8.4 Air Quality Target Value

The dispersion model predicts annual mean values of pollutant concentrations in the Study. To evaluate the simulation results, certain criteria of annual values have to be defined. Besides, it is reasonable to evaluate ambient air quality and control air pollution sources based on long-term values. However, most of the Malaysian air quality guidelines are set for hourly values, eight-hour values and daily values (ten-minutes value, hourly value, and daily value for SO_2, hourly value for NO_2, and hourly and eight-hour value for CO, etc.). The annual mean targets of ambient air quality have to correspond to each of the Malaysian guidelines. These targets are called Air Quality Target Values. The Air Quality Target Values may be a guarantee for the observance of the guideline values.

In the Study, basically, the Air Quality Target Values were determined according to the empirical rule used by the United States Environmental Protection Agency (EPA) and Japan Environment Agency (JEA), that sets annual mean value at half the daily mean. Since the monitoring was conducted at only five stations for a year and insufficient to establish the Air Quality Target Values. Accumulation of the monitoring data for several years at more stations is required for the purpose. Then, the analysis of the monitored data in Kelang Valley Region was carried out to support the justification for adopting this rule.

A certain amount of error is inevitable in measurement of ambient air quality. Therefore some statistical values are adopted for the long-term evaluation. In this examination, 98 percentile values are adopted for the long-term evaluation.

Hourly values in the guidelines are inadequate for estimating the Air Quality Target Value. Because the measured hourly values that are used for evaluation may include unusual pollution sources and malfunctions of measurement equipment. The Malaysian guideline for SO_2 daily mean is 40 ppb and the Malaysian guideline for eight-hour mean of CO is 9 ppm. They were used for the estimation of the Air Quality Target Values. The case of the Japanese standard for CO daily mean value (10 ppm), was also examined for comparison. Since the Malaysian guideline of NO_2 is only defined for hourly value. Hence, the WHO guideline value for NO_2 daily mean (73 ppb) was used for the estimation.

The following three methods were examined to estimate the air quality target values. Schematic diagram of three methods is illustrated in Fig. 8.4.

1. Larsen Model and Linear Regression

   The air quality target values for each station are first obtained by the Larsen Model. At the same time, occurrence frequencies of the guideline values at each station are also obtained. Then the occurrence frequencies of the guideline values and the annual mean values at each station are plotted on lognormal coordinates to obtain the linear regression line. Finally, the air quality target value for the target area is determined from the corresponding annual mean at 98 percentile value on the regression line.

2. Larsen Model and Geometric Mean

   The procedure to obtain the air quality target values for each station are the same as in method 1. Then the air quality target value for the target area is determined as the geometric mean of the air quality target values of each station.

3. Linear Regression between Annual Mean Value and 98 Percentile Values

   A linear regression line is constructed between the annual mean values and 98 percentile values for each station. Then the air quality target value for the target area is determined.

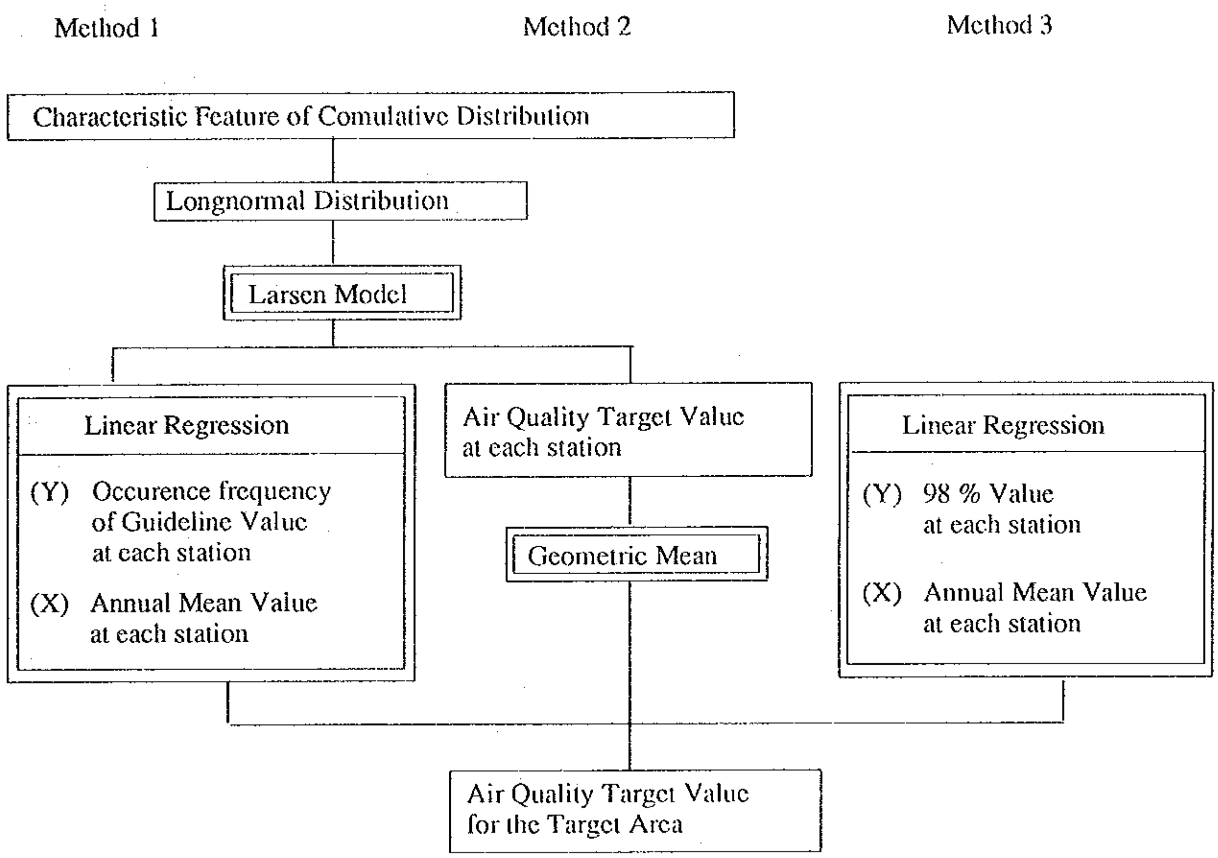


Fig. 8.4 Schematic Diagram of Three Methods to Estimate Air Quality Target Value

The estimated values by the three methods and the recommended Air Quality Target Values are summarized in Table 8.4. The estimated values for SO_2, NO_2 and CO from the monitoring data are close to half values of the guideline or standard values. The fact supports the justification for adopting the empirical rule that the Air Quality Target Value can be set at half of the guidelines or standards for daily value. The value for CO is set taking into consideration the Malaysian guideline.

Finally, the Air Quality Target Values for SO_2, NO_2, and CO are 20 ppb, 37 ppb, and 4 ppm respectively. The Malaysian guidelines have annual mean values for TSP and PM10, and they are chosen as the Air Quality Target Values.

Table 8.4 Air Quality Target Value

		SO_2 Daily	NO_2 Daily	CO 8-Hrs	CO Daily	TSP Yearly	PM10 Yearly
(Unit)		ppb	ppb	0.1 ppm		ug/m^3	ug/m^3
Guidelines /Standards		40 (*)	73 (+)	90 (*)	100 (#)	90 (*)	50 (*)
Method 1, 2	City Hall	15.1	44.7	41.9	54.4		
	UPM	22.0	43.5	----	----		
	Petaling Jaya	22.6	43.7	40.7	51.5		
	Shah Alam	15.6	39.5	32.3	52.0		
Method 1	Whole Area	27.5	44.1	59.2	55.1		
Method 2	Whole Area	18.5	42.8	38.0	52.6		
Method 3	Whole Area	19.2	43.5	42.8	53.3		
Recommended (Yearly)	Whole Area	20	37	40		90	50
Maximum Mean	Fixed Stations	13.3 (PJ)	21.7 (CH)	28.4 (PJ)		81.8 (SA)	56.8 (SA)

*: Malaysian Guidelines, #: Japanese Standards,
+: WHO Guidelines
PJ: Petaling Jaya, CH: City Hall, SA: Shah Alam

8.5 Necessity of Emission Reduction

In 1992, maximum SO_2 concentration in the region was 59.7 ppb, far exceeding the air quality target value of 20 ppb. Maximum NO_2 concentration was 41.1 ppb, exceeding the air quality target value of 37 ppb. Maximum CO concentration was 4.92 ppm and exceeds the air quality target value of 4 ppm.

Factories and motor vehicles are the major contributors to SO_2 concentrations. Contribution from factories are high especially at the points with high SO_2 concentrations such as in Petaling Jaya and Shah Alam. The contributions by each type of pollution sources for NO_2 cannot be estimated because the simulation of NO_2 was carried out with the statistical model. However, NO_2 is converted from NOx and most of NOx is accounted for by motor vehicles. Almost all CO is produced by motor vehicles.

In 2005, SO_2 concentration at the maximum point in the region will be 65.8 ppb. This concentration is much greater than the air quality target value (20 ppb) and greater than the simulated concentration at the maximum point in 1992. SO_2 concentrations at City Hall and Petaling Jaya are at around the air quality target level. NO_2 concentration at the maximum point will be 63.1 ppb, which is much greater than the air quality target (37 ppb). NO_2 concentration at City Hall also exceeds the air quality target value. CO concentrations at the maximum point and City Hall will be 10.5 and 6.9 ppm respectively. Both of them exceed the air quality target value.

The manner and degree in which each type of pollutant source contributes are virtually identical to those of the year 1992.

As a result, ambient air quality of SO_2, NO_2, and CO concentrations are reaching problematic levels in some areas and are predicted to become worse in 2005. Factories are the major contributors to high SO_2 concentrations, while motor vehicles are the responsible for NO_2 and CO concentrations. Control measures to reduce the pollutant emission amounts from factories and motor vehicles should be carried out.

CHAPTER 9 CONTROL OVER AIR POLLUTION SOURCES

9.1 Factories and Establishments

9.1.1 Necessity of Control

From the current emissions given in Chapter 5, emission amounts for the whole KVR in the year 2005 are estimated to be about 41,000 tons of SOx, 30,000 tons of NOx and 10,000 tons of Dust, assuming no control measures are enforced. Each of these emissions will exceed their target value of ground level concentration, according to the simulation study discussed in the previous chapter. Therefore, control measures are very necessary.

9.1.2 Present State of Pollution Control

Environmental Quality (Clean Air) Regulations, 1978, governs the air pollutant emissions from factories. However, it does not regulate SOx, and NOx emissions from combustion sources. Stack heights are determined based on guidelines given in the British Clean Air Act.

Since dust (or particle) emission limits are stated in the Regulations, dust collectors or precipitators are installed in some facilities. No other device was found in KVR to control SOx and NOx from stationary combustion sources.

9.1.3 Basic Techniques of Stationary Source Emission Control

Conversion to lighter and cleaner fuel, higher stacks for better dispersion, suppression of pollutant production in furnaces and direct removal from flue gases are generally applied to control emissions from stationary sources. Also the pollutant production can be reduced by careful control of combustion which is called combustion management. Energy conservation is another generally applied concept for emission reduction.

Fuel conversion is effective in SOx reduction since its emissions are proportional to sulphur contents in fuel. SOx in flue gases can be removed by a scrubbing process (Flue gas desulfurization). Fuel conversion or scrubbing should be endorsed into the national energy policy and economic incentive should also be provided.

NOx generation in furnaces can be reduced by application of a two stage combustion system and low NOx burners (LNB). NOx can be removed thermally or catalytically from flue gases by addition of a reducing agent. Particles or dust are removed by collectors such as multicyclones and electrostatic precipitator (ESP).

9.1.4 Proposed Control Measures

(1) Power Station "A"

1) No. 1 Boiler

Fuel conversion from fuel oil to natural gas
-------------SOx 12,000 tons reduction

2) Nos. 3 & 4 Boilers

Burn coal with 0.6% sulphur content until 2005 as planned
Improve particle removal efficiency of ESP

3) Nos. 5 & 6 Boilers

No. 5 Boiler: Burn 0.6% sulphur content coal as designed originally
No. 6 Boiler: Burn natural gas instead of coal

(2) General Factories

1) Combustion Management (Refer to Sect. 9.1.5)

Appoint licensed combustion engineers on fuel burning facilities, in order to control combustion and to save energy. Install combustion management instruments - O_2 analyzers and Orsat analyzers.

2) Fuel Conversion

Convert to natural gas at facilities burning more than 150 kg/h in P. Jaya and S.Alam and convert to light fuel oil at facilities burning 200 kg/h or more in other areas.

3) Dust Control

Install high efficiency collectors or improve existing collectors at wood burning facilities which are usually large in scale and located in residential area.

4) Wood Waste Boiler

Replace with a uniform chip spreader boiler

(3) Other Control Measures

Cement factory: Prepare emergency operation manual for frequent power failures or enlarge capacity of the emergency stand-by generator.

Nitric acid plant: Replace catalyst at an early stage or reduce plant production capacity.

Relocation: Remove obtrusive factories from residential areas.

Factories: Conclude a pollution control agreement between the government office and a company.

Non-point sources: Cover, sprinkle water, install collectors, and maintain equipment appropriately.

9.1.5 Training of Engineers

Combustion technique in general can manage substantial amounts of pollutant reduction from boilers and furnaces. Factories in KVR seem to lack this basic capability. The technique also aims energy conservation which is one of the direct measures to reduce pollutant emissions.

It is necessary to establish an integrated combustion management system to promote this concept in the industry. The combustion management system is to undertake fuel management, management of energy generation and uses, non-pollution combustion, maintenance of instruments and other matters in an individual factory.

Well trained engineers in non-pollution combustion techniques and energy saving consciousness are urgently needed. They should be trained in the proposed training center which has boilers and analytical instruments for practical use. Training period should be in the range of 1 to 3 months, depending on the class. Graduates who pass governmental examination shall be licensed to be designated class combustion engineers.

The designated class may be divided into two groups; one who operate larger pollutors and the other - the smaller ones. Combustion facilities included in this system should not be in operation without the licensed engineer in the organization.

9.1.6 Energy Saving

Energy saving is a worldwide concern from the fossil fuel conservation and the environmental preservation.

Combustion with a less air/fuel ratio reduces heat loss with flue gas and hence saves fuel. Also it reduces NOx emissions. In addition to this kind of combustion management, waste heat recoveries, co-generation of heat and electricity, and modification of energy consuming processes may play a major role in the saving process.

9.1.7 Technical Supporting System

Industrial sector may need governmental support to implement pollution control measures effectively. Malaysian or foreign specialists must be engaged to provide technical assistance.

9.1.8 Financial Support System

A low interest rate loan system should be initiated by the government to support these industrial activities.

9.2 Motor Vehicles

9.2.1 Necessity of Control

Motor vehicles are one of the major sources of air pollution in the Klang Valley Region. Countermeasures for mobile sources are aimed at reducing the air pollutant emissions caused by motor vehicles.

The Environmental Quality Act (EQA) 1974 outlines all activities relating to preventing or controlling pollution and protecting and enhancing the quality of the environment. Several regulations concerning motor vehicles have been enacted based on this Act. But a huge volume of vehicles crowd the streets in KVR, emitting large amount of pollutants.

The Study in KVR revealed that CO and PM10 concentration around the trunk roads exceeded the air quality guidelines. Without further control measures, NOx pollution may also become serious in the future when traffic becomes heavier.

The annual total distance travelled in KVR is 16 billion kilometers in 1992 with motor cars and motorcycles accounting for 53% and 22% respectively.

9.2.2 Contents of Control Measures

(1) Proposed Motor Vehicle Control Measures

The most feasible measures that are emission gas control, traffic volume control, inspection and maintenance system, public education and others, were selected and evaluated for their effectiveness in terms of required costs of implementation in Malaysia.

The control measures are divided into two groups, i.e., short/medium term and long term. The short/medium term group consists of measures to be implemented by 2005 and whose effects will be perceptible by 2005, the second group contains measures to be commenced preferably around 2005. The proposed measures are shown in Table 9.1.

Table 9.1 (1) Proposed Countermeasures for Motor Vehicles

Item	Short/Medium term	Long term
Exhaust emission control		
a. Enforcement of exhaust gas control		
	(a)Combustion improvement of motorcycle engine ・2-stroke⇒4-stroke ・Smokeless lube oil (b)Strengthen emission regulations ・91/441/EEC	
		(c)Installation of 3-way catalytic converter
b. Control of use of very old vehicles		
	(a)Promotion of low-pollution vehicles for commercial use ECE R15.04,R24,R49 , 91/441/EEC (b)Switch diesel-taxis to petrol (c)Prohibition of registration of new diesel motor car	
c. Fuel control		
	(a)Unleaded gasoline (b)Low-sulphur diesel fuel (c)Supply of oxygenated gasoline	

Table 9.1 (2) Proposed Countermeasures for Motor Vehicles (continued)

Item	Short/Medium term	Long term
Organization/Institution	(a)Vehicles certification system (b)Inspection and maintenance system (c)Installation and operation of chassis dynamometers	
Alternative energy		(a)CNG Taxi (b)Methanol Trucks (c)Palm oil Trucks
Traffic volume conrol		
a.Klang valley transportation plan (Switching to mass-transit system from motor vehicles)	(a)KTM system (b)LRT system (c)Bus system (d)Road network plan · Expressway · Primary distributor · District distributor	
b.Restriction of motor car in congested areas	(a)Restriction of motor cars in city center (b)Introduction of flextime system (c)Traffic reduction in congested areas	
c.Rationalization of commodity transport system		
d.Traffic survey		

(2) Exhaust Emission Control

In Malaysia, spearheaded by the Motor Vehicle (Control of Smoke and Gas Emission) Rules in 1977 to stipulate emissions from diesel vehicles, several rules were enforced to control lead content in petrol, and particulate emission.

The Malaysian government applied ECE. R15.04 on petrol vehicles and ECE.R49 and ECE.R24 (PM concentration) on diesel vehicles in June, 1992. In 1994, Regulation 91/441/EEC will be enforced on petrol vehicles. Estimates of possible emission reduction through the enforcement of various regulations are listed below.

1) Combustion improvement of motorcycle engines

Most of the motorcycles in the Region are equipped with two stroke engines which burn petrol and lube oil together emitting much unburnt fuel. Two types of measures are needed on motorcycles.

(a) Promotion of use of four-stroke motorcycles

Although a four-stroke motorcycle emits more NOx than a two-stroke one, the former emits substantially less CO, HC, and PM because of improved combustion (Table 9.2). Therefore, use of motorcycles with four-stroke engine should be promoted for pollution control.

Table 9.2 Emission Factors for Motorcycles

Vehicle type		Emission factor (g/unit)			Note
Vehicle type	Pollu-tant	Two-stroke engine	Four-stroke engine	Rate	Reference: Compilation of Air Pollutant Emission Factors (EPA, 1977)
Motorcycle	HC	9.9	1.8	0.18	
	CO	24.0	10.0	0.42	
	NOx	0.075	0.15	2.00	
	SOx	0.024	0.014	0.58	
	PM	0.21	0.029	0.14	

(b) Use of smokeless lube oil

Smokeless oil is a type of lube oil which contains polybutene (polyisobutylene) and the oil itself is capable of lubrication, and aids in the combustion of unburnt oil, consequently reducing CO and smoke emissions.

There are no technical drawbacks to use of lube oil containing polybutene, which is widely used in Japan, Taiwan and elsewhere. Thailand standardized it as an industrial product in 1991.

2) Reinforcement of Emission Regulations for Motor Cars

A total number of 700,000 motor cars are in operation in Kelang Valley Region. They are one of the major sources of air pollution. So, an advanced regulation such as 91/441/EEC will be needed to cope with air pollution from motor cars (Table 9.3).

Table 9.3 Effects of Regulation Plans on Emission Factor for Motor Car (Petrol)

Vehicle type		Emission factor (g/unit)			
Vehicle type of census	Pollutant	Present	New regulated value (91/441/EEC)	Rate	Remarks
Motor car	H C C O NOx SOx	1.80 10.36 1.97 0.004	0.74 5.06 1.64 0.004	0.41 0.49 0.83 1.00	Oxydation catalytic converter

About 60% of the motor cars in the Kelang Valley Region, are produced domestically, mainly in the class of 1300-1500 cc. The new Proton model [ISWARA] has been developed to meet the ECE regulation. They are designed so that catalytic converters or other control equipment can be installed easily. Therefore it is technically possible to equip control devices in domestically sold vehicles.

3) Controlling the Use of Very Old Vehicles (Promotion of Use of Low Pollution Vehicles)

There is a strong need to replace old and overused vehicles with low polluting new ones equipped with advanced combustion control systems. As most air pollution in Kelang Valley Region results from CO, PM and HC, the first task will be the modernization of old vehicles, typically taxis and buses, by converting them to those equipped with new engine systems. It is recommended that the Ministry of Transport and commercial transport sectors carry out such a study on trucks, buses, and taxis.

The following factors should be considered in the conversion of high polluting commercial vehicles to less polluting ones:

a) Diesel taxis should be replaced early by petrol vehicles to reduce PM and NOx emissions.

b) Vehicles which cannot pass emission standard tests, should be banned from public roads.

Any diesel vehicle whose engine capacity is less than 1600 cc should not be permitted for registration. Probably 20% reduction of PM emission in KVR can be expected by implementation of these countermeasures.

4) Fuel Control

(a) Promotion of Use of Unleaded Petrol

It is estimated that around 40 - 50% of petrol sold in KVR is unleaded petrol. Leaded petrol contains 0.15 mg of tetra ethyl lead per liter of Petrol. Leaded petrol increases emissions of PM and harmful substances and also poisonous to oxidation and three way catalysts. It is recommended that leaded petrol be banned as soon as possible.

(b) Supply of Low Sulphur Fuel

Malaysian diesel oil contains 0.323% sulphur by weight according to our fuel analysis. Its reduction is the general trend in the world. Diesel oil with 0.2% sulphur by weight is proposed for use in residential areas in the EC. For KVR, the same percentage proposed by EC is recommendable from the view of SOx and PM reduction.

(c) Supply of Oxygenated Petrol

Methanol, MTBE, ethanol, ETBE, etc. are among the compounds containing oxygen that can be added to petrol. Carbon monoxide generation decreases with increasing oxygen concentrations. The use of oxygenated petrol could be a good measure for reducing carbon monoxide in the environment until catalytic converters can be installed in all individual motor vehicles.

(3) Organization/Institution

1) Vehicle Certification System

The vehicle certification system should be composed of items such as problem research, study of technical issues, establishment of emission allowance, drafting of new standards, modification of safety standards, test for type approval, and tests of production samples.

2) Inspection and Maintenance System

All vehicles private, commercial and official use, should adhere to this system. The vehicle which passes emission tests receives a certificate issued by the government and has its registration renewed.

3) Installation and Operation of Chassis Dynamometers

A chassis dynamometer is necessary to keep surveillance of whether exhaust gas regulations are being observed and to set the actual emission factors for motor vehicles running in KVR.

(4) Alternative Energy

The number of registered taxis in the Region are increasing yearly (8,500 in 1988, and 12,000 in 1992), with diesel and old cars being the most dominant. Their increase will have a great impact on the air quality in KVR.

In Japan, conversion of taxis to LPG-fuelled vehicles in large cities has contributed to the reduction of CO, PM and HC emissions.

Table 9.4 gives estimates of emission reduction through the use of CNG by Taxis.

Table 9.4 Emission Factor Changes via Introduction of CNG Taxi

Car Type	Engine Type	Pollu-tants	Existing fuel use engine	CNG fuel use engine	Reduction rate(%)
Taxi	Petrol	CO	2.6	0.14	95
		HC	15.4	7.4	52
		NOx	1.8	0.23	87
		SOx	0.0	0.0	100

Note: Average travel speed⇨20km/h

(5) Traffic Volume Control

1) Klang Valley Transportation Plans

The Klang Valley Transportation Study (1987 JICA) proposed the following master plan for 2005, including regional development pattern and connection of routes.

(a) Public transportation plan

a) Mass transit railway system

b) Bus transport improvement plan

(b) Road network plan

a) Expressway

b) Primary distributor

c) District distributor

In our estimate of future traffic volume, this master plan was assumed to be completed by 2005.

2) Restriction of Motor Cars in City Centre

Heavy traffic congestion on the trunk roads in Kuala Lumpur results in severe damage to the economy and air quality, and should be solved in the future. So, restriction of the number of motor cars entering the congested areas in KL is required. Hourly and seasonal restrictions should be handled in general.

3) Rationalization of Goods Transport

While discussing pollution control from motor vehicles, we cannot overlook trucks. They emit not only NOx and black smoke but noise. Since more vivid fluidity of down-sized goods is anticipated in the future arising from the diversifications and sophistication of consumers demands, it is important to plan appropriate countermeasures against them from the view of air pollution protection.

To promote efficient operation of trucks, it is necessary to suppress the truck traffic volume. This is expected to be accomplished from both the merits of air pollution control and economic advantage.

4) Introduction of Flextime

Severely congested rush hours in the downtown last only for one to two hours in the morning and around three hours in the evening and main occupants (roughly 80%) are commuters to offices and schools. Therefore, shift of office or school hours or introduction of flextime system would be effective to reduce traffic at the rush hours.

9.3 Effect of Source Control Measures

(1) Evaluated Control Measures

The control measures described below were set up in order that the whole KVR may satisfy the air quality targets for SO_2, NO_2 and CO in the year 2005. Control Measures applied to factories and motor vehicles are shown in Tables 9.5 and 9.6 respectively.

Table 9.5 Control Measures Applied to Factories for Examining Quantitative Evaluation

Measures	SOx	NOx	Dust
Power Stations			
(1) Fuel conversion (natural gas)	o		o
(2) Improvement of electr precip.			o
General Factories			
(1) Fuel conversion - natural gas	o		o
- LFO	o		o
(2) Collectors - Multi-cyclone			o
- EP			o
(3) Combustion management	o	o	o
(4) Energy saving	o	o	o

Table 9.6 Control Measures Applied to Motor Vehicles for Examining Quantitative Evaluation

Measures	HC	CO	NOx	SOx	PM
(1) Exhaust gas regulation against new petrol vehicles	o	o	o		o
(2) Measures for transportation					
Introduction of mass transportation systems	o	o	o	o	o
Rehabilitation of existing railway	o	o	o	o	o
Improvement of bus system	o	o	o	o	o
Improvement of road network	o	o	o	o	o

(2) Reduction Amount of Air Pollution Load

The air pollution loads after implementation of the control measures are summarized together with the present ones and future ones without the measures in Table 9.7. The reduction ratio is 48 % for SOx, 26 % for NOx, 51 % for CO, 37 % for PM and 38 % for HC.

Table 9.7 Summary for Air Pollution Load from All sources (1992 & 2005)

(unit: ton/year)

Pollutant	Pollution Source	Present (1992)	Future (2005) Without Measures	Future (2005) With Measures
SOx	Factories			
	Power stations	19,522	30,041	12,759 (58)
	General factories	11,047	11,283	5,345 (53)
	Sub-total	30,569	41,324	18,104 (56)
	Motor Vehicles	3,117	7,079	5,755 (19)
	Airplanes	416	360	360 (0)
	Ships	1,552	2,836	2,836 (0)
	Households	0	0	0 (-)
	Total	35,654	51,599	27,055 (48)
NOx	Factories			
	Power stations	12,792	26,054	22,758 (13)
	General factories	2,979	4,415	4,364 (1)
	Sub-total	15,571	30,469	27,122 (11)
	Motor Vehicles	36,212	82,199	55,728 (32)
	Airplanes	1,320	574	574 (0)
	Ships	989	1,840	1,840 (0)
	Households	162	226	226 (0)
	Total	54,454	115,308	85,490 (26)
PM	Factories			
	Power stations	1,969	2,441	828 (66)
	General factories	7,034	8,163	5,451 (33)
	Sub-total	9,003	10,604	6,279 (41)
	Motor Vehicles	3,243	7,359	4,775 (35)
	Airplanes	115	123	123 (0)
	Ships	200	365	365 (0)
	Households	44	62	62 (0)
	Total	12,605	18,513	11,604 (37)
CO	Motor Vehicles	290,407	659,223	321,430 (51)
HC	Motor Vehicles	73,445	166,720	103,973 (38)

Figures in parentheses are amount of reduction in percentage

(3) Prediction of Pollutant Concentration after Implementation of Control Measures

The results from simulation with the dispersion simulation model of the concentrations at the fixed stations and the maximum concentration point after implementation of control measures are shown in Table 9.8 and Figs. 9.1 - 9.3. The result shows that the predicted concentrations of NO_2 and CO at all stations and mesh points are all below the air quality target value. The, concentration of SO_2 at all stations is below the target value, but that at mesh points in some area was over the target value.

Comparisons in pollutant concentrations at the fixed stations and the maximum concentration point for 1992, 2005 (without control measures) and 2005 (with control measures) are shown in Figs. 9.4 through 9.6.

If no control measures are taken, SO_2 concentration will increase in the future according to increase of fuel consumption by factories and traffic volume, and the concentrations at some areas will exceed the target.

However, if proposed control measures are taken, the concentrations at monitoring stations will remain at the present level, and the maximum concentration will decrease to a lower level.

If no measures are taken, NO_2 concentration in 2005 will increase as well. However, if control measure are taken, the concentration will remain at the current level or below, and the target value will be satisfied the at all points.

CO concentration will also increase in future if no control measures are taken. However, if control measures are taken, the concentration will remain at the current level or below, and the target value will be satisfied at all points.

Table 9.8 Predicted Concentration When Control Measure are Implemented

Items / Stations	SO_2 (ppb)	NOx (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 Mesh Index	29.0 (76,15)	137.2 (58,40)	28.6 (58,40)	2.84 (59,38)
Target Value	20	-	37	4

X : C max. Point Unit : ppb

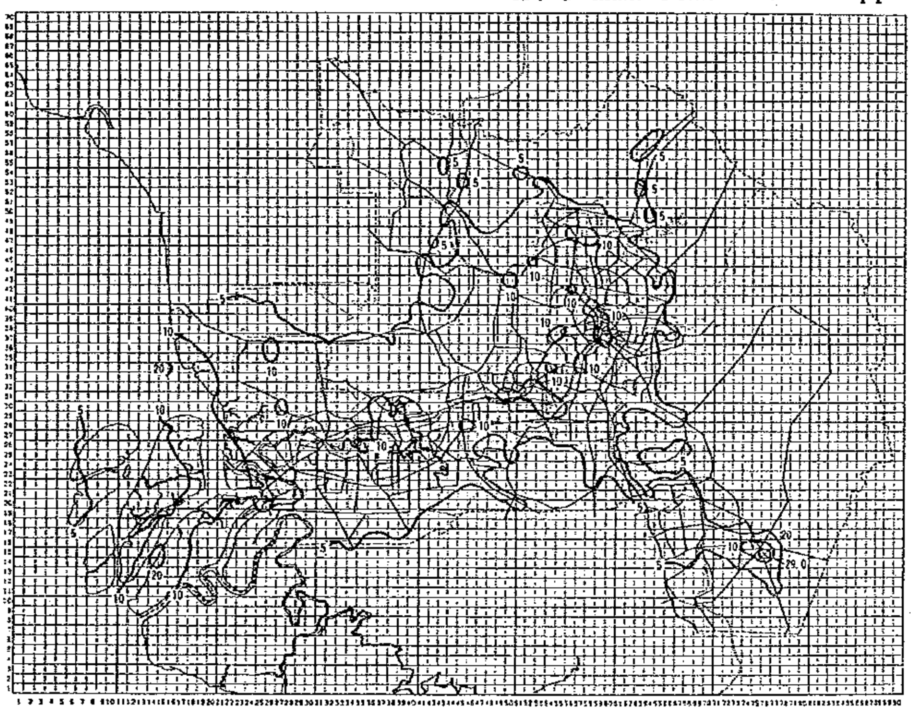


Fig. 9.1 Average Concentration Isopleths for SO_2 (2005) (with control measures)

X : C max. Point　　Unit : ppb

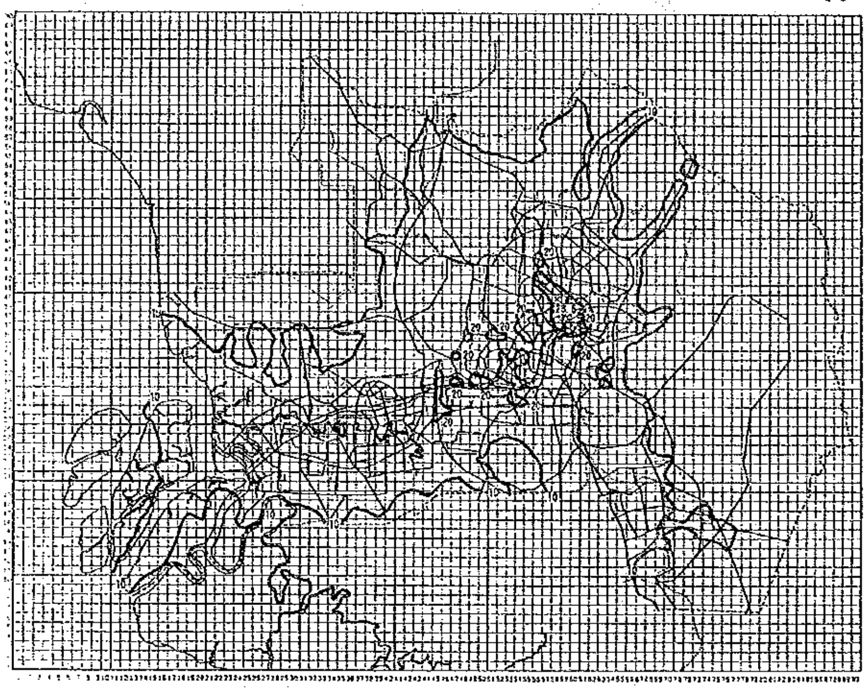


Fig. 9.2　　Average Concentration Isopleths for NO_2 (2005) (with control measures)

X : C max. Point　　Unit : ppm

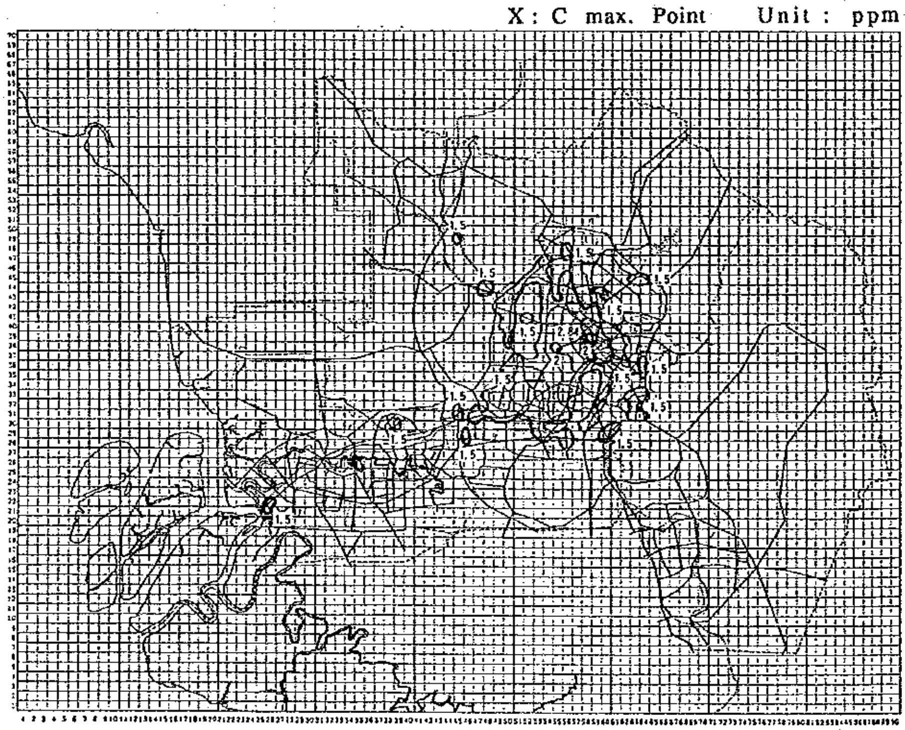


Fig. 9.3　　Average Concentration Isopleths for CO (2005) (with control measures)

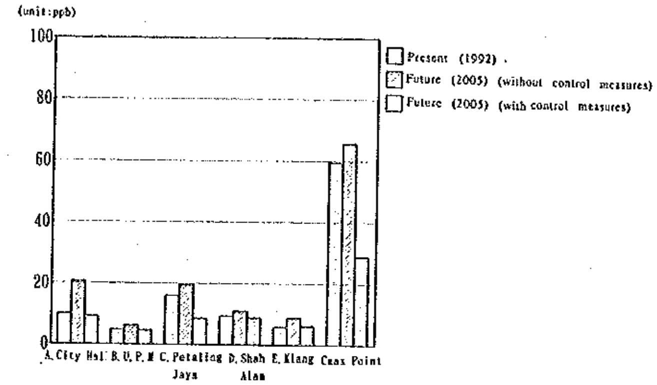


Fig. 9.4 Change of SO_2 Concentration from 1992 to 2005

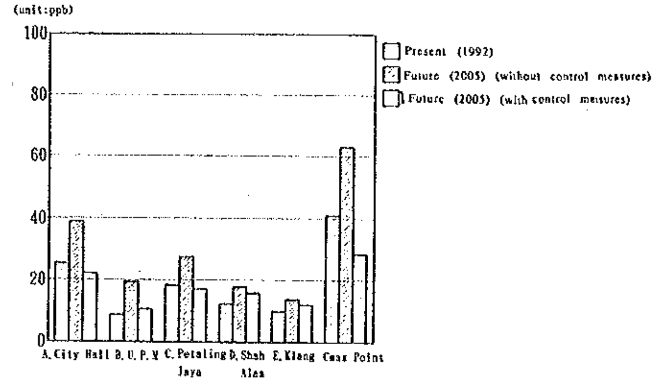


Fig. 9.5 Change of NO_2 Concentration from 1992 to 2005

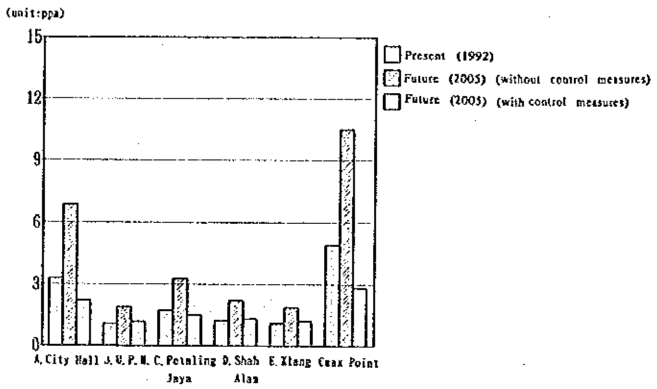


Fig. 9.6 Change of CO Concentration from 1992 to 2005

9.4 Evaluation of Control Measures

(1) NO_2 and CO

The major pollution source of NO_2 and CO are motor vehicles in KVR. Control measures against motor vehicles are classified into two categories as follows.

① Exhaust gas regulation
② Measures for traffic and transportation

In order to evaluate the effect of these two measures on NO_2 and CO concentrations, the following two case studies were made.

① Case 1 (Measures for transportation only)
Traffic volume and road network predicted for 2,005 were used. Meanwhile, the emission factor is identical to the current one.

② Case 2 (Exhaust gas regulation only)
The vehicle emission factor predicted for 2,005 with the effect of the exhaust gas regulation was used. Meanwhile, traffic volume is assumed to be 2.27 times the current volume over the current road network.

The results are summarized in Table 9.9. In Case 1, CO concentration at the maximum concentration point will exceed the air quality target. In Case 2, CO concentrations at City Hall and at the maximum concentration points will exceed the target. For NO_2, the concentration at the maximum concentration point will exceed the target. These case studies show that if the target values for CO and NO_2 are to be satisfied in the whole Kelang Valley Region, both measures, namely, the exhaust gas regulation and the measures for traffic and transportation, will have to be implemented simultaneously.

Table 9.9 Simulated Concentration for Cases 1 and 2 (2005)

Control Measure Case	Case 1		Case 2	
Items / Stations	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 Mesh Index	32.1 (57,34)	4.6 (59,38)	53.2 (54,33)	6.3 (59,37)

(2) SO_2

For SO_2, there are two sites with its concentration exceeding the target value after control measures are taken. They are very close or in the territory of PS-A and the palm factory in Hulu Langat. If these have to strictly satisfy the target value it will be better that either, one of No. 3 or No. 4 boiler of PS-A be converted from coal to natural gas, and the palm factory install higher stacks. On the other hand, there are other places with SO_2 concentration exceeding the target value. They are located in the Port Klang district. Should these places also satisfy the target value then, it will be better for ships to use low-sulphur content oil.

9.5 Open Burning

Solid waste in dump causes fire under the sunshine focused through curved glasses or else, if the dump area is not well managed. Or scavengers may fire them for easy recovery of profitable materials. Open burning is allegedly causing nuisance and air pollution in KVR.

It emits such air pollutants as metal and halogen compounds, and others in addition to SOx, NOx and particles. Metal compounds in the dump evaporate after possible chemical reactions in the intense heat of open burning. Among the metals, concerned as hazardous are arsenic, cadmium, chromium, copper, lead, mercury, zinc, etc. They can be found in dumped chemicals, metals, batteries, fluorescent tubes, pigments, coated paint, and so on. Halogen as chlorine and fluorine compounds found in plastic sheets and resins emits into air by burning, is hazardous to the environment and causes stimulative odour. Mal-odour is also from biodegradation of sulphur and organic compounds in the dump.

Amounts and concentrations of these emissions are interrelated to volumes and compositions of the burning waste, durations and intensities of the burning, wind velocities and others. These data can be measured. However, the data is correct only for the specific open burning sites and periods. Possibility of the data generalization to simulate their contributions to wider air pollution is questionable. Restriction of open burnings and provision of alternatives for them seem currently more rational from the practical standpoint.

To restrict open burning, open dump areas must be managed for earth covering, water spraying, prohibition of trespassers and others, and also useful materials should not be abandoned there.

As an alternative method to dumping combustible waste, incinerators are commonly employed in municipalities. It is better to avoid from burning in municipal incinerators such materials as those emitting environmentally harmful substances and damaging incinerator construction materials. And also it is better to reduce waste amount in order to save investment and operation costs of the incinerators.

The waste collection system should be arranged to collect combustible waste separately from harmful, incombustible and/or recyclable ones. The harmful waste has to be disposed under control methods. Nevertheless, it is unavoidable to have contaminations of harmful waste in the incinerators. They are designed to tolerate these contaminations. As for air pollution, there is usually a train of apparatuses attached to a municipal incinerator to control. Following are examples of the control measures.

Ammonia or urea spray:	to decompose NOx
Lime spray:	to absorb SOx and halogen
ESP or bag filter:	to remove particles of metal and lime compounds, ash & others

CHAPTER 10 AIR QUALITY AND POLLUTION SOURCE MONITORING

10.1 Outline of the Monitoring System

10.1.1 Objectives of the System

In the Kelang Valley Region, there is an apprehension that industrial and economic development may bring about serious and complicated air pollution problems caused by urbanization, the increase in energy consumption, and rapid increase in traffic volume. Therefore, an air pollution monitoring system should be established as soon as possible, before the air quality deteriorates.

The major objective of the air pollution monitoring system is to gather data on air quality and pollutant emission from stationary and mobile souces for the use by regulatory authorities. These data will be effective in accomplishing the following objectives:

1. To confirm the state of compliance with the values set according to environmental recommendation guidelines (i.e., the environmental conservation target.)
2. To monitor the effects of the air pollution control program.
3. To promote countermeasures against urgent air pollution problems.
4. To serve as basic data for use in planning pollution control programs and environmental management programs.
5. To serve as basic data for environmental impact assessment.
6. To serve as basic data for research and investigation that elucidates the mechanism of complex air pollution.
7. To serve as basic data for formulation or examination of traffic policies.

10.1.2 Central Monitoring System

The main functions of the system regarding air pollution monitoring are as follows.

1. To provide an understanding of the condition of air quality and pollution sources so as to enable authorities to cope with an emergency that threatens the human health.
2. To exchange data monitored in KVR with the adjacent areas and meteorology stations in order to understand the condition of air pollution over a wider region.

3. To inform local residents of the current air quality by means of indicators placed along the streets.
4. To observe the operating condition of the monitoring instruments and deal with any breakdowns.
5. To assure, announce, and provide upon request information based on the collected data that is being monitored.

The monitoring data on air quality and pollution sources should be collected at a Central Monitoring Center by means of a telemetric system (Fig. 10.1). Therefore, the establishment of an on-line real time system is needed.

To maintain and manage the monitoring stations efficiently and rationally, it is necessary to operate all monitoring instruments with stable accuracy for a long period and ensure the continued reliability of monitoring data. To accomplish this purpose, the following items are important.

1) Development and Assurance of the Availability of Engineers

The development and mobilization of engineers is urgent and it is the key to the establishment of the monitoring system at an early stage. It is vital to establish a qualification program for the engineers, and to make secure their position and mobility in order to develop and guarantee the availability of the engineers. Moreover, the establishment of a Training Center will be necessary in order to train these engineers using actual monitoring instruments.

2) Education and Training

The operation of any kind of monitoring instrument with stable accuracy for a long period is necessary to maintain the reliability of the monitoring system. The quality of the results, however, depend on the efficiency and maintenance of the monitoring instruments. High technology and know-how are required because of the recent improvements in monitoring methods and instruments. Acquisition of the necessary technology and the accumulation of data are needed to maintain accuracy of the monitoring data.

It is an important role for the Training Center to collect information on the latest technology, educate and train the engineers.

3) Maintenance

Besides establishment of above operation, maintenance and management systems, it will be necessary to invite manufacturers of monitoring equipment and materials to open their branches in Malaysia to do such repair services as maintenance, exchange of parts and prompt supply of expendable supplies regularily and in emergency.

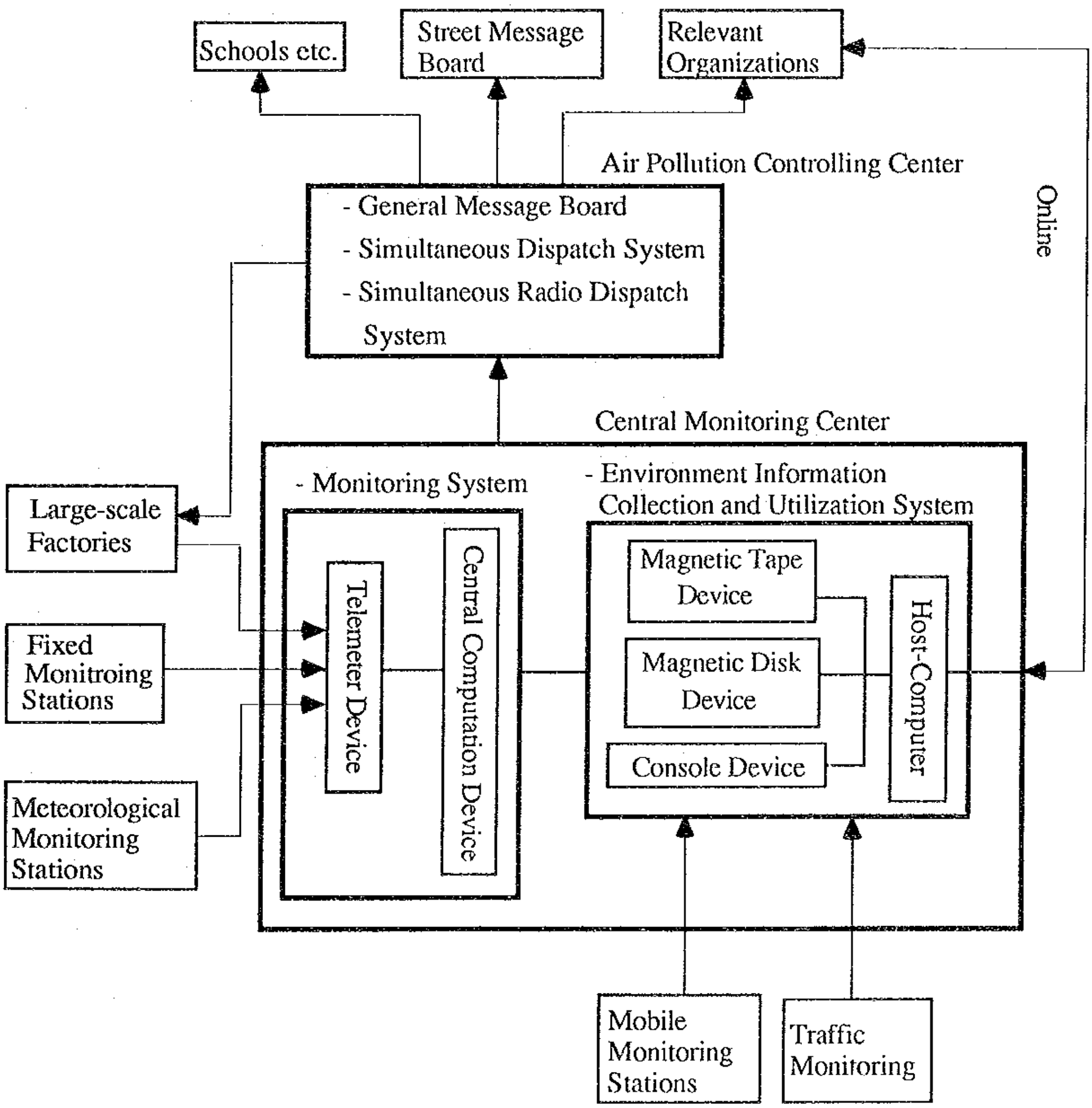


Fig.10.1 Flowchart of the Central Monitoring System for Air Pollution

10.2 Air Quality Monitoring System

The rationale for setting up of monitoring stations is to estimate the spatial distribution of pollutant concentrations in the Region as precisely as possible. The number of monitoring stations needed is determined by referring to many areas which have wide variations in air pollution from the local emissions and weather conditions. As it is unrealistic to monitor air quality only by fixed stations, the use of mobile stations is expected as much as possible. The monitoring stations should be planned by taking into consideration the residential areas which are the main objective of protection and the land use pattern in the present and that expected in the future. The arrangement of the monitoring stations is shown in Fig. 10.2.

1. The five existing monitoring stations should be fixed to provide continuity of monitoring data because they are not affected by specific emission sources and have a tendency to show the average concentration in each area. City Hall, however, is the monitoring station for vehicle exhaust gas.
2. Three fixed monitoring stations will be established at the high SO_2 concentration points in the Federal highway belt area close to large residential areas. Industrialization is expected to continue in this belt area.

   Four mobile stations will be established at high concentration points in areas that in the future is expected to be residential areas.
3. Three fixed monitoring stations will be established along highways with heavy traffic and a high concentration of NO_2, and four mobile monitoring stations will be established at points where data collection will be valuable as support for the functions of these three stations.
4. In the area around the monitoring stations mentioned in 1.~3., twelve mobile stations will be established where large residential areas now exist or are expected to be built in the future.

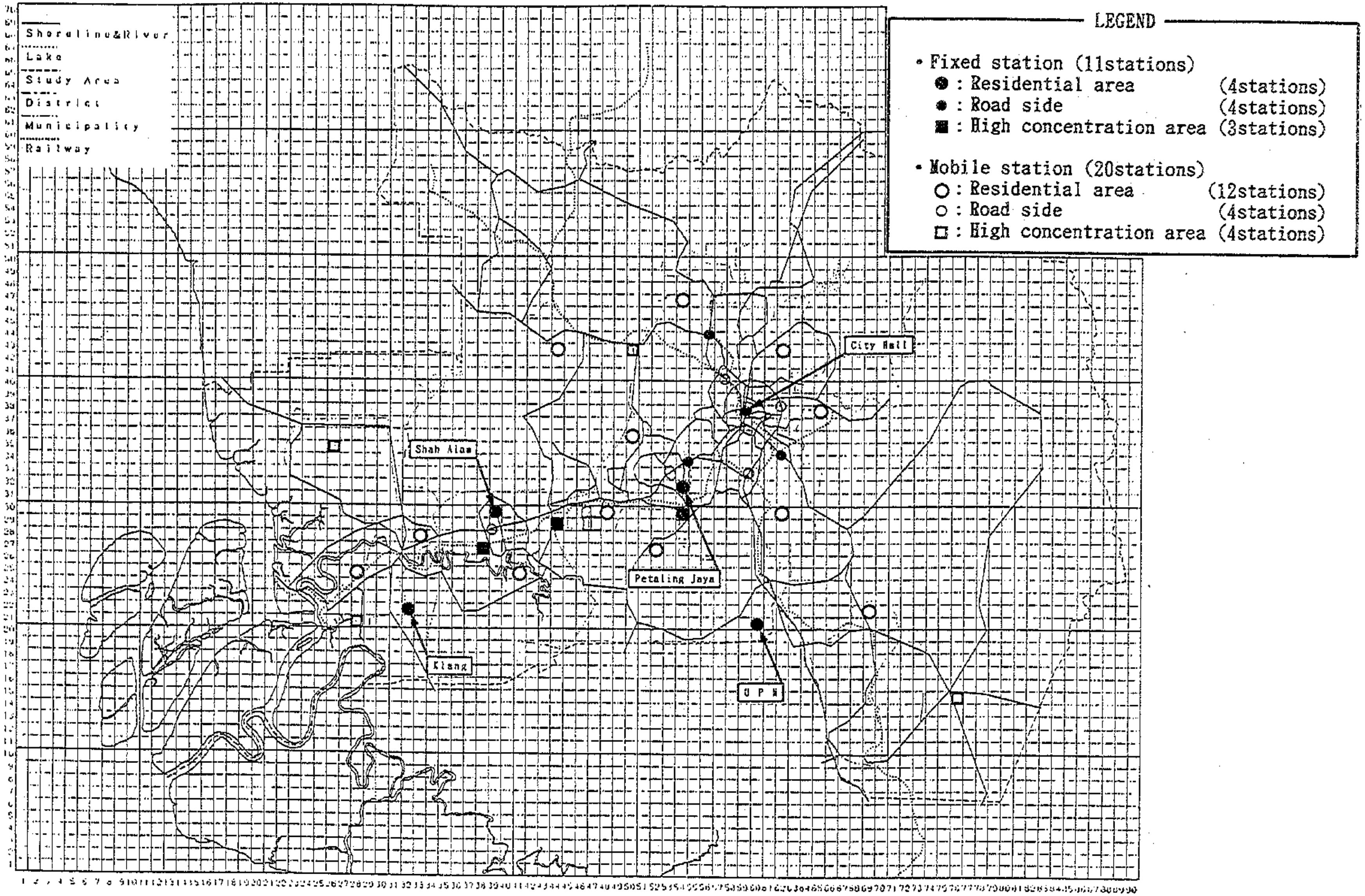


Fig. 10.2 Location Plan of Monitoring Stations

10.3 Pollution Source Monitoring System

10.3.1 Stationary Source Monitoring

(1) Procedures for Pollution Source Monitoring

The procedure monitoring pollution from stationary sources is shown in the flow diagram in Fig. 10.3. Various aspects of emissions from extra large-scale pollution sources can be monitored by the automatic monitoring systems from the Central Monitoring Center. The Central Monitoring Center can request factories to cooperate in controlling pollution during an emergency period when there is potential for producing high concentrations, and in the control of emission rate when weather conditions might favour high concentration. Other pollution sources are classified into two types according to an emission scale, and the frequency of on-site investigation (flue gas measurement) for them is to be established. Based on the results of investigation of emission rate, and the air quality monitoring data reviewed every three years, control measures are to be assessed and it will be required that changes of annual plans be made if pollution has not been reduced.

The area from KL to Federal Highway has in it a broad residential area as well as an industrial area, and these areas are envisioned to become larger as indicated in the land use plan. Therefore, the air quality monitoring and pollution source monitoring system should be given priority in this area, from the standpoint of human health and the living environment .

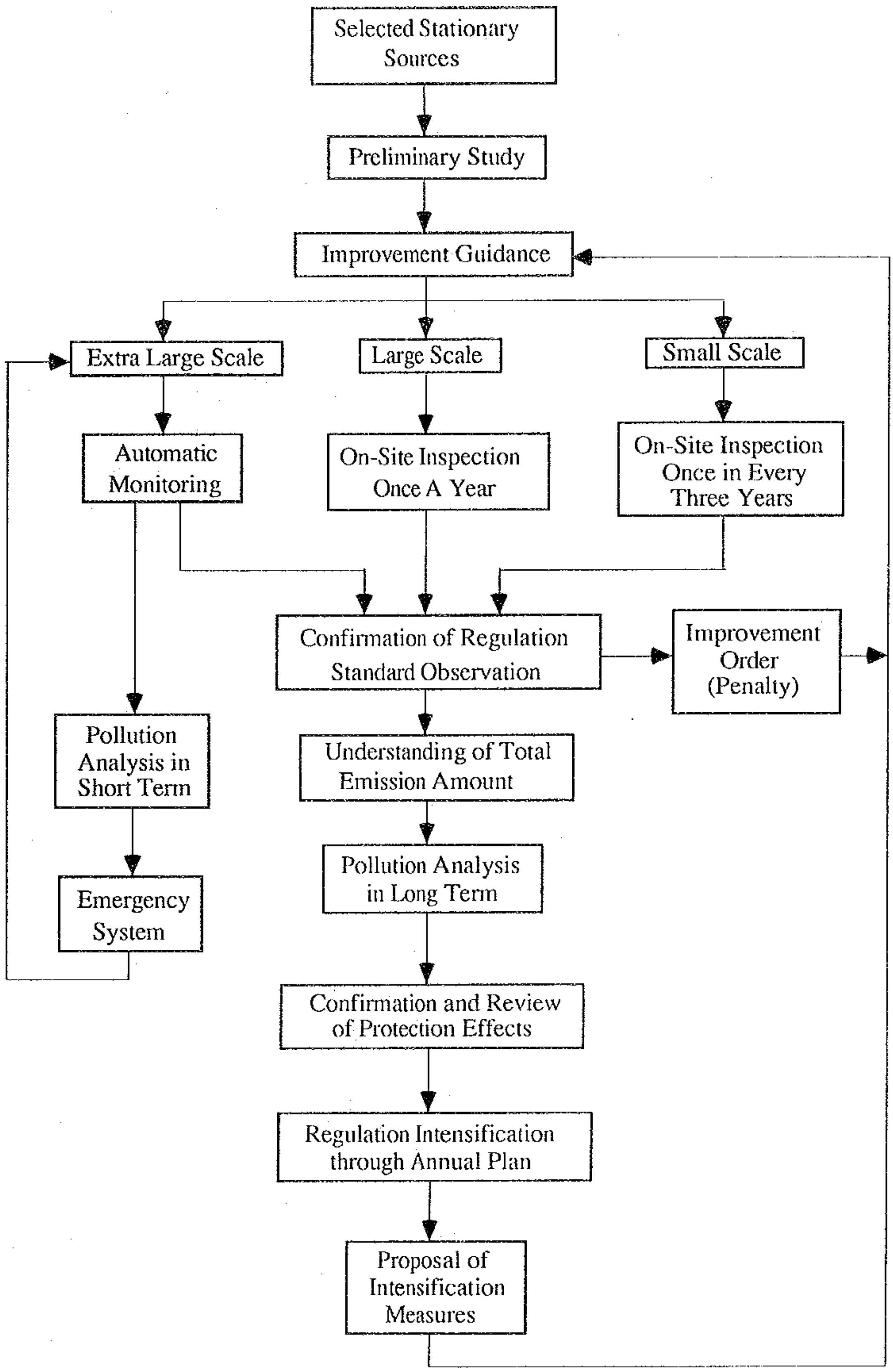


Fig. 10.3 Flow Diagram for Monitoring Pollution from Stationary Sources

(2) Pollution Source Monitoring

86 facilities from four types of industry, (food and kindred products, lumber and wood products, palm oil mill, and electricity supply), emit about 81%~91% of the total pollutant amount. Ten power plants are defined as extra large-scale pollution sources, and 76 facilities and other sources of high emission levels are defined as large-scale pollution sources.

Large-scale and small-scale pollution sources should be monitored by on-site investigation. It will be implemented once a year for large-scale, and once in every three years for small-scale pollution sources by patrol cars. The objectives of this patrol are not only on-site investigations but also the monitoring of harmful sources of smoke and soot. Furthermore, monitoring points for open burning are needed in the patrol course, and open burning should be banned.

10.3.2 Mobile Source Monitoring

(1) Mobile Source Monitoring

It is necessary to have sufficient data on exhaust gas from motor vehicles in order to investigate and design traffic policies. In order to do that, fundamental data such as the present traffic volume and driving patterns are necessary. Fifty monitoring points in this study are considered necessary for monitoring transportation networks, especially when considering the continuity of data needed.

(2) Review of Vehicle Emission Factor

The amount of pollutants in vehicle exhaust gas vary widely depending on various factors. They will also differ from the standard value depending on the driving practices that are determined by law, namely speed. Therefore, chassis dynamometer tests for various driving patterns are necessary to ascertain the exhaust gas amount accurately and measure the emission factor.

CHAPTER 11 GUIDELINES FOR THE AIR QUALITY MANAGEMENT FOR KELANG VALLEY REGION

11.1 Objectives of the Guidelines

The air pollution in KVR is serious. If no measures are taken, the situation will worsen. Enforcement of the measures against air pollution is very difficult because air pollution is mainly caused by socio-economic activity and to mitigate air pollution means to restrain the daily activities. Therefore, it is important to enforce the measures systematically with the agreement and assistance of the people. This guidelines is therefore prepared to be implemented in the area taking into consideration the above facts in order to maintain high ambient air quality for the present moment and the future.

11.2 Application Area of the Guidelines

The application area of the guideline covers Federal Territory of Kuala Lumpur and four districts: Gombak, Hulu Langat, Petaling and Klang. Their location is shown in Fig. 11.1.

11.3 Target Value of Ambient Air Quality

Usually ambient air quality over a large area is assessed by the annual mean value (AMV). The long-term air pollution value such as AMV is a valuable index to check the harmful effects on human health and other living organisms. It is therefore reasonable to control air pollution sources with reference to AMV. The air quality target values for SO_2 and CO were derived from the Malaysian air quality guidelines. The target value for NO_2 was derived from the WHO's guideline. The target values are shown in Table 11.1.

Table 11.1 Target Value of Ambient Air Quality

	SO_2	NO_2	CO
Annual mean value	0.02 ppm (20 ppb)	0.037 ppm (37 ppb)	4 ppm

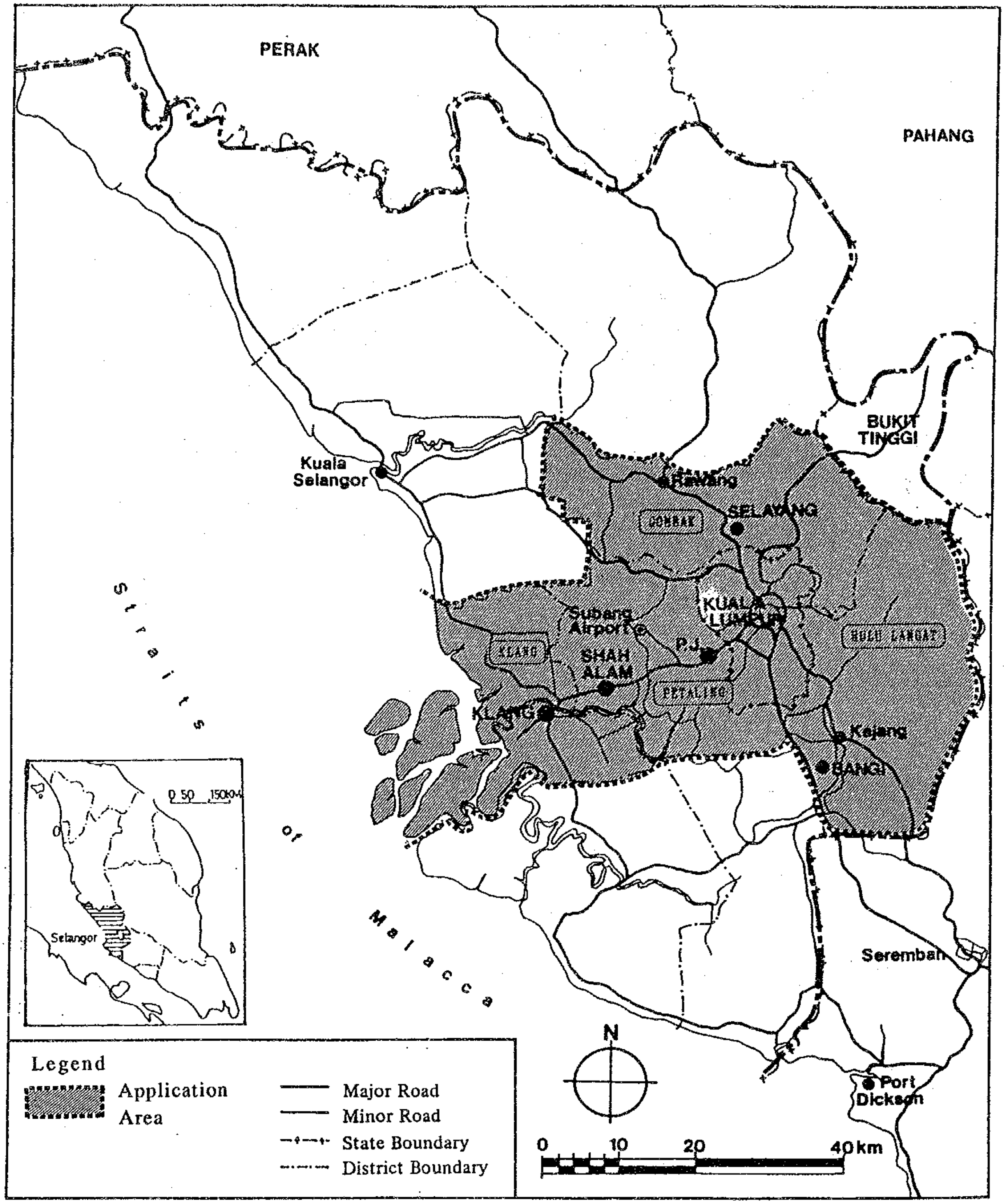


Fig. 11.1 Location Map of Application Area for the Guidelines

11.4 Target Year of the Guidelines

The target year of the guidelines is set for 2005.

11.5 Air Pollution Condition

11.5.1 Air Pollution Load

(1) Present (1992)

The air pollution loads from various sources in KVR are shown in Fig. 11.2. We note that motor vehicles are the main source of HC, CO and NOx, whose contribution to pollutant emission is nearly 100% for CO, 100% of HC and 67% for NOx.

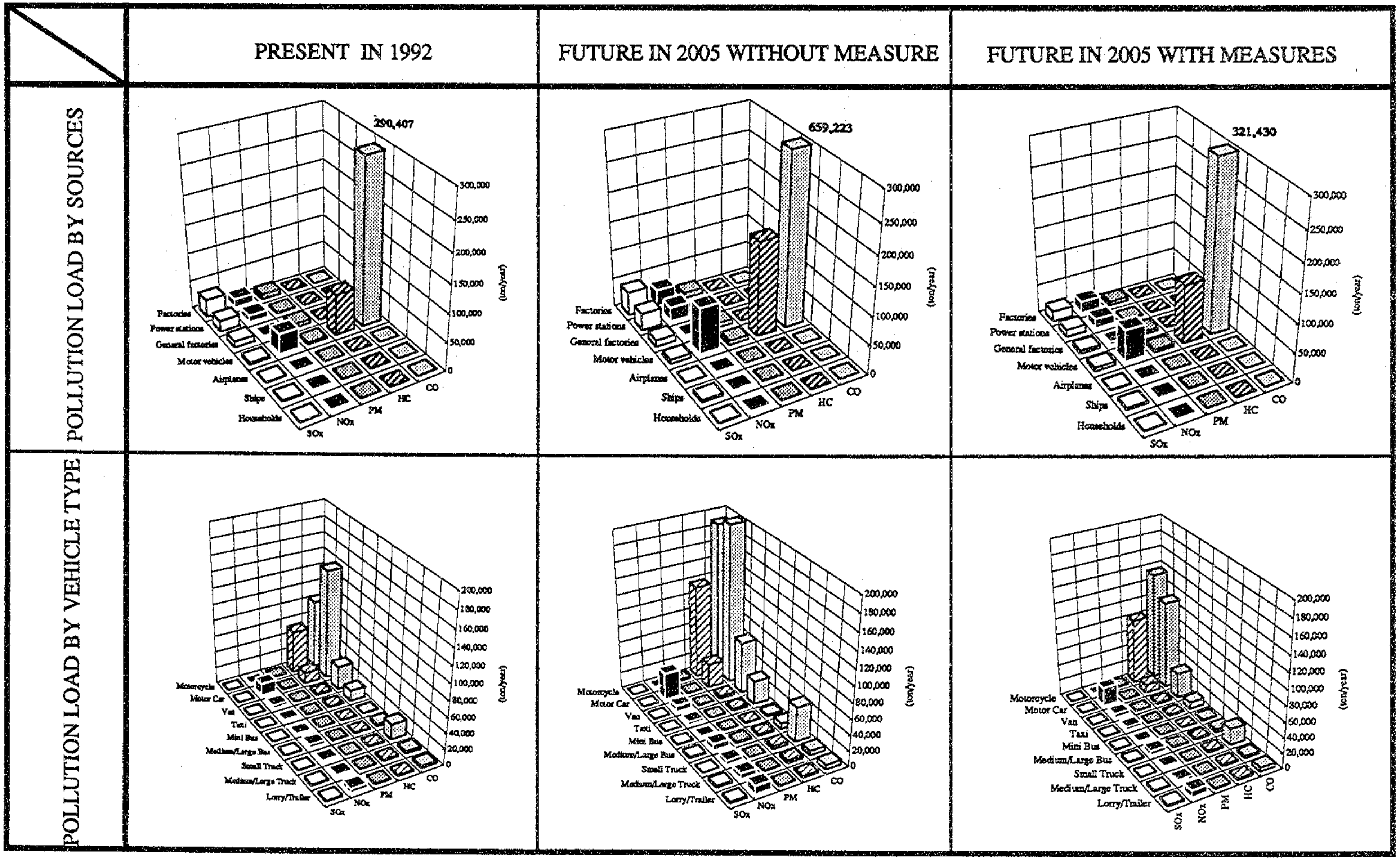
On the other hand factories are the main source of SOx and PM contributing about 88% of SOx and 65% of PM respectively. Among the factories, thermal power plants are the main source of air pollution except for PM. To investigate the relative contribution from the various types of vehicles, their emission rate is presented in the lower part of Fig. 11.2. The most important feature is that motorcycles generate a large portion of CO (29%) and HC (70%). Most of CO (47%) and NOx (43%) are emitted by motor cars.

(2) Future (2005)

There are two simulation cases on future air quality condition; "2005 without control measures" and "2005 with control measures". In the first case conditions in 2005 were simulated based on the assumption that the present transportation system and road network will continue to remain the same as present, however with an increase in traffic volume. In the second case the assumption that the proposed transportation master plan proposed in "JICA, 1987: Klang Valley Transportation Study" will be completed by 2005, and some control measures against mobile sources and stationary sources recommended in the Study would have been enforced. The contents of the master plan include introduction of modern public transportation systems such as Light Rapid Train (LRT) System and Mass Rapid Transit (MRT) Railway System, construction of many new roads and improvement of existing roads.

The increase of pollution load from 1992 to 2005 without measures is 1.45, 2.12, 1.47, 2.27 and 2.27 times for SOx NOx, PM, HC, and CO respectively. However, with measures which the guidelines recommends, 26 to 51% (48% for SOx, 26% NOx, 37% for PM, 38% for HC and 51% for CO) of pollution load in 2005 without measures could be reduced.

Fig. 11.2 Pollution Load by Sources and Vehicle Type



11.5.2 Simulated Pollutant Concentration

(1) Present in 1992

Figs. 11.3(1) through (3) show the present ambient air quality for SO_2, NO_2 and CO in KVR from simulation using the whole year's air pollution and meteorology data at fixed stations. For SO_2, areas exceeding the target value are distributed in industrial areas such as Petaling Jaya, Shah Alam and Klang. There is a maximum concentration of SO_2 in Petaling Jaya with a concentration of 0.06 ppm higher than the target value (0.02 ppm). NO_2 concentration over KVR satisfied the target value except a small area in Petaling Jaya. For CO, an area exceeding the target value appears in the center of KL city, which is caused mainly by large buses and other vehicles.

(2) Ambient air quality in future (2005) without control measures

Figs. 11.4(1) through (3) show the future air quality in 2005 without control measures. The areas where the simulated concentration do not satisfy the target values for SO_2, NO_2 and CO are expected to increase. The air quality in the area ranging from KL to PJ, especially inside of KL is expected to worsen.

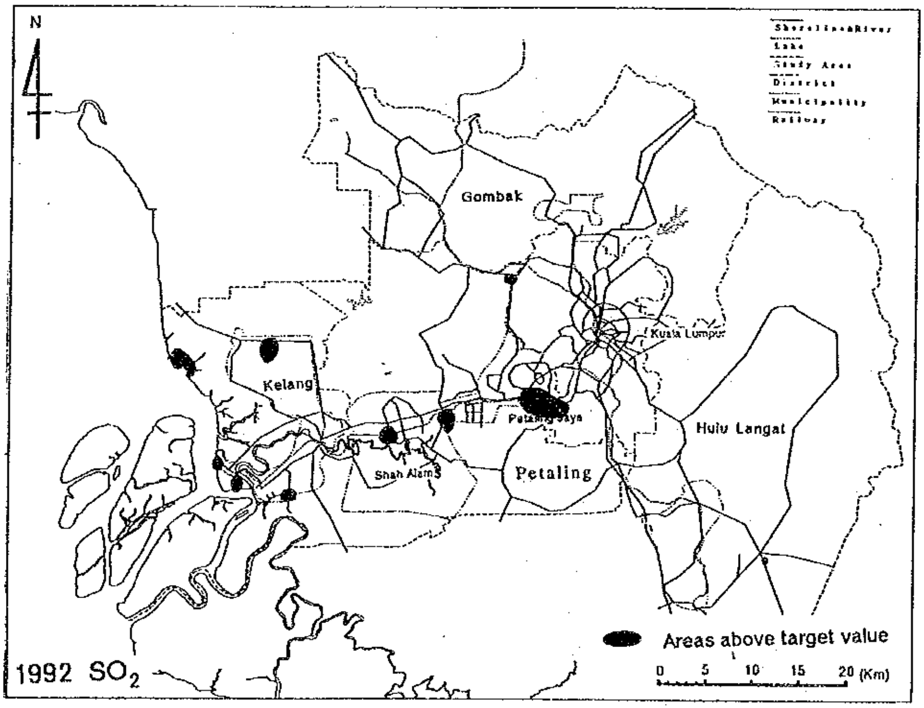


Fig. 11.3 (1) Simulated SO_2 Concentration in 1992

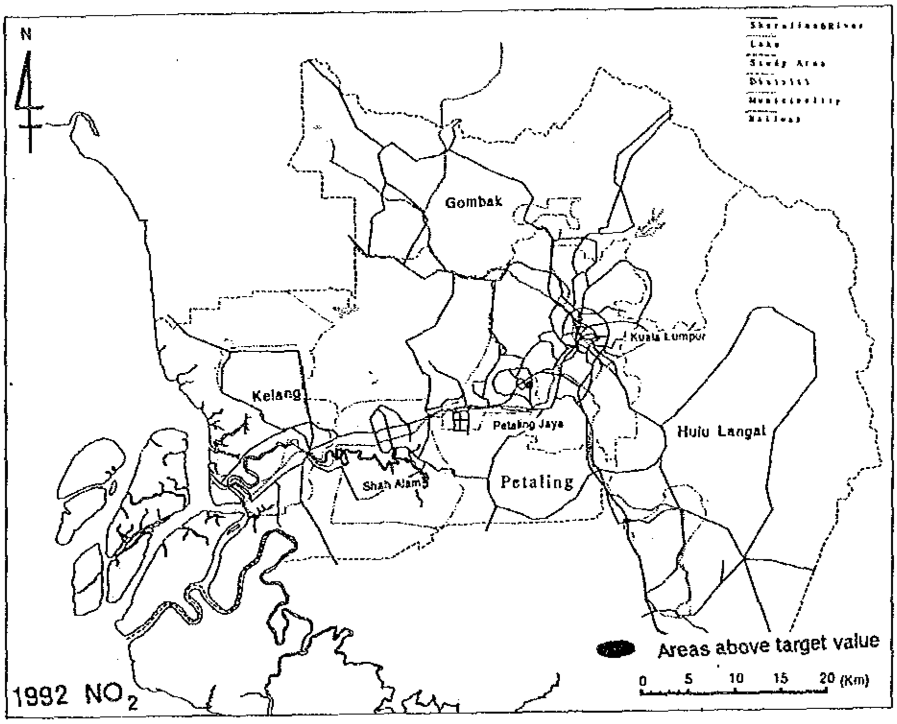


Fig. 11.3 (2) Simulated NO_2 Concentration in 1992

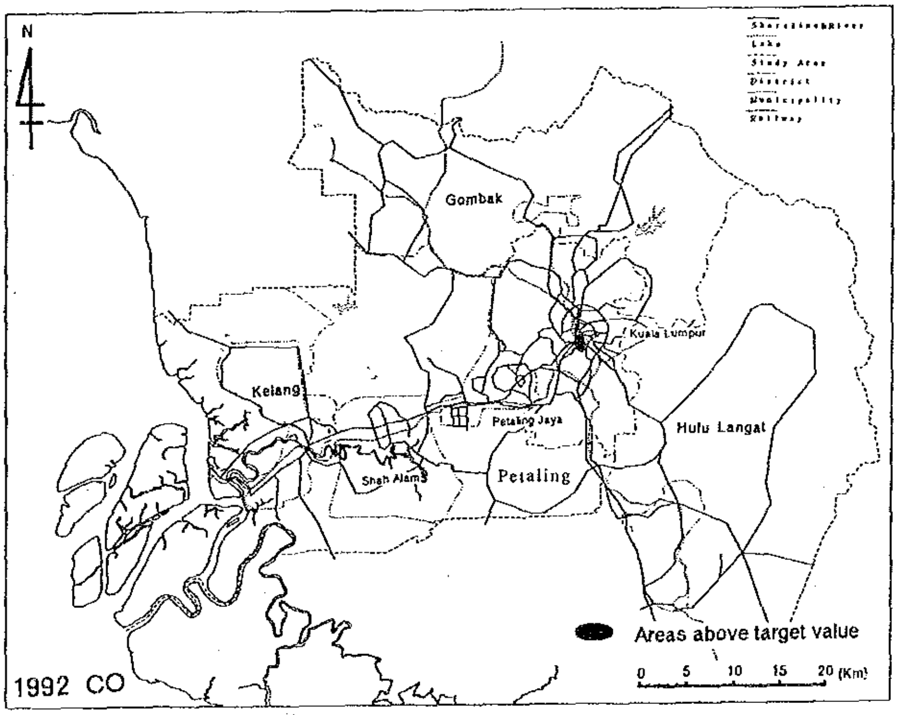


Fig. 11.3 (3) Simulated CO Concentration in 1992

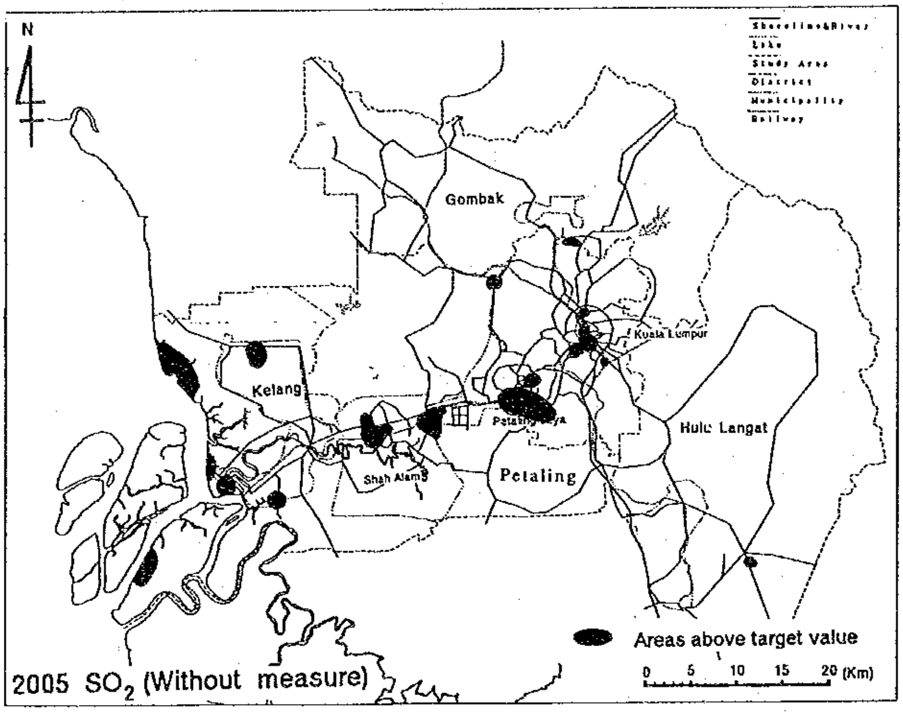


Fig. 11.4 (1) Simulated SO_2 Concentration in 2005 (without measures)

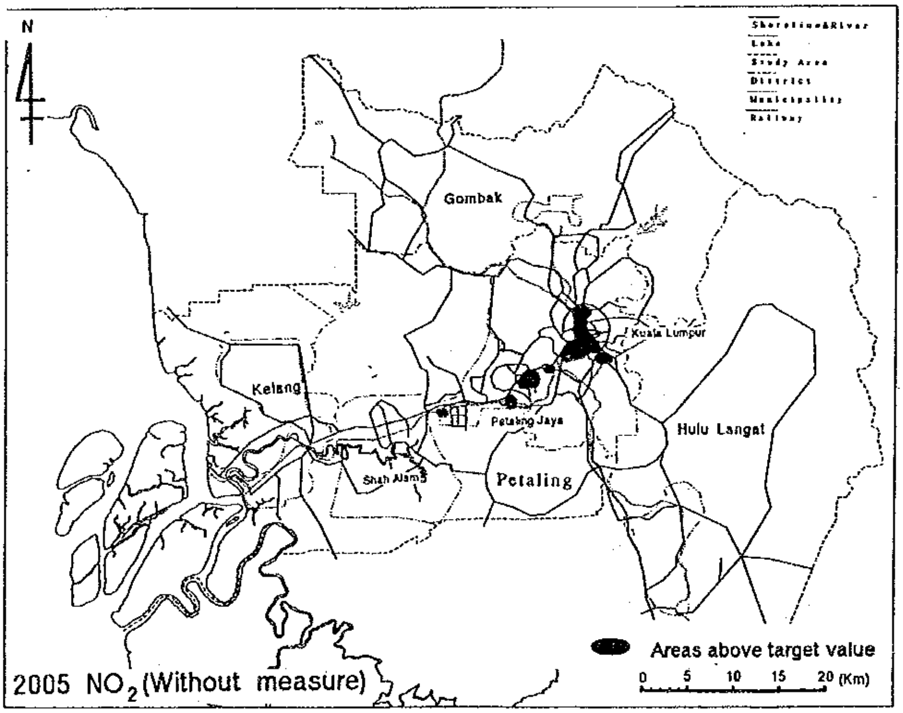


Fig. 11.4 (2) Simulated NO_2 Concentration in 2005 (without measures)

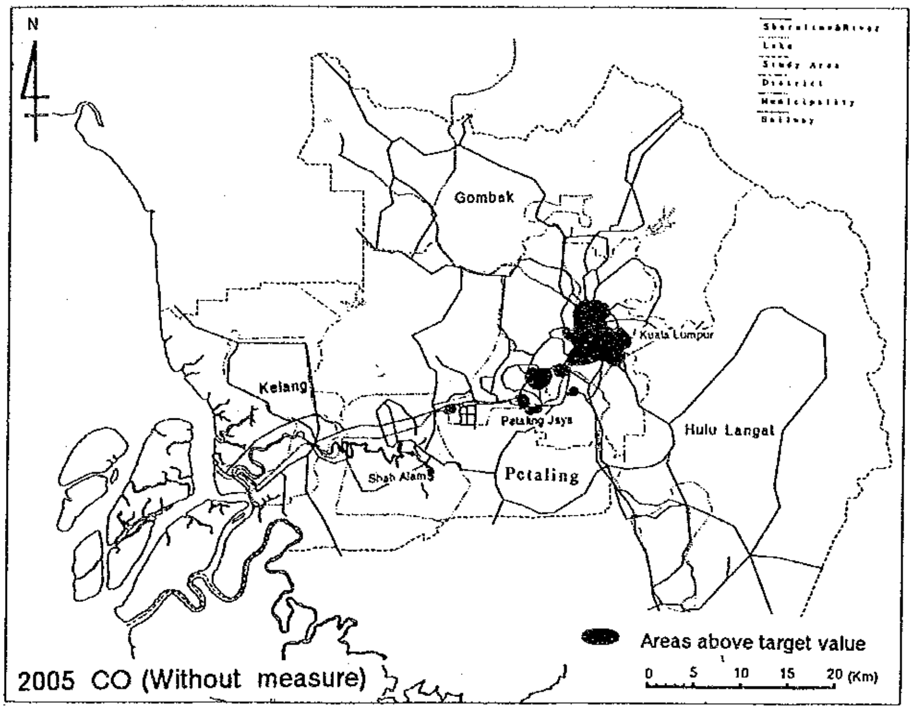


Fig. 11.4 (3) Simulated CO Concentration in 2005 (without measures)

11.6 Control Measures against Air Pollution Sources

11.6.1 Stationary Sources

(1) Thermal Power Stations

According to our estimate in 1992, the contribution to the total emission by the two (2) thermal power stations in the Region is 55%, 23% and 16% for SOx, NOx and PM, respectively. Therefore, it is considered effective to take the necessary measures for their thermal plants especially for SOx control. The following measures are recommended for "A" station.

1) No. 1 Boiler
Fuel conversion from fuel oil to natural gas

2) No. 6 Boiler
Fuel conversion from coal to natural gas

(2) General Factories

Since the simulation results show that high SOx concentration is distributed not only in the areas where the thermal power stations are located but also in other areas such as Petaling Jaya and Shah Alam. The contribution general by factories in 1992 are calculated to be 31%, 5% and 56% for SOx, NOx and PM, respectively. The following are the measures recommended for general factories. These measures for general factories are considered to be quite effective for PM control as well.

The following measures are proposed.

- Heavy fuel oil in facilities with fuel consumption of 150 kg/h and over in Petaling Jaya and Shah Alam should be converted to natural gas. In other areas, heavy fuel oil in facilities with 200 kg/h and over should be converted to light fuel oil.
- Gas fuel should be the principal consideration for new facilities.
- Efficiency of electric precipitator, dust collectors (cyclone) should be improved.

- Old wood combustion boilers should be replaced with new ones.

- It is necessary to facilitate the combustion management and energy conservation by employing licensed licensed combustion engineers.

- Extension of stacks.

11.6.2 Mobile Sources

(1) Exhaust Gas Control

SOx, NOx and PM generated by motor vehicles in 1992 are 9%, 67% and 26% of their total amount. HC and CO are generated mainly by motor vehicles. SOx and PM are generated mainly by large vehicles such as lorry/trailer, medium/large truck and medium/large bus. NOx and CO are generated by light duty vehicles such as motor car, van and taxi, and CO and HC are generated by motorcycle and motor car. It is therefore recommended that necessary measures be taken with regard to each type of vehicle. According to the results of SPM analysis, necessary measures should be taken for diesel vehicles to control PM.

In this aspect, the following measures are recommended.

1) Enforcement of exhaust gas control

- Regulation 91/441/EEC should be enforced on light duty petrol vehicles to reduce air pollution load.

- Motorcycles with 2-stroke engine should be replaced with those with 4-stroke engine, or smokeless lube oil should be used in 2-stroke motorcycles.

- Introduction of CNG taxi.

2) Restriction of light duty diesel vehicles

It is necessary to control the registration of new diesel vehicles such as motor car, van and taxi and expedite change of engine type from diesel to petrol. Strong enforcement should be made on the taxis, because their daily driving distance is considered to be very long and most of them are old with diesel engines.

3) Fuel control

The following measures are proposed to be taken.

- To increase the use of unleaded petrol from the present level of about 50% to 80 - 90%.

- To decrease the sulphur content in diesel oil from 0.3% to 0.2%.

4) Public transportation system

The measures proposed in "The Transportation Master Plan in the Klang Valley Transportation Study, JICA (1987)" should be implemented. The measures are as follows.

- Introduction of Mass Transit Railway System.
- Introduction of Light Rapid Train System.
- Improvement of bus system.
- Road network plan.

11.6.3 Evaluation of Control Measures

Figs. 11.5(1) through (3) show the distribution of concentration of pollutants such as SO_2, NO_2 and CO in 2005 which are plotted based on the results of simulation for the case with the recommended measures. The areas where the ground level concentrations will exceed the target value in 2005 without control measures, will diminish with proposed measures, according to the simulation study. Although the amount of NOx and CO generated by vehicles are considered to have increased remarkably comparing with that in 1992 (see Fig. 11.2), the overall pollution situation is found to improve because of the following reason:

- The measures included in the Transportation Master Plan will effectively disperse traffic volume in KVR and ease traffic congestions on the currently congested roads and in the areas despite of the increase of the total traffic volume in the Region.

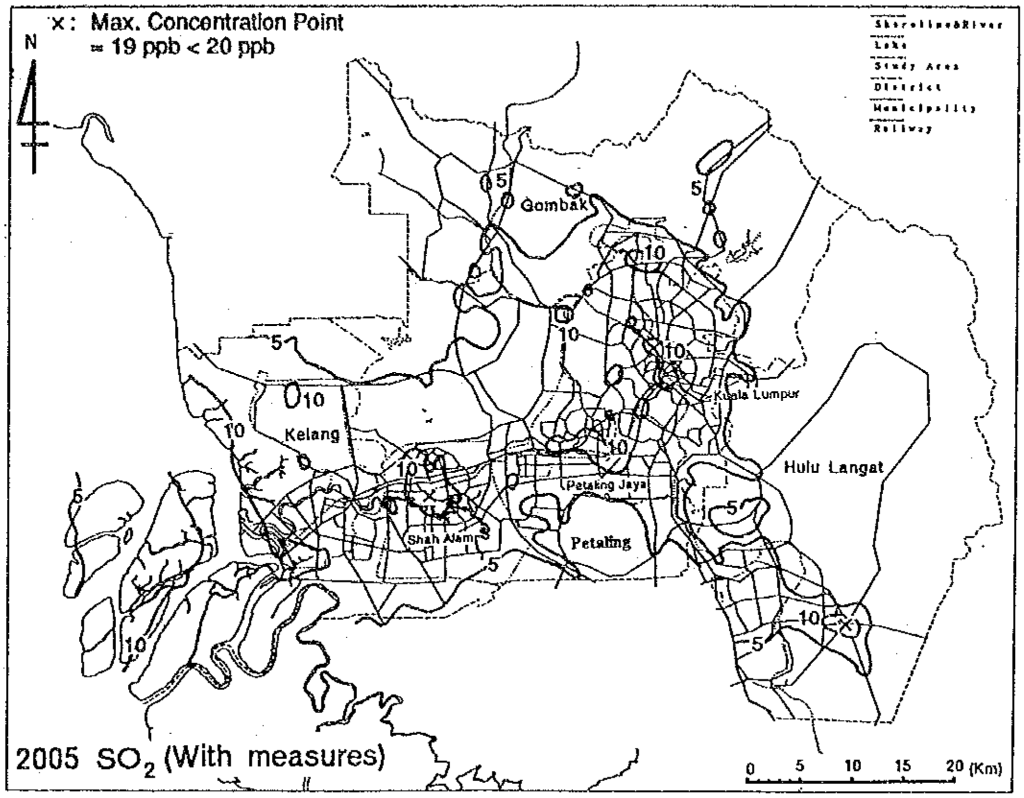


Fig. 11.5 (1) Simulated SO2 Concentration in 2005
(with control measures)

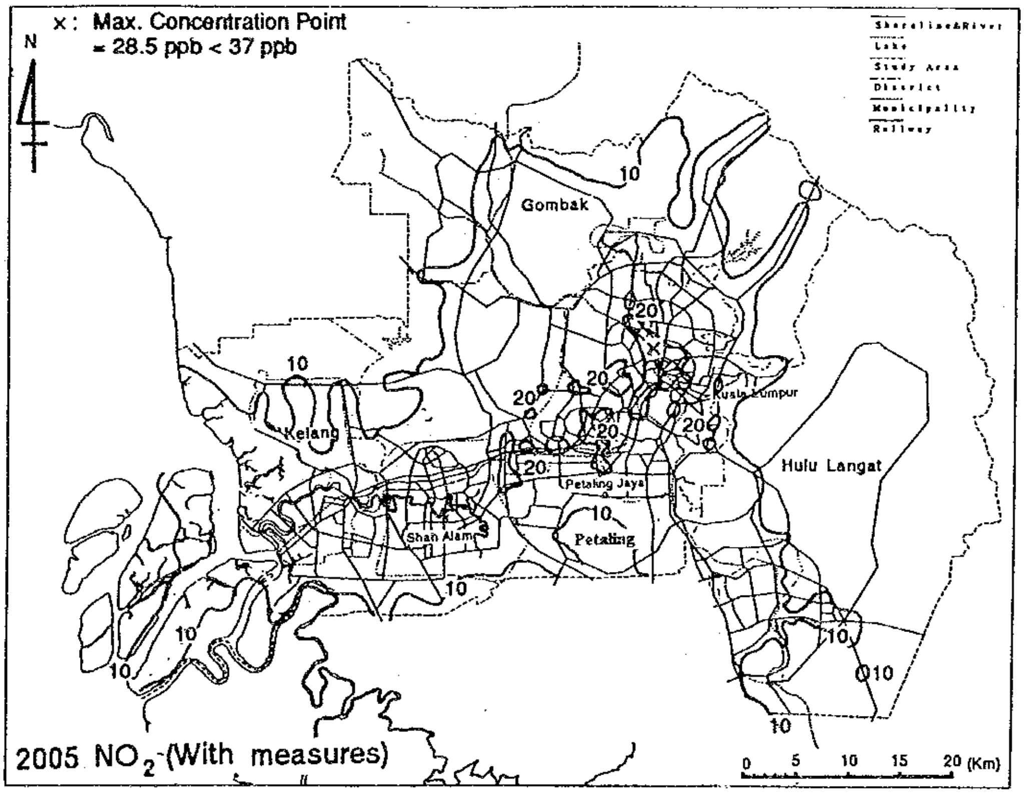


Fig. 11.5 (2) Simulated NO2 Concentration in 2005
(with control measures)

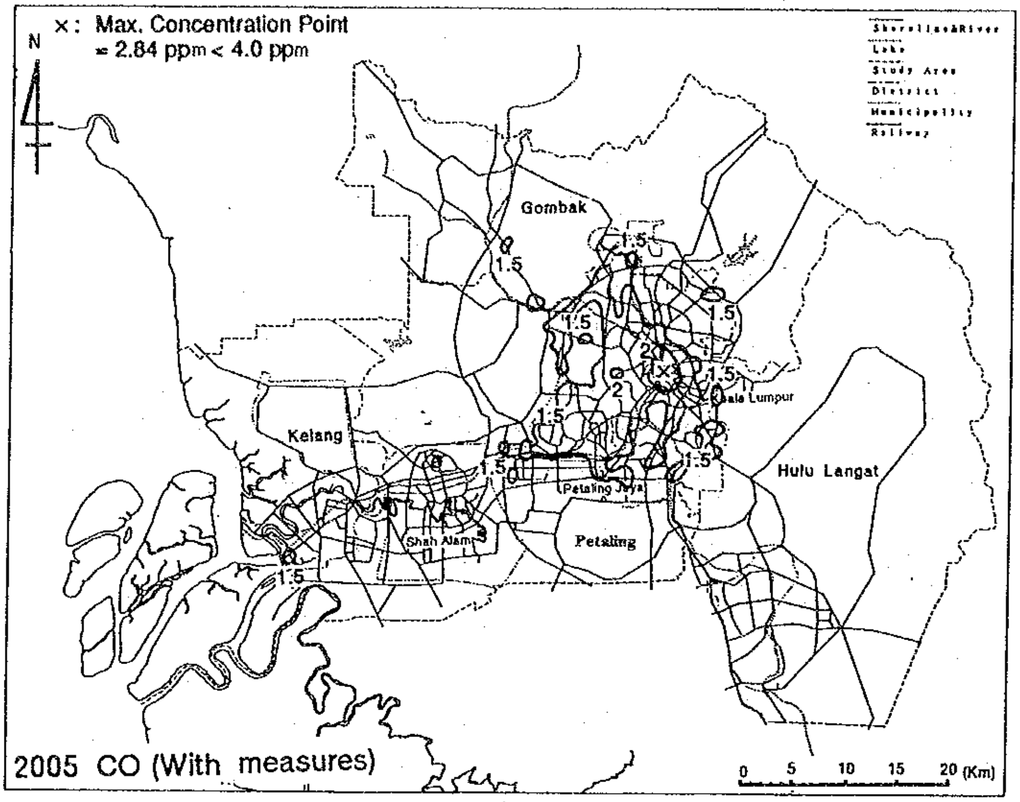


Fig. 11.5 (3) Simulated CO Concentration in 2005
(with control measures)

11.7 Monitoring of Air Quality and Pollution Sources

11.7.1 Ambient Air Quality Monitoring

The location and observation items of the air quality monitoring stations were determined based on the result of ambient air pollution simulation and the present and future land use of the Region, as shown in Fig. 11.6. The total number of the monitoring stations are 11 for fixed station and 20 for mobile station. The monitored data should be collected by the telemetry system which is managed by a control center.

11.7.2 Pollution Source Monitoring

(1) Stationary Sources

It is recommended that large-scale sources such as thermal power station be monitored by an auto-monitoring system (controlled by a central monitoring center). On the large-scale and the middle or small-scale factories, flue gas measurement must be conducted once a year and every three years, respectively.

(2) Mobile Sources

It is important to monitor the pollutant emission by vehicles which are considered to generate significantly large amount of pollutants.

1) Traffic volume monitoring

In order to measure the amount of pollutants generated by vehicles, it is necessary to conduct periodical investigation on traffic volume and patterns.

2) Update of emission factors

It is necessary to update the emission factors for actual driving mode by chassis dynamometer tests.

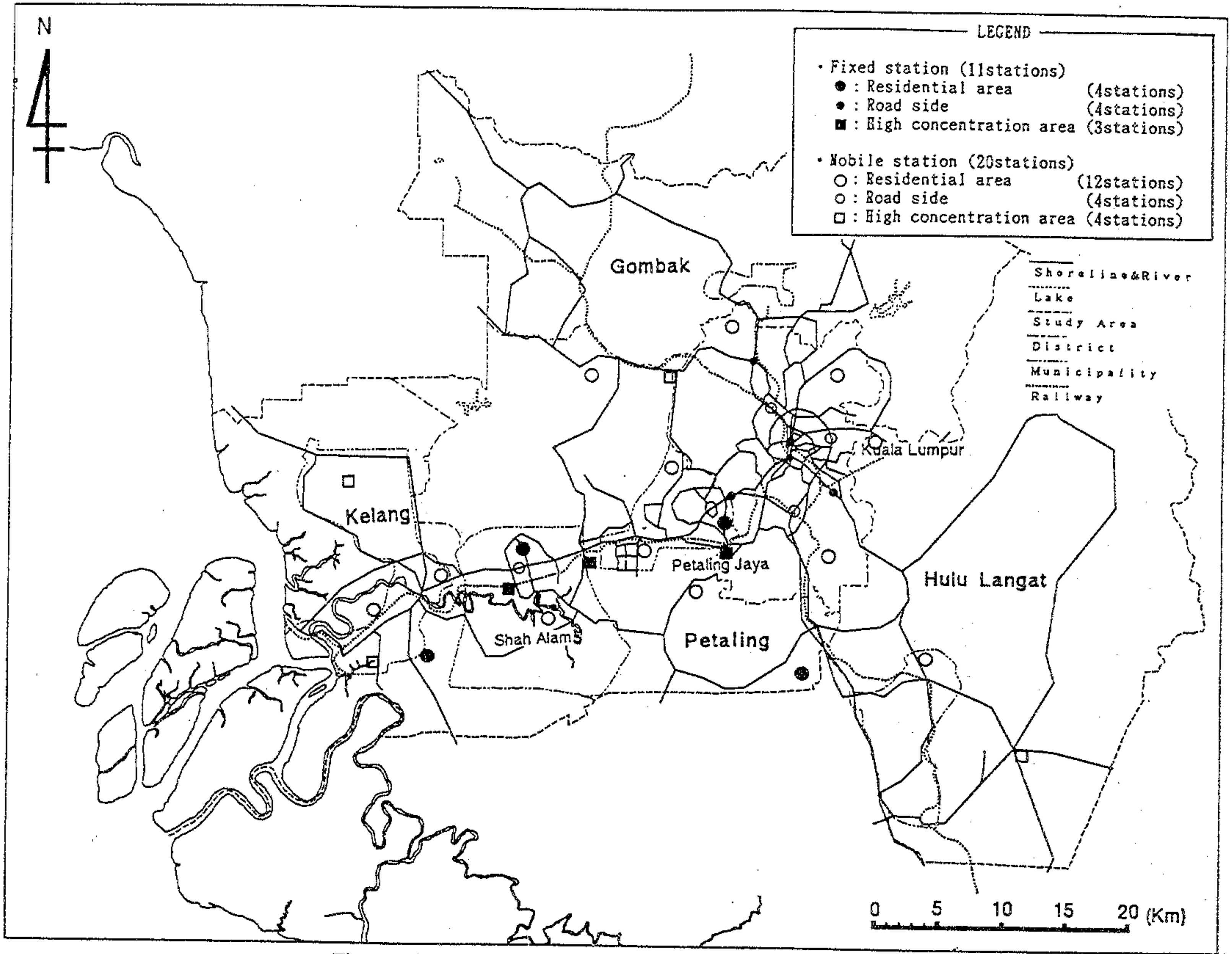


Fig. 11.6 Location Map of Monitoring Stations

11.8 Manpower Development

One of the most important issues is to recruit qualified manpower and staff required for conducting various activities in accordance with the guidelines. Especially, training of many monitoring engineers and combustion engineers is quite urgent, and it is further necessary to assign engineers of various skills for the central control center towards 2005. These training services are mainly for the officers concerned from government agencies in the initial stage, and will be extended to private sectors. In order to make benefit from such training recognizable, it is recommended that a system be established where certificates are awarded and to establish a system to issue authorized licence and to raise the level of their professionalism is enhanced.

11.9 Institutional and Organizational Framework for Implementation of the Guidelines

It is necessary to consider the institutional and organizational framework for the implementation of the guidelines as stated below.

11.9.1 Stationary Sources

The following measures are proposed for pollution reduction from stationary sources.

(1) Combustion Management System

At present there is no regulation on the control of combustion system of factories in Malaysia. Therefore, it is proposed to establish a combustion management system which aims at controlling the combustion in factories especially in view of ambient air pollution and energy conservation.

(2) Financial Support System

A financial support system should be established for promoting and facilitating the activities relating air pollution control.

(3) Conclusion of Pollution Control Agreement

To suppress and control pollutant emissions, and to restrict fuel used, a "Pollution Control Agreement" should be concluded between the government (municipal) office in charge and a company concerned.

11.9.2 Mobile Sources

The following measures are proposed for pollution reduction from motor vehicles.

(1) Car Inspection System

All the vehicles should be inspected every two years in the car inspection center in order to keep the exhaust emission below the standard value.

(2) Introduction of Flextime System

To ease the severe congestions in the mornings and evenings, shift of office or school hours or introduction of flextime system is recommended.

11.9.3 Manpower

It is essential to increase qualified manpower in government agencies and private sectors to participate in the activities as outlined in the guidelines, because the shortage of manpower in DOE is so serious that the present number of manpower in DOE needs to be tripled, and further increase is required if all the measures in accordance with the guidelines are to be implemented.

11.9.4 Establishment of A Comprehensive Air Pollution Control Center

It is proposed that a Comprehensive Air Pollution Control Center be established to organize and promote activities stipulated in the guidelines which are recommended to be carried out in the following centers; (1) Combustion Training Center, (2) Ambient Air Quality Monitoring Engineer Training Center, (3) Pollution Source Monitoring Center and (4) Ambient Air Quality Central Monitoring Center. The organization of the Center is illustrated in Fig. 11.7, and the principal functions of each center are summarized below.

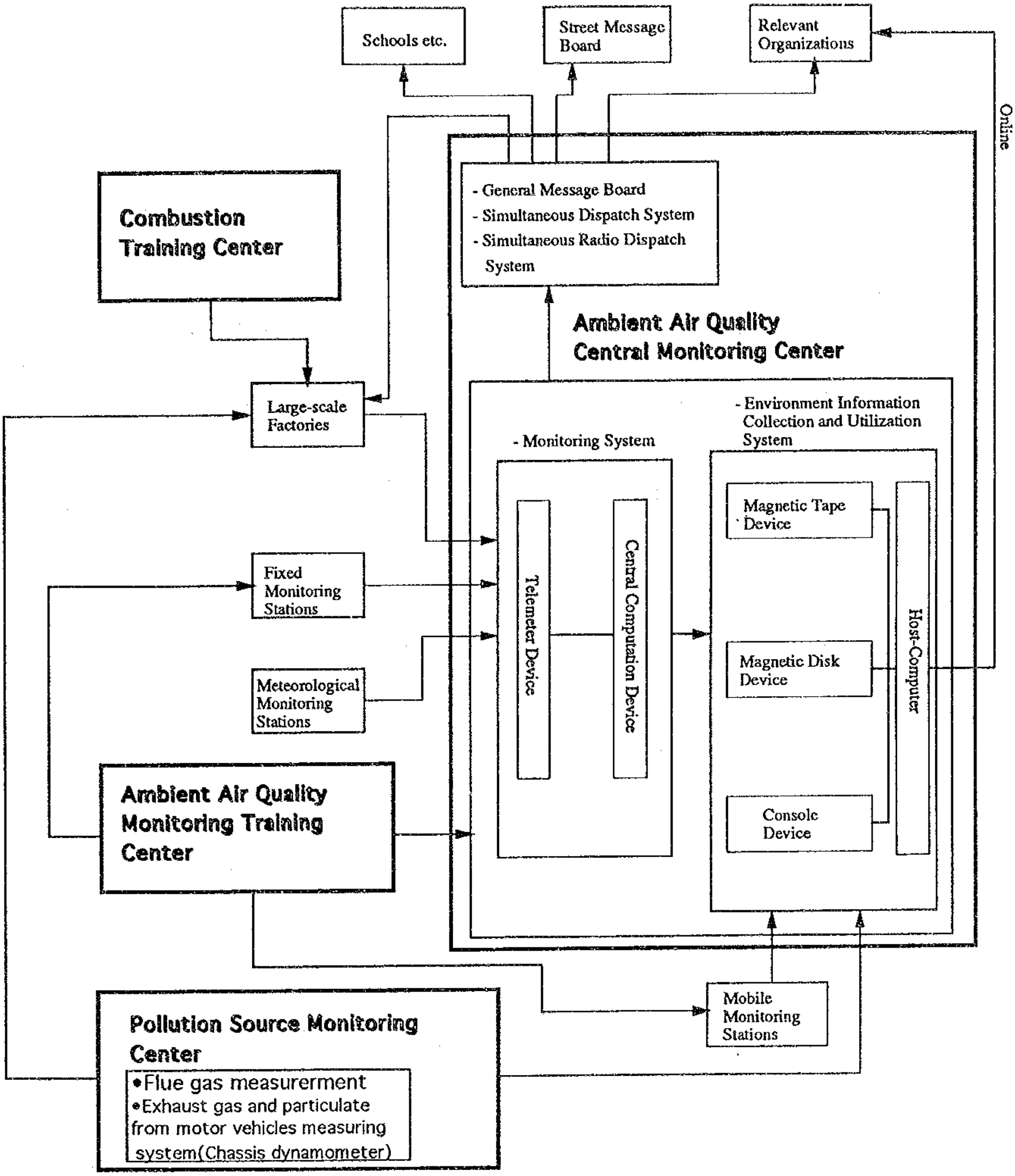


Fig. 11.7 Organization of the Comprehensive Air Pollution Control Center

(1) Combustion Training Center

1) Objectives

The objectives of the Combustion Training Center are:

- to develop own technologies and to promote pollution control and energy saving measures, and
- to train combustion engineers and analysis scientists.

2) Facility and Equipment

- Test combustor:
  each one for liquid and solid fuel (50 to 100 kg/h) with dust collector (cyclone or bag filter).
- Instruments:
  analyzer for O_2, CO_2, CO, SOx, NOx, and dust flow meter for water, fuel, air, stream thermometer.
- Data processor

3) Space:

Lecture room space 100 m^2

4) Capacity:

20 people per section of one to three months

5) Curriculum

- Lecture:
  technologies of fuel, combustion, furnace, operation and maintenance, pollution control, analysis
- Operation:
  combustion, NOx control, analysis

6) Administration and Faculty

Academic and industrial, local or foreign: 7 specialists

(2) Ambient Air Quality Monitoring Training Center

1) Objectives

The objectives of the Ambient Air Quality Monitoring Center are:

- to train personnel for operation and maintenance of the equipment (fixed and mobile stations) for monitoring ambient air quality,
- to train the engineers who will participate in the operation of the Central Monitoring Center to provide the future centerized control system by telemeters, and
- to provide training and facilities for collection data and information on new technologies relating to monitoring ambient air quality.

2) Facility and Equipment

- SOx, NOx, SPM, O_3, CO and HC continuous analysis
- Meteorological continuous analysis

3) Trainer:

3 persons

4) Space

- Office: 50 m^2
- Computer Room: 100 m^2

(3) Pollution Source Monitoring Center

1) Objectives

The objectives of the Pollution Source Monitoring Center are:

- to monitor the pollution sources by carrying out flue gas measurement of the factories considered important as stationary sources, and provide the basic data for air pollution management,
- to monitor pollution level resulting from mobile sources by means of chassis dynamometer test for the emission gas control, and

- to measure the emission factor under actual driving mode by using chassis dynamometer, and verify the pollutant emission from mobile sources.

It is noted that engineers for flue gas measurement will be trained at the Combustion Training Center.

2) Facility and Equipment

- Monitoring cars for flue gas measurement (NOx, SOx, Dust, O_2)
- Chassis dynamometer

3) Staff

- Stationary source monitoring: 8 persons
- Mobile source monitoring: 5 persons

4) Space

- Chassis dynamometer: 600 m^2
- Training room: 150 m^2

(4) Ambient Air Quality Central Monitoring Center

1) Objectives

The objective of the Ambient Air Quality Central Monitoring Center is to collect, through the telemetry system, such data and information as measured and monitored at each monitoring station relating to air quality, meteorology and factory emission, etc. and to provide the relevant organizations in the Region with data and information after analyzing them.

2) Facility and Equipment

- Data transmission system
- Data processing system
- Data exchange system
- Simultaneous information system (street message board)

3) Space

- Office: 50 m^2
- Computer room: 100 m^2
- Stock room: 50 m^2

4) Staff

- Central center: 5 persons
- Maintenance and management of monitoring stations: 7 persons

11.10 Cost Estimate and Schedule for Air Pollution Control

An outline of the implementation schedule and approximate cost estimates for the guidelines are shown in Tables 11.2(1) - through (4). Actual cost for the proposed measures includes so many items. Therefore, mainly the machinery cost was estimated in the Study.

Table 11.2(1) 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
Stationary Sources															
(1)Power Station															
1) "A" Power Station						Operation									
No.1(M.F.O,300Mw)			Fuel conversion M.F.O to N.G.(for SOx & SPM reduction)												-
No.2(N.G. ,300Mw)															-
No.3(Coal,300Mw)				Improvement of Electric Precipitatior's Efficiency											-
No.4(Coal,300Mw)															-
No.5(Coal ,500Mw)															-
No.6(Coal, 500Mw)							Fuel conversion coal to N.G.(for SOx & SPM reduction)								-
No.7(N.G., 500Mw)															-
2) "B" Power Station (N.G. 840MW)		900MW						Unnecessary measures							-
3) "C" Power Station (N.G.)								Unnecessary measures							-
(2)Factory															
1)Cement Factory			Improvement of Electric Precipitators' efficiency												-
2)General Factories			Fuel conversion (HFO to N.G) (Facilities with more150kg/h of M.F.O combustion in Petaling Jaya &Shah Alam)												M$2.9 million
			Fuel conversion (MFO to L.F.O) (Faciliiese with more 200kg/h M.F.O combustion in other areas)												-
						Use of natural gas(new facilities)									
			Dust collector (Cyclon) 3 factories						Dust collector (Cyclon) 3 factories						M$3.0 million
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	

Table 11.2(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
					Raise of stack height										M$0.2 million
							Replacement of wood combustion boiler								M$3.1 million
							Combustion management								-
				Energy saving											-
(3)Combustion Training Center															M$5.7 million

Table 11.2(3) 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								-
b) Use of Smokeless Lube Oil			Preparation				Supply and regulation								10% cost up
2) Application of EC Regulation															M$20/liter (40% cost up)
a) Motor Car		ECE15-04				91/441/EEC						3-way catalytic converter			Oxidation catalytic converter M$1,400/unit cost up
3) Restriction of Diesel Motor Vehicles			Shift from diesel taxi to petrol taxi												-
4) Introduction of CNG Taxi															-
(2) Fuel Control															
1) Unleaded fuel	using ratio 50%		using ratio 80-90%												-
2) Low Sulphur Diesel Fuel	Sulphur content 0.32%		Sulphur content 0.2%												-
(3) Trafic control															
1) Mass Rapid Transit Railway System (MRT)															-
2) Improvement of Bus System															
3) Road Net Work Plan				Transportation Master Plan in 2005 Source; JICA (1987): " KELANG VALLEY TRANSPORTATION STUDY"											
2. Organization & Institution for Motor Vehicles															-
(1) Car Inspection System															M$9.0 million
(2) Introduction of Flexitime System															-

Table 11.2(4) Implementation Plan of Air Pollution Monitoring in Kelang Valley Region (Ambient Air Quality and Air Pollution Source Monitoring)

Item	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
1. Ambient Air Quality Monitoring															
(1) Fixed Station															
1) Residential Area															
a) UPM			○ (Replacement)											→	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$35.19mil.
2. Air Pollution Source Monitoring															
(1) Factory — Existing								○						→	
(1) Factory — new				●							○			→	M$ 0.24 mil.
(2) Motor Vehicle			● (Instration of Chassis Dynamometer)											→	M$ 4mil.(Petrol) M$ 8 mil.(Diesel)
3. Central Monitoring Center									●					→	M$ 35.2 mil.
4. Training Center															
(1) Ambient Air Quality Monitoring Training Center		- - -	- - -											→	M$ 0.76 mil.
(2) Pollution Source Monitoring Training Center			- - - -											→	-

CHAPTER 12 CONCLUSIONS AND RECOMMENDATIONS

1. This is the first comprehensive air pollution study in the Kelang Valley Region (KVR). It was conducted with close cooperation between Malaysian and Japanese teams.

   The Study measured annual meteorology and ambient air quality using five fixed monitoring stations (including three existing ones) and two monitoring cars, and four times measurement on upper level meteorology was conducted. The Study also involved surveys of factories by questionnaires, flue gas measurements and fuel analyses, traffic volume surveys and vehicular exhaust gas emission analyses by chassis dynamometer. An air dispersion simulation model was developed using the above results to simulate the 1992 air quality in the KVR and to predict the one in 2005. Finally the Study evaluated control measures to improve the air quality in the KVR and proposed the related guidelines.

2. The results of the Study suggest strongly that the air pollution in the Region is becoming serious. The Kelang Valley Region emits twice amounts of SOx, 0.8 times of NOx and 1.8 times of CO, as compared to Tokyo. The KVR has twice the area and one quarter of the population to those of Tokyo. Hence, the SOx and CO emission amounts in the unit area are identical in both regions. However, the emission amounts per capita in the KVR are 8 times of SOx, 3 times of NOx and 7 times of CO, to those in Tokyo. The actual emission amounts could be larger than the above figures in the KVR, because emissions from open burning are not included. In addition, since wind is very weak and low inversion layers of 50 meters appear frequently, air pollutants tend to accumulate in the Region. Moreover, high temperature and intense solar radiation in the KVR will promote such chemical reactions as photochemical smog formation.

3. The Study monitored higher CO concentrations in KVR than those in Tokyo. Actually some fixed monitoring stations did not satisfy the Malaysian air quality guidelines for PM10 and CO. Particularly, O_3 concentrations at all stations exceeded the guidelines, suggesting the possibility of bad effect on health.

4. 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 areas. The atmospheric deterioration of KVR is foreseeable from its industrialization, population concentration, traffic growth and so on.

5. In fact, the emission amounts of SOx, NOx, PM, HC and CO in the KVR in 2005 will increase by 1.45, 2.12, 1.47, 2.27 and 2.27 times respectively from the 1992 levels, if no countermeasure is undertaken. The simulation study for SO_2, NO_2 and CO showed remarkably enlarged areas where annual average values exceeded the target values in the KVR. These results demonstrate clearly the necessity to strengthen air pollution control measures.

6. 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.

1) Stationary Sources

- Power Station

  Power stations in KVR emitted 55% of total SOx, 24% of total NOx 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": SOx 42%, NOx 13% and PM 66%.

- General Factories

  General factories emitted 31% of total SOx , 5% of total NOx and 55% of total PM emission in 1992. Six kinds of measures as follows were recommended. The effect of the measures will be 53% of SOx, 0.1% of NOx 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.

2) Mobile Sources

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

The major source is motor cars for CO and NOx, diesel vehicles for PM and SOx, 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 NOx 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 SOx in comparison with the two stroke motorcycle.

  - Smokeless lube 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 SOx 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 taxies 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".

7. The simulation model confirmed that the ambient air quality in 2005 would not deteriorate even under the accomplishment of vigorous economic development plan, if the proposed countermeasures are fully implemented.

8. 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 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.

9. Future requirements

- Publishment 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 SO_2, NO_2 and CO so far, development of new simulation models for SPM and HC is expected in the 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.