3.6.5 Water Allocation between Irrigation and Fishpond

It has been recognized in the Government Regulation No. 77/2001 that irrigation water-use has been given priority to agricultural activities, especially rice fields. However, because this regulation has not been widely socialized, most farmers at the grass root level are not aware about the regulation.

The fishpond owners recognize that irrigation water be used mainly for food crop production. They admit that while operating the business they receive complain from the farmers. The reason was damage of the canal being diverted and water shortage for paddy field. Farmers, in contrary, said that most of the water being used for fishpond is drained-out to the river or surrounding lowlands. With this situation, more farmers demand that fishponds should not be allowed to use irrigation water. Despite the fact that there has been regulation in WUA that applies to fishponds, the actions taken by WUA is considered insufficient to solve water use conflicts between fishpond and rice field. Therefore, farmers are unsatisfied with the current actions made by WUAs.

3.6.6 Development and Conservation in Swamp Area

The sustainability of the swamp development projects depends on the following conditions: Enough government commitment to integrate lowland development as a center for driving force; Enough inter-agencies coordination in lowland management; and Full community involvement in project planning and implementation. Without such circumstances of the projects, the outcomes would be successful only partially.

3.6.7 Komering Irrigation Project and Its Social Impacts

Between 1970s and 90s, drought in the Komering River happened only during the dry season. The cause of **drought** was riverbed siltation due to sedimentation at the river channel. The respondents think that this situation has been worsened since the operation of the Perjaya Headworks. In 2001, the drought incidence happened in the period of June to December with the situation worsened by the lengthened dry season.

Difference of benefits between local people and transmigrants in irrigation projects and social impacts were identified. **Positive impacts** of the irrigation development as reported by respondents are: public transportation services and facilities increase; trade activities increase; information accessibility increase; and direct benefits from sand and stone trading. **Negative impacts** of the Belitang irrigation development as reported by respondents are: Household income decrease due to the decrease in production of food crops, tree/fruit crops, and fish as a result of water shortage in the Komering River presumably caused by the development of Belitang irrigation schemes; Psychologically, local people feel to be subordinate to people in Belitang since development activities (especially agriculture) have been focused more to Belitang than to local villages.

3.6.8 Survey on Water Level Increase in Ranau Lake and the Regulation Dam

The Ranau Regulation Dam is being operated with the "Tentative HWL" of 541.7 m (Effective Depth: 1.2 m) of Ranau Lake from 1995. JICA Study Team conducted in

2003 an interview survey about the impacts of the increase in water level of the Lake Ranau to residents living adjacent to the lake. Most of the respondents (93.5 %) have experienced floods in the rain season from between 1995 to 1998, which depends on their locations, although they had never experienced any flood incidences before 1995. All the respondents reported that their paddy fields would be inundated if the water level increased above the current level. More than 60 % of the respondents mentioned that their houses would be inundated.

3.7 Hydrological Analysis

3.7.1 Hydrological Observation Condition

The hydrological data in the Musi River Basin is observed mainly by two agencies, BMG and Musi Balai PSDA, and management is also performed separately. **Rainfall observation** has been conducted by Musi Balai PSDA at 14 gaging stations and by BMG at more than 39 stations in and around the Musi River Basin. According to the inventory, installation period of gaging station was missing, and the oldest data on record was in the beginning of 1970s.

Presently, Musi Balai PSDA is the principal agency responsible for the **water level observation** in the rivers of the Musi River Basin. There are a total of 22 automatic water level gages with staff gage. The daily water level has been observed by PWRS of South Sumatra since the beginning of 1970s. Hourly water level is available after 1985. **Discharge measurements** have been carried out from the beginning of 1970s at 52 stations. The Center of Research and Development in Bandung develops the rating curve, and estimates the daily discharge. Discharge measurements, as well as water level and rainfall observations, were suspended starting from 2002.

The proper institutional approach for **management** of hydrological activities has not been developed, even with the establishment of Musi Balai PSDA. Therefore, the strengthening of hydrology activities as the primary responsibility of the Balai PSDA in fiscal year 2002 was recommended under the Project IWIRIP.

3.7.2 Rainfall Analysis

The probable 12-hour rainfall was calculated from the data observed at Kenten Station from 1994-2001 as shown in **Table 3.7.1**.

Table 3.7.1 Probable 12-hour Rainfall (Kenten Station at Palembang)

Return Period	1/2	1/5	1/10	1/15	1/20	1/30	1/50	1/100
Probable Rainfall (mm)	104.0	122.5	133.9	140.8	145.3	151.8	160.1	171.1

3.7.3 Runoff Analysis on Flow Regime Estimation

The Runoff Analysis was carried out at each sub-basin to fill gaps in discharge time series data for the water balance analysis. The runoff model was established by using the software MIKE 11. Data between 1985 and 2001 collected from BMG and data of Musi Balai PSDA from 1985 were used. Results are shown in **Table 3.7.2**.

Table 3.7.2 Natural Flow Regime Resulting from Simulation

(m^3/s)

No.	Sub-Basin	C.A. (km^2)	25%	50%	75%	95%	Ave.(wet)	Ave.(dry)	Annual Ave.	
									m^3/s	$m^3/s/100km^2$
1	KO1	4,527	72.8	116.5	188.2	305.8	308.3	163.9	235.9	5.2
2	KO1+KO2	9,908	144.4	229.3	390.5	613.4	608.8	283.1	445.6	4.5
3	OG1	3,990	35.3	58.0	101.6	194.9	193.1	71.9	132.4	3.3
4	OG1+OG2	8,222	73.2	116.4	217.9	388.5	389.7	141.0	265.1	3.2
5	LE1	3,930	61.5	87.3	118.1	201.1	223.4	131.2	177.2	4.5
6	LE1+LE2	7,340	103.1	148.0	231.6	376.1	396.5	197.9	297.0	4.0
7	SE	2,146	19.9	32.6	50.9	72.6	71.9	40.1	56.0	2.6
8	LA1	2,290	23.0	37.8	57.1	88.5	91.8	47.8	69.8	3.0
9	LA1+LA2	2,763	28.1	45.9	69.7	106.9	109.8	57.6	83.6	3.0
10	RA1	3,548	40.1	72.6	116.0	189.4	181.5	114.0	147.7	4.2
11	RA1+RA2	6,026	64.4	104.3	164.9	262.4	256.0	151.5	203.6	3.4
12	KE	1,928	20.1	33.3	52.4	79.3	81.2	41.3	61.2	3.2
13	HA	3,765	46.7	83.3	130.4	209.2	195.0	122.7	158.8	4.2
14	Before KE	6,142	124.7	171.2	229.3	358.3	429.5	229.6	329.3	5.4
15	After RA	19,569	329.7	466.6	681.4	1,015.7	1,032.2	562.9	797.0	4.1
16	After LE	34,821	550.0	798.4	1,191.8	1,776.8	1,774.5	944.1	1,358.4	3.9
17	After KO	54,773	868.8	1,271.1	1,911.0	2,976.2	2,920.7	1,440.0	2,178.7	4.0

KO: Komering, OF: Ogan, LE: Lematang, SE: Semangus, LA: Lakitan, RA: Rawas, KE: Kelingi, HA: Harileko

3.7.4 Flood Routing Simulation for Musi River and Tributaries

The Flood Routing Simulation was carried out for the purpose of estimating the peak discharge of flood and its probability. The Kinematic Channel Routing Module was applied. **Table 3.7.3** shows the probable discharge.

Table 3.7.3 Probable Discharge Resulting from Simulation

(m^3/s)

R.P.(Year)	Musi[1]	Musi[2]	Komering	Ogan	Lematang	Semangus	Kelingi	Lakitan	Rawas	Harileko
2	2,610	4,078	899	690	823	146	168	233	625	445
3	2,872	4,381	990	783	925	171	192	271	771	580
5	3,165	4,718	1092	886	1,039	199	218	313	934	729
10	3,532	5,142	1,221	1,017	1,182	234	251	367	1,138	917
20	3,884	5,549	1,344	1,141	1,319	267	282	418	1,334	1,097
50	4,339	6,076	1,503	1,303	1,496	311	323	484	1,588	1,330
100	4,681	6,470	1,622	1,424	1,629	343	354	534	1,778	1,504

Musi[1]:Tebing Abang, Musi[2]: After confluence of the Komering River

3.7.5 Runoff and Inundation Analysis for Palembang Drainage Planning

To identify the probable flood inundation area, the inundation analysis was carried out for Palembang. The target area covering almost all of Palembang City of about 400 km^2 is divided into 19 catchment areas considering the existing drainage network system. The Storage Function method is employed as the flood run-off model for sub-basins.

3.7.6 Sedimentation

Between 1986 and 1987, the Ministry of Public Works, Institute of Hydraulic Engineering carried out a sediment load survey. Based on the rating curve presented in the survey and the data collected in the present study, the total amount of sediment between 1988 and 1998 was calculated. The estimation and survey results give 5.02 million tons of annual average total sediment. Hence, the annual average specific sediment load (the catchment area at Martapura is 4,320 km^2) is estimated at 3.18 ton/day/km^2.

3.8 River Conditions, Flooding and Inundation

3.8.1 Present River Morphological Condition

The Musi main stream and most of the major tributaries originate in the Barisan Range. The Musi River originates at Mt. Dempo (3,159m) and flows to the northward, joining the Kelingi, Semangus, Lakitan and Rawas rivers. At the confluence of the Rawas River, the Musi River changes its flow direction toward east and joins the Harileko and Lematang rivers before it reaches at Palembang City. Two large tributaries, the Ogan and Komering rivers, join from the right bank at Palembang. The Musi River Basin is shown in **Figure 3.8.1**.

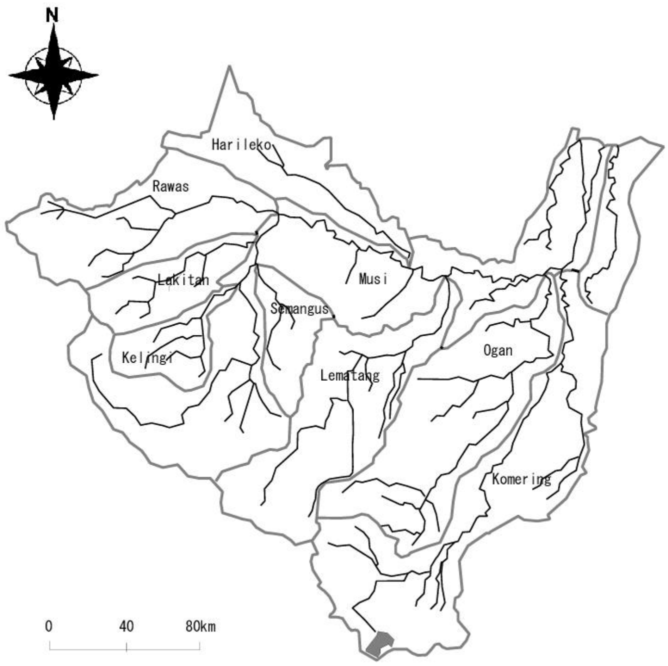

Figure 3.8.1 Musi River Basin

The Musi River Basin has a total catchment area of 59,942 km^2 at the river mouth with channel length of about 640 km. Catchment areas of the main Musi River and its major tributaries are summarized in the **Table 3.8.1**.

Table 3.8.1 Drainage Areas at Major Points of the Musi River

Main river and tributaries	Basin area (km^2)	Cumulative area (km^2)	Location
Musi R.	6,251		
Kelingi R.	1,928	8,179	Confluence of Kelingi R.
Semangus R.	2,146		
Lakitan R.	2,763		
Rawas R.	6,026		
Residual basins	552	19,666	Confluence of Rawas R.
Harileko R.	3,765		
Lematang R.	7,340		
Residual basins	4,065	34,836	Confluence of Lematang R.
Ogan R.	8,233		
Residual basins	1,696	44,765	Palembang City
Komering R.	9,980	54,673	Confluence of Komering R.
Residual basins	5,269	59,942	River mouth (Bangka Strait)

The Musi River Basin is characterized by its wide low-lying lands. As a simplified contour map of the basin shows (**Figure 3.8.2**), the land lower than 25 m above mean sea level (M.S.L.) shares about one third (32%) of the total basin area and the land lower than 100 m M.S.L. shares about two thirds (67%).

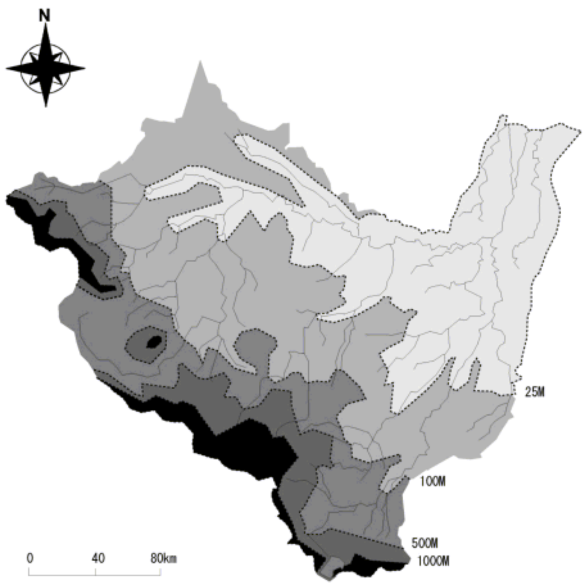

Figure 3.8.2 Contour Map of the Musi River Basin

The Musi River has long stretch of gentle bed slope in the lower reaches. The riverbed slope changes to steep in the upper reaches within relatively short transitional reaches. The average bed slope of the Musi River is 1/40,000 from river mouth to Petaling (200 km from the mouth), 1/12,000 from Petaling to the Semangus River junction (391 km), 1/1,900 from the Semangus River junction to Tebing Tinggi (529 km), and 1/69 in the upstream reaches from Tebing Tinggi. Palembang City is located at about 85 km upstream from the river mouth.

3.8.2 Flooding and Bank Erosion

The **Musi** River suffers from debris flow in the upper reaches, bank erosion in the middle reaches, and sedimentation and flooding in the lower reaches. A debris flow occurred at Muaradua of the upper **Komering**. In the **Ogan** River, bank erosion is active in the middle reaches. In the **Lakitan** River, bank erosion is active in the lower reaches. Deforestation is going on in the **Kelingi** River Basin. In the **Lematang** River debris flows caused by deforestation occurred and small bridge was damaged at Kerinjing in 2001. Floods occur every year at Belimbing of Muara Enim Regency. In 1986, a flush flood occurred at Muara Enim in the Enim River. In the **Harileko** River, flooding occurs at the confluence of the Musi River. Bank erosion is active in the upper and middle reaches in the **Rawas** River. Flooding occurs at Bingin Teluk in the Rawas River and at Noman in Rupit River of the Rawas River system.

At the confluences such as the Musi and Kelingi Rivers, the Musi and Lakitan Rivers, inundations occur frequently when the flood peaks of the two rivers occur simultaneously, and often damage nearby roads. In **Palembang** City, damages due to flood inundation were not so serious formerly. However, due to rapid urbanization of the, urban areas of Palembang City have been expanded even to the flood vulnerable low-lying areas. These urban areas have been suffering from frequent inundations.

In order to cope with the problems, **structural measures** have been carried out so far, mainly in line with the river training schemes proposed by the Musi River Basin Study. **Non-structural measures** conducted by the guidance and/or initiatives of the local government and other organizations are not found in the Study Area. However, the people live in the flood prone and swampy areas individually have taken some traditional measures to alleviate damages adjusting to the flooding conditions.

3.8.3 Inundation of Local Rainfall

Palembang City lies on the low elevation ranging +2 to +4 meters above mean sea level (m, M.S.L.), and has a total area of 403 km^2 of which almost half is in the swampy areas located in the low-lying topography. In rainy season when the tidal swamp and back swamp of the Musi River receive strong rainfall, these lands suffer from inundation due to the stagnant water. The period of **inundation** varies from 1 to 12 hours. About 123 ha of farmlands and residential areas of the Palembang City located in low-lying areas suffer from serious damages due to the inundation. The drainage in Palembang City is divided into 19 drainage systems. The drainage system consists of detention ponds, primary channels, secondary channels, and tertiary channels.

According to the current **regulation**, agencies responsible to the maintenance of the drainage facilities are: Primary drainage network: DPU of Provincial Government; Secondary and tertiary drainage network: DPU of Palembang City; Operation and maintenance of drainage network, including sediment excavation and channel repair: DPU of Palembang City; and Garbage treatment in the channel: Cleaning Service Agent of Palembang City.

Physical **factors of the inundation** are: small capacity of main drainage; very mild slope of drains; low-lying and flood prone areas; constricted and silted drains; solid waste deposited in the drains; insufficient local drainage; no routine maintenance; and, several drains without bank protection walls. In addition, the following social factors should be noted: lack of control for the houses built and to be built within the channel areas; lack of public awareness that the drains should not be used for solid waste disposal; and, lack of funds, maintenance facilities and personnel.

3.8.4 Erosion, Sedimentation and Drought

The critical land of the Musi River basin is approximately 1,510,000 ha, which is about 30% of total forest area of 5,251,000 ha. Sedimentation problem is distinguished in the Komering River. In the upper watershed, active erosion is still ongoing without controlling measures, and the sandy bed loads are transported further toward downstream. Drought problem in the Musi River Basin is distinguished in the Komering River in the reaches from Randu up to Kayu Agung. Even in the upper reaches of the Randu diversion, the areas along the Komering suffer from drought.

3.9 Water Use

3.9.1 Estimation of Present Consumptive Water Use

In this Study, the water uses in the Basin are classified into: domestic, industrial, mining, irrigation, swamp, aquaculture, tourism, livestock, hydropower, inland transport and environmental. In the Basin, the service ratios of **domestic water use** are low with the highest ratio of 31% at Palembang. On the other hand, per capita daily use of household connections (PCDU) ranges from 91 l/p/d (Lahat) to 210 l/p/d (Palembang). The results of analysis are as in **Table 3.9.1**. The total domestic water use in the Musi River Basin in the year 2000 was estimated at 93.6 million m^3/year.

Table 3.9.1 Present Domestic Water Use in the Province, 2000

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*

Note: PCDU (Per Capita Daily Use) *: Assumption (average of Lahat and MURA)

There are no statistics of the **industrial water use** in the Basin. The manufacturing industries, the major water consuming industry, in South Sumatra Province are classified into two categories, namely, large and medium scale industries, and small scale industries and handicraft. Total industrial water demand in the year 2001 was estimated at 365 million m^3/year. The **mining** and quarrying sector gives high contribution to the provincial economy. There are no statistics of the mining water use. The mining water use demand was estimated at 115 million m^3/year for the year 2001.

According to the Irrigation Design Criteria of Indonesia, 1986, the **irrigation** systems can be classified into three categories, as in **Table 3.9.2**. These systems fall in PU systems. Non-PU system is communal irrigation system.

Table 3.9.2 Classification of 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 2,000 ha	Less than 500 ha

Source: Irrigation Design Criteria of Indonesia, 1986

In 2000, the total harvested irrigation area was 77,804 ha in the Musi River Basin, which consisted of 60,079 ha with 2 cropping paddy and 17,725 ha with 1 cropping paddy. Those in Rejang Lebong, Bengkulu Province in the Basin are 1,563 ha (double cropping of 1,537ha and single cropping of 26ha). The total in the Musi River Basin is thus calculated at 79,367ha consisting of double cropping of 61,616ha and single cropping of 17,751ha. As shown in the following table, the situations were almost stable from 1996 to 2000 except in 1998, severe drought year.

Table 3.9.3 Harvested Irrigation Area in South Sumatra Province

Category	Irrigation Area (ha)				
	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

The irrigation water requirement of each irrigation type is estimated, as shown in **Table 3.9.4**. Total irrigation water demand in the year 2000 was thus estimated at 2,758 million m^3/year.

Table 3.9.4 Irrigation Water Requirement by Irrigation Type

Irrigation Type					
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

Major consumptive water uses of the **swamp areas** accrue from paddy cultivation. On the other hand, water supply to farmers in the tidal swamp areas is recognized as one of the most serious problems. Swamp area of the Basin comprises non-tidal swamp and tidal swamp. Non-tidal swamp is seasonally flooded swamp of the river flood plain. Water management is practiced by construction of bunds parallel to the rivers in order to maintain cultivated area flooded when the water level recedes. Tidal swamp locates in the coastal area, and the areas are irrigated and drained by tide through canal networks. The harvested areas in swamps in South Sumatra Province from 1996 to 2000 are as follows:

Table 3.9.5 Harvested Area in Swamp in South Sumatra Province

	Irrigation Area (ha)				
	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

Diversion water requirement for swamp area was calculated as follows: The present paddy water use in swamp areas in the Musi River Basin was calculated at 920 million m^3/year, and that in the whole South Sumatra Province was at 1,961 million m^3/year.

Table 3.9.6 Water Requirement in Swamp Paddy

Irrigation Type	Irrigation Efficiency	Season	Cropping Period (month)	Field Water Req. (mm/year)	Diversion Req. (mm/year)
Non-tidal and Tidal	0.8	Rainy	5	560	700
		Dry	5	785	981

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. The methods of the **aquaculture** are of ponds, paddy fields, cages and fences with water sources of rivers, springs, wells, rain and irrigation systems. Aquaculture water demand in the year 2001 was estimated at 504 million m^3/year.

The total numbers of domestic and foreign visitors arrived to the Province in 2001 was 260,479 and 18,584 persons, respectively. Those to Rejang Lebong, Bengkulu Province in 2000 were 13,089 and 27 persons, respectively. Based on these figures and assuming the average staying duration at two days, total **water use by tourists** in the year 2001 was estimated at 149,000 m^3/year. The major kinds of **livestock** are *milk cow, cow, buffalo, horse, goat, sheep, pig, poultry and duck.* Livestock water demand in the year 2001 was estimated at 14.9 million m^3/year.

Water use for **hydropower** is in-stream use unless it is inter-basin diversion. Musi hydropower station is a large-scale hydropower station and presently under construction. The water for the hydropower will be diverted from the Musi River with drainage area 587 km^2, in Rejang Lebong Regency, Bengkulu Province, and released to the Simpangaur River, finally discharging into Indian Ocean. Annual average of 897 million m^3 water will be diverted outside of the Musi River Basin.

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

Table 3.9.7 Present Consumptive Water Uses of the Basin

Water Use	Volume (million m^3/year)	Ratio to Total (%)	Water Use	Volume (million m^3/year)	Ratio to Total (%)
Domestic	93.6	2.0	Aquaculture	504.0	10.6
Industrial	364.7	7.7	Tourism	0.15	0.0
Mining	115.4	2.4	Livestock	14.9	0.2
Irrigation	2,757.6	57.8	Hydropower	0.0	0.0
Swamp Area	920.3	19.3	**Total**	**4,772.7**	**100.0**

3.9.2 Water Balance Model

Water balance model of the Basin comprising 22 sub-basins and 22 water use blocks has been established in the Study. 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.

3.9.3 Present Water Balance

Water balance under the present water uses and management has been simulated for 15 years. Though water deficits occur 5 times in 15 years at Upper Komering, under 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 is estimated, as follows:

Table 3.9.8 Present Water Balance

Item	Value
(1) Present Water Requirement (MCM/yr)	4,772.7
(2) Present Water Deficit	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%

3.9.4 Projection of Consumptive Water Uses to the Target Year

Consumptive water uses, other than irrigation and swamp area, are projected in this section. Tourism and livestock water uses were excluded because of their small quantities. The results are as follows:

Table 3.9.9 Consumptive Water Demand in the Basin

(million m^3/year)

Sector	Present	2005	2010	2020
Domestic	93.6	141.0	190.0	296.0
Industrial	365.0	405.0	462.0	602.0
Mining	115.0	133.0	159.0	226.0
Aquaculture	504.0	652.0	743.0	798.0
Hydropower	0.0	0.0	898.0	898.0
Tourism & Livestock	15.1	-	-	-
Total	**1,092.7**	**1,331.0**	**2,452.0**	**2,820.0**

3.9.5 Potential Land Resources

Potential land resources have been identified in order to estimate development potential in South Sumatra Province and the Musi River Basin, by system (technical irrigation area, semi technical irrigation area, simple irrigation area, communal irrigation area, and rainfed) and by status of development as shown in **Table 3.9.10**.

Table 3.9.10 Classification of Potential Irrigation Area ('000ha)

System	Classification	Province	Basin *
Technical	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	
	Sub-total (1)	85.0	70.4
Semi Technical	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	
	Sub-total (2)	54.2	61.5
Simple	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	
	Sub-total (3)	23.7	25.0
Communal	With network	70.8	
	No network	97.2	
	Sub-total (4)	168.0	189.2
Rainfed	Can improve	42.8	
	Cannot improve	53.5	
	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

From the viewpoint of swamp cultivation potential, agricultural land can be classified into tidal swamp area and non-tidal swamp area. These potential areas in South Sumatra Province and the Musi River Basin (as of 2001) are, as shown in **Table 3.9.11**.

Table 3.9.11 Classification of Potential Swamp Area ('000ha)

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

3.9.6 Existing Plans and Strategies

Strategies

Development of a system of food self-reliance is given as one of the policy directions by Chapter IV Economic Development of **PROPENAS** (2000-2004). In **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 in the previous plan to: the preservation of food self-reliance, increase of farm income, increase of job opportunities in rural areas, improvement of family nutrient conditions. 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 conflict 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.

Study for Formulation of Irrigation Development Program, Nov. 1993, JICA was carried out to formulate an irrigation development program. By this study, South Sumatra Province is expected as potential food resources area for the rice self-reliance at the national level. Though the study is not new, Indonesian Government still maintains the policy of stable self-sufficiency in rice. Target self-sufficiency rate of Zone 2 (South Sumatra, Jambi, Bengkulu and Lampung) is 120%. Total target development of South Sumatra Province was proposed at 310,300ha for 1991-2020.

For domestic 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.

Existing Plans

Water Resources Service implements development projects comprising irrigation, swamp, flood handling, and coastal protection. These projects can be classified into APBN and APBD projects. Present APBN projects consist of (i) Irrigation and Mainstay Swamp of South Sumatra (composed of eight sub-projects), and (ii) Flood Handling and Coastal Protection of South Sumatra (four sub-projects).

Komering Irrigation Project has been implemented using APBN, and funded by Japanese ODA loan. The project consists of three stages with a total irrigation area of 120,658ha. Actual implementation has been conducted for Stage I (20,968ha) and Phase 1 (25,589ha) of Stage II. Implementation of Phase 2 (16,510ha) of Stage II and conducting of F/S for dams proposed for Stage III has been requested for JBIC loan, but not yet accepted.

Lakitan Irrigation Project is one of the subprojects 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 the Lakitan River (552 km^2). Development consists of two steps; the first step for 6,000ha irrigation area and the second step for 7,950ha of irrigation area.

Directorate 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 the 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.

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. In Step I, infrastructure development starts by primary and secondary drainage canal networks with low cost and simple technology for 7-14 years. Washing of land is carried out. In Step II, construction of tertiary canals with gates and embankment for flood protection is completed for 4-7 years. Network systems have control function, and are operated and maintained intensively together with P3A activities. In Step III, network systems are fully controlled, and have function of semi polder for 4-5 years. Gates and embankment are completed, and irrigation and drainage systems are already separated. Already completed development areas are summarized, as follows:

Table 3.9.12 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

South Sumatra Swamp Improvement Project (SSSIP) was implemented by the DGWR, and funded by Japanese ODA loan. SSSIP was undertaken between 1992 and 1999, with aims: (i) improve the existing drainage facilities in order to increase the paddy yield on the first holding and the coconut yield on the second holding, (ii) practice efficient on-farm water management and train farmers for the purpose of improving their farming practices, and (iii) improve basic social infrastructure such as farm roads and domestic water supply facilities.

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. Telang and Saleh Agricultural Development Project in South Sumatra (TSADP) was one of four core subprojects in IISP-1. 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.

For **tourism development**, Karang Anyar is cultural and historical site along the 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 a 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.

3.10 Inland Waterway Transportation

3.10.1 River Navigation Condition in South Sumatra Province

River transportation in South Sumatra is generally influenced by river conditions for navigation, especially depth, width and water flow. Most of the upper streams of the Musi River depend on the seasonal conditions, while the branches downstream depend more on the tidal water level condition. **Table 3.10.1** shows features of river navigation in the Musi main stream and eight major tributaries.

Table 3.10.1 Existing River Navigation Condition in South Sumatra Province

No.	River Name	River Length (km)		Mean Depth (m)	Mean Width (m)
		Whole Strength	Available for Sailing		
1	Musi	700	450	4.5-8	200
2.	Ogan	350	175	5	90
3.	Lematang	300	240	6	80
4.	Komering	360	280	6	75
5.	Harileko	200	160	10	40
6.	Lalan	260	220	10	150
7.	Lakitan	150	100	3	50
8.	Rawas	230	175	3	50
9.	Kelingi	80	80	2	50
	Total	2,630	1,880		

Source: Laporan Akhir, Studi Pengembangan Angkutan Sungai Di Propinsi Sumatera Selatan, 2001

The existing problem at the upstream-middle reaches is the difficulty of boat navigation due to the low water level during the dry season. In the downstream, sedimentation is a major problem, especially for commercial ship navigation. Discussion in the following sub-sections is for the inland waterway transportation in the downstream of the Musi River, from Palembang to the river mouth area (Ambang Luar).

3.10.2 Present Inland Transport System

Palembang Port is one of the first class river ports/harbors in Indonesia. Port operation is under the management and supervision of the Department of Communication (DOC) and business performance itself is tasked with the Department of Finance (DOF). The agency of DOC is the *Departemen Perhubungan Ditjen Perhubungan Laut Kantor Administrator Pelabuhan Palembang* **(ADPEL)**. The agency of DOF is *PT. (PERSERO) Pelabuhan Indonisia II, Cabang Palembang* **(PELINDO II)**.

The Musi River prior to the start of recorded dredging in 1966 had the maximum depth over the Outer Bar (Ambang Luar) of about 4.1 m and the maximum depths over the remaining shallow bars ranging from about 4.0 to 5.0 m at mean low water. Since 1966, maintenance dredging has been conducted in almost every year.

From 1997 to 2001, maintenance dredging can be identified at 3 locations. The area at the river mouth became large, and the other 2 locations are in the Musi River channel. Volumes of pre-dredge sounding are shown in **Table 3.10.2**. About 90% of the dredging volume came from the river mouth area. Unit cost for maintenance dredging between 1979 and 1989 was about 10 times different and it became more than 35 times different in the year 2002. The latest one in 1998/99 was Rp.2,900/m^3 for 2,171,000 m^3.

Table 3.10.2 Record of Pre-dredge Sounding: 1997-2002

No.	Location	Volume (1,000 m^3)				
		1997-98	1998-99	1999-2000	2000-01	2001-02
1	Ambang Luar C1	332.47	354.18	705.80	857.52	494.88
	a. Lurus					437.12
2	Ambang Luar C2	795.49	957.70	836.87	1,011.23	1,261.81
3	Tg. Carat/Buyut	315.03	395.19	0.00	62.95	82.87
4	Payung Utara	274.42	24.49	134.52	238.93	349.99
5	Payung Barat	216.45	74.15	206.83		136.69
6	Payung Selatan	331.94	42.62	171.91		247.82
7	Penyeberangan Upang	21.57	66.63	10.55		90.72
8	Selat Jaran					
9	Muara Jaran	41.50	157.83	108.62	154.76	70.59
10	Aer Humbang					
11	Sungai Lais		101.21	92.08		194.38
	Total	2,328.87	2,173.99	2,267.18	2,325.39	3,366.85
	River Mouth	2,265.80	1,848.33	2,055.93	2,170.63	3,011.17
		97.3%	85.0%	90.7%	93.3%	89.4%
	River Channel	63.07	325.67	211.25	154.76	355.68
		2.7%	15.0%	9.3%	6.7%	10.6%

Source: ADPEL

3.10.3 Present Inland Transport Condition

The existing Palembang Port is like a seaport, although it is located in the Musi River hinterland 60 miles from Ambang Luar. With the increasing development, industrial companies have located their offices along the Musi River. Half of the industrial companies have loading/unloading facilities for their own needs. The goods flow is around 10,000 thousands tons in these 11 years. Volume of unloading presents steady increase in these years. Passengers have increased remarkably from around 60,000 in 1995 to 260,000 in 2000.

3.10.4 Future Projection of Inland Transport

The total volume of goods at **Palembang Port** between 2001 and 2006 is estimated to increase to 112%. Passengers between 2001 and 2006 are estimated to increase to 180% and 157% for debarkation and embarkation, respectively. **Tanjung Api-api Seaport** (Tg. Api-api Port) has been proposed since the 1980s to solve the sedimentation problem at the navigation channel and the river mouth area, and to save maintenance dredging cost. Construction of the new port is pending negotiation with the developer and looking for financial support.

3.10.5 Issues to be Solved

Sedimentation is a serious problem for waterway users. Especially, it causes damage to commercial, agricultural and passenger transportation. Maintenance dredging is the common measure for sedimentation adopted by local governments and other agencies. However, sediment will be supplied continuously from the upstream reaches unless there are protection works and actions taken for this phenomenon.

3.11 Organization, Institution and Legal Systems

3.11.1 Existing Institutions and Organizational Setup for the Basin Water Management

The new Autonomy Law (No. 22/1999) was enforced in May 1999. But the regulations for its implementation are enacted only for certain units. Thus, the present regional government system is in a transition period. **Regional Governments** are categorized into two levels, namely, Level 1 and Level II. Level I Regional Governments are composed of Provinces (*Propinsi*) and Level II Regional Governments are Districts (*Kabupaten*) or Municipalities (*Kota*). Districts are governments in rural areas and Municipalities are in urban areas.

Tasks of **DGWR, *KIMPRASWIL*** are: (i) To conserve sustainable water resources, (ii) To coordinate and integrate water resources management, (iii) To promote just and fair water resources utilization, (iv) To control and mitigate floods, (v) To empower and improve communities for water resources management, and (vi) To improve availability and accessibility of data and information on water resources development and management.

Roles of **DGWR** have been changed with decentralization of authority and the policy reform. Water resources development and management must sufficiently consider Provincial, District and Municipality government authorities. By the promulgation of New Autonomy Law (No. 22/1999), government demarcations on water resources development and management are simplified. In addition, all stakeholders should have the same right and responsibility from the very beginning stage of the development.

The roles of **National Development Planning Agency (*BAPPENAS*)** include: (i) To formulate short-term, medium-term, and long-term national development plans, (ii) To coordinate planning, endeavoring to harmonize sectoral and regional portions, and to create integration in such planning within the national development plan. It joined WATSAL Steering Committee and set up WATSAL Task Force.

Related Organization in **Regional Level** includes: Water Resources Service of South Sumatra Province. Water Resources Management Office (*Balai PSDA*) for Musi River Basin has been established in 2001, which serves as a technical implementation office under Water Resources Service covering the Musi River Basin. Main tasks of Forestry Service (*Dinas Kehutanan*) South Sumatra Province concerning forest protection are: (i) To formulate forest conservation & protection policy, (ii) To coordinate implementation of forest conservation & protection policy, (iii) To give technical guidance and control forest conservation & protection, and (iv) To provide information on forest conservation & protection to the people.

Tasks of Regional Development Planning Agency (*BAPPEDA*) of South Sumatra Province are: (i) To study, arrange and coordinate planning on middle and long-term development in South Sumatra Province, (ii) To arrange implementation plan and budget, (iii) To coordinate international and domestic cooperation, (iv) To promote public participation in planning activities, (v) To publicize development data/information, and (vi) To evaluate and control development activities.

Major task of Settlement and Regional Infrastructure Service of Palembang Municipality is to enhance the execution of Government and development efficiently in particular in the field of operation and maintenance of the construction of roads, bridges, and city channels. Other related organizations concerning water resources management include DPE, DISTAMB, BAPEDAL, BAPEDALDA, DDN, PT PLN, and PDAMs.

3.11.2 Laws and Regulations on Water Management

Water Resources

Law No. 11/1974 (Water Resources), needs to be amended with a conditionality of WATSAL. The new law is expected to promote environmentally and socially sustainable water resources development and management by strengthening the institutional and regulatory frameworks for river basin management, pollution abatement and water quality management, and irrigation systems. A draft of the amendment is waiting for approval by the national assembly as of January 2003.

Government Regulation No. 22/1982 (Water Management) sets up the basis for river basin management including the requirement for a comprehensive water resources plan for each basin which is to be incorporated in a National Water Plan as part of the National Development Plan.

Government Regulation No. 6/1981 (Irrigation Infrastructure Maintenance and Exploitation Fee) stipulates the detailed contents of irrigation infrastructures exploitation and maintenance (IIEM) fee. Government Regulation No. 27/1991 (Swamps) is to achieve optimal use of swamps as source of water and to sustain its utilization as the implementation of Law No. 11/1974 (Water Resources). Government Regulation No. 35/1991 (Rivers) declares that rivers have multi-purpose uses and delegates responsibility for their development and management to either the National or a regional government in accordance with a classification of their economic importance.

Assuming the Presidential Instruction No. 3/1999 (Irrigation Management Policy Reform), Government Regulation No. 77/2001 (Irrigation) was promulgated in order to promote reforms in irrigation area with introducing transparency and accountability of government and empowerment of farmers. Law No. 22/1999 on decentralization and regional autonomy, Government Regulation No. 25/1999 on fiscal balance between central and regional government, and Presidential Instruction No. 3/1999 (Irrigation Management Policy Reform, *PKPI: Pembaharuan Kebijakan Pengeloaan Irigasi*) provide the basic mandate for policy reform in irrigation management.

Ministerial Regulation of Ministry of Public Works No. 63/PRT/1993 (River Channel, River Usage and Non-usage Areas, Old Unfunctional Rivers) defines river borders and decrees details of their utilization. River borders may not be used for: dumping of garbage, solid and suspended wastes, developing permanent buildings, houses, etc.

According to Ministerial Letter of *KIMPRASWIL* No. 529/KPTS/M/2001 (Procedure for Irrigation Management Authority Transfer to Water Users' Association), Irrigation Management Authority Transfer from the Government and Provincial Government or District/City Government to the formal Water Users Associations (WUAs) must be implemented in a democratic way based on the principle "one irrigation system - one management" (Government Regulation No. 77/2001 on Irrigation). Irrigation Management Authority Transfer is aimed to increase efficiency and effectiveness of irrigation management, to achieve sustainability of irrigation system, to establish autonomous and reliable WUAs, and to increase income of the farmers.

Ministerial Letter of Home Affairs No. 179/1996 (Organization Guidelines of Basin Water Resources Management Unit (*Balai PSDA*)) sates: *Balai PSDA*s are technical implementation units of the Provincial Office of Public Work or of Water Resource.

<u>Environment</u>

In Ministerial Letter of Home Affairs No. 50/2001 (Guidelines for Empowerment of Water Users' Associations), Water User Associations (WUA) is to be established in democracy (from the farmers, by the farmers, and for the farmers).

By Law No. 5/1990 (Conservation of Bio-natural Resource and Its Ecosystem), conservation of bio-natural resource and its ecosystem is aimed to provide efforts in sustaining bio-natural resource and balancing its ecosystem in order to support the increase of prosperity and quality of human beings. Law No. 24/1992 (Spatial Management) declares that spatial plan is form and pattern of spatial utilization. Law No. 23/1997 (Environmental Management) declares: To sustain environmental function; To achieve wise-use of resources; and, To prevent from impacts which may lead to environmental contamination and destruction. In Law No. 41/1999 (Forestry), forest and land rehabilitation is meant to revitalize, sustain, and increase forest and land functions such that its bearing capacity, productivity, and role are secured in order to support living creatures.

In Government Regulation No. 82/2001 (Water Quality Management and Pollution Control), Water Quality Monitoring (Article 13) declares that water quality monitoring for water sources within a district/municipality, inter-districts/municipalities, and inter-provincial/international is conducted by the district/city government, provincial government, and central government respectively. Water quality monitoring is conducted at least once every six months.

3.11.3 WATSAP

For WATSAP and related programs refer also to Section 2.3. Present status is as follows: Government of Indonesia has been slow to meet the detailed conditionality mandated by WATSAL. There are several reasons of the delay including (Bank Information Center, www@bicusa.org):

- Decentralization, without adequate capacity-building and guiding directives, serves to retard governance due to the confusion it generates;
- Over-lapping responsibilities, unclear division of responsibilities between government agencies, fuzzy reporting and accountability lines between various administrative tiers of government, and issuance of parallel regulations by a number of authorities;
- Lack of coordination between government agencies, unreliable data and diagnosis are also the obstacles on the road to institutional reform; and
- New laws and corresponding regulations are not fully known to people due to lack of communication flow. It is further complicated by the lack of ownership felt towards the process as it is believed the restructuring is being carried out at the behest of the World Bank and other external entities with limited national control.

3.11.4 Financial Status of Organizations Related to Water Management

Fiscal decentralization has been implemented in accordance with the Regional Government Law No.22 and the Government Regulation on Fiscal Balance No.25 of 1999. The sources of regional government revenue consist of original income, decentralization fund, regional borrowing, and other revenue. The decentralization fund consists of land & building tax/land right & building acquisition tax, allocation from natural resources revenue, General Allocation Fund (*DAU*) for general purposes, and Specific Allocation Fund (*DAK*) for specific purposes.

Development expenditures of South Sumatra Province are divided into two: one is current expenditure (or routine expenditure) and another is the development expenditure (or investment expenditure). The current expenditure covers salaries, cost of equipment and materials, travel expenses, loan installment, etc. and the development expenditure is spent for projects implementation. Source of the development expenditure consists of both local budget (*APBD*) and the central government funds (*APBN*), which come from General Allocation Fund (*DAU*) and Specific Allocation Funds (*DAK*) discussed above.

Table 3.11.1 shows breakdown of the budget of Provincial Office of Water Resources, South Sumatra Province in 2001. Total budget amounted to Rp.63.1 billion consisting of Rp.19.8 billion from *APBD* and Rp.43.2 billion from *APBN*. Irrigation and swamp development projects account for 70% of total budget while flood control projects account for 20%.

Table 3.11.1 Budget of Water Resources Office of South Sumatra Province in 2002

	Nos. of Proj.	Budget (Rp. billion)	%
I. Local Budget (APBD)	10	19.8	31
1. Irrigation & swamp development	5	6.1	10
2. Water resources dev.	3	6.4	10
3. Flood control	2	7.3	12
II. Central Gov. Budget (APBN)	13	43.2	69
1. Flood control	4	5.1	8
2. Irrigation and swamp dev.	9	38.1	60
III.Total	23	63.1	100

The study team collects data on actual **revenue and expenditure of regencies and municipality** in order to grasp the scales of development expenditures and expenditures for water management sector. Development Budget of the Regencies/Municipality are summarized below:

Table 3.11.2 Development Budget and Budget for Water Management by Regency in 2002 (APBD only, Unit: Rp. billion)

	Development budget	Budget for water resources & irrigation	Ratio in dev. expenditure
Palembang	100.8	2.7	2.7%
OKU	79.1	2.7	3.4%
OKI	142.2	8.9	6.3%
Muara Enim	133.7	3.6	2.7%
Lahat	49.1	3.6	7.3%
Musi Rawas	99.0	2.7	2.7%
MUBA	352.2	10.8	3.1%
Total	956.1	35.0	3.6%

3.12 Database System Established in the Study

3.12.1 Existing Database

Through the investigation to the database system in South Sumatra Province, it was found that two GIS database system (Forestry Department and BAPPEDA GIS database) and one information network system (INFORKOM MIS) existed, and can be considered to provide GIS database to JICA study.

BAPPEDA has used GIS for the spatial planning for a long time. The system software and hardware used in BAPPEDA GIS are PC ArcInfo 3.5, ArcView3.2, Windows98 and Windows NT platforms. JICA study team could collect the following GIS data from BAPPEDA, namely, 1/500,000 Land Use Map in 1980; 1/250,000 Current Spatial Planning Data; 1/50,000 Current Land Use Data (150 sheets)

It is a GIS group in **forestry** department to manage a GIS database, and provide GIS services to forest management group. Even the version of GIS database and system is a little old (PC ArcInfo 3.5 and Arcview3.2), the system is running smoothly and the forest GIS database is kept to be updated year by year.

A network information system, Regional **Management Information System (MIS)**, is going to be established by Information and Communication Department (KANTOR INFORKOM) of South Sumatra Province. Currently, the central system has already been established in KANTOR INFORKOM and linked to Internet. As the same time, a government website has also been set up for introducing profile of the province, major production, tourism and etc. Along with the construction plan, a government Intranet will be established in the future. In the future, all state government offices will be linked by this Intranet. Then, the GIS database established in JICA study can be shared with other government agencies through this network system.

3.12.2 Establishment of Database System

According with above data collection, the GIS database specification is designed as follows. The **1:250,000 scale GIS** data was collected from Forest Department and BAPPEDA and designed into GIS database. JICA Study Team purchased the 1/50,000 topographical data from BAKOSURTANAL for **1:50,000 GIS Database**. Totally 150 sheets covered whole South Sumatra Province. The **coordinate system** used in GIS database was designed as UTM (BESSEL spheroid, and DJAKARTA datum). It is the same coordinate system that used in the 1:50,000 scale topographic map.