Table 4.10 Export Value and Quantity by Island in Indonesia

Upper Unit: 000,000 US$
Lower Unit: 000 M. Ton

Island	Year					Percent of Total in 1990
	1986	1987	1988	1989	1990	
Sumatra	7,806 114,270	8,782 99,893	9,196 79,638	9,934 62,605	11,109 64,999	(43%) (61%)
Java & Madura	3,180 12,482	4,760 13,953	5,225 14,387	6,832 16,288	8,335 16,488	(32%) (15%)
Kalimantan	2,988 17,770	3,216 16,707	3,353 17,304	3,748 19,431	4,667 20,872	(18%) (20%)
Sulawesi	292 737	398 729	671 816	682 778	583 764	(2%) (1%)
Bali & Nusa Tenggara	50 7	66 15	86 13	137 32	157 25	(1%) (0%)
Maluku & Irian Jaya	489 2,828	597 2,954	687 3,225	825 3,129	951 3,632	(4%) (3%)
Indonesia Total	14,805 148,094	17,819 134,251	19,218 115,383	22,158 102,263	25,802 106,780	(100%) (100%)

Source: Statistical Year Book of Indonesia, 1990

Table 4.11 Inter Island and International Cargo Loading and Unloading by Province and Port - 1988

Unit: Ton

Province and Port	Total		Total	(%)
	Inter Island	International		
1. DI Aceh	2,432,740	29,033,859	31,466,599	32.0%
Lhokseumawe	1,213,012	28,620,886	29,833,898	
Other Port	1,219,728	412,973	1,632,701	
2. North Sumatra	4,281,207	2,992,727	7,273,934	7.4%
Belawan	3,502,363	2,782,698	6,285,061	
Sibolga	325,267	115,120	440,387	
Tg.Balai Asahan	55,225	55,811	111,036	
Other Port	398,352	39,098	437,450	
3. West Sumatra	1,690,444	1,167,308	2,857,752	2.9%
Teluk Bayur	1,689,645	1,167,308	2,856,953	
Other Port	799	0	799	
4. Riau	16,616,164	29,898,428	46,514,592	47.3%
Dumai	8,196,795	23,416,963	31,613,758	
Pakanbaru	241,823	419,082	660,905	
Rengat	107,398	41,648	149,046	
Tembilahan	1,252	15,105	16,357	
Other Port	8,068,896	6,005,630	14,074,526	
5. Jambi	851,477	837,399	1,688,876	1.7%
Jambi	540,454	395,324	935,778	
Kuala Tungkal	104,914	264,911	369,825	
Muara Sabak	201,452	177,164	378,616	
Other Port	4,657	0	4,657	
6. South Sumatra	3,952,957	1,259,640	5,212,597	5.3%
Palembang	3,014,329	1,148,698	4,163,027	
Other Port	938,628	110,942	1,049,570	
7. Bengkulu	498,646	182,051	680,697	0.7%
Bengkulu (Pulau Baai)	498,619	182,051	680,670	
Other Port	27	0	27	
8. Lampung	1,801,845	867,421	2,669,266	2.7%
Panjang	1,799,142	867,421	2,666,563	
Other Port	2,703	0	2,703	
Total of Main Ports	21,491,690	59,670,190	81,161,880	
Total of All Ports	32,125,480	66,238,833	98,364,313	100.0%

Source: Cargo Loading and Unloading at Ports in Indonesia - 1988

Of the inter island cargoes, 76% are mixed various commodities and 5% are plantation products such as cooking oil, rubber, etc. In international cargoes, mixed various commodities and plantation products account for about 50%, the rest is wood and other agricultural products. At Palembang port, the inter island cargoes (fertilizer, wood and crude oil) exceed the international cargoes (plantation products, wood and fertilizer).

(2) Cargo O-D Table in Sumatra and Java

Cargo O-D (Origin-Destination) table between provinces in Sumatra and Java is shown in Table 4.12. South Sumatra and Riau hundle the highest loading cargo volume, East Java and DKI Jakarta handle the highest unloading cargo volume and Riau handles the highest loading and unloading cargo volume, followed by South Sumatra and East Java.

4.4.2 Ferry Transportation

The following are the four main ferry services in Indonesia.

• Merak	-	Bakauhuni	Java/Sumatra
• Ujung	-	Kamal	Java/Madura
• Gilimanuk	-	Ketapang	Bali/Java
• Padangbai	-	Lembar	Bali/Lombok

Merak-Bakauhuni ferry service links Java and Sumatra and is one of the most important ferries in Indonesia. It has ten ships at present with 56 round trips/day. Crossings take about two hours.

Capacity and year of starting operation of each ship are shown in Table 4.13.

Table 4.12 Cargo O-D Table in Sumatra

Unit : 100 Ton

Origin \ Destination	11	12	13	14	15	16	17	18	31	32	33	34	35	Origin Total	O-D Total
11 DI Aceh	88	313	44	48	1	1	0	0	546	0	13	0	1,284	2,338	5,206
12 Sumatra Utara	929	2,165	60	1,352	0	468	7	1,069	25,058	8,406	6,498	0	12,318	58,330	98,992
13 Sumatra Barat	62	7,347	28	832	0	64	153	588	4,516	59	5,633	0	32,919	52,201	74,330
14 Riau	122	4,429	1,402	63,205	736	323	44	3,019	11,715	1,132	710	0	4,573	91,410	164,490
15 Jambi	0	41	0	51	124	461	0	0	290	0	20	0	18	1,005	2,722
16 Sumatra Selatan	15	635	6,558	242	341	27,842	0	6,511	17,093	4,931	20,181	0	12,098	96,447	145,606
17 Bengkulu	0	0	20	0	5	0	0	0	0	0	0	0	5	30	5,706
18 Lampung	0	606	4,412	23	0	724	3,923	14,932	3,621	613	121	0	6,199	35,174	64,723
31 DKI Jakarta	331	7,294	1,671	3,809	221	2,174	271	92	0	1,095	58	0	702	17,718	96,631
32 Jawa Barat	1	21	0	126	0	7,186	0	1	16	39	1,093	0	4,520	13,003	45,670
33 Jawa Tengah	0	14	1,240	815	108	321	672	54	14,750	115	123	0	5,458	23,670	58,212
34 Yogyakarta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35 Jawa Timur	1,320	17,797	6,694	2,577	181	9,595	606	3,283	1,308	16,277	92	0	559	60,289	140,942
Destination Total	2,868	40,662	22,129	73,080	1,717	49,159	5,676	29,549	78,913	32,667	34,542	0	80,653	451,615	903,230

Source: Kompilasi Hasil Survai dan Pengolahan Data, Survai Asal Tujuan Transportasi Nasional - 1989, Lembaga Penelitian Perencanaan Wilayah dan Kota, Institut Teknologi Bandung

Table 4.13 Ferry Transport Facilities

No.	Name of Ship (1986)	Capacity of Ship		Year				
		Passenger	Vehicle	'86	'87	'88	'89	'90
1.	Jatra 1	1000	55	O	O	O	O	O
2.	Jatra 2	1000	55	O	O	O	O	O
3.	Lampung	494	40	O	-	O	O	O
4.	Banten	520	20	O	O	-	-	-
5.	Kotabumi	800	55	O	O	O	O	O
6.	Windu Karsa P	300	30	O	O	O	O	O
7.	Nusa Bhakti	350	24	O	O	O	O	-
8.	Nusa Dharma	650	150	O	O	O	O	O
9.	Menggala	500	101	-	O	O	O	O
10.	Baruna	980	102	-	O	O	O	O
11.	Rajabasa	668	102	-	-	O	O	O
12.	Nusa Jaya	800	150	-	-	-	-	O

Source: Directorate General of Land Transport

Note: O = Operational

(1) Commodities and Quantities Transported

Numbers of passengers and vehicles, and tonnes of cargoes are shown in Table 4.14.

From 1986 to 1990, the number of passengers using the ferry increased 1.75 times, cargoes 1.78 times, and 4-wheel vehicles 1.65 times, while only 2-wheel vehicles decreased, by 67%.

Daily foods and raw materials are the main cargoes transported by the ferries. The total tonnage of live animals, unprocessed foods and general cargoes accounts for about 44% of all cargoes and amounts to about 1 million tonnes. Other commodities like sugar, chocolate, alcoholic drink, tobacco and other foods processed from animals and plants, account for about 24%.

Table 4.14 Merak - Bakauhuni Ferry Service

per year

Year	Passenger	Cargo (tonnes)	Vehicle	
			(4-Wheel)	(2-Wheel)
1986	4,760,427	1,779,030	565,582	35,201
1987	5,022,238	1,963,339	642,562	34,530
1988	6,509,207	3,285,580	706,531	39,539
1989	7,030,001	2,667,837	744,734	13,785
1990	8,337,358	3,183,478	935,772	11,348
Per day in 1990	22,842	8,722	2,564	31

Source: Directorate General of Land Transport

Note: Types of Vehicles Carried
------- Motorcycle, Sedan, Jeep, Pick-up, Truck, Bus

(2) O-D Table of Ferry Transport

Cargo and passenger movement by the ferry services are shown in Tables 4.15 and 4.16 respectively.

The largest cargo movements with DKI Jakarta are found to be with the provinces of Lampung, South Sumatra, North Sumatra, Jambi and West Sumatra in that order.

4.5 River Transportation

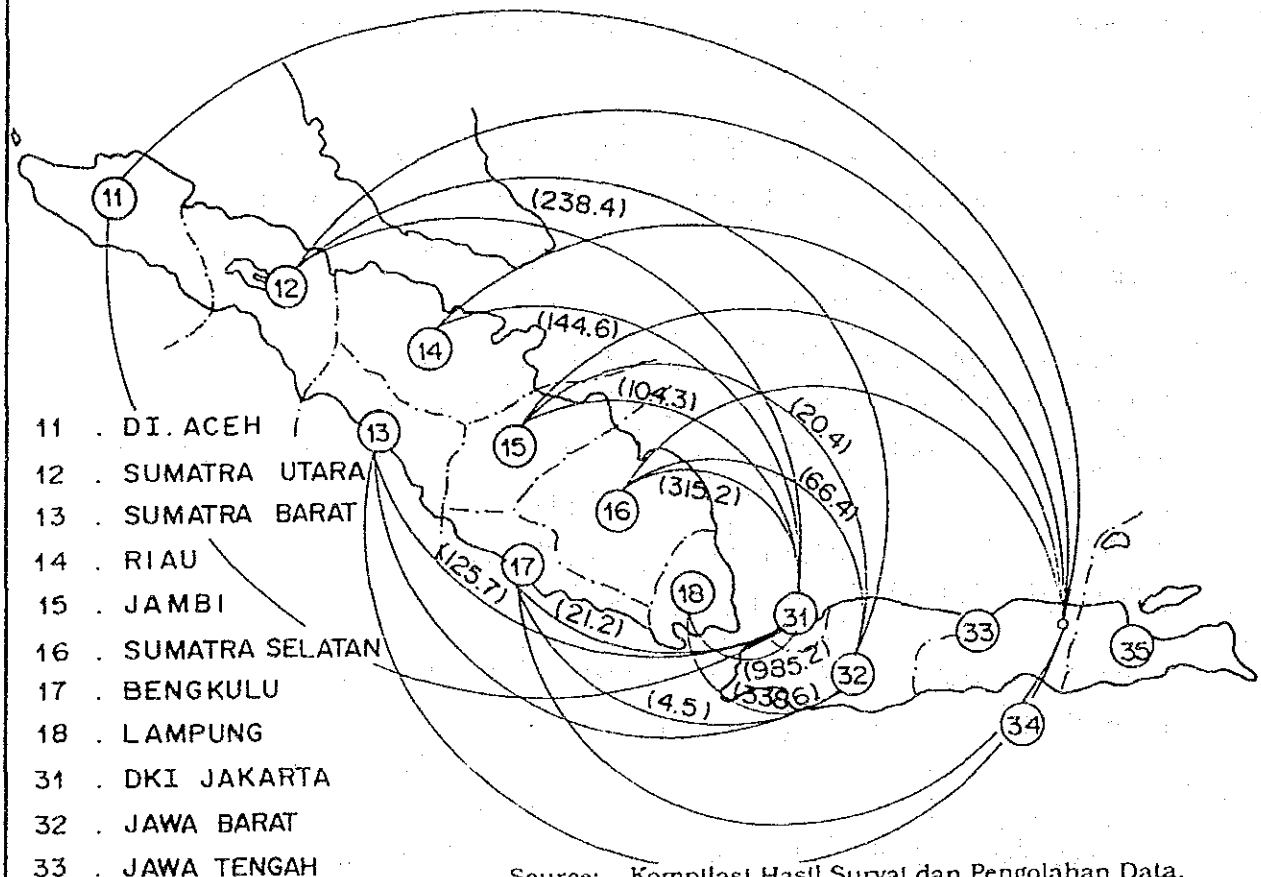
Primary river locations are shown in Fig. 4.9. There are 17 principal rivers in Sumatra, of which 16 flow to the east coast. All the 16 rivers are navigable and are used for transportation of cargoes amounting to 6-8 million tonnes/year in total. The three rivers named Indragiri, Batanghari and Musi are the most highly used. All of these rivers flow from the west to the east, and therefore cross the proposed Sumatra East Coast Highway.

Navigable distance of the primary rivers from the coast and the draught at the end point are shown in Table 4.17.

Table 4.15 O-D Table of Ferry Cargoes (1988)

Unit : 1000 ton

ORIGIN \ DESTINATION	11	12	13	14	15	16	17	18	31	32	33	34	35	TOTAL
11 D.I ACEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12 SUMATRA UTARA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.4	11.4	0.7	0.0	1.5	96.1
13 SUMATRA BARAT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.2	9.6	0.7	0.0	0.4	43.9
14 RIAU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	3.9	0.0	0.0	0.2	15.7
15 JAMBI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.8	19.8	0.1	0.0	0.1	83.9
16 SUMATRA SELATAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	151.9	51.1	1.5	0.0	0.3	204.8
17 BENGKULU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.7	3.1	0.3	0.0	0.0	15.2
18 LAMPUNG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	514.9	219.4	15.4	1.5	5.0	756.2
31 JAKARTA	0.5	156.0	92.5	133.1	40.5	163.3	9.5	470.3	0.0	0.0	0.0	0.0	0.0	1,065.6
32 JAWA BARAT	0.0	4.9	6.8	2.5	0.6	15.3	1.4	119.2	0.0	0.0	0.0	0.0	0.0	150.7
33 JAWA TENGAH	0.3	4.1	7.3	2.1	1.3	9.9	1.4	24.3	0.0	0.0	0.0	0.0	0.0	50.6
34 YOGYAKARTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35 JAWA TIMUR	0.0	3.2	0.5	0.0	0.4	2.7	0.0	10.3	0.0	0.0	0.0	0.0	0.0	17.1
TOTAL	0.8	168.2	107.1	137.7	42.7	191.2	12.3	624.1	869.6	319.2	18.8	1.5	7.5	2,499.7



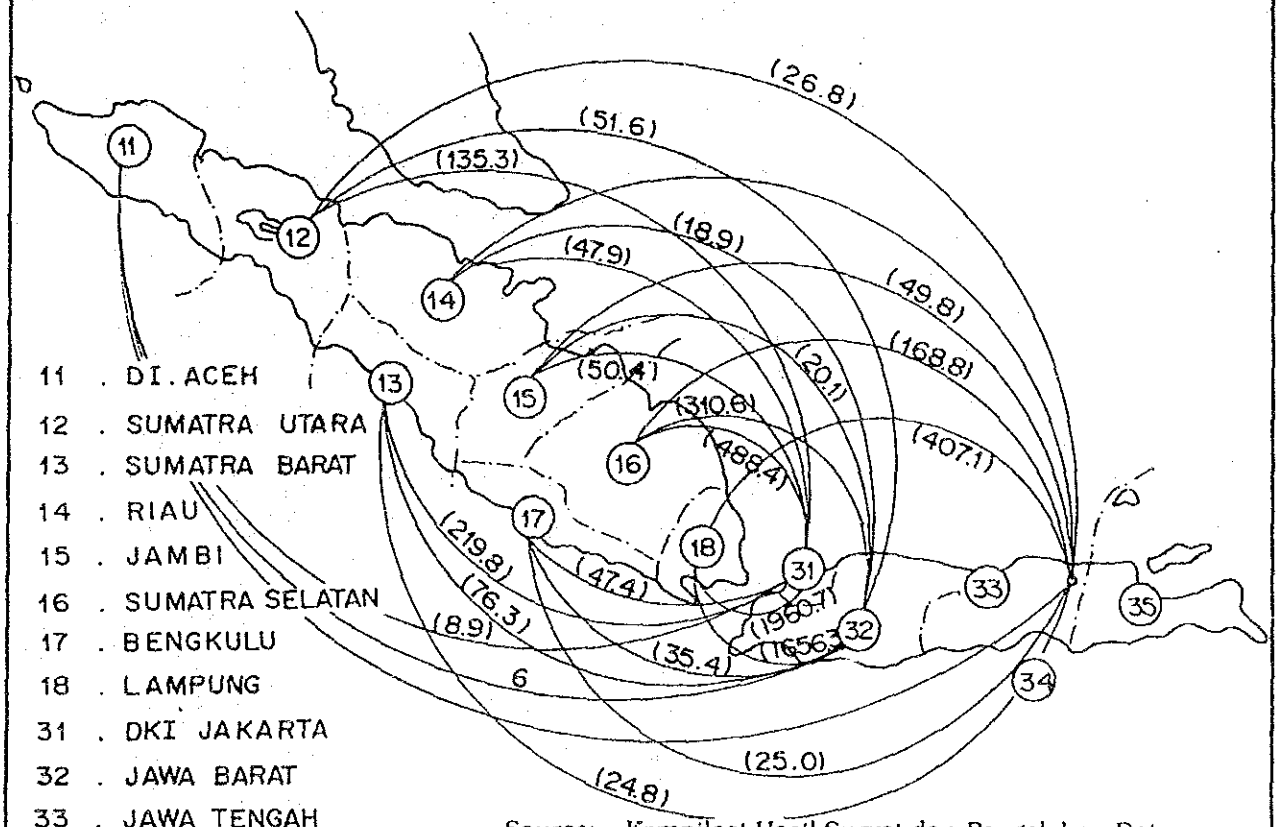
11 . DI. ACEH
12 . SUMATRA UTARA
13 . SUMATRA BARAT
14 . RIAU
15 . JAMBI
16 . SUMATRA SELATAN
17 . BENGKULU
18 . LAMPUNG
31 . DKI JAKARTA
32 . JAWA BARAT
33 . JAWA TENGAH
34 . DI.YOGYAKARTA
35 . JAWA TIMUR

Source: Kompilasi Hasil Surval dan Pengolahan Data, Surval Asal Tujuan Transportasi Nasional - 1989, Lembaga Penelitian Perencanaan Wilayah dan Kota, Institut Teknologi Bandung

Table 4.16 O-D Table of Ferry Passengers (1988)

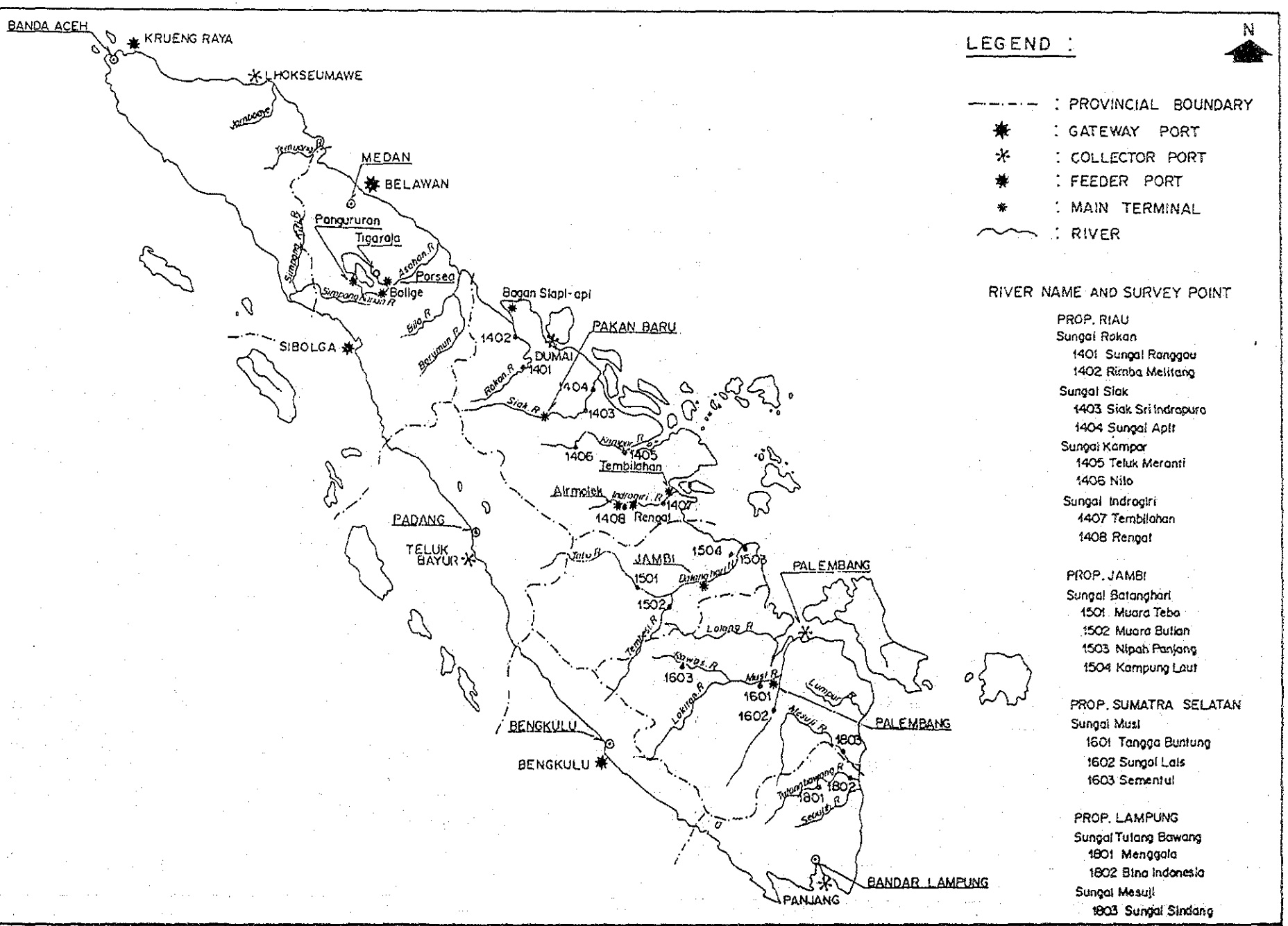
Unit : 1000 pax

ORIGIN \ DESTINATION	11	12	13	14	15	16	17	18	31	32	33	34	35	TOTAL
11 DI ACEH	98.8	2.6	0.3	0.0	0.0	0.0	0.0	0.0	4.0	4.3	1.8	0.6	0.0	112.5
12 SUMATRA UTARA	3.4	0.0	0.0	0.0	0.0	0.8	0.0	0.0	79.4	29.9	13.4	0.0	9.2	136.1
13 SUMATRA BARAT	0.4	0.0	0.0	0.0	0.0	0.6	0.0	0.0	99.6	35.4	9.8	2.4	1.8	150.0
14 RIAU	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	22.0	12.2	14.0	2.4	37.6	88.4
15 JAMBI	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	12.8	6.7	21.4	3.7	7.9	53.3
16 SUMATRA SELATAN	0.2	1.1	0.7	0.1	1.2	107.5	1.3	4.4	242.5	137.3	70.3	27.5	44.1	638.0
17 BENGKULU	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	16.5	10.4	5.5	1.8	3.1	37.7
18 LAMPUNG	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	812.9	778.1	216.8	52.5	96.5	1,961.0
31 JAKARTA	4.9	55.9	120.2	25.9	37.6	245.9	30.9	1,147.8	0.0	0.0	0.0	0.0	0.0	1,669.2
32 JAWA BARAT	1.7	21.7	40.9	6.7	13.4	173.3	25.0	878.2	0.0	0.0	0.0	0.0	0.0	1,160.8
33 JAWA TENGAH	5.1	13.4	15.0	19.2	28.4	98.5	20.0	190.3	0.0	0.0	0.0	0.0	0.0	389.9
34 YOGYAKARTA	0.0	0.8	2.5	3.3	0.8	36.2	5.0	80.1	0.0	0.0	0.0	0.0	0.0	128.9
35 JAWA TIMUR	1.0	9.2	0.8	15.9	18.4	48.3	0.8	127.7	0.0	0.0	0.0	0.0	0.0	222.1
TOTAL	115.6	104.7	180.5	71.1	99.7	716.5	83.1	2,428.5	1,289.7	1,014.3	353.1	91.0	200.1	6,747.9



11 . DI. ACEH
12 . SUMATRA UTARA
13 . SUMATRA BARAT
14 . RIAU
15 . JAMBI
16 . SUMATRA SELATAN
17 . BENGKULU
18 . LAMPUNG
31 . DKI JAKARTA
32 . JAWA BARAT
33 . JAWA TENGAH
34 . DI.YOGYAKARTA
35 . JAWA TIMUR

Source: Kompilasi Hasil Survai dan Pengolahan Data, Survai Asal Tujuan Transportasi Nasional - 1989, *Lembaga Penelitian Perencanaan Wilayah dan Kota*, Institut Teknologi Bandung



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 4.9 Major Rivers and Ports in Sumatra

Table 4.17 Navigability of Selected Rivers in Eastern Sumatra

Name of River	Navigable to	Distance from Coast	Vessel Draught
Mesuji	S.Sodong	130 km	2.5 m
Tulangbawang	Menggala	100 km	2.5 m
Musi	Palembang	85 km	7.5 m
Musi	Muara Kelingi	340 km	1.0 m
Calik/Lalang	Muara Bahar	160 km	5.5 m
Hari	Jambi	140 km	3.0 m
Hari	Muara Tebo	240 km	1.5 m
Retih	Kpg. Kotabaru	55 km	3.0 m
Indragiri	S. Cenako	70 km	3.0 m
Pinai	Air Merah	110 km	2.0 m
Asahan	Bandar Pulau	75 km	2.0 m

Source: Regional Physical Planning Programme for Transmigration Report

Many local cities and towns in the east coastal region have developed along the above rivers taking advantage of river transportation. They have gradually formed various economic zones along each river over long periods of time. Recently the Trans-Sumatra Highway and other road development plans have been or are being executed. These will reduce the role of river transport to some extent but it is still an important mode of transportation for the Sumatra east coast provinces because of the many swampy areas.

One of the problems in river transportation is soil erosion at the upstream end of the rivers. Much eroded soil flows into the rivers, settles downstream and makes ship operation difficult. At the downstream section of Musi river in South Sumatra province dredging started in 1988. The dredging cost is increasing remarkably in order to keep shipways clear.

(1) Cargoes, Commodities and Passengers

Amounts of cargoes and passengers at each river port are shown in Table 4.18. The largest transportation of cargo takes place at the Indragiri river (through Rengat in Riau province) and the Musi river (through Palembang in South Sumatra province).

Transportation of passengers is also highest at these two rivers. On the Indragiri river, the two river ports of Tembilahan (1407) and Rengat (1408) have been surveyed and on the Musi river, the three river ports (1601-3) near Palembang, Kayuagung and Sekayu have been surveyed. The locations are shown in Fig. 4.9.

About 90% of cargoes are transported by three kinds of light river craft, namely speed boats, small motorized boats and long boats. These boats transport passengers and cargoes, including raw materials, between primary coastal cities and inland towns.

Main commodities of the cargoes are as follows:

- Classified cargo
  Rice, salt, cement, processed petroleum, natural manure, artificial fertilizer, etc.
- Processed products of animals
  Tanned hide and processed tanned hide (leather)
- Processed and unprocessed minerals
  Processed stone, cement, asbestos, etc.

(2) O-D Table of River Transport

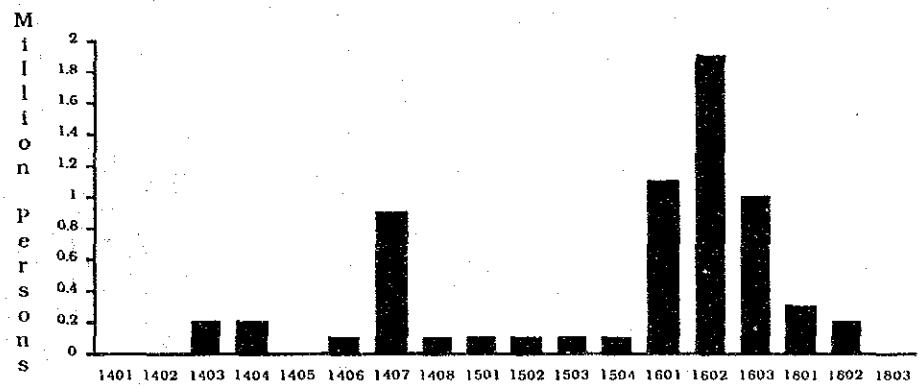
O-D tables of the Indragiri and Musi rivers are shown in Fig. 4.10. Cargoes to/from other provinces account for only 1.8% and 0.5% respectively. Thus only a small amount of cargoes are transported between provinces.

Table 4.18 Passengers and Cargoes in River Transport

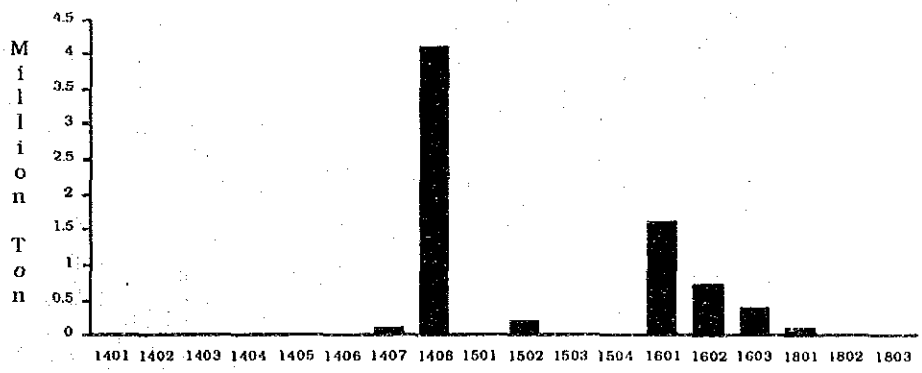
River Port		Amount of Passenger Movement (person)	Amount of Freight Movement (ton)
1401	Sungai Ranggau	16,668	7,529
1402	Rimba Melitang	25,860	484
1403	Siak Sri Indrapura	155,336	16,638
1404	Sungai Apit	225,940	9,623
1405	Teluk Meranti	17,773	7,633
1406	Nilo	82,189	37,131
1407	Tembilahan	941,987	127,850
1408	Rengat	136,374	4,092,182
1501	Muara Tebo	109,664	12,975
1502	Muara Bulian	103,200	247,482
1503	Nipah Panjang	101,946	10,181
1504	Kampung Laut	86,688	31,749
1601	Tangga Buntung	1,054,721	1,578,870
1602	Sungai Lais	1,939,165	697,480
1603	Sementul	965,587	380,839
1801	Menggala	275,168	57,413
1802	Bina Indonesia	202,350	20,690
1803	Sungai Sindang	11,021	17,864

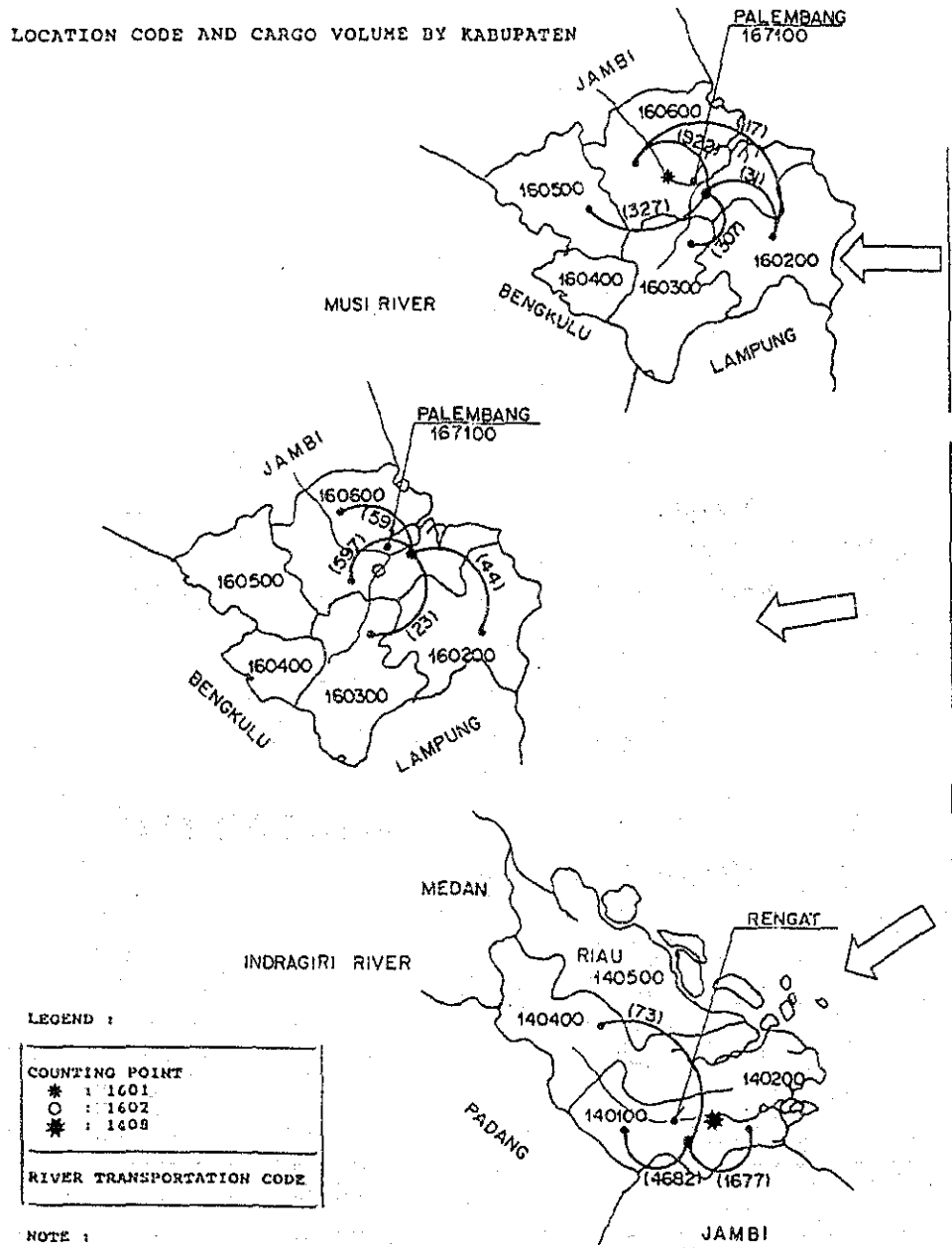
Source: Kompilasi Hasil Survai dan Pengolahan Data, Survai Asal Tujuan Transportasi Nasional - 1989, Lembaga Penelitian Perencanaan Wilayah dan Kota, Institut Teknologi Bandung

Passenger Movement in Sumatra



Cargo Movement in Sumatra





Cargo in River Transport in Tons (1989)

1. Musi River

Counting Point: 1601

Destination / Origin	Code : 160200	160300	160400	160500	160600	160700	160800	167100	Another	Total
Code :										
160200	0	0	0	0	1,229	0	0	18,628	0	19,857
160300	0	0	0	0	340	0	0	44,696	0	45,036
160400	0	0	0	0	0	0	0	0	0	0
160500	0	0	0	0	0	0	0	177,058	0	177,058
160600	566	0	0	0	878	0	0	316,274	0	317,718
160700	0	0	0	0	0	0	0	0	0	0
160800	0	0	0	0	0	0	0	0	0	0
167100	12,085	262,904	2,635	150,050	406,677	0	0	176,830	566	1,011,747
Other	0	0	0	0	0	0	0	7,337	0	7,337
Total	12,651	262,904	2,635	150,050	409,124	0	0	740,823	566	1,578,753

Counting Point: 1602

Destination / Origin	Code : 160200	160300	160400	160500	160600	160700	160800	167100	Another	Total
Code :										
160200	0	0	0	0	0	0	0	13,778	0	13,778
160300	0	0	0	0	0	0	0	14,480	0	14,480
160400	0	0	0	0	0	0	0	0	0	0
160500	0	0	0	0	0	0	0	0	0	0
160600	0	0	0	0	29,640	0	0	219,319	0	248,959
160700	0	0	0	0	0	0	0	0	0	0
160800	0	0	0	0	0	0	0	0	0	0
167100	30,369	8,746	0	0	378,407	0	0	2,647	0	420,169
Other	0	0	0	0	0	0	0	0	0	0
Total	30,369	8,746	0	0	408,047	0	0	250,224	0	697,386

2. Indragiri River

Counting Point: 1408

Destination / Origin	Code : 140100	140200	140300	140400	140500	147200	Total
Code :							
140100	2,341,516	3,704	0	0	0	0	2,345,220
140200	1,673,341	0	0	0	0	0	1,673,341
140300	0	0	0	0	0	0	0
140400	0	199	0	0	0	0	199
140500	0	0	0	0	0	0	0
147200	73,424	0	0	0	0	0	73,424
Total	4,088,281	3,903	0	0	0	0	4,092,184

Source : Survai Asal Tujuan Transportasi Nasional-1989,
Lembaga Penelitian Perencanaan Wilayah & Kota,
Institut Teknologi Bandung

Notes :

160200 : Kabupaten Ogan Komering Ilir
160300 : Kabupaten Muara Enim
160400 : Kabupaten Lahat
160500 : Kabupaten Musi Rawas
160600 : Kabupaten Musi Banyuasin
160700 : Kabupaten Bangka
160800 : Kabupaten Belitung
167100 : Kodya Palembang
140100 : Kabupaten Indragiri Hulu
140200 : Kabupaten Indragiri Hilir
140300 : Kabupaten Kepulauan Riau
140400 : Kabupaten Kampar
140500 : Kabupaten Bengkalis
147200 : Kabupaten Pakanbaru

COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 4.10 Origin and Destination of River Cargo Transportation by Kabupaten

4.6 Air Transportation

Locations of airports and route networks are shown in Fig. 4.11 and Fig. 4.12 respectively. There are 32 airports of various sizes in Sumatra. Two are International being those at Medan and Palembang. Seven are Regional/Major, being those at Tanjung Karang, Pangkalpinang, Jambi, Batam, Pekanbaru, Padang Teluk and Banda Aceh. Twenty three are provincial and municipal airports located in other provinces and islands. Most of them are connected with Jakarta.

Tables 4.19 and 4.20 show the domestic and international air passengers at the principal airports.

Table 4.19 Domestic Air Passengers - 1989

Unit: persons

Airport / Description	Blang Bintang Banda Aceh	Polonia Medan	Tabing Padang	Simpang Tiga Pekan Baru	Kijang Tg. Pinang	Japura Rengat	Dabo Singkep
Departure	23,118	396,149	133,351	148,033	29,280	13,587	10,284
Arrival	21,859	401,605	124,100	150,001	32,836	12,955	10,113
Transit	-	9,926	-	16,172	4,892	4,342	3,141

Source: Statistical Year Book of Indonesia - 1990

Table 4.20 International Air Passengers - 1989

Unit: persons

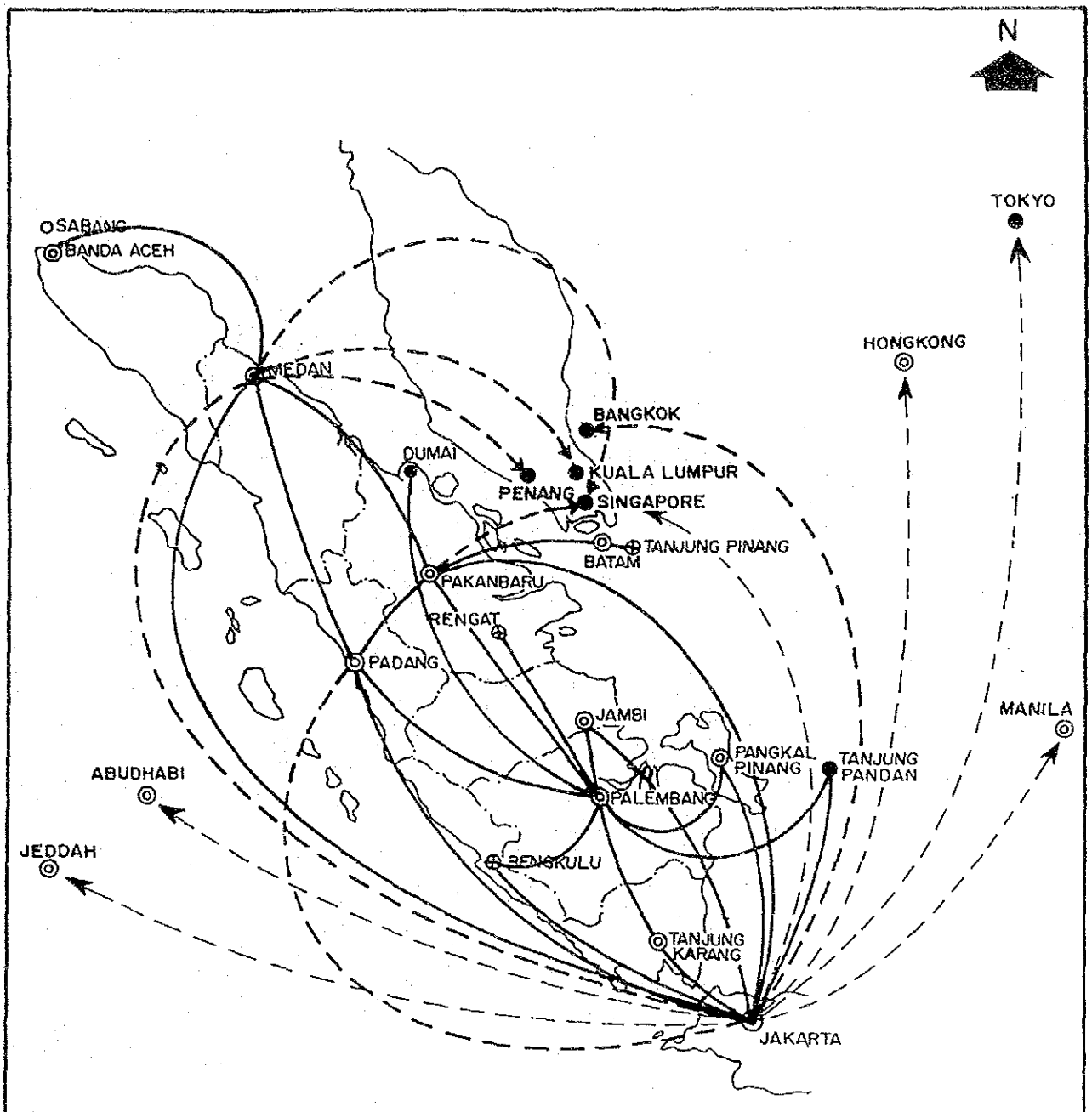
Airport / Description	Polonia Medan	Simpang Tiga Pekan Baru	Kijang Tg. Pinang	Tabing Padang
Departure	133,266	9,294	111	4,472
Arrival	152,483	11,019	984	4,497
Transit	5,458	2,140	404	-

Source: Statistical Year Book of Indonesia - 1990

COASTAL ROADS
IN
EAST COAST OF SUMATRA

Fig. 4.11

Location of Airport by Category Classification of Port



COASTAL ROADS
IN
EAST COAST OF SUMATRA

Fig. 4.12

Air Route Networks of Scheduled Airlines (1991)

Chapter 5

SOCIO-ECONOMIC FRAMEWORK

CHAPTER 5

SOCIO-ECONOMIC FRAMEWORK

5.1 Recent Economic Environment

The world economy after the slowest annual growth in the past decade posted 0.3 percent growth in 1991 due to recession in industrialized economies in North America and Europe coupled with the collapses of the communism region in the Soviet Union and Eastern Europe.

The Asian economy as a whole entered a slowdown path due mainly to prolonged recession in the United States and decline in the Japanese economy, since both countries are significant trade partners for Asian countries. However the dynamic Asian economies such as NIEs are set to continue growing at a good rate largely unaffected by the sluggishness in the industrialized countries.

GDP of development and developing countries grew at a 3.0 to 3.3 percent range within the 1988 to 1989 period, however GDP growth rate of ASEAN and Indonesia were 8.5 % and 7.4 % respectively during the same period.

The concept of the ASEAN Free Trade Area (AFTA), adopted by the ASEAN summit meeting in Singapore in January 1992, will be implemented gradually starting next year and will become fully operational in the year 2008. Under these circumstances, the new perspective will accelerate the development of the Singapore-Johor-Riau (SIJORI) Triangle.

5.2 Fifth Five Year Development Plan (Repelita V)

5.2.1 Repelita V - National Development Plan

(1) National Development Trilogy and Development Policy

National policy of Indonesia on social and economic development is set out in the Five Year Development Plan (Repelita). The current fifth Plan, Repelita V, covers the period of 1989/90 - 1993/94, and is the final phase of the First 25 Year Long Term Development Plan starting in 1969. In line with the past four Plans, the supreme

objective of Repelita V is to increase the standard of living of the entire population. Another objective particular to this Plan is to build a strong foundation for the next development stage. In fact, Repelita V will realize economic "take-off" for the era of self-sustaining development during the subsequent Repelita VI.

Table 5.1 Main Target of Repelita V

Item	Year		Average Annual Growth Rate (%)
	1988/89	1993/94	
1. Population (million)			
Jawa	105.8	114.1	1.5
Other Islands	69.8	78.8	2.4
Total	175.6	192.9	1.9
2. Labour Force (million)			
Jawa	45.6	50.9	2.2
Other Islands	28.9	35.5	4.2
Total	74.5	86.4	3.0
3. Gross Domestic Product (%)			
Agriculture	23.2	21.6	3.6
Mining & Quarrying	15.9	12.6	0.4
Manufacturing	14.4	16.9	8.5
Non-oil/gas	9.6	12.3	10.0
Oil/gas	4.8	4.6	4.2
Construction	5.6	5.8	6.0
Trade	15.9	16.7	6.0
Transport & Communication	5.7	6.0	6.4
Others	19.3	20.4	6.1
GDP	100.0	100.0	5.0
4. Employment (million)			
Agriculture	39.0	43.0	3.0
Manufacturing	6.0	8.3	2.0
Others	27.2	32.4	6.7
Total	72.2	83.7	3.6
5. Investment (Rp. trillion)			
Private	-	131.6	-
Government	-	107.5	-
Total	-	239.1	-

Source: BAPPENAS, Repelita V

Repelita V is an indicative plan which elaborates the development objectives and priorities expressed in the guideline of state policy. As was the case with past Repelita, the guideline specifically calls for a harmonious implementation of the development trilogy, that is, economic growth, equitable distribution of income and national stability. The order of priority among them as indicated in the guideline is: (i) equity, (ii) growth, and (iii) stability.

In accordance with this concern for equity, more national attention is being given to the eastern part of Indonesia, which is comparatively less developed than the western part. A strong thrust of economic growth is no doubt originating from Java and Sumatra. Whether or not the target of Repelita V will be achieved, thus, depends considerably on the performance of Sumatra.

(2) Development Target of Repelita V

Repelita V aims to achieve a balanced economic structure, with emphasis on the agricultural sector (self sufficiency in foodstuffs and promotion of product diversity) and on the industrial sector (promotion of export-oriented commodities, absorption of large manpower and processing of agricultural products).

Further, the government expects the private sector to supplement the shortage of the budget for development. In order to stimulate economic activities of the private sector such institutional improvements as the "deregulation" policy should be emphasized further and continuously.

Target of Repelita V is shown in Tables 5.1 and 5.2.

Table 5.2 Targets of Sectoral Composition of GDP in 1988 and 1993

(%)

Industrial Sector	1988	1993
1. Agriculture	23.2	21.6
2. Mining	15.9	12.6
3. Manufacturing	14.4	16.9
4. Construction	5.6	5.8
5. Commerce	15.9	16.7
6. Transport/Communication	5.7	6.0
7. Others	19.3	20.4
GDP	100.0	100.0

Source: BAPPENAS, Repelita V

5.2.2 Repelita V - Provincial Development Plan

A target of the socio-economic framework of each province is presented by BAPPEDA (Regional Development Planning Board) by province in Sumatra as shown in Table 5.3.

The population in Sumatra was 35.8 million and the population density was 76 persons per square kilometer in 1988. The Repelita V projection of population was about 41 million and a population density of 87 persons per square kilometer in 1993, so that the population growth during the Repelita V results in 2.79 % per annum. The population in Sumatra is projected for every year of Repelita V as shown in Table 5.4.

Based on the projected population, the labor force population is estimated to increase from 20.1 million in 1989 to 22.6 million in 1993 at the average annual growth rate of 2.9 % as shown in Table 5.4.

Employment opportunity in Sumatra is also estimated by industrial sector as shown in Table 5.5.

Table 5.3 Target of Socio-Economic Framework in Each Province of Sumatra

	Average Growth Rate (%)		
DI Aceh	Population 2.4	Agriculture Mining Manufacturing GDP	2.8 1.5 10.0 5.8
North Sumatra	2.0	Agriculture Mining Manufacturing GDP	4.7 4.5 11.0 6.2
West Sumatra	1.0	Agriculture Mining Manufacturing GDP	4.4 10.8 8.5 5.9
Riau	2.7	Agriculture Mining Manufacturing GDP	4.4 6.9 8.5 6.0
Jambi	3.4	Agriculture Mining Manufacturing GDP	3.8 0.5 10.7 5.7
South Sumatra	2.7	Agriculture Mining Manufacturing GDP	3.0 7.5 6.2 5.0
Bengkulu	3.9	Agriculture Mining Manufacturing GDP	5.5 10.4 8.6 6.0
Lampung	4.8	Agriculture Mining Manufacturing GDP	5.5 8.0 8.0 6.6

Source: BAPPEDA, Repelita V

Table 5.4 Projection of Population and Labour Force in Sumatra for Repelita V

Year	Population (x 1,000)	Average Annual Growth Rate	Labor Force (x 1,000)	Average Annual Growth Rate
1989	36,799		20,124	
1990	37,826		20,708	
1991	38,881	1.21 %	21,308	2.9 %
1992	39,966		21,926	
1993	41,081		22,562	

Source: Repelita V, Bappeda and Statistical Year Book of Indonesia, 1988

Table 5.5 Employment Opportunity by Industrial Sector in Sumatra for Repelita V

(Unit : 1,000 persons)

Province	Sector	Year	
		1988	1993
Aceh	Agriculture	811	900
	Mining	4	4
	Manufacturing	57	71
	Others	349	444
	Total	1,222	1,419
North Sumatra	Agriculture	2,230	2,364
	Mining	19	19
	Manufacturing	191	232
	Others	1,248	1,594
	Total	3,687	4,209
West Sumatra	Agriculture	876	977
	Mining	7	8
	Manufacturing	69	76
	Others	459	540
	Total	1,441	1,601
Riau	Agriculture	558	663
	Mining	9	9
	Manufacturing	36	41
	Others	335	424
	Total	937	1,137
Jambi	Agriculture	505	-
	Mining	-	-
	Manufacturing	23	-
	Others	191	-
	Total	*719	869
South Sumatra	Agriculture	1,476	1,799
	Mining	80	87
	Manufacturing	123	170
	Others	704	881
	Total	2,383	2,937
Bengkulu	Agriculture	448	-
	Mining	-	-
	Manufacturing	7	-
	Others	93	-
	Total	*548	-
Lampung	Agriculture	1,979	-
	Mining	-	-
	Manufacturing	151	-
	Others	609	-
	Total	*2,739	-

Note: *shows figures of Statistical Year Book of Indonesia

5.3 Regional Development Plan

5.3.1 Regional Development Scheme

Under the conditions of Replita V with the target of equity and growth, the high potential of agriculture, agro-industry, manufacturing and tourism should be fully utilized to proceed with the regional growth in Sumatra.

(1) Future Development Direction

Sumatra has not integrated itself yet into one economic region being divided into 4 economic zones with little integration between them. The zones are Northern (Aceh and North Sumatra), Central (West Sumatra and Riau), Southern (Jambi/Bengkulu and South Sumatra) and Lampung which is rather strongly connected to Jakarta forming an economic zone of its own. (The concept of "Econoinc Zone" is from the study results of "Northern Sumatra Ingetrated Regional Development Plan (JICA), 1990".)

Future economic performance in Sumatra will mainly proceed based on the three economic poles of Jakarta, Medan and SIJORI triangle as shown in Fig. 5.1.

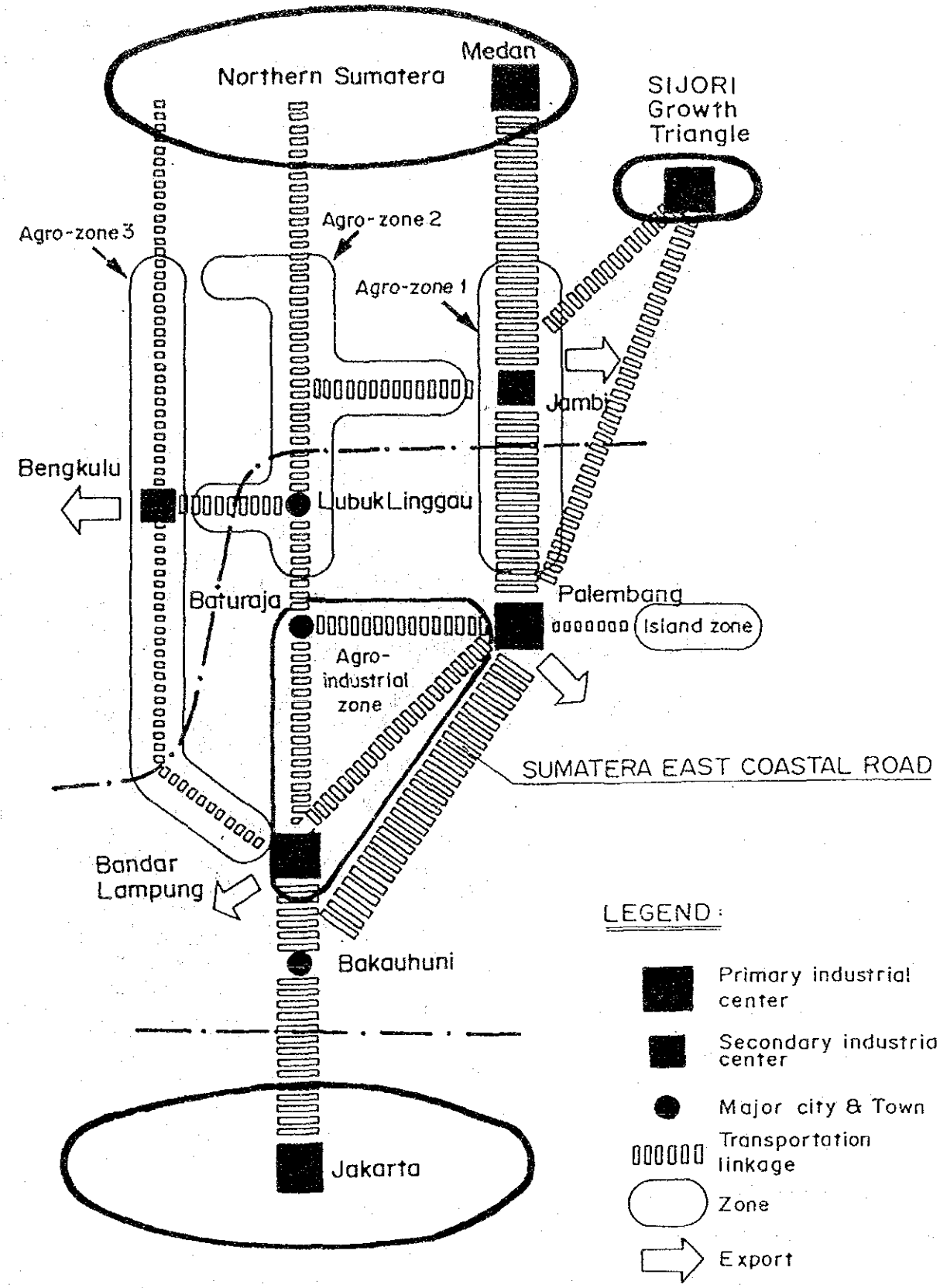
Future economic linkage in Sumatra is shown in Fig. 5.2.

Spacial frameworks describes the distribution patterns over space of major planning elements such as land use, population distribution, transmigration sites, transportation network, irrigation schemes and economic aspects.

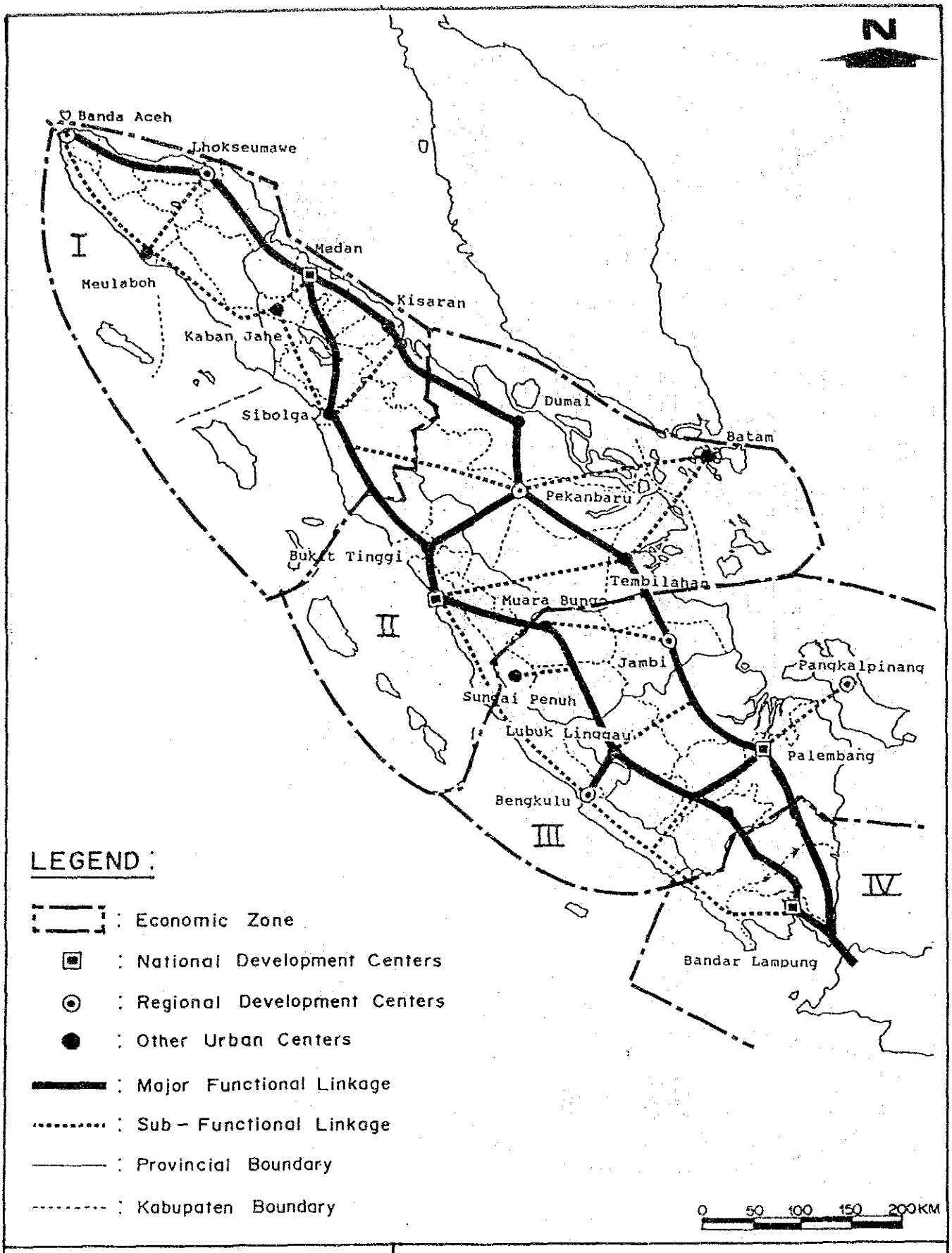
The Provincial Spatial Structure Plans (RSTRP) specify a center system as follows:

1) National Development Center
2) Interregional Development Center
3) Regional Development Center
4) Local Service Center

Future development direction by province is summarized as follows:



COASTAL ROADS IN EAST COAST OF SUMATERA	**Fig. 5.1** **Schematic Concept of Sumatera**



COASTAL ROADS
IN
EAST COAST OF SUMATRA

Fig. 5.2 **Future Economic Linkage in Sumatra**

a) Northern Economic Zone

Medan and Banda Aceh are primary and secondary regional development centers respectively. Tertiary development centers are as follows:

Lhokseumawe, Meulaboh, Kisaran/Tanjung Balai, Kabang Jahe and Sibolga/ Padang Sidempuan

Aceh

Northeast : Food supply, agro-industry based on local resources, and chemical industry

Southeast : Transport access to east and remote area development

North Sumatra

East : Urban development of Medan as a regional center, industrial center, agro-industry linked with estate base, and international tourism zone

West : Diversified and market oriented agriculture, and island development

b) Central Economic Zone

Padang and Pekanbaru are secondary regional development centers. Tertiary development centers are as follows:

Dumai, Batam and Bukittinggi

West Sumatra

Whole province:

Advanced agriculture center, light industry and island development

Riau

Hillside : Estate plantation and transmigration settlement development

Lowland : Swamp area development

c) Southern Economic Zone

Palembang is the primary development center for the Southern part of Sumatra and Jambi and Bengkulu are secondary regional development centers. Tertiary development centers are as follows:

Muara Bungo, Lubuk Linggau and Pangkalpinang

Jambi

Whole province

: Agro-industry linked with estates, small holders, transmigration and foodcrops, etc., road transport for urban and rural area linkage, river transport, and diversified and market oriented agriculture.

South Sumatra

Whole province

: Irrigation development, isolated area development, east low land development, road transport, sea port development, industrial estate and tourism development

Bengkulu

Whole province

: Agriculture for self-sufficiency, agro-industry linked with locally produced material, and integrated rural area development

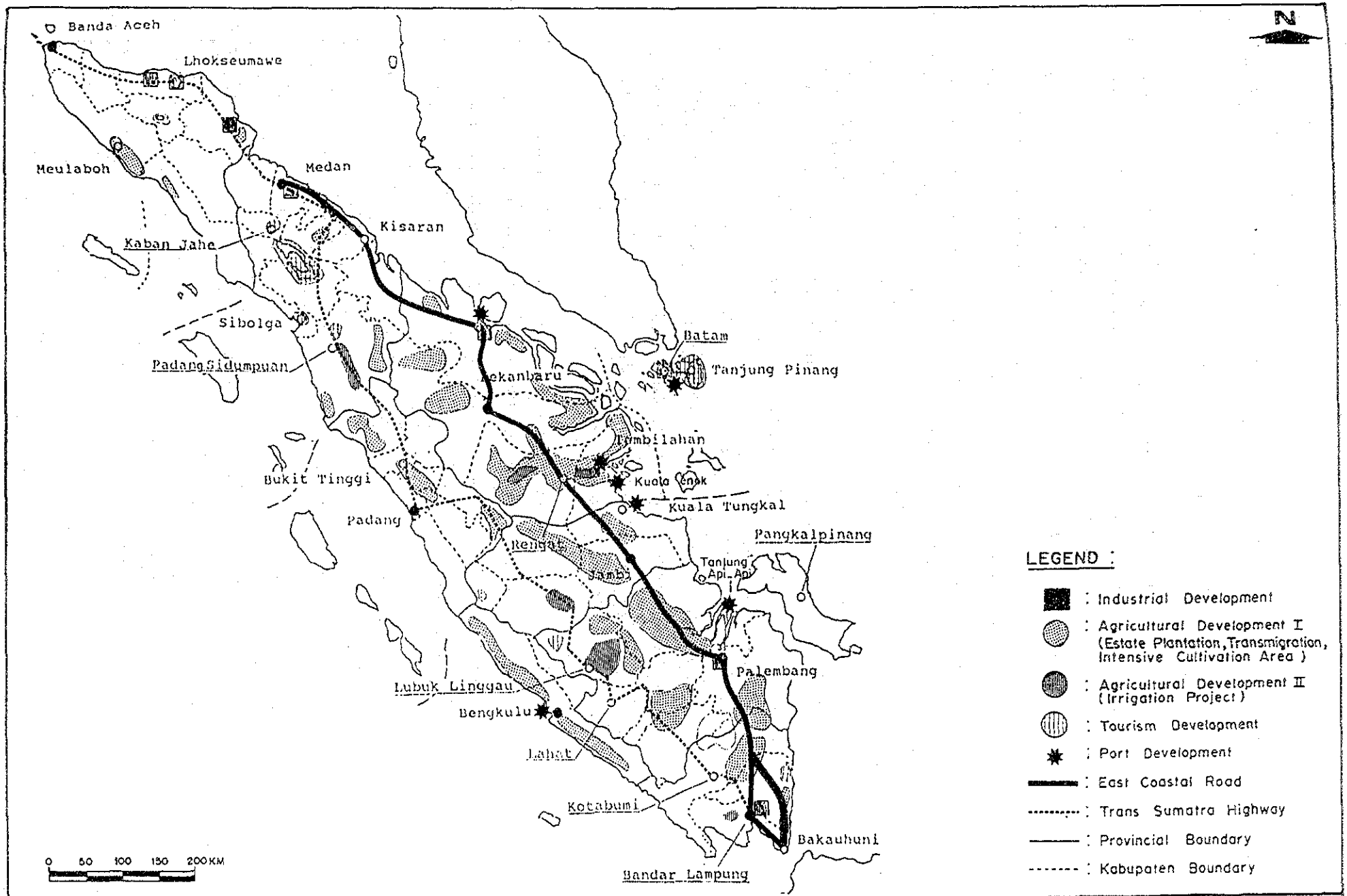
d) Jakarta Economic Zone

Lampung

Whole province

: Agriculture , especially large-scale estates and smallholders, transport, agro-industry, tourism development, and rural and urban development

The related development plans are shown in Fig. 5.3.



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 5.3 Distribution of Development Plans

(2) Singapore - Johor - Riau (SIJORI) Triangle Area Development

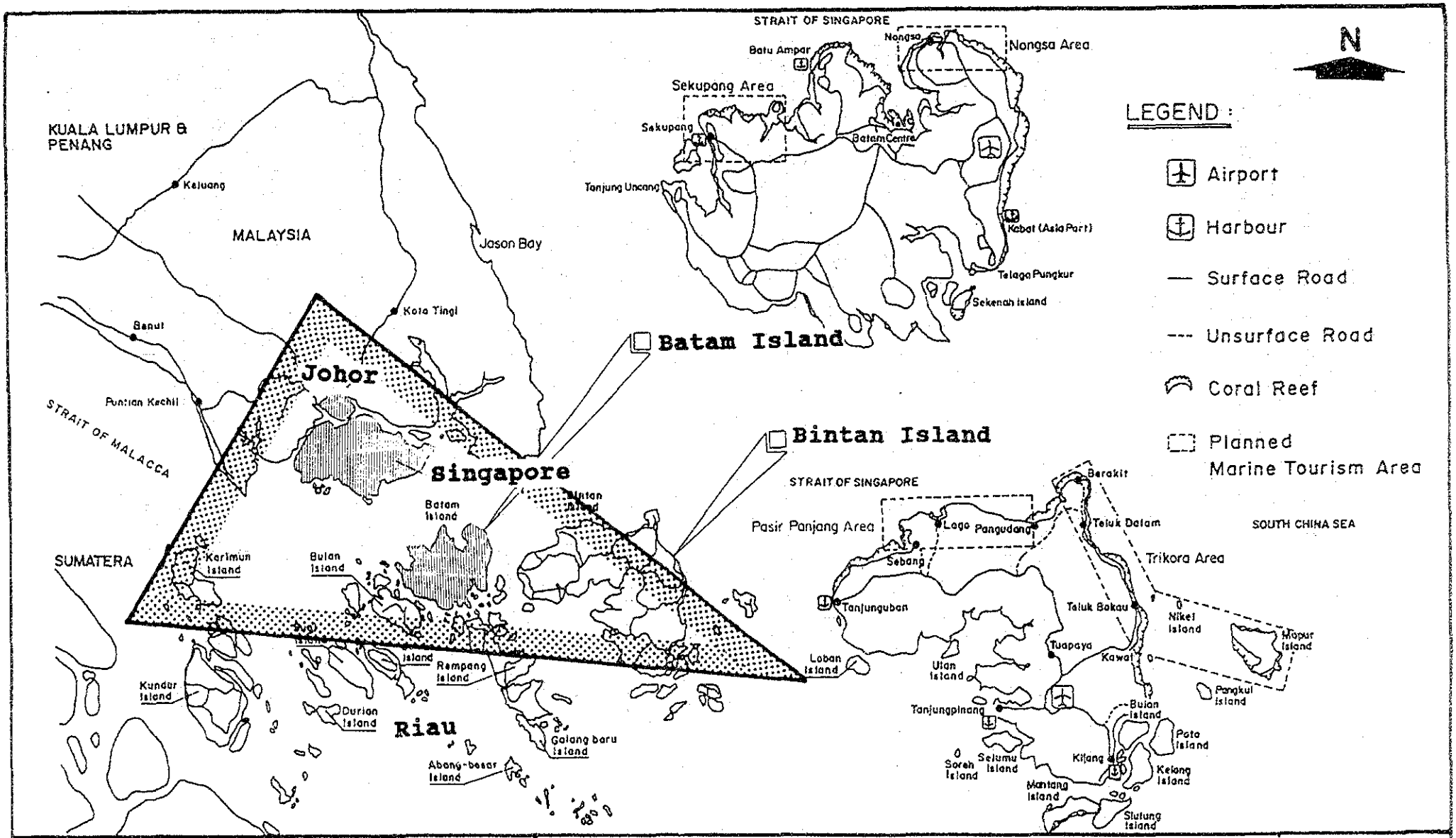
1) Development Background

Batam development masterplan was first prepared in 1972 to develop export-oriented industries and for realization of a leading export processing zone in Indonesia (the actual plan was prepared in 1986), because Batam Island has a geographical advantage being located about 20 km southeast of Singapore. The Batam Industrial Development Authority was established for infrastructure development in 1973. Moreover the Batam industrial area was allowed to function as a Bonded Zone for introduction of foreign investment. However, the development effort passed without producing the desired results.

Singapore has almost reached saturation point of space development in the 1990s. Johor which has more convenient access from Singapore has proceeded in industrial development and will also reach saturation point in the near future.

In view of the above circumstances, a new perspective which would accelerate development of the SIJORI triangle was the commitment at the ASEAN Summit held in Singapore in January 1992 to form the ASEAN Free Trade Area in the next 15 years.

Batam island has been initially developed and the development area in Riau islands is expanding to the Bintan and Karimun islands. It is expected that the economic axis of Batam - Bintan - Karimun - Rempang/Galang - Singapore will form in the future.



COASTAL ROADS
IN
EAST COAST OF SUMATERA

Fig. 5.4 **Sijori Triangle Growth**

2) Development Concept

The basic principal of the development of the SIJORI triangle is to utilize the mutual resources of the three areas in such a way that each area may gain some benefit. The utilization of mutual and different comparative advantages between resources in industrial development will bring about economies of scale.

The functional role of the three areas is classified as follows:

Singapore

financial system, telecommunication, access to international markets and professional personnel

Johor

land for development, energy(gas) and water supply

Riau

land for development, unskilled labor, water supply, raw materials and tourism

3) Development Outline

a) Manufacturing Industry

The majority of the manufacturing industry will be agro-industry, electronics and petroleum-based industry, while others are wood processing, fishery processing, livestock processing such as poultry, beef and pork.

b) Tourism Development

The main target of tourists in Bintan and Batam is Singaporeans and Japanese by excursion trips through Singapore.

c) Port Development

Kabil Directorate General of Sea Communication and Batam Development Authority propose construction of a port complex for crude palm-oil at Kabil in Batam with the following capacity:

Container Terminal	:	150,000	DWT
Tank for Crude Palm-oil	:	75,000	m^3
Annual Handing Capacity of Crude Palm-oil	:	1 million	tons

Sekupang

Annual Handling Capacity of General Cargo	: from	10,000 DWT (Existing)	to	20,000 DWT (Proposed)

Batu Ampar

Annual Handling Capacity of General Cargo	: from	6,000 DWT (Existing)	to	70,000 DWT (Proposed)

5.3.2 Strategic Development Area

According to the Integrated Regional Development Plans in Northern and Southern Parts of Sumatra (JICA), 17 priority development areas have been selected to proceed with sub-regional development of food production, export oriented industry, manufacturing industry, tourism, immigration and economic linkage.

Priority areas were selected based on the following criteria:

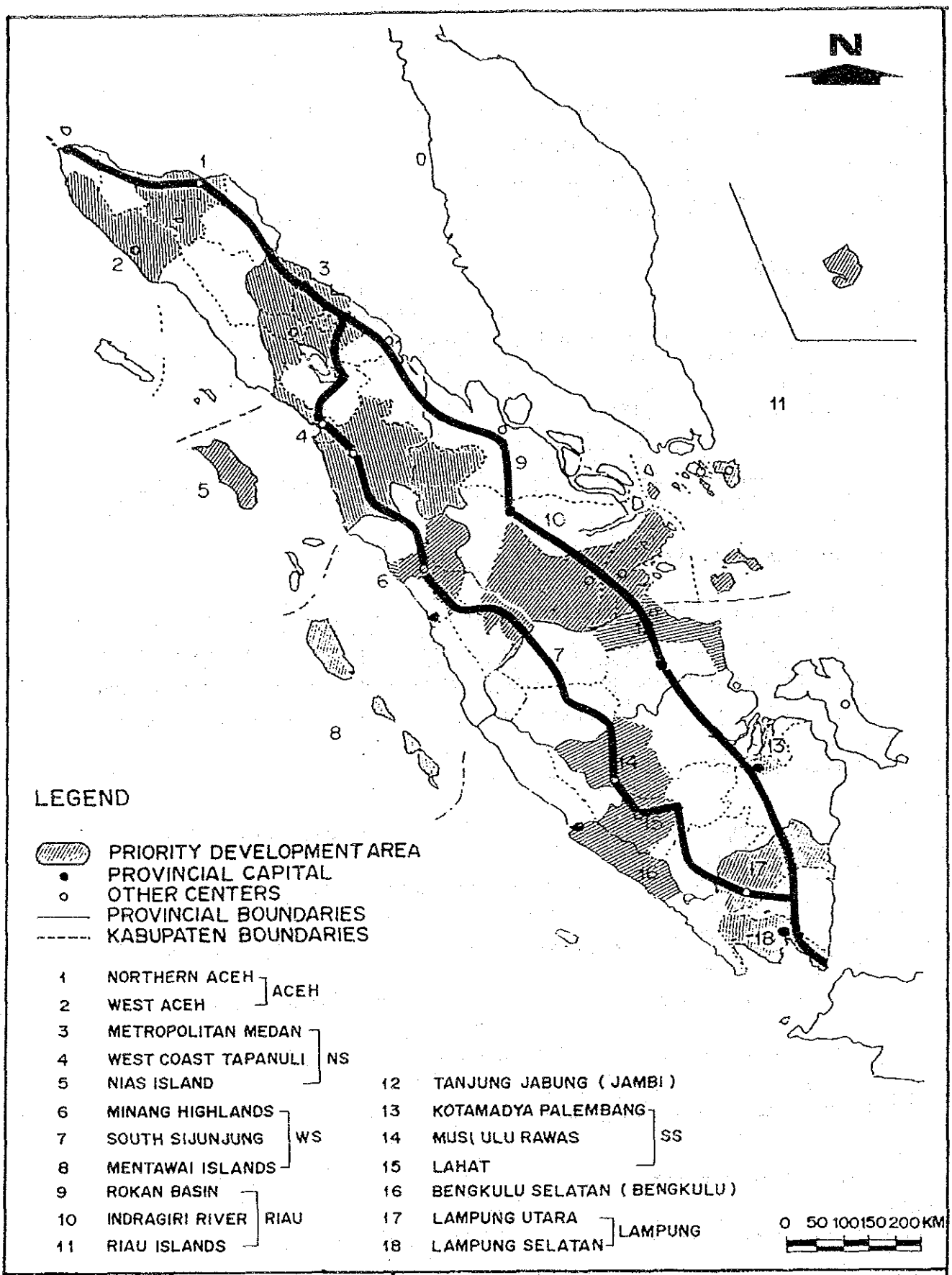
- high potential for efficiently achieving the development objectives;
- areas where strategic cities such as Medan and Palembang are located;
- areas with strong or potentially strong inter-regional relations; and
- areas which can serve as a development model with a unique aspect .

The priority areas selected are shown in Fig. 5.5 and Table 5.6 respectively.

5.3.3 Transport System Development Plan

(1) Development Strategy

The transport network in Sumatra has not been established in a way that it can fully function for smooth inter-provincial and intra-provincial economic activities.



COASTAL ROADS
IN
EAST COAST OF SUMATRA

Fig. 5.5 **Priority Development Areas**

Table 5.6 Integrated Development Program Areas

Area	Characteristics
1. North Aceh	Food supply base, Chemical-industry base and Agro-industry base development
2. West Aceh	Meaulaboh, Development Center for Aceh, west coast and small holder tree crop base
3. Metropolitan Medan	Center of the Region with strong services activities
4. West Coast Tapanuli	Development center for market-oriented agriculture in less advanced areas
5. Nias Islands	A model for island development aiming at a higher integration with the outside economy
6. Minang Highlands	Agricultural center for the Region for food supply base, light industry base and tourism development
7. South Sijunjung	Resettlement area with high potential for commercial-oriented agriculture
8. Mentawau Islands	A model for environmentally conscious development in harmony with the traditional ways of life
9. Rokan Basin	High potential resettlement area combining NES/PIR and food crop production
10. Indragiri River	Model for inter-provincial river basin development and management with special attention to low land swamp.
11. Riau Islands	High export-oriented area with high potential in fishery
12. Tanjun Jabung	High growth potential as an agricultural base aiming at the growth triangle, location of sea port on the east coast
13. Palembang and vicinities	High growth potential as all-round industrial center, infrastructure development for industrialization and rapid urbanization
14. Musi Rawas and Lahat	Economic sub-center in the interior with influence over Bangkulu and Jambi
15. Bengkulu Selatan	High potential of agricultural and fishery development, area relatively close to Java once the western coastal road is improved
16. Lampung Utara	High potential of agricultural development combined with the local transmigration scheme
17. Bandar Lampung Lampung Selatan	High potential as the primary agro-industrial center located at the entrance to Java, infrastructure development for industrialization and rapid urbanization

Transport in Sumatra is generally formulated without linkage and with an unintegrated structure. The following points are considered as reasons for the above structure:

- absolute amount of investment for the transport sector has been inadequate in the past;
- past tendency of the investment was imbalanced, being concentrated to relatively developed areas in the province; and
- measures for comprehensive transport planning have not been adopted in terms of paying attention to the inter dependent relationship between the regional economies.

However the Government is making efforts to improve the above situation through Repelita V and beyond. Development strategy of the transport sector based on Repelita V is as follows:

- small projects with efficient output are to be emphasized;
- maintenance and rehabilitation, rather than new large scale construction, of infrastructure are to be emphasized; and
- the aspect of equity among the levels of society is to be kept in mind.

Development strategy for each transport sector is as follows:

Road

- betterment of existing roads through maintenance and rehabilitation
- betterment of road linkages which connect vital points in transport such as ports
- betterment of strategic roads
- improvement of feeder roads
- formation of a balanced road network in Sumatra and eradication of poor transport service areas as a long term goal

Railway

- improvement of absolute operation systems and facilities (signals, station facilities and so on)
- reinforcement of wagons for heavier freight cars including container cars and improvement of railway alignment
- improvement of cars and locomotives
- innovation of a railway system which cooperates with other transport facilities (ports, feeder roads) and regional industrial activities (agriculture, mining and manufacturing) as a long term goal

Waterways

- expansion of port facilities (berths, yards, transit warehouses and so on) for commercial ports
- improvement of inland waterways (dredging and navigation training)
- shipping services to isolated islands
- creation of integrated and innovative waterways as a network for the long term plan

(2) Development Plan

Road

On-going road betterment projects are shown in Fig. 5.6.

The following are outlines of each project.

(1) South Sumatra Road Betterment Project

The Project covers a road length of 652.8 km in total as Emergency Works in the region of Southern Sumatra and 474.5 km in total of the rehabilitation of roadway in Lubuklinggau - Kotabumi Section as major works.

N

BANDA ACEH

MEDAN

TEBING TINGGI

KISARAN

TANJUNG BALAI

DUMAI

TEMBILAH

RENGAT

PAKAN BARU

TOBA LAKE

RANTAU PRAPAT

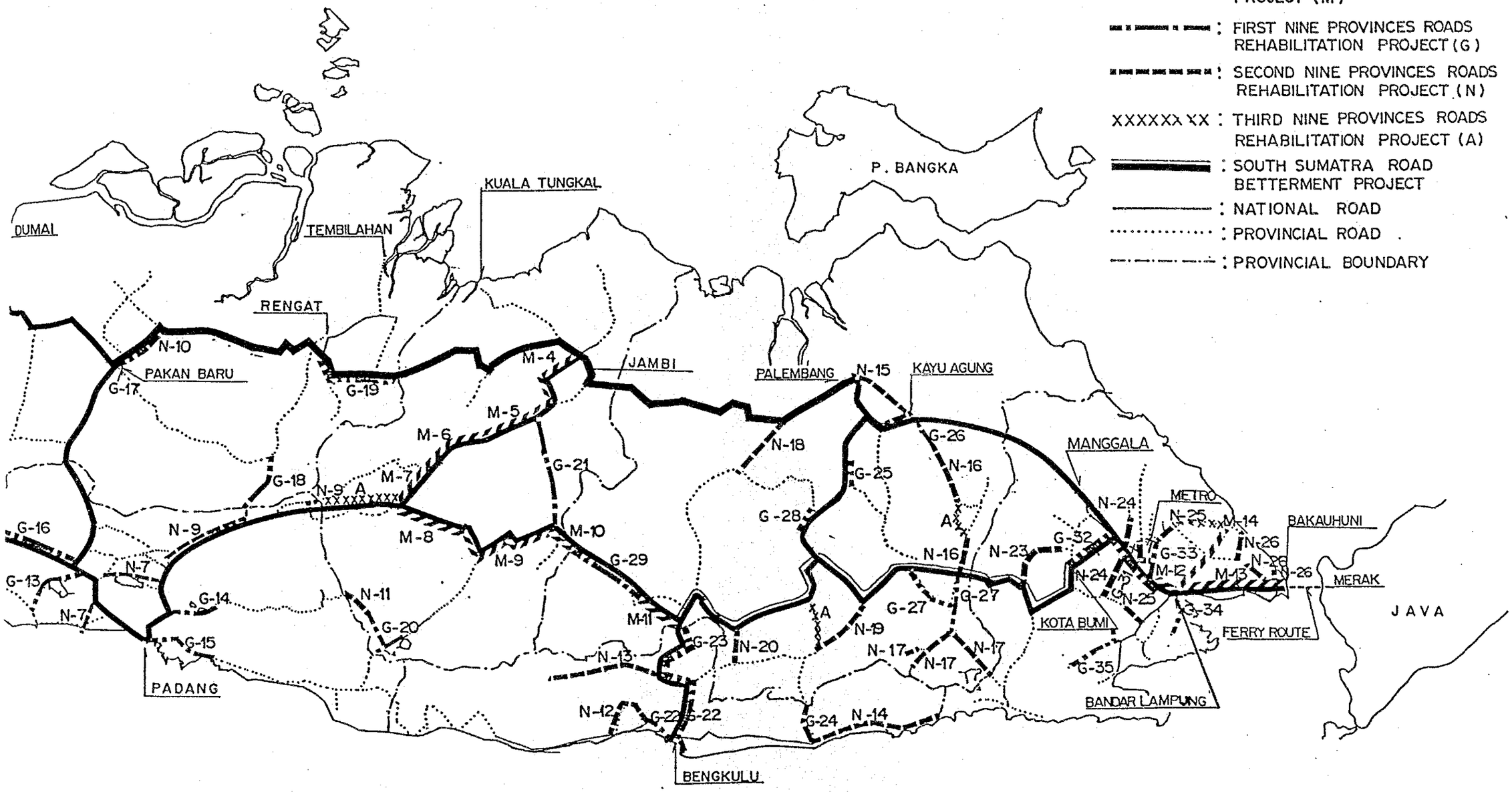
PADANG

G-1 G-2 G-3 G-4 G-5 G-6 G-7 G-8 G-9 G-11 G-12 G-13 G-14 G-15 G-16 G-17 G-18

N-1 N-2 N-3 N-4 N-6 N-7 N-8 N-9 N-10

M-1 M-2 M-3

COASTAL ROADS IN S



SOURCE : BINA MARGA DATA

COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 5.6 ON-GOING (ROAD BETTERMENT) PROJECTS

The major works include rehabilitation of pavement and shoulders (design life: 10 years), widening carriageway (from 4.5 m to 5.5 m or 6.0 m), replacement and construction of bridges (40 locations), and landslide treatment (64 locations).

(2) The 1st and 2nd Nine Provinces Road Projects

Target provinces, packages, lengths, widths, etc. of the 1st and 2nd Nine Provinces projects are summarized in Tables 5.7 and 5.8.

a) Original Implementation Program (1987)

The original implementation program was prepared in 1987 as the "Road and Bridge Rehabilitation Project" in line with the National Development Plans (Repelita). The National Development Plans stressed rehabilitation of existing roads rather than new construction.

The target length of rehabilitation in the original I/P is 6,097 km. The project was implemented in 2 phases (1st and 2nd Nine Provinces Road Rehabilitation Projects) since 1988.

b) The 1st Nine Provinces Road Project (IP-340)

The 1st Nine Provinces Road Project selected road links with relatively better conditions and priority road links in the original I/P.

The project was implemented under the periodic maintenance category with 5 year design life. During the implementation stage the project was carried out similar to the betterment category except for the design life. Widening to a minimum standard width (w = 4.5 m) was included in the project scope of work.

Total Length = 4,270 km

c) The 2nd Nine Provinces Road Project (IP-348)

Road links for the 2nd Nine Provinces were selected and implemented from the remaining links of the original I/P. The project was implemented under the betterment category with 10 year design life.

Total Length = 4,095 km

Table 5.7 First Nine Provinces Road Rehabilitation Project

PROVINCE		PACKAGE	STATUS OF ROAD	LINK NO.	TOTAL LENGTH (KM)	EFFECTIVE LENGTH (KM)	CROSS SECTION				SURFACE COURSE MATERIAL		REMARK
							NUMBER OF LANES	WIDTH (M)					
								CARRIAGEWAY	SHOULDER	ROADBED	CARRIAGEWAY	SHOULDER	
01	DI ACEH	G-1	N	001, 002	120.0	35.5	2	6.0	1.5 x	9.0	AC	AGG (B)	
		G-2	N	003, 004	150.0	67.9	2	6.0	1.5	9.0	AC	AGG (B)	
		G-3	N	005-2,005-3	60.0	21.3	2	7.0	1.5	10.0	AC	AGG (B)	
		G-4	P	017-1	43.3	33.3	2	4.5	1.0	6.5	HRS	AGG (B)	
03	NORTH SUMATRA	G-5	P	031,039	71.0	71.0	2	4.5	0.75	6.0	AC	AGG (B)	
		G-6	N	042,043,044	26.0	26.0	2	6.0	1.0	8.0	AC	AGG (B)	
		G-7	N	051,053	38.0	38.0	2	6.0	1.0	8.0	AC	AGG (A/B)	
		G-8	N	054,057-1	57.0	32.0	2	6.0	1.0	8.0	AC	AGG (B)	
		G-9	N	057	71.0	54.0	2	6.0	1.0	8.0	AC	AGG (B)	
		G-10	P	075	108.0	19.2	2	4.5	0.75/1.0	6.0/6.5	AC	AGG (B)	P. NIAS
		G-11	P	065	70.0	40.0	2	4.5	1.0	6.5	AC	AGG (B)	
		G-12	P	066	46.4	27.0	2	4.5	1.0	6.5	AC	AGG (B)	
06	WEST SUMATRA	G-13	P	025	70.8	70.8	2	4.5	1.0	6.5	HRS	AGG (B)	
		G-14	P	014-1	60.9	32.9	2	4.5	1.0	6.5	HRS	AGG (B)	
		G-15	N	016	71.2	35.2	2	4.5/6.0	1.0/1.5	6.5/9.0	HRS/AC	AGG (B)	
		G-16	N	029,030	109.0	54.0	2	4.5/6.0	1.0/1.5	6.5/9.0	AC	AGG (B)	
09	RIAU	G-17	N	030-1	36.5	36.5	2/4	4.5/14.0	1.0/0	6.5/14.0	HRS	AGG(B)/-	
		G-18	P	010	39.3	39.3	2	4.5	1.0	6.5	HRS	AGG (B)	
		G-19	N	021,025	103.5	21.4	2	4.5	1.0	6.5	HRS/AC	AGG (B)	
11	JAMBI	G-20	P	015,016,017	79.7	32.1	2	4.5	1.0	6.5	HRS	AGG (B)	
		G-21	N	011	97.6	97.6	2	4.5	2.0	8.5	HRS	EARTH	
13	BENGKULU	G-22	N	001,010	85.4	48.9	2	5.0/7.0/8.0	1.0/1.5/1.5	7.0/10.0/11.0	AC	AGG (B)	
		G-23	N	002,003	73.8	73.8	2	4.5/5.0	1.0/1.0	6.5/7.0	HRS	AGG (B)	
		G-24	P	005	43.5	13.7	2	4.5/6.0	1.0/1.0	6.5/8.0	HRS	AGG (B)	
15	SOUTH SUMATRA	G-25	N	001,002	84.8	33.4	2	6.05/7.15	1.5/1.5	9.05/10.15	AC	AGG (B)	
		G-26	P	021-1	40.0	40.0	2	4.5	1.0 ~ 1.5	6.5 ~ 7.5	HRS/HRSL	EARTH	
		G-27	P	041,042,043	100.7	72.9	2	4.5	1.0 ~ 1.5	6.5 ~ 7.5	HRS/HRSL	EARTH/AGG(B)	
		G-28	N	003,004	84.0	23.9	2	6.0	1.5	9.0	ATB	AGG (B)	
		G-29	N	083,084	75.2	16.0	2	6.0	1.5	9.0	AC	AGG (B)	
		G-30	P	058,059	60.1	29.3	2	4.5/7.0	1.25/-	7.0/7.0	HRS	EARTH	P.BANGKA
17	LAMPUNG	G-31	N	001,002,003	58.0	40.1	2	6.2	1.25	8.7	AC	AGG (B)	
		G-32	N	004	44.2	44.2	2	6.0	1.5	9.0	AC	AGG (B)	
		G-33	P	015,016	34.8	18.4	2	6.0	1.25	8.5	HRS	AGG (B)	
		G-34	P	031	36.0	5.5	2	4.5	1.0	6.5	HRS	AGG (B)	
		G-35	P	028,029	35.0	11.0	2	4.5	1.0	6.5	HRS	AGG (B)	

Table 5.8 Second Nine Provinces Road Rehabilitation Project

PROVINCE		PACKAGE	STATUS OF ROAD	LINK NO.	TOTAL LENGTH (KM)	EFFECTIVE LENGTH (KM)	CROSS SECTION				SURFACE COURSE MATERIAL		REMARK
							NUMBER OF LANES	WIDTH (M)					
								CARRIAGEWAY	SHOULDER	ROADBED	CARRIAGEWAY	SHOULDER	
01	DI ACEH	N-1	P	009	86.8	46.0	2	4.5	1.0	6.5	HRS	AGG (B)	
		N-2	N	005	54.0	54.0	2	6.8 ~ 7.0	1.0 ~ 1.5	8.8 ~ 10.0	AC	EARTH	
		N-3	N	006	51.6	51.6	2	5.5 ~ 6.0	1.0	7.5 ~ 8.0	AC	AGG (B)	
		N-4	P	017	127.0	127.0	2	4.5	1.0	6.5	HRS	AGG (B)	
03	NORTH SUMATRA	N-5	P	077	55.0	55.0	2	4.5	1.0	6.5	HRS	AGG (B)	P. NIAS
06	WEST SUMATRA	N-6	P	031,033,034	172.0	79.8	2	4.5	1.0	6.5	HRS	AGG (B)	
		N-7	P	005,028	70.5	41.5	2	4.5 ~ 6.0	1.0	6.5 ~ 8.0	HRS	AGG (B)	
		N-8	N	032	39.5	24.4	2	4.5	1.5	7.5	HRS	AGG (B)	
		N-9	N	050,009	88.5	60.2	2	6.0	2.0	10.0	AC	AGG (B)	
09	RIAU	N-10	N	030-2	36.5	29.5	2	6.0	1.0	8.0	HRS	AGG (B)	
11	JAMBI	N-11	P	025	33.4	33.4	2	4.5	1.0	6.5	HRS	AGG (B)	
13	BENGKULU	N-12	P	012	57.7	37.0	2	4.5	1.0	6.5	HRS	AGG (B)	
		N-13	P	008	88.4	87.4	2	4.5	1.0	6.5	HRS	AGG (B)	
		N-14	P	006	122.0	91.5	2	4.5	1.0	6.5	HRS	AGG (B)	
15	SOUTH SUMATRA	N-15	P	016,017	85.8	85.8	2	4.5/6.0	1.0	6.5/8.0	HRS	AGG (B)	
		N-16	P	021-2,023	71.4	48.1	2	4.5	1.0	6.5	HRS	EARTH	
		N-17	P	044	156.8	144.8	2	4.5	1.0	6.5	HRS	EARTH	
		N-18	P	029	51.6	51.6	2	4.5/6.0	1.0	6.5 ~ 8.0	HRS	SCB	
		N-19	P	034	86.7	86.7	2	4.5	1.0	6.5	HRS	EARTH	
		N-20	P	036	39.0	39.0	2	4.5	1.0	6.5	HRS	EARTH	
		N-21	P	051,052,053, 055,057	116.0	116.0	2	4.5	1.0	6.5	HRS	AGG (B)	P. BANGKA
		N-22	P	060,061,065, 066	102.0	102.0	2	4.5	1.0	6.5	HRS	AGG (B)	P. BANGKA
17	LAMPUNG	N-23	P	048	44.8	44.8	2	4.5	1.0	6.5	ATB	AGG (B)	
		N-24	P	042,044	83.5	83.5	2	4.5	1.0	6.5	HRS/ATB	AGG (B)	
		N-25	P	017,072,040	47.2	47.2	2	6.0/5.0/4.5	1.0	8.0/7.0/6.5	HRS	AGG (B)	
		N-26	P	020,034,035	52.6	52.6	2	4.5	1.0	6.5	HRS	AGG (B)	

Table 5.9 Ex - OECF Road Rehabilitation Project

PROVINCE		PACKAGE	STATUS OF ROAD	LINK NO.	EFFECTIVE LENGTH (KM)	CROSS SECTION				SURFACE COURSE MATERIAL		REMARK
						NUMBER OF LANES	WIDTH (M)					
							CARRIAGEWAY	SHOULDER	ROADBED	CARRIAGEWAY	SHOULDER	
03	NORTH SUMATRA	M-1	N	001,002	58.5	2	6.0/7.0	1.5	9.0/10.0	AC	SST	
		M-2	N	003,004	55.8	2/4	6.0/14.0/20.0	1.5/2.0	9.0/16.0/24.0	AC	SST	
		M-3	N	026	64.5	2/4	7.0/14.0	1.0/2.0	9.0/16.0	AC	SST	
11	JAMBI	M-4	N	002	58.6	2/4	6.0/7.5/10.0/13.0	1.5	9.0/10.5/13.0/16.0	AC	AGG (B)	
		M-5	N	005,006-1	70.4	2	6.0	1.5	9.0	AC	AGG (B)	
		M-6	N	006-2,006-3	50.8	2	6.0	1.5	9.0	AC	SST	
		M-7	N	006-3,008	63.0	2	6.0	1.5	9.0	AC	SST	
		M-8	N	010	80.7	2	6.0	1.5	9.0	AC	SST	
		M-9	N	012-1,012-2	54.1	2	6.0/7.0	1.5	9.0/10.0	AC	SST	
		M-10	N	012-1,013	50.4	2	6.0	1.5	9.0	AC	SST	
15	SOUTH SUMATRA	M-11	N	010	27.2	2	7.0	2.0	11.0	AC	AGG (B)	
17	LAMPUNG	M-12	N	021,022,059	74.7	2/4	7.0/10.2/14.0	2.0	11.0/14.2/18.0	AC	SST	
		M-13	N	054	30.0	2	7.0/9.0/9.8/10.1	1.5	10.0/11.0/11.8/13.1	AC	AGG (B)	
		M-14	P	055,056	57.7	2	6.0 ~ 7.0	1.5	9.0 ~ 10.0	AC	AGG (B)	

d) The 3rd Nine Provinces Road Project (under process by Bina Marga)

During implementation of the 1st and 2nd Nine Provinces Road Projects, some missing links were found among the selected roads. The missing links proposed for the 3rd Nine Provinces Project amount to 282 km.

The remaining effective length is 1,322 km. Therefore, the proposed length for the 3rd Nine Provinces Road Project is 1,600 km.

(3) Ex-OECF Road Rehabilitation Project

Target provinces, packages, lengths, widths, etc. of the Ex-OECF project are summarized in Table 5.9.

The Ex-OECF project aims to rehabilitate national and provincial roads. Design life time is 10 years which is the same as that of the 2nd Nine Provinces Project.

The target roads will be widened based on the standards shown in Table 5.10 and the forecast of the traffic volume. The pavements will also be improved.

With regard to bridges, span lengths less than 20 m are the object of the study. Replacement or improvement will be provided depending on the bridge conditions. Bridges constructed before 1970 will be replaced because the bridge loading conditions were revised at that time.

Table 5.10 Carriageway and Shoulder Standards

unit : meter

DTV	Width of Carriageway (Pd)	Shoulder (S)
< 3,000	4.5	1.0
3,000 - 8,000	6.0	1.5
8,000 - 20,000	7.0	2.0
> 20,000	2 x 7.0	2.0

Source: Bridge Management System, Draft, General Procedures Manual

(4) Heavy Loaded Road Improvement Project

The objective of the Heavy Loaded Road Improvement Project is the strengthening to a 10-ton axle load and a 10-year design life 5,000 km of the strategic road network.

The project aims to establish the distribution of heavy vehicle traffic over national and provincial roads and to determine the road network appropriate for encouraging the transportation of non-oil and gas products both for export and internal consumption.

(5) Projects Funded by APBN

Various APBN (government fund) projects are ongoing in Sumatra. Those related to the east coast of Sumatra are outlined below.

a) Betterment between Kayuagung and Menggala

This section, which is included in this Pre-Feasibility Study, involves bridge and earth works which are ongoing. The bridge works will be completed within 1992 while the earth works will be completed in a few years. Major dimensions of the project are as follows:

Construction length	:	L = 170 km	
Road width	:	Carriageway	W = 4.5 m
		Shoulder	W = 1.0 m
Bridge width	:	Curb to curb	W = 6.0 m

Newly constructed bridges will not be improved, therefore some bridges will remain at 4.5 or 5.5 m in width.

b) Pekanbaru - Rengat

Road betterment works have been ongoing between Sp.Lago and Rengat (part of Pekanbaru - Rengat) excluding the stretches of the 1st and 2nd Nine Provinces Project. According to information from Sub Dinas Bina Marga in Riau province, the length of the betterment is 39 km, the road width 4.5 m and the shoulder width 1.0 m. The work was completed at the end of March 1992.

c) Pekanbaru Bypass

Pekanbaru by-pass which by-passes to the west of Pekanbaru city on the route of Dumai and Padang is under construction. The road width is 6.0 m.

d) Bridge and Road Works between Rengat - Jambi

Rengat - Jambi section is located on the route of the proposed Sumatra East Coast Highway. Bridge works are ongoing in the section. Road works are also on-going at the unpaved section between Taman Raja and Sp. Tuan in Jambi province. These works will be completed within a few years.

Development emphasis is being placed on the following routes over and above the foregoing road projects:

- Tapaktuan to Sibolga (West Coast Road) as a long term plan
- Rengat to Kuala Enok through Tembilan to supply industrial material to Batam and overseas as a medium term plan
- Padang to Sasak new construction as a medium term plan
- Padang to Tapan through Painan improvement project (West Coast Road) as a medium term plan
- Tapan to Bengkulu improvement project (West Coast Road) as a long term plan
- Outer Ring Road for Jambi city as a long term plan
- Outer Ring Road for Palembang city as a long term plan
- Tapan to Bandar Lampung through Bengkulu city improvement project (West Coast Road) as a long term plan
- Toll Road project between Tegineneng and Bakauhuni with Bandar Lampung by-pass as a long term plan

Railway

- Bukit Asam Coal Railway Upgrading Project between Bukit Asam Mining area in central south Sumatra and Tarahan coal port in south Bandar Lampung as a long term plan
- New railway line construction project linking the Southern and Western Sumatra rail network as a long term plan

Waterway

- Kuala Enok port in Riau province and Tanjung Api-api port in South Sumatra province are planned to be gateway ports for transporting raw materials to SIJORI and to reinforce the existing port capacities in these provinces.

  The access road to Tanjung Api-api port is now under construction.

Tajung Api-api Port

The Palembang port is located at a distance of some 90 m from the open sea and cannot receive boats of more than 20,000 tons. More than Rp. 2.5 billions are spent every year on dredging the sediment through the Music River mouth beyond Palembang. Today the Palembang Port operates at a congestion level. The new port is designated to handle the excess cargo flow from the Palembang port at Tanjung Api-api.

According to the Draft Replita VI, Palembang Port is planned to increase its capacity to 4 million tons of throughout by the year 1999/2000.

A container terminal is also planned in the Draft Replita VI for the target throughout of 30,000 TUEs.

Kuala Enok Port

Kuala Enok Port is a good natural deep sea port and expected to take a key role of the development of SIJORI triangle area and a gateway to connect the area with Riau province.

Dumai is expected to be a main port for crude palm oil (CPO) in the Sumatra east coastal region because of CPO potential in its hinterland and constuction of 6 CPO terminals currently underway in the Dumai port. Kuala Enok port will be the second most important one is the Central Sumatra.

Other development projects are as follows:

- Batam center ferry terminal development project (construction of Batam terminal ferry port and dredging of waterway) as a short term plan
- Kuala Tungkal seaport improvement project (new deepwater port) as a long term plan
- Pulau Baai port improvement project (construction of wharf) in Bengkulu, on going

5.4 Future Development Framework

The National Planning Board (BAPPENAS) is preparing the Second Long Term Development Plan (1994/95 - 2019/20) at present. There is no authorized updated long term socio-economic framework at persent. According to discussions with BAPPENAS, the most reliable framework is projected by the Integrated Regional Development Plan for the Northern and Southern Part of Sumatra (JICA). Therefore, these projections are employed for the study as a control total.

5.4.1 Population of Indonesia and Sumatra

(1) Population of the Nation and Sumatra

Initially the national population is projected as the basis of the entire population framework in the planning period up to 2010.

The Central Bureau of Statistics in Indonesia has projected the future population of Indonesia and Provinces, based on the results of the 1980 census and 1985 intercensus surveys. At present the projection is not available.

Projections made by the Demographic Institute, University of Indonesia, are employed by updating the national population in 1990 (not population census data) as the given condition. Population figures given in the 1990 Population Census were used as the base population for future projections of this study. The above estimation method was applied for the Northern and Southern Integrated Regional Development Study (NIRDS and SIRDS) by JICA.

(2) Population Projection by Province in Sumatra

The Progress Report II of the Integrated Regional Development Plan for the Southern Part of Sumatra (JICA, Dec. 1991) projects future population by province in Southern Sumatra and future total population of Northern Sumatra.

In order to estimate future traffic demand as precisely as possible, the population figures of Sumatra without non-permanent residents in the 1990 Population Census is used as the base population for future projection, and the planning period is divided into four 5-year sub-periods.

Population projection by province is conducted based on the figures in the above reports with the following procedure:

1) Population growth rates in the Southern Sumatra Report (JICA Dec. '1991) were used based on the figures of 1990 Population Census for the projection by province in the southern part of Sumatra (Jambi, South Sumatra, Bengkulu and Lampung);

2) Population growth rates in the Northern Sumatra Report (JICA, March 1990) were used for population projections of 4 provinces in the Northern part of Sumatra (Aceh, North Sumatra, West Sumatra and Riau) by the same method for the above 4 provinces;

3) After estimates of the provincial figures, projections of 4 provinces in southern Sumatra were distributed based on total population of the 4 provinces in the Southern Sumatra Report as a control total; and

4) Projections of 4 provinces in northern Sumatra were distributed based on total population of the 4 provinces in the Southern Sumatra Report as a control total.

Projection results for Indonesia and Sumatra are shown in Table 5.11 and Table 5.12 respectively.

Table 5.11 Population Projection by Province In Sumatra

Province	Land Area (Km sq.)	Population (thousand)					Population Density (Km sq.)		
		1990	1995	2000	2005	2010	1990	2000	2010
Aceh	55,392	3,415	3,919	4,440	4,955	5,471	62	80	99
North Sumatra	70,787	10,252	11,588	12,987	14,445	16,027	145	183	226
West Sumatra	49,778	3,999	4,265	4,508	4,721	4,902	80	91	98
Riau	94,561	3,281	3,871	4,515	5,197	5,905	35	48	62
Jambi	44,800	2,014	2,367	2,724	3,077	3,432	45	61	77
South Sumatra	103,688	6,276	7,293	8,310	9,289	10,255	61	80	99
Bengkulu	21,168	1,179	1,410	1,618	1,818	2,018	56	76	95
Lampung	33,307	6,004	6,823	7,613	8,411	9,253	180	229	278
Sumatra -total	473,481	36,420	41,536	46,715	51,913	57,263	77	99	121
Indonesia	1,919,317	179,322	194,516	208,823	221,552	233,315	93	109	122

Table 5.12 Population Growth Rate of Sumatra

Province	Growth Rate (%)			
	1990-1995	1995-2000	2000-2005	2000-2010
Aceh	2.8	2.5	2.2	2.0
North Sumatra	2.5	2.3	2.2	2.1
West Sumatra	1.3	1.1	0.9	0.8
Riau	3.4	3.1	2.9	2.6
Jambi	3.3	2.8	2.5	2.2
South Sumatra	3.0	2.6	2.3	2.0
Bengkulu	3.6	2.8	2.4	2.1
Lampung	2.6	2.2	2.0	1.9
Sumatra -total	2.7	2.4	2.1	2.0
Indonesia	1.6	1.4	1.2	1.0

5.4.2 Gross Regional Domestic Product (GRDP)

Non-oil and gas GRDP data were employed as one of the parameters for future traffic demand forecast because most of the profit related to oil and gas industries directly returns to Jakarta.

The method of GRDP projection by province in Sumatra is almost the same as that for the population projection. The figures in Regional Income of Provinces in Indonesia by Industrial Origin 1983 - 1989 issued by the Central Bureau of Statistics were used as base figures for the projection.

1) GRDP growth rate in the Southern Sumatra Report were used for GRDP projection of 4 provinces in southern Sumatra;

2) GRDP growth rate in the Northern Sumatra Report were used for GRDP projection of 4 provinces in northern Sumatra; and

3) After the estimate of such provincial figures, projection of the 8 provinces were attested using the GRDP projection by JICA as a control total with the same method as the population projection.

GRDP projection result is shown in Table 5.13.

Table 5.13 GRDP Projection by Province in Sumatra

Province	GRDP (billion Rp.)				Per Capita GRDP (thousand Rp.)			
	1990	1995	2000	2010	1990	1995	2000	2010
Aceh	1,737	2,350	3,251	6,204	509	600	732	1,252
North Sumatra	5,744	7,745	10,877	23,329	560	668	838	1,615
West Sumatra	1,804	2,388	3,231	6,025	451	560	717	1,276
Riau	1,653	2,155	2,876	5,759	504	557	637	1,108
Jambi	756	1,122	1,679	3,827	375	474	616	1,244
South Sumatra	3,906	5,433	7,657	15,184	622	745	921	1,635
Bengkulu	457	679	993	2,171	388	482	614	1,194
Lampung	1,934	2,938	4,480	10,789	322	431	588	1,283
Sumatra -total	17,991	24,810	35,044	73,288	494	597	750	1,412
Indonesia	94,346	123,904	164,416	303,164	526	637	787	1,368

Table 5.14 GRDP Growth Rate of Sumatra

Province	Growth Rate (%)		
	1990-1995	1995-2000	2000-2010
Aceh	6.2	6.7	6.7
North Sumatra	6.2	7.0	7.9
West Sumatra	5.8	6.2	6.4
Riau	5.4	5.9	7.2
Jambi	8.2	8.4	8.6
South Sumatra	6.8	7.1	7.1
Bengkulu	8.2	7.9	8.1
Lampung	8.7	8.8	9.2
Sumatra -total	6.6	7.2	7.7
Indonesia	5.6	5.8	6.3

5.4.3 Future Vehicle Ownership

Trend of future vehicle ownership directly influences the magnitude of future traffic demand. The vehicle ownership has been analyzed by a regression model using population, GRDP and per capita GRDP.

As a result of regression analysis, it was found that regression equations with best fit to estimation of vehicle ownership by province are as follows:

Sedan

Aceh	Y_1	=	$89.7148X_1$	-	30,657	($R^2 = 0.8395$)
North-Sumatra	Y_1	=	$205.8483X_1$	-	35,721	($R^2 = 0.9937$)
West-Sumatra	Y_1	=	$112.5384X_1$	-	27,051	($R^2 = 0.9944$)
Riau	Y_1	=	$88.5709X_1$	-	24,516	($R^2 = 0.9288$)
South-Sumatra*	Y_1	=	$469.9546X_1$	-	122,298	($R^2 = 0.9460$)

Where Y_1 : No. of Sedan/100 population
X_1 : Percapita GRDP by Province (at 1983 constant price)
* : including Jambi, Bengkulu and Lampung

Bus

Aceh	Y_2	=	$0.0032X_2$	-	461	($R^2 = 0.8389$)
North-Sumatra	Y_2	=	$0.0047X_2$	+	8,572	($R^2 = 0.8972$)
West-Sumatra	Y_2	=	$0.0117X_2$	-	9,699	($R^2 = 0.9925$)
Riau	Y_2	=	$0.0040X_2$	-	2,520	($R^2 = 0.9813$)
South-Sumatra*	Y_2	=	$0.0115X_2$	-	41,632	($R^2 = 0.8640$)

Where Y_2 : No. of Buses
X_2 : GRDP by Province (million Rp. at 1983 constant price)
* : including Jambi, Bengkulu and Lampung

Truck

Aceh	Y_3	=	$0.0091X_3$	+	874	($R^2 = 0.8232$)
North-Sumatra	Y_3	=	$0.0087X_3$	+	30,583	($R^2 = 0.9917$)
West-Sumatra	Y_3	=	$0.0109X_3$	+	4,712	($R^2 = 0.8162$)
Riau	Y_3	=	$0.0108X_3$	+	3,451	($R^2 = 0.9546$)
South-Sumatra*	Y_3	=	$0.0193X_3$	-	22,081	($R^2 = 0.9575$)

Where Y_3 : No. of Truck
X_3 : GRDP by Province (million Rp. at 1983 constant price)
* : Including Jambi, Bengkulu and Lampung

The future vehicle ownership in the provinces in Sumatra was projected based on the above regression model with projected population and GRDP as shown in Table 5.15.

Table 5.15 Projection of Vehicle Ownership in Sumatra

PROVINCE	SEDANS		
	1991	1997	2010
Aceh	16,533	27,568	71,073
North Sumatra	83,671	114,960	263,903
West Sumatra	25,981	42,524	111,296
Riau	21,009	27,564	61,855
Jambi	9,713	16,931	52,190
South Sumatra	63,063	103,186	253,253
Bengklu	3,417	5,825	16,706
Lampung	25,207	46,893	157,534
Total of Sumatra	248,594	385,449	987,810

PROVINCE	BUSES		
	1991	1997	2010
Aceh	5,443	8,101	19,392
North Sumatra	37,232	50,271	118,218
West Sumatra	12,628	21,832	60,794
Riau	4,453	7,156	20,514
Jambi	6,361	13,146	45,456
South Sumatra	30,779	63,606	219,932
Bengklu	2,776	5,736	19,833
Lampung	5,711	11,801	40,806
Total of Sumatra	105,383	181,648	544,945

PROVINCE	TRUCKS		
	1991	1997	2010
Aceh	17,663	25,221	57,331
North Sumatra	83,635	107,770	233,544
West Sumatra	25,512	34,087	70,385
Riau	22,278	29,576	65,643
Jambi	12,569	20,823	60,129
South Sumatra	63,979	105,994	306,075
Bengklu	13,527	22,410	64,712
Lampung	34,287	56,804	164,031
Total of Sumatra	273,450	402,683	1,021,850

5.4.4 Zonal Planning Parameters

(1) Population of Kabupaten

Population projection of Kabupaten was estimated as follows:

- By applying the annual growth rate of Kabupaten in the Northern and Southern Sumatra Reports by JICA.
- By applying the projected population by Kabupaten based on the projected provincial population as a control total.

(2) Population of Kecamatan

Corresponding to the requirement of traffic demand analysis for alternative routes in Lampung, Kabupaten directly by influenced by the East Coast Highway were further divided into traffic zones. A unit area which comprises a traffic zone was defined in the Kecamatan.

The future population of these zones was based on their historical trend of increase and the prospect of specified development plans. The total of the projected Kecamatan population was adjusted eventually to coincide with the relevant Kabupaten population which had been previously estimated.

(3) GRDP of Kabupaten

GRDP projection by Kabupaten was estimated as follows:

- By applying the annual growth rate of Kabupaten in the Southern Sumatra Report
- By applying the annual growth rate of Kabupaten which belong to strategic priority areas in the Northern Sumatra region, and to use their historical trend for other Kabupatens together with future prospects
- After estimation of the above projection, it is eventually adjusted to coincide with the relevant province which was estimated in 5.4.2.

Population and GRDP projections are shown in Table 5.16 and Table 5.17.

Table 5.16 Population Projection by Kabupaten in Sumatra

Kabupaten	Population				Annual Growth Rate(%)		
	1990	1995	2000	2010	1990-1995	1995-2000	2000-2010
1. Aceh Selatan	342,901	384,536	446,477	534,141	2.32%	3.03%	1.81%
2. Aceh Tenggara	185,768	209,347	242,830	290,794	2.42%	3.01%	1.82%
3. Aceh Timur	585,933	698,656	894,369	1,148,001	3.58%	5.06%	2.53%
4. Aceh Tengah	199,634	221,749	230,395	264,380	2.12%	0.77%	1.39%
5. Aceh Barat	385,594	429,666	498,877	609,836	2.19%	3.03%	2.03%
6. Aceh Besar	424,831	494,661	535,956	668,756	3.09%	1.62%	2.24%
7. Pidire	420,035	466,565	484,757	556,263	2.12%	0.77%	1.39%
8. Aceh Utara	846,284	988,928	1,080,932	1,372,773	3.16%	1.80%	2.42%
Sabang	24,413	25,046	25,447	26,432	0.51%	0.32%	0.38%
9. Tapanuli Selatan	954,245	1,103,878	1,263,688	1,619,256	2.96%	2.74%	2.51%
10. Tapanuli Tengah	285,912	333,176	381,223	488,013	3.11%	2.73%	2.50%
11. Tapanuli Utara	695,777	792,651	856,191	1,004,174	2.64%	1.55%	1.61%
12. Labuhan Batu	733,183	862,495	992,070	1,285,125	3.30%	2.84%	2.62%
13. Asahan	991,954	1,076,892	1,196,558	1,446,397	1.66%	2.13%	1.91%
14. Simalungan	1,024,679	1,072,389	1,136,103	1,248,473	0.91%	1.16%	0.95%
15. Dairi	276,980	311,369	346,403	424,956	2.37%	2.16%	2.06%
16. Karo	257,981	290,011	326,962	411,918	2.37%	2.43%	2.34%
17. Deli Serdang	3,448,950	3,982,930	4,466,783	5,500,604	2.92%	2.32%	2.10%
18. Langkat	994,007	1,087,132	1,244,395	1,596,400	1.81%	2.74%	2.52%
Nias	588,643	674,815	776,959	1,002,175	2.77%	2.86%	2.58%
19. Pesisir Selatan	371,934	401,843	428,925	474,260	1.56%	1.31%	1.01%
20. Solok	470,165	505,971	538,018	585,078	1.48%	1.24%	0.84%
21. Sawah Lunto/Sijun	312,386	349,572	386,525	454,500	2.27%	2.03%	1.63%
22. Tanah Datar	380,709	386,221	389,032	403,931	0.29%	0.15%	0.38%
23. Padang Pariaman	1,132,965	1,219,481	1,303,290	1,410,664	1.48%	1.34%	0.79%
24. Agam	491,520	498,389	500,772	518,404	0.28%	0.10%	0.35%
25. Limapuluh Koto	387,847	406,774	423,349	449,909	0.96%	0.80%	0.61%
26. Pasaman	451,151	496,397	537,756	605,262	1.93%	1.61%	1.19%
27. Indragiri Hulu	367,470	406,941	450,618	565,885	2.06%	2.06%	2.30%
28. Indragiri Ilir	477,958	533,982	598,280	755,734	2.24%	2.30%	2.36%
29. Kampar	966,411	1,173,079	1,393,250	1,911,559	3.95%	3.50%	3.21%
30. Bengkalis	903,919	1,120,112	1,352,988	1,890,756	4.38%	3.85%	3.40%
Kepuluauan Rian	458,463	482,593	508,970	562,473	1.03%	1.07%	1.00%
Batam	106,825	154,099	211,223	218,796	7.60%	6.51%	0.35%
31. Kerinci	279,146	300,684	323,495	372,932	1.50%	1.47%	1.43%
32. Sarolangun Bangko	349,547	426,456	504,133	656,571	4.06%	3.40%	2.68%
33. Batanghari	663,567	816,202	970,951	1,262,694	4.23%	3.53%	2.66%
34. Tanjung Jabung	361,391	394,674	430,083	508,665	1.78%	1.73%	1.69%
35. Bungo Tebo	360,403	428,823	495,756	631,043	3.54%	2.94%	2.44%
36. Ogan Komering Ulu	964,431	1,082,842	1,202,799	1,436,984	2.34%	2.12%	1.79%
37. Ogan Komering Hil	1,912,187	2,280,206	2,629,748	3,230,817	3.58%	2.89%	2.08%
38. Muara Enim	582,097	665,141	751,940	932,447	2.70%	2.48%	2.17%
39. Lahat	601,823	677,696	757,205	925,738	2.40%	2.24%	2.03%
40. Musi Rawas	511,806	600,067	691,382	880,706	3.23%	2.87%	2.45%
41. Musi Banyuasin	883,719	1,068,633	1,257,200	1,628,214	3.87%	3.30%	2.62%
Bangka	513,826	578,605	643,648	769,722	2.40%	2.15%	1.80%
Belitung	192,927	212,102	232,158	274,378	1.91%	1.82%	1.68%
Pangkal Pinang	113,129	128,202	143,945	176,155	2.53%	2.34%	2.04%
42. Bengkulu Selatan	298,202	333,484	372,758	456,437	2.26%	2.25%	2.05%
43. Rejang Lebong	367,965	414,325	465,388	573,223	2.40%	2.35%	2.11%
44. Bengkulu Utara	512,784	662,645	779,879	988,712	5.26%	3.31%	2.40%
45. Lampung Selatan	2,461,283	2,717,494	2,985,011	3,582,722	2.00%	1.90%	1.84%
46. Lampung Tengah	1,899,398	2,031,158	2,161,921	2,438,700	1.35%	1.26%	1.21%
47. Lampung Utara	1,643,428	2,074,581	2,465,802	3,231,678	4.77%	3.52%	2.74%
Total	36,420,486	41,536,363	46,715,573	57,264,615	2.66%	2.38%	2.06%

Table 5.17 GRDP Projection by Kabupatan in Sumatra

Kabupaten	GRDP				Annual Growth Rate(%)		
	1990	1995	2000	2010	1990-1995	1995-2000	2000-2010
1. Aceh Selatan	163,477	216,445	292,052	531,139	5.77%	6.18%	6.16%
2. Aceh Tenggara	59,100	77,142	102,624	184,889	5.47%	5.87%	6.06%
3. Aceh Timur	290,929	401,904	576,375	1,161,885	6.68%	7.48%	7.26%
4. Aceh Tengah	69,510	71,139	99,200	103,966	0.46%	6.88%	0.47%
5. Aceh Barat	175,117	231,855	317,298	604,777	5.77%	6.48%	6.66%
6. Aceh Besar	254,344	339,957	456,550	807,164	5.97%	6.07%	5.86%
7. Pidir	148,678	167,811	234,005	298,664	2.45%	6.88%	2.47%
8. Aceh Utara	564,823	832,613	1,161,047	2,499,230	8.07%	6.88%	7.97%
Sabang	10,665	10,967	11,372	12,401	0.56%	0.73%	0.87%
9. Tapanuli Selata	389,434	540,583	792,103	1,951,667	6.78%	7.94%	9.44%
10.Tapanuli Tengah	503,036	669,767	941,322	2,133,804	5.89%	7.04%	8.53%
11.Tapanuli Utara	262,379	355,833	488,595	966,021	6.28%	6.55%	7.05%
12.Labuhan Batu	392,167	534,357	755,409	1,612,531	6.38%	7.17%	7.88%
13.Asahan	709,977	980,997	1,406,310	3,086,971	6.68%	7.47%	8.18%
14.Simalungun	612,484	842,363	1,201,970	2,614,007	6.58%	7.37%	8.08%
15.Dairi	92,135	121,320	166,326	343,031	5.66%	6.51%	7.51%
16.Karo	143,637	195,427	276,838	609,570	6.35%	7.21%	8.21%
17.Deli Serdang	2,024,111	2,631,861	3,550,434	6,901,487	5.39%	6.17%	6.87%
18.Langkat	486,367	700,608	1,047,071	2,498,056	7.57%	8.37%	9.08%
Nias	128,254	172,302	250,235	611,756	6.08%	7.75%	9.35%
19.Pesisir Selatan	124,173	164,345	216,601	405,417	5.77%	5.68%	6.47%
20.Solok	165,172	222,737	304,685	596,316	6.16%	6.47%	6.95%
21.Sawahlunto/Siju	135,331	174,984	229,509	412,965	5.27%	5.57%	6.05%
22.Tanah Datar	156,931	204,694	272,995	487,179	5.46%	5.93%	5.96%
23.Padang Pariaman	687,141	934,571	1,299,674	2,521,797	6.34%	6.82%	6.85%
24.Agam	194,517	235,325	291,094	446,885	3.88%	4.35%	4.38%
25.Limapuluh Kota	171,054	226,392	312,789	602,140	5.77%	6.68%	6.77%
26.Pasaman	169,946	224,927	303,537	552,348	5.77%	6.18%	6.17%
27.Indragiri Hulu	140,990	171,112	222,579	471,630	3.95%	5.40%	7.80%
28.Indragiri Hilir	240,209	301,464	401,527	819,790	4.65%	5.90%	7.40%
29.Kampar	271,677	349,168	462,874	936,286	5.15%	5.80%	7.30%
30.Bengkalis	684,258	879,432	1,149,382	2,260,798	5.15%	5.50%	7.00%
Kotamadya Batam	57,884	145,389	228,383	453,434	20.22%	9.45%	7.10%
Kepulauan Riau	258,144	308,808	411,309	816,618	3.65%	5.90%	7.10%
31.Kerinci	60,961	77,834	102,298	191,887	5.01%	5.62%	6.49%
32.Sarolangun Bang	118,924	164,536	230,986	489,167	6.71%	7.02%	7.79%
33.Batanghari	333,788	537,329	850,189	2,082,814	9.99%	9.61%	9.37%
34.Tanjung Jabung	127,919	188,028	280,410	613,435	8.01%	8.32%	8.14%
35.Bungo Tebo	113,928	153,964	215,135	449,319	6.21%	6.92%	7.64%
36.Ogan Komering U	316,226	397,820	515,779	904,014	4.70%	5.33%	5.77%
37.Ogan Komering I	1,582,104	2,367,756	3,513,299	7,406,107	8.40%	8.21%	7.74%
38.Liot/Huaraenim	238,145	301,027	395,882	707,112	4.80%	5.63%	5.97%
39.Lahat	242,049	313,330	412,062	722,253	5.30%	5.63%	5.77%
40.Musi Rawas	210,817	287,455	398,157	773,930	6.40%	6.73%	6.87%
41.Musi Banyuasin	711,508	1,007,187	1,441,474	2,963,204	7.20%	7.43%	7.47%
Bangka	417,730	513,087	652,673	1,106,698	4.20%	4.93%	5.42%
Belitung	121,025	150,083	190,914	334,607	4.40%	4.93%	5.77%
Pangkalpinang	66,368	95,715	136,349	266,273	7.60%	7.33%	6.92%
42.Bengkulu Selata	102,724	148,792	220,840	496,247	7.69%	8.22%	8.43%
43.Rejang Lebong	153,079	219,677	320,062	683,543	7.49%	7.82%	7.88%
44.Bengkulu Utara	201,420	310,351	451,959	990,939	9.03%	7.81%	8.17%
45.Lampung Selatan	918,620	1,407,961	2,187,548	5,588,909	8.92%	9.21%	9.83%
46.Lampung Tengah	589,473	878,110	1,299,941	2,925,058	8.30%	8.16%	8.45%
47.Lampung Utara	425,897	652,208	992,538	2,274,772	8.90%	8.76%	8.65%
Total	17,990,756	24,810,849	35,042,570	73,286,906	8.72%	8.80%	9.19%

Chapter 6

TRAFFIC DEMAND FORECAST

CHAPTER 6

TRAFFIC DEMAND FORECAST

6.1 Methodology

The traffic demand forecasting phase of this study comprised the following four major tasks:

1) Network Development:
   This comprised development of computerized base year and future year networks suitable for evaluation of proposed project alternatives.

2) Travel Demand Model Development:
   Calibration of traffic demand forecasting models, as functions of base year socio-economic data and observed travel characteristics.

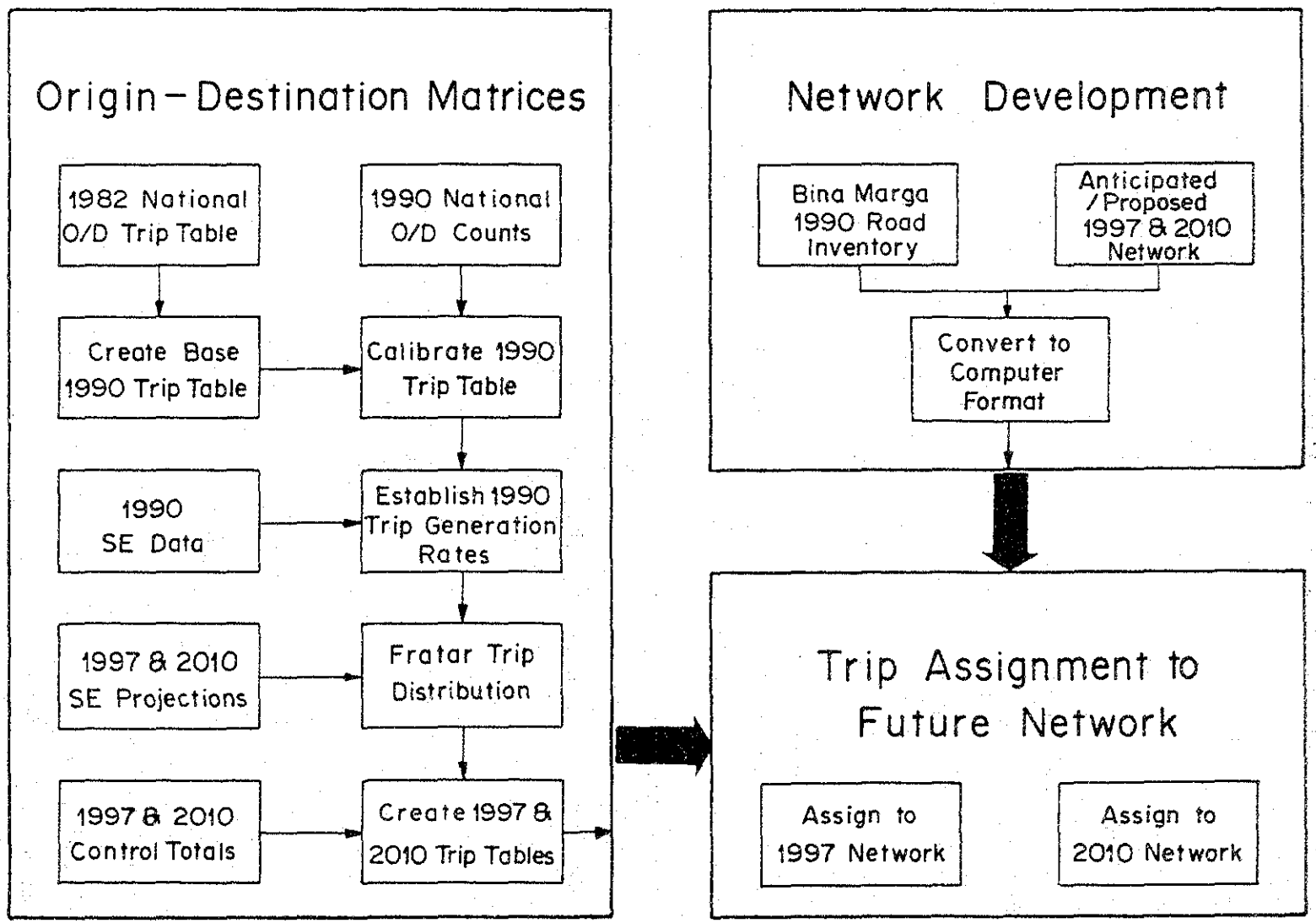
3) Forecasting of Future Traffic Demand:
   Appreciation of the the travel demand models to forecast 1997 and 2010 traffic demand as functions of project socio-economic distributions and road network improvement alternatives.

4) Future Traffic Assignment:
   Assignment of the future traffic demand to the base case and improvement alternatives proposed by the study, providing the basis for economic evaluation of each alternative.

The overall traffic analysis methodology is illustrated in Fig. 6.1.

Traffic demand forecasting models have been developed for each of the five traffic modes being evaluated in this study - sedans, light trucks, heavy trucks, small buses, and large buses; they are based on 1991 National OD Survey.

All network and travel demand modelling was carried out in this study within the framework of the TRANPLAN package of transportation planning software.



COASTAL ROADS IN EAST COAST OF SUMATRA

Fig. 6.1 **Relationships of Tasks in Traffic Demand Forecast**

6.2 Traffic Zone System

The form of the traffic zone system adopted for this study was constrained by the availability of socio-economic data currently available, and which could be reliably predicted for future years, for traffic demand model calibration and application. Given this constraint, the Kabupaten was established as the basic zonal unit.

The study area zone system, as shown in Fig. 6.2, comprises 8 provinces subdivided into 47 internal zones. In addition, three separate internal zones were provided specially for modelling the proposed Tanjung Api-api, Kuala Enok and SIJORI port developments; these are numbered 49-51 respectively. An external zone (48) was defined for Java, to enable explicit modelling of external trips between Sumatra and Java. In total, therefore, there are 50 internal zones and 1 external zone. Table 6.1 lists each zone, and the Kabupaten represented.

6.3 Road Network

6.3.1 Existing Road Network

The existing road network in Sumatra is illustrated in Fig. 6.3. The area covered by the network is extremely large, yet it is very simple with few internal connections. The network consists of just over 2,500 nodes and 2,600 two-way links.

6.3.2 Future Road Network

A future road network is essential to future traffic demand of the East Coast Highway. The future road network was assembled with the following network components based on the existing road network.

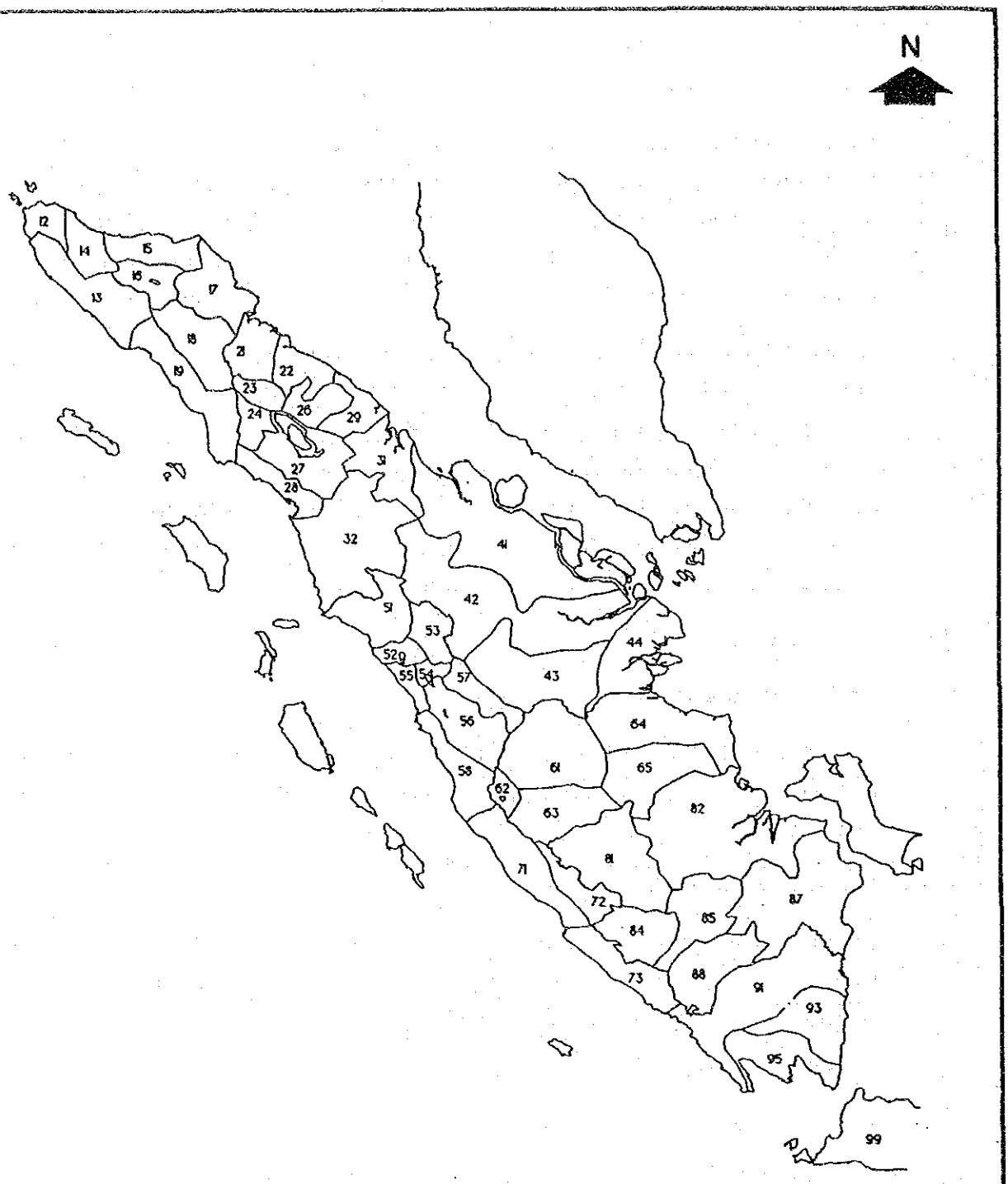
On-going Projects

- South Sumatra Road Betterment Project
- The 1st and 2nd Nine Provinces Road Projects
- APBN (government fund) project
- Ex-OECF Road Rehabilitation Project

Committed Projects

- The 3rd Nine Provinces Road Project
- Heavy Loaded Road Improvement Project

The future road network for the year 1997 and 2010 was built based on the above projects.

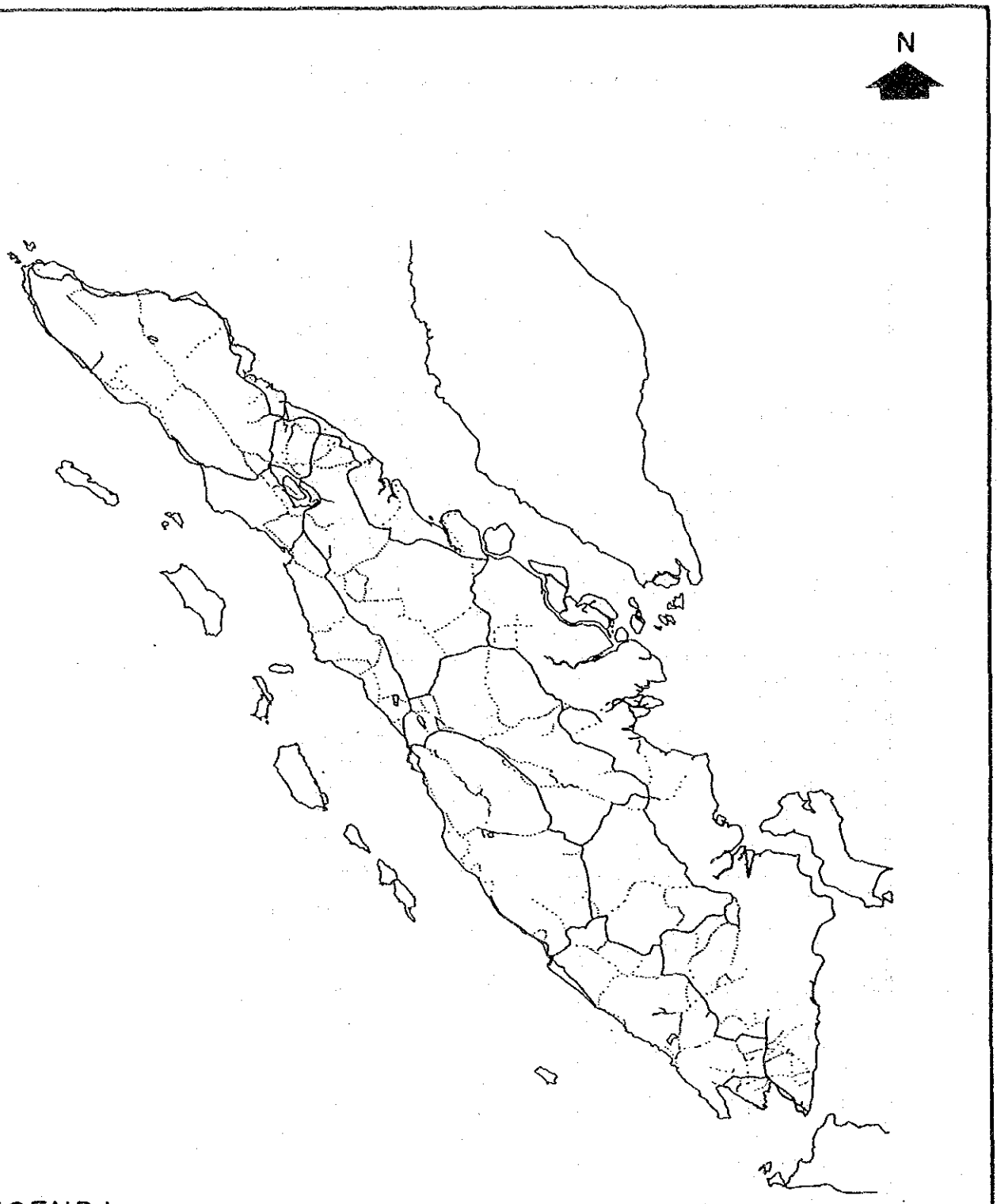


COASTAL ROADS IN EAST COAST OF SUMATRA	**Fig. 6.2** **Traffic Zone System**

Table 6.1 Traffic Zone System

Province	Zone Number	Zone (Kabupaten) Name
Aceh	1	Aceh Selatan
	2	Aceh Tenggara
	3	Aceh Timur
	4	Aceh Tengah
	5	Aceh Barat
	6	Aceh Besar
	7	Pidi
	8	Aceh Utara
Sumatra Utara	9	Tapanuli Selatan
	10	Tapanuli Tengah
	11	Tapanuli Utara
	12	Labuhan Batu
	13	Asahan
	14	Simalungun
	15	Dairi
	16	Karo
	17	Deli Serdang
	18	Langkat
Sumatra Barat	19	Pesisir Selatan
	20	Solok
	21	Sawahlunto
	22	Tanah Datar
	23	Pariaman
	24	Agam
	25	Limapuluh Kota
	26	Pasaman
Riau	27	Indragiri Hulu
	28	Indragiri-Hilir
	29	Kampar
	30	Bengkalis
Jambi	31	Kerinci
	32	Sarolangun Bangko
	33	Batanghari
	34	Tanjung Jabung
	35	Muara Bungo
Sumatra Selatan	36	Ogan Komering Ulu
	37	Ogan Komering Ilir
	38	Muara Enim
	39	Lahat
	40	Musi Rawas
	41	Musi Banyuasin
Bengkulu	42	Bengkulu Selatan
	43	Rejang Lebong
	44	Bengkulu Utara
Lampung	45	Lampung Selatan
	46	Lampung Tengah
	47	Lampung Utara

Source: Study Team



COASTAL ROADS
IN
EAST COAST OF SUMATRA

Fig. 6.3 Road Network in Sumatra

6.4 Development of Travel Demand Models

6.4.1 General

This section summarizes the procedures adopted in calibrating the travel demand models, and the standards of calibration achieved. The basic steps in this model development phase were:

- Calibration of the preliminary 1991 National OD Survey matrices to control counts.
- Development of trip generation models by vehicle type.
- Calibration of trip distribution models by vehicle type.
- Validation of the models for reproducing observed 1991 traffic demand.

6.4.2 Calibration of 1991 National OD Matrices

(1) General

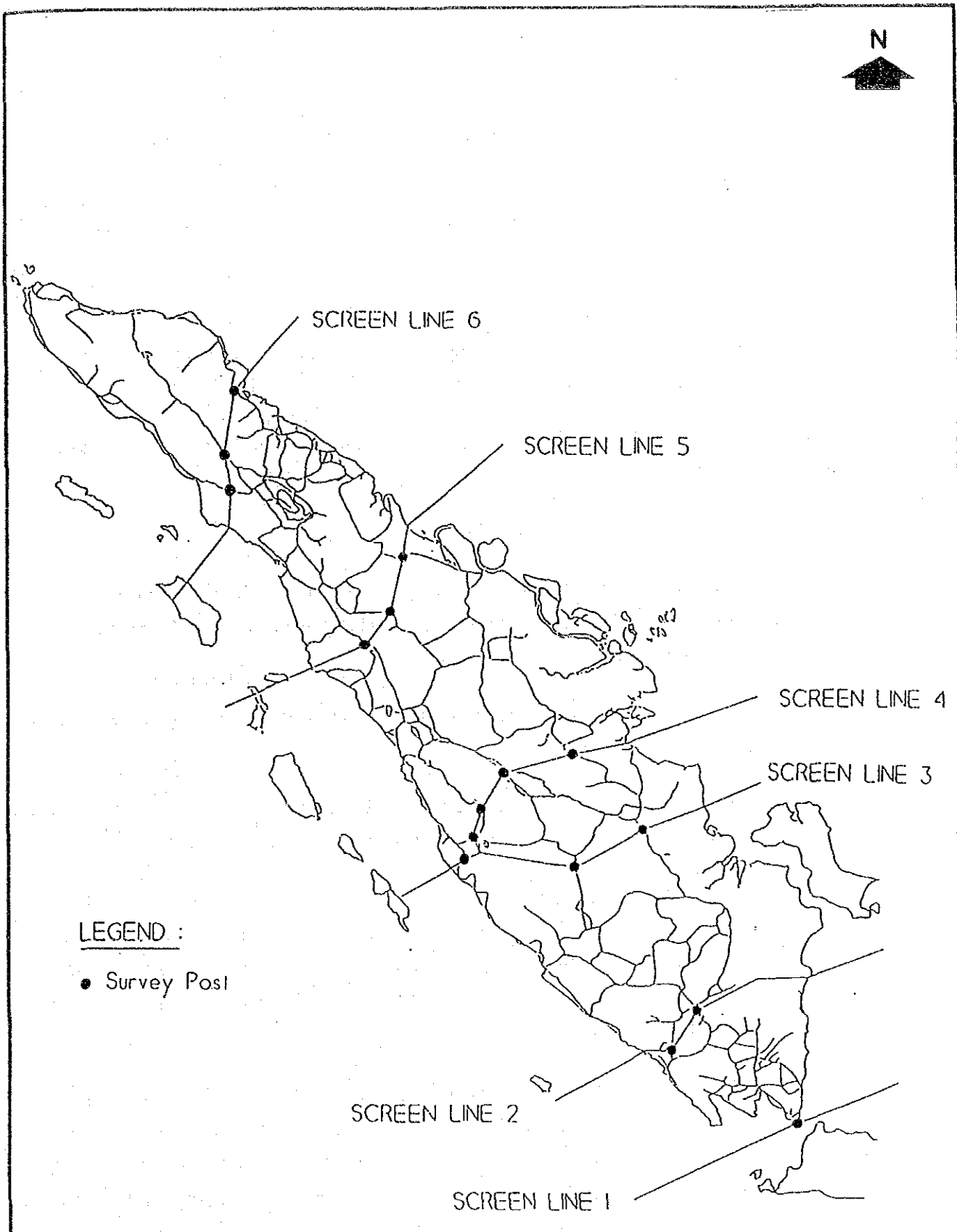
1991 National OD Survey matrices were used as the basis for model development. The matrices provided to this study represent preliminary versions, prior to final checks and adjustments being carried out. The initial step in this study was to compare the matrices with detailed vehicle count information collected as part of the 1991 National OD Survey, and to make necessary adjustments to the matrices so that they closely matched these control counts.

Initial comparisons of compressed province-province modal volumes with ground counts from the 1991 OD Survey, using a series of screenlines running from east to west across Sumatra, indicated significant variations, as summarized in Table 6.2. The screenlines were located along provincial boundaries, at sites of traffic count stations; they ensure that no trip from a zone on one side of the screenline could travel to a zone on the other side without passing through one of the count stations. The location of each screenline is illustrated in Figure 6.4; count station locations are also shown in the figure.

Table 6.2 OD Traffic Matrix Screenline Comparison

Mode	Screenline	OD Volume	Traffic Count	Ratio OD/Count
Sedans	1	1,835	636	2.89
	2	1,501	529	2.84
	3	1,315	530	2.48
	4	1,254	676	1.86
	5	947	640	1.48
	6	1,126	812	1.39
Light Trucks	1	3,397	1,428	2.38
	2	2,924	1,783	1.64
	3	2,422	1,036	2.34
	4	2,180	2,018	1.08
	5	1,654	1,299	1.27
	6	1,899	1,424	1.33
Heavy Trucks	1	314	10	31.40
	2	278	18	15.44
	3	201	26	7.73
	4	181	21	8.62
	5	282	135	2.09
	6	50	9	5.56
Small Buses	1	25	14	1.79
	2	244	285	0.86
	3	330	282	1.17
	4	129	355	0.36
	5	57	40	1.43
	6	73	41	1.78
Large Buses	1	220	202	1.09
	2	243	458	0.53
	3	187	322	0.58
	4	187	512	0.37
	5	128	408	0.31
	6	90	210	0.43

Source: 1991 National OD Survey and the Study Team



COASTAL ROADS IN EAST COAST OF SUMATRA	**Fig. 6.4** **Screenline Locations**

(2) Adjustment Procedure

The observed 1991 OD trip matrices were incrementally adjusted via a two stage procedure:

- Province-province movements were adjusted to agree as closely as possible with screenline counts (refer Table 6.2).
- Intra-provincial flows (between Kabupatens) were then adjusted iteratively to station count totals recorded (during the 1991 National OD Survey) at the road crossings of each Kabupaten boundary.

The respective adjustment procedures are briefly described in the following paragraphs.

1) Inter-Provincial Matrix Adjustment

An iterative calibration procedure was developed, in which adjustments to individual province-province cells were carried out incrementally, screenline by screenline, such that:

- The original observed travel patterns were maintained as closely as possible.
- Adjustments commenced at Screenline 1, (Java-Sumatra ferry), and then proceeded sequentially north along Sumatra to Screenline 6.
- Following the adjustment to matrix cells at each screenline, cells which were assumed to be unaffected by subsequent screenline adjustments were taken as fixed; successive adjustments to other cells were accumulated and averaged in such a way as to dampen out the effects of changes over multiple screenlines.

The procedure was repeated (for each mode) until the adjusted volumes across each screenline converged to the count estimates. Table 6.3 summarizes the matrix calibration standards achieved. It indicates that the adjustment procedure has successfully updated the OD matrices to provide close agreement between OD volumes and observed counts for inter-provincial movements across each screenline.

Table 6.3 OD Traffic Matrix Calibration Standards Inter-Provincial Trips

Mode	Screenline	Adjusted OD Volume	Traffic Count
Sedans	1	635	636
	2	538	529
	3	545	530
	4	661	676
	5	640	640
	6	810	812
Light Trucks	1	1,422	1,428
	2	1,773	1,783
	3	1,074	1,036
	4	2,000	2,018
	5	1,293	1,299
	6	1,425	1,424
Heavy Trucks	1	16	10
	2	16	18
	3	21	26
	4	18	21
	5	131	135
	6	8	9
Small Buses	1	22	14
	2	287	285
	3	281	282
	4	353	355
	5	41	40
	6	43	41
Large Buses	1	225	202
	2	453	458
	3	315	322
	4	508	512
	5	406	408
	6	210	210

Source : The Study Team

2) Intra-Provincial Matrix Adjustment

The 1991 National OD survey collected comprehensive daily traffic counts at each location where a road crosses a Kabupaten boundary. Individual Kabupaten screenlines were thus created by aggregating crossing counts for each Kabupaten.

The adjustment procedure comprised, for each province, the following steps:

- Assignment of inter-provincial trips (by mode) to the provincial road network. Subtraction of these assigned trips from the respective

Kabupaten counts provided estimates of residual intra-provincial (inter-Kabupaten) traffic passing through each count station.

- Assignment of intra-provincial modal trips to the provincial road network, using a stochastic probabalistic multipath technique. Comparison of the assigned volumes with the respective Kabupaten counts identified discrepancies and the corresponding need for intra-provincial matrix adjustments. Due allowance was made in this process for normal route choice limitations in the assignment of both the inter and intra-provincial matrices.

- The pattern of Kabupaten-Kabupaten movements was checked (for each mode), and adjustments to selected movements made to improve the comparison between assigned volumes and the counts. The procedure was repeated until satisfactory agreement was reached.

The intra-provincial adjustment procedure detected some inconsistencies between the assigned traffic volumes/observed matrix flows and counts; these were rationalised in the most appropriate way in each case.

6.4.3 Trip Generation Model Development

Trip generation models were developed for forecasting the numbers of daily motor vehicle trips produced in and attracted to each zone, separately for each mode. Estimation of the separate models was based on a detailed analysis of trip ends from the calibrated OD trip matrices and 1991 zonal socio-economic data. These models forecast inter-zonal (inter-Kabupaten) trips only; intra-zonal trips are not modelled as the 1991 National OD Survey implicitly collected no details of such travel through its choice of roadside interview locations.

Model structure was constrained by socio-economic data availability and the reliability with which forecasts of this data can be prepared for future years. For these reasons, the models were restricted to functions of total zonal population and GKP (gross Kabupaten product). Table 6.4 summarizes the 1991 zonal distribution of these variables, and also reports calibrated 1991 OD trip ends by mode.

Table 6.4 1991 Zonal O-D Trip Ends and Socio-Economic Data

Zone	Trip Attractions by Mode						Socio-Economic Data	
	Sedans	Light Trucks	Heavy Trucks	Small Buses	Large Buses	Total	Total Population	GKP (M Rp.)
1	62	186	0	67	10	325	350873	173034
2	35	68	0	1	16	120	190273	62377
3	305	689	2	79	42	1117	606959	310564
4	37	148	4	5	39	233	203886	69880
5	84	284	1	64	12	445	394056	185354
6	190	329	23	33	133	708	437988	269724
7	123	250	3	84	137	597	428982	152425
8	255	841	19	159	162	1436	873120	610823
9	137	405	39	51	112	744	982548	415869
10	136	302	21	22	74	555	294824	532722
11	212	270	63	28	77	650	714223	278887
12	279	514	73	21	120	1007	757466	417233
13	1073	1591	185	183	178	3210	1008485	757470
14	1033	900	176	123	163	2395	1034147	652848
15	100	251	83	32	64	530	283567	97356
16	442	873	48	146	214	1723	264116	152773
17	3561	4503	467	1871	994	11396	3550027	2133421
18	1675	2206	85	1555	337	5858	1012068	523242
19	83	247	0	17	76	423	377760	131346
20	446	527	0	551	30	1554	477152	175368
21	268	640	18	299	12	1237	319516	142482
22	694	669	23	564	72	2022	381833	165512
23	721	1500	26	368	398	3013	1149847	730805
24	993	773	44	752	205	2767	492922	202089
25	502	764	53	269	83	1671	391589	180934
26	166	250	4	79	86	585	459891	179763
27	67	150	16	27	30	290	375194	146811
28	1	30	0	8	0	39	488865	251809
29	932	2213	241	232	350	3968	1005002	286155
30	822	2021	223	190	232	3488	943904	720724
31	30	215	0	13	45	303	283393	64049
32	70	136	5	69	34	314	363815	126971
33	289	428	11	253	147	1128	691782	367333
34	156	222	3	136	64	581	367240	138238
35	147	164	8	147	3	469	373240	121066
36	271	596	3	251	153	1274	987102	331239
37	1148	2178	52	627	314	4319	1980848	1715780
38	438	638	36	226	181	1519	597876	249690
39	163	307	15	231	48	764	616331	254994
40	183	293	1	314	27	818	528392	224411
41	729	1283	9	535	85	2641	918013	763083
42	105	259	20	288	17	689	305066	110635
43	287	439	6	347	42	1121	376950	164562
44	253	493	24	380	126	1276	539976	219630
45	1196	2636	116	568	332	4848	2511447	1000536
46	863	1421	93	419	43	2839	1925762	638391
47	282	1251	25	268	181	2007	1722454	463796
Total	22044	37353	2367	12952	6300	81016	35340770	18064204

(1) Model Form and Estimation Results

Models of a linear regression form were separately estimated at the Kabupaten level as functions of:

- Total population
- GKP
- GKP/person
- Total population + GKP

Statistically significant models were obtained for sedans, light trucks, and large buses, with the following results:

Sedans:	T_i	=	$0.001217*X_1 - 5.66$
			(t = 9.506)
Light Trucks:	T_i	=	$0.000756*X_1 + 0.000717X*X_2 - 49.390$
			(t = 2.344) (t = 3.593)
Large Bus:	T_i	=	$0.000319*X_1 + 9.138$
			(t = 9.028)
where	T_i	=	Zonal trips generated per day
	X_1	=	GKP (millions Rp)
	X_2	=	Total Kabupaten population

Suitable regression-based models for heavy trucks and small buses could not be obtained as functions of the available socio-economic variables. An alternative approach of forecasting trip generation as functions of trip rates was adopted for these two modes. The variables selected for input to this rates analysis were those considered to be the strongest determinants of future trip levels - GKP for heavy truck, and total population for small bus trips (for mostly private purposes). Given the high variability in trip rates for these modes, the approach taken in this analysis was to:

- Stratify zones by the numbers of trip attractions in the observed OD matrices, and calculate rates for each of these ranges.
- Calculate zone-specific rates for zones having large numbers of observed trips.

(2) Model Implementation

The regression-based models for sedans, light trucks and large buses, whilst statistically significant, are not able to reproduce the observed trip pattern to a satisfactory standard. That is, there are some large variations between observed and modelled trips at the zonal level. This is attributed to the significant proportion of trip generation not explained by the respective variables in the regression equations. Furthermore, direct application of the models would lead to an unacceptably high incidence of bias in the forecast trip ends. The approach taken to overcome this problem was to:

- Use the respective model forms to estimate the relative growth in zonal trip ends between 1991 and each design year.
- Add this net growth in trips to the number of zonal OD trips observed in 1991.

The respective regression and trip rate models each estimate the numbers of trip attractions in each zone. For model application, zonal trip productions are set equal to attractions.

6.4.4 Trip Distribution Model Calibration

(1) Model Form

Conventional gravity models were calibrated for distributing daily trips generated within Sumatra, with a separate model for each of the five modes. They reflect road network levels of service in the travel deterrence functions, and thus have sensitivity to changes in trip distribution patterns which increased accessibility from East Coast Highway improvements will provide. As noted in section 6.4.3 above, they model internal study trips only.

The gravity models are of the doubly-constrained type, with the following formulation:

$$T_{ij} = \frac{P_i A_j F_{t\ ij} K_{ij}}{\sum_i \sum_j P_i A_j F_{t\ ij} K_{ij}}$$

Where T_{ij} = Trips produced in zone i and attracted to zone j

P_i = Trips produced in zone i

A_j = Trips attracted to zone j

$F_{t,ij}$ = Empirically derived travel factor for time t between zones i and j

K_{ij} = Specific zone-zone (or province-province) adjustment factor to allow for the effect of travel linkages not otherwise explained by the gravity mode.

This gravity model formulation constrains balancing of modelled attractions to input trip attractions (as estimated by the trip generation model). Through this process the originally calibrated trip end patterns are maintained.

(2) Calibration Procedure

Required inputs to the calibration procedure were:

- Zonal trip productions and attraction (as derived from the OD matrices).
- Modal trip length frequency distributions from the OD matrices.
- Travel impedance (skim) from the 1991 road network, in the form of minimum interzonal travel times.

This procedure was repeated until best possible agreement between the observed and synthesized trip length frequency distribution curve was obtained.

After completion of the curve fitting procedure, the observed external OD trips were added to the synthesized matrices, and the total observed OD and synthesized trips were compressed to a province-province level.

The trip length frequency distribution by mode and the compressed province-province observed and synthesized matrices by mode in 1991 are shown in Appendix A-6.1 and A-6.2 respectively.

6.4.5 External Traffic

External traffic comprises those motor vehicle trips which travel between Sumatra and Java by ferry. The technique adopted for forecasting their future numbers and travel patterns was to apply growth factors to observed 1991 base year OD travel patterns.

The 1991 matrices forming the basis for future projections were prepared by adjusting 1991 OD matrices to reflect corrected ferry count data (refer section 6.4.2). The process comprised:

- For sedans, light trucks and large buses, the 'calibrated' external OD trip matrices (section 6.4.2) were adjusted by the ratios of the respective ferry count calibrated total matrix volume.

- For heavy trucks, the 'calibrated' external OD matrix comprised only 16 vehicles with a very sparse distribution, whereas the ferry count was for 1065 vehicles on the day of the OD survey. The 'calibrated' matrix was judged as

forming an inadequate basis for adjustment. The alternative approach adapted was to take the uncalibrated 1991 National OD matrix, (which has a reasonable trip distribution pattern in Sumatra), and to adjust this matrix by the ratio of ferry count: uncalibrated total matrix volume.

Small buses are prohibited from crossing to/from Java by ferry, so there is no external trip matrix for this mode.

Comparisons of observed and synthesized traffic volumes crossing each screenline are shown in Tabled 6.5.

Table 6.5 Synthesized Traffic Matrix Screenline Comparison

Mode	Screenline	Synthesized Volume	Traffic Count
Sedans	1	633	636
	2	677	529
	3	666	530
	4	741	676
	5	628	640
	6	833	812
Light Trucks	1	1,422	1,428
	2	1,769	1,783
	3	1,150	1,036
	4	1,906	2,018
	5	1,171	1,299
	6	1,,494	1,424
Heavy Trucks	1	16	10
	2	45	18
	3	40	26
	4	42	21
	5	110	135
	6	33	9
Small Buses	1	0	14
	2	284	285
	3	231	282
	4	283	355
	5	34	40
	6	59	41
Large Buses	1	225	202
	2	548	458
	3	523	322
	4	591	512
	5	447	408
	6	250	210

Source : 1991 National OD Survey and the Study Team

6.4.6 Link Condition and Q-V Model

Condition of the road links were determined by referring to the latest road inventory data by Bina Marga.

- Link length in kilometers
- Annual average daily traffic (AADT)
- Width of carriageway
- Shoulder width
- Shoulder usability
- Pavement roughness (International Roughness Index/IRI)
- Surface type
- Project status (On-going, Committed, or No Project)

Physical descriptive data for links were obtained from various data files provided by Bina Marga and sourced from the "Second Technical Advisory Services on Planning and Programming to BIRPRAN, Bina Marga" financed by the IBRD. Link capacities were developed from calculations involving carriageway width, shoulder usefulness, shoulder width, and the number of non-motorized vehicles using the link. Free flow speeds were calculated based on road roughness and carriageway width. All equations were developed by the IBRD team.

Road links were divided into 3 kinds of road type and Q-V conditions as shown in Fig. 6.5.

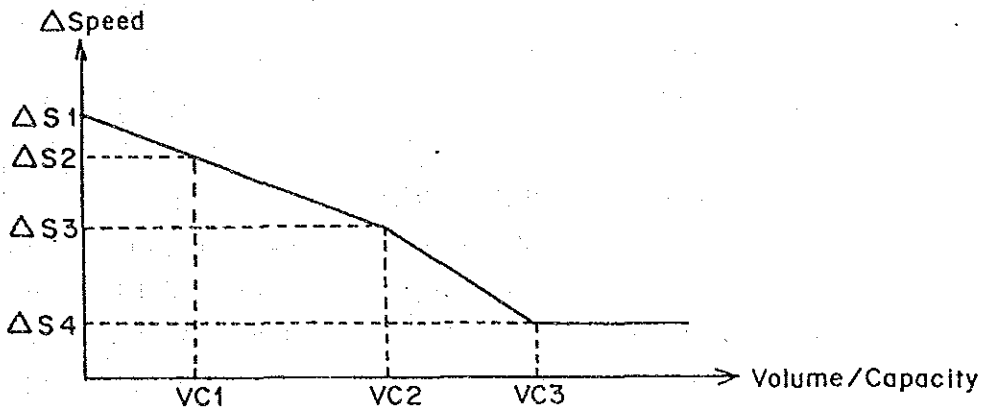
6.4.7 Modelled 1991 OD Trip Matrices

Modelled 1991 modal vehicle trip matrices were prepared by running the trip generation and trip distribution models, and adding in the (modified) external trips. Table 6.5 summarizes the number of trips (attractions) by mode by province.

The modal vehicle trips were converted into passenger car unit equivalents (PCUs) prior to undertaking a traffic assignment (This process is required for input to the assignment procedure where coded network link capacities are in terms of pcus, and the conversion is required to provide common units to enable the travel time adjustments after each loading iteration). Unit pcu equivalence factors adopted in this conversion process were:

• Sedans	1.00
• Light Trucks	1.65
• Heavy Trucks	3.20

Group #	Carriageway Width	VC1	VC2	VC3	ΔS1	ΔS2	ΔS3	ΔS4
1	>12 m	0.2	1.0	1.3	1.00	1.00	0.70	0.30
2	5.5 - 12 m	0.2	1.0	1.3	1.00	0.92	0.64	0.25
3	<5.5 m	0.2	1.0	1.3	1.00	0.80	0.62	0.20



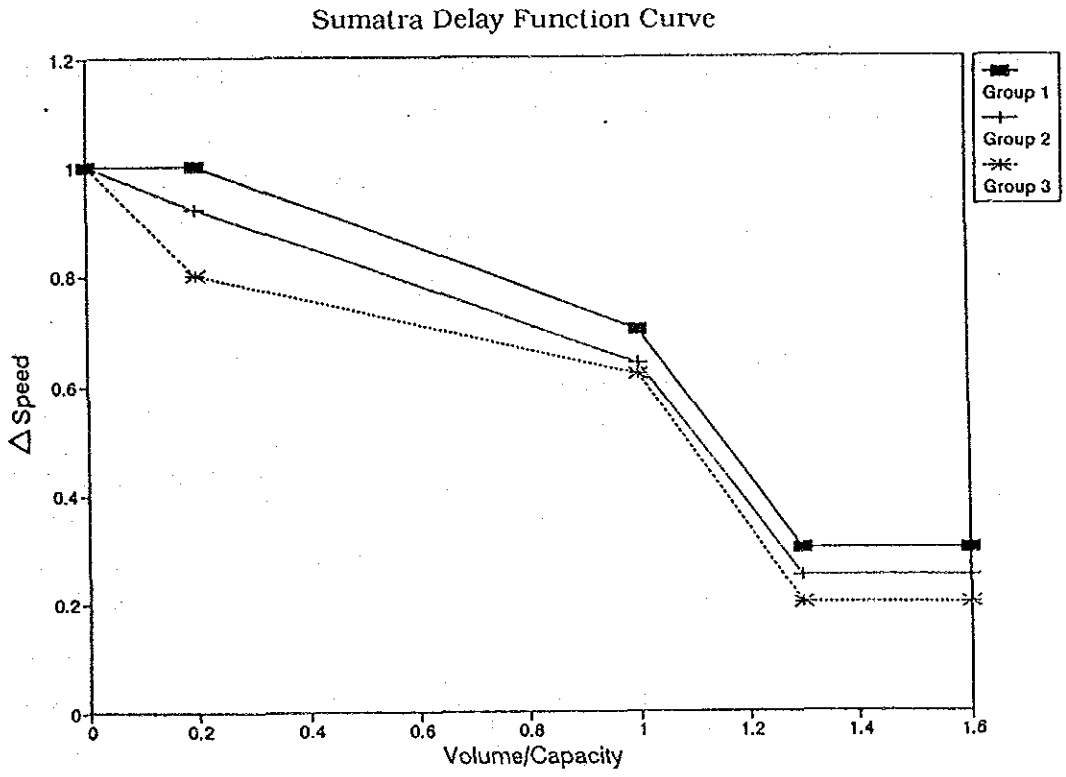


Fig. 6.5 Road Condition and Q-V Model

- Small Buses 1.25
- Large Buses 2.50

The total estimated numbers of provincial PCU trip attractions in the base 1991 modelled matrices are also included in Table 6.6

Table 6.6 Summary 1991 Trip Attractions by Province by Mode

Province	Vehicle Mode						Total PCUs
	Sedan	Light Trucks	Heavy Trucks	Small Buses	Large Buses	Total Vehicles	
Aceh	1,073	2,790	72	482	552	4,969	7,902
North S.	8,622	11,784	1,371	4,039	2,347	28,163	43,369
West S.	1,813	4,405	508	453	623	7,802	12,827
Riau	3,853	5,337	210	2,910	957	13,267	19,366
Jambi	680	1,156	62	620	294	2,812	4,297
South S.	639	1,188	49	1,012	188	3,076	4,491
Bengkulu	2,904	5,264	221	2,179	806	11,374	17,041
Lampung	2,277	5,284	400	1,246	553	9,760	15,215
External	130	546	516	0	133	1,325	3,017
Total	21,991	37,754	3,409	12,941	6,453	82,548	127,525

Source : Model results

Aggregate statistics from assignment of the modelled 1991 pcu trip matrix to the base 1991 road network were:

- Trips assigned 127,525
- Number of pcu-km 24,008,430
- Number of pcu-hours 458,699
- Average pcu speed (km/h) 52.3
- Mean loaded trip length (mins) 205

6.5 Future Traffic Demand

6.5.1 Internal Traffic Demand

The trip generation models were applied to forecast future levels of internal study area demand for each zone, using as input the forecast distribution of the respective socio-economic variables. Overall controls on trip totals were calculated and applied in accordance with the methodology described in section 6.4.3.

Table 6.7 provides a summary of total vehicle trip ends for 1997 and 2010 by province, and includes the implied average annual growth rates in trip levels from 1991-1997-2010.

Control totals were separately derived for each province via the following method:

- Regression equations were estimated to forecast growth in vehicle ownership, for sedans, trucks (all), and buses (all), as functions of provincial GRDP. (The grouping of trucks and buses was required because historical vehicle ownership data in Sumatra does not distinguish between light and heavy trucks, and between small and large buses.)

- The regression models were applied to derive vehicle growth factors for the periods 1991 - 1997 and 1997 - 2010.

- Future trip control totals were estimated by applying the respective growth factors to base year 1991 zonal OD trips.

- The truck and bus control totals were split into the respective sub-categories, on a pro-rata basis using the relative proportions of trips forecast by the trip generation models.

- The modelled trips were aggregated across each province and pro-rated to the respective modal control totals.

6.5.2 External Traffic Demand

Forecasts of future external trips between Java and Sumatra for 1997 and 2010 were prepared by applying province-specific growth factors to the 1991 base external matrices. These factors reflect the projected growth in provincial economic activity; the view was (reasonably) taken that future economic activity levels provide an appropriate basis for estimating future levels of external trips generated

by each respective province. The growth factors used for this analysis are reported in Appendix A-6.3.

Table 6.7 indicates projected continuing high growth in trip generation for the whole of Sumatra over the period 1991 - 2010. Table 6.8 summarizes forecast internal and external trips by mode for 1997 and 2010.

Table 6.7 Growth in Trip Demand by Province 1991-1997-2010

Province	Total Trips (All Modes) by Year			Growth Rate (% p.a.)	
	1991	1997	2010	1991-1997	1997-2010
Aceh	4,937	7,360	17,457	6.88	6.87
North S.	28,034	36,940	83,226	4.71	6.45
West S.	12,996	20,166	49,976	7.60	7.23
Riau	7,787	10,499	24,470	5.11	6.73
Jambi	2,535	5,116	17,593	12.42	9.97
South S.	10,996	19,135	51,586	9.67	7.93
Bengkulu	3,000	5,711	18,593	11.33	9.50
Lampung	9,592	17,642	63,768	10.69	10.39
Total	79,877	122,568	326,669	7.40	7.83

Source : Traffic demand forecasts by the Study Team

Table 6.8 Summary Forecast Internal and External Traffic for 1997 and 2010

Year	Forecast Trips		
	Internal	External	Total
1991			
Sedans	21,722	269	21,991
Light Trucks	36,657	1,097	37,754
Heavy Trucks	2,358	1,051	3,409
Small Bus	12,941	0	12,941
Large Bus	6,189	264	6,453
Total	79,867	2,681	82,548
1997			
Sedans	33,345	445	33,790
Light Trucks	52,546	1,668	54,214
Heavy Trucks	3,723	1,615	5,338
Small Bus	23,597	0	23,597
Large Bus	9,357	433	9,790
Total	122,568	4,161	126,729
2010			
Sedans	85,755	1,234	86,989
Light Trucks	128,187	4,516	132,703
Heavy Trucks	12,153	4,468	16,621
Small Bus	77,715	0	77,715
Large Bus	22,860	1,256	24,116
Total	326,669	11,474	338,144

Source : Traffic demand forecasts by the Study Team

Table 6.9 Forecast 1997 Zonal O-D Trip Ends

Zone	Trip Attractions by Mode					
	Sedans	Light Trucks	Heavy Trucks	Small Bus	Large Bus	Total
1	127	287	2	61	31	508
2	53	111	1	4	22	192
3	419	945	7	123	86	1579
4	44	175	1	9	40	269
5	153	394	4	69	35	654
6	264	467	35	77	152	996
7	144	319	3	64	140	670
8	571	1233	59	375	254	2492
9	388	698	57	165	147	1454
10	413	513	70	15	122	1133
11	352	439	92	110	96	1089
12	513	774	108	39	150	1584
13	1513	1944	276	346	245	4324
14	1400	1184	263	336	216	3398
15	148	312	118	43	63	684
16	522	958	20	92	195	1787
17	4497	5499	648	2515	1009	14168
18	2015	2532	134	2281	356	7318
19	192	357	2	26	116	694
20	707	704	3	1083	69	2565
21	432	816	14	527	36	1824
22	1008	807	24	997	111	2946
23	1450	2038	111	573	625	4797
24	1377	914	27	1206	273	3797
25	779	947	87	623	132	2568
26	334	395	4	103	138	974
27	116	235	13	63	42	468
28	104	161	4	27	28	323
29	1023	2705	363	431	367	4889
30	1111	2649	334	412	311	4818
31	52	267	1	23	82	425
32	132	260	3	120	82	597
33	566	800	42	601	355	2364
34	235	330	3	255	141	966
35	196	273	4	259	32	764
36	369	856	7	447	224	1903
37	2223	3581	92	1469	769	8134
38	496	844	34	280	248	1902
39	255	479	24	289	92	1139
40	283	493	5	655	71	1507
41	1120	1946	28	1205	253	4551
42	197	426	13	546	44	1227
43	428	689	7	730	84	1938
44	452	894	41	966	195	2547
45	2083	4257	250	1161	595	8347
46	1404	2272	194	792	181	4842
47	689	2368	90	1003	302	4452
Total	33345	52546	3723	23597	9357	122568