvement Project
	Zone Based Project (Zone-3)	
7	A.3(1)	Water Harvesting Irrigated Agriculture Improvement Project
	Zone Based Project (Zone-4)	
8	A.4(1)	Rainfed Agriculture Improvement Project
	Zone Crosscutting Projects	
9	B.1(1)	Roleang Chrey Regulator Gates Urgent Improvement Project
10	B.1(2)	Roleang Chrey Regulator and Intakes Improvement Project
11	B.2(1)	Veterinary Services Strengthening and Livestock Raising Improvement Project
12	B.3(1)	Community Inland Fisheries Development Project
13	B.4(1)	Income Generation Projects for Marginal Farmers
Subject-wise Improvement Plan		
14	C.1(1)	Coordination between MOWRAM and MAFF Strengthening Project
15	C.1(2)	Provincial Departments Strengthening Project
16	C.2(1)	Livestock Sub-sector Development Study
17	C.3(1)	Technical Guidelines Preparation Project
18	C.4(1)	Environmental Management Basic Capacity Development Project
19	C.4(2)	Environmental Management Applied Capacity Development Project
20	C.5(1)	Irrigated Agriculture On-Farm Technology Improvement Pilot Project
21	C.6(1)	Irrigation Facility Maintenance Capacity Strengthening Pilot Project
22	C.7(1)	Rainfed Agriculture Improvement Pilot Project
23	C.8(1)	Community Inland Fisheries Development Pilot Project
24	C.9(1)	River Basin Effective Water Use Awareness Raising Project
25	C.10(1)	Institutional and agricultural Support Services Strengthening Project
26	C.11(1)	Hydrological Observation Strengthening Project
27	C.11(2)	Flood Forecasting and Warning Study

Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008
Remarks;
Zone-1: Priority upstream area with 80% irrigation dependability commanded by Roleang Chrey Irrigation System
Zone-2: Downstream area with 50% irrigation dependability commanded by Roleang Chrey Irrigation System
Zone-3: Water harvesting area with small scale irrigation system outside of Roleang Chrey Irrigation System
Zone-4: Rainfed area without irrigation facilities

AA-2.3.3 Hydrology

The hydrological conditions in RCHRSP area up to 2005 are summarized by previous study reports as below.

(1) Rainfall

There are one automatic and 17 ordinary rainfall gauging stations in and around the Prek Thnot River basin. The automatic gauging station was established at Kampong Speu PDOWRAM office in 2000.

According to the rainfall data, average annual rainfall from 2001 to 2004 in the Prek Thnot River basin is 1,225 mm. The seasonal distribution is divided into the rainy season from May to November and the dry season from December to April. The rainy season accounts for about 90% of the annual rainfall. Most of rain is showery and the heaviest annual rainfall occurs in the southwest of the Prek Thnot River basin.

(2) Water Level and Discharge

There were 3 water level gauging stations on the Prek Thnot River as of 2005: Peam Khley, Thnuos Luong and Roleang Chrey. Peam Khley station records the water level during the longest period from 1997 to 2005. Using the observed water levels and the H-Q curve, the estimated monthly discharges are as shown in Table AA-2.3.3.1.

Table AA-2.3.3.1 Summary of Monthly Discharge at Peam Khley

(Unit: MCM)

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

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

AA-2.3.4 Agricultural Development Plan

In the M/P Study, the agricultural development plan consisting of objectives, plan and strategies was elaborated for respective zones. Out of four zones, those for Zone-1 which aims at 80% dependability irrigation, is closely related to the Project.

(1) Zone-1

(a) Development Objectives and Plan

The development objective of Zone-1 is to improve the agricultural productivity by well-harmonized development of agriculture, irrigation and drainage and the relevant institutions. As the targeted indexes, the following are proposed:

Table AA-2.3.4.1 Proposed Cropping Pattern and Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	Area (Intensity)	Crop	Area (Intensity)	Crop	Area (Intensity)
Early Rice	500ha (9%)	Early Rice	500 ha (9%)	Early Rice	1,000 ha (18%)
		Medium Rice	5,160 ha (91%)	Medium Rice	5,160 ha (91%)
Upland Crops	280 ha (5%)			Upland Crops	280 ha (5%)
Total	780 ha (14%)		5,660 ha (100%)		6,440 ha (114%)

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

Table AA-2.3.4.2 Target Crop Yields

Early Rainy Season				Rainy Season			
Crop	Yield (t/ha)			Crop	Yield (t/ha)		
	Target	Present	Increment		Target	Present	Increment
Early Rice	3.30	2.40	0.90	Early Rice	3.30	-	-
Upland Crops	0.70	0.45	0.25	Medium Rice	3.00	2.00	0.90

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

(b) Development Strategies

- Improvement of productivity and increased production of rice is envisaged through the introduction of: (i) a double cropping pattern for early rice to a limited extent and a single cropping of medium rice in the rainy season in the rest of the project area and (ii) improved farming and irrigation practices formulated on the basis of current farming practices which represent, to a certain extent, the capabilities of farming communities, farming constraints and farmers' expectations

- Improvement of productivity and increased production of rice is envisaged through the introduction of improved farming practices supported by the strengthening of agricultural support services employing the farmer participatory concept
- Introduction of water saving rice cultivation methods availing the expansion of the areas to be irrigated to the fullest extent possible through the efficient utilization of valuable water resources,
- The introduction of upland crop/vegetable production in about 5% of the project area in the early rainy season to increase land use intensity and promote crop diversification.

(2) Zone-2

(a) Development Objectives and Plan

The development objective of Zone-2 is the same with that of Zone-1. However, the targeted indexes are different due to the difference in the availability of water. The following are the proposed target indexes forZone-2:

Table AA-2.3.4.3 Proposed Cropping Pattern and Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	**Area (Intensity)**	**Crop**	**Area (Intensity)**	**Crop**	**Area (Intensity)**
Early Rice	1,600ha (14%)			Early Rice	1,600 ha (14%)
		Medium Rice	11,040 ha (100%)	Medium Rice	11,040 ha (91%)
Upland Crops	550 ha (5%)			Upland Crops	550 ha (5%)
Total	2,150 ha (19%)		11,040 ha (100%)		13,190 ha (119%)

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

Table AA-2.3.4.4 Target Crop Yields

Early Rainy Season				Rainy Season			
Crop	**Yield (t/ha)**			**Crop**	**Yield (t/ha)**		
	Target	**Present**	**Increment**		**Target**	**Present**	**Increment**
Upland Crops	0.70	0.45	0.25	Medium Rice	2,80	2.10	0.70

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

(b) Development Strategies

The strategies established for the attainment of the said development objectives in Zone-2 are similar to the case of Zone-1 and include:

- Improvement of productivity and increased production of rice is envisaged by the introduction of: (i) early rice to a limited extent in the early rainy season once in 2 years in accordance with the result of the water balance study (irrigable at 50% dependability) and a single cropping of medium rice over the entire area in the rainy season and (ii) improved farming and irrigation practices,

- Improvement of productivity and increased production of rice is envisaged through the introduction of improved farming practices supported by the strengthening of agricultural support services to initiate the farmer participatory concept,

- Introduction of water saving rice cultivation methods availing expansion of irrigation areas to the greatest extent possible, and

- Introduction of upland crop/vegetable production in about 5% of the project area in the early rainy season to increase land use intensity and promote crop diversification.

(3) Zone-3

(a) Development Objectives and Plan

The development objective of Zone-3 is the same with that of Zone-1. However, the targeted indexes are different due to the more severe water environment. The following are proposed target indexes for Zone-3:

Table AA-2.3.4.5 Proposed Cropping Pattern and Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	**Area (Intensity)**	**Crop**	**Area (Intensity)**	**Crop**	**Area (Intensity)**
		Medium Rice	1,200 ha (100%)	Medium Rice	1,200 ha (100%)
Upland Crops	60 ha (5%)			Upland Crops	60 ha (5%)
Total	60 ha (5%)		1,200 ha (100%)		1,260 ha (105%)

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

Table AA-2.3.4.6 Target Crop Yields

Early Rainy Season				Rainy Season			
Crop	**Yield (t/ha)**			**Crop**	**Yield (t/ha)**		
	Target	**Present**	**Increment**		**Target**	**Present**	**Increment**
Upland Crops	0.70	0.45	0.25	Medium Rice	2.80	2.10	0.70

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

(b) Development Strategies

The strategies established for the attainment of the said development objectives in Zone-3 are similar to the cases of Zones-1 and -2 and include:

- Improvement of productivity and increased production of rice is envisaged through the introduction of improved farming and irrigation practices,
- Improvement of productivity and increased production of rice is envisaged by the strengthening of agricultural support services utilizing the farmer participatory concept,
- Introduction of water saving rice cultivation methods availing the expansion of the irrigation areas to the greatest extent possible, and
- Envisaging the introduction of upland crops/vegetable production in about 5% of the project area in the early rainy season to increase land use intensity and promote crop diversification.

(4) Zone-4

(a) Development Objectives and Plan

The study on the development approaches directed to Zone-4, which consists of rainfed paddy fields, has resulted in ambitious proposals and will present a number of controversial issues. However, for the attainment of the master plan target of improvement of agricultural productivity in the Target Area, the improvement of rainfed agriculture should be duly sought through the integrated interventions of agronomic, extension and farmer organizational approaches. The following are proposed target indexes for Zone-4:

Table AA-2.3.4.7 Proposed Cropping Pattern and Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	**Area (Intensity)**	**Crop**	**Area (Intensity)**	**Crop**	**Area (Intensity)**
		Medium Rice	23,380 ha (100%)	Medium Rice	23,380 ha (100%)
Upland Crops	230 ha (1%)			Upland Crops	230 ha (1%)
Total	230 ha (1%)		23,380 ha (100%)		23,610 ha (101%)

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

Table AA-2.3.4.8 Target Crop Yields

Early Rainy Season				Rainy Season			
Crop	Yield (t/ha)			Crop	Yield (t/ha)		
	Target	Present	Increment		Target	Present	Increment
Upland Crops	0.45	-	-	Medium Rice	2,00	1.50	0.50

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

(b) Development Strategies

The strategies established for the attainment of the said development objectives in Zone-4 include:

- Improvement of productivity and increased production of rice is envisaged by the introduction of improved farming practices; in this regard, the expansion of modified system of rice intensification (SRI) in Kampong Speu Province as proposed earlier and the promising results obtained in the SRI fields indicate the possibility of the attainment of the objectives,
- Improvement of productivity and increased production of rice supported by the strengthening of agricultural support services is envisaged (the approach for strengthening includes training and deployment of village agriculture agents),
- The introduction of upland crop/vegetable production in the early rainy season to a very limited extent in a pilot scale as a trial step for crop diversification in the future,
- In the present Study, the development intervention is formulated as the “Rainfed Agriculture Improvement Project”, and
- The proposed intervention is the strengthening of agricultural support services in the zone implemented by MAFF/PDA in collaboration with NGOs and supported by experts.

AA-2.3.5 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) NMC and 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 AA-2.3.5.1 Irrigation Area by Different Dependability of Prek Thnot River Basin

Zone	Definition	Net irrigable Area
Zone-1	Irrigated by Prek Thnot River with 80% dependability	5,660 ha
	(UNMC Area)	(2,210 ha)
	(USMC Area)	(3,450 ha)
Zone-2	Irrigated by Prek Thnot and Ou Krang Ambel Rivers with 50% dependability	11,040 ha
	(LNMC Area)	(4,290 ha)
	(LSMC Area)	(6,750 ha)
Zone-3	Irrigated by Water Harvesting Pond with 50% dependability	1,200 ha
Zone-4	Rainfed area=23,380 ha	-
	Total of Zone-1 to Zone-4 = 41,280 ha	Total irrigable area=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 two types, which were (i) irrigated agriculture model project and (ii) zone-wise irrigated agriculture improvement projects in five areas (UNMC and USMC in Zone-1, LNMC and LSMC Areas and Ou Krang Ambel Area in Zone-2) as summarized below.

Table AA-2.3.5.2 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 FWUC/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

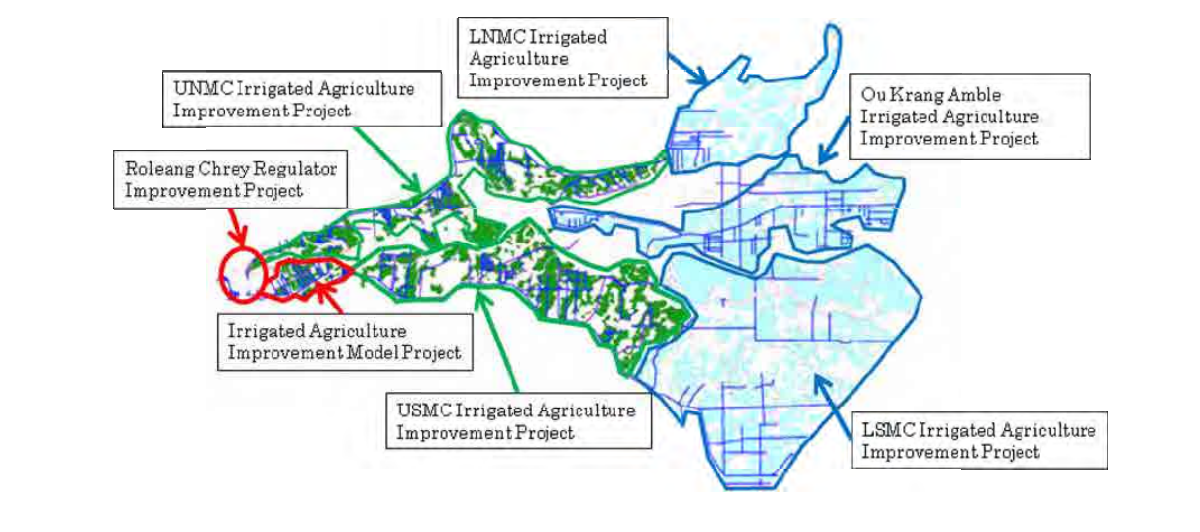
(3) Improvement of Roleang Chrey Headworks

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 two 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 AA-2.3.5.3 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



Source： Prepared by JICA Survey Team based on the Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008

Figure AA-2.3.5.1 Location of Irrigation Improvement Plans in M/P on Comprehensive Agricultural Development of Prek Thnot River Basin

AA-2.3.6 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 AA-2.3.6.1 Required Agricultural Support Services

Activity	Program Required
Field Extension Programs	Rice: Plot & area demonstration, adaptability test, seed multiplication 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

As shown in the table, the introduction of village extension agents like Village Livestock Agents (VLAS) is envisaged as farmer-to-farmer extension providers.

AA-2.3.7 FWUC Formation and Strengthening

In order to execute properly water management and O&M at minor canal level by FWUC, the following strengthening plan is proposed in the M/P Study:

(1) Precise Structure and Responsibilities

Presently, the canal system is not completed, so that the responsibilities of the FWUC are not clear although the "Policy for Sustainability of Operation and Maintenance Irrigation System, June 2000" is available. After completion of proper irrigation systems, the following structure and responsibilities are proposed:

Table AA-2.3.7.1 Proposed Structure and Responsibilities

In-charge	Canal Level	Responsibilities
Government	Headworks/Main canal	O&M of headworks and main canal, and control of gates to secondary canal
FWUC	All canals below secondary canal	Management of FWUGs, Sub-FWUGs and WUGs on O&M of all canals below secondary canal

In-charge	Canal Level	Responsibilities
FWUG	Secondary canal	O&M of secondary canals and control of gates to tertiary canal
Sub-FWUG	Tertiary canal	O&M of tertiary canal and control of gates to watercourse
WUG	Watercourse	O&M of watercourse and control of water distribution to each field

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

(2) Formation of FWUC, FWUG and WUG Considering Tragic History

Formation of FWUC, FWUG, Sub-FWUG and WUG should be carried out carefully keeping the tragic history in mind. The results of various surveys have made it clear that Village Chiefs, Commune Chiefs/Councils and Village Development Committee (VDC) members are playing important roles for smooth formation of the FOs. Village Chiefs, Commune Chiefs/Councils and VDC members are representatives selected from the village people. This is one of the reasons for their success. Formation/strengthening of FWUC, FWUG, Sub-FWUG and WUG should therefore involve them from the beginning stage.

(3) Clear Sharing of Roles of FWUC, FWUG and WUG

The proposed roles of FWUC, FWUG and WUG are as follows:

Table AA-2.3.7.2 Proposed Roles of FWUC, FWUG and WUG

Name of Organization	Membership	Activities
FWUC	- Farmers' representatives from various levels of the irrigation	- Adhering to the decisions made by the steering committee of FWUC
Steering committee of FWUC	- Leaders of FWUGs - Secretary - Accountant	- Solving water conflicts as a federation of FWUGs - Preparation of Irrigation Service Plan
FWUG	- FWUG members	- Attending general meetings - Execution of O&M of secondary canal system
Steering committee of FWUG	- Leaders of Sub-FWUGs - Secretary - Accountant	- Preparation of O&M plan of secondary canals - Convening FWUG members for general meetings
Sub-FWUG	- Leaders of WUGs	- Preparation of O&M plan of tertiary canal - Execution of O&M plan of tertiary canals
WUG	- Land owners/tenants whose land is located in the irrigated area	- Discussing and determining the turns of irrigation water use - Removal of sediments and the other obstacles in watercourses - Collection of ISF from WUG members under FWUC

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

(4) Timely Participation of Beneficial Farmers

Participation of beneficial farmers should be made from the design stage in order to ensure their awareness of the project. Canal layout should be determined under the mutual understanding of the government and beneficial farmers through workshops including Village Chiefs, Commune Chiefs/Councils and VDC members.

(5) Participation of Beneficiary Farmers at Construction Stage

WUG should construct the watercourses under the technical support of PDOWRAM. This activity should also be undertaken with mutual understanding established through workshop including Village Chiefs, Commune Chiefs/Councils and VDC members.

(6) Collection of Irrigation Service Fees

Collection of ISF should be made based on the water request form in which name of farmers, plot area, amount to be paid, kind of crops, and WUG No. should be mentioned. This water request form should be given his finger print, signed by WUG leader and approved by FWUC leader. Each farmer should pay ISF to WUG leader based on this water request form.

AA-2.3.8 Project Cost and Evaluation

(1) Project Cost

Based on the basic conditions and assumptions, the project cost including price contingency is estimated at US$ 75,153,000.

Table AA-2.3.8.1 Project Cost

(Unit US$ 1,000)

		Projects/Studies	Total Cost
Scheme-wise Improvement			
Zone-1			
1	A.1(1)	Irrigated Agriculture Improvement Model Project	1,679
2	A.1(2)	Upper North Main Canal Irrigated Agriculture Improvement Project	11,332
3	A.1(3)	Upper South Main Canal Irrigated Agriculture Improvement Project	9,871
Zone-2			
4	A.2(1)	Lower North Main Canal Irrigated Agriculture Improvement Project	3,190
5	A.2(2)	Lower South Main Canal Irrigated Agriculture Improvement Project	15,183
6	A.2(3)	Ou Krang Ambel Irrigated Agriculture Improvement Project	7,219
Zone-3			
7	A.3(1)	Water Harvesting Irrigated Agriculture Improvement Project	7,427
Zone-4			
8	A.4(1)	Rainfed Agricultural Improvement Project	2,975
Zones Crosscutting			
9	B.1(1)	Roleang Chrey Regulator Gates Urgent Improvement Project	75
10	B.1(2)	Roleang Chrey Regulator and Intakes Improvement Project	4,786
11	B.2(1)	Veterinary Services Strengthening and Livestock Raising Improvement Project	377
12	B.3(1)	Community Inland Fisheries Development Project	413
13	B.4(1)	Income Generation Project for Marginal Farmers	679
Sub-total			65,206
Subject-wise Improvement			
14	C.1(1)	Coordination between MOWRAM and MAFF Strengthening Project	98
15	C.1(2)	Provincial Departments Strengthening Project	330
16	C.2(1)	Livestock Sub-sector Development Study	1,551
17	C.3(1)	Technical Guidelines Preparation Project	1,725
18	C.4(1)	Environmental Management Basic Capacity Development Project	70
19	C.4(2)	Environmental Management Applied Capacity Development Project	520
20	C.5(1)	Irrigated Agriculture On-farm Technology Improvement Pilot Project	800
21	C.6(1)	Irrigation Facility Maintenance Capacity Strengthening Pilot Project	909
22	C.7(1)	Rainfed Agriculture Improvement Pilot Project	100
23	C.8(1)	Community Inland Fisheries Development Pilot Project	110
24	C.9(1)	River Basin Effective Water Use Awareness Raising Project	633
25	C.10(1)	Institutional and agricultural Support Services Strengthening Project	2,928
26	C.11(1)	Hydrological Observation Strengthening Project	53
27	C.11(2)	Flood Forecasting and Warning Study	120
Sub-total			9,947
Total			75,153

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

(2) Economic Evaluation

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

Table AA-2.3.8.2 Economic Irrigation and Drainage Benefit of 9 Evaluated Projects

Evaluated Projects/Sets of Projects		EIRR (%)	NPV in Million Riel (7% discount rate)			
			Benefit	Cost	B-C	B/C
(a)	RCP	13.6	21,996	15,560	6,436	1.4
(b)	RCP + UNMCP	4.7	31,216	39,149	-7,933	0.8
(c)	RCP + OKAIAIP	9.4	38,098	30,715	7,383	1.2
(d)	RCP + UNMCP + OKAIAIP + LNMCP	6.2	55,367	60,785	-5,418	0.9
(e)	RCP + IAIMP	10.6	26,232	20,513	5,719	1.3
(f)	RCP + IAIMP + USMCP	6.2	37,430	40,637	-3,207	0.9
(g)	RCP + IAIMP + USMCP + LSMCP	7.4	73,866	70,414	3,472	1.0
(h)	WHP	0.4	5,216	15,766	-10,550	0.3
(i)	Rainfed	17.6	35,032	8,762	26,270	4.0

Note:
RCP: Roleang Chrey Regulator and Intake Improvement Project
UNMCP: Upper North Main Canal Irrigated Agriculture Improvement Project
USMCP: Upper South Main Canal Irrigated Agriculture Improvement Project
IAIMP: Irrigated Agriculture Improvement Model Project
OKAIAIP: Ou Krang Ambel Irrigated Agriculture Improvement Project
LNMCP: Lower North Main Canal Irrigated Agriculture Improvement Project
LSMCP: Lower South Main Canal Irrigated Agriculture Improvement Project
WHP: Water Harvesting Irrigated Agriculture Improvement Project

AA-2.3.9 Results of Verification Study on Paddy Cultivation

Verification tests were carried out during the period from 2006/2007 to 2007/2008, in order to confirm whether the target yields and cropping pattern of M/P are achievable by introducing improved farming practices or not. While, 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. Outlines of two kinds of tests mentioned above are shown as follows:

Table AA-2.3.9.1 Outline of Verification Test

Season / Crops	2006/07		2007/08		Remarks
	No.	Period	No.	Period	
Early rainy season	-	-	-	-	
- Early rice	-	-	4 plots	Apr. to Aug.	
- Upland crops	-	-	1 plot	May to Jul.	Mung beans
Rainy season	-	-			
- Early rice	-	-	2 plots	Aug. to Dec.	Double cropping (early – early)
- Medium rice	-	-	2 plots	Jul. to Dec.	Double cropping (early – medium)
- Early rice	2 plots	Jul. – Nov.	-	-	Single cropping
- Medium rice	4 plots	Jul. – Dec.	1 plot	Jul. to Dec.	Single cropping

Source: Chapters BII-4 and CI-4, Parts B and C, Volume IV Pilot Projects, Final Report on Comprehensive Agricultural Development of Prek Thnot River Basin 2008

Table AA-2.3.9.2 Outline of Small Scale Adaptability Test

Season / Crops	Rainy Season in 2006/07		Rainy Season in 2007/08	
	Trial Components	Period	Trial Components	Period
Medium rice	- Variety trial	Jul. to Dec.	- Planting method	Jul. to Dec.
	- On-farm water management	Jul. to Dec.	- On-farm water management	Jul. to Dec.
	- Seeding rate & planting method	Jul. to Nov.	- Fertilizer trial	Jul. to Dec.
Early rice	- Variety trial	Jul. to Dec.	- Planting method	Jul. to Nov.
	- On-farm water management	Jul. to Dec.		
	- Seeding rate & planting method	Jul. to Nov.		

Source: Chapters BII-4 and CI-4, Parts B and C, Volume IV Pilot Projects, Final Report on Comprehensive Agricultural Development of Prek Thnot River Basin 2008

Yield of verification tests in 2 years were compared with the target yield of M/P as follows:

Table AA-2.3.9.3 Yield Comparison with Target Yield in Verification Tests

Season / Crops	2006/07		2007/08	
	Target Yield (ton/ha)	Yield obtained in the Test (ton/ha)	Target Yield (ton/ha)	Yield obtained in the Test (ton/ha)
Early rainy season	-	-	-	-
- Early rice	-	-	3.3	3.8 to 4.7
- Upland crops	-	-	0.7	0.53*
Rainy season	-	-		
- Early rice (double cropping)	-	-	3.3	3.7 (3.4 to 4.0)
- Medium rice (double cropping)	-	-	3.0	3.5 (3.1 to 3.7)
- Early rice (single cropping)	3.0	4.0	-	-
- Medium rice (single cropping)	3.0	4.0 (3,2 to 4.8)	3.0	3.6

*: *This lower yield rather than the target might be attributed mainly to wet injury due to heavy rain, inundation for a short period in the initial growth stage, and occasional water shortage during a growing period.*
Source: Chapters BII-4 and CI-4, Parts B and C, Volume IV Pilot Projects, Final Report on Comprehensive Agricultural Development of Prek Thnot River Basin 2008

As shown in the above table, all the verification plots attained yield levels of equal or higher than the target of the master plan. However, the average yield of the medium variety in 2007/2008 decreased by 0.5 ton/ha from that of 4.0 ton/ha at the verification plots in 2006/2007, while the yield of the early variety in 2007/2008 decreased by 0.3 ton/ha from that of 4.0 ton/ha in the verification plots in 2006/2007. Meanwhile results of the small scale adaptability test carried out during the rainy season in 2006/2007 are shown as follows;

Table AA-2.3.9.4 Results of Small Scale Adaptability Test in 2006/2007

Trial/Variety		Treatment	Crop Cut Yield (ton/ha)	Whole Plot Yield (ton/ha)
(1) Medium Rice				
	Variety Trial	Phka Rumchang	3.6	-
		Phka Rumduol	3.9	3.8
		Riang Chey	5.9	3.9
	On-farm Water Management (Riang Chey)	Continuous intermittent	4.7	3.7
		Intermittent in vegetative stage	5.9	4.4
		Continuous flooding	5.1	3.2
	Seeding Rate & Planting Method (Riang Chey)	40 g/m^2 & 2-3 plants/hill	5.5	5.4
		60 g/m^2 & 2-3 plants/hill	5.8	5.7
(2) Early Rice				
	Variety Trial	IR 66	5.4	5.9
		Sen Pidao	5.9	4.5
		IR Kesar	5.2	4.5
	On-farm Water Management (Riang Chey)	Continuous intermittent	5.2	4.1
		Intermittent in vegetative stage	6.1	4.4
		Continuous flooding	5.6	4.9
	Seeding Rate & Planting Method (Riang Chey)	40 g/m^2 & 1 plant/hill	6.1	5.1
		40 g/m^2 & 2-3 plants/hill	5.7	4.6

Note: Trial plot on medium variety in RT2 was suffered from inundation occurred from August 17 to 20 at 1 week after transplanting and was under complete inundation for about 2.5 days. After the inundation, rice plants recovered well and excellent growth was observed. However, from around the middle of vegetative growth, infestation of stem borer became serious and the results of trial were affected seriously by the incident.
Source: Chapters BII-4, Part B, Volume IV Pilot Projects, Final Report on Comprehensive Agricultural Development of Prek Thnot River Basin 2008

Furthermore, results of the small scale adaptability test carried out during the rainy season in 2007/2008 are shown as follows;

Table AA-2.3.9.5 Results of Small Scale Adaptability Test in 2007/2008

Trial/Variety		Treatment	Crop Cut Yield (ton/ha)	Whole Plot Yield (ton/ha)
(1) Medium Rice				
	Planting method (Riang Chey)	1 plant/hill 2 plants/hill 3 plants/hill 4 plants/hill 5 plants/hill	4.4 5.4 3.9 4.3 4.8	3.7 3.8 4.0 3.8 3.9
	Planting method (Sen Pidao)	1 plant/hill 2 plants/hill	3.1 2.7	- -
		3 plants/hill 4 plants/hill 5 plants/hill	2.5 2.4 2.4	- - -
	On-farm water management 1/ (Riang Chey)	Continuous intermittent Intermittent in vegetative phase Continuous flooding	5.1 4.3 4.9	4.3 4.0 3.9
	Fertilization trial 1/ (Riang Chey)	Manure 10 ton/ha only Manure 5 ton/ha only Manure 2.5 ton/ha + fertilizer Fertilizer only	4.6 4.2 4.5 4.6	4.2 3.8 4.3 4.3
(2) Early Rice				
	Planting Method (IR 66)	Regular planting Random planting Seedling broadcasting	4.7 ~ 4.8 4.1 ~ 4.8 4.1 ~ 4.4	4.7 4.5 4.3
		Direct sowing (under puddled condition)	4.1 ~ 4.9	4.5

Source: Chapters CI-4, Part C, Volume IV Pilot Projects, Final Report on Comprehensive Agricultural Development of Prek Thnot River Basin 2008

AA-2.4 Roleang Chrey Regulator and Intakes Improvement Project (Feasibility Study)

AA-2.4.1 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 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 two 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.

AA-2.4.2 Project Works

The project works of the Roleang Chrey Regulator and Intakes Improvement Project in F/S consisting of (i) construction works, (ii) engineering services and (iii) environmental monitoring. The construction works were divided into (i) Roleang Chrey Regulator, (ii) Andong Sla Intake and (iii) Vat Krouch Intake. In preparing the improvement plan of the project, the following points were taken into account. These were (i) maximum use of the existing facility, (ii) easy maintenance, (iii) easy operation, (iv) ensuring of the safety of the regulator and (v) smooth release of required discharge to downstream area.

The components their proposed works of the improvement of the Roleang Chrey Headworks are summarized in the table below.

Table AA-2.4.2.1 Summary of Proposed Project Works in F/S

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

AA-2.4.3 Project Design

Table AA-2.4.3.1 shows summary of design of the proposed project facilities.

Table AA-2.4.3.1 Summary of Design of the 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) Type: Apron with baffle blocks and end sill Length: 23.48 m Backfill concrete and riprap protection
- Provision of retaining wall	Type : Inverted T-shape retaining wall Length : 23.48 m length Height : 11~12 m Embankment supported by retaining wall and riprap protection
Hydro-mechanical Works	
- Construction of by-pass	Capacity: 10 m^3/sec Type: by-pass with inlet, pipe conduit and stilling basin Inlet: equipped with 2 slide gates of four sealing edges Pipe conduit : 2 pipes (Dia=1.0 m. L= 92.42 m) 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 : - replacement of bearing metals by oil less bearings - wheel shafts by corrosion resisting steel shafts Painting of gate leaves Replacement of rubber seals Renewal of hoist
Andong Sla Intake	
Civil Works	
- Intake gate	Capacity : 10.4 m^3/sec (6,500 ha) 25.1 m^3/sec (15,680 ha) - To install two of the four gates to ensure the discharge of 10.4 m^3/sec in this study - To provide a concrete wall for the remaining two gates, so as to enable the installation of a gate in each in the future

Works	Designed Details
- Retaining wall	Type : Reinforced concrete 6.4 m (H) × 7.5 m (W) × 1 set
- Gate Piers	Reinforced concrete L= 10.2 m H=5.4 m 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 Height 4.80 m Design head 4.50 m Hoist Electric driven wire rope winding hoist, one motor two drums 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) 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 Double box type: H=4.6 m, W=4.0 m 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 Quantity: Gate and hoist: 2 Guide frame for stoplog; 2 Stoplog leaf: 1 Clear span: 4.000 m Height: 5.000 m Design head: 4.720 m Hoist Electric driven wire rope winding hoist, one motor two drums Control system 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

AA-2.4.4 Implementation, Operation and Maintenance

(1) Implementation

The project works are composed of four 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, 4 months for tendering. For the implementation of the project, MOWRAM was proposed to be the overall executing agency, and its engineering departments would be responsible for the design and construction stages. For effective construction supervision, it was proposed to establish a construction office at Kampong Speu PDOWRAM.

(2) Operation and Maintenance

Upon completion of construction works, the Kampong Speu PDOWRAM, under the support of the Department of Irrigated Agriculture, would be directly in-charge of the 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.

In the operation plan for Roleang Chrey Regulator, gate operation during both normal and flood conditions was explained. Under normal conditions, and proposed to control upstream water level to El.35.7 m. As for the intake gates of Andong Sla and Vat Krouch under normal condition, it was proposed that the operation be performed in accordance with the irrigation service plan. In order to undertake maintenance work effectively, the maintenance plan for the Roleang Chrey Headworks proposed (i) daily inspections, (ii) periodic inspections, (iii) an annual maintenance program, (iv) required maintenance work, and (v) emergency repairs.

AA-2.4.5 Project Cost and Evaluation

(1) Project Cost

The investment cost consisted of (i) engineering service cost, (ii) direct construction cost, (iii) administration cost, (iv) environmental monitoring cost, and (v) physical and price contingencies. The total investment cost was estimated at US$ 4,991 thousand equivalent to Riel 20,263 million. The summary of the project cost is shown in Table AA-2.4.5.1. The replacement cost for gates and accessories was estimated at US$ 1,374 thousand (Riel 5,579 million), which would be implemented on the 25th year upon completion of the improvement work. Annual O&M cost was estimated to be US$ 9,300 (Riel 38 million).

(2) Project Evaluation

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. The sensitivity analysis revealed at the project was relatively more sensitive to the benefit reduction rather than cost increase, though it can accommodate considerable changes in both these variables.

Table AA-2.4.5.1 Summary of Project Cost

Item	US$ (1,000$)	Riel equivalent (Million Riel)*[1]
Engineer Services	652	2,647
Construction Cost	2,943	11,949
Administration Cost	294	1,194
Environmental Monitoring	3	12
Sub-total	3,892	15,801
Physical Contingency	389	1,579
Price Contingency	710	2,883
Total	4,991	20,263

*Note: *[1]: US$ 1.0 = Riel 4,070 on Jan. 31, 2006*
Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin In the Kingdom of Cambodia, JICA, 2008

AA-2.4.6 Results of Environmental Assessment

In the process of preparation of various improvement plans, a number of environmental issues were investigated in order to implement the proposed project in a more environmentally friendly and sustainable manner. Initial environmental examination of the proposed project concluded as follows:

- As a whole, the development plan of the proposed project was judged as acceptable from an environmental viewpoint, if the proper mitigation measures presented would be undertaken.
- Some of the likely negative impacts on both the social and natural environments, such as limitations of access and water availability during construction, were identified. Therefore,

proper management with the proposed measures and monitoring plan should be implemented in order to avoid/mitigate the anticipated negative impacts.

AA-2.5 Roleang Chrey Regulator Improvement Project (Grant Aid)

AA-2.5.1 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.

AA-2.5.2 Project Works

MOWRAM proposed GOJ to assist the implementation of the rehabilitation of Roleang Chrey Headworks, consisting of the Roleang Chrey Regulator, the Andong Sla Intake and the Vat Krouch Intake. However, the rehabilitation of the Vat Krouch Intake was excluded from the grant aid scheme due to the reason that the prompt realization of the project effects would not be expected, because of the limited flow capacity of downstream of the canal unless the improvement of SMC would be executed. Finally, the following works were agreed between the JICA B/D Team and MOWRAM on November 21, 2007 as the Japan' grant aid scheme:

Table AA-2.5.2.1 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> The existing operator’s hut still function and there was enough space for a new control panel.
Reconstruction of the Intakes with Gates	
- Rehabilitation of the north approach channel to Andong Sla intake	<Excluded> 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> 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.
- Reconstruction of Vat Krouch intake with gates	<Excluded> At present, a gate operator operates gates manually without any serious problems. Necessity of urgent rehabilitation has been not observed.
- Construction of a power transmission line from the regulator to intakes	
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

AA-2.5.3 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 AA-2.5.3.1 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 Gate type : Steel roller gate Clear span: 12.5m Gate high: 6.7m Gate nos.: 5 sets	Replacement of wheel bushings and pins : 40 sets (8sets/gate × 5 gates) Rust removal and re-painting of gate leaf : 5 sets of gates Replacement of rubber seals : 5 sets of gates Replacement of all hoist systems : 5 sets (electric wire-rope winch type with counter weight) Replacement of local control panels : 5 sets Installation of new remote control panels at O&M office : 1 set (including main distribution panels, distribution panels for room lighting connection cables between control panels and hoist system) Installation of lightning arrestors: 3 sets Installation of staff gauge: 5 sets Core-drilling and recovery work on gate piers: 10 locations (Dia. 40 cm × L 50 cm)
- Construction of the downstream river bed protection	Additional ground sill consolidation work : W 72.5 m × L 8 m × H 1.25 m Grouted riprap work : W 40 m × L 42 m × Thickness 0.5 m
- Rehabilitation of the downstream river bank protection	Toe foundation work : W 2 m × H 2m × L 110 m (right bank), L 90 m (left bank) 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 Outlet : W 4.0 m × H 4.7 ~ 6.0 m × L 10.9 m Culvert : Double lane concrete pipes Dia. 1.0 m × L 83 m Manufacturing and Installation of new steel slide gates: 4 sets (total) (Clear span 1.0 m × H 1.0 m, 4 edge-rubber seal, manual operation hoist system with rack pinion/ screw spindle type. Discharge regulation gate: 2 sets, Maintenance gate: 2 sets)
Reconstruction of Andong Sla Intake	
- Reconstruction of the intake	Curtain walls: W 4.0 m × H 2.5 m × 2 nos. (w/new gate sections) W 4.0 m × H 5.2 m × 2 nos. (gate-dismantled sections) Operation deck: W 2.0 m × Clear span 4.0 m × 4 nos. Upstream Transition work: W 18.6~43 m × H 5.2 m × L 5 m Downstream river bed protection work: W 18.6 ~ 33.8 m × Thickness 0.5 m
- Replacement of gates Gate type : Steel radial gate Clear span: 4.0m Gate high: 2.7m	Removal of existing steel radial gates : 4 sets Manufacturing and Installation of new steel radial gates: 2 sets (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

AA-2.5.4 Construction Method

During the B/D Stage and the D/D Stage, the construction methods were examined and finally determined as summarized below both for civil and hydro-mechanical works.

(1) Roleang Chrey Regulator

(a) Temporary diversion work

The work method of temporary diversion was determined by the comparative study of (i) river course diversion plan, (ii) temporary coffer dam plan and (iii) partial closure plan. As a result, the temporary coffer dam plan was selected, in which the existing north approach channel with capacity of about 70 m^3/sec was to be utilized instead of the newly constructed temporary diversion channel. For the protection of said approach channel, a temporary spillway with related facilities with capacity of 40 m^3/sec was planned to be newly constructed on the north approach channel. The water cut-off period would not be implemented during the rainy season of May to November, while it should be implemented during the dry season of December to April.

(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 as follows;

- Temporary diversion works, as above
- Drilling 10 holes (diameter 40 cm and length 50 cm) in the concrete piers of the regulator
- Removal of wheels, bushings and pins through the drilled holes
- Measurement of bushings and pins
- Manufacturing of new bushings and pins from makers after size measurement
- Rust removal and repainting of gate leaves and replacement of rubber seals
- Insertion of new bushings into the existing wheels
- Installation of existing wheel with new bushings and pins on the gate leaf
- Removal of temporary diversion works

(2) Andong Sla Intake

The intake structure should be reconstructed to recover the function of the intake gates, and all the four sets of the existing gates were to be demolished and new two sets of manual radial gates were planned to be installed. Since design discharge of the intake gates is 10.4 m^3/sec, four sets of the existing gates should be dismantled and two sets of new radial gates should be installed at the center of the intake. The work method planned in B/D was as below.

- A temporary diversion channel and temporary coffer dams were to be provided for the intake in order to maintain the irrigation water supply to the north main canal.
- After dismantled the four sets of the existing gates and vertical wall at the upstream of the intake gates, the side wall, guide wall and base slab should be additionally constructed at the upstream of the intake gates, and the existing operation bridge should be re-used.
- Two sets of new radial gates should be replaced.
- At the right and left spaces, reinforced concrete curtain walls should be constructed in place of the dismantled two gates.
- Since the downstream canal bed has been partially scoured, the repair with grouted riprap should be carried out for the dented place.
- The temporary diversion should be removed.

AA-2.5.5 Organization for Construction

In the implementation plan, MOWRAM will be responsible for the implementation of the project and the implementing agency would be the National Project Management Office (NPMO) including the Project Management Unit (PMU) for North Western Area that was established in October 2007. When the Exchange of Notes (E/N) was signed, MOWRAM took care of overall procedures necessary for the implementation of the project. It was planned that a Japanese consulting firm, recommended by

JICA and entrusted by MOWRAM be the project consultant including detailed design and construction supervision. NPMO was planned to be responsible for the Land acquisition and arrangements to get necessary measures against the water cut-off.

AA-2.5.6 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

(a) Direct Effect

The direct effects by the improvement of Roleang Chrey Headworks are as follows:

- The present agricultural productivity of irrigated rainy season paddy of 2.3～2.4 tons/ha and gross farmers' income of US$ 450～US$ 590 /household (HH) will be maintained due to a stable water supply to about 10,000 ha through the improvement of the regulator.
- The stable irrigation water supply with a discharge of about 5 m^3/sec will become possible to Kandal Steung irrigation area of about 1,950 ha (located at about 40 km downstream of the regulator) through the construction of the river outlet structure.
- 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 Andong Sla intake.
- 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.
- 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.

(b) Other Effect

The indirect effects of the project are to contribute to poverty alleviation in the rural area, and stable rice supply in Cambodia, by maintaining present agricultural productivity and farmers' income. In addition, the major irrigation facilities to be improved under the project will become irrigation infrastructures, which will have possibility of increasing agricultural production of irrigated rainy season paddy and farmers' income through future improvement of water management and farming practice.

AA-2.5.7 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.

AA-2.6 The Study on the Rehabilitation and Reconstruction of Agriculture Production System in the Slakou River Basin (Master Plan Study)

AA-2.6.1 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. The Study Area 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 as shown in Figure AA-2.6.1.1.

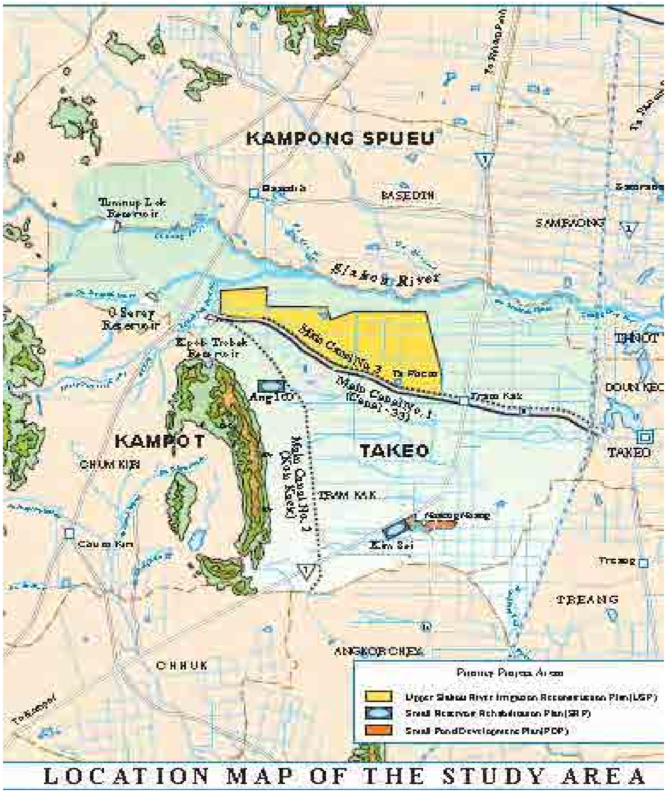


Figure AA-2.6.1.1 Location of Master Plan Study Area

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 the Kingdom of Cambodia.

AA-2.6.2 Project Components

The project aims at: (i) rehabilitating the existing facilities constructed during Pol Pot regime, (ii) improving self-sustainable organization for operation and maintenance to increase agricultural productivities and farmers' income, and a model project for reconstruction of small and medium scale irrigation system widely distributed in the county. The following are the project components studied in M/P:

- Agricultural production program including agriculture support program;
- Irrigation-based development consisting of rehabilitation and reconstruction of irrigation and drainage infrastructures, rural road improvement program and institutional development program, and
- Environmental conservation program

AA-2.6.3 Hydrology

As mentioned above, the M/P Study and F/S for USISRSP were carried out in the period from 2001 to 2002. The results of hydrological study for USISRSP conducted in M/P and F/S are summarized as follows:

(1) Rainfall

There was one rainfall observation station at Takeo PDOWRAM office. The station recorded the rainfall data during the period from 1982 to 2000. According to the record, average annual rainfall is about 1,200 mm. About 90% of rain is concentrated in the rainy season and its peak occurs in October. Rainfall is characterized by erratic and local rainfall pattern. Consequently, spatial correlation in the short term is low.

(2) Water Level and Discharge

There were no available data on water level and discharge in the Slakou River system. Only the Prek Thnot River, a neighboring basin of the Slakou River basin, has the discharge records estimated by the observed water levels and the H-Q curve. Both basins are totally located in the eastern slope of the Elephant Mountains and rainfall patterns are almost similar to the both basins. The topographic conditions and land use patterns are also similar. Thus the Slakou River runoff was estimated by analyzing the relationship between runoff of the Prek Thnot River and rainfall, taking into account variation in rainfall pattern influenced by mountains, and flow characteristics of the Slakou River, especially in the dry season.

The runoff estimate was made on a monthly basis for 20 years from 1966 to 2000 except lack of observation for some years. The simulated runoff compared with actual one is shown in Figure AA-2.6.3.1. From this figure, it could be said that the actual and simulated discharges are almost in the similar pattern.

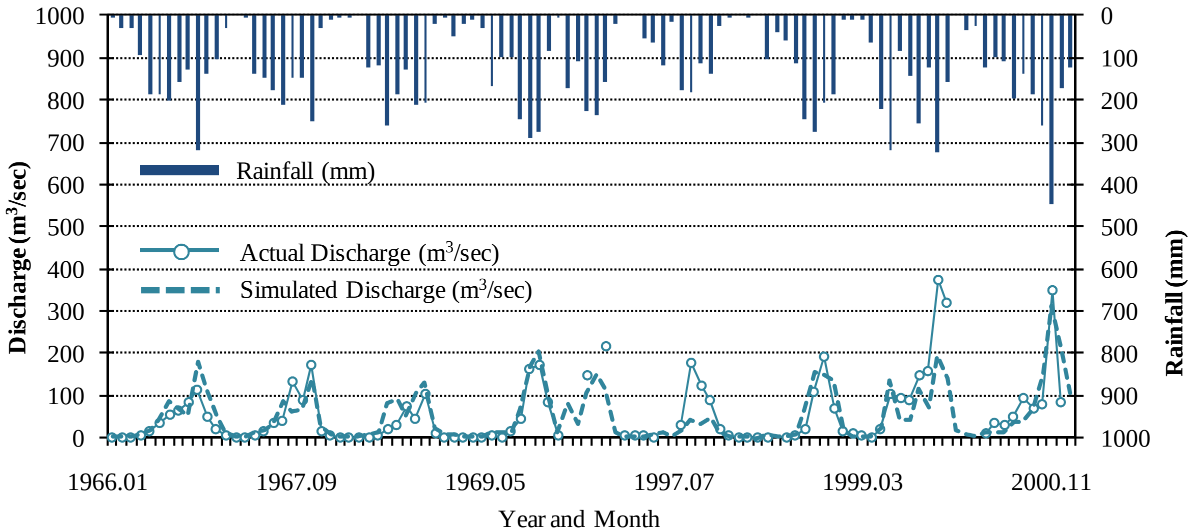


Figure AA-2.6.3.1 Comparison between Actual and Simulated Runoff by Rainfall Distribution Method in Prek Thnot River

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

Based on above model, the runoff of two tributaries at the existing reservoir sites is estimated as shown in Table AA-2.6.3.1.

Table AA-2.6.3.1 Estimated Discharge at two Reservoirs' Sites at Recurrence Period of Five Years and Two Years

(Unit: m^3/sec)

Reservoir	Return Period	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
Kpob Trobek	5 years	0.08	0.04	0.02	0.01	0.01	0.01	0.32	0.47	2.25	1.84	1.19	0.30	0.55
	2 years	0.13	0.06	0.03	0.01	0.01	0.47	0.56	1.15	3.24	4.60	1.88	0.53	1.06
Tumnup Lok	5 years	0.16	0.10	0.06	0.01	0.01	0.01	0.75	1.21	5.52	4.51	2.87	0.68	1.33
	2 years	0.28	0.19	0.09	0.02	0.01	1.16	1.42	2.83	7.87	11.17	4.55	1.28	2.57

Source: The Study on the Rehabilitation and Reconstruction of Agriculture Production System in the Slakou River Basin

AA-2.6.4 Agricultural Development Plan

(1) Crop Selection for Irrigated Agriculture

Proposed crops for the three irrigation development plans are selected on the basis of the following principles.

- To adopt paddy-based farming system in order to attain food sufficiency of the residents in the study area,
- To introduce crop diversification before or after paddy cropping within the extent of available irrigation water in order to increase on-farm income, and
- To select suitable diversified crops by examination of suitability for natural conditions, profitability, marketability of products including processing capacity for industrial development in Cambodia, and present level of farmers farming technique.

Table AA-2.6.4.1 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

(a) Cropping Pattern and Planted Area

The proposed cropping patterns for the three development plans are examined considering efficient use of irrigation water, effectiveness of rainfall, maximization of crop profit, farmers' willingness / attitude and available labor-force. The major items considered are as follows:

- To plant HYV paddy in about 30% of irrigated paddy area in due consideration of attainment of food sufficiency in the study area, increase of ratio of double cropping of paddy with diversified crops, and the farmers willingness and attitude to HYVs (HYVs are higher yield and shorter growing period than improved local varieties, but are not liked by farmers because of their low market price and less pleasant taste of Cambodian people.)
- To carry out land preparation during the heavy rainfall period from July to October, because the highest water demand is for land preparation period,
- To avoid planting diversified crops during the heavy rainfall period to prevent flood or water-logging damages,
- To plant and irrigate diversified crops before or after paddy cropping within the extent of available irrigation water,

- To plant high-profitability crops (vegetables) in the irrigation area taking due consideration on available labor force, marketability, technical level of farming and available supporting system of guidance on farming technique and marketing of products. In particular, for the Small Pond Development (PDP), such high-profitability crops are proposed for the whole irrigation area because one farmhouse operates only 0.07 ha of irrigation area on average.

(b) Unit Yield and Production of Crops

Anticipated unit yields of the irrigated crops are estimated on the basis of the existing high yields, results of agricultural research and information of extension workers. The target yields are estimated as shown below, taking due consideration low soil fertility, cropping under lower sunlight conditions in the rainy season, and application of water saving irrigation method.

Table AA-2.6.4.2 Anticipated Unit Yield under Irrigated Condition

Crop	Yield (ton/ha)		Crop	Yield (ton/ha)	
	Average	Range		Average	Range
Paddy (medium)	2.8	2.5 - 3.0	Average of vegetables *[2]	8.3 *[1]	
Paddy (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 AA-2.6.4.3 Cropped Area, Production and Production Increase in Irrigation Area

Crop	Cropping Area (ha)	Production (ton)	Increment (ton)
Paddy	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

AA-2.6.5 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 increase productivity and promote product diversification. Based on the present availability of water resources, the following three development approaches were studied:

- Upper Slakou River Irrigation Reconstruction Plan (USP in M/P and F/S)
- Small Reservoir Rehabilitation Plan (SRP)
- PDP

RGC, MOWRAM and local government of Takeo Province, Tram Kak District intended to develop a larger area for increasing food production, activation of the local economy and poverty alleviation. According to the results of interview with farmers in the study area, the biggest development need was “irrigation”.

(1) Upper Slakou River Irrigation Reconstruction Plan

Twelve development alternatives for combination of water resources were examined in terms of cost and development scale, technical soundness, negative impact as shown below. It was planned that the benefit area of USP would be fed irrigation water by two main canals (Canal 33 and Koh Kaek Canal) and Canal 24 starting at Kpob Trobek Reservoir and their secondary canals. As a result, Alternative 3-1 (Kpob Trobek- 39 m + Tumnup Lok- 43 m) was selected as the best 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.

Table AA-2.6.5.1 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

(2) Small Reservoir Rehabilitation Plan

Rehabilitation of fifteen small reservoirs with a total irrigation area of about 280 ha was proposed as technically and economically viable rehabilitation plans. Out of these reservoirs, (i) Tumnup Kim Sei Reservoir in Nhaeng Nhang Commune and (ii) Ang 160 Reservoir in Trapeang Thum Khang Tboung Commune are recommended with a top priority as pilot rehabilitation plan. Irrigation areas of these two reservoirs are 42 ha in total.

(3) Small Pond Development Plan

Three types of ponds are proposed as PDP, i.e. (i) small ponds operated by FGs, (ii) small ponds operated by individual farmer, and (iii) small ponds utilizing existing canal. Aiming to provide ponds for all the HHs (at about 250 villages) located outside USP and SRP, PDP with construction of seventy two ponds per village is proposed over 10 years. As a PDP model project, PDP at one village of Nhaeng

Nhang Commune is proposed for F/S.

In addition, in order to assure and enlarge the above irrigation-based development benefits, the following support programs were also studied;

- Rural road improvement program (RIP),
- Institutional development program consisting of strengthening of Farmers Water User Community and Capacity building of MOWRAM

(4) Rural Road Improvement Program

All the roads of 154.3 km were evaluated according to coverage area, present condition, and degree of importance, and priority for the rehabilitation was given to the roads. Out of the first priority roads, the following three roads having a total length of 24.5 km were given the highest priority:

- Trapeang Thum Khang Cheung to Trapeang Kranhung (13 km)
- O Saray to Slakou River road (5.5 km)
- Kpob Svay road (6 km)

(5) Formation of Farmers Water User Community

Formation of FWUC in the Study Area is proposed to have a tier structure system, such as (i) watercourse committee at the watercourse level, (ii) tertiary canal committee at tertiary canal outlets, (iii) secondary canal committee at secondary canal outlets, (iv) main canal committee at the reservoir intake or headwork, and (v) apex committee at the project level. In order to attain the objectives of FWUC, training to members of FWUC is essential. It is proposed that MOWRAM provides training of FWUC formation and operation including technical and administrative matters necessary for O&M of irrigation facilities.

(6) Capacity Building of Ministry of Water Resources and Meteorology

In order to smoothly implement the proposed development plans, the following capacity building of MOWRAM is proposed:

- Strengthening capacity of planning, design and construction management,
- Assignment of specialists for FWUC and O&M, and
- Training of project office staff about planning of irrigation project, design of irrigation facilities, construction supervision, and technology transfer of O&M to FWUC, etc.

AA-2.6.6 Agricultural Support Plan

As agricultural support services, 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 AA-2.6.6.1 Summary of Improvement of Extension Services

Component	Activities / Required inputs
Improvement of extension service	Activities - Implementation of FFSs - Preparation and distribution of technical booklet - Periodical training and guidance for extension workers by research institutes - Training for leader farmers for village level extension activities through FFS - Organization of a extension FG under VDC - Setting- up of demonstration plots in the village - Assignment of field staff (field extension specialists) for technical service - Training of leader farmers - Field level extension specialists (to be recruited from local consultants or NGOs) - Senior extension specialist / Trainer for field level extension specialists - Extension facilities and equipment including transportation and communication facilities

Component	Activities / Required inputs
Promotion of paddy seed multiplication	Activities - Multiplication and distribution of improved paddy seeds Required inputs: - Importing improved breeder seeds - 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

AA-2.6.7 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 AA-2.6.7.1 Economic Efficiency of the 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

AA-2.6.8 Environmental Conservation Program

The following environmental conservation programs were prepared based on (i) the existing condition in and around the Study Area, (ii) the characteristics of the main components of M/P, and, (iii) the results of Initial Environmental Examination (IEE):

- Program for minimizing and controlling negative impacts (water-related hazard prevention, and assistance to affected HHs)
- Program for ensuring environmental sustainability (watershed management and forest resource conservation).

AA-2.7 Upper Slakou River Irrigation Reconstruction Plan (Feasibility Study)

AA-2.7.1 Background

USP was selected as a priority project in the course of the M/P Study as mentioned in Section AA-2.6. USP aims to irrigate 3,500 ha by reconstruction of two reservoirs located on the Slakou River and its tributary, and a diversion canal between the two reservoirs, two main canals (Canal 33 and Koh Kaek Canal) starting at Kpob Trobek Reservoir.

Based on detailed topographic survey as well as 1:10,000 topographic map which becomes available at the initial stage of F/S, however, it was judged that the existing Koh Kaek Main Canal was not completely constructed, so that it did not function even immediately after construction. The elevation of the existing canal bed fluctuates along the canal profile, which would need a cut depth of 6 to 7 m at the maximum for reconstruction of the canal. Moreover, the construction work volume for the excavation, treatment of the cut slope and drainage facilities required for stability of the canal would be very large and maintenance cost as well as the construction cost would also be quite high. Thus the rehabilitation of the existing Koh Kaek Main Canal was not considered as a "suitable model plan of rehabilitation and reconstruction".

Instead of the existing Koh Kaek Main Canal, the following two alternatives were compared mainly on construction costs as shown in Table AA-2.7.1.1:

- Alternative-1: New Koh Kaek Canal (1,600 ha: 11.5 km) + Canal 33 (1,900 ha: 7.3km) + Secondary Canals (36.5 km) + Tertiary Canal System
- Alternative-2: Main Canal 33 (3,500 ha: 7.3 km) + Secondary Canals (44.7 km) + Tertiary Canal System

Table AA-2.7.1.1 Construction Cost of Alternative Plans

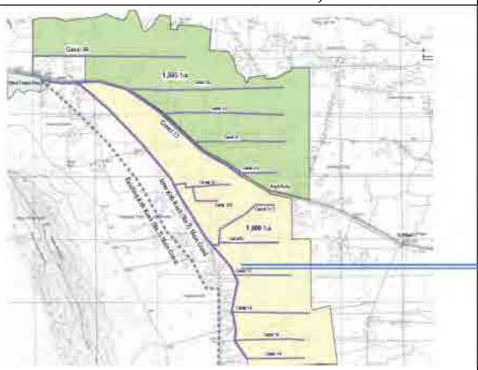
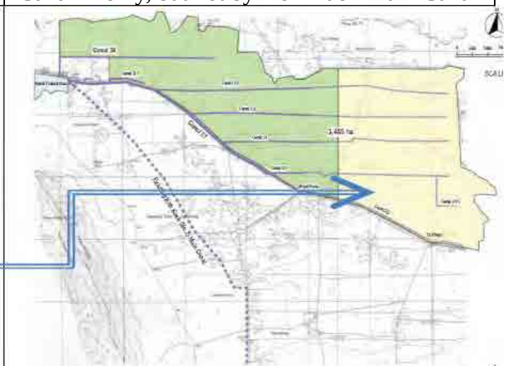
(Unit : US$ 1,000)

Item	Alternative-1	Alternative-2
Main Canal 33	675	797
New Koh Kaek Main Canal	2,171	—
Sub-total	2,846	797
SecoVndary and Tertiary System	4,078	4,781
Total	6,924	5,578
Per ha cost	1.978	1.594

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

Taking into consideration the large difference between construction costs of the two alternatives, the Alternative-2 was finally selected as the irrigation area of USP. The irrigation area of 3,500 ha remained unchanged, but the location of the irrigation area was changed. The above discussions are tabulated as below.

Table AA-2.7.1.2 Alternative Study on Development Area

Item	Alt-1 (Original area in M/P)	Alt-2
Irrigation Area	Area supplied by Koh Kaek Main canal for 1,600 ha and Main canal 33 and Canal 24 of 1,900 ha	Area supplied by Main Canal 33 and Canal 24only, but not by Koh Kaek Main Canal
	 New Koh Kaek Main canal is selected after cost comparison with rehabilitation plan of original route	
Canals	Two main canals of 17.6 km and secondary canals of 36.5 km	One main canal of 7.3 km and secondary canals of 44.7 km
Construction cost	US$ 1.978 per ha	US$ 1.594 per ha
Land acquisition	Land of 18 ha for new main canal is needed	No land for canal construction is needed

Source: *JICA Survey Team*

AA-2.7.2 Project Works

The following project works were proposed based on the irrigated agricultural development plan for the area:

- Rehabilitation and reconstruction of the existing irrigation and drainage facilities covering irrigation area of 3,500 ha,
- Procurement of O&M equipment including marketing assistance facilities, and
- Institutional development

AA-2.7.3 Agricultural Development Plan

(1) Proposed Cropping Pattern and Planted Area

In USP, 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. For planting season of paddy, about 1 month delay from the present practice is proposed for the purpose of effective use of rainfall in the heavy rainy season for the puddling, and the availability of irrigation water from the reservoirs during the late growing season. For paddy of local variety or HYV, one time cropping during the rainy season is proposed. Planting area of HYV paddy is limited to about 30% (1,100 ha) of the paddy field

(2) Anticipated Unit Yields

Target unit yield of paddy was estimated at 2,800 kg/ha for local variety, 3,300 kg/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 productions are 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.

AA-2.7.4 Irrigation and Drainage Development Plan

(1) Development Concept

Most of the existing irrigation facilities were constructed in the mid1970's during the Pol Pot regime, and these now require significant rehabilitation and/or reconstruction. The following are proposed as development concept in F/S:

- 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. To meet this, the purpose of the plan would not be to seek the "perfect" outcome, but to recover the minimum function required for increasing agricultural production as a model plan for similar irrigation developments in Cambodia.
- Reliability level is set at 4 in 5 years or 80% dependability, i.e., the proposed irrigation water supply would be guaranteed 4 times (seasons) out of 5 times (seasons). 24-hour water conveyance will be applied for diversion canal, main canal and secondary canal systems, while rotational irrigation will be applied for on-farm water distribution through tertiary canals and watercourses. The design flood discharge of 1-in-100-year recurrence period is adopted for the design of reservoirs.

- Irrigation canals will consist of main canal, secondary canals, tertiary canal and watercourse. The size of the tertiary block would primarily be set at 50 ha on average, but the tertiary block should exist within one village. The existing canals will have dual purposes for irrigation and drainage, and a certain capacity should be maintained up to the tail end. The existing canal section should fully be utilized.
- Lining would not be considered except for the new canal or unless the minimum allowable current speed could be maintained. Inspection roads for the main and diversion canals would be set at 4 m, while those of the secondary canals would be 2 m taking O&M works
- 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.
- The basic concept of drainage in USP is "maintenance of status quo". In other word, substantial drainage improvement would not be undertaken.

(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 Canal 24, as shown in Figure AA-2.7.4.1. The basic features of the proposed irrigation facilities based on the development concepts mentioned in subsequent section are listed below.

- Net irrigation area: 3,500 ha
- Beneficiaries: 4,020 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, Dike top EL. = 43.3 m, Flood discharge (100 years) = 420 m^3/s, HWL = EL.41.3 m, 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, Dike top EL. =39.0 m, Flood Discharge (100 years) = 195 m^3/sec, HWL=EL.37.3 m, LWL= EL.34.2 m, L=3.3 km)
- Reconstruction of Diversion Canal (Q=3.5 m^3/sec, L=9.4 km) between the above two reservoirs
- Rehabilitation of Main Canal 33 (Q=3.2 m^3/sec L=7.3 km)
- Rehabilitation of Canal 24 (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 (33 ha per block on average) and watercourses (5 ha per quaternary block on average)
- Construction of project office at Angk Roka, Ta Phem Commune

(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 six 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 eight experts such as FWUC Expert, Irrigation O&M Expert, Participatory On-farm Development Expert, were proposed.

The proposed training program to farmers and FWUC staff consisted of the following 6 courses:

- 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)

(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 four 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 canal FWUC offices, and two gate keepers huts
- Computers and ordinary office equipments such as desks, chairs, and cabinets
- One four-wheel drive vehicle, eight motorcycles, three walky-talkies, one generator

It was planned that during the construction time, most of the equipment would be commonly used with the project office and then be handed over to FWUC upon the completion of the project.

AA-2.7.5 Agricultural Support Plan

Four agricultural support plans are proposed in the feasibility study. 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 extension services are as follows:

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

(1) Strengthening Plan of Agricultural Extension Service

Dissemination of improved farming practices and irrigation farming will be done by the extension service activities of Takeo Department of Agriculture, Forestry and Fisheries (DAFF) through VDC and FWUC. DRD will support the establishment and activation of VDC.

The extension plan basically conforms to the present framework of the DAFF extension system, and is proposed to strengthen the present system, especially on activities in the field of Village Extension Workers (VEWs). For this purpose, it is proposed as an agriculture supporting program that extension FGs including VEWs should be organized under VDCs, and demonstration plot (Demo-plots) should be set up in farmers’ fields.

Table AA-2.7.5.1 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 VEWs Period: One day every week during 16 weeks according to the cropping season of the target crop Curriculum of FFS: All farming practices from land preparation to post-harvesting, and Integrated Pest Management (IPM) FFS course: Paddy and diversified crops including vegetables Participants: Around 30 farmers
Demo-plots in Farmers' Field	Objective: Demonstration of improved farming technology and improved varieties for beneficiaries in the field Size: 0.1 ha per plot of farmer's field Farm inputs: Free supply of seeds and fertilizer Activities: Eight Demo-plots to each secondary canal FWUC 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 - Extension officers and District Office of Takeo DAFF 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

(2) Paddy Seed Production Plan

Distribution of improved paddy seed of both local and HYVs is indispensable for increasing of the production and improvement of the quality. It is proposed to multiply paddy seed by FGs of seed production in the priority areas.

Table AA-2.7.5.2 Summary of Paddy Seed Production Plan

Components	Component
Paddy seed production	Requirement: - about 50 - 60 ton per year to 3,500 ha - sowing rate is 50 - 60 kg/ha. - renewal is done every 4 cropping seasons. - seed production in 25 - 30 ha of paddy field Seed growers: about 30 farm HHs Inspection: DAFF

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

(c) Distribution Plan of Farm Input

Farmers would obtain the inputs at a cheaper price and higher quality through the group purchase.

Table AA-2.7.5.3 Summary of Distribution Plan of Farm Input

Components	Component
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. 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

AA-2.7.6 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 AA-2.7.6.1 Project Cost of USP Estimated in F/S

(Unit: Riel million)

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 AA-2.7.6.2 Economic Efficiency of the Project

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

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

AA-2.7.7 Results of Environmental Assessment

The environmental assessment of the projects was preliminarily conducted for integration of desirable mitigation measures and monitoring framework. The following issues, which IEE revealed as likely negative impacts, were studied from available data and information.

- Deterioration of the water-related environment
- Social impact of relocation and land expropriation
- Degradation of forest resources

Main issues pointed out were as follows:

- Expropriation of lands legally used by local people will be negligibly small, though approximately 50% of Kpob Trobek Reservoir area (about 90 ha) and approximate 80% of Tumnup Lok Reservoir area (about 120 ha) have been used illegally.
- Relocation of houses legally built by local people will be negligibly small
- The risk of water-borne diseases might increase due to the appearance of new or renewed water bodies

Following programs and activities were recommended for implementation of the project, taking into consideration their importance and urgency.

- Environmental monitoring against human-health hazard
- Land-affected HHs' assistance

AA-2.8 Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (JICA, February 1995)

AA-2.8.1 Background

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 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 reappraisal 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 objectives of the Master Plan 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.

The Study Area for agricultural development is located about 30 km south of Phnom Penh and covers approximately 18,000 ha, consisting of Tonle Bati Area of 7,000 ha and the Kandal Stung Area of 11,000 ha. The Kandal Stung Area was under the jurisdiction of the Kandal Stung District of Kandal Province, and the Tonle Bati area under the jurisdiction of the Tonle Bati District of Takeo Province. Two areas sandwiched between the Stung Touch and Prek Thnot rivers and extending immediately south of the Tonle Bati River consist of active alluvial flood plains with recent and silty soils. The lands extending south of the Stung Touch River and southwest of the Tonle Bati River are older terraces where natural flooding no longer occurs. In the Study Area, 80 % of the total area was judged suitable for wet season rice, and 84 % was suitable for dry season rice, dry season horticulture, and upland crops. The average land holding size by household was estimated at 1.2 ha for Kandal Stung and 1.3 ha for the Tonle Bati Areas. It was found that agriculture in the Study Area was dominated by rice cultivation and most of the farm land was rainfed lowland rice fields with a rather low average unit yield of about 1.2 to 1.5 ton/ha. A typical pattern was rain-fed single cropping in the wet season. The early rice, medium rice and late rice cultivated during the rainy season in the Study Area was estimated at 600 ha, 8,700 ha, and 3,700 ha, respectively.

During the Pol Pot regime (1975-79), an irrigation canal system was constructed in the Kandal Stung Area. At first, the Prek Thnot By-pass Channel with the Tuk Thla Regulator was constructed at the National Road No.3 crossing, together with a road dike, the Kampong Tuol Regulator, and a flood dike. Irrigation canals and their related structures were then constructed in the Kandal Stung Area, following latitudinal and longitudinal grid lines, regardless of the topographic conditions. The irrigation area envisaged in the Kandal Stung Area was 3,100 ha, for which water was diverted from the right bank of the Prek Thnot River about 1 km south of the Kampong Tuol Regulator. In 1987 to 1991, the rehabilitation of the irrigation facilities was executed by the Department of Hydrology of MAFF and the joint effort of the Kandal Stung District and Kandal Province, under the assistance of Christian NGO (MCC: Mennonite Central Committee). However, the National Road No.3 dike between Kampong Tuol and Tuk Thla Regulators was washed out several times by flood. In August 1994, the road dike was further severely breached by flood. Therefore, the water supply to the Kandal Stung Area has not been ensured since then. Under these circumstances, farmers are compelled to carry out farming by using various kinds of lifting irrigation, such as indigenous tools or small capacity engine driven pumps.

During the period of 1975 - 1979, the canal system of the Tonle Bati Area for 6,000 ha was constructed. Water source of the area was diverted from Lake Tonle Bati. During 1987 - 1990, the irrigation system was rehabilitated by the Department of Hydrology with the assistance of MCC for an area of about 900 ha. However, irrigation facilities were judged not functioning well due to insufficient rehabilitation, insufficient water level/storage of the Lake Tonle Bati, and the lack of an effective O&M system. At the head of the main canal, an intake and pumping station were installed. The pumping station was used for supplying water in the dry season. The operation and maintenance of the facilities was made by the Bati District Office. The major physical and socio-economic constraints identified in the Study are as listed below.

Table AA-2.8.1.1 Major Physical and Socio-economic Constraints Identified in the Study

Item	Description
(1)Soil Mechanical Condition	- Embankment materials surrounding the proposed dike site are considered to be undesirable due to their dispersive properties.
(2)Soils	- Soils in the older terrace geomorphic province, lying Southwest of the Study Area, have low fertility, requiring a large amount of farm inputs for effective production.
(3)Water Resources	- Inadequate timely water resources available in the dry season and through the early months of the wet season, and
	- High potential for severe flooding both in terms of damage to irrigation facilities and by the inundation of cropped areas later in the wet season.
(4)Irrigation and Drainage	- Shortage of experienced engineers and technical staff in planning, design and implementation, and a lack of funds for rehabilitation /reconstruction and operation and maintenance.
	- Inadequate design and implementation due to a lack of design standards and construction specifications, and
	- Lack of a systematic operation of the irrigation system including O&M organization
(5)Rural Infrastructures	- Insufficient number of rural water supply facilities and the drying up of water sources in the dry season.
	- Muddy rural roads in the rainy season making it difficult to maintain daily transportation access,
(6)Agriculture and agro- economy	- Insufficient supply of certified seeds, and agricultural inputs.
	- Lack of supporting services and improved techniques.
	- Lack of sufficiently skilled government staff, and
	- Lack of credit opportunities at reasonable cost/interest rates.
(7) Socio-economic Conditions	- Inadequate provision of facilities for community organization development, and health care services.
	- Muddy rural roads in the rainy season making it difficult to maintain daily transportation access,
(8) Environment	- River and canal bank erosion, and
	- Shortage of firewood supply.

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

AA-2.8.2 Project Components

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

(1) Priority Development (First Stage 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;

(i) urgent improvement of the Tuk Thla and Kampong Tuol Regulators on the Prek Thnot River,
(ii) rehabilitation of irrigation and drainage systems
(iii) rural infrastructures development,
(iv) measures for rural life improvement,
(v) support services to women's group, and
(vi) 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" conditions. The commencement of the irrigation works was expected to be coincided with the implementation time schedule of the Prek Thnot Multipurpose Dam.

AA-2.8.3 Hydrology

The alternating monsoon system controls the climate in the Study Area. The wet season, the Southwest monsoon, is from May to November when about 90 % of total rainfall occurs. The remaining months, the Northeast monsoon, are hot, dry and less humid with a potential of particularly high transpiration demands in March and April. Annual mean rainfall was estimated at 1,365 mm and the monthly temperatures range from 21°C to 35°C.

Runoff from December to April forms a small part of the annual total. From May through the remaining months of the wet season, floods can occur at any time in response to intense rainfall, but the highest floods tend to occur towards the end of the wet season, usually in September or October. The annual runoff of the Prek Thnot River was estimated at 1,130 - 1,620 MCM. The average monthly flow derived from the l0-year series of residual flow at Tuk Thla was estimated as below:

Table AA-2.8.3.1 Average Residual Flow at Tuk Thla for the l0-year Design Period

(Unit: MCM)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
8.0	5.3	4.5	6.4	33.0	79.0	140.9	199.0	318.6	433.7	147.9	69.2	1,446

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

AA-2.8.4 Agricultural Development Plan

(1) Crop Selection for Irrigated Agriculture

The most promising crops were selected based on the results of investigation on the natural and social condition in the project area. Paddy had been 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 main secondary crops in the dry season, in connection with the promotion of livestock production especially pig and poultry. Since vegetable such ads Chinese cabbage, cabbage, string beans, kale, etc. were considered to be introduced as cash crops in the dry season. Green grams, groundnuts, sesame, sweet potato were also 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 rainy season rice, and then to introduce early rainy season rice about 50% in the irrigated area. Meanwhile it was introduced 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. Further under without Prek Thnot Reservoir condition, mixed cultivation of soybeans and maize, and vegetables were about 15%, respectively. As a result, cropping intensity for each alternative were 200% and 180%, respectively as follows:

Table AA-2.8.4.1 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

The present yield of crops in the project area was rather low level mainly due to lack of irrigation water, 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 AA-2.8.4.2 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
Mung beans	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 irrigationcondition 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

The anticipated annual paddy production at the full target level in the area were estimated as shown below:

Table AA-2.8.4.3 Cropped Area and Production of Paddy in the Study Area

	Crop	Net Area (ha)	Planted Area (ha)	Production (ton)
(a)	With Prek Thnot Reservoir Condition			
1)	Irrigation development area			
	Kandal Stung	4,200	6,300	24,360
	Tonle Bati	4,200	6,300	24,360
	Sub-total	8,400	12,600	48,720
2)	Non-Irrigation development area			
	Kandal Stung	3,100	3,224	8,060
	Tonle Bati	900	984	2,460
	Sub-total	4,000	4,208	10,520
3)	Total in Study Area	12,400	16,808	59,240
(b)	Without Prek Thnot Reservoir Condition			
1)	Irrigation development area			
	Kandal Stung	1,950	2,850	11,010
	Tonle Bati	1,600	2,400	9,280
	Sub-total	3,550	5,250	20,290
2)	Non-Irrigation development area			
	Kandal Stung	5,350	5,564	13,910
	Tonle Bati	3,500	3,740	9,350
	Sub-total	8,850	9,304	23,260
3)	Total in Study Area	12,400	14,554	43,550

Source: Page IV-44, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

Further anticipated production of the secondary crops such as maize and soybeans was estimated as shown below:

Table AA-2.8.4.4 Cropped Area and Production of Secondary Crops in the Study Area

	Crop	Kandal Stung		Tonle Bati		Total	
		Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)
(a)	With Prek Thnot Reservoir						
	Maize	1,596	4,788	1,596	4,788	3,192	9,576
	Soybeans	1,596	2,394	1,596	2,394	3,192	4,788
	Vegetables	504	5,040	504	5,040	1,008	10,080
(b)	Without Prek Thnot Reservoir						
	Maize	270	810	240	720	510	1,530
	Soybeans	270	405	240	360	510	765
	Vegetables	270	2,700	240	2,400	510	5,100

Source: Page IV-44, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

(3) Anticipated Livestock Production

About 30% of maize and soybeans produced in the project area was proposed to be fed to pig and poultry. These maize and soybeans were considered to bring about substantial increment newly produced by the project, beside the feed for the existing livestock production. The anticipated production of livestock was estimated as the increased production of pig, which was a very common animal in the Study area. The expected increased production of pig in the Study area was estimated as follows:

Table AA-2.8.4.5 Livestock Production in the Study Area

	Crop	Feed Grain* (ton)	Total No. of Pg (ha)	Increased No. of Pig per HH** (heads)
(a)	With Prek Thnot Reservoir			
	Kandal Stung	2,150	8,600	2.5
	Tonle Bati	2,150	8,600	2.6
	Total	4,300	17,200	

	Crop	Feed Grain* (ton)	Total No. of Pg (ha)	Increased No. of Pig per HH** (heads)
(b)	Non-Irrigation development area			
	Kandal Stung Priority Development Area	360	1,440	0.7
	Tonle Bati Priority Development Area	320	1,280	1.1
	Total	680	2,720	

Note:
** About 30% of production of maize and soybeans*
*** Number of household included in irrigation development area is about 3,500 and 3,320 HHs in Kandal Stung and Tonle Bati Areas, under with Prek Thnot Reservoir condition. Those for without condition, 2,170 and 1,140 in Kandal Stung and Tonle Bati Area, respectively.*
Source: *Page IV-44, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995*

AA-2.8.5 Irrigation and Drainage Development Plan

(1) Kandal Stung Area

The maximum area suitable for irrigation development in Kandal Stung Area was estimated at 4,200 ha, based on the soil and topographic conditions, as well as the water balance study as shown below (refer to Figure AA-2.8.5.1).

(a) Without Prek Thnot Reservoir Case

1,950 ha of the Kandal Stung Area will be served the unregulated river flow of the Prek Thnot River through the Kampong Tuol Regulator, with an irrigation dependable level of 4 out of 5 years. The year 1968 was set as a basic design year according to the simulation.

(b) With Prek Thnot Reservoir Case

The 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 as an extension area. In case that the irrigable area of 1,950 ha under the run-of-river water of the Prek Thnot River is developed as the first stage and the remaining area would be developed as the second stage. The general features of the proposed project works of the irrigation and drainage system are shown in Table AA-2.8.5.1.

(2) Tonle Bati Area

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.

(a) Without Prek Thnot Reservoir Case

This plan could ensure irrigation to an area of 1,600 ha. The water resources are original flow of the Tonle Bati River and the storage of the Lake Tonle Bati.

(b) With Prek Thnot Reservoir Case

The irrigation Plan of this case would ensure sufficient irrigation of the whole area of 4,200 ha. The implementation schedule of the Prek Thnot Multipurpose Project was not formulated at the time, and it was not clear whether the Prek Thnot Reservoir would become operational. Under the situation, it was recommended that the irrigation development of 1,600 ha would be implemented firstly. The proposed project works of the irrigation and drainage system for the Tonle Bati Area are summarized in Table AA-2.8.5.1.

Table AA-2.8.5.1 Principal Features of Irrigation Development Plan Formulated in Master Plan Study

Description	Unit	Overall Stage-1 (8,400 ha)	Kandal Stung Area Stage-1 (1,950 ha)	Kandal Stung Area Stage-2* (2,250 ha)	Tonle Bati Area Stage-1 (1,600 ha)	Tonle Bati Area Stage-2 (2,600 ha)
1) Improvement of Tuk Thla and Kampong Tuol Regulators	(set)	1				
2) Main canal						
- Improvement of main canals	(km)		5.3	0.0	8.3	0.0
3) 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
4) Tertiary canals						
- Improvement/constriction of canals	(km)		56.8	65.5	48.1	78.2
5) Quaternary system	(ha)		1,950	1,750	1,600	2,600
6) Drainage works						
- Main drain	(km)		18.1	20.9	10.4	16.9
- Secondary drain	(km)		64.6	74.5	13.7	22.3
7) Improvement of Lake Tonle Bati Related structures						
- Intake	(nos.)		-	-	1	-
- Pumping station	(nos.)		-	-	1	-
- Spillway of the lake	(nos.)		-	-	1	-
- Lake dike	(km)		-	-	LS	-
8) 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)

AA-2.8.6 Agricultural Support Plan

The proposed supporting services comprised; (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. The Master Plan proposed to establish the Agricultural Development Centers, which would be operated directly under the management of the Department of Extension. And it was planned that operation of the Agricultural Development Centers with sufficient qualified extension workers and facilities would have been transferred to the management under each district office.

(1) Agricultural Extension

The proposed agricultural extension services was mainly targeted to 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 AA-2.8.6.1 Summary of Improvement of Extension Services

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

Source: Page IV-51, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

(2) Agricultural Input System

The proposed input supply system was proposed as one of sections of the Agricultural Development Center. In the MP stage, the existing supply system of the Government channel by the Central Company of Agricultural Material (CCAM) was proposed to be responsible for handling materials, i.e. loading and unloading, transportation to the store and stocking materials, and individual farmer receivers and centers those by on-cart to farmer's home from the storehouse. The number of storage required for each Center was 1, 2, and 3 for Kandal Stung No.1, Kandal Stung No.2, and Tonle Bati, respectively. It was proposed that staffing required for operation of the section and each storage of each Center were 6 persons such as 1 for section chief, 1 for storage manager, 2 for clerks, and 2 for storage keepers.

(3) Supporting Agricultural Development Center

It was proposed that all of the proposed agricultural support services would be extended through the proposed Agricultural Development Center. Each center had 5 sections, i.e. Agricultural Extension, Supply and Marketing, Life Improvement, Operation and Maintenance and Administration. Each section had a section chief with the staff and facilities proposed for each service activity. The staffing and facilities proposed for each Center are summarized below:

Table AA-2.8.6.2 Proposed Organization and Staff for Agricultural Development Centers

Section	Staffing of Agricultural Development Center		
	Kandal Stung No.1	Kandal Stung No.2	Tonle Bati
(a) Administration			
1) General manager	1	1	1
2) Section chief	1	1	1
3) Clerk	1	1	1
4) Accountant	1	1	1
5) Typist	1	1	1
6) Vehicle drivers	5	5	5
7) Office boy	3	3	3
8) Security	2	2	2
(b) Agricultural Extension			
1) Section chief	1	1	1
2) Subject matter specialist	3	3	3
3) Field extension worker	7	10	10
4) Machinery operator	2	-	-
(c) Life Improvement Extension			
1) Section chief (Specialist)	1	1	1
2) Life improvement worker	3	5	6
(d) Supply and Marketing			
1) Section chief	1	1	1
2) Store house manager	1	2	3
3) Clerks	2	4	6
4) Store keeper	2	4	6
(e) Operation and Maintenance			
1) Assistant civil engineer	1	1	1
2) Maintenance work supervisor	2	2	2
3) Machinery operator	2	2	2
4) Ditch tender	-	2	2

Source: Page IV-51, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

AA-2.8.7 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 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 AA-2.8.7.1 Project Cost Estimated in Master Plan 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 center	5.29	2.59
3)	Rural road network	9.21	6.53
4)	Rural water supply system	3.88	1.07
e)	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-Reservoir" condition (priority development area of 3,550 ha) was estimated at 12%.

AA-2.8.8 Environmental Conservation Program

The M/P report indicated that the project does not have a significant impact on the surrounding natural environment because the study area has been a man-made ecosystem for a long period of time. In the other hands, the report had little to do with the social environmental problem such as resettlement, land acquisition and gender etc. However, these contents are based on general and secondary materials, such as field survey related to the environment have not been implemented during the M/P Phase.

Also, the report made mention of environmental problems can cut across institutional boundaries, co-ordination of environmental pollution and management effort has to be carefully handled.

AA-2.9 Master Plan Study on the Agricultural and Rural Development Project in the Suburbs of Phnom Penh (Feasibility Study, JICA, 1995)

AA-2.9.1 Background

The F/S was carried out for the priority development area of 3,550 ha, consisting of 1,950 ha in Kandal Stung Area and 1,600 ha in Tonle Bati Area from 1993 to 1995. The priority area was selected in the Master Plan Study among the suitable irrigation development area of 8,400 ha, and mainly by the availability of water resource (with irrigation dependency of 4 out of 5 years) under the condition of the “without the Prek Thnot Reservoir”, considering uncertainness of implementation of the Prek Thnot Reservoir Project.

AA-2.9.2 Project Components

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

Table AA-2.9.2.1 Proposed Project Component for the Priority Development Area of 3,550 ha in F/S

Component	Description
(1) Agricultura1 development	- Improvement and strengthening of agricultural support services, - Establishment of a Rural Development Center, including a demonstration farm
(2) Irrigation and drainage development	- Improvement of the Tuk Thla and Kampong Tuol Regulators, - Improvement of irrigation and drainage facilities of the Kandal Stung Area of 1,950 ha and Tonle Bati Area of 1,600 ha
(3) Development of rural infrastructures-	- Improvement of rural road network, - Construction of rural water supply facilities, - Improvement of village clinics, - Improvement of school buildings, and - Construction of community halls
(4) Measures for rural life improvement	
(5) Support services to women's group	
(6) Measures for environment problems	

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

AA-2.9.3 Agricultural Development Plan

(1) Proposed Cropping Pattern and Planted Area

The Planned irritation development in the priority area was basically without Prek Thnot Reservoir condition. The proposed cropping patterns were formulated on the basis of the following basic principles which govern the selection of crops and cropping seasons to be introduced under the project conditions:

(i) In rainy season, 100% of irrigable land would be cultivated with paddy

(ii) In 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 Kandal Stung Priority Development Area (1,950ha) and Tonle Bati Development Area (1,600ha) were formulated based on the above mentioned concepts and summarized as follows:

Table AA-2.9.3.1 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)
Paddy	100	1,950	46	900	100	1,600	50	800
Early dry season rice	0	0	46	900	0	0	50	800
Early wet season rice	50	975	0	0	50	800	0	0
Medium wet season rice	30	585	0	0	30	480	0	0
Medium local var. 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 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 AA-2.9.3.2 Target Crop Yield (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: Page IV-61, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

(3) Prospective Crop Production

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

Table AA-2.9.3.3 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: Section 5.1, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

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

(4) Prospective Livestock Production

About 30% of maize and soybeans produced in the project area was proposed to be fed to pig and poultry. Requirement of feed to raise 50kg of pig was estimated at about 250kg of coarse grains. Increased number of pig would be about 1,440 heads in Kandal Stung Priority Development Area, while 1,280 heads for Tole Bati Priority Development Area.

AA-2.9.4 Irrigation and Drainage Development Plan

(1) Development concept

Followings were basic concept/ consideration applied for formulating the proposed irrigation and drainage facilities plan:

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

(2) Proposed Facility Plans

Following structures were proposed for both Kandal Stung and Tonle Bati Areas:

Table AA-2.9.4.1 Proposed Irrigation and Drainage System Improvement under Stage-1 in F/S

Description	Unit	Kandal Stung (1,950 ha)	Tonle 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				
2) 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
3) Drainage Canals				
- Main Drain	(km)	18.1	24.1	42.2
- Secondary/ tertiary drain	(km)	64.6	41.8	106.4

Description		Unit	Kandal Stung (1,950 ha)	Tonle Bati (1,600 ha)	Total (3,550 ha)
4)	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
5)	Improvement of Connection Canal				
	- Connection canal	(km)	-	4.6	4.6
	- Stung Touch Regulator	(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 Prek Thnot River would be carried out by the MAFF. The responsibility of operation and maintenance of the irrigation and drainage systems would be divided into two types of administrative bodies, i.e., a project operation body, responsible for the head regulator to the lateral systems, and water users group responsible for tertiary irrigation and the drainage system.

The Water Management Division in Department of Agricultural Hydraulics and Hydro-meteorology of MAFF would be responsible for the operation, maintenance, and management of the head regulators and localized reservoirs in order to ensure the equitable water management and safe operation of the large facilities. The local governments concerned would be responsible for the operation, maintenance and management of the main canal up to the lateral systems. To co-ordinate smooth operation and maintenance of the irrigation system and water management of the Project, the provincial and district irrigation committees would be organized at provincial and district government levels. It was proposed that they 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.

AA-2.9.5 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, and (iii) operation and maintenance of irrigation and drainage system and provided rural infrastructures such as road and domestic water supply. In this F/S, it was proposed that the Agricultural Development Centers would be operated directly under the management of the Department of Extension. And operation of the Agricultural Development Centers with sufficient qualified extension workers and facilities was proposed to be transferred to the management under each district office.

(1) Agricultural Extension

The agricultural extension services was proposed to cover 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 AA-2.9.5.1 Summary of Improvement of Extension Services

Component	Activities / Required inputs
Improvement of extension service	Activities - Introduction of improved varieties - Supply of planting materials - Demonstration and guidance on cultivation techniques - Extension on livestock production - Strengthening of vaccination service - Monitoring and evaluation

Component	Activities / Required inputs	
Staff recruitment for Agricultural Development Center	Kandal Stung No. 2 (proposed): 2,400 ha 10 persons Tonle Bati (existing): 1,830 ha 3 persons	
Facilities and Equipment	1. Agricultural Development Center:	
	- Office Space for subject matter specialists	3 specialists in each center
	- 4 WD vehicle	3 for each center
	- Minibus(20persons)	1 for each center
	- Mobile extension unit vehicle(4WD)with audio visual equipment and veterinary service	1 in each center
	- Cold storage for Vaccine(Solar energy)	1 in each center
	- Copy/Printing machine	1 in each center
	- Personal computer with printer	1 set in each center
	- Residence	1 residence for each specialist
	- Trial cum demonstration farm	1 ha for each center
	- Electricity supply	1 in each center
	- Portable generator for community hall	2 for each center
	- Farm machinery for demonstration	1 set of mechanized rice farming machinery for each center
	2. Community Hall	
	- Office Space for sfield worker	1 to 3 persons
	- Motor cycle	1 for each worker
	- Residence	1 for each worker
	- Store space for equipment	1 space in each hall
	Trial farm	0.1 ha

Source: Page IV-66, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

(2) Agricultural Input System

The proposed input supply system formed one of sections of the Agricultural Development Center. In the F/S stage, the existing supply system of CCAM was proposed to be responsible for handling materials, i.e. loading and unloading, transportation to the store and stocking materials, and individual farmer receivers and centers those by on-cart to farmer's home from the storehouse. The number of storage required for each Center in the priority area is 2 and 3 for Kandal Stung No.2 and Tonle Bati, respectively. It was proposed that staffing required for operation of the section and each storage of each Center be 6 persons such as 1 for section chief, 1 for storage manager, 2 for clerks, and 2 for storage keepers.

(3) Supporting Agricultural Development Center

All of the proposed agricultural support services are extended through the Proposed Agricultural Development Center. It was proposed that each center be composed of 5 sections, i.e. Agricultural Extension, Supply and Marketing, Life Improvement, Operation and Maintenance and Administration. Each section has a section chief with the staff and facilities proposed for each service activity. The staffing and facilities proposed for each Center were summarized below:

Table AA-2.9.5.2 Proposed Organization and Staff for Agricultural Development Centers

Section	Kandal Stung No.2	Tonle Bati
(a) Administration		
1) General manager	1	1
2) Section chief	1	1
3) Clerk	1	1
4) Accountant	1	1
5) Typist	1	1
6) Vehicle drivers	5	5
7) Office boy	2	2
8) Security	2	2
(b) Agricultural Extension		
1) Section chief	1	1
2) Subject matter specialist	3	3
3) Field extension worker	7	3

Section	Kandal Stung No.2	Tonle Bati
(c) Life Improvement Extension		
1) Section chief (Specialist)	1	1
2) Life improvement worker	3	2
(d) Supply and marketing		
1) Section chief	1	1
2) Store house manager	1	1
3) Clerks	2	2
4) Store keeper	2	2
(e) Operation and Maintenance		
1) Section chief	1	1
2) Maintenance work supervisor	2	2
3) Farm Machinery mechanic	1	1
4) Machinery operator	2	2
5) Ditch tender	2	2

Source: Page IV-72, Annex IV, Vol. III, Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh, 1995

AA-2.9.6 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 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 of US$ 16.8 million accounts 44% of the irrigation and drainage work cost of US$ 38.5 million.

Table AA-2.9.6.1 Cost Estimated for Priority Development of 3,550 ha in Feasibility Study Stage

(Unit: US$ million)

Description	Total (3,550 ha)	Kandal Stung (1,950 ha)	Tonle Bati (1,600 ha)
(a) Construction cost			
1) Irrigation and drainage	38.49	24.51	13.98
a) Tuk Thla and Kampong Tuol Regulators	(16.76)	(16.76)	
b) Irrigation and drainage systems	**(21.73)**	**(7.75)**	**(13.98)**
2) Rural development center	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 *: Calculated by the JICA Survey Team*

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

Breakdown of irrigation and drainage system improvement cost is summarized below. Costs for improvement of the pumping station and connection canal are additionally needed for development of the Tonle Bati System. Lining cost of main and lateral canals and connection canal accounts 40 to 80% of these work costs.

Table AA-2.9.6.2 Breakdown of Estimated Cost for Irrigation and Drainage System Improvement

(Unit: US$ 1,000)

Description		Unit	Kandal Stung Area (1,950 ha)		Tonle 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 Regulator	(nos.)	-		1	677
(e)	Others					
	- Preparatory works		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 only considered for the economic evaluation. But cost for the social and rural infrastructures was not counted since these benefits were not tangibly counted in the study. Thus, total economic investment cost was set at US$ 24.8 million only. Economic benefit 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.

The Economic viability of the priority project for 3,550 ha was evaluated by EIRR. F/S concludes that the priority development (Stage-1) is economically viable since the EIRR is calculated at 11.7%. Financial analysis also estimated 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).

AA-2.9.7 Results of Environmental Assessment

Environmental Assessment has not been studied adequately in F/S. F/S indicated 'Environmental Assessment of Irrigation and Agricultural Development' and 'Environmental Management'. However, above two contents mentioned just general information, not regional feature of the study area.

AA-2.10 Basic Design Study on the Project for the Rehabilitation of the Kandal Stung Irrigation System in the Kingdom of Cambodia (for the Japan's Grant Aid Program, JICA, December 2004)

AA-2.10.1 Background

The Royal Government of Cambodia (RGC) requested that the Government of Japan (GOJ) to provide technical assistance for a study on integrated agricultural development in the suburbs of Phnom Penh including the project area and focusing on the rehabilitation of the existing irrigation facilities in 1992.

In reply to this request, the GOJ undertook “the Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh” from 1993 to 1995. As a result, a project area of 1,950 ha in Kandal Stung area was selected as the first priority area for development. The RGC has requested grant aid assistance from the GOJ for the rehabilitation of the regulators and the main canals aiming at steady supply of irrigation water. The followings are the list of major items requested by the RGC:

TableAA-2.10.1.1 Requested Items under Grant Aid Assistance from the RGC

Component	Quantities
(1) Construction of new headworks	1 no.
(2) Rehabilitation of regulators and the 7th January dam	3 nos.
(3) Demolish of regulator	1 no.
(4) Construction of new intake	1 no.
(5) Rehabilitation of main canal and related structures	5.3 km
(6) Rehabilitation of O&M road	9.3 km

Source: Basic Design Study Report on the Project for the Rehabilitation of the Kandal Stung Irrigation System in the Kingdom of Cambodia, JICA, and December 2004

The GOJ, through JICA, dispatched the Basic Design Study Team to Cambodia from November 2002 to October 2004.

AA-2.10.2 Agricultural and Irrigation Development Plan

The concept applied for the basic design study was as follows:

(1) Size of Major Irrigation Facilities for Rehabilitation

An area of 1,950 ha was chosen for the Project in consideration of the contribution to poverty reduction, which is the ultimate goal of the Project, the RGC’s opinion of the Project, income balance between the beneficiaries and non-beneficiaries and the project cost for rehabilitation.

(2) Cropping Plan

The Project Area is topographically flat with Cambisol soil suitable for rice cultivation. The proposed cropping plan is comprised of double cropping of the IR varieties (early maturing varieties) and single cropping of the local varieties.

(3) Facilities Improvement and Rehabilitation Plan

(i) The Project shall be compatible with the development plan of the model site for the JICA Project-type Technical Cooperation, Technical Service Center (TSC) for Irrigation Systems launched in January 2001.

(ii) Two existing regulators (Tuk Thla and Duam Rues) shall be used in their present condition except for raising the height of the gates, because the flood control function of both regulators have been recovered through the rehabilitation work done by ADB funds.

(iii) The Kampong Tuol Regulator shall be demolished as requested by the RGC.

(iv) As the river flow from late April to early May during the early rainy season is small and unstable, the puddling proposed in the cropping calendar may not be possible. In order to rectify the water deficit for puddling, river water during the dry season shall be stored upstream of National Road No.3 by raising the crest of the existing 7th January Dam and the gate height of the regulators.

(v) New headworks shall be constructed to secure the present capacity of flood discharge, because the capacity will be decreased after demolition of the Kampong Tuol regulator and the raising of the crest height of the 7th January dam and the gate height of the Tuk Tula and the Duam Rues Regulators.

(vi) The rehabilitation of the secondary and tertiary canals and related facilities shall be designed taking into consideration the easy execution of O&M works to be done through farmers' participation after completion of the Project works.

(vii) As the Project covers an irrigable area of 1,950 ha, MOWRAM should take responsibility for O&M works for the main irrigation facilities following the concept in the National Water Resource Strategy Paper. On the other hand, the O&M works for the minor facilities, like tertiary canals and related structures, should be undertaken by FWUC with technical assistance of the Project O&M Office established by MOWRAM.

AA-2.10.3 Project works

The proposed contents of the Project works were as follows:

Table AA-2.10.2.1 Proposed Works under the Japan's Grant Aid

Item	Quantities
(1) Project Area	1,950 ha
(2) Crops	The early maturing IR rice varieties, the local rice varieties, maize, soy beans, and vegetables
(3) Headworks	1 no., Movable weir (all gates), Width 50m, Height 4.8 m, Floodway gate 3 nos., Sluiceway gate 1no., River maintenance flow gate 1 no.
(4) 7th January Dam	1 no., Heightening 0.55 m, Total length of overflow 212 m, Construction of sheet piles (l = 4.0 m)
(5) Tuk Thla Regulator	1 no., Heightening of gate crest 0.40 m, Total width 36.75 m, Construction of sheet piles (l = 4.0m)
(6) Duam Ruse Regulator	1 no., Heightening of gate crest 0.20 m, Total width 5.87 m
(7) Kampong Tuol Regulator	To be demolished
(8) Rehabilitation of main canal	(a) Main canal :Design discharge 2.73 ~1.03 m3/s, 5.3 km long, Concrete block lining for both slopes
	(b) Intake :1 no., Design intake discharge 2.73m3/s, Gate with rubber seal on four sides (B x H = 1.8m x 2.1m, 3sets)
	(c) Turnout :26 nos.
	(d) Check structure :2 nos.
	(e) Crossing structure :8 nos.
	(f) Maintenance flow gate :6 nos.
	(g) O&M road : for main canal 5.3 km, for secondary canal 9.3 km

Source: Basic Design Study Report on the Project for the Rehabilitation of the Kandal Stung Irrigation System in the Kingdom of Cambodia, JICA, and December 2004

AA-2.10.4 Project Cost and Evaluation

(1) Project Cost

The project cost was estimated at US$ 17 million at the exchange rate of US$ 1.0 = Yen 110.8 = Riel 4,000, and its breakdown was as below.

- Japanese grant aid portion: US$ 16.1 million (Yen 1,786 million)
- RGC portion: US$ 0.96 million

RGC portion included the cost of: (i) construction cost of secondary and tertiary canal of US$0.77 million, (ii) removal cost of UXO of US$ 0.16 million and (iii) establishment cost of O&M office.

(2) Expected effects of the Project

The following direct and indirect effects were expected through the implementation of the Project as long as MOWRAM received the necessary support from the related organizations, especially MAFF, local government and JICA Project-type Technical Cooperation.

(a) Direct effects

The existing irrigation system (maximum irrigable area 1,950 ha, about 2,800 households with 13,400 population) would be improved and secure necessary irrigation water to introduce a double cropping system in the Project Area with the rehabilitation of headworks, main irrigation canals, and O&M roads and related structures through Japan's Grant Aid System.

(b) Indirect effects

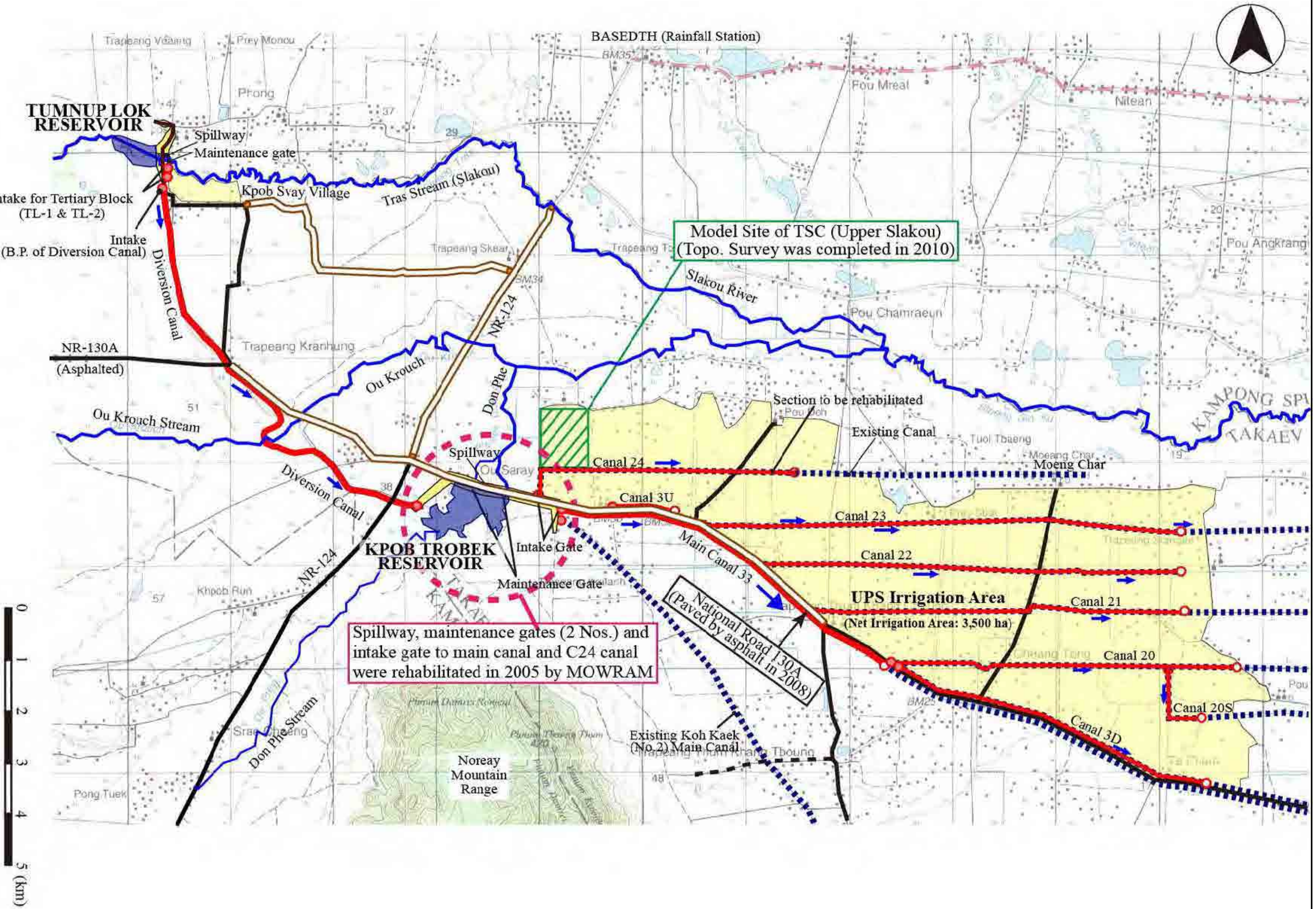
- Realization of irrigated agriculture in the Project Area of 1,950 ha
- Increase of crop intensity (108% to 174%)
- Increase of productivity and quality (Local variety 1.8 to 3.0 ton/ha, IR variety 2.5 to 4.0 ton/ha)
- Increase of Farm Income (US$ 138 to US$ 418)
- Contribution to rural poverty reduction, which is one of the goals of the National Socio Economic Development Plan

ANNEX A

Figures

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency



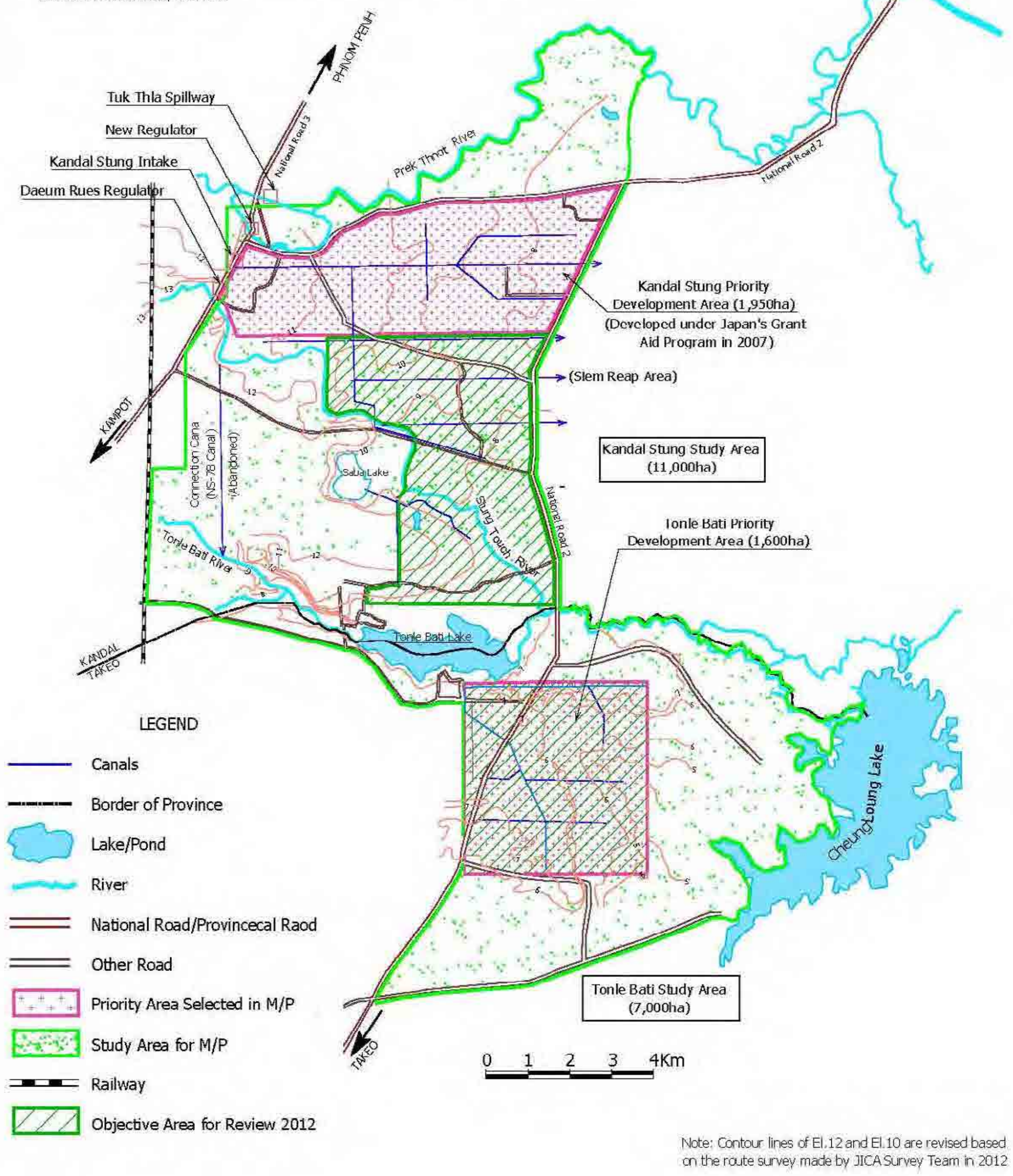
Source: JICA Survey Team

Figure AA-2.7.4.1
General Layout of Upper Slakou Irrigation System Sub-project

Suitable Irrigation Areas

	Kandal Stung	Tonle Bati	Remarks
Study Area of M/P	11.000ha	7.000ha	
Suitable Area for Irrigation Development	4.200ha	4.200ha	With Prek Thnot reservoir identified in M/P Study in 1995
Priority Area	1.950ha	1.600ha	Without Prek Thnot reservoir identified in M/P and excuted F/S in 1995

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



PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AA-2.8.5.1**
Japan International Cooperation Agency	**Overall Irrigation Development Plan Proposed in M/P (1995)**

ANNEX B

Meteorology and Hydrology

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

ANNEX B

METEOROLOGY AND HYDROLOGY

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ANNEX B

METEOROLOGY AND HYDROLOGY

CHAPTER AB-1 GENERAL INFORMATION

AB-1.1 Climate

The climate of Cambodia is dominated by the monsoon like other countries of South Asia and can be distinguished in 2 seasons: a rainy season and a dry season. In summer moist air of the southwest monsoon is drawn landward from the Indian Ocean and the Gulf of Thailand. The southwest monsoon brings the rainy season from mid-May to mid-September or to early October. Then the northeast monsoon flows drier and cooler air early November to March. After that, hotter air prevails in April and early May. The southern one third of the country has a 2-month dry season, while the northern 2/3 has a 4-month dry season. Temperatures are fairly uniform throughout the country, with only small variations from the average annual temperature around 28 °C. At the beginning of the rainy season, daily maximum temperatures rise higher than 38 °C. Minimum temperatures rarely fall down below 20 °C. Basically, April is the hottest month and December and January are the coolest season in Cambodia. Relative humidity is generally high and exceeds 90% at night throughout the year. Conversely, it is about 50% at daytime in the dry season.

Typhoons and tropical cyclones often devastate coastal Vietnam, but rarely cause damage in Cambodia. Total annual rainfall ranges from 1,300 to 2,000 mm over the past decade. However, the amount varies considerably from year to year and from place to place. When southwest monsoon reaches the coast, the southwestern part of the Tonle Sap basin receives precipitation more than 3,000 mm. However, these heavy rainfall flow mostly to the sea and only small portion runs into the rivers in the Tonle Sap basin.

Table AB-1.1.1.1.1 Location of Meteorological Stations in Cambodia

Nº	Provinces	WMO Code	Longitude	Latitude	Altitude	Notes			
1	Bantey Meanchey	48969	102º58'	13º37'	31 m	ECMWF			
2	Bassac								
3	Battambang	48962	103º12'	13º06'	13 m				
4	Kandal	48990	104º49'	11º26'	8 m	ECMWF			
5	Koh Kong	48986	102 59'	11º38'	13 m	ECMWF			
6	Kompomg Cham	48995	105º27'	12º	14 m	ECMWF			
7	Kompong Chhnang	48967	104º40'	12º13'	15 m				
8	Kompong Speu	48992	104º34	11º28'	27 m	ECMWF			
9	Kompong Thom	48965	104º54'	12º41'	13 m	ECMWF			
10	Kompot	48985	104º11'	10º36'	4 m	ECMWF			
11	Krotie	48970	106º10'	12º29'	23 m				
12	Pochentong	48991	104º50'	11º33'	11 m	ECMWF	HKO	KMA	JMA
13	Preh Vihear	48964	105º 09'	14º06'	62 m	ECMWF			
14	Prey Veng	48997	105º19'	11º29'	13 m	ECMWF			
15	Pursat	48968	103º51'	12º33'	18 m				
16	Rattanakiri	48973	106º59'	13º44'	330 m				
17	Siemreap	48966	103º51'	13º22'	15 m		HKO	KMA	
18	Sihanouk Ville	48983	103º29'	10º37'	13 m	ECMWF	HKO	KMA	
19	Stung Treng	48972	105º58'	13º31'	54 m		HKO	KMA	
20	Svay Reing	48998	105º48'	11º50'	6 m				
21	Takeo	48993	104º48'	10º59'	6 m				
22	Mondul Kiri	48971	107º11'	12º27'	690 m				
23	Pailin	48963	102º36'	12º48'	170 m				

Source: MOWRAM

AB-1.2 Topography

Topography is closely influence the hydrological condition. The dominant features of the Cambodian landscape are the Tonle Sap, the Bassac River and the Mekong River System. The Tonle Sap locates at almost center of the country. The Bassac River and the Mekong River cross the country from north to south. The Central Plains surrounding the Tonle Sap occupy 3 quarters of the country. Furthermore, mountains and plateaus enclose the Central Plains; the Elephant Mountains and the Cardamon Mountains located in southwest region, Dangrek Mountains located in the north adjoining the Korat Plateau of Thailand, and the Ratanakiri Plateau and the Chlong Highlands on the east merging with the Central Highlands of Vietnam.

The Tonle Sap basin-Mekong Lowlands region consists of plains with elevations generally of lower than 100 m. The Cardamon Mountains in the southwest rise to more than 1,500 m and include the highest mountain in Cambodia, Phnom Aural at 1,813 m. The Elephant Mountains are an extension of the Cardamon Mountains and range toward south and southeast. The elevations of the mountains range from 500 m to 1,000 m. The Dangrek Mountains at the northern rim of the Tonle Sap basin consist of steep escarpments and the average elevation is around 500 m.

AB-1.3 River System

The Mekong River is the largest river in Cambodia and dominates the hydrology of the country. The river originates in China and flows through Myanmar, Laos and Thailand before entering Cambodia. At Phnom Penh, 2 main arms of the river are confluent: the Bassac River from the south and the Tonle Sap River from the northwest. Average annual discharge at Kracheh of 441,000 m^3 is equivalent to 93% of the total discharge of the Mekong River. The discharge at Kracheh ranges from 1,250 m^3/sec to 66,700 m^3/sec.

One of the roles of the Tonle Sap is a buffer of the Mekong River system: reducing flood discharge and supplying water in the dry season. From mid-June, the discharges of the Mekong River and the Bassac River with the monsoon rains bring flood around the delta. The flood continues for 4 ~ 7 months. During the flood, instead of overflowing its bank, the floodwater reverses the flow of the Tonle Sap River and pours in the Great Lake, say the Tonle Sap.

The water area of the Tonle Sap ranges from 2,600 km^2 in the dry season to 13,000 km^2 in the rainy season. Accordingly, the water level of the lake also changes by an average of 7 m. Until the lake water level drops to its minimum surface size, a band 20 ~ 30 km wide of inundated forest is left dry with deposits of a new layer of sediment. Although these forests are of great significance for fish, the area of forests decreases recently as the result of silting and deforestation[1].

[1] *Statistical Yearbook of Cambodia 2008 (Ministry of Planning, 2008)*

CHAPTER AB-2 SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

AB-2.1 Roleang Chrey Headworks Rehabilitation Sub-project

AB-2.1.1 Meteorology

AB-2.1.1.1 Observation and Data Availability

In Cambodia, there is a meteorological observation station at Pochentong in Phnom Penh near the SPPIDRIP Area, which is managed by Department of Meteorology of MOWRAM. The location of Pochentong observation station is shown in Figure AB-2.1.1.1.1 Observation has been made for temperature, rainfall, relative humidity, wind speed, sunshine hours and evaporation at this observation station. In the previous studies, rainfall data was collected for 105 years from 1901 to 2005, and other data for 15 years from 1991 to 2005. Thus, these data was additionally collected by 2010 in this Survey.

AB-2.1.1.2 Climate Conditions

Tables AB-2.1.1.2.1 to 8 and Figures AB-2.1.1.2.1 and 2 present the monthly meteorological data from 1991 to 2010, which are converted from the daily data. The average monthly meteorological data from 1991 to 2010 are shown in Table AB-2.1.1.2.9.

Table AB-2.1.1.2.9 Average 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)*

As can be seen in the above table, monthly mean temperature at the Pochentong station shows seasonal variation from 26.2 °C in December to 30.6 °C in April. Monthly maximum temperature higher than 31 °C is common. Monthly minimum temperature rarely falls down below 21 °C. Mean annual rainfall at Pochentong is estimated at 1,384 mm. Monthly rainfall shows obvious difference between the dry season and the rainy season. About 80% of annual rainfall concentrates in the rainy season, say May to October. Monthly mean relative humidity ranges from 70% in February and March to 84% in September and October. The relative humidity is high at night and low at daytime throughout the year. Monthly mean wind speed ranges 3.1 m/sec in October to 5.4 m/sec in August. Annual mean evaporation is 4.4 mm/day ranging 3.1 mm/day to 6.2 mm/day.

AB-2.1.1.3 Study on Methodology for Hydrological Analysis applied in Previous Studies

Meteorological conditions highly influence the methodology to be applied for hydrological analysis. In order to know whether the methodology applied for hydrological analysis in the previous studies, a study is therefore made for comparison of meteorological data from 1991 to 2010 with those from 1991 to 2005 which were used in the previous studies. Table AB-2.1.1.3.1 shows the average monthly meteorological data from 1991 to 2005.

Table AB-2.1.1.3.1 Average Meteorological Data at Pochentong Station (1991 - 2005)

Item	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average or Total
Temperature	°C													
Mean		26.4	27.8	29.4	30.5	30.2	29.3	28.7	29.3	28.1	27.5	26.9	26.2	28.3
Maximum		31.6	33.2	34.9	35.7	35.0	33.8	32.7	32.6	32.2	31.3	31.1	30.9	32.9
Minimum		21.2	22.4	23.8	25.3	25.4	24.9	24.6	26.0	24.0	23.7	22.7	21.5	23.8
Rainfall*	mm	7.5	8.4	26.8	70.3	140.8	144.5	148.7	160.3	241.3	259.8	131.9	37.6	1,377
Humidity	%	73.2	70.7	69.7	71.0	75.8	77.8	81.1	81.7	84.6	84.6	79.0	74.9	77.0
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	4.4	5.5	6.3	5.9	4.8	4.5	4.0	3.9	3.3	2.9	3.5	4.1	4.4
Sunshine	hr/day	8.7	8.6	8.3	8.0	7.2	6.3	5.7	5.8	5.5	6.0	7.5	8.3	7.1

Source: 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)*
Note: Wind Speed data during the period from September 2005 to December 2005 are unavailable.

As the result of comparing Table AB-2.1.1.2.9 with Table AB-2.1.1.3.1, there did not find any conspicuous change between both (refer to Figure AB-2.1.1.3.1). From this result, it is judged that the methodology of hydrological analysis adopted in the previous studies could be applied to this Survey.

AB-2.1.2 Hydrology

AB-2.1.2.1 Observation and Data Availability

The hydrological data from 1991 to 2005 were collected in the previous studies. In this Survey, the data from 2006 to 2011 are additionally collected from the Department of Meteorology of MOWRAM.

(1) Rainfall Observation Period

Rainfall observatories set up in/around the Prek Thnot River basin is shown in Table AB-2.1.2.1.1 and Figure AB-2.1.2.1.1. Observation period at each station is shown in the same table.

Table AB-2.1.2.1.1 Observation Period at each Rainfall Station

No	Rainfall Station	Observation Period	No	Rainfall Station	Observation Period
1	Chbar Mon / Kampong Speu	1966 ~ 1969, 1982 ~ 2011	10	Aoral	1997 ~ 2011
2	Phnom Srouch	1966 ~ 1969, 1988 ~ 2011	11	Ou Taroth	2000 ~ 2011
3	Odong	1987 ~ 2003, 2005 ~ 2009	12	Prey Pdou	1997 ~ 2007
4	Srae Klang	2000 ~ 2009	13	Prey Dob	1983 ~ 1990, 2000 ~ 2011
5	Krang Ampil	2000 ~ 2010	14	Sdok	2000 ~ 2011
6	Kirirom	1966 ~ 1969, 2000 ~ 2005	15	Trapeang Chor	2000 ~ 2011
7	Thnal Toteung	1983 ~ 2009	16	Thpong	1987 ~ 2011
8	Basedth	1987 ~ 2011	17	Peam Khley	2000 ~ 2011
9	Kong Pisey	1984 ~ 2011			

Source: Department of Meteorology, MOWRAM

Monthly mean rainfall in each observation station are tabulated in Tables AB-2.1.2.1.2 to 18 and summarized in Table AB-2.1.2.1.19.

(2) Water Level and Discharge Observation

The F/S report mentions that there are some stations on water level and discharge observation, but only Peam Khley station and at the Roleang Chrey Headworks are under operation. Although some water gauging stations were established at the F/S time, the recording period is too short to apply the data for hydrological analysis. In addition, staff gauges at the Roleang Chrey Headworks are installed in the regulating pond and on the right abutment downstream of the headworks. It means that natural conditions of the Prek Thnot River could not be observed at this point. On the other hand, the Peam Khley station installed nearby the Roleang Chrey Headworks (refer to Figure AB-2.1.2.1.2) has long term records since 1901. Considering these conditions, it was decided to collect the water level data observed at the Peam Khley station for hydrological analysis, which is the same approach with F/S.

Monthly discharge data at the Peam Khley station is available for the period from 1901 to 1972 and 1997 to 2011. Daily discharge data is also available at the station for the period from 1997 to 2011. These monthly and daily discharge are calculated based on the observed water level data and rating curve as below.

(3) Discharge Rating Curve

Based on the water level and measured discharge data at Peam Khley station in the period from 1997 to 2010, the discharge rating curve at the station are developed and shown in Figure AB-2.1.2.1.3.

In order to convert the water level to discharge, 2 equations of rating curve are derived by the least square method as expressed below:

Water level > 1.5 m

$Q = 20.0624*(H - 0.94412)^2$

Water level ≤ 1.5 m

$Q = 12.6168 * (H - 0.62546)^2$

Where, *Q: discharge* (m^3/sec)
H: gauged water level (m)

The results of the discharge calculation are shown in Tables AB-2.1.2.1.20 to 33.

AB-2.1.2.2 Prek Thnot River System

The Prek Thnot River originates from the Elephant Mountain Region and flows in the direction of southeast to east from the region. The highest elevation in the Prek Thnot River basin is EL. 1,543 m above the mean sea level.

(1) Delineation of River Basin Boundary

The schematic diagram of the Prek Thnot River system is shown in Figure AB-2.1.2.2.1. The river system consists of 11 sub-basins as shown in Table AB-2.1.2.2.1 and Figure AB-2.1.2.2.2. The catchment area and the length of the river course are about 5,740 km^2 and 230 km at the confluence with the Bassac River, respectively.

Table AB-2.1.2.2.1 Area of Each Sub-basin

Sub-basin	Catchment Area (km^2)	Sub-basin	Catchment Area (km^2)
Trang Krang	294	Tang Haong	1,435
Ta Sal	674	Anlong Ramilch	228
Aveaeng	431	Bat Kmeng	300
Phleah	235	Kandal	78
Aoral	502	Residual	18
Ou Krang Ambel	455	**Total**	**4,650**

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

(2) Longitudinal Slope of Prek Thnot River

According to F/S, the longitudinal slope of the Prek Thnot River from the Peam Khley to the confluence with the Bassac River ranges from 1/2,720 for the upstream reaches to 1/5,100 for the downstream reaches. The longitudinal slope of the river is shown in Figure AB-2.1.2.2.3 and briefly summarized as Table AB-2.1.2.2.2

Table AB-2.1.2.2.2 Longitudinal Slope of Prek Thnot River

Chainage	Slope
0 – 35,000	1/5,100
25,000 – 65,000	1/4,170
65,000 – Roleang Chrey Headworks	1/2,720
Roleang Chrey Headworks – Peam Khley Bridge	1/2,720

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

(3) Discharge Carrying Capacity of Prek Thnot River

In F/S, flow capacity of the Prek Thnot River was estimated through the non-uniform flow calculation with various discharges.

The results of calculation are shown in Table AB-2.1.2.2.3 and Figure AB-2.1.2.2.4-5.

Table AB-2.1.2.2.3 Discharge Carrying Capacity of Prek Thnot River

Chainage (m)	Discharge Carrying Capacity (m^3/s)
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 Headworks)	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

AB-2.1.2.3 Hydrological Analysis

Hydrological analysis consists of 3 parts. These are (i) average depth of rainfall over area, (ii) low flow analysis for water balance calculation and (iii) flood analysis to determine the flood peak discharge for determination of the design discharge for the Roleang Chrey Headworks.

(1) Average Depth of Rainfall over Area

In order to calculate the discharge at the Roleang Chrey Headworks, average depths of rainfall over area are calculated as described below:

According to the rainfall data in/around the Prek Thnot River basin (refer to Tables AB-2.1.2.1.2 to 18), mean annual rainfall in upstream basin of the Peam Khley station and basin of Ou Krang Ambel Reservoir are calculated by the Thiessen method. The results of calculation for upstream basin of the Peam Khley station and basin of Ou Krang Ambel Reservoir are given in Table AB-2.1.2.3.1 and Table AB-2.1.2.3.2, respectively.

Table AB-2.1.2.3.1 Annual Rainfall in each Station and Mean Rainfall in Upstream Basin of Peam Khley

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 AB-2.1.2.3.2 Annual Rainfall in each Station and Mean Rainfall in Basin of Ou Krang Ambel Reservoir

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

(2) Low Flow Analysis

Low flow analysis is conducted to determine the discharge applied to the water balance calculation. Firstly, the probable drought discharges are determined by the hydrological statistical method. Secondary, 5-day discharge at each probability is calculated so that water balance calculation could be carried out by 5-day step.

(a) Probable Drought Discharge at Peam Khley

Based on the record of monthly discharge at the Peam Khley observation station during 85 years (1901 ~ 1971 and 1997 ~ 2010), the probability analysis is carried out to determine the drought discharge at 20% non-exceedance probability and 50% non-exceedance probability.

Drought discharge at 20% non-exceedance probability means that each annual discharge in 4 years out of 5 years would not fall below the drought discharge. In other words, discharges not less than the drought discharge are guaranteed to be available in 4 years out of 5 years. Drought discharge at 50% non-exceedance probability means the same in 1 year out of 2 years. These discharges are applied to water balance calculation in Clause AB-2.1.3.

These drought discharges are determined by the annual discharge with hydrological statistical method.

The year when the 17th lowest annual discharge, or a percentile rank of 20% in 85 years, occurred would be applied as reference year. Namely, monthly mean discharge of the year would be almost equivalent to 50% non-exceedance probability. The reference year of the drought discharge at 50% non-exceedance probability is the year when the 43rd lowest annual discharge occurred.

Consequently, 1911 is selected as the reference year with the discharge at 20% non-exceedance probability. Then, 1948 is selected as the reference year with the discharge at 50% non-exceedance probability.

The general discharge condition and the adopted monthly discharges at Peam Khley station with 20% non-exceedance probability and 50% non-exceedance probability are tabulated in Table AB-2.1.2.3.3.

Table AB-2.1.2.3.3 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
Max	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
Min.	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

Source: JICA Survey Team
**: Non-exceedance probability*

(b) Dependable 5-day Discharge

1) Dependable 5-day Discharge at Peam Khley Observation Station

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. Based on these discharge and irrigation water requirements, water balance calculation would be made.

The 5-day discharges for 20% non-exceedance probability and 50% non-exceedance probability are calculated by the distribution from probable 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 the 14 years from 1997 to 2010. The calculation results for both cases are shown in Table AB-2.1.2.3.4.

Table AB-2.1.2.3.4 5-day Discharge for each Non-exceedance Probability at Peam Khley

(Unit: m^3/sec)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
20% Non-exceedance Probability												
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
50% Non-exceedance Probability												
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

2) 5-day Discharge at Roleang Chrey Headworks

The 5-day discharge 20% non-exceedance probability and 50% non-exceedance probability at the Roleang Chrey Headworks is calculated from those 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 Headworks is as follows (Refer to Table AB-2.1.2.3.5):

$$Qr = Qp \times Ar / Ap$$

Where, *Qr: discharge at Roleang Chrey Headworks (m^3/sec),*
Qp: discharge at Peam Khley (m^3/sec),
Ar: upstream area of Roleang Chrey Headworks (=3,911 km^2),
Ap: upstream area of Peam Khley (=3,654 km^2)

Table AB-2.1.2.3.5 5-day Discharge for each Non-exceedance Probability at Roleang Chrey Headworks

(Unit: m^3/sec)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
20% Non-exceedance Probability												
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
50% Non-exceedance Probability												
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

3) 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 (= 453 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 AB-2.1.2.3.6 5-day Discharge each 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
20% Non-exceedance Probability												
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
50% Non-exceedance Probability												
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

(3) Probable Flood at Roleang Chrey Headworks

In order to determine the design discharge of the Roleang Chrey Headworks, some discussions are given here on flood discharge at the headworks of the Prek Thnot River.

(a) Past Flood Discharge

According to F/S and water level data collected in this Survey, the past annual peak discharges of the Prek Thnot River are estimated as shown in TableAB-2.1.2.3.7.

Table AB-2.1.2.3.7 Annual Peak Discharge of Prek Thnot River at Roleang Chrey Headworks

(Unit: m^3/sec)

Year	Peak Discharge at Roleang Chrey Headworks	Peak Discharge at Peam Khley Station
1991	1,371	
1996		801
1997		826
1998		507
1999		798
2000	1,276	1,276
2001		866
2002		132
2003		926
2004		214
2005		302
2006	1,191	1,125
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 and additional data collected from MOWRAM

Based on the gate caretaker of the Roleang Chrey Headworks, the flood peak in 1991 was the maximum in his career since 1969. The discharge data shown in the table also indicates that the flood peak in 1991 should be the maximum in the past 42 years.

(b) Probable Flood Peak Discharge

Thus the flood peak discharge of the Prek Thnot River in the past 42 years is estimated at 1,371 m^3/sec. This means that the probable flood peak discharge of the Prek Thnot River 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 Headworks is estimated at 1,300 ~ 1,500 m^3/sec (refer to Sub-clause AB-2.1.2.2).

This may correspond to the past flood peak discharge at the headworks site as 1,371 m^3/sec in 1991.

However the available flood peak discharge data of the Prek Thnot River is too limited to conduct the numerical probability analysis for the exceedance probability of more than 20 years.

Accordingly the probable flood peak discharge as the design discharge or the Roleang Chrey Headworks for its reconstruction would be between 1,400 ~ 1,600 m^3/sec from conservative view point on the condition that any river works to increase the river flow capacity in the upstream reaches would not be implemented. After all, in the M/P study, the design flood discharge for rehabilitating the Roleang Chrey Regulator was 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.

AB-2.2 Upper Slakou Irrigation System Rehabilitation Sub-project

AB-2.2.1 Meteorology

As mentioned in Clause AB-2.1.1, there is a meteorological observation station at Pochentong in Phnom Penh near the USISRSP Area, which would be used for estimating water demand for USISRSP. All of hydrological information to be explained here is also shown in the following Sub-section.

AB-2.2.2 Hydrology

AB-2.2.2.1 Observation and Data Availability

(1) Rainfall Observation

In F/S, the rainfall data was collected at Takeo rainfall station. Although daily rainfall records in the Takeo rainfall station are relatively enrich, this station is located at downstream from the USISRSP Area and the rainfall at the station does not directly affect the discharge of the Slakou River (refer to Table AB-2.2.2.1.1 and Figure AB-2.2.2.1.1). While a part of the rainfall data collected in RCHRSP is also available for hydrological analysis in USISRSP. Three out of 17 rainfall observatories in/around the Prek Thnot River basin are selected as the relevant stations to USISRSP: Basedth, Prey Dob and Srae Klong. Accordingly, the rainfall data are collected from not only Takeo Station but also those 3 stations in the Prek Thnot River basin.

Table AB-2.2.2.1.1 Annual Maximum Daily Rainfall Data at Takeo Station (1994-2010)

Year	Annual Maximum Daily Rainfall
1994	93.5
1995	82.0
1996	67.4
1997	56.7
1998	82.2
1999	121.0
2000	89.5
2001	89.0
2002	63.5
2003	47.5
2004	95.0
2005	55.0
2006	59.0
2007	122.0
2008	63.2
2009	41.2
2010	96.5

Source: MOWRAM

(2) Water Level and Discharge Observation

The previous studies mention that there are no water level and discharge observation stations in the Slakou River basin, but some discharge measurement has been done for obtaining verification data for hydrological analysis at the F/S Time, in cooperation with Takeo PDOWRAM. Unfortunately, such discharge measurement has not been done by Takeo PDOWRAM since that time. Thus, no discharge data of the Slakou River system are available.

AB-2.2.2.2 Slakou River System

The Slakou River, called Tras Stream at upstream, is perennial, although the flow becomes negligibly small in the mid dry season. There are 3 reservoirs in the Slakou River basin: Tumnup Lok Reservoir, Kpob Trobek Reservoir and Don Phe Reservoir.

(1) Delineation of River Basin Boundary and Location of Reservoirs

Layout and catchment area of the Slakou River are drawn in Figure AB-2.2.2.2.1. Catchment areas of the reservoirs are shown in Table AB-2.2.2.2.1.

Table AB-2.2.2.2.1 Catchment Area of each Reservoir

Reservoir	Catchment Area (km^2)
Tumnup Lok	332
Kpob Trobek*	137
Don Phe	70

Source: JICA Survey Team
**: Including catchment area of the Don Phe Reservoir*

The Tumnup Lok Reservoir is located on the Slakou River. On the other hand, the Kpob Trobek Reservoir and the Don Phe Reservoir exist on the Don Phe Stream which inflows to the Slakou River at downstream of the Tumnup Lok Reservoir. This stream is perennial, however dries up several months in the dry season at the Kpob Trobek Reservoir site, because all water is abstracted for irrigation around the Don Phe Reservoir located on 8 km upstream of the Kpob Trobek Reservoir.

AB-2.2.2.3 Hydrological Analysis

As mentioned above, continuous observation of water level has not been conducted in the Slakou River basin. On the other hand, a water level observation at the Peam Khley station on the Prek Thnot River, neighboring the Slakou River basin, has been continuously carried out as mentioned in Sub-clause AB2.1.2.1. Moreover, these 2 rivers ordinate from the same region, say Elephant mountain region. In consideration of this condition, the Slakou River discharge was estimated from the discharge of the Prek Thnot River at the Peam Khley observation station in F/S. In this Survey, taking it into consideration that the observation condition has not changed since the F/S Time, the Slakou River discharge is estimated in the same method with F/S.

In order to execute the water balance calculation in the USISRSP Area, the discharges of the Tumnup Lok Reservoir on the Slakou River and the Kpob Trobek Reservoir on the Don Phe Stream are calculated by the runoff model with the average depth of rainfall in each basin. Prior to the discharge calculation, the runoff model is validated by rainfall data newly collected in the Survey.

(1) Runoff Analysis Model

The outline of the runoff analysis model applied is as follows:

Tank model method is usually used for estimate of daily runoff from daily basin rainfall data. However, reliable daily rainfall data are not available and rainfall observation points measuring rainfall for a long period is only 2 stations. Instead of the tank model method, monthly rainfall distribution method is employed to find the relationship between rainfall and discharge.

Rainfall is partly consumed by evapotranspiration and the contribution of rainfall to runoff depends on the amount. If rainfall amount 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 mount 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 are 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, 2 months ago, 3 months and 4 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 can meet to actual runoff as much as possible.

At first, the runoff simulation and coefficients estimate are conducted for the Prek Thnot River at the Peam Khley station with the updated rainfall data. As the results of fitting arrangement, actual and simulated discharges are described in Figure AB-2.2.2.2.2 and the coefficients are determined as follows:

$\alpha = 1.23$ *and* $\beta = 0.006$

$A = 0.68, B = 0.23, C = 0.08, D = 0.015, E = 0.01$, *and* $F = 0.005$

As shown in the figure mentioned 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 is still considered to be highly repeatable at present. Consequently, the runoff analysis model could be applied to the Survey.

(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 is calculated by the Thiessen method. The results of calculation are shown in Table AB-2.2.2.3.1. As shown in this table, the average rainfall over area ranges from 1,000 mm to 1,200 mm.

(3) Low Flow Analysis using Estimated Discharges of Slakou River and Reservoirs

The discharge from each reservoir is calculated by the runoff analysis model as explained above. The rainfall data input to the model are the average depth of rainfall over area calculated previously. Finally, the results of the discharge calculation by validated runoff model using updated rainfall data are shown in Table AB-2.2.2.3.2 and Figure AB-2.2.2.3.1.

Table AB-2.2.2.3.2 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
Max.	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
Min.	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
Max.	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
Min.	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
Max.	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
Min.	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

(4) Flood Discharge at Reservoirs

Actual flood data have not been recorded in the Slakou River basin since the time when F/S carried out. According to F/S, flood discharge of each reservoir are estimated by following 3 methods: (i) a recommended method (hereinafter called as the IRS method) in Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat), (ii) unit hydrograph method and (iii) non-uniform calculation method. Among these 3 methods, non-uniform calculation was conducted only 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 using the remaining 2 methods except non-uniform calculation method, based on additionally collected rainfall data.

(a) IRS Method

IRS method is represented by the following equations:

$$MAF = AREA^{0.9}$$

$$Q_{10} = 1.53 \times MAF$$

$$Q_{100} = 2.20 \times MAF$$

Where, MAF : mean annual flood (m³/sec),
AREA : catchment area (km²)
Q_{10} : *flood expected to occur not more than once every 10 years on an average,*
Q_{100} : *flood expected to occur not more than once every 100 years on an average.*

Consequently, the calculation results in F/S and this Survey are the same because the equations just depend on the catchment area which would not change in some decades. The results of calculation are shown in Table AB-2.2.2.3.3.

Table AB-2.2.2.3.3 Flood Discharge by IRS Method (USISRSP)

Reservoir	Catchment Area (km^2)	Q_{10} (m^3/sec)	Q_{100}(m^3/sec)
Kpob Trobek	137	128	184
Tumnup Lok	332	284	409

Source: JICA Survey Team

(b) Unit Hydrograph Method

Unit hydrograph method is based on a manual used and accepted at Office of Accelerated Rural Development, Ministry of Interior, Thailand. This method is employed for flood estimate of each river and reservoir. Details of calculation are explained in “Planning Guideline for Rehabilitation and Reconstruction of Irrigation System”, made by the F/S Team.

The results of calculation are summarized in Table AB-2.2.2.3.4.

Table AB-2.2.2.3.4 Flood Discharge by Unit Hydrograph Method (USISRSP)

Reservoir	Catchment Area (km^2)	Flood discharge (m^3/sec)		
		100 years	80 years	50 years
Kpob Trobek	137	203	195	177
Tumnup Lok	332	450	433	392

Source: JICA Survey Team

(c) Conclusion

From the calculation results mentioned above, the design flood discharges of each reservoir are shown in Table AB-2.2.2.3.5. Both design flood discharges of 2 reservoirs are larger than those of F/S. From conservative viewpoint and data sufficiency, however, it is proposed to use these flood discharges for rehabilitation of relevant facilities in this Survey.

Table AB-2.2.2.3.5 Proposed Design Discharge of 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

AB-2.3 Kandal Stung-Bati Irrigation System Rehabilitation Sub-project

AB-2.3.1 Meteorology

Although there are some meteorological observation stations around the KSBISRSP Area, the meteorological data at Pochentong is more long-term and more reliable. In this Survey, the meteorological data at Pochentong was used for estimating water demand for KSBISRSP. The average monthly meteorological data at Pochentong from 1991 to 2010 are shown in Table AB-2.3.1.1.

Table AB-2.3.1.1.1 Average 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

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)*
Note: Wind Speed data during the period from September 2005 to December 2010 were unavailable.

As can be seen in the above table, monthly mean temperature at the Pochentong station shows seasonal variation from 26.2 °C in December to 30.6 °C in April. Monthly maximum temperature higher than 31 °C is common. Monthly minimum temperature rarely falls down below 21 °C. Mean annual rainfall at Pochentong is estimated at 1,384 mm. Monthly rainfall shows obvious difference between the dry season and the rainy season. About 80% of annual rainfall concentrates in the rainy season, say May to October. Monthly mean relative humidity ranges from 70% in February and March to 84% in September and October. The relative humidity is high at night and low at daytime throughout the year. Monthly mean wind speed ranges 3.1 m/sec in October to 5.4 m/sec in August. Annual mean evaporation is 4.4 mm/day ranging 3.1 mm/day to 6.2 mm/day.

AB-2.3.2 Hydrology

AB-2.3.2.1 Observation and Data Availability

There is no water level gauging station and discharge measurement station in and around KSBISRSP Area included the Touch River. In this Survey, the discharge at the Touch River and the Tonle Bati River are estimated using discharge observed at Peam Khley station of the Prek Thnot River.

The rainfall gauging stations and the Thiessen polygons in and around the Prek Thnot River basin and KSBISRSP Areas are shown in Figure AB-2.3.2.1.1.

AB-2.3.2.2 Kandal Stung-Bati River System

KSBISRSP areas are irrigated by water from the Prek Thnot River by the Roleang Chrey Headworks, the Ou Krang Ambel River, the Stung Touch River and the Tonle Bati River. As described in Sub-clause AB-2.1.2.2, the Prek Thnot River originates from the Elephant Mountain Region and flows in the direction of southeast to east from the region. The highest elevation in the Prek Thnot River basin is EL. 1,543 m above the mean sea level.

There are 3 reservoirs (i) O Sya Reservoir (ii) Chan Tanal Reservoir and (iii) Ou Krang Ambel Reservoir in the Ou Krang Ambel River. Also there is the Lake Tonle Bati in the Tonle Bati River. Schematic diagram of the Roleang Chrey and KSBISRSP Area is shown in Figure AB-2.3.2.1.2. The catchment areas at key points are shown in Table AB-2.3.2.1.1.

Table AB-2.3.2.1.1 Catchment Area at Key Points of KSBISRSP Area

Location (River)	Catchment Area (km^2)	Sub-basin	Catchment Area (km^2)
Peam Khley W.L. Station (Prek Thnot River)	3,654	O Sya Reservoir (Ou Krang Ambel River)	144
Roleang Chrey Headworks (Prek Thnot River)	3,911	Chan Tanal Reservoir (Ou Krang Ambel River)	268
Stung Touch (near NR2) (Stung Touch River)	148	Ou Krang Ambel Reservoir (Ou Krang Ambel River)	453
Lake Tonle Bati (Tonle Bati River)	238		

Source: JICA Survey Team

AB-2.3.2.3 Rainfall Analysis

(1) Double Mass Curve Analysis

For checking of rainfall data, the double mass curve analysis of accumulated annual rainfall at each rainfall station in and around The Project area was conducted as shown in Figure 2.3.2.3.1. There are no significant errors of rainfall data except some years of Kampong Chhnang station (from year 1991 to 2000) and Thnal Tetung station.

(2) Rainfall Correlation Analysis

For estimation of long term discharge for water balance study, long term basin rainfall was estimated using available rainfall data. Missing rainfall data were interpolated using correlation coefficients of available nearby or key rainfall station data. The annual rainfall correlation coefficients "a" of $Y=a*X$ and the R^2 are shown in Table 2.3.2.3.1.

(3) Interpolation of Missing Data

As described in above, the missing daily rainfall data were interpolated using correlation coefficients of available nearby or key rainfall station data. Table AB-2.3.2.3.2 shows observed and interpolated annual rainfall in/around the KSBISRSP Area.

(4) Long-term Basin Rainfall

Long-term daily basin rainfall from 1982 to 2011 (30 years) was estimated using the Thiessen coefficients and observed and interpolated daily rainfall data. The Thiessen coefficients for each sub-basin included the Stung Touch River and the Tonle Bati River are shown in Table AB-2.3.2.3.3. Estimated annual basin rainfall at sub-basin of the Prek Thnot River, the Stung Touch and the Tonle Bati River are shown in Table AB-2.3.2.3.4.

AB-2.3.2.4 Low Flow Analysis

(1) Estimation of Long-term Discharge by Tank Model

As shown in Figure AB-2.1.2.1.2, there are some water level and discharge gauging station in the Prek Thnot River basin. However, after the downstream of Roleang Chrey headworks, the measured river water level or discharge are effected by irrigation intakes. Thus, in this Survey, the observed daily water level and H-Q rating curve at Peam Khley gauging station was used for water balance study.

The observed daily water level data at Peam Khley gauging station are available from 1997 to 2011 (15 years). For water balance study on irrigation water requirement and available river water, long-term daily discharge for 30 years from 1982 to 2011 was prepared. Missing period from 1982 to 1996 (15 years) are estimated using the Tank Model. The model parameters of the daily Tank Model are calibrated using observed daily discharge at Peam Khley from 1997 to 2011. The calibrated parameters of the daily base Tank Model for Peam Khley gauging station are shown in Figure AB-2.3.2.4.1. Observed daily discharge was calculated using daily observed water level and H-Q rating curve as shown in Section AB-2.1.2.1(3). Figure AB-2.3.2.4.2 shows comparison of observed daily discharge and estimated daily discharge by the Tank Model at Peam Khley. There are some differences between observed and estimated discharge by the Tank Model, however, most of trends of hydrographs are fitted observed and estimated discharge. Observed and estimated monthly mean discharge by the Tank Model is shown in Table AB-2.3.2.4.1.

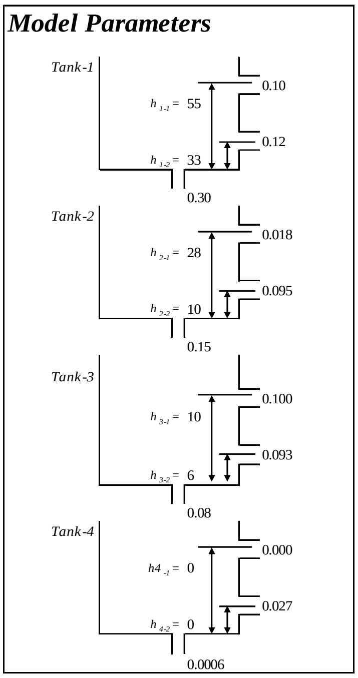


Figure AB-2.3.2.4.1 Calibrated Tank Model Parameters for Peam Khley

After estimation of daily discharge at Peak Khley by Tank Model, 5days mean discharge was prepared for water balance study as shown in Table AB-2.3.2.4.2.

(2) Estimation of Long-term Discharge at Sub-Basin

Using estimated and observed 5days mean discharge at Peam Khley, 5days mean discharge at target points such as reservoirs in the Ou Krang Ambel River, the Stung Touch River and the Lake Tone Bati inflow discharge are estimated using catchment area and annual rainfall as shown in below.

$$Q_t = Q_{PK} \times \frac{A_t}{A_{PK}} \times \frac{R_t}{R_{Pk}}$$

Where, Q_t : *Discharge at target point (m^3/sec)*
Q_{PK} : *Discharge at Peam Khley W.L. gauging station (m^3/sec)*
A_t : *Catchment area at target point (km^2)*
A_{PK} : *Catchment area at Peam Khley W.L. gauging station (km^2)*
R_t : *Annual basin rainfall at target point (mm/year)*
R_{PK} : *Annual basin rainfall at Peam Khley W.L. gauging station (mm/year)*

(3) Reservoir Operation of Existing Reservoirs

There are 3 reservoirs (i) O Sya Reservoir (ii) Chan Tanal Reservoir and (iii) Ou Krang Ambel Reservoir in the Ou Krang Ambel River. Main futures of these 3 reservoirs is shown in Table AB-2.3.2.4.3. Detaille features of Lake Tonle Bati are shown in Table 2.3.2.4.4 and

Figure 2.3.2.4.3. In the reservoir operation simulation, pan evaporation at Pochentong is used for evaporation from reservoir and percolation from reservoir bed was assumed at 2.0 mm/day.

Table AB-2.3.2.4.3 Main Future of Existing Reservoirs in Ou Krang Ambel River and Tonle Bati River

Reservoir	Catchment Area (km^2)	Reservoir Area (m^2)	Effective Storage Volume (MCM)	Irrigation Area (ha)
O Sya Reservoir	144	1,029,000	3.6	730
Chan Tanal Reservoir	268	1,200,000	3.0	1,470
Ou Krang Ambel Reservoir	453	218,000	0.85	450
Tonle Bat Reservoir	238.2	6,240,000	0.85	450

Source: JICA Survey Team

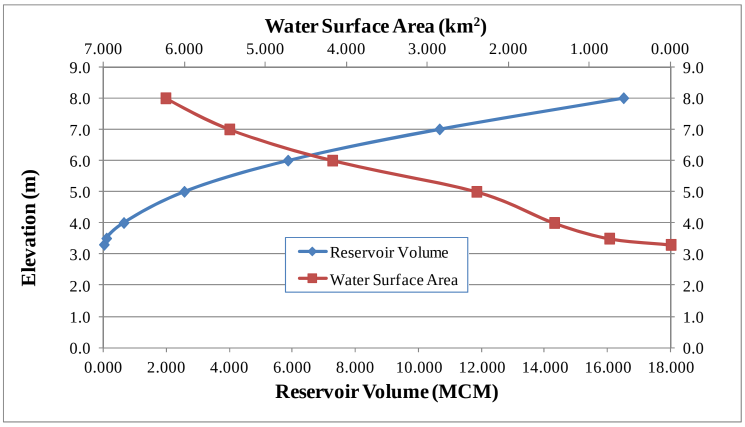
Table AB-2.3.2.4.4 Main Future of Lake Tonle Bati

Reservoir	Tonle Bati Lake
River	Tonle Bati
C.A.	238.2 km^2

Elevation (El.m)	Volume (MCM)	Area (km^2)
3.3	0.000	0.000
3.5	0.076	0.760
4.0	0.626	1.440
5.0	2.546	2.400
6.0	5.836	4.180
7.0	10.651	5.450
8.0	16.496	6.240

Full Supply Level (FSL) (EL.m)	7.8	m
Riverbed Elevation (EL.m)	3.3	m
Dead Wter Level (EL.m)	4.0	m
Freeboard	1.00	m
Dam Height (m)	5.5	
Gross Storage Vol.(x10^6 m^3)	15.33	MCM
Dead Storage (x10^6 m^3)	0.63	MCM
Effective Storage Vol.(x10^6 m^3)	14.70	MCM
Irrigation Area (Priority Area)	1,600	ha

Source: JICA Survey Team



Source: JICA Survey Team

Figure AB-2.3.2.4.3 Reservoir Storage Curve of Lake Tonle Bati

Design outflow from each reservoir on the reservoir operation simulation was decided to achieve irrigation water demand of own command area. The results of reservoir operation simulation of each existing reservoir in the Ou Krang Ambel River and the Tonle Bati River are shown Figures 2.3.2.4.4 and 2.3.2.4.5.

AB-2.3.2.5 Water Balance Study

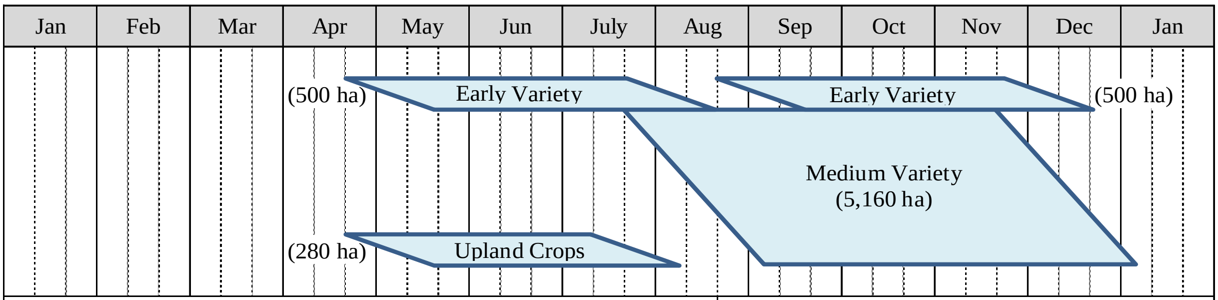
(1) General

The water balance study was reviewed and updated in this 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 areas such 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

(a) Cropping Patterns

Irrigation water requirement for the Roleang Chrey Irrigation System was calculated based on the proposed cropping pattern mentioned in Figure AB-2.3.2.5.1, which consists of early variety and medium variety of paddy and upland crop in a year with overall cropping intensity of 114% with 80% dependability.

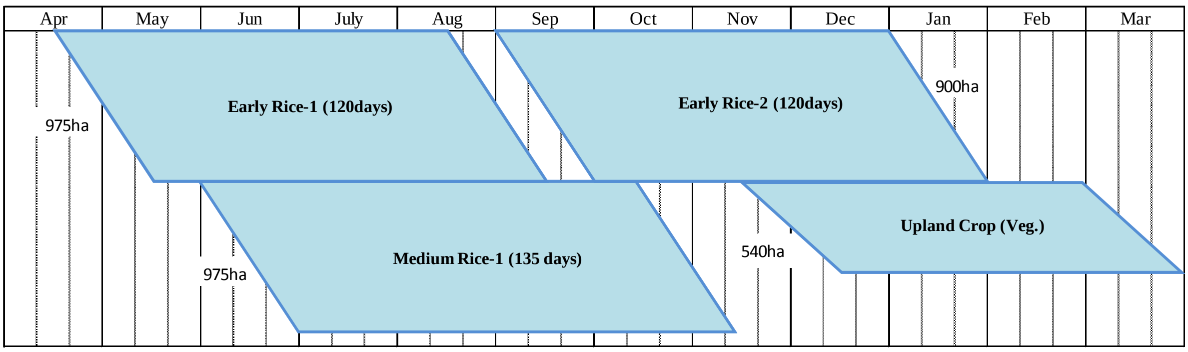


Cropping Pattern	Early: IR 66 or Sen Pidao: 110 days
Double Cropping of Irrigated Rice + (Early variety - early variety)	Seedling: 20 days
Single Cropping of Irrigated Rice + (Medium variety)	Medium: 140 days
Upland crops: 5 %	Seedling: 20 days (20~25)
	Staggering period: 1~ 1.5 month
	Upland Crops: Upland crop & vegetables

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

Figure AB-2.3.2.5.1 Proposed Cropping Patterns for Roleang Chrey System in F/S Review in 2011

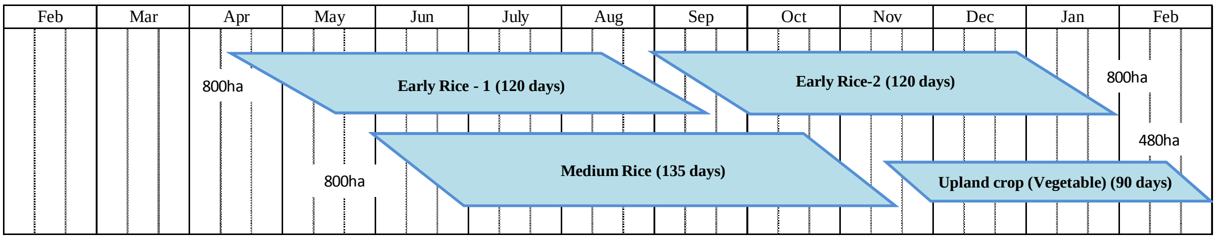
Irrigation water requirement for Kandal Stung (Grant) Irrigation System was calculated based on the proposed cropping pattern mentioned in Figure AB-2.3.2.5.2, which consists of early rice-1 and medium rice-1 and medium rice-2 in a year with overall cropping intensity of 174% with 80% dependability.



Source: *JICA Survey Team*

Figure AB-2.3.2.5.2 Proposed Cropping Patterns for Kandal Stung Area (Grant)

Irrigation water requirement for the Tonle Bati Irrigation System of KSBISRSP was calculated based on the proposed cropping pattern mentioned in Figure AB-2.3.2.5.3, which consists of early variety and medium variety of paddy and upland crop in a year with overall cropping intensity of 180% with 80% dependability.



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

Figure AB-2.3.2.5.3 Proposed Cropping Patterns for Tonle Bati Area KSBISRSP

(b) Applied Method and Estimated Irrigation Water Requirement

The water requirement was calculated by the same procedure in M/P with some modifications, which is summarized in the following table with comparison to those in M/P.

Table AB-2.3.2.5.1 Conditions for Estimate of Irrigation Water Requirement for Roleang Chrey

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 KSBT: Bari Station; 1982-2011
Percolation rate	8 mm/day With introduction of water saving irrigation Method	Remain unchanged
Irrigation efficiency	Paddy; 66% Upland crop; 53%	Remain unchanged

Source: JICA Survey Team

The average diversion water requirement for the Roleang Chrey Headworks estimated in this Survey is shown in table AB-2.3.2.5.2.

Monthly rainfall at Bati station and the estimated effective rainfall, which is used correlation coefficient at 75%, is shown in Table AB-2.3.2.5.3 and Table AB-2.3.2.5.4.

The average diversion water requirements for the Kandal Stung-Bari irrigation System estimated in this Survey is shown in Table AB-2.3.2.5.5.

(c) River Maintenance Flow and Responsible 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 referring to the guidelines of Japan[2]. Irrigation water requirement for the Dangkor Irrigation Systems was used same value as mentioned in M/P.

Table AB-2.3.2.5.6 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*

(3) Water Balance Calculation

(a) 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.

[2] *River maintenance flow; between mean annual draught runoff and 1/10 dependable draught runoff*

Table AB-2.3.2.5.7 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
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 2.3.2.5.8.

Table AB-2.3.2.5.8 Results of Water Balance Simulation for Roleang Chrey and Kandal Stung-Bati Irrigation Area

	Roleang Chrey (Zone-I)	Roleang Chrey (Zone-II)	Dangkor System	Kandal Stung (Grant)	Kandal Stung (Extension)	Bati Area	Kampong Damrey
Total Irrigation Area (ha)	5,660	11,040	300	1,950	0	1,600	0
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%	0%
Dependability	80%	57%	80%	83%		100%	0%

Source: JICA Survey Team

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 83% dependability. While in the Tonle Bati Irrigation Area, total 1,600 ha with crop intensity of 180% was shown 100% dependability. As mentioned above and the conservative viewpoint, it is proposed to use the 80% and 50% dependable areas in M/P. Hydrograph at the Roleang Chrey with total irrigation water demand at the Roleang Chrey Irrigation System and Kandal Stung-Bati Area and the deficit from 1982 to 2011 is shown in Figure AB-2.3.2.5.4. Deficit year are shown in Table AB-2.3.2.5.9. The water balance calculation also clarified that the Kandal Stung (Extension) could not be irrigated without water resources development upstream of the Prek Thnot River.

Table AB-2.3.2.5.9 Deficit Year at Irrigation Area (Present Condition)

Year	R.C.-I	R.C.-II	K.S.(G)	T.B.
1982				
1983	X	X		
1984				
1985				
1986				
1987		X		
1988				
1989				
1990				
1991				
1992	X	X		
1993	X	X	X	
1994				
1995				
1996				
1997		X		

Year	R.C.-I	R.C.-II	K.S.(G)	T.B.
1998	X	X	X	
1999				
2000				
2001		X		
2002	X	X		
2003			X	
2004	X	X		
2005		X		
2006		X		
2007				
2008				
2009		X		
2010		X	X	
2011			X	
Nos. of Deficit	6/30	13/30	5/30	0/30
Dependability	80%	57%	83%	100%

Note: X: Deficit Year (deficit of irrigation water requirement more than 15 days)
Source: JICA Survey Team

AB-2.3.2.6 Flood Analysis

(1) Probable Rainfall

Annual maximum daily point rainfalls at Kampong Speu station from 1983 to 2011 (29 years) are shown in Table AB-2.3.2.6.1. Frequency curve of annual maximum daily point rainfall at Kampong Speu is shown in Figure AB-2.3.2.6.1. Computation method of the Log Peason Type-III is seems to fit the observed annual maximum daily rainfall. According to the Log Peason Type-III Model, probable maximum daily rainfall at return period of 1/50 years and 1/100 years are 127 mm/day and 135 mm/day for Kandal Stung-Bati Irrigation Area, respectively.

Table AB-2.3.2.6.2 Estimated Probable Maximum Daily Rainfall at Kampong Speu

Return Period (Year)	Excess Proba-bility	Computation Method (mm/day)			
		Iwai	Log Peason Type-III	Gumbel	Chow
1.01	0.9901	**44**	**44**	**47**	**51**
1.50	0.6667	**70**	**70**	**70**	**70**
2	0.5000	**78**	**78**	**77**	**77**
5	0.2000	**95**	**95**	**95**	**92**
10	0.1000	**105**	**105**	**106**	**102**
20	0.0500	**115**	**115**	**118**	**112**
25	0.0400	**118**	**118**	**121**	**115**
50	0.0200	**127**	**127**	**132**	**124**
80	0.0125	**132**	**132**	**140**	**131**
100	0.0100	**135**	**135**	**143**	**134**
200	0.0050	**143**	**143**	**154**	**143**
300	0.0033	**148**	**148**	**160**	**149**
500	0.0020	**154**	**154**	**168**	**156**
1,000	0.0010	**162**	**162**	**179**	**165**

Source: JICA Survey Team

(2) Probable Flood

Actual flood data have not been recorded in the Stung Touch River and the Tonle Bati River, flood discharge at the Stung Touch River and the Tonle Bati reservoir are estimated by following 3 methods: (i) a recommended method (hereinafter called as the IRS method) in Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat), (ii) unit hydrograph method and (iii) rational formula method.

(a) IRS Method

IRS method is represented by the following equations. The results of calculation are shown in Table AB-2.3.2.6.3.

$$MAF = AREA^{0.9}$$

$$Q_{10} = 1.53 \times MAF$$

$$Q_{20} = 1.78 \times MAF$$

$$Q_{50} = 2.00 \times MAF$$

$$Q_{100} = 2.20 \times MAF$$

Where, MAF : mean annual flood (m^3/sec),
AREA : catchment area (km^2)
Q_{10} : flood expected to occur not more than once every 10 years on an average,
Q_{100} : flood expected to occur not more than once every 100 years on an average.

Source: Flood Frequency Analysis in Final Report on Irrigation Rehabilitation Project, Sir William Halcrow & Partners Limited in association with Mandala Agricultural Development Corporation, June 1994, Mekong Secretariat.

Table AB-2.3.2.6.3 Estimated Flood Discharge by IRS Method (KSBISRSP)

River / Site		Tonle Bati / Bati Lake (240.2 km^2)				Stung Touch / Duam Ruese (148.2 km^2)			
Return Period	Years	10 years	20 years	50 years	100 years	10 years	20 year	50 years	100 years
Flood Peak Discharge	m^3/sec	212.4	247.1	277.7	305.4	137.6	160.1	179.8	197.8

Source: JICA Survey Team

(b) Unit Hydrograph Method

Unit hydrograph method is employed for flood estimate of each river and reservoir. Details of calculation are explained in "Planning Guideline for Rehabilitation and Reconstruction of Irrigation System", made by the F/S Team. The results of calculation are summarized in Table AB-2.3.2.6.4. The example of estimation of unit hydrograph is shown in Table AB-2.3.2.6.5. The results of unit hydrographs at the Lake Tonle Bati site are shown in Figure AB-2.3.2.6.2.

Table AB-2.3.2.6.4 Estimated Flood Discharge by Unit Hydrograph Method (KSBISRSP)

River/Site	Catchment Area (km^2)	Flood discharge (m^3/sec)					
		10 years	20 years	25 years	50 years	100 years	200 years
Tonle Bati / Bati Lake	240.2	161	189	198	224	249	273
Stung Touch / Duam Ruese	148.2	103	103	108	123	137	151

Source: JICA Survey Team

(c) Rational Formula Method

Rational formula method is used as a reference of peak flood discharge that is estimated by unit hydrograph method. The results of calculation are summarized in Table AB-2.3.2.6.6.

Table AB-2.3.2.6.6 Estimated Flood Discharge by Rational Formula Method (KSBISRSP)

River/Site	Catchment Area (km^2)	Flood discharge (m^3/sec)					
		10 years	20 years	25 years	50 years	100 years	200 years
Tonle Bati / Bati Lake	240.2	171	186	189	204	219	234
Stung Touch / Duam Ruese	148.2	33	35	37	39	43	44

Source: JICA Survey Team

(d) Conclusion

In M/P report, estimated flood discharge of the Stung Touch and the Tonle Bati by Euroconsult (1992) is shown as Table AB-2.3.2.6.7.

Table AB-2.3.2.6.7 Estimated Flood Discharge by Euroconsult (1992)

	Return Period (years)						
	10	20	25	50	100	500	1,000
Prek Thnot at Tuk Thla	860	1,100		1,500	1,900	3,200	3,900
Stung Tonle Bati			103		231		
Stung Toch			54		121		

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.

Compare of above results, estimated flood discharge by the IRS method is largest value. However, considering hydrological point of view, the unit hydrograph method is recommendable and reasonable value. Also, for calculation of reservoir flood routing of the Tonle Bari Lake, the flood hydrograph is required. Therefore, the design flood discharges by unit hydrograph method were used in this Survey in safety side point of view.

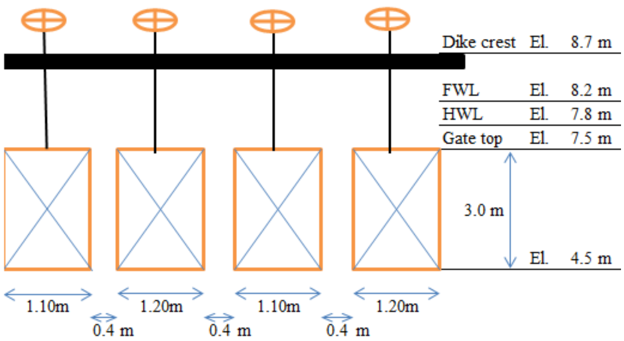
AB-2.3.2.7 Preliminary Analysis on Spillway Capacity of Existing Lake Tonle Bati

For checking of flow capacity of existing spillway of the Lake Tonle Bati, flood routing study was conducted. The schematic principal specifications of existing spillway of the Lake Tonle Bati are shown in Figure AB-2.3.2.7.1. There is a box culvert under the bridge of National Road No.2 (NR2) that is located just downstream of the Lake Tonle Bati.

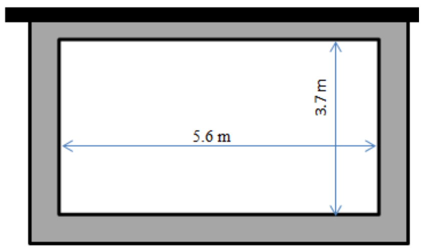
It might be not enough for the flow capacity of box culvert of NR2 in flood period, because of size of culvert and the ground slope. According to interview of village people, inundation water spreads between downstream of spillway of the Lake Tonle Bati and NR2 in the flood period. Therefore, spill out flow from existing spillway of the Lake Tonle Bati seems to be under the "sub-merged weir" flow in flood period.

Spillway of Lake Tonle Bati (Downstream)

Spillway of Lake Tonle Bati (Upstream)



Existing Spillway of Lake Tonle Bati



Box Culvert of NR2

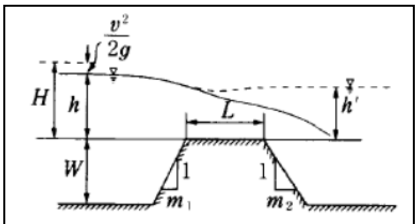
Figure AB-2.3.2.7.1 Principal Specifications of Existing Spillway of Lake Tonle Bati and Downstream Box Culver under NR2

In this flood routing study of existing spillway of the Lake Tonle Bati, 2 cases of condition, which are (a) under "sub-merged weir" condition and (b) "broad-crested weir" (not sub-merged weir) condition, were considered. The used formulas of these weir conditions are shown in below:

(a) sub-merged weir case

$Q=\gamma CBh'(h-h')^{1/2}$

where, *Q: overflow discharge (m^3/sec)*
γ: coefficient for sub-merged weir = 2.6
C: discharge coefficient ($m^{1/2}$/sec) = 1.55
(when $m_1=m_2=0$, $h/L<1/2$)
*B: width of weir (m) = (1.1+1.2)*2=4.6m*
h: upstream overflow height (m)
h': downstream water height (m)
*(assumed h'=h*70%)*



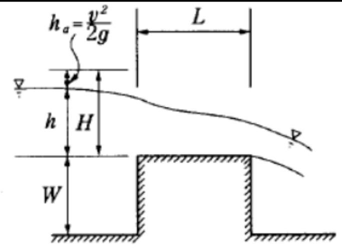
Trapezoidal Weir

(b) broad-crested weir case (Not sub-merged weir condition)

$Q=CBh^{2/3}$

$0<h/L\leq 0.1;$ $C=1.642(h/L)^{0.022}$
$0.1<h/L\leq 0.4;$ $C=1.552+0.083(h/L)$
$0.4<h/L\leq(0.5\sim 1.9);$ $C=1.444+0.352(h/L)$
$(0.5\sim 1.9)\leq h/L;$ $C=1.785+0.237(h/W)$

where, *Q: overflow discharge (m^3/sec)*
C: discharge coefficient ($m^{1/2}$/sec)
*B: width of weir (m) = (1.1+1.2)*2=4.6 m*
h: upstream overflow height (m)
L: length of weir (m) (assumed L=1.5 m)



Broad-Crested Weir

The specifications and conditions of flood routing calculation are shown in Table AB-2.3.2.7.1. Simulated flood routing of existing spillway of the Lake Tonle Bati of 2 cases are shown in Figure AB-2.3.2.7.2 and Figure AB-2.3.2.7.3. According to the results of flood routing simulation, if the overflow from weir is under the “Not sub-merged weir condition”, the reservoir water level will be not over the dike crest elevation of EL. 8.7 m even for return period of 1/200 years flood. However, if over flow from the weir is under the “sub-merged weir condition”, the reservoir water level will be over flow the dike crest elevation of EL. 8.7 m in return period of 1/20 years flood. Considering this results, improvement of existing spillway and widening of downstream box culvert under the NR2 are required.

AB-2.4 Main Canal 35 Rehabilitation Sub-project

AB-2.4.1 Meteorology

As mentioned in Clause AB-2.1.1, although there are some meteorological observation stations nearby MC35RSP area, the meteorological data at Pochentong is more long-term and reliable. In this Survey, the meteorological data at Pochentong was used for estimate water demand for MC35RSP. The average monthly meteorological data at Pochentong from 1991 to 2010 are shown in Table AB-2.4.1.1.

Table AB-2.4.1.1.1 Average 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

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)*
Note: Wind Speed data during the period from September 2005 to December 2010 were unavailable.

As can be seen in the above table, monthly mean temperature at the Pochentong station shows seasonal variation from 26.2 °C in December to 30.6 °C in April. Monthly maximum temperature higher than 31 °C is common. Monthly minimum temperature rarely falls down below 21 °C. Mean annual rainfall at Pochentong is estimated at 1,384 mm. Monthly rainfall shows obvious difference between the dry season and the rainy season. About 80% of annual rainfall concentrates in the rainy season, say May to October. Monthly mean relative humidity ranges from 70% in February and March to 84% in September and October. The relative humidity is high at night and low at daytime throughout the year. Monthly mean wind speed ranges 3.1 m/sec in October to 5.4 m/sec in August. Annual mean evaporation is 4.4 mm/day ranging 3.1 mm/day to 6.2 mm/day.

AB-2.4.2 Hydrology

AB-2.4.2.1 Data Availability

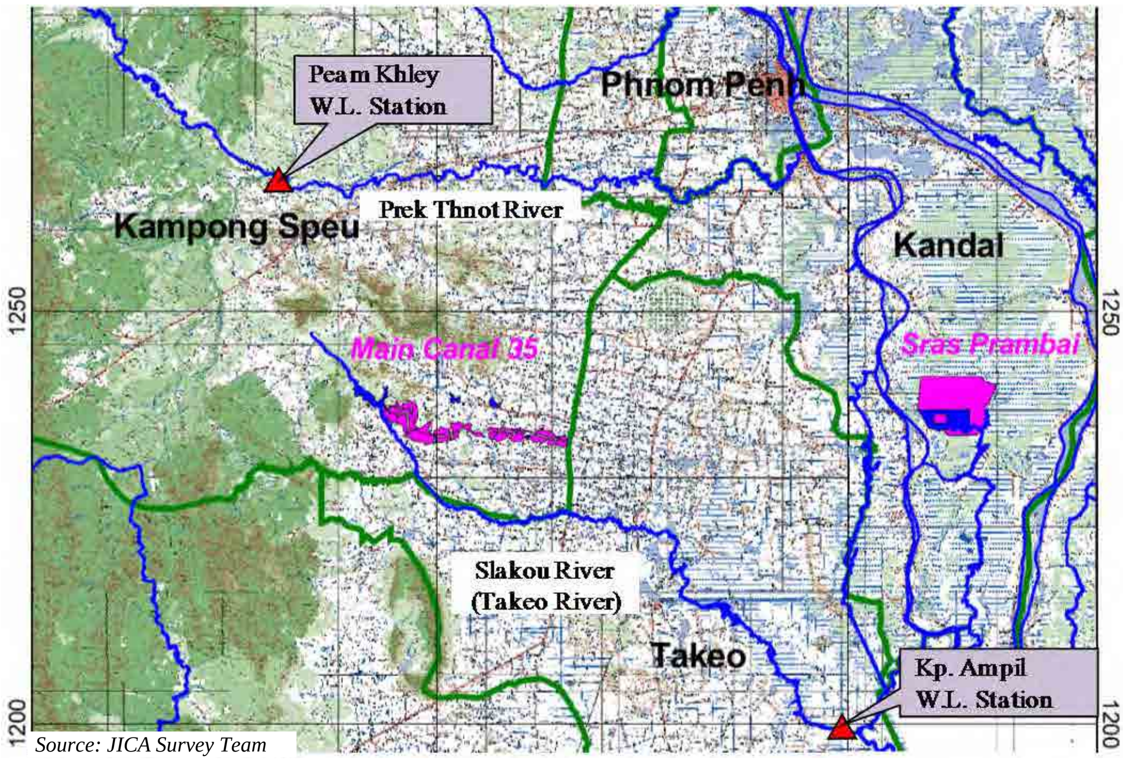
(1) Rainfall Observation

There are 5 rainfall stations in and around MC35RSP area. Those are Phnom Srouch, Kraing Ampil, Sdock, Prey Dop and Kong Pisey rainfall stations as shown in Figure AB-2.4.2.1.1. Observed and estimated annual rainfall in/around MC35RSP Area is already shown in Table AB-2.3.2.3.2.

(2) Water Level and Discharge Observation

The MC35RSP Area belongs to the Slakou River basin. The previous studies mention that there are no water level and discharge observation stations in the Slakou River basin, but some discharge measurement has been done for obtaining verification data for hydrological analysis at the F/S Time, in cooperation with Takeo PDOWRAM. Unfortunately, such discharge measurement has not been done by Takeo PDOWRAM since that time. Thus, no discharge data of the Slakou River System are available.

According to the Department of Hydrology and River Works (DHRW) of MOWRAM, there is a river water level gauging station named Kampong Ampil (or Borey Chulsar) at downstream of the Takeo River which is located just upstream of the confluence of the Takeo River and the Bassac River as shown in Figure AB-2.4.2.1.2. In the flood season, the water level at Kampong Ampil station is affected by back water of the Bassac River as shown in the H-Q rating curve Kampong Ampil (or Borey Chulsar) station (Figure AB-2.4.2.1.3). Therefore, in this Survey, the water level at Kampong Ampil (or Borey Chulsar) was not used for estimation of runoff of MC35RSP.

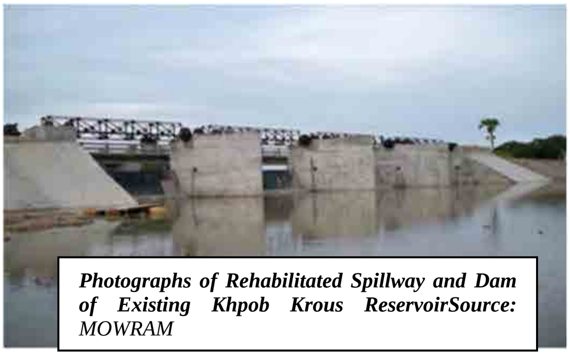


Source: JICA Survey Team

Figure AB-2.4.2.1.2 Location Map of Water Level Station nearby MC35RSP

AB-2.4.2.2 Main Canal 35 River System

The irrigation water for the MC35RSP Area is consist 3 rivers which are the Ou Chraloy River, the Ou Doun Angir River and the Ou Boeng Toap River. There are 3 existing reservoirs which are the Khpob Krous Reservoir at the Ou Chraloy River, the O Kbear Reservoir at the Ou Doun Angir River and small broken reservoir at the Ou Boeng Toap River. The intake structures and spillway structures of the Khpob Krous Reservoir and the O Kbear Reservoir were rehabilitated by MOWRAM funded by ADB Program Loan in 2009 and 2008, respectively. Small old reservoir at the Ou Boeng Toap River is broken and does not function at present.



Photographs of Rehabilitated Spillway and Dam of Existing Khpob Krous ReservoirSource: *MOWRAM*

Rehabilitated Mechanical Spillway Gates

Downstream View of Spillwat Gates

Source: MOWRAM

Photographs of Rehabilitated Spillway of Existing O Kbear Reservoir

Both spillways have automatic mechanical gates.

AB-2.4.2.3 Rainfall Analysis

(1) Double Mass Curve Analysis

For checking of rainfall data, the double mass curve analysis of accumulated annual rainfall at each rainfall station in and around the MC35RSP Area was conducted as shown in Figure 2.3.2.3.1. There are no significant errors of rainfall data in the MC35RSP Area.

(2) Rainfall Correlation Analysis

For estimation of long term discharge for water balance study, long term basin rainfall was estimated by using available rainfall data. Missing rainfall data were interpolated using correlation coefficients of available nearby or key rainfall station data. The annual rainfall correlation coefficients “*a*” of $Y=a*X$ and the R^2 are shown in Table 2.3.2.3.1.

(3) Interpolation of Missing Data

As described in above, the missing daily rainfall data were interpolated by using correlation coefficients of available nearby or key rainfall station data. Table AB-2.3.2.3.2 shows observed and interpolated annual rainfall in/around the MC35RSP Area. Most affected rainfall stations in the MC35RSP Area are Sdock and Prey Dop stations. These mission daily rainfall data were interpolated by using daily rainfall data at Kampong Speu station.

(4) Long-term Basin Rainfall

Long-term daily basin rainfall from 1982 to 2011 (30 years) was estimated by using Thiessen coefficients and observed and interpolated daily rainfall data. The Thiessen coefficients for each sub-basin are shown in Table AB-2.3.2.3.3. Estimated monthly basin rainfall at Sub-basin of MC35RSP Area is shown in Table AB-2.4.2.3.1 to Table AB-2.4.2.3.3.

AB-2.4.2.4 Low Flow Analysis

(1) Estimation of Long-term Discharge by Using Slakou Runoff Analysis Model

As mentioned above, continuous observation of water level has not been conducted in the Slakou River basin except Kampong Ampil water level gauging station where the water level is affected by Bassac River. On the other hand, a water level observation at the Peam Khley station on the Prek Thnot River, neighboring the Slakou River basin, has been continuously carried out as mentioned in Sub-clause AB-2.1.2.1. Moreover, these 2 rivers ordinate from the same region, say Elephant mountain region. In consideration of this condition, the Slakou River discharge was estimated from the discharge of the Prek Thnot River at the Peam Khley observation station.

Therefore, the daily Tank model for the Peam Khley of the Prek Thnot River constructed in Item (1) of Sub-clause AB-2.3.2.4 was adopted to estimate of runoff at each reservoir in this MC35RSP Area. The outline of this runoff analysis model was described in Item (1) of Sub-clause AB-2.3.2.4.

In order to execute the water balance calculation in the MC35RSP Area, the discharges of the Khpob Krous Reservoir at the Ou Chraloy River, the O Kbear Reservoir at the Ou Doun Angir River and small broken reservoir at the Ou Boeng Toap River are calculated by the runoff model with the average depth of rainfall in each basin. Prior to the discharge calculation, the runoff model is validated by rainfall data newly collected in the Survey.

The discharge in each reservoir basin is calculated by the result of Tank Model for the Peam Khley. Parameters of Tank Model are used same as for the Peam Khley. The rainfall data input to the model are the average rainfall over area calculated in Item (4) of Sub-clause AB-2.4.2.3 so as to reflect the rainfall condition in each basin.

Using among 30 years from 1982 to 2011 of estimated daily discharge at each site, the half monthly mean discharge of 20 years from 1992 to 2011 that the period is relatively high reliability are estimated for water balance study.

The results of the runoff calculation are shown in Table AB-2.4.2.4.1 to Table AB-2.4.2.4.3 and summarized in Table AB-2.4.2.4.4 below:

Table AB-2.4.2.4.4 Monthly Discharge in each Reservoir at 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
Max.	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
Min.	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
Max.	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
Min.	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
Max.	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
Min.	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

AB-2.4.2.5 Water Balance Study

(1) Method of Water Balance Study

In this Survey, the water balance simulation was conducted for 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 2 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.

(2) Irrigation Water Demand

Irrigation water requirement for MC35RSP area was calculated based on the proposed cropping calendar mentioned in Figure AB-2.4.2.5.1, which consists of early variety and medium variety. Estimated unit irrigation requirement for Early Rice (Early Rainy Season) and Medium Paddy in MC35RSP Area is shown in Table AB-2.4.2.5.1.

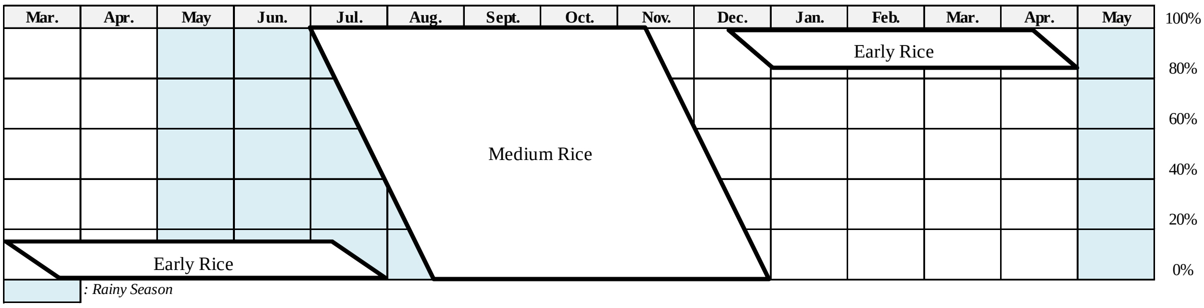


Figure AB-2.4.2.5.1 Proposed Cropping Calendar in MC35RSP

(3) Reservoir Operation

(a) Khpob Krous Reservoir

Main specifications and reservoir storage curve (H-V-A curve) of the Khpob Krous Reservoir at the Ou Chraloy River are shown in Table AB-2.4.2.5.2 and Figure AB-2.4.2.5.2. 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 AB-2.4.2.5.3. In the reservoir operation simulation, pan evaporation at Pochentong is used for evaporation from reservoir and percolation from reservoir bed was assumed at 2.0 mm/day.

Result of reservoir operation of the Khpob Krous Reservoir is shown in Figure AB-2.4.2.5.4.

Table AB-2.4.2.5.2 Main Specifications and Reservoir Storage Curve of Khpob Krous Reservoir

Dam site	Khpob Krous Reservoir	
River	Ou Chraloy	
C.A.	97.7	km^2

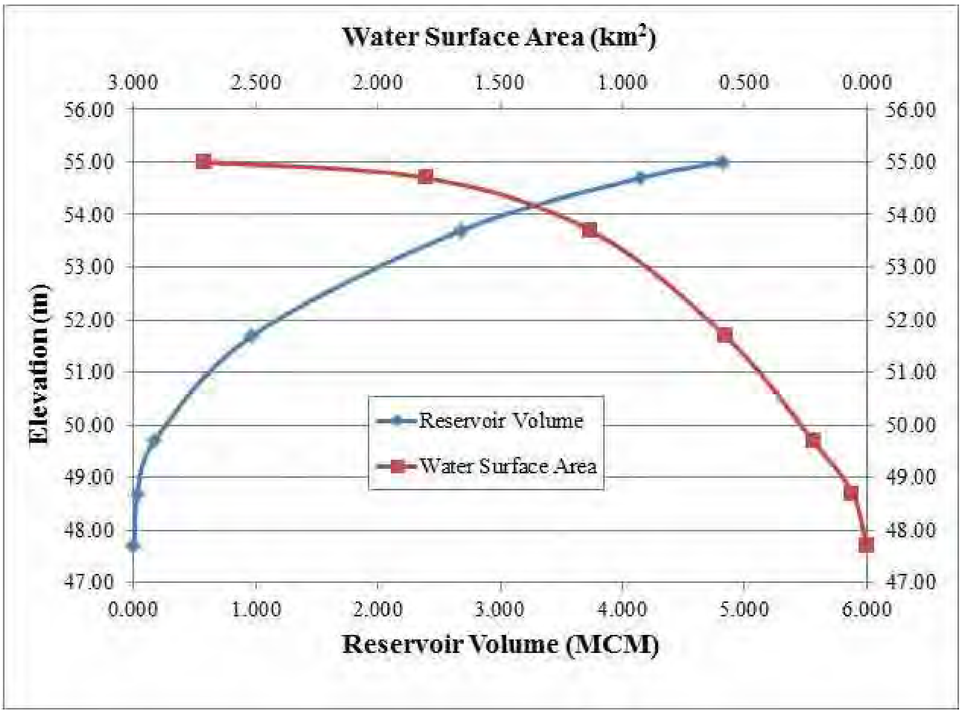
(1)-1. Reservoir Storage Curve

Elevation (EL. m)	Volume ($x10^6$ m^3)	Area (km^2)
47.70	0.000	0.000
48.70	0.030	0.060
49.70	0.170	0.220
51.70	0.970	0.580
53.70	2.680	1.130
54.70	4.145	1.800
55.00	4.822	2.710

(1)-1. Input Data

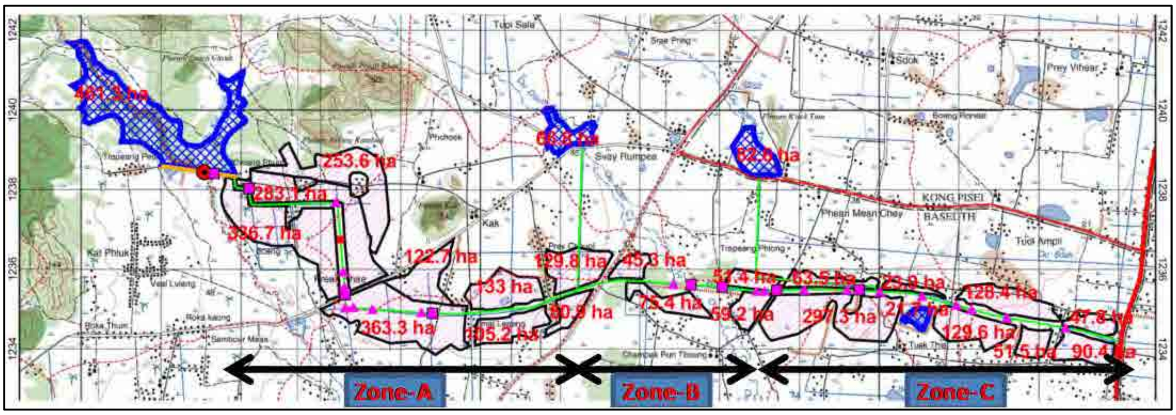
Full Supply Level (FSL) (EL. m)	55.0	m
Riverbed Elevation (EL. m)	47.7	m
L.W.L (EL. m)	52.0	m
Freeboard	1.00	m
Dam Height (m)	8.3	m
Gross Storage Vol.($x10^6$ m^3)	4.82	MCM
Dead Storage ($x10^6$ m^3)	1.23	MCM
Effective Storage Vol.($x10^6$ m^3)	3.60	MCM

Source: JICA Survey Team



Source: JICA Survey Team

Figure AB-2.4.2.5.2 Reservoir Storage Curve of Khpob Krous Reservoir



Source: JICA Survey Team

Figure AB-2.4.2.5.3 Zone of Command Area of MC35RSP

(b) O Kbear Reservoir

Main features and assumed reservoir storage curve (H-V-A curve) of the O Kbear Reservoir at the Ou Doun Angir River are shown in Table AB-2.4.2.5.4 and Figure AB-2.4.2.5.5. 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.

Table AB-2.4.2.5.3 Command Area of MC35RSP

Zone	A	B	C	
1	253.6	64.9	63.5	
2	283.1	45.3	297.3	
3	336.6	75.4	23.9	
4	363.3	51.4	21.7	
5	122.7	59.2	128.4	
6	133.0		129.6	
7	105.2		51.5	
8	50.9		47.8	
9	64.9		90.4	
Total	**1,713.3**	**296.2**	**854.1**	**2,863.6**

Source: JICA Survey Team

The reservoir operation and the design outflow from O Kbear Reservoir were assumed to achieve for irrigation demand of “Zone-B” and “Zone-C” of MC35RSP Area as shown in Figure AB-2.4.2.5.3 above. In the reservoir operation simulation, pan evaporation at Pochentong is used for evaporation from reservoir and percolation from reservoir bed was assumed at 2.0 mm/day.

Result of reservoir operation of the O Kbear Reservoir for irrigation water demand of Zone-B and Zone-C is shown in Figure AB-2.4.2.5.6.

Table AB-2.4.2.5.4 Main Specifications and Reservoir Storage Curve of O Kbear Reservoir

Dam site	O Kbear Reservoir	
River	Ou Doun Angk	
C.A.	92.5	km^2

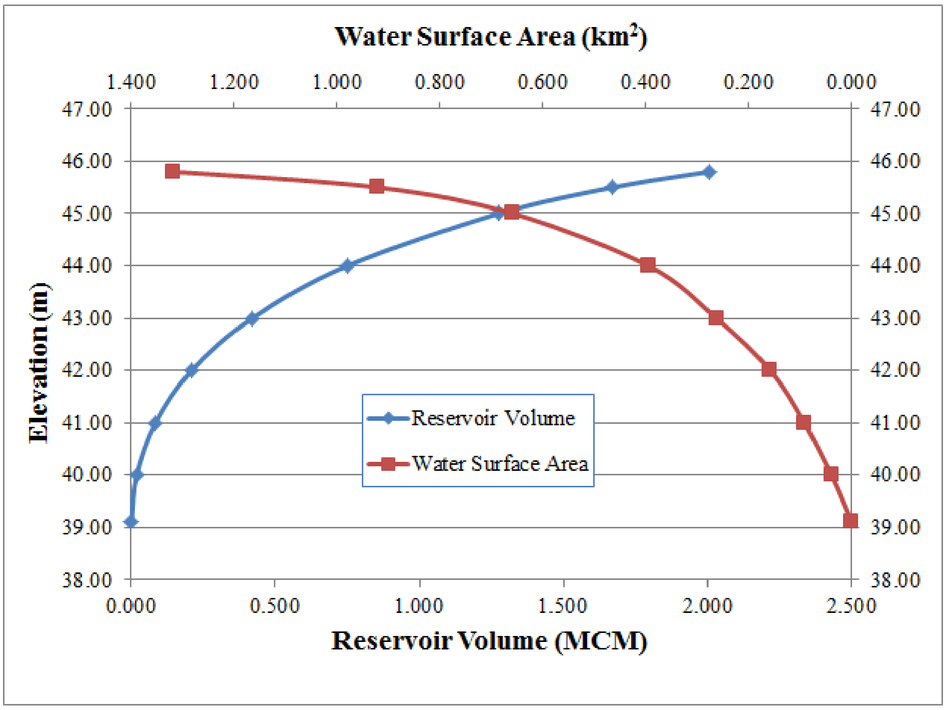
(1)-1. Reservoir Storage Curve

Elevation (EL. m)	Volume ($x10^6$ m^3)	Area (km^2)	
39.10	0.000	0.000	0%
40.00	0.018	0.040	3%
41.00	0.084	0.092	7%
42.00	0.209	0.158	12%
43.00	0.420	0.264	20%
44.00	0.749	0.395	30%
45.00	1.276	0.659	50%
45.50	1.671	0.922	70%
45.80	2.007	1.318	100%

(1)-1. Input Data

Full Supply Level (FSL) (EL. m)	45.1	m
Riverbed Elevation (EL. m)	39.1	m
L.W.L (EL. m)	44.0	m
Freeboard	1.54	m
Dam Height (m)	7.5	m
Gross Storage Vol.($x10^6$ m^3)	1.32	MCM
Dead Storage ($x10^6$ m^3)	0.75	MCM
Effective Storage Vol.($x10^6$ m^3)	0.57	MCM

Source: JICA Survey Team



Source: JICA Survey Team

Figure AB-2.4.2.5.5 Reservoir Storage Curve of O Kbear Reservoir

(c) Ka Ek Tom Reservoir

Main features and assumed reservoir storage curve (H-V-A curve) of the Ka Ek Tom Reservoir are shown in Table AB-2.4.2.5.5 and Figure AB-2.4.2.5.7. 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 at the same date and the assumed ratio of H-V-A curve. Result of reservoir operation of the Ka Ek Tom Reservoir is shown in Figure AB-2.4.2.5.8.

Table AB-2.4.2.5.5 Main Specifications and Reservoir Storage Curve of Ka Ek Tom Reservoir

Dam site	Ka Ek Tom Reservoir	
River	Ou Boeng Toap	
C.A.	13.5	km^2

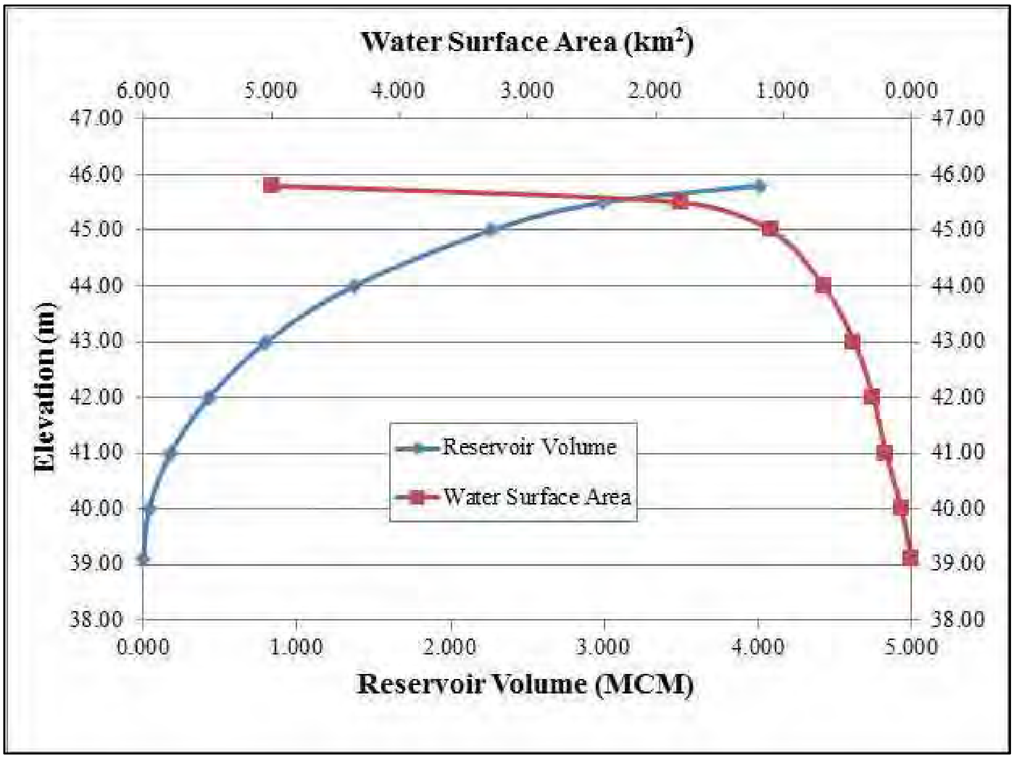
(1)-1. Reservoir Storage Curve

Elevation (EL. m)	Volume ($x10^6$ m^3)	Area (km^2)	
39.10	0.000	0.000	0%
40.00	0.036	0.080	3%
41.00	0.176	0.200	7%
42.00	0.426	0.300	12%
43.00	0.801	0.450	20%
44.00	1.369	0.686	30%
45.00	2.262	1.100	50%
45.50	2.987	1.800	70%
45.80	4.007	5.000	100%

Source: JICA Survey Team

(1)-1. Input Data

Full Supply Level (FSL) (EL. m)	45.6	m
Riverbed Elevation (EL. m)	39.1	m
L.W.L. (EL. m)	44.0	m
Freeboard	1.00	m
Dam Height (m)	7.5	m
Gross Storage Vol.($x10^6$ m^3)	3.33	MCM
Dead Storage ($x10^6$ m^3)	1.37	MCM
Effective Storage Vol.($x10^6$ m^3)	1.96	MCM



Source: JICA Survey Team

Figure AB-2.4.2.5.7 Reservoir Storage Curve of Ka Ek Tom Reservoir

(4) Results of Water Balance Study

Results of water balance simulations of MC35RSP are shown in Table AB-2.4.2.5.6 and Figure AB-2.4.2.5.10. Results of reservoir operation simulations of the Khpob Krous Reservoir, the O Kbear Reservoir and the Ka Ek Tom Reservoir are shown in Figure AB-2.4.2.5.9. According to the water balance simulations, total 1,280 ha of command area with average crop intensity of 115% will be able to irrigate for 80% dependability as shown in Table AB-2.4.2.5.6.

Table AB-2.4.2.5.6 Results of Water Balance Study of MC35RSP (80% Dependability)

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	125 ha	850 ha	0 ha	115%	80%	4
B	276 ha	276 ha	48 ha	276 ha	0 ha	117%	80%	4
C	154 ha	154 ha	25 ha	154 ha	0 ha	116%	80%	4
Total	2,365 ha	1,280 ha	198 ha	1,280 ha	0 ha	115%		

Source: JICA Survey Team

AB-2.4.2.6 Flood Analysis

(1) Probable Rainfall

As described in Section AB-2.3.2.6, the annual maximum daily point rainfalls at Kampong Speu station from 1983 to 2011 (29 years) are shown in Table AB-2.4.2.6.1. Frequency curve of annual maximum daily point rainfall at Kampong Speu is shown in Figure AB-2.3.2.6.1. Computation method of the Log Peason Type-III is used to estimate probable flood for MC35RSP Area.

Table AB-2.4.2.6.1 Estimated Probable Maximum Daily Rainfall at Kampong Speu

Return Period (Year)	Excess Probability	Computation Method (mm/day)			
		Iwai	Log Peason Type-III	Gumbel	Chow
2	0.5000	**78**	**78**	**77**	**77**
5	0.2000	**95**	**95**	**95**	**92**
10	0.1000	**105**	**105**	**106**	**102**
20	0.0500	**115**	**115**	**118**	**112**
25	0.0400	**118**	**118**	**121**	**115**
50	0.0200	**127**	**127**	**132**	**124**
100	0.0100	**135**	**135**	**143**	**134**
200	0.0050	**143**	**143**	**154**	**143**
1,000	0.0010	**162**	**162**	**179**	**165**

Source: JICA Survey Team

(2) Probable Flood

Actual flood data have not been recorded in the MC35RSP Area, the flood discharge at Khpob Krous Reservoir and O Kbear Reservoir are estimated by following 3 methods: (i) a recommended method (hereinafter called as the IRS method) in Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat), (ii) unit hydrograph method and (iii) rational formula method.

(a) IRS Method

IRS method is represented by the following equations. The results of calculation are shown in Table AB-2.4.2.6.3.

$$MAF = AREA^{0.9}$$
$$Q_{10} = 1.53 \times MAF$$
$$Q_{20} = 1.78 \times MAF$$
$$Q_{50} = 2.00 \times MAF$$
$$Q_{100} = 2.20 \times MAF$$

Where, MAF : mean annual flood (m^3/sec),
AREA : catchment area (km^2)
Q_{10} : flood expected to occur not more than once every 10 years on an average,
Q_{100} : flood expected to occur not more than once every 100 years on an average.

Source: Flood Frequency Analysis in Final Report on Irrigation Rehabilitation Project, Sir William Halcrow & Partners Limited in association with Mandala Agricultural Development Corporation, June 1994, Mekong Secretariat.

Table AB-2.4.2.6.2 Estimated Flood Discharge by IRS Method (MC35RSP)

River / Site		Khpob Krous Reservoir (97.7 km^2)				O Kbear Reservoir (92.6 km^2)			
Return Period	Years	10years	20years	50years	100years	10years	20year	50years	100years
Flood Peak Discharge	m^3/sec	95	110	124	136	90	105	118	130

Source: JICA Survey Team

(b) Unit Hydrograph Method

Unit hydrograph method is employed for flood estimate of each river and reservoir. Details of calculation are explained in “Planning Guideline for Rehabilitation and Reconstruction of Irrigation System”, made by the F/S Team. The results of calculation are summarized in Table AB-2.4.2.6.3. The results of unit hydrographs at Khpob Krous Reservoir and O Kbear Reservoir sites are shown in Figure AB-2.4.2.6.1.

Table AB-2.4.2.6.3 Estimated Flood Discharge by Unit Hydrograph Method (MC35RSP)

River/Site	Catchment Area (km^2)	Flood discharge (m^3/sec)					
		10 years	20 years	50 years	100 years	200 years	1,000 years
Khpob Krous Reservoir	97.7	109.2	124.5	143.4	157.0	170.3	200.3
O Kbear Reservoir	92.6	111.3	126.5	145.3	158.8	172.0	201.9

Source: JICA Survey Team

(c) Rational Formula Method

Rational formula method is used as a reference of peak flood discharge that is estimated by unit hydrograph method. The results of calculation are summarized in Table AB-2.4.2.6.4.

Table AB-2.4.2.6.4 Estimated Flood Discharge by Rational Formula Method (MC35RSP)

River/Site	Catchment Area (km^2)	Flood discharge (m^3/sec)			
		10 years	20 years	50 years	100 years
Khpob Krous Reservoir	97.7	113	122	134	144
O Kbear Reservoir	92.6	154	168	185	198

Source: JICA Survey Team

(d) Conclusion

Compare of above results, estimated flood discharge by the unit hydrograph method is largest value for Khpob Krous Reservoir. Considering hydrological point of view, the unit hydrograph method is recommendable and reasonable value. Also, for calculation of reservoir flood routing, the flood hydrograph is required. Therefore, the design flood discharges by unit hydrograph method were used in this Survey.

AB-2.4.2.7 Check of Spillway Capacity of Existing Reservoirs

(1) Khpob Krous Reservoir

The Khpob Krous Dam has 4 automatic mechanical spillway gates as shown in Figure AB-2.4.2.7.1. The flood routing simulations were conducted for checking of capacity of existing spillway of the Khpob Krous Dam with several flood probability and 2 cases of condition of automatic spillway gates those are (i) normal condition and (ii) emergency condition. The normal condition is that all 4 automatic mechanical spillway gates fall down in the flood. The emergency condition is all 4 automatic mechanical spillway gates do not fall down at the flood time if the automatic gates are damaged.

The used formula of these spillway gates are shown in below:

(i) Standard shape of overflow spillway crest (Parabolic shape)

$$Q=nC'BH^{3/2}$$

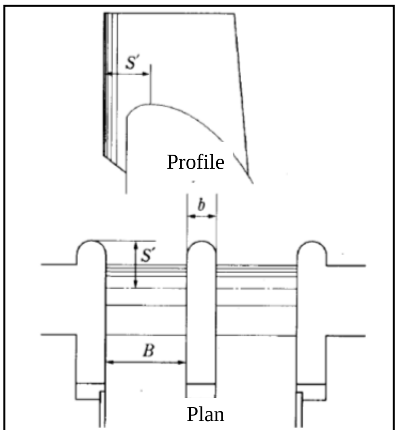
$$C'=C\left\{1-M_d\left(H/H_d\right)^{3/2}\right\}$$

When, n=1 or n≥2 and b/S’ ≥0.8

$$M_d=0.0756\left(H_d/B\right)^{1/2}$$

When, n≥2 and S’ <0.8

$$M_d=0.0756\left(H_d/B\right)^{1/2}\left\{1/n+1.465\frac{n-1}{n}\left(\frac{b}{S'}\right)^{1.7}\right\}$$



Standard Spillway Shape

where, *Q: Overflow discharge (m^3/sec)*
n: Number of span of spillway crest (n=4)
C: Discharge coefficient ($m^{1/2}$/sec)
C': Discharge coefficient with pier or abutment ($m^{1/2}$/sec)
B: Width of a spillway per span (B=7.97 m)
b: With of pier (b=3.0 m)
H: Upstream overflow height (head from crest) (m)
H_d: Design overflow height (head from crest) (m) (assumed H_d=4.0 m)
M_d: Reduction rate of Discharge coefficient when $H=H_d$ with pier or abutment
S': Distance between the upstream end of the pier from spillway crest (S'=11.0 m)

The specifications and conditions of flood routing calculation are shown in Table AB-2.4.2.7.1. Simulated flood routing of existing spillway of the Khpob Krous reservoir of 2 cases are shown in Figure AB-2.4.2.7.2 and Figure AB-2.4.2.7.3. According to the results of flood routing simulation, if all automatic mechanical gates are fallen, the maximum reservoir water level will be not over the dam crest elevation even of EL. 55.50 m even in the return period of 1/200 years flood.

However, if all automatic gates are "not" fallen in emergency case, the reservoir water level will be over flow the dam crest elevation of EL. 55.50 m in return period of 1/10 years flood. Considering this results, maintenance of existing automatic spillway gates are strongly required for future.

(2) O Kbear Reservoir

The O Kbear Dam has 2 automatic mechanical spillway gates in center and 2 normal overflow gates at both sides as shown in Figure AB-2.4.2.7.4. The flood routing simulations were conducted for checking of capacity of existing spillway of the O Kbear with several flood probability and 2 cases of condition of automatic spillway gates those are (i) normal condition and (ii) emergency condition. The normal condition is 2 automatic mechanical spillway gates are fallen in the flood. The emergency condition is 2 automatic mechanical spillway gates are not fallen in the flood that if the automatic gates are broken.

The used formula of these spillway gates are shown in below:

(i) Standard shape of overflow spillway crest (Parabolic shape)

$$Q=nC'BH^{3/2}$$

$$C'=C\left\{1-M_d\left(H/H_d\right)^{3/2}\right\}$$

When, n=1 or n≥2 and b/S' ≥0.8

$$M_d=0.0756\left(H_d/B\right)^{1/2}$$

When, n≥2 and S' <0.8

$$M_d=0.0756\left(H_d/B\right)^{1/2}\left\{1/n+1.465\frac{n-1}{n}\left(\frac{b}{S'}\right)^{1.7}\right\}$$

where, *Q: Overflow discharge (m^3/sec)*
n: Number of span of spillway crest (n=4)
C: Discharge coefficient ($m^{1/2}$/sec)
C': Discharge coefficient with pier or abutment ($m^{1/2}$/sec)
B: Width of a spillway per span (B=7.85 m)
b : With of pier (b=3.0 m for center and b=1.80 m for side)
H : Upstream overflow height (head from crest) (m)
H_d: Design overflow height(head from crest) (m)
(assumed H_d=4.0 m for center spillway and 1.5 m for side spillway)
M_d: Reduction rate of Discharge coefficient when $H=H_d$ with pier or abutment
S': Distance between the upstream end of the pier from spillway crest (S'=11.79 m)

The specifications and conditions of flood routing calculation are shown in Table AB-2.4.2.7.2. Simulated flood routing of existing spillway of the O Kbear reservoir of 2 cases are shown in Figure AB-2.4.2.7.5 and Figure AB-2.4.2.7.6. According to the results of flood routing simulation, even if all 2 automatic mechanical gates are “not” fallen, the maximum reservoir water level will be not over the dam crest elevation even of EL. 47.80 m even in the return period of 1/200 years flood. However, maintenance of existing automatic spillway gates is required for safety of earth-fill dam.

AB-2.5 Srass Prambai Water Recession Rehabilitation Sub-project

AB-2.5.1 Meteorology

Although there are meteorological observation stations nearby Srass Prambai Water Recession Rehabilitation Sub-project (SPWRRSP) Area, the meteorological data at Pochentong is more long-term and more reliable. In this Survey, the meteorological data at Pochentong was used for estimating water demand for SPWRRSP. The average monthly meteorological data at Pochentong from 1991 to 2010 are shown in Table AB-2.5.1.1.1.

Table AB-2.5.1.1.1 Average 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

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)
Note: Wind Speed data during the period from September 2005 to December 2010 were unavailable.

As can be seen in the above table, monthly mean temperature at the Pochentong station shows seasonal variation from 26.2 °C in December to 30.6 °C in April. Monthly maximum temperature higher than 31 °C is common. Monthly minimum temperature rarely falls down below 21 °C. Mean annual rainfall at Pochentong is estimated at 1,384 mm. Monthly rainfall shows obvious difference between the dry season and the rainy season. About 80% of annual rainfall concentrates in the rainy season, say May to October. Monthly mean relative humidity ranges from 70% in February and March to 84% in September and October. The relative humidity is high at night and low at daytime throughout the year. Monthly mean wind speed ranges 3.1 m/sec in October to 5.4 m/sec in August. Annual mean evaporation is 4.4 mm/day ranging 3.1 mm/day to 6.2 mm/day.

AB-2.5.2 Hydrology

AB-2.5.2.1 Data Availability

Daily river water level data nearby SPWRRSP Area are available at the Koh Khel W.L. station in the Tonle Bassac River and the Neak Loung W.L. station in the Mekong River as shown in Table AB-2.5.2.1.1. Other discharge observation data or water level data is not available in the SPWRRSP Area.

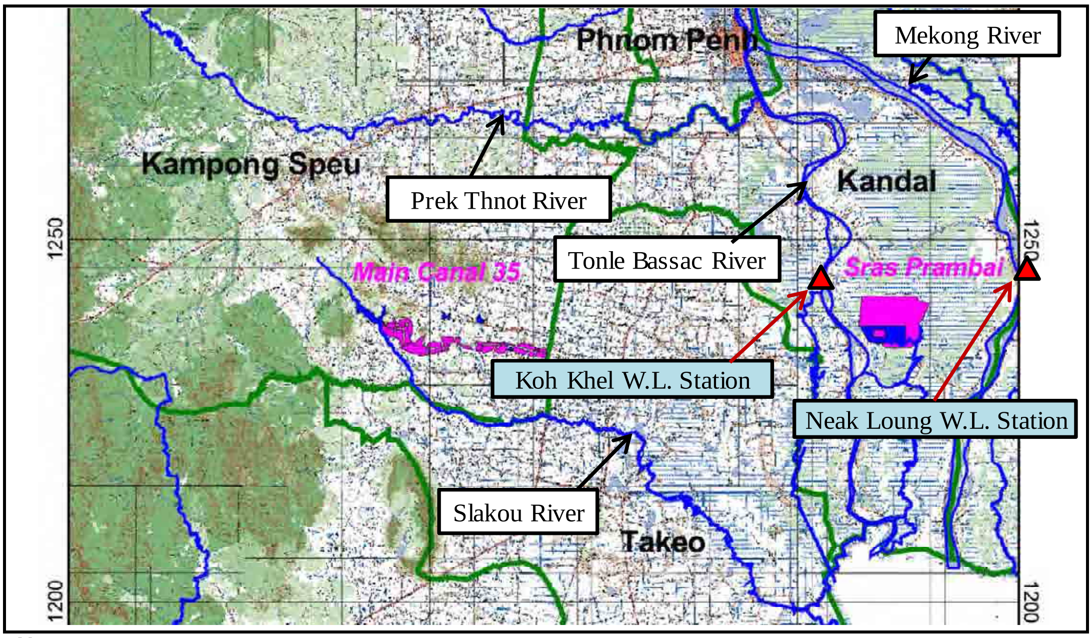
Table AB-2.5.2.1.1 Water Level Gauging Station nearby SPWRRSP Area

W.L.Station	River	Province	Location		Coordinate 48P UTM		Zero Gauge	Data Availability
			Lat, N	Lon, E	X	Y	Height (m)	
Koh Khel	Bassac	Kandal	11°27'00"	105°02'00"	503823	1242455	MSL -1.000 m	1990-to date
Neak Loung	Mekong	Prey Veng	11°15'37"	105°17'13"	530949	1244835	MSL -0.330 m	1926-73, 87-to date

Source: Department of Hydrology and River Works, MOWRAM

AB-2.5.2.2 Srass Prambai River System

SPWRRSP Area is located in flood plain between the Tonle Bassac River and the Mekong River in the Kandal Province. In flood season from July to November, the SPWRRSP Area is inundated by flood of the Tonle Bassac River. After the flood season, recession dry season rice cropping was started by using the inundated water in the area. The location map of SPWRRSP Area is shown in Figure AB-2.5.2.2.1.

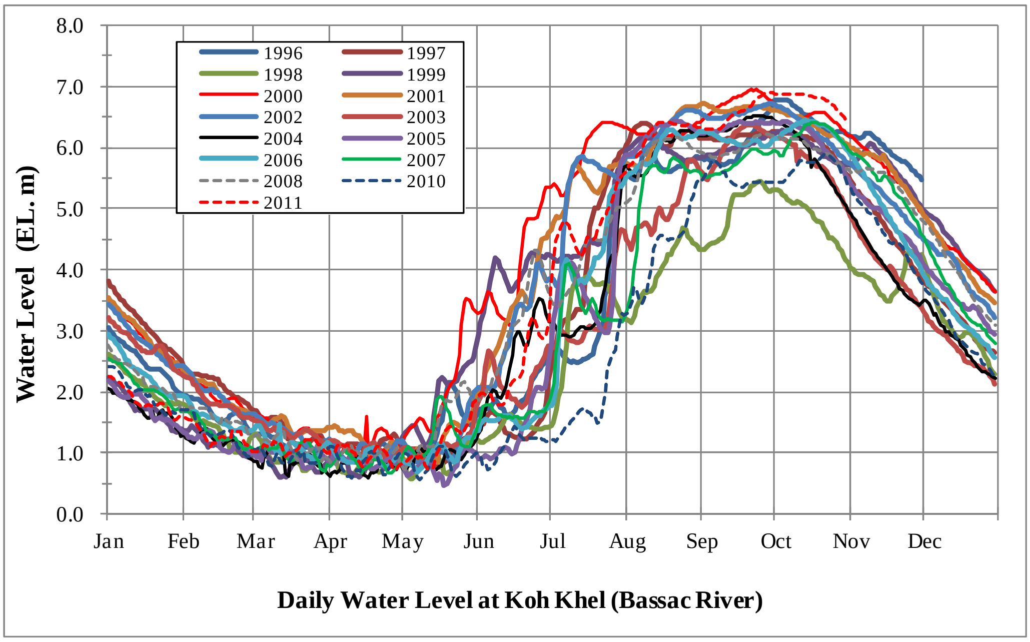


Prepared by JICA Survey Team

Figure AB-2.5.2.2.1 Location Map of SPWRRSP Area

AB-2.5.2.3 Water Level Data of Bassac River and Mekong River

Daily river water level gauge height of the Bassac River at Koh Khel station and the Mekong River at Neak Loung station from 1996 to 2011 are shown in Figure AB-2.5.2.3.1. Figure AB-2.5.2.3.2 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 -1.000m. 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 as shown in Figure AB-2.5.2.3.2. Annual maximum water level from 1996 to 2011 and the non exceedance or return period is shown in Table AB-2.5.2.3.1. The maximum water level of the observed period from 1996 to 2011 was occurred in year 2000 at EL. 6.94 m. According to Table AB-2.5.2.3.1, 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 AB-2.5.2.3.2 Daily Water Level of Tonle Bassac River at Koh Khel

Table AB-2.5.2.3.1 Annual Maximum Water Level of Tonle Bassac River at Koh Khel

No.	Year	Annual Max. Gauge Height (m)	Annual Max. Water Level (EL. m)	Rank	Excess Probability	Non Exceedance Probability	Return Period (Year)
1	1996	7.78	6.78	3	84.4%	15.6%	6.40
2	1997	7.40	6.40	10	40.6%	59.4%	1.68
3	1998	6.44	5.44	16	3.1%	96.9%	1.03
4	1999	7.28	6.28	13	21.9%	78.1%	1.28
5	2000	7.94	6.94	1	96.9%	3.1%	32.00
6	2001	7.72	6.72	4	78.1%	21.9%	4.57
7	2002	7.72	6.72	4	78.1%	21.9%	4.57
8	2003	7.37	6.37	12	28.1%	71.9%	1.39
9	2004	7.53	6.53	6	65.6%	34.4%	2.91
10	2005	7.42	6.42	9	46.9%	53.1%	1.88
11	2006	7.44	6.44	8	53.1%	46.9%	2.13
12	2007	7.40	6.40	10	40.6%	59.4%	1.68
13	2008	7.22	6.22	14	15.6%	84.4%	1.19
14	2009	7.53	6.53	6	65.6%	34.4%	2.91
15	2010	6.89	5.89	15	9.4%	90.6%	1.10
16	2011	7.89	6.89	2	90.6%	9.4%	10.67

Prepared by JICA Survey Team based on water level data by Department of Hydrology and River Works, MOWRAM.

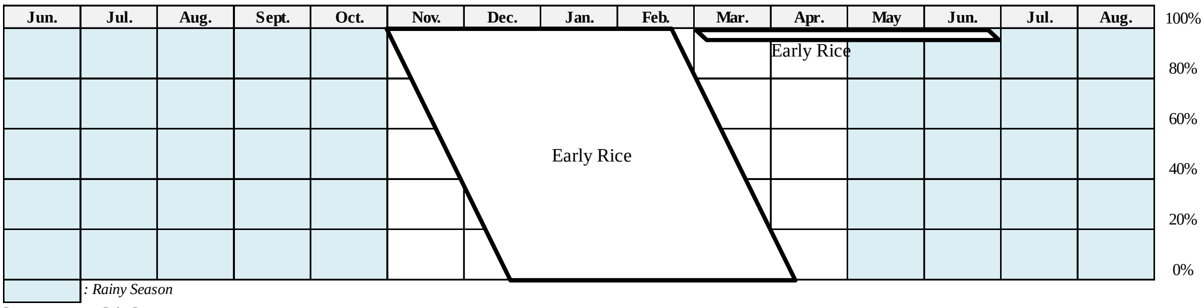
AB-2.5.2.4 Water Balance Study

(1) Method of Water Balance Study

As SPWRRSP aims at recession 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 will dry up and will be cultivated with paddy. The water in the Srass Prambai Reservoir will be used for irrigation. Water balance simulation was conducted using assumed storage capacity curve of the Srass Prambai Reservoir and the estimated irrigation water requirement for proposed cropping calendar. In this water balance study, irrigation water for the command area was assumed to supply from only the Srass Prambai Reservoir, not from remaining water in the command area in recession period for safety side.

(2) Irrigation Water Demand

Irrigation water requirement for SPWRRSP Area was calculated based on the proposed cropping calendar mentioned in Figure AB-2.5.2.4.1, which consists of early medium variety of early rice (recession) and early medium variety of early rice (2nd dry) . Estimated unit irrigation requirement in SPWRRSP Area is shown in Table AB-2.5.2.4.1.



Source: *JICA Survey Team*

Figure AB-2.5.2.4.1 Proposed Cropping Calendar in SPWRRSP

(3) Reservoir Operation of Existing Reservoirs

Reservoir storage curve (H-V-A curve) of the Srass Prambai Reservoir was prepared by based on results of topographic survey by JICA Survey Team as shown in Table AB-2.5.2.4.2 and Figure AB-2.5.2.4.2. The reservoir operation and the design outflow from the Srass Prambai Reservoir were decided to achieve for irrigation water demand of SPWRRSP Area. In the reservoir operation simulation, pan evaporation at Pochentong is used for evaporation from reservoir and percolation from reservoir bed was assumed at 2.0 mm/day.

Table AB-2.5.2.4.2 Specifications and Assumed Reservoir Storage Curve of Srass Prambai Reservoir

Site	Srass Prambai Reservoir
Province	Kandal
River	Bassac & Mekong River

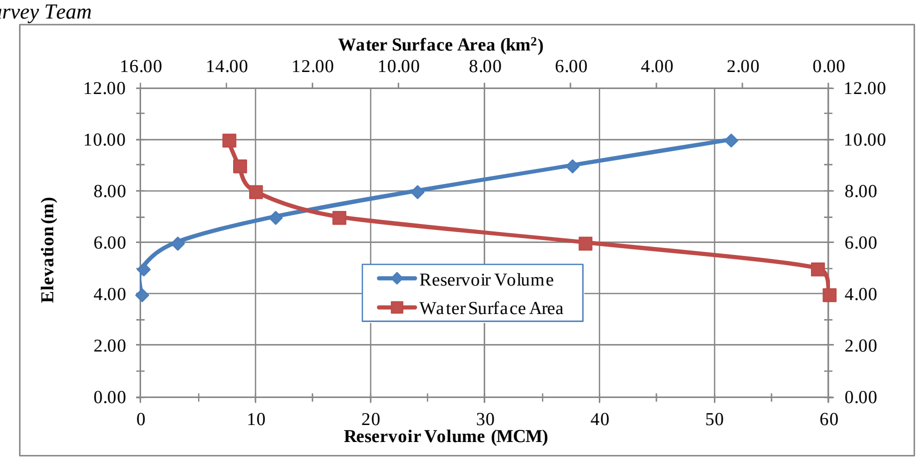
(1) Reservoir Storage Curve

Elevation (EL. m)	Volume ($x10^6$ m^3)	Area (km^2)
4.00	0.000	0.000
5.00	0.135	0.270
6.00	3.110	5.680
7.00	11.655	11.410
8.00	24.035	13.350
9.00	37.570	13.720
10.00	51.415	13.970

(2) Input Data

Full Supply Level (FSL) (EL. m)	8.5	m
Riverbed Elevation (EL. m)	4.0	m
Minimum Water Level (EL. m)	4.5	m
Freeboard	1.00	m
Dam Height (m)	5.5	m
Gross Storage Vol.($x10^6$ m^3)	30.80	MCM
Dead Storage ($x10^6$ m^3)	0.07	MCM
Effective Storage Vol.($x10^6$ m^3)	30.74	MCM

Note: Elevation is by using local bench mark that is not actual topographical elevation.
Source: JICA Survey Team



Note: Elevation is by using local bench mark that is not actual topographical elevation.
Source: JICA Survey Team

Figure AB-2.5.2.4.2 Reservoir Storage Curve of Srass Prambai Reservoir

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.

(4) Results of Water Balance Study

Results of water balance simulations of 20 years from 1991 to 2011 for SPWRRSP are shown in Table AB-2.5.2.4.3 and Figure AB-2.5.2.4.3. Results of reservoir operation for Srass Prambai Reservoir are shown in Figure AB-2.5.2.4.4 and Figure AB-2.5.2.4.5. 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: 66 ha) will be able to irrigate by 80% dependability and total 2,210 ha (early rice recession: 1,400 ha + early rice 2nd dry: 77 ha) within maximum command area of 2,500 ha with crop intensity of 106% will be able to irrigate for 50% dependability as shown in Table AB-2.5.2.4.3.

Table AB-2.5.2.4.3 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	66 ha	1,200 ha	106%	80%	4
2,500 ha	1,400 ha	77 ha	1,400 ha	106%	50%	10

Source: JICA Survey Team

AB-2.6 Daun Pue Irrigation System Rehabilitation Sub-project

AB-2.6.1 Meteorology

There are 2 meteorological observation stations nearby the Daun Pue Irrigation System Rehabilitation Sub-project (DPISRSP) Area at Pochentong in Phnom Penh and Pursat. Unfortunately, Kampong Chhunang (Kampong Chunam) station is now observed only rainfall. Evaporation data at Kampong Chhunang was available only from 1961 to 1972. The meteorological data at Pochentong is more long-term and reliable than Pursat. In this Survey, the meteorological data at Pochentong was used for estimate water demand for DPISRSP. The average monthly meteorological data at Pochentong from 1991 to 2010 are shown in Table AB-2.6.1.1.1.

Table AB-2.6.1.1.1 Average 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

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)*
Note: Wind Speed data during the period from September 2005 to December 2010 were unavailable.

As can be seen in the above table, monthly mean temperature at the Pochentong station shows seasonal variation from 26.2 °C in December to 30.6 °C in April. Monthly maximum temperature higher than 31 °C is common. Monthly minimum temperature rarely falls down below 21 °C. Mean annual rainfall at Pochentong is estimated at 1,384 mm. Monthly rainfall shows obvious difference between the dry season and the rainy season. About 80% of annual rainfall concentrates in the rainy season, say May to October. Monthly mean relative humidity ranges from 70% in February and March to 84% in September and October. The relative humidity is high at night and low at daytime throughout the year. Monthly mean wind speed ranges 3.1 m/sec in October to 5.4 m/sec in August. Annual mean evaporation is 4.4 mm/day ranging 3.1 mm/day to 6.2 mm/day.

AB-2.6.2 Hydrology

AB-2.6.2.1 Data Availability

(1) Rainfall Observation

There are 4 rainfall stations in and around DPISRSP Area. Those are Bamnak (Bannak), Trapeang Chor, Thpong (Tpaung) and Tuek Phos (Tuk Phos) rainfall stations as shown in Figure AB-2.6.2.1.1. However, covered area of Bamnak and Thpong is only small percentage. Therefore, rainfall data of Trapeang Chor and Tuek Phos stations are used for estimation of basin rainfall at DPISRSP Area.

(2) 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 AB-2.6.2.1.2. 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 AB-2.6.2.1.2 Location of Water Level Gauging Station at Stung Srae Bak River

Also discharge observation was conducted from July 2007 to February 2008 by JICA as shown in Figure AB-2.6.2.1.3.

AB-2.6.2.2 Stung Thum and Stung Srae Bak 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 as shown in Figure AB-2.6.2.2.1. With this reason, most floods are inundated at near the confluence. Total length of the Stung Chieb River up to confluence point is 53.2 km.

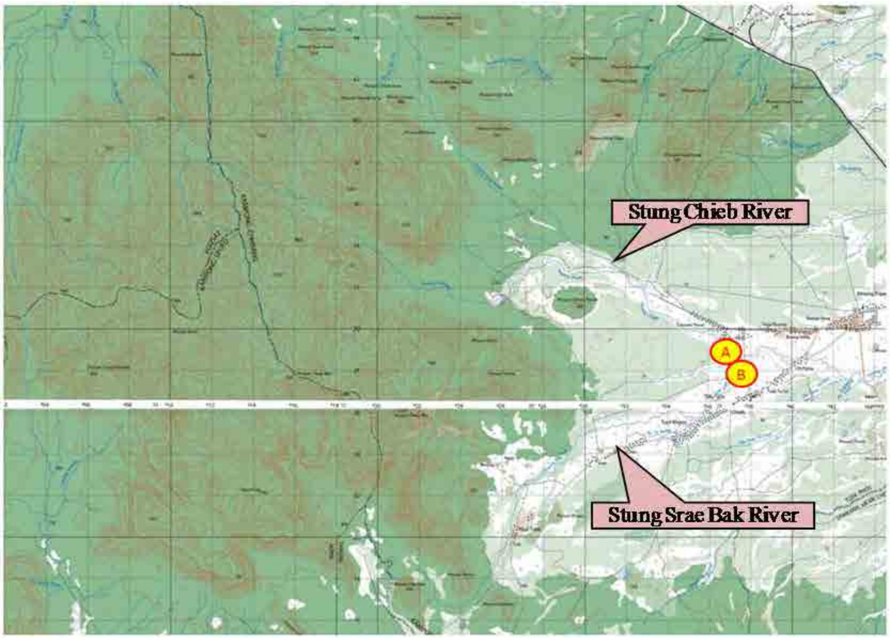


Figure AB-2.6.2.2.1 Topographic Map of DPISRSP Basin

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 Stung 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.

AB-2.6.2.3 Rainfall Analysis

As described in Sub-clause AB-2.3.2.3, double mass curve analysis of annual rainfall and rainfall correlation analysis was conducted. For estimation of long-term discharge for water balance simulation, basin mean rainfall of 30 years from 1982 to 2011 was prepared.

Missing rainfall data at Trapeang Chor station was interpolated using nearby Thpong station rainfall data. Also, missing rainfall data at Tuek Phos station was interpolated using Pochentong station rainfall data. Observed and estimated annual rainfall at Trapeang Chor and Tuek Phos stations is shown in Table AB-2.6.2.3.1 and Table AB-2.6.2.3.2.

Long-term daily basin rainfall from 1982 to 2011 (30 years) was estimated using Thiessen coefficients and observed and interpolated daily rainfall data. The Thiessen polygons and the affected area for each sub-basin are shown in Figure AB-2.6.2.1.1 above. Estimated monthly basin mean rainfall at Chi Prong water level gauging station is shown in Table AB-2.6.2.3.3.

AB-2.6.2.4 Low Flow Analysis

(1) Estimation of Long-term Discharge by Tank Model

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. Observed daily water level and calculated daily discharge at Chi

Prong gauging station are shown in Table AB-2.6.2.4.1 and Table AB-2.6.2.4.2.

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. The calibrated parameters of the daily base Tank Model for Chi Prong gauging station are shown in Figure 2.6.2.4.1. Observed daily discharge was calculated using daily observed water level and H-Q rating curve as shown in Figure AB-2.6.2.1.2. Figure AB-2.6.2.4.2 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 observed and estimated discharge. After estimation of daily discharge at Chi Prong by Tank Model, 5 days mean discharge was prepared for water balance study as shown in Table AB-2.6.2.4.3.

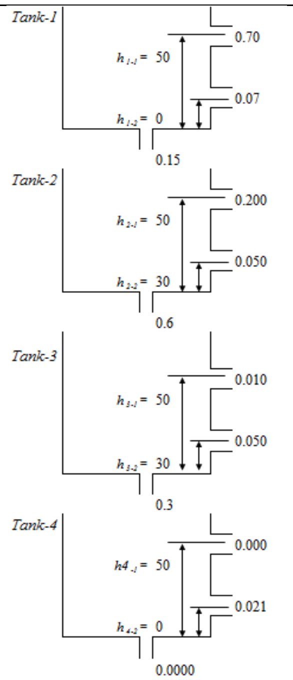


Figure AB-2.6.2.4.1 Calibrated Tank Model Parameters of Chi Prong

(2) Estimation of Long-term Discharge at Sub-Basin

Using estimated and observed 5days mean discharge at Chi Prong, 5days mean discharge at proposed intake site at the Stung Chieb River are estimated using catchment area and annual rainfall as shown in below.

$$Q_t = Q_{cp} \times \frac{A_t}{A_{cp}} \times \frac{R_t}{R_{cp}}$$

Where, Q_t: *Discharge at target point (m³/sec)*
Q_{cp}: *Discharge at Chi Prong W.L. gauging station (m^3/sec)*
A_t: *Catchment area at target point (km^2)*
A_{cp}: *Catchment area at Chi Prong W.L. gauging station (km^2)*
R_t: *Annual basin rainfall at target point (mm/year)*
R_{cp}: *Annual basin rainfall at Chi Prong W.L. gauging station (mm/year)*

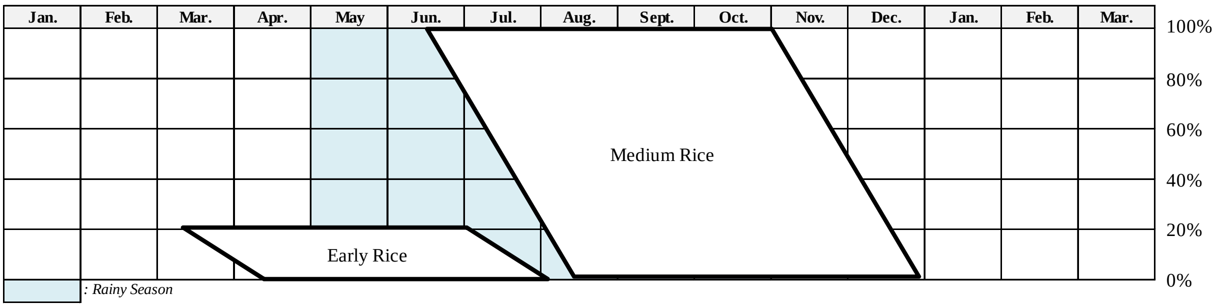
AB-2.6.2.5 Water Balance Study

(1) Method of Water Balance Study

There is no existing reservoir in the DPISRSP Area and the basin. Therefore, simplified water balance study was conducted for DPISRSP Area.

(2) Irrigation Water Demand

Irrigation water requirement for DPISRSP Area was calculated based on the proposed cropping calendar mentioned in Figure AB-2.6.2.5.1, which consists of early variety and medium variety. Estimated unit irrigation requirement for Early Rice (Early Rainy Season) and Medium Paddy in DPISRSP Area is shown in Table AB-2.6.2.5.1.



Source: JICA Survey Team

Figure AB-2.6.2.5.1 Proposed Cropping Calendar in DPISRSP

(3) Results of Water Balance Study

Two case 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. Results of water balance simulations of DPISRSP are shown in Figure AB-2.6.2.5.2 and Figure AB-2.6.2.5.3. According to the water balance simulations, total 1,200 ha of command area with crop intensity of 100% will be able to irrigate for 80% dependability that is case-1 as shown in Table AB-2.6.2.5.2. For 50% dependability, total 1,440 ha of command area will be able to irrigate with crop intensity of 112% as shown in Table AB-2.6.2.5.3. If intake site will construct at downstream of confluence point (Case-2), available irrigation area will be increased. Schematic results of 80% dependability are shown in Figure AB-2.6.2.5.4.

Table AB-2.6.2.5.2 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)
Case-1: Only Stung Chieb River	1,200 ha	0 ha	1,180 ha	100%	80%	4
Case-2: Stung Chieb River + Stung Srae Bak River	1,448 ha	174 ha	1,448 ha	112%	80%	4

Source: JICA Survey Team

Table AB-2.6.2.5.3 Results of Water Balance Study of DPISRSP (50% Dependability)

Study Case	Total Area	Early Rice (Early Rainy)	Mid Rice	Crop Intensity	Dependability	Deficit Year (times/20years)
Case-1: Only Stung Chieb River	1,440 ha	173 ha	1,180 ha	112%	50%	10
Case-2: Stung Chieb River + Stung Srae Bak River	2,335 ha	280 ha	2,335 ha	112%	50%	10

Source: JICA Survey Team

AB-2.6.2.6 Flood Analysis

(1) Probable Rainfall

Annual maximum daily point rainfalls at Kampong Chhunang station from 1983 to 2010 (27 years) are shown in Table AB-2.6.2.6.1. Frequency curve of annual maximum daily point rainfall at Kampong Chhunang is shown in Figure AB-2.6.2.6.1. Computation method of the Log Peason Type-III is used to estimate probable flood for DPISRSP Area as shown in Table AB-2.6.2.6.2.

Table AB-2.6.2.6.2 Estimated Probable Maximum Daily Rainfall at Kampong Chhunang

Return Period (Year)	Excess Probability	Computation Method (mm/day)			
		Iwai	Log Peason Type-III	Gumbel	Chow
1.01	0.9901	49	49	29	38
1.50	0.6667	82	80	79	81

Return Period (Year)	Excess Probability	Computation Method (mm/day)			
		Iwai	Log Peason Type-III	Gumbel	Chow
2	0.5000	95	93	96	95
5	0.2000	132	128	135	129
10	0.1000	159	153	162	152
20	0.0500	186	179	187	174
25	0.0400	195	188	195	180
50	0.0200	224	215	220	202
80	0.0125	244	235	237	216
100	0.0100	254	245	244	223
200	0.0050	286	276	269	244
500	0.0020	330	321	301	271
1,000	0.0010	366	358	326	292

Source: JICA Survey Team

(2) Probable Flood

Actual hourly flood data have not been recorded in the DPISRSP Area, the flood discharge at the Stung Srae Bak River, the Stung Chieb River and the confluence point are estimated by following 3 methods: (i) the IRS method in Irrigation Rehabilitation Study in Cambodia, 1994 (Mekong Secretariat), (ii) unit hydrograph method and (iii) rational formula method.

(a) IRS Method

IRS method is represented by the following equations.

$$MAF = AREA^{0.9}$$

$$Q_{10} = 1.53 \times MAF$$

$$Q_{20} = 1.78 \times MAF$$

$$Q_{50} = 2.00 \times MAF$$

$$Q_{100} = 2.20 \times MAF$$

Where, MAF : mean annual flood (m^3/sec),
AREA : catchment area (km^2)
Q_{10} : flood expected to occur not more than once every 10 years on an average,
Q_{100} : flood expected to occur not more than once every 100 years on an average.

Source: Flood Frequency Analysis in Final Report on Irrigation Rehabilitation Project, Sir William Halcrow & Partners Limited in association with Mandala Agricultural Development Corporation, June 1994, Mekong Secretariat.

(b) Unit Hydrograph Method

Unit hydrograph method is employed for flood estimate of each river and reservoir. Details of calculation are explained in “Planning Guideline for Rehabilitation and Reconstruction of Irrigation System”, made by the F/S Team.

(c) Rational Formula Method

Rational formula method is used as a reference of peak flood discharge that is estimated by unit hydrograph method.

(d) Conclusion

The results of flood peak estimation are summarized in Table AB-2.6.2.6.3.

Table AB-2.6.2.6.3 Estimated Flood Discharge by Rational Formula Method (DPISRSP)

Province			Kampong Chhnang Province							
Basin			Tonle Bati- Stung Touch basin (Daun Pue)							
River			Stung Chieb (Stung Oukhley)				Confluence of St. Chieb & St. Srae Bak River			
Return Period	-	Year	**10**	**20**	**50**	**100**	**10**	**20**	**50**	**100**
Excess Probability		%	10.0%	5.0%	2.0%	1.0%	10.0%	5.0%	2.0%	1.0%
Daily Point Rainfall	R_{24}	mm	153	179	215	245	153	179	215	245
Catchment Area	A	km^2	225.14	225.14	225.14	225.14	343.97	343.97	343.97	343.97
Length of River (main stream)	L	km	53.12	53.12	53.12	53.12				
Flood Peak (by *Rational* Formula)	Q_p	m^3/sec	**119**	**141**	**169**	**191**	**220**	**260**	**311**	**353**
Flood Peak (by *Unit Hydrograph*)	Q_p	m^3/sec	**129**	**173**	**236**	**287**	**209**	**279**	**377**	**456**
Flood Peak by (IRS method)	Q_p	m^3/sec	**200**	**233**	**262**	**288**	**313**	**364**	**409**	**450**

Source: JICA Survey Team

Compare of above results, estimated flood discharge by the unit hydrograph method is comparatively large and similar to IRS method results. Considering hydrological point of view, the unit hydrograph method is recommendable and reasonable value. Therefore, the design flood discharges by unit hydrograph method were used in this Survey.

CHAPTER AB-3 PRELIMINARY STUDY ON INFLUENCE OF ROLEANG CHREY COMMAND AREA WITH DAM PLAN

AB-3.1 General

AB-3.1.1 Purpose

There are several dam plans or projects in the Prek Thnot River basin as shown in Figure AB-3.1.1.1. 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 is high priority and a higher possibility according to MOWRAM.

AB-3.1.2 Conditions for Study

The effect of these proposed dams for the irrigation in the Project area was evaluated by using available information of these dam projects except the “Prek Thnot 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 AB-3.1.2.1 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 KSBT: Bari Station; 1982-2011
Percolation rate for estimation of irrigation water requirement	8 mm/day (With introduction of water saving irrigation Method)
Irrigation efficiency	Paddy; 66%, Upland crop; 53%
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 0 mm/day (not considered for proposed dam)

Source: JICA Survey Team

AB-3.2 Dam Plans in Basin Area of Prek Thnot River

AB-3.2.1 Prek Thnot Dam

In this study, the “Prek Thnot Multipurpose Dam” project was not considered due to the implementation schedule of the Prek Thnot Multipurpose Project is not formulated at present, and it is not clear when the Prek Thnot Dam will become operational.

Study for the Prek Thnot Dam project were made in the period 1960-1967 (Prek Thnot Investigation Team, 1962; WRD-Tahal, 1965; Mekong Secretariat, 1966; SMEC, 1968) and construction of a first phase started in 1969 but was halted a few years later due to 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 66,00 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 irrigable simulation of “with and without” Prek Thnot Dam conditions. In order to confirm the irrigation potential under the “with” Prek Thnot 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.

AB-3.2.2 Proposed 3-Dams by (K-Water)

(1) Feature 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. Location map of these 3 dams is shown in Figure AB-3.2.2.1. The basin characteristics at respective dam sites are as follows:

Table AB-3.2.2.1 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 AB-3.2.2.2 and Table AB-3.2.2.3.

Table AB-3.2.2.2 Features of 3 Dams Located Upstream of Prek Thnot River

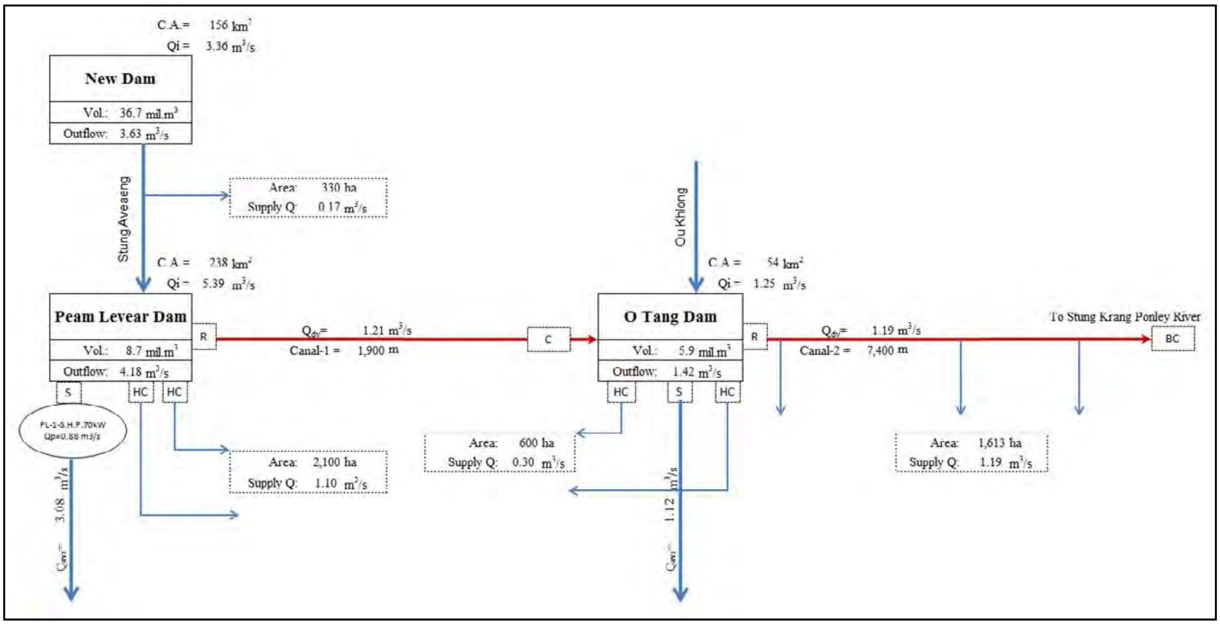
Item	Dam Type	Effective Storage (10^6m^3)	Water Supply for Irrigation (10^6m^3/yr)	Flood Control Storage (10^6m^3/sec)	Power Generation (kW)
New Dam	Earth dam	25.9	73 (4,432 ha × 2 times)	5.3	330
Peam Levear	Earth dam	7.8		2.4	70
O Tang	Earth dam	5.6		2.1	-

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.

(2) Conjunctional Operational System

Figure AB-3.2.2.2 below shows the schematic diagram for water supply of conjunctional operation of current 2 dam and new dam. These 3 dams are planned as combined operation. Reservoir water of the New Dam will supply irrigation own are 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 irrigation areas will be decrease 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

FigureAB-3.2.2.2 Schematic Diagram for Water Sully of 3 Dams by K-Water

(3) Irrigation Water Requirement

Water demands for rural areas in the project area were estimated in the 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 AB-3.2.2.4. Agricultural water demand in the F/S is shown in Table AB-3.2.2.5.

Table AB-3.2.2.4 Water Demand for Rural Areas in the 3-Dams Projects by K-Water

(Unit: MCM)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	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	Sep	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

(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 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 the F/S as shown in Table AB-3.2.2.6.

Table AB-3.2.2.6 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	1.5	0.63	0.25
O Tang Dam	1.19	0.34	0.14	0.06
Total (P/L & 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

(5) Stage-Area-Capacity Curve

Stage-Area-Capacity (H-V-A) curves at 3-dams are shown in Table AB-3.2.2.7 and Figures AB-3.2.2.3. In the F/S, storage area and capacity was prepared using digital map of project site by results of topographic survey.

(6) Reservoir Operation Study

Using given condition of proposed irrigation areas and feature of these 3-dams, reservoir operation simulation was conducted by 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 Sub-clause AB-2.3.2.4, ratio of catchment area and annual basin mean rainfall was used.

The results of our simulation of reservoir operations are shown in Table AB-3.2.2.8 and Figure AB-3.2.2.4. According to results of reservoir operation of 30-years by JICA Survey Team, case-2 of proposed by the F/S is difficult to irrigate with high dependability. Case-3 that is proposed by the F/S as an optimum scale, is able to irrigate with almost 80% dependability. Case-1 is irrigation areas that were shown in Figure AB-3.2.2.2 above. In this condition, if 80% dependability of irrigation is required, irrigation areas of case-4 are recommendable.

Table AB-3.2.2.8 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	2,313 ha	70%	2,398 ha	10%	2,100 ha	77%	1,740 ha	80%
O Tang	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

AB-3.2.3 Proposed Stung Tasal Dam (by WAPCOS)

(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 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 mobilized the 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 Ministry of Environment (MOE) and forest was also cleared along the dam axis.

(2) Main Features

Main features of proposed the Stung Tasal Dam are shown in Table AB-3.2.3.1. Map of catchment area and the reservoir area show in Figure AB-3.2.3.1. Stage-area-capacity curve of proposed the Stung Tasal Dam is shown in Table AB-3.2.3.2 and Figure AB-3.2.3.2.

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 10000 ha. About 8000 ha of the command under the 2 canal systems of downstream of the Roleang Chrey Headworks and 2000 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 70m downstream of the dam.

Table AB-2.7.2.3.2 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.

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 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.

(3) Cost Estimates

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.

(4) Benefits

1) Irrigation

a) Canal irrigation (gravity flow) below Roleang Chrey Headworks = 8000 ha

b) Lift irrigation upstream of Roleang Chrey Headworks = 2000 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.

(5) Economic Evaluation

The B-C ratio for the project is estimated at1.77 and the IRR is 13%.

(6) Irrigation Planning

At the present situation, lift irrigation system is the only option. But this system of irrigation is costly. So, in limited scale such irrigation system has been considered. 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 1999 to serve an area of 16,700 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.

(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.

AB-3.2.4 Proposed Stung Sva Srab Dam and Stung Khleach Dam

(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 AB-3.2.4.1. Location map of these 2 dams is shown in Figure AB-3.2.4.1.

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.

Table AB-3.2.4.1 Preliminary Features of Stung Sva Srab Dam and Stung Khleach Dam

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 –~~ => 188 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. 240 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

(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 by using 1/50,000 scale topographic map as shown in Figure AB-3.2.4.2 and Figure AB-3.2.4.3. Prepared stage-area-capacity curve of proposed Stung Sva Srab Dam and Stung Khleach Dam are shown in Figure AB-3.2.4.4.

(3) Main Features

Salient features of these 2 dams are shown in Table AB-3.2.4.2.

AB-3.3 Preliminary Water Balance Study

AB-3.3.1 Conditions of Water Balance Study

(1) Basin Rainfall

As described in Section AB-2.3.2.3, basin mean rainfall at each proposed dam site was estimated for the period of 1982-2011 by interpolated daily rainfall and the Thiessen coefficient.

(2) Inflow Discharge at Proposed Dam Sites

As described in Section AB-2.3.2.4, inflow discharge at each proposed dam site was estimated for the period of 1982-2011 by 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-days mean discharge at each dam site was prepared.

(3) Water Demand of Roleang Chrey Command Area

Irrigation water requirements at the Roleang Chrey Irrigation Area, the Kandal Stung-Bati Irrigation Area, the Dangkor Irrigation Area, the Kampong Damrey Irrigation Area and the Ou Krang Ambel Irrigation Area were estimated by proposed cropping patterns and conditions that is described in Section AB-2.3.2.5. 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.

(4) Reservoir Operation of Proposed Dams

a) 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.

b) 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.

c) 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.

AB-3.3.2 Result

(1) Study Case

Following cases are evaluated for water balance simulation for preliminary study on influence of the Roleang Chrey command area with dam plans.

Table AB-3.3.2.1 Study Case of Water Balance Study for Proposed Dam Plans

No.	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

(2) Results of Water Balance Study of "with and without" Dam

Summary of case study of water balance simulation of "with/without" dam is shown in Table AB-3.3.2.2.

Table AB-2.7.3.2.2 Summary of Case Study of Water Balance Simulation of "with/without" Dam

(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-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)			Bati (Priority Area)			KSB
	Total Area	Crop Intensity	Dependability	Total Area	Crop Intensity	Dependability	Total Area	Crop Intensity	Dependability	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

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 increase 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 will be increased the crop intensity and the dependability, in the

Kandal Stung (Extension) Area will be able to irrigate “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 AB-3.3.1.1. Result of reservoir operation of the Stung Tasal Dam of Case-2 is shown in Figure AB-3.3.1.2.

AB-3.4 Recommendation

As described above, the Stung Tasal Dam produces a large benefit for the Roleang Chrey Irrigation Area. Therefore, implementation of the Stung Tasal Dam Project is strongly recommended.

Stung Khleach Dam is more large 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 Irrigation Area. Feasibility study of the Stung Khleach Dam and the Stung Sva Slab Dam will be also recommended.

ANNEX B

Tables

Table AB-2.1.1.2.1 Monthly Mean Temperature at Pochentong (1991-2010) (Unit: °C)

Year	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	27.1	27.7	29.3	30.7	30.5	28.8	28.0	27.7	28.1	26.9	26.2	26.3	28.1
1992	25.7	28.1	29.8	n.a.	31.5	29.2	28.5	27.8	27.3	26.2	25.3	25.8	27.7
1993	25.9	26.7	28.5	29.9	29.5	28.0	27.9	27.4	27.5	26.9	26.2	25.6	27.5
1994	26.4	28.7	28.7	30.0	29.8	29.0	28.3	28.7	27.4	27.5	26.2	27.0	28.1
1995	25.4	25.9	28.8	30.2	29.2	28.8	28.4	28.7	27.0	27.4	26.6	25.9	27.7
1996	25.7	26.9	28.4	30.0	29.1	28.7	27.7	27.8	28.0	27.7	27.7	25.4	27.7
1997	25.8	28.0	29.0	30.1	30.3	30.2	28.5	28.8	28.3	28.1	27.7	27.6	28.5
1998	27.1	28.6	30.6	30.4	30.2	29.1	28.7	28.8	28.4	27.1	25.7	24.8	28.3
1999	26.7	27.6	30.5	29.8	29.1	28.6	28.4	28.5	28.6	27.6	27.0	23.9	28.0
2000	27.3	27.7	29.3	29.7	29.7	28.8	28.3	28.5	28.3	27.1	26.8	26.8	28.2
2001	27.1	27.6	28.8	30.5	30.1	29.1	29.1	39.8	28.2	27.6	25.5	26.4	29.2
2002	27.6	28.5	30.8	32.4	31.7	31.5	31.0	29.9	29.4	29.4	28.6	28.7	30.0
2003	25.6	28.1	29.8	30.8	30.0	30.1	28.6	29.2	28.7	28.0	27.8	25.6	28.5
2004	27.2	27.9	30.5	31.5	30.6	29.1	29.5	29.0	28.3	27.6	28.0	26.0	28.8
2005	26.1	29.3	28.0	31.2	32.2	31.0	29.6	29.3	28.8	28.3	28.3	26.9	29.1
2006	28.4	29.6	29.8	30.8	30.8	30.8	29.0	29.0	29.3	28.2	28.5	26.4	29.2
2007	26.4	26.6	29.4	31.3	30.9	29.8	28.9	29.2	29.6	27.8	25.5	25.9	28.4
2008	27.1	28.0	29.2	30.2	29.9	29.6	29.8	28.8	28.6	28.4	27.6	26.5	28.6
2009	25.7	28.4	30.3	30.3	30.1	29.8	28.9	29.1	28.7	29.5	28.0	27.5	28.8
2010	28.4	30.4	31.6	31.5	32.3	31.4	29.7	28.6	29.0	27.9	27.4	26.4	29.5
Average (1991～2010)	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

Source: Department of Meteorology, MOWRAM

Table AB-2.1.1.2.2 Monthly Maximum Temperature at Pochentong (1991-2010) (Unit: °C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	32.3	33.2	34.7	35.7	35.1	32.8	31.3	30.8	31.4	30.1	30.0	30.8	32.4
1992	30.7	33.3	35.5	n.a.	36.7	33.5	32.2	31.4	32.4	29.8	29.7	30.8	32.4
1993	29.9	31.9	33.3	34.9	33.3	31.2	30.8	30.3	30.6	30.6	31.6	30.2	31.6
1994	32.2	34.4	33.8	34.8	34.3	33.2	32.1	32.9	31.1	31.6	31.6	31.7	32.8
1995	29.7	30.2	33.5	34.7	33.6	32.8	32.2	32.7	31.3	31.8	31.7	31.3	32.1
1996	30.3	32.0	33.2	34.7	33.1	32.4	31.0	30.7	31.1	31.2	31.5	29.9	31.8
1997	30.9	32.6	34.4	35.3	35.0	35.1	32.3	32.7	32.0	31.5	31.1	32.1	32.9
1998	32.2	33.6	35.9	35.1	34.7	33.3	32.6	32.4	32.2	30.1	28.9	29.6	32.6
1999	31.5	32.7	36.3	34.6	33.2	32.7	32.1	32.6	32.6	30.9	30.2	27.3	32.2
2000	31.7	32.6	34.2	34.2	34.1	32.9	32.3	32.1	32.0	30.4	30.1	30.2	32.2
2001	31.1	32.6	33.4	35.4	34.5	33.4	33.3	32.3	32.5	31.5	29.3	30.7	32.5
2002	33.9	34.9	37.3	39.3	37.5	37.5	36.4	35.3	34.0	34.3	33.0	33.1	35.5
2003	30.9	33.5	34.8	35.8	34.5	34.7	32.4	33.2	32.7	31.4	32.0	30.1	33.0
2004	32.3	33.4	36.2	36.9	35.4	33.3	33.7	33.0	32.3	31.1	31.8	31.2	33.4
2005	34.6	37.0	37.0	38.5	39.9	38.0	36.2	36.2	35.3	34.0	33.8	33.8	36.2
2006	35.3	36.1	36.5	38.1	37.6	37.5	36.0	35.0	34.5	33.8	34.0	34.0	35.7
2007	34.4	35.1	36.8	38.5	36.8	36.2	34.7	35.4	34.6	33.0	33.5	33.4	35.2
2008	34.1	34.7	36.8	37.2	36.0	37.1	36.5	34.7	34.9	34.0	32.9	32.6	35.1
2009	33.5	36.2	37.4	38.3	36.8	36.5	35.4	35.8	35.1	35.0	34.3	34.5	35.7
2010	35.3	38.1	40.0	38.8	40.0	39.2	35.5	34.8	34.6	33.5	32.5	32.7	36.3
Average (1991～2010)	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

Source: Department of Meteorology, MOWRAM

Table AB-2.1.1.2.3 Monthly Minimum Temperature at Pochentong (1991-2010) (Unit: °C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	21.9	22.1	23.9	25.6	25.8	24.7	24.6	24.6	24.7	23.6	22.4	21.8	23.8
1992	20.6	22.9	24.0	25.8	26.3	24.9	24.7	24.1	22.1	22.6	20.9	20.8	23.3
1993	21.9	21.5	23.6	24.8	25.7	24.7	24.9	24.4	24.3	23.1	20.7	20.9	23.4
1994	20.5	22.9	23.6	25.2	25.3	24.8	24.5	24.4	23.7	23.4	20.7	22.2	23.4
1995	21.0	21.5	24.1	25.7	24.7	24.8	24.5	24.6	22.7	23.0	21.4	20.4	23.2
1996	21.0	21.8	23.5	25.3	25.0	24.9	24.4	24.8	24.8	24.2	23.8	20.8	23.7
1997	20.6	23.3	23.6	24.9	25.6	25.3	24.7	24.9	24.5	24.6	24.2	23.0	24.1
1998	22.0	23.6	25.2	25.6	25.6	24.9	24.7	25.1	24.6	24.0	22.5	20.0	24.0
1999	21.9	22.4	24.7	25.0	24.9	24.5	24.7	24.4	24.5	24.2	23.8	20.5	23.8
2000	22.8	22.7	24.3	25.1	25.3	24.7	24.2	24.8	24.5	23.8	23.4	23.4	24.1
2001	23.1	22.6	24.2	25.6	25.7	24.9	24.9	47.3	23.9	23.8	21.8	22.0	25.8
2002	21.3	22.2	24.4	25.5	25.8	25.6	25.7	24.5	24.8	24.6	24.2	24.2	24.4
2003	20.4	22.8	24.7	25.9	25.6	25.4	24.7	25.1	24.8	24.6	23.7	21.1	24.1
2004	22.0	22.3	24.8	26.0	25.9	24.9	25.3	25.0	24.4	24.2	24.1	20.8	24.1
2005	17.5	21.5	18.9	23.8	24.5	24.0	23.0	22.3	22.2	22.6	22.8	19.9	21.9
2006	21.4	23.0	23.0	23.5	24.0	24.0	22.0	23.0	24.0	22.5	23.0	18.8	22.7
2007	18.4	18.0	22.0	24.0	25.0	23.3	23.0	22.9	24.5	22.5	17.5	18.4	21.6
2008	20.0	21.3	21.5	23.2	23.7	22.0	23.0	22.9	22.3	22.8	22.3	20.3	22.1
2009	17.8	20.6	23.2	22.3	23.3	23.0	22.3	22.3	22.3	24.0	21.7	20.5	21.9
2010	21.4	22.7	23.1	24.1	24.5	23.5	23.8	22.4	23.3	22.3	22.2	20.0	22.8
Average (1991～2010)	20.9	22.1	23.5	24.8	25.1	24.4	24.2	25.2	23.8	23.5	22.4	21.0	23.4

Source: Department of Meteorology, MOWRAM

Table AB-2.1.1.2.4 Monthly Rainfall at Pochentong (1901-2010) (Unit: mm)

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Annual
1901	0.5	28.2	3.9	8.7	108.5	228.5	122.6	110.5	146.4	302.3	170.3	52.9	1,283
1902	0.0	33.3	16.2	0.3	67.2	167.4	126.4	136.7	203.8	195.1	77.2	81.1	1,105
1903	0.6	0.0	0.0	24.0	129.6	169.5	176.1	278.0	292.1	141.4	123.6	136.5	1,471
1904	0.0	0.0	3.9	142.0	238.0	52.0	54.0	143.8	176.5	336.3	270.8	0.0	1,417
1905	0.0	0.5	0.0	0.0	113.8	118.1	212.6	288.3	209.7	386.6	50.3	0.0	1,380
1906	0.0	0.0	0.2	22.8	163.0	231.5	108.0	129.6	256.9	247.1	49.8	3.2	1,212
1907	0.3	0.0	26.6	55.3	100.3	82.9	181.2	105.5	270.6	219.2	270.1	78.3	1,390
1908	4.0	0.0	0.0	51.4	103.6	183.1	194.0	194.4	144.0	402.0	110.9	36.0	1,423
1909	15.4	19.6	4.3	2.1	227.0	192.0	182.1	194.7	195.8	182.9	145.9	51.8	1,414
1910	28.0	19.0	192.9	31.3	135.2	103.2	142.2	153.5	153.8	182.1	82.2	51.3	1,275
1911	0.0	0.0	2.2	111.3	119.1	134.6	272.7	146.3	265.4	114.6	1.6	42.7	1,211
1912	16.3	1.5	0.0	72.3	30.4	77.7	247.1	114.1	218.2	105.3	80.8	4.8	969
1913	0.0	0.0	5.6	48.6	317.5	26.9	242.7	135.4	160.1	390.9	74.4	47.0	1,449
1914	0.0	6.4	1.8	105.9	61.6	90.4	148.8	115.8	154.3	308.3	158.1	67.4	1,219
1915	0.0	0.0	91.8	42.4	58.9	264.8	214.0	100.0	325.6	278.8	106.0	18.2	1,501
1916	0.0	0.0	119.2	12.6	201.1	177.3	358.9	339.7	241.1	649.7	183.3	26.8	2,310
1917	0.0	2.2	1.6	0.0	125.4	261.2	140.6	379.9	443.3	510.1	297.5	55.9	2,218
1918	0.0	0.0	33.8	58.0	141.6	192.3	58.2	140.0	140.1	308.8	95.7	21.5	1,190
1919	0.0	0.0	0.0	143.3	142.4	130.6	144.3	91.0	272.1	172.9	155.0	0.0	1,252
1920	0.0	127.4	50.2	56.7	77.2	135.4	108.7	151.9	93.2	78.1	274.7	123.2	1,277
1921	0.0	0.0	126.7	55.5	84.5	143.9	251.3	143.7	244.7	280.3	96.6	4.5	1,432
1922	0.0	0.0	181.8	23.6	50.6	85.0	135.8	75.5	241.3	439.6	293.7	59.7	1,587
1923	0.5	0.0	13.3	359.2	166.6	92.4	132.7	65.8	210.8	115.6	177.8	2.4	1,337
1924	0.0	0.0	15.0	171.2	162.5	295.5	115.5	179.8	217.0	198.5	95.0	52.6	1,503
1925	18.3	0.0	70.7	51.0	125.5	103.9	195.1	143.3	183.2	133.3	73.7	28.4	1,126
1926	0.0	0.0	0.0	25.8	140.3	156.8	258.8	298.5	239.1	386.9	107.5	176.3	1,790
1927	28.9	0.0	38.8	57.5	133.3	392.8	188.6	133.0	149.6	194.3	29.9	64.9	1,412
1928	14.7	18.8	0.0	229.1	170.5	107.2	162.9	219.4	332.1	242.5	48.5	0.0	1,546
1929	11.0	98.2	40.2	88.4	99.7	139.7	54.6	220.1	223.0	112.0	47.2	14.0	1,148
1930	10.7	2.7	88.0	51.6	214.1	185.4	77.5	164.8	223.6	170.7	160.2	145.4	1,495
1931	0.0	0.0	17.9	25.0	126.6	71.4	133.6	133.5	332.8	268.9	52.9	67.3	1,230
1932	0.0	0.0	2.6	160.0	112.8	73.1	208.5	86.6	218.3	371.1	177.5	43.2	1,454
1933	11.2	0.0	0.0	54.6	135.2	123.3	81.2	157.0	181.0	243.0	65.6	0.0	1,052
1934	0.0	65.1	54.3	93.0	140.9	82.1	138.6	219.1	177.9	243.6	67.1	21.3	1,303
1935	0.0	0.0	0.9	18.6	192.2	270.8	183.1	70.8	241.2	326.5	235.5	93.6	1,633
1936	50.9	6.5	9.3	12.9	83.7	192.8	141.1	187.6	162.7	62.7	50.6	16.6	977
1937	24.6	10.9	15.5	42.0	146.0	97.0	227.3	150.6	252.0	181.5	110.4	18.5	1,276
1938	0.0	0.0	77.5	144.4	172.8	287.3	139.4	117.6	237.7	340.9	132.5	16.1	1,666
1939	15.6	0.0	11.7	42.4	174.1	143.2	108.2	79.2	357.2	141.3	243.9	8.0	1,325
1940	0.0	0.0	1.1	22.2	81.5	38.9	104.0	160.5	203.5	77.6	165.4	80.0	935
1941	0.0	44.0	83.5	82.4	104.4	72.9	98.0	140.6	177.8	377.8	283.7	98.0	1,563
1942	57.3	0.0	52.6	125.3	205.4	135.3	105.3	191.3	315.0	321.2	274.0	8.9	1,792
1943	0.0	0.9	32.4	177.2	235.1	78.6	46.6	161.1	248.8	315.8	135.5	10.6	1,443
1944	57.4	14.0	23.0	81.6	154.5	164.0	88.8	320.8	131.9	362.6	141.4	105.2	1,645
1945	0.0	0.0	17.9	25.0	126.6	71.4	133.6	133.5	332.8	288.9	52.9	67.3	1,250
1946	9.6	10.2	39.1	78.6	395.1	124.3	121.8	44.4	164.5	215.4	101.0	6.3	1,310
1947	0.0	0.0	57.8	177.2	145.5	135.1	145.5	219.2	246.1	311.2	112.7	40.3	1,591
1948	0.0	20.2	29.2	143.5	46.4	115.4	98.7	130.6	406.3	200.4	139.9	0.0	1,331
1949	0.0	14.0	2.8	77.0	150.7	144.7	120.1	90.4	128.2	275.5	191.8	58.6	1,254
1950	16.1	5.3	3.3	39.0	136.0	127.4	120.4	98.2	332.1	173.0	79.9	34.9	1,166
1951	0.8	0.0	0.2	56.4	178.9	130.5	204.8	191.3	186.8	131.0	228.1	7.2	1,316
1952	4.9	1.0	2.0	43.5	107.8	150.1	67.3	198.0	259.0	429.3	137.2	6.5	1,407
1953	1.2	5.6	18.9	26.2	96.3	79.4	139.7	120.9	194.0	212.0	121.2	6.0	1,021
1954	7.5	0.0	73.5	77.5	122.5	133.4	180.1	107.0	171.5	107.7	31.8	87.4	1,100
1955	4.2	0.0	12.0	55.8	127.2	162.5	147.2	97.9	235.1	321.5	276.4	0.0	1,440
1956	2.8	0.4	0.0	106.3	260.3	346.5	128.0	126.4	205.4	129.6	116.3	90.8	1,513
1957	11.6	24.4	80.1	79.0	53.0	37.5	126.9	261.7	400.8	361.6	87.1	0.0	1,524

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Annual
1958	0.0	9.0	8.3	50.3	197.8	96.5	145.6	135.7	133.8	293.7	3.6	0.2	1,075
1959	0.0	0.0	94.1	70.8	63.7	92.0	101.2	161.8	152.0	227.8	85.1	67.7	1,116
1960	2.4	4.2	14.9	15.2	267.5	94.3	84.4	117.4	128.4	212.3	102.2	3.7	1,047
1961	7.8	15.8	10.5	30.6	113.1	226.5	37.3	71.2	142.3	271.6	116.5	28.8	1,072
1962	1.5	0.0	0.6	45.3	206.2	44.3	87.4	102.1	402.0	428.0	95.3	0.0	1,413
1963	0.5	0.0	58.5	0.0	199.2	111.6	135.3	149.7	271.6	222.9	164.9	2.5	1,317
1964	0.0	0.6	0.0	9.1	263.1	121.5	201.8	110.2	227.6	200.8	175.7	23.3	1,334
1965	0.7	17.3	10.4	57.4	150.7	86.1	148.4	189.7	326.5	271.1	103.3	74.7	1,436
1966	2.9	9.8	6.5	24.8	214.1	258.0	205.2	180.5	244.2	281.6	153.7	53.8	1,635
1967	5.4	2.4	0.0	134.6	116.1	327.1	245.8	119.7	308.3	179.2	34.2	0.1	1,473
1968	0.0	0.0	0.0	92.7	113.8	153.8	151.0	85.3	182.5	278.7	17.6	0.0	1,075
1969	18.9	25.8	1.2	18.6	77.0	112.3	49.9	162.0	283.1	344.4	29.3	1.3	1,124
1970	2.3	0.0	7.1	15.4	227.6	105.5	52.3	249.4	119.0	515.6	183.6	186.4	1,664
1971	0.0	1.3	1.3	0.0	123.1	212.4	230.0	377.9	322.0	328.5	48.6	22.3	1,667
1972	0.0	6.3	27.2	126.5	69.9	290.7	108.2	81.2	119.9	205.0	239.9	19.2	1,294
1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1974	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1975	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1976	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1977	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1978	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1979	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1980	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1981	12.0	11.3	0.0	45.4	143.5	70.9	224.7	126.6	239.2	151.1	264.0	0.0	1,289
1982	0.4	0.5	14.2	181.0	196.8	159.4	74.9	161.1	246.7	218.5	107.5	0.1	1,361
1983	0.0	0.0	0.0	0.0	47.5	55.1	170.1	300.2	174.1	203.1	155.4	3.2	1,109
1984	1.4	1.1	0.0	128.7	62.2	142.6	127.1	106.1	264.3	292.7	51.5	1.1	1,179
1985	0.0	1.1	0.0	157.6	102.7	77.0	117.6	92.5	283.7	260.8	188.7	0.9	1,283
1986	0.0	4.5	4.5	48.7	149.8	90.9	181.3	224.5	301.3	235.1	86.9	23.8	1,351
1987	0.0	0.0	0.0	0.0	24.6	150.2	91.9	183.6	474.3	257.1	323.8	0.0	1,506
1988	0.0	22.9	22.2	96.3	70.2	172.9	152.9	177.8	445.0	137.4	71.4	0.0	1,369
1989	15.0	0.0	54.0	63.2	183.5	38.4	86.6	162.4	397.6	328.6	107.3	0.0	1,437
1990	0.0	0.0	0.0	26.2	227.1	63.8	166.8	174.6	246.6	98.3	138.7	0.0	1,142
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	0.0	0.0	18.0	94.3	234.6	146.8	156.4	208.9	277.1	243.6	22.4	11.2	1,413
1996	14.9	0.0	5.2	103.6	173.9	151.8	99.5	150.3	343.3	213.3	345.6	15.0	1,616
1997	0.0	26.0	7.4	19.2	108.6	157.9	212.9	98.1	340.1	337.1	94.6	6.0	1,408
1998	0.0	0.0	0.0	74.2	73.4	225.9	217.2	180.0	247.6	219.4	269.7	25.1	1,533
1999	45.5	23.3	20.3	165.3	119.5	159.3	274.4	185.2	274.0	194.9	136.7	60.3	1,659
2000	56.5	8.3	52	190.8	206.2	240.3	234.4	147.3	124.7	442.5	124.7	301.1	2,129
2001	74.4	0.0	171	55	104.7	139.2	110.6	245.8	254	410.4	40.5	9.2	1,615
2002	0.0	0.0	0.4	20.3	80.2	144.7	99.4	178.9	236.1	302.3	165.8	58.2	1,286
2003	0.0	0.4	7.5	42.8	174.6	188.0	287.5	98.7	255	193.3	42.8	13.4	1,304
2004	0.4	0.0	0.0	94.8	116.1	164.2	91.1	101.1	203.4	201.7	118.8	0.0	1,092
2005	0.0	0.0	0.0	74.3	74.8	51.9	125.6	217.2	324.8	378.9	132.5	46.7	1,427
2006	0.0	0.0	32.8	64.1	81.7	136.2	120.0	262.8	281.6	192.9	12.4	23.0	1,208
2007	0.0	0.0	33.4	39.8	201.4	252.0	141.0	263.6	159.2	212.1	71.3	0.0	1,374
2008	74.1	0.6	112.0	83.4	197.3	219.1	169.6	289.6	290.2	259.4	190.7	0.0	1,886
2009	0.0	14.6	1.7	112.7	241.5	148.2	151.8	273.6	303.8	123.8	84.4	0.0	1,456
2010	25.4	0.0	35.6	55.9	26.9	254.3	84.1	233.0	324.3	387.1	94.3	69.9	1,591
Average (1901~2010)	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

Souce: *Prek Thnot Multipurpose Project, Reappraisal Report Volume 5.2 - Annexe I, Australian Catholic Relief by Euroconsultant, December 1991*
Department of Meteorology, MOWRAM

Table AB-2.1.1.2.5 Monthly Mean Relative Humidity at Pochentong (1991-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	72.0	68.0	66.6	68.0	74.8	80.7	84.9	84.6	86.8	86.6	78.3	74.9	77.2
1992	71.7	68.7	68.3	71.3	75.3	78.1	81.8	84.3	85.0	85.0	76.3	76.5	76.9
1993	72.7	68.4	70.7	67.6	77.5	79.1	83.4	83.1	85.0	82.7	77.1	77.3	77.1
1994	76.4	75.0	77.0	72.2	74.8	77.4	85.9	82.0	88.7	86.7	80.4	83.8	80.0
1995	71.4	69.3	68.7	68.2	75.3	78.9	80.5	83.7	85.4	85.0	79.8	75.1	76.8
1996	72.1	67.1	65.7	75.3	78.7	78.9	89.5	90.0	89.7	88.8	82.5	72.4	79.2
1997	72.6	74.4	73.1	72.9	73.6	73.1	80.6	80.8	83.5	84.5	80.3	n.a.	77.2
1998	75.1	74.8	68.0	70.6	73.6	73.1	80.6	80.8	83.5	84.5	80.3	68.1	76.1
1999	72.9	70.7	74.9	71.7	82.5	80.4	81.8	81.8	85.7	86.3	79.3	72.6	78.4
2000	72.0	68.5	73.0	76.0	78.0	88.0	74.0	78.0	82.0	89.5	82.0	76.0	78.1
2001	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2002	73.0	73.0	70.0	72.0	75.0	76.0	73.0	82.0	82.0	83.0	81.0	82.0	76.8
2003	74.3	70.7	68.7	71.3	78.1	76.8	83.4	80.0	83.0	83.6	76.3	71.6	76.5
2004	73.9	69.5	65.7	68.1	71.8	78.2	77.8	77.9	83.3	80.0	75.8	72.5	74.5
2005	74.3	71.9	65.0	68.8	72.2	71.0	78.4	75.4	80.0	78.6	76.0	71.4	73.6
2006	68.0	69.0	74.0	76.0	77.0	77.0	78.0	80.0	84.0	83.0	79.0	73.0	76.5
2007	67.0	70.0	74.0	72.0	79.0	80.0	79.0	79.0	83.0	82.0	76.0	70.0	75.9
2008	70.0	67.0	67.0	71.0	77.0	77.0	75.0	80.0	81.0	82.0	79.0	71.0	74.8
2009	67.0	71.0	68.0	75.0	79.0	75.0	78.0	79.0	84.0	82.0	75.0	70.0	75.3
2010	71.7	70.1	65.8	68.2	69.0	79.2	79.9	81.5	82.9	84.1	77.3	74.6	75.4
Average (1991～2010)	71.8	70.4	69.6	71.4	76.0	77.8	80.3	81.3	84.1	84.1	78.5	74.0	76.4

Source: Department of Meteorology, MOWRAM

Table AB-2.1.1.2.6 Monthly Mean Wind Speed at Pochentong (1991-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	2.0	4.0	2.0	2.0	3.0	6.0	2.0	4.0	2.0	3.0	2.0	1.5	2.8
1992	2.0	4.0	3.0	3.0	3.0	5.0	2.0	3.0	n	3.0	4.0	3.0	3.2
1993	2.0	4.0	5.0	3.0	3.0	2.0	3.5	4.5	4.5	3.5	4.5	3.5	3.6
1994	4.0	1.5	3.0	4.0	4.0	4.5	3.5	3.0	2.5	2.5	4.0	2.0	3.2
1995	1.5	3.0	3.0	2.0	6.0	4.0	3.0	2.0	1.0	1.5	4.0	5.0	3.0
1996	2.5	3.4	3.2	3.1	2.7	2.7	3.3	3.4	2.5	1.2	2.4	3.0	2.8
1997	2.5	3.0	5.0	6.5	4.5	4.0	5.0	6.0	5.0	2.5	3.0	4.0	4.3
1998	5.5	4.0	5.0	5.0	4.5	4.0	5.0	6.0	5.0	2.5	3.0	4.0	4.5
1999	5.0	4.0	6.0	7.0	7.0	7.0	6.5	9.0	8.0	5.5	7.0	8.0	6.7
2000	3.5	8.0	6.0	2.0	3.0	7.0	5.0	9.0	8.0	2.0	2.0	2.5	4.8
2001	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2002	2.9	2.4	2.4	3.9	2.4	4.1	-	4.4	4.5	3.9	4.3	3.7	3.5
2003	4.0	4.3	4.5	4.4	5.6	6.2	5.1	6.3	4.8	4.1	4.3	5.3	4.9
2004	4.0	4.1	4.3	4.4	5.5	6.1	6.0	6.9	5.6	4.4	5.9	5.3	5.2
2005	4.0	4.0	4.5	4.0	6.4	5.5	6.5	8.5	n.a.	n.a.	n.a.	n.a.	-
2006	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2007	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2008	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2009	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2010	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
Average (1991～2010)	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

Source: Department of Meteorology, MOWRAM

Table AB-2.1.1.2.7 Monthly Mean Sunshine Hour at Pochentong (1991-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	n.a.	n.a.	n.a.	n.a.	8.5	5.5	5.4	5.5	5.2	4.3	n.a.	n.a.	5.7
1992	8.1	8.9	9.2	8.4	7.7	5.1	6.0	3.6	n	6.7	8.5	7.7	7.3
1993	8.3	8.7	7.9	7.8	7.1	5.1	5.8	5.2	4.9	5.7	8.0	7.4	6.8
1994	8.5	8.4	7.1	8.9	7.1	4.7	3.7	5.2	5.0	6.9	9.0	7.4	6.8
1995	8.4	9.7	7.9	9.8	7.6	7.1	6.3	6.6	4.9	6.1	5.8	7.7	7.3
1996	8.8	8.6	9.5	7.2	6.2	7.1	5.0	6.5	4.4	5.2	6.0	n.a.	6.8
1997	9.0	7.0	9.0	6.8	6.2	7.2	4.6	5.1	5.6	6.5	7.9	9.5	7.0
1998	9.9	9.3	10.2	9.1	8.0	6.8	8.0	7.9	7.7	5.3	6.9	9.7	8.2
1999	10.0	9.5	10.2	9.4	8.8	6.1	7.0	7.0	7.5	5.7	7.0	9.4	8.1
2000	7.5	7.6	6.2	7.3	6.3	6.3	6.0	6.5	5.6	5.5	7.4	8.2	6.7
2001	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2002	8.6	7.8	7.0	5.6	6.6	7.7	6.1	4.1	4.3	5.5	7.4	8.3	6.6
2003	9.4	8.9	8.8	8.7	7.1	7.0	6.2	6.8	4.9	5.4	8.4	7.3	7.4
2004	8.1	7.9	8.0	7.3	6.8	5.5	5.8	5.5	5.6	7.7	8.1	8.8	7.1
2005	7.9	9.0	7.1	7.5	7.4	6.7	3.8	5.6	6.4	7.8	7.6	7.6	7.0
2006	8.5	8.7	7.4	7.4	6.9	7.0	5.4	5.1	5.5	6.0	7.9	8.6	7.0
2007	7.6	9.4	8.3	7.6	7.3	7.1	5.6	5.6	6.2	5.5	7.1	8.8	7.2
2008	7.7	8.1	8.9	8.4	7.9	7.4	8.0	7.0	7.1	7.1	7.6	8.6	7.8
2009	8.9	8.3	8.4	7.9	7.5	8.0	6.8	7.2	5.9	7.7	8.5	9.0	7.8
2010	7.9	9.3	9.1	8.5	8.4	7.4	7.0	5.9	6.8	5.7	6.6	5.9	7.4
Average (1991～2010)	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

Source: Department of Meteorology, MOWRAM

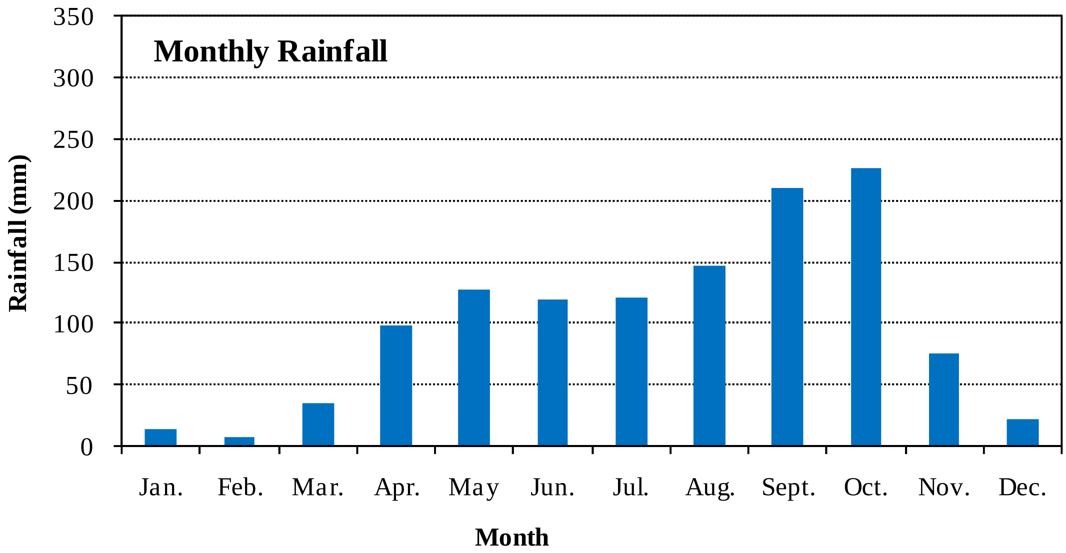
Table AB-2.1.1.2.8 Monthly Mean Evaporation at Pochentong (1991-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
1991	6.1	7.2	9.2	8.6	4.9	6.1	5.3	4.7	3.6	3.6	3.5	5.3	6.1
1992	5.5	6.3	8.3	5.1	5.1	4.0	4.6	4.1	3.7	3.2	3.6	5.2	5.5
1993	5.9	6.7	8.7	8.7	5.0	7.4	4.6	3.4	3.2	3.0	4.0	4.9	5.9
1994	5.5	7.4	8.6	7.8	5.5	4.7	4.3	6.2	2.7	2.2	4.2	5.4	5.5
1995	6.1	7.7	8.6	6.8	6.1	4.4	4.4	5.1	3.0	2.7	3.0	4.1	6.1
1996	5.3	5.5	7.8	6.3	4.1	4.1	4.4	3.6	2.4	2.6	3.4	3.7	5.3
1997	4.7	5.5	7.5	7.1	7.0	4.8	5.0	3.7	2.9	2.2	2.2	2.2	4.7
1998	4.3	5.1	6.9	4.7	4.2	3.9	3.1	2.9	2.6	2.5	3.6	4.7	4.3
1999	4.5	5.6	5.2	6.0	4.4	4.7	3.8	4.4	2.8	2.7	3.7	4.3	4.5
2000	4.6	6.2	6.1	7.5	4.5	5.5	4.6	3.9	2.7	2.8	3.3	4.3	4.6
2001	4.2	5.6	6.7	7.3	5.5	3.8	2.7	3.2	2.4	2.3	3.9	5.0	4.2
2002	5.4	6.0	7.5	7.5	6.7	4.4	3.7	4.1	3.4	2.6	4.6	4.1	5.4
2003	4.7	5.5	5.8	6.6	6.3	6.2	7.4	8.0	6.6	5.7	5.2	4.3	4.7
2004	2.6	3.8	4.5	5.3	4.0	4.1	3.2	3.0	4.2	2.8	2.9	3.1	2.6
2005	4.8	6.9	5.5	6.5	4.3	2.7	2.1	2.7	2.3	1.8	3.5	4.4	4.8
2006	5.2	5.0	7.6	4.8	3.1	2.1	1.3	1.7	2.2	1.8	2.1	3.6	5.2
2007	2.4	3.6	4.5	5.3	3.8	4.1	3.0	2.9	4.2	2.9	2.4	3.0	2.4
2008	3.8	5.6	4.8	4.2	4.9	6.1	5.3	4.7	3.6	3.6	3.5	5.3	3.8
2009	1.8	3.3	3.7	2.2	2.3	1.9	1.6	1.5	1.4	1.1	1.3	2.4	1.8
2010	4.7	6.9	4.8	4.6	4.1	4.2	4.1	4.1	3.5	3.0	3.8	3.5	4.7
Average (1991～2010)	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

Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.2 Rainfall Data at Chbar Mon Station (1966-2010) (Unit: mm)

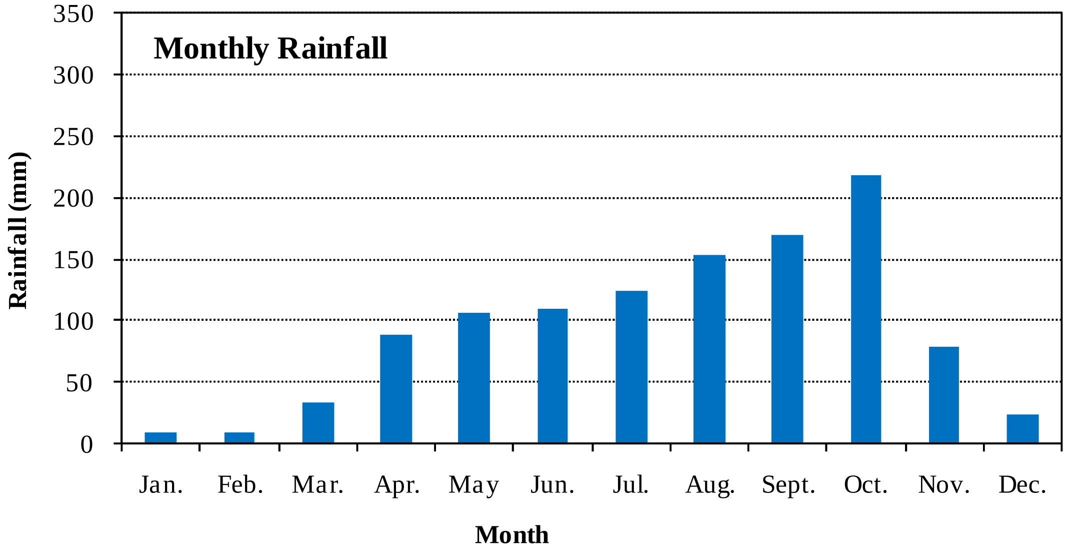
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	0.0	25.0	31.2	49.9	147.8	152.7	202.5	104.4	90.6	366.4	94.6	84.2	1,349.3
1967	24.0	0.0	0.0	110.0	105.5	166.5	131.0	87.0	195.5	200.0	18.3	1.6	1,039.4
1968	0.0	0.0	0.0	80.7	63.5	287.9	162.2	31.7	202.4	158.2	24.0	0.0	1,010.6
1969	58.0	9.0	0.0	39.5	127.2	99.3	46.1	214.4	251.3	281.9	105.2	3.2	1,235.1
1983	0.0	0.0	0.0	2.4	180.5	77.4	191.6	264.7	133.8	417.2	112.1	21.6	1,401.3
1984	0.0	3.7	2.7	63.1	118.7	162.1	113.6	90.0	321.5	306.3	11.2	0.0	1,192.9
1985	0.0	62.4	0.0	304.2	315.4	134.4	94.3	50.5	320.4	113.5	87.3	0.0	1,482.4
1986	8.4	4.6	0.0	96.3	92.4	105.5	80.3	69.6	245.8	202.3	105.5	60.9	1,071.6
1987	0.0	0.0	0.5	5.4	126.7	106.0	47.7	133.7	229.3	88.8	28.5	0.0	766.6
1988	0.0	0.0	17.0	100.2	121.4	189.8	103.0	110.0	153.4	139.4	53.5	0.0	987.7
1989	4.5	0.0	67.1	12.0	175.8	53.6	111.7	134.5	211.7	28.9	174.9	0.0	974.7
1990	0.0	0.0	5.5	44.3	134.9	80.5	103.7	121.6	130.4	70.1	105.9	5.2	802.1
1991	0.0	7.8	0.0	85.7	65.4	178.5	208.0	171.1	176.8	166.0	0.0	13.2	1,072.5
1992	0.0	0.0	0.0	26.1	51.0	112.9	194.0	106.0	162.3	184.8	32.3	4.6	874.0
1993	54.0	0.0	48.0	21.5	33.0	102.0	44.1	63.9	206.1	319.7	58.3	1.0	951.6
1994	0.0	0.0	116.1	13.5	79.3	96.9	191.9	164.7	285.5	155.5	0.0	77.5	1,180.9
1995	0.0	0.0	5.0	0.0	159.9	62.5	99.6	106.8	307.0	319.0	51.8	10.0	1,121.6
1996	7.5	0.0	0.0	155.8	124.5	116.8	111.8	96.7	256.4	319.0	189.0	12.4	1,389.9
1997	0.0	0.0	33.5	149.1	87.3	76.0	166.7	125.1	124.5	347.1	35.0	6.6	1,150.9
1998	0.0	6.7	0.0	136.7	54.4	64.5	178.6	310.2	401.9	95.4	192.3	11.7	1,452.4
1999	11.8	17.0	36.5	247.7	292.4	61.0	116.3	315.3	138.9	307.2	151.9	61.3	1,757.3
2000	29.1	9.0	97.5	122.9	126.6	106.8	132.5	170.3	271.0	441.9	177.7	131.2	1,816.5
2001	189.7	0.0	216.9	46.1	65.2	215.9	78.9	213.2	345.9	328.9	18.0	4.3	1,723.0
2002	0.0	0.0	98.7	113.5	38.3	49.2	25.4	204.3	109.7	163.0	80.4	54.3	936.8
2003	0.0	0.0	22.3	58.9	104.2	36.5	232.9	89.1	166.7	151.0	18.8	2.6	883.0
2004	3.4	18.5	12.3	72.7	145.3	126.7	144.9	33.1	149.3	205.4	37.8	0.0	949.4
2005	0.0	0.0	1.3	75.3	42.6	81.7	239.1	71.5	149.2	301.0	88.0	64.3	1,114.0
2006	1.2	44.1	18.8	201.5	171.5	101.9	54.4	284.5	206.5	80.3	6.3	7.4	1,178.4
2007	0.0	0.0	62.6	156.5	237.2	172.2	169.8	179.7	302.1	261.6	108.1	0.0	1649.8
2008	0.0	0.0	67.1	237.4	150.0	134.0	39.5	206.2	233.1	207.7	168.8	0.0	1,443.8
2009	14.5	0.0	8.8	282.6	268.2	119.7	129.8	142.2	181.2	241.7	16.5	0.0	1,405.2
2010	48.3	22.1	148.6	54.6	40.5	214.2	61.4	147.3	143.1	244.1	67.7	22.7	1,214.6
Average	14.2	7.2	34.9	98.9	126.5	120.2	125.2	144.2	212.6	225.4	75.6	20.7	1,205.6



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.3 Rainfall Data at Phnom Srouch Station (1966-2010) (Unit: mm)

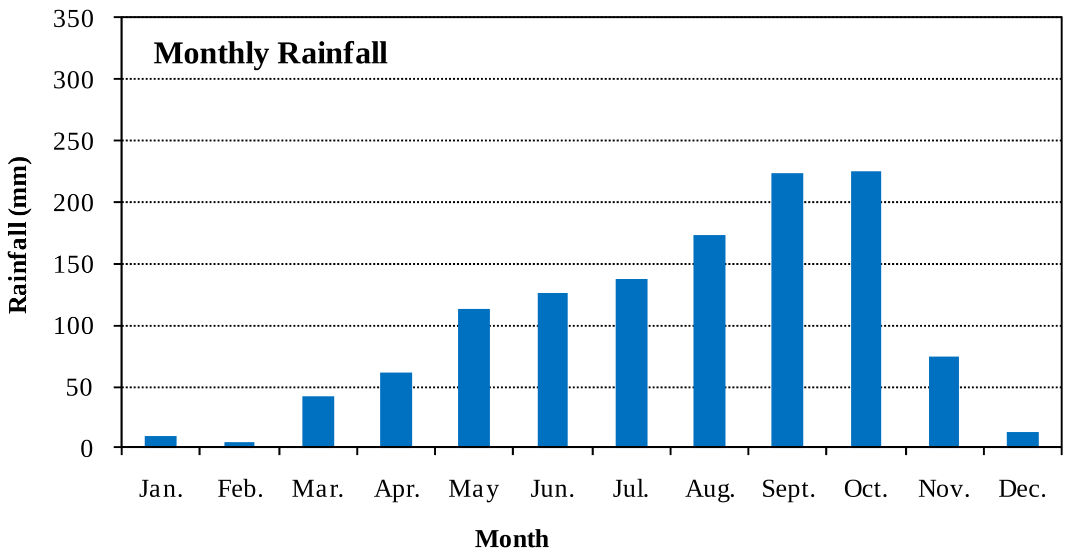
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	4.2	31.2	21.4	92.2	212.4	215.0	188.2	227.6	146.2	261.2	166.4	115.0	1,681.0
1967	30.2	0.0	0.0	179.6	170.0	188.0	251.0	141.4	123.2	278.0	42.8	15.0	1,419.2
1968	0.0	5.6	0.0	129.7	140.9	264.7	155.0	147.1	219.6	197.8	23.3	7.9	1,291.6
1969	35.2	25.8	7.1	10.1	183.2	89.2	121.1	210.4	283.7	281.6	66.5	2.6	1,316.5
1983	0.0	0.0	0.0	82.0	43.7	100.0	70.7	273.5	187.7	117.3	20.5	11.6	907.0
1984	0.0	0.0	0.0	0.0	99.7	163.9	82.3	142.7	158.9	155.4	40.4	0.0	843.3
1985	0.0	0.0	0.0	171.2	166.7	67.2	96.3	55.9	194.0	299.7	120.1	0.0	1,171.1
1986	27.0	37.6	10.7	36.5	40.2	129.7	88.6	131.4	162.3	78.8	205.3	128.3	1,076.4
1987	0.0	0.0	0.0	15.0	74.0	165.7	17.1	88.7	124.3	119.5	119.2	0.0	723.5
1988	0.0	5.0	23.0	118.5	83.5	49.8	56.0	52.0	171.5	113.0	0.0	0.0	672.3
1989	0.0	0.0	29.5	105.5	259.5	5.5	46.0	82.0	394.0	183.0	0.0	0.0	1,105.0
1990	0.0	0.0	0.0	101.5	52.0	46.0	35.0	90.0	97.5	112.5	174.7	0.0	709.2
1991	0.0	12.0	25.9	50.1	25.0	234.2	160.5	387.3	165.8	208.5	0.0	0.0	1,269.3
1992	16.0	0.0	0.0	58.8	15.0	53.5	105.5	75.5	200.5	349.0	0.0	0.0	873.8
1993	15.0	0.0	76.0	12.0	102.5	61.0	96.0	78.0	219.5	291.0	41.0	0.0	992.0
1994	0.0	0.0	106.0	15.5	100.0	64.0	118.2	219.0	106.5	67.0	0.0	4.5	800.7
1995	0.0	0.0	41.0	0.0	55.0	36.0	107.5	169.7	295.0	198.5	51.0	18.0	971.7
1996	0.0	0.0	0.0	94.0	84.0	159.0	221.5	98.5	172.7	175.0	171.2	21.5	1,197.4
1997	0.0	0.0	71.0	6.0	62.0	0.0	160.0	191.0	80.0	72.0	12.0	0.0	654.0
1998	0.0	3.0	0.0	81.0	24.0	46.0	116.5	238.5	237.0	286.0	168.7	12.0	1,212.7
1999	6.0	6.0	79.0	223.5	315.0	63.0	149.8	147.2	98.0	297.5	98.0	45.5	1,528.5
2000	36.0	35.0	133.0	68.0	89.5	206.5	151.1	145.9	86.7	404.1	138.0	88.0	1,581.8
2001	126.5	0.0	94.5	63.1	41.0	126.0	206.3	210.0	172.2	458.5	33.0	43.0	1,574.1
2002	0.0	0.0	0.0	238.6	79.3	66.5	17.0	237.9	113.8	161.0	165.8	57.2	1,137.1
2003	0.0	0.0	35.0	106.0	39.2	137.9	368.5	183.7	184.1	198.4	19.5	0.0	1,272.3
2004	0.0	88.7	35.0	55.4	115.9	141.2	38.5	37.0	127.0	123.4	63.5	0.0	825.6
2005	0.0	0.0	0.0	51.0	37.0	118.0	203.2	67.6	163.3	320.8	77.0	87.0	1,124.9
2006	0.0	0.0	89.0	105.5	149.0	33.0	58.8	307.2	143.2	69.5	14.5	0.0	969.7
2007	0.0	0.0	41.0	221.0	242.2	162.0	149.9	180.4	157.0	124.0	180.2	0.0	1,457.7
2008	0.0	0.0	63.5	168.0	110.6	132.5	67.5	113.0	217.0	468.0	151.5	0.0	1,491.6
2009	0.0	25.5	8.0	153.5	105.0	44.0	141.5	81.5	122.5	265.0	61.5	0.0	1,008.0
2010	8.0	0.0	69.0	24.0	98.0	13.06	146.0	87.0	118.0	267.0	86.0	130.0	1,169.0
Average	9.5	8.6	33.1	88.7	106.7	109.5	124.7	153.1	170.1	218.8	78.5	24.6	1,125.9



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.4 Rainfall Data at Odong Station (1966-2010) (Unit: mm)

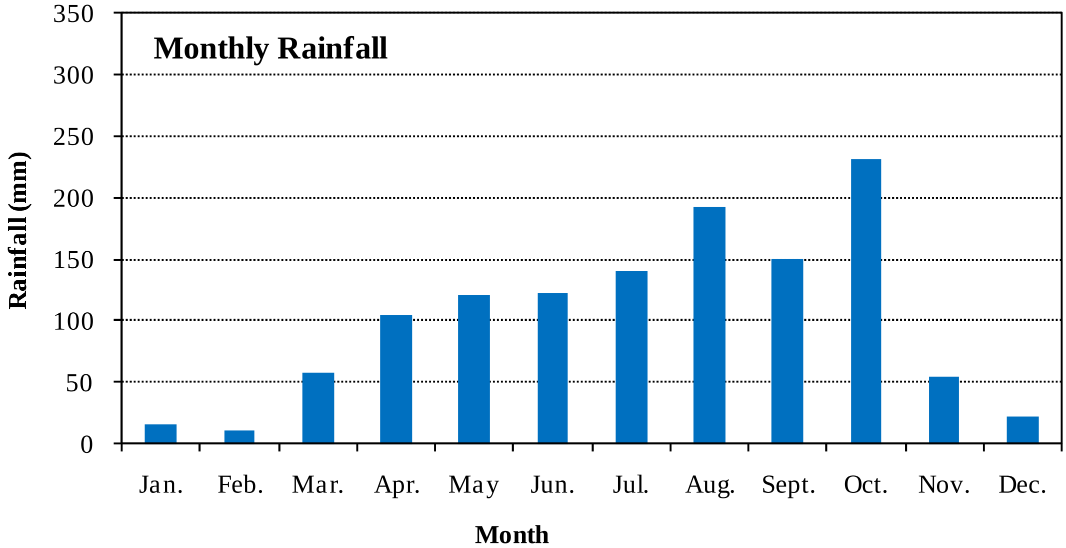
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	0.0	0.0	1.3	25.0	58.3	73.0	52.9	173.5	109.9	172.4	317.5	0.0	983.8
1988	0.0	0.0	0.0	185.0	71.5	225.5	139.0	214.4	165.6	137.0	0.0	0.0	1,138.0
1989	0.0	0.0	0.0	0.0	180.1	102.1	123.0	155.0	176.0	185.5	0.0	0.0	921.7
1990	0.0	9.0	13.0	16.0	156.5	71.0	181.5	134.4	177.0	136.2	60.6	0.0	955.2
1991	0.0	0.0	38.0	31.4	101.2	372.0	274.9	109.5	157.3	228.5	0.0	0.0	1,312.8
1992	0.0	0.0	0.0	11.0	171.2	13.0	120.3	80.3	175.2	443.7	57.0	0.0	1,071.7
1993	0.0	39.0	58.0	45.0	36.0	313.0	21.0	42.0	148.5	225.0	13.0	0.0	940.5
1994	0.0	0.0	171.5	0.0	75.5	153.0	42.0	242.5	340.3	131.5	2.5	0.0	1,158.8
1995	0.0	0.0	9.0	8.0	161.0	65.0	169.0	222.0	240.5	206.0	19.0	0.0	1,099.5
1996	0.0	0.0	0.0	57.5	140.8	20.0	76.0	86.6	234.5	232.5	163.5	0.0	1,011.4
1997	0.0	15.5	13.0	47.5	0.0	78.0	189.0	231.0	211.0	304.5	51.0	0.0	1,140.5
1998	0.0	0.0	0.0	61.0	79.0	58.0	364.0	176.0	264.0	262.5	175.0	0.0	1,439.5
1999	0.0	20.0	16.5	136.0	226.5	120.0	158.5	186.5	201.0	163.0	114.0	55.5	1,397.5
2000	38.5	4.5	78.0	89.5	137.5	224.5	166.0	235.5	227.5	319.0	124.0	85.5	1,730.0
2001	59.5	0.0	125.5	0.0	96.0	45.0	134.0	288.2	303.0	373.4	42.0	31.0	1,497.6
2002	0.0	0.0	20.0	106.0	7.0	44.0	101.0	185.5	206.4	113.0	112.0	71.0	965.9
2003	0.0	0.0	88.0	103.0	104.0	94.0	183.0	30.5	318.0	n.a.	n.a.	n.a.	-
2004	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2005	0.0	0.0	0.0	95.3	108.0	78.0	122.3	140.3	187.5	342.5	24.5	0.0	1,098.4
2006	13.0	0.0	39.0	103.0	57.0	135.0	66.0	263.5	291.5	110.5	22.0	0.0	1,100.5
2007	0.0	0.0	87.5	52.0	147.0	191.5	150.0	180.0	226.2	155.5	115.2	0.0	1,304.9
2008	62.0	0.0	94.0	85.0	267.0	221.5	118.0	88.5	303.0	145.0	123.0	0.0	1,507.0
2009	0.0	30.5	39.0	138.0	214.5	24.0	95.5	235.5	322.0	202.0	18.0	0.0	1,319.0
2010	41.0	0.0	77.0	6.5	0.0	196.1	117.5	278.8	163.5	375.0	66.4	49.8	1,371.6
Average	9.3	5.2	42.1	60.9	112.9	126.8	137.6	173.0	223.9	225.6	73.6	13.3	1,203.0



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.5 Rainfall Data at Srae Klang Station (1966-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	39.8	154.3	112.3	405.3	111.8	74.9	-
2001	81.4	0.0	142.5	57.2	73.8	169.1	232.6	224.3	202.0	300.9	6.6	0.0	1,490.4
2002	59.1	0.0	0.0	162.4	101.4	63.1	49.2	370.6	137.2	152.2	102.9	32.6	1,230.7
2003	0.0	0.0	100.3	77.6	58.8	127.3	358.8	142.2	139.2	306.8	5.2	0.0	1,316.2
2004	0.0	42.9	0.0	62.3	140.4	161.3	48.0	108.7	180.3	158.6	14.2	0.0	916.7
2005	1.7	0.0	3.1	93.6	0.0	69.3	223.3	75.0	169.1	234.0	74.3	109.8	1,053.2
2006	0.0	7.3	21.4	42.5	263.5	112.4	99.8	221.0	130.3	24.8	0.0	0.0	923.0
2007	0.0	40.3	121.8	115.5	88.5	78.8	212.6	251.4	165.2	251.4	35.9	0.0	1,361.4
2008	0.0	0.0	18.4	183.1	116.6	153.9	0.0	265.3	130.0	370.1	144.1	5.4	1,386.9
2009	0.0	0.0	116.5	155.0	245.2	161.6	133.6	103.6	142.8	114.3	58.5	0.0	1,231.1
2010	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
Average	15.8	10.1	58.2	105.5	120.9	121.9	139.8	191.6	150.8	231.8	55.4	22.3	1,212.2

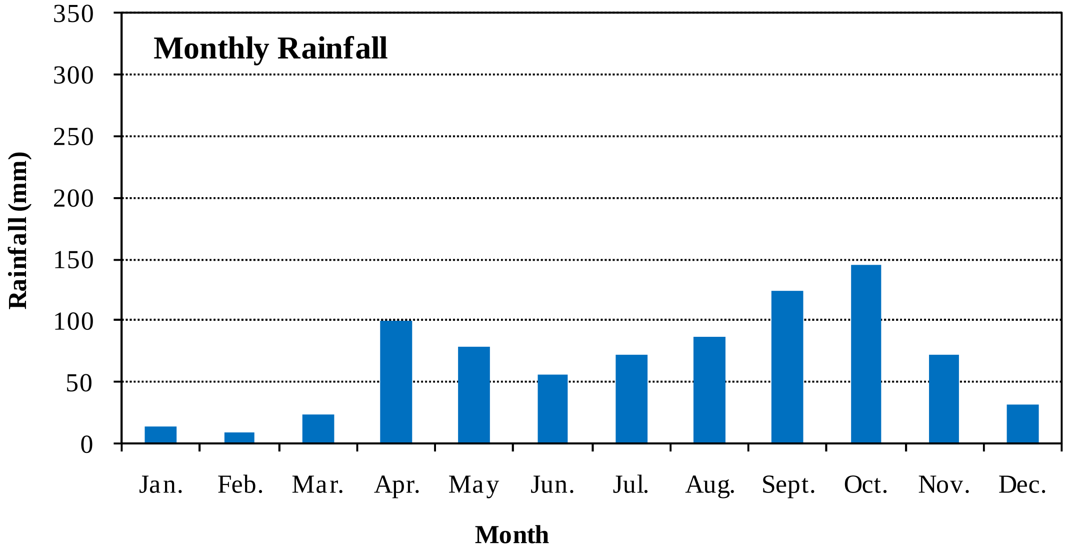


Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.6 Rainfall Data at Krang Ampil Station (1966-2010)

(Unit: mm)

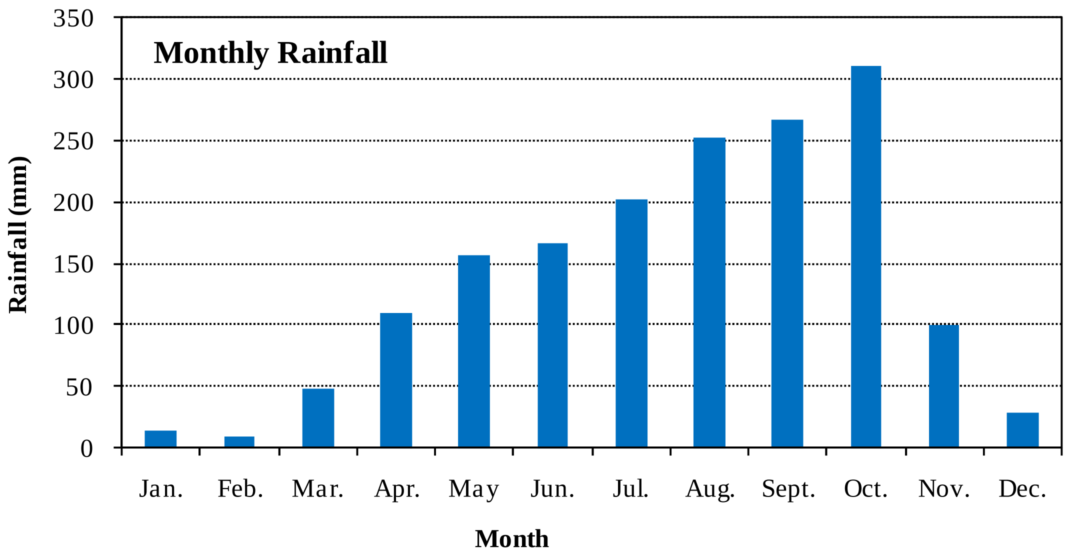
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	32.7	67.1	72.0	122.8	86.7	163.6	-
2001	121.5	0.0	60.2	28.6	53.4	144.8	104.8	80.5	234.1	315.5	36.2	57.8	1,237.4
2002	0.0	0.0	17.8	205.8	51.7	45.3	17.4	103.7	119.0	224.5	186.3	27.5	999.0
2003	0.0	0.0	5.4	157.5	162.5	37.4	262.8	93.1	61.4	91.4	21.5	3.5	896.5
2004	0.0	18.4	7.4	30.0	53.0	19.4	20.5	12.3	139.7	56.7	13.2	0.0	370.6
2005	0	0	3.7	14.1	11	14.1	15.7	13.6	8.1	11.5	13.1	17.8	122.7
2006	0	0	8.8	8.1	10	4.7	6.9	17.3	13.9	115.2	0	0	184.9
2007	0	0	42.5	110	163.7	143.5	103.2	147	157.6	128.3	115.5	0	1,111.3
2008	0	0	28	157.5	137.9	96.2	46.7	265	198.6	125.9	117.7	0	1,173.5
2009	0	52.5	26.3	207.2	99.5	23	116.1	81	205.2	243.2	29.9	0	1,083.9
2010	12.5	24.4	32	74.8	54	29.2	73.6	85.2	149.8	161.5	177.7	75	949.7
Average	13.4	9.5	23.2	99.4	79.7	55.8	72.8	87.8	123.6	145.1	72.5	31.4	813.0



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.7 Rainfall Data at Kirirom Station (1966-2010) (Unit: mm)

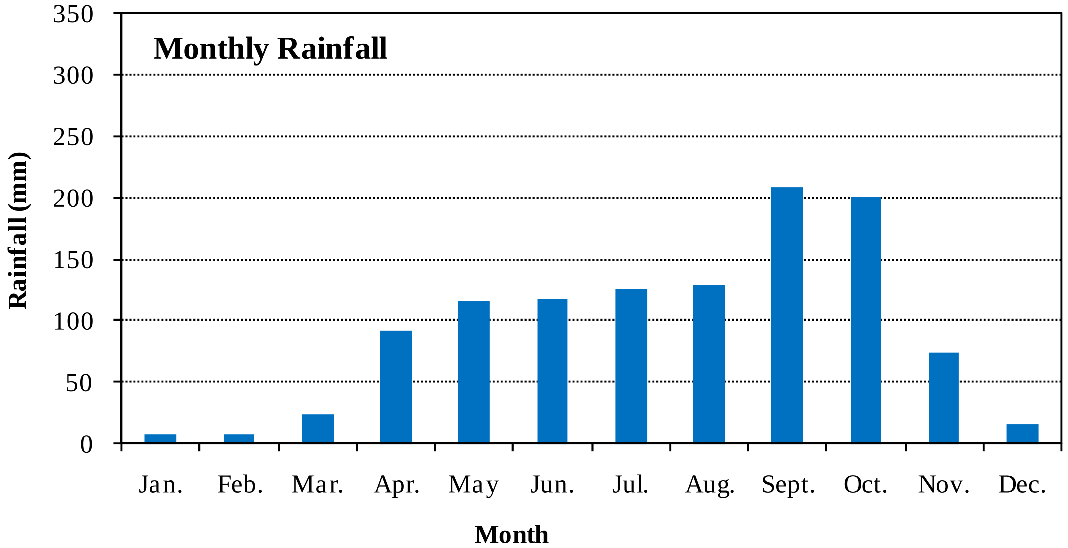
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	0.2	40.3	63.1	213.9	226.5	190.5	248.6	105.4	181.9	367.5	168.2	120.1	1,926.2
1967	32.1	0.0	6.4	99.6	223.2	186.6	335.2	355.7	93.7	318.2	34.3	10.0	1,695.0
1968	1.4	17.8	0.0	232.5	203.4	177.5	355.3	347.0	227.0	382.9	11.9	3.7	1,960.4
1969	69.3	21.8	20.5	44.7	235.7	142.3	205.8	432.8	441.1	235.7	66.8	2.0	1,918.5
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7.7	300.2	201.4	493.5	141.6	71.2	2,165.4
2001	91.7	0.0	100.4	77.0	129.5	416.6	388.1	283.4	185.0	451.2	53.0	98.7	2,274.6
2002	0.0	0.0	29.1	116.7	112.5	88.7	94.3	102.5	178.7	239.7	135.6	60.5	1,158.3
2003	0.0	6.5	105.3	93.5	82.6	106.3	341.0	185.3	261.5	160.5	0.0	0.0	1,342.5
2004	0.0	0.0	0.0	21.9	84.3	296.9	225.1	248.9	133.4	192.4	0.0	0.0	1,202.9
2005	0.0	0.0	0.0	0.0	93.6	146.1	347.5	240.9	185.3	309.6	36.3	0.0	1,359.3
2006	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2007	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2008	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2009	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2010	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
Average	13.4	9.3	48.9	110.1	156.3	167.1	201.4	252.5	267.2	310.2	99.7	28.5	1,664.5



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.8 Rainfall Data at Thnal Toteung Station (1966-2010) (Unit: mm)

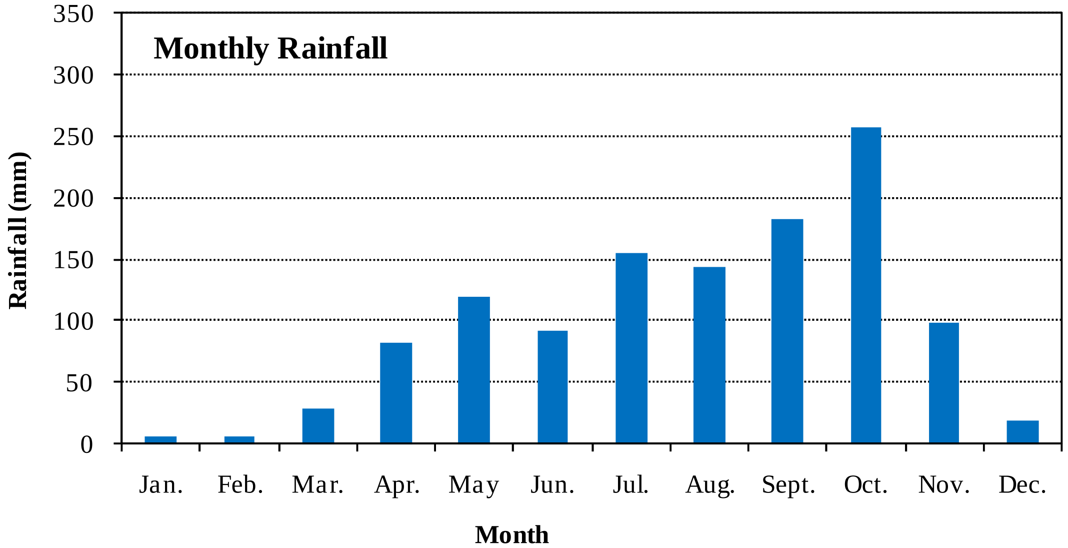
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	0.0	0.0	0.0	0.0	259.8	70.7	327.0	270.4	185.7	202.3	72.0	54.9	1,442.8
1984	0.2	0.6	0.0	92.3	126.2	178.1	116.8	63.3	264.2	335.8	16.8	0.0	1,194.3
1985	0.5	0.0	8.9	323.1	305.9	335.0	119.0	44.8	491.3	183.5	109.6	0.0	1,921.6
1986	0.0	0.0	0.0	64.5	38.4	40.0	74.3	61.3	315.6	325.2	35.5	30.4	985.2
1987	0.0	0.0	0.0	59.0	76.8	28.0	62.9	95.5	88.6	199.2	126.1	0.0	736.1
1988	0.0	0.0	0.5	99.3	82.4	311.4	169.1	62.4	286.5	143.0	0.0	0.0	1,154.6
1989	21.5	0.0	51.1	4.5	98.5	72.7	272.7	75.5	452.3	280.7	136.3	0.0	1,465.8
1990	0.0	0.0	0.0	65.5	71.5	47.6	39.4	74.3	195.9	44.6	112.3	0.0	651.1
1991	0.0	0.0	6.8	73.3	28.6	220.2	192.1	288.3	243.0	207.1	3.3	24.3	1,287.0
1992	0.0	5.1	0.0	124.6	32.4	61.3	207.2	202.0	199.4	261.2	21.3	1.1	1,115.6
1993	5.0	0.0	33.2	32.2	157.7	148.3	91.7	64.0	153.0	258.7	56.1	0.0	999.9
1994	0.0	0.0	134.6	42.0	72.0	84.3	169.5	176.2	322.6	118.3	0.0	23.4	1,142.9
1995	0.0	0.0	1.9	2.7	258.5	182.5	54.5	168.2	163.0	244.2	59.7	3.9	1,139.1
1996	7.6	0.0	0.0	112.9	127.4	135.8	111.5	96.8	157.7	349.5	288.3	0.0	1,387.5
1997	0.0	0.0	42.5	79.1	35.2	47.8	210.9	54.8	241.8	189.6	48.4	0.0	950.1
1998	0.0	0.0	0.0	112.3	45.0	128.1	115.9	198.8	302.4	80.1	246.8	25.7	1,255.1
1999	10.5	170.0	5.0	187.5	152.9	75.0	63.5	283.0	180.4	145.8	132.0	0.0	1,405.6
2000	32.0	0.0	55.0	64.0	31.0	131.2	83.0	117.0	82.0	420.3	111.9	171.8	1,299.2
2001	112.0	0.0	94.0	56.0	114.0	113.0	92.0	243.0	126.0	369.0	24.0	0.0	1,343.0
2002	0.0	0.0	0.0	178.0	75.0	118.0	21.0	14.0	106.0	122.0	61.0	35.0	730.0
2003	0.0	0.0	32.0	28.0	59.0	117.6	190.0	55.0	117.0	114.0	28.0	0.0	740.6
2004	0.0	0.0	12.7	103.5	80.5	101.3	163.5	12.0	144.2	14.0	0.0	0.0	631.7
2005	0.0	0.0	0.0	73.7	53.7	91.5	81.1	79.2	128.5	124.1	88.2	50.7	770.7
2006	0.0	8.7	25.9	81.9	218.0	121.2	28.5	157.8	120.7	85.9	5.9	0.0	854.5
2007	0.0	2.3	93.6	55.7	167.1	96.1	144.6	106.4	147.5	149.5	37.0	0.0	999.8
2008	0.0	7.6	10.1	116.0	150.1	71.1	79.1	202.2	307.3	244.0	163.2	18.5	1,369.2
2009	0.0	0.0	17.3	259.5	213.3	57.7	131.9	207.6	125.9	186.9	34.0	0.0	1,234.1
2010	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
Average	7.0	7.2	23.2	92.3	116.0	118.0	126.4	128.7	209.2	199.9	74.7	16.3	1,118.8



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.9 Rainfall Data at Basedth Station (1966-2010) (Unit: mm)

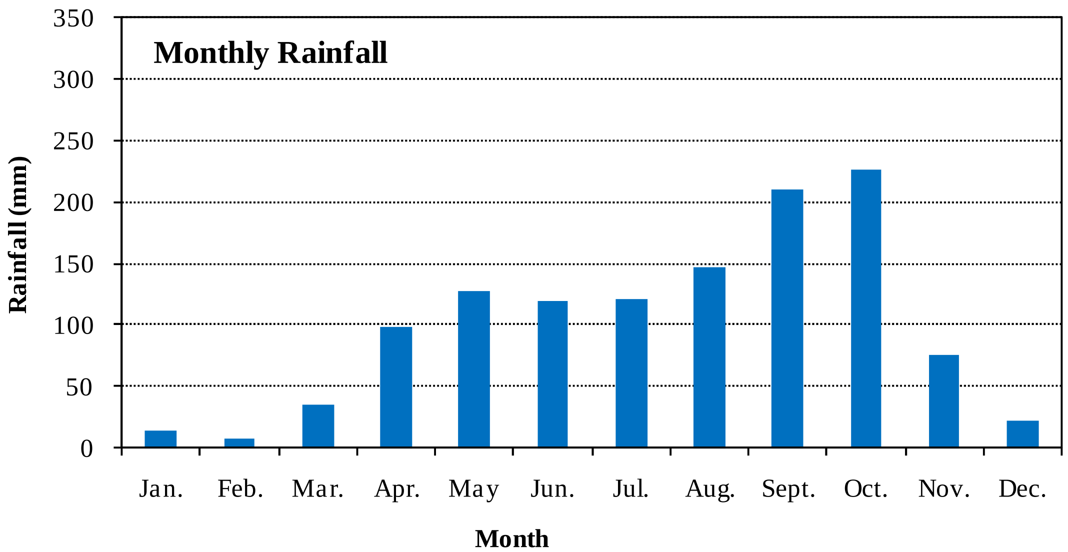
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	0.0	0.0	0.0	27.5	0.0	8.0	11.7	186.7	142.0	180.0	264.2	0.0	820.1
1988	0.0	0.0	47.0	190.5	95.0	232.0	199.0	77.4	277.4	133.6	0.0	0.0	1,251.9
1989	0.0	0.0	100.8	55.5	62.5	12.5	246.7	77.4	192.7	270.7	0.0	0.0	1,018.8
1990	0.0	0.0	20.5	57.0	92.0	54.8	62.0	93.8	113.5	155.9	171.1	0.0	820.6
1991	0.0	12.0	15.5	146.3	106.6	241.0	198.6	263.2	143.8	289.9	0.0	0.0	1,416.9
1992	0.0	0.0	0.0	11.0	171.2	13.0	120.3	80.3	175.2	443.7	57.0	0.0	1,071.7
1993	25.0	46.0	75.0	86.5	141.5	35.7	36.3	14.6	156.0	282.0	108.3	0.0	1,006.9
1994	0.0	0.0	40.4	57.0	107.3	140.3	243.7	73.5	105.4	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	0.0	0.0	0.0	24.5	235.5	111.0	244.5	150.0	349.7	460.5	138.3	0.0	1,714.0
1997	0.0	0.0	0.0	50.0	20.0	30.0	34.0	172.5	127.5	93.5	61.0	0.0	588.5
1998	0.0	0.0	0.0	90.0	186.1	92.0	123.0	116.5	205.0	231.0	275.0	18.0	1,336.6
1999	18.0	29.5	40.0	69.0	101.5	105.5	124.8	305.3	313.4	365.0	166.5	15.0	1,653.5
2000	15.0	33.5	35.0	132.0	119.5	152.5	140.0	140.5	91.5	335.5	174.5	59.0	1,428.5
2001	66.0	0.0	99.5	66.5	82.0	85.5	207.5	187.5	309.0	354.5	0.0	101.0	1,559.0
2002	0.0	0.0	0.0	197.5	160.5	75.5	65.0	111.6	77.6	205.0	163.0	19.0	1,074.7
2003	0.0	6.5	17.0	122.5	82.0	69.9	432.5	180.5	146.5	0.0	0.0	0.0	1,057.4
2004	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2005	0.0	0.0	0.0	29.5	125.4	122.3	189.1	75.6	138.6	343.1	175.5	152.2	1,351.3
2006	1.0	6.0	18.0	77.9	132.2	77.6	76.5	311.2	249.7	142.0	0.0	0.0	1,092.1
2007	2.5	0.0	25.3	76.4	226.6	145.2	194.1	133.3	210.8	291.5	110.8	0.0	1,416.5
2008	0.0	0.0	35.4	85.2	169.6	86.0	99.3	168.7	153.3	349.6	111.6	22.8	1,281.5
2009	0.0	0.0	22.0	99.0	109.4	62.7	146.3	159.3	205.1	173.2	16.4	0.0	993.4
2010	9.8	0.0	43.2	52.2	108.7	78.0	203.3	82.3	148.1	309.7	63.8	24.0	1,123.1
Average	6.2	6.1	28.8	82.0	119.8	92.3	154.5	143.7	183.3	257.6	98.0	19.6	1,194.1



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.10 Rainfall Data at Kong Pisey Station (1966-2010) (Unit: mm)

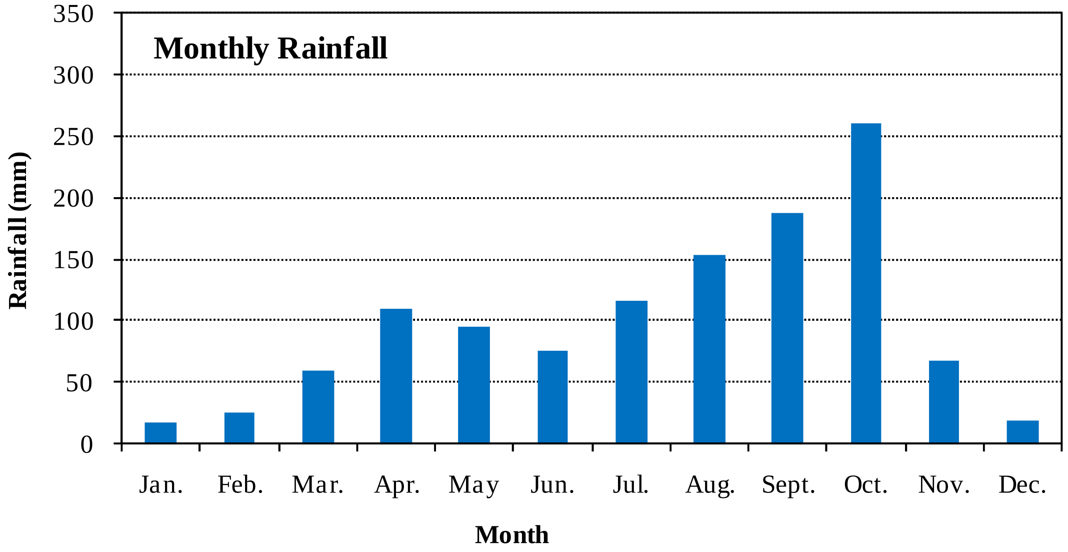
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	0.0	25.0	31.2	49.9	147.8	152.7	202.5	104.4	90.6	366.4	94.6	84.2	1,349.3
1967	24.0	0.0	0.0	110.0	105.5	166.5	131.0	87.0	195.5	200.0	18.3	1.6	1,039.4
1968	0.0	0.0	0.0	80.7	63.5	287.9	162.2	31.7	202.4	158.2	24.0	0.0	1,010.6
1969	58.0	9.0	0.0	39.5	127.2	99.3	46.1	214.4	251.3	281.9	105.2	3.2	1,235.1
1983	0.0	0.0	0.0	2.4	180.5	77.4	191.6	264.7	133.8	417.2	112.1	21.6	1,401.3
1984	0.0	3.7	2.7	63.1	118.7	162.1	113.6	90.0	321.5	306.3	11.2	0.0	1,192.9
1985	0.0	62.4	0.0	304.2	315.4	134.4	94.3	50.5	320.4	113.5	87.3	0.0	1,482.4
1986	8.4	4.6	0.0	96.3	92.4	105.5	80.3	69.6	245.8	202.3	105.5	60.9	1,071.6
1987	0.0	0.0	0.5	5.4	126.7	106.0	47.7	133.7	229.3	88.8	28.5	0.0	766.6
1988	0.0	0.0	17.0	100.2	121.4	189.8	103.0	110.0	153.4	139.4	53.5	0.0	987.7
1989	4.5	0.0	67.1	12.0	175.8	53.6	111.7	134.5	211.7	28.9	174.9	0.0	974.7
1990	0.0	0.0	5.5	44.3	134.9	80.5	103.7	121.6	130.4	70.1	105.9	5.2	802.1
1991	0.0	7.8	0.0	85.7	65.4	178.5	208.0	171.1	176.8	166.0	0.0	13.2	1,072.5
1992	0.0	0.0	0.0	26.1	51.0	112.9	194.0	106.0	162.3	184.8	32.3	4.6	874.0
1993	54.0	0.0	48.0	21.5	33.0	102.0	44.1	63.9	206.1	319.7	58.3	1.0	951.6
1994	0.0	0.0	116.1	13.5	79.3	96.9	191.9	164.7	285.5	155.5	0.0	77.5	1,180.9
1995	0.0	0.0	5.0	0.0	159.9	62.5	99.6	106.8	307.0	319.0	51.8	10.0	1,121.6
1996	7.5	0.0	0.0	155.8	124.5	116.8	111.8	96.7	256.4	319.0	189.0	12.4	1,389.9
1997	0.0	0.0	33.5	149.1	87.3	76.0	166.7	125.1	124.5	347.1	35.0	6.6	1,150.9
1998	0.0	6.7	0.0	136.7	54.4	64.5	178.6	310.2	401.9	95.4	192.3	11.7	1,452.4
1999	11.8	17.0	36.5	247.7	292.4	61.0	116.3	315.3	138.9	307.2	151.9	61.3	1,757.3
2000	29.1	9.0	97.5	122.9	126.6	106.8	132.5	170.3	271.0	441.9	177.7	131.2	1,816.5
2001	189.7	0.0	216.9	46.1	65.2	215.9	78.9	213.2	345.9	328.9	18.0	4.3	1,723.0
2002	0.0	0.0	98.7	113.5	38.3	49.2	25.4	204.3	109.7	163.0	80.4	54.3	936.8
2003	0.0	0.0	22.3	58.9	104.2	36.5	232.9	89.1	166.7	151.0	18.8	2.6	883.0
2004	3.4	18.5	12.3	72.7	145.3	126.7	144.9	33.1	149.3	205.4	37.8	0.0	949.4
2005	0.0	0.0	0.0	59.9	86.1	44.1	102.4	167.8	90.6	320.0	88.0	104.0	1,062.9
2006	1.2	44.1	18.8	201.5	171.5	101.9	54.4	284.5	206.5	80.3	6.3	7.4	1,178.4
2007	0.0	0.0	62.6	156.5	237.2	172.2	169.8	179.7	302.1	261.6	108.1	0.0	1,649.8
2008	0.0	0.0	67.1	237.4	150.0	134.0	39.5	206.2	233.1	207.7	168.8	0.0	1,443.8
2009	14.5	0.0	8.8	282.6	268.2	119.7	129.8	142.2	181.2	241.7	16.5	0.0	1,405.2
2010	48.3	22.1	148.6	54.6	40.5	214.2	61.4	147.3	143.1	244.1	67.7	22.7	1,214.6
Average	14.2	7.2	34.9	98.5	127.8	119.0	121.0	147.2	210.8	226.0	75.6	21.9	1,204.0



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.11 Rainfall Data at Aoral Station (1966-2010) (Unit: mm)

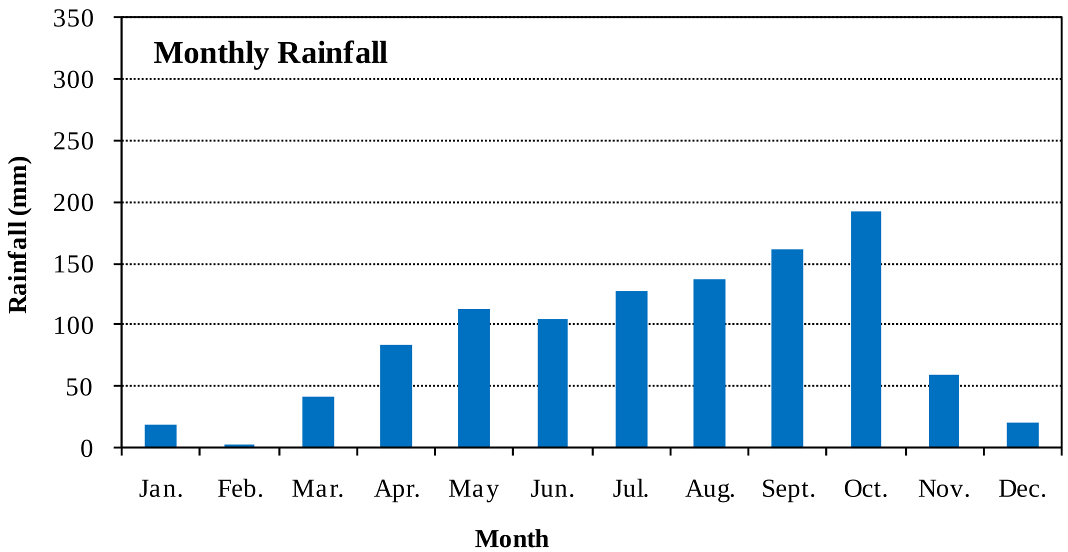
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	0.0	0.0	11.1	27.6	0.0	23.1	25.7	204.5	207.9	165.8	6.8	0.0	672.5
1998	0.0	80.0	0.0	94.4	88.9	9.5	141.2	137.6	237.1	179.2	91.9	55.0	1,114.8
1999	32.0	29.0	63.0	115.1	101.1	143.2	124.0	327.0	55.0	269.0	189.0	0.0	1,447.4
2000	0.0	0.0	45.0	257.2	106.0	92.0	93.0	54.2	165.4	454.1	64.4	61.0	1,392.3
2001	94.5	0.0	194.5	34.0	87.9	92.2	65.0	142.6	240.5	421.3	43.0	28.3	1,443.8
2002	0.0	0.0	0.0	37.6	53.2	89.0	26.8	88.5	117.7	358.3	73.0	51.4	895.5
2003	0.0	45.6	137.1	19.3	143.6	38.6	405.1	279.7	188.7	248.2	14.5	14.4	1,534.8
2004	53.7	6.5	60.5	44.5	132.2	154.3	126.0	47.4	219.1	144.3	67.4	0.0	1,055.9
2005	0.0	0.0	5.5	87.0	60.8	53.2	124.8	87.6	98.2	324.3	83.2	14.4	939.0
2006	7.8	24.3	36.3	75.0	99.6	47.2	105.8	196.7	311.6	98.2	21.0	0.0	1,023.5
2007	0.0	0.0	45.2	101.0	154.2	147.8	118.9	182.1	192.2	238.2	117.2	0.0	1,296.8
2008	5.2	0.0	111.4	225.8	124.2	75.6	43.4	163.7	184.2	205.2	98.1	0.0	1,236.8
2009	10.0	76.0	81.4	264.3	58.2	12.2	59.8	87.4	204.3	207.7	12.8	0.0	1,074.1
2010	32.0	85.6	43.4	154.6	131.4	89.8	165.0	151.6	191.4	323.2	64.0	33.8	1,465.8
Average	16.8	24.8	59.6	109.8	95.8	76.3	116.0	153.6	186.7	259.8	67.6	18.5	1,185.2



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.12 Rainfall Data at Ou Taroth Station (1966-2010) (Unit: mm)

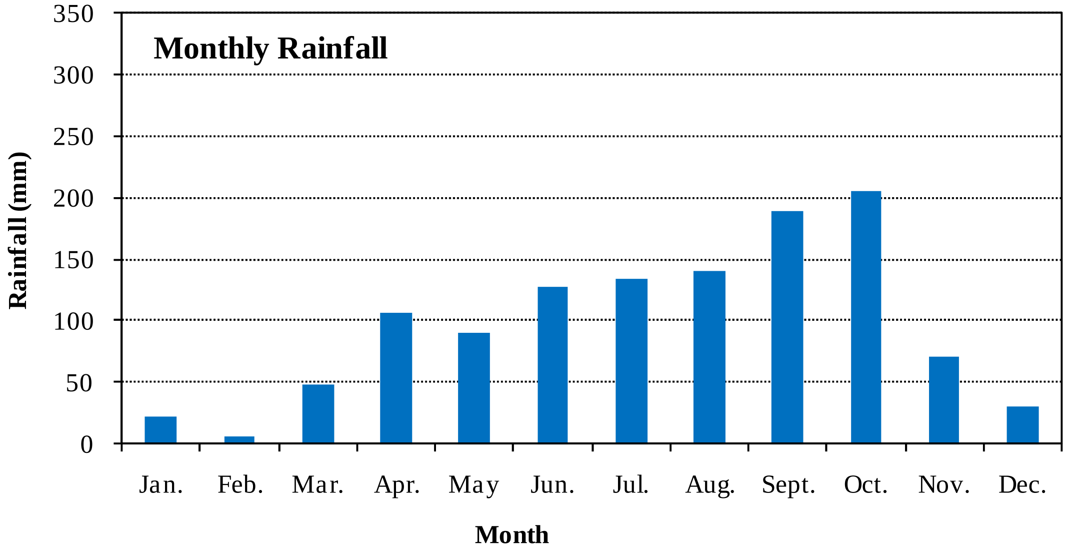
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	37.0	202.0	113.3	392.4	133.2	119.4	997.3
2001	147.7	0.0	120.0	37.8	106.5	119.3	91.4	165.3	350.7	319.6	0.0	0.0	1,458.3
2002	0.0	0.0	67.2	143.8	38.5	110.5	38.5	178.7	96.0	130.5	188.4	23.0	1,015.1
2003	0.0	0.0	36.5	97.6	154.8	45.1	438.2	129.5	114.8	152.0	39.7	0.0	1,208.2
2004	32.7	0.0	0.0	78.8	138.4	93.0	130.3	37.5	94.1	180.3	0.0	0.0	785.1
2005	0.0	0.0	0.0	0.0	92.2	9.5	235.9	122.4	76.5	312.1	58.3	0.0	906.9
2006	0.0	0.0	0.0	0.0	168.5	378.6	74.9	251.6	306.7	100.1	6.3	0.0	1,286.7
2007	0.0	0.0	70	75	203.5	141.8	103.3	134.7	145.6	120.5	18.1	0.0	1,012.5
2008	0.0	0.0	39.8	157.2	111.2	55.7	0.0	38.1	205.6	148.5	42.3	0.0	798.4
2009	0.0	13.1	73.4	191.7	40.3	56.0	186.1	136.1	183.5	132.1	10.8	0.0	1,023.1
2010	4.8	12.1	9.2	49.8	80.8	44.0	60.9	105.8	81.5	120.4	156.0	89.2	814.5
Average	18.5	2.5	41.6	83.2	113.5	105.4	127.0	136.5	160.8	191.7	59.4	21.1	1,027.8



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.13 Rainfall Data at Prey Pdou Station (1966-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	0.0	0.0	51.0	86.2	77.4	58.7	234.5	202.7	207.5	227.1	16.3	13.2	1,174.6
1998	0.0	0.0	0.0	124.2	16.0	126.6	193.4	309.2	305.8	121.7	194.2	13.3	1,404.4
1999	8.7	0.0	51.0	126.1	111.5	88.1	61.1	163.8	183.8	191.7	131.7	37.6	1,155.1
2000	37.5	0.0	74.6	75.5	79.2	134.7	111.2	187.5	208.4	358.3	125.2	160.0	1,552.1
2001	200.0	0.0	187.8	58.0	92.0	224.4	89.0	189.0	208.7	343.2	27.7	19.0	1,638.8
2002	0.0	0.0	0.0	257.0	54.5	94.8	22.7	82.7	96.2	166.8	90.6	16.5	881.8
2003	0.0	0.0	50.6	38.8	144.6	149.8	294.8	54.6	146.9	190.1	20.2	5.6	1,096.0
2004	0.0	0.0	4.0	94.7	69.3	135.5	125.3	11.9	215.0	196.5	30.1	0.0	882.3
2005	0.0	0.0	0.0	89.3	60.9	93.1	113.2	77.5	178.4	229.1	108.5	68.8	1,018.8
2006	0.0	65.0	27.2	168.2	133.3	170.3	74.8	165.5	181.4	99.0	1.5	0.0	1,086.2
2007	0.0	0.0	89.2	56.6	157.1	119.9	152.7	104.8	143.0	142.3	32.3	0.0	997.9
2008	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2009	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2010	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
Average	22.4	5.9	48.7	106.8	90.5	126.9	133.9	140.8	188.6	206.0	70.8	30.4	1,171.6

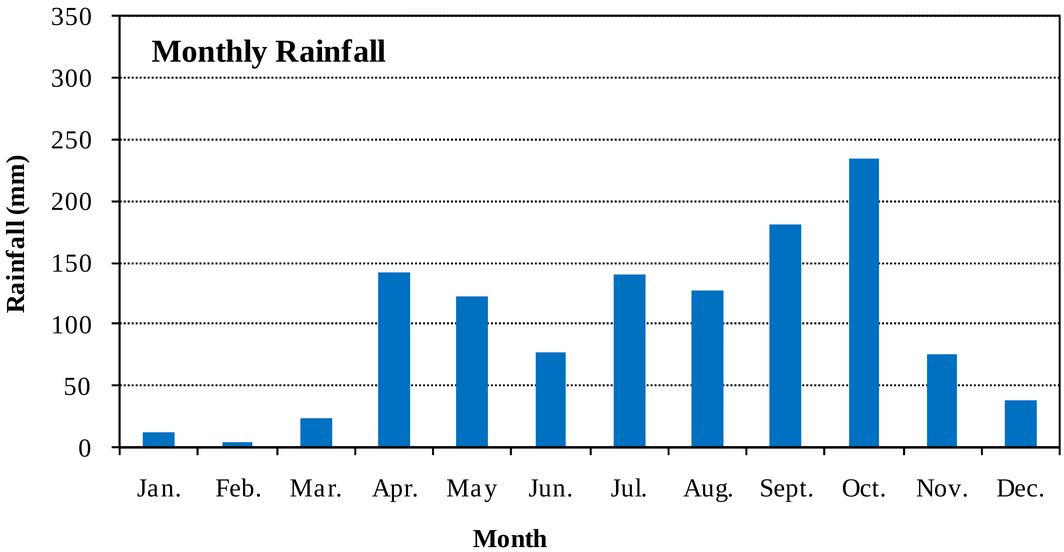


Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.14 Rainfall Data at Prey Dob Station (1966-2010)

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2001	105.6	0.0	124.2	70.0	52.5	39.0	153.3	196.7	329.7	286.4	14.1	67.4	1,438.9
2002	0.0	0.0	0.0	173.0	140.9	68.7	49.1	135.5	121.0	162.7	117.7	59.3	1,027.9
2003	0.0	0.0	24.7	76.8	87.6	121.5	347.9	192.4	n.a.	n.a.	n.a.	n.a.	-
2004	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2005	0.0	0.0	0.0	93.3	156.3	54.1	158.9	66.8	147.6	247.4	134.0	144.8	1,203.2
2006	0.0	33.4	16.2	81.9	181.5	0.0	163.9	43.8	120.3	172.5	13.0	0.0	826.5
2007	0.0	0.0	0.0	104.8	133.6	144.0	79.7	160.9	141.1	279.0	115.6	0.0	1,158.7
2008	0.0	0.0	0.0	238.4	105.0	64.6	32.4	101.4	140.7	170.9	115.2	34.7	1,003.3
2009	0.0	0.0	0.0	339.0	176.1	84.4	119.9	118.3	245.5	302.2	30.9	0.0	1,416.3
2010	0.0	0.0	49.3	98.6	64.5	122.4	154.1	136.8	197.1	250.7	69.9	0.0	1,143.4
Average	11.7	3.7	23.8	141.8	122.0	77.6	139.9	128.1	180.4	234.0	76.3	38.3	1,152.3

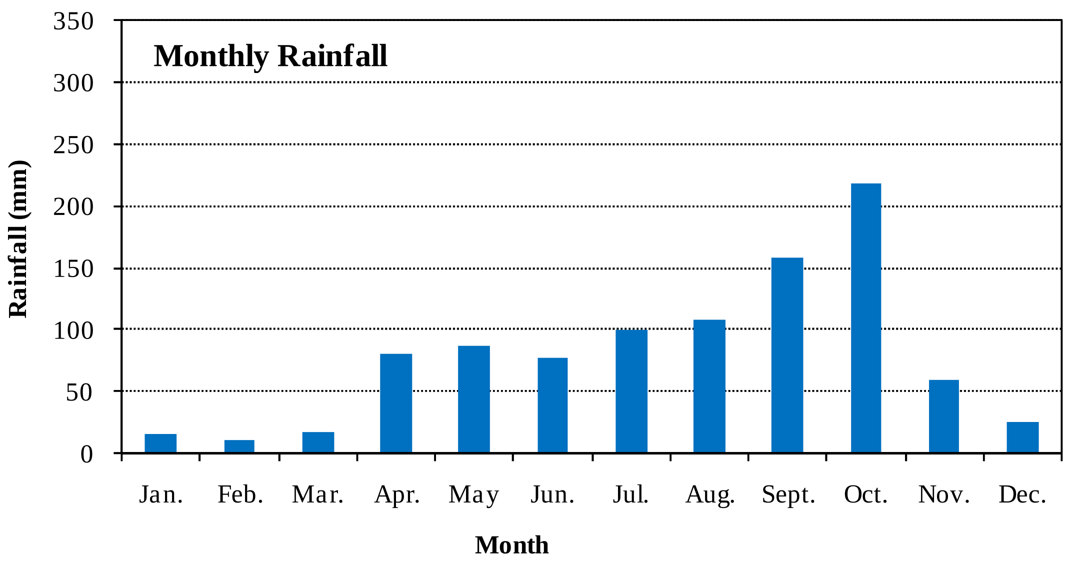


Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.15 Rainfall Data at Sdok Station (1966-2010)

(Unit: mm)

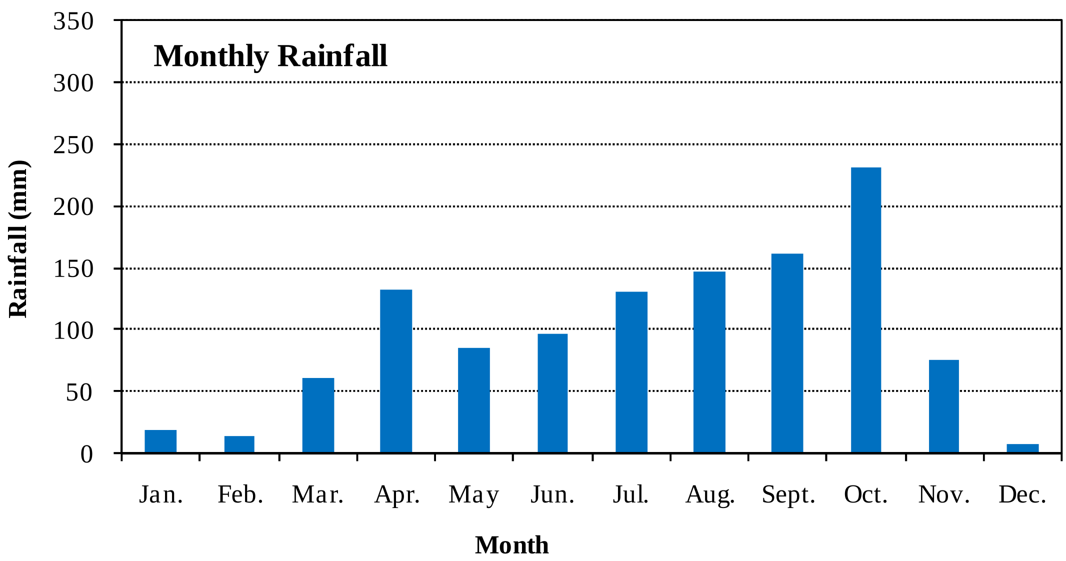
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	14.0	97.2	88.9	381.8	100.4	75.7	-
2001	137.1	0.0	90.6	116.1	91.6	24.4	195.4	135.7	384.2	362.0	15.2	69.5	1,621.8
2002	0.0	0.0	0.0	248.0	203.0	84.7	34.0	157.6	107.0	143.4	163.1	29.5	1,170.3
2003	0.0	0.0	0.0	83.8	122.3	97.3	438.5	109.7	80.2	316.0	16.0	11.9	1,275.7
2004	0.0	24.9	0.0	46.6	128.2	199.8	23.0	47.3	282.3	157.5	54.5	0.0	964.1
2005	0.0	0.0	0.0	100.5	89.0	73.0	143.3	101.0	69.6	255.2	71.6	68.4	971.6
2006	13.0	10.5	0.0	0.0	16.9	14.3	50.7	180.0	258.9	91.7	11.2	0.0	647.2
2007	0.0	27.9	31.1	65.0	46.5	90.2	52.8	44.5	98.6	74.0	70.5	0.0	601.1
2008	0.0	27.7	46.5	102.8	88.9	57.1	33.8	168.5	48.4	165.1	6.5	7.9	753.2
2009	0.0	11.2	8.2	27.2	53.8	63.7	33.4	50.8	203.5	198.2	29.2	0.0	679.2
2010	0	13.3	0	19.8	31.1	74.9	77.7	91	119.4	251.8	112.4	18.9	810.3
Average	15.0	11.6	17.6	81.0	87.1	77.9	99.7	107.6	158.3	217.9	59.1	25.6	949.5



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.16 Rainfall Data at Trapeang Chor Station (1966-2010) (Unit: mm)

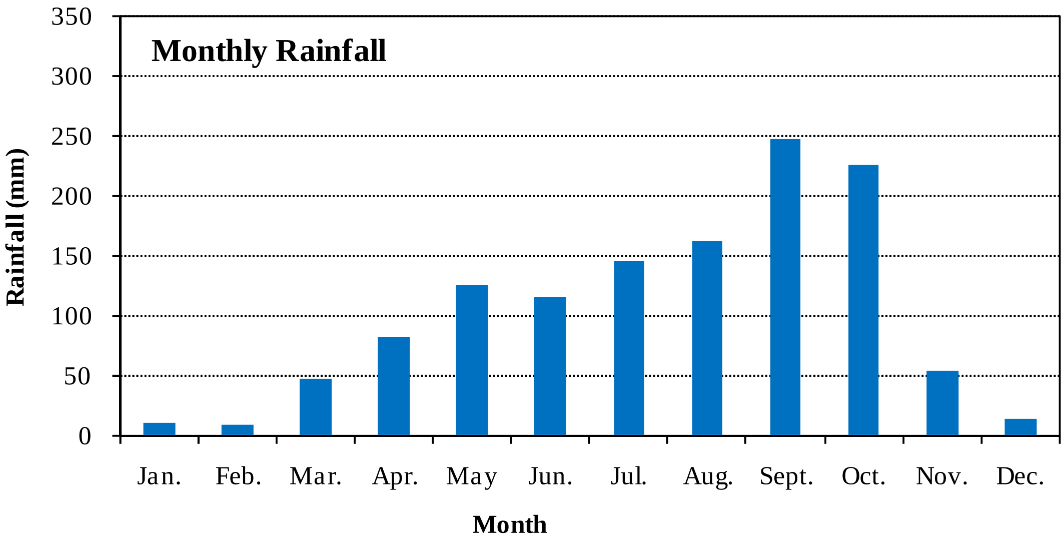
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	72.5	110.7	129.2	481.7	37.1	39.4	1,450.0
2001	115.4	0.0	115.7	44.3	77.9	113.1	27.6	172.0	174.1	342.8	59.9	0.0	1,242.8
2002	0.0	0.0	0.0	76.2	74.5	127.8	34.9	345.4	145.1	197.4	169.9	25.4	1,196.6
2003	0.0	5.7	88.4	189.7	84.8	142.6	213.6	87.3	162.4	249.4	0.0	5.7	1,229.6
2004	0.0	0.0	48.9	98.7	166.4	149.5	66.1	123.0	294.7	83.8	31.2	0.0	1,062.3
2005	1.7	0.0	34.3	48.7	73.1	84.1	42.9	159.0	40.8	176.0	156.3	0.0	816.9
2006	29.5	22.5	99.5	326.2	0.0	57.7	100.4	139.5	252.5	289.5	60.0	0.0	1,377.3
2007	0.0	0.0	34.4	59.2	83.9	86.1	80.1	77.8	126.9	177.0	71.2	0.0	796.6
2008	0.0	7.2	103.3	224.5	125.4	53.7	14.8	70.9	118.1	256.8	142.0	15.6	1,132.3
2009	10.0	58.2	66.3	192.5	39.8	13.2	490.2	183.6	126.2	211.5	0.0	0.0	1,391.5
2010	26.7	40.2	20.4	70.8	128.8	140.0	230.0	118.0	178.5	320.8	62.2	34.6	1,371.0
Average	18.3	13.4	61.1	133.1	85.5	96.8	124.8	144.3	159.0	253.3	71.8	11.0	1,161.7



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.17 Rainfall Data at Thpong Station (1966-2010) (Unit: mm)

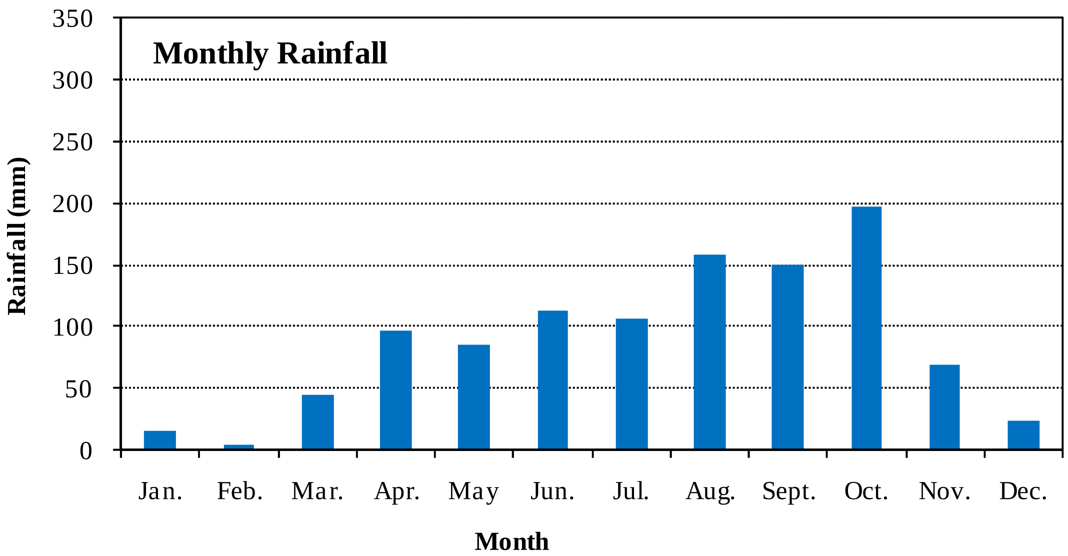
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	0.0	0.0	0.0	29.9	108.8	87.9	34.6	71.1	135.1	140.2	0.0	0.0	607.6
1988	0.5	0.0	8.7	94.8	140.8	187.8	142.6	108.2	213.8	125.0	0.0	0.0	1,022.2
1989	5.0	0.0	100.2	34.7	171.2	103.2	262.0	109.1	201.1	179.0	0.0	0.0	1,165.5
1990	0.0	0.0	46.5	63.6	161.6	102.9	144.2	171.6	264.4	129.8	169.4	0.0	1,254.0
1991	0.0	0.0	26.6	38.5	48.3	129.3	278.2	304.8	286.9	128.8	0.0	0.0	1,241.4
1992	0.0	0.0	0.0	34.0	127.0	73.9	175.7	65.7	266.1	101.1	0.0	15.0	858.5
1993	142.0	0.0	0.0	0.0	0.0	44.1	61.2	85.2	198.6	305.0	40.0	0.0	876.1
1994	0.0	0.0	212.0	19.0	83.0	85.5	68.5	88.7	332.7	189.3	34.0	47.5	1,160.2
1995	0.0	0.0	28.0	0.0	149.0	181.0	269.5	300.5	289.2	197.8	35.1	9.6	1,459.7
1996	0.0	0.0	0.0	46.4	89.0	109.0	142.5	141.5	311.5	324.0	161.0	31.5	1,356.4
1997	0.0	39.9	77.5	73.0	62.5	53.0	237.4	161.3	337.0	215.0	48.9	0.0	1,305.5
1998	0.0	5.0	0.0	120.3	65.9	159.8	192.5	203.9	308.6	270.5	98.2	3.3	1,428.0
1999	25.4	24.0	33.0	251.3	248.0	154.3	126.2	204.2	308.1	173.1	75.2	29.5	1,652.3
2000	12.9	0.0	150.9	170.9	144.3	106.0	211.8	145.9	68.6	287.8	97.9	59.8	1,456.8
2001	9.1	0.0	69.1	51.3	147.7	99.5	70.5	278.2	360.3	480.0	33.3	17.0	1,616.0
2002	0.0	0.0	31.7	30.1	104.1	160.4	19.8	152.8	126.5	267.7	93.9	48.9	1,035.9
2003	0.0	0.0	76.4	125.3	219.0	100.2	204.8	96.1	273.2	310.7	15.1	0.0	1,420.8
2004	8.5	67.8	53.3	7.7	188.7	154.5	145.6	56.4	203.9	148.7	42.6	0.0	1,077.7
2005	0.0	0.0	0.0	17.3	79.7	45.4	136.6	110.8	254.7	287.0	26.6	8.8	966.9
2006	4.5	21.6	0.0	99.2	135.1	127.2	138.8	210.2	299.8	195.4	44.7	0.0	1,276.5
2007	18.0	0.0	62.5	112.7	139.1	76.4	72.2	208.4	200.5	156.1	65.8	0.0	1,111.7
2008	20.8	0.0	20.3	218.4	203.7	83.0	77.6	209.6	208.7	291.5	114.3	0.0	1,447.9
2009	0.0	32.8	87.3	267.4	121.0	92.2	159.3	161.5	233.5	174.5	36.2	0.0	1,365.7
2010	11.4	3.7	57.2	76.8	59.1	244.5	117.3	263	248.4	321.8	58.2	72.2	1,533.6
Average	10.8	8.1	47.6	82.6	124.9	115.0	145.4	162.9	247.1	225.0	53.8	14.3	1,237.4



Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.18 Rainfall Data at Peam Khley Station (1966-2010) (Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1966	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1967	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1968	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1983	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1984	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1985	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1986	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1987	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1990	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1995	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1997	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
1999	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	-
2000	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	14.9	133.0	93.4	406.3	83.4	98.6	829.6
2001	159.1	0.0	78.6	0.0	31.0	145.1	116.1	135.9	205.0	330.1	44.9	37.5	1,283.3
2002	0.0	0.0	68.0	172.7	77.1	91.7	56.6	193.4	149.9	210.4	93.8	47.7	1,161.3
2003	0.0	0.0	51.2	113.8	46.2	111.5	373.6	153.1	187.5	243.5	48.9	0.0	1,329.3
2004	0.0	42.9	0.0	42.4	80.7	115.9	140.2	15.8	194.6	140.2	34.8	0.0	807.5
2005	0.0	0.0	0.0	101.4	98.5	30.8	147.1	60.4	86.8	195.3	90.7	27	838.0
2006	1.6	0.0	5.5	70.8	94.9	147.1	89.4	270.8	198.0	81.0	1.9	4.7	965.7
2007	0.0	0.0	145.3	84.2	132.8	155.9	93.3	265.2	157.9	161	143.2	0.0	1,338.8
2008	0.0	0.0	36.6	140	173.1	156.3	0.0	171.7	131.2	175.2	76.2	0.0	1,060.3
2009	0.0	0.0	0.0	228.6	93.9	46.7	62.0	205.7	135.1	105.5	44.3	0.0	921.8
2010	0.0	0.0	58.9	19.0	24.3	128.4	82.3	145.0	113.2	115.9	95.8	46.2	829.0
Average	16.1	4.3	44.4	97.3	85.3	112.9	106.9	159.1	150.2	196.8	68.9	23.8	1,033.1



Source: Department of Meteorology, MOWRAM

(Unit: mm)

Table AB-2.1.2.1.19 Annual Rainfall of Prek Thnot River Basin (1961-2010)

Year	Total Basin	1 Phum Chum	2 Trapeang Chor	3 Aoral/ Oral	4 Prey Kahiech	5 Pochentong	6 Ou Taroth	7 Kirirom	8 Church	9 Srae Klong	10 Kong Pisey	11 Peam Khley	12 Thnal Toteung	13 Thpong	14 Krang Ampil	15 Phnum Sruoch	16 Kompong Speu	17 Prey Pdou	18 Roleang Chrey	19 Sdok
C.A.(km^2)	5740	789	630	607	326	514	249	291	190	347	242	153	94	127	115	159	30	239	246	391
Thiessen	100%	13.7%	11.0%	10.6%	5.7%	8.9%	4.3%	5.1%	3.3%	6.0%	4.2%	2.7%	1.6%	2.2%	2.0%	2.8%	0.5%	4.2%	4.3%	6.8%
1961	n.a.	n.a.	n.a.	n.a.	n.a.	1,072	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1962	n.a.	n.a.	n.a.	n.a.	n.a.	1,413	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1963	n.a.	n.a.	n.a.	n.a.	n.a.	1,317	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1964	n.a.	n.a.	n.a.	n.a.	n.a.	1,334	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1965	n.a.	n.a.	n.a.	n.a.	n.a.	1,436	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1966	n.a.	n.a.	n.a.	n.a.	n.a.	1,635	n.a.	1926	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,681	1,349	n.a.	n.a.	n.a.
1967	n.a.	n.a.	n.a.	n.a.	n.a.	1,473	n.a.	1695	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,419	1,039	n.a.	n.a.	n.a.
1968	n.a.	n.a.	n.a.	n.a.	n.a.	1,075	n.a.	1960	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,292	1,011	n.a.	n.a.	n.a.
1969	n.a.	n.a.	n.a.	n.a.	n.a.	1,124	n.a.	1919	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,317	1,235	n.a.	n.a.	n.a.
1970	n.a.	n.a.	n.a.	n.a.	n.a.	1,664	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1981	n.a.	n.a.	n.a.	n.a.	n.a.	1,289	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1982	n.a.	n.a.	n.a.	n.a.	n.a.	1,361	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1983	n.a.	n.a.	n.a.	n.a.	n.a.	1,109	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,443	n.a.	n.a.	907	1,401	n.a.	n.a.	n.a.
1984	n.a.	n.a.	n.a.	n.a.	n.a.	1,179	n.a.	n.a.	n.a.	n.a.	720	n.a.	1,194	n.a.	n.a.	843	1,193	n.a.	n.a.	n.a.
1985	n.a.	n.a.	n.a.	n.a.	n.a.	1,283	n.a.	n.a.	n.a.	n.a.	1,230	n.a.	1,922	n.a.	n.a.	1,171	1,482	n.a.	n.a.	n.a.
1986	n.a.	n.a.	n.a.	n.a.	n.a.	1,351	n.a.	n.a.	n.a.	n.a.	999	n.a.	985	n.a.	n.a.	1,076	1,072	n.a.	n.a.	n.a.
1987	n.a.	n.a.	n.a.	n.a.	n.a.	1,506	n.a.	n.a.	n.a.	n.a.	725	n.a.	736	608	n.a.	724	767	n.a.	n.a.	n.a.
1988	n.a.	n.a.	n.a.	n.a.	n.a.	1,369	n.a.	n.a.	n.a.	n.a.	911	n.a.	1,155	1,022	n.a.	672	988	n.a.	n.a.	n.a.
1989	n.a.	n.a.	n.a.	n.a.	n.a.	1,437	n.a.	n.a.	n.a.	n.a.	826	n.a.	1,466	1,166	n.a.	1,105	975	n.a.	n.a.	n.a.
1990	n.a.	n.a.	n.a.	n.a.	n.a.	1,142	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	651	1,254	n.a.	709	802	n.a.	n.a.	n.a.
1991	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	940	n.a.	1,287	1,241	n.a.	1,269	1,073	n.a.	n.a.	n.a.
1992	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	844	n.a.	1,116	859	n.a.	874	874	n.a.	n.a.	n.a.
1993	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,334	n.a.	1,000	876	n.a.	992	952	n.a.	n.a.	n.a.
1994	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,004	n.a.	1,143	1,160	n.a.	801	1,181	n.a.	n.a.	n.a.
1995	n.a.	n.a.	n.a.	n.a.	n.a.	1,413	n.a.	n.a.	n.a.	n.a.	1,160	n.a.	1,139	1,460	n.a.	972	1,122	n.a.	n.a.	n.a.
1996	n.a.	n.a.	n.a.	n.a.	n.a.	1,616	n.a.	n.a.	n.a.	n.a.	1,315	n.a.	1,388	1,356	n.a.	1,197	1,390	n.a.	n.a.	n.a.
1997	n.a.	n.a.	n.a.	673	n.a.	1,408	n.a.	n.a.	n.a.	n.a.	941	n.a.	950	1,306	n.a.	654	1,151	1,175	n.a.	n.a.
1998	n.a.	n.a.	n.a.	1,115	n.a.	1,533	n.a.	n.a.	n.a.	n.a.	1,280	n.a.	1,255	1,428	n.a.	1,213	1,452	1,404	n.a.	n.a.
1999	n.a.	n.a.	n.a.	1,447	n.a.	1,659	n.a.	n.a.	n.a.	n.a.	1,381	n.a.	1,406	1,652	n.a.	1,529	1,757	1,155	n.a.	n.a.
2000	n.a.	n.a.	n.a.	1,392	n.a.	2,129	n.a.	n.a.	n.a.	n.a.	1,387	n.a.	1,299	1,457	n.a.	1,582	1,817	1,552	n.a.	n.a.
2001	1,529	(1,377)	1,243	1,444	(1,883)	1,615	1,458	2,275	(1,752)	1,490	1,407	1,283	1,343	1,616	1,237	1,574	1,723	1,639	(1,503)	1,622
2002	1,092	(996)	1,197	896	(1,195)	1,286	1,015	1,158	(1,207)	1,231	1,062	1,161	730	1,036	999	1,137	937	882	(1,049)	1,170
2003	1,294	(1,433)	1,230	1,535	(1,329)	1,304	1,208	1,343	(1,325)	1,316	1,102	1,329	741	1,421	897	1,272	883	1,096	(1,106)	1,276
2004	984	(1,058)	1,062	1,056	(1,060)	1,092	785	1,203	(1,012)	917	885	808	632	1,078	371	826	949	882	(878)	964
2005	1,010	(898)	817	939	(1,206)	1,427	907	1,359	(1,155)	1,053	1,063	838	771	967	123	1,125	1,114	1,019	(976)	972
2006	1,060	(1,141)	1,377	1,024	(1,009)	1,208	1,287	1,095	(980)	923	920	966	855	1,277	185	970	1,178	1,086	(1,072)	647
2007	1,195	(1,130)	797	1,297	(1,504)	1,374	1,013	1,646	(1,456)	1,361	1,276	1,339	1,000	1,112	1,111	1,458	1,650	998	(1,494)	601
2008	1,290	(1,202)	1,132	1,237	(1,535)	1,886	798	1,684	(1,486)	1,387	1,052	1,060	1,369	1,448	1,174	1,492	1,444	1,357	(1,252)	753
2009	1,162	(1,180)	1,392	1,074	(1,185)	1,456	1,023	1,138	(1,200)	1,231	858	922	1,234	1,366	1,084	1,008	1,405	1,330	(1,164)	679
2010	1,267	(1,434)	1,371	1,466	(1,249)	1,591	815	1,320	(1,225)	1,178	1,181	829	(1,119)	1,534	950	1,109	1,281	1,336	(1,055)	810
Mean	1,188	(1,185)	1,162	1,185	(1,315)	1,405	1,031	1,551	(1,280)	1,209	1,069	1,054	1,119	1,237	813	1,124	1,208	1,208	(1,155)	949

Note: ( ) means that the data is not available and estimated

Source: Department of Meteorology, MOWRAM

Table AB-2.1.2.1.20 Discharge of Prek Thnot River at Peam Khley Station (1997)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	36.79	16.11	7.44	3.17	(1.44)	(14.38)	24.23	26.05	138.12	85.51	97.74	31.08
2	35.91	15.69	7.23	3.09	(1.40)	(14.30)	23.94	25.54	101.29	80.69	81.79	30.32
3	34.98	15.27	7.02	3.05	(1.35)	(14.25)	23.68	24.99	80.44	101.50	70.80	29.56
4	34.13	14.84	6.85	2.96	(1.31)	(14.13)	27.62	24.49	62.47	198.09	65.98	28.80
5	33.24	14.46	6.64	2.88	(1.27)	(14.00)	217.55	23.98	49.31	187.52	61.87	28.08
01-05	35.01	15.28	7.04	3.03	1.35	14.21	63.40	25.01	86.33	130.66	75.63	29.57
6	32.40	14.04	6.47	2.79	(1.23)	(13.91)	322.56	23.43	90.67	196.02	57.86	27.36
7	31.59	13.66	6.30	2.71	(1.18)	(13.83)	234.13	22.92	256.08	188.83	54.30	26.69
8	30.75	13.28	6.13	2.66	(1.18)	(17.68)	236.12	22.50	186.85	171.49	51.72	25.97
9	29.99	12.94	5.96	2.58	(1.18)	(29.44)	224.19	84.71	202.62	164.94	50.75	25.29
10	29.18	12.60	5.79	2.54	(1.27)	(87.97)	200.12	73.76	196.61	155.63	49.82	24.66
06-10	30.78	13.31	6.13	2.66	1.21	32.56	243.42	45.46	186.57	175.38	52.89	25.99
11	28.42	12.22	5.63	2.45	(1.44)	(235.69)	174.45	84.75	178.47	151.70	48.89	24.02
12	27.70	11.93	5.46	2.37	(18.14)	(183.08)	139.44	91.18	148.40	154.11	47.92	23.39
13	26.98	11.59	5.33	2.33	(77.94)	(186.68)	100.06	85.89	247.58	145.48	46.99	22.80
14	26.26	11.25	5.16	2.24	(114.31)	(177.79)	83.10	68.81	469.86	129.54	46.01	22.16
15	25.59	10.95	5.03	2.20	(134.36)	(169.89)	66.10	54.30	735.58	104.42	45.08	21.61
11-15	26.99	11.59	5.32	2.32	69.24	190.63	112.63	76.99	355.98	137.05	46.98	22.80
16	24.91	10.66	4.91	2.16	(147.56)	(159.95)	51.60	45.17	536.51	143.88	44.15	21.02
17	24.23	10.36	4.74	2.07	(144.47)	(150.14)	44.45	37.68	423.72	391.24	43.26	20.47
18	23.60	10.11	4.61	2.03	(129.16)	(130.47)	40.26	33.71	391.11	398.05	42.33	19.96
19	22.96	9.81	4.48	1.99	(100.95)	(96.26)	36.71	30.28	343.54	328.99	41.40	19.41
20	22.37	9.56	4.36	1.90	(66.23)	(73.84)	33.66	27.36	289.27	312.28	40.47	18.90
16-20	23.62	10.10	4.62	2.03	117.67	122.13	41.34	34.84	396.83	314.89	42.33	19.95
21	21.74	9.26	4.23	1.86	(51.47)	(56.50)	31.04	24.95	226.09	288.22	39.59	18.44
22	21.19	9.01	4.15	1.82	(36.03)	(42.93)	30.66	24.61	166.16	278.66	38.66	17.93
23	20.60	8.80	4.02	1.78	(26.86)	37.26	30.28	24.45	130.05	284.75	37.77	17.47
24	20.05	8.54	3.89	1.73	(22.96)	33.37	29.90	152.55	111.18	295.28	36.92	17.00
25	19.50	8.29	3.81	1.69	(19.75)	30.07	29.48	224.10	97.74	296.72	36.03	16.54
21-25	20.61	8.78	4.02	1.78	31.41	40.03	30.27	90.13	146.24	288.73	37.79	17.47
26	18.99	8.08	3.72	1.65	(17.04)	27.28	29.01	374.83	99.55	278.79	35.19	16.11
27	18.48	7.87	3.64	1.57	(14.80)	25.25	28.55	270.75	124.46	249.90	34.34	15.69
28	17.97	7.66	3.55	1.52	(14.25)	25.04	28.04	263.60	130.13	218.48	33.50	15.27
29	17.51		3.43	1.48	(14.34)	24.78	27.57	245.88	122.31	180.25	32.69	14.84
30	17.00		3.34	(1.48)	(14.38)	24.53	27.07	216.53	102.43	137.53	31.89	14.46
31	16.58		3.26		(14.38)		26.56	186.08		116.05		14.04
26-end	17.76	7.87	3.49	1.54	14.87	25.38	27.80	259.61	115.78	196.83	33.52	15.07
Mean	25.53	11.39	5.05	2.22	38.50	70.82	84.58	94.19	214.62	206.92	48.19	21.59
Max.	36.79	16.11	7.44	3.17	147.56	235.69	322.56	374.83	735.58	398.05	97.74	31.08
Min.	16.58	7.66	3.26	1.48	1.18	13.83	23.68	22.50	49.31	80.69	31.89	14.04

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.21 Discharge of Prek Thnot River at Peam Khley Station (1998)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	1.87	0.95	3.61	0.69	(2.97)	0.58	1.02	22.81	30.88	380.66	57.02	23.90
2	1.77	1.09	2.06	0.69	(2.97)	1.25	0.95	17.11	27.81	431.17	59.07	25.02
3	1.77	1.17	2.17	0.75	(2.84)	1.68	1.33	14.57	23.84	453.78	61.15	32.08
4	1.68	1.09	1.87	0.82	(2.84)	1.87	1.59	12.23	53.69	368.52	94.98	30.88
5	1.68	0.95	1.68	0.82	(2.84)	2.49	2.38	12.23	61.85	508.78	84.80	29.32
01-05	1.75	1.05	2.28	0.76	2.89	1.57	1.45	15.79	39.61	428.58	71.40	28.24
6	1.87	0.95	1.59	0.64	(2.84)	1.87	5.57	27.06	71.35	434.90	84.80	27.81
7	1.87	0.88	1.96	0.53	(2.84)	1.68	6.62	21.14	76.75	245.19	109.47	22.14
8	1.77	0.82	1.87	0.48	(2.84)	1.50	3.47	11.98	68.36	225.94	112.30	20.18
9	1.77	0.95	1.96	0.38	(2.97)	1.41	2.49	9.00	57.02	227.29	118.07	18.92
10	1.77	0.82	1.68	0.38	(2.97)	1.17	1.96	7.57	65.43	246.59	99.40	17.70
06-10	1.81	0.88	1.81	0.48	2.89	1.52	4.02	15.35	67.78	275.98	104.81	21.35
11	1.59	0.69	1.50	0.95	(2.97)	0.88	1.50	6.26	66.15	241.00	74.41	15.96
12	1.41	0.64	1.25	1.33	(2.97)	0.69	1.59	6.99	44.89	223.26	61.15	14.84
13	1.77	0.69	1.02	1.09	(2.97)	0.64	3.34	9.87	69.10	230.00	46.71	14.30
14	1.59	0.64	0.95	0.95	(3.23)	0.88	3.34	9.65	52.38	181.27	33.30	8.37
15	1.59	0.58	1.33	0.95	(3.23)	1.02	2.61	12.73	53.03	180.07	30.88	8.58
11-15	1.59	0.65	1.21	1.06	3.07	0.82	2.47	9.10	57.11	211.12	49.29	12.41
16	1.41	0.48	1.25	0.82	(2.97)	2.38	2.61	4.92	119.04	146.89	47.94	7.97
17	1.59	0.48	0.95	0.69	(3.10)	1.96	3.61	22.81	84.80	125.98	94.11	7.57
18	1.77	0.48	1.09	0.64	(2.97)	1.96	3.21	15.67	88.97	102.10	118.07	6.99
19	1.87	0.58	1.17	0.53	(2.97)	1.77	20.50	27.81	134.15	87.29	128.00	6.81
20	1.77	0.69	0.88	0.82	(3.23)	1.68	19.23	30.49	132.09	72.87	98.51	6.44
16-20	1.68	0.54	1.07	0.70	3.05	1.95	9.83	20.34	111.81	107.03	97.33	7.16
21	1.59	1.77	0.88	4.46	(4.53)	1.50	3.47	23.15	97.62	61.15	72.87	6.26
22	1.68	1.59	0.69	4.31	(5.87)	1.41	3.21	25.60	64.70	53.69	51.10	6.09
23	1.77	3.09	0.58	2.17	(5.69)	1.68	2.72	27.43	65.43	44.89	41.94	5.91
24	1.77	2.17	0.48	1.96	(5.69)	1.50	2.61	19.54	71.35	35.38	35.38	5.74
25	1.59	2.27	0.43	1.77	(5.52)	2.06	3.47	27.81	65.43	41.94	29.32	5.41
21-25	1.68	2.18	0.61	2.93	5.46	1.63	3.10	24.71	72.91	47.41	46.12	5.88
26	1.59	2.17	0.48	1.77	(4.53)	1.96	4.31	55.68	131.06	57.70	27.06	5.24
27	1.41	9.43	0.58	1.77	(4.53)	1.59	3.88	51.74	253.67	84.80	24.89	5.08
28	1.25	5.08	0.64	1.59	(3.10)	1.33	6.62	29.71	299.83	76.75	24.54	4.76
29	1.17		0.64	1.50	(4.22)	1.17	5.08	11.99	321.94	55.68	20.82	4.61
30	1.09		0.64	(1.25)	(4.37)	1.09	15.39	10.73	321.94	55.01	0.00	4.46
31	0.82		0.64		(4.53)		23.84	9.32		56.35		4.46
26-end	1.22	5.56	0.60	1.57	4.21	1.43	9.85	28.19	265.69	64.38	19.46	4.77
Mean	1.61	1.54	1.24	1.25	3.62	1.49	5.27	19.21	102.49	185.06	64.74	13.03
Max.	1.87	9.43	3.61	4.46	5.87	2.49	23.84	55.68	321.94	508.78	128.00	32.08
Min.	0.82	0.48	0.43	0.38	2.84	0.58	0.95	4.92	23.84	35.38	0.00	4.46

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.22 Discharge of Prek Thnot River at Peam Khley Station (1999)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	4.46	1.87	1.96	0.69	24.89	51.74	97.62	131.06	118.07	31.28	795.24	118.07
2	4.16	1.77	1.96	1.25	29.32	46.71	123.98	93.25	220.59	44.89	787.68	234.09
3	4.31	1.87	1.87	2.27	42.52	63.99	255.10	73.64	241.00	48.57	767.69	241.00
4	4.92	2.17	1.96	2.96	86.45	79.12	243.79	172.93	315.55	55.68	697.40	315.55
5	14.57	1.96	2.17	6.99	84.80	32.08	252.25	231.36	387.68	85.62	755.33	387.68
01-05	6.48	1.93	1.99	2.83	53.60	54.73	194.55	140.45	256.58	53.21	760.67	259.28
6	31.68	1.77	1.96	14.03	74.41	117.09	238.22	451.87	403.72	106.67	780.15	403.72
7	31.28	3.21	2.17	13.50	43.11	210.07	224.60	446.18	361.68	122.98	639.51	361.68
8	5.74	3.34	2.84	9.21	38.53	203.63	31.28	373.70	272.56	126.99	434.90	278.51
9	5.91	3.09	2.27	9.87	23.49	187.35	22.14	312.37	242.39	223.26	463.37	235.47
10	6.44	2.96	2.84	11.98	23.84	97.62	23.15	306.07	260.86	271.09	459.52	277.02
06-10	16.21	2.87	2.42	11.72	40.68	163.15	107.88	378.04	308.24	170.20	555.49	311.28
11	4.46	3.09	2.96	11.98	21.47	82.34	29.71	157.95	138.34	241.00	315.55	25.02
12	4.31	2.84	3.09	27.06	23.84	74.41	27.43	118.07	114.20	274.04	310.79	23.53
13	4.16	2.84	2.27	27.06	24.54	69.10	28.18	95.86	82.34	306.07	302.94	28.55
14	5.57	2.38	1.87	30.10	24.89	65.43	27.81	27.81	78.33	370.24	307.64	21.74
15	4.92	2.17	1.87	17.70	25.60	53.69	25.96	25.96	75.19	405.52	171.75	21.04
11-15	4.69	2.66	2.41	22.78	24.07	68.99	27.82	85.13	97.68	319.37	281.73	23.98
16	4.31	2.17	1.77	13.50	42.52	49.19	27.43	33.71	73.64	438.64	164.78	16.49
17	4.16	2.06	1.77	10.10	91.52	31.68	28.94	43.11	72.11	449.97	116.13	7.19
18	4.92	1.96	1.59	8.58	269.61	32.08	21.14	63.99	69.85	461.44	109.47	8.22
19	4.92	1.96	1.50	7.37	136.24	60.45	20.50	83.97	81.53	484.83	97.62	8.65
20	3.74	2.06	1.41	6.62	137.28	83.15	20.50	80.72	102.10	488.78	121.00	15.00
16-20	4.41	2.05	1.61	9.24	135.44	51.31	23.70	61.10	79.85	464.73	121.80	11.11
21	3.47	1.96	1.33	7.37	121.00	92.38	17.41	89.82	122.98	508.78	162.49	23.90
22	3.09	2.27	1.25	11.26	123.98	92.38	16.53	93.25	126.99	523.03	58.38	23.90
23	2.96	1.77	1.25	15.96	313.96	83.97	14.57	83.97	137.28	520.98	56.35	20.70
24	2.84	1.87	1.25	20.18	446.18	81.53	12.73	82.34	126.99	508.78	51.74	32.76
25	2.84	1.87	1.77	25.60	436.77	106.67	11.74	79.12	82.34	504.75	49.82	17.73
21-25	3.04	1.95	1.37	16.07	288.38	91.39	14.59	85.70	119.32	513.27	75.76	23.80
26	2.61	1.77	1.59	41.36	69.85	88.97	55.68	85.62	57.70	539.55	44.89	18.37
27	2.38	1.96	1.50	41.36	73.64	83.97	71.35	102.10	49.19	556.32	39.65	17.73
28	2.17	1.77	1.09	40.79	27.43	82.34	134.15	94.11	44.89	562.68	34.12	18.37
29	1.96		0.82	42.52	45.49	79.12	141.51	103.00	39.09	525.08	32.48	18.37
30	1.87		0.69	40.22	46.71	91.52	142.58	106.67	31.68	625.99	31.68	25.40
31	1.96		0.69		44.29		144.73	103.00		740.63		48.93
26-end	2.16	1.83	1.06	41.25	51.24	85.19	115.00	99.09	44.51	591.71	36.57	24.53
Mean	6.04	2.24	1.78	17.32	97.36	85.79	81.70	140.21	151.03	359.81	305.34	106.27
Max.	31.68	3.34	3.09	42.52	446.18	210.07	255.10	451.87	403.72	740.63	795.24	403.72
Min.	1.87	1.77	0.69	0.69	21.47	31.68	11.74	25.96	31.68	31.28	31.68	7.19

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.23 Discharge of Prek Thnot River at Peam Khley Station (2000)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	22.14	6.09	9.87	3.09	13.77	13.24	51.10	32.48	105.75	136.24	370.24	26.69
2	21.14	5.91	9.65	2.84	14.03	14.57	34.54	32.08	113.25	152.37	221.92	23.49
3	19.86	5.57	9.65	3.09	27.81	30.88	34.96	37.98	110.41	136.24	154.59	22.14
4	19.23	5.41	11.50	3.34	57.02	74.41	32.89	33.30	83.97	88.97	149.07	18.31
5	18.61	5.24	12.99	3.61	57.02	99.40	26.33	60.45	65.43	65.43	83.97	15.96
01-05	20.20	5.64	10.73	3.19	33.93	46.50	35.96	39.26	95.76	115.85	195.96	21.32
6	18.00	5.08	13.50	3.47	52.38	112.30	54.35	22.14	52.38	134.15	66.88	14.84
7	16.82	4.76	14.30	3.74	43.70	95.86	72.87	22.14	40.22	136.24	54.35	13.77
8	16.24	4.46	14.03	4.16	38.53	75.97	69.85	28.18	40.22	116.13	46.10	12.99
9	15.67	4.31	13.24	4.76	18.31	68.36	47.33	27.06	41.36	73.64	37.98	12.48
10	15.12	4.16	12.48	4.16	15.67	71.35	38.53	25.96	53.69	68.36	32.08	12.23
06-10	16.37	4.56	13.51	4.06	33.72	84.77	56.59	25.10	45.58	105.70	47.48	13.26
11	14.03	4.02	14.03	3.74	15.39	48.57	63.99	23.49	47.33	65.43	30.10	12.23
12	13.50	3.61	13.50	4.16	18.31	32.08	111.35	29.32	44.89	121.00	28.18	11.02
13	12.99	3.34	15.12	4.76	22.81	25.96	121.99	28.18	63.27	225.94	26.69	10.55
14	12.48	3.09	15.67	5.41	59.76	21.80	101.19	24.89	66.88	371.97	26.69	10.32
15	11.50	2.96	6.62	5.74	57.02	18.00	99.40	30.88	57.70	1,151.46	25.96	10.78
11-15	12.90	3.40	12.99	4.76	34.66	29.28	99.58	27.35	56.01	387.16	27.53	10.98
16	11.02	2.84	15.39	6.09	21.47	15.39	155.71	24.54	62.56	1,263.50	26.69	10.32
17	10.78	3.34	14.03	27.81	16.53	18.00	170.58	25.60	44.29	1,209.94	34.96	9.65
18	10.32	3.61	20.82	75.19	16.53	18.31	161.35	32.48	54.35	1,088.51	124.98	9.43
19	9.65	3.88	13.50	81.53	15.39	41.36	203.63	31.68	54.35	657.76	146.89	8.79
20	9.00	3.88	8.37	72.87	13.77	69.85	235.47	53.03	59.07	575.50	160.21	7.97
16-20	10.16	3.51	14.42	52.70	16.74	32.58	185.35	33.47	54.92	959.04	98.75	9.23
21	8.58	5.08	6.44	67.62	12.99	53.03	118.07	76.75	59.07	252.25	113.25	34.54
22	8.17	5.57	4.92	88.97	12.48	34.96	83.15	87.29	69.85	227.29	74.41	94.11
23	7.77	5.57	3.61	135.19	13.24	33.30	67.62	124.98	75.97	217.93	57.02	83.97
24	7.57	10.10	3.61	94.98	12.99	30.49	54.35	126.99	108.53	236.84	41.36	79.12
25	13.50	10.32	3.61	68.36	16.24	28.56	62.56	130.03	105.75	343.18	33.71	28.56
21-25	9.12	7.33	4.44	91.03	13.59	36.07	77.15	109.21	83.83	255.50	63.95	64.06
26	12.73	10.55	3.88	72.11	18.31	28.56	62.56	186.13	88.13	216.61	31.28	66.88
27	11.02	10.55	3.61	59.76	23.84	32.48	95.86	177.67	72.87	141.51	31.68	30.88
28	9.43	9.87	3.47	57.02	20.18	32.48	126.99	143.65	83.97	109.47	33.30	11.74
29	8.58	9.65	3.21	22.14	20.18	57.02	72.11	133.12	143.65	143.65	29.32	10.55
30	8.79		2.84	17.41	21.80	51.74	53.69	108.53	159.08	257.97	26.33	9.65
31	7.77		3.09		21.80		34.96	101.19		368.52		9.43
26-end	9.72	10.16	3.35	45.69	21.02	40.46	74.36	141.72	109.54	206.29	30.38	23.19
Mean	12.97	5.61	9.69	33.57	25.46	44.94	87.72	65.23	74.27	334.00	77.34	23.66
Max.	22.14	10.55	20.82	135.19	59.76	112.30	235.47	186.13	159.08	1,263.50	370.24	94.11
Min.	7.57	2.84	2.84	2.84	12.48	13.24	26.33	22.14	40.22	65.43	25.96	7.97

Note: ( ) means that the data is not available and estimated
Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.24 Discharge of Prek Thnot River at Peam Khley Station (2001)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	9.00	6.81	1.50	9.65	3.34	2.17	67.62	8.17	165.93	385.92	96.74	8.58
2	8.17	6.09	2.61	14.84	1.77	1.59	41.36	7.77	149.07	304.50	116.13	8.37
3	7.57	5.24	2.06	15.67	1.50	1.50	39.09	8.79	109.47	361.68	101.19	8.37
4	6.62	5.24	1.96	14.03	1.41	1.68	105.75	9.87	95.86	471.12	88.97	8.37
5	6.26	4.92	1.59	7.77	1.96	12.23	235.47	7.97	87.29	416.42	111.35	8.37
01-05	7.52	5.66	1.94	12.39	2.00	3.83	97.86	8.51	121.52	387.93	102.88	8.41
6	7.57	4.92	1.41	5.57	1.77	2.96	334.93	10.55	68.36	323.55	80.72	6.26
7	9.43	4.92	1.59	4.46	1.59	3.09	579.81	24.89	50.46	359.97	69.85	6.26
8	8.58	4.76	1.59	4.16	1.41	19.86	775.15	27.43	35.38	394.77	48.57	6.09
9	7.77	4.46	1.59	3.61	2.06	11.74	704.51	23.49	28.56	455.69	41.94	5.74
10	7.18	3.88	1.50	2.96	3.21	6.99	275.53	18.00	27.43	702.14	34.12	5.41
06-10	8.11	4.59	1.53	4.15	2.01	8.93	533.99	20.87	42.04	447.22	55.04	5.95
11	6.99	3.61	1.33	2.72	1.87	11.50	180.07	19.54	27.06	862.27	29.32	5.41
12	6.99	3.88	1.77	2.61	1.59	9.00	141.51	67.62	25.60	800.30	25.25	5.41
13	7.57	3.47	1.77	2.38	1.33	6.26	133.12	119.04	22.81	678.60	24.54	5.91
14	51.74	3.21	1.68	2.17	1.33	4.61	99.40	138.34	20.82	412.77	24.54	13.24
15	92.38	3.09	1.33	2.17	1.87	3.74	49.82	86.45	34.54	301.39	24.54	11.02
11-15	33.14	3.45	1.57	2.41	1.60	7.02	120.78	86.20	26.17	611.07	25.64	8.20
16	87.29	2.96	1.87	1.77	2.27	4.16	41.36	77.53	34.96	398.34	23.84	11.02
17	33.71	3.09	4.92	1.59	2.27	3.74	38.53	65.43	46.10	191.05	22.81	7.57
18	23.49	2.84	10.78	1.59	2.38	3.61	33.30	70.60	62.56	123.98	21.80	6.81
19	16.24	2.72	11.02	1.50	3.47	3.88	27.06	82.34	100.30	100.30	15.67	6.44
20	14.30	2.61	27.06	1.59	4.16	4.61	21.47	101.19	93.25	106.67	15.12	6.09
16-20	35.01	2.84	11.13	1.61	2.91	4.00	32.35	79.42	67.43	184.07	19.85	7.58
21	12.99	2.17	30.49	1.59	3.88	8.58	17.70	94.98	94.98	119.04	13.77	6.09
22	12.48	1.77	26.69	1.50	3.61	5.91	14.57	103.92	101.19	126.99	12.73	4.46
23	13.24	2.27	24.89	1.41	3.74	4.76	11.50	132.09	107.60	189.81	12.48	10.10
24	10.78	2.61	14.30	1.41	3.09	4.46	22.47	140.45	201.08	286.04	12.48	4.31
25	9.00	2.49	9.87	1.41	2.96	7.57	17.11	136.24	241.00	343.18	11.02	4.31
21-25	11.70	2.26	21.25	1.46	3.45	6.26	16.67	121.53	149.17	213.01	12.50	5.85
26	7.77	1.87	8.79	1.33	1.59	17.11	16.82	70.60	259.41	298.28	10.55	4.31
27	6.81	1.59	6.26	1.33	1.41	14.84	15.67	53.69	278.51	181.27	10.10	4.16
28	6.26	1.59	4.76	2.27	1.41	77.53	14.30	45.49	269.61	119.04	9.65	4.02
29	6.44		3.88	3.47	1.09	71.35	11.74	60.45	292.13	95.86	9.21	3.88
30	6.44		4.02	3.61	1.02	75.97	11.26	102.10	377.17	83.97	8.79	3.61
31	6.99		14.30		2.06		9.00	161.35		75.97		3.34
26-end	6.79	1.68	7.00	2.40	1.43	51.36	13.13	82.28	295.37	142.40	9.66	3.89
Mean	16.71	3.54	7.39	4.07	2.21	13.57	131.84	66.98	116.95	324.87	37.59	6.56
Max.	92.38	6.81	30.49	15.67	4.16	77.53	775.15	161.35	377.17	862.27	116.13	13.24
Min.	6.26	1.59	1.33	1.33	1.02	1.50	9.00	7.77	20.82	75.97	8.79	3.34

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.25 Discharge of Prek Thnot River at Peam Khley Station (2002)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	3.34	1.09	0.38	1.25	4.76	1.25	4.46	4.02	47.33	66.15	33.71	24.89
2	3.09	1.09	0.38	1.09	3.88	1.59	3.47	2.72	72.11	67.62	43.70	61.85
3	3.09	1.09	0.38	1.09	2.72	0.75	3.34	2.27	86.45	66.15	60.45	37.98
4	2.84	1.09	0.38	0.82	1.68	0.69	3.09	2.06	83.97	60.45	52.38	26.69
5	2.84	1.09	0.38	0.69	1.41	0.69	3.61	1.77	74.41	75.19	39.65	26.33
01-05	3.04	1.09	0.38	0.99	2.89	1.00	3.59	2.57	72.86	67.11	45.98	35.55
6	2.84	1.09	0.38	0.58	1.25	0.58	3.34	1.77	52.38	68.36	32.08	23.49
7	2.61	1.09	0.23	0.38	1.41	0.64	2.96	5.74	43.11	102.10	19.86	21.80
8	2.17	1.17	0.23	0.38	1.68	0.58	2.84	3.47	28.56	121.00	13.24	18.00
9	1.96	1.17	0.23	0.34	1.96	0.58	15.96	11.02	24.89	116.13	11.98	20.50
10	1.96	1.25	0.23	0.30	1.59	0.53	12.23	9.65	24.54	83.15	11.98	29.71
06-10	2.31	1.16	0.26	0.40	1.58	0.58	7.47	6.33	34.70	98.15	17.83	22.70
11	1.77	1.25	0.20	0.23	1.87	0.53	7.97	7.57	28.94	46.71	14.57	26.33
12	1.77	1.09	0.20	3.47	1.96	0.69	5.57	6.99	30.49	56.35	14.30	19.23
13	1.96	1.09	0.20	4.46	2.17	0.82	5.24	5.57	25.25	64.70	13.50	14.03
14	1.96	1.09	0.95	5.08	3.88	2.06	3.47	7.37	24.89	53.69	17.11	11.50
15	1.96	1.09	0.64	2.49	3.61	2.61	4.61	11.50	20.50	54.35	16.24	9.00
11-15	1.89	1.13	0.43	3.15	2.70	1.34	5.37	7.80	26.01	55.16	15.14	16.02
16	1.96	1.09	0.38	2.49	2.96	2.38	3.34	25.96	17.11	33.71	13.24	8.37
17	1.96	1.09	0.38	3.09	2.96	2.17	2.96	31.28	13.77	23.15	18.31	7.57
18	1.96	1.09	0.38	3.74	2.49	2.61	4.61	24.19	11.50	18.92	11.98	6.99
19	1.96	1.09	0.38	2.06	2.17	3.34	5.24	47.33	14.84	17.11	28.18	5.74
20	1.96	1.09	0.30	1.87	2.27	2.84	4.61	69.10	40.22	12.48	30.49	5.74
16-20	1.96	1.09	0.37	2.65	2.57	2.67	4.15	39.57	19.49	21.07	20.44	6.88
21	1.96	1.09	0.30	1.68	1.87	2.61	3.74	91.52	41.94	10.32	26.69	5.74
22	1.96	1.09	0.48	1.50	1.77	2.38	2.72	135.19	43.11	9.65	26.33	5.74
23	1.96	1.02	0.58	1.96	1.77	2.27	2.17	112.30	55.01	8.58	23.49	9.21
24	1.96	1.02	0.58	1.77	1.59	1.96	1.96	91.52	53.69	8.17	18.92	8.79
25	1.96	1.02	0.69	2.17	1.68	1.96	1.02	88.97	54.35	10.10	15.67	6.26
21-25	1.96	1.05	0.53	1.82	1.73	2.24	2.32	103.90	49.62	9.36	22.22	7.15
26	1.77	1.02	0.82	3.09	1.77	3.34	1.33	69.85	82.34	39.09	15.67	5.74
27	1.77	1.02	1.59	1.77	1.77	3.88	2.06	49.82	66.88	75.97	12.73	5.08
28	1.77	1.02	1.77	1.50	1.59	26.69	2.06	46.71	44.89	79.92	10.32	4.46
29	1.77		3.74	1.41	1.25	12.73	1.96	35.38	44.89	49.19	9.00	3.88
30	1.09		2.38	2.17	1.25	7.37	2.06	40.22	42.52	37.43	8.37	3.88
31	1.09		1.96		1.25		4.92	46.10		32.08		3.74
26-end	1.54	1.02	2.04	1.99	1.48	10.80	2.40	48.01	56.31	52.28	11.22	4.46
Mean	2.10	1.10	0.71	1.83	2.14	3.10	4.16	35.13	43.16	50.58	22.14	15.11
Max.	3.34	1.25	3.74	5.08	4.76	26.69	15.96	135.19	86.45	121.00	60.45	61.85
Min.	1.09	1.02	0.20	0.23	1.25	0.53	1.02	1.77	11.50	8.17	8.37	3.74

Note: ( ) means that the data is not available and estimated
Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.26 Discharge of Prek Thnot River at Peam Khley Station (2003)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	3.34	0.69	1.50	3.88	7.77	4.31	22.81	72.87	139.39	163.63	65.43	15.67
2	3.09	0.64	1.02	6.09	3.34	6.62	16.53	51.74	103.00	257.97	45.49	15.12
3	2.84	0.69	0.88	3.88	2.38	7.57	16.82	53.03	59.76	438.64	34.96	15.12
4	2.96	0.69	0.64	2.17	3.21	6.99	17.11	46.10	47.33	449.97	29.32	15.12
5	1.77	0.69	0.58	3.47	4.46	7.97	38.53	83.15	37.98	323.55	26.33	15.12
01-05	2.80	0.68	0.92	3.90	4.23	6.69	22.36	61.38	77.49	326.75	40.31	15.23
6	2.61	0.95	0.48	2.84	3.74	6.81	51.74	133.12	33.71	293.66	23.49	15.67
7	2.61	1.09	0.48	8.58	2.38	6.09	28.56	104.83	35.38	358.28	21.47	15.39
8	2.61	0.69	0.30	2.17	2.06	4.16	23.84	99.40	66.88	442.40	18.92	15.12
9	2.27	0.58	0.48	2.27	2.17	3.74	19.23	79.92	31.68	378.91	18.61	15.67
10	1.96	0.48	0.48	2.27	1.96	3.09	16.53	66.88	46.10	253.67	18.61	15.67
06-10	2.41	0.76	0.44	3.63	2.46	4.78	27.98	96.83	42.75	345.39	20.22	15.51
11	1.68	0.53	3.09	2.84	1.50	2.61	19.23	53.69	72.11	192.29	18.92	15.12
12	1.59	0.48	12.48	1.59	1.50	1.68	57.70	29.32	60.45	132.09	20.18	15.12
13	1.87	0.34	18.92	1.41	2.27	1.68	56.35	23.84	46.10	134.15	20.18	15.12
14	1.87	0.26	11.74	1.25	2.49	1.68	121.00	23.84	41.36	102.10	19.86	15.12
15	1.77	0.23	6.81	1.09	2.38	1.50	136.24	23.15	46.10	117.09	19.54	15.67
11-15	1.75	0.37	10.61	1.64	2.03	1.83	78.10	30.77	53.23	135.54	19.73	15.23
16	1.68	0.23	3.09	1.09	3.34	1.50	150.17	25.25	42.52	235.47	19.23	15.67
17	1.59	0.30	2.84	0.95	3.88	2.27	154.59	24.89	44.89	359.97	18.92	15.67
18	1.59	0.30	2.72	0.95	5.74	2.61	154.59	25.25	49.19	365.09	18.00	15.67
19	1.59	0.34	2.49	1.25	4.76	1.96	37.43	24.19	71.35	265.22	17.41	15.12
20	1.59	0.38	4.76	0.82	4.46	1.77	53.03	24.89	91.52	182.48	17.41	15.12
16-20	1.60	0.31	3.18	1.01	4.44	2.02	109.96	24.89	59.90	281.64	18.19	15.45
21	1.41	0.38	5.91	0.82	4.76	1.68	32.89	30.88	154.59	149.07	16.82	15.12
22	1.09	0.38	4.46	0.69	6.26	1.59	27.43	40.79	169.41	131.06	16.24	15.12
23	1.09	0.48	4.46	0.82	9.00	1.68	42.52	38.53	83.15	118.07	17.41	15.67
24	0.95	0.75	3.47	0.75	9.43	2.27	252.25	37.43	72.11	178.87	17.41	15.12
25	0.88	0.64	4.46	0.69	9.21	4.46	496.73	28.18	65.43	354.89	16.24	15.12
21-25	1.09	0.53	4.55	0.76	7.73	2.33	170.37	35.16	108.94	186.39	16.82	15.23
26	0.38	0.69	8.79	1.09	6.09	5.08	921.12	41.94	57.02	575.50	16.24	15.12
27	0.53	0.95	27.43	0.88	4.16	5.41	770.17	39.65	109.47	440.52	15.67	15.12
28	0.69	0.95	15.67	2.06	3.47	11.74	527.13	35.38	104.83	201.08	15.67	15.12
29	0.75		8.17	3.61	4.61	14.30	286.04	34.12	110.41	122.98	15.67	15.12
30	0.95		5.91	9.65	6.09	17.70	213.99	37.43	109.47	90.67	15.67	15.12
31	0.88		4.76		4.92		113.25	47.94		75.97		15.12
26-end	0.70	0.87	11.79	3.46	4.89	10.84	471.95	39.41	98.24	251.12	15.79	15.12
Mean	1.69	0.57	5.46	2.40	4.32	4.75	157.28	47.79	73.42	254.36	21.84	15.29
Max.	3.34	1.09	27.43	9.65	9.43	17.70	921.12	133.12	169.41	575.50	65.43	15.67
Min.	0.38	0.23	0.30	0.69	1.50	1.50	16.53	23.15	31.68	75.97	15.67	15.12

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.27 Discharge of Prek Thnot River at Peam Khley Station (2004)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	15.67	9.21	4.16	2.84	3.34	2.84	10.10	23.15	11.98	19.86	9.87	5.08
2	15.67	9.21	4.16	2.84	3.34	2.72	9.65	38.53	13.77	25.96	8.58	5.08
3	15.12	9.21	3.88	2.84	3.61	2.96	10.10	57.70	12.48	41.36	7.57	4.76
4	15.12	9.21	3.88	3.09	3.34	3.34	12.73	47.33	12.99	32.48	7.18	4.46
5	15.67	8.79	3.61	3.09	3.09	3.61	11.74	9.00	12.73	51.74	6.81	4.16
01-05	15.45	9.13	3.94	2.94	3.34	3.09	10.86	35.14	12.79	34.28	8.00	4.71
6	15.67	8.79	3.61	3.09	2.84	3.88	10.78	19.86	10.55	139.39	6.09	3.88
7	15.12	8.37	3.34	3.09	2.84	3.88	10.10	17.70	9.65	217.93	6.09	3.61
8	15.12	8.37	3.34	3.09	3.09	4.31	9.65	15.12	9.21	161.35	5.41	3.34
9	15.67	8.79	3.34	3.34	3.09	6.99	8.79	15.12	8.79	115.16	4.76	8.37
10	15.67	8.37	3.09	3.34	3.47	7.77	8.37	13.50	8.79	80.72	4.46	3.09
06-10	15.45	8.54	3.34	3.19	3.07	5.37	9.54	16.26	9.40	142.91	5.36	4.46
11	15.67	8.37	3.09	3.09	3.88	7.77	7.97	11.74	9.00	43.70	4.46	3.09
12	15.67	7.97	3.09	3.09	3.74	8.37	7.18	18.61	10.32	45.49	4.16	2.84
13	15.12	7.57	3.09	3.09	3.61	8.17	6.81	34.96	11.50	84.80	4.16	2.84
14	15.12	7.57	3.09	3.09	3.47	8.79	6.99	54.35	13.24	141.51	3.88	2.61
15	15.12	7.18	3.09	2.84	4.16	10.55	6.62	45.49	28.94	79.12	4.02	2.61
11-15	15.34	7.73	3.09	3.04	3.77	8.73	7.11	33.03	14.60	78.93	4.14	2.80
16	15.12	6.81	3.09	3.09	4.31	44.29	6.99	32.89	39.09	37.98	4.46	2.61
17	11.98	6.81	3.09	3.09	4.31	105.75	6.81	23.49	29.71	29.32	4.31	2.72
18	11.98	6.44	3.09	3.09	4.76	58.38	7.97	23.15	66.15	27.43	4.16	2.72
19	11.98	6.09	3.09	3.34	4.92	24.89	9.00	18.61	89.82	18.92	3.88	2.84
20	12.48	5.74	2.84	3.34	4.61	28.94	7.97	19.86	103.92	17.41	3.88	2.84
16-20	12.71	6.38	3.04	3.19	4.58	52.45	7.75	23.60	65.74	26.21	4.14	2.75
21	11.98	5.74	2.84	3.34	4.16	21.14	7.18	22.14	119.04	20.50	3.61	2.84
22	11.50	5.41	2.84	3.34	3.88	19.86	6.99	27.43	83.97	19.86	3.61	2.72
23	11.50	5.41	2.84	3.09	3.88	19.23	15.12	28.94	61.15	19.23	3.34	2.72
24	10.55	5.08	2.84	3.09	3.61	19.23	24.89	26.33	43.70	17.41	3.09	2.61
25	10.55	5.08	2.84	3.09	3.34	18.61	18.00	25.96	28.56	15.67	2.84	2.61
21-25	11.22	5.34	2.84	3.19	3.77	19.61	14.44	26.16	67.29	18.53	3.30	2.70
26	10.10	4.76	2.84	3.09	3.21	12.23	15.96	23.15	23.49	15.12	2.96	2.61
27	9.65	4.76	2.61	3.09	3.09	9.00	14.57	21.80	22.81	14.30	3.09	2.38
28	9.21	4.46	2.61	3.09	3.09	7.97	16.24	20.18	25.60	12.99	3.88	2.38
29	9.21		2.61	3.34	3.09	7.97	24.89	18.00	20.50	12.48	3.09	2.27
30	9.21		2.61	3.34	2.84	8.37	25.25	12.48	180.07	11.98	4.76	2.38
31	9.21		2.61		2.84		25.96	11.02		11.26		2.61
26-end	9.43	4.66	2.65	3.19	3.03	9.11	20.48	17.77	54.49	13.02	3.56	2.44
Mean	13.14	7.13	3.13	3.12	3.58	16.39	11.98	25.08	37.38	51.05	4.75	3.28
Max.	15.67	9.21	4.16	3.34	4.92	105.75	25.96	57.70	180.07	217.93	9.87	8.37
Min.	9.21	4.46	2.61	2.84	2.84	2.72	6.62	9.00	8.79	11.26	2.84	2.27

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.28 Discharge of Prek Thnot River at Peam Khley Station (2005)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	2.61	2.38	2.38	1.87	3.09	2.61	2.17	142.58	17.70	23.15	88.13	20.50
2	2.38	2.38	2.27	1.87	3.09	2.61	2.27	250.83	16.24	22.47	71.35	19.86
3	2.38	2.38	2.27	1.87	2.96	2.49	2.27	283.01	15.96	23.49	57.02	22.81
4	2.38	2.38	2.38	2.84	2.84	2.38	3.47	104.83	18.92	25.25	47.94	22.14
5	2.27	2.38	2.38	3.09	2.84	2.38	3.61	104.83	15.12	26.69	39.09	27.81
01-05	2.41	2.38	2.34	2.30	2.96	2.49	2.76	177.22	16.79	24.21	60.71	22.62
6	2.27	2.49	2.38	4.46	2.84	2.38	3.61	132.09	16.53	23.84	53.69	35.38
7	2.61	2.49	2.38	4.31	18.92	2.17	3.61	70.60	15.67	83.15	92.38	48.57
8	2.61	2.49	2.27	3.88	2.72	2.49	3.61	77.53	14.84	49.19	69.85	69.85
9	2.61	2.38	2.27	3.61	2.61	2.96	3.88	87.29	14.03	41.94	93.25	51.10
10	2.72	2.38	2.27	8.37	2.61	3.21	7.37	77.53	16.24	47.33	112.30	31.68
06-10	2.56	2.45	2.32	4.93	5.94	2.64	4.41	89.01	15.46	49.09	84.29	47.31
11	2.72	2.38	2.17	3.09	2.61	2.96	15.67	74.41	21.80	48.57	94.11	27.43
12	2.61	2.49	2.17	3.09	2.61	3.09	18.00	70.60	22.47	59.07	74.41	25.60
13	2.72	2.49	2.06	2.84	2.38	3.09	18.00	71.35	23.15	44.89	66.15	22.81
14	2.72	2.61	2.06	2.84	2.38	3.34	15.12	79.12	23.15	43.70	53.69	19.54
15	2.72	2.61	2.06	2.84	2.38	3.34	12.23	83.15	26.69	59.76	49.19	18.31
11-15	2.70	2.52	2.11	2.94	2.47	3.16	15.80	75.73	23.45	51.20	67.51	22.74
16	2.72	2.61	2.06	2.61	2.38	3.09	11.26	83.15	31.28	60.45	41.36	14.84
17	2.72	2.61	1.96	2.61	2.38	3.09	8.79	75.19	57.02	63.27	32.48	13.50
18	2.72	2.49	1.96	2.72	2.61	2.84	8.37	37.43	55.01	63.99	30.49	12.73
19	2.72	2.49	1.96	2.72	2.61	2.84	7.97	33.71	56.35	53.03	30.10	12.23
20	2.84	2.38	1.96	2.84	2.61	2.84	7.97	29.32	40.79	38.53	54.35	11.98
16-20	2.75	2.52	1.98	2.70	2.52	2.94	8.87	51.76	48.09	55.86	37.76	13.06
21	2.84	2.38	1.96	2.84	2.38	2.61	7.97	23.15	161.35	35.38	48.57	11.26
22	2.84	2.38	1.87	2.61	2.38	2.61	8.58	20.50	268.14	37.43	32.08	10.10
23	2.72	2.38	1.87	2.61	2.17	2.38	7.57	19.86	146.89	43.70	25.25	11.26
24	2.72	2.38	1.96	2.84	3.47	2.38	8.37	19.86	56.35	112.30	22.81	12.23
25	2.72	2.49	1.96	3.09	2.61	2.61	8.58	22.47	46.10	253.67	21.47	12.23
21-25	2.77	2.40	1.92	2.80	2.60	2.52	8.21	21.17	135.77	96.50	30.03	11.41
26	2.61	2.49	1.96	2.84	2.49	2.61	23.49	21.80	30.88	306.07	21.14	11.98
27	2.61	2.49	1.96	3.09	2.61	2.38	19.86	20.82	25.25	197.29	20.18	11.98
28	2.61	2.38	1.87	2.96	2.38	2.38	41.36	19.86	28.56	187.35	20.18	11.74
29	2.61		1.87	3.47	2.38	2.38	33.30	18.92	87.29	170.58	21.80	11.74
30	2.38		1.77	3.47	2.61	2.27	39.65	18.31	24.54	115.16	21.80	10.78
31	2.38		1.77		2.61		136.24	18.92		88.97		9.65
26-end	2.53	2.46	1.87	3.17	2.51	2.41	48.98	19.77	39.30	177.57	21.02	11.31
Mean	2.62	2.45	2.08	3.14	3.15	2.69	15.94	70.74	46.48	79.02	50.22	21.08
Max.	2.84	2.61	2.38	8.37	18.92	3.34	136.24	283.01	268.14	306.07	112.30	69.85
Min.	2.27	2.38	1.77	1.87	2.17	2.17	2.17	18.31	14.03	22.47	20.18	9.65

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.29 Discharge of Prek Thnot River at Peam Khley Station (2006)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	9.21	4.61	4.76	4.16	5.41	18.00	16.24	21.80	143.65	257.97	23.84	14.84
2	8.79	4.61	4.61	4.16	5.41	15.96	16.24	28.18	115.16	231.36	23.49	14.30
3	9.43	4.76	5.24	4.31	5.08	13.77	34.96	26.33	88.97	199.81	22.81	14.03
4	10.10	4.61	5.57	5.08	4.92	11.02	125.98	34.12	108.53	194.78	19.86	13.50
5	9.87	4.61	5.24	5.74	5.24	10.55	236.84	24.89	93.25	215.30	19.86	12.99
01-05	9.48	4.64	5.09	4.69	5.21	13.86	86.05	27.06	109.91	219.84	21.97	13.93
6	9.65	4.61	5.24	4.61	6.62	11.26	170.58	34.96	151.27	236.84	19.54	13.24
7	9.65	4.76	5.57	4.46	8.17	16.53	107.60	104.83	142.58	241.00	19.23	12.23
8	9.21	4.76	5.74	4.76	12.99	25.25	99.40	231.36	109.47	212.68	18.61	9.21
9	6.81	4.61	5.57	5.24	16.82	18.92	70.60	382.41	70.60	180.07	17.70	6.44
10	5.91	4.61	5.24	5.91	12.23	18.00	51.74	429.31	61.15	154.59	16.53	6.44
06-10	8.25	4.67	5.47	5.00	11.36	17.99	99.98	236.57	107.01	205.03	18.32	9.51
11	5.41	4.46	4.76	7.97	9.43	17.11	39.09	228.64	61.85	208.78	15.67	6.99
12	34.12	4.46	4.46	9.87	8.17	13.24	31.68	129.01	79.92	310.79	16.24	6.81
13	5.74	4.61	4.61	9.00	6.62	10.78	23.15	117.09	115.16	453.78	15.96	6.81
14	5.91	4.46	4.92	8.79	5.41	9.21	24.89	86.45	168.25	253.67	15.39	6.99
15	5.91	4.02	4.46	8.79	4.92	9.21	33.30	123.98	169.41	204.91	14.57	6.99
11-15	11.42	4.40	4.64	8.88	6.91	11.91	30.42	137.04	118.92	286.39	15.57	6.92
16	6.09	4.02	4.46	7.37	5.08	8.17	35.38	628.23	80.72	141.51	14.03	6.99
17	5.74	4.02	4.16	6.09	8.79	8.17	56.35	1115.27	79.92	113.25	14.03	6.81
18	5.41	4.31	4.31	5.91	12.23	14.57	88.97	1027.33	116.13	129.01	14.30	6.62
19	5.57	4.61	4.16	6.99	10.78	15.12	126.99	802.83	152.37	140.45	17.11	6.09
20	5.91	4.46	4.31	7.18	9.43	13.24	138.34	425.61	160.21	119.04	20.18	5.74
16-20	5.74	4.28	4.28	6.71	9.26	11.85	89.20	799.85	117.87	128.65	15.93	6.45
21	5.57	4.16	4.31	6.44	13.50	17.11	94.11	189.81	204.91	103.92	18.31	5.57
22	5.57	4.61	4.31	6.09	23.49	20.50	66.88	149.07	265.22	85.62	16.82	5.74
23	5.74	5.24	4.46	5.74	28.18	23.15	72.11	121.99	243.79	76.75	15.96	5.74
24	5.24	5.24	4.16	6.26	18.00	27.81	51.10	113.25	242.39	63.99	14.57	5.74
25	4.76	4.61	4.16	5.24	14.30	20.82	44.89	126.99	278.51	46.71	14.03	5.57
21-25	5.38	4.77	4.28	5.95	19.50	21.88	65.82	140.22	246.96	75.40	15.94	5.67
26	5.08	4.46	4.16	4.46	15.96	20.82	48.57	31.68	255.10	46.71	14.57	5.57
27	5.24	4.76	4.16	4.31	15.39	20.50	64.70	75.19	210.07	45.49	14.30	4.02
28	4.92	4.76	4.16	4.16	15.39	20.50	86.45	65.43	349.85	32.48	14.03	3.88
29	4.76		4.16	4.61	15.39	22.14	31.68	66.15	504.75	27.81	15.12	3.74
30	4.76		4.16	5.08	17.11	18.92	22.47	100.30	412.77	27.43	19.23	3.74
31	4.61		4.16		19.54		19.23	135.19		23.84		3.74
26-end	4.90	4.66	4.16	4.53	16.46	20.57	45.52	78.99	346.51	33.96	15.45	4.12
Mean	7.44	4.57	4.64	5.96	11.61	16.34	68.73	231.54	174.53	154.20	17.20	7.65
Max.	34.12	5.24	5.74	9.87	28.18	27.81	236.84	1115.27	504.75	453.78	23.84	14.84
Min.	4.61	4.02	4.16	4.16	4.92	8.17	16.24	21.80	61.15	23.84	14.03	3.74

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.30 Discharge of Prek Thnot River at Peam Khley Station (2007)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	3.88	3.34	2.17	4.46	5.91	12.99	40.22	19.23	102.10	73.64	51.74	18.61
2	4.16	3.09	2.17	4.16	10.32	11.02	42.52	17.41	84.80	95.86	44.89	17.70
3	4.31	3.09	2.17	4.02	11.50	13.50	40.22	17.41	79.12	153.48	32.89	16.82
4	4.46	3.09	1.96	3.88	13.24	15.67	41.94	30.10	72.87	154.59	23.84	16.24
5	4.46	2.96	1.96	3.88	16.24	15.12	52.38	27.43	87.29	140.45	22.81	14.57
01-05	4.26	3.11	2.09	4.08	11.44	13.66	43.46	22.31	85.24	123.60	35.23	16.79
6	4.31	3.09	1.96	3.74	15.12	17.70	124.98	18.92	139.39	193.53	29.71	13.77
7	4.31	2.84	2.06	3.74	12.48	17.41	182.48	18.61	101.19	197.29	27.43	12.73
8	4.16	2.84	1.96	3.61	9.43	11.98	207.48	20.50	70.60	193.53	23.84	11.26
9	4.16	2.84	1.96	3.88	11.02	12.48	142.58	51.10	54.35	191.05	23.84	11.02
10	4.16	2.84	1.96	3.88	12.48	10.55	96.74	60.45	51.74	269.61	23.15	10.55
06-10	4.22	2.89	1.98	3.77	12.10	14.02	150.85	33.91	83.45	209.00	25.59	11.87
11	4.16	2.84	1.87	3.88	61.85	12.23	75.19	100.30	51.10	289.07	22.47	10.55
12	4.16	2.84	1.87	3.47	67.62	11.74	41.36	140.45	65.43	365.09	22.14	10.32
13	4.02	2.84	1.77	4.76	63.27	9.00	33.71	187.35	66.15	527.13	47.33	10.32
14	4.16	2.84	1.77	4.61	97.62	9.21	28.94	90.67	73.64	518.94	77.53	10.10
15	4.16	2.72	1.77	4.61	189.81	9.21	19.54	66.15	66.88	361.68	73.64	10.10
11-15	4.14	2.82	1.81	4.27	96.04	10.28	39.75	116.98	64.64	412.38	48.62	10.28
16	4.16	2.72	1.68	4.46	215.30	11.98	13.50	51.10	95.86	230.00	71.35	9.65
17	3.88	2.61	1.59	4.46	170.58	11.98	18.92	62.56	117.09	216.61	70.60	9.65
18	3.88	2.61	1.59	4.46	112.30	12.48	39.09	94.98	168.25	181.27	59.76	9.43
19	4.02	2.61	1.50	4.46	61.85	11.02	33.30	83.15	103.92	167.09	58.38	8.79
20	3.88	2.49	1.59	7.18	43.70	11.98	24.54	75.19	95.86	138.34	51.74	8.37
16-20	3.97	2.61	1.59	5.00	120.75	11.89	25.87	73.40	116.19	186.66	62.37	9.18
21	3.74	2.49	1.59	4.16	39.09	21.80	23.84	51.10	145.81	126.99	47.94	8.37
22	3.74	2.38	1.77	4.16	30.49	55.68	19.23	56.35	177.67	89.82	41.94	7.97
23	3.74	2.49	1.59	3.88	18.92	55.01	18.00	67.62	210.07	85.62	24.19	7.77
24	3.74	2.61	1.59	3.34	16.24	59.07	21.80	57.70	167.09	112.30	24.19	7.37
25	3.74	2.61	1.50	2.84	15.67	109.47	25.60	55.68	133.12	118.07	23.84	7.18
21-25	3.74	2.52	1.61	3.68	24.08	60.20	21.70	57.69	166.75	106.56	32.42	7.73
26	3.74	2.49	1.59	3.09	13.50	60.45	25.60	74.41	100.30	129.01	23.15	6.99
27	3.61	2.38	4.16	3.61	11.02	48.57	25.96	80.72	109.47	121.00	22.81	6.62
28	3.61	2.17	7.18	3.47	13.77	40.22	19.23	109.47	88.13	84.80	20.82	6.44
29	3.47		6.81	3.34	18.31	37.98	23.15	96.74	74.41	76.75	19.23	6.26
30	3.47		6.44	3.61	15.96	39.09	30.49	126.99	80.72	64.70	19.23	5.91
31	3.34		4.92		13.77		23.15	145.81		57.70		5.74
26-end	3.54	2.35	5.18	3.42	14.39	45.26	24.60	105.69	90.60	88.99	21.05	6.33
Mean	3.96	2.74	2.47	4.04	45.43	25.89	50.18	69.54	101.15	184.68	37.55	10.23
Max.	4.46	3.34	7.18	7.18	215.30	109.47	207.48	187.35	210.07	527.13	77.53	18.61
Min.	3.34	2.17	1.50	2.84	5.91	9.00	13.50	17.41	51.10	57.70	19.23	5.74

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.31 Discharge of Prek Thnot River at Peam Khley Station (2008)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	5.57	5.74	5.41	8.17	63.99	13.24	15.67	18.31	55.01	116.13	49.82	23.84
2	5.41	5.24	5.08	7.97	54.35	11.02	14.30	22.47	53.69	129.01	45.49	22.47
3	4.92	4.92	5.08	6.81	79.12	13.50	13.50	16.53	44.89	101.19	40.79	21.80
4	4.61	4.61	4.92	5.41	56.35	15.39	13.24	14.84	40.22	88.13	39.09	20.50
5	4.46	4.46	4.76	5.74	46.10	15.39	15.67	14.03	39.65	83.97	37.43	19.86
01-05	4.99	4.99	5.05	6.82	59.98	13.71	14.48	17.24	46.69	103.69	42.53	21.69
6	4.31	4.31	4.61	6.09	28.94	17.70	15.96	19.23	68.36	67.62	35.38	19.23
7	3.88	5.41	4.46	6.26	20.50	17.11	14.57	20.18	39.09	57.70	34.96	18.61
8	3.88	7.37	6.09	6.09	19.54	11.98	17.70	21.47	90.67	53.03	33.30	18.61
9	3.74	5.74	6.26	6.99	18.61	12.48	16.24	169.41	186.13	8.79	32.48	18.00
10	4.61	5.57	5.41	7.37	17.70	10.55	15.39	263.76	93.25	39.09	27.06	17.41
06-10	4.08	5.68	5.37	6.56	21.06	13.97	15.97	98.81	95.50	45.25	32.64	18.37
11	4.61	6.99	4.76	6.44	17.41	12.23	13.77	206.19	95.86	37.98	22.81	17.11
12	6.62	6.09	4.46	6.26	19.54	11.74	12.23	87.29	131.06	34.54	21.80	16.24
13	6.44	5.91	4.92	6.09	47.94	9.00	10.78	46.71	21.47	52.38	21.14	15.96
14	6.09	5.41	5.91	5.91	128.00	9.00	9.43	54.35	198.55	72.87	20.82	15.39
15	5.91	5.41	5.41	5.41	177.67	9.21	8.58	58.38	215.30	84.80	20.82	15.39
11-15	5.93	5.96	5.09	6.02	78.11	10.24	10.96	90.58	132.45	56.51	21.48	16.02
16	5.91	6.81	5.41	6.26	163.63	11.98	7.97	83.15	182.48	97.62	20.50	14.57
17	5.91	5.91	5.24	6.26	94.11	11.98	6.99	49.19	141.51	118.07	20.18	14.57
18	5.74	5.41	4.76	5.41	88.97	12.48	6.09	43.11	134.15	199.81	19.86	14.03
19	5.74	5.74	4.61	5.08	80.72	11.02	5.57	49.82	136.24	217.93	19.86	13.24
20	5.57	5.74	4.61	4.92	62.56	11.98	4.92	62.56	154.59	119.04	34.12	12.73
16-20	5.78	5.92	4.93	5.59	98.00	11.89	6.31	57.57	149.79	150.49	22.90	13.83
21	5.57	5.41	4.16	4.76	37.98	22.14	4.76	78.33	115.16	131.06	46.71	11.98
22	5.41	4.46	4.46	5.91	25.60	55.68	4.46	52.38	96.74	181.27	47.33	11.50
23	5.91	3.47	4.61	6.62	28.18	54.35	4.92	39.09	73.64	178.87	40.22	11.02
24	6.44	3.88	4.76	6.99	32.08	59.76	17.70	34.54	57.70	169.41	38.53	10.55
25	7.57	3.88	4.92	5.24	28.94	109.47	7.77	32.48	53.03	206.19	32.48	10.32
21-25	6.18	4.22	4.58	5.91	30.56	60.28	7.92	47.36	79.26	173.36	41.05	11.07
26	7.18	3.61	5.57	4.02	21.80	60.45	10.10	30.10	74.41	260.86	27.43	10.10
27	6.81	3.61	7.18	3.47	17.70	48.57	17.70	32.89	84.80	213.99	23.49	9.65
28	5.41	3.21	7.57	4.76	16.82	40.22	21.47	56.35	76.75	232.72	22.14	9.43
29	4.92	4.16	9.65	14.30	20.50	37.98	20.82	53.03	77.53	321.94	21.80	9.21
30	5.41		9.65	30.88	23.49	39.09	18.92	58.38	93.25	306.07	20.50	8.58
31	5.57		8.58		19.54		17.70	61.85		262.31		8.58
26-end	5.88	3.65	8.03	11.49	19.98	45.26	17.79	48.77	81.35	266.31	23.07	9.26
Mean	5.49	5.12	5.59	7.06	50.27	25.89	12.42	59.69	97.51	136.92	30.61	14.85
Max.	7.57	7.37	9.65	30.88	177.67	109.47	21.47	263.76	215.30	321.94	49.82	23.84
Min.	3.74	3.21	4.16	3.47	16.82	9.00	4.46	14.03	21.47	8.79	19.86	8.58

Note: ( ) means that the data is not available and estimated
Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.32 Discharge of Prek Thnot River at Peam Khley Station (2009)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	8.17	3.34	2.06	0.20	84.80	18.61	4.16	59.76	79.92	71.35	33.30	7.97
2	7.97	3.21	2.06	1.17	93.25	15.67	6.62	54.35	114.20	70.60	28.94	7.77
3	7.57	3.21	1.96	1.77	138.34	17.41	12.99	75.19	150.17	57.02	27.43	7.57
4	7.37	3.21	1.96	1.33	112.30	46.10	10.32	109.47	161.35	44.89	22.14	7.37
5	7.37	3.09	1.96	2.38	57.70	108.53	8.37	103.00	172.93	62.56	27.81	7.18
01-05	7.69	3.21	2.00	1.37	97.27	41.26	8.49	80.35	135.71	61.29	27.92	7.57
6	6.99	3.09	1.96	3.09	56.35	115.16	7.18	283.01	162.49	177.67	31.68	7.18
7	6.81	3.09	1.87	32.48	47.33	63.99	6.99	344.84	151.27	259.41	24.89	6.81
8	6.62	3.09	1.87	55.01	49.82	57.02	9.00	227.29	130.03	380.66	24.89	6.62
9	6.44	2.96	1.87	46.71	39.09	51.74	13.24	135.19	128.00	434.90	19.86	6.26
10	6.44	2.84	1.77	15.12	37.43	44.89	20.82	91.52	126.99	310.79	15.39	5.74
06-10	6.66	3.01	1.87	30.48	46.00	66.56	11.45	216.37	139.76	312.69	23.34	6.52
11	6.26	2.84	1.77	12.99	43.70	23.15	30.10	71.35	191.05	253.67	22.47	5.41
12	6.26	2.84	0.95	12.99	48.57	19.86	19.54	64.70	227.29	298.28	27.43	5.08
13	6.09	2.72	0.95	15.96	49.82	17.41	15.96	131.06	152.37	253.67	20.50	4.61
14	5.74	2.61	0.95	14.57	66.15	15.67	27.43	88.97	112.30	175.29	16.53	4.31
15	5.57	2.61	0.95	16.24	54.35	15.67	72.87	64.70	94.11	141.51	15.39	4.16
11-15	5.98	2.72	1.11	14.55	52.52	18.35	33.18	84.16	155.42	224.49	20.46	4.71
16	5.57	2.61	0.38	18.31	43.70	14.57	93.25	46.71	81.53	102.10	12.99	4.02
17	5.24	2.49	0.38	15.96	35.38	11.98	72.11	27.43	100.30	93.25	11.50	4.02
18	4.76	2.49	0.38	16.53	49.82	10.10	80.72	21.47	68.36	121.00	9.21	2.84
19	4.76	2.38	0.38	14.30	41.94	17.11	95.86	28.56	62.56	113.25	10.32	2.84
20	4.46	2.38	0.38	12.73	19.86	20.50	139.39	18.31	79.92	141.51	9.65	2.72
16-20	4.96	2.47	0.38	15.56	38.14	14.85	96.27	28.50	78.53	114.22	10.73	3.29
21	4.46	2.38	0.38	11.26	22.14	18.00	110.41	15.96	100.30	152.37	9.65	2.61
22	4.31	2.27	0.38	9.87	19.54	14.84	121.00	12.48	85.62	132.09	9.65	2.49
23	4.16	2.27	0.38	9.00	23.15	13.24	141.51	23.49	79.92	72.11	9.43	2.49
24	4.16	2.27	0.07	8.17	18.31	10.78	177.67	37.98	112.30	72.87	8.79	2.38
25	4.02	2.17	0.07	10.78	15.67	12.73	219.26	44.29	152.37	102.10	8.79	2.27
21-25	4.22	2.27	0.26	9.82	19.76	13.92	153.97	26.84	106.10	106.31	9.26	2.45
26	3.88	2.17	0.07	14.03	12.99	11.50	165.93	38.53	238.22	175.29	9.21	2.27
27	3.74	2.17	0.07	15.67	10.78	9.43	120.02	32.48	234.09	109.47	10.32	2.27
28	3.74	2.17	0.07	19.23	17.70	7.97	136.24	49.82	310.79	111.35	9.65	2.17
29	3.61		0.07	30.49	26.33	6.26	62.56	84.80	177.67	58.38	9.21	2.06
30	3.47		0.07	65.43	53.69	5.08	44.89	121.99	93.25	37.43	8.58	1.96
31	3.34		0.20		25.96		67.62	98.51		39.65		1.96
26-end	3.63	2.17	0.09	28.97	24.58	8.05	99.54	71.02	210.80	88.60	9.40	2.12
Mean	5.46	2.68	0.93	16.79	45.68	27.17	68.20	84.10	137.72	149.24	16.85	4.37
Max.	8.17	3.34	2.06	65.43	138.34	115.16	219.26	344.84	310.79	434.90	33.30	7.97
Min.	3.34	2.17	0.07	0.20	10.78	5.08	4.16	12.48	62.56	37.43	8.58	1.96

Note: ( ) means that the data is not available and estimated
Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.33 Discharge of Prek Thnot River at Peam Khley Station (2010)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	1.96	0.23	2.84	2.38	10.78	1.77	23.49	14.30	43.70	37.43	39.65	14.57
2	1.96	0.23	2.61	2.84	9.87	1.41	21.80	13.77	23.15	112.30	34.54	13.77
3	1.77	0.23	2.17	3.34	9.00	1.02	23.49	16.53	27.43	189.81	31.68	12.23
4	1.68	0.23	1.96	3.74	8.17	0.69	55.01	22.81	29.32	162.49	29.32	11.50
5	1.50	0.23	1.77	3.61	9.43	0.75	20.18	22.81	22.14	161.35	27.43	10.55
01-05	1.77	0.23	2.27	3.18	9.45	1.13	28.79	18.04	29.15	132.67	32.53	12.52
6	1.25	0.23	1.59	3.21	10.32	0.75	18.92	19.86	20.50	207.48	23.49	10.32
7	1.17	0.20	1.59	2.84	9.65	0.69	19.54	18.31	52.38	221.92	22.47	11.98
8	1.17	0.20	1.59	2.72	11.74	0.69	25.60	16.24	87.29	167.09	25.60	11.26
9	1.17	0.20	1.50	2.38	10.78	1.09	22.81	16.53	70.60	141.51	34.54	10.55
10	1.09	0.20	1.41	2.38	9.65	0.82	22.81	15.67	66.88	123.98	34.96	9.87
06-10	1.17	0.20	1.53	2.71	10.43	0.81	21.94	17.32	59.53	172.40	28.21	10.80
11	1.09	0.17	1.17	2.61	8.79	0.82	20.82	22.81	66.15	125.98	32.08	9.21
12	1.09	0.17	1.17	2.49	9.21	0.75	19.86	20.82	63.99	318.74	28.94	8.79
13	1.02	0.17	1.02	2.38	9.21	0.95	19.23	18.92	71.35	346.50	27.81	8.79
14	1.02	0.14	0.95	2.38	8.17	0.95	18.31	17.70	83.15	520.98	23.84	8.17
15	0.95	0.14	0.82	2.17	7.57	1.87	19.23	16.82	105.75	716.45	23.49	7.97
11-15	1.04	0.15	1.03	2.41	8.59	1.07	19.49	19.41	78.08	405.73	27.23	8.58
16	0.95	0.14	0.64	2.17	6.99	2.38	17.70	14.84	87.29	723.66	25.60	14.57
17	0.88	0.14	0.53	2.61	6.26	2.17	16.53	14.03	72.87	628.23	23.49	37.43
18	0.82	0.14	0.43	3.74	5.57	2.38	32.48	14.03	63.27	514.86	22.14	43.11
19	0.82	0.00	0.38	4.46	5.08	1.96	51.10	22.14	56.35	298.28	20.82	29.32
20	0.82	0.00	0.30	4.76	4.46	2.38	44.89	26.33	51.74	178.87	18.92	18.61
16-20	0.86	0.08	0.46	3.55	5.67	2.26	32.54	18.27	66.30	468.78	22.19	28.61
21	0.82	0.00	0.30	9.00	4.31	2.27	49.82	31.68	47.33	170.58	17.70	16.53
22	0.53	0.20	0.17	13.50	3.74	8.17	66.15	31.68	44.89	84.80	15.96	14.30
23	0.34	2.38	0.11	12.99	3.21	19.23	73.64	57.70	49.19	98.51	14.84	12.73
24	0.26	1.96	0.07	12.73	2.84	19.54	57.02	77.53	46.10	49.19	13.24	11.74
25	0.26	2.17	0.00	11.50	2.61	17.70	43.11	106.67	48.57	33.71	18.00	11.50
21-25	0.44	1.34	0.13	11.94	3.34	13.38	57.95	61.05	47.22	87.36	15.95	13.36
26	0.26	3.21	0.53	10.55	2.49	15.96	29.32	132.09	50.46	40.22	20.50	10.78
27	0.26	4.02	2.72	9.87	2.27	15.67	25.96	91.52	45.49	64.70	19.86	9.87
28	0.26	3.21	4.31	12.73	2.72	18.61	17.70	72.11	41.36	59.07	19.54	9.65
29	0.26		4.02	12.73	2.38	23.84	16.24	65.43	39.09	53.69	18.31	9.00
30	0.26		3.34	11.74	2.27	30.49	15.39	60.45	34.96	45.49	16.24	9.00
31	0.23		2.72		1.96		14.57	55.01		43.11		8.79
26-end	0.26	3.48	2.94	11.53	2.35	20.91	19.87	79.44	42.27	51.05	18.89	9.52
Mean	0.90	0.73	1.44	5.89	6.50	6.59	29.77	37.00	53.76	214.23	24.17	13.76
Max.	1.96	4.02	4.31	13.50	11.74	30.49	73.64	132.09	105.75	723.66	39.65	43.11
Min.	0.23	0.00	0.00	2.17	1.96	0.69	14.57	13.77	20.50	33.71	13.24	7.97

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.1.2.1.34 Discharge of Prek Thnot River at Peam Khley Station (2011)

(Unit: m^3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	8.58	0.64	0.14	13.77	12.11	18.61	19.86	98.51	164.78	82.75	34.54	16.24
2	8.47	0.58	0.14	12.99	12.73	19.86	21.47	136.24	125.98	64.70	30.49	15.96
3	8.17	0.58	0.11	12.48	12.48	19.54	20.50	125.98	92.38	78.33	23.49	15.67
4	7.97	0.55	0.09	11.98	11.98	18.76	20.02	100.30	81.12	69.10	22.47	15.39
5	7.77	0.53	0.09	12.73	11.86	18.00	22.47	52.06	66.15	71.35	21.47	15.12
01-05	8.19	0.58	0.11	12.79	12.23	18.96	20.86	102.62	106.08	73.25	26.49	15.68
6	7.18	0.48	0.09	12.86	12.48	18.92	19.86	49.82	63.99	117.09	23.84	14.57
7	6.81	0.48	0.08	12.86	12.73	19.70	22.14	35.38	58.72	178.27	29.32	14.57
8	6.44	0.43	0.11	12.48	12.11	19.86	20.34	27.43	55.68	256.54	44.59	15.12
9	6.44	0.38	0.14	12.73	11.50	19.23	19.54	26.69	53.69	290.60	62.21	15.96
10	5.91	0.34	0.13	12.73	10.78	19.39	19.23	25.25	57.36	313.96	156.27	15.39
06-10	6.56	0.42	0.11	12.73	11.92	19.42	20.22	32.91	57.89	231.29	63.25	15.12
11	5.57	0.34	0.11	13.11	10.32	19.23	18.92	23.15	107.60	338.22	66.15	15.25
12	5.24	0.30	0.09	13.11	10.10	19.86	18.31	23.15	126.99	359.97	48.57	15.12
13	5.24	0.30	0.07	12.73	9.98	18.92	22.47	22.14	232.72	306.07	39.65	14.57
14	5.08	0.30	0.07	12.48	9.65	19.39	24.71	21.14	339.04	306.07	31.68	14.57
15	1.77	0.26	0.00	13.37	9.43	18.61	22.81	22.81	338.22	193.53	30.88	14.03
11-15	4.58	0.30	0.07	12.96	9.90	19.20	21.44	22.48	228.91	300.77	43.39	14.71
16	1.72	0.26	0.11	12.61	9.43	18.00	21.80	23.84	287.55	84.80	29.71	14.03
17	1.63	0.26	0.13	12.48	8.89	17.70	20.34	22.81	257.25	80.72	28.56	13.50
18	1.59	0.25	0.14	10.55	8.89	17.70	19.23	30.10	199.81	116.13	22.98	13.50
19	1.50	0.23	0.11	12.61	11.86	17.41	18.61	50.46	63.27	93.25	21.97	13.24
20	1.50	0.21	0.11	12.61	12.11	18.00	18.31	48.57	138.86	121.00	22.47	13.24
16-20	1.59	0.24	0.12	12.17	10.24	17.76	19.66	35.15	189.35	99.18	25.14	13.51
21	1.45	0.20	0.13	12.23	12.73	18.00	18.00	55.68	132.09	163.63	21.14	13.24
22	1.41	0.20	0.18	11.98	12.61	17.85	17.70	53.03	196.03	158.51	20.50	12.73
23	1.41	0.21	0.20	12.23	11.86	18.61	17.41	54.68	268.14	144.19	20.18	12.86
24	1.37	0.20	6.09	13.63	11.50	18.31	18.00	62.56	317.94	165.93	19.86	13.11
25	1.29	0.17	19.86	12.73	11.26	18.00	17.41	59.07	252.96	116.13	19.23	12.48
21-25	1.39	0.19	5.29	12.56	11.99	18.16	17.70	57.00	233.43	149.68	20.18	12.89
26	1.09	0.17	19.23	12.35	11.74	17.70	17.26	74.03	74.41	84.80	18.61	12.23
27	0.95	0.17	18.31	11.98	13.63	17.55	20.66	174.11	137.28	69.10	18.31	11.98
28	0.82	0.14	17.41	11.98	14.16	17.70	19.86	241.00	141.51	56.35	17.70	11.74
29	0.79		16.53	11.50	13.50	18.61	20.50	310.79	136.24	48.57	17.41	11.74
30	0.72		15.39	11.50	21.31	18.31	20.18	260.86	111.35	41.94	16.82	11.74
31	0.69		14.70		19.23		34.33	199.81		37.16		11.02
26-end	0.84	0.16	16.93	11.86	15.60	17.98	22.13	210.10	120.16	56.32	17.77	11.74
Mean	3.76	0.33	4.20	12.51	12.10	18.58	20.39	81.01	155.97	148.67	32.70	13.87
Max.	8.58	0.64	19.86	13.77	21.31	19.86	34.33	310.79	339.04	359.97	156.27	16.24
Min.	0.69	0.14	0.00	10.55	8.89	17.41	17.26	21.14	53.69	37.16	16.82	11.02

Note: ( ) means that the data is not available and estimated

Source: Department of Hydrology and River Works, MOWRAM

Table AB-2.2.2.3.1 Annual Rainfall at each Station and Average Rainfall in Basins of each Reservoir

(Unit: mm)

Reservoir	Tumnup Lok				Kpob Trobek	Don Phe
Rainfall Station	Srae Klong	Prey Dob	Basedth	Total	Basedth	Basedth
Catchment Area (km^2)	122	60	150	332	137	70
Thiessen Coefficient	36.8%	18.1%	45.1%	100%	100%	100%
1966	1586.4	1068.9	1632.6	1513.5	1632.6	1632.6
1967	1377.7	857.8	1423.1	1304.1	1423.1	1423.1
1968	1276.0	838.1	1321.0	1217.1	1321.0	1321.0
1969	1295.9	991.1	1341.0	1261.0	1341.0	1341.0
1983*	969.5	1104.4	1013.4	1013.7	1013.4	1013.4
1984*	918.7	962.4	962.4	946.3	962.4	962.4
1985	1180.0	1159.7	1224.6	1196.4	1224.6	1224.6
1986	1104.5	879.7	1148.9	1083.8	1148.9	1148.9
1987	823.2	671.8	820.1	794.4	820.1	820.1
1988	782.4	822.5	1251.9	1001.4	1251.9	1251.9
1989	1127.3	813.7	1018.8	1021.6	1018.8	1018.8
1990	811.8	696.0	820.6	794.8	820.6	820.6
1991	1258.2	880.3	1416.9	1261.4	1416.9	1416.9
1992	943.0	745.0	1071.7	965.2	1071.7	1071.7
1993	1037.2	797.9	1006.9	980.2	1006.9	1006.9
1994	884.8	954.2	896.7	902.7	896.7	896.7
1995	1021.0	913.8	1065.1	1021.5	1065.1	1065.1
1996	1200.9	1096.6	1714.0	1413.4	1714.0	1714.0
1997	767.8	933.7	588.5	717.0	588.5	588.5
1998	1213.1	1139.2	1336.6	1255.4	1336.6	1336.6
1999	1464.8	1347.0	1653.5	1528.6	1653.5	1653.5
2000	1474.4	1387.3	1428.5	1437.9	1428.5	1428.5
2001	1490.4	1438.9	1559.0	1512.0	1559.0	1559.0
2002	1230.7	1027.9	1074.7	1123.6	1074.7	1074.7
2003	1316.2	1167.7	1057.4	1172.6	1057.4	1057.4
2004	916.7	796.4	1239.4	1040.5	1239.4	1239.4
2005	1053.2	1203.2	1351.3	1214.8	1351.3	1351.3
2006	923.0	826.5	1092.1	981.8	1092.1	1092.1
2007	1361.4	1158.7	1416.5	1349.6	1416.5	1416.5
2008	1386.9	1003.3	1281.5	1269.9	1281.5	1281.5
2009	1231.1	1416.3	993.4	1157.4	993.4	993.4
2010	1178.3	1143.4	1123.1	1147.1	1123.1	1123.1
Average	1082.2	891.6	1143.3	1075.3	1143.3	1143.3

Source: JICA Survey Team

Table AB-2.3.2.3.1 Correlation Coefficients of Annual Rainfall at each Station

CORREL "R"	Aoral	Bamnak	Basedth	Bati	Chbar Mon	Kampong Chhnang	Kampong Speu	Kirirom	Klang Ampil	Kong Pisey	Krakor	Krang Tamoung	Odongk	Ou Taroth	Peam Khley	Phnum Srouch	Pochentong	Prey Dob	Prey Pdau	Samrong	Sdok	Srae Klong	Takeo	Takhmao	Thnal Tetung	Thpong	Tram knar	Trapeang Chor	Tuek Phos
Aoral	1.0000	0.5875	0.5701	0.3762	0.1656	0.1099	0.4525	0.8127	-0.1091	0.6236	0.3927	0.5160	0.4648	0.2652	0.3465	0.6595	0.3607	0.3445	0.5056	-0.6415	0.2620	0.6829	0.7239	-0.6855	0.4713	0.7708	-0.0496	0.2051	0.7519
Bamnak	0.5875	1.0000	0.5058	0.5820	0.5125	0.3382	0.6817	0.9387	0.5529	0.7477	0.6140	0.6292	0.7764	0.3169	0.1222	0.7620	0.6842	0.2065	0.5716	-0.1138	0.4399	0.6220	0.6899	-0.9041	0.5137	0.4094	0.7778	-0.3210	0.4229
Basedth	0.5701	0.5058	1.0000	0.4351	0.3128	0.1347	0.6273	0.8750	0.4429	0.6385	0.3959	0.6489	0.4107	0.4837	0.6072	0.7729	0.4775	0.3246	0.3464	0.1330	0.5700	0.7045	0.5245	-0.3757	0.5105	0.4749	0.5943	-0.3860	0.4804
Bati	0.3762	0.5820	0.4351	1.0000	-0.0040	0.0353	-0.3350	0.7769	-0.2226	0.2801	0.4888	0.4026	-0.4211	0.7245	0.8767	0.2933	-0.4420	-0.3312	-0.3918	-0.3397	0.8579	0.3149	0.4370	1.0000	-0.2440	-0.0257	0.1682	-0.1108	0.1773
Chbar Mon	0.1656	0.5125	0.3128	-0.0040	1.0000	-0.2304	0.5780	0.1196	0.7199	0.4480	-0.0894	0.5187	0.5659	0.3132	0.3130	0.5032	0.5182	0.3676	0.4211	0.5252	0.4076	0.6747	0.4215	-0.1463	0.1342	0.4383	0.7930	-0.0155	0.4376
Kampong Chhnang	0.1099	0.3382	0.1347	0.0353	-0.2304	1.0000	-0.1410	0.0430	0.4603	-0.0115	0.0352	0.4492	0.1424	-0.1891	0.0034	-0.0920	-0.1795	0.3202	0.1505	0.4597	-0.4649	0.2311	-0.1677	-0.3638	0.2411	-0.1208	0.5703	-0.3608	0.1904
Kampong Speu	0.4525	0.6817	0.6273	-0.3350	0.5780	-0.1410	1.0000	0.6417	0.6855	0.6160	0.3747	0.5581	0.7647	0.5913	-0.0177	0.5585	0.5916	0.6599	0.8953	0.4711	0.5627	0.5267	0.5156	-0.4715	0.5968	0.7028	0.1441	0.3153	0.2530
Kirirom	0.8127	0.9387	0.8750	0.7769	0.1196	0.0430	0.6417	1.0000	0.6536	0.8902	0.5950	0.8814	0.8239	0.9040	0.6101	0.8073	0.7919	0.9848	0.9691	-0.3125	0.8708	0.7972	0.9221	-1.0000	0.8904	0.9163	-1.0000	0.3946	0.6613
Klang Ampil	-0.1091	0.5529	0.4429	-0.2226	0.7199	0.4603	0.6855	0.6536	1.0000	0.3130	-0.4070	0.6755	0.7452	0.2593	0.1588	0.6544	0.6933	0.3576	0.5745	0.7693	0.2600	0.6840	0.0254	-0.7152	0.8652	0.2128	0.7702	-0.2722	-0.0890
Kong Pisey	0.6236	0.7477	0.6385	0.2801	0.4480	-0.0115	0.6160	0.8902	0.3130	1.0000	0.4059	0.4551	0.4719	0.2751	0.3947	0.6997	0.3662	0.3633	0.4539	-0.0129	0.6108	0.7547	0.7635	-0.5305	0.3463	0.4299	0.5318	-0.3515	0.4811
Krakor	0.3927	0.6140	0.3959	0.4888	-0.0894	0.0352	0.3747	0.5950	-0.4070	0.4059	1.0000	-0.2204	0.1802	0.6027	-0.1961	0.0802	0.1837	-0.3633	0.2586	-0.0017	0.6325	-0.3303	0.5003	-0.6100	0.1784	0.2517	-0.2002	0.0778	0.1575
Krang Tamoung	0.5160	0.6292	0.6489	0.4026	0.5187	0.4492	0.5581	0.8814	0.6755	0.4551	-0.2204	1.0000	0.6195	0.4141	0.6631	0.8042	0.6356	0.3023	0.6321	0.0406	0.3181	0.8396	0.3318	-0.6145	0.8210	0.5777	0.5650	0.0811	0.7591
Odongk	0.4648	0.7764	0.4107	-0.4211	0.5659	0.1424	0.7647	0.8239	0.7452	0.4719	0.1802	0.6195	1.0000	0.0027	-0.1769	0.7066	0.7354	0.4020	0.8404	0.3314	-0.0774	0.5806	0.4183	-0.6335	0.5369	0.5957	0.6105	0.1006	0.4054
Ou Taroth	0.2652	0.3169	0.4837	0.7245	0.3132	-0.1891	0.5913	0.9040	0.2593	0.2751	0.6027	0.4141	0.0027	1.0000	0.5885	0.3064	-0.1921	0.2308	0.3676	0.0289	0.9640	0.3025	0.5131	-0.7070	0.1607	0.3698	-0.0973	0.3102	0.1139
Peam Khley	0.3465	0.1222	0.6072	0.8767	0.3130	0.0034	-0.0177	0.6101	0.1588	0.3947	-0.1961	0.6631	-0.1769	0.5885	1.0000	0.4723	-0.2087	0.1311	-0.0337	-0.3085	0.7447	0.7818	0.3836	0.0345	0.0559	0.1221	0.4077	-0.1438	0.4205
Phnum Srouch	0.6595	0.7620	0.7729	0.2933	0.5032	-0.0920	0.5585	0.8073	0.6544	0.6997	0.0802	0.8042	0.7066	0.3064	0.4723	1.0000	0.6681	0.2566	0.5665	0.0119	0.3869	0.9083	0.6988	-0.5150	0.3882	0.5551	0.7163	-0.2220	0.7506
Pochentong	0.3607	0.6842	0.4775	-0.4420	0.5182	-0.1795	0.5916	0.7919	0.6933	0.3662	0.1837	0.6356	0.7354	-0.1921	-0.2087	0.6681	1.0000	0.3166	0.7077	0.1563	-0.2138	0.6169	0.2767	-0.3790	0.2679	0.6133	0.4031	0.0319	0.4781
PreyDob	0.3445	0.2065	0.3246	-0.3312	0.3676	0.3202	0.6599	0.9848	0.3576	0.3633	-0.3633	0.3023	0.4020	0.2308	0.1311	0.2566	0.3166	1.0000	0.5318	-0.1456	0.7772	0.5124	0.3781	-0.5768	0.4054	0.2847	-0.4337	-0.0194	0.1316
PreyPdau	0.5056	0.5716	0.3464	-0.3918	0.4211	0.1505	0.8953	0.9691	0.5745	0.4539	0.2586	0.6321	0.8404	0.3676	-0.0337	0.5665	0.7077	0.5318	1.0000	0.0730	0.2999	0.6313	0.3726	-0.7051	0.7821	0.7654	0.0853	0.4523	0.3806
Samrong	-0.6415	-0.1138	0.1330	-0.3397	0.5252	0.4597	0.4711	-0.3125	0.7693	-0.0129	-0.0017	0.0406	0.3314	0.0289	-0.3085	0.0119	0.1563	-0.1456	0.0730	1.0000	-0.5715	-0.2116	-0.1016	1.0000	0.2745	-0.3765	0.6091	-0.2320	-0.1203
Sdok	0.2620	0.4399	0.5700	0.8579	0.4076	-0.4649	0.5627	0.8708	0.2600	0.6108	0.6325	0.3181	-0.0774	0.9640	0.7447	0.3869	-0.2138	0.7772	0.2999	-0.5715	1.0000	0.4980	0.6895	-0.5919	0.0895	0.2422	-0.7135	0.1821	0.0014
SraeKlong	0.6829	0.6220	0.7045	0.3149	0.6747	0.2311	0.5267	0.7972	0.6840	0.7547	-0.3303	0.8396	0.5806	0.3025	0.7818	0.9083	0.6169	0.5124	0.6313	-0.2116	0.4980	1.0000	0.6013	-0.9906	0.6684	0.6031	0.4472	-0.0062	0.8583
Takeo	0.7239	0.6899	0.5245	0.4370	0.4215	-0.1677	0.5156	0.9221	0.0254	0.7635	0.5003	0.3318	0.4183	0.5131	0.3836	0.6988	0.2767	0.3781	0.3726	-0.1016	0.6895	0.6013	1.0000	-0.6210	0.3129	0.3940	0.2001	-0.1122	0.5381
Takhmao	-0.6855	-0.9041	-0.3757	1.0000	-0.1463	-0.3638	-0.4715	-1.0000	-0.7152	-0.5305	-0.6100	-0.6145	-0.6335	-0.7070	0.0345	-0.5150	-0.3790	-0.5768	-0.7051	1.0000	-0.5919	-0.9906	-0.6210	1.0000	-0.5493	-0.3596	-1.0000	0.0985	-0.2993
ThnalTetung	0.4713	0.5137	0.5105	-0.2440	0.1342	0.2411	0.5968	0.8904	0.8652	0.3463	0.1784	0.8210	0.5369	0.1607	0.0559	0.3882	0.2679	0.4054	0.7821	0.2745	0.0895	0.6684	0.3129	-0.5493	1.0000	0.4285	0.5310	0.2410	0.5139
Thpong	0.7708	0.4094	0.4749	-0.0257	0.4383	-0.1208	0.7028	0.9163	0.2128	0.4299	0.2517	0.5777	0.5957	0.3698	0.1221	0.5551	0.6133	0.2847	0.7654	-0.3765	0.2422	0.6031	0.3940	-0.3596	0.4285	1.0000	-0.1586	0.6525	0.5932
Tramknar	-0.0496	0.7778	0.5943	0.1682	0.7930	0.5703	0.1441	-1.0000	0.7702	0.5318	-0.2002	0.5650	0.6105	-0.0973	0.4077	0.7163	0.4031	-0.4337	0.0853	0.6091	-0.7135	0.4472	0.2001	-1.0000	0.5310	-0.1586	1.0000	-0.5712	0.3772
Trapeang Chor	0.2051	-0.3210	-0.3860	-0.1108	-0.0155	-0.3608	0.3153	0.3946	-0.2722	-0.3515	0.0778	0.0811	0.1006	0.3102	-0.1438	-0.2220	0.0319	-0.0194	0.4523	-0.2320	0.1821	-0.0062	-0.1122	0.0985	0.2410	0.6525	-0.5712	1.0000	0.1308
Tuek Phos	0.7519	0.4229	0.4804	0.1773	0.4376	0.1904	0.2530	0.6613	-0.0890	0.4811	0.1575	0.7591	0.4054	0.1139	0.4205	0.7506	0.4781	0.1316	0.3806	-0.1203	0.0014	0.8583	0.5381	-0.2993	0.5139	0.5932	0.3772	0.1308	1.0000

R2	Aoral	Bamnak	Basedth	Bati	Chbar Mon	Kampong Chhnang	Kampong Speu	Kirirom	Klang Ampil	Kong Pisey	Krakor	Krang Tamoung	Odongk	Ou Taroth	Peam Khley	Phnum Srouch	Pochentong	Prey Dob	Prey Pdau	Samrong	Sdok	Srae Klong	Takeo	Takhmao	Thnal Tetung	Thpong	Tram knar	Trapeang Chor	Tuek Phos
Aoral	1.0000	0.3452	0.3250	0.1416	0.0274	0.0121	0.2048	0.6605	0.0119	0.3889	0.1542	0.2663	0.2160	0.0704	0.1201	0.4350	0.1301	0.1187	0.2557	0.4115	0.0686	0.4664	0.5240	0.4699	0.2221	0.5941	0.0025	0.0421	0.5654
Bamnak	0.3452	1.0000	0.2559	0.3388	0.2627	0.1144	0.4647	0.8812	0.3057	0.5591	0.3770	0.3959	0.6028	0.1004	0.0149	0.5807	0.4681	0.0427	0.3268	0.0130	0.1935	0.3868	0.4760	0.8173	0.2639	0.1676	0.6049	0.1031	0.1789
Basedth	0.3250	0.2559	1.0000	0.1893	0.0978	0.0181	0.3935	0.7656	0.1962	0.4077	0.1567	0.4210	0.1686	0.2340	0.3686	0.5974	0.2280	0.1054	0.1200	0.0177	0.3249	0.4963	0.2751	0.1411	0.2606	0.2255	0.3532	0.1490	0.2308
Bati	0.1416	0.3388	0.1893	1.0000	0.0000	0.0012	0.1122	0.6035	0.0495	0.0784	0.2390	0.1621	0.1774	0.5249	0.7687	0.0860	0.1954	0.1097	0.1535	0.1154	0.7359	0.0991	0.1909	1.0000	0.0595	0.0007	0.0283	0.0123	0.0314
Chbar Mon	0.0274	0.2627	0.0978	0.0000	1.0000	0.0531	0.3341	0.0143	0.5183	0.2007	0.0080	0.2690	0.3203	0.0981	0.0980	0.2532	0.2685	0.1351	0.1773	0.2758	0.1661	0.4553	0.1777	0.0214	0.0180	0.1921	0.6289	0.0002	0.1915
Kampong Chhnang	0.0121	0.1144	0.0181	0.0012	0.0531	1.0000	0.0199	0.0018	0.2118	0.0001	0.0012	0.2018	0.0203	0.0358	0.0000	0.0085	0.0322	0.1026	0.0226	0.2114	0.2162	0.0534	0.0281	0.1324	0.0581	0.0146	0.3252	0.1302	0.0363
Kampong Speu	0.2048	0.4647	0.3935	0.1122	0.3341	0.0199	1.0000	0.4118	0.4699	0.3794	0.1404	0.3115	0.5848	0.3497	0.0003	0.3119	0.3500	0.4355	0.8016	0.2219	0.3166	0.2775	0.2659	0.2223	0.3561	0.4939	0.0208	0.0994	0.0640
Kirirom	0.6605	0.8812	0.7656	0.6035	0.0143	0.0018	0.4118	1.0000	0.4272	0.7924	0.3541	0.7769	0.6788	0.8171	0.3722	0.6518	0.6272	0.9699	0.9391	0.0976	0.7583	0.6355	0.8502	1.0000	0.7928	0.8397	1.0000	0.1557	0.4373
Klang Ampil	0.0119	0.3057	0.1962	0.0495	0.5183	0.2118	0.4699	0.4272	1.0000	0.0980	0.1656	0.4563	0.5553	0.0672	0.0252	0.4282	0.4806	0.1279	0.3300	0.5918	0.0676	0.4678	0.0006	0.5115	0.7487	0.0453	0.5932	0.0741	0.0079
Kong Pisey	0.3889	0.5591	0.4077	0.0784	0.2007	0.0001	0.3794	0.7924	0.0980	1.0000	0.1648	0.2071	0.2227	0.0757	0.1558	0.4895	0.1341	0.1320	0.2060	0.0002	0.3730	0.5696	0.5830	0.2814	0.1200	0.1848	0.2828	0.1235	0.2315
Krakor	0.1542	0.3770	0.1567	0.2390	0.0080	0.0012	0.1404	0.3541	0.1656	0.1648	1.0000	0.0486	0.0325	0.3633	0.0385	0.0064	0.0338	0.1320	0.0669	0.0000	0.4001	0.1091	0.2503	0.3720	0.0318	0.0633	0.0401	0.0061	0.0248
Krang Tamoung	0.2663	0.3959	0.4210	0.1621	0.2690	0.2018	0.3115	0.7769	0.4563	0.2071	0.0486	1.0000	0.3838	0.1715	0.4397	0.6468	0.4040	0.0914	0.3995	0.0016	0.1012	0.7050	0.1101	0.3776	0.6740	0.3337	0.3193	0.0066	0.5762
Odongk	0.2160	0.6028	0.1686	0.1774	0.3203	0.0203	0.5848	0.6788	0.5553	0.2227	0.0325	0.3838	1.0000	0.0000	0.0313	0.4993	0.5409	0.1616	0.7062	0.1099	0.0060	0.3371	0.1750	0.4014	0.2882	0.3548	0.3727	0.0101	0.1644
Ou Taroth	0.0704	0.1004	0.2340	0.5249	0.0981	0.0358	0.3497	0.8171	0.0672	0.0757	0.3633	0.1715	0.0000	1.0000	0.3464	0.0939	0.0369	0.0533	0.1352	0.0008	0.9292	0.0915	0.2633	0.4999	0.0258	0.1367	0.0095	0.0962	0.0130
Peam Khley	0.1201	0.0149	0.3686	0.7687	0.0980	0.0000	0.0003	0.3722	0.0252	0.1558	0.0385	0.4397	0.0313	0.3464	1.0000	0.2231	0.0436	0.0172	0.0011	0.0951	0.5545	0.6112	0.1472	0.0012	0.0031	0.0149	0.1662	0.0207	0.1768
Phnum Srouch	0.4350	0.5807	0.5974	0.0860	0.2532	0.0085	0.3119	0.6518	0.4282	0.4895	0.0064	0.6468	0.4993	0.0939	0.2231	1.0000	0.4463	0.0658	0.3210	0.0001	0.1497	0.8251	0.4883	0.2652	0.1507	0.3082	0.5131	0.0493	0.5634
Pochentong	0.1301	0.4681	0.2280	0.1954	0.2685	0.0322	0.3500	0.6272	0.4806	0.1341	0.0338	0.4040	0.5409	0.0369	0.0436	0.4463	1.0000	0.1002	0.5008	0.0244	0.0457	0.3805	0.0766	0.1437	0.0718	0.3761	0.1625	0.0010	0.2286
PreyDob	0.1187	0.0427	0.1054	0.1097	0.1351	0.1026	0.4355	0.9699	0.1279	0.1320	0.1320	0.0914	0.1616	0.0533	0.0172	0.0658	0.1002	1.0000	0.2828	0.0212	0.6040	0.2626	0.1430	0.3327	0.1644	0.0811	0.1881	0.0004	0.0173
PreyPdau	0.2557	0.3268	0.1200	0.1535	0.1773	0.0226	0.8016	0.9391	0.3300	0.2060	0.0669	0.3995	0.7062	0.1352	0.0011	0.3210	0.5008	0.2828	1.0000	0.0053	0.0900	0.3985	0.1388	0.4972	0.6117	0.5858	0.0073	0.2046	0.1449
Samrong	0.4115	0.0130	0.0177	0.1154	0.2758	0.2114	0.2219	0.0976	0.5918	0.0002	0.0000	0.0016	0.1099	0.0008	0.0951	0.0001	0.0244	0.0212	0.0053	1.0000	0.3266	0.0448	0.0103	1.0000	0.0754	0.1418	0.3710	0.0538	0.0145
Sdok	0.0686	0.1935	0.3249	0.7359	0.1661	0.2162	0.3166	0.7583	0.0676	0.3730	0.4001	0.1012	0.0060	0.9292	0.5545	0.1497	0.0457	0.6040	0.0900	0.3266	1.0000	0.2480	0.4754	0.3503	0.0080	0.0587	0.5091	0.0332	0.0000
SraeKlong	0.4664	0.3868	0.4963	0.0991	0.4553	0.0534	0.2775	0.6355	0.4678	0.5696	0.1091	0.7050	0.3371	0.0915	0.6112	0.8251	0.3805	0.2626	0.3985	0.0448	0.2480	1.0000	0.3616	0.9812	0.4467	0.3637	0.1999	0.0000	0.7367
Takeo	0.5240	0.4760	0.2751	0.1909	0.1777	0.0281	0.2659	0.8502	0.0006	0.5830	0.2503	0.1101	0.1750	0.2633	0.1472	0.4883	0.0766	0.1430	0.1388	0.0103	0.4754	0.3616	1.0000	0.3857	0.0979	0.1552	0.0401	0.0126	0.2896
Takhmao	0.4699	0.8173	0.1411	1.0000	0.0214	0.1324	0.2223	1.0000	0.5115	0.2814	0.3720	0.3776	0.4014	0.4999	0.0012	0.2652	0.1437	0.3327	0.4972	1.0000	0.3503	0.9812	0.3857	1.0000	0.3017	0.1293	1.0000	0.0097	0.0896
ThnalTetung	0.2221	0.2639	0.2606	0.0595	0.0180	0.0581	0.3561	0.7928	0.7487	0.1200	0.0318	0.6740	0.2882	0.0258	0.0031	0.1507	0.0718	0.1644	0.6117	0.0754	0.0080	0.4467	0.0979	0.3017	1.0000	0.1836	0.2820	0.0581	0.2641
Thpong	0.5941	0.1676	0.2255	0.0007	0.1921	0.0146	0.4939	0.8397	0.0453	0.1848	0.0633	0.3337	0.3548	0.1367	0.0149	0.3082	0.3761	0.0811	0.5858	0.1418	0.0587	0.3637	0.1552	0.1293	0.1836	1.0000	0.0252	0.4258	0.3519
Tramknar	0.0025	0.6049	0.3532	0.0283	0.6289	0.3252	0.0208	1.0000	0.5932	0.2828	0.0401	0.3193	0.3727	0.0095	0.1662	0.5131	0.1625	0.1881	0.0073	0.3710	0.5091	0.1999	0.0401	1.0000	0.2820	0.0252	1.0000	0.3263	0.1422
Trapeang Chor	0.0421	0.1031	0.1490	0.0123	0.0002	0.1302	0.0994	0.1557	0.0741	0.1235	0.0061	0.0066	0.0101	0.0962	0.0207	0.0493	0.0010	0.0004	0.2046	0.0538	0.0332	0.0000	0.0126	0.0097	0.0581	0.4258	0.3263	1.0000	0.0171
Tuek Phos	0.5654	0.1789	0.2308	0.0314	0.1915	0.0363	0.0640	0.4373	0.0079	0.2315	0.0248	0.5762	0.1644	0.0130	0.1768	0.5634	0.2286	0.0173	0.1449	0.0145	0.0000	0.7367	0.2896	0.0896	0.2641	0.3519	0.1422	0.0171	1.0000

Source: JICA Survey Team

Table AB-2.3.2.3.2 Observed and Estimated Annual Rainfall in/around The Project Area (1/2)

(Unit: mm)

Year	Aoral	Bamnak	Basedth	Bati	Chbar Mon	Kampong Chhnang	Kampong Speu	Kirirom	Klang Ampil	Kong Pisey	Odongk	Ou Taroth	Peam Khley
1982	1,089	1,381	1,165	1,012	*1,321*	1,514	1,304	*1,470*	*1,100*	1,159	*1,529*	*1,080*	989
1983	1,330	1,162	1,424	1,380	1,235	1,497	1,391	1,928	1,173	1,237	1,287	1,152	1,237
1984	1,119	1,468	1,199	1,161	1,401	1,759	1,171	1,622	987	1,041	1,626	970	1,041
1985	1,414	1,115	1,514	1,467	1,193	1,733	1,479	2,050	1,247	1,230	1,235	1,225	1,316
1986	1,074	939	1,150	1,114	1,482	1,448	1,124	1,557	948	999	1,040	931	1,000
1987	554	1,103	*969*	939	1,072	1,644	946	1,312	798	725	1,222	784	842
1988	932	989	1,252	1,102	767	1,310	1,111	1,540	937	911	1,095	921	989
1989	1,063	789	1,019	988	988	1,369	997	1,381	840	826	874	826	886
1990	1,143	1,036	821	789	975	1,257	795	1,102	671	707	1,147	659	708
1991	1,132	927	1,417	1,035	802	2,290	1,044	1,446	880	940	1,026	865	928
1992	783	943	1,072	926	1,073	2,109	934	1,294	787	844	1,044	774	831
1993	799	1,053	996	942	874	879	950	1,317	801	1,334	1,166	787	845
1994	1,058	1,193	925	1,052	952	2,205	1,061	1,471	895	1,004	1,580	879	944
1995	1,331	1,407	1,231	1,193	1,181	1,248	1,202	1,667	1,014	1,160	1,449	996	1,070
1996	1,237	1,319	1,714	1,406	1,122	1,602	1,418	1,965	1,196	1,315	1,491	1,175	1,261
1997	*1,190*	1,479	*1,361*	1,318	1,390	1,326	1,329	1,842	1,121	941	1,638	1,101	1,182
1998	1,115	1,412	1,337	1,478	1,151	1,581	1,490	2,065	1,257	1,280	1,564	1,234	1,326
1999	1,447	1,330	1,647	1,411	1,452	1,839	1,423	1,972	1,200	1,381	1,493	1,179	1,266
2000	1,392	1,964	1,302	1,395	1,757	1,463	1,699	2,016	1,433	1,387	1,832	1,443	1,333
2001	1,444	1,460	1,559	1,781	1,817	1,255	1,768	1,991	1,237	1,407	1,289	1,458	1,283
2002	896	922	1,075	1,285	1,723	1,160	937	1,129	999	1,062	1,177	1,015	1,161
2003	1,535	1,204	1,365	1,240	937	1,119	1,049	1,588	897	1,102	1,404	1,208	1,329
2004	1,056	1,108	887	1,055	883	1,249	949	1,189	*801*	885	1,181	785	808
2005	939	1,019	1,351	996	1,114	1,349	1,114	1,362	*939*	1,063	1,304	907	838
2006	1,024	1,092	1,092	1,150	1,178	1,248	1,178	1,252	*994*	860	1,497	1,287	966
2007	1,297	1,525	1,438	1,213	1,650	1,724	1,111	1,587	1,111	1,354	1,172	1,013	1,339
2008	1,237	1,282	1,282	1,040	1,444	1,420	1,188	1,513	1,174	1,052	1,025	798	1,060
2009	1,084	993	993	1,039	1,405	1,635	1,340	1,326	1,084	858	988	1,023	922
2010	1,466	1,123	1,123	981	1,281	1,220	1,220	1,794	950	1,181	1,577	815	829
Average	1,144	1,198	1,230	1,169	1,228	1,498	1,197	1,578	1,016	1,077	1,309	1,010	1,053
Max.	1,535	1,964	1,714	1,781	1,817	2,290	1,768	2,065	1,433	1,407	1,832	1,458	1,339
Min.	554	789	821	789	767	879	795	1,102	671	707	874	659	708

Notes: Italic value is estimated annual rainfall of interpolation by using correlation coefficient and nearby or key station's rainfall data.
Source: Prepared by JICA Survey Team based on daily rainfall data by MOWRAM.

Table AB-2.3.2.3.2 Observed and Estimated Annual Rainfall in/around The Project Area (2/2)

(Unit: mm)

Year	Phnum Srouch	Pochen-tong	Prey Dob	Prey Pdau	Samrong	Sdok	Srae Klong	Takeo	Takhmao	Thnal Tetung	Thpong	Tramkok	Trapeang Chor
1982	1,099	1,366	*1,199*	*1,233*	*1,271*	*1,177*	1,150	*1,240*	*1,367*	*1,216*	1,205	*1,174*	1,040
1983	907	1,121	1,279	1,316	1,356	1,256	1,395	643	1,446	1,443	1,458	1,097	1,307
1984	843	1,179	1,076	1,107	1,141	1,057	1,174	*1,113*	1,007	1,194	1,227	1,245	1,100
1985	1,171	1,283	1,360	1,399	1,442	1,335	1,483	1,165	1,251	1,922	1,551	1,060	1,390
1986	1,076	1,351	1,033	1,063	1,095	1,014	1,127	602	1,291	985	1,178	1,317	1,056
1987	724	1,551	870	895	922	855	949	509	1,013	736	608	952	545
1988	1,070	1,370	1,022	1,051	1,083	1,003	1,114	566	1,364	1,155	1,022	681	916
1989	1,105	1,352	916	943	971	900	999	1,223	1,557	1,466	1,166	878	1,045
1990	709	1,142	731	752	775	718	797	643	978	651	1,254	866	1,124
1991	1,269	1,254	960	987	1,017	942	1,046	1,045	979	1,287	1,241	713	1,113
1992	874	1,095	859	883	910	843	936	1,088	840	1,116	859	953	770
1993	992	1,121	874	899	926	858	953	1,369	928	1,000	876	777	785
1994	801	1,224	976	1,004	1,034	958	1,064	1,158	1,518	1,143	1,160	845	1,040
1995	972	1,413	1,106	1,137	1,172	1,086	1,206	1,203	1,447	1,139	1,460	1,049	1,308
1996	1,197	1,639	1,304	1,341	1,382	1,280	1,422	1,327	1,345	1,388	1,356	997	1,216
1997	1,279	1,408	1,222	1,175	1,295	1,200	1,332	946	1,294	950	1,306	1,235	1,170
1998	1,213	1,484	1,370	1,404	1,452	1,345	1,494	1,221	1,416	1,255	1,428	1,023	1,280
1999	1,529	1,665	1,309	1,155	1,387	1,285	1,427	1,540	1,638	1,406	1,652	1,290	1,481
2000	1,582	2,147	1,355	1,552	1,698	*1,534*	1,443	1,594	1,444	1,299	1,457	1,561	1,395
2001	1,574	1,589	1,439	1,639	1,716	1,622	1,490	1,614	1,430	1,343	1,616	1,614	1,243
2002	1,137	1,286	1,028	882	1,194	1,170	1,231	1,220	1,253	730	1,036	1,531	1,197
2003	1,272	1,272	1,124	1,096	*1,421*	1,276	1,316	1,384	1,409	741	1,421	850	1,230
2004	826	1,222	873	882	851	964	917	1,016	1,068	632	1,078	875	1,062
2005	1,125	1,427	1,203	1,019	1,356	972	1,053	1,202	1,092	774	967	990	817
2006	970	1,171	920	1,086	1,284	*1,064*	923	1,135	1,268	855	1,280	1,180	1,498
2007	1,461	1,367	1,159	998	1,177	*1,003*	1,361	1,501	1,075	1,000	1,112	1,537	803
2008	1,492	1,912	969	1,357	1,077	753	1,387	1,022	1,373	1,369	1,448	1,447	1,132
2009	1,016	1,605	1,416	1,330	1,132	*1,210*	1,231	1,017	1,091	1,234	1,366	925	1,392
2010	1,169	1,439	1,143	1,336	1,043	791	1,223	1,428	1,718	1,137	1,534	1,020	1,371
Average	1,119	1,395	1,107	1,135	1,193	1,085	1,195	1,129	1,272	1,123	1,252	1,092	1,132
Max.	1,582	2,147	1,439	1,639	1,716	1,622	1,494	1,614	1,718	1,922	1,652	1,614	1,498
Min.	709	1,095	731	752	775	718	797	509	840	632	608	681	545

Notes: Italic value is estimated annual rainfall of interpolation by using correlation coefficient and nearby or key station's rainfall data.
Source: Prepared by JICA Survey Team based on daily rainfall data by MOWRAM.

Table AB-2.3.2.3.3 Thiessen Coefficient of Rainfall Stations in/around The Project Area

Sub-Basin	Trapeang Chor	Aoral	Thpong	Kirirom	SraeKhlong	Peam Khley	Phnom Srouch	Kampong Speu	Prey Pdau	Krang Ampil	Sdock	Kong Pisey	Tram Khnar	Thnal Totueng	Tonle Bati	Takhmao	Odongk	Total
New Dam	100.0																	100.0
Peam Levear Dam	100.0																	100.0
O Tang Dam	100.0																	100.0
Stung Aveaeng	82.4	17.6																100.0
Stung Trong Krang	89.5	10.5																100.0
Prek Bangchar	25.0	75.0																100.0
Stung Tasal Dam	2.2	97.8																100.0
Stung Tasal (Sangkea Tasal)	1.6	98.4																100.0
Phleach Dam		79.4		20.6														100.0
Phleach		89.6		10.4														100.0
Stung Sva Slab Dam				100.0														100.0
Stung Sva Slab (Krang Check)				100.0														100.0
Stung Prek Thnot1	3.0	61.6	0.0	4.7		30.6												100.0
Stung Tang Hoang				22.0	54.6	9.2	14.3											100.0
Peam Khley						100.0												100.0
up to Peam Khley	21.5	35.3	0.0	15.3	15.1	8.9	4.0											100.0
Roleang Chrey						43.69	48.19	2.47		5.37	0.28							100.0
up to Roleang Chrey	20.19	33.10	0.00	14.38	14.17	11.00	6.66	0.15		0.33	0.02							100.0
Thnuos Luong						39.3		46.5		14.1								100.0
Trapeang Kyorng						0.4		44.7	6.8	44.5	3.7							100.0
Ou Anlong Kor	1.5	2.5	56.3			8.9		19.9	11.0									100.0
Dangkor									24.3	5.7				68.2	1.8			100.0
up to Dangkor	16.0	26.2	5.4	11.3	11.1	10.7	5.2	5.4	2.5	2.9	0.2			3.1	0.1			100.0
Stung Touch									18.7	6.9		23.3	7.9	33.1	10.1			100.0
Tonle Bati										5.35	3.60	31.77	37.88		21.40			100.0
Stung Prek Thnot 2														5.3	37.0	56.7	1.1	100.0

Source: JICA Survey Team

Table AB-2.3.2.3.4 Estimated Annual Basin Rainfall at Sub-Basin of Prek Thnot River

(Unit: mm/year)

		Estimated Annual Basin Rainfall [mm/year]													
	Sub-Basin	Peam Khley W.L. Station	Rolean Chrey Headworks Natural Flow	Deaum rues Headworks (Kandal Stung)	Stung Tochi Sub-basin	Tonle Bati Sub-basin	Proposed Stung Tasal Dam	Proposed New Dam (proposed by K-water)	Proposed Peam Levear Dam	Proposed O Tang Dam	Proposed Khleach (Pleach) Dam	Proposed Stung Sva Slab Dam	O Saya Reservoir	Chan Tanal Reservoir	Ou Krang Ambel Reservoir
	C.A.[km^2]	3,654.0	3,911.0	4,990.4	148.2	238.2	495.0	155.8	237.5	53.6	110.9	215.6	144.0	268.0	453.0
1	1982	1,137	1,131	1,126	1,052	1,029	1,088	1,041	1,041	1,041	1,128	1,470	1,160	1,160	1,160
2	1983	1,401	1,382	1,378	1,319	1,212	1,329	1,307	1,307	1,307	1,392	1,928	1,404	1,404	1,404
3	1984	1,183	1,168	1,163	1,054	1,040	1,119	1,100	1,100	1,100	1,171	1,623	1,182	1,182	1,182
4	1985	1,498	1,483	1,488	1,502	1,221	1,413	1,390	1,390	1,390	1,480	2,050	1,493	1,493	1,493
5	1986	1,146	1,139	1,125	1,040	1,142	1,074	1,056	1,056	1,056	1,124	1,557	1,134	1,134	1,134
6	1987	760	761	768	805	865	554	545	545	545	633	1,312	725	725	725
7	1988	1,044	1,031	1,036	1,021	870	932	916	916	916	995	1,540	1,036	1,036	1,036
8	1989	1,084	1,078	1,077	1,081	884	1,062	1,045	1,045	1,045	1,096	1,381	1,078	1,078	1,078
9	1990	1,025	1,006	975	715	783	1,143	1,124	1,124	1,124	1,139	1,102	1,055	1,055	1,055
10	1991	1,150	1,147	1,135	1,051	871	1,131	1,113	1,113	1,113	1,164	1,446	1,142	1,142	1,142
11	1992	889	887	891	954	900	782	770	770	770	836	1,294	871	871	871
12	1993	910	911	909	1,022	994	798	785	785	785	853	1,317	887	887	887
13	1994	1,098	1,084	1,079	1,035	947	1,057	1,040	1,040	1,040	1,101	1,471	1,100	1,100	1,100
14	1995	1,321	1,303	1,284	1,133	1,115	1,330	1,309	1,309	1,309	1,366	1,667	1,333	1,333	1,333
15	1996	1,372	1,364	1,359	1,320	1,206	1,236	1,216	1,216	1,216	1,312	1,965	1,354	1,354	1,354
16	1997	1,103	1,092	1,116	1,061	1,152	684	1,170	1,170	1,170	794	1,842	1,267	1,267	1,267
17	1998	1,376	1,369	1,372	1,293	1,226	1,119	1,280	1,280	1,280	1,213	2,065	1,419	1,419	1,419
18	1999	1,519	1,511	1,488	1,330	1,340	1,448	1,481	1,481	1,481	1,502	1,972	1,510	1,510	1,510
19	2000	1,498	1,497	1,494	1,407	1,453	1,392	1,395	1,395	1,395	1,457	2,016	1,502	1,502	1,502
20	2001	1,482	1,479	1,491	1,472	1,564	1,439	1,243	1,243	1,243	1,501	1,991	1,609	1,609	1,609
21	2002	1,080	1,083	1,056	974	1,288	902	1,197	1,197	1,197	920	1,129	1,009	1,009	1,009
22	2003	1,416	1,407	1,345	961	1,031	1,528	1,230	1,230	1,230	1,540	1,588	1,303	1,303	1,303
23	2004	1,025	1,012	988	811	916	1,056	1,062	1,062	1,062	1,069	1,183	1,006	1,006	1,006
24	2005	993	993	987	938	1,011	936	817	817	817	983	1,362	987	987	987
25	2006	1,196	1,182	1,164	964	1,043	1,034	1,495	1,495	1,495	1,087	1,633	1,207	1,207	1,207
26	2007	1,248	1,256	1,222	1,154	1,353	1,286	803	803	803	1,322	1,540	1,119	1,119	1,119
27	2008	1,292	1,291	1,289	1,253	1,195	1,234	1,124	1,124	1,124	1,279	1,646	1,342	1,342	1,342
28	2009	1,274	1,256	1,255	1,110	928	1,091	1,392	1,392	1,392	1,164	1,858	1,311	1,311	1,311
29	2010	1,374	1,350	1,324	1,147	1,051	1,464	1,371	1,371	1,371	1,489	1,690	1,383	1,383	1,383
	Average	1,203	1,195	1,186	1,103	1,091	1,126	1,132	1,132	1,132	1,176	1,608	1,204	1,204	1,204
	Max.	1,519	1,511	1,494	1,502	1,564	1,528	1,495	1,495	1,495	1,540	2,065	1,609	1,609	1,609
	Min.	760	761	768	715	783	554	545	545	545	633	1,102	725	725	725

Source: JICA Survey Team

Table AB-2.3.2.4.1 Observed and Estimated Monthly Mean Discharge at Peak Khley

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
1982	*9.07*	*4.13*	*1.83*	*23.20*	*59.75*	*75.37*	*23.59*	*19.36*	*145.46*	*113.40*	*63.49*	*22.77*	*46.79*
1983	*10.10*	*4.44*	*1.95*	*0.83*	*41.01*	*20.73*	*51.61*	*179.45*	*81.57*	*323.46*	*180.83*	*38.38*	*77.86*
1984	*18.38*	*8.44*	*3.70*	*2.11*	*46.06*	*41.51*	*36.27*	*23.69*	*195.02*	*390.12*	*53.20*	*24.23*	*70.23*
1985	*10.34*	*5.07*	*4.46*	*129.77*	*198.74*	*89.03*	*72.78*	*22.28*	*187.13*	*163.69*	*38.83*	*32.84*	*79.58*
1986	*13.38*	*6.06*	*2.70*	*12.11*	*19.58*	*25.58*	*24.07*	*25.77*	*96.32*	*220.92*	*178.51*	*48.22*	*56.10*
1987	*23.92*	*11.10*	*4.94*	*2.14*	*12.27*	*18.00*	*12.71*	*9.66*	*111.81*	*81.98*	*86.82*	*25.01*	*33.36*
1988	*11.50*	*5.02*	*2.18*	*14.98*	*60.82*	*75.98*	*77.51*	*52.00*	*104.11*	*179.40*	*52.12*	*21.34*	*54.75*
1989	*9.25*	*4.05*	*1.93*	*2.41*	*42.84*	*21.02*	*162.17*	*34.94*	*158.28*	*195.79*	*44.52*	*19.96*	*58.10*
1990	*8.55*	*3.73*	*2.85*	*4.07*	*38.86*	*33.28*	*49.55*	*44.98*	*126.11*	*80.27*	*112.90*	*25.78*	*44.24*
1991	*11.69*	*5.16*	*2.27*	*1.95*	*4.97*	*26.74*	*212.89*	*177.01*	*244.06*	*123.82*	*40.65*	*18.74*	*72.50*
1992	*8.03*	*3.46*	*1.50*	*0.74*	*5.57*	*15.46*	*92.36*	*29.07*	*138.12*	*169.76*	*35.29*	*16.69*	*43.00*
1993	*23.56*	*16.80*	*8.54*	*4.30*	*1.94*	*1.46*	*3.45*	*3.66*	*19.63*	*177.37*	*32.59*	*18.38*	*25.97*
1994	*8.70*	*3.86*	*55.87*	*19.77*	*11.67*	*32.02*	*21.97*	*78.58*	*215.13*	*151.57*	*37.05*	*20.36*	*54.71*
1995	*11.58*	*5.35*	*2.65*	*3.41*	*15.71*	*108.60*	*102.76*	*239.53*	*274.11*	*294.63*	*56.08*	*27.16*	*95.13*
1996	*11.96*	*5.19*	*2.25*	*11.03*	*39.29*	*50.28*	*81.30*	*110.44*	*215.71*	*336.77*	*233.87*	*68.28*	*97.20*
1997	25.53	11.39	5.05	2.22	38.50	70.82	84.58	94.19	214.62	206.92	48.19	21.59	68.63
1998	1.61	1.54	1.24	1.25	3.62	1.49	5.27	19.21	102.49	185.06	64.74	13.03	33.38
1999	6.04	2.24	1.78	17.32	97.36	85.79	81.70	140.21	151.03	359.81	305.34	106.27	112.91
2000	12.97	5.61	9.69	33.57	25.46	44.94	87.72	65.23	74.27	334.00	77.34	23.66	66.21
2001	16.71	3.54	7.39	4.07	2.21	13.57	131.84	66.98	116.95	324.87	37.59	6.56	61.02
2002	2.10	1.10	0.71	1.83	2.14	3.10	4.16	35.13	43.16	50.58	22.14	15.11	15.10
2003	1.69	0.57	5.46	2.40	4.32	4.75	157.28	47.79	73.42	254.36	21.84	15.29	49.10
2004	13.14	7.13	3.13	3.12	3.58	16.39	11.98	25.08	37.38	51.05	4.75	3.28	15.00
2005	2.84	2.61	2.38	8.37	18.92	3.34	136.24	283.01	268.14	306.07	112.30	69.85	101.17
2006	7.44	4.57	4.64	5.96	11.61	16.34	68.73	231.54	174.53	154.20	17.20	7.65	58.70
2007	4.46	3.34	7.18	7.18	215.30	109.47	207.48	187.35	210.07	527.13	77.53	18.61	131.26
2008	5.49	5.12	5.59	7.06	50.27	25.89	12.42	59.69	97.51	136.92	30.61	14.85	37.62
2009	5.46	2.68	0.93	16.79	45.68	27.17	68.20	84.10	137.72	149.24	16.85	4.37	46.60
2010	0.90	0.73	1.44	5.89	6.50	6.59	29.77	37.00	53.76	214.23	24.17	13.76	32.89
2011	3.76	0.33	4.20	12.51	12.10	18.58	20.39	81.01	155.97	148.67	32.70	13.87	42.01
Avearge	7.34	3.50	4.06	8.64	35.84	29.88	73.85	97.17	127.40	226.87	59.55	23.18	58.11
Max.	25.53	11.39	9.69	33.57	215.30	109.47	207.48	283.01	268.14	527.13	305.34	106.27	131.26
Min.	0.90	0.33	0.71	1.25	2.14	1.49	4.16	19.21	37.38	50.58	4.75	3.28	15.00

Notes: Italic values from 1982 to 1996 are estimated discharge by Tank Model.
Source: JICA Survey Team. (Daily water level data from 1997 to 2011 are from MOWRAM)

(Unit: MCM)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1982	*24.3*	*10.0*	*4.9*	*60.1*	*160.0*	*195.4*	*63.2*	*51.8*	*377.0*	*303.7*	*164.6*	*61.0*	*1,476.1*
1983	*27.0*	*10.7*	*5.2*	*2.1*	*109.8*	*53.7*	*138.2*	*480.6*	*211.4*	*866.4*	*468.7*	*102.8*	*2,476.9*
1984	*49.2*	*20.4*	*9.9*	*5.5*	*123.4*	*107.6*	*97.1*	*63.4*	*505.5*	*1,044.9*	*137.9*	*64.9*	*2,229.8*
1985	*27.7*	*12.3*	*12.0*	*336.4*	*532.3*	*230.8*	*194.9*	*59.7*	*485.0*	*438.4*	*100.6*	*88.0*	*2,518.0*
1986	*35.8*	*14.7*	*7.2*	*31.4*	*52.4*	*66.3*	*64.5*	*69.0*	*249.7*	*591.7*	*462.7*	*129.2*	*1,774.6*
1987	*64.1*	*26.9*	*13.2*	*5.5*	*32.9*	*46.7*	*34.1*	*25.9*	*289.8*	*219.6*	*225.0*	*67.0*	*1,050.5*
1988	*30.8*	*12.1*	*5.8*	*38.8*	*162.9*	*196.9*	*207.6*	*139.3*	*269.8*	*480.5*	*135.1*	*57.2*	*1,737.0*
1989	*24.8*	*9.8*	*5.2*	*6.3*	*114.8*	*54.5*	*434.4*	*93.6*	*410.3*	*524.4*	*115.4*	*53.5*	*1,846.7*
1990	*22.9*	*9.0*	*7.6*	*10.5*	*104.1*	*86.3*	*132.7*	*120.5*	*326.9*	*215.0*	*292.6*	*69.1*	*1,397.2*
1991	*31.3*	*12.5*	*6.1*	*5.1*	*13.3*	*69.3*	*570.2*	*474.1*	*632.6*	*331.6*	*105.4*	*50.2*	*2,301.7*
1992	*21.5*	*8.4*	*4.0*	*1.9*	*14.9*	*40.1*	*247.4*	*77.9*	*358.0*	*454.7*	*91.5*	*44.7*	*1,364.9*
1993	*63.1*	*40.7*	*22.9*	*11.1*	*5.2*	*3.8*	*9.2*	*9.8*	*50.9*	*475.1*	*84.5*	*49.2*	*825.4*
1994	*23.3*	*9.3*	*149.6*	*51.2*	*31.3*	*83.0*	*58.9*	*210.5*	*557.6*	*406.0*	*96.0*	*54.5*	*1,731.2*
1995	*31.0*	*12.9*	*7.1*	*8.8*	*42.1*	*281.5*	*275.2*	*641.6*	*710.5*	*789.1*	*145.3*	*72.7*	*3,018.0*
1996	*32.0*	*12.5*	*6.0*	*28.6*	*105.2*	*130.3*	*217.8*	*295.8*	*559.1*	*902.0*	*606.2*	*182.9*	*3,078.6*
1997	68.4	27.5	13.5	5.8	103.1	183.6	226.6	252.3	556.3	554.2	124.9	57.8	2,174.0
1998	4.3	3.7	3.3	3.2	9.7	3.9	14.1	51.5	265.6	495.7	167.8	34.9	1,057.7
1999	16.2	5.4	4.8	44.9	260.8	222.4	218.8	375.5	391.5	963.7	791.4	284.6	3,580.0
2000	34.7	14.1	26.0	87.0	68.2	116.5	234.9	174.7	192.5	894.6	200.5	63.4	2,107.1
2001	44.8	8.6	19.8	10.6	5.9	35.2	353.1	179.4	303.1	870.1	97.4	17.6	1,945.5
2002	5.6	2.6	1.9	4.7	5.7	8.0	11.1	94.1	111.9	135.5	57.4	40.5	479.1
2003	4.5	1.4	14.6	6.2	11.6	12.3	421.2	128.0	190.3	681.3	56.6	40.9	1,569.0
2004	35.2	17.9	8.4	8.1	9.6	42.5	32.1	67.2	96.9	136.7	12.3	8.8	475.6
2005	7.6	6.3	6.4	21.7	50.7	8.7	364.9	758.0	695.0	819.8	291.1	187.1	3,217.2
2006	19.9	11.0	12.4	15.4	31.1	42.4	184.1	620.2	452.4	413.0	44.6	20.5	1,867.0
2007	11.9	8.1	19.2	18.6	576.7	283.7	555.7	501.8	544.5	1,411.9	201.0	49.8	4,183.0
2008	14.7	12.8	15.0	18.3	134.6	67.1	33.3	159.9	252.7	366.7	79.3	39.8	1,194.3
2009	14.6	6.5	2.5	43.5	122.3	70.4	182.7	225.3	357.0	399.7	43.7	11.7	1,479.9
2010	2.4	1.8	3.9	15.3	17.4	17.1	79.7	99.1	139.3	573.8	62.6	36.8	1,049.3
2011	10.1	0.8	11.2	32.4	32.4	48.2	54.6	217.0	404.3	398.2	84.8	37.1	1,331.1
Avearge	19.7	8.6	10.9	22.4	96.0	77.5	197.8	260.3	330.2	607.7	154.4	62.1	1,847.3
Max.	68.4	27.5	26.0	87.0	576.7	283.7	555.7	758.0	695.0	1,411.9	791.4	284.6	4,183.0
Min.	2.4	0.8	1.9	3.2	5.7	3.9	11.1	51.5	96.9	135.5	12.3	8.8	475.6

Notes: Italic values from 1982 to 1996 are estimated discharge by Tank Model.
Source: JICA Survey Team. (Daily water level data from 1997 to 2011 are from MOWRAM)

Table AB-2.3.2.4.2 5days Mean Dsichagre at Peak Khley, Prek Thnot River

(Unit: m^3/sec)

Year	DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	01-5	35.01	15.28	7.04	3.03	1.35	14.21	63.40	25.01	86.33	130.66	75.63	29.57
	06-10	30.78	13.31	6.13	2.66	1.21	32.56	243.42	45.46	186.57	175.38	52.89	25.99
	11-15	26.99	11.59	5.32	2.32	69.24	190.63	112.63	76.99	355.98	137.05	46.98	22.80
	16-20	23.62	10.10	4.62	2.03	117.67	122.13	41.34	34.84	396.83	314.89	42.33	19.95
	21-25	20.61	8.78	4.02	1.78	31.41	40.03	30.27	90.13	146.24	288.73	37.79	17.47
	26-end	17.76	7.87	3.49	1.54	14.87	25.38	27.80	259.61	115.78	196.83	33.52	15.07
1998	01-5	1.75	1.05	2.28	0.76	2.89	1.57	1.45	15.79	39.61	428.58	71.40	28.24
	06-10	1.81	0.88	1.81	0.48	2.89	1.52	4.02	15.35	67.78	275.98	104.81	21.35
	11-15	1.59	0.65	1.21	1.06	3.07	0.82	2.47	9.10	57.11	211.12	49.29	12.41
	16-20	1.68	0.54	1.07	0.70	3.05	1.95	9.83	20.34	111.81	107.03	97.33	7.16
	21-25	1.68	2.18	0.61	2.93	5.46	1.63	3.10	24.71	72.91	47.41	46.12	5.88
	26-end	1.22	5.56	0.60	1.57	4.21	1.43	9.85	28.19	265.69	64.38	19.46	4.77
1999	01-5	6.48	1.93	1.99	2.83	53.60	54.73	194.55	140.45	256.58	53.21	760.67	259.28
	06-10	16.21	2.87	2.42	11.72	40.68	163.15	107.88	378.04	308.24	170.20	555.49	311.28
	11-15	4.69	2.66	2.41	22.78	24.07	68.99	27.82	85.13	97.68	319.37	281.73	23.98
	16-20	4.41	2.05	1.61	9.24	135.44	51.31	23.70	61.10	79.85	464.73	121.80	11.11
	21-25	3.04	1.95	1.37	16.07	288.38	91.39	14.59	85.70	119.32	513.27	75.76	23.80
	26-end	2.16	1.83	1.06	41.25	51.24	85.19	115.00	99.09	44.51	591.71	36.57	24.53
2000	01-5	20.20	5.64	10.73	3.19	33.93	46.50	35.96	39.26	95.76	115.85	195.96	21.32
	06-10	16.37	4.56	13.51	4.06	33.72	84.77	56.59	25.10	45.58	105.70	47.48	13.26
	11-15	12.90	3.40	12.99	4.76	34.66	29.28	99.58	27.35	56.01	387.16	27.53	10.98
	16-20	10.16	3.51	14.42	52.70	16.74	32.58	185.35	33.47	54.92	959.04	98.75	9.23
	21-25	9.12	7.33	4.44	91.03	13.59	36.07	77.15	109.21	83.83	255.50	63.95	64.06
	26-end	9.72	10.16	3.35	45.69	21.02	40.46	74.36	141.72	109.54	206.29	30.38	23.19
2001	01-5	7.52	5.66	1.94	12.39	2.00	3.83	97.86	8.51	121.52	387.93	102.88	8.41
	06-10	8.11	4.59	1.53	4.15	2.01	8.93	533.99	20.87	42.04	447.22	55.04	5.95
	11-15	33.14	3.45	1.57	2.41	1.60	7.02	120.78	86.20	26.17	611.07	25.64	8.20
	16-20	35.01	2.84	11.13	1.61	2.91	4.00	32.35	79.42	67.43	184.07	19.85	7.58
	21-25	11.70	2.26	21.25	1.46	3.45	6.26	16.67	121.53	149.17	213.01	12.50	5.85
	26-end	6.79	1.68	7.00	2.40	1.43	51.36	13.13	82.28	295.37	142.40	9.66	3.89
2002	01-5	3.04	1.09	0.38	0.99	2.89	1.00	3.59	2.57	72.86	67.11	45.98	35.55
	06-10	2.31	1.16	0.26	0.40	1.58	0.58	7.47	6.33	34.70	98.15	17.83	22.70
	11-15	1.89	1.13	0.43	3.15	2.70	1.34	5.37	7.80	26.01	55.16	15.14	16.02
	16-20	1.96	1.09	0.37	2.65	2.57	2.67	4.15	39.57	19.49	21.07	20.44	6.88
	21-25	1.96	1.05	0.53	1.82	1.73	2.24	2.32	103.90	49.62	9.36	22.22	7.15
	26-end	1.54	1.02	2.04	1.99	1.48	10.80	2.40	48.01	56.31	52.28	11.22	4.46
2003	01-5	2.80	0.68	0.92	3.90	4.23	6.69	22.36	61.38	77.49	326.75	40.31	15.23
	06-10	2.41	0.76	0.44	3.63	2.46	4.78	27.98	96.83	42.75	345.39	20.22	15.51
	11-15	1.75	0.37	10.61	1.64	2.03	1.83	78.10	30.77	53.23	135.54	19.73	15.23
	16-20	1.60	0.31	3.18	1.01	4.44	2.02	109.96	24.89	59.90	281.64	18.19	15.45
	21-25	1.09	0.53	4.55	0.76	7.73	2.33	170.37	35.16	108.94	186.39	16.82	15.23
	26-end	0.70	0.87	11.79	3.46	4.89	10.84	471.95	39.41	98.24	251.12	15.79	15.12
2004	01-5	15.45	9.13	3.94	2.94	3.34	3.09	10.86	35.14	12.79	34.28	8.00	4.71
	06-10	15.45	8.54	3.34	3.19	3.07	5.37	9.54	16.26	9.40	142.91	5.36	4.46
	11-15	15.34	7.73	3.09	3.04	3.77	8.73	7.11	33.03	14.60	78.93	4.14	2.80
	16-20	12.71	6.38	3.04	3.19	4.58	52.45	7.75	23.60	65.74	26.21	4.14	2.75
	21-25	11.22	5.34	2.84	3.19	3.77	19.61	14.44	26.16	67.29	18.53	3.30	2.70
	26-end	9.43	4.66	2.65	3.19	3.03	9.11	20.48	17.77	54.49	13.02	3.56	2.44
2005	01-5	2.41	2.38	2.34	2.30	2.96	2.49	2.76	177.22	16.79	24.21	60.71	22.62
	06-10	2.56	2.45	2.32	4.93	5.94	2.64	4.41	89.01	15.46	49.09	84.29	47.31
	11-15	2.70	2.52	2.11	2.94	2.47	3.16	15.80	75.73	23.45	51.20	67.51	22.74
	16-20	2.75	2.52	1.98	2.70	2.52	2.94	8.87	51.76	48.09	55.86	37.76	13.06
	21-25	2.77	2.40	1.92	2.80	2.60	2.52	8.21	21.17	135.77	96.50	30.03	11.41
	26-end	2.53	2.46	1.87	3.17	2.51	2.41	48.98	19.77	39.30	177.57	21.02	11.31
2006	01-5	9.48	4.64	5.09	4.69	5.21	13.86	86.05	27.06	109.91	219.84	21.97	13.93
	06-10	8.25	4.67	5.47	5.00	11.36	17.99	99.98	236.57	107.01	205.03	18.32	9.51
	11-15	11.42	4.40	4.64	8.88	6.91	11.91	30.42	137.04	118.92	286.39	15.57	6.92
	16-20	5.74	4.28	4.28	6.71	9.26	11.85	89.20	799.85	117.87	128.65	15.93	6.45
	21-25	5.38	4.77	4.28	5.95	19.50	21.88	65.82	140.22	246.96	75.40	15.94	5.67
	26-end	4.90	4.66	4.16	4.53	16.46	20.57	45.52	78.99	346.51	33.96	15.45	4.12
2007	01-5	4.26	3.11	2.09	4.08	11.44	13.66	43.46	22.31	85.24	123.60	35.23	16.79
	06-10	4.22	2.89	1.98	3.77	12.10	14.02	150.85	33.91	83.45	209.00	25.59	11.87
	11-15	4.14	2.82	1.81	4.27	96.04	10.28	39.75	116.98	64.64	412.38	48.62	10.28
	16-20	3.97	2.61	1.59	5.00	120.75	11.89	25.87	73.40	116.19	186.66	62.37	9.18
	21-25	3.74	2.52	1.61	3.68	24.08	60.20	21.70	57.69	166.75	106.56	32.42	7.73
	26-end	3.54	2.35	5.18	3.42	14.39	45.26	24.60	105.69	90.60	88.99	21.05	6.33
2008	01-5	4.99	4.99	5.05	6.82	59.98	13.71	14.48	17.24	46.69	103.69	42.53	21.69
	06-10	4.08	5.68	5.37	6.56	21.06	13.97	15.97	98.81	95.50	45.25	32.64	18.37
	11-15	5.93	5.96	5.09	6.02	78.11	10.24	10.96	90.58	132.45	56.51	21.48	16.02
	16-20	5.78	5.92	4.93	5.59	98.00	11.89	6.31	57.57	149.79	150.49	22.90	13.83
	21-25	6.18	4.22	4.58	5.91	30.56	60.28	7.92	47.36	79.26	173.36	41.05	11.07
	26-end	5.88	3.65	8.03	11.49	19.98	45.26	17.79	48.77	81.35	266.31	23.07	9.26
2009	01-5	7.69	3.21	2.00	1.37	97.27	41.26	8.49	80.35	135.71	61.29	27.92	7.57
	06-10	6.66	3.01	1.87	30.48	46.00	66.56	11.45	216.37	139.76	312.69	23.34	6.52
	11-15	5.98	2.72	1.11	14.55	52.52	18.35	33.18	84.16	155.42	224.49	20.46	4.71
	16-20	4.96	2.47	0.38	15.56	38.14	14.85	96.27	28.50	78.53	114.22	10.73	3.29
	21-25	4.22	2.27	0.26	9.82	19.76	13.92	153.97	26.84	106.10	106.31	9.26	2.45
	26-end	3.63	2.17	0.09	28.97	24.58	8.05	99.54	71.02	210.80	88.60	9.40	2.12
2010	01-5	1.77	0.23	2.27	3.18	9.45	1.13	28.79	18.04	29.15	132.67	32.53	12.52
	06-10	1.17	0.20	1.53	2.71	10.43	0.81	21.94	17.32	59.53	172.40	28.21	10.80
	11-15	1.04	0.15	1.03	2.41	8.59	1.07	19.49	19.41	78.08	405.73	27.23	8.58
	16-20	0.86	0.08	0.46	3.55	5.67	2.26	32.54	18.27	66.30	468.78	22.19	28.61
	21-25	0.44	1.34	0.13	11.94	3.34	13.38	57.95	61.05	47.22	87.36	15.95	13.36
	26-end	0.26	3.48	2.94	11.53	2.35	20.91	19.87	79.44	42.27	51.05	18.89	9.52

Source: JICA Survey Team

Table AB-2.3.2.5.2 Average Diversion Water Requirement for Roleang Chrey System

		Early Paddy (Early Rainy)		Early Paddy (Rainy)		Mid Paddy		Upland Crop	
		Unit Water Req.	Div. Water Req.	Unit Water Req.	Div. Water Req.	Unit Water Req.	Div. Water Req.	Unit Water Req.	Div. Water Req.
Month	5-day	(L/sec/ha)	(m3/sec)	(L/sec/ha)	(m3/sec)	(L/sec/ha)	(m3/sec)	(L/sec/ha)	(m3/sec)
Jan	1-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	26-end	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb	1-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	26-end	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar	1-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	11-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	16-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	26-end	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr	1-5	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00
	6-10	0.42	0.42	0.00	0.00	0.00	0.00	0.00	0.00
	11-15	0.79	0.79	0.00	0.00	0.00	0.00	0.00	0.00
	16-20	1.27	1.27	0.00	0.00	0.00	0.00	0.00	0.00
	21-25	1.54	1.54	0.00	0.00	0.00	0.00	0.12	0.12
	26-end	1.81	1.81	0.00	0.00	0.00	0.00	0.17	0.17
May	1-5	1.59	1.59	0.00	0.00	0.00	0.00	0.12	0.12
	6-10	1.54	1.54	0.00	0.00	0.00	0.00	0.14	0.14
	11-15	1.39	1.39	0.00	0.00	0.00	0.00	0.16	0.16
	16-20	1.27	1.27	0.00	0.00	0.00	0.00	0.17	0.17
	21-25	1.36	1.36	0.00	0.00	0.00	0.00	0.12	0.12
	26-end	1.35	1.35	0.00	0.00	0.00	0.00	0.14	0.14
Jun	1-5	1.37	1.37	0.00	0.00	0.00	0.00	0.14	0.14
	6-10	1.41	1.41	0.00	0.00	0.00	0.00	0.17	0.17
	11-15	1.45	1.45	0.00	0.00	0.00	0.00	0.20	0.20
	16-20	1.45	1.45	0.00	0.00	0.00	0.00	0.24	0.24
	21-25	1.43	1.43	0.00	0.00	0.00	0.00	0.27	0.27
	26-end	1.42	1.42	0.00	0.00	0.00	0.00	0.30	0.30
Jul	1-5	1.32	1.32	0.00	0.00	0.08	0.08	0.29	0.29
	6-10	1.12	1.12	0.00	0.00	0.23	0.23	0.25	0.25
	11-15	0.93	0.93	0.00	0.00	0.45	0.45	0.21	0.21
	16-20	0.64	0.64	0.00	0.00	0.72	0.72	0.17	0.17
	21-25	0.36	0.36	0.00	0.00	0.86	0.86	0.11	0.11
	26-end	0.18	0.18	0.00	0.00	0.99	0.99	0.06	0.06
Aug	1-5	0.00	0.00	0.11	0.11	1.03	1.03	0.00	0.00
	6-10	0.00	0.00	0.32	0.32	1.12	1.12	0.00	0.00
	11-15	0.00	0.00	0.62	0.62	1.22	1.22	0.00	0.00
	16-20	0.00	0.00	1.02	1.02	1.24	1.24	0.00	0.00
	21-25	0.00	0.00	1.21	1.21	1.19	1.19	0.00	0.00
	26-end	0.00	0.00	1.40	1.40	1.09	1.09	0.00	0.00
Sep	1-5	0.00	0.00	1.04	1.04	0.51	0.51	0.00	0.00
	6-10	0.00	0.00	0.97	0.97	0.48	0.48	0.00	0.00
	11-15	0.00	0.00	0.80	0.80	0.45	0.45	0.00	0.00
	16-20	0.00	0.00	0.68	0.68	0.54	0.54	0.00	0.00
	21-25	0.00	0.00	0.76	0.76	0.62	0.62	0.00	0.00
	26-end	0.00	0.00	0.76	0.76	0.65	0.65	0.00	0.00
Oct	1-5	0.00	0.00	0.72	0.72	0.60	0.60	0.00	0.00
	6-10	0.00	0.00	0.76	0.76	0.63	0.63	0.00	0.00
	11-15	0.00	0.00	0.79	0.79	0.65	0.65	0.00	0.00
	16-20	0.00	0.00	0.79	0.79	0.74	0.74	0.00	0.00
	21-25	0.00	0.00	0.78	0.78	0.82	0.82	0.00	0.00
	26-end	0.00	0.00	0.77	0.77	0.84	0.84	0.00	0.00
Nov	1-5	0.00	0.00	1.46	1.46	1.47	1.47	0.00	0.00
	6-10	0.00	0.00	1.24	1.24	1.26	1.26	0.00	0.00
	11-15	0.00	0.00	1.02	1.02	1.12	1.12	0.00	0.00
	16-20	0.00	0.00	0.71	0.71	0.97	0.97	0.00	0.00
	21-25	0.00	0.00	0.41	0.41	0.83	0.83	0.00	0.00
	26-end	0.00	0.00	0.21	0.21	0.68	0.68	0.00	0.00
Dec	1-5	0.00	0.00	0.00	0.00	0.57	0.57	0.00	0.00
	6-10	0.00	0.00	0.00	0.00	0.34	0.34	0.00	0.00
	11-15	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00
	16-20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	21-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	26-end	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: JICA Survey Team

Table AB-2.3.2.5.3 Observed Monthly Rainfall at Tonle Bati Station

(Unit: mm/month)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1983	0	0	0	2	179	77	190	268	96	436	111	21	1380
1984	0	4	3	63	118	163	108	89	321	282	11	0	1161
1985	0	56	0	254	307	143	138	52	316	114	88	0	1467
1986	8	5	0	93	91	105	88	69	234	175	187	60	1114
1987	0	0	0	8	122	87	47	122	224	88	240	0	939
1988	0	0	17	85	125	192	102	109	182	237	53	0	1102
1989	4	0	0	0	175	56	111	133	229	280	0	0	988
1990	0	0	5	45	134	80	96	120	129	70	105	5	789
1991	0	8	0	85	56	157	206	170	175	165	0	13	1035
1992	0	0	0	26	42	112	192	105	160	253	32	5	926
1993	54	0	48	21	33	101	44	63	204	317	58	0	942
1994	0	0	74	13	77	96	190	165	284	131	5	16	1052
1995	0	0	60	0	177	44	107	190	265	275	75	0	1193
1996	7	0	0	155	123	116	111	96	254	344	187	12	1406
1997	0	0	0	0	191	245	93	120	296	321	30	22	1318
1998	0	0	17	100	143	120	77	202	363	305	139	11	1478
1999	14	0	40	139	237	146	279	167	322	68	0	0	1411
2000	0	0	83	98	113	154	130	107	98	419	110	83	1395
2001	151	0	100	128	101	27	215	149	422	398	17	76	1781
2002	0	0	0	272	223	93	37	173	118	158	179	32	1285
2003	0	0	72	72	92	82	478	47	142	240	15	0	1240
2004	0	0	0	22	118	137	116	69	261	254	78	0	1055
2005	0	0	0	36	22	74	76	124	172	299	104	89	996
2006	0	0	5	103	133	136	88	261	249	152	23	0	1150
2007	0	0	39	11	95	254	216	126	185	233	56	0	1213
2008	20	4	62	111	131	42	26	88	156	221	111	69	1040
2009	0	0	0	248	151	56	52	179	111	124	118	0	1039
2010	18	0	38	28	38	95	136	67	157	326	47	30	981
Ave.	10	3	24	79	127	114	134	130	219	239	78	19	1174

Source: MOWRAM

Table AB-2.3.2.5.4 Estimated Effective 5days Rainfall for KSBT Area

corelation coefficient: 75% (Unit: mm/5days)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1983	0.000	0.000	0.000	0.298	21.642	9.608	22.926	32.440	12.013	52.690	13.822	2.591	14.173
1984	0.000	0.491	0.324	7.872	14.300	20.343	13.077	10.773	40.104	34.059	1.388	0.000	11.927
1985	0.000	7.491	0.000	31.711	37.118	17.901	16.724	6.298	39.459	13.736	10.946	0.000	15.070
1986	1.008	0.611	0.000	11.566	11.025	13.079	10.617	8.350	29.232	21.211	23.343	7.306	11.449
1987	0.000	0.066	0.000	1.041	14.720	10.884	5.723	14.720	28.054	10.653	29.938	0.000	9.643
1988	0.000	0.000	2.039	10.624	15.068	24.025	12.333	13.221	22.736	28.721	6.632	0.000	11.324
1989	0.540	0.000	0.000	0.000	21.163	7.017	13.401	16.136	28.624	33.819	0.000	0.000	10.154
1990	0.000	0.000	0.660	5.566	16.172	10.041	11.577	14.528	16.165	8.410	13.128	0.624	8.104
1991	0.000	1.036	0.000	10.624	6.766	19.649	24.954	20.527	21.918	19.915	0.000	1.584	10.632
1992	0.000	0.000	0.000	3.236	5.039	13.971	23.274	12.717	19.996	30.568	4.004	0.552	9.515
1993	6.478	0.000	5.759	2.665	3.959	12.645	5.291	7.666	25.550	38.306	7.227	0.000	9.682
1994	0.000	0.000	8.995	1.674	9.274	12.025	23.022	19.975	35.517	15.864	0.625	1.933	10.811
1995	0.000	0.000	7.245	0.000	21.383	5.483	12.963	23.005	33.096	33.301	9.326	0.000	12.252
1996	0.900	0.000	0.000	19.314	14.936	14.479	13.413	11.601	31.785	41.641	23.430	1.488	14.448
1997	0.000	0.000	0.000	0.000	23.154	30.620	11.277	14.516	36.943	38.870	3.719	2.639	13.541
1998	0.000	0.000	2.039	12.521	17.276	15.000	9.358	24.474	45.372	36.951	17.356	1.320	15.182
1999	1.680	0.000	4.799	17.356	28.673	18.223	33.711	20.155	40.290	8.278	0.000	0.000	14.499
2000	0.000	0.000	10.077	12.260	13.664	19.190	15.776	12.915	12.206	50.730	13.785	10.058	14.337
2001	18.217	0.000	12.038	15.941	12.171	3.350	25.963	18.031	52.751	48.099	2.087	9.235	18.302
2002	0.000	0.000	0.000	34.050	26.973	11.629	4.518	20.940	14.691	19.054	22.394	3.920	13.207
2003	0.000	0.000	8.710	9.013	11.081	10.225	57.835	5.685	17.763	29.032	1.888	0.000	12.738
2004	0.000	0.000	0.000	2.788	14.323	17.175	13.972	8.323	32.575	30.726	9.750	0.000	10.839
2005	0.000	0.000	0.000	4.500	2.673	9.188	9.230	15.024	21.500	36.169	13.000	10.766	10.234
2006	0.000	0.000	0.605	12.813	16.028	17.013	10.645	31.621	31.125	18.387	2.875	0.000	11.810
2007	0.000	0.000	4.681	1.375	11.431	31.750	26.081	15.206	23.063	28.137	7.000	0.000	12.458
2008	2.419	0.536	7.500	13.913	15.786	5.250	3.145	10.585	19.500	26.734	13.875	8.347	10.688
2009	0.000	0.000	0.000	31.000	18.266	7.000	6.230	21.593	13.913	15.048	14.775	0.000	10.674
2010	2.177	0.000	4.597	3.513	4.633	11.825	16.500	8.117	19.625	39.399	5.925	3.629	10.075
Ave.	1.194	0.365	2.860	9.901	15.311	14.235	16.198	15.684	27.342	28.875	9.723	2.357	12.063

Source: JICA Survey Team

Table AB-2.3.2.5.5 Average Diversion Water Requirement for Kandal Stung-Bati Irrigation System

Diversion Water Requirement for Tonle Bati Area in F/S (Unit: lit/s/ha)

Month	5-day	Eary Rice	Medium Rice-1	Medium Rice-2	Upland Crop
Jan	1-5	0.000	0.000	0.346	0.979
	6-10	0.000	0.000	0.173	1.054
	11-15	0.000	0.000	0.000	1.130
	16-20	0.000	0.000	0.000	1.229
	21-25	0.000	0.000	0.000	1.134
	26-end	0.000	0.000	0.000	1.406
Feb	1-5	0.000	0.000	0.000	1.340
	6-10	0.000	0.000	0.000	1.302
	11-15	0.000	0.000	0.000	1.265
	16-20	0.000	0.000	0.000	0.903
	21-25	0.000	0.000	0.000	0.448
	26-end	0.000	0.000	0.000	0.104
Mar	1-5	0.000	0.000	0.000	0.000
	6-10	0.000	0.000	0.000	0.000
	11-15	0.000	0.000	0.000	0.000
	16-20	0.000	0.000	0.000	0.000
	21-25	0.000	0.000	0.000	0.000
	26-end	0.000	0.000	0.000	0.000
Apr	1-5	0.000	0.000	0.000	0.000
	6-10	0.000	0.000	0.000	0.000
	11-15	0.056	0.000	0.000	0.000
	16-20	0.056	0.000	0.000	0.000
	21-25	0.056	0.000	0.000	0.000
	26-end	0.947	0.000	0.000	0.000
May	1-5	0.946	0.000	0.000	0.000
	6-10	1.088	0.000	0.000	0.000
	11-15	1.176	0.000	0.000	0.000
	16-20	1.337	0.000	0.000	0.000
	21-25	1.461	0.000	0.000	0.000
	26-end	0.689	0.057	0.000	0.000
Jun	1-5	0.825	0.055	0.000	0.000
	6-10	0.825	0.055	0.000	0.000
	11-15	0.825	0.945	0.000	0.000
	16-20	0.825	0.945	0.000	0.000
	21-25	0.816	1.083	0.000	0.000
	26-end	0.807	1.165	0.000	0.000
Jul	1-5	0.639	1.221	0.000	0.000
	6-10	0.632	1.331	0.000	0.000
	11-15	0.624	0.580	0.000	0.000
	16-20	0.650	0.661	0.000	0.000
	21-25	0.575	0.661	0.000	0.000
	26-end	0.515	0.661	0.000	0.000
Aug	1-5	0.348	0.673	0.000	0.000
	6-10	0.248	0.673	0.000	0.000
	11-15	0.151	0.673	0.000	0.000
	16-20	0.061	0.673	0.000	0.000
	21-25	0.000	0.673	0.000	0.000
	26-end	0.000	0.673	0.047	0.000
Sep	1-5	0.000	0.234	0.053	0.000
	6-10	0.000	0.234	0.053	0.000
	11-15	0.000	0.234	0.944	0.000
	16-20	0.000	0.234	0.944	0.000
	21-25	0.000	0.221	0.983	0.000
	26-end	0.000	0.209	0.968	0.000
Oct	1-5	0.000	0.143	0.987	0.000
	6-10	0.000	0.111	1.019	0.000
	11-15	0.000	0.086	0.161	0.000
	16-20	0.000	0.046	0.193	0.000
	21-25	0.000	0.023	0.189	0.000
	26-end	0.000	0.000	0.186	0.000
Nov	1-5	0.000	0.000	0.799	0.000
	6-10	0.000	0.000	0.792	0.000
	11-15	0.000	0.000	0.784	0.000
	16-20	0.000	0.000	0.777	0.116
	21-25	0.000	0.000	0.777	0.187
	26-end	0.000	0.000	0.777	0.267
Dec	1-5	0.000	0.000	1.070	0.404
	6-10	0.000	0.000	1.054	0.443
	11-15	0.000	0.000	1.039	0.482
	16-20	0.000	0.000	0.861	0.594
	21-25	0.000	0.000	0.682	0.705
	26-end	0.000	0.000	0.504	0.940

Diversion Water Requirement for Kandal Stung Area (Unit: lit/s/ha)

Month	5-day	Eary Rice	Medium Rice-1	Medium Rice-2	Upland Crop
Jan	1-5	0.000	0.000	0.000	0.979
	6-10	0.000	0.000	0.000	1.054
	11-15	0.000	0.000	0.000	1.130
	16-20	0.000	0.000	0.000	1.229
	21-25	0.000	0.000	0.000	1.134
	26-end	0.000	0.000	0.000	1.406
Feb	1-5	0.000	0.000	0.000	1.340
	6-10	0.000	0.000	0.000	1.302
	11-15	0.000	0.000	0.000	1.265
	16-20	0.000	0.000	0.000	0.903
	21-25	0.000	0.000	0.000	0.448
	26-end	0.000	0.000	0.000	0.104
Mar	1-5	0.038	0.000	0.000	0.000
	6-10	0.038	0.000	0.000	0.000
	11-15	0.631	0.000	0.000	0.000
	16-20	0.631	0.000	0.000	0.000
	21-25	0.792	0.000	0.000	0.000
	26-end	0.849	0.000	0.000	0.000
Apr	1-5	1.032	0.000	0.000	0.000
	6-10	1.165	0.000	0.000	0.000
	11-15	1.299	0.000	0.000	0.000
	16-20	1.395	0.000	0.000	0.000
	21-25	1.522	0.000	0.000	0.000
	26-end	1.055	0.000	0.000	0.000
May	1-5	0.851	0.000	0.000	0.000
	6-10	0.845	0.000	0.000	0.000
	11-15	0.839	0.000	0.000	0.000
	16-20	0.833	0.000	0.000	0.000
	21-25	0.814	0.000	0.000	0.000
	26-end	0.796	0.000	0.000	0.000
Jun	1-5	0.754	0.000	0.000	0.000
	6-10	0.666	0.000	0.000	0.000
	11-15	0.578	0.000	0.000	0.000
	16-20	0.491	0.027	0.000	0.000
	21-25	0.403	0.027	0.000	0.000
	26-end	0.327	0.473	0.000	0.000
Jul	1-5	0.175	0.472	0.000	0.000
	6-10	0.117	0.527	0.000	0.000
	11-15	0.058	0.582	0.000	0.000
	16-20	0.000	0.636	0.036	0.000
	21-25	0.000	0.691	0.036	0.000
	26-end	0.000	0.668	0.631	0.000
Aug	1-5	0.000	0.814	0.630	0.000
	6-10	0.000	0.870	0.705	0.000
	11-15	0.000	0.927	0.781	0.000
	16-20	0.000	0.957	0.857	0.000
	21-25	0.000	1.014	0.933	0.000
	26-end	0.000	0.626	0.905	0.000
Sep	1-5	0.000	0.268	0.772	0.000
	6-10	0.000	0.268	0.802	0.000
	11-15	0.000	0.268	0.238	0.000
	16-20	0.000	0.268	0.268	0.000
	21-25	0.000	0.268	0.268	0.000
	26-end	0.000	0.268	0.268	0.000
Oct	1-5	0.000	0.189	0.189	0.000
	6-10	0.000	0.185	0.189	0.000
	11-15	0.000	0.181	0.189	0.000
	16-20	0.000	0.165	0.189	0.000
	21-25	0.000	0.149	0.189	0.000
	26-end	0.000	0.134	0.189	0.000
Nov	1-5	0.000	0.527	0.824	0.000
	6-10	0.000	0.458	0.809	0.000
	11-15	0.000	0.390	0.794	0.000
	16-20	0.000	0.321	0.702	0.116
	21-25	0.000	0.252	0.611	0.187
	26-end	0.000	0.184	0.519	0.267
Dec	1-5	0.000	0.162	0.586	0.404
	6-10	0.000	0.081	0.462	0.443
	11-15	0.000	0.000	0.339	0.482
	16-20	0.000	0.000	0.216	0.594
	21-25	0.000	0.000	0.108	0.705
	26-end	0.000	0.000	0.000	0.940

Source: JICA Survey Team

Table AB-2.3.2.6.1 Annual Maximum Daily Point Rainfall at Kampong Speu

No.	Year	Annual Max. Daily Rainfall Date	Daily Rainfall (mm.day)	Rank	Excess Proba-bility	Return Period (Year)
1	1983	24-Oct-1983	81.7	13	56.90%	2.32
2	1984	28-Sep-1984	100.1	5	84.48%	6.44
3	1985	18-Apr-1985	95.0	7	77.59%	4.46
4	1986	17-Nov-1986	72.3	21	29.31%	1.41
5	1987	15-Sep-1987	60.2	25	15.52%	1.18
6	1988	23-Oct-1988	53.4	27	8.62%	1.09
7	1989	04-Jul-1989	70.5	23	22.41%	1.29
8	1990	10-Nov-1990	71.0	22	25.86%	1.35
9	1991	22-Apr-1991	48.0	28	5.17%	1.05
10	1992	10-Oct-1992	97.5	6	81.03%	5.27
11	1993	27-Sep-1993	41.5	29	1.72%	1.02
12	1994	12-Sep-1994	80.3	16	46.55%	1.87
13	1995	10-May-1995	72.6	19	36.21%	1.57
14	1996	25-Oct-1996	83.5	10	67.24%	3.05
15	1997	10-Jun-1997	59.0	26	12.07%	1.14
16	1998	15-Oct-1998	81.0	15	50.00%	2.00
17	1999	26-Jul-1999	64.0	24	18.97%	1.23
18	2000	27-Sep-2000	109.5	2	94.83%	19.33
19	2001	13-Jan-2001	83.0	11	63.79%	2.76
20	2002	23-Aug-2002	111.5	1	98.28%	58.00
21	2003	02-May-2003	76.0	17	43.10%	1.76
22	2004	11-Sep-2004	94.9	8	74.14%	3.87
23	2005	23-Oct-2005	81.5	14	53.45%	2.15
24	2006	07-Apr-2006	72.5	20	32.76%	1.49
25	2007	12-Nov-2007	82.1	12	60.34%	2.52
26	2008	17-Oct-2008	100.4	4	87.93%	8.29
27	2009	03-Oct-2009	75.4	18	39.66%	1.66
28	2010	25-Mar-2010	103.1	3	91.38%	11.60
29	2011	05-Nov-2011	85.4	9	70.69%	3.41
	Max.		111.5			

Source: MOWRAM

Table AB-2.3.2.6.5 Estimation of Unit Hydrograph Methof for Tonle Bati (1/3)

Estimate of Flood Peak for Tonle Bati

100 Year Flood   Peak Flood Discharge = 248.6 m^3/s

1) From the 1: 50,000 or 1: 100,000 topographic map

a) A = Catchment area 240.2 km^2

b) L = Legth of stream measured from dam site to the watershed divide

52.2 km

c) c.o.a = centroid of drainage area

d) Lc = length along stream from the centroid

26 km

e) s = average slope of stream in the watershed

	point 1	point 2
El. (m)	8	713
Length (m)	0	52,200
Slope		0.0135

f) t_{lag} = lag time, hrs = 1.90* (LLc/√s)^0.162

8.66 hours

The lag time is defined as the time from the midpoint of the storm to the peak flow of that storm

Tp = flood arrival time = 1.11 * t_{lag} (usually rounded to the mearest half hour)

say 10.0 hours

Tp/5 = plotting interval or the duration of the individual storm

2 hours

2) From the graph of rainfall

Probable Daily Rainfall R24 135 mm/day   4 Log Peason Type-III

Rainfall Intencity by Mononobe

$Ri=R_{24}/24*(24/t)^n$ n= 0.50

	1 Δt hrs	2 Ri mm/hr	3 pt cm	4 Reduction	5 3*4 cm	6 PΔt cm	7 ARD cm	8 6-7 cm	9 Rank	10 Order	11 Ri cm
1	0.0	0	0.00	0.00	0.00	0.00	0.0	0.00	11	6	0.18
2	2.0	19.5	3.90	0.85	3.31	3.31	0.6	2.71	1	4	0.44
3	4.0	13.8	5.51	0.90	4.96	1.65	0.6	1.05	2	3	0.65
4	6.0	11.3	6.75	0.92	6.21	1.25	0.6	0.65	3	1	2.71
5	8.0	9.7	7.80	0.93	7.25	1.04	0.6	0.44	4	2	1.05
6	10.0	8.7	8.72	0.94	8.20	0.94	0.6	0.34	5	5	0.34
7	12.0	8.0	9.55	0.94	8.98	0.78	0.6	0.18	6		
8	14.0	7.4	10.32	0.94	9.70	0.72	0.6	0.12	8		
9	16.0	6.9	11.03	0.95	10.48	0.78	0.6	0.18	7		
10	18.0	6.5	11.70	0.95	11.11	0.64	0.6	0.04	9		
11	20.0	6.2	12.33	0.95	11.72	0.60	0.6	0.00	10		
12	22.0	5.9	12.93	0.95	12.29	0.57	0.6	0.00	11		

Column 1: Δt, time in hrs (from Tp/5 determination)

Column 2: Rainfall Intencity by Mononobe Formula $Ri=R_{24}/24*(24/t)^n$

Column 3: pt, rainfall, cumulative, in cm (Rainfall depth, frequency and duration curve for specific area)

Column 4: % reduction due to variation in storm intensity over the watershed area

Column 5: Column 2 * Column 3

Column 6: incremental rainfall, or rainfall during each Δt period

Column 7: amount of infiltration, ARD assumes 0.3 cm per hour and that the infiltration rate is constant throughout the storm

Column 10: Column 5 - Column 6 = surface runoff. These values represent the runoff from each of substorms.

Column 11: The values from Column 7 are rearranged to achieve a median composite of Q_{peak} . A bell-shaped curve seems to do the job. The Design of Small Dams recommends ordering them in the following pattern: 6, 4, 3, 1, 2, 5.

Source: JICA Survey Team

Table AB-2.3.2.6.5 Estimation of Unit Hydrograph Methof for Tonle Bati (2/3)

3) Determine an unit hydrograph for the watershed from the Dimensionless Unithydrograph (DUH)

	1 hrs	2	3	4
1	0.0	0.0	0.00	0.00
2	2.0	0.2	0.10	5.01
3	4.0	0.4	0.31	15.52
4	6.0	0.6	0.66	33.04
5	8.0	0.8	0.93	46.55
6	10.0	1.0	1.00	50.05
7	12.0	1.2	0.93	46.55
8	14.0	1.4	0.78	39.04
9	16.0	1.6	0.56	28.03
10	18.0	1.8	0.39	19.52
11	20.0	2.0	0.28	14.02
12	22.0	2.2	0.21	10.51
13	24.0	2.4	0.15	7.51
14	26.0	2.6	0.11	5.51
15	28.0	2.8	0.08	4.00
16	30.0	3.0	0.06	3.00
17	32.0	3.2	0.04	2.00
18	34.0	3.4	0.03	1.50
19	36.0	3.6	0.02	1.00
20	38.0	3.8	0.02	0.75
21	40.0	4.0	0.01	0.50
22	42.0	4.2	0.00	0.00
23	44.0	4.4	0.00	0.00
24	46.0	4.6	0.00	0.00
25	48.0	4.8	0.00	0.00
26	50.0	5.0	0.00	0.00
27	52.0	5.2	0.00	0.00
28	54.0	5.4	0.00	0.00
29	56.0	5.6	0.00	0.00
30	58.0	5.8	0.00	0.00
31	60.0	6.0	0.00	0.00
32	62.0	6.2	0.00	0.00
33	64.0	6.4	0.00	0.00
34	66.0	6.6	0.00	0.00
35	68.0	6.8	0.00	0.00
36	70.0	7.0	0.00	0.00
37	72.0	7.2	0.00	0.00
38	74.0	7.4	0.00	0.00
39	76.0	7.6	0.00	0.00
40	78.0	7.8	0.00	0.00
41	80.0	8.0	0.00	0.00
42	82.0	8.2	0.00	0.00
43	84.0	8.4	0.00	0.00
44	86.0	8.6	0.00	0.00
45	88.0	8.8	0.00	0.00
46	90.0	9.0	0.00	0.00
47	92.0	9.2	0.00	0.00
48	94.0	9.4	0.00	0.00
49	96.0	9.6	0.00	0.00
50	98.0	9.8	0.00	0.00
	Sum of DUH		6.67	

Column 1: Δt, time in hrs (from Tp/5 determination)
Column 2: $\Delta t/Tp$
Column 3: DUH ordinates from graph
Column 4: DUH ordinate from Column 3 divided by F where

F = $(0.36*\Delta t*\Sigma DUH)$ / (Watershed, km^2) = $\boxed{0.019978}$

Source: JICA Survey Team

Table AB-2.3.2.6.5 Estimation of Unit Hydrograph Methof for Tonle Bati (3/3)

4) Determine inflow hydrograph (unit hydrograph ordinate from step 3 multiplied by the substorm runoff from step 2)
The number above each column represent the excess for the substorm flows in cm.

	Time, hr	0.18	0.44	0.65	2.71	1.05	0.34	Total
1	0.0	0	0	0	0	0	0	0.0
2	2.0	0.91	0	0	0	0	0	0.9
3	4.0	2.83	2.20	0	0	0	0	5.0
4	6.0	6.02	6.82	3.26	0	0	0	16.1
5	8.0	8.49	14.51	10.10	13.59	0	0	46.7
6	10.0	9.13	20.45	21.49	42.12	5.25	0	98.4
7	12.0	8.49	21.99	30.29	89.68	16.27	1.72	168.4
8	14.0	7.12	20.45	32.57	126.37	34.65	5.33	226.5
9	16.0	5.11	17.15	30.29	135.88	48.82	11.34	248.6
10	18.0	3.56	12.31	25.40	126.37	52.49	15.98	236.1
11	20.0	2.56	8.58	18.24	105.99	48.82	17.19	201.4
12	22.0	1.92	6.16	12.70	76.09	40.95	15.98	153.8
13	24.0	1.37	4.62	9.12	52.99	29.40	13.40	110.9
14	26.0	1.00	3.30	6.84	38.05	20.47	9.62	79.3
15	28.0	0.73	2.42	4.88	28.54	14.70	6.70	58.0
16	30.0	0.55	1.76	3.58	20.38	11.02	4.81	42.1
17	32.0	0.37	1.32	2.61	14.95	7.87	3.61	30.7
18	34.0	0.27	0.88	1.95	10.87	5.77	2.58	22.3
19	36.0	0.18	0.66	1.30	8.15	4.20	1.89	16.4
20	38.0	0.14	0.44	0.98	5.44	3.15	1.37	11.5
21	40.0	0.09	0.33	0.65	4.08	2.10	1.03	8.3
22	42.0	0.00	0.22	0.49	2.72	1.57	0.69	5.7
23	44.0	0.00	0.00	0.33	2.04	1.05	0.52	3.9
24	46.0	0.00	0.00	0.00	1.36	0.79	0.34	2.5
25	48.0	0.00	0.00	0.00	0.00	0.52	0.26	0.8
26	50.0	0.00	0.00	0.00	0.00	0.00	0.17	0.2
27	52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
28	54.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
29	56.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
30	58.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
31	60.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
32	62.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
33	64.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
34	66.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
35	68.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
36	70.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
37	72.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
38	74.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
39	76.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
40	78.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
41	80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
42	82.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
43	84.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
44	86.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
45	88.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
46	90.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
47	92.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
48	94.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
49	96.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
50	98.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0

Peak Q 248.6 m^3/s

Source: JICA Survey Team

Table AB-2.3.2.7.1 Specifications and Conditions of Flood Routing of Lake Tonle Bati

C.A.	240.2 km^2

(1) Reservoir Storage Curve

Elevation (El.m)	Volume (x10^6 m^3)	Area (km^2)	D.C.L (m)
3.3	0.000	0.000	
3.5	0.076	0.760	
4.0	0.626	1.440	
5.0	2.546	2.400	
6.0	5.836	4.180	
7.0	10.651	5.450	
8.0	16.496	6.240	
9.0	*23.116*	*7.000*	

(2) Input Data

High Water Level (HWL) (EL.m)	**7.80**	m	6
Riverbed Elevation (EL.m)	3.30	m	
Minimum Supply Water Level (Plan) (MSWL)	7.00	m	6
Low Water Level at Present Condition (LWL)	5.50	m	4
Freeboard	0.90	m	
Dam Height (m)	**5.40**		
Gross Storage Vol.(x10^6 m^3)	**15.33**	MCM	
Dead Storage (upto MSWL) (x10^6 m^3)	**10.65**	MCM	
Effective Storage Vol.(x10^6 m^3)	**4.68**	MCM	

(3) Spillway

Dike Crest Elevation (EL.m)	**8.70**	m	7
Spillway Gate Top Elevation (EL.m)	**7.50**	m	6
Spillway Crest Elevation (EL.m)	**4.50**	m	3
Number of Spillway Span (*n*)	**4**		*n*
Width of Spillway per Span (*B*)	**1.15**	m	*B*
Width of Peer per Peer (*b*)	**0.40**	m	*b*
Length of Spillway Crest (*L*)	***1.50***	m	*L*

Source: JICA Survey Team

Table AB-2.4.2.3.1 Estimated Monthly Basin Rainfall at Khpob Krous Reservor, Ou Chraloy River

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1982	0.29	0.37	10.49	132.76	132.47	128.44	55.31	113.55	181.10	168.12	79.14	0.07	1,002.1
1983	0.00	0.00	0.00	14.57	144.19	74.57	156.54	248.46	102.98	352.74	88.11	18.25	1,200.4
1984	0.00	2.82	2.06	48.36	106.28	150.46	95.81	90.57	271.09	240.38	14.81	0.00	1,022.6
1985	0.00	42.96	0.00	221.44	261.56	120.43	121.14	48.67	272.58	133.79	85.92	0.00	1,308.5
1986	10.59	9.35	1.66	76.73	76.24	100.51	81.18	73.43	204.82	146.91	175.32	66.32	1,023.1
1987	0.00	0.38	0.00	8.73	104.95	92.63	38.99	107.24	191.68	86.21	202.46	0.00	833.3
1988	0.00	0.78	16.52	83.69	108.64	155.35	87.00	92.01	166.34	199.90	40.75	0.00	951.0
1989	3.43	0.00	4.58	16.40	174.68	43.96	92.22	115.19	237.10	243.15	0.00	0.00	930.7
1990	0.00	0.00	4.19	49.97	110.75	68.84	78.94	106.22	114.47	70.88	107.81	3.96	716.0
1991	0.00	7.81	4.03	73.06	46.84	157.12	183.37	190.51	160.43	158.84	0.00	10.05	992.0
1992	2.49	0.00	0.00	29.02	34.32	94.15	164.16	92.47	154.01	248.31	24.60	3.50	847.0
1993	43.46	0.00	48.37	18.24	41.06	87.17	48.51	60.79	191.09	288.42	50.78	0.00	877.9
1994	0.00	0.00	73.58	12.69	74.42	83.83	164.53	160.85	234.76	111.12	3.84	12.97	932.6
1995	0.00	0.00	52.37	0.00	144.30	39.28	99.00	172.43	249.18	242.27	65.22	2.80	1,066.9
1996	5.71	0.00	0.00	133.27	107.88	113.67	119.58	88.96	222.13	291.56	170.56	12.79	1,266.1
1997	0.00	0.00	11.03	0.93	156.63	188.13	96.46	121.84	239.40	257.96	24.71	16.76	1,113.9
1998	0.00	0.47	12.95	89.51	113.41	99.31	77.51	192.44	315.60	279.04	132.85	10.24	1,323.3
1999	11.60	0.93	42.74	141.37	230.99	121.75	237.30	150.83	262.76	98.79	15.23	7.07	1,321.4
2000	5.60	5.44	84.65	85.89	100.66	150.00	123.64	105.49	90.09	384.78	107.02	78.16	1,321.4
2001	135.21	0.00	90.73	106.50	83.14	42.07	195.68	146.39	348.91	376.27	18.29	65.20	1,608.4
2002	0.00	0.00	0.28	245.88	181.41	81.26	31.10	169.24	108.24	147.40	163.88	33.77	1,162.5
2003	0.00	0.00	5.52	88.40	110.01	102.68	424.88	120.94	96.05	294.22	16.63	9.92	1,269.3
2004	0.04	34.67	5.60	48.20	126.20	189.24	26.96	45.40	255.72	152.45	55.55	0.00	940.0
2005	0.00	0.00	0.02	92.23	80.09	79.93	153.52	95.17	85.04	265.37	72.48	71.07	994.9
2006	10.79	9.28	14.08	19.05	39.42	18.32	51.88	200.70	239.59	87.88	11.62	0.10	702.7
2007	0.00	23.13	33.44	89.95	66.28	114.66	68.68	67.22	108.60	82.62	88.17	0.00	742.7
2008	0.00	22.96	48.85	113.79	93.04	69.43	39.24	161.38	76.95	211.56	30.77	6.55	874.5
2009	0.00	14.07	9.69	49.64	62.47	60.00	51.49	56.04	190.94	209.28	34.23	0.00	737.9
2010	1.44	11.41	11.22	21.31	41.86	78.40	93.54	90.29	119.66	252.75	109.32	21.38	852.6
2011	0.00	32.74	53.07	39.14	44.37	123.17	93.50	224.40	34.12	111.56	103.64	0.47	860.2

Source: JICA Survey Team

Table AB-2.4.2.3.2 Estimated Monthly Basin Rainfall at O Kbear Reservor, Ou Doun Angir River

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1982	0.29	0.37	10.48	132.64	132.35	128.31	55.25	113.44	180.93	167.96	79.07	0.07	1,001.2
1983	0.00	0.00	0.00	2.18	163.54	70.26	173.24	245.13	87.85	398.16	101.08	19.58	1,261.0
1984	0.00	3.28	2.39	56.22	106.95	148.03	99.33	81.50	290.13	255.85	9.92	0.00	1,053.6
1985	0.00	49.94	0.00	230.93	282.97	129.62	127.10	46.69	286.32	104.89	80.33	0.00	1,338.8
1986	7.44	4.07	0.00	84.99	85.21	94.96	80.57	62.90	213.01	162.85	167.33	55.27	1,018.6
1987	0.00	0.44	0.26	7.91	108.64	79.03	42.98	110.41	203.27	83.90	218.34	0.00	855.2
1988	0.00	0.00	15.05	80.12	113.71	173.76	94.84	97.61	165.24	218.02	47.37	0.00	1,005.7
1989	3.98	0.00	0.00	0.00	156.19	52.01	100.79	120.85	208.13	256.35	3.65	0.00	902.0
1990	0.00	0.00	4.99	40.70	122.20	73.43	87.48	109.78	118.22	63.55	96.00	4.71	721.1
1991	0.00	6.91	0.00	75.99	51.34	145.14	186.66	155.28	160.85	152.42	0.00	11.69	946.3
1992	0.00	0.00	0.00	24.76	41.10	101.00	174.64	94.09	147.45	231.16	28.60	4.07	846.9
1993	49.37	0.00	42.50	19.39	31.00	93.52	39.57	58.96	187.46	296.72	54.57	0.00	873.1
1994	0.00	0.00	69.41	13.33	71.26	88.67	174.22	149.49	259.33	118.84	4.53	14.26	963.3
1995	0.00	0.00	54.83	0.00	160.86	41.11	98.10	174.09	242.37	252.01	68.30	0.59	1,092.3
1996	7.50	0.00	0.00	140.45	113.33	105.15	101.11	87.50	233.30	315.34	171.69	11.45	1,286.8
1997	0.36	0.00	1.84	1.80	172.68	220.81	85.04	110.41	269.78	290.35	26.56	19.48	1,199.1
1998	0.00	0.00	15.05	92.23	128.80	108.20	72.58	183.25	329.95	279.42	130.48	9.74	1,349.7
1999	13.38	0.27	35.42	127.65	214.07	132.25	250.83	151.96	294.61	67.22	4.22	0.93	1,292.8
2000	1.15	0.21	77.06	90.69	102.78	140.53	118.43	105.92	117.86	354.93	99.68	84.11	1,293.3
2001	128.64	0.00	96.48	104.79	81.54	28.14	184.05	151.06	368.29	345.87	15.33	68.78	1,573.0
2002	0.00	0.00	0.21	230.12	185.62	79.08	37.14	151.14	111.88	149.70	152.46	36.33	1,133.7
2003	0.00	0.00	5.90	81.00	113.84	104.09	414.94	129.51	88.18	272.31	16.21	9.34	1,235.3
2004	0.75	24.66	2.79	51.21	128.64	177.58	51.46	42.87	245.88	164.93	49.70	0.00	940.5
2005	0.00	0.00	0.00	97.81	105.02	67.80	146.06	94.41	88.74	254.88	86.90	87.51	1,029.1
2006	9.58	15.82	4.65	18.63	61.41	33.79	77.70	148.98	224.63	110.88	11.45	0.00	717.5
2007	0.00	20.57	23.31	75.03	68.35	106.15	60.59	75.09	112.79	128.67	81.73	0.00	752.3
2008	0.31	20.42	34.76	136.22	92.95	59.69	33.49	150.59	73.22	168.94	35.38	5.82	811.8
2009	0.00	8.66	6.13	103.40	85.27	69.08	54.12	69.04	211.51	222.67	29.76	0.00	859.6
2010	0.51	9.80	13.19	39.08	40.05	89.08	97.72	102.86	139.51	251.71	101.16	0.12	884.8
2011	0.00	29.12	56.04	25.72	47.19	111.92	65.18	213.70	20.48	96.39	105.42	0.13	771.3

Source: JICA Survey Team

Table AB-2.4.2.3.3 Estimated Monthly Basin Rainfall at Ou Boeng Toap Reservor

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1982	0.31	0.38	10.95	138.58	138.28	134.07	57.73	118.52	189.04	175.49	82.61	0.08	1,046.0
1983	0.00	0.00	0.00	2.20	165.09	70.92	174.88	247.45	88.68	401.93	102.04	19.77	1,273.0
1984	0.00	2.91	2.12	49.87	102.23	145.65	102.92	82.74	276.77	250.48	8.80	0.00	1,024.5
1985	0.00	44.30	0.00	228.15	298.35	124.27	132.03	42.47	277.53	111.47	82.56	0.00	1,341.1
1986	6.60	3.61	0.00	87.86	95.78	92.37	83.06	62.50	211.14	177.57	151.61	56.08	1,028.2
1987	0.00	0.39	1.58	9.52	96.37	76.87	42.06	107.23	195.56	102.11	217.36	0.00	849.0
1988	0.00	0.00	13.35	93.34	114.00	165.49	104.16	86.79	161.54	225.16	42.02	0.00	1,005.9
1989	3.53	0.00	0.00	0.00	138.55	56.07	99.33	116.44	203.97	262.85	22.40	0.00	903.1
1990	0.00	0.00	5.03	41.09	123.36	74.13	88.31	110.82	119.33	64.15	96.91	4.76	727.9
1991	0.00	6.13	0.00	67.97	52.91	153.96	178.69	157.59	165.27	163.79	0.00	10.37	956.7
1992	0.00	0.00	0.00	30.64	57.01	95.94	169.97	84.68	155.08	234.22	25.37	3.61	856.5
1993	51.96	0.00	37.70	19.08	36.86	99.81	37.85	64.78	192.37	336.73	63.88	0.00	941.0
1994	0.00	0.00	77.42	19.07	78.00	93.26	177.13	143.47	259.75	114.65	4.40	12.65	979.8
1995	0.00	0.00	55.75	0.00	158.67	46.70	99.76	177.02	246.45	256.25	69.45	3.65	1,113.7
1996	11.14	0.00	0.00	137.69	116.75	102.39	100.80	87.48	239.90	321.79	175.09	12.63	1,305.7
1997	2.19	0.00	11.29	11.03	162.62	206.92	84.92	115.13	270.40	275.81	23.56	17.28	1,181.2
1998	0.00	0.00	13.35	96.55	121.08	101.57	82.84	176.33	323.59	283.06	149.96	8.64	1,357.0
1999	17.02	1.63	31.42	132.62	202.76	128.30	233.10	151.63	297.27	91.80	25.93	5.69	1,319.2
2000	7.05	1.31	82.42	96.81	101.28	142.84	115.54	128.77	196.26	280.96	96.93	109.01	1,359.2
2001	104.46	0.00	106.08	74.96	53.81	38.42	151.52	192.60	319.95	309.34	16.65	66.39	1,434.2
2002	0.00	0.00	1.31	184.24	134.41	59.99	44.01	131.52	128.40	170.24	125.65	53.17	1,032.9
2003	0.00	0.00	21.10	70.90	91.67	124.11	349.40	180.57	108.06	156.43	16.52	2.04	1,120.8
2004	2.67	28.29	10.17	62.48	127.59	114.47	130.08	30.45	147.64	183.88	37.12	0.00	874.8
2005	0.00	0.00	0.00	88.43	146.06	52.64	150.66	81.54	139.28	257.99	127.29	138.85	1,182.7
2006	0.00	29.10	18.59	71.93	181.42	85.23	147.03	73.09	133.49	159.91	11.66	0.00	911.4
2007	0.00	0.00	2.33	102.19	127.22	155.12	84.12	160.93	159.63	283.90	111.79	0.00	1,187.2
2008	1.90	0.00	2.92	224.81	103.91	68.42	32.74	99.72	144.14	185.10	117.14	0.00	980.8
2009	0.00	2.50	0.51	303.76	172.01	84.04	107.54	121.39	226.91	284.63	31.60	0.00	1,334.9
2010	3.11	0.00	50.76	89.84	65.54	132.82	153.72	135.75	195.23	251.91	69.46	0.72	1,148.9
2011	0.00	0.00	44.66	41.22	53.85	94.44	66.83	164.43	19.65	79.05	105.94	0.80	670.9

Source: JICA Survey Team

Table AB-2.4.2.4.1 Estimated Monthly Mean Dischage at Khpob Krous Reservor, Ou Chraloy River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1993	0.25	0.18	0.16	0.19	0.11	0.15	0.22	0.15	0.44	4.35	0.86	0.51	0.63
1994	0.24	0.11	0.27	0.26	0.21	0.71	1.06	3.51	4.61	2.59	0.88	0.42	1.24
1995	0.18	0.08	0.06	0.13	0.33	0.89	1.00	3.38	6.21	8.46	1.79	0.79	1.95
1996	0.35	0.15	0.07	0.79	1.46	1.50	2.12	2.25	4.26	8.05	6.23	1.75	2.42
1997	0.68	0.30	0.15	0.19	2.08	1.45	1.52	2.18	3.74	4.56	2.40	0.83	1.68
1998	0.38	0.17	0.14	1.41	3.50	0.71	0.40	1.48	2.35	3.59	3.44	0.79	1.54
1999	0.35	0.21	0.24	3.84	3.48	0.86	1.70	1.43	5.13	5.31	1.86	0.72	2.10
2000	0.32	0.19	0.50	0.67	0.65	0.52	1.02	1.57	1.51	7.54	1.27	0.81	1.39
2001	2.71	0.87	1.39	1.93	0.79	0.62	5.59	3.20	7.40	14.43	2.65	1.87	3.65
2002	0.56	0.26	0.12	3.67	3.53	0.98	0.61	2.56	1.19	2.08	2.59	0.88	1.59
2003	0.43	0.19	0.09	0.34	1.94	0.89	8.46	1.71	1.08	5.91	1.11	0.52	1.92
2004	0.22	0.17	0.13	0.07	0.77	3.18	0.58	0.28	5.30	2.81	0.66	0.36	1.20
2005	0.17	0.07	0.03	0.11	0.26	0.31	1.34	1.46	0.77	4.69	1.40	0.94	0.97
2006	0.85	0.35	0.17	0.08	0.04	0.03	0.05	2.59	4.77	1.70	0.77	0.38	0.98
2007	0.16	0.10	0.09	0.13	0.36	0.81	0.72	0.46	0.38	0.50	1.56	0.45	0.48
2008	0.21	0.12	0.11	0.37	0.74	0.50	0.30	1.95	0.70	2.57	1.50	0.48	0.80
2009	0.21	0.10	0.05	0.04	0.17	0.22	0.18	0.12	2.12	3.08	0.87	0.42	0.63
2010	0.18	0.08	0.04	0.02	0.01	0.03	0.14	0.31	0.32	3.47	1.53	0.69	0.57
2011	0.34	0.18	0.15	0.19	0.12	0.16	0.65	2.00	1.25	0.81	0.97	0.47	0.61
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
Max.	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
Min.	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

Source: JICA Survey Team

Table AB-2.4.2.4.2 Estimated Monthly Mean Dischage at O Kbear Reservor, Ou Doun Angir River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1992	0.46	0.21	0.09	0.04	0.02	0.35	2.00	0.74	1.77	4.64	0.91	0.44	0.98
1993	0.20	0.17	0.11	0.13	0.07	0.17	0.19	0.12	0.33	3.70	0.71	0.43	0.53
1994	0.21	0.09	0.19	0.19	0.15	0.63	0.99	2.70	4.24	2.43	0.76	0.36	1.08
1995	0.16	0.07	0.06	0.11	0.43	0.95	0.84	2.80	4.88	7.12	1.53	0.65	1.64
1996	0.29	0.13	0.06	0.74	1.33	1.09	1.39	1.59	3.65	7.17	5.28	1.44	2.01
1997	0.56	0.25	0.11	0.05	2.73	4.22	1.78	1.21	4.68	5.94	1.24	0.55	1.95
1998	0.27	0.12	0.05	0.18	0.44	0.32	0.22	1.30	5.92	5.86	2.21	0.88	1.48
1999	0.40	0.18	0.09	1.07	4.34	1.87	5.13	4.57	7.65	1.98	0.93	0.43	2.40
2000	0.18	0.08	0.31	0.51	1.15	0.56	1.13	1.08	1.00	7.57	1.96	1.31	1.41
2001	2.29	0.78	1.30	1.57	0.64	0.49	4.19	2.68	6.45	11.06	2.03	1.58	2.94
2002	0.46	0.21	0.09	2.62	2.91	0.77	0.49	1.72	0.88	1.74	1.93	0.69	1.21
2003	0.35	0.16	0.07	0.21	1.52	0.74	6.64	1.40	0.85	4.21	0.85	0.40	1.47
2004	0.17	0.10	0.07	0.03	0.66	2.30	0.46	0.28	4.09	2.58	0.55	0.28	0.96
2005	0.13	0.06	0.03	0.06	0.24	0.25	0.74	1.14	0.61	3.52	1.05	0.88	0.73
2006	0.98	0.31	0.15	0.07	0.04	0.03	0.37	1.49	3.00	1.66	0.66	0.32	0.76
2007	0.14	0.07	0.06	0.07	0.33	0.70	0.44	0.31	0.26	0.69	1.05	0.38	0.38
2008	0.18	0.09	0.07	0.46	0.39	0.39	0.23	1.50	0.52	1.53	0.89	0.34	0.55
2009	0.15	0.07	0.03	0.17	0.21	0.24	0.21	0.13	2.18	2.97	0.77	0.37	0.63
2010	0.16	0.07	0.03	0.02	0.01	0.06	0.14	0.21	0.29	2.97	1.18	0.53	0.48
2011	0.24	0.12	0.12	0.15	0.10	0.10	0.30	1.54	0.90	0.60	0.80	0.37	0.45
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
Max.	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
Min.	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

Source: JICA Survey Team

Table AB-2.4.2.4.3 Estimated Monthly Mean Dischage at Ka Ek Tom Reservor, Ou Boeng Toap River

(Unit: m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1992	0.07	0.03	0.01	0.01	0.01	0.05	0.30	0.10	0.30	0.75	0.14	0.07	0.16
1993	0.03	0.03	0.02	0.02	0.01	0.04	0.03	0.02	0.06	0.75	0.13	0.08	0.10
1994	0.04	0.02	0.04	0.04	0.03	0.12	0.17	0.41	0.67	0.37	0.12	0.06	0.17
1995	0.02	0.01	0.01	0.02	0.06	0.16	0.14	0.46	0.79	1.15	0.25	0.10	0.27
1996	0.05	0.02	0.01	0.11	0.22	0.17	0.22	0.25	0.60	1.16	0.85	0.23	0.32
1997	0.09	0.04	0.02	0.01	0.39	0.61	0.28	0.20	0.74	0.88	0.19	0.08	0.29
1998	0.04	0.02	0.01	0.03	0.06	0.05	0.03	0.19	0.90	0.94	0.42	0.15	0.24
1999	0.07	0.03	0.01	0.19	0.65	0.28	0.74	0.70	1.22	0.40	0.19	0.09	0.38
2000	0.04	0.02	0.06	0.09	0.18	0.09	0.18	0.23	0.35	1.03	0.27	0.28	0.24
2001	0.29	0.11	0.23	0.16	0.07	0.05	0.51	0.57	0.86	1.54	0.30	0.23	0.41
2002	0.07	0.03	0.02	0.27	0.28	0.08	0.06	0.21	0.14	0.35	0.27	0.13	0.16
2003	0.06	0.03	0.01	0.02	0.17	0.14	0.81	0.28	0.22	0.24	0.09	0.05	0.18
2004	0.02	0.01	0.01	0.01	0.11	0.15	0.11	0.10	0.30	0.46	0.08	0.04	0.12
2005	0.02	0.01	0.00	0.02	0.08	0.06	0.06	0.16	0.22	0.61	0.29	0.24	0.15
2006	0.21	0.06	0.04	0.04	0.17	0.14	0.39	0.12	0.17	0.47	0.11	0.05	0.17
2007	0.02	0.01	0.00	0.03	0.17	0.30	0.11	0.08	0.21	0.65	0.35	0.11	0.17
2008	0.05	0.02	0.01	0.39	0.11	0.07	0.04	0.03	0.10	0.30	0.38	0.09	0.13
2009	0.04	0.02	0.01	0.74	0.14	0.17	0.09	0.09	0.48	0.80	0.15	0.07	0.23
2010	0.03	0.01	0.01	0.05	0.04	0.19	0.13	0.22	0.23	0.82	0.14	0.08	0.17
2011	0.04	0.02	0.01	0.02	0.03	0.03	0.04	0.22	0.12	0.05	0.22	0.06	0.07
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
Max.	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
Min.	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

Table AB-2.4.2.5.1 Estimated Half Monthly Unit Irrigation Water Requirement in MC35RSP

(Unit: l/sec/ha)

Early Rice (Early Rainy Season)

		Jan		Feb		Mar		Apr		May		Jun		Jul		Nov		Dec	
	Year	1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
1	**1992**			0.73	1.47	2.49	2.83	2.23	2.20	2.15	1.41	0.35							
2	**1993**			0.76	1.52	2.60	2.94	3.11	3.08	1.74	1.14	0.85							
3	**1994**			0.68	1.36	2.10	2.45	2.62	2.58	1.93	1.27	0.80							
4	**1995**			0.76	1.52	2.32	2.67	2.81	2.78	2.15	1.41	0.57							
5	**1996**			0.76	1.52	2.19	2.53	3.19	3.16	1.65	1.08	0.78							
6	**1997**			0.76	1.52	2.60	2.94	3.03	3.00	1.30	0.85	0.63							
7	**1998**			0.76	1.52	2.60	2.94	2.86	2.83	2.73	1.80	0.82							
8	**1999**			0.76	1.52	2.60	2.94	2.59	2.56	1.63	1.07	0.68							
9	**2000**			0.71	1.41	2.32	2.67	2.73	2.69	2.18	1.43	0.64							
10	**2001**			0.00	0.00	1.00	2.03	3.19	3.16	2.07	1.36	0.54							
11	**2002**			0.76	1.52	1.94	2.28	2.75	2.72	2.32	1.52	0.69							
12	**2003**			0.76	1.52	2.60	2.94	1.87	1.84	1.79	1.18	0.72							
13	**2004**			0.74	1.49	2.49	2.83	2.37	2.34	2.32	1.52	0.73							
14	**2005**			0.76	1.52	2.57	2.92	2.81	2.78	2.23	1.47	0.40							
15	**2006**			0.76	1.52	2.60	2.94	3.00	2.97	2.04	1.34	0.61							
16	**2007**			0.75	1.51	2.49	2.83	2.67	2.64	1.99	1.30	0.71							
17	**2008**			0.76	1.52	2.43	2.78	2.70	2.67	1.35	0.88	0.56							
18	**2009**			0.76	1.52	2.35	2.70	2.62	2.58	1.74	1.14	0.69							
19	**2010**			0.76	1.52	2.46	2.81	2.53	2.50	2.15	1.41	0.74							
20	**2011**			0.76	1.52	2.32	2.67	2.84	2.80	2.15	1.41	0.71							

Medium Paddy

		Jan		Feb		Mar		Apr		May		Jun		Jul		Nov		Dec	
	Year	1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
1	**1992**			0.19	0.39	0.80	1.15	1.04	1.09	0.99	0.94	1.84	1.21	0.61					
2	**1993**			0.29	0.58	0.18	0.32	1.26	1.31	1.04	1.00	1.07	0.70	0.61					
3	**1994**			0.35	0.70	1.03	1.45	0.24	0.29	1.43	1.38	1.90	1.25	0.57					
4	**1995**			0.30	0.61	0.74	1.07	0.51	0.57	0.77	0.72	1.77	1.17	0.60					
5	**1996**			0.36	0.72	1.51	2.09	1.50	1.56	0.10	0.06	0.31	0.00	0.00					
6	**1997**			0.38	0.76	0.84	1.21	0.00	0.00	0.08	0.05	1.90	1.25	0.62					
7	**1998**			0.20	0.40	0.45	0.68	0.87	0.93	1.59	1.55	1.22	0.80	0.62					
8	**1999**			0.39	0.79	0.89	1.26	0.00	0.00	0.44	0.39	0.89	0.58	0.49					
9	**2000**			0.20	0.40	0.35	0.54	0.43	0.49	1.10	1.05	1.48	0.98	0.55					
10	**2001**			0.37	0.73	0.24	0.41	0.00	0.00	1.18	1.13	1.82	1.20	0.60					
11	**2002**			0.37	0.73	0.51	0.76	0.68	0.74	1.95	1.91	0.84	0.55	0.45					
12	**2003**			0.21	0.41	1.20	1.67	0.17	0.21	0.19	0.14	1.22	0.80	0.60					
13	**2004**			0.45	0.90	0.37	0.57	1.04	1.09	2.45	2.40	1.90	1.25	0.62					
14	**2005**			0.28	0.56	0.89	1.26	0.00	0.00	0.96	0.91	1.90	1.25	0.62					
15	**2006**			0.33	0.66	0.29	0.46	0.81	0.87	1.35	1.30	1.90	1.25	0.59					
16	**2007**			0.12	0.25	0.74	1.07	0.00	0.00	0.52	0.47	1.90	1.25	0.62					
17	**2008**			0.00	0.00	0.80	1.15	0.62	0.68	0.71	0.67	0.76	0.50	0.62					
18	**2009**			0.28	0.56	0.82	1.18	0.24	0.29	0.00	0.00	1.80	1.18	0.62					
19	**2010**			0.28	0.55	1.03	1.45	1.04	1.09	0.00	0.00	0.93	0.61	0.53					
20	**2011**			0.00	0.00	0.60	0.87	0.73	0.79	0.00	0.00	1.42	0.94	0.60					

Early Paddy (Dry)

		Jan		Feb		Mar		Apr		May		Jun		Jul		Nov		Dec	
	Year	1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
1	**1992**	2.57	2.78	3.07	3.01	2.11	0.97										0.76	1.52	2.42
2	**1993**	2.57	2.78	3.15	3.10	2.18	1.01										0.63	1.52	2.42
3	**1994**	2.40	2.62	2.90	2.85	1.85	0.85										0.52	1.52	2.42
4	**1995**	2.57	2.78	3.15	3.10	2.00	0.92										0.75	1.45	2.31
5	**1996**	2.57	2.78	3.15	3.10	1.91	0.87										0.59	1.52	2.42
6	**1997**	2.57	2.78	3.15	3.10	2.18	1.01										0.46	1.52	2.42
7	**1998**	2.57	2.78	3.15	3.10	2.18	1.01										0.62	1.52	2.42
8	**1999**	2.57	2.78	3.15	3.10	2.18	1.01										0.15	1.45	2.31
9	**2000**	2.46	2.67	2.99	2.93	2.00	0.92										0.39	1.45	2.31
10	**2001**	2.46	2.67	2.93	2.88	2.03	0.94										0.38	1.27	2.03
11	**2002**	2.13	2.34	3.15	3.10	1.74	0.79										0.76	1.08	1.76
12	**2003**	2.57	2.78	3.15	3.10	2.18	1.01										0.40	1.43	2.28
13	**2004**	2.57	2.78	3.10	3.04	2.11	0.97										0.72	1.52	2.42
14	**2005**	2.57	2.78	3.15	3.10	2.16	1.00										0.65	1.52	2.42
15	**2006**	2.57	2.78	3.15	3.10	2.18	1.01										0.38	0.85	1.40
16	**2007**	2.70	2.78	3.13	3.07	2.11	0.97										0.76	1.52	2.68
17	**2008**	2.54	2.75	3.15	3.10	2.07	0.96										0.51	1.52	2.42
18	**2009**	2.57	2.78	3.15	3.10	2.02	0.93										0.51	1.41	2.25
19	**2010**	2.57	2.78	3.15	3.10	2.09	0.96										0.73	1.52	2.42
20	**2011**	2.51	2.73	3.15	3.10	2.00	0.92										0.62	1.41	2.25

Source: JICA Survey Team

Table AB-2.4.2.7.1 Specifications and Conditions of Flood Routing of Khpob Krous Reservoir

Return Period	200	year

1/50 years
1/100 years
1/200 years
1/500 years
1/1,000 years

Damsite	Khpob Krous Reservoir
River	Ou Chraloy
C.A.	97.7 km^2

Spillway Crest Elevation (El.m) = 53.74~55m

Case: Automatic Spillway Gates are fallen (Normal Cas

Selection of Case: Automatic Spillway Gates are Functioned (fallen) or Not functioned (Not fallen)

◉ Automatic Spillway Gates are Fallen 1

○ Not Fallen

(1) Reservoir Storage Curve

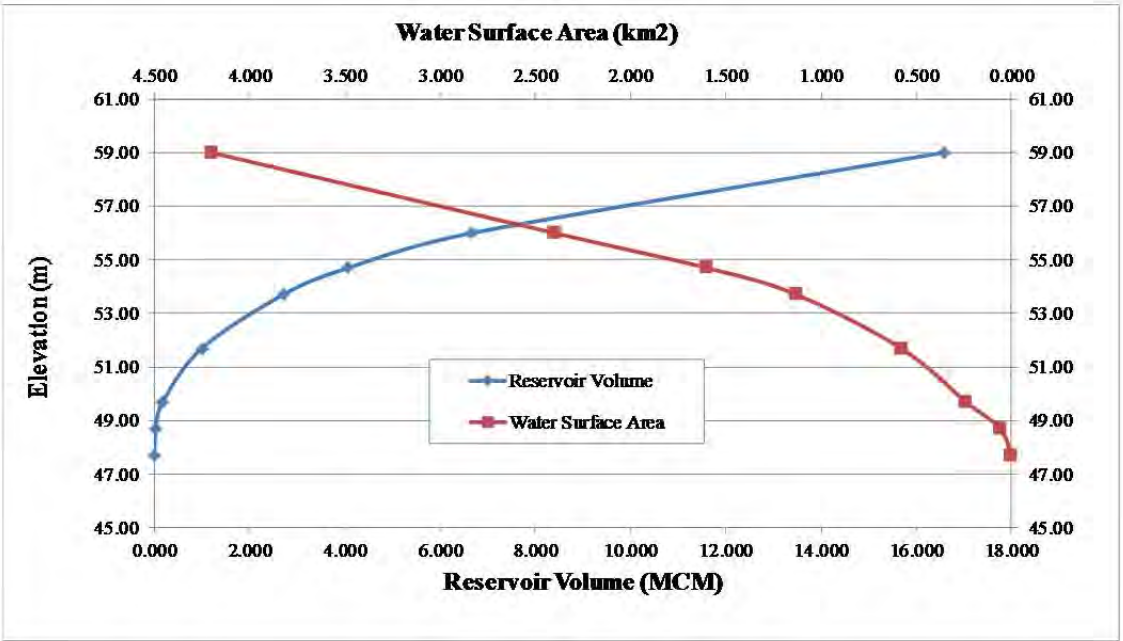
Elevation (El.m)	Volume ($x10^6 m^3$)	Area (km^2)	D.C.L (m)
47.70	0.000	0.000	
48.70	0.030	0.060	
49.70	0.180	0.240	
51.70	1.000	0.580	
53.70	2.710	1.130	
54.70	4.075	1.600	
56.00	*6.675*	*2.400*	
59.00	*16.575*	*4.200*	

(2) Input Data

Full Supply Level (FSL) (EL.m)	55.00	m	6
Riverbed Elevation (EL.m)	47.70	m	
Minimum Wter Level (EL.m)	52.00	m	4
Freeboard	0.50	m	
Dam Height (m)	7.8		
Gross Storage Vol.($x10^6 m^3$)	4.68	MCM	
Dead Storage ($x10^6 m^3$)	1.26	MCM	
Effective Storage Vol.($x10^6 m^3$)	3.42	MCM	

(3) Spillway

Dam Crest Elevation (EL.m)	55.50	m	6
Top of Automatic Spillway Gate (EL.m)	*55.00*	m	6
Spillway Crest Elevation (EL.m)	*53.00*	m	4
Number of Spillway Span (*n*)	4		*n*
Width of Spillway per Span (*B*)	7.97	m	*B*
Width of Peer per Peer (*b*)	3.00	m	*b*
Design Head at Spillwat Crest (*Hd*)	4.00	m	*Hd*
Length between Peer Tip & Spillway Crest (*S'*)	11.00	m	*S'*
b/S'	0.27	m	*b/S'*
Md=0.0756(Hd/B)^(1/2)*(1/n+1.465*(n-1)/n*(b/S')^1.7)	0.0199	m	*Md*
Radius of curvature *R = 0.920*Hd*	3.68	m	*R*



Source: JICA Survey Team
Project Proposal for Khpob Krous Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, April, 2008

Table AB-2.4.2.7.2 Specifications and Conditions of Flood Routing of O Kbear Reservoir

Return Period	200	year
1/50 years		
1/100 years		
1/200 years		
1/500 years		
1/1,000 years		

Damsite	O Kbear Reservoir
River	Ou Doun Angk
C.A.	92.5 km^2

Spillway Crest Elevation (El.m) = 44.41~45.8m

Case: Automatic Spillway Gates are fallen (Normal Case

Selection of Case: Automatic Spillway Gates are Functioned (fallen) or Not functioned (Not fallen)

◉ Aoutmatic Spillway Gates are Fallen — 1

○ Not Fallen

(1) Reservoir Storage Curve

Elevation (El.m)	Volume (x10^6 m^3)	Area (km^2)	D.C.L (m)	
39.10	0.000	0.000		0%
40.00	0.016	0.035		3%
41.00	0.074	0.082		7%
42.00	0.186	0.141		12%
43.00	0.373	0.234		20%
44.00	0.666	0.351		30%
45.00	1.134	0.586		50%
45.50	1.486	0.820		70%
45.80	1.784	1.171		100%
47.80	*5.956*	*3.000*		
50.00	*14.756*	*5.000*		

(2) Input Data

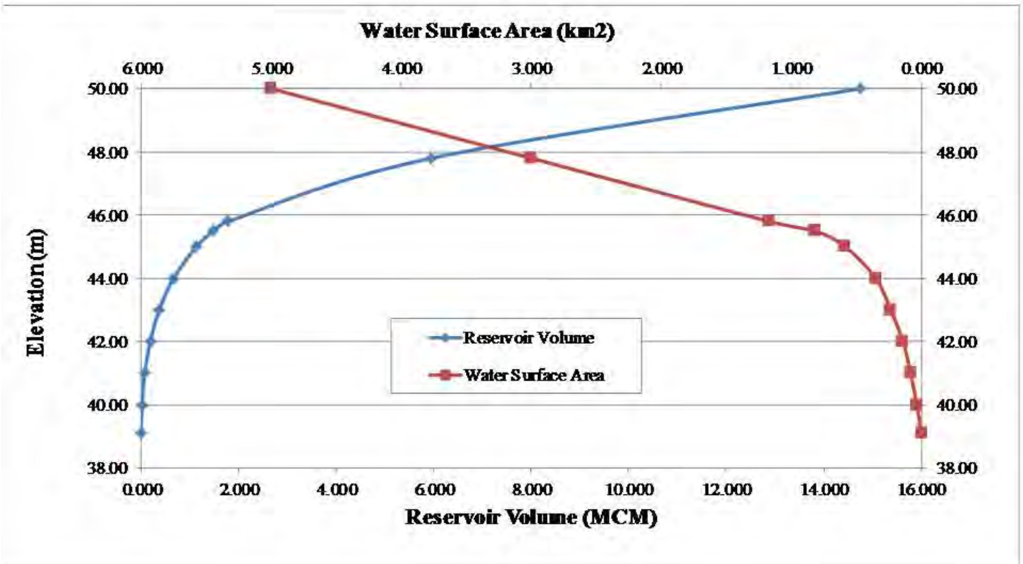
Full Supply Level (FSL) (EL.m)	45.80	m	9
Riverbed Elevation (EL.m)	39.10	m	
Minimum Wier Level (EL.m)	44.00	m	6
Freeboard	0.80	m	
Dam Height (m)	7.5		
Gross Storage Vol.(x10^6 m^3)	1.78	MCM	
Dead Storage (x10^6 m^3)	0.67	MCM	
Effective Storage Vol.(x10^6 m^3)	1.12	MCM	

(3) Spillway (Automatic Spillway Gate x 2 spans)

Dam Crest Elevation (EL.m)	47.80	m	10
Top of Automatic Spillway Gate (EL.m)	45.80	m	9
Spillway Crest Elevation (EL.m)	43.50	m	5
Number of Spillway Span (*n*)	2		*n*
Width of Spillway per Span (*B*)	7.85	m	*B*
Width of Peer per Peer (*b*)	3.00	m	*b*
Design Head at Spillwat Crest (*Hd*)	4.00	m	*Hd*
Length between Peer Tip & Spillway Crest (*S'*)	11.79	m	*S'*
b/S'	0.25	m	*b/S'*
Md=0.0756(Hd/B)^(1/2)*(1/n+1.465*(n-1)/n*(b/S')^1.7)	0.0308	m	*Md*
Radius of curvature *R = 0.920*Hd*	3.68	m	*R*

(4) Spillway (Side Spillway x 2 spans)

Spillway Crest Elevation (EL.m)	45.85	m	9
Number of Spillway Span (*n*)	2		*n*
Width of Spillway per Span (*B*)	7.85	m	*B*
Width of Peer per Peer (*b*)	1.80	m	*b*
Design Head at Spillwat Crest (*Hd*)	1.50	m	*Hd*
Length between Peer Tip & Spillway Crest (*S'*)	11.79	m	*S'*
b/S'	0.15	m	*b/S'*
Md=0.0756(Hd/B)^(1/2)*(1/n+1.465*(n-1)/n*(b/S')^1.7)	0.0175	m	*Md*
Radius of curvature *R = 0.920*Hd*	1.38	m	*R*



Source: *JICA Survey Team (Note: Reservoir Storage Curve was assumed)*
Project Proposal for O Kbear Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, January, 2007

Table AB-2.5.2.4.1 Estimated Half Monthly Unit Irrigation Water Requirement in SPWRRSP

(Unit: Litter/sec/ha)

Early Rice (Recession)

Month	Nov		Dec		Jan		Feb		Mar		Apr		May		Jun	
Year	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30
1992	0.44	0.88	1.35	1.83	2.32	2.31	1.99	1.50	1.05	0.50						
1993	0.32	0.64	1.35	1.83	2.34	2.32	2.00	1.51	1.05	0.50						
1994	0.45	0.90	1.30	1.76	2.34	2.32	2.00	1.51	0.79	0.36						
1995	0.43	0.86	1.33	1.80	2.34	2.32	2.00	1.51	1.02	0.48						
1996	0.17	0.34	1.31	1.77	2.27	2.26	2.00	1.51	1.04	0.49						
1997	0.37	0.75	1.33	1.80	2.34	2.32	1.91	1.44	1.04	0.49						
1998	0.23	0.45	1.30	1.76	2.34	2.32	2.00	1.51	1.05	0.50						
1999	0.33	0.66	1.21	1.64	2.16	2.14	1.92	1.45	1.02	0.48						
2000	0.34	0.68	0.64	0.88	2.11	2.09	1.97	1.49	0.96	0.45						
2001	0.42	0.83	1.34	1.81	2.04	2.02	2.00	1.51	0.78	0.36						
2002	0.31	0.62	1.21	1.64	2.34	2.32	2.00	1.51	1.05	0.50						
2003	0.44	0.87	1.36	1.84	2.34	2.32	2.00	1.51	1.04	0.49						
2004	0.35	0.70	1.36	1.84	2.34	2.32	2.00	1.51	1.05	0.50						
2005	0.34	0.69	1.23	1.67	2.34	2.32	2.00	1.51	1.05	0.50						
2006	0.44	0.88	1.30	1.76	2.34	2.32	2.00	1.51	0.93	0.44						
2007	0.39	0.78	1.36	1.84	2.34	2.32	2.00	1.51	1.00	0.47						
2008	0.26	0.52	1.30	1.76	2.04	2.02	2.00	1.51	0.87	0.41						
2009	0.38	0.76	1.36	1.84	2.24	2.22	1.99	1.50	1.05	0.50						
2010	0.39	0.77	1.36	1.84	2.34	2.32	2.00	1.51	0.99	0.47						
2011	0.39	0.79	1.34	1.81	2.34	2.32	2.00	1.51	1.03	0.49						

Early Rice (2nd Dry)

Month	Nov		Dec		Jan		Feb		Mar		Apr		May		Jun	
Year	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30
1992								1.65	2.95	2.60	2.43	2.51	2.28	2.15	0.90	
1993								1.65	2.95	2.60	2.58	2.66	2.44	2.31	1.03	
1994								1.65	2.29	1.93	2.33	2.42	2.00	1.87	1.00	
1995								1.65	2.89	2.53	2.41	2.50	1.57	1.44	0.79	
1996								1.65	2.93	2.58	2.11	2.20	1.93	1.80	0.79	
1997								1.60	2.92	2.56	2.50	2.58	2.21	2.08	0.82	
1998								1.65	2.95	2.60	2.26	2.35	2.53	2.40	0.68	
1999								1.60	2.87	2.51	1.90	1.99	2.18	2.05	0.81	
2000								1.65	2.95	2.60	2.43	2.51	2.28	2.15	0.90	
2001								1.65	2.27	1.92	2.35	2.43	2.24	2.11	0.84	
2002								1.65	2.95	2.60	2.50	2.58	2.31	2.18	0.86	
2003								1.65	2.93	2.58	2.38	2.46	2.05	1.92	0.77	
2004								1.65	2.95	2.60	2.18	2.27	2.13	2.00	0.74	
2005								1.65	2.95	2.60	2.26	2.35	2.33	2.20	1.05	
2006								1.65	2.65	2.30	2.31	2.40	2.29	2.16	0.96	
2007								1.65	2.82	2.46	2.41	2.50	1.85	1.72	0.62	
2008								1.65	2.50	2.15	2.23	2.32	1.83	1.70	0.71	
2009								1.65	2.95	2.60	1.57	1.65	1.57	1.44	0.85	
2010								1.65	2.80	2.45	2.35	2.43	2.51	2.38	0.62	
2011								1.65	2.90	2.55	2.03	2.12	2.10	1.97	0.92	

Source: JICA Survey Team

Table AB-2.6.2.3.1 Observed and Interpolated Monthly Rainfall at Trapeang Chor River Basin

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1982	0.3	0.4	10.9	137.8	137.5	133.4	57.4	117.9	188.0	174.6	82.2	0.1	1,040
1983	0.0	0.0	0.0	2.3	169.5	72.8	179.6	254.1	91.1	412.8	104.8	20.3	1,307
1984	0.0	3.5	2.5	59.7	112.0	154.2	102.4	84.4	304.0	266.8	10.5	0.0	1,100
1985	0.0	53.0	0.0	240.4	290.8	135.7	131.0	49.3	299.1	107.6	83.0	0.0	1,390
1986	0.0	4.3	0.0	87.7	86.4	99.1	83.2	65.4	221.6	166.2	177.0	57.2	1,048
1987	0.0	0.0	0.0	26.8	97.5	78.8	31.0	63.7	121.1	125.7	0.0	0.0	545
1988	0.4	0.0	7.8	85.0	126.2	168.3	127.8	97.0	191.7	112.1	0.0	0.0	916
1989	4.5	0.0	89.8	31.1	153.5	92.5	234.9	97.8	180.3	160.5	0.0	0.0	1,045
1990	0.0	0.0	41.7	57.0	144.9	92.2	129.3	153.8	237.0	116.4	151.9	0.0	1,124
1991	0.0	0.0	23.8	34.5	43.3	115.9	249.4	273.2	257.2	115.5	0.0	0.0	1,113
1992	0.0	0.0	0.0	30.5	113.8	66.2	157.5	58.9	238.5	90.6	0.0	13.4	770
1993	127.3	0.0	0.0	0.0	0.0	39.5	54.9	76.4	178.0	273.4	35.9	0.0	785
1994	0.0	0.0	190.0	17.0	74.4	76.6	61.4	79.5	298.2	169.7	30.5	42.6	1,040
1995	0.0	0.0	25.1	0.0	133.6	162.2	241.6	269.4	259.2	177.3	31.5	8.6	1,309
1996	0.0	0.0	0.0	41.6	79.8	97.7	127.7	126.8	279.2	290.4	144.3	28.2	1,214
1997	0.0	35.8	69.5	65.4	56.0	47.5	212.8	144.6	302.1	192.7	43.8	0.0	1,170
1998	0.0	4.5	0.0	107.8	59.1	143.2	172.6	182.8	276.6	242.5	88.0	3.0	1,280
1999	22.8	21.5	29.6	225.3	222.3	138.3	113.1	183.0	276.2	155.2	67.4	26.4	1,481
2000	11.6	0.0	135.3	153.2	129.4	95.0	189.9	130.8	61.5	258.0	87.8	53.6	1,306
2001	8.2	0.0	61.9	46.0	132.4	89.2	63.2	249.4	323.0	430.3	29.9	15.2	1,449
2002	0.0	0.0	28.4	27.0	93.3	143.8	17.7	137.0	113.4	240.0	84.2	43.8	929
2003	0.0	0.0	68.5	112.3	196.3	89.8	183.6	86.1	244.9	278.5	13.5	0.0	1,274
2004	7.6	60.8	47.8	6.9	169.2	138.5	130.5	50.6	182.8	133.3	38.2	0.0	966
2005	0.0	0.0	0.0	15.5	71.4	40.7	122.4	99.3	228.3	257.3	23.8	7.9	867
2006	4.0	19.4	0.0	88.9	121.1	114.0	124.4	188.4	268.7	175.2	42.8	0.0	1,147
2007	16.1	0.0	56.0	101.0	124.7	68.5	64.7	186.8	179.7	139.9	59.0	0.0	997
2008	18.6	0.0	18.2	195.8	182.6	74.4	69.6	187.9	187.1	261.3	102.5	0.0	1,298
2009	0.0	29.4	78.3	239.7	108.5	82.6	142.8	144.8	209.3	156.4	32.4	0.0	1,224
2010	10.2	3.3	51.3	68.8	53.0	219.2	105.1	235.8	222.7	288.5	52.2	64.7	1,375
2011	0.4	0.0	9.4	108.8	109.7	75.6	187.1	210.8	201.6	257.3	55.3	5.8	1,222
Average	7.7	7.9	34.9	80.5	119.7	104.9	129.0	142.9	220.7	207.5	55.7	13.0	1,124
Max	127.3	60.8	190.0	240.4	290.8	219.2	249.4	273.2	323.0	430.3	177.0	64.7	1,481

Source: JICA Survey Team (based on observation data from MOWRAM)

Table AB-2.6.2.3.2 Observed and Interpolated Monthly Rainfall at Tuek Phos Rivr Basin

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1982	0.4	0.5	14.4	182.3	181.9	176.4	76.0	155.9	248.7	230.9	108.7	0.1	1,376
1983	0.0	0.0	0.0	0.0	47.9	55.5	163.5	321.7	175.7	204.9	156.5	3.2	1,129
1984	1.4	1.1	0.0	129.9	62.7	141.6	130.0	92.1	272.9	303.0	48.0	4.9	1,188
1985	0.0	1.1	0.0	115.6	119.2	105.0	118.5	93.2	285.8	261.3	191.4	0.9	1,292
1986	0.0	4.5	0.0	53.6	150.6	91.9	162.7	245.1	256.5	262.2	110.2	24.0	1,361
1987	0.0	0.0	0.0	0.0	24.8	151.3	128.0	195.5	476.6	243.9	322.3	20.1	1,563
1988	0.0	23.1	0.0	91.0	99.1	164.6	164.8	179.1	440.2	146.5	71.9	0.0	1,380
1989	0.0	0.0	54.4	63.7	184.8	38.7	87.2	92.6	398.1	334.7	108.1	0.0	1,362
1990	0.0	0.0	0.0	22.9	232.3	64.3	168.0	175.9	244.4	101.9	140.8	0.0	1,150
1991	0.0	0.0	0.0	84.0	44.3	295.9	305.5	194.2	123.1	211.7	2.2	1.7	1,263
1992	3.1	2.5	0.6	35.3	86.0	122.8	221.1	199.8	205.7	211.0	11.0	3.8	1,103
1993	0.0	0.0	0.0	0.0	47.5	55.8	163.5	321.7	175.7	204.9	156.5	3.2	1,129
1994	0.4	0.0	165.4	61.5	158.9	72.0	128.7	157.7	316.4	147.8	0.0	23.7	1,233
1995	0.0	0.0	18.1	40.9	265.1	173.2	155.9	210.9	280.2	245.4	22.6	11.3	1,424
1996	0.0	0.0	0.0	95.0	201.6	103.8	129.6	66.0	145.2	345.6	197.0	196.1	1,480
1997	0.0	75.0	45.0	54.2	90.0	138.0	117.0	196.5	401.0	356.0	90.7	11.0	1,574
1998	0.0	0.0	0.0	22.0	55.0	86.0	223.4	277.3	235.4	127.0	133.0	0.0	1,159
1999	0.0	0.0	8.0	75.0	275.0	180.0	109.0	192.0	457.0	301.0	194.1	80.0	1,871
2000	0.0	1.0	17.0	163.0	167.7	202.0	222.1	299.4	298.0	203.4	79.8	37.0	1,690
2001	53.2	0.0	175.0	9.5	162.7	144.2	125.2	320.3	428.0	190.7	16.8	8.6	1,634
2002	0.0	0.0	51.7	59.0	103.5	154.1	125.6	265.0	262.0	74.0	204.0	98.0	1,397
2003	0.0	0.0	25.0	168.5	333.0	113.0	221.0	129.0	338.0	338.0	130.5	10.0	1,806
2004	24.0	0.0	16.0	33.0	96.0	142.0	73.0	294.0	211.0	0.0	0.0	0.0	889
2005	0.0	0.0	7.0	30.0	171.0	165.0	173.0	191.0	382.0	223.0	0.0	0.0	1,342
2006	0.0	52.0	29.0	55.1	74.0	192.0	143.0	311.0	245.0	167.0	0.0	15.0	1,283
2007	0.0	0.0	0.0	83.0	238.0	184.0	195.0	220.0	418.0	291.0	0.0	0.0	1,629
2008	0.0	0.0	0.0	159.0	200.0	93.0	306.0	207.0	271.0	260.0	218.0	0.0	1,714
2009	0.0	0.0	61.1	158.8	69.2	25.0	174.0	202.8	326.6	331.4	18.0	0.0	1,367
2010	37.6	0.0	46.8	101.0	129.8	253.2	178.5	162.1	211.2	469.6	186.5	53.0	1,829
2011	0.4	0.0	9.4	108.8	109.7	97.8	187.1	210.8	201.6	257.3	55.3	5.8	1,244
Average	4.1	5.5	25.3	74.0	140.4	133.9	161.7	205.8	294.1	234.1	100.6	20.9	1,401
Max	53.2	75.0	175.0	182.3	333.0	295.9	306.0	321.7	476.6	469.6	322.3	196.1	1,871

Source: JICA Survey Team (based on observation data from MOWRAM)

Table AB-2.6.2.3.3 Estimated Monthly Basin Mean Rainfall at Chi Prong W.L. Station

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1982	0.4	0.5	13.4	169.7	169.1	164.2	70.6	145.2	231.3	214.7	101.0	0.1	1,280
1983	0.0	0.0	0.0	0.6	82.8	60.6	168.1	302.2	151.5	264.3	141.8	8.1	1,180
1984	1.0	1.8	0.7	109.7	76.8	145.2	122.0	89.8	281.8	292.4	37.3	3.5	1,162
1985	0.0	16.0	0.0	151.4	168.4	113.7	122.2	80.5	289.7	217.3	160.2	0.6	1,320
1986	0.0	4.5	0.0	63.4	132.3	94.1	140.0	193.8	246.4	234.4	129.5	33.4	1,272
1987	0.0	0.0	0.0	7.7	45.7	130.6	100.2	157.6	374.6	210.1	229.7	14.4	1,271
1988	0.0	16.4	2.2	89.3	106.8	165.6	154.1	155.3	368.6	136.7	51.4	0.0	1,246
1989	1.3	0.0	64.4	54.4	175.9	54.1	129.4	94.2	335.7	284.5	77.1	0.0	1,271
1990	0.0	0.0	12.0	32.6	207.2	72.2	156.9	169.2	242.2	106.1	144.1	0.0	1,143
1991	0.0	0.0	6.9	69.8	43.9	244.4	289.4	216.8	161.4	184.1	1.6	1.2	1,220
1992	2.2	1.8	0.4	33.9	93.8	106.6	203.0	159.4	215.0	176.7	7.8	6.7	1,007
1993	36.5	0.0	0.0	0.0	33.9	51.2	132.4	251.3	176.5	224.7	122.1	2.3	1,031
1994	0.3	0.0	172.5	48.8	134.6	73.2	109.4	135.0	311.3	154.1	8.7	29.1	1,177
1995	0.0	0.0	20.1	29.1	227.5	170.0	180.2	227.4	274.3	225.9	25.1	10.5	1,390
1996	0.0	0.0	0.0	79.7	166.7	101.9	129.1	83.5	183.9	329.5	181.8	148.0	1,404
1997	0.0	63.7	52.0	57.7	80.2	112.1	144.3	181.4	349.6	309.2	77.1	7.8	1,435
1998	0.0	1.3	0.0	46.6	56.1	102.3	208.7	250.2	223.1	160.1	120.0	1.1	1,170
1999	6.6	6.2	14.2	118.0	259.9	168.1	110.3	189.6	405.2	259.2	157.9	64.7	1,760
2000	3.4	0.7	50.9	160.1	156.8	171.4	212.9	251.0	230.2	218.9	82.1	41.9	1,580
2001	40.3	0.0	142.6	20.0	153.8	128.4	107.3	300.0	397.7	259.3	20.6	10.6	1,581
2002	0.0	0.0	45.0	49.8	100.6	151.1	94.8	228.4	219.3	121.5	169.7	82.5	1,263
2003	0.0	0.0	37.5	152.4	293.9	106.1	210.3	116.7	311.4	173.0	10.9	0.0	1,412
2004	19.4	17.4	25.1	25.5	117.1	140.8	89.7	224.1	202.8	38.3	11.0	0.0	911
2005	0.0	0.0	5.0	26.0	142.4	129.5	158.6	164.6	338.1	232.9	6.8	2.3	1,206
2006	1.2	35.7	20.7	64.9	87.4	169.6	137.7	275.8	251.8	169.3	12.3	10.7	1,237
2007	4.6	0.0	16.0	88.2	205.3	79.2	157.7	210.5	349.7	247.7	17.0	0.0	1,376
2008	5.4	0.0	5.2	169.6	195.2	87.6	238.2	201.4	247.0	260.1	184.8	0.0	1,595
2009	0.0	8.4	66.0	182.1	80.3	41.5	165.3	186.1	292.9	281.2	22.1	0.0	1,326
2010	29.7	1.0	48.1	91.7	107.8	243.4	157.3	183.5	214.7	417.5	148.0	56.4	1,699
2011	0.0	0.0	103.2	79.1	197.8	191.9	309.3	247.3	216.9	189.9	73.9	14.0	1,623
Average	5.3	6.0	28.3	75.6	134.6	123.4	151.7	187.1	271.6	220.8	84.8	18.5	1,308
Max	40.3	63.7	172.5	182.1	293.9	244.4	289.4	302.2	405.2	417.5	229.7	148.0	1,760

Source: JICA Survey Team (based on observation data from MOWRAM)

Table AB-2.6.2.4.1 Observed Daily Mean Gauge Heigth at Chi Prong (1/2)

Station: Chi Prorng
River: Stung Srae Bak

Year: 2007 (Unit: m)

Date	Jan. 1	Feb. 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12	Annal
1			0.60	0.67	0.81	0.94	0.90	0.89	2.00	2.39	1.34	1.08	
2			0.61	0.64	0.79	0.90	0.90	0.90	1.80	2.25	1.31	1.07	
3			0.61	0.62	0.80	0.95	0.94	1.00	1.90	2.06	1.31	1.07	
4			0.60	0.62	1.72	0.89	1.20	0.95	2.30	1.80	1.37	1.06	
5			0.60	0.63	1.11	0.92	1.19	0.90	2.07	1.85	1.33	1.04	
6			0.60	0.61	1.00	0.84	1.10	0.90	1.62	2.41	1.28	1.08	
7			0.62	0.61	0.96	0.80	1.30	0.90	1.49	1.82	1.23	1.08	
8			0.64	0.61	0.90	0.85	1.40	0.93	1.52	2.40	1.20	1.08	
9			0.62	0.61	0.95	0.80	1.45	0.95	1.45	2.35	1.18	1.07	
10			0.64	0.61	1.11	0.95	1.15	0.93	1.45	2.58	1.18	1.07	
11			0.62	0.61	1.14	0.90	1.15	0.90	1.53	2.29	1.25	0.90	
12			0.62	0.61	1.17	0.90	1.10	0.90	1.66	2.17	1.53	0.90	
13			0.62	0.61	1.29	0.85	0.95	0.93	1.74	2.57	1.44	0.90	
14			0.61	0.62	1.71	0.88	0.90	1.05	1.94	2.47	1.53	0.90	
15			0.61	0.61	1.82	1.15	1.15	1.15	2.56	2.19	1.43	0.90	
16			0.61	0.61	1.44	1.20	1.25	1.24	2.98	2.22	1.34	0.90	
17			0.61	0.61	1.26	0.99	1.05	1.19	2.44	1.90	1.25	0.90	
18			0.61	0.60	1.19	0.96	1.05	1.20	2.87	1.82	1.33	0.90	
19			0.65	0.64	1.04	0.89	1.15	1.19	1.83	1.75	1.43	0.90	
20			0.68	0.66	0.98	0.84	1.05	1.34	2.28	2.12	1.30	0.90	
21			0.67	0.64	0.95	1.05	1.10	1.45	2.09	1.76	1.20	0.91	
22			0.65	0.63	1.01	1.05	1.10	1.40	1.69	1.73	1.23	0.91	
23			0.63	0.63	1.12	1.25	1.10	1.30	1.49	1.65	1.23	0.91	
24			0.63	0.60	1.23	1.25	1.10	1.35	1.42	1.57	1.13	0.92	
25			0.70	0.67	1.29	0.99	1.05	1.80	1.62	1.50	1.15	0.93	
26			0.70	0.86	1.21	0.96	1.00	1.90	2.13	1.43	1.12	0.90	
27			0.74	0.80	1.10	0.90	1.05	1.75	2.04	1.50	1.10	0.89	
28			0.66	0.87	1.00	0.94	1.00	2.30	2.77	1.51	1.10	0.88	
29			0.67	1.04	1.20	0.95	1.00	1.95	2.43	1.42	1.10	0.88	
30			0.66	1.01	1.15	0.90	0.90	1.80	2.05	1.39	1.08	0.87	
31			0.65		1.00		0.90	1.70		1.35		0.87	
Average			0.64	0.67	1.14	0.95	1.08	1.26	1.97	1.94	1.26	0.95	
Max.			0.74	1.04	1.82	1.25	1.45	2.30	2.98	2.58	1.53	1.08	
Min.			0.60	0.60	0.79	0.80	0.90	0.89	1.42	1.35	1.08	0.87	

Source: "Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia", March 2009, JICA

Year: 2008 (Unit: m)

Date	Jan. 1	Feb. 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12	Annal
1	0.96	0.83	0.75	0.96	1.01	1.01	1.16	0.89	1.67	1.19	2.93	1.13	
2	1.15	0.82	0.75	1.15	0.98	0.98	1.20	0.91	1.35	1.45	2.62	1.11	
3	0.99	0.83	0.76	0.99	0.93	0.93	1.28	0.95	1.18	1.50	2.56	0.86	
4	0.90	0.83	0.75	0.90	0.92	0.90	1.24	1.07	1.01	1.37	2.62	0.80	
5	1.01	0.82	0.86	1.01	0.91	0.91	1.23	1.24	1.14	1.25	1.66	0.77	
6	1.14	0.81	0.92	1.14	0.98	0.98	1.17	1.29	0.90	1.25	1.46	0.79	
7	0.93	0.81	0.81	0.98	0.96	0.96	1.42	1.16	0.90	1.45	1.36	0.69	
8	0.89	0.80	0.79	0.85	0.95	0.95	1.40	1.13	0.90	1.30	1.37	0.68	
9	0.85	0.80	0.76	0.86	0.93	0.93	1.39	1.14	1.08	1.22	1.36	0.80	
10	0.83	0.80	0.75	0.84	0.93	0.93	1.27	1.14	1.20	1.42	1.27	0.47	
11	0.79	0.80	0.75	0.79	0.91	0.91	1.38	1.22	1.15	1.25	1.18	0.42	
12	0.78	0.80	0.75	0.78	0.89	0.89	1.21	1.19	1.15	1.14	1.20	0.47	
13	0.77	0.80	0.75	0.77	0.89	0.89	1.20	1.14	1.14	1.14	1.14	0.43	
14	0.76	0.79	0.75	0.76	0.87	0.87	1.14	1.24	1.42	1.13	1.49	0.44	
15	0.76	0.79	0.75	0.76	0.86	0.86	1.13	1.46	1.56	1.15	1.70	0.41	
16	0.76	0.79	0.75	0.76	1.05	1.05	1.18	1.50	1.28	1.26	1.75	0.87	
17	0.76	0.79	0.75	0.76	1.06	1.06	1.19	1.46	1.24	1.28	1.60	0.73	
18	0.78	0.78	0.74	0.78	1.13	1.53	1.16	1.61	1.20	1.24	1.45	0.76	
19	0.78	0.77	0.74	0.78	1.50	1.00	1.01	1.72	1.12	1.16	1.42	0.73	
20	0.77	0.77	0.74	0.77	0.95	0.95	0.90	1.41	1.01	1.13	1.41	0.66	
21	0.76	0.77	0.74	0.76	0.96	0.96	0.90	1.29	0.90	1.32	1.35	0.66	
22	0.74	0.78	0.74	0.74	0.75	0.75	0.90	1.20	0.90	1.24	1.32	0.70	
23	0.74	0.79	0.74	0.74	0.94	0.94	1.00	1.14	0.90	1.40	1.33	0.70	
24	0.75	0.78	0.78	0.81	1.22	1.27	1.10	1.11	0.90	1.33	1.33	0.75	
25	0.85	0.76	0.78	0.83	1.29	1.29	1.10	0.90	0.90	1.20	1.24	0.75	
26	0.92	0.76	0.75	0.92	1.28	1.28	1.43	1.01	0.90	1.48	1.25	0.75	
27	0.90	0.77	0.84	0.92	1.13	1.13	1.51	1.99	1.09	1.42	1.29	0.75	
28	0.90	0.76	0.82	0.90	1.00	1.00	1.24	1.84	1.29	1.24	1.41	0.75	
29	1.13	*0.75*	0.79	1.13	0.95	0.95	1.14	1.61	1.42	2.08	1.43	0.79	
30	1.08		0.91	1.08	1.09	0.90	1.04	1.34	1.79	2.05	1.28	0.78	
31	0.95		0.83		1.27		0.87	1.29		1.47		0.76	
Average	0.87	0.79	0.78	0.87	1.01	1.00	1.18	1.28	1.15	1.34	1.56	0.71	1.04
Max.	1.15	0.83	0.92	1.15	1.50	1.53	1.51	1.99	1.79	2.08	2.93	1.13	2.93
Min.	0.74	0.75	0.74	0.74	0.75	0.75	0.87	0.89	0.90	1.13	1.14	0.41	0.41

Source: "Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia", March 2009, JICA

Table AB-2.6.2.4.1 Observed Daily Mean Gauge Heigth at Chi Prong (2/2)

Year: 2009 (Unit: m)

Date	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annal
	1	2	3	4	5	6	7	8	9	10	11	12	
1	0.85	0.74	0.74	0.90	0.95	0.77	0.80	0.87	0.80	0.98	0.93	0.70	
2	0.85	0.74	0.74	0.88	0.87	0.74	0.77	0.84	1.80	0.91	0.90	0.70	
3	0.85	0.74	0.74	0.80	1.17	0.73	0.73	0.79	1.63	1.41	1.05	0.69	
4	0.84	0.74	0.74	0.80	1.13	0.74	0.83	0.76	1.68	1.32	1.73	0.69	
5	0.78	0.74	0.74	0.80	0.89	0.74	1.23	0.73	1.81	1.25	1.17	0.69	
6	0.75	0.74	0.74	0.75	0.80	0.69	0.94	0.71	1.75	1.43	1.07	0.68	
7	0.75	0.74	0.74	0.75	0.73	0.68	1.18	0.69	1.83	1.46	1.01	0.66	
8	0.74	0.74	0.74	0.75	0.74	0.66	1.08	0.67	1.54	1.44	1.00	0.65	
9	0.74	0.74	0.74	0.70	0.90	0.65	0.94	0.73	1.49	1.89	0.98	0.65	
10	0.74	0.74	0.74	0.70	0.82	0.69	0.91	0.82	1.66	1.78	0.90	0.64	
11	0.74	0.74	0.74	0.70	0.81	0.71	0.88	0.84	1.48	1.58	0.90	0.64	
12	0.74	0.74	0.74	0.65	0.79	0.74	0.86	0.80	1.74	1.28	0.89	0.63	
13	0.74	0.74	0.74	0.65	0.77	0.70	0.78	0.78	1.75	1.20	0.85	0.63	
14	0.74	0.74	0.74	0.65	0.74	0.69	0.76	0.79	1.75	1.29	0.85	0.62	
15	0.74	0.74	0.74	0.60	0.72	0.71	0.76	0.83	1.77	1.26	0.84	0.62	
16	0.74	0.74	0.74	0.59	0.70	0.89	0.82	0.85	1.61	1.18	0.89	0.62	
17	0.74	0.87	0.74	0.58	0.78	0.83	0.82	1.06	2.02	1.14	0.85	0.62	
18	0.74	1.00	0.74	0.57	0.76	0.76	0.78	1.16	1.56	1.12	0.83	0.62	
19	0.74	1.00	0.74	0.57	0.75	0.75	0.75	1.05	1.73	1.24	0.81	0.61	
20	0.74	1.00	0.74	0.59	0.72	0.76	0.73	0.96	1.80	1.41	0.80	0.60	
21	0.74	1.00	0.74	0.61	0.78	0.74	0.74	0.89	1.74	1.36	0.80	0.60	
22	0.74	1.00	0.74	0.64	0.88	0.72	0.73	1.28	1.60	1.38	0.78	0.60	
23	0.74	1.00	0.74	0.63	0.94	0.71	0.77	1.22	1.79	1.53	0.76	0.59	
24	0.74	1.00	0.74	0.77	0.83	0.70	0.78	1.25	1.72	1.33	0.75	0.59	
25	0.74	1.00	0.74	0.63	0.76	0.69	0.84	1.09	1.75	1.30	0.75	0.59	
26	0.74	1.00	0.74	0.63	0.82	0.69	0.93	0.96	1.79	1.28	0.74	0.58	
27	0.74	1.00	0.74	0.65	1.04	0.70	1.00	0.88	1.69	1.24	0.73	0.57	
28	0.74	1.00	0.74	0.81	0.88	0.69	0.97	0.80	1.55	1.18	0.72	0.56	
29	0.74		0.74	0.82	0.78	0.74	0.88	0.94	1.48	1.08	0.72	0.56	
30	0.74		0.86	0.97	0.77	0.78	0.88	1.08	1.41	1.05	0.71	0.56	
31	0.74		0.97		0.74		0.86	1.20		1.02	0.70	0.56	
Average	0.76	0.85	0.75	0.70	0.83	0.72	0.86	0.91	1.66	1.30	0.88	0.62	0.90
Max.	0.85	1.00	0.97	0.97	1.17	0.89	1.23	1.28	2.02	1.89	1.73	0.70	2.02
Min.	0.74	0.74	0.74	0.57	0.70	0.65	0.73	0.67	0.80	0.91	0.70	0.56	0.56

Source: "Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia", March 2009, JICA

Table AB-2.6.2.4.2 Calculated Daily Mean Discharge at Chi Prong (1/2)

Station: Chi Prorng
River: Stung Srae Bak

Year: 2007 Q= 13.199 * (H − 0.4339)^2 (Unit: m^3/sec)

Date	Jan. 1	Feb. 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12	Annal
1			0.36	0.74	1.87	3.31	2.87	2.69	32.37	50.25	10.72	5.42	
2			0.39	0.53	1.63	2.87	2.87	2.87	24.63	43.29	10.02	5.26	
3			0.39	0.46	1.77	3.45	3.31	4.23	28.37	34.90	10.13	5.34	
4			0.36	0.46	21.66	2.75	7.75	3.52	45.96	24.63	11.57	5.17	
5			0.36	0.48	5.94	3.06	7.55	2.87	35.33	26.47	10.60	4.85	
6			0.36	0.39	4.23	2.12	5.86	2.87	18.41	51.28	9.34	5.51	
7			0.43	0.39	3.65	1.77	9.90	2.87	14.72	25.18	8.37	5.51	
8			0.56	0.41	2.87	2.29	12.32	3.18	15.57	51.02	7.75	5.42	
9			0.46	0.39	3.45	1.77	13.63	3.52	13.49	48.21	7.25	5.34	
10			0.56	0.39	5.94	3.52	6.77	3.18	13.63	60.51	7.25	5.34	
11			0.43	0.41	6.49	2.87	6.77	2.87	15.71	45.47	8.79	2.87	
12			0.43	0.41	7.06	2.87	5.86	2.87	19.68	39.55	15.71	2.87	
13			0.46	0.41	9.67	2.29	3.52	3.18	22.34	59.94	13.36	2.87	
14			0.41	0.46	21.49	2.57	2.87	5.01	29.74	54.72	15.86	2.87	
15			0.41	0.41	25.36	6.77	6.77	6.77	59.66	40.47	13.10	2.87	
16			0.41	0.41	13.23	7.75	8.79	8.58	85.56	42.11	10.72	2.87	
17			0.39	0.41	8.90	4.01	5.01	7.55	53.12	28.37	8.68	2.87	
18			0.41	0.36	7.45	3.58	5.01	7.75	78.01	25.18	10.48	2.87	
19			0.59	0.53	4.85	2.69	6.77	7.55	25.54	22.69	12.97	2.87	
20			0.80	0.67	3.86	2.18	5.01	10.84	44.74	37.52	9.90	2.87	
21			0.74	0.56	3.45	5.01	5.86	13.63	36.20	23.04	7.75	2.99	
22			0.59	0.48	4.38	5.01	5.86	12.32	20.66	22.00	8.26	2.99	
23			0.48	0.48	6.12	8.79	5.86	9.90	14.58	19.52	8.26	2.99	
24			0.51	0.36	8.37	8.79	5.86	11.08	12.70	17.04	6.40	3.12	
25			0.93	0.74	9.67	4.01	5.01	24.63	18.57	14.86	6.77	3.18	
26			0.93	2.40	7.95	3.65	4.23	28.37	37.75	12.97	6.12	2.81	
27			1.24	1.72	5.77	2.87	5.01	22.86	33.84	14.86	5.86	2.69	
28			0.67	2.51	4.23	3.31	4.23	45.96	72.03	15.14	5.86	2.63	
29			0.70	4.77	7.75	3.52	4.23	30.34	52.59	12.70	5.86	2.57	
30			0.65	4.30	6.77	2.87	2.87	24.63	34.47	11.94	5.51	2.51	
31			0.62		4.23		2.87	21.16		11.08		2.51	
Average			0.55	0.91	7.42	3.74	5.84	10.96	33.67	31.84	9.31	3.64	
Max.			1.24	4.77	25.36	8.79	13.63	45.96	85.56	60.51	15.86	5.51	
Min.			0.36	0.36	1.63	1.77	2.87	2.69	12.70	11.08	5.51	2.51	

Year: 2008 Q= 13.199 * (H − 0.4339)^2 (Unit: m^3/sec)

Date	Jan. 1	Feb. 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12	Annal
1	3.58	2.02	1.28	3.58	4.38	4.38	6.96	2.75	20.00	7.45	82.24	6.30	
2	6.67	1.97	1.32	6.67	3.86	3.86	7.75	2.93	11.08	13.63	63.08	6.03	
3	4.01	2.02	1.36	4.01	3.18	3.18	9.34	3.52	7.25	15.00	59.66	2.34	
4	2.87	2.02	1.32	2.87	3.06	2.87	8.47	5.34	4.38	11.44	63.08	1.72	
5	4.30	1.92	2.40	4.30	2.99	2.99	8.26	8.47	6.49	8.79	19.84	1.45	
6	6.58	1.87	3.06	6.58	3.94	3.94	7.15	9.67	2.87	8.79	13.90	1.67	
7	3.18	1.87	1.82	3.86	3.65	3.65	12.70	6.96	2.87	13.63	11.20	0.87	
8	2.75	1.77	1.67	2.23	3.45	3.45	12.32	6.30	2.87	9.90	11.44	0.77	
9	2.23	1.77	1.40	2.34	3.25	3.25	12.07	6.58	5.42	8.16	11.20	1.72	
10	2.02	1.77	1.32	2.12	3.18	3.18	9.23	6.49	7.75	12.83	9.23	0.01	
11	1.67	1.77	1.32	1.67	2.93	2.93	11.69	8.05	6.77	8.79	7.25	0.00	
12	1.54	1.77	1.32	1.54	2.75	2.75	7.95	7.55	6.77	6.58	7.75	0.02	
13	1.49	1.72	1.32	1.49	2.69	2.69	7.65	6.58	6.49	6.58	6.49	0.00	
14	1.40	1.67	1.32	1.40	2.45	2.45	6.58	8.58	12.70	6.30	14.58	0.00	
15	1.40	1.67	1.32	1.40	2.34	2.34	6.40	13.90	16.59	6.77	21.16	0.01	
16	1.40	1.67	1.32	1.40	5.01	5.01	7.35	15.00	9.45	9.01	22.86	2.45	
17	1.40	1.67	1.28	1.40	5.09	5.09	7.45	13.90	8.58	9.45	17.95	1.16	
18	1.54	1.58	1.24	1.54	6.30	15.71	6.96	18.26	7.65	8.47	13.63	1.40	
19	1.54	1.45	1.24	1.54	14.86	4.16	4.30	21.83	6.12	6.96	12.83	1.12	
20	1.49	1.45	1.24	1.49	3.52	3.52	2.87	12.58	4.30	6.40	12.58	0.67	
21	1.40	1.49	1.24	1.40	3.65	3.65	2.87	9.67	2.87	10.25	11.08	0.65	
22	1.24	1.58	1.24	1.24	1.32	1.32	2.87	7.75	2.87	8.58	10.25	0.93	
23	1.20	1.63	1.20	1.24	3.31	3.31	4.23	6.58	2.87	12.32	10.60	0.93	
24	1.28	1.58	1.54	1.82	8.05	9.12	5.86	5.94	2.87	10.48	10.60	1.32	
25	2.23	1.40	1.54	2.07	9.67	9.67	5.86	2.87	2.87	7.75	8.47	1.32	
26	3.12	1.40	1.28	3.12	9.34	9.34	12.97	4.38	2.87	14.31	8.68	1.32	
27	2.87	1.49	2.12	3.12	6.30	6.30	15.14	31.76	5.68	12.70	9.56	1.32	
28	2.81	1.40	1.97	2.81	4.23	4.23	8.47	26.10	9.67	8.58	12.58	1.32	
29	6.30	1.34	1.67	6.30	3.52	3.52	6.49	18.26	12.83	35.55	12.97	1.63	
30	5.51		2.99	5.51	5.68	2.87	4.85	10.72	24.27	34.47	9.45	1.58	
31	3.55		2.07		9.23		2.51	9.67		14.17		1.40	
Average	2.73	1.68	1.57	2.74	4.75	4.49	7.60	10.29	7.54	11.42	19.54	1.40	6.31
Max.	6.67	2.02	3.06	6.67	14.86	15.71	15.14	31.76	24.27	35.55	82.24	6.30	82.24
Min.	1.20	1.34	1.20	1.24	1.32	1.32	2.51	2.75	2.87	6.30	6.49	0.00	0.00

Source: JICA Survey Team (based on "Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia", March 2009, JICA)

Table AB-2.6.2.4.2 Calculated Daily Mean Discharge at Chi Prong (2/2)

Year: 2009 Q= 13.199 * (H − 0.4339)^2 (Unit: m^3/sec)

Date	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annal
	1	2	3	4	5	6	7	8	9	10	11	12	
1	2.29	1.24	1.24	2.87	3.52	1.45	1.72	2.51	1.77	3.86	3.18	0.93	
2	2.29	1.24	1.24	2.57	2.45	1.24	1.45	2.18	24.63	2.99	2.87	0.90	
3	2.23	1.24	1.24	1.77	7.06	1.12	1.16	1.63	18.73	12.45	5.01	0.87	
4	2.18	1.24	1.24	1.77	6.30	1.24	2.02	1.40	20.50	10.25	22.00	0.87	
5	1.58	1.24	1.24	1.77	2.75	1.20	8.37	1.12	24.99	8.79	7.06	0.87	
6	1.32	1.24	1.24	1.32	1.77	0.87	3.31	0.97	22.69	12.97	5.26	0.80	
7	1.32	1.24	1.24	1.32	1.16	0.77	7.25	0.83	25.73	13.76	4.38	0.67	
8	1.24	1.24	1.24	1.32	1.24	0.65	5.42	0.74	16.15	13.23	4.23	0.62	
9	1.24	1.24	1.24	0.93	2.87	0.59	3.38	1.12	14.72	27.79	3.86	0.59	
10	1.24	1.24	1.24	0.93	1.97	0.83	2.93	1.97	19.84	23.74	2.87	0.56	
11	1.24	1.24	1.24	0.93	1.87	1.01	2.63	2.18	14.44	17.19	2.81	0.53	
12	1.24	1.24	1.24	0.62	1.67	1.20	2.40	1.72	22.52	9.34	2.75	0.51	
13	1.24	1.24	1.24	0.62	1.45	0.93	1.58	1.58	22.86	7.75	2.29	0.51	
14	1.24	1.24	1.24	0.62	1.24	0.83	1.36	1.67	22.86	9.67	2.29	0.46	
15	1.24	1.24	1.24	0.36	1.04	0.97	1.36	2.02	23.56	9.01	2.18	0.46	
16	1.24	1.24	1.24	0.32	0.93	2.75	1.97	2.29	18.26	7.25	2.75	0.46	
17	1.24	2.51	1.24	0.28	1.54	2.07	1.92	5.09	33.21	6.58	2.23	0.46	
18	1.24	4.23	1.24	0.23	1.36	1.40	1.58	6.96	16.59	6.12	2.07	0.46	
19	1.24	4.23	1.24	0.24	1.32	1.28	1.32	4.93	22.17	8.58	1.82	0.41	
20	1.24	4.23	1.24	0.32	1.08	1.40	1.12	3.65	24.63	12.58	1.77	0.36	
21	1.24	4.23	1.24	0.39	1.58	1.20	1.20	2.69	22.52	11.32	1.72	0.36	
22	1.24	4.23	1.24	0.53	2.57	1.08	1.12	9.34	17.79	11.69	1.58	0.34	
23	1.24	4.23	1.24	0.51	3.31	0.97	1.45	8.16	24.27	15.71	1.40	0.32	
24	1.24	4.23	1.24	1.45	2.02	0.90	1.54	8.79	21.66	10.60	1.32	0.32	
25	1.24	4.23	1.24	0.51	1.40	0.83	2.18	5.68	22.86	9.90	1.32	0.30	
26	1.24	4.23	1.24	0.51	1.92	0.87	3.18	3.58	24.27	9.34	1.24	0.28	
27	1.24	4.23	1.24	0.59	4.77	0.93	4.16	2.57	20.83	8.58	1.16	0.24	
28	1.24	4.23	1.24	1.87	2.57	0.87	3.72	1.77	16.44	7.35	1.08	0.21	
29	1.24		1.24	1.92	1.58	1.20	2.63	3.31	14.31	5.42	1.08	0.21	
30	1.24		2.34	3.72	1.45	1.58	2.57	5.42	12.58	4.93	0.97	0.21	
31	1.24		3.79		1.24		2.40	7.75		4.53	0.93	0.21	
Average	1.38	2.46	1.35	1.10	2.23	1.14	2.59	3.41	20.28	10.43	3.14	0.49	4.17
Max.	2.29	4.23	3.79	3.72	7.06	2.75	8.37	9.34	33.21	27.79	22.00	0.93	33.21
Min.	1.24	1.24	1.24	0.23	0.93	0.59	1.12	0.74	1.77	2.99	0.93	0.21	0.21

Source: *JICA Survey Team (based on "Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia", March 2009, JICA)*

Table AB-2.6.2.4.3 Observed and Estimated Half Monthly Mean Discharge by Tank Model at Chi Prong

(Unit: m^3/sec)

Year	Month Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1992	1-15	2.82	1.44	0.78	0.44	0.62	2.33	3.26	5.06	6.84	16.97	7.52	3.97	
	15-end	2.06	1.09	0.54	0.47	3.01	2.04	6.36	10.18	14.98	11.31	5.43	2.86	4.70
1993	1-15	2.19	1.41	0.78	0.39	0.78	0.23	1.36	11.46	7.65	8.33	9.13	4.67	
	15-end	2.18	1.08	0.51	0.39	0.39	0.39	1.51	7.20	6.99	10.84	6.91	3.35	3.77
1994	1-15	2.43	1.25	0.86	2.97	2.66	2.92	4.10	1.78	7.70	13.92	6.71	3.76	
	15-end	1.74	0.90	8.86	3.94	5.85	2.25	2.33	4.48	13.76	10.77	4.96	2.67	4.76
1995	1-15	1.91	0.99	0.49	0.39	15.76	6.03	6.03	13.44	10.52	29.00	9.37	4.88	
	15-end	1.37	0.78	0.46	0.89	4.19	5.22	9.03	9.11	17.54	12.97	6.73	3.62	7.12
1996	1-15	2.58	1.33	0.78	0.76	2.42	4.67	4.67	3.26	6.71	10.28	15.64	11.23	
	15-end	1.81	0.95	0.41	2.56	7.42	4.15	4.70	3.84	8.35	29.63	13.29	10.11	6.37
1997	1-15	6.39	4.70	2.43	2.09	1.35	1.62	7.60	4.93	13.36	34.64	12.37	6.42	
	15-end	4.68	3.34	2.91	1.85	2.10	3.42	4.31	8.00	16.03	20.31	8.98	4.60	7.44
1998	1-15	3.31	1.73	0.94	0.39	0.75	3.29	10.60	9.97	9.82	9.92	8.90	4.99	
	15-end	2.40	1.26	0.73	0.60	0.81	1.67	4.80	13.92	14.62	11.72	8.28	3.62	5.40
1999	1-15	2.61	1.33	0.78	1.09	4.49	8.66	7.13	5.82	41.43	28.43	23.05	9.53	
	15-end	1.86	0.99	0.46	2.32	16.25	7.80	4.58	7.25	16.10	12.90	9.74	6.02	9.20
2000	1-15	4.28	2.22	1.20	6.47	5.22	8.56	6.00	8.40	11.64	24.64	8.09	4.83	
	15-end	3.08	1.65	1.59	2.92	3.40	5.59	9.54	12.90	11.95	11.36	7.07	3.91	6.95
2001	1-15	3.71	1.80	1.74	2.87	2.64	4.51	2.92	10.65	22.27	23.36	12.66	6.47	
	15-end	2.64	1.35	9.44	2.09	4.38	4.49	3.35	12.26	24.43	17.84	8.93	4.72	8.01
2002	1-15	3.39	1.75	0.94	2.27	1.56	1.88	2.95	10.36	14.54	9.08	13.08	7.38	
	15-end	2.40	1.26	2.08	1.44	2.91	6.16	4.48	12.24	13.63	10.18	8.56	5.92	5.87
2003	1-15	4.00	2.09	1.14	4.39	18.40	7.91	10.70	7.33	7.39	12.74	6.47	3.44	
	15-end	2.86	1.54	1.59	7.96	13.70	7.46	7.66	5.31	22.81	10.20	4.70	2.45	7.27
2004	1-15	2.17	1.46	0.68	0.47	4.05	5.04	3.03	6.52	12.82	5.85	2.92	1.54	
	15-end	1.40	0.81	0.98	0.57	1.84	4.88	3.38	13.16	7.70	4.09	2.14	1.12	3.70
2005	1-15	0.78	0.39	0.26	0.16	0.44	2.87	8.01	9.71	26.70	11.77	9.45	5.06	
	15-end	0.56	0.39	0.00	0.26	7.95	5.48	7.81	6.92	16.21	21.14	6.92	3.62	6.41
2006	1-15	2.61	1.54	0.81	0.88	0.70	2.53	5.43	8.82	13.81	26.05	8.20	4.65	
	15-end	1.86	1.20	0.85	1.07	2.84	9.50	7.27	17.77	20.39	11.80	6.32	3.28	6.70
2007	1-15	2.35	1.22	0.43	0.45	8.21	2.95	6.57	3.50	25.98	43.73	10.65	4.50	
	15-end	1.72	0.84	0.67	1.38	6.69	4.54	5.15	17.95	41.36	20.69	7.96	2.83	7.71
2008	1-15	3.05	1.84	1.57	3.07	3.21	3.19	8.97	6.91	8.02	9.64	26.81	1.53	
	15-end	2.43	1.51	1.57	2.40	6.19	5.79	6.31	13.45	7.05	13.09	12.27	1.28	6.31
2009	1-15	1.54	1.24	1.24	1.31	2.56	0.99	3.09	1.58	19.73	12.19	4.87	0.68	
	15-end	1.24	3.87	1.47	0.89	1.91	1.29	2.13	5.12	20.83	8.78	1.53	0.32	4.17
2010	1-15	2.82	1.91	1.04	1.38	4.18	7.39	8.01	5.80	9.92	46.20	12.53	8.20	
	15-end	3.21	1.42	2.47	4.62	2.84	7.81	5.87	7.44	11.41	14.85	17.75	9.47	8.28
2011	1-15	5.32	2.74	1.49	2.79	2.80	8.43	29.44	13.39	12.22	16.50	14.49	5.56	
	15-end	3.82	2.08	8.61	3.21	6.46	6.47	11.50	14.90	14.93	12.92	7.39	3.94	8.85
Average		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
Max.		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
Min.		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*

Table AB-2.6.2.4.4 Observed and Estimated Monthly Mean Discharge by Tank Model at Chi Prong

(Unit: m^3/sec)

Month Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1992	*2.43*	*1.27*	*0.65*	*0.46*	*1.86*	*2.18*	*4.86*	*7.70*	*10.91*	*14.05*	*6.47*	*3.40*	*4.70*
1993	*2.19*	*1.26*	*0.64*	*0.39*	*0.58*	*0.31*	*1.44*	*9.26*	*7.32*	*9.62*	*8.02*	*3.99*	*3.77*
1994	*2.07*	*1.09*	*4.99*	*3.46*	*4.31*	*2.58*	*3.18*	*3.17*	*10.73*	*12.29*	*5.83*	*3.19*	*4.76*
1995	*1.63*	*0.89*	*0.48*	*0.64*	*9.79*	*5.62*	*7.58*	*11.20*	*14.03*	*20.73*	*8.05*	*4.23*	*7.12*
1996	*2.19*	*1.15*	*0.59*	*1.66*	*5.00*	*4.41*	*4.68*	*3.56*	*7.53*	*20.27*	*14.46*	*10.65*	*6.37*
1997	*5.51*	*4.07*	*2.68*	*1.97*	*1.74*	*2.52*	*5.90*	*6.52*	*14.70*	*27.24*	*10.68*	*5.48*	*7.44*
1998	*2.84*	*1.51*	*0.83*	*0.49*	*0.78*	*2.48*	*7.61*	*12.01*	*12.22*	*10.85*	*8.59*	*4.28*	*5.40*
1999	*2.22*	*1.17*	*0.62*	*1.71*	*10.56*	*8.23*	*5.81*	*6.56*	*28.76*	*20.41*	*16.39*	*7.72*	*9.20*
2000	*3.66*	*1.95*	*1.40*	*4.70*	*4.28*	*7.08*	*7.83*	*10.72*	*11.80*	*17.78*	*7.58*	*4.36*	*6.95*
2001	*3.16*	*1.60*	*5.72*	*2.48*	*3.54*	*4.50*	*3.14*	*11.48*	*23.35*	*20.51*	*10.79*	*5.57*	*8.01*
2002	*2.88*	*1.52*	*1.52*	*1.85*	*2.26*	*4.02*	*3.74*	*11.33*	*14.08*	*9.65*	*10.82*	*6.63*	*5.87*
2003	*3.41*	*1.83*	*1.37*	*6.18*	*15.98*	*7.69*	*9.13*	*6.29*	*15.10*	*11.43*	*5.59*	*2.93*	*7.27*
2004	*1.77*	*1.14*	*0.83*	*0.52*	*2.91*	*4.96*	*3.21*	*9.95*	*10.26*	*4.94*	*2.53*	*1.33*	*3.70*
2005	*0.67*	*0.39*	*0.13*	*0.21*	*4.32*	*4.18*	*7.91*	*8.27*	*21.46*	*16.61*	*8.18*	*4.32*	*6.41*
2006	*2.22*	*1.38*	*0.83*	*0.98*	*1.80*	*6.02*	*6.38*	*13.44*	*17.10*	*18.69*	*7.26*	*3.94*	*6.70*
2007	*2.02*	*1.05*	0.60	2.03	9.67	6.23	6.41	11.67	17.09	22.78	8.14	4.28	*7.71*
2008	2.73	1.68	1.57	2.74	4.75	4.49	7.60	10.29	7.54	11.42	19.54	1.40	6.31
2009	1.38	2.46	1.35	1.10	2.23	1.14	2.59	3.41	20.28	10.43	3.14	0.49	4.17
2010	*3.02*	*1.68*	*1.78*	*3.00*	*3.49*	*7.60*	*6.91*	*6.65*	*10.66*	*30.02*	*15.14*	*8.85*	*8.28*
2011	*4.55*	*2.43*	*5.17*	*3.00*	*4.69*	*7.45*	*20.18*	*14.17*	*13.57*	*14.65*	*10.94*	*4.72*	*8.85*
Average	**2.63**	**1.58**	**1.69**	**1.98**	**4.73**	**4.68**	**6.30**	**8.88**	**14.42**	**16.22**	**9.41**	**4.59**	**6.45**
Max.	**5.51**	**4.07**	**5.72**	**6.18**	**15.98**	**8.23**	**20.18**	**14.17**	**28.76**	**30.02**	**19.54**	**10.65**	**9.20**
Min.	**0.67**	**0.39**	**0.13**	**0.21**	**0.58**	**0.31**	**1.44**	**3.17**	**7.32**	**4.94**	**2.53**	**0.49**	**3.70**

Source: JICA Survey Team

Table AB-2.6.2.5.1 Estimated Half Monthly Unit Irrigation Water Requirement in DPISRSP

(Unit: l/sec/ha)

Mid Paddy

Month	Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Year	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
1992								0.28	0.31	0.55	0.92	1.18	1.05	1.09	0.97	0.78	1.47	1.00	0.49	
1993								0.38	0.46	0.78	0.26	0.25	1.16	1.09	0.81	0.60	0.64	0.48	0.38	
1994								0.35	0.56	0.93	1.16	1.49	0.24	0.29	1.40	1.11	1.52	1.00	0.46	
1995								0.21	0.49	0.81	0.85	1.10	0.52	0.56	0.74	0.58	1.42	0.94	0.48	
1996								0.31	0.57	0.94	1.67	2.12	1.51	1.56	0.11	0.07	0.71	0.46	0.23	
1997								0.26	0.61	0.99	0.96	1.24	0.00	0.00	0.06	0.04	1.52	1.00	0.49	
1998								0.34	0.32	0.56	0.55	0.60	0.76	0.81	1.46	1.13	0.86	0.64	0.49	
1999								0.21	0.63	1.03	1.01	1.29	0.00	0.00	0.31	0.23	0.60	0.35	0.28	
2000								0.18	0.32	0.56	0.44	0.58	0.43	0.48	1.07	0.84	1.19	0.78	0.44	
2001								0.26	0.58	0.96	0.33	0.44	0.00	0.00	1.15	0.91	1.45	0.96	0.48	
2002								0.24	0.58	0.96	0.61	0.80	0.68	0.73	1.92	1.52	0.68	0.44	0.36	
2003								0.30	0.33	0.58	1.34	1.71	0.17	0.20	0.16	0.11	0.97	0.64	0.48	
2004								0.26	0.72	1.16	0.46	0.60	1.04	1.09	2.42	1.92	1.52	1.00	0.49	
2005								0.23	0.45	0.76	1.01	1.29	0.00	0.00	0.77	0.73	1.52	1.00	0.49	
2006								0.19	0.53	0.88	0.37	0.49	0.82	0.87	1.32	1.04	1.52	1.00	0.47	
2007								0.20	0.20	0.38	0.85	1.10	0.00	0.00	0.49	0.38	1.52	1.00	0.49	
2008								0.33	0.00	0.00	0.92	1.18	0.63	0.67	0.68	0.53	0.61	0.40	0.49	
2009								0.42	0.45	0.76	0.94	1.21	0.24	0.29	0.00	0.00	1.44	0.95	0.49	
2010								0.11	0.44	0.75	1.16	1.49	1.04	1.09	0.00	0.00	0.74	0.49	0.42	
2011								0.17	0.00	0.06	0.70	0.91	0.74	0.78	0.00	0.00	1.14	0.75	0.48	

Early Paddy (Early Rainy)

Month	Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Year	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31
1992	0.76	1.52	2.34	2.68	2.43	2.40	1.87	1.23	0.32											
1993	0.76	1.52	2.59	2.92	2.68	2.65	2.37	1.56	0.45											
1994	0.39	0.77	2.15	2.48	1.91	1.88	2.23	1.47	0.54											
1995	0.72	1.48	1.71	2.04	0.99	0.93	1.29	0.76	0.47											
1996	0.76	1.52	1.93	2.26	1.66	1.63	2.04	1.34	0.55											
1997	0.66	1.32	2.20	2.54	2.41	2.38	1.79	1.18	0.57											
1998	0.76	1.52	2.42	2.76	2.65	2.62	2.15	1.41	0.33											
1999	0.74	1.49	2.07	2.40	1.17	1.14	1.52	0.99	0.59											
2000	0.73	1.45	1.46	1.79	1.88	1.85	1.35	0.88	0.33											
2001	0.38	0.75	2.53	2.87	1.94	1.91	1.76	1.16	0.55											
2002	0.64	1.29	2.18	2.51	2.32	2.29	1.68	1.10	0.55											
2003	0.71	1.41	1.43	1.77	0.78	0.75	1.98	1.30	0.34											
2004	0.73	1.45	2.37	2.70	2.38	2.35	1.76	1.16	0.66											
2005	0.74	1.49	2.37	2.70	1.88	1.85	1.63	1.07	0.44											
2006	0.70	1.40	2.20	2.54	2.52	2.49	1.43	0.94	0.51											
2007	0.76	1.52	2.01	2.34	1.41	1.38	1.49	0.97	0.23											
2008	0.76	1.52	1.49	1.82	1.69	1.66	2.12	1.40	0.00											
2009	0.62	1.25	1.49	1.82	2.54	2.51	2.59	1.71	0.44											
2010	0.66	1.32	1.90	2.23	2.16	2.13	1.02	0.66	0.43											
2011	0.62	1.25	1.85	2.18	1.83	1.80	1.29	0.85	0.02											

Source: JICA Survey Team

Table AB-2.6.2.6.1 Annual Maximum Daily Rainfalls at Kampong Chhunang

No.	Year	Annual Max. Daily Rainfall		Rank	Excess Proba-bility	Return Period (Year)
		Date	Daily Rainfall (mm)			
1	1983	18-May-1983	81.5	19	31.48%	1.46
2	1984	13-Oct-1984	139.0	4	87.04%	7.71
3	1985	18-Sep-1985	87.7	15	46.30%	1.86
4	1986	25-Oct-1986	104.6	10	64.81%	2.84
5	1987	10-Nov-1987	96.3	14	50.00%	2.00
6	1988	16-Aug-1988	112.0	8	72.22%	3.60
7	1989	06-Mar-1989	103.0	12	57.41%	2.35
8	1990	13-Aug-1990	128.0	7	75.93%	4.15
9	1991	11-Jul-1991	151.0	3	90.74%	10.80
10	1992	11-Aug-1992	226.0	1	98.15%	54.00
11	1993	27-Jan-1993	54.0	27	1.85%	1.02
12	1994	17-Sep-1994	110.0	9	68.52%	3.18
13	1996	16-Jun-1996	84.2	17	38.89%	1.64
14	1997	17-May-1997	63.5	23	16.67%	1.20
15	1998	25-Sep-1998	130.0	5	83.33%	6.00
16	1999	02-Oct-1999	130.0	5	83.33%	6.00
17	2000	31-Oct-2000	60.3	25	9.26%	1.10
18	2001	12-Mar-2001	72.1	21	24.07%	1.32
19	2002	20-Aug-2002	61.0	24	12.96%	1.15
20	2003	13-Sep-2003	64.7	22	20.37%	1.26
21	2004	02-Sep-2004	83.0	18	35.19%	1.54
22	2005	25-Oct-2005	98.5	13	53.70%	2.16
23	2006	19-Jul-2006	174.0	2	94.44%	18.00
24	2007	28-Sep-2007	85.0	16	42.59%	1.74
25	2008	17-Sep-2008	58.0	26	5.56%	1.06
26	2009	21-Oct-2009	76.0	20	27.78%	1.38
27	2010	25-Mar-2010	103.1	11	61.11%	2.57
	Max.		226.0			

Source: MOWRAM

Table AB-3.2.2.3 Main Features of Results of F/S on 3 Dams (K-Water)

Classification	Unit	Rehabilitation		New Dam
		Peam Levear	O Tang	
Catchment				
Area	km^2	237.5	53.6	155.8
Annual mean runoff	$10^6m^3/yr$	5.49	1.24	3.60
Reservoir				
Flood water level (FWL)	EL.m	136.0	136.0	170.0
Normal high water level (NHWL)	EL.m	135.0	135.0	169.0
Low water level (LWL)	EL.m	129.0	129.5	162.7
Total storage	10^6m^3	8.7	5.9	36.7
Flood control storage	10^6m^3	2.4	2.1	5.3
Effective storage	10^6m^3	7.8	5.6	25.9
Inactive storage	10^6m^3	0.8	0.3	10.8
Dam				
Type	-	Earth Dam	Earth Dam	Earth Dam
Crest level	EL.m	136	136	172
Length	m	2,800	2,250	1,280
Height	m	5.5	5.5	20
Effectiveness				
Water supply				
- Agricultural water	$10^6m^3/yr$	73 (4,432ha x 2 times)		
Flood control (200years)				
- Maximum inflow (design flood)	m^3/s	240	98	437
- Maximum outflow	m^3/s	181	38	122
- Maximum reduction amount	m^3/s	59	60	315
Hydropower generation				
Capacity	kW	70	-	330
Annual mean power generation	GWh/yr	0.2	-	1.4
Submergence				
Area	km^2	2.7	2.1	5.54
Project cost				
Construction cost	10^6USD	3,644	1,652	10,977
Compensation cost + other cost	10^6USD	1,510	1,090	4,504
Total cost	10^6USD	5,154	2,742	15,481
Economic feasibility analysis				
B/C		1.17		
NPV	10^6USD	3,951		
IRR	%	14.07		

Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water

Table AB-3.2.2.5 Agricultural Water Demand for 3-Dams by K-Water

(Unit: MCM)

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Peam	Monthly Mean	6.20	4.45	0.00	0.00	0.00	0.17	4.79	5.18	0.92	1.27	6.46	10.48	39.92
Levear	1st 10 days	2.11	2.33	0.00	0.00	0.00	0.00	0.13	3.50	0.06	0.72	0.13	5.26	14.25
2,398ha	2nd 10 days	1.98	1.50	0.00	0.00	0.00	0.00	2.29	0.97	0.47	0.21	2.68	2.62	12.72
	3rd 10 days	2.11	0.62	0.00	0.00	0.00	0.17	2.36	0.71	0.39	0.34	3.64	2.60	12.95
	Monthly Mean	4.98	3.58	0.00	0.00	0.00	0.14	3.85	4.16	0.74	1.02	5.19	8.42	32.06
O Tang	1st 10 days	1.70	1.87	0.00	0.00	0.00	0.00	0.11	2.81	0.05	0.57	0.11	4.22	11.44
1,926ha	2nd 10 days	1.59	1.21	0.00	0.00	0.00	0.00	1.84	0.78	0.38	0.17	2.16	2.11	10.22
	3rd 10 days	1.70	0.50	0.00	0.00	0.00	0.14	1.90	0.57	0.31	0.27	2.92	2.09	10.40
	Monthly Mean	11.19	8.03	0.00	0.00	0.00	0.31	8.63	9.34	1.66	2.28	11.64	18.90	71.98
Subtotal	1st 10 days	3.81	4.20	0.00	0.00	0.00	0.00	0.24	6.31	0.11	1.29	0.24	9.48	25.69
4,324ha	2nd 10 days	3.57	2.71	0.00	0.00	0.00	0.00	4.14	1.74	0.85	0.38	4.84	4.73	22.94
	3rd 10 days	3.81	1.12	0.00	0.00	0.00	0.31	4.26	1.29	0.70	0.62	6.56	4.69	23.35
New	Monthly Mean	0.97	0.70	0.00	0.00	0.00	0.03	0.75	0.81	0.14	0.20	1.01	1.64	6.26
Dam	1st 10 days	0.33	0.37	0.00	0.00	0.00	0.00	0.02	0.55	0.01	0.11	0.02	0.82	2.23
376ha	2nd 10 days	0.31	0.24	0.00	0.00	0.00	0.00	0.36	0.15	0.07	0.03	0.42	0.41	1.99
	3rd 10 days	0.33	0.10	0.00	0.00	0.00	0.03	0.37	0.11	0.06	0.05	0.57	0.41	2.03
	Monthly Mean	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
Total	1st 10 days	4.14	4.57	0.00	0.00	0.00	0.00	0.26	6.86	0.12	1.40	0.26	10.31	27.92
4,700ha	2nd 10 days	3.88	2.94	0.00	0.00	0.00	0.00	4.50	1.89	0.92	0.41	5.26	5.14	24.94
	3rd 10 days	4.14	1.22	0.00	0.00	0.00	0.34	4.63	1.40	0.76	0.67	7.13	5.09	25.38

(Unit: m^3/sec)

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Peam	Monthly Mean	2.32	1.84	0.00	0.00	0.00	0.07	1.79	1.93	0.35	0.47	2.49	3.91	1.27
Levear	1st 10 days	2.45	2.70	0.00	0.00	0.00	0.00	0.15	4.05	0.07	0.83	0.15	6.09	1.37
2,398ha	2nd 10 days	2.29	1.74	0.00	0.00	0.00	0.00	2.65	1.12	0.54	0.24	3.11	3.04	1.23
	3rd 10 days	2.22	0.90	0.00	0.00	0.00	0.20	2.48	0.75	0.45	0.36	4.21	2.73	1.20
	Monthly Mean	1.86	1.48	0.00	0.00	0.00	0.05	1.44	1.55	0.28	0.38	2.00	3.14	1.02
O Tang	1st 10 days	1.97	2.17	0.00	0.00	0.00	0.00	0.12	3.25	0.06	0.67	0.12	4.89	1.10
1,926ha	2nd 10 days	1.84	1.39	0.00	0.00	0.00	0.00	2.13	0.90	0.44	0.19	2.50	2.44	0.99
	3rd 10 days	1.78	0.72	0.00	0.00	0.00	0.16	2.00	0.60	0.36	0.29	3.38	2.20	0.96
	Monthly Mean	4.18	3.32	0.00	0.00	0.00	0.12	3.22	3.49	0.64	0.85	4.49	7.06	2.28
Total	1st 10 days	4.41	4.86	0.00	0.00	0.00	0.00	0.28	7.30	0.13	1.49	0.28	10.98	2.48
4,324ha	2nd 10 days	4.13	3.13	0.00	0.00	0.00	0.00	4.79	2.02	0.98	0.44	5.60	5.48	2.21
	3rd 10 days	4.01	1.62	0.00	0.00	0.00	0.36	4.48	1.35	0.81	0.65	7.60	4.93	2.16
New	Monthly Mean	0.36	0.29	0.00	0.00	0.00	0.01	0.28	0.30	0.06	0.07	0.39	0.61	0.20
Dam	1st 10 days	0.38	0.42	0.00	0.00	0.00	0.00	0.02	0.64	0.01	0.13	0.02	0.95	0.22
376ha	2nd 10 days	0.36	0.27	0.00	0.00	0.00	0.00	0.42	0.18	0.09	0.04	0.49	0.48	0.19
	3rd 10 days	0.35	0.14	0.00	0.00	0.00	0.03	0.39	0.12	0.07	0.06	0.66	0.43	0.19
	Monthly Mean	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
Total	1st 10 days	4.80	5.29	0.00	0.00	0.00	0.00	0.30	7.94	0.14	1.62	0.30	11.93	2.69
4,700ha	2nd 10 days	4.49	3.40	0.00	0.00	0.00	0.00	5.20	2.19	1.06	0.47	6.09	5.95	2.41
	3rd 10 days	4.35	1.76	0.00	0.00	0.00	0.39	4.87	1.47	0.88	0.71	8.26	5.36	2.35

Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water

Table AB-3.2.2.7 Stage-Area-Capacity Curves at 3-Dams

Peam Levear Dam

Stage (El.m)	Capacity ($10^6 m^3$)	Area (km^2)
126.0	0.000	0.008
127.0	0.021	0.034
128.0	0.115	0.154
129.0	0.369	0.353
130.0	0.842	0.592
131.0	1.581	0.887
132.0	2.705	1.361
133.0	4.259	1.746
134.0	6.236	2.209
135.0	8.680	2.679
136.0	11.033	3.107

New Dam

Stage (El.m)	Capacity ($10^6 m^3$)	Area (km^2)
153.0	0.000	0.354
154.0	0.428	0.503
155.0	0.970	0.581
156.0	1.587	0.652
157.0	2.277	0.727
158.0	3.131	0.982
159.0	4.201	1.158
160.0	5.418	1.276
161.0	6.754	1.396
162.0	8.213	1.522
163.0	10.120	2.292
164.0	12.638	2.743
165.0	15.551	3.084
166.0	18.800	3.415
167.0	22.379	3.743
168.0	26.508	4.516
169.0	31.330	5.127
170.0	36.663	5.540
171.0	42.417	5.967
172.0	48.608	6.416

O Tang Dam

Stage (El.m)	Capacity ($10^6 m^3$)	Area (km^2)
128.0	0.000	0.024
129.0	0.064	0.104
130.0	0.303	0.374
131.0	0.801	0.623
132.0	1.577	0.928
133.0	2.709	1.336
134.0	4.241	1.729
135.0	5.948	2.218
136.0	8.021	2.851

Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water

Table AB-3.2.3.1 Salient Features of Proposed Stung Tasal Dam

Sl. No		
1	**Province**	Kampong Speu
2	**District**	Aoral
3	**Latitude**	11^{o}11'
4	**Longitude**	104^o 04'
5	**River**	Stung Tasal
6	**Catchment area upto dam site**	495 km^2
7	**Average annual rainfall**	1,210 mm
8	**Dependable Flows:**	
	50%	154.11 MCM
	75%	133.42 MCM
	90%	98.29 MCM
9	**Design flood**	
	50 year return period	1,847 m^3/sec
	100 year retuni period	2,029 m^3/sec
10	**Probable Maximum Flood (PMF)**	35,177 m^3/sec
11	**Available runoff at**	
	At 50% dependability	144.45 MCM
	At 75% dependability	125.09 MCM
	At 90% dependability	92.13 MCM
12	**Reservoir data**	
	Average River Bed Level	89.2 El.m
	Maximum water level (MWL)	108.7 El.m
	Full reservoir level (FRL)	107.2 El.m
	Outlet elevation	95.0 El.m
	Dead Storage level	94.2 El.m
	Gross storage at FRL	147.627 MCM
	Dead storage (MDDL)	8.01 MCM
	Live storage	139.61 MCM
13	**Dam**	
	(A) Spillway	
	Length of spillway	90.5 m
	Crest level	107.2 EL.m
	(B) Rockfill Dam	
	Top of dam	110.2 EL.m
	Length	650 m
	(C) Inteke for Penstock	
	Top of dam	110.2 EL.m
	Length of penstock	70 m
	(D) Power House	
	Type of Power House	Surface type
	Minimum tail water level	90.2 EL.m
	Type.ofturbine	Kaplan
	Installed capacity	750 kW
	Gross head	17 m
	Design head	13.6 m
14	**Estimate of Cost**	
	Land	Nil
	Rockfill Dam	6.64 US$ Million
	Spillway	4.57 US$ Million
	Power Plant and Civil Works	0.84 US$ Million
	Electrical Works	0.32 US$ Million
	Other Expenditures*	1.03 US$ Million
	Total	**13.4 US$ Million**

*Note: *lnclude Coffer Dam, Buildings/Colony, Roads/Communications, Environmental Management Plan etc.*
Source: "Stung Tasal Dam Project" Volume-I, Design Engineering Report, WAPCOS Limited, December 2008.

Table AB-3.2.4.2 Salient Features of Proposed Stung Sva Slab Dam and Stung Khleach Dam

Dam site	**Stueng Sva Slab Dam**	
River	Stueng Sva Slab	
C.A.	215.6	km^2

(1)-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

Source: JICA Survey Team

(1)-1. 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	$x10^{\wedge 6}$ m^3
Sediment Level for 50 years (EL.m)	241.16	m
Sediment Volume for 100years	7.7616	$x10^{\wedge 6}$ m^3
Sediment Level for 100 years (EL.m)	242.33	m

Dam site	**Stueng Khleach Dam**	
River	Stueng Khleach	
C.A.	109.8	km^2

(1)-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

Source: JICA Survey Team

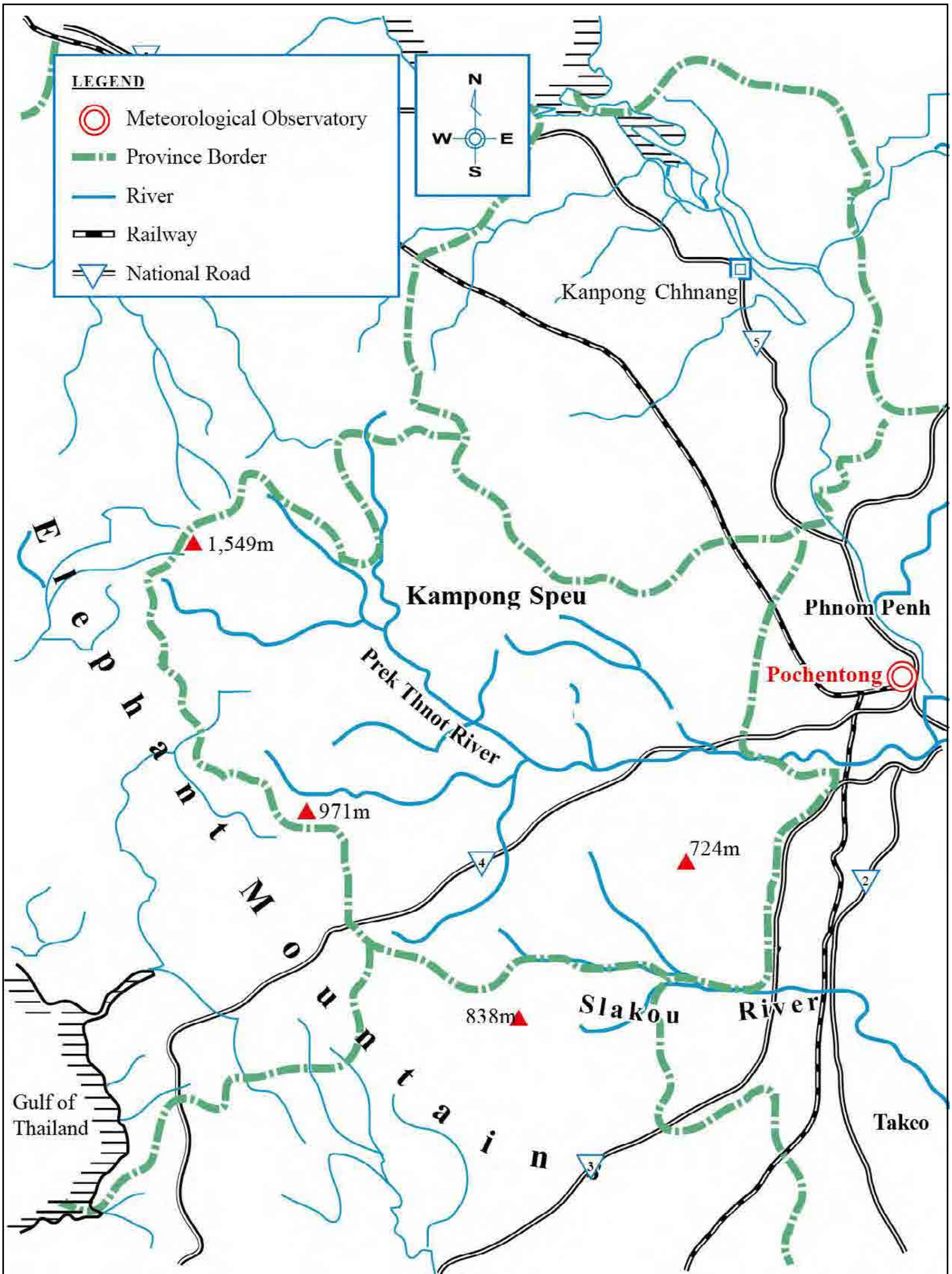
(1)-1. Input Data

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

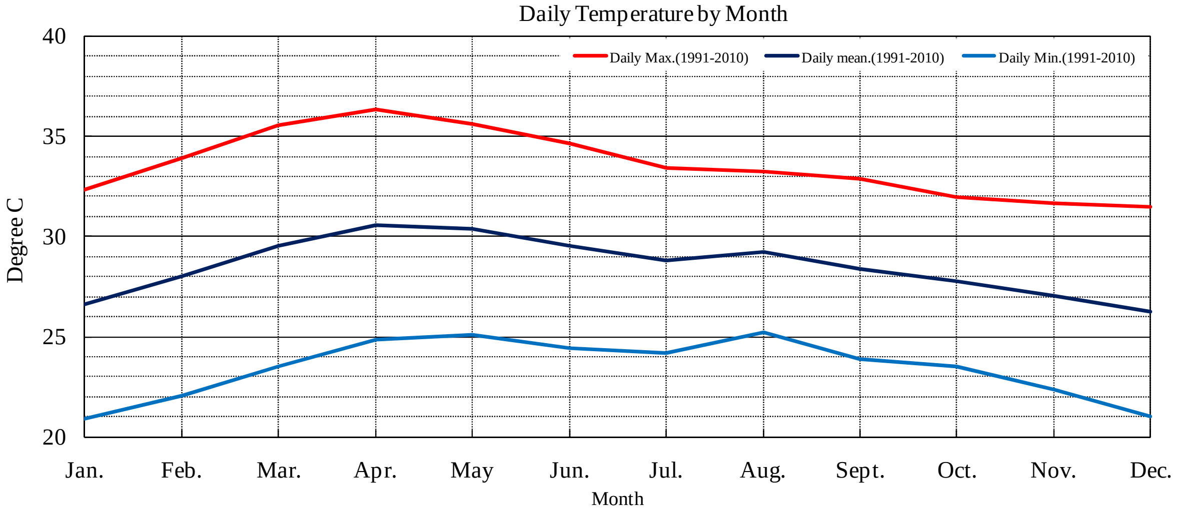
ANNEX B

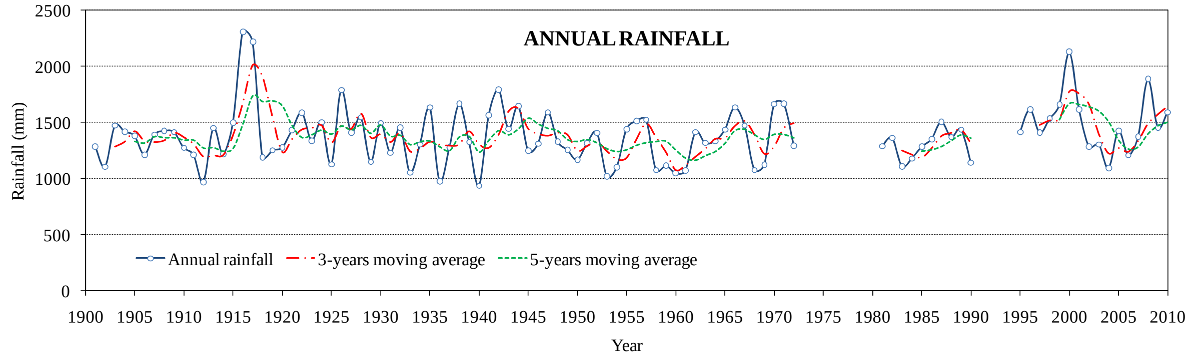
Figures

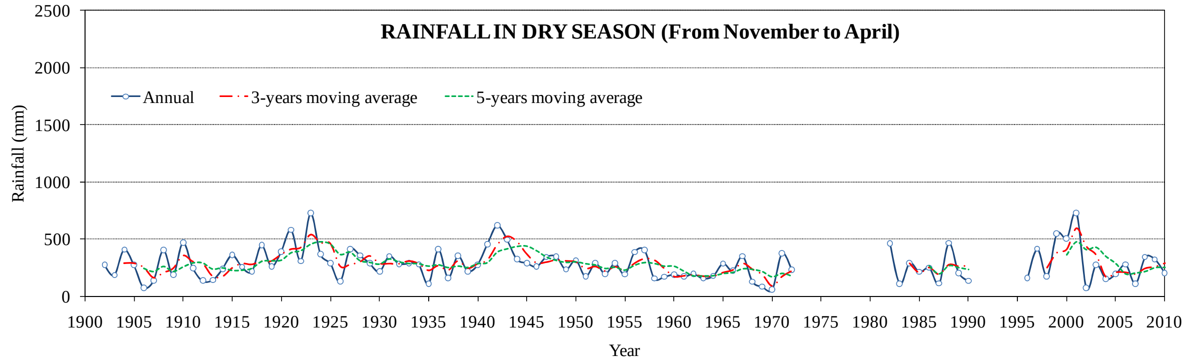


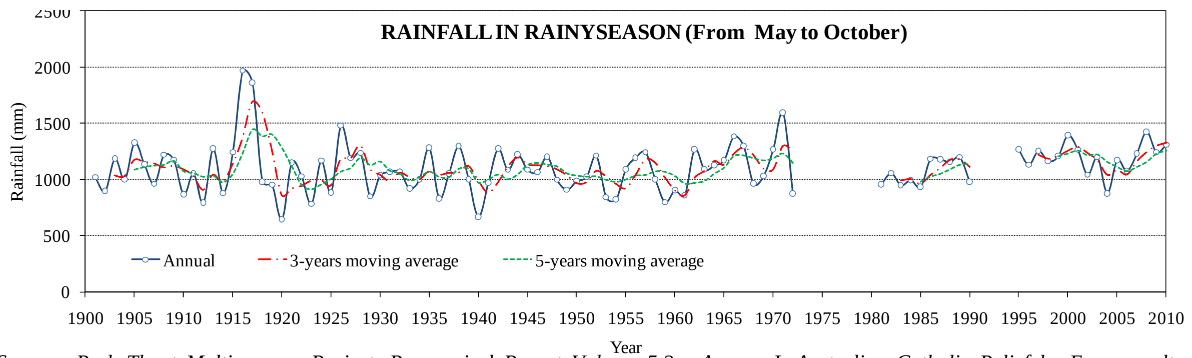
Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.1.1.1.1** **Location Map of Pochentong Observatory**
Japan International Cooperation Agency	



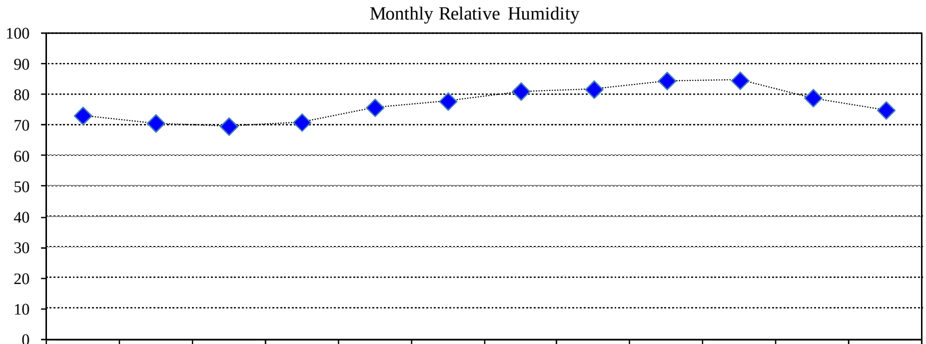




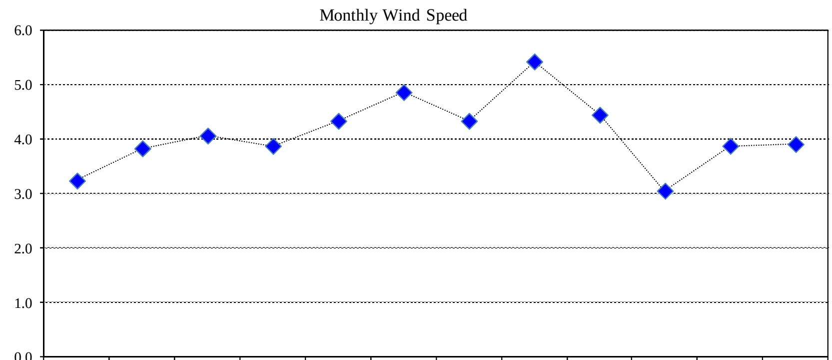


Souce: *Prek Thnot Multipurpose Project, Reappraisal Report Volume 5.2 - Annexe I, Australian Catholic Relief by Euroconsultant, December 1991*
MOWRAM

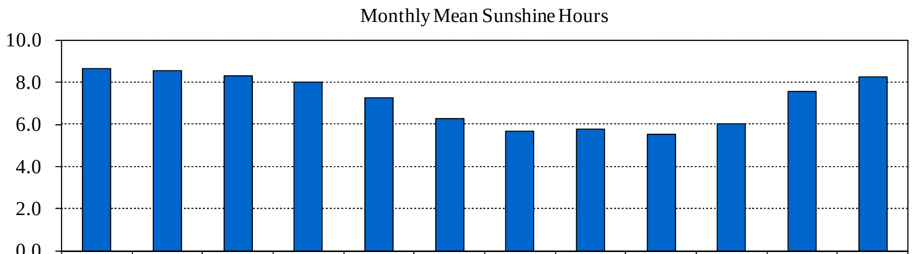
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.1.1.2.1**
Japan International Cooperation Agency	**Climate Condition at Pochentong Observatory (Temperature during 1991 ~ 2010 and Rainfall**



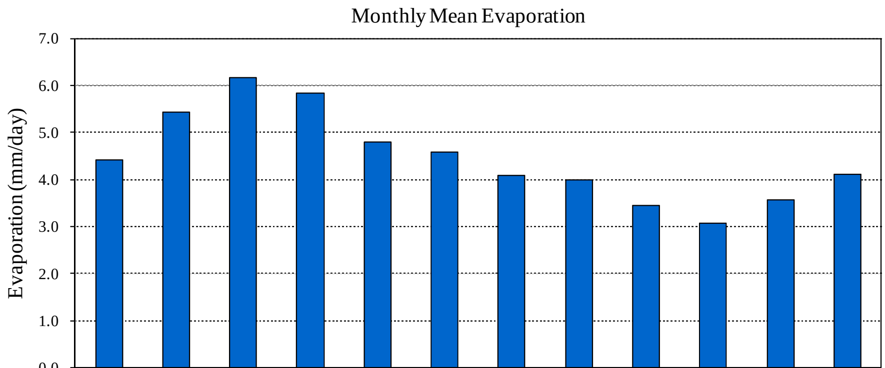
	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative Humidity	73.2	70.7	69.7	71.0	75.8	77.8	81.1	81.7	84.6	84.6	79.0	74.9



	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind Speed	3.2	3.8	4.1	3.9	4.3	4.9	4.3	5.4	4.4	3.1	3.9	3.9



	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Sunshine Hours	8.7	8.6	8.3	8.0	7.2	6.3	5.7	5.8	5.5	6.0	7.5	8.3



	Jan	Fab	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Evaporation	4.4	5.4	6.2	5.8	4.8	4.6	4.1	4.0	3.5	3.1	3.6	4.1

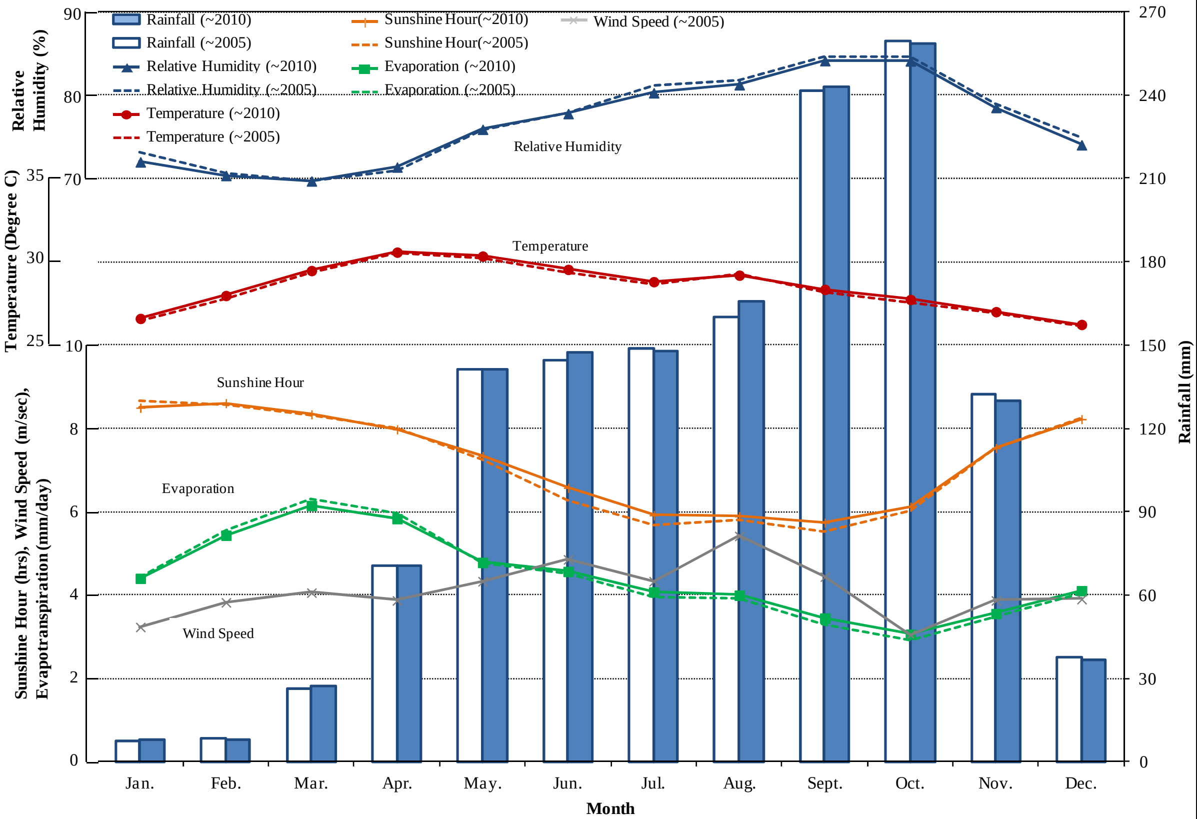
Source: MOWRAM

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

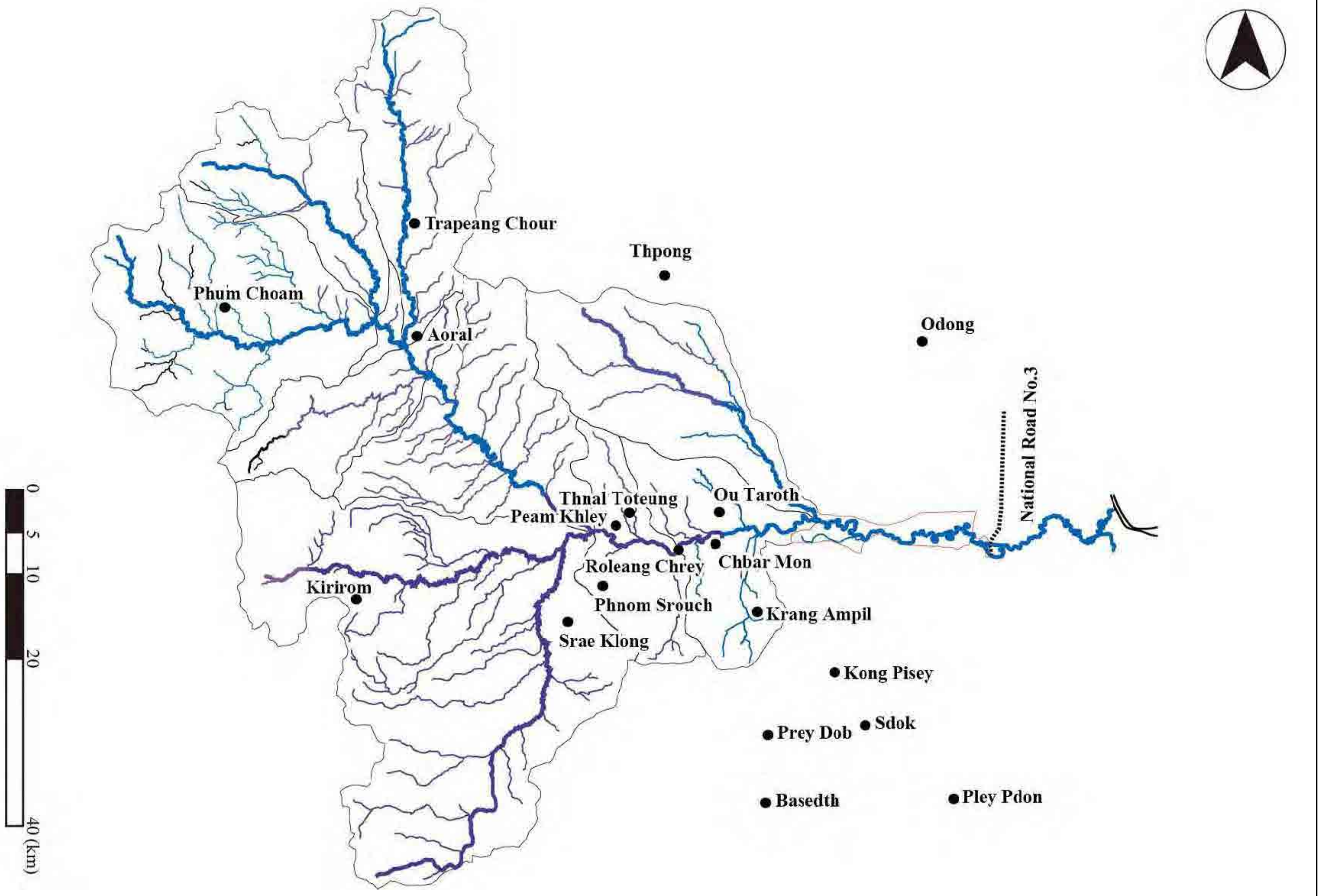
Figure AB-2.1.1.2.2

Climate Condition at Pochentong Observatory (Relative Humidity, Wind Speed, Sunshine Hour



Source: MOWRAM,
Prek Thnot Multipurpose Project, Reappraisal Report Volume 5.2 - Annexe I, Australian Catholic Relief by Euroconsultant, December 1991

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.1.1.3.1** **Comparison of Climate Conditions between that up to 2005 and that up to 2010**
Japan International Cooperation Agency	



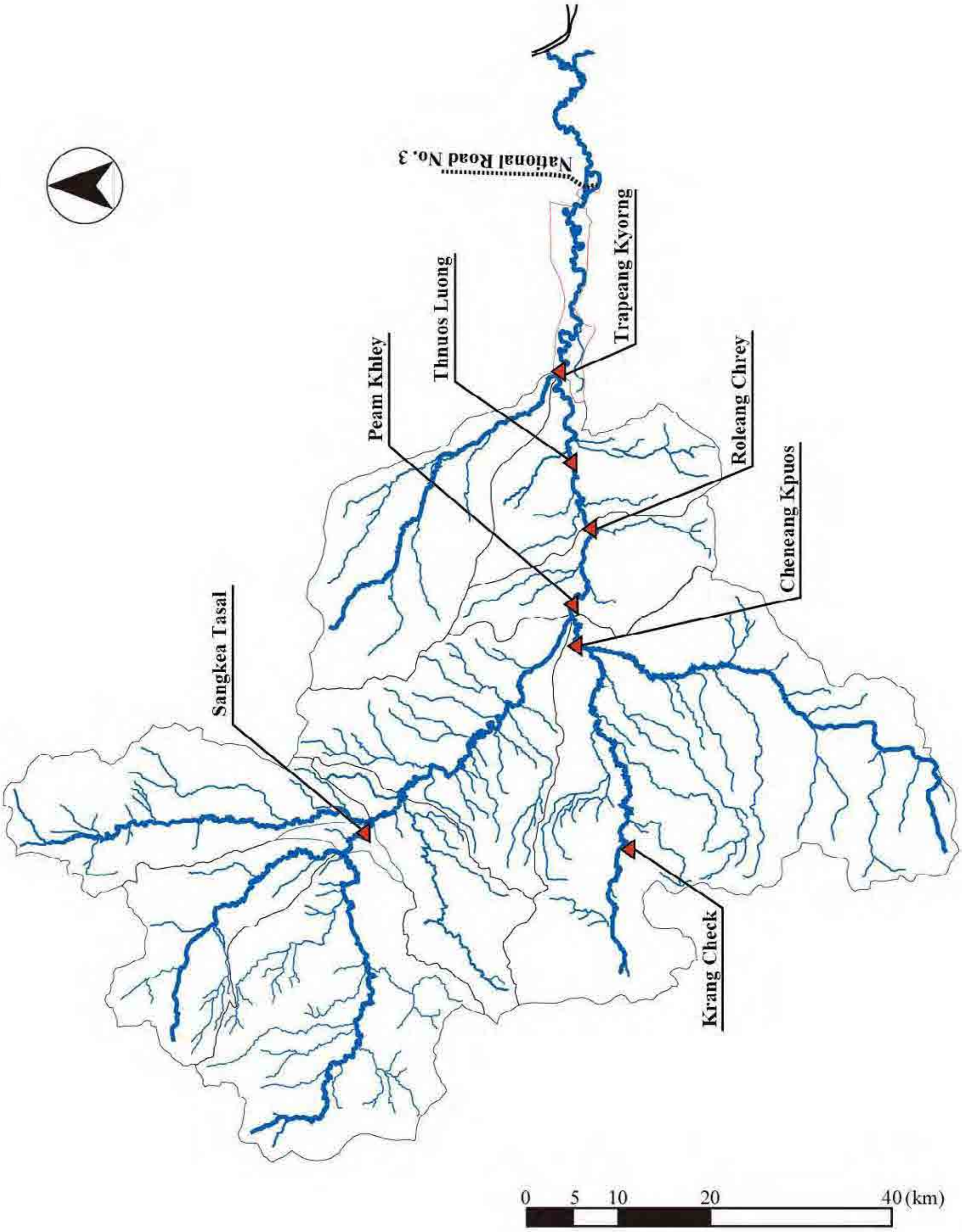
Source: *The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.1.2.1

Location Map of Rainfall Observatory

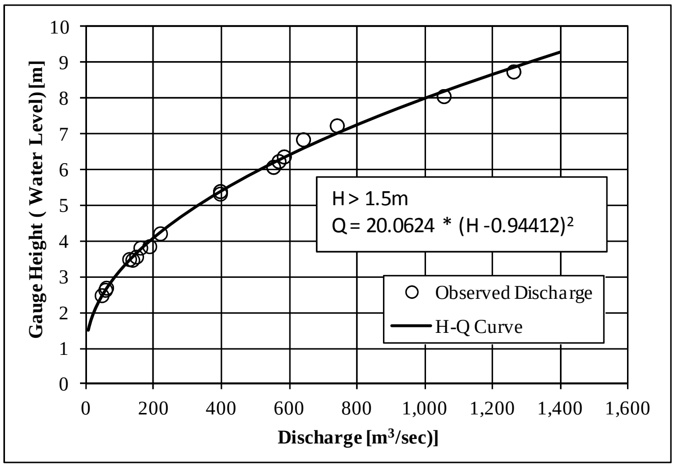


Source: The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.1.2.1.2** **Location Map of Water Level Observatory**
Japan International Cooperation Agency	

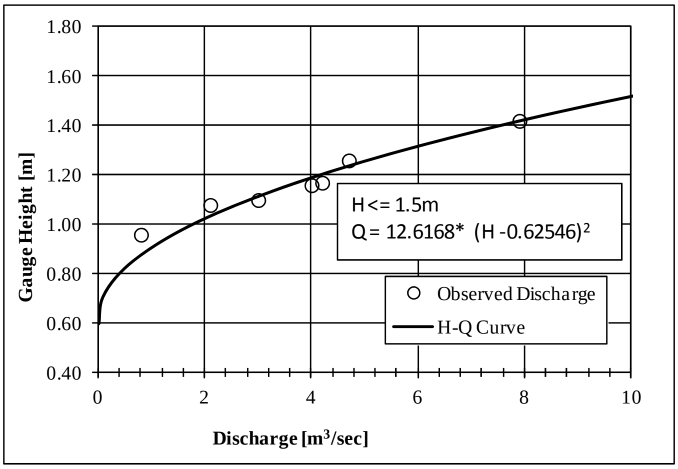
Water Level > 1.5m

No.	Date	H (m)	Q (m^3/sec)
1	10-Sept.-96	3.57	147.4
2	12-Sept.-96	3.50	126.7
3	16-Oct.-96	3.48	136.0
4	17-Oct.-2000	8.75	1,260.8
5	18-Oct.-2000	8.06	1,054.9
6	18-Oct.-96	3.82	159.7
7	24-Oct.-96	4.22	217.9
8	28-Oct.-99	6.24	567.7
9	29-Oct.-99	6.08	551.8
10	2-Nov.-99	7.24	739.6
11	2-Sept.96	2.64	56.1
12	30-Aug.-96	2.49	45.4
13	4-Dec.-96	2.70	58.8
14	4-Nov.-99	6.85	639.9
15	5-Nov.-96	6.37	583.2
16	7-Apr.-96	5.40	395.0
17	7-Nov.-96	5.33	394.8
18	9-Sept.-96	3.86	186.2



Water Level <= 1.5m

No.	Date	H (m)	Q (m^3/sec)
1	15-Dec.-97	1.10	3.0
2	15-Jan.-97	1.26	4.7
3	16-Jan.-98	0.96	0.8
4	1-Mar.97	1.42	7.9
5	21-Feb.-97	1.16	4.0
6	28-Feb.-01	1.08	2.1
7	28-Jan.-97	1.17	4.2

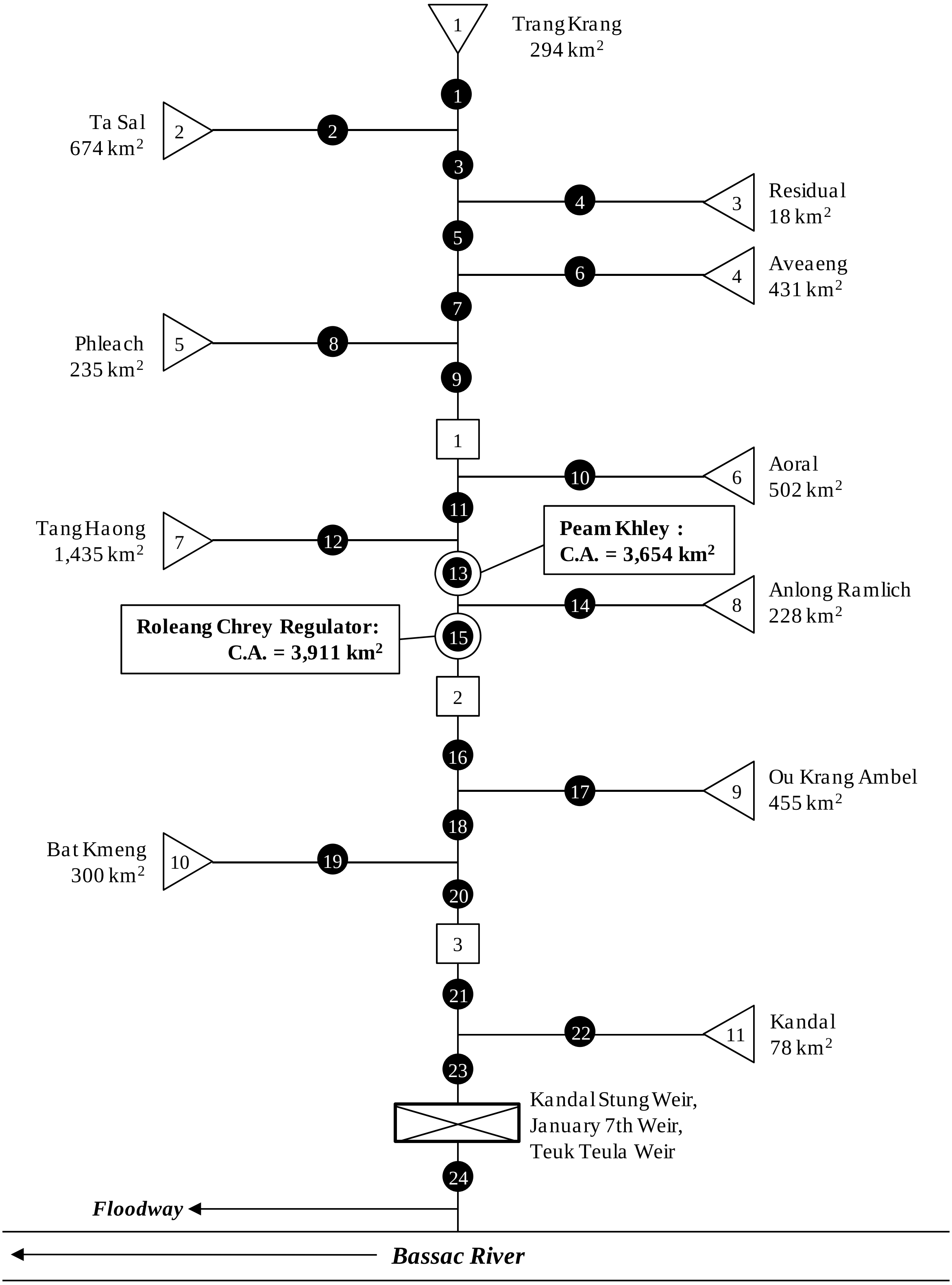


PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

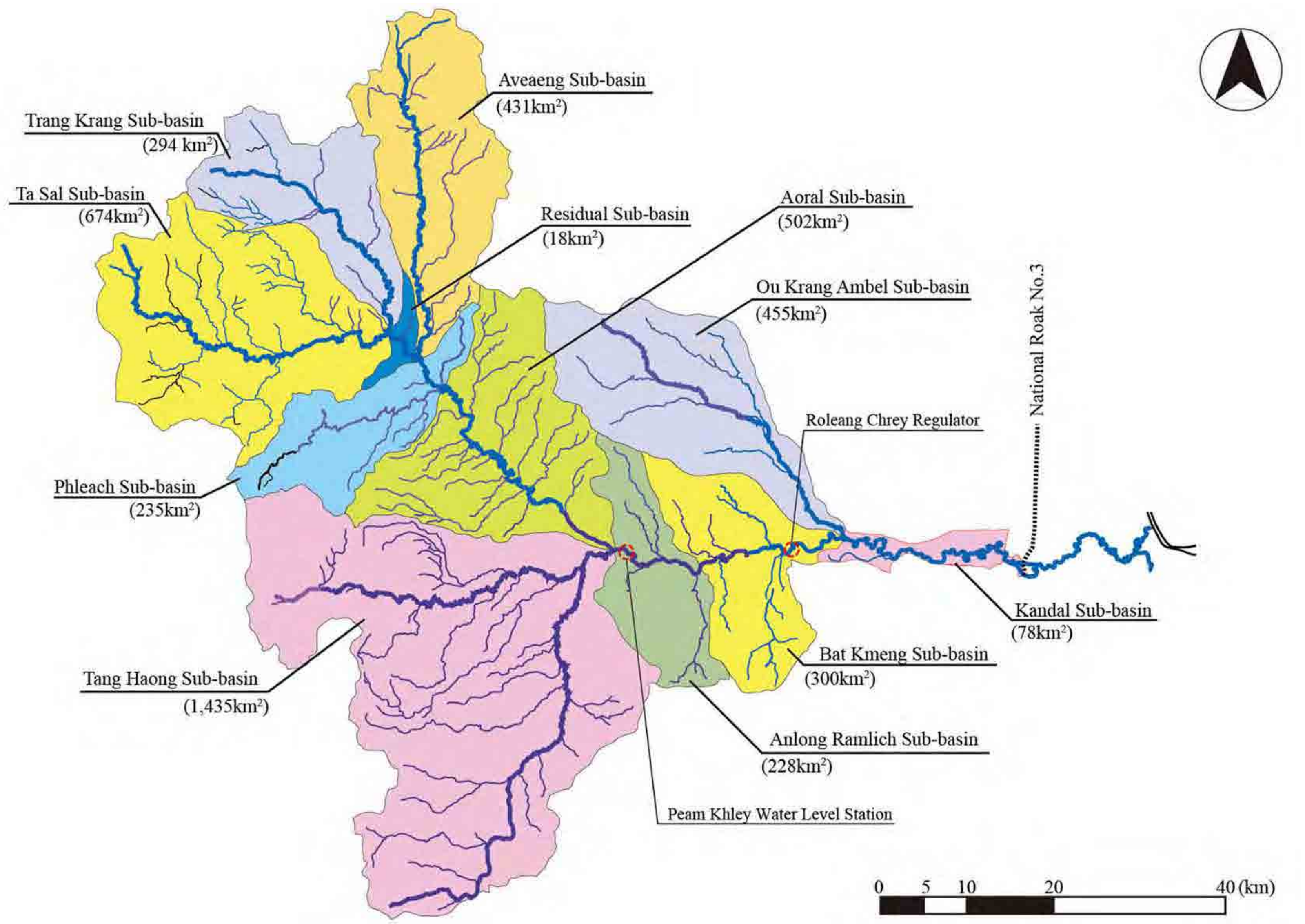
Figure AB-2.1.2.1.3

H-Q Rating Curve at Peam Khley



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

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.1.2.2.1** **Schematic Diagram of Prek Thnot River System**
Japan International Cooperation Agency	



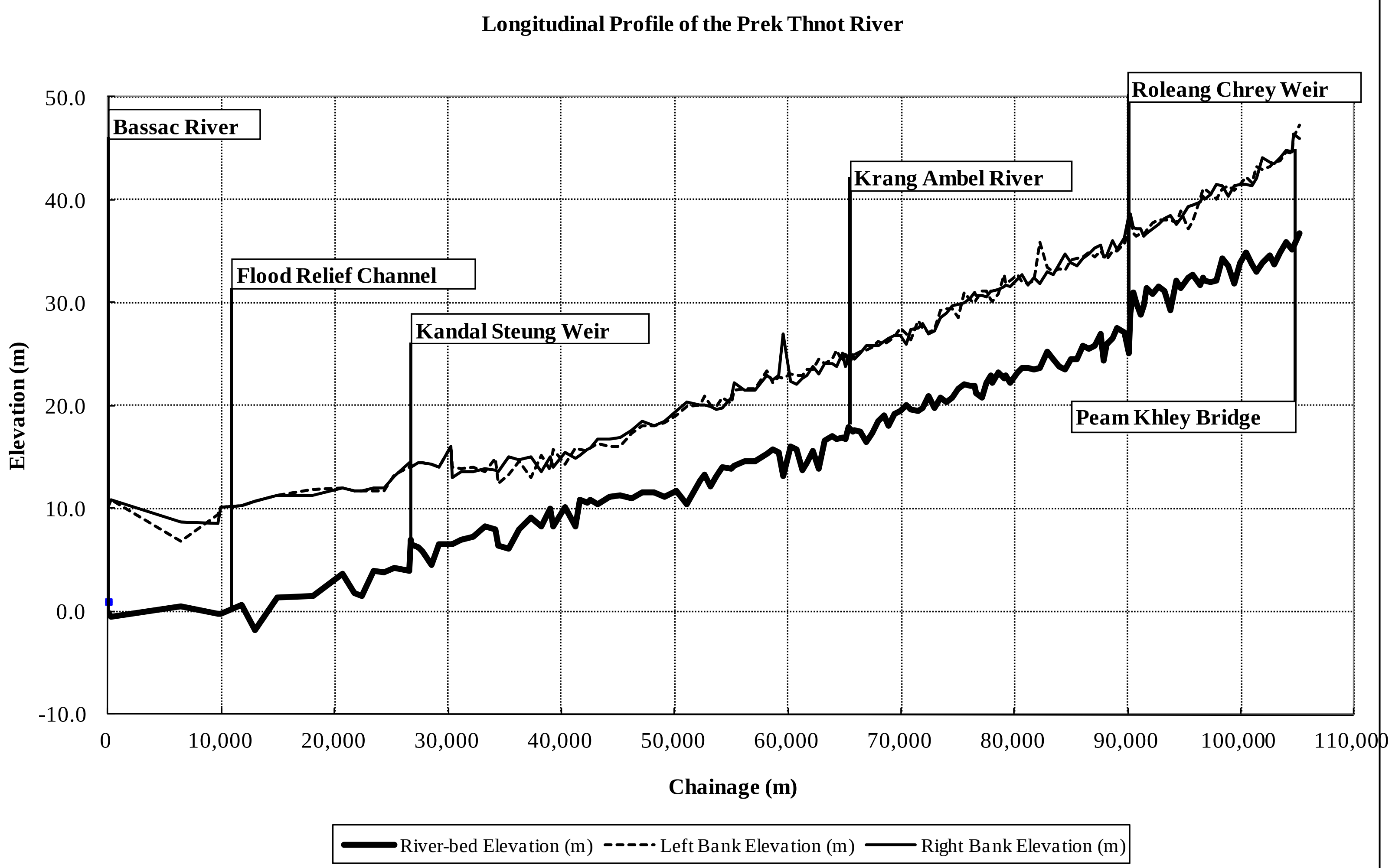
Source: *The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.1.2.2.2

Sub-basins of Prek Thnot River

Japan International Cooperation Agency



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

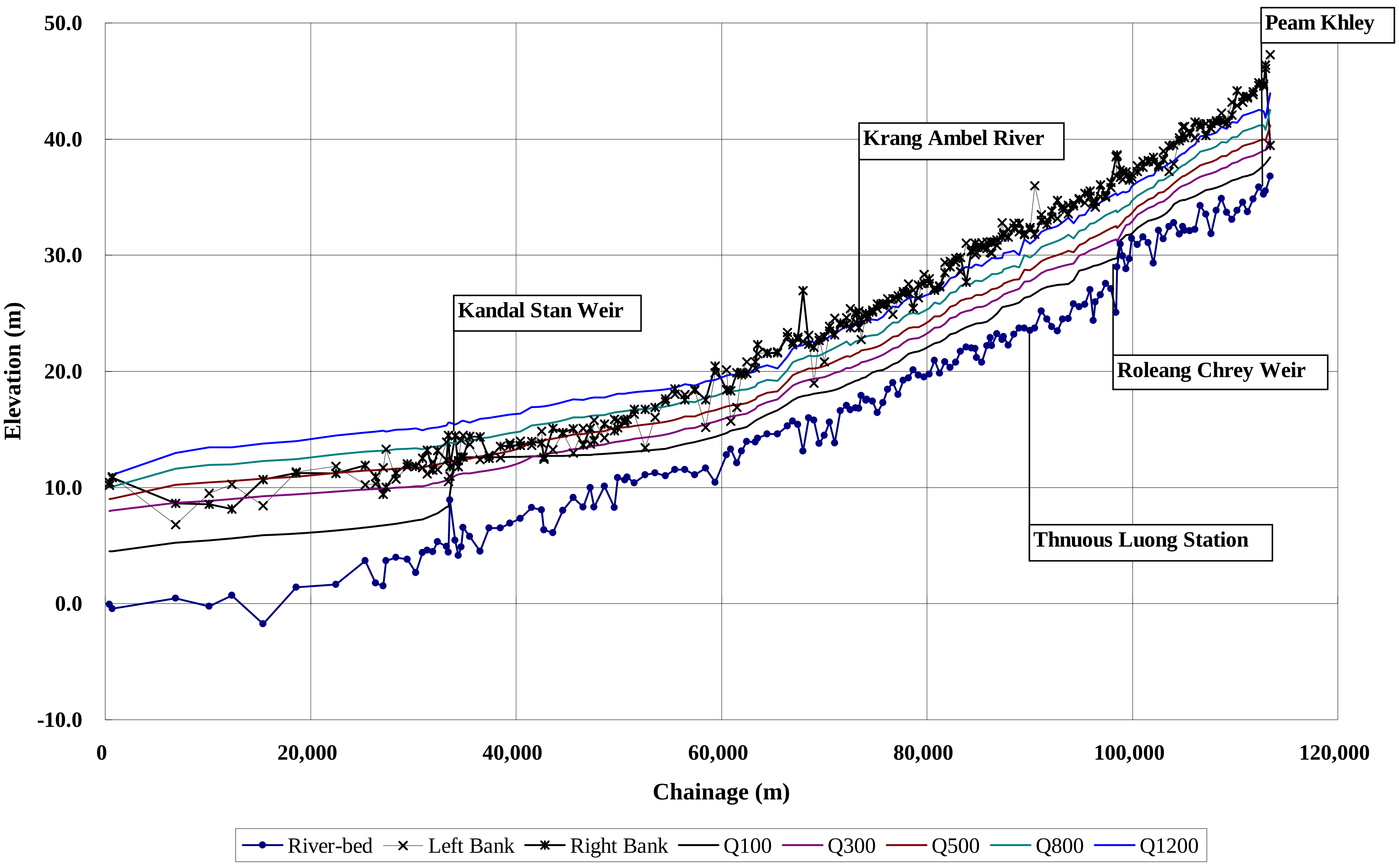
Figure AB-2.1.2.2.3

Longitudinal Slope of Prek Thnot River

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

Figure AB-2.1.2.2.4
Longitudinal Profile of Water Level of Prek Thnot River (1)



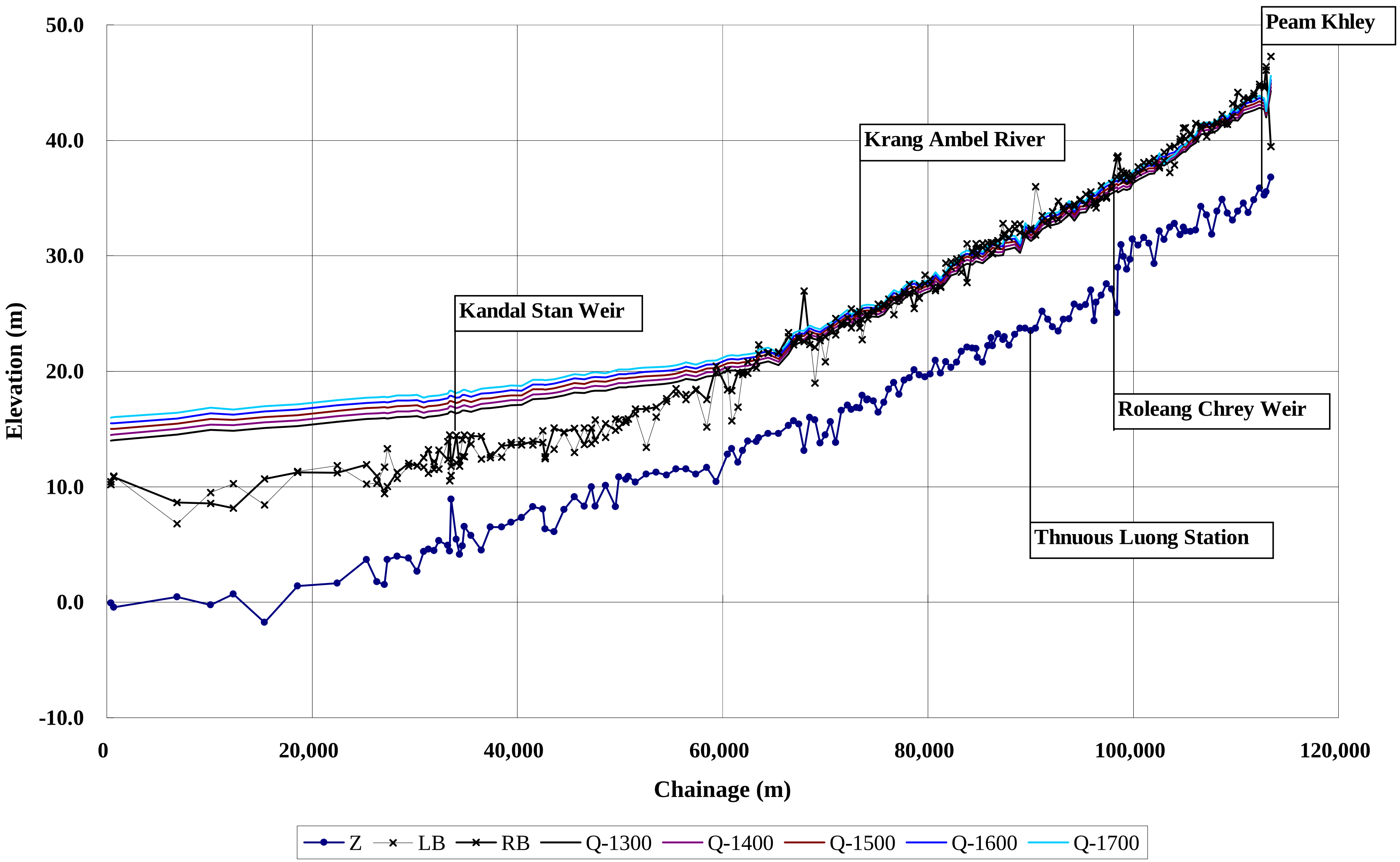
Source: *The Study on Comprehensive Agricultural Development of Prek Thnot River Basin in the Kingdom of Cambodia, JICA, 2008*

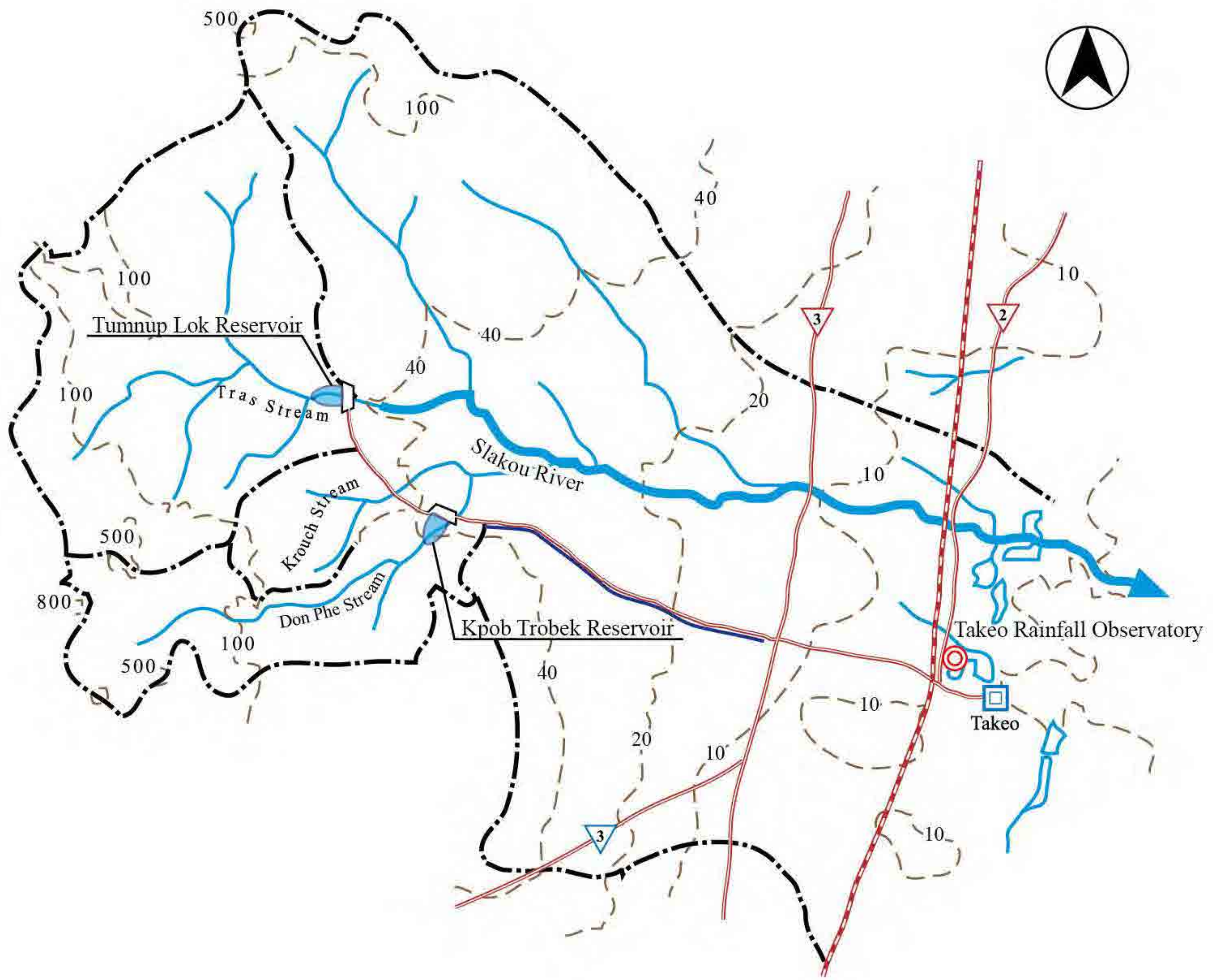
Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.1.2.2.5
Longitudinal Profile of Water Level of Prek Thnot River (2)

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





Source: JICA Survey Team

Figure AB-2.2.1.1
Location of Takeo Rainfall Observatory

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

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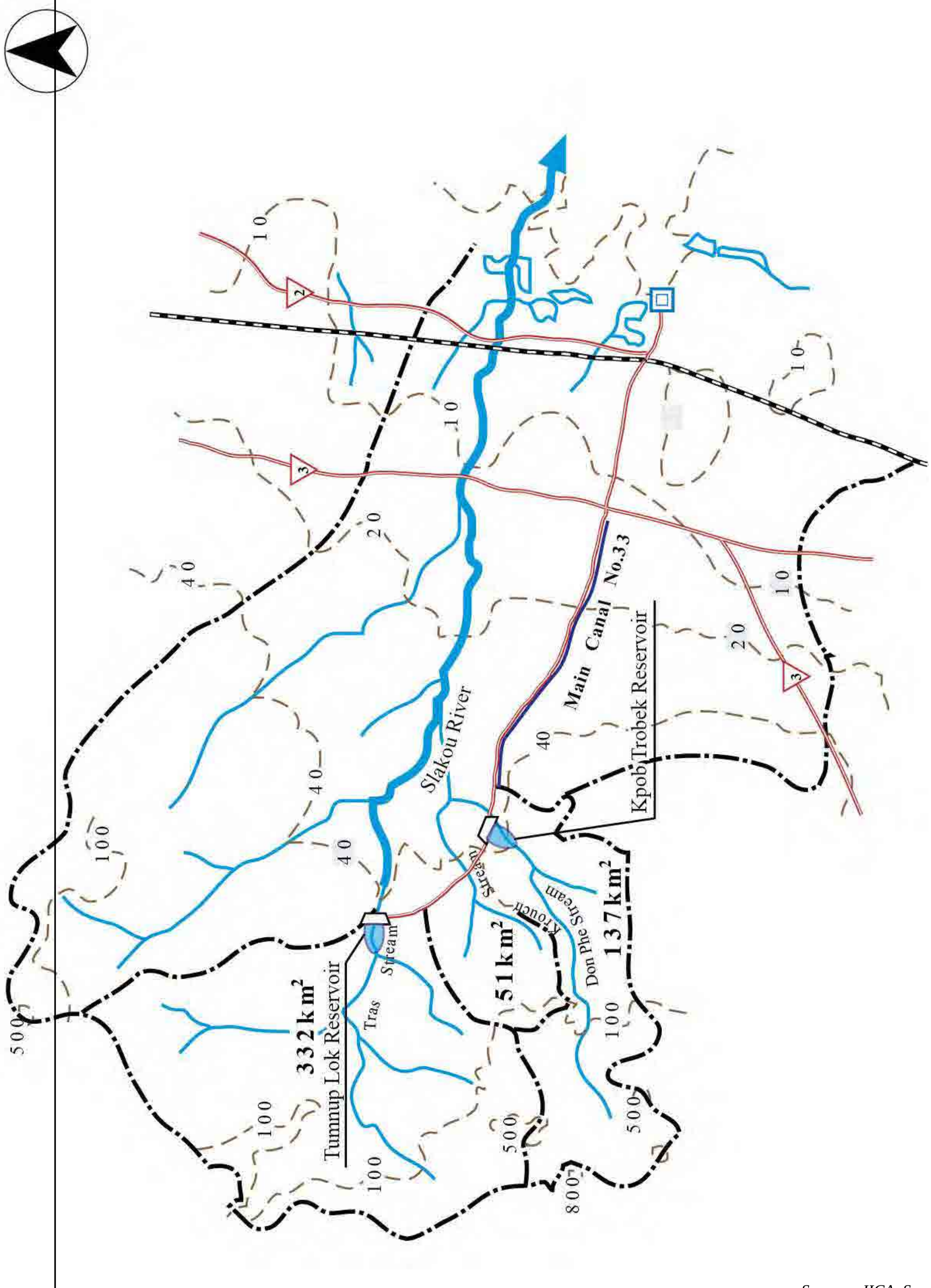


Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.2.2.2.1**
Japan International Cooperation Agency	**Location Map of Slakou River, Tumnup Lok Reservoir and Kpob Trobek Reservoir**

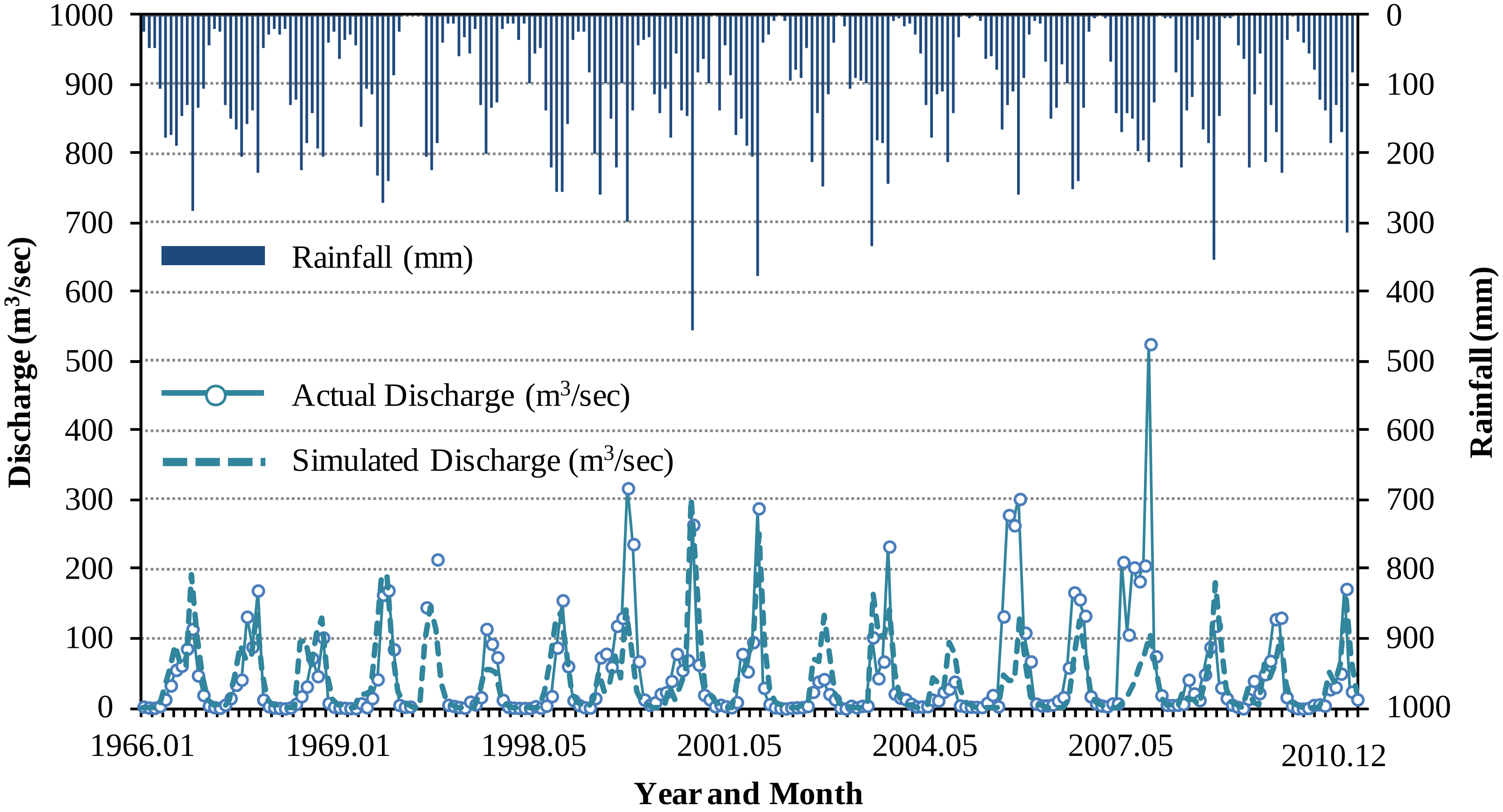
Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.2.2.2

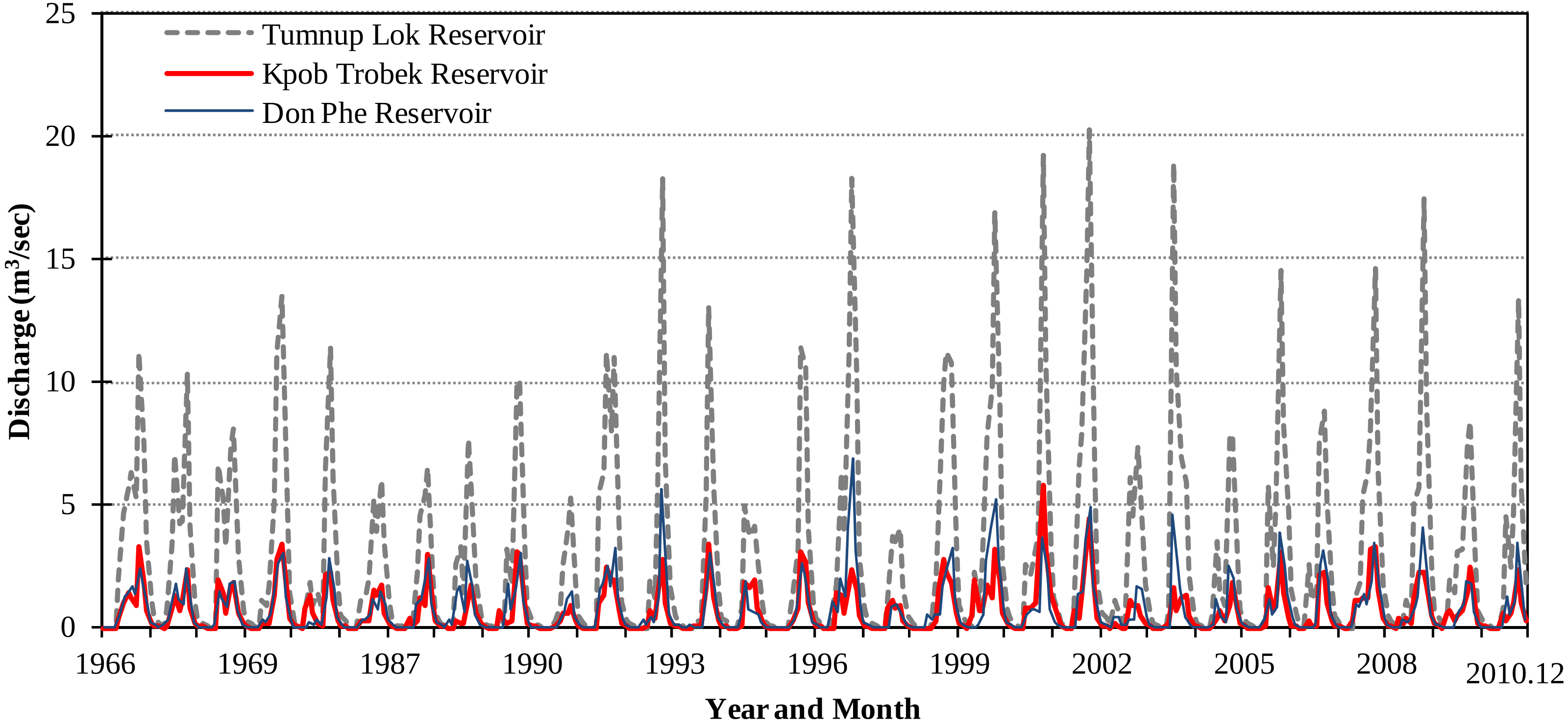
Validity of the Runoff Analysis Model at Peam Khley Station on Prek Thnot River

Source: JICA Survey Team



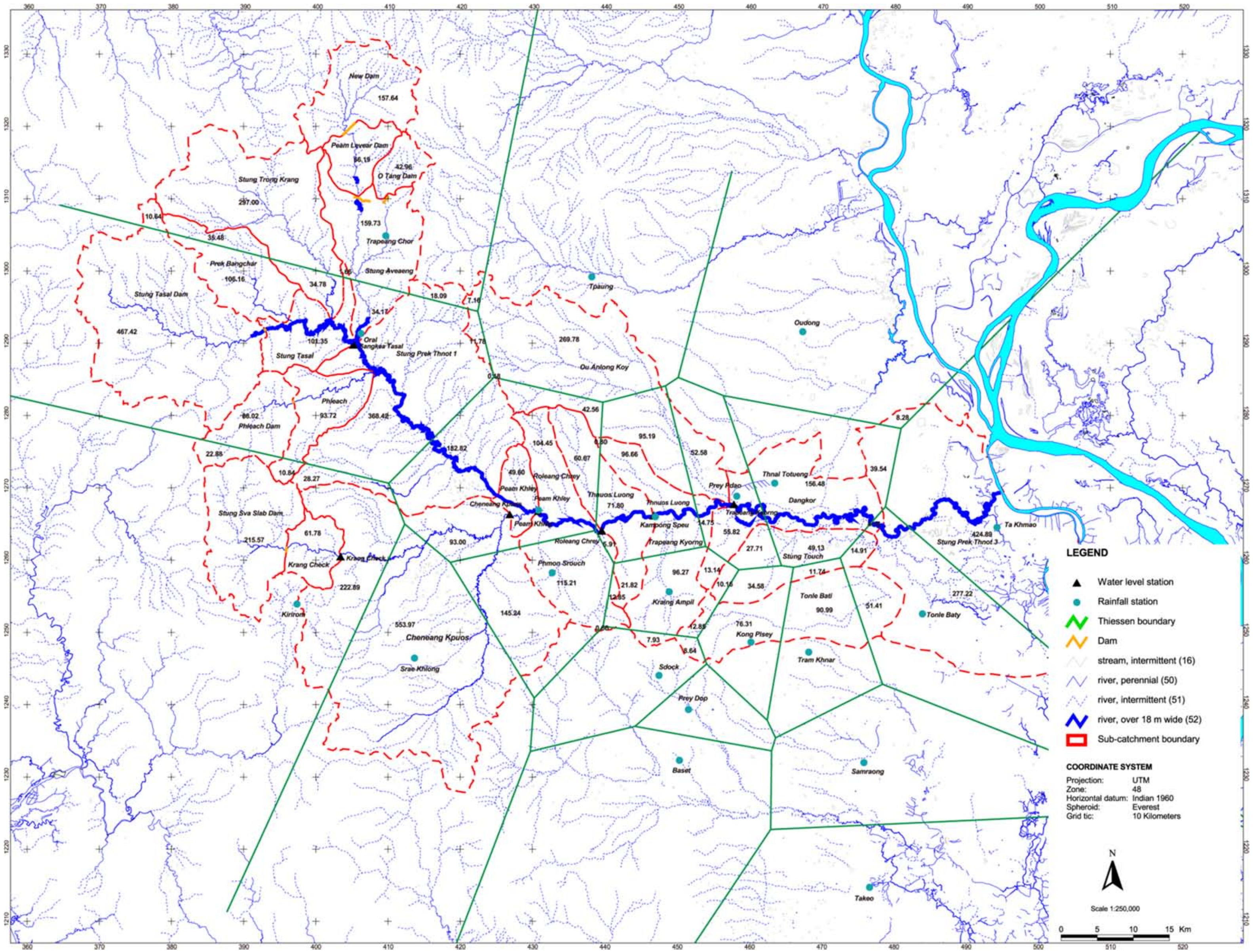
Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT



Source: JICA Survey Team

Figure AB-2.2.2.3.1
Discharge of each Reservoir Basin



Source: JICA Survey Team

Figure AB-2.3.2.1.1
Rainfall Stations and the Thiessen Polygons in/around Prek Thnot River Basin

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

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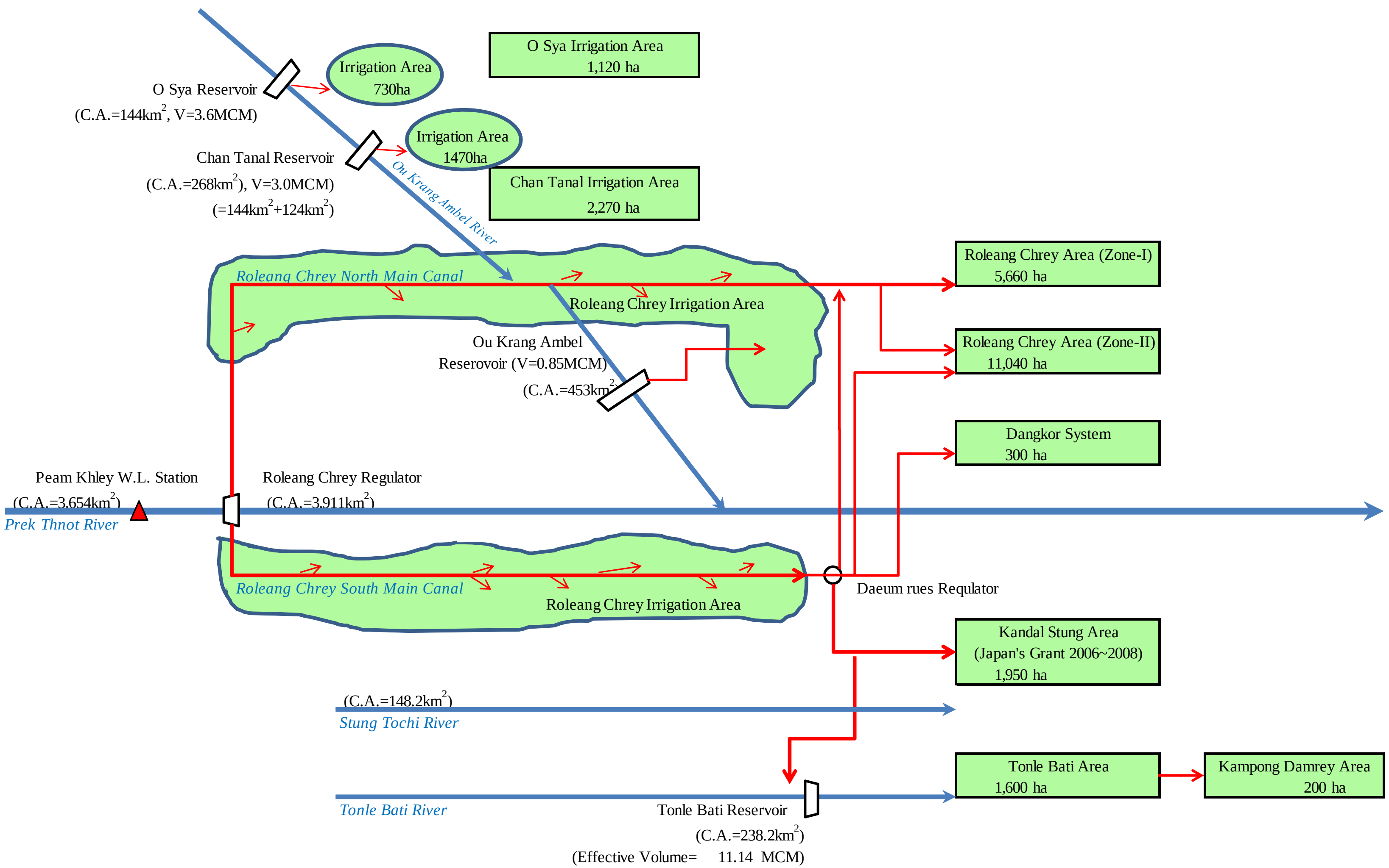
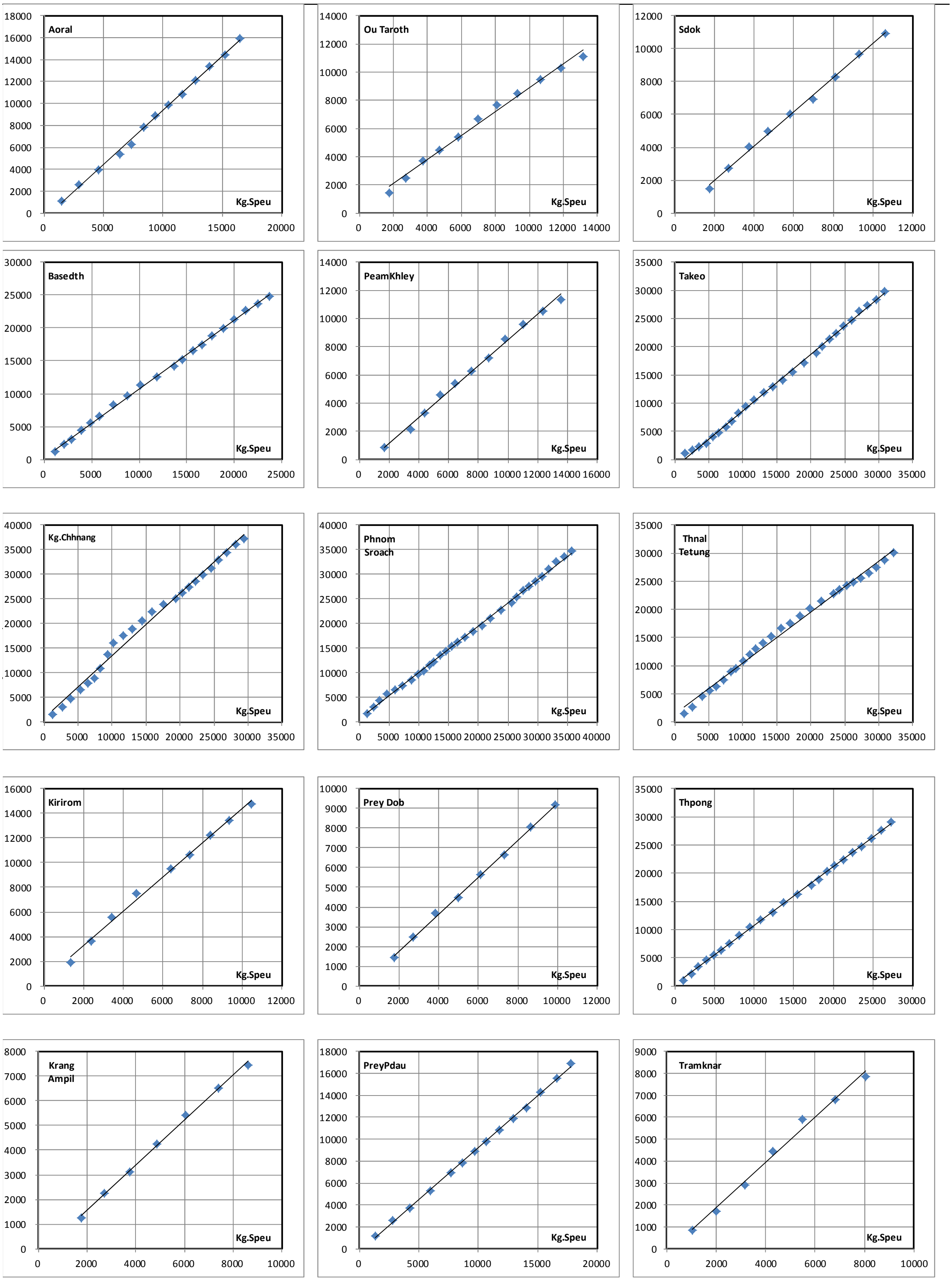


Source: JICA Survey Team

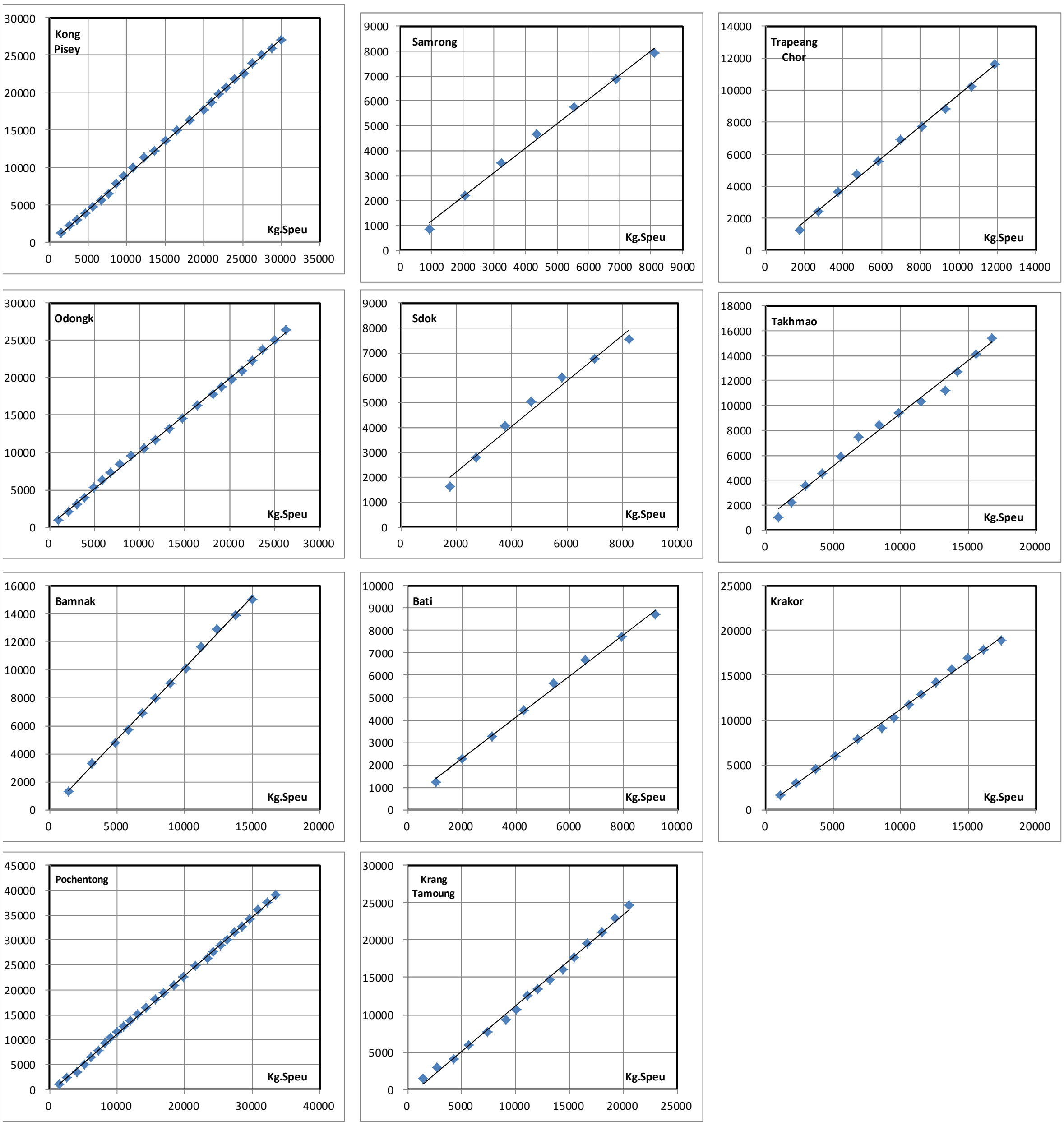
Figure AB-2.3.2.1.2

Schematic Diagram of Roleang Chrey and Kandal Stung-Bati Irrigation Area



Source: Prepared by JICA Survey Team based on Rainfall Data by MOWRAM

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.3.2.3.1**
Japan International Cooperation Agency	**Double Mass Curves of Accumulated Annual Rainfall (1/2)**



Source: Prepared by JICA Survey Team based on Rainfall Data by MOWRAM

Figure AB-2.3.2.3.1

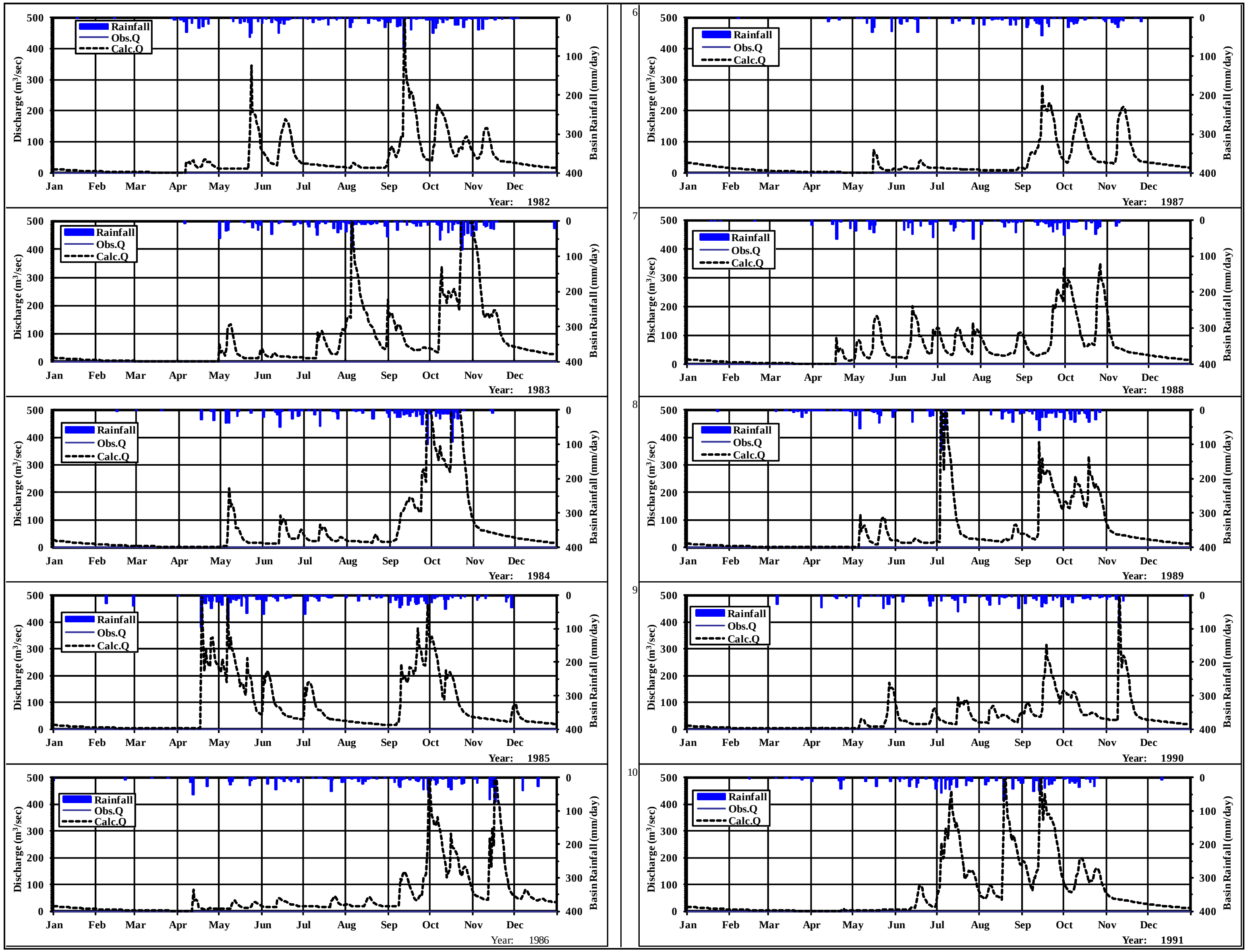
Double Mass Curves of Accumulated Annual Rainfall (2/2)

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.3.2.4.2

Observed and Estimated Daily Discharge by the Tank Model at Peam Khley (1/3)



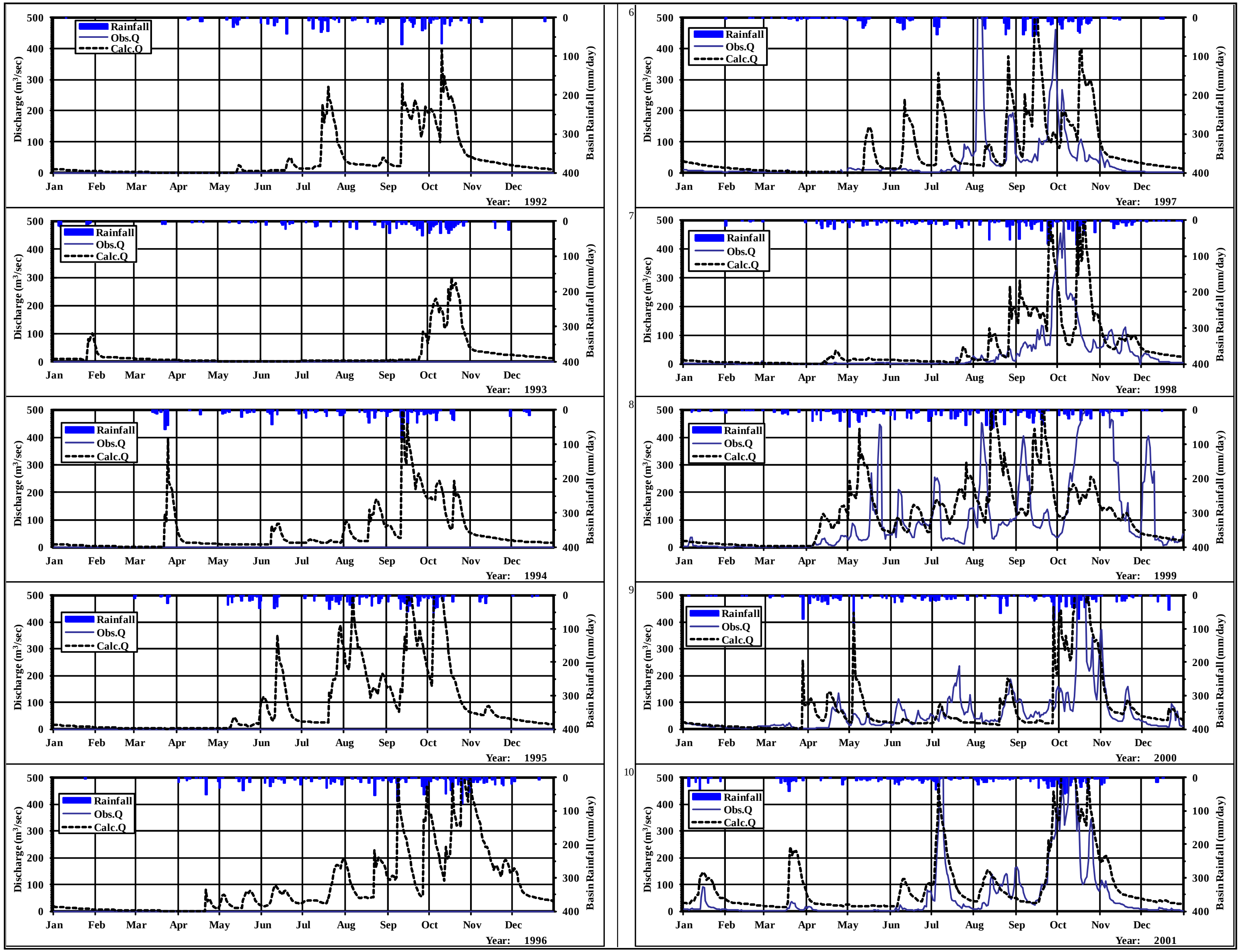
Source: JICA Survey Team

Japan International Cooperation Agency

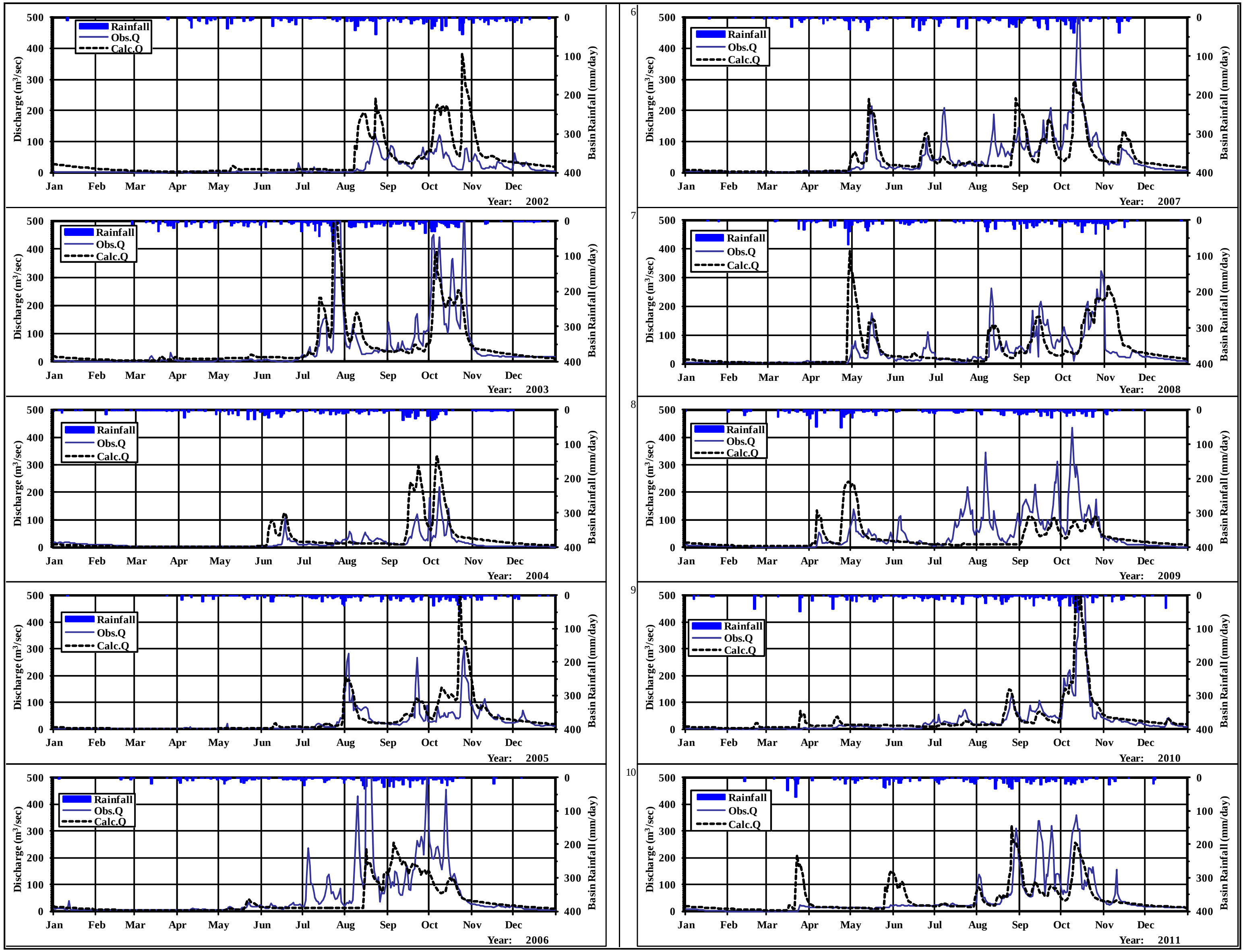
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.3.2.4.2

Observed and Estimated Daily Discharge by the Tank Model at Peam Khley (2/3)



Source: JICA Survey Team



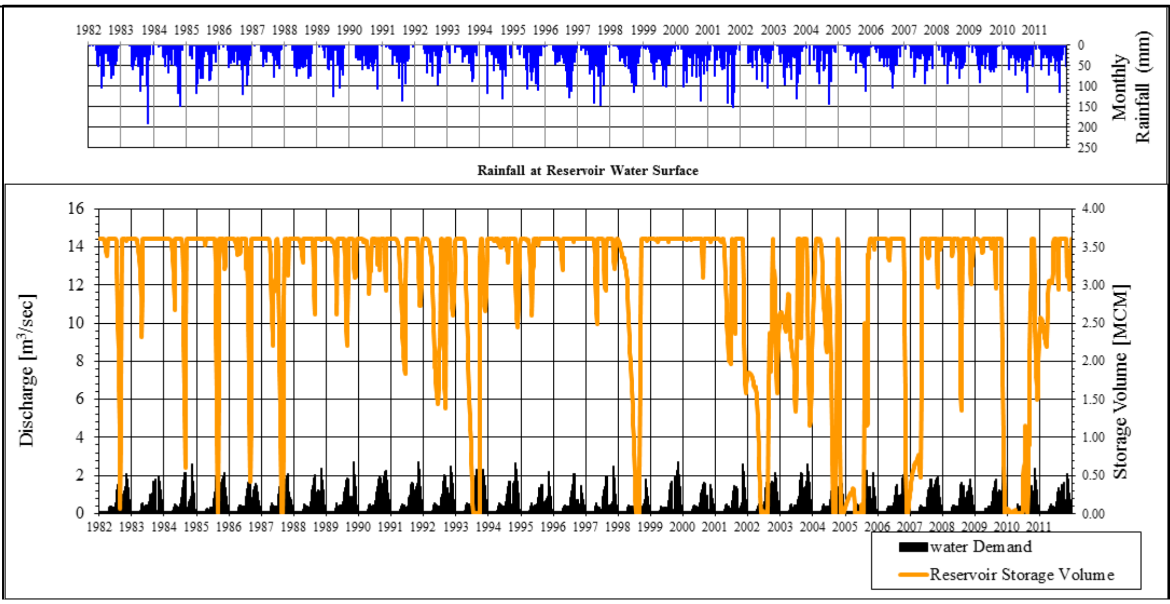
Source: JICA Survey Team

Figure AB-2.3.2.4.2

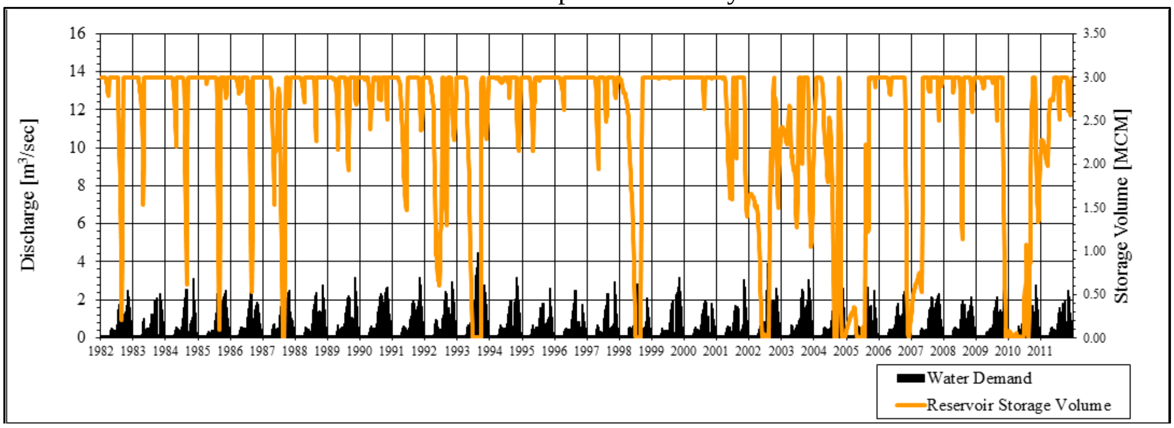
Observed and Estimated Daily Discharge by the Tank Model at Peam Khley (3/3)

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

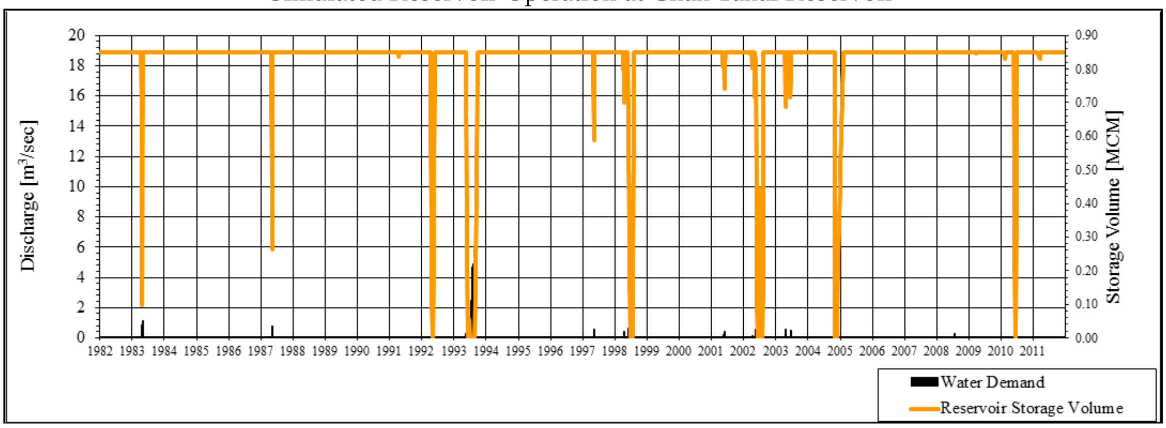
Japan International Cooperation Agency



Simulated Reservoir Operation at O Sya Reservoir



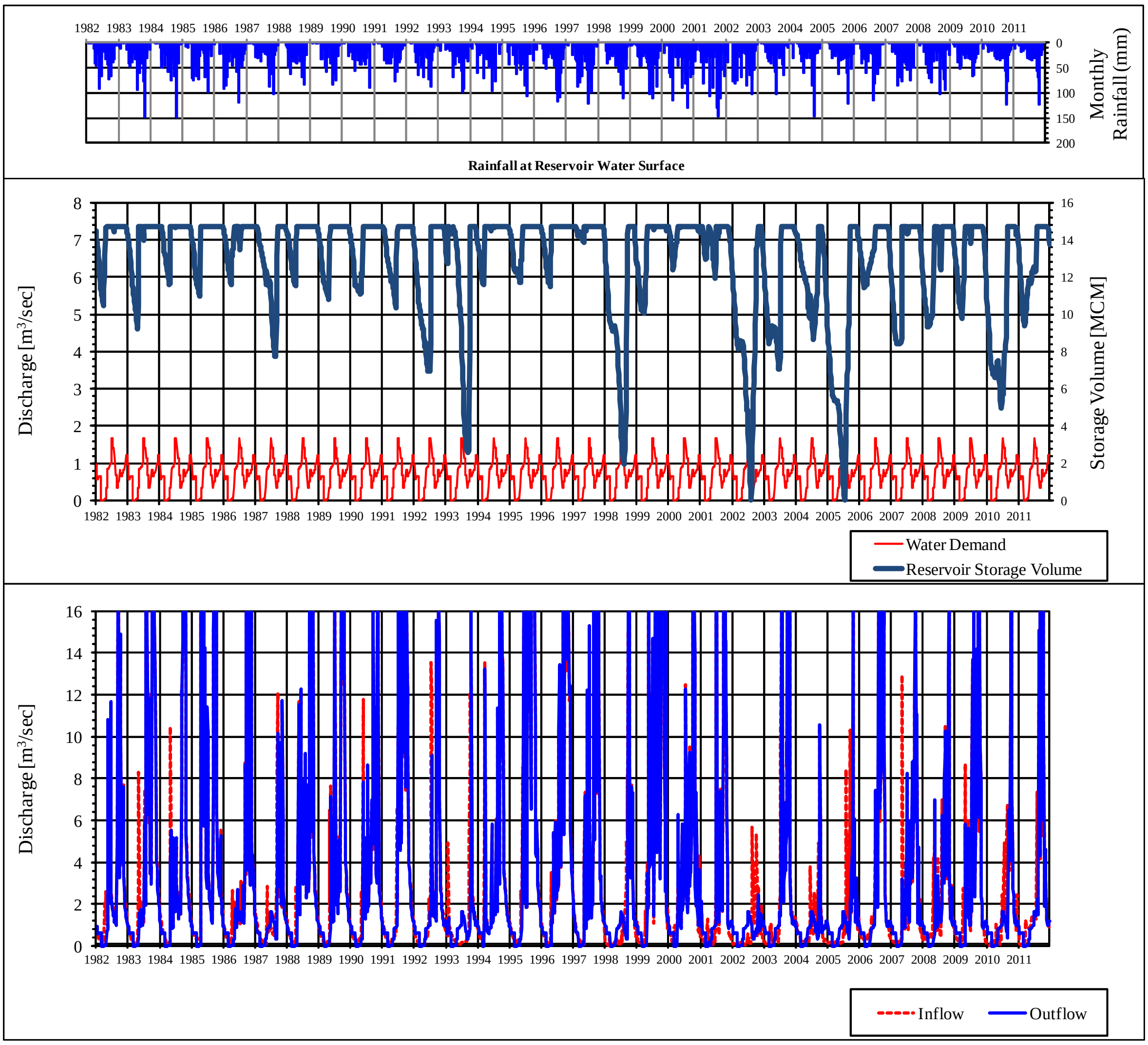
Simulated Reservoir Operation at Chan Tanal Reservoir



Simulated Reservoir Operation at Ou Krang Ambel Reservoir

Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.3.2.4.4**
Japan International Cooperation Agency	**Results of Reservoir Operation Simulation of Existing Reservoir in Ou Krang Ambel River**



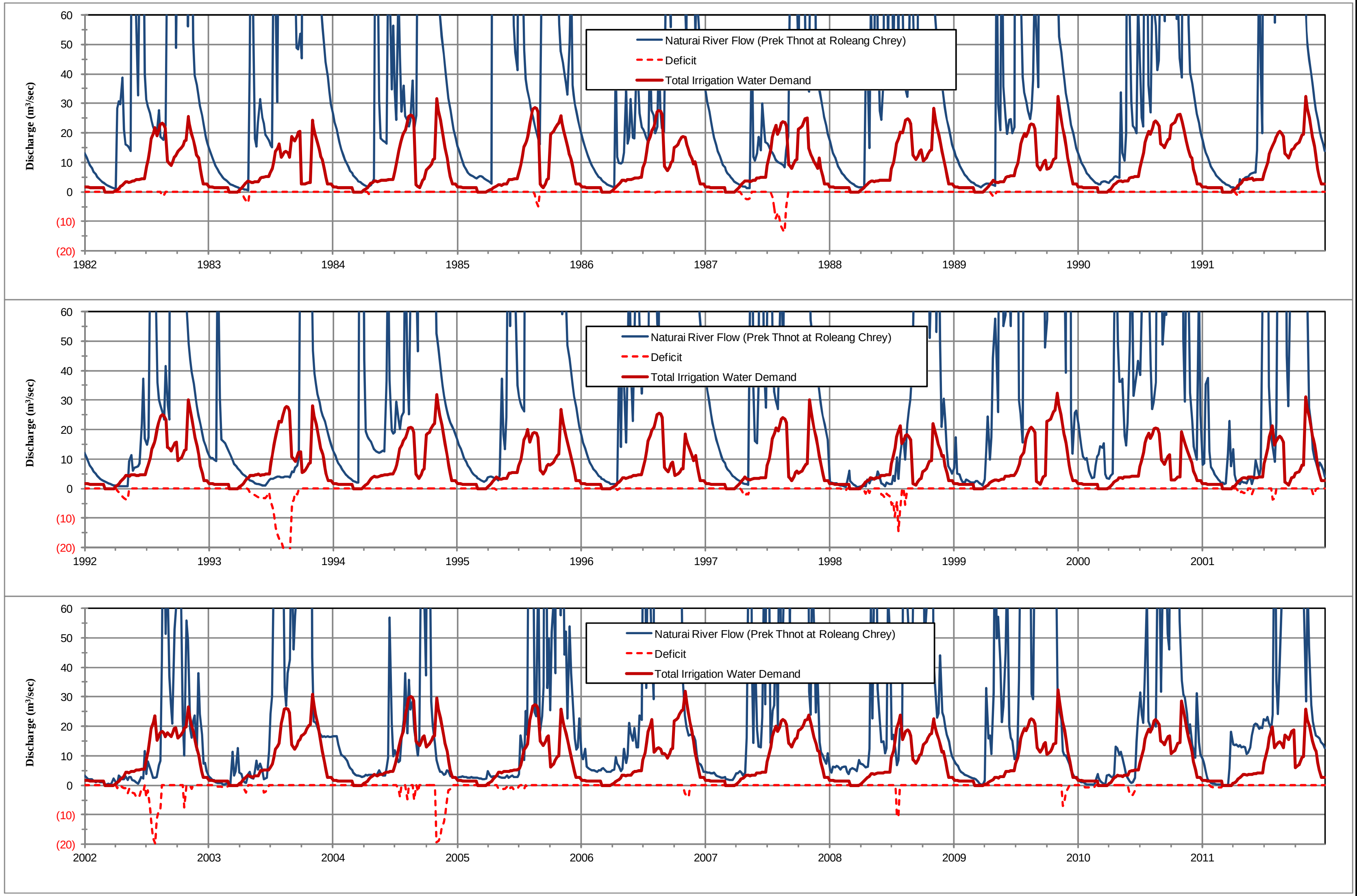
Simulated Reservoir Operation at Lake Tonle Bati

Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.3.2.4.5** **Results of Reservoir Operation Simulation of Existing Lake Tonle Bati**
Japan International Cooperation Agency	

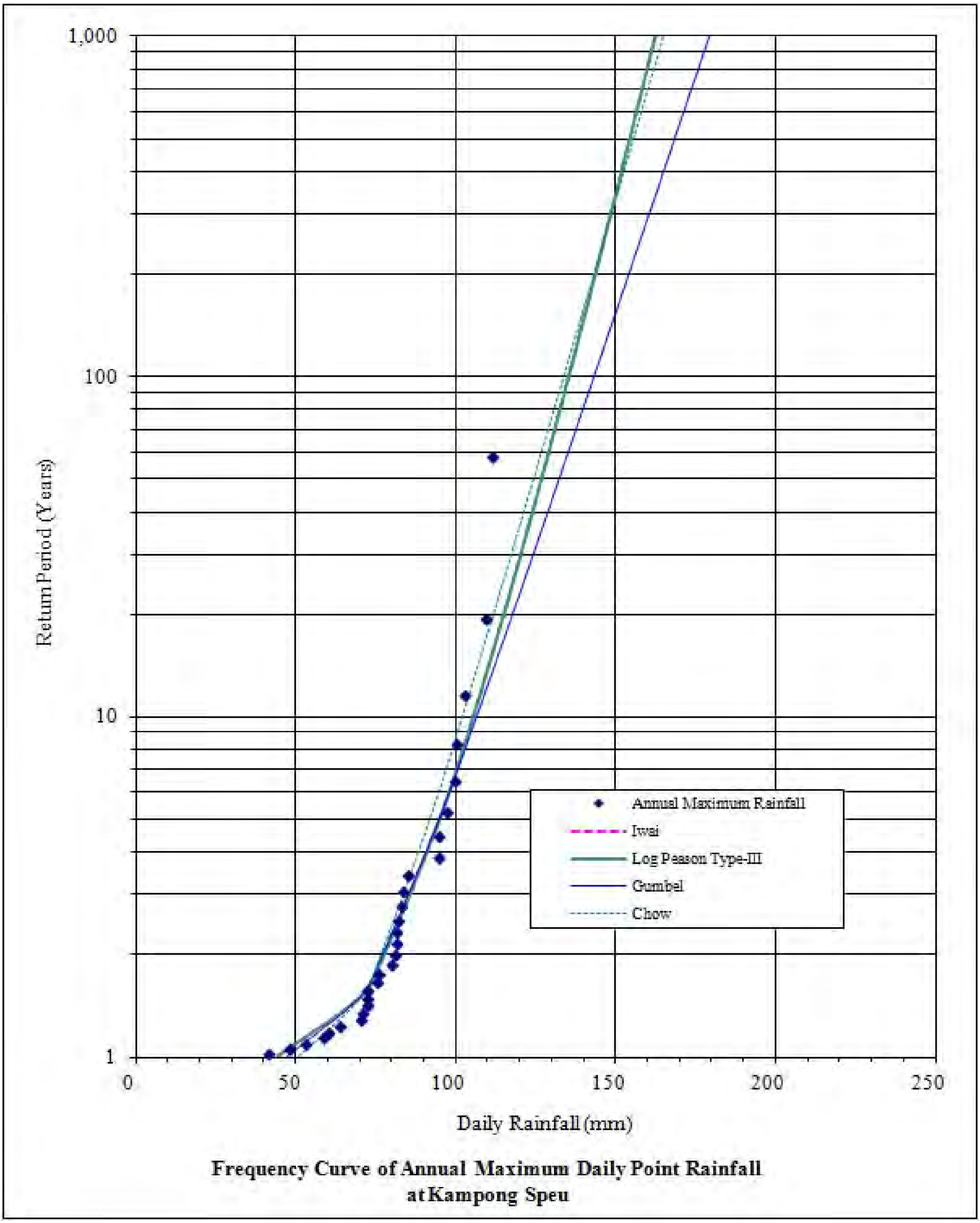
Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT



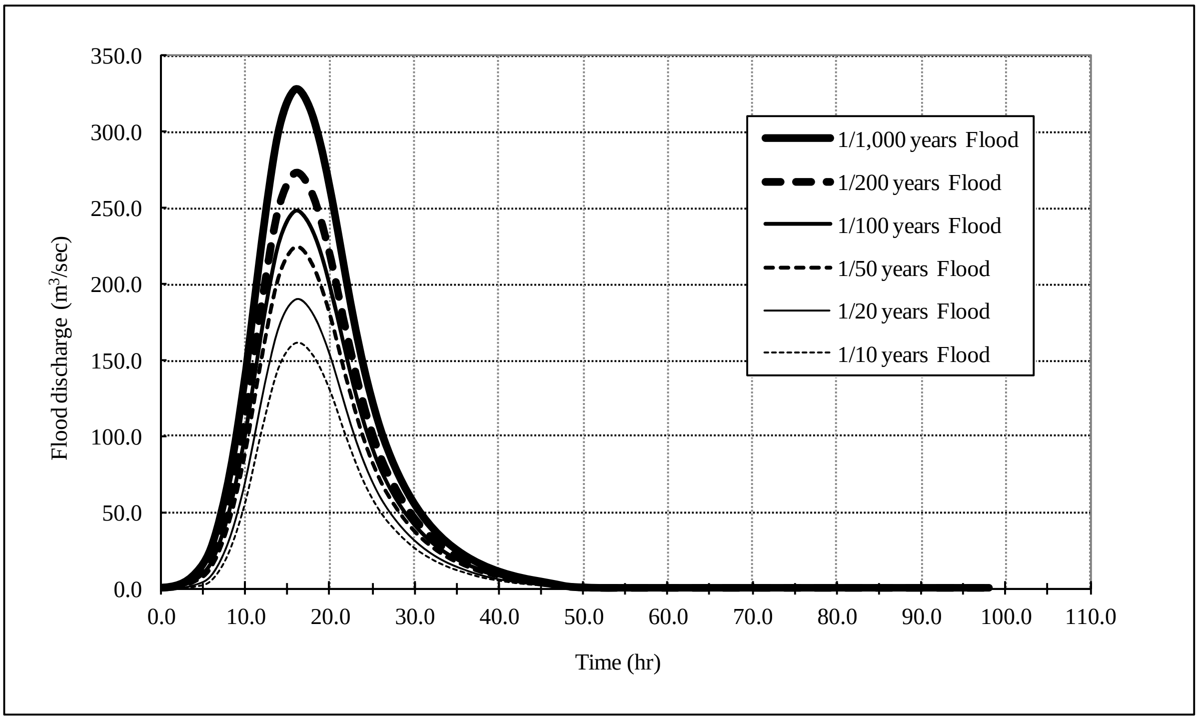
Source: *JICA Survey Team*

Figure AB-2.3.2.5.4
Hydrograph at Roleang Chrey with Total Irrigation Water Demand and Deficit

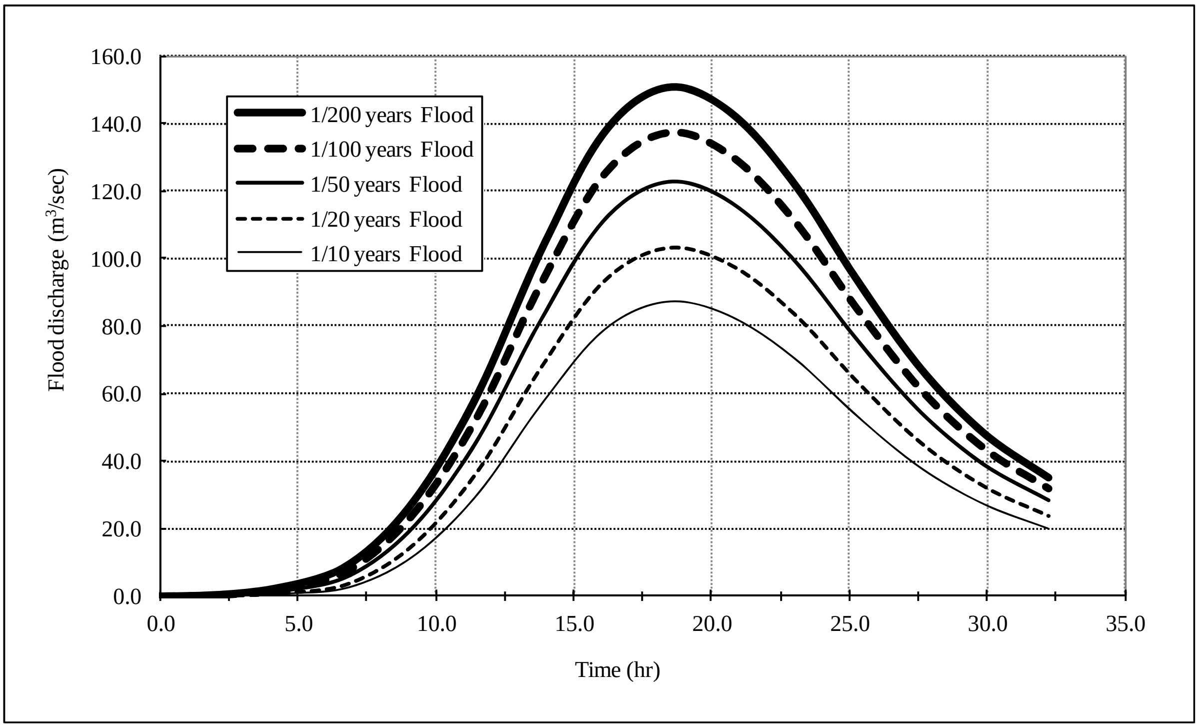


Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.3.2.6.1** **Frequency Curve of Annual Maximum Daily Point Rainfall at Kampong Speu**
Japan International Cooperation Agency	



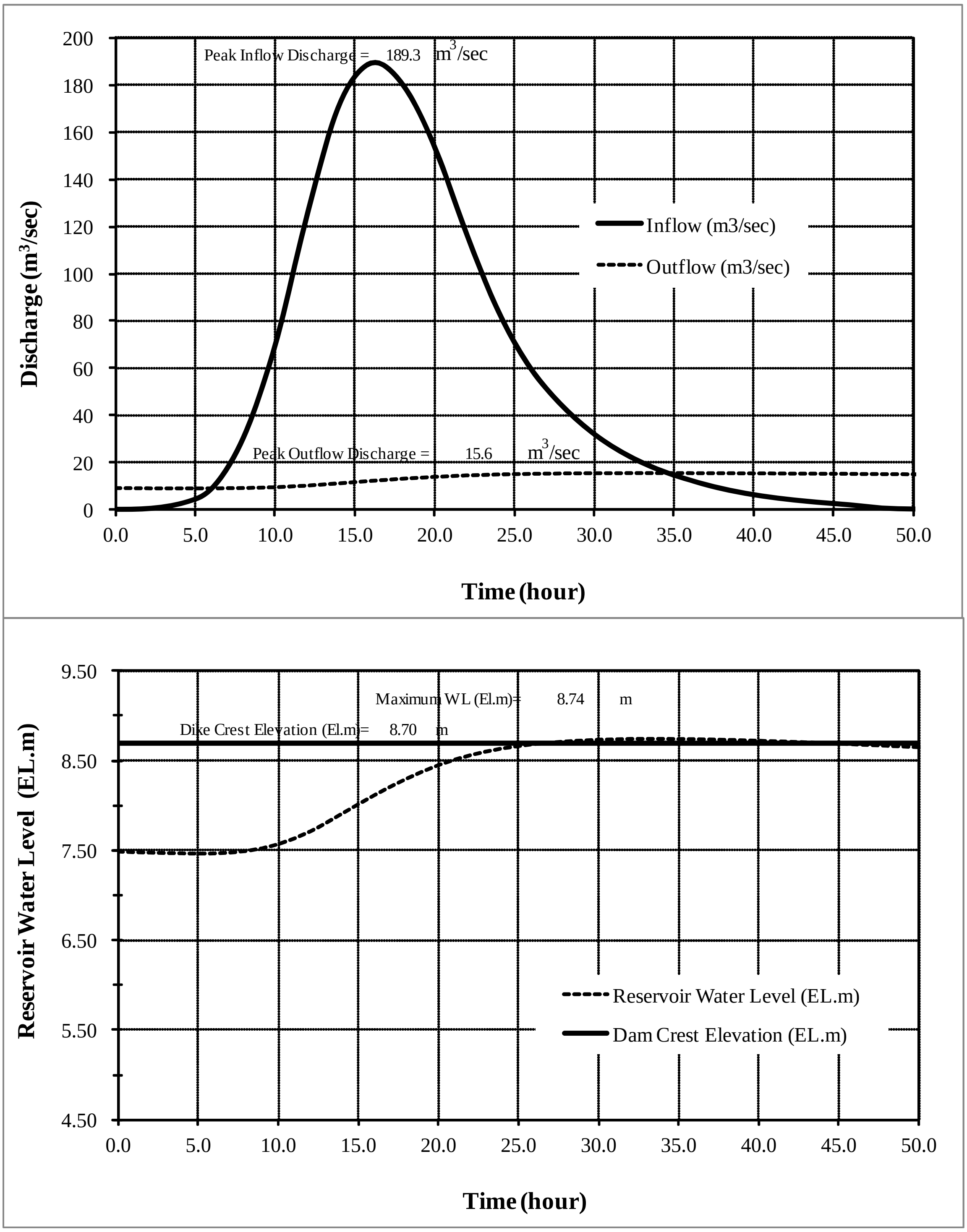
Probable Flood by Unit Hydrograph Method at Tonle Bati Lake



Probable Flood by Unit Hydrograph Method at Duam Ruese of Stung Tochi River

Source: JICA Survey Team

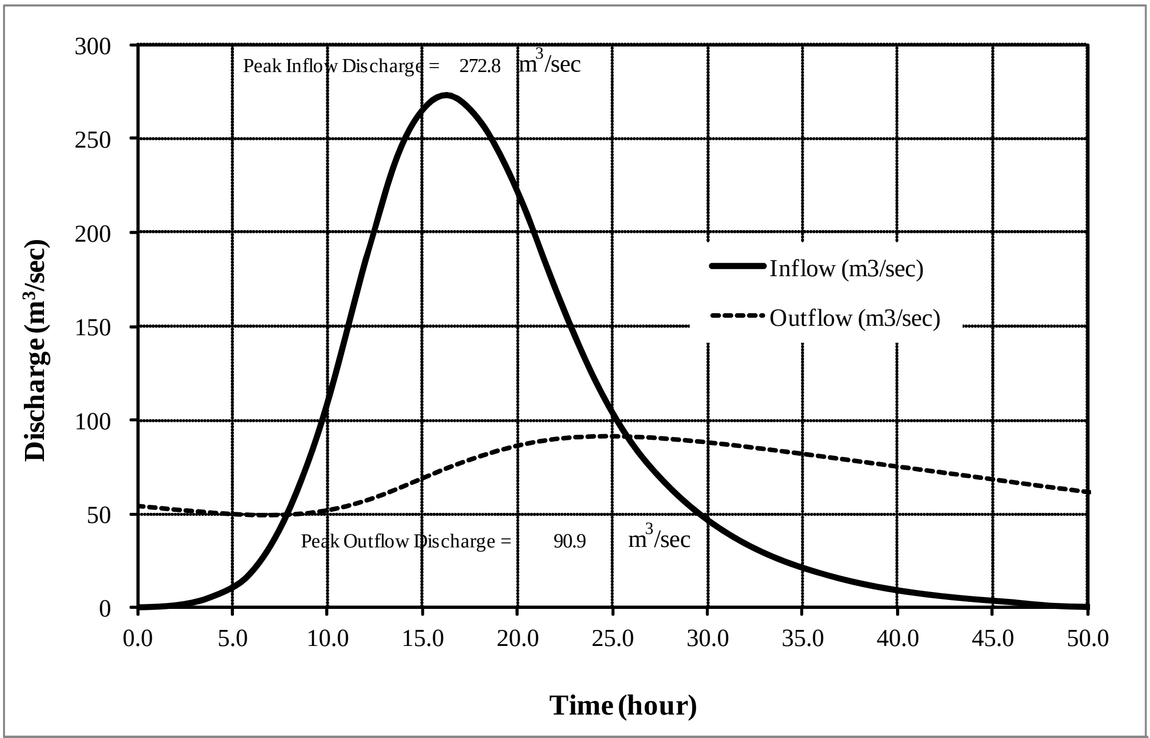
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.3.2.6.2**
Japan International Cooperation Agency	**Estimated Probable Flood Hydrograph of Tonle Bati Lake and Stung Tochi River**

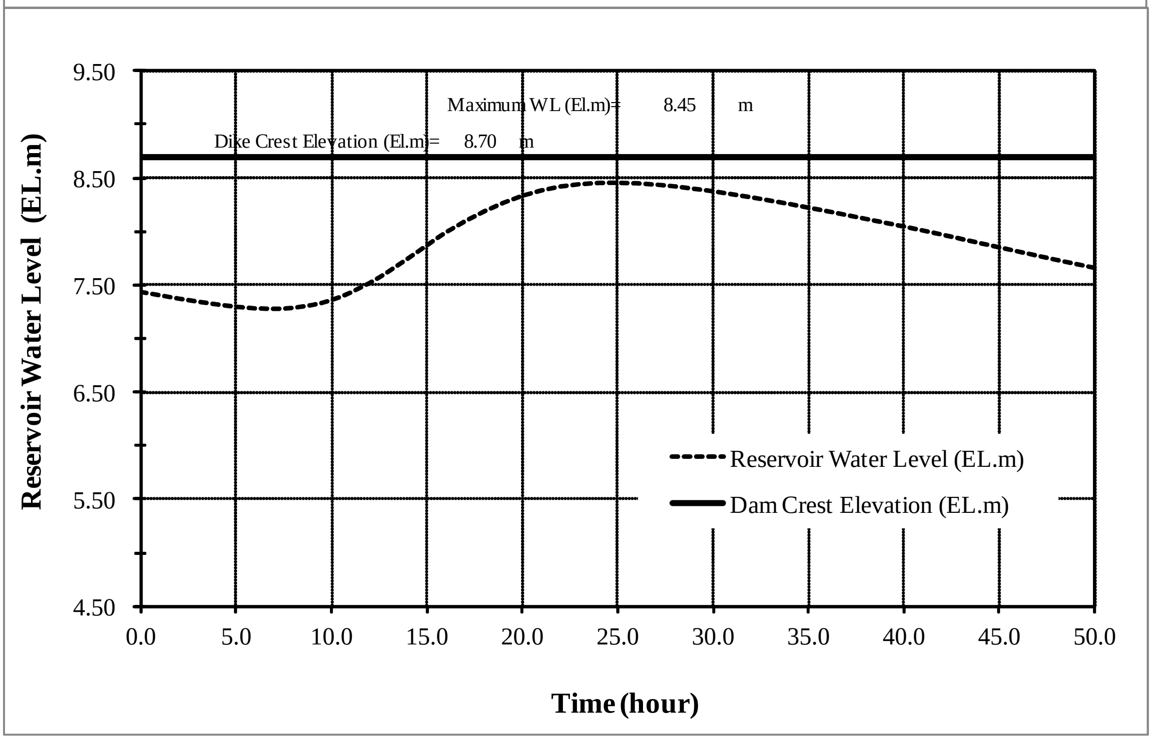


Excess Probability = 1/20 years Flood

Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.3.2.7.2**
Japan International Cooperation Agency	**Flood Routing of Existing Spillway of Bati Reservoir (Sub-merged Condition)**





Excess Probability = 1/200 years Flood

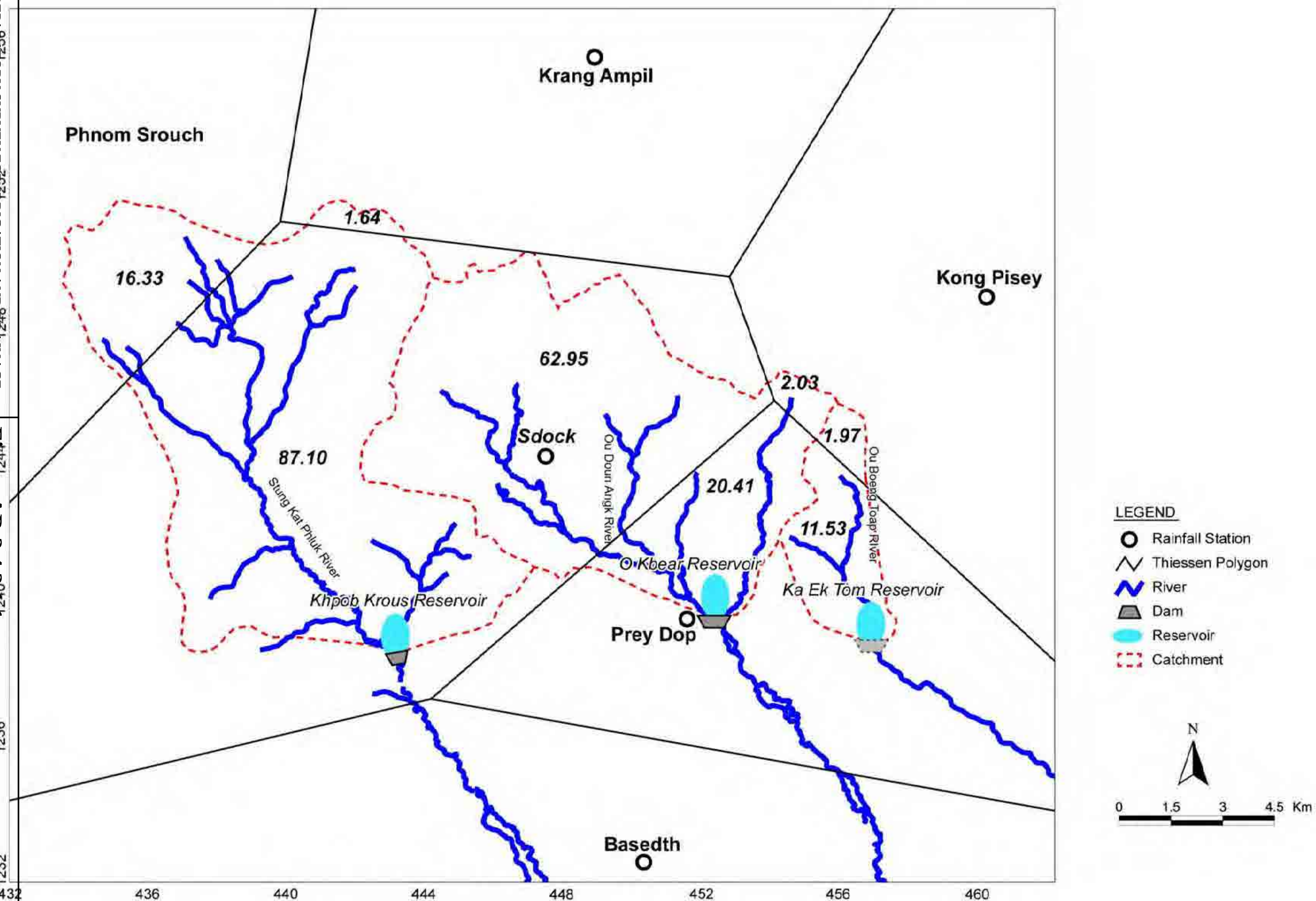
Source: JICA Survey Team

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.4.2.1

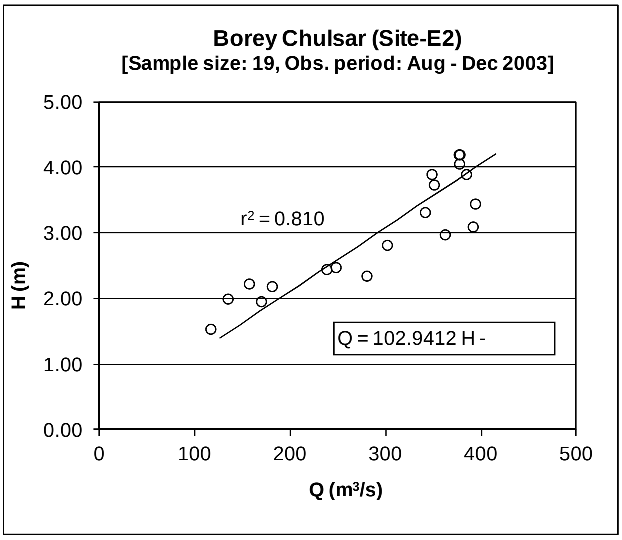
Rainfall Stations and the Thiessen Polygons in/around MC35RSP Area

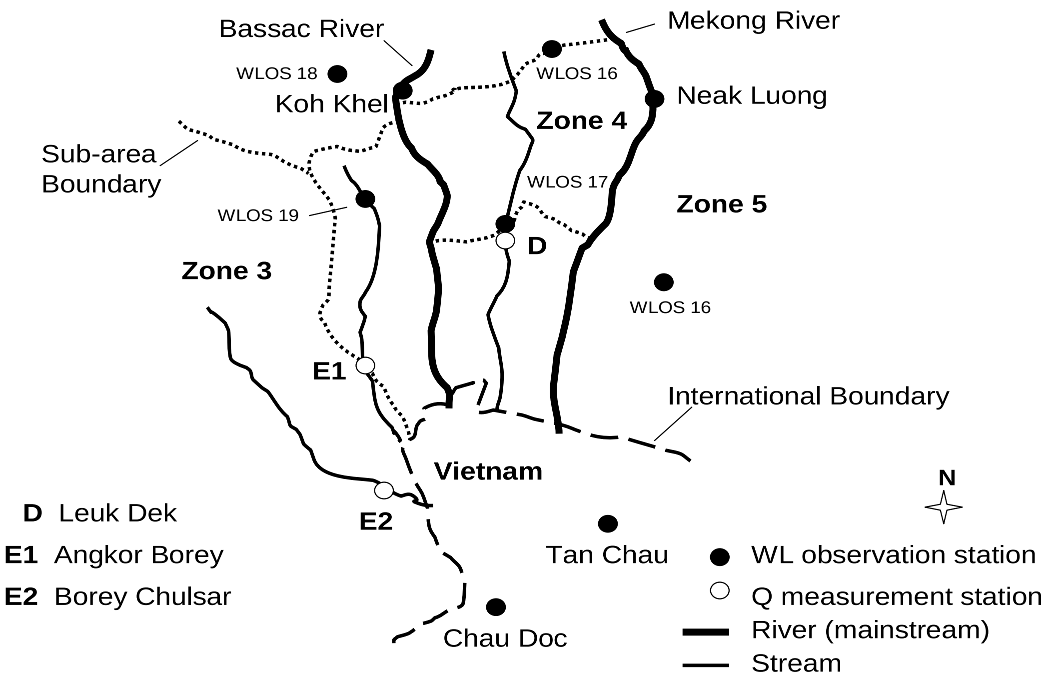


Discharge Measurements Data of Borey Chulsar at Site E2

#	Date	Gauge Heigh, m	Mean Discharge, m3/s	Comments
1	4-Aug-03	2.00	134.35	Rain
2	11-Aug-03	2.19	180.64	
3	18-Aug-03	2.35	279.85	
4	25-Aug-03	2.45	237.78	Small rain
5	1-Sep-03	2.98	361.89	
6	8-Sep-03	3.10	391.20	
7	15-Sep-03	3.45	393.61	
8	22-Sep-03	3.90	384.20	
9	29-Sep-03	4.20	376.49	
10	6-Oct-03	4.20	377.39	Water over the bank
11	13-Oct-03	4.06	376.93	Water over the bank
12	20-Oct-03	3.90	348.06	Water over the bank
13	27-Oct-03	3.74	350.45	
14	3-Nov-03	3.32	341.07	
15	10-Nov-03	2.82	301.30	
16	17-Nov-03	2.48	247.54	
17	24-Nov-03	2.23	156.6	
18	30-Nov-03	1.96	169.3	
20	15-Dec-03	1.54	116.3	Wind
21	22-Dec-03	1.46	4.01	Wind, Back water

19	8-Dec-03	1.70	54.6	Wind





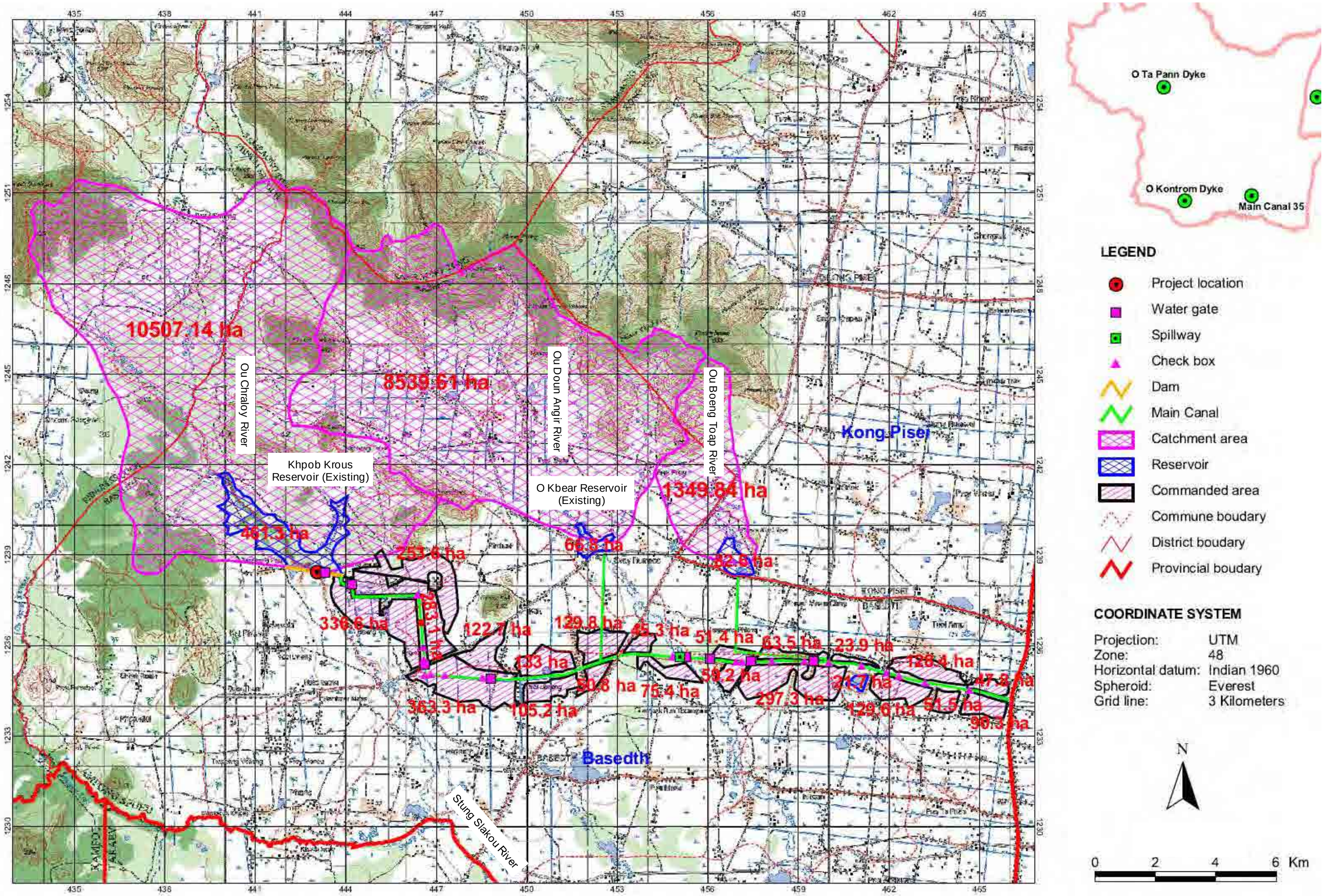
Discharge measurement stations on sites – D and E

Source: Department of Hydrology and River Works (DHRW), MOWRAM

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT	**Figure AB-2.4.2.1.3**
Japan International Cooperation AgencyJapan	**H-Q Rating Curve at Kampong Ampil W.L. Station (Downstream of Takeo)**

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency



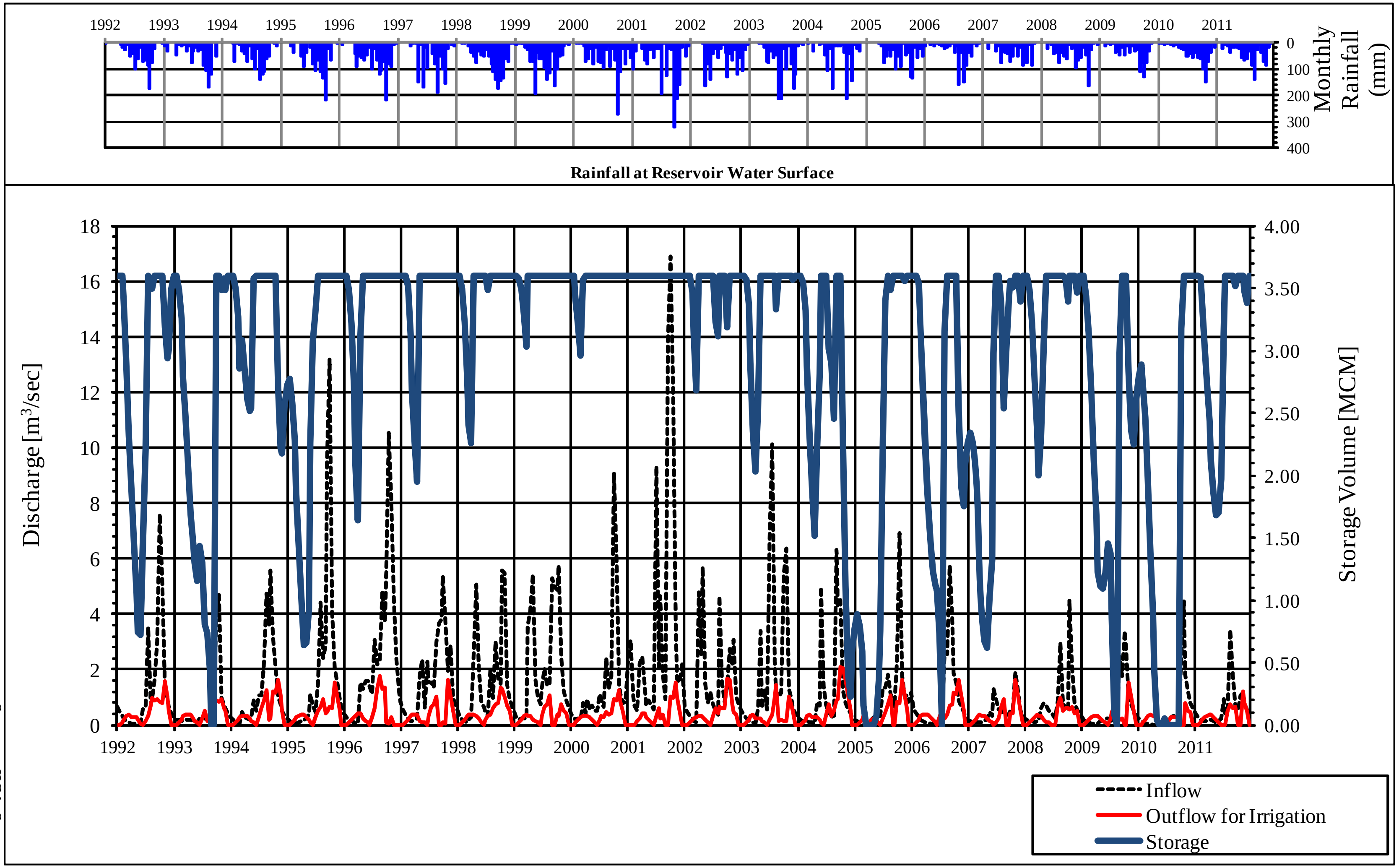
Source: JICA Survey Team

Figure AB-2.4.2.2.1
River System and Existing Reservoirs in MC35RSP Area

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

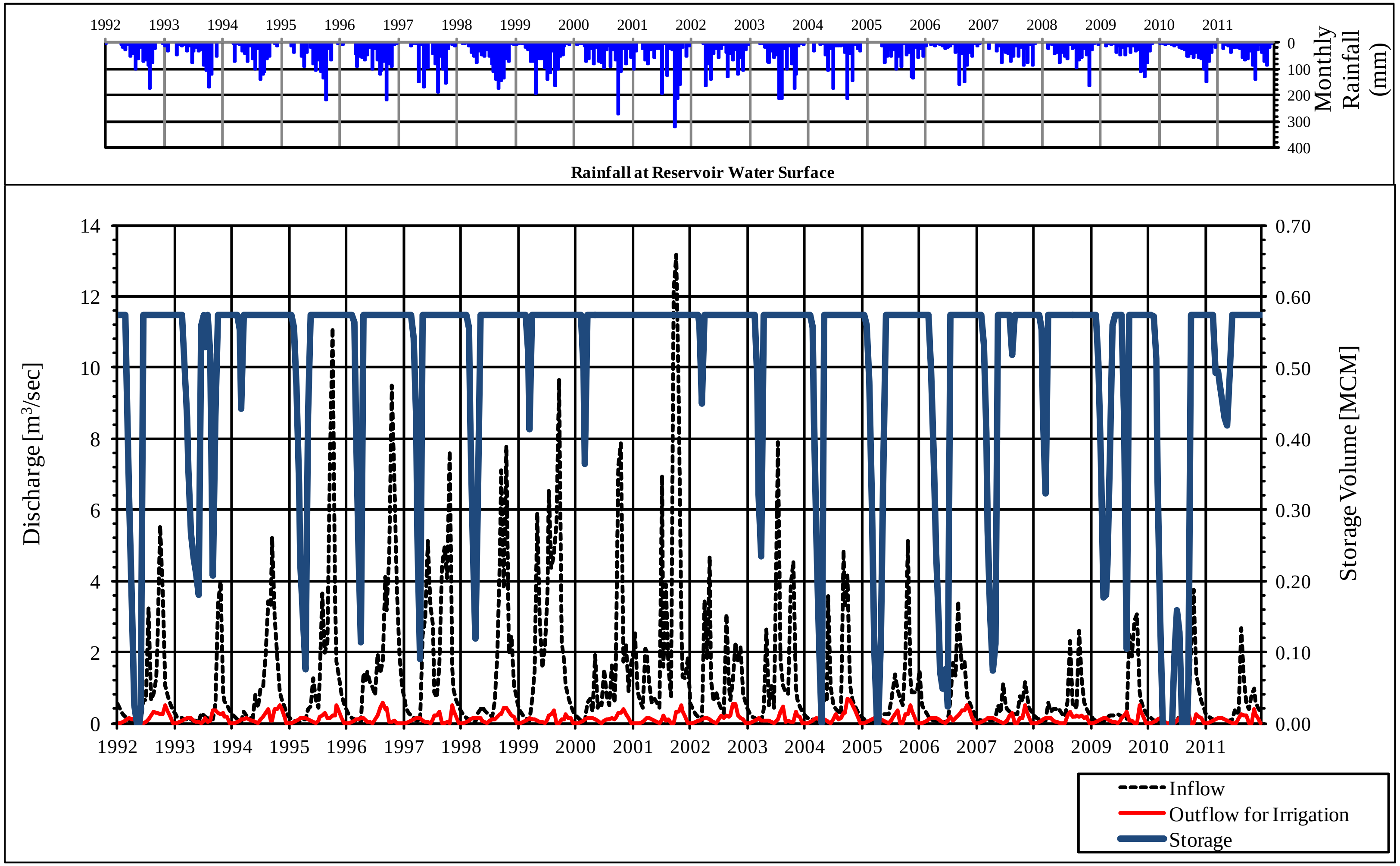
Figure AB-2.4.2.5.4
Results of Reservoir Operation of Khpob Krous Reservoir for Zone-A of MC35RSP



Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

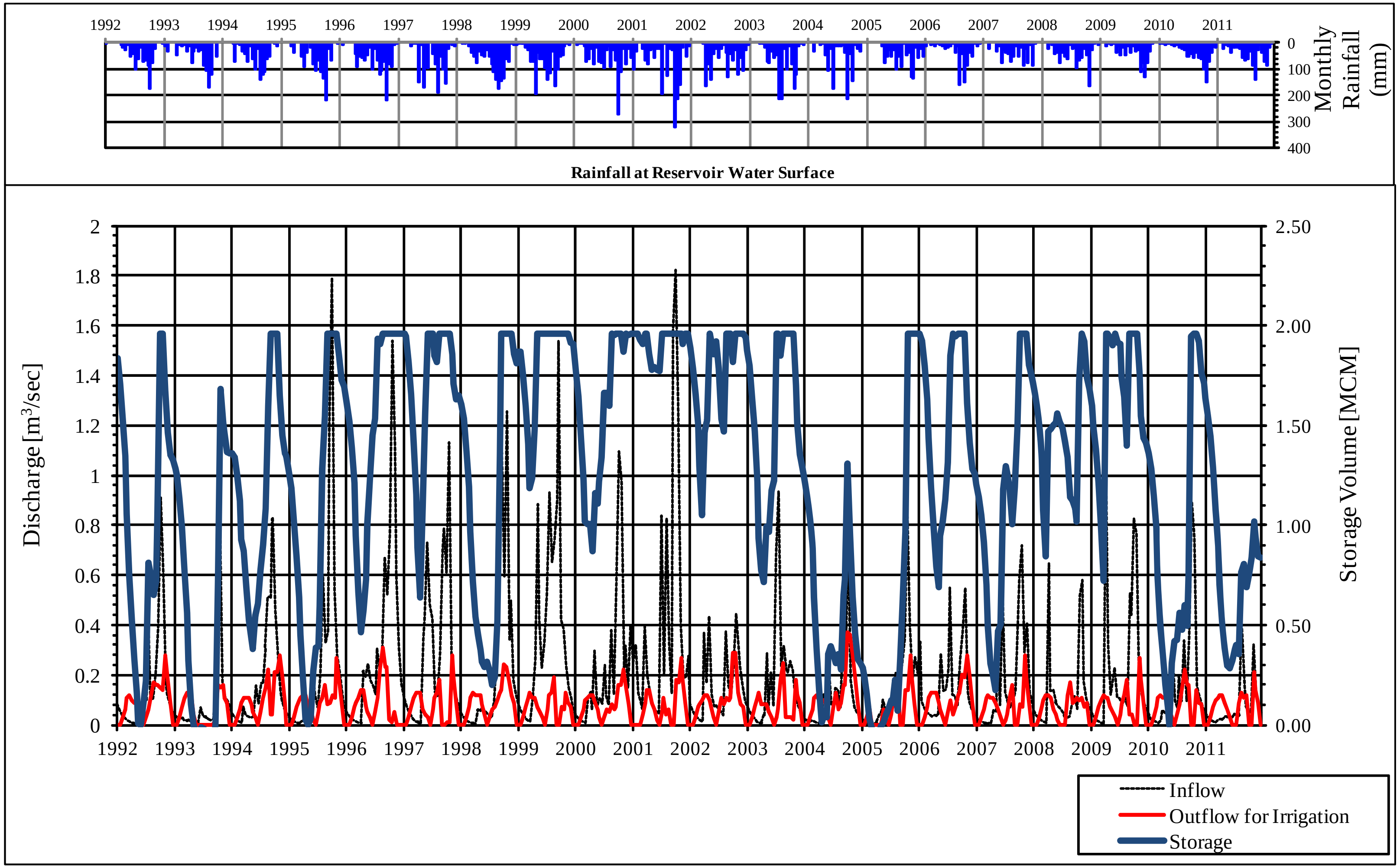


Source: JICA Survey Team

Figure AB-2.4.2.5.6
Results of Reservoir Operation of O Kbear Reservoir for Zone-B&C of MC35RSP

Japan International Cooperation Agency

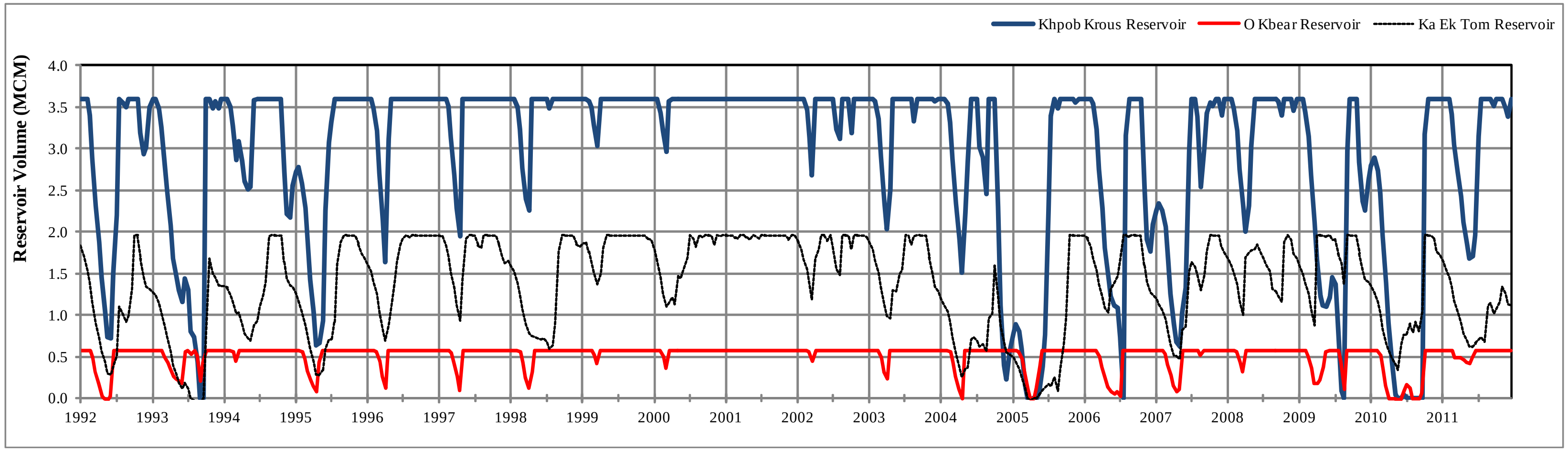
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

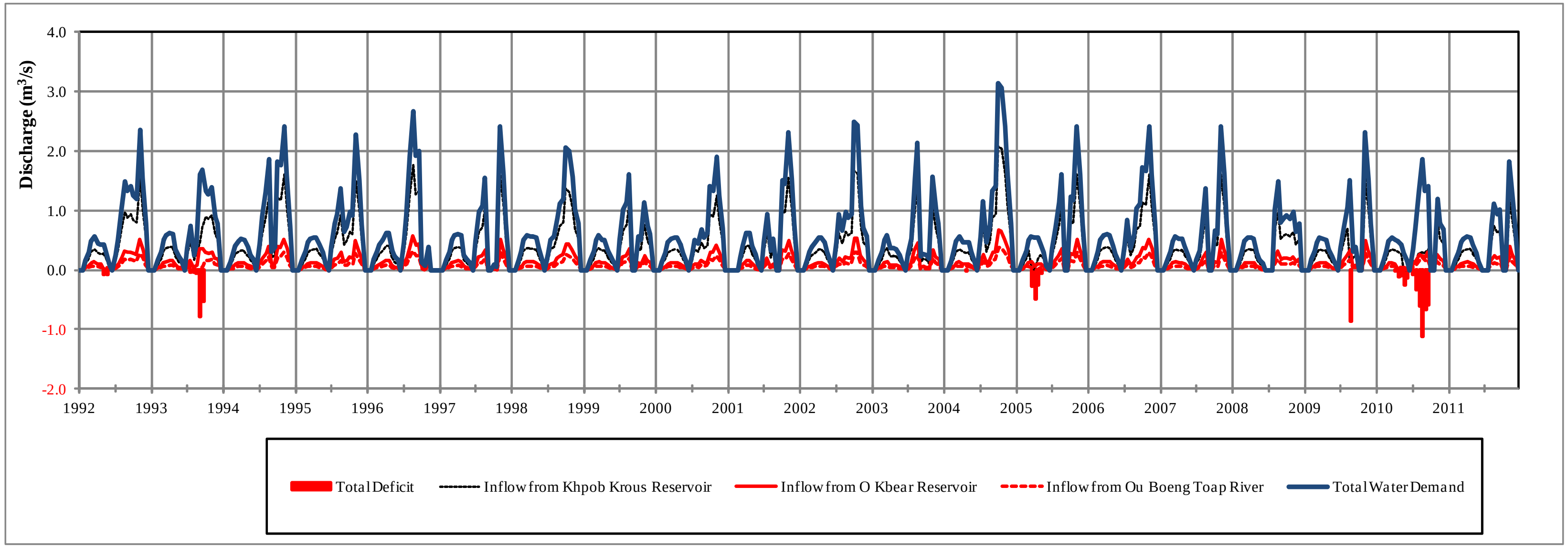


Source: JICA Survey Team

Figure AB-2.4.2.5.8

Results of Reservoir Operation of Ka Ek Tom Reservoir for Zone-B&C of MC35RSP



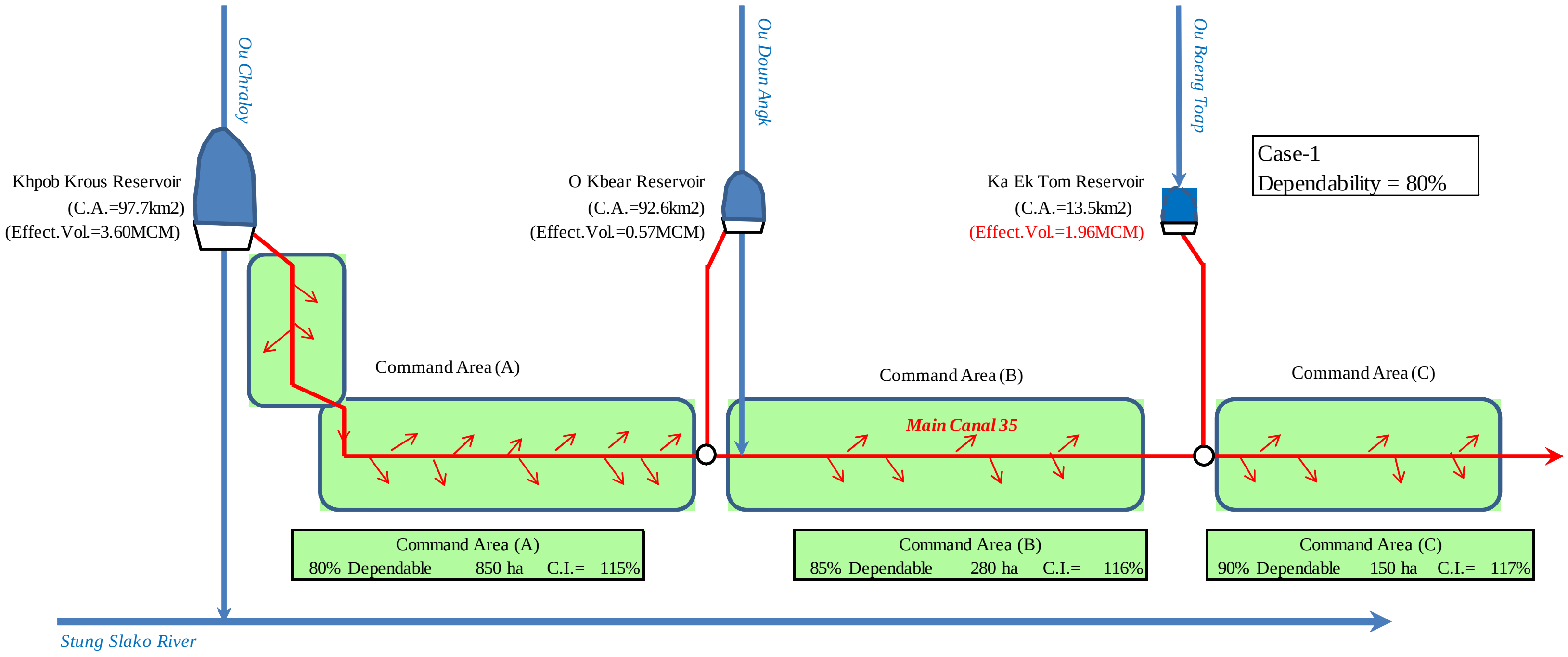


Source: JICA Survey Team

Figure AB-2.4.2.5.9
Results of Reservoir Operation Simulations of MC35RSP (80% Dependability)

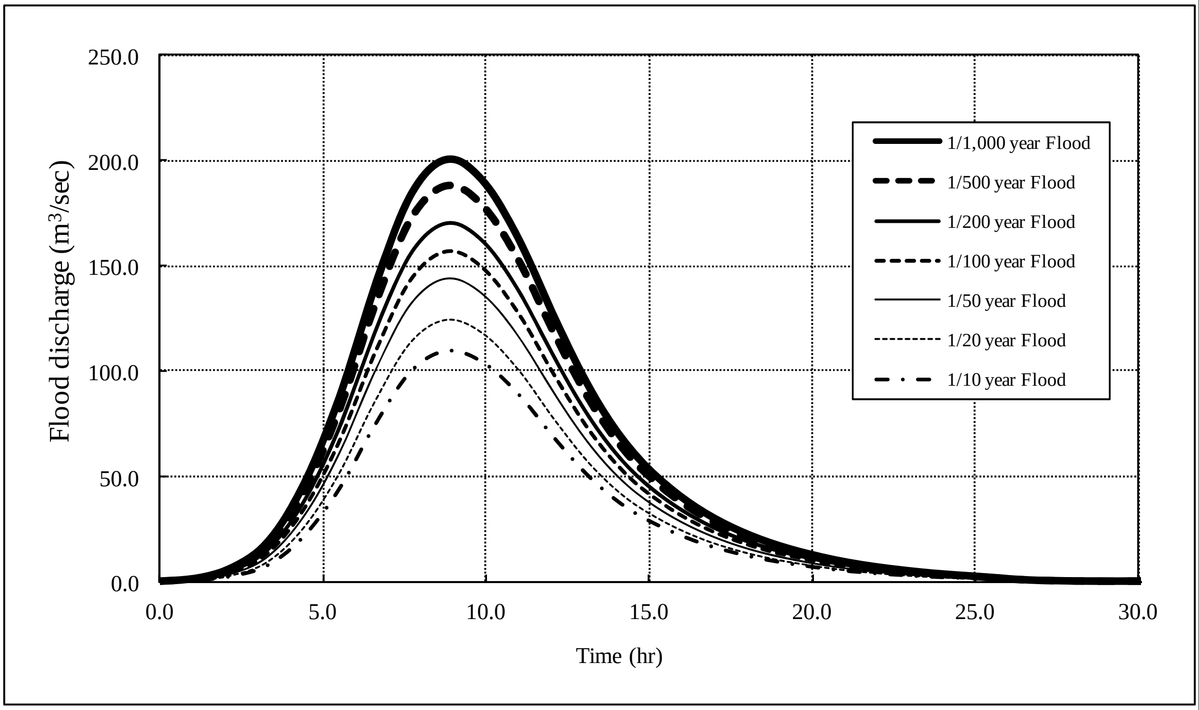
Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

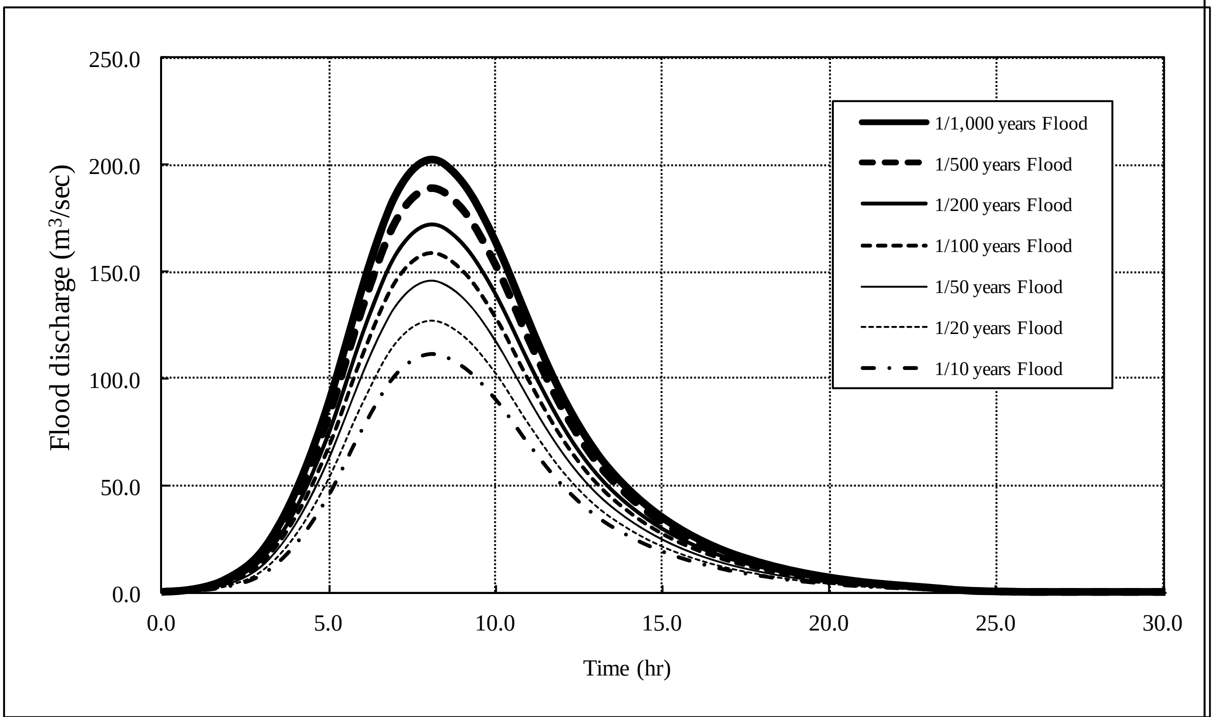


Source: *JICA Survey Team*

Figure AB-2.4.2.5.10
Results of Water Balance Study of MC35RSP (80% Dependability)



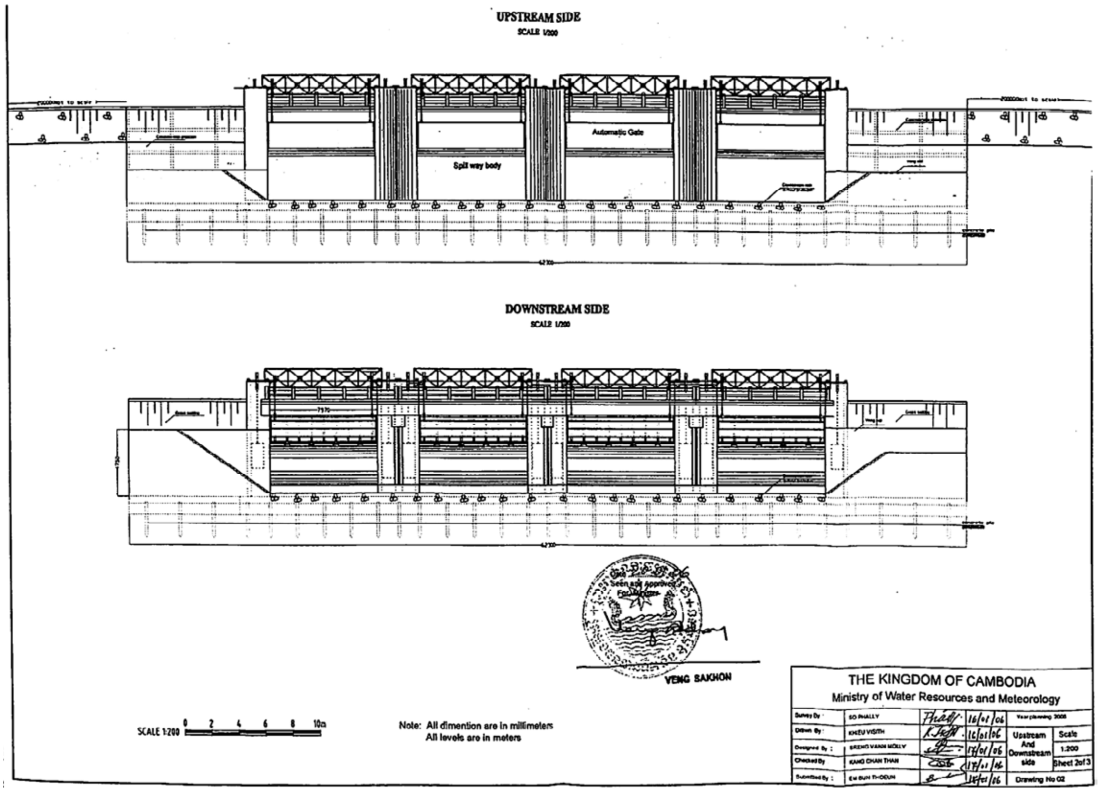
Estimated Probable Flood Hydrograph at Khpob Krous Reservoir

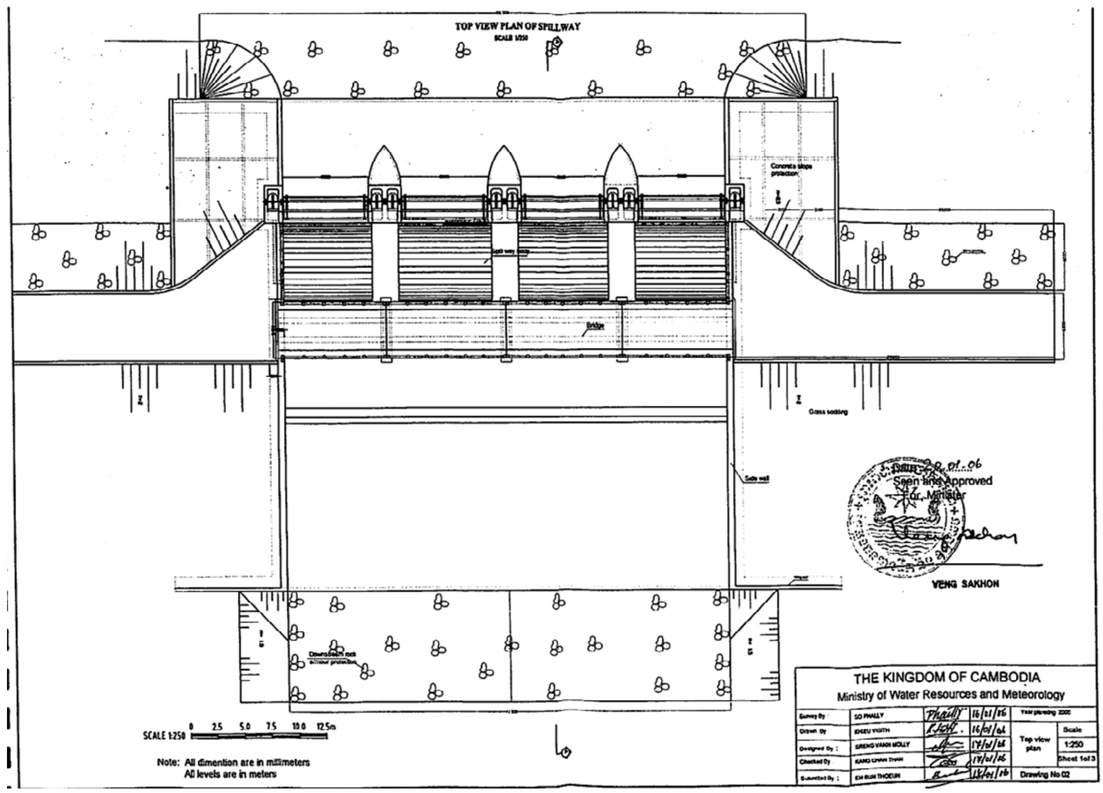


Estimated Probable Flood Hydrograph at O Kbear Reservoir

Source: JICA Survey Team

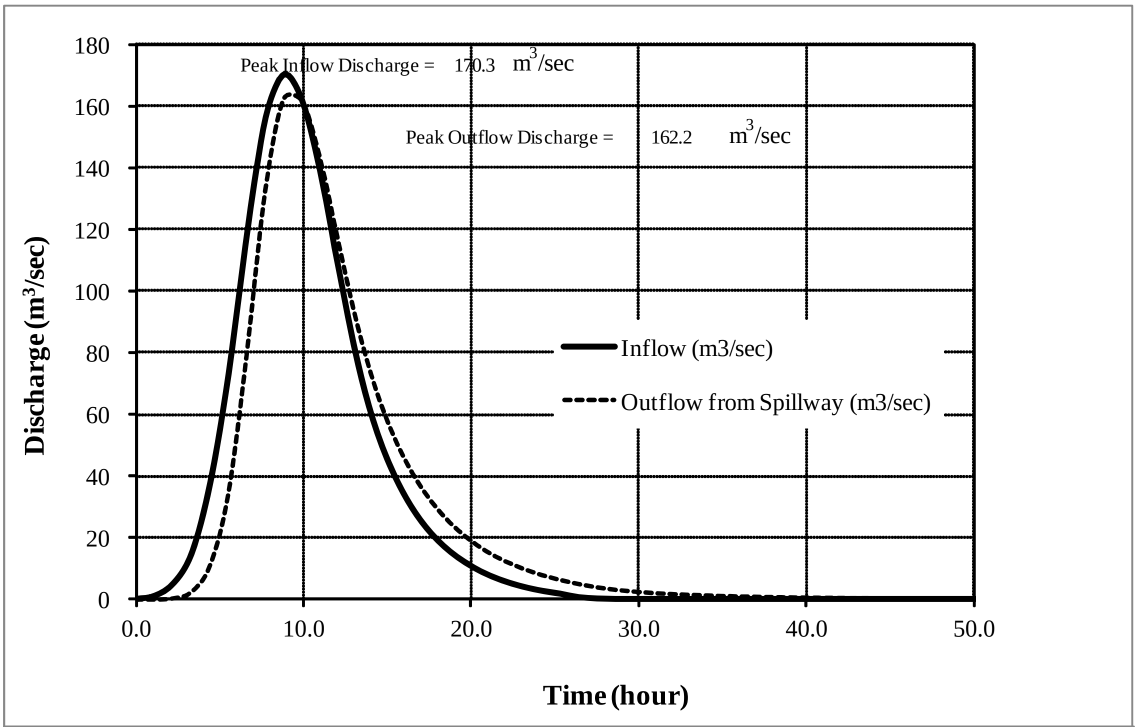
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.4.2.6.1**
Japan International Cooperation Agency	**Estimated Probable Flood Hydrograph for MC35RSP by Unit Hydrograph Method**

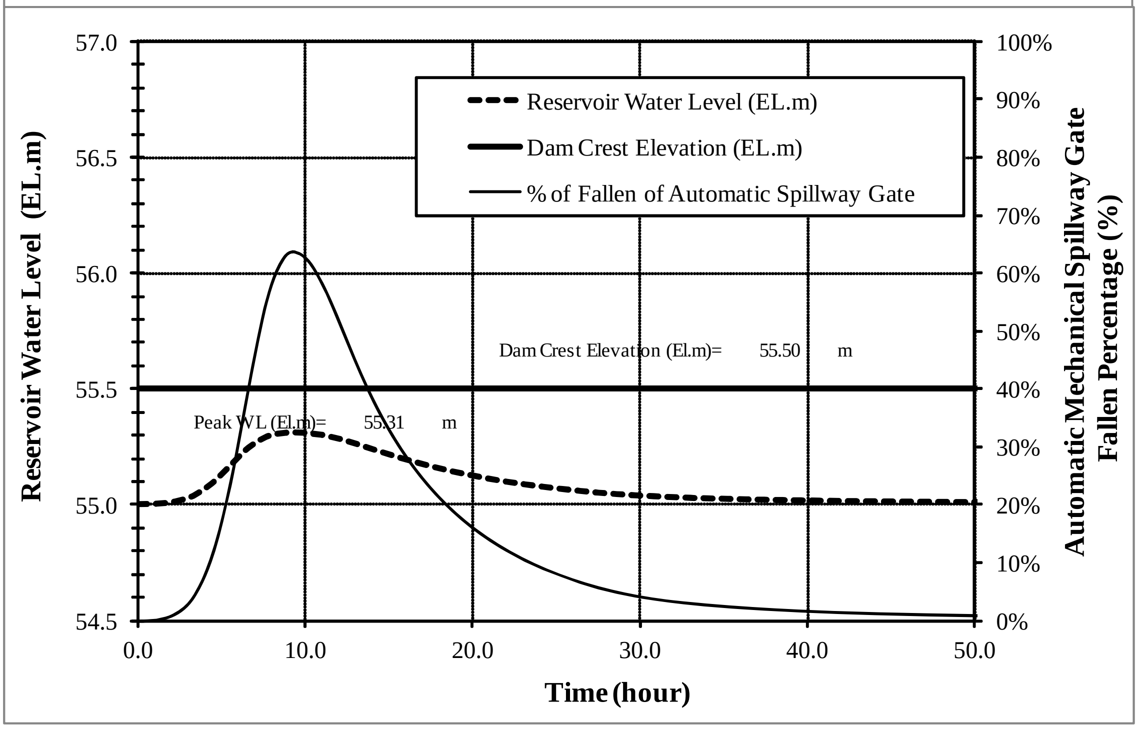




Source: Project Proposal for Khpob Krous Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, April, 2008

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.4.2.7.1**
Japan International Cooperation Agency	**Spillway Design of Khpob Krous Reservoir**

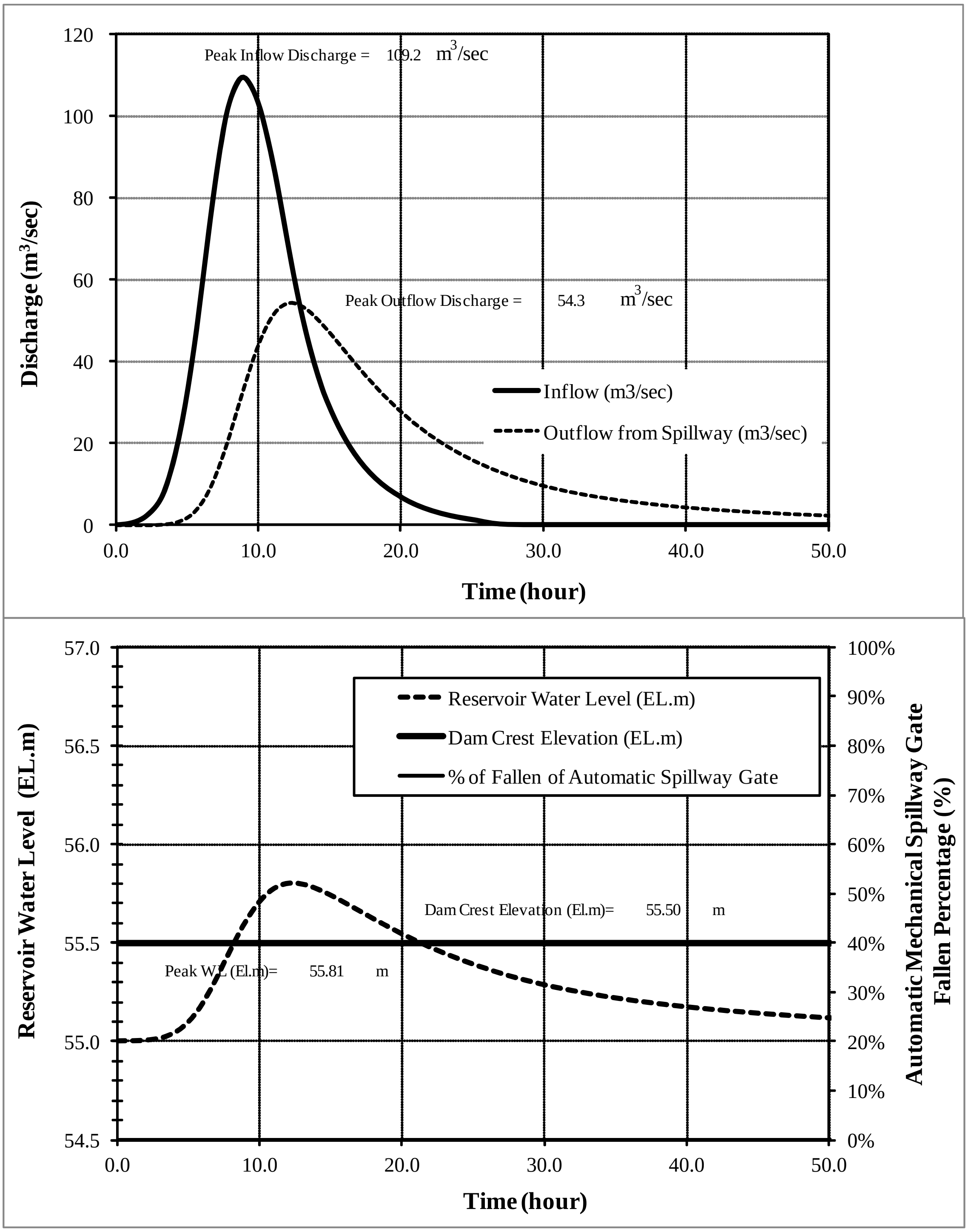




Case-1 : All Automatic Spillway Gates are Fallen (1/200 years Flood)

Source: JICA Survey Team

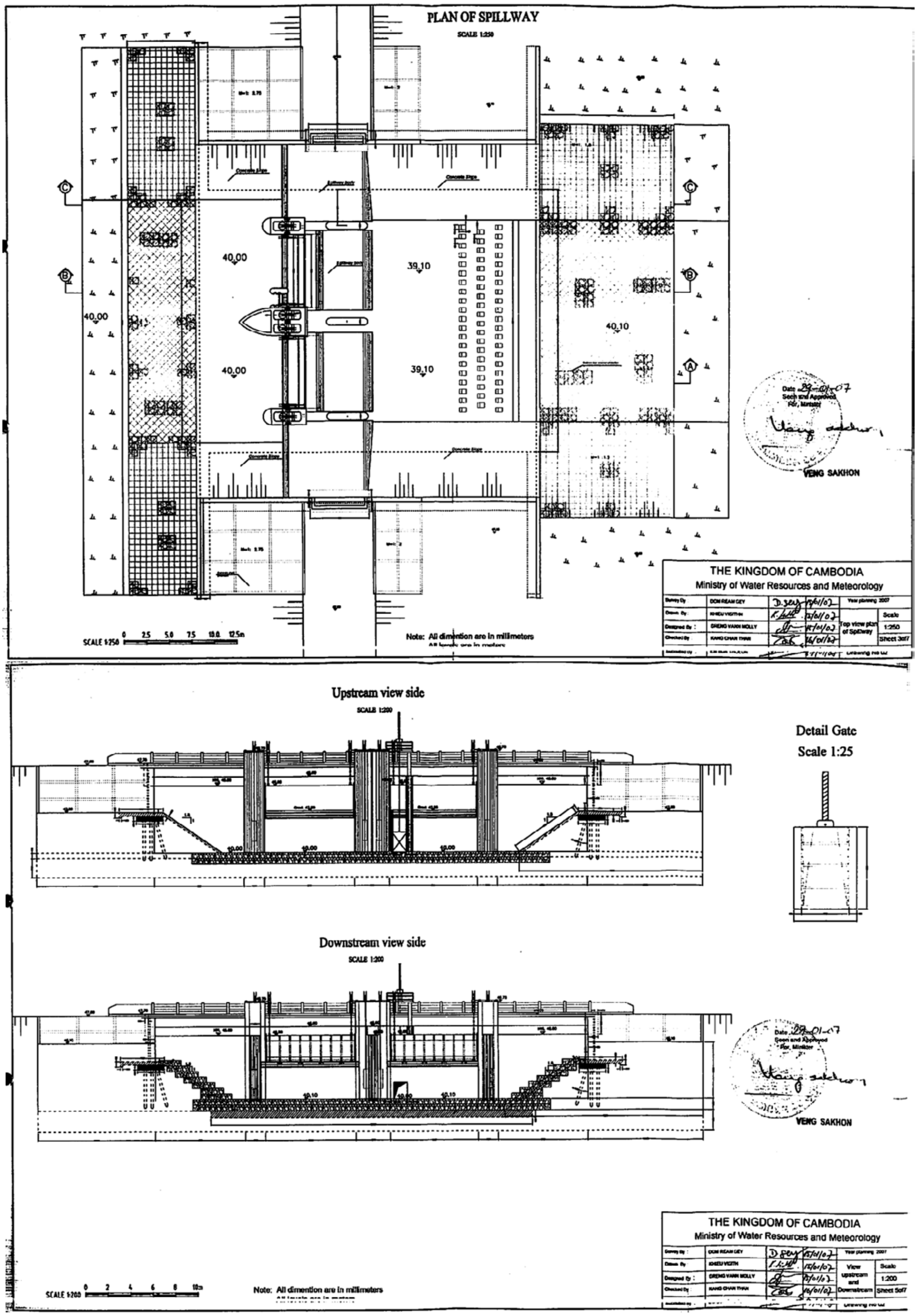
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.4.2.7.2** **Result of Flood Routing of Khpob Krous Reservoir (Case-1)**
Japan International Cooperation Agency	



Case-2 : All Automatic Spillway Gates are "Not" Fallen (1/10 years Flood)

Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.4.2.7.3** **Result of Flood Routing of Khpob Krous Reservoir (Case-2)**
Japan International Cooperation Agency	

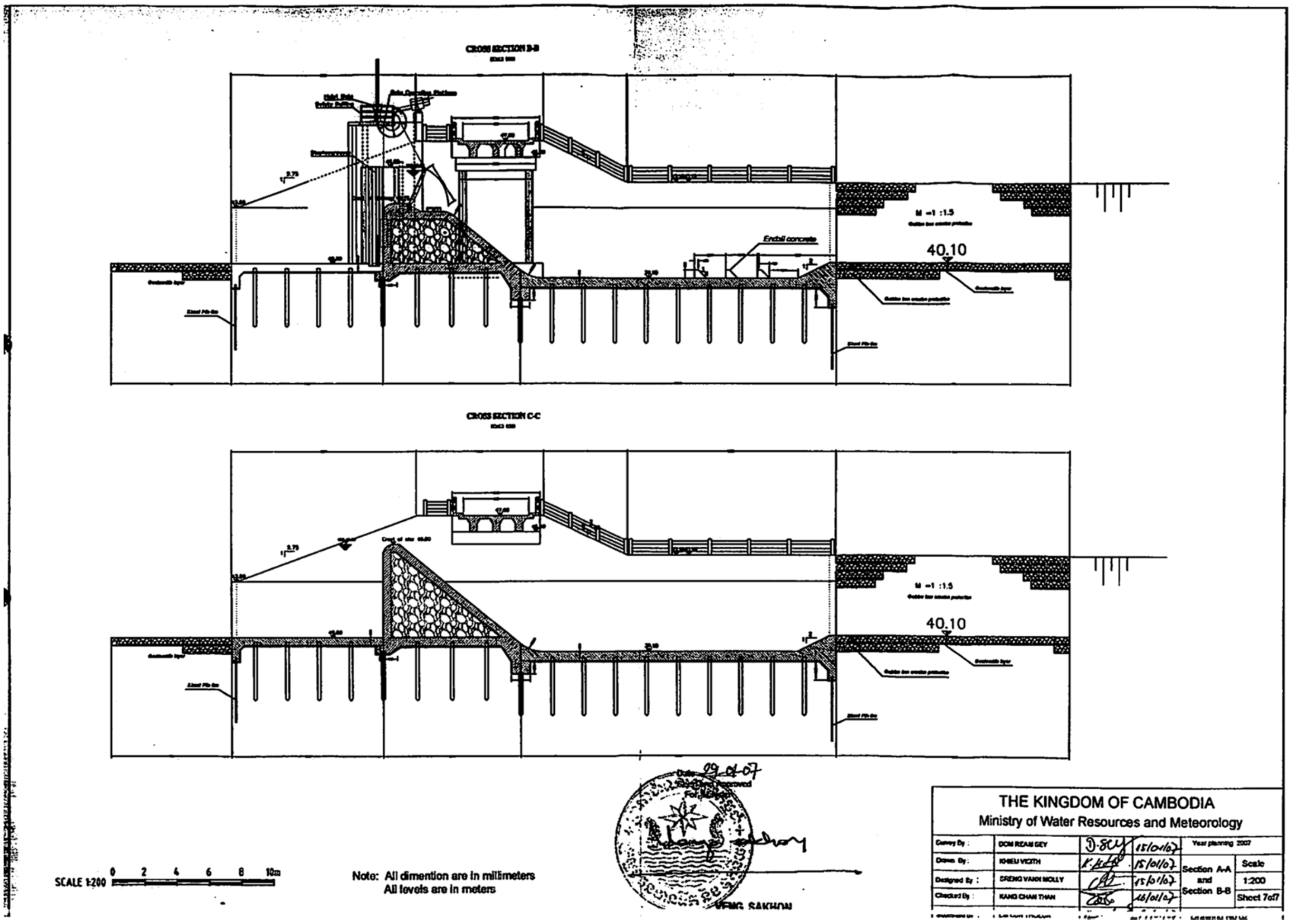


Source: Project Proposal for O Kbear Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, January, 2007

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.4.2.7.4** **Spillway Design of O Kbear Reservoir (1/2)**
Japan International Cooperation Agency	

Japan International Cooperation Agency

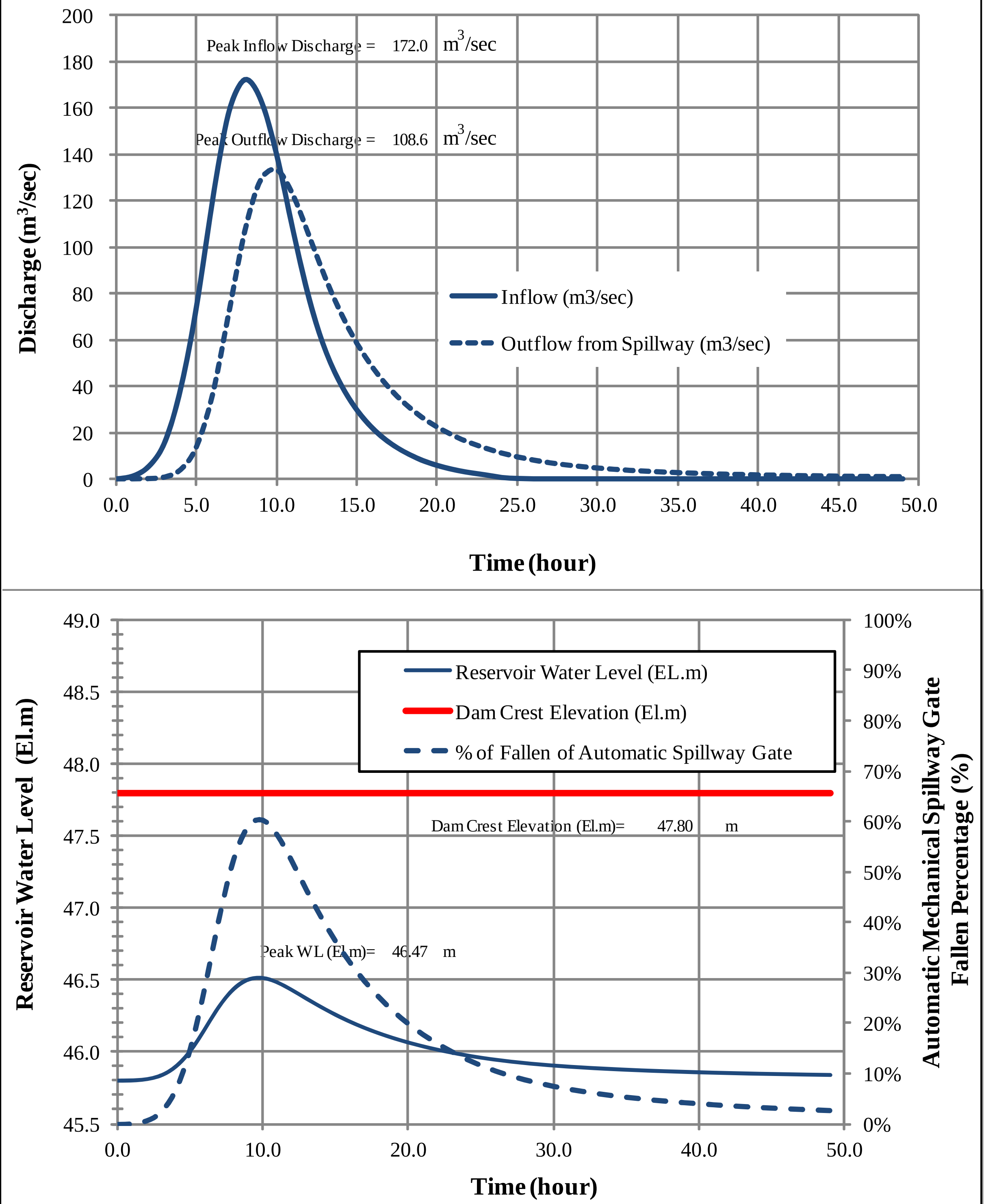
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT



Source: *Project Proposal for O Kbear Reservoir Rehabilitation Project in Kampong Speu Province, MOWRAM, January, 2007*

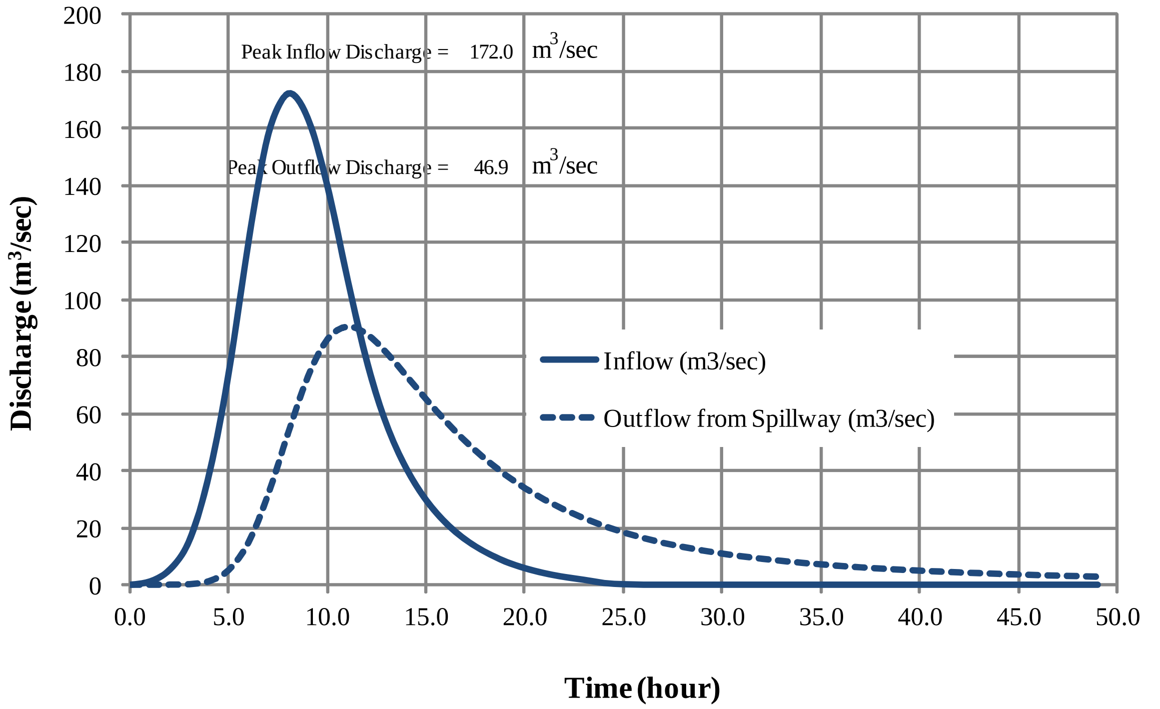
Figure AB-2.4.2.7.4

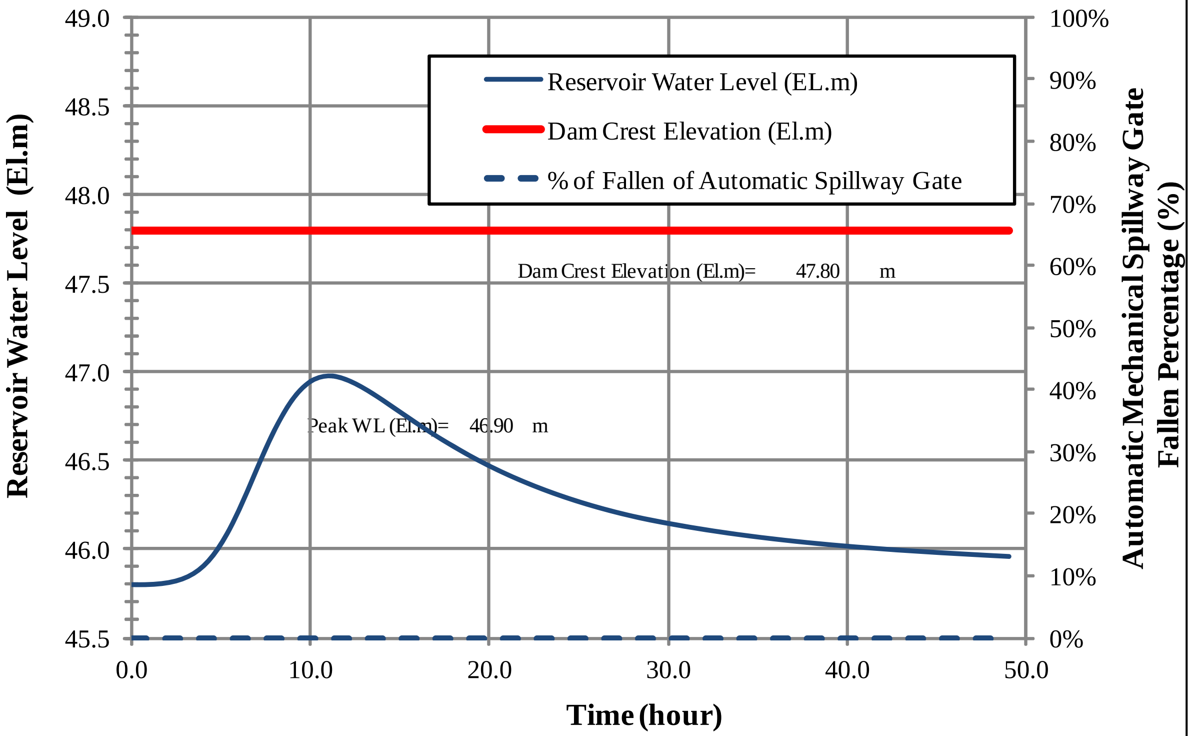
Spillway Design of O Kbear Reservoir (2/2)



Case-1 : All Automatic Spillway Gates are Fallen (1/200 years Flood)

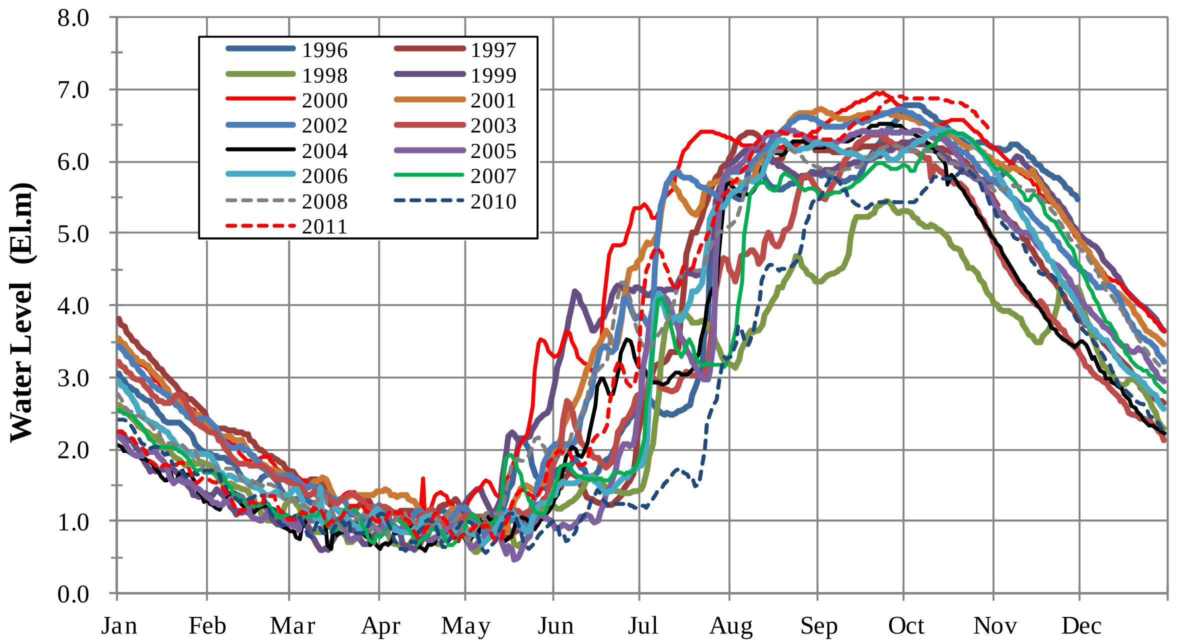
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	*Source: JICA Survey Team* **Figure AB-2.4.2.7.5** **Result of Flood Routing of O Kbear Reservoir (Case-1; All Automatic Gates are Fallen)**
Japan International Cooperation Agency	



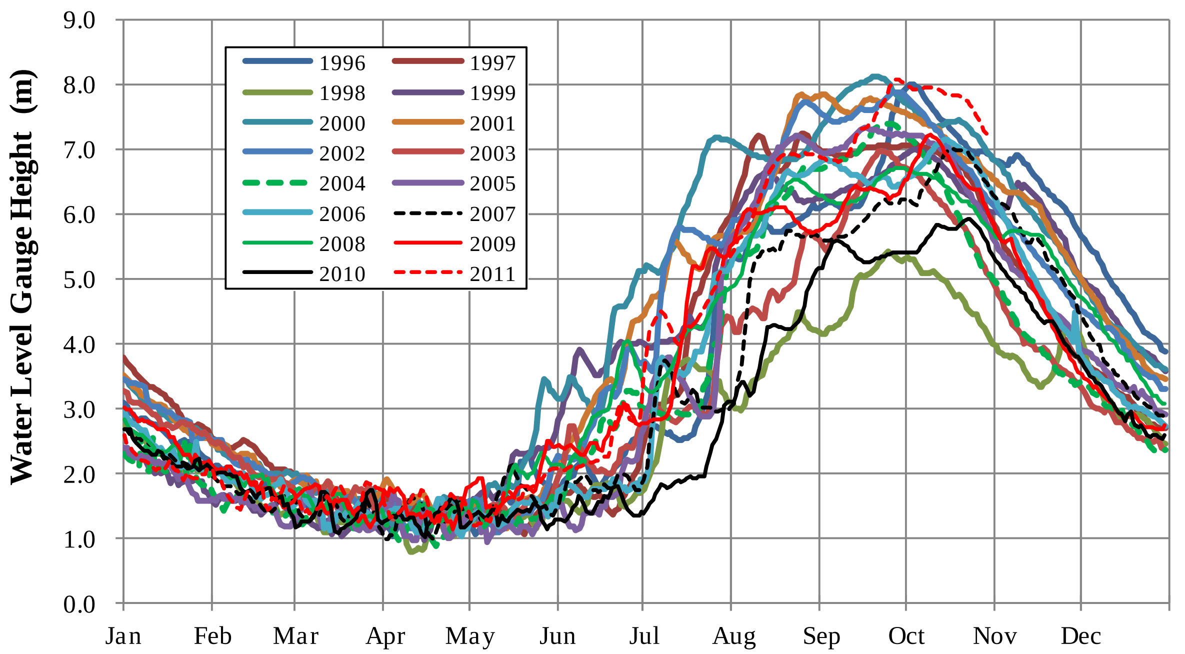


Case-2 : All Automatic Spillway Gates are "Not" Fallen (1/200 years Flood)

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	*Source: JICA Survey Team* **Figure AB-2.4.2.7.6**
Japan International Cooperation Agency	**Result of Flood Routing of O Kbear Reservoir (Case-2; All Automatic Gates are Not Fallen)**



Daily Water Level at Koh Khel (Bassac River)



Daily Water Level at Neak Loung (Mekong River)

Source: Department of Hydrology and River Works, MOWRAM

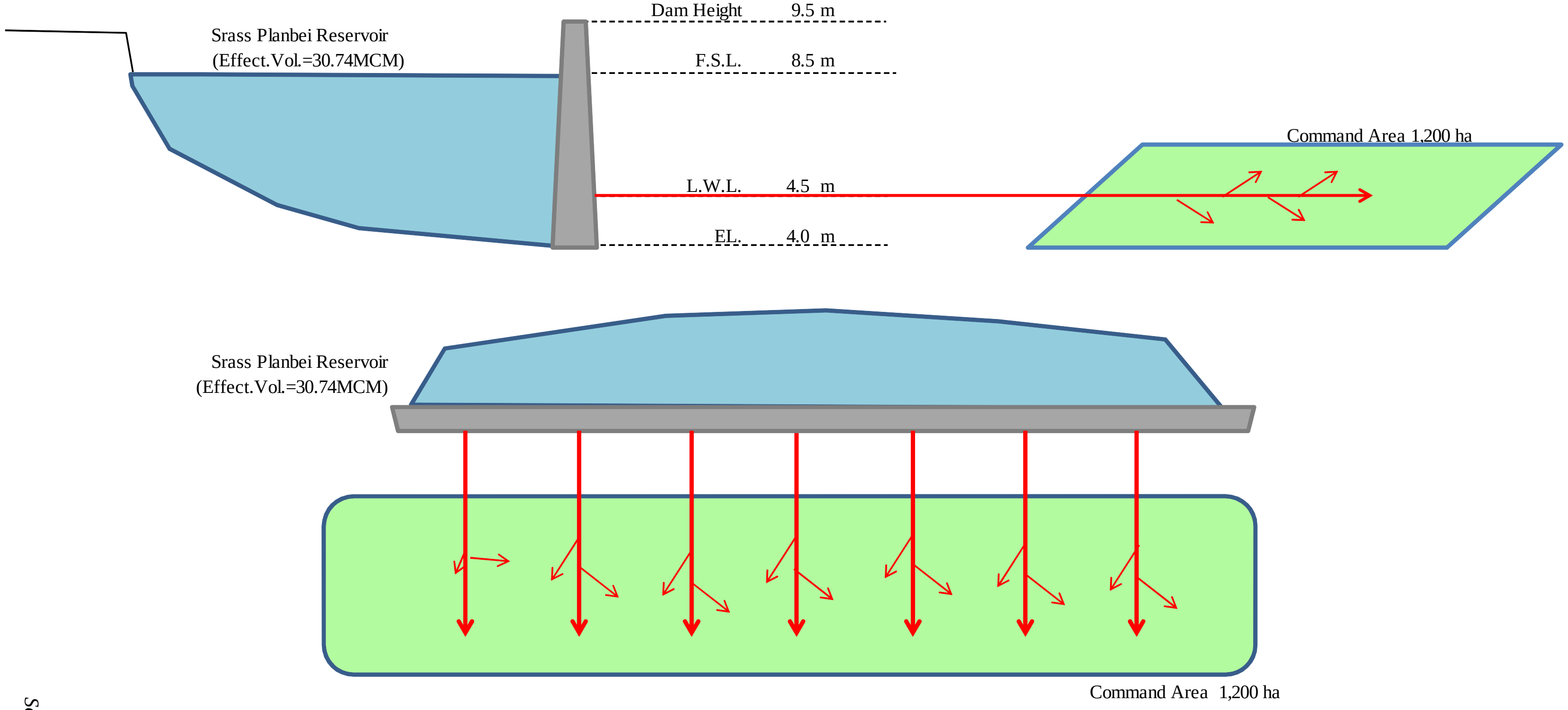
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.5.2.3.1**
Japan International Cooperation Agency	**Daily Gauge Height at Koh Khel and Neak Loung Stations**

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-2.5.2.4.3

Results of Water Balance Study of SPWRRSP (80% Dependability)



Source: JICA Survey Team

Condition of Water Balance Study for Srass Prambai Rehabilitation Project

Sras Prambai Irrigation Area

Max. Command Area (ha)	Total Irr. Area	Early Rice (2nd Dry)	Early Rice (Recession)	Crop Intensity
2,500ha	1,200ha	66ha	1,200ha	105.5%

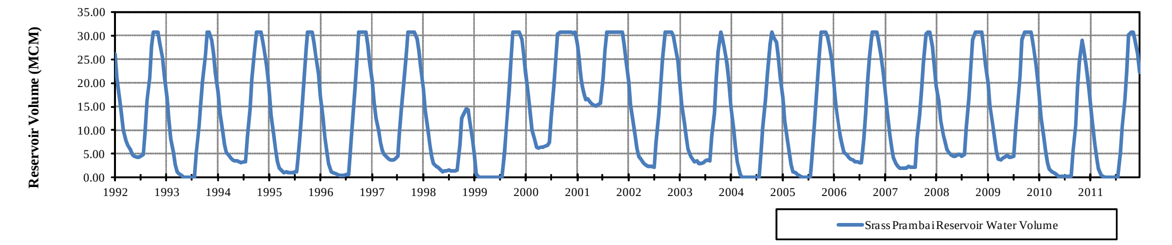
Dependa-bility	Deficit Year (times/20years)
80%	4

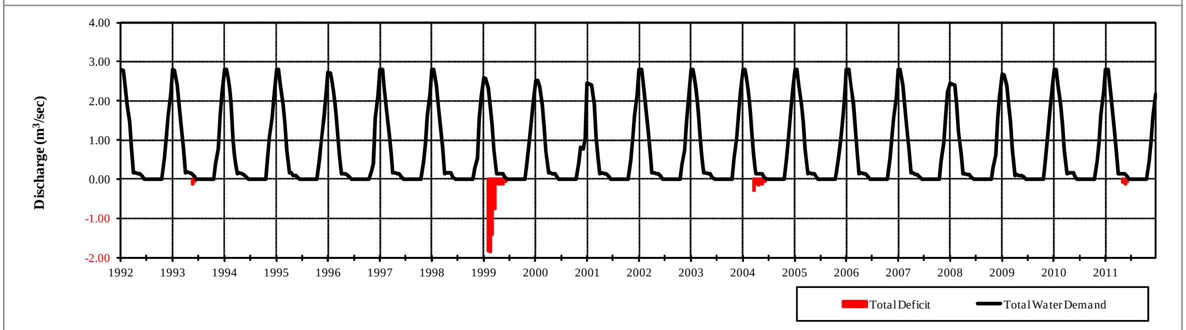
Case- 1
Dependability = 80%

Feature of Reservoir

Name of Reservoir	Effective Vol. (MCM)	FSL (EL.m)	LWL (EL.m)
Srass Prambai Reservoir	30.74	8.50	4.50

Assumed Dike Intake (EL.m)	Assumed Inflow from Bassac (m^3/sec)
5.00	4.00





Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.5.2.4.4** **Results of Reservoir Operation Simulations of Srass Prambai Reservoir (80% Dependability)**
Japan International Cooperation Agency	

Condition of Water Balance Study for Srass Prambai Rehabilitation Project

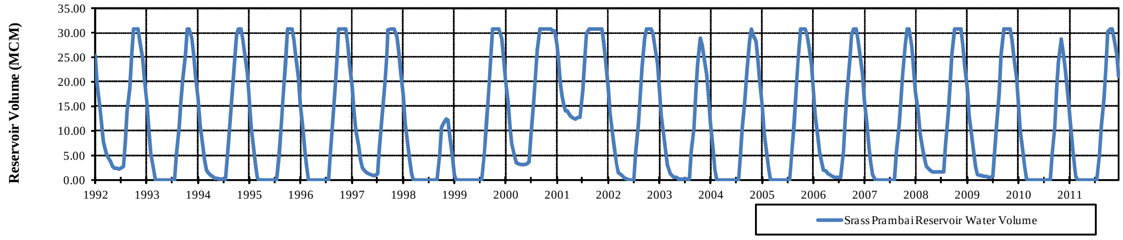
Sras Prambai Irrigation Area

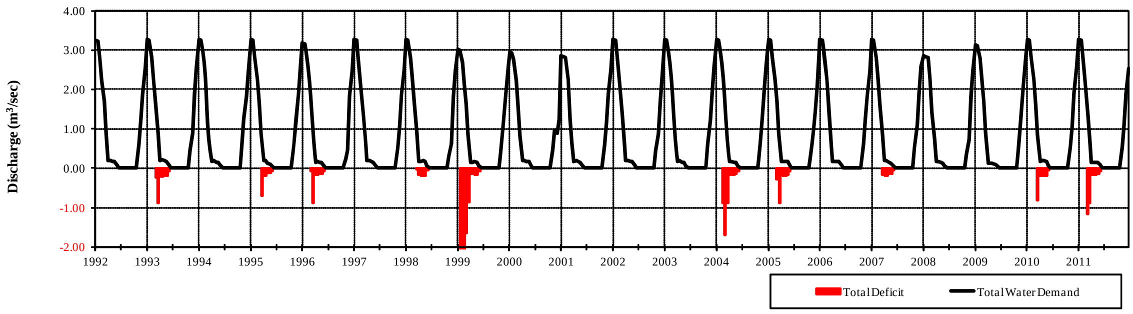
Max. Command Area (ha)	Total Irr. Area	Early Rice (2nd Dry)	Early Rice (Recession)	Crop Intensity		Dependa-bility	Deficit Year (times/20years)
2,500ha	1,400ha	77ha	1,400ha	106%	X	50%	10

Case- 2
Dependability = 50%

Feature of Reservoir

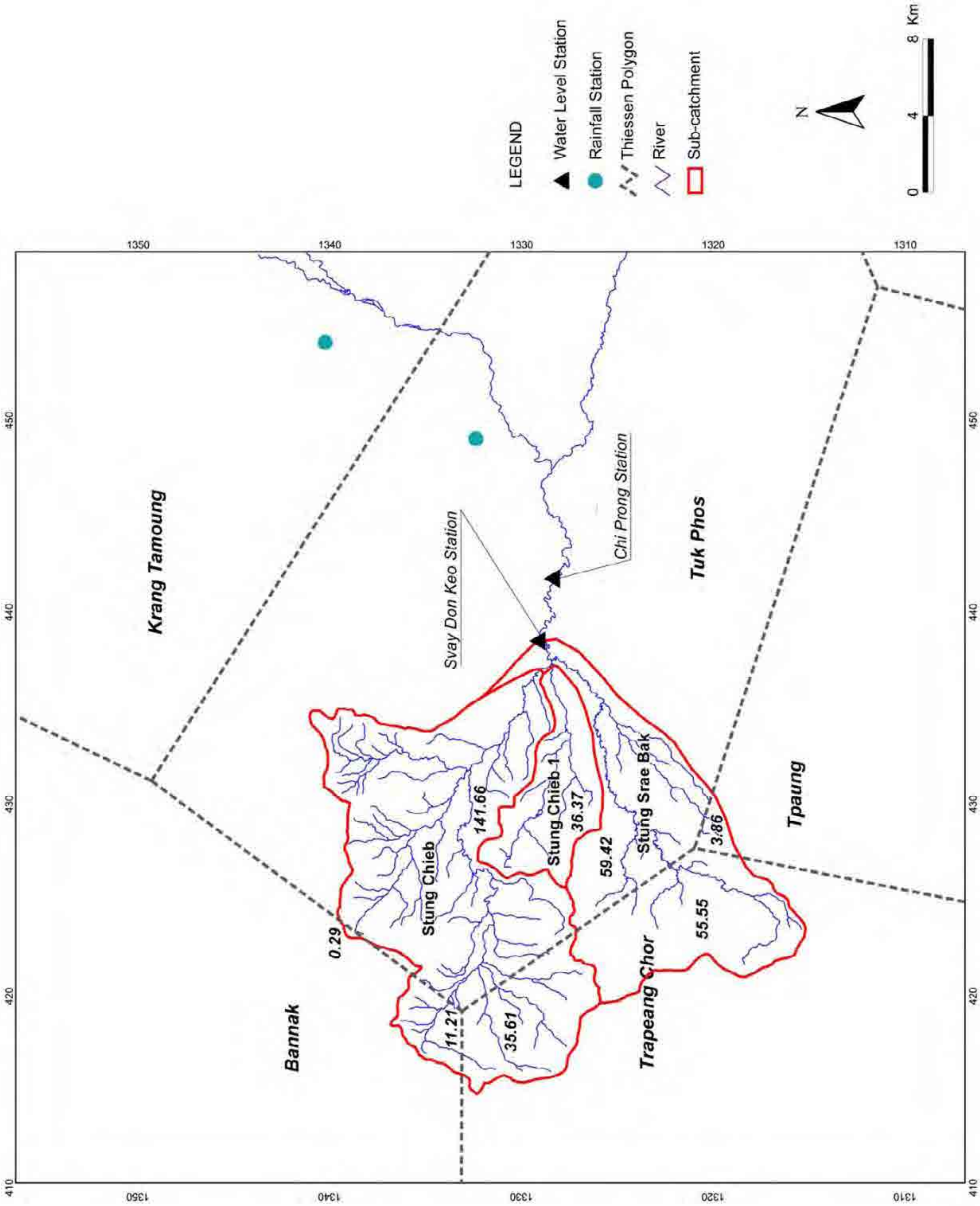
Name of Reservoir	Effective Vol. (MCM)	FSL (EL.m)	LWL (EL.m)	Assumed Dike Intake (EL.m)	Assumed Inflow from Bassac (m^3/sec)
Srass Prambai Reservoir	30.74	8.50	4.50	5.00	4.00





Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.5.2.4.5**
Japan International Cooperation Agency	**Results of Reservoir Operation Simulations of Srass Prambai Reservoir (50% Dependability)**

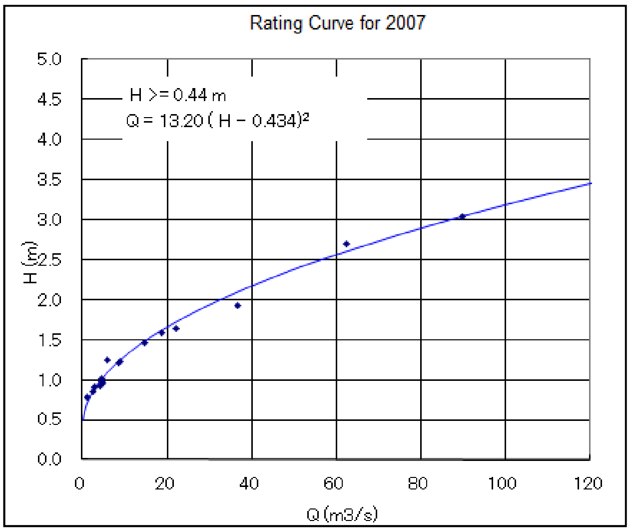


Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT Japan International Cooperation Agency	**Figure AB-2.6.2.1.1** **Rainfall, W.L. Stations and the Thiessen Polygons in/around DPISRSP Area**

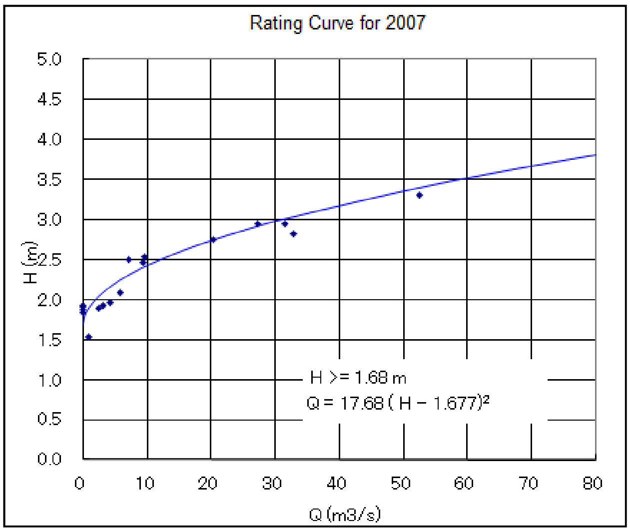
Discharge Observation Data at Ta Kab (Chi Prong)

No.	Year	Date		H (m)	Q (m^3/s)
1	2007	Jul	6	1.24	8.84
2	2007	Jul	15	1.02	4.48
3	2007	Jul	29	0.97	4.67
4	2007	Aug	13	0.94	4.09
5	2007	Aug	28	2.71	62.33
6	2007	Sep	11	1.60	18.48
7	2007	Sep	19	1.64	22.15
8	2007	Sep	29	3.05	89.42
9	2007	Oct	7	1.94	36.67
10	2007	Oct	27	1.47	14.47
11	2007	Nov	7	1.26	5.67
12	2007	Nov	22	1.22	8.58
13	2007	Dec	10	0.99	4.26
14	2007	Dec	24	0.91	2.72
15	2008	Jan	11	0.86	2.24
16	2008	Jan	28	0.92	2.73
17	2008	Feb	11	0.79	1.06



Discharge Observation Data at Svay Don Keo

No.	Year	Date		H (m)	Q (m^3/s)
1	2007	Jul	3	2.83	32.70
2	2007	Jul	13	2.10	5.68
3	2007	Jul	26	1.91	0.00
4	2007	Aug	10	1.85	0.00
5	2007	Aug	25	1.94	3.12
6	2007	Sep	9	1.98	4.24
7	2007	Sep	17	2.47	9.23
8	2007	Sep	26	2.76	20.33
9	2007	Oct	5	2.54	9.48
10	2007	Oct	25	3.32	52.37
11	2007	Nov	5	2.96	31.46
12	2007	Nov	20	2.95	27.11
13	2007	Dec	8	2.50	7.00
14	2007	Dec	20	1.90	2.45
15	2008	Jan	9	1.55	0.85
16	2008	Jan	27	1.94	0.00
17	2008	Feb	9	1.89	0.00

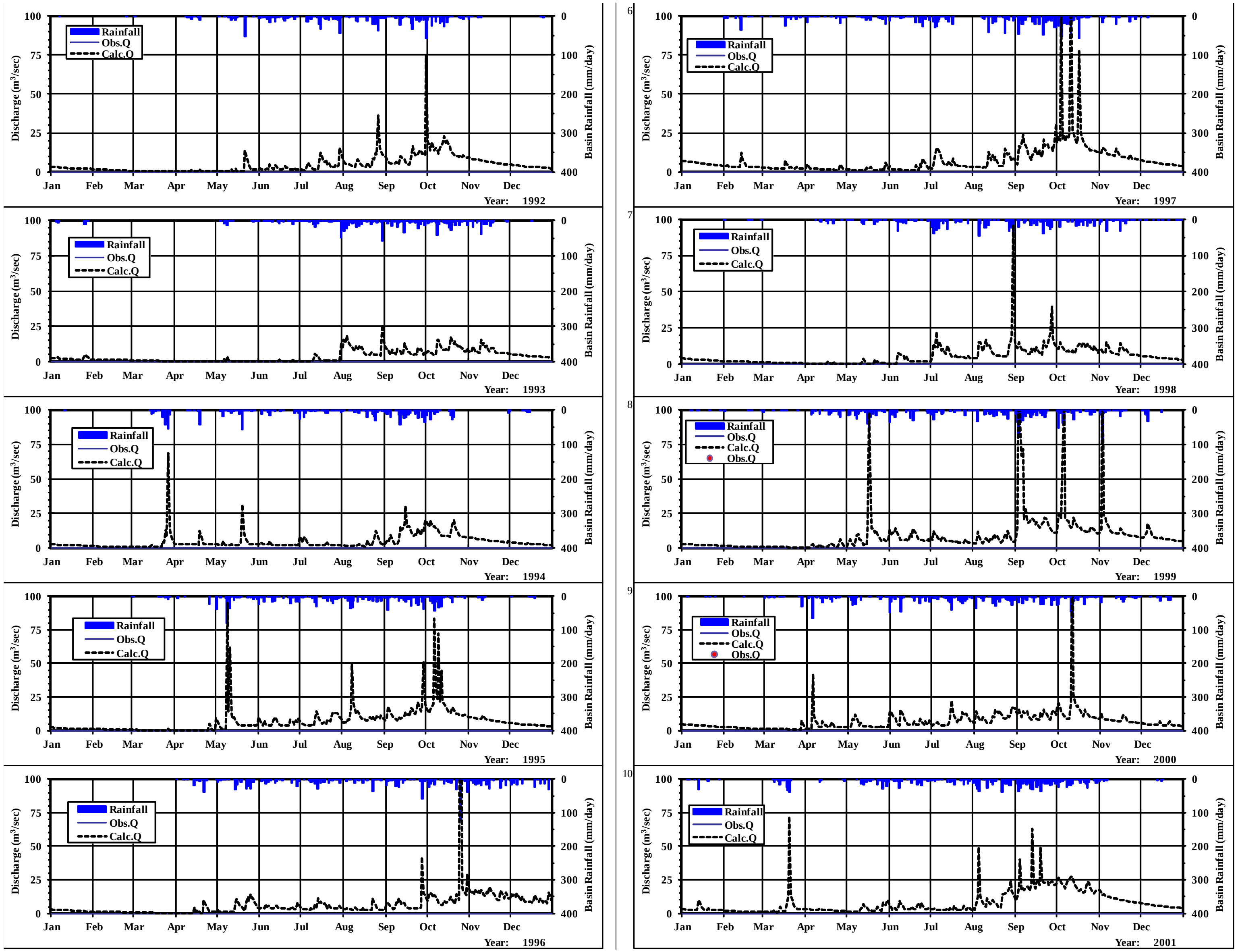


Source: *"Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia", JICA, March, 2009, Appendix-A, Section A8.3.4, p.A-44*

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.6.2.1.3**
Japan International Cooperation Agency	**Discharge Observation Data and Rating Curve at Chi Prong and Svay Don Keo**

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency



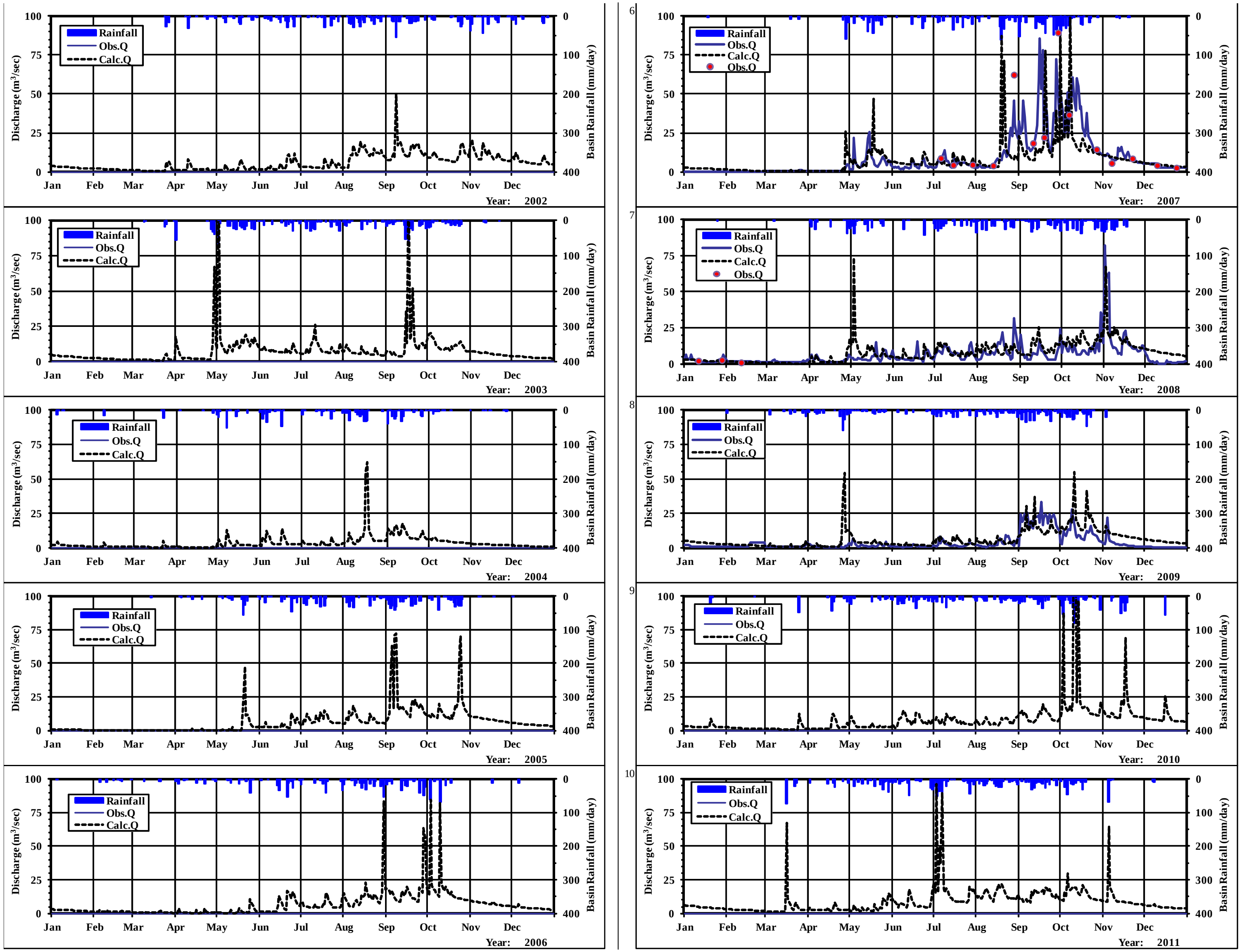
Source: JICA Survey Team

Figure AB-2.6.2.4.2

Observed and Estimated Daily Discharge by the Tank Model at Chi Prong (1/2)

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

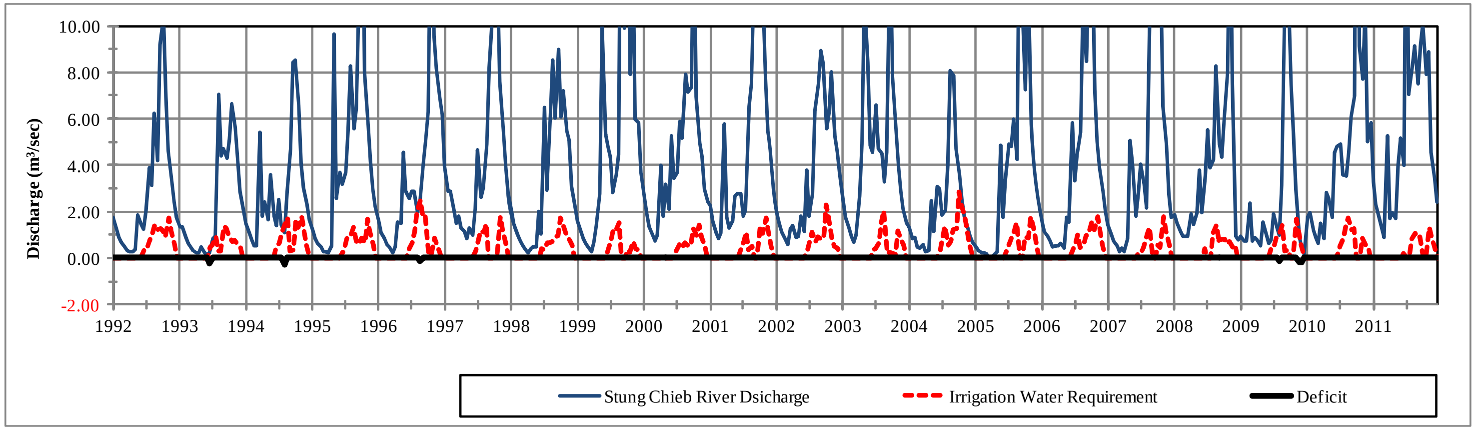


Source: JICA Survey Team

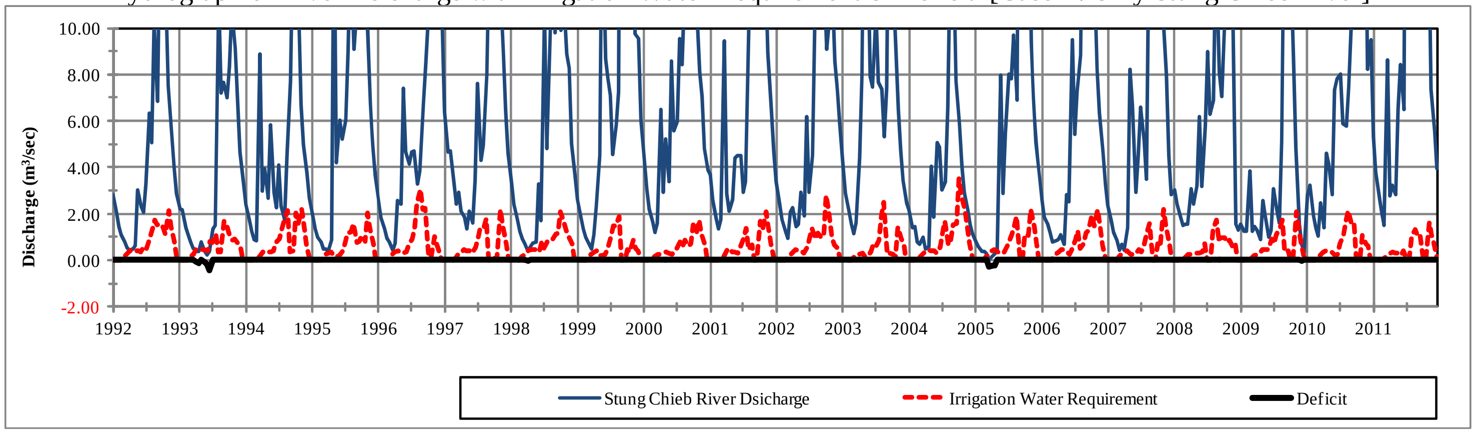
Figure AB-2.6.2.4.2
Observed and Estimated Daily Discharge by the Tank Model at Chi Prong (2/2)

Condition of Water Balance Study for Daun Pue Rehabilitation Project

Total Command Area	1,448 ha					Dependa-bility	Deficit Year (times)
Max	Total	Early Paddy (Early Rainy)	Mid Paddy	Crop Intensity			
Case-1: Only Noth River	1,200 ha	0 ha	1,180 ha	100%		80%	4
Case-2: North + South River	1,448 ha	174 ha	1,448 ha	112%		80%	4



Hydrograph of River Dsicharge with Irrigation Water Requirement & Deficit [Case-1: Only Stung Chieb River]



Hydrograph of River Dsicharge with Irrigation Water Requirement & Deficit [Case-2: Stung Chieb River + Stung Srae Bak]

Source: JICA Survey Team

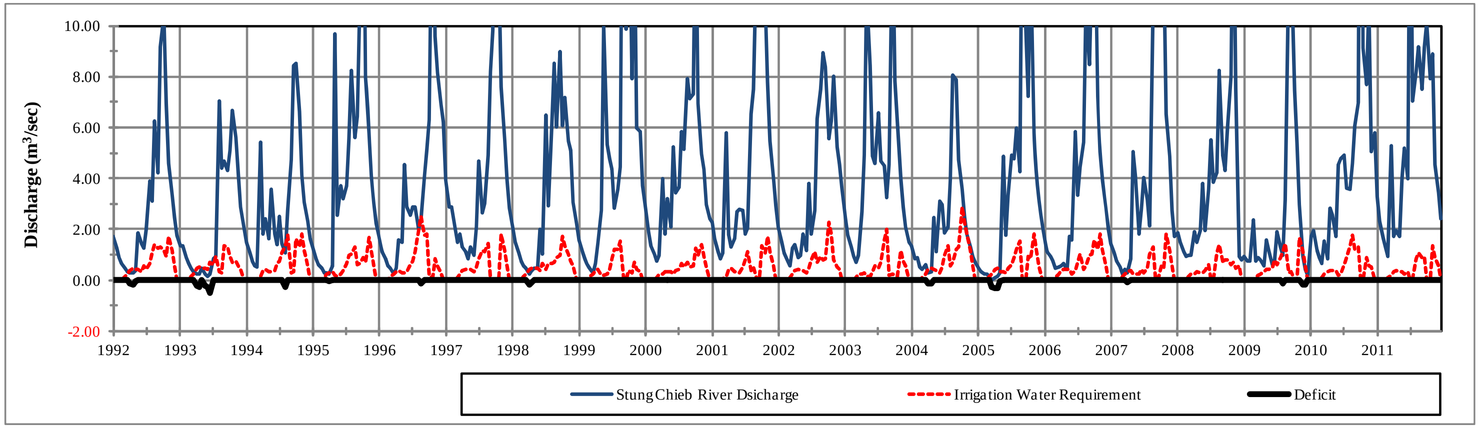
Figure AB-2.6.2.5.2
Results of Water Balance Study of DPISRSP (80% Dependability)

Condition of Water Balance Study for Daun Pue Rehabilitation Project

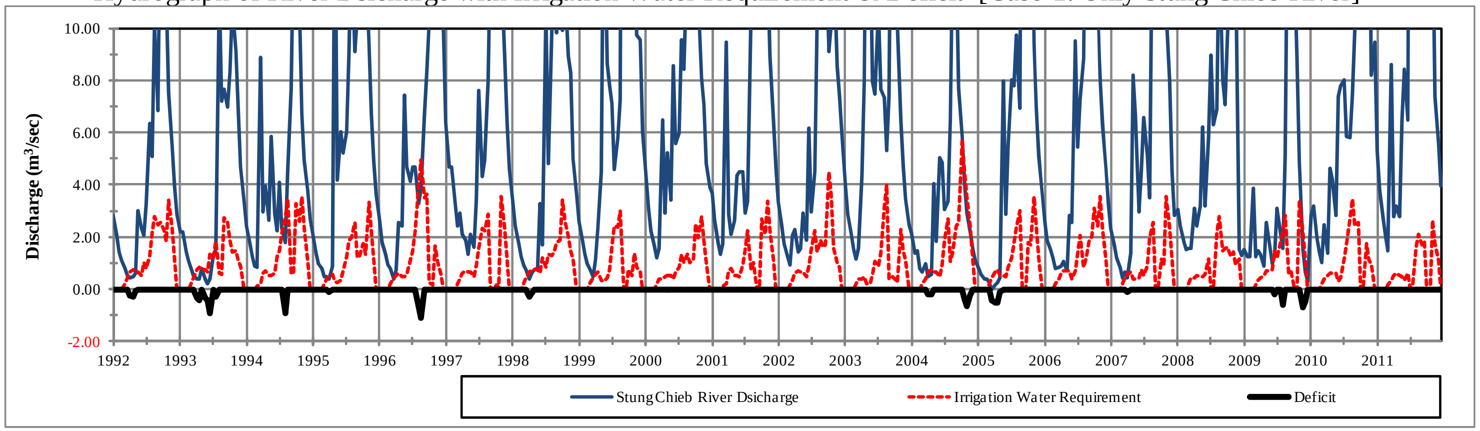
Total Command Area: 1,448 ha

Max	Total	Early Paddy (Early Rainy)	Mid Paddy	Crop Intensity
Case-1: Only Noth River	1,440 ha	172 ha	1,180 ha	112%
Case-2: North + South River	2,335 ha	280 ha	2,335 ha	112%

Dependa-bility	Deficit Year (times)
50%	10
50%	10



Hydrograph of River Dsicharge with Irrigation Water Requirement & Deficit [Case-1: Only Stung Chieb River]



Hydrograph of River Dsicharge with Irrigation Water Requirement & Deficit [Case-2: Stung Chieb River + Stung Srae Bak]

Source: JICA Survey Team

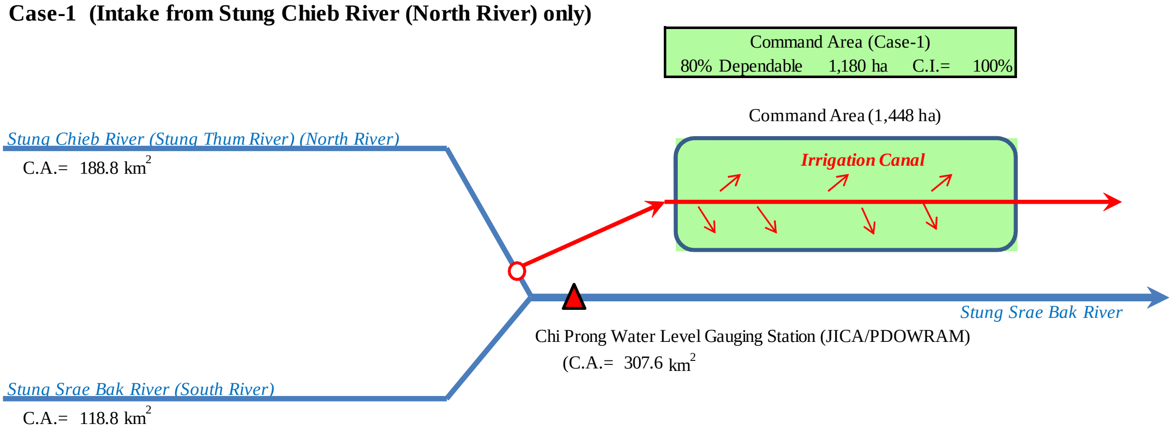
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

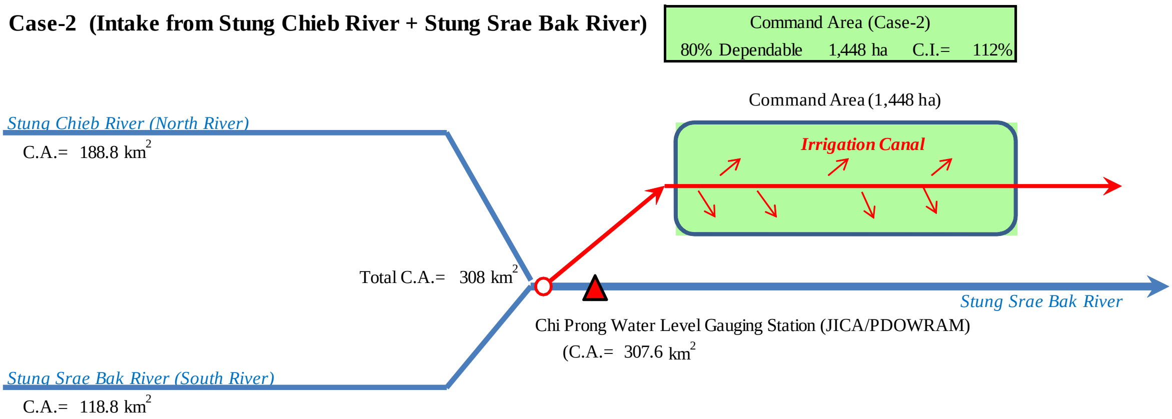
Figure AB-2.6.2.5.3

Results of Water Balance Study of DPISRSP (50% Dependability)

Case-1 (Intake from Stung Chieb River (North River) only)



Case-2 (Intake from Stung Chieb River + Stung Srae Bak River)

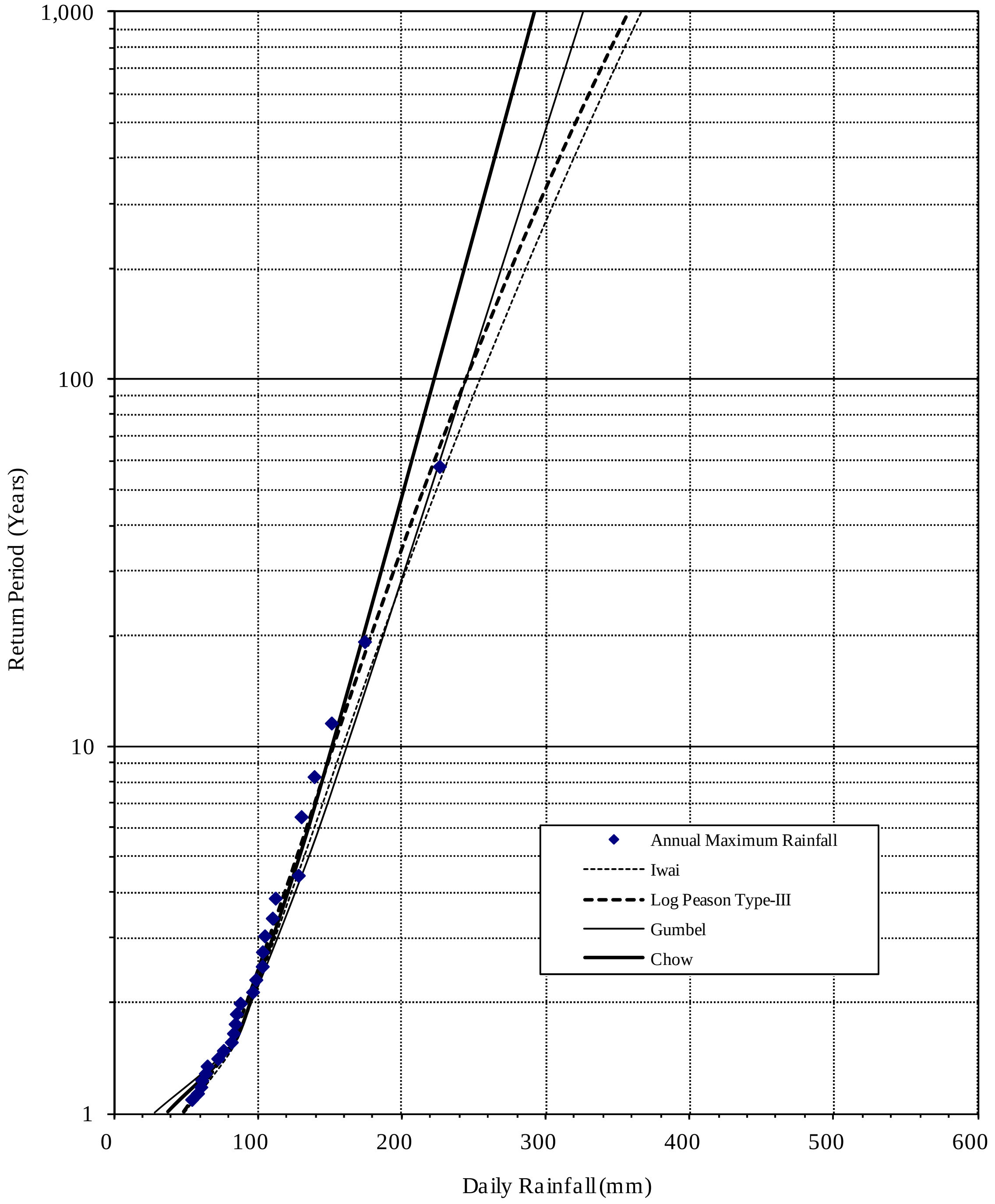


Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

Figure AB-2.6.2.5.4
Schematic Results of Water Balance Study of DPISRSP (80% Dependability)



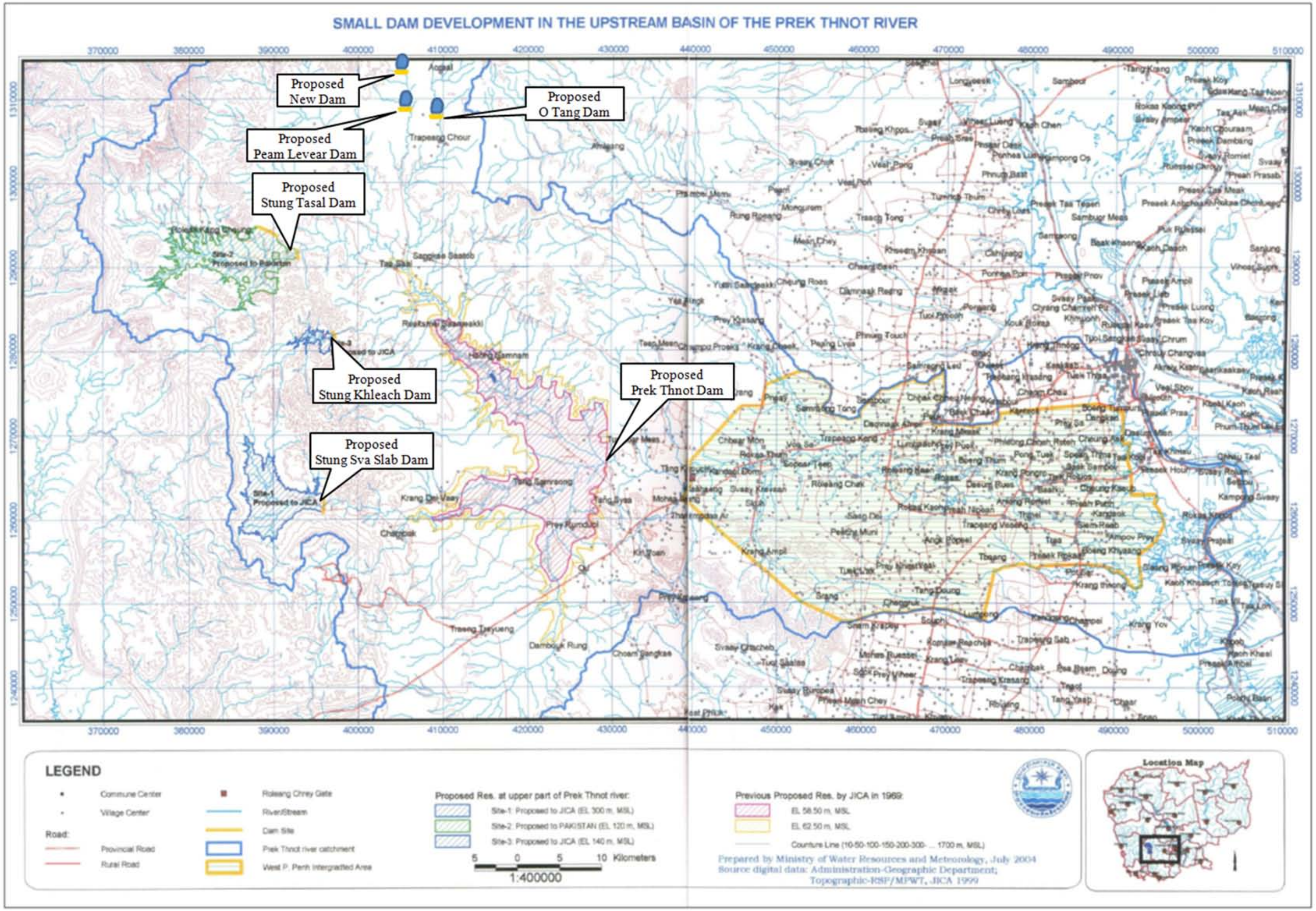
Frequency Curve of Annual Maximum Daily Point Rainfall at Kampong Speu

Source: JICA Survey Team

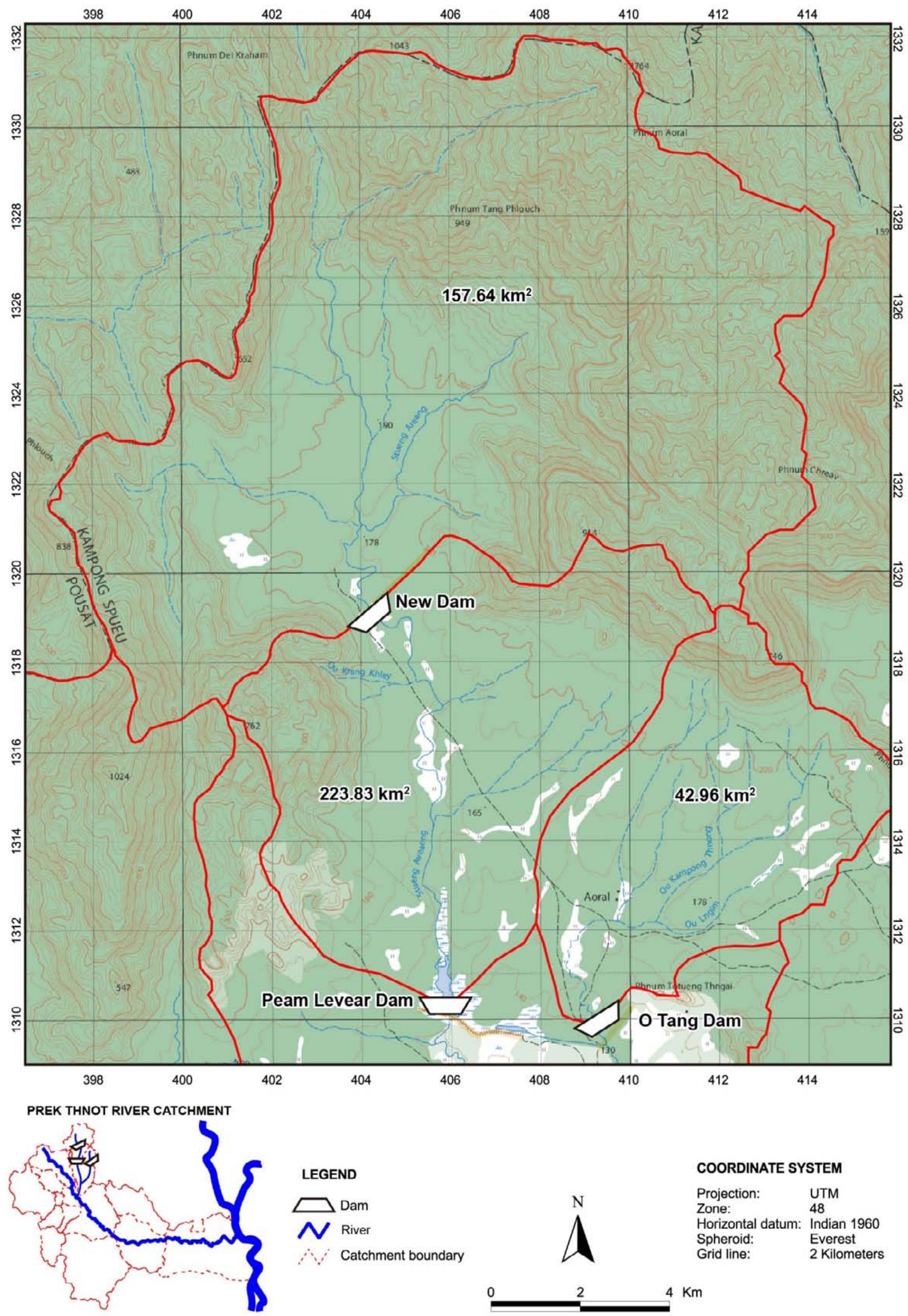
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-2.6.2.6.1**
Japan International Cooperation Agency	**Frequency Curve of Annual Maximum Daily Point Rainfall at Kampong Chhnang**

Figure AB-3.1.1.1

Location Map of Proposed Dam Projects in Prek Thnot River Basin

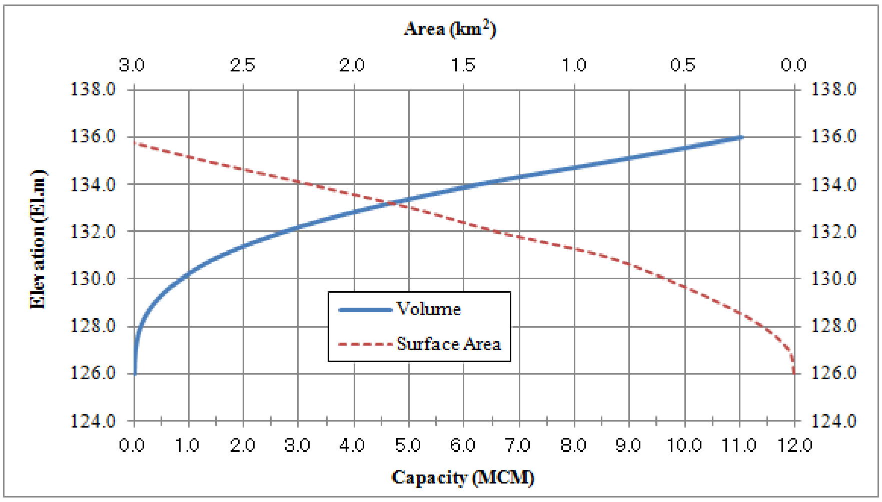


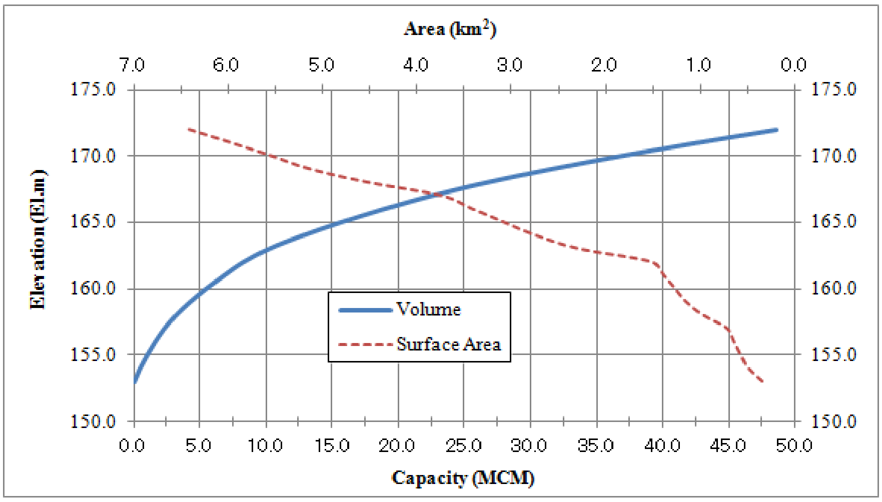
Source: MOWRAM, 2004

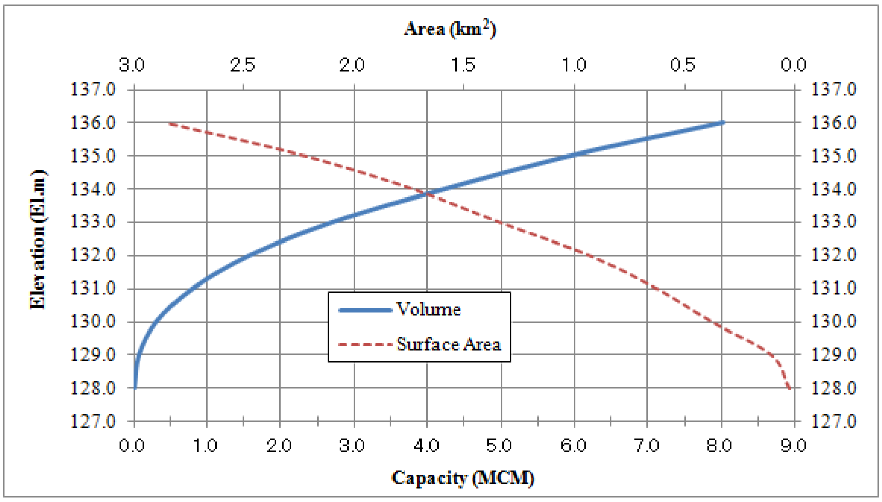


Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.2.1**
Japan International Cooperation Agency	**Location Map of Proposed New Dam, Peam Levear Dam and O Tang Dam**

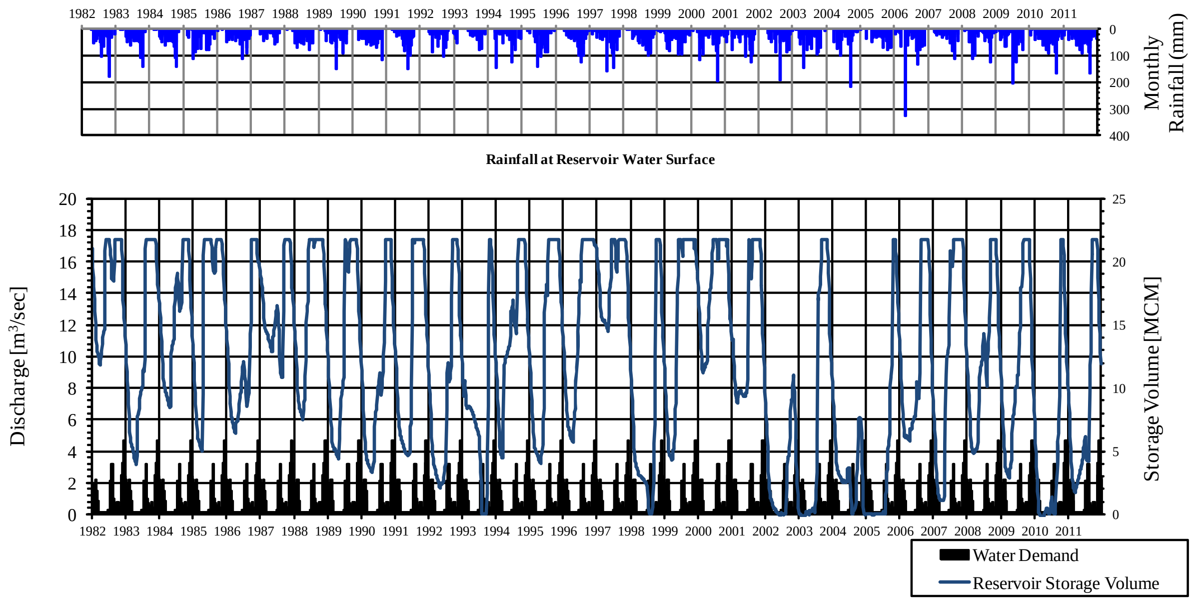




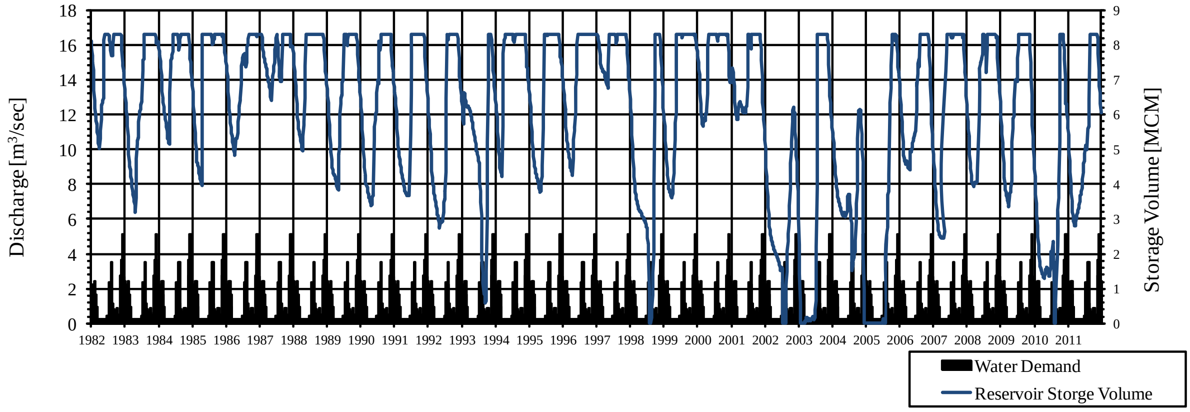


Source: "The Feasibility Study on Water Resources Development Project for the Prek Thnot River Basin", Feb.2010, K-water

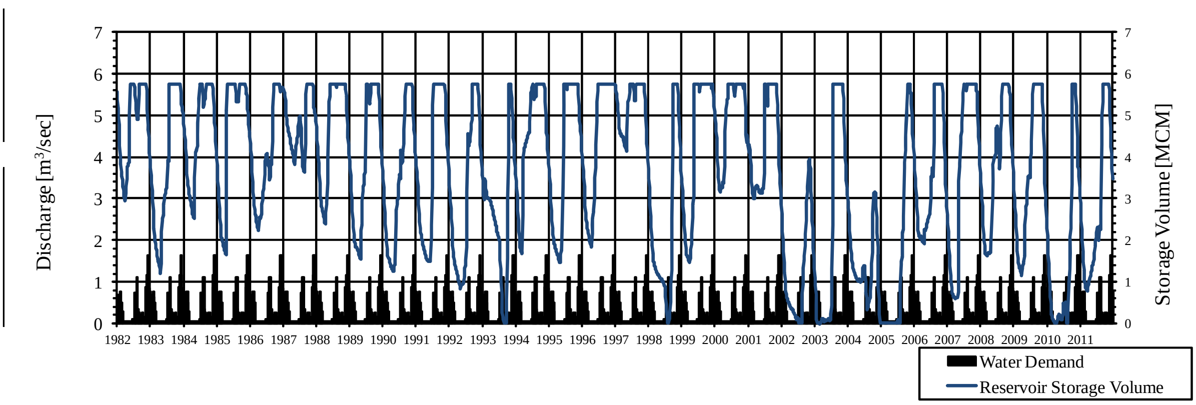
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.2.3**
Japan International Cooperation Agency	**Stage-Area-Capacity Curves at 3-dams**



New Dam



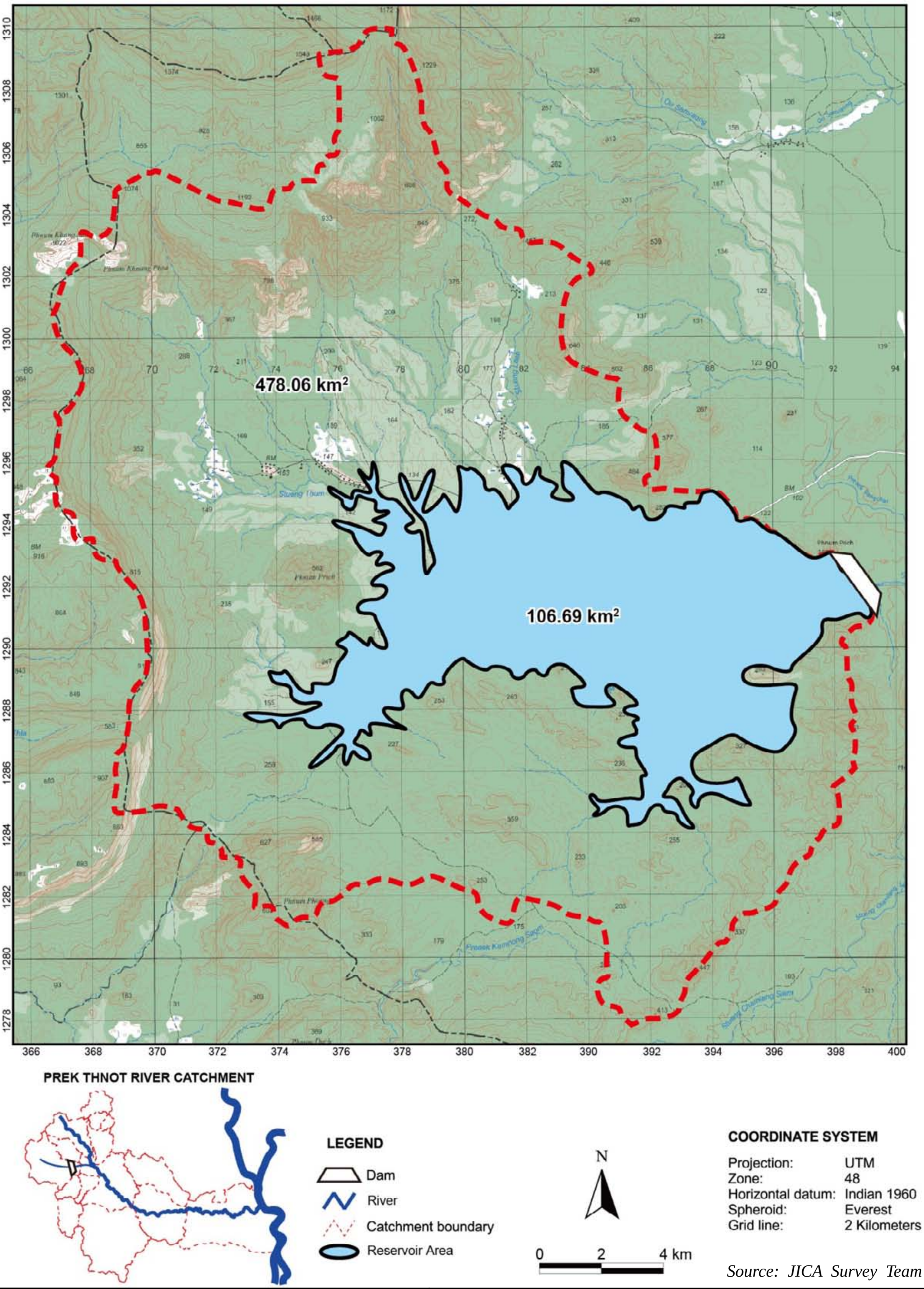
Peam Levear Dam



O Tang Dam

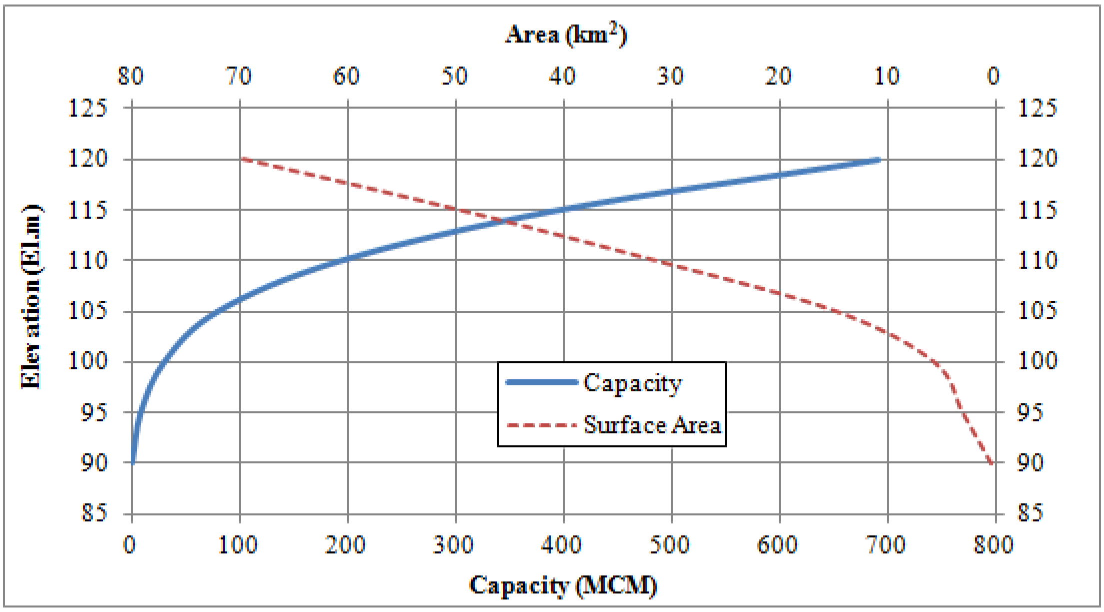
Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.2.4**
Japan International Cooperation Agency	**Results of Reservoir Operations of Proposed 3-Dams (80% Dependability)**



Source: JICA Survey Team

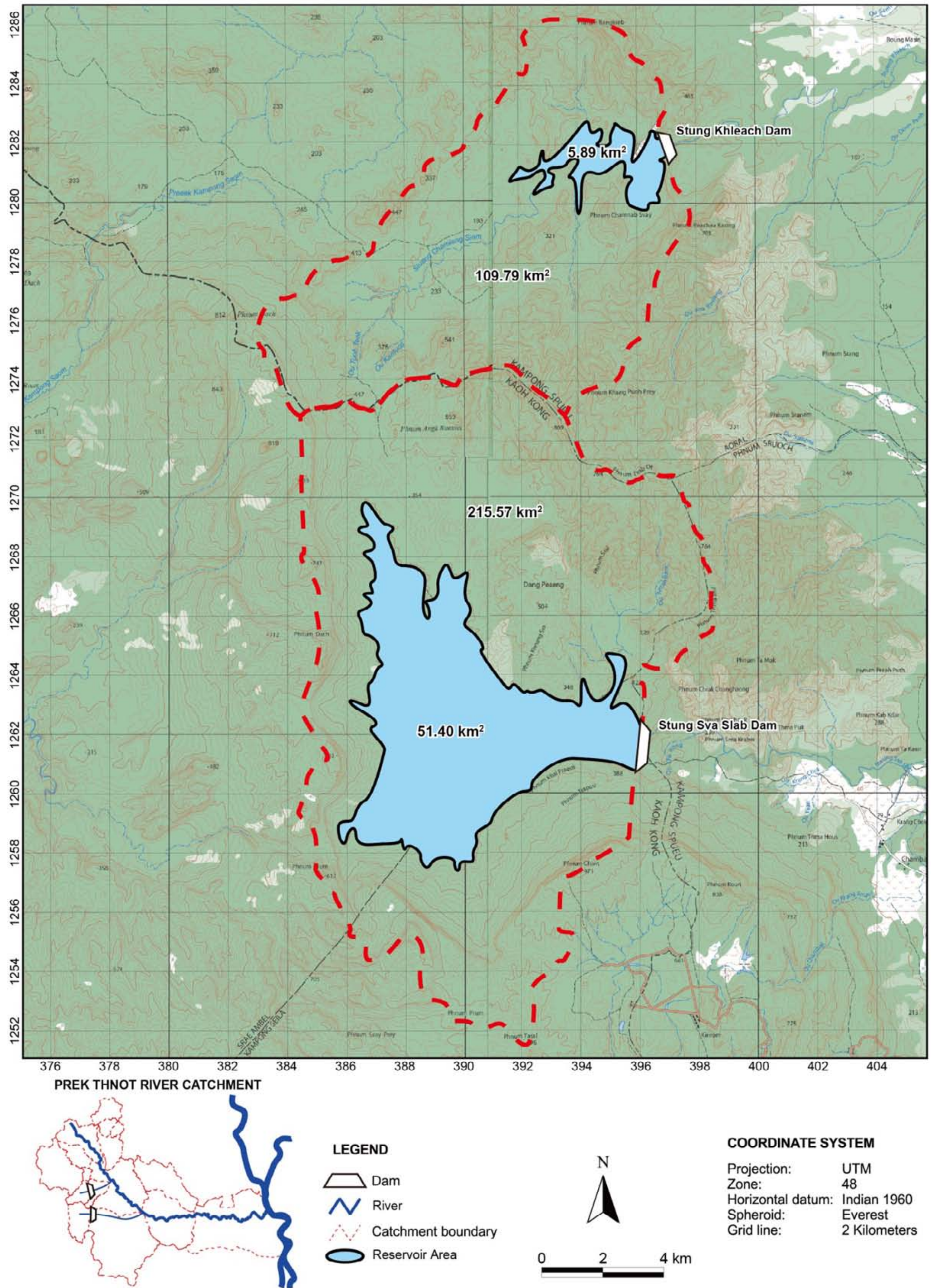
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.3.1**
Japan International Cooperation Agency	**Catchment Area and Reservoir Area of Proposed Stung Tasal Dam**



Stage-Area-Capacity Curve of Proposed Stung Tasal Dam

Source: "Stung Tasal Dam Project" Volume-I, Design Engineering Report, WAPCOS Limited, December 2008.

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.3.2**
Japan International Cooperation Agency	**Stage-Area-Capacity Curve of Proposed Stung Tasal Dam**



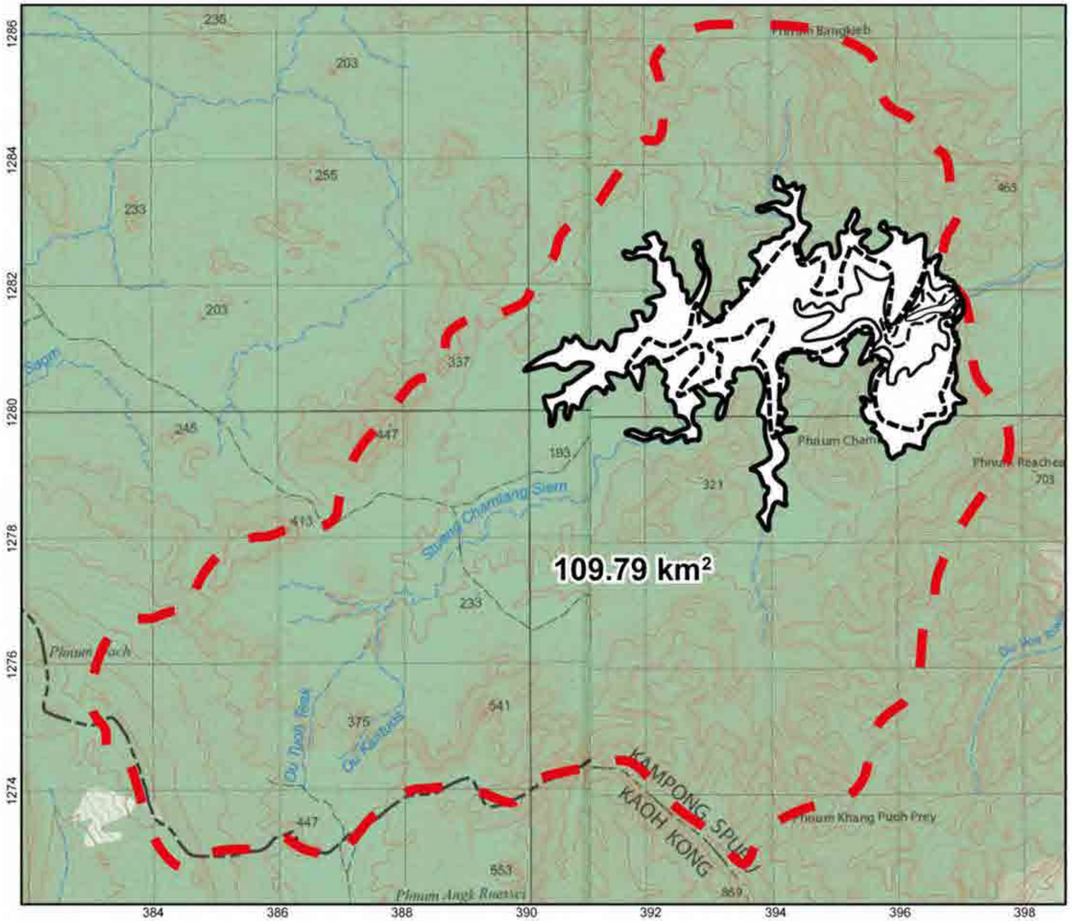
Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.4.1**
Japan International Cooperation Agency	**Location Map of Proposed Stung Sva Slab Dam and Stung Khleach Dam**

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AB-3.2.4.2
Reservoir Area of Proposed Stung Sva Srab Dam



Reservoir	Area (km^2)
Reservoir 100 m	0.08
Reservoir 110 m	0.35
Reservoir 120 m	1.75
Reservoir 140 m	5.59
Reservoir 160 m	12.65

LEGEND

- Catchment Boundary
- Reservoir 100 m
- Reservoir 110 m
- Reservoir 120 m
- Reservoir 140 m
- Reservoir 160 m

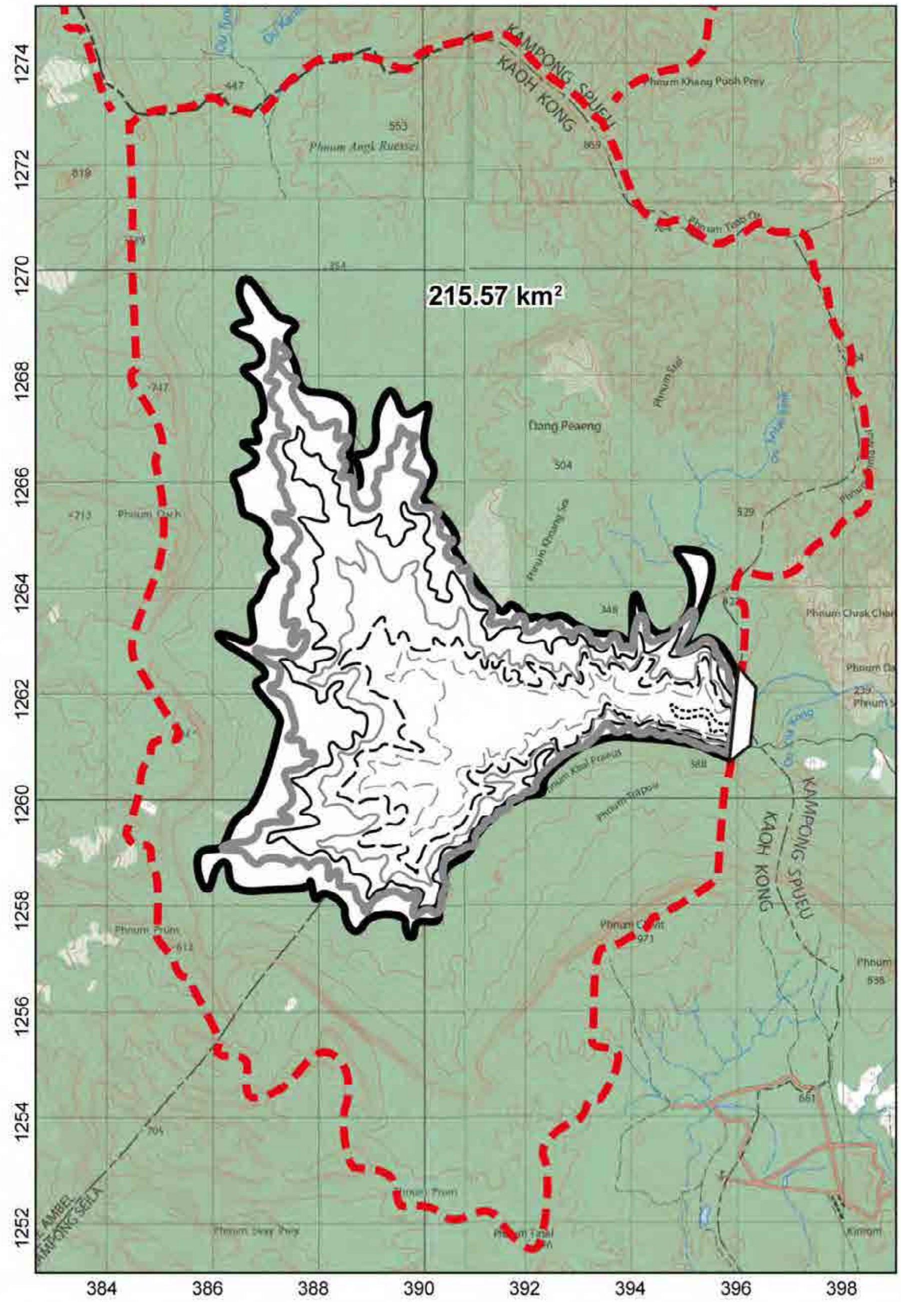
COORDINATE SYSTEM

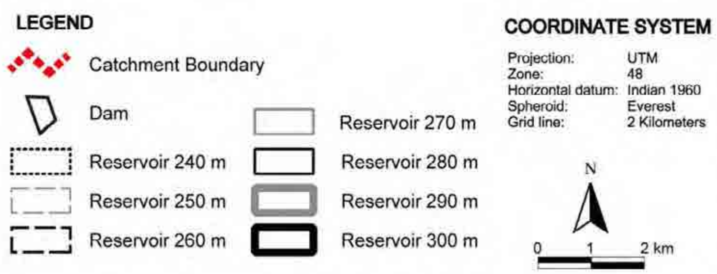
Projection:	UTM
Zone:	48
Horizontal Datum:	Indian 1960
Spheroid:	Everest
Grid Line:	2 km

N

0 1 2 3 km

Source: JICA Survey Team

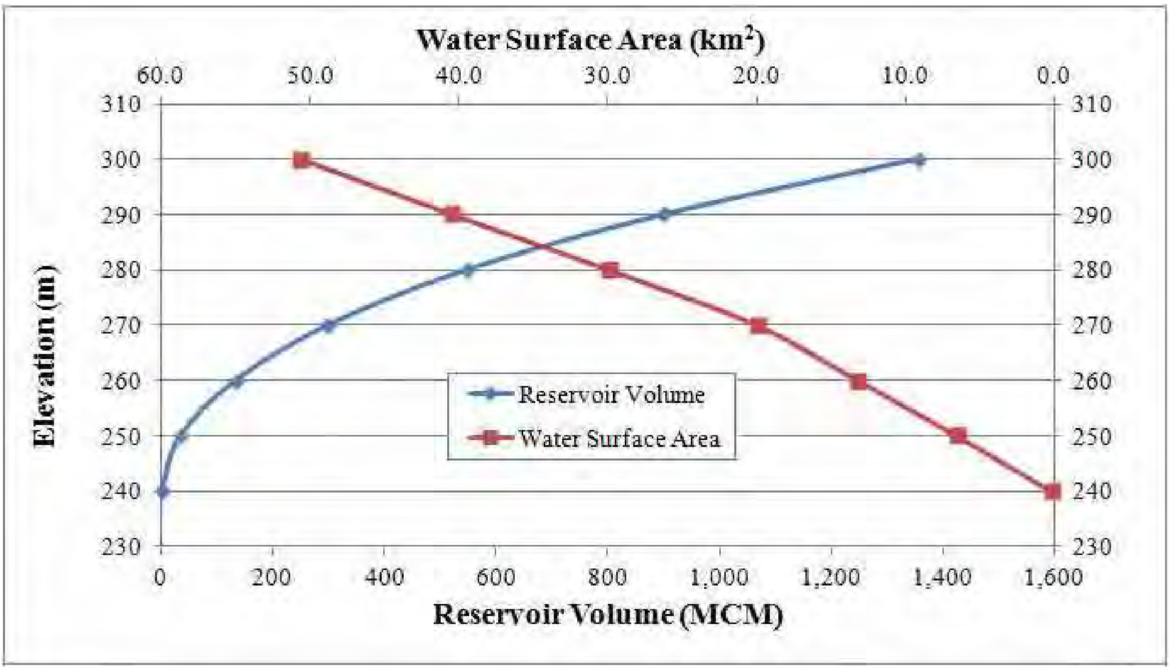




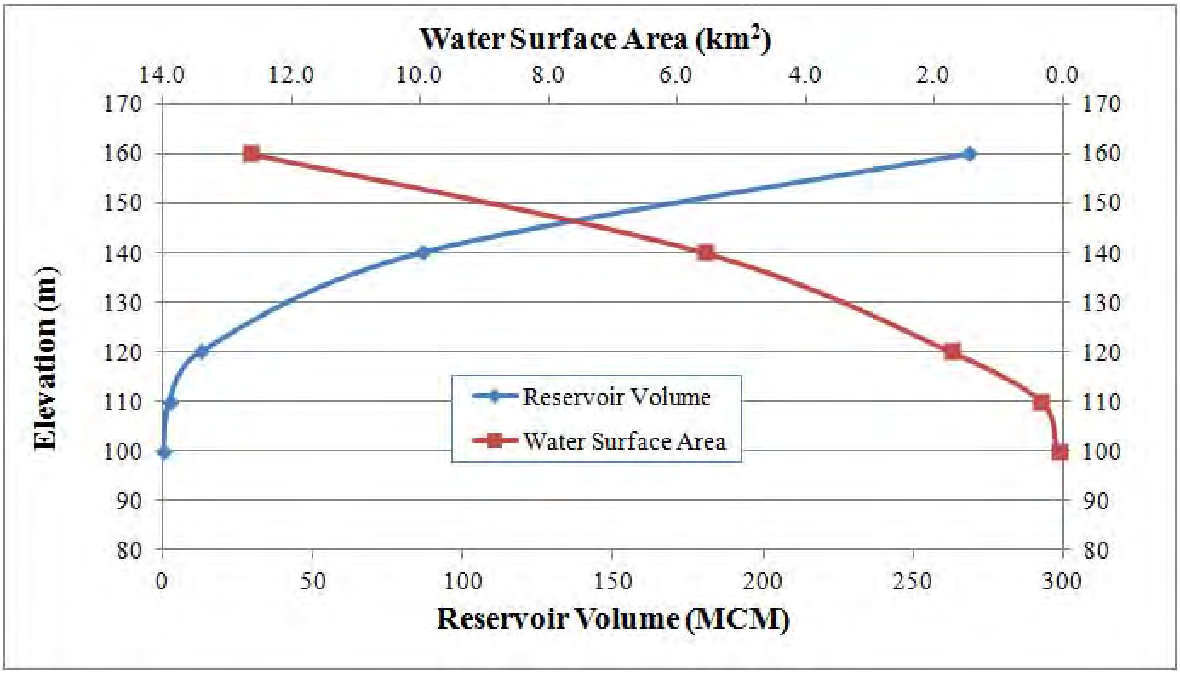
Reservoir	Area (km^2)
Reservoir 240 m	0.17
Reservoir 250 m	6.50
Reservoir 260 m	13.19
Reservoir 270 m	19.98
Reservoir 280 m	12.65
Reservoir 290 m	40.49
Reservoir 300 m	50.68

Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.4.3** **Reservoir Area of Proposed Stung Khleach Dam**
Japan International Cooperation Agency	



H-V-A Curve at Proposed Stung Sva Slab Dam



H-V-A Curve at Proposed Stung Khleach Dam

Source: JICA Survey Team

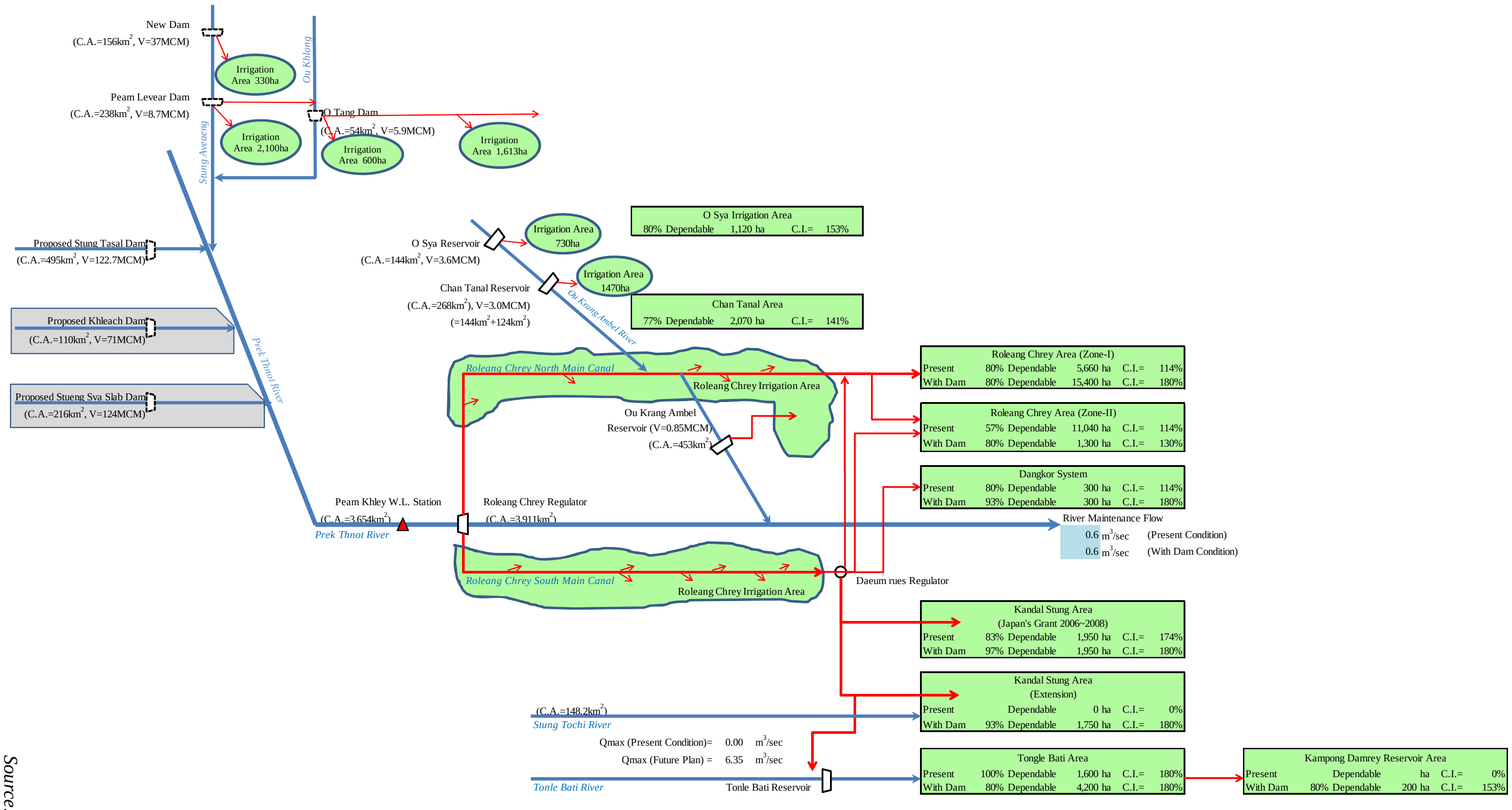
PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.2.4.4**
Japan International Cooperation Agency	**Stage-Are-Capacity Curve at Proposed Stung Sva Srab Dam and Stung Khleach Dam**

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE
SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

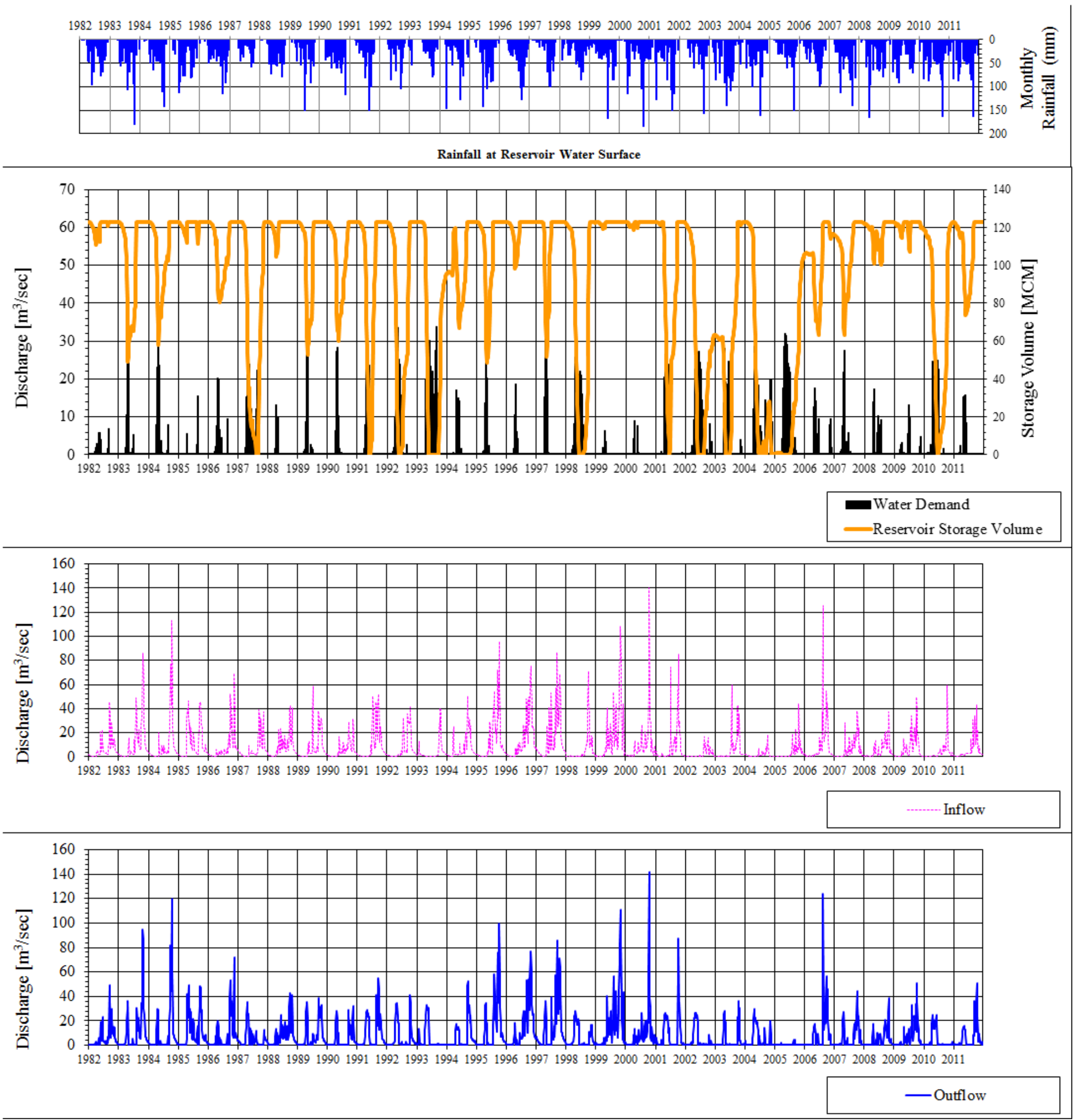
Japan International Cooperation Agency

Figure AB-3.3.1.1

Results of Water Balance Study "With/Without" Tasal Dam (Case-2)



Source: JICA Survey Team



Source: JICA Survey Team

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT	**Figure AB-3.3.1.2**
Japan International Cooperation Agency	**Result of Reservoir Operation of Stung Tasal Dam (Case-2)**

ANNEX C

Agriculture

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

ANNEX C
AGRICULTURE

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ANNEX C

AGRICULTURE

CHAPTER AC-1 GENERAL INFORMATION

AC-1.1 Overview of Agriculture in Cambodia

AC-1.1.1 Paddy Cultivation in Cambodian

During the last 10-year period of 2001-2010, the total rice production in the country (rainy and dry season rice) considerably increased from 4.10 million tons of paddy in 2001 to about 8.24 million tons in 2010, except the worse climate condition occurred in 2002 and 2004 when rice production slightly dropped, as shown as follows:

Table AC-1.1.1.1 Paddy Production in Cambodia from 2002 to 2011

Item	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Cultivated Area (1,000 ha)	2,137	2,314	2,374	2,444	2,541	2,586	2,616	2,719	2,796	2,912
- Rainy season	1,845	2,-31	2.076	2,122	2.212	2,241	2,255	2,334	2,391	2,497
- Dry season	291	283	298	321	329	345	361	385	404	415
Total Harvested Area (1,000 ha)	1,994	2,242	2,109	2,414	2,516	2,567	2,613	2,675	2,777	2,710
- Rainy season	1,709	1,967	1,816	2,094	2,189	2,222	2,252	2,291	2,373	2,295
- Dry season	285	275	293	320	328	344	360	384	404	415
Average Unit Yield (ton/ha)	1.92	2.10	1.98	2.48	2.49	2.62	2.75	2.84	2.97	3.11
- Rainy season	1.71	1.95	1.73	2.26	2.27	2.41	2.54	2.62	2.76	2.91
- Dry season	3.12	3.18	3.54	3.90	3.94	3.96	4.03	4.13	4.20	4.20
Total Production (1,000 ton)	3,823	4,711	4,170	5,987	6,264	6,727	7,175	7,586	8,249	8,417
- Rainy season	2,916	3,838	3,132	4,734	4,973	5,364	5,722	6,001	6,549	6,674
- Dry season	907	873	1,038	1,252	1,290	1,363	1,453	1,584	1,700	1,743

Source: 2002 to 2010: Annual Report for Agriculture Forestry and Fisheries 2010-2011, MAFF, 2011: Internal data of MAFF 2012

For 2010, paddy production was produced higher than 2009 (increase of 8.7% or 663,580 tons). This result was based on the attempt to recovers as well as the efforts made by the farmers with better knowledge and know-how on paddy production, farm management, changing the farming techniques, especially the application seeds of new and high yielding varieties.[1] Area and production of paddy by provinces in 2008 are shown in Table AC-1.1.1.2. As can be seen in this table, production of Kampong Speu, Kandal, Takeo, and Kampong Chhnang Provinces are 13th, 9th, 2nd, and 10th among 24 provinces in rank, respectively. As for crop yield of paddy, these 4 related provinces show 19th, 1st, 3rd, and 7th among 24 provinces in rank, respectively.

AC-1.1.2 Prices of Agricultural Commodities

Information on wholesale and retail prices of major agricultural commodities has been currently collected in 14 provinces (Banthey Meanchey, Battambang, Kampong Cham, Kampong Chhnang,

1 *Annual Report for Agriculture Forestry and Fisheries 2010-2011, MAFF*

Kampong Speu, Kampong Thom, Kampot, Kandal, Phnom Penh, Prey Veng, Pursat, Shinanouk Ville, Siem Reap, and Takeo) by the Agricultural Marketing Office (AMO)[2] of MAFF since 2006. Currently AMO has offices in 24 provinces. Major activities of AMO are to collect price data from 22 selected markets and other collection points, and further disseminate price information through local AM and FM radio stations as well as publish monthly price information bulletins. Furthermore, AMO operates SMS price information system for traders and producers, including 21 agricultural commodities and 14 markets.

Seasonal fluctuations in market prices of paddy as well as upland crops including vegetables are a common phenomenon in the SPPIDRIP Area and Phnom Penh City. In case of paddy, cultivation of photosensitive varieties is common, but there is so limited paddy cultivation during the dry season due to less provision of irrigation facilities. Therefore, paddy prices become the lowest from January to February just after the peak harvesting season and the highest from September to October before the harvesting season. There also find price differences between local medium/late varieties (mixed) and improved early varieties (IR varieties) in the SPPIDRIP Area. Meanwhile seasonal fluctuation of vegetable prices in the SPPIDRIP Area is generally identified. Monthly wholesale prices (2010 and 2011) of rice and major vegetables in Phnom Penh City and 3 related provinces[3] such as Kandal, Takeo, and Kampong Chhnang are shown as follows:

Table AC-1.1.2.1 Monthly Wholesale Prices of Rice and Vegetables in Phnom Penh City, 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, 2011

Table AC-1.1.2.2 Monthly Wholesale Prices of Paddy, Rice, and Vegetables in Kandal Province, 2011

(Unit: Riel/kg)

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Paddy (IR)	1,083	0	932	1,170	1,058	1,090	1,123	1,150	1,200	1,200	1,400	1,150
Paddy (Phka Khney)	1,060	1,023	1,072	1,095	1,135	1,193	1,250	1,300	1,360	1,360	1,600	1,217
Paddy ((Srov Sar)	995	950	1,012	1,043	1,100	1,130	1,168	1,200	1,340	1,340	1,507	1,167
Rice (Phka khney)	2,100	1,350	1,800	1,825	1,950	1,933	2,100	2,100	2,300	2,300	2,600	2,167
Rice (IR)	900	0	1,570	1,663	1,825	1,900	1,900	1,900	2,000	2,000	2,400	1,967

2 http://www.agriculturalmarketinformation.org.kh/
3 Collection activity on price information in Kampong Speu was aborted in 2010.

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rice (Srov Sar)	1,815	1,616	1,600	1,750	1,900	2,000	2,000	2,000	2,200	2,200	2,517	2,000
Ground nut	6,550	6,500	6,600	6,800	6,500	4,875	-	-	-	-	-	-
Mung bean	5,650	5,200	5,533	5,743	4,500	4,583	4,400	3,600	3,543	3,543	5,840	4,638
Soybean	2,033	2,150	2,200	2,243	2,900	2,967	3,356	3,163	3,000	3,000	2,560	2,300
Cabbage	1,291	980	927	1,018	1,100	1,433	2,800	1,790	1,760	1,760	1,950	2,036
Cucumber	1,255	1,360	1,436	1,242	1,257	1,400	1,600	1,733	2,040	2,040	1,988	2,045
Tomato	1,791	650	936	1,610	1,657	1,990	2,100	2,162	2,440	2,440	2,888	2,955

Source: PDA Kandal 2012

Table AC-1.1.2.3 Monthly Wholesale Prices of Paddy, Rice, and Vegetables in Takeo Province, 2011

(Unit: Riel/kg)

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Paddy (mixed)	1,000	958	1,013	1,060	1,208	1,220	1,220	1,250	1,300	1,475	1,588	1,168
Paddy (IR)	-	-	-	968	1,070	1,100	1,067	1,100	1,113	1,263	1,388	1,275
Rice (mix)	1,700	1,673	1,721	1,749	1,950	-	-	-	2,060	2,265	2,490	1,975
Rice (IR)	-	-	1,692	-	1,910	2,000	2,000	2,028	1,900	2,058	2,121	2,075
Rice (Kra Horm)	-	-	1,913	-	-	1,870	1,767	1,800	-	-	-	-
Cabbage	1,161	1,053	900	982	958	1,100	1,273	1,381	1,460	1,500	1,567	1,730
Chinese Kale	2,203	2,287	2,500	3,242	2,830	3,127	3,042	2,870	3,070	3,188	3,200	3,124
Cucumber	1,145	957	989	1,248	1,085	1,237	1,194	1,386	1,513	1,464	1,972	1,627
Tomato	1,406	1,077	733	1,390	1,442	1,553	1,727	1,728	1,857	2,103	2,156	1,879

Source: PDA Takeo, 2012

Table AC-1.1.2.4 Monthly Wholesale Prices of Paddy, Rice, and Vegetables in Kampong Chhnang Province, 2011

(Unit: Riel/kg)

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Paddy (Kongsoy)	1,205	1,233	1,250	1,270	1,383	1,500	1,500	1,547	1,542	1,704	1,471	1,333
Paddy Mixed	960	900	920	993	1,033	1,100	1,100	1,184	1,208	1,530	1,256	1,058
Paddy Phka romdoul	-	-	-	-	-	-	1,550	1,568	1,557	1,705	1,488	1,200
Paddy Phka Malis	-	-	-	-	-	-	1,480	1,538	1,545	2,050	1,478	1,200
Rice (Kong Soy)	2,215	2,225	2,350	2,383	2,443	2,500	2,500	2,490	2,667	3,037	3,013	2,692
Rice (Mixed)	1,670	1,700	1,606	1,683	1,745	1,948	2,000	2,135	2,167	2,394	2,478	1,942
Rice phka romdoul	-	-	-	-	-	-	2,575	2,620	2,653	3,013	3,013	2,700
Rice Phka malis	-	-	-	-	-	-	2,567	2,628	2,650	3,025	3,025	2,700
Cabbage	1,180	1,118	969	1,078	1,200	1,350	1,606	1,733	1,724	1,764	2,103	1,950
Chinese Kale	1,723	1,618	3,197	2,544	2,453	4,022	2,936	3,731	4,306	4,415	4,985	4,433
Cucumber	1,117	842	1,428	1,096	1,097	1,161	1,183	1,133	1,818	1,415	1,485	1,797
Tomato	1,440	633	495	1,370	1,519	1,631	3,239	2,105	2,361	2,776	2,024	2,080

Source: PDA Kampong Chhnang 2012

As shown in the above tables, seasonal fluctuations of market prices of paddy as well as other secondary crops (cereals, vegetables, etc.) are common in the survey area as well as in Phnom Penh. Generally paddy prices are lower from January to February, then just after the peak harvesting season, while higher from September to October before harvesting season. Furthermore, price difference between local and improved varieties is caused from consumers' preference. In general, farmers grow local varieties in rainy season for their home consumption and cultivate improved varieties for marketing during early rainy season and dry season.

AC-1.1.3 Demand and Supply of Rice

The Royal Government of Cambodia (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 AC-1.1.3.1 Projection of Paddy Production and Export in Cambodia 2010 - 2015

Items	2008	2009	2010	2011	2012	2013	2014	2015
Cultivated area in wet season (million ha)	2.26	2.33	2.34	2.35	2.36	2.37	2.38	2.39
Cultivated area in dry season (million ha)	0.36	0.39	0.38	0.38	0.41	0.42	0.45	0.48
Total Production (million ton)	7.18	7.59	7.30	7.62	8.09	8.44	8.85	9.08
Seed and Post-harvest loss (million ton)	0.93	1.00	0.95	0.99	1.05	1.10	1.15	1.18
Consumable amount (million ton)	6.25	6.59	6.35	6.63	7.04	7.34	7.70	7.90
Population (million)	13.78	13.84	14.05	14.26	14.47	14.69	14.91	15.13
Domestic consumption (million ton)	3.08	3.09	3.14	3.19	3.23	3.28	3.33	3.38
Paddy for export (million ton)	3.16	3.51	3.32	3.44	3.80	4.06	4.37	4.51
Milled rice for export (million ton)	2.03	2.25	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, the total production of paddy less seed and post-harvest loss will increase by about 26% from 2008 to 2015, while domestic consumption will increase 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 43% from 2008 to 2015. For this, RGC stresses the promotion of paddy production as mentioned above.

AC-1.1.4 Seed Supply

Current predominant rice seed production and supply system in Cambodia is illustrated in Figure AC-1.1.4.1. As shown in the figure, main rice seed production system consists of: (i) production of breeder seed (B/S) by Cambodian Agricultural Research and Development Institute (CARDI); (ii) production of foundation seed (Fo/S) by state farms, CARDI and agricultural experimental station; and (iii) production of certified seed (Ce/S) and commercial seed (Co/S) production by seed producers and seed growers. Because of the limitation of demand for quality seed, however, it could not be assessed that the quality seed production and supply system has been established in the country as a whole. In addition, due to lack of the national seed policy and seed production and certification system, seed inspection and certification is implemented arbitrary by individual seed producers and quality seeds produced are usually called commercial seed.

As indicated in Figure AC-1.1.4.1, major quality seed producers in the country include: (i) CARDI; (ii) state farms and agricultural experimental stations of Department of Agronomy and Agricultural Land Improvement (DAALI) in MAFF; (iii) 4 seed companies established under Agricultural Quality Improvement Project (AQIP); and (iv) seed growers/seed growers groups. In and around the SPPIDRIP Area, Prey Pdao Agricultural Experimental Station in Angk Snuol District to a limited extent, and Super Seed Company in Kandal Province as well as Golden Seed Company in Takeo Province supply certified seeds to dealers, farmers or else. Certified seed production by the Station in 2010 was about

Golden Seed Company (Takeo Province)

20 tons and that of the Company was about 400 tons. Major varieties produced by the Station are IR 66, Sen Pidao and CAR 4 and products are mainly distributed to individual farmers and partly to NGOs and other projects. Major varieties produced by the Company are Pkha Rumduoul, Riang Chey, IR 66 and Sen Pidao and major distribution destinations are seed dealers, NGOs, government projects and individual farmers.

Furthermore, MAFF has proposed 10 promising rice varieties in order to promote paddy production as well as rice export, which is targeted in Policy Paper[4], since the year of 2010. Table AC-1.1.4.1 shows characteristics of major rice varieties including 10 promising varieties.

Predominant seed source of rice is self-multiplied seeds (products of previous season) followed by seeds exchange with other farmers in the SPPIDRIP Area. Further, seed replacement frequency is also low and demand for quality seeds is negligibly low at present.

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

AC-1.2 National and Sectoral Policies Related to the Agricultural Development

AC-1.2.1 Agriculture Strategic Development Plan 2009-2013

The Agricultural Strategic Development Plan (ASDP) 2009-2013 was 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 to the national economic development and accelerate the poverty reduction through enhancement of agricultural productivity as well as diversification and commercialization of agricultural products in due consideration of sound environmental protection and food safety. To achieve these 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: Sustainable forestry resource management. Out of these 5 priority programs, the strategic approach which is closely related to SPPIDRIP is that "more focuses should put on the strengthening and expanding the agricultural extension services by strengthening 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.

4 Policy Paper on the Promotion of Paddy Production and Rice Export, July 2010

AC-1.2.2 Policy Paper and Action Plan for Implementing Policy Paper on the 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. This Policy Paper 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. MAFF has prepared its detail action plan for further implementation to realize the policy measures and actions which are defined in this policy paper.

In order to achieve this policy goal and direction, the "Enhancement of the Productivity", especially focusing on "Rice Intensification" and "Diversification", is considered as the key successful approaches. Aiming to increase rice production, the effectiveness of supporting services and other necessary interventions is regarded as important through agricultural research and technology output transfer coupled with development of the best rice seed varieties which are suitable to weather and soil conditions and especially identification of the important rice seed varieties required by market.

The actions for implementation prepared by MAFF are focused on: (i) measures related to paddy production; (ii) measures related to paddy 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 farmer organizations (FOs), strengthening of capability of farmers and agricultural cooperatives, and efficient use of agricultural land.

AC-1.3 Relevant Organizations

AC-1.3.1 Ministry of Agriculture, Forestry and Fisheries

(1) Organization Structure

The organization structure of MAFF is shown in Figure AC-1.3.1.1. 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. CARDI is placed under the jurisdiction of the Ministry as one of public institutions. The Number of central staff is reported to be 4,269 as of June 2011.

Among the departments of MAFF, the Department of Agriculture Extension supervises each 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 District Agriculture Office (DAO).

(2) Functions

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

- Organize and operate the development policies in agriculture sector 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, monitoring 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 advice to 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 the Mekong Basin in accordance with the rile 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 the Ministry of Economy and finance 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 as follows:

Table AC-1.3.1.1 Summary of Budget and Expenditures of MAFF

Item	2007	2008	2009	2010	2011	2012
Budget (million Riel)	39,274	42,873	48,758	54,779	64,048	87,695
(Thousand US$)*	9,617	10,498	11,939	13,413	15,683	21,473
Actual Expenditure (million Riel)	36,896	49,132	52,257	54,525	57,878	n.a.
(Thousand US$)*	9,034	12,030	12,796	13,351	14,172	n.a.

Note: n.a. : not available
Source: Department of Finance, MAFF
**: US$1=Riel 4,084 (November 2011)*

AC-1.3.2 Provincial Department of Agriculture

(1) Organization and Staffing

PDA is established at each province as sub-ordinate agemcy of MAFF. PDA generally has several technical offices such as agricutural extension, veterinary & animal production, agricultural machinery, agricultural legislation, agro-industry and agronomy & land improvement and administrative offices, subordinating some DAO. The total number of PDA staff including DAO is reported to be 2,834 as June 2011, and that of each PDA including DAO ranges from 100 to 300.

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 Développement Africole Cambodgien (CEDAC) and New Human.

Organization and staffing of the relevant PDAs in Kampong Speu, Kandal, Takeo, and Kampong Chhnang Provinces are shown in the following table as well as in Figures AC-1.3.2.1 to AC-1.3.2.4.

Table AC-1.3.2.1 Organization and Staffing of PDAs

Item	Provincial Department of Agriculture (PDA)			
	Kampong Speu	Kandal	Takeo	Kampong Chhnang
No. of Technical Office	6	6	8	7
No. of planning and administrative offices	2	2	2	1
No. of Districts	8	11	10	8
No. of staff	248	170	192	107

Source) PDA Kampong Speu, 2011, PDA Kandal, 2011, PDA Takeo, 2011, PDA Kampong Chhnang, 2012

The annual budgets of Kampong Speu, Takeo, Kandal, and Kampong Chhnang PDAs are shown as follows:

Table AC-1.3.2.2 Annual Budgets of the Related Provinces

PDA	2007		2008		2009		2010		2011	
	10^6 Riel	10^3US$	10^6 Riel	10^3US$	10^6 Riel	10^3US$	10^6 Riel	10^3US$	10^6 Riel	10^3US$
Kampong Spue	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$=4,084 Riel (November 2011)*
Source: Department of Accounting and Finance, MAFF, 2012

(2) Major Extension Activities of PDA

Based on the Annual Report for 2011/12 of each PDA, annual extension activities conducted by each PDA are shown as follows:

Table AC-1.3.2.3 Extension Activities in the Relevant Provinces (2011)

Activities	Subjects	No(s). of Activities by Provinces			
		Kampong Speu	Kandal	Takeo	Kampong Chhnang
Training	Paddy Production	3	37	2	23
	Vegetable production	3	6		-
	Mushroom production	-	1		-
	Soil improvement	-	-		-
	Integrated Farming System	-	3	158	20
	GAP / IPM /Organic farming	-	-	2	-
	Marketing information	-	-		-
	Livestock raising	20	-		21
	Fish business	-	-		-
	Plant nutrient	-	-		-
	Food processing	-	-		-
	Credit	-	-		-
	Fruit production	-	-		-
	Capacity development	-	6	1	24

Activities	Subjects	No(s). of Activities by Provinces			
		Kampong Speu	Kandal	Takeo	Kampong Chhnang
Demonstration	Paddy production	1	-	2	12
Farmers Field School	Vegetable production	3	5		4

Note: IPM: Integrated Pest Management, GAP: Good Agricultural Practices
Source: Annual Report 2011/12, each PDA

Major extension activities were commonly conducted under certain financial and technical assistance from support agencies such as international organization, donor countries, NGOs, etc. Regarding demonstration activities, PDA and DAO prepare action plan for implementation of demonstration activity as well as training materials such as handout, guideline, etc., depending on the situation of the target area. Those training materials were prepared based on some master textbook, guideline, etc., which are prepared by MAFF.

AC-1.4 Paddy Cultivation in Relevant Provinces

AC-1.4.1 Paddy Production

Current situation of paddy production in 4 provinces based on the latest provincial statistics is shown as follows:

Table AC-1.4.1.1 Area, Unit Yield and Production of Paddy in Kampong Speu Province

No.	District	Rainy Season 2010			Dry Season 2011			Rainy Season 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	Bosedth	22,323	2.67	59,481	91	3.13	285	22,435	3.10	69,547
2	Chba mon	3,126	2.85	8,970	241	3.20	772	3,133	3.26	10,219
3	Kong Pisei	14,948	2.66	39,825	18	3.21	58	15,164	2.87	43,582
4	Oral	5,935	3.12	18,517	0		0	6,084	2.85	17,324
5	Udong	15,522	2.48	38,541	40	3.00	120	16,130	3.13	50,490
6	Phnom srouch	16,040	2.85	45,720	39	3.45	135	16,504	3.22	53,179
7	Samraong Tong	23,484	2.61	61,228	175	3.20	561	25,052	3.18	79,586
8	Tpong	9,581	2.73	26,156	0		0	9,684	3.13	30,342
Total		110,959	2.69	298,437	604	3.19	1,929	114,186	3.10	354,269

Note:
- *Chba Mon, Kong Pisei, and Samaraong Tong Districts are related with RCHRSP*
- *Bosedth District is related with MC35RSP.*

Source: Agricultural Statistics 2010 /11 and 2011/12, Provincial Department of Agriculture, Kampong Speu Province

Table AC-1.4.1.2 Area, Unit Yield and Production of Paddy in Kandal Province

No	District	Rainy Season 2010			Dry Season 2011			Rainy Season 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	Kandal Stung	12,453	2.95	36,794	600	3.60	2,160	10,974	3.01	33,060
2	Kean Svay	930	3.50	3,255	5,964	4.20	25,049	1,582	3.80	6,012
3	Ksach Kandal	6,231	2.68	16,684	5,500	3.60	19,800	2,737	2.57	7,036
4	Koh Tom	2,864	3.29	9,416	14,506	4.25	61,651	3,297	3.73	12,281
5	Laek Duck	1,232	4.15	5,112	4,750	4.30	20,425	1,293	3.96	5,120
6	Lvea Em	739	4.40	3,251	6,653	4.20	27,943	584	4.20	2,453
7	Muk Kompoul	462	4.08	1,885	6,600	4.10	27,060	790	3.90	3,081
8	Sang Snuol	9,276	2.77	25,731	0		0	5,831	2.90	16,918
9	Pongea Loe	4,384	2.78	12,173	6,957	4.29	29,846	3,225	2.91	9,371
10	Saang	5,276	2.85	15,037	10,443	4.25	44,383	4,835	2.97	14,336
11	Ta Kmao	54	2.96	160	17	3.82	65	73	2.55	186
Total		43,901	2.95	129,498	61,990	4.17	258,382	35,221	3.12	109,854

Note:
- *Sang Snuol District is related with RCHRSP.*
- *Kandal Steung District is related with KSBISRSP*
- *Kaoh Thum District is related with SPWRRSP.*

Source Agricultural Statistics 2010 /11 and 2011/12, Provincial Department of Agriculture, Kandal Province

Table AC-1.4.1.3 Area, Unit Yield and Production of Paddy in Takeo Province

No.	District	Rainy Season 2010			Dry Season 2011			Rainy Season 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	5,739	3.74	21,469
2	Bati	20,120	3.16	63,601	2,257	3.90	8,802	20,603	3.25	67,061
3	Bareychulsa	4,942	3.37	16,631	15,870	4.90	77,763	5,324	3.81	20,271
4	Kirivong	27,971	3.23	90,391	10,590	4.60	48,714	25,960	3.53	91,592
5	Kos Ondaet	16,137	3.13	50,476	14,921	4.70	70,129	16,070	3.64	58,472
6	Preykabas	16,847	3.17	53,426	6,310	4.60	29,026	21,146	3.37	71,160
7	Samraong	20,685	3.22	66,625	5,418	4.10	22,214	21,599	3.27	70,711
8	Doun Kaev	3,568	3.32	11,861	3,169	4.20	13,310	3,564	3.37	12,024
9	Tram Kak	39,156	3.32	129,888	35	3.20	112	38,190	3.44	131,336
10	Treang	29,006	3.27	94,976	5,115	4.10	20,972	32,618	3.23	105,249
	Total	183,804	3.24	596,439	80,904	4.59	371,110	190,813	3.40	649,345

Note:
- *Tram Kak District is related with USISRSP.*
- *Bati District is related with KSBISRSP.*

Source: Agricultural Statistics 2010/11 and 2011/12, Provincial Department of Agriculture, Takeo Province

Table AC-1.4.1.4 Area, Unit Yield and Production of Paddy in Kampong Chhnang Province

No.	District	Rainy Season 2010			Dry Season 2011			Rainy Season 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	Boribo	15,693	2.65	41,585	2,190	3.80	8,320	13,593	2.83	38,468
2	Chulkiri	75	2.00	150	8,510	4.05	34,465	15	2.13	32
3	Kompong Chhnang	57	2.11	120	675	4.07	2,750	92	2.30	212
4	Kompongleng	8,380	2.09	17,515	36,402	4.06	14,775	6,495	2.33	15,101
5	Kompong Trolach	14,710	2.77	40,740	6,300	4.00	25,200	13,763	2.92	40,119
6	Rolea pa ear	26,691	2.75	73,400	2,820	4.00	11,280	25,533	2.91	74,301
7	Samaki Mean Chey	17,310	2.70	46,730	0		0	18,030	2.81	50,663
8	Teuk Phos	21,090	2.70	56,832	0		0	22,790	3.15	71,788
	Total	104,006	2.66	277,072	56,897	4.01	96,790	100,311	2.90	290,684

Note:
- *Teuk Phos District is related with DPISRSP.*

Source: Agricultural Statistics 2010/11 and 2011/12, Provincial Department of Agriculture, Kampong Chhnang Province

As shown in the above tables, unit yield of paddy in Takeo Province is the highest, and second highest province is Kandal Province.

AC-1.4.2 Demand and Supply of Paddy at Provincial Level

Current demand and supply of rice in 4 provinces that is Kampong Speu, Kandal, Takeo, and Kampong Chhnang Provinces is shown in Tables AC-1.4.2.1 to 1.4.2.4 and summarized as follows:

Table AC-1.4.2.5 Current Food Balance in the Related 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) (ton)	198,428	212,927	569,646	223,418
Population (person)	775,704	1,383,298	879,328	520,398
Domestic consumption (ton)	110,926	197,811	125,743	74,416
Surplus of milled rice (ton)	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 such as Phnom Penh as well as export to Vietnam or Thailand. Especially, Takeo and Kampong Chhnang Provinces are positioned as granary for Phnom Penh City and other big cities.

AC-1.4.3 Poverty Conditions

Poverty estimates for 3 regions (Phnom Penh City, other urban areas, and rural areas) identify the concentration of the poor in specific locality and help to target development activities as follows:

Table AC-1.4.3.1 Changes in Poverty Rates, 2004 and 2007

Region	Headcount Index (%)		% of All Poor	
	2004	2007	2004	2007
Total poverty line*1				
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*2				
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, 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 AC-1.4.3.2 shows a continuing downward trend in poverty, based on the Commune Data Base (CDB) managed by the National Committee for Sub-national Democratic Development.

Table AC-1.4.3.2 Poverty Rate in the Related Provinces (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
Takeo	31.6	30.7	29.2	28.1	26.8	25.2	23.4
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

As shown in the above table, serious poverty situation is still shown in Kampong Speu and Kampong Chhnang Provinces, while there are no serious situations in other provinces. Furthermore the table also illustrates a continuing downward trend in poverty.

Poverty is defined as the percentage of population with daily per capita consumption below the national poverty line. Poverty line in 2007 was calculated as follows. Furthermore, Achieving Cambodia's Millennium Development Goals 2010, Ministry of Planning, (MOP) shows the updated national poverty line as follows:

Table AC-1.4.3.3 National Poverty Lines by Regions (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)

Region	Category	2004	2007
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

As mentioned in the above table, the average poverty line in rural area for 2007 is 2,367 Riel per capita per day, or about US$ 0.58. Adopting this poverty line, the current situations on poverty status in RCHRSP, USISRSP, and KSBISRSP were confirmed, based on the results by the socio-economic survey, which was conducted by the JICA Survey Team, as describing in AC-2.1.2, AC-2.2.2, and AC-2.3.2.

CHAPTER AC-2 SOUTHWEST PHNOM PENH IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

AC-2.1 Roleang Chrey Headworks Rehabilitation Sub-project

AC-2.1.1 Administrative Situation

RCHRSP is related to 5 districts with 2 provinces as shown in Table AC-2.1.1.1 and summarized as follows:

Table AC-2.1.1.2 List of Related Districts, Communes, and Villages

Province	District	Nos. of Communes	Nos. of village	
			Total	in the area
Kampong Speu	Chbar Mon	5	56	29
	Kong Pisei	4	74	55
	Samraong Tong	9	189	92
	Sub-total	18	319	176
Kandal	Kandal Stueng	3	32	32
	Angk Snuol	8	141	113
	Sub-total	11	173	145
Total	5 Districts	29	492	321

Source: Data base supplied from Population Census 2008, Ministry of Planning

AC-2.1.2 Socio-economic Conditions

AC-2.1.2.1 General

Socio-economic conditions in RCHRSP Area were confirmed through the socio-economic survey (the questionnaire survey to the sample farm households (HHs)), which was done in July and August 2011. This survey aims at clarification of agricultural, social, economic and marketing conditions at farmer level in this area. This survey was carried out, considering the zoning, which was formulated in the M/P Study[5]. Namely RCHRSP Area covers 2 zones such as Zone 1 and Zone 2. The questionnaire survey covered 170 HHs in total, by interviewing 85 HHs each zone.

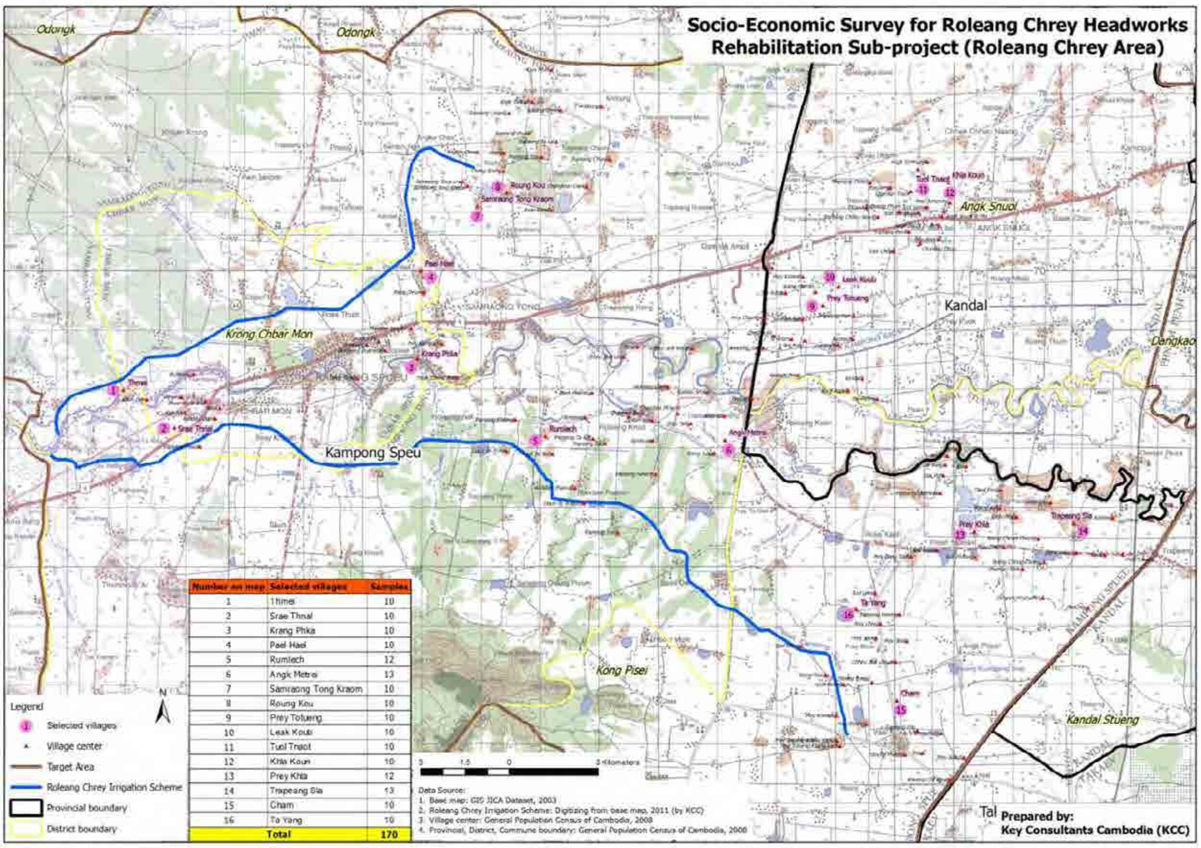
Zonal distribution of sample HHs and the locations of sampled villages for each zone are shown in the following Table AC-2.1.2.1.1 and Figure AC-2.1.2.1.1.

Table AC-2.1.2.1.1 Socio-economic Survey Sample Distribution

Zone	Province	District	Commune	Village	Sample Numbers
Zone 1	Kampong Speu	Chbar Mon	Kandaol Dom	Thmei	10
				Srae Thnal	10
			Sopoar Tep	Krang Phka	10
				Pael Hael	10
		Samroang Tong	Roleang Kreul	Rumlech	12
				Angk Metrei	13
			Samraong Tong	Samraong Tong Kraom	10
				Roung Kou	10
Zone 2	Kandal	Angk Snuol	Lumhach	Prey Totueng	10
				Leak Koub	10
			Peuk	Tuol Tnaot	10
				Khla Koun	10
	Kampong Speu	Kong Pisei	Preah Nipean	Prey Khla	12
				Trapeang Sla	13
			Veal	Cham	10
				Ta Yang	10
				Total	170

Source: JICA Survey Team

5 *Final Report for the Study on Comprehensive Agricultural Development of Prek Thnot River Basin, 2008*



Source: JICA Survey Team

Figure AC-2.1.2.1.1 Locations of Selected Villages for Socio-economic Survey

The following sections show essential results obtained through the socio-economic survey. The remaining data and information are elaborated in Attachment-1 of ANNEX C.

AC-2.1.2.2 Demographic Conditions

General characteristics of farm HHs in RCHRSP are shown below.

Table AC-2.1.2.2.1 General Characteristics of Farm Households

Items	Zone 1	Zone 2	Whole Area
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

In RCHRSP Area, average family size is 5.41 persons per HH for all samples. Meanwhile male-female balance 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 3.88 persons for all samples. Further literacy rate of sampled HH members is 74% for total samples.

AC-2.1.2.3 Living Conditions

(1) Water for Drinking

Source, location, and availability on drinking water are shown as follows:

Table AC-2.1.2.3.1 Source of Drinking Water

Source	Dry Season		Rainy Season	
	Nos.	%	Nos.	%
Tube pile well	27	16	13	7
Dug well	14	8	5	2
Reservoir/ Pond	58	35	5	2
Spring/ River	26	15	7	3
Bought	26	15	3	2
Rain	7	4	131	77
Piped water	12	7	12	7
Total	170	100	170	100

Note: n means number of responses
Source: Socio-economic survey, 2011

Perennial surface water collection is the main source of drinking water in dry season.

Table AC-2.1.2.3.2 Location of Drinking Water

Location	Dry Season		Rainy Season	
	Nos.	%	Nos.	%
Within the premises	58	34	137	81
Near the premises	80	47	28	16
Away from the premises	32	19	5	3
Total	170	100	170	100

Note: n means number of responses
Source: Socio-economic survey, 2011

Existence of surface drinking water is within premises and easy to obtain in the whole area.

Table AC-2.1.2.3.3 Availability of Drinking Water

Availability	Dry Season		Rainy Season	
	Nos.	%	Nos.	%
Easy to obtain	109	64	146	86
Difficult to obtain	45	26	22	13
Very difficult to obtain	16	9	2	1
Total	170	100	170	100

Note: n means number of responses
Source: Socio-economic survey, 2011

Although the water shortage is significantly alleviated due to rainfall, there still remain the HHs facing the difficulty to meet its drinking water consumption level.

(2) Type of Fuel for Cooking

Source of fuel for cooking are shown as follows:

Table AC-2.1.2.3.4 Source of Fuel for Cooking

Source	Zone 1 (%)	Zone 2 (%)	Whole (%)
Firewood	96	94	95
Charcoal	2	1	2
Gas cylinder		1	1
Electricity		3	1
Other	1	1	1
Total	100	100	100

Source: Socio-economic survey, 2011

Furthermore, around 50% of respondents replied it is difficult to get firewood.

(3) Type of Sources for Lighting

Recently most HHs have used battery more than other sources for lighting. Battery not only use for lighting but with many materials by as media of TV, video, and contact within fan for rice cleaning winnower. Sources of lighting are shown as below.

Table AC-2.1.2.3.5 Source of Lighting

Source of Lighting	Zone 1 (%)	Zone 2 (%)	Whole (%)
City power	33	44	38
Generator	7	11	9
Kerosene	5	7	6
Candle		1	1
Battery	53	38	45
Others	2	0	1
Total	100	100	100

Source: Socio-economic survey, 2011

AC-2.1.2.4 Farm Economy

The proportional income volumes from various income sources are calculated for each sources and zones as shown below.

Table AC-2.1.2.4.1 Proportional Income Volumes from Different Sources (Unit: %)

No	Type of Income	Zone 1 (Kampong Speu)	Zone 2 (Kampong Speu)	Zone 2 (Kandal)
1	Selling paddy/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/ hairy 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
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 agricultural income is less than 40% for each zone. It is less than non-agricultural income. "Salary from permanent job" is bearing especially high proportion of zone-wide total income. In addition, data on income and expenditure was processed to work out the daily income and expenditure per capita among sampled HH population.

Table AC-2.1.2.4.2 Daily Income and Expenditure Per-capita of Sampled Population

Income Strata	Average HH Income (US$)	Average HH Expenditure (US$)	Average HH Population (Nos.)	Per Capita Daily Income (US$)	Per Capita Daily Expenditure (US$)
Zone 1 (Kampong Speu)					
1st	2,879	2,280	6.2	1.29	1.02
2nd	1,670	1,314	5.6	0.83	0.65
3rd	1,310	991	5.4	0.67	0.51
4th	920	726	4.4	0.58	0.46
Zone 2 (Kampong Speu)					
1st	2,671	1,829	5.8	1.28	0.88
2nd	1,531	1,370	5.8	0.73	0.66
3rd	1,179	1,053	5.5	0.60	0.53
4th	774	768	4.7	0.45	0.45
Zone 2 (Kandal)					
1st	2,619	2,289	6.7	1.09	0.95
2nd	2,351	1,548	6.2	1.05	0.69
3rd	1,448	1,032	5.1	0.79	0.56
4th	906	681	4.4	0.57	0.43

Source: Socio-economic survey, 2011

In Zone 1, sample HHs were divided into 20 HH intervals, while 10 HH intervals in Zone 2. In this interval, 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 Dollar 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 AC-1.4.3.3, it is judged that 4th strata and 3rd strata fall down below the poverty line provisionally. Accordingly around 50% of farm HHs in the RCHRSP area are supposed to be still under the poverty line.

It is judged that there is some regional difference on living condition as well as agricultural productivity between zones. Regarding per-capita daily expenditure by zones, Zone 1 is higher than Zone2, while Kandal in Zone 2 is also better than Kampong Speu Province in Zone 2.

AC-2.1.2.5 Agricultural Activities

Agricultural situation in the command area of RCHRSP has hardly changed from the previous study time up to now. Therefore, it is judged that the rice 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 with different growth durations of early to late as the same as the previous time. In addition, traditional farming practice adapted to the agro-climatic conditions in the area is another characteristic of the rice production in the area.

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 Present cropping calendar and patterns in the area from the previous study time.

(1) 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 AC-2.1.2.5.1 Farm Land Holding Size of Farm Households

(Unit: ha)

Category	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	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	1.16	0.91	1.03

Source: Socio-economic survey, 2011

(2) Holding Situation of Livestock

Holding situation of livestock, which was obtained through the socio-economic survey, is shown as follows:

Table AC-2.1.2.5.2 Holding of Adult Livestock

Livestock	Zone 1			Zone 2			Whole		
	Respondent		Number of adult	Respondent		Number of adult	Respondent		Number of adult
	No(s).	%	Average	No(s).	%	Average	No(s).	%	Average
Cows / Oxen	60	71	2	69	81	3	129	76	2
Water buffalo	0	0	0	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0	0	0	0
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

AC-2.1.3 Weaknesses of Paddy Production in the Target Area

Through the socio-economic survey, the following constraints are clarified.

Table AC-2.1.3.1 Ranked Constraints on Paddy Cultivation

Subject	Ranked Constraints
(1) Farming Practices	1st rank: Crop damage due to pests and diseases
	2nd rank: Low paddy yield
	3rd rank: Weed problem
(2) Physical Conditions	1st rank: Shortage of irrigation water in the rainy season
	2nd rank: Shortage of irrigation water in the early rainy season
	3rd rank: Drainage problem
(3) Marketing	1st rank: Unstable market price of paddy
	2nd rank: Low market price of paddy
	3rd rank: Low market price of other agricultural commodities
(4) Low Productivity	1st rank: Draught in rainy season
	2nd rank: Water shortage in the early rainy season
	3rd rank: Poor drainage / poor soil / seed quality

Source: Socio-economic Survey

It is proposed that agricultural extension services should be strengthened, in order to improve or minimize the constraints mentioned above.

AC-2.1.4 Examination of Previous Development Plan

In order to make a water balance study and project evaluation for RCHRSP, it is necessary to prepare the agricultural development plan for the relevant command area. A study was therefore made for preparation of the agricultural development plan through review of previous studies, field visit, analysis on the latest data and information collected, interview with PDA staff and some beneficiary farmers. The results of the study are as follows:

(1) Cropping Pattern and Intensity

The M/P Study proposed the following cropping pattern for each zone:

Table AC-2.1.4.1 Proposed Cropping Patterns and Intensity 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, 2008

These cropping patterns and intensity will be applied to this survey because there are no changes on promotion of rice production in national policies and social-conditions in the Roleang Chrey command area since the M/P Study has been conducted. As for the availability of water resources, it was already confirmed through the water balance study in the previous 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 will be employed as they are in this Survey.

(3) Crop Yields

Rainy Season Cropping in RCHRSP

Current unit yields of crops are 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 is 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. 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. Thus, the target unit yield of crops will be determined by referring to these data.

(4) Agricultural Support Service

In the scope of RCHRSP, not only rehabilitation of Roleang Chrey Headworks, but also the rehabilitation of major canals is included. This means that agricultural support services like extension service are essential for improving the agricultural productivity in command area covering by major canals. Thus, agricultural extension services will be included in RCHRSP.

The objective of RCHRSP is to improve agricultural productivity, especially irrigated rice. 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 the South Main Canal. Meanwhile TSC-3 will carry out technical support services including agricultural extension activities up to 2014 in the target area of 222 ha which is located in 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.

AC-2.1.5 Agricultural Development Plan

AC-2.1.5.1 Present and Future Command Area in Roleang Chrey Irrigation System

Roleang Chrey Irrigation System has no plans to expand some irrigation areas. Therefore, there is no difference of the present command area between present and future conditions as follows:

Table AC-2.1.5.1.1 Command Area in Roleang Chrey Irrigation System (Unit: ha)

Zone	Command Area		Paddy Field	
			Present	With Project
Zone-1	IAIMP*	Irrigated Agriculture Improvement Model Project Area	580	570**
	UNMC	Upper North Main Canal Irrigated Agriculture Improvement Project	2,230	2,230
	USMC	Upper South Main Canal Irrigated Agriculture Improvement Project	2,900	2,900
Zone-2	LNMC	Lower North Main Canal Irrigated Agriculture Improvement Project	1,400	1,400
	LSMC	Lower South Main Canal Irrigated Agriculture Improvement Project	6,880	6,880
	OKAI	Ou Krang Ambel Irrigated Agriculture Improvement Project	2,930	2,930
Total			16,920	16,910

Note:
**: IAIMP is called as Roleang Chrey Headworks Rehabilitation Sub-project (RCHRSP).*
***: 10 ha of right of way for on-farm development is considered.*
Source: JICA Survey Team,

AC-2.1.5.2 Present Cultivated Area of Major Crops

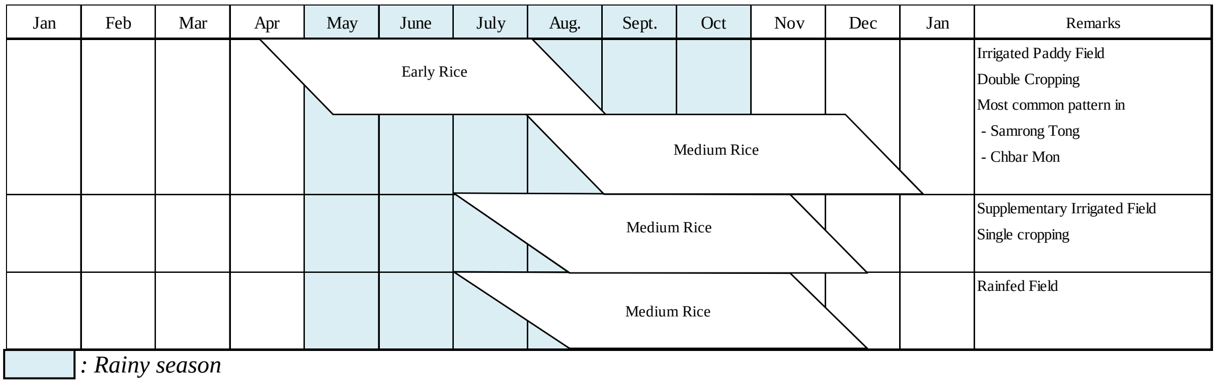
Present cultivated area of major crops in the command area is shown as follows:

Table AC-2.1.5.2.1 Present Cultivated Area of Major Crops (Unit: ha)

Crops	Zone 1			Zone 2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
(1) Paddy							
(a) Early Rainy Season							
- Early rice	200	220	150	70	340	150	1,130
(b) Rainy Season							
- Early rice	0	0	0	0	0	0	0
- Medium rice (irrigated)	580	1,560	1,860	550	3,440	1,160	9,150
- Medium variety (rainfed)	0	670	1,040	850	3,440	1,770	7,080
(2) Upland crops and Vegetables	0	20	10	10	80	20	140
(3) Total Cultivated Area	780	2,470	3,060	1,480	7,300	3,100	17,500
(4) Physical Area	580	2,230	2,900	1,400	6,880	2,930	16,920
(5) Cropping intensity (%)	135	111	106	106	106	106	103

Note: refer Table AC-2.1.5.1.1 on full name of 6 command area.
Source: JICA Survey Team,

Current cropping pattern of major crops is shown as follows:



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

Figure AC-2.1.5.2.1 Present Cropping Pattern

AC-2.1.5.3 Cultivated Area of Paddy with Malfunctioned Regulator

It is adequately anticipated that Roleang Chrey Regulator cease to function properly before long if no rehabilitation is carried out soon. Therefore the present irrigated area mentioned in Table AC-2.1.5.3.1 would become rainfed area totally, as shown below:

Table AC-2.1.5.3.1 Cultivation Area with Malfunctioned Regulator (Unit: ha)

Crops	Zone 1			Zone 2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
(1) Paddy							
(a) Early Rainy Season							
-Early rice	0	0	0	0	0	0	0
(b) Rainy Season							
-Early rice	0	0	0	0	0	0	0
-Medium rice (irrigated)	0	0	0	0	0	0	0
-Medium rice (rainfed)	580	2,230	2,900	1,400	6,880	2,930	16,920
(2) Upland crops and Vegetables	0	20	10	10	80	20	140
(3) Total Cultivated Area	580	2,250	2,910	1,410	6,960	2,950	17,060
(4) Physical Area	580	2,230	2,900	1,400	6,880	2,930	16,920
(5) Cropping intensity (%)	100	101	100	101	106	106	103

Source: JICA Survey Team,

AC-2.1.5.4 Cultivated Area of Paddy after Rehabilitation of the Regulator

After rehabilitation of the intake (regulator), it is envisaged that the irrigation condition should be come back to the present one, and thus agricultural situation could be recovered up to the current one, as shown as follows:

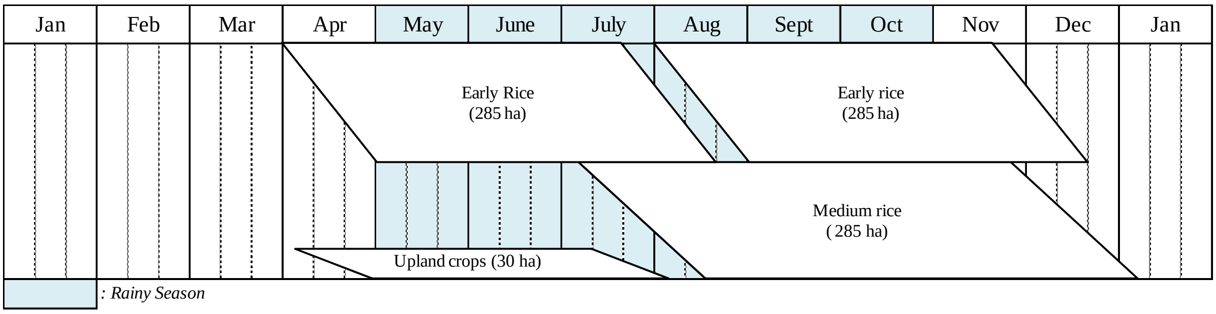
Table AC-2.1.5.4.1 Cultivated Area of Major Crops under the With-project Condition

(Unit: ha)

Crops	Zone 1			Zone 2			Total
	IAIMP*	UNMC	USMC	LNMC	LSMC	OKAI	
(1) Paddy	855	2,450	3,050	1,470	6,530	3,080	18,125
(a) Early Rainy Season							
- Early rice	285	220	150	70	340	150	1,215
(b) Rainy Season							
- Early rice	285	0	0	0	0	0	285
- Medium rice (irrigated)	285	1,560	1,860	550	3,440	1,160	8,855
- Medium rice (rainfed)	0	670	1,040	850	3,440	1,770	7,770
(2) Upland crops and Vegetables	30	20	10	10	80	20	170
(3) Total Cultivated Area	885	2,470	3,060	1,480	6,610	3,100	18,295
(4) Physical Area	580	2,230	2,900	1,400	6,880	2,930	16,920
(5) Cropping intensity (%)	155	111	106	106	96	106	108

*Note: * It is envisaged that on-farm development be carried out in IAIMP area.*
Source: JICA Survey Team,

Furthermore, it is planned that on-farm development in IAIMP be implemented as the Model Area, and software component activities be arranged for improvement of productivity of paddy. Therefore it is expected that the following double cropping could be applied.



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 AC-2.1.5.4.1 Proposed Cropping Pattern for IAIMP

AC-2.1.5.5 Farming Practices and Input Requirement for Major Crops

Through field survey, present and proposed farming practices as well as farm input requirement were reviewed. In principle, it is not necessary to change major practices as well as major requirement, although minor adjustment on input requirement was done. Present and proposed updated crop budgets for majors are shown in Tables AC-2.1.5.5.1 and AC-2.1.5.5.2.

AC-2.1.5.6 Crop Production under Present and With-project Conditions

Current yield levels as well as target yield of paddy in each category of paddy field in RCHRSP Area were set, based on the statistical data, the results of the socio-economic survey, etc., as shown in Table AC-2.1.5.6.1. Present yield of paddy by command areas is shown as follows:

Table AC-2.1.5.6.2 Present Unit Yield of Paddy with the Functioned Intake (Unit: kg/ha)

Crops	Zone 1			Zone 2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
(1) Early Rainy Season						
-Early rice (HVY)	2,790	2,790	2,790	2,790	2,790	2,790
(2) Rainy Season						
-Medium rice (irrigated)	2,310	2,310	2,310	2,310	2,310	2,310
-Medium rice (rainfed)	-	2,120	2,120	2,120	2,120	2,120

Source: JICA Survey Team,

In the case that the intake will be in mal-function before long, it is assumed that all paddy cultivation shall be carried out under rainfed condition, applying medium variety as well as current yield for rainfed paddy as shown below:

Table AC-2.1.5.6.3 Unit Yield of Paddy with the Malfunctioned Intake (Unit: kg/ha)

Crops	Zone 1			Zone 2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
(1) Early Rainy Season						
-Early rice (HVY)	-	-	-	-	-	-
(2) Rainy Season						
-Medium rice (irrigated)		-	-	-	-	-
-Medium rice (rainfed)	2,120	2,120	2,120	2,120	2,120	2,120

Source: JICA Survey Team,

Furthermore, in the future, on-farm facility including drainage system in IAIMP could be developed, and establishment of FWUC as well as implementation of agricultural extension services is arranged only for IAIMP as the model area, therefore, it is expected that paddy yield under irrigated condition be improved as follows:

Table AC-2.1.5.6.4 Unit Yield of Paddy after Rehabilitation of the Intake (Unit: kg/ha)

Crops	Zone 1			Zone 2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
(1) Early Rainy Season						
-Early rice	4,000	2,790	2,790	2,790	2,790	2,790
(2) Rainy Season						
-Early rice	4,000	-	-	-	-	-
-Medium rice (irrigated)	3,500	2,310	2,310	2,310	2,310	2,310
-Medium rice (rainfed)	-	2,120	2,120	2,120	2,120	2,120

Source: JICA Survey Team,

Based on the assumption on unit yield mentioned above, current and target productions in RCHRSP are shown in Table AC-2.1.5.6.5, and summarized as follows:

Table AC-2.1.5.6.6 Paddy Production after Rehabilitation of the Intake (Unit: ton)

Crops	Zone 1			Zone 2			Total
	IAIMP	UNMC	USMC	OKAI	OKAI	LSMC	
(1) Early Rainy Season	-	-	-	-	-	-	-
-Early rice	1,140	610	420	200	950	420	3,740
(2) Rainy Season							
-Early rice	1,140	-	-	-	-	-	1,140
-Medium rice (irrigated)	1,000	3,600	4,300	1,270	7,950	2,680	20.800
-Medium rice (rainfed)	-	1,420	2,210	1,800	7,290	3,750	16,470
Total	3,280	5,630	6,930	3,270	16,190	6,850	42,150

Source: JICA Survey Team,

AC-2.1.6 Strengthening of Agricultural Extension Services

AC-2.1.6.1 Basic Approach

Basic approaches for strengthening of agricultural extension services were formulated in the M/P Study (2007), and reviewed in the Survey (2011).

The strengthening of agricultural extension services is applied only for the area of IAIMP. It is planned that on-farm development should be conducted in the area, and hence it is strongly proposed that farmers should be trained in order to improve their skills on paddy cultivation, and promote crop diversification. Furthermore, through training programs, it is expected that skills on water management as well as maintenance of irrigation facilities be transferred to famers.

Meanwhile, it is judged that staffs of DAO and PDA have some experience and knowledge for implementation of extension activities. However, it is highly necessary to obtain more experience and knowledge, in order to formulate annual action plan for extension services, and carry out extension activities more effectively and smoothly.

AC-2.1.6.2 Development Strategies and Scope of Intervention

(1) Development Strategies

The development strategies are specified as follows;

(i) In principle, constraints on paddy production, which are specified in Section AC-2.1.3, should be improved or minimized through extension activities, in order to increase rice production and income;

(ii) Intensive introduction of agricultural extension services is to be envisioned with the aim of attaining the project target at an early stage as possible; and

(iii) Extension service should be carried out effectively and smoothly, applying an annual cycle of “Plan – Do – Check – Act”. Activities of each component in this cycle are indicated as follows:

- Plan: Annual action plan of extension service should be formulated, considering the constraints as well as proposed activities as shown in the following table.

Table AC-2.1.6.2.1 Constraints on Paddy Cultivation and Proposed Extension Services in RCHRSP

Subject	Constraints	Proposed Activities of Extension Services	
		Subjects	Ways to be required
(a) Farming Practices	1) Crop damage due to pests and diseases	- Introduction of IPM	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour
	2) Low paddy yield	- Proposed farming practices - Introduction of quality seeds	
	3) Weed problem	- Introduction of IPM	
(b) Water management	1) Shortage of irrigation water	- Rehabilitation of irrigation facilities - Improvement of water management	- Rehabilitation work - Training for water management
	2) Drainage problem	- Rehabilitation of drainage facilities	
(c) Marketing	1) Unstable and low market price of crops	- Selection of profitable varieties - Selection of other profitable crops - Adjustment of harvesting season - Shipping control - Strengthening bargaining power of famers	- Lecture (short training) - Mass guidance / workshop

Source: JICA Survey Team

Targets of each extension activity as well as annual plan are obviously required. Further, in order to carry out extension services, extension materials such as guideline, handouts, etc. are highly required. Those materials should be prepared by extension staff of PDA and DAO, referring the existing materials[6], which were prepared by the central government or other supporting organizations such as international organizations, donors, NGOs, etc.;

- Do: Extension services should be implemented based on the plan mentioned above;
- Check: Extension activities should be measured, and thus those results could be compared with the targets shown in the "Plan". Some differences could be analyzed to clarify those root causes. Major points for this checking are shown as follows:
  - Adaptability of extension service plan;
  - Management on implementation of extension activities;
  - Progress on the extension service activities;
  - Results of the extension service activities; and
- Act: Based on the results in the checking mentioned above, scope as well as target for the next extension activities could be refined.

(2) Scope of the Intervention

The plan is formulated for the period of 4 years from 2017 to 2020, aiming at improvement of farmers' skills as well as experience through strengthening agricultural extension services. Such services should be provided by extension staff of PDA and DAO through the Project Implementation Unit. The envisioned major activities under the plan include: (i) field programs and farmer/farmer group training programs aiming at improvement of farmers' capability and skills on irrigated agriculture farming practices and water management; and (ii) empowerment and motivation of farmers including village extension workers (VEWs). Further, it is required that skills and experience of extension staff be strengthened by intervention of national consultant as well as foreign consultant.

6 Refer Attachment 5 of ANNEX C

AC-2.1.6.3 Strengthening Plan of Agricultural Extension Services

(1) Proposed Agricultural Extension Services

Agricultural extension services required for the promotion of adoption of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage are as shown in the following table.

Table AC-2.1.6.3.1 Proposed Agricultural Extension Services

Activities	Program to be Required	Subjects
Training of Trainers	Capacity building	- Preparation of action plan - Monitoring and evaluation of extension work
Field Programs	Demonstration with proposed farming practices	- Paddy cultivation - Upland crops cultivation - Vegetables cultivation
	Water management for paddy cultivation	- Gate control - Water control in field - Operation and maintenance
Farmer/ Farmer Group Training Programs	Training course (2-day course)	Following subjects to be arranged, according to requirement of farmers - Major topics: - How to identify insects or diseases - Introduction of proper agro-chemicals - Timing of fertilizer application - Market information - Cooperative activity
	Farmer field school for paddy cultivation	- Major farming practices should be covered. - Integrated pest management (IPM) activities should be proposed. - Skills for seed multiplication by farmers should be disseminated.
	Study tour to visit advanced area and/or farmers	Following subjects to be arranged, according to requirement of farmers - Paddy cultivation - Vegetable cultivation - Cooperatives management
Mass Guidance/ Workshop	Mass guidance/workshop	Following subjects to be arranged, according to requirement of farmers - Dialogue among farmers, extension staff, and researchers - Water management - IPM - Book keeping - Recording daily farming practices - Cooperative work

Source: JICA Survey Team

Logical matrix of major activities on extension services are shown in Table AC-2.1.6.3.2 and framework of extension services are shown as follows:

Table AC-2.1.6.3.3 Framework of Agricultural Extension Services

Activities	Size	Times per group	Frequency
(a) Training of Trainers	10 staff	1 time	4 times per 4 years (once a year)
(b) Field Programs			
1) Demonstration Plots (irrigated)			
- Paddy cultivation	0.1 to 0.2 ha	3 plots per FWUG	- 9 plots/ 3 FWUGs/ 3years - 3 plots/year
- Upland crops cultivation	0.1 ha	1 plot per FWUG	- 3 plots/ 3 FWUGs/ year - 3 plots/ year
- Vegetable cultivation	0.1 ha	1 plot per FWUG	- 3 plots/ 3 FWUGs/ year - 3 plots/ year
2) Water management			
- Paddy cultivation	One tertiary block	2 times per FWUG	- 6 times / 3 FWUGs/ year - 6 times /year
(c) Farmer/Farmer Group Training Programs			
1) Training course	2-day course	1 time per FWUG	- 3 times/ 3FWUG/ year - 3 times/ year

Activities	Size	Times per group	Frequency
2) FFS/ IPM	30 participants	1 time per FWUG	- 3 times/ 3FWUG/ year - 3 times/ year
3) Study tour	30 participants	1 time per FWUG	- 3 times/ 3 FWUGs/ year - 3 times / year
(d) Mass Guidance/Workshop	30 participants	2 time per FWUG	- 6 times / 3 FWUGs/ 2 year - 3 times / year

Note: around 200 ha for one FWUG, around 3 FWUGs in RCHRSP
Source: JICA Survey Team

(2) Assignment of Foreign and National Consultants

Foreign consultant in collaboration with national consultant conducts preparatory work before implementation of training of trainers and training of farmers. Namely, those consultants prepare guidelines on preparation of annual action plan as well as checking and analysis for work progress of training of farmers. Those guidelines are used in training of trainers for extension staff of PDA and DAO. Therefore, extension staff could arrange extension materials such as hand-outs as well as any other materials for farmers.

As shown in the following table, it is proposed that preparatory work and training of trainers be carried out as task work of foreign consultant as well as national consultant. Meanwhile regarding training of farmers, national consultant has to support training of farmers to be carried out by extension staff of PDA and DAO, as assistant work. Further, national consultant checks and analyzes work progress and performance on training of farmers, and propose some actions as well as attentions for training activities in the following season as task work.

Table AC-2.1.6.3.4 Matrix on Task and Assistant Work of Foreign and National Consultants

Activities	Foreign Consultant		National Consultant	
	Task Work	Assistant Work	Task Work	Assistant Work
(a) Preparatory work				
1) Preparation of guideline for annual action plan	○	-	○	-
2) Preparation of guideline for monitoring and evaluation of extension activities	○	-	-	-
(b) Training of Trainers				
1) Preparation of annual action plan	○	-	○	-
2) Preparation of hand outs and other materials to be required	○	-	○	-
3) Preparation of guideline for monitoring and evaluation of extension activities	○	-	○	-
(c) Training of Farmers				
1) Field programs	-	-	-	○
2) Farmer/Farmer Group Training Programs	-	-	-	○
3) Mass guidance / Workshop: 12 courses	-	-	-	○
4) Field programs	-	-	-	○
(d) Periodical checking and analysis on work progress and performance of extension activities to be carried out by extension staff of PDA and DAO	-	-	○	-

Note: ○: responsible work of consultants
Source: JICA Survey Team

Assignment periods of foreign and national consultants are proposed as follows:

Table AC-2.1.6.3.5 Assignment Period of Consultants to be Required for RCHRSP

(Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
(a) Preparatory work	0.1	0.06	-	0.06	-	0.06	-	0.06	0.1	0.24
(b) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
(c) Training of farmers	-	0.3	-	0.3	-	0.6	-	-	-	1.2
(d) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
Total	0.3	0.86	-	0.86	-	1.16	-	0.56	0.3	3.44

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(3) Proposed Budgets of Extension Activities

Furthermore, budgets for each extension activity are shown in Table AC-2.1.6.3.6. Implementation and cost schedule of the proposed agricultural extension services strengthening plan was prepared based on the above conditions as well as budgets, as shown in Table AC-2.1.6.3.7, thus summarized as follows:

Table AC-2.1.6.3.8 Estimated Direct Costs for Agricultural Extension Services in RCHRSP

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
(a) Training of Trainers	520	520	520	520	2,080
(b) Field Programs					
1) Demonstration Plots (irrigated)					
- Paddy cultivation	2,760	2,760	2,760	0	8,280
- Upland crops cultivation	0	0	2,700	0	2,700
- Vegetable cultivation	0	0	2,730	0	2,730
2)Water management					
- Paddy cultivation	0	9,660	0	0	9,660
(c) Farmer/Farmer Group Training Programs					
1) Training course	1,230	0	0	0	1,230
2) FFS/ IPM	0	4,740	0	0	4,740
3) Study tour	0	1,290	0	0	1,290
(d) Mass Guidance/Workshop	780	780	0	0	1,560
Total	5,290	19,750	8,710	520	34,270

Source: JICA Survey Team

The total estimated direct costs for the services are about US$34,270.

AC-2.2 Upper Slakou Irrigation System Rehabilitation Sub-project

AC-2.2.1 Administrative Situation

Tram Kak District of Takeo Province is related with USISRSP as shown in Table AC-2.2.1.1 and summarized as follows:

Table AC-2.2.1.2 List of Related District, Communes, and Villages

Province	District	Commune	No. of village	
			Total	in the area
Takeo	Tram Kak	1 Cheang Tong	16	11
		2 Ou Saray	12	3
		3 Ta Phem	23	5
		4 Trapeang Thum Khang Cheung	11	7
Total	1 District	4 Communes	62	26

Source: Data base supplied from Population Census 2008, Ministry of Planning

AC-2.2.2 Socio-economic Conditions

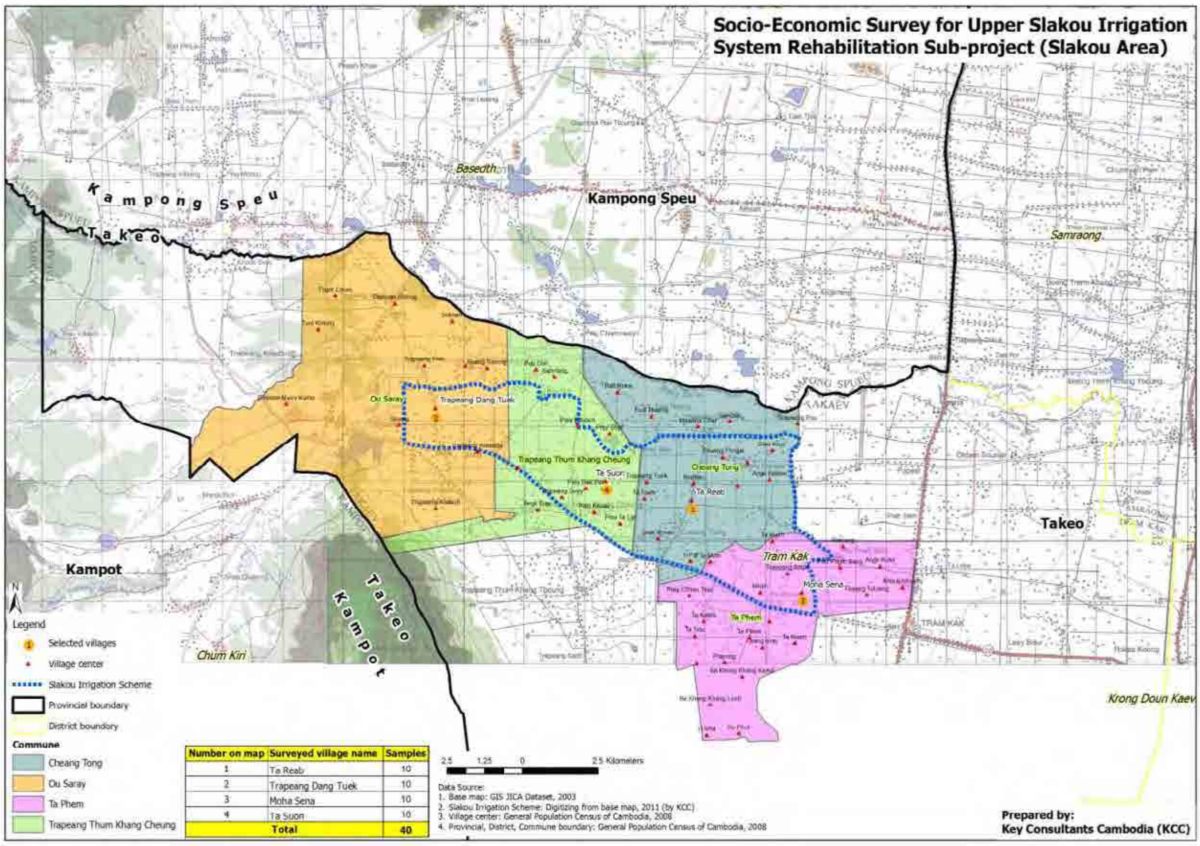
AC-2.2.2.1 General

Socio-economic conditions in USISRSP Area were confirmed through the socio-economic survey (the questionnaire survey to the sample farm HHs), which was done in July and August 2011.The questionnaire survey covered 40 HHs in total. Sampled villages and distribution of sample HHs by villages are shown in the following table and figure.

Table AC-2.2.2.1.1 Socio-economic Survey Sample Distribution

Province	District	Commune	Village	Sample Number
Takeo	Tram Kak	Cheang Tong	Ta Reab	10
		Ou Saray	Trapeang Dang Tuek	10
		Ta Phem	Moha Sena	10
		Trapeang Thum Khang Cheung	Ta Suon	10
Total				40

Source: JICA Survey Team



Source: JICA Survey Team

Figure AC-2.2.2.1.1 Location of Selected Villages for Socio-economic Survey

The following sections show essential results obtained through the socio-economic survey. The remaining data and information are given in Attachment-2 of ANNEX C.

AC-2.2.2.2 Demographic Conditions

- 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.
- Family member	Average family member is 5.33 persons per HH for all samples in USISRSP.
- Male-Female balance	Male-female balance of the sampled HH members are male 51% and female 49% for the average of all samples
- Age composition	An outstanding feature of HH members' age composition in the survey area is that the proportion of 11 to 20 years age groups is prominent (23%) compared to other age groups.
- Education / Literacy	More than 80% of population has received education more than primary school level. Literacy rate is over 80%.

AC-2.2.2.3 Living Conditions

(1) Water for Drinking

Source, location, and availability on drinking water are shown as follows:

Table AC-2.2.2.3.1 Source of Drinking Water

Source	Dry Season		Rainy Season	
	No(s).	%	No(s).	%
Tube pile well	10	25	7	17.5
Dug well	27	67.5	16	40
Reservoir/ Pond	1	2.5	1	2.5
Spring/ River	1	2.5	16	40
Bought	-	-	-	-
Rain	1	2.5	7	17.5
Piped water	-	-	-	-
Total	40	40	40	40

Note: n means number of responses
Source: Socio-economic survey conducted by JICA Survey Team, 2011

In this area, tube pipe well as well as dug well is common during the period dry season.

Table AC-2.2.2.3.2 Location of Drinking Water

Location	Dry Season		Rainy Season	
	Nos.	%	Nos.	%
Within the premises	16	40	27	68
Near the premises	16	40	9	22
Away from the premises	8	20	4	10
Total	40	100	40	100

Note: n means number of responses
Source: Socio-economic survey conducted by JICA Survey Team, 2011

Existence of surface drinking water is within premises and relatively easy to obtain in the whole area.

Table AC-2.2.2.3.3 Availability of Drinking Water

Availability	Dry Season		Rainy Season	
	Nos.	%	Nos.	%
Easy to obtain	21	52	28	70
Difficult to obtain	12	30	10	25
Very difficult to obtain	7	18	2	5
Total	40	100	40	100

Note: n means number of responses
Source: Socio-economic survey conducted by JICA Survey Team, 2011

Although the water shortage is significantly alleviated due to rainfall, there still remain the HHs facing difficulty to meet its drinking water consumption level.

(2) Type of Fuel for Cooking

Source and availability of fuel for cooking are shown as follows:

Table AC-2.2.2.3.4 Source and Availability of Fuel for Cooking

Source			Availability		
Items	No(s). of Respondents	%	Items	Nos. of Respondents	%
Firewood	38	95	Easy to obtain	17	43
Gas cylinder (LPG)	1	2	Difficult to obtain	18	45
Other	1	3	Very difficult to obtain	5	12
Total	40	100	Total	40	100

Source: Socio-economic survey conducted by JICA Survey Team, 2011

Furthermore, around 50% of respondents replied it was difficult to get firewood.

(3) Type of Sources for Lighting

Recently most HHs have used battery more than other sources for lighting. Battery not only use for lighting but with many materials by as media of TV, video, and contact within fan for rice cleaning winnower. Sources of lighting are shown as below.

Table AC-2.2.2.3.5 Source and Availability of Lighting

Source			Availability		
Item	**Nos. of Respondents**	**%**	**Item**	**No(s). of Respondents**	**%**
Kerosene	5	12	Easy to obtain	29	73
Battery	33	83	Difficult to obtain	10	25
Other	2	5	Very difficult to obtain	1	2
Total	40	100	Total	40	100

Source: Socio-economic survey conducted by JICA Survey Team, 2011

AC-2.2.2.4 Farm Economy

The proportional income volumes from various income sources are calculated for each source shown below.

Table AC-2.2.2.4.1 Proportional Income Volumes from Different Sources

No	Type of Income	Proportion (%)
1	Selling paddy/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 conducted by JICA Survey Team, 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 paddy 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 AC-2.2.2.4.2 Daily Income and Expenditure Per Capita of Sampled Population

Income Strata	Average HH Income (US$)	Average HH Expenditure (US$)	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	1020	6.5	0.46	0.44
4th	662	611	4.2	0.44	0.40

Source: Socio-economic survey conducted by JICA Survey Team, 2011

In the above table, sample HHs were divided into 10 HH intervals. In this interval, 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 Dollar with the current effective exchange rate that is US$ 1 = Riel 4,084 in November 2011.

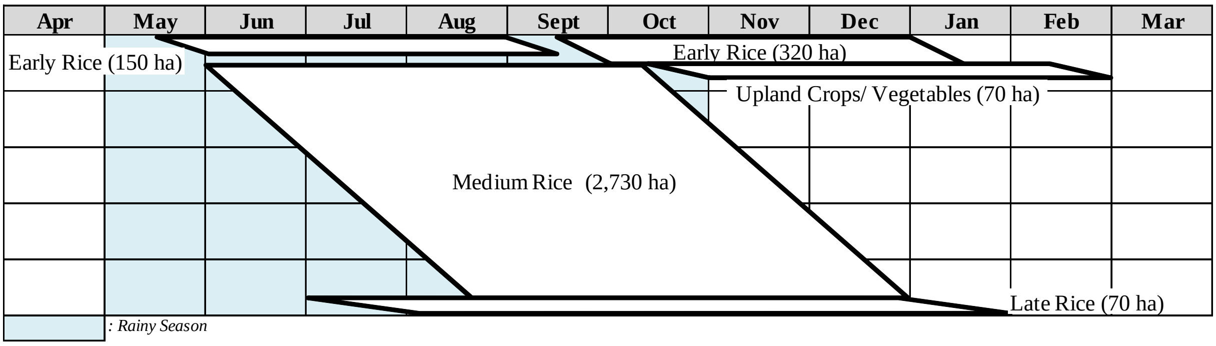
Applying the poverty line (equal to per capita daily expenditure of US$ 0.58, setting for Cambodia rural area by the Achieving Cambodia's Millennium Development Goals 2010) shown in Table AC-1.4.3.3, it is judged that 4th strata and 3rd strata fall below the poverty line. Accordingly around 50% of farm HHs in the USISRSP Area are supposed to be still under the poverty line.

AC-2.2.2.5 Agricultural Activities

(1) Paddy Production

Beneficiary's House

Paddy is a major crop in the sub-project area. Diversified crops are minor 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 those crops were planted less than several percents of their farmland. In a part of paddy field, double cropping paddy combined with early maturing varieties of HYVs is undertaken since irrigation water becomes available by rehabilitation of the 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. Present cropping pattern is shown as follows:



Source: JICA Survey Team

Figure AC-2.2.2.5.1 Present Cropping Pattern for USISRSP

(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 AC-2.2.2.5.1 Farm Land Holding Size of Average Farm Household (Unit: ha)

Land Holding (Land Owned) (ha)								Land Holding Land Use (Land Operated/) (ha)							
Paddy Field								Paddy Field							
Irrigated paddy field	supplementary Irrigated paddy field	Irrigated field Total	Rainfed paddy field	Total 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	Upland for field crop	Upland for field crop	Total Farm Land
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 conducted by JICA Survey Team, 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 field has been fallow without any activities.

(3) Holding Situation of Livestock

Holding situation of livestock, which was obtained through the socio-economic survey, is tabulated below:

Table AC-2.2.2.5.2 Holding of Livestock

Livestock	Adult			Young		
	Respondent		Average (heads)	Respondent		Average (heads)
	No(s).	%		No(s).	%	
Cows / Oxen	39	40	2	18	40	1
Water buffalo	1	1	2	0	-	0
Goat / Sheep	0	-	0	0	-	0
Swine	12	12	3	0	-	0
Chicken	34	35	23	24	53	28
Duck	12	12	8	3	7	10

Note: n means number of responses
Source: Socio-economic survey conducted by JICA Survey Team, 2011

AC-2.2.3 Weaknesses of Paddy Production in the Target Area

Through the socio-economic survey, the following constraints come out.

Table AC-2.2.3.1 Ranked Constraints on Paddy Cultivation

Subject	Ranked Constraints
(1) Farming Practices	1st rank: Crop damage due to pests and diseases
	2nd rank: Weed problem
	3rd rank: Low paddy yield
(2) Physical Conditions	1st rank: Shortage of irrigation water in the rainy season
	2nd rank: Shortage of irrigation water in the early rainy season
	3rd rank: Drainage problem
(3) Marketing	1st rank: Unstable market price of paddy
	2nd rank: Limitation of market of paddy
	3rd rank: Low market price of other agricultural commodities
(4) Low Productivity	1st rank: Draught in the rainy season
	2nd rank: Water shortage in the early rainy season
	3rd rank: Poor drainage / poor soil / seed quality

Source: Socio-economic survey conducted by JICA Survey Team, 2011

It is proposed that agricultural extension services should be strengthened, in order to improve or minimize the constraints mentioned above.

AC-2.2.4 Examination of Previous Development Plan

(1) Agricultural Development

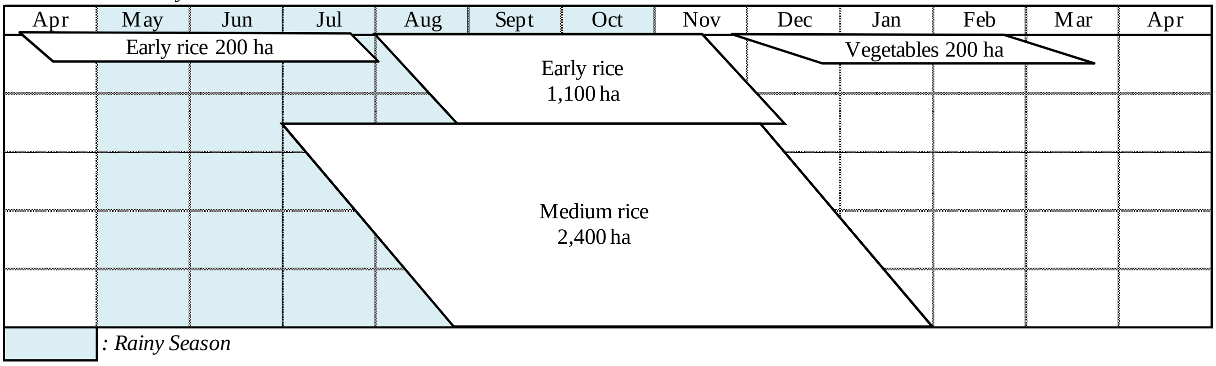
The agricultural development plan proposed in F/S 2002 was reviewed through the site visit, analysis on collected latest data and information, discussion with PDA staff, to determine the water demand for water balance study and to contribute to preparation of the appropriate scope of USISRSP for appraisal on application of Japan's loan. The review results are given in the following table:

Table AC-2.2.4.1 Review on Agricultural Development Plan

Item	F/S	Review in 2011
(a) 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 AC-2.2.2.5.1. Taking into consideration of current cropping pattern, the double cropping of paddy is proposed as shown in Figure AC-2.2.4.1.

Item	F/S	Review in 2011
(b) Farming Practices	3 to 4 times of the current fertilizer application volume at the F/S Time are proposed. In addition, improved seed of paddy for both local varieties and HYVs is proposed to be produced 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.
(c) 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.	These target yields of paddy proposed in F/S should be re-estimated based on the current statistic data and also by referring to the results of Verification Study executed in the Study on Comprehensive Agricultural Development of Prek Thnot River Basin.

Source: JICA Survey Team modified, based on the pattern prepared in the F/S 2002
JICA Survey Team



Source: Upper Slakou River Irrigation Reconstruction Plan (F/S) (2002)
JICA Survey Team

Figure AC-2.2.4.1 Proposed Cropping Pattern for USISRSP

(2) 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 the subjects proposed in F/S focusing on the extension services. The results of review are mentioned in Table AC-2.2.4.2.

Paddy Cultivation in the Project Area

Table AC-2.2.4.2 Review on Agricultural Extension Services

Item	F/S	Review in 2011
(a) 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.
(b) 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: - All FGs should produce benefit for members of FGs. - Member fee of FGs should be minimized.	The proposal on formation of FGs in F/S should be taken into consideration. Basically, it is proposed that FGs be members of FWUC. This subject is discussed in ANNEX E.

Item	F/S	Review in 2011
	- Well-organized and -operated VDC's know-how should be utilized. - Training should be provided to members of FGs in order to create a sense of solidarity and mutual aid, and avoid violation of rules. - Management persons of FGs should get a reasonable allowance in proportion to the profits of their FG activity.	
(c) 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. Regarding rice production, MAFF has promoted rice production, and proposed to use the recommendable 10 varieties to each province In principle, the system of seed production and seed distribution should be managed by MAFF in cooperation with CARDI and 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.
(d) 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

AC-2.2.5 Agricultural Development Plan

AC-2.2.5.1 Present and Future Command Area

In the development plan, the area will be fully developed as shown in the below table.

Table AC-2.2.5.1.1 Cultivated Area under Present and With-project Conditions

(Unit: ha)

Category	Present / Without-project	With-project	Increment
(1) Paddy	3,270	3,700	430
(a) Early Rainy Season			
- Early rice	150	200	50
(b) Rainy Season			
- Early rice	320	1,100	780
- Medium rice (irrigated)	0	2,400	2,400
- Medium rice (rainfed)	2,730	0	-2,730
- Late rice (rainfed)	70		-70
(2) Upland Crops and Vegetables	70	200	130
(3) Total Cultivated Area	3,340	3,900	560
(4) Fallow Land	380	0	-380
(5) Physical Area	3,500	3,500	0
(6) Cropping Intensity (%)	95	111	16

Source: JICA Survey Team,

AC-2.2.5.2 Farming Practices and Input Requirement for Major Crops

Through the Survey, present and proposed farming practices as well as farm input requirement were reviewed. In principle, it is not necessary to change major practices as well as major requirement, although minor adjustment on input requirement was done. Present and proposed updated crop budgets for majors are shown in Tables AC-2.2.5.2.1 and AC-2.2.5.2.2.

AC-2.2.5.3 Crop Production under Present and With-project Conditions

Current and proposed yield levels as well as target yield of paddy in each category of paddy field in the USISRSP Area were set up, based on the statistical data, the results of the socio-economic survey, etc., as shown in Table AC-2.2.5.3.1, and summarized as follows:

Table AC-2.2.5.3.2 Present and Proposed Unit Yield of Paddy (Unit: ton/ha)

Category	Present / Without-project *1	With-project *2
(1) Early Rainy Season		
- Early rice	2.13	4.00
(2) Rainy Season		
- Early rice	2.13	4.00
- Medium rice (irrigated)	-	3.50
- Medium rice (rainfed)	2.09	-
- Late rice (rainfed)	2.09	-

Note
**1: considering the result of socio-economic survey 2011.*
**2: considering the result of verification trial, which was conducted in F/S time of the Study on Comprehensive Agricultural Development of Prek Thnot River Basin*
Source: JICA Survey Team,

Based on the assumption on unit yield mentioned above, target production in USISRSP is shown as follows:

Table AC-2.2.5.3.3 Paddy Production under Present (Without-project) and With-project Conditions
(Unit: ton)

Category	Present / Without-project	With-project	Increment
(1) Early Rainy Season			
- Early rice	320	800	480
(2) Rainy Season			
- Early rice	682	4,400	3,718
- Medium rice (irrigated)	0	8,400	8,400
- Medium rice (rainfed)	5,706	-	-5,7060
- Late rice (rainfed)	146	-	-146
Total	6,854	13,600	6,746 (6,750)

Source: JICA Survey Team,

AC-2.2.6 Strengthening of Agricultural Extension Services

AC-2.2.6.1 Basic Approach

The concepts as well as approaches, which were specified in F/S, were reviewed and confirmed in the Survey, considering the results of the interview to government staff and farmers as well as socio-economic survey.

It is strongly proposed that farmers should be trained in order to improve their skills on paddy cultivation, and promote crop diversification. Furthermore, through training programs, it is expected that skills on water management as well as maintenance of irrigation facilities be transferred to famers.

Meanwhile, it is judged that staffs of DAO and PDA have some experience and knowledge for implementation of extension activities. However, it is highly necessary to obtain more experience and knowledge, in order to formulate annual action plan for extension services, and carry out extension activities more effectively and smoothly.

AC-2.2.6.2 Development Strategies and Scope of Intervention

(1) Development Strategies

The development strategies are specified as follows:

(i) In principle, constraints on paddy production, which are specified in Section AC-2.1.3, should be improved or minimized through extension activities, in order to increase rice production and income;

(ii) Intensive introduction of agricultural extension services is to be envisioned with the aim of attaining the project target at an early stage as possible;

(iii) Extension service should be carried out effectively and smoothly, applying an annual cycle of "Plan – Do – Check – Act". Activities of each component in this cycle are indicated as follows:

- Plan: Annual action plan of extension service should be formulated, considering the constraints as well as proposed activities as shown in the following table.

Table AC-2.2.6.2.1 Constraints on Paddy Cultivation and Proposed Extension Services in USISRSP

Subject	Constraints	Activities to be Proposed for Extension Services	
		Subjects	Ways to be required
(a) Farming Practices	1) Crop damage due to pests and diseases	- Introduction of IPM	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour
	2) Low paddy yield	- Proposed farming practices - Introduction of quality seeds	
	3) Weed problem	- Introduction of IPM	
(b)Water management	1) Shortage of irrigation water	- Rehabilitation of irrigation facilities - Improvement of water management	- Rehabilitation work - Training for water management
	2) Drainage problem	- Rehabilitation of drainage facilities	
(c) Marketing	1) Unstable and low market price of crops	- Selection of profitable varieties - Selection of other profitable crops - Adjustment of harvesting season - Shipping control - Strengthening bargaining power of famers	- Lecture (short training) - Mass guidance / workshop
	2) Lack of market for paddy	- Finding market - Improvement of quality of paddy - Selection of varieties to be cultivated	- Lecture (short training) - Mass guidance / workshop - Study tour

Source: JICA Survey Team

Targets of each extension activity as well as annual plan are obviously required. Further, in order to carry out extension services, extension materials such as guideline, handouts, etc. are highly required. Those materials should be prepared by extension staff of PDA and DAO, referring the existing materials[7], which were prepared by the central government or other supporting organizations such as international organizations, donors, NGOs, etc.;

- Do: Extension services should be implemented based on the plan mentioned above;

- Check: Extension activities should be measured, and thus those results could be compared with the targets shown in the "Plan". Some differences could be analyzed to clarify those root causes. Major points for this checking are shown as follows:

  - Adaptability of extension service plan;
  - Management on implementation of extension activities;

7 Refer Attachment 5 of ANNEX C

- Progress on the extension service activities;
- Results of the extension service activities; and

- Act: Based on the results in the checking mentioned above, scope as well as target for the next extension activities could be refined.

(2) Scope of the Intervention

The plan is formulated for the period of 4 years from 2017 to 2020, aiming at improvement of farmers' skills as well as experience through strengthening agricultural extension services. Such services should be provided by extension staff of PDA and DAO through the Project Implementation Unit. The envisioned major activities under the plan include: (i) field programs and farmer/farmer group training programs aiming at improvement of farmers' capability and skills on irrigated agriculture farming practices and water management; and (ii) empowerment and motivation of farmers including village extension workers (VEWs). Further, it is required that skills and experience of extension staff be strengthened by intervention of national consultant as well as foreign consultant.

AC-2.2.6.3 Strengthening Plan of Agricultural Extension Services

(1) Proposed Agricultural Extension Services

Agricultural support services required for the promotion of adoption of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage are shown in Table AC-2.1.6.3.1.

Logical matrix of major activities on extension services are shown in Table AC-2.1.6.3.2, and further framework of extension services are shown as follows:

Table AC-2.2.6.3.1 Framework of Extension Services for USISRSP

Activities	Size	Times per group	Frequency
(a) Training of Trainers	10 staff	1 time	4 times per 4 years (once a year)
(b) Field Programs			
1) Demonstration Plots (irrigated)			
- Paddy cultivation	0.1 to 0.2 ha	2 plots per FWUG	- 36 plots/ 18 FWUGs/ 3years - 6 to 15 plots/year
- Upland crops cultivation	0.1 ha	1 plot per FWUG	- 18 plots/ 18 FWUGs/ 2 years - 9 plots/ year
- Vegetable cultivation	0.1 ha	1 plot per FWUG	- 18 plots/ 18 FWUGs/ 3 years - 3 to 12 plots/ year
2) Water management			
- Paddy cultivation	One tertiary block	2 times per FWUG	- 36 plots/ 18 FWUGs/ 4years - 6 to 18 plots/year
(c) Farmer/Farmer Group Training Programs			
1) Training course	2-day course	1 time per FWUG	- 18 times/ 18 FWUGs / 3 years - 9 times/ year
2) FFS/ IPM	30 participants	1 time per FWUG	- 18 times/ 18 FWUGs / 3 years - 9 times/ year
3) Study tour	30 participants	1 time per FWUG	- 18 times/ 18 FWUGs / year
(d) Mass Guidance/Workshop	30 participants	2 time per FWUG	- 36 times/ 18 FWUGs / 3 years - 12 times/ year

Note: around 200 ha for one FWUG, around 18 FWUGs in USISRSP
Source: JICA Survey Team

(2) Assignment of Foreign and National Consultants

Foreign consultant in collaboration with national consultant conducts preparatory work before implementation of training of trainers and training of farmers. Namely, those consultants prepare guidelines on preparation of annual action plan as well as checking and analysis for work progress of training of farmers. Those guidelines are used in training of trainers for extension staff of PDA and DAO. Therefore, it is expected that extension staff arrange extension materials such as hand-outs as well as any other materials for farmers.

As shown in Table AC-2.1.6.3.4, it is proposed that preparatory work and training of trainers be carried out as task work of foreign consultant as well as national consultant. Meanwhile regarding training of farmers, national consultant has to support training of farmers to be carried out by extension staff of PDA and DAO, as assistant work. Further, national consultant checks and analyzes work progress and performance on training of farmers, and thus propose some actions as well as attentions for training activities in the following season as task work.

Assignment period of foreign and national consultants are shown as follows:

Table AC-2.2.6.3.2 Assignment Period of Consultants to be Required for USISRSP (Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
(a) Preparatory work	0.1	0.06	-	0.06	-	0.06	-	0.06	0.1	0.24
(b) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
(c) Training of farmers	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(d) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(e) Total	0.3	0.86	-	0.86	-	0.86	-	0.86	0.3	3.44

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(3) Proposed Budgets of Extension Activities

Furthermore, budgets for each extension activity are shown in Table AC-2.1.6.3.6. Implementation and cost schedule of the proposed agricultural extension services strengthening plan was prepared based on the above conditions as well as budgets, as shown in Table AC-2.2.6.3.3, thus summarized as follows:

Table AC-2.2.6.3.4 Estimated Direct Costs for Agricultural Extension Services for USISRSP

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
(a) Training of Trainers	520	520	520	520	2,080
(b) Field Programs					
1) Demonstration Plots (irrigated)					
- Paddy cultivation	5,520	13,800	13,800	0	33,120
- Upland crops cultivation	0	8,100	8,100	0	16,200
- Vegetable cultivation	2,730	2,730	10,920	0	16,380
2) Water management					
- Paddy cultivation	9,660	19,320	28,980-	0	57,960
(c) Farmer/Farmer Group Training Programs					
1) Training course	0	2,460	2,460	2,460	7,380
2) FFS/ IPM	0	9,480	9,480	9,480	28,440
3) Study tour	0	7,740	0	0	7,740
(d) Mass Guidance/Workshop	3,120	3,120	3,120	0	9,360
Total	21,550	67,270	77,380	12,460	178,660

Source: JICA Survey Team

The total direct costs required for implementation of such programs are estimated to be about US$178,660.

AC-2.3 Kandal Stung – Bati Irrigation System Rehabilitation Sub-Project

AC-2.3.1 Administrative Situation

The Kandal Stung Area is related to Kandal Stung District of Kandal Province, while the Bati Area is related to Bati District of Takeo Province as shown in Tables AC-2.3.1.1 and AC-2.3.1.2, and summarized as follows:

Table AC-2.3.1.3 List of Related Districts, Communes, and Villages

Province	District	Communes	Nos. of village
Kandal	Kandal Stung	Along Romiet	6
		Thmei	5
		Kouk Trab	9
		Preaek Roka	4
		Tbaeng	7
		Trapeang Veaeng	5
		Trea	9
Total for Kandal Stung Area			45
Takeo	Bati	Champei	7
		Pot Sar	11
		Krang thnong	8
		Kandoeng	8
		Trapeang Sab	15
Total for Bati Area			49

Source: Data base supplied from Population Census 2008, Ministry of Planning

AC-2.3.2 Socio-economic Conditions

AC-2.3.2.1 General

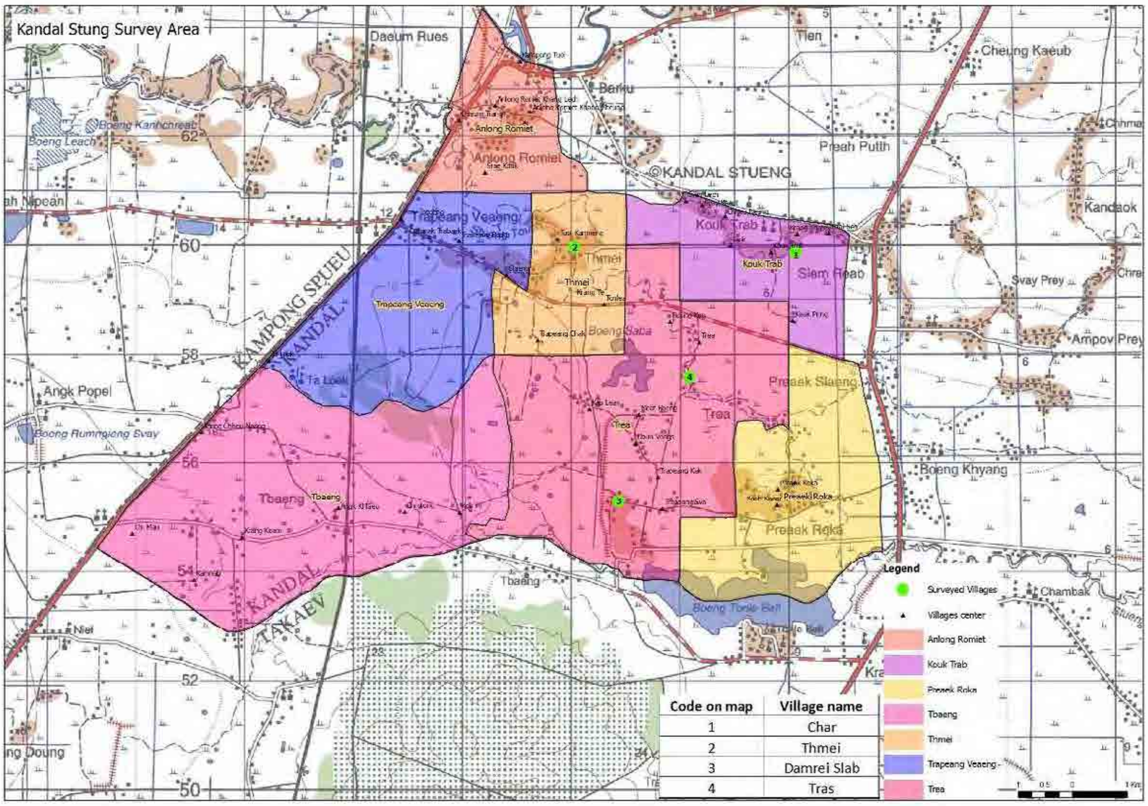
Socio-economic conditions in the Kandal Stung Area were confirmed through the socio-economic survey (the questionnaire survey to the sample farm HHs), which was done in December 2011 and January 2012. This survey aims at clarification of agricultural, social, economic and marketing conditions at farmer level in this area. The questionnaire survey covered 20 HHs in total.

Distribution of sample HHs and the locations of sampled villages are shown in the following Table AC-2.3.2.1.1 and Figures AC-2.3.2.1.1 and AC-2.3.2.1.2..

Table AC-2.3.2.1.1 Socio-economic Survey Sample Distribution

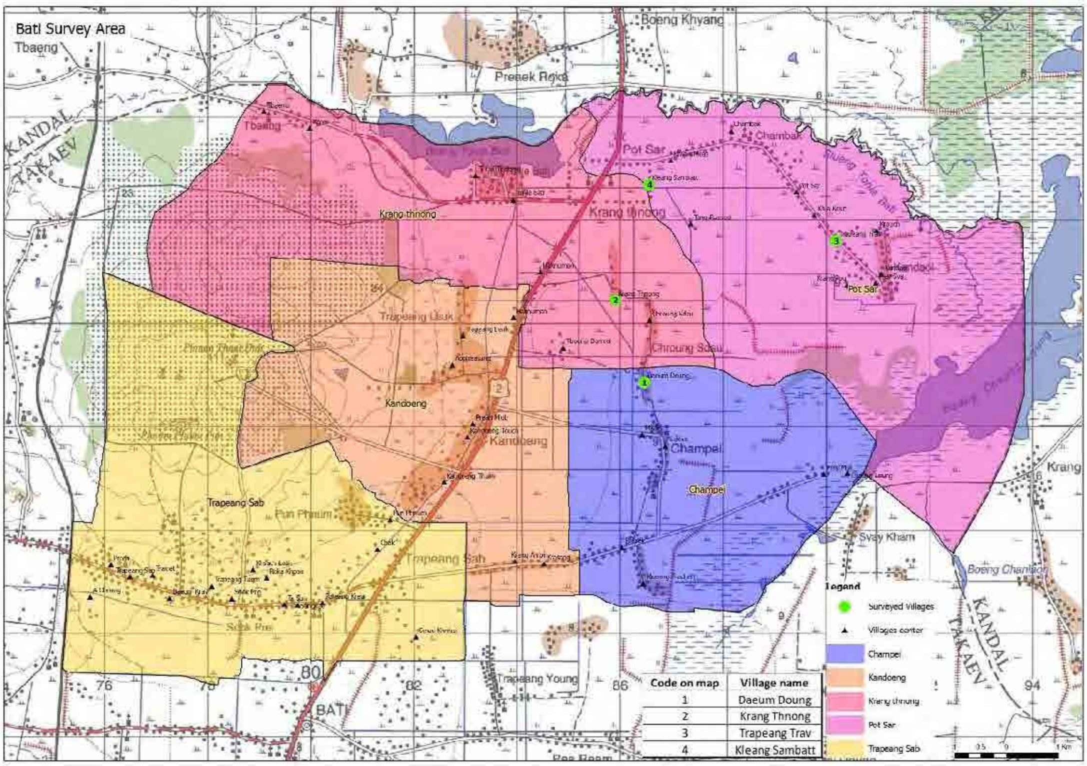
Area	Province	District	Commune	Village	Sample Number
Kandal Stung	Kandal	Kandal Stung	Kouk Trab	Char	5
			Thmei	Thmei	5
			Trea	Damrei Slab	5
				Tras	5
Total					20
Bati	Takeo	Bati	Pot Sar	Kleang Sambatt	5
				Trapeang Trav	5
			Krang Thnong	Krang Thnong	5
			Champei	Daeum Doung	5
Total					20

Source: JICA Survey Team



Source: Socio-economic survey, 2012

Figure AC-2.3.2.1.1 Locations of Selected Villages for Socio-economic Survey in the Kandal Stung Area



Source: Socio-economic survey, 2012

Figure AC-2.3.2.1.2 Locations of Selected Villages for Socio-economic Survey in the Bati Area

The following sections show essential results obtained through the socio-economic survey. The remaining data and information are elaborated in Attachment-3 of ANNEX C.

AC-2.3.2.2 Demographic Conditions

General characteristics of farm HHs in KSBISRSP are shown below.

Table AC-2.3.2.2.1 General Characteristics of Farm Households

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 areas of Kandal Stung and Bati are similar.

AC-2.3.2.3 Living Conditions

(1) Water for Drinking

Source, location, and availability on drinking water are shown as follows:

Table AC-2.3.2.3.1 Source of Drinking Water

Source	Kandal Stung				Bati			
	Dry Season		Rainy Season		Dry Season		Rainy Season	
	No(s).	%	No(s).	%	No(s).	%	No(s).	%
Tube pile well	9	45	6	30	8	40	6	30
Dug well	10	50	8	40	1	5	1	5
Reservoir/ Pond	1	5	0	0	9	45	3	15
Spring/ River	0	0	0	0	0	0	0	0
Bought	0	0	0	0	1	5	0	0
Rain	0	0	6	30	1	5	10	50
Piped water	0	0	0	0	0	0	0	0
Total	20	100	20	100	20	100	20	100

Note:
- Nos. means number of responses
- Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

As shown in the above table, tube pipe well and dug well are the main source of drinking water in dry and rainy seasons.

Table AC-2.3.2.3.2 Location of Drinking Water

Location	Kandal Stung				Bati			
	Dry Season		Rainy Season		Dry Season		Rainy Season	
	No(s).	%	No(s).	%	No(s).	%	No(s).	%
Within the premises	9	45	13	65	6	30	11	55
Near the premises	8	40	5	25	11	55	7	35
Away from the premises	3	15	2	10	3	15	2	10
Total	20	100	20	100	20	100	20	100

Note:
- Nos. means number of responses
- Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

As shown in the above table, existence of surface drinking water is generally within premises and easy to obtain in the whole area.

Table AC-2.3.2.3.3 Availability of Drinking Water

	Kandal Stung				Bati			
	Dry Season		Rainy Season		Dry Season		Rainy Season	
	No(s).	%	No(s).	%	No(s).	%	No(s).	%
Easy to obtain	12	60	17	85	11	55	17	85
Difficult to obtain	7	35	3	15	8	40	3	15
Very difficult to obtain	1	5	0	0	1	5	0	0
Total	20	100	20	100	20	100	20	100

Note:
- Nos. means number of responses
- Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

Although the water shortage is significantly alleviated due to rainfall, there still remain the HHs facing the difficulty to meet its drinking water consumption level.

(2) Type of Fuel for Cooking

Source of fuel for cooking are shown as follows:

Table AC-2.3.2.3.4 Source of Fuel for Cooking

	Kandal Stung		Bati	
	No(s).	%	No(s).	%
Firewood	20	100	20	100
Charcoal	0	0	0	0
Gas cylinder (LPG)	0	0	0	0
Electricity	0	0	0	0
Other	0	0	0	0
Total	20	100	20	100

Note:
- Nos. means number of responses
- Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

Furthermore, around 50% of respondents replied it is difficult to get firewood.

(3) Type of Sources for Lighting

Recently most HHs have used city power more than other sources for lighting. City power is used not only for lighting but also for TV, video, etc. Sources of lighting are shown as below.

Table AC-2.3.2.3.5 Source of Lighting

	Kandal Stung		Bati	
	No(s).	%	No(s).	%
City power	19	95	19	95
Generator	0	0	0	0
Kerosene	1	5	0	0
Candle	0	0	0	0
Battery	0	0	1	5
Other	0	0	0	0
Total	20	100	20	100

Note: Refer Attachment-3 in ANNEX-C for details
Charge of city power: 1,200 Riel per KWh
Source: Socio-economic survey, 2012

AC-2.3.2.4 Farm Economy

The proportional income volumes from various income sources are calculated for each source as shown below.

Table AC-2.3.2.4.1 Proportional Income Volumes from Different Sources (Unit: %)

No	Type of Income	Kandal Stung	Bati
1	Selling paddy/rice	14.4	30.5
2	Selling vegetables (red pepper/ tobacco/ water melon/ others)	0.7	-
3	Selling fruits (mango/ papaya, banana/ orange/ others)	0.1	0.8
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
16	Total	100.0	100.0

Note: Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

From the above table, the following characteristics are observed:

(i) Agricultural income is less than non-agricultural income in the Kandal Stung Area, while Agricultural income is higher than non-agricultural income at the Bati Area;

(ii) The income sources of sampled HHs are diversified not only in variety but also in proportional volume;

(iii) Among agricultural income sources, the "Selling paddy/rice" is the most viable cash income source in both Kandal Stung and Bati Areas; and

(iv) 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 source is mostly earned from garment factory by young lady.

Straw Mushroom as secondary crop after harvesting rainy season rice

Table AC-2.3.2.4.2 Daily Income and Expenditure Per Capita of Sampled Population

Income Strata	Average HH Income (US$)	Average HH Expenditure (US$)	Average HH Population (Nos.)	Per Capita Daily Income (US$)	Per Capita Daily Expenditure (US$)
Kandal Stung					
1st	2,822	2,576	6.4	1.22	1.12
2nd	1,432	1,205	4.5	0.88	0.74
Bati					
1st	2,796	2,179	5.6	1.39	1.08
2nd	1,616	1,335	5.9	0.76	0.63

Note: Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

Sample HHs were arranged from the highest income HH to the lowest, in order to form 1st and 2nd 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 AC-1.4.3.3, it is judged that they are not below the poverty line provisionally.

AC-2.3.2.5 Agricultural Activities

(1) Paddy Cultivation and Production in the Project 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 rainy season, and cropping intensity is around 100% as shown in Tables AC-2.3.2.5.1 and AC-2.3.2.5.2, and summarized as follows:

Table AC-2.3.2.5.3 Paddy Cultivation in Kandal Stung Area

No.	Related Commune	Cultivated Area in 2010/111				Cropping Intensity (%)
		Early Rice	Medium Rice	Late Rice	Total	
1	Along Romiet					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 AC-2.3.2.5.4 Paddy Cultivation in Bati Area

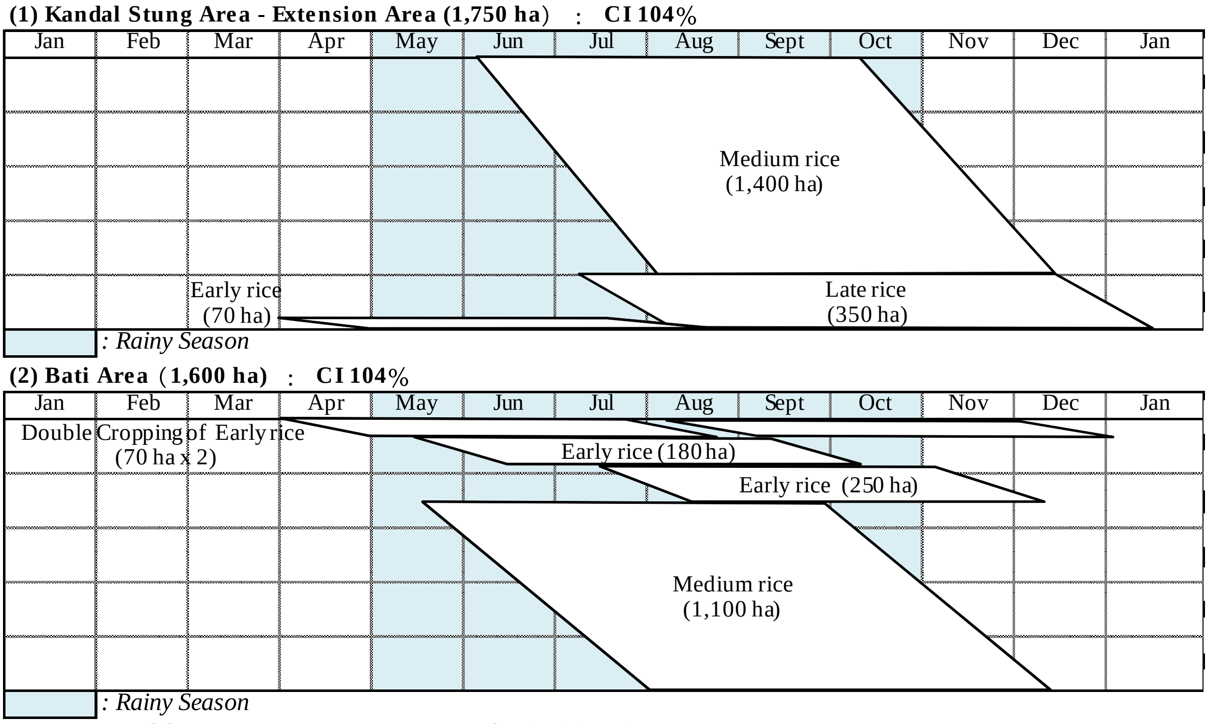
No.	Related Commune	2010		2011	
		Harvested Area (ha)	Cropping Intensity (%)	Harvested Area (ha)	Cropping Intensity (%)
1	Champei	1,751	115	1,789	118
2	Pot Sar	2,525	128	2,696	137
3	Krang thnong	1,615	106	1,664	110
4	Kandoeng	1,196	116	1,235	120
5	Trapeang Sab	1,144	108	1,153	107
Total		8,231	116	8,537	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) early rainy season, which paddy is cultivated from March to June in irrigated areas; (ii) rainy season, which rice is cultivated from July to October both in rainfed and irrigated areas; and (iii) 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 judged that there are not big differences between previous and present cropping patterns in the area from the previous study time as shown in the following figure.

Paddy Field after Transplanting in Kandal Stung Area (August 2011)

Paddy Field after Transplanting in Bati Area (August 2011)



Source: Upper Slakou River Irrigation Reconstruction Plan (F/S) (2002)
JICA Survey Team1

Figure AC-2.3.2.5.1 Present Cropping Patterns for KSBISRSP

(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 AC-2.3.2.5.5 Farm Land Holding Size of Average Farm Household

(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 AC-2.3.2.5.6 Holding of Adult Livestock (Unit: Nos.)

Livestock	Kandal Stung		Bati	
	Holders	No. of Livestock*	Holders	No. of Livestock*
Cows / Oxen	12	4	20	2
Water buffalo	0	0	0	0

Livestock	Kandal Stung		Bati	
	Holders	No. of Livestock*	Holders	No. of Livestock*
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
- Refer Attachment-3 in ANNEX-C for details
- Average per respondent on each livestock
Source: Socio-economic survey, 2012

AC-2.3.3 Weaknesses of Paddy Production in the Target Area

Through the socio-economic survey, the following constraints are identified.

Table AC-2.3.3.1 Ranked Constraints on Paddy Cultivation

Subject	Rank	Kandal Stung Area	Bati Area
(1) Farming Practices	1st	Weed problem	Crop damage due to pests and diseases
	2nd	Low paddy yield	Weed problem
	3rd	Crop damage due to pests and diseases	Expensive farm inputs
(2) Physical Conditions	1st	Shortage of irrigation water in rainy season	Shortage of irrigation water in rainy season
	2nd	Shortage of irrigation water in early rainy season	Shortage of irrigation water in early rainy season
	3rd	Drainage problem	Drainage problem
(3) Marketing	1st	Low market price of paddy	Unstable market price of paddy
	2nd	Unstable market price of paddy	Low market price of paddy
	3rd	Unstable market price of other crops	Limitation of market of paddy / rice
(4) Low Productivity	1st	Draught in rainy season	Draught in rainy season
	2nd	Water shortage in the early rainy season	Water shortage in the early rainy season
	3rd	Poor soil	Poor drainage

Note: Refer Attachment-3 in ANNEX-C for details
Source: Socio-economic survey, 2012

It is proposed that agricultural extension services should be strengthened, in order to improve or minimize the constraints mentioned above.

AC-2.3.4 Examination of Previous Development Plan

(1) Agricultural Development

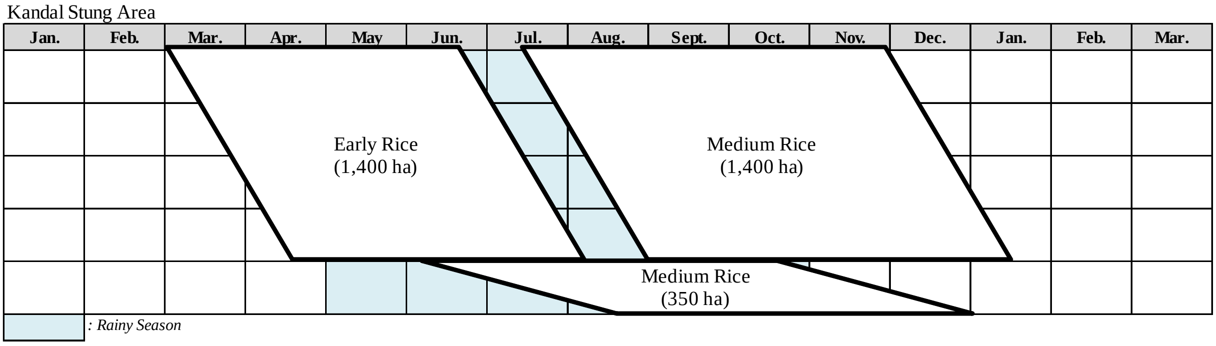
The agricultural development plan proposed in F/S (1995) was reviewed through the site visit, analysis on collected latest data and information from the relevant institutes, discussion with PDA and DAO staff, to determine the water demand for water balance study, and also to contribute to preparation of the appropriate scope of this Sub-project. The review results are given in the following table:

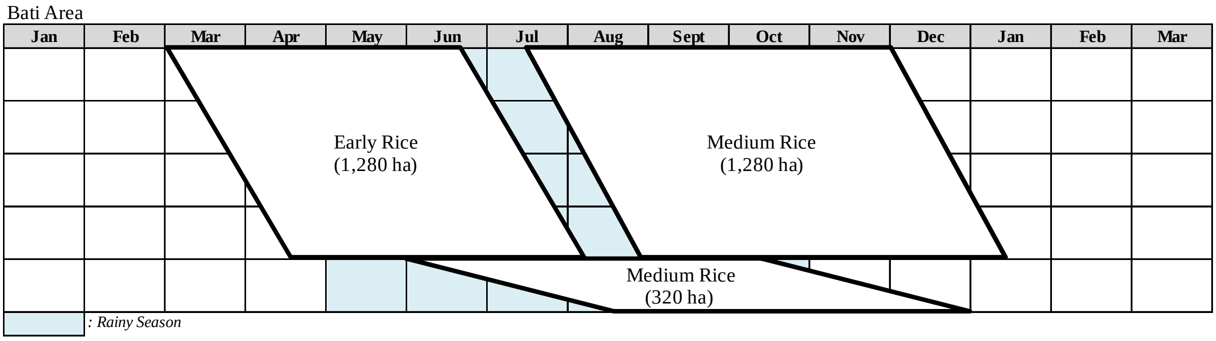
Table AC-2.3.4.1 Review on Agricultural Development Plan

Item	F/S	Review in 2011
(a) 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. (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 available in this area, although its area is limited. 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 of current cropping pattern, just double cropping of paddy is proposed as shown in Figure AC-2.3.4.1. (b) 180% of cropping intensity is proposed, considering the water availability.
(b) Farming Practices	Comparing the present situation, 3 to 4 times of the fertilizer application volume were proposed at the F/S stage. 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. However, dosage amount of fertilizer could be reviewed.

Item	F/S	Review in 2011
(c) 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 F/S stage.

Source: JICA Survey Team





Source: JICA Survey Team

Figure AC-2.3.4.1 Proposed Cropping Patterns for KSBISRSP

(2) Strengthening of Agricultural Extension Services

In KSBISRSP, agricultural supporting services development plan was proposed to raise crop and livestock production in order to increase farm HH 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 the subjects proposed in the F/S focusing on the extension services. The results of review are shown in the following table.

Table AC-2.3.4.2 Review on Agricultural Extension Services

Item	F/S	Review in 2011
(a) 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. - 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. - There are no clear relationship between PDA/DAO and these agricultural development centers, regarding extension activities. - 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.

Item	F/S	Review in 2011
(b) Establishment of Agricultural Development Centre	In the F/S, it was proposed that existing Agricultural Development Centre be rehabilitated, while one Center be newly constructed.	As mentioned in (a), there is currently no relationship between PDA / DAO and the Centre, regarding agricultural extension activities, although they have some cooperative activities. Accordingly, establishment of the centre is excluded for the development plan.
(c) 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

AC-2.3.5 Agricultural Development Plan

AC-2.3.5.1 Present and Future Command Area

In the development plan, the area will be fully developed as shown in the below table.

Table AC-2.3.5.1.1 Present and Proposed Cultivated Area (Unit: ha)

Category	Present / Without-project	With-project	Increment
(1) Kandal Stung area (1,750 ha)			
(a) Early Rainy Season			
- Early rice (irrigated)	70	1,400	1,330
(b) Rainy Season			
- Early rice (irrigated)	0		
- Early rice (rainfed)	0		
- Medium rice (irrigated)	0	1,750	1,750
- Medium rice (rainfed)	1,750	0	-1,750
(c) Total Cultivated Area	1,820	3,150	1,330
(Cropping intensity (%))	(104)	(180)	(76)
(2) Bati area (1,600 ha)			
(a) Early Rainy Season			
- Early rice (irrigated)	70	1,280	1,210
(b) Rainy Season			
- Early rice (irrigated)	-	-	-
- Early rice (rainfed)	500	0	-500
- Medium rice (irrigated)	0	1,600	1,600
- Medium rice (rainfed)	1,100	0	-1,100
(c)Total Cultivated Area	1,670	2,880	1,210
(Cropping intensity (%)	(104)	(180)	(76)
(3) Total	3,580	6,030	2,450

Source: JICA Survey Team

AC-2.3.5.2 Farming Practices and Input Requirement for Major Crops

Through the field survey, present and proposed farming practices as well as farm input requirement were reviewed. In principle, it is not necessary to change major practices as well as major requirement, although minor adjustment on input requirement was done. Present and proposed updated crop budgets for paddy are shown in Tables AC-2.3.5.2.1 and AC-2.3.5.2.2.

AC-2.3.5.3 Crop Production under Present and With-project Conditions

Current and proposed yield levels as well as target yield of paddy in each category of paddy field in the KSBISRSP area were set up, based on the statistical data of PDA as well as DAO, data from RCHRSP, the results of the socio-economic survey, etc., as shown in Table AC-2.3.5.3.1 and summarized as follows:

Table AC-2.3.5.3.2 Present and Proposed Unit Yield of Paddy (Unit: ton/ha)

Category	Present / Without-project*1	With-project*2
(1) Early Rainy Season		
- Early rice	2.58	4.00
(2) Rainy Season		
- Early rice (irrigated)	2.58	4.00
- Medium rice (irrigated)	-	3.50
- Medium rice (rainfed)	2.09	-

Note:
**1: considered the result of socio-economic survey.*
**2: considered the result of verification trial, which was conducted in F/S stage of RCISRSP.*
Source: JICA Survey Team,

Based on the assumption on unit yield mentioned above, target production in USISRSP is shown as follows:

Table AC-2.3.5.3.3 Paddy Production under Present (Without-project) and With-project Conditions

(1) Kandal Stung Area

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)	
(a) Early Rainy Season							
- Early rice	70	2.58	181	1,400	4.00	5,600	5,419
(b) 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

(2) Bati Area

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)	
(a) Early Rainy Season							
- Early rice	70	2.58	181	1,280	4.00	5,120	4,939
(b) Rainy Season							
- Early rice (irrigated)	500	2.58	1,290	-	-	-	- 1,290
- 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

(3) Whole Area

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)	
(a) Early Rainy Season							
- Early rice	140	2.58	362	2,680	4.00	10,720	10,358
(b) 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

Source: JICA Survey Team

AC-2.3.6 Strengthening of Agricultural Extension Services

AC-2.3.6.1 Basic Approach

The concepts as well as approaches, which were specified in F/S, was reviewed and confirmed in the Survey, considering the results of the interview to government staff and farmers as well as socio-economic survey.

It is strongly proposed that farmers should be trained in order to improve their skills on paddy cultivation as well as upland crops cultivation. Furthermore, through training programs, it is expected that skills on water management as well as maintenance of irrigation facilities be transferred to famers.

Meanwhile, it is judged that staffs of DAO and PDA have some experience and knowledge for implementation of extension activities. However, it is highly necessary to obtain more experience and knowledge, in order to formulate annual action plan for extension services, and carry out extension activities more effectively and smoothly.

AC-2.3.6.2 Development Strategies and Scope of Intervention

(1) Development Strategies

The development strategies are specified as follows:

(i) In principle, constraints on paddy production, which are specified in Section AC-2.1.3, should be improved or minimized through extension activities, in order to increase rice production and income;

(ii) Intensive introduction of agricultural extension services is to be envisioned with the aim of attaining the project target at an early stage as possible;

(iii) Extension service should be carried out effectively and smoothly, applying an annual cycle of "Plan – Do – Check – Act". Activities of each component in this cycle are indicated as follows:

- Plan: Annual action plan of extension service should be formulated, considering the constraints as well as proposed activities as shown in the following table;.

Table AC-2.3.6.2.1 Constraints on Paddy Cultivation and Proposed Extension Services in KSBISRSP

Subject	Constraints	Activities to be Proposed for Extension Services	
		Subjects	Ways to be required
(a) Farming Practices	1) Crop damage due to pests and diseases	- Introduction of IPM	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour
	2) Low paddy yield	- Proposed farming practices - Introduction of quality seeds	
	3) Weed problem	- Introduction of IPM	
(b)Water management	1) Shortage of irrigation water	- Rehabilitation of irrigation facilities - Improvement of water management	- Rehabilitation work -Training for water management
	2) Drainage problem	- Rehabilitation of drainage facilities	
(c) Marketing	1) Unstable and low market price of crops	- Selection of profitable varieties - Selection of other profitable crops - Adjustment of harvesting season - Shipping control - Strengthening bargaining power of famers	- Lecture (short training) - Mass guidance / workshop
	2) Lack of market for paddy	- Finding market - Improvement of quality of paddy - Selection of varieties to be cultivated	- Lecture (short training) - Mass guidance / workshop - Study tour
	3) Expensive farm inputs	- Proposed farming practices	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour

Source: JICA Survey Team

Targets of each extension activity as well as annual plan are obviously required. Further, in order to carry out extension services, extension materials such as guideline, handouts, etc. are highly required. Those materials should be prepared by extension staff of PDA and DAO, referring the existing materials[8], which were prepared by the central government or other supporting organizations such as international organizations, donors, NGOs, etc.;

8 Refer Attachment 5 of ANNEX C

- Do: Extension services should be implemented based on the plan mentioned above;
- Check: Extension activities should be measured, and thus those results could be compared with the targets shown in the "Plan". Some differences could be analyzed to clarify those root causes. Major points for this checking are shown as follows:

  - Adaptability of extension service plan;
  - Management on implementation of extension activities;
  - Progress on the extension service activities;
  - Results of the extension service activities; and
- Act: Based on the results in the checking mentioned above, scope as well as target for the next extension activities could be refined.

(2) Scope of the Intervention

The plan is formulated for the period of 4 years from 2017 to 2020 aiming at improvement of farmers' skills as well as experience through strengthening agricultural extension services. Such services should be provided through the establishment of an institution responsible for the provision of the services as stated earlier. The envisioned major activities under the plan include: (i) field programs and farmer/farmer group training programs aiming at improvement of farmers' capability and skills on irrigated agriculture farming practices and water management; and (ii) empowerment and motivation of farmers including village extension workers (VEWs). Further, it is required that skills and experience of extension staff be strengthened by intervention of national consultant as well as foreign consultant.

AC-2.3.6.3 Strengthening Plan of Agricultural Extension Services

(1) Proposed Agricultural Extension Services

Agricultural support services required for the promotion of adoption of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage are shown in Table AC-2.1.6.3.1.

Logical matrix of major activities on extension services are shown in Table AC-2.1.6.3.2, and further framework of extension services are shown as follows:

Table AC-2.3.6.3.1 Framework of Extension Services for KSBISRSP

Activities	Size	Times per group	Frequency	
			Kandal Stung	Bati
(a) Training of Trainers	10 staff	1 time	4 times per 4 years (once a year)	4 times per 4 years (once a year)
(b) Field Programs				
1) Demonstration Plots (irrigated)				
- Paddy cultivation	0.1 to 0.2 ha	2 plots per FWUG	- 18 plots/ 9 FWUGs/ 3years - 6 plots/year	- 16 plots/ 8FWUGs/3years - 4 to8 plots/year
- Upland crops cultivation	0.1 ha	1 plot per FWUG	- 9 plots/ 9 FWUGs/ 2years - 3 to 6 plots/ year	- 8 plots/ 8 FWUGs/ year - 8 plots/ year
- Vegetable cultivation	0.1 ha	1 plot per FWUG	- 9 plots/ 9 FWUGs/ 2years - 3 to 6 plots/ year	- 8 plots/ 8 FWUGs/ 2years - 4 plots/ year
2) Water management				
- Paddy cultivation	One tertiary block	2 times per FWUG	- 18 plots/ 9FWUGs/3years - 3 to 9 plots/year	- 16 plots/ 8FWUGs/3years - 4 to 8 plots/year

Activities	Size	Times per group	Frequency	
			Kandal Stung	Bati
(c) Farmer/Farmer Group Training Programs				
1) Training course	2-day course	1 time per FWUG	- 9 plots/ 9 FWUGs/ 3 y - 3 plots/ year	- 8 plots/ 8 FWUGs/ 4years - 2 plots/ year
2) FFS/ IPM	30 participants	1 time per FWUG	- 9 times / 9 FWUGs/ 3 y - 3 plots/ year	- 8 times/ 8 FWUGs/3years - 2 to 4 times / year
3) Study tour	30 participants	1 time per FWUG	- 9 times / 9 FWUGs/ 3 y - 3 plots/ year	- 8 times/ 8FWUGs/ 4years - 2 times / year
(d) Mass Guidance/Workshop	30 participants	2 time per FWUG	- 18 times / 9 FWUGs/ 4 y - 3 to 6 times / year	- 16 times/ 8FWUGs/ 4years - 4 times / year

Note: around 200 ha for one FWUG, around 9 FWUGs for Kandal Stung area, while 8 FWUGs for Bati area
Source: JICA Survey Team

(2) Assignment of Foreign and National Consultants

Foreign consultant in collaboration with national consultant conducts preparatory work before implementation of training of trainers and training of farmers. Namely, those consultants prepare guidelines on preparation of annual action plan as well as checking and analysis for work progress of training of farmers. Those guidelines are used in training of trainers for extension staff of PDA and DAO. Therefore, extension staff could arrange extension materials such as hand-outs as well as any other materials for farmers.

As shown in Table AC-2.1.6.3.4, it is proposed that preparatory work and training of trainers be carried out as task work of foreign consultant as well as national consultant. Meanwhile regarding training of farmers, national consultant has to support training of farmers to be carried out by extension staff of PDA and DAO, as assistant work. Further, national consultant checks and analyzes work progress and performance on training of farmers, and propose some actions as well as attentions for training activities in the following season as task work.

Assignment period of foreign and national consultants are shown as follows:

Table AC-2.3.6.3.2 Assignment Period of Consultants to be Required for KSBISRSP

(a) Kandal Stung (Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
1) Preparatory work	0.05	0.05	-	0.05	-	0.05	-	0.05	0.05	0.2
2) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
3) Training of farmers	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
4) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
Total	0.25	0.85	-	0.85	-	0.85	-	0.85	0.25	3.4

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(b) Bati (Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
1) Preparatory work	0.05	0.05	-	0.05	-	0.05	-	0.05	0.05	0.2
2) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
3) Training of farmers	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
4) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
Total	0.25	0.85	-	0.85	-	0.85	-	0.85	0.25	3.4

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(3) Proposed Budgets of Extension Activities

Furthermore, budgets for each extension activity are shown in Table AC-2.1.6.3.4. Implementation and cost schedule of the proposed agricultural extension services strengthening plan was prepared based on the above conditions as well as budgets, as shown in Table AC-2.3.6.3.3, thus summarized as follows:

Table AC-2.3.6.3.4 Estimated Direct Costs for Agricultural Extension Services for KSBISRSP

(a) Kandal Stung Area

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
1) Training of Trainers	520	520	520	520	2,080
2) Field Programs					
a) Demonstration Plots (irrigated)					
- Paddy cultivation	5,520	5,520	5,520	0	16,560
- Upland crops cultivation	0	2,700	5,400	0	8,100
- Vegetable cultivation	0	2,730	5,460	0	8,190
b) Water management					
- Paddy cultivation	4,830	9,660	14,490	0	28,980
3) Farmer/Farmer Group Training Programs					
a) Training course	0	1,230	1,230	1,230	3,690
b) FFS/ IPM	0	4,740	4,740	4,740	14,220
c) Study tour	1,290	1,290	1,290	0	3,870
4) Mass Guidance/Workshop	780	1,560	1,560	780	4,680
Total	12,940	29,950	40,210	7,270	90,370

Source: JICA Survey Team

(b)Bati Area

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
1) Trainers' Training	520	520	520	520	2,080
2) Field Programs					
a) Demonstration Plots (irrigated)					
- Paddy cultivation	3,680	3,680	7,360	0	14,720
- Upland crops cultivation	0	0	7,200	0	7,200
- Vegetable cultivation	0	3,640	3,640	0	7,280
b) Water management					
- Paddy cultivation	6,440	6,440	12,880	0	25,760
3) Farmer/Farmer Group Training Programs					
a) Training course	820	820	820	820	3,280
b) FFS/ IPM	0	6,320	3,160	3,160	12,640
c) Study tour	860	860	860	860	3,440
4) Mass Guidance/Workshop	1,040	1,040	1,040	1,040	4,160
Total	13,360	23,320	37,480	6,400	80,560

Source: JICA Survey Team

The total direct costs required for implementation of such programs in Kandal Stung and Bati areas are estimated to be about US$90,370 and US$80,560, respectively.

AC-2.4 Main Canal 35 Rehabilitation Sub-project

AC-2.4.1 Administrative Situation

MC35RSP Area is located in Basedth District of Kampong Speu Province as shown in Figure AC-2.4.1.1. Administrative situation for this Sub-project is shown in Table AC-2.4.1.1 and summarized as follows:

Table AC-2.4.1.2 List of Related Communes and Villages

Province	District	Communes	No. of Villages
Kampong Speu	Basedth	1. Basedth	22
		2. Pheari Mean Chey	13
		3. Pou Mreal	18
		4.Tuol Ampil	15
		5. Kak	14
		6. Preah Khae	9
		7. Kat Phluk	11
		8. Niteam	15

Source: No. of villages: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

AC-2.4.2 Socio-economic Conditions

AC-2.4.2.1 Demographic Conditions

General characteristics of farm HHs in the related communes are shown below.

Table AC-2.4.2.1.1 General Characteristics of Farm Households

Communes	Total Population (person)	Total No of HH	Average Family Size (person)	Working-age Population (person)	Literacy Rate (%)
1. Basedth	10,737	2,565	4.2	6,418	71.3
2. Pheari Mean Chey	7,639	1,690	4.5	4,404	67.9
3. Pou Mreal	9,203	2,187	4.2	3,969	74.9
4.Tuol Ampil	9,464	2,059	4.6	5,336	67.3
5. Kak	5,173	1,258	4.1	2,812	66.8
6. Preah Khae	5,541	1,289	4.3	3,035	57.8
7. Kat Phluk	7,647	1,663	4.6	4,325	64.4
8. 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

AC-2.4.2.2 Living Conditions

(1) Water for Drinking

Actual situation on sources and locations on drinking water in the related communes is shown as follows:

Table AC-2.4.2.2.1 Source of Drinking Water (Unit: HH)

Commune	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. Meanwhile, water source is not located in their premises, but near or away from their premises as shown in the following table:

Table AC-2.4.2.2.2 Location of Drinking Water (Unit: HH)

Commune	Type of Sources			
	Within the premises	Near the premises	Away from the premises	Total
1. Basedth	372	1,131	1,062	2,565
2. Pheari Mean Chey	155	418	1,117	1,690
3. Pou Mreal	198	857	1,132	2,187
4.Tuol Ampil	181	631	1,247	2,059
5. Kak	65	490	703	1,258
6. Preah Khae	122	513	654	1,289
7. Kat Phluk	137	889	637	1,663
8. Niteam	178	323	1,160	1,661

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

(2) Type of Fuel for Cooking

Sources of fuel for cooking are shown as follows:

Table AC-2.4.2.2.3 Source of Fuel for Cooking (Unit: HH)

Commune	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

As mentioned in the above table, major fuel for cooking is firewood. Firewood is available in market, while gathering firewood from surrounding area of farmers' houses is also common.

(3) 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 AC-2.4.2.2.4 Source of Lighting (Unit: HH)

Commune	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

AC-2.4.2.3 Agricultural Activities

(1) Present Land Use in the Sub-project Area

Area of the sub-project area is originally estimated at 1,935 ha. Further the area was revised to 900 ha, according to the water balance study as follows:

Table AC-2.4.2.3.1 Present Land Use in the Sub-project Area

(1) Proposal (Unit: ha)

Land Use		Physical Land	Cultivated Area				
			Paddy by Season			Upland Crops	Total
			Dry	Early Rainy	Rainy		
Irrigated Paddy Field	Low land	50	-	-	50	-	50
	Recession area	-	-	-	-	-	-
Rainfed Paddy Field		1,885	-	-	1,885	-	1,885
Upland Field			-	-	-	-	-
Non-agricultural Land			-	-	-	-	-
Right of Way			-	-	-	-	-
Total		1,935	-	-	1,935	-	1,935
Cropping Intensity (%)							100

(2) After water balance study (Unit: ha)

Land Use		Physical Land	Cultivated Area				
			Paddy by Season			Upland Crops	Total
			Dry	Early Rainy	Rainy		
Irrigated Paddy Field	Low land	50	-		50	-	50
	Recession area	-	-	-	-	-	-
Rainfed Paddy Field		850	-	-	850	-	850
Upland Field			-	-	-	-	-
Non-agricultural Land			-	-	-	-	-
Right of Way			-	-	-	-	-
Total		900	-	-	900	-	900
Cropping Intensity (%)							100

Source: JICA Survey Team

(2) Paddy Cultivation and Production in the Related Communes

Paddy cultivation in this sub-project is carried out only during rainy season due to shortage of river water as well as rainfall.

Current situation of paddy production in the district is shown in Table AC-2.4.2.3.2 and summarized as follows:

Table AC-2.4.2.3.3 Paddy Cultivation in the Related Communes of Basedth District

Commune	Wet Season in 2010			Dry Season in 2010/11			Total		
	ha	ton/ha	ton	Ha	ton/ha	ton	ha	ton/ha	Ton
1. Basedth	1,890	2.69	5,082	0	0.00	0	1,890	2.69	5,082
2. Pheari Mean Chey	1,250	2.39	2,986	0	0.00	0	1,250	2.39	2,986
3. Pou Mreal	1,603	1.88	3,012	12	3.00	36	1,615	1.89	3,048
4.Tuol Ampil	1,350	2.61	3,519	0	0.00	0	1,350	2.61	3,519
5. Kak	1,363	2.53	3,442	0	0.00	0	1,363	2.53	3,442
6. Preah Khae	1,250	2.99	3,743	30	3.20	96	1,280	3.00	3,839
7. Kat Phluk	1,490	2.49	3,706	0	0.00	0	1,490	2.49	3,706
8. Niteam	1,190	2.38	2,828	9	2.90	26	1,199	2.38	2,854
Total	11,386	2.49	28,318	51	3.10	158	11,437	2.49	28,476

Note: ha: harvested area, ton/ha: unit yield, ton: production
Source: District Agricultural Office 2012

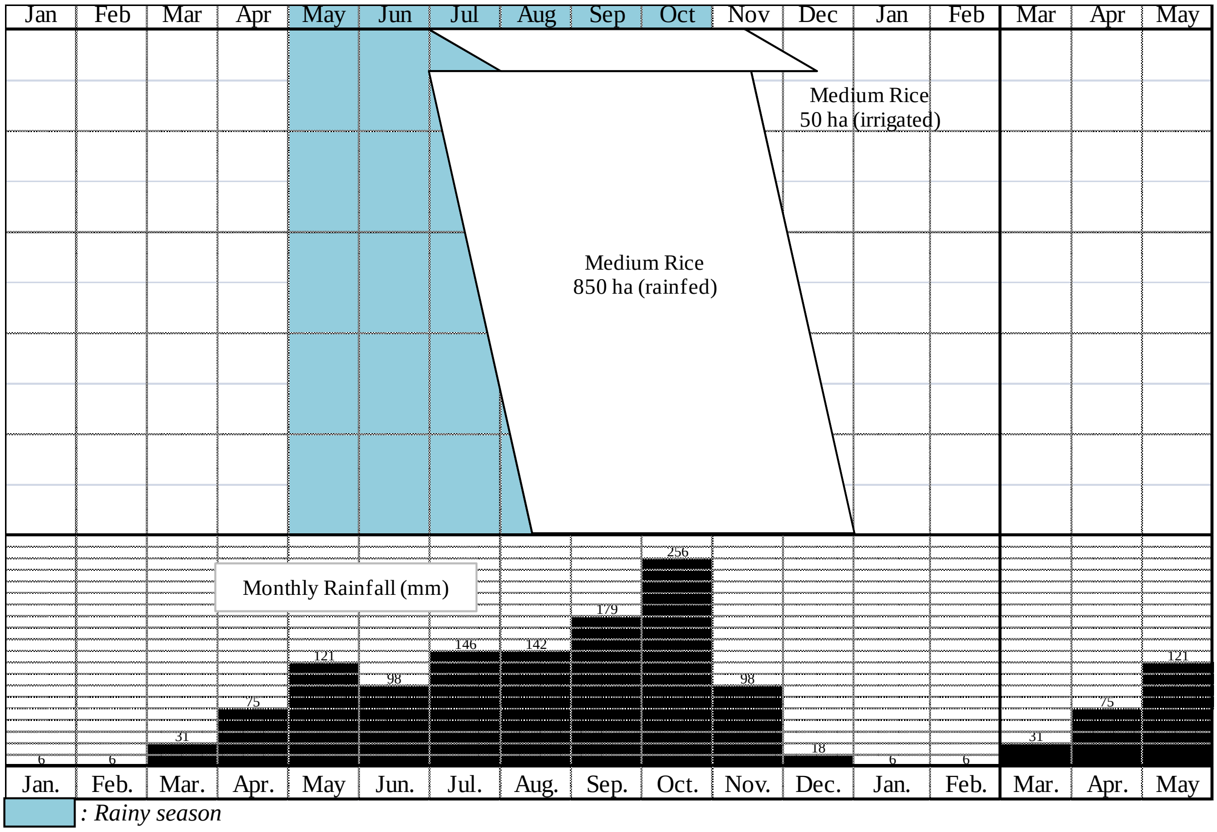
Rainy season cropping is mainly from July to December. Medium rice and late rice are cultivated under rainfed condition. Double cropping (early rainy season – rainy season) of paddy cultivation with early rice is carried out in the limited area near the reservoir, but early rainy season cropping is not practiced every year. Main canal has been blocked and broken every place, hence it is difficult to irrigate the down-stream area. Further, water management is not conducted properly. Sometimes the gate of the reservoir is opened depending on urgent requests from farmers. However, such management is not controlled properly. Typical farming practices are shown in Table AC- 2.4.2.3.4 and cropping calendar of paddy cultivation in the recession area is shown as follows:

Table AC-2.4.2.3.5 Cropping Calendar of Paddy Cultivation in MC35RSP Area

Period	Activities	Remarks
July and August	Land preparation Nursery preparation	- Land preparation by draft animal (cattle) is popular (70%). While Land preparation by hand tractor is also available.
Late July to late September	Transplanting	- seedling age: 20 to 30 days - Direct sowing is not common in the sub-project area. - Man-power for transplanting is enough.
August to October	Management of paddy growing	- There are no serious insects and diseases except Brown Plant Hopper.. - No water management - Occasionally, farmers' groups request sluicing water to PDOWRAM. - Supplemental irrigation by pump is also popular. - Partly, there are some damages by flood as well as drought.
November to December	Cutting Threshing Transportation	- Manual cutting by sickle is popular (95%), while combine harvester also used slightly. Reaper is not available. - Manual threshing at farmers' home yard is common in this area (90%). - For transportation, traders come to farmers' houses and buy products directly. Or farmers bring them to rice millers at Kampong Chhnang. - Traders don't mind moisture content of paddy. Therefore buying price is slightly lower.
January to June	Off-season for paddy cultivation	- Income during off-season: Garment factory, construction worker, animal raising, vegetable cultivation, etc.

Source: JICA Survey Team

Present cropping pattern is shown as follows:



Source: JICA Survey Team

Figure AC-2.4.2.3.1 Present Cropping Pattern for MC35RSP

Paddy Field in the Sub-project Area

Paddy cultivation during rainy season under irrigated condition (2nd cropping)

Farmer's house in the Sub-project Area

Carrying harvested paddy to home yard

Harvested paddy is normally threshed at farmers' home yard, and thus sold to traders at farm gate. Around 10 traders are available in and around the sub-project area, while rice millers are not available in and around the area, although mobile rice miller is popular here.

Traders in the Sub-project area

Mobile rice miller

(3) Inventory of Farm Machinery

In the Sub-project area, major farming practices such as land preparation, cutting and threshing are done by small machine. Inventory of machinery in the related communes is shown as follows:

Table AC-2.4.2.3.6 Inventory of Farm Machinery in the Related Communes (Unit: no(s).)

Commune	4-wheel Tractor	Hand tractor	Threshing Machine	Rice Mill (S. scale)	Rice Mill (M./L. scale)
1. Basedth	0	4	6	68	0
2. Pheari Mean Chey	1	2	0	35	0
3. Pou Mreal	1	0	0	51	0
4.Tuol Ampil	0	8	0	32	0
5. Kak	0	13	3	40	0

Commune	4-wheel Tractor	Hand tractor	Threshing Machine	Rice Mill (S. scale)	Rice Mill (M./L. scale)
6. Preah Khae	0	19	11	18	0
7. Kat Phluk	1	7	22	17	0
8. Niteam	0	4	6	107	0
Total	3	56	49	368	0

Source: Commune Database 2010, National Committee for Sub-National Democratic Development (NCDD)

As shown in the above table, number of farm machinery is relatively limited. Therefore, draft animal and manual cutting are popular for land preparation and harvesting, respectively.

(4) Holding Situation of Livestock

Holding situation of livestock in the related communes is shown as follows:

Table AC-2.4.2.3.7 Inventory of Livestock in the Related Communes (Unit: Head)

Livestock	Cow	Buffalo	Pig	Chicken	Duck
1. Basedth	7,015	23	1,744	14,396	2,372
2. Pheari Mean Chey	3,121	0	1,071	10,278	338
3. Pou Mreal	5,204	50	1,741	30,896	3,406
4.Tuol Ampil	4,959	0	2,025	18,443	2,846
5. Kak	4,216	26	787	7,526	1,608
6. Preah Khae	3,422	53	1,377	7,503	1,563
7. Kat Phluk	5,428	383	1,728	8,932	908
8. Niteam	4,693	11	779	8,214	2,978
Total	38,058	546	11,252	106,188	16,019

Source: Inventory of livestock, DAO Basedth District 2012

AC-2.4.3 Weaknesses of Paddy Production in the Target Area

Through interview to staff of District Agricultural Office as well as farmers, the following constraints were identified.

Table AC-2.4.3.1 Constraints on Paddy Cultivation

Subject	Constraints
(1) Farming Practices	Crop damage due to pests and diseases
	Farm inputs are high-priced.
	Dosage of fertilizer is not enough.
	Application timing is not suitable.
	No. of seedlings per hill on transplanting is too much.
(2) Physical Conditions	No water management
	Shortage of irrigation water in early rainy and dry seasons
(3) Marketing	Low market price of paddy
	Unstable market price of paddy
	It is difficult to negotiate price with rice millers

Source: JICA Survey Consultant, 2012

It is proposed that agricultural extension services should be strengthened, in order to improve or minimize the constraints mentioned above.

AC-2.4.4 Examination of Previous Development Plan

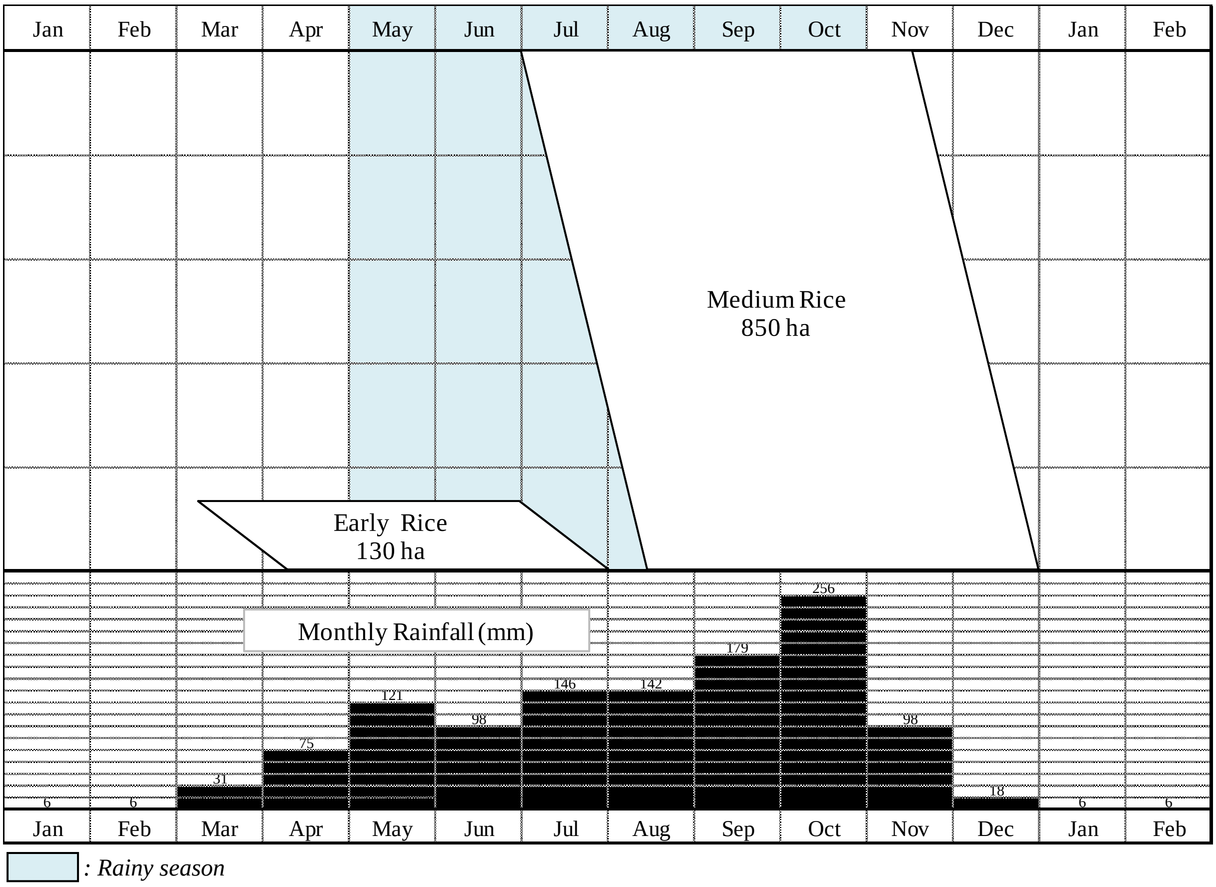
(1) Agricultural Development

The agricultural development plan proposed in 2009 was reviewed through the site visit, analysis on the latest data and information collected 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 AC-2.4.4.1 Review on Agricultural Development Plan

Item	Proposal in 2009	Review in 2011
(a) Project area	(i) Sub-project area of 3,018 was estimated in the proposal.	(i) The proposed area of 3,018 ha was changed into 1,935 ha (Zone-A) through discussion with MOWRAM/PDOWRAM. Further this area was squeezed up to 900ha, according to the water balance study.
(b) Cropping Pattern and cultivated area	(i) No cropping pattern (ii) Unit cost on increase of agricultural input for existing cultivated area: US$ 50/ha (iii)Cultivated area is shown as follows: Before rehabilitation - Rainy season: 3,018 ha After rehabilitation - Early rainy season 120 ha - Rainy season 3,018 ha - Dry season 250 ha (iv)Cropping intensity: 112%	(i) Based on some interview to PDOWRAM, PDA, DAO, and farmers, proposed cropping pattern was prepared as shown in Figure AC-2.4.4.1. (ii) Breakdown on unit cost of US$ 50/ha is not available. Therefore, Present and proposed production costs of paddy could be estimated, based on production costs in RCHRSP, USISRSP and KSBISRSP, and interview to DAO and farmers. (iii)Proposed areas for early rainy and dry seasons or 120ha and 250ha are not confirmed. It is necessary to do water balance study. (iv)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 to secure the maximum irrigated area in rainy season. Further cropping intensity should be increased, if water is still available.
(c) 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
(d) Unit Yield of Paddy	(i) Target unit yield of paddy was estimated as follows: Before rehabilitation - Rainy season: 1.8 ton/ha After rehabilitation - Early rainy season: 3.0 ton/ha - Rainy season: 2.5 ton/ha - Dry season: 3.0 ton/ha (ii) These yields are estimated, based on the interview to farmers, but not from PDA and DAO.	(i) 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.
(e) Agricultural Extension Service	In the proposal, cost for implementation of agricultural extension service 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 US$ 12/ha. Namely US$ 10/ha is reasonable.

Source: JICA Survey Team



Source: JICA Survey Team

Figure AC-2.4.4.1 Proposed Cropping Pattern for MC35RSP

(2) 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 HH income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under the 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:

(i) Training materials including guideline, pamphlet, handout, poster, etc. are available[9]. 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 filing in District Agricultural Office;

(ii) If training materials are filed in the office, it is not necessary to newly prepare them every cropping season. Actually there are no files in the office. Therefore, training materials are required to be prepared every time; and

(iii) Purpose and target of implementation of demonstration is not clear. Further there are no monitoring activities after completion of demonstration activities. Namely, the purpose of

9 Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF.

training activities might be to implement demonstration activities, not for dissemination of proposed farming practices.

Considering the current situation mentioned above, the following training activities would be proposed for smooth implementation of demonstration activities:

(i) Preparation of action plan for demonstration activities;
(ii) Preparation of training materials;
(iii) Preparation of guideline on demonstration activities, based on the existing materials[10]; an.
(iv) Filing of training materials.

Furthermore, it is proposed that exchange of materials and information as well as cooperation among PDAs and DAOs be facilitated periodically.

AC-2.4.5 Agricultural Development Plan

AC-2.4.5.1 Present and Future Command Area

Land use in the command area is shown in the following table.

Table AC-2.4.5.1.1 Present and Future Land Use in the Command Area (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 Season	Early Rainy	Rainy Season		
Irrigated Paddy Field	Low land	50	-	-	50	-	50	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	0	900	0	900	900	0	130	850	0	980
Cropping Intensity (%)							100						115

Source: JICA Survey Team

AC-2.4.5.2 Farming Practices and Input Requirement for Major Crops

Proposed farming practices as well as farm input requirement were clarified through the interview to the related institutes and farmers, as shown in Table AC- 2.4.2.3.4. In principle, it is not necessary to change major practices as well as major requirement, although minor adjustment on input requirement was done. Present and proposed updated crop budgets for majors are shown in Tables AC-2.4.5.2.1 and AC-2.4.5.2.2.

AC-2.4.5.3 Crop Production under Present and With-project Conditions

Current yield and target yield of paddy in MC35RSP Area were settled, based on the statistical data of PDA as well as DAO, and data from RCHRSP as well as USISRSP, as follows:

Table AC-2.4.5.3.1 Present and Proposed Unit Yield of Paddy (Unit: ton/ha)

Category	Present / Without-project*1	With-project*2
(1) Early Rainy Season		
- Early rice (irrigated)		4.0
(2) Rainy Season		

10 *Refer Attachment 5 of ANNEX C*

Category	Present / Without-project*1	With-project*2
- Medium rice (irrigated)	2.13	3.5
- Medium rice (rainfed)	2.09	-

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 RCHRSP*
Source: JICA Survey Team,

Based on the assumption on unit yield and cultivated area mentioned above, current and target production in this sub-project area is shown as follows:

Table AC-2.4.5.3.2 Present and Proposed Paddy Production

Paddy	Present / Without-project Condition			With-project Condition			Increment Production (ton)
	Area (ha)	Unit Yield (ton/ha)	Production (ton)	Area (ha)	Unit Yield (ton/ha)	Production (ton)	
(1) Early Rainy Season							
- Early rice (irrigated)				130	4.0	520	520
(2) 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

Source: JICA Survey Team

AC-2.4.6 Strengthening of Agricultural Extension Services

AC-2.4.6.1 Basic Approach

Mission of agricultural extension services is to increase unit yield of paddy and improve paddy production in the sub-project area. Therefore, it is strongly proposed that farmers should be trained in order to improve their skills on paddy cultivation, and promote crop diversification. Furthermore, through training programs, it is expected that skills on water management as well as maintenance of irrigation facilities be transferred to famers.

Meanwhile, it is judged that staffs of DAO and PDA have some experience and knowledge for implementation of extension activities. However, it is highly necessary to obtain more experience and knowledge, in order to formulate annual action plan for extension services, and carry out extension activities more effectively and smoothly.

AC-2.4.6.2 Development Strategies and Scope of Intervention

(1) Development Strategies

The development strategies are specified as follows;

(i) In principle, constraints on paddy production, which are specified in Section AC-2.1.3, should be improved or minimized through extension activities, in order to increase rice production and income;

(ii) Intensive introduction of agricultural extension services is to be envisioned with the aim of attaining the project target at an early stage as possible;

(iii) Extension service should be carried out effectively and smoothly, applying an annual cycle of "Plan – Do – Check – Act". Activities of each component in this cycle are indicated as follows:

- Plan: Annual action plan of extension service should be formulated, considering the constraints as well as proposed activities as shown in the following table;

Table AC-2.4.6.2.1 Constraints on Paddy Cultivation and Proposed Extension Services in MC35RSP

Subject	Constraints	Activities to be Proposed for Extension Services	
		Subjects	Ways to be required
(a) Farming Practices	1) Crop damage due to pests and diseases	- Introduction of IPM	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour
	2) Low paddy yield	- Proposed farming practices - Introduction of quality seeds	
	3) Weed problem	- Introduction of IPM	
	4) Improper farming practices	- Proposed farming practices	
(b) Water management	1) Shortage of irrigation water	- Rehabilitation of irrigation facilities - Improvement of water management	- Rehabilitation work - Training for water management
	2) Drainage problem	- Rehabilitation of drainage facilities	
(c) Marketing	1) Unstable and low market price of products	- Selection of profitable varieties - Selection of other profitable crops - Adjustment of harvesting season - Shipping control - Strengthening bargaining power of famers	- Lecture (short training) - Mass guidance / workshop
	2) Expensive farm inputs	- Proposed farming practices	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour

Source: JICA Survey Team

Targets of each extension activity as well as annual plan are obviously required. Further, in order to carry out extension services, extension materials such as guideline, handouts, etc. are highly required. Those materials should be prepared by extension staff of PDA and DAO, referring the existing materials[11], which were prepared by the central government or other supporting organizations such as international organizations, donors, NGOs, etc.;

- Do: Extension services should be implemented based on the plan mentioned above;
- Check: Extension activities should be measured, and thus those results could be compared with the targets shown in the "Plan". Some differences could be analyzed to clarify those root causes. Major points for this checking are shown as follows:

  - Adaptability of extension service plan;
  - Management on implementation of extension activities;
  - Progress on the extension service activities;
  - Results of the extension service activities; and
- Act: Based on the results in the checking mentioned above, scope as well as target for the next extension activities could be refined.

(2) Scope of the Intervention

The plan is formulated for the period of 4 years from 2017 to 2020, aiming at improvement of farmers' skills as well as experience through strengthening agricultural extension services. Such services should be provided by extension staff of PDA and DAO through the Project Implementation Unit. The envisioned major activities under the plan include: (i) field programs and farmer/farmer group training programs aiming at improvement of farmers' capability and skills on irrigated agriculture farming practices and water management; and (ii) empowerment and motivation of farmers including village extension workers (VEWs). Further, it is required that skills and experience of extension staff be strengthened by intervention of national consultant as well as foreign consultant.

11 Refer Attachment 5 of ANNEX C

AC-2.4.6.3 Strengthening Plan of Agricultural Extension Services

(1) Proposed Agricultural Extension Services

Agricultural support services required for the promotion of adoption of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage are shown in Table AC-2.1.6.3.1.

Logical matrix of major activities on extension services are shown in Table AC-2.1.6.3.2, and further framework of extension services are shown as follows:

Table AC-2.4.6.3.1 Framework of Extension Services for MC35RSP

Activities	Size	Times per group	Frequency
(a) Training of Trainers	10 staff	1 time	4 times per 4 years (once a year)
(b) Field Programs			
1) Demonstration Plots (irrigated)			
- Paddy cultivation	0.1 to 0.2 ha	2 plots per FWUG	- 8 plots/ 4 FWUGs/ 3years - 2 to 4 plots/year
- Upland crops cultivation	0.1 ha	1 plot per FWUG	- 4 plots/ 4 FWUGs/ year
- Vegetable cultivation	0.1 ha	1 plot per FWUG	- 4 plots/ 4 FWUGs/ 2 years - 2 plots/ year
2) Water management			
- Paddy cultivation	One tertiary block	2 times per FWUG	- 8 times / 4 FWUGs/ 3years - 2 to 4 times /year
(c) Farmer/Farmer Group Training Programs			
1) Training course	2-day course	1 time per FWUG	- 4 times/ 4 FWUGs/ 4 years - 1 time/ year
2) FFS/ IPM	30 participants	1 time per FWUG	- 4 times/ 4 FWUGs/ 4 years - 1 time/ year
3) Study tour	30 participants	1 time per FWUG	- 4 times/ 4 FWUGs/ 4 years - 1 time/ year
(d) Mass Guidance/Workshop	30 participants	2 time per FWUG	- 8 times/ 4 FWUGs/ 4 years - 2 times/ year

Note: around 200 ha for one FWUG, around 18 FWUGs in USISRSP
Source: JICA Survey Team

(2) Assignment of Foreign and National Consultants

Foreign consultant in collaboration with national consultant conducts preparatory work before implementation of training of trainers and training of farmers. Namely, those consultants prepare guidelines on preparation of annual action plan as well as checking and analysis for work progress of training of farmers. Those guidelines are used in training of trainers for extension staff of PDA and DAO. Therefore, extension staff could arrange extension materials such as hand-outs as well as any other materials for farmers.

As shown in Table AC-2.1.6.3.4, it is proposed that preparatory work and training of trainers be carried out as task work of foreign consultant as well as national consultant. Meanwhile regarding training of farmers, national consultant has to support training of farmers to be carried out by extension staff of PDA and DAO, as assistant work. Further, national consultant checks and analyzes work progress and performance on training of farmers, and propose some actions as well as attentions for training activities in the following season as task work.

Assignment period of foreign and national consultants are shown as follows:

Table AC-2.4.6.3.2 Assignment Period of Consultants to be Required for MC35RSP

(Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
(a) Preparatory work	0.1	0.06	-	0.06	-	0.06	-	0.06	0.1	0.24
(b) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
(c) Training of farmers	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(d) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
Total	0.3	0.86	-	0.86	-	0.86	-	0.86	0.3	3.44

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(3) Proposed Budgets of Extension Activities

Furthermore, budgets for each extension activity are shown in Table AC-2.1.6.3.4. Implementation and cost schedule of the proposed agricultural extension services strengthening plan was prepared based on the above conditions as well as budgets, as shown in Table AC-2.4.6.3.3, thus summarized as follows:

Table AC-2.4.6.3.4 Estimated Direct Costs for Agricultural Extension Services for MC35RSP

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
(a) Trainers' Training	520	520	520	520	2,080
(b) Field Programs					
1) Demonstration Plots (irrigated)					
- Paddy cultivation	1,840	1,840	3,680	0	7,360
- Upland crops cultivation	0	0	3,600	0	3,600
- Vegetable cultivation	0	1,820	1,820	0	3,640
2) Water management					
- Paddy cultivation	3,220	3,220	6,440	0	12,880
(c) Farmer/Farmer Group Training Programs					
1) Training course	410	410	410	410	1,640
2) FFS/ IPM	1,580	1,580	1,580	1,580	6,320
3) Study tour	430	430	430	430	1,720
(d) Mass Guidance/Workshop	520	520	520	520	2,080
Total	8,520	10,340	19,000	3,460	41,320

Source: JICA Survey Team

The total direct costs required for implementation of such programs are estimated to be about US$41,320.

AC-2.5 Srass Prambai Water Recession Rehabilitation Sub-project

AC-2.5.1 Administrative Situation

SPWRRSP Area is located in Kaoh Thum District of Kandal Province as shown in Figure AC-2.5.1.1. Administrative situation for this Sub-project is shown in Table AC-2.5.1.1 and summarized as follows:

Table AC-2.5.1.2 List of Related Communes and Villages

Province	District	Communes	No. of Villages
Kandal	Kaoh Thum	1. Kampong Kong	11
		2. Kaoh Thum Ka	6
		3. Kaoh Thum Kha	5
		4. Leuk Daek	11
		5. Porthi Ban	9

Source: No. of villages: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

AC-2.5.2 Socio-economic Conditions

AC-2.5.2.1 Demographic Conditions

General characteristics of farm HHs in the related communes are shown below.

Table AC-2.5.2.1.1 General Characteristics of Farm Households

Communes	Total Population (person)	Total No of HH	Average Family Size (person)	Working-age Population (person)	Literacy Rate (%)
1. Kampong Kong	11,450	2,430	4.7	6,945	79.3
2. Kaoh Thum Ka	5,424	1,255	4.4	3,224	80.4
3. Kaoh Thum Kha	6,784	1,545	4.4	4,466	92.0
4. Leuk Daek	13,176	2,818	4.6	7,856	76.8
5. 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

AC-2.5.2.2 Living Conditions

(1) Water for Drinking

Actual situation on sources and locations on drinking water in the related communes is shown as follows:

Table AC-2.5.2.2.1 Source of Drinking Water (Unit: HH)

Commune	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

As shown in the above table, major source of drinking water in the related communes is spring, river, stream, etc. While piped water as well as wells are also relatively common.

Table AC-2.5.2.2.2 Location of Drinking Water (Unit: HH)

Commune	Type of Sources			
	Within the premises	Near the premises	Away from the premises	Total
1. Kampong Kong	459	1,037	934	2,430
2. Kaoh Thum Ka	179	813	263	1,255
3. Kaoh Thum Kha	878	430	237	1,545
4. Leuk Daek	288	2,299	231	2,818
5. Porthi Ban	115	1,748	533	2,396

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Regarding availability of drinking water, source of drinking water is relatively near the promises, except Kampong Kong Commune.

(2) Type of Fuel for Cooking

Sources of fuel for cooking are shown as follows:

Table AC-2.5.2.2.3 Source of Fuel for Cooking (Unit: HH)

Commune	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

As mentioned in the above table, major fuel for cooking is firewood. Firewood is available in market, while gathering firewood from surrounding area of farmers' houses is also common.

(3) Type of Sources for Lighting

Recently city power has become common in Kaoh Thum Kha Commune, however battery and kerosene are still common in the related commune as shown in the following table:

Table AC-2.5.2.2.4 Source of Lighting (Unit: HH)

Commune	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

AC-2.5.2.3 Agricultural Activities

(1) Land Use in the Sub-project Area

Land use in the sub-project area is shown in the following table.

Table AC-2.5.2.3.1 Present Land Use in the Sub-project Area (Unit: ha)

Land Use		Physical Land	Cultivated Area				
			Paddy by Season			Upland Crops	Total
			Dry	Early Rainy	Rainy		
Irrigated Paddy Field	Low land	-	-	-	-	-	-
	Recession area	700	700	-	-	-	700
Rainfed Paddy Field		-	-	-	-	-	-
Upland Field		-	-	-	-	-	-
Non-agricultural Land		-	-	-	-	-	-
Fallow land		500	-	-	-	-	-
Total		1,200	700	-	-	-	700
Cropping Intensity (%)							58

Source: JICA Survey Team

(2) Paddy Cultivation and Production in the Project Area

This sub-project area is a kind of recession area of paddy cultivation. 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. Paddy productivity is relatively high as shown in Table AC-2.5.2.3.2 and summarized as follows:

Table AC-2.5.2.3.3 Paddy Cultivation in the Related Communes (2009/10)

Commune	Wet Season			Dry Season			Total	
	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
1. Kampong Kong	592	3.96	2,344	1,400	4.50	6,300	1,992	8,371
2. Kaoh Thum Ka	204	3.49	711	50	4.00	200	254	503
3. Kaoh Thum Kha	218	3.22	702	50	4.00	200	268	908
4. Leuk Daek	25	4.00	100	750	4.50	3,375	775	3,475
5. Porthi Ban	64	3.50	224	850	4.25	3,612	914	3,836
Total	1,103	3.70	4,081	3,100	4.42	13,687	4,203	17,093

Source: District Agricultural Office 2012

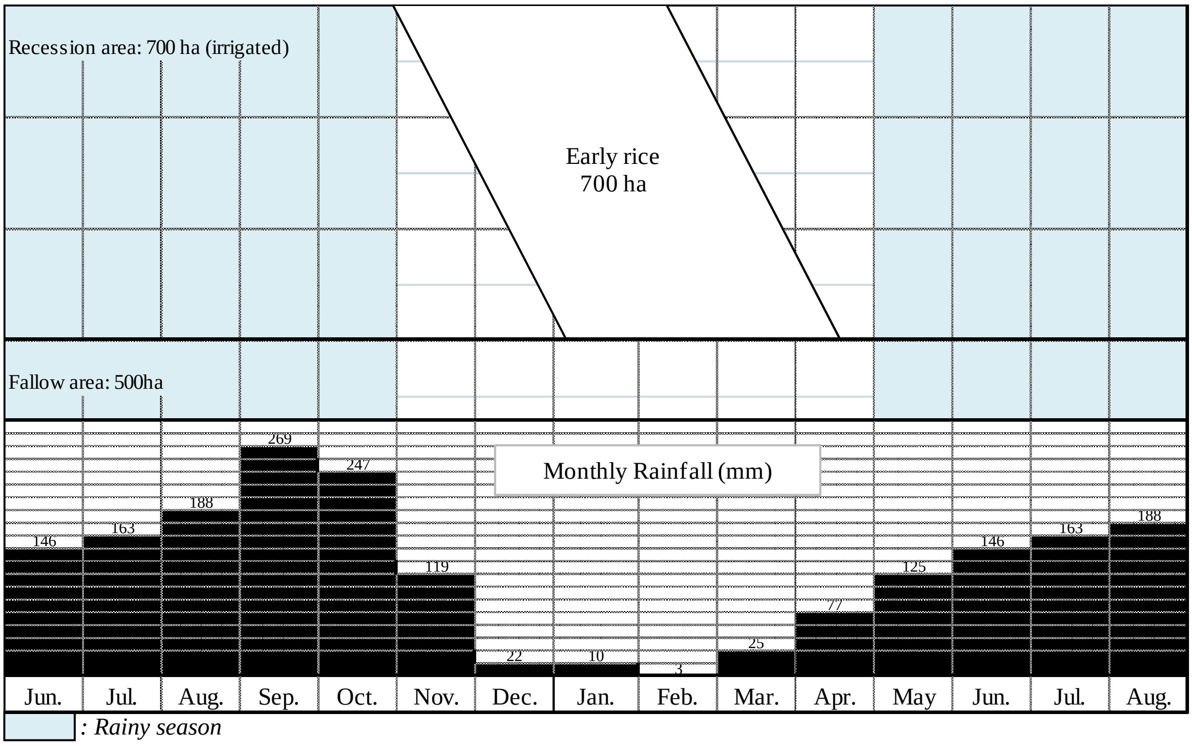
Paddy cultivation in this recession area is carried out under fully irrigated condition with pumping up flooded water from the existing canals. Currently, it is difficult to control the water level of flooded water in the existing canals as well as reservoir due to poor function of irrigation facilities. Current and proposed farming practices for paddy cultivation is shown in Table AC- 2.5.2.3.4, and cropping calendar of paddy cultivation in the recession area is shown as follows:

Table AC-2.5.2.3.5 Cropping Calendar of Paddy Cultivation in SPWRRSP Area

Period	Activities	Remarks
August (Beginning)	Land preparation (only plowing) before flooding (Plowing by hand tractor or 4-wheel tractor)	- Flooding in paddy field starts. - Plowing by 4-wheel tractor (80%) and hand tractors (20%)
September to October	No activities due to flooded condition	- Peak season of flooding
November to December	Land preparation (Harrowing and leveling) Sowing (Direct sowing)	- Harrowing and leveling by hand tractor (80%), while 20%. by 4-wheel tractor. - When farm machinery cross canal, boats are used. - Direct sowing is common. It is said that area for transplanting is small (1 to 2 %). - Major variety is early varieties such as Vietnamese variety (name:504) and IR66 - Early varieties to be applied - Paddy cultivation to be continued, depending on reduction of water level. - Irrigation is indispensable. - Daily water reducing rate: 1 to 2 cm
January to February	Management of paddy growing	- There are no serious insects and diseases. - Daily water reducing rate: around 10 cm
February (late) March April (begging)	Cutting Threshing Transportation	- Cutting by rented reaper is common. - Threshing by rented engine thresher is common in this area. - For transportation, traders come to farmers' fields and buy products. - Traders don't mind moisture content of paddy. Therefore buying price is slightly lower, compared with other area. - Harvesting in the beginning of April is very limited or not more than 20% out of total harvested area. - Number of thresher in the related communes is not enough, but it is easy to hire it from other communes.
April to July	No activities due to shortage of water	- Paddy cultivation might face several damages by rats, insects, when harvesting is delayed. - Normally, water in canals is very limited. If water is available, farmers cultivate some upland crops, lotus, etc.

Source: JICA Survey Team

Present cropping pattern in the area is shown as follows:



Source/: JICA Survey Team

Figure AC-2.5.2.3.1 Present Cropping Pattern for SPWRRSP

Dry Season Cropping of Paddy

Dry Season Cropping of Paddy

Thresher (local made)

Harvesting by Reaper

(3) Inventory of Farm Machinery

In the Sub-project area, major farming practices such as land preparation, cutting and threshing are done by small machine. Inventory of farm machinery is shown as follows:

Table AC-2.5.2.3.6 Inventory of Farm Machinery in the Related Communes (Unit: no(s).)

Commune	4-wheel Tractor	Hand Tractor	Pump	Reaper	Engine thresher	Rice miller	
						small	large
1. Kampong Kong	8	33	624	22	12	0	12
2. Kaoh Thum Ka	3	5	29	0	1	6	0
3. Kaoh Thum Kha	13	2	35	0	0	6	0
4. Leuk Daek	3	49	5	7	6	5	0
5. Porthi Ban	2	35	1,226	8	11	12	0
Total	29	124	1,919	37	30	29	12

Source: DAO, Kaoh Thum District, 2012

(4) Holding Situation of Livestock

Holding situation of livestock in the related communes is shown as follows:

Table AC-2.5.2.3.7 Inventory of Livestock in the Related Communes (Unit: head)

Commune	Type of Livestock				
	Cattle	Buffalo	Pig	Chicken	Duck
1. Kampong Kong	1,181	0	1,333	9,493	2,133
2. Kaoh Thum Ka	537	0	1,166	4,912	515
3. Kaoh Thum Kha	589	0	627	1,540	249
4. Leuk Daek	863	0	3,579	11,983	949
5. Porthi Ban	1,251	0	1,339	2,834	1,548

Source: DAO, Kaoh Thum District, 2012

AC-2.5.3 Weaknesses of Paddy Production in the Target Area

Through interview to staff of District Agricultural Office as well as farmers, the following constraints are identified.

Table AC-2.5.3.1 Constraints on Paddy Cultivation

Subject	Constraints
(1) Farming Practices	Weed problem
	Crop damage due to pests and diseases (mainly Brown Plant Hopper)
	Seed amount is too much.
	Dosage of fertilizer is not enough.
	Application timing is not suitable.
(2) Physical Conditions	Lack of access roads to paddy fields
	Shortage of water in February
	No function of reservoir
	No water control in canals
	High fuel cost for pumping operation
(3) Marketing	Low market price of paddy
	Unstable market price of paddy
	Price negotiation with traders is difficult.

Source: JICA Survey Team, 2012

It is proposed that agricultural extension services should be strengthened, in order to improve or minimize the constraints mentioned above.

AC-2.5.4 Examination of Previous Development Plan

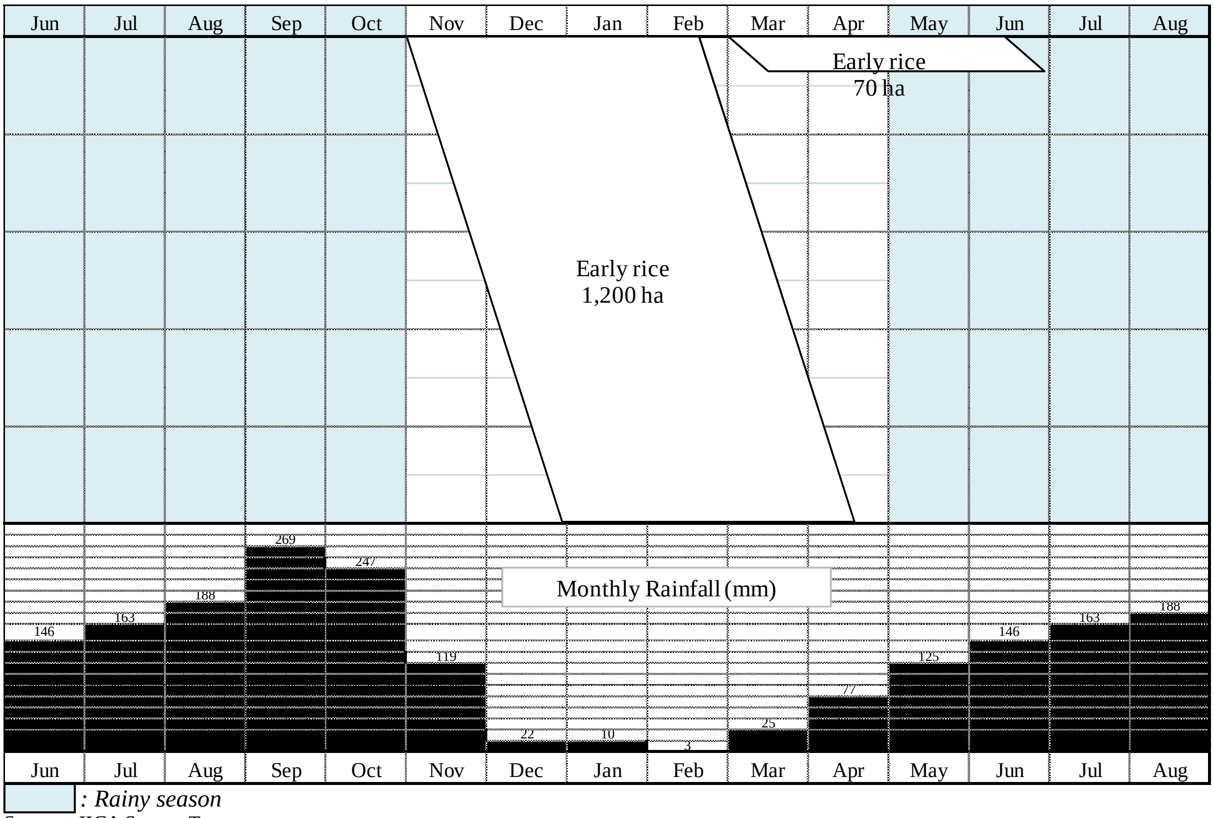
(1) Agricultural Development

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 AC-2.5.4.1 Review on Agricultural Development Plan

Item	Proposal in 2009	Review in 2011
(a) Project area	Sub-project areas: Before rehabilitation - Dry season: 700 ha After rehabilitation - Dry season 1,200 ha	a) Sub-project area should be fixed. b) Sub-project areas before and after rehabilitation should be same. Namely balance before and after rehabilitation is 500ha. Its current situation of land use is not clear. JICA survey team judged that the remaining area of 500 ha is fallow land.
(b) Cropping Pattern and cultivated area	1) No cropping pattern 2) In the proposal, there is no mention about unit cost on increase of agricultural input for existing cultivated area. 3) Cultivated area: PDOWRAM expected paddy cultivation in the 2nd dry season.	a) Based on some interview to PDOWRAM, PDA, DAO, and farmers, proposed cropping pattern was prepared as shown in Figure AC-2.5.4.1. b) Breakdown on unit cost on increase of agricultural input for existing cultivated area is not available. Therefore, present and proposed production costs of paddy were estimated as shown in Tables AC-2.5.4.2 and AC-2.5.4.3, 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 to secure the maximum irrigated area in dry season. Further cropping intensity should be increased, if water is still available.
(c) 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
(d) Unit Yield of Paddy	1) Target unit yield of paddy was estimated at 3.2 ton/ha before rehabilitation, while 3.5 ton/ha after rehabilitation. 2) 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. More yield level must be recommended.

Source: JICA Survey Team



Source: JICA Survey Team

Figure AC-2.5.4.1 Proposed Cropping Pattern for SPWRRSP

(2) 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 HH income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under the project. 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:

(i) Training materials including guideline, pamphlet, handout, poster, etc. are available[12]. 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 filing in District Agricultural Office;

(ii) If training materials are filed in the office, it is not necessary to newly prepare them every cropping season. Actually there are no files in the office. Therefore, training materials are required to be prepared every time; and

(iii) Purpose and target of implementation of demonstration is not clear. Further there are no monitoring activities after completion of demonstration activities. Namely the purpose of training activities might be to implement demonstration activities, not for dissemination of proposed farming practices.

Considering the current situation mentioned above, the following training activities would be proposed for smooth implementation of demonstration activities:

(i) Preparation of action plan for demonstration activities;

(ii) Preparation of training materials;

(iii) Preparation of guideline on demonstration activities, based on the existing materials[13]; and.

(iv) Filing of training materials.

Furthermore, it is proposed that exchange of materials and information as well as cooperation among PDAs and DAOs be facilitated periodically.

AC-2.5.5 Agricultural Development Plan

AC-2.5.5.1 Present and Future Command Area

In the development plan, the area will be fully developed as shown in the below table.

Table AC-2.5.5.1.1 Present and Future Land Use in the Command Area (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	-	-	-	-	-	0	-	-	-	-	-	0
	Recession area	700	700	-	-	-	700	1,200	1,200	70	-	-	1,270
Rainfed Paddy Field		-	-	-	-	-	0	-	-	-	-	-	0
Upland Field		-	-	-	-	-	0	-	-	-	-	-	0
Non-agricultural Land		-	-	-	-	-	0	-	-	-	-	-	0
Fallow Land		500	-	-	-	-	0	-	-	-	-	-	0
Total		1,200	700	0	0	0	700	1,200	1,200	70	0	0	1,270
Cropping Intensity (%)							58						106

Source: JICA Survey Team,

12 *Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF.*
13 *Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF*

AC-2.5.5.2 Farming Practices and Input Requirement for Major Crops

Proposed farming practices as well as farm input requirement were clarified through the interview to the related institutes and farmers, as shown in Table AC- 2.5.2.3.4. In principle, it is not necessary to change major practices as well as major requirement, although minor adjustment on input requirement was done. Present and proposed updated crop budgets for majors are shown in Tables AC-2.4.5.2.1 and AC-2.4.5.2.2..

AC-2.5.5.3 Crop Production under Present and With-project Conditions

Current and proposed yield levels as well as target yield of paddy in each category of paddy field in the SPWRRSP area were fixed, based on the statistical data of PDA as well as DAO, and the results of interview to farmers, as follows:

Table AC-2.5.5.3.1 Present and Proposed Unit Yield of Paddy (Unit: ton/ha)

Category	Present / Without-project*1	With-project*1
(1) Dry Season		
- Early rice	3.5	5.0
(2) Early Rainy Season		
- Early rice	-	5.0

Note
**1: considered the result of field investigation including interviews to farmers*
**2: considered the result of field investigation including interviews to farmers and statistical data*
Source: JICA Survey Team,

Based on the assumption on unit yield mentioned above, target production is shown as follows:

Table AC-2.5.5.3.2 Present and Proposed Paddy Production

Paddy	Present / Without-project Condition			With-project Condition			Increment Production (ton)
	Area (ha)	Unit Yield (ton/ha)	Production (ton)	Area (ha)	Unit Yield (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

Source: JICA Survey Team

AC-2.5.6 Strengthening of Agricultural Extension Services

AC-2.5.6.1 Basic Approach

Mission of agricultural extension services is to increase unit yield of paddy and improve paddy production in the sub-project area. Therefore, it is strongly proposed that farmers should be trained in order to improve their skills on paddy cultivation, and promote crop diversification. Furthermore, through training programs, it is expected that skills on water management as well as maintenance of irrigation facilities be transferred to famers.

Meanwhile, it is judged that staffs of DAO and PDA have some experience and knowledge for implementation of extension activities. However, it is highly necessary to obtain more experience and knowledge, in order to formulate annual action plan for extension services, and carry out extension activities more effectively and smoothly.

AC-2.5.6.2 Development Strategies and Scope of Intervention

(1) Development Strategies

The development strategies are specified as follows;

(i) In principle, constraints on paddy production, which are specified in Section AC-2.1.3, should be improved or minimized through extension activities, in order to increase rice production and income.

(ii) Intensive introduction of agricultural extension services is to be envisioned with the aim of attaining the project target at an early stage as possible,

(iii) Extension service should be carried out effectively and smoothly, applying an annual cycle of "Plan – Do – Check – Act". Activities of each component in this cycle are indicated as follows:

- Plan: Annual action plan of extension service should be formulated, considering the constraints as well as proposed activities as shown in the following table;

Table AC-2.5.6.2.1 Constraints on Paddy Cultivation and Proposed Extension Services in SPWRRSP

Subject	Constraints	Activities to be Proposed for Extension Services	
		Subjects	**Ways to be required**
(a) Farming Practices	1) Crop damage due to pests and diseases	- Introduction of IPM	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour
	2) Low paddy yield	- Proposed farming practices - Introduction of quality seeds	
	3) Weed problem	- Introduction of IPM	
	4) Improper farming practices	- Proposed farming practices	
(b) Water management	1) Shortage of irrigation water	- Rehabilitation of irrigation facilities - Improvement of water management	- Rehabilitation work - Training for water management
	2) Drainage problem	- Rehabilitation of drainage facilities	
(c) Marketing	1) Unstable and low market price of products	- Selection of profitable varieties - Selection of other profitable crops - Adjustment of harvesting season - Shipping control - Strengthening bargaining power of famers	- Lecture (short training) - Mass guidance / workshop
	2) Expensive farm inputs	- Proposed farming practices	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour

Source: JICA Survey Team

Targets of each extension activity as well as annual plan are obviously required. Further, in order to carry out extension services, extension materials such as guideline, handouts, etc. are highly required. Those materials should be prepared by extension staff of PDA and DAO, referring the existing materials[14], which were prepared by the central government or other supporting organizations such as international organizations, donors, NGOs, etc.;

- Do: Extension services should be implemented based on the plan mentioned above;

- Check: Extension activities should be measured, and thus those results could be compared with the targets shown in the "Plan". Some differences could be analyzed to clarify those root causes. Major points for this checking are shown as follows:

  - Adaptability of extension service plan;

14 *Refer Attachment 5 of ANNEX C*

- Management on implementation of extension activities;
- Progress on the extension service activities;
- Results of the extension service activities; and

- Act: Based on the results in the checking mentioned above, scope as well as target for the next extension activities could be refined.

(2) Scope of the Intervention

The plan is formulated for the period of 4 years from 2017 to 2020, aiming at improvement of farmers' skills as well as experience through strengthening agricultural extension services. Such services should be provided by extension staff of PDA and DAO through the Project Implementation Unit. The envisioned major activities under the plan include: (i) field programs and farmer/farmer group training programs aiming at improvement of farmers' capability and skills on irrigated agriculture farming practices and water management; and (ii) empowerment and motivation of farmers including village extension workers (VEWs). Further, it is required that skills and experience of extension staff be strengthened by intervention of national consultant as well as foreign consultant.

AC-2.5.6.3 Strengthening Plan of Agricultural Extension Services

(1) Proposed Agricultural Extension Services

Agricultural support services required for the promotion of adoption of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage are shown Table AC-2.1.6.3.1.

Logical matrix of major activities on extension services are shown in Table AC-2.1.6.3.2, and further framework of extension services are shown as follows:

Table AC-2.5.6.3.1 Framework of Extension Services for SPWRRSP

Activities	Size	Times per group	Frequency
(a) Training of Trainers	10 staff	1 time	4 times per 4 years (once a year)
(b) Field Programs			
1) Demonstration Plots (irrigated)			
- Paddy cultivation	0.1 to 0.2 ha	2 plots per FWUG	- 12 plots/ 6 FWUGs/ 3years - 3 to 6 plots/year
- Upland crops cultivation	0.1 ha	1 plot per FWUG	- 6 plots/ 6 FWUGs/ 2 years - 2 to4 plots/ year
- Vegetable cultivation	0.1 ha	1 plot per FWUG	- 6 plots/ 6 FWUGs/ 2 years - 2 to4 plots/ year
2) Water management			
- Paddy cultivation	One tertiary block	2 times per FWUG	- 12 times / 6 FWUGs/ 3years - 3 to 6 times /year
(c) Farmer/Farmer Group Training Programs			
1) Training course	2-day course	1 time per FWUG	- 6 times/ 6 FWUG/ 3 years - 2 times/ year
2) FFS/ IPM	30 participants	1 time per FWUG	- 6 times/ 6 FWUG/ 3 years - 2 times/ year
3) Study tour	30 participants	1 time per FWUG	- 6 times/ 6 FWUG/ 3 years - 2 times/ year
(d) Mass Guidance/Workshop	30 participants	2 time per FWUG	- 12 times/6 FWUG/ 4 years - 3 times/ year

Note: around 200 ha for one FWUG, around 18 FWUGs in USISRSP
Source: JICA Survey Team

(2) Assignment of Foreign and National Consultants

Foreign consultant in collaboration with national consultant conducts preparatory work before implementation of training of trainers and training of farmers. Namely, those consultants prepare guidelines on preparation of annual action plan as well as checking and analysis for work progress of training of farmers. Those guidelines are used in training of trainers for extension staff of PDA and DAO. Therefore, extension staff could arrange extension materials such as hand-outs as well as any other materials for farmers.

As shown in Table AC-2.1.6.3.4, it is proposed that preparatory work and training of trainers be carried out as task work of foreign consultant as well as national consultant. Meanwhile regarding training of farmers, national consultant has to support training of farmers to be carried out by extension staff of PDA and DAO, as assistant work. Further, national consultant checks and analyzes work progress and performance on training of farmers, and proposes some actions as well as attentions for training activities in the following season as task work.

Assignment period of foreign and national consultants are shown as follows:

Table AC-2.5.6.3.2 Assignment Period of Consultants to be Required for SPWRRSP

(Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
(a) Preparatory work	0.1	0.06	-	0.06	-	0.06	-	0.06	0.1	0.24
(b) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
(c) Training of farmers	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(d) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(e) Total	0.3	0.86	-	0.86	-	0.86	-	0.86	0.3	3.44

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(3) Proposed Budgets of Extension Activities

Furthermore, budgets for each extension activity are shown in Table AC-2.1.6.3.4. Implementation and cost schedule of the proposed agricultural extension services strengthening plan was prepared based on the above conditions as well as budgets, as shown in Table AC-2.5.6.3.3, thus summarized as follows:

Table AC-2.5.6.3.4 Estimated Direct Costs for Agricultural Extension Services for SPWRRSP

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
(a) Training of Trainers	520	520	520	520	2,080
(b) Field Programs					
1) Demonstration Plots (irrigated)					
- Paddy cultivation	2,760	2,760	5,520	0	11,040
- Upland crops cultivation	0	1,800	3,600	0	5,400
- Vegetable cultivation	0	1,820	3,640	0	5,460
2) Water management					
- Paddy cultivation	4,830	4,830	9,660	0	19,320
(c) Farmer/Farmer Group Training Programs					
1) Training course	0	820	820	820	2,460
2) FFS/ IPM	0	3,160	3,160	3,160	9,480
3) Study tour	0	860	860	860	2,580
(d) Mass Guidance/Workshop	780	780	780	780	3,120
Total	8,890	17,350	28,560	6,140	60,940

Source: JICA Survey Team

The total direct costs required for implementation of such programs are estimated to be about US$60,940.

AC-2.6 Daun Pue Irrigation System Rehabilitation Sub-project

AC-2.6.1 Administrative Situation

DPISRSP Area is located in Teuk Phos District of Kampong Chhnang Province as shown in Figure AC-2.6.1.1. Administrative situation for this Sub-project is shown in Table AC-2.6.1.1 and summarized as follows:

Table AC-2.6.1.2 List of Related Communes and Villages

Province	District	Communes	No. of Villages
Kampong Chhnang	Teuk Phos	1. Chaong Maong	8
		2.Chieb	11
		3. Khlong Popok	7
		4. Akohivoadth	9
		5. Tang Krasang	12

Source: No. of villages: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

AC-2.6.2 Socio-economic Conditions

AC-2.6.2.1 Demographic Conditions

General characteristics of farm HHs in the related communes are shown below.

Table AC-2.6.2.1.1 General Characteristics of Farm Households (Unit: HH)

Communes	Total Population (person)	Total No of HH	Average Family Size (person)	Working-age Population (person)	Literacy Rate (%)
1. Chaong Maong	6,083	1,309	4.7	3,695	72.8
2.Chieb	6,706	1,419	4.7	3,728	70.9
3. Khlong Popok	5,459	1,247	4.4	3,383	78.4
4. Akohivoadth	8,703	1,829	4.7	5,253	68.4
5. 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

AC-2.6.2.2 Living Conditions

(1) Water for Drinking

Actual situation on sources and locations on drinking water in the related communes is shown as follows:

Table AC-2.6.2.2.1 Source of Drinking Water (Unit: HH)

Commune	Type of Sources							
	PW	TPW	DW	Rain	Sp/Ri	Bought	Others	Total
1. Chaong Maong	24	628	544	0	111	0	2	1,309
2.Chieb	40	837	328	11	200	0	3	1,419
3. Khlong Popok	11	1,063	131	1	39	0	2	1,247
4. Akohivoadth	25	1,129	498	53	38	14	72	1,829
5. 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

As shown in the above table, major sources for drinking water are wells including tube well and dug well and spring/river as well. Meanwhile, there is no difference on availability of drinking water as shown in the following table.

Table AC-2.6.2.2.2 Location of Drinking Water (Unit: HH)

Commune	Type of Sources			
	Within the premises	Near the premises	Away from the premises	Total
1. Chaong Maong	427	431	451	1,309
2.Chieb	411	682	326	1,419
3. Khlong Popok	365	645	237	1,247
4. Akohivoadth	714	718	397	1,829
5. Tang Krasang	659	638	673	1,970

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

(2) Type of Fuel for Cooking

Sources of fuel for cooking are shown as follows:

Table AC-2.6.2.2.3 Source of Fuel for Cooking (Unit: HH)

Commune	Type of Sources					
	Firewood	Charcoal	Gas Cylinder	Electricity	Others	Total
1. Chaong Maong	1,301	2	2	0	4	1,309
2.Chieb	1,403	3	3	0	10	1,419
3. Khlong Popok	1,228	12	6	0	1	1,247
4. Akohivoadth	1,652	146	15	0	16	1,829
5. Tang Krasang	1,953	4	7	0	6	1,970

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

As mentioned in the above table, major fuel for cooking is firewood. Firewood is available in market, while gathering firewood from surrounding area of farmers' houses is also common.

(3) 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 AC-2.6.2.2.4 Source of Lighting (Unit: HH)

Commune	Sources of Lighting						
	City Power	Generator	Kerosene	Candle	Battery	Others	Total
1. Chaong Maong	4	7	1,152	0	144	2	1,309
2.Chieb	17	5	1,021	1	372	3	1,419
3. Khlong Popok	11	7	918	0	310	1	1,247
4. Akohivoadth	24	425	1,190	1	182	7	1,829
5. 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

AC-2.6.2.3 Agricultural Activities

(1) Land Use in the Sub-project Area

Land use in the sub-project area is shown in the following table.

Table AC-2.6.2.3.1 Present Land Use in the Sub-project Area (Unit: ha)

Land Use		Physical Land	Cultivated Area				
			Paddy by Season			Upland Crops	Total
			Dry	Early Rainy	Rainy		
Irrigated Paddy Field	Low land	-	-	-	-	-	-
	Recession area	-	-	-	-	-	-
Rainfed Paddy Field		1,060	-	-	1,060	-	1,060
Upland Field		-	-	-	-	-	-
Non-agricultural Land		-	-	-	-	-	-
Fallow land		150	-	-	-	-	-
Total		1,210	700	-	1,060	-	1,060
Cropping Intensity (%)							88

Source: JICA Survey Team

Paddy Field in Daun Pue Area
(Buffalo as draft animal is common)

Paddy Field in Daun Pue Area

(2) Paddy Cultivation and Production in the 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.

Current situation of paddy production in the District is shown in Table AC-2.6.2.3.2 and summarized as follows:

Table AC-2.6.2.3.3 Paddy Cultivation during the Rainy Season in the Related Communes

Commune	2007		2008		2009		2010		2011	
	ha	ton	ha	ton	ha	ton	ha	ton	ha	ton
1. Chaong Maong	2,335	6,520	2,421	6,833	2,335	5,579	2,294	6,550	2,494	8,437
2.Chieb	2,771	7,252	2,776	7,465	2,726	5,938	2,662	7,241	2,885	8,908
3. Khlong Popok	1,923	5,155	2,021	5,185	2,011	4,374	1,988	5,202	2,216	6,947
4. Akohivoadth	2,998	7,896	3,156	8,030	3,186	7,426	3,111	8,471	3,252	10,468
5. Tang Krasang	2,955	8,218	2,869	8,047	2,858	6,712	2,793	7,757	2,924	9,192
Total	12,982	35,041	13,243	35,560	13,116	30,029	12,848	35,221	13,771	43,952

Note: ha: Harvested area, ton: Production
Source: Data on paddy production 2007/08, 2008/09, 2009/10, 2010/11, 2011/12, DAO Teuk Phos District, 2012

Rainy season cropping is mainly from June to December. Medium rice and late rice are cultivated under rainfed condition, while paddy cultivation with supplementary irrigation is also carried out in the limited area near the river intake, but not every year. However, double cropping of paddy is not available due to shortage of river water. Typical current farming practices for paddy cultivation is shown in Table AC-2.6.2.3.4

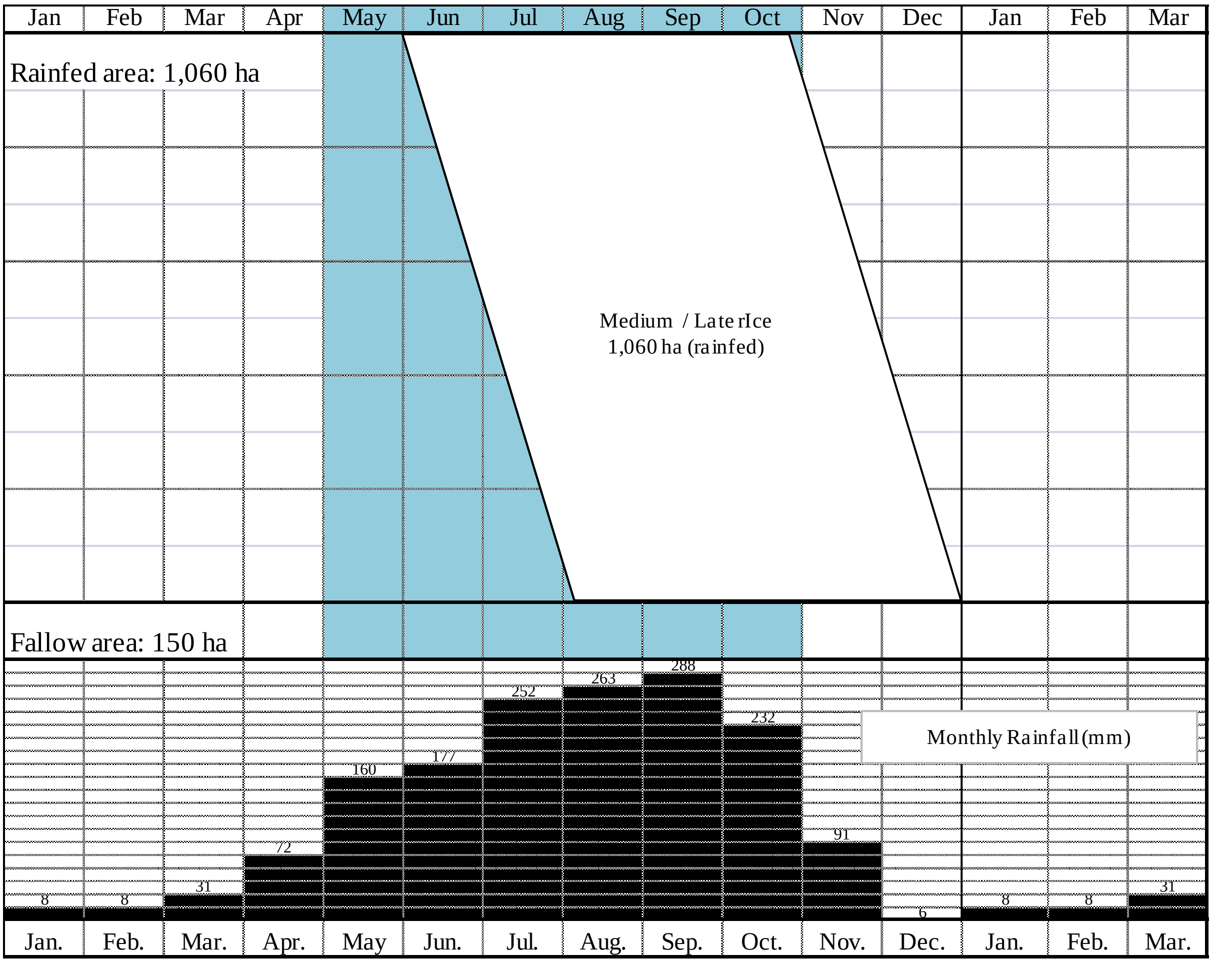
Cropping calendar of paddy cultivation in the recession area is shown as follows:

Table AC-2.6.2.3.5 Cropping Calendar of Paddy Cultivation for DPISRSP

Period	Activities	Remarks
June and July	Land preparation Nursery preparation	- by hand tractor or buffalo (50% :50%)
Late June to beginning August	Transplanting	-seedling age: 20 to 30 days -Direct sowing is not common in the sub-project area. - Man-power for transplanting is enough.
July to September	Management of paddy growing	-There are no serious insects and diseases.
November to December	Cutting Threshing Transportation	-Manual cutting is common. - Cooperative work among farmers is common. -Threshing by man-power at farmers' home yard is common in this area. -For transportation, traders come to farmers' houses and buy products directly. Or farmers bring them to rice millers at Kampong Chhnang. -Traders don't mind moisture content of paddy. Therefore buying price is slightly lower.
January to June	Off-season for paddy cultivation	- Temporary job: Factory, construction worker, sugar palm, etc.

Source: JICA Survey Team

Current cropping pattern is shown as follows:



: *Rainy season*

Source: JICA Survey Team

Figure AC-2.6.2.3.1 Present Cropping Pattern for DPISRSP

Harvested paddy is normally threshed at farmers' home yard, and thus 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 City as well as Phnom Penh City.

Beneficiary's House and Home Yard

Rice Miller at Kampong Chhnang (Milling capacity: 12ton/day, 8 month-operation)

(3) Inventory of Farm Machinery

In the Sub-project area, major farming practices such as land preparation, cutting and threshing are done by small machine. Inventory of machinery in the related communes is shown as follows:

Table AC- 2.6.2.3.6 Inventory of Farm Machinery in Teuk Phos District

No.	Commune	4-wheel tractor	Hand tractor	Pump	Harvester / Reaper	Engine Thresher	Rice miller
1	Khlong Popok	-	13	35	-	3	14
2	Chaong Maong	-	76	63	-	5	59
3	Chieb	-	18	75	-	4	50
4	Toul Khpos	-	20	12	-	2	17
5	Kbal Tuek	-	8	7	-	1	26
6	Tang Krasang	-	22	15	-	5	32
7	Krag skear	1	24	84	-	2	68
8	Akphivoadth	1	33	45	-	5	35
Total		2	214	336	-	27	301

Source: DAO Teuk phos, 2012

(4) Holding Situation of Livestock

Holding situation of livestock is shown as follows:

Table AC-2.6.2.3.7 Inventory of Livestock in the Related Communes

Commune	Cattle and Buffalo			No. of Owners of Pig (heads)	No. of Owners of Chicken (heads)	No. of Owners of Duck (heads)	Total HH in Commune
	Total No. (heads)	No. of Owners (HH)	No.. per HH (heads)				
1. Chaong Maong	3,848	1,340	2.9	1,151	1,348	43	1,309
2.Chieb	3,973	1,457	2.7	999	1,481	123	1,419
3. Khlong Popok	3,061	1,195	2.6	469	1,071	45	1,247
4. Akohivoadth	4,679	1,775	2.6	1,352	1,615	44	1,829
5. Tang Krasang	5,330	1,932	2.8	1,427	1,884	67	1,970
Total	20,891	7,699	2.7	5,398	7,399	322	7,774

Source: Commune Database 2010, National Committee for Sub-National Democratic Development (NCDD)

In this District, water buffalo is also popular. Farmers use them as draft animals for land preparation as well as transportation.

AC-2.6.3 Weaknesses of Paddy Production in the Target Area

Through the socio-economic survey, the following constraints are identified.

Table AC-2.6.3.1 Constraints on Paddy Cultivation

Subject	Constraints
(1) Farming Practices	Weed problem
	Low paddy yield
	Crop damage due to pests and diseases
	Seed amount is too much.
	Dosage of fertilizer is not enough.
	Application timing is not suitable.
(2) Physical Conditions	Shortage of irrigation water in early and dry seasons
(3) Marketing	Low market price of paddy
	Unstable market price of paddy
	Price negotiation with traders is difficult.

Source: JICA Survey Team, 2012

It is proposed that agricultural extension services should be strengthened, in order to improve or minimize the constraints mentioned above.

AC-2.6.4 Examination of Previous 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:

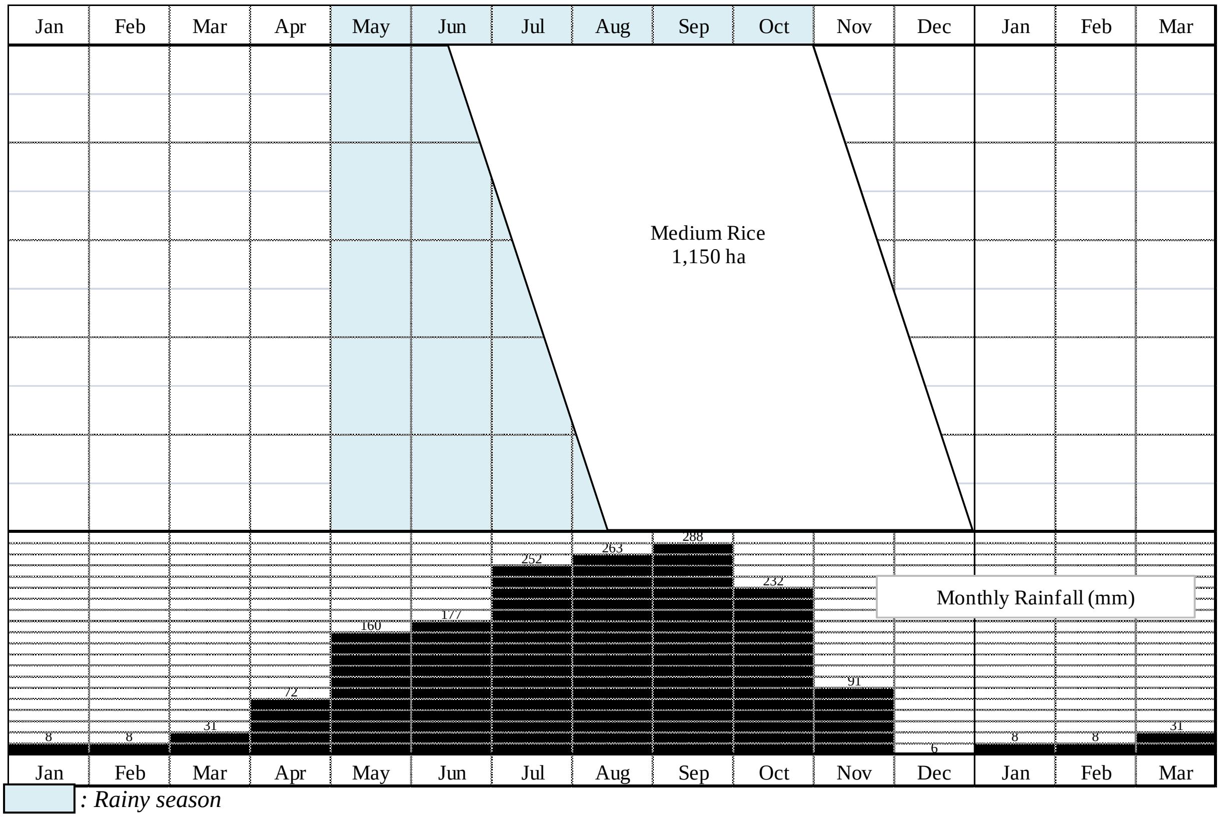
Demonstration of Modernized Nursery Bed
(Less seed amount proposed)

Table AC-2.6.4.1 Review on Agricultural Development Plan

Item	Proposal in 2009	Review in 2011
(1) Project area	(i) Sub-project area of 1,151 ha was estimated in the proposal.	(i) The proposed area of 1,151 ha was roughly confirmed on the topographic map. (ii) Sub-project area should be same area before and after rehabilitation.
(2) Cropping Pattern and cultivated area	(i) No cropping pattern (ii) Unit cost on increase of agricultural input for existing cultivated area: <u>US$ 50/ha</u> (iii)Unit cost on increase of agricultural input for newly cultivated area: <u>US$ 150/ha</u> (iv) Cultivated area is shown as follows: Before rehabilitation - Rainy season: 150 ha - Rainy season (rainfed): 1,001 ha After rehabilitation - Rainy season 1,151 ha (v) Cropping intensity: 112%	(i) Based on some interview to PDOWRAM, PDA, DAO, and farmers, proposed cropping pattern was prepared as shown in Figure AC-2.6.4.1, according to the result of water balance study. (ii) Breakdown on unit cost of US$50/ha and US$150/ha is not available. Therefore, present and proposed production costs of paddy were estimated as shown in Tables AC-2.6.4.2 and AC-2.6.4.3, based on production costs in RCHRSP, USISRSP and KSBISRSP, and interview to DAO and farmers. (iii)It is necessary to do water balance study, in order to confirm the proposed area. It is understandable that the most important point for agricultural development is to secure the maximum irrigated area in rainy season. Further cropping intensity should be increased, if water is still available.
(3) Beneficiaries	In the proposal, the related communes, number of villages, and number of beneficiaries are specified.	Estimated number of beneficiaries by village should be tentatively identified
(4) Unit Yield of Paddy	(i) Target unit yield of paddy was estimated as follows: Before rehabilitation - Rainy season: 1.2 ton/ha - Rainy season(rainfed): 0.8 ton/ha After rehabilitation - Rainy season: 2.0 ton/ha (ii) These yields are estimated, based on the interview to farmers, but not from PDA and DAO.	(i) Proposed target unit yield of paddy is relatively reasonable. However, proposed yield with project condition is slightly lower. It is necessary to review them, based on the latest statistical data as well as farmers' interview.
(5) Agricultural Extension Service	In the proposal, cost for implementation of agricultural extension service was estimated as unit cost per ha of US$ 10/ha.	In the proposal, there is no breakdown for US$ 10/ha. JICA Survey Team estimated at around US$ 12/ha. Namely US$10/ha is reasonable.

Source: JICA Survey Team

Proposed cropping pattern is shown as follows:



Source: JICA Survey Team

Figure AC-2.6.4.1 Proposed Cropping Pattern for DPISRSP

(2) 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 HH income, and to enable farmers to enjoy the improved rural life with full use of the facilities constructed under the 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:

(i) Training materials including guideline, pamphlet, handout, poster, etc. are available[15]. 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 filing in District Agricultural Office;

(ii) If training materials are filed in the office, it is not necessary to newly prepare them every cropping season. Actually there are no files in the office. Therefore, training materials are required to be prepared every time; and

(iii) Purpose and target of implementation of demonstration is not clear. Further there are no monitoring activities after completion of demonstration activities. Namely the purpose of training activities might be to implement demonstration activities, not for dissemination of proposed farming practices.

15 Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF.

Considering the current situation mentioned above, the following training activities would be proposed for smooth implementation of demonstration activities:

(i) Preparation of action plan for demonstration activities;
(ii) Preparation of training materials;
(iii) Preparation of guideline on demonstration activities, based on the existing materials[16]; and.
(iv) Filing of training materials.

Furthermore, it is proposed that exchange of materials and information as well as cooperation among PDAs and DAOs be facilitated periodically.

AC-2.6.5 Agricultural Development Plan

AC-2.6.5.1 Present and Future Command Area

In the development plan, the area will be fully developed as shown in the below table.

Table AC-2.6.5.1.1 Present and Future Land Use in the Command Area

(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							1,150			1,150		1,150
	Recession area												0
Rainfed		1,060			1,060		1,060						0
Upland Field													0
Fallow Land		150											0
Right of way								60					0
Total		1,210	0	0	1,060	0	1,060	1,210	0	0	1,150	0	1,150
Cropping Intensity (%)							88						100

Source: JICA Survey Team,

AC-2.6.5.2 Farming Practices and Input Requirement for Major Crops

Proposed farming practices as well as farm input requirement were clarified through the interview to the related institutes and farmers, as shown in Table AC-2.6.2.3.4. In principle, it is not necessary to change major practices as well as major requirement, although minor adjustment on input requirement was done. Present and proposed updated crop budgets for majors are shown in Tables AC-2.4.5.2.1 and AC-2.4.5.2.2.

AC-2.6.5.3 Crop Production under Present and With-project Conditions

Current and proposed yield levels as well as target yield of paddy in each category of paddy field in the DPISRSP area were set, based on the statistic data of PDA as well as DAO, and data from RCHRSP as well as USISRSP, as follows:

Table AC-2.6.5.3.1 Present and Proposed Unit Yield of Paddy (Unit: ton/ha)

Category	Present / Without-project*1	With-project*2
(1) Rainy Season		
- Medium rice (irrigated)	-	3.50
- Medium rice (rainfed)	2.09	-

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 RCHRSP*
Source: JICA Survey Team,

16 *Refer Attachment-1 for master textbook and guidelines, which are prepared by MAFF*

Based on the assumption on unit yield mentioned above, target production is shown as follows:

Table AC-2.6.5.3.2 Present and Proposed Paddy Production

Paddy	Present / Without-project Condition			With-project Condition			Increment Production (ton)
	Area (ha)	Unit Yield (ton/ha)	Production (ton)	Area (ha)	Unit Yield (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

Source: JICA Survey Team

AC-2.6.6 Strengthening of Agricultural Extension Services

AC-2.6.6.1 Basic Approach

Mission of agricultural extension services is to increase unit yield of paddy and improve paddy production in the sub-project area. Therefore it is strongly proposed that farmers should be trained in order to improve their skills on paddy cultivation, and promote crop diversification. Furthermore through training programs, it is expected that skills on water management as well as maintenance of irrigation facilities be transferred to famers.

Meanwhile, it is judged that staffs of DAO and PDA have some experience and knowledge for implementation of extension activities. However, it is highly necessary to obtain more experience and knowledge, in order to formulate annual action plan for extension services, and carry out extension activities more effectively and smoothly.

AC-2.6.6.2 Development Strategies and Scope of Intervention

(1) Development Strategies

The development strategies are specified as follows;

(i) In principle, constraints on paddy production, which are specified in Section AC-2.1.3, should be improved or minimized through extension activities, in order to increase rice production and income;

(ii) Intensive introduction of agricultural extension services is to be envisioned with the aim of attaining the project target at an early stage as possible;

(iii) Extension service should be carried out effectively and smoothly, applying an annual cycle of "Plan – Do – Check – Act". Activities of each component in this cycle are indicated as follows:

- Plan: Annual action plan of extension service should be formulated, considering the constraints as well as proposed activities as shown in the following table;

Table AC-2.6.6.2.1 Constraints on Paddy Cultivation and Proposed Extension Services in DPISRSP

Subject	Constraints	Activities to be Proposed for Extension Services	
		Subjects	Ways to be required
(a) Farming Practices	1) Crop damage due to pests and diseases	- Introduction of IPM	- Lecture (short training) - Demonstration - Farmers' field school - Mass guidance / workshop - Study tour
	2) Low paddy yield	- Proposed farming practices - Introduction of quality seeds	
	3) Weed problem	- Introduction of IPM	
	4) Improper farming practices	- Proposed farming practices	

Subject	Constraints	Activities to be Proposed for Extension Services	
		Subjects	Ways to be required
(b) Water management	1) Shortage of irrigation water	- Rehabilitation of irrigation facilities - Improvement of water management	- Rehabilitation work - Training for water management
(c) Marketing	1) Unstable and low market price of products	- Selection of profitable varieties - Selection of other profitable crops - Adjustment of harvesting season - Shipping control - Strengthening bargaining power of famers	- Lecture (short training) - Mass guidance / workshop

Source: JICA Survey Team

Targets of each extension activity as well as annual plan are obviously required. Further, in order to carry out extension services, extension materials such as guideline, handouts, etc. are highly required. Those materials should be prepared by extension staff of PDA and DAO, referring the existing materials[17], which were prepared by the central government or other supporting organizations such as international organizations, donors, NGOs, etc.

- Do: Extension services should be implemented based on the plan mentioned above;
- Check: Extension activities should be measured, and thus those results could be compared with the targets shown in the "Plan". Some differences could be analyzed to clarify those root causes. Major points for this checking are shown as follows:
  - Adaptability of extension service plan:
  - Management on implementation of extension activities;
  - Progress on the extension service activities;
  - Results of the extension service activities; and
- Act: Based on the results in the checking mentioned above, scope as well as target for the next extension activities could be refined.

(2) Scope of the Intervention

The plan is formulated for the period of 4 years from 2017 to 2020, aiming at improvement of farmers' skills as well as experience through strengthening agricultural extension services. Such services should be provided by extension staff of PDA and DAO through the Project Implementation Unit. The envisioned major activities under the plan include: (i) field programs and farmer/farmer group training programs aiming at improvement of farmers' capability and skills on irrigated agriculture farming practices and water management; and (ii) empowerment and motivation of farmers including village extension workers (VEWs). Further, it is required that skills and experience of extension staff be strengthened by intervention of national consultant as well as foreign consultant.

AC-2.6.6.3 Strengthening Plan of Agricultural Extension Services

(1) Proposed Agricultural Extension Services

Agricultural support services required for the promotion of adoption of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage are shown in Table AC-2.1.6.3.1.

Logical matrix of major activities on extension services are shown in Table AC-2.1.6.3.2, and further framework of extension services are shown as follows:

17 Refer Attachment 5 of ANNEX C

Table AC-2.6.6.3.1 Framework of Agricultural Extension Services for DPISRSP

Activities	Size	Times per group	Frequency
(a) Training of Trainers	10 staff	1 time	4 times per 4 years (once a year)
(b) Field Programs			
1) Demonstration Plots (irrigated)			
- Paddy cultivation	0.1 to 0.2 ha	2 plots per FWUG	- 12 plots/ 6 FWUGs/ 3years - 3 to 6 plots/year
- Upland crops cultivation	0.1 ha	1 plot per FWUG	- 6 plots/ 6 FWUGs/ 2 years - 2 to 4 plots/ year
- Vegetable cultivation	0.1 ha	1 plot per FWUG	- 6 plots/ 6 FWUGs/ 2 years - 2 to 4 plots/ year
2) Water management			
- Paddy cultivation	One tertiary block	2 times per FWUG	- 12 times / 6 FWUGs/ 3years - 3 to 6 times /year
(c) Farmer/Farmer Group Training Programs			
1) Training course	2-day course	1 time per FWUG	- 6 times / 6 FWUGs/ 3 years - 2 times / year
2) FFS/ IPM	30 participants	1 time per FWUG	- 6 times / 6 FWUGs/ 3 years - 2 times / year
3) Study tour	30 participants	1 time per FWUG	- 6 times / 6 FWUGs/ 3 years - 2 times / year
(d) Mass Guidance/Workshop	30 participants	2 time per FWUG	- 12 times / 6 FWUGs/ 4years - 3 times /year

Note: around 200 ha for one FWUG, around 18 FWUGs in USISRSP
Source: JICA Survey Team

(2) Assignment of Foreign and National Consultants

Foreign consultant in collaboration with national consultant conducts preparatory work before implementation of training of trainers and training of farmers. Namely, those consultants prepare guidelines on preparation of annual action plan as well as checking and analysis for work progress of training of farmers. Those guidelines are used in training of trainers for extension staff of PDA and DAO. Therefore extension staff could arrange extension materials such as hand-outs as well as any other materials for farmers.

As shown in Table AC-2.1.6.3.4, it is proposed that preparatory work and training of trainers be carried out as task work of foreign consultant as well as national consultant. Meanwhile regarding training of farmers, national consultant has to support training of farmers to be carried out by extension staff of PDA and DAO, as assistant work. Further, national consultant checks and analyzes work progress and performance on training of farmers, and propose some actions as well as attentions for training activities in the following season as task work.

Assignment period of foreign and national consultants are proposed as follows:

Table AC-2.6.6.3.2 Assignment Period of Consultants to be Required for DPISRSP

(Unit: M/M)

Particular	2017		2018		2019		2020		Total	
	F	N	F	N	F	N	F	N	F	N
(a) Preparatory work	0.1	0.06	-	0.06	-	0.06	-	0.06	0.1	0.24
(b) Training of trainers	0.2	0.2	-	0.2	-	0.2	-	0.2	0.2	0.8
(c) Training of farmers	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(d) Checking and analysis	-	0.3	-	0.3	-	0.3	-	0.3	-	1.2
(e) Total	0.3	0.86	-	0.86	-	0.86	-	0.86	0.3	3.44

Note: F: Foreign consultant, N: National consultant
Source: JICA Survey Team

(3) Proposed Budgets of Extension Activities

Furthermore, budgets for each extension activity are shown in Table AC-2.1.6.3.4. Implementation and cost schedule of the proposed agricultural extension services strengthening plan was prepared based on the above conditions as well as budgets, as shown in Table AC-2.6.6.3.3, thus summarized as follows:

Table AC-2.6.6.3.4 Estimated Direct Costs for Agricultural Extension Services for DPISRSP

Activity	Estimated Cost (US$)				
	2017	2018	2019	2020	Total
(a) Training of Trainers	520	520	520	520	2,080
(b) Field Programs					
1) Demonstration Plots (irrigated)					
- Paddy cultivation	2,760	2,760	5,520	0	11,040
- Upland crops cultivation	0	1,800	3,600	0	5,400
- Vegetable cultivation	0	1,820	3,640	0	5,460
2) Water management					
- Paddy cultivation	4,830	4,830	9,660	0	19,320
(c) Farmer/Farmer Group Training Programs					
1) Training course	0	820	820	820	2,460
2) FFS/ IPM	0	3,160	3,160	3,160	9,480
3) Study tour	0	860	860	860	2,580
(d) Mass Guidance/Workshop	780	780	780	780	3,120
Total	8,890	17,350	28,560	6,140	60,940

Source: JICA Survey Team

The total direct costs required for implementation of such programs are estimated to be about US$ 60,940.

ANNEX C

Tables

ANNEX C

Tables

Table AC-1.1.1.2 Area and Production of Paddy by Provinces in 2008/09

No.	Province/city	Cultived area(ha)	Destroyed Area(ha)	Harvested area(ha)	Yield (ton/ha)	Production (ton)
1	Banteay Meanchey	216,690	499	216,191	2.542	549,553
2	Battambang	249,966	541	249,425	2.697	672,765
3	Kampong Cham	219,278	-	219,278	3.195	700,662
4	Kampong Chhnang	128,136	290	128,136	2.807	359,632
5	Kampong Speu	105,343	56	105,287	2.336	245,942
6	Kampong Thom	184,747	231	184,747	2.359	435,741
7	Kampot	127,980	-	127,980	2.767	354,123
8	Kandal	100,804	127	100,677	3.619	364,300
9	Koh Kong	9,619	-	9,619	2.341	22,518
10	Kratie	43,757	60	43,757	2.561	112,053
11	Mondulkiri	16,506	114	16,392	1.826	29,932
12	Phnom Penh city	5,231	-	5,231	3.473	18,166
13	Preah Vihear	37,873	231	37,642	2.000	75,286
14	Prey veng	322,993	-	322,993	3.079	994,580
15	Pursat	102,275	-	102,275	2.645	270,534
16	Rotanakiri	24,906	562	24,346	1.862	45,332
17	Siem reap	194,790	155	194,778	2.121	413,147
18	Preah sihanuok	12,747	70	12,732	2.500	31,830
19	Stueng treng	23,045	-	23,045	2.500	57,613
20	Svay rieng	175,241	163	175,078	2.388	418,143
21	Takeo	255,667	60	255,607	3.427	875,884
22	Otdor Meanchey	50,447	-	50,447	2.072	104,509
23	Kep	3,000	4	3,000	2.611	7,833
24	Pailin	4,700	-	4,700	3.276	15,395
Total		2,615,741	3,163	2,613,363	2.746	7,175,473

Source: Agricultural Statistics 2008-2009, Department of Planning and Statistics, MAFF

Table AC-1.1.4.1 Improved Rice Varieties Released by CARDI

Variety	Year Released	Adaptability	Photoperiod Sensitivity	Growth Period (days) or Flowering Date	Yield Level (ton/ha)	Resistance to BPH	Aroma	Proposed Variety from MAFF
Early Maturing Variety (less than 120 days)								
IR 66	1990	IRR/RFL	insensitive	105 ~ 115 days	4.0 ~ 6.5	MS	none	●
Sen Pidao	2002	IRR/RFL	insensitive	105 ~ 115 days	4.0 ~ 6.5	MS	aromatic	●
IR 72	1990	IRR/RFL	insensitive	110 ~ 120 days	3.5 ~ 6.0	S	none	
IR 36		IRR/RFL	insensitive	110 ~ 120 days	3.5 ~ 6.0	MR	none	
Kru	1990	IRR/RFL	insensitive	110 ~ 115 days	3.5 ~ 6.0		none	
IR Kesar	1993	IRR/RFL	insensitive	105 ~ 120 days	4.0 ~ 6.0	MR	none	
Chul'sa	1999	IRR/RFL	insensitive	95 ~ 110 days	4.0 ~ 6.0	MR	none	●
Medium Maturing Variety (longer than 120 days and less than 150 days)								
Riang Chey	1999	IRR/RFL	sensitive	Nov. 5 - 11	3.5 ~ 5.5	MS	none	●
CAR 11	1997	IRR/RFL	sensitive	Nov. 5 - 11	2.5 ~ 4.5	S	none	
CAR 3	1995	IRR/RFL	sensitive	Oct. 30 - Nov. 7	2.5 ~ 4.5	HS	none	
Santepheap 1	1992	RFL	insensitive	130 ~ 140 days	4.0 ~ 6.0	MS	none	
Santepheap 2	1992	RFL	insensitive	130 ~ 140 days	4.0 ~ 6.0	MS	none	
Santepheap 3	1992	RFL	insensitive	140 ~ 145 days	4.0 ~ 6.5	S	none	
Pkha Romeat	2007	RFL	sensitive	Oct. 15-25	3.5 ~ 5.8	S	Scented/ Soft texture	●
Pkha Romdeng	2007	RFL	sensitive	Oct. 10-25	3.5 ~ 5.8	S	Scented/ Soft texture	●
Pkha Chansensor	2009	RFL	sensitive	Oct. 25- Nov 2	3.5 ~ 5.0	unknown	none	●
Pkha Rumdoul	1999	IRR/RFL	sensitive	Oct. 30 - Nov. 7	3.5 ~ 5.5	S	aromatic	●
Pkha Rumchek	1999	IRR/RFL	sensitive	Oct. 25 - Nov. 1	3.0 ~ 5.0	MS	aromatic	
Late Maturing Variety (longer than 150 days)								
CAR 4	1995	RFL	highly sensitive	Nov. 8 - 15	2.5 ~ 5.0	MS	none	●
CAR 6	1995	RFL	highly sensitive	Nov. 9 - 16	2.5 ~ 5.0	S	none	●

Note: IRR: irrigated field RFL: rainfed lowland BPH: Brown Plant Hopper
HS: highly susceptible S: susceptible MS: moderately susceptible
MR: Moderatelt resistant

Source: Rice Varieties Released by the Varietal Recommendation Committee of Cambodia (1990-2000), CARDI, 2001

Table AC-1.4.2.1 Food Balance in Kampong Speu Province

(Unit: ton)

No.	District	Population	Total production	Seed and loss during harvestng 13%	Remaining	Milling Rate 64%	Rice Demand	Balance
1	Boseth	129,260	70,043	9,106	60,937	39,000	18,484	20,516
2	Chbar mon	50,557	10,891	1,416	9,475	6,064	7,230	-1,166
3	Kong pisey	122,210	43,596	5,667	37,929	24,274	17,476	6,798
4	Oral	32,350	17,324	2,252	15,072	9,646	4,626	5,020
5	Oudong	129,018	50,614	6,580	44,034	28,182	18,450	9,732
6	Phnom Srouch	103,065	53,307	6,930	46,377	29,681	14,738	14,943
7	Samrong tong	154,294	80,226	10,429	69,797	44,670	22,064	22,606
8	Thpong	54,950	30,371	3,948	26,423	16,911	7,858	9,053
	Total	775,704	356,372	46,328	310,044	198,428	110,926	87,502

Note) Per capita consumption: 143 kg

Source) Annual Report 2011/12, PDA Kampong Speu Province

Table AC-1.4.2.2 Food Balance in Kandal Province

(Unit: ton)

No.	District	Population	Total production	Seed and loss during harvestng 13%	Remaining	Milling Rate 64%	Rice Demand	Balance
1	Kandal steung	108,209	35,940	4,672	31,268	20,012	15,474	4,538
2	Kean svay	138,982	33,144	4,309	28,835	18,454	19,874	-1,420
3	Khsach kandal	160,981	35,141	4,568	30,573	19,567	23,020	-3,454
4	Koh Thom	185,449	75,281	9,786	65,494	41,916	26,519	15,397
5	Leuk dek	69,734	25,565	3,323	22,242	14,235	9,972	4,263
6	Lvea Em	93,601	31,563	4,103	27,460	17,574	13,385	4,189
7	Muk Kompoul	86,159	30,471	3,961	26,510	16,966	12,321	4,646
8	Angk Snoul	96,804	16,918	2,199	14,719	9,420	13,843	-4,423
9	Pon gnea leu	115,372	38,621	5,021	33,600	21,504	16,498	5,006
10	Sa ang	248,040	59,486	7,733	51,753	33,122	35,470	-2,348
11	Takmoa (city)	79,967	282	37	245	157	11,435	-11,278
	Total	1,383,298	382,412	49,712	332,699	212,927	197,811	15,116

Note) Per capita consumption: 143 kg

Source) Annual Report 2011/12, PDA Kandal Province

Table AC-1.4.2.3 Food Balance in Takeo Province

(Unit: ton)

No.	District	Population	Total production	Seed and loss during harvestng 13%	Remaining	Milling Rate 64%	Rice Demand	Balance
1	Angborey	48,901	101,555	13,202	88,353	56,546	6,993	49,553
2	Bati	129,275	78,561	10,213	68,348	43,743	18,486	25,257
3	Bareychulsa	28,944	95,043	12,356	82,688	52,920	4,139	48,781
4	Kirivong	97,427	145,142	18,869	126,274	80,815	13,932	66,883
5	Kos Ondaet	51,637	115,512	15,017	100,496	64,317	7,384	56,933
6	Preykabas	95,586	95,685	12,439	83,246	53,277	13,669	39,609
7	Samraong	116,586	97,829	12,718	85,111	54,471	16,672	37,799
8	Doun Kaev	38,636	27,844	3,620	24,224	15,503	5,525	9,978
9	Tram Kak	160,424	131,536	17,100	114,436	73,239	22,941	50,299
10	Treang	111,912	134,364	17,467	116,896	74,814	16,003	58,810
Total		879,328	1,023,072	132,999	890,072	569,646	125,744	443,902

Note) Per capita consumption: 143 kg

Source) Annual Report 2011/12, PDA Takeo Province

Table AC-1.4.2.4 Food Balance in Kampong Chhnang Province

(Unit: ton)

No.	District	Population	Total production	Seed and loss during harvestng 13%	Remaining	Milling Rate 64%	Rice Demand	Balance
1	Boribo	56,562	48,474	6,302	42,172	26,990	8,088	18,902
2	Chol Kiri	37,230	39,368	5,118	34,250	21,920	5,324	16,596
3	Kampong chhnang ci	42,135	3,257	423	2,834	1,814	6,025	-4,211
4	Kampong leng	51,747	31,697	4,121	27,576	17,649	7,400	10,249
5	Kampong Trolach	90,093	69,038	8,975	60,063	38,440	12,883	25,557
6	Rolea pa ear	102,845	86,653	11,265	75,388	48,248	14,707	33,541
7	Samaki Meanchey	76,317	50,664	6,586	44,078	28,210	10,913	17,297
8	Teuk phos	63,469	72,104	9,374	62,730	40,147	9,076	31,071
Total		520,398	401,255	52,164	349,091	223,418	74,416	149,002

Note) Per capita consumption: 143 kg

Source) Annual Report 2011/12, PDA Takeo Province

Table AC-2.1.1.1 Related Districts, Communes, Villages, and Population

Province	District	Commune		Population 2008	Annual Rate %	Population Projection*1 up to 2011
Kampong Speu	Chbar Mon	1	Chbar Mon	8700	1.14	9,000
		2	Kandaol Dom	7138	0.52	7,200
		3	Roka Thum	16284	1.55	17,100
		4	Sopoar Tep	6687	1.07	6,900
		5	Svay Kravan	8041	1.4	8,400
	Kong Pisei	1	Angk Popel	5947	2.62	6,400
		2	Preah Nipean	12186	2.65	13,200
		3	Roka Kaoh	7243	2.27	7,700
		4	Veal	8966	2.3	9,600
	Samraong Tong	1	Roleang Chak	8101	1.82	8,600
		2	Kahaeng	6920	0.93	7,100
		3	Roleang Kreul	12071	2.21	12,900
		4	Saen Dei	11349	1.67	11,900
		5	Tang Krouch	8281	2.12	8,800
		6	Trapeang Kong	17356	3.88	19,500
		7	Voa Sa	13373	1.76	14,100
		8	Samraong Tong	6574	2.1	7,000
		9	Sambour	8313	2.49	8,900
Sub-total	3 Districts	18 Communes		173530		184,300
Kandal	Kandal Stueng	1	Daeum Rues	8215	2.76	8,900
		2	Roka	2918	1.52	3,100
		3	Roleang Kaen	5034	1.67	5,300
	Angk Snuol	1	Boeng Thum	7312	3.63	8,100
		2	Chhak Chheu Neang	4824	4.97	5,600
		3	Damnak Ampil	6360	3.42	7,000
		4	Krang Mkak	5013	3.08	5,500
		5	Lumhach	8051	2.96	8,800
		6	Peuk	8504	3.67	9,500
		7	Prey Puok	7694	2.92	8,400
		8	Samraong Leu	9187	4.27	10,400
Sub-total	2 Districts	11 Communes		73112		80,600
Total	5 Districts	29 Communes		246,642	0	264,900

*Note: *1: estimated by the JICA survey team*
Source: Data base supplied from Ministry of Interior, 2009

Table AC-2.1.5.5.1 Financial Crop Budget under Present Condition for RCHRSP

Name of crops	Unit	Early RIce (Irrigated) Q'ty	Early RIce (Irrigated) Price (Riel)	Early RIce (Irrigated) Value (1000Riel)	Medium Rice (Irrigated) Q'ty	Medium Rice (Irrigated) Price (Riel)	Medium Rice (Irrigated) Value (1000Riel)	Medium Rice (Rainfed) Q'ty	Medium Rice (Rainfed) Price (Riel)	Medium Rice (Rainfed) Value (1000Riel)	Mungbean Q'ty	Mungbean Price (Riel)	Mungbean Value (1000Riel)
1. Gross Income	Riel			4,088			3,697			3,318			1,950
Main products	kg	2,790	1,150	3,209	2,310	1,250	2,888	2,120	1,250	2,650	500	3,850	1,925
By-product	kg	2,511	350	879	2,310	350	809	1,908	350	668	500	50	25
		(straw)			(straw)			(straw)			(waste bean)		
2. Production Cost	Riel			1,224			1,163			1,236			1,458
2.1 Inputs	Riel			757			734			734			1,023
Seed	kg	40	0	0	50	0	0	80	0	0	50	11,000	550
Farm manure (compost)	ton	2,000	200	400	2,000	200	400	2,000	200	400	2,000	200	400
Fertilizer Urea	kg	70	2,300	161	60	2,300	138	60	2,300	138	15	2,300	35
DAP	kg	60	3,000	180	60	3,000	180	60	3,000	180	10	3,000	30
KCl	kg	0	2,700	0	0	2,700	0	0	2,700	0	0	2,700	0
Agro-chemicals	liter	0.5	15,000	8	0.5	15,000	8	0.5	15,000	8	0.0	15,000	0
Farming equipment and tools	LS	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8
2.2 Labor	P-d	110		91	105		63	100		140	50		105
Hired labor	P-d	13	7,000	91	9	7,000	63	20	7,000	140	15	7,000	105
Family labor	P-d	97	0	0	96	0	0	80	0	0	35	0	0
2.3 Paid Services	Riel			376			366			362			330
Land preparation	LS	2.0		320	2		320	2		320			320
1st Plowing	LS	1.0	140,000	140	1.0	140,000	140	1.0	140,000	140	1.0	140,000	140
2nd Plowing + Paddling	LS	1.0	180,000	180	1.0	180,000	180	1.0	180,000	180	1.0	180,000	180
Transportation	kg	2,790	20	56	2,310	20	46	2,120	20	42	500	20	10
3. Net Return	Riel			2,864			2,534			2,082			492
(N.Return/P. Cost Ratio)				2.34			2.18			1.68			0.34

Name of crops	Unit	Cucumber* Q'ty	Cucumber* Price (Riel)	Cucumber* Value (1000Riel)	String Bean* Q'ty	String Bean* Price (Riel)	String Bean* Value (1000Riel)	Tomato* Q'ty	Tomato* Price (Riel)	Tomato* Value (1000Riel)
1. Gross Income	Riel			5,620			5,715			5,415
Main products	kg	4,000	1,400	5,600	3,000	1,900	5,700	3,000	1,800	5,400
By-product	kg	400	50	20	300	50	15	300	50	15
		(waste fruit)			(stem and waste bean)			(waste fruit)		
2. Production Cost	Riel			1,038			1,180			1,005
2.1 Inputs	Riel			638			800			625
Seed	kg	3	6,000	18	30	6,000	180	0.3	15,000	5
Farm manure (wet)	ton	2,000	200	400	2,000	200	400	2,000	200	400
Fertilizer Urea	kg	40	2,300	92	40	2,300	92	40	2,300	92
DAP	kg	20	3,000	60	20	3,000	60	20	3,000	60
KCl	kg	0	2,700	0	0	2,700	0	0	2,700	0
Agro-chemicals	liter	4	15,000	60	4	15,000	60	4	15,000	60
Farming equipment and tools	LS	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8
2.2 Labor	P-d	90		0	90		0	90		0
Hired labor	P-d	0	7,000	0	0	7,000	0	0	7,000	0
Family labor	P-d	90		0	90		0	90		0
2.3 Paid Services	Riel			400			380			380
Land preparation	LS	2		320	2		320	2		320
Plowing	LS	1	140,000	140	1	140,000	140	1	140,000	140
Paddling	LS	1	180,000	180	1	180,000	180	1	180,000	180
Transportation	kg	4,000	20	80	3,000	20	60	3,000	20	60
3. Net Return	Riel			4,582			4,535			4,410
(N.Return/P. Cost Ratio)				4.41			3.84			4.39

Note: *: Cucumber, String bean, and Tomato are substitutes of all suitable vegetables in the area.

Average Net Return per ha of vegetables: 4,509 Riel '000

Table AC-2.1.5.5.2 Financial Crop Budget under With-Project Condition in RCHRSP

Name of crops	Unit	Paddy (Early Variety) (Irrigated)			Paddy (Medium Variety) (Irrigated)			Mungbean		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			5,860			5,600			1,955
Main products	kg	4,000	1,150	4,600	3,500	1,250	4,375	500	3,850	1,925
By-product	kg	3,600	350	1,260	3,500	350	1,225	600	50	30
		(straw)			(straw)			(waste bean)		
2. Production Cost	Riel			1,555			1,512			1,458
2.1 Inputs	Riel			1,092			1,059			1,023
Seed Purchased	kg	16.5	2,600	43	21.5	2,600	56	50	11,000	550
Self-stocked	kg	33.5	0	0	43.5					
Farm manure (wet)	ton	3,000	200	600	3,000	200	600	2,000	200	400
Fertilizer Urea	kg	100	2,300	230	80	2,300	184	15	2,300	35
DAP	kg	45	3,000	135	45	3,000	135	10	3,000	30
KCl	kg	25	2,700	68	25	2,700	68	0	2,700	0
Agro-chemicals	liter	0.5	15,000	8	0.5	15,000	8	0.0	15,000	0
Farming equipment and tools	LS	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8
2.2 Labor	P-d			63			63			105
Hired labor	P-d	9	7,000	63	9	7,000	63	15	7,000	105
Family labor	P-d	81	0	0	81	0	0	35	0	0
2.3 Paid Services	Riel			400			390			330
Land preparation	LS	2		320	2		320	2		320
Plowing	LS	1	140,000	140	1	140,000	140	1	140,000	140
Paddling	LS	1	180,000	180	1	180,000	180	1	180,000	180
Transportation	kg	4,000	20	80	3,500	20	70	500	20	10
3. Net Return	Riel			4,305			4,088			497
(N.Return/P. Cost Ratio)				2.77			2.70			0.34

Name of crops	Unit	Cucumber*			String Bean*			Tomato*		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			11,240			9,525			12,635
Main products	kg	8,000	1,400	11,200	5,000	1,900	9,500	7,000	1,800	12,600
By-product	kg	800	50	40	500	50	25	700	50	35
		(waste fruit)			(stem and waste bean)			(waste fruit)		
2. Production Cost	Riel			2,098			2,018			2,065
2.1 Inputs	Riel			1,576			1,563			1,563
Seed	kg	3	6,000	18	30	6,000	180	0.3	15,000	5
Farm manure (wet)	ton	4,000	200	800	4,000	200	800	4,000	200	800
Fertilizer Urea	kg	150	2,300	345	100	2,300	230	150	2,300	345
DAP	kg	70	3,000	210	50	3,000	150	70	3,000	210
KCl	kg	50	2,700	135	50	2,700	135	50	2,700	135
Agro-chemicals	liter	4	15,000	60	4	15,000	60	4	15,000	60
Farming equipment and tools	LS	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8
2.2 Labor	P-d	120		42	120		35	120		42
Hired labor	P-d	6	7,000	42	5	7,000	35	6	7,000	42
Family labor	P-d	114		0	115		0	114		0
2.3 Paid Services	Riel			480			420			460
Land preparation	LS	2		320	2		320	2		320
Plowing	LS	1	140,000	140	1	140,000	140	1	140,000	140
Paddling	LS	1	180,000	180	1	180,000	180	1	180,000	180
Transportation	kg	8,000	20	160	5,000	20	100	7,000	20	140
3. Net Return	Riel			9,142			7,507			10,570
(N.Return/P. Cost Ratio)				4.36			3.72			5.12

Note: *: Cucumber, String bean, and Tomato are substitutes of all suitable vegetables in the area.

Average Net Return per ha of vegetables: 9,073 Riel '000

Table AC-2.1.5.6.1 Yield Estimation for With & Without-Project Conditions for RCHRSP

(1) Statistic Data: Paddy Yields by Province and District

Province / Related Districts	PDA Annual Report 1/						MAFF		
	Early Rice			Medium Rice			2010 2/	2008 3/	
	2010	2009	2008	2010	2009	2008	Average	Early	Medium
Kampong Speu									
Cgbar Mon	2.77			2.90					
Kong Sipei	2.54			2.60					
Samraoing Tong	2.45			2.71					
Whole Province	2.59			2.74			2.29	2.20	2.40
Kandal									
Whole Province	3.50			2.82			2.95	3.36	2.76
Takeo									
Tram Kak	3.30	3.20	2.70	3.35	3.18	2.96			
Whole Province	3.25	2.95	2.90	3.24	2.85	2.91	3.25	2.98	2.98

Source:

1/ : Annual Report 2010/2011 *2/: Annual Report 2010 - 2011* *3/: Agricultural Statistics 2008 - 2009*

(2) Results of Socio-economic Survey: Average yield 1/

Zone	Paddy Yield (ton/ha)			Remarks
	Irrigated		Rainfed	
	Wet Season	Dry season	Wet Season	
Kampong Speu				
Zone-1	2.31	2.79	1.88	No. of respondents: 85
Zone-2	2.26	-	2.12	No. of respondents: 85
Upper Slakou	2.13		2.09	No. of respondents: 40

1/: Results of Socio-economic Survey conducted by the JICA Study Team, 2011

(3) Results of Socio-economic Survey: Yield Distribution 1/

Irrigation Category	Paddy Yield (ton/ha) Rainy Season Local Variety	Paddy Yield (ton/ha) Dry Season Improved Variety	Irrigation Status	Remarks
Category 1	0.7 ~ 6.0	0 ~ 6.0	Fully irrigated field	No. of respondents: 46
Category 2	1.1 ~ 6.0	-	Supplemental irrigation in rainy season	No. of respondents: 141
Category 3	0 ~ 5.4	-		
Category 4	0.03 ~ 4.0	-	Rainfed field	No. of respondents: 124
Overall Average	0 ~ 6.0			No. of respondents: 182

1/: Results of Socio-economic Survey conducted by the JICA Study Team, 2007

(4) Verification Trial conducted in the JICA Previous Study in 2006/07 and 2007/08

Year	Season	Rice Category	Yield
2006 / 2007	Wet season	Early Rice	3.8 to 4.7
		Early Rice	4.0
		Medium Rice	3.2 to 4.8
2007 / 2008	Wet season	Early Rice	3.8 to 4.7
		Early Rice	3.4 to 4.0
		Medium Rice	3.1 to 3.7

Source: Final Report of the Study on Comprehensive Agricultural Development on Prek Thnot River Basin, 2008

(5) Demonstration Results of CARDI Conducted in Rainfed Fields in 2005/06 Rainy Season: 5 plots in each province

Location	Yield Range	Full Practices 1/	Location	Yield Range	Full Practices 1/
Kampong Speu	1.77 ~ 3.00 t/ha	3.00 t/ha	Kampong Speu	1.68 ~ 3.16 t/ha	3.16 t/ha

1/: Yield in plot with full recommended practices of seed quality, fertilizer, pest management, land leveling

(6) Estimated Yield Levels of Paddy in the Target Area under With and Without-Project

On the basis of the statistic data & results of the Socio-economic Survey, the With & Without-Project paddy yield level in the RCHRSP Area estimated as follows:

Estimated Current Yield Levels in the Target Area

Condition	Roleang Chrey			
	Irrigated		Rainfed	
	Early variety	Medium variety	Early variety	Medium variety
Present	2.79	2.31	-	2.12
Without Project	2.79	2.31	-	2.12
With Project	4.00	3.50	-	-

Note:

Early variety: Early maturing variety rice

Medium variety: Medium maturing variety rice

Table AC-2.1.5.6.5 Paddy Production in RCHRSP (1/4)

(1) Current Condition

(a)Unit Yield (Unit: kg/ha)

Variety	Zone-1			Zone-2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
1. Paddy						
1) Early Wet Season Rice						
- Early Variety	2,790	2,790	2,790	2,790	2,790	2,790
2) Wet Season Ricwe						
- Early Variety						
- Medium Variety (irrigated)	2,310	2,310	2,310	2,310	2,310	2,310
- Medium Variety (rainfed)		2,120	2,120	2,120	2,120	2,120

(b) Cultivated area (Unit: ha)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							0
1) Early Wet Season Rice							
- Early Variety	200	220	150	70	340	150	1,130
2) Wet Season Ricwe							
- Early Variety		0	0	0	0	0	0
- Medium Variety (irrigated)	580	1,560	1,860	550	3,440	1,160	9,150
- Medium Variety (rainfed)	0	670	1,040	850	3,440	1,770	7,770
Total	1,550	2,450	3,050	1,470	7,220	3,080	18,050

(c) Production (Unit: ton)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							
1) Early Wet Season Rice							
- Early Variety	558	614	419	195	949	419	3,154
2) Wet Season Ricwe							0
- Early Variety	0						0
- Medium Variety (irrigated)	1,340	3,604	4,297	1,271	7,946	2,680	21,138
- Medium Variety (rainfed)	0	1,420	2,205	1,802	7,293	3,752	16,472
2. Total Cultivated Area	1,898	5,638	6,921	3,268	16,188	6,851	40,764

Source: JICA Survey Team

Table AC-2.1.5.6.5 Paddy Production in RCHRSP (2/4)

(2) Future Condition With the Malfunctioned Regulator

(a)Unit Yield (Unit: kg/ha)

Variety	Zone-1			Zone-2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
1. Paddy						
1) Early Wet Season Rice						
- Early Variety						
2) Wet Season Ricwe						
- Early Variety						
- Medium Variety (irrigated)						
- Medium Variety (rainfed)	2,120	2,120	2,120	2,120	2,120	2,120

(b) Cultivated area (Unit: ha)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							0
1) Early Wet Season Rice							
- Early Variety							0
2) Wet Season Ricwe							
- Early Variety							0
- Medium Variety (irrigated)							0
- Medium Variety (rainfed)	580	2,230	2,900	1,400	6,880	2,930	16,920
Total	1,350	2,230	2,900	1,400	6,880	2,930	16,920

(c) Production (Unit: ton)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							
1) Early Wet Season Rice							
- Early Variety	0	0	0	0	0	0	0
2) Wet Season Ricwe							0
- Early Variety	0						0
- Medium Variety (irrigated)	0	0	0	0	0	0	0
- Medium Variety (rainfed)	1,230	4,728	6,148	2,968	14,586	6,212	35,872
2. Total Cultivated Area	1,230	4,728	6,148	2,968	14,586	6,212	35,872

Source: JICA Survey Team

Table AC-2.1.5.6.5 Paddy Production in RCHRSP (3/4)

(3) Future Condition before Rehabilitation of the Regulator

(a)Unit Yield (Unit: kg/ha)

Variety	Zone-1			Zone-2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
1. Paddy						
1) Early Wet Season Rice						
- Early Variety	2,790	2,790	2,790	2,790	2,790	2,790
2) Wet Season Ricwe						
- Early Variety						
- Medium Variety (irrigated)	2,310	2,310	2,310	2,310	2,310	2,310
- Medium Variety (rainfed)		2,120	2,120	2,120	2,120	2,120

(b) Cultivated area (Unit: ha)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							0
1) Early Wet Season Rice							
- Early Variety	200	220	150	70	340	150	1,130
2) Wet Season Ricwe							
- Early Variety		0	0	0	0	0	0
- Medium Variety (irrigated)	580	1,560	1,860	550	3,440	1,160	9,150
- Medium Variety (rainfed)	0	670	1,040	850	3,440	1,770	7,770
Total	1,550	2,450	3,050	1,470	7,220	3,080	18,050

(c) Production (Unit: ton)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							
1) Early Wet Season Rice							
- Early Variety	558	614	419	195	949	419	3,154
2) Wet Season Ricwe							0
- Early Variety	0						0
- Medium Variety (irrigated)	1,340	3,604	4,297	1,271	7,946	2,680	21,138
- Medium Variety (rainfed)	0	1,420	2,205	1,802	7,293	3,752	16,472
2. Total Cultivated Area	1,898	5,638	6,921	3,268	16,188	6,851	40,764

Source: JICA Survey Team

Table AC-2.1.5.6.5 Paddy Production in RCHRSP (4/4)

(4) Future Condition after Rehabilitation of the Regulator

(a)Unit Yield (Unit: kg/ha)

Variety	Zone-1			Zone-2		
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI
1. Paddy						
1) Early Wet Season Rice						
- Early Variety	4,000	2,790	2,790	2,790	2,790	2,790
2) Wet Season Ricwe						
- Early Variety	4,000					
- Medium Variety (irrigated)	3,500	2,310	2,310	2,310	2,310	2,310
- Medium Variety (rainfed)		2,120	2,120	2,120	2,120	2,120

(b) Cultivated area (Unit: ha)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							0
1) Early Wet Season Rice							
- Early Variety	285	220	150	70	340	150	1,215
2) Wet Season Ricwe							
- Early Variety	285	0	0	0	0	0	285
- Medium Variety (irrigated)	285	1,560	1,860	550	3,440	1,160	8,855
- Medium Variety (rainfed)	0	670	1,040	850	3,440	1,770	7,770
Total	1,625	2,450	3,050	1,470	7,220	3,080	18,125

(c) Production (Unit: ton)

Variety	Zone-1			Zone-2			Total
	IAIMP	UNMC	USMC	LNMC	LSMC	OKAI	
1. Paddy							
1) Early Wet Season Rice							
- Early Variety	1,140	614	419	195	949	419	3,736
2) Wet Season Ricwe							0
- Early Variety	1,140						1,140
- Medium Variety (irrigated)	998	3,604	4,297	1,271	7,946	2,680	20,796
- Medium Variety (rainfed)	0	1,420	2,205	1,802	7,293	3,752	16,472
2. Total Cultivated Area	3,278	5,638	6,921	3,268	16,188	6,851	42,144

Source: JICA Survey Team

Table AC-2.1.6.3.2 Logical Matrix for Agricultural Extension Services (1/5)

Programme: Plot Demonstration: Paddy Cultivation

Subject	Indicators	Means of Verification
IMPACT (one year later) 1. Successful operation may motivate surrounding farmers to follow the packaged technologies.	1. Over 70% of the participants of FFDs follow the package technology. 2. Production in participants' fields will increase by 30%.	1. Questionnaire survey 2. Yield survey
OUTCOME (one cropping season later) 1. Participants apply the package technology on their own fields continuously.	1. Over 50% of the participants of FFSs apply the practice on their own field. 2. Production in participants' fields will increase by 20%.	1. Questionnaire survey 2. Yield survey
OUTPUT (just after completion of activities) 1. Participants will be interested in the implementation of the package technology.	1. More than 50% of participants of FFDs want to carry out package farming technology. 2. more that 4 ton/ha in demo plots	1. Questionnaire surveys 2. Yield survey 3. Progress report 4. Final report
ACTIVITIES 1. Preparatory Work 1.1 Selection of location 1.2 Explanation of work schedule 2. Field Practices for farmers 2.2 Coaching participant farmers 2.3 Implementation of proposed farming technologies implementation: 2.4 Farmer Field School (FFS) for each farming practice 3. Lectures 3.1 Farming recording 3.2 Faming benefit cost analysis 3.3 Harvesting and taking sample for yield assessment 3.4 Importance of group activity	***INPUT*** 1. Extension Worker 2. Participants - Implementation of farming technologies: around 30 farmers - Farmers' Field Days: 30 farmers 3. Size and No. of Demo Farm: 0..1 to 0.2 ha/plot 4. Package of proposed farming technologies - Land preparation - Application of fertilizer - On-farm water management - Plant protection - Harvesting method - Seed multiplication by farmers - Result presentation - Evaluation and preparation of action plan for the following season 5. Farm Inputs - Seed - Fertilizer - Agro-chemicals 6. Materials for training - Pamphlet : Farming recording : Package of proposed farming technologies	

Table AC-2.1.6.3.2 Logical Matrix for Agricultural Extension Services (2/5)

Programme: Field Training: On-farm Water Management

Subject	Indicators	Means of Verification
IMPACT (one year later) 1. Farmers' activities will be carried out effectively.	1. In more than 80% of target new paddy farmer, the unit yield will be increased rather than previous cropping seasons.	1. Questionnaire survey 2. Interview
OUTCOME (1 cropping seasons later) 1. Farmer may apply their knowledge on water management in their own fields.	1. More than 80% of target new paddy farmers will apply the instructed farming practices.	1. Questionnaire survey 2. Interview
OUTPUT (just after completion of activities) 1. Participants understand points of proposed farming practices for paddy cultivation. 2. Participants understand importance and necessity of water management.	1. 100% of target new paddy farmers will be satisfied to get training programme.	1. Questionnaire survey 2. Interview 3. Technical monitoring formats 4. Final report
ACTIVITIES 1. Introduction Guidance - Introduction of programme and schedule - Technical guidance for paddy cultivation - Technical guidance for water management - Initial field guidance 2. Field Guidance - Paddy cultivation - Water management Timing of irrigation Timing of drainage On-farm water management	***INPUT*** 1. Participants: more or less 30 persons 2. Place: One tertiary block 3. Location :to be decided 4. Duration: One cropping season of paddy cultivation - Introduction guidance - Field guidance: 2 days 5. Material - for technical guidance of paddy cultivation and water management - for technical guidance of operation and maintenance concerning water management	

Table AC-2.1.6.3.2 Logical Matrix for Agricultural Extension Services (3/5)

Programme: Farmer / Farmers' Group Training on Water Management for Paddy Cultivation

Subject	Indicators	Means of Verification
IMPACT (one year later) 1. Successful operation may motivate surrounding farmers to follow the technologies.	1. Once a month, meeting for water management is arranged. 2. Once a week, maintenance work is arranged.	1. Interview 2. Questionnaire survey
OUTCOME (One cropping season later) 1. Farmers may apply their knowledge on their own fields.	1. Once a month, meeting for water management is arranged. 2. Once a week, maintenance work is arranged.	1. Interview 2. Questionnaire survey
OUTPUT (just after completion of activities) 1. Farmers become aware of the advantages and necessity of water management.	1. 100% of participants have positive impression and interest on water management.	1. Questionnaire survey 2. Progress report 3. Final Report
ACTIVITIES 1. Lecture for Water Management - Irrigation system - Drainage system - Distribution and utilization of irrigation water - Collaboration between FWUG and PDOWRAM - Regulation on FWUG - Responsibility of FWUG 2. Lecture for Paddy Cultivation (*depending on the requirement of farmers*) 3. Field Practice - Topics in paddy cultivation - Water management - Others	***INPUT*** Training should be arranged for representatives of farmers and farmers' groups, based on their requirements. - Participants: Around 30 persons of representatives of farmers' groups and FWUG, including village extension workers - Period: 2 days x 6 hr/day 1st day: In-class training 2nd day: Field practice	

Table AC-2.1.6.3.2 Logical Matrix for Agricultural Extension Services (4/5)

Programme: Mass Guidance / Workshop

Subject	Indicators	Means of Verification
IMPACT (one year later) 1. Further programme shall be established and conducted.	1. More than 80% of participants could be satisfied in the implementation of the programme.	1. Questionnaire survey 2. Interview 3. Technical monitoring formats
OUTCOME (1 cropping seasons later) 1. Needs from the field are adopted from the further extension programme.	1. More than 50% of participants could be satisfied in the implementation of the programme.	1. Questionnaire survey 2. Interview 3. Technical monitoring formats
OUTPUT (just after completion of activities) 1. Participants have strong interest concerning extension activities.	1. 100% of participants have positive impression and interest on extension activities.	1. Questionnaire survey 2. Technical monitoring formats 3. Final report
ACTIVITIES 1.1 Socialization of extension programs through Participative Approach. 1.2 Extraction of the current constraints. 1.3 Extraction of the farmers' needs. 1.4 Evaluation of programme performance.	***INPUT*** - Executors: Staff of DAO and Extension Office , PDA - Target group: Farmer / Farmers' groups Village Extension Worker Village chief - Place: Village - No. of Participants: around 30 persons - Date: Depending on the specific subject - Period: Once - Time: Depending on the specific subject - Materials to be prepared including questionnaire	

Table AC-2.1.6.3.2 Logical Matrix for Agricultural Extension Services (5/5)

Programme: Seed Campaign

<table>
<tr><th>Subject</th><th>Indicators</th><th>Means of Verification</th></tr>
<tr><td>IMPACT (one year later)

1. Adoption rate of quality seeds in the target village will be improved.</td><td>1. More than 80% of farmers in the target village apply quality seeds.</td><td>1. Questionnaire survey
2. Interview</td></tr>
<tr><td>OUTCOME (1 cropping season later)

1. Guidance provided in a large scale to disseminate importance & benefits to use quality seeds and to promote utilization of the seeds.</td><td>1. More than 50% of participants apply quality seeds.</td><td>1. Questionnaire survey
2. Interview</td></tr>
<tr><td>OUTPUT (just after completion of activities)

1. Participants have strong interest concerning production and quality.</td><td>1. 100% of participants have positive impression and interest on seed production and application of quality seeds.</td><td>1. Questionnaire survey
2. Technical monitoring formats
3. Final report</td></tr>
<tr><td>ACTIVITIES
1. Lecture
1.1 Guidance on merits of use of quality seed
1.2 Guidance on seed production, quality control system and available quality seed suppliers
1.3 Management of seed quality

2. Field guidance
2.1 Field guidance & campaign at demonstration program sites under AESP
2.2 Meeting at the field with seed grower
2.3 Meeting effort with industrialist of quality seed (Sang hyang seri and PT. Petani)</td><td colspan="2">INPUT
- Participants: 50 persons
- Farmers’ groups
- P3A members
- Seed producers
- Staff of BPSB
- Working team
- Staff of BBI
- Staff of KCD
- Staff of PRAS
- Staff of DASO
- Facilitators
- Duration: one day
- Materials
- Poster
- Leaflet</td></tr>
</table>

Table AC-2.1.6.3.6 Budget Plan of Training Programs (1/5)

(1) Training of Trainers Programs (10 persons per scheme) (Unit: USD)

No.	Description	Unit	Unit Price	2-day Training			Remarks
				Q'ty	days	Total	
1	Material for trainer						
1.1	Flipchart	set	5.00	1		5	
1.2	Marker	box	2.20	1		2	
1.3	Sticker	piece	0.50	1		1	
1.4	A4 paper	Ream	3.20	1		3	
	Total(1)					**11**	
2	Material for participant						
2.1	Handout	set	1	10		10	
2.2	Notebook	no	0.50	10		5	
2.3	Pen	no	0.20	10		2	
	Total(2)					**17**	
3	Other expenditure						
3.1	Snack + Lunch	ls	3	15	2	90	including 10 trainees
3.2	Allowance	ls	10	10	2	200	for trainees (10 persons)
3.3	Fuel	ls	10	10	2	200	for trainees (10 persons)
	Total(3)					**490**	
4	Final Report	Set	3	0		**0**	
Total						**518** **(520)**	

Note: formulated, based on

Table AC-2.1.6.3.6 Budget Plan of Training Programs (2/5)

(2)Farmers' Training Programs (30 persons) (Unit: USD)

No.	Description	Unit	Unit Price	2-day Training			Remarks
				Q'ty	days	Total	
1	Material						
1.1	Material for trainer	pax	3	10		30	
1.2	Flipchart	set	5.00	2		10	
1.3	Marker	box	2.20	1		2	
1.4	Sticker	piece	0.50	1		1	
1.5	A4 paper	Ream	3.20	1		3	
	Total(1)					**46**	
2	Material for participant						
2.1	Handout	set	1	30		30	
2.2	Notebook	no	0.50	30		15	
2.3	Pen	no	0.20	30		6	
	Total(2)					**51**	
3	Other expenditure						
3.1	Snack + Lunch	ls	3	30	2	180	
3.2	Allowance	ls	10	3	2	60	1 from PDA and 2 from DAO
3.3	Fuel	ls	10	3	2	60	1 from PDA and 2 from DAO
	Total(3)					**300**	
4	Final Report	Set	3	5		**15**	
	Total					**412** **(410)**	

(3) Study Tour (30 persons) (Unit: USD)

No.	Description	Unit	Unit Price	Q'ty	days	Total	Remarks
I	Training Facilitaties						
1.1	Souvenior	set	5	5		25	
1.2	Snack and Lunch	no./day	3	30	1	90	
1.4	Rent car	car-day	120	2	1	240	
	Total(1)					**355**	
2	Other expenditure						
2.1	Allowance	ls	10	3	1	30	1 from PDA and 2 from DAO
2.2	Fuel	ls	10	3	1	30	1 from PDA and 2 from DAO
	Total(2)					**60**	
3	Final Report	Set	3	5		**15**	
	Total					**430** **(430)**	

(4) Mass Guidance / Workshop (30 persons) (Unit: USD)

No.	Description	Unit	Unit Price	50 participants			Remarks
				Q'ty	days	Total	
1	Material						
1.1	Material for trainer	pax	3	10		30	
1.2	Flipchart	set	5.00	2		10	
1.3	Marker	box	2.20	1		2	
1.4	Sticker	piece	0.50	1		1	
1.5	A4 paper	Ream	3.20	1		3	
	Total(1)					**46**	
2	Material for participant						
2.1	Handout	set	1	30		30	
2.2	Notebook	no	0.50	30		15	
2.3	Pen	no	0.20	30		6	
	Total(2)					**51**	
3	Other expenditure						
3.1	Snack and lunch	man-day	3	30	1	90	
3.2	Allowance	ls	10	3	1	30	1 from PDA and 2 from DAO
3.3	Fuel	ls	10	3	1	30	1 from PDA and 2 from DAO
	Total(3)					**150**	
4	Final Report	Set	3	5		**15**	
	Total					**262** **(260)**	

Table AC-2.1.6.3.6 Budget Plan of Training Programs (3/5)

(5) Farmers' Field School (30 participants)

(i) Farm Inputs for FFS (Unit: US$)

No	Description	Unit	Unit Price	Paddy Q'ty	Paddy Amount 1 ha	Paddy Amount 0.2 ha	Paddy Amount 5 ha	Paddy Amount 20 ha	Upland Crops Q'ty	Upland Crops Amount 1 ha	Upland Crops Amount 0.1 ha	Vegetables Q'ty	Vegetables Amount 1 ha	Vegetables Amount 0.1 ha
1	Presentation Material													
1.1	Seed 3 kinds (20kg/place)	kg	0.75	60	45	9	225	900	20	15	2	7	5	1
1.2	DAP (18.46.00)	kg	0.60	50	30	6	150	600	80	48	5	105	63	6
1.3	Potassium(00-00-00)	kg	0.70	30	21	4	105	420	40	28	3	100	70	7
1.4	Urea (46.00.00)	kg	0.60	100	60	12	300	1,200	30	18	2	70	42	4
	Total (1)				156 (160)	31 (30)	780 (780)	3,120 (3,120)		109 (110)	11 (10)		180 (180)	18 (20)

(ii) Common items (Unit: US$)

No	Description	Unit	Unit Price	Q'ty	Amount	Remarks
1	Training Material					
1.1	Material for Trainer	pax	3	10	30	
1.2	Flipchart	set	5.00	2	10	
1.3	Marker	box	2.20	1	2	
1.4	Sticker	piece	0.50	1	1	
1.5	A4 paper	Ream	3.20	1	3	
	Total (1)				**46**	
2	Material for participant					
2.1	Handout	set	1	30	30	
2.2	Notebook	no	0.50	30	15	
2.3	Pen	no	0.20	30	6	
2.4	Certificate	no	1.00	30	30	
	Total (2)				**51**	
3	Other expenditure					
3.1	Snack	ls	1.00	480	480	30 persons x 16 times
3.2	Allowance	ls	10.00	48	480	3 persons x 16 times
3.3	Fuel	ls	10.00	48	480	3 persons x 16 times
	Total (4)				**1,440**	
4	Final report	set	3.00	5	**15**	
	Total(1,2,3,4)				**1,552 (1,550)**	

(iii) Total (Unit: US$)

No	Description	Paddy 1 ha	Paddy 0.2 ha	Paddy 5 ha	Paddy 20 ha	Upland Crops 1 ha	Upland Crops 0.1 ha	Vegetables 1 ha	Vegetables 0.1 ha
1	Farm inputs	160	30	780	3,120	110	10	180	20
2	Common items	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550
	Total (2)	**1,710**	**1,580**	**2,330**	**4,670**	**1,660**	**1,560**	**1,730**	**1,570**

Table AC-2.1.6.3.6 Budget Plan of Training Programs (4/5)

(6) Short-term Tarining with Demonstration Plot (30 participants)

(i) Farm Inputs for short-term training (Unit: US$)

No	Description	Unit	Unit Price	Paddy		Upland Crops		Vegetables		Remarks
				Q'ty per ha	Amount per 0.2ha	Q'ty per ha	Amount per 0.1ha	Q'ty per ha	Amount per 0.1ha	
1	Farm inputs									
1.1	Seed 3 kinds (20kg/place)	kg	0.75	60	9	20	2	7	1	
1.2	DAP (18.46.00)	kg	0.60	50	6	80	5	105	6	
1.3	Potassium(00-00-00)	kg	0.70	30	4	40	3	100	7	
1.4	Urea (46.00.00)	kg	0.60	100	12	30	2	70	4	
	Total (1)				**31**		**11**		**18**	

(ii) Common items (Unit: US$)

No	Description	Unit	Unit Price	Q'ty	Amount	Remarks
2	Training Material					
2.1	Material for Trainer	pax	3	10	30	
2.2	Flipchart	set	5.00	2	10	
2.3	Marker	box	2.20	1	2	
2.4	Sticker	piece	0.50	1	1	
2.5	A4 paper	Ream	3.20	1	3	
	Total (1)				**46**	
3	Material for participant					
3.1	Handout	set	1	30	30	
3.2	Notebook	no	0.50	30	15	
3.3	Pen	no	0.20	30	6	
	Total (2)				**51**	
4	Other expenditure					
4.1	Snack for two field days	ls	1.00	60	60	(transplanting / harvesting), 30 persons x 2 times
4.2	Allowance	ls	10.00	36	360	Maintenance work, 2 persons x 18 times
4.3	Fuel	ls	10.00	36	360	Maintenance work, 2 persons x 18 times
	Total (4)				**780**	
5	Final report	set	3.00	5	**15**	
	Total(2,3,4)				**892**	

(iii) Total (i + ii) (Unit: US$)

No	Description	Paddy	Upland Crops	Vege.
1	Farm inputs	31	11	18
2	Common items	892	892	892
	Total	**923**	**903**	**910**
		(920)	**(900)**	**(910)**

Table AC-2.1.6.3.6 Budget Plan of Training Programs (5/5)

(7) Water Management Training

No	Description	Unit	Unit Price	Q'ty	Amount	Remarks
1	Training Material					
1.1	Material for Trainer	pax	3	10	30	
1.2	Flipchart	set	5.00	2	10	
1.3	Marker	box	2.20	1	2	
1.4	Sticker	piece	0.50	1	1	
1.5	A4 paper	Ream	3.20	1	3	
	Total (1)				**46**	
2	Material for participant					
2.1	Handout	set	1	30	30	
2.2	Notebook	no	0.50	30	15	
2.3	Pen	no	0.20	30	6	
	Total (2)				**51**	
3	Other expenditure					
3.1	Snack for two field days	ls	1.00	60	60	30 persons x 2 times
3.2	Allowance	ls	10.00	72	720	PDWORAM and PDA, 4 persons x 18 times
3.3	Fuel	ls	10.00	72	720	PDWORAM and PDA, 4 persons x 18 times
	Total (4)				**1,500**	
4	Final report	set	3.00	5	**15**	
	Total(2,3,4)				**1,612** **(1,610)**	

AC-T-23

Table AC-2.1.6.3.7 Implementation and Cost Schedules for Agricultural Support Services in RCHRSP

Roleang Chrey (580 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017				2018				2019				2020				Overall			
			Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)
			Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual	
1. Trainers' training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	unit	920		3	3	2,760	3		3	2,760		3	3	2,760			0		3	6	9	8,280
- Upland Crops (0.1 ha)	unit	900			0	0			0	0	3		3	2,700			0	0	3	0	3	2,700
- Vegetables (0.1 ha)	unit	910							0	0	3		3	2,730			0	0	3	0	3	2,730
2.2 Water management (20ha)																						
- Irrigated Rice	unit	1,610			0	0	3	3	6	9,660			0	0			0	0	3	3	6	9,660
Sub-total			0	3	3	2,760	6	3	9	12,420	6	3	9	8,190	0	0	0	0	12	9	21	23,370
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	unit	410		3	3	1,230			0	0			0	0			0	0	0	3	3	1,230
3.2 FFS/IPM (30 participants)	unit	1580			0	0		3	3	4,740			0	0			0	0	0	3	3	4,740
3.3 Study Tour	unit	430			0	0	3		3	1,290			0	0			0	0	3	0	3	1,290
Sub-total			0	3	3	1,230	3	3	6	6,030	0	0	0	0	0	0	0	0	3	6	9	7,260
4. Mass Guidance/Workshop																						
4.1 30 Participants	unit	260	3		3	780	3		3	780			0	0			0	0	6	0	6	1,560
Total						5,290				19,750				8,710				520				34,270

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017				2018				2019				2020				Overall			
			Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.3	9,780	9,780														0.3	9,780	9,780	
1.2 Allowance	day	100	9	900	900														9	900	900	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					12,180	0			0	0			0	0			0	0			12,180	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.86	2,580		2,580	0.86	2,580		2,580	1.16	3,480		3,480	0.56	1,680		1,680	3.44	10,320		10,320
2.2 Allowance	day	30	26	780		780	26	780		780	35	1,050		1,050	17	510		510	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,410			0	3,410			0	4,580			0	2,240			0	13,640

Source: JICA Survey Team

Table AC-2.2.1.1 Related Districts, Communes, Villages, and Population in USISRSP

Province	District	Commune		No. of village		Population in Communes		
				Total	in the area	2008 *	Annual Rate (%)	2011 **
Takeo	Tram Kak	1	Cheang Tong	16	11	10,121	0.63	11,300
		2	Ou Saray	12	3	11,993	1.55	15,600
		3	Ta Phem	23	5	13,535	0.58	14,900
		4	Trapeang Thum Khang Cheung	11	7	7,454	0.09	7,600
Total	1 District	4 Communes		62	26	43,103		49,400

*Note: * from population census 2008]*

*** Project applying annual growth rate*

Source: Report2 Spatial Distribution and Growth of Population in Cambodia, General Population Census of Cambodia 2008

Table AC 2.2.5.2.1 Financial Crop Budget under Present/Without-Project Conditions in USISRSP

Name of crops		Unit	Paddy Early Variety) (Irrigated)			Paddy (Mediumariety) (Irrigated)			Cucumber		
			Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income		Riel			3,121			3,345			5,620
Main products		kg	2,130	1,150	2,450	2,090	1,250	2,613	4,000	1,400	5,600
By-product		kg	1,917	350	671	2,090	350	732	400	50	20
			(straw)			(straw)			(corn stalk)		
2. Production Cost		Riel			1,264			1,242			1,038
2.1 Inputs		Riel			761			740			638
Seed (purchased)		kg	15	1,800	27	15	2,400	36	3	6,000	18
Seed (Self-stocked)		kg	50	0	0	65	0	0		0	
Farm manure (wet)		ton	2,000	200	400	2,000	200	400	2,000	200	400
Fertilizer	Urea	kg	60	2,300	138	60	2,300	138	40	2,300	92
	DAP	kg	60	3,000	180	50	3,000	150	20	3,000	60
	KCl	kg	0	2,700	0	0	2,700	0	0	2,700	0
Agro-chemicals		liter	0.5	15,000	8	0.5	15,000	8	4	15,000	60
Farming equipment and tools		LS	1	8,000	8	1	8,000	8	1	8,000	8
2.2 Labor		P-d	100		140	100		140	90		0
Hired labor		P-d	20	7,000	140	20	7,000	140	0	7,000	0
Family labor		P-d	80		0	80		0	90		0
2.3 Draft animal		Riel			363			362			400
Land preparation		LS	2		320	2		320	2		320
Plowing		LS	1	140,000	140	1	140,000	140	1	140,000	140
Paddling		LS	1	180,000	180	1	180,000	180	1	180,000	180
Transportation		kg	2,130	20	43	2,090	20	42	4,000	20	80
3. Net Return		Riel			1,857			2,103			4,582
(N.Return/P. Cost Ratio)					1.47			1.69			4.41

Name of crops		Unit	String Bean			Tomato		
			Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income		Riel			5,715			5,415
Main products		kg	3,000	1,900	5,700	3,000	1,800	5,400
By-product		kg	300	50	15	300	50	15
			(waste fruit)			(stem and waste bean)		
2. Production Cost		Riel			1,180			1,005
2.1 Inputs		Riel			800			625
Seed (purchased)		kg	30	6,000	180	0.3	15,000	5
Seed (Self-stocked)		kg	0	0		0	0	
Farm manure		ton	2,000	200	400	2,000	200	400
Fertilizer	Urea	kg	40	2,300	92	40	2,300	92
	DAP	kg	20	3,000	60	20	3,000	60
	KCl	kg	0	2,700	0	0	2,700	0
Agro-chemicals		liter	4	15,000	60	4	15,000	60
Farming equipment and tools		LS	1	8,000	8	1	8,000	8
2.2 Labor		P-d	90		0	90		0
Hired labor		P-d	0	7,000	0	0	7,000	0
Family labor		P-d	90		0	90		0
2.3 Draft animal		Riel			380			380
Land preparation		Ani-d	2		320	2		320
Plowing		Ani-d	1	140,000	140	1	140,000	140
Paddling		Ani-d	1	180,000	180	1	180,000	180
Transportation		Ani-d	3,000	20	60	3,000	20	60
3. Net Return		Riel			4,535			4,410
(N.Return/P. Cost Ratio)					3.84			4.39

Note: *: Cucumber, String bean, and Tomato are substitutes of all suitable vegetables in the area.

Average Net Return per ha of vegetables: 4,474 Riel '000

Table AC-2.2.5.2.2 Financial Crop Budget under With-Project Condition in USISRSP

Name of crops	Unit	Paddy (Impr. Local V.)			Paddy (H.Y.V)			Cucumber		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			4,375			4,600			2,920
Main products	kg	3,500	1,250	4,375	4,000	1,150	4,600	2,000	1,400	2,800
By-product	kg	3,500	0	0	3,500	0	0	2,400	50	120
		(straw)			(straw)			(corn stalk)		
2. Production Cost	Riel			966			995			789
2.1 Inputs	Riel			513			532			429
Seed (purchased)	kg	65	1,800	117	50	1,800	90	20	1,800	36
Seed (self-stocked)	kg									
Farm manure (wet)	ton	3	200	1	3	200	1	0	200	0
Fertilizer Urea	kg	80	2,300	184	100	2,300	230	80	2,300	184
DAP	kg	45	3,000	135	45	3,000	135	40	3,000	120
KCl	kg	25	2,700	68	25	2,700	68	30	2,700	81
Agro-chemicals	liter	0	15,000	0	0	15,000	0	0	15,000	0
Farming equipment and tools	LS	1	8,000	8	1	8,000	8	1	8,000	8
2.2 Labor	Riel			63			63			0
Hired labor	P-d	9	7,000	63	9	7,000	63	0	7,000	0
Family labor	P-d	81		0	81	0	0	80	0	0
2.3 Paid Services	Riel			390			400			360
Land preparation	LS	2		320	2		320	2		320
Plowing (1st)	LS	1	140,000	140	1	140,000	140	1	140,000	140
Paddling / 2nd Plowing	LS	1	180,000	180	1	180,000	180	1	180,000	180
Transportation	kg	3,500	20	70	4,000	20	80	2,000	20	40
3. Net Return	Riel			3,409			3,605			2,131
(N.Return/P. Cost Ratio)				3.53			3.62			2.70

Name of crops	Unit	Strinb Beans			Tomato		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			9,525			12,635
Main products	kg	5,000	1,900	9,500	7,000	1,800	12,600
By-product	kg	500	50	25	700	50	35
		(waste fruit)			(stem and waste bean)		
2. Production Cost	Riel			1,838			2,065
2.1 Inputs	Riel			1,383			1,563
Seed (purchased)	kg		6,000	0	0	15,000	5
Seed (self-stocked)	kg	30					
Farm manure (wet)	ton	4,000	200	800	4,000	200	800
Fertilizer Urea	kg	100	2,300	230	150	2,300	345
DAP	kg	50	3,000	150	70	3,000	210
KCl	kg	50	2,700	135	50	2,700	135
Agro-chemicals	liter	4	15,000	60	4	15,000	60
Farming equipment and tools		1	8,000	8	1	8,000	8
2.2 Labor	Riel			35			42
Hired labor	P-d	5	7,000	35	6	7,000	42
Family labor	P-d	115		0	114		0
2.3 Paid Services	Riel			420			460
Land preparation	LS	2		320	2		320
Plowing	LS	1	140,000	140	1	140,000	140
Paddling	LS	1	180,000	180	1	180,000	180
Transportation	kg	5,000	20	100	7,000	20	140
3. Net Return	Riel			7,687			10,570
(N.Return/P. Cost Ratio)				4.18			5.12

Note: *: Cucumber, String bean, and Tomato are substitutes of all suitable vegetables in the area.

Average Net Return per ha of vegetables: 8,358 Riel '000

Table AC-2.2.5.3.1 Yield Estimation under With & Without-project Conditions for USISRSP

(1) Statistic Data: Paddy Yields by Province and District

Province / Related Districts	PDA Annual Report 1/						MAFF		
	Early Rice			Medium Rice			2010 2/	2008 3/	
	2010	2009	2008	2010	2009	2008	Average	Early	Medium
Takeo									
Tram Kak	3.30	3.20	2.70	3.35	3.18	2.96			
Whole Province	3.25	2.95	2.90	3.24	2.85	2.91	3.25	2.98	2.98

Source:

1/ : Annual Report 2010/2011 *2/: Annual Report 2010 - 2011* *3/: Agricultural Statistics 2008 - 2009*

(2) Results of Socio-economic Survey: Average yield 1/

Zone	Paddy Yield (ton/ha)			Remarks
	Irrigated		Rainfed	
	Wet Season	Dry season	Wet Season	
Upper Slakou	2.13		2.09	No. of respondents: 40

1/: Results of Socio-economic Survey conducted by the JICA Study Team, 2011

(3) Results of Socio-economic Survey: Yield Distribution 1/

Irrigation Category	Paddy Yield (ton/ha)		Irrigation Status	Remarks
	Rainy Season Local Variety	Dry Season Improved Variety		
Category 1	0.7 ~ 6.0	0 ~ 6.0	Fully irrigated field	No. of respondents: 46
Category 2	1.1 ~ 6.0	-	Supplemental irrigation in rainy season	No. of respondents: 141
Category 3	0 ~ 5.4	-		
Category 4	0.03 ~ 4.0	-	Rainfed field	No. of respondents: 124
Overall Average	0 ~ 6.0			No. of respondents: 182

1/: Results of Socio-economic Survey conducted by the JICA Study Team, 2007

(4) Verification Trial conducted in the JICA Previous Study in 2006/07 and 2007/08

Year	Season	Rice Category	Yield
2006 / 2007	Wet season	Early Rice	3.8 to 4.7
		Early Rice	4.0
		Medium Rice	3.2 to 4.8
2007 / 2008	Wet season	Early Rice	3.8 to 4.7
		Early Rice	3.4 to 4.0
		Medium Rice	3.1 to 3.7

Source: Final Report of the Study on Comprehensive Agricultural Development on Prek Thnot River Basin, 2008

(5) Demonstration Results of CARDI Conducted in Rainfed Fields in 2005/06 Rainy Season: 5 plots in each province

Location	Yield Range	Full Practices 1/	Location	Yield Range	Full Practices 1/
Kampong Speu	1.77 ~ 3.00 t/ha	3.00 t/ha	Kampong Speu	1.68 ~ 3.16 t/ha	3.16 t/ha

1/: Yield in plot with full recommended practices of seed quality, fertilizer, pest management, land leveling

(6) Estimated Yield Levels of Paddy in the Target Area under With and Without-Project

On the basis of the statistic data & results of the Socio-economic Survey (2011), the With & Without-Project paddy yield level in the USISRSP Area estimated as follows:

Estimated Current Yield Levels in the Target Area (ton/ha)

Condition	Upper Slakou	
	Early Variety (irrigated)	Medium Variety (rainfed)
Present	2.13	2.09
Without Project	2.13	2.09
With Project	4.00	3.50

Note:

Early variety: Early maturing variety rice

Medium variety: Medium maturing variety rice

Table AC-2.2.6.3.3 Implementation and Cost Schedules for Agricultural Support Services in USISRSP

Upper Slako (3,500 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017				2018				2019				2020				Overall			
			Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)
			Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual	
1. Trainers' Training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	unit	920		6	6	5,520	6	9	15	13,800	6	9	15	13,800			0	0	12	24	36	33,120
- Upland Crops (0.1 ha)	unit	900			0	0		9	9	8,100		9	9	8,100			0	0	0	18	18	16,200
- Vegetables (0.1 ha)	unit	910		3	3	2,730	3		3	2,730	3	9	12	10,920			0	0	6	12	18	16,380
2.2 Water management (20ha)																						
- Irrigated Rice	unit	1,610		6	6	9,660	6	6	12	19,320	9	9	18	28,980			0	0	15	21	36	57,960
Sub-total			0	15	15	17,910	15	24	39	43,950	18	36	54	61,800	0	0	0	0	33	75	108	123,660
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	unit	410			0	0		6	6	2,460		6	6	2,460	6		6	2,460	6	12	18	7,380
3.2 FFS/IPM (30 participants)	unit	1580			0	0		6	6	9,480		6	6	9,480	6		6	9,480	6	12	18	28,440
3.3 Study Tour	unit	430			0	0	18		18	7,740			0	0			0	0	18	0	18	7,740
Sub-total			0	0	0	0	18	12	30	19,680	0	12	12	11,940	12	0	12	11,940	30	24	54	43,560
4. Mass Guidance/Workshop																						
4.1 30 Participants		260	6	6	12	3,120	6	6	12	3,120	6	6	12	3,120			0	0	18	18	36	9,360
Total						21,550				67,270				77,380				12,460				178,660

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017				2018				2019				2020				Overall			
			Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.3	9,780	9,780														0.3	9,780	9,780	
1.2 Allowance	day	100	9	900	900														9	900	900	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					12,180	0			0	0			0	0			0	0			12,180	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	3.44	10,320		10,320
2.2 Allowance	day	30	26	780		780	26	780		780	26	780		780	26	780		780	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,410			0	3,410			0	3,410			0	3,410			0	13,640

Source: JICA Survey Team

Table AC-2.3.1.1(1) Demographic Situation of the Related Communes for Kandal Stung Area

Province	District	Commune	Village	Total HH	Total Population
Kandal	Kandal Stueng	Anlong Romiet	Anlong Romiet Khang Cheung	120	617
			Anlong Romiet Khang Tboung	98	560
			Anlong Roniet Khang Lech	103	522
			Daeum Trang	226	1,105
			Kampong Tuol	197	837
			Srae Kouk	120	609
			Total	864	4,250
		Barku	Barku	177	901
			Khmut	93	473
			Ou Andoung	136	674
			Pou Doh	98	497
			Svay Ming	320	1,566
			Tboung Kdei	144	774
			Veal Kandal	120	509
			Total	1,088	5,394
		Thmei	Krang Tei	36	152
			Thmei	180	804
			Tonlea	80	404
			Trapeang Chak	77	370
			Tuol Kamrieng	89	463
			Total	462	2,193
		Kouk Trab	Char	134	600
			Chheu Neang	84	448
			Kbal Seh	97	488
			Kouk Pring	100	421
			Kouk Trab	113	509
			Krang Thmey	97	449
			Liek	93	456
			Svay Kaeut	86	427
			Svay Lech	150	647
			Total	954	4,445
		Kong Noy	Kong Noy	118	588
			Serei Sambatt	74	362
			Trapeang Samret	60	330
			Veal Thlan	82	409
			Total	334	1,689
		Preah Putth	Ben Baor	41	247
			Bonna	97	471
			Krang Sbov	142	616
			Krang Trea	73	341
			Preah Putth	83	402
			Total	436	2,077
		Preaek Roka	Boeng K'aek	196	904
			Chambak Trab	239	1,115
			Kaoh Knaor	235	1,038
			Preaek Roka	363	1,637
			Total	1,033	4,694
		Roluos	Kandal	251	1,143
			Krapeu Troum	203	864
			Preah Theat	144	615
			Total	598	2,622
		Spean Thma	Anhchanh	111	458
			Doung	38	223
			Kouk Ovloek	72	330
			Meun Tra	90	444

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Table AC-2.3.1.1(2) Demographic Situation of the Related Communes for Kandal Stung Area

Province	District	Commune	Village	Total HH	Total Population
			Phum Ha	89	409
			Preaek Chrey	82	362
			Spean Thma	92	420
			Svay Mean Leak	54	258
			Total	628	2,904
		Tbaeng	Angk Khlaeu	158	621
			Chi Mau	60	288
			Chrolong	124	601
			Kamnab	107	521
			Kok Til	79	442
			Krang Chheu Neang	143	665
			Krang Koam	162	799
			Total	833	3,937
		Tien	Kantuy Tuek	36	175
			Krang	58	285
			Krang Krouch	114	508
			Sala	79	348
			Thma	47	215
			Thmei	145	666
			Total	479	2,197
		Trapeang Veaeng	Damnak Trabaek	71	295
			Prey Totueng	204	955
			Slaeng	189	846
			Ta Loek	125	596
			Trapeang Barku	186	909
			Total	775	3,601
		Trea	Damrei Slab	122	490
			Doun Vongs	112	518
			Kab Leav	99	450
			Moat Boeng	113	532
			Roung Kou	166	836
			Trapeang Kak	128	673
			Trapeang Sva	161	751
			Tras	164	831
			Trea	91	507
			Total	1,156	5,588

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Table AC-2.3.1.2 Demographic Situation of the Related Communes for Bati Area

Province	District	Commune	Village	Total HH	Total Population
Takeo	Bati	Champei	Moeang Prachen	177	835
			Preaek	153	730
			Prey Mul	193	817
			Cheung Loung	67	293
			Trakiet	240	931
			Mkak	251	1097
			Daeum Doung	189	848
			Total	1,270	5,551
		Pot Sar	Krang Pou	264	1293
			Prey Sva	175	857
			Kandaol	136	675
			Trapeang Trav	293	1478
			Krouch	169	786
			Tang Ruessei	152	709
			Khla Koun	116	479
			Pot Sar	345	1605
			Kleang Sambatt	248	1242
			Khvan Meas	154	753
			Chambak	251	1234
			Total	2,303	11,111
		Krang thnong	Tboung Damrei	190	919
			Chroung Sdau	187	864
			Krang Thnong	221	1060
			Haknuman	186	940
			Tonle Bati	313	1602
			Thnal Teaksen	334	1719
			Khnar	149	721
			Tbaeng	212	964
			Total	1,792	8,789
		Kandoeng	Krasang	135	628
			Krang Ampil	131	573
			Kandoeng Thum	373	1827
			Kandoeng Touch	259	1190
			Preah Mlob	124	611
			Aopheasang	324	1469
			Trapeang Leuk	197	1018
			Haknuman	104	476
			Total	1,647	7,792
		Trapeang Sab	Smau Khnhei	468	2324
			Sangkae	167	794
			Ta Su	262	1137
			Roleang Kreul	168	759
			Sdok Prei	349	1657
			Daeum Kray	82	369
			A Cheang	210	1062
			Trapeang Tuem	279	1344
			Roka Khpos	101	463
			Trapeang Sab	271	1211
			Trakiet	151	662
			Khsach Lob	163	732
			Prech	215	1003
			Chak	259	1182
			Pun Phnum	472	2212
			Total	3,617	16,911

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Table AC-2.3.2.5.1 Harvested Area of Paddy in Wet Season in Kandal Stung District

No.	Commune	Harvested Area in Wet Season (ha) in 2010				Cropping Intensity (%)	Remarks *1
		Early Rice	Medium Rice	Late Rice	Total		
1	Amper Prey	41	437	110	588	107	
2	Anlong Remeath	12	280	39	331	104	Extension Area
3	Ba Ku	105	430	61	596	121	Existing area
4	Boeng Khyang	105	545	119	769	116	
5	Cheung Kaeub	122	560	169	851	117	
6	Daem Rues	50	790	231	1,071	105	
7	Kandaok	103	472	89	664	118	
8	Thmei	20	276	75	371	106	Extension Area
9	Kok Trap	88	404	123	615	117	Extension Area
10	Kung Noy	21	184	40	245	109	Existing area
11	Preah Puth	136	314	76	526	135	Existing area
12	Preaek Kampues	0	300	308	608	100	
13	Prek Poka	9	337	292	638	101	Extension Area
14	Preaek Slaeng	53	378	126	557	111	
15	Roka	21	457	59	537	104	
16	Roleang Kaen	0	453	59	512	100	
17	Roleous	32	275	18	325	111	Existing area
18	Siem Reap	53	314	65	432	114	
19	Spean Thma	5	264	226	495	101	
20	Tbeng	0	626	77	703	100	Extension Area
21	Tien	41	302	63	406	111	Existing area
22	Tra Peang Veng	0	556	164	720	100	Extension Area
23	Trea	30	497	49	576	105	Extension Area
Whole District		1,047	9,451	2,638	13,136	109	
Existing area		335	1,505	258	2,098	119	
Extension area		159	2,976	819	3,954	104	

Note: *1: It is assumed that the existing and extension areas of the Kandal Stung Irrigation Scheme are located partly in the respective communes.

Source: Internal data of District Agricultural Office, Kandal Stung District, 2011

Table AC-2.3.2.5.2 Harvested Area of Paddy Cultivation in Bati District

(1) Year of 2010 (Unit: ha)

No	Commune Name	Direct sowing and transplanted (ha)					Cropping Intensity (%)
		Early1	Early2	Medium	Deep water	Total (2)	(2)/(1)
1	Cham bork	155	260	1,053	0	1,468	112
2	Thnort	60	275	739	0	1,074	106
3	Pear Ream	180	320	1,680	10	2,190	109
4	Doung	95	330	769	100	1,294	108
5	Cham Pei	230	355	1,116	50	1,751	115
6	Puth Sar	555	415	1,515	40	2,525	128
7	Krorng Thnong	98	307	1,210	0	1,615	106
8	Kondeng	167	328	701	0	1,196	116
9	Tropaeng Sap	80	236	828	0	1,144	108
10	Tropaeng Krosang	0	250	742	0	992	100
11	Krang Leav	0	235	1,255	0	1,490	100
12	Koma Reachea	0	196	719	0	915	100
13	LumPong	0	145	427	0	572	100
14	Sopy	0	183	786	0	969	100
15	Tangdoung	0	165	760	0	925	100
Total		1,620	4,000	14,300	200	20,120	109

Note) Early 1: Early rice during early rainy season, Early 2: Early rice during rainy season

Source: Internal data, Bati District Agricultural Office, 2011

(2) Year of 2011 (Unit: ha)

No	Commune Name	Direct sowing and transplanted (ha)					Cropping Intensity (%)
		Early1	Early2	Medium	Deep water	Total (2)	(2)/(1)
1	Chambak	155	260	1,053	-	1,468	112
2	Tnaot	72	275	739	-	1,086	107
3	Pea Ream	240	320	1,680	10	2,250	112
4	Doung	165	330	769	100	1,364	114
5	Champei	267	355	1,117	50	1,789	118
6	Pot Sar	726	415	1,515	40	2,696	137
7	Krarng Thnong	147	307	1,210	-	1,664	110
8	Kandoeng	206	328	701	-	1,235	120
9	Trapeang Sab	80	236	837	-	1,153	107
10	Trapeang Krasang	-	250	742	-	992	100
11	Krang Leav	-	235	1,270	-	1,505	100
12	Komar Reachea	-	196	729	-	925	100
13	Lumpong	-	145	427	-	572	100
14	Sour Phi	-	183	786	-	969	100
15	Tang Doung	-	165	770	-	935	100
Total		2,058	4,000	14,345	200	20,603	111

Note) Early 1: Early rice during early rainy season, Early 2: Early rice during rainy season

Source: Internal data, Bati District Agricultural Office, 2012

Table AC-2.3.5.2.1 Financial Crop Budget under Present / Without-project Conditions in KSBISRSP

Items			Unit	Early Rice (Supplementary Irrigation) Q'ty	Price (Riel)	Value (1000Riel)	Medium Rice (Supplementary Irrigation) Q'ty	Price (Riel)	Value (1000Riel)
1.	Gross Income		Riel			4,088			3,616
	Main products		kg	2,790	1,150	3,209	2,310	1,250	2,888
	By-product		kg	2,511	350	879	2,079	350	728
				(straw)			(straw)		
2.	Production Cost		Riel			2,640			2,166
2.1	Inputs		Riel			784			770
	Seed	Purchased	kg	15	1,800	27	15	2,400	36
		Self-stocked	kg	65	0	0	65	0	0
	Farm manure (wet)		ton	2,000	200	400	2,000	200	400
	Fertilizer	Urea	kg	70	2,300	161	60	2,300	138
		DAP	kg	60	3,000	180	60	3,000	180
		KCl	kg	0	2,700	0	0	2,700	0
	Agro-chemicals		liter	0.5	15,000	8	0.5	15,000	8
	Farming equipment and tools		LS	1.0	8,000	8	1.0	8,000	8
2.2	Labor		P-d	105		70	105		70
	Hired labor		P-d	10	7,000	70	10	7,000	70
	Family labor		P-d	95	0	0	95	0	0
2.3	Paid Services		Riel			1,786			1,326
	Land preparation		LS	2.0		480	2.0		480
	Plowing		LS	1.0	230,000	230	1.0	230,000	230
	Paddling		LS	1.0	250,000	250	1.0	250,000	250
	Water pump		LS	1.0	800,000	800	1.0	800,000	800
	Harvesting		LS	1.0	450,000	450	0.0	450,000	0
	Transportation		kg	2,790	20	56	2,310	20	46
3.	Net Return		Riel			1,448			1,450
	(N.Return/P. Cost Ratio)					0.55			0.67

Table AC-2.3.5.2.2 Financial Crop Budget under With-project Condition in KSBISRSP

Items			Unit	Early Rice (Full Irrigation)			Medium Rice (Full Irrigation)		
				Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1.	Gross Income		Riel			5,860			5,600
	Main products		kg	4,000	1,150	4,600	3,500	1,250	4,375
	By-product		kg	3,600 (straw)	350	1,260	3,500 (straw)	350	1,225
2.	Production Cost		Riel			2,952			2,918
2.1	Inputs		Riel			1,079			1,055
	Seed	Purchased	kg	16.5	1,800	30	21.5	2,400	52
		Self-stocked	kg	33.5	0	0	43.5	0	0
	Farm manure (wet)		ton	3,000	200	600	3,000	200	600
	Fertilizer	Urea	kg	100	2,300	230	80	2,300	184
		DAP	kg	45	3,000	135	45	3,000	135
		KCl	kg	25	2,700	68	25	2,700	68
	Agro-chemicals		liter	0.5	15,000	8	0.5	15,000	8
	Farming equipment and tools		LS	1.0	8,000	8	1.0	8,000	8
2.2	Labor		P-d			63		0	63
	Hired labor		P-d	9	7,000	63	9	7,000	63
	Family labor		P-d	81	0	0	81	0	0
2.3	Paid Services		Riel			1,810			1,800
	Land preparation		LS	2.0		480	2.0		480
	Plowing		LS	1.0	230,000	230	1.0	230,000	230
	Paddling		LS	1.0	250,000	250	1.0	250,000	250
	Water pump		LS	1.0	800,000	800	1.0	800,000	800
	Harvesting		LS	1.0	450,000	450	1.0	450,000	450
	Transportation		kg	4,000	20	80	3,500	20	70
3.	Net Return		Riel			2,908			2,682
	(N.Return/P. Cost Ratio)					0.99			0.92

Table AC-2.3.5.3.1 Yield Estimation for With & Without-Project Conditions for KSBISRSP

(1) Statistic Data: Paddy Yields by Province and District

Province / Related Districts	PDA Annual Report 1/						MAFF		
	Early Rice			Medium Rice			2010 2/	2008 3/	
	2010	2009	2008	2010	2009	2008	Average	Early	Medium
Kandal									
Kandal Stung	3.32	-	-	2.95	-	-	-	-	-
Takeo									
Bati	3.07	3.30	-	3.20	3.22	3.14	-	-	-
Whole Province	3.25	2.95	2.90	3.24	2.85	2.91	3.25	2.98	2.98

Source:

1/ : Annual Report 2008/09, 2009/10, 2010/11 *2/: Annual Report 2010 - 2011* *3/: Agricultural Statistics 2008 - 2009*

(2) Results of Socio-economic Survey: Average yield 1/

Zone	Paddy Yield (ton/ha)			Remarks
	Irrigated		Rainfed	
	Wet Season	Dry season	Wet Season	
Kandal Stung	2.63	3.16	2.09	No. of respondents: 20
Bati	2.58	2.30	2.53	No. of respondents: 20

1/: Results of Socio-economic Survey conducted by the JICA Study Team, 2011

(3) Results of Socio-economic Survey: Yield Distribution 1/

Irrigation Category	Paddy Yield (ton/ha)		Irrigation Status	Remarks
	Rainy Season Local Variety	Dry Season Improved Variety		
Category 1	0.7 ~ 6.0	0 ~ 6.0	Fully irrigated field	No. of respondents: 46
Category 2	1.1 ~ 6.0	-	Supplemental irrigation in rainy season	No. of respondents: 141
Category 3	0 ~ 5.4	-		
Category 4	0.03 ~ 4.0	-	Rainfed field	No. of respondents: 124
Overall Average	0 ~ 6.0			No. of respondents: 182

1/: Results of Socio-economic Survey conducted by the JICA Study Team, 2007

(4) Verification Trial conducted in the JICA Previous Study in 2006/07 and 2007/08

Year	Season	Rice Category	Yield
2006 / 2007	Wet season	Early Rice	3.8 to 4.7
		Early Rice	4.0
		Medium Rice	3.2 to 4.8
2007 / 2008	Wet season	Early Rice	3.8 to 4.7
		Early Rice	3.4 to 4.0
		Medium Rice	3.1 to 3.7

Source: Final Report of the Study on Comprehensive Agricultural Development on Prek Thnot River Basin, 2008

(5) Demonstration Results of CARDI Conducted in Rainfed Fields in 2005/06 Rainy Season: 5 plots in each province

Location	Yield Range	Full Practices 1/	Location	Yield Range	Full Practices 1/
Kampong Speu	1.77 ~ 3.00 t/ha	3.00 t/ha	Kampong Speu	1.68 ~ 3.16 t/ha	3.16 t/ha

1/: Yield in plot with full recommended practices of seed quality, fertilizer, pest management, land leveling

(6) Estimated Yield Levels of Paddy in the Target Area under With and Without-Project

On the basis of the statistic data & results of the Socio-economic Survey (2012), the With & Without-Project paddy yield level in the KSBISRSP Area estimated as follows:

Estimated Current Yield Levels in KSBISRSP (ton/ha)

Condition	Upper Slakou	
	Early Rice (irrigated)	Medium Rice (rainfed)
Present	2.58	2.09
Without Project	2.58	2.09
With Project	4.00	3.50

Note:

Early rice: Early maturing variety rice

Medium rice: Medium maturing variety rice

Table AC-2.3.6.3.3 Implementation and Cost Schedules for Agricultural Support Services in KSBISRSP (1/2)

Kandal Stung (1,750 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017				2018				2019				2020				Overall			
			Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)
			Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual	
1. Trainers' Training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	unit	920		6	6	5,520		6	6	5,520	3	3	6	5,520			0		3	15	18	16,560
- Upland Crops (0.1 ha)	unit	900			0	0		3	3	2,700	3	3	6	5,400			0	0	3	6	9	8,100
- Vegetables (0.1 ha)	unit	910						3	3	2,730	3	3	6	5,460			0	0	3	6	9	8,190
2.2 Water management (20ha)																						
- Irrigated Rice	unit	1,610		3	3	4,830	3	3	6	9,660	3	6	9	14,490			0	0	6	12	18	28,980
Sub-total			0	9	9	10,350	3	15	18	20,610	12	15	27	30,870	0	0	0	0	15	39	54	61,830
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	unit	410			0	0	3		3	1,230	3		3	1,230	3		3	1,230	9	0	9	3,690
3.2 FFS/IPM (30 participants)	unit	1580			0	0		3	3	4,740		3	3	4,740	3		3	4,740	3	6	9	14,220
3.3 Study Tour	unit	430		3	3	1,290	3		3	1,290	3		3	1,290			0	0	6	3	9	3,870
Sub-total			0	3	3	1,290	6	3	9	7,260	6	3	9	7,260	6	0	6	5,970	18	9	27	21,780
4. Mass Guidance/Workshop																						
4.1 30 Participants		260	3		3	780	6		6	1,560	6		6	1,560	3		3	780	18	0	18	4,680
Total						12,940				29,950				40,210				7,270				90,370

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017				2018				2019				2020				Overall			
			Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.25	8,150	8,150														0.25	8,150	8,150	
1.2 Allowance	day	100	7.5	750	750														7.5	750	750	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					10,400	0			0	0			0	0			0	0			10,400	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.85	2,550		2,550	0.85	2,550		2,550	0.85	2,550		2,550	0.85	2,550		2,550	3.4	10,200		10,200
2.2 Allowance	day	30	26	780		780	26	780		780	26	780		780	26	780		780	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,380			0	3,380			0	3,380			0	3,380			0	13,520

Source: JICA Survey Team

Table AC-2.3.6.3.3 Implementation and Cost Schedules for Agricultural Support Services in KSBISRSP (2/2)

Bati (1,600 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017 Volume Early Rainy Season	2017 Volume Rainy Season	2017 Volume Annual	2017 Amount (US$)	2018 Volume Early Rainy Season	2018 Volume Rainy Season	2018 Volume Annual	2018 Amount (US$)	2019 Volume Early Rainy Season	2019 Volume Rainy Season	2019 Volume Annual	2019 Amount (US$)	2020 Volume Early Rainy Season	2020 Volume Rainy Season	2020 Volume Annual	2020 Amount (US$)	Overall Volume Early Rainy Season	Overall Volume Rainy Season	Overall Volume Annual	Overall Amount (US$)
1. Trainers' training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	unit	920		4	4	3,680	2	2	4	3,680	4	4	8	7,360			0	0	6	10	16	14,720
- Upland Crops (0.1 ha)	unit	900			0	0			0	0	4	4	8	7,200			0	0	4	4	8	7,200
- Vegetables (0.1 ha)	unit	910						4	4	3,640		4	4	3,640			0	0	0	8	8	7,280
2.2 Water management (20ha)																						
- Irrigated Rice	unit	1,610		4	4	6,440	2	2	4	6,440	4	4	8	12,880			0	0	6	10	16	25,760
Sub-total			0	8	8	10,120	4	8	12	13,760	12	16	28	31,080	0	0	0	0	16	32	48	54,960
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	unit	410		2	2	820	2		2	820	2		2	820	2		2	820	6	2	8	3,280
3.2 FFS/IPM (30 participants)	unit	1580			0	0	2	2	4	6,320		2	2	3,160	2		2	3,160	4	4	8	12,640
3.3 Study Tour	unit	430		2	2	860	2		2	860	2		2	860	2		2	860	6	2	8	3,440
Sub-total			0	4	4	1,680	6	2	8	8,000	4	2	6	4,840	6	0	6	4,840	16	8	24	19,360
4. Mass Guidance/Workshop																						
4.1 30 Participants		260	4		4	1,040	4		4	1,040	4		4	1,040	4		4	1,040	16	0	16	4,160
Total						**13,360**				**23,320**				**37,480**				**6,400**				**80,560**

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017 Quantity	2017 Total	2017 F/C	2017 L/C	2018 Quantity	2018 Total	2018 F/C	2018 L/C	2019 Quantity	2019 Total	2019 F/C	2019 L/C	2020 Quantity	2020 Total	2020 F/C	2020 L/C	Overall Quantity	Overall Total	Overall F/C	Overall L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.25	8,150	8,150														0.25	8,150	8,150	
1.2 Allowance	day	100	7.5	750	750														7.5	750	750	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					10,400	0			0	0			0	0			0	0			10,400	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.85	2,550		2,550	0.85	2,550		2,550	0.85	2,550		2,550	0.85	2,550		2,550	3.4	10,200		10,200
2.2 Allowance	day	30	26	780		780	26	780		780	26	780		780	26	780		780	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,380			0	3,380			0	3,380			0	3,380			0	13,520

Source: JICA Survey Team

Table AC-2.4.1.1 Related Districts, Communes, Villages, and Population (1/3)

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Basedth	Prey Rumduol Khang Lech		142	586	297	289
			Prey Rumduol Khang Tboung	○	159	608	287	321
			Prey Rumduol Khang Cheung	○	163	698	364	334
			Prey Rumduol Khang Kaeut		122	593	311	282
			Chamkar Tuol	○	80	316	139	177
			Tuol Khcheay		114	484	225	259
			Boeng Thnong	○	160	752	357	395
			Ta Prach		101	348	167	181
			Boeng Sdok	○	130	565	275	290
			Sampoar	○	141	571	277	294
			Kromhun	○	105	421	199	222
			Khpob Veaeng		93	425	201	224
			Trapeang Chhuk	○	119	492	223	269
			Prey Khley	○	106	441	224	217
			Kanlang	○	100	411	200	211
			Chas	○	146	594	293	301
			Tmat Leng	○	121	468	222	246
			Srae Traok	○	76	301	143	158
			Trapeang Phong	○	80	327	152	175
			Prey Kouk Trab	○	153	670	331	339
			Boeng Sangkae	○	64	290	141	149
			Prey Chheu Teal	○	90	376	178	198
			Total		2,565	10,737	5,206	5,531

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Pheari Mean Chey	Tuek Thla	○	97	527	259	268
			Sach Trei	○	128	619	312	307
			Samraong Pong Tuek	○	129	648	300	348
			Prey Roung	○	138	600	276	324
			Ta Saom Ak	○	87	448	227	221
			Trapeang Phlong	○	169	641	309	332
			Ta Thomm		136	593	279	314
			Das Skor		45	191	96	95
			Prey Ngoung		137	559	269	290
			Prey Kanhchan		84	350	174	176
			Pheari		127	479	231	248
			Thmei		201	954	493	461
			Preah Mlob		212	1,030	516	514
			Total		1,690	7,639	3,741	3,898

Table AC-2.4.1.1 Related Districts, Communes, Villages, and Population (2/3)

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Pou Mreal	Chamraeun Phal		66	291	155	136
			Prey Khle		101	360	171	189
			Thmei		47	211	109	102
			Prey Tbaeng		120	465	225	240
			Ta Nuon		221	902	462	440
			Ta Daeng Thmei		156	683	327	356
			Salam		163	651	347	304
			Pou		159	644	302	342
			Trapeang Khnar		96	448	223	225
			Ta Daeng Chas		180	800	407	393
			Mreal Tnaot Khang Tboung	〇	107	431	211	220
			Ou Char	〇	148	571	268	303
			Mreal Thum	〇	158	696	336	360
			Chambak Run Khang Tboung	〇	152	727	361	366
			Chambak Run Khang Cheung	〇	91	343	153	190
			Srae Khmaer	〇	75	308	139	169
			Mreal Tnaot Khang Cheung	〇	93	456	237	219
			Angk Daek Kandal		54	216	99	117
			Total		2,187	9,203	4,532	4,671

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Tuol Ampil	Prey Khla	〇	115	476	220	256
			Trapeang Tonloab	〇	96	427	209	218
			Kae Sraeng	〇	94	451	211	240
			Prey Sralaeng	〇	212	1,010	480	530
			Damnak Trach	〇	233	1,046	486	560
			Roka Pok	〇	112	501	256	245
			Mi Leav	〇	117	485	225	260
			Phan	〇	112	514	240	274
			Trapeang Chumrov		139	556	288	268
			Ta Meun	〇	129	602	288	314
			Sangkream Bour	〇	151	777	374	403
			Angk Rongeang		121	527	271	256
			Trapeang Khyang		151	755	383	372
			Angk Kdei		157	707	345	362
			Prey Peay		120	630	291	339
			Total		2,059	9,464	4,567	4,897

Table AC-2.4.1.1 Related Districts, Communes, Villages, and Population (3/3)

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Kak	Prech	○	89	345	172	173
			Ta Reach	○	184	758	346	412
			Prey Snuol		51	210	95	115
			Krang Traok	○	132	578	282	296
			Trapeang Krasang		39	161	84	77
			Ruessei Veal	○	49	215	105	110
			Toap Mreak	○	80	297	142	155
			Khnar		50	198	92	106
			Trapeang Pring		84	321	162	159
			Trapeang Chhuk		122	516	263	253
			Kbal Thnal		82	314	159	155
			Cheung Phnum		100	428	202	226
			Trapeang Teab		71	327	157	170
			Phchoek		125	505	243	262
			Total		1,258	5,173	2,504	2,669

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Preah Khae	Tnaot Mdaeum	○	93	395	217	178
			Prey Ba Krong	○	231	971	476	495
			Boeng	○	101	396	191	205
			Trapeang Veaeng	○	180	820	407	413
			Thnal	○	91	374	181	193
			Thnal Dach	○	153	636	291	345
			Khlouk	○	169	674	311	363
			Khnang Phum	○	155	724	311	413
			Trapeang Prei		116	551	261	290
			Total		1289	5541	2646	2895

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Kat Phluk	Ou		121	556	273	283
			Chambak		129	562	259	303
			Roka Kaong		221	981	500	481
			Roka Thum		72	347	172	175
			Youl Toung		52	206	106	100
			Kraol Krasang		137	685	340	345
			Phnum Koub		199	891	437	454
			Veal Lvieng		194	800	384	416
			Prey Sampoar		193	920	498	422
			Thlok Bei		140	661	326	335
			Trapeang Peuk		205	1,038	523	515
			Total		1,663	7,647	3,818	3,829

Province	District	Commune	Village	related to the Sub-project	Total HH	Total Population	Male	Female
Kampong Speu	Basedth	Nitean	Dei Kraham		128	589	295	294
			Tram Kang		227	988	463	525
			Serei Andaet		50	234	120	114
			Pou Tbaeng		90	445	206	239
			Trapeang Khnar		85	368	159	209
			Hangs		112	543	265	278
			Trapeang Chhuk		91	434	209	225
			Trapeang Sdau		62	232	91	141
			Krasang Ta Kong	○	136	565	273	292
			Noreay	○	75	315	160	155
			Trapeang Tuk	○	171	710	359	351
			Trapeang Rumdenh	○	134	506	224	282
			Trapeang Andoung	○	101	378	179	199
			Trapeang Sala	○	98	406	198	208
			Trapeang Khyang	○	101	357	175	182
			Total		1,661	7,070	3,376	3,694

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Table AC-2.4.2.3.2 Paddy Cultivation in Basedth District

No.	Communes	Rainy Season in 2010			Dry Season in 2010-11			Annual Total in 2010-11		
		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	Preah Khae	1,250	2.994	3,743	30	3.200	96	1,280	2.999	3,839
2	Svay Rumpear	1,350	2.853	3,851	26	3.200	83	1,376	2.859	3,934
3	Kak	1,363	2.525	3,442	0	0.000	0	1,363	2.525	3,442
4	Tuol Sala	1,250	2.328	2,910	4	3.200	13	1,254	2.331	2,923
5	Tuol Ampil	1,350	2.607	3,519	0	0.000	0	1,350	2.607	3,519
6	Svay Chacheb	1,610	3.200	5,152	0	0.000	0	1,610	3.200	5,152
7	Pou Mreal	1,603	1.879	3,012	12	3.000	36	1,615	1.887	3,048
8	Pou Chamraeun	1,350	2.459	3,319	5	3.100	16	1,355	2.461	3,335
9	Pou Angkrang	2,350	2.414	5,672	0	0.000	0	2,350	2.414	5,672
10	Phong	1,350	3.230	4,360	0	0.000	0	1,350	3.230	4,360
11	Pheari Mean Chey	1,250	2.389	2,986	0	0.000	0	1,250	2.389	2,986
12	Pheakdei	1,677	3.517	5,898	5	3.000	15	1,682	3.515	5,913
13	Nitean	1,190	2.376	2,828	9	2.900	26	1,199	2.380	2,854
14	Kat Phluk	1,490	2.487	3,706	0	0.000	0	1,490	2.487	3,706
15	Basedth	1,890	2.689	5,082	0	0.000	0	1,890	2.689	5,082
Total		22,323	2.665	59,481	91	3.127	285	22,414	2.666	59,765

Source) Report on Agricultural Work for 2010/11, Basedth District

No.	Communes	Rainy Season in 2010			Dry Season in 2010-11			Annual Total in 2010-11		
		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	Basedth	1,890	2.689	5,082	0	0.000	0	1,890	2.689	5,082
2	Pheari Mean Chey	1,250	2.389	2,986	0	0.000	0	1,250	2.389	2,986
3	Pou Mreal	1,603	1.879	3,012	12	3.000	36	1,615	1.887	3,048
4	Tuol Ampil	1,350	2.607	3,519	0	0.000	0	1,350	2.607	3,519
5	Kak	1,363	2.525	3,442	0	0.000	0	1,363	2.525	3,442
6	Preah Khae	1,250	2.994	3,743	30	3.200	96	1,280	2.999	3,839
7	Kat Phluk	1,490	2.487	3,706	0	0.000	0	1,490	2.487	3,706
8	Nitean	1,190	2.376	2,828	9	2.900	26	1,199	2.380	2,854
Total		11,386	2.490	28,318	51	3.100	158	11,437	2.490	28,476

Source) Report on Agricultural Work for 2010/11, Basedth District

Table AC-2.4.2.3.4 Prevailing and Proposed Paddy Cultivation Practices for MC35RSP Area

Farming Practices	Prevailing Practices		Proposed Practices	
Condition of Paddy Field	Rainfed		Irrigated	
Major rice varieties	Early rice:	IR 66	Early rice:	IR 66
		Sen Pidao		Sen Pidao
		504 (Nam Kong Bong)		Chulisa
	Medium rice:	Pkha Romdeng	Medium rice:	Riang Chey,
		Pkha Mlis		Pkha Romeat
				Pkha Romdeng
				Pkha Chansensor
				Pkha Rumduoul
	Late rice:	Chma Prum (local)	Late rice:	CAR4
		Koung Krohorm (local)		CAR6
		Nieng Sor (local)		
		Chuna Lo Et (local)		
Seeding rate (kg/ha)	45 ~ 60 kg/ha		45 ~ 60 kg/ha	
			Seed multiplication every 3 years	
Land preparation	Draft animal (70%) / Hand tractor (30%)		Draft animal / Hand tractor	
Planting method	Transplanting		Transplanting	
Planting distance	Transplanting		Transplanting	
		20 x 20 cm (random)		30 x 30 cm (random)
		25 x 25 cm (random)		15 x 20 cm (random)
		15 x 20 cm (random)		
	Random planting prevailing		Random planting prevailing	
Age of seedling	15 ~ 30 days (or more depending on water availability in a field)		about 30 days	
Fertilization				
1st application	Timing: at time of land preparation		Timing: at time of land preparation	
- Urea (kg/ha)	Limited		Limited	
- DAP (kg/ha)	50 ~ 75 kg/ha		75 ~ 100 kg/ha	
- KCl (kg/ha)	Not applied		Not applied	
- Compost	Applied by farmer holding cattle		Applied by farmer holding cattle	
2nd application	Timing: panicle initiation (10-15 days after transplanting)		Timing: panicle initiation (10-15 after transplanting)	
- Urea (kg/ha)	50 ~ 75 kg/ha		75 ~ 100 kg/ha	
Agro-chemical spray	Application limited (OSIN)		Application limited (OSIN, Trebong etc.)	
	Insect: Brown Plant Hopper		Insect: Brown Plant Hopper	
Manual weeding	3 times per a cropping season		3 times per a cropping season	
Harvesting	Manual (95%)		Manual (95%)	
	Combine harvester (5%)		Combine harvester (5%)	
Threshing	Manual at home yard (90%)		Manual at home yard (90%)	
	Use of thresher limited (10%)		Use of thresher limited (10%)	
Drying	Sun drying in home yard after threshing		Sun drying in home yard after threshing	
Yield Level:				
Rainy season				
Rainfed condition	1.0 ~ 2.5 ton/ha			
Irrigated condition	2.0 ~ 3.0 ton/ha		3.5 ~ 4.0 ton/ha	

Source: JICA survey Team, based on the interview to PDA Kampong Speu, DAO Basedth, and farmers

Table AC-2.4.5.2.1 Financial Crop Budget under Present and Without-project Conditions for MC35RSP, SPWRRSP and DPISRSP

Name of crops	Unit	Main Canal 35						Srass Prambai			Daun Pue		
		Early Rice			Medium Rice			Early Rice (Irrigated)			Medium Rice		
		Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income	Riel			3,121			3,345			5,128			3,345
Main products	kg	2,130	1,150	2,450	2,090	1,250	2,613	3,500	1,150	4,025	2,090	1,250	2,613
By-product	kg	1,917	350	671	2,090	350	732	3,150	350	1,103	2,090	350	732
		(straw)			(straw)			(straw)			(straw)		
2. Production Cost	Riel			1,237			1,206			2,440			1,206
2.1 Inputs	Riel			734			704			612			704
Seed (self-stocked)		80		0	80	0	0	130		0	80	0	0
Seed (early rice)	kg	0	1,800	0	0	1,800	0	120	1,800	216	0	1,800	0
Seed (medium rice)	kg	0	2,400	0	0	2,400	0	0	2,400	0	0	2,400	0
Farm manure (wet)	ton	2,000	200	400	2,000	200	400	0	200	0	2,000	200	400
Fertilizer Urea	kg	60	2,300	138	60	2,300	138	100	2,300	230	60	2,300	138
DAP	kg	60	3,000	180	50	3,000	150	50	3,000	150	50	3,000	150
KCl	kg	0	2,700	0	0	2,700	0	0	2,700	0	0	2,700	0
Agro-chemicals	liter	0.5	15,000	8	0.5	15,000	8	0.5	15,000	8	0.5	15,000	8
Farming equipment and tools	LS	1	8,000	8	1	8,000	8	1	8,000	8	1	8,000	8
2.2 Labor	P-d	100		140	100		140	40		28	100		140
Hired labor	P-d	20	7,000	140	20	7,000	140	4	7,000	28	20	7,000	140
Family labor	P-d	80		0	80		0	36	0	0	80		0
2.3 Machinery	Riel			363			362			1,800			362
Land preparation	LS	2		320	2		320	2		480	2		320
Plowing	LS	1	140,000	140	1	140,000	140	1	230,000	230	1	140,000	140
Paddling	LS	1	180,000	180	1	180,000	180	1	250,000	250	1	180,000	180
Water pump	LS	0	800,000	0	0	800,000	0	1	800,000	800	0	800,000	0
Harvesting	LS	0	450,000	0	0	450,000	0	1	450,000	450	0	450,000	0
Transportation	kg	2,130	20	43	2,090	20	42	3,500	20	70	2,090	20	42
3. Net Return	Riel			1,884			2,139			2,688			2,139
(N.Return/P. Cost Ratio)				1.52			1.77			1.10			1.77

Table AC-2.4.5.2.2 Financial Crop Budget under With-project Condition for MC35RSP, SPWRRSP and DPISRSP

Name of crops		Unit	Main Canal 35						Srass Prambai			Daun Pue		
			Early Rice			Medium Rice			Early Rice			Medium Rice		
			Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)
1. Gross Income		Riel			5,860			5,600			7,325			5,600
Main products		kg	4,000	1,150	4,600	3,500	1,250	4,375	5,000	1,150	5,750	3,500	1,250	4,375
By-product		kg	3,600 (straw)	350	1,260	3,500 (straw)	350	1,225	4,500 (straw)	350	1,575	3,500 (straw)	350	1,225
2. Production Cost		Riel			1,602			1,612			3,292			1,612
2.1 Inputs		Riel			1,139			1,159			1,434			1,159
Seed (early rice)		kg	50	1,800	90			0	150	1,800	270			0
Seed (medium rice)		kg			0	65	2,400	156			0	65	2,400	156
Farm manure (wet)		kg	3,000	200	600	3,000	200	600	3,000	200	600	3,000	200	600
Fertilizer	Urea	kg	100	2,300	230	80	2,300	184	150	2,300	345	80	2,300	184
	DAP	kg	45	3,000	135	45	3,000	135	45	3,000	135	45	3,000	135
	KCl	kg	25	2,700	68	25	2,700	68	25	2,700	68	25	2,700	68
Agro-chemicals		liter	0.5	15,000	8	0.5	15,000	8	0.5	15,000	8	0.5	15,000	8
Farming equipment and tools		LS	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8	1.0	8,000	8
2.2 Labor		Riel	90		63	90		63	40		28	110		63
Hired labor		P-d	9	7,000	63	9	7,000	63	4	7,000	28	9	7,000	63
Family labor		P-d	81		0	81	0	0	36		0	81	0	0
2.3 Paid Services		Riel			400			390			1,830			390
Land preparation		LS	2		320	2		320	2		480	2		320
Plowing (1st)		LS	1	140,000	140	1	140,000	140	1	230,000	230	1	140,000	140
Paddling / 2nd Plowing		LS	1	180,000	180	1	180,000	180	1	250,000	250	1	180,000	180
Water pump		LS	0	800,000	0	0	800,000	0	1	800,000	800	0	800,000	0
Harvesting		LS	0		0	0		0	1	450,000	450			
Transportation		kg	4,000	20	80	3,500	20	70	5,000	20	100	3,500	20	70
3. Net Return		Riel			4,258			3,988			4,033			3,988
(N.Return/P. Cost Ratio)					2.66			2.47			1.23			2.47

Table AC-2.4.6.3.3 Implementation and Cost Schedules for Agricultural Support Services for MC35RSP

Main Canal 35 (850 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017 Volume Early Rainy Season	2017 Volume Rainy Season	2017 Volume Annual	2017 Amount (US$)	2018 Volume Early Rainy Season	2018 Volume Rainy Season	2018 Volume Annual	2018 Amount (US$)	2019 Volume Early Rainy Season	2019 Volume Rainy Season	2019 Volume Annual	2019 Amount (US$)	2020 Volume Early Rainy Season	2020 Volume Rainy Season	2020 Volume Annual	2020 Amount (US$)	Overall Volume Early Rainy Season	Overall Volume Rainy Season	Overall Volume Annual	Overall Amount (US$)
1. Trainers' Training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	time	920		2	2	1,840		2	2	1,840	2	2	4	3,680			0	0	2	6	8	7,360
- Upland Crops (0.1 ha)	time	900			0	0			0	0	2	2	4	3,600			0	0	2	2	4	3,600
- Vegetables (0.1 ha)	time	910						2	2	1,820		2	2	1,820			0	0	0	4	4	3,640
2.2 Water management (20ha)																						
- Irrigated Rice	time	1,610		2	2	3,220		2	2	3,220	2	2	4	6,440			0	0	2	6	8	12,880
Sub-total			0	4	4	5,060	0	6	6	6,880	6	8	14	15,540	0	0	0	0	6	18	24	27,480
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	time	410		1	1	410		1	1	410		1	1	410	1		1	410	1	3	4	1,640
3.2 FFS/IPM (30 participants)	time	1580		1	1	1,580		1	1	1,580		1	1	1,580	1		1	1,580	1	3	4	6,320
3.3 Study Tour	time	430		1	1	430		1	1	430		1	1	430	1		1	430	1	3	4	1,720
Sub-total			0	3	3	2,420	0	3	3	2,420	0	3	3	2,420	3	0	3	2,420	3	9	12	9,680
4. Mass Guidance/Workshop																						
4.1 30 Participants	time	260	2		2	520	2		2	520	2		2	520	2		2	520	8	0	8	2,080
Total						**8,520**				**10,340**				**19,000**				**3,460**				**41,320**

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017 Quantity	2017 Total	2017 F/C	2017 L/C	2018 Quantity	2018 Total	2018 F/C	2018 L/C	2019 Quantity	2019 Total	2019 F/C	2019 L/C	2020 Quantity	2020 Total	2020 F/C	2020 L/C	Overall Quantity	Overall Total	Overall F/C	Overall L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.3	9,780	9,780														0.3	9,780	9,780	
1.2 Allowance	day	100	9	900	900														9	900	900	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					12,180	0			0	0			0	0			0	0			12,180	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	3.44	10,320		10,320
2.2 Allowance	day	30	26	780		780	26	780		780	26	780		780	26	780		780	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,410			0	3,410			0	3,410			0	3,410			0	13,640

Source: JICA Survey Team

Table AC-2.5.1.1 Demographic Situation in Kaoh Thum District

Province	District	Commune	Village	Total HH	Total Population	Male	Female
Kandal	Kaoh Thum	Pouthi Ban	Kampong Kor	236	1161	612	549
			Kbal Chrouy	198	960	484	476
			Pouthi Ban	292	1249	621	628
			Preaek Hang	283	1315	664	651
			Preaek Mrinh	254	1065	507	558
			Preaek Ta Doh	221	937	462	475
			Preaek Ta In	230	1195	602	593
			Preaek Ta Roatn	377	1723	843	880
			Preaek Thmei	305	1524	766	758
			Total	2,396	11,129	5,561	5,568
		Kaoh Thum Ka (A)	Chong Kaoh Thmei	266	990	478	512
			Chong Kaoh Thum	218	1085	467	618
			Kandal Kaoh Thum	158	836	408	428
			Kbal Kaoh Thmei	95	407	200	207
			Kbal Kaoh Thum	273	1105	534	571
			Pou Tonle	245	1001	450	551
			Total	1,255	5,424	2,537	2,887
		Kaoh Thum Kha (B)	Preaek Be	440	2015	1029	986
			Preaek Samraong	263	1042	531	511
			Preaek Ta Ker	296	1316	684	632
			Sampan	262	1202	695	507
			Svay Ta Mekh	284	1209	563	646
			Total	1,545	6,784	3,502	3,282
		Kampong Kong	Chrung Meas	139	570	280	290
			Kampong Kong	261	1218	588	630
			Kbal Damrei Kraom	167	732	336	396
			Kbal Damrei Leu	249	1146	542	604
			Lvea Toung	272	1422	687	735
			Preaek Hang	247	1058	521	537
			Preaek Ph'av	138	648	321	327
			Preaek Ruessei	406	2007	985	1022
			Trabaek Pok	151	753	346	407
			Tuol Doun Koam	168	864	388	476
			Tuol Sangkae	232	1032	511	521
			Total	2,430	11,450	5,505	5,945
		Leuk Daek	Anlong Slat	207	997	500	497
			Chamkar Doung	139	631	280	351
			Khleang Kaeut	261	1259	626	633
			Khleang Lech	381	1923	989	934
			Leuk Daek	227	1030	510	520
			Peam Phtoul Kaeut	231	1154	558	596
			Peam Phtoul Lech	303	1308	659	649
			Pouthi Mitt	195	920	445	475
			Preaek Andoung	361	1787	881	906
			Samraong	187	742	368	374
			Tuol Slaeng	326	1425	664	761
			Total	2,818	13,176	6,480	6,696

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Table AC-2.5.2.3.2 Paddy Cultivation in Kaoh Thum District

(1) Year of 2009/10

No.	Commune	Rainy Season			Dry season			Total	
		ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
1	Chheu Kmau	200	3.50	700	1,500	4.50	6,750	1,700	7,450
2	Chrouy Ta kaev	78	3.71	289	900	4.50	4,050	978	4,339
3	Kampong Kong	592	3.96	2,344	1,400	4.50	6,300	1,992	8,371
4	Kaoh Thum ka	204	1.49	303	50	4.00	200	254	503
5	Kaoh Thum kha	218	3.25	708	50	4.00	200	268	908
6	Leuk daek	25	4.00	100	750	4.50	3,375	775	3,475
7	Pouthi Ban	64	3.50	224	850	4.25	3,612	914	3,836
8	Preaek Chrey	150	4.00	600	900	5.00	4,500	1,050	5,100
9	Preaek Sdei	359	3.97	1,424	2,200	4.50	9,900	2,559	11,324
10	Preaek Thmei	609	3.00	1,827	250	4.25	1,062	859	2,889
11	Sampov Pun	1,297	4.40	5,713	3,650	5.50	20,075	4,947	29,448
	Total	3,796	3.75	14,232	12,500	4.80	60,024	16,296	77,643

(2) Year of 2010/11

No.	Commune	Rainy Season			Dry season			Total	
		ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
1	Chheu Kmau	231	-	-	2603	-	-	2,834	-
2	Chrouy Ta kaev	493	-	-	972	-	-	1,465	-
3	Kampong Kong	592	-	-	2815	-	-	3,407	-
4	Kaoh Thum ka	177	-	-	750	-	-	927	-
5	Kaoh Thum kha	201	-	-	500	-	-	701	-
6	Leuk daek	0	-	-	4170	-	-	4,170	-
7	Pouthi Ban	64	-	-	981	-	-	1,045	-
8	Preaek Chrey	0	-	-	1893	-	-	1,893	-
9	Preaek Sdei	160	-	-	2384	-	-	2,544	-
10	Preaek Thmei	609	-	-	261	-	-	870	-
11	Sampov Pun	692	-	-	4587	-	-	5,279	-
	Total	3,219	-	-	21,916	-	-	25,135	-

Source: District Agricultural Office 2011

Table AC-2.5.2.3.4 Prevailing and Proposed Paddy Cultivation Practices for SPWRRSP Area

Farming Practices	Prevailing	Proposed
Condition of Paddy Field	Rainfed	Irrigated
Major rice varieties	Early rice: IR 66 Sen Pidao 504 (Nam Kong Bong)	Early rice: IR 66 Sen Pidao
Seeding rate (kg/ha)	200 ~ 240 kg/ha Seed multiplication every 3 years	150 ~ 180 kg/ha Seed multiplication every 3 years
Land preparation	4-wheel tractor / Hand tractor	4-wheel tractor / Hand tractor
Planting method	Direct sowing	Direct sowing
Fertilization		
1st application	Timing: at time of land preparation	Timing: at time of land preparation
- Urea (kg/ha)	Not applied	Limited
- DAP (kg/ha)	Not applied	50 ~ 75 kg/ha
- KCl (kg/ha)	Not applied	Not applied
- Compost	Applied by farmer holding cattle	Applied by farmer holding cattle
2nd application	Timing: panicle initiation (10-15 days after transplanting)	Timing: panicle initiation (10-15 after transplanting)
- Urea (kg/ha)	50 ~ 75 kg/ha	50 ~ 75 kg/ha
3rd application	Timing: panicle initiation (40 days after transplanting)	Timing: panicle initiation (10-15 after transplanting)
- Urea (kg/ha)	50 ~ 75 kg/ha	50 ~ 75 kg/ha
Agro-chemical spray	Application limited (unknown) Brown Plant Hopper Stem borer Army worm	Application limited (Trebong etc.) Brown Plant Hopper Stem borer Army worm
Weeding	3 times per a cropping season SIRIUS 10WP	3 times per a cropping season SIRIUS 10WP
Harvesting	Reaper	Reaper
Threshing	Thresher (threshing in a field)	Thresher (threshing in a field)
Drying	Sun drying in home yard after threshing	Sun drying in home yard after threshing
Yield Level:		
Dry season		
Irrigated condition	3.0 ~ 4.0 ton/ha	4.5 ~ 5.0 ton/ha

Source: JICA survey Team, based on the interview to PDA Kandal, DAO Khao Thum, and farmers

Table AC-2.5.6.3.3 Implementation and Cost Schedules for Agricultural Support Services for SPWRRSP

Srass Prambai (1,200 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017 Volume Early Rainy Season	2017 Volume Rainy Season	2017 Volume Annual	2017 Amount (US$)	2018 Volume Early Rainy Season	2018 Volume Rainy Season	2018 Volume Annual	2018 Amount (US$)	2019 Volume Early Rainy Season	2019 Volume Rainy Season	2019 Volume Annual	2019 Amount (US$)	2020 Volume Early Rainy Season	2020 Volume Rainy Season	2020 Volume Annual	2020 Amount (US$)	Overall Volume Early Rainy Season	Overall Volume Rainy Season	Overall Volume Annual	Overall Amount (US$)
1. Trainers' Training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	unit	920	3		3	2,760	3		3	2,760	3	3	6	5,520			0	0	9	3	12	11,040
- Upland Crops (0.1 ha)	unit	900			0	0	2		2	1,800	2	2	4	3,600			0	0	4	2	6	5,400
- Vegetables (0.1 ha)	unit	910					2		2	1,820	2	2	4	3,640			0	0	4	2	6	5,460
2.2 Water management (20ha)																						
- Irrigated Rice	unit	1,610	3		3	4,830	3		3	4,830	3	3	6	9,660			0	0	9	3	12	19,320
Sub-total			6	0	6	7,590	10	0	10	11,210	10	10	20	22,420	0	0	0	0	26	10	36	41,220
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	unit	410			0	0	2		2	820	2		2	820	2		2	820	6	0	6	2,460
3.2 FFS/IPM (30 participants)	unit	1580			0	0	2		2	3,160	2		2	3,160	2		2	3,160	6	0	6	9,480
3.3 Study Tour	unit	430			0	0	2		2	860	2		2	860	2		2	860	6	0	6	2,580
Sub-total			0	0	0	0	6	0	6	4,840	6	0	6	4,840	6	0	6	4,840	18	0	18	14,520
4. Mass Guidance/Workshop																						
4.1 30 Participants		260		3	3	780		3	3	780		3	3	780	3		3	780	3	9	12	3,120
Total						**8,890**				**17,350**				**28,560**				**6,140**				**60,940**

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017 Quantity	2017 Total	2017 F/C	2017 L/C	2018 Quantity	2018 Total	2018 F/C	2018 L/C	2019 Quantity	2019 Total	2019 F/C	2019 L/C	2020 Quantity	2020 Total	2020 F/C	2020 L/C	Overall Quantity	Overall Total	Overall F/C	Overall L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.3	9,780	9,780														0.3	9,780	9,780	
1.2 Allowance	day	100	9	900	900														9	900	900	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					12,180	0			0	0			0	0			0	0			12,180	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	3.44	10,320		10,320
2.2 Allowance	day	30	26	780		780	26	780		780	26	780		780	26	780		780	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,410			0	3,410			0	3,410			0	3,410			0	13,640

Source: JICA Survey Team

Table AC-2.6.1.1 Demographic Situation in the Daun Pue Rehabilitation Sub-project Area

Province	District	Commune	Village	Total HH	Total Population	Male	Female
Kampong Chhnang	Tuek Phos	Chaong Maong	Thmei	120	610	303	307
			Chaong Maong	301	1,322	628	694
			Khsaet	136	584	297	287
			Peareang	141	675	339	336
			Doun Mau	135	673	328	345
			Akleangkae	211	928	439	489
			Svay Chek	138	659	331	328
			Trapeang Chum	127	632	288	344
			Total	1,309	6,083	2,953	3,130

Province	District	Commune	Village	Total HH	Total Population	Male	Female
Kampong Chhnang	Tuek Phos	Chieb	Kouk Penh	98	481	242	239
			Chhak Kandaol	129	591	280	311
			Toap Ta Lat	117	619	300	319
			Chi Prang	157	740	356	384
			Kaoh Kandal	84	404	188	216
			Ta Nay	134	663	315	348
			Prey Tang Thnong	69	318	154	164
			Boeng Steng	81	379	185	194
			Sae Robang	105	470	222	248
			Tumnob Thmei	212	951	478	473
			Kaoh Khtoum	233	1,090	522	568
			Total	1,419	6,706	3,242	3,464

Province	District	Commune	Village	Total HH	Total Population	Male	Female
Kampong Chhnang	Tuek Phos	Khlong Popok	Yout	102	453	227	226
			Ta Kab	119	509	244	265
			Khlong Popok	144	635	305	330
			Boeng Steng	161	704	331	373
			Trapeang Chrey	222	1,002	492	510
			Kraoy Voat	238	1,066	519	547
			Trapeang Krabau	261	1,090	532	558
			Total	1,247	5,459	2,650	2,809

Province	District	Commune	Village	Total HH	Total Population	Male	Female
		Akphivoadth	Tuek Chum	109	531	259	272
			Srae Khtum	100	420	194	226
			Ropeak	93	391	177	214
			Trapeang Pring	161	728	332	396
			Baek Chak	42	199	99	100
			Trapeang Reang	251	1278	621	657
			Srae Prich	197	1050	479	571
			Damreb	104	473	229	244
			Srae Ta Chey	772	3633	1786	1847
			Total	1,829	8,703	4,176	4,527

Province	District	Commune	Village	Total HH	Total Population	Male	Female
		Tang Krasang	Romeas	236	1067	540	527
			Srae Uk	165	767	372	395
			Thmei	121	455	215	240
			Tbaeng Khpos	251	1016	473	543
			Kouk Nang	113	434	192	242
			Kouk Puoch	135	477	205	272
			Chas	146	558	264	294
			Krang Ma	92	444	202	242
			Chambak Kantreanh	226	803	357	446
			Tang Krasang	71	293	151	142
			Krang Ta Mom	225	951	432	519
			Veal Sbov	189	815	386	429
			Total	1,970	8,080	3,789	4,291

Source: Map Layers and Databases, 2008 General Population Census of Cambodia, Ministry of Planning

Table AC-2.6.2.3.2 Paddy Production in Teuk Phos District

Year: 2007

Commune	Upland Rice			Early Rice			Medium Rice			Late Rice			Total	
	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
Khlong Popok	5	1.00	5	717	2.30	1,649	856	2.80	2,397	345	3.20	1,104	1,923	5,155
Chaong Maong	4	1.00	4	525	2.20	1,155	1,372	2.80	3,842	434	3.50	1,519	2,335	6,520
Chieb	12	1.00	12	882	2.20	1,940	1,435	2.80	4,018	442	2.90	1,282	2,771	7,252
Toul Khpos	14	1.21	17	722	2.30	1,661	1,083	2.90	3,141	215	3.20	688	2,034	5,507
Kbal Tuek	18	1.22	22	628	2.50	1,570	1,312	2.90	3,805	227	3.00	681	2,185	6,078
Tang Krasang	3	1.00	3	585	2.20	1,287	1,615	2.80	4,522	752	3.20	2,406	2,955	8,218
Krag skear	19	1.21	23	1,087	2.30	2,500	2,020	2.70	5,459	634	2.90	1,839	3,760	9,821
Akphivoadth	3	1.00	3	617	2.30	1,419	1,843	2.70	4,976	535	2.80	1,498	2,998	7,896
Total	78	1.14	89	5,763	2.29	13,181	11,536	2.79	32,160	3,584	3.07	11,017	20,961	56,447

Note: ha: Harvested area, ton/ha: Unit yield, ton: Production

Year: 2008

Commune	Upland Rice			Early Rice			Medium Rice			Late Rice			Total	
	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
Khlong Popok	3	2.33	7	717	2.2	1577	938	2.6	2439	363	3.2	1162	2,021	5,185
Chaong Maong	4	2.25	9	749	2.2	1648	1237	3	3711	431	3.4	1465	2,421	6,833
Chieb	8	2.25	18	958	2.3	2203	1368	2.8	3830	442	3.2	1414	2,776	7,465
Toul Khpos	4	2.25	9	827	2.2	1819	1091	3	3273	235	3.4	799	2,157	5,900
Kbal Tuek	8	2.25	18	752	2.3	1730	1123	3	3369	258	3.5	903	2,141	6,020
Tang Krasang	2	2.00	4	726	2.2	1597	1389	2.8	3889	752	3.4	2557	2,869	8,047
Krag skear	7	2.14	15	1288	2.2	2834	1887	2.7	5095	793	3.4	2696	3,975	10,640
Akphivoadth	2	2.00	4	752	2	1504	1756	2.5	4390	646	3.3	2132	3,156	8,030
Total	38	2.21	84	6769		14912	10789		29996	3920		13128	21,516	58,120

Note: ha: Harvested area, ton/ha: Unit yield, ton: Production

Year: 2009

Commune	Upland Rice			Early Rice			Medium Rice			Late Rice			Total	
	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
Khlong Popok	2	1.50	3	854	1.80	1537	862	2.20	1896	293	3.20	938	2,011	4,374
Chaong Maong	4	1.75	7	687	1.90	1305	1159	2.30	2666	485	3.30	1601	2,335	5,579
Chieb	8	1.75	14	1037	1.80	1867	1233	2.20	2713	448	3.00	1344	2,726	5,938
Toul Khpos	9	1.89	17	853	2.00	1706	1005	2.50	2513	285	3.20	912	2,152	5,148
Kbal Tuek	12	1.92	23	656	2.00	1312	1058	2.50	2645	497	3.00	1491	2,223	5,471
Tang Krasang	2	2.00	4	1059	1.88	1991	1292	2.40	3101	505	3.20	1616	2,858	6,712
Krag skear	6	1.67	10	1675	1.67	2797	1763	2.20	3879	567	3.00	1701	4,011	8,387
Akphivoadth	3	1.67	5	1062	1.80	1911	1596	2.40	3830	525	3.20	1680	3,186	7,426
Total	46	1.80	83	7883	1.83	14426	9968	2.33	23243	3605	3.13	11283	21,502	49,035

Note: ha: Harvested area, ton/ha: Unit yield, ton: Production

Year: 2010

Commune	Upland Rice			Early Rice			Medium Rice			Late Rice			Total	
	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
Khlung Po pork	2	1.50	3	763	1.85	1412	995	3.05	3035	228	3.30	752	1,988	5,202
Chorng morng	5	1.40	7	585	1.89	1106	1292	3.06	3954	412	3.60	1483	2,294	6,550
Cheab	8	1.38	11	920	1.97	1812	1357	3.02	4098	377	3.50	1320	2,662	7,241
Toul Khpous	6	1.33	8	750	2.02	1515	1134	3.13	3549	215	3.61	776	2,105	5,848
Kbal Teuk	15	1.33	20	594	2.03	1206	1192	3.37	4017	428	3.87	1657	2,229	6,900
Tang Krosang	0	-	0	935	1.99	1861	1415	3.12	4416	443	3.34	1480	2,793	7,757
Krorm Sda	8	1.38	11	1579	1.76	2779	1887	2.74	5170	464	3.30	1531	3,938	9,491
Aphivath	0	-	0	930	1.92	1786	1725	2.95	5089	456	3.50	1596	3,111	8,471
Total	44	1.36	60	7056	1.91	13477	10997	3.03	33328	3023	3.50	10595	21,120	57,460

Note: ha: Harvested area, ton/ha: Unit yield, ton: Production

Year: 2011

Commune	Direct Sowing			Early Variety			Medium Variety			Late Variety			Total	
	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton/ha	ton	ha	ton
Khlong Popok	2	2.00	4	466	2.60	1,212	1,520	3.20	4,864	228	3.80	867	2,216	6,947
Chaong Maong	4	2.00	8	303	2.73	828	1,772	3.40	6,024	415	3.80	1,577	2,494	8,437
Chieb	4	1.50	6	748	2.60	1,945	1,757	3.20	5,622	376	3.55	1,335	2,885	8,908
Tuol Khpos	3	2.00	6	565	2.62	1,480	1,571	3.30	5,184	214	3.70	792	2,353	7,462
Kbal Tuek	8	2.00	16	260	2.70	702	1,673	3.20	5,353	432	3.70	1,598	2,373	7,669
Tang Krasang	2	1.50	3	656	2.41	1,581	1,831	3.30	6,042	435	3.60	1,566	2,924	9,192
Krang Skear	5	1.60	8	1,463	2.40	3,513	2,348	3.20	7,511	477	3.55	1,693	4,293	12,725
Akphivoadth	-	-	-	637	2.60	1,656	2,160	3.30	7,128	455	3.70	1,684	3,252	10,468
Total	28	1.82	51	5,098	2.53	12,917	14,632	3.26	47,728	3,032	3.66	11,112	22,790	71,808

Note: ha: Harvested area, ton/ha: Unit yield, ton: Production

Source) DAO, Tuek Phos District, 2011

Table AC-2.6.2.3.4 Present and Proposed Paddy Cultivation Practices for DPISRSP Area

Farming Practices	ailing		Proposed	
Condition of Paddy Field	Rainfed		Irrigated	
Major rice varieties	Early rice:	IR 66 Sen Pidao 504 (vietnam variety)	Early rice:	IR 66 Sen Pidao Chulisa
	Medium rice:	Riang Chey, Phka Rumduoul Phka Mlis Srey Krem (local)	Medium rice:	Riang Chey, Pkha Romeat Pkha Romdeng Pkha Chansensor Pkha Rumduoul
	Late rice:	CAR4	Late rice:	CAR4 CAR6
Seeding rate (kg/ha)	45 ~ 60 kg/ha	(50 kg/ha)	40 ~ 50 kg/ha Seed multiplication every 3 years	
Land preparation	Draft animal/ Hand tractor		Draft animal/ Hand tractor	
Planting method	Transplanting		Transplanting	
Planting distance		20 x 20 cm (random) 25 x 25 cm (random) 15 x 20 cm (random)		30 x 30 cm (random) 15 x 20 cm (random)
	Random planting prevailing		Random planting prevailing	
Age of seedling	About 30 days (or more depending on water availability in a field)		About 30 days (or more depending on water availability in a field)	
Fertilization				
1st application	Timing: at time of land preparation		Timing: at time of land preparation	
- Urea (kg/ha)	not common		not common	
- DAP (kg/ha)	30 ~ 50 kg/ha		50 ~ 75 kg/ha	
- KCl (kg/ha)	Not applied		Not applied	
- Compost	Not applied		Applied by farmer holding cattle	
2nd application	Not appli panicle initiation		at panicle initiation	
- Urea (kg/ha)	0 ~ 15 kg/ha		15 kg/ha	
Agro-chemical spray	Application limited (unknown)		Application limited (Trebong etc.)	
Manual weeding	3 times per a cropping season		3 times per a cropping season	
Harvesting	Manual		Manual	
Threshing	by thresher at farmers' home yard		by thresher at farmers' home yard	
Drying	Sun drying in home yard after threshing		Sun drying in home yard after threshing	
Yield Level:				
Rainy season				
Rainfed condition	1.0 ~ 2.5 ton/ha			
Irrigated condition	2.0 ~ 3.0 ton/ha		3.5 ~ 4.0 ton/ha	

Source: JICA survey Team, based on the interview to PDA Kampong Chhnang, DAO Teuk Phos, and farmers

Table AC-2.6.6.3.3 Implementation and Cost Schedules for Agricultural Support Services for DPISRSP

Daun Pue (1,150 ha)

(1) Direct Cost for Training Programs

Activities	Unit	Unit Program Cost (US$) 1/	2017				2018				2019				2020				Overall			
			Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)	Volume			Amount (US$)
			Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual		Early Rainy Season	Rainy Season	Annual	
1. Trainers' Training	time	520	1		1	520	1		1	520	1		1	520	1		1	520	4	0	4	2,080
2. Field Programs																						
2.1 Demonstration Plot																						
- Irrigated Rice (0.2 ha)	unit	920		3	3	2,760		3	3	2,760	3	3	6	5,520			0	0	3	9	12	11,040
- Upland Crops (0.1 ha)	unit	900			0	0		2	2	1,800	2	2	4	3,600			0	0	2	4	6	5,400
- Vegetables (0.1 ha)	unit	910						2	2	1,820	2	2	4	3,640			0	0	2	4	6	5,460
2.2 Water management (20ha)																						
- Irrigated Rice	unit	1,610		3	3	4,830		3	3	4,830		6	6	9,660			0	0	0	12	12	19,320
Sub-total			0	6	6	7,590	0	10	10	11,210	7	13	20	22,420	0	0	0	0	7	29	36	41,220
3. Farmer/Farmer Group Training Programs																						
3.1 Training Course																						
- 2 Days (30 participants)	unit	410			0	0	2		2	820	2		2	820	2		2	820	6	0	6	2,460
3.2 FFS/IPM (30 participants)	unit	1580			0	0		2	2	3,160		2	2	3,160	2		2	3,160	2	4	6	9,480
3.3 Study Tour	unit	430			0	0	2		2	860	2		2	860	2		2	860	6	0	6	2,580
Sub-total			0	0	0	0	4	2	6	4,840	4	2	6	4,840	6	0	6	4,840	14	4	18	14,520
4. Mass Guidance/Workshop																						
4.1 30 Participants		260	3		3	780	3		3	780	3		3	780	3		3	780	12	0	12	3,120
Total						**8,890**				**17,350**				**28,560**				**6,140**				**60,940**

Note:

1/: Refering base costs for extension programs, 2011, DAE, MAFF

Source: JICA Survey Team

(2) Cost for Consultants

(Unit: US$)

Activities	Unit	Unit Cost	2017				2018				2019				2020				Overall			
			Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C	Quantity	Total	F/C	L/C
1. Foreign Consultant																						
1.1 Remuneration	M/M	32,591	0.3	9,780	9,780														0.3	9,780	9,780	
1.2 Allowance	day	100	9	900	900														9	900	900	
1.3 Mobilization	no.	1,500	1	1500	1,500														1	1,500	1,500	
Sub-Total (1)					12,180	0			0	0			0	0			0	0			12,180	0
2. National Consultant																						
2.1 Remuneration	M/M	3,000	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	0.86	2,580		2,580	3.44	10,320		10,320
2.2 Allowance	day	30	26	780		780	26	780		780	26	780		780	26	780		780	104	3,120		3,120
2.3 Mobilization	no.	50	1	50		50	1	50		50	1	50		50	1	50		50	4	200		200
Sub-Total (2)					0	3,410			0	3,410			0	3,410			0	3,410			0	13,640

Source: JICA Survey Team

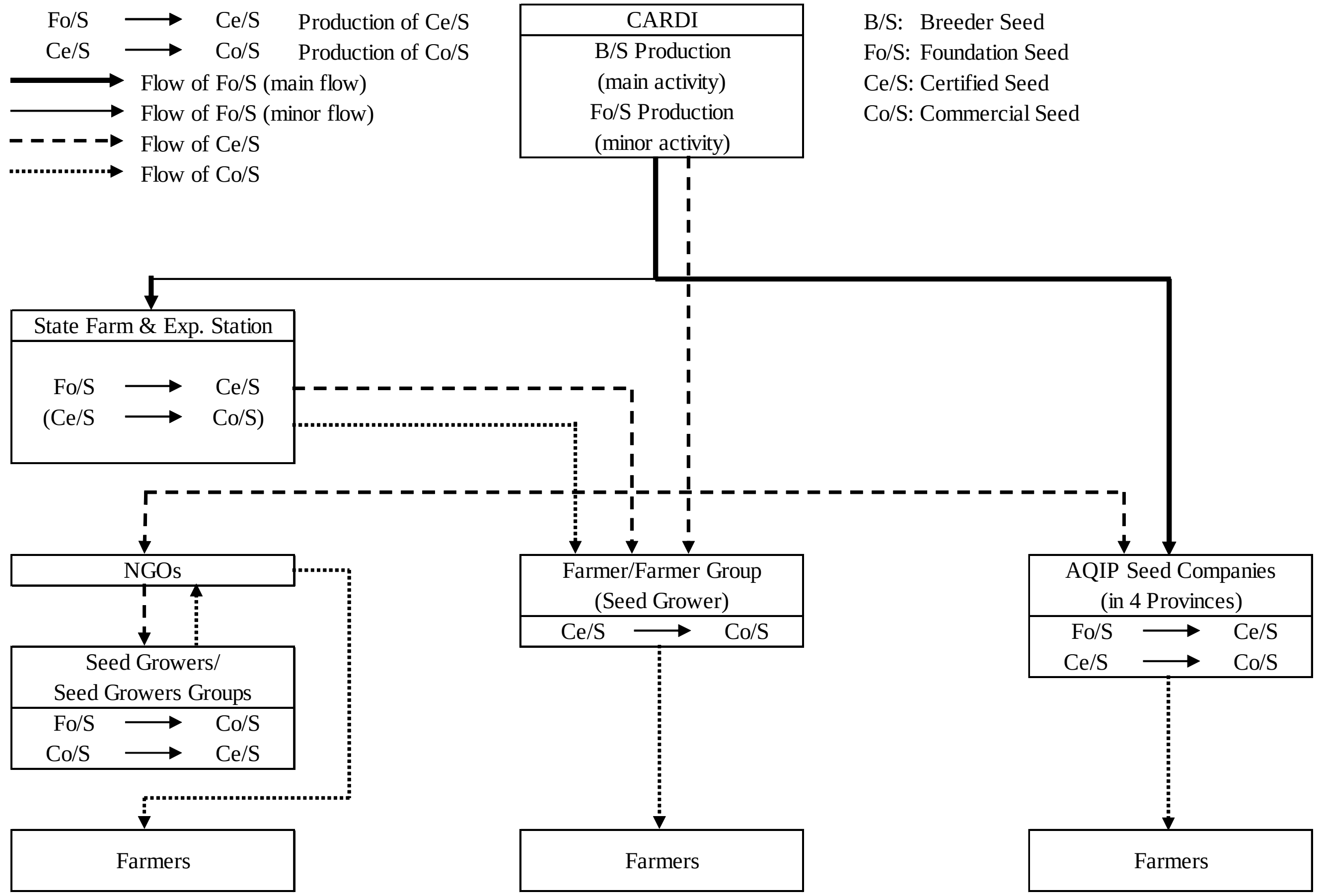
ANNEX C

Figures

Japan International Cooperation Agency

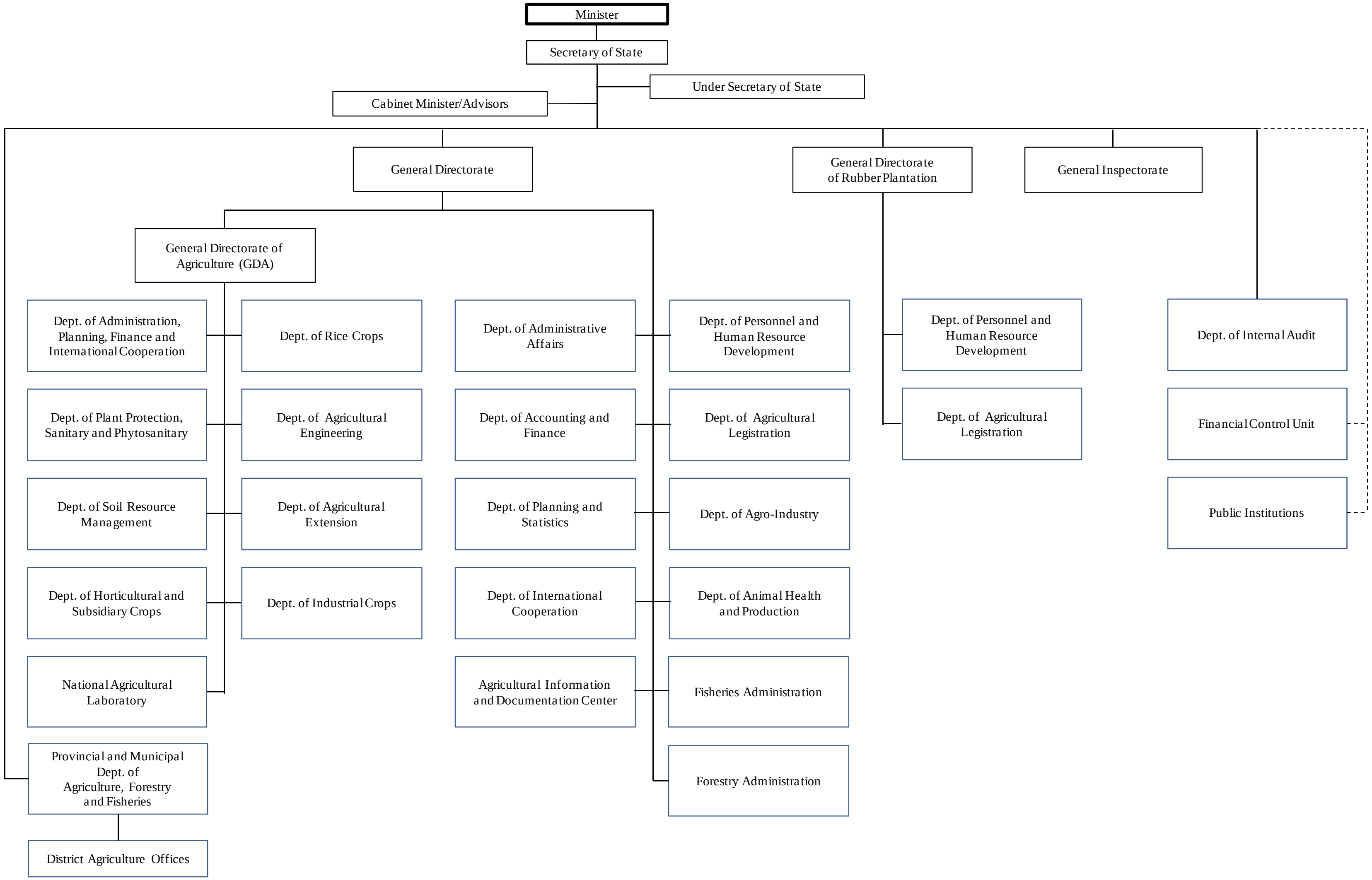
PREPARATORY SURVEY FOR IRRIVGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROMVEMENT PROJECT

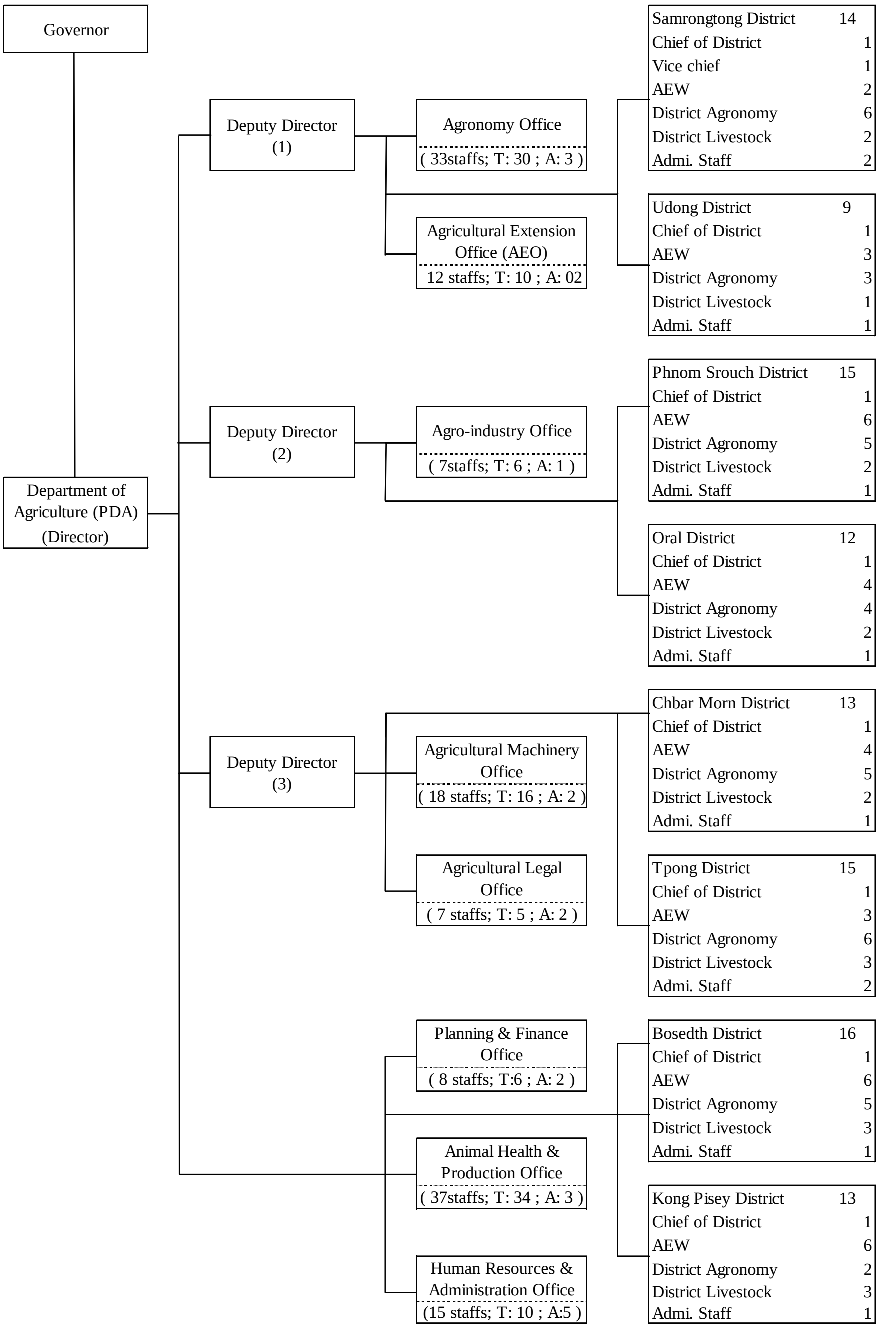
Figure AC-1.1.4.1
Current Predominant Rice Seed Production & Supply System in Cambodia



State Farm & Exp. Station: Tuol Samroang Rice Seed Farm (Battanbong)
AQIP Seed Companies: 4 Seed Companies established under AQIP; Super Seed Company (Kandal), Golden Seed Company (Takeo), Prey Veng Seed Company (Prey Veng), Prasot Seed Company (Pursat)

Figure AC-1.3.1.1
Organizational Structure of Ministry of Agriculture, Forestry and Fisheries

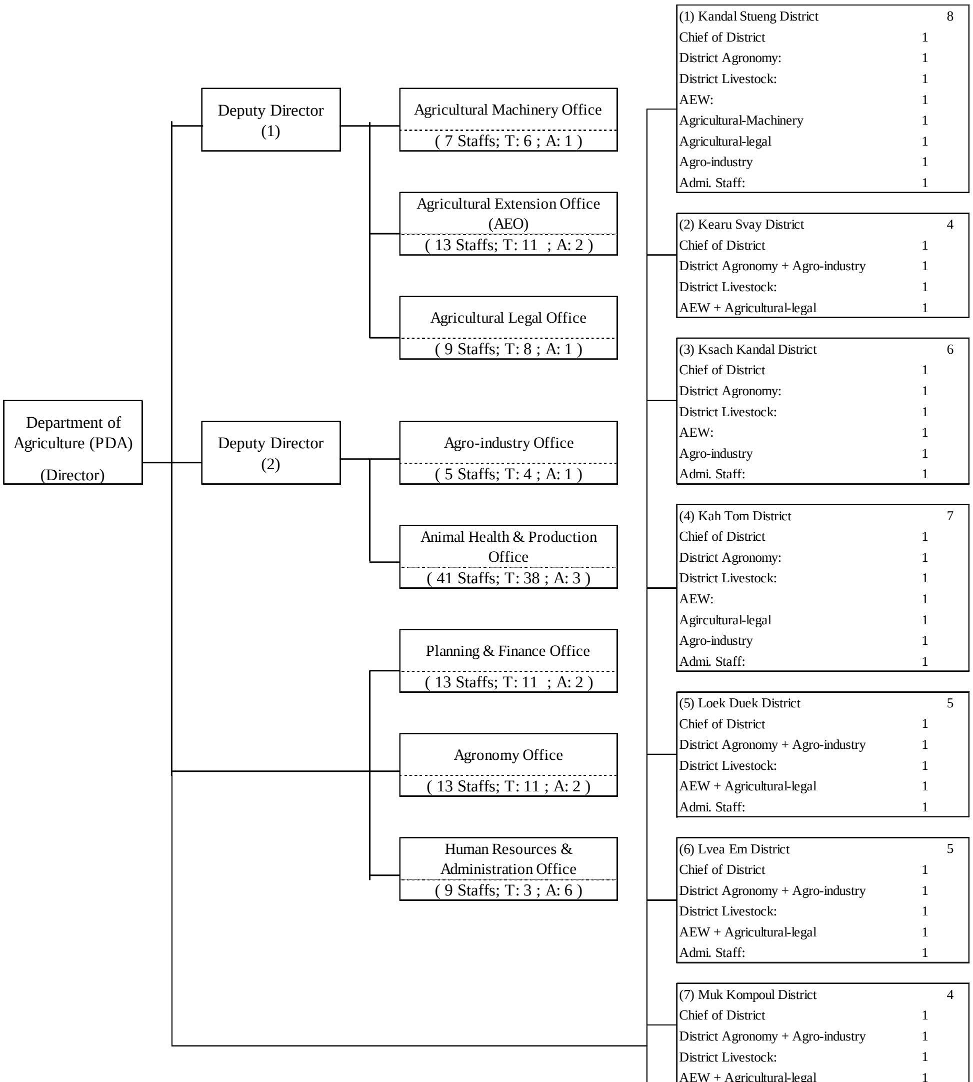




Staffing

Director	1	District Agricutlural Office	
Deputy Director	3	Samrongtong District	14
Agriculture Extension office	12	Udong District	9
Animal Health & Production Office	37	Phnom Srouch District	15
Agricultural Machinary Office	18	Oral District	12
Agronomy Office	33	Chbar Morn District	13
Agro-Industry Office	7	Tpong District	15
Agricultural Legal Office	7	Bosedth District	16
Planning and Accounting Office	8	Kong Pisey District	13
Human Resources & Administration office	15		
Total			248

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Figure AC-1.3.2.1**
Japan International Cooperation Agency	**Organization Structure of Kampong Speu Provincial Department of Agriculture**



Staffing

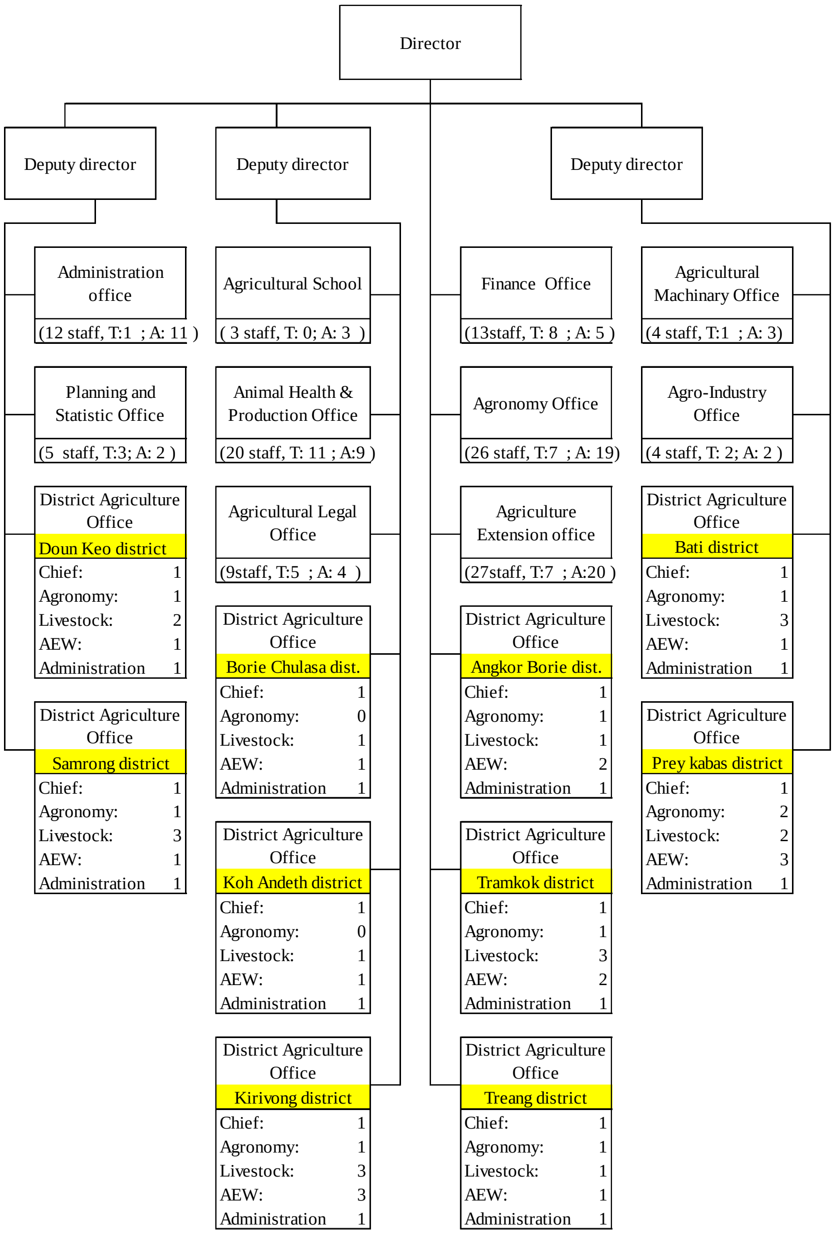
Director	1
Deputy Director	2
Agricultural Machinery Office	7
Agricultural Extension Office (AEO)	13
Agricultural Legal Office	9
Agro-industry Office	5
Animal Health & Production Office	41
Planning & Finance Office	13
Agronomy Office	13
Human Resources & Administration Office	9
District Agricutlural Office	
Kandal Stueng District	8
Kearu Svay District	4
Ksach Kandal District	6
Kah Tom District	7
Loek Duek District	5
Lvea Em District	5
Muk Kompoul District	4
Aug Snoul District	4
Pongea Loe District	4
Saang District	4
Ta Kmao District	6
Total	170

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Figure AC-1.3.2.2

Organization Structure of Kandal Provincial Department of Agriculture



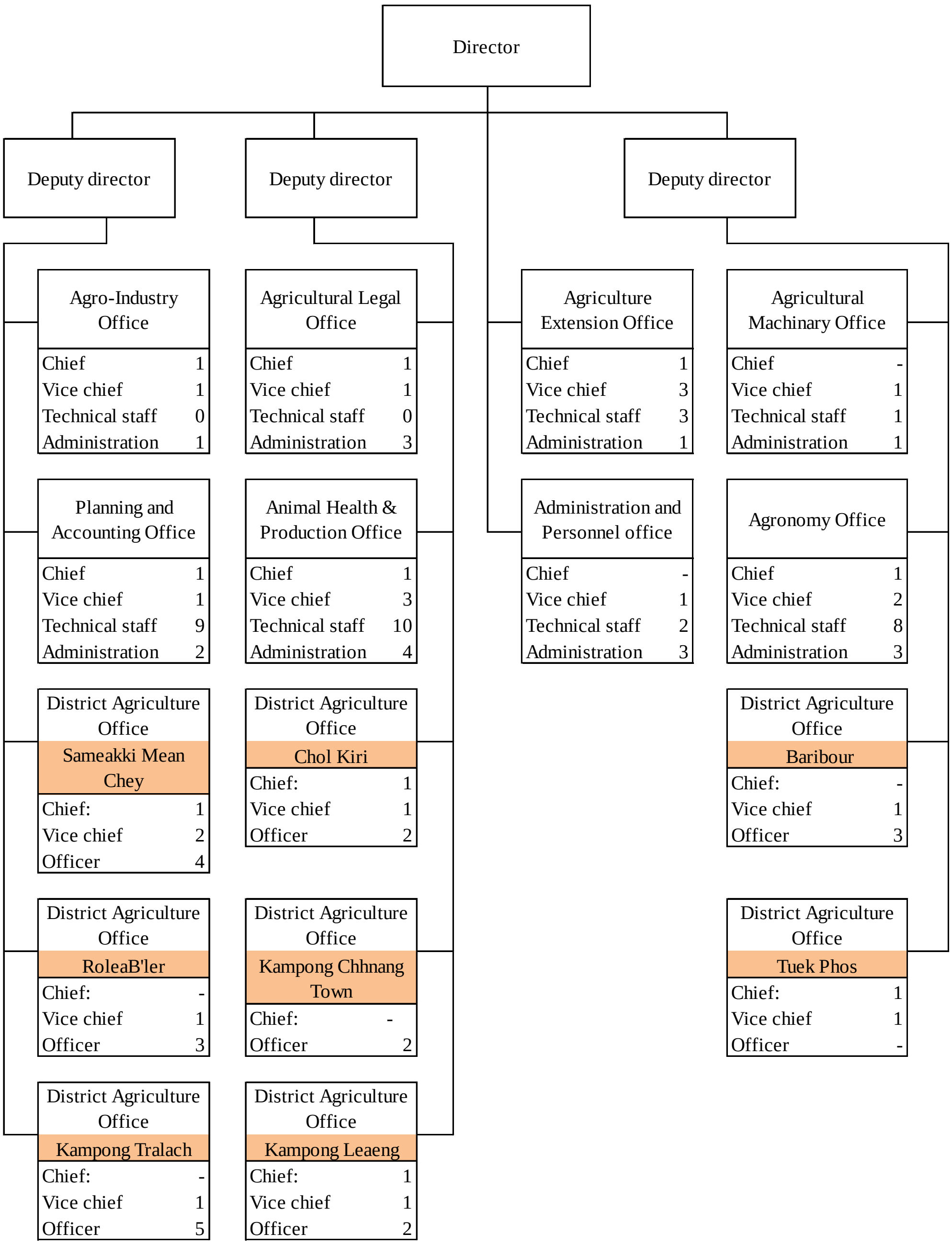
Staffing

Director	1	District Agricultural Office	
Deputy Director	3	Doun Keo district	6
Administration office	12	Bati district	7
Agricultural school	3	Borie Chulasa dist.	4
Finance office	13	Angkor Borie dist.	6
Agricutlural Machinery Office	4	Samrong district	7
Planning and Statistics Office	5	Prey kabas district	9
Animal Health & Production Office	20	Koh Andeth district	4
Agronomy Office	26	Tramkok district	8
Agro-inducstry Office	4	Kirivong district	9
Agricutlural Legal Office	9	Treang district	5
Agricultural Extension Office	27		
Total			192

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Figure AC-1.3.2.3
Organization Structure of Takeo Provincial Department of Agriculture



Staffing

Director	1	District Agriculture Office	
Deputy Director	3	Sameakki Mean Chey	7
Agriculture Extension office	8	Chol Kiri	4
Animal Health & Production Office	18	Baribour	4
Agricultural Machinary Office	3	RoleaB'ler	4
Agronomy Office	14	Tuek Phos	2
Agro-Industry Office	3	Kampong Tralach	6
Agricultural Legal Office	5	Kampong Leaeng	4
Planning and Accounting Office	13	Kampong Chhnang	2
Administration and Personnel office	6	Total	107

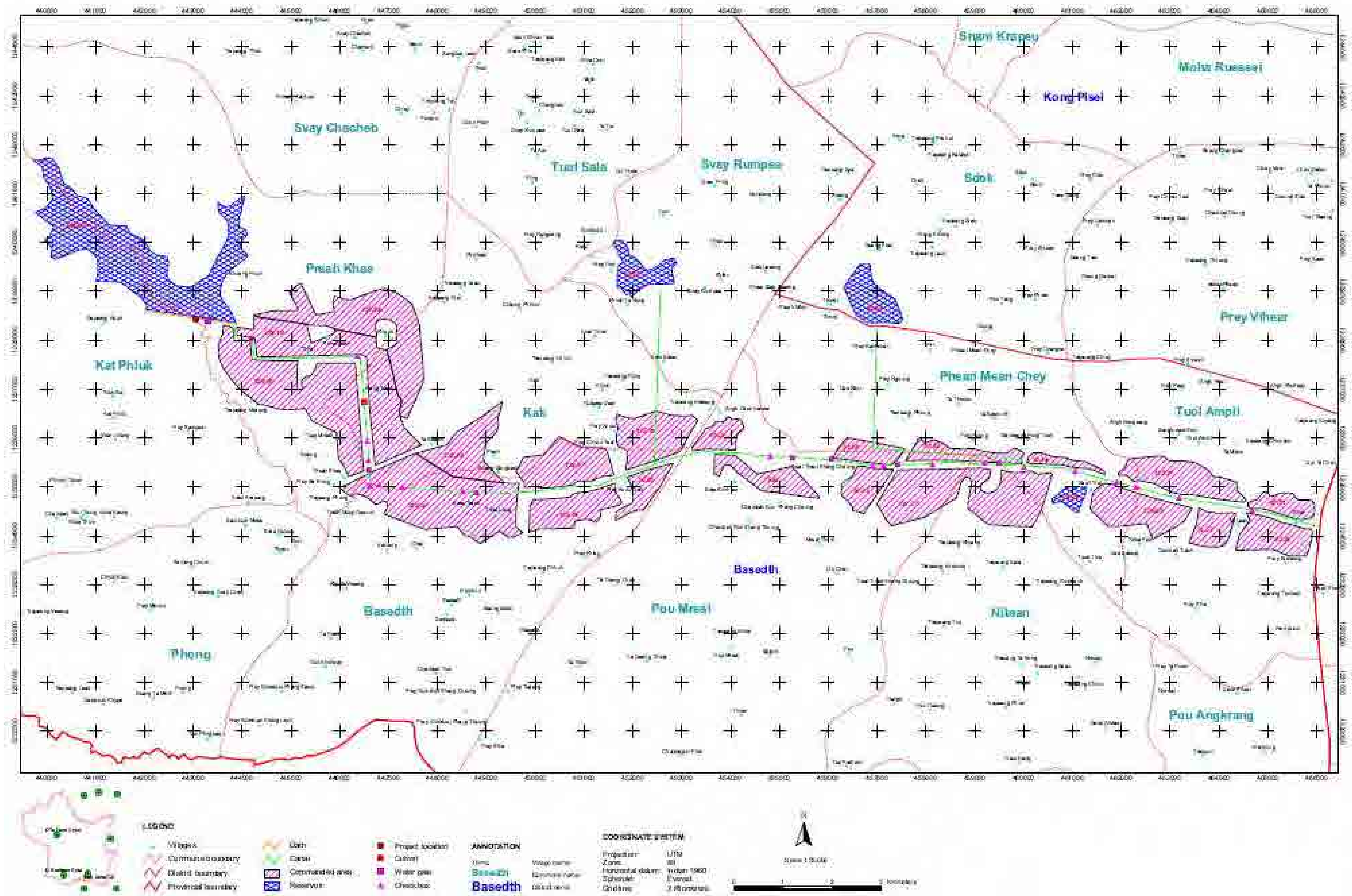
Figure AC-1.3.2.4

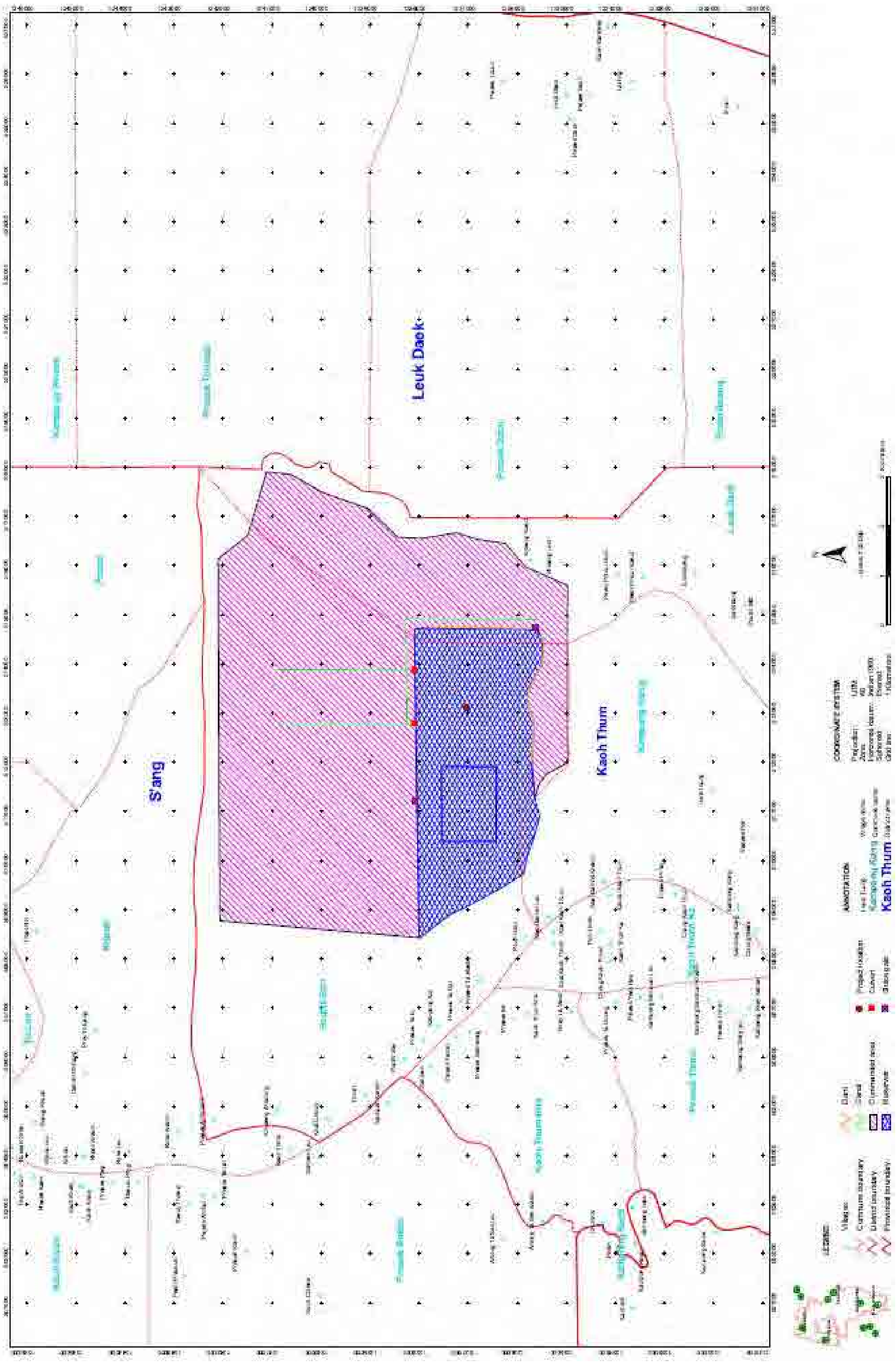
Organization Structure of Kampong Chhnang Provincial Department of Agriculture

Japan International Cooperation Agency

PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Figure AC-2.4.1.1
Location of the Related Communes for MC35RSP

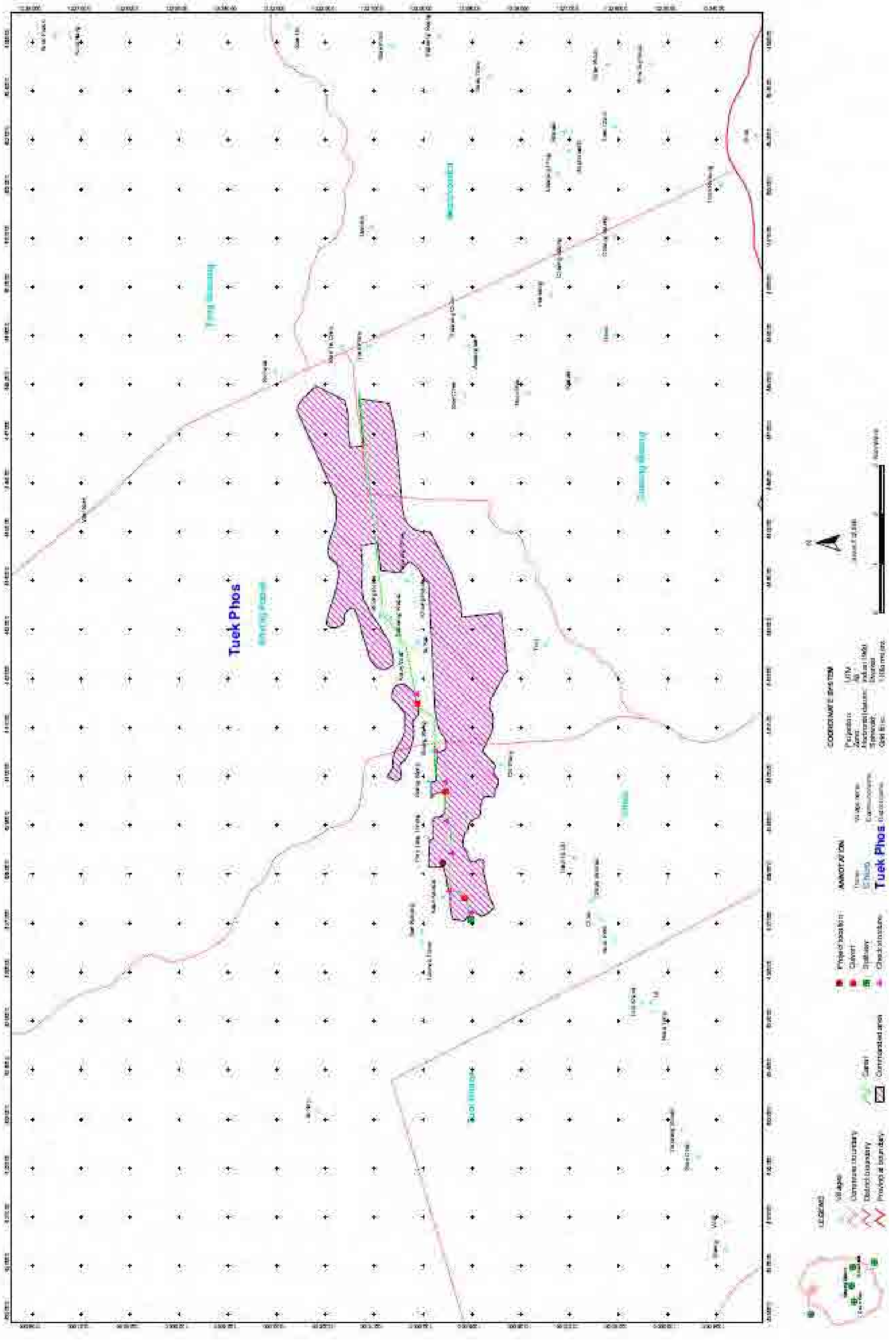




PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

Figure AC-2.5.1.1
Location of the Related Communes for SPWRRSP



PREPARATORY SURVEY FOR IRRIGATION AND DRAINAGE SYSTEM REHABILITATION AND IMPROVEMENT PROJECT

Japan International Cooperation Agency

Figure AC-2.6.1.1

Location of the Related Communes for DPISRSP

ANNEX C

Attachments

ANNEX C

Attachment 1

Results of Socio-economic Survey for

Roleang Chrey Headworks Rehabilitation Sub-project

ANNEX C
ATTACHMENT 1

Socio-economic Survey
for
Roleang Chrey Headworks Rehabilitation Sub-project

List of Tables

Page

Page

Table AC-A1-1 Average of Family Member per Household

	Zone 1	Zone 2	Whole
N	85	85	170
Average HH size	5	5	5

Note: Question I-3 in the questionnaire

Table AC-A1-2 Number of Working-Age Members

	Zone 1	Zone 2	Whole
N	85	85	170
Average	3.86	3.91	3.88

Note: - Working age: from 15 to 64 years old
-Question I-4 in the questionnaire

Table AC-A1-3 Main Income Sources of Heads of Sampled Households

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Farmer	63	74	64	75	127	75
Non-farm labor	1	1	0	0	1	1
Salary worker	10	12	6	7	16	9
Private business	5	6	1	1	6	4
Others	6	7	14	16	20	12
Total	85	100	85	100	170	100

Note: Question I-5 in the questionnaire

Table AC-A1-4 Male-Female Balance of Sampled Households

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Male	220	48	232	50	452	49
Female	234	52	234	50	468	51
Total	454	100	466	100	920	100

Note: Question I-6 in the questionnaire

Table AC-A1-5 Age Compositions of Sampled Household Members

	Zone 1				Zone 2				Whole			
	n	%	Male	Female	n	%	Male	Female	n	%	Male	Female
0 - 14 years	95	21	53	42	102	22	62	40	197	21	115	82
15 - 24	126	28	62	64	113	24	53	60	239	26	115	124
25 - 34	78	17	37	41	92	20	43	49	170	18	80	90
35 - 44	30	7	13	17	43	9	23	20	73	8	36	37
45 - 54	59	13	26	33	44	9	22	22	103	11	48	55
55 - 64	35	8	14	21	40	9	18	22	75	8	32	43
65 years and over	31	7	15	16	32	7	11	21	63	7	26	37
Total	454	100	220	234	466	100	232	234	920	100	452	468

Note: Question I-6 in the questionnaire

Table AC-A1-6 Education Levels of Sampled Household Members

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
No formal education	14	3	21	5	35	4
Not going to school	61	13	48	10	109	12
Before school age	7	2	5	1	12	1
Non-formal education for adults	0	0	1	0	1	0
Non education	21	5	21	5	42	5
Drop-out at primary school	74	16	77	17	151	16
Graduate from primary school	51	11	62	13	113	12
Drop-out at junior high school	58	13	79	17	137	15
Graduate from junior high school	31	7	25	5	56	6
Drop-out at high school	27	6	9	2	36	4
Graduate from high school	29	6	15	3	44	5
More than high school	12	3	14	3	26	3
Presently going to school	69	15	89	19	158	17
Total	454	100	466	100	920	100

Note: Question I-6 in the questionnaire

Table AC-A1-7 Main Occupations of Sampled Household Members

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Farmer	158	35	181	39	339	37
On-farm labor	0	0	1	0	1	0
Non-farm labor	16	4	5	1	21	2
Salary worker	91	20	91	20	182	20
Private business	10	2	12	3	22	2
Housekeeping (cooking, washing, child care, etc.)	14	3	13	3	27	3
No job	12	3	8	2	20	2
Student	88	19	104	22	192	21
Child (below school age)	39	9	36	8	75	8
Others	26	6	15	3	41	4
Total	454	100	466	100	920	100

Note: Question I-6 in the questionnaire

Table AC-A1-8 Literacy Rate in Total Family Members

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Unable to write, read, and calculate for making living	115	25	121	26	236	26
Able to write, read, and calculate for making living	339	75	345	74	684	74
Total	454	100	466	100	920	100

Note: Question I-6 in the questionnaire

Table AC-A1-9 Village-level Organizations Husbands Belong

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Farmer's water users' community	5	6	1	1	6	4
Credit group by government		0	1	1	1	1
Micro-credit group by NGO	2	2	5	6	7	4
Production group	1	1	2	2	3	2
Religion group	1	1		0	1	1
Drinking water users' group	1	1	1	1	2	1
Youth group	0	0	1	1	1	1
Veteran group	3	4	1	1	4	2
Women's group	0	0	1	1	1	1
Others	12	14	4	5	16	9
Non member	60	71	68	80	128	75
Total	85	100	85	100	170	100

Note: Question I-7 in the questionnaire

Table AC-A1-10 Village-level Organizations Wifes Belong

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Farmer's water users' community	7	8	0	0	7	4
Micro-credit group by NGO	2	2	5	6	7	4
Production group	0	0	1	1	1	1
Religion group	2	2	0	0	2	1
Drinking water users' group	1	1	1	1	2	1
Women's group	2	2	3	4	5	3
Others	13	15	4	5	17	10
Non member	58	68	71	84	129	76
Total	85	100	85	100	170	100

Note: Question I-7 in the questionnaire

Table AC-A1-11 Main Sources of Drinking Water in Dry Season

	Dry Season						Wet Serason					
	Zone 1		Zone 2		Whole		Zone 1		Zone 2		Whole	
	n	%	n	%	n	%	n	%	n	%	n	%
Tube pile well	16	19	11	13	27	16	10	12	3	4	13	7
Dug well	4	5	10	12	14	8	1	1	4	5	5	3
Resevoir/ Pond	16	19	42	49	58	34	3	4	2	2	5	3
Spring/ River	26	31	0	0	26	15	7	8	0	0	7	3
Bought	8	9	18	21	26	15	3	4	0	0	3	2
Rain	3	4	4	5	7	4	55	65	76	89	131	76
Piped water	12	14	0	0	12	7	6	7	6	7	12	6
Total	85	100	85	100	170	100	85	100	85	100	170	100

Note: Question II-1 in the questionnaire

Table AC-A1-12 Location of Drinking Water in Dry Season

	Dry Season						Wet Serason					
	Zone 1		Zone 2		Whole		Zone 1		Zone 2		Whole	
	n	%	n	%	n	%	n	%	n	%	n	%
Within the premises	30	35	28	33	58	34	60	71	77	91	137	81
Near the premises	49	58	31	36	80	47	22	26	6	7	28	16
Away from the premises	6	7	26	31	32	19	3	4	2	2	5	3
Total	85	100	85	100	170	100	85	100	85	100	170	100

Note: Question II-1 in the questionnaire

Table AC-A1-13 Availability of Drinking Water in Dry Season

	Dry Season						Wet Serason					
	Zone 1		Zone 2		Whole		Zone 1		Zone 2		Whole	
	n	%	n	%	n	%	n	%	n	%	n	%
Easy to obtain	63	74	46	54	109	64	76	89	70	#REF!	146	86
Difficult to obtain	20	24	25	29	45	26	9	11	13	#REF!	22	13
Very difficult to obtain	2	2	14	16	16	9	0	0	2	#REF!	2	1
Total	85	100	85	100	170	100	85	100	85	#REF!	170	100

Note: Question II-1 in the questionnaire

Table AC-A1-14 Sources of Fuel for Cooking

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Firewood	82	96	80	94	162	2295
Charcoal	2	2	1	1	3	43
Gas cylinder (LPG)	0	0	1	1	1	14
Electricity	0	0	2	2	2	28
Other	1	1	1	1	2	28
Total	85	100	85	100	170	2408

Note: Question II-2 in the questionnaire

Table AC-A1-15 Availability of Fuel for Cooking

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Easy to obtain	40	47	45	53	85	452
Difficult to obtain	39	46	34	40	73	388
Very difficult to obtain	6	7	6	7	12	64
Total	85	100	85	100	170	903

Note: Question II-2 in the questionnaire

Table AC-A1-16 Lighting Source

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
City power	28	33	37	44	65	38
Generator	6	7	9	11	15	9
Kerosene	4	5	6	7	10	6
Candle	0	0	1	1	1	1
Battery	45	53	32	38	77	45
Other	2	2	0	0	2	1
Total	85	100	85	100	170	100

Note: Question II-3 in the questionnaire

Table AC-A1-17 Availability of Lighting Sources

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Easy to obtain	57	67	51	60	108	64
Difficult to obtain	27	32	34	40	61	36
Very difficult to obtain	1	1			1	1
Total	85	100	85	100	170	100

Note: Question II-3 in the questionnaire

Table AC-A1-18 Assets of Sampled Family

	Zone 1			Zone 2			Whole		
	Qty.	n	per HH	Qty.	n	per HH	Qty.	n	per HH
Radio	44	42	0.5	33	31	0.4	77	73	0.5
TV	78	70	0.9	82	75	1.0	160	145	0.9
Bicycle	95	70	1.1	91	61	1.1	186	131	1.1
Motorcycle	80	62	0.9	97	66	1.1	177	128	1.0
Car	6	5	0.1	6	6	0.1	12	11	0.1
Car battery	57	48	0.7	46	42	0.5	103	90	0.6
Tractor	1	1	0.0	0	0	0.0	1	1	0.0
Hand tractor	9	9	0.1	4	4	0.0	13	13	0.1
Mosquito net	277	85	3.3	251	85	3.0	528	170	3.1
Cellular phone	146	69	1.7	158	75	1.9	304	144	1.8
Telephone	8	8	0.1	5	5	0.1	13	13	0.1
Water pump	33	31	0.4	27	26	0.3	60	57	0.4
Tape recorder	16	15	0.2	20	20	0.2	36	35	0.2

Note: Question II-4 in the questionnaire

Note: Total Number of Intervewed Household is 85HH for Zone 1 and 85HH for Zone 2

Table AC-A1-19 Ownership of Residence

	Owned(1)		Owned (2)		Lent		Borrowed	
	n	%	n	%	n	%	n	%
Zone 1	85	100	-	-	-	-	-	-
Zone 2	85	100	-	-	-	-	-	-
Whole area	170	100	-	-	-	-	-	-

Note: -Question II-5 in the questionnaire

-Owned (1): already paid, Owned (2): udner payment

Table AC-A1-20 Materials of Residene

	C&B		Palm leaves		Timber		Others	
	n	%	n	%	n	%	n	%
Zone 1	6	7	5	6	55	65	19	22
Zone 2	5	6	5	6	52	61	23	27
Whole area	11	6	10	6	107	63	42	25

Note: -Question II-5 in the questionnaire

-C&B: Cement and Bricks

Table AC-A1-21 Typpe of House

	Traditional		One-storied		Two-storied		Others	
	n	%	n	%	n	%	n	%
Zone 1	53	62	22	26	3	4	7	8
Zone 2	62	73	14	16	4	5	5	6
Whole area	115	68	36	21	7	4	12	7

Note: -Question II-5 in the questionnaire

-Other means that Small thatch house

Table AC-A1-22 Number of Rooms

	1		2		3		No rooms		Average	
	n	%	n	%	n	%	n	%	n	%
Zone 1	35	42	24	28			18	21	59	35
Zone 2	41	48	27	32	2	2	15	18	23	27
Whole area	76	45	51	30	2	1	33	19	82	48

Note: Question II-5 in the questionnaire

Table AC-A1-23 Toile Availability

	with toilet		without toilet	
	n	%	n	%
Zone 1	56	66	29	34
Zone 2	52	61	33	39
Whole area	108	64	62	36

Note: Question II-5 in the questionnaire

Table AC-A1-24 Toilet Facilitty

	Connected to sewerage		Septic tank		Pit latrine		Others	
	n	%	n	%	n	%	n	%
Zone 1	2	2	48	56	7	8	28	33
Zone 2	1	1	50	59	2	2	32	38
Whole area	3	2	98	58	9	5	60	35

Note: -Question II-5 in the questionnaire

-Zone 1: Other means that 14% go to forest near house while 2% use neighbor's toilet, use relative toilet

- Zone 2: Other means that 26% go to forest near house while 2% use neighbor's toilet, use relative toilet

Table AC-A1-25 Medical Service Facility

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Hospital	8	9	7	8	15	9
Clinic	34	40	37	44	71	42
Health center	43	51	41	48	84	49
Total	85	100	85	100	170	100

Note: Question II-6 in the questionnaire

Table AC-A1-26 How do you go there?

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
By Walk	3	4	2	2	5	3
By Taxi	12	14	17	20	29	17
By Owned motor bike	61	72	64	75	125	74
By Bicycle	9	11	2	2	11	6
Total	85	100	85	100	170	100

Note: Question II-6 in the questionnaire

Table AC-A1-27 Main Activities of Female and Male.

	Zone 1				Zone 2				Whole			
	Male		Female		Male		Female		Male		Female	
	n	%	n	%	n	%	n	%	n	%	n	%
Housekeeping	0	0	11	13	0	0	6	7	0	0	17	10
Cooking	1	1	2	2	0	0	4	5	1	1	6	4
Farming	62	73	46	54	61	72	51	60	123	72	97	57
Handy crafting	0	0	0	0	0	0	1	1	0	0	1	1
Care of children/ elders	0	0	0	0	0	0	4	5	0	0	4	2
Care of livestock	0	0	0	0	0	0	0	0	0	0	0	0
Marking Plam sugar	0	0			4	5	0	0	4	2	0	0
Others(spec)	22	26	26	31	20	24	19	22	42	25	45	26
Total	85	100	85	100	85	100	85	100	170	100	170	100

Note: Question II-7 in the questionnaire

Table AC-A1-28 Main Income Sources of Female and Male

	Zone 1				Zone 2				Whole			
	Male		Female		Male		Female		Male		Female	
	n	%	n	%	n	%	n	%	n	%	n	%
Selling paddy	48	56	46	54	47	55	50	59	95	56	96	56
Working for other's field	14	16	6	7	10	12	6	7	24	14	12	7
Selling palm sugar	3	4	3	4	7	8	0	0	10	6	3	2
Selling handy craft	0	0	0	0	0	0	0	0	0	0	0	0
Working for a weaving factory	0	0	11	13	0	0	13	15	0	0	24	14
Working for bricks factory	0	0	0	0	0	0	0	0	0	0	0	0
Selling straw mat	0	0	0	0	0	0	0	0	0	0	0	0
Selling cotton/ silk	0	0	2	2	0	0	0	0	0	0	2	1
Other(spec)	20	24	17	20	21	25	16	19	41	24	33	19
Total	85	100	85	100	85	100	85	100	170	100	170	100

Note: Question II-7 in the questionnaire

Table AC-A1-29 Number of Income Sources per Household

Zone 1 (Kampong Speu)										
No. of Income Sources	1	2	3	4	5	6	7	8	9	Total
No. of HH	1	21	20	23	13	5	1	1	0	85
Zone 2 (Kampong Speu)										
No. of Income Sources	1	2	3	4	5	6	7	8	9	Total
No. of HH	2	15	10	9	5	2	1	0	1	45
Zone 2 (Kandal)										
No. of Income Sources	1	2	3	4	5	6	7	8	9	Total
No. of HH	3	10	13	8	2	2	1	1	0	40

Note: Question III-1 in the questionnaire

Table AC-A1-30 Households Earning only from Agricultural and Non-Agricultural Incomes

	Zone 1	Zone 2	
		Kampong Speu	Kandal
Agricultural Income Only	1	2	0
Non-Agriculture Income Only	9	9	6

Note: -Question III-1 in the questionnaire
-On-farm labor is classified in non-agricultural income
-Selling forest vegetable/ crop is classified in non-agricultural income

Table AC-A1-31 Income Proportion from Different Sources (%)

	Zone 1	Zone 2	
		Kampong Speu	Kandal
1. Selling paddy/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
14. Selling forest vegetable/ crop	-	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

Note: Question III-1 in the questionnaire

Table AC-A1-32 Income Structure Against 4 Income Strata for RCHRSP

(Unit: Riel'000)

Income Strata	Average Income	Income Structure														
		Agricultural Income						Non-agricultural Income								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Selling paddy/rice	Selling vegetables	Selling fruits	Selling palm sugar	Selling livestock/ poultry products	Selling fishes	Salary from permanent job	Wage from temporary on-farm job	Wage from temporary off-farm job	Private business	Remittance from family members	Selling firewood/ charcoal	Selling handicraft/ cottage industry products	Selling forest vegetable/ crop	Others
Zone 1 (Kampong Speu)																
1st	11,756	1,604	108	158	295	1,031	250	2,825	1,622	330	1,090	385	990	0	0	1,070
2nd	6,779	1,221	60	32	259	358	5	1,726	338	1,687	247	408	0	0	0	440
3rd	5,350	1,317	0	23	0	251	336	1,434	356	646	283	396	6	0	0	304
4th	3,754	832	0	16	76	80	60	729	568	600	348	310	0	0	8	128
Zone 2 (Kampong Speu)																
1st	10,908	2,487	200	100	480	798	384	2,124	400	960	120	670	0	360	0	1,825
2nd	6,253	642	218	125	25	382	394	1,267	210	780	0	1,830	0	0	50	330
3rd	4,816	490	89	110	75	491	288	1,268	304	823	100	336	0	40	30	372
4th	3,161	525	127	91	0	172	147	1,403	93	314	40	84	56	0	0	110
Zone 2 (Kandal)																
1st	10,695	1,320	35	17	1,144	1,820	0	2,310	273	140	1,550	10	0	525	1,500	50
2nd	9,603	1,465	1	0	1,170	100	20	1,656	70	720	2,180	0	0	1	0	2,220
3rd	5,914	272	0	7	671	305	0	1,882	50	1,714	240	8	0	0	0	765
4th	3,698	605	0	50	460	183	0	537	180	818	0	441	0	0	0	424

Note: Question III-1 in the questionnaire

11,756

Table AC-A1-33 Income Structure against 4 Income Strata for RCHRSP

(Unit: %)

Income Strata	Average Income	Income Structure														
		Agricultural Income						Non-agricultural Income								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Selling paddy/rice	Selling vegetables	Selling fruits	Selling palm sugar	Selling livestock/ poultry products	Selling fishes	Salary from permanent job	Wage from temporary on-farm job	Wage from temporary off-farm job	Private business	Remittance from family members	Selling firewood/charcoal	Selling handicraft/ cottage industry products	Selling forest vegetable/ crop	Others
Zone 1 (Kampong Speu)																
1st	11,756	13.65	0.91	1.34	2.51	8.77	2.13	24.03	13.79	2.81	9.27	3.27	8.42	0.00	0.00	9.10
2nd	6,779	18.00	0.89	0.46	3.82	5.28	0.07	25.45	4.99	24.89	3.64	6.02	0.00	0.00	0.00	6.49
3rd	5,350	24.61	0.00	0.43	0.00	4.69	6.28	26.80	6.64	12.07	5.28	7.40	0.11	0.00	0.00	5.68
4th	3,754	22.15	0.00	0.44	2.02	2.13	1.60	19.41	15.12	15.99	9.27	8.25	0.00	0.00	0.20	3.41
Zone 2 (Kampong Speu)																
1st	10,908	22.80	1.83	0.92	4.40	7.32	3.52	19.47	3.67	8.80	1.10	6.14	0.00	3.30	0.00	16.73
2nd	6,253	10.27	3.49	2.00	0.40	6.10	6.30	20.26	3.36	12.47	0.00	29.27	0.00	0.00	0.80	5.28
3rd	4,816	10.17	1.85	2.28	1.56	10.20	5.98	26.33	6.31	17.09	2.08	6.98	0.00	0.83	0.62	7.72
4th	3,161	16.61	4.01	2.89	0.00	5.44	4.64	44.37	2.95	9.93	1.27	2.66	1.77	0.00	0.00	3.46
Zone 2 (Kandal)																
1st	10,695	12.35	0.33	0.16	10.70	17.02	0.00	21.60	2.55	1.31	14.49	0.09	0.00	4.91	14.03	0.47
2nd	9,603	15.26	0.01	0.00	12.18	1.04	0.21	17.24	0.73	7.50	22.70	0.00	0.00	0.01	0.00	23.12
3rd	5,914	4.60	0.00	0.12	11.34	5.16	0.00	31.82	0.85	28.98	4.06	0.14	0.00	0.00	0.00	12.94
4th	3,698	16.36	0.00	1.35	12.44	4.94	0.00	14.52	4.87	22.12	0.00	11.93	0.00	0.00	0.00	11.47

Note: Question III-1 in the questionnaire

Table AC-A11-34 Expenditure Structure Against 4 Income Strata in RCHRSP

(Unit: Riel'000)

Income Strata	Total Annual Expenditure	Expenditure ('000 Riel)									
		1	2	3	4	5	6	7	8	9	10
		Rice	Other foods	Health/ medicine	Education	Clothes	Firewood/ Kerosene/ Electricity	Transpor-tation	Tax	Others	Total
Zone 1 (Kampong Speu)											
1st	11,756	1,049	2,173	1,429	1,413	551	526	1,476	33	661	9,311
2nd	6,779	833	1,355	619	1,138	345	309	437	13	319	5,367
3rd	5,350	914	1,151	483	367	292	267	315	13	247	4,048
4th	3,754	637	874	419	159	198	207	219	11	242	2,968
Zone 2 (Kampong Speu)											
1st	10,908	1,011	1,813	642	1,415	615	521	813	68	575	7,472
2nd	6,253	1,023	1,384	764	668	424	346	604	6	377	5,596
3rd	4,816	984	1,187	675	296	356	153	283	2	366	4,301
4th	3,161	705	736	480	295	360	130	207	3	221	3,137
Zone 2 (Kandal)											
1st	10,695	1,064	1,853	1,074	1,682	648	715	1,636	67	609	9,347
2nd	9,603	1,055	1,383	489	1,332	341	796	542	17	368	6,323
3rd	5,914	808	1,119	667	424	325	302	345	5	221	4,215
4th	3,698	700	868	270	243	183	162	215	3	138	2,782

Note: Question III-2 in the questionnaire

Table AC-A1-35 Expenditure Structure Against Income Strata in RCHRSP

(Unit:%)

Income Strata	Total Annual Expenditure	Expenditure ('000 Riel)									
		1	2	3	4	5	6	7	8	9	10
		Rice	Other foods	Health/ medicine	Education	Clothes	Firewood/ Kerosene/ Electricity	Transpor-tation	Tax	Others	Total
Zone 1 (Kampong Speu)											
1st	11,756	11	23	15	15	6	6	16	0	7	100
2nd	6,779	16	25	12	21	6	6	8	0	6	100
3rd	5,350	23	28	12	9	7	7	8	0	6	100
4th	3,754	21	29	14	5	7	7	7	0	8	100
Zone 2 (Kampong Speu)											
1st	10,908	14	24	9	19	8	7	11	1	8	100
2nd	6,253	18	25	14	12	8	6	11	0	7	100
3rd	4,816	23	28	16	7	8	4	7	0	9	100
4th	3,161	22	23	15	9	11	4	7	0	7	100
Zone 2 (Kandal)											
1st	10,695	11	20	11	18	7	8	18	1	7	100
2nd	9,603	17	22	8	21	5	13	9	0	6	100
3rd	5,914	19	27	16	10	8	7	8	0	5	100
4th	3,698	25	31	10	9	7	6	8	0	5	100

Note: Question III-2 in the questionnaire

Table AC-A1-36 Per Capita Income and Expenditure in RCHRSP

(Unit: US$)

Income Strata	Annual Income	Annual Expenditure	Family Size (person)	Percapita Daily Income	Per Capita Daily Expenditure
Zone 1 (Kampong Speu)					
1st	2,861	2,266	6.20	1,28	1.02
2nd	1,650	1,306	5.60	0.82	0.65
3rd	1,302	985	5.40	0.67	0.51
4th	914	722	4.40	0.58	0.46
Zone 2 (Kampong Speu)					
1st	2,655	1,818	5.80	1.27	0.87
2nd	1,522	1,362	5.80	0.73	0.65
3rd	1,172	1,047	5.50	0.59	0.53
4th	769	763	4.73	0.45	0.45
Zone 2 (Kandal)					
1st	2,603	2,275	6.70	1.08	0.94
2nd	2,337	1,539	6.20	1.05	0.69
3rd	1,439	1,026	5.10	0.78	0.56
4th	900	677	4.40	0.57	0.43

Note: Questions III-1 and III-2 in the questionnaire

Table AC-A1-37 Investment in Livestock

(Unit: head)

	Zone 1				
	Chicken	Ducks	Cattle	Buffalo	Pig
N	31	13	30	0	9
Average	9	8	3	0	3
Median	5	5	2	0	2
Minimum	1	2	1	0	1
Maximum	60	30	5	0	7
	Zone 2				
	Chicken	**Ducks**	**Cattle**	**Buffalo**	**Pig**
N	31	10	33	0	6
Average	9	8	3	0	5
Median	5	10	2	0	4
Minimum	1	3	1	0	1
Maximum	60	13	7	0	9
	Whole				
	Chicken	**Ducks**	**Cattle**	**Buffalo**	**Pig**
N	62	23	63	0	15
Average	9	8	3	0	3
Median	5	5	2	0	2
Minimum	1	2	1	0	1
Maximum	60	30	7	0	9

Note: Question III-3 in the questionnaire

Table AC-A1-38 Investment in House, Private business and Land

(Unit: Riel)

	Zone 1			Zone 2			Whole		
	House	Private Business	Land	House	Private Business	Land	House	Private Business	Land
N	11	5	3	3	3	2	14	8	5
Average	2,798,182	3,034,000	9,133,333	1,500,000	1,526,667	5,200,000	2,520,000	2,468,750	7,560,000
Median	2,000,000	1,000,000	8,600,000	1,800,000	1,080,000	5,200,000	1,900,000	1,040,000	8,000,000
Minimum	600,000	70,000	2,800,000	300,000	300,000	2,400,000	300,000	70,000	2,400,000
Maximum	6,680,000	12,000,000	16,000,000	2,400,000	3,200,000	8,000,000	6,680,000	12,000,000	16,000,000

Note: Question III-3 in the questionnaire

Table AC-A1-39 Saving in any Forms (IV-1)

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Money in bank	1	1	0	0	1	1
Land	1	1	1	1	2	1
Livestock	1	1	4	5	5	3
Cash	10	12	7	8	17	10
Others	4	5	2	2	6	4
No saving	68	80	71	84	139	82
Total	85	100	85	100	170	100

Note: -Question IV-1 in the questionnaire

-Zone 1: Others means 2.4% development commuiity, 1.2% new unity community and 1.2% village credit

- Zone 2: Others means 1.2% Tontine, 1.2% Palm Sugar

Table AC-A1-40 Saving Amount and Interest Rate

	Zone 1		Zone 2		Whole	
	Amount	Interest	Amount	Interest	Amount	Interest
N	17	7	14	1	31	8
Average	2,082,941	31	2,686,929	10	2,355,710	29
Median	600,000	36	2,028,000	10	1,500,000	36
Minimum	100,000	18	100,000	10	100,000	10
Maximum	12,000,000	36	8,000,000	10	12,000,000	36

Note: Question IV-1 in the questionnaire

Table AC-A1-41 Purpose for Savings

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
For safety	1	1	1	1	2	1
Saving for future expenditure	6	7	8	9	14	8
Saving for emergency needs	10	12	5	6	15	9
No savings	68	80	71	84	139	82
Total	85	100	85	100	170	100

Note: Question IV-1 in the questionnaire

Table AC-A1-42 Source of Loans/Debts

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Friend/Relatives	5	6	3	4	8	5
Trader	1	1	2	2	3	2
NGO	6	7	15	18	21	12
Commercial bank	27	32	25	29	52	31
Others	4	5	2	2	6	4
No debt	42	49	38	45	80	47
	85	100	85	100	170	100

Note: Question IV-2 in the questionnaire

Table AT-RC-43 Purpose for Loans/Debts

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Seeds/fertilizers/agro-chemicals	0	0	7	8	7	4
Farm equipment/tools	0	0	4	5	4	2
Animals	0	0	4	5	4	2
Food	0	0	2	2	2	1
Assets	0	0	6	7	6	4
Land	0	0	2	2	2	1
Children's education	0	0	1	1	1	1
Debt repayment	0	0	5	6	5	3
Ceremonial occasions	0	0	2	2	2	1
Business	0	0	7	8	7	4
Building/repair of house	1	1	2	2	3	2
Others	0	0	4	5	4	2
No loans/debts	84	99	39	46	123	72
Total	85	100	85	100	170	100

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AT-RC-44 Collateral for Loans/Debts

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Nothing	0	0	6	7	6	4
Land	0	0	27	32	27	16
Others	1	1	12	14	13	8
Not borrow	84	99	40	47	124	73
Total	85	100	85	100	170	100

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AT-RC-45 Loans and Debts

	Zone 1			Zone 2			Whole		
	Amount (Riel)	Interest rate %/y	Amount Repaid (Riel)	Amount (Riel)	Interest rate %/y	Amount Repaid (Riel)	Amount (Riel)	Interest rate %/y	Amount Repaid (Riel)
N	43	40	27	46	43	27	89	83	54
Average	3,173,302	31	1,435,630	3,364,348	31	1,653,037	3,272,045	31	1,544,333
Median	2,000,000	36	480,000	3,200,000	34	1,200,000	2,000,000	36	828,000
Minimum	150,000	6	0	50,000	0	30,000	50,000	0	0
Maximum	28,000,000	46	8,160,000	12,000,000	42	7,200,000	28,000,000	46	8,160,000

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-46 Livestock: Number of Adult

	Zone 1					
	Respondent		number of adult			
	n	%	Average	Median	Minimum	Maximum
Cows / Oxen	60	71	2	2	1	10
Water kbuffalo	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0
Swine	11	13	4	2	1	12
Chicken	42	49	6	5	1	40
Duck	16	19	8	7	2	20
	Zone 2					
	Respondent		**number of adult**			
	n	**%**	**Average**	**Median**	**Minimum**	**Maximum**
Cows / Oxen	69	81	3	2	1	10
Water kbuffalo	0	#REF!	0	0	0	0
Goat / Sheep	0	#REF!	0	0	0	0
Swine	5	6	3	1	1	8
Chicken	47	55	6	3	1	60
Duck	8	9	6	6	1	10
	Whole					
	Respondent		**number of adult**			
	n	**%**	**Average**	**Median**	**Minimum**	**Maximum**
Cows / Oxen	129	76	2	2	1	10
Water kbuffalo	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0
Swine	16	9	4	2	1	12
Chicken	89	52	6	4	1	60
Duck	24	14	7	6	1	20

Note: Question V-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-47 Livestock: Number of Young

	Zone 1					
	Respondent		number of young			
	n	%	Average	Median	Minimum	Maximum
Cows / Oxen	27	32	1	1	1	4
Water kbuffalo	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0
Swine	2	2	5	5	1	8
Chicken	27	32	15	10	5	60
Duck	4	5	22	7	2	70
	Zone 2					
	Respondent		**umber of young**			
	n	**%**	**Average**	**Median**	**Minimum**	**Maximum**
Cows / Oxen	31	36	1	1	1	3
Water kbuffalo	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0
Swine	4	5	8	8	6	10
Chicken	24	28	14	12	2	30
Duck	2	2	7	7	5	9
	Whole					
	Respondent		**umber of young**			
	n	**%**	**Average**	**Median**	**Minimum**	**Maximum**
Cows / Oxen	58	34	1	1	1	4
Water kbuffalo		0	0	0	0	0
Goat / Sheep		0	0	0	0	0
Swine	6	4	7	8	1	10
Chicken	51	30	14	10	2	60
Duck	6	4	17	7	2	70

Note: Question V-1 in the questionnaire

Table AC-A1-48 Food Sufficiency in Wet and Dry Season for Livestock Rearing

	Zone 1				Zone 2				Whole			
	Wet season		Dry season		Wet season		Dry season		Wet season		Dry season	
	n	%	n	%	n	%	n	%	n	%	n	%
1. Cows / Oxen												
Sufficient	23	27	11	13	17	20	9	11	40	24	20	12
Just enough	30	35	35	41	41	48	30	35	71	42	65	38
Short	9	11	13	15	10	12	27	32	19	11	40	24
Very short	0	0	1	1	1	1	3	4	1	1	4	2
Non	23	27	23	27	16	19	16	19	39	23	39	23
Total	85	100	85	100	85	100	85	100	170	100	170	100
2. Water kbuffalo												
Sufficient	0	0	0	0	0	0	0	0	0	0	0	0
Just enough	0	0			0	0	0	0	0	0	0	0
Short	0	0	0	0	0	0	0	0	0	0	0	0
Very short	0	0	0	0	0	0	0	0	0	0	0	0
Non	85	100	85	100	85	100	85	100	170	100	170	100
Total	85	100	85	100	85	100	85	100	170	100	170	100
3. Goat / Sheep									0	0	0	0
Sufficient	0	0	0	0	0	0	0	0	0	0	0	0
Just enough	0	0	0	0	0	0	0	0	0	0	0	0
Short	0	0	0	0	0	0	0	0	0	0	0	0
Very short	0	0	0	0	0	0	0	0	0	0	0	0
Non	85	100	85	100	85	100	85	100	170	100	170	100
Total	85	100	85	100	85	100	85	100	170	100	170	100
4. Swine												
Sufficient	2	2	2	2	0	0	0	0	2	1	2	1
Just enough	9	11	9	11	5	6	5	6	14	8	14	8
Short	0	0	0	0	0	0	0	0	0	0	0	0
Very short	0	0	0	0	0	0	0	0	0	0	0	0
Non	74	87	74	87	80	94	80	94	154	91	154	91
Total	85	100	85	100	85	100	85	100	170	100	170	100

Note: Question V-1 in the questionnaire

Table AT-RC-49 Fruit Trees Holded

	Zone 1					Zone 2					Whole				
	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average
Sugar palm	53	62	1	30	7	48	56	1	50	8	101	59	1	50	7
Coconut palm	54	64	1	20	4	52	61	1	8	3	106	62	1	20	3
Mango	61	72	1	40	5	61	72	1	100	7	122	72	1	100	6
Jackfruit	35	41	1	227	9	44	52	1	6	2	79	46	1	227	5

Note: Question V-2 in the questionnaire

Table AC-A1-50 Agricultural Land Holding

	Land Holding_Land Owned (ha)								Land Holding_Land Use (Land Operated/) (ha)							
	Paddy Field								Paddy Field							
Item	Irrigated paddy field	supplementary Irrigated paddy field	Irrigated field Total	Rainfed paddy field	Total 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	Upland for field crop	Upland for field crop	Total Farm Land
Zone 1																
Total	24.0	19.3	43.3	36.3	79.6	9.9	0.7	90.2	26.0	22.8	48.9	38.7	87.6	9.9	0.7	98.1
No. of Respondent	44	32	59	48	83	18	2	85	44	33	60	51	85	18	2	85
Per Resondent	0.5	0.6	0.7	0.8	1.0	0.5	0.4	1.1	0.6	0.7	0.8	0.8	1.0	0.5	0.4	1.2
Per Sample (85 samples)	0.28	0.23	0.51	0.43	0.94	0.12	0.01	1.06	0.31	0.27	0.57	0.46	1.03	0.12	0.01	1.15
Zone 2																
Total	10.0	9.9	19.9	43.0	63.0	3.5	0.0	66.4	13.8	14.9	28.7	44.7	73.4	3.5	0.0	76.8
No. of Respondent	19	16	32	65	85	16	0	85	20	17	33	65	85	16	0	85
Per Resondent	0.5	0.6	0.6	0.7	0.7	0.2	0.0	0.8	0.7	0.9	0.9	0.7	0.9	0.2	0.0	0.9
Per Sample (85 samples)	0.12	0.12	0.23	0.51	0.74	0.04	0.00	0.78	0.16	0.18	0.34	0.53	0.86	0.04	0.00	0.90
Whole																
Total	34.1	29.2	63.3	79.3	142.6	13.3	0.7	156.6	39.8	37.7	77.6	83.4	160.9	13.3	0.7	175.0
No. of Respondent	63	48	91	113	168	34	2	170	64	50	93	116	170	34	2	170
Per Resondent	0.5	0.6	0.7	0.7	0.8	0.4	0.4	0.9	0.6	0.8	0.8	0.7	0.9	0.4	0.4	1.0
Per Sample (170 samples)	0.20	0.17	0.37	0.47	0.84	0.08	0.00	0.92	0.23	0.22	0.46	0.49	0.95	0.08	0.00	1.03

Note: Question VI-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-51 Land Holding Status

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Owner cultivator	77.0	90.6	75.0	88.2	152.0	89.4
Owner cum sharecropper	2.0	2.4	1.0	1.2	3.0	1.8
Sharecropper	2.0	2.4	2.0	2.4	4.0	2.4
Owner cum tenant	4.0	4.7	7.0	8.2	11.0	6.5
Total	85.0	100.0	85.0	100.0	170.0	100.0

Note: Question VI-2 in the questionnaire

Table AC-A1-52 Land Rental Charge

		Zone 1					Zone 2					Whole				
				Amount charge (riel/ha/season)					Amount charge (riel/ha/season)					Amount charge (riel/ha/season)		
		n	%	Min.	Max.	Ave.	n	%	Min.	Max.	Ave.	n	%	Min.	Max.	Ave.
In cash	Irrigated paddy field	1	1.2	150,000	150,000	150,000	0	0	0	0	0	1	0.6	150,000	150,000	150,000
	Rainfed paddy field	1	1.2	500,000	500,000	500,000	2	2.4	30,000	600,000	315,000	3	1.8	30,000	600,000	376,667
	Upland field	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0
				% of harvest					% of harvest					% of harvest		
		n	%	Min.	Max.	Ave.	n	%	Min.	Max.	Ave.	n	%	Min.	Max.	Ave.
In kind	Irrigated paddy field	3	3.5	50	50	50	8	9.4	10	50	26.28	11	6.5	10	50	32.75
	Rainfed paddy field	4	4.7	33	50	46	3	3.5	10	30	20	7	4.1	10	50	34.76
	Upland field	1	1.2	50	50	50	0	0	0	0	0	1	0.6	50	50	50
Free of charge		0	0	0	0	0	2	2.4	0	0	0	2	1.2	0	0	0
Others		0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0

Note: Question VI-3 in the questionnaire

Table AC-A1-53 Decision Maker for Crop Selection in Rented Land

	Irrigated paddy		Rainfed paddy		Upland field	
	n	%	n	%	n	%
Zone 1						
1. Land owner	0	0	0	0	n/a	n/a
2. Tenant	4	4.7	5	5.9	n/a	n/a
3. Both	0	0	1	1.2	n/a	n/a
4. Other	0	0	0	0	0	0
Zone 2						
1. Land owner	0	0	1	1.2	1	1.2
2. Tenant	5	5.9	9	10.6	1	1.2
3. Both	1	1.2	0	0	0	0
4. Other	0	0	0	0	0	0
Whole						
1. Land owner	0	0	1	0.6	1	0.6
2. Tenant	9	5.3	14	8.2	1	0.6
3. Both	1	0.6	1	0.6	n/a	n/a
4. Other	0	0	0	0	0	0

Note: Question VI-3 in the questionnaire

Table AC-A1-54 Land Use and Cropped Area, Cropping Intensity, Production, Unit Yield and Marketing Volume of Paddy by Strata

	Land Use (ha)								Cropped Area of Paddy (ha)				
	Paddy Field								Irrigated Paddy				
Item	Irrigated Field	Supplementary Irrigated Field	Irrigated Field Total	Rainfed Field	Total Paddy Field	Upland Field for Field Crop	Upland Field for Tree Crop	Total Farm Land	Wet Season	Dry season	Total	Rainfed Paddy	Total
Zone 1													
Total	26	23	49	39	88	10	1	98	48	8	57	44	101
No. of Respondent	44	33	60	51	85	18	2	85	60	22	60	51	85
Per Respondent	1	1	1	1	1	1	0	1	1	0	1	1	1
Per Sample (85 samples)	0.31	0.27	0.57	0.46	1.03	0.12	0.01	1.15	0.57	0.10	0.66	0.52	1.18
Zone 2													
Total	14	15	29	45	73	3	0	77	32	0	32	46	78
No. of Respondent	20	17	33	65	85	16	0	85	32	0	32	65	85
Per Respondent	1	1	1	1	1	0	0	1	1	0	1	1	1
Per Sample (85 samples)	0	0	0	1	1	0	0	1	0	0	0	1	1
Whole													
Total	40	38	78	83	161	13	1	175	80	8	88	90	178
No. of Respondent	64	50	93	116	170	34	2	170	92	22	92	116	170
Per Respondent	1	1	1	1	1	0	0	1	1	0	1	1	1
Per Sample (170 samples)	0	0	0	0	1	0	0	1	0	0	1	1	1

	Cropping Intensity of Paddy (%)					Paddy Production (kg)				Paddy Yield (kg/ha)				Marketed Volume of Paddy (kg & %)				
	Irrigated Field					Irrigated Paddy				Irrigated Paddy				Irrigated Paddy				
Item	Wet Season	Dry Season	Annual	Rainfed Field	Overall	Wet Season	Dry Season	Rainfed Paddy	Total Production	Wet Season	Dry Season	Average	Rainfed Paddy	Wet Season	Dry Season	Rainfed Paddy	Total	Proportion to Total Production
Zone 1																		
Total	99	17	116	114	115	111,340	23,190	82,962	217,492	2,310	2,794	2,381	1,879	48,220	11,690	39,448	99,358	46
No. of Respondent	60	60	60	51	85	57	19	48	85	60	22	60	51	41	14	27	62	62
Per Respondent						1,953	1,221	1,728	2,559					1,176	835	1,461	1,603	63
Per Sample (85 samples)	99	9	116	114	115	1,310	273	976	2,559					567	138	464	1,169	46
Zone 2																		
Total	110	0	110	103	106	71,278	0	97,303	168,581	2,262	0	2,262	2,115	33,994	0	25,920	59,914	36
No. of Respondent	32	32	32	65	85	32	0	66	85	32	0	32	65	26	0	23	44	44
Per Respondent						2,227	0	1,474	1,983					1,307	0	1,127	1,362	69
Per Sample (85 samples)	110	0	110	103	106	839	0	1,145	1,983					400	0	305	705	36
Whole																		
Total	103	11	113	108	111	182,618	23,190	180,265	386,073	2,291	2,794	2,338	1,999	82,214	11,690	65,368	159,272	41
No. of Respondent	92	92	92	116	170	89	19	114	170	92	22	92	116	67	14	50	106	106
Per Respondent						2,052	1,221	1,581	2,271					1,227	835	1,307	1,503	66
Per Sample (170 samples)	103	5	113	108	111	1,074	136	1,060	2,271					484	69	385	937	41

Note: Question VII-1, VIII-1 in the questionnaire

Table AT-RC-55 No. of Livestock and Fish for Selling in 2010

(Unit: no)

	Zone 1					Zone 2					Whole				
	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average
Cows	20	15	1	4	1	19	22	1	3	1	39	23	1	4	1
Oxen	14	16	1	5	2	19	22	1	3	2	33	19	1	5	2
Water buffalo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swine / Pig	6	7	1	12	5	7	8	2	10	5	13	8	1	12	5
Poultry	20	24	3	105	16	13	15	5	62	23	33	19	3	105	18
Egg	0	0	0	0	0	1	1	30	30	30	1	1	30	30	30
Fish	2	2	10	12	11	1	1	20	20	20	3	2	10	20	14

Note: Question VIII-2 in the questionnaire

Table AT-RC-56 Selling Price of Livestock and Fish

(Unit: Riel)

	Zone 1					Zone 2					Whole				
	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average
Cows	20	24	400,000	3,000,000	1,509,750	19	22	500,000	2,500,000	1,356,579	39	23	400,000	3,000,000	1,435,128
Oxen	14	16	350,000	5,000,000	1,592,857	19	22	1,080,000	3,000,000	1,920,000	33	19	350,000	5,000,000	1,781,212
Water buffalo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swine / Pig	6	7	100,000	1,000,000	500,000	7	8	600,000	1,500,000	865,714	13	8	100,000	1,500,000	696,923
Poultry	20	24	10,000	20,000	14,000	13	15	10,000	20,000	15,692	33	19	10,000	20,000	14,667
Egg	0	0	0	0	0	1	1	500	500	500	1	1	500	500	500
Fish	2	2	10,000	12,000	11,000	1	1	10,000	10,000	10,000	3	2	10,000	12,000	10,667

Note: Question VIII-2 in the questionnaire

Table AC-A1-57 Income from Livestock and Fish

(Unit: Riel)

	Zone 1					Zone 2					Whole				
	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average	n	%	Minimum	Maximum	Average
Cows	20	24	400,000	6,000,000	2,245,500	19	22	500,000	5,000,000	1,986,842	39	23	400,000	6,000,000	2,119,487
Oxen	14	16	700,000	10,000,000	2,850,000	19	22	1,080,000	6,000,000	3,167,368	33	19	700,000	10,000,000	3,032,727
Water kbuffalo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swine / Pig	6	7	200,000	7,000,000	2,516,667	7	8	2,400,000	10,000,000	4,185,714	13	8	200,000	10,000,000	3,415,385
Poultry	20	24	42,000	1,575,000	224,050	13	15	100,000	806,000	322,385	33	19	42,000	1,575,000	262,788
Egg	0	0	0	0	0	1	1	15,000	15,000	15,000	1	1	15,000	15,000	15,000
Fish	2	2	100,000	144,000	122,000	1	1	200,000	200,000	200,000	3	2	100,000	200,000	148,000

Note: Question VIII-2 in the questionnaire

Table AC-A1-58 Food Supply Condition for Rice

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Own harvest/ product exceed the household demand	34	40	31	36	65	38
Own harvest/ product is just enough to the household demand	25	29	33	39	58	34
Purchased (or exchanged) to meet the household demand	20	24	14	16	34	20
Insufficient	6	7	7	8	13	8
Total	85	100	85	100	170	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-59 Food Supply Condition for Vegetables

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Own harvest/ product exceed the household demand	1	1	1	1	2	1
Own harvest/ product is just enough to the household demand	3	4	4	5	7	4
Purchased (or exchanged) to meet the household demand	67	79	69	81	136	80
Insufficient	14	16	11	13	25	15
Total	85	100	85	100	170	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-60 Food Supply Condition for Other Cereals

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Own harvest/ product exceed the household demand	2	2	0	0	2	1
Own harvest/ product is just enough to the household demand	3	4	0	0	3	2
Purchased (or exchanged) to meet the household demand	61	72	57	67	118	69
Insufficient	19	22	28	33	47	28
Total	85	100	85	100	170	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-61 Food Supply Condition for Meat

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Own harvest/ product exceed the household demand			0	0	0	0
Own harvest/ product is just enough to the household demand			0	0	0	0
Purchased (or exchanged) to meet the household demand	64	75	60	71	124	73
Insufficient	21	25	25	29	46	27
Total	85	100	85	100	170	100

Note: Question VIII-3 in the questionnaire

Table AC-A1-62 Food Supply Condition for Roots and Tuber Crops

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Own harvest/ product exceed the household demand	0	0	0	0	0	0
Own harvest/ product is just enough to the household demand	3	4	4	5	7	4
Purchased (or exchanged) to meet the household demand	61	72	61	72	122	72
Insufficient	21	25	20	24	41	24
Total	85	100	85	100	170	100

Note: Question VIII-3 in the questionnaire

Table AC-A1-63 Food Condition for Fish

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Own harvest/ product exceed the household demand	0	0	0	0	0	0
Own harvest/ product is just enough to the household demand	0	0	0	0	0	0
Purchased (or exchanged) to meet the household demand	62	73	60	71	122	72
Insufficient	23	27	25	29	48	28
Total	85	100	85	100	170	100

Note: Question VIII-3 in the questionnaire

Table AC-A1-64 Threshing (Method)

	Zone 1		Zone 2		Whole	
Respo	n	%	n	%	n	%
Engine thresher	29	34	13	15	42	25
Pedal thresher	1	1	0	0	1	1
Manual threshing	55	65	72	85	127	75
Total	85	100	85	100	170	100

Note: Question IX-1 in the questionnaire

Table AC-A1-65 Threshing Ownership

	Zone		Zone		Whole	
Respo	n	%	n	%	n	%
Own	47	55	65	76	112	66
Borrowed	38	45	20	24	58	34
Cooperative	0	0	0	0	0	0
Total	85	100	85	100	170	100

Note: Question IX-1 in the questionnaire

Table AC-A1-66 Charge for Borrowing Treshing

	Zone 1	Zone 2	Whole
N	36	20	56
Media	155,000	120,000	135,000
Mean	158,811	148,450	155,111
SE	18,159	23,044	14,173
Minim	20,000	20,000	20,000
Maxim	500,000	400,000	500,000

Note: Question IX-1 in the questionnaire

Table AC-A1-67 Drying (Method)

	Zone 1		Zone 2		Whole	
Response	n	%	n	%	n	%
Dryer (machine)	0	0	0	0	0	0
Sun drying	85	100	85	100	170	100
Total	85	100	85	100	170	100

Note: Question IX-1 in the questionnaire

Table AC-A1-68 Drying Owneryship

	Zone 1		Zone 2		Whole	
Respo	n	%	n	%	n	%
Own	85	100	85	100	170	100
Borrowed	0	0	0	0	0	0
Coorperative	0	0	0	0	0	0
Total	85	100	85	100	170	100

Note: -Charge on drying is not available
-Question IX-1 in the questionnaire

Table AC-A1-69 Cleaning Ownership

	Zone 1		Zone 2		Whole	
Respo	n	%	n	%	n	%
Own	45	53	60	71	105	62
Borrowed	40	47	25	29	65	38
Coorperative	0	0	0	0	0	0
Total	85	100	85	100	170	100

Note: Question IX-1 in the questionnaire

Table AC-A1-70 Cleaning (Method)

	Zone 1		Zone 2		Whole	
Respo	n	%	n	%	n	%
Engine winnower	50	59	30	35	80	47
Manual winnower	10	12	7	8	17	10
Manual without winnower	25	29	48	56	73	43
Total	85	100	85	100	170	100

Note: Question IX-1 in the questionnaire

Table AC-A1-71 Charge for Cleaning

	Zone 1	Zone 2	Whole
N	10	12	22
Media	18,000	22,350	20,200
Mean	22,790	32,050	27,841
SE	3,498	7,384	4,356
Minim	10,000	1,500	1,500
Maxim	40,800	100,000	100,000

Note: Question IX-1 in the questionnaire

Table AC-A1-72 Rice Milling Cost

	Zone 1	Zone 2	Whole
N	49	48	97
Media	50,000	45,000	50,000
Mean	51,245	44,792	48,052
SE	1,411	1,664	1,132
Minim	30,000	30,000	30,000
Maxim	66,000	75,000	75,000

Note: Question IX-1 in the questionnaire

Table AC-A1-73 Kind of Container used for Storing Paddy

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Bag	24	28	16	19	40	24
Bamboo basket	23	27	29	34	52	31
Wooden box	22	26	28	33	50	29
Others	16	19	12	14	28	16
Total	85	100	85	100	170	100

Note: Question IX-2 in the questionnaire

Table AC-A1-74 Paddy Storage Amount (kg)

	Zone 1	Zone 2	Whole
N	85	85	170
Median	2,000	1,500	1,800
Mean	2,567	1,983	2,275
SE Mean	189	170	129
Minimum	200	150	150
Maximum	7,254	10,000	10,000

Note: Question IX-2 in the questionnaire

Table AC-A1-75 Storage Period of Paddy (month)

	Zone 1	Zone 2	Whole
N	85	85	170
Median	12	11	12
Mean	10	11	10
SE Mean	0	0	0
Minimum	1	3	1
Maximum	12	16	16

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-76 Container for Storing Rice

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Bag	71	84	72	85	143	84
Bamboo basket	0	0	0	0	0	0
Wooden box	0	0	0	0	0	0
Others	14	16	13	15	27	16
Total	85	100	85	100	170	100

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A1-77 Rice Storage Amount (kg)

	Zone 1	Zone 2	Whole
N	85	85	170
Median	60	80	75
Mean	72	77	74
SE Mean	3	3	2
Minimum	20	20	20
Maximum	190	150	190

Note: Question IX-2 in the questionnaire

Table AC-A1-78 Storage Period of Rice (month)

	Zone 1	Zone 2	Whole
N	85	85	170
Median	1	1	1
Mean	1	1	1
SE Mean	1	1	1
Minimum	1	1	1
Maximum	1	1	1

Note: Question IX-2 in the questionnaire

Table AC-A1-79 Most Dominant Loss of Paddy

	Zone 1		Zone 2		Whole	
(one alternative)	n	%	n	%	n	%
During harvesting	23	27	28	33	51	30
At threshing	20	24	14	16	34	20
At drying			2	2	2	1
At cleaning			3	4	3	2
At storage	33	39	34	40	67	39
At other time (specify)	9	11	4	5	13	8
Total	85	100	85	100	170	100

Note: Question IX-2 in the questionnaire

Table AC-A1-80 Second Dominant Loss

	Zone 1		Zone 2		Whole	
(one alternative)	n	%	n	%	n	%
During harvesting	12	14	18	21	30	18
At threshing	39	46	35	41	74	44
At drying	13	15	4	5	17	10
At Cleaning	7	8	9	11	16	9
At storage	12	14	14	16	26	15
At other time (specify)	2	2	5	6	7	4
Total	85	100	85	100	170	100

Note: Question IX-2 in the questionnaire

Table AC-A1-81 Total Post Harvest Losses

(Unit: %)

	Zone 1	Zone 2	Whole
N	85	85	170
Median	3	4	3
Mean	4	5	5
Minimum	1	1	1
Maximum	10	10	10

Note: Question IX-2 in the questionnaire

Table AC-A1-82 Marketing Timing for Rice (IX-3)

Response	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Just after harvest	17	20	3	4	20	12
When cash in needed	35	41	32	38	67	39
When price is high	10	12	10	12	20	12
Non reply	23	27	40	47	63	37
Total	85	100	85	100	170	100

Note: Question IX-3 in the questionnaire

Table AC-A1-83 Marketed Rice

Just after Harvesting

	Zone 1	Zone 2	Whole
N	17	3	20
Median	1,440	1,000	1,320
Mean	1,881	2,000	1,899
Minimum	300	300	300
Maximum	4,000	4,700	4,700

Note: Question IX-3 in the questionnaire

Table AC-A1-84 Marketed Rice

When Cash is Needed

	Zone 1	Zone 2	Whole
N	35	32	67
Median	1,000	1,000	1,000
Mean	1,361	1,022	1,198
Minimum	80	80	80
Maximum	5,000	2,500	5,000

Note: Question IX-3 in the questionnaire

Table AC-A1-85 Marketed Volume of Rice

When Price is High

	Zone 1	Zone 2	Whole
N	10	10	20
Median	1,995	1,500	1,995
Mean	1,974	2,130	2,052
Minimum	500	500	500
Maximum	5,000	7,000	7,000

Note: Question IX-3 in the questionnaire

Table AC-A1-86 Sold Rice Product

Response	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Field dried paddy	9	11	2	2	11	6
Sun dried paddy	52	61	43	51	95	56
Milled rice	1	1	0	0	1	1
Non reply	23	27	40	47	63	37
Total	85	100	85	100	170	100

Note: Question IX-3 in the questionnaire

Table AC-A1-87 Market Destination

Response	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Rice miller in village	11	13	7	8	18	11
Rice miller in commune center	1	1	6	7	7	4
Rice miller in district center	2	2	3	4	5	3
Collector/middleman	45	53	28	33	73	43
Local market	2	2	1	1	3	2
Others (specify)	1	1			1	1
System	23	27	40	47	63	37
Total	85	100	85	100	170	100

Note: Question IX-3 in the questionnaire

Table AC-A1-88 Processing of Rice for Selling

Response	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Noodle	2	2	1	1	3	2
Confectionary	13	15	17	20	30	18
Powder			1	1	1	1
Liquor	3	4	3	4	6	4
Others	23	27	22	26	45	26
Not process for sell	44	52	41	48	85	50
Total	85	100	85	100	170	100

Note: Question IX-4 in the questionnaire

Table AC-A1-89 Marketing Destination of Vegetables

Response	Vegetable						Livestock					
	Zone 1		Zone 2		Whole		Zone 1		Zone 2		Whole	
	n	%	n	%	n	%	n	%	n	%	n	%
Market in village	15	18	18	21	33	19	17	20	12	14	29	17
Market in commune center	6	7	5	6	11	6	5	6	6	7	11	6
Market in district center	11	13	1	1	12	7	11	13	2	2	13	8
Collector/middleman	6	7	19	22	25	15	27	32	43	51	70	41
Other (specify)	6	7	4	5	10	6	4	5	1	1	5	3
Not Sold	41	48	38	45	79	46	21	25	21	25	42	25
Total	85	100	85	100	170	100	85	100	85	100	170	100

Note: Question IX-5in the questionnaire

Table AC-A1-90 Marketing Destination of Fish

Response	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Market in village	15	18	17	20	32	19
Market in commune center	5	6	4	5	9	5
Market in district center	9	11	1	1	10	6
Collector/middleman	6	7	17	20	23	14
Other (specify)	5	6	1	1	6	4
System	45	53	45	53	90	53
Total	85	100	85	100	170	100

Note: Question IX-5in the questionnaire

Table AC-A1-91 Farm Gate Price of Paddy, Milled Rice, and Farm Inputs

		Price	Zone 1					Zone 2				
			N	%	Minimum	Maximum	Average	N	%	Minimum	Maximum	Average
Paddy	Early rice (1st wet)	Riel/kg	56	66	700	1,500	1,076	53	62	900	1,500	1,159
	Early rice (2nd wet)	Riel/kg	36	42	800	1,500	1,092	35	41	900	1,500	1,159
	Medium rice	Riel/kg	59	69	800	1,500	1,059	51	60	900	1,900	1,178
	Early rice (dry)	Riel/kg	40	47	500	1,500	918	32	38	700	1,250	963
Milled rice	Early rice (1st wet)	Riel/kg	41	48	1,100	3,500	2,132	36	42	2,000	3,500	2,517
	Early rice (2nd wet)	Riel/kg	28	33	1,800	3,600	2,271	29	34	1,900	3,500	2,510
	Medium rice	Riel/kg	40	47	1,500	2,500	2,130	35	41	1,800	3,500	2,391
	Early rice (dry)	Riel/kg	30	35	1,800	2,500	2,010	26	31	1,800	2,500	2,112
Seed paddy	Early rice ( )	Riel/kg	33	39	850	5,000	1,633	20	24	1,000	2,500	1,585
	Medium rice ( )	Riel/kg	25	29	900	6,500	1,654	19	22	1,000	2,500	1,532
	Maize ( )	Riel/kg	10	12	1,500	7,000	3,390	6	7	2,500	3,500	3,017
	Beans ( )	Riel/kg	9	11	2,500	7,500	5,478	10	12	2,300	7,500	4,810
Fertilizer	Urea	Riel/kg	62	73	2,000	5,000	2,667	64	75	2,000	3,200	2,508
	DAP	Riel/kg	58	68	2,000	4,000	3,031	51	60	2,100	4,000	2,912
	KCl	Riel/kg	10	12	2,400	3,800	3,170	2	2	2,500	3,000	2,750
Land preparation by ox	Plow	Riel/ha	7	8	100,000	200,000	166,929	6	7	100,000	200,000	154,167
	Plow + Harrow	Riel/ha	34	40	170,000	450,000	250,588	43	51	175,000	400,000	242,326
	Harrow	Riel/ha	2	2	150,000	160,000	155,000	3	4	150,000	200,000	166,667
Land preparation by hand tractor	Plow	Riel/ha	7	8	150,000	300,000	235,714	5	6	180,000	250,000	221,000
	Plow + Harrow	Riel/ha	46	54	200,000	500,000	382,717	42	49	250,000	500,000	347,976
	Harrow	Riel/ha	5	6	100,000	300,000	210,000	3	4	150,000	250,000	200,000
Transportation	House to market ( )	Riel/kg	33	39	20	100	49	20	24	25	100	51
	House to market ( )	Riel/kg	19	22	20	100	70	11	13	25	80	50
	House to market ( )	Riel/kg	3	4	20	800	440	0	0	0	0	0

Note: Questions IX-6 and IX-7 in the questionnaire

Table AC-A1-92 Frequency of Extension Worker's Visiting

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
1. once per <2 weeks	3	3.53	0	0	3	2
2. Once per 2 weeks - 1 month			5	5.88	5	3
3. Seldom visited	82	96.47	80	94.12	162	95
Total	85	100	85	100	170	100

Note: Question X-1 in the questionnaire

Table AC-A1-93 Satisfaction to Extension Services

Degree	Capacity of Extension Worker						Qualityh of Extension Services					
	Zone 1		Zone 2		Whole		Zone 1		Zone 2		Whole	
	n	%	n	%	n	%	n	%	n	%	n	%
1. Sufficient	24	28	13	15	37	22	29	34	18	21	47	28
2. not sufficient	15	18	15	18	30	18	12	14	10	12	22	13
3. No service provided	46	54	57	67	103	61	44	52	57	67	101	59
Total	85	100	85	100	170	100	85	100	85	100	170	100

Note: Question X-1 in the questionnaire

Table AC-A1-94 Request to Extension Services

Degree	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
1. Need more extension services worker for technical of agriculture	37	44	22	26	59	35
2. Compost making training	1	1	0	0	1	1
3. Disseminate from modern famer to others	1	1	10	12	11	6
4. Fertilizer application technique and methodology	16	19	3	4	19	11
5. Fish raising technical and methodology	1	1	0	0	1	1
6. Livestock/ Animal raising technical and methodology	17	20	32	38	49	29
7. Vegetable growing technical and methodology	5	6	2	2	7	4
8. Quality paddy rice seed and livestock variety sellection	2	2	13	15	15	9
9. Other and no idea	5	6	3	4	8	5
Total	85	100	85	100	170	100

Note: Question X-1 in the questionnaire

Table AC-A1-95 Procurement of Seeds

	Wanted Seeds						Certified Seeds					
	Zone 1		Zone 2		Whole		Zone 1		Zone 2		Whole	
	n	%	n	%	n	%	n	%	n	%	n	%
1. Easy	23	27.06	15	17.65	38	22	22	25.88	16	18.82	38	22
2. Difficult	6	7.06	10	11.76	16	9	7	8.24	8	9.41	15	9
3. Not possible	56	65.88	60	70.59	116	68	56	65.88	61	71.76	117	69
Total	85	100	85	100	170	100	85	100	85	100	170	100

Note: Question X-2 in the questionnaire

Table AC-A1-96 Seed Supply Timing

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
1. In time	20	23.53	16	18.82	36	21
2. Delayed	9	10.59	9	10.59	18	11
3. Not obtained	56	65.88	60	70.59	116	68
Total	85	100	85	100	170	100

Note: Question X-2 in the questionnaire

Table AC-A1-97 Price of Quality Seed

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
1. Too expensive	19	22.35	14	16.47	33	19
2. Acceptable	13	15.29	12	14.12	25	15
3. Not purchased	53	62.35	59	69.41	112	66
Total	85	100	85	100	170	100

Note: Question X-2 in the questionnaire

Table AC-A1-98 Procurement of Wanted Fertilizer

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Easy	48	56	42	49	90	53
Difficult	11	13	4	5	15	9
Not possible	26	31	39	46	65	38
Total	85	100	85	100	170	100

Note: Question X-3 in the questionnaire

Table AC-A1-99 Fertilizer Supply Timing

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
In time	49	58	42	49	91	54
Delayed	7	8	4	5	11	6
Not obtained	29	34	39	46	68	40
Total	85	100	85	100	170	100

Note: Question X-3 in the questionnaire

Table AC-A1-100 Proce of Fertilizer

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Too expensive	64	75	48	56	112	66
Acceptable	5	6	9	11	14	8
Not purchased	16	19	28	33	44	26
Total	85	100	85	100	170	100

Note: Question X-3 in the questionnaire

Table AC-A1-101 Access to Farm Credit

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Easy	19	22	17	20	36	21
Difficult	3	4	4	5	7	4
Not possible	63	74	64	75	127	75
Total	85	100	85	100	170	100

Note: Question X-4 in the questionnaire

Table AC-A1-102 Timing of Provision of Credit

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Easy	18	21	16	19	34	20
Difficult	4	5	5	6	9	5
Not possible	63	74	64	75	127	75
Total	85	100	85	100	170	100

Note: Question X-4 in the questionnaire

Table AC-A1-103 Amount of Credit

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Sufficient	22	26	16	19	38	22
Not sufficient			4	5	4	2
Not provided	63	74	65	76	128	75
Total	85	100	85	100	170	100

Note: Question X-4 in the questionnaire

Table AC-A1-104 Procedures of Credit Application

Response (one alternative)	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Easy	15	18	15	18	30	18
Difficult	7	8	5	6	12	7
Not possible	63	74	65	76	128	75
Total	85	100	85	100	170	100

Note: Question X-4 in the questionnaire

Table AC-A1-105 Farming Constraints on Agronomic and Farm Management Situations

	Degree of Constraints in Zone 1												Total Score	Rating	Degree of Constraints in Zone 2												Total Score	Rating
	Most Serious (4 points)			2nd Serious (3 points)			3rd Serious 2points)			4th Serious (1 point)					Most Serious (4 points)			2nd Serious (3 points)			3rd Serious 2points)			4th Serious (1 point)				
	No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score		
Low yield of crops (paddy)	23	27	92	4	5	12	5	6	10	8	9	8	122	2	23	27	92	8	9	24	11	13	22	10	12	10	148	2
Crop losses due to pest & disease	34	40	136	21	25	63	9	11	18	4	5	4	221	1	37	44	148	24	28	72	3	4	6	2	2	2	228	1
Weed problem	2	2	8	21	25	63	7	8	14	10	12	10	95	3	8	9	32	13	15	39	9	11	18	5	6	5	94	3
Crop losses due to wild animal	4	5	16	6	7	18	12	14	24	5	6	5	63	5	7	8	28	3	4	9	7	8	14	3	4	3	54	6
Difficulty for hiring draft animal/machinery	4	5	16	3	4	9	3	4	6	5	6	5	36	9	3	4	12	6	7	18	2	2	4	2	2	2	36	8
Labor shortage	3	4	12	5	6	15	14	16	28	11	13	11	66	4	2	2	8	7	8	21	14	16	28	8	9	8	65	4
Insufficient extension services	0	0	0	3	4	9	10	12	20	6	7	6	35	10	0	0	0	4	5	12	12	14	24	11	13	11	47	7
Shortage of farming capital	6	7	24	2	2	6	2	2	4	7	8	7	41	7	0	0	0	2	2	6	4	5	8	4	5	4	18	11
Difficulty for obtaining quality seeds	0	0	0	3	4	9	4	5	8	11	13	11	28	11	0	0	0	8	9	24	10	12	20	12	14	12	56	5
Difficulty for purchasing fertilizers	3	4	12	6	7	18	2	2	4	3	4	3	37	8	0	0	0	2	2	6	1	1	2	6	7	6	14	12
Expensive farm inputs	3	4	12	5	6	15	9	11	18	4	5	4	49	6	3	4	12	2	2	6	3	4	6	12	14	12	36	8
Poor soil conditions	1	1	4	2	2	6	4	5	8	3	4	3	21	12	1	1	4	3	4	9	5	6	10	5	6	5	28	10
Marketing problems of products	0	0	0	1	1	3	2	2	4	4	5	4	11	14	0	0	0	0	0	0	2	2	4	3	4	3	7	14
Lack of farm credit	1	1	4	2	2	6	2	2	4	3	4	3	17	13	1	1	4	1	1	3	2	2	4	2	2	2	13	13
Other (specify)	1	1	4	1	1	3	0	0	0	1	1	1	8	15	0	0	0	2	2	6	0	0	0	0	0	1	7	14
Other (specify)	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Total	85	100	340	85	100	255	85	100	170	85	100	85	850		85	100	340	85	100	255	85	100	170	85	100	86	851	

Note: Question XI-1 in the questionnaire

Table AC-A1-106 Physical Farming Constraints

	Degree of Constraints in Zone 1									Total Score	Rating	Degree of Constraints in Zone 2									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1					Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Irrigation water shortage in wet season	46	54	138	19	22	38	5	6	5	181	1	61	72	183	7	8	14	11	13	11	208	1
Irrigation water shortage in dry season	28	33	84	39	46	78	3	4	3	165	2	11	13	33	63	74	126	6	7	6	165	2
Inundation/flooding	4	5	12	2	2	4	8	9	8	24	5	0	0	0	1	1	2	5	6	5	7	7
Drainage problem	4	5	12	11	13	22	44	52	44	78	3	10	12	30	9	11	18	49	58	49	97	3
Lack of farm road	0	0	0	3	4	6	9	11	9	15	7	1	1	3	0	0	0	7	8	7	10	5
Lack of transportation means	1	1	3	5	6	10	3	4	3	16	6	1	1	3	1	1	2	4	5	4	9	6
Leveling problem of paddy field	2	2	6	6	7	12	12	14	12	30	4	1	1	3	4	5	8	3	4	3	14	4
Others(specify)	0	0	0	0	0	0	1	1	1	1	8	0	0	0	0	0	0	0	0	0	0	8
Total	85	100	255	85	100	170	85	100	85	510		85	100	255	85	100	170	85	100	85	510	

Note: Question XI-2 in the questionnaire
Source: Socio-economic survey, 2011

Table AC-A1-107 Constraints on Marketing

	Degree of Constraints in Zone 1									Total Score	Rating	Degree of Constraints in Zone 2									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1					Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Unstable market prices of paddy/rice	44	51.76	132	15	17.65	30	6	7.06	6	168	1	58	68.24	174	10	11.76	20	5	5.88	5	199	1
Low market prices of paddy/rice	23	27.06	69	22	25.88	44	2	2.35	2	115	2	21	24.71	63	35	41.18	70	6	7.06	6	139	2
Limitation of market of paddy/rice	7	8.24	21	10	11.76	20	11	12.94	11	52	4	2	2.35	6	8	9.41	16	7	8.24	7	29	5
Unstable market prices of other crops	7	8.24	21	15	17.65	30	16	18.82	16	67	3	0	0.00	0	13	15.29	26	10	11.76	10	36	4
Low market prices of other crops	2	2.35	6	5	5.88	10	8	9.41	8	24	6	1	1.18	3	2	2.35	4	10	11.76	10	17	7
Limitation of market of other crops	0	0	0	3	3.53	6	4	4.71	4	10	9	1	1.18	3	3	3.53	6	7	8.24	7	16	8
Unstable market prices of livestock	0	0	0	9	10.59	18	18	21.18	18	36	5	0	0	0	9	10.59	18	22	25.88	22	40	3
Low market prices of livestock	1	1.18	3	3	3.53	6	9	10.59	9	18	7	1	1.18	3	3	3.53	6	10	11.76	10	19	6
Limitation of market of livestock	0	0	0	2	2.35	4	5	5.88	5	9	10	1	1.18	3	1	1.18	2	4	4.71	4	9	9
Lack of or poor farm to market road	1	1.18	3	1	1.18	2	6	7.06	6	11	8	0	0.00	0	1	1.18	2	4	4.71	4	6	10
Other(specify)	0	0.00	0	0	0.00	0	0	0.00	0	0	11	0	0.00	0	0	0.00	0	0	0.00	0	0	11
Total	85	100	255	85	100	170	85	100	85	510		85	100	255	85	100	100	85	100	85	510	

Note: Question XI-3 in the questionnaire

Table AC-A1-108 Reasons for Limited Productivity of Crops

Target Area	Degree of Constraints in Zone 1									Total Score	Rating	Degree of Constraints in Zone 2									Total Score	Rating
Reasons for Limited Productivity (Answer)	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1					Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Drought in wet season	47	55	141	15	18	30	3	4	3	174	1	63	74	189	6	7	12	9	11	9	210	1
Water shortage in dry season	13	15	39	29	34	58	7	8	7	104	2	12	14	36	56	66	112	3	4	3	151	2
Shortage of farming capital	3	4	9	3	4	6	7	8	7	22	7	2	2	6	5	6	10	9	11	9	25	4
Poor seed quality	3	4	9	9	11	18	4	5	4	31	4	0	0	0	4	5	8	13	15	13	21	6
Poor soil	5	6	15	15	18	30	15	18	15	60	3	2	2	6	1	1	2	16	19	16	24	5
Limited application of fertilizer	2	2	6	2	2	4	6	7	6	16	9	0	0	0	2	2	4	3	4	3	7	9
Damages caused by wild animal (rat)	4	5	12	0	0	0	16	19	16	28	5	0	0	0	3	4	6	12	14	12	18	7
Poor drainage	1	1	3	5	6	10	9	11	9	22	7	6	7	18	7	8	14	3	4	3	35	3
Flooding/inundation	2	2	6	1	1	2	2	2	2	10	11	0	0	0	0	0	0	2	2	2	2	11
Inadequate farming technologies	0	0	0	3	4	6	9	11	9	15	10	0	0	0	0	0	0	10	12	10	10	8
Damages caused by pest & disease	5	6	15	3	4	6	7	8	7	28	5	0	0	0	1	1	2	5	6	5	7	9
Others	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	12
Total	85	100	255	85	100	170	85	100	85	510		85	100	255	85	100	170	85	100	85	510	

Note: Question XI-4 in the questionnaire

Table AC-A1-109   Activities/Practices for Improvement of Rice Productivity

Target Area	No. & Proportion of Respondents Implemented Activities/Practices in Zone 1										No. & Proportion of Respondents Implemented Activities/Practices in Zone 2									
	1		2		3		4		Overall		1		2		3		4		Overall	
Activities Implemented	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Increased fertilization doses	26	31	24	28	8	9	4	5	62	18	30	35	31	36	6	7	4	5	71	21
Applied of compost/manure	49	58	24	28	3	4	2	2	78	23	44	52	31	36	6	7	1	1	82	24
Used quality seed (local variety)	2	2	17	20	30	35	7	8	56	16	4	5	8	9	37	44	9	11	58	17
Used quality seed (high yielding variety)	2	2	6	7	13	15	14	16	35	10	1	1	8	9	9	11	15	18	33	10
Constructed of farm pond	0	0	0	0	3	4	1	1	4	1	1	1	0	0	2	2	3	4	6	2
Started to use water pump for irrigation	3	4	9	11	18	21	17	20	47	14	3	4	2	2	14	16	25	29	44	13
Improved farming practices	1	1	3	4	6	7	19	22	29	9	1	1	4	5	5	6	15	18	25	7
Improved post-harvest practices	1	1	2	2	3	4	16	19	22	6	1	1	0	0	6	7	9	11	16	5
Changed marketing methods	0	0	0	0	1	1	4	5	5	1	0	0	0	0	0	0	4	5	4	1
Others	1	1	0	0	0	0	1	1	2	1	0	0	1	1	0	0	0	0	1	0
Total	85	100	85	100	85	100	85	100	340	100	85	100	85	100	85	100	85	100	340	100

Note: Question XI-5 in the questionnaire

Table AC-A1-110 Necessary Activities for Improvement of Rice Productivity

	Degree of Necessity of Activity in Zone 1												Total Score	Rating	Degree of Necessity of Activity in Zone 2												Total Score	Rating
	Most Required Score: 4			2nd Most Required Score: 3			3rd Most Required Score: 2			4th Most Required Score: 1					Most Required Score: 4			2nd Most Required Score: 3			3rd Most Required Score: 2			4th Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score		
Improvement of farming practices	30	35	120	9	11	27	4	5	8	8	9	8	163	2	34	40	136	15	18	45	15	18	30	6	7	6	217	1
Use of quality seed (local variety)	15	18	60	11	13	33	5	6	10	0	0	0	103	4	11	13	44	24	28	72	8	9	16	2	2	2	134	4
Use of quality seed (high yielding variety)	19	22	76	23	27	69	12	14	24	1	1	1	170	1	20	24	80	15	18	45	9	11	18	1	1	1	144	2
Use of adequate doses of fertilizer	13	15	52	20	24	60	19	22	38	7	8	7	157	3	10	12	40	17	20	51	21	25	42	5	6	5	138	3
Improved leveling of paddy field	3	4	12	9	11	27	20	24	40	14	16	14	93	5	3	4	12	5	6	15	5	6	10	15	18	15	52	6
Planting at proper time	2	2	8	7	8	21	10	12	20	16	19	16	65	6	2	2	8	2	2	6	5	6	10	10	12	10	34	8
Intensive weeding	2	2	8	4	5	12	8	9	16	22	26	22	58	7	1	1	4	4	5	12	13	15	26	33	39	33	75	5
Formation/strengthening of farmers organization	1	1	4	2	2	6	7	8	14	16	19	16	40	8	2	2	8	3	4	9	9	11	18	13	15	13	48	7
Others	0	0	0	0	0	0	0	0	0	1	1	1	1	9	2	2	8	0	0	0	0	0	0	0	0	0	8	9
Total	85	100	340	85	100	255	85	100	170	85	100	85	850		85	100	340	85	100	255	85	100	170	85	100	85	850	

Note: Question XI-6 in the questionnaire

Table AC-A1-111 Necessary Physical Works for Improvement of Rice Productivity

	Degree of Necessity of Activity in Zone 1									Total Score	Rating	Degree of Necessity of Activity in Zone 2									Total Score	Rating
	Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1					Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Irrigation water supply for wet season	50	59	150	21	25	42	8	9	8	200	1	64	75	192	9	11	18	11	13	11	221	1
Irrigation water supply for dry season	26	31	78	51	60	102	5	6	5	185	2	14	16	42	67	79	134	3	4	3	179	2
Mitigation of inundation/flooding	0	0	0	4	5	8	8	9	8	16	4	1	1	3	1	1	2	12	14	12	17	4
Drainage improvement	8	9	24	7	8	14	57	67	57	95	3	6	7	18	8	9	16	59	69	59	93	3
Others	1	1	3	2	2	4	7	8	7	14	5	0	0	0	0	0	0	0	0	0	0	5
Total	85	100	255	85	100	170	85	100	85	510		85	100	255	85	100	170	85	100	85	510	

Note: Question XI-7 in the questionnaire

Table AC-A1-112 Constraints on Livestock Management

	Degree of Constraints in Zone 1									Total Score	Rating	Degree of Constraints in Zone 2									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1					Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Low productivity	13	15	39	3	4	6	1	1	1	46	5	12	14	36	3	4	6	8	9	8	50	5
Shortage of feed	13	15	39	8	9	16	6	7	6	61	3	10	12	30	9	11	18	8	9	8	56	3
Low or unstable market prices	3	4	9	10	12	20	14	16	14	43	6	6	7	18	13	15	26	4	5	4	48	6
Market availability	1	1	3	5	6	10	9	11	9	22	8	2	2	6	2	2	4	5	6	5	15	8
Losses due to diseases	38	45	114	15	18	30	11	13	11	155	1	49	58	147	11	13	22	7	8	7	176	1
Insufficient veterinary services	7	8	21	27	32	54	16	19	16	91	2	2	2	6	31	36	62	20	24	20	88	2
Insufficient extension services	5	6	15	9	11	18	15	18	15	48	4	1	1	3	13	15	26	23	27	23	52	4
Difficulty in obtaining good breed	3	4	9	7	8	14	11	13	11	34	7	3	4	9	3	4	6	7	8	7	22	7
Others	2	2	6	1	1	2	2	2	2	10	9	0	0	0	0	0	0	3	4	3	3	9
Total	85	100	255	85	100	170	85	100	85	510		85	100	255	85	100	170	85	100	85	510	

Note: Question XII in the questionnaire

Table AC-A1-113 Preferable Cropping Pattern

	Zone 1		Zone 2		Whole	
	n	%	n	%	n	%
Early Rice (Wet) + Early Rice (Wet)	18	21	23	27	41	24
Early Rice (Wet) + Medium Rice (Wet)	5	6	3	4	8	5
Upland crops (Dry) + Medium Rice (Wet)	6	7	11	13	17	10
Upland crops (Dry) + Early rice (Wet)	16	19	15	18	31	18
Early rice (Wet) + Early (Wet) + Upland Crops	15	18	17	20	32	19
Medium rice (Wet) + Upland Crops	3	4	10	12	13	8
Medium rice (Wet) only	22	26	6	7	28	16
Total	85	100	85	100	170	100

Note: Question XV-1 in the questionnaire

Table AC-A1-114 Expectations for Improvement

	Degree of Expectation in Zone 1									Total Score	Rating	Degree of Expectation in Zone 2									Total Score	Rating
	Most Expected Score: 3			2nd Most Expected Score: 2			3rd Most Expected Score: 1					Most Expected Score: 3			2nd Most Expected Score: 2			3rd Most Expected Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Productivity improvement of wet season rice	49	58	147	18	21	36	8	9	8	191	1	58	68	174	15	18	30	3	4	3	207	1
Productivity improvement of dry season rice	25	29	75	41	48	82	2	2	2	159	2	17	20	51	51	60	102	1	1	1	154	2
Productivity improvement of field crops	3	4	9	1	1	2	12	14	12	23	5	4	5	12	4	5	8	8	9	8	28	5
Productivity improvement of vegetables	0	0	0	7	8	14	12	14	12	26	4	0	0	0	4	5	8	22	26	22	30	4
Productivity improvement of livestock/poultry	1	1	3	3	4	6	8	9	8	17	8	2	2	6	1	1	2	9	11	9	17	6
Increasing livestock holding size & production	3	4	9	7	8	14	23	27	23	46	3	2	2	6	5	6	10	28	33	28	44	3
Increasing poultry holding size & production	1	1	3	5	6	10	5	6	5	18	7	0	0	0	3	4	6	7	8	7	13	7
Strengthening/formation of farmers organizations	1	1	3	2	2	4	12	14	12	19	6	1	1	3	2	2	4	6	7	6	13	7
Improvement of post-harvest operation	2	2	6	1	1	2	3	4	3	11	9	1	1	3	0	0	0	1	1	1	4	9
Others	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	10
Total	85	100	255	85	100	170	85	100	85	510		85	100	255	85	100	170	85	100	85	510	

Note: Question XV-2 in the questionnaire

Table AC-A1-115 Requirement on Improvement in Water Issue

	Degree of Expectation in Zone 1									Total Score	Rating	Degree of Expectation in Zone 2									Total Score	Rating
	Primarily Expected Score: 3			Secondary Expected Score: 2			Thirdly Expected Score: 1					Primarily Expected Score: 3			Secondary Expected Score: 2			Thirdly Expected Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Adequate(volume/timing) irrigation water supply in wet season	45	53	135	21	25	42	6	7	6	183	1	65	76	195	9	11	18	6	7	6	219	1
Adequate(volume/timing) irrigation water supply in dry season	27	32	81	48	56	96	5	6	5	182	2	14	16	42	69	81	138	0	0	0	180	2
Mitigation of inundation & flooding	0	0	0	2	2	4	6	7	6	10	6	2	2	6	2	2	4	6	7	6	16	5
Construction/rehabilitation of farm road	6	7	18	7	8	14	13	15	13	45	4	0	0	0	0	0	0	28	33	28	28	4
Construction/rehabilitation of farm to market road	1	1	3	1	1	2	8	9	8	13	5	0	0	0	0	0	0	3	4	3	3	7
Drainage improvement	6	7	18	5	6	10	40	47	40	68	3	4	5	12	5	6	10	36	42	36	58	3
Leveling of paddy field	0	0	0	1	1	2	4	5	4	6	7	0	0	0	0	0	0	5	6	5	5	6
Others (specify)	0	0	0	0	0	0	3	4	3	3	8	0	0	0	0	0	0	1	1	1	1	8
Total	85	3,613	255	85	7,225	170	85	2,408	85	510		85	#REF!	255	85	#REF!	170	85	#REF!	85	510	

Note: Question XV-3 in the questionnaire

Table AC-A1-116 Requirement on Agricultural Support Services

Target Area	Degree of Necessity of Support in Zone 1									Total Score	Rating	Degree of Necessity of Support in Zone 2									Total Score	Rating
	Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1					Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1				
Agricultural Support Required	No.	%	Score	No.	%	Score	No.	%	Score			No.	%	Score	No.	%	Score	No.	%	Score		
Field Extension services (demonstration / field guidance)	42	49	126	10	12	20	16	19	16	162	1	42	49	126	10	12	20	16	19	16	162	1
Provision of quality seed	16	19	48	31	36	62	9	11	9	119	2	16	19	48	31	36	62	9	11	9	119	2
Farmer training (technical & host-harvest operation)	12	14	36	31	36	62	15	18	15	113	3	12	14	36	31	36	62	15	18	15	113	3
Farmer training (organization, marketing, farm management)	2	2	6	5	6	10	5	6	5	21	6	2	2	6	5	6	10	5	6	5	21	6
Support to organize farmers	1	1	3	1	1	2	5	6	5	10	8	1	1	3	1	1	2	5	6	5	10	8
Provision of market information	0	0	0	0	0	0	12	14	12	12	7	0	0	0	0	0	0	12	14	12	12	7
Provision of farm credit	4	5	12	3	4	6	9	11	9	27	5	4	5	12	3	4	6	9	11	9	27	5
Provision of fertilizer	8	9	24	4	5	8	14	16	14	46	4	8	9	24	4	5	8	14	16	14	46	4
Others (specify)	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	9
Total	85	#DIV/0!	255	85	#DIV/0!	255	85	#DIV/0!	255	765		85	#DIV/0!	255	85	#DIV/0!	255	85	#DIV/0!	255	765	

Note: Question XV-4 in the questionnaire

ANNEX C

Attachment 2

Results of Socio-economic Survey for

Upper Slakou Irrigation System

Rehabilitation Sub-project

ANNEX C
ATTACHMENT 2

Socio-economic Survey
for
Upper Slakou Irrigation System Rehabilitation Sub-project

List of Tables

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Table AC-A2-1 Family Member per Household

N	40
Average HH size	5

Note: Question I-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-2 Number of Working-Age Population in Household (From 15 to 64 years old)

N	40
Average	4

Note: Question I-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-3 Main Income Source of Sampled Household Heads

	n	%
Farmer	35	88
Salary worker	2	5
Private business	2	5
Others	1	3
Total	40	100

Note: Question I-5 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2- 4 Male-Female Balance of the Sampled Households

	n	%
Male	107	51
Female	104	49
Total	211	100

Note: Question I-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-5 Age Compositions of Sampled Household Members

	n	%	Male	Female
0 - 14 years	41	19	21	20
15 - 24	67	32	36	31
25 - 34	24	11	10	14
35 - 44	28	13	11	17
45 - 54	19	9	12	7
55 - 64	17	8	8	9
65 years and over	15	7	6	9
Total	211	100	104	107

Note: Question I-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-6 Education Levels of Sampled Household Members

	n	%
No formal education	8	4
Not going to school	20	10
Non-formal education for adults	1	1
Non education	6	3
Drop-out at primary school	30	14
Graduate from primary school	18	9
Drop-out at junior high school	23	11
Graduate from junior high school	26	12
Drop-out at high school	12	6
Graduate from high school	15	7
More than high school	10	5
Presently going to school	42	20
Total	211	100

Note: Question I-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-7 Main Occupations of Sampled Household Members

	n	%
Farmer	79	37
On-farm labor	9	4
Non-farm labor	5	2
Salary worker	25	12
Private business	10	5
Housekeeping (cooking, washing, child care, etc.)	6	3
No job	8	4
Student	54	26
Child (below school age)	13	6
Others	2	1
Total	211	100

Note: Question I-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-8 Literacy Rate of Sampled Household Members

	n	%
Yes	174	83
No	37	18
Total	211	100

Note: Question I-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-9 Village-level Organizations the Husbands are Belonging

	n	%
Farmer's water users' community	4	11
Credit group by government	7	19
Micro-credit group by NGO	3	8
Production group	1	3
Religion group	3	8
Drinking water users' group	1	3
Youth group	1	3
Veteran group	3	8
Others	14	38
Total	37	100

Note: Question I-7 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-10 Village-level Organizations the Wives are Belonging

	n	%
Farmer's water users' community	5	13
Credit group by government	2	5
Micro-credit group by NGO	2	5
Production group	2	5
Religion group	4	10
Drinking water users' group	1	3
Youth group	1	3
Veteran group	4	10
Women's group	3	8
Others	16	40
Total	40	100

Note: Question I-7 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-11 Main Sources of Drinking Water

	Dry Season		Wet Season	
	n	**%**	n	%
Tube pile well	10	25	7	18
Dug well	27	68	16	40
Resevoir/ Pond	1	3	1	3
Spring/ River	1	3		
Rain	1	3	16	40
Total	40	100	40	100

Note: Question II-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-12 Location of Drinking Water

	n	**%**	**n**	**%**
Within the premises	16	40	27	68
Near the premises	16	40	9	23
Away from the premises	8	20	4	10
Total	40	100	40	100

Note: Question II-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-13 Availability of Drinking Water

	n	**%**	**n**	**%**
Easy to obtain	21	53	28	70
Difficult to obtain	12	30	10	25
Very difficult to obtain	7	18	2	5
Total	40	100	40	100

Note: Question II-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-14 Sources of Fuel for Cooking

	n	%
Firewood	38	95
Gas cylinder (LPG)	1	3
Other	1	3
Total	40	100

Note: Question II-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-15 Availability of Fuel for Cooking

	n	%
Easy to obtain	17	43
Difficult to obtain	18	45
Very difficult to obtain	5	13
Total	40	100

Note: Question II-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-16 Main Sources of Lighting

	n	%
Kerosene	5	13
Battery	33	83
Other	2	5
Total	40	100

Note: Question II-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-17 Availability of Lighting Sources

	n	%
Easy to obtain	29	73
Difficult to obtain	10	25
Very difficult to obtain	1	3
Total	40	100

Note: Question II-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-18 Assets of Sampled Family

	Qty.	n	%
Radio	22	21	53
TV	31	31	78
Bicycle	56	33	83
Motorcycle	38	31	78
Car	0	0	0
Car battery	42	37	93
Tractor	0	0	0
Hand tractor	0	0	0
Mosquito net	118	40	100
Cellular phone	56	37	93
Telephone	0	0	0
Water pump	7	6	15
Tape recorder	5	5	13

Note: Question II-4 in the questionnaire

Source: Socio-economic survey, 2011

Note: Total Number of Intervewed Household is 40HH

Source: Socio-economic survey, 2011

Table AC-A2-19 Ownership of Residence

	Owned(1)		Owned (2)		Lent		Borrowed	
	n	%	n	%	n	%	n	%
Slakou	38	95	2	5	0	-	0	-

Note: Owned (1): already paid, Owned (2): udner payment

Source: Socio-economic survey, 2011

Note: Question II-5 in the questionnaire

Table AC-A2-20 Material for Residene

	C&B		Palm leaves		Timber		Others	
	n	%	n	%	n	%	n	%
Slakou	2	5	2	5	33	83	3	8

Note: Timber house with tile roofing is found that there are 77.5%

Source: Socio-economic survey, 2011

Note: Question II-5 in the questionnaire

Table AC-A2-21 Type of House

	Traditional		One-storied		Two-storied		Others	
	n	%	n	%	n	%	n	%
Slakou	27	68	10	25	1	3	2	5

Note: Other means that Small thatch house

Source: Socio-economic survey, 2011

Note: Question II-5 in the questionnaire

Table AC-A2-22 Number of Rooms

	1		2		No rooms		Average	
	n	%	n	%	n	%	n	%
Slakou	11	28	7	18	22	55	18	45

Source: Socio-economic survey, 2011

Note: Question II-5 in the questionnaire

Table AC-A2-23 Toilet Availability

	with toilet		without toilet	
	n	%	n	%
Slakou	17	43	23	58

Note: Question II-5 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-24 Toilet Facility

	Septic tank		Pit latrine		Others	
	n	%	n	%	n	%
Slakou	14	35	4	10	22	55

Note: Question II-5 in the questionnaire

Source: Socio-economic survey, 2011

Note: Other means that 68% go to forest near house while 32% use neighbor's toilet

Source: Socio-economic survey, 2011

Table AC-A2-25 Medical Service Facility

	n	%
Hospital	1	3
Clinic	3	8
Health center	35	88
Others	1	3
Total	40	100

Note: Question II-6 in the questionnaire

Source: Socio-economic survey, 2011

Note: Other means that they have call doctor to check at home

Source: Socio-economic survey, 2011

Table AC-A2-26 How fo you go there?

	n	%
By Walk	1	3
By Taxi	6	15
By Owned motor bike	29	73
By Bicycle	4	10
Total	40	100

Note: Question II-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-27 Female and Male Main Activities in Village

	Male		Female	
	n	%	n	%
Housekeeping	0	0	2	5
Cooking	0	0	1	3
Farming	38	95	37	93
Handy crafting	0	0	0	0
Care of children/ elders	0	0	0	0
Care of livestock	0	0	0	0
Marking Plam sugar	0	0	0	0
Others(Construction Worker	2	5	0	0
Total	40	100	40	100

Source: Socio-economic survey, 2011

Note: Question II-7 in the questionnaire

Table AC-A2-28 Female and Male Main Cash Income Sources in Village

	Male		Female	
	n	%	n	%
Selling paddy	31	78	30	75
Working for other's field	8	20	4	10
Selling palm sugar	0	0	0	0
Selling handy craft	1	3	0	0
Working for a weaving factory	0	0	3	8
Working for bricks factory	0	0	0	0
Selling straw mat	0	0	0	0
Selling cotton/ silk	0	0	0	0
Other(Livestock Raising)	0	0	3	8
Total	40	100	40	100

Note: Question II-7 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-29 Number of Income Sources per Household

No. of Income Sources	1	2	3	4	5	6	7	8	Total
No. of HH	0	1	7	12	11	4	4	1	40

Note: Question III-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-30 Number of Households Earning only from Agricultural and Non-Agricultural Incomes

Agricultural Income Only	2
Non-Agriculture Income Only	0

Note: Question III-1 in the questionnaire

Source: Socio-economic survey, 2011

Note1 : On-farm labor is classified in non-agricultural income

Note2: Selling forest vegetable/ crop is classified in non-agricultural income

Source: Socio-economic survey, 2011

Table AC-A2-31 Total Proportional Income Volumes from Different Sources (%)

1. Selling paddy/rice	23
2. Selling vegetables (red pepper/ tobacco/ water melon/ others)	3
3. Selling fruits (mango/ papaya, banana/ hairly fruit/ orange/ others)	3
4. Selling palm sugar	0
5. Selling livestock/ poultry products	16
6. Selling fishes	2
SUB TOTAL of Agricultural Income	*47*
7. Salary from permanent job	11
8. Wage from temporary on-farm job	3
9. Wage from temporary off-farm job	11
10. Private business (transportation, trading, shop, etc.)	11
11. Remittance from family members	7
12. Selling firewood/charcoal	4
13. Selling handicraft/ cottage industry products	-
14. Selling forest vegetable/ crop	0
15. Others	7
SUB TOTAL of Non-Agricultural Income	*53*
16. Total	100

Note: Question III-1 in the questionnaire

Source: Socio-economic survey, 2011

Average and Median Household Income per Slakou Areas

N	40
Average/HH ('000 Riel)	8,384
Median/HH ('000 Riel)	7,540
Minimum	2,330
Maximum	18,555

Note: Question III-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-32 Income Structure Against 4 Income Strata for Slakou Areas (Value: ’000 Riel)

INCOME STRATA	AVERAGE HH INCOME	INCOME STRUCTURE ('000 Riel)														
		AGRICULTURAL INCOME						NON-AGRICULTURAL INCOME								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Selling paddy/ rice	Selling vegeta bles	Selling fruits	1	Selling livesto ck/ poultry produc ts	Selling fishes	Salary from perma nent job	Wage from tempo rary on-farm job	Wage from tempora ry off-farm job	Private busines s	Remitta nce from family member s	Selling firewoo d/charco al	Selling handicra ft/ cottage industry product s	Sellin g forest veget able/ crop	Others
1st	9035	1240	130	155	0	1830	0	1118	50	1230	2120	240	0	0	66	856
2nd	6357	1530	161	310	10	664	420	505	515	920	220	728	18	0	10	346
3rd	4423	1526	195	158	0	583	30	546	92	35	120	482	480	0	0	178
4th	2702	933	135	26	73	515	20	192	108	207	0	25	280	0	4	185

Note: Question III-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-33 Income Structure Against 4 Income Strata for Slakou Areas (Composition: %)

Income Strata	Annual Income	INCOME STRUCTURE (%)														
		AGRICULTURAL INCOME						NON-AGRICULTURAL INCOME								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Selling	Selling	Selling	Selling	Selling	Selling	Salary	Wage	Wage	Private	Remitta	Selling	Selling	Sellin	Others
1st	9035	14	1	2	0	20	0	12	1	14	23	3	0	0	1	9
2nd	6357	24	3	5	0	10	7	8	8	14	3	11	0	0	0	5
3rd	4423	34	4	4	0	13	1	12	2	1	3	11	11	0	0	4
4th	2702	35	5	1	3	19	1	7	4	8	0	1	10	0	0	7

Note: Question III-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-34 Expenditure Structure Against Income Strata for Slakou Areas (Value: ’000 Riel)

INCOME STRATA	Total Annual Expenditure	EXPENDITURE ('000 Riel)									
		1	2	3	4	5	6	7	8	9	10
		Rice	Other foods	Health/ medicine	Education	Clothes	Firewood/K erosene/Ele ctricity	Transportati on	Tax	Others	Total
1st	9035	1,381	1,084	502	1,855	199	200	383	6	449	6,059
2nd	6357	1,364	894	890	425	265	70	201	6	366	4,481
3rd	4423	1,578	921	254	449	293	221	162	3	284	4,165
4th	2702	965	518	325	223	118	86	110	8	142	2,494

Note: Question III-2 in the questionnaire

Source: Socio-Eonomic Survey, 2011

Table AC-A2-35 Expenditure Structure Against Income Strata for Slakou Areas (Composition: %)

INCOME STRATA	Total Annual Expenditure	EXPENDITURE ('000 Riel)									
		1	2	3	4	5	6	7	8	9	10
		Rice	Other foods	Health/ medicine	Education	Clothes	Firewood/K erosene/Ele ctricity	Transportati on	Tax	Others	Total
1st	9035	23	18	8	31	3	3	6	0	7	100
2nd	6357	30	20	20	9	6	2	4	0	8	100
3rd	4423	38	22	6	11	7	5	4	0	7	100
4th	2702	39	21	13	9	5	3	4	0	6	100

Note: Question III-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-36 Daily Income and Expenditure Per Capita of Sampled Population for Slakou Areas

INCOME STRATA	AVERAGE HH INCOME	AVERAGE HH EXPENDITURE	Average HH Pop. (No.)	Per Capita Daily Income (US$)	Per Capita Daily Expenditure (US$)
1st	2,199	1,475	5.8	1.05	0.71
2nd	1,547	1,090	4.8	0.90	0.63
3rd	1,076	1,014	6.5	0.46	0.43
4th	658	607	4.2	0.43	0.40

Note: Question III-1 , III-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-37 Investment in Livestock During Last Years (Heads)

	Slakou				
	Chicken	Ducks	Cattle	Buffalo	Pig
N	28	13	35	1	11
Average	16	14	3	2	4
Median	7	10	2	2	2
Minimum	1	2	1	2	1
Maximum	50	35	8	2	20

Note: Question III-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-38 Investment in House, Private Business and Land During Last Years ('000 Riel)

	House	Private Business	Land
N	8	7	3
Average	1,105	2,331	3,600
Median	660	1,500	2,000
Minimum	100	220	800
Maximum	3,000	4,800	8,000

Note: Question III-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-39 Saving in any Forms

	n	%
Money in bank	1	6
Land	1	6
Livestock	9	53
Cash	3	18
Others	3	18
Total	17	100

Note: Question VI-1 in the questionnaire

Source: Socio-economic survey, 2011

Note: Others means 100% Saving group

Table AC-A2-40 Amount Saving and Interest Rate of the Saving

	(US$)	Rate (%)/y
N	17	6
Average	1,874	31
Median	1,150	36
Minimum	50	18
Maximum	8,000	36

Note: Question VI-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-41 Purpose of the Saving

	Purpose
N	17
Average	47% Saving for
Median	emergency needs
Minimum	53% Saving for future
Maximum	expenditure

Note: Question VI-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-42 Source of Loans/Debts

	n	%
Friend/Relatives	7	39
Trader	1	6
NGO	6	33
Commercial bank	4	22
Total	18	100

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-43 Purpose for Loans/Debts

	n	%
Seeds/fertilizers/agro-chemicals	3	17
Animals	4	22
Assets	1	6
Land	1	6
Children's education	1	6
Ceremonial occasions	3	17
Reclamation/Rehabilitation of farm lan	1	6
Building/repair of house	1	6
Others	3	17
Total	18	100

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-44 Collateral for Loans/Debts

	n	%
Nothing	9	23
Land	8	20
Total	17	43

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-45 Loans and Debts

	Amount ('000)	Interest rate %/y	Amount Repaid ('000)
N	18	11	5
Average	1,561	34.3	816
Median	1,000	36.0	1,000
Minimum	400	24.0	50
Maximum	4,000	48.0	1,600

Note: Question IV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-46 Livestock: Number of Adult

	Respondent		number of adult			
	n	%	Average	Median	Minimum	Maximum
Cows / Oxen	39	39.8	2	2	1	4
Water kbuffalo	1	1.0	2	2	2	2
Goat / Sheep	0	-	0	0	0	0
Swine	12	12.2	3	2	1	10
Chicken	34	34.7	23	15	3	100
Duck	12	12.2	8	8	2	20

Note: Question V-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-47 Livestock: Number of Young

	Respondent		number of adult			
	n	%	Average	Median	Minimum	Maximum
Cows / Oxen	18	40.0	1	1	1	2
Water kbuffalo	0	-	0	0	0	0
Goat / Sheep	0	-	0	0	0	0
Swine	0	-	0	0	0	0
Chicken	24	53.3	28	25	3	60
Duck	3	6.7	10	8	2	20

Note: Question V-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-48 Livestock: Food Sufficiency in Wet and Dry season

	Wet season		Dry season	
	n	%	n	%
1. Cows / Oxen				
Sufficient	15	38	8	21
Just enough	15	38	18	46
Short	9	23	12	31
Very short	0	0	1	3
Total	39	100	39	100
2. Water kbuffalo				
Sufficient	0	0	0	0
Just enough	1	100		
Short	0	0	1	100
Very short	0	0	0	0
Total	1	100	1	100
3. Goat / Sheep				
Sufficient	0	0	0	0
Just enough	0	0	0	0
Short	0	0	0	0
Very short	0	0	0	0
Total	0	0	0	0
4. Swine				
Sufficient	3	25	2	17
Just enough	8	67	7	58
Short	1	8	3	25
Total	12	100	12	100

Note: Question V-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-49 Fruit Trees

	n	%	Minimum	Maximum	Average
Sugar palm	31	29	1	25	6
Coconut palm	36	33	1	25	8
Mango	35	32	1	50	9
Jackfruit	6	6	1	5	2

Note: Question V-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-50 Agricultural Land Holding

Item	Land Holding (Land Owned) (ha)								Land Holding_Land Use (Land Operated/) (ha)							
	Paddy Field								Paddy Field							
	Irrigated paddy field	supplementary Irrigated paddy field	Irrigated field Total	Rainfed paddy field	Total 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	Upland for field crop	Upland for field crop	Total Farm Land
Slakou																
Total	9	9	18	53	71	7	0	78	10	9	19	25	43	7	0	50
No. of Respondent	12	10	20	30	40	13	0	40	12	10	20	31	40	13	0	40
Per Resondent	0.75	0.92	0.91	1.76	1.77	0.53	0.00	1.94	0.79	0.92	0.93	0.80	1.08	0.53	0.00	1.25
Per Sample (40 samples)	0.23	0.23	0.45	1.32	1.77	0.17	0.00	1.94	0.24	0.23	0.47	0.62	1.08	0.17	0.00	1.25

Note: Question VI-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-51 Land Holding Status

	n	%
Owner cultivator	34	85
Owner cum sharecropper	3	8
Owner cum tenant	3	8
Total	40	100

Note: Question VI-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-52 Land Rental Charge

		n	%	Amount charge (riel/ha/season)		
				Min.	Max.	Average
In cash	Irrigated paddy field	1	3	216000	216000	216000
	Rainfed paddy field	0	0	0	0	0
	Upland field	0	0	0	0	0
		n	%	% of harvest		
				Min.	Maximum	Average
In kind	Irrigated paddy field	1	3	50	50	50
	Rainfed paddy field	4	10	10	50	33
	Upland field	0	0	0	0	0
Free of charge		0	0	0	0	0
Others		0	0	0	0	0

Note: Question VI-3 in the questionnaire

Source: Socio-economic survey, 2011

Table ACA2-53 Decision Maker for Crop Selection in Rented Land

	Irrigated paddy field		Rainfed paddy field		Upland field	
	n	%	n	%	n	%
Slakou						
1. Land owner	0	0	1	3	0	0
2. Tenant	1	3	4	10	0	0
3. Both	0	0	0	0	0	0
4. Other	0	0	0	0	0	0

Note: Question VI-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-54 Land Use and Cropped Area, Cropping Intensity, Production, Unit Yield & Marketing Volume of Paddy by Category of Land

Item	Land Use (ha)								Cropped Area of Paddy (ha)				
	Paddy Field								Irrigated Paddy				
	Irrigated Field	Supplementary Irrigated Field	Irrigated Field Total	Rainfed Field	Total Paddy Field	Upland Field for Field Crop	Upland Field for Tree Crop	Total Farm Land	Wet Season	Dry season	Total	Rainfed Paddy	Total
Slakou Area													
Total	9.5	9.2	18.7	24.7	43.3	6.9	0.0	50.2	21.2	6.6	27.8	31.0	58.7
No. of Respondent	12.0	10	20	31.0	40	13.0	0.0	40	20	7	20	30	40
Per Respondent	0.79	0.92	0.93	0.80	1.08	0.53	0.00	1.25	1.06	0.94	1.39	1.03	1.47
Per Sample (40 samples)	0.24	0.23	0.47	0.62	1.08	0.17	0.00	1.25	0.53	0.17	0.69	0.77	1.47

Item	Cropping Intensity of Paddy (%)					Paddy Production (kg)			
	Irrigated Field					Irrigated Paddy			
	Wet Season	Dry Season	Annual	Rainfed Field	Overall	Wet Season	Dry Season	Rainfed Paddy	Total Production
Slakou Area									
Total	113	35	149	126	136	45,040	4,300	64,865	114,205
No. of Respondent	20	18	20	30	40	20	4	31	40
Per Respondent						2,252	1,075	2,092	2,855
Per Sample (40 samples)	113	15	149	126	136	1,126	108	1,622	2,855

Item	Paddy Yield (kg/ha)				Marketed Volume of Paddy (kg & %)				
	Irrigated Paddy				Irrigated Paddy				
	Wet Season	Dry Season	Average	Rainfed Paddy	Wet Season	Dry Season	Rainfed Paddy	Total	Proportion to Total Production
Slakou Area									
Total	2,128	652	1,777	2,094	20,832	1,400	27,949	50,181	44
No. of Respondent	20	7	40	30	19	2	24	38	38
Per Respondent					1,096	700	1,165	1,321	46
Per Sample (40 samples)					521	35	699	1,255	44

Note: Question VII-1, VIII-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-55 Livestock & Fish: Sold Product inLast Year

(Unit:0)

	n	%	Minimum	Maximum	Average
Cows	14	21	2	2	2
Oxen	15	22	1	8	2
Water kbuffalo	0	0	0	0	0
Swine / Pig	11	16	1	8	3
Poultry	26	38	1	160	34
Egg	1	1	1825	1825	1825
Fish	1	1	30	30	30

Note: Question VIII-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-56 Livestock & Fish: Price

(Unit:Riel)

	n	%	Minimum	Maximum	Average
Cows	13	19	700,000	250,000	1,376,923
Oxen	15	22	406,250	4,000,000	2,140,417
Water kbuffalo	0	0	0	0	0
Swine / Pig	11	16	250,000	1,000,000	586,667
Poultry	26	39	10,000	520,000	44,827
Egg	1	1	500	500	500
Fish	1	1	7,000	7,000	7,000

Note: Question VIII-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-57 Livestock & Fish: Income

(Unit:Riel)

	n	%	Minimum	Maximum	Average
Cows	13	19	700,000	5,000,000	1,823,077
Oxen	15	22	800,000	8,000,000	3,230,000
Water kbuffalo	0	0	0	0	0
Swine / Pig	11	16	250,000	7,200,000	1,955,455
Poultry	26	39	60,000	1,920,000	507,115
Egg	1	1	912,500	912,500	912,500
Fish	1	1	210,000	210,000	210,000

Note: Question VIII-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-58 Food Supply Condition for Rice

Response (one alternative)	n	%
Own harvest/ product exceed the household demand	32	80
Own harvest/ product is just enough to the household demand	5	13
Purchased (or exchanged) to meet the household demand	3	8
Total	40	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-59 Food Supply Condition for Vegetables

Response (one alternative)	n	%
Own harvest/ product exceed the household demand	4	10
Own harvest/ product is just enough to the household demand	3	8
Purchased (or exchanged) to meet the household demand	31	78
Insufficient	2	5
Total	40	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-60 Food Supply Condition for Other Cereals

Response (one alternative)	n	%
Own harvest/ product exceed the household demand	3	8
Own harvest/ product is just enough to the household demand	10	25
Purchased (or exchanged) to meet the household demand	25	63
Insufficient	2	5
Total	40	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-61 Food Supply Condition for Meat

Response (one alternative)	n	%
Own harvest/ product exceed the household demand	1	3
Purchased (or exchanged) to meet the household demand	30	75
Insufficient	9	23
Total	40	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-62 Food Supply Condition for Roots and Tuber Crops

Response (one alternative)	n	%
Own harvest/ product exceed the household demand	3	8
Own harvest/ product is just enough to the household demand	6	15
Purchased (or exchanged) to meet the household demand	25	63
Insufficient	6	15
Total	40	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-63 Food Condition for Fish

Response (one alternative)	n	%
Own harvest/ product exceed the household demand	1	3
Purchased (or exchanged) to meet the household demand	31	78
Insufficient	8	20
Total	40	100

Note: Question VIII-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-64 Threshing (Method)

Response	n	%
Engine thresher	15	38
Manual threshing	25	63
Total	40	100

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-65 Threshing Ownership

Response	n	%
Own	21	53
Borrowed	19	48
Total	40	100

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-66 Charge in Case of Borrowing Treshing

N	19
Median	166,000
Mean	167,395
SE Mean	22,889
Minimum	20,000
Maximum	400,000

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-67 Drying (Method)

Response	n	%
Sun drying	40	100
Total	40	100

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-68 Drying Owneryship

Resp.	n	%
Own	40	100
Total	40	100

Note:Charge on drying is not available

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-69 Cleaning Ownership

Response	n	%
Own	22	55
Borrowed	18	45
Total	40	100

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-70 Cleaning (Method)

Response	n	%
Engine winnower	15	38
Manual winnower	6	15
Manual without winnower	19	48
Total	40	100

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-71 Charge for Cleaning

N	3
Median	25,000
Mean	31,667
SE Mean	9,280
Minimum	20,000
Maximum	50,000

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-72 Rice Milling Cost

N	21
Median	60,000
Mean	50,476
SE Mean	3,202
Minimum	3,000
Maximum	65,000

Note: Question IX-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-73 Paddy Storage (Kind of Container Used)

	n	%
Bag	4	10
Bamboo basket	27	68
Wooden box	7	18
Others	2	5
Total	40	100

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A22-74 Paddy Storage Amount

N	40
Median	2800
Mean	2855
SE	237
Minimu	120
Maxim	8000

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-75 Paddy (Maximum Storage Period; Month)

N	40
Median	12
Mean	11
SE	0
Minimu	3
Maxim	12

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-76 Rice (Kind of Container)

	n	%
Bag	35	88
Bambo	0	0
Woode	0	0
Others	5	12
Total	40	100

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-77 Rice (Storage Amount; kg)

N	40
Median	60
Mean	56
SE	4
Minimum	30
Maxim	120

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-78 Rice (Maximum Storage Period; Month)

N	40
Median	1
Mean	1
SE Mean	0
Minimu	1
Maxim	1

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-79 Most Dominant Loss of Paddy

Response (one alternat	n	%
During harvesting	21	53
At threshing,	18	45
At drying	0	0
At cleaning	1	3
At storage	0	0
Total	40	100

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-80 Second Dominant Loss

Response(one alternat	n	%
During harvesting	7	18
At threshing,	17	43
At drying	7	18
At cleaning	5	13
At storage	4	10
Total	40	100

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-81 Estimated Total Post Harvest Losses in % of Total Products

N	40
Median	3
Mean	4
Minimum	1
Maximum	10

Note: Question IX-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-82 Marketing Time of Rice and Sold Rice Product (Slakou):

Response	n	%	Sold product (Kg)				
			Total Volume	Median	Mean	Min.	Max.
Just after harvest	5	13	10,400	2,000	2,080	2,000	2,400
When cash in needed	25	63	29,008	950	1,160	200	6,000
When price is high	8	20	10,773	1,250	1,347	100	3,000
Total	38	95	50,181	1,000	1,321	100	6,000
Non reply	2	5	0	0	0	0	0
Total	40	100	50,181	1,000	1,321	100	6,000

Note: Question IX-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-86 Sold Rice Product

Response	n	%
Field dried paddy	4	10
Sun dried paddy	33	83
Milled rice	1	3
Non reply	2	5
Total	40	100

Note: Question IX-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-87 Market Destination

Response	n	%
Rice miller in village	11	28
Collector/middleman	22	55
Local market	5	13
Non reply	2	5
Total	40	100

Note: Question IX-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-88 Processing of Rice for Selling

Response	n	%
Noodle	3	8
Confectionary	2	5
Liquor	3	8
Others	7	18
Not process for sell	25	63
Total	40	100

Note: Question IX-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-89 Marketing Destination of Vegetables

Response	Vegetable		Livestock	
	n	%	n	%
Market in village	10	25	13	33
Market in commune center	1	2.5	2	5
Market in district center	3	7.5	1	3
Collector / middleman			19	48
Not Sold	26	65	5	13
Total	40	100	40	100

Note: Question IX-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-90 Marketing Destination of Fish

Response	n	%
Market in village	1	3
Collector/middleman	1	3
Not sold	38	95
Total	40	100

Note: Question IX-5 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-91 Farm Gate Price of Paddy and Milled Rice and Farm Inputs

		Price	N	%	Minimum	Maximum	Average
Paddy	Early rice (1st wet)	Riel/kg	26	30.23	800	1,230	1,047
	Early rice (2nd wet)	Riel/kg	17	19.77	900	1,300	1,106
	Medium rice	Riel/kg	26	30.23	900	1,400	1,150
	Early rice (dry)	Riel/kg	17	19.77	800	1,230	996
Milled rice	Early rice (1st wet)	Riel/kg	20	37.74	1,500	2,200	1,960
	Early rice (2nd wet)	Riel/kg	7	13.21	1,500	2,000	1,929
	Medium rice	Riel/kg	19	35.85	1,800	2,500	2,063
	Early rice (dry)	Riel/kg	7	13.21	1,900	2,000	1,971
Seed paddy	Early rice ( )	Riel/kg	19	24.05	1,000	2,500	1,527
	Medium rice ( )	Riel/kg	16	20.25	1,000	1,500	1,271
	Maize ( )	Riel/kg	20	25.32	3,000	6,000	4,775
	Beans ( )	Riel/kg	24	30.38	3,500	7,000	6,292
Fertilizer	Urea	Riel/kg	29	40.85	2,000	3,500	2,470
	DAP	Riel/kg	33	46.48	2,160	3,500	2,750
	KCl	Riel/kg	9	12.68	2,200	3,200	2,622
Land preparation by ox	Plow	Riel/ha	15	30.00	100,000	200,000	148,667
	Plow + Harrow	Riel/ha	20	40.00	175,000	300,000	243,250
	Harrow	Riel/ha	15	30.00	100,000	150,000	110,667
Land preparation by hand tractor	Plow	Riel/ha	10	35.71	100,000	250,000	160,000
	Plow + Harrow	Riel/ha	10	35.71	250,000	350,000	288,000
	Harrow	Riel/ha	8	28.57	100,000	250,000	143,750
Transportation	House to market ( )	Riel/kg	2	8.70	30	40	35
	House to market ( )	Riel/kg	21	91.30	10	60	45
	House to market ( )	Riel/kg	0	0	0	0	0

Note: Question IX-7 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-92 Visit of Extension Worker

	n	%
once per < 2 weeks	1	3
once per 2 weeks~1 month	14	35
Seldom visited	25	63
Total	40	100

Note: Question X-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-95 Procurement of Seeds

	Wanted Seeds		Certified Seeds	
	n	%	n	%
Easy	25	63	23	58
Difficult	6	15	7	18
Not possible	9	23	10	25
Total	40	100	40	100

Note: Question X-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-96 Seed Supply Timing

	n	%
In time	25	63
Delayed	5	13
Not obtained	10	25
Total	40	100

Note: Question X-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-97 Quality Seed Price

	n	%
Too expensive	20	50.00
Acceptable	17	42.50
Not purchased	3	7.50
Total	40	100.00

Note: Question X-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-98 Procurement of Wanted Fertilizer

Resp. (one alternative)	n	%
Easy	33	83
Difficult	3	8
Not possible	4	10
Total	40	100

Note: Question X-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A22-99 Fertilizer Supply Timing

Resp. (one alternative)	n	%
In time	35	88
Delayed	1	3
Not obtained	4	10
Total	40	100

Note: Question X-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-100 Fertilizer Price

Resp. (one alternative)	n	%
Too expensive	29	73
Acceptable	10	25
Not purchased	1	3
Total	40	100

Note: Question X-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-101 Access to Farm Credit

Resp. (one alternative)	n	%
Easy	4	10
Difficult	7	18
Not possible	29	73
Total	40	100

Note: Question X-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-102 Timing of Provision

Resp. (one alternative)	n	%
Easy	4	10
Difficult	7	18
Not possible	29	73
Total	40	100

Note: Question X-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-103 Amount of Credit

Resp. (one alternative)	n	%
Sufficient	7	18
Not sufficient	3	8
Not provided	30	75
Total	40	100

Note: Question X-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-104 Procudures for Credit Application

Resp. (one alternative)	n	%
Easy	4	10
Difficult	7	18
Not possible	29	73
Total	40	100

Note: Question X-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-105 Farming Constraints

Farming constraint (farm management)	Degree of Constraints												Total Score	Rating
	Most Serious Score: 4			2nd Serious Score: 3			3rd Serious Score: 2			4th Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score		
Low yield of crops (paddy)	9	23	36	4	10	12	3	8	6	2	5	2	56	3
Crop losses due to pest & disease	11	28	44	10	25	30	3	8	6	3	8	3	83	1
Weed problem	7	18	28	8	20	24	6	15	12	6	15	6	70	2
Crop losses due to wild animal	0	0	0	3	8	9	6	15	12	3	8	3	24	6
Difficulty for hiring draft animal/machinery	4	10	16	3	8	9	0	0	0	2	5	2	27	5
Labor shortage	3	8	12	6	15	18	5	13	10	2	5	2	42	4
Insufficient extension services	0	0	0	0	0	0	4	10	8	6	15	6	14	8
Shortage of farming capital	2	5	8	0	0	0	2	5	4	1	3	1	13	9
Difficulty for obtaining quality seeds	0	0	0	0	0	0	1	3	2	3	8	3	5	14
Difficulty for purchasing fertilizers	0	0	0	2	5	6	1	3	2	2	5	2	10	11
Expensive farm inputs	1	3	4	1	3	3	5	13	10	3	8	3	20	7
Poor soil conditions	0	0	0	2	5	6	2	5	4	2	5	2	12	10
Marketing problems of products	1	3	0	1	3	3	2	5	4	3	8	3	10	11
Lack of farm credit	2	5	8	0	0	0	0	0	0	2	5	2	10	11
Other (specify)	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Total	40	100	160	40	100	120	40	100	80	40	100	40	396	

Note: Question XI-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-106 Farming Constraints (Physical)

Faming Constraints/Physical (Answer)	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Irrigation water shortage in wet season	24	2400	72	14	1400	28	0	0	0	100	1
Irrigation water shortage in dry season	13	1300	39	16	1600	32	7	140	7	78	3
Inundation/flooding	0	0	0	1	100	2	1	20	1	3	2
Drainage problem	2	200	6	7	700	14	23	460	23	43	4
Lack of farm road	1	100	3	0	0	0	4	80	4	7	5
Lack of transportation means	0	0	0	1	100	2	2	40	2	4	8
Leveling problem of paddy field	0	0	0	1	100	2	3	60	3	5	6
Others	0	0	0	0	0	0	0	0	0	0	6
											9
Total	40	4000	120	40	4000	80	40	800	40	240	

Note: Question XI-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-107 Marketing Constraints

Marketing Constraints	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Unstable market prices of paddy/rice	24	60	72	4	10	8	1	3	1	81	1
Low market prices of paddy/rice	4	10	12	7	18	14	1	3	1	27	4
Limitation of market of paddy/rice	3	8	9	9	23	18	5	13	5	32	2
Unstable market prices of other crops	5	13	15	6	15	12	4	10	4	31	3
Low market prices of other crops	1	3	3	7	18	14	4	10	4	21	5
Limitation of market of other crops	0	0	0	2	5	4	2	5	2	6	9
Unstable market prices of livestock	2	5	6	0	0	0	6	15	6	12	7
Low market prices of livestock	0	0	0	1	3	2	7	18	7	9	8
Limitation of market of livestock	0	0	0	1	3	2	2	5	2	4	10
Lack of or poor farm to market road	1	3	0	3	8	6	8	20	8	14	6
Total	40	100	117	40	100	80	40	100	40	237	

Note: Question XI-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-108 Reasons for Limited Productivity of Crops in the Rice Field of Interviewee (not specific to last year

Reasons for Limited Productivity (Answer)	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Drought in wet season	29	73	87	6	15	12	2	5	2	101	1
Water shortage in dry season	8	20	24	20	50	40	4	10	4	68	2
Shortage of farming capital	1	3	3	1	3	2	1	3	1	6	7
Poor seed quality	0	0	0	2	5	4	0	0	0	4	9
Poor soil	1	3	3	2	5	4	12	30	12	19	3
Limited application of fertilizer	0	0	0	1	3	2	2	5	2	4	9
Damages caused by wild animal (rat)	0	0	0	1	3	2	5	13	5	7	6
Poor drainage	1	3	3	4	10	8	5	13	5	16	4
Flooding/inundation	0	0	0	0	0	0	0	0	0	0	11
Inadequate farming technologies	0	0	0	0	0	0	5	13	5	5	8
Damages caused by pest & disease	0	0	0	3	8	6	4	10	4	10	5
Others	0	0	0	0	0	0	0	0	0	0	11
Total	40	100	120	40	100	80	40	100	40	240	

Note: Question XI-4 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-109 Activities/Practices to Improve Rice Productivity Implemented by the Interviewee in the Past 3 Years (Plural Answer)

Activities Implemented	No. & Proportion of Respondents Implemented Activities/Practices										Remarks
	1		2		3		4		Overall		
	No.	%	No.	%	No.	%	No.	%	No.	%	
Increased fertilization doses	10	25	12	30	3	8	2	5	27	17	No. of respondents per Slakou Area : 40
Applied of compost/manure	23	58	7	18	9	23	1	3	40	25	
Used quality seed (local variety)	0	0	7	18	8	20	3	8	18	11	
Used quality seed (high yielding variety)	1	3	8	20	2	5	5	13	16	10	
Constructed of farm pond	1	3	2	5	0	0	1	3	4	3	4 activities selected/respondent
Started to use water pump for irrigation	4	10	1	3	7	18	8	20	20	13	
Improved farming practices	1	3	1	3	7	18	7	18	16	10	Total answers per Slakou Area : 40
Improved post-harvest practices	0	0	2	5	4	10	10	25	16	10	
Changed marketing methods	0	0	0	0	0	0	3	8	3	2	
Others	0	0	0	0	0	0	0	0	0	0	
Total	40	100	40	100	40	100	40	100	160	100	

Note: Question XI-5 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-110 Necessary Activities to Improve Rice Productivity in the Field of the Interviewee (Farming & Farm Management; Plural Answer)

Necessary Activities	Degree of Necessity of Activity												Total Score	Rating
	Most Required Score: 4			2nd Most Required Score: 3			3rd Most Required Score: 2			4th Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score		
Improvement of farming practices	16	40	64	2	2	6	1	3	2	2	2	2	74	2
Use of quality seed (local variety)	4	10	16	2	2	6	6	15	12	2	2	2	36	6
Use of quality seed (high yielding variety)	7	18	28	11	11	33	2	5	4	4	4	4	69	3
Use of adequate doses of fertilizer	7	18	28	13	13	39	8	20	16	2	2	2	85	1
Improved leveling of paddy field	3	8	12	5	5	15	5	13	10	7	7	7	44	5
Planting at proper time	2	5	8	5	5	15	8	20	16	6	6	6	45	4
Intensive weeding	0	0	0	2	2	6	7	18	14	11	11	11	31	7
Formation/strengthening of farmers organization	1	3	4	0	0	0	3	8	6	6	6	6	16	8
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Total	40	100	160	40	40	120	40	100	80	40	40	40	400	

Note: Question XI-6 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-111 Necessary Physical Works to Improve Rice Productivity in the Field of the Interviewee

Necessary Physical Works	Degree of Necessity of Activity									Total Score	Rating
	Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Irrigation water supply for wet season	28	70	84	13	33	26	1	3	1	111	1
Irrigation water supply for dry season	12	30	36	25	63	50	1	3	1	87	2
Mitigation of inundation/flooding	0	0	0	0	0	0	2	5	2	2	4
Drainage improvement	0	0	0	2	5	4	36	90	36	40	3
Others	0	0	0	0	0	0	0	0	0	0	
Total	40	100	120	40	100	80	40	100	40	240	

Note: Question XI-7 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-112 Livestock Constraints

Livestock Constraints	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Low productivity	8	20	24	2	5	4	5	13	5	33	2
Shortage of feed	4	10	12	8	20	16	1	3	1	29	5
Low or unstable market prices	4	10	12	7	18	14	4	10	4	30	3
Market availability	1	3	3	2	5	4	5	13	5	12	7
Losses due to diseases	18	45	54	6	15	12	7	18	7	73	1
Insufficient veterinary services	4	10	12	7	18	14	4	10	4	30	3
Insufficient extension services	0	0	0	7	18	14	13	33	13	27	6
Difficulty in obtaining good breed	1	3	3	1	3	2	1	3	1	6	8
Others	0	0	0	0	0	0	0	0	0	0	9
Total	40	100	120	40	100	80	40	100	40	240	

Note: Question XII in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-113 Cropping pattern, If Water is Available in Dry Season

	n	%
Early Rice (Wet) + Early Rice (Wet)	7	18
Early Rice (Wet) + Medium Rice (Wet)	3	8
Upland crops (Dry) + Medium Rice (Wet)	7	18
Upland crops (Dry) + Early rice (Wet)	12	30
Early rice (Wet) + Early (Wet) + Upland Crops	2	5
Medium rice (Wet) only	9	23
Total	40	100

Note: Question XV-1 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-114 Farming (Agronomic & Farm Management)

Expectations for Improvement	Degree of Expectation									Total Score	Rating
	Most Expected Score: 3			2nd Most Expected Score: 2			3rd Most Expected Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Productivity improvement of wet season rice	24	60	72	12	30	24	0	0	0	96	1
Productivity improvement of dry season rice	11	28	33	20	50	40	3	8	3	76	2
Productivity improvement of field crops	0	0	0	2	5	4	10	25	10	14	4
Productivity improvement of vegetables	0	0	0	0	0	0	9	23	9	9	6
Productivity improvement of livestock/poultry	1	3	3	2	5	4	7	18	7	14	4
Increasing livestock holding size & production	3	8	9	3	8	6	2	5	2	17	3
Increasing poultry holding size & production	0	0	0	1	3	2	5	13	5	7	7
Strengthening/formation of farmers organizations	0	0	0	0	0	0	4	10	4	4	8
Improvement of post-harvest operation	1	3	3	0	0	0	0	0	0	3	9
Others	0	0	0	0	0	0	0	0	0	0	10
Total	40	100	120	40	100	80	40	100	40	240	

Note: Question XV-2 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-115 Requirement of Improvement in Water Issue

Farming (physical)	Degree of Expectation									Total Score	Rating
	Primarily Expected Score: 3			Secondary Expected Score: 2			Thirdly Expected Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Adequate(volume/timing) irrigation water supply in wet season	22	55	66	18	45	36	1	3	1	103	1
Adequate(volume/timing) irrigation water supply in dry season	16	40	48	22	55	44	0	0	0	92	2
Mitigation of inundation & flooding	0	0	0	0	0	0	2	5	2	2	6
Construction/rehabilitation of farm road	1	3	3	0	0	0	13	33	13	16	4
Construction/rehabilitation of farm to market road	0	0	0	0	0	0	3	8	3	3	5
Drainage improvement	1	3	3	0	0	0	19	48	19	22	3
Leveling of paddy field	0	0	0	0	0	0	2	5	2	2	6
Total	40	100	120	40	100	80	40	100	40	240	

Note: Question XV-3 in the questionnaire

Source: Socio-economic survey, 2011

Table AC-A2-116 Requirement on Agricultural Support Services

Agricultural Support Required	Degree of Necessity of Support									Total Score	Rating
	Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Field Extension services (demonstration / field guidance)	26	65	78	3	8	6	2	5	2	86	1
Provision of quality seed	2	5	6	18	45	36	7	18	7	49	3
Farmer training (technical & host-harvest operation)	9	23	27	13	33	26	8	20	8	61	2
Farmer training (organization, marketing, farm management)	2	5	6	2	5	4	3	8	3	13	4
Support to organize farmers	0	0	0	1	3	2	7	18	7	9	5
Provision of market information	1	3	3	0	0	0	3	8	3	6	8
Provision of farm credit	0	0	0	2	5	4	4	10	4	8	6
Provision of fertilizer	0	0	0	1	3	2	6	15	6	8	6
Others (specify)	0	0	0	0	0	0	0	0	0	0	9
Total	40	100	120	40	100	120	40	100	120	360	

Note: Question XV-4 in the questionnaire

Source: Socio-economic survey, 2011

ANNEX C

Attachment 3

Results of Socio-economic Survey for

Kandal Stung – Bati Irrigation System

Rehabilitation Sub-project

ANNEX C
ATTACHMENT 3

Socio-economic Survey
for
Kandal Stung – Bati Irrigation System Rehabilitation Sub-project

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Table AC-A3-1 Average of Family Member per Household

	Kandal Stung	Bati
N	20	20
Average HH size	5.45	5.75

Source: Socio-economic survey, January 2012

Table AC-A3-2 Number of Working-Age Members

	Kandal Stung	Bati
N	20	20
Average	3.70	3.70

Source: Socio-economic survey, January 2012

Table AC-A3-3 Main Income Sources of Heads of Sampled Households

	Kandal Stung		Bati	
	n	%	n	%
Farmer	20	100	18	90
Non-farm labor	0	0	0	0
Salary worker	0	0	0	0
Private business	0	0	2	10
Others	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-4 Male-Female Balance of the Sampled Households

	Kandal Stung		Bati	
	n	%	n	%
Male	52	48	60	52
Female	57	52	55	48
Total	109	100	115	100

Source: Socio-economic survey, January 2012

Table AC-A3-5 Age Compositions of Sampled Households Members

	Kandal Stung				Bati			
	n	%	Male	Female	n	%	Male	Female
0 - 14 years	32	29	17	15	32	28	15	17
15 - 24	22	20	10	12	27	23	15	12
25 - 34	18	17	6	12	16	14	8	8
35 - 44	14	13	10	4	10	9	6	4
45 - 54	11	10	4	7	12	10	5	7
55 - 64	9	8	4	5	9	8	5	4
65 years and over	3	3	1	2	9	8	6	3
Total	109	100	52	57	115	100	60	55

Source: Socio-economic survey, January 2012

Table AC-A3-6 Education Levels of Sampled Households Members

	Kandal Stung		Bati	
	n	%	n	%
No formal education	2	2	3	3
Not going to school	9	8	9	8
Before school age	0	0	1	1
Non-formal education for adults	0	0	0	0
Non education for adults	5	5	6	5
Drop-out at primary school	14	13	11	10
Graduate from primary school	10	9	10	9
Drop-out at junior high school	15	14	24	21
Graduate from junior high school	12	11	11	10
Drop-out at high school	10	9	6	5
Graduate from high school	3	3	2	2
More than high school	0	0	2	2
Presently going to school	29	27	30	26
Total	109	100	115	100

Source: Socio-economic survey, January 2012

Table AC-A3-7 Main Occupations of Sampled Households Members

	Kandal Stung		Bati	
	n	%	n	%
Farmer	48	44	42	37
On-farm labor	0	0	0	0
Non-farm labor	5	5	0	0
Salary worker	13	12	21	18
Private business	3	3	6	5
Housekeeping (cooking, washing, child care, etc.)	0	0	4	3
No job	0	0	1	1
Student	31	28	34	30
Child (below school age)	9	8	7	6
Others	0	0	0	0
Total	109	100	115	100

Source: Socio-economic survey, January 2012

Table AC-A3-8 Literacy Rate in Sampled Households Members

	Kandal Stung		Bati	
	n	%	n	%
Unable to write, read, and calculate for making living	32	29	33	29
Able to write, read, and calculate for making living	77	71	82	71
Total	109	100	115	100

Source: Socio-economic survey, January 2012

Table AC-A3-9 Village-level Organizations for Husbands

	Kandal Stung		Bati	
	n	%	n	%
Farmer's water users' community	0	0	1	5
Credit group by government	0	0	1	5
Micro-credit group by NGO	5	25	1	5
Production group	0	0	0	0
Religion group	0	0	1	5
Drinking water users' group	7	35	1	5
Youth group	0	0	0	0
Veteran group	2	10	0	0
Women's group	0	0	0	0
Others	3	15	2	10
Non member	3	15	13	65
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-10 Village-level Organizations for Wives

	Kandal Stung		Bati	
	n	%	n	%
Farmer's water users' community	0	0	1	5
Credit group by government	0	0	1	5
Micro-credit group by NGO	4	20	1	5
Production group	0	0	0	0
Religion group	1	5	1	5
Drinking water users' group	4	20	1	5
Women's group	0	0	1	5
Others	3	15	2	10
Non member	8	40	12	60
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-11 Main Sources of Drinking Water

Item	Dry Season				Rainy Season			
	Kandal Stung		Bati		Kandal Stung		Bati	
	n	%	n	%	n	%	n	%
Tube pile well	9	45	8	40	6	30	6	30
Dug well	10	50	1	5	8	40	1	5
Reservoir/ Pond	1	5	9	45	0	0	3	15
Spring/ River	0	0	0	0	0	0	0	0
Bought	0	0	1	5	0	0	0	0
Rain	0	0	1	5	6	30	10	50
Piped water	0	0	0	0	0	0	0	0
Total	20	100	20	100	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-12 Location of Drinking Water

Item	Dry Season				Rainy Season			
	Kandal Stung		Bati		Kandal Stung		Bati	
	n	%	n	%	n	%	n	%
Within the premises	9	45	6	30	13	65	11	55
Near the premises	8	40	11	55	5	25	7	35
Away from the premises	3	15	3	15	2	10	2	10
Total	20	100	20	100	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-13 Availability of Drinking Water

Item	Dry Season				Rainy Season			
	Kandal Stung		Bati		Kandal Stung		Bati	
	n	%	n	%	n	%	n	%
Easy to obtain	12	60	11	55	17	85	17	85
Difficult to obtain	7	35	8	40	3	15	3	15
Very difficult to obtain	1	5	1	5	0	0	0	0
Total	20	100	20	100	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-14 Sources of Fuel for Cooking

	Kandal Stung		Bati	
	n	%	n	%
Firewood	20	100	20	100
Charcoal	0	0	0	0
Gas cylinder (LPG)	0	0	0	0
Electricity	0	0	0	0
Other	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-15 Availability of Fuel for Cooking

	Kandal Stung		Bati	
	n	%	n	%
Easy to obtain	13	65	6	30
Difficult to obtain	7	35	13	65
Very difficult to obtain	0	0	1	5
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-16 Sources of Lighting

	Kandal Stung		Bati	
	n	%	n	%
City power	19	95	19	95
Generator	0	0	0	0
Kerosene	1	5	0	0
Candle	0	0	0	0
Battery	0	0	1	5
Other	0	0	0	0
Total	20	100	20	100

Note: Charge of city power: 1,200 Riel per KWh

Source: Socio-economic survey, January 2012

Table AC-A3-17 Availability of Lighting Source

	Kandal Stung		Bati	
	n	%	n	%
Easy to obtain	17	85	17	85
Difficult to obtain	3	15	3	15
Very difficult to obtain	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-18 Assets of Sampled Family

	Kandal Stung			Bati		
	Qty.	n	Per HH	Qty.	n	Per HH
Radio	6	6	0.30	10	10	0.50
TV	19	18	0.95	21	20	1.05
Bicycle	24	17	1.20	29	19	1.45
Motorcycle	20	17	1.00	19	16	0.95
Car	0	0	0.00	0	0	0.00
Car battery	6	6	0.30	4	3	0.20
Tractor	0	0	0.00	0	0	0.00
Hand tractor	0	0	0.00	2	2	0.10
Mosquito net	60	19	3.00	63	20	3.15
Cellular phone	37	19	1.85	25	19	1.25
Telephone	3	3	0.15	4	4	0.20
Water pump	10	9	0.50	13	13	0.65
Tape recorder	8	8	0.40	5	5	0.25

Note: Total Number of Interviewed Household is 20HH for Kandal Stung and 20HH for Bati

Source: Socio-economic survey, January 2012

Table AC-A3-19 Ownership of Residence

	Owned (already paid)		Owned (under payment)		Lent		Borrowed	
	n	%	n	%	n	%	n	%
Ownership (Kandal Stung)	20	100	-	-	-	-	-	-
Ownership (Bati)	20	100	-	-	-	-	-	-

Source: Socio-economic survey, January 2012

Table AC-A3-20 Material of Residence

	Cement and Bricks		Palm leaves		Timber		Others	
	n	%	n	%	n	%	n	%
Material (Kandal Stung)	2	10	3	15	10	50	5	25
Material (Bati)	2	10	1	5	11	55	6	30

Note: Kandal Stung area: Timber house with tile roofing =35%, Timber house with metal/zinc roofing =15%, Palm leaves metal/zinc roofing=15%;

*: **Bati area:** Timber house with tile roofing =30%, Timber house with metal/zinc roofing =20%*

Source: Socio-economic survey, January 2012

Table AC-A3-21 Type of House

	Traditional		One-storied		Two-storied		Others	
	n	%	n	%	n	%	n	%
Type of House (Kandal Stung)	6	30	7	35	-	-	7	35
Type of House (Bati)	9	45	5	25	-	-	6	30

Note: Other means that Cement/bricks on the ground & Wooden on the cement/bricks

Source: Socio-economic survey, January 2012

Table AC-A3-22 Number of Rooms

	1		2		3 and over		No rooms		Average	
	n	%	n	%	n	%	n	%	n	%
No. of rooms (Kandal Stung)	12	60	8	40	-	-			10	50
No. of rooms (Bati)	12	60	7	35	1	5			7	33

Source: Socio-economic survey, January 2012

Table AC-A3-23 Toilet Availability

	Household with toilet		Household without toilet	
	n	%	n	%
Toilet availability (Kandal Stung)	10	50	10	50
Toilet availability (Bati)	18	90	2	10

Source: Socio-economic survey, January 2012

Table AC-A3-24 Toilet Facility

	Connected to sewerage		Septic tank		Pit latrine		Others*	
	n	%	n	%	n	%	n	%
Toilet facility (Kandal Stung)	-	-	10	50	-	-	10	50
Toilet facility (Bati)	-	-	18	90	-	-	2	10

*Note: * Other means that 15% go to forest and field near house while the remain they use relative's toilet and some of them they bury for Kandal Stung.*

*Note: * Other means that use son and daughter's toilet **for Bati**.*

Source: Socio-economic survey, January 2012

Table AC-A3-25 Medical Service Facility

	Kandal Stung		Bati	
	n	%	n	%
Hospital	-	-	4	20
Clinic	6	30	-	-
Health center	14	70	16	80
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-26 Transportation Means to Medical Facility

	Kandal Stung		Bati	
	n	%	n	%
By Walk	1	5	-	-
By Taxi	-	-	-	-
By Owned motor bike	17	85	17	85
By Bicycle	-	-	2	10
Others	2	10	1	5
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-27 Main Activities of Female and Male

	Kandal Stung				Bati			
	Male		Female		Male		Female	
	n	%	n	%	n	%	n	%
Housekeeping	0	0	0	0	0	0	0	0
Cooking	0	0	0	0	0	0	0	0
Farming	20	100	20	100	20	100	20	100
Handy crafting	0	0	0	0	0	0	0	0
Care of children/ elders	0	0	0	0	0	0	0	0
Care of livestock	0	0	0	0	0	0	0	0
Marking Palm sugar	0	0	0	0	0	0	0	0
Others(spec)	0	0	0	0	0	0	0	0
Total	20	100	20	100	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-28 Most Important Income Sources of Female and Male

	Kandal Stung				Bati			
	Male		Female		Male		Female	
	n	%	n	%	n	%	n	%
Selling paddy	20	100	20	100	20	100	20	100
Working for other's field	0	0	0	0	0	0	0	0
Selling palm sugar	0	0	0	0	0	0	0	0
Selling handy craft	0	0	0	0	0	0	0	0
Working for a weaving factory	0	0	0	0	0	0	0	0
Working for bricks factory	0	0	0	0	0	0	0	0
Selling straw mat	0	0	0	0	0	0	0	0
Selling cotton/ silk	0	0	0	0	0	0	0	0
Other(spec)	0	0	0	0	0	0	0	0
Total	20	100	20	100	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-29 Number of Income Sources per Household

Kandal Stung										
No. of Income Sources	1	2	3	4	5	6	7	8	9	Total
No. of HH	0	1	7	10	2	0	0	0	0	20
Bati										
No. of Income Sources	1	2	3	4	5	6	7	8	9	Total
No. of HH	1	3	7	4	4	1	0	0	0	20

Source: Socio-economic survey, January 2012

Table AC-A3-30 Households Earning only Agricultural and Non-Agricultural Incomes

	Kandal Stung	**Bati**
Agricultural Income Only	0	2
Non-Agriculture Income Only	3	0

Note1 : On-farm labor is classified in non-agricultural income

Note2: Selling forest vegetable/ crop is classified in non-agricultural income

Source: Socio-economic survey, January 2012

Table AC-A3-31 Proportion of Incomes by Different Sources

	Kandal Stung	**Bati**
1. Selling paddy/rice	14.4	30.5
2. Selling vegetables (red pepper/ tobacco/ water melon/ others)	0.7	-
3. Selling fruits (mango/ papaya, banana/ hairy fruit/ orange/ others)	0.1	0.8
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
16. Total	100.0	100.0

Source: Socio-economic survey, January 2012

Table AC-A3-32 Income Structure against Income Strata (Riel)

INCOME STRATA	AVERAGE HH INCOME	INCOME STRUCTURE ('000 Riel)														
		AGRICULTURAL INCOME						NON-AGRICULTURAL INCOME								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Selling paddy/rice	Selling vegetables	Selling fruits	Selling palm sugar	Selling livestock/ poultry products	Selling fishes	Salary from permanent job	Wage from temporary on-farm job	Wage from temporary off-farm job	Private business	Remittance from family members	Selling firewood/charcoal	Selling handicraft/ cottage industry products	Selling forest vegetable/ crop	Others
Kandal Stung																
1	16,870	3,620	0	0	0	0	0	0	0	4,200	3,650	0	0	0	0	5,400
2	13,460	1,840	0	0	0	0	0	720	0	0	6,600	0	0	4,300	0	0
3	13,300	5,500	0	0	0	600	0	4,800	0	2,400	0	0	0	0	0	0
4	13,045	600	0	0	0	0	0	0	0	0	2,845	9,600	0	0	0	0
5	10,330	3,150	500	200	0	0	0	2,880	0	3,600	0	0	0	0	0	0
6	10,260	0	0	0	0	4,000	0	4,800	0	960	0	500	0	0	0	0
7	9,610	550	60	0	0	0	0	0	0	2,000	7,000	0	0	0	0	0
8	9,506	900	0	0	0	156	0	0	0	0	3,650	4,800	0	0	0	0
9	9,200	600	600	0	0	0	0	4,800	0	0	1,200	0	0	0	0	2,000
10	8,725	525	0	0	0	3,000	0	0	0	5,200	0	0	0	0	0	0
11	8,200	0	0	0	0	120	0	7,200	0	400	0	0	0	0	0	480
12	7,050	600	0	0	0	0	50	0	0	1,000	5,400	0	0	0	0	0
13	6,955	0	0	0	0	0	0	0	0	1,400	2,555	3,000	0	0	0	0
14	6,300	0	0	0	0	0	0	0	3,240	1,560	0	1,500	0	0	0	0
15	6,200	0	0	0	0	0	0	5,000	0	0	0	0	0	1,200	0	0
16	5,692	2,612	0	0	0	200	0	2,880	0	0	0	0	0	0	0	0
17	5,045	3,325	0	0	0	0	0	720	0	0	0	1,000	0	0	0	0
18	4,900	500	0	0	0	400	0	0	0	1,000	0	0	0	0	0	3,000
19	4,350	0	0	30	0	0	0	2,880	0	0	0	1,440	0	0	0	0
20	3,325	525	0	0	0	1,000	0	0	600	1,200	0	0	0	0	0	0
Average in total	**8,616**	**1,242**	**58**	**12**	**0**	**474**	**3**	**1,834**	**192**	**1,246**	**1,645**	**1,092**	**0**	**275**	**0**	**544**
1st	**11,431**	**1,729**	**116**	**20**	**0**	**776**	**0**	**1,800**	**0**	**1,836**	**2,495**	**1,490**	**0**	**430**	**0**	**740**
2nd	**5,802**	**756**	**0**	**3**	**0**	**172**	**5**	**1,868**	**384**	**656**	**796**	**694**	**0**	**120**	**0**	**348**
Bati																
1	15,920	400	0	0	0	4,000	0	11,520	0	0	0	0	0	0	0	0
2	12,970	4,950	0	0	0	7,000	720	0	0	0	0	100	0	0	0	200
3	12,158	7,558	0	0	0	4,600	0	0	0	0	0	0	0	0	0	0
4	12,140	1,800	0	0	0	80	0	0	0	0	4,500	5,760	0	0	0	0
5	11,200	1,200	0	0	0	6,000	0	0	0	0	0	0	0	4,000	0	0
6	10,915	780	0	0	0	775	0	4,000	0	2,360	3,000	0	0	0	0	0
7	9,960	4,200	0	0	0	0	0	5,760	0	0	0	0	0	0	0	0
8	9,125	1,500	0	0	0	2,150	0	125	0	1,200	0	2,150	0	0	0	2,000
9	9,030	1,450	0	0	0	1,500	0	2,880	0	0	2,000	1,200	0	0	0	0
10	8,350	3,900	0	0	0	0	0	800	0	0	0	3,650	0	0	0	0
11	8,200	1,800	0	0	0	4,000	0	0	0	0	0	2,400	0	0	0	0
12	7,850	6,000	0	600	0	0	0	0	0	0	1,250	0	0	0	0	0
13	7,300	2,450	0	0	0	2,500	0	0	0	0	2,350	0	0	0	0	0
14	6,900	900	0	0	0	0	0	0	400	800	0	4,800	0	0	0	0
15	6,750	4,950	0	0	0	0	0	0	0	0	1,800	0	0	0	0	0
16	6,620	2,320	0	0	0	120	0	0	0	1,680	0	0	0	0	0	2,500
17	6,110	2,000	0	750	0	0	0	3,360	0	0	0	0	0	0	0	0
18	5,990	330	0	0	0	60	0	4,800	0	500	300	0	0	0	0	0
19	5,000	5,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	4,774	994	0	0	0	600	300	2,880	0	0	0	0	0	0	0	0
Average in total	**8,863**	**2,724**	**0**	**68**	**0**	**1,669**	**51**	**1,806**	**20**	**327**	**760**	**1,003**	**0**	**200**	**0**	**235**
1st	**11,327**	**2,774**	**0**	**0**	**0**	**2,611**	**72**	**2,508**	**0**	**356**	**950**	**1,436**	**0**	**400**	**0**	**220**
2nd	**6,549**	**2,674**	**0**	**135**	**0**	**728**	**30**	**1,104**	**40**	**298**	**570**	**720**	**0**	**0**	**0**	**250**

Source: Socio-economic survey, January 2012

Table AC-A3-33 Income Structure against Income Strata (%)

INCOME STRATA	AVERAGE HH INCOME	INCOME STRUCTURE (%)															
		AGRICULTURAL INCOME						NON-AGRICULTURAL INCOME									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Selling paddy/rice	Selling vegetables	Selling fruits	Selling palm sugar	Selling livestock/ poultry products	Selling fishes	Salary from permanent job	Wage from temporary on-farm job	Wage from temporary off-farm job	Private business	Remittance from family members	Selling firewood/charcoal	Selling handicraft/ cottage industry products	Selling forest vegetable/ crop	Others	Total
Kandal Stung																	
1st	11,431	15.12	1.01	0.17	0.00	6.79	0.00	15.75	0.00	16.06	21.82	13.04	0.00	3.76	0.00	6.47	100.0
2nd	5,802	13.03	0.00	0.05	0.00	2.96	0.09	32.20	6.62	11.31	13.71	11.96	0.00	2.07	0.00	6.00	100.0
Bati																	
1st	11,327	24.82	0.00	0.00	0.00	23.36	0.64	22.44	0.00	3.19	8.50	12.85	0.00	3.58	0.00	1.97	101.3
2nd	6,549	40.83	0.00	2.06	0.00	11.12	0.46	16.86	0.61	4.55	8.70	10.99	0.00	0.00	0.00	3.82	100.0

Source: Socio-economic survey, January 2012

Table AC-A3-34 Expenditure Structure against Income Strata ('000 Riel)

Income Strata	Avearge HH Income	EXPENDITURE ('000 Riel) 1 Rice	2 Other foods	3 Health/ medicine	4 Education	5 Clothes	6 Firewood/ Kerosene/ Electricity	7 Transport	8 Tax	9 Others	10 Total
Kandal Stung											
1	16,870	0	3,600	200	2,640	400	3,000	1,825	5	700	12,370
2	13,460	280	3,285	2,200	1,825	160	554	3,750	6	1,000	13,060
3	13,300	0	3,600	800	3,600	800	144	1,800	5	1,200	11,949
4	13,045	0	3,650	700	2,400	1,000	240	2,738	9	2,000	12,737
5	10,330	0	2,920	300	1,800	100	110	3,650	5	1,000	9,884
6	10,260	0	1,825	250	365	360	420	3,720	10	3,200	10,150
7	9,610	0	2,920	400	600	800	1,095	1,825	5	600	8,245
8	9,506	0	3,650	360	204	1,000	372	1,862	5	960	8,412
9	9,200	0	3,650	1,000	800	750	360	1,825	5	600	8,990
10	8,725	360	3,600	100	0	800	461	2,448	5	800	8,573
11	8,200	0	1,825	600	3,285	360	300	240	0	1,440	8,050
12	7,050	0	1,800	500	480	150	144	900	5	300	4,279
13	6,955	0	2,665	700	800	750	360	1,000	5	400	6,679
14	6,300	900	1,095	1,200	0	0	626	900	0	715	5,436
15	6,200	0	1,825	650	500	750	900	360	5	400	5,390
16	5,692	0	2,555	100	0	200	84	365	5	240	3,549
17	5,045	0	1,278	120	0	400	288	1,825	20	170	4,101
18	4,900	0	2,160	40	1,200	100	192	900	5	200	4,797
19	4,350	420	1,825	100	0	100	1,022	120	0	600	4,187
20	3,325	90	840	150	120	120	42	300	5	700	2,367
Average	**8,616**	**103**	**2,528**	**524**	**1,031**	**455**	**536**	**1,618**	**5**	**861**	**7,660**
1st	**11,431**	**64**	**3,270**	**631**	**1,423**	**617**	**676**	**2,544**	**6**	**1,206**	**10,437**
2nd	**5,802**	**141**	**1,787**	**416**	**639**	**293**	**396**	**691**	**5**	**517**	**4,883**
Bati											
1	15,920	0	5,400	4,000	2,160	400	288	3,000	5	300	15,553
2	12,970	0	2,555	100	400	120	336	913	5	1,500	5,928
3	12,158	0	3,650	500	548	60	230	10	0	230	5,228
4	12,140	0	3,650	1,200	1,095	1,680	240	2,519	10	1,290	11,684
5	11,200	0	3,650	450	500	600	400	900	5	750	7,255
6	10,915	0	3,650	800	650	2,160	500	950	5	850	9,565
7	9,960	0	3,600	50	960	200	180	2,700	5	1,500	9,195
8	9,125	0	3,650	300	2,600	120	528	480	0	600	8,278
9	9,030	243	1,825	1,500	1,095	160	628	1,750	5	600	7,806
10	8,350	0	4,380	240	730	600	540	949	6	340	7,785
11	8,200	260	1,890	400	240	200	180	360	5	500	4,035
12	7,850	0	2,555	200	548	400	180	1,825	5	1,000	6,713
13	7,300	0	1,500	700	470	700	450	800	5	340	4,965
14	6,900	324	2,700	400	480	1,000	180	0	0	1,500	6,584
15	6,750	0	3,000	400	1,825	50	132	500	6	100	6,013
16	6,620	230	3,000	120	1,460	200	144	840	3	840	6,837
17	6,110	0	3,600	150	720	600	360	100	0	500	6,030
18	5,990	0	2,880	120	0	150	180	1,380	5	300	5,015
19	5,000	0	950	600	470	500	400	900	9	200	4,029
20	4,774	0	1,460	360	300	50	200	900	6	600	3,876
Average	**8,863**	**53**	**2,977**	**630**	**863**	**498**	**314**	**1,089**	**4**	**692**	**7,118**
1st	**11,327**	**24**	**3,601**	**914**	**1,074**	**610**	**387**	**1,417**	**4**	**796**	**8,827**
2nd	**6,549**	**81**	**2,354**	**345**	**651**	**385**	**241**	**760**	**4**	**588**	**5,409**

Source: Socio-economic survey, January 2012

Table AC-A3-35 Expenditure Structure against Income Strata (%)

Income Strata	Avearge HH Income	EXPENDITURE (%) 1 Rice	2 Other foods	3 Health/ medicine	4 Education	5 Clothes	6 Firewood/ Kerosene/ Electricity	7 Transport	8 Tax	9 Others	10 Total
Kandal Stung											
1st	**11,431**	**0.61**	**31.33**	**6.05**	**13.64**	**5.91**	**6.47**	**24.38**	**0.05**	**11.56**	**100.00**
2nd	**5,802**	**2.89**	**36.59**	**8.52**	**13.08**	**6.00**	**8.11**	**14.15**	**0.10**	**10.58**	**100.00**
Bati											
1st	**11,327**	**0.28**	**40.79**	**10.35**	**12.16**	**6.91**	**4.38**	**16.05**	**0.05**	**9.02**	**100.00**
2nd	**6,549**	**1.50**	**43.51**	**6.38**	**12.04**	**7.12**	**4.45**	**14.06**	**0.08**	**10.87**	**100.00**

Table AC-A3-36 Per Capita Income and Expenditure

INCOME STRATA	AVERAGE HH INCOME	AVERAGE HH EXPENDITURE	Average HH Pop. (No.)	Per Capita Daily Income (US$)	Per Capita Daily Expenditure (US$)
Kandal Stung					
1st	2,858	2,609	6.40	1.24	1.13
2nd	1,450	1,221	4.50	0.90	0.75
Bati					
1st	2,832	2,207	5.60	1.40	1.09
2nd	1,637	1,352	5.90	0.77	0.64

Source: Socio-economic survey, January 2012

Table AC-A3-37 Investment in Livestock

	Kandal Stung					Bati				
	Chicken	Ducks	Cattle	Buffalo	Pig	Chicken	Ducks	Cattle	Buffalo	Pig
N	6	3	3	0	0	4	0	7	0	1
Average*	6	8	3	0	0	18	0	2	0	8
Median	3	5	3	0	0	10	0	2	0	8
Minimum	2	3	2	0	0	10	0	1	0	8
Maximum	20	15	5	0	0	40	0	2	0	8

*Note: * Average per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-38 Investment in House, Private Business and Land

	Kandal Stung			Bati		
	House	Private Business	Land	House	Private Business	Land
N	1	2	1	1	2	0
Average*	6,400,000	2,050,000	14,640,000	1,500,000	5,950,000	0
Median	6,400,000	2,050,000	14,640,000	1,500,000	5,950,000	0
Minimum	6,400,000	1,500,000	14,640,000	1,500,000	1,500,000	0
Maximum	6,400,000	2,600,000	14,640,000	1,500,000	10,400,000	0

*Note: * Average per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-39 Saving in any Forms

	Kandal Stung		Bati	
	n	%	n	%
Money in bank	0	0	0	0
Land	1	5	0	0
Livestock	0	0	0	0
Cash	1	5	1	5
Others	1	5	2	10
No saving	17	85	17	85
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Note: Kandal Stung-Others means saving money by playing tongtine. Also, for Bati-Others means saving money by playing tongtine

Table AC-A3-40 Saving Amount and Interest Rate

	Kandal Stung		Bati	
	Amount (Riel)	Interest Rate (%)/y	Amount (Riel)	Interest Rate (%)/y
N	3	1	3	1
Median	12,000,000	36	2,000,000	120
Average*	10,213,333	36	2,400,000	120
Minimum	4,000,000	36	1,000,000	120
Maximum	14,640,000	36	4,200,000	120

*Note: * Average per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-41 Purpose for Savings

	Kandal Stung		Bati	
	n	%	n	%
For safety	1	5	0	-
Saving for future expenditure	0	0	2	10
Saving for emergency needs	2	10	1	5
No savings	17	85	17	85
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-42 Source of Loans / Debts

	Kandal Stung		Bati	
	n	%	n	%
Friend/Relatives	3	15	3	15
Trader	0	0	0	0
NGO	2	10	1	5
Commercial bank	10	50	7	35
Others	0	0	1	5
No debt	5	25	8	40
	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-43 Purpose for Loans / Debts

	Kandal Stung		Bati	
	n	%	n	%
Seeds/fertilizers/agro-chemicals	4	20	3	15
Farm equipment/tools	0	0	0	0
Animals	1	5	2	10
Food	0	0	0	0
Assets	4	20	0	0
Land	1	5	1	5
Children's education	0	0	0	0
Debt repayment	1	5	0	0
Ceremonial occasions	0	0	0	0
Business	1	5	2	10
Building/repair of house	0	0	1	5
Others	3	15	3	15
No loans/debts	5	25	8	40
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-44 Collateral for Loans / Debts

	Kandal Stung		Bati	
	n	%	n	%
Nothing	3	15	1	5
Land	8	40	8	40
Others	4	20	3	15
Not borrow	5	25	8	40
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-45 Loans and Debts

	Kandal Stung			Bati		
	Amount (Riel)	Interest rate %/y	Amount Repaid (Riel)	Amount (Riel)	Interest rate %/y	Amount Repaid (Riel)
N	15	13	12	12	10	7
Median	2,000,000	36	1,175,000	2,200,000	34	960,000
Average*	3,673,333	46	1,269,000	2,600,000	33	1,933,000
Minimum	400,000	30	108,000	200,000	22	267,000
Maximum	12,000,000	120	4,000,000	6,000,000	42	4,104,000

*Note: * Average per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-46 Livestock: Number of Adult

	Kandal Stung						Bati					
	Respondent		number of adult				Respondent		number of adult			
	n	%	Average*	Median	Minimum	Maximum	n	%	Average*	Median	Minimum	Maximum
Cows / Oxen	12	60	4	2	1	20	20	100	2	2	1	3
Water buffalo	0	0	0	0	0	0	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0	0	0	0	0	0	0
Swine	0	0	0	0	0	0	2	10	2	2	1	3
Chicken	17	85	5	4	1	15	11	55	4	4	1	5
Duck	4	20	5	5	4	5	5	25	6	6	1	8

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-47 Livestock: Number of Young

	Kandal Stung						Bati					
	Respondent		number of young				Respondent		number of young			
	n	%	Average*	Median	Minimum	Maximum	n	%	Average*	Median	Minimum	Maximum
Cows / Oxen	4	20	3	3	1	6	8	40	1	1	1	2
Water buffalo	0	0	0	0	0	0	0	0	0	0	0	0
Goat / Sheep	0	0	0	0	0	0	0	0	0	0	0	0
Swine	0	0	0	0	0	0	0	0	0	0	0	0
Chicken	8	40	9	9	1	20	10	50	11	9	5	30
Duck	3	15	11	12	5	15	1	5	7	7	7	7

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-48 Food Sufficiency in Rainy and Dry Seasons for Livestock Rearing

	Kandal Stung				Bati			
	Wet season		Dry season		Wet season		Dry season	
	n	%	n	%	n	%	n	%
1. Cows / Oxen								
Sufficient	6	30	4	20	9	45	6	30
Just enough	6	30	4	20	9	45	5	25
Short	0	0	3	15	2	10	9	45
Very short	0	0	1	5	0	0	0	0
Non	8	40	8	40	0	0	0	0
Total	20	100	20	100	20	100	20	100
2. Water buffalo								
Sufficient	0	0	0	0	0	0	0	0
Just enough	0	0	0	0	0	0	0	0
Short	0	0	0	0	0	0	0	0
Very short	0	0	0	0	0	0	0	0
Non	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0
3. Goat / Sheep								
Sufficient	0	0	0	0	0	0	0	0
Just enough	0	0	0	0	0	0	0	0
Short	0	0	0	0	0	0	0	0
Very short	0	0	0	0	0	0	0	0
Non	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0
4. Swine								
Sufficient	0	0	0	0	0	0	0	0
Just enough	0	0	0	0	1	5	1	5
Short	0	0	0	0	0	0	0	0
Very short	0	0	0	0	0	0	0	0
Non	0	0	0	0	19	95	19	95
Total	0	0	0	0	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-49 Fruit Trees Held by Farmers

	Kandal Stung						Bati					
	n	%	Average*	Median	Minimum	Maximum	n	%	Average*	Median	Minimum	Maximum
Sugar palm	8	40	4	4	2	10	8	40	3	3	1	4
Coconut palm	15	75	2	2	1	7	5	25	1	1	1	3
Mango	14	70	6	4	1	25	13	65	10	5	1	60
Jackfruit	9	45	2	2	1	6	6	30	2	2	1	3

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-50 Agricultural Land Holding

	Land Holding Land Owned (ha)								Land Holding Land Use (Land Operated/) (ha)							
	Paddy Field								Paddy Field							
Item	Irrigated paddy field	supplementary Irrigated paddy field	Irrigated field Total	Rainfed paddy field	Total 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	Upland for field crop	Upland for field crop	Total Farm Land
Kandal Stung																
Total	2.05	6.94	8.99	7.63	16.62	1.66	0.06	18.34	2.66	7.24	9.90	6.68	16.58	0.96	-	17.54
No. of Respondent	5	14	16	10	20	6	1	20	6	14	16	9	20	5	0	20
Per Respondent	0.41	0.50	0.56	0.76	0.83	0.28	0.06	0.92	0.44	0.52	0.62	0.74	0.83	0.19	-	0.88
Per Sample (20 samples)	0.10	0.35	0.45	0.38	0.83	0.08	0.00	0.92	0.13	0.36	0.50	0.33	0.83	0.05	-	0.88
Bati																
Total	8.89	8.49	17.38	3.54	20.92	0.40	-	21.32	9.49	12.59	22.08	4.04	26.12	0.40	-	26.52
No. of Respondent	10	11	18	6	19	2	0	19	10	13	20	6	20	2	0	20
Per Respondent	0.89	0.77	0.97	0.59	1.10	0.20	-	1.12	0.95	0.97	1.10	0.67	1.31	0.20	-	1.33
Per Sample (20 samples)	0.44	0.42	0.87	0.18	1.05	0.02	-	1.07	0.47	0.63	1.10	0.20	1.31	0.02	-	1.33

Source: Socio-economic survey, January 2012

Table AC-A3-51 Land Holding Status

	Kandal Stung		Bati	
	n	%	n	%
Owner cultivator	19	95.00	15	75.00
Owner cum sharecropper	1	5.00	4	20.00
Sharecropper	0	0.00	0	0.00
Owner cum tenant	0	0.00	1	5.00
Total	20	100.00	20	100.00

Source: Socio-economic survey, January 2012

Table AC-A3-52 Land Rental Charge

		Kandal Stung					Bati				
				Amount charge (riel/ha/season)					Amount charge (riel/ha/season)		
		n	%	Minimum	Maximum	Average*	n	%	Minimum	Maximum	Average*
In cash	Irrigated paddy field	4	20	900,000	1,600,000	1,075,000	0	0	0	0	0
	Rainfed paddy field	0	0	-	-	-	0	0	-	-	-
	Upland field	0	0	0	0	0	0	0	0	0	0
				% of harvest					% of harvest		
		n	%	Minimum	Maximum	Average*	n	%	Minimum	Maximum	Average*
In kind	Irrigated paddy field	4	20	30	50	35	3	15	30	50	40
	Rainfed paddy field	0	0	0	0	0	1	5	30	30	30
	Upland field	0	0	0	0	0	0	0	0	0	0
Free of charge		0	0	0	0	0	0	0	0	0	0
Others		0	0	0	0	0	0	0	0	0	0

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-53 Decision Maker for Crop Selection in Rented Land

	Irrigated paddy field		Rainfed paddy field		Upland field	
	n	%	n	%	n	%
Kandal Stung						
1. Land owner	0	0	0	0	0	0
2. Tenant	2	10	1	5	0	0
3. Both	1	5	0	0	0	0
4. Other	0	0	0	0	0	0
Bati						
1. Land owner	1	5	0	0	0	0
2. Tenant	6	30	1	5	0	0
3. Both	0	0	0	0	0	0
4. Other	0	0	0	0	0	0

Source: Socio-economic survey, January 2012

Table AC-A3-54 Land Use and Cropped Area, Cropping Intensity, Production, Unit Yield and Marketing Volume of Paddy

Item	Land Use (ha)								Cropped Area of Paddy (ha)					Cropping Intensity of Paddy (%)					Paddy Production (kg)				Paddy Yield (kg/ha)				Marketed Volume of Paddy (kg & %)				
	Paddy Field								Irrigated Paddy					Irrigated Field					Irrigated Paddy				Irrigated Paddy				Irrigated Paddy				
	Irrigated Field	Supplementary Irrigated Field	Irrigated Field Total	Rainfed Field	Total Paddy Field	Upland Field for Field Crop	Upland Field for Tree Crop	Total Farm Land	Wet Season	Dry season	Total	Rainfed Paddy	Total	Wet Season	Dry Season	Annual	Rainfed Field	Overall	Wet Season	Dry Season	Rainfed Paddy	Total Production	Wet Season	Dry Season	Average	Rainfed Paddy	Wet Season	Dry Season	Rainfed Paddy	Total	Proportion to Total Production
Kandal Stung																															
Total	2.66	7.24	9.90	6.68	16.58	0.96	-	17.54	10.41	1.45	11.86	7.87	19.73	105	15	120	118	119	27,420	4,582	16,646	48,648	2,634	3,160	2,698	2,115	11,390	3,600	7,500	22,490	46
No. of Respondent	6	14	16	9	20	5	0	20	16	6	16	10	20	16	16	16	10	20	16	6	10	20	16	6	16	10	11	5	5	14	14
Per Respondent	0.44	0.52	0.62	0.74	0.83	0.19	-	0.88	0.65	0.24	0.74	0.79	0.99						1,714	764	1,665	2,432					1,035	720	1,500	1,606	66
Per Sample (20 samples)	0.13	0.36	0.50	0.33	0.83	0.05	-	0.88	0.52	0.07	0.59	0.39	0.99	105	15	120	118	119	1,371	229	832	2,432					570	180	375	1,125	46
Bati																															
Total	9.49	12.59	22.08	4.04	26.12	0.40	-	26.52	24.57	2.63	27.20	4.04	31.24	111	12	123	100	120	63,406	6,040	10,200	79,646	2,581	2,297	2,553	2,525	38,885	5,380	4,100	48,365	61
No. of Respondent	10	13	20	6	20	2	0	20	19	5	20	6	20	20	20	20	6	20	19	5	6	20	19	5	20	6	19	5	4	20	20
Per Respondent	0.95	0.97	1.10	0.67	1.31	0.20	-	1.33	1.29	0.53	1.36	0.67	1.56						3,337	1,208	1,700	3,982					2,047	1,076	1,025	2,418	61
Per Sample (20 samples)	0.47	0.63	1.10	0.20	1.31	0.02	-	1.33	1.23	0.13	1.36	0.20	1.56	111	12	123	100	120	3,170	302	510	3,982					1,944	269	205	2,418	61

Source: Socio-economic survey, January 2012

Table AC-A3-55 No. of Livestock and Fish: for Selling in 2010

	Kandal Stung					Bati				
	n	%	Minimum	Maximum	Average*	n	%	Minimum	Maximum	Average*
Cows	2	10	1	2	2	6	30	1	1	1
Cattle	1	5	1	1	1	5	25	1	2	2
Water buffalo	0	0	0	0	0	0	0	0	0	0
Swine / Pig	0	0	0	0	0	1	5	4	4	4
Poultry	5	25	6	30	17	5	25	3	10	7
Egg	0	0	0	0	0	0	0	0	0	0
Fish	1	5	10	10	10	2	10	60	144	102

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-56 Selling Price of Livestock and Fish

	Kandal Stung					Bati				
	n	%	Minimum	Maximum	Average*	n	%	Minimum	Maximum	Average*
Cows	2	10	1,000,000	1,500,000	1,250,000	5	25	600,000	2,000,000	1,160,000
Cattle	1	5	4,000,000	4,000,000	4,000,000	5	25	1,500,000	4,000,000	2,800,000
Water buffalo	0	0	0	0	0	0	0	0	0	0
Swine / Pig	0	0	0	0	0	1	5	750,000	750,000	750,000
Poultry	5	25	10,000	20,000	14,400	5	25	10,000	15,000	13,400
Egg	0	0	0	0	0	0	0	0	0	0
Fish	1	5	5,000	5,000	5,000	2	10	5,000	5,000	5,000

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-57 Income from Livestock and Fish

	Kandal Stung					Bati				
	n	%	Minimum	Maximum	Average*	n	%	Minimum	Maximum	Average*
Cows	2	10	1,000,000	3,000,000	2,000,000	6	30	600,000	2,000,000	1,233,333
Cattle	1	5	4,000,000	4,000,000	4,000,000	5	25	1,500,000	7,000,000	4,500,000
Water buffalo	0	0	0	0	0	0	0	0	0	0
Swine / Pig	0	0	0	0	0	1	5	3,000,000	3,000,000	3,000,000
Poultry	5	25	120,000	600,000	295,200	5	25	60,000	150,000	97,000
Egg	0	0	0	0	0	0	0	0	0	0
Fish	1	5	50,000	50,000	50,000	2	10	300,000	720,000	510,000

Note: Average per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-58 Food Supply Condition for Rice

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Own harvest/ product exceed the household demand	9	45	14	70
Own harvest/ product is just enough to the household demand	6	30	2	10
Purchased (or exchanged) to meet the household demand	5	25	4	20
Insufficient	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-59 Food Supply Condition for Vegetables

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Own harvest/ product exceed the household demand	0	0	0	0
Own harvest/ product is just enough to the household demand	0	0	1	5
Purchased (or exchanged) to meet the household demand	7	35	5	25
Insufficient	13	65	14	70
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-60 Food Supply Condition (Other Cereals)

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Own harvest/ product exceed the household demand	0	0	0	0
Own harvest/ product is just enough to the household demand	0	0	0	0
Purchased (or exchanged) to meet the household demand	1	5	1	5
Insufficient	19	95	19	95
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-61 Food Supply Condition for Meat

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Own harvest/ product exceed the household demand	0	0	0	0
Own harvest/ product is just enough to the household demand	0	0	0	0
Purchased (or exchanged) to meet the household demand	7	35	8	40
Insufficient	13	65	12	60
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-62 Food Supply Condition for Roots and Tuber Crops

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Own harvest/ product exceed the household demand	1	5	0	0
Own harvest/ product is just enough to the household demand	0	0	0	0
Purchased (or exchanged) to meet the household demand	3	15	0	0
Insufficient	16	80	20	100
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-63 Food Supply Condition for Fish

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Own harvest/ product exceed the household demand	0	0	0	0
Own harvest/ product is just enough to the household demand	0	0	1	5
Purchased (or exchanged) to meet the household demand	3	15	5	25
Insufficient	17	85	14	70
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-64 Threshing (method)

Response	Kandal Stung		Bati	
	n	%	n	%
Engine thresher	8	40	6	30
Pedal thresher	2	10	2	10
Manual threshing	10	50	12	60
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-65 Ownership for Threshing

Response	Kandal Stung		Bati	
	n	%	n	%
Own	10	50	11	55
Borrowed	10	50	8	40
Cooperative	0	0	1	5
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-66 Charge for Borrowing Thresher

	Kandal Stung	Bati
N	10	8
Median	83,750	244,000
Mean*	99,450	231,750
SE Mean	18,043	57,470
Minimum	50,000	36,000
Maximum	250,000	450,000

*Note: * Mean per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-67 Drying (method)

Response	Kandal Stung		Bati	
	n	%	n	%
Dryer (machine)	0	0	0	0
Sun drying	20	100	20	100
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-68 Manpower for Drying

Response	Kandal Stung		Bati	
	n	%	n	%
Own	19	95	18	90
Borrowed	1	5	2	10
Cooperative	0	0	0	0
Total	20	100	20	100

Note:Charge on drying is not available

Source: Socio-economic survey, January 2012

Table AC-A3-69 Cleaning (method)

Response	Kandal Stung		Bati	
	n	%	n	%
Engine winnower	14	70	13	65
Manual winnower	0	0	0	0
Manual without winnower	6	30	7	35
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-70 Ownership of Winnower

Response	Kandal Stung		Bati	
	n	%	n	%
Own	7	35	8	40
Borrowed	13	65	10	50
Cooperative	0	0	2	10
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-71 Charge for Cleaning

	Kandal Stung	Bati
N	5	4
Median	20,000	55,000
Mean*	22,400	79,750
SE Mean	7,730	45,406
Minimum	2,000	9,000
Maximum	50,000	200,000

*Note: * Mean per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-72 Rice Milling Cost

	Kandal Stung	Bati
N	14	9
Median	22,500	25,000
Mean*	21,429	25,000
SE Mean	1,522	1,443
Minimum	10,000	20,000
Maximum	30,000	30,000

*Note: * Mean per respondent*

Source: Socio-economic survey, January 2012

Table AC-A3-73 Kind of Container used for Storing Paddy

	Kandal Stung		Bati	
	n	%	n	%
Bag	6	30	9	45
Bamboo basket	9	45	6	30
Wooden box	5	25	3	15
Others	0	0	2	10
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-74 Paddy Storage Amount (kg)

	Kandal Stung	Bati
N	20	20
Median	1,975	3,600
Mean	2,432	3,982
SE Mean	337	393
Minimum	480	1,800
Maximum	6,400	8,306

Source: Socio-economic survey, January 2012

Table AC-A3-75 Storage Period of Paddy (month)

	Kandal Stung	Bati
N	20	20
Median	12	12
Mean	12	12
SE Mean	0	0
Minimum	6	8
Maximum	18	12

Source: Socio-economic survey, January 2012

Table AC-A3-76 Container for Storing Milled Rice

	Kandal Stung		Bati	
	n	%	n	%
Bag	17	85	16	80
Bamboo basket	0	0	0	0
Wooden box	0	0	0	0
Others	3	15	4	20
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-77 Storing Amount of Milled Rice (kg)

	Kandal Stung	Bati
N	20	20
Median	50	58
Mean	57	57
SE Mean	5	2
Minimum	20	50
Maximum	100	75

Source: Socio-economic survey, January 2012

Table AC-A3-78 Storage Period of Milled Rice

	Kandal Stung	Bati
N	20	20
Median	1	1
Mean	1	1
SE Mean	0	0
Minimum	1	1
Maximum	2	1

Source: Socio-economic survey, January 2012

Table AC-A3-79 Most Dominant Loss on Paddy

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
During harvesting	2	10	3	15
At threshing	6	30	9	45
At drying	2	10	0	0
At cleaning	1	5	0	0
At storage	9	45	7	35
At other time (specify)	0	0	1	5
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-80 Second Dominant Loss on Paddy

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
During harvesting	1	5	2	10
At threshing	7	35	6	30
At drying	6	30	6	30
At Cleaning	3	15	2	10
At storage	0	0	3	15
At other time (specify)	3	15	1	5
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-81 Total Post Harvest Losses on Paddy

	Kandal Stung	Bati
N	20	20
Median	3	2
Mean	3	2
Minimum	1	1
Maximum	7	5

Source: Socio-economic survey, January 2012

Table AC-A3-82 Market Time for Paddy

Response	n	%	Sold product (Kg)				
			Total Volume	Median	Mean*	Min.	Max.
Kandal Stung							
Just after harvest	0	0	0	0	0	0	0
When cash in needed	10	50	12,620	600	1,262	450	3,000
When price is high	4	20	9,870	2,185	2,468	500	5,000
Total	14	70	22,490	1,750	2,418	300	7,165
Non reply	6	30	0	0	0	0	0
Total	20	100	22,490	1,750	2,418	300	7,165
Bati							
Just after harvest	4	20	15,165	3,500	3,791	1,000	7,165
When cash in needed	15	75	31,700	1,500	2,113	300	5,000
When price is high	1	5	1,500	1,500	1,500	1,500	1,500
Total	20	100	48,365	675	1,606	450	5,000
Non reply	0	0	0	0	0	0	0
Total	20	100	48,365	675	1,606	450	5,000

*Note: * Mean per respondent on each subject*

Source: Socio-economic survey, January 2012

Table AC-A3-83 Marketing of Paddy and Milled Rice

Response	Kandal Stung		Bati	
	n	%	n	%
Field dried paddy	1	5	0	0
Sun dried paddy	10	50	19	95
Milled rice	3	15	1	5
Non reply	6	30	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-84 Market Destination

Response	Kandal Stung		Bati	
	n	%	n	%
Rice miller in village	4	20	8	40
Rice miller in commune center	1	5	0	0
Rice miller in district center	0	0	0	0
Collector/middleman	8	40	12	60
Local market	1	5	0	0
Others (No rice to sell)	6	30	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-85 Processing of Rice

Response	Kandal Stung		Bati	
	n	%	n	%
Noodle	3	15	1	5
Confectionary	1	5	3	15
Powder	0	0	0	0
Liquor	1	5	0	0
Others	0	0	0	0
Not process for sell	15	75	16	80
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-86 Marketing Destination of Vegetables

Response	Kandal Stung		Bati	
	n	%	n	%
Market in village	14	70	16	80
Market in commune center	0	0	1	5
Market in district center	4	20	0	0
Collector/middleman	2	10	3	15
Other (specify)	0	0	0	0
Not Sold	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-87 Marketing Destination of Livestock

Response	Kandal Stung		Bati	
	n	%	n	%
Market in village	13	65	15	75
Market in commune center	2	10	1	5
Market in district center	4	20	0	0
Collector/middleman	1	5	4	20
Other (specify)	0	0	0	0
Not sold	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-88 Marketing Destination of Fish

Response	Kandal Stung		Bati	
	n	%	n	%
Market in village	15	75	16	80
Market in commune center	0	0	1	5
Market in district center	4	20	0	0
Collector/middleman	1	5	3	15
Other (specify)	0	0	0	0
System	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-89 Farm Gate Price of Products and Farm Inputs

		Price	Kandal Stung					Bati				
			N	%	Minimum	Maximum	Average	N	%	Minimum	Maximum	Average
Paddy	Early rice (1st wet)	Riel/kg	15	75	900	1,500	1,087	13	65	900	1,500	1,156
	Early rice (2nd wet)	Riel/kg	4	20	1,100	1,500	1,300	1	5	1,200	1,200	1,200
	Medium rice	Riel/kg	8	40	900	1,300	1,150	12	60	1,000	1,500	1,150
	Early rice (dry)	Riel/kg	4	20	1,000	1,400	1,100	6	30	900	1,500	1,117
Milled rice	Early rice (1st wet)	Riel/kg	10	50	1,800	2,500	2,200	4	20	2,000	2,500	2,375
	Early rice (2nd wet)	Riel/kg	2	10	2,600	2,800	2,700	1	5	2,200	2,200	2,200
	Medium rice	Riel/kg	6	30	2,300	3,000	2,700	10	50	2,100	3,300	2,700
	Early rice (dry)	Riel/kg	2	10	2,000	2,400	2,200	3	15	2,000	2,500	2,300
Seed paddy	Early rice ( )	Riel/kg	15	75	1,400	3,000	2,120	10	50	1,500	3,500	2,110
	Medium rice ( )	Riel/kg	7	35	1,800	3,200	2,700	10	50	1,500	3,500	2,610
	Maize ( )	Riel/kg							0			
	Beans ( )	Riel/kg							0			
Fertilizer	Urea	Riel/kg	17	85	2,200	3,000	2,500	18	90	2,000	2,800	2,317
	DAP	Riel/kg	14	70	2,500	3,600	3,043	15	75	2,200	3,000	2,539
	KCl	Riel/kg	2	10	2,500	2,700	2,600	1	5	2,300	2,300	2,300
Land preparation by ox	Plow	Riel/ha	6	30	80,000	250,000	180,833		0			
	Plow + Harrow	Riel/ha	11	55	112,500	250,000	200,227	12	60	150,000	400,000	210,000
	Harrow	Riel/ha	1	5	50,000	50,000	50,000		0			
Land preparation by hand tractor	Plow	Riel/ha						3	15	180,000	400,000	326,667
	Plow + Harrow	Riel/ha	16	80	225,000	450,000	298,438	18	90	200,000	500,000	309,722
	Harrow	Riel/ha							0			
Transportation	House to market ( )	Riel/kg	6	30	15	60	33	11	55	10	60	31
	House to market ( )	Riel/kg							0			
	House to market ( )	Riel/kg							0			

Source: Socio-economic survey, January 2012

Table AC-A3-90 Frequency of Extension Workers' Visiting

	Kandal Stung		Bati	
	n	%	n	%
1. once per <2 weeks	0	0	0	0
2. Once per 2 weeks - 1 month	4	20	4	20
3. Seldom visited	16	80	16	80
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-91 Technical Capacity of Extension Workers

Degree	Kandal Stung		Bati	
	n	%	n	%
1. Sufficient	14	70	5	25
2. not sufficient	3	15	6	30
3. No service provided	3	15	9	45
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-92 Satisfaction to Extension Services

Degree	Kandal Stung		Bati	
	n	%	n	%
1. Satisfied	13	65	8	40
2. Not satisfied	4	20	4	20
3. No services provided	3	15	8	40
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-93 Request to Extension Services

Degree	Kandal Stung		Bati	
	n	%	n	%
Extend agricultural extension services	3	15	5	25
Fertilizer application technical	2	10	3	15
Japan's fertilize application technical	0	0	1	5
Irrigation system using and early rice planting at dry season tech	1	5	0	0
Provide credit services for agriculture	2	10	0	0
Provide more time on agricultural extension services	4	20	5	25
Request for good quality rice seed	0	0	1	5
Rice planting to get more yield technical	6	30	4	20
Rice planting, Livestock raising & fish raising	1	5	1	5
Vegetable growing technical	1	5	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-94 Procurement of Seeds

	Wanted Seeds				Certified Seeds			
	Kandal Stung		Bati		Kandal Stung		Bati	
	n	%	n	%	n	%	n	%
1. Easy	15	75	12	60	13	65	11	55
2. Difficult	3	15	5	25	5	25	6	30
3. Not possible	2	10	3	15	2	10	3	15
Total	20	100	20	100	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-95 Seed Supply Timing

	Kandal Stung		Bati	
	n	%	n	%
1. In time	15	75	13	65
2. Delayed	2	10	3	15
3. Not obtained	3	15	4	20
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-96 Price of Quality Seed

	Kandal Stung		Bati	
	n	%	n	%
1. Too expensive	8	40	6	30
2. Acceptable	9	45	12	60
3. Not purchased	3	15	2	10
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-97 Procurement of Fertilizer to be Requried

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Easy	17	85	18	90
Difficult	3	15	0	0
Not possible	0	0	2	10
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-98 Supply Timing of Fertilizer

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
In time	17	85	18	90
Delayed	3	15	0	0
Not obtained	0	0	2	10
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-99 Price of Fertilizer

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Too expensive	12	60	10	50
Acceptable	8	40	8	40
Not purchased	0	0	2	10
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-100 Access to Farm Credit

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Easy	9	45	10	50
Difficult	2	10	1	5
Not possible	9	45	9	45
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-101 Timing of Credit Provision

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Easy	10	50	10	50
Difficult	1	5	1	5
Not possible	9	45	9	45
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-102 Amount of Credit

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Sufficient	9	45	9	45
Not sufficient	2	10	2	10
Not provided	9	45	9	45
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-103 Procedures of Credit Application

Response (one alternative)	Kandal Stung		Bati	
	n	%	n	%
Easy	9	45	9	45
Difficult	2	10	2	10
Not possible	9	45	9	45
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-104 Constraints on Agronomic and Farm Management Situations

Farming constraint (agronomic/farm management)	Degree of Constraints												Total Score	Rating
	Most Serious Score: 4			2nd Serious Score: 3			3rd Serious Score: 2			4th Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung														
Low yield of crops (paddy)	5	25	20	1	5	3	1	5	2	2	10	2	27	3
Crop losses due to pest & disease	7	35	28	2	10	6	3	15	6	1	5	1	41	1
Weed problem	3	15	12	5	25	15	2	10	4	0	0	0	31	2
Crop losses due to wild animal	0	0	0	2	10	6	2	10	4	0	0	0	10	7
Difficulty for hiring draft animal/machinery	0	0	0	1	5	3	0	0	0	0	0	0	3	14
Labor shortage	0	0	0	2	10	6	0	0	0	2	10	2	8	9
Insufficient extension services	0	0	0	0	0	0	3	15	6	0	0	0	6	11
Shortage of farming capital	3	15	12	2	10	6	0	0	0	0	0	0	18	4
Difficulty for obtaining quality seeds	0	0	0	1	5	3	1	5	2	2	10	2	7	10
Difficulty for purchasing fertilizers	0	0	0	1	5	3	3	15	6	1	5	1	10	7
Expensive farm inputs	1	5	4	1	5	3	3	15	6	2	10	2	15	6
Poor soil conditions	1	4	4	1	5	3	1	5	2	7	35	7	16	5
Marketing problems of products	0	0	0	1	5	3	0	0	0	1	5	1	4	12
Lack of farm credit	0	0	0	0	0	0	1	5	2	2	10	2	4	12
Other (specify)	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Other (specify)	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Total	20	100	80	20	100	60	20	100	40	20	100	20	200	
Target Area: Bati														
Low yield of crops (paddy)	1	5	4	1	5	3	5	25	10	2	10	2	19	4
Crop losses due to pest & disease	7	35	28	1	5	3	4	20	8	2	10	2	41	1
Weed problem	4	20	16	1	5	3	2	10	4	1	5	1	24	2
Crop losses due to wild animal	0	0	0	2	10	6	1	5	2	1	5	1	9	9
Difficulty for hiring draft animal/machinery	1	5	4	2	10	6	1	5	2	0	0	0	12	6
Labor shortage	0	0	0	3	15	9	1	5	2	2	10	2	13	5
Insufficient extension services	0	0	0	1	5	3	1	5	2	2	10	2	7	13
Shortage of farming capital	1	5	4	2	10	6	0	0	0	2	10	2	12	6
Difficulty for obtaining quality seeds	0	0	0	2	10	6	1	5	2	0	0	0	8	11
Difficulty for purchasing fertilizers	1	5	4	0	0	0	1	5	2	0	0	0	6	14
Expensive farm inputs	3	15	12	0	0	0	2	10	4	4	20	4	20	3
Poor soil conditions	1	5	4	1	5	3	0	0	0	1	5	1	8	11
Marketing problems of products	0	0	0	3	15	9	1	5	2	1	5	1	12	6
Lack of farm credit	1	5	4	1	5	3	0	0	0	2	10	2	9	9
Other (specify)	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Other (specify)	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Total	20	100	80	20	100	60	20	100	40	20	100	20	200	

Source: Socio-economic survey, January 2012

Table AC-A3-105 Physical Farming Constraints

Faming Constraints/Physical (Answer)	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Irrigation water shortage in wet season	7	35	21	8	40	16	1	5	1	38	1
Irrigation water shortage in dry season	8	40	24	5	25	10	1	5	1	35	2
Inundation/flooding	1	5	3	1	5	2	2	10	2	7	4
Drainage problem	4	20	12	4	20	8	7	35	7	27	3
Lack of farm road	0	0	0	1	5	2	2	10	2	4	6
Lack of transportation means	0	0	0	0	0	0	3	15	3	3	7
Leveling problem of paddy field	0	0	0	1	5	2	4	20	4	6	5
Others(specify)	0	0	0	0	0	0	0	0	0	0	8
Others(specify)	0	0	0	0	0	0	0	0	0	0	8
Others(specify)	0	0	0	0	0	0	0	0	0	0	8
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Irrigation water shortage in wet season	11	55	33	4	20	8	2	10	2	43	1
Irrigation water shortage in dry season	7	35	21	9	45	18	3	15	3	42	2
Inundation/flooding	0	0	0	0	0	0	2	10	2	2	6
Drainage problem	1	5	3	6	30	12	8	40	8	23	3
Lack of farm road	0	0	0	1	5	2	1	5	1	3	5
Lack of transportation means	0	0	0	0	0	0	2	10	2	2	6
Leveling problem of paddy field	1	5	3	0	0	0	2	10	2	5	4
Others(specify)	0	0	0	0	0	0	0	0	0	0	8
Others(specify)	0	0	0	0	0	0	0	0	0	0	8
Others(specify)	0	0	0	0	0	0	0	0	0	0	8
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-106 Constraints on Marketing

Marketing Constraints (Answer)	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Unstable market prices of paddy/rice	8	40	24	4	20	8	2	10	2	34	2
Low market prices of paddy/rice	10	50	30	4	20	8	2	10	2	40	1
Limitation of market of paddy/rice	1	5	3	2	10	4	3	15	3	10	4
Unstable market prices of other crops	1	5	3	5	25	10	3	15	3	16	3
Low market prices of other crops	0	0	0	1	5	2	2	10	2	4	6
Limitation of market of other crops	0	0	0	0	0	0	0	0	0	0	10
Unstable market prices of livestock	0	0	0	3	15	6	2	10	2	8	5
Low market prices of livestock	0	0	0	0	0	0	1	5	1	1	9
Limitation of market of livestock	0	0	0	1	5	2	2	10	2	4	6
Lack of or poor farm to market road	0	0	0	0	0	0	3	15	3	3	8
Other(specify)	0	0	0	0	0	0	0	0	0	0	10
Other(specify)	0	0	0	0	0	0	0	0	0	0	10
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Unstable market prices of paddy/rice	11	55	33	3	15	6	1	5	1	40	1
Low market prices of paddy/rice	3	15	9	9	45	18	2	10	2	29	2
Limitation of market of paddy/rice	3	15	9	3	15	6	3	15	3	18	3
Unstable market prices of other crops	0	0	0	0	0	0	4	20	4	4	8
Low market prices of other crops	1	5	3	1	5	2	1	5	1	6	6
Limitation of market of other crops	0	0	0	1	5	2	3	15	3	5	7
Unstable market prices of livestock	0	0	0	3	15	6	1	5	1	7	4
Low market prices of livestock	0	0	0	0	0	0	2	10	2	2	9
Limitation of market of livestock	0	0	0	0	0	0	2	10	2	2	9
Lack of or poor farm to market road	2	10	6	0	0	0	1	5	1	7	4
Other(specify)	0	0	0	0	0	0	0	0	0	0	11
Other(specify)	0	0	0	0	0	0	0	0	0	0	11
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-107 Reasons for Limited Productivity of Paddy

Reasons for Limited Productivity (Answer)	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Drought in wet season	7	35	21	7	35	14	3	15	3	38	1
Water shortage in dry season	5	25	15	3	15	6	0	0	0	21	2
Shortage of farming capital	0	0	0	0	0	0	3	15	3	3	8
Poor seed quality	1	5	3	2	10	4	0	0	0	7	5
Poor soil	3	15	9	5	25	10	2	10	2	21	2
Limited application of fertilizer	1	5	3	0	0	0	2	10	2	5	7
Damages caused by wild animal (rat)	1	5	3	1	5	2	1	5	1	6	6
Poor drainage	2	10	6	1	5	2	4	20	4	12	4
Flooding/inundation	0	0	0	1	5	2	1	5	1	3	8
Inadequate farming technologies	0	0	0	0	0	0	3	15	3	3	8
Damages caused by pest & disease	0	0	0	0	0	0	1	5	1	1	11
Others	0	0	0	0	0	0	0	0	0	0	12
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Drought in wet season	9	45	27	4	20	8	2	10	2	37	1
Water shortage in dry season	6	30	18	9	45	18	1	5	1	37	1
Shortage of farming capital	2	10	6	1	5	2	1	5	1	9	4
Poor seed quality	0	0	0	0	0	0	2	10	2	2	8
Poor soil	0	0	0	2	10	4	2	10	2	6	6
Limited application of fertilizer	1	5	3	2	10	4	1	5	1	8	5
Damages caused by wild animal (rat)	0	0	0	0	0	0	2	10	2	2	8
Poor drainage	1	5	3	2	10	4	8	40	8	15	3
Flooding/inundation	0	0	0	0	0	0	0	0	0	0	11
Inadequate farming technologies	1	5	3	0	0	0	0	0	0	3	7
Damages caused by pest & disease	0	0	0	0	0	0	1	5	1	1	10
Others	0	0	0	0	0	0	0	0	0	0	11
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-108 Farming Practices conducted for Improvement of Paddy Productivity

Activities Implemented	No. & Proportion of Respondents Implemented Activities/Practices										Remarks
	1		2		3		4		Overall		
	No.	%	No.	%	No.	%	No.	%	No.	%	
Target Area: Kandal Stung											
Increased fertilization doses	5	25	5	25	8	40	2	10	20	25	
Applied of compost/manure	10	50	8	40	0	0	0	0	18	23	
Used quality seed (local variety)	2	10	1	5	3	15	4	20	10	13	
Used quality seed (high yielding variety)	0	0	0	0	4	20	1	5	5	6	
Constructed of farm pond	0	0	1	5	1	5	2	10	4	5	
Started to use water pump for irrigation	2	10	4	20	3	15	4	20	13	16	
Improved farming practices	1	5	1	5	0	0	2	10	4	5	
Improved post-harvest practices	0	0	0	0	1	5	4	20	5	6	
Changed marketing methods	0	0	0	0	0	0	0	0	0	0	
Others	0	0	0	0	0	0	1	5	1	1	
Total	20	100	20	100	20	100	20	100	80	100	
Target Area: Bati											
Increased fertilization doses	1	5	8	40	4	20	2	10	15	75	
Applied of compost/manure	11	55	8	40	0	0	1	5	20	100	
Used quality seed (local variety)	2	10	0	0	2	10	4	20	8	40	
Used quality seed (high yielding variety)	1	5	1	5	5	25	1	5	8	40	
Constructed of farm pond	0	0	1	5	1	5	1	5	3	15	
Started to use water pump for irrigation	4	20	1	5	4	20	4	20	13	65	
Improved farming practices	1	5	0	0	4	20	2	10	7	35	
Improved post-harvest practices	0	0	1	5	0	0	4	20	5	25	
Changed marketing methods	0	0	0	0	0	0	0	0	0	0	
Others	0	0	0	0	0	0	1	5	1	5	
Total	20	100	20	100	20	100	20	100	80	100	

Source: Socio-economic survey, January 2012

Table AC-A3-109 Farming Practices to be Required for Improvement of Paddy Productivity

Necessary Activities	Degree of Necessity of Activity: Most Required Score: 4			2nd Most Required Score: 3			3rd Most Required Score: 2			4th Most Required Score: 1			Total Score	Rating
	No.	%	Score	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung														
Improvement of farming practices	9	45	36	1	5	3	2	10	4	1	5	1	44	1
Use of quality seed (local variety)	1	5	4	8	40	24	1	5	2	0	0	0	30	4
Use of quality seed (high yielding variety)	4	20	16	3	15	9	3	15	6	2	10	2	33	3
Use of adequate doses of fertilizer	4	20	16	4	20	12	3	15	6	0	0	0	34	2
Improved leveling of paddy field	1	5	4	1	5	3	6	30	12	2	10	2	21	5
Planting at proper time	0	0	0	2	10	6	3	15	6	5	25	5	17	6
Intensive weeding	1	5	4	0	0	0	0	0	0	7	35	7	11	7
Formation/strengthening of farmers organization	0	0	0	1	5	3	2	10	4	3	15	3	10	8
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Total	20	100	80	20	100	60	20	100	40	20	100	20	200	
Target Area: Bati														
Improvement of farming practices	2	10	8	3	15	9	1	5	2	2	10	2	21	5
Use of quality seed (local variety)	3	15	12	2	10	6	3	15	6	1	5	1	25	4
Use of quality seed (high yielding variety)	5	25	20	4	20	12	1	5	2	0	0	0	34	2
Use of adequate doses of fertilizer	7	35	28	4	20	12	1	5	2	3	15	3	45	1
Improved leveling of paddy field	1	5	4	2	10	6	3	15	6	4	20	4	20	6
Planting at proper time	1	5	4	4	20	12	5	25	10	2	10	2	28	3
Intensive weeding	0	0	0	0	0	0	4	20	8	4	20	4	12	7
Formation/strengthening of farmers organization	0	0	0	1	5	3	2	10	4	4	20	4	11	8
Others	1	5	4	0	0	0	0	0	0	0	0	0	4	9
Total	20	100	80	20	100	60	20	100	40	20	100	20	200	

Source: Socio-economic survey, January 2012

Table AC-A3-110 Physical Works for Improvement of Paddy Productivity

Necessary Physical Works	Degree of Necessity of Activity									Total Score	Rating
	Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Irrigation water supply for wet season	8	40	24	6	30	12	2	10	2	38	2
Irrigation water supply for dry season	8	40	24	9	45	18	3	15	3	45	1
Mitigation of inundation/flooding	0	0	0	1	5	2	3	15	3	5	4
Drainage improvement	4	20	12	4	20	8	12	60	12	32	3
Others	0	0	0	0	0	0	0	0	0	0	5
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Irrigation water supply for wet season	8	40	24	7	35	14	4	20	4	42	2
Irrigation water supply for dry season	9	45	27	10	50	20	2	10	2	49	1
Mitigation of inundation/flooding	0	0	0	0	0	0	0	0	0	0	4
Drainage improvement	3	15	9	3	15	6	14	70	14	29	3
Others	0	0	0	0	0	0	0	0	0	0	4
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-111 Constraints on Livestock Management

Livestock Constraints	Degree of Constraints									Total Score	Rating
	Most Serious Score: 3			2nd Serious Score: 2			3rd Serious Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Low productivity	1	5	3	4	20	8	2	10	2	13	4
Shortage of feed	1	5	3	2	10	4	1	5	1	8	6
Low or unstable market prices	6	30	18	1	5	2	3	15	3	23	2
Market availability	0	0	0	1	5	2	0	0	0	2	8
Losses due to diseases	9	45	27	3	15	6	0	0	0	33	1
Insufficient veterinary services	3	15	9	4	20	8	6	30	6	23	2
Insufficient extension services	0	0	0	5	25	10	2	10	2	12	5
Difficulty in obtaining good breed	0	0	0	0	0	0	5	25	5	5	7
Others	0	0	0	0	0	0	1	5	1	1	9
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Low productivity	2	10	6	4	20	8	4	20	4	18	3
Shortage of feed	1	5	3	1	5	2	1	5	1	6	7
Low or unstable market prices	3	15	9	1	5	2	0	0	0	11	5
Market availability	0	0	0	2	10	4	1	5	1	5	8
Losses due to diseases	10	50	30	2	10	4	1	5	1	35	1
Insufficient veterinary services	2	10	6	5	25	10	5	25	5	21	2
Insufficient extension services	1	5	3	3	15	6	4	20	4	13	4
Difficulty in obtaining good breed	1	5	3	2	10	4	4	20	4	11	5
Others	0	0	0	0	0	0	0	0	0	0	9
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-112 Preferable Cropping Pattern

	Kandal Stung		Bati	
	n	%	n	%
Early Rice (Early rainy) + Early Rice (Rainy)	0	0	0	0
Early Rice (Early rainy) + Medium Rice (Rainy)	0	0	1	5
Upland crops (Early rainy) + Medium Rice (Rainy)	0	0	0	0
Upland crops (Early rainy) + Early rice (Rainy)	0	0	0	0
Early rice (Early rainy) + Early (Rainy) + Upland Crops (Dry)	4	20	2	10
Medium rice (Rainy) + Upland Crops (Dry)	0	0	1	5
Medium rice (Rainy) only	0	0	0	0
Early Rice(Early rainy)+Early Rice(Rainy)+Early Rice(Dry)	13	65	7	35
Early Rice(Early rainy)+Medium Rice(Rainy)+Early Rice(Dry)	3	15	9	45
Others ( )	0	0	0	0
Total	20	100	20	100

Source: Socio-economic survey, January 2012

Table AC-A3-113 Expectations for Improvement on Farming

Expectations for Improvement	Degree of Expectation									Total Score	Rating
	Most Expected Score: 3			2nd Most Expected Score: 2			3rd Most Expected Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kendal Stung											
Productivity improvement of wet season rice	8	40	24	6	30	12	2	10	2	38	2
Productivity improvement of dry season rice	9	45	27	9	45	18	0	0	0	45	1
Productivity improvement of field crops	1	5	3	3	15	6	1	5	1	10	3
Productivity improvement of vegetables	0	0	0	1	5	2	2	10	2	4	6
Productivity improvement of livestock/poultry	0	0	0	0	0	0	1	5	1	1	8
Increasing livestock holding size & production	1	5	3	1	5	2	5	25	5	10	3
Increasing poultry holding size & production	0	0	0	0	0	0	3	15	3	3	7
Strengthening/formation of farmers organizations	1	5	3	0	0	0	5	25	5	8	5
Improvement of post-harvest operation	0	0	0	0	0	0	1	5	1	1	8
Others	0	0	0	0	0	0	0	0	0	0	10
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bait											
Productivity improvement of wet season rice	12	60	36	5	25	10	2	10	2	48	1
Productivity improvement of dry season rice	7	35	21	10	50	20	2	10	2	43	2
Productivity improvement of field crops	1	5	3	4	20	8	1	5	1	12	3
Productivity improvement of vegetables	0	0	0	0	0	0	2	10	2	2	6
Productivity improvement of livestock/poultry	0	0	0	0	0	0	3	15	3	3	5
Increasing livestock holding size & production	0	0	0	1	5	2	6	30	6	8	4
Increasing poultry holding size & production	0	0	0	0	0	0	1	5	1	1	8
Strengthening/formation of farmers organizations	0	0	0	0	0	0	2	10	2	2	6
Improvement of post-harvest operation	0	0	0	0	0	0	1	5	1	1	8
Others	0	0	0	0	0	0	0	0	0	0	10
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-114 Requirement on Physical Improvement

Farming (physical)	Degree of Expectation									Total Score	Rating
	Primarily Expected Score: 3			Secondary Expected Score: 2			Thirdly Expected Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Adequate(volume/timing) irrigation water supply in wet season	7	35	21	7	35	14	2	10	2	37	2
Adequate(volume/timing) irrigation water supply in dry season	10	50	30	8	40	16	1	5	1	47	1
Mitigation of inundation & flooding	1	5	3	1	5	2	1	5	1	6	5
Construction/rehabilitation of farm road	1	5	3	0	0	0	4	20	4	7	4
Construction/rehabilitation of farm to market road	0	0	0	0	0	0	4	20	4	4	6
Drainage improvement	1	5	3	2	10	4	8	40	8	15	3
Leveling of paddy field	0	0	0	2	10	4	0	0	0	4	6
Others (specify)	0	0	0	0	0	0	0	0	0	0	8
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Adequate(volume/timing) irrigation water supply in wet season	11	55	33	5	20	10	3	15	3	46	1
Adequate(volume/timing) irrigation water supply in dry season	7	35	21	11	55	22	1	5	1	44	2
Mitigation of inundation & flooding	1	5	3	0	0	0	0	0	0	3	5
Construction/rehabilitation of farm road	1	5	3	1	5	2	4	20	4	9	4
Construction/rehabilitation of farm to market road	0	0	0	1	5	2	0	0	0	2	6
Drainage improvement	0	0	0	2	10	4	10	50	10	14	3
Leveling of paddy field	0	0	0	0	0	0	2	10	2	2	6
Others (specify)	0	0	0	0	0	0	0	0	0	0	8
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

Table AC-A3-115 Requirement on Agricultural Support Services

Agricultural Support Required	Degree of Necessity of Support									Total Score	Rating
	Most Required Score: 3			2nd Most Required Score: 2			3rd Most Required Score: 1				
	No.	%	Score	No.	%	Score	No.	%	Score		
Target Area: Kandal Stung											
Field Extension services (demonstration / field guidance)	8	40	24	1	5	2	3	15	3	29	2
Provision of quality seed	4	20	12	7	35	14	3	15	3	29	2
Farmer training (technical & host-harvest operation)	5	20	15	5	25	10	5	25	5	30	1
Farmer training (organization, marketing, farm management)	0	0	0	1	5	2	1	5	1	3	7
Support to organize farmers	0	0	0	2	10	4	4	20	4	8	5
Provision of market information	1	5	3	2	10	4	1	5	1	8	5
Provision of farm credit	0	0	0	0	0	0	2	10	2	2	8
Provision of fertilizer	2	10	6	2	10	4	1	5	1	11	4
Others (specify)	0	0	0	0	0	0	0	0	0	0	9
Total	20	100	60	20	100	40	20	100	20	120	
Target Area: Bati											
Field Extension services (demonstration / field guidance)	4	20	12	3	15	6	4	20	4	22	3
Provision of quality seed	6	30	18	7	35	14	3	15	3	35	1
Farmer training (technical & host-harvest operation)	5	25	15	5	25	10	1	5	1	26	2
Farmer training (organization, marketing, farm management)	0	0	0	2	10	4	2	10	2	6	6
Support to organize farmers	0	0	0	0	0	0	5	25	5	5	7
Provision of market information	0	0	0	1	5	2	2	10	2	4	8
Provision of farm credit	1	5	3	1	5	2	2	10	2	7	5
Provision of fertilizer	4	20	12	1	5	2	1	5	1	15	4
Others (specify)	0	0	0	0	0	0	0	0	0	0	9
Total	20	100	60	20	100	40	20	100	20	120	

Source: Socio-economic survey, January 2012

ANNEX C

Attachment 4

Questionnaire for Socio-economic Survey

Questionnaire

Sample No. [ ]

Date (M/D/Y):	/ /		Project		
Enumerator:			Team Leader:		
Province:		Q-1	District:		Q-2
Commune:		Q-3	Village:		Q-4
			Type of village	1 Paddy (*srock srae*) 2 Upland crop	Q-5

Sample No.: All questionnaires shall be attached sequential numbers, i.e. 001, 002, ---, 200.

Date (M/D/Y): Data format shall be written as "06/22/11" (Month: June /Date: 22nd /Year: 2011). This item is not necessarily given in the data summary.

Enumerator: Name of enumerator shall be written in block letters. This item is not necessarily given in the data summary.

Team Leader: Enter name of team leader after proofreading. This item is not necessarily given in the data summary.

PART 1 Socio-Economic Survey

SECTION I GENERAL INFORMATION

I-1 Name and Age of interviewee — Name [ ] Q-6; Age [ ] Q-7

I-2 Who is it? [ ] Q-8
1 Male head of the household
2 Female head of the household
3 Oldest son of the household
4 Oldest daughter of the household
5 Other ( )

Note
I-1 Write interviewee's name (full name in block letters). This item is not necessarily given in the data summary.
I-2 Circle a code number and write her/ his age.

I-3 Total number of household members [ ] Q-9
I-4 Number of working available aged persons in the household (Older than 10, younger than 64) [ ] Q-10
I-5 Main activity of this household (income source) [ ] Q-11

Note: Choose main activity of this household from codes below.

Main activity	Code	Remarks
Farmer	1	Own/rented land, and agricultural income is more than other one.
On-farm labor	2	Wage for labor work on farm is more than other income.
Non-farm labor	3	Wage for labor work except on farm is more than other income.
Salary worker	4	Salary is more than other work.
Private business	5	Income from private business is more than other work.
Others	6	Specify.

I-6 Household member in the same house

	Sex		Age		Education		Main occupation		Literacy	
1	M / F	Q-12		Q-13		Q-14		Q-16	Y / N	Q-17
2	M / F	Q-18		Q-19		Q-20		Q-22	Y / N	Q-23
3	M / F	Q-24		Q-25		Q-26		Q-28	Y / N	Q-29
4	M / F	Q-30		Q-31		Q-32		Q-34	Y / N	Q-35
5	M / F	Q-36		Q-37		Q-38		Q-40	Y / N	Q-41
6	M / F	Q-42		Q-43		Q-44		Q-46	Y / N	Q-47
7	M / F	Q-48		Q-49		Q-50		Q-52	Y / N	Q-53
8	M / F	Q-54		Q-55		Q-56		Q-58	Y / N	Q-59
9	M / F	Q-60		Q-61		Q-62		Q-64	Y / N	Q-65
10	M / F	Q-66		Q-67		Q-68		Q-70	Y / N	Q-71

Note:

Sex: Choose sex of this member. "M" means male and "F" means female.

Age: Enter age of the members at present.

Education: Education background shall be chosen from codes below.

for adult (>18 yr)	Code	for children (<18 yr)	Code
No formal education	1	Presently going to school	9
Drop-out at primary school	2	Not going to school	10
Graduate from primary school	3	Before school age	11
Drop-out at junior high school	4	Non-formal education for adults	12
Graduate from junior high school	5		
Drop-out at high school	6		
Graduate from high school	7		
More than high school	8		

Main occupation: Main occupation shall be chosen from codes below.

Main occupation	Code	Main occupation	Code
Farmer	1	Housekeeping (cooking, washing, child care, etc.)	6
On-farm labor	2	No job	7
Non-farm labor	3	Student	8
Salary worker	4	Child (below school age)	9
Private business	5	Others	10

* Definition of Main Occupation: "A person who has more than 1 job, the work that most of his/ her working time is spent is regarded as a main occupation. In case, he/ she engages in only 1 job, it is regarded as a main occupation" (NIS, 1995)

Literacy: If he/she is able to write, read, and calculate for making living, choose "Y".

I-7 Member of village organization (husband) in

1 [ ] Q-72 2 [ ] Q-73 3 [ ] Q-74 4 [ ] Q-75 5 [ ] Q-76

Note: Choose village organization codes below which head of the family belong to. If there are other organization, fill in the name.

Village organization	Code	Village organization	Code
Farmer's water users' community	1	Marketing group	7
Credit group by government	2	Youth group	8
Micro-credit group by NGO	3	Veteran group	9
Production group	4	Women's group	10
Religion group	5	Others ( )	11
Drinking water users' group	6		

I-8 Member of village organization (wife)

1 [ ] Q-77 2 [ ] Q-78 3 [ ] Q-79 4 [ ] Q-80 5 [ ] Q-81

Note: Choose village organizations codes below which housewife belong to. If there are other organizations.

Village organization	Code	Village organization	Code
Farmer's water users' community	1	Marketing group	7
Credit group by government	2	Youth group	8
Micro-credit group by NGO	3	Veteran group	9
Production group	4	Women's group	10

Religion group	5	Others ( )	11
Drinking water users' group	6		

SECTION II LIVING CONDITION

II-1 Source of drinking Water

	Main source		Location		Availability	
Dry season		Q-82		Q-83		Q-84
Wet season		Q-85		Q-86		Q-87

Note: Choose water source primary and its availability.

Water source	Code	Water source	Code
Tube pipe well	1	Bought	5
Dug well	2	Rain	6
Reservoir / Pond	3	Piped water	7
Spring / River	4		

Availability	Code	Availability	Code		Location	Code	Location	Code
Easy to obtain	1	Very difficult to obtain	3		Within the premises	1	Away from the premises	3
Difficult to obtain	2				Near the premises	2		

II-2 Type of Fuel for cooking

		Fuel source		Availability	
1	Most important		Q-94		Q-95

Note: Choose fuel source primary and secondary (supplemental), and its availability.

Fuel source for cooking	Code	Fuel source for cooking	Code
Firewood	1	Gas cylinder (LPG)	4
Kerosene	2	Electricity	5
Charcoal	3	Others	6
		None	7

Availability	Code	Availability	Code
Easy to obtain	1	Very difficult to obtain	3
Difficult to obtain	2		

II-3 Main source for light used

		Lighting Source		Availability	
1	Most important		Q-98		Q-99

Note: Choose fuel source primary and secondary (supplemental), and its availability.

Fuel source for lighting	Code	Fuel source for lighting	Code
City power	1	Candle	4
Generator	2	Battery	5
Kerosene	3	Others	6
		None	7

Availability	Code	Availability	Code
Easy to obtain	1	Very difficult to obtain	3
Difficult to obtain	2		

II-4 Facilities with your household

		No.	
1	Radio		Q-102
2	TV		Q-103
3	Bicycle		Q-104
4	Motorcycle		Q-105
5	Car		Q-106
6	Car battery		Q-107
7	Tractor (4 wheel)		Q-111
8	Hand tractor		Q-112
9	Mosquito net		Q-113
10	Cellular phone		Q-114
11	Telephone		Q-115
12	Water pump		Q-116
13	Tape recorder		Q-117

II-5 Residence

Q-120 Ownership		1 Owned (already paid) 2 Owned (under payment) 3 Lent 4 Borrowed
Q-121 Material (e.g. Number 34=Wood house with Tile roofing; 12= Cement and bricks house with Metal/ Zinc roofing…)		1 Cement and bricks 2 Palm leaves 3 Wood 4 Others (Cement and bricks at ground floor and Wooden at first floor) 1.Thatch/ Palm leaves roofing 2.Metal/ Zinc roofing 3.Asbestos roofing 4.Tile roofing 5.Concrete roofing
Q-122 Type of House		1 Traditional 2 One-storied 3 Two-storied 4 Others ( )
Q-123 Number of rooms		
Q-124 Toilet availability		1. Household with toilet, 2. Household without toilet
Q-125 Toilet facility		1.Connected to sewerage, 2. Septic tank, 3. Pity latrine, 4. others

II-6 Social Service

1. Health and medical service When you/ your family get/gets sick, Q-129 Where do you go? Q-130 How do you go there?		 1 Hospital 2 Clinic 3 Health center 4 Others ( ) By 1 Walk 2 Motor taxi/ Tuktuk 3 Owned motor bike 4 Bike 5 Others ( )

II-7 Gender in Development

	1. Daily activities		
	Q-137 What are FEMALE's main activities in your village?		1 Housekeeping 2 Cooking 3 Farming 4 Handy crafting 5 Care of children/ elders 6 Care of livestock 7 Making Palm sugar 8 Others ( )
	Q-138 What are MALE's main activities in your village?		1 Housekeeping 2 Cooking 3 Farming 4 Handy crafting 5 Care of children/ elders 6 Care of livestock 7 Making Palm sugar 8 Others ( )
	2. Income source		
	Q-139 What are FEMALE's main cash income sources in your village?		1 Selling paddy 2 Working for other's field 3 Selling palm sugar 4 Selling handy craft 5 Working for a weaving factory 6 Working for bricks factory 7 Selling straw mat 8 Selling cotton/ silk 9 Others ( )
	Q-140 What are MALE's main cash income sources in your village?		1 Selling paddy 2 Working for other's field 3 Selling palm sugar 4 Selling handy craft 5 Working for a weaving factory 6 Working for bricks factory 7 Selling straw mat 8 Selling cotton/ silk 9 Others ( )

SECTION III INCOME AND EXPENDITURE

III-1 Cash income sources in last year(Last year: January 2010 – December 2010)

1	Selling paddy/rice	riel/Yr	Q-143	9	Wage from temporary off-farm job	riel/Yr	Q-151
2	Selling vegetables (red pepper/ tobacco/ water melon/ others)	riel/Yr	Q-144	10	Private business (transportation, trading, shop, etc.)	riel/Yr	Q-152
3	Selling fruits (mango/ papaya, banana/ hairly fruit/ orange/ others)	riel/Yr	Q-145	11	Remittance from family members	riel/Yr	Q-153
4	Selling palm sugar	riel/Yr	Q-146	12	Selling firewood/charcoal	riel/Yr	Q-154
5	Selling livestock/ poultry products	riel/Yr	Q-147	13	Selling handicraft/ cottage industry products	riel/Yr	Q-155
6	Selling fishes	riel/Yr	Q-148	14	Selling forest vegetable/ crop	riel/Yr	Q-156
7	Salary from permanent job	riel/Yr	Q-149	15	Others (Specify: Q-158)	riel/Yr	Q-157
8	Wage from temporary on-farm job	riel/Yr	Q-150	16	Total	riel/Yr	Q-159

Note: Write cash income of this household in 2010 (total of one year). If the interviewee answer in US$, convert to riel (US$ = 4,000 riel).

III-2 Expenditure for consumption (Last year: January 2010 – December 2010)

1	Rice	riel/Yr	Q-160	……………..kg/day ……………..riel/kg	…………..Bag/mnth ……………..riel/Bag
2	Other foods	riel/Yr	Q-161	riel/day	riel/mnth
3	Health/ medicine	riel/Yr	Q-162	riel/day	riel/mnth
4	Education	riel/Yr	Q-163	riel/day	riel/mnth
5	Clothes	riel/Yr	Q-164	riel/day	riel/mnth
6	Firewood/Kerosene/Electricity/Battery	riel/Yr	Q-165	riel/day	riel/mnth
7	Transportation (Motor taxi/Gasoline)	riel/Yr	Q-166	riel/day	riel/mnth
8	Tax	riel/Yr	Q-167	riel/day	riel/mnth
9	Others (Ceremony/ Wedding)	riel/Yr	Q-168	riel/day	riel/mnth
10	Total	riel/Yr	Q-169	riel/day	riel/mnth

Note Write expenditure for consumption of this household in 2010. Total of expenditure should be less than total of income.
If the interviewee answer in US$, convert to riel l (US$ = 4,000 riel).

III-3 Investment of productive and fixed assets in the last year (January 2010 – December 2010)

1	Livestock		
1-1	Chicken	Head(s)	Q-170
1-2	Ducks	Head(s)	Q-171
1-3	Cattle	Head(s)	Q-172
1-4	Water buffalo	Head(s)	Q-173
1-5	Pig	Head(s)	Q-174
1-6	Horse	Head(s)	Q-175
1-7	Goat	Head(s)	Q-176
1-8	Others ( )	Head(s)	Q-177
2	Housing (building/ maintenance)	Riel	Q-178
3	Private business	Riel	Q-179
4	Land	Riel	Q-180

SECTION IV SAVINGS AND LOAN

IV-1 Savings of any type at present

Note If family member(s) have savings, choose "Y" and choose type of the savings and purposes from the codes below. If the family member(s) do not have saving, choose "2" and fill in Q-190.

	Source	Amount	Interest rate	Purpose	Reason for no Saving
1 Yes 2 No Q-181	Q-182	Q-183	Q-184	Q-185	Q-190
	Q-186	Q-187	Q-188	Q-189	

Source of savings	Code
Money in bank	1
Land	2
Livestock	3
Cash	4
Others	5

Purpose for savings	Code
For safety	1
Saving for future expenditure	2
Saving for emergency needs	3

IV-2 Loans and debts at present

Note If the family member(s) have loan(s) and debt(s), choose "Y" and choose the source of loan(s) and debt(s), write interest rate (per year, %), choose purpose for loan(s) and debt(s) and Collateral from code below and write amount of repayment per year. If the family member(s) do not have loan(s), choose "N" and choose reasons from codes below.

1 Yes 2 No Q-191

Source	Amount	Interest rate	Purpose	Collateral	Amount repaid
Q-192	Q-193	Q-194	Q-195	Q-196	Q-197
Q-198	Q-199	Q-200	Q-201	Q-202	Q-203

Source of loans/debts	Code	Purpose for loans/debts	Code	Purpose for loans/debts	Code
Money lender	1	Seeds/fertilizers/agro-chemicals	1	Debt repayment	8
Friend/Relatives	2	Farm equipment/tools	2	Ceremonial occasions	9
Trader	3	Animals	3	Business	10
NGO	4	Food	4	Reclamation/Rehabilitation of farm land	11
Commercial bank	5	Assets	5	Building/repair of house	12
Rice miller	6	Land	6	Others	13
Others	7	Children's education	7		

Collateral for loans/debts	Code	Collateral for loans/debts	Code
Nothing	1	Jewelry	4
Land	2	Others	5
Crop products	3		

Reason for No:

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SECTION V LIVESTOCK / FRUITS TREES

V-1 LIVESTOCK

Note: Write number of each livestock and choose codes for feed sufficiency from answer code.

		Number		Food sufficiency	
		Adult	Young	Wet season	Dry season
1	Cows/ Oxen	Q-204	Q-205	Q-206	Q-207
2	Water buffalo	Q-208	Q-209	Q-210	Q-211
3	Goat/ Sheep	Q-212	Q-213	Q-214	Q-215
4	Swine	Q-216	Q-217	Q-218	Q-219
5	Chicken	Q-220	Q-221		
6	Duck	Q-222	Q-223		

Answer code & answer for food sufficiency

1. Sufficient	3. Short
2. Just enough	4. Very short

V-2 FRUITS TREES

Note :Indicate estimated numbers of sugar palm and major three fruit trees possessed by the interviewee.

		No. of trees			No. of trees
1	Sugar palm	Q-224	3	Mango	Q-226
2	Coconut palm	Q-225	4	Jackfruit	Q-227

SECTION VI LAND HOLDING AND CROPPED AREA

VI-1 Land holding (only for farm land)

Note: Write area of farmland by item. “Land owned” + “Land rented from others” – “Land leased to others” = “Land operated”. If the household is categorized as complete landless labor farmer, all the items must be “0 ha”.Please differentiate irrigated paddy field by gravitation (irrigation canal) from supplementary irrigated field by pumping. If both gravity and pumping irrigation are employed, indicate detail in box of “Note”.

		Land owned	Land rented from others	Land leased to others	Land operated
1	Irrigated paddy field	ha Q-228	ha Q-229	ha Q-230	ha Q-231
2	Irrigated paddy field (supplementary pump irrigated)	ha Q-232	ha Q-233	ha Q-234	ha Q-235
3	Rainfed paddy field	ha Q-236	ha Q-237	ha Q-238	ha Q-239
4	Upland for field crop	ha Q-240	ha Q-241	ha Q-242	ha Q-243
5	Upland for tree crop	ha Q-244	ha Q-245	ha Q-246	ha Q-247
6	Total	ha Q-248	ha Q-249	ha Q-250	ha Q-251

VI-2 Land holding status (fill in answer code)

Note: The categorization of the land holding status shall be chosen from the codes shown in Questionnaire. The evaluation of the land holding status shall be chosen from the codes below.

Q-252

1	Owner cultivator	2	Owner cum sharecropper	3	Sharecropper
4	Owner cum tenant	5	Tenant	6	Not operating any farm land

VI-3 Condition for land tenure

Note: Write land rental charge. If the household pays land rental charge in kind, choose the codes for responsibility to pay production cost. If the household use land without any kind of payment, choose "Free of charge". Choose the codes below for decision maker for crop selection in rental land.

1. Land rental charge

			Rental charge		Production cost born by		Answer code
1	In cash	Irrigated paddy field	riel/ha/season	Q-253		Q-254	1. Land owner
		Rainfed paddy field	riel/ha/season	Q-255		Q-256	2. Tenant
		Upland field	riel/ha/season	Q-257		Q-258	3. Both
2	In kind	Irrigated paddy field	% of harvest	Q-259		Q-260	4. Other
		Rainfed paddy field	% of harvest	Q-261		Q-262	
		Upland field	% of harvest	Q-263		Q-264	
3	Free of charge			Q-265			
4	Others	Specify:				Q-266	

2. Decision maker for crop selection in rented land

1	Irrigated paddy field	Q-267	3	Upland field		Q-269
2	Rainfed paddy field	Q-268				

Answer code

1. Land owner
2. Tenant
3. Both
4. Other

SECTION VII LAND USE

VII-1 Cropped Area

Note: Write land use by category for last cropping season. If this farmer uses reservoir and/or canal for cultivation, fill out its area.

		Dry season						Wet season					
		Early Dry season			Late Dry season			Early Wet season			Late Wet season		
Paddy Field													
1	Irrigated paddy	ha	Q-270		ha	Q-271		ha	Q-272		ha	Q-273	
2	Rainfed paddy	ha	Q-274		ha	Q-275		ha	Q-276		ha	Q-277	
3	( )	ha	Q-278		ha	Q-279		ha	Q-280		ha	Q-281	
4	Others	ha	Q-282		ha	Q-283		ha	Q-284		ha	Q-285	
Upland Field													
1	( )	ha	Q-286		ha	Q-287		ha	Q-288		ha	Q-289	
2	Others	ha	Q-290		ha	Q-291		ha	Q-292		ha	Q-293	

SECTION VIII PRODUCTION

VIII-1 Crops

Note: "Production" – self-consumption = "Sold Production". The "Price" shall be average of the year. "Income" = "Product Sold" x "Unit Price".

	Commodity	Production		Sold product		Price		Income	
1	Irrigated paddy (wet season)	kg	Q-311	Kind: kg	Q-312	riel/kg	Q-313	riel	Q-314
2	Irrigated paddy (dry season)	kg	Q-315	Kind: kg	Q-316	riel/kg	Q-317	riel	Q-318
3	Rainfed paddy	kg	Q-319	Kind: kg	Q-320	riel/kg	Q-321	riel	Q-322
4	Fruits	kg	Q-323	kg	Q-324	riel/kg	Q-325	riel	Q-326
5	Sugar Palm	Kind: kg	Q-327	Kind: kg	Q-328	riel/kg	Q-329	riel	Q-330
6	Others (specify)	kg	Q-331	kg	Q-332	riel/kg	Q-333	riel	Q-334
7	Others (specify)	kg	Q-335	kg	Q-336	riel/kg	Q-337	riel	Q-338
8	Others (specify)	kg	Q-339	kg	Q-340	riel/kg	Q-341	riel	Q-342

VIII-2 Livestock & Fish

Note: Write number of livestock/poultry sold in last year, unit prices and gross return.

	Livestock/Fish	Sold product in last year		Price (riel/unit)		Income	
1	Cow	(no.)	Q-343	riel	Q-344	riel	Q-345
2	Cattle	(no.)	Q-346	riel	Q-347	riel	Q-348
3	Water Buffalo	(no.)	Q-349	riel	Q-350	riel	Q-351
4	Swine/Pig	(no.)	Q-352	riel	Q-353	riel	Q-354
5	Poultry	(no.)	Q-355	riel	Q-356	riel	Q-357
6	Egg	(no.)	Q-358	riel	Q-359	riel	Q-360
7	Fish	kg	Q-361	riel/kg	Q-362	riel	Q-363

VIII -3 Food condition/ availability

Note: The food condition/ availability shall be chosen from the codes given in Questionnaire.

		Condition				Condition	
1	Rice		Q-364	5	Vegetables		Q-365
2	Other cereals		Q-366	6	Meat		Q-367
3	Roots and tuber crops		Q-368	7	Fish		Q-369

Note: Answer & answer code

1. Own harvest/ product exceed the household demand	3. Purchased (or exchanged) to meet the household demand
2. Own harvest/ product is just enough to the household demand	4. Insufficient

SECTION IX POST-HARVEST, PROCESSING AND MARKETING

IX -1 Post-harvest operation of rice

Note: Write kind of machinery and its ownership (Own/ Borrow/ Cooperative) if interviewee uses it, and its charge for borrowing. The codes indicated in Questionnaire shall be chosen for each processing. Write unit for borrowing charges, e.g. riel/ time, riel/hour or riel/day. In case of rice milling cost, indicate who receive rice bran.

Operation	Method		Ownership		Charge in case of borrowing	
Threshing		Q-397		Q-398		Q-399
Drying		Q-400		Q-401		Q-402
Cleaning		Q-403		Q-404		Q-405
Rice milling cost	In case rice bran received by interviewee				riel/ton	Q-407

Method						Ownership	
Threshing	Code	Drying	Code	Cleaning	Code	Ownership	Code
Engine thresher	1	Dryer (machine)	1	Engine winnower	1	Own	1
Pedal thresher	2	Sun drying	2	Manual winnower	2	Borrowed	2
Manual threshing	3		3	Manual without winnower	3	Cooperative	3

IX -2 Storage and post-harvest losses of rice

Note: Write means of storage of rice. The kind of container shall be chosen from the codes given in Questionnaire

Product	Kind of container		Amount to be stored		Maximum storage period	
Paddy		Q-408	…………………..Kg or (......bags, 1bag=…..Kg)	Q-409	months	Q-410
Rice		Q-411	…………………..Kg or (......bags, 1bag=…..Kg)	Q-412	months	Q-413

Bag	Code 1	Bamboo basket	Code 2	Wooden box	Code 3	Others	Code 4

Post-harvest losses of rice

Note: Choose the two (2) dominant losses on the processing from the codes given in Questionnaire and write roughly estimated total post-harvest losses in % of total products.

Most dominant loss [ ] Q-416 2nd dominant losses [ ] Q-417 Total losses [%] Q-418

During harvesting	Code 1	At threshing	Code 2	At drying	Code 3
At Cleaning	Code 4	At storage	Code 5	At other time (specify)	Code 6

IX-3 Marketing of rice

Note: Indicate marketing timing of rice in according to the question. Form of sold products (dry unhusked rice/paddy; milled rice etc) and marketing destination (to whom sell products) by the codes given in Questionnaire.

Timing	1. Just after harvest	2. When cash is needed	3. When price is high		Q-419
Sold product	1. Field dried paddy	2. Sun dried paddy	3. Milled rice		Q-420
Destination	1. Rice miller in village	2. Rice miller in commune center	3. Rice miller in district center		Q-421
	4. Collector/middleman	5. Local market	6. Others (specify)		

IX-4 Processing of rice (for selling being done by interviewee)

Note: If interviewee process white rice for sell, choose kind of the rice processing from the codes given.

1. Noodle	2. Confectionary	3. Powder	4. Liquor	5. Others		Q-423

IX-5 Marketing of other products

Note: Indicate marketing destination of other products by choosing the codes given in Questionnaire.

Crop	Fill in answer code		Answer code & answer
Vegetables		Q-426	1. Market in village
Livestock		Q-427	2. Market in commune center
Fish		Q-428	3. Market in district center
			4. Collector/middleman
			5. Other (specify)

IX-6 Selling Price of Paddy and Milled Rice

Note: Please give us the following prices

Crop	Paddy			Milled Rice		
Early rice (1st wet)		Riel/kg	Q-424a		Riel/kg	Q-424b
Early rice (2nd wet)		Riel/kg	Q-424c		Riel/kg	Q-424d
Medium rice		Riel/kg	Q-424e		Riel/kg	Q-424f
Early rice (dry)		Riel/kg	Q-424g		Riel/kg	Q-424h

IX-7 Farm Gate Price of Farm Inputs

Note: Please give us the following prices

Input	Farm Gate Price		
Seed paddy			
Early rice ( )		Riel/kg	Q-424i
Medium rice ( )		Riel/kg	Q-424j
Maize ( )		Riel/kg	Q-424k
Beans ( )		Riel/kg	Q-424l
Urea		Riel/kg	Q-424m
DAP		Riel/kg	Q-424n
KCl		Riel/kg	Q-424o
Land preparation by ox			
Plow		Riel/ha	Q-424p
Plow + Harrow		Riel/ha	Q-424q
Harrow		Riel/ha	Q-424r
Land preparation by hand tractor			
Plow		Riel/ha	Q-424s
Plow + Harrow		Riel/ha	Q-424t
Harrow		Riel/ha	Q-424u
Transportation			
House to market ( )		Riel/kg	Q-424v
House to market ( )		Riel/kg	Q-424w
House to market ( )		Riel/kg	Q-424x

SECTION X AGRICULTURAL SUPPORT SERVICES

Note: Reponses shall be chosen from the codes given in Questionnaire.

X-1 Extension services

Question	Answer code & answer				
Visit of extension worker	1. once per < 2 weeks	2. once per 2 weeks~1 month	3. Seldom visited		Q-429
Technical capability of extension workers	1. Sufficient	2. Not sufficient	3. No services provided		Q-430
Are you satisfied with current extension services	1. Satisfied	2. Not satisfied	3. No services provided		Q-431
What kind of extension services are needed ? (specify)					Q-432

X-2 Rice seed supply

Question	Answer code & answer				
Procurement of wanted seeds	1. Easy	2. Difficult	3. Not possible		Q-433
Procurement of certified/quality seeds	1. Easy	2. Difficult	3. Not possible		Q-434
Seed supply timing	1. In time	2. Delayed	3. Not obtained		Q-435
Quality seed prices	1. Too expensive	2. Acceptable	3. Not purchased		Q-436

X-3 Farm inputs supply

Question	Answer code & answer				
Procurement of wanted fertilizer	1. Easy	2. Difficult	3. Not possible		Q-437
Fertilizer supply timing	1. In time	2. Delayed	3. Not obtained		Q-438
Fertilizer prices	1. Too expensive	2. Acceptable	3. Not purchased		Q-439

X-4 Farm credit

Question	Answer code & answer				
Access to farm credit	1. Easy	2. Difficult	3. Not possible		Q-440
Timing of provision	1. In time	2. Delayed	3. Not provided		Q-441
Amount of credit	1. Sufficient	2. Not sufficient	3. Not provided		Q-442
Procedures for credit application	1. Easy	2. Difficult	3. Not possible		Q-443

SECTION XI FARMING CONSTRAINTS AND IMPROVEMENT

XI-1 Farming constraints (agronomic & farm management)

Note: Ask about agronomic and farming constraints to the interviewee and indicate up to 4 constraints (maximum) in order of seriousness by consulting the answer codes given in Questionnaire.

What are serious agronomic & farm management constraints for farming ? (select plural answer)

1. Most serious [1st] Q-444a 2. 2nd serious [2nd] Q-444b 3rd serious [3rd] Q-444c 4th serious [4th] Q-444d Q-444

Note
Answer and answer code

1	Low yield of crops (paddy)	9	Difficulty for obtaining quality seeds
2	Crop losses due to pest & disease	10	Difficulty for purchasing fertilizers
3	Weed problem	11	Expensive farm inputs
4	Crop losses due to wild animal	12	Poor soil conditions
5	Difficulty for hiring draft animal/machinery	13	Marketing problems of products
6	Labor shortage	14	Lack of farm credit
7	Insufficient extension services	15	Others (specify)
8	Shortage of farming capital	16	Others (specify)

XI-2 Farming constraints (physical)

Note: Ask about physical constraints for farming to the interviewee and indicate up to 3 constraints (maximum) in order of seriousness by consulting the answer codes given in Questionnaire.

What are serious physical constraints for farming? (select plural answer)

1. Most serious constraints [1st] Q-445a 2. 2nd serious constraints [2nd] Q-445b 3rd serious constraints [3rd] Q-445c Q-445

Note
Answer and answer code

1	Irrigation water shortage in wet season	6	Lack of transportation means
2	Irrigation water shortage in dry season	7	Leveling problem of paddy field
3	Inundation/flooding	8	Others (specify)
4	Drainage problem	9	Others (specify)
5	Lack of farm road	10	Others (specify)

XI-3 Marketing constraints

Note: Ask about marketing constraints to the interviewee and indicate up to 3 constraints (maximum) in order of seriousness by consulting the answer codes given in Questionnaire.

1. Most serious constraints [1st] Q-446a 2. 2nd serious constraints [2nd] Q-446b 3rd serious constraints [3rd] Q-446c Q-446

Answer and answer code

1	Unstable market prices of paddy/rice	7	Unstable market prices of livestock
2	Low market prices of paddy/rice	8	Low market prices of livestock
3	Limitation of market of paddy/rice	9	Limitation of market of livestock
4	Unstable market prices of other crops	10	Lack of or poor farm to market road
5	Low market prices of other crops	11	Others (specify)
6	Limitation of market of other crops	12	Others (specify)

XI-4 Reasons for limited productivity of crops in the rice field of interviewee (not specific to last year)

Note: Ask reasons for limited (low) productivity of crops in the rice fields of the interviewee and indicate up to 3 constraints (maximum) in order of seriousness by consulting the answer codes given in Questionnaire. Reasons should not be specific to last year but general problems faced by the interviewee.

1. Most serious constraints [1st] Q-447a 2. 2nd serious constraints [2nd] Q-447b 3rd serious constraints [3rd] Q-447c Q-447

Answer and answer code

1	Drought in wet season	7	Damages caused by wild animal (rat)
2	Water shortage in dry season	8	Poor drainage
3	Shortage of farming capital	9	Flooding/inundation
4	Poor seed quality	10	Inadequate farming technologies
5	Poor soil	11	Damages caused by pest & disease
6	Limited application of fertilizer	12	Others (specify)

XI-5 Activities/practices to improve rice productivity implemented by the interviewee in the past 3 years (plural answer)

Note: Ask activities or practices carried out to improve rice productivity by the interviewee in the past 3 years by consulting the answer codes given in Questionnaire. Indicate all activities/practices implemented.

1.	2.	3.	4.
Q-448a	Q-448b	Q-448c	Q-448d

Q-448

Answer and answer code

1	Increased fertilization doses	6	Started to use water pump for irrigation
2	Applied of compost/manure	7	Improved farming practices
3	Used quality seed (local variety)	8	Improved post-harvest practices
4	Used quality seed (high yielding variety)	9	Changed marketing methods
5	Constructed of farm pond	10	Others (specify)

XI-6 Necessary activities to improve rice productivity in the field of the interviewee (farming & farm management; plural answer)

Note: Ask farming or farm management activities or practices necessary for the improvement of rice productivity in the field of interviewee by consulting the answer codes given in Questionnaire. Indicate up to 4 activities/practices required (maximum) in order of degree of necessity.

1. Most required [1st] Q-449a 2. 2nd required [2nd] Q-449b 3rd required [3rd] Q-449c 4th required [4th] Q-449d Q-449

Answer and answer code

1	Improvement of farming practices	7	Intensive weeding
2	Use of quality seed (local variety)	8	Formation/strengthening of farmers organization
3	Use of quality seed (high yielding variety)	9	Others (specify:)
4	Use of adequate doses of fertilizer	10	Others (specify:)
5	Improved leveling of paddy field	11	Others (specify:)
6	Planting at proper time	12	Others (specify:)

XI-7 Necessary physical works to improve rice productivity in the field of the interviewee (plural answer)

Note: Ask physical works necessary for the improvement of rice productivity in the field of interviewee by consulting the answer codes given in Questionnaire. Indicate up to 3 works required (maximum) in order of degree of necessity.

1. Most required [1st] Q-450a 2. 2nd required [2nd] Q-450b 3rd required [3rd] Q-450c Q-450

Answer and answer code

1	Irrigation water supply for wet season	7	
2	Irrigation water supply for dry season	8	
3	Mitigation of inundation/flooding	9	Others (specify)
4	Drainage improvement	10	Others (specify)

SECTION XII LIVESTOCK CONSTRAINTS

Note: Ask livestock constraints to the interviewee by consulting the answer codes given in Questionnaire. Indicate up to 3 constraints in order of degree of seriousness.

1. Most serious constraints [1st] Q-451a 2. 2nd serious constraints [2nd] Q-451b 3rd serious constraints [3rd] Q-451c Q-451

Answer and answer code

1	Low productivity	6	Insufficient veterinary services
2	Shortage of feed	7	Insufficient extension services
3	Low or unstable market prices	8	Difficulty in obtaining good breed
4	Market availability	9	Others (specify)
5	Losses due to diseases	10	Others (specify)

SECTION XIII IRRIGATION, WATER MANAGEMENT & FARMERS WATER USERS COMMUNITY AND GROUP (FWUC & FWUG)

Note: Fill in Questionnaire Sheet according to the instructions given in the Sheet

XIII-1 About FWUC

	Question	Answer code & answer				
1	Are you a member of FWUC	1. Yes	2. No	3. Not know		Q-532
2	Did you pay irrigation fee in last year; if yes how much	1. Yes	2. No	3. No fee charged		Q-539
		riel/ha				Q-540

XIII-2 About FWUG

1	Are you a member of FWUG	1. Yes	2. Not know			Q-542
8	Did you pay irrigation fee in last year; if yes how much	1. Yes	2. No	3. No fee charged		Q-549
		riel/ha				Q-550

SECTION XIV FLOOD DAMAGE

Note: Fill in Questionnaire Sheet according to the instructions given in the Sheet

1. Do you suffer from flood damage? Q- 552

1. YES	2. No

If you select 'Yes',

2. How often do you suffer from flood in a year Q- 553

1. Once a year	2. Twice a year	3. 3 times a year	4. 4 times or more a year

3. How many days does one flood continues on average? Q- 554

1. 1 day	2. 2 days	3. 3 days	4. 4 days or more

4. How do the floods damage you? (multiple answers are allowed) Q- 555

Q- 555a Q- 555b

1. Paddy	2. Vegetable Field	6. Large Livestock e.g. Buffalo, Cow	5. Poultry	4. Fish
3. Household Goods e.g. House, Motorcycle	7. Family's Life	8. Others ( )		

SECTION XV EXPECTATIONS

Note: Ask expectations of the interviewee on agronomic & farm management, farming system, physical aspects. And agricultural support services by consulting the answer codes given in Questionnaire. Indicate up to 3 responses in order of degree of expectation or requirement.

XV-1 Which kind of cropping pattern do you require, if water is available in dry season?

Q- 453

1	Early Rice (Wet) + Early Rice (Wet)	5	Early rice (Wet) + Early (Wet) + Upland Crops
2	Early Rice (Wet) + Medium Rice (Wet)	6.	Medium rice (Wet) + Upland Crops
3	Upland crops (Dry) + Medium Rice (Wet)	7.	Medium rice (Wet) only
4	Upland crops (Dry) + Early rice (Wet)	8	Others ( )

XV-2 Which kind of improvement do you want?

1. Most required [1st] Q-452a 2. 2nd required [2nd] Q-452b 3rd required [3rd] Q-452c Q-452

Answer and answer code

1	Productivity improvement of wet season rice	6	Increasing livestock holding size & production
2	Productivity improvement of dry season rice	7	Increasing poultry holding size & production
3	Productivity improvement of field crops	8	Strengthening or formation of farmers organizations
4	Productivity improvement of vegetables	9	Improvement of post-harvest operation
5	Productivity improvement of livestock/poultry	10	Others (specify)

XV-3 Which kind of improvement in water issue do you want?

1. Most required [1st] Q-454a 2. 2nd required [2nd] Q-454b 3rd required [3rd] Q-454c Q-454

Answer and answer code

1	Adequate (volume/timing) irrigation water supply in wet season	6	Drainage improvement
2	Adequate (volume/timing) irrigation water supply in dry season	7	Leveling of paddy field
3	Mitigation of inundation & flooding	8	Others (specify)
4	Construction/rehabilitation of farm road	9	Others (specify)
5	Construction/rehabilitation of farm to market road	10	Others (specify)

XV-4 Agricultural support services

1. Most required [1st] Q-455a 2. 2nd required [2nd] Q-455b 3rd required [3rd] Q-455c Q-455

Answer and answer code

1	Field Extension services (demonstration / field guidance)	6	Provision of market information
2	Provision of quality seed	7	Provision of farm credit
3	Farmer training (technical & host-harvest operation)	8	Provision of fertilizer
4	Farmer training (organization, marketing, farm management)	9	Others (specify)
5	Support to organize farmers	10	Others (specify)

ANNEX C

Attachment 5

Master Textbooks, Guidelines, and Handouts for Extension Activities

ANNEX C
ATTACHMENT 5

Master Textbooks, Guidelines, and Handouts for Extension Activities

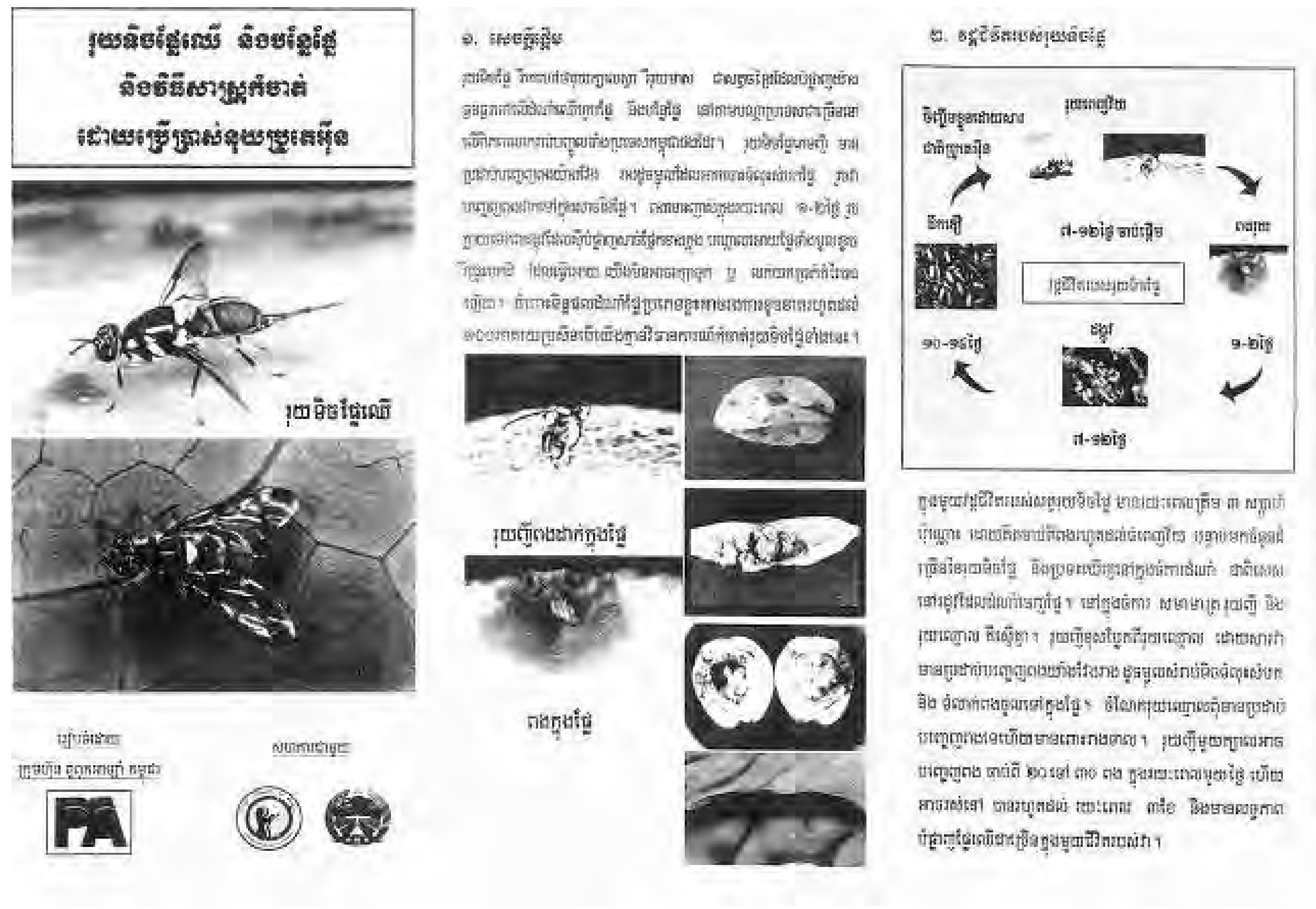
List of Materials

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-1

Handout on Fruit Fly Management



Japan International Cooperation Agency

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Material AC-A5-2

Handout on Stem Borers Management

មន្ទីរកសិកម្មខេត្តកណ្តាល

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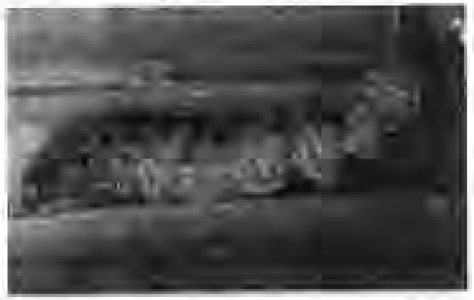

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ឆ្នាំ ២០១០

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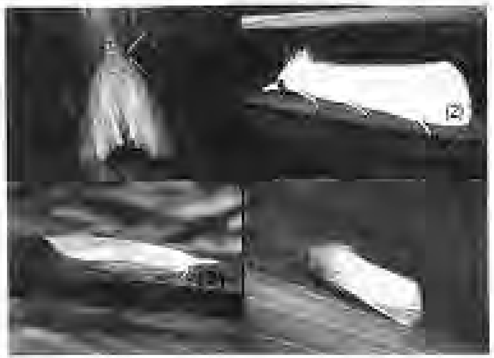

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៣-វដ្តជីវិត

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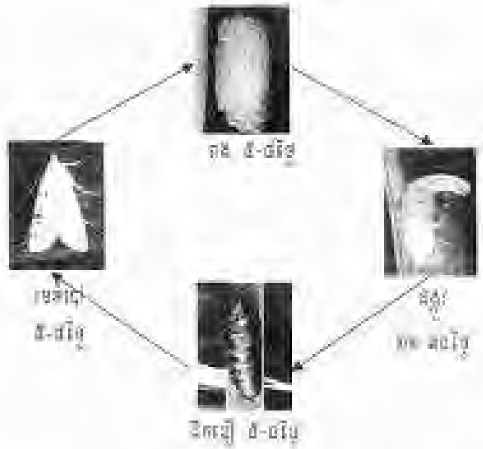

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-3

Handout on Thrip Management

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ទ្រីប

អាស័យដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទ : (០២៣) ៩៨៣ ៤៦១

: (០១២) ៨២៤ ៤២៩

ឧបត្ថម្ភដោយ : អង្គការនិធិអ៊ុធី VVOB

ឆ្នាំ ២០១០

ទ្រីប

១.លក្ខណៈរូបសាស្ត្រ

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Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-4

Handout on Safe Operation of Pesticide

[illegible]

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នាយកដ្ឋាន

ស្រោចស្រព និង កែលំអដីកសិកម្ម

ការិយាល័យ

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និងការការពារបរិស្ថាន

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Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-5

Handout on Stem Borer Management

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វិធានការបង្ការ និងកំចាត់

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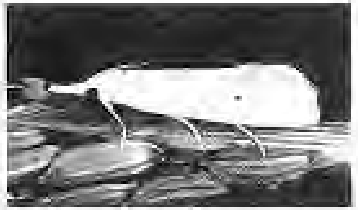

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នាយកដ្ឋាន

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ការិយាល័យ

ការពារដំណាំ និងត្រួតពិនិត្យគុណភាពអនាម័យ

ដង្កូវស៊ីរូងដើម

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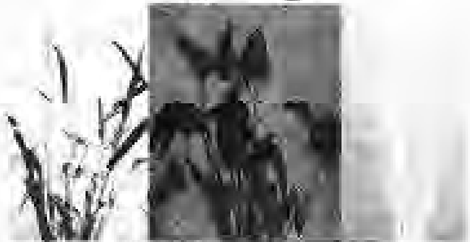
Material AC-A5-6

Handout on Weed Management

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ស្មៅចង្រៃ



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ទីនាក់ទំនងទូរស័ព្ទលេខ៖ ០១២ ៨៨៣ ៩៦១

ឧបត្ថម្ភដោយ៖ អង្គការ VVOB ឆ្នាំ ២០១០

ស្មៅចង្រៃ

១.ប្រភេទស្មៅចង្រៃ

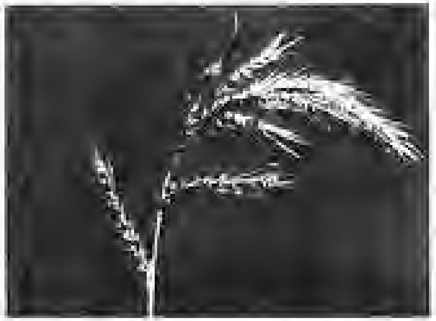
ស្មៅជារុក្ខជាតិដែលមានដុះនៅត្រង់ទីកន្លែងដែលគេមិនចង់បានវា ស្មៅគឺជារុក្ខជាតិមួយចង្រៃបំផុតលើដំណាំស្រូវ។ វាដុះនៅក្នុងស្រែដោយខ្លួនឯងហើយដុះកាន់តែច្រើននៅពេលណាដែលយើងធ្វើដីមិនបានស្អាតល្អ។

កសិករមួយចំនួនមិនត្រូវការឱ្យវាដុះនៅក្នុងស្រែរបស់ពួកគាត់ទេព្រោះទិន្នផលស្រូវអាចនឹងធ្លាក់ចុះ បើសិនជាមានដុះស្មៅច្រើននៅក្នុងស្រែ។

ស្មៅជាកត្តាចង្រៃមួយដែលមានឥទ្ធិពលអាក្រក់ដល់ដំណាំស្រូវដូចជា៖ វាដុះប្រជែងជាមួយស្រូវហើយដណ្ដើម យកសារធាតុចិញ្ចឹម ពន្លឺ និងទឹកពីស្រូវ។ វាអាចជាជំរកដល់សត្វល្អិតចង្រៃឬសត្វកណ្ដុរ និងជម្ងឺ ធ្វើឱ្យស្មុគស្មាញប្រមូលផលប្រឡាយ និងធ្វើឱ្យគុណភាពទិន្នផលស្រូវថយចុះ។ តាំងឱ្យមានពេលវេលាក្នុងការកំចាត់។

ជាទូទៅគេចែកស្មៅចង្រៃជា ៣ក្រុម ៖ក្រុមស្មៅស្លឹកតូច ក្រុមស្មៅស្លឹកធំ និង ក្រុមស្មៅកក់។

- **ក្រុមស្មៅស្លឹកតូច**៖ ជាប្រភេទស្មៅដែលមានស្លឹកតូច សរសៃស្លឹកដុះស្រប និងវែង មុខកាត់នៃដើមមានរាងមូលហើយស្លឹករបស់វាដុះនៅលើដើមម្ដុំយគ្នា។ ឧទាហរណ៍៖ ស្មៅចកក្រាល



- **ក្រុមស្មៅស្លឹកធំ**៖ ជាប្រភេទស្មៅដែលមានទំហំ និង សរសៃស្លឹកខសគ្នា ហើយស្លឹករបស់វាមានទំហំធំជាងពួកស្មៅស្លឹកតូចនិងស្មៅកក់។ ឧទាហរណ៍៖ កំប្លោក...

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

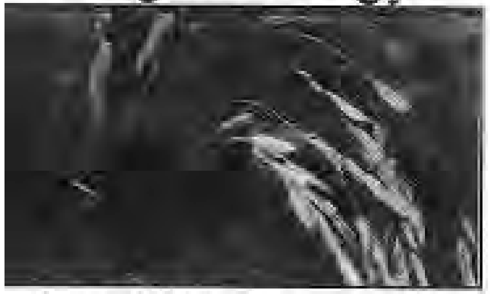
Material AC-A5-7

Handout of Rice Fungi Management

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ជំងឺផ្សិតលើដំណាំស្រូវ



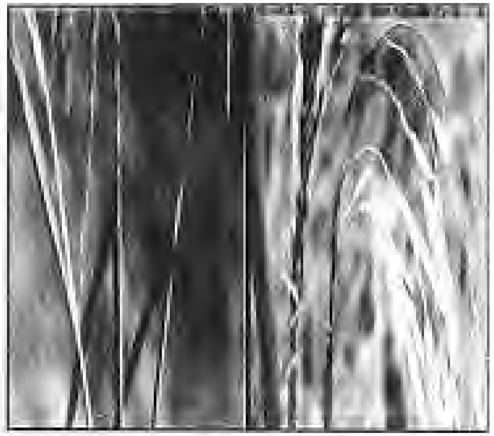
អាសយដ្ឋានទំនាក់ទំនង: ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ: ០២៣ ៥៨៣ ៤៦១

ឧបត្ថម្ភដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

១-ជំងឺប្លាស់ : ជំងឺនេះកើតមាននៅលើស្លឹកស្រូវ ស្លឹក ដើម ថ្នាំង និងកួរស្រូវ។ នៅលើស្លឹកមានស្នាមអុចពណ៌ត្នោតប្រផេះលេចឡើងនៅលើផ្ទៃស្លឹក ស្នាមអុចទាំងនោះមានរាងពងក្រពើ ដែលផ្ទៃកណ្ដាលមានពណ៌ប្រផេះហើយគែមជុំវិញមានពណ៌ត្នោត។

-នៅលើដើម : នៅលើថ្នាំងដើមខាងលើនៃដើមស្រូវមានលេចឡើងស្នាមចំណុចពណ៌ខ្មៅតូចៗរាងមូល ស្នាមចំណុច នោះរីករាលដាលជុំវិញថ្នាំងហើយបណ្ដាលឲ្យថ្នាំងនោះប្រែពណ៌ខ្មៅស្អុយហើយបាក់ងាយ ។ ការកើតជំងឺនេះនៅលើកួរស្រូវធ្វើឲ្យគុណភាពគ្រាប់ធ្លាក់ចុះ និង បន្ថយទិន្នផល ។



វិធានការ ការពារ និងកំចាត់

- ដាំពូជដែលធន់ នឹងជំងឺ
- ជៀសវាងការប្រើប្រាស់ជីអ៊ុយរ៉េច្រើនពេកនៅរដូវវស្សា។
- កុំស្ទូងញឹកពេក និង ជ្រៅពេក
- ដកកាត់ផ្លាស់ - សំអាតស្មៅក្នុងស្រែ និងលើភ្លឺស្រែ

២-ជំងឺគុតត្នោត : ជាជំងឺដែលរាលដាលលើស្លឹកស្រូវ ។

រោគសញ្ញា

យើងអាចឃើញសញ្ញាជំងឺលេចចេញគ្រាប់នៅលើស្លឹកនិងសំបកគ្រាប់ ។ ស្នាមចេញនៅលើស្លឹក មានរាងពងក្រពើ មានទំហំ និង សណ្ឋានប្រហាក់ប្រហែលគ្នា ដូចគ្រាប់ល្ង ស្នាមខ្លះដែលចេញថ្មីៗមានសណ្ឋានតូចៗរាងជារង្វង់ ហើយ

AC-A5-7

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-8

Handout on Black Bugs Management

មន្ទីរកសិកម្មខេត្តកណ្តាល

សង្កើចខ្មៅ

ស័យដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទាក់ទំនងទូរស័ព្ទ : (០២៣) ៥៤៣ ៤៦១

: (០១២) ៨២៤ ៤២៥

រៀបរៀងដោយ : អង្គការទិចិអូមី VVOB

ឆ្នាំ ២០១០

សង្កើចខ្មៅ

១.លក្ខណៈរូបសាស្ត្រ និង ជីវសាស្ត្រ

មេសង្កើចខ្មៅមានពណ៌ត្នោតស្រអាប ឬខ្មៅស្រអាប ។ ពេលថ្ងៃវាប្រមូលផ្តុំគ្នានៅគល់ស្រូវជុំតពីទឹក នៅពេលយប់វាឡើងទៅផ្នែកខាងលើដើមស្រូវ ហើយជញ្ជក់យកទឹកដើមស្រូវ ។ មេសង្កើចសំងំនៅតាមគុម្ពព្រៃ ក្នុងអំឡុងពេលរដូវប្រាំង ។ នៅពេលរដូវវស្សា ពួកវាហើរទៅរកស្រែហើយបង្កើតកូន ២-៣ ជំនាន់ រួចហើយពួកវាត្រឡប់ទៅរស់នៅលើទីទួលវិញ ។ មេសង្កើចខ្មៅមានសមត្ថភាពអាចហើរបានចម្ងាយឆ្ងាយ ។

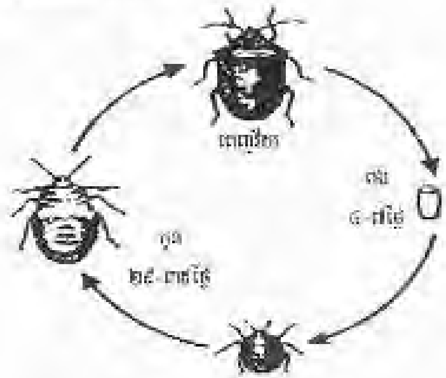
២.វដ្តជីវិត

សង្កើចខ្មៅទាក់ទាញយ៉ាងខ្លាំងដោយសារពន្លឺភ្លើង និងខែពេញបូណ៌មី ។ អន្ទាក់ភ្លើងប្រើបានផលក្នុងការប្រមូលចាប់មេសង្កើចខ្មៅឡើយ ។

មេសង្កើចខ្មៅអាចពងបានប្រហែល ២០០ពង ក្នុងមួយជីវិតវា ។ ពងនីមួយៗមានពណ៌បៃតងស្រាលតម្រៀបជា ២-៤ជួរ ហើយមានចំនួនជាង ១៥ ពង ។ វាពងនៅផ្នែកខាងក្រោមស្លឹក ផ្នែកជិតទឹក, ដើមស្រូវ ឬស្មៅ និងនៅលើដីដែលក្រហែង ។

ក្រោយពងបាន ៤-៧ ថ្ងៃ កើតជាកូនសង្កើចញាស់ ។ មុនញាស់ ពងមានពណ៌ប្រែពណ៌បៃតងទៅជាពណ៌ផ្កាឈូក ។ កូនសង្កើចខ្មៅមានពណ៌ត្នោត ឬលឿង និងមានចំនុចខ្មៅ ហើយមានប្រវែងប្រហែល ២-៨ មិល្លីម៉ែត្រ ។ កូនទើបញាស់រួមជាមួយ វាតែងនៅជិតពង រួចហើយទៅរកស៊ីនៅគល់ស្រូវតែម្តង ។ ពីកូនទៅពេញវ័យមានរយៈពេល២៩-៣៥ថ្ងៃ ។

មេសង្កើចមានពណ៌ខ្មៅ និងមានប្រវែង ៨-៩ មិល្លីម៉ែត្រ ។ វដ្តជីវិតរបស់សង្កើចខ្មៅគិតពីពេលពងរហូតដល់ពេញវ័យមានរយៈពេល ៣៣-៤១ ថ្ងៃ ហើយមេសង្កើចខ្មៅអាចរស់នៅបានរហូតដល់ទៅ ៧ ខែ ។



Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

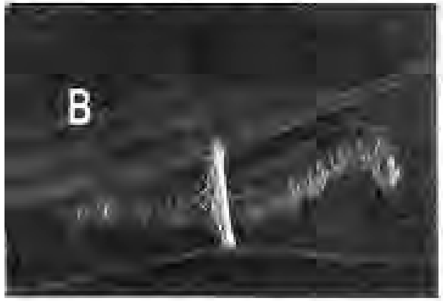
Japan International Cooperation Agency

Figure AC-A5-9

Handout on Leaf Folder Management

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ដង្កូវមូរស្លឹក



ទីស្នាក់ការមន្ទីរ : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទាក់ទងទូរស័ព្ទ : (០២៣) ៥៣៣ ៤៦១

: (០១២) ៨២៤ ៤២៥

ឧបត្ថម្ភដោយ : អង្គការទិចិម្មុខ VVOB

ឆ្នាំ ២០១០

ដង្កូវមូរស្លឹក

១-លក្ខណៈទូទៅ

ដង្កូវមូរស្លឹកកើតឡើងនៅគ្រប់ប្រព័ន្ធដាំដុះស្រូវ និងវាមានវត្តមានគ្រប់ដំណាក់កាលនៃការលូតលាស់ស្រូវ ។ ដង្កូវមូរស្លឹកច្រើនមាននៅកន្លែងមានម្លប់និងកន្លែងដែលគេប្រើប្រាស់ជីច្រើន ។ នៅតំបន់ដាំស្រូវច្រើន ពពួកដង្កូវមូរស្លឹកមានវត្តមានពេញមួយឆ្នាំ ជាពិសេសប្រទេសដែលមានអាកាសធាតុក្ដៅ ពពួកដង្កូវមូរស្លឹកមានសកម្មភាពខ្លាំងនៅរដូវវស្សា ។

២-លក្ខណៈរូប

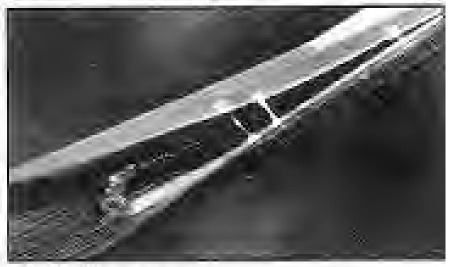
មេអំបៅញី និងឈ្មោល មានរូបរាងស្រដៀងគ្នាប្រហាក់ប្រហែលគ្នា ប៉ុន្តែមេអំបៅឈ្មោលមានទំហំតូចជាងមេអំបៅញី ។ មេអំបៅមានពណ៌លឿងត្នោត ។ នៅពេលវាទុំស្លាបវានៅលើផ្ទៃរបស់វាបត់ចុះ ធ្វើអោយខ្លួនវាមានរាងដូចត្រីកោណសម័ង្ស ។ នៅលើស្លាបមុខមានខ្សែបន្ទាត់ពណ៌លឿងខាងក្រហម ។ នៅចុងស្លាបមុខមានវិធុពណ៌ត្រចៀក ស្លាបក្រោយពណ៌លឿងត្នោតមានខ្សែបន្ទាត់ ២ បន្ទាត់មុខស្លាប ។

-ពង : មានពណ៌លឿងស្រាលៗ ឬ ពណ៌លឿងខ្ចី

-ដង្កូវ : មានពណ៌លឿងខ្ចី ឬ ពណ៌បៃតងខ្ចី

-ដឹកឌឿ : មានពណ៌ត្នោតក្រហម ឬ ពណ៌ក្រហមត្នោត

-មេអំបៅ : មានពណ៌លឿងត្នោត



៣-លក្ខណៈជីវសាស្ត្រ

មេអំបៅហើរនៅពេលយប់ ហើយនៅពេលថ្ងៃវាពួននៅគុម្ពស្រូវ ឬគុម្ពស្មៅ។ មេអំបៅអាចហើរបានឆ្ងាយរាប់គីឡូម៉ែត្រ។ មេអំបៅញីអាចពងបានលើសពី ១០០ គ្រាប់ ដាក់លើផ្ទៃស្លឹក ក្បែរកន្លែងដែលសរសៃកណ្ដាលស្លឹក ពងមានពណ៌ស្រាលៗ ឬពណ៌លឿងខ្ចី និងមានទំហំប្រហែល ១មីលីម៉ែត្រ ។

៤-វដ្ដជីវិត

-មេអំបៅ ១ក្បាល អាចពងបានលើសពី ១០០គ្រាប់

-មេអំបៅ : មានរយៈពេល ១០ថ្ងៃ

-ពង : មានរយៈពេល ៤-៦ថ្ងៃទើបញាស់

-ជីវិតជាដង្កូវ : មានរយៈពេល ១៥-៣០ថ្ងៃ

-ដឹកឌឿ : មានរយៈពេល ៦-១០ថ្ងៃ

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-10

Handout on Rice Bugs Management

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ស្រីងបញ្ចក់ទឹកដោះ

អាស័យដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

លេខទំនាក់ទំនងទូរស័ព្ទ : (០២៣) ៥៨៣ ៤៦១

: (០១២) ៧២៤ ៤២៥

រៀបរៀងដោយ : មន្ទីរកសិកម្ម

ឆ្នាំ ២០១០

ស្រីងបញ្ចក់ទឹកដោះ

១-លក្ខណៈទូទៅ

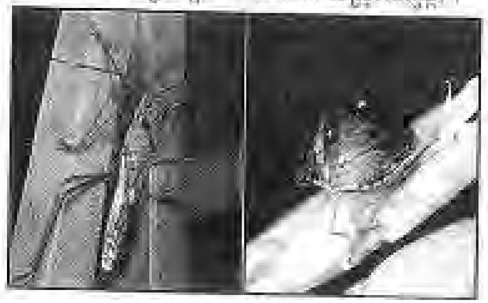
ស្រីងបញ្ចក់ទឹកដោះនៅលើដំណាំស្រូវ មាន ៣ ប្រភេទគឺ :

-ស្រីងស្លាបធំ : ពណ៌បៃតង ។

-ស្រីងស្លាបមធ្យម : ពណ៌ប្រផេះ ឬ ពណ៌ត្នោត

-ស្រីងស្លាបតូច : ពណ៌បៃតងប្រផេះ ឬ ពណ៌ត្នោតខ្ចី ។

ស្រីងពេញវ័យមានរាងតូចវែង និងស្លាបវែងជាងពោះ ។ បច្ចុប្បន្នមានប្រហែល ២ប្រភេទ ប្រភេទខ្លួនវែង និងខ្លួនខ្លី ។ ស្រីងពេញវ័យដែលកើតពេលព្រឹកព្រលឹម ហើយមានជើង និងអង់តែនវែង ។ សកម្មភាពបំផ្លាញខ្លាំងនៅពេលព្រឹកព្រលឹម និងល្ងាចនៅពេលមេឃស្រទុំ ។ ពេលថ្ងៃក្ដៅវាពួនលាក់នៅផ្នែកខាងក្រោមស្លឹកស្រូវ ។ កូននិងមេបំផ្លាញដោយបឺតជញ្ជក់ទឹកដោះគ្រាប់ស្រូវ ។ គ្រាប់ស្រូវដែលត្រូវបានបឺតជញ្ជក់នឹងក្លាយជាគ្រាប់ស្កក ឬមានស្នាមខ្មៅ ។



២-លក្ខណៈរូប

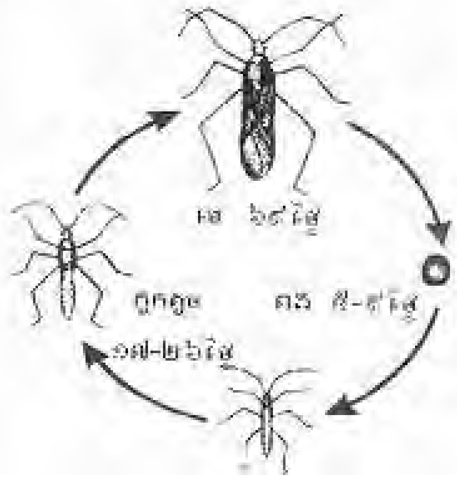
- ពង : រាងជាជួរនៅលើស្លឹក និងនៅលើកួរស្រូវដែលមានពណ៌ក្រហមត្នោត និងមានរាងដូចទូកអណ្ដែត ។ វាអាចពងបាន ២០០-៣០០ពងក្នុង១វដ្ដជីវិតរបស់វា ។
- កូន : មិនមានស្លាបពេញលេញ មានពណ៌បៃតងខ្ចី ។ កូនលូតលាស់ពេញវ័យនៅលើស្លឹក និងកួរស្រូវ ។
- មេពេញវ័យ : ពេលពេញវ័យមានពណ៌បៃតងប្រផេះ ឬ ត្នោត រាងតូចវែង និងមានក្លិនអាក្រក់ ស្អុយ ខ្លាំង ។

៣-វដ្ដជីវិត

-មេ : មានរយៈពេល ៦៩ថ្ងៃ

-ពង : មានរយៈពេល ៥-៩ថ្ងៃ

-កូន : មានរយៈពេល ១៧-២៦ថ្ងៃ



Japan International Cooperation Agency

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Material AC-A5-11

Handout on Caseworm Management

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ដង្កូវបំពង់កាត់ស្លឹក

អាសយដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទ : (០២៣) ៥៨៣ ៤៦១

: (០១២) ៨២៤ ៤២៥

ឧបត្ថម្ភដោយ : អង្គការវីវីអូប៊ី VVOB

ឆ្នាំ ២០១០

ដង្កូវបំពង់កាត់ស្លឹក

១-លក្ខណៈទូទៅ

ដង្កូវបំពង់កាត់ស្លឹក ជាប្រភេទសត្វចង្រៃម្យ៉ាងដែលបំផ្លាញដំណាំស្រូវ ការពិនិត្យកត់ត្រាលើការបាត់បង់ផលដែលកើតមានលើស្រូវនៅកម្ពុជា ជាពិសេសលើស្រូវវស្សា ។ វាជាសត្វល្អិតពេញវ័យរស់នៅបានទាំងក្នុងទឹក និងលើគោក ។ ក្នុងវ័យជាដង្កូវវាស៊ីបំផ្លាញស្លឹកស្រូវដោយកាត់ស្លឹកស្រូវធ្វើជាបំពង់ ហើយកាត់ចុះមកក្រោមធ្វើជាខ្ទមបណ្ដែតលើផ្ទៃទឹក ។ ដង្កូវប្រភេទនេះ វារស់នៅក្នុងបំពង់ស្លឹកស្រូវ ហើយបណ្ដែតខ្លួនលើផ្ទៃទឹកនៅពេលថ្ងៃ ពេលយប់វាវារឡើងលើដើមស្រូវដោយទំពក់ដើម្បីស៊ីស្លឹកស្រូវជាអាហារ ។

ដង្កូវប្រភេទនេះច្រើនកើតនៅលើដីស្រែដែលពុំបានរៀបចំស្មើល្អ និងលើស្រែដែលមានទឹកដក់ជាប្រចាំ ។ មេអំបៅពេញវ័យចូលចិត្តពន្លឺភ្លើង និង ...ដែលអាចរកឃើញ ៥០ពង ។

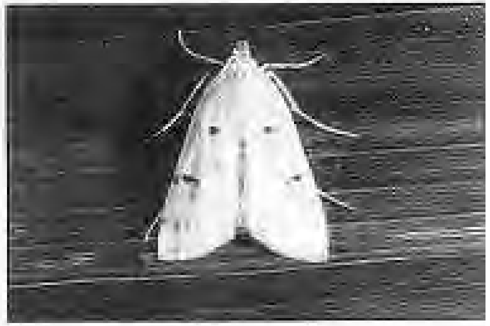
២-លក្ខណៈរូប

-ពង : មានពណ៌សព្រាលៗ/ពណ៌លឿងខ្ចី ប្រវែង... ទឹកលឿង (ពងរបស់វាមានរាងមូលស្អិតៗ មានទំហំមិនស្មើគ្នា តំរៀបជាជួរនៅខាងក្រោមផ្ទៃស្លឹក ពិតប្រាកដប្រែជាពណ៌លឿងចាស់)

-ដង្កូវ : មានពណ៌លឿងខ្ចី ឬ ខៀវស្រាលៗ ...អាចកន្ទុយ

-ដឹកឿ : មានពណ៌សព្រាលៗ ឬ ពណ៌ទឹកដោះគោ (ពណ៌ត្នោត)

-មេអំបៅ : មានពណ៌ស្លាបទឹកប្រាក់ សស្លេក... (ស្លាបពណ៌ត្នោតខ្ចី) ហើយមានចំណុចខ្មៅនៅលើស្លាប



៣-វដ្តជីវិត

-មេអំបៅ : មានរយៈពេល ៧ថ្ងៃ (ពងនៅលើ ស្លឹកស្រូវដែលធ្លាក់ដល់ផ្ទៃទឹក)

-ពង : មានរយៈពេល ៣-៤ថ្ងៃ

AC-A5-11

Japan International Cooperation Agency

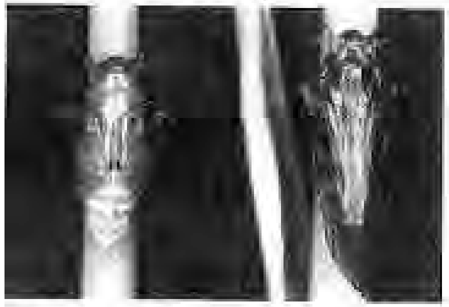
Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Material AC-A5-12

Handout on Brown Plant Hopper Management

មន្ទីរកសិកម្មខេត្តកណ្ដាល

មមាចត្នោត



ស័យដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទាក់ទំនងទូរស័ព្ទ : (០២៣) ៥៨៣ ៤៦១

: (០១២) ៨២៤ ៤២៩

ឧបត្ថម្ភដោយ : អង្គការធិធិអ្នូមី VVOB

ឆ្នាំ ២០១០

មមាចត្នោត

១-លក្ខណៈទូទៅ

មមាចត្នោត កើតមានឡើងនៅលើស្រែដែលប្រើប្រាស់ប្រភេទពូជស្រូវស្រាល និងស្រូវដែលមានមូលដ្ឋានបរិភោគភ្លៀង។ វាអាចកើតមានច្រើនបំផុត នៅពេលដែលមានការប្រើប្រាស់ថ្នាំកសិកម្មមិនបានសមស្របទៅតាមបច្ចេកទេសណាមួយ។ វាចាក់បឺតជាតិទឹកនៅក្នុងដើមស្រូវ និង នៅលើស្លឹក។

២-លក្ខណៈរូបសាស្ត្រ

-ពង : ជាចង្កោម ក្នុងមួយៗមាន ៧-១៥ពង ស្ថិតនៅក្នុងជាលិកាស្រទាប់ស្លឹក និងទងស្លឹក។ ពងត្រូវការរយៈពេល ៧-៩ ថ្ងៃដើម្បីញាស់។

-កូន : កូនដែលញាស់មានពណ៌សថ្មី ហើយមានការវិវត្តឆ្លងកាត់ ៥ ដំណាក់កាល រយៈពេល ១៣-១៥ ថ្ងៃ។

-មេពេញវ័យ : មានពណ៌ត្នោតចាស់

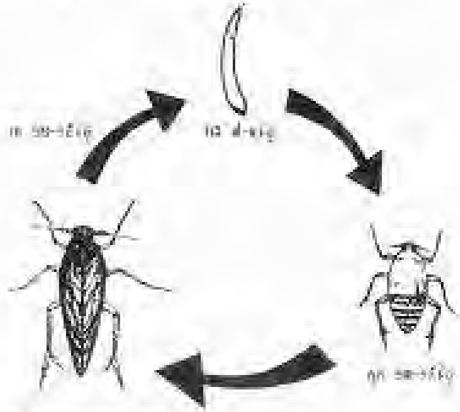
៣-វដ្តជីវិត

វដ្តជីវិតរបស់មមាចត្នោតមានរយៈពេល ៣០ថ្ងៃ។ ពេលពេញវ័យ ... រូបមមាចត្នោតញីមួយអាចពងបាន ៥០០ ពង។

-មមាចពេញវ័យ : មានរយៈពេល ១២-១៥ថ្ងៃ

-ពង : មានរយៈពេល ៧-៩ថ្ងៃ ទើបញាស់

-កូន : មានរយៈពេល ១៣-១៥ថ្ងៃ



៤-ដំណាក់កាលបំផ្លាញ

-បំផ្លាញដោយផ្ទាល់ : នៅដំណាក់កាលលូតលាស់ ...

-បំផ្លាញដោយប្រយោល : នៅដំណាក់កាល ... ស្រូវចេញផ្កា

Japan International Cooperation Agency

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Material AC-A5-13

Handout on Application of Chemical Fertilizer

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ជីគីមីនិងការប្រើប្រាស់

អាស័យដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទ : (០២៣) ៥៨៣ ៤៦១

: (០១២) ៨២៤ ៤២៥

ឆ្នាំ ២០១០

ជីគីមីនិងការប្រើប្រាស់

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-14

Handout of Rice Virus Disease Management

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្តាល

ជំងឺវីរុសលើដំណាំស្រូវ

អាសយដ្ឋានទំនាក់ទំនង: ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ: ០២៣ ៩៨៣ ៩៦១

ឧបត្ថម្ភដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

១-ជំងឺស្លឹកស : ដើមស្រូវដែលកើតជំងឺនេះឡើងខ្ពស់ តែស្លឹករបស់វាអាចលូតលាស់ធម្មតា ។

រោគសញ្ញា

- នៅលើស្លឹកចេញឆ្នូតតាមបណ្តោយពណ៌សលឿងស្លេក វា ចេញស្នាមខ្ទុះៗ ។
- គ្រាប់ស្រូវមានទំហំតូច ហើយមានពណ៌ត្នោតខ្មៅ ស្អុត ។ ដើមស្រូវដែលកើតជំងឺនេះវាមិនងាប់ទេ ប៉ុន្តែអាចងាប់ដែរបើសិនវាកើតនៅពេលស្រូវលូតលាស់ខ្ចីពេក ។

២-ជំងឺលឿងទុំស្លឹក : មានសភាពទេញ ហើយពុំសូវរីកគុម្ព ស្លឹកវាឡើងពណ៌លឿងដូចមាស ប្រែពណ៌ក្រហម ។

រោគសញ្ញា

- ដំបូងពណ៌លឿងនៅជិតចុងស្លឹក ក្នុងស្លឹកគេសង្កេតឃើញ មានឆ្នូតរាងកង់ ពេលសម្លឹងស្របពន្លឺថ្ងៃមុខសរសៃស្លឹ
- ស្លឹកឡើងទុំ ហើយស្ងួត ចាប់ផ្តើមពីចុងស្លឹក
- ដើមស្រូវដែលកើតជំងឺនេះអាចងាប់បាត់ពេលដែលស្រូវនៅខ្ចីហើយគ្រាប់ស្រូវភាគច្រើនអាចគ្មានគ្រាប់
- មេរោគជំងឺនេះ គឺពពួកមមាចត្នោត

AC-A5-14

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-15

Handout on Harvest Technique

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ
មន្ទីរកសិកម្មខេត្តកណ្ដាល

ការប្រមូលផល

អាសយដ្ឋានទំនាក់ទំនង: ផ្ទះលេខ ១០៨(តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ: ០២៣ ៩៨៣ ៥២១

ឧបត្ថម្ភដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

ការប្រមូលផល

១.តើត្រូវធ្វើដូចម្ដេចដើម្បីដឹងថាស្រូវរបស់អ្នកដល់ពេលត្រូវច្រូត?

-ស្រូវរបស់អ្នកមានអាយុ ៣០ ថ្ងៃបន្ទាប់ពីចេញផ្កា

-វាលស្រែរបស់អ្នកមានពណ៌លឿងទុំ

-៨០-៨៥% នៃគ្រាប់ស្រូវផ្នែកខាងចុងកួរមានពណ៌លឿងចំណែកគ្រាប់ផ្នែកខាងដើមកួរនៅខៀវនៅឡើយ

២.អត្ថប្រយោជន៍នៃការប្រមូលផលទាន់ពេលវេលា

-អង្ករកិនមានគុណភាពខ្ពស់ (គ្រាប់មិនសូវបាក់)និងមានតម្លៃខ្ពស់។

-កាត់បន្ថយនូវការជ្រុះគ្រាប់ស្រូវពីកួរ ដែលបណ្ដាលឲ្យបាត់បង់គ្រាប់ស្រូវ បាក់កួរស្រូវ មានការបំផ្លិចបំផ្លាញដោយកណ្ដុរ និងបក្សី។

៣. អ្វីដែលអ្នកត្រូវដឹងក្នុងកិច្ចការប្រមូលផលស្រូវ

-កុំច្រូតស្រូវទុំលឿន ដោយមិនបានកំណត់ការបោកបែន ហើយគ្រាប់ស្អុយផុយ។

-ត្រូវបង្ហូរទឹកចេញពីស្រែ ៧-១០ថ្ងៃមុនពេលច្រូតកាត់

-ជៀសវាងច្រូតកាត់នៅពេលគ្រាប់ស្រូវទទឹកសើម។ ឬក៏ត្រូវហាលសណ្ដាប់ ២-៣ថ្ងៃទើបបោកបែន។

ការបោកបែន

បន្ទាប់ពីច្រូតកាត់រួចកណ្ដាប់ស្រូវត្រូវបានដឹកជញ្ជូនទៅកាន់ទីធ្លាដើម្បីធ្វើការបោកបែន រួចហាលទុក ១-២ ថ្ងៃមុនពេលបោកបែន។ ការបោកបែនអាចធ្វើឡើងដោយដៃ ឬដោយម៉ាស៊ីន។

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-16

Handout on Rice Plant Growth Stages

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្តាល

វដ្តជីវិត និង ដំណាក់កាល

លូតលាស់របស់ដំណាំស្រូវ

អាស័យដ្ឋានទំនាក់ទំនង: ផ្លូវលេខ ១០៣(តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ: ០២៣ ៩៤៣ ៤៦១

ឧបត្ថម្ភដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

វដ្តជីវិត និង ដំណាក់កាល

លូតលាស់របស់ដំណាំស្រូវ

១.វគ្គលូតលាស់ (ពីបណ្តុះទៅដល់ចាប់ផ្តើមពោះ)

-វគ្គនេះចែកចេញជា ៤ ដំណាក់កាលតូចៗទៀតគឺ:

-ដំណាក់កាលទី០ (ដុះពន្លក): ចាប់ផ្តើមពីគ្រាប់ពន្លក រហូតដល់លូតស្លឹកទី១។

-ដំណាក់កាលទី១ (សំណាប): ចាប់តាំងពីលូតស្លឹកទី១ រហូតដល់បែកគុម្ព (បែកខ្នែងទី១)។

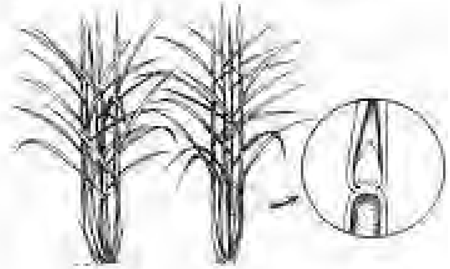
- ដំណាក់កាលទី២ (បែកគុម្ព): ចាប់តាំងពីបែកខ្នែងទី១ រហូតដល់បែកគុម្ពអតិបរមា ។

- ដំណាក់កាលទី៣ (ពន្លូតដើម): ចាប់តាំងពីបែកគុម្ពធំ រហូតដល់ពេលកកើតកួរ។

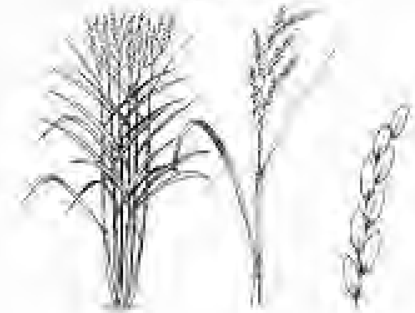
២.វគ្គបន្តពូជ (រយៈពេល ៣៥ ថ្ងៃ)

វគ្គនេះចែកចេញជា ៣ ដំណាក់កាលតូចៗទៀតគឺ:

-ដំណាក់កាលទី៤ (កកើតកួរ): ចាប់តាំងពីមានពន្លកពពោះ នៅក្នុងស្រទាប់ដើមរហូតដល់ផើម។



-ដំណាក់កាលទី៥ (ចេញកួរ): ចាប់តាំងពីផើម រហូតដល់ចេញកួរផុតពីស្លឹកទងដើម។



AC-A5-16

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-17

Handout on Direct Sowing and Transplanting

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ការព្រួស ឬ ស្ទូងដំណាំស្រូវ

អាស័យដ្ឋានទំនាក់ទំនង: ផ្លូវលេខ ១០៨(តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ: ០២៣ ៩៨៣ ៩៦១

ឧបត្ថម្ភដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

ការព្រួស ឬ ស្ទូងដំណាំស្រូវ

១-ស្រូវព្រួស

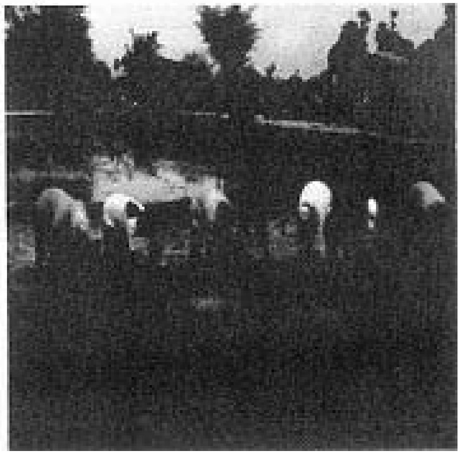
កសិករភាគច្រើនដែលមានផ្ទៃដីទំហំធំហើយខ្វះកំលាំងពលកម្មច្រើនធ្វើស្រូវព្រួស។ ប្រសិនបើមានការថែទាំដិតដល់ ស្រូវព្រួសនឹងផ្តល់ឱ្យនូវទិន្នផលប្រហាក់ប្រហែលនិងស្រូវស្ទូងដែរ។ គេអាចធ្វើស្រូវព្រួសជាមួយស្រូវស្រាល ស្រូវកណ្តាលនិងស្រូវធ្ងន់(រួមទាំងស្រូវឡើងទឹកផងដែរ)។ ចំនួនគ្រាប់ពូជដែលប្រើប្រាស់ជាមធ្យមពី ៨០ ទៅ ១២០ គីឡូក្រាមក្នុងមួយហិកតា។

ការព្រួសគ្រាប់ពូជអាចធ្វើឡើងនៅពេលដែលគ្រាប់ពូជ មានដុះពន្លក ប្រេះមាត់ចាប(១-២ មីលីម៉ែត្រ)។ យើងត្រូវចាប់គ្រាប់ពូជហើយដើរព្រួសឱ្យបានស្មើៗគ្នា និងធ្វើឱ្យបានសព្វទីកន្លែងលើស្រែ។ ដើម្បីព្រួសឱ្យបានស្មើ និងសព្វល្អយើងត្រូវបែងចែកស្រែឱ្យទៅជាកូនស្រែតូចៗប៉ុនៗគ្នា ដោយការដោតបង្គោលសញ្ញា។ បែងចែក គ្រាប់ពូជសំរាប់ព្រួសលើកូនស្រែទាំងនោះឱ្យបានស្មើៗគ្នា។ ក្រោយពីព្រួសបានពី ១៥ ទៅ ២០ថ្ងៃត្រូវចុះទៅពិនិត្យស្រែហើយធ្វើការស្ទូក ឬជួសនៅកន្លែងណា ដែលគ្រាប់ពូជមិនបានដុះ ឬដុះរង្វើលពេក (ដកពីកន្លែងដែលដុះញឹកទៅស្ទូក ឬជួស)។

២-ស្រូវស្ទូង

២.១:ការដកសំណាប :

ដកតែសំណាបណាដែលមានដើមថ្លោសល្អត្រូវដកថ្នមៗ (កាន់ដល់គល់នៅពេលដក)។



Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

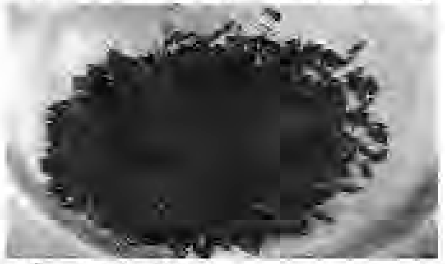
Material AC-A5-18

Handout on Seed Preparatory Work (Cleaning, Soaking and Incubation)

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្តាល

បច្ចេកទេសសំអាត ត្រាំ និងផ្អាប់គ្រាប់ពូជ



អាស័យដ្ឋានទំនាក់ទំនង៖ ផ្លូវលេខ ១០៣(តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ៖ ០២៣ ៩០៣ ៥២១

ឧបត្ថម្ភដោយ៖ អង្គការ VVOB ឆ្នាំ ២០១០

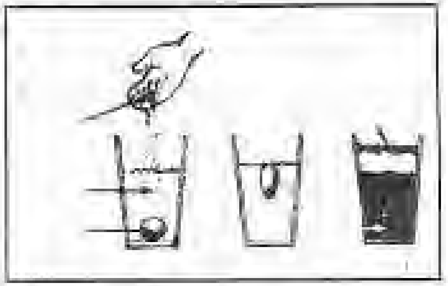
បច្ចេកទេសសំអាត ត្រាំ និងផ្អាប់គ្រាប់ពូជ

១.ការសំអាតគ្រាប់ពូជ

-ចាក់ទឹក៣/៤នៃចំណុះធុងទំហំមធ្យមមួយដាក់ទឹក និងពងមាន់ ឬពងទាក្នុងធុងទឹករួចដាក់អំបិលចូលរហូតដល់ពងអណ្តែតដូចដែលបង្ហាញនៅក្នុងរូប (ជាធម្មតាអំបិល ២.៥០គីឡូក្រាម ជាមួយទឹក ១០លីត្រ)។ ត្រូវប្រើពងថ្មីចំនួន ៣ គ្រាប់ (ប្រសិនបើប្រើពងចាស់គឺមានការពិបាកក្នុងការសង្កេតដោយហេតុថាពងចាស់ងាយអណ្តែត បើទោះបីជាអំបិលតិចក៏ដោយ)។

- យកពងចេញពីក្នុងទឹក ដាក់គ្រាប់ពូជចូលទៅក្នុងទឹកអំបិល។ បន្ទាប់មកស្ទូចកូររោយឱ្យបានសព្វល្អ ពេលនោះអ្នកនឹងឃើញមានគ្រាប់ពូជខ្លះអណ្តែតឡើងមក។ គ្រាប់ពូជដែលអណ្តែតឡើងមកគឺស្រាល ស្កៀត និងមិនទាន់ទុំល្អ (គ្រាប់ពូជទាំងនេះគឺមិនមានគុណភាពល្អទេ ហើយមិនគួរត្រូវបានប្រើប្រាស់សំរាប់ការដាំដុះនោះឡើយ ប៉ុន្តែអាចអោយសត្វស៊ីបាន។

ផ្ទុសគ្រាប់ដែលអណ្តែតឡើងមកទាំងអស់នេះចេញ ហើយលាងសំអាតគ្រាប់ពូជដែលនៅសល់ជាមួយទឹកស្អាត។ គ្រាប់ដែលនៅសល់នៅក្នុងទឹកអំបិល គឺធ្ងន់ ពេញគ្រាប់ និងទុំល្អ។ គ្រាប់ពូជទាំងនេះគឺមានគុណភាពល្អ និងគួរតែត្រូវបានប្រើប្រាស់សំរាប់ធ្វើការដាំដុះ។



២.ការត្រាំគ្រាប់ពូជ៖

-ដាក់គ្រាប់ពូជល្អចូលទៅក្នុងការ៉ុងដែលបោកសំអាតរួចហើយត្រាំទុកក្នុងទឹករយៈពេល ២៤ ម៉ោង។

- សំអាតគ្រាប់ពូជម្តងទៀតនៅក្នុងទឹកអំបិលដើម្បីបំបែកគ្រាប់ពូជមិនល្អដែលនៅមាន។ លាងទឹកអំបិលចេញពីគ្រាប់ពូជល្អម្តងទៀត។

Japan International Cooperation Agency

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Material AC-A5-19

Handout on Seed Selection

AC-A5-19

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ការជ្រើសរើសពូជស្រូវ

អាស័យដ្ឋានទំនាក់ទំនង: [illegible]

ទំនាក់ទំនងទូរស័ព្ទលេខ: [illegible]

ឧបត្ថម្ភដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

ការជ្រើសរើសពូជស្រូវ

១.លក្ខណៈនៃការជ្រើសរើសពូជ

[illegible]

ការជ្រើសរើស:

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

២.ហេតុអ្វីត្រូវប្រើប្រាស់ពូជដែលមានគុណភាពល្អ?

- [illegible]
- [illegible]
- [illegible]

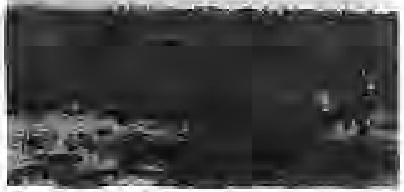
៣.បរិមាណគ្រាប់ពូជដែលត្រូវការ

- [illegible] ១-២ [illegible] ១០ [illegible]

Material AC-A5-20

Handout of Land Preparation for Direct Sowing and Transplanting

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ
មន្ទីរកសិកម្មខេត្តកណ្ដាល
ការរៀបចំដីស្រែពាព្រួស និងសន្ទូង



អាសយដ្ឋានទំនាក់ទំនង៖ ផ្លូវលេខ ១០៣(តាខ្មៅ)
ទំនាក់ទំនងទូរស័ព្ទលេខ៖ ០២៣ ៩៨៣ ៩៦១

ឧបត្ថម្ភដោយ៖ អង្គការ VVOB ឆ្នាំ ២០១០

ការរៀបចំដីស្រែពាព្រួស និងសន្ទូង

១. ហេតុអ្វីការរៀបចំដីមានសារៈសំខាន់?

– កប់ជញ្ជ្រាំង ចំបើង ស្មៅ និងរុក្ខជាតិ ផ្សេងៗ ដែលសល់ពីការច្រូតកាត់ទៅក្នុងដីឱ្យវាពុករលួយក្លាយទៅជាអាហារសម្រាប់ស្រូវ។

- ហាលដីដើម្បីសំលាប់ពពួកបាក់តេរី និងសត្វល្អិតចង្រៃនៅក្នុងដី។

- ធ្វើឱ្យដីនូវរុក្ខជាតិងាយចាក់ឫស រក្សាសំណើមដី ដោយបន្ថយការហួតសំណើមដីស្រទាប់ក្រោម។

២. សកម្មភាពផ្សេងៗនៃការរៀបចំដីស្រែ

– ភ្ជួរ និងរាស់
– ការជួសជុលភ្លឺស្រែ

២.១. ភ្ជួរលើកទី១៖

ភ្ជួរលើកទី១អាចអនុវត្តបន្ទាប់ពីច្រូតកាត់រួចភ្លាមៗ ដើម្បីកប់កាកសំណល់រុក្ខជាតិចូលទៅក្នុងដីស្រែ។

២.២. ភ្ជួរលើកទី២៖

អនុវត្តមុនពេលព្រួស ឬស្ទូង៧-១០ថ្ងៃ

២.៣. ភ្ជួរលើកទី៣៖

អនុវត្តន៍បន្ទាប់ពីភ្ជួរលើកទី២ ចំនួន៧-១០ថ្ងៃ ក្នុងជំរៅ១០-១៥ស.ម។ ក្នុងគោលបំណងដើម្បីងាយ ស្រួលរាស់ និងរៀបចំដីស្រែសំរាប់ព្រួស ឬស្ទូង ម្តងៗ ការភ្ជួរលើកនេះនិងធ្វើឱ្យដីខ្លួនស្រួលស្ទូង ដំណ ស្រូវដុះលូតលាស់បានល្អ មានឫសចេញចូលក្នុង ហើយអាចកំចាត់ពពួកស្មៅ សត្វល្អិតចង្រៃ និងជំ ផ្សេងៗ។

Material AC-A5-21

Handout on Preparation of Nursery Bed

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

មន្ទីរកសិកម្មខេត្តកណ្តាល

បច្ចេកទេសរៀបចំដីថ្នាលសំណាប

អាស័យដ្ឋានទំនាក់ទំនង: ផ្ទះលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទលេខ: ០២៣ ៩៨៣ ៨២១

បោះពុម្ពដោយ: អង្គការ VVOB ឆ្នាំ ២០១០

បច្ចេកទេសរៀបចំដីថ្នាលសំណាប

១. គោលបំណងនៃការរៀបចំដីថ្នាលសំណាប

- សំរាប់ស្រោចទឹកក្នុងពេលដែលរាំងស្ងួតដែលតែងតែកើតមាន សេសណើ និងក្នុងដី
- ការពារក្នុងជាតិ និងស្មៅកើតឡើងនៅក្នុងដីឱ្យថយចុះ ព្រោះទៅជាការបាត់សំរាប់ស្រូវ
- សំរាប់ក្នុងការកើត និងសត្វល្អិតចង្រៃដែលមាននៅក្នុងដីដូចជាធ្វើឱ្យដីធូរ ខ្យល់ចេញចូលបានល្អ ជួយកម្ចាត់មេរោគដី

២. ការជ្រើសរើសទីកន្លែង:

ជ្រើសរើសកន្លែងដែលរាបស្មើ និងមានជីជាតិល្អ

- ពិនិត្យប្រភពទឹក
- ថ្នាលសំណាបត្រូវតែទទួលពន្លឺថ្ងៃពេញលេញ មិនស្ថិតនៅក្រោមម្លប់
- ថ្នាលសំណាបត្រូវស្ថិតនៅក្បែរប្រភពទឹក និងងាយបញ្ចូល-បញ្ចេញទឹក
- វាលស្រែត្រូវស្ថិតឆ្ងាយពីភ្លើងអគ្គិសនីឬឆ្ងាយពីភូមិចម្ងាយ ជិតស្រែសន្ទូង
- ថ្នាលសំណាបសំរាប់ស្ទូងសម្រាប់ត្រូវស្ថិតឆ្ងាយពី ថ្នាលដែលមានចម្ងាយពី ៥-១០ម៉ែត្រ

៣. ការរៀបចំដីថ្នាលសំណាប

ក្នុងការរៀបចំថ្នាលសំណាបយើងត្រូវកាប់ដី និង កំទេចដីអោយបានម៉ត់ល្អ សំរាប់ទាញសំណាបយកទៅស្ទូងបានងាយស្រួលដោយមិនធ្វើឱ្យដាច់ឫសរបស់វា ដែលមាន

មុនពេលចាប់ផ្តើមព្រោះសំណាប យើងត្រូវពិនិត្យមើលទប់ភ្លឺក្នុងដីរៀបអោយរាបស្មើដើម្បីងាយស្រួលក្នុងការគ្រប់គ្រងទឹកពេលសំណាបកំពុងលូតលាស់

ថ្នាលសំណាបត្រូវរៀបចំពី ១៥-២០ថ្ងៃ មុនពេលស្ទូង ហើយត្រូវភ្ជួររាស់រយៈពេលពី ២-៣ ដង ព្រោះជីកោះបានល្អ

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

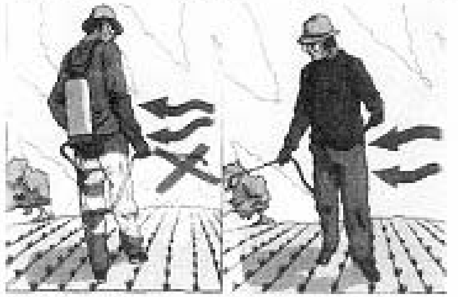
Japan International Cooperation Agency

Material AC-A5-22

Handout on Safe Operation of Pesticide

មន្ទីរកសិកម្មខេត្តកណ្ដាល

សុវត្ថិភាពប្រើប្រាស់ថ្នាំកសិកម្ម



អាស័យដ្ឋានទំនាក់ទំនង : ផ្លូវលេខ ១០៣ (តាខ្មៅ)

ទំនាក់ទំនងទូរស័ព្ទ : (០២៣) ៩៨៣ ៨៦១

: (០១២) ៨២៤ ៨២៥

ឧបត្ថម្ភដោយ : អង្គការវីអូប៊ី VVOB

ឆ្នាំ ២០១០

សុវត្ថិភាពប្រើប្រាស់ថ្នាំកសិកម្ម

១-ការការពារខ្លួន

ដើម្បីកាត់បន្ថយនូវការប្រឈមមុខនឹងគ្រោះថ្នាក់ដោយជាតិពុល ក្នុងពេលបាញ់ថ្នាំ អ្នកត្រូវពាក់អាវដៃវែង ស្លៀកខោជើងវែង ស្រោមដៃកៅស៊ូ មួកបាំងមុខ ម៉ាស់ ឬក្រម៉ាសំរាប់រុំមាត់ និងច្រមុះ វ៉ែនតាការពារ។ សំលៀកបំពាក់ទាំងនេះមិនត្រូវឱ្យរហែក ឬធ្លុះធ្លាយទេ ហើយត្រូវទុកដាក់ដោយឡែកសំរាប់ប្រើលើកក្រោយទៀត។

(Pictograms containing practical advice)

២-វិធីការពារខ្លួននៅពេលលាយថ្នាំ

- ការលាយថ្នាំវាមានសារៈសំខាន់ណាស់ ដើម្បីឱ្យការបាញ់ថ្នាំមានប្រសិទ្ធភាពល្អ។ មុនពេលចាប់ផ្តើមលាយថ្នាំយើងត្រូវស្គាល់សំភារៈខ្លះៗដូចជា :
- ធុងបាញ់ថ្នាំ , ថ្នាំពុល (គ្រាប់ ទឹក និងម្សៅ), ទឹក , ធុងជ័រ , បន្ទះឫស្សី , ស្លាបព្រា , ស្រោមដៃ និង ម៉ាស់

បន្ទាប់ពីប្រមូលសំភារៈរួចមកយើងត្រូវ :

-អានផ្លាកសញ្ញាថ្នាំឱ្យបានច្បាស់លាស់ ដើម្បីអោយដឹងពីកំរិតថ្នាំដែលត្រូវប្រើប្រាស់

-អានពីសេចក្តីណែនាំ អំពីការលាយ និង ឧបករណ៍សំរាប់បាញ់ ឬ ដាក់ថ្នាំ

-បើសិនជាមិនច្បាស់ អ្នកអាចស្នើសុំបុគ្គលិកផ្នែកកសិកម្មដែលនៅជិតមូលដ្ឋានរបស់អ្នក នៅមុនពេលទិញឬប្រើប្រាស់

-បើអ្នកអនុវត្តបានតាមកំរិតកំណត់ទាំងថ្នាំ និង ទឹកដែលត្រូវលាយ អ្នកពិតជាអាចជៀសផុតពីការបាត់បង់សុខភាព លុយកាក់ ពេលវេលា និងផលដំណាំ... ។

[illegible]	[illegible] WHO		[illegible]		
			[illegible]	[illegible]	[illegible]
[illegible]	Extremely hazardous	Class Ia	[illegible]	[illegible]	[illegible]
[illegible]	Highly hazardous	Class Ib	[illegible]	[illegible]	[illegible]
[illegible]	Moderately hazardous	Class II			
[illegible]	Slightly Hazardous	Class III	[illegible]	[illegible]	[illegible]
[illegible]	Low hazard	Unlikely to present acute hazard in normal use	[illegible]	[illegible]	

៣-វិធីការពារពេលកំពុងបាញ់ថ្នាំ

-ពេលកំពុងបាញ់ថ្នាំមិនត្រូវឱ្យមានមនុស្សឈរមើល ឬសត្វចិញ្ចឹមនៅក្នុងស្រែ

-ហាមបាញ់ថ្នាំបញ្ច្រាស់ទិសខ្យល់

-ហាមបាញ់ថ្នាំពេលមេឃកំពុងក្តៅខ្លាំង

-ហាមហូបចំណី ឬជក់បារីនៅពេលបាញ់ថ្នាំ

Japan International Cooperation Agency

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

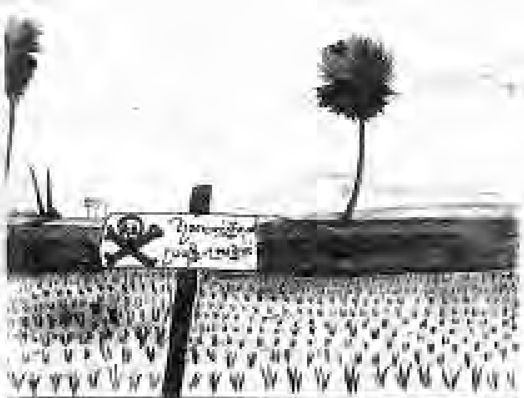
Material AC-A5-23

Handout on Safe Operation of Spraying

- មិនត្រូវបាញ់ថ្នាំនៅក្នុងពេលខ្យល់កំពុងបក់បោកខ្លាំងដែលអាចបណ្តាលឱ្យទឹកថ្នាំហើរខុសពីគោលដៅ។
- មិនត្រូវប្រើមាត់ផ្លុំក្បាលបឺតដែលស្ទះ ត្រូវសំអាតវាដោយប្រើបំណែកឈើតូចៗ ឬដើមស្មៅ និងទឹក។
- មិនត្រូវបាញ់ថ្នាំពេលមានអាកាសធាតុក្តៅខ្លាំងពេក ព្រោះការបែកញើសពេលបាញ់ថ្នាំបណ្តាលឱ្យស្បែកហើយងាយស្រូបយកជាតិពុល (រូបទី ២)។
- មិនត្រូវឱ្យក្មេងអាយុក្រោម ១៨ឆ្នាំ បាញ់ថ្នាំឡើយ (រូបទី៣)។
- មិនត្រូវប្រើប្រាស់ឧបករណ៍លេចធ្លាយដើម្បីយកមកបាញ់ថ្នាំទេ។ ការលេចធ្លាយវានឹងបណ្តាលឱ្យប៉ះពាល់ដល់សុខភាពអ្នកបាញ់ថ្នាំ។

រូបទី៥

- លាងសំអាត និងត្រួតពិនិត្យឧបករណ៍បាញ់ថ្នាំនៅពេលចប់ការងារ។
- ត្រូវចាក់ទឹកលាងសំអាតឧបករណ៍បាញ់ថ្នាំនៅក្នុងរណ្តៅ រួចលុបដីពីលើ។
- ត្រូវដាក់ស្លាកសញ្ញាក្បាលខ្មោច ដោយសរសេរថា "ប្រុងប្រយ័ត្នក្នុងស្រែនេះទើបតែបាញ់ថ្នាំពុលរួច" (រូបទី៤)។
- មិនត្រូវរើសត្រីប្រកាច់ជិតងាប់ ឬត្រីងាប់ក្នុងស្រែដែលកំពុងបាញ់ថ្នាំ ឬទើបបាញ់ថ្នាំរួចនោះឡើយ វានឹងពុលដល់អ្នកហូបចុក (រូបទី៥)។



រូបទី៤

មន្ទីរកសិកម្មខេត្តកណ្តាល

ការកាត់បន្ថយគ្រោះថ្នាក់ ពេលកំពុងបាញ់ថ្នាំកសិកម្ម

ក្រុមជំនាញៈ ការិយាល័យក្សេត្រសាស្ត្រ និងកែលំអដីកសិកម្ម

អាសយដ្ឋានៈ ផ្លូវ១០៣ ក្រុងតាខ្មៅ ខេត្តកណ្តាល

ទូរស័ព្ទៈ (៨៥៥) ២៣ ៩៨៣ ៤០១

(៨៥៥) ១២ ៩៥៤ ២៥៣

ឧបត្ថម្ភដោយៈ អង្គការទស្សនៈពិភពលោកកម្ពុជា

World Vision

Material AC-A5-24

Handout of Danger Reduction after Spraying

៣. ការការពារបរិស្ថាន

ការការពារបរិស្ថានគឺជាការកាត់បន្ថយការបំពុលបរិស្ថាន ដូច្នេះអ្នកប្រើប្រាស់ថ្នាំកសិកម្មត្រូវតែ ៖

- ហាមប្រើប្រាស់ថ្នាំកសិកម្ម ដែលមិនបានចុះបញ្ជីការដោយក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ។
- ហាមប្រើប្រាស់ថ្នាំកសិកម្មស្ថិតក្នុងបញ្ជីហាមឃាត់ និងមិនឱ្យប្រើប្រាស់ដោយ ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ។
- កុំប្រើប្រាស់ថ្នាំកសិកម្មណាដែលមានសារធាតុ មានគ្រោះថ្នាក់ធ្ងន់ធ្ងរទៅលើសត្វល្អិតមានប្រយោជន៍ ឬគ្រោះថ្នាក់ដល់សត្វក្នុងទឹក (រូបទី ៤)។

រូបទី៤

- កុំប្រើប្រាស់ថ្នាំកសិកម្មនៅកន្លែងដែលជិតប្រភពទឹក និងផ្ទះសម្បែង ឬកន្លែងកំសាន្ត ។
- ជ្រើសរើសថ្នាំណាដែលមានកម្រិតពុលទាប ឬតិចតួច ចំពោះមនុស្ស និងសត្វ។
- ត្រូវដាក់ស្លាកសញ្ញានៅកន្លែងដែលបាញ់ថ្នាំដោយសរសេរថា "គ្រោះថ្នាក់ ឬថ្នាំពុល" ឬសញ្ញាក្បាលខ្មោច។
- ជ្រើសរើសថ្នាំណា ដែលមិនសូវប៉ះពាល់ដល់សត្វមានប្រយោជន៍ ដែលរួមចំណែកក្នុងការការពារដំណាំ ព្រោះសត្វមានប្រយោជន៍ទាំងនោះជាសត្រូវធម្មជាតិដែលតាមបំផ្លាញសត្វល្អិតចង្រៃ។
- កន្លែងដែលមានថ្នាំកំពប់ ឬលេចធ្លាយត្រូវប្រញាប់ចាក់ដីលុបឱ្យស្រូបយកទឹកថ្នាំ ឬសំអាតឱ្យជ្រះដោយប្រុងប្រយ័ត្ន។
- មិនត្រូវទុកធុងកញ្ចប់ដបប្រឡាក់ថ្នាំនិងថ្នាំកសិកម្មចោលឡើយ។
- មិនត្រូវចាក់ថ្នាំនៅសល់ ឬទឹកលាងឧបករណ៍បាញ់ថ្នាំ ទៅក្នុងប្រភពទឹកទន្លេ បឹងបួរ អូរ ស្ទឹង ព្រែក ឬអណ្ដូងឡើយ ។
- ត្រូវចាក់ទឹកថ្នាំដែលនៅសល់ ទៅក្នុងរណ្ដៅនៅកន្លែងដែលគ្មានគ្រោះថ្នាក់ រួចលុបដីឱ្យបានជិត។

មន្ទីរកសិកម្មខេត្តកណ្ដាល

ការកាត់បន្ថយគ្រោះថ្នាក់ ក្រោយពេលបាញ់ថ្នាំកសិកម្ម និងការការពារបរិស្ថាន

រៀបចំដោយ ការិយាល័យក្សេត្រសាស្ត្រ និងផលិតភាពកសិកម្ម
អាសយដ្ឋាន ផ្លូវ១០៣ ក្រុងតាខ្មៅ ខេត្តកណ្ដាល
ទូរស័ព្ទ (៨៥៥) ២៣ ៥៣៣ ៤២១
(៨៥៥) ១២ ៩៥៤ ២៥៣

ឧបត្ថម្ភដោយ: អង្គការទស្សនៈពិភពលោកកម្ពុជា

World Vision

ស្រពនៅពេលជួបគ្រោះរាំងស្ងួតរយៈពេលខ្លី
- ជៀសវាងការទុកស្រែឲ្យស្ងួតរយៈពេលយូរពេកនាំឲ្យស្មៅដុះ និង ធ្វើឲ្យប៉ះពាល់ដល់ការលូតលាស់របស់ដំណាំស្រូវ
- ថែទាំប្រព័ន្ធភ្លឺឲ្យបានរឹងមាំ និងគត់មត់ល្អ។

៥. ការគ្រប់គ្រងសមាសភាពចង្រៃ

(វិធានចម្រុះ អនុវត្តតាមរយៈ ការពារដំណាំ)

ការគ្រប់គ្រងស្មៅចង្រៃ

- ភ្ជួររាស់ដី និងរាស់ឲ្យបានយ៉ាងតិច ១៥ ថ្ងៃ មុននឹងភ្ជួររាស់សម្រាប់ស្ទូង
- រៀបចំប្លង់ដីស្រែឲ្យបានស្មើល្អ និងជៀសវាងការទុកស្រែឲ្យគោករយៈពេលយូរ
- ធ្វើស្មៅបំផុសដីនៅក្នុងវគ្គលូតលាស់ឲ្យបាន ១-២ដង តាមស្ថានភាពស្មៅដោយដៃ ឬឧបករណ៍ធ្វើស្មៅ។

ការគ្រប់គ្រងសត្វចង្រៃបំផ្លាញដំណាំ

- គ្រូកសិកររក្សាលំនឹងរវាងសត្វបំផ្លាញដំណាំ និងសត្វមានប្រយោជន៍ក្នុងស្រែឲ្យបានជាប្រចាំ
- ប្រើប្រាស់វិធានការចម្រុះការពារដំណាំដូចជា វិធានការមេកានិច ជីវៈ និងជីវសាស្ត្រ
- ប្រើប្រាស់ថ្នាំផ្សំពីរុក្ខជាតិ ដែលមាននៅក្នុងតំបន់ៗ

ការគ្រប់គ្រងជំងឺ

- ប្រើប្រាស់ពូជធន់នឹងជំងឺ និងពូជដែលមិនកើតជំងឺ
- ផ្តល់សារធាតុចិញ្ចឹមគ្រប់គ្រាន់និងមានតុល្យភាព
- បំបាត់ជំរកជំងឺ តាមរយៈធ្វើអនាម័យស្រែ
- កម្ចាត់ភ្នាក់ងារចម្លងជំងឺ
- ប្រើប្រាស់ថ្នាំសម្លាប់ជំងឺក្នុងករណីមានផ្ទុះរាលដាលខ្លាំង។

៦. ការប្រមូលផល និងការទុកដាក់

(ច្រូតស្រូវដែលទុំ សម្ងួតសមរម្យ ទុកដាក់ត្រឹមត្រូវ)

- ប្រមូលផលនៅពេលស្រូវទុំពី ៨០-៨៥%
- បោកបែន និងហាលសម្ងួតឲ្យបានល្អ ដោយរក្សាសំណើមត្រឹមពី ១២-១៣%
- ស្រូវដែលសម្រិតសម្រាំងទុកពូជ ត្រូវទុកឲ្យទុំល្អ ហើយត្រូវច្រូតបោកបែន និងរក្សាទុកដាច់ដោយឡែកពីស្រូវសម្រាប់ធ្វើស្បៀង ឬលក់
- ដាក់ស្លាកសម្គាល់លើបាវស្រូវពូជទៅតាមប្រភេទពូជនីមួយៗ
- ទុកដាក់ស្រូវឲ្យបានគត់មត់ល្អ។

ការទុកដាក់ផលស្រូវក្រោយពេលច្រូតកាត់

ស្រូវផាព្រះមេ

បច្ចេកទេសប្រពលវប្បកម្មដំណាំស្រូវ

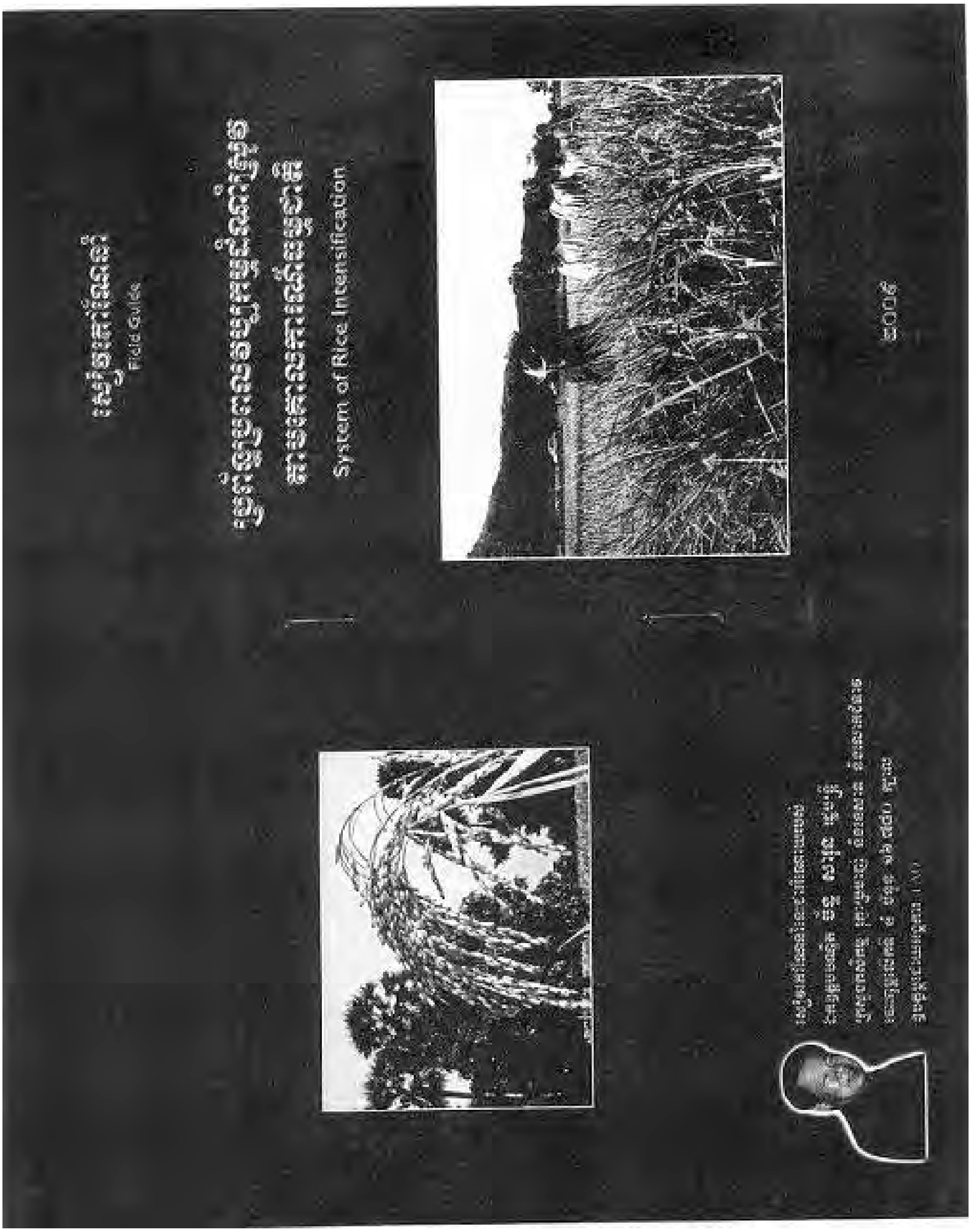
រៀបចំដោយ

នាយកដ្ឋានដំណាំស្រូវនៃអគ្គនាយកដ្ឋានកសិកម្ម

សហការជាមួយអង្គការអុកស្វាម

ខែ មិនា ឆ្នាំ ២០១១

អាសយដ្ឋានទំនាក់ទំនង : ផ្ទះលេខ ៥៦ ផ្លូវលេខ ៦៥៦ សង្កាត់ទឹកល្អក់ ៣ ខណ្ឌទួលគោក រាជធានីភ្នំពេញ
ទូរស័ព្ទលេខ : ០២៣ ៨៨៥ ២៨៨
អ៊ីម៉ែល : maff-sri@camintel.com
គេហទំព័រ : www.foodsecurity.gov.kh/sri



Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-26**
Japan International Cooperation Agency	**Handout on SRI Method**

AC-A5-27

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-27

Pocket Guide on Banned and Restricted Pesticides

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[illegible]

[illegible]

[illegible]

QCAM Project

c/o Department of Agricultural Legislation, Ministry of Agriculture, Forestry and Fisheries
#200 Preah Norodom Blvd., Phnom Penh, Cambodia

Department of Agricultural Legislation
#200 Preah Norodom Blvd., Phnom Penh, Cambodia

General Directorate of Agriculture
N° 54, St. 656, Sangkat Toek Laak III, Khan Toul Kork, Phnom Penh, Cambodia

QCAM/MAFF-JICA

ジャイカ
JICA

កូនសៀវភៅសម្រាប់មន្ត្រីអធិការកិច្ច ស្តីអំពីថ្នាំកសិកម្មដែលហាមឃាត់ និងថ្នាំកសិកម្ម ដែលអនុញ្ញាតឱ្យប្រើប្រាស់ស្ថិតក្នុងលក្ខខណ្ឌ

POCKET GUIDE FOR INSPECTORS ON BANNED AND RESTRICTED PESTICIDES

គម្រោងស្តីពីការពង្រឹងសមត្ថភាពសម្រាប់ ការត្រួតពិនិត្យបទដ្ឋានគុណភាពសម្ភារកសិកម្ម (ជីគីមី និង ថ្នាំកសិកម្ម)

Project of Capacity Building for Quality Standard Control of Agricultural Materials (Chemical Fertilizers and Pesticides) (QCAM)

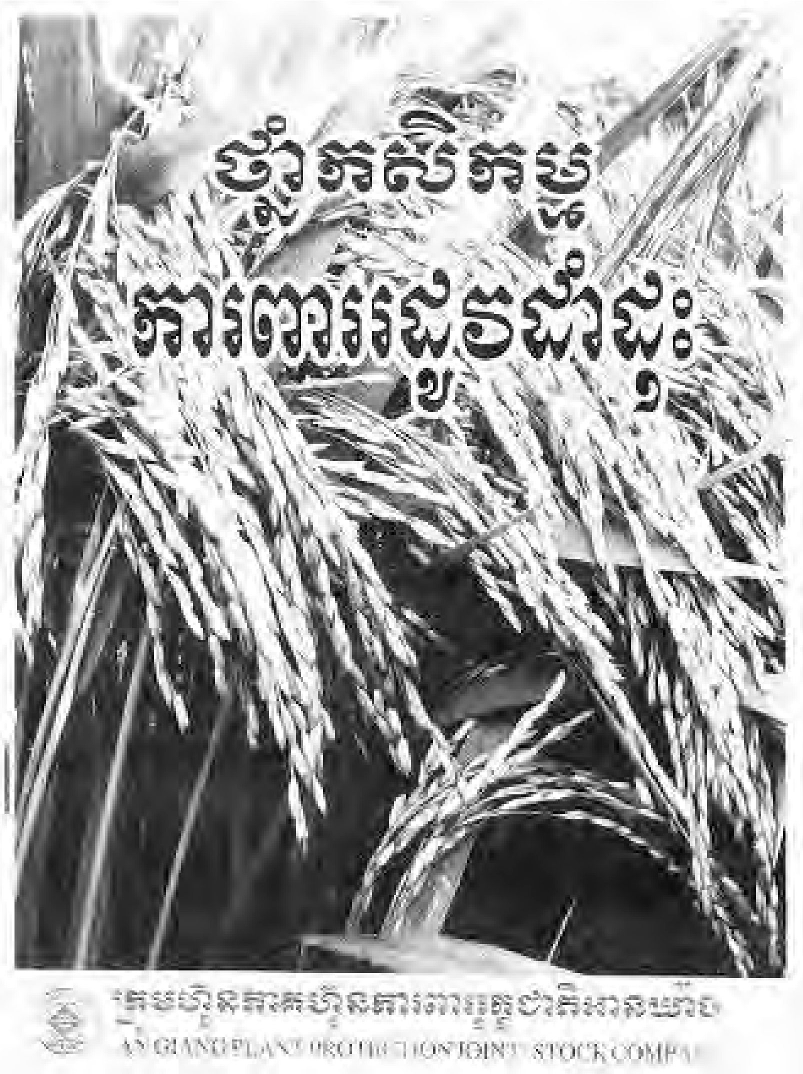
ធ្នូ-២០១០/December-2010

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

Material AC-A5-28

Handout on Utilization of Pesticide

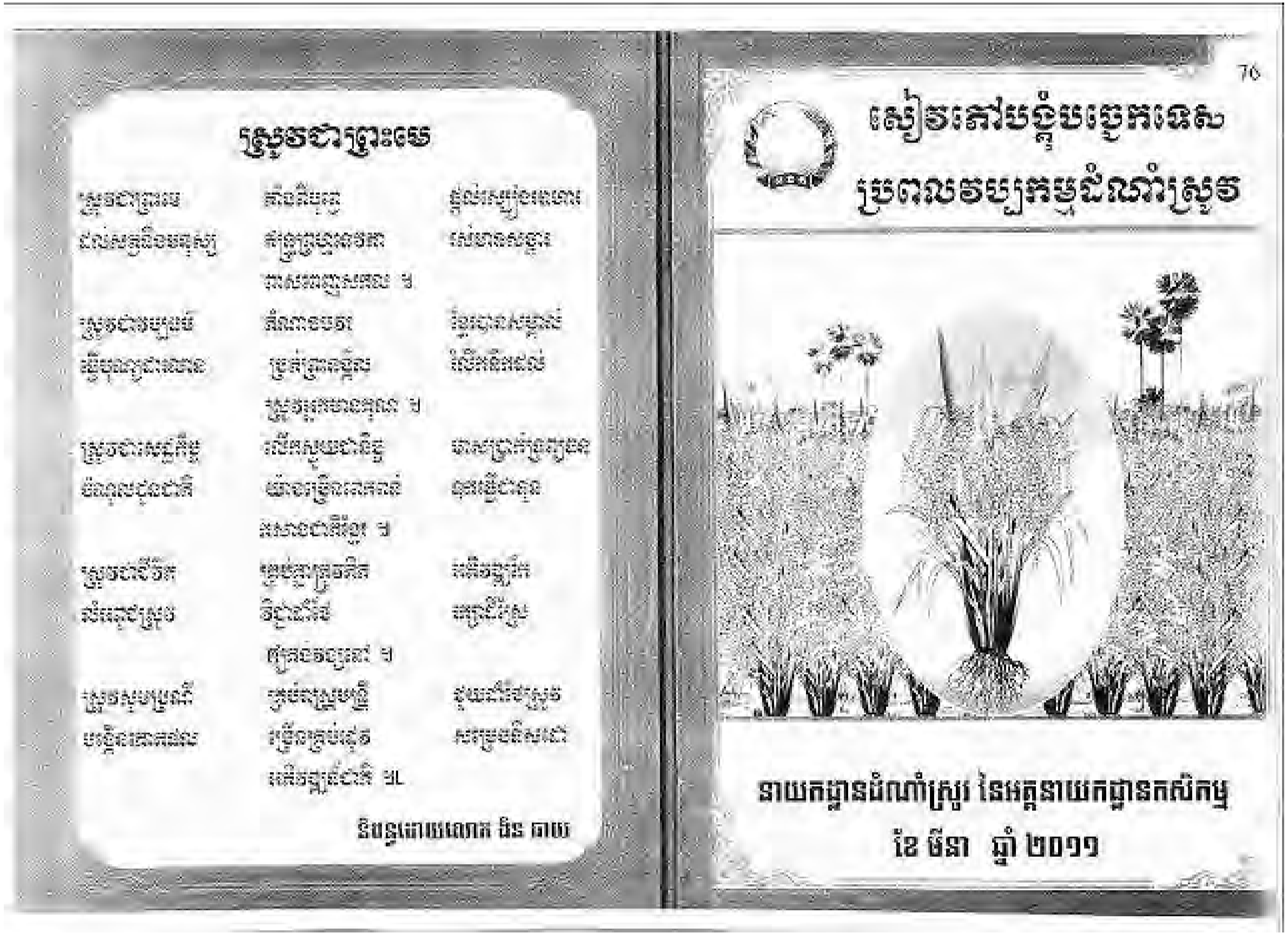


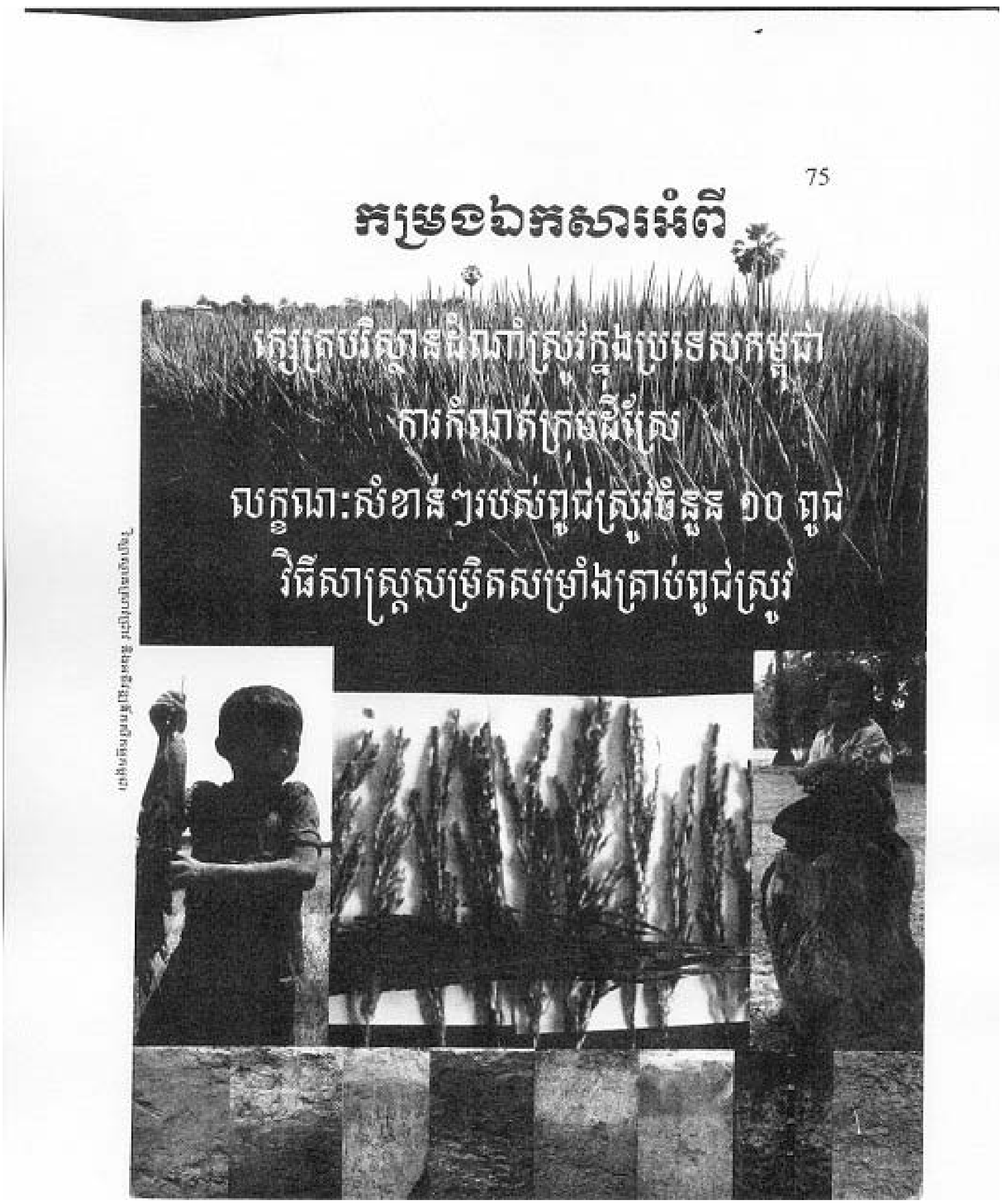
Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project

Japan International Cooperation Agency

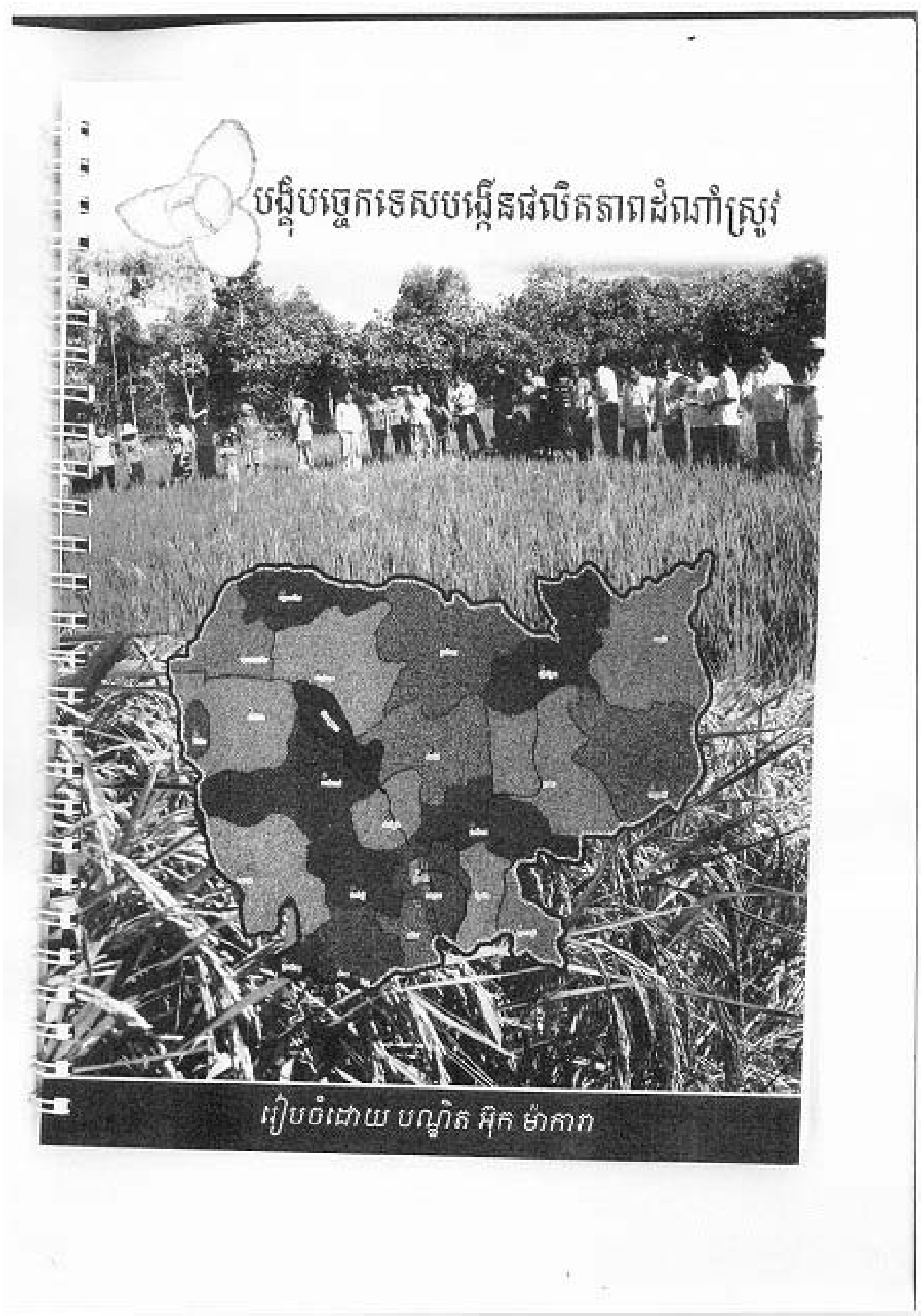
Material AC-A5-29

Guideline on Land Classification for 10 Important Varieties





Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-30**
Japan International Cooperation Agency	**Guideline on Land Classification for 10 Important Varieties**



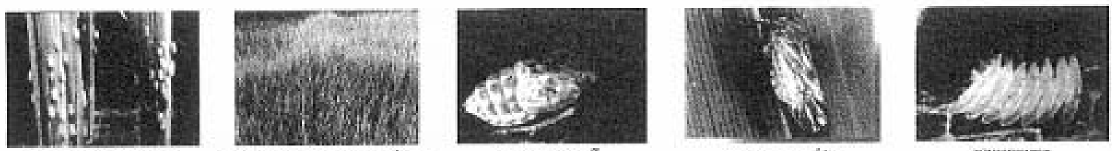
Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-31** **Guideline on Rice Production Technique**
Japan International Cooperation Agency	

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-32** **Guidebook of Good Agricultural Practice**
Japan International Cooperation Agency	

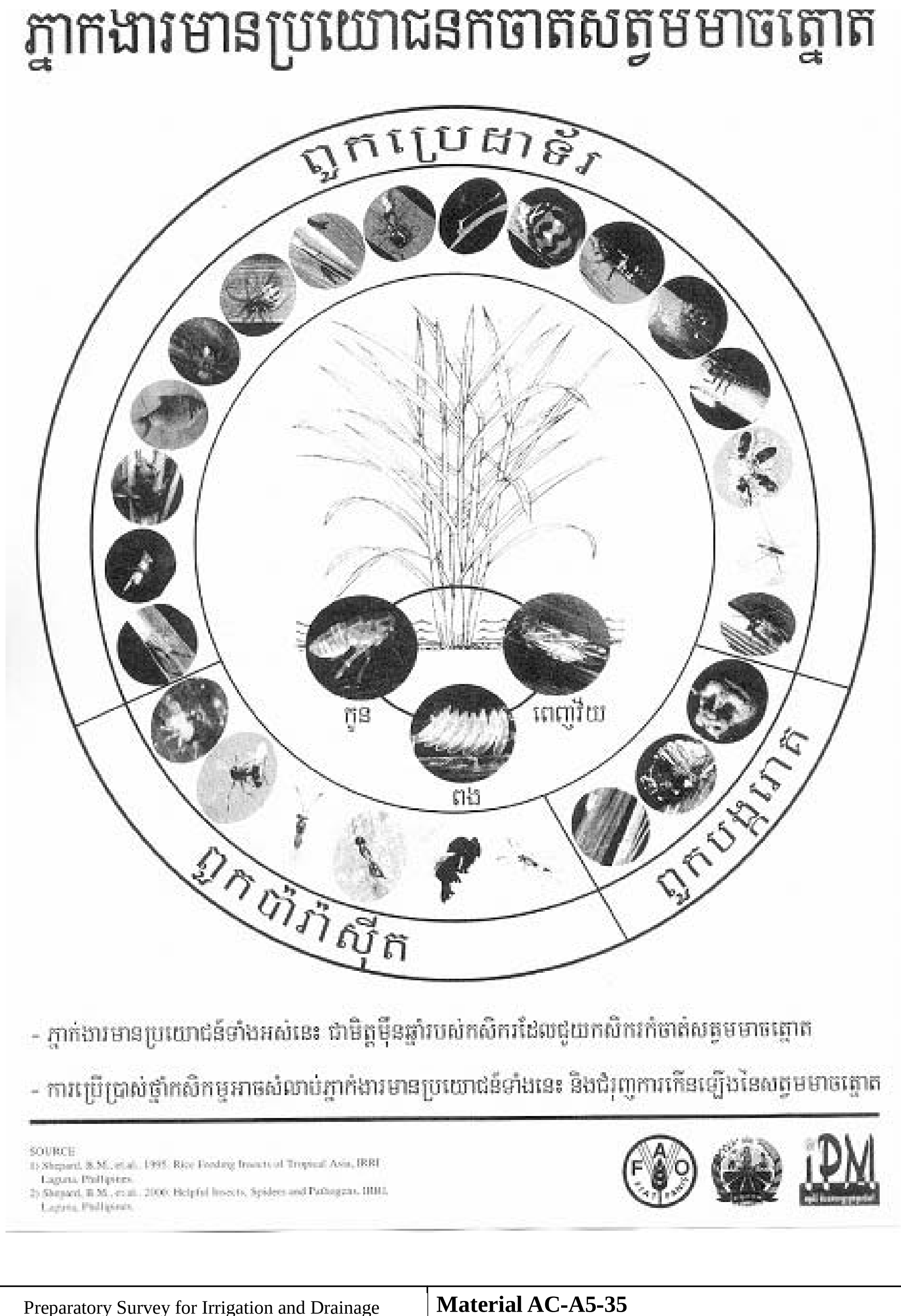
Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-33**
Japan International Cooperation Agency	**Guidebook of Paddy Cultivation**

សូមប្រយ័ត្ន !

សំណាប និងសន្ទូងដែលស្ថិតក្នុងដំណាក់កាលបែកគុម្ពរហូតដល់ចេញផ្កា នៅរដូវប្រាំងនេះ អាចនឹងទទួលរងការបំផ្លាញពីមមាចត្នោត



Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-34**
Japan International Cooperation Agency	**Handout on Brown Plant Hopper Management**



Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-35** **Handout on IPM (Natural Enemies Insect)**
Japan International Cooperation Agency	

សៀវភៅណែនាំអំពី
ការគ្រប់គ្រងសមាសភាពចង្រៃ

Guide Book for Pest Management

គម្រោងពង្រឹងសមត្ថភាពសម្រាប់ការត្រួតពិនិត្យ
បមាណីគុណភាពសម្ភារកសិកម្ម
(ជីគីមី និងថ្នាំកសិកម្ម)

Project of Capacity Building of
Quality Standard Control of Agricultural Materials
(chemical fertilizers and pesticides)

សីហា ២០១១ / August 2011

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-36** **Guide Book for Pest Management**
Japan International Cooperation Agency	

ការចិញ្ចឹមជ្រូកជាលក្ខណៈគ្រួសារ

សេចក្តីផ្តើម :

ជ្រូកគឺជាប្រភពចំណូលមួយក្នុងគ្រួសាររបស់កសិករក្រៅពីធ្វើស្រែចំការនិងមានលទ្ធភាពលើកស្ទួយសេដ្ឋកិច្ចគ្រួសារ ជាពិសេស សំរាប់ប្រជាកសិករនៅតាមជនបទ ។

ការចិញ្ចឹមជ្រូកតាមលក្ខណៈបច្ចេកទេសត្រឹមត្រូវទោះការចិញ្ចឹមនោះ ជាទ្រង់ទ្រាយតូចតាច ឬចិញ្ចឹមតាមបែបឧស្សាហកម្មក្តីក៏ត្រូវការបច្ចេកទេសច្បាស់លាស់ក្នុងការចិញ្ចឹមទទួលបានលទ្ធផលល្អ មានការសន្សំសំចៃប្រាក់ ចំណេញពេលវេលានិងថវិកាទៀតផង ។យើងត្រូវស្គាល់ពីចរិតលក្ខណៈរបស់ជ្រូក ដោយយកចិត្តទុកដាក់លើការរៀបចំទ្រុងអោយបានត្រឹមត្រូវមានបរិយាកាសល្អមាន ការជ្រើសរើសពូជ ការផ្តល់ចំណី ការការពារជំងឺអោយបានត្រឹមត្រូវ និងមានការថែរក្សាតាមដានជាប្រចាំ ។

ដើម្បីឈានទៅដល់គោលបំណង និង ទទួលបានសារៈប្រយោជន៍ គប្បីស្វែងយល់ ពីកត្តាសំខាន់ៗក្នុងការចិញ្ចឹម ព្រោះកត្តាទាំងនេះមានផលប្រយោជន៍ណាស់មិនអាចខ្វះកត្តាណាមួយបានឡើយ ។

១- ការរៀបចំទ្រុង

២- ការជ្រើសរើសពូជ

៣- ការផ្តល់ចំណី និងទឹក

៤-ការថែទាំ និងការធ្វើអនាម័យ

៥- ការគ្រប់គ្រង និងតាមដានជំងឺ

១. ការសាងសង់ទ្រុង

ទ្រុងត្រូវសង់ទៅតាមប្រភេទដែលយើងចង់ចិញ្ចឹម ជ្រូកសាច់ ជ្រូកយកកូន ជ្រូកបា ដើម្បីងាយស្រួលថែទាំ និងសំអាត ជាទូទៅទ្រុងត្រូវតែសង់តាមបែបបទដូចខាងក្រោម :

- នៅកន្លែងទីទួល ស្ងួត និងជិតប្រភពទឹក
- មានខ្យល់ចេញចូលល្អ ចំងាយ ពន្លឺ គ្រប់គ្រាន់
- ផ្ទៃក្រោមរាបស្មើ រាងទេរបន្តិច ងាយស្រួលបោសសំអាត និងបង្ហូរទឹក
- ចូរសង់បណ្តោយថ្ងៃ
- ទំហំទ្រុងសំរាប់ជ្រូកក្នុងមួយក្បាល គឺ អាស្រ័យទៅលើប្រភេទជ្រូក ដូចជា :

ជ្រូកសាច់ ២ ម² ជ្រូកបា ៦ម² ជ្រូកមេ ៤ ម² ជ្រូក បំបៅកូន ៨-១០ ម²

២. ពូជ និងការជ្រើសរើសពូជ

Preparatory Survey for Irrigation and Drainage System Rehabilitation and Improvement Project	**Material AC-A5-37**
Japan International Cooperation Agency	**Handout of Pig Raising**