

MALAYSIA

AIR QUALITY MANAGEMENT STUDY
FOR THE JOHORE VALLEY REGION

WORK REPORT

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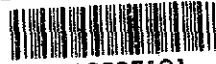
**AIR QUALITY MANAGEMENT STUDY
FOR KELANG VALLEY REGION**

FINAL REPORT

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AUGUST 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of Malaysia, the Government of Japan decided to conduct a Master Plan Study on Air Quality Management Study for Kelang Valley Region in Malaysia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malaysia a study team headed by Mr. Makoto Miyakawa, SUURI-KEIKAKU CO., LTD. and composed of members from SUURI-KEIKAKU CO., LTD. and Pacific Consultants International seven times between December 1991 and June 1993.

The team held discussions with the officials concerned of the Government of Malaysia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

August 1993



Kensuke Yanagiya

President

Japan International Cooperation Agency

EXECUTIVE SUMMARY

1. Introduction

1.1 Background and Objective of the Study

Kelang Valley Region (2,830 km², about 2.95 million people) consisting of Kuala Lumpur (the capital of Malaysia) and its vicinity has been experiencing worsening air pollution in recent years as a result of the rapid growth of the traffic volume, urbanization and industrial activities.

The objective of the Study was to prepare a guideline for air quality management for Kelang Valley Region with special emphasis on improving air quality monitoring capability, identification of major pollution sources, prediction of future air pollution and proposition of feasible control measures. At the same time, the Study was expected to contribute to tangible technology transfer to Malaysian counterparts.

1.2 Outline of the Study

The Study area is the Kelang Valley Region, approximately 60 km from east to west and 40 km from south to north, consisting of the Federal Territory (Kuala Lumpur) and Klang, Petaling, Gombak and Hulu Langat of Selangor State.

The Study was conducted from December 1991 to August 1993. The Study consisted of the basic and analytical study with the following components as shown in Fig. 1.1.

1.3 Overview of the Study Area

(1) Natural Environment

The Study area is a basin located in the southwestern part of the Malaysian Peninsula, surrounded by mountains exceeding 1,500 m height on the east and the Straits of Melaka on the west.

Malaysia experiences a tropical rain forest climate, which is influenced by monsoons from the South China Sea and the Indian Ocean. The

Northeast monsoon season from December through February and the Southwest monsoon from June through August are generally the dry seasons for the western part of Peninsular Malaysia. Two transitional seasons from March through May and September through November are rainy seasons with high humidity. The monthly mean values of temperature range from about 26°C to about 28°C.

The wind is very weak throughout the year; the Study showed the annual average of wind speed is about 1 m/s in the Region and that low inversion layers appeared frequently. Hence, air pollutants tend to accumulate in the Region.

(2) Social Conditions

According to the latest census carried out in August 1991 and a preliminary count report released in March 1992, the total population in Malaysia is 17.57 million. Among them, 2.95 million people (about 17% of the total population) live in the Kelang Valley Region.

The Malaysian economy has been expanding rapidly. The average growth rate was 6.7% during the period 1971-1990, and is expected to be 7.0% between 1991-2000. In Kuala Lumpur, the growth of big industries is expected to decline. Future growth will be in the small scale industries, repair and service activities and medium-sized industries with higher employment densities. In Selangor State, industries such as electrical & electronics and machinery & transport equipment are expected to develop rapidly.

Kuala Lumpur is the most urbanized area (80% of the total area), followed by Petaling (33%). Agricultural fields occupies the largest area in Klang (47%) whereas forest occupies the largest area in Gombak (55%) and Hulu Langat (40%).

(3) Traffic and Transportation

Motor vehicles are the major means of land transportation in the Region. The total number of registered vehicles in the Federal Territory of Kuala Lumpur and Selangor State is about 1.57 million at the end of 1991 and the percentage of petrol and diesel vehicles were 91% and 9% respectively. As to the percentage of types of vehicles,

motorcycle accounts for 44%, followed by motor car at 43% and they account for 87% of the total vehicles. However, introduction of mass transportation system such as Light Rapid Train System and improvement of existing railways are expected to start in the near future.

For air transport, Subang International Airport is the only commercial airport in the Region which is being operated at full capacity. The new "Sepang International Airport" will be completed by 1997.

Port Klang handles cargo traffic. However, since the port is becoming congested, the west port will be constructed at first in Pulau Lumut during the 6th Malaysian Plan Period.

(4) Energy

The main facilities in Kelang Valley Region are boilers. They use mainly heavy fuel oil, while most other facilities burn light fuel oil.

In this Region, natural gas will be supplied to households and factories in the near future.

Several thermal power plants are now under construction or planned by the year 2000.

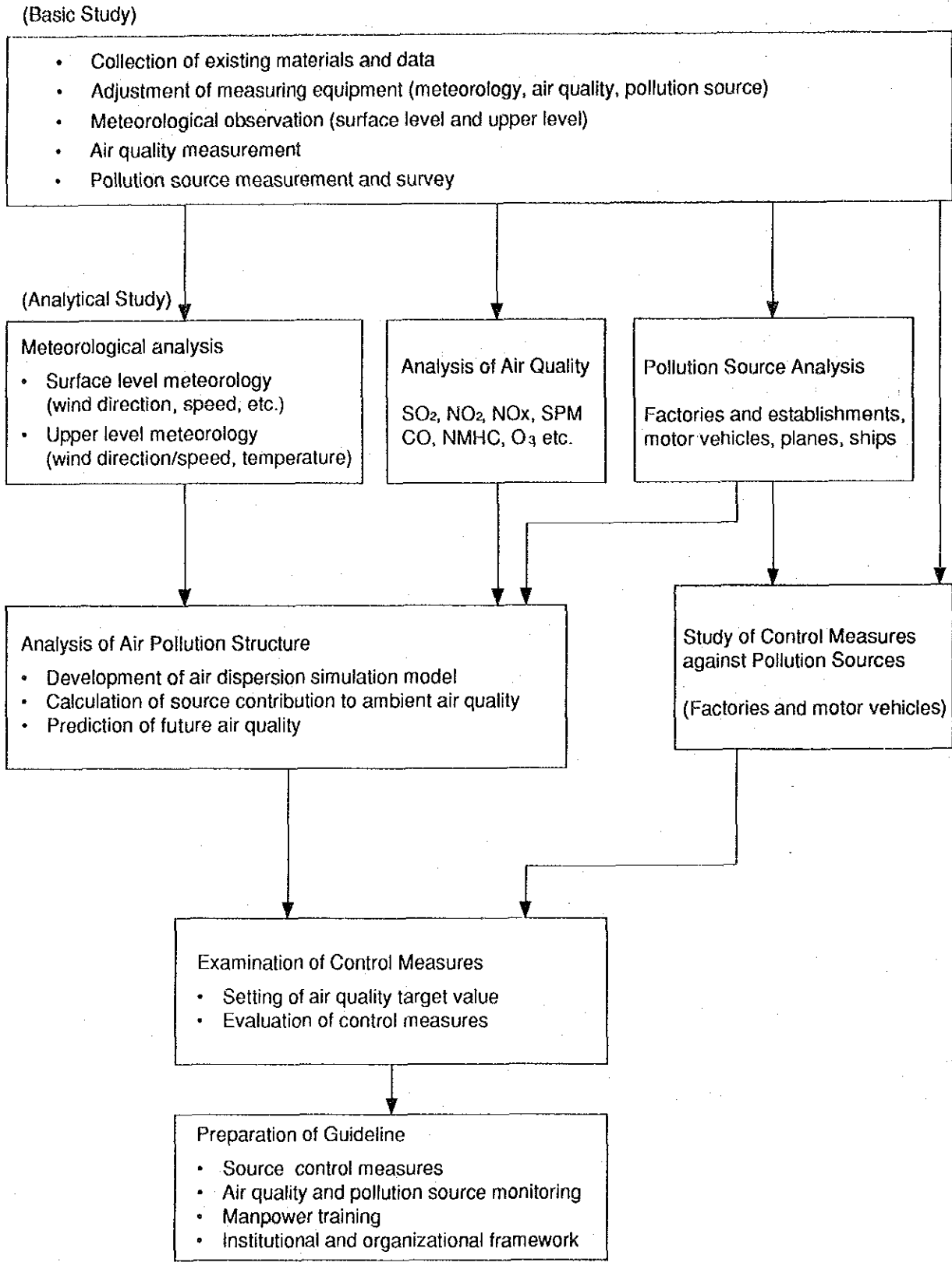


Fig. 1.1 Outline of the Study

2. Present State of Ambient Air Quality

2.1 Features of Air Quality

Ambient air quality was monitored at five fixed stations from March 1992 to February 1993. Table 2.1 shows average concentrations throughout the period at these stations.

The SO₂ value ranged from 7.7 to 13.3 ppb in average. The NO₂ value ranged from 8.6 to 21.7 ppb while the CO value from 0.7 to 2.8 ppm in average. As regards SPM, the average value ranged from 24.1 to 67.6 µg/m³.

Table 2.2 shows the state of compliance with the air quality guidelines. It is noticed that the TSP and PM₁₀ values were estimated indirectly from the SPM values.

Values of, SO₂, NO₂ and TSP were all below the guidelines. As for CO, 8 hours value exceeded the guideline at City Hall and Petaling Jaya.

For PM₁₀, both of yearly and daily values exceeded the guidelines at Shah Alam. For O₃, all stations did not satisfy the guidelines.

Table 2.1 Average Concentration at Fixed Stations (1992)

Station	SO ₂ ppb	NO ₂ ppb	NO _x ppb	CO ppm	SPM µg/m ³	O ₃ ppb	NMHC 10 ppbC
City Hall	10.4	21.7	103.3	2.7	50.7	9.5	-
UPM	8.0	8.6	18.1	-	24.1	10.0	-
Petaling Jaya	13.3	19.3	49.4	2.8	58.8	9.7	79.1
Shah Alam	7.7	15.2	31.4	0.7	67.6	10.9	22.5
Klang	8.5	11.4	26.6	-	60.8	12.4	-

Table 2.2 Compliance State with Air Quality Guidelines (1992)

Pollutant	SO ₂		NO ₂	CO		TSP		PM10		O ₃	
	Daily	Hourly	Hourly	8 Hours	Hourly	Yearly	Daily	Yearly	Daily	8 Hours	Hourly
	40	130	170	9	30	90	260	50	150	60	100
Guidelines	(ppb)		(ppb)	(ppm)		(µg/g)		(µg/m ³)		(ppb)	
City Hall	o	o	o	x	o	o	o	o	o	x	x
UPN	o	o	o	-	-	o	o	o	o	o	x
Petaling Jaya	o	o	o	x	o	o	o	o	o	x	x
Shah Alam	o	o	o	o	o	o	o	x	x	x	x
Klang	o	o	o	-	-	o	o	o	o	x	x

o: satisfy

x: exceed

-: no measurement

2.2 Diurnal Change of Pollutant Concentration

Fig. 2.1 shows diurnal change of pollutant concentration at fixed stations in 1992 as an example.

There are mainly three typical patterns on the diurnal changes.

The first one is a 'two peak pattern' with a sharp peak in the morning and a moderate peak in the evening through the night. Most of the diurnal changes of CO and Nitrogen Oxides showed this pattern. Some diurnal changes of SPM and Hydrocarbons also showed this pattern. This two peak pattern is considered to indicate influence of motor vehicles.

The second one is a 'single minimum pattern' with the minimum in the daytime. Some diurnal changes of SPM showed this pattern. It is noticed that SPM concentration rose up in the evening through the night and the concentration did not decrease till the morning.

The third is a 'single peak pattern' with the peak in the afternoon. O₃ diurnal changes at all stations showed this pattern. This pattern is mainly caused by sunshine.

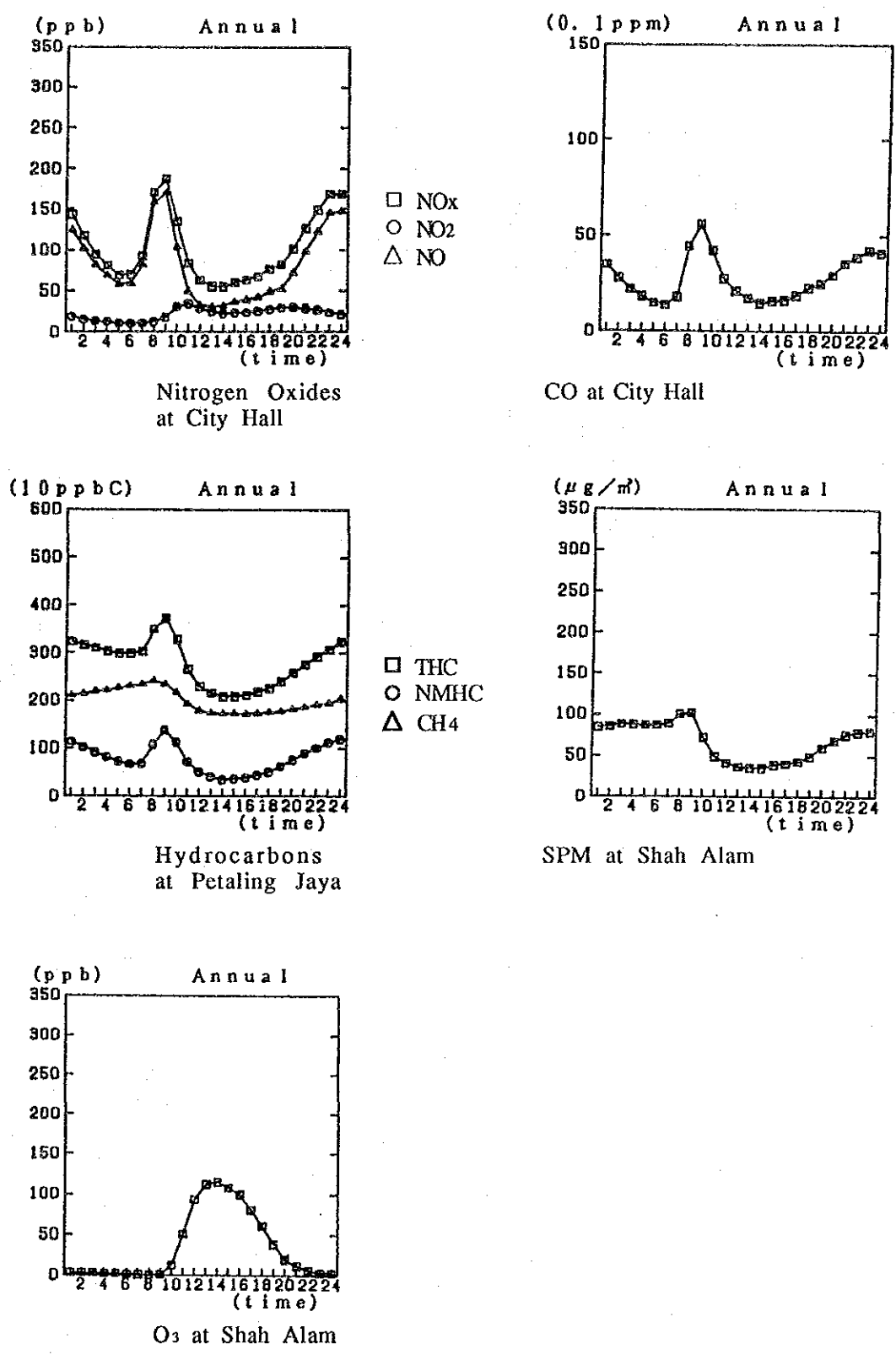


Fig. 2.1 Diurnal Change of Pollutant Concentration (1992)

3. Structure of Air Pollution

The present air pollution load by source in 1992 in the Kelang Valley Region was estimated as shown in Table 3.1. The SO_x emission from factories is 31,000 tons/year (86%) among the total of 36,000 tons/year. The NO_x emission from motor vehicles was 36,000 tons/year (67%) among the total of 54,000 tons/year. The PM emission from factories was 9,000 tons/year (71%) among the total of 13,000 tons/year. CO and HC emissions were solely calculated for motor vehicles as 290,000 tons/year and 73,000 tons/year respectively.

Table 3.1 Current Air pollution Load from Various Sources (1992)

	(Unit: ton/year)				
	SO _x	NO _x	PM	CO	HC
Factories					
Power stations	19,522	12,792	1,969	-	-
General factories	11,047	2,979	7,034	-	-
Sub-total	30,569 (85.7)	15,771 (29.0)	9,003 (71.4)	-	-
Motor vehicles	3,117 (8.7)	36,212 (66.5)	3,243 (25.7)	290,407 (100)	73,445 (100)
Airplanes	416 (1.2)	1,320 (2.4)	115 (0.9)	-	-
Ships	1,552 (4.4)	989 (1.8)	200 (1.6)	-	-
Households	0 (0.0)	162 (0.3)	44 (0.4)	-	-
Total	35,654 (100)	54,454 (100)	12,605 (100)	290,407 (100)	73,445 (100)

Figures in parenthesis are percentage values(%). Air pollutant emission from open burning activities and earthworks are not included in this Table.

PM emission from petrol and diesel vehicles is given in Table 3.2.

Diesel vehicles account for 59% of the total PM emission from motor vehicles.

Table 3.2 Current PM Emission from Petrol and Diesel Vehicles (1992)

Engine Type	PM Emission (ton/year)	
Petrol	1,327	(40.9)
Diesel	1,914	(59.1)
Total	3,241	(100.0)

3.2 Contribution to Concentration by Source

Using an air dispersion simulation model, annual average concentration of SO₂, NO₂ and CO at each monitoring station and mesh point was calculated. Contribution to SPM concentration by source was calculated by Chemical Mass Balance (CMB) method because no reliable simulation model for SPM has not been developed yet.

Contribution to concentration of SO₂ and NO_x by source at each fixed station and the maximum concentration point is shown in Figs 3.1 and 3.2 respectively. Average contribution to SPM concentration by source is shown in Fig. 3.3.

(1) SO₂

The contribution ratio to the estimated value was 7 - 88% for factories and 7 - 71% for motor vehicles.

The contribution ratio of factories is higher than that of other sources at all points excluding City Hall.

(2) NO_x

The contribution ratio of motor vehicles to the estimated value was very high at 44 - 98%.

(3) SPM

The major contributors to SPM are combustion of diesel oil (mainly diesel vehicles) accounting for 36% of the total, and wood combustion including open burning (15%).

Fig 3.1 Contribution of Sources to SO₂ Concentration (1992)

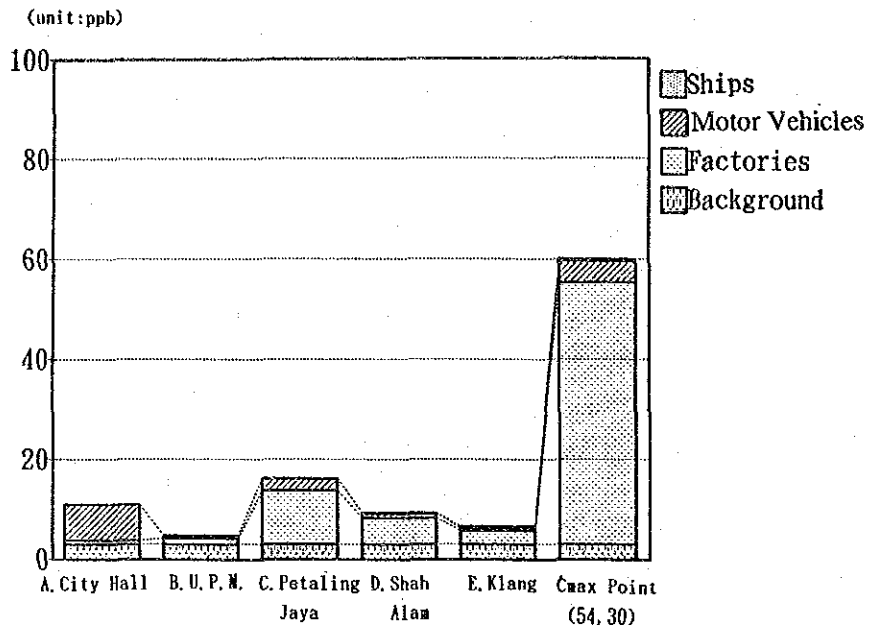
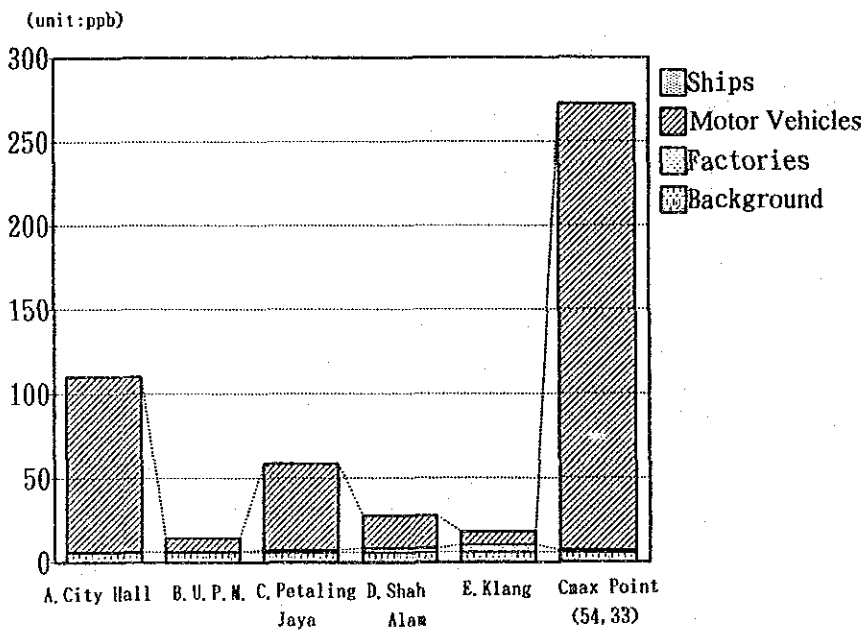
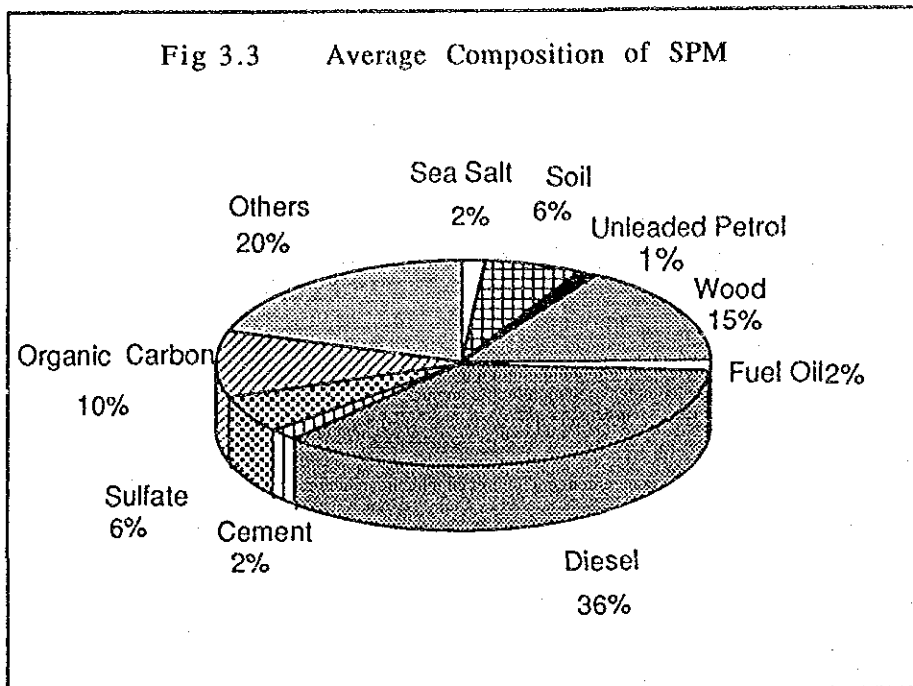


Fig 3.2 Contribution of Sources to NO_x Concentration (1992)





3.3 Regional Distribution of Air Pollutant Concentration

Regional concentration distribution simulated by air dispersion simulation for SO₂, NO₂ and CO is summarized as follows.

(1) SO₂

Concentration is high in Petaling Jaya area and in areas east of Klang. The Maximum concentration is 59.7 ppb, exceeding the air quality target value (20 ppb). The high concentration areas are located in the industrial zones in Petaling Jaya, Shah Alam, and Klang.

(2) NO₂

Concentration is high in Kuala Lumpur and Petaling Jaya areas where vehicle traffic is very dense. The maximum concentration is 41.1 ppb, exceeding the target value (37 ppb).

(3) CO

Concentration is high in Kuala Lumpur and Petaling Jaya areas where traffic volume is very high. The maximum concentration is 4.9 ppm, exceeding the target value (4 ppm).

4. Future Situation of Air Pollution

4.1 Future Air Pollution Load (2005) (without measures)

The air pollution load in the future (2005) (without measures) is summarized in Table 4.1.

The annual total emission is 52,000 tons for SO_x, 115,000 tons for NO_x, 18,000 tons for PM, 660,000 tons for CO, and 170,000 tons for HC.

The growth rate of air pollutants between 1992 and 2005 is 1.45 times for SO_x, 2.12 times for NO_x, 1.47 times for PM, 2.27 times for CO and HC.

Table 4.1 Future Air Pollution Load from Various Sources (2005)
(without control measures)

(Unit: ton/year)					
	SO _x	NO _x	PM	CO	HC
Factories					
Power stations	30,040	26,038	2,423	-	-
General factories	11,283	4,415	8,163		
Sub-total	41,323 (80.1)	30,453 (26.4)	10,586 (57.2)	-	-
Motor vehicles	7,079 (13.7)	82,199 (71.3)	7,359 (39.8)	659,223 (100)	166,720 (100)
Airplanes	360 (0.7)	574 (0.5)	123 (0.7)	-	-
Ships	2,836 (5.5)	1,840 (1.6)	365 (2.0)	-	-
Households	0 (0.0)	226 (0.2)	62 (0.3)	-	-
Total	51,598 (100)	115,292 (100)	18,495 (100)	659,223 (100)	166,720 (100)

Figures in parenthesis are percentage values(%). Air pollutant emission from open burning activities and earthworks are not included, but that from PS-C Power Station outside KVR is included in this Table.

4.2 Air Quality Target Value

Pollutants to be covered by the guidelines are mainly SO₂, CO, and NO₂ originated from factories and motor vehicles. Air quality target values were set to evaluate predicted air quality concentration in the future and effectiveness of control measures.

The target value for SO₂ and CO was established based on the Malaysian guidelines while that of NO₂ was established based on the corresponding WHO's guideline.

The target values set in the Study are given in Table 4.2.

Table 4.2 Air Quality Target Value

Pollutant	Target Concentration
SO ₂	20 ppb
NO ₂	37 ppm
CO	4 ppm

4.3 Predicted Air Quality after Implementation of Control Measures

Predicted concentration for SO₂, NO_x, NO₂ and CO at fixed stations and the maximum concentration point in 2005 when proposed control measures are implemented is shown in Table 4.3.

Table 4.3 Predicted Annual Average Concentration (2005)
(with control measures)

Stations	Items	SO ₂ (ppb)	NO _x (ppb)	NO ₂ (ppb)	CO (ppm)
A. City Hall		9.2	85.2	22.2	2.20
B. UPM		4.5	20.7	10.5	1.19
C. Petaling Jaya		8.5	51.9	17.1	1.51
D. Shah Alam		8.7	44.7	15.8	1.33
E. Klang		6.1	27.1	12.1	1.21
Cmax Point		19.0	137.2	28.6	2.84
Mesh Index		(76,15)	(58,40)	(58,40)	(59,38)
Target Value		20	-	37	4

The concentration of SO₂, NO₂ and CO at fixed stations and the maximum concentration point will shift from the present state as shown in Figs. 4.1 through 4.3; the future state is described separately by the case whether proposed measures are implemented or not.

(1) SO₂

When no control measures are taken, SO₂ concentration will rise in the future according to the increase of emission quantity. However, by taking proper control measures, the concentration at fixed stations will remain at the present level, and the target value will be achieved at all points in Kelang Valley Region.

(2) NO₂

NO₂ concentration will increase as well when no measures are taken. But, when proper measures are taken, the concentration at fixed stations will remain at the present level or below, and the target level will be satisfied at all points.

(3) CO

CO concentration will also increase in the future when no measures are taken. However, when proper control measures are taken, the concentration at fixed stations will remain at the present level or below, and the target level will be satisfied at all points.

Fig 4.1 Change of SO₂ Concentration from 1992 to 2005

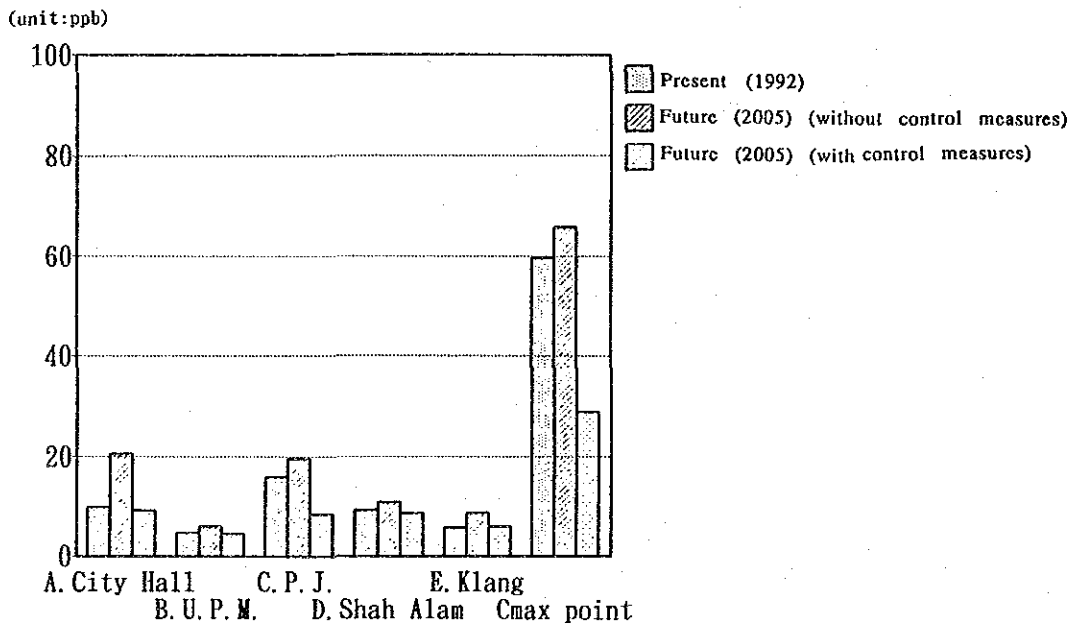


Fig. 4.2 Change of NO₂ Concentration from 1992 to 2005

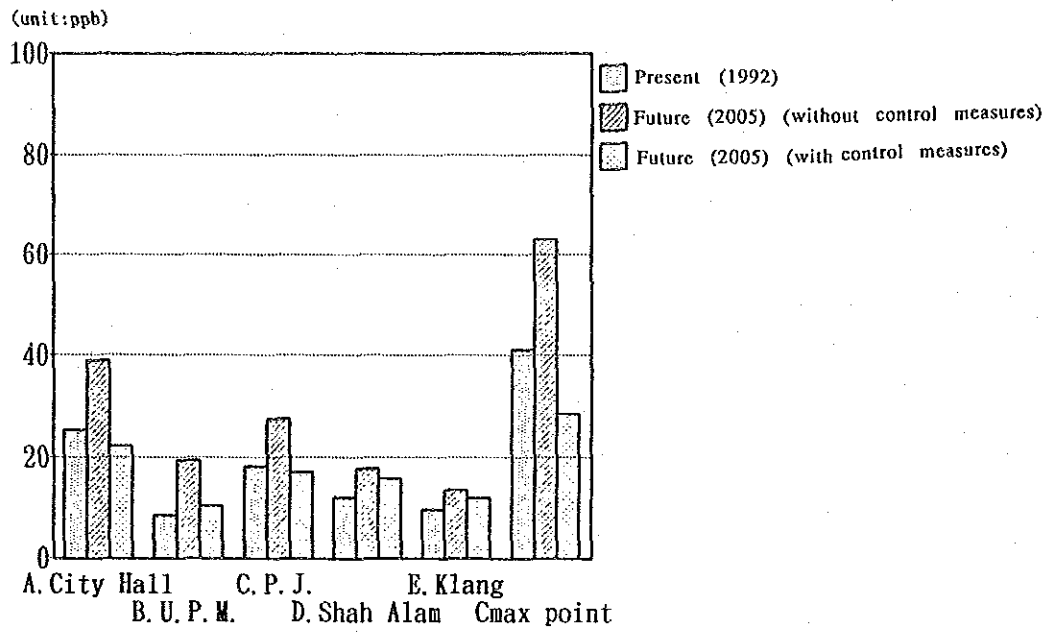
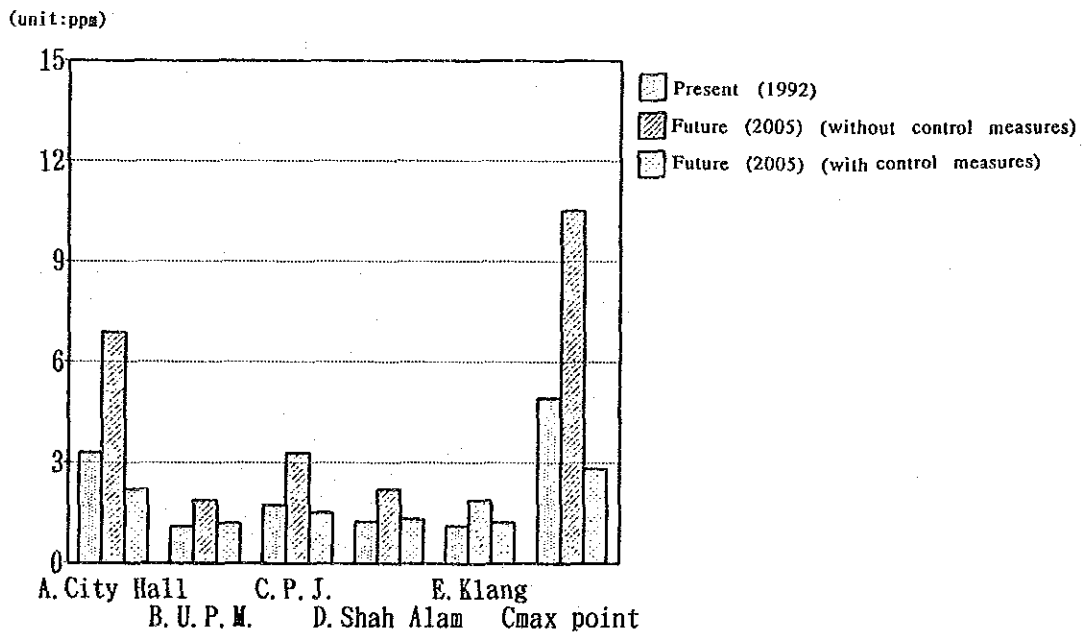


Fig. 4.3 Change of CO Concentration from 1992 to 2005



4.3 Evaluation of Control Measures

The major pollution source of NO₂ and CO are motor vehicles in Kelang Valley Region. Control measures against motor vehicles are classified into two categories as follows.

- (1) Exhaust gas regulation
- (2) Measures for traffic and transportation

For vehicle exhaust gas regulation, the Government of Malaysia is to implement Regulation 91/441/EEC for light duty petrol vehicles.

For traffic and transportation, it has been implementing the "Transportation Master Plan for 2005" proposed in Klang Valley Transportation Study by JICA, 1989.

In order to evaluate the effect of these two measures on NO₂ and CO concentrations, the following two cases were assumed and studied.

Case 1

Only the Transportation Master Plan is completed by 2005.

Case 2

Only Regulation 91/441/EEC is implemented in 1995.

The results are summarized in Table 4.4.

In Case 1, CO concentration at the maximum concentration point will exceed the target value. In Case 2, the NO₂ concentration at the maximum concentration point will exceed the target value. The CO concentration at City Hall and at the maximum concentration point will also exceed the target value.

These case studies show that if the target values for NO₂ and CO are to be satisfied throughout Kelang Valley Region, both measures, namely the vehicle exhaust gas regulation and the measures for traffic and transportation must be implemented simultaneously.

Table 4.4 Computed Concentration with Control Measures by Case

Control Measure Case	Case 1		Case 2	
Items	NO ₂ (ppb)	CO (ppm)	NO ₂ (ppb)	CO (ppm)
A. City Hall	24.3	3.5	35.7	4.2
B. UPM	11.7	1.7	11.1	1.3
C. Petaling Jaya	19.3	2.2	24.1	2.1
D. Shah Alam	17.8	1.9	15.7	1.5
E. Klang	13.3	1.7	12.3	1.3
Cmax Point	32.1	4.6	53.2	6.3
Mesh Index	(57,34)	(59,38)	(54,33)	(59,37)

5. Presentation of Guideline for Air Quality Management

5.1 Basic Conditions

The Department of Environment has made efforts to prevent air pollution in Kelang Valley Region since the Environmental Quality Act was published in 1974. According to the result of the air quality monitoring at 5 fixed stations, however, concentration of carbon monoxide (CO) and suspended particulate matter (PM₁₀) exceeded the air quality guideline at Shah Alam. Particularly, concentration of ozone (O₃) exceeded the guideline at all stations.

Malaysia is one of the most significantly developing countries in the world. Its average annual GDP growth rate is amazingly 6.7% from 1971 to 1990 and is expected to be 7.0% between 1991 - 2000. This economic growth is particularly apparent in urban area. The atmospheric deterioration of the KVR is foreseeable from its industrialization, population concentration, traffic growth and so on.

In order to protect the health of the citizens and to preserve the comfortable living environment, air quality management for the Region is indispensable.

5.2 Proposed Measures

(1) General Consideration

Measures for air quality management should cover not only direct control of pollution sources (factories, motor vehicles, etc.), but also their background conditions, such as improvement of traffic and transportation, and road network, rationalization of land use, fuel improvement. They also should cover improvement of institutional and organizational framework and manpower training and improvement of air quality and pollution source monitoring.

Following measures were recommended to prevent the atmospheric deterioration with almost no adverse effects on economic growth. These measures are considered to be practical measures for implementation by the concerned agencies of the Malaysian Government. The proposed measures, their rough costs and their implementation schedule are summarized in Tables 5.1 through 5.3.

(2) Stationary Sources

- Power Station

Power Stations in KVR emitted 55% of total SO_x, 24% of total NO_x and 16% of total PM in 1992. Fuel conversion (fuel oil or coal to natural gas) was recommended as the practical measure. It will contribute to reduction of pollutant amount in comparison with the case of "2005 without measures": SO_x 42%, NO_x 13% and PM 66%.

- General Factories

General factories emitted 31% of total SO_x, 5% of total NO_x and 55% of total PM in 1992. Six kinds of measures as follows were recommended. The effect of the measures will be 53% of SO_x, 0.1% of NO_x and 33% of PM reductions respectively. Proper combustion management will lead to energy saving and pollutant emission reduction. Energy saving by the proposed combustion management, etc. will lead to 10% reduction in fuel consumption.

- Fuel conversion (fuel oil to light fuel oil/natural gas)
- Combustion management
- Use of natural gas (new facilities)

- Energy saving
 - Enhancement of dust removal
 - Extension of stacks
- Solid Waste Management System

The Study could not deal adequately with open burning of solid wastes and others directly because of scant information about this practice. But its effect on air pollution in KVR can not be ignored. Though open burning is principally illegal, it is prevalent with solid wastes. Establishment of solid waste management system could reduce open burning to a considerable extent.

(3) Mobil Sources

Motor vehicles are the major pollution source among mobile sources in KVR.

The major source is motor cars for CO and NO_x, diesel vehicles for PM and SO_x, and motorcycles for CO and HC. Accordingly, following measures were recommended, based on the type of vehicle.

- Exhaust Emission Control
 - Installation of catalytic converters to petrol vehicles

Oxidation catalytic converter can reduce 51% of CO 17% of NO_x and 59% of HC from petrol vehicles.
 - Introduction of four stroke motorcycles

The four stroke motorcycle emit only 14% of PM, 18% of HC, 42% of CO and 58% of SO_x in comparison with the two stroke motorcycle.
 - Smokeless lub oil for two stroke motorcycles

The use of smokeless lube oil into the two stroke motorcycle can reduce black smoke.
 - Quality control of fuel

Use of unleaded petrol is necessary for oxidation catalytic converter. Reduction of sulphur content in diesel oil from 0.3% to 0.2% is necessary for reduction of SO_x and PM.

- Restriction of light duty diesel vehicles
Restriction of diesel vehicles is very important to reduce PM and SOx emission. To begin with, the restriction of light duty diesel vehicles, initially targeting taxis and commercial vehicles was recommended.

- Execution of Transportation Master Plan by 2005(*)

The Transportation Master Plan was prepared to improve the traffic situation in KVR, where the transportation system is exceedingly dependent on motor vehicles, and hence to mitigate the traffic congestion in the Region. The simulated result showed that it will play quite a significant role in mitigating air pollution. Therefore, the realization of this master plan in time, as scheduled is quite essential for improving the air quality in the Region.

* Source: JICA (1989), Klang Valley Transportation Study

If the exhaust gas regulation for petrol vehicles and the Master Plan are implemented, vehicular pollutant emission of SOx, NOx, PM, HC and CO in the case of "2005 with control measure" will be reduced by 19%, 32%, 35%, 38% and 51% respectively in comparison with the case of "2005 without measures".

(4) Institution and Organization

In order to implement the countermeasures smoothly and to confirm their effectiveness, following supporting actions are essential.

1) Strengthening of DOE's capacity in institution and organization

DOE is one of the most important organizations concerned to air pollution control in KVR. However, shortage of staff is a serious problem at present which may worsen in future. In order to strengthen DOE, recruiting the qualified manpower and staff is a matter requiring urgent consideration.

2) Installment of ambient air quality and source monitoring systems

During the Study, five fixed stations and two monitoring cars were set up in KVR. However they are not adequate to monitor ambient air quality effectively. Eleven fixed stations, 20 mobile stations in

all were recommended to be installed by 2005. Vehicle exhaust gas monitoring system with chassis dynamometers and flue gas measurement system for stationary source monitoring were also recommended.

3) Establishment of a combustion management system.

It was proposed to establish a regulation system which aims at controlling the combustion in factories with dual objectives of ambient air pollution control and energy conservation. It is also necessary to establish a system which subsidizes the activities relating to air pollution control.

4) Car Inspection System

It was proposed to establish a car inspection system which aims to keep in-use vehicles in good condition, which will lead to reduce air pollutant emission from them.

5) Foundation of Comprehensive Air Pollution Control Center

Considering the shortage in qualified engineers to participate in the activities for controlling air pollution at present in the country, it is necessary to train such engineers as soon as possible prior to the implementation of the measures which the Study proposed in the guidelines. In order to increase the number of such engineer, it was proposed to establish "the Comprehensive Air Pollution Control Center" in the earliest stage of the implementation. The center will consist of four centers as follows.

- Ambient Air Quality Central Monitoring Center
- Combustion Training Center
- Ambient Air Quality Monitoring Training Center
- Pollution Source Monitoring Center

The shortage of senior engineers for training such engineers is also a serious problem in the country. Such specialists and experts required for training the national engineers shall be supplemented with foreign expertise as required.

Table 5.1 (1) Implementation Plan of Measures against Air Pollution in Kelang Valley Region (Stationary Sources)

Stationary Sources	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
(1) Power Station						Operation									
1) "A" Power Station (N.G., 300Mw)						Fuel conversion M.F.O to N.G. (for SOx & SPM reduction)									-
No.2 (N.G., 300Mw)															-
No.3 (Coal, 300Mw)															-
No.4 (Coal, 300Mw)						Improvement of Electric Precipitator's Efficiency									-
No.5 (Coal, 500Mw)															-
No.6 (Coal, 500Mw)															-
No.7 (N.G., 500Mw)															-
2) "B" Power Station (N.G., 840MW)															-
3) "C" Power Station (N.G.)															-
(2) Factory															
1) Cement Factory		900MW													
2) General Factories						Improvement of Electric Precipitators' efficiency									-
						Fuel conversion (HFO to N.G.) (Facilities with more 150kg/h of M.F.O combustion in Petaling Jaya & Shah Alam)									M\$2.9 million
						Fuel conversion (MFO to L.F.O) (Facilities with more 200kg/h M.F.O combustion in other areas)									-
						Use of natural gas (new facilities)									M\$3.0 million
					Dust collector (Cyclon) 3 factories										
					Dust collector (Cyclon) 3 factories										
					Dust collector (Cyclon) 3 factories										

Table 5.1 (2) Implementation Plan of Measures against Air Pollution in Kelang Valley Region (Stationary Sources)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
						↑									M\$0.2 million
							↑								M\$3.1 million
						↑									
(3) Combustion Training Center															M\$5.7 million

Table 5.2 Implementation Plan of Measures against Air Pollution in Kelang Valley Region (Mobile Sources)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
1. Motor Vehicles															
(1) Emission Control															
1) Combustion Improvement of Motorcycle															
a) Shift from 2-cycle M/C to 4-cycle M/C								Almost Completion							10% cost up
b) Use of Smokeless Lube Oil								Supply and regulation							M\$20/liter (40% cost up)
2) Application of EC Regulation															
a) Motor Car				ECE15-04	Preparation										Oxidation catalytic converter M\$1,400/unit cost up
						91/441/EEC					3-way catalytic converter				
3) Restriction of Diesel Motor Vehicles															
4) Introduction of CNG Taxi				Shift from diesel taxi to petrol taxi											
(2) Fuel Control															
1) Unleaded fuel															
2) Low Sulphur Diesel Fuel															
(3) Traffic control															
1) Mass Rapid Transit Railway System (MRT)															
2) Improvement of Bus System															
3) Road Net Work Plan															
2. Organization & Institution for Motor Vehicles															
(1) Car Inspection System															
(2) Introduction of Flexitime System															M\$9.0 million

Table 5.3 Implementation Plan of Air Pollution Monitoring in Kelang Valley Region
(Ambient Air Quality and Air Pollution Source Monitoring)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
1. Ambient Air Quality Monitoring															
(1) Fixed Stations															
1) Residential Area															
a) UPM			○	○											M\$2.11mil.
b) P.J.	●						○						○		M\$2.69mil.
c) S.A.	●						○								M\$2.69mil.
d) Klang		○							○						M\$2.11mil.
2) Road Side															
a) City Hall		○							○						M\$2.69mil.
b) New station				●							○				M\$1.65mil.
c) New station				●							○				M\$1.62mil.
d) New station					●	●							○		M\$1.59mil.
3) High Concentration Area															
a) New station				●							○				M\$1.56mil.
b) New station				●							○				M\$1.52mil.
c) New station					●	●							○		M\$1.48mil.
(2) Mobile Station															
1) Existing Monitoring Car															
No.1	●							○							M\$2.44mil.
No.2	●								○						M\$2.44mil.
2) New Monitoring Car															
No.3			●									○			M\$4.32mil.
No.4				●								○			M\$4.28mil.
Total															M\$35.19mil.
2. Air Pollution Source Monitoring															
(1) Factory															
Existing								○							
new				●											M\$0.24 mil.
(2) Motor Vehicle															
			●												M\$4mil.(Petrol)
															M\$8 mil.(Diesel)
									●						M\$35.2 mil.
3. Central Monitoring Center															
4. Training Center															
(1) Ambient Air Quality Monitoring Training Center															
															M\$0.76 mil.
(2) Pollution Source Monitoring Training Center															

6. Future Requirements

- Publication of enforceable air quality standards

Malaysian Air Quality Guidelines (1989) actually don't have any legal enforcement. Hence, it is necessary to establish Ambient Air Quality Standards to control air pollution fundamentally.

- Study of air pollution effects on public health and ecosystem

According to the result of ambient air quality monitoring in KVR, there may be some people whose health is affected due to air pollution in KL, Shah Alam or Petaling Jaya. It is important to study such air pollution effects on health in particular and ecosystem in general.

- Reconstruction of the simulation model

The simulation result in the Study was based on only one year data. Hence, it is necessary to check the validity of the simulation model after accumulation of air quality and source data for two to three years period.

- Development of simulation model for SPM and HC

Though simulation model for air pollution can apply only to SO₂, NO₂ and CO so far, development of new simulation models for SPM and HC is expected in future in order to make their quantitative assessment.

- Accurate survey of air quality in high pollution areas and on road sides

The objective of the Study was to clarify the overall situation of the air pollution in and around the city of KL, but not at any particular local point or an area in the city. It is difficult to clarify the local air pollution by the method and the model applied for the simulation. The results of this simulation does not indicate the local situation of any small spot or strip even when the pollution situation thereof exceeds the target value. For instance, pollutant concentration along main roads with heavy traffic may exceed the air quality guidelines. Therefore, the measures proposed herein for 2005 may not guarantee improvement of such local pollution situation. A more detailed study in each area is

necessary to identify the pollution situation of such areas. For this objective, the data obtained by the proposed monitoring system can be effectively utilized.

- Study of haze causes

Though the Study did not aim to clarify the cause of haze in the Region, ambient SPM samples were collected and analyzed. However, no haze was observed during the survey period. Nevertheless, it is recommended to carry out study on haze, centering on its chemistry.

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Glossary of Abbreviations

1ry	primary
2ry	secondary
8HAV	8 Hour Average Value
AAGR	Actual Average Annual Growth
ADB	Asian Development Bank
A/F	Air Fuel Ratio
Af	Tropical Rainforest Climate
AI	Secondary Air Injection System
AMV	Annual Mean Value
AQM	Air Quality Management
AS	Secondary Air Suction System
Auxil (Aux)	Auxiliary
Cf	Referred to (Numbered, Corresponded Article of Item)
CH	City Hall
CH ₄	Methane
CLD	Chemiluminescence
CMB	Chemical Mass (or Element) Balance
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CONC	Concentration or Concentrated
COP	Conformity of Product
CVS	Constant Volume Sample
C-zone	smallest segment of an area, especially in traffic
DAHV	Daily Average of Hourly Value
deg.C	difference of two centigrade temperatures
De-	removal of --
DF/R	Draft Final Report
DOC	Department of Chemistry, MSTE
DOE	Department of Environment, MSTE
DP	Dash Pot System
DPF	Diesel Particulate Filter
DR	Differential Growth Rate

EC	European Community
ECE(EEC)	European Economic Community
E.F.	Emission Factor
EFI	Electronic Fuel Injection System
EGR	Exhaust Gas Recycle
EIA	Environment Impact Assessment
EM	Engine Modification
EP	Electrostatic Precipitator
EPA	Environmental Protection Agency of the U.S.A.
EPU	Economic Planning Unit, Prime Minister's Department
EQA	Environmental Quality Act
ESP	Electrostatic Precipitator
ETBE	Ethyl Tertiary Butyl Ether
EVAP	Fuel Evaporation Control System
FGD	Flue Gas Desulfurization
F. H.	Federal Highway
FID	Flame Ionization Detection Gas Chromatography
Fig.	Figure
FO	Fuel Oil
FT	Federal Territory
F/R	Final Report
GDP	Growth Domestic Product
GRDP	Gross Regional Domestic Product
GRT	Gross Tonnage
GVW	Gross Vehicle Weight
HC	Hydrocarbons
HCS	Analyzer measuring NMHC, THC and CH ₄ separately
HFO	Heavy Fuel Oil
IC/R	Inception Report
IDO	Industrial Diesel Oil
IFO	Industrial Fuel Oil
IMP	Industrial Master Plan
IT/R	Interim Report

J	Japan
JACTIM	Japan Chamber of Trade and Industry, Malaysia
JEA	Japan Environment Agency
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JKR	Jabatan Kerja Raya (District Public Works Department)
Jln	Jalan (Street)
KL	Kuala Lumpur
HL.S	KL-Serembar (Expressway)
HL.K	KL-Karal (Highway)
KPA	Klang Port Authority
KTM	Keretapi Tanah Malayu (Malayan Railway)
KVEIP	Kelang Valley Environmental Improvement Project
KVPP	Kelang Valley Perspective Plan
KVPS	Kelang Valley Planning Secretariat
KVR	Kelang Valley Region
KVTS	Klang Valley Transportation Study (#6007)
L	Long Term
LFO	Light Fuel Oil
LNB	Low NOx Burner
LPG	Liquefied Petroleum Gas
LRT	Light Rail Transit or Light Rapid Train
M\$	Malaysian Ringgit (Malaysian Dollar) 50 Yen (1992 prio)
MAQG	Malaysian Air Quality Guidelines
MFO	Middle Fuel Oil
MIC	Manufacturing Industry Code
MIER	Malaysian Institute of Economic Research
MMS	Malaysian Meteorological Service
MP	Malaysia Plan (such as 5MP = the fifth MP)
MRT	Mass Rapid Transit
MSTE	Ministry of Science, Technology and Environment
MTBE	Methyl Tertiary Butyl Ether
M/C	Motor Cycle

N	Nitrogen or Gas at normal condition such as m ³ N, Nm ³
NDIR	Non-Dispersive Infrared Absorption
NG	Natural Gas
NMHC	Non-Methane Hydrocarbons
NO	Nitrogen Monoxide
NOx	Nitrogen Oxides
NOxs	Analyzer measuring NO ₂ , NO _x and NO separately
NO ₂	Nitrogen Dioxide
N.R.	Net Radiation
OC	Oxidation Catalyst
OD	Origin/Destination of Traffic
OPP	Outline Perspective Plan
O ₂	Oxygen
O ₃	Ozone
P	Pasquill's Atmospheric Stability Number
P.a.	Preannum
PbO ₂	Lead dioxide method for SO ₂ simplified measurement
PCR	Preliminary Count Report
PCV	Positive Crankcase Ventilation System
PETRONAS	Petroleum Nasional Berhad
PFBC	Pressurized Fluidized Bed Combustion
P-G	Pasquill Gifford
PG-	code for fuel; see Appendix
PIB	Poly Iso Butylene
PJ	Petaling Jaya
PM	Particle Matter
PMG	Premium Motor Gasoline
PM ₁₀	Inhalable Particulate
PORIM	Palm Oil Research Institute of Malaysia
ppb	parts per billion
ppbC	parts per billion Carbon
pphmC	parts per hundredth million Carbon
ppm	parts per million
PR/R	Progress Report
PS-	code for Power Station A, B or C

RMG	Regular Motor Gasoline
RTD	Road Transport Department
RW	Reference Weight
S	Short Term
SA	Shah Alam
SC	Ignition Timing Control System
SCFT	Standard Cubic Feet
SGR	Self Gas Recirculation
SIRIM	Standards and Industrial Research Institute of Malaysia
SOF	Soluble Organic Fraction
SO _x	Sulphur Oxides
TNB	Tenaga Nasional Berhad
TP	Throttle Positioner System
TSP	Total Suspended Particulate Matter
TV	Traffic Volume
TWC	Three Way Catalyst
UM	Universiti Malaya
UPM	Universiti Pertanian Malaysia
UV	Ultraviolet Fluorescence
W.D.	Wind Direction
WHO	World Health Organization
W.S.	Wind Speed

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background and Objective of the Study

1.1.1 Background of the Study

Kelang Valley Region (2,830 km², about 2.95 million people) consisting of Kuala Lumpur (the capital of Malaysia) and its vicinity has been experiencing worsening air pollution in recent years as a result of the rapid growth of traffic volume, urbanization and industrial activities.

The Department of Environment of Ministry of Science, Technology and Environment (DOE) started ambient air quality monitoring in the late 1970s, centering on suspended particulate (TSP), carbon monoxide (CO), sulphur dioxides (SO₂) and ozone (O₃). And in 1984 automatic monitoring systems for SPM, CO, SO₂, O₃ and NO_x (nitrogen oxide) were installed at three sites by the University Pertanian Malaysia (UPM). But DOE has not established a basic system necessary for air pollution control yet.

Malaysia is expected to further develop its national economy, which will necessitate more efficient and effective anti-pollution steps. In this context, an air pollution control plan is required to prevent air pollution problems.

Under a technical assistance grant from the Asian Development Bank (ADB) to the Government of Malaysia, the Kelang Valley Environmental Improvement Project (KVEIP) was carried out over a period from August 1986 to April 1987. This survey included the formulation of a preliminary Air Quality Management (AQM) plan as one of its project components, and recommended the preparation of a detailed AQM plan and its implementation.

Upon this recommendation, the Government of Malaysia asked the Government of Japan in January 1989 for technical cooperation to conduct a study on the present state of air pollution, air pollution control, improvement of air quality monitoring system and formulation of an air pollution control plan in the Kelang Valley Region, and training of engineers in DOE through the study.

In response to this request, the Government of Japan decided to conduct an Air Quality Management Study for Kelang Valley Region (hereinafter referred to as "the Study"). Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a preliminary survey team to Malaysia in March 1990 and both JICA and the representative of Economic Planning Unit on behalf of the Government of Malaysia agreed to the Scope of the Work for the Study, on which basis the Study was conducted. The Study was undertaken from December 1991 to August 1993. This report describes the results of the Study.

1.1.2 Objective of the Study

The Study aimed to prepare an implementable guideline for air quality management for Kelang Valley Region with special emphasis on improving air quality monitoring capability, identification of major pollution sources, prediction of future air pollution and recommendation of feasible control measures. At the same time, the Study was expected to contribute to tangible technology transfer to Malaysian counterparts and the formulation of manpower training programs.

1.2 Outline of the Study

(1) Study Area

The Study area is Kelang Valley Region which is shown in Fig. 1.2.1. It is approximately 60 km from east to west and 40 km from south to north, consisting of the Federal Territory (Kuala Lumpur) and Klang, Petaling, Gombak and Hulu Langat of Selangor State.

(2) Scope of the Study

The Study work was executed in Kelang Valley Region and Japan. As shown in Fig. 1.2.2, the Study included a basic study and an analytical study.

1) Basic Study

a) Collection of Existing Data

- o Meteorology and climate
- o Ambient air quality
- o Stationary sources: factories and establishments, and households
- o Mobile sources: motor vehicles, airplanes and ships

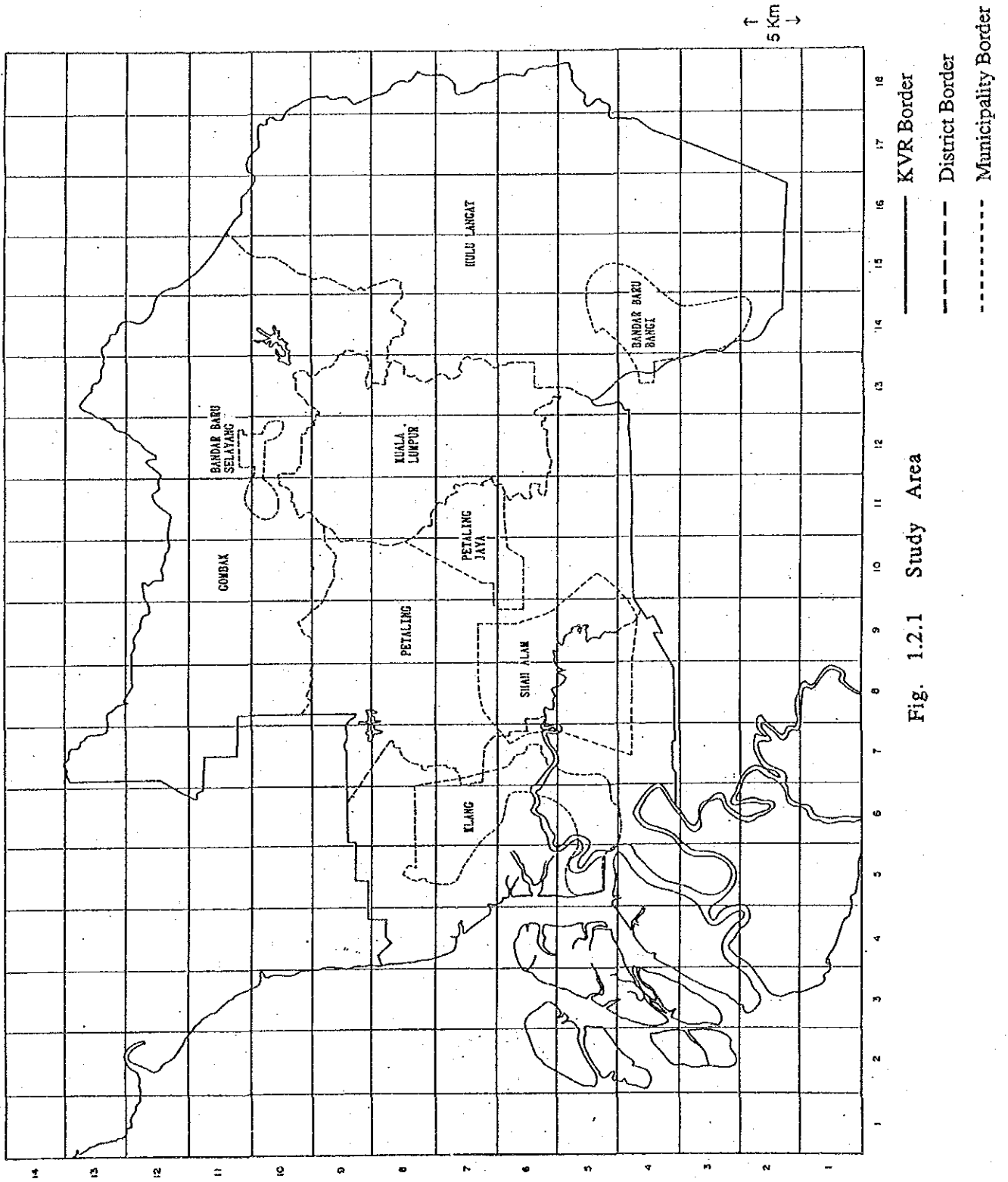


Fig. 1.2.1 Study Area

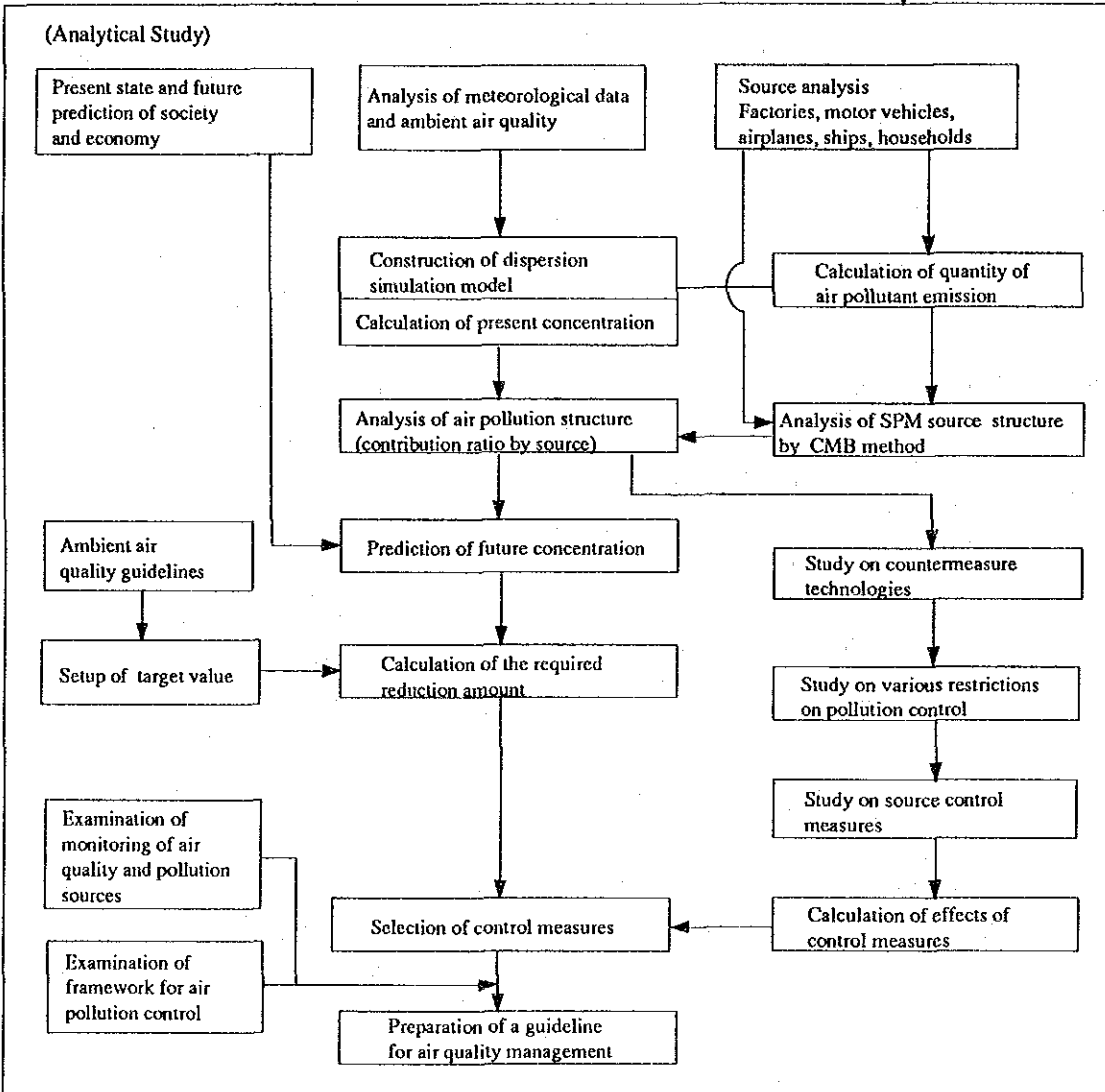
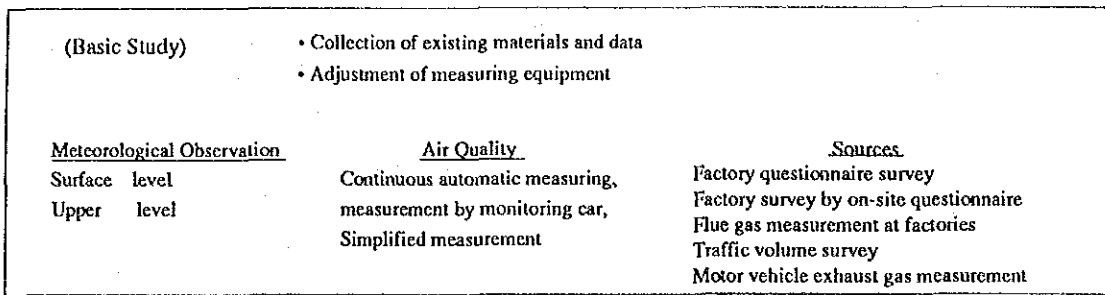


Fig. 1.2.2 Outline of the Study

- Socio-economic conditions
 - Pollution control measures
 - Air pollution control: laws, regulations, standards and guidelines
- b) Installation and Adjustment of Measuring Equipment
- Ambient air quality monitoring
 - continuous measurement
 - simplified measurement
 - Meteorological observation
 - surface level meteorology
 - upper level meteorology
 - Factory flue gas measurement
 - Vehicle exhaust gas measurement at idling state
- c) Field Investigation
- Surface level meteorology
 - wind direction and wind speed
 - solar radiation and net radiation
 - Upper level meteorology
 - vertical profile of wind direction, wind speed and temperature
 - Ambient air quality
 - continuous measurement at fixed and mobile stations (SO₂, NO, NO₂, NO_x, SPM, CO, NMHC, CH₄, THC and O₃)
 - simplified measurement in wide area (SO₂, NO₂ and NO_x)
 - simplified measurement across roads (CO)
 - ambient SPM sampling
 - Factories and establishments
 - questionnaire survey (facility type, fuel consumption and stack)
 - on-site questionnaire survey (facility, operation and air pollution control)
 - flue gas measurement (Dust, SO₂, NO_x, O₂ and flue gas volume)
 - analysis of fuel components
 - Motor vehicles
 - traffic volume survey
 - travel speed survey
 - exhaust gas measurement by chassis dynamometer test (HC, CO, NO_x and fuel economy)
 - exhaust gas measurement at idling state (HC, CO and NO_x)
 - analysis of fuel components

d) Implementation of air dispersion simulation system in MMS computer

2) Analytical Study

- o Analysis of socio-economic conditions
 - society, population, economy, industry, land use, transport and energy
- o Analysis of air pollution control
 - laws, regulations, standards, guidelines and administrative organizations
- o Analysis of meteorological data
 - surface level meteorology
 - upper level meteorology
- o Analysis of ambient air quality
 - continuous monitoring data at fixed and mobile stations
 - measurement data by simplified method
- o Analysis of pollution sources and estimation of pollution load
 - stationary sources (factories and establishments, and households)
 - mobile sources (motor vehicles, airplanes and ships)
- o Development of air dispersion simulation model and analysis of air pollution structure (SO₂, NO_x, NO₂ and CO)
 - construction of air dispersion simulation model
 - calculation of regional pollutant concentration
 - contribution to concentration by sources
- o SPM component analysis by CMB method
 - PM component of emission sources
 - SPM components of ambient air
 - contribution to SPM by sources
- o Prediction of air quality in the future and estimation of required reduction amount of air pollution load
 - prediction of air pollution load from sources
 - prediction of ambient air quality
 - setting of air quality target value
 - reduction amount of air pollution load
- o Study of air pollution control
 - control measures for sources (factories and motor vehicles)
 - technical and social restrictions
 - cost estimates
 - effect of control measures on pollution load and air quality

- Monitoring of air quality and pollution sources
 - air quality monitoring system
 - monitoring of emission from factories and motor vehicles
- Formulation of guideline
 - air quality target
 - target year
 - air quality monitoring
 - pollution control measures
 - rough cost
 - schedule
 - execution organization
- Preparation of air dispersion simulation system

(2) Study Schedule

The Study was conducted from December 1991 to August 1993. The Study schedule and study work flowchart are shown in Figs. 1.2.3 and 1.2.4 respectively.

(3) Technology Transfer

The Study team was able to transfer technology to the Malaysian counterparts regarding fundamental knowledge of measurement principles, measurement methods and equipment maintenance on meteorological observation, air quality monitoring, exhaust and flue gas measurements and chemical analysis. Technology transfer was also made on the analytical study. During the Study, three counterparts were trained in Japan in areas of air quality monitoring, air dispersion simulation and air quality management. Besides, the air dispersion simulation system for Kelang Valley Region was installed in the MMS computer. The substance of technology transfer is described below.

1) Field Work

- Meteorological observation
 - surface level meteorology
 - upper level meteorology
- Measurement of ambient air quality
 - continuous monitoring at fixed and mobile stations
 - measurement and chemical analysis by simplified method
- Factory flue gas measurement
- Vehicle exhaust gas measurement at idling state

2) Analytical Work

- Analysis of measured data
 - meteorological data
 - ambient air quality
 - SPM analysis by CMB method
 - emission factor
- Estimation of air pollution load
- Air dispersion simulation model
- Air pollution control measures
- Air quality management plan

(4) Equipment Used for the Study

Table 1.2.1 shows the major equipment used in the field investigations. The equipment used for the field investigations will be handed-over to the Malaysian relevant counterpart agencies after the Study is completed to continue monitoring of air quality and pollution sources.

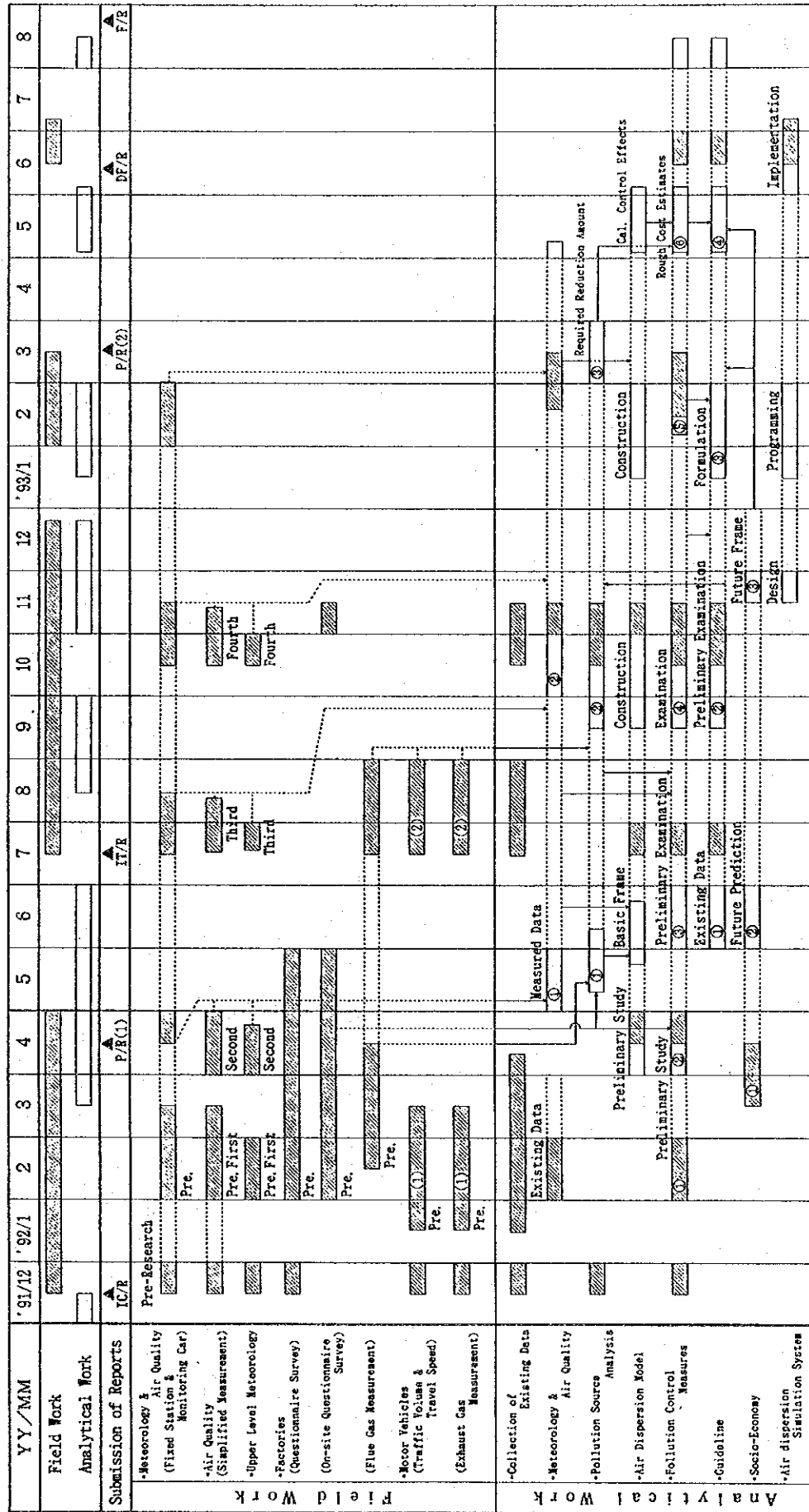


Fig. 1.2.3 Study Schedule

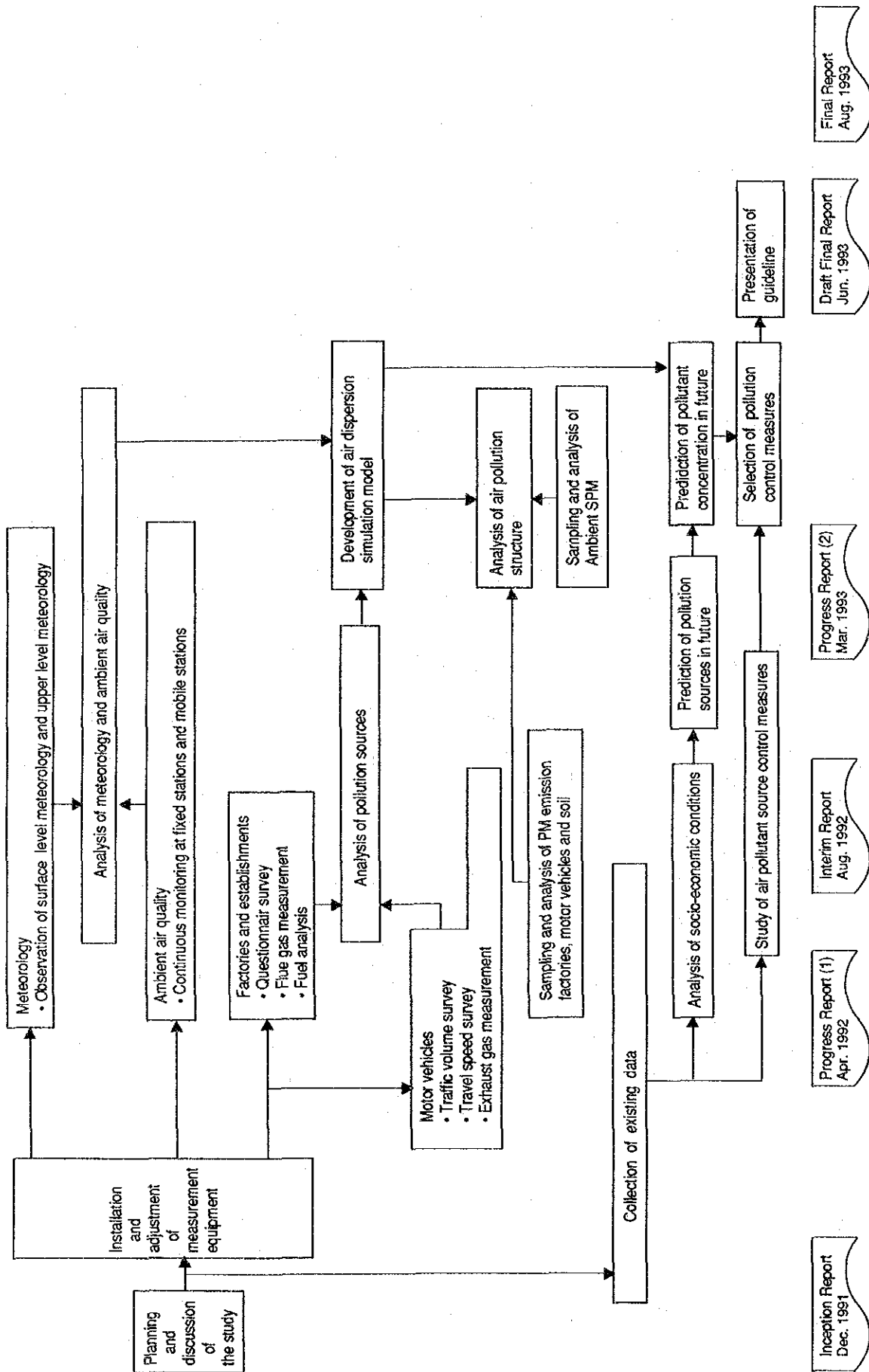


Fig. 1.2.4 Study Work Flow

Table 1.2.1 Major Equipment Used in the Study

Upper level meteorological observation	
- Upper level sonde observation system	1 Set
- Digital theodolite system	1 Set
Surface level meteorological observation	
- Solar and Net radiation system	1 Set
- Wind direction and Wind speed	1 Set
Ambient air quality monitoring at fixed monitoring station	2 Sets
- Container	
- Monitors for SO ₂ , NO _x , SPM, CO, HC and O ₃	
- Wind direction and Wind speed	
Ambient air quality monitoring at mobile monitoring station	2 Sets
- Monitoring vehicle	
- Monitors for SO ₂ , NO _x , SPM, CO, HC and O ₃	
- Wind direction and Wind speed	
Factory flue gas measurement	
- Sampler and Analyzer for Dust, SO ₂ , NO _x , O ₂ and gas velocity	1 Set
Motor vehicle flue gas measurement	
- Flue gas measurement system for HC, CO and NO _x	1 Set
Traffic volume survey	
- Tally counter	100 Sets
Chemical analysis	
- Analysis equipment	1 Set
Data processing system	
- Personal computer system	2 Sets

1.3 Organization for the Study

The Study was carried out jointly by JICA and the Government of Malaysia in cooperation with related agencies.

1.3.1 Malaysian Organization

The Economic Planning Unit of the Prime Minister's Department (EPU) was the main coordinator for the Study, and the main counterpart agency was the Department of Environment, Ministry of Science, Technology and Environment (DOE). Counterpart Team was formed to execute the Study smoothly. Steering Committee and Technical Committee were formed to provide advice and consultations. Members of the Steering Committee, Technical Committee and leaders of the Counterpart Team are shown in Tables 1.3.1, 1.3.2 and 1.3.3 respectively.

Table 1.3.1 Members of the Steering Committee

No.	Name	Department
1.	Abdul Rahman Jamal Director Regional Economics Section (Chairman)	EPU
2.	Hasnol Zam Zam Ahmad (Secretary)	EPU
3.	YM. Tengku Azman bin Tengku Mat	Ministry of Housing & Local Government
4.	R. Letchumanan	Ministry of Energy, Telecommunication and Post
5.	Ismail Mohamad	Ministry of Transport
6.	Leong Chow Peng	MMS
7.	Arisfadilah bin Sariat	EPU
8.	Noor Aini Ahmad	MOSTE
9.	Harvinder Kaur	EPU (Industry)
10.	Abdul Rahman Hj. Ahmad	Health Department, City Hall
11.	YM. Tengku Bakry Shah b. Tengku Johan	DOE
12.	Nor A'zman Rosli	DOE
13.	Mohd. Suhaimi Ahmad	EPU (Energy)
14.	Mohamad Yazid Md. Din	EPU (Energy)
15.	Mohd Fazi Matori	Ministry of Works

Table 1.3.2 Members of the Technical Committee

No.	Name	Agency
1.	Ir. Tan Meng Leng Deputy Director (Chairman)	DOE
2.	YM Tengku Bakry Shah Tengku Johan (Secretary)	DOE
3.	Mrs. Wan Ramlah Bt. Hj. Wan Ibrahim	DOE
4.	Mr. Ismail Isnin	DOE
5.	Ms. Azuri Azizah Saedon	DOE
6.	Mr. Marzuki B. Mokhtar	DOE
7.	Mr. S. Madhi B. S. Junaidi	DOE
8.	Mr. Masami Mizuguchi	DOE (JICA)
9.	Mr. Terutaka Ishikawa	DOE (JICA)
10.	Mr. Nor A'zman Rosli	DOE
11.	Mr. Hassan Mat	DOE (S'GOR)
12.	Mr. Ahmad Samsudin Che Abas	DOE
13.	Mrs. Wan Noraini Bt. Wan Hamzah	DOE
14.	Ms. Rosnani Bt. Ahmad Kasrin	DOE
15.	Mr. Abdul Rahman B. Hj. Ahmad	CITY HALL
16.	Mr. Dzulfakar B. Maisran	CITY HALL
17.	Mr. Wong Kok Fah	DOC
18.	Mrs. Leong Chow Peng	MMS
19.	Dr. M. Subramaniam	MMS
20.	Mr. Tan Choon Kim	SAMC
21.	Mr. Harjeet Singh	SSS
22.	Mrs. Latifah Bt. Hj. Mohd. Yatim	UPLK
23.	Ass. Prof. Dr. Azizan B. Abu Samah	UM
24.	Mr. Azman Zainal Abidin	UPM
25.	Ms. Lee Tzee Wan	PETRONAS
26.	Mr. Cheah Wai Kong	TNB

Table 1.3.3 Leaders of the Counterpart Team

1	YM. Tengku Bakry Shah Tengku Johan DOE	Supervision
2	Mrs. Wan Noraini Wan Hamzah DOE	Socio-economic Analysis and Development Plan
3	Mrs. Hajah Rosnani Ibrahim DOE	Guideline
4	Mr. Nor A'zman Rosli DOE	Stationary Source Control
5	Mr. Mohd Izzuddin Abd Ghani DOE	Mobile Source Control
6	Mr. Nor A'zman Rosli DOE	Equipment Management
7	Dr. Azizan Abu Samah UM	Modelling and Simulation
8	Mrs. Rahani Hussin DOE	Pollution Source Investigation
9	Mr. Azman Zainal Abidin UPM	Air Quality Monitoring
10	Mrs. Leong Chow Peng MMS	Meteorological Observation
11	Mr. Lum Koon Woon DOC	Chemical Analysis

1.3.2 Japanese Organization

JICA, the official agency of the technical cooperation, chose Suuri keikaku Co., Ltd. and Pacific Consultants International as the consultants in charge of the Study. JICA formed Advisory Committee to ensure smooth execution of the Study. Members of the Study Team and Advisory Committee are shown in Tables 1.3.4 and 1.3.5 respectively.

Table 1.3.4 Members of the Study Team

1	Mr. Makoto Miyakawa Suuri-Keikaku Co., Ltd.	Overall Supervision/Organization and Institution
2	Mr. Ikuo Inoue Japan Machinery & Metals Inspection Institute	Meteorological Observation
3	Mr. Masanori Fuzikawa Japan Machinery & Metals Inspection Institute	Air Quality Monitoring
4	Mr. Mitsuru Fukuhara Japan Machinery & Metals Inspection Institute	Stationary Source Investigation
5	Mr. Yoichi Enokido Pacific Consultants International	Mobile Source Investigation
6	Mr. Ikushi Okada Japan Machinery & Metals Inspection Institute	Monitoring System
7	Mr. Akeo Fukayama Suuri-Keikaku Co., Ltd.	Meteorology and Air Quality Analysis
8	Mr. Seisuke Suzuki Suuri-Keikaku Co., Ltd.	Pollution Source Analysis
9	Mr. Haruo Kikuchi Suuri-Keikaku Co., Ltd.	Modeling and Simulation Analysis
10	Mr. Yukihiro Nakano Suuri-Keikaku Co., Ltd.	Air Dispersion Simulation System
11	Mr. Hidenori Kaku Suuri-Keikaku Co., Ltd.	Mobile Source control
12	Mr. Shinzo Hirasawa Suuri-Keikaku Co., Ltd.	Stationary Source control
13	Mr. Norifumi Yamamoto Pacific Consultants International	Air Pollution Control Planning
14	Mr. Fumiaki Onoda Pacific Consultants International	Socio-economic Analysis/Development Plan
15	Mr. Tetsuaki Yokochi Japan Machinery & Metals Inspection Institute	Equipment Management/Chemical Analysis

Table 1.3.5 Members of the Advisory Committee

1	Dr. Hidetsuru Matsushita Professor, Graduate School of Nutritional and Environmental Science, University of Shizuoka Prefecture	Chairman/Overall Supervision
2	Mr. Susumu Ota Deputy director of Planning and Coordination Division, Planning and Coordination Bureau, Environment Agency	Air Pollution control
3	Mr. Naoya Tsukamoto Global Environment Specialist, Control and Coordination Division, Global Environmental Department, Environment Agency	Atmospheric Environment Analysis
4	Mr. Fumio Ueno Assistant Director, Office of Industrial Development, Industrial Base Division, Department of Commerce, Industry, Labor and Tourism, Hokkaido Government	Pollution Source Measurement

1.3.3 Counterpart Assignments

Counterpart assignments are shown in Table 1.3.6.

1.3.4 Organizational Structure

The organizational structure for the Study is shown in Fig. 1.3.1.

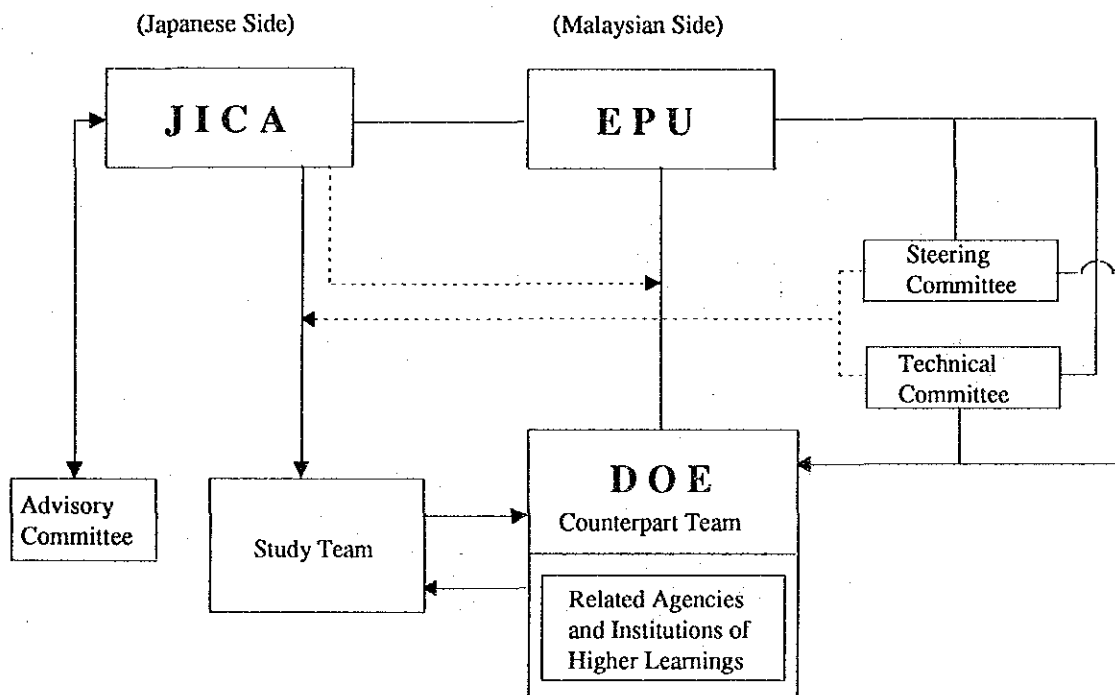


Fig. 1.3.1 Organizational Diagram for the Study

Table 1.3.6 Counterpart Assignments

No.	Work Field	Members of the Counterpart Team	Agency	Members of the Study Team
1	Supervision of the Entire Study	Leader : Mr. Tengku Bakry Shah Tengku Johan	DOE	Mr. Makoto Miyakawa
2	Socio-Economic Analysis/ Development Plan	Leader : Mrs. Wan Noraini Wan Hamzah Member : Mrs. Hariyah Amy Yahya	DOE	Mr. Fumiaki Onoda
3	Guideline	Leader : Mrs. Hajah Rosnani Ibrahim Member : Mrs. Wan Ranlah Mrs. Mariana Mohd Nor	DOE	Mr. Norifumi Yamamoto
4	Stationary Source Control	Leader : Mr. Nor A'zman Rosli Member : Mr. Ahmad Samsudin Che Abas	DOE	Mr. Shinzo Hirasawa (Stationary Source Control) Mr. Ikushi Okada (Monitoring System)
5	Mobile Source Control	Leader : Mr. Mohd Izzuddin Abd Chani Member : Mr. Marzuki Mokhtar Mr. Razali Yaakob	DOE	Mr. Hidenori Kaku
6	Equipment Management	Leader : Mr. Nor A'zman Rosli Member : Mr. Ahmad Samsudin Che Abas Mrs. Wan Noraini Wan Hamzah Mrs. Hariyah Amy Yahya	DOE	Mr. Tetsuaki Yokochi (Equipment Management) Mr. Masanori Fuzikawa (Monitoring System)
7	Modelling and Simulation	Leader : Dr. Azizan Abu Samah Co-Leader: Mr. Azman Zainal Abidin Co-Leader: Mr. Tengku Bakry Shah Tengku Johan Member : Mrs. Leong Chow Peng : Mr. Subramaniam Moten Mr. Chang Tin Yee	UM UPM DOE NES MNS MNS	Mr. Haruo Kikuchi (Modelling and Simulation) Mr. Akeo Fukayama (Meteorology and Air Quality) Mr. Yukihiro Nakano (Air Dispersion Simulation System)
8	Pollution Sources (On-site questionnaire) (Flue gas measurement) (Mobile sources)	Leader : Mrs. Rahani Hussin Member : Mr. Nor A'zman Rosli Mr. Ahmad Samsudin Che Abas Member : Mr. Nor A'zman Rosli Mr. Ishak Rauf Mr. Muhd. Ruzita Abdul Hamid Mr. Tham Chee Man Mr. Othman Mustam Mr. Yazid Suaidi Member : Mr. Mohd Izuddin Abd Chani Mr. Marzuki Mokhtar Mr. Razali Yaakob Mr. Nor A'zman Rosli Mr. Ahmad Samsudin Che Abas	DOE DOE	Mr. Seisuke Suzuki Mr. Shinzo Hirasawa Mr. Mitsuru Fukuhara Mr. Yoichi Enokido
9	Air Quality Monitoring	Leader : Mr. Azman Zainal Abidin Member : Mr. Nor A'zman Rosli Mr. Ahmad Samsudin Che Abas	UPM DOE	Mr. Masanori Fujikawa
10	Meteorological Observation	Leader : Mrs. Leong Chow Peng Co-Leader: Mr. Azman Zainal Abidin Member : Mr. Liu Sze Fook	MNS UPM MNS	Mr. Ikuo Inoue
11	Chemical Analysis	Leader : Mr. Lum Kon Woon Member : Mr. Pua Hiang	DOC	Mr. Tetsuaki Yokochi

CHAPTER 2 OVERVIEW OF THE STUDY AREA

CHAPTER 2 OVERVIEW OF THE STUDY AREA

The natural and social environment of the Study area summarized from existing data is as follows.

2.1 Natural Environment

(1) Topography

The Study area, Kelang Valley Region, a basin located in the southwest part of the Malaysia Peninsula (Fig. 2.1) is surrounded by mountains exceeding 1,500 m on the east, and the Straits of Melaka on the west.

The Klang River is the main river, which is joined by many branch rivers and flows into the Straits of Melaka through the Straits of Klang.

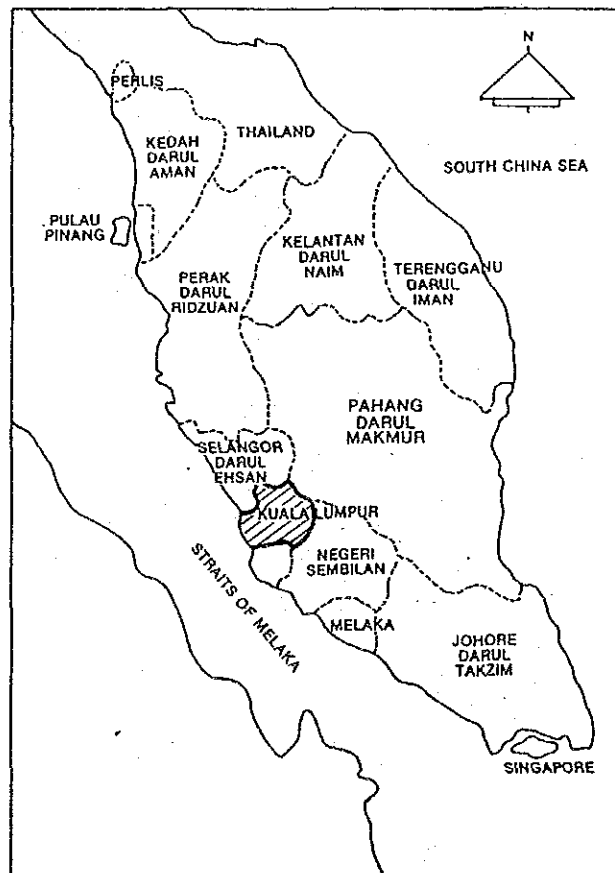


Fig. 2.1 Location of Kelang Valley Region

(2) Climate

Malaysia adheres to a tropical rainforest climate (Af), which is influenced by monsoons from the South China Sea and the Indian Ocean. The Northeast monsoon season from December through February and the Southwest monsoon season from June through August are the dry seasons. Two transitional seasons from March through May and September through November are rainy seasons with high humidity.

2.2 Social Environment

2.2.1 Society and Administration

(1) Society

Malaysia is a constitutional monarchy consisting of 13 states, under which local authorities are established.

(2) Administration and Government Structures

Kampung is the smallest administrative division. Fig. 2.2.1 is a conceptual model of administrative structure in a district. Municipalities are established along trunk roads. Rubber or oil-palm estates are private land. As for the administrative structure, each state is divided into districts, which in turn are divided into smaller divisions called mukim and kampung (Fig. 2.2.2).

At the district level and below, local authorities, such as district councils and municipal councils, exist along with district offices. There are exceptions. Two cities, Kuala Lumpur and Ipoh have a mayor and a city council. Estates lie outside the sphere of various administrative services because they are private properties.

Administratively, the Kelang Valley Region consists of the Federal Territory of Kuala Lumpur, four districts, i.e., Gombak, Hulu Langat, Petaling and Klang, and four municipalities, i.e., Shah Alam, Petaling Jaya, Klang and newly born Ampang Jaya of the state of Selangor at present. And new municipalities such as Bangi and Selayang will be established in the near future. Kuala Lumpur is a federal territory. Each of Ampang Jaya, Klang, Petaling Jaya, and Shah Alam has a municipal council; each of Gombak, Hulu Langat, and Petaling has a district council.

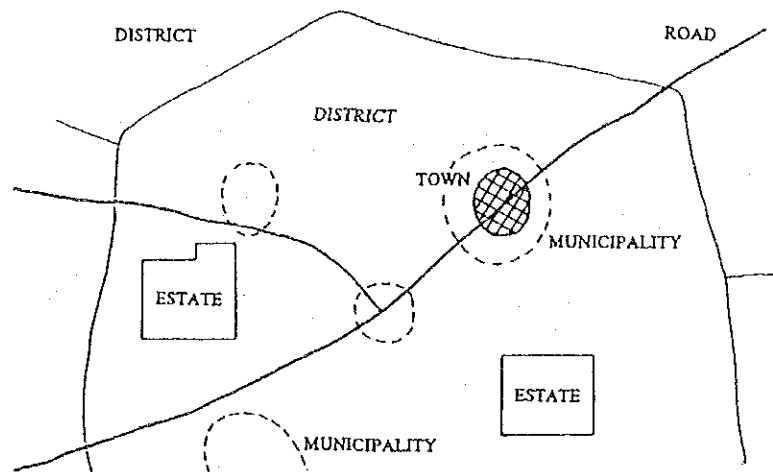


Fig.2.2.1 Conceptual Model of Administrative Structure in a District

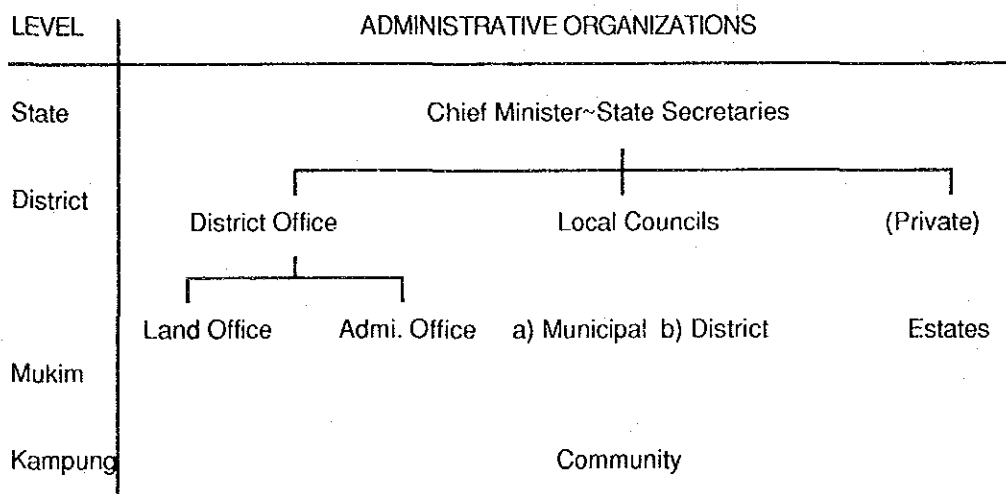


Fig.2.2.2 State Government and Local Authorities

2.2.2 Development Plans and Population

(1) Development Plans

Each of the constituent administrative bodies in KVR has its own structural development plan (some of them have been published). To ensure smooth execution and coordination of these development plans in the Kelang Valley Region, the federal government set up the Kelang Valley Planning Secretariat (KVPS) in the prime minister's office. KVPS consolidated these plans into a Kelang Valley Perspective Plan in 1984, which was revised in 1988 (KVPP'88). Our forecast mainly relies on this revised plan.

Among the official prognosis for future course of the national economy, the most far reaching is in the Second Outline Perspective Plan (OPP2) which provides basic forecasts for the beginning of the next century. We are bound to make use of actual trends to the present and planned ones set by the OPP2 to 2000 as the basis of our forecast.

(2) Population

The latest census was carried out in August 1991 and a preliminary count report (PCR) was released in March 1992. According to this report, the total population in Malaysia is 17.57 million. Of the total, 2.95 million people (about 17% of the total population) live in the Kelang Valley Region.

Table 2.2.1 shows the area, population and population density in the Kelang Valley Region according to the 1980 census and KVPP'88's estimates.

The 1991 population census has revealed the following two facts.

- 1) The actual average annual growth rate (AAGR) of the region's population during the period between 1980 and 1991 is about one point lower than the prediction because of lower migratory inflow from other states than predicted.
- 2) The population sprawl from the Federal Territory of Kuala Lumpur is more conspicuous and is directed more toward the north and east than estimated in the predictions. This phenomenon culminated in the birth of the Ampang Jaya municipality, adjacent to Kuala Lumpur at its northeast boundary in March 1992.

(3) Prospects for Development

We have compared the PCR and KVPP'88 figures and calculated tentative figures for the year 2005 (see Table 2.2.2). The AAGR figure for the population for the period of 1991 and 2000 for all of Malaysia was derived from the OPP2. We did not delve into the population and household estimates made in the KVPP'88, as the figures will soon change whenever a new series of population statistics based on the latest census are published.

Furthermore, planning has begun on the construction of a new international airport in Sepang district, which is not mentioned in the KVPP'88. This will surely influence not only the air and related transport infrastructures but also the general pattern of land use in the region, and further the boundary of the region itself.

Topographically, Kelang Valley Region includes the upper reach of the Selangor basin in its northeastern part and the upper and middle reaches of the Langat basin in its eastern part. In the future, Kuala Langat district, the lower reach of the Langat, and Sepang district will be administratively integrated into the greater Kuala Lumpur metropolitan region.

Table 2.2.1 Population 1980 Census and Estimates

	*1	Census 1980			Population		Estimate(*2) AAGR: %(*2)			
	Area	Dens.	AHhn.		1990	2000	80-85	-90	-95	-00
	km2	1000 / km2			1000	1000				
KUALA LUMPUR	243	1036.9	4267	4.75	1550	2200	4.1	4.1	3.6	3.6
GOMBAK	650	175.9	271	5.03	245	344	3.6	3.0	3.4	3.4
Selayang	1	3.5	3500		5	7	3.6	3.0	3.4	3.4
Ampang Jaya #	5	n.a.								
Other UA	14	70.2	5014							
Non-UA	630	102.1	162							
HULU LANGAT	826	188.4	288	5.32	289	406	4.5	4.1	3.4	3.4
Ampang Jaya #	4	13.0	3250							
Bangi	n.a.	33.3			73	103	8.2	7.6	3.4	3.4
Other UA #2	41	65.6								
Non-UA	781	76.4	98							
PETALING	484	382.3	790	4.61	659	926	4.4	6.5	3.5	3.4
Shah Alam	135	20.2	150		155	218	14.5	26.3	3.43	3.4
Petaling Jaya	43	220.1	5119		306	430	3.6	3.0	3.4	3.4
Other UA	22	58.4	2655							
Non-UA	284	83.7	295							
KLANG	627	296.1	472	5.60	412	597	3.6	3.0	3.4	3.4
Klang	61	203.4	3334		283	398	3.6	3.0	3.4	3.4
Other UA	0									
Non-UA	566									
Other UA	77				47	66	3.6	3.0	3.4	3.4
Non-UA	2261				735	1032	3.6	3.0	3.4	3.4
KELANG VALLEY	2830	2079.6	735	4.90	3155	4454	4.0(J)	4.3(K)	3.4(L)	3.4(M)
MALAYSIA	329758	13136	40							

Legend : UA=Urban Area, Dens=Density, AHhn=Average Household Number

Data on Ampang Jaya : New Strait Times, Mar.19,20

#2 Other UA includes Bangi's

*1 Yearbook 90 : Bureau of Statistics

*2 KVPP' 88