SECTOR I

WATER USE

1. WATER USE CONDITIONS

1.1 Questionnaire Survey

Water uses are classified into consumptive uses and in-stream uses. In this Study, the consumptive uses are classified into domestic, industrial, mining, irrigation, aquaculture, tourism, livestock and hydropower (inter-basin diversion). The in-stream uses include recreation, inland transport and environmental purposes, etc. The questionnaire survey is conducted to collect necessary data and information of these water uses (**Data Book II** and **III**). The survey covers:

Table I1.1.1 Local Governments Covered by Questionnaire Survey

Province	Regency/Municipality	Remarks
South Sumatra	OKU, OKI, Muaraenim, Lahat, MURA, MUBA, Palembang, Pagaralam, Prabumulih	Cover each whole administrative area
Bengkulu	Rejang Lebong	Cover 4 eastern districts only, Curup, Padang Ulak Tanding, Kepahiang and Kota Padang

1.2 Water Right

The water right and taxation systems were established by Law No.34, 2000 and Provincial Regulation No.25, 2001. Every water use of ground and surface water is subject to these law and regulation, except for water uses by local governments and BUMN (Central Government Companies) and those for irrigation, households and governmental researches. Taxes are collected by UPDT (Local Implementation Unit) under provincial governors.

1.3 Estimation of Present Consumptive Water Use

1.3.1 Domestic

(1) Water Supply System

In 1998, water supply in South Sumatra Province became under the responsibility of each regency or municipality. Before 1998, water supply systems, PDAM, IKK and village systems, were constructed under "Clean Water Supply and Management Project of South Sumatra Province (P3AB)" financed by APBD (**Annex I1.3.1**). IKK systems were constructed during 1982 to 1995, and village systems in 1995 only. PDAM and Regional Water Management Board (BPAM) operated and maintained those systems.

In line with the decentralization, P3AB changed its name as "Project for Development of Infrastructure and Facilities in Living Area (P2SP)" in 1997. In 1998, the responsibility of water supply was handed over to Local Governments as fore mentioned. P2SP is managed by CIPTA KARYA.

Under P2SP, PDAM systems have been constructed. On the other hand, IKK and village systems were handed over to regencies or municipalities after the decentralization. Each PDAM operates and maintains its IKK and village systems. Many village systems, however, do not produce clean water.

In addition, water supply systems have been constructed under INPRES. Therefore, the existing water supply systems are PDAM, IKK and INPRES substantially.

Population of rural and remote areas, where those systems do not cover, obtain their daily water from wells, rivers and rains.

(2) Service Ratio and per Capita Daily Use

Based on the collected data and information, present conditions of domestic water use in each regency/municipality are analysed (**Annex I1.3.2**). Service ratio and per capita daily use of household connections (PCDU) are, as follows:

Table I1.3.1 Present per Capita Daily Use

Item	OKU	OKI	Muara-enim	Lahat	MURA	MUBA	PLB	Rejang Lebong
Service Ratio (%)	5	3	9	7	8	1	31	17
PCDU (l /p /d)	110	110	126	91	112	163	210	100*

*: Assumption as the average of Lahat and MURA

(3) Present Domestic Water Use

Based on the present population and conditions, present domestic water use of the administrative area (as of 2000) is estimated (**Annex I1.3.3**). Water use of the Basin is estimated based on the population ratios (0.6 for OKI; 0.5 for MUBA), as follows:

Table I1.3.2 Present Domestic Water Use (Unit: l/s)

Area	OKU		OKI		Muaraenim		Lahat	
	Piped	Rural	Piped	Rural	Piped	Rural	Piped	Rural
Admin.	84	256	33	198	102	155	52	148
Basin	84	256	20	119	102	155	52	148

Area	MURA		MUBA		Palembang		Rejang Lebong		Total
	Piped	Rural	Piped	Rural	Piped	Rural	Piped	Rural	
Admin.	68	141	28	289	1,293	243	61	67	3,218
Basin	68	141	14	145	1,293	243	61	67	2,968

1.3.2 Industrial

(1) Manufacturing Industry

Manufacturing industries in South Sumatra Province are classified into two categories: (i) large and medium scale industries; and (ii) small scale industries and handicraft. Present conditions of those industries are, as follows:

Table I1.3.3 Small Scale Industries in South Sumatra Province

Small Scale Industrial Group	2000		2001	
	Establish-ments	Person Engaged	Establish-ments	Person Engaged
Manufacture of Food & Beverages	19,307	59,044	16,206	52,319
Manufacture of Textiles, Clothing & Leather	1,739	8,616	1,507	8,283
General Manufacturing Industries	5,766	23,827	4,809	20,115
Manufacture of Fabricated Metal Product and Industrial Service Received	3,578	10,313	4,102	9,524
Manufacture of Chemicals & Structural Material Industries	6,840	19,495	4,325	16,164
Total	37,230	121,295	30,949	106,405

Source: SUMATERA SELATAN DALAM ANGKA 2001, BPS

Table I1.3.4 Large and Medium Manufacturing by Industrial Code, 2000

Industrial Code		Establish-ments	Number of Workers	Output Value (million Rp.)
15	Food & Beverages	44	9,864	1,766,703
17 /18	Textile/Garment	8	673	4,073
20	Woods, Wood-Made Goods, and Handicrafts	59	15,997	621,370
21 /22	Publishing, Printing & Recording Media Reproduction	4	743	4,161
24	Chemistry & Chemistry made Goods	8	7,012	1,824,189
25	Latex& Latex-made Goods	29	6,887	2,301,066
26	Non Metal Quarrying Goods	7	919	260,709
27 /28 /29	Basic Metal/Metal made Goods/Mechanical & Spare Parts	8	408	28,492
35	Transportation other than 4-Weel or more	6	611	14,320
36	Furniture & other Processing Manufacturing	6	2,385	18,194
Total		179	45,499	6,843,277

Source: SUMATERA SELATAN DALAM ANGKA 2001, BPS

(2) Present Industrial Water Use

There are no statistics of the industrial water use. Therefore, retribution on the industrial water use is investigated from UPTD by the questionnaire survey.

The retribution is collected from surface and groundwater users. One local government estimates present retribution covers about 40% of the total water use. Based on this information, the collected data are multiplied by 2.5 in order to estimate the whole figures. Water use of the Basin is estimated using the population ratios fore mentioned. In this Study, gross water use is estimated, which means the water use excluding recycle water use. The results (as of 2001) are, as follows:

Table I1.3.5 Present Industrial Water Use ('000 m3/year)

Regency/ Municipality	Surface Water* (1)	Groundwater (2)	Total (3)	Administrative (3) x 2.5	Basin
OKU	510.0	0.0	510.0	1,275.0	1,275
OKI	n.a.	n.a.	1,989.0	4,972.5	2,984
Muaraenim	n.a.	n.a.	3,182.1	7,955.3	7,955
Lahat	n.a.	n.a.	144.2	360.5	361
MURA	41.0	4.7	45.7	114.3	114
MUBA	589.3	7,682.8	8,272.1	20,680.3	10,340
Palembang	n.a.	n.a.	110,903.1	277,257.8	277,258
Pagaralam	57.2	0.0	57.2	143.0	143
Prabumulih	716.9	1,069.4	1,786.3	4,465.8	4,466
Rejang Lebong	5,940.0	18,000.0	23,940.0	59,850.0	59,850
Total	7,854.4 (23 %#)	26,756.9 (77 %)	150,829.7	377,074.5	364,746

*: Including piped water, #: (1) x100 / ((1)+ (2))

1.3.3 Mining

(1) Mining and Quarrying

Mining and quarrying sector gives high contribution to the provincial economy, e.g.: natural gas for urea industry; coal for electricity production; crude oil for petroleum industry production, and so on. The production of mining commodities (as of 2000) was, as follows:

Table I1.3.6 Mineral and Quarrying Production in South Sumatra Province

Mineral Quarry	Location	Unit	Production, 2000
Crude Oil	Prabumulih, Muaraenim, MUBA, Lahat, OKU	BBLS	41,609,309
Natural Gas	Prabumulih, Muaraenim, MUBA, Lahat, OKU	MMSCF	270,753
Coal	Muaraenim, Lahat	Ton	9,612,240
Andesite	Muara Enim	M^3	41,360
Clay	OKU	M^3	68,690
Limestone	OKU	Ton	96,310
Sand	OKI	M^3	612,950

Source: SUMATERA SELATAN DALAM ANGKA 2001, BPS

(2) Present Mining Water Use

There are no statistics of the mining water use. Therefore, the mining water use is investigated by the questionnaire survey. In this Study, gross water use is estimated. Using the population ratios, the present mining water use (as of 2001) is estimated, as follows:

Table I1.3.7 Present Mining Water Use ('000 m3/year)

Regency/ Municipality	Surface Water (1)	Groundwater (2)	Administrative	Basin
OKU (Oil & Gas)	476.2	0.0	476.2	476
Muaraenim (Coal)	291.9	0.0	291.9	292
MURA (Oil & Gas)	0.0	277.5	277.5	278
Palembang (Oil & Gas)	n.a.	n.a.	114,315.3	114,315
Total	768.1 (73%#)	277.5 (27%)	115,360.9	115,361

#: (1) x100 / ((1)+ (2))

1.3.4 Irrigation

(1) Irrigation System

According to Irrigation Design Criteria of Indonesia, 1986, irrigation systems can be classified, as follows:

Table I1.3.8 Irrigation Systems in Indonesia

Item	System Classification		
	Technical	Semi Technical	Simple
Main Canal	Permanent	Permanent or semi-permanent	Temporal
Measuring Device	Good	Ordinal	Bad
Canal System	Separate	Incomplete separate	Irrigation-cum-drainage
Tertiary Canal	Exist	No or partial exist	No exist
Irrigation Efficiency	50 – 60%	40 – 50%	Less than 40%
Scale	No limit	Up to 2,000ha	Less than 500ha

These systems fall in PU systems. On the other hand, there is non-PU system, namely communal irrigation system. The salient features of those systems are, as follows:

(a) Technical Irrigation System

Water intake and distribution are controlled according to crop water requirements. In the Basin, there are two technical irrigation systems, Tugumulyo and Komering Irrigation Projects. This system is normally mono-cropped with paddy sometimes followed by palawija or vegetable crops.

(b) Semi Technical Irrigation System

These systems locate in the mountain and piedmont zones on the alluvial soils along rivers. Irrigation water is less controlled than the technical one. The cropping intensity is less than technical due to limited water supply.

(c) Simple Irrigation System

These systems locate in the mountain zones where intermountain valley floors and numerous streams from the surrounding mountain ridges provide suitable conditions for small irrigation works. There is no control of water intake and distribution in the systems. Cropping intensity is less than semi technical due to lack of water during the dry season.

(d) Communal Irrigation

Communal irrigation systems were started from 1995 in order to increase and stabilize the rice production of the country. Communal irrigation systems have been constructed by farmers with assistance of central government.

(2) Harvested Area

Harvested paddy areas of the Province are indicated below, and irrigation paddy area in Rejang Lebong in the Basin is 1,563ha (double cropping 1,537ha; single cropping 26ha) (**Annex I1.3.4**). Consequently the total is 79,367ha, double cropping 61,616ha and single cropping 17,751ha. Area in 1998 was considerably small due to the serene drought hit overall Indonesia.

Table I1.3.9 Harvested Irrigation Area in South Sumatra Province

Irrigation Area (ha)	Year				
	1996#)	1997#)	1998##)	1999##)	2000##)
2 Cropping	57,048	55,319	31,211	57,659	60,079
1 Cropping	19,042	21,828	7,077	24,020	17,725
Total	76,090	77,147	38,288	81,679	77,804

Source: #) Sumatera Selatan Dalam Angka Tahun 1998, Dinas Pertanian Tanaman Pangan
##) Statistic Tanaman Pangan 2000

(3) Irrigation Water Requirement

Irrigation water requirements are estimated based on consumptive crop use (ETcrop). ETcrop is computed, as:

$$ETcrop = Kc \times ETo$$

Where, ETo is evapotranspiration of reference crop, and Kc is crop coefficient.

(a) Cropping Pattern

Cropping period and pattern are studied based on the questionnaire survey and existing reports. The determined cropping period and pattern are, as follows:

Table I1.3.10 Irrigation Cropping Pattern

Irrigation Type	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Technical				**Rainy 4 Mon.**				**Dry 4 Mon.**				
Semi T, Simple, Communal			**Rainy 4 Mon.**					**Dry 4 Mon.**				

(b) ETo

In Musi River Basin Study, ETo was calculated for seven stations using Penman method. Based on the figures, 4 mm/day is adopted as ETo of the Basin throughout the year.

(c) Kc

Based on the following figures, 1.10 is adopted as Kc of the Basin throughout the year:

Table I1.3.11 Crop Coefficients

Crop	Growth Stage				
	Planting	**Germination hardly any Cover**	**Crop development until full cover**	**Mid-season full cover until start of maturing**	**Ripening, maturing to harvest**
Open Water	1.20	-	-	-	-
Paddy	-	1.10	1.10	1.10	0.95

Source: FAO 1977

(d) Land Preparation

200mm is considered for soil saturation and initial water layer establishment.

(e) Percolation

Daily rate of 4mm/day is considered for percolation and seepage losses.

(f) Effective Rainfall (ER)

Referring to the design criteria, 50% of mean monthly rainfall with a return period of five years is considered as effective rainfall. Referring to the mean monthly rainfalls calculated in Musi River Basin Study, the following effective rainfalls are adopted in the Study:

Table I1.3.12 Effective Rainfall

Crop Season	Monthly Average ER (mm/month)
Rainy Season	90
Dry Season	45

(g) Total Irrigation Requirement (IR)

Total irrigation requirement for rice is calculated, as follows:

IR =ET crop – Effective Rainfall + Percolation + Land Preparation

(h) Irrigation Water Requirement (DR)

Irrigation water requirement at diversion (DR) is estimated, as follows:

DR =IR /(irrigation efficiency)

Table I1.3.13 Irrigation Water Requirements

Irrigation Type	Irrigation Efficiency	Cropping	Cropping Period (Month)	Field Water Req. (mm/year)	Diversion Req. (mm/year)
Technical	0.6	Rainy	4	848	1,413
		Dry	4	1,028	1,713
Semi Technical	0.5	Rainy	4	848	1,692
		Dry	4	1,028	2,056
Simple & Communal	0.4	Rainy	4	848	2,120
		Dry	4	1,028	2,570

(4) Present Irrigation Water Use

(a) Administrative Area Basis

Based on the harvested areas and irrigation water requirements, present irrigation water use of each administrative area (as of 2000) is estimated, as follows:

Table I1.3.14 Present Irrigation Water Use of Administrative Areas

Area & Use	OKU	OKI	Muara.	Lahat	MURA	MUBA	PLB	Re. L.	Total
Tech. (1 C.)	0	0	0	0	357	0	0	0	357
Tech. (2 C.)	16,575	603	0	0	8,305	0	0	0	25,483
Semi T. (1 C.)	0	0	1,700	0	125	0	70	0	1,895
Semi T. (2 C.)	2,986	0	300	5,208	580	0	0	1,475	10,549
Simple (1 C.)	680	0	1,165	2,071	872	315	105	26	5,234
Simple (2 C.)	2,638	0	911	6,417	1,015	100	0	62	11,143
Comm. (1 C.)	1,580	0	700	4,734	921	2,330	0	0	10,265
Comm. (2 C.)	3,428	0	30	9,516	1,367	100	0	0	14,441
Area T. (ha)	27,887	603	4,806	27,946	13,542	2,845	175	1,563	79,367
Water Use ('000 m^3/year)	962,457	18,850	123,679	1,086,720	438,239	65,454	3,410	58,742	2,757,551

(b) Basin Basis

In order to estimate the present irrigation water use of the Basin, locations of irrigation areas in OKI and MUBA Regencies are studied (**Annex I1.3.5**). As a result, the water use of administrative basis is judged as the water use of the Basin.

1.3.5 Swamp Area

Major consumptive water uses of the swamp areas accrue from paddy cultivation. On the other hand, water supply to transmigration farmers in the tidal swamp areas is recognized as one of the most serious problems. The estimated paddy water requirements and the present water supply of transmigration farmers are, as follows:

(1) Paddy Water Requirement

(a) Paddy Cultivation Method

Swamp area of the Basin comprises non-tidal swamp and tidal swamp. Paddy cultivation methods of the swamp from the viewpoint of water consumption are, as follows:

(i) Non-tidal Swamp

Non-tidal swamp is seasonally flooded swamp of the river flood plain. They locate in the southwest of Palembang, around Kayuagung and along Musi River from Muaralakitan to Palembang. Water management is practised by construction of bunds parallel to

the rivers in order to maintain cultivated area flooded, when the water level recedes.

(ii) Tidal Swamp

Tidal swamp locates in the north delta of Palembang. The areas are irrigated and drained by tide through canal networks.

(b) Harvested Area

In South Sumatra Province, the total harvested area of the swamp in 2000 was 267,497ha, which consists of double cropping 9,039ha and single cropping 258,458ha (**Annex I1.3.6**). Single cropping area in 1998 was considerably small due to the serene drought (**Figures I1.3.1** and **I1.3.2)**.

Table I1.3.15 Harvested Area in Swamp in South Sumatra Province

Harvested Area (ha)	Year				
	1996#)	1997#)	1998##)	1999##)	2000##)
2 Cropping	8,709	14,372	31,807	10,403	9,039
1 Cropping	257,638	260,049	150,389	274,329	258,458
Total	266,347	274,421	182,196	284,732	267,497

Source: #) Sumatera Selatan Dalam Angka Tahun 1998, Dinas Pertanian Tanaman Pangan
##) Statistic Tanaman Pangan 2000

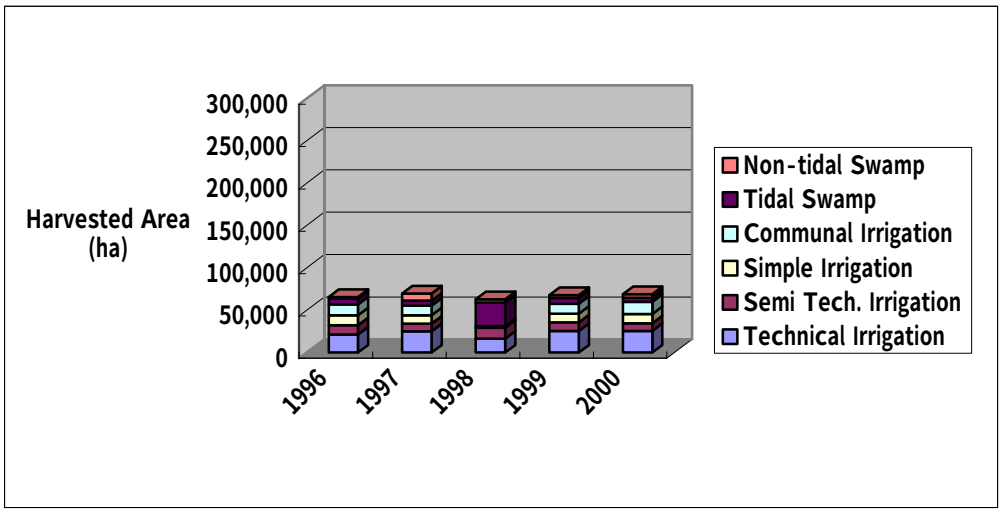


Figure I1.3.1 Harvested Area of Double Cropping

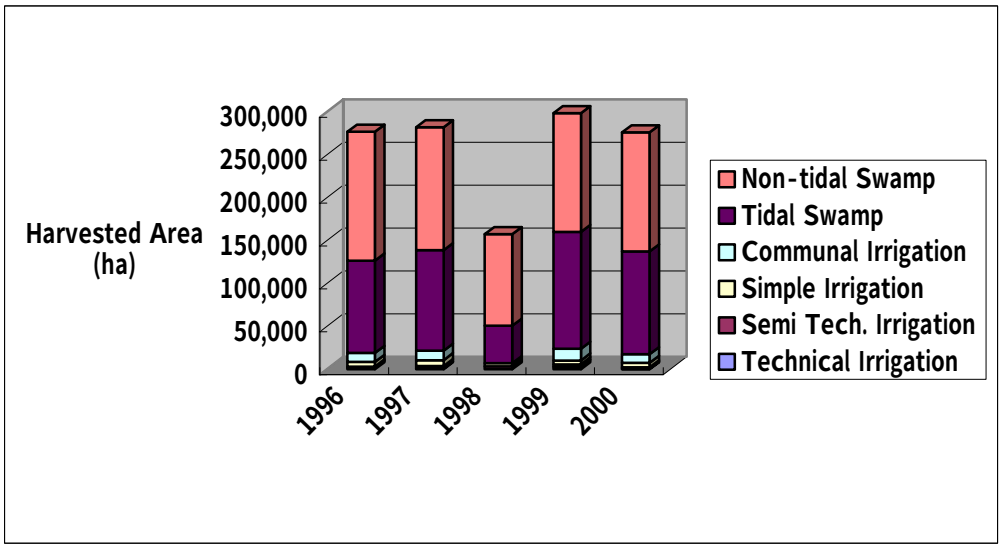


Figure I1.3.2 Harvested Area of Single Cropping

(c) Paddy Water Requirement

(i) Cropping Pattern

Cropping period and pattern are studied based on the questionnaire survey and existing reports. The determined cropping period and pattern are, as follows:

Table I1.3.16 Swamp Cropping Pattern

Swamp	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Tidal & Non-tidal			Rainy 5 Mon.					Dry 5 Mon.				

(ii) Water Requirement

Followed to the same method as the irrigation water requirement, water requirements of swamp paddy are estimated. Considered swamp conditions, percolation rate is judged to be 1 mm/day and its irrigation efficiency could be 0.8. The results of the estimation are, as follows:

Table I1.3.17 Water Requirement

Swamp	Irrigation Efficiency	Cropping Pattern	Cropping Period (Month)	Field Water Req. (mm/year)	Diversion Req. (mm/year)
Tidal & Non-tidal	0.8	Rainy	5	560	700
		Dry	5	785	981

(d) Present Water Use of Swamp

(i) Administrative Area Basis

Based on the harvested areas and paddy water requirements, the present water use of the administrative area (as of 2000) is estimated, as follows:

Table I1.3.18 Present Swamp Water Use of Province

Area & Use	OKU	OKI	Muara.	Lahat	MURA	MUBA	PLB	Re. L.	Total
Non-tidal (1 C.)	6,772	70,192	16,206	0	3,168	37,420	5,178	0	138,936
Non-tidal (2 C.)	906	2,685	0	0	86	540	75	0	4,292
Tidal (1 C.)	0	8,560	0	0	0	110,912	50	0	119,522
Tidal (2 C.)	0	1,500	0	0	0	3,222	25	0	4,747
Area T. (ha)	7,678	82,937	16,206	0	3,254	152,094	5,328	0	267,497
Water Use ('000 m^3/year)	62,634	621,614	113,442	0	23,622	1,101,563	38,277	0	1,961,152

(ii) Basin Basis

In order to estimate the harvested areas of the Basin, the locations of irrigation areas are studied (**Annex I1.3.5**). As the results, the non-tidal areas of OKI and MUBA Regencies are reduced to 40% and 50%, respectively. And tidal areas of OKI and MUBA are reduced to 0% and 40%, respectively. Based on these areas, the water use of the Basin (as of 2000) is estimated, as follows:

Table I1.3.19 Present Swamp Water Use of the Basin

Area & Use	OKU	OKI	Muara.	Lahat	MURA	MUBA	PLB	Re. L.	Total
Non-tidal (1 C.)	6,772	28,077	16,206	0	3,168	18,710	5,178	0	78,111
Non-tidal (2 C.)	906	1,074	0	0	86	270	75	0	2,411
Tidal (1 C.)	0	0	0	0	0	44,365	50	0	44,415
Tidal (2 C.)	0	0	0	0	0	1,289	25	0	1,314
Area T. (ha)	7,678	29,151	16,206	0	3,254	64,634	5,328	0	126,251
Water Use ('000 m^3/year)	62,634	214,593	113,442	0	23,622	467,732	38,277	0	920,300

(2) Water Supply of Transmigration Farmers in Tidal Swamp Area

The total population of transmigration farmers in tidal swamp area of South Sumatra Province is around 432,800 persons with 105,300 families, showing average family size of 4.1 persons (as of 2002). Domestic water sources for those farmers are rainwater, surface water (rivers, canals and from forests), shallow groundwater and buying/transport water. Following tables show general features in the wet and dry seasons:

Table I1.3.20 Water Uses in Dry Season

Application	Water Sources				
	Rainfall	Surface Water	Hand-Dug Wells	Buying Water	Transport from PLB
- Drinking	*	(-)	(-)	(-)	(--)
- Cooking	*	(-)	(-)	(-)	(--)
- Washing		*	*		
- Ritual Purposes		*	*		
- Bathing		*	*		
- Sanitation		*	*		

Source: Musi River Basin Study, Annex No.2, Dec. 1989.
* Water Source in normal situation
(-) Water Source in case of rainwater shortage
(--) Water Source in state of emergency (1982)

Table I1.3.21 Water Uses in Wet Season

Application	Water Sources				
	Rainfall	Surface Water	Hand-Dug Wells	Buying Water	Transport from PLB
- Drinking	*				
- Cooking	*				
- Washing	(+)	*	*		
- Ritual Purposes	(+)	*	*		
- Bathing	(+)	*	*		
- Sanitation		*	*		

Source: Musi River Basin Study, Annex No.2, Dec. 1989.
* Water Source in normal situation
(+) Water Source in case of rainwater surplus

Conditions of the present water sources are, as follows:

(a) Rainwater

Conventionally, rainwater is collected on homestead roofs (average 30 m^2) to obtain drinking water. Collected water is stored in steel drums (200 liters each, frequently oil drums lined with plastic sheet). A family with 4-5 persons possesses 2-4 drums to store rainwater. In the wet season, there is no shortage of clean water from the roof catchments. The collection capacity of this system is inadequate to ensure a supply of drinking water throughout the dry season. Tanks are dry for months during the dry season, and this recourses farmer to shallow well or canal water. In saline intrusion areas, those supplementary sources are not useable.

(b) Surface Water

Rivers and canals in tidal swamp areas are strongly influenced by tides and saline intrusion. Although extent of saline intrusion depends on hydraulic condition of the rivers/canals, approximate locations of dry season saline intrusion is around 40 km inland from the sea. These locations show most of resettlements are under the influence. During the dry season, base flow from the peaty soils and settlement drainage areas is highly acidic and contaminated by human wastes and transportation. Therefore, local surface water is not a potable source for most of the year. Surface water is mostly used for laundry and washing, but this may be the focus of water related diseases.

(c) Groundwater

Shallow groundwater exists, but is of poor quality due to high salinity and/or high content of organic matter combined with low pH. Although the knowledge of groundwater potential is rather limited, groundwater for potable water supply is not an option due to the great depth of potential aquifers and the contamination by seawater.

1.3.6 Aquaculture

(1) Aquaculture in the Basin

Based on the questionnaire survey, major fish for aquaculture are *patin, gold fish, nila, gurame, mas, lele dumbo and toman*. Aquaculture is cultivated in fishponds, paddy fields, cages and fences, as follows:

Table I1.3.22 Present Aquaculture Cultivation

Method	OKU	OKI	Muara-enim	Lahat	MURA	MUBA	PLB	Pagar-alam	Prabu m-ulih	Rejang Lebong	Total
Pond (ha)	3,550	164	409	1,552	703	275	29	169	12	545	7,408
Paddy (ha)	4,050	166	286	1,429	2,036	0	0	128	0	146	8,241
Cage (unit)	28 (ha)	11,111	764	0	0	1,412	150	6	20	67 (ha)	-
Fence (ha)	0	1	0	0	0	0	0	0	0	5	6

(2) Aquaculture Water Requirement

Aquaculture water use is estimated for the fishponds and paddy fields. This is because the cages and fences are placed in rivers.

(a) Fishpond

Water use by fishponds is estimated, as follows:

(i) Open Water Evaporation

Open water evaporation was calculated by Musi River Basin Study. Annual evaporations at Tugumulyo, Pagaralam and Belitang range from 1,525 to 1,835mm showing small seasonal fluctuation. Based on these figures, 5mm/day is considered as open water evaporation from the fishponds.

(ii) Seepage

Seepage from the fishpond beds is assumed at 4mm/day.

(iii) Water for Impounding

Based on the questionnaire survey, one m water is impounded in the fishponds once a year in most cases. This operation is done during the high water season from January to May.

(iv) Total Water Requirement

Based on these figures, the total requirement is estimated as:

(5 + 4) x 365 + 1,000 =4,285mm/year

(b) Paddy Fields

Water use of the aquaculture paddy fields is estimated, as follows:

(i) Open Water Evaporation and Seepage

5mm/day and 4mm/day are considered as open water evaporation and seepage from the paddy fields.

(ii) Impounding Water

Based on the questionnaire survey, 0.4m water is assumed as impounding water.

(iii) Total Water Requirement

Based on these figures, the total requirement is estimated. In the estimation, irrigation efficiency is assumed at 0.45. Result of the estimation is, as follows:

((5 + 4) x 2.5 x 30 (day) + 400) /0.45 = 2,389mm/year

(3) Present Aquaculture Water Use

Based on the areas of fishponds and paddy fields and water requirements, present water use of the administrative area (as of 2001) is estimated. Water use of the Basin is estimated based on the population ratios, as follows:

Table I1.3.23 Present Aquaculture Water Use (Unit: '000 m3/year)

Area	OKU	OKI	Muara - enim	Lahat	MURA	MUBA	PLB	Pagar-alam	Prabu m-ulih	Rejang Lebong	Total
Admin	248,872	10,981	24,358	100,642	78,776	11,784	1,221	10,300	529	26,841	514,304
Basin	248,872	6,589	24,358	100,642	78,776	5,892	1,221	10,300	529	26,841	504,020

1.3.7 Tourism

(1) Number of Tourists

The total numbers of domestic and foreign visitors to the Province in 2001 were 260,952 and 18,584 persons, respectively. Monthly numbers of domestic visitors are, as follows:

Table I1.3.24 Number of Indonesian Visitors

Month	OKU	OKI	Muara.	Lahat	MURA	MUBA	PLB	Total
Jan.	560	986	410	286	934	210	10,500	13,886
Feb.	503	726	860	420	1,752	185	11,241	15,687
Mar.	461	715	1,280	344	880	312	10,200	14,192
Apr.	831	1,338	1,932	298	993	401	10,892	16,685
May	610	1,997	2,304	423	1,021	550	11,200	18,105
Jun.	810	986	2,943	621	1,314	305	20,640	27,619
Jul.	934	1,462	3,645	366	1,124	443	21,692	29,666
Aug.	862	967	3,708	459	1,012	412	22,346	29,766
Sep.	865	1,064	3,131	305	901	470	16,321	23,057
Oct.	712	986	3,398	495	1,025	405	17,124	24,145
Nov.	615	925	3,027	467	910	372	16,201	22,517
Dec.	845	1,211	3,402	520	1,134	395	18,120	25,627
Total	8,608	13,363	30,040	5,004	13,000	4,460	186,477	260,952

Source) SUMATERA SELATAN DALAM ANGKA 2001

On the other hand, the total numbers of domestic and foreign visitors to Rejang Lebong in 2000 were 13,089 and 27 persons, respectively (Rejang Lebong Dalam Angka, 2000).

(2) Stay and Accommodation

Based on the questionnaire survey, visitors stay in the Province for one to three days in most cases. They usually stay at hotel, own house or relative's house. In this Study, stay at hotel or relative's house for two days is assumed for the estimation.

(3) Present Tourist Water Use

Based on the tourist numbers and per capita daily uses, present tourist water use of the administrative area (as of 2001) is estimated. Water use of the Basin is estimated based on the population ratios, as follows:

Table I1.3.25 Present Tourist Water Use ('000 m3/year)

Regency/ Municipality, etc.	Visitor (man /day)	PCDU (l /p /d)	Administrative#	Basin
Domestic				
OKU	17,200	110	2.53	2.53
OKI	26,700	110	4.02	2.41
Muaraenim	60,100	126	10.84	10.84
Lahat	10,000	91	1.18	1.18
MURA	26,000	112	3.56	3.56
MUBA	8,920	163	1.87	0.94
PLB	373,000	210	112.96	112.96
Rejang Lebong	26,200	100	3.31	3.31
Foreign	37,200	210	11.27	11.27
Total	585,320	--	151.54	149.00

#: Including unaccounted-for water and loss

1.3.8 Livestock

(1) Livestock Heads

The major livestock are *milk cow, cow, buffalo, horse, goat, sheep, pig, poultry and duck.* The total heads of livestock are, as follows:

Table I1.3.26 Heads of Livestock (Year: 2000-2002)

Area	Milk Cow	Cow	Buffalo	Horse	Goat	Sheep	Pig	Poultry (1,000)	Duck (1,000)
Province	160	393,665	81,657	1,820	482,053	55,676	27,268	13,517	1,996
Rejang L.	52	2,117	431	0	6,495	262	51	35	26
Total	212	395,782	82,088	1,820	488,548	55,938	27,319	13,552	2,022

(2) Livestock Unit Consumption

Water use is estimated based on the following unit consumptions, which are collected by the questionnaire survey:

Table I1.3.27 Unit Consumption of Livestock (l /d /h)

Milk Cow	Cow	Buffalo	Horse	Goat	Sheep	Pig	Poultry	Duck
100	30	30	30	15	15	50	1	5

(3) Present Livestock Water Use

Based on the head numbers and unit consumptions, present livestock water use on the administrative area (as of 2001) is estimated. Water use of the Basin is estimated based on the population ratios, as follows:

Table I1.3.28 Present Livestock Water Use (m3/d)

Area	OKU	OKI	Muara - enim	Lahat	MURA	MUBA	PLB	Pagar-alam	Prabu m-ulih	Rejang Lebon g	Total
Admin.	11,374	11,783	10,719	3,093	4,730	4,097	1,048	181	232	349	47,606
Basin	11,374	7,070	10,719	3,093	4,730	2,049	1,048	181	232	349	40,845

1.3.9 Hydropower

(1) Present Condition of Electricity Supply in Southern Sumatra Area

Electricity system of State Electricity Corporation (PLN) in South Sumatra and Lampung Provinces is interconnected with 150kV transmission lines. For the extension of the interconnection to Bengkulu system, trial operation for one of the planned two circuits, connecting Lubuklinggau of South Sumatra system and Curup of Bengkulu system, just started in October 2002.

The electricity is supplied by power stations with major ones as steam and gas turbine plants with a total capacity of 71MW in Keramasan Palembang, coal fired steam of 4 ×65MW =260MW in Bukit Asam, Muara Enim Regency, and Besai Hydropower station of 2 ×45MW =90MW in Lampung Province. The existing power stations with their type of generation and installed capacity are, as follows:

Table I1.3.29 Existing Power Stations in South Sumatra – Lampung System

System /Type	Location	Unit	Installed Capacity (MW)
Keramasan			(153.6)
Steam	Keramasan	2×12.8MW	25.6
Gas turbine	Keramasan	2×11.8MW	102.8
	Keramasan	1×21.4MW	
	Bombaru	1×12.8MW	
	SPTGA	1×45.0MW	
Diesel	Sungai Juaro	2×12.6MW	25.2
Bukit Asam			(272.8)
Steam (Coal)	Bukit Asam	4×65.0MW	260.0
Diesel	Bukit Asam	2×6.4MW	12.8
Bandar Lampung			(299.9)
Gas turbine	Tarahan	1×21.4MW	91.4
	Apung	1×30.0MW	
	Tegineneng	2×20.0MW	
Diesel	Tarahan, Tegineneng, etc.	5×6.4MW	90.5
		3×9.4MW, etc.	
Hydro	Besai	2×45.0MW	118.0
	Batu Tegi	2×14.0MW	
Total			726.3

Source: PLN

As shown in the table, the total capacity of the hydropower station in the South Sumatra – Lampung system is 118.0MW (Besai and Batu Tegi in Lampung Province) sharing a 16% of the total capacity, while that of coal fired steam power plant in Tanjung Enim is 260.0MW sharing a 36% of the total.

(2) Rural Electrification

Electrification in rural areas where are not covered by PLN trunk network is important to promote economic activities and social welfare in these areas. Rural electrification in South Sumatra Province is conducted both by PLN and Energy Development and Mine Services, South Sumatra Province.

Rural electrification by PLN is called as Village Electricity. In the Palembang System area, there are 19 stations with a total number of generators at 61. In Lahat System area, there are 22 stations with a total of 73 generators. Common generators are 100 to 220kW, and over 1,000kW are rare.

Energy Development and Mine Services, South Sumatra Province is promoting rural electrification by microhydro power stations. Existing microhydro power stations are listed below. As shown in the table, more than half of the stations are not operated mainly due to the poor maintenance of the equipment.

Table I1.3.30 Existing Microhydro Power Stations in South Sumatra Province

Location	Start Operation	Installed Capacity (kW)	Status
Desa Cahaya Alam, Kec. Pembantu Aremantai, Muara Enim	1991	10	Not operated
Kec. Pembantu Aremantai	1992	5	Not operated
Desa Cukoh Nau, Kec. Pulau Beringin, OKU	1993	15	Not operated
Desa Datar Lebar, Kec. Pembantu Aremantai, Muara Enim	1993	5	Not operated
Desa Tg, Agung/Siring, Kec. Pembantu Aremantai, Muara Enim	1993	5	Not operated
Desa Babatan/Aik Dingin, Kec. Induk Semendo, Muara Enim	1994	10	Under operation
Desa Penindaian/Siring, Kec. Induk Semendo, Muara Enim	1994	10	Not operated
Desa Ulu Danau, Kec. Pulau Beringin, OKU	1997-98	30	Under operation
Desa Muara Sindang, Kec. Muara Dua Kisam, OKU	1998/99	20	Under operation
Desa Cahaya Alam, Kec. Pemb. Aremantai, Muara Enim	1999/2000	40	Finished project & begin operation
Desa Tanjung Kurung Ilir, Kec. Kota Agung, Lahat	Not yet	40	Planning

Note: Data as of January 2001
Source: Energy Development and Mine Services, South Sumatra Province

1.3.10 Basin Total

Present consumptive water uses of the Basin are summarized, as follows:

Table I1.3.31 Present Consumptive Water Uses of the Basin

Water Use	Present Consumptive Water Use ('000m^3/year)	Present Consumptive Water Use (%)
Domestic	93,599 (93,600)	2.0
Industrial	364,746 (365,000)	7.7
Mining	115,361 (115,000)	2.4
Irrigation	2,757,551 (2,760,000)	57.8
Swamp Area	920,300 (920,000)	19.3
Aquaculture	504,020 (504,000)	10.6
Tourism	149 (150)	0.0
Livestock	14,908 (14,900)	0.2
Hydropower	0	0.0
Total	**4,772,650**	**100.0**

Note: (Round number)

1.4 Present Water Balance

1.4.1 Water Balance Model

(1) Basin Model

Water balance model of the Basin comprises 22 sub-basins and 22 water use blocks (**Annex I1.4.1**). These sub-basins correspond to the basin division of hydrological analysis of this Study, and outflow from each sub-basin is generated by the hydrological analysis. Each sub-basin corresponds to its water use block. Water balance is calculated at each sub-basin using those outflow and water uses. In order to grasp the result of water balance, those 22 sub-basins are grouped into 17 water balance nodes, as follows:

Table I1.4.1 Basin Model Structure

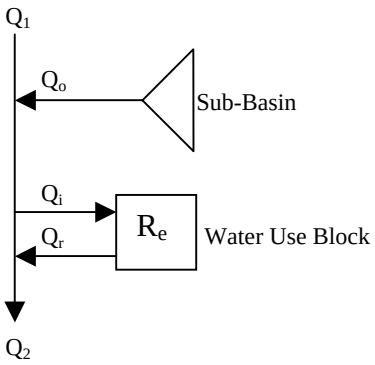
No.	Name of Sub-Basin/Water Use Block	Name of Water Balance Node
1	MU1 (Musi River 1)	1. Upper Musi
2	MU2 (Musi River 2)	
3	MU3 (Musi River 3)	6. Middle Musi
4	KE (Kelingi River)	2. Kelingi
5	SE (Semangus River)	3. Semangus
6	LA1 (Upper Lakitan River)	4. Upper Lakitan
7	LA2 (Lower Lakitan River)	5. Lower Lakitan
8	MU4 (Musi River 4)	16. Lower Musi
9	RA1 (Upper Rawas River)	7. Upper Rawas
10	RA2 (Lower Rawas River)	8. Lower Rawas
11	MU5 (Musi River 5)	16. Lower Musi
12	HA (Harileko River)	9. Harileko
13	MU6 (Musi River 6)	16. Lower Musi
14	LE1 (Upper Lematang River)	10. Upper Lematang
15	LE2 (Lower Lematang River)	11. Lower Lematang
16	MU7 (Musi River 7)	16. Lower Musi
17	OG1 (Upper Ogan River)	12. Upper Ogan
18	OG2 (Lower Ogan River)	13. Lower Ogan
19	KO1 (Upper Komering River)	14. Upper Komering
20	KO2 (Lower Komering River)	15. Lower Komering
21	MU8 (Musi River 8)	17. Musi Mouth
22	PA (Padang River)	

(2) Water Balance Formula

Water balance is carried out using surface water. However, groundwater consumed by the industrial and mining uses is included in the water balance. This is because a greater portion of this groundwater is the origin of base flow. Return flows from paddy fields are also considered in the water balance. Principle formula of the water balance is, as follows:

$$Q_2 = Q_1 + Q_o - Q_i + Q_r$$
$$D_e = (R_e - Q_1 - Q_o) > 0.0$$

Where,
: Q_2 = discharge after water consumption
: Q_1 = inflow to sub-basin
: Q_o = generated natural outflow from sub-basin
: Q_i = intake flow for water consumption
: Q_r = return flow (assumed as 20% of paddy water)
: R_e = required water uses
: D_e = deficit



Typical Sub-Basin Model

1.4.2 Water Use of Sub-Basin

As the water balance is carried out by sub-basin, the estimated water uses should be allocated to each sub-basin. Methods of this allocation are, as follows:

(1) Irrigation and Swamp Water Uses

Water uses for the irrigation and swamp in each regency/municipality are allocated to each sub-basin based on the ratio of its irrigation or swamp area to that of regency. These ratios are shown in **Annex I1.4.2**.

(2) Other Water Uses

Other water uses are allocated to each sub-basin based on the ratio of its population to that of regency. These ratios are shown in **Annex I1.4.3**.

1.4.3 Conditions of Present Water Balance

Water balance under present management is calculated under the following conditions:

(1) Calculation Period and Balance Unit Time

Calculation period is 15 years from 1986 to 2000, based on the possibility of meteorological and hydrological data. Balance unit is decade.

(2) River Maintenance Flow

Maintenance flow at Perjaya Headworks of Komering Irrigation Project is considered in the calculation. The maintenance flow is 35 m^3/s.

(3) Diversion at Randu

Diversion from Komering River to Ogan River is considered at Randu branch. Diversion ratio of Komering to Ogan is assumed at 2:8 based on the present condition.

1.4.4 Results of Present Water Balance

After programming of water balance model, water balance under the present water uses and management (as of 2000) is simulated for 15 years. Results of the calculation are summarized in terms of drought recurrence interval in years (**Annex I1.4.4**). In this Study, the drought means occurrence of the water deficit in its water balance node in a year. In addition, quantitative degree of the deficit is summarized in **Annex I1.4.5**. Based on those results, the present water uses of the Basin are summarized, as follows:

Table I1.4.2 Present Conditions of Water Uses

Water Balance Node	Drought Recurrence	Degree of Water Deficits	Remarks
Upper & Lower Lakitan	15 years	Deficit of lower Lakitan of 1992 pattern may be considerable*. Other case is not considerable.	
Kelingi	5 years	Deficit of 1992 pattern may be considerable*. Other cases are not considerable.	In Kelingi sub-basin, Tugumulyo Irrigation Scheme was already developed with 80% dependability.
Others	15< years	No deficits during 15 years	

*) Considerable: ratio of total deficit to annual water requirement is more than 10 %

Although not considerable level, water deficits occur 5 times in 15 years at Upper Komering, where commanding Komering Irrigation Project. These deficits can be solved by water supply from Lake Ranau (effective capacity: 254 million m^3).

Based on the water balance, the ratio of present water use to potential surface water of the Basin (**2.2 Surface Water Potential**) is estimated, as follows:

(1) Present Water Requirement (MCM/year) (**Table I1.3.31**):	4,772.7
(2) Present Water Deficit (**Annex I1.4.5**):	5.9
(3) Present Water Use: (1)-(2) =	4,766.8
(4) Potential Surface Water:	73,700
(5) Present Water Use Ratio: (3)/(4) =	6.5%

1.5 Projections of Consumptive Water Uses

Consumptive water uses, other than irrigation and swamp area, are projected in this section. Tourism and livestock water uses are not projected because of their small quantities.

1.5.1 Domestic Use

Domestic use is projected based on the projected population and present conditions. Parameters necessary for the projection are assumed based on the short-term development plan of each regency/municipality and relating data (**Annex I1.3.3**). The results are, as follows:

Table I1.5.1 Projection of Administrative Domestic Water Use (Unit: l/s)

Year	OKU		OKI		Muaraenim		Lahat	
	Piped	Rural	Piped	Rural	Piped	Rural	Piped	Rural
(2000)	84	256	33	198	102	155	52	148
2005	109	276	46	244	153	163	75	153
2010	159	294	79	264	177	180	104	161
2020	260	330	156	305	246	207	173	176

Year	MURA		MUBA		Palembang		Rejang Lebong		Total
	Piped	Rural	Piped	Rural	Piped	Rural	Piped	Rural	
(2000)	68	141	28	289	1,293	243	61	67	3,218
2005	83	153	122	317	2,592	166	81	72	4,805
2010	112	167	283	346	3,855	122	108	76	6,487
2020	185	195	715	400	6,472	48	182	83	10,133

Table I1.5.2 Projection of Basin Domestic Water Use (Unit: l/s)

Year	OKU		OKI		Muaraenim		Lahat	
	Piped	Rural	Piped	Rural	Piped	Rural	Piped	Rural
(2000)	84	256	20	119	102	155	52	148
2005	109	276	28	146	153	163	75	153
2010	159	294	47	158	177	180	104	161
2020	260	330	94	183	246	207	173	176

Year	MURA		MUBA		Palembang		Rejang Lebong		Total
	Piped	Rural	Piped	Rural	Piped	Rural	Piped	Rural	
(2000)	68	141	14	145	1,293	243	61	67	2,968
2005	83	153	61	159	2,592	166	81	72	4,470
2010	112	167	142	173	3,855	122	108	76	6,035
2020	185	195	358	200	6,472	48	182	83	9,392

1.5.2 Industrial Use

Industrial water use is projected based on the expected annual growth rate of 2.8 % (manufacturing growth target of scenarios 2). As for Rejang Lebong, expected annual growth rate of 2.0% is applied. The results of the estimation are, as follows:

Table I1.5.3 Projection of Administrative Industrial Water Use ('000 m3/year)

Regency/ Municipality	(2001)	2005	2010	2020
OKU	1,275.0	1,424	1,635	2,155
OKI	4,972.5	5,553	6,375	8,403
Muaraenim	7,955.3	8,884	10,200	13,444
Lahat	360.5	403	462	609
MURA	114.3	128	147	193
MUBA	20,680.3	23,096	26,515	34,948
Palembang	277,257.8	309,639	355,485	468,547
Pagaralam	143.0	160	183	242
Prabumulih	4,465.8	4,987	5,726	7,547
Rejang Lebong	59,850.0	64,784	71,526	87,190
Total	377,074.5	419,058	478,254	623,278

Table I1.5.4 Projection of Basin Industrial Water Use ('000 m3/year)

Regency/ Municipality	(2001)	2005	2010	2020
OKU	1275	1,424	1,635	2,155
OKI	2,984	3,332	3,825	5,042
Muaraenim	7,955	8,884	10,200	13,444
Lahat	361	403	462	609
MURA	114	128	147	193
MUBA	10,340	11,548	13,258	17,474
Palembang	277,258	309,639	355,485	468,547
Pagaralam	143	160	183	242
Prabumulih	4466	4,987	5,726	7,547
Rejang Lebong	59,850	64,784	71,526	87,190
Total	364,746	405,289	462,447	602,443

1.5.3 Mining Water Use

Mining water use is projected based on the expected annual growth rate of 3.6 % (average annual real growth of mining & quarrying 1994-2001). The results of the estimation are, as follows:

Table I1.5.5 Projection of Mining Water Use ('000 m3/year)

Regency/ Municipality = Basin Base	(2001)	2005	2010	2020
OKU (Oil & Gas)	476.2	549	655	932
Muaraenim (Coal)	291.9	336	401	572
MURA (Oil & Gas)	277.5	320	382	543
Palembang (Oil & Gas)	114,315.3	131,687	157,160	223,841
Total	115,360.9	132,892	158,598	225,888

1.5.4 Aquaculture Use

Expected areas of the fishponds and aquaculture paddy fields, until 2010, are collected from each regency/municipality by the questionnaire survey. The aquaculture use in 2020 is estimated using the ratio of per capita GRDP (scenario 2 of 2020 to 2000, e.g. 5,679,000/3,776,000=1.5). If 2020 figure becomes less than that of 2010, 2010 figure is adopted as 2020. The results of the estimation are, as follows:

Table I1.5.6 Projection of Administrative Aquaculture Water Use ('000m3/year)

Year	OKU	OKI	Muara-enim	Lahat	MURA	MUBA	PLB	Pagar alam	Prabu mulih	Rejang Lebong	Total
2001	248,872	10,981	24,358	100,642	78,776	11,784	1,221	10,300	529	26,841	514,304
2005	317,053	14,395	32,309	143,034	91,088	14,098	1,350	17,633	814	33,513	665,287
2010	334,686	17,633	42,988	163,663	103,682	15,812	1,380	35,266	1,093	41,979	758,182
2020	373,308	17,633	42,988	163,663	118,164	17,676	1,832	35,266	1,093	41,979	813,602

Table I1.5.7 Projection of Basin Aquaculture Water Use ('000m3/year)

Year	OKU	OKI	Muara-enim	Lahat	MURA	MUBA	PLB	Pagar alam	Prabu mulih	Rejang Lebong	Total
2001	248,872	6,589	24,358	100,642	78,776	5,892	1,221	10,300	529	26,841	504,020
2005	317,053	8,637	32,309	143,034	91,088	7,049	1,350	17,633	814	33,513	652,480
2010	334,686	10,580	42,988	163,663	103,682	7,906	1,380	35,266	1,093	41,979	743,223
2020	373,308	10,580	42,988	163,663	118,164	8,838	1,832	35,266	1,093	41,979	797,711

1.5.5 Hydropower Use

(1) Musi Hydroelectric Power Project

Since Musi Hepp falls under inter-basin diversion, its hydropower use is estimated based on the operation rule (tentative) and estimated flow regime at intake, as follows:

(a) Operation Rule

When, Qd >= 63.6m^3/s (minimum discharge for downstream 1.6m^3/s + plant discharge 62.0m^3/s), Qi = 62.0m^3/s

When, Qd <= 63.6m^3/s, Qi = Qd – 1.6m^3/s

Where, Qd = natural flow at intake (587km^2)
Qi = water intake for power generation

(b) Flow Regime

Flow regime at intake is estimated based on Ulak-Bandung station at Pangi River (409km^2), which has discharge data from 1992 to 1999. Using these data, rating curve at the intake is prepared, as follows:

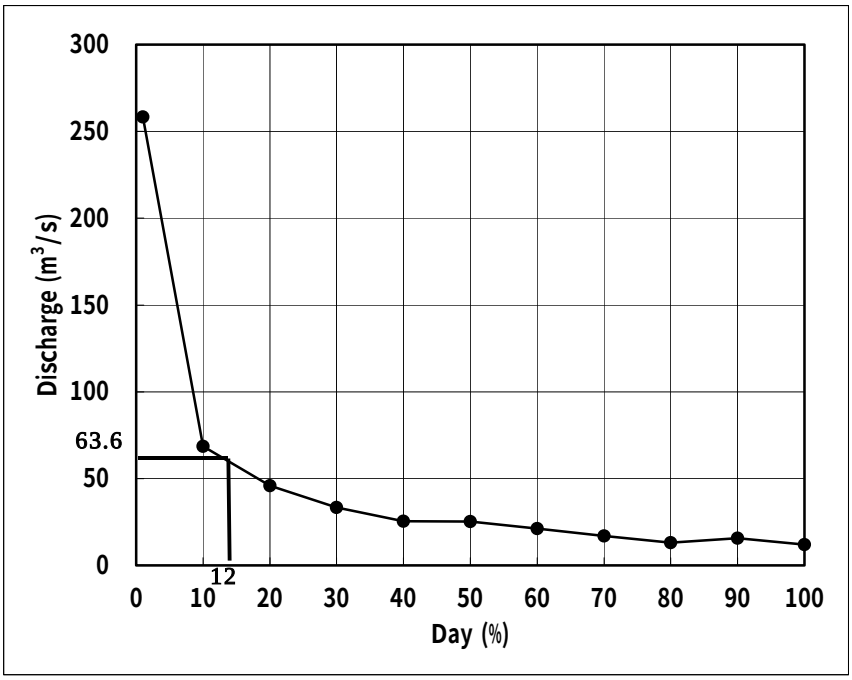


Figure I1.5.1 Rating Curve at Musi Hepp Intake

(2) Hydropower Water Use

Based on the rating curve, 63.6m^3/s is judged to be 12% discharge. Water use is estimated:

62.0 x 365 x 0.12 x 86,400 + 662,896,210 (for 88 %) = 897.5 million m^3/year

1.5.6 Summary of Projected Water Uses

Projected water uses of the Basin are summarized, as follows:

Table I1.5.8 Projected Consumptive Water Uses in the Basin ('000m3/year)

Consumptive Water Use	Present	2005	2010	2020
Domestic	93,600	141,000	190,000	296,000
Industrial	365,000	405,000	462,000	602,000
Mining	115,000	133,000	159,000	226,000
Aquaculture	504,000	652,000	743,000	798,000
Hydropower	0	0	898,000	898,000
Tourism & Livestock	15,050	--	--	--
Total	1,092,650	1,331,000	2,452,000	2,820,000

2. POTENTIAL NATURAL RESOURCES

2.1 Land Potential

2.1.1 Potential Irrigation Area

From the viewpoint of irrigation potential, agricultural land can be classified into technical irrigation area, semi technical irrigation area, simple irrigation area and communal irrigation area. These potential areas including rainfed (as of 2001) are, as follows (**Annex I2.1.1**):

Table I2.1.1 Classification of Potential Irrigation Area ('000ha)

System	Classification	Province Area	Basin Area*
	Functioned	34.3	
	Non optimal	0.0	
	With primary network & non paddy	0.2	
	No primary network & paddy	16.0	
	No primary network & non paddy	34.5	
Technical	Sub-total (1)	85.0	70.4
	Functioned	22.4	
	Non optimal	8.8	
	With primary network & non paddy	11.1	
	No primary network & paddy	3.2	
	No primary network & non paddy	8.7	
Semi Technical	Sub-total (2)	54.2	61.5
	Functioned	6.0	
	Non optimal	1.3	
	With primary network & non paddy	1.2	
	No primary network & paddy	2.4	
	No primary network & non paddy	12.8	
Simple	Sub-total (3)	23.7	25.0
	With network	70.8	
	No network	97.2	
Communal	Sub-total (4)	168.0	189.2
	Can improve	42.8	
	Cannot improve	53.5	
Rainfed	Sub-total (5)	96.3	78.8
Total	Sub-total (1)+(2)+(3)+(4)+(5)	427.3	424.9

*) Including land potential area (assumed) in Rejang Lebong, Bengkulu Province

2.1.2 Potential Swamp Area

From the viewpoint of swamp cultivation potential, agricultural land can be classified into tidal and non-tidal. These potential areas (as of 2001) are, as follows (**Annex I2.1.2**):

Table I2.1.2 Classification of Potential Swamp Area ('000ha)

Swamp	Classification	Province Area	Basin Area
	Developed & used for food crops	149.7	
	Developed & not used paddy field	12.2	
	Undeveloped & agricultural	587.5	
Tidal	Sub-total (1)	749.4	264.0
	Developed & used for food crops	28.7	
	Developed & but not used	43.2	
	Undeveloped & agricultural	423.6	
Non-tidal	Sub-total (2)	495.5	321.7
Total	Sub-total (1)+(2)	1,244.9	585.7

2.2 Surface Water Potential

2.2.1 Generated River Discharges

Runoff discharges of each sub-basin are generated in the hydrological analysis of this Study. The number of sub-basins is 22, and generation period is 15 years from 1986 to 2000. The generated discharges are of natural flows and used in the water balance calculation (for details, refer to Sector G "Hydrological Analysis").

Surface water potential of the Basin is estimated using generated discharges at Musi and Padang Rivers. The potential of surface water is estimated at 73,700 MCM/year (average of 15 years).

2.2.2 River Maintenance Flow

River maintenance flows should be considered in the water use development, namely in proposed water management. In this Study, river maintenance flow is in-stream use for water remaining in the rivers, including recreation, inland transport and environmental purposes, etc. River maintenance flow is the minimum water release during water intake, and has the priority over other consumptive water uses.

Although methods for determining river maintenance flows are still under development, river maintenance flows of Musi River are set at 10-year drought discharges except for Upper Komering (**Annex I2.1.3**). In the estimation of drought discharges, the generated discharges are used.

3. EXISTING PLANS AND STRATEGIES

3.1 Propenas 2000 –2004

Policy directions and programs of **Chapter IV Economic Development** has strong relation to water use management, as follows:

3.1.1 Related Policy Directions

(a) Develop a system of food self reliance based on a diversity of food sources, institutions and local culture. This effort should ensure the availability of food and nutrients in adequate quantity and quality at affordable prices while improving the income of farmers and fishermen, and raising production, that are to be stipulated by law.

(b) Improve the provision and maintenance of public facilities and infrastructure, including transportation, telecommunication, electricity, and clean water. Infrastructure provision should support balanced economic development, serve community needs at affordable prices, and open up isolated areas.

3.1.2 Development Programs for Agriculture, Food and Irrigation

(a) Program for Agribusiness Development: This program has five main objectives: (1) improved yield, quality and output in food crops, horticulture, husbandry, fishery, plantation, and forestry; (2) improved job and business opportunities in rural areas; (3) increased value added created in agriculture, fishery, plantations, husbandry and forestry communities; (4) increased public and private investment in agriculture and rural areas; and (5) preservation of natural resources and the environment.

(b) Program for Improved Food Self Reliance: The objectives of this program are: (1) improved sustainability of production and availability of rice, wheat, at the same time, increasing production, and availability and consumption of non-rice as a source of carbohydrates and protein; (2) increased diversity and quality of food consumed by the community and reducing rice consumption per capita; (3) increased quality of food consumed and the reduced number of families at risk of malnutrition; (4) increased utilization of agricultural production and processing technology; (5) enactment of law and established participatory food institutions; (6) increased productivity and quality of food marketed; (7) reduced volume of food imports and increased production of import substitutes; (8) developed food industry and businesses; (9) increased participation of the community and private sector investment in the development of food business activities; (10) established fishery system that ensures a mutually beneficial relationship between fish catching activities and fish cultivation undertakings, in the context of supporting food-self reliance.

(c) Program to Develop and Manage Irrigation: The objectives of this program are: (1) the reorganization of duties and roles of the central and regional governments

managing irrigation systems. This involves delegating the authority for the decision making to community organizations; (2) empowered community water management organizations to improve water system operations, ensuring their success as they accept wider responsibility for irrigation management; (3) improved delegation of authority in irrigation network management to communities as the water manager; (4) restructured financing of irrigation network operations and maintenance, rehabilitation, and improvement; (5) improved agricultural, agribusiness, and rural activities and the realized food self-reliance. This will be done through greater efficiency, rehabilitating and expanding irrigation networks, including the reclamation marshlands to support higher income and welfare of farmers; (6) protection of irrigated lands from being converted for other uses, through enforcement of the law and regulations including the application of the spatial plan; (7) increased supply of water to residential, urban, industrial areas and for other non agricultural purposes; (8) increased effectiveness and efficiency of operations, maintenance, and development of the infrastructure to control floods and beach abrasion; (9) improved maintenance, repair, and upgrading of dams, lakes, ponds and other watershed construction; (10) improved management and repair of river flows to maintain and increase their function and use; (11) increased integration in the use of ground water and surface water and improved coordination in controlling pollution of ground water and surface water.

3.1.3 Programs for Making Available of Facilities and Infrastructure for Supporting Economic Development

For accelerating the economic recovery of Indonesia, the development of facilities and infrastructure and their service extension activities is to take into account the following criteria: (1) to directly as well as indirectly create job opportunities; (2) must support area economic development; (3) must create the largest possible economic benefits to the communities around the infrastructure project; and (4) must be economically and financially feasible thereby able to attract domestic as well as foreign investors.

There are four programs, namely: (1) maintaining the level of facilities and infrastructure services; (2) continuing the restructuring and reforming of facilities and infrastructure; (3) increasing accessibility of society to facilities and infrastructure services; and (4) developing transportation facilities and infrastructure.

3.1.4 Program for Developing and Managing Water Resources

The objectives of this program are: (1) realized restructuring of various institutions and regulations and management of water resources that uphold fair water use rights; and (2) increased utilization and productivity of water resources through increased efficiency and effectiveness and self reliance in the operation and maintenance and preservation of water intake infrastructure and natural water sources.

3.2 Strategic Planning of Water Resources Development, Water Resources Service of South Sumatra Province 2001-2004, Revised April 2002

There are changes of the goals of agriculture development from the production increase for rice self-reliance to: the preservation of food self-reliance, increase of farm income, increase of job opportunities in rural areas, improvement of family nutrient conditions. These goals are to be attained by the coordination of the directions, working steps and approaches of the water use management mainly for irrigation problems.

The value of water shifts from a communal resource, which is abundant and can be consumed with almost no cost, to an economic resource bearing social function. In addition, water supply scarcity, water demand competition between irrigation and other usages, irrigated land conversion to other usages need an effective irrigation management policy to sustain the irrigation system as well as to secure water right for all stakeholders.

The Government of South Sumatra Province develops and utilizes the water resources to support the developments of following superior sectors:

1. *Agriculture sector for food crops*
2. *Estate sector*
3. *Mining sector*
4. *Tourism sector*
5. *Marine sector*
6. *Small scale industry and community based handcraft sector*

3.2.1 Problems in Development of Water Resources Facilities and Infrastructure

(1) Unstableness of management, operation and maintenance of the water resources networks (irrigation, swamp and river)

(2) Low level of society participation in management, operation and maintenance of the water resources networks (irrigation, swamp and river)

(3) Deterioration of environmental quality of the basins

(4) Non-existence of institution that manages the water resources (river basin)

(5) Un-readiness of governments, private sectors and societies to carry out PKPI

(6) Low local financing capacity to manage the east coastal swamp area, etc.

3.2.2 Goals of Water Resources Development

(1) To support stabilization of the rice self-reliance

(2) To support the preparation of enough raw water, continuous supply of standard quality water, development of environmental knowledge, and expansion of industrial, tourism and settlement sectors

(3) To improve water management systems for the flood control and coastal protection

3.2.3 Targets of Water Resources Development

(1) Accomplishment of basic water facilities and infrastructure that can support the increase of productivities of the superior sectors

(2) Increase in completion of the irrigation network that can support optimal productivities of the superior sectors

(3) Availability of enough and qualified standard water to satisfy all the necessities

(4) Accomplishment of water management well functioning for the prevention of floods and droughts

(5) Accomplishment of irrigation management systems that are suitable with the reformation of irrigation management policy as mentioned in Government Regulation No.77/2001

3.2.4 Policy Directions

(1) To develop water resources on the effective, efficient and environmental knowledge bases

(2) To strengthen maintenance of the water resources facilities and infrastructure

(3) To enhance coordination, integration and synchronization of the irrigation operation and management

(4) To transfer authority of irrigation management to WUAs

(5) To increase quality and quantity of the water resources with preservation of environment

3.2.5 Development Strategies

(1) To strengthen operation and maintenance systems of the swamp and irrigation networks

(2) To propel accomplishment and repair of the irrigation systems, especially technical and semi technical irrigation systems, through empowering WUAs

(3) To realize program for the irrigation policy reformation

(4) To enhance the water resources management and flood control, mentioning:

(5) To develop water resources management, including:

1. *Supplying of irrigation network infrastructure*
2. *Domestic standard water networks*
3. *Urban area and industry*
4. *Electricity generation from water resources (PLTA)*
5. *Effluent treatment facilities*
6. *Wetland and swamp reclamation infrastructure*
7. *Fishery and dyke infrastructure*
8. *Waterway transportation infrastructure*
9. *Water tour/tourism and recreation, etc.*

(6) To enhance water resources management by established Musi and Sugihan Balai PSDAs

3.2.6 Development Efforts

(1) To carry out development, management and conservation of the rivers, lakes and other water resources

(2) To develop and manage the irrigation and swamp networks

(3) To guide institutions and counselling activities

3.2.7 Development Programs

(1) Programs for development, management and conservation of the rivers, lakes and other water resources, consisting:

1. *River improvement, flood control and coastal protection*
2. *River maintenance and training for the protection of production and settlement areas*
3. *To enhance management of the natural resources by established Balai PSDAs*
4. *To prepare the design of Management Authority Board of Musi River Basin*
5. *Comprehensive study on Musi River Basin*
6. *Management of the data base and geographical information systems*

(2) Programs for development and management of the swamp irrigation networks and other water resources networks, comprising:

1. *Survey and investigation for the plans, and detailed design of the water resources developments*
2. *Improvement of semi technical irrigation systems into technical irrigation*
3. *To maximize development of the tidal and non-tidal swamp areas*
4. *To strengthen maintenance of the water management systems of the swamp areas:*

cultural area in Karang Anyar as historical tourism site

5. *To enhance role of the data centre and water resources information of the swamp areas*

(3) Programs for guidance for the institutions and counselling officers, as follows:

1. *To enforce human resources by the education and training*
2. *To increase career level and management ability through the education and training of counselling officers*
3. *Guidance of the water resources development*
4. *Guidance of the irrigation management and development*
5. *Cooperative study with universities to enforce the human resources*
6. *To enhance guidance ability of the human resources by Training of Trainer (TOT)*

3.3 Relevant Development Plans and Projects

3.3.1 Water Supply Development

Corporate Plan is middle term (5-year) management plan of each PDAM, consisting of various technical and non-technical aspects. Based on the plan, management and financial programs of PDAM are formulated and implemented. Among those Corporate Plans 2001-2005, case study of Corporate Plans is carried out for PDAM "Tirta Musi" Palembang and PDAM Lematang Enim (**Annex I3.3.1** and **Annex I3.3.2)**.

3.3.2 Irrigation Development

(1) Irrigation Projects of Water Resources Service, South Sumatra Province

Water Resources Service implements development projects comprising irrigation, swamp, flood handling and coastal protection. These projects can be classified into APBN and APBD projects:

(a) APBN Projects

APBN projects consist of: (1) Irrigation and Mainstay Swamp of South Sumatra; and (2) Flood Handling and Coastal Protection of South Sumatra.

Irrigation and Mainstay Swamp of South Sumatra consists of the following eight subprojects:

1. *Planning, Guidance and Supervision*
2. *First Area Irrigation*
3. *Second Area Irrigation*
4. *Water User Training*
5. *First Area Swamp Development*
6. *Second Area Swamp Development*
7. *Irrigation in North Komering*

8. *Irrigation in South Komering*

Flood Handling and Coastal Protection of South Sumatra consists of the following four subprojects:

1. *Flood Handling*
2. *Water Resources Management*
3. *Planning*
4. *Repairs and Equipment Reconditioning*

(b) APBD Projects

APBD projects are, as follows:

1. *Program for repairs of on-farm systems of the irrigation/swamp networks*
2. *Program for rehabilitation and expansion of the irrigation/swamp networks*
3. *Improvement of river and flood handling*
4. *Program for institutional guideline*
5. *Survey, investigation and design of the water resources networks*
6. *Program for water resources development*

(2) Komering Irrigation Project

Komering Irrigation Project has been implemented using APBN, and funded by Japanese ODA loan. Main concepts of the project are (**Table I3.3.1**):

- Increase and stabilize crop yield and production in the existing irrigation area through rehabilitation and improvement of the facilities and a stable water supply through the year

- Introduce a diversified cropping pattern including the rainy season paddy and dry season paddy as the main crops and palawija (upland crops) through provision of year-round irrigation

- Increase agricultural production by opening new agricultural lands which have favourable physical conditions for agricultural development

- Strengthen the existing institutions for agricultural support services for an effective operation of the Project

With the above development, the project would contribute to the regional development from the following viewpoints:

(a) This project will act as a pilot project for the agricultural development in the Upper Komering river basin.

(b) South Sumatra and Lampung Provinces are importing rice every year from Java Island. After completion of the project, the self-sufficiency of rice can be attained in these provinces.

(c) A quick return of the investment can be obtained from existing Belitang Area of 20,970ha, since this area is furnished with a developed canal system and the farmers in this area are familiar with the irrigation practices.

Table I3.3.1 Outline of Komering Irrigation Project

Components	Implemented (ha)	2002 Request (ha)
Stage I: 1990/91-1996/97	**20,968**	
Ranau Regulating/40 MW		
Perjaya Headworks		
Belitang Area	20,968	
Stage II (Phase 1): 1996/97-2001/02	**25,589**	
Settling Basin		
Komering North Area	18,077	
Komering South Area	7,512	
Stage II (Phase 2)		**16,501**
New Muncak Kabau		5,570
Komering South Area		10,931
Ranau Dyke		
Stage III		**57,600**
Komering I Dam/108 MW		
Komering II Dam/35.7 MW		
Muaradua Dam/23.8 MW		
Lempuing Area		13,100
Tulang Bawang Area		44,500
Total **Stage I,II&III = 120,658ha**	**46,557**	**16,501 (St II, Ph 2)** **57,600 (F/S)** **Total = 74,101ha**

(3) Lakitan Irrigation Project

Lakitan Irrigation Project is one (1) subproject of Project Type Sector Loan for Water Resources Development (II). This project is implemented by Water Resources Service of South Sumatra Province as APBN project, and funded by Japanese ODA loan.

Potential irrigation area is 13,950ha, and water source is Lakitan River (552km^2). Development consists of two steps, as follows:

First Step	**2003 - 2006**
Intake Dam	*1 No*
Main Canal	*29 km*
Secondary Canal	*22 km*
Tertiary System	*6,000 ha*
Drainage Canal	*16.3 km*
Inspection Road	*140 km*
Second Step	**2006 -**
Tertiary System	*7,950 ha*

(4) Temedak Irrigation Project

Directorate of General of Water Resources, Department of Settlement and Regional Infrastructure, Bengkulu Province has intension to carry out Temedak Irrigation Project. Intake site is planned at Musi River, about 20km downstream of intake dam of Musi Hydroelectric Power Project. Irrigation area is 5,000ha, 2,000ha in Bengkulu Province and 3,000ha in Lahat Regency.

(5) Study for Formulation of Irrigation Development Program, 1993 JICA

Study for Formulation of Irrigation Development Program, Nov. 1993, was carried out to formulate an irrigation development program, which provided the current and future Repelita with rationale guideline, in line with overall food production increase program, thus, contributing to the sustenance of self-sufficiency in rice. By this study, South Sumatra Province is expected as potential food resources area for the rice self-reliance at the national level. The outline of this study is, as follows:

(a) Strategic Zones

Zone 1 (Northern Sumatra) and Zone 2 (Southern Sumatra, comprising South Sumatra, Jambi, Bengkulu and Lampung) will be strategic zones for further development as having big potential for development with moderate level of human resources and infrastructure. Zone 5 (Sulawesi) already has many proposed projects for development, and further room for development is limited. Zone 4 (Kalimantan) and Zone 6 (Eastern region) will not be able to develop fast despite of big development potential due to lack of human resources and infrastructure. Only limited development will be expected. Zone 3 (Java & Bali) has already been fully developed and almost no room for further development, although large deficit of rice is anticipated in future.

(b) Strategy for Irrigation Development of Zone 2

For its location advantage for exporting rice to surrounding deficit region including Java (not at present but in future) and Kalimantan regions, large irrigation development should be sought in the region. Also small to medium scale irrigation development should be promoted to increase agricultural productivity.

(c) Target Production and Irrigation Development Area

In order to attain self-sufficiency rate of 100% at the national level, about 1.3 million ha of new irrigation area is required adding to the area of all program and on-going irrigation schemes to product 66.5 million tons of paddy in 2020. Target self-sufficiency rate of Zone 2 is 120%.

(d) Annual Target Development Area

After allocation of the total newly development area of 1.3 million ha to each province, annual target development of South Sumatra Province is proposed, as follows:

Table I3.3.2 Annual Irrigation Development Area of South Sumatra Province

(Unit: 1,000ha)

1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016-2020	Total
13.7	25.2	91.5	103.5	76.4	0.0	310.3

Table I3.3.3 Annual Irrigation Development Area of South Sumatra Province

(Unit: 1,000ha)

Period by Repelitas	1994-1998	1999-2003	2004-2008	2009-2013	2014-2018	Total
New Construction	0.0	37.4	113.2	97.2	19.2	267.0
Rehabilitation	1.1	0.0	0.0	0.0	0.0	1.1
Small Scale	18.5	18.5	0.0	0.0	0.0	37.0
Total	19.6	55.9	113.2	97.2	19.2	305.1

3.3.3 Swamp Development

(1) Past Swamp Development

In South Sumatra Province, tidal swamp development began from Cintamanis and Delta Upang in 1969. The next reclamations were Telang and Saleh in 1975, and Karang Agung, Pulau Rimau and Air Sugihan Kiri in 1980. Swamp development is carried out by step implementation, as follows:

(a) Step I

Infrastructure development starts by primary and secondary drainage canal networks with low cost and simple technology. Networks are open system, and are operated and maintained in a simple and low cost way. In this step, washing of land is carried out. Period of this step is 7-14 years.

(b) Step II

Construction of tertiary canals with gates and embankment for flood protection (optimisation) is completed. Network systems have control function, and are operated and maintained intensively together with P3A activities. Period of this step is 4-7 years. Step II consists of non-modification step and modification step. In non-modification step, drainage and irrigation systems are still combined. In modification step, drainage and irrigation systems are separated.

(c) Step III

Network systems are fully controlled, and have function of semi polder. Gates and embankment are completed, and irrigation and drainage systems are already separated. Period of this step is 4-5 years.

Those development areas are summarised, as follows (**Annex I3.3.3 and I3.3.4**):

Table I3.3.4 Developed Swamp Area of South Sumatra Province

Swamp Type	Development Step	Net Area (ha)
Tidal	Step I	95,658
	Step II	91,931
	Total	187,589
Non-tidal	Step I	18,148
	Step II	10,600
	Total	28,748

Source) Inventarisasi Daerah Irigasi Dan Rawa, Dinas PU Pengairan Propinsi Sumatera Selatan Tahun 2001

(2) Study for Agricultural Drainage: Towards an Interdisciplinary and Integrated Approach

This study was carried out by World Bank–Netherlands Partnership under Environmental Window Program for Water Resources Management, and was undertaken between April 2002 and November 2002. The study aimed to:

(a) Improve understanding of drainage systems as socio-technical and environmental systems

(b) Document and evaluate different institutional models in use in drainage sector at both uses and agency levels

The study included a comprehensive investigation of the drainage in Indonesia, Bangladesh, Egypt, Pakistan, Mexico and Netherlands, representing different drainage situations. The study involved historical development of the drainage technology and management in relation to its agro–economical, social, environmental and economic-political settings. Drainage situations of Indonesia, including swamp area of South Sumatra Province, were investigated from the view point of: Indonesia with humid tropical climate where coastal and inland wetlands are reclaimed, and where drainage of the reclaimed lands requires meticulous management because of occurrence of soils like peat and acid sulphate.

(3) South Sumatra Swamp Improvement Project

South Sumatra Swamp Improvement Project (SSSIP) was one component of a larger plan aimed at improving infrastructure and developing agriculture. SSSIP was implemented by the Directorate General of Water Resources, Ministry of Settlement and Regional Infrastructure, and funded by Japanese ODA loan. SSSIP was undertaken between 1992 and 1999. SSSIP aimed to:

(a) Improve the existing drainage facilities in order to increase the paddy yield on the first holding and the coconut yield on the second holding

(b) Practice efficient on-farm water management and train farmers for the purpose of improving their farming practices

(c) Improve basic social infrastructure such as farm roads and domestic water supply facilities

The gross project area of SSSIP was 40,700ha, consisting of the existing swamp development schemes of Pulau Rimau (22,600ha) and Air Sugihan Kiri (18,100ha). The total number of households in the project area was around 13,200, with a total population of 60,700, as of 2001.

The major items of the project scope were: (1) rehabilitation and upgrading works of existing canals/drains; (2) construction of new canals/drains; (3) construction of water control structures; (4) construction of domestic water supply facilities (domestic water tank 13,284 units).

(4) Integrated Irrigation Sector Project in Indonesia

Integrated Irrigation Sector Project (IISP-1) was financed by Asian Development Bank, and undertaken between 1990 and 1999. The project was designed to support the Government's development goals in the agriculture sector, namely consolidating rice productivity gains, broadening the agriculture base, creating rural employment opportunities, and achieving balanced regional development. The project was specially aimed to accelerate agricultural development in the major rice producing provinces of Central Java, Daerah Istimewa Yogyakarta, Southeast Sulawesi, South Sumatra, and West Sumatra.

The project consisted of six components: (1) irrigation development, including rehabilitation and upgrading of irrigation and drainage schemes; introduction of efficient operation and maintenance (EOM); transfer of operation and maintenance responsibilities from central to provincial agencies and water users associations (WUAs); and institutional strengthening; (2) introduction of an irrigation service fee; (3) agricultural development through tertiary development units for testing water management techniques, improvement of seed farms, land development, and strengthening of WUAs; (4) soil and water conservation; (5) women in development; and (6) strengthening of coordination and monitoring.

Telang and Saleh Agricultural Development Project in South Sumatra (TSADP) was one of four core subprojects in IISP-1, and was implemented by the Directorate General of Water Resources, Ministry of Public Works. The gross project area of TSADP was 60,000ha, consisting of the existing swamp development schemes of Telang I (26,680ha), Telang II (13,800ha) and Saleh (19,090ha). TSADP included intensive rehabilitation and institutional support on a 10,000ha pilot study area. The scope of TSADP included:

1. Environmental impact assessment and monitoring
2. Rehabilitation and upgrading of the primary drainage infrastructure in the whole area
3. Rehabilitation and upgrading of the secondary and tertiary drainage infrastructure in the pilot area
4. Rehabilitation and upgrading of the roads and bridge infrastructure in the pilot area
5. Installation of individual drinking water facilities in the pilot area
6. Introduction of EOM, training and strengthening of organizations
7. Hydrological research, demonstrations and monitoring
8. Pre-feasibility study of connecting road to Palembang
9. Preparation for the second phase of the project

(5) Strategic Planning of Demography and Transmigration Service of South Sumatra Province 2000-2004

Demography and Transmigration Service of South Sumatra Province formulated the strategic planning of demography and transmigration for the period 2000-2004. Target numbers of government sponsored and spontaneous transmigration are 5,836 families and 4,142 families, respectively. Annual targets of the development are, as follows:

Table I3.3.5 Transmigration Development in South Sumatra Province

Fiscal Year	Government Sponsored		Spontaneous	
	New Settlement No.	Family No.	Village No.#	Family No.
2000	2	400	0	0
2001	4	1,100	4	450
2002	5	1,085	7	1,051
2003	6	1,661	8	1,349
2004	6	1,590	9	1,292
Total	23	5,836	28	4,142

Source: Rencana Strategik, Dinas Transmigrasi dan Kependudukan, Propinsi Sumatera Selatan, Tahun 2000-2004
#: Locating in MUBA, OKI, OKU, Muaraenim and MURA Regencies

3.3.4 Tourism Development

Karang Anyar is cultural and historical site along Musi River. The project, strengthening of water system maintenance in Karang Anyar, started in 1994/95. Land acquisition 29.2ha and canal normalization 8.4km have been completed, as of 2002. The project will complete in 2005 with the total cost of Rp. 29,882,317,000. This project is carried out under the cooperation of Dinas PU Pengairan, Dinas PU Cipta Karya and Dinas PU Bina Marga. The salient features of the project are, as follows:

Table I3.3.6 Project for Strengthening of Water System Maintenance in Karang Anyar

Fiscal Year	Land Acquisition		Canal Normalization #		Other Structures	Administration
	Area (ha)	Rp. '000	Length (km)	Rp. '000	Rp. '000	Rp. '000
'94/95 – '02	29.2	6,285,961	8.4	7,721,594	983,576	25,186
'03 – '05	0	0	0	0	14,866,000	0
Total	29.2	6,285,961	8.4	7,721,594	15,849,576	25,186

Source: Dinas PU Pengairan, Sumatera Selatan, as of January 2003
#) Including weir construction

3.3.5 Hydropower Development

Electric power is one of the most important measures in meeting the energy development policy. Electric power development can promote economic activities and social welfare, in urban areas as well as rural areas. Rural electrification also can stimulate economic activities and can enhance the intellect and welfare of the people in the rural areas. Hydropower development is conducted by PLN, and Energy Development and Mine Services, South Sumatra Province.

(1) Future Demand and Supply Plan

Future demand and supply plan has been prepared by PLN until the year 2012. Growth rates in energy (GWh) demand are assumed at 8.1% for 2002, 6.3% for 2003-2005, and 7.6% for 2006-2012. To meet the projected demand increase, the following power stations are scheduled for operation:

Table I3.3.7 Scheduled Major Power Stations in South Sumatra–Lampung–Bengkulu System

Scheduled Year	Location	Type	Installed Capacity
2001.11	Indralaya	Gas turbine	50MW
2003	Betung	Gas turbine	20MW
2005	Musi	Hydropower	3×70=210MW
2006	Tarahan	Gas turbine	2×100=200MW
2007	-	New steam	135MW
2008	-	New steam	135MW

Source: PLN

(2) Potential Hydropower Stations in the Basin

According to EU funded "Musi River Basin Study, 1989" and information available at Energy Development and Mine Services (Dinas Pertambangan dan Pengembangan Energi), South Sumatra Province, potential hydropower stations in the Basin are identified as follows (**Annex I3.3.5**):

Table I3.3.8 Potential Hydropower Stations in the Musi River Basin

Name	River	Purpose	Installed Capacity Annual Energy
1. Padang Bindu	Enim	Flood, Industrial Water, Hydropower	37 MW 293 GWh/year
2. Buluh/Lematang IV	Lematang	Hydropower	70 MW 467 GWh/year
3. Muara Dua (Gunung Pasir)	Selabung	Flood, Irrigation, Hydropower	15 MW
4. Ranau	Selabung	Hydropower, Irrigation	60 MW 167 GWh/year
5. Tj. Pura	Ogan		27 MW 116 GWh/year
6. Kota Agung	Selabung		37 MW 163 GWh/year
7. Sejemput	Lematang		100 MW 43 GWh/year
8. Sula	Kutu & Rawas		13 MW 56 GWh/year
9. Muara Lintang	Musi		21 MW 92 GWh/year
10. Panjung	Lematang		22 MW 100 GWh/year
11. Baru	Selabung		35 MW 153 GWh/year
12. Lematang IV	Lematang		10 MW 53 GWh/year

Source: "Musi River Basin Study, 1989"

These hydropower stations are not included in the power supply plan of PLN up to 2012. Economic feasibility of these hydropower projects seems not so high with the highest B/C of 0.96 for the Ranau project (No.4 in the above table).

(3) Potential Microhydro Power Stations in the Basin

Energy Development and Mine Services, South Sumatra Province identified possible site for microhydro power development as shown below, and details in **Annex I3.3.6**.

Table I3.3.9 Potential Microhydro Power Stations in South Sumatra Province

District	Location	Installed Capacity (kW)
Lahat	Kota Agung	1,059.3
	Jarai	355.5
	Lahat Kota	92.9
	Pajar Bulan	105.6
	Ulu Musi	879.7
	Pagar Alam	921.2
	PL. Pinang	323.4
	Dempo Selatan	40.7
MURA	Ma. Beliti	1,939.4
	Rawas Ulu	39.7
OKU	PL. Beringin	818.3
	Bd. Agung	112.9
	Md. Kisam	687.9
Muara Enim	Tj. Agung	1,729.7
	Semendo	40.1
	Arumentai	190.4

Source: Energy Development and Mine Services, South Sumatra Province

In addition to the identified potential microhydro development site, "Musi River Basin Study, 1989" identified locations of irrigation weirs in the Basin as shown in **Annex I3.3.7**. Utilization of these numerous weirs for the microhydro power development should be studied in the future as a part of rural electrification.

(4) Musi Hydroelectric Power Project (Musi HEPP)

Musi Hydropower Station is scheduled to start operation at January 2006 with a capacity of 210MW. With Musi Hydropower of 210MW, share of hydropower as of 2005 will rise to 40%. After that, no hydropower is scheduled until 2012 and the share of hydropower will decrease to 22% in the year 2008.

Musi Hepp is a run-of-river type power development scheme, and is under the construction with ADB loan. Power generation of Musi Hepp is planned with the 95% dependable firm discharge of 15.5m^3/s, and its plant discharge for three units is designed at 62.0m^3/s under the conditions of six hours of peak generation per day. Water for the hydropower will be diverted from Musi River with drainage area 587km^2, in Rejang Lebong Regency, Bengkulu Province, and outlet into Simpangaur River, finally discharging into Indian Ocean. Bengkulu Province plan to utilize this disposal water for irrigation (about 22,000ha) and clean water supply (2-6m^3/s).

4. IRRIGATION AND SWAMP DEVELOPMENT POTENTIAL

4.1 Evaluation of Major On-going and In-coming Projects

Three on-going and in-coming irrigation projects, namely Komering, Lakitan and Temedak Irrigation Projects, are evaluated from the viewpoint of water resources development. Using projected 2020 water uses, water balance analysis is carried out in order to confirm their 80% dependability, which is the standard method for planning irrigation development in Indonesia. In the dependability confirmation, considerable water deficits (annual deficits more than 10% of annual total irrigation demand) are counted, because water deficits can be controlled by adjusting cropping pattern.

4.1.1 Komering Irrigation Project

(1) Stage I and Stage II (Phase 1 & 2)

New irrigation development of 63,058ha (Stage I 20,968ha and Stage II 42,090ha) is evaluated. As the results, dependability of the development is estimated at more than 80%, meaning this development is possible from the viewpoint of water resources, due to the water supply from Lake Ranau (254 MCM), as follows:

Table I4.1.1 Evaluation of Komering Irrigation Project

Year	Water Deficit from Dev. (MCM/year)	Water Supply from Lake Ranau (MCM/year)	Deficit (MCM/year)
1986	0.0	0.0	0
1987	67.0	67.0	0
1988	190.9	190.9	0
1989	10.9	10.9	0
1990	67.1	67.1	0
1991	154.7	154.7	0
1992	2.9	2.9	0
1993	23.1	23.1	0
1994	344.7	254.0	90.7
1995	26.0	26.0	0
1996	35.9	35.9	0
1997	53.0	53.0	0
1998	205.6	205.6	0
1999	25.7	25.7	0
2000	0.0	0.0	0

Note) Calculated dependability = 14/15 = 93%

(2) Stage III

New irrigation development under Stage III is 57,600ha (13,100ha in South Sumatra Province and 44,500ha in Lampung Province). Water resources for this development are planned as: Komering I Dam (120 million m^3), Komering II Dam (40 million m^3) and Muaradua Dam (150 million m^3). Stage III is expected

to be under feasibility study stage. By this feasibility study, topological, geological and socio-economical data of those dam/reservoir sites are to be collected. Without these data, evaluation of this development is impossible.

4.1.2 Lakitan Irrigation Project

New irrigation development (13,950ha) of Lakitan Irrigation Project is evaluated. As the results, its dependability is estimated at more than 80%, as follows:

Table I4.1.2 Evaluation of Lakitan Irrigation Project

Year	Water Deficit from Dev. (MCM/year)	Deficit/Requirement# (%)
1986	0.0	0.0
1987	0.0	0.0
1988	2.8	0.6
1989	0.0	0.0
1990	0.0	0.0
1991	0.0	0.0
1992	240.3	55.1
1993	15.8	3.6
1994	5.7	1.3
1995	0.0	0.0
1996	10.5	2.4
1997	3.8	0.9
1998	8.6	2.0
1999	6.1	1.4
2000	4.1	0.9

#) Requirement from development = 436.1 (MCM/year)
Note) Calculated dependability = 14/15 = 93% (using considerable deficits which are deficits more than 10% of 436.1 MCM/year)

4.1.3 Temedak Irrigation Project

New irrigation development (5,000ha) of Temedak Irrigation Project is evaluated under the presence of Musi Hepp. As the results, its dependability is estimated at more than 80%, as follows:

Table I4.1.3 Evaluation of Temedak Irrigation Project

Year	Water Deficit from Dev. (MCM/year)	Deficit/Requirement# (%)
1986	0.0	0.0
1987	0.0	0.0
1988	0.0	0.0
1989	0.0	0.0
1990	0.0	0.0
1991	0.0	0.0
1992	0.0	0.0
1993	0.0	0.0
1994	0.0	0.0
1995	0.0	0.0
1996	0.0	0.0
1997	4.7	3.0
1998	6.4	4.1
1999	0.0	0.0
2000	0.0	0.0

#) Requirement from development = 156.3 (MCM/year)
Note) No considerable deficits

4.2 Potential Irrigation and Swamp Area

4.2.1 Expectation of Potential Irrigation and Swamp Area

(1) Method of Determining Potential Irrigation and Swamp Area

Potential land mentioned in **2. Potential Natural Resources** are allocated to each sub-basin based on the ratio of its basin area to that of regency/municipality. Three on-going and in-coming irrigation projects are included in potential land (**Annex I4.2.1 and I4.2.2**).

Using these potential lands and projected 2020 water uses, water balance is carried out to estimate the dependability of agricultural development. In the water balance, diversion at Randu is not considered because weir is constructing at the diversion site. Final water deficits, after the determination, are shown in **Annex I4.2.3**. Determination procedure of potential irrigation and swamp area at each sub-basin is, as follows:

1. *Give potential areas with double cropping*
2. *If dependability is less than 80% (using considerable deficits), some double cropping area is simply changed to single cropping by try and error*
3. *If dependability is still less than 80%, areas of swamp, communal and/or simple irrigation are reduced by try and error*
4. *If dependability is still less than 80%, semi technical irrigation area is reduced by try and error*
5. *Potential development areas are determined, if dependability becomes more than 80%*

(2) Expected Potential Irrigation and Swamp Area

Based on the study, the potential areas in the Basin are summarised, as follows (**Annex I4.2.4**):

Table I4.2.1 Potential Irrigation and Swamp Area in the Basin

Irrigation Type (Potential Land ha)	Double Cropping (ha)	Single Cropping (ha)	Total (ha)
Technical (70,400)	137,500	0	137,500
Semi Technical (61,500)	40,100	0	40,100
Simple (25,000)	18,300	0	18,300
Communal (189,200)	106,800	0	106,800
Non-tidal (321,700)	167,900	62,300	230,200
Tidal (264,000)	220,700	43,300	264,000
Total	691,300	105,600	796,900

Consequently, potential area of technical irrigation becomes 137,500ha, which is greater than the land potential for technical irrigation, 70,430ha. This increase comes from the developments of Komering, Lakitan and Temedak Irrigation Projects.

(3) Water Use of Potential Irrigation and Swamp Area

Water requirement from the potential area is estimated at:

Potential Irrigation Area	11,668.4
Potential Swamp Area	7,271.6
Total (MCM/year)	18,940.0

Based on this water balance, ratio of water use, under potential irrigation and swamp area and other projected 2020 consumptive water uses, is estimated, as follows:

(1) Potential Water Use (MCM/year):	21,760
(2) Water Deficit (**Annex I4.2.3**):	866
(3) Water Use: (1)–(2) =	20,894
(4) Potential Surface Water:	73,700
(5) Water Use Ratio: (3)/(4) =	28%

4.2.2 Potential Irrigation and Swamp Development and Rice Self-Reliance

(1) Self-Reliance Circumstances of Rice

Indonesia achieved self-reliance of rice in 1984 by the introduction of high yield varieties and irrigation development. However, recent urbanization and industrialization around large cities have resulted in the decrease of productive paddy fields. On the other hand, the demand on rice has increased in accordance with the population growth. In addition, rice production decreased drastically by El Nino in 1994 and 1997. In 1998, the rice production also decreased by the long drought and price increase of agricultural inputs which was triggered by the monetary crisis mid 1997. Under these circumstances, self-reliance ratio dropped to 84.2 % in 1999. Rice import of the country and South Sumatra Province is, as follows:

Table I4.2.2 Imports of Rice of Indonesia (Net Weight: Ton)

Year	1997	1998	1999	2000	2001
Total	349,681	2,895,118	4,751,398	1,355,666	644,733

Source: Statistik Indonesia 2001

Table I4.2.3 Imports of Rice of South Sumatra Province (Unit: Kg)

Year: 1999	2000	2001
Husked Rice: 64,873	Husked Rice: 23,622, Semi-milled/Wholly Milled Rice: 63,380,263	Semi-milled/Wholly Milled Rice: 6,244

Source: Statistik Perdagangan Luar Negeri Ekspor 1999, 2000 & 2001

(2) Potential Irrigation and Swamp Development Area

Based on the potential and present harvest areas (**Table I1.3.19**), potential irrigation and swamp development areas in the Basin (as of 2000) are estimated, as follows:

Table I4.2.4 Potential Irrigation and Swamp Development in the Basin

Irrigation Type	Double Cropping (ha)	Single Cropping# (ha)	Total (ha)
Technical			
- Potential Area	137,500	0	137,500
- Present H. Area	25,483+25,589 (KIP*)	357	51,429
- Potential Dev.	86,428	-179	86,249
Semi Technical			
- Potential Area	40,100	0	40,100
- Present H. Area	10,549	1,859	12,408
- Potential Dev.	29,551	-930	28,621
Simple			
- Potential Area	18,300	0	18,300
- Present H. Area	11,143	5,234	16,377
- Potential Dev.	7,157	-2,617	4,540
Communal			
- Potential Area	106,800	0	106,800
- Present H. Area	14,441	10,265	24,706
- Potential Dev.	92,359	-5,133	87,226
Non-tidal			
- Potential Area	167,900	62,300	230,200
- Present H. Area	2,411	78,111	80,522
- Potential Dev.	165,489	-7,906	157,583
Tidal			
- Potential Area	220,700	43,300	264,000
- Present H. Area	1,314	44,415	45,729
- Potential Dev.	219,386	-558	218,828

#) Decrease: evaluated at 50% area, *) KIP = Komering Irrigation Project, Stage II, Phase 1

(3) Potential Development and Rice Self-Reliance

By Study for Formulation of Irrigation Development Program 1993, South Sumatra Province was designated as potential food resources area for the rice self-reliance at the national level. By this study, large irrigation development was targeted for South Sumatra Province as indicated below.

Table I4.2.5 Target Development by Study for Formulation of Irrigation Development Program,1993 (Unit: '000ha)

Development	1994-2003	2004-2018	Total
New Construction	37.4	229.6	267.0
Rehabilitation	1.1	0.0	1.1
Small Scale	37.0	0.0	37.0
Total	75.5	229.6	305.1

Roughly speaking, 300,000ha irrigation development was targeted for the Province, and 47,000ha and 20,000ha have been developed already by Komering Irrigation Project (Stage I and Stage II, Phase1) and communal irrigation development (in equivalent to double cropping area), respectively. Development remained for the Province is *233,000ha*.

On the other hand, potential irrigation and swamp development areas in the Basin are estimated at *207,000ha* and 376,000ha, respectively (**Table I4.2.4**).

Therefore, full irrigation development and some swamp development in the Basin will meet the said target.

Considering land potential outside of the Basin (OKI: *15,000ha* of irrigation and 354,000ha of agricultural swamp; MUBA: 305,000ha of agricultural swamp), however, even after realization of this target, there is still large room remained for development in the swamp area and upland area, around 1 million ha and 15,000 ha respectively. In addition, there remain also rainfed areas.

(4) Necessity of Program for Irrigation and Swamp Development

The potential development area is studied to clarify the possibility of rice production of South Sumatra Province, one of rice production centres outside Jawa, in line with the 1993 program. It is then concluded that the target established in the 1993 program can be achievable as mentioned above.

On the other hand, the agribusiness development and the improved food self-reliance are programmed as stipulated in Propenas 2000-2004. These programs aim to raise farmers' living standard through improving production of rice and non-rice. In addition, minimum self-reliance rate of rice is set at 85% for provincial level (BAPPENAS). This means rice is imported during the periods of deficit, using financial source made by exports of other cash crops.

Considering the potential irrigation and swamp area as well as these current directions of food and irrigation development, there is a necessity of program for irrigation and swamp development in order to realize the sustainability of irrigation and swamp development, thus contributing to the stable self-reliance of rice and food security at provincial and national level. So as to realize the sustainability, proper distribution of development areas should be determined based on the re-established development target and potential areas in each sub-basin.

5. WATER USE MANAGEMENT

5.1 Overview

Propenas 2000-2004 has formulated five development priorities, and one of them is accelerating economic recovery and strengthening the foundation of sustainable and fair development on the basis of the people's economic system. Propenas stipulates this aim can be realized only with the management of natural resources that ensures the preservation of the supporting capacity of the environmental and the conservation of natural resources.

In line with Propenas, Strategic Planning of Water Resources Development 2000-2004, Water Resources Service, describes the water resources should always be protected, conserved and maintained by realizing comprehensive management that ensures environmental and sustainable development. And one of the goals of water resources development is to support stabilization of the rice self-reliance.

On the other hand, the development of the Basin will proceed until every sub-basin burdens drought return period of maximum five years, meaning at most deficit occurs one year in five years.

If water resources utilization is to proceed out of control, it results in environmental damage and degradation of water resources that ultimately reduces the supporting capacity of the environment and resources, thus endangering the implementation of sustainable development.

In line with these, super goal of the Study has been set as: (1) increase the physical and mental happiness of people through the proper management of the river basin; (2) maintain sustainable development with conservation of environment; and (3) realize equitable, balanced and sustainable regional development in the whole basin.

5.2 Identified Issues of Water Use Management

Many problems are raised in answers to the questionnaire survey, etc. (**Annex I5.2.1**). According to diagnosis of these problems from the viewpoint of water use management, major issues to be solved are identified, as follows (**Annex I5.2.2**):

(1) Water Supply to Wide Area

Each PDAM supplies potable water for domestic purpose, including small industrial purposes, etc. However, quantity and quality of supplied water are not sufficient. In addition, there still remain numbers of urban and rural inhabitants who cannot receive portable water supply services. This issue is to be solved mainly from the viewpoint of basic human needs.

(2) Necessity of Sustainable Irrigation and Swamp Development

Irrigation and swamp development is necessary in order to achieve the stable self-reliance of rice and food security at provincial and national level, as well as to realize sustainable regional development. This issue is to be solved in a sustainable way, namely, be developed with the management of water resources that ensures the preservation of the supporting capacity of the environmental and the conservation of water resources.

(3) Water Supply to Farmers in Tidal Swamp Area

Living environment of the farmers in tidal swamp area is undesirable mainly because of difficulties of obtaining drinking and cooking water. This issue is to be solved from the viewpoint of basic human needs.

(4) Conflict between Aquaculture and Irrigation Water Uses

Aquaculture in paddy fields experiences severe conflicts with irrigation. Irrigation water cannot reach to the downstream of irrigation system due to aquaculture. On the other hand from aquaculture side, quantity and quality of water is not stable due to irrigation. This issue should be solved in order to realize equitable and sustainable regional development.

(5) Enhancing Water Utilization for Tourism

Water Resources Service, South Sumatra Province has the intension to utilize water resources to support the tourism development, like canal network improvement at Karang Anyar. However, water utilization of river water is difficult because of flow regimes, etc. This issue should be solved in order to realize balanced and sustainable regional development. In other words, tourism industry is expected to make a significant contribution to the economies and significant role in generating employment opportunities to localities where it is promoted.

(6) Necessity of Water Management Model

It is difficult to manage water resources and use systems in a comprehensive way, because those systems are highly complex. This issue should be solved in order to achieve sustainable development with conservation of environment in the whole Musi River Basin.

5.3 Goals and Strategies of Water Use Management

5.3.1 Goals of Water Use Management

Considering the identified issues, provincial strategies and super goal, the following three goals are established for the water use management, as follows:

(1) To promote water utilization for basic human needs

From the viewpoint of water related basic human needs, the major issues to be solved are: water supply to wide area, covering rural communities and urban poor who do not receive portable water supply services; and water supply to farmers in tidal swamp area, where rainwater is the major water resources for drinking and cooking. In order to increase the physical and mental happiness of those people, water utilization is to be promoted for the use of basic human needs adopting bottom up approach.

(2) To promote water utilization for sustainable development

There is a necessity to develop water utilization of the Musi River Basin, namely, irrigation and swamp development, and tourism development, etc. The development is to be promoted with the management of water resources that ensures the preservation of the supporting capacity of the environmental and the conservation of water resources. Bottom up approach is to be adopted in the promotion.

(3) To develop water management systems

Water management systems are to be developed not from the viewpoint of symptomatic treatments of water use problems. The major necessary systems are: methods of solving the conflicts between aquaculture and irrigation water uses; and water use management modeling of the whole Basin. Solving methods of aquaculture are indispensable since irrigation and aquaculture are important economic sectors in the Basin. On the other hand, the water use management model is a necessary system tools because water resources and use systems are highly complex. For the development, bottom up approach is to be adopted.

5.3.2 Strategies of Water Use Management

In order realize the above three goals, the following six strategies are formulated (**Table I5.3.1**):

(1) To promote sustainable water supply to wide area

Water supply, major component of basic human needs, to rural communities and urban poor, who do no receive portable water supply services, is to be promoted in a sustainable way. In order to make it sustainable, people's participation from the planning stage is necessary.

(2) To promote sustainable irrigation and swamp development

South Sumatra Province is designated as potential food resources area for the rice self-reliance at the national level, and provincial goals of water resources development include supporting stabilization of the rice self-reliance. Therefore, irrigation and swamp development is to be promoted. However, water

consumption of irrigation and swamp development is large, therefore, the development out of control will results in environmental damage and degradation of water resources that ultimately reduces the supporting capacity of the environment and resources, thus endangering the implementation of sustainable development in the Basin. Thus, irrigation and swamp development is to be promoted in a sustainable way. In order to ensure sustainable development, the results of this Study, especially the potential irrigation and swamp development area, should be considered.

(3) To promote utilization of rainwater in tidal swamp area

Rainwater is the major available water resources for drinking and cooking in the tidal swamp area. Therefore, rainwater utilization is to be promoted. However, farmers in the tidal swamp area do not have the facilities to utilize the rainwater effectively. In order to promote the utilization, rainwater storing and sanitation facilities are necessary for the farmers.

(4) To develop solving methods for conflicts between aquaculture and irrigation

Aquaculture and irrigation are important from the viewpoints of their quantities of consumptive water uses as well as economic sectors. Those water use activities will be activated in the future. Therefore, methods for solving these conflicts are to be developed through bottom up approach.

(5) To promote water utilization for tourism

Tourism industry is expected to be a significant economic sector and significant role in generating employment opportunities to localities where it is promoted. Therefore, promotion of water use to support tourism development is necessary for balanced and sustainable regional development. The promotion is to be made adopting bottom up approach.

(6) To develop water management model of Musi River Basin

In order to achieve and realize the sustainable water management, equitable and balanced water uses, and conservation of environment in Musi River basin, water use management model is to be developed. In the modelling, people's participation is necessary in order to make this model sustainable.

Table I5.3.1 Goals and Strategies of Water Use Management

Super Goal of the Comprehensive Water Management	Goals of Water Use Management	Strategies of Water Use Management
(1) Increase the physical and mental happiness of people through the proper management of the river basin; (2) Maintain sustainable development with conservation of environment; and (3) Realize equitable, balanced and sustainable regional development in the whole basin	(1) To promote water utilization for basic human needs	To promote sustainable water supply to wide area
		To promote utilization of rainwater in tidal swamp area
	(2) To promote water utilization for sustainable development	To promote sustainable irrigation and swamp development
		To promote water utilization for tourism
	(3) To develop water management systems	To develop solving methods for conflicts between aquaculture and irrigation
		To develop water management model of Musi River Basin

5.4 Formulation of Programs for Water Use Management

In order to achieve the goals and realize the strategies until target year 2020, following programs are formulated:

5.4.1 Program 1-1: Sustainable Water Supply to Wide Area

(1) Approach of Program

Supply-led approaches had been financially and operationally unsustainable and, therefore, failed to supply clean water to the poor or rural communities. In the Musi River Basin, those situations are almost same, e.g. village systems, etc. Requirement of financial sustainability and improved services for the poor or rural communities resulted in the recognition of water as an economic good.

This conceptual shift was embedded in the Demand-Responsive Approach (World Bank, 1998, *Demand Responsive Approaches to Community Water Supply: Moving from Policy to Practice, East and Southern Africa*), which brings water users into the process of implementing the long-term delivery of water services. The Demand Responsive Approach (DRA) has emerged as an innovative strategy for assisting willing communities to improve their water supply services. It recognizes the existing capacity of communities to take responsibility for identifying and solving their water supply problems. The approach holds potential for improvements in achieving user satisfaction, sustainability and resource mobilization by re-orienting the supply agencies to respond to community demand for improved services. The DRA is to create incentives for communities to improve their water services in a cost-effective and sustainable manner. The approach emphasizes sustainability, and requires

water users be directly engaged in the process of selecting, financing, implementing and managing water services.

This program, sustainable water supply to wide area, is formulated in line with this approach. **Figure I5.4.1** shows key principles of the approach, including relationship between the approach and program.

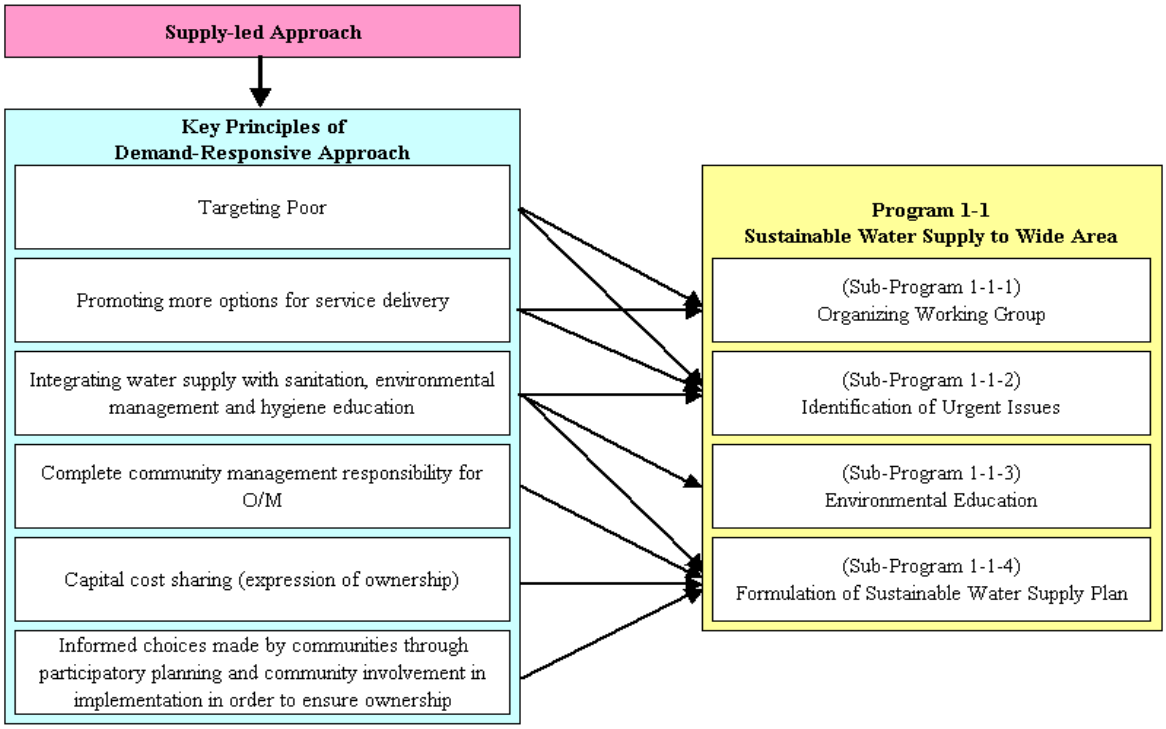


Figure I5.4.1 Relationship of Demand-Responsive Approach and the Program

(2) Objective

Objectives of the program are: (1) to formulate sustainable water supply plan to wide area; and (2) to promote physical and mental happiness of wider people by the plan.

The following table shows drink water resources, indicating large percentage of the households do not receive clean water supply services:

Table I5.4.1 Household Percentage According to Drink Water Resources in South Sumatra Province in 2000

Regency/ Municipality	Pipe	Pump	Protected Well	Non Protected Well	Protected Spring	Non Protected Spring	River	Rainwater	Others
OKU	7.18	0.54	50.04	18.38	3.25	1.64	18.27	0.13	0.55
OKI	5.51	1.11	39.03	17.80	0.14	0.27	29.91	4.21	2.03
Muaraenim	10.95	0.63	37.57	33.31	5.61	0.75	7.93	0.31	2.94
Lahat	5.75	1.16	54.53	18.07	6.95	0.85	12.53	0.00	0.17
MURA	9.82	0.31	42.60	29.58	1.83	1.99	13.73	0.00	0.15
MUBA	2.36	0.47	41.40	11.78	0.11	0.22	13.60	29.49	0.58
Palembang	69.60	0.84	11.21	10.26	0.00	0.00	5.75	1.07	1.26

Source: *"Keadaan Sosial Ekonomi Masyarakat Propinsi Sumatera Selatan Tahun 2000"*, BPS.

(3) Program Area

Whole Musi River Basin

(4) Executing Agency

Water Resources Service of South Sumatra Province, and PDAMs in the Basin, with cooperation of Bengkulu Provincial Government.

PDAMs shall be responsible for implementation of the formulated plan.

(5) Activities

(a) Sub-Program 1-1-1: Organizing Working Group

This sub-program includes the activities of Water Resources Service of South Sumatra Province and PDAMs: (1) opening public consultation in each commanding area; (2) increasing understanding of the program approach; and (3) organizing working groups comprising around 10 members each, representatives of urban poor, rural habitants, NGOs and normal water uses.

(b) Sub-Program 1-1-2: Identification of Urgent Issues

This sub-program includes the activities of Water Resources Service of South Sumatra Province, PDAMs and working groups: (1) understanding household water economy (water availability, access, use, direct financial costs, economic and social returns to water use, flexibility in household expenditure and labor availability, etc.); (2) identifying impacts of changes of water resources and for whom within and between households; (3) understanding relationship between water use and household poverty; and (4) identification of urgent and key issues.

(c) Sub-Program 1-1-3: Environmental Education

This sub-program includes the activities of Water Resources Service of South Sumatra Province, PDAMs and working groups: (1) understanding relationship between water supply, environmental management and public hygiene; and (2) formulating environmental and hygiene education program of how to change a way of life in order to improve their hygiene, etc.

(d) Sub-Program 1-1-4: Formulation of Sustainable Water Supply Plan

This sub-program includes the activities of Water Resources Service of South Sumatra Province, PDAMs and working groups: (1) identifying what intervention benefits which people and what cost; (2) identifying appropriate technological choices; (3) holding public consultation; and (4) formulating sustainable water supply plan to wider people including hygiene education program.

(6) Cost and Beneficiaries

(a) Program Cost

Plan Formulation: 13 (person) x 18 (month) x 4 (day/month) x 150,000 (Rp./day) x 8 (PDAM) = Rp. 1,123.2 million

PC: 100 (person/day) x 150,000 (Rp./day) x 2 (time) = Rp. 30 million

Administration (5%): Rp. 57.7 million

Total: Rp. 1,210.9 million

This program cost should be burden by Service.

(b) Beneficiaries

Urban poor and rural communities in the Basin, who do not receive clean water supply (about 5.5 million persons, as of 2000)

(7) Implementation Schedule

Implementation period is 1.5 years (**Figure I5.4.7**).

(8) Environmental Impacts

This program is to improve the water supply conditions of urban poor and rural communities. Therefore, no significant negative impacts are expected.

5.4.2 Program 1-2: Sustainable Irrigation and Swamp Development

(1) Concept of Sustainable Development

Based on Study for Formulation of Irrigation Development Program (1993, JICA), South Sumatra Province is designated as potential food resources area for the rice self-reliance at the national level, given 120% of the self-reliance rate of Zone 2 (South Sumatra, Jambi, Bengkulu and Lampung) and about 300,000ha of irrigation development in South Sumatra Province until 2018. And the provincial goals of water resources development include supporting stabilization of the rice self-reliance.

In line with this context, this program, sustainable irrigation and swamp development, is proposed in order to promote stable self-reliance of rice and food security at provincial and national level. The development must be sustainable way, namely water resources utilization must proceed with control, ensuring the conservation of water resources and environment.

Figure I5.4.2 shows concept flow of this sustainable development. In the concept flow, there are four main subjects, re-establishing development target, pre F/S, F/S and D/D, as follows:

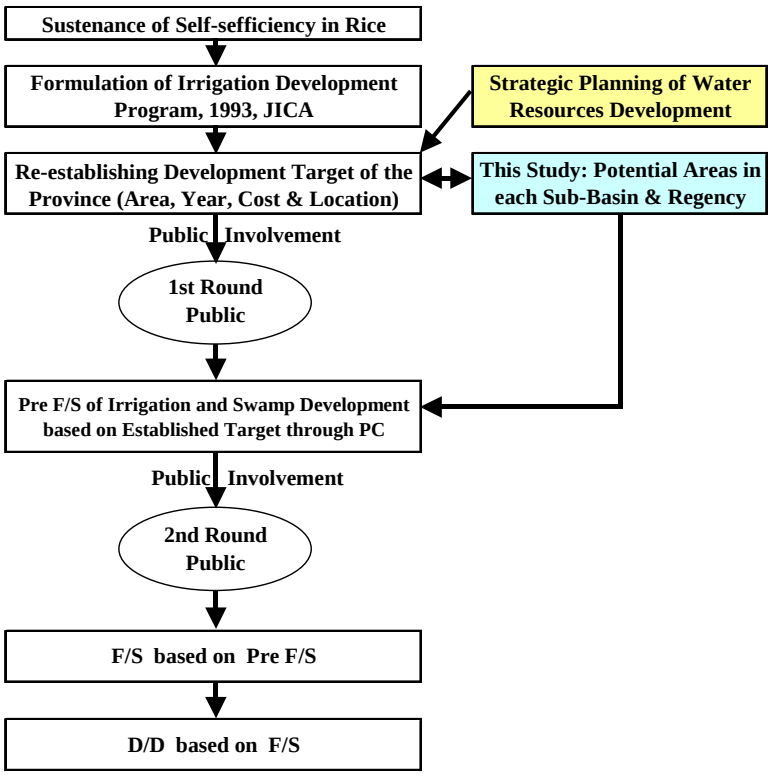


Figure I5.4.2 Concept Flow of Sustainable Development

(a) Re-establishing Development Target

In re-establishing development target (development area, target year, project location and investment cost, etc.) based on Study for Formulation of Irrigation Development Program, the following three viewpoints must be considered:

(i) Potential Irrigation and Swamp Area

As the results of this Study, it may be concluded that full irrigation development and some swamp development in the Basin will meet said 300,000ha of irrigation development ("**4.2.2 (3) Potential Development and Rice Self-Reliance**", and **Table I5.4.2**).

Table I5.4.2 Potential Development Area in the Basin

Development Type	Potential Development Area (ha in equivalent double cropping)
Technical	86,200
Semi Technical	28,600
Simple	4,540
Communal	87,200
Non-tidal	158,000
Tidal	219,000

In addition to this conclusion, **Figure I5.4.4** shows potential irrigation and swamp area, determined on the potential land and water resources, in each regency/municipality and sub-basin (for detailed figures, refer to **Annex I4.2.4**).

(ii) Paddy Supply and Demand

The following figure shows concept of paddy supply and demand of the Province. The paddy demand is foreseeable based on the projected population and projection of per capita rice consumption. On the other hand, the paddy supply depends upon the irrigation and swamp development speed determined by target year and target development area. Therefore, the target year, target development area and investment cost should be determined firstly based on the national and provincial policies/intensions to food/rice security with mutual consent.

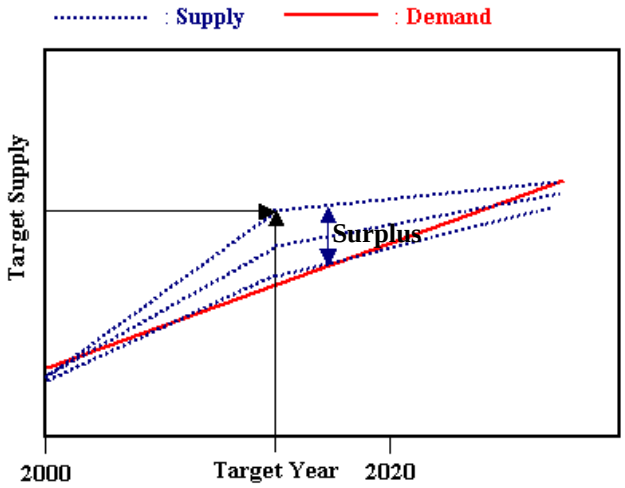


Figure I5.4.3 Concept of Paddy Supply and Demand

(iii) Public Consultation

Roles of communities, WUAs and local governments are important in the irrigation and swamp development. Therefore, public consultation will be held, mainly aiming at:

- Providing community's intension
- Participating in establishing development target and decision making
- Educating themselves on irrigation water conservation

(b) Pre F/S

Pre F/S will be carried out in order to clarify the irrigation and swamp development based on the established target. The scope of this pre F/S will include:

- Survey on water, land and human resources
- Survey on soil conditions and cropping pattern
- Irrigation and drainage planning
- Natural and social environment
- Cost estimates and implementing schedule
- Economic and financial analysis

(c) F/S

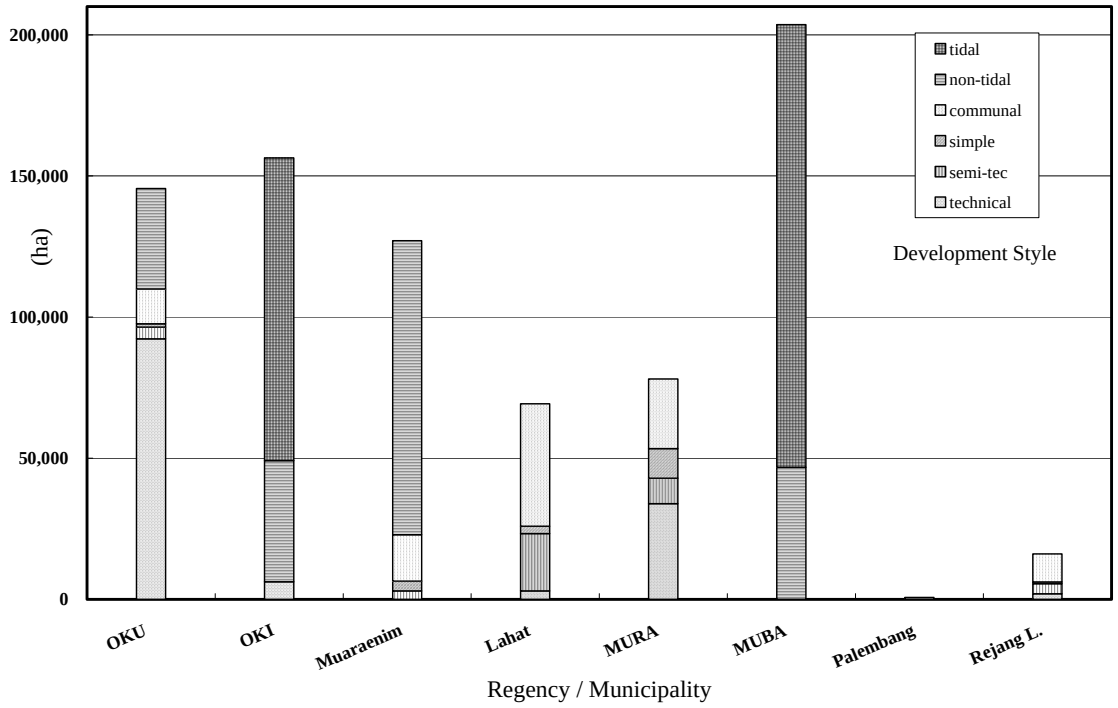
F/S will be carried out based on the pre F/S. The scope of F/S will include:

- Supervision of sub-contracted works
- Collection and review of existing data and information
- Survey of project area (natural, socio-economical and environmental conditions)
- Formulation of development plan
- Environmental study
- Formulation of implementation plan
- Cost estimation
- Project evaluation

(d) D/D

D/D will be carried out with the following scope:

- Detailed design and drawing
- Construction planning and cost estimate
- Preparation of tender document



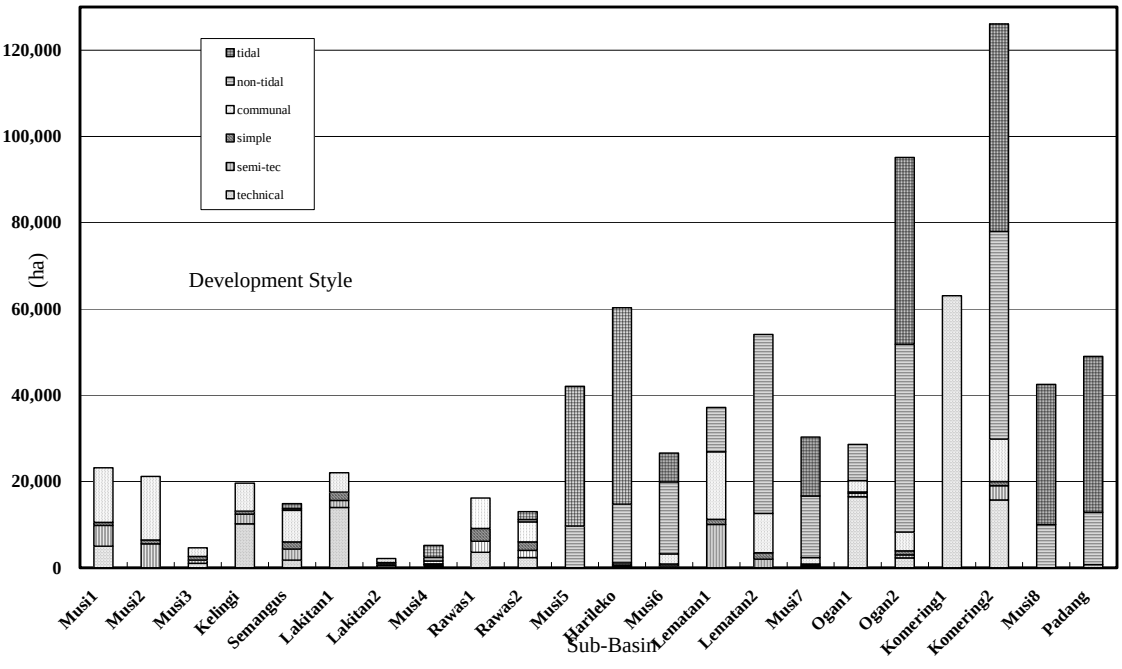


Figure I5.4.4 Potential Irrigation and Swamp Area

(2) Objective

Objectives of the program are: (1) to promote stable self-reliance of rice and food security at provincial and national level; and (2) to carry out Pre F/S, F/S and D/D aiming to realize sustainable irrigation and swamp development in South Sumatra Province.

(3) Program Area

South Sumatra Province

(4) Executing Agency

Ministry of Settlement and Regional Infrastructure, and Water Resources Service of South Sumatra Province with cooperation of Jambi, Bengkulu and Lampung Provincial Governments

(5) Related Agency

Regency/Municipality Governments in the Province: responsible for providing data and information, and participation to PC as representative of the residents to contribute establishing development target and decision making.

(6) Activities

(a) Sub-Program 1-2-1: Establishing Development Target of the Province

This sub-program includes the activities of Ministry and Service: (1) determining target areas and year of irrigation and swamp development based on the results of this Study; (2) determining candidate locations for irrigation and swamp development; and (3) holding public consultation.

(b) Sub-Program 1-2-2: Implementation of Pre F/S

This sub-program includes the activities of Ministry and Service: (1) preparation of Pre F/S; (2) executing Pre F/S; and (3) holding public consultation..

(c) Sub-Program 1-2-3: Implementation of F/S

This sub-program includes the activities of Ministry and Service: (1) preparation of F/S; and (2) executing F/S.

(d) Sub-Program 1-2-4: Implementation of D/D

This sub-program includes the activities of Ministry and Service: (1) preparation of D/D; and (2) executing D/D.

(7) Cost and Beneficiaries

(a) Program Cost

(i) Establishing Development Target

Establishment: 90 (day) x 150,000 (Rp./day) = Rp. 13.5 million

PC: 100 (person/day) x 150,000 (Rp./day) = Rp. 15 million

Administration (5%): Rp. 1.4 million

Sub-total: Rp. 29.9 million

(ii) Pre F/S

Engineering: 120 (m/m) x 15 (Rp. million/m/m) = Rp. 1,800 million

Administration (5%): Rp. 90 million

PC: Rp. 15 million

Sub-total: Rp. 1,905 million

(iii) F/S

Total irrigation and swamp development area of around 80,000ha is assumed in the following cost estimates:

Engineering: 80 (m/m) x 200 (Rp. million/m/m) = Rp. 16 billion

Investigation: Rp. 4 billion

Administration (5%): Rp. 1 billion

Sub-total: Rp. 21 billion

(iv) D/D

Total detailed design area of around 80,000ha is assumed in the following cost estimates:

Engineering(1): 300 (m/m) x 150 (Rp. million/m/m) = Rp. 45 billion

Engineering(2): 1,200 (m/m) x 15 (Rp. million/m/m)= Rp. 18 billion

Investigation: Rp. 15 billion

Administration (5%): Rp. 3.9 billion

Sub-total: Rp. 81.9 billion

(v) Total

Rp. 104,834.9 million

(b) Beneficiaries

Direct, Province population 6.9 million persons (2000); indirect, 206 million population of Indonesia (2000)

(8) Implementation Schedule

Implementation period is 8.5 years (**Figure I5.4.7**).

(9) Environmental Impacts

Potentially significant negative impacts of swamp development are predicted, as follows:

(a) Pyrite oxidation/ soil toxicity causing plants to die

(b) Construction of water management structures causing destabilized water table, may leading to drought in the area (optimal gate operation is required)

(c) Reclamation causing damages of mangrove forests, may leading to hazard to wildlife

(d) Reclamation of swamp areas possibly causing hazardous to fish and wildlife

In any way, development is to be necessary to conform to GOI regulations and to prepare an environmental impact assessment (AMDAL) in advance.

5.4.3 Program 1-3: Rainwater Utilization in Tidal Swamp Area

(1) Method of Rainwater Utilization

(a) Rainwater Storing Facilities

The rainwater (about 2,000 mm/year) will be stored during rainy season, and utilized for drinking and cooking during dry season. There are two facility alternatives of how to tap the rainwater, as follows:

Alternative 1: Individual Water Tank

Storage Capacity: 10 (liters/person/day) x 4 (person/household) x 100 (days) – 1,000 (existing steel drums, etc.) = 3,000 (liters/household)

Polyethylene water tank with 3 m^3 is considered in this Program.

Alternative 2: Communal Rainwater Pond

Rainwater collection pond of reinforced concrete structure

Alternative 1 is recommendable because this method is already successfully practiced under fore mentioned South Sumatra Swamp Improvement Project, JBIC (domestic water tank 13,284 units, **Photo I5.4.1**). On the other hand, alternative 2 has the difficulty in the rainwater collection because the conditions of gutters and conduit pipes are not suitable.

Photo I5.4.1 Domestic Water Tank Provided by SSSIP

(b) Sanitation Facilities

With the rainwater storing facilities, only drinking and cooking water will be stored. Therefore, washing and bathing water will be still surface water. Under this situation, the focus is the water related diseases. Hence, sanitation facilities are necessary at the same time.

Mostly, type of human waste disposal in the area is toilet on river/canal. Considering water conditions of the area, toilet with pit privy should be avoided because the pit is filled with water when tidal water is high. Therefore, septic tank should be designed to place on the ground.

(2) Objective

Objectives of the program are: (1) to provide rainwater storing and sanitation facilities to farmers in tidal swamp area; and (2) to increase the physical and mental happiness of the farmers.

(3) Program Area

Tidal swamp areas in South Sumatra Province

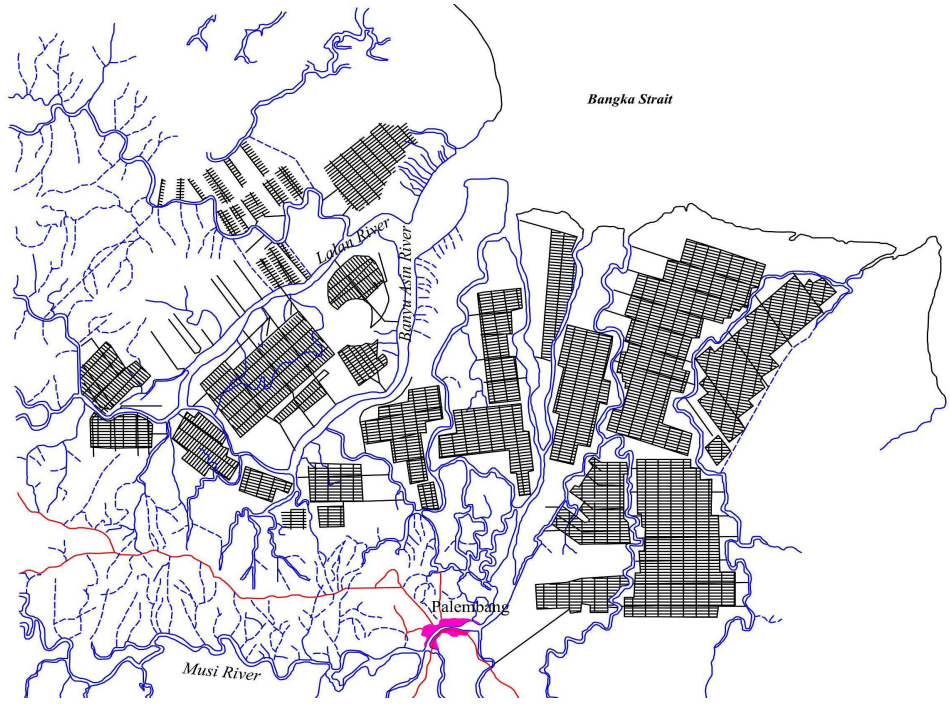


Figure I5.4.5 Location of Resettlement Areas in Tidal Swamp Area

(4) Executing Agency

Water Resources Service of South Sumatra Province, and OKI, MUBA and Banyuasin Regency Governments

(5) Activities

(a) Sub-Program 1-3-1: Preparation

This sub-program includes the activities of OKI, MUBA and Banyuasin Regency Governments under the coordination of Service: (1) surveying number of the target farmers, their present facilities of water supply and sanitation, and costs; and (2) opening public consultation.

(b) Sub-Program 1-3-2: Proving Rainwater Storing and Sanitation Facilities

This sub-program includes the activity of OKI, MUBA and Banyuasin Regency Governments under the coordination of Service: (1) providing one water tank and one septic tank to each subject household.

(6) Cost and Beneficiaries

(a) Program Cost

(i) Facilities

Facilities: 2 (Rp. million/HH: water tank 1 million and septic tank 1 million) x 92,000 (HH) = Rp. 184 billion

- OKI (10%): Rp. 18.4 billion
- MUBA (25%): Rp. 46 billion
- Banyuasin (65%): Rp. 119.6 billion

Preparation and Administration (8%): Rp. 14.7 billion

- Province: Rp. 1.8 billion (1% of Facilities Cost)
- OKI: Rp. 1.3 billion (10% of the rest)
- MUBA: Rp. 3.2 billion (25% of the rest)
- Banyuasin: Rp. 8.4 billion (65% of the rest)

Total: Rp. 198.7 billion

- Province: Rp. 1.8 billion
- OKI: Rp. 19.7 billion
- MUBA: Rp. 49.2 billion
- Banyuasin: Rp. 128 billion

(b) Beneficiaries

Around 370,000 persons (92,000 households) in the tidal swamp area, mostly in former MUBA (2002)

(7) Implementation Schedule

Implementation period is 10 years (**Figure I5.4.7**).

(8) Environmental Impacts

This program is to improve living conditions of the farmers in tidal swamp area through providing rainwater storing and sanitation facilities. Therefore, no significant negative impacts are expected.

5.4.4 Program 1-4: Aquaculture Water Management

(1) Method of Water Management

Aquaculture practiced in the Basin can be classified into fishpond, paddy field, fish cage and fence. The major issues relating water management occur in the aquaculture in fishpond located in paddy field especially in MURA, namely there are conflicts between aquaculture and irrigation. These conflicts are:

- From irrigation side: irrigation water cannot reach to the downstream of irrigation system because the aquaculture use is not included in the scope of original system design.
- From aquaculture side: quality and quantity of water are not stable due to the influence of irrigation.
- From operational aspect: operation of checks and intake gates becomes complicated because their water use patterns are different.

In order to solve the conflicts, areas for aquaculture and irrigation are better to be separated from the viewpoint of water management, e.g. check/gate operation and farm conditions, etc. If land uses cannot be controlled, aquaculture areas are better to be gathered by reallocation or exchange of farm lots.

(2) Objective

Objectives of the program are: (1) to develop solving methods of conflicts between aquaculture and irrigation water uses; and (2) to realize equitable and sustainable regional development in the Basin.

(3) Program Area

Whole Musi River Basin (59,932 km^2)

At present, conflicts between aquaculture and irrigation occur in the Basin. The following table shows present aquaculture areas:

Table I5.4.3 Present Aquaculture Area of Fishpond (ha)

OKU	OKI	Muaraenim	Lahat	MURA
3,550	164	409	1,552	703

MUBA	Palembang	Pagaralam	Prabumulih	Rejang L.	Total
275	29	169	12	545	7,408

(4) Executing Agency

Water Resources Service, Agriculture Service and Fishery Service of South Sumatra Province with cooperation of Bengkulu Provincial Government.

(5) Related Agency

Regency/Municipality Governments in the Basin: responsible for providing data and information, participation to PC as representative of the residents to contribute formulating solution methods, and execution of solution methods to solve the conflicts.

(6) Activities

(a) Sub-Program 1-4-1: Researching Solution Methods

This sub-program includes of the activities of Services: (1) holding public consultation; (2) investigating situations of conflicts, including their background and history, locations, numbers of cases, land tenure system, etc.; and (3) surveying methods of reallocation or exchange of farm lots, consisting of (may be similar to the methods adopted in land consolidation):

- Intension survey on reallocation or exchange of farm lots
- Cadastral mapping
- Evaluation of farm lots
- Determination of prices of the lots
- Liquidation methods
- Registration of reallocated or exchanged lands

(b) Sub-Program 1-4-2: Disseminating of the Methods

This sub-program includes the activity of Services: (1) disseminating the methods to regencies/municipalities.

(7) Program Cost

PC: 100 (person/day) x 150,000 (Rp./day) = Rp. 15 million

Research and Dissemination: 3 (person) x 24 (month) x 5 (day/month) x 150,000 (Rp./day) = Rp. 54 million

Administration (5%): Rp. 3.5 million

Total: Rp. 72.5 million

(8) Implementation Schedule

Implementation period is 2 years (**Figure I5.4.7**).

(9) Environmental Impacts

This program is to solve conflicts between aquaculture and irrigation by gathering farm lots. Therefore, potential negative impacts accrue from the liquidation of land exchange. On the other hand from natural environment, no significant negative impacts are to be expected.

5.4.5 Program 1-5: Enhancing Water Utilization for Tourism

(1) Context of Program and Situation Addressed

Strategic Planning of Water Resources Development, South Sumatra Province, stipulates that the Government of South Sumatra Province develops and utilizes the water resources to support the developments of the superior sectors, including tourism sector. Being a highly labor-intensive industry, tourism is expected to make a significant contribution to the economies and significant role in generating employment opportunities to localities where it is promoted. However, the river water utilization is difficult because of flow regimes, etc. There is therefore a need to enhance the water utilization for tourism for balanced and sustainable regional development in the Basin. Related project is one being carried out by Water Resources Service of South Sumatra Province, Strengthening of Water System Maintenance in Karang Anyar, Palembang.

(2) Objective

Objectives of the program are: (1) to support tourism development by promotion of water utilization; and (2) to realize balanced and sustainable regional development in the Basin.

(3) Program Area

Whole Musi River Basin (except for Palembang because of on-going Karang Anyar project)

(4) Executing Agency

Water Resources Service of South Sumatra Province, and Regency/ Municipality Government in the Basin with cooperation of Bengkulu Provincial Government

(5) Activities

(a) Sub-Program 1-5-1: Survey, Investigation and Design (SID)

This sub-program includes the activities of Regency/ Municipality Governments under the coordination of Service with cooperation of Bengkulu Provincial Government: (1) opening public consultation; (2) selection of program site (one site per one Regency/Municipality); (3) collection of natural, economical and social data including traffic and

communication, etc.; and (4) SID of water network and financial analysis. Candidates of program sites are, as follows:

Table I5.4.4 Candidates of Tourism Resources for Program

Regency/ Municipality	Candidates of the Program
OKU	Bendali Rantau K, Ranau Lake, etc.
OKI	Teluk Gelam Lake, Lebung Karangan, etc.
Muaraenim	Gemuhak Hot Water, Segayam Lake, etc.
Lahat	Tepian Lematang, Ribang Gayau, etc.
MURA	Rayo Lake, Karya Sakti Hot Water, etc.
MUBA (new)	Sekayu, etc.
Banyuasin	Padang River, etc.
Pagaralam	Thebat Gheban, Lematang Water Fall, etc.
Prabumulih	Bunut Lake, etc.
Rejang Lebong	Talang Kering Lake, Air Sempiang Water Fall, etc.

(b) Sub-Program 1-5-2: Implementation

This sub-program includes the activities of Regency/ Municipality Governments under the coordination of Service with cooperation of Bengkulu Provincial Government: (1) implementation of Program; and (2) tourism education to society.

(6) Cost and Beneficiaries

(a) Program Cost

SID and Implementation: Rp. 5 billion (per site, assumed based on Karang Anyar) x 10 (site) = Rp. 50 billion

Administrative (5%): Rp. 2,500 million
- Province: Rp. 250 million
- Each Regency/Municipality: Rp. 225 million

Total: Rp. 52,500 million
- Province: Rp. 250 million
- Each Regency/Municipality: Rp. 5,225 million

(b) Beneficiaries

4.9 million persons (2002)

(7) Implementation Schedule

Implementation period is 5 years (**Figure I5.4.7**).

(8) Environmental Impacts

This program is to support tourism development by enhancing water utilization, e.g. construction of canals and ponds. Significant negative impacts are not expected from the natural and social environmental points of view.

5.4.6 Program 1-6: Modeling of Water Use Management

(1) Concept of Modeling

The water use management model will facilitate the testing of development scenarios (unique combination of hydrological conditions, water demands and proposed interventions) proposed by planners (e.g. MP Team mentioned in draft New Governmental Regulation, Article 24), leading to statements of the environmental impacts associated with each scenario. The model must be designed to ensure replicable and auditable tests, and to be accessible in a secure manner to planners.

Three main elements of the model are, as follows (**Figure I5.4.6**):

(a) Information and Knowledge Base

The information and knowledge base will be a comprehensive system covering all aspects of water resources development in the Basin. The base is expected to be dynamic, and should undergo progressive updating by Musi Balai PSDA and related agencies. It is important therefore that the user interfaces and data structures are designed to permit this easily. The base will include, but not be restricted to:

- Primary hydrological (quantity, quality) databases
- Primary water use databases, including both consumptive and non-consumptive uses and detailed information on existing water-related infrastructure
- Socio-economic databases
- Land use and soils databases (GIS)
- Elevation models of floodplains (GIS)
- River cross sections
- Freshwater and estuary ecosystems, fisheries and environmental databases
- Results of modeling runs and impact assessment

(b) Basin and Environmental Modeling

Containing the primary simulation models (hydrological, basin simulation and hydrodynamic models) and the secondary models (water quality, sediment and environment as required).

The adopted hydrological model should have a strong conceptual and deterministic base, and should be a continuous simulation model, running on as long a period of homogeneous historical rainfall records as can be constructed. The model should be able to be run on daily or monthly time steps. Data permitting, the objective should be to use daily data.

The basin simulation model will be the core of the Modeling. It is a tool through which the impacts of water resources developments, such as irrigation, hydropower, and wastewater discharge are synthesized on water availability and quality downstream. The model will permit integration of impacts from a wide variety of developments with complex or simple operational procedures. The model will be driven by inputs derived from observed stream-flow and data generated by the hydrological model. It is expected to run in a continuous simulation mode. It will represent the river system, major infrastructure, and diversions and return flows from uses from the main stream and its tributaries. The model will be demonstrated to be capable of modeling pollutant and sediment transport, albeit in a simplified manner. Multi-purpose reservoir simulations will be required, incorporating complex operational rules, and permitting synthesis of power production. Among other things, output from the model will include time series of river flows and quality at desired locations, reservoir operations, hydropower production, irrigation diversions and demands, and drainage returns.

The hydrodynamic model should extend from midstream include the river mouth delta and major swamp canals. The hydrodynamic model would be run with upstream inputs from the basin simulation and hydrological models. The hydrodynamic model will include water quality components. The model will include salinity, as saline intrusion is an impact of water resources development. Erosion/sedimentation, acidification and pollution are also important considerations.

(c) Impact Assessment Tools

Most of the environmental and socio-economic impacts will be associated with the aquatic environment, and consideration must be given to the development of appropriate indicators, through which potential impacts can be captured. In line with this idea, tools for the determination and assessment of environmental and socio-economic impacts will be developed. The hydrodynamic model should provide primary data for development of the indicators. It will also be important to consider

navigation requirements, and the potential impact of changes in flow on this.

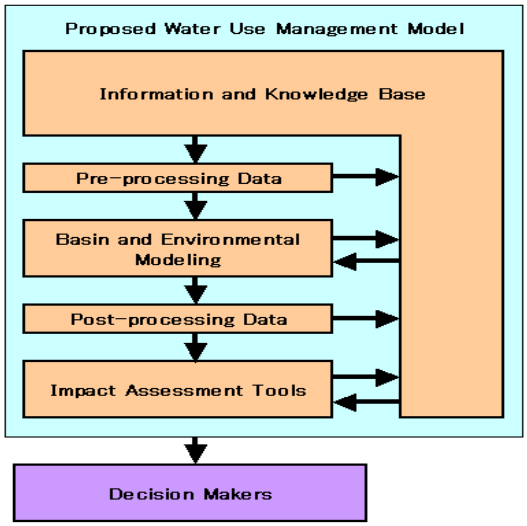


Figure I5.4.6 Proposed Water Use Management Model

(2) Objective

Objectives of the program are: (1) to promote a mechanism to improve sustainable water management in the Basin; (2) to promote equitable and balanced water uses in the Basin; and (3) to enhance conservation of environment of the Basin.

The program will contribute: (1) supporting decision making (not a substitute for decision making); (2) providing effective and replicable outputs; (3) transparent and flexible management; and (4) scenario management.

(3) Program Area

Whole Musi River Basin (59,932 km^2)

(4) Executing Agency

Ministry of Settlement and Regional Infrastructure, and Water Resources Service of South Sumatra Province with cooperation of Jambi, Bengkulu and Lampung Provincial Governments

(5) Related Agency

Forestry Service of South Sumatra Province, Meteorological and Geophysical Agency (BMG) and Regional Technical Implementation Unit (UPTD): responsible for assistance of model development, updating of information and knowledge base, data preparation and participation to workshops and training.

(6) Activities

(a) Sub-Program 1-6-1: Information and Knowledge Base Development

This sub-program includes: (1) review of relevant programs; (2) identify actual modeling needs and data requirement; (3) database structures, and computer and communication networks; (4) database access; (5) preparation of procurement packages; (6) information and knowledge base development; and (7) public consultation/workshop.

(b) Sub-Program 1-6-2: Basin Modeling Development

This sub-program includes: (1) hydrological review; (2) review of historic water resources development and water use; (3) review of available models; (4) design of modeling structure; (5) preparation of procurement packages; (6) development of models; and (7) workshop.

(c) Sub-Program 1-6-3: Environmental Analysis and Modeling

This sub-program includes: (1) identification of data needs; (2) tools for impact analysis; (3) environmental assessments; (4) scenario modeling and evaluation; and (5) workshop.

(7) Cost and Beneficiaries

(a) Program Cost

Engineering: 60 (m/m) x 200 (Rp. million/m/m) = Rp. 12,000 million

Hardware, Software and Workshop: Rp. 900 million

Administration (5%): Rp. 645 million

Total: Rp. 13,545 million

(b) Beneficiaries

Basin population 6.3 million persons (2002)

(8) Implementation Schedule

Implementation period is 2 years (**Figure I5.4.7**).

(9) Environmental Impacts

This program is to establish systems for sustainable water management in the Basin. Therefore, no significant negative impacts are expected.

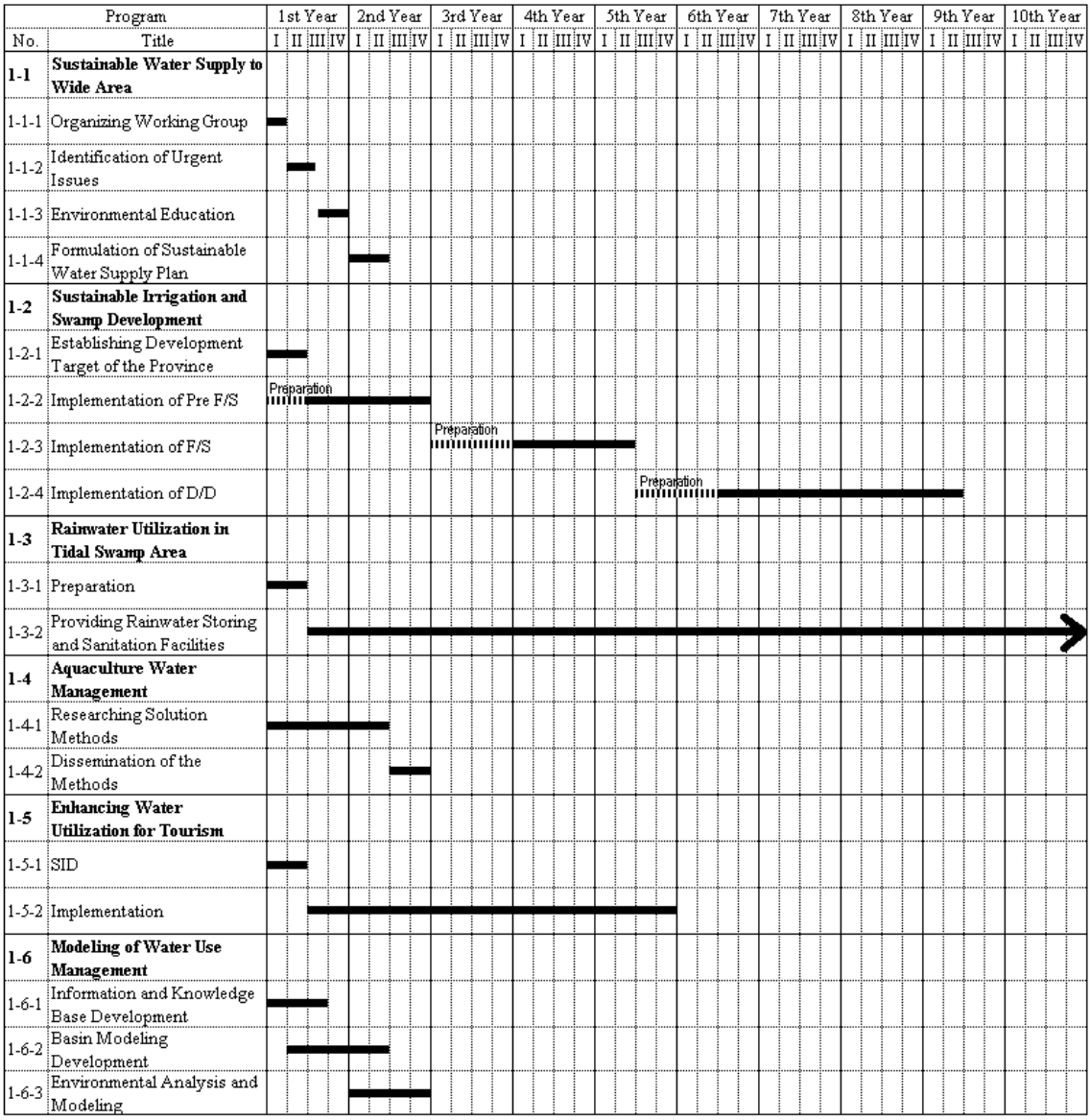


Figure I5.4.7 Implementation Plan of Water Use Management Programs