Table 2.2.2 Population 1991 Census and Estimates

	Census				Revised Estimate		
	1991			AAGR	AAGR(*3)	Population	Dens.
	Population	Dens.	AHhn.	80-90	91-05	2005	
	1,000	/km2				1,000	/km2
KUALA LUMPUR	1,145	4,712	4.46	0.9%	0.8%	1,280	5,262
GOMBAK	353	543	4.81	6.5%	6.7%	879	1,352
Selayang							
Ampang Jaya #	115						
Other UA							
Non-UA							
HULU LANGAT	411	497	4.68	7.3%	5.8%	904	1,094
Ampang Jaya #	200						
Bangi							
Other UA #2							
Non - UA							
PETALING	633	1,308	4.76	4.7%	3.0%	954	1,971
Shah Alam							
Petaling Jaya							
Other UA							
Non - UA							
KLANG	407	649	5.20	2.9%	3.0%	617	984
Klang							
Other UA							
Non - UA							
KELANG VALLEY	2,948	1,042	4.77	(S) 3.2%	2.6%	4,247	1,501
MALAYSIA	17,567	53	4.91	2.7%	2.3%	24,152	73

Legend: refer to Table 2.2.1
3 S(L+M)/(J+K): (for J, K, L and M, see Table 2.2.1)
J,K,L,M:refer to Table 2.2.1

2.2.3 Economy and Industry

(1) Economy

1) Malaysian Economy

The Malaysian economy has developed in accordance with government economic plans. The 5th Malaysian Plan (MP5) covering the period 1986-90 ended in 1990. The OPP2 covering the period 1991-2000 and the 6th Malaysia Plan (MP6) covering the period 1991-1995 are now under way.

In the Study we chose Gross Domestic Product (GDP) as a representative index of economic activity. The achievement of the

MP5, MP6 and OPP2 targets are shown in Table 2.2.3. The average GDP growth rate was 6.7 percent during 1971-90 and is expected to be 7.0 percent between 1991 and 2000. The production structure during 1995-2000 is also shown in Table 2.2.3. The weight of primary sector activity is expected to decrease from 28.1 percent in 1990 to 18.3 percent in 2000, while that of the secondary sector is expected to grow from 30.2 percent to 38.7 percent.

Table 2.2.3 Gross Domestic Product by Sector (Malaysia)

(M$ million in 1978 prices)

Sector	Gross Domestic Product				Average Annual Growth Rate (%)			Share to GDP (%)			
					Achieved	Target	Target				
	1985	1990	1995	2000	85-89	90-94	95-99	1985	1990	1995	2000
Agriculture & Forestry	11,854	14,829	17,580	20,820	4.6	3.5	3.4	20.7	18.7	15.5	13.4
Mining & Quarrying	5,958	7,688	8,280	8,910	5.2	15.0	1.5	10.4	9.7	7.3	5.7
Manufacturing	11,268	21,381	36,860	58,010	13.7	11.5	9.5	19.7	27.0	32.4	37.2
Construction	2,738	2,788	4,100	5,470	0.4	8.0	5.9	4.8	5.5	3.6	3.5
Electricity, Gas & Water	948	1,511	2,480	3,910	9.8	10.0	10.0	1.7	1.9	2.2	2.5
Transport, Storage & Communications	3,630	5,489	9,030	14,200	8.6	10.5	10.0	6.4	6.9	7.9	9.1
Warehouse & Retail Trade Hotel & Restaurants	6,911	8,700	13,410	19,640	4.7	9.0	7.9	12.1	11.0	11.8	12.6
Finance, Real Estate & Business Services	5,121	7,650	12,070	16,490	8.4	9.5	6.4	9.0	9.7	10.6	10.6
Government Services	6,957	8,459	10,440	13,080	4.0	4.3	4.6	12.2	10.7	9.2	8.4
Other Services	1,301	1,656	2,480	3,400	4.9	8.0	6.9	2.3	2.1	2.2	2.2
(-) Imputed Bank Service Charges	1,834	4,020	7,280	13,710	17.0	12.5	13.5	3.2	5.1	6.4	8.8
(+) Import Duties	2,246	2,972	4,270	5,560	5.8	7.5	5.4	3.9	3.8	3.8	3.6
Gross Domestic Product at purchasers' value	57,098	79,103	113,720	155,780	6.7	7.5	6.5	100.0	100.0	100.0	100.0
PRIMARY SECTOR	17,942	22,223	25,190	28,250	4.4	2.5	2.3	31.4	28.1	22.3	18.3
SECONDARY SECTOR	14,102	23,853	39,900	60,330	11.1	10..8	8.6	24.7	30.2	35.0	38.7
TERTIARY SECTOR	25,049	33,027	48,530	67,200	5.7	8.0	6.7	43.9	41.7	42.7	43.0

Source: MP5 and OPP2

2) Economy in the Kelang Valley Region

Gross Regional Domestic Product (GRDP) by sector for the Federal Territory of Kuala Lumpur and the State of Selangor is given in the OPP2 and the KVPP'88. We did not use the figures of the KVPP'88 to maintain the consistency of the calculations. As we were able to find the GRDP of Kelang Valley Region in OPP2, we used those of the Federal Territory of Kuala Lumpur and the State of Selangor instead. Table 2.2.4 provides GRDP figures in 1990 and 2000.

Table 2.2.4 Estimate of Gross Regional Domestic Product by Sector (Federal Territory and State of Selangor)

(M$ million in 1978 prices)

Sector		Federal Territory	Selangor	Total
Agriculture, forestry and fishing	1990	0.0	1,034.9	1,034.9
	2000	0.0	1,225.1	1,225.1
Mining	1990	17.4	300.8	318.2
	2000	13.8	204.2	218.0
Manufacturing	1990	1,776.7	7,855.4	9,632.1
	2000	2,916.8	19,874.8	22,791.6
Construction	1990	544.7	460.5	1,005.2
	2000	738.7	791.5	1,530.2
Utilities	1990	290.3	175.7	466.0
	2000	514.0	406.4	920.4
Transoprt, storage and communication	1990	593.5	1,420.5	2,104.0
	2000	1,308.4	3,173.7	4,482.1
Wholesale, retail, hotel and restaurant	1990	2,577.9	1,418.7	3,996.6
	2000	5,527.1	3,177.4	8,704.5
Finance, insurance, real estate, business and dwelling	1990	2,243.5	719.8	2,963.3
	2000	4,599.0	1,552.3	6,151.3
Government services	1990	1,528.8	927.6	2,456.4
	2000	2,343.8	1,355.0	3,698.8
Other services	1990	470.3	347.2	817.5
	2000	92235	749.5	1,672.0
GRDP at factor cost	1990	10,043.1	14,661.1	24,704.2
	2000	18,884.1	32,509.9	51,394.0
GRDP at purchasers' value	1990	9,911.8	14,469.7	24,381.2
	2000	17,946.4	30,895.7	48,842.1

Source: OPP2

Table 2.2.5 shows the sectoral proportion of the Gross Regional Domestic Product to the Gross Domestic Product. Whole sale and finance sectors contribute more in FT; those of manufacturing and transport predominate in Selangor.

Table 2.2.5 Regional Share of Gross Domestic Product (Federal Territory and State of Selangor)

Unit: %

Sector		Federal Territory	Selangor	Total
Agriculture, forestry and fishing	1990 2000	0.0 0.0	7.0 5.9	7.0 5.9
Mining	1990 2000	0.2 0.2	3.9 2.3	4.1 2.4
Manufacturing	1990 2000	8.3 5.0	36.7 34.3	45.0 39.3
Construction	1990 2000	19.5 13.5	16.5 14.5	36.1 28.0
Utilities	1990 2000	19.2 13.1	11.6 10.4	30.8 23.5
Transport, storage and communication	1990 2000	10.8 9.2	25.9 22.4	36.7 31.6
Wholesale, retail, hotel and restaurant	1990 2000	29.6 28.1	16.3 16.2	45.9 44.3
Finance, insurance, realestate and business	1990 2000	29.3 27.9	9.4 9.4	38.7 37.3
Government services	1990 2000	18.1 17.9	11.0 10.4	29.0 28.3
Other services	1990 2000	28.4 27.1	21.0 22.0	49.4 49.2
GRDP at factor cost	1990 2000	12.5 11.5	18.3 19.8	30.8 31.4
GRDP at purchasers' value	1990 2000	12.5 11.5	18.3 19.8	30.8 31.4

(2) Industry

1) Federal Territory of Kuala Lumpur

There is not enough information about industries in the Federal Territory of Kuala Lumpur. The Kuala Lumpur Structure Plan 1984 provides some in terms of the factory space. Related data can also be found in Section 2.2.4. Table 2.2.6 gives the actual situation (1983) and plans for land to be occupied by industries. Rough industrial growth by sector may be glimpsed by referring to the GRDP of the Federal Territory of Kuala Lumpur (see Table 2.2.4).

According to the Kuala Lumpur Strcutre Plan 1984, the growth of the big, heavy polluting industries which require large land area is expected to decline. Future growth will be expected in small industries, repair and service activities and medium-sized industries with higher employment densities.

Table 2.2.6 Industrial Land in Federal Territory

Unit : ha

Planning Unit	Actual 1983	Planned 1990	Planned 2000
Central Area	5.3	0	0
Jinjang	130.8	119	119
Sentul	71.6	144	144
Setapak	44.5	93	102
Wangsa Maju	22.6	43	175
Datok Keramat	0	21	30
Maluri	11.2	45	76
Bukit Anggerik	14	74	74
Bandar Tun Razak	14	98	98
Seputeh	42.1	54	54
BukitIndah	125.2	53	53
Bukit Jalil	12.1	39	126
Damansara	0	0	0
Penchala	2.3	46	91
Edinburgh	32.5	36	45
MINDEF	51.3	0	0
Sungai Besi Camp	0	5	6
Chan Sow Lin	0	151	151
TOTAL	579.5	1,021	1,344

Source : K.L. Structure Plan 1984

2) Selangor State

Table 2.2.7 shows the six largest industrial sectors in the State of Selangor in 1981.

All the data was derived from the Selangor Industrial Action Plan. Basic data on the manufacturing industries in the state is given in Tables 2.2.8 and 2.2.9. The Industrial Master Plan of Selangor State (IMP) made use of the projections of industrial growth in terms of output, employment creation, and value added in Malaysia. The plan extended its projection up to 2005 for the first two items, in terms of the State of Selangor. It used two methods. They are constant-share projection (CSP) and shift-share projection (SSP)(*) with two alternative growth scenarios (see Table 2.2.11).

* SSP: X(t)=output in a region at time of t, Y(t)=output in nation at time of t, DR(t)=differential growth rate=X(t+1)/X(t)-Y(t+1)/Y(t),

X(t+1)/X(t)=Y(t+1)/Y(t)+ DR(t), then we assume DR(t) at a base year to be constant over time, i.e., DR(t)=DR for all t. (see Table 2.2.10) If DR>0, then

SSP>CSP. That is the case for Selangor.

Table 2.2.7 Share in Revenue and Employment in 1981 by Major Six Industrial Sectors (Selangor State)

Industrial Sector	% share of revenue	rank by revenue	% share of labour	rank by employment
Food products(311 - 312)	25.8	1	10.4	2
Electrical goods (383)	19.9	2	25.6	1
Rubber products	5.4	3	5.0	6
Fabricated metal products (381)	5.1	4	7.4	3
Transport -equipment(384)	5.1	5	5.7	4
Non-electrical machinery(382)	4.9	6	5.6	5
Subtotal	66.2		59.7	

Figures in parenthesis mean Manufacturing Industry Codes.

Source: Selangor Industrial Action Plan.

Table 2.2.8 Basic Data on Manufacturing Industries by Industry Group, 1987 (Selangor State)

MIC	Description	No. of Estb.	Employ-ment	Land Area ('000 sq.ft)	No. of Estb. %	Employ-ment %	Land Area %	Mean Employ-ment Size	Mean Land Area Size ('000 sq.ft)	Lasnd/ Employ-ment
311	Food Manufacturing	42	979	434.2	3.2	5.3	1.8	23.9	10.3	444
321	Textiles	9	757	65.2	0.7	4.1	0.3	84.1	7.2	86
322	Near Apparel, excluding Footwear	25	253	84.8	1.9	1.4	0.3	10.1	3.3	335
323	Leather & Fur	4	55	17.0	0.3	0.3	0.1	13.8	4.3	309
324	Footwear, excluding Vulcanised Rubber	13	259	66.2	1.0	1.4	0.3	19.9	5.1	256
331	Wood & Cork excluding Furniture	111	2464	6453.2	8.5	13.3	26.1	22.4	58.7	2619
332	Furniture & Fixtures	83	1102	1091.7	6.4	6.0	4.4	13.3	13.2	991
341	Paper Products	13	1276	826.7	1.0	6.9	3.3	98.3	63.6	648
342	Print, Publish & Coal	37	602	292,2	2.8	3.3	1.2	16.3	7.9	485
351	Industrial Chemicals	19	442	674.7	1.5	2.4	2.7	23.3	35.5	1526
352	Other Chemical Products	13	369	86.6	1.0	2.0	0.4	28.4	7.2	235
354	Miscellaneous Petroleum Products & Coal	2	21	7.0	0.2	0.1	0.0	10.5	3.5	333
355	Rubber Products	46	995	1705.3	3.5	5.4	6.9	22.1	37.2	1714
356	Plastic Products, n.e.c.	57	971	626.9	4.4	5.3	2.5	17.0	11.2	646
361	Pottery, China & Earthenware	10	259	613.0	0.8	1.4	2.5	25.9	61.3	2367
362	Glass & Glass Products	10	822	20.1	0.8	4.4	0.1	82.2	2.5	24
369	Non-metalic Mineral Products	15	102	815.2	1.2	0.6	3.3	7.3	54.3	7992
371	Iron & Steel Basic Industries	165	1968	2995.9	12.7	10.6	12.1	12.0	18.3	1522
372	Non-ferrous Metal Basic Industries	30	254	264.6	2.3	1.4	1.1	8.5	8.8	1042
381	Fabricated Metal Products excluding Machinery, Apparatus, Appliances & Supplies	30	176	171.8	2.3	1.0	2.7	5.9	5.7	976
382	Machinery excluding Electrical	19	117	358.4	1.5	0.6	1.5	6.2	18.9	3063
383	Electrical Machinery, Apparatus Appliances & Supplies	44	568	308.5	3.4	3.0	1.2	13.0	7.0	551
384	Transport Equipment	401	2205	3521.5	30.9	11.9	14.3	5.6	8.8	1597
385	Professional, Scientific Measuring & Controlling Equipment	2	7	2.6	0.2	0.0	0.0	3.5	1.3	371
390	Other Manufacturing	99	1469	3194.5	7.6	7.9	12.9	15.0	32.6	2175
	Total	1299	18484	24697.8	100.0	100.0	100.0	14.4	19.1	1336

Source: Selangor Industrial Action Plan Industrial Listing, 1987

Table 2.2.9 Basic Data on Manufacturing Industries by Location, 1987 (Selangor State)

Location	District	No. of Estb.	Employ-ment	Land Area ('000 sq.ft)	No. of Estb. %	Employ-ment %	Land Area ('000 sq.ft)	Mean Employ-ment Size	Mean Land Area Size ('000 sq.ft)	Land/ Employ-ment
Gombak	Gombak	62	522	203.8	4.8	2.8	0.8	9.0	3.4	390
Batu Caves & Selongor	Gombak	200	2473	4327.6	15.4	13.4	17.5	12.4	21.6	1750
Rawang	Gombak	62	586	1407.8	4.8	3.2	5.7	9.5	22.7	2402
Kelang & Sg Rasa	Kelang	207	2259	1991.1	15.9	12.2	8.1	10.9	10.0	881
Kapar & Meru	Kelang	20	965	2668.0	1.5	5.2	10.8	48.3	133.4	2765
Pelabuhan Kelang	Kelang	26	386	996.6	2.0	2.1	4.0	14.8	41.5	2572
Kampung Puchong	Petaling	120	1360	2486.1	9.2	7.4	10.1	11.5	20.5	1828
Subang	Petaling	40	996	806.5	3.1	5.4	3.3	26.2	20.7	810
Sg Buloh	Petaling	87	1550	2062.7	6.7	8.4	9.4	18.2	24.3	1331
Kg Subang	Petaling	75	1853	1871.6	5.8	10.0	7.6	25.0	25.3	1010
Seri Kembangan	Petaling	125	1479	628.3	9.6	8.0	2.5	11.8	5.0	425
Bzranang	Ulu Langat	66	334	727.6	5.1	1.8	2.9	5.4	13.3	2178
Kajang/Sg Chua	Ulu Langat	44	1397	815.0	3.4	7.6	3.3	31.8	18.5	583
Semenyih	Ulu Langat	34	167	211.7	2.6	0.9	0.9	4.9	6.2	1268
Vatu 9 Cheras	Ulu Langat	24	518	818.5	1.8	2.8	3.8	21.6	34.1	1580
Balakong	Ulu Langat	35	808	1890.4	2.7	4.4	4.4	23.1	31.2	1350
Batu 11 Cheras	Ulu Langat	55	650	1259.2	4.2	3.5	5.1	11.8	22.9	1937
Batang Kali	Ulu Langat	17	181	319.0	1.3	1.0	1.3	10.6	18.8	1762
Total		1299	18484	24691.5	100.0	100.0	102.0	14.3	19.3	1336

Source: Selangor Industrial Action Plan Industrial Listing, 1987

Table 2.2.10 Projection of Output and Employment of Manufacturing Industries, Selangor (Shift-Share Case)

Shift-Share Projection of Output of Manufacturing Industries, Selangor, 1985-2005 (according IMP Projection)

	1985-1990			1990-1995			1995-2000			2000-2005			
Sector	1985	RM	DR	1990	RM	DR	1995	RM	DR	2000	RM	DR	2005
Food Processing	4818	7.3	1.6	6142	5.0	0.8	8142	6.0	0.8	11309	5.9	0.8	15626
Textiles	401	10.3	-1.8	603	10.1	-0.9	936	10.0	-0.9	1446	9.9	-0.9	2222
Food Products	1824	6.9	5.1	1805	6.1	2.6	2777	6.5	2.6	4290	6.4	2.6	6594
Chemical & Petrochemical Products	1545	7.3	-1.9	2010	6.2	8.9	2682	6.6	-8.9	3432	6.5	-0.9	4561
Rubber Products	810	8.7	1.3	1385	8.3	8.6	1998	8.3	8.6	3059	8.2	8.6	4657
Non-metalic Mineral Products	868	8.9	1.6	1450	8.4	0.8	2251	8.5	0.8	3518	8.4	0.8	5443
Basic Metal Products	1037	9.4	5.0	2032	8.8	2.5	3470	8.9	2.5	5951	8.8	2.5	10150
Machinery & Transport Equipment	2694	9.1	3.3	4833	9.1	1.6	8035	8.9	1.6	13229	8.8	1.6	21668
Electrical & Electronics	2922	18.6	0.0	4836	9.8	1.3	8185	18.8	1.3	13971	9.9	1.3	23720
Total Manufacturing	15323	8.4		25014	7.5		38396	7.9		60197	7.9		94581

Shift-Share Projection of Employment of Manufacturing Industries, Selangor, 1985-2005 (according IMP Projection)

	1985-1990			1990-1995			1995-2000			2000-2005			
Sector	1985	RM	DR	1990	RM	DR	1995	RM	DR	2000	RM	DR	2005
Food Processing	23361	5.2	1.14	31310	3.9	8.62	39884	4.2	8.56	49236	4.8	8.54	61567
Taxtiles	8658	8.7	-1.52	12230	7.7	-8.69	17140	7.9	-8.71	24254	7.7	-8.78	34841
Food Products	21272	4.3	3.17	30481	3.0	1.22	37441	3.3	1.32	46954	3.1	1.26	58222
Chemical & Petrochemical Products	19321	5.5	-1.43	23564	5.8	-0.73	29077	5.0	-0.68	35937	4.8	-0.66	44877
Rubber Products	11875	8.2	1.23	18634	8.0	8.58	28130	7.8	0.56	42026	7.6	0.56	62253
Non-metalic Mineral Products	11296	7.5	1.35	17264	7.5	0.71	25645	7.2	0.68	37474	7.8	0.67	54272
Basic Metal Products	19414	7.9	4.28	34391	7.8	2.22	55474	7.6	2.13	88250	7.4	2.18	139932
Machinery & Transport Equipment	29832	7.8	2.83	49479	8.2	1.44	78342	7.7	1.30	128981	7.5	1.36	185088
Electrical & Electronics	40458	9.5	0.00	63603	9.1	1.21	103841	9.0	1.17	160505	8.8	1.16	271812
Total Manufacturing	185179	7.8		280957	6.6		414094	6.8		613618	6.8		989564

Table 2.2.11 Output and Employment Projection Results for Selangor, 1985 - 2005

	Output (M$ bil. 1981 constant Price)					Employment ('000)				
	1985	1990	0995	2000	2005	1985	1990	1995	2000	2005
IMP Scenario										
1) Constant-share assumption	15.3	22.9	32.8	48.0	70.2	185.2	263.6	370.8	523.7	738.6
2) Shift-share assumption	15.3	25.0	38.4	60.2	94.6	185.2	281.0	414.4	613.8	989.6
Alternative 1 Scenario										
1) Constant-share assumption	15.3	20.5	29.4	43.1	63.0	185.2	235.2	331.1	467.7	659.6
2) Shift-share assumption	15.3	22.4	34.5	54.1	84.9	185.2	249.0	367.3	544.6	887.7
Alternative 2 Scenario										
1) Constant-share assumption	15.3	20.5	27.4	36.7	49.1	185.2	235.2	309.9	402.1	520.9
2) Shift-share assumption	15.3	22.4	32.2	46.2	66.5	185.2	249.0	343.5	467.2	635.7

	Growth rates per annum			Growth rates per annum		
	1985-1990	1990-1995	1995-2000	1985-1990	1990-1995	1995-2000
IMP Scenario						
1) Constant-share assumption	8.4	7.5	7.9	7.3	7.1	7.1
2) Shift-share assumption	10.3	9.0	9.4	8.7	8.1	8.2
Alternative 1 Scenario						
1) Constant-share assumption	6.8	7.5	8.0	4.9	7.1	7.2
2) Shift-share assumption	7.9	9.0	9.4	6.1	8.1	8.2
Alternative 2 Scenario						
1 Constant-share assumption	6.0	6.0	6.0	4.9	5.7	5.3
2) Shift-share assumption	7.9	7.5	7.5	6.1	6.6	6.3

	% share of Malaysia					% share of Malaysia				
	1985	1990	0995	2000	2005	1985	1990	1995	2000	2005
IMP Scenario										
1) Constant-share assumption	30.0	30.0	30.0	30.0	30.0	25.0	25.0	25.0	25.0	25.0
2) Shift-share assumption	29.8	32.5	34.9	34.8	40.2	24.4	26.4	28.3	30.2	32.2
Alternative 1 Scenario										
1) Constant-share assumption	30.0	30.0	30.0	30.0	30.0	25.0	25.0	25.0	25.0	25.0
2) Shift-share assumption	29.8	32.6	34.9	37.4	48.2	24.4	26.2	28.1	30.8	32.0
Alternative 2 Scenario										
1) Constant-share assumption	30.0	30.0	30.0	30.0	30.0	25.0	25.0	25.0	25.0	25.0
2) Shift-share assumption	29.8	32.6	35.0	37.5	40.3	24.4	26.2	28.1	29.9	31.9

2.2.4 Land Use, Urban Area and Solid Waste

Tables 2.2.12 (1) and (2) show the use of land in the Kelang Valley Region and its urban area in 1986. Urban area map and city hierarchy of the region are given in Figs.2.2.3 and 2.2.4.

Table 2.2.12 (1) Landuse in 1986 (1)

unit :ha

	F. T.		Petaling		Klang		Gombak		H.Langat		KVR	
Agri.Field	3,530	14.5%	13,947	28.6%	29,437	46.7%	12,232	18.7%	30,626	36.9%	89,772	31.6%
Forest	63	0.3%	11,981	24.6%	397	0.6%	35,578	54.5%	33,035	39.8%	81,054	28.5%
Mine	972	4.0%	838	1.7%	20	0.0%	2,051	3.1%	64	0.1%	3,945	1.4%
Marsh	0	0.0%	1,020	2.1%	24,678	39.2%	1,085	1.7%	1,847	2.2%	28,630	10.1%
URBAN AREA	**19,805**	**81.3%**	**16,053**	**32.9%**	**3,653**	**5.8%**	**8,361**	**12.8%**	**8,803**	**10.6%**	**56,675**	**19.9%**
Sec.Jungle	0	0.0%	1,490	3.1%	922	1.5%	2,063	3.2%	3,091	3.7%	7,566	2.7%
Others	0	0.0%	3,401	7.0%	3,878	6.2%	3,948	6.0%	5,478	6.6%	16,705	5.9%
Total	24,370	100.0%	48,730	100.0%	62,985	100.0%	65,318	100.0%	82,944	100.0%	284,347	100.0%

Souce: KVPP'88 Ch.4

Table 2.2.12 (2) Landuse in 1986 (2) Urban Area

unit : ha

	F. T.		Petaling		Klang		Gombak		H.Langat		KVR	
Residential	8,430	42.6%	11,388	70.9%	1,274	34.9%	1,674	20.0%	3,425	38.9%	26,190	46.2%
Commercial	1,334	6.7%	414	2.6%	112	3.1%	90	1.1%	423	4.8%	2,373	4.2%
Industrial	624	3.2%	1,870	11.6%	306	8.4%	170	2.0%	454	5.2%	3,424	6.0%
Public Service	3,106	15.7%	1,405	8.7%	578	15.8%	172	2.1%	1,303	14.8%	6,564	11.6%
Recreation	945	4.8%	4,737	29.5%	56	1.5%	160	1.9%	1,652	18.8%	7,549	13.3%
Others	5,366	27.1%	-3,759	-23.4%	1,327	36.3%	6,096	72.9%	1,546	17.6%	10,575	18.7%
Total	19,805	100.0%	16,053	100.0%	3,653	100.0%	8,361	100.0%	8,803	100.0%	56,675	100.0%

Souce: KVPP'88 Ch.4

Land requirements for various purposes associated with the advancement of urbanization in the region are estimated in the KVPP'88 (see Table 2.2.13). The Table clearly shows that the Federal Territory of Kuala Lumpur will be short of land by 2000, which partly explains the urban sprawl phenomena beyond its boundaries. The negative figure in Petaling in Table 2.2.12 (2) clearly shows that actual urban area has exceeded the designated area.

Fig.2.2.5 shows the urban development strategy in the Kelang Valley Region planned by the KVPP.

The quantity of solid waste will increase with population growth. The KVPP'88 estimates of the increase are shown in Table 2.2.14.

Development plans for the collection of waste and sanitary landfills are given in Fig.2.2.6 and 2.2.7.

Table 2.2.13 Future Land Requirement in Urban Area between 1985 and 2000

unit : ha

	F. T.		Petaling		Klang		Gombak		H.Langat		KVR	
Residential	6,144	55.2%	3,697	47.1%	1,460	37.3%	2,641	41.1%	1,382	52.5%	15,324	47.9%
Commercial	143	1.3%	83	1.1%	69	1.8%	20	0.3%	20	0.8%	335	1.0%
Industrial	1,919	17.2%	2,712	34.6%	1,678	42.8%	3,056	47.5%	361	13.7%	9,726	30.4%
Public Service	914	8.2%	441	5.6%	225	5.7%	122	1.9%	480	18.2%	2,182	6.8%
Recreation	2,014	18.1%	916	11.7%	484	12.4%	590	9.2%	391	14.8%	4,395	13.7%
Total	11,134	100.0%	7,849	100.0%	3,916	100.0%	6,429	100.0%	2,634	100.0%	31,962	100.0%
1985-1990	2,866	25.7%	2,612	33.3%	998	25.5%	1,421	22.1%	598	22.7%	8,496	26.6%
1990-1995	3,301	29.6%	1,710	21.8%	1,066	27.2%	1,513	23.5%	715	27.1%	8,304	26.0%
1995-2000	4,966	44.6%	3,528	44.9%	1,852	47.3%	3,496	54.4%	1,320	50.1%	15,161	47.4%
Total	11,134	100.0%	7,849	100.0%	3,916	100.0%	6,429	100.0%	2,634	100.0%	31,962	100.0%

Source: KVPP'88 Ch.4

Table 2.2.14(1) Solid Waste 1980 - 2005

(Unit : ton/day)

	1980	1985	1990	1995	2000	2005
FT	965	1,977	2,386	2,619	3,070	3,478
Petaling	693	1,058	1,185	1,347	1,547	1,784
Klang	261	318	497	675	875	1,077
Gombak	76	202	399	574	825	1,082
Hulu Langat	131	226	360	483	626	770
Total	2,126	3,781	4,827	5,697	6,943	8,191

Table 2.2.14(2) Average Annual Growth Rate of Solid Waste

(Unit : %)

	1980-85	1985-90	1990-95	1995-00	2000-05
FT	15.4	3.8	1.9	3.2	2.5
Petaling	8.8	2.3	2.6	2.8	2.9
Klang	4.0	9.3	6.3	5.4	4.2
Gombak	21.6	14.6	7.5	7.5	5.6
Hulu Langat	11.5	9.8	6.1	5.3	4.2
Total	12.2	5.0	3.4	4.0	3.4

Source : KVPP '88

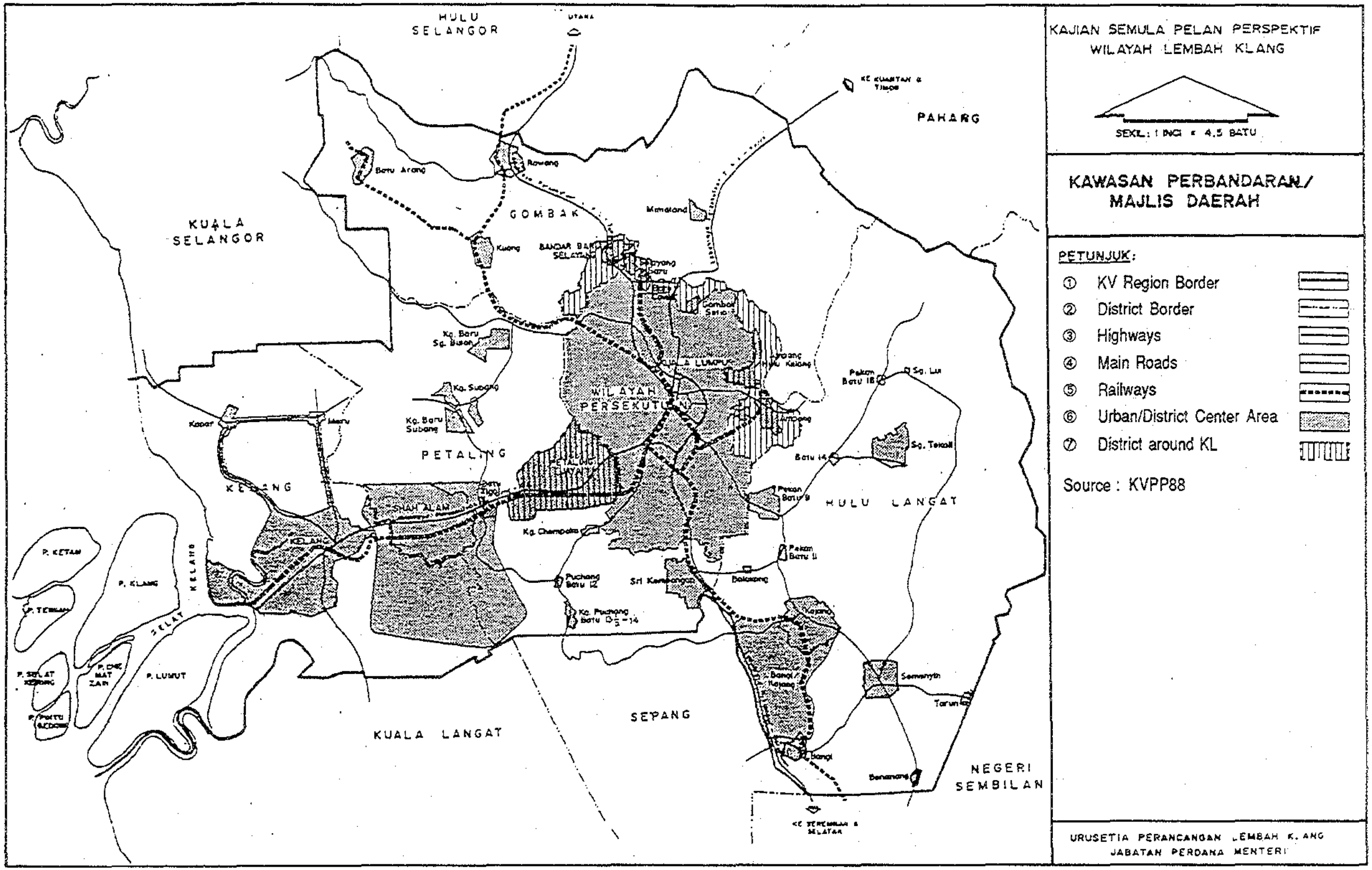


Fig. 2.2.3 Urban Area Map of Kelang Valley Region

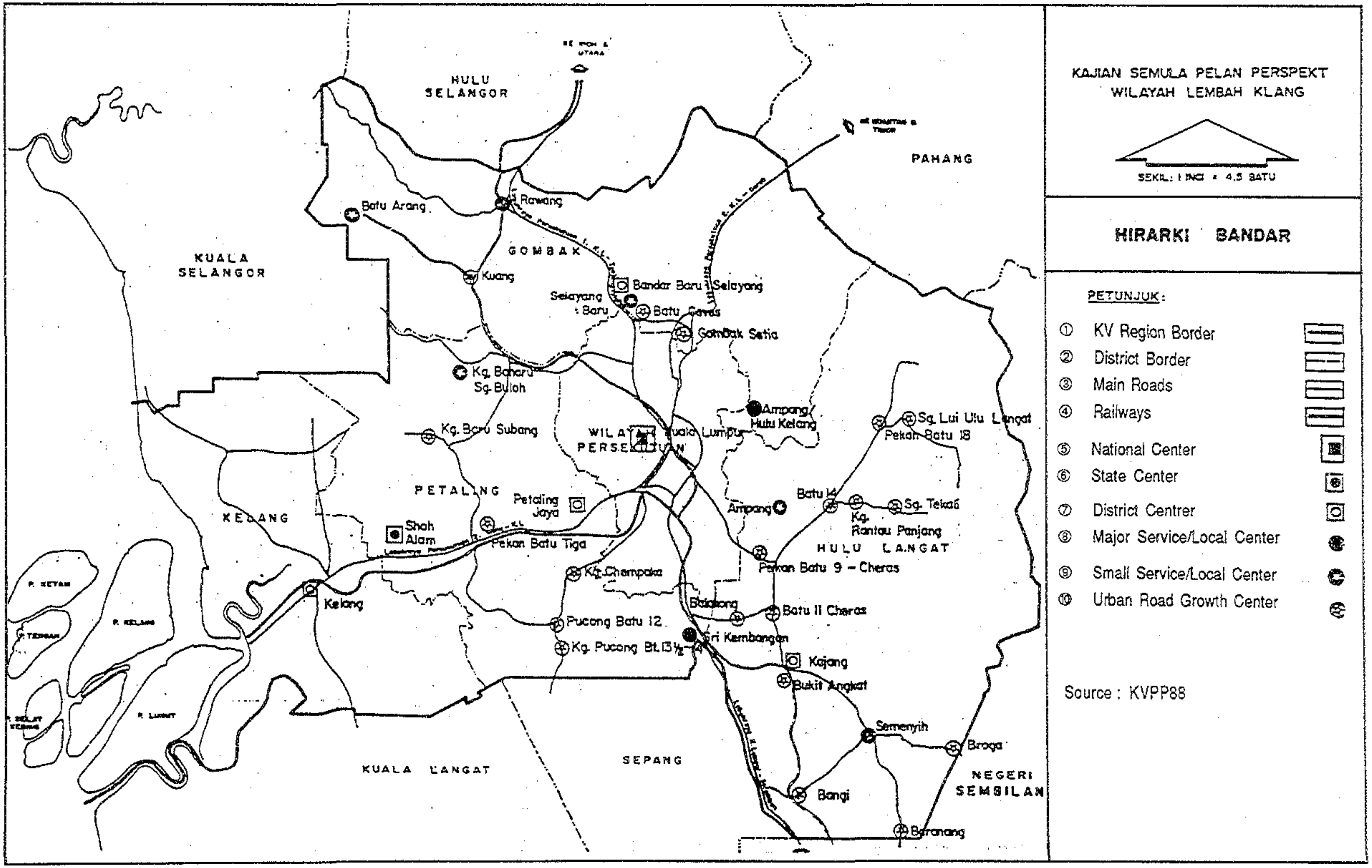


Fig. 2.2.4 City Hierarchy in Kelang Valley Region

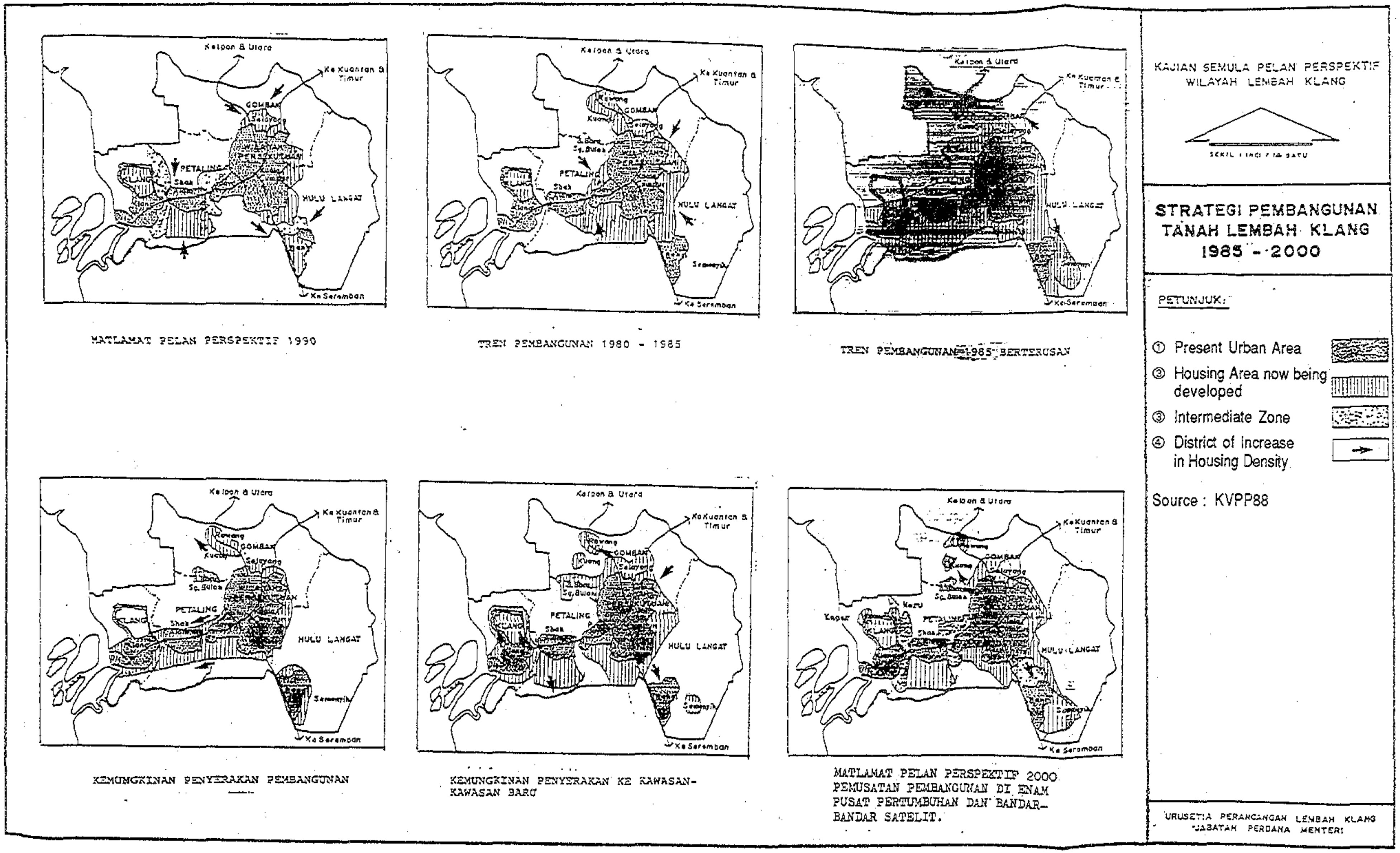


Fig. 2.2.5 Urban Development Strategy Map in Kelang Valley Region

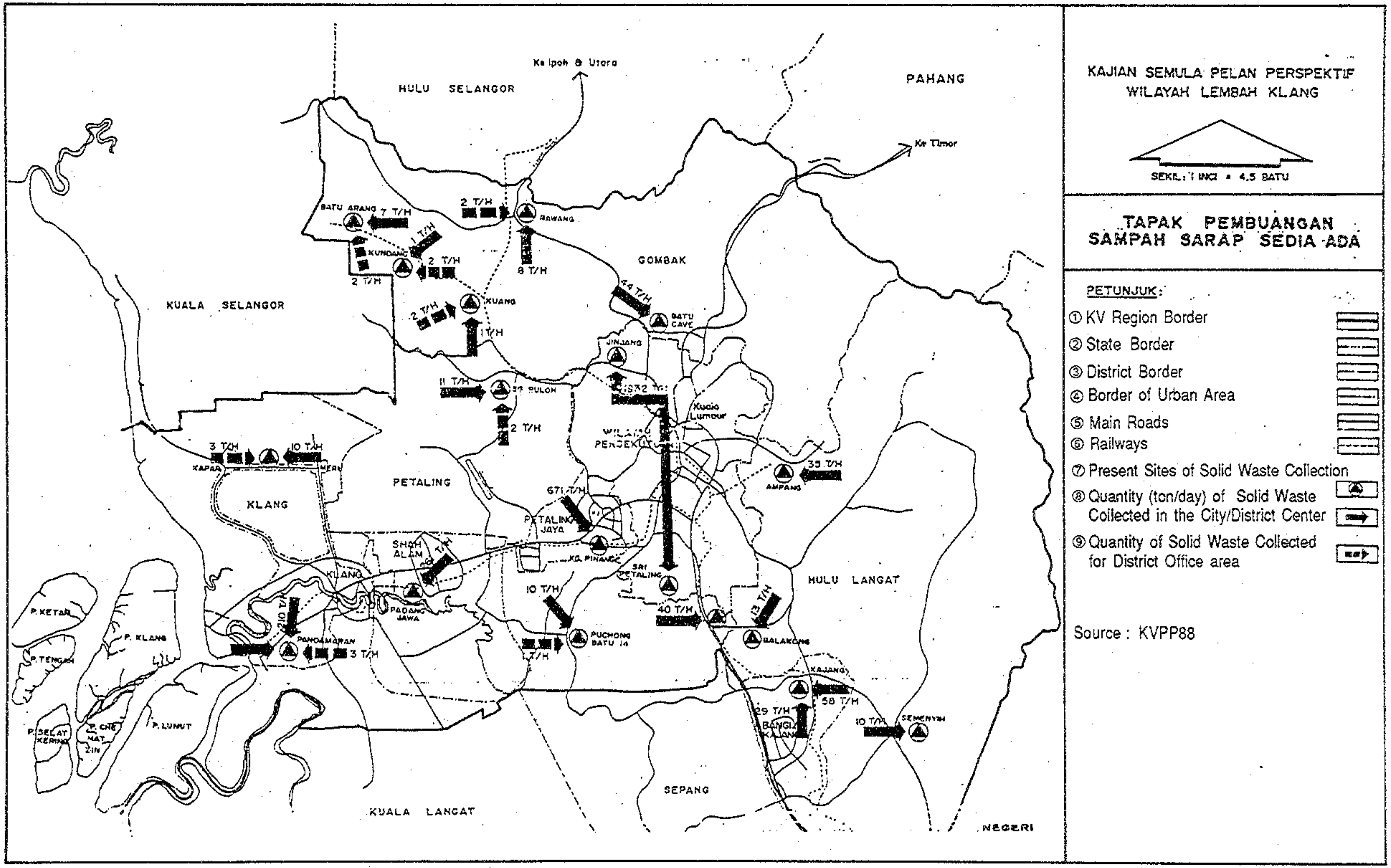


Fig. 2.2.6 Plan for Waste Collection in Kelang Valley Region

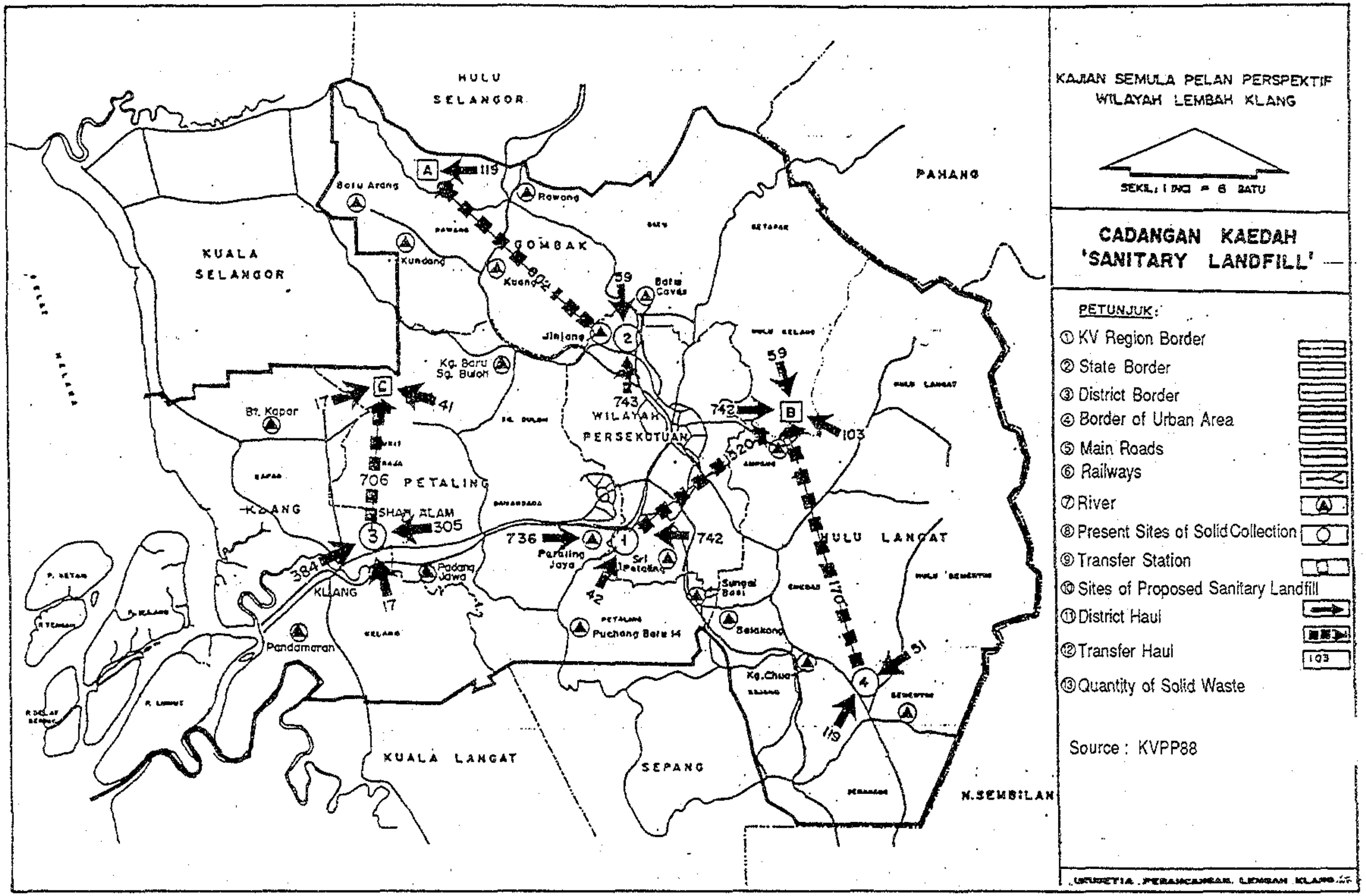


Fig. 2.2.7 Plan for Sanitary Landfills in Kelang Valley Region

2.2.5 Transport

(1) Land Transport

1) Road

The total length of roads in the Federal Territory of Kuala Lumpur and State of Selangor is given in Table 2.2.15; the maps of distribution of roads within Kelang Valley Region are shown in Figs. 2.2.8(1) and (2).

Table 2.2.15 Road Length: Federal Territory of Kuala Lumpur and State of Selangor

unit: km

	Federal Territory of K.L		State of Selangor			
	Total	paved:%	Federal	State	Total	paved:%
1985	346	87%	678	2,782	3,460	77%
1990	1,066	97%	690	7,862	8,582	86%

Source: KVPP'88

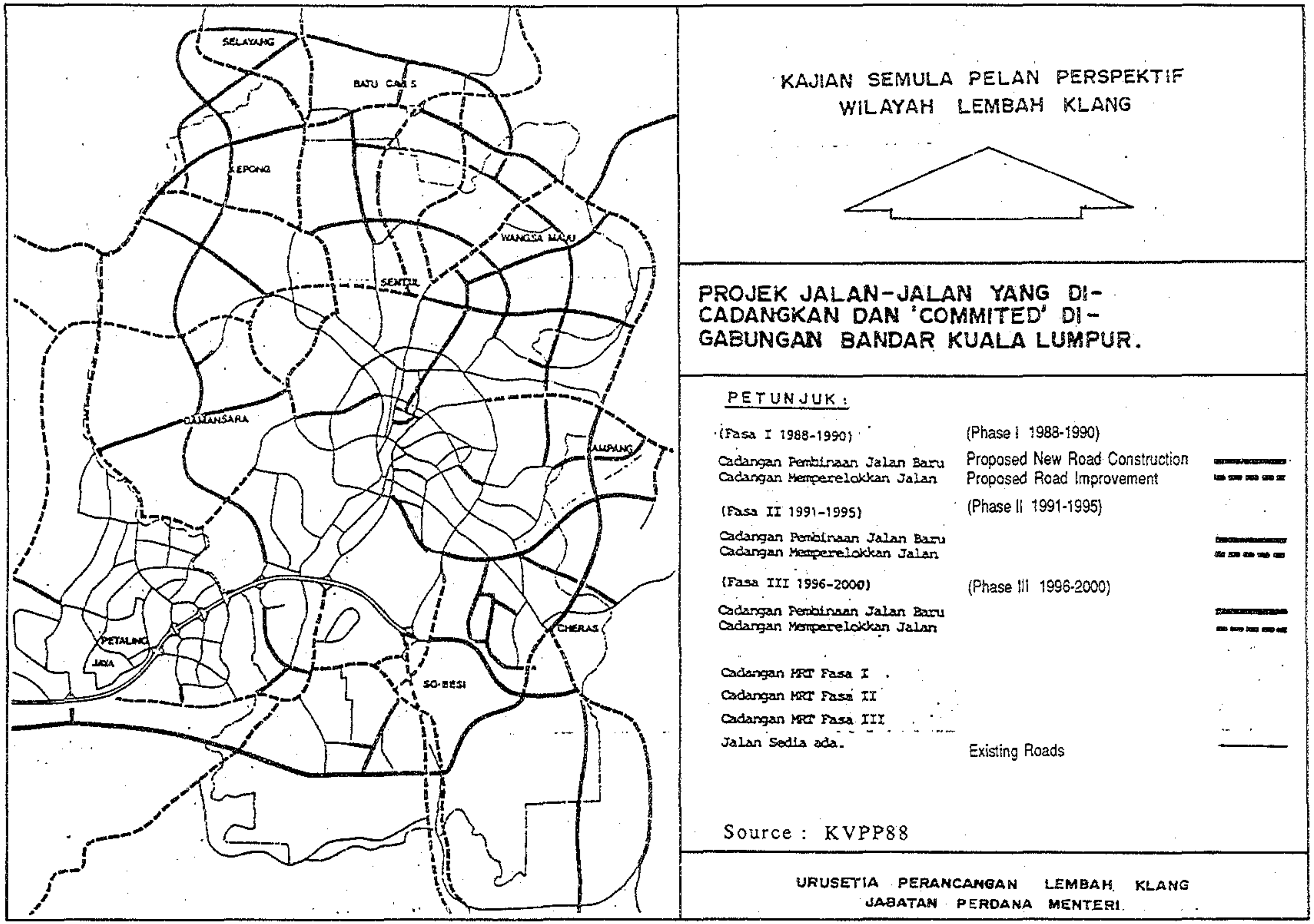


Fig. 2.2.8 (1) Road Network in Kuala Lumpur

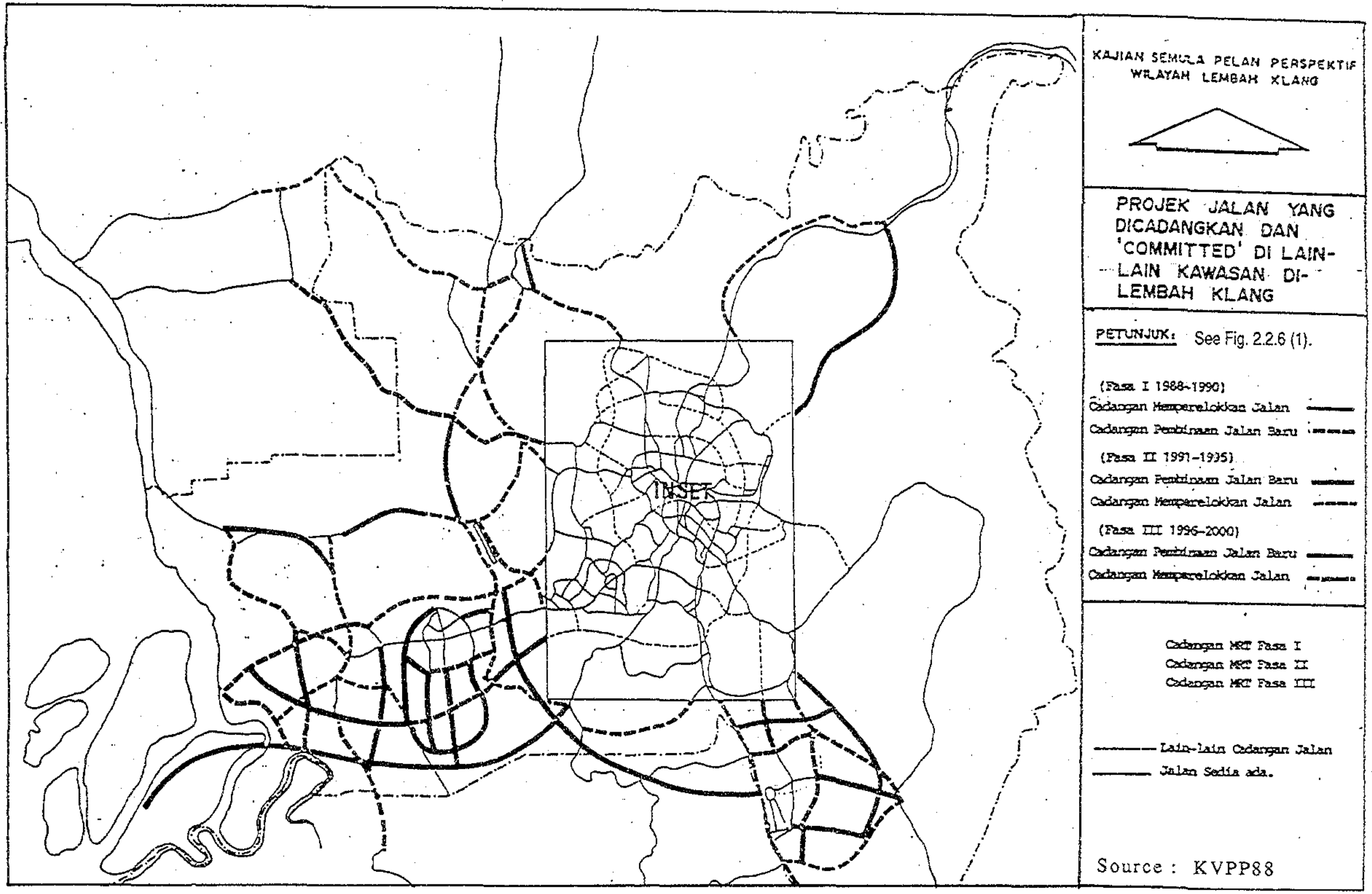
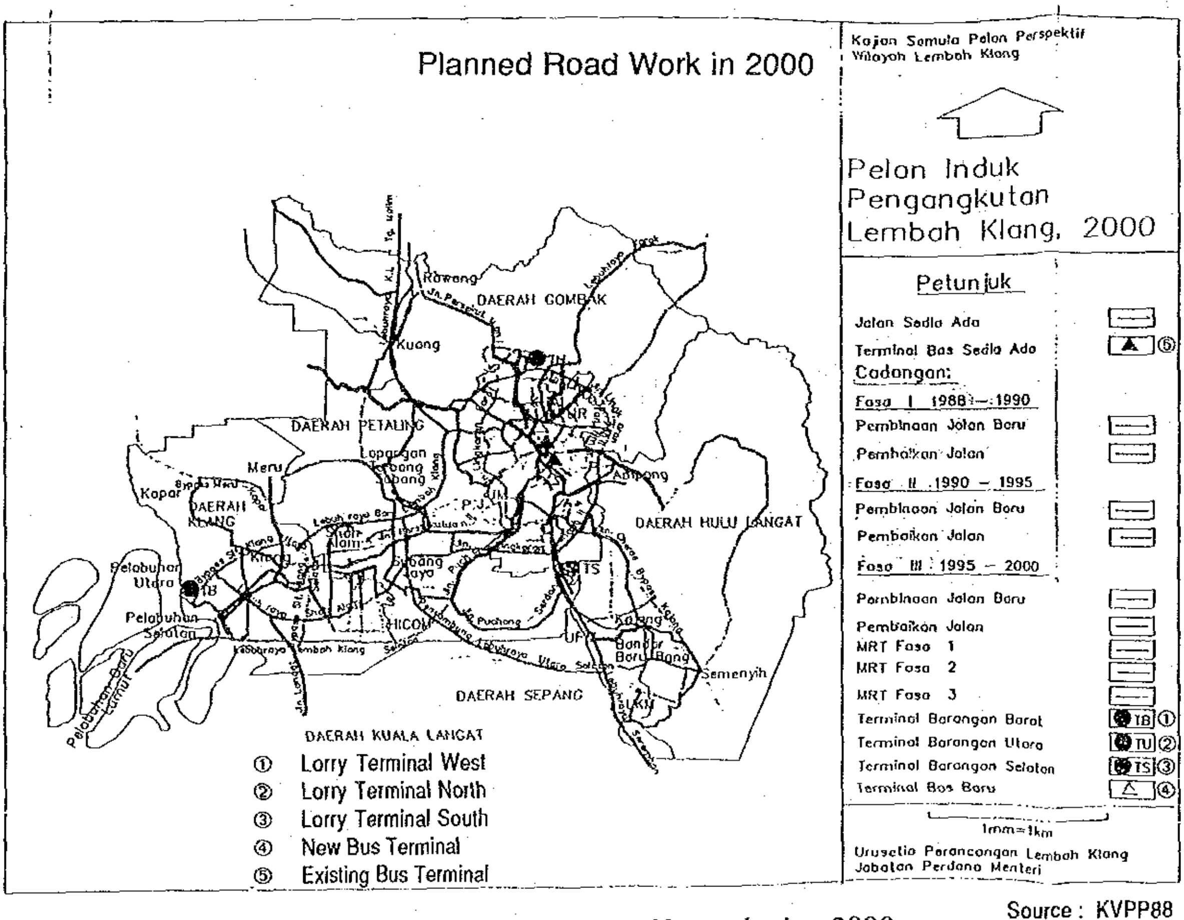


Fig. 2.2.8 (2) Road Network in Kelang Valley Region

Two construction programs are to be implemented within Kelang Valley Region, during the 6th Malaysian Plan period for expressways, i.e., the upgrading of the KL-Karak Expressway and North-South Toll Expressway (privatized project*) and two projects for highways, i.e., the KL-Petaling Jaya Traffic Dispersal Scheme and the road and bridge construction to Pulau Lumut, Klang (approach to West Port of Klang).

* financed not by the government but by a private party approved by the government. BOT [Build, Operate and Transfer (to the government after certain periods of operation)] is a type of privatized project.

A planned road network in 2000 is shown in Fig.2.2.9.



Source : KVPP88

Fig.2.2.9 Planned Road Network in 2000

2) Vehicles

Table 2.2.16 shows the cumulative number of vehicles registered in the Federal Territory of Kuala Lumpur and the State of Selangor at the end of 1991.

Table 2.2.16 Number of Vehicles

Vehicle Type	Federal Territory of K.L			Selangor				
	1991			1980	1983	1991		
	Total	Petrol	Diesel	Total	Total	Total	Petrol	Diesel
Motorcycle	210,021	210,021	0	276,388	341,340	479,015	479,015	0
Motor Car	290,917	283,611	7,306	214,258	255,755	380,255	369,596	10,659
Taxi	5,355	3,503	1,852	4,793	5,138	6,215	2,385	3,830
Rental Car	2,391	2,351	40	0	0	739	535	204
Bus	3,747	89	3,658	3,548	3,936	4,800	427	4,373
Lorry	39,355	23,499	15,856	47,725	54,726	84,363	42,619	41,744
Others	42,240	4,153	38,087	0	0	18,889	4,132	14,757
Total	594,026	527,227	66,799	546,712	660,895	974,276	898,709	75,567

Source:Industrial Action Plan 1984, Dep. of Road Transport

The total number of registered vehicles in Federal Territory of Kuala Lumpur and Selangor State in 1991 is about 1.57 million. The share of petrol and diesel vehicles are 91% and 9% respectively.

Motorcycles account for 44% of the total registered vehicles, followed by motor car at 43%. Together, they account for 87% of the total vehicles.

Vehicle types with a high diesel ratio are buses (94%), others (86%), taxis (49%), and lorries (47%).

The average annual vehicle growth rate in the State of Selangor is shown in Table 2.2.17. During 1980-1983 and 1983-1991, the average annual total vehicle growth rate decreased slightly from 6.5% to 5.0%, while those of motorcycles and motor cars dropped sharply from about 20% to 5%.

Table 2.2.17 Average Annual Vehicle Growth Rate (Selangor State)

unit: %

Vehicle Type	'80 - '83	'83 - '91
Motorcycle	20.1	4.3
Motor car	21.1	5.1
Taxi	9.0	2.4
Rent a Car	na	na
Bus	3.5	2.5
Lorry	4.7	5.6
Others	na	na
Total	6.5	5.0

Source: Industrial Action Plan, 1984

(a) Means of Transport

a) Industrial Use of Lorries

The Kelang Valley Transport/Selangor Industrial Action Plan Survey 1987 estimates the number of industrial trips generated in the State of Selangor as given in Table 2.2.18.

Table 2.2.18 Industrial Trips Generated in Selangor in 1985

	Trips/car(16h)	Trips/ha
Petaling Jaya	53,438	70
Klang Central	26,147	231
Gombak West	21,376	110
Hulu Langat South	14,887	33
Shah Alam	na	15
Selangor (on average)	na	34

Source: Selangor Industrial Action Plan, 1987

Fig. 2.2.10 includes the figures on trip attraction and generation to Selangor; Fig. 2.2.11(1) on traffic conditions in 1985, and Fig.2.2.11 (2) forecast for 2005.

The same survey shows that the mode of transport for industrial products are as follows:

Road 91.2 %, road and sea 5.6 %, road and air 1.3 %, road and rail 1.3 %, rail and sea 0.3 %, and rail and air 0.3 %.

b) Bus

Major bus routes within Kelang Valley Region are shown in Fig.2.2.12. There were a dozen private bus service companies in operation with a total fleet of 1,141 buses in 1984. The total daily scheduled bus services amounted to 18,341 (see Table 2.2.19).

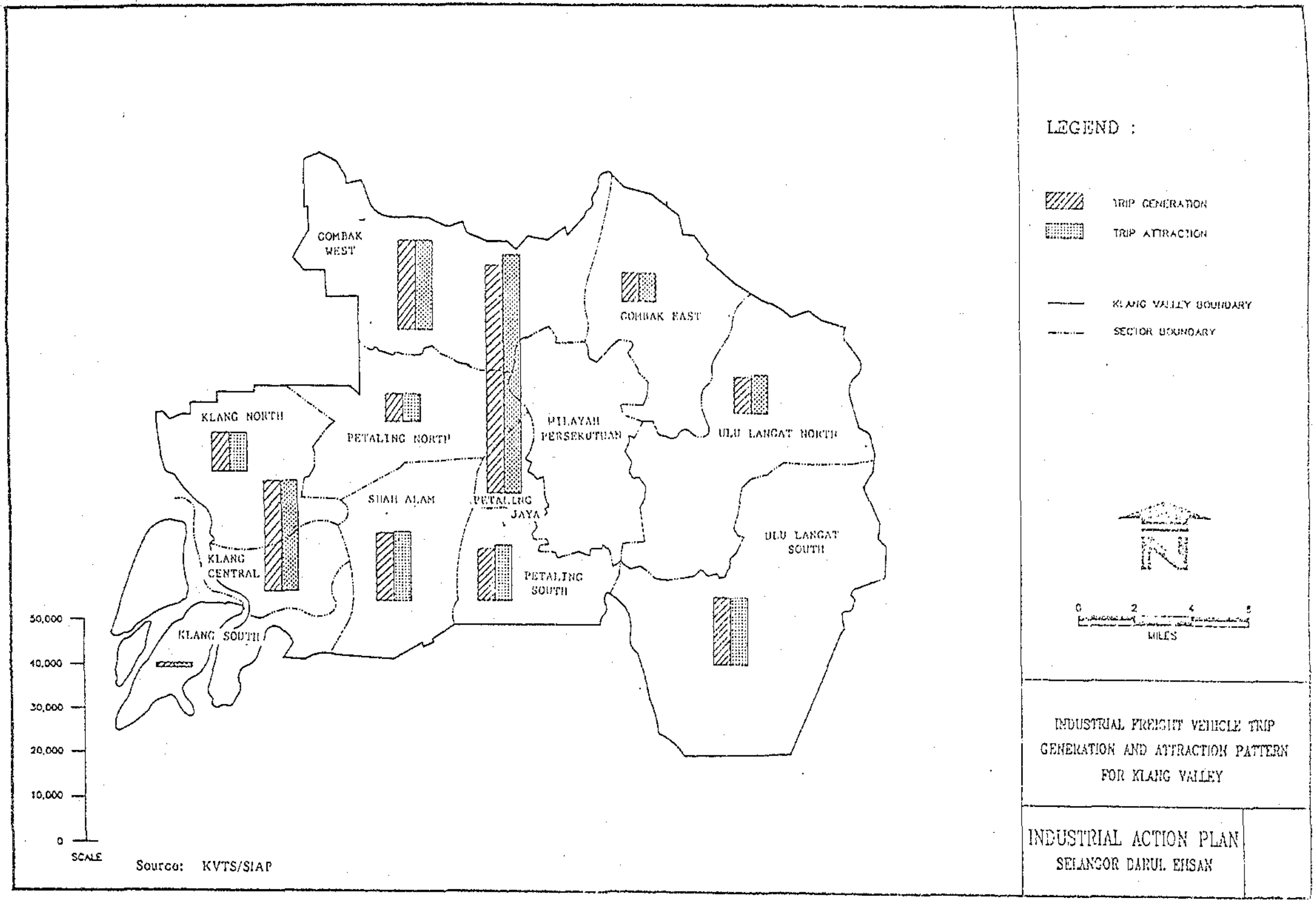


Fig. 2.2.10 Trip Generation and Attraction in Selangor

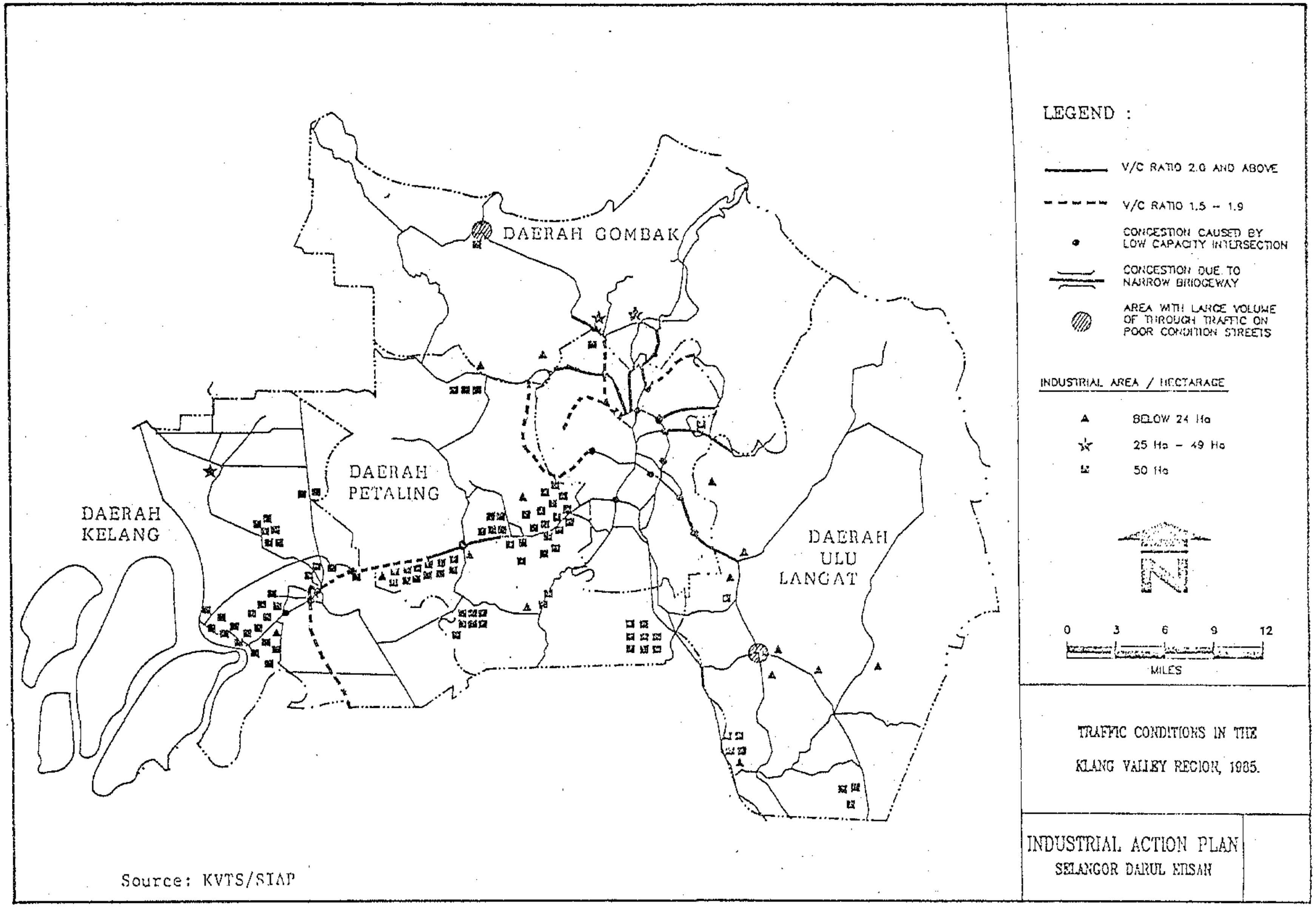


Fig. 2.2.11 (1) Traffic Conditions in Selangor in 1985

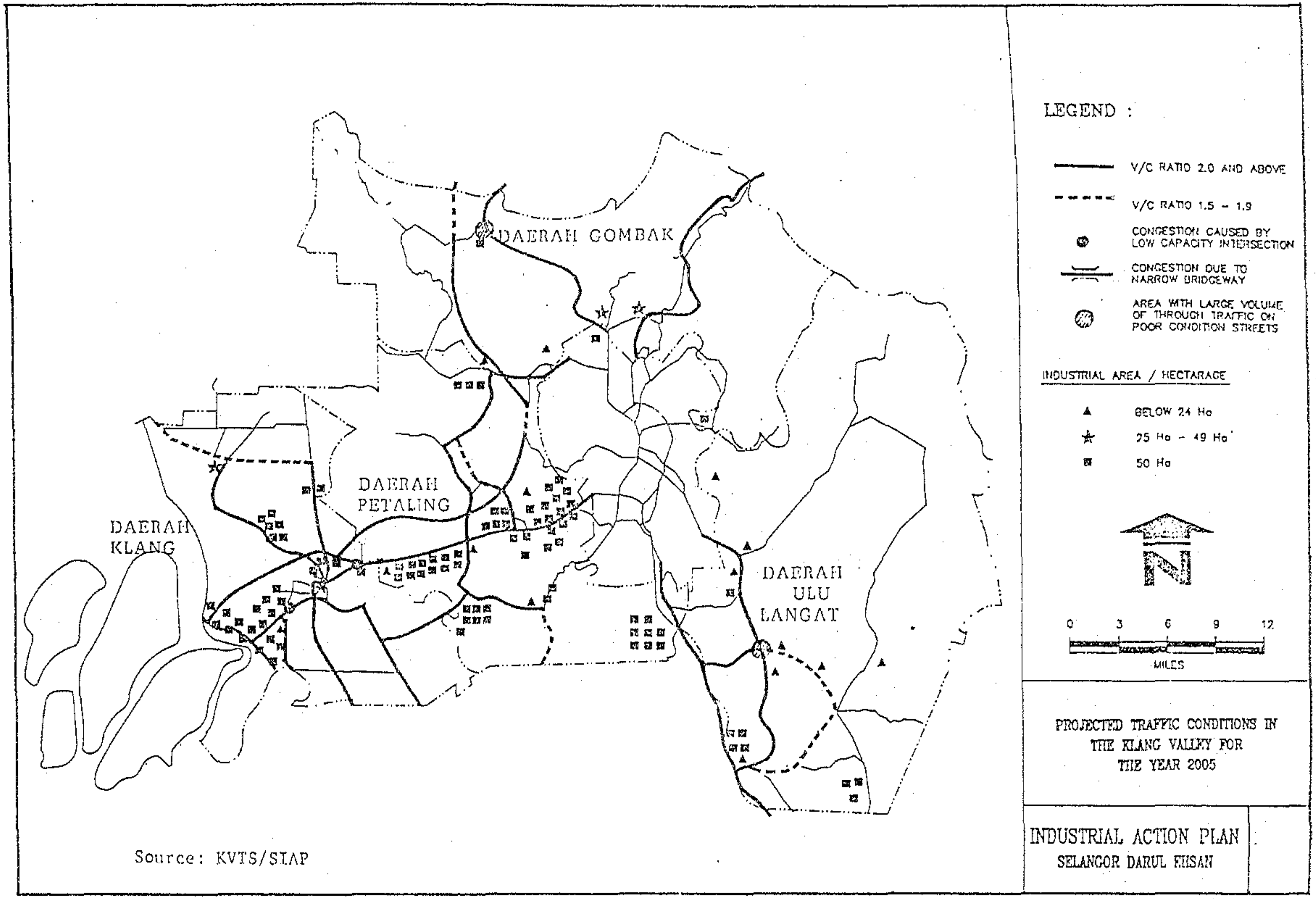
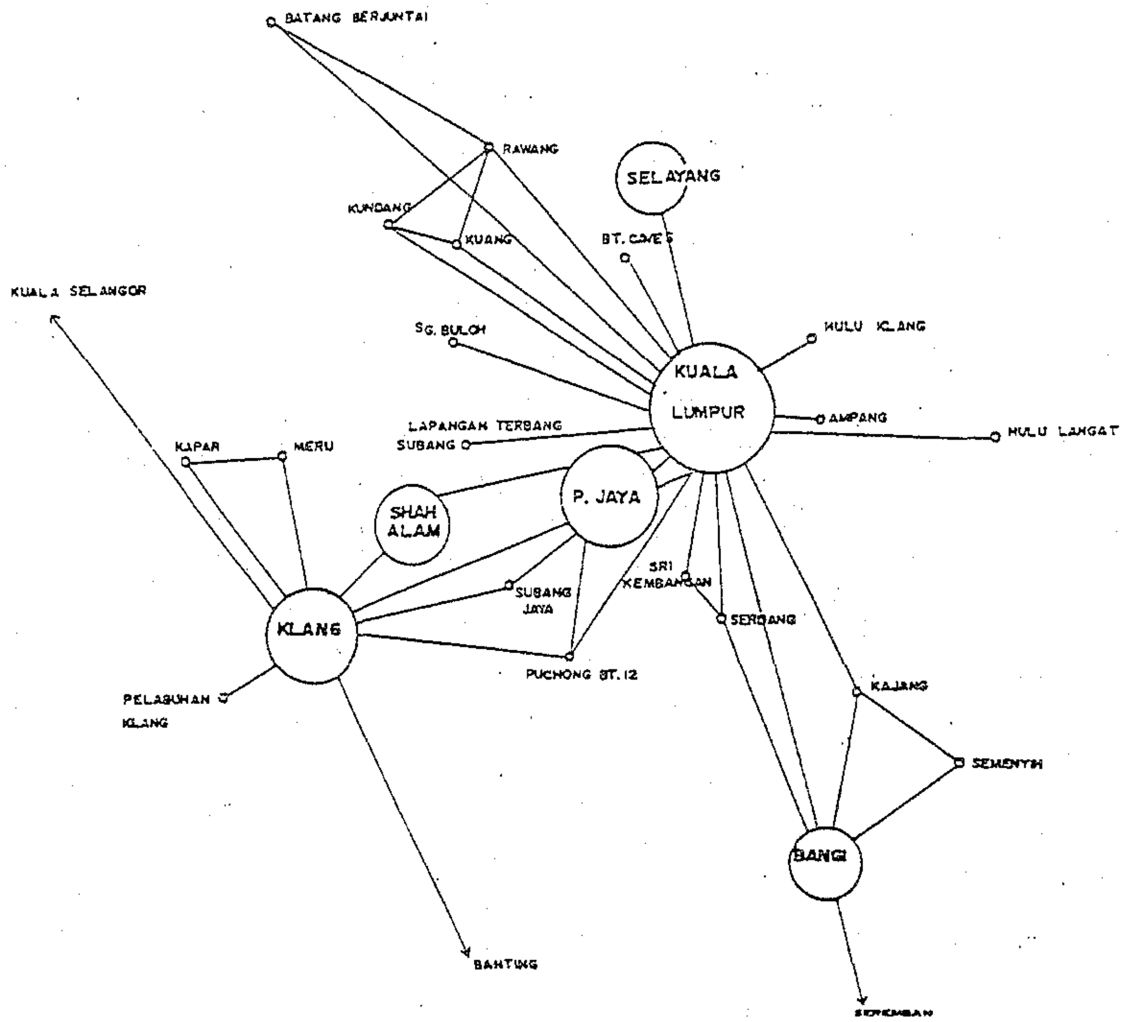


Fig. 2.2.11 (2) Traffic Conditions in Selangor in 2005



Source : KVPP88

Fig. 2.2.12 Bus Routes in Kelang Valley Region

Table 2.2.19 Total Daily Bus Service in Kelang Velley Region

Bus Company	No. of Buses (Unit)	No. of Routes (Unit)	Total Operating Length (km)	No. of Scheduled Daily Trip (Unit)
Lean Omnibus	87	31	628	1,501
Lean Ngiap Omnibus	10	1	48	46
Selangor Omnibus	65	14	361	634
Klang - Banting	98	25	407	1,009
Kuala Selangor Omnibus	45	10	206	681
Foh Hup Omnibus	118	19	417	1,839
Kuala Selangor Omnibus	128	41	788	2,596
Leng Seng Omnibus	72	13	180	1,162
Len chee Omnibus	30	8	84	884
Toong Fong Omnibus	108	24	297	1,323
Sri Jaya Kenderaan Sdn. Bhd.	361	64	1,003	6,408
Total	1,141	257	4,567	18,341

Source: Laporan Teknikal Kajian Pengangkutan Wilayah Lembah Klang

Government bus services were also available on 64 routes. Actual operation was entrusted to some of the above mentioned bus companies. Express "inter-regional" bus services were operated on the routes given in Fig.2.2.13. Mini-bus services were also operated. A total of 490 mini-buses were in service on 39 routes. Meanwhile, 851 school buses and 152 factory buses were in service as of June 30, 1985.

c) Taxis

There were 5,928 taxis in KL in 1984. The ratio of the number of taxis to the population reached 5.88 to 1000. This figure is extremely high in comparison with Johor Bahru and Penang, where corresponding figures are 1.60 and 0.58 respectively. A 10% decrease in their numbers took place between 1984 and 1991.

(b) Traffic Demand and Volume

Traffic volume on major roads in Kelang Valley Region in 1985 is shown in Figs. 2.2.14 (1) and (2). Future traffic demand is given in Table 2.2.20.

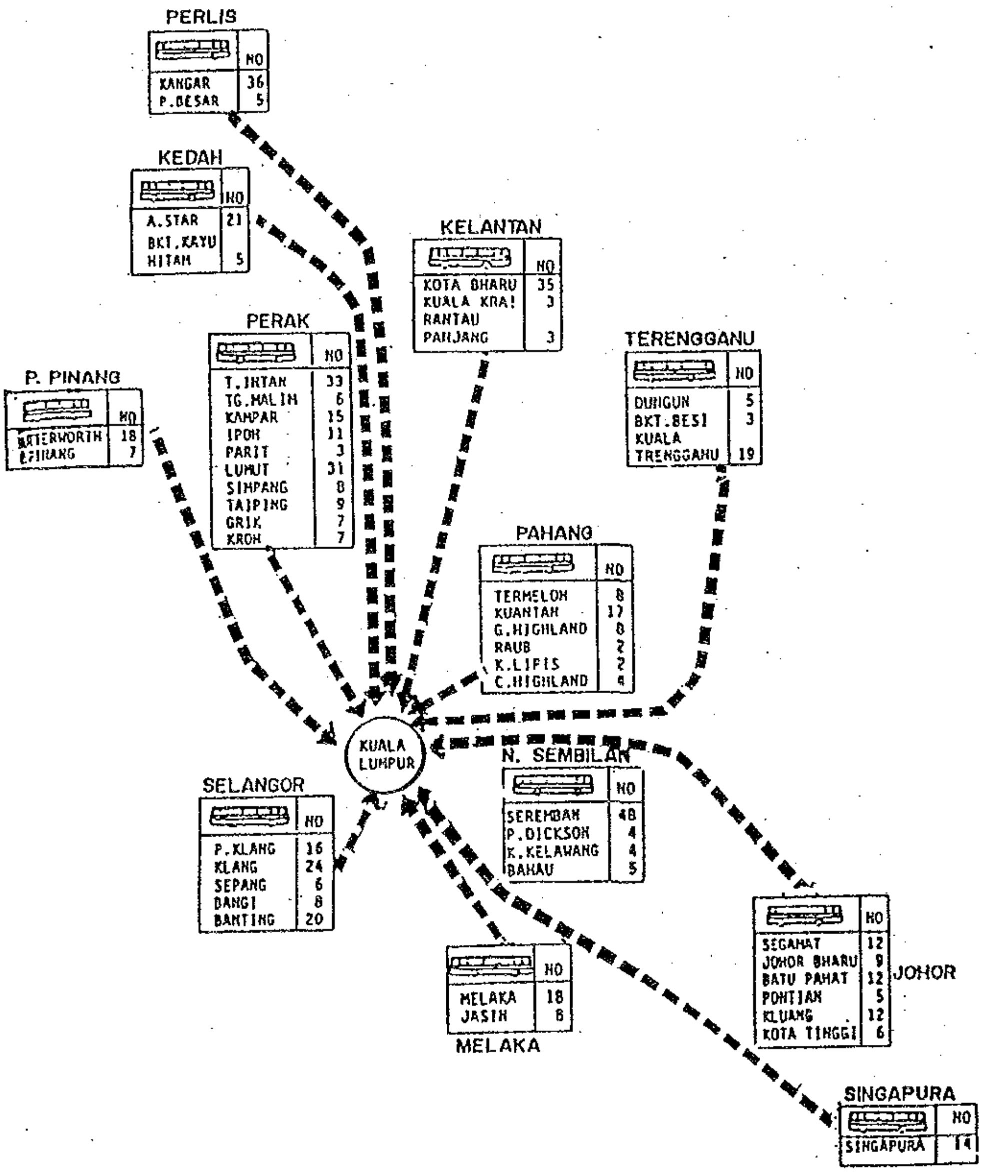
Table 2.2.20 Future Traffic Demand in Kelang Valley Region

(Unit : Trips per person per day)

Purpose of Journey	Year			Average Yearly Growth Rate (%)	
	1985	1995	2000	1985 - 1995	1995 - 2000
To Work Places	936,500 (14.6%)	1,596,700 (15.5%)	2,239,000 (15.3%)	5.5	3.4
To School	678,200 (10.6%)	1,086,600 (10.6%)	1,533,800 (10.5%)	4.8	3.5
Commercial	402,900 (6.3%)	692,900 (6.7%)	1,013,500 (6.9%)	5.6	3.9
Personal	1,701,200 (26.5%)	2,642,500 (25.%)	3,796,400 (26.0%)	4.5	3.7
To Home	2,706,700 (42.1%)	4,258,500 (41.4%)	6,045,200 (41.3%)	4.6	3.6
Total	6,425,500 (100%)	10,277,200 (100%)	14,627,900 (100%)	4.8	3.6

Source : Kajian Pengangkutan Wilayah Lembah Klang

Perkhidmatan Bus Express 'Inter-Regional'
Menghubungkan Kuala Lumpur Dengan
Bandar-bandar Utama DiSemenanjung Malaysia.



Source : KVPP88

Fig.2.2.13 Express "Inter-Regional" Bus Routes

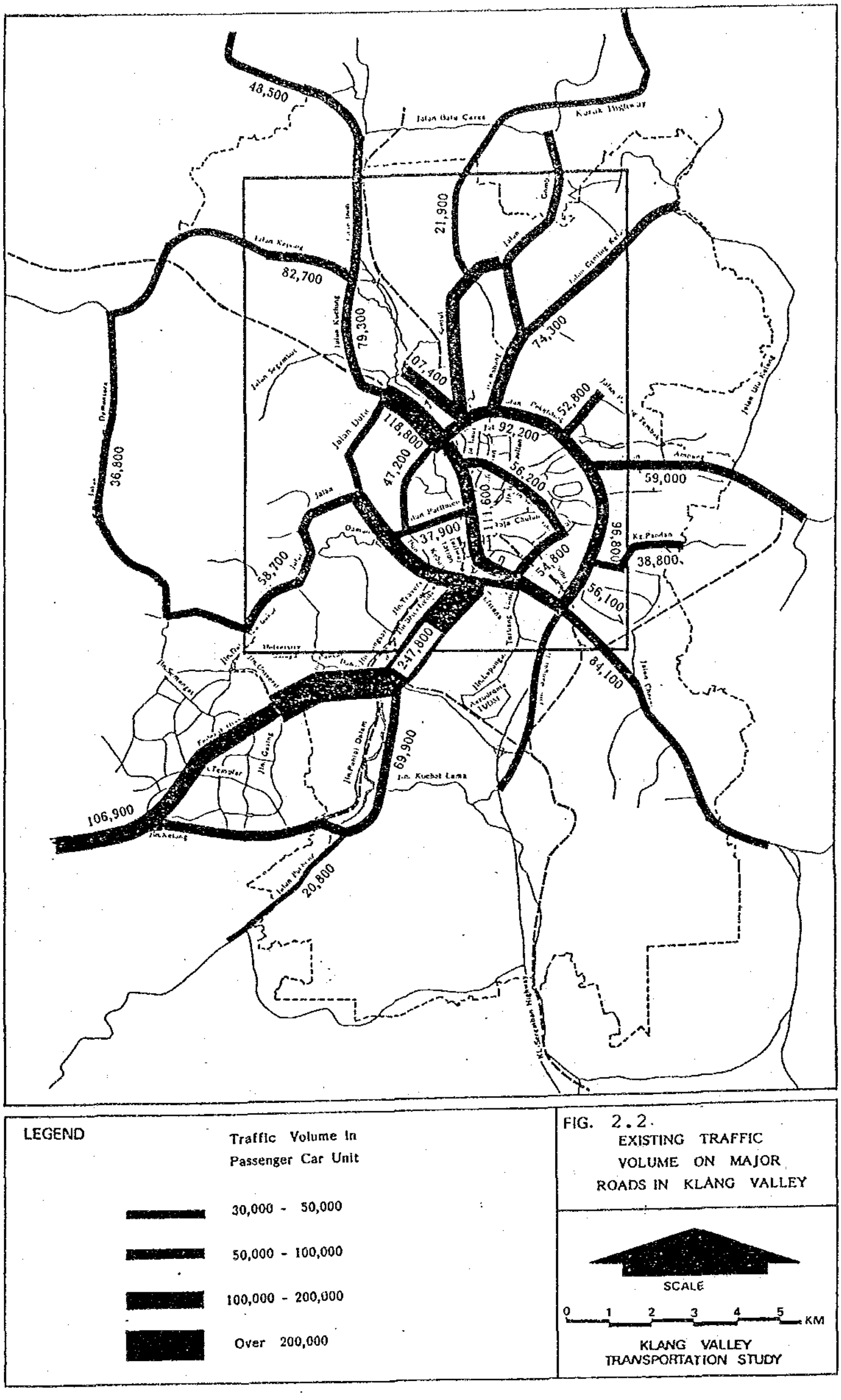


Fig.2.2.14 (1) Traffic Volume on Major Roads in Kelang Valley Region

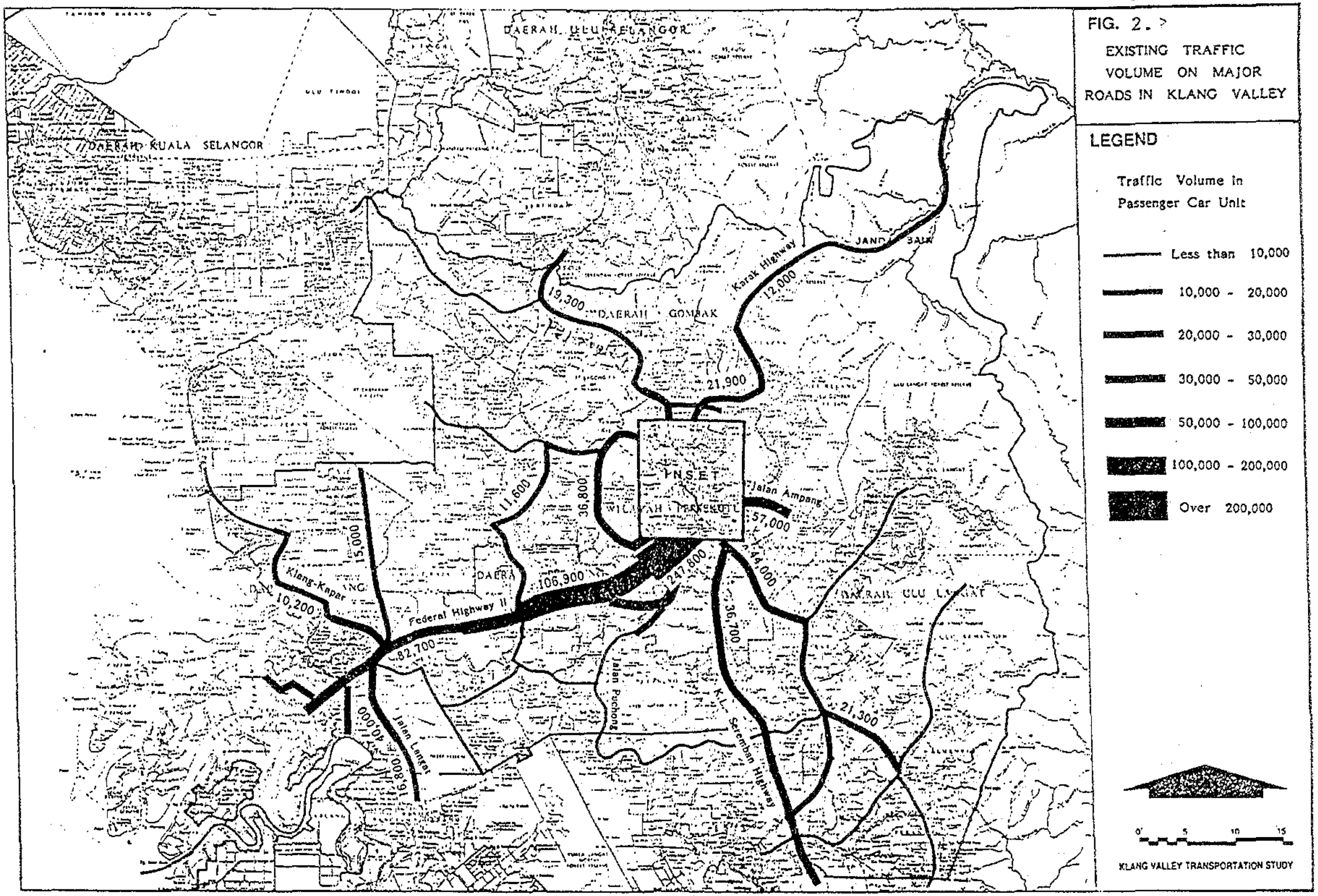


Fig. 2.2.14 (2) Traffic Volume on Major Roads in Kelang Valley Region

3) Railways

The main line of the Malaysian Railway runs through the Kelang Valley Region from north to south via Kuala Lumpur Central Station (KL). The length of the track between Rawang (Northern border town of Kelang Valley Region) and Bangi (southern border town of Kelang Valley Region) is 69.8 km.

As of April 1992, there were six regular daily train services each for northbound and return passengers on the main line; six for southbound and return. There was a local line operating between KL and Port Klang, the length of the track is 43.3 km. Four rail bus services each link KL and Port Klang and four services each between KL and Petaling Jaya. There were also about 20 freight train services a day on average.

During the 6th Malaysian Plan period, the sectors between Rawang and Seremban (on the main line), between KL and Port Klang, and between Subang Jaya (on the Port Klang line; 15.2 km from KL) and Subang International Airport (6.5 km from Subang Jaya) will be double-tracked. Further the lines between Batu Cave and Batu Junction (on the main line) via Sentul (10.4 km in length), and between KL and Ampang will be revitalized by 2005. Commuter Services will be also introduced between Rawang and Seremban, and between Batu Cave and Port Klang by then. Ultimately, the railway system within and around Kelang Valley Region will be electrified. There are also plans to construct a monorail system between Selayang and Taman Connaught, Manjalar, and Peoples Park. There also will be a light rapid transit system within the urban area of the Federal Territory of Kuala Lumpur.

Some planned figures on railway operations in mid-'90s at the time of 1985 is as follows:

(a) Number of Diesel Multi-units

Passenger	Main Line	48 trains/day	
	Rail Bus*	28 - do -	* Sentul-- KL-- Port Klang
Freight	Main Line	120 - do -	

(b) Number of Rolling Stock

Diesel Locomotive*	main Line	89	Passenger Coach	304
	Shunting	39	Freight Wagon	5,012
Diesel Rail Car		40		
* Engine	NTA855	350 ps/2100rpm		
	KTA 19	600 ps/2100rpm		
	MRA 24	2,400 ps		

(c) Maximum Speed

Express	88 km/h
Rail Bus	90 km/h
Other Passenger	72 km/h
Freight	56km/h.

Source: Kelang Valley Transport Study 1985

(2) Air Transport

Aircraft movement in peninsular Malaysia is given in Table 2.2.21(1). The number of air landings and take-offs at Subang Airport in recent years and their related aspects are shown through Tables 2.2.21(2) to (4). Its estimated annual growth rate of the commercial flight movement is around 10% between 1986 and the present.

Subang International Airport is the only commercial airport in KVR and is operated to the limits of its capacity. So its facilities are to be upgraded during the 6th Malaysian Plan along with privatization of operations at Subang International Airport. (Malaysian Airline system has been privatized for some time, and its management is improved since then.) Fig. 2.2.15 shows its implementation programs.

The 6th Malaysian Plan envisaged construction of new airport facilities in the periphery of the Federal Territory of Kuala Lumpur during upcoming 7th Malaysian Plan. Presently a new "Sepang International Airport" is being planned by the Department of Civil Aviation. According to the plan, two 3,800 m runways will be completed by 1997, and international passenger traffic will be handled exclusively by the Sepang International Airport. Fig. 2.2.16 shows its location. It also shows some proposals on related development such as connecting roads between the two international airports.

Our tentative traffic forecast at Subang and Sepang airports is given in Table 2.2.22.

(3) Maritime Transport

Cargo traffic at the Port Klang, the total operation of which will soon be privatized, is given in Table 2.2.23. (Klang Container Terminal has been privatized for some time. Its productivity has risen; and its union has become an advocate of privatization.) Because facilities for handling have not been expanded to meet the increase in the quantity of cargo handled, the port has become congested, turnaround time has increased, and the number of cargo ships waiting outside the port has grown. This situation will continue until the new west port is commissioned in 1994.

The first phase of the west port construction is being carried out in Pulau Lumut during the 6th Malaysian Plan period; and a subsequent plan after 2000 is being envisaged. Figs.2.2.17 (1) and (2) give a perspective of the plans.

Table 2.2.21(1) Aircraft Movement in Peninsular Malaysia

	PENINSULAR MALAYSIA				
	Commercial			Others	Total
	Domestic	International	Total		
1980	82,420	38,110	90,530	n.a.	n.a.
1987	61,516	31,428	92,944	n.a.	n.a.
1988	76,264	33,878	110,142	n.a.	n.a.
1989	87,468	37,344	124,812	93,156	217,968
1990	96,988	45,540	142,538	110,858	253,396

Source : Annual Air Transport Statistics '86, '90

Table 2.2.21(2) Aircraft Movement at Subang Airport

		Commer-cial	Military	Test / Training	Govern-ment	Private+ F.Club	TOTAL
1989		n.a.	n.a.	n.a.	n.a.	n.a.	73,070
1990		78,030	4,312	2,510	1,000	532	86,384
1991	Jan	6,904	388	134	146	38	7,610
	Feb	6,796	346	80	96	50	7,368
	Mar	6,327	367	107	121	44	6,966
	Apr	7,230	400	232	134	4	8,000
	May	7,516	468	0	110	12	8,106
	Jun	7,446	364	658	74	76	8,618
	Jul	7,466	338	86	134	96	8,120
	Aug	7,526	432	42	124	98	8,222
	Sep	7,114	310	92	116	26	7,658
	TTL	64,325	3,413	1,431	1,055	444	70,668
	12/9*	85,767	7,551	1,908	1,407	592	94,224

Source : Annual Air Transport Statistics '86, '90
Denpartment of Civil Aviation, Air Malaysia, ABC.

Table 2.2.21(3) Growth Rate of Aircraft Movement at Subang Airport

1989		73070
1990	18.2%	86384
1991	9.1%	94224
1992	12.9%	106348

* Commercial : '92/0.91
Commercial/Total in '90=0.90
Commercial/Total in '91=0.91

Table 2.2.21(4) Scheduled Commercial Flights at Subang Airport in 1992

unit : flights/year

Equipment	International	Domestic	Total	
A310	8,447		8,447	
A300	5,319		5,319	
A737	17,207	45,156	62,363	
A747	5,527		5,527	
A757	521		521	
A767	939		939	
DC10	4,484		4,484	
F27	417		417	
F50	626	3,963	4,589	
IL6	313		313	
L10	521		521	
L15	209		209	
TU4	313		313	
DO8	-	2,816	2,816	
TOTAL	44,843	51,934	96,777	10.2%
%	46%	54%		('86-'92)
Ref:1986	24,080	29,944	54,024	
	45%	55%		

Source : Department of Civil Aviation, Air Malaysia, ABC.

Table 2.2.22 Air Traffic Forecast

	Total	Subang	Sepang	gr.Sub.	gr.Sep.
1992	106,348	106,348	0	8.5%	-
1995	135,838	135,838	0	8.5%	-
1997	159,911	91,501	68,410	3.0%	5.0%
2000	179,179	99,986	79,193		

gr.=growth rate per year

'92-'97 : 8.5%=> 7%-10% : according to the Sixth Malaysian Plan

'97-'00 : Consultants' Estimate

Table 2.2.23 Sea Transport at Port Klang

	1989	1990	1991	1994	1995	2000	2005	2010
Cargo Container- 000TEU	399	497	608	872	940	1,283	1,727	2,318
'000t	7,297	9,137	11,650	16,568	17,860	24,377	32,813	44,042
*1General '000t	11,009	12,968	14,870	17,531	17,940	19,430	20,678	21,788
TOTAL '000t	18,306	22,105	26,520	34,099	35,800	43,807	53,491	65,830
Growth Rate		20.8%	20.0%	8.7%	5.0%	4.1%	4.1%	4.2%

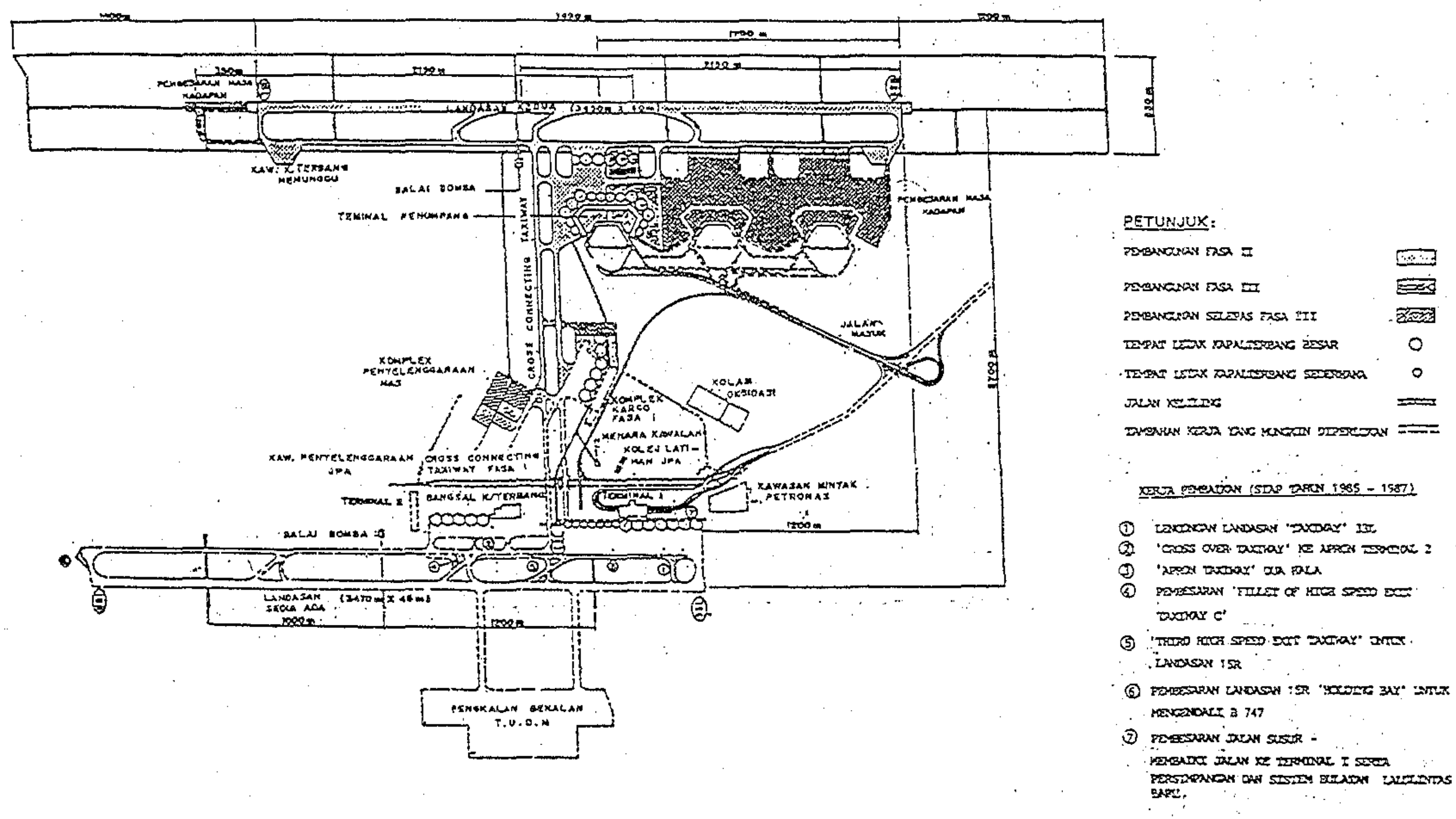
*1 including dry and liquid bulk

Vessels : Foreign Trade
No. 3,331
Weight 000NRT 21,333
NRT : Net Registered Tonnage

Berth		1990	1991	1994	1995	2000	2005	2010
Number	South	8	8	8	8	8	8	8
	North	18	18	18	18	18	18	18
	West	0	0	0	0	25	25	25
	Kuala Langat	0	0	0	0	0	+	+
Total		26	26	31	36	51	51+	51+
Length (m)	South	1,078	1,078	1,078	1,078	1,078	1,078	1,078
	North	3,983	3,983	3,983	3,983	3,983	3,983	3,983
	West	0	0	1,000	2,000	5,000	5,000	5,000
	Kuala Langat	0	0	0	0	0	+	+
Total		5,060	5,060	6,060	7,060	10,060	10,060+	10,060+
Unit Cargo Handling:t/m		4,368	5,241	5,627	5,071	4,354	?	?

Turnaround Time	unit : hour/100t	
Dry Bulk	12.0	17.3
Liquid Bulk	12.6	13.5
General Break Bulk	18.9	18.8
Container	-	8.0

Source : Klang Port Authority Publications



Source : KVPP88

Fig. 2.2.15 Subang Airport Map

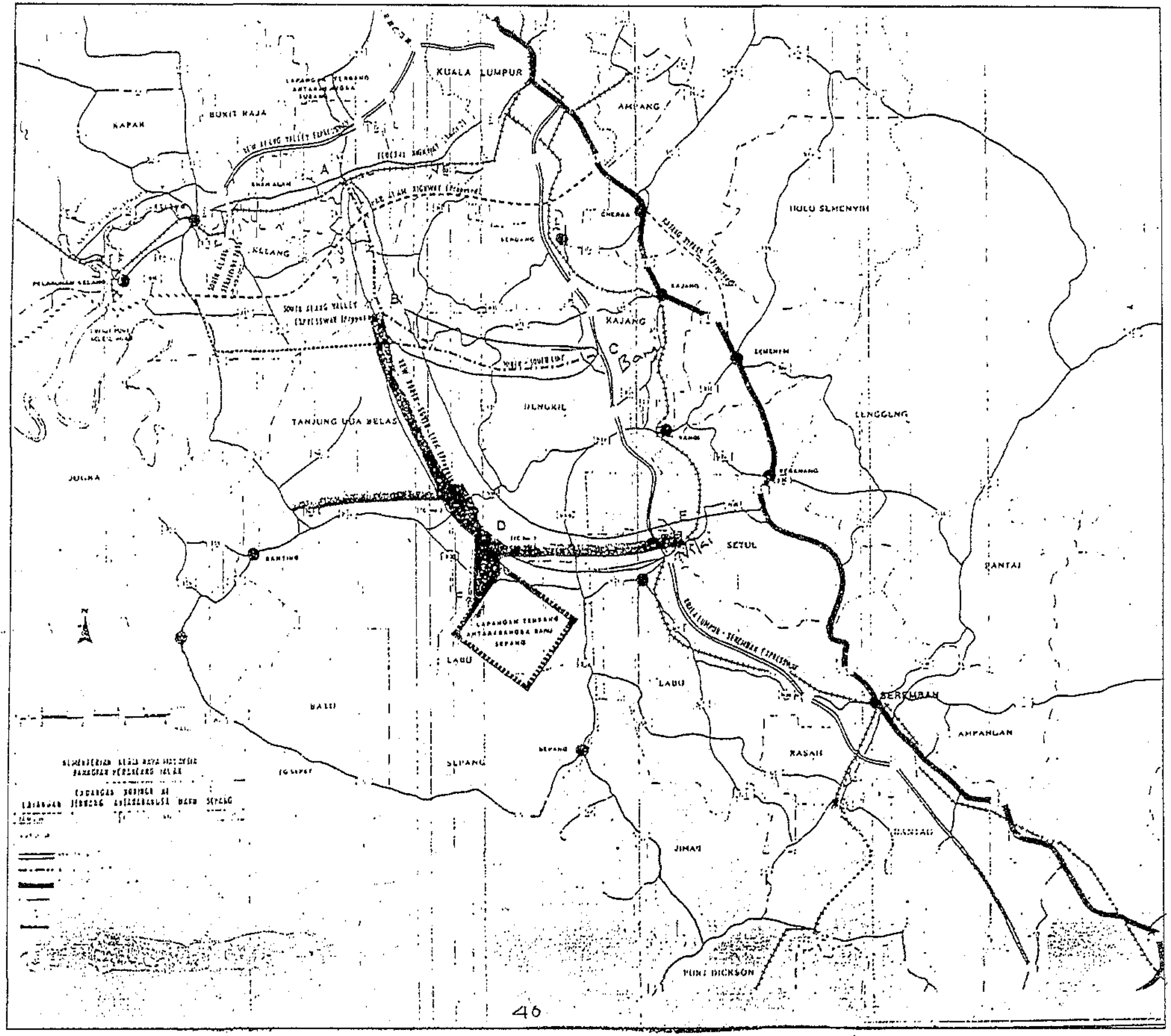
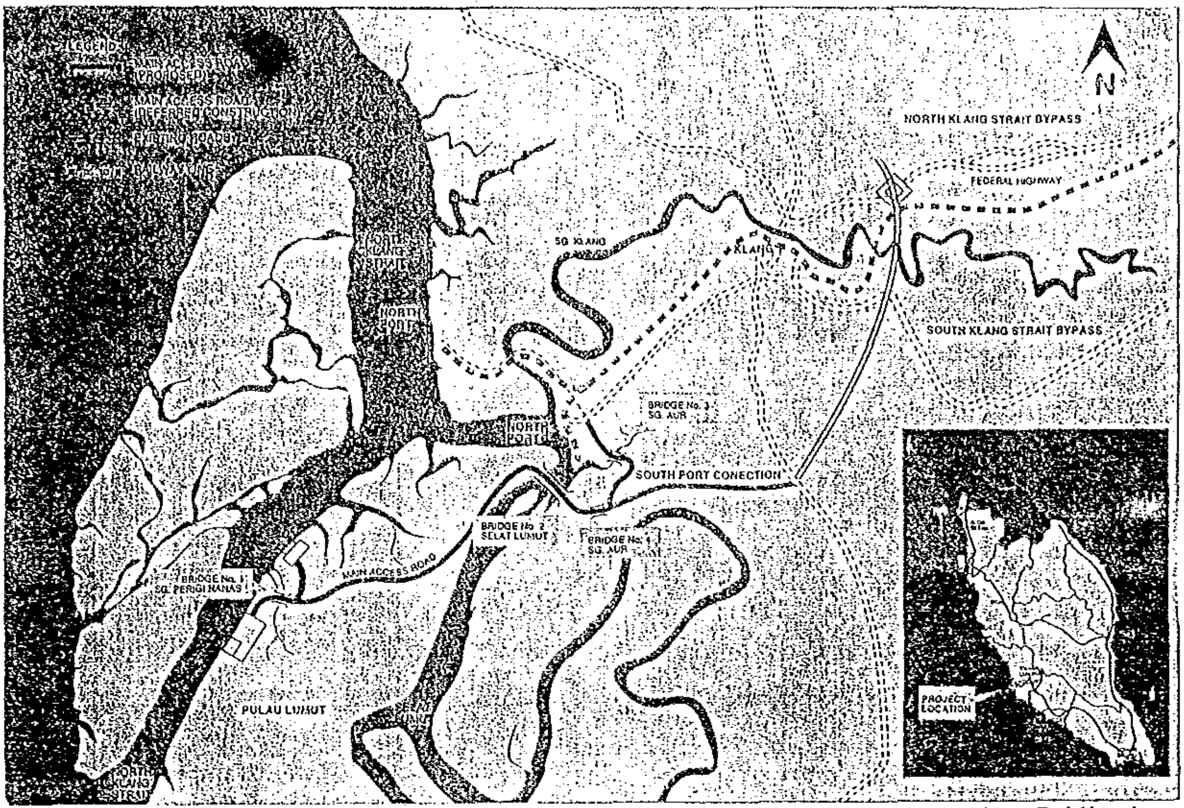


Fig. 2.2.16 Planned Location of Sepang International Airport

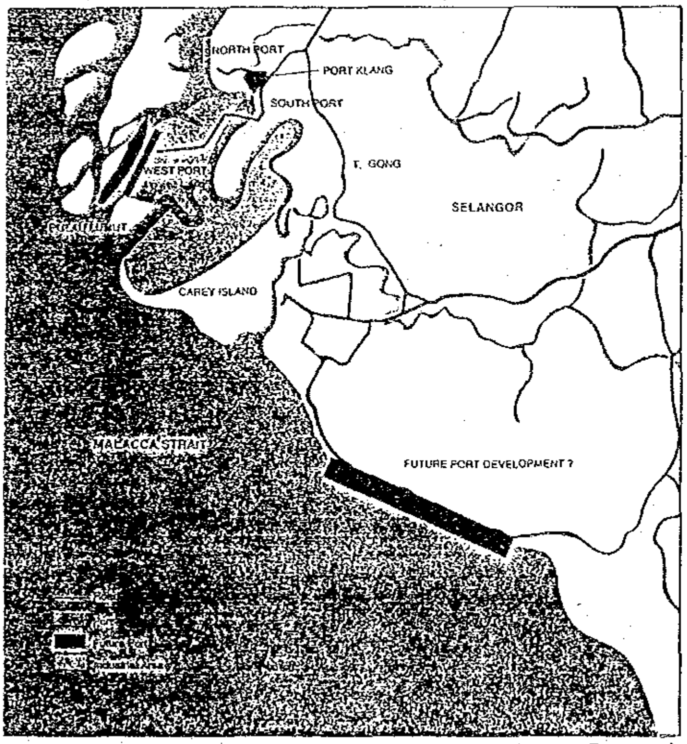
Source : KVPP88



Source : Klang Port Authority Publications

Fig.2.2.17 (1) Klang Port Development Plan

West Port and Related Development



Source : Klang Port Authority Publications

Fig.2.2.17 (2) Future Port Development in the 21st Century

2.2.6 Energy

(1) Malaysia

Recent changes, estimates and forecasts in the relationship between primary commercial energy supply and demand in Malaysia by source and sector are shown in Tables 2.2.24 and 2.2.25.

Supply has been always ahead of demand thanks to the on-time execution of planned source development.

Table 2.2.24 Supply and Demand for Commercial Energy by Source (Malaysia)

Unit:Tril.Joules
AAGR:%

	1985	1990	1995	5MP	6MP
SUPPLY					
Crude & Products	406.3	482.7	603.7	3.5	4.6
Gas(*1)	109.0	221.4	452.5	15.2	15.4
Coal & Coke	15.1	63.3	49.1	33.2	-5.0
Hydro	42.6	46.5	50.9	1.8	1.8
Total	573.0	813.9	1,156.2	7.3	7.3
DEMAND					
Petro.Products	282.7	376.1	480.0	5.9	5.0
Gas	25.0	51.2	184.6	15.4	29.2
Coal & Coke	15.1	26.6	34.4	12.0	5.3
Electricity	45.1	8.6	138.5	11.8	12.0
Total	367.9	532.5	837.5	7.7	9.5

Source: The Sixth Malaysia Plan 1991-1995
Legend: AAGR=average Annual Growth Rate,
5MP =The Fifth Malaysia Plan
6MP =The Sixth Malaysia Plan
*1 export of liquefied natural gas is excluded.

Table 2.2.25 Demand for Commercial Energy by Sector (Malaysia)

Unit:Tril.Joules
AAGR:%

	1985	1990	1995	5MP	6MP
Agriculture, Forestry	35.3	37.9	42.8	1.4	2.5
Mining, Quarrying	15.1	21.3	23.0	7.1	1.5
Manufacturing	74.0	137.3	286.4	13.2	15.8
Construction	12.0	15.6	22.4	5.4	7.5
Transport	158.3	228.4	343.8	7.6	8.5
Commercial, Services	20.5	28.9	43.6	7.1	8.6
Residential	36.6	41.3	49.2	2.4	3.6
Non-Energy	16.1	21.8	26.3	6.2	3.8
Total	367.9	532.5	837.5	7.7	9.5

Source: The Sixth Malaysia Plan 1991-1995

PETRONAS has been conducting its own survey, and Table 2.2.26 shows changes, estimates and forecasts of market demand for petroleum products in Malaysia by fuel type:

Table 2.2.26 Trend of Market Demand for Petroleum Products: Malaysia (Lower Case)

Unit: mil.litre

	1985	1990	1995	2000
LPG	405.2	986.6	1,559.0	2,179.0
PMG	2,473.9	3,463.4	5,056.7	6,697.0
RMG	226.5	238.5	227.0	207.3
Kerosene	390.0	270.0	200.0	175.5
Jet Fuel	502.6	696.1	1,064.2	1,585.5
Auto Diesel Oil	4,211.2	5,570.0	6,043.3	8,318.7
Fuel Oil(FO)	838.4	1,140.5	911.2	1,159.6
FO for TNB(*1)	1,737.0	2,517.7	167.3	0.0
Subtotal	10,784.8	14,882.8	15,228.7	20,322.7
Others	957.9	606.6	922.5	1,173.5
Total	11,742.7	15,489.4	16,151.2	21,496.2
AAGR:%		5.7	0.8	5.9

Legend: PMG=Premium Motor Gasoline, RMG=Regular MG,
TNB=National Electric Board
*1 All the TNB's generators will be gas-based from 1996 onwards.
Source : Petronas

Gas has been and will be substituted for oil products as fuel. The supply/demand projections for propane and butane in peninsular Malaysia made by PETRONAS are given in Table 2.2.27.

Table 2.2.27 Supply/Demand Projections for Gas in Peninsular Malaysia

Unit:1000MT

		1992	1995	2000
Supply:	Propane	335	840	1,442
	Butane	239	608	1,038
Demand:	Propane	180	230	666
	Butane	341	434	747

Source: PETRONAS

The second phase of the trans-peninsular gas pipeline was completed in 1990. It is bifurcated at Gemas, Negara Sembilan, a branch goes southward to Johor Bahru, where the Pasir Gudang power station is located. (There is a plan to supply gas to the Senoko power station in Singapore, which is located just across the Johore strait.) The other branch which goes northward reaches Klang. Fuel switching in the electricity sector is remarkable under the 6th Malaysian Plan (see Table 2.2.28).

Table 2.2.28 Projection of Electricity Generation

	1985	1990	1995	1996(*1)
Generation:GWh	14,000	25,500	34,300	-
Share of Gas:%	8.9	23.9	75.0	100.0

Source: The 6th Malaysian Plan
*1 Projection of PETRONAS; see *1 of Table 2.2.26.

The total reserve of natural gas in the 29 wells located off-shore of peninsular Malaysia was estimated around 24.5 trillion SCFT according to the 1985 Energy Report.

The prices of various kinds of fuel in 1991 are as follows:

LPG=M$1.18/kg, PMG=M$1.13/l, RMG=M$1.05/l, Diesel=M$0.65,

Fuel Oil=M$0.23.

The Malaysian standard for motor gasoline has been improved. Lead content of PMG was reduced from 0.4 gr/l in 1985 to 0.15gr/l in 1991, and sulphur content from 0.2 wt% to 0.15 wt%. Unleaded petrol is being sold in Kelang Valley at the same price as PMG.

The Malaysian Standard MS123 specifies requirements for diesel fuel. Sulphur content for the grades one and two is limited to 1.0 wt%.

(2) Kelang Valley

PETRONAS also made an estimate of fuel consumption in Kelang Valley for 1990. Marked demand growth rates and their trends of oil products in KVR were estimated using Table 2.2.26 and given in Table 2.2.29 (1 & 2).

Two major stationary sources of pollution in the electricity sector, the Port Klang power station (total 1200MW) in Kapar and Connaught Bridge power station (total 520 MW) in Klang started generating power via gas supplied through the trans-Malaysian pipe line in 1992.

On the other hand, third power station is under construction at Serdang (SPS) and new generators are planned to be installed at both existing power stations, i.e., Port Klang Power Station (PKPS) and Connaught Bridge Power Station (CBPS); two of 12 generators to be installed will be driven by coal-fueled steam turbines (see Table 2.2.30).

Some of the households, commercial establishments, hotels and factories in the Kelang Valley Region are provided with LPG in cylinder. In 1985, the supply satisfied about 30 percent of the Kelang Valley Region's potential demand (see Table 2.2.31).

Table 2.2.29 (1) Annual Growth Rate of Oil Market Demand: Malaysia

Unit: mil.litre

	1985-1990	1990-1995	1995-2000
LPG	19.48%	9.58%	6.93%
PMG	6.96%	7.86%	5.78%
RMG	1.07%	-0.98%	-1.80%
Kerosene	-7.09%	-5.83%	-2.58%
Jet Fuel	6.73%	8.86%	8.30%
Auto Diesel	5.75%	1.64%	6.60%
Fuel Oil(FO)	6.35%	-4.39%	4.94%
FO for TNB	7.71%	-41.86%	-100.00%
Total	6.65%	0.46%	5.94%

Table 2.2.29 (2) Oil Market Demand Trends : Kelang Valley

Unit: mil.litre

	1990	1995	2000
LPG	204.00	322.36	450.55
PMG	981.00	1,300.89	1,722.88
RMG	6.00	5.71	5.22
Kerosene	49.00	36.30	31.85
Jet Fuel	543.00	830.14	1,236.79
Auto Diesel	801.00	869.06	1,196.28
Fuel Oil(FO)	171.00	136.62	173.86
FO for TNB	790.00	52.50	0.00
Total	3,455.00	3,535.30	4,717.83

Source : PETRONAS

Tablc2.2.30 Proposed Installation of Generators in Kelang Valley Region

MW

	1992	1993	1995	1996	2000<<
PKPS	-	-	1X500:CST	1X500:CST	1X500:GT
CBPS	3X130:GT	-	-	-	-
SPS	-	6X125:GT	-	-	-
TOTAL	390	750	500	500	500

Legend : GT = Gas Tubine, CST = Coal-Fuel Steam Turbine

Table 2.2.31 Gas Demand and LPG Supply

Unit:1,000Nm3

	1985			2000
	Demand	Supply	S/D:%	Demand (times of '85 demand)
Household	125.0	73.0	58.4	2.15 -- 2.24
Commerce	43.4	33.3	76.9	2.18 -- 2.31
Hotel	7.5	1.6	21.7	2.54
Industry	242.3	15.0	6.2	1.98 -- 3.22
TOTAL	418.2	122.9	29.4	2.06 -- 2.82

Source: KVPP'88

The introduction of city gas to the Kelang Valley Region is being planned. At its initial stage, for which construction will start from 1992, it will cover an area of between 200 and 300 km^2, i.e., Kuala Lumpur, Petaling Jaya, Subang Jaya, Shah Alam and Klang. The total service area will be extended to between 500 and 600 km^2 in 2000, which includes Kajang, south of Kuala Lumpur.

2.3 Institutional Framework for Air Pollution Control

2.3.1 Laws and Regulations

The most important law in Malaysia concerned with environmental pollution is the Environmental Quality Act, 1974 (amended in 1985). This law provides a framework for all states in Malaysia to regulate their environmental policies. Under the law, the director general of Department of Environment (established in 1975) is given the authority, power and duties to control pollution. Table 2.3.1 shows the laws and regulations concerning environment, six are on air pollution control;

* Environmental Quality Act,1974
* Motor Vehicles (Construction and Use) Rules, 1959
* Factories and Machineries Act, 1967
* Motor Vehicles (Control Smoke and Gas Emission) Rules,1977
* Road Traffic Ordinance, 1958 (amended 1985)
* Environmental Quality (Clean Air) Regulations, 1987

"Environmental Quality (Clean Air) Regulations, 1987" which is closely connected with the Study, consists of eight parts and 59 articles. The outline of this law is shown in Table 2.3.2.

Table 2.3.1 List of Laws Connected with Environment in Malaysia

NO	Law Name	General environment	EIS	Land use	Water pollution	Air pollution	Toxic & hazardous /Soil erosion	Marine pollution	Forest conservation	Wildlife conservation	Development of mining industry
1	Environmental Quality Act,1974(amended,1985)	o	o			o	o	o			
2	Town and Country Planning Act,1976			o							
3	Housing Developers(Control and Licensing)Act,1966,Rev.1973			o							
4	National Land Code,1965			o							
5	Land Conservation Act,1960			o							
6	Land (Group Settlement) Act,1960			o							
7	Local Government Act(M.L.Act 171),1974				o		o				
8	Street, Drainage and Building Act(M.L.Act 133)				o		o				
9	Water(Amendment)Enactment, 1970				o						
10	Environmental Quality (Prescribed Premises) (Crude Palm Oil)Regulations, 1977				o						
11	Environmental Quality (Prescribed Premises) (Raw Natural Rubber)Regulations, 1978				o						
12	Environmental Quality (Prescribed Premises) (Sewage and Industrial Effluents)Regulations, 1978				o						
13	Motor Vehicles(Construction and Use)Rule, 1977					o					
14	Factories and Machineries Act, 1967					o	o				
15	Motor Vehicles(Control Smoke and Gas Emission)Rules, 1977					o					
16	Road Traffic Ordinance,1958(amended, 1985)					o					
17	Environmental Quality (Clean Air)Regulations, 1987					o					
18	Control of Drugs and Cosmetics Regulations, 1984						o				
19	Pesticides Act, 1974						o				
20	Poisons Ordinance, 1952						o				
21	Dangerous Drugs Ordinance, 1952						o				
22	Atomic Energy Act, 1974						o				
23	Hydrogen Cyanide(Fumigation)Act, 1967						o				
24	Regulations 1970,(Amended,1983)						o				
25	Petroleum Mining Act, 1966							o			
26	Continental Shelf Act, 1984							o			
27	Protected Places Ordinance								o		
28	National Forestry Act, 1984								o		
29	Forest Enactment of States								o		
30	National Park Act, 1980								o	o	
31	Protection of Wild Life Act, 1972									o	
32	Wild Life and Birds Protection Ordinance, 1955									o	
33	Fishery Act,1985									o	
34	Petroleum Development Act, 1974										o
35	State of Mining Enactment(FMS)Cap.147(1929)										o
36	Petroleum Mining Enactment, 1966										o

Table 2.3.2 Outline of Environmental Quality (Clean Air) Regulations, 1987

Part No.	Title	Outline
1.	Preliminary	Interpretation, Application
2.	Industrial facilities adjacent to residential areas	Owner or occupier who plans to install new facilities as described in attached list shall be approved by the Director General of DOE.
3.	Burning of waste	Owner or occupier of industrial or trade premises shall burn waste in an incinerator. Open burning is allowed conditionally.
4.	Dark smoke	The occupier of any industrial or trade premises shall not emit dark smoke which is darker than that designated as shade No.1 on the Ringelmann chart and shall provide observation device if directed so by the Director General of DOE.
5.	Air impurities	These regulations prescribe permissible limits of air impurities concentrations in the operation of factories. If directed so by the Director General of DOE, the occupier shall measure emissions.
6.	Miscellaneous provisions	Emergency requirement, authorized officers to produce identification and receipt, prohibition order and so forth.
7.	Penalty and fees	omitted
8.	Compounding of offenses	omitted

2.3.2 Administrative Organization

The leading administrative organization covering environmental problems in Malaysia is the Department of Environment (DOE). DOE is a subordinate organization of the Ministry of Science, Technology and Environment which consists of MMS, DOC, SIRIM and so on. DOE is composed of three divisions and 10 regional offices all over the country, as shown in Fig 2.3.1. Their main duties are as follows:

* Development Division

~Environment Impact Assessment (EIA)
~Development of environmental policy (Criteria, standards etc.)
~Environmental inputs to development planning
~Environmental education

* Control Division

~Environmental quality monitoring
~Enforcement of environmental regulations

* Administration Division

~General administration and coordination
~Manpower planning and training

* Regional Offices

~Environmental quality monitoring and enforcement of environmental regulations in each area covered by the offices
~Adjustment of state government and DOE environmental policy enforcement.

2.3.3 Ambient Air Quality Guidelines

The Malaysian government has not adopted air quality standards formally yet; however, it has used the Recommended Malaysian Guidelines (Table 2.2.3) in order to evaluate air quality in Malaysia since 1988 which was based on the study report (#3001, #3002, and #3003).

The study was more broadly based than just a consideration of the WHO guidelines. The findings of the United State Environmental Protection Agency, standards developed in many other countries and a variety of published documents were also taken into account.

Health implications of these pollutants are described as follows (partly from #3001 and #3002). The additional information is included in Section 2.4 of the Supporting Report.

CO combines with haemoglobin to form carboxyhaemoglobin (COHb) in a human body and disturbs the uptake of oxygen into blood. Increase of COHb causes cardiovascular and neurobehavioural effects. The aggravation of symptoms in angina pectoris patients by a certain COHb level is also of great concern as an adverse health effect.

NO_2 has been said to have more effects on a human body than NO. Short-term exposure effects by NO_2 are decrements in pulmonary function, lung function changes of bronchitic subjects, increases of airway reactivity in asthmatic subjects and so on. Studies with animals by long-term exposure show some effects. Effects are caused in lung, spleen, liver, and blood. Structural changes range from a change in cell types in the tracheobronchial and pulmonary regions to emphysema-like effects. NO_2 also increases susceptibility to bacterial infection of lung.

Short-term acute effects by O_3 are notable, beginning with eye irritation, and symptomatic chest and upper respiratory tract effects at higher levels, particularly in susceptible populations. Pulmonary function decrements, cough, and headache can occur in children or asthmatics with O_3 concentrations of around 100 or 200 ppb.

SO_2 and Particulate Matter have synergism effect to human health. Some epidemiological data indicate that SO_2 increases mortality, decrease lung function in sensitive children, and increases respiratory morbidity.

Because Particulate Matter with a diameter below 10 μm can be easily inhaled into lung, PM10 concentration is more important from a health point of view. Some epidemiological data indicate morbidity increase of chronic bronchitis, increase of airway resistance, and increase of mortality in weak and old people. Moreover decline of visibility causes annoyance reaction of the public.

Hydrocarbons are consisted of various chemical compounds and most of hydrocarbons are said not to affect human being or animals with present concentration levels. However, some hydrocarbons like formaldehyde and acrolein stimulate eyes and respiratory organs in a specific working place. Benzene, benzopyrene, and benzoanthracene are said to be carcinogen or mutagen. Moreover NMHC (Non-Methane Hydrocarbon) has high reactivity in O_3 production. NMHC should be controlled to reduce O_3 concentration.

Lead is a cumulative poison and enters the body by inhalation and by ingestion of the dust or from some component of the food chain in which it has accumulated. Health effects of lead are hematological (an anemia or hemoglobin reduction in the blood) and neurological (a decrease in mental ability) and are more pronounced in children and the fetus of pregnant women.

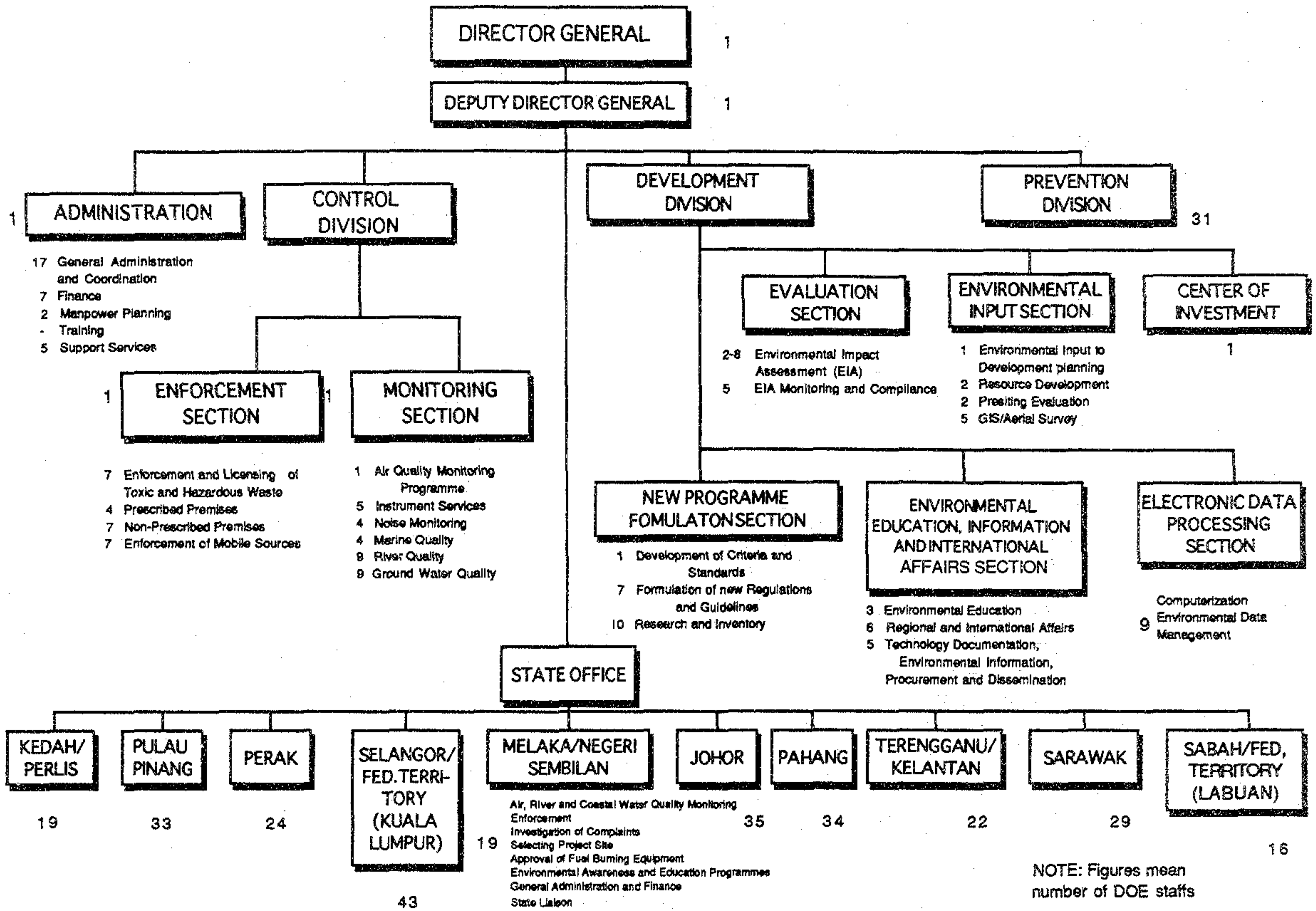


Fig. 2.3.1 Department of Environment: Organizational Structure 1991

Table 2.3.3 Recommended Malaysian Guidelines
(at 25.0 Celsius and 101.13 kpa)

POLLUTANT	AVERAGING TIME	MALAYSIA GUIDELINES		TARGET YEAR FOR COMPLIANCE
		(ppm)	(ug/m3)	
OZONE	1 HOUR 8 HOUR	0.10 0.06	200 120	1995
CARBON MONOXIDE	1 HOUR 8 HOUR	30 9	35# 10#	1995
NITROGEN DIOXIDE	1 HOUR	0.17	320	1990
SULFUR DIOXIDE	10 MINUTE 1 HOUR 24 HOUR	0.19 0.13 0.04	500 350 105	1990
PARTICLES TSP	24 HOUR 1 YEAR		260 90	1995
PM10	24 HOUR 1 YEAR		150 50	1995
LEAD	3 MONTH		1.5	1991

RECOMMENDED MALAYSIAN SECONDARY GUIDELINES

POLLUTANT	AVERAGING TIME	MALAYSIA GUIDELINES (mg/m2/day)	TARGET YEAR FOR COMPLIANCE
DUSTFALL	1 YEAR	133	1995

#:mg/m3

2.3.4 Emission Standards

Environmental Quality (Clean Air) Regulations, 1987 mandates control of air pollutants from stationary sources. Emission standards for air pollutants from factories are shown in Table 2.3.4. Mobile source control was prescribed in the Motor Vehicle (Control Smoke and Gas Emission) Rules, 1977. These rules regulate diesel smoke density by adopting less than 50 Hartridge Smoke Units or equivalent.

In connection with emission standards, regulation standard of lead content of petrol was revised from 0.4g/l to 0.15g/l by Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations, 1985.

Table 2.3.4 Emission Standards for Stationary Sources

ITEMS	TARGET FACILITIES	EMISSION STANDARDS			UNITS
		A	B	C	
1. Solid particles concentration	Heating of metals	0.3	0.25	0.2	mg/Nm^3
	Others	0.6	0.5	0.4	
2. Metals and metallic compounds					
(a) Mercury		0.02	0.01	0.01	
(b) Cadmium		0.025	0.015	0.015	
(c) Lead	Any source	0.04	0.025	0.025	mg/Nm^3
(d) Antimony		0.04	0.025	0.025	
(e) Arsenic		0.04	0.025	0.025	
(f) Zinc		0.15	0.01	0.01	
(g) Copper		0.15	0.01	0.01	
3. (a) Acid Gases	Manufacture of sulfuric acid	7.5	0.6	3.5	SO_3 g/Nm^3
(b) Sulfuric acid mist, SO_3	Except for above	0.3	0.25	0.2	SO_3 g/Nm^3
(c) Chlorine gas	Any source	0.3	0.25	0.2	HCl g/Nm^3
(d) Hydrogen chloride	Any source	0.6	0.5	0.4	HCl g/Nm^3
(e) Fluorine, hydro-fluoric acid	Manufacture of aluminium	-	-	0.02	HF, g/Nm^3
(f) Fluorine, hydro-fluoric acid	Except for above	0.15	0.125	0.100	HF, g/Nm^3
(g) hydrogen sulphide	Any source	6.25	5.00	5.00	ppm
(h) Oxide of nitrogen	Manufacture of nitric acid	4.60	4.60	1.70	SO_2 g/Nm^3
(i) Oxides of nitrogen	Except for above	3.00	2.50	2.00	SO_2 g/Nm^3
4. Dust or solid particles	Asphalt concrete plant				
	Stationary plant	0.5	0.4	0.3	
	Mobile plant	0.7	0.7	0.4	mg/Nm^3
	Portland cement plant				
	Kiln	0.4	0.2	0.2	
	Clinker etc.	0.4	0.2	0.1	
5. Asbestos and free silica	Any source	0.4	0.2	0.12	mg/Nm^3

Note: (1) (a) All new facilities shall comply with Standard C.
(2) All existing facilities shall comply with Standard A within two years and comply with Standard B within three years, from the date these regulations come into force.

2.3.5 Air Pollution Monitoring

(1) Air Quality Monitoring

In 1991, the measurements of total suspended particulates (TSP), atmospheric lead, heavy metals and dust fallout were continued at 217 monitoring stations throughout the country. Measurement of fine particulate fractions of less than 10 micrometre (PM10) was conducted at 7 sites in the same year.

(2) Pollution Source Monitoring

As for monitoring of motor vehicles, DOE with the cooperation of the Traffic Police and the Road Transport Department continued on a regular basis to monitor compliance on black smoke emission from diesel vehicles in 1991. Monitoring of compliance on lead level in petrol was also conducted by DOE.

As for stationary sources, DOE continued to monitor black smoke emission from factories and open burning activities in 1991. And their surveillance was strengthened by establishment of a telephone hotline in the Selangor Department of Environment and aerial surveillance by the Air Police Traffic Unit.

CHAPTER 3 METEOROLOGY

CHAPTER 3 METEOROLOGY

3.1 Surface Level Meteorology

3.1.1 Outline of the Observation

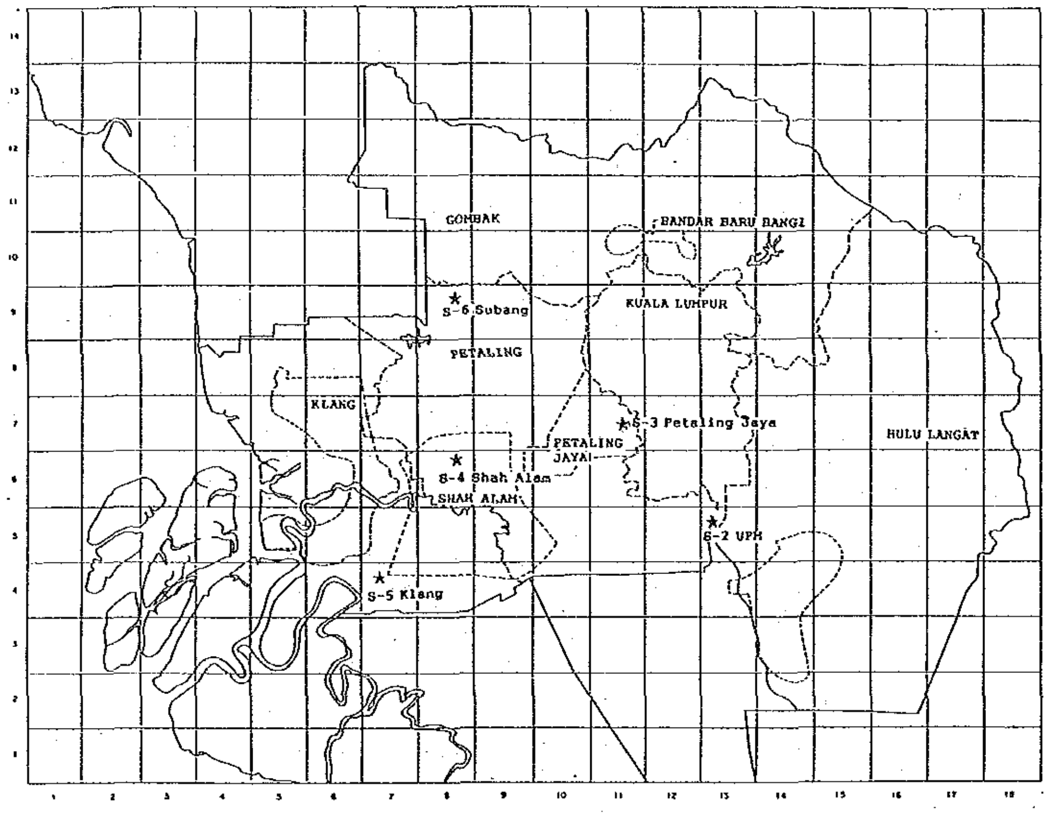
Outline of the meteorological stations under the Study is shown in Table 3.1.1 and the locations of the meteorological stations are shown in Fig. 3.1.1.

Table 3.1.1 Outline of the Meteorological Stations

Station Name		Observed Items						
		WD	WS	SUN	NETR	TEMP	HUM	RAIN
S-2	UPM	O	O	-	-	O	O	O
S-3	Petaling Jaya	O	O	O	O	-	-	-
S-4	Shah Alam	O	O	-	-	-	-	-
S-5	Klang	O	O	-	-	O	O	O

Abbreviation WD: Wind Direction, WS: Wind Speed
SUN: Solar Radiation, NETR: Net Radiation
TEMP: Temperature, HUM: Relative Humidity
RAIN: Rainfall Amount

In addition to the data above, the meteorological data at Subang (MMS) and Petaling Jaya (MMS) were provided by MMS (Malaysian Meteorological Service).



Legend

S-2	UPM
S-3	Petaling Jaya
S-4	Shah Alam
S-5	Klang

★ : Meteorological Station

Fig. 3.1.1 Locations of Meteorological Stations

3.1.2 Analysis of the Observed Data

This analysis was conducted for the observed data of the following periods.

UPM	March, 1992 → February, 1993
Petaling Jaya	March, 1992 → February, 1993
Shah Alam	March, 1992 → February, 1993
Klang	July, 1992 → February, 1993
Subang(MMS)	March, 1992 → February, 1993
Petaling Jaya(MMS)	March, 1992 → February, 1993

Characteristic features of the surface level meteorology in Kelang Valley Region are as follows.

Generally, the wind is weak. At UPM, calm (equal to or below 0.4 m/s wind speed) frequencies are very high and exceed 50%. The histogram of wind speed at UPM is shown in Fig. 3.1.2. Annual averages of wind speed at all stations are from 0.5 m/s to 1.3 m/s.

Stability index is used to indicate the atmospheric stability. Index 'A' means strong unstable condition and index 'G' means strong stable condition. 'D' class is neutral condition, and is divided into 'DD' (daytime neutral) and 'DN' (nighttime neutral). The detailed definition of the stability index is shown in Table 3.1.2.

Table 3.1.2 Pasquill's Stability Index Table

	flux of solar radiation T (W/m2)				net flux of radiation Q (W/m2)		
Wind Speed (m/s)	$T \geqq 600$	$600 > T$ $T \geqq 300$	$300 > T$ $T \geqq 150$	$150 > T$	$Q > -20$	$-20 \geqq Q$ $Q > -40$	$-40 \geqq Q$
<2	A	A - B	B	D	D	G	G
2 - 3	A - B	B	C	D	D	E	F
3 - 4	B	B - C	C	D	D	D	E
4 - 6	C	C - D	D	D	D	D	D
6<	C	D	D	D	D	D	D

A common feature of all stations is the high frequency of unstable class (from A to B) and stable class (G). These conditions are caused by strong radiation and weak wind. The stability index histograms for Petaling Jaya are shown in Fig. 3.1.3.

Diurnal variations of meteorological parameters show regular patterns. Wind speed, radiation, and temperature all show single peak patterns with the peak occuring during the daytime. The diurnal variation of wind speed at UPM is shown in Fig. 3.1.4, the diurnal variation of net radiation at Petaling Jaya is shown in Fig. 3.1.5, and the diurnal variation of temperature at UPM is shown in Fig. 3.1.6. Relative humidity has a minimum during the daytime. Rainfall occurs mainly in the afternoons and evenings. The diurnal variation of relative humidity and rainfall amount at UPM are shown in Fig. 3.1.7 and Fig. 3.1.8.

Wind roses for Shah Alam are shown in Fig. 3.1.9. N wind direction has high frequencies during the period, but the wind speeds are low. In June through August, relatively strong winds are observed in the S and SSW directions. In October, NNW wind direction has high frequency.

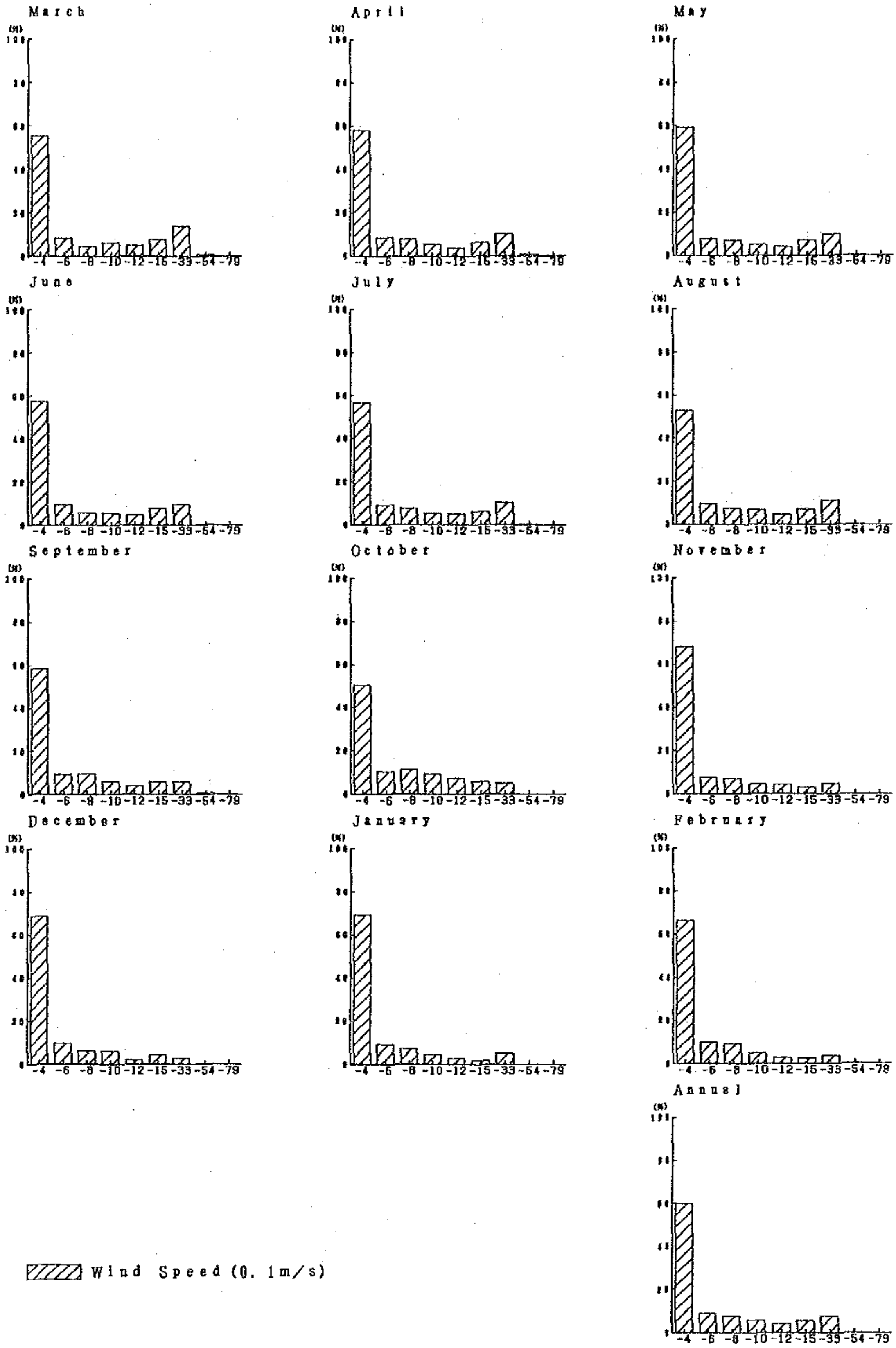


Fig. 3.1.2 Wind Speed Histogram at UPM
(Mar. 1992 ~ Feb. 1993)

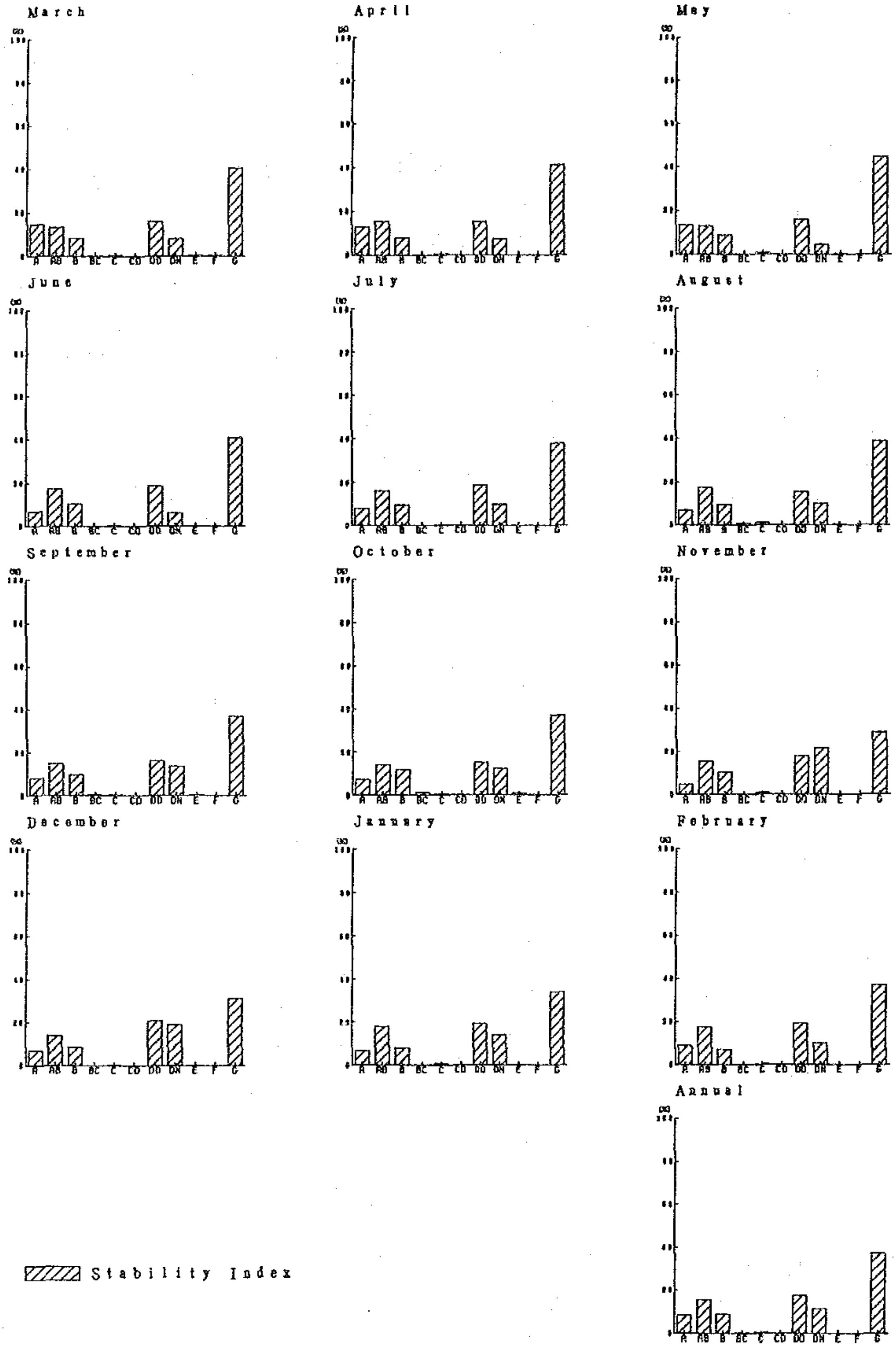


Fig. 3.1.3 Stability Index Histogram at Petaling Jaya (Mar. 1992 ~ Feb. 1993)

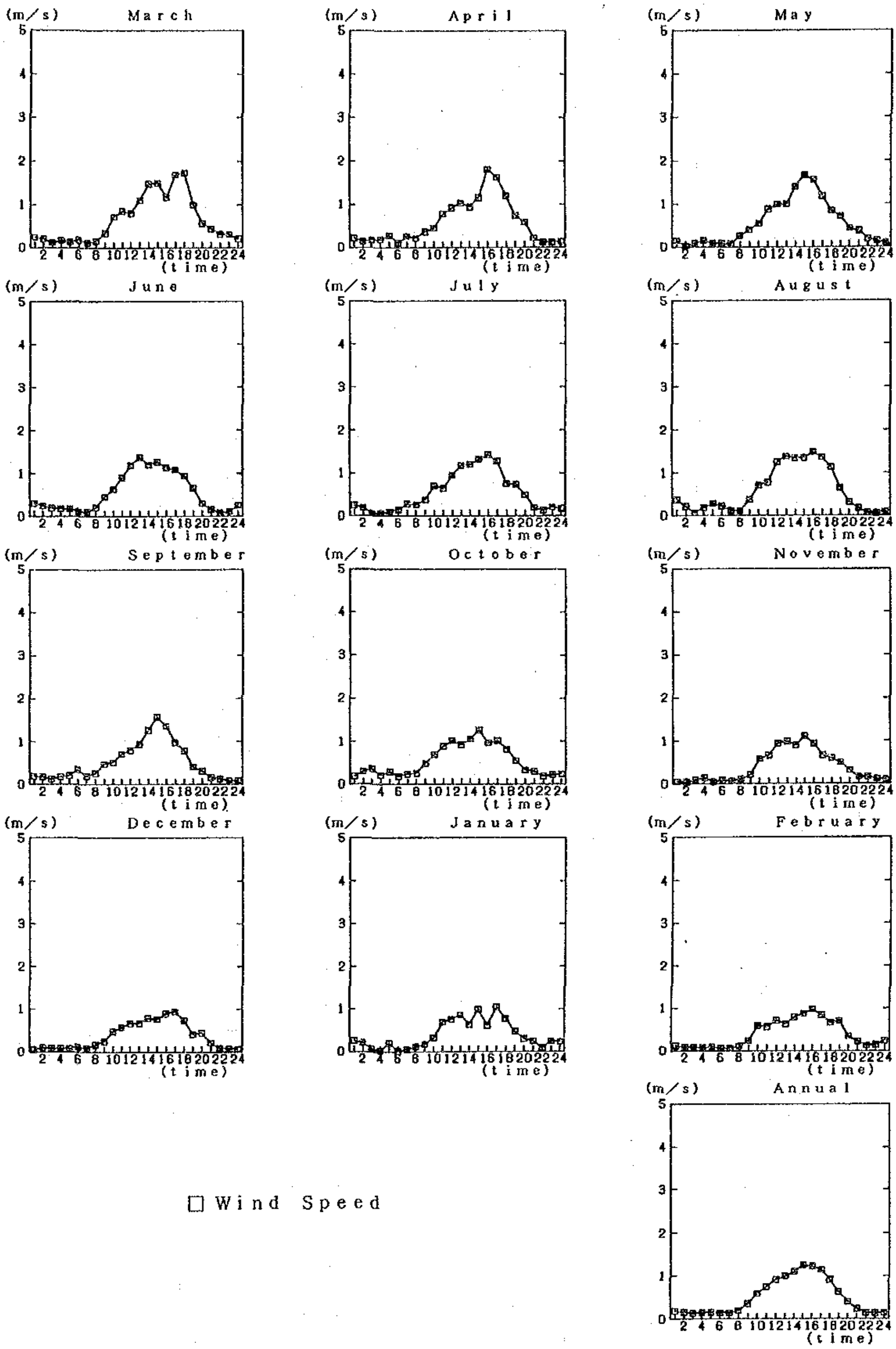


Fig. 3.1.4 Diurnal Variation of Wind Speed at UPM
(Mar. 1992 ~ Feb. 1993)

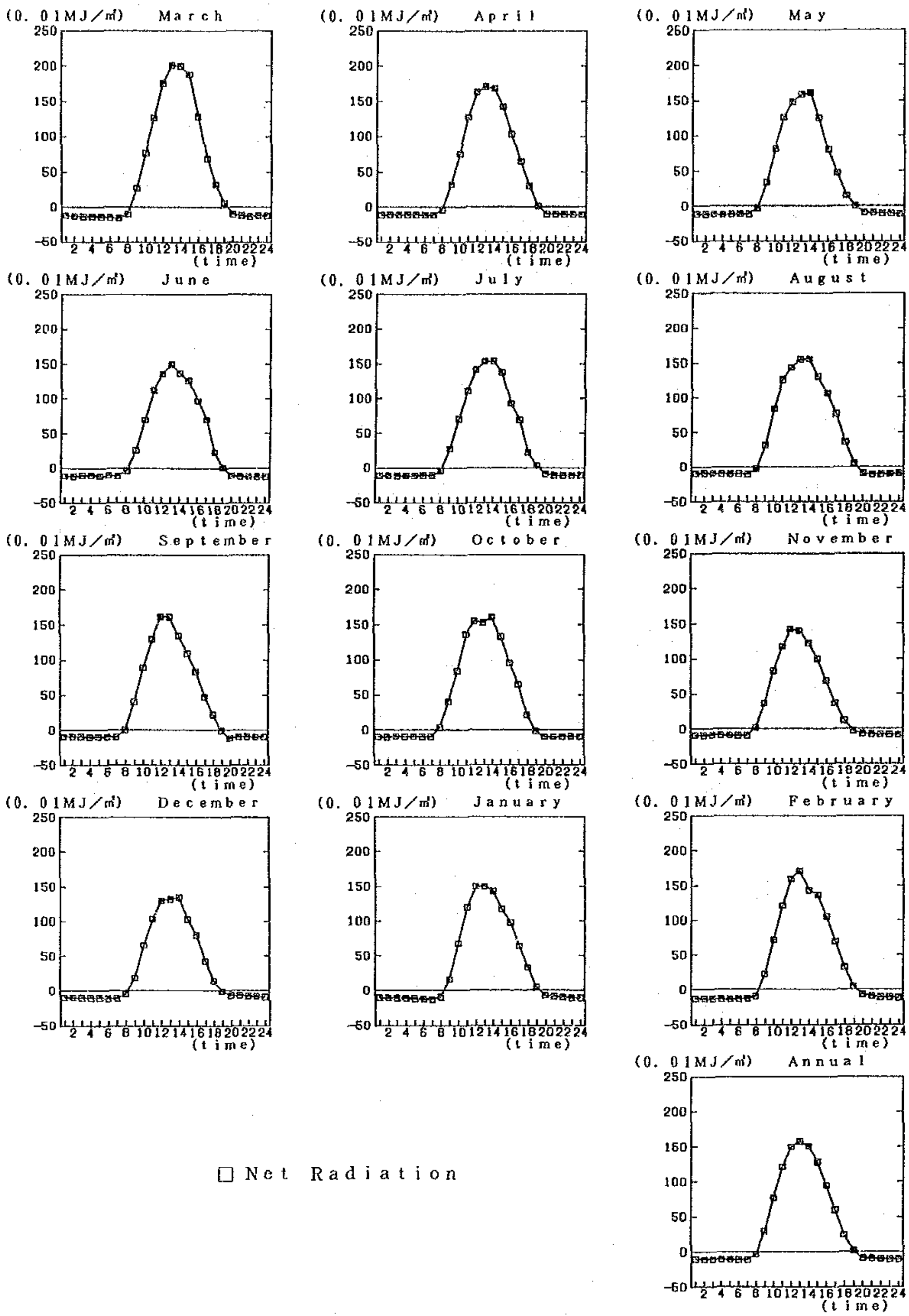


Fig. 3.1.5 Diurnal Variation of Net Radiation at Petaling Jaya (Mar. 1992 ~ Feb. 1993)

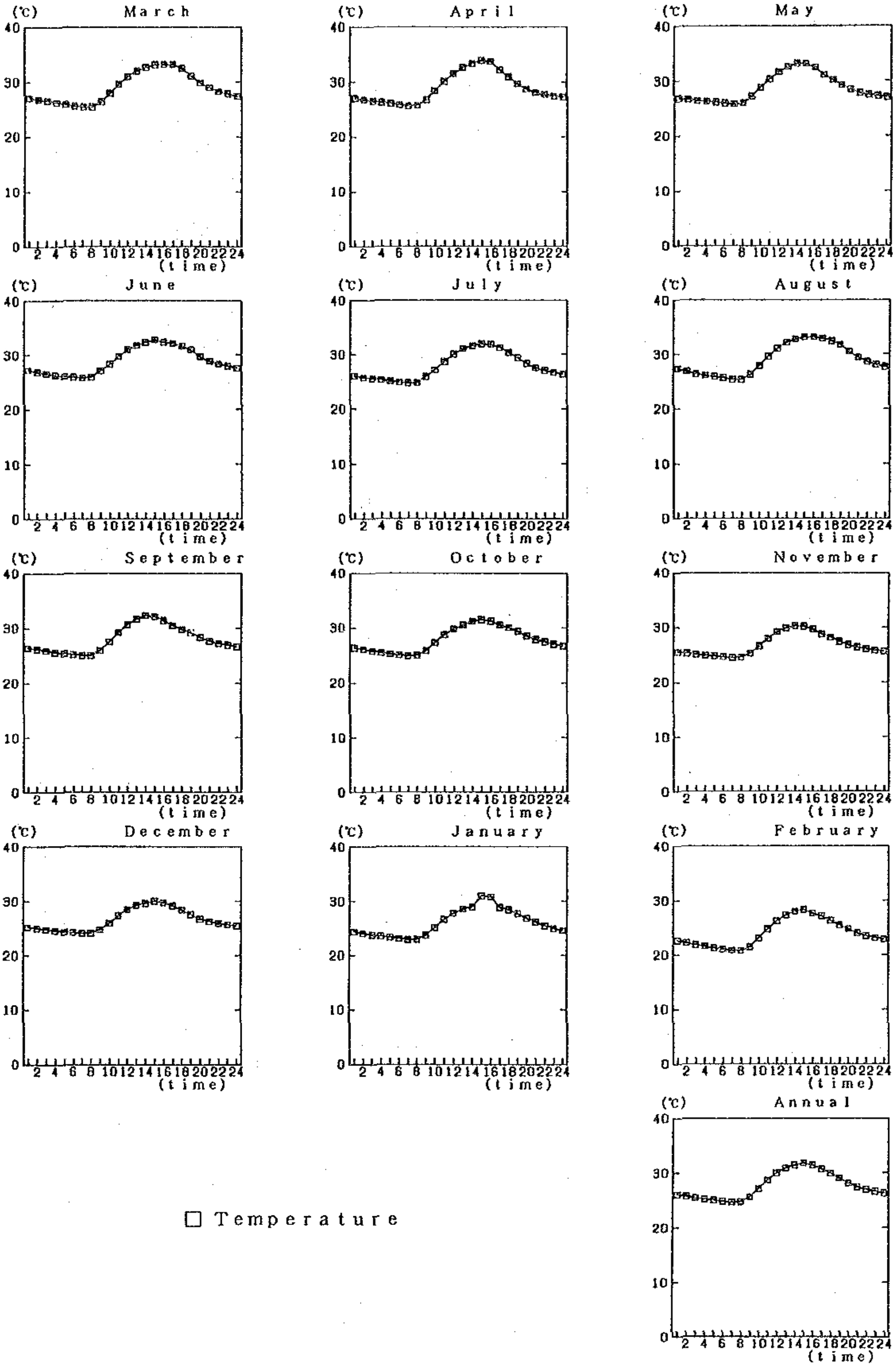


Fig. 3.1.6 Diurnal Variation of Temperature at UPM (Mar. 1992 ~ Feb. 1993)

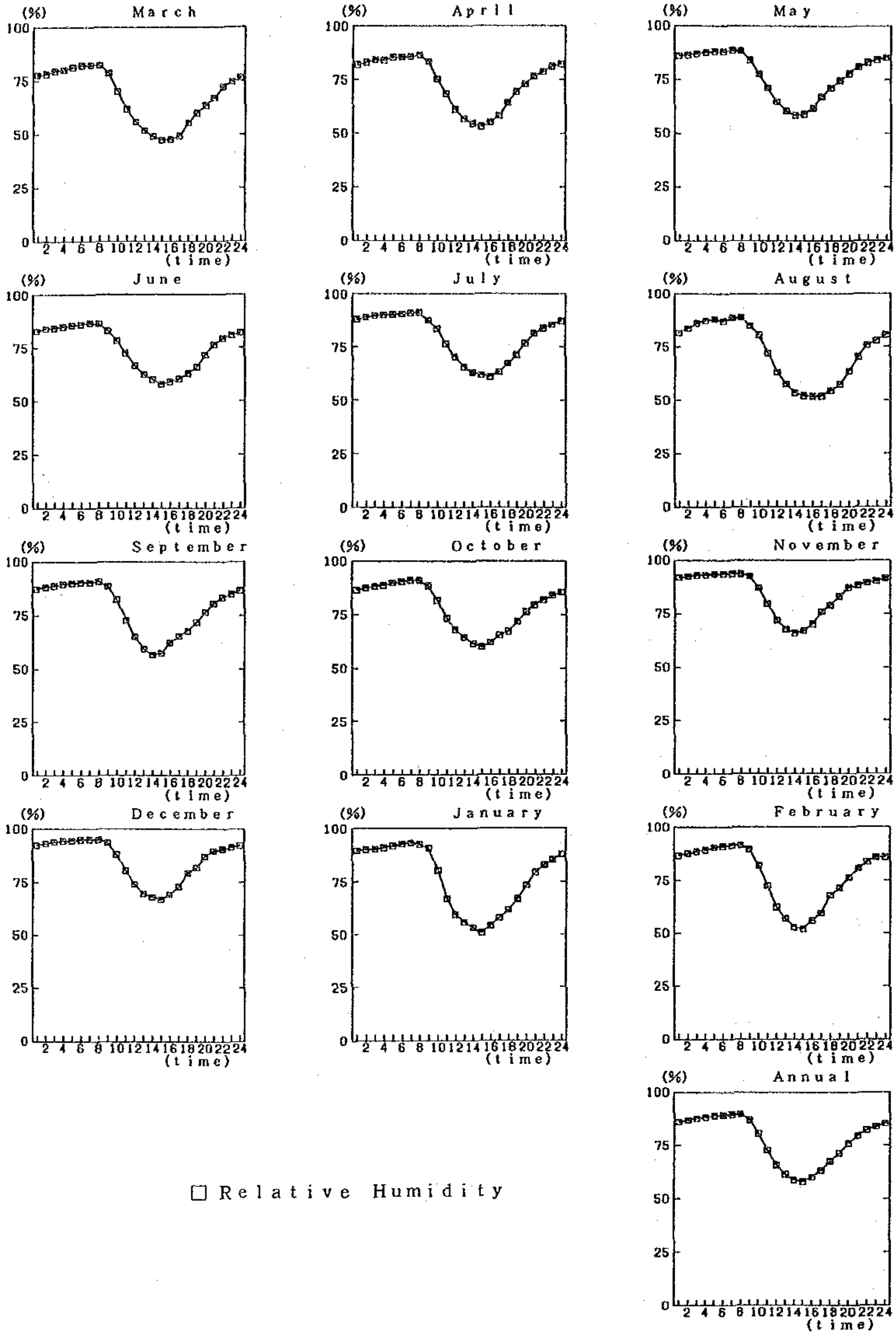


Fig. 3.1.7 Diurnal Variation of Relative Humidity at UPM (Mar. 1992 ~ Feb. 1993)

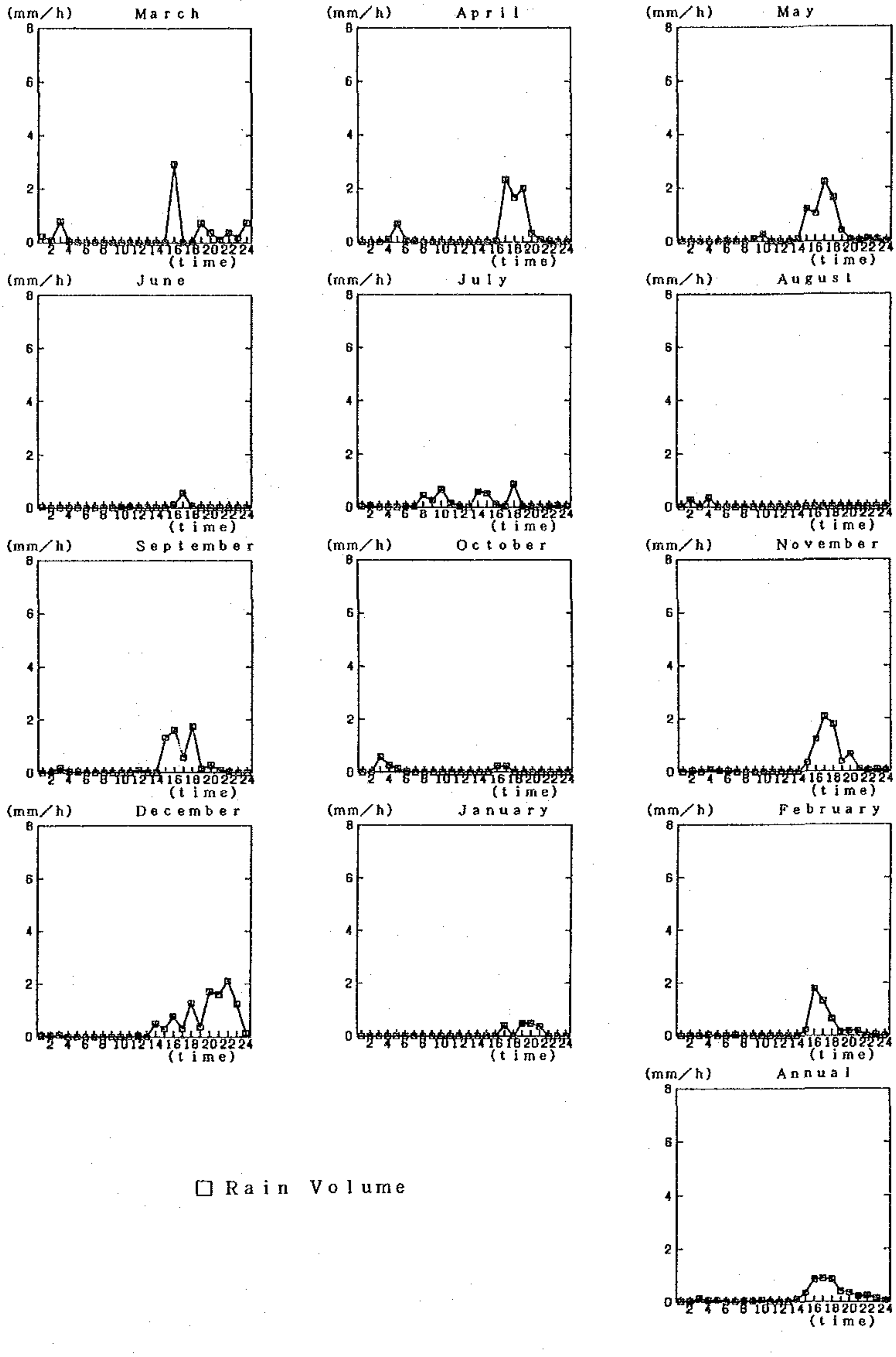


Fig. 3.1.8 Diurnal Variation of Rainfall Amount at UPM
(Mar. 1992 ~ Feb. 1993)

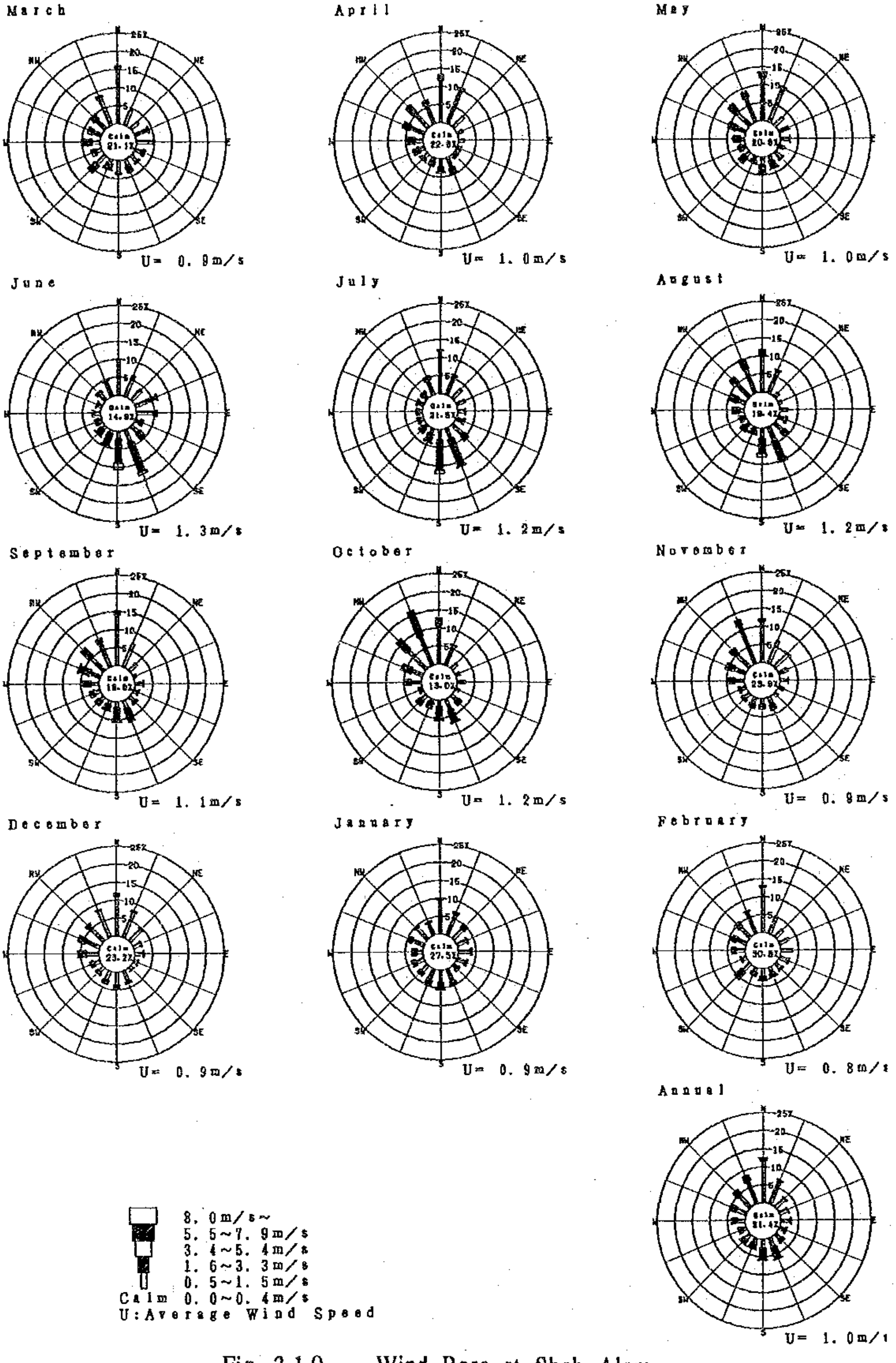


Fig. 3.1.9 Wind Rose at Shah Alam
(Mar. 1992 ~ Feb. 1993)

Similarities of the winds at each station are shown in Tables 3.1.3 and Table 3.1.4.

Similarities were defined for wind vectors (r) and wind directions (R) as follows.

$$r(V_A, V_B) = \frac{\Sigma V_{Ai} \cdot V_{Bi} \cdot \cos\theta_i}{\Sigma V_{Ai} \cdot V_{Bi}}$$

V_{Ai}, V_{Bi}: Scalar of wind vector at point A and point B

θ_i: Angle (radian) between wind vector at point A and wind vector at point B

$$R = \cos\theta,\ \theta = \frac{1}{N}\Sigma\theta_i$$

Table 3.1.3 Similarities of Wind Vectors (Mar. 1992 ~ Feb. 1993)

	UPM	PJ	SA	Klang	Subang
Petaling Jaya	0.24				
Shah Alam	0.26	0.49			
Klang	-0.16	0.53	0.47		
Subang(MMS)	0.25	0.64	0.79	0.56	
Petaling Jaya(MMS)	0.46	0.71	0.67	0.42	0.76

Table 3.1.4 Similarities of Wind Directions (Mar. 1992 ~ Feb. 1993)

	UPM	PJ	SA	Klang	Subang
Petaling Jaya	0.18				
Shah Alam	0.24	0.55			
Klang	-0.23	0.54	0.61		
Subang(MMS)	0.27	0.67	0.80	0.61	
Petaling Jaya(MMS)	0.41	0.68	0.65	0.43	0.74

Abbreviation PJ: Petaling Jaya, SA: Shah Alam

Generally, similarities are not so high. Wind direction similarity between Shah Alam and Subang (MMS) shows the highest value.

Monthly changes in wind speed, solar radiation, temperature, relative humidity, and rainfall amount are shown in Fig. 3.1.10 through Fig. 3.1.14. The monthly patterns of wind speed, solar radiation, temperature, and relative humidity show no significant change. Generally, rainfall amount is higher in November and December, and lower in June through September.

Histograms of wind speed and stability index, wind roses, and diurnal changes of meteorological parameters at the remaining stations are included in Section 1.1 of the Supporting Report.

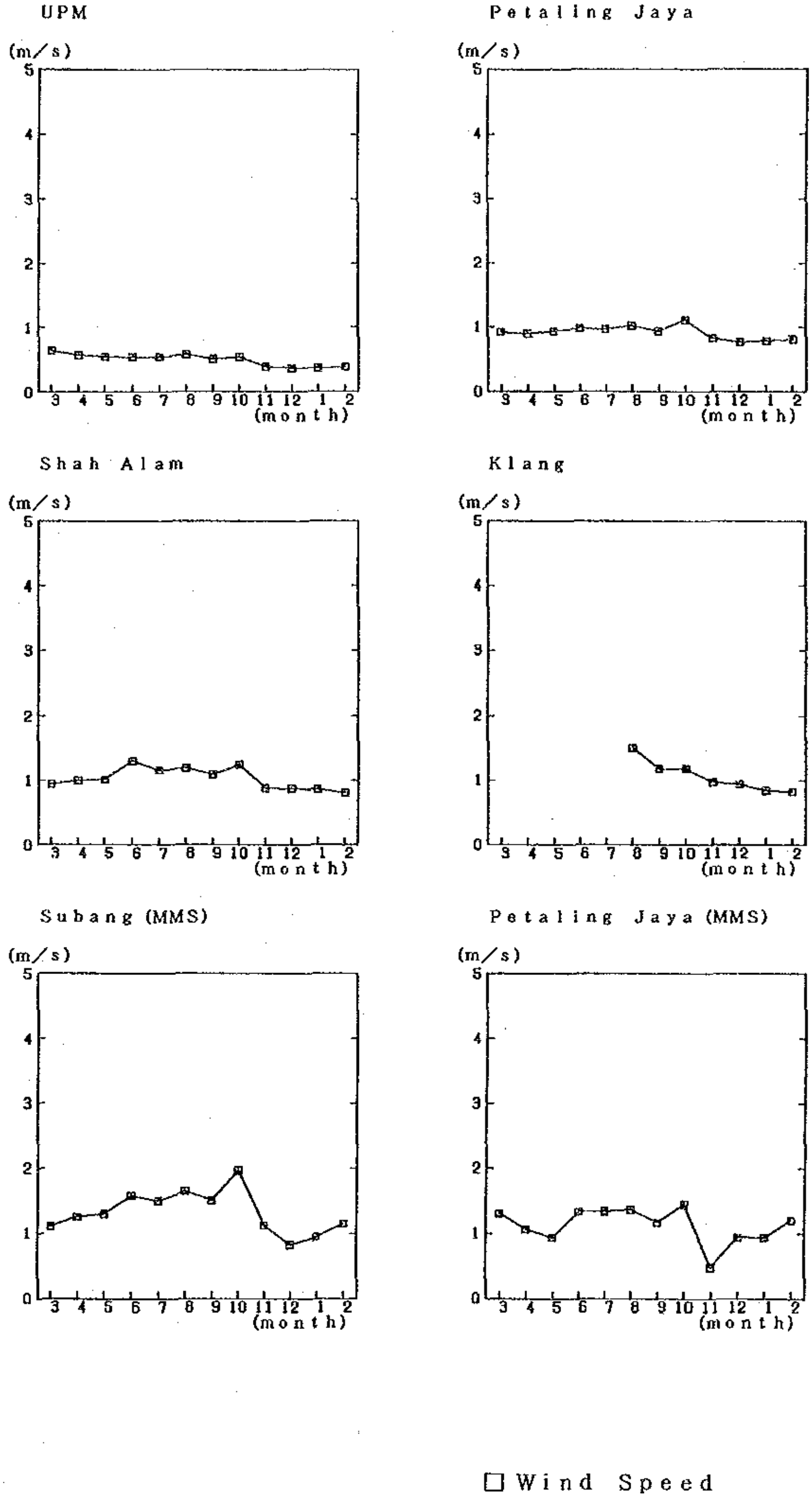


Fig. 3.1.10 Monthly Change of Wind Speed (Mar. 1992 ~ Feb. 1993)

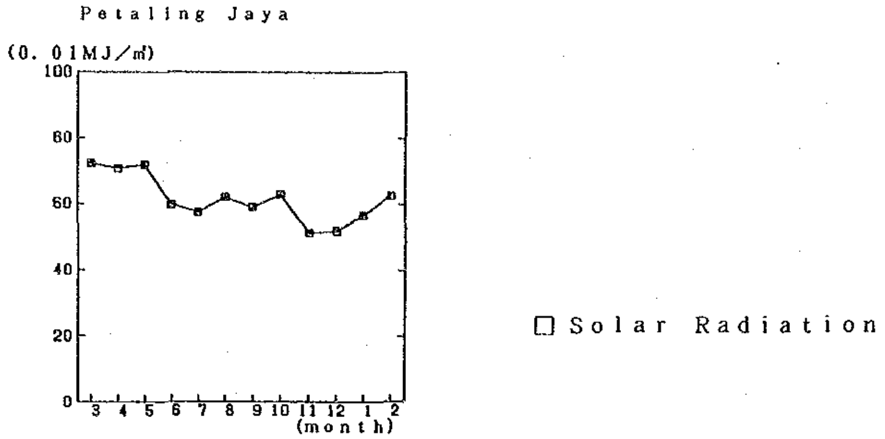


Fig. 3.1.11 Monthly Change of Solar Radiation
(Mar. 1992 ~ Feb. 1993)

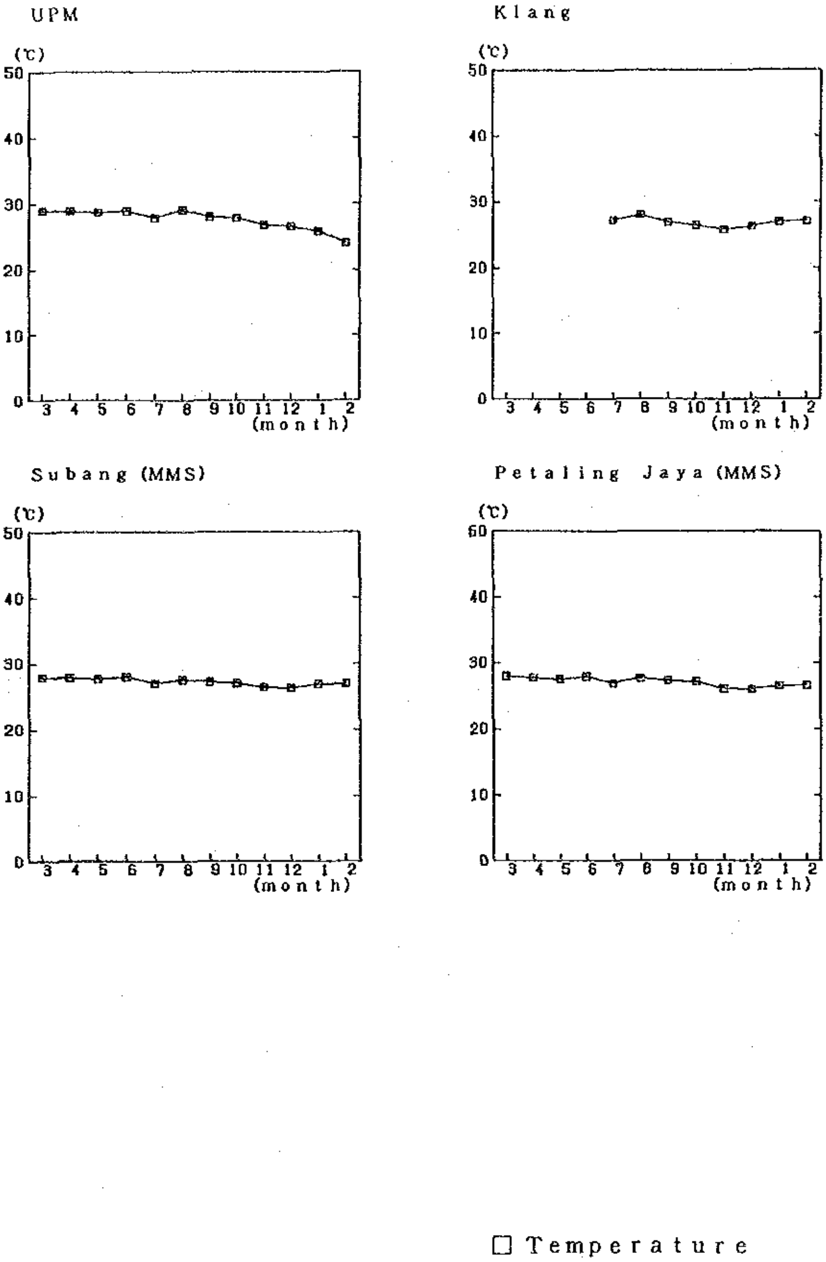


Fig. 3.1.12 Monthly Change of Temperature
(Mar. 1992 ~ Feb. 1993)

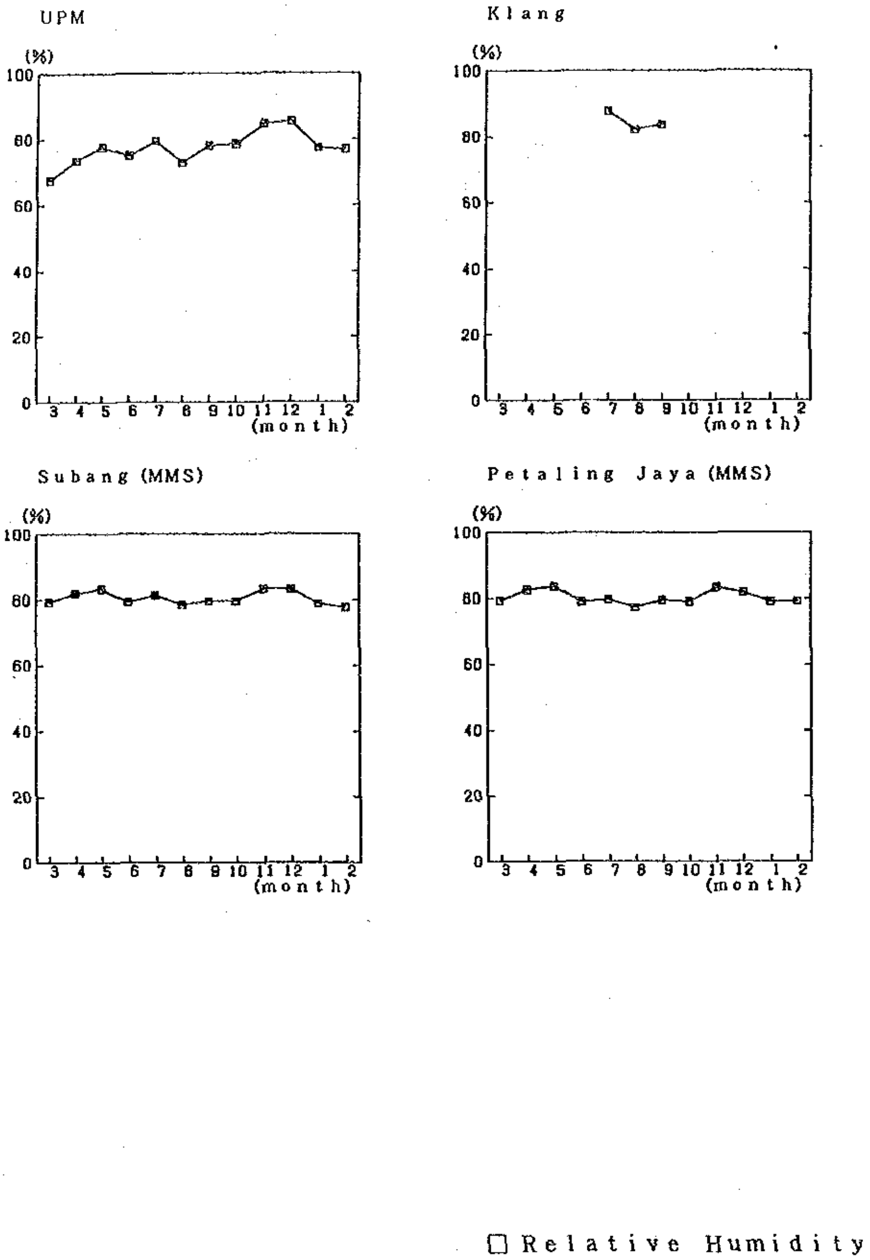


Fig. 3.1.13 Monthly Change of Relative Humidity (Mar. 1992 ~ Feb. 1993)

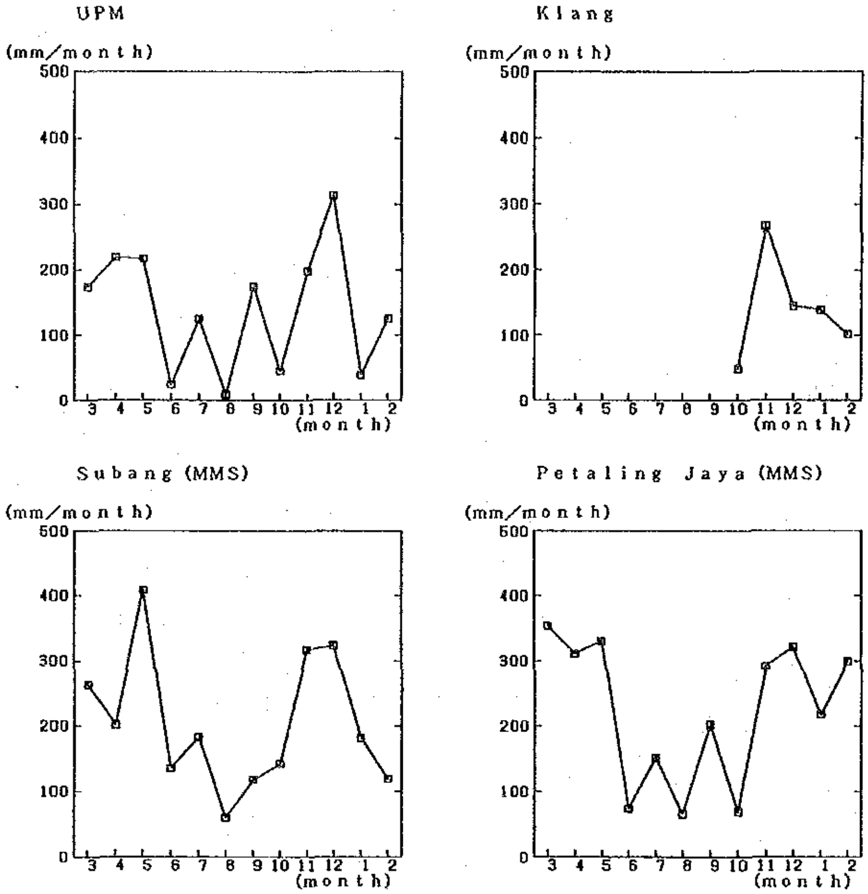


Fig. 3.1.14 Monthly Change of Rainfall Amount
(Mar. 1992 ~ Feb. 1993)

3.2 Upper Level Meteorology

3.2.1 Outline of the Observation

Observations of upper level meteorology were carried out four times at UPM in 1992. Outline of the observation is summarized in Table 3.2.1.

Table 3.2.1 Outline of the Upper Level Observation

Measurement Item	Instrument
Wind Direction Wind Speed	Pilot-balloon Theodlite System (TAMAYA TD-3)
Temperature	Radio Sonde System (MEISEI JWA-76T)

Four times of the observation periods are as follows.

1st (February)	20th/February	→	26th/February
2nd (April)	15th/April	→	21st/April
3rd (July & August)	29th/July	→	4th/August
4th (October)	21st/October	→	27th/October

Observations were carried out eight times at 0, 3, 6, 9, 12, 15, 18, 21 o'clock or six times at 6, 9, 12, 15, 18, 21 o'clock a day during the observation periods.

3.2.2 Analysis of the Observed Data

Vertical profiles of wind speed and temperature during each period are summarized in Fig. 3.2.1. Each observation is expressed by a profile and they are grouped according to the times of the observations. Vertical profiles of each observation day are included in the Supporting Report. Wind roses at each altitude are also included in the Supporting Report.

Vertical profiles of temperature show a common feature. Inversion layers are created during the nighttime and break down during the morning. During the daytime unstable conditions occur at the lower level.

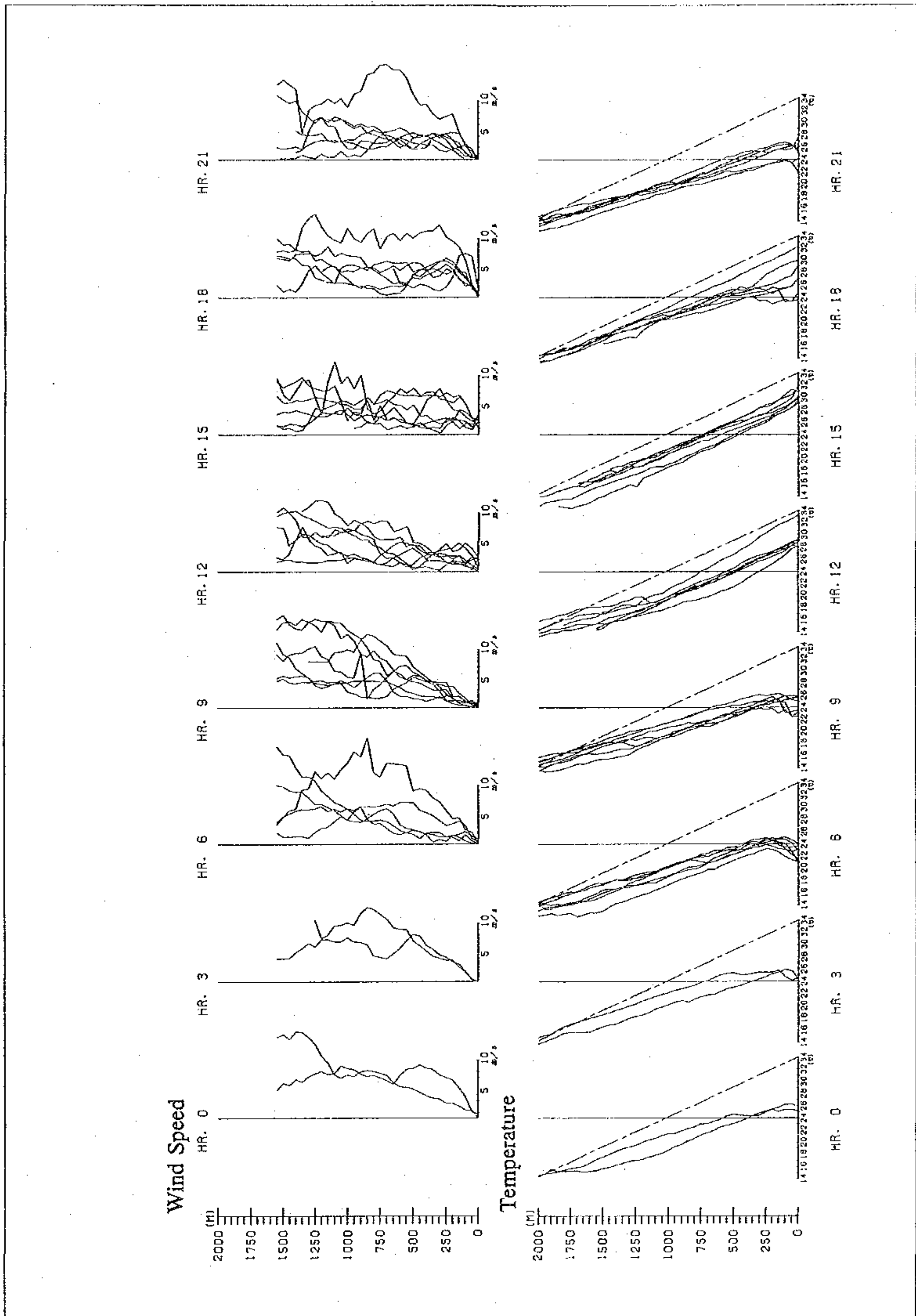


Fig. 3.2.1 (1) Vertical Profiles of Wind Speed and Temperature at UPM (20th ~ 26th/Feb./1992)

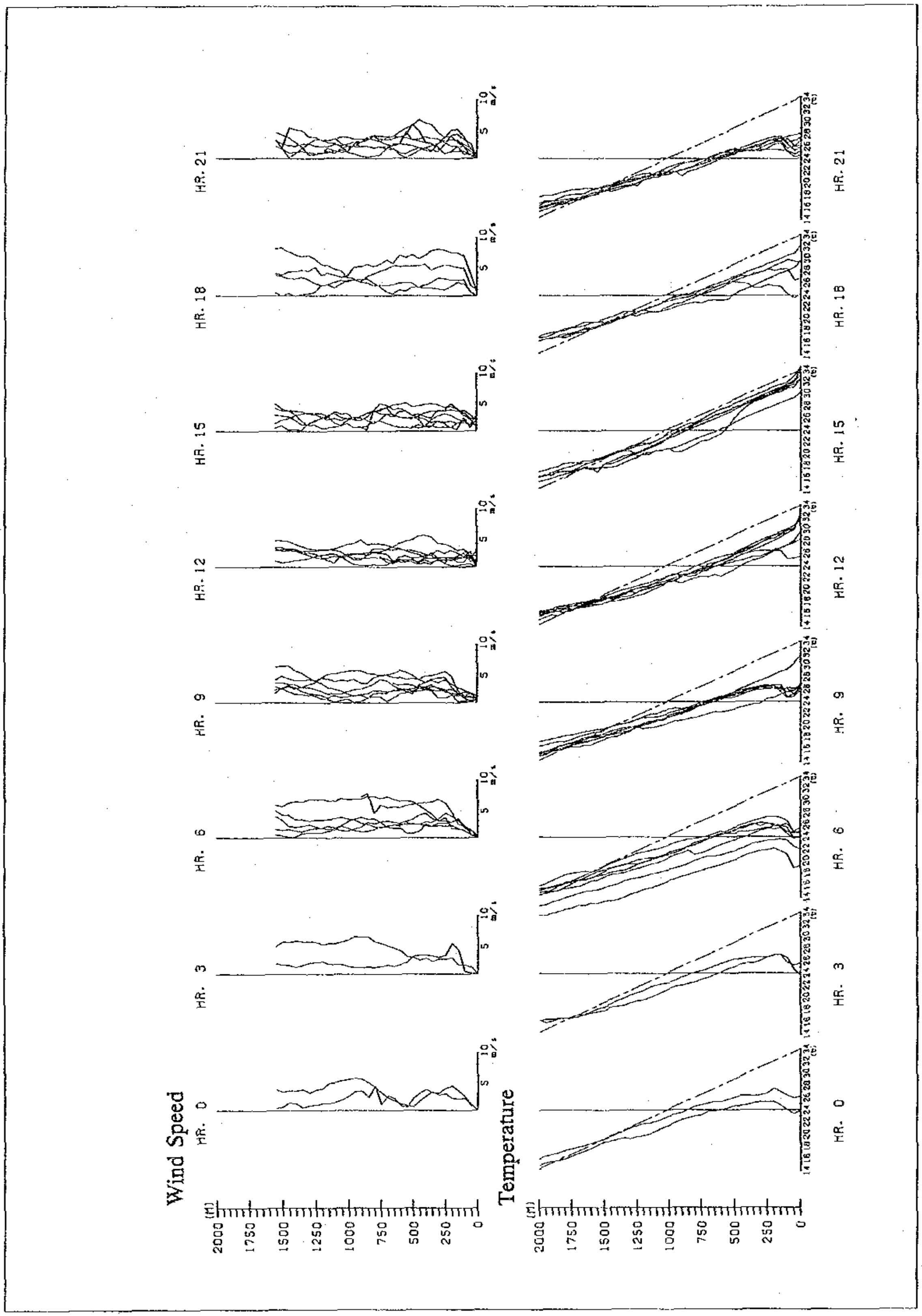


Fig. 3.2.1 (2) Vertical Profiles of Wind Speed and Temperature at UPM (15th ~ 21st/Apr./1992)

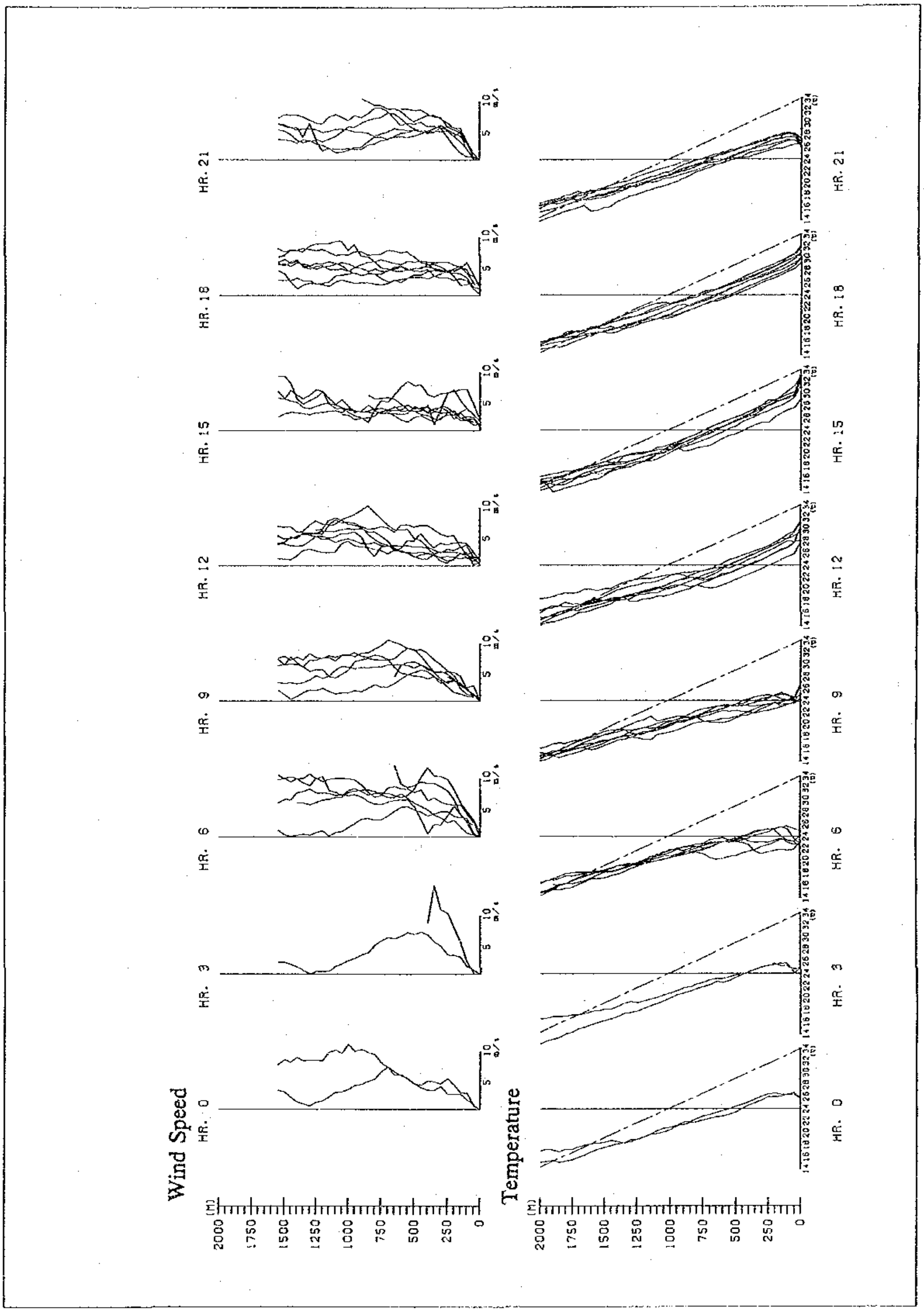


Fig. 3.2.1 (3) Vertical Profiles of Wind Speed and Temperature at UPM (29th/Jly. ~ 4th/Aug./1992)

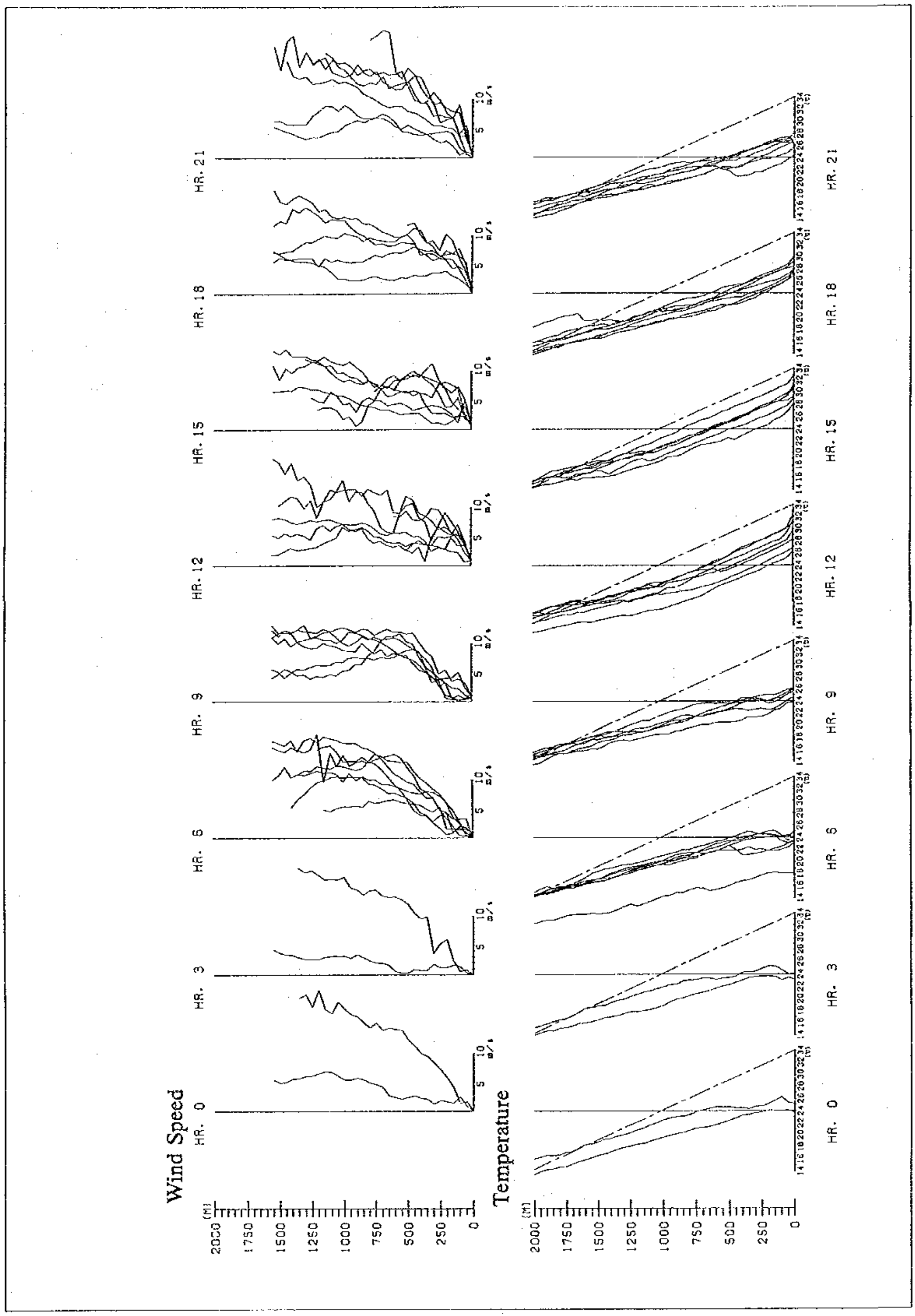


Fig. 3.2.1 (4) Vertical Profiles of Wind Speed and Temperature at UPM (21st ~ 27th/Oct./1992)

Frequencies of occurrences of surface layer inversions are shown in Tables 3.2.2 and 3.2.3. Inversion is defined as temperature increase of more than 0.01 °C per meter with height.

In February, July and August, the frequency of occurrences of surface layer inversions reaches 20%. During the Night (from 19:00 to 2:00), the frequency of occurrences exceeds 30 %. During the Early Morning (from 2:00 to 6:00), the frequency of occurrences is more than 25% and two inversion layers reached 150 meters' height.

Table 3.2.2 Frequency of Occurrences of Surface Layer Inversions in Seasons at UPM (1992)

Height	February	April	July and August	October	Average and Total
50m	15.2% (7)	0.0% (0)	17.8% (8)	4.4% (2)	9.4% (17)
100m	4.3% (2)	0.0% (0)	2.2% (1)	0.0% (0)	1.7% (3)
150m	2.2% (1)	2.3% (1)	0.0% (0)	0.0% (0)	1.1% (2)
Total	(46)	(44)	(45)	(45)	(180)

In parenthesis: Number of Data
Height: Top height of surface inversion layer

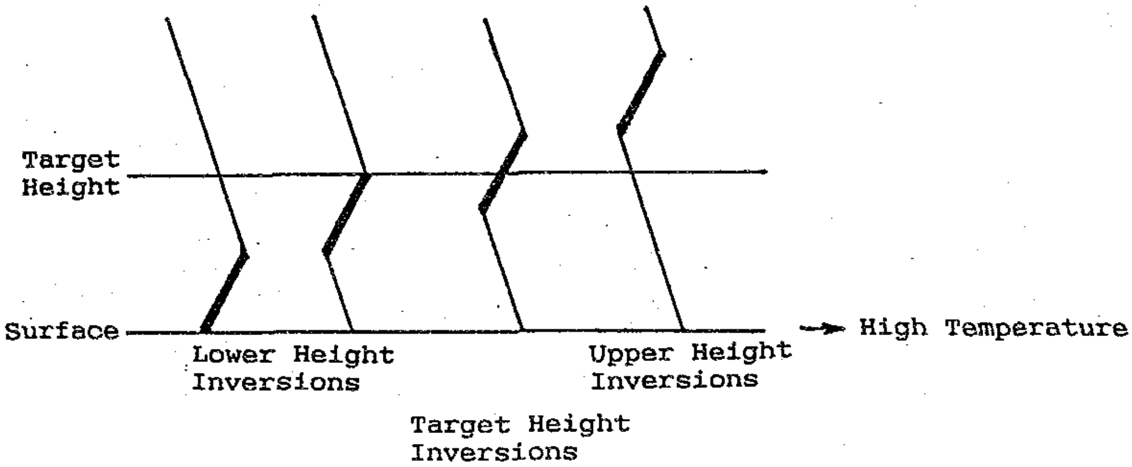
Table 3.2.3 Frequency of Occurrences of Surface Layer Inversions in Time Zones at UPM (1992)

Height	Morning	Afternoon	Night	Early Morning	Average and Total
50m	0.0% (0)	1.2% (1)	33.3% (12)	11.4% (4)	9.4% (17)
100m	0.0% (0)	0.0% (0)	0.0% (0)	8.6% (3)	1.7% (3)
150m	0.0% (0)	0.0% (0)	0.0% (0)	5.7% (2)	1.1% (2)
Total	(27)	(82)	(36)	(35)	(180)

In parenthesis: Number of Data
Height: Top height of surface inversion layer
Time Zones Morning : from 6:00 to 11:00
Afternoon : from 11:00 to 19:00
Night : from 19:00 to 2:00
Early Morning : from 2:00 to 6:00

In the analysis of upper layer inversion, 'target height' was determined by taking into consideration the effective stack height. Then upper layer inversions were classified into three categories. The categories are 'target height inversion (THI)', 'upper height inversion (UHI)', and 'lower height inversion (LHI)'. The target height and target height inversion, upper height inversion, and lower height inversion are illustrated in Fig. 3.2.2. Target height inversion is said to be the most problematic one and upper height inversion is the second problematic one for air pollution. Lower height inversion does not influence the pollution from the target stack. Inversions which are below twice the target height are tabulated. If the target height is set at 100 meters, then inversions below 200 meters are tabulated.

Fig. 3.2.2 Relations among Target Height and Three Inversion Categories



In the Study, target heights were set at 50 meters, 200 meters, and 400 meters respectively, because the effective stack height of the highest stack in Klang Valley Region varied from about 200 meters to about 400 meters depending on meteorological conditions.

Frequencies of occurrences of upper layer inversions with target height set at 50 meters are shown in Tables 3.2.4 and 3.2.5. Frequency of occurrence of target height inversions in April exceeds 30%. During early morning, frequency of occurrence of target height inversion is very high and about 49%.

Frequencies of occurrences of upper layer inversions with target height set at 200 meters are shown in Tables 3.2.6 and 3.2.7. Three times of target height inversions occur and one time of upper height inversion occurs during the whole periods. Two times of target height inversions occur in the Morning, and one time of target inversion occurs in the Afternoon. One time of upper height inversion occurs in the Early Morning.

Frequencies of occurrences of upper layer inversions with target height set at 400 meters are shown in Tables 3.2.8 and 3.2.9. One time of target height inversion occurs and two times of upper height inversions occur during the whole periods. One time of target height inversion and one time of upper height inversion occur in the Early Morning, and one time of target inversion occurs in the Night.

Table 3.2.4 Frequency of Occurrences of Upper Layer Inversions in Seasons at UPM (1992, Target height: 50 meters)

	February	April	July and August	October	Average and Total
None	67.4% (31)	68.2% (30)	73.3% (33)	88.9% (40)	74.4%(134)
Lower	15.2% (7)	0.0% (0)	17.8% (8)	4.4% (2)	9.4% (17)
Target	17.4% (8)	31.8% (14)	8.9% (4)	6.7% (3)	16.1% (29)
Upper	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
Total	(46)	(44)	(45)	(45)	(180)

In parenthesis: Number of Data

Table 3.2.5 Frequency of Occurrences of Upper Layer Inversions in Time Zones at UPM (1992, Target height: 50 meters)

	Morning	Afternoon	Night	Early Morning	Average and Total
None	81.5% (22)	96.3% (79)	52.8% (19)	40.0% (14)	74.4%(134)
Lower	0.0% (0)	1.2% (1)	33.3% (12)	11.4% (4)	9.4%(17)
Target	18.5% (5)	2.4% (2)	13.9% (5)	48.6% (17)	16.1%(29)
Upper	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0%(0)
Total	(27)	(82)	(36)	(35)	(180)

In parenthesis: Number of Data
Time Zones: Same as Table 3.2.3

Table 3.2.6 Frequency of Occurrences of Upper Layer Inversions in Seasons at UPM (1992, Target height: 200 meters)

	February	April	July and August	October	Average and Total
None	56.5% (26)	45.5% (20)	66.7% (30)	84.4% (38)	63.3%(114)
Lower	41.3% (19)	52.3% (23)	31.1% (14)	13.3% (6)	34.4%(62)
Target	2.2% (1)	2.3% (1)	0.0% (0)	2.2% (1)	1.7%(3)
Upper	0.0% (0)	0.0% (0)	2.2% (1)	0.0% (0)	0.6%(1)
Total	(46)	(44)	(45)	(45)	(180)

In parenthesis: Number of Data

Table 3.2.7 Frequency of Occurrences of Upper Layer Inversions in Time Zones at UPM (1992, Target height: 200 meters)

	Morning	Afternoon	Night	Early Morning	Average and Total
None	51.9% (14)	92.7% (76)	44.4% (16)	22.9% (8)	63.3%(114)
Lower	40.7% (11)	6.1% (5)	55.6% (20)	74.3% (26)	34.4%(62)
Target	7.4% (2)	1.2% (1)	0.0% (0)	0.0% (0)	1.7%(3)
Upper	0.0% (0)	0.0% (0)	0.0% (0)	2.9% (1)	0.6%(1)
Total	(27)	(82)	(36)	(35)	(180)

In parenthesis: Number of Data
Time Zones: Same as Table 3.2.3

Table 3.2.8 Frequency of Occurrences of Upper Layer Inversions in Seasons at UPM (1992, Target height: 400 meters)

	February	April	July and August	October	Average and Total
None	56.5% (26)	45.5% (20)	64.4% (29)	80.0% (36)	61.7%(111)
Lower	43.5% (20)	54.5% (24)	33.3% (15)	15.6% (7)	36.7%(66)
Target	0.0% (0)	0.0% (0)	0.0% (0)	2.2% (1)	0.6%(1)
Upper	0.0% (0)	0.0% (0)	2.2% (1)	2.2% (1)	1.1%(2)
Total	(46)	(44)	(45)	(45)	(180)

In parenthesis: Number of Data

Table 3.2.9 Frequency of Occurrences of Upper Layer Inversions in Time Zones at UPM (1992, Target height: 400 meters)

	Morning	Afternoon	Night	Early Morning	Average and Total
None	51.9% (14)	92.7% (76)	41.7% (15)	17.1% (6)	61.7%(111)
Lower	48.1% (13)	7.3% (6)	55.6% (20)	77.1% (27)	36.7%(66)
Target	0.0% (0)	0.0% (0)	0.0% (0)	2.9% (1)	0.6%(1)
Upper	0.0% (0)	0.0% (0)	2.8% (1)	2.9% (1)	1.1%(2)
Total	(27)	(82)	(36)	(35)	(180)

In parenthesis: Number of Data
Time Zones: Same as Table 3.2.3

Similarities of the winds at surface, 50m, 100m, 200m, 300m, 400m, 500m, 1000m, 1500m are shown in Tables 3.2.10 and 3.2.11.

The definitions of similarities for wind vectors and wind directions are as the same as described in section 3.1.2.

Both wind vectors and wind directions from 50m level to 500m level show high similarities with values of more than 0.90 between the adjacent levels. The similarities between 500m level and 1000m level are less compared to the ones between 1000m level and 1500m level.

Table 3.2.10 Similarities of Wind Vectors among Different Heights at UPM (1992)

Surface	Sur.	50m	100m	200m	300m	400m	500m	1000m
50m	0.24							
100m	0.20	0.94						
200m	0.10	0.85	0.94					
300m	-0.02	0.80	0.84	0.95				
400m	0.00	0.71	0.78	0.90	0.97			
500m	-0.07	0.64	0.72	0.86	0.95	0.98		
1000m	-0.13	0.42	0.46	0.63	0.74	0.79	0.85	
1500m	-0.21	0.34	0.43	0.56	0.65	0.72	0.77	0.93

Abbreviation Sur.: Surface

Table 3.2.11 Similarities of Wind Directions among Different Heights at UPM (1992)

Surface	Sur.	50m	100m	200m	300m	400m	500m	1000m
50m	0.16							
100m	0.15	0.95						
200m	0.12	0.89	0.94					
300m	0.01	0.83	0.87	0.96				
400m	-0.02	0.76	0.81	0.92	0.97			
500m	-0.04	0.71	0.76	0.88	0.95	0.98		
1000m	-0.13	0.57	0.63	0.75	0.82	0.89	0.92	
1500m	-0.21	0.52	0.60	0.69	0.75	0.82	0.86	0.96

Abbreviation Sur.: Surface

To estimate upper layer wind speed, power law equation as below was used.

$$(Uz / Us) = (Z / Zs)^P$$

Uz: Upper level wind speed
Us: Surface level wind speed
Z : Upper level height
Zs: Surface level height

Wind speed data from the observations were used to estimate P-values of the equation.

Calculated P-values at each stability index class are summarized in Table 3.2.12.

P-values for stability index A - B are the smallest and the ones for stability index G are the largest.

Table 3.2.12 P-values by Stability Index at UPM (1992)

	Stability Index			
Height	A - B	C - D	G	Average
12m	- (51)	- (29)	- (39)	- (164)
50m	0.49 (51)	0.92 (29)	1.48 (39)	0.68 (177)
100m	0.50 (51)	0.81 (29)	1.34 (39)	0.68 (177)
150m	0.46 (51)	0.76 (29)	1.26 (39)	0.65 (177)
200m	0.44 (51)	0.73 (29)	1.20 (39)	0.63 (177)
250m	0.44 (51)	0.69 (29)	1.16 (39)	0.61 (177)
300m	0.41 (51)	0.69 (29)	1.12 (39)	0.59 (176)
350m	0.41 (51)	0.66 (29)	1.10 (39)	0.58 (176)
400m	0.43 (51)	0.65 (29)	1.08 (39)	0.58 (176)
450m	0.44 (51)	0.65 (29)	1.06 (39)	0.57 (175)
500m	0.43 (51)	0.63 (29)	1.04 (39)	0.56 (175)

In parenthesis: Number of Data

3.3 Analysis of Other Related Data

Data of some meteorological parameters were provided by MMS (Malaysian Meteorological Service).

Wind Roses at Petaling Jaya (MMS) are shown in Fig. 3.3.1. The wind roses were constructed for four seasons with the data from 1974 to 1988 (#3035). The notable feature of the wind roses is very high frequency of calm (equal to or below 0.2 m/s) wind condition. During the southwest monsoon period, southerly wind is the most frequent next to calm wind. During the northeast monsoon period, E'ly to NE'ly wind are most frequent next to calm wind condition.

Monthly changes of rainfall amount for 10-year averaged mean and recent two years at Petaling Jaya (MMS) and Subang (MMS) are shown in Fig. 3.3.2. In spite of some fluctuations between the years, large rainfall amount is observed in March through May and in October through December. Monthly rainfall changes of the 10-year averaged mean show two peaks in April and November. In contrast, less rainfall amount is observed in January and June through August.

Monthly changes of temperature for 10-year averaged mean and recent two years at Petaling Jaya (MMS) and Subang (MMS) are shown in Fig. 3.3.3. The monthly mean values of temperature range from about 26°C to about 28°C. The monthly mean values in June are the highest and the ones in December or January is the lowest.

Diurnal changes of temperature, rainfall amount, and relative humidity are shown in Figs. 3.3.4 through 3.3.6. The diurnal changes of the parameters are similar to the ones described in section 3.1.2. The diurnal change of temperature has a single peak in the daytime. Rainfall mainly occurs in the afternoon and evening. Annually in about half to two thirds of the days in a year, thunderstorms occur. Most of the rainfall may be from thunderstorms and the heavy rainfall occurs in a relatively short interval. The diurnal change of relative humidity has a minimum in the daytime.

Some sets of F-test were conducted for some meteorological parameters to verify the normality of the year 1992 in meteorological conditions compared with the last 11 years (from 1981 to 1991). The meteorological parameters examined are wind direction, temperature, relative humidity, and sunshine duration. Level of the F-test is set at 1.0%. As a result, the normality of the year 1992 is verified on these meteorological parameters. The results of F-test are included in Section 1.3 of the Supporting Report.

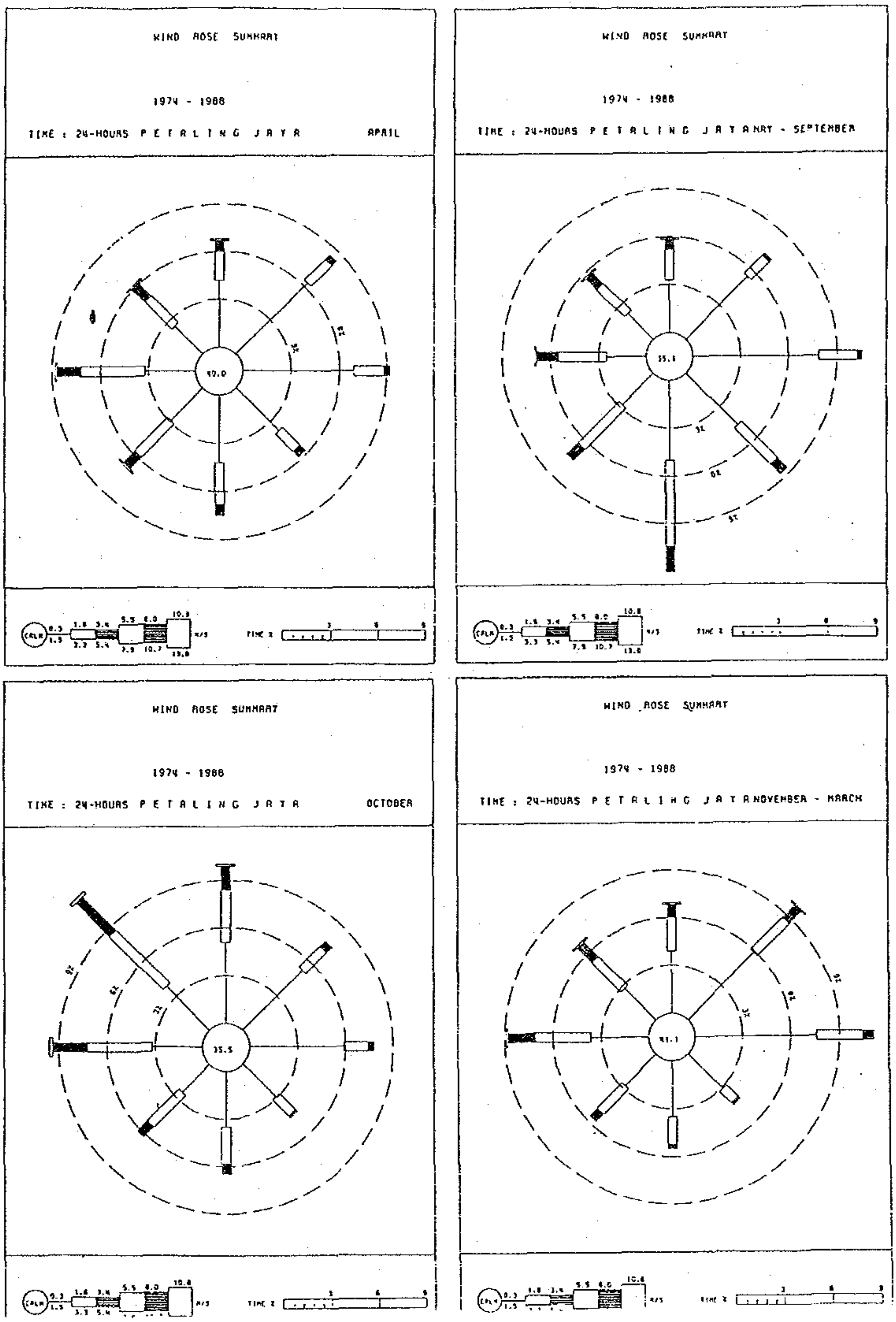


Fig. 3.3.1 Summary of Wind Roses in 1974 through 1988

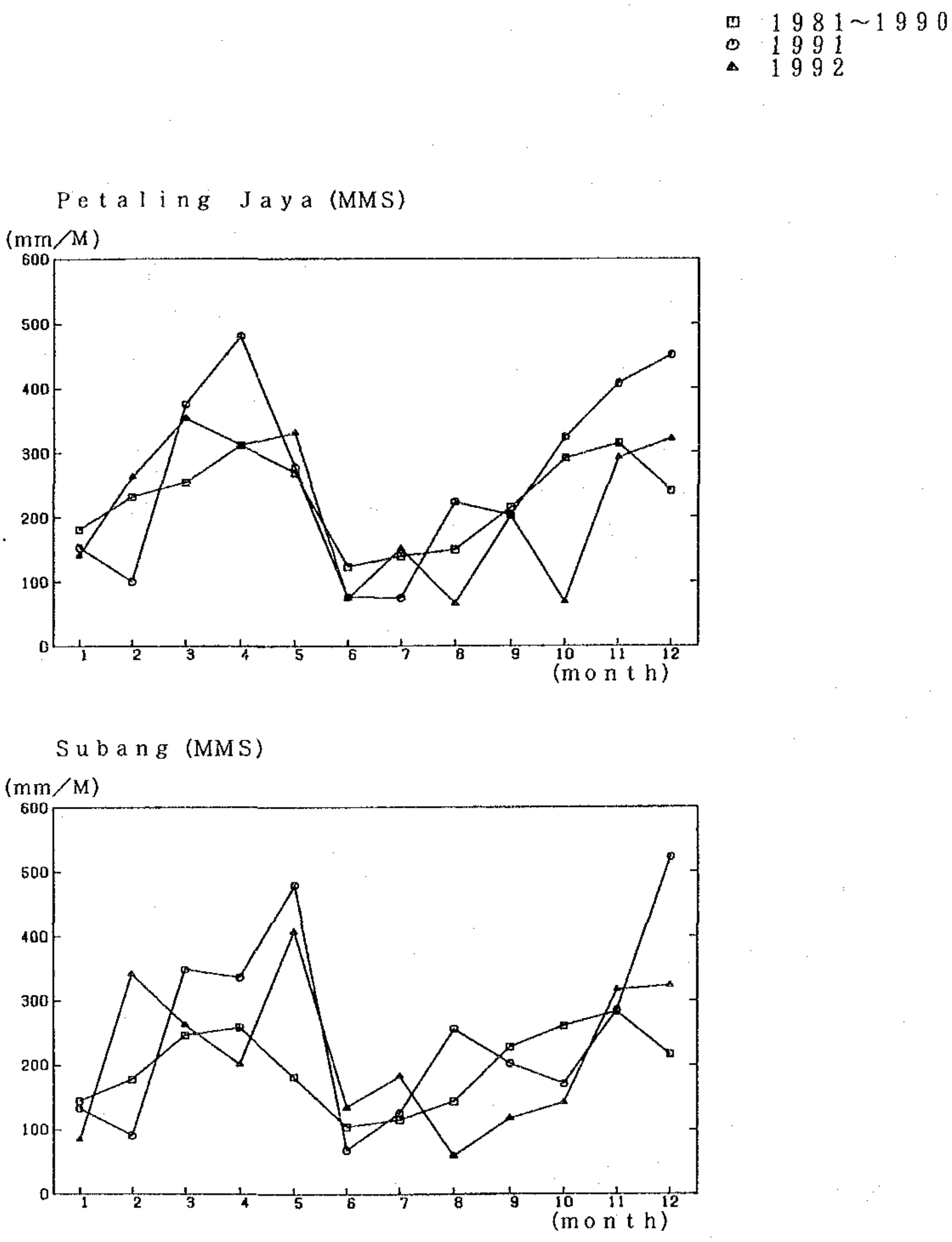


Fig. 3.3.2 Monthly Changes of Rainfall Amount in 1981 through 1992

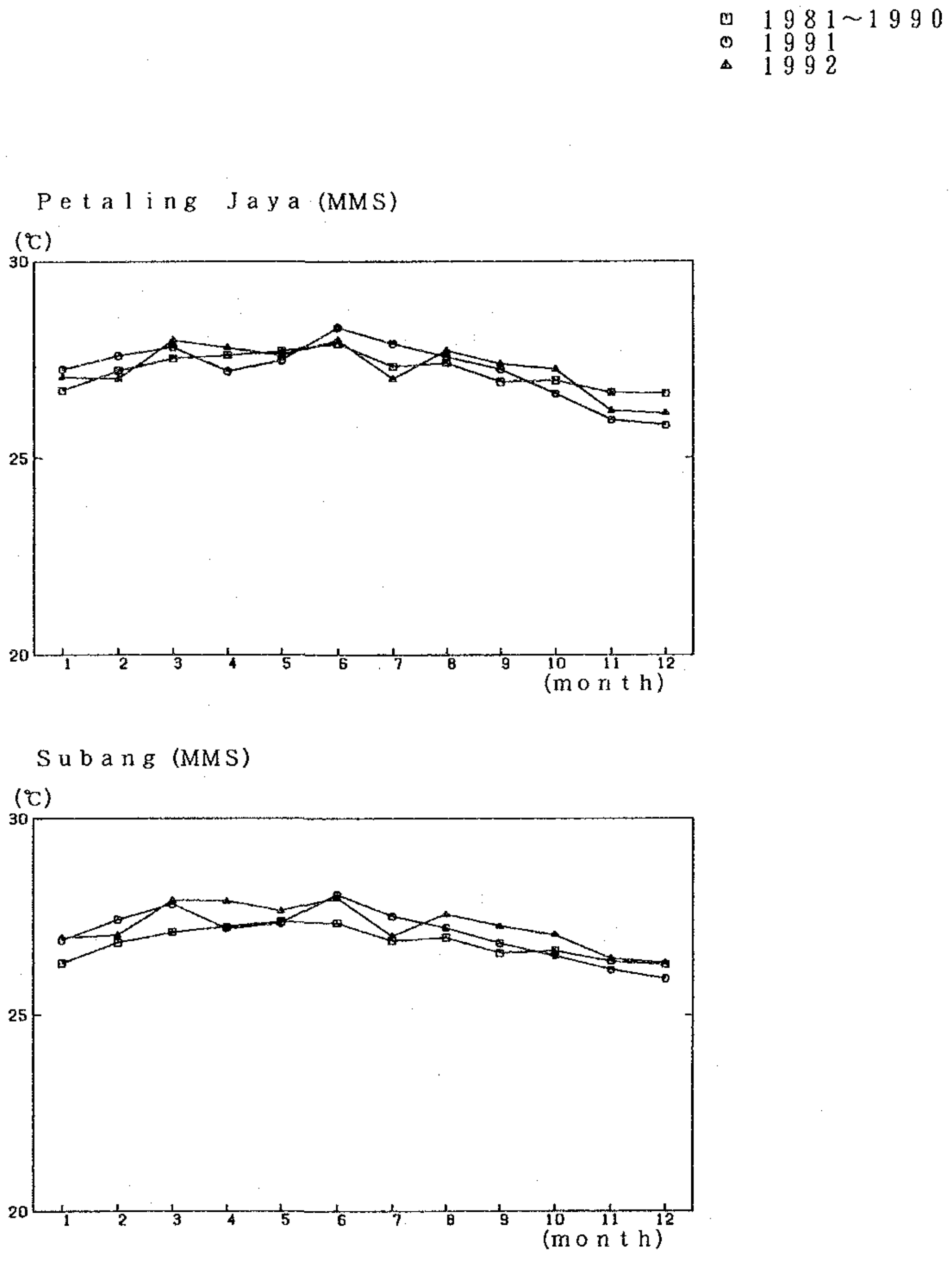


Fig. 3.3.3 Monthly Changes of Temperature in 1981 through 1992

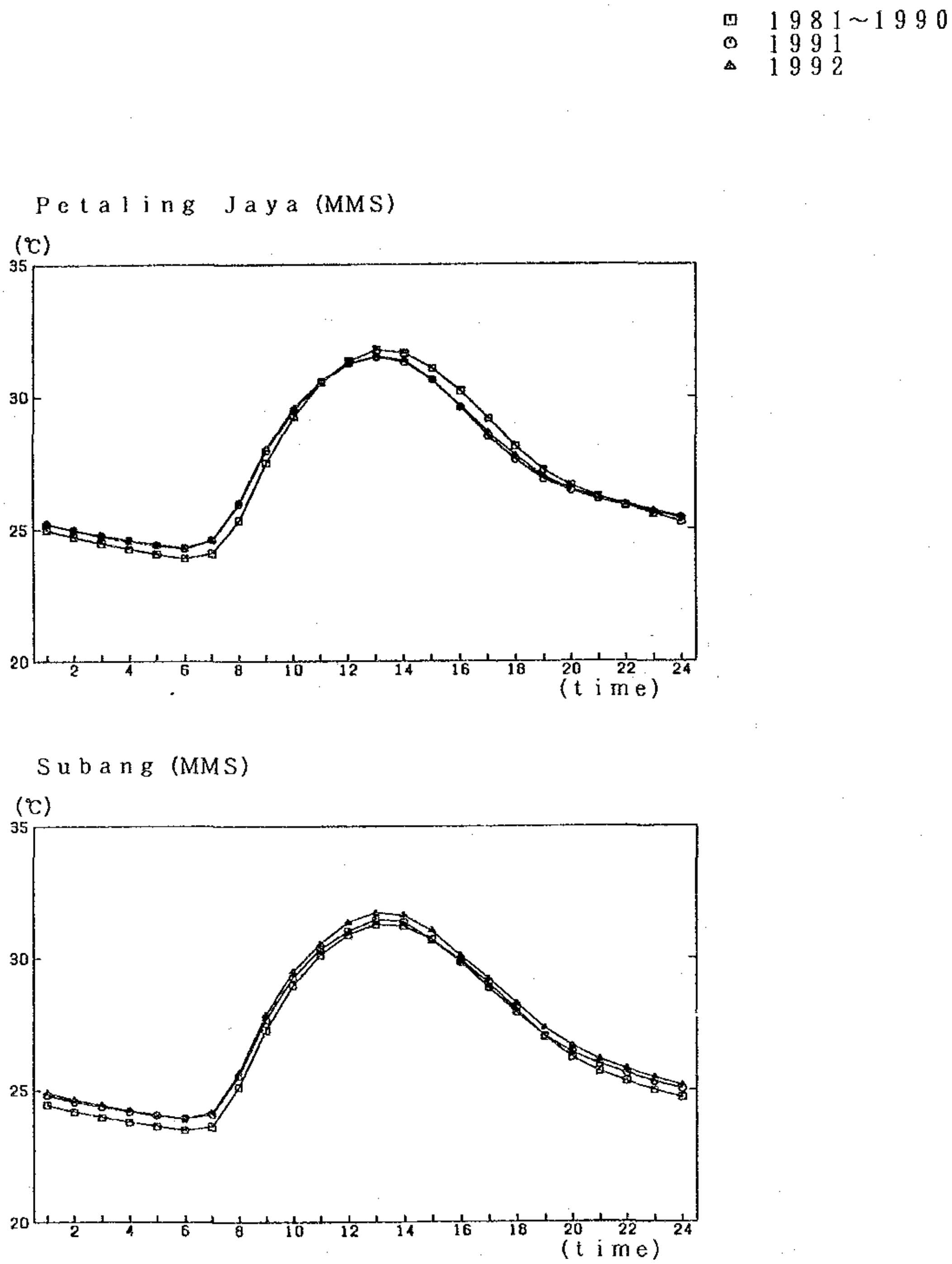


Fig. 3.3.4 Diurnal Changes of Temperature in 1981 through 1992

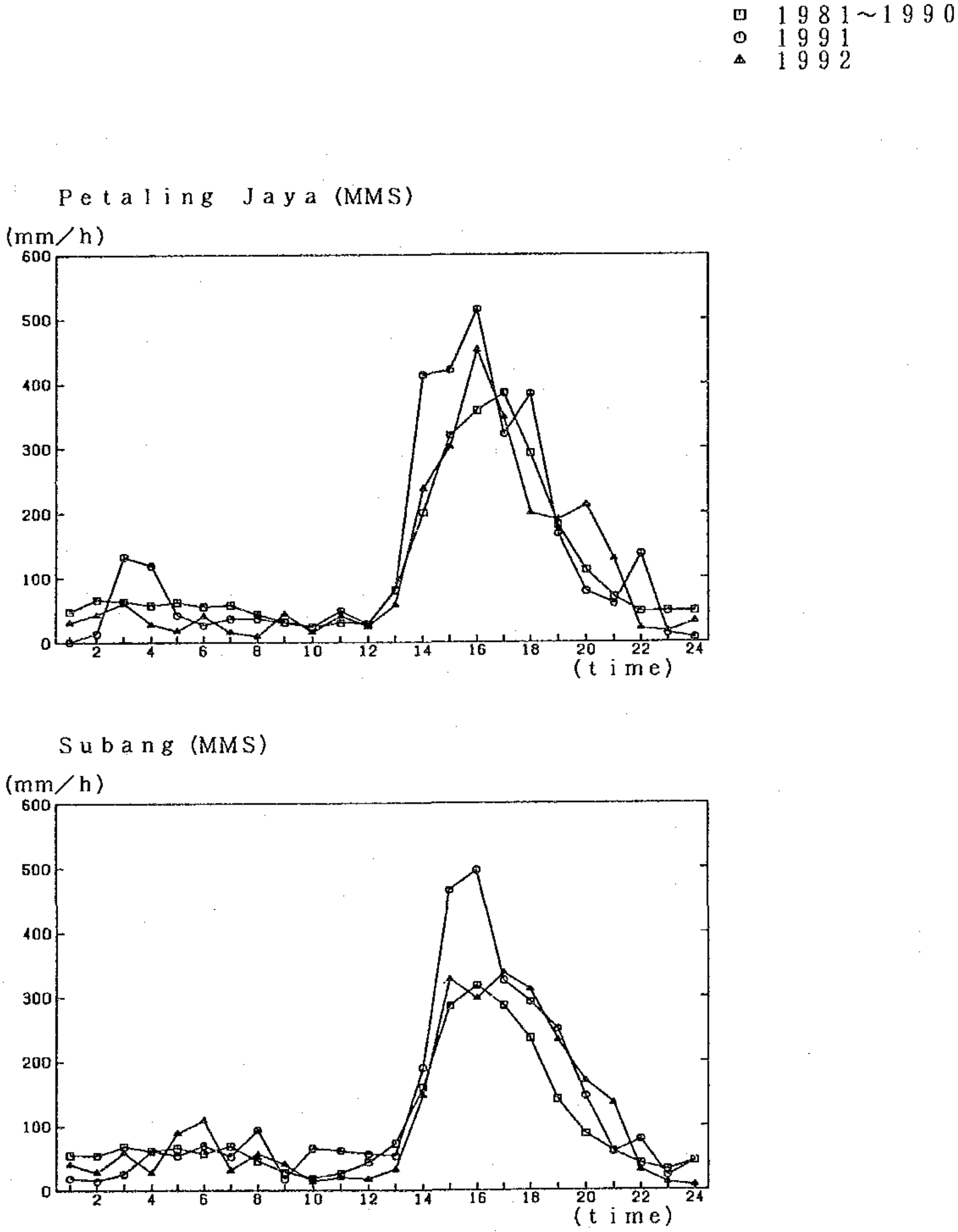


Fig. 3.3.5 Diurnal Changes of Rainfall Amount in 1981 through 1992

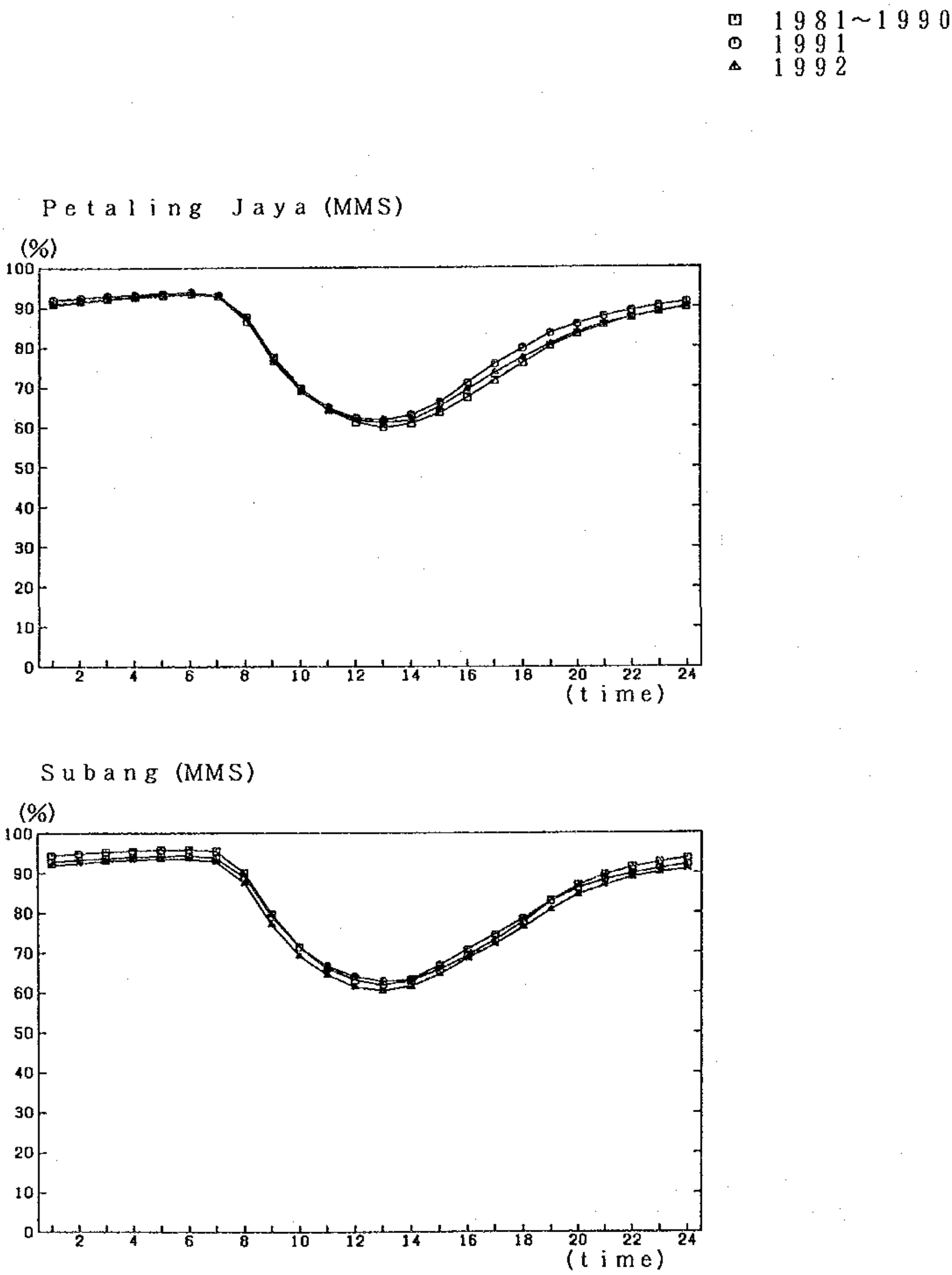


Fig. 3.3.6 Diurnal Changes of Relative Humidity in 1981 through 1992

3.4 Summary

Meteorological characteristics in Kelang Valley Region based on the analysis conducted are summarized as follows.

Wind speed is very low and therefore pollutants are likely to stagnate in the atmosphere.

Strong stable and strong unstable conditions occur with high frequencies because of weak wind and strong radiation. Pollutants tend to be contained within the lower atmosphere under stable conditions and stirred up to higher levels under unstable conditions.

Diurnal changes of meteorological parameters such as wind speed, radiation, and temperature show single peak pattern. Rainfall mainly occurs in the afternoons and evenings.

Inversion layers are created during the nighttime and break during the morning. Unstable condition occur at the lower layers during the daytime.

Surface layer inversions occur during the night through the early morning with frequencies of higher than 25%. During the early morning, occurrence frequency of target height inversions with target height set at 50 meters is very high and exceeds 45%. These frequent inversion occurences may affect pollution severely at specific height.

Strong solar radiation and high temperature suggest greater possibilities of photochemical reaction and such conditions could contribute to the formation of NO_2, O_3, and SPM.

Taking into consideration the above meteorological conditions, it is concluded that air pollution in the Kelang Valley Region has the potential of becoming more serious.

CHAPTER 4 AMBIENT AIR QUALITY

CHAPTER 4 AMBIENT AIR QUALITY

4.1 Monitoring of the Ambient Air Quality

4.1.1 Outline of the Air Quality Monitoring

Ambient air quality was monitored at five fixed stations and thirteen mobile stations. Outline of air quality monitoring is shown in Table 4.1.1 and the monitoring methods used are shown in Table 4.1.2. The locations of the monitoring stations for ambient air quality are shown in Fig. 4.1.1.

In this Chapter, 'Nitrogen Oxides' means NO_2, NOx, and NO, and 'Hydrocarbons' means NMHC, THC, and CH_4. The sum of NO_2 and NO is NOx and the sum of NMHC and CH_4 is THC.

Table 4.1.1 Outline of Monitoring Stations

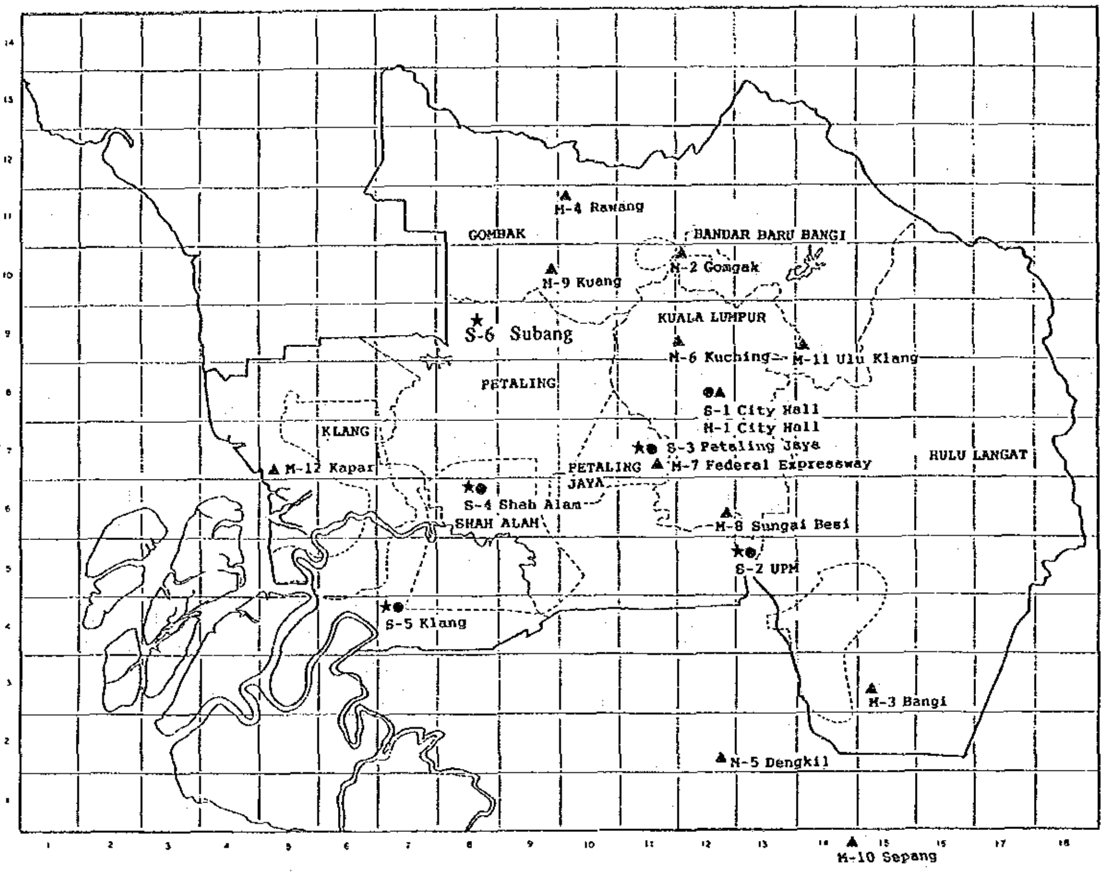
Station Name	Monitoring Items					
	SPM	SO_2	CO	NOxs	O_3	HCs
S-1 City Hall	O	O	O	O	O	-
S-2 UPM	O	O	-	O	O	-
S-3 Petaling Jaya	O	O	O	O	O	O
S-4 Shah Alam	O	O	O	O	O	O
S-5 Klang	O	O	-	O	O	-
M-X (Mobile Stations)	O	O	O	O	O	O

Note NOxs : Nitrogen Oxides(NO_2, NOx, NO)
HCs : Hydrocarbons(NMHC, THC, CH_4)

Table 4.1.2 Summary of Monitoring Instruments

Monitoring Item	Method
SO_2	Ultraviolet Fluorescence
Nitrogen Oxides	Chemiluminescence
CO	Non-Dispersive Infrared Absorption
SPM	Beta-ray Attenuation
Hydrocarbons	Flame Ionization Detection Gas Chromatography
O_3	Ultraviolet Absorption or Chemiluminescence*

*: City Hall, UPM, Klang



Legend

● : Fixed Station

S-1	City Hall
S-2	UPM
S-3	Petaling Jaya
S-4	Shah Alam
S-5	Klang

▲ : Mobile Station

★ : Meteorological Station

Fig. 4.1.1 Locations of Monitoring Stations