

*Part-A*  
*Master Plan Study*

## CHAPTER 2      OUTLINE OF THE MASTER PLAN STUDY

### 2.1      General

The Study consists of two Phases: (i) formulation of irrigation and drainage development Master Plan (M/P) in the four River Basins (Phase I); and (ii) preparation of Pre-Feasibility Study (Pre-F/S) for six priority sub-projects selected in Phase I (Phase II).

The chart in the next page shows general procedure of the Study from the formulation of M/P to the preparation of Pre-F/S. This Chapter 2 shows a result of Phase-I including selection of priority sub-projects for Phase-II.

### 2.2      Background

#### 2.2.1      Natural and Socio-Economic Conditions of the Country

Natural and socio-economic conditions are shown in the table to the right. The Tonle Sap Lake system contains the Tonle Sap Lake, the Tonle Sap River and their tributaries. The Battambane River, the Moung Russei River, and the Pursat River flow into the Tonle Sap Lake while the Boribo River flows into the Tonle Sap River.

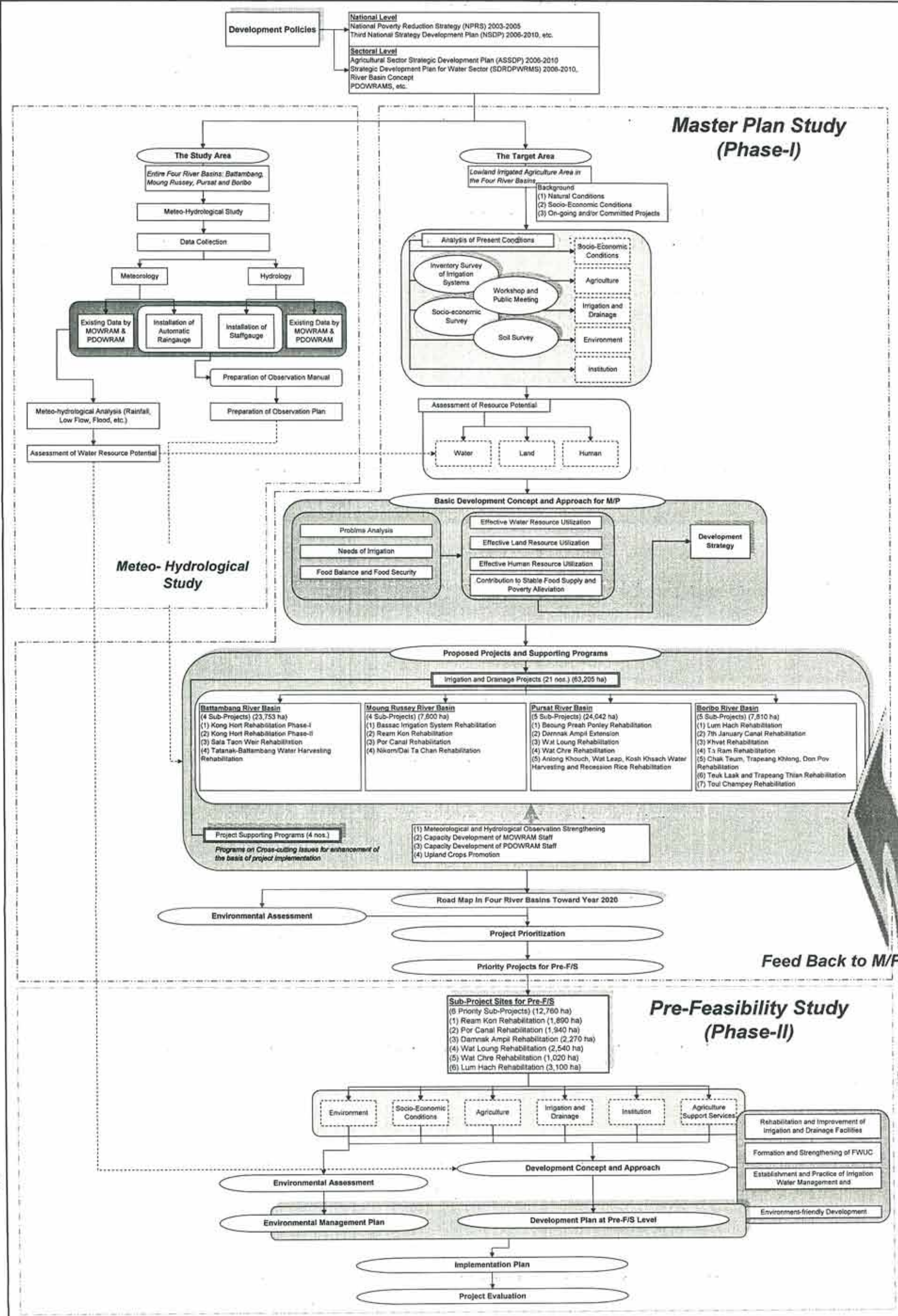
Rice is a principal crop and attaining food security through increased rice production is a priority theme. The area of paddy cultivation is estimated to be 2 million ha; however, irrigation water supply is limited due to severe deterioration of the water infrastructure. As rainfed cultivation prevails, crop production remains low and unstable. Currently, expansion of agricultural land is limited and increases in crop production must rely on improvements in crop yield. Thus, in order to improve the agricultural productivity it is essential to expand the irrigated area through provision of proper irrigation systems and to expand the dissemination of suitable farming technology.

Natural & Socio-Economic Conditions	
Item	Features
Natural Condition	
Land	181,035 km <sup>2</sup> (20 % used for agriculture)
Rainfall (Annual Average)	1,400 mm (central lowland) to 5,000 mm (central coastal & highland), 90 % concentrated in the wet season
Temperature	28 degrees Celsius (Annual average)
Region	<ul style="list-style-type: none"> <li>• Plain Region</li> <li>• Tonle Sap Region</li> <li>• Plateau/mountainous Region</li> <li>• Coastal Region</li> </ul>
Water Network System	<ul style="list-style-type: none"> <li>• Mekong River System</li> <li>• Tonle Sap System</li> <li>• Coastal Zone</li> </ul>
Socio-Economic Condition	
Population	13.8 million (2006) (85 % in the rural area), growth rate of 1.7 % per annum
GDP	US\$ 448 per capita (2006)
Poverty	36 % under the poverty line
Agriculture	34 % in GDP, 71 % of the population

Prepared by JICA Study Team

#### 2.2.2      National Development Policies

Major national development policies are as follows: (i) National Poverty Reduction Strategy 2003- 2005 (NPRS) and (ii) Third National Strategy Development Plan (NSDP 2006-2010). Both put high priority on developing the agriculture sector in order to alleviate poverty and to ensure economic growth in the country.



Prepared by JICA Study

**Study Procedure for Basin-Wide Basic Irrigation and Drainage Master Plan**

**Points on National Development Policies**

**National Poverty Reduction Strategy 2003-2005 (NPRS)**

**Eight Priority Action for Poverty Reduction**

Number	Priority Action
1	Maintaining macroeconomic stability
2	Improving rural livelihood
3	Expanding job opportunity
4	Improving capabilities
5	Strengthening institutions and improving governance
6	Reducing vulnerability and strengthening social inclusions
7	Promoting gender equity
8	Priority focus on population

Source: RGC (2002), National Poverty Reduction Strategy 2003-2005 (NPRS)

**Third National Strategy Development Plan (NSDP 2006-2010)**

**Rectangular Strategy for Growth, Employment, Equity and Efficiency elaborated in the Plan**

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

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

**NSDP Indicators Relevant to Agriculture and Water Sector (extracted from NSDP 2006-2010)**

Indicator	2005 estimate	2010 target
Rice production area (1,000 Ha)	2,374	2,500
Rice yield (ton/ha)	1.97	2.4
Irrigated area including supplementary irrigation (Ha of rice area)	588,687	650,000

Source: RGC (2006), Strategy for Agriculture and Water 2006-2010 referred to NSDP 2006-2010 (pp xvii)

Sectoral policies for agriculture and irrigation include:

- Agricultural Sector Strategic Development Plan 2006-2010,
- Strategic Development Plan for the Water Sector 2006-2010 (Draft),
- Water, Irrigation Management and Land Program, and

- Policy for Participatory Irrigation Management and Development (PIMD).

They all elaborate the necessity of improvement of agricultural productivity and expansion of irrigated area through rehabilitation and construction of irrigation systems.

**Points on Sectoral Development Policies**

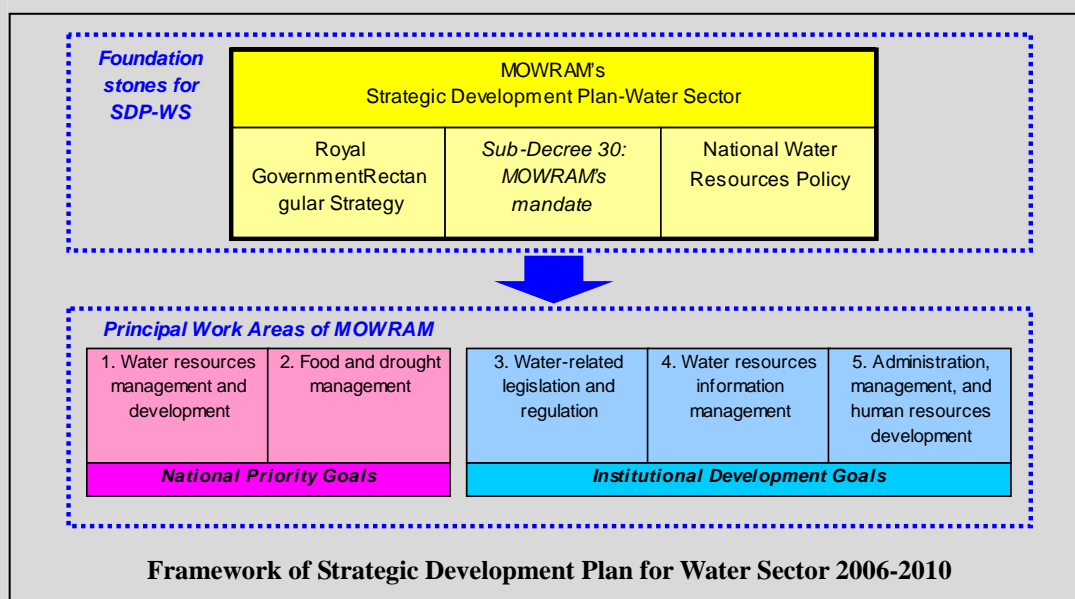
**Agricultural Sector Strategic Development Plan 2006-2010**

**Seven Specific Objectives**

Number	Objective
1	Food Security, productivity and diversification
2	Improvement and strengthening of agricultural research and extension systems
3	Improvement of market access for agricultural products
4	Set-up of institutional framework and legislative development framework for agriculture
5	Land reform consisting of land tenure, land market development, and pro-poor land access
6	Fisheries reform
7	Forestry reform consisting of promotion of conservation, management of sustainable forests and ensuring of better management of natural protected areas

Source: MAFF

**Strategic Development Plan for Water Sector 2006-2010 (Draft)**



**Water, Irrigation Management and Land Program**

- ✚ Long term vision:  
To ensure enough, safe and accessible food and water for all people, reduce poverty, and contribute to economic growth, while ensuring the sustainability of natural resources.
- ✚ Over-arching goal:  
To contribute poverty reduction, food and economic growth through enhancing agricultural productivity and diversification, and improving water resources development and management.

The transfer of O&M responsibilities to Farmer Water User Communities (FWUCs) is also emphasized by MOWRAM through the strategy of Irrigation Management Transfer (IMT). Under PIMD and IMT policy, MOWRAM has issued six modules as follows:

- Module 1: Introduction to Participatory Irrigation Management and

Development (PIMD)

- Module 2: Participatory Irrigation Management and Development; Policy, Legal and Institutional Framework
- Module 3: Planning and Implementing Participatory Irrigation Management and Development at the National Level
- Module 4: Implementation of Participatory Irrigation Management and Development at Provincial and Irrigation System Levels
- Module 5: Establishing and Developing the Farmer Water Users Community
- Module 6: Monitoring and Evaluation System for PIMD

### 2.2.3 Approach by River Basin Concept

Agriculture still plays an important role in the country's economy, within which rice production is dominant. However, its production differs among the localities. The three provinces, Battambang, Pursat and Kampong Chhnang have been greatly contributing to the food supply in the country. According to the Study by MRC in 1994, Battambang and Pursat Provinces are the first and the second largest provinces having water constraints while they are endowed with abundant rainfall. Therefore, those two provinces appear to have larger potentials in agricultural production increase through the promotion of irrigation and drainage rehabilitation.

Poverty headcount ratios (PHR) of the Basins are tabulated on the right. Kampong Speu Province, Kompong Chhnang and Pursat Provinces show higher ratios than the national average. The Four River Basins overall do not necessarily show significantly high poverty ratios, instead they have potential for stable rice production through promoting irrigation development by utilizing available inherent resources.

**Provincial Level Poverty Head Count Ratio**

Province	PHR (%)
Battambang	33.69
Kompong Chhnang/Pursat	39.57
Kompon Speu	57.22
Kandal	22.24
National	35.13

Source; A Poverty Profile of Cambodia 2004

### 2.2.4 Major On-going, Committed, and Studied Projects in the Study Area

There are various projects and technical assistances related with the Four River Basins listed below:

- Northwest Irrigation Sector Project (ADB)
- Multi-purpose Water Resource Development in Krang Ponley River Basin (KOICA)
- Damnak Ampil Weir Construction Project (MOWRAM)
- Char Rek Weir Construction Project (MOWRAM)
- Battambang Rural Area Nurture and Development Project (JICA)
- Technical Service Centre Project (Phase 2) (JICA)
- Bassac Reservoir Rehabilitation Project (Grant Aid for Grassroots Human Security, Japan)

- Thlea Maom Irrigation Rehabilitation Project (MOWRAM)
- Toul Kou Irrigation Project (Grant Aid for Grassroots Human Security, Japan)
- Tonle Sap Lowland Stabilization Project (ADB)
- Water Resources Potential for Hydropower and Irrigation Development in Cambodia (KOICA)

Except for the Damnak Ampil and the Bassac, such already committed and/or on-going projects are excluded from the M/P. However, they are carefully considered for resource potential assessment and allocation studies under the M/P. In addition, lessons learnt from technical cooperation project are utilized for the formulation of M/P.

## 2.3 Four River Basins

### 2.3.1 Socio-Economic Conditions

Administrative information and socio-economic conditions of the Four River Basins are tabulated as follows.

**Summary of Administrative Information of Four River Basin (1/2)**

No.	Item	Battambang	Moung Russei	Pursat	Boribo	Total/Average of Four River Basin
	Catchment Area (km <sup>2</sup> )	6,050	3,700	5,900	7,200	22,850
1	Number of Provinces	3	2	1	4	6
2	Number of Districts	6	5	6	11	31
3	Number of Communes	45	30	38	111	231
4	Number of Families	63,399	44,226	46,989	146,281	300,895
5	Population	332,766	230,291	240,948	742,203	1,546,208
6	Population Density (person/km <sup>2</sup> )	61	62	35	112	68
7	Average Family Size (person/family)	4.5	5.2	5.1	5.1	5.1

Note: Since Provinces, Districts and Communes are overlapped, total number is not necessarily given from the total of number of each river basin.

Prepared by JICA Study Team based on the SEILA Database 2005

**Summary of Social Indicators of the Four River Basin (2/2)**

No.	Item	Battambang	Moung Russei	Pursat	Boribo	Average of Four River Basin
1	Children going to School		80 %	81 %	<b>89 %</b>	85 %
2	Illiteracy Ratio	15 %	<b>18 %</b>	17 %	13 %	15 %
3	Access to Piped Water	21 %	23 %	27 %	<b>51 %</b>	37 %
4	Number of Livestock per Household	0.55 nos.	1.09 nos.	1.06 nos.	<b>1.12 nos.</b>	0.98 r
5	Farmers having Irrigated Fields	3 %	5 %	8 %	<b>20 %</b>	12 %
6	Farmers using Fertilizer	30 %	53 %	34 %	<b>61 %</b>	48 %
7	Farmers using Pesticide	21 %	19 %	6 %	<b>20 %</b>	18 %
8	Minutes to Nearest Market	<b>30 min.</b>	38 min.	46 min.	37 min.	37 min.
9.	Average Farm size	1.9 ha	2.2 ha	1.1 ha	1.2 ha	-

Prepared by JICA Study Team based on the SEILA Database 2005 and Commune Survey on Crops & Livestock, 2003

## 2.3.2 Transportation and Energy

### (1) Roads

The National Road 5 (NR5) running from Phnom Penh to Poipet (Border to Thai) is the only one arterial road in the Study Area. The NR5 connects to other National Roads, NR1 to NR6, in Phnom Penh. The Study Area is connected with Sihanoukville port by NR4, Vietnam by NR1, and northeastern part of Cambodia by NR6 and NR7. The NR5 has been recently paved and all bridges were repaired between Phnom Penh and Battambang. It will take about 3.5 hours from Phnom Penh to Battambang by bus.

The secondary roads in the Study Area are still in poor condition as seen in other areas of the country. In Pursat and Kampong Chhnang Provinces, both the road density and road density index are higher than those of average in Cambodia. However, those indices of paved roads of the Battambang and Pursat Provinces are lower than those of the country as tabulated below.

**Road Density and Road Density Index in the Provinces of the Study Area**

Description	Battambang Province	Pailin Province	Pursat Province	Kampong Chhnang P.	Total or average in Cambodia
Road density (km/km <sup>2</sup> )					
- All roads (km/km <sup>2</sup> )	0.141	0.404	0.175	0.220	0.169
- Paved roads (km/km <sup>2</sup> )	0.011	1.801	0.008	0.019	0.014
Road Density Index					
- All roads	0.497	0.015	0.960	0.759	0.663
- Paved roads	0.039	0.067	0.043	0.066	0.054

Source: The Study on the Road Network Development in Cambodia, Final Report (JICA 2006)

### (2) Railways

The Royal Railways Cambodia operates two railway lines (gauge=1,000mm), i.e. the Northern line and the Southern line.

- Northern line: Phnom Penh - Romeas (Kampong Chhnang) – Pursat - Moung Russei - Battambang - Sisophon - Poipet (border to Thai), 385km approx.
- Southern line: Phnom Penh - Takeo - Kompot - Sihanoukville, 265km approx.

The Northern line constructed in 1942 runs in the Study Area. Although land mines were cleaned up in the tracks, the line is interrupted between Sisophon and Poipet, which is 48km away and is leading to Thailand, due to some stolen tracks. The Southern line was built in the 1960s in order to connect Phnom Penh and Sihanoukville port. Both lines are not yet electrified and using diesel locomotives. Temporary repairs had completed by 1996 with the support from the Asian Development Bank and other institutions. A train runs only during daytime due to the security reason. It runs one round trip a day or every two days due to bad roadbed condition and defective signals. Running speed is between 10km to 35km per hour, which is slower than road transportation. A train takes 11 hours between Phnom Penh and Sihanoukville while a bus takes 3.5 hours only.

The Project of Rehabilitation of the Railway in Cambodia is being implemented from January



2008 until October 2010 under financial and technical assistance by ADB for further repairs. There are about 32 railways stations in Northern line between Phnom Penh and Battambang. The following 16 stations which are located in the Study Area and will be rehabilitated by the above project:

Province	District	Name of stations
Kampong Speu	Odongk	-Bat Doeng
Kampong Chhnang	Sameakki Mean Chey	-Domnak Srnach, -Tbeng Khpuos, -Meanork, -Romeas, -Kraing Skea, -Kdol
Pursat	Krakor	-Bomnak, -Kamreng, -Tateung Thngai
	Sampov Meas	-Pursat
	Bakan	-Boeung Khnar, -Svay Daun Keo
Battambang	Moung Russei	-Moung Russei, -Phnom Thop Dei
	Sangkae	-Battambang

Source: Railway stations in Cambodia, Ministry of Public Works

The others stations are small and will be left as they are.

### (3) Sea Transportation

Cambodia has two main international ports, namely, Phnom Penh port and Sihanoukville port.

Phnom Penh port is a river port on the Mekong River, which leads to the South China Sea through Vietnam. The port, which is close to both production and consumption areas, handles mainly oil products, timber, general merchandise, agricultural products, rubber, and flour. The water depth is around 3.5m during dry season. It is suited for up to 2,000 dwt vessel.

Sihanoukville port is an ocean port facing the Gulf of Thailand and the southern end of the Asian Highway. It is located 240km from Phnom Penh and linked by National Road No.4 and the Southern line of railway. As the port faces the ocean and it has capability in handling mass transport, main cargoes of the port are container, timber, large-scale machinery, cement, rice, sugar, and fertilizer. It can hold maximum 10,000-dwt vessels and has facilities for containers. The rehabilitation of the pier and the construction of new container facilities are being done by using the ADB loan. The wharf was expanded and existing facilities were also rehabilitated by the Yen Loan by Japan. It has no facilities for refrigerated containers.

Main destination and origin of cargoes for both ports is Singapore. Sihanoukville port has also Thailand, Australia, and China as major destinations and origins.

As National Road 4 between Sihanoukville and Phnom Penh is paved and more cargoes with container are now transported, and cargoes that used to go through Phnom Penh port are being sifted to Sihanoukville port. Route between Jakarta and Sihanoukville is recently regularized as a result of increasing rice transport.

### (4) Energy

The electrification ratio in Cambodia is estimated at 15.3% including urban areas in 2004. Rural electrification is being promoted by adopting mini grid development by renewable energy and or rechargeable battery, instead of waiting for expansion of grid system from urban areas. In spite of the above effort, the electrification ratio is left in low in rural areas. The

electrification ratio in the Study Area is summarized in the following table. In the table the ratio in Pailin is doubtful as number of households electrified is bigger than total households of census as described in the data source. The total electrification ratio is very low in Battambang Province. That in Pursat and Kampong Chhnang Provinces is close to or slightly higher than that in Cambodia.

#### Electrification Ratio in the Provinces of the Study Area

Description	Battambang Province	Pailin Province	Pursat Province	Kampong Chhnang Pr.	Total or average in Cambodia
Electrif. Ratio by grid/mini-grid					
- No. of customers	18,512	1,589	7,325	6,285	350,345
- Ratio (%)	10.9	16.9	10.2	7.5	15.3
Electrif. Ratio by rechargeable batteries					
- Estimated customers	1,117	10,311	29,310	42,348	881,904
- Ratio (%)	0.7	109.6	41.0	50.7	38.5
Total electrif. ratio incl. batteries					
- Total customers	19,629	11,900	36,635	48,633	1,232,249
- Ratio(%)	11.5	126.5	51.2	58.2	53.8

Source: The Master Plan Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia (JICA 2006)

The ratio of households which use electricity for lighting is summarized below. The total ratio of urban and rural is lower than that in Cambodia as a whole except for Kampong Pailin Province.

#### Electrification Ratio in the Provinces of the Study Area

Description	Battambang Province	Pailin Province	Pursat Province	Kampong Chhnang P.	Total or average in Cambodia
Urban	45.9	23.1	28.3	73.8	53.6
Rural	7.3	-	6.3	10.1	8.5
Total	13.9	23.1	9.6	11.7	15.1

Source: The Master Plan Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia (JICA 2006)

### 2.3.3 Meteorology and Hydrology

Climate of the Four River Basins is classified into tropical monsoon or savannah zones. Annual mean temperature ranges from 27.8 to 28.5 degrees Celsius. Rainfall in the Basins is distributed from 900 mm to 1,700 mm

with 80 % dependability.

In general, the plain area in the Moug Russei River Basin has less rainfall while the northern part of the Boribo has comparatively much more rainfall. The maximum daily rainfall and 3-day

#### Probable Maximum Daily Rainfall and 3-day Rainfall (10-year Return Period)

Unit: mm

River Basin	Daily	3-day
Battambang	120	174
Moug Russei	155	220
Pursat	129	191
Boribo	140	206

Prepared by JICA Study Team

#### Available River Discharge with 80 % Dependability

Unit: m<sup>3</sup>/sec

River Basin	Station	Dry Season (Dec – Apr.)	Rainy Season (May – Nov)
Battambang	Battambang	1.2 – 13.3	2.9 – 92.7
Moug Russei	Moug Russei	0.3 – 3.2	2.3 – 18.8
(Svay Don Keo River)	Svay Don Keo	0.3 – 3.3	2.4 – 19.2
Pursat	Khum viel	4.1 – 14.9	7.3 – 166.0
Boribo	Boribo	1.6 – 4.3	2.5 – 42.0

Prepared by JICA Study Team

rainfall with 10-year return period is tabulated above.

Mean monthly discharge was analyzed to estimate available water resources in the basin as shown on the right.

### 2.3.4 Agriculture

The rice production, the most important activity in the Basins is characterized by low and unstable productivity under rainfed conditions. Agricultural features under the systems currently employed in the Basins are tabulated as follows:

**Agricultural Features of Irrigation Systems of the Four River Basin (1/2)**

Item	Battambang	Mouung Russei
Area of Irrigated Paddy Fields	21,604 ha (including recession fields of 78ha)	12,058 ha (including recession fields of 1,571 ha)
Rice Cropped Area & Intensity	<ul style="list-style-type: none"> <li>• Wet season: 21,259 ha &amp; intensity 98%</li> <li>• Dry season: 707 ha &amp; intensity 3% (including recession rice)</li> <li>• Early wet season: 5 ha &amp; intensity 0.02%</li> <li>• Annual: 21,967 ha &amp; intensity 102%</li> </ul>	<ul style="list-style-type: none"> <li>• Wet season: 9,057 ha &amp; intensity 75%</li> <li>• Dry season: 3,106 ha &amp; intensity 26% (including recession rice)</li> <li>• Recession field (dry season): 1,571 ha &amp; intensity 13%</li> <li>• Annual: 12,163 ha &amp; intensity 101%</li> </ul>
Yield information reported	2.2 ton/ha in wet season in supplemental irrigation fields, 3.1 ton/ha in dry season & 1.0-1.2 ton/ha in rainfed fields.	2.2 ton/ha in wet season in supplemental irrigation fields, 3.0 ton/ha in dry season & 0.8-0.9 ton/ha in rainfed fields.

Source: The Inventory Survey Report

**Agricultural Features of Irrigation Systems of the Four River Basin (2/2)**

Item	Pursat	Boribo
Area of Irrigated Paddy Fields	40,190 ha (including recession fields of 455 ha)	52,467 ha (including recession fields of 3,115 ha)
Rice Cropped Area & Intensity	<ul style="list-style-type: none"> <li>• Wet season: 39,673 ha &amp; intensity 99%</li> <li>• Dry season: 2,425 ha &amp; intensity 6% (including recession rice)</li> <li>• Recession field (dry season): 455 ha &amp; intensity 1%</li> <li>• Annual: 42,330 ha &amp; intensity 105%</li> </ul>	<ul style="list-style-type: none"> <li>• Wet season: 47,022 ha &amp; intensity 90%</li> <li>• Dry season: 7,420 ha &amp; intensity 14% (including recession rice)</li> <li>• Recession field (dry season): 3,115 ha &amp; intensity 6%</li> <li>• Annual: 54,442 ha &amp; intensity 104%</li> </ul>
Yield information reported	2.2 ton/ha in wet season in supplemental irrigation fields, 3.1 ton/ha in dry season & 0.8-0.9 ton/ha in rainfed fields.	2.2 ton/ha in wet season in supplemental irrigation fields, 1.0 ton/ha in rainfed fields.(Lum Hach System)

Note: Recession field is the area endowed with natural irrigation and fertilization from periodic flooding and recession.

Source: The Inventory Survey Report

Compared with rice, production of upland crops have been challenging until now. Cropped areas of major upland crops for the Battambang and the Boribo are tabulated as follows:

**Cropped Areas of Major Upland Crops in the Battambang River Basin**

Crops	Area (ha)	(%)	Crops	Area (ha)	(%)
Corn	8,653	40	Cassava	3,037	14
Soybeans	3,763	17	Sweet Potatoes	66	-
Mungbeans	2,781	13	Sesame	2,296	10
Groundnuts	1,298	6	Total	21,893	100

Source: PDA Battambang

**Cropped Area of Major Upland Crops in the Boribo River Basin**

Crops	Area (ha)	(%)	Crops	Area (ha)	(%)
Corn	813	24	Cassava	458	13
Soybeans	0	-	Sweet Potatoes	794	23
Mungbeans	842	25	Sesame	38	1
Groundnuts	478	14	Total	3,422	100

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

On the other hand, the area of upland crops of the Moug Russei still remains only 2,300 ha (2 % of annual rice area) and 800 ha (1 % of annual rice area) in the Pursat. The major upland crop in those two basins is corn. Within the Study Area, as shown above, the Battambang River Basin is comparatively promising in that upland crops area is estimated at 21,900 ha or about 22 % of annual cropped rice area. Major crops in the Battambang River Basin are corn followed by mungbeans. In the western areas bordering with Thailand, in Ratanak Mondol District of Battambang and Pailin District of the basin and other border districts, upland crop cultivation of substantial scales are carried out and several large scale marketing facilities are in operation as the collection & distribution centres in the producing areas.

In the prevailing paddy marketing channels, farmers sell paddy to local collectors who are quite often farmers themselves but who do that kind of business as a side activity. The local collectors market the rice to wholesalers or to rice millers. The wholesalers then sell the rice to traders/large scale wholesalers in/from Phnom Penh or other provinces, who export or market some of the products to buyers from Viet Nam or Thailand. Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy. No serious constraints with market destination reported.

**Present Capacity to Pay**

River Basin	Typical Size	Capacity to Pay
Battambang	2.0 ha (rainfed)	Riel 112,000 (3 % of gross income)
Moug Russei	2.0 ha (rainfed)	Riel 52,000 (1 % of gross income)
Pursat	1.1 ha (rainfed)	Riel 44,000 (1 % of gross income)
Boribo	1.2 ha (rainfed)	Riel 122,000 (6 % of gross income)

Prepared by JICA Study Team

The government institution providing agricultural support services at the basin level is PDA. In addition, several projects are carried out with support by donor agencies including JICA, ADB, EU and so forth.

The result of farm economic analysis is tabulated on the right showing present capacity to pay (net surplus) of a typical farm family. Two River Basins, the Battambang and the Boribo show higher levels than the others.

### 2.3.5 Irrigation and Drainage

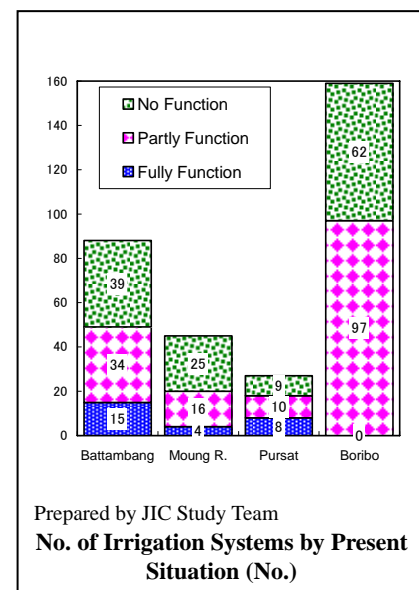
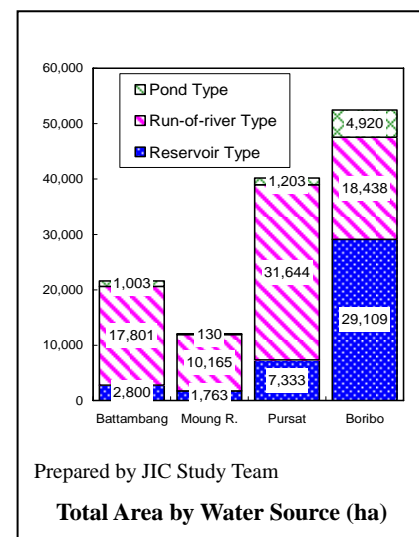
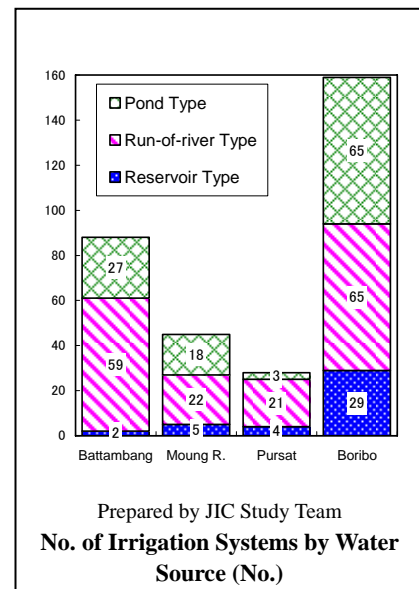
Current conditions of irrigation and drainage systems were studied based on a previous inventory survey conducted by JICA, a topographic survey, and an inventory survey carried out in the course of the Study. There are 320 irrigation systems in the Four River Basins, the types of which are shown on the right. Some locational characteristics are observed from the figure. In Battambang River Basin, the river type systems are prevailing while in the Boribo River Basin the pond type systems represent 41 % ( $=65/(65+65+29)$ ) of all the systems in the basin, which is remarkably higher than the other Basins. This would be in accordance with water resources as well as topographic conditions in the basin.

Figures of total area served by the various water sources could help clarify some characteristics inherent in the Basin. In general, a major part of the basin area is occupied by the river type systems except for the Boribo. In there, the reservoir type covers 55 % ( $=18,438/(29,109+18,438+4,920)$ ) of the total area while 4,920 ha, pond type systems are used in 9.3 % of the area but they represent 41 % of the total number of systems since most of the pond type systems are developed on a small-scale.

The condition of the irrigation systems have been broken into three categories : (i) fully functional, (ii) partly functional and (iii) non-functional, as shown on the right. The chart shows that most of the irrigation systems are facing some level of malfunction. Only 27 systems, 8.5 % of the systems are categorized as “fully function.”

Functionality from the view point of total area a similar tendency is also observed as illustrated below. Only 8,537 ha, equivalent to 6.8 % of the total area, are covered by “fully functional” systems.

Although rehabilitation was carried out recently, a considerable number of the systems are still in a mal-functional condition. In the case of the Battambang, only 14 out of 52 recently rehabilitated systems have recovered their full function. This is because many of them received only emergency rehabilitation to a part of the system such as culvert construction. Water control



structures including checks and turnouts with gates have not been restored in most of the systems possibly due to (i) lack of funds for comprehensive rehabilitation, and (ii) fundamental lack of canals and water control structures. Major problems common in the Four River Basins are as follows: (i) low ratio of farms under irrigation, (ii) lack of comprehensive rehabilitation work, (iii) deterioration of dykes in pond irrigation systems, (iv) low ratio of establishment of FWUC, (v) lack of canal capacity, (vi) deteriorated irrigation structures and (vii) lack of irrigation structures.

At present, development of drainage systems in the irrigation systems significantly lag behind. There are almost no drainage canals observed in most of the systems in the Four River Basins. According to a field survey of 12 irrigation systems of the Basins, farmers of 7 systems pointed out that they are currently facing some sort of water logging and/or drainage problems in the system areas.

Flooding, particularly along the Tonle Sap Lake in the eastern part of the River Basins, is observed in every wet season. Flooding is an important part of the regional ecology as flooded forests and seasonal wetlands are important for biodiversity as well as essential water resources for recession fields although it also has some negative impacts on farming. An estimated area of 4,240 km<sup>2</sup>, representing 18.5 % of the total area of the Four River Basin, is affected by floods of more than 8 days duration, the period which causes fundamental damage to crop growth.

In accordance with “Circular No.1 on Implementation Policy for Sustainable Irrigation Systems,” one of the principles emphasized is that the FWUCs placed in each irrigation system are the formal legal entities recognized by the Government and Civil Society. Whether they have been officially registered or not is frequently not clear. As shown in the following table, the establishment of FWUCs is still in progress with only 17 % of systems having FWUCs in the Basins.

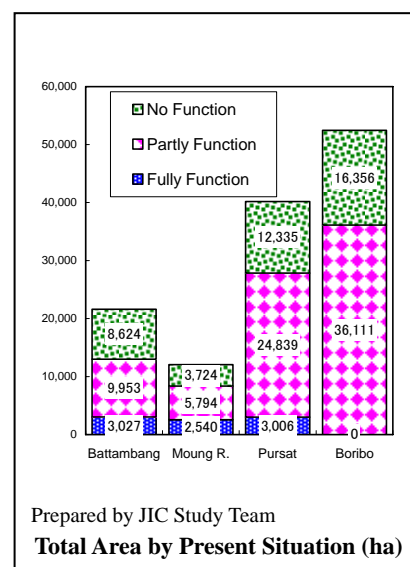
**Number of Irrigation Systems with FWUC already Established in Four River Basins**

River Basin	Number of Systems	Number of Systems having FWUCs	%
Battambang	88	20	22.7
Moung Russei	45	7	15.6
Pursat	28	8	28.6
Boribo	159	19	11.9
Total	320	54	16.9

Prepared by JICA Study Team based on Inventory Survey of Irrigation Systems

### 2.3.6 Mines and Unexploded Ordnance

Mines and Unexploded Ordnance (UXO) are one of the most serious constrains for any development including the irrigation sector in Cambodia and the Four River Basins are not left out. There are several organizations currently assisting field surveys, de-mining operations and



mine/UXO victim assistance. The category of mines and UXO-affected areas are as follows: (i) Residual Minefields, (ii) Suspected Minefields, (iii) Confirmed Minefields, (iv) Completed Minefields, (v) Level 1 Survey Area, (vi) B 52 Bombing and (vii) US bombs Record from 1965 to 1975 in accordance with the Cambodian Mine Action Centre (CMAC), description of which are tabulated as follows:

#### Category of Areas affected by Mines and UXO

No.	Category	Definition	Risk
1	Residual Minefield	The areas were affected by mines, however, the land has been already developed as fields or residence.	Risky
2	Suspected Minefield	These areas were suspected as being affected by mines, which are currently not developed with any purpose remaining as grassland.	Risky
3	Confirmed Minefield	CMAC Technical Survey Team has already checked that the lands are with risks for mines needing to be cleaned.	Risky
4	Completed Minefield	The areas have been already cleaned by CAMC.	No Risky
5	Level 1 Survey Area	The areas have some risks with mines surveyed by Cambodian Mine Action Authority (CMAA).	Risky
6	B 52 Bombing	This is the data given by US army showing that the areas were affected by machinegun attack. The areas centering attacked point with 50 m diameter needs to be surveyed before development.	Risky
7	US bombs Record from 1965 to 1975	This is the record provided by US army as well. The areas centering bombed point with 1.5 km diameter needs to be surveyed before any development.	Risky

Prepared by JICA Study Team based on Interview to CMAC

According to the criteria, the total area needs to be cleared before irrigation development is shown in the table occupying 1.7 % of total area of the four River Basins.

### 2.3.7 Environment

There is insufficient detailed information about the local economy for the Basins or at the Provincial level. The main industry is agriculture, mainly non-irrigated or rainfed farming. In terms of resource allocation, illegal farming is often observed in the reservoir area, which needs to be carefully resettled when project is implemented. Environmental awareness of communities differs among the users of the various systems. As already mentioned, only 17 % of the irrigation systems have FWUCs, however, some collaborative activities are observed for environmental conservation such as controlling fishing yield and tree planting in the systems as well as in the watersheds.

Protected areas in the Basins defined by the Royal Decree of Protected Areas consist of: (i) Phnom Samkos Wildlife sanctuary, (ii) Samlaut Multiple Use Area, (iii) Tonle Sap Multiple Use Area, (iv) Aural Wildlife Sanctuary and (v) the Cardamom Protected Forest. All the irrigation systems within the basin areas are located outside such protected areas. Ratios of

#### Land with Mines and UXO Risk

River Basin	Area (km <sup>2</sup> )	% of Basin Area
Battambang	139.7	2.3 %
Moung Russei	27.0	0.7 %
Pursat	25.0	0.4 %
Boribo	193.5	2.7 %
Total	385.2	1.7 %

Prepared by JICA Study Team



**Illegal Cropping in the Reservoir Area (Pursat Province)**

forest cover in the basins range from 30 % in the Boribo to 69 % in the Pursat.

Water quality for irrigation is stipulated in the Sub-decree on Water Pollution Control. However, there is only one water quality monitoring station in the Battambang River Basin managed under MOWRAM. According to reports received during the public consultations, Ream Kon and Por Canal systems surrounded by urban areas are suffering from deterioration of water quality due to wastes from surrounding households. Soil erosion and contamination are also observed in many systems. The situation of water-borne disease such as malaria and dengue also needs to be considered for irrigation development although it differs among the systems. In some systems, more than 80 % of the participants in the workshops pointed out this issue.

**Box: Category of Protected Areas**

1. **National Parks:** Areas reserved for nature and scenic views to be protected for scientific, educational and entertainment purposes
2. **Wildlife Sanctuary:** Natural areas preserved at their natural conditions in order to protect wildlife, vegetation and ecology balance
3. **Protected Landscape:** Areas to be maintained as scenic views for pleasure and tourism
4. **Multiple Use Areas:** Areas necessary for the stability of the water, forestry, wildlife, and fisheries resource, for pleasure, and for the conservation of nature with a view of assuring economic development

Source: Royal Decree on the Protection of Protected Areas

## 2.4 Assessment of Resources Potential

Irrigation development largely depends upon three essential resource factors: (i) water resources, (ii) land resources and (iii) human resources, which were assessed under the Study to prepare irrigation development plans through maximum utilization of available resources by considering specific regional characteristics.

### 2.4.1 Water Resource Potential

In the water resource assessment, the type of water source is defined as: (i) river/stream, (ii) reservoir (Bassac Reservoir in the Moung Russei Basin only as having been proposed by MOWRAM), (iii) pond and (iv) ground water. The assessment method consists of following six steps: (i) define the catchment area, (ii) calculate monthly discharge, (iii) calculate other water demands, (iv) calculate irrigation water demand, (v) select critical month, (vi) calculate available water amount and (vii) calculate irrigable area. The irrigable area in the wet-2 season in each river basin is summarized as follows.

**Irrigable Area of the Four River Basin -Result of Water Resources Assessment-**

River Basin	Sub-Basin	Irrigable Area (ha)	Potential/Current
Battambang	Battambang (Main)	28,000	1.53
	Battambang Plain	1,100	0.37
	Residual	2,400	-
Moung Russei	Moung Russei		
	(Without Bassac Reservoir)	2,600	2.45
	(With Bassac Reservoir)	10,000	9.43
	Svay Don Keo	2,400	1.33
	Residual (SRB d2)	800	-
	Residual (SRB d3)	1,100	-



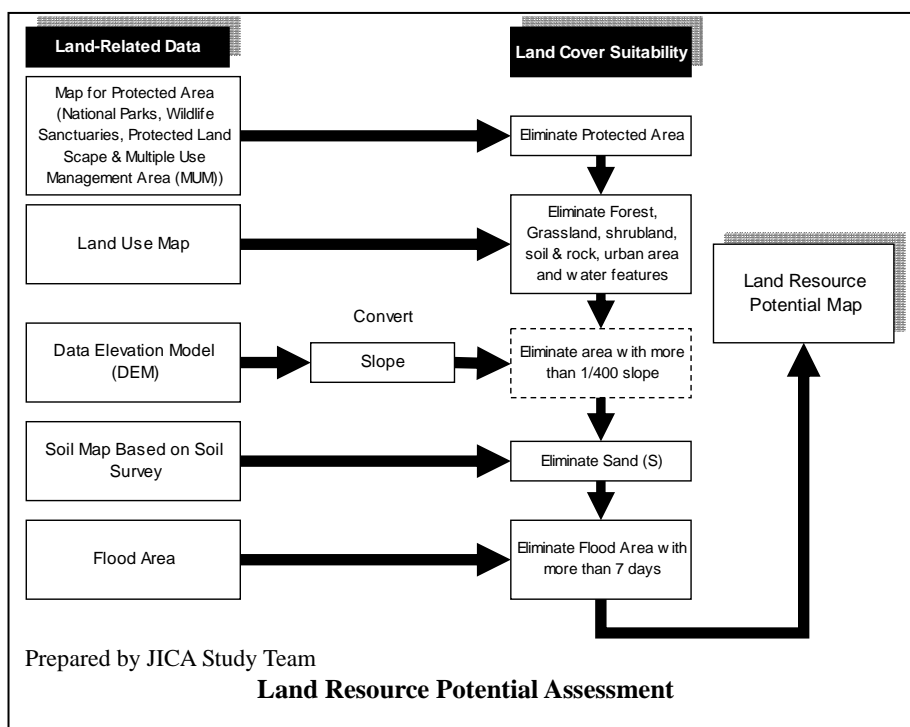
River Basin	Sub-Basin	Irrigable Area (ha)	Potential/Current
Pursat	Pursat (SRB e1)	45,600	1.12
	Residual (SRB f1)	600	1.06
	Residual (SRB f2)	1,500	-
Boribo	Boribo RB (Bombak – Boribo SRB g1)+g2))	3,400	1.51
	Boribo RB (Bombak – Boribo SRB g1)+g4))	3,700	0.47
	Boribo RB (Boribo-North SRB h1)	900	0.18
	Boribo RB (Boribo-MN SRB i1)	2,320	0.97
	Boribo RB (n, MN Residual SRB h2)+i2))	1,070	-
	Boribo RB (Boribo-MS SRB j1))	3,400	0.17
	Boribo RB (Boribo-South SRB k1))	1,300	0.15
	Boribo RB (MS,S Residual j2)+k2))	600	-
Total		102,790 (without Bassac Reservoir) 110,190 (with Bassac Reservoir)	

Prepared by JICA Study Team

## 2.4.2 Land Resource Potential

Land resources were assessed mainly using GIS data consisting of: (i) protected area, (ii) land use, (iii) Data Elevation Model (DEM), (iv) soil map and (v) flood area as the flow illustrated on the right:

The result shown in the table to the right indicates that 417,900 ha representing 18.4 % of the entire river basin areas can be developed for paddy field from the view point of land potential.



**Land Resources in the River Basin**

River Basin	Suitable (ha)	% in Basin
Battambang	87,900	14.5
Moung Russei	67,400	18.2
Pursat	93,300	15.7
Boribo	169,300	23.7
Total	417,900	18.4

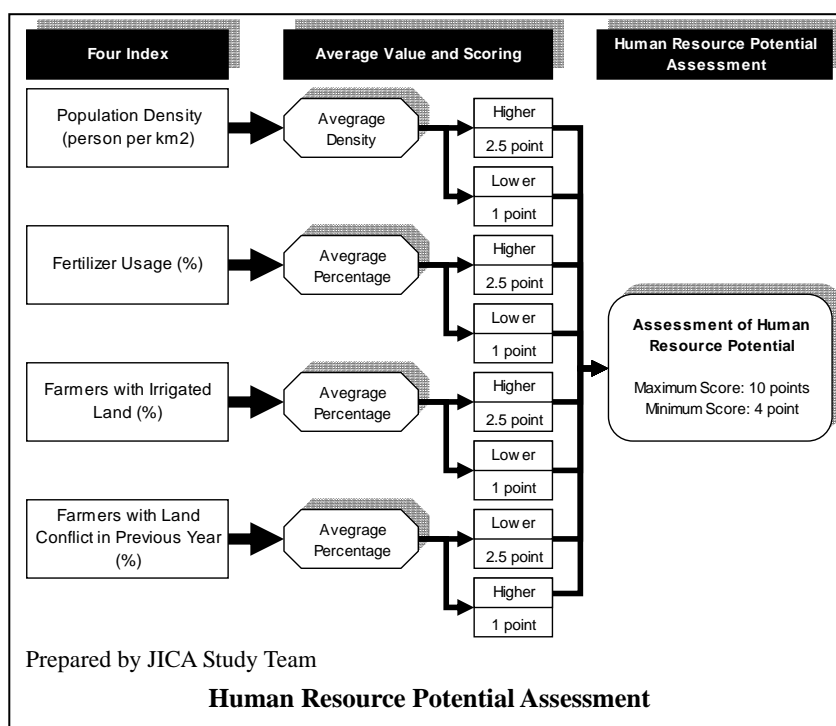
Prepared by JICA Study Team

### 2.4.3 Human Resource Potential

Human resource potential was assessed at district level through two main aspects: (i) availability of agricultural labor and (ii) level of farmers' agricultural techniques so as to identify the level of irrigated agriculture management.

In this regard, four indexes consisting of: (i) population density, (ii) farmers' experience with

fertilizer, (iii) farmers with irrigated farms and (iv) land conflicts in the previous year.<sup>1</sup> Assessment procedure is illustrated above and the result are as summarized in the following table:



**Result of Human Resource Potential Assessment (District Level)**

Units: Number of Districts

Level	Battambang	Moung Russei	Pursat	Boribo	Total
Very High (8.51-10 points)	0	0	0	3	3
High (7.01- 8.5 points)	0	0	0	3	3
Moderate (5.51 -7.0 points)	3	2	3	4	12
Low (4.0-5.5 points)	2	1	2	2	7
Very Low (4.0 points)	3	2	1	0	6
Total	8	5	6	12	31

Prepared by JICA Study Team

The districts in Boribo River Basin have comparatively high ratings while others have nearly similar ratings concentrating on “moderate” to “very low.” These results are utilized as one of the criteria for prioritization of proposed sub-projects.

<sup>1</sup> All the data is derived from SEILA Database (2005). Village data is reclassified by JICA Study Team to generate district level data for this comparison.

## **2.5 Concept and Approach to Basic Irrigation and Drainage Master Plan**

### **2.5.1 Problem Analysis and Need for Irrigation and Drainage Development**

In the previous sections, present conditions of four River Basins are explained including their constraints and potentials backed by relevant political and legal framework of the irrigation sector, field investigation and quantitative resource assessment. On the basis of those outputs, this section analyzes constraints of irrigation development to find out those co-relations, which support pinpointing needs of irrigation development as well as preparing development approach in four River Basins.

Through the field survey and analysis it has been determined that the main problems in the irrigation sector are “ineffective utilization of water, land and human resources,” or another way to describe the core problem of irrigation is that “Available resources are not utilized in an effective, sustainable and equitable manner.” Through digging out exercises, this core problem is caused by three primary categories of issues: ineffective water resources utilization; ineffective land resources utilization and; ineffective human resources utilization, followed by various sub-issues as listed below and illustrated afterward. In addition, problem tree in details are attached in Figure 2.5-1.

#### WR: Water Resources are not effectively utilized.

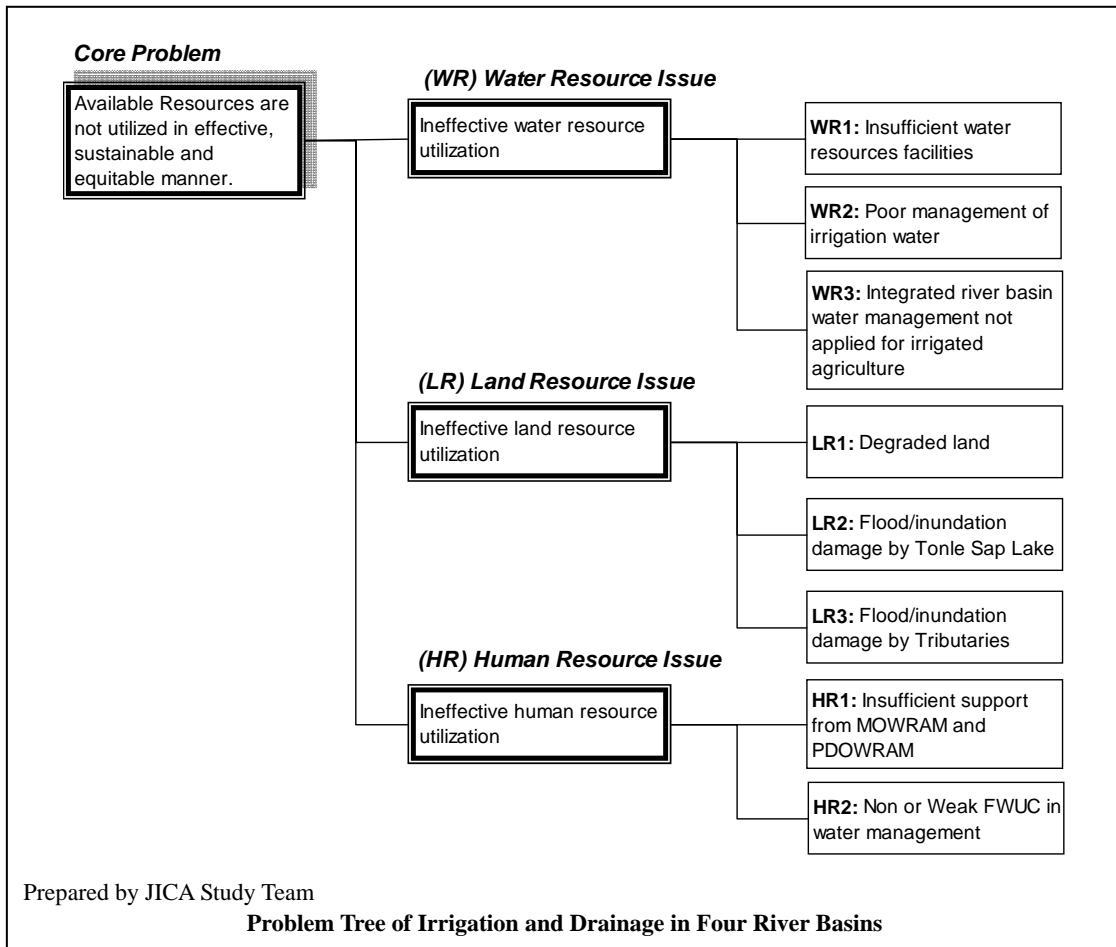
- WR1 Water resource facilities are insufficient.
- WR2 Irrigation water management remains low level.
- WR3 Integrated river basin water management is not applied for irrigated agriculture.

#### LR: Land Resources are not effectively utilized.

- LR1 Land and soil degradation have been making farmland unproductive
- LR2 Land are affected and/or damaged by flood/inundation by Tonle Sap Lake
- LR3 Land are Land are affected and/or damaged by flood/inundation by Tributaries.

#### HR: Human Resources are not effectively utilized.

- HR1 Support form MOWRAM and PDOWRAM is insufficient in order to revitalize irrigation systems.
- HR2 FWUCs are not established or still weak to carry out O&M of irrigation facilities and water management at tertiary level.



Those problems are not solely independent. Rather, they are mutually correlated. Therefore, it is required to take holistic measures to tackle such problems.

Resource utilization from the view point of water, land and manpower is highly improved by taking an integrated approach in irrigation development. There is not a shadow of doubt that in order to improve agricultural productivity, water resource facilities need to be rehabilitated urgently. Land resources can also be effectively utilized by considering flood management in currently affected areas. Those, water and land resources can be managed by strengthened human resources related with irrigation which mainly consist of MOWRAM and PDOWRAM staffs and farmers. Food security maintenance is one of the most important commitments by the Government. The Four River Basins shall be required to continue to play the important role of powerhouse and granary for the country's food supply in the future.

### 2.5.2 Food Balance and Food Security

Cambodia achieved self-sufficiency in rice in 1995 with the support of the production from the Four River Basins. According to the statistics, the Basins have been contributing to 17 % of the national requirements on average. On this basis, the food balance of years 2010, 2015 and 2020 were projected using different assumptions as tabulated below:

### Results of Food Balance using Different Assumptions

(Unit: 1,000 ton)

Assumptions/ Consumption	Paddy Requirements 1/			Contribution 2/			Balance 3/		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
Assumption 1 (Seed and post harvest loss: 13 %, Conversion rate to milled rice: 64 %: the figure utilized for the Food Balance Sheet of 2001 afterward)									
143 kg/person (MAFF)	4,302	4,821	5,406	731	820	919	71	-18	-117
155 kg/person (FAO)	4,449	4,985	5,591	756	847	950	46	-45	-148
167 kg/person (Vietnam)	4,793	5,371	6,023	815	913	1,023	-13	-111	-222
Assumption 2 (Seed and post harvest loss: 17 %, Conversion rate to milled rice: 62 %: the figure utilized for MAFF Food Balance Sheet before 2000)									
143 kg/person (MAFF)	4,696	5,261	5,901	798	894	1,003	4	-92	-201
155 kg/person (FAO)	4,814	5,394	6,049	818	917	1,028	-16	-115	-226
167 kg/person (Vietnam)	5,187	5,811	6,517	882	988	1,108	-80	-186	-306

1/: Estimated national paddy requirements for self-sufficiency

2/: 17% of the national requirements; expected contribution of the river basins to national production

3/: Paddy production increases required from the present level (802,000 tons) in the river basins

Note: Population increase is based on Population Projection published by the Ministry of Planning.

Consumption per capita is considered in three cases: (i) 143 kg/person assumed by the MAFF for the Food Balance Sheet, (ii) 155 kg estimated by FAO and (iii) 167 kg/person, the figure of Vietnam as a reference. The case: assumption 2 with 155kg/person consumption is utilized for the targeting setting of the M/P. Therefore, an increase in production is essential in the Four River Basins in order for it to continue to play the important role of powerhouse and granary for the country's food supply in the future.

### 2.5.3 Development Objectives and Strategies

Development objective is to utilize available resources under irrigation systems in effective, sustainable and equitable manner. In order to enhance the irrigation sector in accordance with this objective, strategies have been delineated from two aspects:

- (i) rehabilitation and development of irrigation facilities, and
- (ii) formation and strengthen FWUC and O&M.

As for the rehabilitation and development of water resources infrastructure, the following basic strategies for irrigation and drainage are envisaged:

#### ***Basic Strategies for Irrigation and Drainage Development***

- (i) Complete water supply for wet season paddy as first priority,
- (ii) Utilization of existing canals,
- (iii) Utilization of existing water resources,
- (iv) Construction of weirs for river irrigation systems,
- (v) Construction of additional canals and structures, and
- (vi) Rehabilitation of reservoir and pond irrigation systems for water harvesting.

“Formation and strengthen FWUC and O&M” needs to focus on five points in conformity with the government policy:

#### ***Basic Strategies for Formation and Strengthen of FWUC and O&M System***

- (i) Arrangement of Clear Responsibilities between FWUC and Agencies Concerned,
- (ii) Involvement of Rural Administration particularly commune councils, village chiefs and

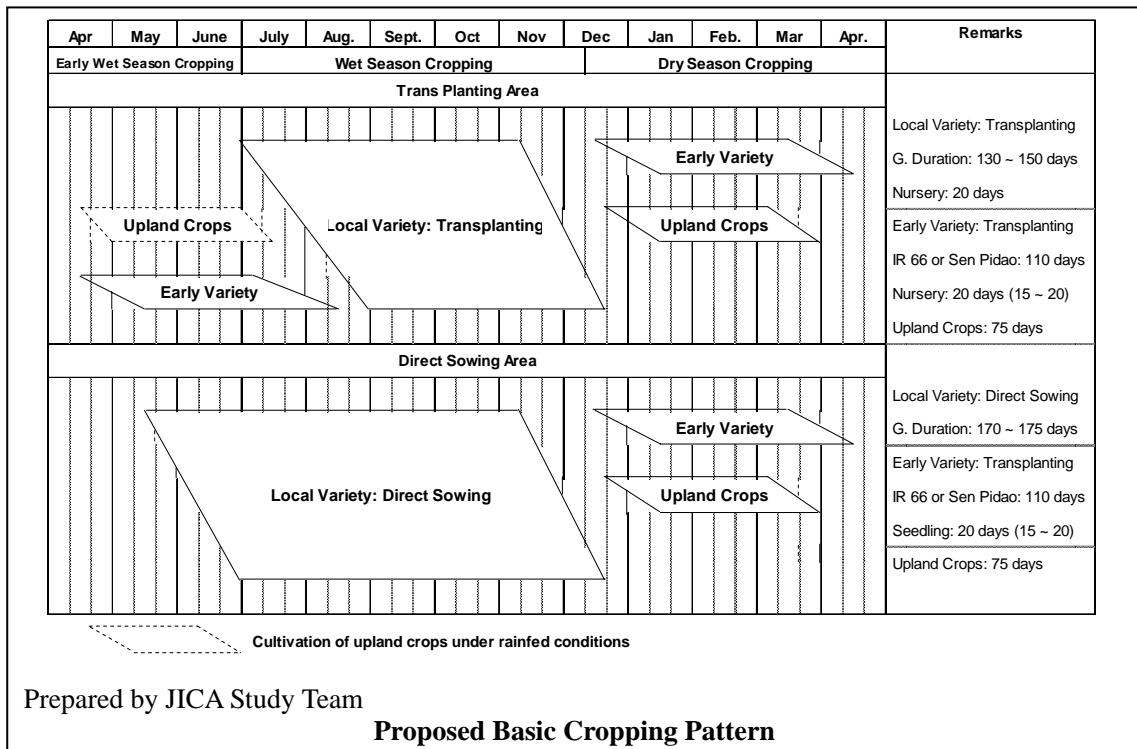
- Village Development Committees (VDC),
- (iii) Preparation of comprehensive O&M training programs,
  - (iv) Adoption of PIMD, and
  - (v) Participation of FWUG at the construction stage.

The strategy of the drainage improvement plan is also formulated, and it should focus on: (i) paddy fields as a main target, (ii) maximum utilization of small streams, and (iii) application of extensive drainage improvement in general.

In relation to irrigation and drainage development, the proposed agricultural development concept and strategy include the following four points:

- Basic Strategy for Agricultural Development**
- (i) Improvement of productivity and increased production of rice through cropping of medium to late medium rice in the wet season and improved farming practices,
  - (ii) Strengthening of agricultural support services for farmers' participation,
  - (iii) Introduction of early rice and upland crops in the early wet and dry season to increase land use intensity, and
  - (iv) Envisaging the introduction of upland crop production under rainfed conditions in the early wet season.

On the basis of these points, proposed basic cropping pattern is illustrated below:



The cropping intensity targeted under the plan is as follows:

- Cropping intensity in the wet season of 100% is envisaged in the pattern,
- Intensities of rice in the early wet season and rice and upland crops in the dry season are to be estimated through the water balance study on the individual projects, and
- In transplanting areas, introduction of upland crops in the early wet season under rainfed conditions is envisaged to the extent of 5% of the transplanting area.

As for the recession areas and areas where only dry season rice is cultivated due probably to inundation in the wet season, the current patterns and intensities are adopted as proposed ones.

The target crop yields under the present plan in which normal irrigation is ensured are studied based on the current yield levels at normal (full) irrigation areas in the basins and the results of the Pilot Project carried out under the Study on Comprehensive Agricultural Development in Prek Thnot River Basin, JICA and are set as shown in the following table in comparison with the present yield levels.

**Target Yields and Present Yield Levels**

(Unit: ton/ha)

Wet Season				Early Wet/Dry Season			
Crop 1/	Target	Present	Increment	Crop 1/	Target	Present	Increment
Improvement of Irrigation Status: Present: Normal Irrigation → With-project: Normal Irrigation							
Medium Rice (T)	3.5	3.0	0.5	Early Rice (T)	3.5	3.0	0.5
Medium Rice (D)	2.8	2.0	0.8	Upland Crops (I)	0.7	-	-
				Upland Crops (R)	0.5	-	-
Improvement of Irrigation Status: Present: Supplemental Irrigation → With-project: Normal Irrigation							
Medium Rice (T)	3.5	2.0	1.5	Early Rice (T)	3.5	2.5	1.0
Medium Rice (D)	2.8	1.5	1.3	Upland Crops (I)	0.7	-	-
				Upland Crops (R)	0.5	-	-
Improvement of Irrigation Status: Present: Rainfed → With-project: Normal Irrigation							
Medium Rice (T)	3.5	1.5	2.0	Early Rice (T)	3.5	-	-
Medium Rice (D)	2.8	1.0	1.8	Upland Crops (I)	0.7	-	-
				Upland Crops (R)	0.5	-	-

1/: T --- transplanting; D --- direct sowing; I --- under irrigation; R --- under rainfed condition

Upland crops represented by mungbeans

Prepared by JICA Study Team

The yield increases of 0.5 to 2.0 ton/ha in wet season rice and 0.5 to 1.0 ton/ha in early wet & dry season rice is envisaged under the plan. Current and target yield level of recession rice is set at 2.0 ton/ha and 2.5 ton/ha, respectively.

Improvement in farming practices envisaged from the current prevailing practices are: i) proper land leveling & preparation, ii) use of quality seed and adequate seeding rate, iii) raised nursery bed, planting of younger seedling, regular planting and reduced no. of plants per hill (in transplanting), iii) fertilization (increased & timely application including compost or cow dung), iv) introduction of proper on-farm water management & water saving culture, vi) intensified weeding and vi) improvement of post-harvesting practices.

## 2.6 Formation of Irrigation and Drainage Development Plan

### 2.6.1 General

The target area is determined based on the principles as follow: (i) first priority put on existing and potential areas given in the JICA Inventory Survey (2006), (ii) irrigable areas for each basin on the basis of water resource potential, (iii) consideration of on-going and committed projects by the government as well as donor agencies, (iv) geographic location of the irrigation systems, particularly considering the river systems and (v) unique characteristics of each river basin.

## 2.6.2 Irrigation and Drainage System

In total, 63,205 ha were proposed under the M/P for irrigation and drainage development on the basis of the following concepts: (i) maximum utilization of available water resources, (ii) consideration of the status of activities by other donor agencies, (iii) grouping of several existing irrigation systems for formulation of the projects taking geographic distribution into account and (iv) consideration of the natural characteristics of each River Basin. Present conditions of the irrigation systems in this area as assessed by the JICA Inventory Survey, proposed and number of irrigation systems encompassed are tabulated on the right:

**Proposed Irrigation Area in the Four River Basin**

River Basin	Existing		Proposed	
	Inventory existing area (ha)	Number of irrigation systems (No.)	(ha)	Number of project (No.)
Battambang	17,478	63	23,753	4
Moung Russei	650	5	7,600	4
Pursat	20,717	10	24,042	5
Boribo	5,110	39	7,810	8
Total	43,955	117	63,205	21

Note: There are 320 nos. of irrigation system in the four river basins in accordance with JICA Inventory (2006). From these, 117 irrigation systems are selected as targets for the development from the view point of available water resources. In the M/P, such systems are integrated into 21 projects by considering topography and river system, details of which are shown in section 2.7.

Prepared by JICA Study Team

## 2.6.3 Agriculture

The agricultural development plan assumed that current planting methods for rice, transplanting and direct sowing will be maintained in the future as such planting methods have been employed by farmers and were dictated by their land holding sizes and availability of labor forces. Proposed crops were selected with the following principles: (i) rice, current exclusive crop in the main cropping season, wet season, is selected as a crop are to be introduced, (ii) upland crops/vegetables in the dry season are to be introduced in addition to dry season rice, (iii) early rice in the early wet season is to be introduced in transplanting areas, (iv) upland crops are to be introduced in the early wet season in transplanting areas to improve land use intensity in paddy fields and (v) mungbeans are selected as one candidate upland crop to be used for domestic consumption, to improve the nutritional status of the farm families and to ameliorate soil conditions.

**Proposed Cropped Area and Intensity**

River Basin		Cropped Area (ha)	Intensity (%)
Battambang	Rice	23,753	100
	Upland Crops	205	1
	Total	-	101
Moung Russei	Rice	7,660	101
	Upland Crops	130	2
	Total	-	103
Pursat	Rice	26,241	109
	Upland Crops	702	3
	Total	-	112
Boribo	Rice	7,810	100
	Upland Crops	400	5
	Total	-	105

Prepared by JICA Study Team

The cropping intensity under the plan as shown in the table is determined as follows: (i)



cropping intensity in the wet season is 100 %; (ii) intensities of rice in the early wet season and rice and upland crops in the dry season under rainfed conditions are determined based on the water balance study; and (iii) in transplanting areas, introduction of upland crops in the early wet season under rainfed conditions is envisaged to cover 5% of the transplanting area.

Agricultural support services required consist of: (i) Technology Development, (ii) Field Extension, (iii) Farmer/Farmer Group Training, (iv) Mass Guidance and Workshops, and (v) Staff Training. In addition, for the improvement of land use intensity and promotion of upland crop production in paddy fields, development and dissemination of upland crop farming technology is essential. For this purpose, the promotion of technical development cum extension projects for upland crop production is necessary.

## 2.7 Formulation of Master Plan for Irrigation and Drainage Development

Under the M/P, the following 21 sub-projects and 4 project support programs were proposed as promising projects to improve irrigation and drainage in the Four River Basins. Each sub-project consists of:

- (i) Rehabilitation of irrigation and drainage facilities,
- (ii) FWUC training, and
- (iii) Agriculture and other support.

On the other hand, the project support programs cover cross-cutting issues for enhancement of the basis of project implementation. The information on 21 sub-projects are shown in Table 2.7-1 to 2.7-22 and summarize as follows:

**Proposed Irrigation and Drainage Sub-Projects**

No.	River Basin	Sub-Project Name	Proposed Area(ha)	Total Investment Cost (US\$ 1,000)	EIRR (%)	Capacity to Pay Increase (Times)
1	Battambang	Kong Hort Rehabilitation (Phase I)	10,040	27,267	8.7	8.8
2	Battambang	Kong Hort Rehabilitation (Phase II)	2,733	9,340	3.3	2.3
3	Battambang	Sala Taon Weir Rehabilitation	10,400	58,239	2.7	6.7
4	Battambang	Ratanak-Battambang Water Harvesting	580	2,266	4.9	5.5
5	Moung Russei	Bassac Irrigation System Rehabilitation	3,500	7,447	11.0	6.2
6	Moung Russei	Ream Kon Rehabilitation	2,300	5,357	10.5	6.0
7	Moung Russei	Por Canal Rehabilitation	1,200	2,402	12.4	5.7
8	Moung Russei	Nikom/Dai Ta Chan Rehabilitation	600	2,150	7.6	7.0
9	Pursat	Beoun Preah Ponley Rehabilitation	8,500	18,897	11.9	3.3
10	Pursat	Damnak Ampil Extension	8,000	17,175	11.1	1.4
11	Pursat	Wat Loung Rehabilitation	3,940	8,545	11.4	3.2
12	Pursat	Wat Chre Rehabilitation	1,000	2,800	9.4	3.1
13	Pursat	Anlong Knouchi, Wat Leal, Kosh Khsach Water Harvesting and Recession Rice Rehabilitation	2,602	6,036	8.5	1.5

No.	River Basin	Sub-Project Name	Proposed Area(ha)	Total Investment Cost (US\$ 1,000)	EIRR (%)	Capacity to Pay Increase (Times)
14	Boribo	Lum Hach Rehabilitation	3,700	10,174	7.1	1.5
15	Boribo	7 <sup>th</sup> January Canal Rehabilitation	2,000	5,339	7.3	1.6
16	Boribo	Khvet Rehabilitation.	250	890	7.8	2.7
17	Boribo	Ta Ram Rehabilitation.	180	981	4.1	2.7
18	Boribo	Chak Teum, Trapeang Khlong, Don Pov Rehabilitation.	980	2,465	11.0	2.7
19	Boribo	Teuk Laak, Trapeang Thlan Rehabilitation.	230	744	7.6	2.7
20	Boribo	Toul Champey Rehabilitation	360	685	13.9	2.7
21	Boribo	Chan Keak Rehabilitation	110	355	7.1	2.4
Total			63,205	189,553	-	-

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#### Proposed Project Support Programs

No.	Program Name	Necessity	Objective
1	Meteorological and Hydrological Observation strengthening Program	<ul style="list-style-type: none"> <li>Meteorological and hydrological data, which is not currently being collected sufficiently, is an essential and basic data for irrigation development as well as for future integrated river basin management.</li> </ul>	<ul style="list-style-type: none"> <li>To enhance the technical ability of MOWRAM and PDOWRAM staffs in meteo-hydrological observation, data processing and analysis</li> </ul>
2	Capacity Development Support Program for MOWRAM	<ul style="list-style-type: none"> <li>At present, the MOWRAM manual only focuses on planning and hydraulic design and therefore, it needs to be developed further together with capacity development of staffs so as to enable them to carry out proposed sub-projects under M/P.</li> </ul>	<ul style="list-style-type: none"> <li>To enhance technical ability of MOWRAM staff in planning, design, construction management and O&amp;M</li> </ul>
3	Capacity Development Support Program for PDOWRAM and MOWRAM	<ul style="list-style-type: none"> <li>This program will be necessary in order to accelerate decentralized implementation mechanisms under the support of MOWRAM.</li> </ul>	<ul style="list-style-type: none"> <li>To strengthen technical capability of PDOWRAM staff in O&amp;M of irrigation facilities and river basin control</li> </ul>
4	Upland Crops Production Promotion Program	<ul style="list-style-type: none"> <li>Upland crop cultivation needs to be expanded through technology development, adaptability trials and gradual dissemination by implementing pilot programs.</li> </ul>	<ul style="list-style-type: none"> <li>To develop appropriate farming technologies for upland crops in paddy fields, and</li> <li>To disseminate developed farming technologies or practices to farming communities in the Four River Basins</li> </ul>

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**2.8 Road Map of Irrigation and Drainage Development in the Four River Basins Toward Year 2020**

**2.8.1 Basic Concept for the Preparation of the Road Map 2020**

The Road Map 2020 covering the action plan of irrigation and drainage development in the four River Basins from 2008 until 2020, was prepared on the basis of following concepts:

<b><i>Concept of Road Map 2020</i></b>	
(i)	Stepwise Approach Consistent with Relevant Policy and Plans,
(ii)	Supporting Participatory Irrigation Management and Development (PIMD) under Irrigation Management Transfer (IMT),
(iii)	Development Prioritization through a Comprehensive Set of Criteria,
(iv)	Model Project Implementation for Ripple Effect, and
(v)	Contribution to the Maintenance of the Country’s Food Self-Sufficiency

**(1) Stepwise Approach Consistent with Precedent Policy and Plan**

In the preparation of the Road Map 2020, it is of importance to set out objectively verified target in a specific time frame so that: (i) action can be controlled, (ii) regular monitoring and evaluation can be facilitated, and (iii) review and revision, if any, can be carried out through a learning process. The Road Map 2020 covers the duration of 13 years, therefore, based on abovementioned principles, it is prepared for three time slices: (i) short term, (ii) medium term and (iii) long term with having respective thematic goal and sets of quantifiable target.

Third National Strategy Development Plan (2006-2010) follows this five-year segmentation. MOWRAM also disclosed Strategic Development Plan (Draft) for 2006 – 2010. Therefore, in order to maintain the consistency, the Road Map 2020 is prepared in compliance with those RGC policy and MOWRAM plans with the time slice of five years. Based on the discussion, The Road Map 2020 is prepared for three phases as follows:

- Short Term                      Year 2008-2010,
- Medium Term                    Year 2011-2015 and,
- Long Term                        Year 2016-2020.

**(2) Supporting Participatory Irrigation Management and Development under Irrigation Management Transfer**

MOWRAM emphasizes transfer of irrigation management services to FWUCs through the promotion of Participatory Irrigation Management and development (PIMD) under Irrigation Management Transfer (IMT) policy, which is in the framework of RGC’s decentralization and deconcentration. According to empirical evidence, however, IMT requires steady step as well as gradual scaling-up with careful policy and implementation design through considering physical, institutional as well as political issues. In compliance with this, the Road Map 2020 also put high priority on supporting this process stepwise. IMT support is carried out through physical rehabilitation and capacity development of the Government and FWUCs with appurtenant supporting programs so as to finally create irrigation sector into vital and self-reliant structure in the course of the Road Map 2020.

**(3) Development Prioritization through Comprehensive Set of Criteria**

Effective water resource development and management is recognized as one of the most important sectors in the country as stated in relevant policy and plans. Among others, irrigation and drainage development as public works is put higher priority in order to contribute to country's economic development as well as poverty alleviation. It must be noticed, however, that irrigation and drainage development gives impact to extensive areas including local economy, rural institution, environment and so forth. Prioritization of proposed projects under the Road Map 2020 carefully considers comprehensive set of criteria consisting of resource factor, economic factor, social factor, environmental factor and others, as detailed in section 9.2.

**(4) Model Project Implementation for Ripple Effect**

Prioritization as explained above is one of the most important steps in order to determine projects' implementation order. However, there are different types of projects as proposed including: (i) large scale projects, (ii) medium scale projects, (iii) small-scale reservoir projects, (iv) recession rice projects and so on in Four River Basins. If project is implemented also in consideration of establishment of development model for different irrigation types, it will be definitely useful to spread into other river basins. Since target Four River Basins are granary of the country and furthermore they have large potentials to be one of the advanced areas for irrigation and drainage development, it will be essential to prepare development model through project implementation under the Road Map 2020 to introduce development approach and methodology to other river basins. Therefore, implementation order under Road Map 2020 considers both: (i) prioritization score based on the set of criteria and (ii) balanced mix of different type of irrigation projects for promoting ripple effect.

**(5) Contribution to the Maintenance of Country's Food Self-Sufficiency**

There are no rooms for doubt that the four River basins must take an active part in maintaining country's food security in the future as having been conducting until now. According to the food balance analysis in section 6.2, the four River Basins produced 802,000 ton of rice per year (averagely between 2002 and 2005) playing a role for providing 17 % of share in the country's food production. By applying the estimate of MAFF, paddy production in the country overall requires 6.05 million ton per year while, in order to catch up this, the four River Basins need to produce 1.03 million ton per year by maintaining current share of paddy production by the Basins against entire country's production, 17 %, which means that 226,000 ton per year increment must be attained from current production level by the four River Basins.

The mission of irrigation and drainage development under the Road Map 2020 are to follow up this future food requirement. Therefore, the Road Map 2020 is prepared by satisfying abovementioned quantifiable figures as part of its target, actions of which are taken by minutely considering available physical, financial and institutional resources.

**2.8.2 Prioritization of Proposed Sub-Projects**

Sub-Projects formulated are ranked and prioritized using comprehensive sets of criteria, the

description of which is shown afterward with the score allocated to each:

**Criteria and Scores Allocated for Sub-Project Prioritization**

- (i) Resource Factor (30 points),
- (ii) Economic Factor (20 points),
- (iii) Social Factor (20 points),
- (iv) Environmental Factor (10 points),
- (v) Ease of Implementation (10 points), and
- (vi) Maturity Factor (10 points).

(1) Resource Factor

Resource factor is evaluated from the view point of three aspects necessary for irrigation and drainage, water, land and human using the result obtained in section 2.4.

Evaluation Category	Sub-category	Evaluation Protocol
a Resource Factor (30 points)	(i) Water Resource (Specific Discharge of July) (10 points)	10: 11.0 or more 8: 8.0 – less than 11.0 6: 6.0 – less than 8.0 4: 4.0 – less than 6.0 2: Less than 4.0 (Unit: lit/sec/km <sup>2</sup> )
	(ii) Land Resource (10 points)	10: Suitable 4: Sandy soil
	(iii) Human Resource (10 points)	Score is given from the assessment of Human Resources as abovementioned. District-based score with min. 4.0 to max. 10.0

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(2) Economic Factor

Level of economic viability can be evaluated from Economic Internal Rate of Return (EIRR). In addition, EIRR would be supplemented by other indexes as type of water abstraction method. Implementation period is also considered to assess quickness of benefit materialization.

Evaluation Category	Sub-category	Evaluation Protocol
b Economic Factors (20 points)	(i) EIRR (10 points)	10: More than 15.0 % 8: 12.1 – 15.0 % 6: 9.1 – 12.0 % 4: 6.0 – 9.0 % 1: Less than 6.0 %
	(ii) Irrigation Type (5 points)	5: Gravity 1: Pump
	(iii) Contribution to Local Economy (5 points)	5: Large (5,000 ha or more) 2: Moderate (2,000 to less than 5,000 ha) 1: Small (less than 2,000 ha)

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(3) Social Factor

One of the readiesses for implementation can be assessed by using organization, FWUC set-up. Although no FWUC exist at present, it is reported that there are some certain levels of community based activities such as periodical irrigation facilities rehabilitation. Such social

capital, fundamental for project implementation, is considered in the assessment. Marketability represented by “time to nearest market” is also important social factors to be carefully given due weight. Poverty Head Count Ratio at Provincial Level is, finally, taken into account to assess the importance of projects.

Evaluation Category	Sub-category	Evaluation Protocol
c Social Factor (20 points)	(i) Organizational Set-up (5 points)	5: FWUC already established 1: FWUC not yet established
	(ii) Level of Community based Collaborative Activity (5 points)	5: Active 1: Not so distinguished
	(iii) Poverty Level (Provincial Level Poverty Head Count Ratio) (5 points)	5: More than 55.1 % 4: 45.1 to 55.0 % 3: 35.1 to 45.0 % 2: 20 – 35.0 % 1: Less than 20 %
	(iv) Marketability (time to nearest market) (5 points)	5: Easily Accessible (less than 30 min.) 3: Moderate Condition (30 – 50 min.) 1: Poor Accessibility (more than 50 min.)

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#### (4) Environmental Factor

The projects are prioritized in accordance with possibility of social and natural environmental status. In this assessment, three aspects, necessity of involuntary resettlement by the projects, water quality suitable for agriculture and degree of water-borne disease in the communities are considered.

Evaluation Category	Sub-category	Evaluation Protocol
d Environmental Factor (10 points)	(i) Involuntary Resettlement (5 points)	5: No Problem 0: Some
	(ii) Water Quality for Agriculture (3 points)	3: No problem 0: Some
	(iii) Water-borne Disease (2 points)	2: No problem 0: Some

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#### (5) Ease of Implementation

The ease of implementation for projects shall be evaluated based on physical accessibility to the site, including distance from main road and road condition in the wet season.

Evaluation Category	Sub-category	Evaluation Protocol
e Ease of Implementation (10 points)	(i) Accessibility to Site (10 points)	10: Less than 5 km 6: 5 km to 20 km 2: More than 20 km

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#### (6) Maturity Factor

Level of maturity for each project is assessed by two status, intention of the Government consisting of MOWRAM and PDOWRAM and availability of basic data such as rehabilitation plan report.

Evaluation Category		Sub-category		Evaluation Protocol	
f	Maturity Factor (10 points)	(i)	Intention of the Government (5 points)	5: Highly prioritized by the Government	1: Low Priority
		(ii)	Availability of Basic Data (5 points)	5: Available	1: None

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In the analytical process, mines and UXO risks still remain in the Four River Basins are also considered as obstacles for the implementation.

#### Result of Prioritization of Proposed Sub-Projects

No.	Sub-Project Name	Resource	Econ.	Social	Envi.	Imple.	Matu.	Total	Rank	UXO
		30	20	20	10	10	10	100		
1	Kong Hort Rehabilitation (Phase I)	21	14	9.17	10	6	6	66.17	7	High
2	Kong Hort Rehabilitation (Phase II)	21	8	9.17	10	6	6	60.17	16	High
3	Sala Taon Weir Rehab.	21.5	11	9.61	0	10	6	58.11	17	Low
4	Ratanak-Battambang Water Harvesting	20.3	7	9.07	10	6	2	54.37	21	High
5	Bassac Irrigation System Rehabilitation	21	13	9	10	2	10	65.00	10	High
6	Ream Kon Rehabilitation	21	13	9	7	10	6	66.00	8	Low
7	Por Canal Rehabilitation	21	14	9	8	10	6	68.00	5	Low
8	Nikom/Dai Ta Chan Rehabilitation	21	10	9	10	10	6	66.00	8	Low
9	Beoun Preah Ponley Rehabilitation	21	16	8	10	6	6	67.00	6	Low
10	Damnak Ampil Extension	23	16	12	10	6	10	77.00	1	Low
11	Wat Loung Rehab.	23	13	8.72	10	10	6	70.72	3	Low
12	Wat Chre Rehab.	23	12	8	10	6	10	69.00	4	Low
13	Anlong Knouchi, Wat Leal, Kosh Khsach Water Harvesting and Recession Rice Rehabilitation	23	11	10.88	10	6	2	62.88	13	High
14	Lum Hach Rehab.	22.5	11	10	8	10	10	71.50	2	Low
15	7 <sup>th</sup> January Canal Rehab.	21	11	8	10	6	6	62.00	14	Low
16	Khvet Rehabilitation.	26	10	8	8	2	2	56.00	18	Low
17	Ta Ram Rehabilitation.	26	7	8	10	2	2	55.00	19	Low
18	Chak Teum, Trapeang Khlong, Don Pov Rehabilitation.	23	12	10.83	10	2	6	63.83	12	Low

No.	Sub-Project Name	Resource	Econ.	Social	Envi.	Imple.	Matu.	Total	Rank	UXO
		30	20	20	10	10	10	100		
19	Teuk Laak, Trapeang Thlan Rehabilitation.	21	10	9.72	10	2	2	54.72	20	Low
20	Toul Champey Rehabilitation	26	14	8	10	2	2	62.00	14	Low
21	Chan Keak Rehabilitation	24.5	10	8	10	10	2	64.50	11	Low

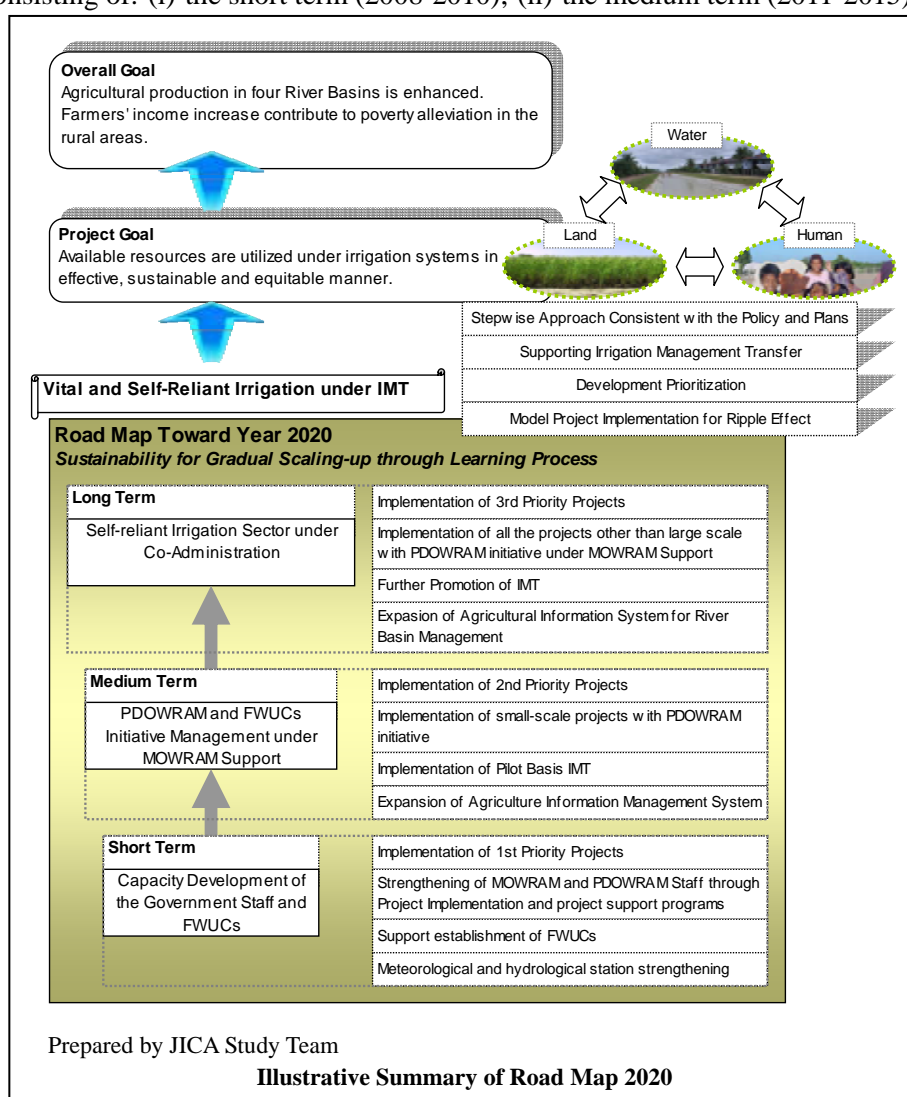
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## 2.8.3 Road Map of Irrigation and Drainage Development in the Four River Basins Toward Year 2020

### (1) Development Scenario

Taking the concept and the prioritization result into account, the Road Map 2020 is elaborated for three terms consisting of: (i) the short term (2008-2010); (ii) the medium term (2011-2015) and (iii) the long term (2016-2020) as illustrated as follows, each of which has thematic focal point and quantifiable target.

The Road Map 2020 must take learning process with gradual expansion in order to ensure sustainability, therefore, periodic revision and update will be required based on the new data that will be collected and



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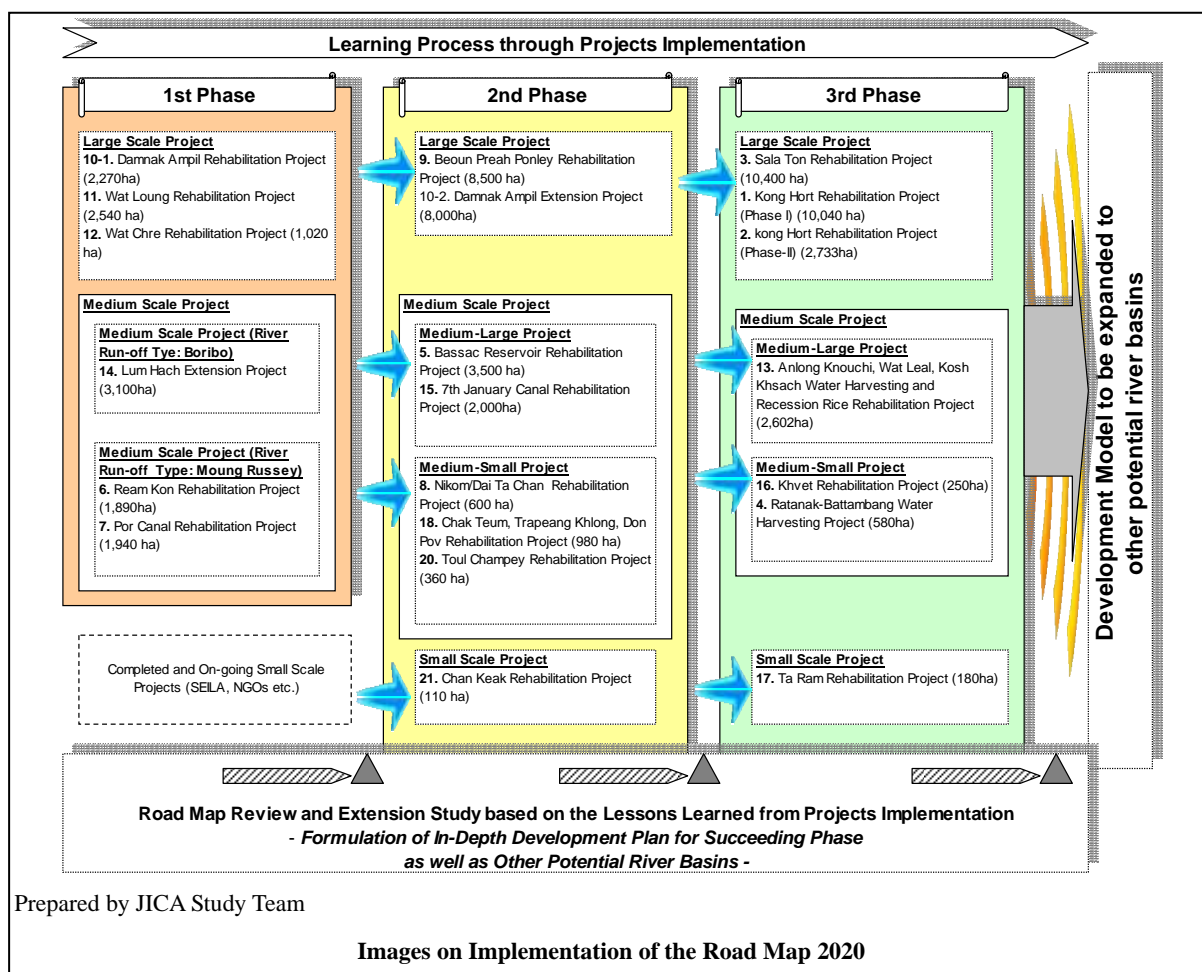
### Illustrative Summary of Road Map 2020

experience gained from project implementation. In addition, technical and financial assistance from International Donor Agencies will be required in the course of the Road Map 2020.



(2) Action Plan

The proposed sub-projects under the Road Map 2020 are to be implemented stepwise through revising and/or upgrading the plan of succeeding phases based on lessons to be learned in the implementation. The review and extension study during the project implementation are proposed as effective means in this process. Under the Road Map 2020, the implementation schedule of proposed sub-projects is designed as follows.<sup>2</sup>



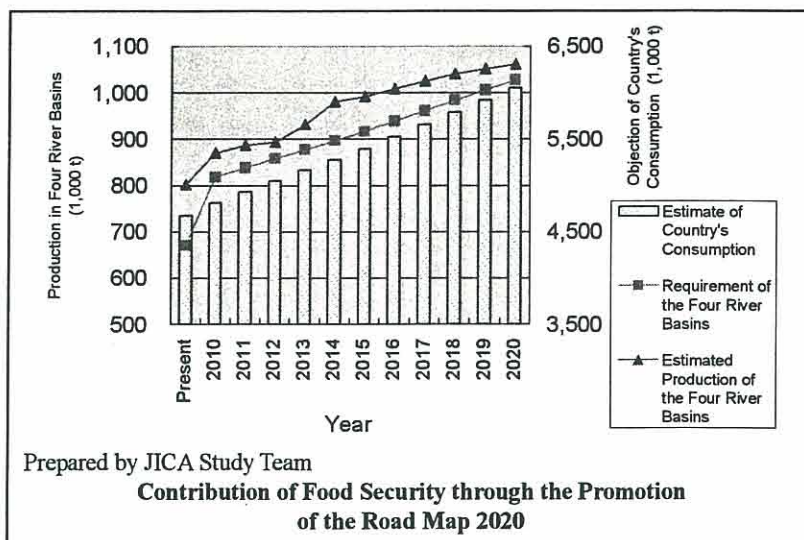
<sup>2</sup> The areas of five sub-projects selected for the Pre-F/S has been changed through Pre-F/S as tabulated as follows.

Area of Sub-Project (Feed-Back from Pre-F/S)		
No.	M/P	Pre-F/S
Ream Kon Sub-Project	2,300 ha	1,890 ha
Por Canal Sub-Project	1,200 ha	1,940 ha
Damnak Ampil Rehabilitation Sub-Project	8,000 ha (Extension)	2,270 ha (Existing)
Wat Loung Rehabilitation Sub-Project	3,940 ha	2,540 ha
Wat Chre Rehabilitation Sub-Project	1,000 ha	1,020 ha
Lum Hach Rehabilitation Sub-Project	3,700 ha	3,100 ha

In addition, Damnak Ampil Extension Sub-Project proposed in the original M/P will be shifted to the second phase of the Road Map 2020. Instead, rehabilitation of Damank Ampil Existing Area is proposed for the first phase as a result of Pre-F/S.

(3) Contribution to Food Security

In the Road Map 2020, 63,205 ha of irrigation areas are proposed to be rehabilitated and/or developed, which will contribute to poverty alleviation in rural areas in the four River Basins. An increase of in production of approximately 259,000 ton of paddy per year is expected from the implementation of the 21 proposed Sub-Projects, which will bring production up to the level required of the Four River Basins in order to support the country's food self-sufficiency. In addition, capacity-to-pay of farm households under the proposed Sub-Project is expected to increase by 2.5 to 9.6 times from current levels bridging the gap of income between urban and rural areas. It is strongly recommended that other supporting services that are needed in order to increase the value-added by agriculture, such as agricultural extension, marketing of products, input supply, rural credit and rehabilitation of rural infrastructure, are carried out concurrently so that increase of food production is guaranteed and farmers' incomes are increased leading to the irrigation sector becoming vital and attractive. This needs Inter-Ministerial Coordination by MOWRAM and MAFF in collaboration with other relevant Ministries.

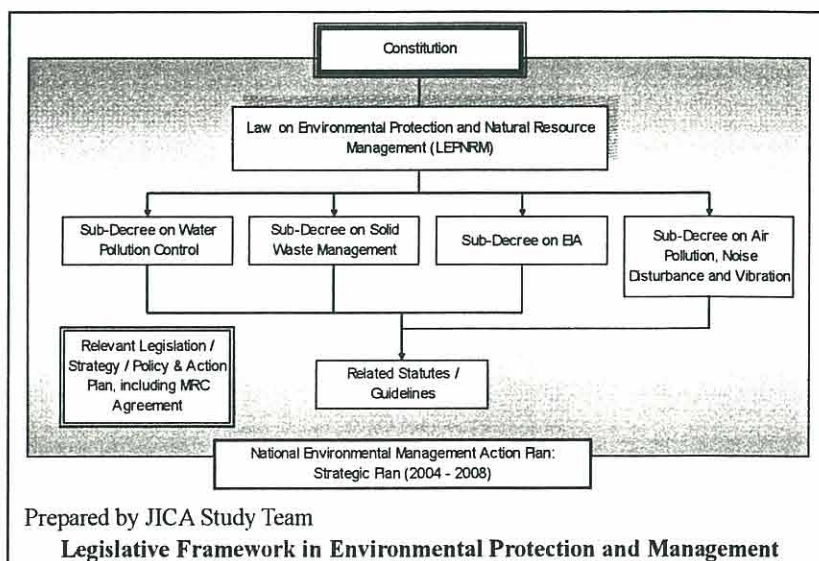


2.9 Environmental Assessment

2.9.1 List of Laws and Regulations

(1) Law on Environmental Protection and Natural Resource Management and Sub-Decrees

Relevant laws and regulations with those provisions are summarized in Table 2.9-1 and illustrated as follows:



(2) Environment-related Polices and Plans

In terms of environmental management policy, MOE together with the line-agencies has prepared the National Environmental Action Plan (NEAP) and has been regularly updating the Strategic Plan for environmental management based on the above-explained set of laws and sub-decrees.

(3) Development Activities in the Protected Areas

Declaration No. 1033 on Protected Areas (1994) prohibits the following activities in order to conserve those areas:

- Article 1: Construction of the saw mills, charcoal ovens, brick kilns, tile kilns, limestone ovens, tobacco ovens
- Article 2: hunt or the placement of hunting traps, the fishing of mammals, amphibians, reptiles and aquatic animals for tusks, bones, feathers, horns, leathers and blood
- Article 3: Deforestation for land use
- Articles 4: Exploitation of minerals and the use of explosives
- Article 5: Bringing of the domestic animals such as dogs
- Article 6: Water pollution activities such as the use of explosives, poisons, chemicals, electricity and dumping waste into the water surface or onto the land
- Articles 7: Use of machineries and heavy cars which could cause smoke pollution, and use of microphones which could cause noise pollution

The Article 8 of the Declaration stipulated that *researchers and experiments in protected areas shall be approved by the Ministry of Environment*. Although there are no irrigation systems to be developed in the protected areas, monitoring particularly water quality in the downstream of the system would be required to give adverse environmental impact toward protected areas.

(4) Land Policy and Legal Framework

The new Land Law, passed in August 2001, incorporates a number of significant changes and enhancement from previous Land Law 1992. The new Law consists of eight articles shown on the right. This issue can be also supplemented by the Law on Water Resources Management that the beds and banks of rivers, streams, lakes, canals, and reservoirs are owned by the State.

Land Law 2001			
General Provisions			
Article 1	Private	and	Public
	Ownership		
Article 2	Acquisition of Ownership		
Article 3	The Regime of Private Ownership		
Article 4	The Forms of Ownership		
Article 5	Immovable Property Used as Surety		
Article 6	Cadastre		
Article 7	Penalty Provisions		
Articles 8	Final Provisions		
Source:	MLMUPC (2002)		

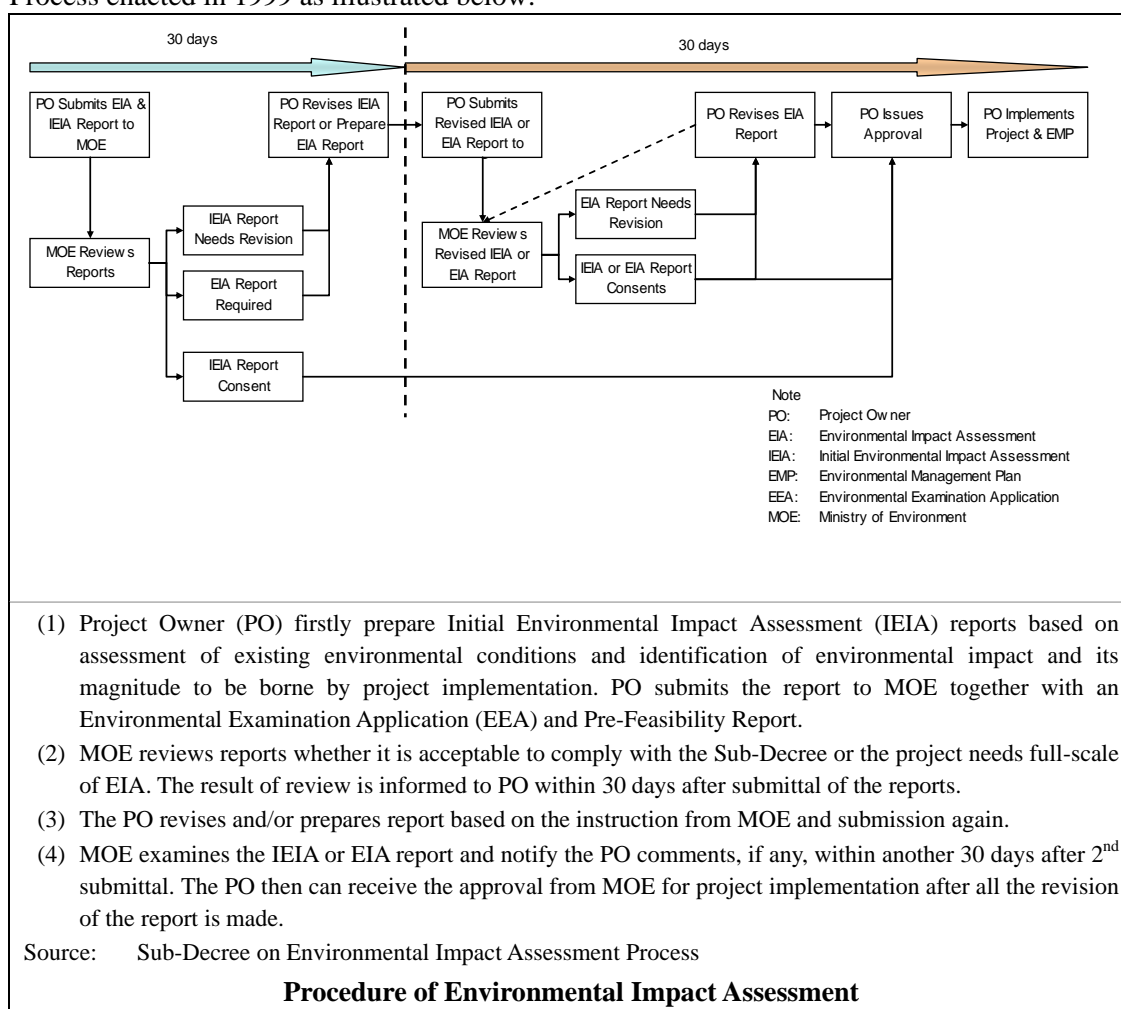
(5) Resettlement Policy

There are no stipulated documents at present, however, in the irrigation sector, it used to be not compulsory for the Government to compensate farmers land for tertiary development while

compensation is supposed to be made to farmers for main and secondary facilities development in irrigation systems. Resettlement Unit under MOWRAM is currently drafting sub-decree and guideline on the basis of ADB resettlement policy in order for smooth consensus building and resettlement among stakeholders. ADB policy in resettlement<sup>3</sup> emphasized, on the other hand, following points: (i) People affected should be at least as well off after resettlement as they were before; (ii) Social preparation is an important process for reducing tension and obtaining cooperation; (iii) People affected temporarily are counted and must be compensated and assisted accordingly; and (iv) All affected persons, including those without title to land, must be compensated for all their losses at replacement cost.

## 2.9.2 Process of Environmental Impact Assessment

Procedure of EIA is stipulated in the Sub-decree on Environmental Impact Assessment Process enacted in 1999 as illustrated below:



## 2.9.3 Result of Environmental Assessment

An Initial Environmental Examination (IEE) was carried out for the M/P from the view point of: (i) social environment, (ii) natural environment and (iii) pollution. Potential negative impacts and possible mitigation measures are tabulated as follows:

<sup>3</sup> Asian Development Bank (ADB) (1998), Summary of the Handbook on Resettlement, A Guide to Good Practice

### Summary of Potential Negative Environmental Impact and Mitigation Measures

Potential Negative Impact	Project Concerned	Status/Reason	Mitigation Measures
<b><i>Social Environment</i></b>			
Involuntary Resettlement and/or land acquisition	All Projects	<ul style="list-style-type: none"> <li>• Due to expansion of canal width and construction of reservoir</li> <li>• Particularly for Sala Taon Projects, resettlement is required for the people currently living along the river.</li> </ul>	<ul style="list-style-type: none"> <li>• Consensus building through stakeholder meetings</li> </ul>
Local Conflict over Interest	All Projects	<ul style="list-style-type: none"> <li>• Inflow of construction labors</li> <li>• Limitation of water during construction</li> <li>• Unequal water distribution within system</li> </ul>	<ul style="list-style-type: none"> <li>• Education program for construction labor</li> <li>• FWUCs strengthening program</li> </ul>
Sanitation Deterioration	Kong Hort, Sala Taon, Beoun Preah Ponley, and Damnak Ampil	Particularly larger scale sub-projects <ul style="list-style-type: none"> <li>• Caused due to inflow of labors</li> </ul>	<ul style="list-style-type: none"> <li>• Provision of proper facilities by the Contractor</li> </ul>
Risk against infectious disease	All Projects	<ul style="list-style-type: none"> <li>• Caused due to inflow of labors</li> </ul>	<ul style="list-style-type: none"> <li>• Stakeholder meeting to raise awareness</li> </ul>
<b><i>Natural Environment</i></b>			
Coastal Area Deterioration	Kong Hort, Sala Taon, Beoun Preah Ponley, and Damnak Ampil	Particularly larger scale sub-projects <ul style="list-style-type: none"> <li>• Increase of fertilizer and chemical application</li> </ul>	<ul style="list-style-type: none"> <li>• Site reconnaissance</li> <li>• Water quality monitoring</li> </ul>
Flora, Fauna and Biodiversity	All Projects	<ul style="list-style-type: none"> <li>• Change of fish habitat, more or less, by constructing weir and reservoir</li> </ul>	<ul style="list-style-type: none"> <li>• Site reconnaissance</li> <li>• Water quality monitoring</li> </ul>
<b><i>Pollution</i></b>			
Air Pollution	Kong Hort, Sala Taon, Beoun Preah Ponley, and Damnak Ampil	Particularly larger scale sub-projects <ul style="list-style-type: none"> <li>• Dust during construction phase</li> </ul>	<ul style="list-style-type: none"> <li>• Sprinkling, particularly, during earth works</li> <li>• Minimize idling time</li> </ul>
Water Pollution	All Projects	<ul style="list-style-type: none"> <li>• Disposal of living waste by labor during construction</li> <li>• Increase of fertilizer and chemical application</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness program</li> <li>• Water quality monitoring</li> </ul>
Soil Contamination	All Projects	<ul style="list-style-type: none"> <li>• Increase of fertilizer and chemical application</li> </ul>	<ul style="list-style-type: none"> <li>• Soil sampling and analysis</li> </ul>
Waste	All Projects	<ul style="list-style-type: none"> <li>• Disposal of living waste by labor during construction</li> </ul>	<ul style="list-style-type: none"> <li>• Provision of proper facilities by the Contractor</li> <li>• Education program to construction labor</li> </ul>
Noise and Vibration	All Projects	<ul style="list-style-type: none"> <li>• Due to machinery during construction phase</li> </ul>	<ul style="list-style-type: none"> <li>• Apply appropriate working hour</li> </ul>
Accidents	All Projects	<ul style="list-style-type: none"> <li>• Due to machinery during construction phase</li> </ul>	<ul style="list-style-type: none"> <li>• Stakeholder meeting to raise awareness</li> <li>• Training of operators for construction machinery</li> </ul>

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The conclusions on the basis of sub-project components are summarized as follows:

- (i) Proposed Sub-Projects and Project Supporting Programs are not expected to raise a great magnitude of negative environmental impacts in or around sites if proposed mitigation measures such as environmental awareness and education programs, water quality monitoring, soil sampling and analysis are carried out concurrently with system operation, and
- (ii) Measures for involuntary resettlement are of importance. Although potential impacts in this matter are not very high. The IEE judged it to be a small impact, however, it should be emphasized that the resettlement and the land acquisition process is to follow a careful stepwise approach gradually to build consensus among stakeholders with appropriate compensation. Since irrigation development has an impact on the entire local economy, not only on irrigated agriculture, various stakeholders need to be involved in this consensus building process.

## 2.10 Selection of Sub-Projects for Pre-Feasibility Study and Definition of Terminology

### 2.10.1 Selection of Sub-Projects

A Pre-F/S will be executed in the next phase with the purpose of upgrading maturity of proposed Sub-Projects from the view point of technical, economic and social aspects so as to accelerate implementation of the proposed Road Map. Target Sub-Projects for the Pre-F/S were selected on the basis of the following concepts:

***Criteria of Sub-Project Selection for Pre-F/S***

- (i) Highly Prioritized Sub-Projects in the M/P,
- (ii) Assist Preparation of Development Model at Pre-Feasibility Level, and
- (iii) Ensure security for the Study.

On this basis, the following six Sub-Projects were selected for the Pre-F/S.

**List of Sub-Projects for Pre-Feasibility Study<sup>4</sup>**

No.	Sub-Project	River Basin	Scale	Model	Area
1.	Damnak Ampil Extension	Pursat	Large	River Run off	8,000 ha
2.	Wat Loung Rehabilitation		Medium	River Run off	3,940 ha
3.	Wat Chre Rehabilitation		Medium	River Run off	1,000 ha
4.	Lum Hach Rehabilitation	Boribo	Medium	River Run off	3,700 ha
5.	Ream Kon Rehabilitation	Moung Russei	Medium	River Run off	2,300 ha
6.	Por Canal Rehabilitation		Medium	River Run off	1,200 ha
	Total Area				20,140 ha

Prepared by JICA Study Team

Three Sub-Projects consisting of Damnak Ampil Rehabilitation, Wat Loung Rehabilitation and Wat Chre Rehabilitation in the Pursat River Basin are in the same river system, of which the centre is Damnak Ampil Gate as a main intake from the Pursat River. Therefore, the study as well as implementation shall be carried out at the same time and/or stage-wise. Such aspect

<sup>4</sup> As explained in page 2-32, target areas of the six sub-projects have been changed through detailed study in the Pre-F/S. The total area of the six sub-projects is finally proposed to be 12,760 ha.

is also applied for two other sub-projects: Ream Kon Rehabilitation and Por Canal Rehabilitation in the Moung Russei River Basin. On the other hand, Lum Hach Rehabilitation is the highest priority in the Boribo River Basin and can be a good example of medium scale pond development.

### **2.10.2 Definition – Project and Sub-Project**

Six Pre-F/S sites are proposed for the first phase in the Road Map 2020, which are grouped into one package as a project, **West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project**. In this Report, therefore, the word, “project” and “sub-project” are defined as follows:

- ***Project:***

West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project formulated by grouping six sites categorized into phase I of the proposed Road Map 2020; and

- ***Sub-Project:***

Six sites selected for Pre-F/S targets consisting of:

- (i) Ream Kon Rehabilitation (Moung Russei River Basin in Battambang Province),
- (ii) Por Canal Rehabilitation (Moung Russei River Basin in Battambang Province),
- (iii) Damnak Ampil Rehabilitation (Pursat River Basin in Pursat Province),
- (iv) Wat Loung Rehabilitation (Pursat River Basin in Pursat Province),
- (v) Wat Chre Rehabilitation (Pursat River Basin in Pursat Province), and
- (vi) Lum Hach Rehabilitation (Boribo River Basin in Kampong Chhnang Province).

***Part-B***  
***Pre-Feasibility Study***



## CHAPTER 3 PROJECT AREA

### 3.1 Location and Administration

#### 3.1.1 Location

The six Sub-projects which were selected in the Master Plan Study for the first implementation are located in Pursat, Moug Russei and Boribo River Basins. All Sub-project areas are located in the west of Tonle Sap along the National Road No.5. The location of each Sub-project is summarized as follows:

**Location of Sub-project Areas**

No.	Sub-project	River Basin	Province	Location	Coordinate of water source structure (UTM Indian Thailand approx.)
1.	Ream Kon Rehabilitation	Moug Russei	Battambang	238 km from Phnom Penh to Moug Russei, and 0.3 km from the Moug Russei town to northeast	N=1412840 E=333212 Right side of the Moug Russei River
2.	Por Canal Rehabilitation	Moug Russei	Battambang	280 km from Phnom Penh to Moug Russei, and 0.5 km from the Moug Russei town to northeast	N=1412599 E=332454 Left side of the Moug Russei River
3.	Damnak Ampil Rehabilitation	Pursat	Pursat	180 km from Phnom Penh to Pursat, and 20 km from the town by rural road #148 to the existing Damnak Ampil Weir	N=1380406 E=370829 Damnak Ampil weir, Left side of the Pursat River
4.	Wat Loung Rehabilitation	Pursat	Pursat	8 km backward from the existing Damnak Ampil Weir to Pursat	N=1382468 E=37500 Left side of Pursat River
5.	Wat Chre Rehabilitation	Pursat	Pursat	204 km from Phnom Penh to Boeung Khnar, and 700m from the Boeung Khnar town to northeast	N=1397400 E=362500 Right side of the Boeung Khnar River
6.	Lum Hach Rehabilitation	Boribo	Kg. Chhnang	126 km from Phnom Penh to Boribo district, and 24 km from the Ponley town to southwest	N=1362350 E=425885 Right side of the Boribo River

Prepared by JICA Study Team

#### 3.1.2 Administration

The six Sub-projects are located in Battambang, Pursat, and Kampong Chhnang Provinces.

**Administration of Sub-project Areas**

No.	Sub-project	Province	Districts	Communes	Villages
1	Ream Kon Rehabilitation	Battambang	Moug Rusei	Kear, Chrey, Prey Svay (3 communes)	1 village in Kear, 4 villages in Chrey, 1 village Prey Svay
2	Por Canal Rehabilitation	Battambang	Moug Rusei	Chrey, Kear, Ta Loas, Kor Koah (4 communes)	4 villages in Chrey, 9 villages in Ta Loas
3	Damnak Ampil Rehabilitation	Pursat	Sampov Meas	Lorlok Sar, Snam preah, Trapeang Chong, Phteah Rung, Bak Chenhchien (5 communes)	Dam Nak Ampil
4	Wat Loung	Pursat	Sampov	LorlokSar, Trapeang	Wat Loung, Kos

No.	Sub-project	Province	Districts	Communes	Villages
	Rehabilitation		Meas, Bakan	Chong, Snam Preah, Khnar Totueng, Boeng Khnar (5 communes)	
5	Wat Chre Rehabilitation	Pursat	Bakan	Boeung Khnar, Me Tuek (2 communes)	Wat Chre
6	Lum Hach Rehabilitation	Kg. Chhnang	Boribo & Roleaphaea	Krang Skear, Anchanh Rung, Prasneb, Phsar (4 communes)	Anchanh Rung, Damrei Koun, Prey Preal, Andoung Rovieng, Thmei, Trapeang Ampil

Prepared by JICA Study Team

## 3.2 Natural Conditions

### 3.2.1 Topography

#### (1) Temporary Bench Marks

JICA Study Team set Temporary Bench Mark (TBM) in every Sub-project area by a concrete typical monument or at the existing permanent structure. The coordinate and elevation of the TBM are summarized in Table 3.2-1.

#### (2) Ream Kon Rehabilitation Sub-project

The Sub-project area extends in 11km from National Road No. 5 to east along right bank of the Moung Russei River, and 6km to south from right bank of the River. JICA Study Team set a Temporary Bench Mark (TBM-06) The area has a downhill slope to northeast; ground surface elevation varies from EL.15.0m to EL.10.0m. The land slope is between 1/2500 and 1/3000 from west to east, and 1/2000 and 1/2500 from south to north. The existing main canal runs from west to east, and divides the area into two i.e., northern part and southern part. The southern area has an uphill slope from main canal.

The dike along the Moung Russei River near the existing headworks varies between EL.16.8 m and EL.17.8 m in the left bank, and EL.16.5 m and EL.16.9 m in the right bank.

#### (3) Por Canal Rehabilitation Sub-project

The Sub-project area is located opposite side of Ream Kon Sub-project area, extends in 8 km to north from left bank of Moung Russei River, and 6 km in width from west to east. The area has a downhill slope to northeast; ground surface elevation varies from EL.14.7 m to EL.11.5 m. The land slope is between 1/1500 to 1/2000 from south to north, and 1/3000 from west to east.

#### (4) Damnak Ampil Rehabilitation Sub-project

The Sub-project area is located 3km far from left bank of Damnak Ampil Headworks on the Pursat River.

The existing irrigation area extends in 7.3 km to west and in 6.5 km to north from the Damnak Ampil Main Canal which was rehabilitated by MOWRAM in 2006. The area has a downhill

slope to north; ground surface elevation varies from EL.16.8 m to EL.13.7 m<sup>1</sup>. The ground slope is between 1/2500 and 1/3000 from south to north, and 1/7500 from east to west. The existing main canal is 7.3 km long, and its base varies from EL.15.50 m to EL.14.04 m (1/5000) in accordance with the design made by MOWRAM in 2005.

The extension irrigation area extends in 13km to west from west boundary of the existing irrigation area. It extends in 7 km to north from existing canal. The ground surface varies from EL.16.2 m to EL.8.5 m; the ground slope is about 1/3000 from south to north, and 1/2500 from east to west. According to the topographic survey by the Study Team, the base of the existing canal which was excavated in 1970s varies from EL.13.4 m to EL.10.0 m in 13.4 km.

(5) Wat Loung Rehabilitation Sub-project

The Sub-project area is located along the left bank of Pursat River between Ou (stream) Bakan and National Road No.5; both run from southeast to northwest in parallel. The area has a downhill slope to northwest; ground surface elevation varies from EL.15.9 m to EL.10.8 m. The ground slope is between 1/3500 and 1/3700 from south to north, and 1/2500 from east to west.

(6) Wat Chre Rehabilitation Sub-project

The Sub-project area is located along the northern bank of National Road No. 5, spreads along both right and left banks of the Boeung Khnar River which is downstream of Ou Bakan. The area has a downhill slope to north and west; ground surface elevation varies from EL.13.5 m to EL.10.5 m. The ground slope is about 1/1500 from south to north, and 1/2500 from east to west.

The new Wat Chre Diversion Weir site is considered at one kilometer upstream of the existing weir which is severely damaged and currently not in use, so that the upward (reverse) inclination of main canal will be avoided and gravity irrigation will be applied over larger area than at present. The Diversion Weir should be constructed at the place where the shape of river-course is rather straight, with consideration for the structural and hydraulic stability. The intake site is considered about 100 m upstream from the Diversion Weir.

(7) Lum Hach Rehabilitation Sub-project

The Sub-project area is located in the middle reach of the Boribo River up to National Road No. 5. The area extends in 24 km from southwest to northeast. The ground surface elevation varies from EL.39.6 m to about EL.20.0 m. The ground slope is about 1/500 to 1/1000 in the upstream area, and 1/1500 and 1/2000 in the downstream area.

The proposed headworks site is located at narrow section of the Boribo River, and has a wide pocket in the upstream. The river bed elevation is between EL.33.0 m and 34.0 m. The top elevation of the river banks are at EL.41.0 m for left bank, while only at EL.39.0 m for right bank, respectively.

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<sup>1</sup> There shows differences in elevation between national survey grid and design drawings of the Damanak Ampil Headworks in the Project Proposal for the Rehabilitation of Damanak Ampil Irrigation Project prepared by MOWRAM (2004). In the study, the ground surface elevation of two sub-projects: (i) the Damanak Ampil and (ii) the Wat Loung was surveyed using the data shown in MOWRAM's proposal (refer to Table 3.2-1).

### 3.2.2 Meteorology and Hydrology

#### (1) Major Works

##### 1) Data Collection and Observation

Additional data such as rainfall of the existing observation network in 2007 were collected by the Study Team in order to increase number of the maximum rainfall data as much as possible. For the observation by the equipment installed in the Study, field visit to 28 stations (14 rainfall and 14 water level stations) for (i) data collection, (ii) inspection of observation conditions and (iii) discharge measurement, were conducted by the Study Team under site control of MOWRAM and PDOWRAM counterparts, until September, 2008. From technical viewpoint, counterpart personnel of MOWRAM and PDOWRAMs accumulated their experience both in the field and office works during the Study so far, and they can continue the observation by themselves to the extent of satisfactory level. As shown in Table 3.2-2 and mentioned below, flood information was collected through interview to village people and PDOWRAMs. To support flood analysis, following table is prepared based on the results of Household Survey conducted for social and environmental study.

**Flood Information based on Results of Household Survey**

Question	Prolay Po	Ream Kon	Wat Loung	Wat Chrea	Lum Hach
<b>Flood Damage</b>					
1 Do you suffer from flood damage?					
Yes	55%	70%	50%	13%	8%
2 How often do you suffer from flood in a year?					
1~4 times	55%	70%	45%	10%	8%
2-3 YEARS ONE TIME	-	-	5%	3%	-
3 How many days does one flood continues on average?					
3 days or more	48%	70%	38%	13%	5%
4 How do the floods damage you?					
Paddy, Veg. field or Poultry	43%	60%	40%	10%	8%
Family's Life	13%	10%	8%	-	-

Prepared by JICA Study Team, through arrangement of selected data from results of "Household Survey" carried out by Social and Environmental Sector in the Study

##### 2) Study

For irrigation water balance study, five-day discharge data are prepared for the six Sub-projects, namely Ream Kon, Por Canal, Damnak Ampil, Wat Loung, Wat Chre and Lum Hach. Probable flood discharges are also estimated for the Sub-projects. Irrigation water sources of the Sub-projects consist of three rivers, namely the Moung Russei (Dauntry, through proposed Basak reservoir), Pursat and Boribo Rivers in Figure 3.2-1. In this section 3.2, "river basin" of Moung Ruusei, Pursat or Boribo means respective single river basin, but it does not mean larger "River Basin", which is composed of plural river basins. During field visit, basic technology to make rating curve was again transferred to the counterparts with practical calculation example. In two counterpart meetings, technical ideas and opinions were exchanged and flood flow Phenomena of the Pursat River were explained.

(2) Moug Russei River for Ream Kon and Por Canal Rehabilitation Sub-projects

1) Moug Russei River Basin

The Ream Kon and Por Canal Rehabilitation Sub-project areas and Moug Russei (Dauntry) river basin are illustrated in Figure 3.2-2. The Basak reservoir is planned to be constructed on the river. A damaged weir exists and a main canal starts at Prek Chik, where two water level stations were installed in the Study, one on the river and another on the main canal. In the Prek Chik irrigation main canal, there seems no water flow at least in 2007 at the head of the canal except in flood time.

2) Average monthly meteorological data

Meteo-hydrological observation and data collection have been carried out in the Moug Russei River Basin, in order to utilize those data for irrigation and drainage plan and facility design for the Ream Kon and the Por Canal Rehabilitation Sub-projects at Pre-F/S level, respectively. The average monthly meteorological data of the Moug Russei River Basin is tabulated as follows:

**Average Monthly Meteorological Values at Moug Russei River Basin:  
Ream Kon and Por Canal Rehabilitation Sub-projects**

Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean (°C)	25.7	27.7	29.6	30.4	30.1	29.6	29.0	28.7	28.0	27.5	26.6	25.4	28.2
Relative humidity (%)	70	66	67	68	72	73	74	77	79	81	78	74	73
Wind velocity (m/s)	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.1	0.8	0.8	0.9	0.9	1.0
Sunshine hours (hr/day)	9.5	9.0	8.8	7.7	7.3	5.6	6.4	5.0	5.5	6.6	7.4	8.5	7.3
Evaporation (mm/day)	4.0	4.7	4.8	4.9	4.5	4.3	3.7	3.6	3.0	3.2	3.2	3.4	3.9
(mm)	122	131	148	147	138	128	113	111	90	97	95	104	1423

Note: Data = Average of Battambang and Pursat Stations' data except sunshine hours

Sunshine hours = that of Battambang Station \* Wind velocity is adjusted to the equivalent one at 2 m height.

Prepared by JICA Study Team

3) Five-Day Discharge

As presented in Table 3.2-3, five-day discharges for five years are prepared for water balance study on the Basak reservoir. Annual average discharge from 2001 to 2005 is calculated 3.23 m<sup>3</sup>/s or 102 MCM/year at Basak reservoir and 1.00 m<sup>3</sup>/s or 32 MCM/year from residual area between the reservoir and Moug Russey water level station (station name: based on Station List prepared by MOWRAM). Since available discharge data are quite limited along the Moug Russei River and there are five years of data at Svay Don Keo, discharges for Moug Russei River at Moug Russey station are calculated based on the discharges of Svay Don Keo river, as done in Phase 1 of the Study. Newly gained data in 2007 at both Moug Russey and Prek Chik (river) stations on the Moug Russei River, suggest that river discharges at Prek Chik (river) station are a little smaller in the dry season and a little larger in the wet season than at Moug Russey station. Along the river course between the Basak reservoir and Prek Chik, change in river discharge is judged negligibly small as water coming in and going out is quite limited. Considering these matters as well as safety side standpoint, the Basak reservoir five-day discharges are estimated in use of conversion coefficients of 0.9 (Jan.-Apr.) and 1.0 (May-Dec.) from discharge of Moug Russey station to Basak reservoir site.

4) Flood discharge

Probable flood discharges at Moung Russey station is estimated as shown in table below, based on (i) those at Svay Don Keo, (ii) the latest data in 2007 on the Moung Russei River and (iii) estimated flow capacity of the river for a counter check. Flood discharges are small at Svay Don Keo or 54 m<sup>3</sup>/s in recent average. On 21st November, 2007, a flood of 80 m<sup>3</sup>/s was observed at Moung Russey station on the Moung Russei River. Probable flood discharge at Moung Russey is estimated multiplying by flood discharge at Svay Don Keo by 1.5 (= 80/54). Obtained discharges are counter checked with cross-sectional flow capacity. Flood discharge

T	Qd(max)	Qpeak
(year)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)
2	80	100
5	90	110
10	100	120
20	110	130
50	130	160
100	160	190

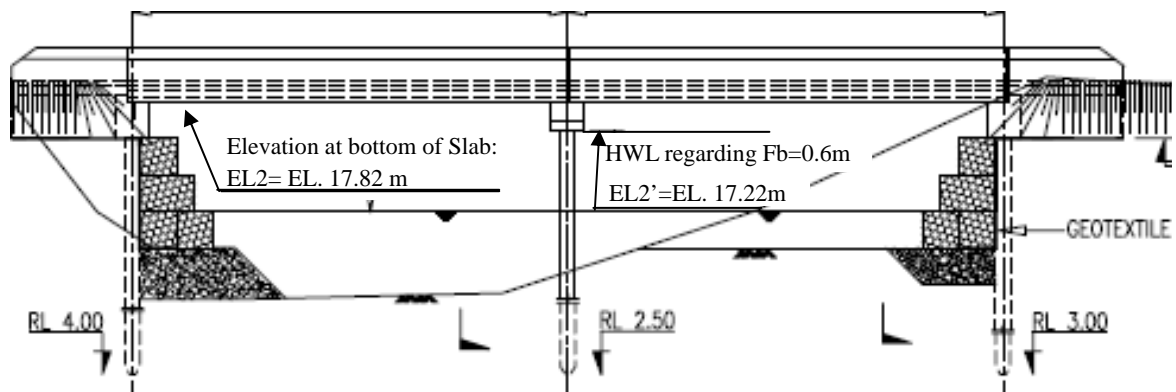
Prepared by JICA Study Team

of 100-year return period is estimated from hydraulic calculation with estimated flood height. A part of flood flow between Prek Chik and Moung Russey stations is diverted to Prek Chik main canal. Not small amount (nearly a half in case of above flood in 2007) of the Prek Chik flood flow is probably bifurcated at about 6 km south (about 10 km in river channel length) from the Moung Russey station. Peak discharges (Q peak) are calculated by multiplying Qd (max) by ratio of Q peak/Qd (max). The ratio at Moung Russey station, is lower than that at Prek Chik, because flood wave shape becomes milder downstream in this reach. In use of half hourly discharge data observed in the Study at Prek Chik in 2007, the ratio of 1.4 is obtained at Prek Chik (river) station. From above, the ratio of 1.2 is selected at Moung Russey station.

It is noted that the presented flood discharges are usable under present conditions, but not under river improved conditions. If river improvement or training works be done in future, flood discharge would increase accordingly.

5) Flow Capacity of the Moung Russei River at the bridge on the National Road No.5

A bridge on the National Road No. 5 (herein after called as the NR5 Bridge) is located at about 1km upstream of the Moung Russei Headworks. The bridge is one of the most important structures in the region. The elevation of slab-bottom EL2 of the bridge is measured at EL.17.82m as shown below.



Prepared by JICA Study Team based on field survey and information from Ministry of Public Works

**Schematic Diagram of River Cross Section of Bridge on National Road No.5**

The existing Moug Russei weir has slide gates. The elevation of gate sill is EL. 15.0 m and is much higher than the existing river bed (EL.11.70 m). The flow capacity of the Moug Russei River at the NR5 Bridge is studied by non-uniform flow hydraulic calculation for three cases by changing elevation of gate sill of the existing Moug Russei Weir and allowable maximum water level at the bridge. The conditions and results for 3 cases are as follows:

**Conditions and Results for Case Study on Flow Capacity of Moug Russei River**

CASE	Conditions				Results	Remarks
	Headworks	EL.of Gate Sill	Allowable Maximum WL at Bridge	Free board	Flow Capacity at Bridge on NR5	
1	Existing	EL.15.00m	EL.17.82m	Fb=0.0m	100 (m <sup>3</sup> /s)	Flood at T=2 years
2	New	EL.11.70m	EL.17.22m	Fb=0.6m	150 (m <sup>3</sup> /s)	Flood at about T=40 years
3	New		EL.17.82m	Fb=0.0m	180 (m <sup>3</sup> /s)	Flood at T=100 years

Prepared by JICA Study Team

The above results reveal that the Moug Russei River has a flow capacity of 180 m<sup>3</sup>/sec at the Bridge on the NR5, provided that the existing gate sill will be lowered from EL.15.0 m to EL.11.70 m (Case-3). It is noted that the free board (Fb) of the NR5 Bridge will be 0.6 m at Q=150 m<sup>3</sup>/sec (Case-2) and Fb=0 at Q=100 m<sup>3</sup>/sec (Case-3). Furthermore, without reconstruction of the headworks, the bridge may be inundated with flood discharge at T=2 years (Case-1).

6) Design flood discharge for Moug Russei Headworks

A flood discharge (QF): QF =180 m<sup>3</sup>/sec is practically determined as the design flood discharge of the headworks based on the flow capacity analysis on the NR5 Bridge with no freeboard (Case 3 above). This is close to the estimated probable flood discharge of 190 m<sup>3</sup>/sec (Return period T=100years for the Moug Russei River at Moug Russey Station, based on the meteo-hydrological study explained in the previous page. It is noted that the return period of T=100years is commonly employed for designing of important structures in Japan.

On the other hand, for the safety of the NR5 Bridge, either the following measure is to be implemented along the Moug Russei River in order to create free board under the NR5 Bridge with the 180 m<sup>3</sup>/sec.

- a) Excavation and enlargement of the river section downstream of the NR5 Bridge;
- b) Provision of permanent river diversion system in the upstream in order to reduce the flood discharge which reaches at NR5 Bridge

Since implementation of “measure a)” seems to be difficult due to the present land use condition along the river (housing), the "measure b)" seems to be adequate. However, necessity of the "measure b)" should be studied and discussed with agencies concerned taking into consideration the needs of protection of NR5 Bridge from the 180 m<sup>3</sup>/s in future The plan and cost for "measure b)" are not contained in the present study.

Finally, the design flood water levels (HWLF) for two locations are estimated by non-uniform

flow calculation as follows:

$HWL_F1=17.2\text{m}$  at the proposed weir site,

$HWL_F2=17.82\text{m}$  at Bridge on National Road No.5.

(3) Pursat River and Tributary for Damnak Ampil, Wat Loung and Wat Chre Rehabilitation Sub-projects

1) Pursat River Basin

Figure 3.2-3 shows the Pursat river basin and three rehabilitation Sub-projects, namely Damnak Ampil, Wat Loung and Wat Chre. Of these three Sub-projects in the Study, irrigation water sources are planned to be the Pursat River where water is taken through intake and main canal located at just upstream of the existing Damnak Ampil Weir. With the largest catchment area (4,480 km<sup>2</sup> at Damnak Ampil weir) in the Study Area, the Pursat River has three main tributaries and comparatively wide upstream mountainous area and narrow middle stream catchment area or natural levee bands.

2) Average monthly meteorological data

Meteo-hydrological observation and data collection have been carried out in the Pursat River Basin, in order to utilize those data for irrigation and drainage plan and facility design for the Damnak Ampil, the Wat Loung, Wat Chre Rehabilitation Sub-projects at Pre-F/S level, respectively. The average monthly meteorological data of the Boribo River Basin is tabulated as follows:

**Average Monthly Meteorological Values at Purat River Basin:  
Damnak Ampil, Wat Loung and Wat Chre Rehabilitation Sub-projects**

Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean (°C)	26.3	28.1	29.5	30.4	30.2	29.9	29.3	29.1	28.4	27.8	26.8	25.9	28.5
Mean max. (°C)	31.7	33.9	35.1	35.6	35.3	34.9	34.1	33.7	32.6	31.6	30.9	30.4	35.6
Mean min. (°C)	20.8	22.2	24.0	25.1	25.2	24.9	24.4	24.5	24.2	24.0	22.8	21.4	20.8
Relative humidity (%)	66	63	65	66	67	68	68	71	74	76	74	71	69
Wind velocity (m/s)	0.80	0.78	0.68	0.60	0.48	0.37	0.40	0.37	0.32	0.48	0.50	0.58	0.53
Sunshine hours (hr/day)	-	-	-	-	-	-	-	-	-	-	-	-	-
Evaporation (mm/day)	3.7	4.5	4.4	4.5	4.2	4.1	3.3	3.5	2.8	3.2	3.1	3.0	3.7
(mm)	115	126	138	135	130	121	102	107	83	98	93	92	1340

Prepared by JICA Study Team

3) Five-day Discharge

Based on the daily discharge data at Khum Viel (CA = 4,596 km<sup>2</sup>) and Bac Trakoun (CA = 4,245 km<sup>2</sup>) hydrological stations, five-day discharges for 10 years from 1995 to 2005 (except for 1997) are estimated as presented in Table 3.2-4. Annual average discharge is calculated at 76.4 m<sup>3</sup>/sec or 2,426 MCM/year. Some parts of the data are supplemented using correlation. Recent water level data of Bac Trakoun station are observed by MOWRAM and Public Works Research Institute (PWRI), Japan.

4) Flood Discharge of the Pursat River

According to the information from village people and PDOWRAM of Pursat, the largest flood in the memory of the people occurred in 1996. The 1996 flood, composed of plural peaks, caused large scale overbank flow along reach from confluence at Samroang and inundated



alluvial plain widely.

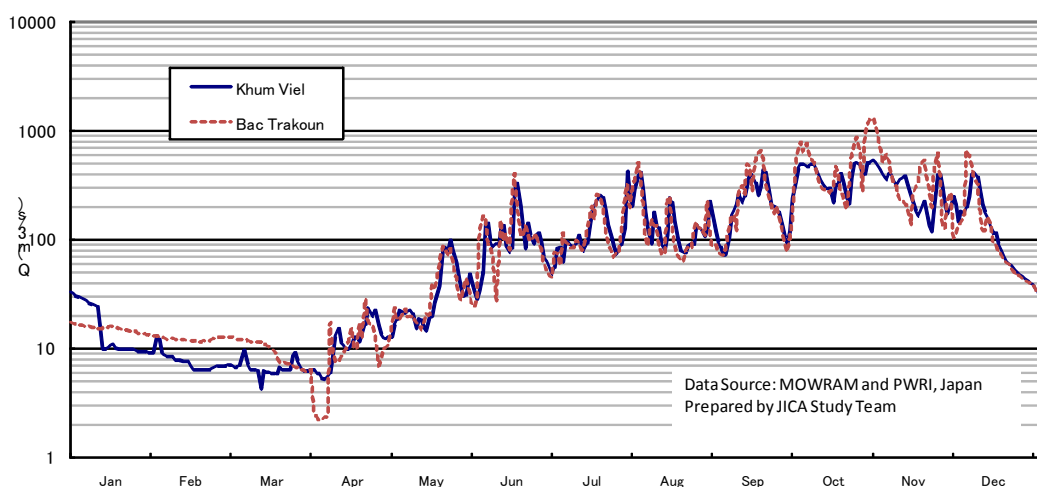
The maximum daily discharges in 1996 are 1,330 m<sup>3</sup>/sec at Bac Trakoun and 540 m<sup>3</sup>/sec at Khum Viel, respectively. River flow capacity at upstream Bac Trakoun is larger than that at downstream Khum Viel as below. As river water rises higher, river channel storage functions particularly along meandering middle reach. High water begins to intrude to old river courses. Then, overbank flow occurs firstly from downstream reach and spreads towards upward. Probable flood discharges at Damnak Ampil are as shown in table above.

**Flood Discharge**

T	Qd(max)	Q peak
(year)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)
2	620	710
5	840	970
10	980	1130
20	1090	1270
50	1240	1440

Prepared by JICA Study Team

To estimate Q peak at Bac Trakoun, the maximum hourly discharges are compared with daily discharges for such days that have daily discharge of 300 m<sup>3</sup>/sec or more in 2005. At Khum Viel, the Q peak ratio is considered lower than that at Bac Trakoun, because flood wave is milder there. The ratio of Q peak/Qd (max) is estimated 1.2 at Bac Trakoun and 1.05 at Khum Viel, respectively. The maximum hourly discharge is regarded as the peak discharge at Bac Trakoun. The hourly data used here are originally observed by MOWRAM and PWRI.



Prepared by JICA Study Team

**Daily Discharge at Khum Viel and Bac –Trakoun in 1996**

5) Design Flood discharge of Boeng Khnar River for Wat Chre Sub-project

Design flood discharge of the Boeng Khnar River for the Wat Chre Headworks is determined, in proportion to the flood discharge at Damnak Ampil Headworks. Calculated result is shown in the following table: In this study, a design flood discharge of T=100 year return period is employed as a design condition, considering both the importance of bridge and headworks, which is commonly employed in Japan for important infrastructures.

As shown in the succeeding table, the flood discharge at T=100 year return period for Wat Chre is estimated as 63m<sup>3</sup>/sec ≒ 65 m<sup>3</sup>/sec.

Design flood water level ( $HWL_F$ ) at two locations were determined as follows:

- a) Weir site:  $HWL_{F1}=13.6m$ , based on non-uniform flow hydraulic calculations at design flood discharge of  $Q_F =65 m^3/sec$ .

**Estimation of Design Flood Discharge for Boeng Khnar River(T=100 year return period)**

	Damnak Ampil	
CA(km <sup>2</sup> )	4,479	T=100year Qp/CA
Qp (m <sup>3</sup> /s)	1,560	
q' (m <sup>3</sup> /s/km <sup>2</sup> )	0.3483	
CA1(km <sup>2</sup> )	180	Wat Chre
qp' (m <sup>3</sup> /s)	63	q' x CA1

Prepared by JICA Study Team

- b) Bridge on the National Road No.5 site:  $HWL_{F2}=14.2m$ , based on non-uniform flow hydraulic calculations at design flood discharge of  $Q_F =65 m^3/sec$ .

This is low enough compared to the allowable maximum water level of WL.15.66 m at the bridge on NR 5, considering a free board (Fb=0.8m).

–El. Slab bottom EL2: EL.16.46 m

–Allowable maximum water level: WL.15.66 m(=EL2 – Fb (=0.8m))

(4) Boribo River for Lum Hach Rehabilitation Sub-project

1) Boribo River Basin

Lum Hach Rehabilitation Sub-project area and Boribo river basin (as small one) are illustrated in Figure 3.2-4. Catchment area of the Boribo river at Lum Hach site is 735 km<sup>2</sup>, of which 384 km<sup>2</sup> (52%) is that of the Bomnak river basin. Proposed Lum Hach headworks is planned to be located at just downstream of the confluence of several tributaries of the Boribo river, where a reservoir was constructed in Pol Pot era and was broken after the era.

2) Average monthly meteorological data

Meteo-hydrological observation and data collection have been carried out in the Boribo River Basin, in order to utilize those data for irrigation and drainage plan and facility design for the Lum Hach Rehabilitation Sub-project at Pre-F/S level. The average monthly meteorological data of the Boribo River Basin is tabulated as follows:

**Average Monthly Meteorological Values at Boribo River Basin:  
Lum Hach Rehabilitation Sub-project**

Boribo River Basin													
Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean (°C)	26.3	27.9	29.4	30.3	30.1	29.4	28.8	28.7	28.2	27.5	26.7	25.9	28.2
Relative humidity (%)	69	66	67	69	72	73	74	77	79	80	77	73	73
Wind velocity (m/s)	2.0	2.3	2.4	2.2	2.3	2.5	2.2	2.7	2.3	1.6	2.1	2.1	2.2
Sunshine hours (hr/day)	8.5	8.5	8.2	8.0	7.2	6.0	5.7	5.6	5.5	5.8	7.4	8.1	7.0
Evaporation (mm/day)	4.1	5.1	5.4	5.3	4.5	4.4	3.7	3.8	3.2	3.1	3.4	3.6	4.1
(mm)	127	142	167	158	140	130	115	115	94	96	101	111	1494

Note: Data = Average of Pochentong and Pursat Stations' data except sunshine hours

Sunshine hours = that of Pochentong Station \* Wind velocity is adjusted to the equivalent one at 2 m height.

Prepared by JICA Study Team

### 3) Five-day Discharge Data

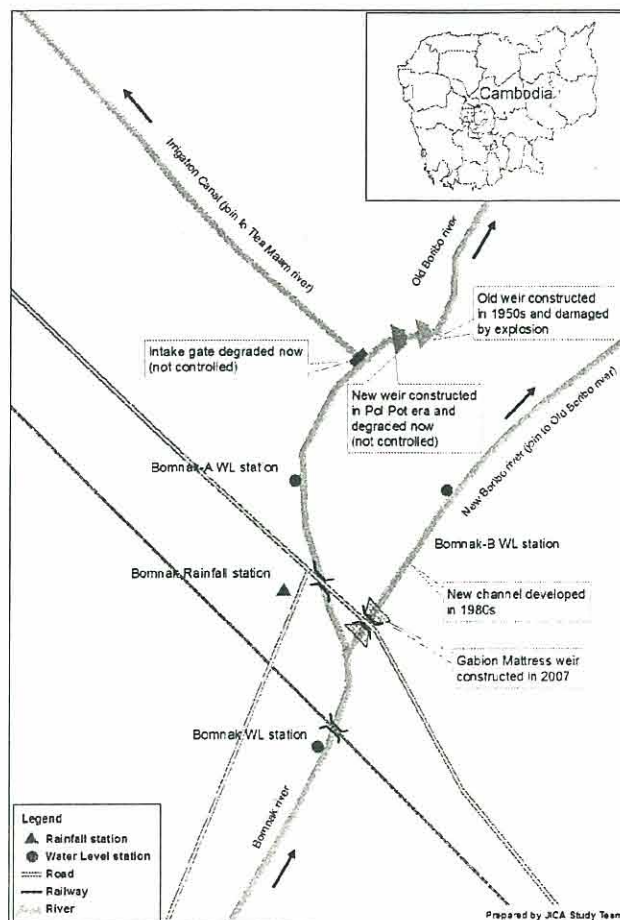
Boribo station on the Boribo river has water level and discharge data of more than five years, which are used in the Study. The hydrological data in 2007 are added after the data were checked and judged applicable. As presented in table below, eight cases of five-day discharges are prepared from the daily discharges, according to water distribution conditions at Bomnak Diversion including water consumption nearby. Five-day discharges in Case 2 and 7, are compiled in Tables 3.2-5 and 3.2-6, respectively.

#### Case Setting of Water Distribution through Bomnak Diversion and Results

Case	Distribution		Qmax from Bomnak to Tlea Maam river (m3/s)	Additional water source from east stream	Result of calculation				
	Boribo river Lum Hach headworks	Tlea Maam river & Bomnak			Annual average discharge (specific)			Ratio of Case X vs Case 2	
					(m3/s)	(MCM)	(mm)		(lit/s/km2)
0	100 : 0		10	-	19.3	612	833	26.3	1.25
1	50 : 50		5	-	16.3	517	703	22.2	1.06
2	50 : 50		10	-	15.4	487	662	20.9	1.00
3	50 : 50		20	-	14.6	463	630	19.9	0.95
4	25 : 75		10	-	14.2	449	610	19.3	0.92
5	0 : 100		10	-	13.3	421	573	18.1	0.86
6	0 : 100		10	Stream No.1	13.4	423	576	18.2	0.87
7	0 : 100		10	Stream No1&2	14.1	448	609	19.2	0.92

Prepared by JICA Study Team

Cases 5 to 7 are studied against future possibility that most of low flow may be taken for the Tlea Maam river basin or consumed in upstream area. In Case 6 and 7, water from outside of the Boribo river basin is supplemented. The additional water source consists of runoff from streams in upper or northwestern side of 7th January Canal. Catchment area of stream No.1 is just southeast of the Boribo river basin and stream No.2 is next southeastern one. In Case 0 and 1, annual discharges are relatively ample in the Study Area most probably due to relatively higher rainfall in the upstream mountainous basin. As in table in the previous page, the annual average discharge is calculated 15.4 m<sup>3</sup>/sec or 487 MCM/year in Case 2, and 14.1 m<sup>3</sup>/sec or 448 MCM/year in Case 7.



Prepared by JICA Study Team

#### Bomnak Diversion

4) Flood Discharge

According to the information from village people, there was a large flood in early 1950s between Lum Hach and National Road No.5 (NR5) along the Boribo river. The flood, being the largest flood in recent 70 years, occurred probably in 1952 judging from interviewee's age and available rainfall data. Almost all the alluvial plain was considered inundated with water depth of 0.5 – 2 m for 3 – 15 days. The second largest flood occurred in 1983. The Boribo river was smaller before construction of the 7th January dyke. After construction of the dyke and at the time of missing gate control system due to political confusion, the two gate structures were not opened during floods for a few years,

<b>T</b>	<b>Qd(max)</b>	<b>Qpeak</b>
<b>(year)</b>	<b>(m<sup>3</sup>/s)</b>	<b>(m<sup>3</sup>/s)</b>
2	160	220
5	190	270
10	210	290
20	230	320
50	270	380
100	310	430

Prepared by JICA Study Team

resulting in flood water overtopping of the dyke and break of the dyke finally. Annual maximum daily discharges are picked up and probability calculation is performed. Since automatic water level recorders in the Study measure water level every hour or half hour, the maximum hourly or half hourly discharge in a year is regarded as annual peak discharge in this section 3.2. The peak discharge of Bomnak-A and B stations, ratio of peak flood and annual maximum discharges is calculated and average of 1.4 is obtained. The same value is used for estimation of the probable Boribo flood as presented in table above, considering relatively steep river profile gradient at Boribo station. Peak discharge of 100-year return period is estimated from river flow capacity at Boribo station. Flood discharge at Lum Hach site is regarded as the same as that at Boribo station, because neither river flow capacity nor flood scale does not increase in the flood plain like Boribo river downstream basin. There may come out a question that the flood scale may be larger at Lum Hach than at Boribo station. However, the river has enlarged channel cross section by unnaturally increased large flood as abovementioned. Therefore, the river is considered to have sufficient capacity to receive certain scale (such as 10-year return period) of flood at present, which is supported by local general information that recent floods were not so serious.

**3.2.3 Soils and Land Suitability**

Soils distributed in the Sub-project areas are examined based on the reconnaissance level soil map prepared in the Master Plan Stage of the present Study. In the map, soils are classified at soil sub-unit level following the FAO/UNESCO classification system.

The soils distributed in the individual Sub-project areas and their land suitability for rice and upland crops production evaluated according to the FAO classification system (Framework for Land Evaluation, FAO, 1976) are as follows;

### Soil Distribution & Land Suitability Classification of Sub-project Areas

Soil Sub-unit	Distribution (%)						Land Suitability Class	
	RK	PC	DA	WL	WC	LH	Rice	Upland Crops
Gleyic Luvisol (LVg)	100	100	-	-	-	-	S2	S3
G. Acrisol/P. Acrisol (ACg/ACp)	-	-	100	100	100	-	S3	S3
Gleyic Acrisol (ACg)	-	-	-	-	-	56	S3	S3
Plinthic Acrisol (ACp)	-	-	-	-	-	38	S3	S3
Dystric Fluvisol (FLd)	-	-	-	-	-	6	S2	S2/S3

Note: RK - Ream Kon, PC - Por Canal, DA - Damnak Ampil, WL - Wat Loung, WC - Wat Chre, LH - Lum Hach  
 G. Acrisol/P. Acrisol (ACg/ACp): association of Gleyic Acrisol & Plinthic Acrisol

Prepared by JICA Study Team

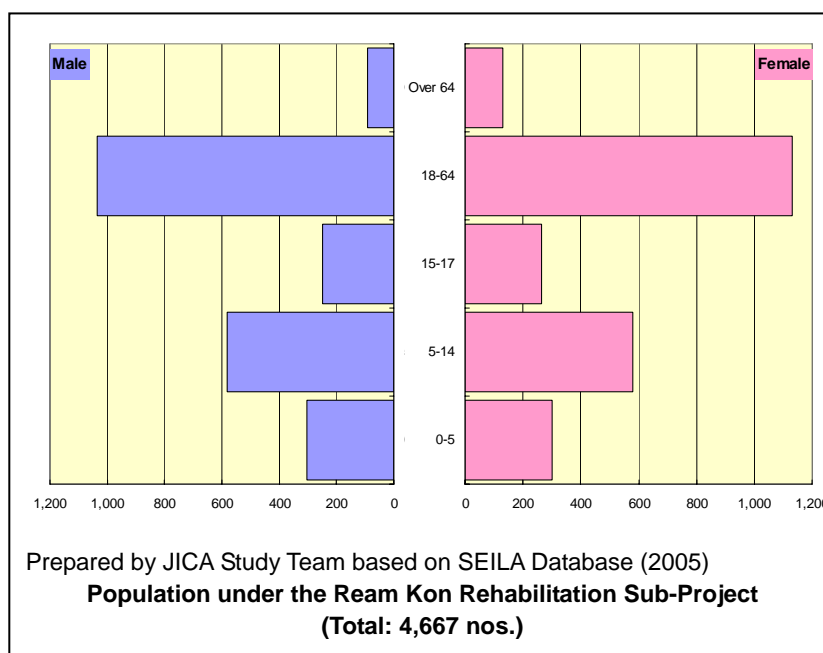
As shown in the table, the entire Sub-project areas of Ream Kon and Por Canal are classified as moderately suitable for rice production and marginally suitable for upland crops production. Similarly, all the Sub-project areas of Damnak Ampil, Wat Loung and Wat Chre and almost entire Sub-project area of Lum Hach are classified as marginally suitable for rice and upland crops production.

### 3.3 Ream Kon Rehabilitation Sub-Project

#### 3.3.1 Socio-Economic Conditions

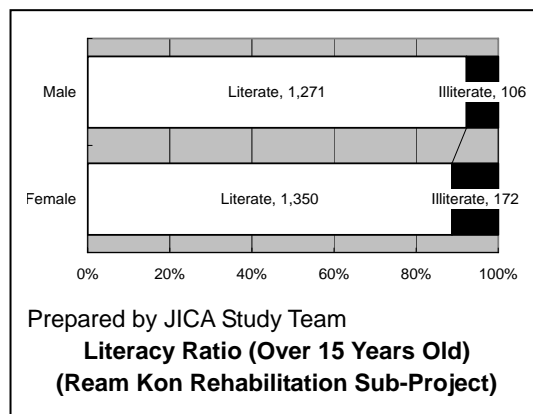
##### (1) Population, Community and Ethnicity

The Sub-project is located in Moung Russei District in Battambang Province primarily covering three communes: (i) Kear, (ii) Chrey and (iii) Prey Svay. Total household under the command area approximately is 900 nos. The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities in the Sub-project area.



(2) Education

Educational level of villagers are generally low as tabulate below, as most of farmers in the Sub-project area have had only “drop-out at junior high school.” On the other hand, The literacy rate in the villages is not necessarily low because of the religious and community-based activities.



**Education Career of Farmers**

N=40

Career	No Formal Education	Drop-out at primary school	Graduate from primary school	Drop-put at junior high school	Graduate from junior high school	Drop-out at high school	Graduate from high school	More than high school	Others
Number & %									
Number	1	14	9	13	2	1	0	0	0
Percentage	2.5 %	35.0 %	22.5 %	32.5 %	5.0 %	2.5 %	-	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

(3) Health and Hazard

According to the interview survey to farmers, dengue, malaria, diarrhea etc. were pointed out as the commonly contracted diseases in the Sub-project area. Insufficient knowledge among communities about the diseases is one of the main reasons for expansion of those. On the other hand, lack of water source particularly in dry season would be the reason for diarrhea disease. Situation of access to health and medical services in the Sub-project area is shown as follows:

**When you/your family get/gets sick, where do you go?**

N=40

	Hospital	Clinic	Health Centre	Others
Number	7	2	30	1
Percentage	17.5 %	5.0 %	75.0 %	2.5 %

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Additionally, results of the interview survey show that only 10 % of the interviewee have some kind of social security service/insurance.

(4) Economic Condition

1) Main Economic Activity

Main economic activity in the community under the Ream Kon Sub-project area is agriculture. Other activities observed are collection of forest products, livestock raising, temporary workers for construction etc. Due to their better quality of rice, rice noodle processing in the village nearby is active, the target market of which is Moug Russei Town.



**Rice Noodle Processing at Ream Kon Village Makras as one of the value-added activities since 1980s (February 8<sup>th</sup>, 2008)**

2) Local Living Standard

Local living standard were rapidly assessed by way of poverty ranking and focal group discussion. Poverty level was classified into four: (i) Destitute (poorest), (ii) Poor, (iii) Fair, and (iv) Rich. Poverty is multi-dimensional, complex, and each local community embraces different concepts of risks. Classification is, therefore, made from the view point of (i) income level, (ii) asset owned including land, (iii) education level, (iv) satisfaction level of basic human needs, and (v) financial transaction with financial institutions, and levels of each item are determined by the workshop attendants. The result is as follows showing that “Poor” and “Destitute” occupies over 60 % of community members:

**Income, its Source and Land Owned by Farmers at Ream Kon Rehabilitation Sub-project**

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
Destitute	81	9%	0 – 1,000	Labor	0-0.3
Poor	468	52%	1,000-3,000	Labor out of village and/or Land owner farmer	0.3-1
Fair	315	35%	3,000-6,000	Land owner farmer, workers	1-3
Rich	36	4%	6,000-20,000	Land Owner, Trader	3-15
Total	900	100%			

Prepared by JICA Study Team based on Workshop carried out during the Study

In relation to local economic conditions, land holding status was surveyed, results of which are as follows:

**Land Holding Status**

N=40

	Owner Cultivator	Owner cum Sharecropper	Sharecropper	Owner cum Tenant	Tenant	Not Operating Any Farm
Number	34	0	2	4	0	0
Percentage	85.0 %	-	5.0 %	10.0 %	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Owner cultivator occupies high percentage that 85 % of total farmers are categorized in “Owner Cultivator.”

3) Community-based Organizations

Community-based organizations are one of the important engines for supporting economic activities. The following table shows community-based organizations in which farmers currently are involved.

**Member of Community-based Organization**

N=40

	FWUC and/or FWUG	Credit (Gov.)	Credit (NGOs)	Agriculture	Religion	Drinking Water	Market	Youth	Veteran	Women	No
Organization	17	0	2	0	2	0	1	12	2	2	2
Percentage	42.5%	0%	5.0%	0%	5.0%	0%	2.5%	30.0%	5.0%	5.0%	5.0%

Prepared by JICA Study Team based on Workshop carried out during the Study

Here, although 42.5 % of farmers replied that they are the member of FWUC and/or water users' group, however, there is no FWUC in Ream Kon area registered by Battambang PDOWRAM. In actuality, the activities remain unorganized and not as a group in system level. Activities through youth organization seems scanty.

### 3.3.2 Agriculture

#### (1) Present Land Use

The present land use of the Ream Kon Rehabilitation Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including field under rainfed condition). There exist no paddy fields under normal irrigation condition in the area. The present land use of the area is estimated as follows:

**Present Land Use of the Sub-project Area**

Land Use Sub-category	Area & Proportion		
	(ha)	(%)	(%)
Normal Irrigation Paddy Field	-	-	-
Supplemental Irrigation Paddy Field	50	2	-
Rainfed Paddy Field	1,970	98	-
Paddy Field Total	2,020	100	93
Right-of-ways	150	-	7
Sub-project Area	2,170	-	100

Prepared by JICA Study Team

As shown in the table, irrigation water supply conditions in the Sub-project area are very poor and the paddy fields under rainfed conditions account for 98% of the total fields in the area.

#### (2) Agro-demography and Land Holding

Agro-demographic and land holding features in the project communes (major communes located in the Sub-project area) estimated based on the Commune Survey on Crops & Livestock, 2003, MAFF are as follows;

**Agro-demographic Features in the Project Communes in 2003**

Items	Average 1/	Range 1/
% of Farm Households to Total Households	82%	67 – 98%
%. of None Farm Households (No. of none crop producing households)	18%	2 – 33%
% of Farm Households Producing Wet Season Rice	91%	76 – 99%
Average Family Size (in 2005, SEILA Data Base)	5.1	4.9 – 5.4

1/: Average & range of Prey Svay, Chrey & Kear Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

The access to data/information on land tenure was rather limited. However, the Commune Survey provides some information on the land tenure and holding statuses as follows:

**Land Holding Features of the Project Communes in 2003**

Indicator	Average 1/	Range 1/
% of Landless Households	18%	2 – 33%
%. of Farm Households with Holding Size Less Than 10a	27%	4 – 38%
% of Farm Households with Holding Size More Than 3ha	55%	33 – 80%

1/: Average & range of Prey Svay, Chrey & Kear Commune

Source: Commune Survey, 2003, MAFF

From the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at 2.2 ha as shown in Table 3.3-1. Proportion of households



having less than 0.1 ha is calculated at 27% and the same of more than 3ha is at 55%.

(3) Crop Production in the Sub-project Area

1) General

The present agricultural conditions in the Sub-project area have been studied based on the results of interview survey with the project commune offices, village chiefs and DAO Moung Ruessei, statistic data of DAO and PDA and findings of the field survey by the Study Team. The summary sheet of the statistic data on rice production in the major communes are presented in Table 3.3-2 to 3.3-4.

Rice production is the most important agricultural activities in the Sub-project and it is characterized by low and unstable productivity under rainfed conditions and by a single cropping of rice in wet season under both direct sowing and transplanting method. However, rice cultivation in early wet season by pump irrigation is practiced to a certain extent. Further, prolonged rice cropping season with the cultivation of both early wet and wet season rice and of rice varieties of different growth durations and traditional farming practices are other characteristics of the rice production in the area.



2) Cropping Season and Variety

Rice cropping seasons in the area are: i) early wet season from April to July under direct sowing and ii) wet season from May/July to November/January under direct sowing and July/September to November/January under transplanting. The early wet season rice is generally grown supplemented by pump irrigation as stated earlier. In the area, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Major varieties grown in the area are as follows;

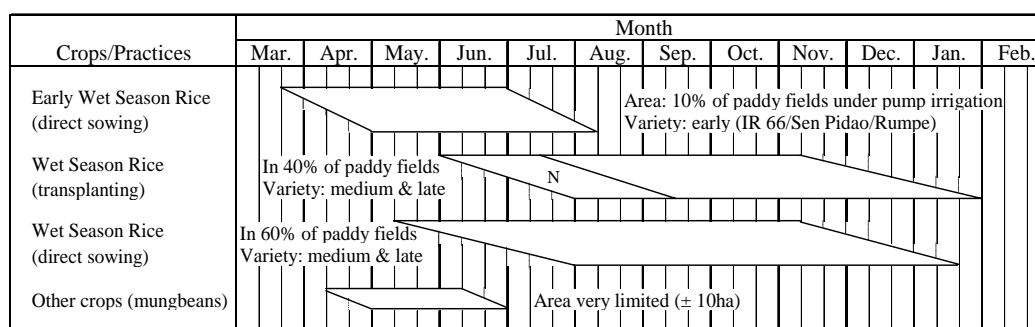
**Major Varieties Grown in the Sub-project Area**

Season	Duration	Variety
Early Wet Season	Early	IR 66, Sen Pidao, Rumpe
Wet Season	Medium	Phka.Khney, Phka Rumdoul, Phka Rumchang, Somali, Rian Chey
	Late	CAR 4, CAR 6, Komping Puoy, Neang Mine

Prepared by JICA Study Team

3) Cropping Calendar and Pattern

The prevailing cropping calendar in the area estimated based on the interview survey results is illustrated as shown in the following figure.



Prepared by JICA Study Team

### Prevailing Cropping Calendar in Paddy Fields: Ream Kon Sub-project Area

A single cropping of wet season rice under rainfed condition is a prevailing cropping pattern, while a double cropping of early wet season rice and wet season rice is also carried out in about 10% of the paddy fields in the area. The prevailing planting method of rice is direct sowing in the area. About 60% of rice cropped areas in wet season and all rice cropped areas in early wet season are cultivated under direct sowing method. Cultivation of other crops than rice in paddy fields is extremely limited at present. The prevailing cropping patterns in the area are estimated as shown in the following table.

**Prevailing Cropping Patterns in the Sub-project Area**

Cropping Pattern	Area
Single cropping of wet season rice	Predominant pattern; in 90% of the area
Double cropping of rice (early wet season - wet season)	In about 10% of the area; mostly in supplemental irrigation fields

Prepared by JICA Study Team

#### 4) Cropped Area

The current cropped areas of rice and other crops in the Sub-project area have been estimated based on the various data and information and field surveys as summarized below.

**Estimated Cropped Area & Cropping Intensity in the Sub-project Area**

Cropping Season	Irrigation Status	Cropped Area			Cropping Intensity (%)
		Rice		Other Crops	
		Area (ha)	Intensity (%)		
Early Wet Season	Pumping 1/	200	10	10ha	10
Wet Season	Supplemental	50	2	--	2
	Rainfed	1,970	98	-	98
Annual	-	2,220	110	10ha	110

1/: Including most of supplemental irrigation field

Prepared by JICA Study Team

As shown in the table, the cropping intensity of rice is estimated at 10% in early wet season and 100% in wet season. The overall annual cropping intensity in the paddy fields is estimated at 111% including upland crops.

#### 5) Yield and Production

Yields of paddy in the Sub-project area are estimated on the basis of the statistic data of PDA/DAO and SEILA Data Base, the results of interview surveys, Socio-economic Survey and Inventory Survey by JICA as shown in the following table.

**Estimated Paddy Yield Level in the Sub-project Area (ton/ha)**

Irrigation Status	Early Wet Season	Wet Season	
	Direct Sowing	Direct Sowing	Transplanting
Supplemental Irrigation 1/	2.5	1.5	2.2
Rainfed Condition	-	1.0	1.7

1/: Including pump irrigation in early wet season.

Prepared by JICA Study Team

The current yield level of paddy in wet season under rainfed condition is estimated at 1.0 ton/ha in direct sowing and 1.7 ton/ha in transplanting. Under supplemental irrigation, paddy yields are estimated at 1.5 ton/ha and 2.2 ton/ha, respectively for direct sowing and transplanting. Early wet season rice yield is estimated at 2.5 ton/ha under pump irrigation. A current yield of upland crop (mungbeans) is estimated at 0.5 ton/ha.

On the basis of the estimated cropped areas and yields, the production of paddy in the area is estimated as shown in the following table.

**Estimated Paddy Production in the Sub-project Area**

Irrigation Status	Cropped Area & Production of Paddy (ha & ton)						Annual Production
	E. Wet Season		Wet Season				
	Direct Sowing		Direct Sowing		Transplanting		
	Area	Production	Area	Production	Area	Production	
Pumping Irrigation	200	500	-	-	-	-	500
Supplemental Irrigation	-	-	30	45	20	44	89
Rainfed Condition	-	-	1,182	1,182	788	1,340	2,522
Total	200	500	1,212	1,227	808	1,384	3,111

Prepared by JICA Study Team

As shown, the current paddy production in the Sub-project area is estimated at 500 tons in early wet season, 2,610 tons in wet season and 3,110 tons annually. The annual production volume of upland crop (mungbeans) in the area is estimated at 5 ton.

#### 6) Prevailing Farming Practices

Some specific features of rice farming practices in the area are as follows;

**Prevailing Farming Practices in the Sub-project Area**

Practices	Prevailing Practices
Planting Method in Wet Season	Transplanting 40% & direct sowing 60%
Land Preparation 1/	Hand tractor 65% & draft animal 35%
Seeding Rate in Direct Sowing	120 - 150 kg/ha
Variety in Wet Season	Both local & improved varieties

1/: See Table 3.3-4

Prepared by JICA Study Team

#### (4) Farm Machinery and Equipment

The inventory on farm machinery and equipment in the project communes is as follows;

**Inventory of Farm Machinery in the Project Communes in 2007**

Tractor	Hand Tractor	Water Pump	Engine Thresher	Tractor Attachment	
				Plow	Harrow
21	478	213	20	18	12

Source: DAO Moung Ruessei

The number of hand tractors in the communes is substantial and mechanical land preparation work is prevailing practices, partly because of larger land holding size per farm household compared with Sub-project areas in other provinces. The number of water pumps, appeared to be used for supplemental water supply to paddy fields, is also substantial in the communes

(5) Post-harvest and Marketing

Threshing of paddy by engine thresher or hiring service is prevailing practice in the Sub-project area. After threshing, paddies except for those kept for family consumption are generally marketed without drying partly because of insufficient drying space and no drying yard. Paddies for family consumption are sun-dried in a home yard.

Prevailing marketing channels of paddy in the area are marketing to village collectors or rice millers at village level. In the former channel, farmers sell paddy to the local collectors who himself are quite often farmers. The local collectors market paddy to the wholesalers or to the rice millers. The wholesalers sell rice further to the traders/large scale wholesalers in/from Phnom Penh or other provinces, who export or market some products to Viet Nam or Thai buyers. Other crops produced in the area are mostly sold in market at village level. Because of limited market volume by individual farmers, farmers have little bargaining power in price setting in general.

Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy as is the case in other Sub-project areas. Major constraints reported by the rice millers in the project district are: i) price competition with Viet Nam buyers, ii) mainly purchasing sun-dried paddy because of no drying facility and failed completion with Viet Nam and Thai buyers who accept field dried paddy (wet paddy), iii) price fluctuation and iv) limited capital to buy in bulk after harvest.

(6) Current Capacity to Pay

For the estimation of the current capacity-to-pay, farm economic analyses on typical farms were made based on the crop budget analyses and the results of the Socio-economic Survey conducted in 2007 as shown in Table 3.3-5. As shown in the table, the current farm economy of the typical farm A (transplanting) indicate net surplus (capacity to pay) of Riel 569,000 or 8% of the total income. While, the typical farm B (direct sowing) indicates net deficit of Riel 243,000 or 4% of the income.

(7) Results of Socio-economic Survey

The results of the Socio-economic Survey carried out aiming at identifying problems and constraints for farming, activities implemented for improvement of rice productivity by farmers and expectations for improvement of farming activities are presented in a narrative manner in Table 3.3-6. Major constraints in rice farming identified are low paddy yield and irrigation water shortage even in wet season. Farmers expectations for farming and physical works (irrigation/drainage) are **productivity improvement of wet season rice and adequate irrigation water supply in wet season**, respectively.

### 3.3.3 Irrigation and Drainage

(1) Outline of the Existing Irrigation System

The system was constructed between 1975 and 1978. A headworks was constructed on the Moug Russei River to utilize river water for the Ream Kon system and Por Canal system. Unfortunately, frequent floods destroyed the headworks and canal system immediately after

their construction. The JICA Inventory Survey in 2006 has reported that the system is “partly functioning” at present, and the JICA Study Team has also confirmed this situation. The inventory survey result is summarized in Table 3.3-7. There are very few important facilities such as tertiary canals, turnouts/diversions/off-takes, checks, etc.

(2) Existing Irrigation Facilities

1) Headworks

The headworks does not function to maintain the intake water level for irrigation (Photo 1). Further, due to lost function of movable gates and high elevation of the end sill of the gates, flood water can not flow to the downstream smoothly. A diversion channel was constructed at just downstream of the Moung Russei River during the construction period. The diversion facility was completely broken. At present most of the river water flows into the diversion channel (Photo 2). This causes the difficulty of taking irrigation water in irrigation systems located in the downstream.

The concrete structure has many cracks and reinforcing bars are exposed for a long time resulting in severe rusty. Based on the information from PDOWRAM, iron and other steel were collected from villages in order to make reinforcing bars during the construction time (Photo 3&4). Further, as discussed in the section 3.2.2 (2), the existing gate sill is very high from river bed by about 3m, and that limits the flow capacity of the Moung Russei River under the Bridge on the National Road No.5.

The intake is located on the right bank of the Moung Russei River, at about one kilometer upstream from the headworks. No gates exist at present. The intake structure is also deteriorated even after rehabilitation in 1986.

2) Canals

The flow capacity of existing main canal is examined by applying non-uniform flow hydraulic formula to the canal sections surveyed by the Study Team. The calculation reveals that the main canal has a flow capacity between 1.5 m<sup>3</sup>/sec to 0.3 m<sup>3</sup>/sec. On the contrary, the water level of the main canal is too low for gravity irrigation.

Irrigation water has not flown in the secondary canals for long time. Flow capacity of the canal section is reduced by sedimentation, and is covered with grasses. The water level is also too low in the secondary canals for gravity irrigation.



**1. Upstream view of existing weir Gate lost function**



**2. Broken diversion facility**



**3. Damaged concrete**



**4. Exposed reinforcing bars**

3) Structures

There is a check structure and road crossing culvert in the main canal and secondary canal respectively. These are no function due to deterioration. Many additional structures are to be constructed by the Sub-project.

4) Dyke

The existing dyke located in the upstream of the Sub-project area is cut at several locations by residents. In those locations, there are no water control facilities. The storage function of the dyke system is lost and farmers are cultivating in the former pond area (60 ha approx.).

Some sections of the dyke crest are used for rural road to connect villages. However, road condition is poor and is not accessible by jeep in most of the sections.

(3) Present Irrigation Water Use, O&M, and FWUC

Detailed survey result on the present irrigation water use in the Sub-project area is referred to the section 3.3.1. At present, most of the farmers rely only on rain. They start paddy cultivation when their farm land become wet/ inundated by rain and/or flood, accordingly, floods in the early stage of wet season are welcome by farmers. If a long drought occurs during the growing stage of paddy, farmers pump up water from canals or streams using small pumps.

No O&M activities have been recently executed by PDOWRAM, since it requires a full-scale rehabilitation of irrigation system with high cost. There is no registered FWUC or FWUGs in the Sub-project area.

(4) Drainage condition

There are no clear drainage canals in the Sub-project area at present. The drainage water from the outside of the Sub-project area such as western area (Anlong Koub Irrigation area) and southern area flows into irrigation canals by breaking the canal dyke and this additional water is utilized for irrigation. Detailed survey result on the flood condition in the Sub-project area is referred to the section 3.3.1.

The main causes of floods are assumed to be mainly following two types: (i) flood from upstream areas and (ii) affect from rising water level in the Lake Tonle Sap during wet season. The southern part of the Sub-project area suffers from flood from adjacent irrigation area (Anlong Koub irrigation area). Therefore, the drainage system should be developed by the Sub-project in order to avoid inundation problem.

In the eastern part of the Sub-project area, rising water level of the Lake Tonle Sap affects the drainage condition of the Moug Russei River and other tributaries i.e., Ou Anlong Rolus. High water level causes water-logging in the low land. The current direction of the Moug Russei River should be modified to the original river course after construction of the new headworks in order to supply water to the others irrigation systems located in the downstream.

(5) Other problems

Accessibility in the Sub-project area is very poor condition. Establishment of a farm road network is necessary for transportation of agriculture input and output. The existing canal inspection roads are to be rehabilitated and paved for farm road.

### 3.3.4 Environment

(1) Vegetation and Land Use

The present land use of the Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including field under rainfed condition). There exist no paddy fields under normal irrigation condition in the area.

(2) Wild Life

Wildlife are rarely observed in and around the Sub-project areas since the areas have been already cleared for agriculture particularly paddy cultivation. All the protected or conserved areas are located in the outside of Sub-project areas. There are no detailed information, however, wild animals observed in and around the area include: (i) wild pig, (ii) rabbits, (iii) some species of reptiles such as snakes and turtles in accordance with the field interview.

(3) Protected Areas

Figure 3.3-1 shows protected areas of the Moug Russei River Basin where the Sub-project is located. Phnom Samkos Wildlife Sanctuary and Tonle Sap Multiple Use Area is situated, characteristics of which are tabulated as follows:

**Protected Area in Moug Russei River Basin**

Protected Area	Province	Total Area (ha) (Area in Basin, %)	Relevance with Basin Irrigation	Some Unique Characteristics
Phnom Samkos Wildlife Sanctuary	Crossing Battambang and Pursat Province	333,750 (31,300, 9.4 %)	The upstream of irrigation systems	High altitude area with a wide diversity of forest types. Supports a range of threatened birds in the area
Tonle Sap Multiple Use Area	Pursat Province	316,250 (10,500, 3.3 %)	The downstream of irrigation systems	Long-standing ichthyological reserve. Great biological, hydrological and cultural/economic importance.

Prepared by JICA Study Team based on Ministry of Environment (2004), State of Environment Report

Phnom Samkos are located in the upstream of most of irrigation systems in the river basin, therefore, there would be no serious impact through irrigation promotion in this basin. On the other hand, Tonle Sap Multiple Use Area is in the downstream of the Sub-project. Increase of usage in fertilizer and pesticide generally seen through promoting irrigation development would possibly more or less affect water quality, if inappropriate and excessive application is carried out. On the other hand, there are no protected areas or conserved area within the command area of Ream Kon Rehabilitation Sub-project.

(4) Historical and Religious Sites

There are no archeological and/or historical significance in and/or around the Ream Kon Sub-project area.

(5) Noise and Air Quality

There is no data related with noise and air quality in and around Sub-project areas. It is conceivable that no serious noise pollution source exist in this area. In addition, as for air quality, only power generators of the private company and traffic particularly National Road No. 5 and access to the command area, distance of which is 5 km from the national road to the command area, would give negative impact to some extent. Those are, however, not serious at present.

(6) Water Quality

Water quality was preliminary assessed through field survey in the wet season, June 12<sup>th</sup>, 2008. The indicators analyzed are: (i) pH, (ii) Electric Conductivity (EC) and (iii) Total Dissolved Solid (TDS). The results are tabulated as follows:

**Result of Water Quality Analysis**

Name	Sampling Point	Date	pH	EC ( $\mu\text{S}/\text{cm}$ )	TDS (mg/l)
Ream Kon Rehabilitation	Near proposed intake	12-Jun-08	7.6	91.2	45.8
	Up to mid-stream of main canal	12-Jun-08	7.4	88.9	44.4
	Mid-stream of main canal	12-Jun-08	7.3	84.4	41.3
	Downstream of main canal	12-Jun-08	7.1	85.4	42.8
	Drainage	12-Jun-08	7.4	80.3	40.3
Water Quality Standard	River		6.5-8.5	None (<70 $\mu\text{S}/\text{cm}$ ) Slight to Moderate (70-300 $\mu\text{S}/\text{cm}$ )	<450
	Lakes and Reservoirs		6.5-8.5	Severe (>300 $\mu\text{S}/\text{cm}$ )	

Note: Water quality standard is given from relevant document as follows:

pH: Ministry of Environment (1999), Sub-decree on Water Pollution Control

EC and TDS: FAO (1994), Water Quality for Agriculture, Irrigation and Drainage Paper 29

Prepared by JICA Study Team based on field sampling and analysis

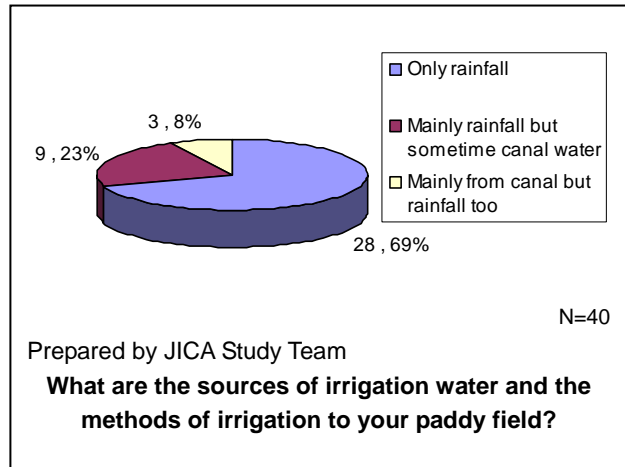
According to the relevant guidelines: (i) MOE, Sub-Decree on Water Pollution Control and (ii) FAO, EC is comparatively high, judged “slight to moderate” condition. Although this level does not significantly affect agricultural production, water quality monitoring regularly needs to be carried out to maintain permissible level.



(7) Present Water Use by Affected Communities

1) Drinking and Domestic Water Use

Main water source for drinking and domestic water among communities is tube pipe well followed by dug well. People also depend on rain water particularly in the wet season. Percentage of river water usage is quiet limited at Ream Kon Sub-project.



2) Irrigation Water Use

Since existing irrigation facilities particularly intake weir are significantly deteriorated, irrigation water is not stably provided from the system. Instead, farmers are largely dependent on rainfall and flood water especially in the wet season. Interview survey asking for present source of irrigation water and method of irrigation is illustrated on the right. Nearly 70 % of the farmers have replied that they rely only on rainfall. Others mention some water is provided through irrigation facilities, however, it actually means rainwater just flow through the canals to the paddy field during heavy rain. Therefore, rehabilitation of irrigation facilities will surely contribute to the constancy of irrigation water supply in the Sub-project command area.

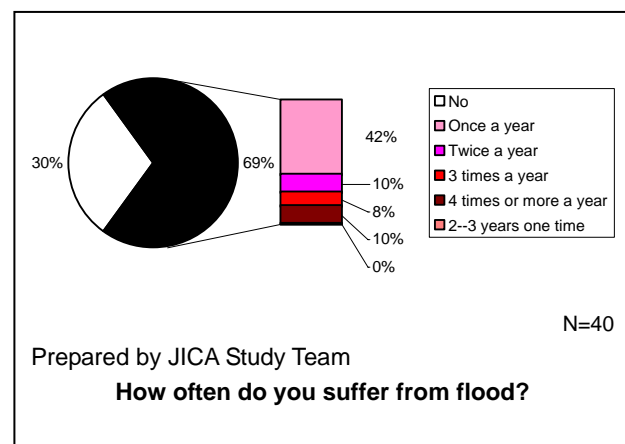


Existing Weir not Functioning (May 28<sup>th</sup>, 2007)

Under such conditions, farmers' groups are not functioning as a group for O&M of irrigation facilities and water management. In parallel with facilities rehabilitation, FWUC establishment and strengthening would be of critical importance for sustainable irrigation development and management.

3) Flood Condition

Although it would be difficult to control and regulate, flood water is also an important source of water for agriculture. Necessity of flood management is huge in any irrigation development. In accordance with the interview survey, current flood condition is illustrated on the right showing that nearly 69 % of the people are suffering from flooding at least once a year. The asset damaged by flood is mostly reported to be paddy field.



(8) Workshop and Public Consultation

Workshop and public meetings were organized to confirm community members' opinions toward the sub-project as well as environmental management for the formulation of the development plan.

**Participants of Workshop and Public Consultation**

No.	Organization	Participants
1.	National Counterparts and Steering Committee Member	Representative from MOWRAM (Department of Planning)
2.	Provincial Counterparts and Personnel Concerned	-
3.	Commune Councils	Chiefs and the members of the councils (6 members: Chrey and Prey Svay)
4.	JICA Study Team	Member of the Team
5.	Villagers	Villagers relevant to Ream Kon Rehabilitation Sub-Project (10 members: Ankraong, Toul Tathaon, Chrey I, Chrey II, O-Kreat, Ream Kon and Kor)

Prepared by JICA Study Team

Main issues discussed are as follows:

- 1) The result of participatory problem census, as tabulated below, shows that stable irrigation water supply is placed highest priority and of critical importance for farmers. Therefore, necessity of irrigation rehabilitation was justified from the view point of public opinion.

**Result of Participatory Problem Census by the Representative Farmer**

Rank	Problems	Problem Solution
I	Lack of water for irrigation	Request to <u>rehabilitate irrigation facilities</u>
II	Lack of techniques for agriculture	Ask support from the Ministry, Department and Institutions related with the project to send extension worker for agriculture to <u>train the farmers</u> at the sites.
III	Lack of good production seed	Ask support from the Ministry, Department and Institutions related with the project to provide good seed to the farmers.
IV	Lack of community group for water management	FWUC needs to participate in management, operation and maintenance of the scheme.
V	Lack of market for Agriculture production	Request to the Government for finding the market for agriculture production in and/or outside the country.

Prepared by JICA Study Team based on Workshop carried out during the Study

- 2) Through the discussion, although the Study is at the pre-feasibility level, sub-project component consisting of: (i) rehabilitation of irrigation and drainage facilities including Ream Kon headworks, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities have been agreed by all the participants.



Discussion of Institutional Linkage in the Public Consultation at Ream Kon (February 7<sup>th</sup>, 2008)

- 3) The level of awareness for participation in irrigation O&M and water management have been assessed from the view points of: (i) participation in construction of tertiary facilities, (ii) participation in FWUCs' activities and (iii) participation in O&M of irrigation system. According to the results, awareness on participation in FWUCs' activities is lower. In particular, agreement toward irrigation service fee would be

lower. On the other hand, awareness on the participation to the construction works and O&M shows comparatively higher.

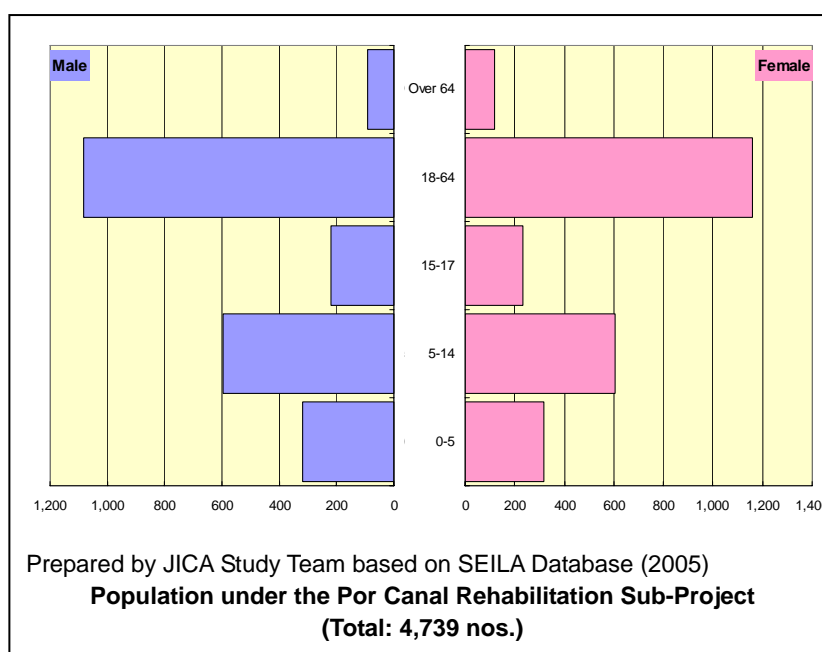
- 4) NGOs' and/or donors' activities adhere to each commune rather than Sub-Project unit for community based activities such as: (i) ECOSORN, (ii) Racha, (iii) KRDA, (iv) CEDAC, (v) SEILA etc assisting small scale infrastructure development and farming support etc.
- 5) It was confirmed that there are currently no serious environmental problems in and around the command area. Social environmental issues were rather considered in the meeting. At present, cultivation and fish pond operation is carried out by farmers in the Moung Russei River and canal areas where it is stipulated as state property areas. Although farmers have really understood that such activities are drawn up before the commencement of the construction works according to the discussion in the workshop, proper steps and mitigation measures are required for consensus building among relevant institutions and farmers.

### 3.4 Por Canal Rehabilitation Sub-Project

#### 3.4.1 Socio-Economic Condition

##### (1) Population, Community and Ethnicity

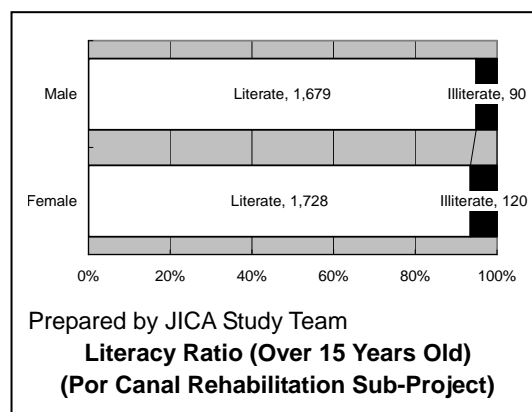
The Sub-project is located in Moung Russei District in Battambang Province primarily covering four communes: (i) Kear, (ii) Chrey, (iii) Ta Loas and (iv) Kor Koah. Total household under the command area approximately is 924 nos. Among others, the upstream of Kear commune is covered by the Por Canal while the downstream is under the Ream Kon Sub-project.



The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities under the Sub-project area.

(2) Education

Educational level of villagers are generally low as tabulate below, as most of farmers in the Sub-project area have had only “drop-out at junior high school.” On the other hand, The literacy rate in the villages is not necessarily low because of the religious and community-based activities.



**Education Career of Farmers**

N=40

Career	No Formal Education	Drop-out at primary school	Graduate from primary school	Drop-put at junior high school	Graduate from junior high school	Drop-out at high school	Graduate from high school	More than high school	Others
Number & %									
Number	4	14	7	8	4	1	1	1	0
Percentage	10.0 %	35.0 %	17.5 %	20.0 %	10.0 %	2.5 %	2.5%	2.5%	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

(3) Health and Hazard

According to the interview survey to farmers, dengue, malaria, diarrhea etc. were pointed out as the commonly contracted diseases in the Sub-project area. Insufficient knowledge among communities about the diseases is one of the main reasons for expansion of those. On the other hand, lack of water source particularly in dry season would be the reason for diarrhea disease. Situation of access to health and medical services in the Sub-project area is shown as follows:

**When you/your family get/gets sick, where do you go?**

N=40

	Hospital	Clinic	Health Centre	Others
Number	7	5	24	4
Percentage	17.5 %	12.5 %	60.0 %	10.0 %

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Health Centre is the major medical facilities accessible to communities. Additionally, results of the interview survey show that no interviewees have some kind of social security service/insurance.

(4) Economic Condition

1) Main Economic Activity

As shown in the following table, main economic activity in the community under the Por Canal Sub-project area is agriculture. Other activities observed are collection of forest products, livestock raising, temporary workers for construction etc. Due to their better quality of rice, rice noodle processing in the village under Ream Kon Sub-project located nearby is active, the target market of which is Moung Russei Town. Therefore, communes under Por

Canal would be also promising to promote such rice-based processing activities for value-addition.

### Main Activity of the Household

N=40

	Farmer	On-farm Labor	Non-Farm Labor	Salary Worker	Private Business	Others
Number	38	0	0	1	0	1
Percentage	95.0 %	-	-	2.5%	-	2.5 %

Prepared by JICA Study Team based on Interview Survey carried out during the Study

## 2) Local Living Standard

Local living standard were rapidly assessed by way of poverty ranking and focal group discussion. Poverty level was classified into four: (i) Destitute (poorest), (ii) Poor, (iii) Fair, and (iv) Rich. Poverty is multi-dimensional, complex, and each local community embraces different concepts of risks. The result is shown as follows showing that “Poor” and “Destitute” occupies over 60 % of community members:

### Income, its Source and Land Owned by Farmers at Por Canal Rehabilitation Sub-project

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
Destitute	129	14%	0-700	Labor	0-0.5
Poor	444	48%	700-2,000	Labor out of village and/or land owner	0.5-1.5
Fair	332	36%	2,000-7,000	Land owner farmer, workers	1.5-5
Rich	19	2%	7,000-20,000	Land Owner, Trader	5-30
Total	924	100%			

Prepared by JICA Study Team based on Workshop carried out during the Study

In relation to local economic conditions, land holding status was surveyed, results of which are as follows:

### Land Holding Status

N=40

	Owner Cultivator	Owner cum Sharecropper	Sharecropper	Owner cum Tenant	Tenant	Not Operating Any Farm
Number	29	2	1	4	2	2
Percentage	72.5 %	5.0%	2.5 %	10.0 %	5.0%	5.0%

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Owner cultivator occupies high percentage that 72.5 % of total farmers are categorized in “Owner Cultivator.”

## 3) Community-based Organizations

Community-based organizations are one of the important engines for supporting economic activities. The following table shows community-based organizations in which farmers currently are involved.

### Member of Community-based Organization

N=40

	FWUC and/or FWUG	Credit (Gov.)	Credit (NGOs)	Agriculture	Religion	Drinking Water	Market	Youth	Veteran	Women	No
Organization	16	0	2	1	0	0	1	18	0	1	1
Percentage	40.0%	0%	5.0%	2.5%	0%	0%	2.5%	45.0%	0%	2.5%	2.5%

Prepared by JICA Study Team based on Workshop carried out during the Study

Here, although 40.0 % of farmers replied that they are the member of FWUC and/or water users' group, however, there is no FWUC in Por Canal area registered by Battambang PDOWRAM. In actuality, the activities remain unorganized and not as a group in system level. Activities through youth organization seems canty.

### 3.4.2 Agriculture

#### (1) Present Land Use

The present land use of the Sub-project area has been classified according to current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including field under rainfed condition). There exist no paddy fields under normal irrigation condition in the area. The present land use of the area is estimated as follows:

**Present Land Use of the Sub-project Area**

Land Use Sub-category	Area & Proportion		
	(ha)	(%)	(%)
Normal Irrigation Paddy Field	-	-	-
Supplemental Irrigation Paddy Field	100	5	-
Rainfed Paddy Field	1,970	95	-
Paddy Field Total	2,070	100	93
Right-of-ways	160	-	7
Sub-project Area	2,230	-	100

Prepared by JICA Study Team

As shown in the tables, irrigation water supply conditions in the Sub-project area are very poor and the paddy fields under rainfed conditions account for 95% of the total fields in the area.

#### (2) Agro-demography and Land Holding

Agro-demographic and land holding features in the project communes (major communes located in the Sub-project area) estimated based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented as follows:

**Agro-demographic Features in the Project Communes in 2003**

Items	Average 1/	Range 1/
% of Farm Households to Total Households	77%	67 – 95%
%. of None Farm Households (No. of none crop producing households)	23%	5 – 33%
% of Farm Households Producing Wet Season Rice	81%	68 – 97%
Average Family Size (in 2005, SEILA Data Base)	5.2	5.0 – 5.4

1/: Average & range of Kear, Ta Loas & Kakaoh Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

According to the Commune Survey, land tenure and holding statuses in the project communes are estimated as shown in the following table.

### Land Holding Features of the Project Communes in 2003

Indicator	Average 1/	Range 1/
% of Landless Households	23%	5 – 33%
% of Farm Households with Holding Size Less Than 10a	16%	2 – 34%
% of Farm Households with Holding Size More Than 3ha	61%	33 – 90%

1/: Average & range of Kear, Ta Loas & Kakaoh Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From rice cropped area in wet season, average holding size of paddy field is roughly estimated at 2.4 ha/farm as shown in Table 3.4-1. Proportion of land holding households having less than 0.1 ha air calculated at 16% and the same having more than 3ha is at 61%.

#### (3) Crop Production in the Sub-project Area

##### 1) General

Rice production is the most important agricultural activities in the Sub-project area. Its features in the area are similar to those in the Ream Kon Sub-project area and are characterized by low and unstable productivity, a single cropping in wet season under both direct sowing and transplanting method, prolonged rice cultivation season and traditional farming practices. However, rice cultivation in the early wet season by way of pump irrigation is practiced to a substantial extent. The summary sheet of the statistic data on rice production in the major communes are presented in Table 3.4-2 to 3.4-4.



##### 2) Cropping Season and Variety

Rice cropping seasons in the area are similar to those in the Ream Kon Sub-project area and consist of: i) early wet season from April to July/August under direct sowing and ii) wet season from May/July to November/January under direct sowing and August/September to December/January under transplanting. The early wet season rice is generally grown supplemented by pump irrigation.

In the area, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Major varieties grown in the area are as follows;

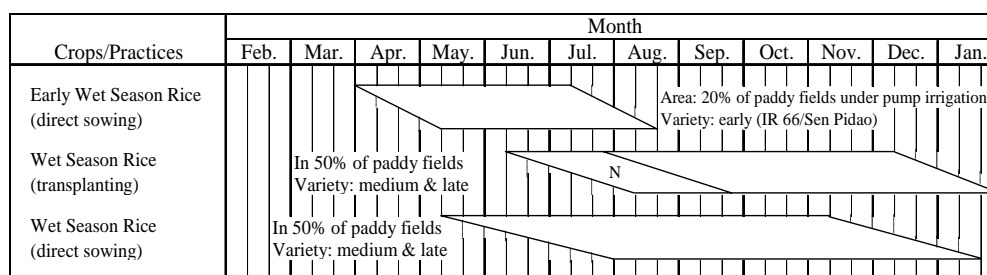
#### Major Varieties Grown in the Sub-project Area

Season	Growth Duration	Variety
Early Wet Season	Early	IR 66, Sen Pidao
Wet Season	Medium	Phka. Khney, Riang Chey, Sen Chey, Srov Sor
	Late	Komping Puoy, CAR 4, CAR 6, , Neang Khon

Prepared by JICA Study Team

##### 3) Cropping Calendar and Pattern

The prevailing cropping calendar in the area estimated based on the interview survey results is illustrated as shown in the following figure.



Prepared by JICA Study Team

### Prevailing Cropping Calendar in Paddy Fields: Por Canal Sub-project Area

A single cropping of wet season rice under rainfed condition is a prevailing cropping pattern, while a double cropping of early wet season rice and wet season rice is estimated to be carried out in about 20% of the paddy fields in the area. About 50% of rice cropped areas in wet season and all of the rice cropped areas in early wet season rice are cultivated under direct sowing method. Cultivation of other crops than rice is not practiced in the paddy fields. The prevailing cropping patterns in the area are estimated as shown in the following table.

#### Prevailing Cropping Patterns in the Sub-project Area

Cropping Pattern	Area
Single cropping of wet season rice	Predominant pattern; in 80% of the area
Double cropping of rice (early wet season - wet season)	In about 20% of the area; mostly in supplemental irrigation fields

Prepared by JICA Study Team

#### 4) Cropped Area

The current cropped areas of rice and other crops in the area have been estimated based on the various data and information and the findings of the field survey as summarized below.

#### Estimated Cropped Area & Cropping Intensity in the Sub-project Area

Cropping Season	Irrigation Status	Cropped Area			Cropping Intensity (%)
		Rice		Other Crops	
		Area (ha)	Intensity (%)		
Early Wet Season	Pumping 1/	410	20	-	20
Wet Season	Supplemental	100	5	-	5
	Rainfed	1,970	95	-	95
Sub-total		2,070	100	-	100
Annual	-	2,480	120	-	120

1/: Including most of supplemental irrigation paddy field

Prepared by JICA Study Team

As shown, the cropping intensity of rice is estimated at 20% in early wet season and 100% in wet season. The annual cropping intensity in the paddy fields is estimated at 120%.

#### 5) Paddy Yield and Production

Yields of paddy in the Sub-project area are estimated on the basis of the statistic data of PDA/DAO and SEILA Data Base, the results of interview surveys, Socio-economic Survey and Inventory Survey by JICA as summarized in the following table.



### Estimated Paddy Yield Level in the Sub-project Area (ton/ha)

Irrigation Status	Early Wet Season	Wet Season	
	Direct Sowing	Direct Sowing	Transplanting
Supplemental Irrigation 1/	2.5	1.5	2.2
Rainfed Condition	-	1.0	1.7

1/: Including pump irrigation in early wet season.

Prepared by JICA Study Team

The current yield level of paddy in wet season under rainfed condition is estimated at 1.0 ton/ha in direct sowing and 1.7 ton/ha in transplanting. Under supplemental irrigation, paddy yields are estimated at 1.5 ton/ha and 2.2 ton/ha, respectively for direct sowing and transplanting. Early wet season rice yield is estimated at 2.5 ton/ha under pump irrigation.

On the basis of the estimated cropped areas and yields, the production of paddy in the area is estimated as follows;

### Estimated Paddy Production in the Sub-project Area

Irrigation Status	Cropped Area & Production of Paddy (ha & ton)						Annual Production
	E. Wet Season		Wet Season				
	Direct Sowing		Direct Sowing		Transplanting		
	Area	Production	Area	Production	Area	Production	
Pumping Irrigation	410	1,025	-	-	-	-	1,025
Supplemental Irrigation	-	-	50	75	50	110	185
Rainfed Condition	-	-	985	985	985	1,675	2,660
Total	410	1,025	1,035	1,060	1,035	1,785	3,870

Prepared by JICA Study Team

As shown, the current paddy production in the Sub-project area is estimated at 1,020 tons in early wet season, 2,850 tons in wet season and 3,870 tons annually.

#### 6) Prevailing Farming Practices

Some specific features of rice farming practices of rice in the area are similar to those in the Ream Kon Sub-project as shown in the following table.

### Prevailing Farming Practices in the Sub-project Area

Practices	Prevailing Practices
Planting Method in Wet Season	Transplanting 50% & direct sowing 50%
Land Preparation 1/	Hand tractor 62% & draft animal 38%
Seeding Rate in Direct Sowing	120 - 150 kg/ha
Variety in Wet Season	Both local & improved varieties

1/: See Table 3.4-4

Prepared by JICA Study Team

#### (4) Farm machinery and Equipment

The inventory on farm machinery and equipment in the project communes is as follows;

### Inventory of Farm Machinery in the Project Communes in 2007

Tractor	Hand Tractor	Water Pump	Engine Thresher	Tractor Attachment	
				Plow	Harrow
32	304	109	40	28	19

Source: DAO Moung Ruessei

The number of tractors and hand tractors in the communes is substantial and mechanical land preparation work is prevailing practices, partly because of larger land holding size per farm household. The number of water pumps is rather limited in the communes compared to the same in the Ream Kon project communes.

(5) Post-harvest and Marketing

The post-harvest operations in the Sub-project area are similar to those in the Ream Kon Sub-project area and threshing of paddy by engine thresher is common. After threshing, paddies except for those kept for family consumption are generally marketed without drying partly because of insufficient drying space and no drying yard.

Prevailing marketing channel of paddy in the area is similar to the same in the Ream Kon area and village collector is a main market destination. Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy as is the case in other Sub-project areas. Major constraints reported by the rice millers in the project district are discussed in the section 3.3.1(5).

(6) Current Capacity to Pay

The present farm economic analyses of the typical farms are presented in Table 3.3-5. As shown in the table, the current farm economy of the typical farm Type A (transplanting) indicate net surplus (capacity to pay) of Riel 1,593,000 or 18% of the total income and the same of the Type B (direct sowing) indicates net surplus of Riel 271,000 or 4 % of the income. The net surplus of the Type B is about 17% of the same of the Type A. In both cases, the current capacity to pay is limited attributed mainly to low productivity of rainfed paddy.



**1. Damaged concrete and reinforcing bars exposed**

(7) Results of Socio-economic Survey

The results of the Socio-economic Survey are presented in a narrative manner in Table 3.4-5. Major constraints in rice farming identified are low paddy yield and irrigation water shortage even in wet season. Farmers expectations for farming and physical works (irrigation/drainage) are **productivity improvement of wet season rice and adequate irrigation water supply in wet season**, respectively.



**2. Crack of wing wall of intake**

### 3.4.3 Irrigation and Drainage

(1) Outline of the Existing Irrigation System

The Por Canal system was constructed between 1975 and 1978. A headworks which was constructed on the Moung Russei River for the Ream Kon system was also used for the Por Canal Sub-project, however, frequent floods destroyed the headworks and canal system. The JICA Inventory Survey in 2006 has reported that the system is “partly functioning” at present, i.e., “run-of-river type irrigation system”, and the JICA Study Team has also confirmed this situation. The inventory survey result is summarized in Table 3.4-6.

(2) Existing Irrigation Facilities

1) Intake

The intake for Por Canal Sub-project is located on the left bank of the Moung Russei River at about 800 m upstream of the headworks. The intake structure is seriously deteriorated by cracks and some of the reinforcing bars are exposed for a long time. The intake gate is also deteriorated and not functioning well due to lack of maintenance (Photos1, 2). Therefore, re-construction of the intake structure is inevitable.

2) Canals

The flow capacity of existing main canal is examined by applying non-uniform flow hydraulic formula to the canal sections surveyed by the Study Team. The calculation reveals that the main canal has a flow capacity of between  $5.0\text{m}^3/\text{sec}$  and  $0.5\text{m}^3/\text{sec}$ . On the contrary, the water level in the main canal as well as secondary canals is too low for gravity irrigation. Although some of canals in the area have been rehabilitated recently, there are no water control facilities on the canals.

3) Structures

There are a check structure and diversion structures in the main canal system. Seven road crossing structures are fairly functioning. Many additional structures, however, need to be constructed.

(3) Present irrigation water use, O&M, and FWUC

Detailed survey result on the present irrigation water use in the Sub-project area is referred to the section 3.4.1. At present, most of the farmers rely only on rain. They start paddy cultivation when their farm land become wet/ inundated by rain and/ or flood, accordingly, floods in the early stage of wet season are welcome by farmers. If a long drought occurs during the growing stage of paddy, farmers pump up water from canals or streams using small pumps.

Frequent rehabilitation works have been carried out by PDOWRAM to the main and some secondary canals. These rehabilitation works were funded by various sources, such as commune fund, SEILA program, ECOSORN, etc. However, the design of repair seems not to be performed based on the integrated rehabilitation plan including hydraulics, water distribution plan, etc. There is no registered FWUC or FWUGs in the Sub-project area..

(4) Drainage System

There are no clear drainage canals in the Sub-project area at present. The excess water from the west of the Sub-project area (Prek Taam Irrigation area) flows into Sub-project area. The flood mainly affects on paddy and human life. Detailed survey result on the flood condition in the Sub-project area is referred to the section 3.4.1.

The collector drain should be developed at the western border of the Sub-project area in order to prevent inundation.

(5) Other problems

Accessibility in the Sub-project area is very poor. Establishment of a farm road network is

necessary for transportation of agriculture input and output. The existing canal inspection roads are to be rehabilitated and paved for farm road.

#### **3.4.4 Environment**

##### **(1) Vegetation and Land Use**

The present land use of the Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including field under rainfed condition). There exist no paddy fields under normal irrigation condition in the area.

##### **(2) Wild Life**

Wildlife are rarely observed in and around the Sub-project areas since the areas have been already cleared for agriculture particularly paddy cultivation. All the protected or conserved areas are located in the outside of Sub-project areas. There are no detailed information, however, wild animals observed in and around the area include: (i) wild pig, (ii) rabbits, (iii) some species of reptiles such as snakes and turtles in accordance with the field interview.

##### **(3) Protected Areas**

Figure 3.3-1 shows protected areas of the Moung Russei River Basin where the Sub-project is located. Phnom Samkos Wildlife Sanctuary and Tonle Sap Multiple Use Area is situated, characteristics of which are introduced in the section 3.3.4.

On the other hand, there are no protected areas or conserved area within the command area of Por Canal Rehabilitation Sub-project.

##### **(4) Historical and Religious Sites**

There are no archeological and/or historical significance in and/or around the Por Canal Sub-project area.

##### **(5) Noise and Air Quality**

There is no data related with noise and air quality in and around Sub-project areas. It is conceivable that no serious noise pollution source exist in this area. In addition, as for air quality, only power generators of the private company and traffic particularly National Road No. 5 and access to the command area, distance of which is 3 km from the national road to the command area, would give negative impact to some extent. Those are, however, not serious at present.

##### **(6) Water Quality**

Water quality was preliminary assessed through field survey in the wet season, June 12<sup>th</sup>, 2008. The indicators analyzed are: (i) pH, (ii) Electric Conductivity (EC) and (iii) Total Dissolved Solid (TDS). The results are tabulated as follows:

### Result of Water Quality Analysis

Name	Sampling Point	Date	pH	EC ( $\mu\text{S}/\text{cm}$ )	TDS ( $\text{mg}/\text{l}$ )
Por Canal Rehabilitation	River at existing intake	12-Jun-08	7.4	66.2	33.1
	Main canal at BP of command area	12-Jun-08	7.6	63.6	31.7
	Mid-stream of main canal	12-Jun-08	7.4	64.1	32.0
	Drainage	12-Jun-08	7.3	68.1	34.1
Water Quality Standard	River		6.5-8.5	None (<70 $\mu\text{S}/\text{cm}$ ) Slight to Moderate (70-300 $\mu\text{S}/\text{cm}$ )	<450
	Lakes and Reservoirs		6.5-8.5	Severe (>300 $\mu\text{S}/\text{cm}$ )	

Note: Water quality standard is given from relevant document as follows:

pH: Ministry of Environment (1999), Sub-decree on Water Pollution Control

EC and TDS: FAO (1994), Water Quality for Agriculture, Irrigation and Drainage Paper 29

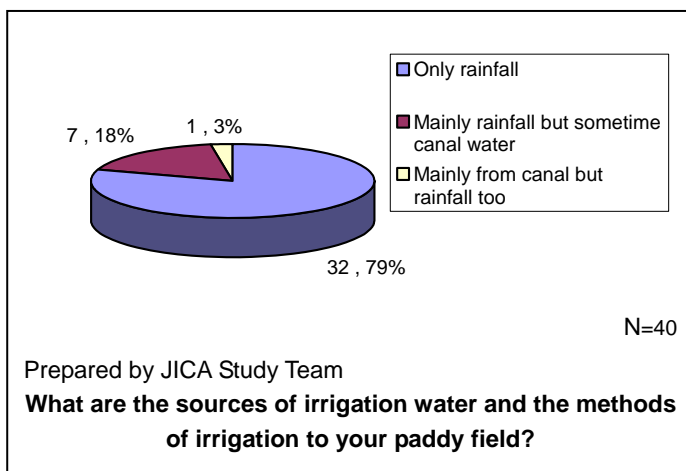
Prepared by JICA Study Team based on field sampling and analysis

According to the relevant guidelines, all three parameters are within permissible level, and, thus, there were no concerns on salinity in the irrigation water.

#### (7) Present Water Use by Affected Communities

##### 1) Drinking and Domestic Water Use

Main water source for drinking and domestic water among communities is reservoir and/or pond followed by dug well particularly in dry season. People largely depend on rain water in the wet season. Percentage of river water usage is 10 to 15 % of the community members under Por Canal Sub-project.



Main Canal with no Permanent Structures, Water Diverted using Wood Check (June 12<sup>th</sup>, 2008)

##### 2) Irrigation Water Use

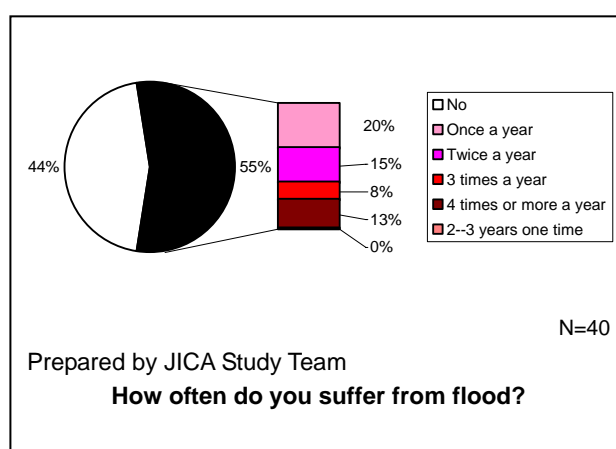
Although facilities such as secondary canals are partially rehabilitated through the assistance of SEILA program, ECOSORN and/or using commune fund, existing irrigation facilities are significantly deteriorated and no tertiary level facilities have been developed. Irrigation water

is, therefore, not stably supplied from the system. Instead, farmers are largely dependent on rainfall and flood water especially in the wet season. Interview survey asking for present source of irrigation water and method of irrigation is illustrated on the right. Nearly 80 % of the farmers have replied that they rely only on rainfall at present. Others mention some water is provided through irrigation facilities, however, it actually means rainwater just flow through the canals to the paddy field during heavy rain. Therefore, rehabilitation of irrigation facilities will surely contribute to the constancy of irrigation water supply in the Sub-project command area.

Under such conditions, farmers' groups are not functioning as a group for O&M of irrigation facilities and water management. In parallel with facilities rehabilitation, FWUC establishment and strengthening would be of critical importance for sustainable irrigation development and management.

### 3) Flood Condition

Although it would be difficult to control and regulate, flood water is also an important source of water for agriculture. Necessity of flood management is huge in any irrigation development in Cambodia. In accordance with the interview survey, current flood condition is illustrated on the right showing that 55 % of the people are suffering from flooding at least once a year. The asset damaged by flood is mostly reported to be paddy field.



### (8) Workshop and Public Consultation

Workshop and public meetings were organized in order to confirm community members' opinions toward the sub-project as well as environmental management at the site for the formulation of the development plan.

#### Participants of Workshop and Public Consultation

No.	Organization	Participants
1.	National Counterparts and Steering Committee Member	Representative from MOWRAM (Department of Planning)
2.	Provincial Counterparts and Personnel Concerned	-
3.	Commune Councils	Chiefs and the members of the councils (8 members: Taloas, Kear, Ko Kor and Chrey)
4.	JICA Study Team	Member of the Team
5.	Villagers	Villagers relevant to Por Canal Rehabilitation Sub-Project (26 members: Taloas, Veal, Prolay Sdav, Ma Naok, Sour Sdey, Steung Thmei, Chong Prolay, Wat Chas, Kear I, Kear II, Kear III, Por I and Por II)

Prepared by JICA Study Team

Main issues discussed are as follows:

- 1) The result of participatory problem census, as tabulated below, shows that stable irrigation

water supply is placed highest priority and of critical importance for farmers followed by farming improvement. Therefore, necessity of irrigation rehabilitation together with the agricultural support was justified from the view point of public opinion.

### Result of Participatory Problem Census by the Representative Farmers

Rank	Problems	Problem Solution
I	Lack of water for irrigation	Request to <u>rehabilitate</u> irrigation and drainage facilities
II	Lack of techniques for agriculture	Ask support from Ministry, Department and Institutions related with the project to send extension worker for agriculture to <u>train the farmers</u> at the sites.
III	Lack of participation in O&M	Need FWUC to participate in the <u>management, operation and maintenance</u> of the scheme.
IV	Lack of good quality seed	Ask support from the Ministry, Department and Institutions related with the project to provide <u>quality seed</u> to the farmers.
V	Lack of water pump station	Request irrigation <u>pump</u> for the farmers.

Prepared by JICA Study Team based on Workshop carried out during the Study

- 2) Through the discussion, sub-project component consisting of: (i) rehabilitation of irrigation and drainage facilities particularly canals and drains within the system, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities have been fully agreed by all the participants.
- 3) Water quality deterioration was especially pointed out by the participants as one of the problems due to the effluence from houses located along the main canal just after the intake from the Moung Russei River. Although water quality analysis shows that the quality is within the normal range, the team suggested the importance of monitoring as well as education program during the sub-project implementation.
- 4) The level of awareness for participation in irrigation O&M and water management have been assessed from the view points of: (i) participation in construction of tertiary facilities, (ii) participation in FWUCs' activities and (iii) participation in O&M of irrigation system. According to the results, similar to the Ream Kon Rehabilitation sub-project, awareness on participation in FWUC's particularly irrigation service fee payment is lower.
- 5) NGOs' and/or donors' activities adhere to each commune rather than Sub-Project unit such as: (i) ECOSORN, (ii) K.A.W.P., (iii) SEILA, (iv) Vision Fund, (v) World Vision etc. In particular, communities have been benefited from the assistance of ECOSORN for the development of tertiary irrigation facilities under the initiative of villagers and the commune council.
- 6) It was confirmed that there are currently no serious environmental problems in and around the command area. Social environmental issues were rather considered in the meeting. At present, cultivation and fish pond operation is carried out by farmers in the Moung Russei River and canal areas as similarly observed in the Ream Kon. Although farmers have really understood that such activities are drawn up before the commencement of the construction works according to the discussion in the workshop, proper steps and mitigation measures are required for consensus building among relevant institutions and farmers.



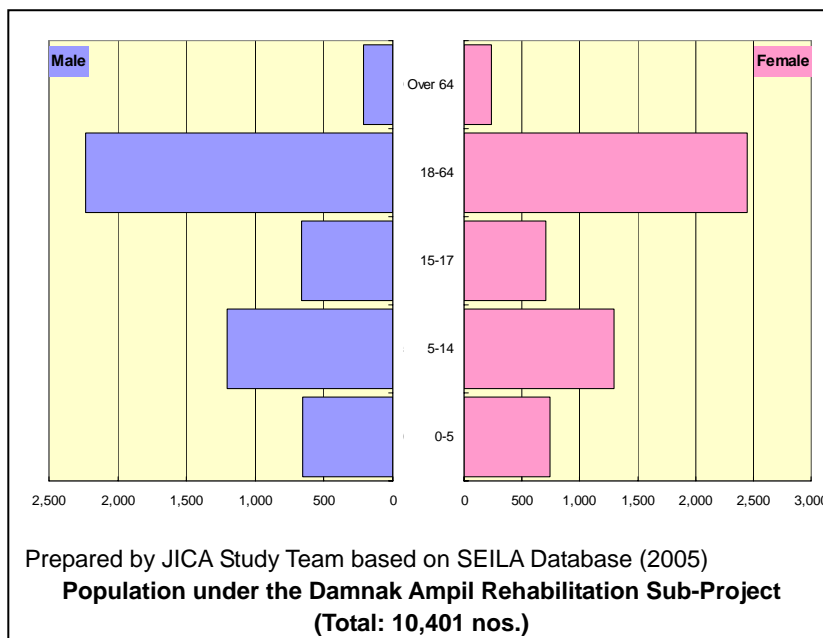
Houses Located along the Main Canal at Por Canal Rehabilitation Sub-Project (February 7<sup>th</sup>, 2008)

### 3.5 Damnak Ampil Rehabilitation Sub-Project

#### 3.5.1 Socio-Economic Condition

##### (1) Population, Community and Ethnicity

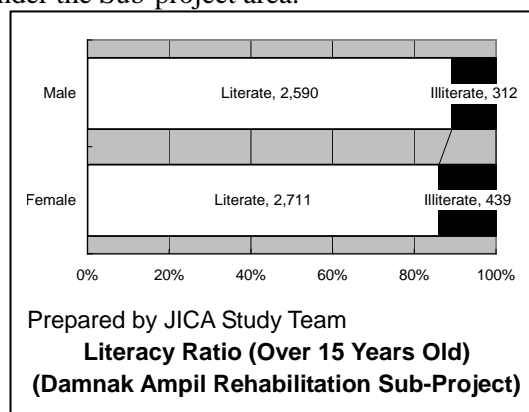
The Sub-project covers Sampov Meas and Bakan Districts in Pursat Province covering five communes: (i) Lolok Sar, (ii) Trapeang Chong, (iii) Snam Preah, (iv) Phateah Rung and (v) Bak Chenhchien. Total household under the command area approximately is 2,000 nos.



The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities under the Sub-project area.

##### (2) Education

Educational level of villagers are generally low as tabulate below, as most of farmers in the Sub-project area have had only “no formal education” and/or “drop-out at primary school.” On the other hand, the literacy rate in the villages is not necessarily low because of the religious and community-based activities.



#### Education Career of Farmers

N=30

Career Number & %	No Formal Education	Drop-out at primary school	Graduate from primary school	Drop-put at junior high school	Graduate from junior high school	Drop-out at high school	Graduate from high school	More than high school	Others
Number	9	10	2	6	2	1	0	0	0
Percentage	30.0%	33.3%	6.7%	20.0%	6.7%	3.3%	-	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study



(3) Health and Hazard

According to the interview survey to farmers, dengue, malaria, diarrhea etc. were pointed out as the commonly contracted diseases in the Sub-project area. Insufficient knowledge among communities about the diseases is one of the main reasons for expansion of those. On the other hand, lack of water source particularly in dry season would be the reason for diarrhea disease. Situation of access to health and medical services in the Sub-project area is shown as follows:



Socio-Economic Survey in the Commune (May 30<sup>th</sup>, 2008)

**When you/your family get/gets sick, where do you go?**

N=30

	Hospital	Clinic	Health Centre	Others
Number	2	3	22	3
Percentage	6.7%	10.0%	73.3%	10.0%

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Health Centre is the major medical facilities accessible to communities. Additionally, results of the interview survey show that no interviewees have some kind of social security service/insurance.

(4) Economic Condition

1) Main Economic Activity

As shown in the following table, all the interviewee under the Damnak Ampil Sub-project replied that the main economic activity is agriculture. Other activities observed in the community during field survey are: (i) collection of livestock raising, (ii) temporary workers for construction, (iii) kiosk selling vegetables and/or processed products for value-addition.

**Main Activity of the Household**

N=30

	Farmer	On-farm Labor	Non-Farm Labor	Salary Worker	Private Business	Others
Number	30	0	0	0	0	0
Percentage	100.0%	-	-	-	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

2) Local Living Standard

Local living standard were rapidly assessed by way of poverty ranking and focal group discussion. Poverty level was classified into four: (i) Destitute (poorest), (ii) Poor, (iii) Fair, and (iv) Rich. The result is as follows showing that “Poor” and “Destitute” occupies 55 % of community members:

**Income, its Source and Land Owned by Farmers at Damnak Ampil Rehabilitation Sub-project**

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
Destitute	30	1.5 %	0-1,000	Labors	0.5
Poor	1,070	53.5%	1,000-3,000	Labor, go to Thai border, garment factory worker	0.5-1

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
				and/or land owner	
Fair	850	42.5%	3,000-5,000	Trader, husbandry, Working on rice field, land owner	1-2
Rich	50	2.5%	5,000-8,000	Money lender, Trader, land owner	>2
Total	2,000	100%			

Prepared by JICA Study Team based on Workshop carried out during the Study

In relation to local economic conditions, land holding status was surveyed, results of which are as follows:

### Status of Land Holding

N=30

	Owner Cultivator	Owner cum Sharecropper	Sharecropper	Owner cum Tenant	Tenant	Not Operating Any Farm
Number	29	0	0	1	0	0
Percentage	96.7%	-	-	3.3%	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Owner cultivator occupies high percentage that 96.7 % of total farmers are categorized in “Owner Cultivator.”

### 3) Community-based Organizations

Community-based organizations are one of the important engines for supporting economic activities. The following table shows community-based organizations in which farmers currently are involved.

### Member of Community-based Organization

N=30

	FWUC and/or FWUG	Credit (Gov.)	Credit (NGOs)	Agriculture	Religion	Drinking Water	Market	Youth	Veteran	Women	No
Organization	1	0	1	0	4	0	0	2	0	4	20
Percentage	3.3%	-	3.3%	-	13.3%	-	-	6.7%	-	13.3%	66.7%

Prepared by JICA Study Team based on Workshop carried out during the Study

Religious organization is major under the Damnak Ampil Sub-project. Although, FWUC has been already established and under processing for registration at PDOWRAM Pursat, awareness among farmers are not necessarily high at present.

### 3.5.2 Agriculture

#### (1) Present Land Use

The present land uses of the Damnak Ampil Rehabilitation Sub-project are exclusively paddy fields under different irrigation statuses. Accordingly, the land uses of the areas are classified depending on current irrigation statuses into 2 sub-categories of : i) supplemental irrigation paddy field and ii) rainfed paddy field (including fields under rainfed condition) as shown in the following table.

### Present Land Use of the Sub-project Area

Land Use Sub-category	Area		
	(ha)	(%)	(%)
Normal Irrigation Paddy Field	-	-	-
Supplemental Irrigation Paddy Field	500	21	-
Rainfed Paddy Field	1,930	79	-
Paddy Field Total	2,430	100	93
Right-of-ways	180	-	7
Sub-project Area	2,610	-	100

Prepared by JICA Study Team

As shown in the tables, irrigation water supply conditions in the Sub-project area are better compared with other Sub-project areas and the paddy fields under supplemental irrigation and rainfed conditions account respectively for about 21% and 79% of the total paddy fields.

#### (2) Agro-demography and Land Holding

Agro-demographic and land holding features in the project communes (major communes located in the Sub-project area) estimated based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented as follows;

#### Agro-demographic Features in the Project Communes in 2003

Items	Average 1/	Range 1/
% of Farm Households to Total Households	89%	88 – 90%
%. of None Farm Households (No. of none crop producing households)	11%	10 – 12%
% of Farm Households Producing Wet Season Rice	100%	100%
Average Family Size (in 2005, SEILA Data Base)	5.3	5.1 – 5.5

1/: Average & range of Trapeang Chong & Snam Preah Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

According to the Commune Survey, land tenure and holding statuses in the project communes are estimated as shown in the following table.

#### Land Holding Features of the Project Communes in 2003

Indicator	Average 1/	Range 1/
% of Landless Households	11%	10 – 12%
%. of Farm Households with Holding Size Less Than 10a	8%	0 – 15%
% of Farm Households with Holding Size More Than 3ha	15%	12 – 18%

1/: Average & range of Trapeang Chong & Snam Preah

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at 1.2ha as shown in Table 3.5-1. Proportion of households having less than 0.1ha is calculated at 8% and the same of more than 3ha is at 15%.

#### (3) Crop Production in the Sub-project Area

##### 1) General

Rice production in the area is characterized by low and unstable productivity mostly under rainfed conditions, prolonged cropping season with cultivation of rice varieties of different growth durations and traditional farming practices as is the case in the other Sub-project areas. Rice cultivation in dry season by pump irrigation is practiced in a limited extent. Statistic data on rice production in the major communes are shown in Table 3.5-2 to 3.5-4.

2) Cropping Season and Variety

Rice cropping season in the area is almost exclusively wet season from July/August to November/December. Dry season rice cultivation is practiced from January/February to April in a limited extent. In the area, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Major varieties grown are as follows;

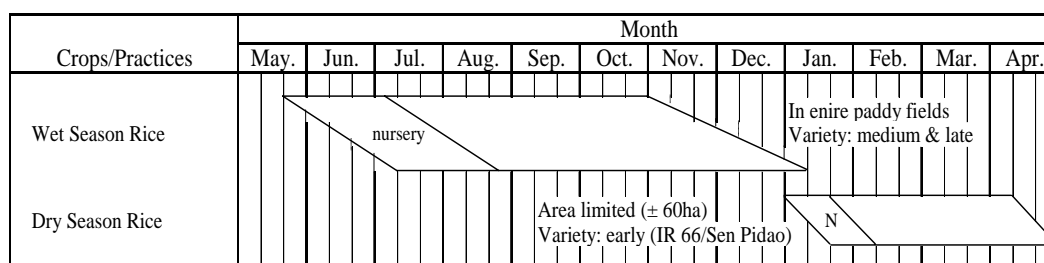
**Major Varieties Grown in the Sub-project Area**

Season	Growth Duration	Variety
Wet Season	Medium	Phka. Rumdoul, Phka Khney, Phka Mulis, Somali
	Late	Neang Pong, CAR 4, CAR 7, CAR 9, Kang Threung
Dry Season	Early	IR, Sen Pidao

Prepared by JICA Study Team

3) Cropping Calendar and Pattern

The prevailing cropping calendar in the area estimated based on the interview survey results is illustrated as shown in the following figure.



Prepared by JICA Study Team

**Prevailing Cropping Calendar in Paddy Fields: Damnak Ampil Sub-project Area**

As stated earlier, a single cropping of wet season rice is an almost exclusive cropping pattern in the area as an extent of dry season rice cultivation is limited. Cultivation of other crops in paddy fields was not reported.

4) Cropped Area

The current cropped areas of rice and other crops in the area have been estimated on the basis of various data and information and the findings of the field survey as summarized below.

**Estimated Cropped Area & Cropping Intensity in the Sub-project Area**

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	2,430	-	100
Dry Season	60	-	2
Annual	2,490	-	102

*Note the extent of the sub-project area is being finalized.*

Prepared by JICA Study Team

As shown in the table, the cropping intensity of rice is estimated at 100% in wet season and only at 2% in dry season. The annual cropping intensity in the paddy fields is estimated to be 102% including dry season rice.

5) Paddy Yield and Production

Yields of paddy in the Sub-project area are estimated based on the statistic data of PDA/DAO and SEILA Data Base, the results of interview surveys, Socio-economic Survey and Inventory Survey by JICA as summarized in the following table.

**Estimated Paddy Yield & Production in the Sub-project Area**

Irrigation Status	Yield Level		Cropped Area		Production
	Wet Season	Dry Season	Wet Season	Dry Season	
Under Rainfed Condition	1.5 t/ha	-	1,930 ha	-	2,895 ton
Supplemental Irrigation 1/	2.0 t/ha	2.5 t/ha	500 ha	60 ha	1,150 ton
Total	-	-	2,430 ha	60 ha	4,045 ton

1/: Including pumping irrigation in dry season.

Prepared by JICA Study Team

The current yield level of paddy in wet season is estimated at around 1.5 ton/ha under rainfed condition and 2.0 ton/ha under supplemental irrigation and 2.5 t/ha in dry season under pump irrigation. Current production of paddy in the area is estimated at 3,900 tons in wet season, 150 tons in dry season and 4,050 tons annually.

6) Prevailing Farming Practices

Some specific features of rice farming practices in the area are as follows;

**Prevailing Farming Practices in the Sub-project Area**

Practices	Prevailing Practices
Planting Method in Wet Season 1/	Transplanting 92% & direct sowing 8%
Land Preparation 1/	Hand tractor $\pm$ 20% & draft animal $\pm$ 80%
Variety in Wet Season	Both local & improved varieties

1/: See Table 3.5-4

Prepared by JICA Study Team

(4) Farm machinery and Equipment

The inventory on farm machinery and equipment in the project communes is presented below.

**Inventory of Farm Machinery in the Project Communes in 2007**

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Big
11	70	445	29	247	7

Source: PDA Pursat

The number of hand tractors in the communes is substantial; however, land preparation work by draft animal is still prevailing practices. The number of water pumps, appeared to be used for supplemental water supply to paddy fields, is large in the communes. The number of rice mills appears to be more than sufficient for milling demand because marketing of paddy is commonly carried out in the form of unhusked rice.

(5) Post-harvest and Marketing

Use of engine thresher by hiring service is prevailing threshing method of paddy in the Sub-project area. After threshing, paddies except for those for family consumption are generally marketed without drying partly because of insufficient drying space and no drying

yard. Paddies for family consumption are sun-dried in a home yard.

The results of the Socio-economic Survey indicate that prevailing marketing channels of paddy in the area are marketing to village rice millers followed by rice millers in commune centers. A main marketing destination of other crops is also markets at village level. Major constraints for paddy marketing identified through the Survey are unstable market prices of paddy followed by low market prices of paddy.



Major constraints reported by the rice millers in the project district are similar to those reported by rice millers in Moug Ruessei District and include: i) price competition with Viet Nam buyers, ii) no drying facility or insufficient drying spaces and failed completion with Viet Nam and Thai buyers who accept field dried paddy (wet paddy), iii) unstable price influenced by demand in Viet Nam and iv) poor management and limited activity of the Pursat Rice Millers Association.

#### (6) Current Capacity to Pay

The present farm economic analyses of the typical farms are presented in Table 3.3-5. As shown in the table, the current farm economy of the typical farm Type A (rainfed field) indicate net surplus (capacity to pay) of Riel 192,00 or 4% of the total income and the same of the Type B (supplemental irrigation) indicates net surplus of Riel 685,000 or 12 % of the income. In both cases, the current capacity to pay is limited attributed mainly to small land holding size and low productivity of paddy under limited water supply or rainfed condition.

#### (7) Results of Socio-economic Survey

The results of the Socio-economic Survey are presented in a narrative manner in Table 3.5-5. Major constraints in rice farming identified are low paddy yield and irrigation water shortage in dry season. Farmers expectations for farming and physical works (irrigation/drainage) are **productivity improvement of wet season rice and adequate irrigation water supply in wet season**, respectively.

### 3.5.3 Irrigation and Drainage

#### (1) Outline of the Existing Irrigation System

The system was constructed along the left bank of the Pursat River between 1975 and 1976, however, the system including headworks was severely damaged by floods in 1979. In 2006, rehabilitation work was conducted by MOWRAM; construction of a new headworks and rehabilitation of the upstream section of the main canal (7.3 km of total length 23 km) in order to supply irrigation water to about 2,270 ha. At the same time, one check structure, nine off-takes and other structures were also constructed.

The extension of the main canal has been proposed up to Svay Don Keo River (about 16 km to northwest) for future supply of irrigation water to extension area as well as several irrigation systems along the Svay Don Keo River.

(2) Existing Irrigation Facilities

1) Headworks

The former headworks was constructed on the Pursat River in 1975, and was completely washed away by floods in 1979. The new headworks was reconstructed at the same location in 2006 (Photo 1). It has seven automatic flood gates which are expected to fall down and stand automatically in accordance with the fluctuation of water level in the river. The headworks has also two sluice gates on both sides of the structure. The type and dimensions of these gates are described in Table 3.5-6. The intake was also reconstructed in 2006, with a maximum flow capacity of about  $8\text{m}^3/\text{s}$  at the water level EL.17.0 m, however, no gate is installed.



**1. Damnak Ampil Weir**

The automatic flood gates are designed; to fall down at a design high water level of EL.16.85 m or more; to rise up at a design low water level of EL.13.70 m or below. The gates work well with high water level, however, once they fell, they hardly rise up during wet season, and that leads to far low water level at the inlet of the main canal, i.e., water level is hardly maintained at design intake water level of EL.17.0 m. Based on the information obtained so far, the causes are considered to be as follows:

- (i) The design water level “EL.13.70 m or below” for rise is too low compared with the design intake water level of EL.17.0 m.
- (ii) During the wet season, water level in the Pursat River is mostly more than EL.13.70 m due to the abundant runoff from the catchment area.
- (iii) Some objection or extra friction between some of counterweights and concrete guide holes impedes smooth fall of the counterweights to pull up the gates.

Based on the information and request obtained, the following counter measures are to be provided to improve the behavior of the gates:

- a) To increase counterweights to raise the design high water level for fall down from EL.16.85 m to EL.17.20 m
- b) To provide manual or power hoist to stand gates at EL.16.50 m approx.
- c) To provide some mechanical measure for a stepwise fall down in accordance with the water level

It is considered that the above, item (a) and (b) must be improved, and item (c), if necessary.

2) Canals

The existing main canal runs from the Pursat River to northwestward, with a total length of about 20 km, of which the upper reach of 7.3 km has been rehabilitated in 2006. The rehabilitated main canal has a design dimension of base width=7.0 m, design water depth = 1.5 m and design flow capacity =  $8.0\text{ m}^3/\text{sec}$ , respectively.

The remaining downstream reach of about 16 km is very deteriorated by erosion, slope sliding, sedimentation, etc. at present. The flow capacity is assumed to be less than  $5\text{ m}^3/\text{sec}$  on

average.

Three secondary canals were constructed in the Sub-project area, however, these canals are seriously deteriorated; erosion, slope sliding and sedimentation, and the canal base is rather high compared with the main canal. Rehabilitation is required in all secondary canals and tertiary canals are to be newly constructed.

The existing main canal will further require rehabilitation to increase the flow capacity in the upstream. The possibility of increasing of flow capacity is to be studied.

### 3) Structures

Structures were constructed in 2006 including one cross regulator and nine off-takes. However, they are not used efficiently because water level in the main canal is very low (Photo 2, 3).

### (3) Present irrigation water use, O&M, and FWUC

Detailed survey result on the present irrigation water use in the Sub-project area is referred to the section 3.5.1. At present, most of the farmers rely only on rain. They start paddy cultivation when their farm land become wet/ inundated by rain and/ or flood, and accordingly, they welcome floods in the early stage of wet season. If a long drought occurs during the growing stage of paddy, farmers pump up water from canals or streams using small pumps.

FWUC was established in 2005 and its registration is under processing. However, only 7% of interviewees answered that they are member of the FWUC.

### (4) Drainage condition

The flood suffering area is assumed to be near the Pursat River and another stream (Stueng Chambot) which flows northwest border of the Sub-project area. Detailed survey result on the flood condition in the Sub-project area is referred to the section 3.5.1.



**2. Check Structure on Main Canal**



**3. Inlet of Secondary Canal**

## 3.5.4 Environment

### (1) Vegetation and Land Use

The present land use of the Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of : i) paddy fields with normal irrigation, ii) supplemental irrigation paddy field and iii) rainfed paddy field (including field under rainfed condition). Rainfed paddy field particularly in the wet season is the major land use in the Damnak Ampil command area.



(2) Wild Life

Wildlife are rarely observed in and around the Sub-project areas since the areas have been already cleared for agriculture particularly paddy cultivation. All the protected or conserved areas are located in the outside of Sub-project areas. There are no detailed information, however, wild animals observed in and around the area include: (i) wild pig, (ii) rabbits, (iii) some species of reptiles such as snakes and turtles in accordance with the field interview.

(3) Protected Areas

Figure 3.3-1 shows protected areas of the Pursat River Basin where the Damnak Ampil Sub-project is located. There are four protected areas: (i) Aural Wildlife Sanctuary, (ii) Phnom Samkos Wildlife Sanctuary, (iii) Tonle Sap Multiple Use Area and (iv) Cardamom Protected Forest situated in the Basin, characteristics of which are tabulated as follows:

**Protected Area in Pursat River Basin**

Protected Area	Province	Total Area (ha) (Area in Basin, %)	Relevance with Basin Irrigation	Some Unique Characteristics
Aural Wildlife Sanctuary	Pursat Province	253,750 (57,900, 22.8 %)	The upstream of irrigation systems in southern basin area	Highest mountain (1743m) in Cambodia with a wide diversity of vegetation ranging from dry Dipterocarpus / Podocarpus forest to medium altitude evergreen forest.
Phnom Samkos Wildlife Sanctuary	Crossing Battambang and Pursat Province	333,750 (98,900, 29.6 %)	The upstream of irrigation systems	High altitude area with a wide diversity of forest types. Supports a range of threatened birds in the area
Tonle Sap Multiple Use Area	Pursat Province	316,250 (26,800, 8.5 %)	The downstream of irrigation systems in northern part of basin	Long-standing ichthyological reserve. Great biological, hydrological and cultural/economic importance.
Cardamom Protected Forest	Pursat Province	401,300 (102,600, 25.6 %)	The upstream of systems in south-east basin area	Known to contain almost all the country's known mammals, birds, reptiles and amphibians. This is partly due to the very high diversity of habitats, some of which occur nowhere else in Cambodia such as large expanses of fire-regulated ferns, upper montane forest, high elevation marshes and blackwater rivers.

Prepared by JICA Study Team based on Ministry of Environment (2004), State of Environment Report and Fauna and Flora International

Aural, Phnom Samkos and Cardamom are located in the upstream of most of irrigation systems in the river basin, therefore, there would be no serious impact through irrigation development in the basin. On the other hand, Tonle Sap Multiple Use Area is in the downstream of the Sub-project. Increase of usage in fertilizer and pesticide generally seen through promoting irrigation development would possibly more or less affect water quality, if inappropriate and



Community Forest Managed by the Community (February 2<sup>nd</sup>, 2008)

excessive application is carried out.

There are no protected areas or conserved area within the command area of the Damnak Ampil Rehabilitation Sub-project.

Instead, commune members have been planting trees for the mitigation of soil erosion assisted by the Provincial Department of Environment (DOE), Pursat, along the right side of the main canal. Such awareness among communes would be appreciable for the future community-based environmental management under the Sub-project.

(4) Historical and Religious Sites

There are no archeological and/or historical significance in and/or around the Damnak Ampil Sub-project area.

(5) Noise and Air Quality

There is no data related with noise and air quality in and around Sub-project areas. It is conceivable that no serious noise pollution source exist in this area. In addition, as for air quality, only power generators of the private company and traffic particularly National Road No. 5 and access to the command area, distance of which is 10 km from the national road to the command area, would give negative impact to some extent. Those are, however, not serious at present.

(6) Water Quality

Water quality was preliminary assessed through field survey in the wet season, June 12<sup>th</sup>, 2008. The indicators analyzed are: (i) pH, (ii) Electric Conductivity (EC) and (iii) Total Dissolved Solid (TDS). The results are tabulated as follows:

**Result of Water Quality Analysis**

Name	Sampling Point	Date	pH	EC ( $\mu\text{S}/\text{cm}$ )	TDS ( $\text{mg}/\text{l}$ )
Damnak Ampil Rehabilitation	BP of main canal	12-Jun-08	7.6	29.5	14.6
	Mid-stream of secondary canal	12-Jun-08	6.1	51.5	25.9
	EP of existing main canal	12-Jun-08	6.2	36.4	18.1
Water Quality Standard	River		6.5-8.5	None (<70 $\mu\text{S}/\text{cm}$ ) Slight to Moderate (70-300 $\mu\text{S}/\text{cm}$ ) Severe (>300 $\mu\text{S}/\text{cm}$ )	<450

Note: Water quality standard is given form relevant document as follows:

pH: Ministry of Environment (1999), Sub-decree on Water Pollution Control

EC and TDS: FAO (1994), Water Quality for Agriculture, Irrigation and Drainage Paper 29

Prepared by JICA Study Team based on field sampling and analysis



Water Stagnation in the Command Area due to no Drainage Developed (June 12<sup>th</sup>, 2008)



Community-managed Pond as one of the Domestic Water Source (February 2<sup>nd</sup>, 2008)



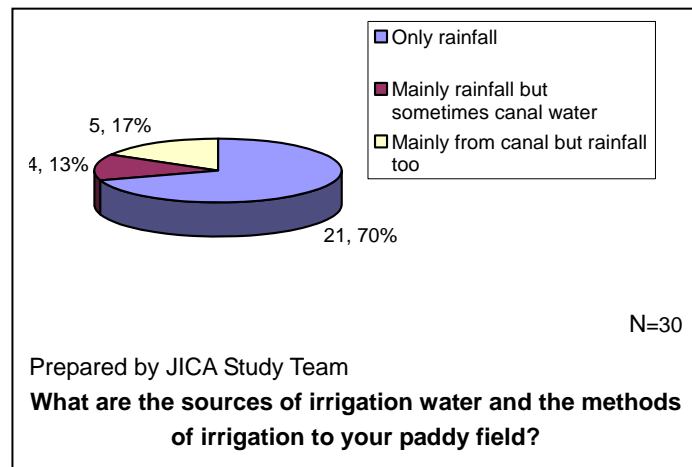
Outlet of Diversion Structure with no Secondary Canal Constructed (February 2<sup>nd</sup>, 2008)

According to the relevant guidelines, two points, mid-stream of secondary canal and EP of existing main canal, shows lower level of pH than that in standard. These would be possibly given from water stagnation and inflow of effluent at sample sites.

(7) Present Water Use by Affected Communities

1) Drinking and Domestic Water Use

Main water source for drinking and domestic water among communities is reservoir and/or pond followed by dug well particularly in dry season. People largely depend on rain water in the wet season as generally seen in rural areas.



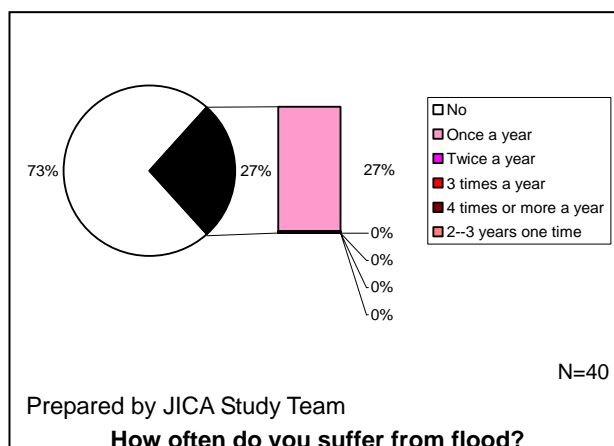
2) Irrigation Water Use

Damnak Ampil gate and main canal with the length of 7 km was constructed by MOWRAM in 2007. However, development of secondary and tertiary canals and drains still lag behind. Irrigation water is, therefore, not stably distributed within the command area. Instead, farmers are largely dependent on rainfall and flood water especially in the wet season. Interview survey asking for present source of irrigation water and method of irrigation is illustrated as follows showing that 70 % of the farmers primarily rely only on rainfall at present. Others mention some water is provided through irrigation facilities. Therefore, rehabilitation of irrigation facilities particularly promotion of secondary and tertiary canals development will surely contribute to the constancy of irrigation water supply in the Sub-project command area.

Under such conditions, farmers' groups are not functioning as a group for O&M of irrigation facilities and water management. Although, FWUC has been established, awareness and/recognition among farmers are quite low. In parallel with facilities rehabilitation, therefore, FWUC strengthening would be of critical importance for sustainable irrigation development and management.

3) Flood Condition

Although it would be difficult to control and regulate, flood water is also an important source of water for agriculture. Necessity of flood management is huge in any irrigation development. In accordance with the interview survey, current flood condition is illustrated on the right showing that 27 % of the people are suffering from flooding at once a year, water of which comes from the Pursat River. The asset damaged by flood is mostly reported to be paddy field.



(8) Workshop and Public Consultation

Workshop and public meetings were organized, in January 2008 to confirm community members' opinions toward the sub-project as well as environmental management for the formulation of the development plan.

**Participants of Workshop and Public Consultation**

No.	Organization	Participants
1.	National Counterparts and Steering Committee Member	Representative from MOWRAM (Department of Planning)
2.	Provincial Counterparts and Personnel Concerned	Chief of Meteorology Section, PDOWRAM Pursat
3.	Commune Councils	Chiefs and the members of the councils (7 members: Rolok Sar, Snam Preah and Khnar Toteung)
4.	JICA Study Team	Member of the Team
5.	Villagers	Villagers relevant to Damnak Ampil Rehabilitation Sub-Project (12 members: Damnak Ampil, Daob Bath, Khmar, Aren, Cheung Phleung, Thaak Tachab, Koh Krasaing, Krapeu Ro, Koh Wat, Koh Svay, Toul Ankraong and Kamprak Kon)

Prepared by JICA Study Team

Main issues discussed in the workshop are as follows:

- 1) Through the discussion, sub-project component consisting of: (i) rehabilitation of irrigation and drainage facilities, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities have been agreed by all the participants.1) NGOs' and/or donors' activities adhere to each commune rather than Sub-Project unit such as: (i) Racha, (ii) Abdo, (iii) SEILA Program etc. Management of community forest along the main canal is also supported by those groups.
- 3) A question was raised by the participant whether the sub-project under the Pre-F/S include extension area as proposed in the M/P. The Study Team replied that the necessity of revitalization of existing area needs to be firstly



Presentation of Opinion toward the Sub-Project Component at Damnak Ampil (January 31<sup>st</sup>, 2008)

put priority, then the construction of extension area are in the next step which would be in the second phase of the Road Map 2020. The participant agreed to the explanation.

- 4) The level of awareness for participation in irrigation O&M and water management have been assessed from the view points of: (i) participation in construction of tertiary facilities, (ii) participation in FWUCs' activities and (iii) participation in O&M of irrigation system. According to the results, awareness on participation in FWUCs' activities quite higher showing that all the participants have agreed to the participation in construction, FWUCs' activities and O&M.
- 5) It was confirmed that there are currently no serious environmental problems in and around the command area. Social environmental issues were rather considered in the meeting. At present, no secondary and tertiary level facilities. Instead, the areas for prospective canal alignment are partly utilized for cultivation. Although farmers have really understood that such activities are drawn up before the commencement of the construction works according to the discussion in the workshop, proper steps and mitigation measures are required for consensus building among relevant institutions and farmers. Consensus building for land acquisition is also important to promote development of the tertiary level facilities.

### 3.6 Wat Loung Rehabilitation Sub-Project

#### 3.6.1 Socio-Economic Condition

##### (1) Population, Community and Ethnicity

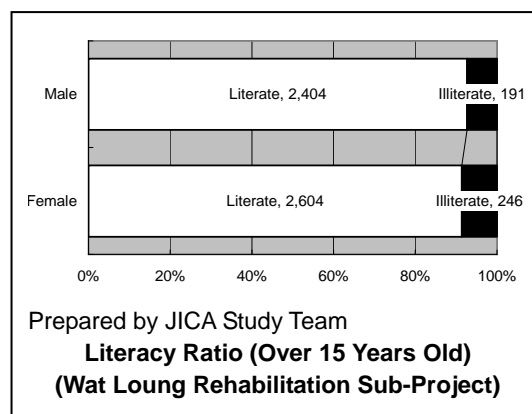
The Wat Loung Rehabilitation Sub-project covers Sampov Meas and Bakan Districts in Pursat Province primarily covering five communes: (i) Lolok Sar, (ii) Trapeang Chong, (iii) Snam Preah, (iv) Khnar Totueng and (v) Boeng Khnar. Total household under the command area approximately is 1,700 nos.

The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities under the Sub-project area.



(2) Education

Educational level of villagers are generally low as tabulate below, as over 60 % of farmers in the Sub-project area have had only “no formal education” and/or “drop-out at primary school.” On the other hand, the literacy rate in the villages is not necessarily low because of the religious and community-based activities.



**Education Career of Farmers**

N=40

Career Number & %	No Formal Education	Drop-out at primary school	Graduate from primary school	Drop-put at junior high school	Graduate from junior high school	Drop-out at high school	Graduate from high school	More than high school	Others
Number	6	17	10	2	2	2	0	0	1
Percentage	15.0 %	42.5 %	25.0 %	5.0 %	5.0 %	5.0 %	-	-	2.5%

Prepared by JICA Study Team based on Interview Survey carried out during the Study

(3) Health and Hazard

According to the interview survey to farmers, dengue, malaria, diarrhea etc. were pointed out as the commonly contracted diseases in the Sub-project area. Insufficient knowledge among communities about the diseases is one of the main reasons for expansion of those. On the other hand, lack of water source particularly in dry season would be the reason for diarrhea disease. Situation of access to health and medical services in the Sub-project area is shown as follows:

**When you/your family get/gets sick, where do you go?**

N=40

	Hospital	Clinic	Health Centre	Others
Number	0	1	39	0
Percentage	-	2.5%	97.5%	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Health Centre is the major medical facilities accessible to communities. Additionally, results of the interview survey show that no interviewees have some kind of social security service/insurance.

(4) Economic Condition

1) Main Economic Activity

As shown in the following table, all the interviewee under the Wat Loung Sub-project replied that the main economic activity is agriculture. Other activities observed in the community during field survey are: (i) collection of livestock raising, (ii) temporary workers for construction, (iii) kiosk selling vegetables and/or processed products for value-addition.



Buffalo Grazing in the Off-Cropping Season (February 2<sup>nd</sup>, 2008)

### Main Activity of the Household

N=40

	Farmer	On-farm Labor	Non-Farm Labor	Salary Worker	Private Business	Others
Number	37	0	2	0	1	0
Percentage	92.5 %	-	5.0%	-	2.5%	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

#### 2) Local Living Standard

Local living standard were rapidly assessed by way of poverty ranking and focal group discussion. Poverty level was classified into four: (i) Destitute (poorest), (ii) Poor, (iii) Fair, and (iv) Rich. The result is as follows showing that “Poor” and “Destitute” occupies 80 % of community members:

#### Income, its Source and Land Owned by Farmers at Wat Loung Rehabilitation Sub-project

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
Destitute	77	25%	0-2,000	Labor	0- 0.03
Poor	171	56.5%	2,000-5,000	Labor out of village and/or land owner	0.03-1
Fair	49	16.5%	5,000-10,000	Land owner farmer	1-3
Rich	6	2%	>10,000	Land Owner, Trader	3-5
Total	303	100%			

Prepared by JICA Study Team based on Workshop carried out during the Study

In relation to local economic conditions, land holding status was surveyed, results of which are as follows:

#### Status of Land Holding

N=40

	Owner Cultivator	Owner cum Sharecropper	Sharecropper	Owner cum Tenant	Tenant	Not Operating Any Farm
Number	39	0	0	1	0	0
Percentage	97.5 %	-	-	2.5%	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Owner cultivator occupies high percentage that 97.5 % of total farmers are categorized in “Owner Cultivator.”

#### 3) Community-based Organizations

Community-based organizations are one of the important engines for supporting economic activities. The following table shows community-based organizations in which farmers currently are involved.

#### Member of Community-based Organization

N=30

	FWUC and/or FWUG	Credit (Gov.)	Credit (NGOs)	Agriculture	Religion	Drinking Water	Market	Youth	Veteran	Women	No
Organization	0	0	0	0	0	0	0	0	3	0	37
Percentage	-	-	-	-	-	-	-	-	7.5%	-	92.5%

Prepared by JICA Study Team based on Workshop carried out during the Study

Community-based organization here is inactive in the Sub-project area. Since no water has been provided by deteriorated facilities, no FWUC and/or even water users' group are not existing.

### 3.6.2 Agriculture

#### (1) Present Land Use

The present land uses of the Wat Loung Rehabilitation Sub-project area are classified depending on current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including fields under rainfed condition) as follows;

**Present Land Use of the Sub-project Area**

Land Use Sub-category	Area		
	(ha)	(%)	(%)
Normal Irrigation Paddy Field	-	-	-
Supplemental Irrigation Paddy Field	130	5	-
Rainfed Paddy Field	2,590	95	-
Paddy Field Total	2,720	100	93
Right-of-ways	200	-	7
Sub-project Area	2,920	-	100

Prepared by JICA Study Team

As shown, irrigation water supply conditions in the Sub-project area are very poor and the paddy fields under rainfed conditions account for 95% of the total paddy fields in the area.

#### (2) Agro-demography and Land Holding

Agro-demographic and land holding features in the project communes (major communes located in the Sub-project area) estimated based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented as shown in the following table.

**Agro-demographic Features in the Project Communes in 2003**

Items	Average 1/	Range 1/
% of Farm Households to Total Households	90%	88 – 94%
%. of None Farm Households (No. of none crop producing households)	10%	6 – 12%
% of Farm Households Producing Wet Season Rice	100%	100%
Average Family Size (in 2005, SEILA Data Base)	5.2	5.1 – 5.5

1/: Average & range of Trapeang Chong, Snam Preah & Khnar Totueng Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA C commune Data Base, 2005

According to the Commune Survey, land tenure and holding statuses in the project communes are estimated as shown in the following table.

**Land Holding Features of the Project Communes in 2003**

Indicator	Average 1/	Range 1/
% of Landless Households	10%	6 – 12%
%. of Farm Households with Holding Size Less Than 10a	6%	0 – 15%
% of Farm Households with Holding Size More Than 3ha	16%	12 – 20%

1/: Average & range of Trapeang Chong & Snam Preah

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the rice cropped area in wet season, average holding size of paddy field is roughly estimated at 1.4 ha/farm as shown in Table 3.6-1. Proportion of land holding households having less than 0.1 ha is calculated at 6% and the same of more than 3 ha is at 16%.



(3) Crop Production in the Sub-project Area

1) General

Rice production in the Wat Loung Rehabilitation Sub-project area is characterized by low and unstable productivity mostly under rainfed conditions, prolonged rice cultivation season with the cultivation of rice varieties of different growth durations of medium to late and traditional farming practices as is the case in the other Sub-project areas. Rice cultivation in dry season by pump irrigation is practiced in a limited extent. Further, vegetable production in dry season is also practiced in paddy fields, basically under rainfed conditions. The summary sheet of the statistic data on rice production in the major communes are presented in Table 3.6-2 to 3.6-4.

2) Cropping Season and Variety

Rice cropping season in the Wat Loung Rehabilitation Sub-project area is similar to the same in the Damnak Ampil Rehabilitation Sub-project area and is almost exclusively wet season from July/August to November/January. Dry season rice cultivation is practiced from December to April/May in a limited extent. In the area, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Major varieties grown are as follows:

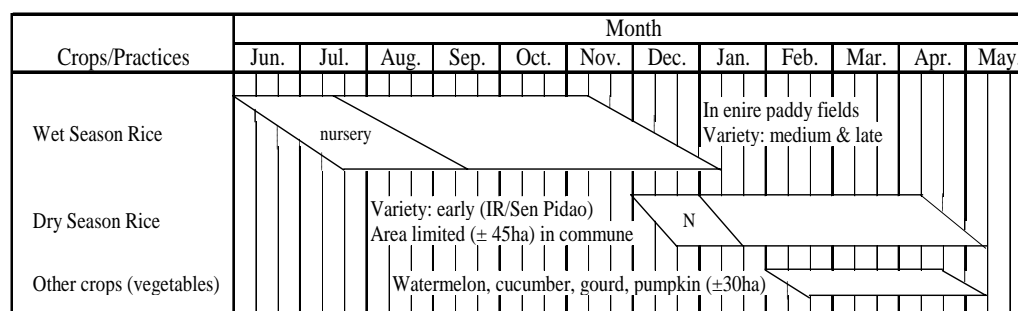
**Major Varieties Grown in the Sub-project**

Season	Growth Duration	Variety
Wet Season	Medium	Phka. Rumdoul, Phka Khney, Phka Mulis, Somali
	Late	Neang Pong, CAR 4
Dry Season	Early	IR, Sen Pidao

Prepared by JICA Study Team

3) Cropping Calendar and Pattern

The prevailing cropping calendar in the area estimated based on the interview survey results is illustrated as shown in the following figure.



Prepared by JICA Study Team

**Prevailing Cropping Calendar in Paddy Fields: Wat Loung Sub-project Area**

As stated earlier, a single cropping of wet season rice is an almost exclusive cropping pattern in the area because an extent of dry season rice cultivation is extremely limited. Cultivation of other crops such as watermelon, cucumber, gourd and pumpkin in paddy fields is practiced in dry season in limited extent as shown in the figure.

4) Cropped Area

The current cropped areas of rice and other crops in the Wat Loung Rehabilitation Sub-project area have been estimated based on the basis of various data and information and the findings of the field survey as follows:

**Estimated Cropped Area & Cropping Intensity in the Sub-project Area**

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	2,720	-	100
Dry Season	45	30	3
Annual	2,765	30	103

*Note: the extent of the sub-project area is being finalized*

Prepared by JICA Study Team

As shown in the table, the cropping intensity of rice is estimated at 100% in wet season. The overall annual cropping intensity in the paddy fields is estimated to be 103% including rice and other crops grown in the dry season.

5) Crop Yield and Production

Yields of paddy in the Wat Loung Rehabilitation Sub-project area are estimated based on the statistic data of PDA/DAO and SEILA Data Base, the results of interview surveys, Socio-economic Survey and Inventory Survey by JICA as shown in the following table.

**Estimated Paddy Yield & Production in the Sub-project Area**

Irrigation Status	Yield Level		Cropped Area		Production
	Wet Season	Dry Season	Wet Season	Dry Season	
Under Rainfed Condition	1.5 t/ha	-	2,590 ha	-	3,885 tons
Supplemental Irrigation 1/	2.0 t/ha	2.5 t/ha	130 ha	45 ha	373 tons
Total	-	-	2,720 ha	45 ha	4,258 tons

*1/: Including pumping irrigation in dry season.*

Prepared by JICA Study Team

The current yield level of paddy in wet season is estimated at around 1.5 ton/ha under rainfed condition and 2.0 ton/ha under supplemental irrigation and 2.5 ton/ha in dry season under pump irrigation. Current production of paddy in the area is estimated at 4,150 tons in wet season, 110 tons in dry season and 4,260 tons annually. Current yields of vegetables are estimated at watermelon 5.5 ton/ha and cucumber 6.0ton/ha based. The production volume of the crops is estimated at some 170 tons.

6) Prevailing Farming Practices

Some specific features of rice farming practices in the Wat Loung Rehabilitation Sub-project area are similar to those in the Damnak Ampil Sub-project area as follows;

**Prevailing Farming Practices in the Sub-project Area**

Practices	Prevailing Practices
Planting Method in Wet Season 1/	Transplanting 92% & direct sowing 8%
Land Preparation 1/	Hand tractor ±20% & draft animal ±80%
Variety in Wet Season	Both local & improved varieties

*1/: See Table 3.6-4*

Prepared by JICA Study Team

(4) Farm Machinery and Equipment

The inventory on farm machinery and equipment in the project communes is as follows;

**Inventory of Farm Machinery in the Project Communes in 2007**

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Big
13	118	600	38	274	9

Source: PDA Pursat

The number of hand tractors in the communes is substantial; however, land preparation work by draft animal is still prevailing practices. The number of water pumps is also substantial in the communes. The number of rice mills appears to be more than sufficient for milling demand because marketing of paddy is commonly carried out in the form of unhusked rice.



(5) Post-harvest and Marketing

Prevailing threshing method is by engine thresher of hiring service followed by pedal thresher and manual threshing in the Sub-project area. After threshing, paddies except for those kept for family consumption are generally marketed without drying partly because of insufficient drying space and no drying yard. Paddies for family consumption are sun-dried on plastic sheet in a home yard.

The results of the Socio-economic Survey indicate that prevailing marketing channels of paddy in the area are marketing to rice millers in commune centers followed by collectors at village level. A main marketing destination of other crops is markets at village level. Major constraints for paddy marketing identified through the Survey are unstable market prices of paddy followed by low market prices of paddy as is the case in other Sub-project areas.

(6) Current Capacity to Pay

The present farm economic analyses of the typical farms are presented in Table 3.6-5. As shown in the table, the current farm economy of the Type A (rainfed field) indicate net surplus (capacity to pay) of Riel 632,000 or 12% of the total income and the same of the Type B (supplemental irrigation) indicates net surplus of Riel 1,207,000 or 20% of the income. The current capacity to pay of the Type B farm is about 190% of the same of the Type A farm.

(7) Results of Socio-economic Survey

The results of the Socio-economic Survey are presented in a narrative manner in Table 3.6-6. Major constraints in rice farming identified are low paddy yield and irrigation water shortage even in wet season. Farmers expectations for farming and physical works (irrigation/drainage) are **productivity improvement of wet season rice** and **adequate irrigation water supply in wet season**, respectively.

### 3.6.3 Irrigation and Drainage

#### (1) Outline of the Existing Irrigation System

The Wat Loung Irrigation System was constructed along the left bank of the Pursat River in 1977 to irrigate about 7,000 ha. The system was damaged in 1979 and not functioning at present. The JICA Inventory Survey in 2006 has reported that the system is “mal function” and further more the number of structure is very limited at present. The JICA Study Team has also confirmed this situation. The inventory survey result is summarized in Table 3.6-7.

The area is located at right bank of Ou Bakan and Boeung Khnar River.

#### (2) Existing Irrigation Facilities



1. Ruins of pier of headworks in the Pursat River

2. Inlet of Wat Loung Main Canal

##### 1) Headworks

The headworks was constructed on the Pursat River in 1977, and was completely washed away by floods in 1979. At present only piers can be seen in the Pursat River (Photo 1). There is no intake structure at present. The inlet of the main canal seems to be abandoned during construction (Photo 2).

The existing site for headworks is located at 3.5 km downstream of the newly built Damank Ampil Weir by MOWRAM on the Pursat River in 2006. It seems that irrigation water supply from Damnak Ampil Weir is more economical than construction of the new headworks at the existing site.

##### 2) Canals

The existing main canal runs 17km from the existing intake site, on the left bank of the Pursat River, to northwestward and finally joins with Boeung Khnar River, at about 9km upstream of proposed site of Wat Chre Headworks. The hydraulic calculation reveals the main canal has a flow capacity of between 0.15 m<sup>3</sup>/sec and 1.0 m<sup>3</sup>/sec. The canal does not function well because water inflow from Pursat River is limited during flood time (Photos 3 to 5). The Sub-project is lack of secondary and tertiary canal systems.

The main canal bends to northward, and its canal base elevation declines gradually to northward.



**3. Main Canal: Beginning Point (BP)**



**4. Main Canal: 12.0 km from BP**



**5. Main Canal: End Point before flows to Boeung Khnar River**

The ground surface level of the western area is relatively lower than water level maintained by the Damnak Ampil Weir. Therefore, heightening of the dyke by one meter is necessary in the upper reach of the main canal, when the water level is raised at headworks.

3) Structures

There are no functioning structures in the Sub-project except for two bridges.

(3) Present irrigation water use, O&M, and FWUC

Detailed survey result on the present irrigation water use in the Sub-project area is referred to the section 3.6.1. At present, most of the farmers rely only on rain. They start paddy cultivation when their farm land become wet/ inundated by rain and/ or flood, accordingly, floods in the early stage of wet season are welcome by farmers. If a long drought occurs during the growing stage of paddy, farmers pump up water from canals or streams using small pumps.

No O&M activities have been recently executed by PDOWRAM, since it requires a full-scale rehabilitation of irrigation system with high cost. There is no registered FWUC or FWUGs in the Sub-project area.

(4) Drainage condition

Based on the topographic condition, the flood suffering area is assumed to be the area adjacent to upper reach of the main canal. The flood seems to mainly come from Pursat River through the existing Wat Loung main canal. Detailed survey result on the flood condition in the Sub-project area is referred to the section 3.6.1.

(5) Other problems

In the upstream of the Boeung Khnar River, there located four existing irrigation systems, which utilize water from the Boeung Khnar River. Of them, the Thnos Tachap system (1,200Ha approx.) is located in the most upstream and it can be irrigated by Wat Loung Sub-project owing to the topographic conditions. The runoff of the river is not enough for another three irrigation systems because its catchment area is relatively small and located in the plain area in which rainfall is less. Two irrigation systems i.e., Bakan and Krouchi Seuchi systems are able to receive water from secondary canals of Damnak Ampil Irrigation system in future. Wat Chre Sub-project is proposed to receive water from Damnak Ampil Headworks through Wat Loung Main Canal.

### 3.6.4 Environment

#### (1) Vegetation and Land Use

The present land use of the Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of: i) paddy fields with normal irrigation, ii) supplemental irrigation paddy field and iii) rainfed paddy field (including field under rainfed condition). Rainfed paddy field particularly in the wet season is the major land use in the Wat Loung command area.

#### (2) Wild Life

Wildlife are rarely observed in and around the Sub-project areas since the areas have been already cleared for agriculture particularly paddy cultivation. All the protected or conserved areas are located in the outside of Sub-project areas. There are no detailed information, however, wild animals observed in and around the area include: (i) wild pig, (ii) rabbits, (iii) some species of reptiles such as snakes and turtles in accordance with the field interview.

#### (3) Protected Areas

Figure 3.3-1 shows protected areas of the Pursat River Basin where the Wat Loung Sub-project is located. There are four protected areas: (i) Aural Wildlife Sanctuary, (ii) Phnom Samkos Wildlife Sanctuary, (iii) Tonle Sap Multiple Use Area and (iv) Cardamom Protected Forest situated in the Basin, characteristics of which are explained in the section 3.5.4.

There are no protected areas or conserved area within the command area of Wat Loung Rehabilitation Sub-project.

#### (4) Historical and Religious Sites

There are no archeological and/or historical significance in and/or around the Wat Loung Sub-project area.

#### (5) Noise and Air Quality

There is no data related with noise and air quality in and around Sub-project areas. It is conceivable that no serious noise pollution source exist in this area. In addition, as for air quality, only power generators of the private company and traffic particularly National Road No. 5 and access to the command area, distance of which is 10 km from the national road to the command area, would give negative impact to some extent. Those are, however, not serious at present.

#### (6) Water Quality

Water quality was preliminary assessed at two points, BP and midstream of existing main canal through field survey in the wet season, June 12<sup>th</sup>, 2008. The indicators analyzed are: (i) pH, (ii) Electric Conductivity (EC) and (iii) Total Dissolved Solid (TDS). The results are tabulated as follows:

### Result of Water Quality Analysis

Name	Sampling Point	Date	pH	EC ( $\mu\text{S}/\text{cm}$ )	TDS ( $\text{mg}/\text{l}$ )
Wat Loung Rehabilitation	BP of existing main canal	13-Jun-08	7.8	35.9	17.9
	Mid-stream of existing main canal	13-Jun-08	6.6	59.1	29.5
Water Quality Standard	River		6.5-8.5	None (<70 $\mu\text{S}/\text{cm}$ ) Slight to Moderate (70-300 $\mu\text{S}/\text{cm}$ ) Severe (>300 $\mu\text{S}/\text{cm}$ )	<450

Note: Water quality standard is given form relevant document as follows:

pH: Ministry of Environment (1999), Sub-decree on Water Pollution Control

EC and TDS: FAO (1994), Water Quality for Agriculture, Irrigation and Drainage Paper 29

Prepared by JICA Study Team based on field sampling and analysis

According to the relevant guidelines, all three parameters are within permissible level, and, thus, there were no concerns on salinity in the irrigation water.

#### (7) Present Water Use by Affected Communities

##### 1) Drinking and Domestic Water Use

Main water source for drinking and domestic water among communities is dug well and river followed by tube pipe well. People largely depend on rain water in the wet season as generally seen in rural areas.



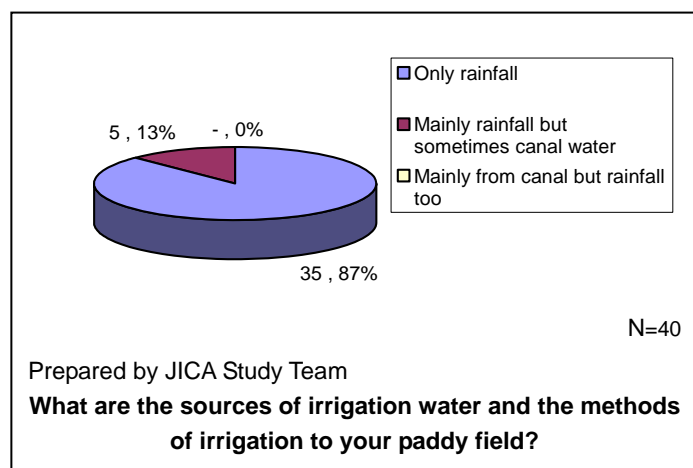
Beginning Point of Main Canal, since no Headworks, water inflows only in the flood period (February 2<sup>nd</sup>, 2008)

##### 2) Irrigation Water Use

Main canal was originally constructed during Pol Pot Regime, however, it is significantly deteriorated. No headworks have been established. In such situation, no water has been provided while water flows into the main canal only in the flood period in the wet season.

Instead, farmers are largely dependent on rainfall and flood water especially in the wet season.

Interview survey asking for present source of irrigation water and method of irrigation is illustrated as follows showing that 87 % of the farmers primarily rely only on rainfall at present. Others mention some water is provided through irrigation facilities. Therefore, rehabilitation of irrigation facilities particularly promotion of secondary and

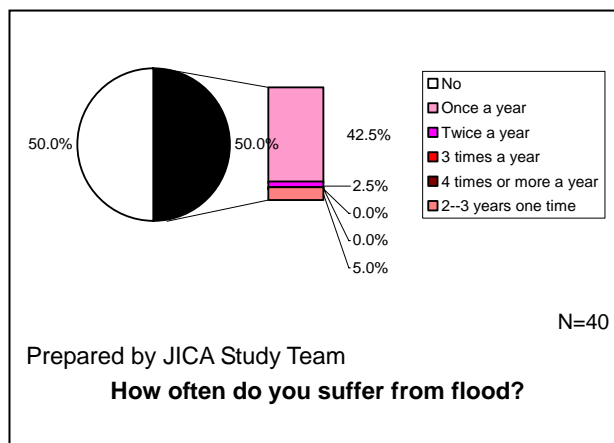


tertiary canals development will surely contribute to the constancy of irrigation water supply in the Sub-project command area.

Under such conditions, no farmers' group are there for O&M of irrigation facilities and water management. In parallel with facilities rehabilitation, therefore, FWUC strengthening would be of critical importance for sustainable irrigation development and management.

### 3) Flood Condition

Although it would be difficult to control and regulate, flood water is also an important source of water for agriculture in the Wat Loung Sub-project. Necessity of flood management is huge in any irrigation development. In accordance with the interview survey, current flood condition is illustrated on the right showing that 45 % of the people are suffering from flooding at least once a year, water of which comes from the Pursat River through the main canal. The asset damaged by flood is mostly reported to be paddy field.



### (8) Workshop and Public Consultation

Workshop and public meetings were organized, in February 2008 to confirm community members' opinions toward the sub-project as well as environmental management at the site for the formulation of the development plan.

#### Participants of Workshop and Public Consultation

No.	Organization	Participants
1.	National Counterparts and Steering Committee Member	Representative from MOWRAM (Department of Planning)
2.	Provincial Counterparts and Personnel Concerned	Chief of Meteorology Section, PDOWRAM Pursat
3.	Commune Councils	Chiefs and the members of the councils (6 members: Chamroeun Phal, Khnar Toteung, Trapiaing Choung and Rum Lech)
4.	JICA Study Team	Member of the Team
5.	Villagers	Villagers and village chiefs relevant to Wat Loung Rehabilitation Sub-Project (11 members: Kdey Kvav, Wat Loung, Chum Rum Siem, Bak Mek, Boeung Chhuk, Khnar Toteung, Damnak Toteung, Preh Chmback, Bou Stronge, Khvav, and Sdok Khla)

Prepared by JICA Study Team

Main issues discussed are as follows:

- 1) The result of participatory problem census, as tabulated below, shows that stable irrigation water supply is placed highest priority and of critical importance for farmers. Therefore, necessity of irrigation rehabilitation was justified from the view point of public opinion.



**Result of Participatory Problem Census by the Representative Farmers**

Rank	Problems	Problem Solution
I	Lack of water for irrigation	Request to <u>rehabilitate irrigation scheme</u> and need to participate for <u>FWUG to manage, operate and maintenance.</u>
II	Lack of capital for agriculture	Ask support from Authorities to coordinate with <u>the bank</u> for the farmer to be able to lend the money and can be <u>organized community help each other.</u>
III	Lack of techniques for agriculture	Ask support from the Ministry, Department and relevant institutions for the assistance to dispatch extension worker for agriculture to train the farmers
IV	Low cost of paddy, Insect destroyed	Request Government to find the market for agriculture products in Cambodia and/or outside the country.
V	Insect destroyed, Low cost of paddy	Ask support from Ministry, Department and Institutions related with the project to send extension worker for <u>agriculture to train the farmers</u> at the sites

Prepared by JICA Study Team based on Interview Survey carried out during the Study

- 2) Through the discussion, although the Study is at the pre-feasibility level, sub-project component consisting of: (i) rehabilitation of irrigation and drainage facilities, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities have been agreed by all the participants.
- 5) NGOs' and/or donors' activities adhere to each commune rather than Sub-Project unit such as: (i) Pon Leu Koma and (ii) Pak etc. DANIDA and ADB (Northwest Irrigation Sector Project) are also playing influential roles in institutional support for irrigation.
- 6) It was confirmed that there are currently no serious environmental problems in and around the command area. Social environmental issues were rather considered in the meeting. At present, no secondary and tertiary level facilities have been constructed. Instead, the areas for prospective main canal alignment are partly utilized for cultivation especially in the wet season. Farmers have really understood that such activities are drawn up before the commencement of the construction works according to the discussion in the workshop, however, proper steps and mitigation measures are required for consensus building among relevant institutions and farmers. Consensus building for land acquisition is also important to promote development of the tertiary level facilities.

### 3.7 Wat Chre Rehabilitation Sub-Project

#### 3.7.1 Socio-Economic Condition

##### (1) Population, Community and Ethnicity

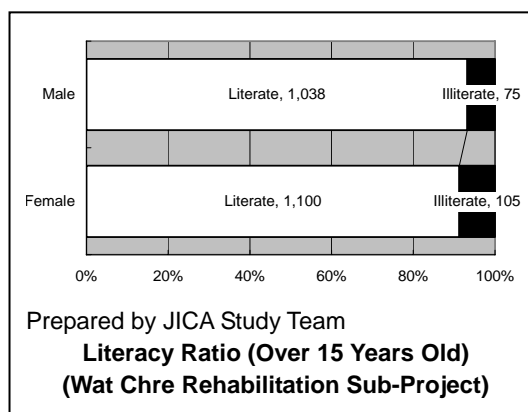
The Sub-project covers Bakan Districts in Pursat Province primarily covering two communes: (i) Boeung Khnar and (ii) Me Tuek. Total household under the command area approximately is 728 nos.

The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities under the Sub-project area.



##### (2) Education

Educational level of villagers are generally low as tabulated below, as most of farmers in the Sub-project area have had only “no formal education” and/or “drop-out at primary school.” On the other hand, the literacy rate in the villages is not necessarily low because of the religious and community-based activities.



#### Education Career of Farmers

Career Number & %	N=40								
	No Formal Education	Drop-out at primary school	Graduate from primary school	Drop-put at junior high school	Graduate from junior high school	Drop-out at high school	Graduate from high school	More than high school	Others
Number	10	17	5	6	0	2	0	0	0
Percentage	25.0%	42.5 %	12.5%	15.0%	-	5.0 %	-	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

##### (3) Health and Hazard

According to the interview survey to farmers, dengue, malaria, diarrhea etc. were pointed out as the commonly contracted diseases in the Sub-project area. Insufficient knowledge among

communities about the diseases is one of the main reasons for expansion of those. On the other hand, lack of water source particularly in dry season would be the reason for diarrhea disease. Situation of access to health and medical services in the Sub-project area is shown as follows:

**When you/your family get/gets sick, where do you go?**

N=40

	Hospital	Clinic	Health Centre	Others
Number	8	1	31	0
Percentage	20.0%	2.5%	77.5%	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Health Centre is the major medical facilities accessible to communities. Additionally, results of the interview survey show that no interviewees have some kind of social security service/insurance.

(4) Economic Condition

1) Main Economic Activity

As shown in the following table, all the interviewee under the Wat Chre Sub-project replied that the main economic activity is agriculture. Other activities observed in the community during field survey are: (i) collection of livestock raising, (ii) temporary workers for construction, (iii) kiosk selling vegetables and/or processed products for value-addition and (iv) noodle processing etc.



Rice Noodle Processing for Local Consumption (February 5<sup>th</sup>, 2008)

**Main Activity of the Household**

N=30

	Farmer	On-farm Labor	Non-Farm Labor	Salary Worker	Private Business	Others
Number	40	0	0	0	0	0
Percentage	100.0%	-	-	-	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

2) Local Living Standard

Local living standard were rapidly assessed by way of poverty ranking and focal group discussion. Poverty level was classified into four: (i) Destitute (poorest), (ii) Poor, (iii) Fair, and (iv) Rich. The result is as follows showing that “Poor” and “Destitute” occupies 71 % of community members:

**Income, its Source and Land Owned by Farmers at Wat Chre Rehabilitation Sub-project**

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
Destitute	211	29%	0-1,200	Labor	0-0.005
Poor	306	42%	1,200-2,000	Labor out of village and/or land owner	0.005-0.5
Fair	175	24%	2,000-5,000	Land owner farmer	0.5-1.5
Rich	36	5%	>5,000	Land Owner, Trader	1.5-4
Total	728	100%			

Prepared by JICA Study Team based on Workshop carried out during the Study

In relation to local economic conditions, land holding status was surveyed, results of which are as follows:

#### Status of Land Holding

N=30

	Owner Cultivator	Owner cum Sharecropper	Sharecropper	Owner cum Tenant	Tenant	Not Operating Any Farm
Number	37	0	0	3	0	0
Percentage	92.5 %	-	-	7.5%	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Owner cultivator occupies high percentage that 92.5 % of total farmers are categorized in “Owner Cultivator.”

### 3) Community-based Organizations

Community-based organizations are one of the important engines for supporting economic activities. The following table shows community-based organizations in which farmers currently are involved.

#### Member of Community-based Organization

N=30

	FWUC and/or Water Users' Group	Credit (Gov.)	Credit (NGOs)	Agriculture	Religion	Drinking Water	Market	Youth	Veteran	Women	No
Organization	0	0	0	0	1	0	0	0	4	0	35
Percentage	-	-	-	-	2.5%	-	-	-	10.0%	-	87.5%

Prepared by JICA Study Team based on Workshop carried out during the Study

Community-based organization here is inactive in the Sub-project area. Since no water has been provided by deteriorated facilities, no FWUC and/or even water users' group are not existing.

### 3.7.2 Agriculture

#### (1) Present Land Use

The present land uses of the Sub-project area are classified depending on current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including fields under rainfed condition) as follows:.

#### Present Land Use of the Sub-project Area

Land Use Sub-category	Area		
	(ha)	(%)	(%)
Normal Irrigation Paddy Field	-	-	-
Supplemental Irrigation Paddy Field	60	6	-
Rainfed Paddy Field	1,030	94	-
Paddy Field Total	1,090	100	93
Right-of-ways	80	-	7
Sub-project Area	1,170	-	100

Prepared by JICA Study Team

As shown in the tables, irrigation water supply conditions in the Sub-project area are very

poor and the paddy fields under rainfed conditions account for about 94% of the total paddy fields.

(2) Agro-demography and Land Holding

Agro-demographic and land holding features in the project communes (major communes located in the Sub-project area) estimated based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented as follows;

**Agro-demographic Features in the Project Communes in 2003**

Items	Average 1/	Range 1/
% of Farm Households to Total Households	93%	89 – 95%
%. of None Farm Households (No. of none crop producing households)	7%	5 – 11%
% of Farm Households Producing Wet Season Rice	97%	91 – 100%
Average Family Size (in 2005, SEILA Data Base)	5.4	5.2 - 5.7

1/: Average & range of Boeng Khnar, Me Tuek & Ou Ta Paong Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

According to the Commune Survey, land tenure and holding statuses in the project communes are estimated as shown in the following table.

**Land Holding Features of the project Communes in 2003**

Indicator	Average 1/	Range 1/
% of Landless Households	7%	5 – 11%
%. of Farm Households with Holding Size Less Than 10a	2%	0 – 5%
% of Farm Households with Holding Size More Than 3ha	18%	8 - 29%

1/: Average & range of Boeng Khnar, Me Tuek & Ou Ta Paong Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the rice cropped area in wet season, average holding size of paddy field is roughly estimated at 1.6 ha/farm as shown in Table 3.7-1. Proportion of land holding households having less than 0.1 ha is calculated at 2% and the same of more than 3 ha is at 18%.

(3) Crop Production in the Sub-project Area

1) General

Rice production is the most important agricultural activities in the Sub-project area and the same in the area is characterized by low and unstable productivity under rainfed conditions, prolonged cropping season and traditional farming practices. Rice cultivation in early wet and dry season is not practiced because of unavailability of irrigation water. Statistic data on rice production in the major communes are presented in Table 3.7-2 to 3.7-4.

2) Cropping Season and Variety

Rice cropping season in the area is similar to those in other Sub-project areas in the district and rice plants are grown from July/August to November/January in rainfed fields. In the area, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Major varieties grown are as follows:

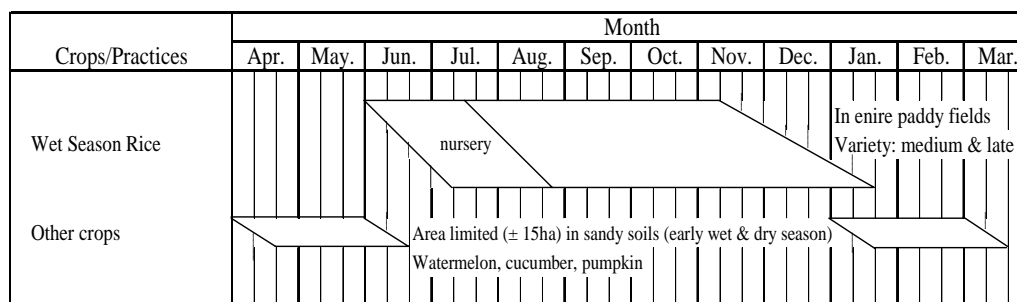
### Major Varieties Grown in the Sub-project Area

Season	Growth Duration	Variety
Wet Season	Medium	Phka. Rumdoul, Phka Khney, Phka Mulis
	Late	Neang Pong, Phka Sla

Prepared by JICA Study Team

### 3) Cropping Calendar and Pattern

The prevailing cropping calendar in the area estimated based on the interview survey results is illustrated as shown in the following figure.



Prepared by JICA Study Team

### Prevailing Cropping Calendar in Paddy Fields: Wat Chre Sub-project Area

As stated earlier, a single cropping of wet season rice is an exclusive cropping pattern in the area. Cultivation of other crops such as watermelon, cucumber and pumpkin in paddy fields is practiced both early wet and dry season in the area though in limited extent as shown in the figure.



### 4) Cropped Area

The current cropped areas of rice and other crops in the area have been estimated on the basis of various data and information and the findings of the field survey as summarized as follows;

#### Estimated Cropped Area & Cropping Intensity in the Sub-project Area

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	1,090	-	100
Early Wet Season	-	15	1.4
Dry Season	-	15	1.4
Annual	1,090	30	103

Prepared by JICA Study Team

As shown in the table, the cropping intensity of rice is estimated at 100% in wet season. The overall annual cropping intensity in the paddy fields is estimated to be 103% including other crops grown in the early wet and dry season.

### 5) Crop Yield and Production

Yields of paddy in the Sub-project area are estimated on the basis of the statistic data of PDA/DAO and SEILA Data Base, the results of interview surveys, Socio-economic Survey and Inventory Survey by JICA as shown in the following table.

### Estimated Paddy Yield & Production in the Sub-project Area

Irrigation Status	Yield Level		Cropped Area		Production
	Wet Season	Dry Season	Wet Season	Dry Season	
Under Rainfed Condition	1.5 t/ha	-	1,030 ha	-	1,545 tons
Supplemental Irrigation	2.0 t/ha	-	60 ha	-	120 tons
Total	-	-	1,090 ha	-	1,665 tons

Prepared by JICA Study Team

The current yield level of paddy in wet season is estimated at around 1.5 ton/ha under rainfed condition and 2.0 ton/ha under supplemental irrigation. Annual production of paddy in the area is estimated at 1,670 tons.

Current yields of vegetables are estimated at watermelon 5.5 ton/ha and cucumber 6.0ton/ha. The production volume of the crops is estimated at some 170 tons.

#### 6) Prevailing Farming Practices

Some specific features of rice farming practices in the area are as follows;

#### Prevailing Farming Practices in the Sub-project Area

Practices	Prevailing Practices
Planting Method in Wet Season 1/	Transplanting $\pm$ 90%
Land Preparation 2/	Hand tractor $\pm$ 40% & draft animal $\pm$ 60%
Variety in Wet Season	Both local & improved varieties

1/: Results of the interview survey with a commune office    2/: See Table 3.7-4

Prepared by JICA Study Team

#### (4) Farm machinery and Equipment

The inventory on farm machinery and equipment in the project communes is as follows;

#### Inventory of Farm Machinery in the Project Communes in 2007

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Big
42	177	454	65	247	10

Source: PDA Pursat

The number of tractors and hand tractors in the communes is substantial; however, land preparation work by draft animal is more common compared with the same by machinery. The number of water pumps is also substantial in the communes and the number of rice mills appears to be more than sufficient for milling demand because marketing of paddy is commonly carried out in the form of unhusked rice.

#### (5) Post-harvest and Marketing

Prevailing threshing method is by engine thresher of hiring service followed by pedal thresher in the Sub-project area. After threshing, paddies except for those kept for family consumption are generally marketed without drying partly because of insufficient drying space and no drying yard. Paddies for family consumption are sun dried on plastic sheet in a home yard and stored.

The results of the Socio-economic Survey indicate that the prevailing marketing channel of paddy in the area is marketing to village markets followed by village collectors. Major constraints for paddy marketing identified through the Survey are unstable market prices of

paddy followed by low market prices of paddy as is the case in other Sub-project areas.

(6) Current Capacity to Pay

The present farm economic analyses of the typical farms are presented in Table 3.6-5. As shown in the table, the current farm economy of the typical farm Type A (rainfed) indicate net surplus (capacity to pay) of Riel 670,000 or 14% of the total income and the same of the Type B (supplemental irrigation) indicates Riel 1,328,000 or 24% of the income. The current capacity to pay of the Type B farm is 198% of the same of the Type A farm.

(7) Results of Socio-economic Survey

The results of the Socio-economic Survey are presented in a narrative manner in Table 3.7-5. Major constraints in rice farming identified are low paddy yield and irrigation water shortage in dry season. Farmers expectations for farming and physical works (irrigation/drainage) are **productivity improvement of wet season rice and adequate irrigation water supply in wet season**, respectively.

### 3.7.3 Irrigation and Drainage

(1) Outline of the Existing Irrigation System

The system was constructed on the Boeung Khnar River to utilize the river water in 1977. The system was damaged between 1979 and 1980. The JICA Inventory Survey in 2006 has reported that the system is “mal function” and the number of structure is very limited at present. The JICA Study Team has also confirmed this situation. The inventory survey result is summarized in Table 3.7-6.

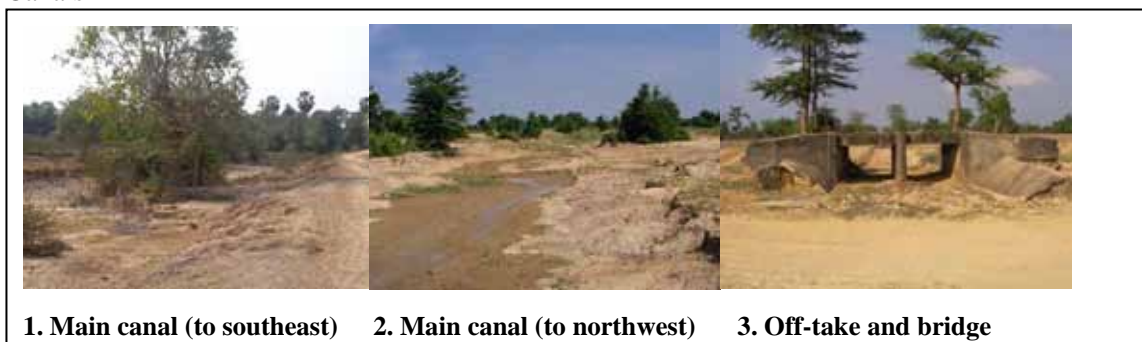
The area is divided into two areas i.e., eastern and western areas by the Boeung Khanr River. The eastern part is located along the right bank of the Boeung Khnar River with an area of about 1,000 ha. The western part is located on the left bank of the said river with an area of about 300 ha.

(2) Existing Irrigation Facilities

1) Headworks

The headworks does not exist at present, due to collapse and flash away caused by past floods. There is no intake structure to control water taking from the Boeung Khnar River.

2) Canals



Two main canals run from the headworks on the Boeung Khnar River to southeast and



northwest, respectively. The canal base of the former main canal is inclined upward to southeast in the first 1.2 km (Photo 1). The ground height in the eastern area is higher than water level at existing headwork site. The main canal bends at an angle of about 90 degrees to northward, with a gradual declination of the canal base. Based on this topographical condition, it is recommendable to shift new headwork site to the upstream of the present ruined weir site. It is also recommended to start a new main canal from new headwork to connect with the existing main canal, so that the canal with upward inclination is able to be used reversely as a secondary canal.

The ground surface along the latter main canal to northwest area is lower than water level maintained by the former ruined headworks (Photo 2)

### 3) Structures

There are no functioning structures in the Sub-project except for one bridge (Photo 3).

### (3) Present irrigation water use, O&M, and FWUC

Detailed survey result on the present irrigation water use in the Sub-project area is referred to the section 3.7.1. At present, most of the farmers rely only on rain. They start paddy cultivation when their farm land become wet/ inundated by rain and/ or flood, accordingly, floods in the early stage of wet season are welcome by farmers. If a long drought occurs during the growing stage of paddy, farmers pump up water from canals or streams using small pumps.

No O&M activities have been recently executed by PDOWRAM, since it requires a full-scale rehabilitation of irrigation system with high cost. There is no registered FWUC or FWUGs in the Sub-project area.

### (4) Drainage condition

The flood suffering area is assumed to be marsh located in the western rim area of the Sub-project. The ground elevation of the rim area seems to be very low less than EL.10.0m, and this area is excluded from the Sub-project. Detailed survey result on the flood condition in the Sub-project area is referred to the section 3.7.1.

The Boeung Khnar River is a natural main drain of the Sub-project area.

### (5) Other problems

Four irrigation systems are identified in the Boeung Khnar River including Wat Chre Sub-project, and the total irrigation area sums up to about 3,000 ha. The runoff mainly consists of drained water from Damnak Ampil Sub-project area, but is not enough for four irrigation systems because its catchment area is relatively small (300 km<sup>2</sup> approx.), and located in the plain area in which rainfall is less. A supplemental irrigation water supply is essential to the systems from Pursat River.

Wat Chre Sub-project is located at the most downstream of the Boeung Khnar River, and is quite apart and independent from the other irrigation systems. A few alternative routes should be considered to convey water from Damank Ampil Headwork to the Wat Chre Sub-project.

### 3.7.4 Environment

#### (1) Vegetation and Land Use

The present land use of the Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of: i) paddy fields with normal irrigation, ii) supplemental irrigation paddy field and iii) rainfed paddy field (including field under rainfed condition). Rainfed paddy field particularly in the wet season is the major land use in the Wat Chre Sub-project command area.

#### (2) Wild Life

Wildlife are rarely observed in and around the Sub-project areas since the areas have been already cleared for agriculture particularly paddy cultivation. All the protected or conserved areas are located in the outside of Sub-project areas. There are no detailed information, however, wild animals observed in and around the area include: (i) wild pig, (ii) rabbits, (iii) some species of reptiles such as snakes and turtles etc. in accordance with the field interview.

#### (3) Protected Areas

Figure 3.3-1 shows protected areas of the Pursat River Basin where the Wat Chre Sub-project is located. There are four protected areas: (i) Aural Wildlife Sanctuary, (ii) Phnom Samkos Wildlife Sanctuary, (iii) Tonle Sap Multiple Use Area and (iv) Cardamom Protected Forest situated in the Basin, characteristics of which are explained in the section 3.5.4

There are no protected areas or conserved area within the command area of Wat Chre Rehabilitation Sub-project.

#### (4) Historical and Religious Sites

There are no archeological and/or historical significance in and/or around the Wat Chre Sub-project area.

#### (5) Noise and Air Quality

There is no data related with noise and air quality in and around Sub-project areas. It is conceivable that no serious noise pollution source exist in this area. In addition, as for air quality, only power generators of the private company and traffic particularly national road No. 5 and access to the command area, distance of which is 7 km from the National Road No.5 to the command area, would give negative impact to some extent. Those are, however, not serious at present.

#### (6) Water Quality

Water quality was preliminary assessed through field survey in the wet season, June 13<sup>th</sup>, 2008. The indicators analyzed are: (i) pH, (ii) Electric Conductivity (EC) and (iii) Total Dissolved Solid (TDS). The results are tabulated as follows:

### Result of Water Quality Analysis

Name	Sampling Point	Date	pH	EC ( $\mu\text{S}/\text{cm}$ )	TDS ( $\text{mg}/\text{l}$ )
Wat Chre Rehabilitation	Existing intake weir	13-Jun-08	6.2	51.4	25.6
	Mid to down-stream of existing main canal	13-Jun-08	6.6	34.8	17.3
	Downstream of main canal	13-Jun-08	6.9	33.2	16.6
Water Quality Standard	River		6.5-8.5	None (<70 $\mu\text{S}/\text{cm}$ ) Slight to Moderate (70-300 $\mu\text{S}/\text{cm}$ ) Severe (>300 $\mu\text{S}/\text{cm}$ )	<450

Note: Water quality standard is given form relevant document as follows:

pH: Ministry of Environment (1999), Sub-decree on Water Pollution Control

EC and TDS: FAO (1994), Water Quality for Agriculture, Irrigation and Drainage Paper 29

Prepared by JICA Study Team based on field sampling and analysis

According to the relevant guidelines, a point, existing intake weir site, shows lower level of pH than that in standard. These would be possibly given from water stagnation and inflow of effluent from surrounding areas.

#### (7) Present Water Use by Affected Communities

##### 1) Drinking and Domestic Water Use

Main water source for drinking and domestic water among communities is dug well and tube pipe well followed by reservoir/pond. People largely depend on rain water in the wet season as generally seen in rural areas of Pursat Province.



Boeung Khnar River as one of the Domestic Water Source in the Community (February 5<sup>th</sup>, 2008)

##### 2) Irrigation Water Use

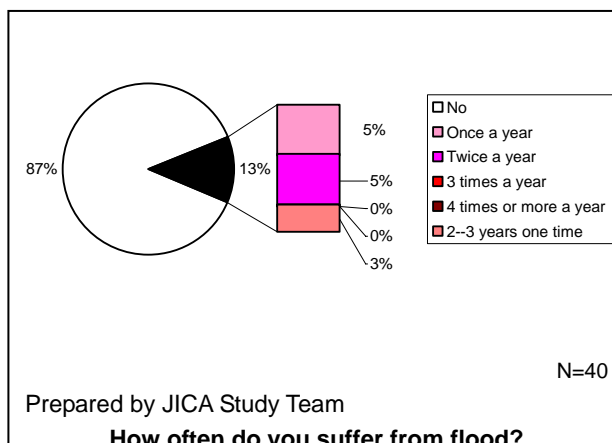
Headworks and main canal was originally constructed during Pol Pot Regime, however, it is significantly deteriorated. Also, water level of the main canal, therefore, water cannot be irrigated by gravity so that farmers along the canal sometimes use pump to obtain supplemental water from the canal for their farm. In addition, development of secondary and tertiary canals and drains still lag behind. Irrigation water is, therefore, not stably distributed within the command area. Instead, farmers are only dependent on rainfall and flood water especially in the wet season.

Interview survey asking for present source of irrigation water and method of irrigation is illustrated as follows showing that all the farmers rely only on rainfall at present. Therefore, rehabilitation of irrigation facilities particularly promotion of secondary and tertiary canals development will surely contribute to the constancy of irrigation water supply in the Sub-project command area.

Under such conditions, farmers' groups are not functioning as a group for O&M of irrigation facilities and water management. In parallel with facilities rehabilitation, therefore, FWUC strengthening would be of critical importance for sustainable irrigation development and management.

3) Flood Condition

Although it would be difficult to control and regulate, flood water is also an important source of water for agriculture. Necessity of flood management is huge in any irrigation development. In accordance with the interview survey, current flood



condition is illustrated on the right showing that 13 % of the people are suffering from flooding at once a year, water of which comes from the Boeung Khnar River. The asset damaged by flood is mostly reported to be paddy and vegetable field.

(8) Workshop and Public Consultation

Workshop and public meetings were organized in February 2008 to confirm community members' opinions toward the sub-project as well as environmental management at the site for the formulation of the development plan.

**Participants of Workshop and Public Consultation for Wat Chre Rehabilitation Sub-Project**

No.	Organization	Participants
1.	National Counterparts and Steering Committee Member	Representative from MOWRAM (Department of Planning)
2.	Provincial Counterparts and Personnel Concerned	Chief of Meteorology Section, PDOWRAM Pursat
3.	Commune Councils	Chiefs and the members of the councils (7 members: Boeung Khnar, Khnar Toteung, Svay Donkeo and O-Tapaong)
4.	JICA Study Team	Member of the Team
5.	Villagers	Villagers and village chiefs relevant to Wat Chre Rehabilitation Sub-Project (21 members: Prey Damrey, Rung, Prey Svay, Prey Phdav, Preh Malau, Trach Kraol, Sro Kar, Deum Chres, Chamka Leu, Khnach Romeas, Deum Roka, Kroch Saeuy, Phtas Sla, Kampang, Nikum, Chaob, Svay Donkeo, Phsa Andeth and Anlong Kray)

Prepared by JICA Study Team

Main issues discussed are as follows:

- 1) The result of participatory problem census, as tabulated below, shows that stable irrigation water supply is placed highest priority and of critical importance for farmers. Therefore, necessity of irrigation rehabilitation was justified from the view point of public opinion.

### Result of Participatory Problem Census by the Representative Farmers

Rank	Problems	Problem Solution
I	Lack of water for irrigation	Request to <u>rehabilitate irrigation</u> scheme
II	Lack of techniques for agriculture	Ask support from Ministry, Department and Institutional are related with the project to come for help, to send extension worker for <u>agriculture to train the farmers</u> at the sites.
III	Lack of participation	Need FWUG to participate in <u>the management, operation and maintenance</u> of the scheme.
IV	Lack of good production seed	Need support from Ministry, Department and Institutions related with the project to come for help, to provide <u>quality seed</u> to the farmers.
V	Lack of capital for agriculture	Ask support from Authorities to coordinate with the bank for the farmers to be able to lend the money and be organized community help each other.

Prepared by JICA Study Team

- 2) Through the discussion, although the Study is at the pre-feasibility level, sub-project component consisting of: (i) rehabilitation of irrigation and drainage facilities, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities have been agreed by all the participants.
- 3) NGOs' and/or donors' activities adhere to each commune rather than Sub-Project unit such as: (i) Pon Leu Koma, (ii) DANIDA, (iii) SEILA Program etc. particularly for small scale infrastructure development etc.
- 4) The level of awareness for participation in irrigation O&M and water management have been assessed from the view points of: (i) participation in construction of tertiary facilities, (ii) participation in FWUCs' activities and (iii) participation in O&M of irrigation system. According to the results, awareness on participation in all the activities are higher as similar to the Damnak Ampil Rehabilitation sub-project.
- 5) It was confirmed that there are currently no serious environmental problems in and around the command area. Social environmental issues were rather considered in the meeting. It is observed that the areas of main canal is partly utilized for cultivation and/or fishing. Although farmers have really understood that such activities are drawn up before the commencement of the construction works according to the discussion in the workshop, proper steps and mitigation measures are required for consensus building among relevant institutions and farmers. In addition, at present, no secondary and tertiary level facilities developed. Consensus building for land acquisition is also an important issue to promote development of the tertiary level facilities.



Production-Marketing Flow Identified through the Workshop at Wat Chre (February 4<sup>th</sup>, 2008)

### 3.8 Lum Hach Rehabilitation Sub-Project

#### 3.8.1 Socio-Economic Condition

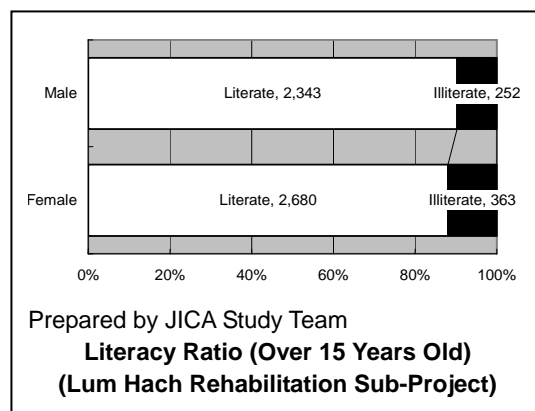
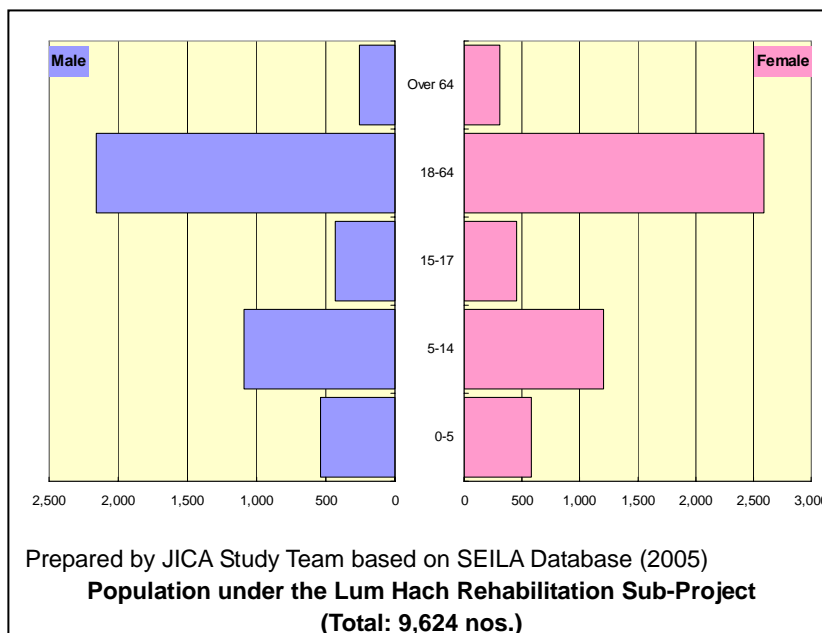
##### (1) Population, Community and Ethnicity

The Sub-project covers Boribo Districts in Kampong Chhnang Province covering four communes: (i) Krang Skear, (ii) Anchanh Rung, (iii) Prasneb and (iv) Phsar. Total household under the command area is approximately 2,066 nos.

The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities under the Sub-project area.

##### (2) Education

Educational level of villagers are generally low as tabulated below, as most of farmers in the Sub-project area have had only “no formal education” and/or “drop-out at primary school.” On the other hand, the literacy rate in the villages is not necessarily low because of the religious and community-based activities.



#### Education Career of Farmers

N=60

Career	No Formal Education	Drop-out at primary school	Graduate from primary school	Drop-put at junior high school	Graduate from junior high school	Drop-out at high school	Graduate from high school	More than high school	Others
Number & %									
Number	8	39	7	2	2	1	0	1	0
Percentage	13.3%	65.0 %	11.7%	3.3%	3.3%	1.7%	-	1.7%	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

##### (3) Health and Hazard

According to the interview survey to farmers, dengue, malaria, diarrhea etc. were pointed out as the commonly contracted diseases in the Sub-project area. Insufficient knowledge among

communities about the diseases is one of the main reasons for expansion of those. On the other hand, lack of water source particularly in dry season would be the reason for diarrhea disease. Situation of access to health and medical services in the Sub-project area is shown as follows:

**When you/your family get/gets sick, where do you go?**

N=60

	Hospital	Clinic	Health Centre	Others
Number	3	0	53	4
Percentage	5.0%	-	88.3%	6.7%

Prepared by JICA Study Team based on Interview Survey carried out during the Study

Health Centre is the major medical facilities accessible to communities. Additionally, results of the interview survey show that no interviewees have some kind of social security service/insurance.

(4) Economic Condition

1) Main Economic Activity

As shown in the following table, all the interviewee under the Lum Hach Sub-project replied that the main economic activity is agriculture. Other activities observed in the community during field survey are: (i) collection of livestock raising, (ii) temporary workers for construction and (iii) kiosk selling vegetables and/or processed products for value-addition etc.

**Main Activity of the Household**

N=60

	Farmer	On-farm Labor	Non-Farm Labor	Salary Worker	Private Business	Others
Number	57	1	0	0	0	2
Percentage	95.0%	1.7%	-	-	-	3.3%

Prepared by JICA Study Team based on Interview Survey carried out during the Study

2) Local Living Standard

Local living standard were rapidly assessed by way of poverty ranking and focal group discussion. Poverty level was classified into four: (i) Destitute (poorest), (ii) Poor, (iii) Fair, and (iv) Rich. The result is as follows showing that “Poor” and “Destitute” occupies 59 % of community members:

**Income, its Source and Land Owned by Farmers at Lum Hach Rehabilitation Sub-project**

Classification	Number of Family	Percentage	1. Income		2. Asset
			Average Income per day (Riels)	Source of Income (main economic activity)	Land (ha)
Destitute	186	9%	0-200	Labor	1
Poor	1,033	50%	200-500	Land owner farmer and/or Labor out of village	1 – 1.5
Fair	764	37%	500-1500	Land owner farmer	1.5 - 5
Rich	83	4%	>1500	Land Owner, Trader	>5
Total	2,066	100%			

Prepared by JICA Study Team based on Workshop carried out during the Study

In relation to local economic conditions, land holding status was surveyed, results of which are as follows:

### Status of Land Holding

N=60

	Owner Cultivator	Owner cum Sharecropper	Sharecropper	Owner cum Tenant	Tenant	Not Operating Any Farm
Number	60	0	0	0	0	0
Percentage	100.0%	-	-	-	-	-

Prepared by JICA Study Team based on Interview Survey carried out during the Study

All the farmers are categorized into “owner cultivator.”

### 3) Community-based Organizations

Community-based organizations are one of the important engines for supporting economic activities. The following table shows community-based organizations in which farmers currently are involved.

### Member of Community-based Organization

N=60

	FWUC and/or Water Users' Group	Credit (Gov.)	Credit (NGOs)	Agriculture	Religion	Drinking Water	Market	Youth	Veteran	Women	No
Organization	0	0	0	0	0	0	0	0	0	0	60
Percentage	-	-	-	-	-	-	-	-	-	-	100.0%

Prepared by JICA Study Team based on Workshop carried out during the Study

Community-based organization here is inactive in the Sub-project area. Since no water has been provided by deteriorated facilities, no FWUC and/or even water users' groups do not exist.

### 3.8.2 Agriculture

#### (1) Present Land Use

The present land uses of the Sub-project area are classified depending on current irrigation statuses into 2 sub-categories of: i) supplemental irrigation paddy field and ii) rainfed paddy field (including fields under rainfed condition) as follows;

### Present Land Use of the Sub-project Area

Land Use Sub-category	Area		
	(ha)	(%)	(%)
Normal Irrigation Paddy Field	-	-	-
Supplemental Irrigation Paddy Field	200	6	-
Rainfed Paddy Field	3,120	94	-
Paddy Field Total	3,320	100	93
Right-of-ways	250	-	7
Sub-project Area	3,570	-	100

Prepared by JICA Study Team

As shown in the tables, irrigation water supply conditions in the Sub-project area are very



poor and the paddy fields under rainfed conditions account for about 94% of the total paddy fields in the area.

(2) Agro-demography and Land Holding

Agro-demographic and land holding features in the project communes (major communes located in the Sub-project area) estimated based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented as follows;

**Agro-demographic Features in the Project Communes in 2003**

Items	Average 1/	Range 1/
% of Farm Households to Total Households	98%	95 - 100%
%. of None Farm Households (No. of none crop producing households)	3%	0 – 5%
% of Farm Households Producing Wet Season Rice 2/	-	100%
Average Family Size (in 2005, SEILA Data Base)	4.5	4.4 - 4.5

1/: Average & range of Anhchanh Rung & Phase Commune 2/: Only for Inching Rung Commune

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

According to the Commune Survey, land tenure and holding statuses in the project communes are estimated as shown in the following table.

**Land Holding Features of the Project Communes in 2003**

Indicator	Average 1/	Range 1/
% of Landless Households	3%	0 – 5%
%. of Farm Households with Holding Size Less Than 10a	0%	0%
% of Farm Households with Holding Size More Than 3ha	2%	0 - 3%

1/: Average & range of Anhchanh Rung & Phase

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at about 1.4 ha as shown in Table 3.8-1. There exist no farm households with land holding size less than 0.1 ha and the same of more than 3 ha is at 2%, which suggest rather even land holding status in the Sub-project area compared with the holding statuses in other Sub-project areas.



(3) Crop Production in the Sub-project Area

1) General

Rice production is the most important agricultural activities in the Sub-project area and it is characterized by low and unstable productivity under rainfed conditions or nearly rainfed conditions in coarse textured soils, prolonged cropping season and traditional farming practices as is the case in the other Sub-projects. Rice cultivation in the early wet and dry season is not practiced currently. The summary sheet of the statistic data on rice production in the major communes are presented in Table 3.8-2 and 3.8-3.

2) Cropping Season and Variety

Rice cropping seasons in the Sub-project area is similar to those in the Sub-project areas in Balkan District and rice plants are grown from July/August to November/December under rainfed conditions. A number of rice varieties are cultivated and cropping seasons vary

substantially depending on varieties grown. Major varieties grown in the area are as follows;

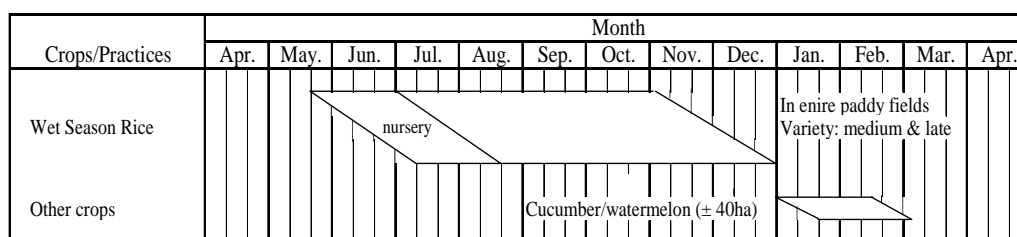
### Major Varieties Grown in the Sub-project Area

Season	Growth Duration	Variety
Wet Season	Early	Sen Pidao
	Medium	Phka Rumduol, Phka Samley, Phka Sla
	Late	CAR 4, Neang Sor

Prepared by JICA Study Team

### 3) Cropping Calendar and Pattern

The prevailing cropping calendar in the area estimated based on the interview survey results is illustrated as shown in the following figure.



Prepared by JICA Study Team

### Prevailing Cropping Calendar in Paddy Fields: Lum Hach Sub-project Area

A single cropping of wet season rice is an exclusive cropping pattern in the area as shown.

### 4) Cropped Area

The current cropped areas of rice and other crops in the area have been estimated based on the basis of various data and information and the findings of the field survey as summarized below.

### Estimated Cropped Area & Cropping Intensity in the Sub-project Area

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	3,320	-	100
Early Wet Season	-	40	1
Annual	3,320	40	101

*Note: the extent of the sub-project area is being finalized*

Prepared by JICA Study Team

As shown in the table, the cropping intensity of rice is estimated at 100% in wet season. The overall annual cropping intensity in paddy fields is estimated to be 101% including other crops grown in dry season.

### 5) Crop Yield and Production

Yields of paddy in the Sub-project area are estimated on the basis of the statistic data of PDA/DAO and SEILA Data Base, the results of interview surveys, Socio-economic Survey and Inventory Survey by JICA as shown in the following table.

### Estimated Paddy Yield & Production in the Sub-project Area

Irrigation Status	Yield Level		Cropped Area		Production
	Wet Season	Dry Season	Wet Season	Dry Season	
Under Rainfed Condition	1.2 t/ha	-	3,120 ha	-	3,744 tons
Supplemental Irrigation	1.7 t/ha	-	200 ha	-	340 tons
Total	-	-	3,320 ha	-	4,084 tons

Prepared by JICA Study Team

The current yield level of paddy in wet season is estimated at around 1.2 ton/ha under rainfed condition and 1.7 ton/ha under supplemental irrigation. Current annual production of paddy in the area is estimated at 4,100 tons.

Current yield of other crops are estimated at watermelon 5.5 ton/ha and cucumber 6.0 ton/ha and the production volume of the crops is estimated at some 230 tons.

#### 6) Prevailing Farming Practices

Farming practices of rice in the Sub-project area are characterized by: i) cultivation of improved variety (Phka Rumduol) commonly practiced, ii) transplanting exclusively employed for planting and iii) prevailing of land preparation by draft animal to mechanical land preparation.

#### (4) Farm machinery and Equipment

The inventory on farm machinery and equipment in the project communes is presented below.

#### Inventory of Farm Machinery in the Project Communes in 2007

Tractor	Hand	Water	Engine	Rice Mill	
	Tractor	Pump	Thresher	Small	Big
0	41	146	10	147	0

Source: PDA Kampong Chhnang

Land preparation works by draft animal are predominant practices in the area. The number of rice mills appears to be more than sufficient for milling demand because marketing of paddy is commonly carried out in the form of unhusked rice.

#### (5) Post-harvest and Marketing

Different from other Sub-project areas, manual threshing is prevailing in the Sub-project area followed by use of engine thresher under hiring service. After threshing, paddies except for those kept for family consumption are generally marketed without drying soon after harvest partly because of insufficient drying space and no drying yard. Paddies for family consumption are sun dried on plastic sheet in a home yard and stored.

According to the results of interview with the project commune office (Anchang Rung), the prevailing marketing channel of paddy is marketing to village collectors. The local collectors market paddy to wholesalers or to rice millers. However, because of limited holding size of paddy field and low productivity of paddy, market surplus of paddy is limited.

Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy as is the case in other Sub-project areas.

The number of sizable rice miller in the project district is limited to one. Major constraints reported by the rice miller are: i) difficulty to procure sun-dried paddy because field dried paddies are procured by Viet Nam buyers and ii) no drying facility to dry wet paddies.

(6) Current Capacity to Pay

The farm economic analyses of the typical farms are presented in Table 3.6-5. As shown in the table, the current farm economy of the typical farm Type A (rainfed field) indicate net surplus (capacity to pay) of Riel 266,000 or 9% of the total income and the same of the Type B (supplemental irrigation) indicates net surplus of Riel 842,000 or 23% of the income.

(7) Results of Socio-economic Survey

The results of the Socio-economic Survey are presented in a narrative manner in Table 3.8-4. Major constraints in rice farming identified are low paddy yield and irrigation water shortage in dry season. Farmers expectations for farming and physical works (irrigation/drainage) are **productivity improvement of wet season rice and adequate irrigation water supply in wet season**, respectively.

### 3.8.3 Irrigation and Drainage

(1) Outline of the Existing Irrigation System

The system was constructed on the Boribo River to utilize river water between 1976 and 1977. The system was damaged between 1981 and 1982, and is functioning in the very limited area of less than 300 ha. The JICA Inventory Survey in 2006 has reported that more than 30 irrigation sub-systems are mixed up under the name of Lum Hach Irrigation System; these sub-systems are irrigated by many rivers including the Boribo River. However, the system is “partly functioning” and the JICA Study Team has also confirmed this situation. The inventory survey result is summarized in Table 3.8-5.

Two major irrigation systems i.e., O Rolus Irrigation System and Lum Hach Irrigation System are irrigated by the Boribo River. The O Roluss Irrigation System (3,400 ha) is located along the left bank of the Boribo River. The main water source is expected from the Boribo River because the O Roluss stream has a very small catchment area (12.8 km<sup>2</sup>). The rehabilitation work of the O Roluss Irrigation System has been conducted since 2006 by MOWRAM/PDOWRAM. Therefore, the present study on the Lum Hach Sub-project concentrates on the irrigation area located along the right bank of the Boribo River. In terms of the water distribution, the present Study considers direct water distribution to both the Lum Hach Sub-project and the O Roluss Irrigation System, respectively.

(2) Existing Irrigation Facilities

1) Headworks

The former headworks was constructed in the Boribo River in order to raise water level in the river as well as to create a small storage in the river. The former headworks however, was completely washed away, probably due to its unstable and not preferable location from the technical point of view, i.e., the river course bends at an angle of nearly 90 degrees, and the riverbed declines at rather steep inclination. Therefore, for a new headworks, it is important to

carefully chose a site that is stable and technically preferable.



### Candidate Site for New Lum Hach Headworks

In this Study, a candidate site for headworks has been proposed at about 500m upstream of the former site (photo above). The proposed headwork site has a wide area in the upstream, which can be used for storage. Based on the preliminary topographic survey by the Study Team, the relationship for Water level-Area-Volume is assumed to be as follows:

#### Water level – Area - Volume Relationship

Ground level (EL. m)	35.0	36.0	37.0	38.0	39.0	40.0	41.0	50.0
Area (Ha)	14	33	57	101	143	640	820	2,450
Volume (10 <sup>6</sup> m <sup>3</sup> )	0.09	0.33	0.78	1.57	2.79	6.7	14.0	161.2

Note: The figures higher than EL.40.0 m are assumed from the topographic map with a scale of 1 to 100,000 with 10 m contour interval.

River length=3.5 km, average width of the river route=20 m

There is no intake structure to control water taking from the Boribo River. New intake structures are to be constructed as a part of the new headworks for both the Lum Hach Sub-project and the O Roluss Irrigation System.

According to the preliminary topographic survey results, around 40 households are living in the upstream area of the new proposed headworks, and their residential areas are located at the elevation of EL.40.0 m or more. The area below EL.40.0 m consists of paddy field, pasture land/flood plain, and water-route.

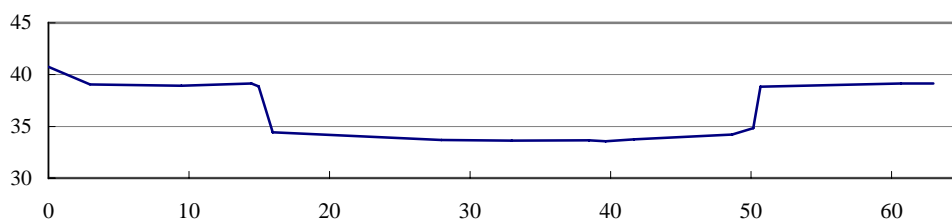
## 2) Canals

A main canal, namely 7th January Canal, was constructed with a total length of 27 km to convey water from the Boribo River, also to harvest water from independent small streams. However, this main canal has been left unused due to collapse of the former headworks.

The elevation of existing main canal base is EL.36.6 m at the beginning point (herein after called as B.P.). Due to high elevation of the canal base and no water level control structure in the river, river water hardly flows into the main canal at present. It has canal base with an gradual upward inclination as it goes to downstream, i.e., canal base elevation of EL.38.0 m at the cumulative distance of 3.1 km from B.P.

Along the 7th January Canal, dispersible soil can be observed in the first upper 1.3 km from the BP. At a cumulative distance of BP. + 750, the width of the canal section reaches up to 50 m and the bank height ranges from 5.0 m to 8.0 m. Moreover, on its left bank there exist a large opening, that seems to be one of the old river courses of the Ou Lea Pong. This wide cross section is able to be used as a kind of retarding pond/ storage to regulate flow in the

main canal.



Prepared by JICA Study Team based on topographic survey by the JICA Study Team

### **Cross Section at B.P.+750 m**

Two existing secondary canals branch from the main canal in the Sub-project area proposed.

The existing secondary canal No. 1 branches at 0.77 km downstream of the B.P. of the existing main canal. The canal is used as a secondary canal in the Sub-project with rehabilitation. The ground elevation ranges from EL.38.0m to EL.39.3m. The existing secondary canal No. 2 branches at 3.1km from the B.P. of the existing main canal. The canal is to be rehabilitated and expanded, and to be used as the downstream part of the proposed main canal of the Sub-project in order to cover all irrigation areas in the downstream. However, paddy field elevation ranges from EL.39.3 m to EL. 35.0 m in the upstream reach of 2 km.

#### 3) Structures

An existing off-take structure on the existing Secondary Canal No.1 is extraordinary large for the irrigation area, and gate sill elevation is higher than that of the main canal by more than 2.0 m. The structure should be removed and a new off-take structure is to be constructed. There is a check structure in the main canal at the cumulative distance of 3.1 km; at which gates are not installed, and structure is seriously deteriorated. This location is to be the end of the proposed main canal. A new end structure is to be added to the existing structure. Bridges and culverts exist and fairly functioning in the secondary canal. Many additional structures are to be constructed by the Sub-project.

#### (3) Present irrigation water use, O&M, and FWUC

Detailed survey result on the present irrigation water use in the Sub-project area is referred to the section 3.8.1. At present, most of the farmers rely only on rain. They start paddy cultivation when their farm land become wet/ inundated by rain and/ or flood, accordingly, floods in the early stage of wet season are welcome by farmers. If a long drought occurs during the growing stage of paddy, farmers pump up water from canals or streams using small pumps.

No O&M activities have been recently executed by PDOWRAM, since it requires a full-scale rehabilitation of irrigation system with high cost. There is no registered FWUC or FWUGs in the Sub-project area.

#### (4) Drainage condition

Drainage or flood problems are not serious in the Sub-project area. Detailed survey result on the flood condition in the Sub-project area is referred to the section 3.8.1.

There are two drainage canals in the Sub-project area at present though they are not reported in the JICA Inventory 2006. Those drains seem to have double function; of irrigation and drainage. The total length of the two existing drains is assumed at 6.0 km, respectively. The existing drains finally flow into the Boribo River at the downstream edge of the Sub-project area. The Boribo River, however, sometimes intrudes to the drains and causes inundation in the Sub-project area when the water level is high in the river. A water control structure should be provided at the confluence.

(5) Other problems

The main rural roads are in fair condition except for wet season. In wet seasons, rural roads get muddy and are not able to use even by 4WD vehicle. Establishment of a stable farm road network is necessary for transportation of agriculture input and output. The existing canal inspection roads are to be rehabilitated and paved for farm roads.

### 3.8.4 Environment

(1) Vegetation and Land Use

The present land use of the Sub-project area is paddy field under different irrigation statuses. Accordingly, the land use of the area has been classified based on current irrigation statuses into 2 sub-categories of: i) paddy fields with normal irrigation, ii) supplemental irrigation paddy field and iii) rainfed paddy field (including field under rainfed condition). Rainfed paddy field particularly in the wet season is the major land use in the Lum Hach Sub-project command area.

(2) Wild Life

Wildlife are rarely observed in and around the Sub-project areas since the areas have been already cleared for agriculture particularly paddy cultivation. All the protected or conserved areas are located in the outside of Sub-project areas. There are no detailed information, however, wild animals observed in and around the area include: (i) wild pig, (ii) rabbits, (iii) some species of reptiles such as snakes and turtles in accordance with the field interview.

(3) Protected Areas

Figure 3.3-1 shows protected areas of the Boribo River Basin where the Lum Hach Sub-project is located. In Boribo River Basin, There are two protected areas: (i) Aural Wildlife Sanctuary and (ii) Tonle Sap Multiple Use Area, characteristics of which are tabulated as follows:

**Protected Area in Boribo River Basin**

Protected Area	Province	Total Area (ha) (Area in Basin, %)	Relevance with Basin Irrigation	Some Unique Characteristics
Aural Wildlife Sanctuary	Kampong Chhnang Province	253,750 (68,500, 27.0 %)	The upstream of irrigation systems in southern basin area	Highest mountain (1743m) in Cambodia with a wide diversity of vegetation ranging from dry Dipterocarpus / Podocarpus forest to medium altitude evergreen forest.
Tonle Sap Multiple Use Area	Kampong Chhnang Province	316,250 (12,600, 4.0 %)	The downstream of irrigation systems in northern part of basin	Long-standing ichthyological reserve. Great biological, hydrological and cultural/economic

Protected Area	Province	Total Area (ha) (Area in Basin, %)	Relevance with Basin Irrigation	Some Unique Characteristics
				importance.

Prepared by JICA Study Team based on Ministry of Environment (2004), State of Environment Report

Aural Wildlife Sanctuary is located in the upstream of the Sub-project, therefore, there would be no serious impact through irrigation development in the basin. On the other hand, Tonle Sap Multiple Use Area is in the downstream of the Sub-project. Increase of usage in fertilizer and pesticide generally seen through promoting irrigation development would possibly more or less affect water quality, if inappropriate and excessive application is carried out.

On the other hand, there are no protected areas or conserved area within the command area of Lum Hach Rehabilitation Sub-project.

(4) Historical and Religious Sites

There are no archeological and/or historical significance in and/or around the Lum Hach Sub-project area.

(5) Noise and Air Quality

There is no data related with noise and air quality in and around Sub-project areas. It is conceivable that no serious noise pollution source exist in this area. In addition, as for air quality, only power generators of the private company and traffic particularly National Road No. 5 and access to the command area, distance of which is 20 km from the national road to the command area, would give negative impact to some extent. Since the road condition in the command area is comparatively poor, traffic is observed inactive. Their impacts on noise and air quality in the command area are, therefore, not serious at present.

(6) Water Quality

Water quality was preliminary assessed through field survey in the wet season, June 12<sup>th</sup>, 2008. The indicators analyzed are: (i) pH, (ii) Electric Conductivity (EC) and (iii) Total Dissolved Solid (TDS). The results are tabulated as follows:

**Result of Water Quality Analysis**

Name	Sampling Point	Date	pH	EC (μS/cm)	TDS (mg/l)
Lum Hach Rehabilitation	Upstream of existing wooden check structure	14-Jun-08	7.2	29.6	14.6
	Mid-stream of main canal	14-Jun-08	6.9	32.5	16.0
	Downstream of main canal	14-Jun-08	6.2	25.1	12.3
Water Quality Standard	River		6.5-8.5	None (<70 μS/cm) Slight to Moderate (70-300 μS/cm) Severe (>300μS/cm)	<450

Note: Water quality standard is given from relevant document as follows:

pH: Ministry of Environment (1999), Sub-decree on Water Pollution Control

EC and TDS: FAO (1994), Water Quality for Agriculture, Irrigation and Drainage Paper 29

Prepared by JICA Study Team based on field sampling and analysis



According to the relevant guidelines, a point, downstream of main canal, shows lower level of pH than that in standard. These would be possibly given from water stagnation and inflow of effluent from surrounding areas including fish pond in the main canal areas.

(7) Present Water Use by Affected Communities

1) Drinking and Domestic Water Use

Main water source for drinking and domestic water among communities is dug well on which nearly 90 % of the respondents depend in both dry and wet season. Percentage of the people using river water for drinking and domestic purpose would be limited under the Sub-project.



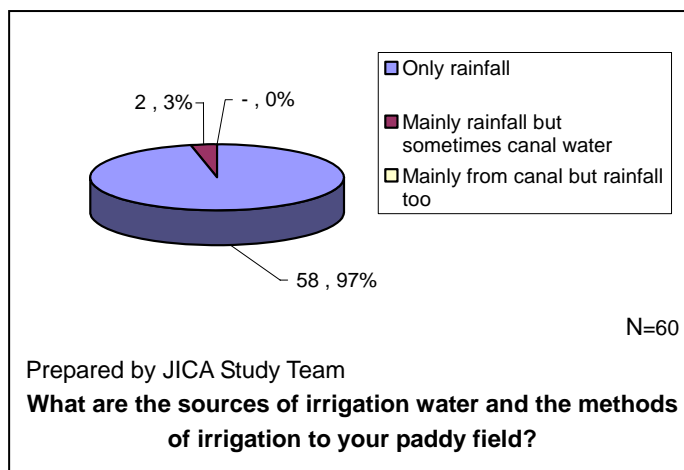
Existing Makeshift Check Structure Constructed by Community Members (January 29<sup>th</sup>, 2008)



Upland, not Irrigated by Gravity (January 29<sup>th</sup>, 2008)

2) Irrigation Water Use

There is only makeshift check structure at the most upstream of the Sub-project, therefore, water cannot be controlled for irrigation. Also, water level of the main canal, therefore, water cannot be irrigated by gravity so that farmers along the canal sometimes use pump to obtain supplemental water from the canal for their farm. In addition, development of secondary and tertiary canals and drains still lag behind. Irrigation water is, therefore, not stably distributed within the command area. Instead, farmers are only dependent on rainfall and flood water especially in the wet season.

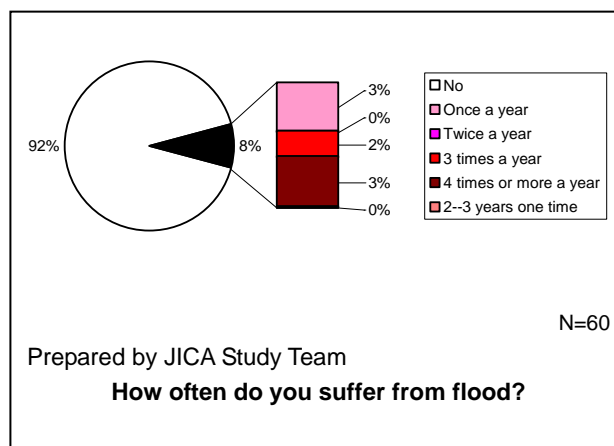


Interview survey asking for present source of irrigation water and method of irrigation is illustrated as follows showing that nearly all the farmers rely only on rainfall at present. Therefore, rehabilitation of irrigation facilities particularly promotion of secondary and tertiary canals development will surely contribute to the constancy of irrigation water supply in the Sub-project command area.

Under such conditions, farmers' groups are not functioning as a group for O&M of irrigation facilities and water management. Although, FWUC has been established, awareness and/recognition among farmers are quite low. In parallel with facilities rehabilitation, therefore, FWUC strengthening would be of critical importance for sustainable irrigation development and management.

### 3) Flood Condition

Although it would be difficult to control and regulate, flood water is also an important source of water for agriculture. Necessity of flood management is huge in any irrigation development. In accordance with the interview survey, current flood condition is illustrated on the right showing that 8 % of the people are suffering from flooding at least once a year, water of which comes from the Boribo River. The asset damaged by flood is mostly reported to be paddy field.



### (8) Workshop and Public Consultation

Workshop and public meetings were organized in January 2008 to confirm community members' opinions toward the sub-project as well as environmental management at the site for the formulation of the development plan.

#### Participants of Workshop and Public Consultation for Lum Hach Rehabilitation Sub-Project

No.	Organization	Participants
1.	National Counterparts and Steering Committee Member	Representative from MOWRAM (Department of Planning)
2.	Provincial Counterparts and Personnel Concerned	Director of PDOWRAM Kampong Chhnang, Chief of Meteorology Section, and Governor of Boribo District
3.	Commune Councils	Chiefs and the members of the councils (12 members: Lum Chach, Phsar I, Kraing Skear, Melum, Prosneth, Chak, Chagva and Anh Chanh Rong)
4.	JICA Study Team	Member of the Team
5.	Villagers	Villagers relevant to Lum Hach Rehabilitation Sub-Project (14 members: Kbal Thnaol, Prey Tamoung, Prey Tamoung, Trapaing Malu, Toul Samrong, Toul Roka, Prosneth, Chor, O-Rumchek, Tapang, Taing Trapaing, Anh Chanh Rong, Andong Roveang and Thlok Chrov)

Prepared by JICA Study Team

Main issues discussed are as follows:

- 1) The result of participatory problem census, as tabulated below, shows that stable irrigation water supply is placed highest priority and of critical importance for farmers. Therefore, necessity of irrigation rehabilitation was justified from the view point of public opinion.

#### Result of Participatory Problem Census by the Representative Farmers

Rank	Problems	Problem Solution
I	Lack of water for irrigation	Request to <u>rehabilitate irrigation scheme</u>
II	Lack of techniques for agriculture	Ask support from Ministry, Department and Institutions related with the project to dispatch extension worker for <u>agriculture to train the farmers</u> at the sites
III	Lack of participation	Need <u>FWUG</u> to participate in <u>managing, operating and maintaining</u> of the scheme.
IV	Lack of good production seed	Need support from Ministry, Department and Institutions related with the project to provide <u>quality seed</u> to the farmers

Rank	Problems	Problem Solution
V	Lack of capital for agriculture	Ask support from Authorities to coordinate with the bank for the farmer to be able to lend money and be organized for helping each other

Prepared by JICA Study Team

- 2) Through the discussion, although the Study is at the pre-feasibility level, sub-project component consisting of: (i) rehabilitation of irrigation and drainage facilities, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities have been fully agreed by all the participants.
- 3) A participant mentioned concern of unequal distribution between the upstream and the downstream since the main and secondary canals of Lum Hach rehabilitation sub-project would be longer due to its layout. The team emphasized the importance of water management using rehabilitated facilities to achieve effective water management.
- 4) As covered by sandy soil, participants mentioned the seriousness of soil erosion under the command area, which would be, however, improved through drainage development.
- 5) NGOs' and/or donors' activities adhere to each commune rather than Sub-Project unit such as: (i) Pon Leu Koma, (ii) DANIDA, (iii) SEILA Program etc. In particular, contribution of SEILA program was stressed for the infrastructure development.
- 6) It was confirmed that there are currently no serious environmental problems in and around the command area. Social environmental issues were rather considered in the meeting. It is observed that the areas of main canal is partly utilized for cultivation and/or fishing. In addition, upstream of proposed headworks are encroached for illegal farming. Although farmers have really understood that such activities are drawn up before the commencement of the construction works according to the discussion in the workshop, proper steps and mitigation measures need to be carried out for consensus building among relevant institutions and farmers in accordance with the sub-decree of MOWRAM.



Gully Erosion as Pointed Out by the Participants in the Workshop (January 29<sup>th</sup>, 2008)

### 3.9 Agricultural Support Services

The current statuses of agricultural support services in the Sub-project areas are discussed among the project district-wisely (district where Sub-project areas are located) as most of the services are provided by district basis.

#### 3.9.1 Sub-projects in Moung Ruessei District (Ream Kon & Por Canal Rehabilitation Sub-project)

- (1) Agricultural Extension Activities
  - 1) Institutions

The government institutions involved in agricultural support services at the province level is

PDA Battambang. The PDA (Provincial Department of Agriculture) is a provincial level agricultural agency under the provincial government and is an agency responsible for agricultural development and provision of agricultural supporting services at province, district, commune and village levels. The PDA is composed of 6 technical offices and two planning/administrative offices. The PDA has its branch offices at district level called District Agricultural Office (DAO).

The district agricultural office covering the two Sub-project areas is DAO Moung Ruessei. The DAO has three sections; agronomy, extension and livestock. However, staffing of the office is limited to 10 personnel in total and extension activities of the office appear to be very limited.

International and bilateral cooperation organization having activities in the district is EU, and a major NGO having agricultural sector support activities is KRDA (local NGO).

## 2) Extension Services

The government extension services at the Sub-project area level (commune & village) are basically to be provided by DAO under the support and guidance of PDA. Major agricultural extension activities provided in the province are programs under NCCD (decentralization program after SEILA) by the government and activities under donors and NGOs. However, current services by the government appear to be extremely limited due primarily to financial constraints.

Major agricultural support activities operated in the project communes are activities under ECOSORN (Economic & Social Relaunch of Northwest Provinces; integrated rural development activities including crop & livestock sub-sector) and provision of quality rice seeds and extension of improved farming practices are carried out in the communes.

Under the new extension system, the recruiting and deployment of Village Agricultural Extension Agent (VAA) at each village is planned by the end of 2008. The introduction of farmer-to-farmer extension is envisaged under the system.

## 3) Current Support Activities in the Project Communes

Current major agricultural support program operated in the project communes of the Ream Kon and Por Canal Sub-project areas are as shown in the following table.



**Current Support Activities in the Project Communes**

Agency	Ream Kon Project Communes	Por Canal Project Communes
EOSORN	Quality rice seed supply	Quality rice seed supply, rehabilitation of irrigation facilities
NCCD 1/	Irrigation canal & road construction	Irrigation canal & road construction

1/ Activities under NCCD (SEILA follow-up)

Source: Project commune offices

### (2) Seed and Farm Inputs Supply

Common channel of quality seed supply in and around the Sub-project areas is through provision of seed under support programs of PDA/DAO, donors or others. Commercial seed suppliers in the areas are farm inputs suppliers in district center (Moung Ruessei) but their

supply volume is limited as demand for quality seeds is limited at present

According to the results of the Socio-economic Survey, predominant seed source of rice is self-multiplied seeds (products of previous season) followed by seeds exchange with other farmers in the areas and demand for quality seeds appears to be very low at present. In contrast to such situation, the results of the Survey indicate no serious constraints for quality seed procurement in the Sub-project areas as follows;

#### Seed Supply Conditions in the Sub-project Areas

Enquiry	Ream Kon Sub-project	Por Canal Sub-project
	Reponses (39 sample farmers)	Reponses (40 sample farmers)
Seed Source of Rice	Own products: 74%; exchange with others: 11%	Own products: 74%; exchange with others: 14%
Frequency of Seed Replacement	Once: per 3 cropping: 72%; over 4 cropping: 28%	Once: per 3 cropping: 73%; over 4 cropping: 27%
Procurement of Wanted Seed	Easy: 74%; difficult/possible: 26%	Easy: 63%; difficult/not possible: 37%
Procurement of Quality Seed	Easy: 62%; difficult/not possible: 48%	Easy: 58%; difficult/not possible: 42%
Price of Quality Seed	Too expensive: 4%; acceptable: 31%	Too expensive: 30%; acceptable: 23%

Source: Socio-economic Survey by the JICA Study team, 2007

Farm input supplies in the project district are mostly carried out by dealers in district center and local markets at commune or district level.

#### (3) Rural Credit

The deployment of ACLEDA Bank and MFIs is rapidly expanding in the country and Battambang Province in recent years. Major formal rural credit operators in the project district include ACLEDA Bank and PRASAC MFI. The numbers of branch (province level) and sub-branch offices (district level) of ACLEDA Bank in the project province (Battambang) and district are as follows;

#### Deployment of Branch & Sub-branch Offices of ACLEDA

Institute	Branch Offices	Sub-branch Offices	Project District
ACLEDA	2 in province	10 in province	1 sub-branch office

Source: ACLEDA Bank Plc

The sub-branch office of ACLEDA Bank is located in Moung Commune neighboring to the project communes. In addition, there deployed a district office of PRASAC MFI in the commune. The terms and conditions of micro credit (farm & small-scale industry credit) of ACLEDA Bank are as shown in the following table.

#### Terms & Conditions for Farm Credit of ACLEDA Bank

Institute	Credit Period & Interest rate		Conditions
ACLEDA	6 months < R.500,000; interest 3.0%/month	12 months >R.500,000 interest: 3.0%/month	Provision of collateral & approval of commune council

Source: ACLEDA Bank Plc., Branch Office

Further, a local NGO (KRDA) is providing micro credit services in the district. However, non-institutional credit providers such as money lenders, rice millers, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

(4) Agricultural Cooperatives

The formation of agricultural cooperatives is promoted by MAFF/PDA in the country with the support of NGOs. The number of cooperatives formed in Battambang Province and the project district is as follows;

**No. of Agricultural Cooperatives in Province & Moug Ruessei District (2008)**

Province	Project District	Project Communes
32 cooperatives	4 cooperatives	3 cooperatives (Chrey & Ta Loas Commune)

Prepared by JICA Study Team

However, the statuses of cooperatives in the district are still at an infant level and no cooperative activities such as procurement, shipment & selling activities are carried out. The total members of the 4 cooperatives in the district are 170 and 43 members per cooperatives on average. An average capital of the cooperatives is very limited to Riel 1,200,000.-. One cooperative in Chery Commune operates saving & credit services to members.

**3.9.2 Sub-projects in Bakan District (Dannak Ampil, Wat Loung & Wat Chre Rehabilitation Sub-projects)**

(1) Agricultural Extension Activities

1) Institutions

The government institutions involved in agricultural support services at the province level is PDA Pursat. The PDA has its branch offices at district level called District Agricultural Office (DAO). The district agricultural Office covering the Sub-project area is DAO Bakan. The DAO has two sections of agronomy and livestock. However, staffing of the office is limited to 6 in total and extension activities of the office appear to be very limited.

International organizations having agricultural activities in the district include EU (SLPP: livestock sub-sector activities, not covering the project communes) and FAO (food security program). Several local NGOs are involved in agricultural sector support activities.

2) Extension Services

The government extension services at the Sub-project area level (commune & village) are basically to be provided by DAO under the support and guidance of PDA. Major agricultural extension activities provided in the province are programs under NCCD by the government and activities under donors and NGOs. However, current services by the government appear to be very limited due primarily to financial constraints.

Under the new extension system at village level, recruiting of VAA from Village Livestock Agent (VLA) or key farmers has been carried out in the province and project district.

3) Current Support Activities in the Project Communes

Current major agricultural support activities operated in the project communes of the Dannak Ampil, Wat Loung and Wat Chre Sub-project areas are as follows;

### Current Support Activities in the Project Communes

Agency	Damnak Ampil/Wat Loung Project Communes	Wat Chre Project Communes
Ox-Farm	Livestock, rice bank, farm credit	Agricultural support by local NGOs
NCCD 1/	Irrigation canal/road rehabilitation	Irrigation canal/road rehabilitation

1/ Activities under NCCD (SEILA follow-up)

Source: Project commune offices

#### (2) Seed and Farm Inputs Supply

Primary source of quality seed supply in and around the Sub-project areas is provision of seed under support programs of PDA/DAO, donors or others. Commercial seed suppliers are farm inputs suppliers in district center (Bakan) but their supply volume is limited as is the case in Moug Ruessi.

According to the results of the Socio-economic Survey, predominant seed source of rice is self-multiplied seeds (products of previous season) followed by seeds exchange with other farmers in the areas. Further, seed replacement frequency is also low and demand for quality seeds appears to be low at present. In contrast to such situation, the Survey results indicate no serious constraints for quality seed procurement in the Sub-project areas as follows;

#### Seed Supply Conditions in the Sub-project Areas

Project	Seed Source of Rice	Procurement of Wanted Seed	Procurement of Quality Seed
DA	Own products: 57%; exchange with others: 20%	Easy: 100%	Easy: 83%; difficult/not possible: 17%
WL	Own products: 79%; exchange with others: 16%	Easy: 79%; difficult/possible: 21%	Easy: 54%; difficult/not possible: 46%
WC	Own products: 78%; exchange with others: 18%	Easy: 68%; difficult/possible: 32%	Easy: 56%; difficult/not possible: 44%

Note: DA - Damnak Ampil (30 samples), WL - Wat Loung (38 samples), WC - Wat Chre (37 samples)

Source: Socio-economic Survey by the JICA Study team, 2007 & 2008

Farm input supplies in the project district are mostly carried out by dealers in district centers and local markets at commune or district level.

#### (3) Rural Credit

The deployment of ACLEDA Bank and MFIs is rapidly expanding in the country and Pursat Province in recent years. Formal rural credit operators in the project district include ACLEDA Bank, PRASAC MFI and Hattha Kaksekar Ltd. The numbers of branch (province level) and sub-branch offices (district level) of ACLEDA Bank operated in the project province (Pursat) and district are as follows;



#### Deployment of Branch & Sub-branch Offices of ACLEDA & AMRET

Institute	Branch Offices	Sub-branch Offices	Project District
ACLEDA	2 in province	7 in province	1 branch & 1 sub-branch office

Source: DAO Bakan

The branch and sub-branch office in the district are located in the project communes of Tropeang Chong and Ou Ta Pomg Commune. In addition, there deployed 2 district offices of Hattha Kaksekar and 1 sub-branch office of PRASAC in and around the project communes. The terms and conditions of micro credit (farm & small-scale industry credit) of PRASAC MFI are similar to those of ACLEDA Bank as shown in the following table.

### Terms & Conditions for Farm Credit of PRASAC MFI

Institute	Credit Period & Interest rate	Conditions
PRASAC MFI	4 ~ 12 months interest 3.0%/month	Provision of collateral & approval of commune council

Source: PRASAC MFI, Branch Office

However, non-institutional credit providers such as money lenders, rice millers, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

#### (4) Agricultural Cooperatives

The formation of agricultural cooperatives is promoted by MAFF/PDA in the country with the support of NGOs. The number of cooperatives formed in Pursat Province and the project district is as follows;

#### No. of Agricultural Cooperatives in Province & Bakan District (2008)

Province	Project District	Project Communes
12 cooperatives	3 cooperatives	No cooperatives formed

Prepared by JICA Study Team

However, the statuses of cooperatives in the district are still at an infant level and no cooperative activities such as procurement, shipment & selling activities are carried out. The total members of the 3 cooperatives in the district are 131 and 44 members per cooperatives on average. An average capital of the cooperatives is very limited to Riel 1,500,000.-.

### 3.9.3 Sub-project in Boribo District (Lum Hach Rehabilitation Sub-project)

#### (1) Agricultural Extension Activities

##### 1) Institutions

The government institutions involved in agricultural support services at the province level is PDA Kampong Chhnang. The PDA is composed of 6 technical offices and two planning/administrative offices. The PDA has its branch offices at district level called District Agricultural Office (DAO). The district agricultural Office covering the Sub-project area is DAO Boribo. The DAO has three sections of agronomy, extension & agricultural legislation and livestock. However, staffing of the office is limited to 7 in total and extension activities of the office appear to be limited.



International and bilateral cooperation organizations having activities in the district include EU (SLPP: livestock sub-sector activities), FAO, ADB (in Tonle Sap area) and WFP. Major NGOs involved in agricultural sector support activities are World Vision, CEDAC and New Human.

##### 2) Extension Services

The government extension services at the Sub-project area level (commune & village) are basically to be provided by DAO under the support and guidance of PDA. Major agricultural extension activities in the province provided are programs under NCCD by the government and activities under donors and NGOs. However, current services by the government appear



to be very limited due mainly to financial constraints.

In the project district, the deployment of Village Agricultural Extension Agent (VAA) at each village is targeted by recruiting from Village Livestock Agent (VLA) or key farmers and 73 VAAs were recruited for 64 villages in the district. The introduction of farmer-to-farmer extension is envisaged under the system.

### 3) Current Support Activities in the Project Communes

Current major agricultural support activities operated in the project commune (Anchanh Rung) include demonstrations of improved rice farming practices by PDA/DAO. The program is operated by 15 farmers and a total size of demonstration plots is 2.1 ha. In addition, agricultural support activities by NGOs include integrated farming scheme of New Human, food for work program of WFP and home garden scheme of CEDAC.

Major activities under NCCD in the project communes (Anchanh Rung, Phsar) are road construction and animal vaccination.

### (2) Seed and Farm Inputs Supply

Common channel of quality seed supply in and around the Sub-project area is through provision of seed under support programs of PDA/DAO, donors or others as is the case in other Sub-project areas. Commercial seed suppliers are farm inputs suppliers in district center but their supply volume is limited because of limited demand

According to the results of the Socio-economic Survey, predominant seed source of rice is self-multiplied seeds (products of previous season) followed by seeds exchange with other farmers in the areas. Further, seed replacement frequency is low and demand for quality seeds appears to be very low at present. In contrast to such situation, the Survey results indicate no serious constraints for quality seed procurement in the Sub-project area as follows;

#### Seed Supply Conditions in the Sub-project Areas

Enquiry	Reponses (200 sample farmers)
Seed Source of Rice	Own products: 83%; exchange with others: 10%
Frequency of Seed Replacement	Once per 3 cropping: 46%; once per over 4 cropping: 54%
Procurement of Wanted Seed	Easy: 82%; difficult/not possible: 12%
Procurement of Quality Seed	Easy: 54%; difficult/not possible: 46%
Price of Quality Seed	Too expensive: 18%; acceptable: 14%; not purchased: 68%

Source: Socio-economic Survey by the JICA Study team, 2007

### (3) Rural Credit

The deployment of ACLEDA Bank and MFIs is rapidly expanding in the country and Kompong Chhnang Province in recent years. Formal rural credit operators in the project district include ACLEDA Bank, PRASAC MFI, Credit MFI and Cambodian Entrepreneur Building Ltd. The numbers of branch (province level) and sub-branch offices (district level) of ACLEDA Bank in the project province and district are as shown in the following table.

#### Deployment of Branch & Sub-branch Offices of ACLEDA

Institute	Branch Offices	Sub-branch Offices	Project District
ACLEDA	1 in province	7 in province	1 sub-branch office

Source: ACLED Bank Plc

The sub-branch office in the district is located in Ponley Commune neighboring to the project communes. In addition, district offices of PRASAC, Credit MFI and Cambodian Entrepreneur Building Limited are also established in the commune.

The terms and conditions of micro credit (farm credit & small-scale industry) of Credit MFI are similar to those of ACLEDA Bank and PRASAC MFI as follows;

**Terms & Conditions for Farm Credit of Credit MFI**

Institute	Credit Period & Interest Rate	Conditions
Credit MFI	4 ~ 12 months < R.4,000,000; interest 3%/month	Collateral & approval of commune council (no collateral below R. 800,000.-)

*Source: Credit MFI, Boribo Office*

Further, NGOs such as World Vision are providing micro credit services in the district. However, non-institutional credit providers such as money lenders, rice millers, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

(4) Agricultural Cooperatives

The formation of agricultural cooperatives in Kampong Chhnang Province is still limited and only 3 cooperatives are formed in the province. No cooperatives are formed in the project district as shown below.

**Agricultural Cooperatives in Kampong Chhnang (2008)**

District	Major Activities
Kampong Tralach	Rice production, saving & credit
Tuek Phos	Saving & credit
Rolea Bier	Cooperatives of agricultural products traders

*Source: PDA Kampong Chhnang*

**3.10 Relevant Institution**

**3.10.1 Ministry of Water Resources and Meteorology**

(1) Mission and Organization

Ministry of Water Resources and Meteorology (MOWRAM) was established in 1999 under Sub-decree 58, 1999. The mission of MOWRAM is to conduct and manage the water resources and meteorology of the country. The organization structure of MOWRAM is depicted in Figure 3.10-1. MOWRAM has ten Departments in central office.

The number of staff amounts 705 and 744 in central office and in provincial office respectively. They are categorized by 5 groups as follows:

**Classification of Staff in MOWRAM**

Category	Engineer	Technician	Vocational	Qualified	Non-qualified
Central	271	184	28	12	210
Province	80	138	78	26	422

*Source: MOWRAM*

The Engineering Department shares 289 staff, and is the largest Department in terms of number of staff. It is responsible for survey, planning, design and construction. The Engineering Department is in charge of development of irrigation system with the area of

more than 200 ha.

The Irrigated Agriculture Department shares 106 staff, and is the second largest Department. It is responsible for design, construction and operation and maintenance of pump, and organizing farmers water users community. The number of staff in Engineering Department and Irrigated Agriculture Department amount more than 50% of total staff in the central office.

The establishment of Technical Service Center (TSC) in MOWRAM was approved by the Sub-decree of the Government of Cambodia in December 2006 as one of the Departments in MOWRAM following to the commencement of Phase-2 of Technical Assistance Project provided by JICA. A Director was appointed in February 2007, and declarations were set up in May 2007. It has more 10 engineering or technical staff. The mission of TSC at present is:

- Establishment of training system of MOWRAM and PDOWRAM staff (preparation of curriculum and material for training),
- Implementation of the training,
- Preparation of technical manuals,
- Collection, custody and provision of technical information,
- On-the-job training of MOWRAM and PDOWRAM staff,
- On-the-job training and technical supporting service for tertiary canal system development,
- On-the-job training and technical supporting service for participatory water management, etc.

JICA has been providing Technical Assistance Project to TSC since 2001. Phase 1 of the Technical Assistance Project started January 2001 and ended January 2006. The Phase 2 started January 2006 and continues until July 2009.

(2) National Project Management Office

Besides, MOWRAM established a National Project Management Office (NPMO) originally in December 2006 and restructured in the latter half of 2007, organization of which is illustrated in Figure 3.10-2, to coordinate, manage and implement all projects related to the water resources development sector. It consists of three units: (i) South-East Project Management Unit (SEPMU), (ii) North-West Project Management Unit (NWPMU) and (iii) Project Management Unit for the Government Budget. The task demarcation is as follows:

**Task Demarcation among Units under NPMO**

Unit	Task
South-East Project Management Unit (SEPMU)	<ul style="list-style-type: none"> <li>• Loan and grant assistance project by donor agencies</li> <li>• Covered provinces: Kampot, Kandal, Krong Kep, Kg. Cham, Kra Tie, Monduliri, Phnom Penh capital, Prey Veng, Rattanakiri, Stueng Treng, Svay Rieng, Takeo</li> </ul>
North-West Project Management Unit (NWPMU)	<ul style="list-style-type: none"> <li>• Loan and grant assistance project by donor agencies</li> <li>• Location coverage including: Bantey Meanchey, Battambang, Koh Kong, Kg Chhnang, Kg. Som city, Kg. Speu, Kg. Thom, Pailin, Preah Vihear, Pursat, Seim Reap, Udon Meanchey</li> </ul>
Project Management	<ul style="list-style-type: none"> <li>• Government fund project for the whole country</li> </ul>

Unit	Task
Unit for the Government Budget	

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The NPMO act as the focal point for project implementation and carries out the day-to-day project management and administration. The NPMO has a director and three Deputy Directores. The Minister of MOWRAM is a director of the NPMO. Staffs in MOWRAM perfor two posts in both NPMO and the Departments as necessity arises.

Should the agreement of financial assistance for implementation of Sub-projects proposed in the present study be made by the government and the donor, the South-East Project Management Unit (SEPMU) will be an executing office in MOWRAM. The person in charge and staff are nominated in SEPMU, and the budget preparation is started.

(3) Budget

Approved annual budget for central office from 2005 to 2007 is given as follows:

**Annual Budget for Central Office (Unit: million Riel)**

Year	2005	2006	2007
Budget	12,330	13,171	13,210

Source: MOWRAM

(4) Provincial Departments (PDOWRAM)

MOWRAM has a Provincial Department Office of Water Resources and Meteorology (PDOWRAM) in each province. Each PDOWRAM subordinates district offices in each districts (183 district offices in total). Figure 3.10-3 shows a typical organization structure of PDOWRAM. Major technical missions of PDOWRAM are to (a) prepare short, medium and long term development plan, (b) research and observe natural disasters, (c) collect meteorological and hydrological data, (d) make operation and maintenance of irrigation system, (e) organize and train FWUC, and (f) study, plan, design and construct small scale constructions. The total number of staff is summarized as follows:

**Number of staff in PDOWRAM Offices (Unit: person)**

Battambang	Pursat	Kampong Chhnang
88	29	35

Source: MOWRAM

(5) Budget for PDOWRAM

Annual budget for three PDOWRAM Offices from 2005 to 2007 is shown as follows:

**Annual Budget for PDOWRAM Offices (Unit: million Riel)**

Year	Battambang	Pursat	Kampong Chhnang
2005	317	131	138
2006	487	297	219
2007	725	308	230

Source: MOWRAM

Annual budget for PDOWRAM offices has been increasing year by year. This increase in budget is deemed due to decentralization policy.

### 3.10.2 Ministry of Agriculture, Forestry and Fisheries

(1) Central

The primary mission of Ministry of Agriculture, Forestry and Fisheries (MAFF) is to support the economic growth of Cambodia by providing high quality services in agriculture sector leading to ensuring food security, increased agricultural output and add value on a sustainable and cost effective basis to agricultural, fishery and forestry based sectors.

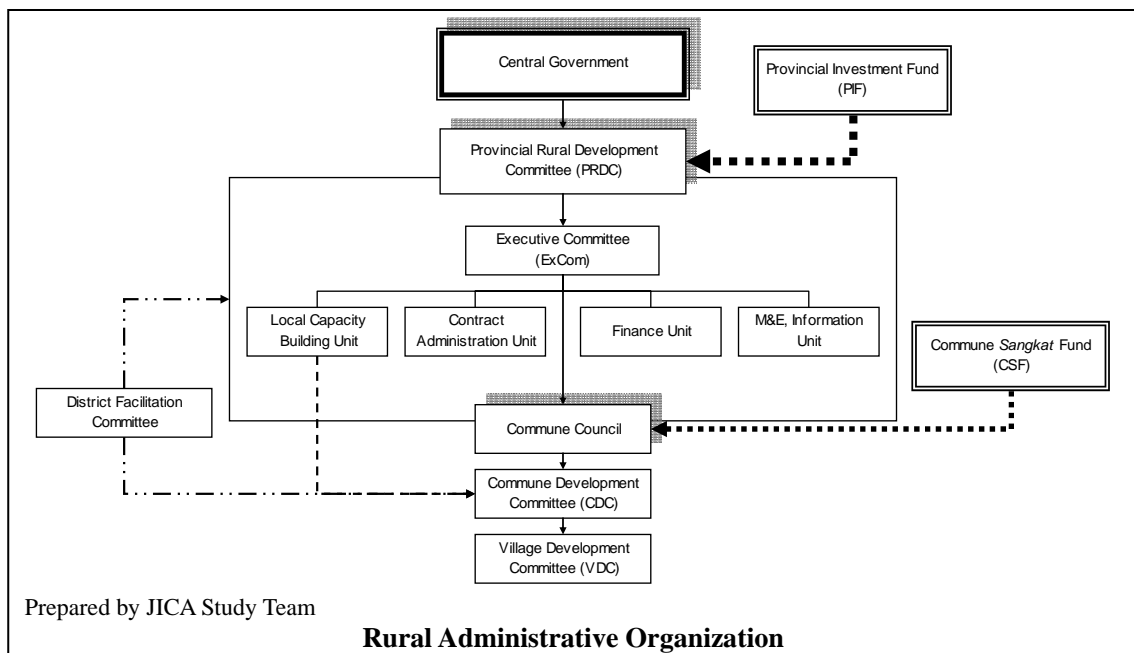
In order to accomplish this mission, MAFF has 12 technical Departments, two Administrations (Fisheries and Forestry) and Technical Centers and 24 Provincial Departments under the body as depicted in Figure 3.10-4.

(2) Provincial Department

Provincial Department of Agriculture (PDA) is a provincial agency of MAFF. Figure 3.10-5 shows a typical organizational structure of PDA. PDA has several technical offices and a few administration offices with some District Offices. The total numbers of staff including District Offices are about 200 to 300.

### 3.10.3 Rural Administration

The relation of rural administration under the provincial to the village level is illustrated as follows:



The rural administration is generally centered by the Provincial Rural Development Committee (PRDC) with coordination of relevant sectoral agencies, under which there are District, Commune and Village Organizations performing each tasks. In this section, the function of PRDC, Commune Council and Village Development Committee (VDC) is explained as follows:

(1) Provincial Rural Development Committee

Provincial Rural Development Committee (PRDC) was originally established in 1999 under the Decision on the Establishment of the Provincial Rural Development Committee. PRDC is headed by Provincial Governor or Deputy Provincial Governor consisting of relevant Provincial Implementing Organizations including PDOWRAM. After the decentralized mechanism assisted by the SEILA program, Provincial Investment Fund (PIF) is established directly allocated to Province to implement projects based on rural needs. Under PRDC, there is an Executive Committee (ExCom) consisting of four units: (i) Local Capacity Building Unit, (ii) Contract Administration Unit, (iii) Finance Unit, and (iv) Monitoring Evaluation and Information Unit. It is responsible for execution of approved work plans and budgets and manages fund allocated to the province for development activities.

(2) Commune Council

There are 1,621 communes and *sangkats* in the country. Out of this total, six Sub-projects involve 23 communes, each of which has commune council. Commune councils, under the Ministry of Interior, are the lowest administrative bodies headed by a Commune Chief. The Commune Administration Act 2001 gave Commune Councils “local affairs” duties to: (i) maintain security and public order; (ii) manage public services; (iii) promote welfare; (iv) economic and social development; (v) protect and conserve the environment; and (vi) promote tolerance and mutual understanding.<sup>1</sup>

Commune and *sangkats* Council elections took place in 2002. Council chief and members are elected every 5 years. Each council has approximately 7 to 15 members depending upon size of communes. Commune councils have their own budget consisting of tax and non-tax revenues. In addition, being supported by commune *Sangkat* fund (CSF) allocated from the Government, averagely \$12,000 per annum per commune, small-scale rural infrastructure development is implemented including development of tertiary irrigation systems under communes’ initiative. In such development, community members are required to contribute 10 % of development cost either by cash or participation to construction. In addition, councils are also support the implementation of the Land Law 2001 conducting land use planning, resolve local plots disputes and monitor illegal use. In the irrigation systems located in target river basin, there are many cases observed that farmers are illegally farming in reservoir area and canals, some of which are monitored and regulated by commune councils.

Currently, one of the greatest constrains in communes councils are insufficient budget and staffs capable of project implementation to be met for local needs. In promotion of irrigation sector, it would be effective if inter-coordination among relevant organization including

**Number of CCs under the Sub-Projects**

Sub-Project	Numbers
Ream Kon	3
Por Canal	4
Damnak Ampil	5
Wat Loung	5
Wat Chre	2
Lum Hach	4
Total	23

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<sup>1</sup> Asian Development Bank (2006), Proposed Asian Development Fund Grant and Technical Assistance Grant Kingdom of Cambodia: Commune Council Development Project 2

communes councils is facilitated to implement projects under decentralization and deconcentration policy.

(3) Village Development Committee

At village level, Village Development Committees (VDCs) organized in each village are responsible to assist Commune Councils at village level. Number of VDCs under six Sub-projects are tabulated on the right. They plan and monitor development activities in the village although budget is not directly allocated to them. They are originally established in accordance with the guidelines approved by the Government in 1999.<sup>2</sup>

**Number of VDCs under the Sub-Projects**

Sub-Project	Numbers.
Ream Kon	6
Por Canal	13
Damnak Ampil	1
Wat Loung	2
Wat Chre	1
Lum Hach	6
Total	29

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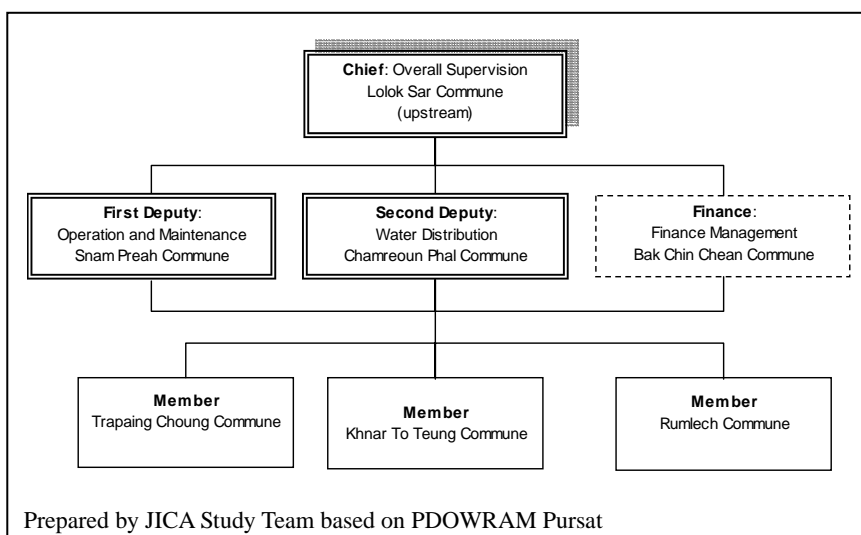
VDC members are elected by villagers as village representatives: two members, one man and one woman, represent the village through a quota system providing 40 % of representation for women on the VDCs.<sup>3</sup> Therefore, VDCs are one of the opportunities for local people to participate in decision-making at local level. VDCs prepare village development action plan and submit to Commune Councils for their consideration.

**3.10.4 Other Organizations**

(1) Farmer Water User Community

In accordance with “the Circular No. 1 on Implementation Policy for Sustainable Irrigation Systems,” it is emphasized as one of principles that FWUCs are formal legal entities recognized by the Government and Civil Society. FWUCs have been established based on the FWUC statute issued in 2000.

Out of six Sub-projects, only Damnak Ampil Rehabilitation Sub-projects is the sole Sub-projects that has already established FWUC although they have not yet registered at PDOWRAM and their activities are not necessarily



<sup>2</sup> Decision on the Establishment of the Provincial Rural Development Committee (1999)

<sup>3</sup> Henny Andersen (2004), Cambodia.s Seila Program: A Decentralized Approach to Rural Development and Poverty Reduction

outstanding until now. The organization, as illustrated as follows, is headed by the Chief appointed from Lolok Sar Commune located at the most upstream of the Sub-project. Other board members, including two deputy chief and finance are, from the representative of relevant communes under the Sub-project.

In order to vitalize irrigation sector as well as to promote Participatory Irrigation Management and Development (PIMD) under Irrigation Management Transfer (IMT) policy, the MOWRAM has already developed set of Module to strengthen FWUCs. In those series, following steps are recommended to establish and strengthen FWUCs at irrigation systems:<sup>4</sup>

- Step 1: Initial Meeting to identify constraints and opportunities within communities
- Step 2: Identify irrigation area and potential members for FWUC through Participatory Rural Appraisal (PRA)
- Step 3: Consensus building among FWUC for activities plan
- Step 4: Preparation of FWUC statute and by-laws
- Step 5: Establishment of FWUC and selection of leaders
- Step 6: Capacity building of FWUC for preparation of irrigation service plan
- Step 7: Finalization of irrigation service plan
- Step 8: Preparation and adoption of management transfer agreement
- Step 9: Rehabilitation of systems through FWUC participation
- Step 10: Provision of periodical support services to continue FWUC capacity building based on lessons learned from above activities

## (2) Other Local Based Organization

Apart from organizations explained above, there are also a number of means available for community members to directly participate in local development activities through locally based organizations such as (i) Wats, (ii) parent teacher associations, and (iii) health centre management and feed back committees as discussed in the institutional linkage mapping prepared in the public meetings at the Sub-projects.

In addition, there are varieties of Farmers Organizations (FOs), defined in the Status of FOs in Cambodia, MAFF 1999 as: “An organization which is a collective entity of farmers in a village or in a number of contiguous villages who have come together for an economic activity related to agriculture.” There are 4 kinds of FOs: (i) Agricultural Cooperatives, (ii) Community Forestry Communities, (iii) Fishery Communities, and (iv) Village Animal Health Worker Associations (VAHW).

Local based NGOs, as well as supporting institutions, are another opportunities for the people to directly participate in rural development. For example, the Association of Cambodian Local Economic Development Agencies (ACLEDA), originally established with assistance of International Labor Organization (ILO) in 1993, has been playing an important role in

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<sup>4</sup> MOWRAM (2003), Module 5 on Establishing and Developing the Farmer Water Users Community (FWUC)  
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providing micro credit in the rural areas including assistance of farmers' groups in purchasing agricultural input. Micro credit loan by ACLEDA presently sum up 70 % of total amount in the country. In the workshop and public meeting at six Sub-projects, ACLEDA was also listed up by the participants as one of the important credit institutions accessible. In addition to establishment of neighborhood and banks, ACLEDA's activities also involves: (i) business opportunity identification, (ii) practical training in entrepreneurship and small business management, (iii) support to development of business plans, (iv) facilitating access to skill training and so forth. In order to facilitate diversification of rural activities based on irrigated farming, it would be effective to have coordination with such organizations.