TABLES

II SOCIO-ECONOMY

Table II.2.1 POPULATION BY ISLAND & PROVINCE IN INDONESIA

Unit of population : 10^3 Person

No.	Island	Province	1971 Population	1971 Share (%)	1980 Population	1980 Share (%)	1990 Population	1990 Share (%)	1995 Population	1995 Share (%)	2000 Population	2000 Share (%)	Average Annual Growth Rate(%) 1971/80	1980/90	1971/90	1990/2000
1		Daerah Istimewa Aceh	2,009	1.69	2,611	1.77	3,416	1.90	3,860	1.98	4,283	2.04	2.95	2.72	2.83	2.29
2		Sumatra Utara	6,622	5.55	8,361	5.67	10,256	5.72	11,145	5.71	11,915	5.66	2.62	2.06	2.33	1.51
3		Sumatra Barat	2,793	2.34	3,407	2.31	4,000	2.23	4,328	2.22	4,632	2.20	2.23	1.62	1.91	1.48
4		Riau	1,642	1.38	2,169	1.47	3,304	1.84	3,925	2.01	4,615	2.19	3.14	4.30	3.75	3.40
5	SUMATRA	Jambi	1,006	0.84	1,446	0.98	2,021	1.13	2,383	1.22	2,774	1.32	4.11	3.40	3.74	3.22
6		Sumatra Selatan	3,441	2.89	4,630	3.14	6,313	3.52	7,233	3.70	8,142	3.87	3.35	3.15	3.25	2.58
7		Bengkulu	519	0.44	768	0.52	1,179	0.66	1,415	0.72	1,673	0.80	4.45	4.38	4.41	3.56
8		Lampung	2,777	2.33	4,625	3.14	6,018	3.35	6,680	3.42	7,303	3.47	5.83	2.67	4.15	1.95
		Total	20,809	17.46	28,017	19.00	36,507	20.35	40,970	20.98	45,337	21.54	3.36	2.68	3.00	2.19
9		DKI Jakarta	4,579	3.84	6,503	4.41	8,259	4.60	9,161	4.69	10,055	4.78	3.97	2.42	3.15	1.99
10		Jawa Barat	21,624	18.14	27,453	18.61	35,384	19.73	39,337	20.14	43,285	20.57	2.69	2.57	2.63	2.04
11	JAWA	Jawa Tengah	21,877	18.35	25,373	17.20	28,521	15.90	29,688	15.20	30,551	14.52	1.66	1.18	1.41	0.69
12		DI Yogyakarta	2,489	2.09	2,751	1.87	2,913	1.62	2,917	1.49	2,897	1.38	1.12	0.57	0.83	-0.05
13		Jawa Timur	25,517	21.41	29,189	19.79	32,504	18.12	33,886	17.35	34,972	16.62	1.51	1.08	1.28	0.73
		Total	76,086	63.83	91,269	61.88	107,581	59.97	114,988	58.88	121,761	57.86	2.04	1.66	1.84	1.25
14		Bali	2,120	1.78	2,470	1.67	2,778	1.55	2,902	1.49	3,006	1.43	1.71	1.18	1.43	0.79
15		Nusa Tenggara Barat	2,203	1.85	2,725	1.85	3,370	1.88	3,655	1.87	3,914	1.86	2.39	2.15	2.26	1.51
16	NUSA TENGGARA	Nusa Tenggara Timur	2,295	1.93	2,737	1.86	3,269	1.82	3,583	1.83	3,865	1.84	1.98	1.79	1.88	1.69
17		Timor Timur	-	-	555	0.38	748	0.42	843	0.43	921	0.44	-	3.03	-	2.10
		Total	6,618	5.55	8,487	5.75	10,165	5.67	10,983	5.62	11,706	5.56	2.80	1.82	2.28	1.42
18		Kalimantan Barat	2,020	1.69	2,486	1.69	3,229	1.80	3,652	1.87	4,053	1.93	2.33	2.65	2.50	2.30
19		Kalimantan Tengah	702	0.59	954	0.65	1,396	0.78	1,637	0.84	1,887	0.90	3.47	3.88	3.68	3.06
20	KALIMANTAN	Kalimantan Selatan	1,699	1.43	2,065	1.40	2,598	1.45	2,900	1.49	3,203	1.52	2.19	2.32	2.26	2.12
21		Kalimantan Timur	734	0.62	1,218	0.83	1,877	1.05	2,331	1.19	2,856	1.36	5.79	4.42	5.07	4.29
		Total	5,155	4.32	6,723	4.56	9,100	5.07	10,521	5.39	11,999	5.70	2.99	3.07	3.04	2.80
22		Sulawesi Utara	1,718	1.44	2,115	1.43	2,478	1.38	2,652	1.36	2,821	1.34	2.34	1.60	1.95	1.31
23		Sulawesi Tengah	914	0.77	1,290	0.87	1,711	0.95	1,948	1.00	2,202	1.05	3.90	2.86	3.36	2.56
24	SULAWESI	Sulawesi Selatan	5,181	4.35	6,062	4.11	6,982	3.89	7,578	3.88	8,149	3.87	1.76	1.42	1.58	1.56
25		Sulawesi Tenggara	714	0.60	942	0.64	1,350	0.75	1,594	0.82	1,849	0.88	3.13	3.66	3.41	3.20
		Total	8,527	7.15	10,409	7.06	12,521	6.98	13,772	7.05	15,022	7.14	2.24	1.86	2.04	1.84
26	MALUKU and	Maluku	1,090	0.91	1,411	0.96	1,856	1.03	2,095	1.07	2,331	1.11	2.91	2.78	2.84	2.30
27	IRIANJAYA	Irian Jaya	923	0.77	1,174	0.80	1,649	0.92	1,956	1.00	2,285	1.09	2.71	3.46	3.10	3.31
		Total	2,013	1.69	2,585	1.75	3,505	1.95	4,051	2.07	4,615	2.19	2.82	3.09	2.96	2.79
	INDONESIA		119,208	100.00	147,490	100.00	179,379	100.00	195,283	100.00	210,439	100.00	2.39	1.98	2.17	1.61

Source:Statistical Year Book of Indonesia,1992 ,Central Bureau of Statistics

Note:Figures of 1995 and 2000 are forecasted by Central Bureau of Statistics.

Table II.2.2 POPULATION OF STUDY AREA

Unit : Person

Province	Kabupaten/Kotamdaya	1982			1987			1991			Average Growth Rate(%)		
		Population	Share(%)		Population	Share(%)		Population	Share(%)		1982/87	1987/91	1982/91
			Study Area	Province		Study Area	Province		Study Area	Province			
Riau	Kab.Kampar	422,360	12.1	18.1	573,416	14.4	20.6	587,164	13.3	17.6	6.31	0.59	3.73
	Kab.Indragiri Hulu	259,032	7.4	11.1	330,452	8.3	11.9	379,859	8.6	11.4	4.99	3.54	4.35
	Kab.Indragiri Hilir	414,309	11.8	17.8	437,777	11.0	15.8	486,037	11.0	14.5	1.11	2.65	1.79
	Kodya.Pekanbaru	192,196	5.5	8.2	212,704	5.3	7.7	394,133	8.9	11.8	2.05	16.67	8.31
	Sub-total	1,287,897	36.8	55.2	1,554,349	39.0	55.9	1,847,193	41.9	55.2	3.83	4.41	4.09
	Province	2,333,156	-	100.0	2,778,803	-	100.0	3,345,467	-	100.0	3.56	4.75	4.09
West Sumatra	Kab.Solok	364,720	10.4	10.3	414,145	10.4	10.7	431,389	9.8	10.4	2.57	1.03	1.88
	Kab.Sawahlunto/Sijunjur	242,114	6.9	6.9	277,175	6.9	7.2	311,630	7.1	7.5	2.74	2.97	2.84
	Kab.Tanahdatar	324,488	9.3	9.2	351,970	8.8	9.1	350,296	7.9	8.5	1.64	-0.12	0.85
	Kab.Agam	396,119	11.3	11.2	414,624	10.4	10.7	416,465	9.4	10.1	0.92	0.11	0.56
	Kab.Limapuluh Kota	281,553	8.0	8.0	300,134	7.5	7.8	305,070	6.9	7.4	1.29	0.41	0.90
	Kab.Pasaman	371,352	10.6	10.5	426,260	10.7	11.0	470,456	10.7	11.4	2.80	2.50	2.66
	Kodya.Solok	32,900	0.9	0.9	37,217	0.9	1.0	42,675	1.0	1.0	2.50	3.48	2.93
	Kodya.Sawahlunto	14,185	0.4	0.4	15,349	0.4	0.4	15,740	0.4	0.4	1.59	0.63	1.16
	Kodya.Padang Panjang	34,216	1.0	1.0	34,876	0.9	0.9	39,698	0.9	1.0	0.38	3.29	1.66
	Kodya.Bukittinggi	71,999	2.1	2.0	76,220	1.9	2.0	86,771	2.0	2.1	1.15	3.29	2.10
	Kodya.Payakumbu	81,971	2.3	2.3	86,094	2.2	2.2	93,812	2.1	2.3	0.99	2.17	1.51
	Sub-total	2,215,617	63.2	62.9	2,434,064	61.0	62.9	2,564,002	58.1	61.9	1.90	1.31	1.64
	Province	3,524,198	-	100.0	3,871,962	-	100.0	4,141,444	-	100.0	1.90	1.70	1.81
	Total of Study Area	3,503,514	100.0	-	3,988,413	100.0	-	4,411,195	100.0	-	2.63	2.55	2.59

Source : 1. Riau in Figures, 1992, Statistical Office of Riau Province
2. West Sumatra in Figures, 1992, Statistical Office of West Sumatra Province

Table II.2.3 POPULATION DENSITY BY ISLAND & PROVINCE IN INDONESIA

Unit:Person/km²

No.	Island	Province	Area (km²)	Share (%)	1971	1980	1990	1995	2000	Average Annual Growth Rate(%) 1971/80	1980/90	1971/90	1990/2000
1	SUMATRA	Daerah Istimewa Aceh	55,392	2.89	36.3	47.1	61.7	69.7	77.3	2.95	2.72	2.83	2.29
2		Sumatra Utara	70,787	3.69	93.5	118.1	144.9	157.4	168.3	2.62	2.06	2.33	1.51
3		Sumatra Barat	49,778	2.59	56.1	68.4	80.4	87.0	93.0	2.23	1.62	1.91	1.48
4		Riau	94,561	4.93	17.4	22.9	34.9	41.5	48.8	3.14	4.30	3.75	3.40
5		Jambi	44,800	2.33	22.5	32.3	45.1	53.2	61.9	4.11	3.40	3.74	3.22
6		Sumatra Selatan	103,688	5.40	33.2	44.7	60.9	69.8	78.5	3.35	3.15	3.25	2.58
7		Bengkulu	21,168	1.10	24.5	36.3	55.7	66.8	79.0	4.45	4.38	4.41	3.56
8		Lampung	33,307	1.74	83.4	138.9	180.7	200.6	219.3	5.83	2.67	4.15	1.95
		Total	473,481	24.67	43.9	59.2	77.1	86.5	95.8	3.36	2.68	3.00	2.19
9	JAWA	DKI Jakarta	661	0.03	7,761.0	11,022.0	12,494.7	13,858.5	15,211.5	3.97	1.26	2.54	1.99
10		Jawa Barat	46,229	2.41	467.0	592.9	765.4	850.9	936.3	2.69	2.59	2.63	2.04
11		Jawa Tengah	34,206	1.78	639.6	741.8	833.8	867.9	893.1	1.66	1.18	1.41	0.69
12		DI Yogyakarta	3,169	0.17	785.4	868.1	919.2	920.4	914.3	1.12	0.57	0.83	-0.05
13		Jawa Timur	47,921	2.50	532.5	609.1	678.3	707.1	729.8	1.51	1.08	1.28	0.73
		Total	132,186	6.89	575.6	690.5	813.9	869.9	921.1	2.04	1.66	1.84	1.25
14	NUSA TENGGARA	Bali	5,561	0.29	381.2	444.2	499.6	521.9	540.6	1.71	1.18	1.43	0.79
15		Nusa Tenggara Barat	20,177	1.05	109.2	135.1	167.0	181.1	194.0	2.39	2.15	2.26	1.51
16		Nusa Tenggara Timur	47,876	2.49	47.9	57.2	68.3	74.8	80.7	1.98	1.79	1.88	1.69
17		Timor Timur	14,874	0.77	-	37.3	50.3	56.7	61.9	-	3.03	-	2.10
		Total	88,488	4.61	74.8	95.9	114.9	124.1	132.3	2.80	1.82	2.28	1.42
18	KALIMANTAN	Kalimantan Barat	146,760	7.65	13.8	16.9	22.0	24.9	27.6	2.33	2.65	2.50	2.30
19		Kalimantan Tengah	152,600	7.95	4.6	6.3	9.1	10.7	12.4	3.47	3.88	3.68	3.06
20		Kalimantan Selatan	37,660	1.96	45.1	54.8	69.0	77.0	85.0	2.19	2.32	2.26	2.12
21		Kalimantan Timur	202,440	10.55	3.6	6.0	9.3	11.5	14.1	5.79	4.42	5.07	4.29
		Total	539,460	28.11	9.6	12.5	16.9	19.5	22.2	2.99	3.07	3.04	2.80
22	SULAWESI	Sulawesi Utara	19,023	0.99	90.3	111.2	130.3	139.4	148.3	2.34	1.60	1.95	1.31
23		Sulawesi Tengah	69,726	3.63	13.1	18.5	24.5	27.9	31.6	3.90	2.86	3.36	2.56
24		Sulawesi Selatan	72,781	3.79	71.2	83.3	95.9	104.1	112.0	1.76	1.42	1.58	1.56
25		Sulawesi Tenggara	27,686	1.44	25.8	34.0	48.8	57.6	66.8	3.13	3.66	3.41	3.20
		Total	189,216	9.86	45.1	55.0	66.2	72.8	79.4	2.24	1.86	2.04	1.84
26	MALUKU and IRIANJAYA	Maluku	74,505	3.88	14.6	18.9	24.9	28.1	31.3	2.91	2.78	2.84	2.30
27		Irian Jaya	421,981	21.99	2.2	2.8	3.9	4.6	5.4	2.71	3.46	3.10	3.31
		Total	496,486	25.87	4.1	5.2	7.1	8.2	9.3	2.82	3.09	2.96	2.79
	INDONESIA		1,919,317	100.00	62.1	76.8	93.5	101.7	109.6	2.39	1.98	2.17	1.61

Source:Statistical Year Book of Indonesia,1992 ,Central Bureau of Statistics

Note: 1.Population density of DKI Jakarta and Jawa Barat of 1971 and 1980 is before expanded (DKI Jakarta;590 km² and Jawa Barat;46,300km²)

2. Figures of 1995 and 2000 are forecasted by Central Bureau of Statistics.

Table II.2.4 POPULATION DENSITY OF STUDY AREA

Unit : Person/ km^2

Province	Kabupaten/Kotamdya	Area (km^2)*	1982	1987	1991	Average Annual Growth Rate(%)		
						1982/87	1987/91	1982/91
Riau	Kab.Kampar	30,564	13.8	18.8	19.2	6.31	0.59	3.73
	Kab.Indragiri Hulu	12,539	20.7	26.4	30.3	4.99	3.54	4.35
	Kab.Indragiri Hilir	12,326	33.6	35.5	39.4	1.11	2.65	1.79
	Kodya.Pekanbaru	632	304.0	336.4	623.4	2.05	16.67	8.31
	Total	56,061	23.0	27.7	32.9	3.83	4.41	4.09
	Province	94,561	24.7	29.4	35.4	3.56	4.75	4.09
West Sumatra	Kab.Solok	7,084	51.5	58.5	60.9	2.57	1.03	1.88
	Kab.Sawahlunto/Sijunjur	6,092	39.7	45.5	51.2	2.74	2.97	2.84
	Kab.Tanah Datar	1,336	242.9	263.5	262.2	1.64	-0.12	0.85
	Kab.Agam	2,232	177.4	185.7	186.6	0.92	0.11	0.56
	Kab.Lima Puluh Kota	3,354	83.9	89.5	90.9	1.29	0.41	0.90
	Kab.Pasaman	7,835	47.4	54.4	60.0	2.80	2.50	2.66
	Kodya.Solok	25	1,316.0	1,488.7	1,707.0	2.50	3.48	2.93
	Kodya.Sawahlunto	321	44.2	47.8	49.0	1.59	0.63	1.16
	Kodya.Padang Panjang	27	1,286.3	1,311.1	1,492.4	0.38	3.29	1.66
	Kodya.Bukittinggi	25	2,891.5	3,061.0	3,484.8	1.15	3.29	2.10
	Kodya.Payakunbu	80	1,023.4	1,074.8	1,171.2	0.99	2.17	1.51
	Total	28,411	78.0	85.7	90.2	1.90	1.31	1.64
	Province	49,778	70.8	77.8	83.2	1.90	1.70	1.81
	Total of Study Area	84,472	41.5	47.2	52.2	2.63	2.55	2.59

Source : 1. Riau in Figures, 1992, Statistical Office of Riau Province
2. West Sumatra in Figures, 1992, Statistical Office of West Sumatra Province

Note : *Areas include the areas outside of the Study Area

Table II.2.5 POPULATION PROJECTION

(1) Indragiri River Basin

Unit : person

Year	1994	1999	2004	2009	2014	2019
Kab.Indragiri Hulu	331,446	392,715	464,160	543,189	624,926	713,633
Kab.Indragiri Hilir	157,551	173,825	188,163	202,594	216,749	230,938
Sub-Total	488,997	566,541	652,323	745,784	841,675	944,571
Kab.Solok	223,326	244,402	263,381	281,785	297,922	314,984
Kab.Swl/Sijunjung	183,556	211,307	241,407	276,476	315,706	360,058
Kab. Tanah Datar	356,775	367,334	376,104	389,067	400,083	411,412
Kab. Agam	190,842	195,856	200,203	207,103	212,967	218,997
Kab.Limahpuluh Kota	243,749	255,043	265,015	281,163	295,213	309,965
Kodya.Solok	47,914	55,869	63,644	75,224	86,362	97,140
Kodya.Swl/Sijunjung	16,399	17,159	17,829	18,600	19,260	19,806
Kodya.Padang Panjang	42,068	45,453	48,534	52,802	56,603	60,260
Kodya.Payakunbuh	101,466	112,825	123,442	137,699	149,661	161,545
Kodya.Bukittingi	93,775	93,775	93,775	93,775	93,775	93,775
Sub-Total	1,499,870	1,599,023	1,693,334	1,813,694	1,927,553	2,047,942
Total	1,988,867	2,165,564	2,345,657	2,559,478	2,769,228	2,992,514
Kab.Indragiri Hilir(SWS) *1)	346,612	382,416	413,959	445,707	476,848	508,065
Grand Total	2,335,479	2,547,980	2,759,616	3,005,185	3,246,077	3,500,579

Note: SWS stands for In-between area

(2) Kampar River Basin

Unit : person

Year	1994	1999	2004	2009	2014	2019
Kab.Indragiri Hulu	65,417	77,510	91,610	107,208	123,341	140,849
Kab.Kampar	362,414	418,774	476,474	539,353	604,101	671,217
Sub-Total	427,831	496,284	568,085	646,561	727,441	812,065
Kab.Limahpuluh Kotak	68,750	71,935	74,748	79,302	83,265	87,426
Kab. Pasaman	25,543	28,247	30,755	34,115	37,164	39,913
Sub-Total	94,292	100,182	105,503	113,417	120,429	127,339
Total	522,124	596,466	673,587	759,978	847,870	939,404
Kodya Pekanbaru	496,826	649,332	858,754	1,135,719	1,466,835	1,872,095
Grand Total	1,018,950	1,245,799	1,532,341	1,895,697	2,314,705	2,811,499

Table II.3.1 GDP AND GRDP IN INDONESIA

Unit:10⁹ Rp.

No.	Island	Province	1984	1985	1986	1987	1988	1989	1990	1991	Average Annual Growth Rate(%)		
											1984/87	1987/91	1984/91
1	SUMATRA	Daerah Istimewa Aceh	4,099	4,210	4,230	4,593	5,010	5,418	5,716	6,000	3.87	6.91	5.59
2		Sumatra Utara	3,735	3,886	4,132	4,492	4,999	5,479	5,935	6,387	6.34	9.20	7.97
3		Sumatra Barat	1,300	1,356	1,424	1,491	1,597	1,712	1,832	1,955	4.68	7.01	6.00
4		Riau	6,785	6,501	7,336	8,178	8,502	8,945	8,772	8,817	6.42	1.90	3.81
5		Jambi	519	556	586	629	697	774	845	883	6.62	8.85	7.89
6		Sumatra Selatan	3,857	4,061	4,249	4,248	4,509	4,864	4,879	5,131	3.27	4.83	4.16
7		Bengkulu	278	300	332	357	397	427	460	498	8.69	8.68	8.68
8		Lampung	1,183	1,270	1,396	1,529	1,645	1,780	1,920	2.011	8.93	7.09	7.87
		Total	21,756	22,140	23,685	25,517	27,356	29,399	30,359	31,682	5.46	5.56	5.52
9	JAWA	DKI Jakarta	9,205	9,679	10,164	10,758	11,469	12,586	13,665	14,709	5.33	8.13	6.93
10		Jawa Barat	11,940	12,671	13,505	14,008	15,111	16,409	17,959	19,231	5.47	8.24	7.05
11		Jawa Tengah	8,232	8,919	9,460	10,016	10,652	11,340	12,134	13,003	6.76	6.74	6.75
12		DI Yogyakarta	810	821	885	921	976	1,038	1,085	1,141	4.37	5.50	5.02
13		Jawa Timur	11,513	12,147	12,896	13,524	14,420	15,495	16,737	17,924	5.51	7.30	6.53
		Total	41,700	44,237	46,910	49,227	52,628	56,868	61,580	66,008	5.69	7.61	6.78
14	NUSA TENGGARA	Bali	989	1,073	1,154	1,252	1,355	1,473	1,604	1,737	8.18	8.53	8.38
15		Nusa Tenggara Barat	575	593	629	648	691	751	818	879	4.06	7.92	6.25
16		Nusa Tenggara Timur	536	556	585	608	632	668	708	748	4.29	5.32	4.88
17		Timor Timur	88	94	99	107	117	125	140	155	6.73	9.71	8.42
		Total	2,188	2,316	2,467	2,615	2,795	3,017	3,270	3,519	6.12	7.71	7.02
18	KALIMANTAN	Kalimantan Barat	899	962	1,104	1,206	1,404	1,470	1,575	1,679	10.29	8.62	9.33
19		Kalimantan Tengah	504	536	590	633	687	719	773	844	7.89	7.46	7.64
20		Kalimantan Selatan	961	988	1,017	1,105	1,198	1,283	1,374	1,464	4.76	7.29	6.20
21		Kalimantan Timur	5,237	5,276	5,318	5,315	5,309	5,445	5,812	6,187	0.49	3.87	2.41
		Total	7,601	7,762	8,029	8,259	8,598	8,917	9,534	10,174	2.81	5.35	4.25
22	SULAWESI	Sulawesi Utara	681	705	730	770	825	873	957	1,046	4.18	7.96	6.32
23		Sulawesi Tengah	374	393	419	449	486	535	581	635	6.28	9.05	7.86
24		Sulawesi Selatan	1,830	1,966	2,094	2,167	2,363	2,609	2,785	3,062	5.80	9.03	7.63
25		Sulawesi Tenggara	322	335	366	386	421	465	526	598	6.23	11.57	9.25
		Total	3,207	3,399	3,609	3,772	4,095	4,482	4,849	5,341	5.56	9.08	7.56
26	MALUKU and IRIANJAYA	Maluku	516	539	601	674	734	783	858	918	9.31	8.03	8.58
27		Irian Jaya	791	775	819	848	924	1,020	1,094	1,221	2.35	9.54	6.40
		Total	1,307	1,314	1,420	1,522	1,658	1,803	1,952	2,139	5.21	8.88	7.29
TOTAL OF 27 PROVINCES			77,759	81,168	86,120	90,912	97,130	104,486	111,544	118,863	5.35	6.93	6.25
TOTAL OF 27 PROVINCES *)			60,585	64,391	68,688	72,883	78,788	85,179	92,026	98,673	6.35	7.87	7.22
INDONESIA			83,037	85,082	90,080	94,518	99,936	107,437	115,217	123,181	4.41	6.85	5.80
INDONESIA *)			63,435	66,884	70,993	75,128	80,678	87,371	94,000	100,194	5.80	7.46	6.75

Source: Statistical Year Book of Indonesia, 1993 Central Bureau of Statistics

Note: 1.*) Excluding oil and oil products.

2. At 1983 constant price

3. The difference between the total of GRDP of 27 Provinces and the GDP of Indonesia is due to the difference in coverage and statistical discrepancies.

Table II. 3.2 TREND OF PRODUCT AGGREGATES AND PER CAPITA INCOME

Description	1987	1988	1989	1990	1991	1992	1993	Average Annual Growth Rate(%)		
								1987/90	1990/93	1987/93
1. Gross Domestic Product (10^9 Rp.)	94,518	99,936	107,437	115,217	123,181	131,102	139,571	6.82	6.60	6.71
2. Per Capita Gross Domestic Product (Rp.)	556,478	576,282	614,872	646,671	679,118	710,612	743,778	5.13	4.77	4.95
3. Gros National Product (10^9 Rp.)	90,270	96,455	103,710	110,986	118,746	126,146	134,008	7.13	6.48	6.81
4. Per Capita Gross National Product (Rp.)	531,470	556,205	593,546	622,924	654,664	683,751	714,131	5.44	4.66	5.05
5. National Income (10^9 Rp.)	80,145	85,101	90,326	97,231	104,460	110,643	117,191	6.65	6.42	6.54
6. Per Capita Income (Rp.)	471,859	490,738	516,947	545,720	575,907	599,718	624,513	4.97	4.60	4.78
7. Gross Domestic Product without Petrolium, Gas, and their products (10^9 Rp.)	75,128	80,669	87,371	94,001	100,194	110,643	122,181	7.76	9.13	8.44
8. Mid-year Population (10^3 person)	169,850	173,415	174,730	178,170	181,384	184,491	187,651	1.61	1.74	1.68

Source: 1. Statistical Year Book of Indonesia, 1990,1992, & 1993.Central Bureau of Statistics
2. Economic Indicator, February,1994, Central Bureau of Statistics

Note: 1. Figures are at 1983 constsnt market price.

Table II.3.3 GROSS DOMESTIC PRODUCT BY INDUSTRIAL ORIGIN

Unit: 10^9 Rp.

Industrial Origin	1987		1988		1989		1990		1991		1992		1993		Average Annual Growth Rate(%)		
	GDP	Share(%)	GDP	Share(%)	GDP	Share(%)	GDP	Share(%)	GDP	Share(%)	GDP	Share(%)	GDP	Share(%)	1987/90	1990/93	1987/93
1 Agriculture, Livestock, Forestry & Fisheries	20,223.5	21.40	21,168.3	21.18	21,917.8	20.40	22,356.9	19.40	22,663.1	18.40	24,139.2	18.41	24,512.0	17.56	3.40	3.12	3.26
2 Mining & Quarrying	16,365.5	17.31	15,892.8	15.90	16,663.8	15.51	17,531.7	15.22	19,321.7	15.69	18,993.2	14.49	19,587.6	14.03	2.32	3.77	3.04
3 Manufacturing Industries	16,235.3	17.18	18,182.3	18.19	19,855.7	18.48	22,336.9	19.39	24,481.6	19.87	26,856.1	20.48	29,035.2	20.80	11.22	9.14	10.17
4 Electricity, Gas, & Water Supply	494.6	0.52	548.9	0.55	615.6	0.57	725.7	0.63	842.8	0.68	928.2	0.71	1,021.6	0.73	13.63	12.07	12.85
5 Construction	4,802.9	5.08	5,259.1	5.26	5,878.0	5.47	6,672.9	5.79	7,475.0	6.07	8,171.0	6.23	9,089.4	6.51	11.58	10.85	11.22
6 Trade, Hotel, & Restaurant	14,356.2	15.19	15656.8	15.67	17,338.1	16.14	18,568.6	16.12	19,606.1	15.92	21,103.1	16.10	23,113.6	16.56	8.95	7.57	8.26
7 Transportation & Communication	4,938.5	5.22	5,211.5	5.21	5,811.5	5.41	6,367.9	5.53	6,869.4	5.58	7,595.0	5.79	8,418.3	6.03	8.84	9.75	9.30
8 Banking, & Other Financial Intermediaries	3,659.3	3.87	3,752.2	3.75	4,290.7	3.99	4,893.8	4.25	5,535.1	4.49	6,249.2	4.77	7,008.5	5.02	10.17	12.72	11.44
9 Ownership of Dwellings	2,653.8	2.81	2,762.2	2.76	2,877.7	2.68	2,998.8	2.60	3,119.7	2.53	3,249.3	2.48	3,395.8	2.43	4.16	4.23	4.19
10 Public Administration & Defense	7,366.1	7.79	7,932.1	7.94	8,396.9	7.82	8,783.3	7.62	9,052.1	7.35	9,320.0	7.11	9,508.8	6.81	6.04	2.68	4.35
11 Services	3,422.1	3.62	3,569.8	3.57	3,790.8	3.53	3,980.8	3.46	4,214.5	3.42	4,497.3	3.43	4,880.0	3.50	5.17	7.02	6.09
12 Gross Domestic Product	94,517.8	100.00	99,936.0	100.00	107,436.6	100.00	115,217.3	100.00	123,181.1	100.00	131,101.6	100.00	139,570.8	100.00	6.82	6.60	6.71

Source: 1. Statistical Year Book of Indonesia, 1990,1992, and 1993. Central Bureau of Statistics

2. Economic Indicator, February,1994, Central Bureau of Statistics

Note: 1. Figures are at 1983 constant market price.

Table II.3.4 AREA HARVESTED, PRODUCTION AND YIELD RATE OF MAIN FOODSTUFF IN INDONESIA

Crops	Items	Unit	1989	1990	1991	1992	Av. Annual Growth Rate (%) (1989/92)
Paddy	Area Harvested	1,000 ha	10,531.2 (62.2)	10,502.4 (62.0)	10,281.5 (60.7)	11,103.3 (65.5)	1.78
	Production	1,000 ton	44,725.6 (62.0)	45,178.8 (62.6)	44,688.2 (61.9)	48,240.0 (66.8)	2.55
	Yield rate	ton/ha	4.25	4.30	4.35	4.34	0.76
Wetland Paddy	Area Harvested	1,000 ha	9,374.9 (55.3)	9,377.5 (55.3)	9,168.5 (54.1)	9,799.1 (57.8)	1.49
	Production	1,000 ton	42,371.3 (58.7)	42,825.3 (59.3)	42,330.9 (58.6)	45,413.6 (62.9)	2.34
	Yield rate	ton/ha	4.52	4.57	4.62	4.63	0.84
Dryland Paddy	Area Harvested	1,000 ha	1,156.3 (6.8)	1,124.9 (6.6)	1,113.0 (6.6)	1,304.2 (7.7)	4.09
	Production	1,000 ton	2,354.3 (3.3)	2,353.5 (3.3)	2,357.3 (3.3)	2,826.4 (3.9)	6.28
	Yield rate	ton/ha	2.04	2.09	2.12	2.17	2.10
Maize	Area Harvested	1,000 ha	2,944.2 (17.4)	3,158.1 (18.6)	2,909.1 (17.2)	3,629.3 (21.4)	7.22
	Production	1,000 ton	6,192.5 (8.6)	6,734.0 (9.3)	6,255.9 (8.7)	7,995.4 (11.1)	8.89
	Yield rate	ton/ha	2.10	2.13	2.15	2.20	1.56
Cassava	Area Harvested	1,000 ha	1,407.9 (8.3)	1,311.6 (7.7)	1,319.1 (7.8)	1,351.3 (8.0)	-1.36
	Production	1,000 ton	17,117.2 (23.7)	15,829.6 (21.9)	15,954.5 (22.1)	16,515.9 (22.9)	-1.18
	Yield rate	ton/ha	12.16	12.07	12.09	12.22	0.18
Sweet Potatoes	Area Harvested	1,000 ha	240.2 (1.4)	208.7 (1.2)	214.3 (1.3)	229.9 (1.4)	-1.45
	Production	1,000 ton	2,224.3 (3.1)	1,971.5 (2.7)	2,039.2 (2.8)	2,171.0 (3.0)	-0.81
	Yield rate	ton/ha	9.26	9.45	9.52	9.44	0.65
Peanuts	Area Harvested	1,000 ha	620.8 (3.7)	635.0 (3.7)	628.3 (3.7)	719.7 (4.2)	5.05
	Production	1,000 ton	619.6 (0.9)	650.6 (0.9)	652.1 (0.9)	739.0 (1.0)	6.05
	Yield rate	ton/ha	1.00	1.02	1.04	1.03	0.95
Soybeans	Area Harvested	1,000 ha	1,198.1 (7.1)	1,334.1 (7.9)	1,368.2 (8.1)	1,665.7 (9.8)	11.61
	Production	1,000 ton	1,315.1 (1.8)	1,487.4 (2.1)	1,555.5 (2.2)	1,869.7 (2.6)	12.44
	Yield rate	ton/ha	1.10	1.11	1.14	1.12	0.75
Total	Area Harvested	1,000 ha	16,942.4 (100.0)	17,149.9 (100.0)	16,720.5 (100.0)	18,699.2 (100.0)	3.34
	Production	1,000 ton	72,194.3 (100.0)	71,851.9 (100.0)	71,145.4 (100.0)	77,531.0 (100.0)	2.41
	Yield rate	ton/ha	4.26	4.19	4.25	4.15	-0.91

Source: Statistical Year Book of Indonesia, 1993. Central Bureau of Statistics.

Note: Figures in parentheses are percentages to Total.

Table II.3.5 PRODUCTION OF MAIN FOODSTUFF BY ISLAND AND PROVINCE IN INDONESIA (1992)

(Unit: ton)

No	Island	Province	Paddy			Maize	Cassava	Sweet Potates	Peanuts	Soybeans	Total
			Wetland Paddy	Dryland Paddy	Total						
1	SUMATRA	Daerah Istimewa Aceh	1,293,314	25,183	1,318,497	27,108	103,407	37,558	22,117	166,820	1,675,507
2		Sumatra Utara	2,715,280	179,914	2,895,194	262,412	373,983	135,096	18,350	44,216	3,729,251
3		Sumatra Barat	1,737,665	29,100	1,766,765	25,717	100,905	30,089	10,206	13,982	1,947,664
4		Riau	350,610	123,122	473,732	25,982	111,605	21,158	4,455	11,037	647,969
5		Jambi	501,002	88,838	589,840	10,147	199,550	24,714	2,575	9,202	836,028
6		Sumatra Selatan	1,300,278	250,659	1,550,937	52,494	408,347	46,047	12,836	19,259	2,089,920
7		Bengkulu	312,719	37,156	349,875	32,550	91,261	69,376	7,644	13,422	564,128
8		Lampung	1,354,692	322,176	1,676,868	530,388	2,283,774	49,878	12,888	179,793	4,733,589
		Total	9,565,560	1,056,148	10,621,708	966,798	3,672,832	413,916	91,071	457,731	16,224,056
9	JAWA	DKI Jakarta	31,433	-	31,433	18	608	63	28	-	32,150
10		Jawa Barat	10,406,341	457,052	10,863,393	318,775	2,153,207	483,336	139,919	154,048	14,112,678
11		Jawa Tengah	7,970,148	166,630	8,136,778	1,992,123	3,447,858	272,057	148,680	297,580	14,295,076
12		DI Yogyakarta	532,312	103,649	635,961	185,817	682,597	12,000	48,946	84,793	1,650,114
13		Jawa Timur	5,338,060	268,796	5,606,856	3,023,344	3,601,307	269,536	152,557	543,010	13,196,610
		Total	24,278,294	996,127	25,274,421	5,520,077	9,885,577	1,036,992	490,130	1,079,431	43,286,628
14	NUSA TENGGARA	Bali	836,071	4,303	840,374	110,425	236,194	102,033	14,535	28,900	1,332,461
15		Nusa Tenggara Barat	1,108,783	32,518	1,141,301	37,548	77,862	54,866	25,682	121,176	1,458,435
16		Nusa Tenggara Timur	249,475	123,331	372,806	376,569	840,787	91,219	7,928	5,191	1,694,500
17		Timor Timur	45,879	-	45,879	82,275	49,524	11,571	3,077	1,371	193,697
		Total	2,240,208	160,152	2,400,360	606,817	1,204,367	259,689	51,222	156,638	4,679,093
18	KALIMANTAN	Kalimantan Barat	529,336	193,053	722,389	16,781	212,377	19,396	1,947	8,524	981,414
19		Kalimantan Tengah	222,747	97,196	319,943	3,457	58,434	10,376	706	4,413	397,329
20		Kalimantan Selatan	1,088,242	88,979	1,177,221	22,847	102,463	18,325	16,270	5,825	1,342,951
21		Kalimantan Timur	121,849	111,399	233,248	10,181	93,369	18,767	2,490	3,337	361,392
		Total	1,962,174	490,627	2,452,801	53,266	466,643	66,864	21,413	22,099	3,083,086
22	SULAWESI	Sulawesi Utara	285,676	21,980	307,656	129,581	94,621	40,351	6,935	39,935	619,079
23		Sulawesi Tengah	421,746	28,119	449,865	17,157	88,843	20,532	4,128	9,676	590,201
24		Sulawesi Selatan	3,437,594	34,862	3,472,456	591,838	560,093	78,703	61,651	88,191	4,852,932
25		Sulawesi Tenggara	187,159	29,784	216,943	87,991	243,472	18,484	6,101	10,353	583,344
		Total	4,332,175	114,745	4,446,920	826,567	987,029	158,070	78,815	148,155	6,645,556
26	MALUKU and	Maluku	2,513	5,398	7,911	17,653	267,643	59,565	3,555	1,484	357,811
27	IRIANJAYA	Irian Jaya	25,946	3,164	29,110	4,281	31,764	175,940	2,844	4,175	248,114
		Total	28,459	8,562	37,021	21,934	299,407	235,505	6,399	5,659	605,925
	INDONESIA		42,406,870	2,826,361	45,233,231	7,995,459	16,515,855	2,171,036	739,050	1,869,713	74,524,344

Source: Statistical Year Book of Indonesia, 1993.Central Bureau of Statistics

Table II.3.6 PRODUCTION OF ESTATES BY TYPE OF CROP IN INDONESIA

(Unit: 1,000ton)

Crops		1987	1988	1989	1990	1991	1992	Av. Annual Growth Rate(%) (1987/92)
Perennial Crops	Rubber	1,141.3	1,173.3	1,180.2	1,228.7	1,301.5	1,334.8	3.18
	Coconut	2,098.5	2,144.0	2,221.4	2,331.5	2,478.3	2,510.9	3.65
	Crude Palm Oil	1,381.2	1,609.3	1,860.4	2,096.9	1,843.6	2,186.0	9.62
	Oil Palm	165.2	156.1	183.7	377.0	413.3	699.6	33.47
	Palm Kernel	326.6	355.9	447.1	521.2	491.6	90.8	-22.59
	Coffee	388.6	391.1	409.0	410.0	425.5	432.9	2.18
	Cocoa	43.5	79.4	107.4	139.0	149.9	163.5	30.32
	Tea	127.9	133.8	146.8	160.5	152.9	141.0	1.97
	Clove	71.0	81.2	56.4	66.9	84.4	75.3	1.18
	Kapok	53.3	57.7	56.9	63.4	63.6	65.1	4.08
	Cashew Nut	24.0	23.2	27.9	29.8	31.3	32.5	6.25
	Nutmeg	15.3	14.6	15.1	16.8	17.0	16.4	1.40
	Cassiavera	26.4	25.4	24.3	26.5	26.7	26.9	0.38
	Candlenut tree	27.8	24.3	28.5	35.6	35.8	35.8	5.19
	Areca nut	19.3	18.3	20.9	23.0	23.2	23.3	3.84
	Pepper	49.3	65.3	67.8	69.9	62.5	62.6	4.89
	Vanila	1.8	2.4	2.0	1.3	1.3	1.7	-1.14
	Cardamom	-	1.2	1.2	1.6	1.6	1.6	7.46
	Cinchona	3.1	2.7	1.8	1.9	2.1	2.7	-2.73
	Sub-total	5,964.1	6,359.2	6,858.8	7,601.5	7,606.1	7,903.4	5.79
Annual Crops	Tobaco	112.6	116.9	80.9	56.3	141.9	145.3	5.23
	Citronella	0.3	0.2	0.3	0.3	0.3	0.4	5.92
	Caster Oil Seeds	1.4	1.1	2.8	2.0	2.1	2.1	8.45
	Patchouli	-	3.3	3.3	2.9	2.9	2.9	-3.18
	Ginger	-	63.3	63.3	79.1	81.5	82.6	6.88
	Sugar Cane	2,085.8	2,004.1	2,071.4	2,173.2	2,233.3	2,344.6	2.37
	Rosella	22.6	13.4	9.7	14.8	5.3	9.3	-16.27
	Sub-total	2,222.7	2,202.3	2,231.7	2,328.6	2,467.3	2,587.2	3.08
Total		8,186.8	8,561.5	9,090.5	9,930.1	10,073.4	10,490.6	5.08

Source: Statistical Year Book of Indonesia, 1993.Central Bureau of Statistics

Note: Average growth rates of "Cardamon", "Patchouli" and "Ginger" are during the period from 1988 to 1992.

Table II.3.7 ESTABLISHMENTS, PERSONS ENGAGED, AND VALUE OF GROSS OUTPUT OF MANUFACTURING ESTABLISHMENTS

Classification of Manufacturing Industry	Number of Establishments				Persons Engaged				Value of Gross Outputs(10^9 Rp.:at market price)			
	Large/Medium	Small	Household	Total	Large/Medium	Small	Household	Total	Large/Medium	Small	Household	Total
Food, Beverage and Tobacco	4,459	38,271	833,228	875,958	643,021	309,603	1,483,593	2,436,217	18,430	1,491	2,709	22,630
Textiles, Clothing, and Leather	3,935	19,788	298,761	322,484	907,161	174,734	431,497	1,513,392	15,044	1,121	1,125	17,290
Wood and Wood Products, including Furniture	1,948	27,277	1,009,670	1,038,895	445,209	216,185	1,460,646	2,122,040	10,249	820	1,273	12,342
Paper and Paper Products, Printing and Publishing	703	1,272	6,178	8,153	102,429	11,415	12,224	126,068	4,425	51	49	4,525
Chemicals, Petroleum, Coal, Rubber, and Plastic Products	1,993	1,409	1,329	4,731	377,775	11,647	2,542	391,964	14,611	36	8	14,655
Non Metalic Mineral Products, except Products of Petroleum and Coal	1,393	24,411	153,252	179,056	129,919	171,789	300,353	602,061	3,337	278	369	3,984
Basic Metals	116	-	-	116	37,520	-	-	37,520	5,647	-	-	5,647
Fabricated Metal Products, Machinery and Equipment	1,658	7,824	29,395	38,877	305,179	68,128	62,327	435,634	14,053	293	277	14,623
Other Manufacturing Industries	289	2,429	19,171	21,889	45,754	20,005	33,144	98,903	456	103	84	643
Total	16,494	122,681	2,350,984	2,490,159	2,993,967	983,506	3,786,326	7,763,799	86,252	4,193	5,894	96,339

Source: Statistical Year Book of Indonesia, 1993. Central Bureau of Statistics.

Table II.3.8 ACTUAL GOVERNMENT RECEIPTS AND EXPENDITURES

(Unit: 10^9 Rp.)

Year	Routine			Development			Total		
	Receipts	Expenditures	Public Savings	Receipts	Expenditures	Surplus	Receipts	Expenditures	Balance
1984	15,905	9,429	6,476	3,478	9,952	-6,474	19,383	19,381	2
1985	19,253	11,952	7,301	3,572	10,873	-7,301	22,825	22,825	0
1986	16,141	13,559	2,582	5,752	8,332	-2,580	21,893	21,891	2
1987	20,803	17,481	3,322	6,158	9,477	-3,319	26,961	26,958	3
1988	23,004	20,739	2,265	9,991	12,251	-2,260	32,995	32,990	5
1989	28,740	24,331	4,409	9,429	13,834	-4,405	38,169	38,165	4
1990	39,546	29,998	9,548	9,905	19,452	-9,547	49,451	49,450	1
1991	41,585	30,228	11,357	10,409	21,764	-11,355	51,994	51,992	2
1992	47,452	34,031	13,421	10,716	24,135	-13,419	58,168	58,166	2
Ave. Annual Growth Rate(%)									
1984/88	9.66	21.78	-23.10	30.19	5.33	23.13	14.22	14.22	25.74
1988/92	19.84	13.18	56.02	1.77	18.47	-56.10	15.23	15.23	-20.47
1984/92	14.64	17.40	9.54	15.10	11.71	-9.54	14.72	14.73	0.00

Source: 1. Statistical Year Book of Indonesia, 1993, Central Bureau of Statistics
2. Monthly Statistical Bulletin, Feb.1994, Central Bureau of Statistics.

Table II.3.9 ACTUAL GOVERNMENT RECEIPTS

(Unit: 10^9 Rp.)

Government Receipts	1984		1988		1992		Average Annual Growth Rate(%)		
	Receipts	Share(%)	Receipts	Share(%)	Receipts	Share(%)	1984/88	1988/92	1984/92
I. Routine Receipts									
1. Oil and Gas Receipts	10,430	53.81	9,527	28.87	15,330	26.35	-2.24	12.63	4.93
2. Non Oil and Gas Receipts	5,475	28.25	13,477	40.85	32,122	55.22	25.26	24.25	24.75
1) Income Tax	2,121	10.94	3,949	11.97	11,913	20.48	16.81	31.79	24.08
2) Value Added Tax on Goods and Services and Tax on the Sale of Luxuries Goods	878	4.53	4,505	13.65	10,714	18.42	50.50	24.18	36.71
3) Import Duties	530	2.73	1,192	3.61	2,652	4.56	22.46	22.13	22.30
4) Excises Duties	873	4.50	1,390	4.21	2,381	4.09	12.33	14.40	13.36
5) Export Tax	91	0.47	156	0.47	8	0.01	14.42	-52.41	-26.21
6) Others Tax	138	0.71	292	0.88	360	0.62	20.61	5.37	12.73
7) Taxes on Land and Building	157	0.81	424	1.29	1,101	1.89	28.19	26.94	27.57
8) Non Tax Receipts	687	3.54	1,569	4.76	2,993	5.15	22.93	17.52	20.20
9) Other Oil Receipts	-	-	-	-	-	-	-	-	-
Subtotal	15,905	82.06	23,004	69.72	47,452	81.58	9.66	19.84	14.64
II. Development Receipts									
1. Program Aid	69	0.36	2,041	6.19	512	0.88	133.21	-29.23	28.47
2. Project Aid	3,409	17.59	7,950	24.09	10,204	17.54	23.58	6.44	14.69
Subtotal	3,478	17.94	9,991	30.28	10,716	18.42	30.19	1.77	15.10
Total	19,383	100.00	32,995	100.00	58,168	100.00	14.22	15.23	14.72

Source: 1. Statistical Year Book of Indonesia, 1993, Central Bureau of Statistics
2. Monthly Statistical Bulletin, Feb.1994, Central bureau of Statistics.

Table II.3.10 ACTUAL GOVERNMENT EXPENDITURES

(Unit: 10^9 Rp.)

Government Expenditures	1984		1988		1992		Average Annual Growth Rate(%)		
	Expen.	Share(%)	Expen.	Share(%)	Expen.	Share(%)	1984/88	1988/92	1984/92
I. Routine Expenditures									
1.Personnel Expenditures	3,047	15.72	4,998	15.15	9,466	16.27	13.17	17.31	15.22
2.Material Expenditures	1,183	6.10	1,492	4.52	2,870	4.93	5.97	17.77	11.72
3.Subsidies to Regions	1,883	9.72	3,038	9.21	5,283	9.08	12.70	14.83	13.76
4.Debt Payments	2,776	14.32	10,940	33.16	15,217	26.16	40.90	8.60	23.70
5.Other	540	2.79	271	0.82	1,195	2.05	-15.83	44.91	10.44
Subtotal	9,429	48.65	20,739	62.87	34,031	58.51	21.78	13.18	17.40
II. Development Expenditures									
1. Institution	3,474	17.92	1,855	5.62	7,858	13.51	-14.52	43.46	10.74
2. Subsidy to Village	93	0.48	112	0.34	327	0.56	4.76	30.72	17.02
3. Development Subsidy to Regencies	195	1.01	267	0.81	825	1.42	8.17	32.58	19.76
4. Development Subsidy to Provinces	253	1.31	334	1.01	701	1.21	7.19	20.36	13.59
5. Development of Primary Schools	572	2.95	130	0.39	655	1.13	-30.95	49.82	1.71
6. Facilities/Public/Health Central	65	0.34	99	0.30	320	0.55	11.09	34.08	22.05
7. Infrastructure Development	101	0.52	180	0.55	1,225	2.11	15.54	61.52	36.61
8. Subsidies to The Reconstruction and The Development of Market	25	0.13	3	0.01	1	0.00	-41.14	-24.02	-33.13
9. Subsidies for Registration and Reforestation	61	0.31	16	0.05	95	0.16	-28.44	56.10	5.69
10.East Timor	4	0.02	6	0.02	-	-	10.67	-	-
11.Taxes on Land and Building	157	0.81	344	1.04	891	1.53	21.66	26.86	24.24
12.Fertilizer Subsidy	732	3.78	200	0.61	175	0.30	-27.70	-3.28	-16.38
13.Government Capital Participation	336	1.73	125	0.38	150	0.26	-21.90	4.66	-9.59
14.Others	475	2.45	629	1.91	708	1.22	7.27	3.00	5.12
15.Project Aid	3,409	17.59	7,950	24.10	10,204	17.54	23.58	6.44	14.69
16.Reserves	-	-	-	-	-	-	-	-	-
Subtotal	9,952	51.35	12,250	37.13	24,135	41.49	5.33	18.48	11.71
Total	19,381	100.00	32,989	100.00	58,166	100.00	14.22	15.23	14.73

Source: 1. Statistical Year Book of Indonesia, 1993, Central Bureau of Statistics
2. Monthly Statistical Bulletin, Feb.1994, Central bureau of Statistics.

Table II.3.11 TREND OF EXPORTS AND IMPORTS

(Unit:FOB 10^6 US$)

Year	Including Petroleum and Gas			Excluding Petroleum and Gas		
	Export	Import	Balance	Export	Import	Balance
1956	926.2	860.1	66.1	670.9	799.7	-128.8
1957	954.4	803.3	151.1	651.6	720.2	-68.6
1958	790.7	544.1	246.6	475.5	484.3	-8.8
1959	931.0	481.9	449.1	645.3	436.6	208.7
1960	840.8	577.7	263.1	620.0	551.9	68.1
1961	788.2	796.2	-8.0	527.3	746.6	-219.3
1962	663.7	647.0	16.7	447.9	608.0	-160.1
1963	697.8	521.4	176.4	429.1	489.8	-60.7
1964	724.2	679.9	44.3	457.7	671.6	-213.9
1965	707.7	694.7	13.0	435.7	682.1	-246.4
1966	678.7	526.7	152.0	475.3	519.2	-43.9
1967	665.4	649.2	16.2	425.8	636.6	-210.8
1968	730.7	715.8	14.9	433.2	709.7	-276.5
1969	853.7	780.7	73.0	470.8	769.8	-299.0
1970	1,108.1	1,001.5	106.6	661.8	986.8	-325.0
1971	1,233.6	1,102.8	130.8	755.7	1,082.4	-326.7
1972	1,777.7	1,561.7	216.0	864.6	1,531.4	-666.8
1973	3,210.8	2,729.1	481.7	1,602.1	2,685.3	-1,083.2
1974	7,426.3	3,841.9	3,584.4	2,214.9	3,658.9	-1,444.0
1975	7,102.5	4,769.8	2,332.7	1,791.7	4,516.3	-2,724.6
1976	8,546.5	5,673.1	2,873.4	2,542.4	5,235.4	-2,693.0
1977	10,852.6	6,230.3	4,622.3	3,474.5	5,497.9	-2,023.4
1978	11,643.2	6,690.4	4,952.8	3,657.8	6,110.4	-2,452.6
1979	15,590.1	7,202.3	8,387.8	5,426.4	6,408.8	-982.4
1980	23,950.4	10,834.4	13,116.0	6,168.8	9,085.9	-2,917.1
1981	25,164.5	13,272.1	11,892.4	4,501.3	11,550.4	-7,049.1
1982	22,328.3	16,858.9	5,469.4	3,929.2	13,314.1	-9,384.9
1983	21,145.9	16,351.8	4,794.1	5,005.3	12,207.0	-7,201.7
1984	21,887.8	13,882.1	8,005.7	5,869.7	11,185.3	-5,315.6
1985	18,586.7	10,259.1	8,327.6	5,868.8	8,987.5	-3,118.7
1986	14,805.0	10,718.4	4,086.6	6,528.4	9,632.0	-3,103.6
1987	17,135.6	12,370.3	4,765.3	8,579.5	11,302.3	-2,722.8
1988	19,218.5	13,248.5	5,970.0	11,536.9	12,339.4	-802.5
1989	22,158.9	16,359.6	5,799.3	13,480.1	15,164.4	-1,684.3
1990	25,675.3	21,837.1	3,838.2	14,604.2	19,916.6	-5,312.4
1991	29,142.3	25,868.8	3,273.5	18,071.2	23,558.5	-5,487.3
1992	33,967.0	27,279.6	6,687.4	23,296.1	25,164.6	-1,868.5
Average Annual Growth Rate(%)						
1956/66	-3.06	-4.79	8.68	-3.39	-4.23	10.20
1966/76	28.83	26.83	34.17	18.26	26.00	-50.93
1976/86	5.65	6.57	3.58	9.89	6.29	-1.43
1986/92	14.84	16.85	8.55	23.62	17.36	8.11
1956/92	10.52	10.08	13.68	10.36	10.05	-7.71

Source: Statistical Year Book of Indonesia, 1993, Central Bureau of Statistics.

Table II.3.12 VALUE OF EXPORTS BY SITC GROUPS

Unit:FOB 10^6 US$

	SITC Commodity Group	1989		1990		1991		1992		Average Annual Growth Rate (%)
		Value	Share(%)	Value	Share(%)	Value	Share(%)	Value	Share(%)	
0	Foodstuff & Live Animals	2,078.2	9.38	2,292.8	8.93	2,539.1	8.71	2,468.7	7.27	5.91
1	Beverage and Tobacco	114.6	0.52	135.7	0.53	154.4	0.53	218.1	0.64	23.92
2	Raw Materials, Inedible	2,796.5	12.62	1,969.6	7.67	2,372.6	8.14	2,625.4	7.73	-2.08
3	Mineral Fuels, Lubricants & Related Materials	8,760.1	39.53	11,239.2	43.77	11,169.5	38.33	11,273.4	33.19	8.77
4	Animal & Vegetable Oils & Fats	456.6	2.06	420.0	1.64	561.6	1.93	762.4	2.24	18.64
5	Chemicals	499.4	2.25	621.1	2.42	852.8	2.93	795.2	2.34	16.77
6	Manufactured Goods Classified by Materials	5,112.8	23.07	5,643.7	21.98	6,488.5	22.26	8,434.0	24.83	18.16
7	Machinery & Transport Equipment	202.0	0.91	367.0	1.43	668.4	2.29	1,448.1	4.26	92.82
8	Miscellaneous Manufactured Articles	1,882.6	8.50	2,864.1	11.16	4,190.3	14.38	5,790.2	17.05	45.43
9	Commodities & Transactions Not Classified According to Kin	256.1	1.16	122.1	0.48	145.1	0.50	151.5	0.45	-16.05
	Total	22,158.9	100.00	25,675.3	100.00	29,142.3	100.00	33,967.0	100.00	15.30

Source: Statistical Year Book of Indonesia, 1993, Central Bureau of Statistics.
Note: "SITC" stands for "Standard International Trade Classification".

Table II.3.13 VALUE OF IMPORTS BY SITC GROUPS

Unit:CIF 10^6 US$

	SITC Commodity Group	1989		1990		1991		1992		Average Growth Rate (%)
		Value	Share(%)	Value	Share(%)	Value	Share(%)	Value	Share(%)	
0	Foodstuff & Live Animals	910.9	5.57	851.8	3.90	1,080.6	4.18	1,274.1	4.67	11.83
1	Beverage and Tobacco	33.6	0.21	54.0	0.25	74.4	0.29	88.9	0.33	38.31
2	Raw Materials, Inedible	1,673.9	10.23	1,885.0	8.63	2,150.9	8.32	2,408.8	8.83	12.90
3	Mineral Fuels, Lubricants & Related Materials	1,252.6	7.66	1,937.2	8.87	2,323.0	8.98	2,104.3	7.71	18.88
4	Animal & Vegetable Oils & Fats	150.5	0.92	25.5	0.12	41.2	0.16	148.9	0.55	-0.36
5	Chemicals	2,873.4	17.56	3,393.6	15.54	3,423.3	13.24	3,776.0	13.84	9.53
6	Manufactured Goods Classified by Materials	2,638.0	16.13	3,552.9	16.27	4,138.4	16.00	4,668.1	17.11	20.95
7	Machinery & Transport Equipment	6,181.9	37.79	9,327.8	42.72	11,630.5	44.98	11,700.1	42.89	23.70
8	Miscellaneous Manufactured Articles	633.6	3.87	796.7	3.65	980.1	3.79	1,095.7	4.02	20.03
9	Commodities & Transactions Not Classified According to Kind	11.2	0.07	12.5	0.06	17.4	0.07	14.7	0.05	9.49
	Total	16,359.6	100.00	21,837.0	100.00	25,859.8	100.00	27,279.6	100.00	18.58

Source: Statistical Year Book of Indonesia, 1993, Central Bureau of Statistics.
Note: "SITC" stands for "Standard International Trade Classification".

Table II.3.14 GROSS REGIONAL DOMESTIC PRODUCT

Unit : Million Rp.

Province	Kabupaten/Kotamadya	1986			1987			1988			1989			1990			Average
		GRDP	Share(%)		GRDP	Share(%)		GRDP	Share(%)		GRDP	Share(%)		GRDP	Share(%)		Growth Rate(%)
			Study Area	Province		Study Area	Province		Study Area	Province		Study Area	Province		Study Area	Province	1986/90
Riau	Kab.Kampar	166,096	11.4	2.3	173,692	11.7	2.1	188,672	12.3	2.2	207,871	13.1	2.3	230,834	13.4	2.6	8.58
	Kab.Indragiri Hulu	76,114	5.2	1.0	83,279	5.6	1.0	94,948	6.2	1.1	104,066	6.6	1.2	114,466	6.7	1.3	10.74
	Kab.Indragiri Hilir	139,737	9.6	1.9	148,036	10.0	1.8	155,549	10.1	1.8	168,657	10.6	1.9	186,312	10.8	2.1	7.46
	Kodya.Pekanbaru	143,767	9.9	2.0	155,586	10.5	1.9	168,274	11.0	2.0	187,944	11.8	2.1	211,029	12.3	2.4	10.07
	Sub-total	525,714	36.2	7.2	560,593	37.8	6.9	607,443	39.6	7.1	668,538	42.1	7.5	742,641	43.2	8.5	9.02
	Province (Including Oil)	7,336,300	505.1	100.0	8,178,232	552.0	100.0	8,501,533	554.3	100.0	8,931,940	562.9	100.0	8,747,289	509.3	100.0	4.50
West Sumatra	Kab.Solok	137,696	9.5	9.7	134,164	9.1	9.0	136,155	8.9	8.5	128,461	8.1	7.5	135,128	7.9	9.5	-0.47
	Kab.Sawahlunto/Sijunjui	106,516	7.3	7.5	107,537	7.3	7.2	104,870	6.8	6.6	108,547	6.8	6.3	117,050	6.8	8.2	2.39
	Kab.Tanah Datar	121,638	8.4	8.5	122,729	8.3	8.2	125,614	8.2	7.9	122,037	7.7	7.1	128,107	7.5	9.0	1.30
	Kab.Agam	128,878	8.9	9.1	130,646	8.8	8.8	130,040	8.5	8.1	131,581	8.3	7.7	139,513	8.1	9.8	2.00
	Kab.Lima Puluh Kota	121,178	8.3	8.5	120,769	8.2	8.1	121,540	7.9	7.6	123,527	7.8	7.2	131,270	7.6	9.2	2.02
	Kab.Pasaman	155,450	10.7	10.9	155,536	10.5	10.4	150,887	9.8	9.4	149,665	9.4	8.7	161,551	9.4	11.3	0.97
	Kodya.Solok	17,723	1.2	1.2	16,120	1.1	1.1	17,245	1.1	1.1	17,250	1.1	1.0	18,231	1.1	1.3	0.71
	Kodya.Sawahlunto	19,683	1.4	1.4	18,351	1.2	1.2	23,151	1.5	1.4	22,205	1.4	1.3	24,086	1.4	1.7	5.18
	Kodya.Padang Panjang	22,979	1.6	1.6	21,961	1.5	1.5	22,387	1.5	1.4	21,838	1.4	1.3	23,287	1.4	1.6	0.33
	Kodya.Bukittinggi	55,328	3.8	3.9	52,539	3.5	3.5	54,065	3.5	3.4	52,529	3.3	3.1	53,771	3.1	3.8	-0.71
	Kodya.Payakumbu	39,646	2.7	2.8	40,561	2.7	2.7	40,349	2.6	2.5	40,476	2.6	2.4	42,762	2.5	3.0	1.91
	Sub-total	926,716	63.8	65.1	920,912	62.2	61.7	926,304	60.4	58.0	918,116	57.9	53.6	974,756	56.8	68.5	1.27
	Province	1,423,634	98.0	100.0	1,491,461	100.7	100.0	1,596,840	104.1	100.0	1,712,067	107.9	100.0	1,832,855	106.7	128.7	6.52
	Total of Study Area	1,452,430	100.0	-	1,481,505	100.0	-	1,533,747	100.0	-	1,586,654	100.0	-	1,717,397	100.0	-	4.28

Source : 1. Riau in Figures, 1992, Statistical Office of Riau Province
2. West Sumatra in Figures, 1992, Statistical Office of West Sumatra Province.

Note : 1.Kodya. Sawahlunto includes coal products.
2.At 1983 Constant Market Price

Table II.3.15 GRDP PER CAPITA

Unit :Rupiah

Province	Kabupaten/Kotamadya	1986	1987	1988	1989	1990	Average Growth Rate(%) 1986/90
Riau	Kab.Kampar	166,096	173,692	188,672	207,871	230,834	8.58
	Kab.Indragiri Hulu	76,114	83,279	94,948	104,066	114,466	10.74
	Kab.Indragiri Hilir	139,737	148,036	155,549	168,657	186,312	7.46
	Kodya.Pekanbaru	451,251	463,736	476,278	505,143	538,602	4.52
	Sub-total	343,728	360,661	385,150	412,651	414,450	4.79
	Province	2,681,477	2,847,342	2,654,979	2,661,923	2,478,492	-1.95
West Sumatra	Kab.Solok	338,400	329,719	334,612	315,703	317,830	-1.56
	Kab.Sawahlunto/Sijunju	355,614	359,020	350,116	362,393	396,317	2.75
	Kab.Tanah Datar	337,451	340,476	348,479	338,557	376,471	2.77
	Kab.Agam	302,735	306,888	305,464	309,083	344,005	3.25
	Kab.Lima Puluh Kota	392,825	391,499	394,000	400,441	441,014	2.94
	Kab.Pasaman	353,959	354,153	343,570	340,786	360,038	0.43
	Kodya.Solok	517,567	470,765	503,612	503,754	429,136	-4.58
	Kodya.Sawahlunto	1,261,776	1,176,386	1,484,133	1,423,478	1,585,024	5.87
	Kodya.Padang Panjang	657,734	628,593	640,805	625,086	606,950	-1.99
	Kodya.Bukittinggi	735,881	698,790	719,089	698,655	645,074	-3.24
	Kodya.Payakunbu	452,282	462,714	460,293	461,746	473,146	1.13
	Sub-total	386,376	378,343	372,561	364,310	390,790	0.28
	Province	380,599	392,562	414,154	437,113	460,687	4.89
	Average of Study Area	369,770	371,452	377,447	383,226	400,681	2.03

Source : 1. Riau in Figures, 1992, Statistical Office of Riau Province
2. West Sumatra in Figures, 1992, Statistical Office of West Sumatra Province.

Note : Kodya. Sawahlunto includes coal products.
At 1983 Constant Market Price

Table II.3.16 GROSS REGIONAL PRODUCT BY INDUSTRIAL ORIGIN (1990)

Unit : Million Rp.

Province	Kab./Kodya.	Agriculrure	Mining & Quarrying	Manuf. Industry	Electricity & Water Supply	Construction	Trade, Hotel & Restaurants	Transportation & Communi-cation	Banking & Other Financial Institution	Ownership of Dwelling	Public Admi-nistration & Deffence	Other Service	GRDP
Riau	Kab.Kampar	111,779	2,069	22,009	312	7,272	37,320	16,468	1,087	12,140	15,869	4,510	230,834
	Kab.Indragiri Hulu	47,183	6,273	6,216	847	2,965	17,124	8,356	5,162	6,948	10,542	2,850	114,466
	Kab.Indragiri Hilir	71,972	149	9,297	652	4,267	47,137	20,811	4,546	12,464	11,551	3,465	186,312
	Kodya.Pekanbaru	9,138	21	18,043	3,271	10,805	72,045	31,654	22,158	20,470	16,249	7,175	211,029
	Sub-total	240,072	8,512	55,565	5,082	25,308	173,626	77,290	32,953	52,022	54,212	18,000	742641.46
	Province	474,978	6,867,497	377,883	22,743	27,117	564,200	156,576	66,479	77,851	82,225	29,741	8,747,289
West Sumatra	Kab.Solok	69,361	878	7,446	541	4,946	28,688	6,013	973	4,202	7,635	4,446	135,128
	Kab.Sawahlunto/Sijunjung	50,589	1,838	11,377	222	8,732	25,493	4,776	1,323	2,844	6,929	2,926	117,050
	Kab.Tanah Datar	53,549	1,025	12,657	512	4,778	30,144	8,186	2,101	3,472	8,058	3,625	128,107
	Kab.Agam	58,512	921	17,788	1,521	3,753	34,641	7,004	377	4,311	6,320	4,367	139,513
	Kab.Lima Puluh Kota	50,670	748	21,961	302	3,623	30,848	5,421	407	4,358	8,782	4,148	131,270
	Kab.Pasaman	80,824	1,082	8,384	339	5,380	43,150	5,557	1,809	4,491	5,929	4,604	161,551
	Kodya.Solok	3,289	239	928	578	1,263	2,244	1,695	1,021	407	5,883	684	18,231
	Kodya.Sawahlunto	390	13,616	602	125	2,543	2,144	1,811	371	164	2,016	303	24,086
	Kodya.Padang Panjang	4,203	158	1,719	480	911	3,102	5,307	908	398	5,165	936	23,287
	Kodya.Bukittinggi	4,705	376	7,329	1,817	2,210	13,916	10,899	2,188	790	7,119	2,420	53,771
	Kodya.Payakunbu	8,899	205	3,891	795	1,163	14,607	4,340	1,655	941	4,930	1,334	42,762
	Sub-total	384,991	21,087	94,083	7,233	39,302	228,978	61,011	13,133	26,378	68,767	29,794	974,756
	Province	548,021	25,074	208,149	20,094	67,322	412,004	158,516	46,885	38,126	142,887	50,320	1,832,855
	Total of Study Area	625,063	29,599	149,647	12,315	64,610	402,604	138,300	46,086	78,400	122,979	47,794	1,717,397

Source : 1. Riau in Figures, 1992, Statistical Office of Riau Province
2. West Sumatra in Figures, 1992, Statistical Office of West Sumatra Province.

Note : 1.Kodya. Sawahlunto includes coal products.
2.At 1983 Constant Market Price

Table II.3.17 PRODUCTION OF FOODSTUFF IN STUDY AREA (1991)

Unit : ton

Province	Kab./Kodya.	Wet Paddy	Dry Paddy	Maize	Cassava	Sweet Potatoes	Peanuts	Soy Bean	Small Green Pea	Total
Riau	Kab.Kampar	48,715	46,520	13,231	40,544	3,149	5,093	13,169	2,455	172,876
	Kab.Indragiri Hulu	31,883	12,264	3,152	21,352	2,339	1,029	1,851	446	74,316
	Kab.Indragiri Hilir	188,009	3,399	12,356	20,781	4,991	75	1,734	486	231,831
	Kodya.Pekanbaru	123	30	78	4,276	129	8	21	5	4,670
	Sub-total	268,730	62,213	28,817	86,953	10,608	6,205	16,775	3,392	483,693
	Province	366,698	69,449	32,395	155,407	18,704	7,432	19,246	4,071	673,402
West Sumatra	Kab.Solok	233,221	161	1,308	5,429	3,274	365	720	151	244,629
	Kab.Sawahlunto/Sijunjung	93,110	21,928	1,092	31,927	1,005	1,052	4,138	595	154,847
	Kab.Tanah Datar	184,721	27	6,482	10,816	6,511	889	614	134	210,194
	Kab.Agam	228,297	264	4,040	15,833	12,771	532	424	51	262,212
	Kab.Lima Puluh Kota	155,802	945	8,461	13,450	2,809	183	720	6	182,376
	Kab.Pasaman	228,509	7,614	1,701	5,337	3,184	5,398	8,383	1,236	261,362
	Kodya.Solok	12,495	-	18	896	230	52	14	15	13,720
	Kodya.Sawahlunto	12,495	-	14	1,207	152	10	9	8	13,895
	Kodya.Padang Panjang	6,757	-	155	252	799	28	-	-	7,991
	Kodya.Bukittinggi	4,656	-	113	637	631	12	-	-	6,049
	Kodya.Payakunbu	26,611	-	606	3,388	557	16	11	-	31,189
	Sub-total	1,186,674	30,939	23,990	89,172	31,923	8,537	15,033	2,196	1,388,464
	Province	1,671,802	31,448	25,708	114,691	35,784	10,644	17,581	2,697	1,910,355
	Total of Study Area	1,455,404	93,152	52,807	176,125	42,531	14,742	31,808	5,588	1,872,157

Source : 1. Riau in Figures,1992,Statistical Office of Riau Province.
2 . West Sumatra in Figures,1991,Statistical Office of West Sumatra Province.

Table II.3.18 PRODUCTION OF ESTATE BY CROP (1991)

Unit :ton

Province	Kab./Kodya.	Rubber	Coconut	Palm Oil	Cassia Vera	Sugar Cane	Coffee	Gambir	Clove	Enau	Others	Total
Riau	Kab.Kampar	26,613	10,684	119,298	12	36	284	-	22	-	79	157,028
	Kab.Indragiri Hulu	46972	2,252	52,768	1	81	363	-	119	-	250	102,806
	Kab.Indragiri Hilir	671	196,816	-	-	-	176	-	-	-	151	197,814
	Kodya.Pekanbaru	-	-	-	-	-	-	-	-	-	-	-
	Sub-total	74,256	209,752	172,066	13	117	823	-	141	-	480	457,648
	Province	112,075	250,955	351,540	13	117	1,686	202	1,020	-	633	718,241
West Sumatra	Kab.Solok	2,092	2,926	-	2,276	180	3,047	-	220	13	58	10,812
	Kab.Sawahlunto/Sijunjung	20,744	3,147	-	1,097	38	307	-	34	11	1	25,379
	Kab.Tanah Datar	2,369	2,218	-	1,014	9,261	943	2	52	931	35	16,825
	Kab.Agam	169	5,762	-	2,995	9,424	1,482	-	49	1	212	20,094
	Kab.Lima Puluh Kota	2,052	4,024	-	238	23	1,055	2,327	173	86	508	10,486
	Kab.Pasaman	12,515	4,024	-	1,294	45	3,064	-	42	337	171	21,492
	Kodya.Solok	-	11	-	4	-	14	-	16	-	0	45
	Kodya.Sawahlunto	107	372	-	13	11	16	-	4	1	0	524
	Kodya.Padang Panjang	-	5	-	23	6	25	-	1	-	0	60
	Kodya.Bukittinggi	-	4	-	3	-	5	-	1	-	0	13
	Kodya.Payakunbu	-	647	-	45	-	28	-	63	-	1	784
	Sub-total	40,048	23,140	-	9,002	18,988	9,986	2,329	655	1,380	986	106,514
	Province	43,938	63,443	-	9,997	19,027	11,587	2,466	815	1,391	1,266	153,930
	Total of Study Area	114,304	232,892	172,066	9,015	19,105	10,809	2,329	655	1,380	1,466	564,162

Source : 1. Riau in Figures,1992,Statistical Office of Riau Province.

2. West Sumatra in Figures,1991,Statistical Office of West Sumatra Province.

Table II.3.19 NUMBER OF MANUFACTURING ESTABLISHMENTS

(1) Riau Province (1991)

Province	Kbupaten/Kotamadya	Food	Cloth & Leather	Chemical & Construction	General	Metal	Total
Riau	Kab.Kampar	307	13	149	8	108	585
	Kab.Indragiri Hulu	215	55	245	222	96	833
	Kab.Indragiri Hilir	332	168	71	146	94	811
	Kodya.Pekanbaru	244	376	644	119	384	1,767
	Total	1,098	612	1,109	495	682	3,996
	Province	2,935	954	1,651	941	1,206	7,687

Source : 1.Riau in Figures,1992,Statistical Office of Riau Province.

(2) West Sumatra Province (1990)

Province	Kabupaten/Kotamadya	Food	Cloth & Leather	Wood Products (Inc. Furniture)	Paper, Printig & Publishing	Chemical Petrolium, Coal,Rubber & Plastic	Non Metalic Except Petrolium & Coal	Basic Metal Indutries	Fabricated Machinary & Equipment	Others	Total
West Sumatra	Kab.Solok	543	269	606	-	5	149	-	69	225	1,866
	Kab.Sawahlunto/Sijunjung	178	68	115	1	2	172	-	32	45	613
	Kab.Tanah Datar	1,725	725	4,204	-	-	178	-	98	441	7,371
	Kab.Agam	3	1,250	910	1	7	150	11	214	591	3,137
	Kab.Lima Puluh Kota	1,488	791	691	4	4,074	443	-	240	1,074	8,805
	Kab.Pasaman	1,439	164	435	1	353	171	-	202	79	2,844
	Kodya.Solok	127	86	47	6	8	51	-	13	3	341
	Kodya.Sawahlunto	136	53	12	1	7	-	1	19	15	244
	Kodya.Padang Panjang	52	77	13	4	-	26	-	39	7	218
	Kodya.Bukittinggi	216	277	78	14	4	142	4	35	31	801
	Kodya.Payakunbu	332	89	65	3	12	84	7	28	104	724
	Total	6,239	3,849	7,176	35	4,472	1,566	23	989	2,615	26,964
	Province	8,360	5,003	9,656	80	4,714	2,297	24	1,415	2,777	34,326

Source : 1. West Sumatra in Figures,1991,Statistical Office of West Sumatra Province.

III LAND USE

SECTOR III
LAND USE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 PHYSICAL DESCRIPTION OF STUDY AREA

1.1 Vegetation

According to the remote sensing analysis and field investigation, vegetation in the study area can be classified into four (4) types, namely, forest, plantation, farm crops and grass/bush.

Forests are further divided into primary forests and secondary forests. Secondary forest which is less than 20 m in height is a forest that has been regrown after cutting and burning. The diversity in secondary forests is lower than in primary forests.

Rubber, oil palm and coconut palm are planted in plantations. The diversity in plantations is generally low except rubber plantations. Grass/ bush can be divided into some types such as artificial vegetation or non-intensive cultivated land, bush, and alang-alang grass. Alang-alang grass is a compensatory vegetation and occupies abandoned places after shifting cultivation. Farm crops include paddy and upland crops. Paddy, maize, soybean, peanut, cassava and some vegetable crops are planted as farm crops.

Vegetation of the study area conforms to the topography which is generally classified into three: mountainous, hilly and flat plain areas. Vegetation in each classification is explained below.

(1) Mountainous Area

The mountainous area is located at the upper reaches of the Kampar and Indragiri river basins and is composed of steep slopes. Primary and secondary forests cover almost all of the area. Some protected forest areas are found in the mountainous area.

(2) Hilly Area

The hilly area is located in the middle reaches of the Kampar and Indragiri river basins. This area has a large number of population and is well developed. Therefore, artificial vegetation such as plantation and farm crops are widely distributed.

(3) Flat Plain Area

The flat plain area is composed of swamp and alluvial plain areas. The swamp area occupies the downstream areas of the Kampar and Indragiri river basins with low altitude of approx. 20 m below. Alluvial plains are distributed along the Kampar and Indragiri rivers. Wide alluvial plains have been developed for farm crops, plantation crops and grass/bush. On the other hand, the swamp area is covered with primary and secondary forests.

1.2 Soils

According to the report of the Regional Planning Program for Transmigraiton, the study area is categorized into three regions from the agricultural aspect as below.

- Eastern coastal swampland which consists of swamp area and alluvial plain along the Kampar and Indragiri rivers and their tributaries;
- Eastern plains and hills located between the coastal swampland in the east and the Barisan range in the west; and
- The Barisan range.

Soils of the coastal swampland consist of alluvial soil downstream of the Kampar and the Indragiri river basins and peat soil on coastal areas and the area sandwiched by the two rivers where organic materials have deeply accumulated. Peat soil in this area is extremely acidic with high water contents. Soil layer is comparatively thin in the vicinity of the rivers, and sometimes exceed 3 meters. Agricultural use of peat soil area may be possible where the peat layer is thin. However, in areas with thicker peat layer, development would be difficult from technical and economic viewpoints. Furthermore, coastal swamp soils are highly saline.

Soils of the eastern plains and hills consist of soil with high organic content in the surface layer, weathered tuffaceous sediments in the subsurface layer, and well weathered soils generally lying on hilly areas which are called reddish yellow podosol.

Soil of the first two regions is further classified into groups from the viewpoint of land system and soil-forming processes as follows.

<u>SOIL GROUP AND TOPOGRAPHY</u>

Topographical Region	Soil Group
Eastern Coastal Swampland	Alluvial plain soil Peat soil
Eastern Plains and Hills	Old marine terrace soil Undulating plain soil Hilly plain soil

These soil groups are described in more detail as follows:

SOIL CLASSIFICATION

Soil Group	Soil
Alluvial Plain Soil	Tidal swamp soil Riverine alluvial soil Meander valley alluvial soil Alluvial valley soil Fan alluvial soil
Peat Soil	Shallow peat swamp soil Peat swamp soil Deep peat swamp soil
Old Marine Terrace Soil	
Undulating Plain Soil	
Hilly Plain Soil	

The main characteristics and occupied area of these soils in the study area are summarized in Table III.1.1.

The areal ratio of soil groups in the study area is summarized below.

Unit: %

Soil Group	Kampar River Basin	Indragiri River Basin	In-between Area
Alluvial Plain Soil	5	13	30
Peat Soil	31	9	70
Old Marine Terrace Soil	10	8	0
Undulating Plain Soil	17	17	0
Hilly Plain Soil	10	16	0
Barisan Range	27	37	0
Total	100	100	100

The alluvial plain soil of the Kampar and Indragiri river basins covers 124,400 ha and 212,400 ha, respectively. In alluvial plain soil areas, meander belt alluvial soil widely spreads, occupying 60% of the alluvial plain soil along the Kampar River and 30% along the Indragiri River.

In the area of peat soil, shallow peat swamp soil and deep peat swamp soil are dominant in the Kampar river basin occupying 50% and 40% of the peat soil, and shallow peat swamp soil is dominant in the Indragiri river basin occupying 70% of the peat soil.

CHAPTER 2 LAND USE

2.1 Present Land Use

The present land use in the study area is classified into seven (7) categories. The areal ratio of each category is given in Table III.2.1 and Fig. III.2.1, as summarized below.

Unit: %

Category	Kampar River Basin	Indragiri River Basin	In-between Area	Study Area
Forest	67.5	55.0	97.7	69.8
Bush and Grassland	7.0	7.9	0.8	6.0
Shifting Cultivation	3.8	4.9	0.3	3.4
Upland Cultivation	1.0	2.6	0.6	1.4
Wet Land Cultivation	1.6	4.4	0.5	2.3
Tree Crops/Estate	19.0	24.8	0.1	16.9
Settlement	0.1	0.4	0.0	0.2
Total	100.0	100.0	100.0	100.0

As shown in the table above, around 70% of the study area is occupied by forest. In the forest area, tidal forest is distributed near the coastal area and peat swamp forest widely spreads back of the coastline and around the downstream of rivers. Bush and grassland which develop after shifting cultivation is abandoned or forests are cleared, are located at fringes of forest areas.

Scattered shifting cultivation in the study area is mainly carried out by local and transmigrant farmers in Riau Province. Cultivation areas are abandoned after some years and they develop into bush and grassland areas locally known as alang-alang.

Oil palm cultivation is carried out in large-scale commercial plantations, while Rubber and coconut cultivation is carried out in small-scale plantations by private farmer and small companies. They are located along the Kampar and Indragiri rivers.

2.2 Future Land Use

Based on the data on the planning of future land use (draft) prepared by the Regional Development Planning Bureau (BAPPEDA) in Riau and West Sumatra provinces, future land use in the study area was formulated (refer to Table III.2.2. and Fig. III.2.2).

From the viewpoint of agriculture, the following items are pointed out to formulate the future land use plan.

- The area for present agricultural production activities should be secured, and increase of productivity should be targeted.
- Present plantation which are already permitted by the government should be maintained.
- Wayward shifting cultivation should be controlled.
- Protected forest, conservation forest and limited production forest should be protected from the viewpoint of protection of forest resources and prevention of soil erosion.
- Existing natural forest should be protected extensively.
- The area of wild grassland such as alang-alang and bush should be converted to potential area for agricultural development.
- The development of peat area should be considered carefully, and necessary survey should be carried out.
- Attention should be drawn to the urgent requirement for watershed conservation along the provincial boundary between West Sumatra and Riau.
- The development priority order is (1) food crops, (2) plantation, (3) other crops including pasture and agroforest.

TABLES

III LAND USE

Table III.1.1 SOIL CLASSIFICATION IN STUDY AREA

Soil Classification	Kampar River Basin		Indragiri River Basin		In-between Area		Total	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Alluvial Plain Soil	124,300	5.1	211,100	13.0	320,300	30.3	655,700	12.8
Tidal Swamp Soil	3,500		0		93,300		96,800	
Riverine Alluvial Soil	15,600		78,200		227,000		320,800	
Meander Valley Alluvial Soil	84,200		65,800		0		150,000	
Alluvial Valley Soil	19,600		33,600		0		53,200	
Fan Alluvial Soil	1,400		33,500		0		34,900	
Peat Soil	767,200	31.3	137,800	8.5	737,700	69.7	1,642,700	32.0
Shallow Peat Swamp Soil	413,400		100,900		493,100		1,007,400	
Peat Swamp Soil	46,100		12,500		12,600		71,200	
Deep Peat Swamp Soil	307,700		24,400		232,000		564,100	
Old Marine Terrace Soil	234,300	9.5	137,200	8.4	0	0.0	371,500	7.2
Undulating Plain Soil	420,400	17.1	273,700	16.8	0	0.0	694,100	13.5
Hilly Plain Soil	252,200	10.3	265,700	16.3	0	0.0	517,900	10.0
Barisan Range	656,400	26.7	601,300	37.0	0	0.0	1,257,700	24.5
Total	2,454,800	100.0	1,626,800	100.0	1,058,000	100.0	5,139,600	100.0

Data Sources:
Report on Regional Physical Planning Program for Transmigration by National Coordination Agency for Surveys and Mapping

Table III.2.1 PRESENT LAND USE IN STUDY AREA

Category	Kampar River Basin		Indragiri River Basin		In-between Area		Total	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
1) Forest	1,657,300	67.5	883,150	54.3	1,033,800	97.7	3,574,250	69.5
2) Bush and Grassland	170,800	7.0	131,910	8.1	8,300	0.8	311,010	6.1
3) Shifting Cultivation	92,500	3.8	85,970	5.3	2,800	0.3	181,270	3.5
4) Upland Cultivation	24,600	1.0	41,140	2.5	6,800	0.6	72,540	1.4
5) Wetland Cultivation	40,400	1.6	71,160	4.4	4,900	0.5	116,460	2.3
6) Tree Crops/ Estate	465,700	19.0	409,010	25.1	1,400	0.1	876,110	17.0
7) Settlement	3,500	0.1	4,460	0.3	0	0.0	7,960	0.2
Total	2,454,800	100.0	1,626,800	100.0	1,058,000	100.0	5,139,600	100.0

Data Sources : Analytical Results of Landsat Information by PUS-DATA, DPU, Indonesian Government

Table III.2.2 FUTURE LAND USE IN STUDY AREA

Category	Kampar Basin (ha)	Indragiri Basin (ha)	In-between Area (ha)	Total	
				Area (ha)	Ratio (%)
1) Area to be protected for Future Use	581,600	121,970	218,400	921,970	18.0
2) Food Crop Farming, Animal Husbandry, Agro Industry Area	51,400	121,870	12,900	186,170	3.6
3) Plantation Development Area	682,200	426,160	681,300	1,789,660	34.8
4) Forestry Development Area	794,600	262,640	137,300	1,194,540	23.2
5) Urban Development and Transmigration Settlement Area	42,400	28,830		71,230	1.4
6) Area to be developed in accordance with Central Government Policy (Special Priority)	31,500	-	-	31,500	0.6
7) City Development Area	8,900	7,350	8,100	24,350	0.5
8) Other Purpose Development Area	112,700	366,020	-	478,720	9.3
9) Conservation Area	149,500	291,960	-	441,460	8.6
(a) Conservation Forest, Wildlife, Natural Resources	132,500	253,890	-	-	-
(b) Erosion Area	17,000	38,070	-	-	-
Total	2,454,800	1,626,800	1,058,000	5,139,600	100.0

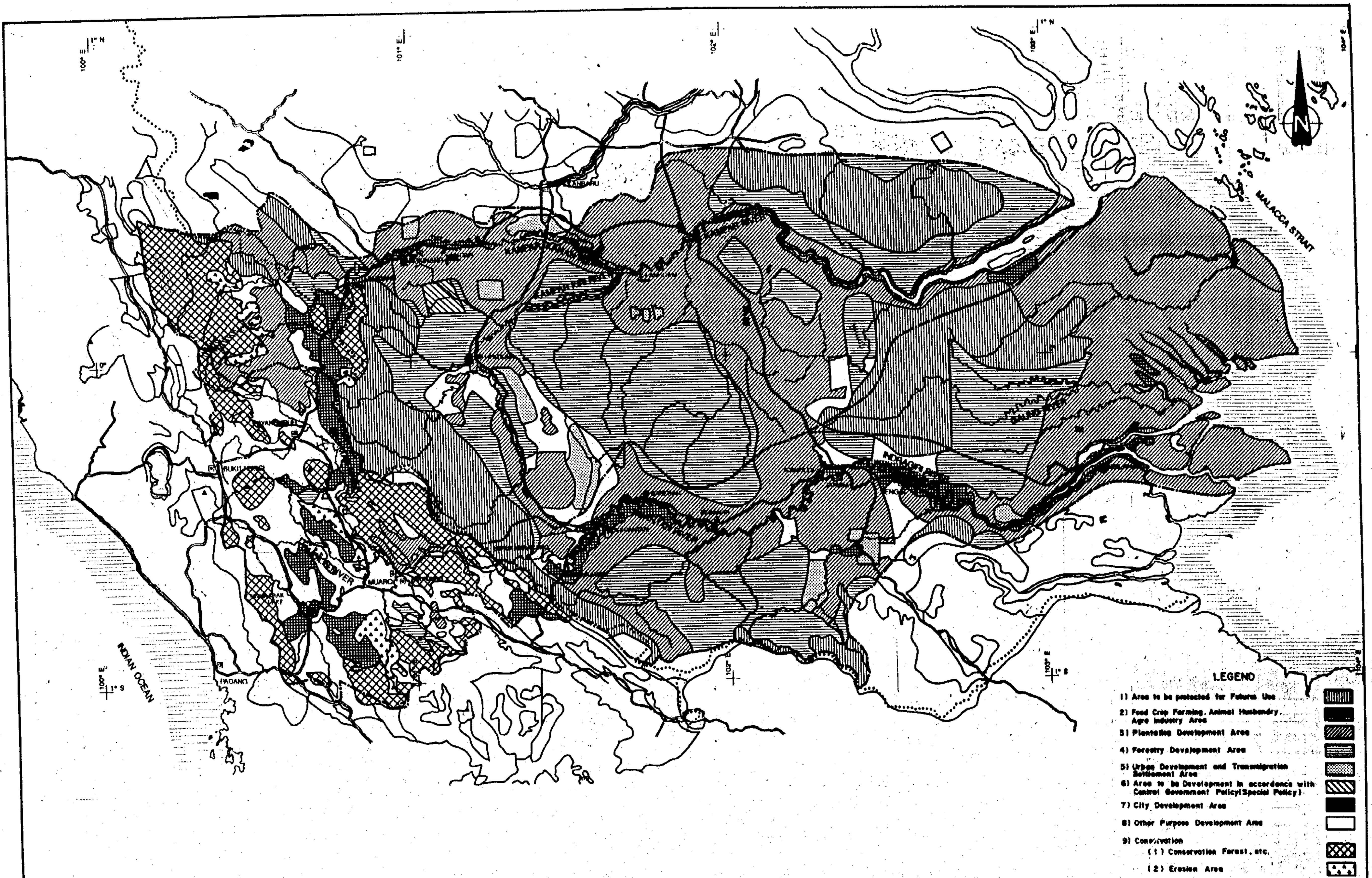
Data Sources : Future Land Use (Draft) prepared by BAPPEDA, Riau Province and West Sumatra Province

FIGURES

III LAND USE

THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.III.2.1 PRESENT LAND USE IN STUDY AREA



THE STUDY ON
KAMPAR-INDRAGIRI RIVER BASIN DEVELOPMENT PROJECT
IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.III.2.2 FUTURE LAND USE IN STUDY AREA

IV GEOLOGY AND SOIL MECHANICS

SECTOR IV
GEOLOGY AND SOIL MECHANICS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

Investigations during the Overall Development Plan stage focussed on geological conditions and soil mechanical properties of the study area and proposed facility sites. On the other hand, investigations in the Feasibility Study stage concentrated on areas for priority projects and consisted of the following items of work:

(1) Field Survey

- Geological mapping
- Collection of hydro-geological data
- Drilling and in-situ permeability testing
- Test pit excavation
- Sampling

(2) Laboratory Testing

An overview of the drilling and test pit investigations with their locations is given in Tables IV.1.1 and IV.1.2.

CHAPTER 2 GENERAL GEOLOGY

2.1 Sumatra Island

According to modern interpretations, the Island of Sumatra is part of the Continental Sundaland Plate, which includes most of Southeast Asia. Subduction of oceanic crust from the Indian Ocean occurs currently in N-NE direction, obliquely beneath Sumatra and at a rate of 6 cm per year. The subduction zone is marked by a trench, off the west coast of Sumatra. Subduction leads to magma generation, followed by intrusion and to stress build-up in the overlying plate.

The stress is accommodated by folding and faulting. Some authors suggest that in the case of Sumatra the subduction already began in Permian times, with an increasing activity from Tertiary to Recent times and culminating with the formation of a volcanic arc along the Barisan mountains, striking NW-SE, in the west part of Sumatra.

Stresses induced by the oblique subduction have been released by dextral fault movement, parallel to the plate margin. Such an example is the NW-SE striking Sumatra Fault System.

The east part of the island corresponds to the back-arc environment, where a series of elongated, extensional basins have been generated. This area is called the Central Sumatra Basin. The features named above control the present tectonic activity of the island.

The study area is bounded by the Barisan mountains and their foothills on its SW side. To the NE, the study area extends into the central basin.

2.2 Study Area

The study area is covered by the following geological maps [Scale 1/ 250,000, edited by the Geological Survey (Bandung)]:

- Solok Quadrangle (unpublished)
- Padang Quadrangle
- Pakanbaru Quadrangle
- Rengat Quadrangle.

Fig. IV.2.1 is a simplified geological map of the entire project area. The geological history of this area can be summarized as described below.

The sedimentation started in the Carboniferous-Permian times, with the deposition of clastic sediments (shale, quartzite, sandstone) and some limestones of the Kuantan formation. The formation is supposed to be 5,000 m thick. During the Upper Mesozoic these rocks have been subjected to folding, faulting and metamorphism, accompanied by granite and diorite intrusions. This activity was probably related to the Thai- Malayan orogenesis. The rocks of the Kuantan formation have been deformed and slightly metamorphosed (greenschist facies) at that time.

There are no Jurassic or Cretaceous rocks in this area and therefore the idea of a long period of non-deposition has to be considered.

The Tertiary deformation is controlled by basement block faulting and wrenching (Sumatra Fault System). The development of a dextral wrench fault is consequent with the oblique subduction of the Indian Ocean Plate. The general result of the Tertiary to Quaternary period of faulting was the uplift of the Barisan volcanic arc and the development of the basin and range topography in the Barisan foothills. In the foothills the grabens are filled by Tertiary sediments while the horsts expose pre-Tertiary basement. Such examples can be seen in the Pakanbaru Quadrangle.

The oldest Tertiary formation in the study area is exposed only in the Barisan mountains. The sedimentation intensified during early Miocene, evidenced by large exposures of the Ombilin formation in the Barisan mountains and the Telisa formation in the foothills area, both consisting of marl, limestone and sandstone. Basalt and andesite flows in the Barisan mountains, mark a new phase of tectonic activity during the Middle Miocene. At this time the sedimentation stopped in the Barisan range. Outcrops of the Pliocene Palembang formation, consisting of claystone, sandstone and tuff, can be found only in the foothills and the Central Basin.

The last major period of uplift and block faulting occurred during the Plio-Pleistocene. In the Barisan range the volcanic activity is evidenced by the andesitic-basaltic breccias of the Malintang, Talong and Marapi mountains and the deposition of pumice tuff and volcanic ash, exposed in the area of Payakumbuh.

The uplift and subsidence continue to the present day in the foothills area. Further east, the subsidence results in large areas of alluvium, deep swamps and coastal deposits.

The main, active structure in the Solok Quadrangle is the NW-SE striking Sumatra Fault System, mentioned before. It is a Miocene structure, showing dextral, horizontal movement. Numerous faults with parallel trend are present. They appear to have only a vertical sense of movement and their relationship to the wrenching is not clear. Most of them have a long, continuous movement record, from the Miocene to the Plio-Pleistocene.

Earlier N-S trending faults exist in the Central Sumatra Basin. There is evidence of their reactivation during the Miocene and even Quaternary.

At hot springs and high heat fresent, basement movements continue, accompanied by uplift and subsidence. Some of the fault structures described above are still active while others have been reaclows are testifying the fault activity.

CHAPTER 3 GEOLOGICAL CONDITION AT POSSIBLE DAMSITES

The geological conditions of the six possible damsites shown in Fig. IV.3.1 as selected in SECTOR XII, DAM ENGINEERING, are as described below. The local geological maps were based on the geological map of Solok, scale 1/250,000 (Bandung, unpublished). Some adjustments were required to meet the field evidence.

3.1 Kapoernan Damsite

The local geological setting is represented in Fig. IV.3.2(1/6). Rocks exposed in this area belong to the Miocene Telisa and Shapas formations. Folds and faults with a NW-SE trend cross the area.

At the damsite the bedrock consists of conglomeratic sandstone with siltstone intercalations, slightly soft. Rock outcrops are scarce and the slopes are covered by weathering soil, with loose boulders. Under the soil cover the rock is probably weathered. The depth of weathering shall be inquired during later stages of investigation.

From the structural point of view, the damsite is located on the NE limb of a wide anticline. The dip direction of the beds is accordingly NE.

In the reservoir area, both the Sihapas and the Telisa formations can be found. The Telisa formation consists of calcareous siltstones and limestones.

3.2 Kampar Kiri No. 1 Damsite

The local geological setting is represented in Fig. IV.3.2(2/6) and Table IV.3.1. The table summarizes the exposed rock formations, in the corresponding stratigraphic order. The oldest rocks are the limestones of the Kuantan formation, around the village of Gema. These limestones have been strongly affected by dissolution. They appear now as loose, rounded blocks, surrounded by reddish soil. The limestones occur only downstream of the damsite.

The predominant rocks are those of the upper member of the Kuantan formation, with a heterogeneous lithology. The rocks are generally harder downstream of the dam site and rather soft in the reservoir area. The Kuantan formation is covered unconformaly by the Tertiary Telisa and Palembang formations. The former is exposed SE from Tanjungbelit and the latter NE from it. Downstream from Tanjungbelit, the river is bordered by a Quaternary alluvial plain.

Table IV.3.2 summarizes the geological conditions at the damsite and in the reservoir area. More details are described in the following paragraphs.

3.2.1 Damsite

The outcrops on the left abutment are limited to a narrow band above the water. They consist of black meta-pelites (slightly metamorphic mudstones) with brown weathering color. Cleavage is only slightly developed. The rock is slightly soft, a so called CM rock. A few tens of meters downstream the rock is slightly harder.

It is a gray shale, without cleavage. The bedding is difficult to recognize. It is weathered along the joints and macro-fractures. On the slope there is a yellow soil mixed with boulders and 50 m above the river water there is weathered, white sandstone. The exact elevation of the latter has to be checked.

The foundation rock on the left abutment is expected to be mudstone and shale. Because of the cleavage, the upper zone of the bedrock is weathered and weak. It will be necessary to remove it from the foundation. Furthermore, where the cleavage is intensively developed, the rock is more pervious and treatment by grouting will be necessary.

The lower slope of the right abutment is covered by yellow soil with rock fragments. The main fraction is fine sand and silt and the clay percentage varies (more clayey on the shale). At the foot of the slope the soil thickness is at least 10 m and only 2 m on the upper slope. At about 30 m above the river bed an outcrop of strongly weathered sandstone has been found, followed by a large outcrop of hard quartzite, about 75 m above the river bed. It has a very fine texture.

The right abutment will be founded partially on mudstone/shale and partially on quartzite/ sandstone. Deep excavation of the lower slope will be needed, till about 75 m above the river bed, in order to remove the soil cover and the weathered sandstone. Above this elevation the rock is hard and massive and good for foundation.

When a rock fill dam with spillway is considered, the spillway can be located on the narrow hill, the Bukit Pulauale , on the right river bank. As mentioned above, the top zone of the hill is quartzite and the middle slope consists of weathered sandstone. The deep excavation required for the spillway will be mainly in quartzite and in the bottom zone, in weathered sandstone.

The exact elevations of the different outcrops and the thickness of the river channel sediments (sands and gravels) are subject to the future investigation.

3.2.2 Reservoir Area

According to the geological map (refer to Fig. IV.3.2) in the reservoir area the lithology is the same as at the damsite. It consists of mudstones, siltstones, shales and fine sandstones. The generally lower and smoother topography indicates that the soft rocks are predominant. At the village of Muarabio for example, the rock is a weathered shale, covered by river terrace deposits.

The rocks described above have low permeability and the reservoir is generally watertight. The only discontinuity which could lead to water loss is the strike-slip fault crossing the area at Muarabio. This fault has not been identified in the field yet. Its existence and influence shall be checked during the succeeding investigations.

3.2.3 Construction Material

Pervious material for the filter zones can be found in the river bed. From Tanjungbelit up to the dam site there are many sediment bars in the river channel. They consist of clean sands (SW) covered by clean gravels (GW). The sediment bars are of small dimensions and several of them will have to be explored.

Sources for rock material are the quartzites and fresh sandstones. A potential quarry site is located 2.5 km downstream of the damsite, on the right river bank. At this location, the entire hill consists of quartzite.

The material supplied by the excavation of the upper part of the spillway, about 35 m deep, consists of quartzite and it can be used as rock material. The deeper material, weathered sandstone, is weak and not adequate.

Sites for impervious core materials are more difficult to locate. The yellow soil covering the slopes (weathering soil of the Lower Kuantan member) can possibly be used but its limited thickness (a few meters) makes it inadequate. Close to the dam site only small and irregular accumulations of such soil have been found at the foot of the slopes.

There are thicker, yellow soil deposits at the village of Muarabio, about 2 km upstream of the damsite, which shall be investigated in later stages.

The hills behind the village of Tanjungbelit (downstream) have a thicker soil cover. This soil is possibly the weathering product of the Telisa formation (clayey marl, sandstone). It is a reddish soil, clayey and silty with many pebbles 3-5 cm in diameter, but also containing few boulders, more than 70 cm in diameter. Laboratory testing is required for better identification.

3.3 Kampar Kiri No. 2 Damsite

The local geological setting is presented in Fig. IV.3.2(3/6) and the stratigraphy in Table IV.3.1. The table summarizes the exposed rock formations in the corresponding stratigraphic order.

This area consists of predominantly "softer" rocks, as reflected by the gentle and low topography along the Singingi (Kampar Kiri) River. Such rocks belong to the Tertiary formations, claystones and uncemented sandstones, and to the older Kuantan formation. The contact between the former two and the Kuantan formation is an unconformity.

"Harder" rocks do exist in the area of the Sembacang Mountain, east of the tributary river Sepuh. According to the geological map (Fig. IV.2.1) these rocks should belong to the Tuhur formation: slates, silicified shales, etc. The rocks encountered during the field investigation do not correspond to the above description, but look rather similar to the sandstones and quartsites of the Kuantan formation.

Table IV.3.2 summarizes the geological conditions at the dam site and in the reservoir area. More details are given in the following subsections.

3.3.1 Damsite

On both riverbanks the rock exposures are scarce. The steep slopes are covered by soil and loose blocks of weathered quartzite and sandstone. The steep topography is usually an indicator of "harder" rock in the underground.

On the left abutment, just above the water, a small outcrop of sandstone is visible. The rock is slight to moderately weathered, the bedding is not well developed. Better observation of the bedrock has been done in the upper stream (less than 100 m) where it consists of massively bedded gray-green quartzite, with very fine texture and hard. The thickness of the beds is 1.5-2 m. The beds are steeply inclined downstream. Joints are perpendicular to the bedding and widely spaced.

On the right abutment, there are no outcrops till the top of the hill. The loose quartzite/sandstone blocks of the slope cover is significant for such rocks under the surface.

Assuming the existence of fairly hard rock (sandstone or quartzite), the dam will have a good foundation bed and no major treatment will be necessary. Excavation of the slope material (colluvium; thickness unknown) and of the upper weathered rock layer will be necessary. If the foundation rock is a quartzite the permeability is expected to be low. Such massive and cemented rocks are characterized by fracture-porosity only.

3.3.2 Reservoir Area

The two widest zones of the reservoir extend from NW to SE (conform to the general geological trend), one at Padalangindarung and the other upstream of the Sepuh River. Both zones have a smooth topography, with relatively low elevations. According to the geological map (refer to Fig. IV.3.2) the rocks here are dark clayey marls. Almost no outcrops of marl could be seen in the river section. The marls are often buried under river terrace material, consisting of mainly fine, yellow sand. In the wide zone at the Sepuh River, weakly cemented conglomerates have been found lying under the terrace deposits.

In between the two "marl-zones" sandstone and quartzite outcrops are frequent. According to the geological map, the upper member of the Kuantan formation should be exposed in this area. The reservoir area is watertight because its largest part is covered by marl.

One reversed fault appears on the geological map (refer to Fig. IV.2.1), at the Sepuh River, but the fault could not be identified in the field.

3.3.3 Construction Material

Rock material can be taken as well from a quarry site, less than 1 km upstream of the damsite. Sources for concrete aggregates (sand and gravel), or filter zone materials are numerous along the river. Many sediment bars have been seen within a distance of 5 km downstream of the dam.

Rock material can be taken as well from a quarry site, less than 1 km upstream of the damsite, where the slope of the riverbank consists of massive quartzite.

Impervious core material is more difficult to find. The "marl" formation can be suggested as a source of material (especially weathered marl). Therefore the surroundings of the Sepuh River shall be checked, on some distance from the Kampar River. The riverbanks of the latter consist of predominantly fine sands which are not suitable.

Another source of core material could be the weathering soil of the Palembang formation (sandstone, claystone, tuff, clay etc.). Such soils can be found around Muaralembu. The distance to the damsite is rather far, more than 8 km.

3.4 Upper Sinamar Damsite

The local geological setting is presented in Fig. IV.3.2(4/6) and the stratigraphy in Table IV.3.1.

In the downstream area, the Permo-Carboniferous limestone of the Kuantan formation spreads out widely. It is often bordered by the "shale member" which crops out only in the riverbed. The exposed rocks look different from the typical Kuantan formation and rather similar to the rocks of the Tuhur formation. They are mostly dark-gray shale and slate and in the vicinity of the Kalo-Kalo village, black, silicified shale. The origin of the rocks has to be clarified during the future investigation.

The area upstream consists of the lahar deposits of the Malintang Volcano which are now covered by paddy fields. These deposits extend only along the right riverbank. The hills on the left riverbank consist of rocks of the Kuantan formation and weathered granite.

3.4.1 Damsite

For topographical and geological reasons briefly explained below, the most adequate location for the dam axis is S 0° 19' 00" of latitude and E 100° 46' 30" of longitude.

The rock at the damsite consists of black shale (slightly metamorphic) or meta-phylite with intercalations of brown quartzite. The quartzite has a very fine texture. The rock is rather fresh and medium hard. Bedding is well developed and at some locations cleavage affects the shales and siltstones transforming the rock into a slate. The beds dip to the east or south-east, 30° to 40°. According to the geological map these rocks belong to the lower Kuantan "shale" member, but their lithological aspect is different. Bedrock outcrops can be seen only in the riverbed. The higher slopes are covered by yellowish soil.

From the point of view of topography, the river valley is rather wide at the damsite and the river channel shows a sharp turn. The topography is more favorable downstream but the dam axis cannot be shifted, because of the occurrence of limestone. The limestone is massive and karstified. The contact between limestone and shale/quartzite appears to be an unconformity.

3.4.2 Reservoir Area

In the reservoir area mostly shale/mudstone and siltstone, soil terraces and strongly weathered granite and granitic sand have been encountered. The soil terraces often consist of slightly cohesive soil of volcanic origin and are intensively cultivated.

Upstream of the damsite, the right riverbank consists of thick deposits of residual volcanic soil with isolated big boulders and blocks of basalt or andesite. Such material comes from the Malintang volcano (lahar deposit). The soil deposit covers the bedrock. The top of the bed rock appears to be at the level of the river.

Close to the upper end of the reservoir, between Taratak and Batukabau, the area consists of limestone. For a dam with a contemplated height of 70 to 80 m, this area will not be submerged. The reservoir is considered to be watertight.

3.4.3 Construction Material

Aggregates, mainly gravel and sand , are available in small quantities in the riverbed.

Good quarry rock is difficult to find. The rock described at the damsite contains only a limited volume of quartzite. Selective extraction will be required to separate it from the shales and slates.

Another source of rock material in the area would be the granite. Fresh, hard granite has not been found so far.

Limestone can be used for concrete aggregate and rockfill, in spite of its less resistance against abrasion. There are several examples of successfull usage, worldwide.

Impervious core material can be taken from the thick soil terraces, the lahar deposits.

3.5 Sukam Damsite

The local geological setting is presented in Fig. IV.3.2(5/6) and the stratigraphy in Table IV.3.1.

The oldest exposed rocks are the Cretaceous granites, unconformaly covered by the Tertiary Ombilin formation. Only the lower and upper members of this formation are exposed. The upper member consists of "softer" rocks, while the lower member is harder. The rocks exposed at the damsite seem to belong to the lower member, massive sandstone/quartzite, and not to the upper member, as presented on the official geological map (Solok 1/250,000). This matter has to be checked in the future investigation.

3.5.1 Damsite and Reservoir Area

The dam axis is located 3 km downstream of the Lalan village. The topography is a canyon, developed in massive sandstone, with steep walls 25-30 m high.

According to the official geological map, the damsite is located in the Upper member of the Ombilin formation: clay and marls with sandstone intercalations. Nevertheless, only sandstones have been seen so far. The rock seemed to be continuous at least 50 m above the riverbed. The sandstone is medium hard. The well developed beds (1-2 m thick) show shallow dips, 15° to the southwest.

The upper slope is covered by soil, and it is used for rubber plantations. A possible interpretation is that the sandstone is overlain by softer marl beds, extending up to the top of the hills.

The sandstone is a strong foundation rock. The thickness of sandstone, above the river has to be checked carefully. In case the dam height exceeds 50 m, the foundation could be soft marl. In such a case, excavation down to the top of the sandstone will be required. The sandstone has low permeability except in strongly fractured zones. The reservoir area consists of a wide plain where alluvial and residual soils have accumulated. There are large paddy fields and the area is relatively densely populated. The surrounding hills consist of sandstones of the Lower member of the Ombilin formation.

3.5.2 Construction Material

Concrete aggregates are produced in a quarry downstream, close to the road to Solok. The material is taken from the river and screened. Only 20% of it is gravel and 80% sand. The sand quality is not suitable for concrete because it contains small platy fragments of marl, which can easily brake down to smaller sizes. Other sources of fine aggregates should be investigated.

The coarse aggregates from the river are insufficient and have to be supplemented by crushed sandstone. Quarry sites are possible at several locations along the river.

3.6 Kuantan Damsite

The local geological setting is presented in Fig. IV.3.2(6/6) and the stratigraphy in Table IV.3.1.

Most of the area of concern is covered by the Kuantan formation, divided into three members. It appears that the sedimentation of the limestone occurred in parallel with the sedimentation of quartzite and later also shale. This means that quartzite, limestone and shale can interspere and the age relationship between them is complex.

The limestone for example, is the Middle member and usually lies on the quartzite (Lower member) but locally also under the quartzite. Therefore, the alternating pattern of rocks along the Kuantan River is not entirely the result of folding but also due to the interference of the different facies (lithologies).

The rocks of the Kuantan formation have been slightly affected by metamorphism. All gradations from shale to slate/phyllite and from sandstone to quartzite can be found. The term "shales" used in this context include low to non metamorphic mudstones and siltstones. A more adequate designation would be "meta-phylite".

During the Cretaceous the Paleozoic rocks have been intruded by granites as a result of the activity along the Great Sumatran Fault. Younger rocks belong to the Tertiary Telisa formation exposed at Lubukambacang, which covers the Kuantan formation unconformaly. Downstream from Lubukambacang the alluvial plain of the Kuantan River consists of unconsolidated sediments.

3.6.1 Damsite

At the damsite the river valley is bordered by steep slopes. The riverbanks consist of mainly quartzite. The fresh rock is gray-whitish, has a fine to very fine grained texture, and hard. The weathering color is brown-gray. It falls apart along joints, marked by a thin limonite film. The outcrops are massive; the thickness of the beds varies between 1 and 3 m. The rock is folded.

The main joint planes are oriented 060/85°, widely spaced. Short joints or fracture cleavage planes, closely spaced are developed only in narrow , discontinuous zones.

The dam foundation bed is a hard quartzite, considered to be a good support for a concrete gravity dam, 60 - 70 m high. The upper slopes do not show any rock exposure. Here, the quartzite is presumed to be covered by a thin layer of colluvium (slope material) which will have to be removed from the dam foundation. Shales and mudstones could possibly occur in-between the quartzite beds, in which case the dam foundation becomes heterogeneous and weaker. This possibility will have to be confirmed in order to establish countermeasures.

The permeability of massive quartzite is related to the frequency of joints and fractures. Generally, it is expected to be low and grouting will be required only at isolated (disturbed) spots or in case of soft rock occurrence.

3.6.2 Reservoir Area

The rocks in the reservoir area are mostly old rocks, belonging to the Kuantan formation. All three members of the said formation are exposed upstream of the damsite. The youngest rocks are granites intruded into the limestones and shales, causing local mineralizations.

The most extensive is the quartzite member of the Kuantan formation. It consists of massive hard rock, with gray-brown weathering color. The bedding is well preserved. The quartzite member is folded in sharp kink-folds with vertical axial planes, almost perpendicular to the river channel.

As seen in the river section at Padangtarap, the quartzite lies on the limestone member. Here, the limestone forms the lowest topography. All surrounding hills consist of either the shale or the quartzite member. The so called "shale" member has already been described above.

Except for the limestone, all rocks described above have low permeability and do not affect the watertightness of the reservoir.

It has been discovered that limestone beds are developed widely in the reservoir area of the Kuantan Dam. The limestone is karstified and it can have an important influence on the watertightness of the reservoir.

Information about the ground water in the catchment area is rather scarce. Especially, the ground water level at the watershed is important. A high water table would minimize the possibility of leakage. The amount of possible leakage however is difficult to estimate without full knowledge of the distribution of cavities in the limestone.

3.6.3 Construction Material

The Kuantan River is a considerable source of concrete aggregates although not the most convenient. There are no accumulations of aggregates in the vicinity of the damsite or upstream of it. This is probably due to the high energy of the river discharge flow, which carries the material further downstream. The first accumulations are two islands about 5 km downstream of the damsite. The material consists of mainly sand and only thin layers of gravel. The quantities extractable here are insufficient.

During low water level more sand/gravel bars appear in the riverbed between Lubukambacang and Lubukjambi, but one strong rain shower is sufficient to make the river rise and submerge these deposits again.

Down the river from Teluk Kuantan, in the meandering portion, the sediment accumulations are mostly consisting of fine sand, which is not suitable as a fine aggregate.

The fine aggregates are abundant in the river while the coarse aggregates could be insufficient. Crushed quarry rock will be a good complementary source. The quartzites of the Kuantan formation are adequate for this purpose. In the vicinity of the dam site and upstream of it, the bedrock consists of quartzite. Selective extraction is recommended because of mudstone intercalations between the quartzites. The mudstones are supposed to be rather thin at the named locations.

CHAPTER 4 GEOLOGICAL INVESTIGATION OF KUANTAN DAMSITE AND RESERVOIR AREA

During the Feasibility Study, the Kuantan damsite and its reservoir area have been investigated in detail. The investigation comprises field survey and drilling.

4.1 Kuantan Damsite

The lithological characteristics of this area have been described in CHAPTER 3. From the general geological picture of the upstream reaches of the river, the best dam foundation seems to be the quartzite member of the Kuantan formation. The area composed of quartzites has been studied in detail. The geology is complex and several structural problems have been identified, as mentioned below.

- Even in the "quartzite member" the shale intercalations are frequent. The shale can be 1 to several tens of meters thick. The intercallations are irregular and laterally discontinuous, but certainly present within 100 m of rock section.
- The orientation of the bedrock is oblique to the river channel. In perpendicular section (dam axis) quartzite and shale alternate. No site with a homogeneous quartzite foundation could be identified.
- Folding of the bedrock resulted into disturbance, rupture and brecciation of the beds. The fold intensity increases upstream of the tributary river.

Within this context three alternatives have been envisaged for the location of the dam, as shown in Figs. IV.4.1 and IV.4.2.

The upstream alternative is located close to the site recently investigated by the PLN. Their study reported poor geological conditions at this location. Accordingly the upstream alternative has been abandoned.

At the downstream alternative the geological conditions are satisfactory. The topographic setting, narrow valley, bordered by steep slopes of hard quartzitic rock, implies some design adjustments. This alternative has been rejected for civil engineering reasons.

The midstream alternative presents the best topographical conditions for the construction of the dam and the power station, and the geological conditions have been judged promising during the preliminary study. This location has been chosen for the detailed investigation. It is referred to as the dam axis further on.

4.1.1 Regional Geological Structure

The main features of the geological structure sketched from a satellite photograph are presented in Fig. IV.4.3.

Several kilometers long lineament crosses the region from NW to SE. Its trend is sub parallel to the Sumatra Fault. On both sides thin lines mark the traces of mountain ridges. It seems that the ridges are curved. On the east side they turn from NW-SE (parallel to the lineament) to E-W (perpendicular to it). Such a pattern corresponds to a strike-slip fault with dextral movement. The curved ridges can be seen as drag folds, resulting from shearing along the fault.

In the field the lineament is marked by a large zone of mineralization, the surrounding rocks are black and their original nature difficult to recognize, brecciation is common. No displacement has been evidenced along this lineament.

An interesting fact is the intensification of the folding and the mineralization in the area upstream of the lineament. It seems to separate a gently folded zone to the east from the tightly folded, disturbed zone to the west. This is one of the reasons why the damsite has been located on the east side, 5.0 km downstream of the lineament.

From this figure, it can be explained why the geological trend in the damsite area follows the directions NW-SE and E-W. To the west, the geological trend is NE-SW, marked by lineaments, fold axes and lithological contacts.

Large topographical flat areas can be distinguished in the upstream area of the river (refer to Fig. IV.4.5). These are almost always underlain by limestone, not visible from the surface. An exception is the area from Airamo - Kapalakoto which seems to be underlain by thick clayey deposits, possibly of Tertiary age.

4.1.2 Geological Structure at Damsite

Fig. IV.4.1 presents the detailed geological map of the damsite area. The regional geological trend is reflected by the main fold axis, the strike of the bedding and the rock outcrop patterns.

Bedding

At the dam axis and upstream, the bedding strike is WNW-ESE, oblique to the riverbed and to the dam axis. In consequence, several bands of quartzite and shale cross the river and intersect the dam axis. About 100 m downstream, the strike turns progressively towards E-W and becomes parallel to the river.

The dip direction shows more variation; S, SW and NE are predominant. Dip values are generally steeper in the shales. However, it is not always clear if the planes measured in shale correspond to the bedding or to secondary cleavage planes. The dips in the quartzite vary between 40° and 70° in the river section and become flatter, 20-30° on the slopes.

Fig. IV.4.2 presents three alternative cross-sections for the Kuantan Dam. The dips marked on the drawings are apparent dips. The dip directions are regular except for the upstream section. On the right riverbank, the bedding rotates and becomes parallel to the section line. Therefore, it appears to be horizontal on the section.

Folds

The area is traversed by two main folds, a syncline and an anticline, with curved fold axis, turning from NW progressively towards E. The folds are more than 1 km long.

The anticline forms a steep and elongated ridge on the right riverbank. Its south limb is marked by a straight and narrow valley which can be mistaken for a fault. The valley is developed in shale, parallel to the strike of the beds, which gives a straight line geometry. The same shale level can be followed over several hundred of meters as far as Saddle A. Here, the valley plunges to the opposite side. Saddle A is located on the watershed. In case of a fault traversing the saddle, there could be leakage from the reservoir. As explained above, there is no evidence of faulting.

The axis of the anticline plunges towards E, into the Kuantan River. On the opposite riverbank a syncline is developed, followed by an anticline, 100 m downstream. Such an offset is generally the result of a strike-slip fault. There are no other indications on the existence of such a structure.

The left riverbank consists of steep dipping rocks, showing a series of small folds. At the downstream dam axis alternative, there is no geological continuity between the riverbanks.

The syncline crosses the river in the vicinity of the dam axis. Its trace can be followed on the left riverbank, but it is for the most part interpreted on the right riverbank.

Faults

One fault has been identified 60 m upstream from the dam axis, on the right riverbank. There is no offset along this fault. The massive quartzite beds show a kink where they have been cut through by the fault. The dip direction changes from SW to NE.

The fault continues for about 150 m, through the valley of the Sipitung River, on the left bank, and finally disappears. Here, there is no evidence of an offset either.

Joints

The bedrock at the damsite is intensively affected by jointing. From the drilling data the joint intensity is higher on the left bank. A total of 200 joints have been measured in the region of the dam axis and represented on a steronet in Fig. IV.4.4. The maxima in this figure indicate the predominant joint directions.

When the data of both riverbanks are plotted together the predominant dip directions of the joint planes are:

- Conjugated set: N011W/80-90° and N012E/80-90°, the conjugated planes make an angle of 25° with each other; and
- Joint family of N90/ 80°.

When presented separately the predominant joint directions are:

- Right Bank: N000/70°, joints sub-perpendicular to the bedding, filled by white quartz; N10W/80° and N090E/80°.
- Left Bbank: N010E/80-90°.

All the joints presented above are a few tens of cm to more than 1 m long, the spacing is often less than 15 cm, most of them contain iron oxide fill or white quartz fill. On a smaller scale, many irregular, mm-thick joints are developed. These are responsible for debrecciation of the quartzite beds.

The shale is often affected by cleavage, especially in the shallow zone. The cleavage planes seem to be sub-parallel to the bedding. The spacing is between 1- 5 cm.

Landslides

A few large landslides have been seen on the left river bank, 200-300 m downstream of the damsite. The very steep mountains consist of shale. The shale is weathered and forms a thick cover soil of clayey composition. After cutting of the slope vegetation, the naked soil has been exposed to the rain and it slid.

At the damsite, the upper slopes consist of quartzite and the cover soil is relatively thin. No danger of sliding has been noticed so far.

In the reservoir area, at some locations, the river is bordered by steep, shale slopes and sliding could occur.

4.1.3 Geotechnical Characteristics of Dam Foundation

Fig. IV.4.2 presents three alternative cross-sections across the river and middle cross-section pass through the dam axis. This section shows the results of the drilling. In the riverbed, no drilling has been done so far. The thickness of the channel sediments is supposed to be 5-6 m at the damsite and less upstream.

The Foundation Bed

The foundation bed at the dam axis and downstream is heterogeneous. The quartzite is interrupted by a shale bed, traversing the river obliquely, and thinning out upstream.

Samples of shale and quartzite have been analyzed in the laboratory and the results are shown in Table IV.4.1. The specific gravity of the quartzite is 2.5, the density is 2.5 g/cm^3 and the absorption values are low, between 1 and 2 %. The specific gravity of the shale is 1.9, its density around 2 g/cm^3. Water absorption is high, up to 13% on the right bank and only 7% on the left bank.

Both shale and quartzite are jointed. The joints are 1 mm to a few cm thick and filled by red-brown iron oxide, often weathered. Around some joints, a large zone of usually white rock is colored red-brown, by the iron oxide.

(1) Right Riverbank

The right bank consists of quartzite with irregular shale intercallations, usually 0.5 to 1.5 m thick.

The quartzite is qualitatively described as a B or a CH rock, meaning, it is hard to fairly hard. In some portions, the rock is hard but affected by intense jointing. As a whole, the rock mass looses its strength and splits along the joint planes. Brecciated rock has been described as CM. The average RQD of the quartzite is 65%.

The unconfined compressive strength varies from 308 kg/cm^2 in CH quartzite to more than 1,000 kg/cm^2 in B quartzite. The average value is close to 500 kg/cm^2, meaning, the quartzite is strong.

The shale belongs to the category of soft rocks. Fresh shale is relatively strong, usually CM and even CH, when there are no joints. In the shallow portion of hole DA-1, the shale is strongly affected by cleavage and very soft, D-rock.

The unconfined compressive strength varies between 30 and 75 kg/cm^2.

(2) River Channel

The foundation bed in the river channel consists of partly quartzite and partly of shale. The shale layer continues on the left river bank , hole DA-3, where it has been sampled and tested. The thickness of the shale layer is 60 m.

(3) Left Riverbank

The lower part of the left riverbank consists of shale as shown in drill log DA-3. Fairly strong shale, RQD 50% occurs between 7 and 22 m of depth. Till 45 m the rock is weakened by jointing, RQD 40%. Weak rock has been found between 45 and 65 m, where the RQD is negligible.

The unconfined compressive strength is 168 kg/cm^2 in strong shale, and around 70 kg/cm^2 , between 22 and 45 m. Below, the rock is expected to be much weaker.

The upper slope bank consists of quartzite of very poor quality. Although the rock itself is fresh and hard, it is completely dislocated into small fragments (brecciation) as a result of jointing. Over the entire length of the hole, the RQD is negligible.

Samples below 40 m of depth have been tested for unconfined compressive strength, and the obtained value is 350 kg/cm^2, meaning, moderately strong rock.

The brecciated quartzite is possibly limited to a narrow zone but, it cannot be judged from only one drilling. Because of the steep dip of the quartzite beds the vertical drilling cuts through the same layer for a big part of its length. Test adits are recommended to be excavated in the future.

Following the description above, the foundation bed is less strong on the left riverbank.

Design Criteria

For the right bank, consisting of hard to moderately hard quartzite, angle of friction of 40° and shear strength of 20 kg/cm^2 are recommended. On the left riverbank the quartzite is brecciated. The design criteria have been adjusted in a conservative way to 35° for angle of friction and 15 kg/cm^2 for shear strength.

The fresh shale is estimated to have an angle of friction of 35° and a shear strength of 10-15 kg/cm^2. In-situ testing of the shear strength of the foundation is strongly recommended on the left riverbank.

Ground Water Level

Monitoring of the ground water table has been done during the drilling activity. The height of the water table on the right river bank is represented in Fig. IV.4.6. The influence of the floods can be clearly seen from the pattern of the curves, especially in DA-2. There is less influence on the upper slope.

On the left riverbank there was no long time monitoring. From the drilling results the ground water shows a pattern which is similar to the right riverbank.

Permeability of the Foundation

Permeability test results are summarized in Table IV.4.2. The upper soil layer, including slope deposits, residual soil, weathered rock, is permeable, k = 10^{-3} cm/s. This layer is 5 m to 10 m thick on the right riverbank. On the left bank, only the lower slope has a pervious layer, 10 m thick.

The right bank consists of mainly quartzite. Between 10 and 35 m of depth the quartzite permeability is 2×10^{-5} to 5×10^{-5} cm/s (2 to 5 Lu) and between 35 and 70 m the permeability is 10-5 to 5×10^{-6} cm/s (0.4 to 1.4 Lu). Such permeability values are considered to be low.

The lower slope of the left bank consists of shale. The permeability values are similar to those of the right bank, 2×10^{-5} between 10 and 40 m of depth and 1.4×10^{-5} between 45 and 55 m of depth.

The upper slope of the left bank consists of brecciated quartzite. Between 15 and 50 m of depth, the permeability is estimated to be 2×10^{-5} to 5×10^{-5} cm/s (3 to 5 Lu). Between 30 and 35 m, the permeability is higher, 10^{-4} cm/s or 11 Lu, possibly as a result of intensive fracturing. Even though the quartzite is strongly fractured and jointed, the rock as a whole seems to be a compact body with acceptable permeability values.

Foundation Treatment and Recommendations

On the right bank, 5 m of overburden shall be excavated on the low slope and 12 m on the upper slope, for the following two reasons:

- To ensure the watertightness of the foundation, the permeability $k = 10^{-3}$ cm/s of the overburden, being too high; and
- To satisfy the strength requirements of the foundation bed.

The left bank needs special consideration. Excavation of minimal 10 m of depth is necessary in the shale bed and recommendable in the brecciated quartzite zone, for the same reasons as mentioned above.

The rock quality in the brecciated zone (hole DA-4) does not improve with the depth. The rock itself is strong and not weathered, but weak as a whole. Deep excavation and replacement with a thick layer of concrete is required over its whole length.

After excavation, on the right bank the foundation bed has a permeability value in the range of 3 to 5 Lu till El. 40 m and around 1 Lu for the deeper portion. The left bank shows more variation. On the lower slope the permeability is comparable to the right river bank. On the upper slope from 0 to 50 m of depth the average permeability is 3 Lu. There is a high pervious zone, 11 Lu, between 30 and 35 m of depth. In the lower portion the permeability is 1-2 Lu.

The pervious zones in DA-3 and DA-4 (> 10 Lu) can be treated by deep grouting. In the other portions, conventional curtain and consolidation grouting are sufficient. In the brecciated quartzite zone, consolidation grouting is necessar to unify the rock.

In future investigations, it is recommended to excavate test adits on the left riverbank and identify the length of the fractured quartzite zone. The strength of the rock and its shear characteristics shall be tested by in-situ plate load tests.

4.1.4 Characteristics of Foundation of Power Station

The power station will be located on the right riverbank, about 80 m downstream from the dam axis. At this location the topography shows a gentle slope, probably an older terrace eroded by the river. The subsurface condition is shown in Fig. IV.4.2.

The upper layer consists of a terrace deposit, big blocks and boulders of quartzite, rounded, with yellow, silty soil. The deposit is 12 m thick and becomes thinner with increasing distance from the river. Below it, there is massive quartzite, as described at the dam axis location.

4.2 Reservoir Area

The geological condition of the reservoir area is discussed briefly in Section 3.6. The most important problem for the reservoir is the watertightness. This can be affected