

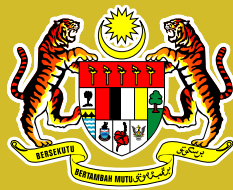
MALAYSIA ENVIRONMENTAL QUALITY REPORT 2006



Department of Environment
Ministry of Natural Resources and Environment
Malaysia



MALAYSIA
Environmental
Quality Report
2006



**Department of Environment
Ministry of Natural Resources
and Environment
Malaysia**

Department of Environment, Malaysia

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Foreword

In compliance with Section 3(1)(i) of the Environmental Quality Act 1974, the 2006 Environmental Quality Report is hereby published.

As in the previous years, the quality of the environment with respect to river and marine water quality remained within normal variations. In quantitative terms, out of 146 river basins monitored, 7 (4.8%) had been categorised as polluted, a marked improvement compared to 15 rivers polluted (10.3%) in 2005.



In 2006, Malaysia experienced short periods of slight to moderate haze from July until October mainly due to transboundary pollution. The land and forest fires in several provinces in Sumatra and Kalimantan, Indonesia coupled with the direct influence of south westerly winds contributed to the deterioration of air quality during these periods. Apart from these haze episodes, there were no other serious air pollution incidences.

2006 had been a challenging year with respect to scheduled wastes management. Arising from amendments to existing regulations, new wastes categories were identified, in particular e-wastes which had resulted in an increase in the volume of wastes handled.

While DOE will take innovative measures to strengthen its effectiveness in regulating compliance, no effort will be spared to enhance public environmental awareness and overcome apathy towards safeguarding the environment. "Let actions speak louder than words".

"Environmental Conservation, Our Shared Responsibility"

With best wishes,

A handwritten signature in black ink, appearing to read 'Rosnani Ibarahim', with a horizontal line underneath.

Dato' Hajah Rosnani Ibarahim

*Director General of Environmental Quality
Malaysia*

30 April 2007



CHAPTER 1

AIR

QUALITY

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AIR QUALITY MONITORING

The Department of Environment (DOE) monitors the country’s ambient air quality through a network of 51 stations (**Map 1.1** and **Map 1.2**). These monitoring stations are strategically located in residential, urban and industrial areas to detect any significant change in the air quality which may be harmful to human health and the environment.

The National Air Quality Monitoring Network is also supplemented by manual air quality monitoring stations (High Volume Samplers) located at 19 different sites. At these sites, total suspended particulates, particulate matter (PM₁₀) and several heavy metals such as lead are measured once in every six days.

AIR QUALITY STATUS

The air quality status for Malaysia is determined according to the Air Pollutant Index (API) as shown in **Table 1.1**. The overall air quality for Malaysia in 2006 deteriorated slightly compared to the previous year. Several unhealthy days were recorded at various locations in Klang Valley, Melaka, Negeri Sembilan, Perak, Pahang, Johor, Terengganu and Sarawak.

In 2006, Malaysia experienced short periods of slight to moderate haze from July until October mainly due to transboundary pollution. The land and forest fires in

several provinces in Sumatra and Kalimantan, Indonesia as reported by the ASEAN Specialised Meteorological Center (ASMC) coupled with the direct influence of south westerly winds contributed to the deterioration of air quality during these periods.

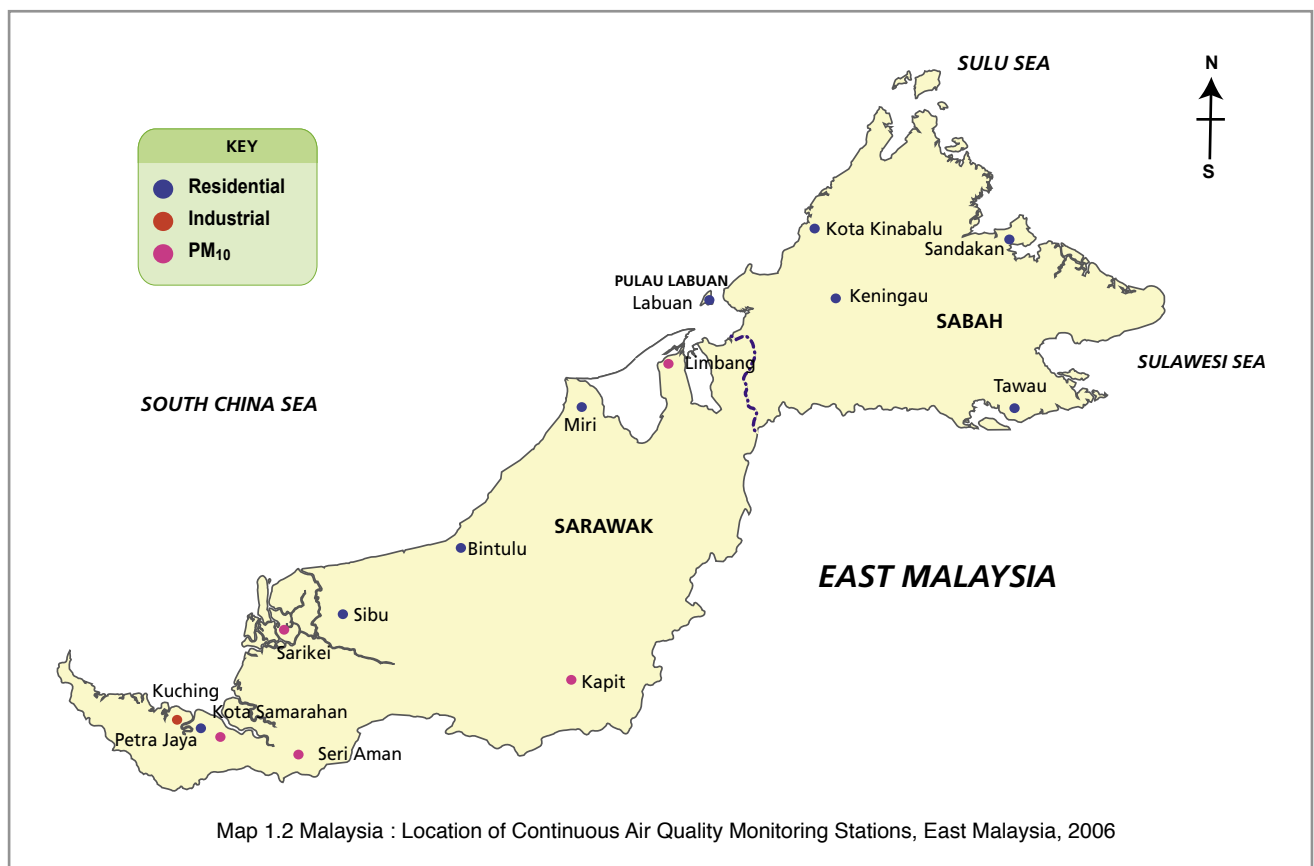
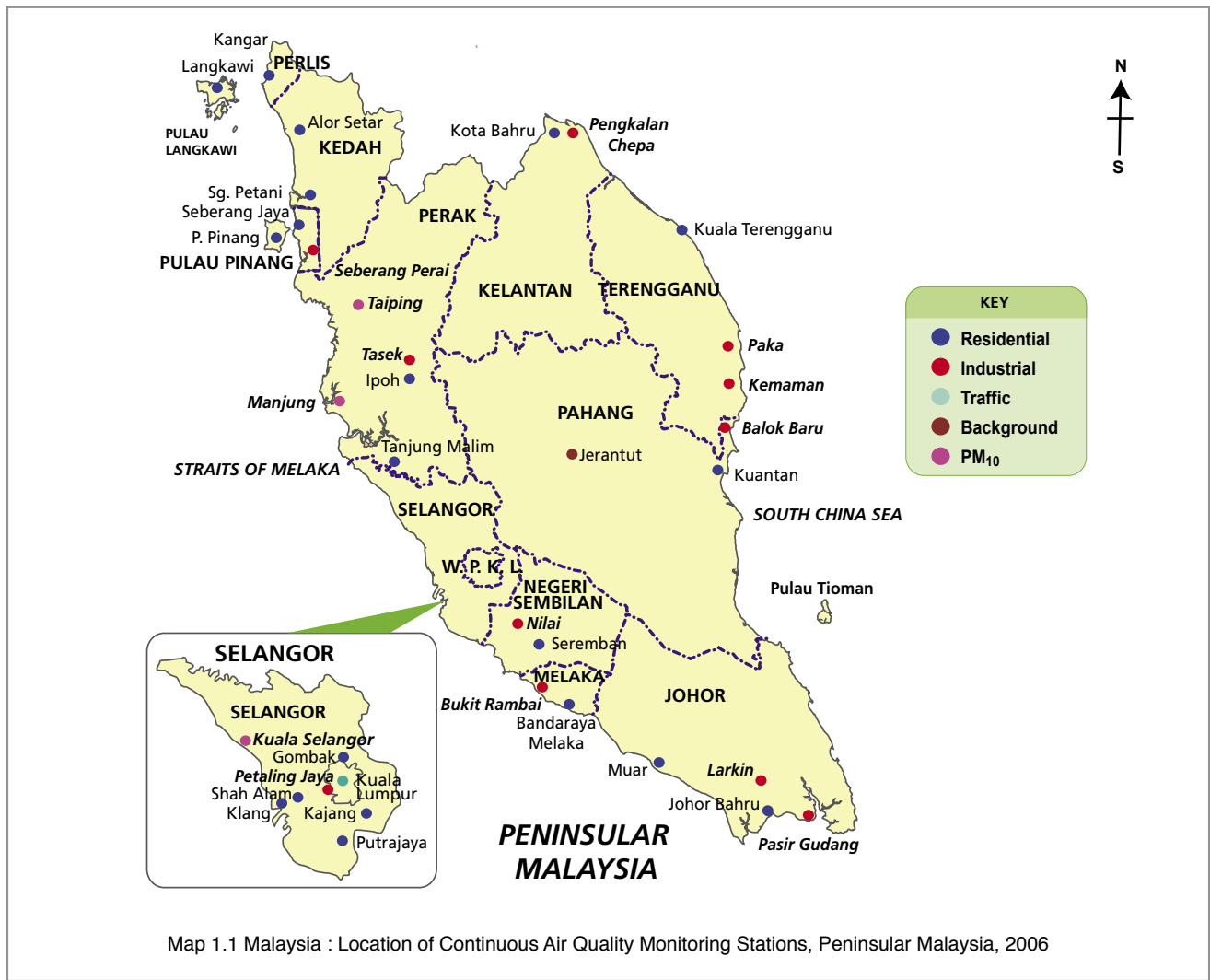
Apart from these haze episodes, there were no other serious air pollution incidences in 2006. Although the annual average concentrations of pollutants measured in 2006 i.e. Carbon Monoxide (CO), Nitrogen Dioxide (NO₂), Ozone (O₃), Sulphur Dioxide (SO₂) and Particulate Matter (PM₁₀) were found to be generally acceptable i.e below the stipulated levels under the Malaysian Ambient Air Quality Guidelines, Particulate Matter (PM₁₀) and ground level Ozone (O₃) remained the pollutants of concerned in

Table 1.1 Malaysia : Air Pollutant Index (API)

API	AIR QUALITY STATUS
0 – 50	Good
51 – 100	Moderate
101 – 200	Unhealthy
201 – 300	Very Unhealthy
> 300	Hazardous



Zero burning technique (DOE photo library)



the country due to their occasional high level occurrences caused by transboundary pollution in the case of PM₁₀ and conducive atmospheric condition that enhances the formation of ground level O₃.

Air Quality Status in the West Coast Klang Valley

The Klang Valley is more prone to air pollution than other areas due to its geographical position, large-scale industrial and commercial activities, densely populated areas and high vehicular traffic. The prevailing winds in the Klang Valley are generally weak resulting in stable atmospheric conditions which cause pollutants in the air to stagnate.

In 2006, the air quality in the Klang Valley was good 23 percent of the time, 70 percent moderate and the remaining 7 percent at an unhealthy level. PM₁₀ was the predominant pollutant in the dry season during the south-westerly monsoon. The highest number of unhealthy days was recorded in Gombak (48 days) (**Figure 1.1**). The overall air quality status in Klang Valley is shown in **Figure 1.2**.

Northern Region

In the northern region of the West Coast of Peninsular Malaysia, comprising the States of Perlis, Kedah (including Langkawi), Pulau Pinang and Perak, the overall air quality was between good and moderate most of the time. More than 50 percent good air quality days were recorded in

Langkawi, Alor Setar, Pulau Pinang (USM) and Tanjung Malim. On the other hand, less than 50 percent good air quality days were recorded in Sungai Petani, Seberang Jaya, Seberang Prai, Taiping, Ipoh, Tasek and Manjung.

The air quality stations in Pulau Pinang (USM), Seberang Jaya, Tanjung Malim, Ipoh, Tasek and Taiping recorded several unhealthy days mainly due to high PM₁₀ caused by transboundary pollution.

Southern Region

Similarly, the status of air quality in 2006 observed in the southern region of the West Coast of Peninsular Malaysia, which includes the States of Negeri Sembilan, Melaka and Johor, was between good to moderate most of the time, with the exception of a few unhealthy days. In Negeri Sembilan, the air quality station in Seremban recorded 65 percent moderate air quality days, 31 percent good air quality days and 4 percent unhealthy air quality days. In Nilai, the air quality was moderate for 81 percent of the time, 14 percent good and 5 percent unhealthy. In Bandaraya Melaka, the air quality was moderate for more than 50 percent of the time, while in Bukit Rambai the air quality was moderate 95 percent of the time. Both areas recorded several unhealthy air quality days mainly due to transboundary pollution during the south-west monsoon. All four stations in Johor recorded less than 50 percent good air quality days and several unhealthy days in 2006. PM₁₀ was the predominant

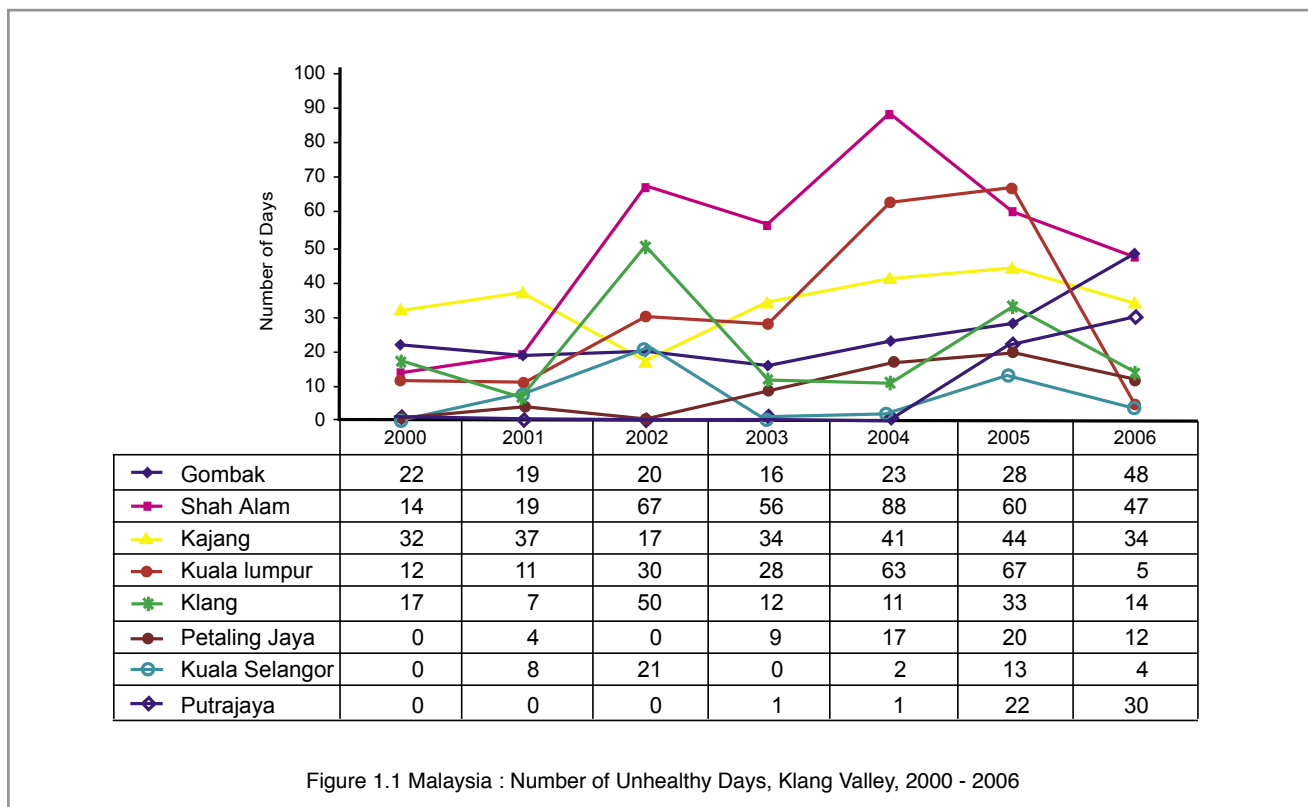


Figure 1.1 Malaysia : Number of Unhealthy Days, Klang Valley, 2000 - 2006

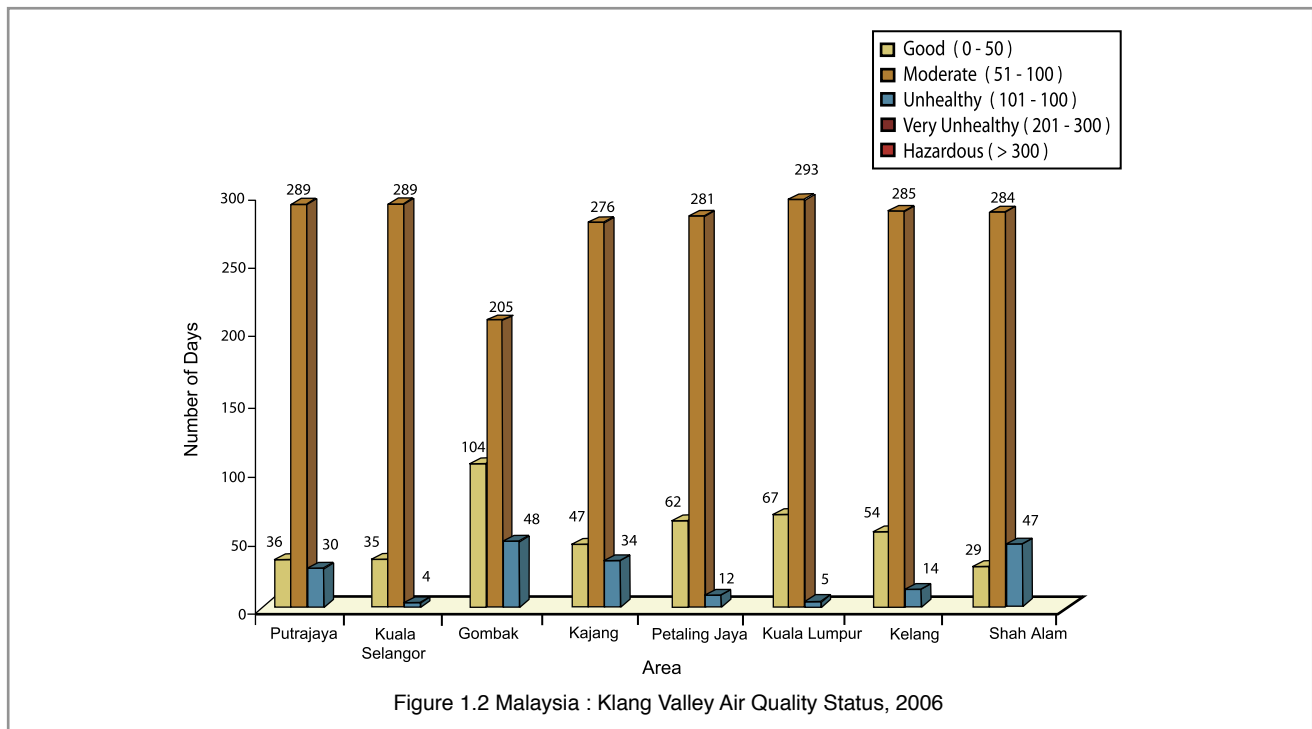


Figure 1.2 Malaysia : Klang Valley Air Quality Status, 2006

pollutant causing unhealthy days in these areas. **Figure 1.3** shows the overall air quality status for the West Coast of Peninsular Malaysia.

Air Quality Status in the East Coast

The air quality in the East Coast of Peninsular Malaysia remained good most of the time in 2006. Areas such as Kuantan, Kota Bahru, Jerantut, Paka, Kemaman and Pengkalan Chepa experienced good air quality for more than 50 percent of the time, while Kuala Terengganu and Balok Baru experienced more moderate air quality than good air quality in 2006. Six unhealthy days were recorded

in Balok Baru and three unhealthy days in Kemaman due to high levels of PM₁₀ and ozone. The overall air quality status in the East Coast is shown in **Figure 1.4**.

Air Quality Status in Sabah, Labuan and Sarawak

The air quality in Sandakan, Kota Kinabalu and Keningau in Sabah was good for more than 74 percent of the time, while Tawau recorded more moderate air quality than good air quality days and two unhealthy days. In Labuan, the air quality was good 80 percent of the time and moderate for the remaining 20 percent. The overall air quality in Sarawak

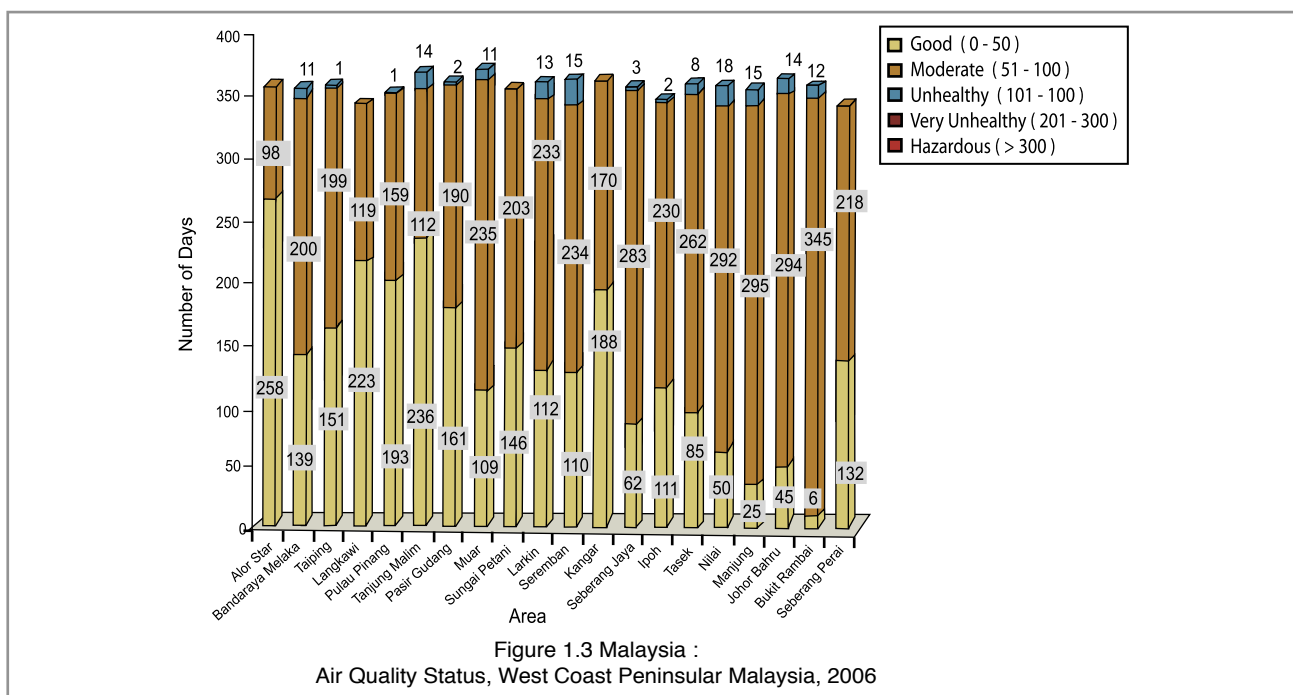


Figure 1.3 Malaysia : Air Quality Status, West Coast Peninsular Malaysia, 2006

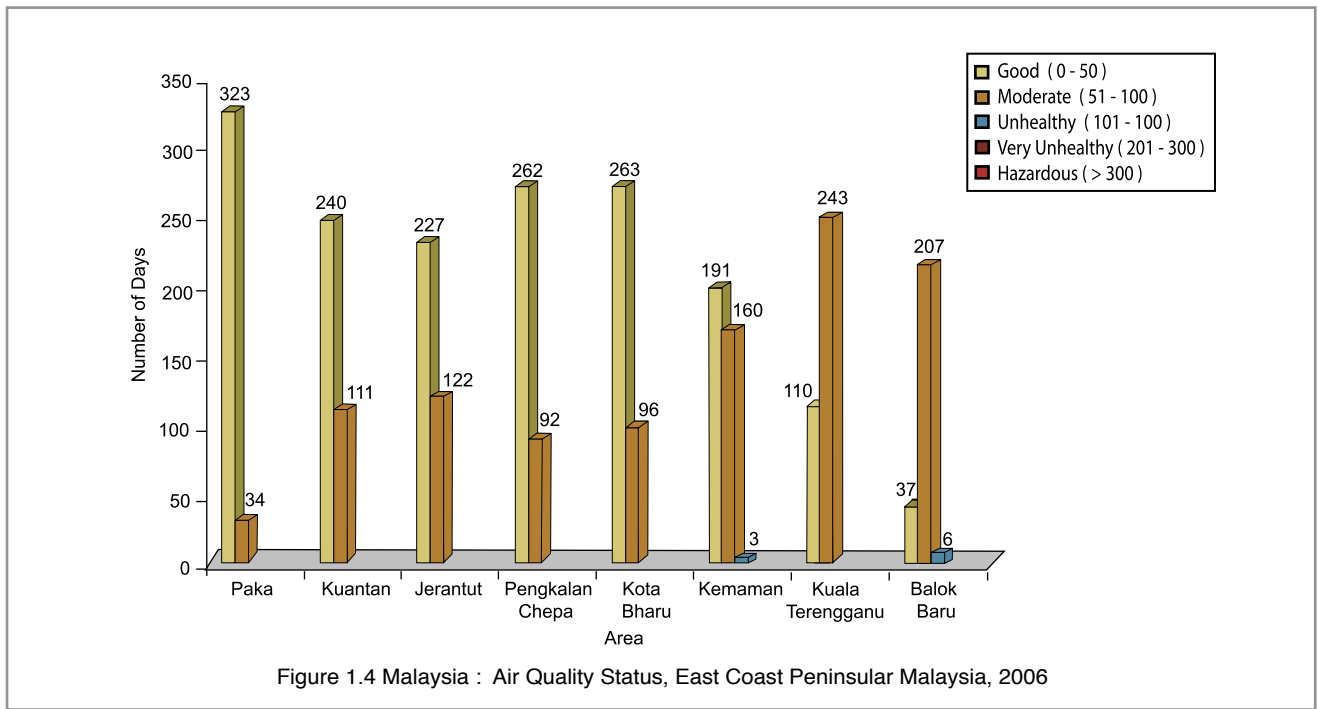


Figure 1.4 Malaysia : Air Quality Status, East Coast Peninsular Malaysia, 2006

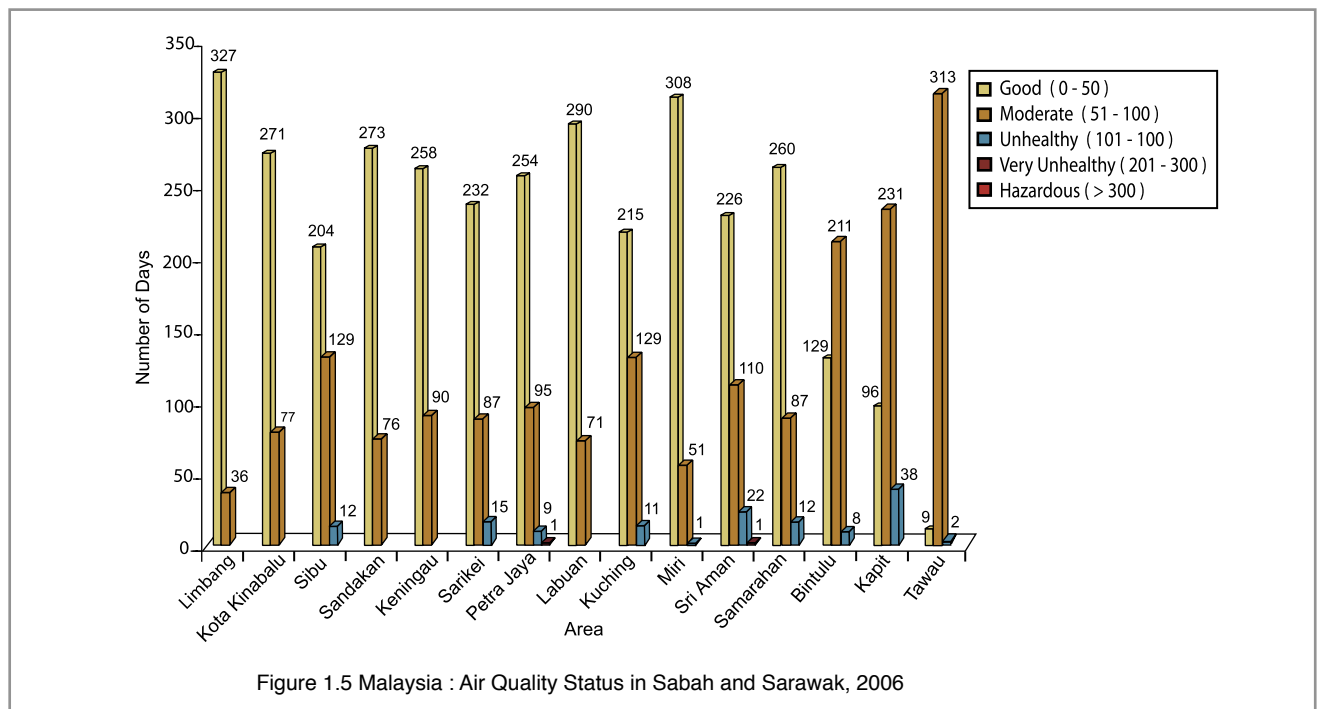


Figure 1.5 Malaysia : Air Quality Status in Sabah and Sarawak, 2006

deteriorated due to transboundary haze pollution between July to October 2006 except for Limbang station. Sri Aman recorded the highest number of unhealthy days (22 days) due to high levels of particulate matter (PM₁₀).

AIR QUALITY TREND

Six criteria pollutants, namely Carbon Monoxide (CO), Nitrogen Dioxide (NO₂), Ozone (O₃), Sulphur Dioxide (SO₂) and Particulate Matter (PM₁₀) were monitored continuously at 51 locations, while lead (Pb) concentration was measured once in every six days at two locations. The air quality trend for the period 1998 to 2006 was computed by averaging

direct measurements from the monitoring sites on a yearly basis and cross-reference with the Malaysian Ambient Air Quality Guidelines shown in **Table 1.2**.

Particulate Matter (PM₁₀)

Particulate matter is the general term used to describe respirable particles of less than 10 microns in size. They are from motor vehicle exhaust, heat and power generation, industrial processes and open burning activities. Particulate matter may also form in the atmosphere by the transformation of precursor emissions such as SO₂ and NO_x (to form Sulphates and Nitrates). In addition, significant

Table 1.2 Malaysia : Ambient Air Quality Guidelines

Pollutant	Averaging Time	Malaysia Guidelines	
		ppm	($\mu\text{g}/\text{m}^3$)
Ozone (O_3)	1 Hour	0.10	200
	8 Hour	0.06	120
Carbon Monoxide** (CO)	1 Hour	30.0	35
	8 Hour	9.0	10
Nitrogen Dioxide (NO_2)	1 Hour	0.17	320
	24 Hour	0.04	10
Sulphur Dioxide (SO_2)	1 Hour	0.13	350
	24 Hour	0.04	105
Particulate Matter (PM_{10})	24 Hour		150
	12 Month		50
Total Suspended Particulate (TSP)	24 Hour		260
	12 Month		90
Lead (Pb)	3 Month		1.5

Note :
 **(mg/m^3)

amount of fine particulates can also arise from uncontrolled biomass burning activities either within or from outside the country (transboundary pollution).

PM_{10} can cause eye and throat irritation, and its accumulation in the respiratory system is associated with numerous respiratory problems such as decreased lung function. High levels of particulate matter can also pose health risk to sensitive groups such as children, the elderly and individuals with asthma or cardiopulmonary diseases.

PM_{10} can also cause undesirable impact on the environment. The presence of high levels of PM_{10} in the atmosphere is a major cause of reduced visibility, resulting in hazy conditions especially during the dry season. Other environmental impacts can occur when particulate matter is deposited onto soil, plants, water or other materials. Depending on the chemical composition of these substances, when particulate matter is deposited in sufficient quantities, it may change the nutrient balance and acidity in soil, interfere with plant metabolism and change the composition of materials.

PM_{10} continues to be the dominant pollutant in many areas in Malaysia. The annual average levels of PM_{10} concentration in the ambient air between 1998 and 2006 were just below the Malaysian Ambient Air Quality Guidelines for PM_{10} .

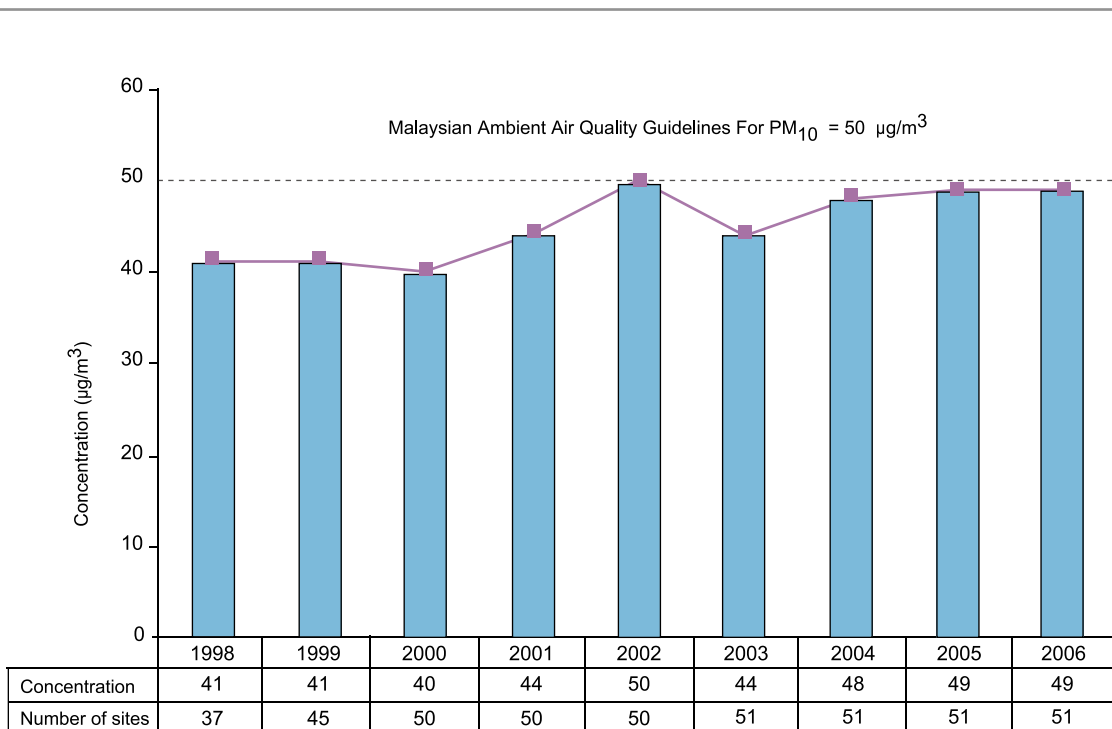


Figure 1.6 Malaysia : Annual Average Concentration of Particulate Matter (PM_{10}), 1998 - 2006

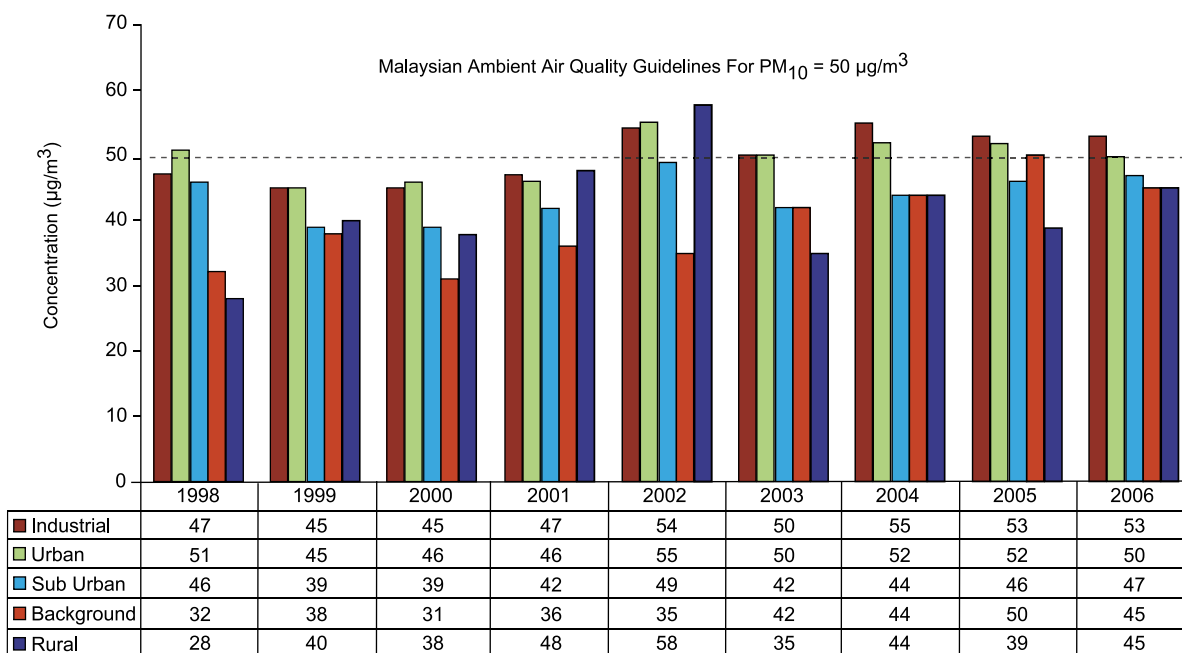


Figure 1.6 (a) Malaysia :
Annual Average Concentration of Particulate Matter (PM₁₀)
by Land Use, 1998 - 2006

In 2006 the annual average value of PM₁₀ concentration remained the same as in 2005 (**Figure 1.6**). The breakdown of the annual average levels of PM₁₀ for various categories of land use is shown in **Figure 1.6(a)**.

Sulphur Dioxide (SO₂)

Sulphur dioxide is a colourless, pungent, irritating, water-soluble reactive gas. This gas is formed during the combustion process of fuel containing sulphur (e.g. oil and coal) mainly from industrial activities. High concentrations of SO₂ in the atmosphere increase the risk of adverse symptoms in asthmatic patients and irritate the respiratory system. Other effects associated with long-term exposure to high concentrations of SO₂ include respiratory illnesses, alterations in lung function and aggravation of existing cardiovascular diseases.

There are also environmental concerns associated with high concentrations of SO₂. Sulphur dioxide along with NO_x is a major precursor to acidic deposition, which contributes to the acidification of soils, lakes and streams resulting in adverse impact on the ecosystem. Sulphur dioxide can also be harmful to plant life and accelerates the corrosion of buildings and monuments.

The annual average levels of SO₂ in the ambient air between 1998 and 2006 (**Figure 1.7**) were well below the Malaysian Ambient Air Quality Guidelines. **Figure 1.7(a)** shows the annual average concentrations of sulphur dioxide for different categories of land use. The concentrations of SO₂ were consistently higher in industrial areas where the main emission sources were located. Compared to 1998, there had been a noticeable drop in SO₂ level in 2006 (72%). This could be attributed to measures taken to promote the use of cleaner fuel such as natural gas for industrial combustion processes and vehicles.

Nitrogen Dioxide (NO₂)

Nitrogen dioxide (NO₂) is a reddish brown, highly reactive gas that is formed in the ambient air through the oxidation of nitrogen monoxide (NO). Nitrogen oxides (NO_x) is the term used to describe the total sum of NO, NO₂ and other oxides of nitrogen. The major sources of man-made NO_x emissions are high-temperature combustion processes, such as those occurring in automobiles and power plants. Most of the NO_x (95%) from combustion processes are emitted as NO and the rest as NO₂. Nitrogen monoxide (NO) is readily converted to NO₂ in the environment.

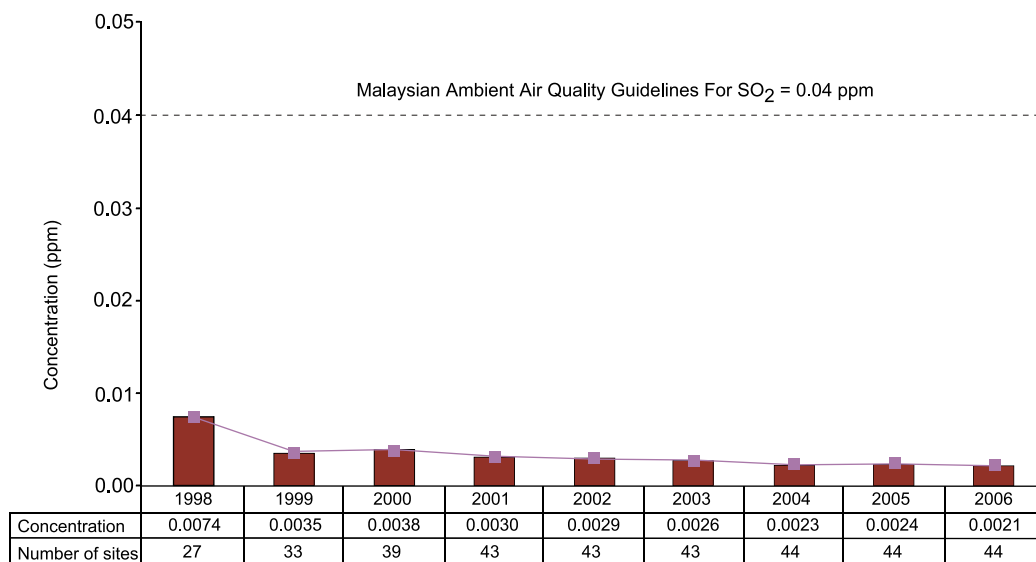


Figure 1.7 Malaysia :
Annual Average Concentration of Sulphur Dioxide (SO₂), 1998 - 2006

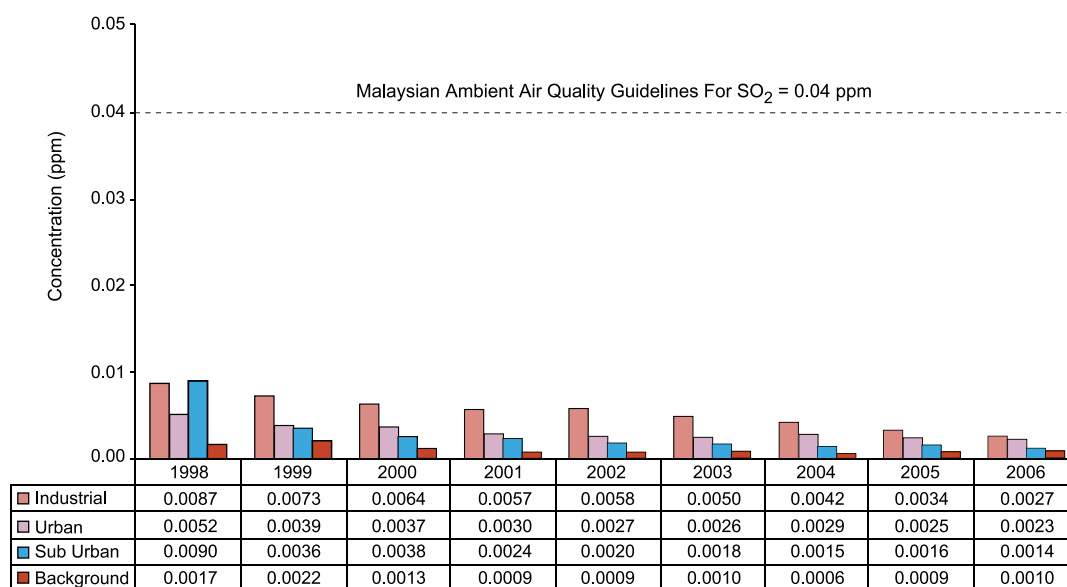


Figure 1.7 (a) Malaysia :
Annual Average Concentration of Sulphur Dioxide (SO₂) by Land Use, 1998 - 2006

Short term exposure to NO₂ may lead to changes in airway responsiveness and lung function in individuals with pre-existing respiratory illnesses and increases respiratory illness in children. Long term exposure may increase susceptibility to respiratory infection and cause alteration in lung function. Nitrogen oxides also react in the air to form ground-level ozone and fine particle pollution, both of which are associated with adverse health impacts.

Nitrogen oxides contribute to a wide range of environmental effects, including the formation of acid rain and potential changes in the composition and competition of some species of vegetation in wetland and terrestrial systems,

visibility impairment, acidification of freshwater bodies, eutrophication of estuarine and coastal waters and increase in levels of toxins harmful to aquatic life.

For the period 1998 to 2006, the annual average concentrations of NO₂ in the ambient air in Malaysia as shown in **Figure 1.8** and **Figure 1.8(a)** were well below the Malaysian Ambient Air Quality Guidelines. In 2006, the NO₂ concentration decreased four percent compared to 2005. Nitrogen dioxide concentrations were high in urban and industrial areas mainly due to emissions from automobiles and combustion processes.

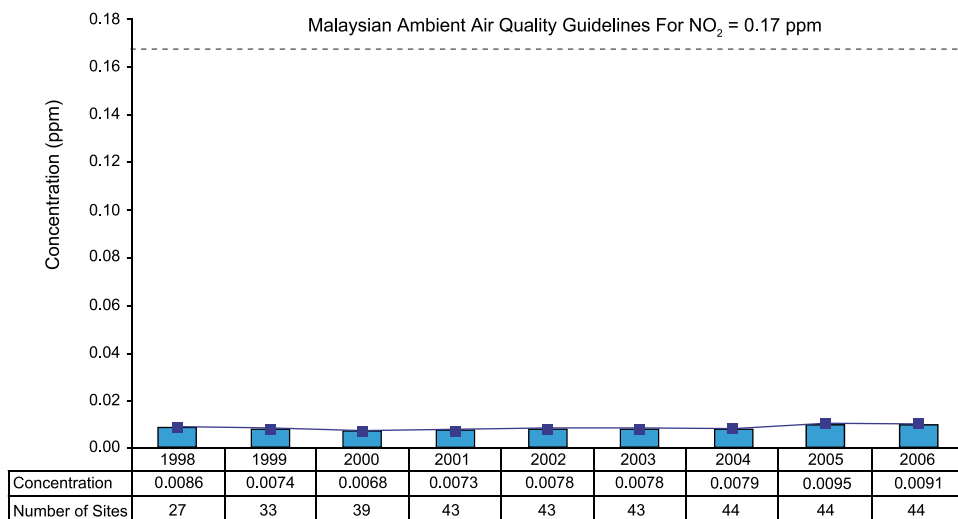


Figure 1.8 Malaysia :
Annual Average Concentration of Nitrogen Dioxide (NO₂), 1998 - 2006

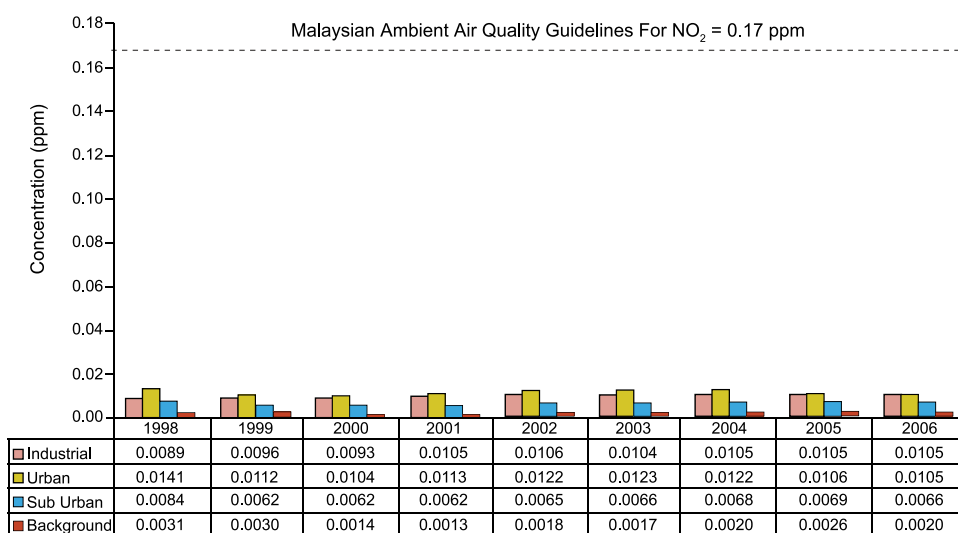


Figure 1.8 (a) Malaysia :
Annual Average Concentration of Nitrogen Dioxide (NO₂) by Land Use, 1998 - 2006

Ground Level Ozone (O₃)

Ozone is not emitted directly into the air but is formed by the reaction of Volatile Organic Compounds (VOCs) and NO_x in the presence of heat and sunlight. Ground-level ozone forms readily in the atmosphere, usually in the warm sunny urban atmosphere. VOCs are emitted from various sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products, and other industrial sources. Nitrogen oxides are emitted from motor

vehicles, power plants and combustion sources. Changes in weather patterns contribute to yearly differences in ozone concentrations. Ozone and the precursor pollutants that form ozone can also be transported hundreds of kilometres away depending on wind direction.

Exposure to high concentrations of ground-level ozone has been linked to numerous health effects. Repeated exposures

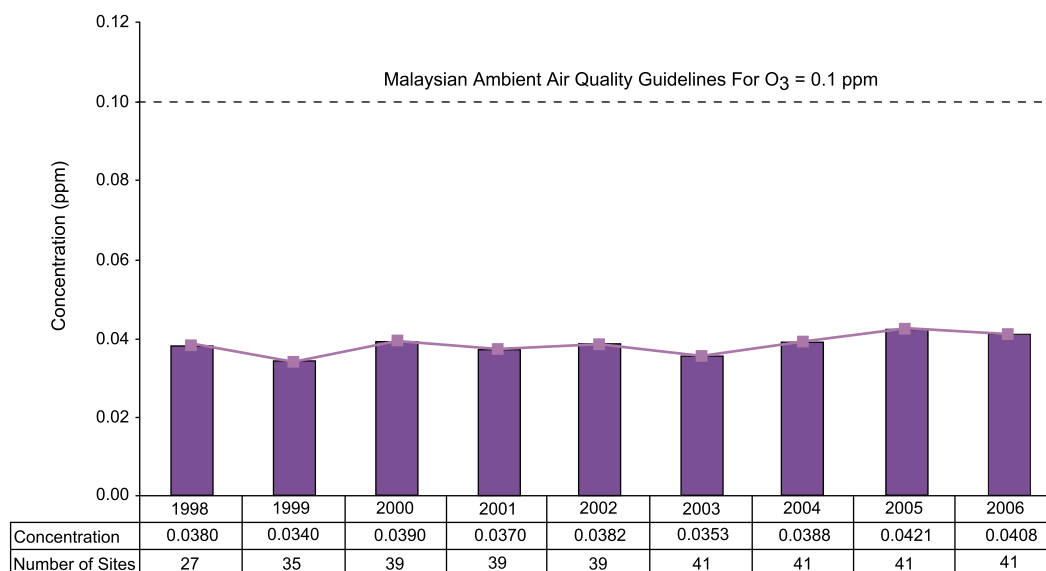


Figure 1.9 Malaysia :
Annual Average Daily Maximum 1 Hour Concentration of Ozone (O₃), 1998 - 2006

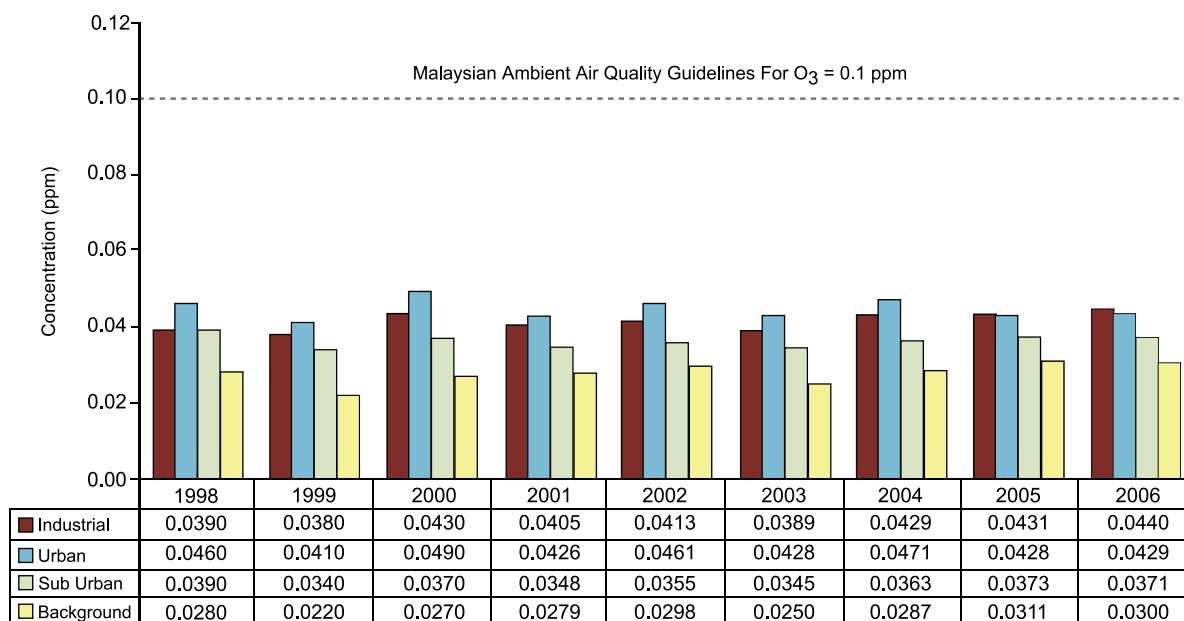


Figure 1.9 (a) Malaysia :
Annual Average Daily Maximum 1 Hour Concentration of Ozone (O₃)
by Land Use, 1998 - 2006

to ozone can make people more susceptible to respiratory infections resulting in lung inflammation and aggravate pre-existing respiratory diseases such as asthma. Ozone also affects vegetation and ecosystems, leading to reduction in agricultural and commercial forest yields, reduced growth and survivability of tree seedlings, and increase plant susceptibility to diseases, pests, and other environmental stresses. In long lived species, these effects may become evident only after several years or decades. Thus, ozone has the potential for long-term effect on forest ecosystems.

Figure 1.9 shows the annual average daily maximum one-hour ozone concentrations in ambient air for 1998 to 2006. There were fluctuations in the trend observed throughout this period. In 2006, the annual average daily maximum one-hour ozone concentrations decreased 39 percent compared to 2005. **Figure 1.9(a)** describes the ozone concentration for various land use categories between 1998 and 2006. Higher levels of ozone were consistently recorded in urban areas, due to the presence of the precursor ozone (i.e. NO_x from motor vehicle emissions).

Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless and at high concentration, a poisonous gas. Carbon monoxide is formed when the carbon present in fuel is not burnt completely. CO is emitted mainly from motor vehicle exhaust. Other sources of CO emission include industrial processes and open burning activities.

Carbon monoxide enters the bloodstream through the lungs and reduces oxygen delivery to organs and tissues. The health threat from exposure to CO is most serious to those who suffer from cardiovascular diseases. At high levels of exposure, CO can be poisonous even to healthy people. Visual impairment, reduced work capability and poor learning ability are among the health effects associated with exposure to elevated CO levels.

The annual eight-hourly average concentrations of carbon monoxide throughout the country measured from 1998 to 2006 were well below the Malaysian Ambient Air Quality Guidelines (**Figure 1.10**). The concentration of CO was

consistently higher in urban areas where the main sources of emission were motor vehicles. **Figure 1.10(a)** shows CO concentrations for various categories of land use.

Lead (Pb) Concentration

Excessive exposure to lead (Pb) may cause neurological impairment such as mental retardation and behavioural disorders. Even at low dosage, lead exposure is associated with damage in foetus nervous system and in young children resulting in learning deficiency and lowered IQ.

In the past, motor vehicles were the main sources of Pb emissions into the atmosphere. The Pb levels monitored in the atmosphere were high in the eighties. However, as a result of Government efforts to promote the use of unleaded petrol since 1991 and the total phase out of leaded petrol in 1998, the Pb level in the atmosphere had declined significantly. In 2006, the average level of atmospheric Pb monitored in the Klang Valley remained low as in previous years (**Figure 1.11**).



Open burning at illegal garbage dumpsite (DOE photo library)

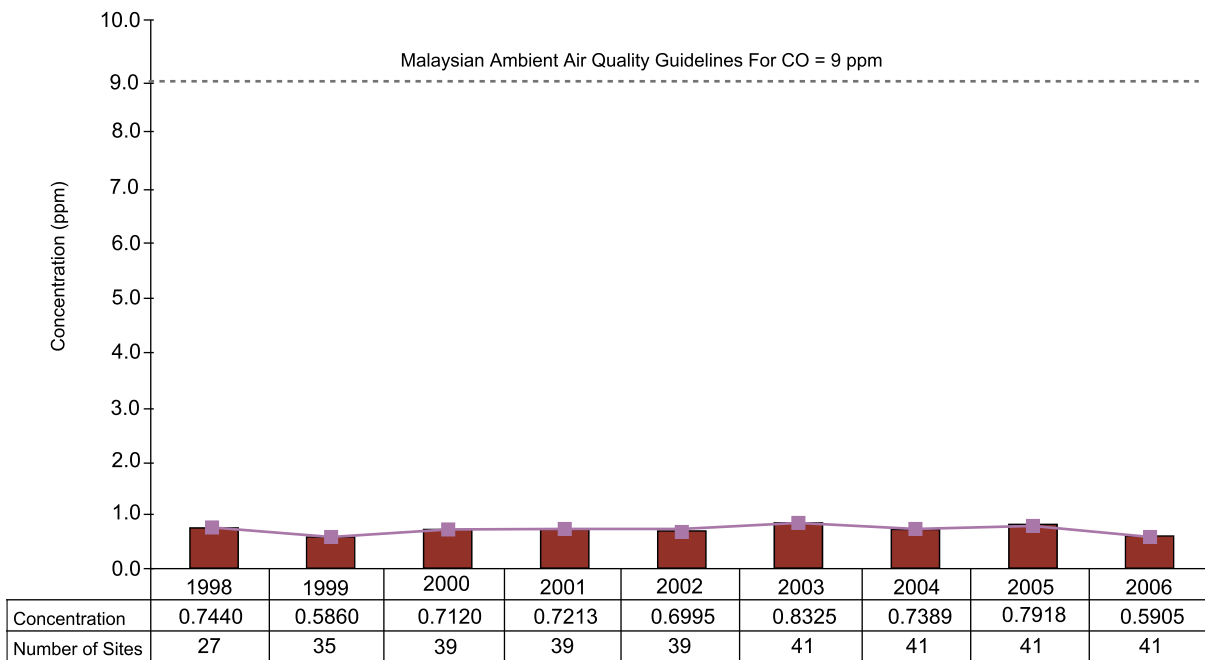


Figure 1.10 Malaysia :
Annual Average Concentration of Carbon Monoxide (CO),1998 - 2006

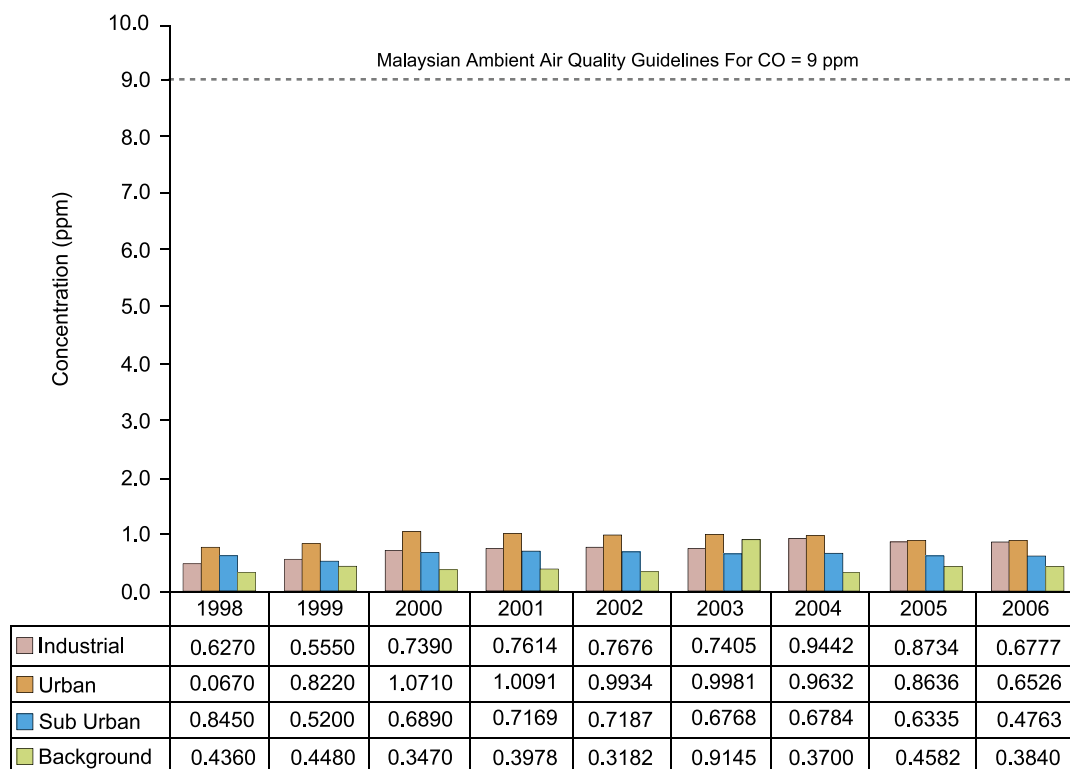


Figure 1.10 (a) Malaysia :
Annual Average Concentration of Carbon Monoxide (CO) by Land Use,1998 - 2006

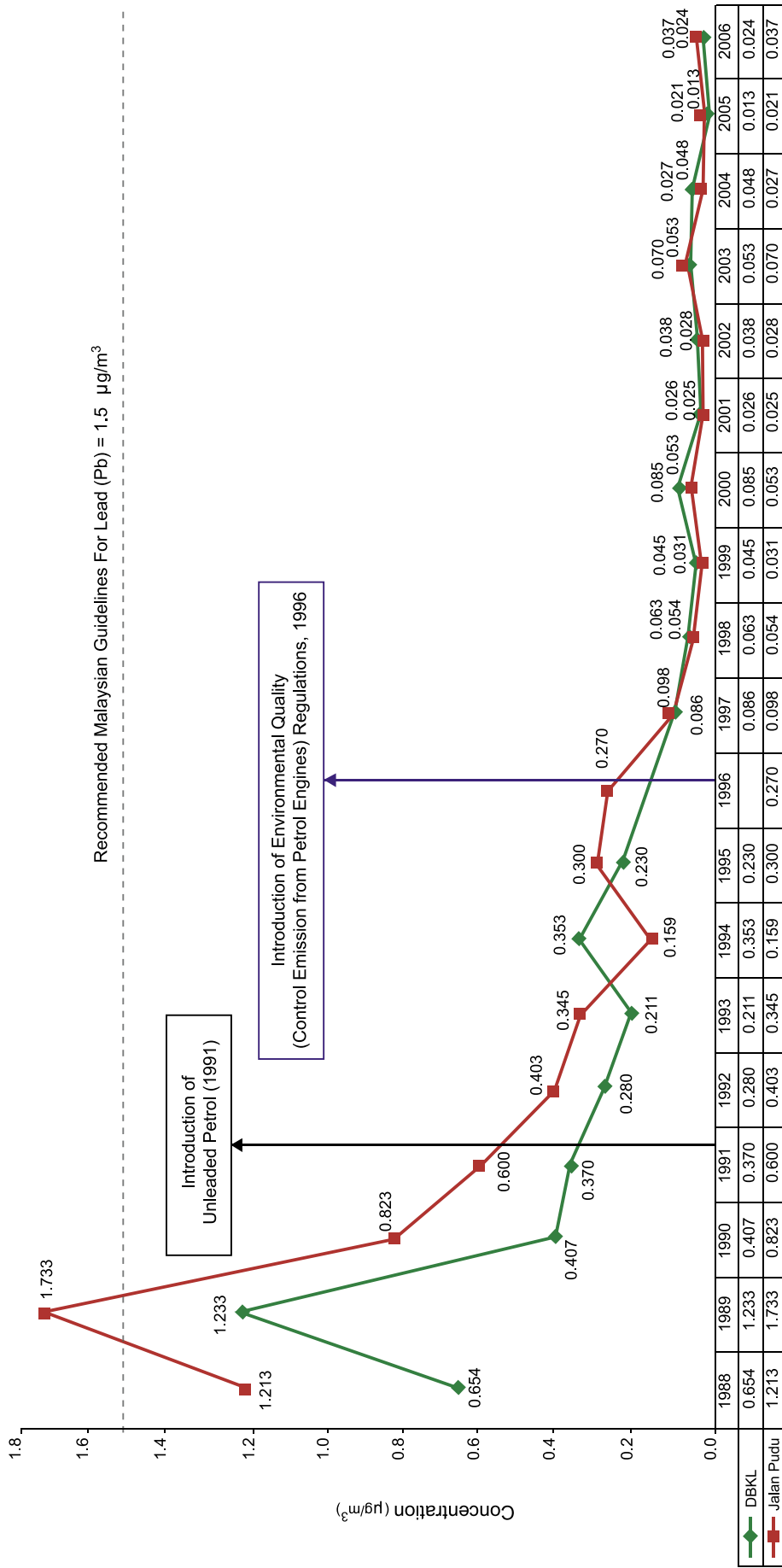


Figure 1.11 Malaysia : Air Quality Trend : Ambient Lead (Pb) Concentration in Klang Valley, 1988 - 2006



CHAPTER 2

NOISE

MONITORING

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NOISE MONITORING PROGRAMME

In June 2006, Department of Environment (DOE) conducted the National Ambient Noise Monitoring Programme to determine the Malaysian ambient noise status. Noise measurements were conducted in Negeri Sembilan, Wilayah Persekutuan Kuala Lumpur, Pahang, Kelantan, Terengganu, Perlis, Pulau Pinang, Sarawak, Sabah and Wilayah Persekutuan Putrajaya. The data obtained were analysed according to the Planning Guidelines

For Environmental Noise Limits And Control 2004. The L_{Aeq} calculated represented the existing noise levels in those areas. The L_{Aeq} for 24 hours, daytime (7:00 a.m. to 10:00 p.m.) and night time (10:00 p.m. to 7:00 a.m.) were plotted as in **Figures 2.1** and **2.2**. (Note: The Planning Guidelines For Environmental Noise Limits And Control 2004 may be used by relevant approving authorities in planning new areas to be developed so as to avoid unnecessary noise disturbances due to incompatible uses and inadequate buffer zones between the areas) (**Schedules 1, 2 and 3**).

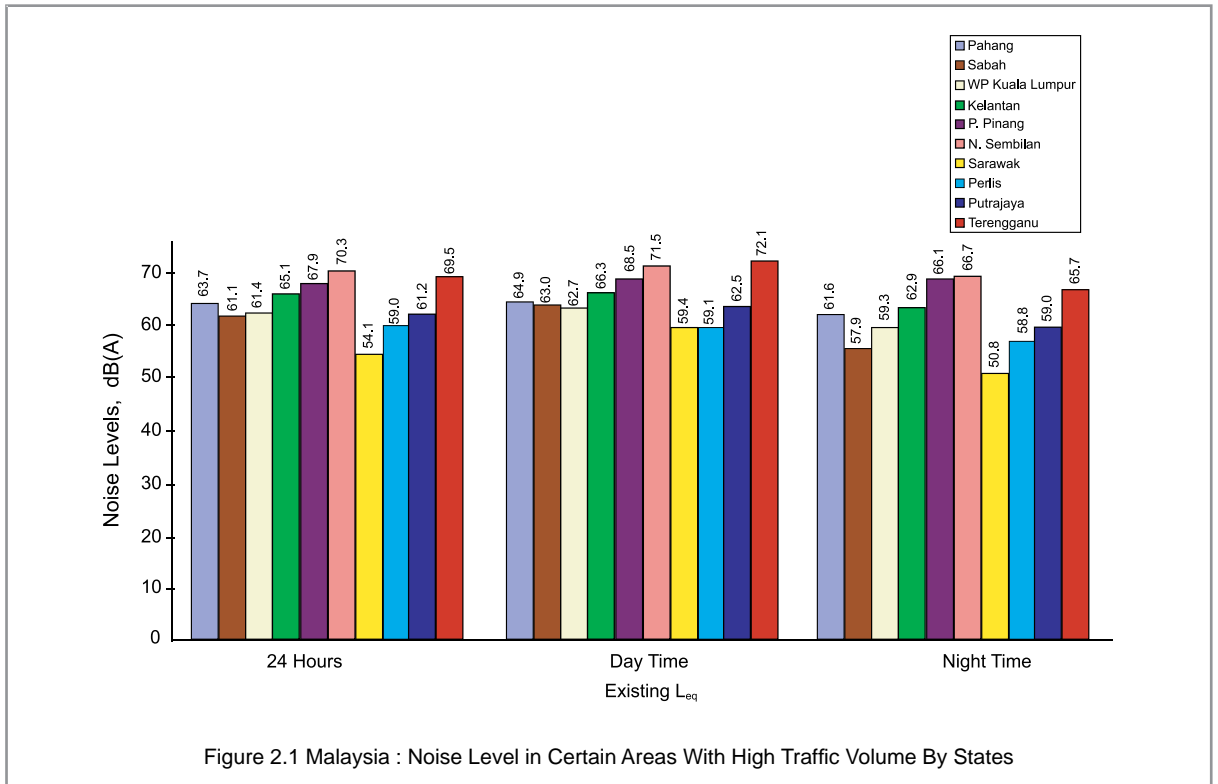


Figure 2.1 Malaysia : Noise Level in Certain Areas With High Traffic Volume By States

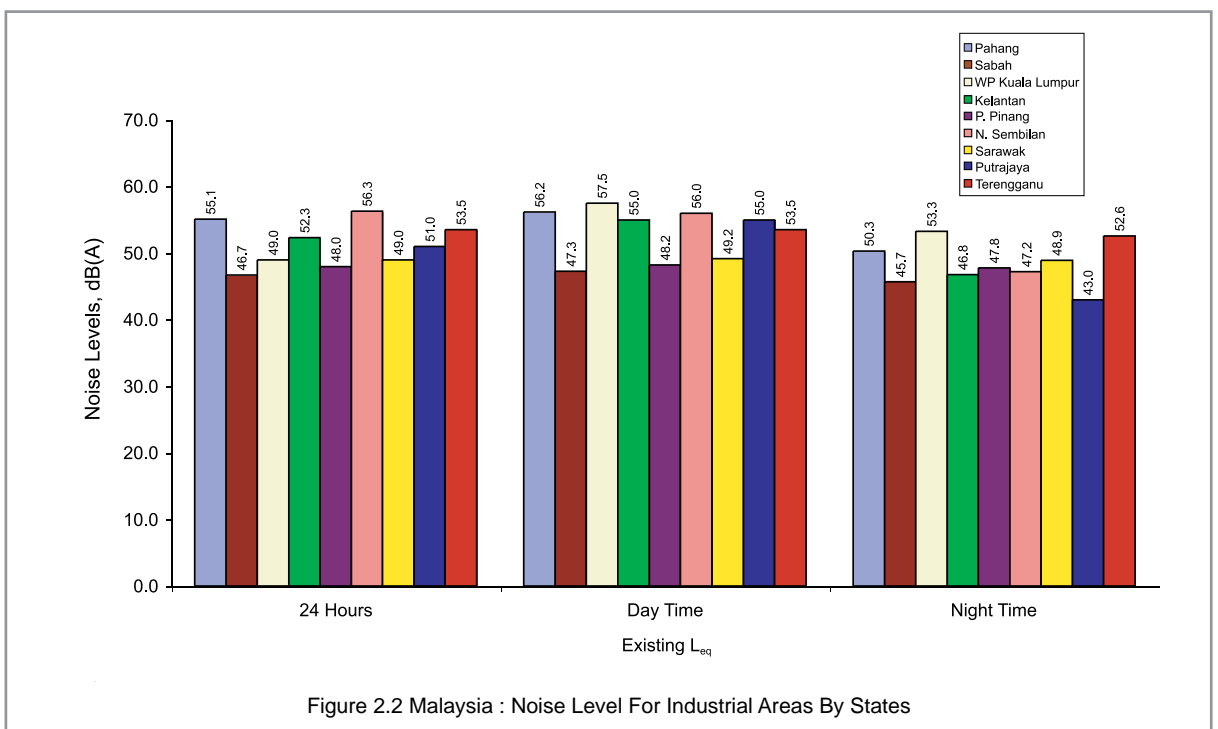


Figure 2.2 Malaysia : Noise Level For Industrial Areas By States

SCHEDULE 1
MAXIMUM PERMISSIBLE SOUND LEVEL (L_{Aeq}) OF RECEIVING LAND USE
FOR PLANNING AND NEW DEVELOPMENT

Receiving Land Use Category	Day Time 7:00 a.m. – 10:00 p.m.	Night Time 10:00 p.m. – 7:00 a.m.
Noise Sensitive Areas, (Low Density Residential Areas), Institutional (School, Hospital) Areas and Worship Areas	50 dB(A)	40 dB(A)
Suburban Residential Areas (Medium Density Areas), Public Spaces, Parks and Recreational Areas	55 dB(A)	45 dB(A)
Urban Residential (High Density Areas) and Designated Mixed Development Areas (Residential - Commercial Areas)	60 dB(A)	50 dB(A)
Commercial Business Areas	65 dB(A)	55 dB(A)
Designated Industrial Areas	70 dB(A)	60 dB(A)

Source : The Planning Guidelines for Environmental Noise Limits and Control, 2004

SCHEDULE 2
MAXIMUM PERMISSIBLE SOUND LEVEL (L_{Aeq}) OF NEW DEVELOPMENT (ROADS, RAILS AND INDUSTRIES) IN AREAS OF
EXISTING HIGH ENVIRONMENTAL NOISE CLIMATE

Receiving Land Use Category	Day Time 7:00 a.m. – 10:00 p.m.	Night Time 10:00 p.m. – 7:00 a.m.
Noise Sensitive Areas and Low Density Residential Areas	$L_{90} + 10$ dB(A)	$L_{90} + 5$ dB(A)
Suburban and Urban Residential Areas	$L_{90} + 10$ dB(A)	$L_{90} + 5$ dB(A)
Commercial and Business Areas	$L_{90} + 10$ dB(A)	$L_{90} + 10$ dB(A)
Industrial Areas	$L_{90} + 10$ dB(A)	$L_{90} + 10$ dB(A)

Source : The Planning Guidelines for Environmental Noise Limits and Control, 2004

Note :

L_{90} is the measured ninety percentile sound level for the respective time period of the existing areas of interest in the absence of the proposed new development.

SCHEDULE 3
 LIMITING SOUND LEVEL (L_{Aeq}) FROM ROAD TRAFFIC
 (FOR PROPOSED NEW ROADS AND/OR REDEVELOPMENT OF EXISTING ROADS)

Receiving Land Use Category	Day Time 7:00 a.m. – 10:00 p.m.	Night Time 10:00 p.m. – 7:00 a.m.
Noise Sensitive Areas (Low Density Residential Areas)	55 dB(A)	50 dB(A)
Suburban Residential Areas (Medium Density Areas)	60 dB(A)	55 dB(A)
Urban Residential Areas (High Density Areas)	65 dB(A)	60 dB(A)
Commercial Business Areas	70 dB(A)	60 dB(A)
Industrial Areas	75 dB(A)	65 dB(A)

Source : The Planning Guidelines for Environmental Noise Limits and Control, 2004



Noise monitoring – Construction site piling (DOE photo library)



CHAPTER 3

RIVER WATER

QUALITY

Map 3.1 Malaysia : Water Quality Status for River Basins of Peninsular Malaysia, 2006	•25•
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RIVER WATER QUALITY MONITORING

The Department of Environment (DOE) started its monitoring programme in 1978 to establish baselines and detect water quality changes in river water quality. This has since been extended to identifying of pollution sources as well. Water samples are collected at regular intervals from designated stations for in-situ and laboratory analysis to determine its physico-chemical and biological characteristics. The Water Quality Index (WQI) used to evaluate the status of the river water quality consists of parameters such as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen ($\text{NH}_3\text{-N}$), Suspended Solids (SS) and pH. The WQI serves

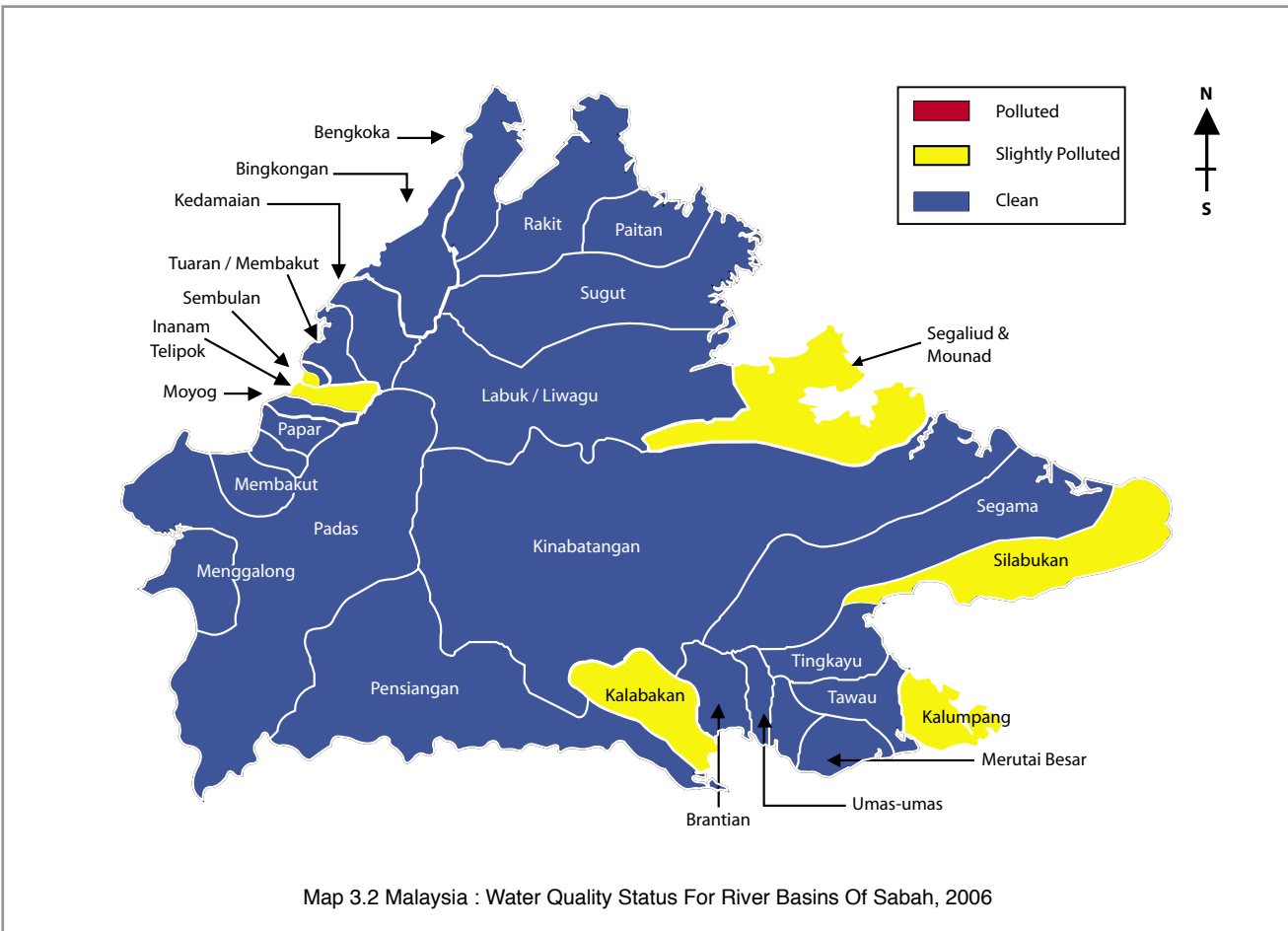
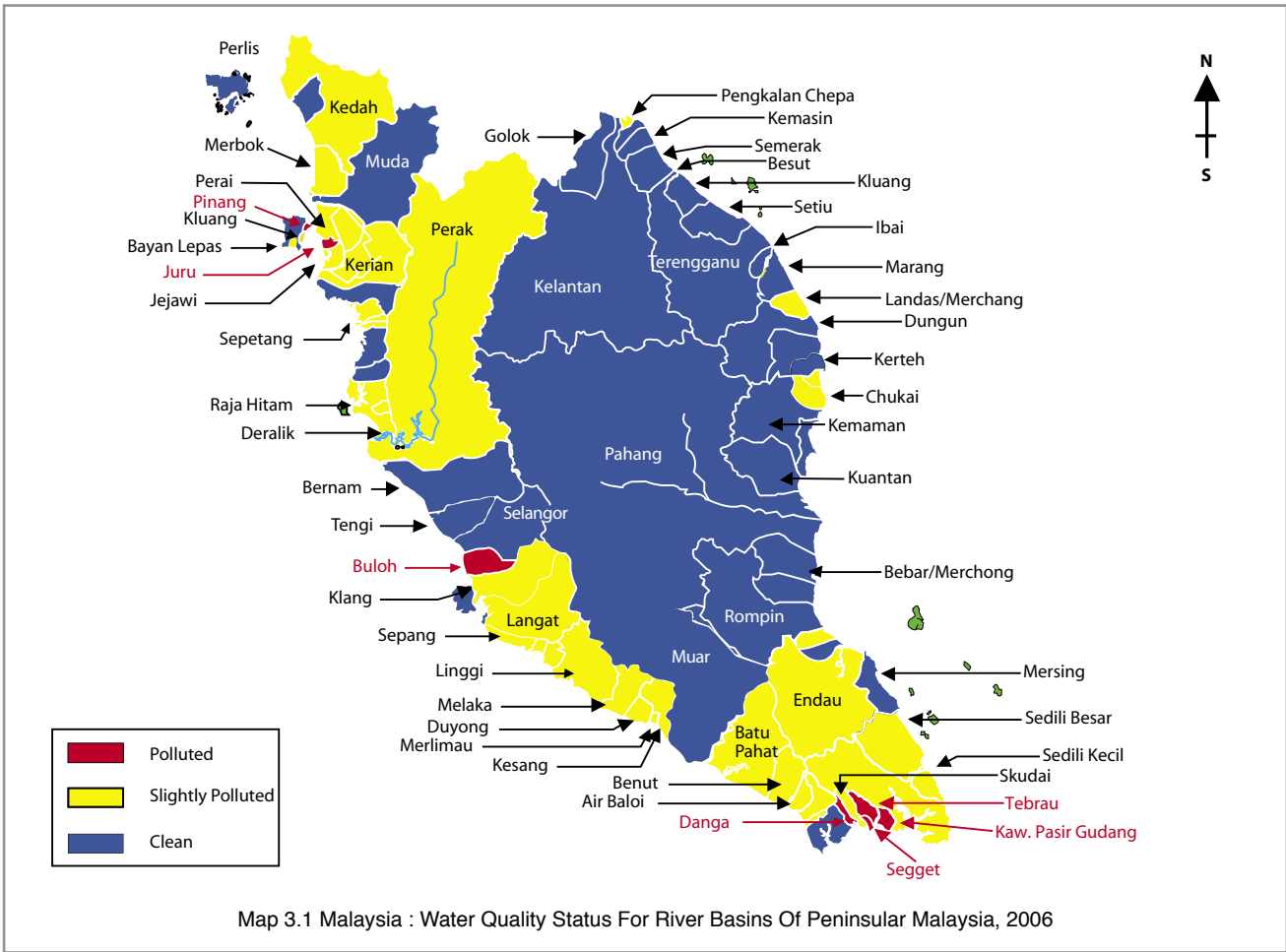
as a basis for environmental assessment of a watercourse in relation to pollution load categorization and designation of classes of beneficial uses as provided for under the National Water Quality Standards for Malaysia (NWQS)(ANNEX) .

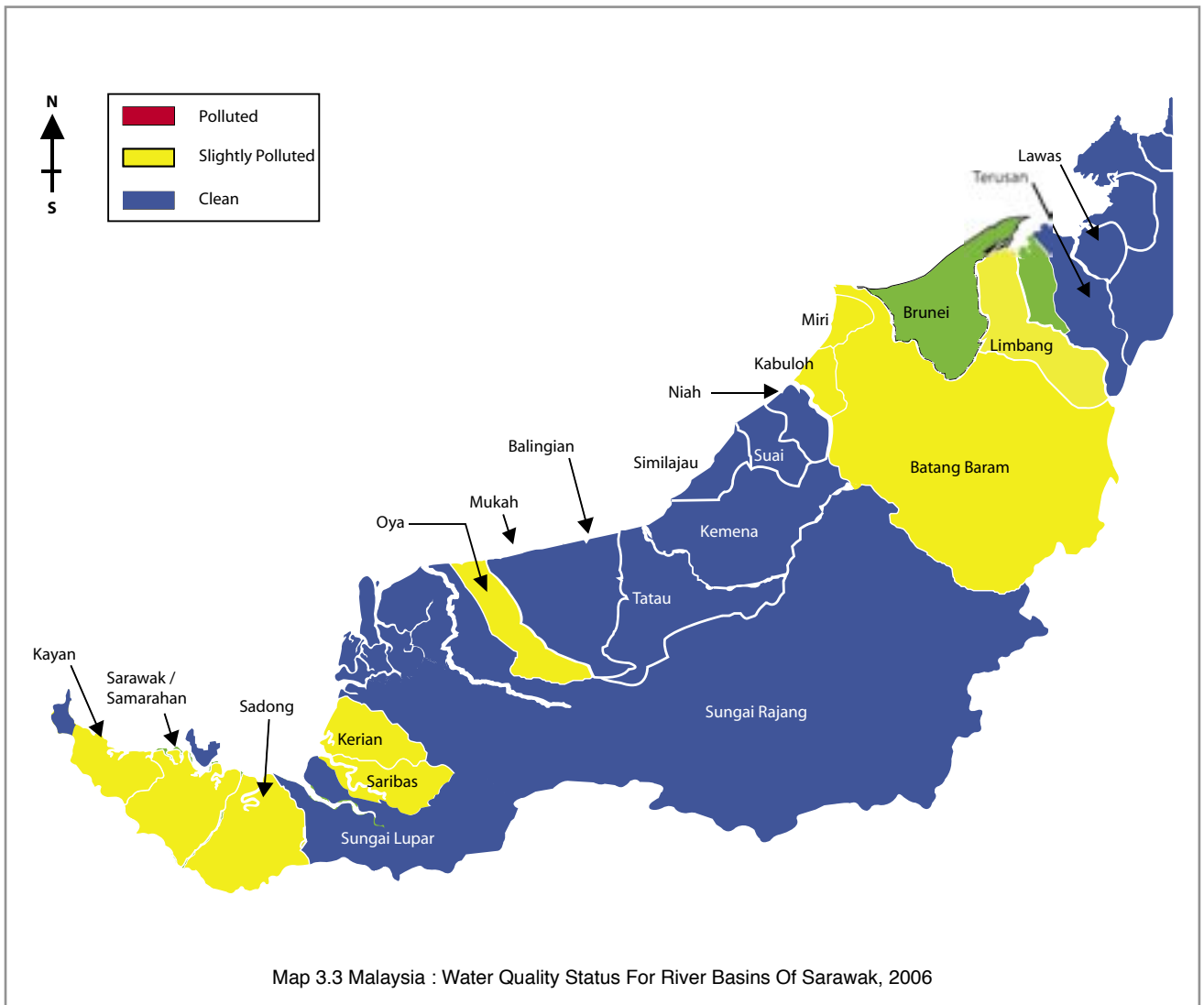
RIVER WATER QUALITY STATUS

In 2006, a total of 1,064 water quality monitoring stations located within 146 river basins were monitored (**Map 3.1, 3.2 and 3.3**). Out of these 1,064 monitoring stations, 619 (58%) were found to be clean, 359 (34%) slightly polluted and 86 (8%) polluted (**Table 3.1, 3.2 and 3.3**). Stations located upstream were generally clean, while those downstream were either slightly polluted or polluted. In terms of river basin water quality, 80 river basins (55%) were clean, 59 (40%) slightly polluted and 7 (5%) were polluted (**Figure 3.1**). The major pollutants were Biochemical Oxygen Demand (BOD), Ammoniacal Nitrogen



Clean river : Upstream Sungai Tuaran, Sabah (DOE photo library)





(NH₃-N) and Suspended Solids (SS). In 2006, 22 river basins were categorized as being polluted by BOD, 41 river basins by NH₃-N and 42 river basins by SS. High BOD was contributed largely by untreated or partially treated sewage and discharges from agro-based and manufacturing industries. The main sources of NH₃-N were domestic sewage and livestock farming, whilst the sources for SS were mostly earthworks and land clearing activities.

Cumulative water quality data compiled from 15 continuous water quality monitoring (CWQM) stations are presented in **Figures 3.2, 3.3, 3.4** and **3.5**. Based on the 90-percentile value, low dissolved oxygen levels were most frequent in Sungai Klang (52.8% saturation) followed by Sungai Perai (53.0% saturation) and Sungai Putat (54.9% saturation) (**Figure 3.2**). High ammonium levels were recorded more

frequently in Sungai Putat (7.3 mg/l) followed by Sungai Klang (6.8 mg/l) and Sungai Skudai (4.3 mg/l) (**Figure 3.3**). High turbidity level was most frequently detected at Sungai Langat (862.2 NTU), followed by Sungai Klang (636.4 NTU) and Sungai Melaka (597.40 NTU) (**Figure 3.4**). Meanwhile pH value of 6.3 was recorded at Sungai Selangor, pH 6.4 at Sungai Terengganu and pH 6.6 at Sungai Melaka (**Figure 3.5**).

Continuous monitoring is vital for early detection of pollution influx. Over the years, a number of pollution incidences had been observed at several continuous monitoring stations. For the period of January to December 2006, 21 incidences of distinctive pollution influx were observed (**Table 3.4**).

Table 3.1 Malaysia : Water Quality Status of Clean River Basins, 2006

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
PERLIS	01	PERLIS	9	83 (78)	JARUM	1	84	C	II
					JERNIH	2	85	C	II
					KOK MAK	1	80	SP	II
					NGULANG	1	82	C	II
					PELARIT	1	91	C	II
					PERLIS	1	68	SP	III
					SERAI	1	82	C	II
WANG KELIAN	1	93	C	II					
KEDAH	01PLA	KISAP	1	93 (90)	KISAP	1	93	C	I
	01PLC	MELAKA	2	90 (87)	MELAKA	1	87	C	II
	03	KEDAH	9	84 (81)	PETANG	1	93	C	I
					JANING	1	93	C	I
					KEDAH	1	72	SP	III
					PADANG TERAP	4	85	C	II
PEDU	1	90	C	II					
PENDANG	1	77	SP	II					
TEKAI	1	86	C	II					
KEDAH/ P.PINANG	05	MUDA	13	82 (81)	CHEPIR	1	85	C	II
					JERUNG	2	65	SP	III
					KARANGAN	1	87	C	II
					KETIL	2	84	C	II
					MUDA	4	86	C	II
					PEGANG	1	92	C	II
					SEDIM	1	82	C	II
					TAWAR	1	79	SP	II
PERAK	09	KURAU	6	84 (83)	ARA	1	92	C	II
	11	BERUAS	6	84 (87)	KURAU	5	80	SP	II
					BRUAS	3	83	C	II
DENDANG	1	88	C	II					
ROTAN	2	84	C	II					
PERAK/ SELANGOR	14	BERNAM	13	85 (85)	BERNAM	7	82	C	II
					INKI	1	91	C	II
					SLIM	2	89	C	II
					TEROLAK	3	90	C	II
SELANGOR	15	TENGI	3	83 (84)	TENGI	3	83	C	II
	16	SELANGOR	13	82 (80)	BATANG KALI	1	88	C	II
					KANCING	1	87	C	II
					KERLING	1	93	C	I
					KUNDANG	1	70	SP	III
					RAWANG	1	74	SP	III
					SELANGOR	6	85	C	II
					SEMBAH	1	67	SP	III
					SERENDAH	1	87	C	II
N.SEMBILAN	20J	LUKUT	1	82 (79)	LUKUT	1	82	C	II
JOHOR/ N. SEMBILAN	25	MUAR	39	81 (79)	AIR PANAS	1	91	C	II
					GEMAS	1	80	SP	II
					GEMENCHEH	2	83	C	II
					JUASEH	1	88	C	II
					KELAMAH	1	59	P	III
					LABIS	3	77	SP	II
					MEDA	1	87	C	II
					MERBUDU	1	83	C	II
					MERLIMAU	1	68	SP	III
					MUAR	16	85	C	II
					P. MENKUANG	1	85	C	II
					PALONG	4	83	C	II
					SARANG BUAYA	1	79	SP	II
					SEGAMAT	1	85	C	II
					SENARUT	1	61	SP	III
					SEROM	1	72	SP	III
SPG. LOI	1	66	SP	III					
TENANG	1	73	SP	III					
JOHOR	30A	SEDILI BESAR	10	81 (78)	AMBAT	1	86	C	II
					DOHOL	1	89	C	II
					MUPUR	1	62	SP	III
					PASIR PANJANG	1	74	SP	III
					SEDILI BESAR	5	82	C	II
					TEMUBOR KANAN	1	88	C	II
					31A	MERSING	2	87 (83)	MERSING
31B	JEMALUANG	2	81 (82)	JEMALUANG	2	81	C	II	

Table 3.1 Malaysia : Water Quality Status of Clean River Basins, 2006 (Continued)

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
PAHANG	32A	PONTIAN	2	89 (89)	PONTIAN	1	89	C	II
					SEPAYANG	1	69	SP	III
	32AE	ANAK ENDAU	2	89 (85)	ANAK ENDAU	2	89	C	II
	33	ROMPIN	16	88 (85)	AUR	1	88	C	II
					BAKAR	1	72	SP	III
					JEKATIH	2	90	C	II
					JERAM	1	89	C	II
					KEPASING	1	85	C	II
					KERATONG	3	87	C	II
					PUKIN	3	89	C	II
					ROMPIN	4	87	C	II
	34B	BEBAR	5	84 (85)	BEBAR	1	81	C	II
					MERBA	1	82	C	II
					SERAI	2	83	C	II
					TEMIANG	1	90	C	II
	34M	MERCHONG	2	85 (81)	KELAYAT	1	89	C	II
					MERCHONG	1	81	C	II
	35P	PAHANG	91	88 (87)	ANAK SG. LEPAR	1	75	SP	III
					BATU	1	78	SP	II
					BELAYAR	1	89	C	II
					BENTONG	4	89	C	II
					BENUS	2	90	C	II
					BERA	3	84	C	II
					BERKAPOR	1	88	C	II
					BERTAM	3	86	C	II
					BILUT	1	85	C	II
					BURUNG	1	94	C	I
					CHINI	1	86	C	II
					HABU	1	90	C	II
					JELAI	2	89	C	II
					JEMPOL	2	89	C	II
					JENGKA	2	85	C	II
					KELAU	2	89	C	II
					KERTAM	1	84	C	II
					KOYAN	1	89	C	II
					KUNDANG	1	81	C	II
					LENGGOK	1	92	C	II
					LEPAR	3	87	C	II
					LIPIS	3	90	C	II
					LUIT	1	87	C	II
					MARAN	1	88	C	II
					MENTIGA	2	85	C	II
					PAHANG	8	87	C	II
					PENJURING	1	94	C	I
					PERTANG	2	89	C	II
					PERTING	1	93	C	II
					RINGLET	1	81	C	II
SEMANTAN					3	86	C	II	
SERTING					5	78	SP	II	
T. PAYA BUNGOR					1	84	C	II	
TAHAN					1	93	C	I	
TANGLIR					1	90	C	II	
TASIK BERA	1	87	C	II					
TASIK CHINI	10	96	C	I					
TEKAL	1	79	SP	II					
TEKAM	2	88	C	II					
TELANG	1	91	C	II					
TELEMONG	1	92	C	II					
TELOM	2	88	C	II					
TEMBELING	1	90	C	II					
TERANUM	1	94	C	I					
TERAS	1	93	C	I					
TERLA	1	92	C	II					
TRIANG	2	87	C	II					
TRINGKAP	1	85	C	II					
36	KUANTAN	15	82 (80)	BELAT	1	87	C	II	
				CHARU	1	90	C	II	
				GALING BESAR	1	49	C	II	
				GALING KECIL	1	56	P	IV	
				KENAU	1	92	P	III	
				KUANTAN	8	87	C	II	
				PINANG	1	86	C	II	
RIAU	1	81	C	II					
37B	BALOK/TONGGOK	6	82 (76)	BALOK	4	81	C	II	
				TONGGOK	2	82	C	II	
37A	CERATING	1	84 (83)	CERATING	1	84	C	II	

Table 3.1 Malaysia : Water Quality Status of Clean River Basins, 2006 (Continued)

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
TERENGGANU	38	KEMAMAN	9	89 (88)	CHERUL	2	91	C	II
					KEMAMAN	3	91	C	II
					NERAM	1	80	SP	II
					PERASING	1	89	C	II
					RANSAN	2	81	C	II
	39K	KERTIH	2	85 (87)	KERTIH	2	85	C	II
	40	PAKA	6	85 (87)	BESUL	1	89	C	II
					PAKA	2	85	C	II
					RASAU	2	86	C	II
	41	DUNGUN	5	91 (88)	RENGAT	1	78	SP	II
					DUNGUN	4	91	C	II
	42I	IBAI	3	81 (83)	TELEMBOH	1	86	C	II
					IBAI	3	81	C	II
	42M	MARANG	3	82 (82)	KERAK	1	74	SP	III
					MARANG	1	90	C	II
					TEMALA	1	85	C	II
	43	TERENGGANU	12	84 (85)	BERANG	2	93	C	I
					NERUS	4	78	SP	II
PUEH					2	80	SP	II	
TELEMONG					1	87	C	II	
TERENGGANU					3	86	C	II	
44	SETIU	5	89 (85)	SETIU	4	89	C	II	
				TAROM	1	82	C	II	
46	BESUT	4	90 (90)	BESUT	3	91	C	II	
				JERTIH	1	89	C	II	
47A	MERANG	1	82 (84)	MERANG	1	82	C	II	
47B	KLUANG	1	89 (83)	KLUANG	1	89	C	II	
KELANTAN	47K	KEMASIN	2	83 (82)	KEMASIN	2	83	C	II
					SEMERAJ	3	84 (77)	C	II
	48	KELANTAN	42	86 (87)	ARING	1	82	C	II
					BELATOP	2	82	C	II
					BER	1	88	C	II
					BEROK	3	85	C	II
					BETIS	1	90	C	II
					CHIKU	1	85	C	II
					GALAS	5	86	C	II
					KELANTAN	3	83	C	II
					KELESA	1	87	C	II
					KERILLA	2	90	C	II
					KETIL	1	90	C	II
					LEBIR	4	84	C	II
					NAL	3	92	C	II
					NENGGIRI	3	83	C	II
					PEHI	1	88	C	II
	PERGAU	6	89	C	II				
RELAI	2	83	C	II					
SOKOR	1	85	C	II					
TUANG	1	89	C	II					
48PD	PENKALAN DATU	3	81 (85)	PENKALAN DATU	3	81	C	II	
49	GOLOK	7	89 (88)	GOLOK	5	90	C	II	
				LANAS	1	88	C	II	
				TASIK GARU	1	89	C	II	
SARAWAK	50S	SEMUNSAM	1	86 (89)	SEMUNSAM	1	86	C	II
					LUPAR	8	88 (83)	C	II
	53	LUPAR	8	88 (83)	AI	2	92	C	II
					LUPAR	3	85	C	II
					SEKERANG	1	89	C	II
					SETERAP	1	87	C	II
					UNDUP	1	87	C	II
					56	RAJANG	19	84 (82)	BALOI
	58	MUKAH	4	81 (81)	BINATANG	1	91	C	II
					JULAU	1	90	C	II
					KANOWIT	1	88	C	II
					MERADONG	1	81	C	II
					RAJANG	12	83	C	II
					SALIM	1	80	SP	II
					SARIKEI	1	85	C	II
	59	BALINGIAN	2	83 (83)	BALINGIAN	2	83	C	II
60	TATAU	1	82 (82)	TATAU	1	82	C	II	
61	KEMENA	5	83 (81)	KEMENA	4	84	C	II	
				SIBIU	1	81	C	II	
62	SIMILAJAU	2	87 (84)	SIMILAJAU	2	87	C	II	
63	SUAI	1	81 (83)	SUAI	1	81	C	II	
64	NIAH	4	82 (83)	NIAH	2	86	C	II	
				SEKALOH	2	75	SP	III	
69	TRUSAN	1	85 (89)	TRUSAN	1	85	C	II	
70	LAWAS	3	90 (85)	LAWAS	3	90	C	II	

Table 3.1 Malaysia : Water Quality Status of Clean River Basins, 2006 (Continued)

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
SABAH	71L	LAKUTAN	1	90 (87)	LAKUTAN	1	90	C	II
	71LG	LINGKUNGAN	2	90 (89)	BUKAU	1	90	C	II
					LINGKUNGAN	1	90	C	II
	71MG	MENGALONG	2	89 (86)	MENGALONG	2	89	C	II
					PADAS	10	87 (86)	ANSIP	1
	BUNSI	1	90	C				II	
	LIAWAN	1	87	C				II	
	PADAS	3	86	C				II	
	PANGATAN	1	84	C				II	
	PEGALAN	2	86	C				II	
	TANDULU	1	91	C				II	
	72BW	BONGAWAN	1	86 (82)				BONGAWAN	1
	72KM	KIMANIS	1	88 (82)	KIMANIS	1	88	C	II
	73	MEMBAKUT	1	87 (83)	MEMBAKUT	1	87	C	II
	74	PAPAR	3	88 (89)	PAPAR	3	88	C	II
	76	MOYOG	4	91 (91)	MOYOG	4	91	C	II
	77	DAMIT/TUARAN	5	88 (90)	DAMIT	2	85	C	II
					SONG SAI	1	89	C	II
	78	KEDAMAIAN	4	91 (90)	TUARAN	2	90	C	II
					KEDAMAIAN	1	91	C	II
					TEMPASUK	2	91	C	II
	78T	TENGHILAN	1	88 (91)	WARIU	1	91	C	II
					TENGHILAN	1	89	C	II
	79	BINGKONGAN	6	91 (87)	BANDAU	1	90	C	II
					MENGGARIS	2	93	C	II
					TANDEK	3	90	C	II
	80	BENGKOKA	2	88 (89)	BENGKOKA	2	87	C	II
	83	SUGUT	6	91 (92)	BONGKUD	1	93	C	I
					LOHAN	1	93	C	I
					MERALI	1	91	C	II
					SUGUT	3	90	C	II
	83P	PAITAN	1	85 (82)	PAITAN	1	85	C	II
	84	LABOK	7	89 (89)	KINIPIR	2	89	C	II
					LABOK	1	84	C	II
					LIWAGU	2	90	C	II
					MALIAU	1	94	C	I
					TUNGUD	1	87	C	II
	84SP	SAPI	4	83 (86)	SAPI	3	81	C	II
					SUALONG	1	91	C	II
	86	KINABATANGAN	10	81 (84)	KARAMUAK	1	88	C	II
KINABATANGAN					2	81	C	II	
KOYAH					1	83	C	II	
LEEPANG					1	77	SP	II	
MENANGGUL					1	80	SP	II	
PIN					1	82	C	II	
TAKALA					1	81	C	II	
TENEGANG BESAR					2	79	SP	II	
87	SEGAMA	3	85 (87)	SEGAMA	3	85	C	II	
88T	TUNGKU	2	88 (82)	TUNGKU	2	88	C	II	
89	TINGKAYU	2	84 (86)	TINGKAYU	2	84	C	II	
91	APAS	1	92 (89)	APAS	1	92	C	II	
91B	BALUNG	1	89 (82)	BALUNG	1	89	C	II	
92	TAWAU	4	88 (88)	TAWAU	4	88	C	II	
93	UMAS-UMAS	1	90 (84)	UMAS-UMAS	1	85	C	II	
94	BRANTIAN	1	85 (86)	BRANTIAN	1	83	C	II	
96	MEROTAI	3	83 (85)	MEROTAI	3	90	C	II	

Notes :

1. WQI based on 6 major parameters : BOD, COD, SS, pH, DO and NH₃-N
2. River water quality status : C = Clean, SP = Slightly polluted and P = Polluted
3. River class based on NWQS
4. () = Overall WQI for 2005
5. Overall WQI for river basin is calculated by averaging WQI from all sampling stations in each river basin

Table 3.2 Malaysia : Water Quality Status of Slightly Polluted River Basins, 2006

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
KEDAH	01PLB 04	KUAH	1	71 (65)	KUAH	1	71	SP	III
		MERBOK	11	68 (59)	BAKAR ARANG	1	59	P	III
	BATU				1	45	P	IV	
	BONGKOK				1	75	SP	III	
	BUKIT MERAH				1	70	SP	III	
	KOROK				1	51	P	IV	
	MERBOK				1	80	SP	II	
	PETANI				1	51	P	IV	
	TOK PAWANG				2	66	SP	III	
	TUPAH				2	77	SP	II	
P. PINANG	06T	BAYAN LEPAS	3	60 (58)	BAYAN LEPAS	1	63	SP	III
					TIRAM	2	59	P	III
	06P	PERAI	20	64 (60)	AIR MELINTAS	1	44	P	IV
					JARAK	5	68	SP	III
					KARANGAN	1	87	C	II
					KELADI	1	66	SP	III
					KEREH	2	50	P	IV
					KUBANG SEMANG	1	56	P	III
					KULIM	3	83	C	II
					PERAI	2	62	SP	III
					PERTAMA	1	50	P	IV
					SELUANG	1	58	P	III
	SELUANG BAWAH	2	60	SP	III				
	06K	KLUANG	4	75 (72)	ARA	2	80	SP	II
					KLUANG	1	72	SP	III
					RELAU	1	65	SP	III
07	JEJAWI	7	60 (59)	CEMPEDAK	1	32	P	IV	
				JAWI	1	47	P	IV	
				JUNJONG	3	60	SP	III	
				MACHANG BUBOK	1	70	SP	III	
				TENGAH	1	61	SP	III	
P.PINANG/ PERAK	08	KERIAN	9	79 (74)	KECHIL	2	91	C	II
					KERIAN	4	82	C	II
					SELAMA	2	66	SP	III
					SERDANG	1	77	SP	II
PERAK	10	SEPETANG	15	80 (79)	BATU TEGUH	4	83	C	II
					JANA	1	76	SP	III
					LARUT	1	76	SP	III
					LIDIN	1	77	SP	II
					LIMAU	1	91	C	II
					MALAI	1	55	P	III
					SEPETANG	2	72	SP	III
					TEMERLOH	2	89	C	II
					TRONG	1	90	C	II
					TUPAI	1	79	SP	II
	12	RAJA HITAM/ MANJONG	8	75 (70)	DERHAKA	2	79	SP	II
					MANJONG	2	87	C	II
					NYIOR	1	92	C	II
					RAJA HITAM	3	60	SP	III
	12W	DERALIK/WANGI	4	78 (76)	DERALIK	2	79	SP	II
					WANGI	2	76	SP	III
	13	PERAK	58	76 (75)	BATANG PADANG	3	87	C	II
					BIDOR	3	83	C	II
					CHENDERANG	2	84	C	II
					CHEPOR	1	92	C	II
					CUAR	1	88	C	II
					KAMPAR	2	90	C	II
					KANGSAR	2	82	C	II
					KEPAYANG	2	61	SP	III
					KERDAH	2	69	SP	III
					KINJANG	1	93	C	I
					KINTA	8	69	SP	III
					KLAH	2	88	C	II
					KLIAN BARU	2	66	SP	III
					KUANG	1	81	C	II
					NYAMOK	1	51	P	IV
					PARI	2	62	SP	III
					PELUS	2	89	C	II
PERAK					8	83	C	II	
PINJI					2	55	P	III	
RAIA					2	88	C	II	
SELUANG					1	67	SP	III	
SEROKAI	2	53	P	III					
SINTANG	1	49	P	IV					
SUNGKAI	2	88	C	II					
SUNGKAI MATI	2	73	SP	III					
TUMBOH	1	70	SP	III					

Table 3.2 Malaysia : Water Quality Status of Slightly Polluted River Basins, 2006 (Continued)

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS					
SELANGOR/ WP KUALA LUMPUR	18	KLANG	30	63 (55)	AMPANG	1	69	SP	III					
					BATU	3	59	P	III					
					BUNOS	1	62	SP	III					
					DAMANSARA	3	68	SP	III					
					GOMBAK	3	74	SP	III					
					JINJANG	2	56	P	III					
					KERAYONG	2	56	P	III					
					KEROH	2	61	SP	III					
					KLANG	11	63	SP	III					
					KUYOH	1	68	SP	III					
		PENCALA	1	51	P	IV								
SELANGOR	19	LANGAT	28	77 (74)	ANAK CHUAU	1	87	C	II					
					BALAK	1	64	SP	III					
					BATANG BENAR	2	73	SP	III					
					BATANG LABU	2	78	SP	II					
					BATANG NILAI	2	65	SP	III					
					BERANANG	1	82	C	II					
					BUAN	1	77	SP	II					
					CHUAU	2	91	C	II					
					JIJAN	1	86	C	II					
					LANGAT	8	74	SP	III					
					LIMAU MANIS	1	61	SP	III					
					LUI	1	91	C	II					
					PAJAM	1	76	SP	III					
					RINCHING	1	81	C	II					
					SEMENYIH	3	83	C	II					
	20	SEPANG	4	71 (67)	RAMBAI	1	49	P	IV					
					SEPANG	3	78	SP	II					
N. SEMBILAN	21	LINGGI	21	76 (73)	BATANG PENAR	3	71	SP	III					
					CHEMBONG	1	84	C	II					
					KAYU ARA	1	74	SP	III					
					KEPAYONG	1	78	SP	II					
					KUNDUR BESAR	1	90	C	II					
					LINGGI	6	73	SP	III					
					PAROI	1	74	SP	III					
					PEDAS	1	85	C	II					
					REMBAU	2	85	C	II					
					SENAWANG	1	70	SP	III					
					SIMIN	1	73	SP	III					
TEMIANG	2	72	SP	III										
MELAKA	22	MELAKA	21	74 (71)	BTG. MELAKA	2	85	C	II					
					DURIAN TUNGGAL	1	84	C	II					
					KEMUNTING	1	85	C	II					
					KERU	1	86	C	II					
					MELAKA	9	70	SP	III					
					PUTAT	2	68	SP	III					
					REMBIA	2	67	SP	III					
					TAMPIN	3	86	C	II					
						23	DUYONG	4	76 (72)	DUYONG	3	72	SP	III
										GAPAM	1	89	C	II
		24	KESANG	7	76 (76)	CHIN-CHIN	1	63	SP	III				
						CHOHONG	2	86	C	II				
						KESANG	3	80	SP	II				
						TANGKAK	1	60	SP	III				
		24A	MERLIMAU	4	64 (58)	MERLIMAU	4	64	SP	III				
	24B/T	TUANG/BARU	2	64 (70)	BARU	1	64	SP	III					
					TUANG	1	63	SP	III					
	24L	LINGGI	3	80 (77)	SIMPANG EMPAT	1	79	SP	II					
					SIPUT	2	80	SP	II					
	24SM	SRI MELAKA	2	64 (62)	AYER SALAK	1	59	P	III					
					SRI MELAKA	1	68	SP	III					
JOHOR	26	BATU PAHAT	20	72 (72)	AMRAN	1	81	C	II					
					BANTANG	1	93	C	I					
					BATU PAHAT	1	58	P	III					
					BEKOK	5	79	SP	II					
					BERLIAN	1	72	SP	III					
					CHAAH	1	87	C	II					
					LENIK	1	81	C	II					
					MEREK	1	84	C	II					
					MERPO	1	69	SP	III					
					SEMBERONG	2	60	SP	III					
					SIMPANG KANAN	2	56	P	III					
					SIMPANG KIRI	3	65	SP	III					
		27A	AIR BALOI	3	62 (59)	AIR BALOI	3	62	SP	III				

Table 3.2 Malaysia : Water Quality Status of Slightly Polluted River Basins, 2006 (Continued)

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
	27B	BENUT	7	76 (72)	BENUT	4	75	SP	III
					PINGGAN	1	63	SP	III
					PT. HAJI YASSIN	1	84	C	II
					ULU BENUT	1	84	C	II
	28A	PONTIAN BESAR	7	69 (68)	AIR HITAM	1	76	SP	III
					AYER MERAH	1	68	SP	III
					KELAPA SAWIT	1	58	P	III
					PONTIAN BESAR	4	71	SP	III
	28B	PONTIAN KECIL	2	77 (80)	PONTIAN KECIL	2	77	SP	II
	28C	SKUDAI	11	63 (64)	MELANA	2	59	P	III
					SKUDAI	9	64	SP	III
	28E	KEMPAS	2	60 (56)	KEMPAS	2	60	SP	III
	28G	RAMBAH	2	80 (69)	RAMBAH	2	80	SP	II
	29	JOHOR	39	80 (81)	ANAK SG. SAYONG	2	54	P	III
					BELITONG	1	86	C	II
					BERANGAN	1	64	SP	III
					BKT. BESAR	2	62	SP	III
					CHEMANGAR	1	82	C	II
					JOHOR	5	85	C	II
					LAYANG	1	91	C	II
					LAYAU KIRI	1	86	C	II
					LEBAM	1	80	SP	II
					LINGGIU	1	87	C	II
					PANTI	1	78	SP	II
					PAPAN	1	83	C	II
					PELEPAH	1	92	C	II
					PENGGELI	1	88	C	II
					REMIS	1	87	C	II
					SANTI	1	86	C	II
SAYONG					5	86	C	II	
SEBOL					1	81	C	II	
SELUYUT					1	82	C	II	
SEMANGER					1	86	C	II	
SEMENCHU					1	84	C	II	
SENING					1	71	SP	III	
SERAI					1	56	P	III	
TELOR	1	87	C	II					
TEMON	1	88	C	II					
TIRAM	4	79	SP	II					
29S	SANGLANG	1	66 (63)	SANGLANG	1	66	SP	III	
30	PULAI	3	68 (74)	PULAI	2	74	SP	III	
				ULU CHOHO	1	57	P	III	
30B	SEDILI KECIL	6	77 (74)	ANAK SEDILI KECIL	1	49	P	IV	
				BAHAN	2	81	C	II	
				SEDILI KECIL	3	83	C	II	
30C	PALOI	1	77 (88)	PALOI	1	77	SP	II	
31C	KIM-KIM	2	75 (71)	KIM-KIM	2	75	SP	III	
32	ENDAU	25	78 (78)	A.S. SEMBERONG	1	84	C	II	
				DENGAR	1	80	SP	II	
				ENDAU	2	86	C	II	
				JASIN	1	91	C	II	
				JEBONG	1	71	SP	III	
				KAHANG	1	87	C	II	
				LENGGA	1	57	P	III	
				LENGGOR	1	80	SP	II	
				MAMAI	1	83	C	II	
				MELANTAI	1	62	SP	III	
				MENKIBOL	3	70	SP	III	
				PALOH	1	82	C	II	
				PAMOL	1	61	SP	III	
				SELAI	1	92	C	II	
				SEMBERONG	6	79	SP	II	
				SINGOL	1	73	SP	III	
				TAMOK	1	86	C	II	
TERENGGANU	39C	CHUKAI	6	77 (73)	BUNGKUS	1	79	SP	II
					CHUKAI	1	85	C	II
					IBOK	2	86	C	II
					RUANG	2	67	SP	III
42L	LANDAS	2	78 (79)	LANDAS	1	74	SP	III	
				MERCHANG	1	90	C	II	
KELANTAN	48PC	PENGKALAN CHEPA	6	70 (67)	ALOR B	1	56	P	III
					ALOR LINTAH	1	61	SP	III
					KELADI	1	79	SP	II
					PENGKALAN CHEPA	3	75	SP	III

Table 3.2 Malaysia : Water Quality Status of Slightly Polluted River Basins, 2006 (Continued)

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
SARAWAK	50	KAYAN	3	80 (86)	KAYAN	3	80	SP	II
	51	SARAWAK	15	79 (82)	KELANTAN	1	50	P	IV
					KUAP	2	71	SP	III
					MAONG KIRI	1	63	SP	III
					SARAWAK	5	83	C	II
					SARAWAK KANAN	2	81	C	II
					SARAWAK KIRI	1	84	C	II
					SEMADANG	1	87	C	II
					SEMENGGOH	1	62	SP	III
					TABUAN	1	74	SP	III
					51BS	SAMARAHAN	2	78 (81)	SAMARAHAN
	52	SADONG	7	80 (83)	KARANGAN	2	78	C	II
					SADONG	4	81	SP	II
					TARAT	1	78	C	II
	54	SARIBAS	3	80 (77)	LAYAR	2	81	C	II
					SARIBAS	1	78	SP	II
	55	KERIAN	3	78 (77)	KERIAN	2	77	SP	II
					SEBLAK	1	80	SP	II
	57	OYA	3	80 (79)	OYA	3	80	SP	II
	65	KABULOH	6	80 (77)	KABULOH	2	73	SP	III
KEJAPIL					1	84	C	II	
SATAP					1	83	C	II	
SIBUTI					2	86	C	II	
66	MIRI/LUTONG	7	72 (72)	ADONG	1	70	SP	III	
				DALAM	1	63	SP	III	
				LUTONG	2	64	SP	III	
				MIRI	2	73	SP	III	
				PADANG LIKU	1	89	C	II	
67	BARAM	5	80 (80)	BARAM	4	79	SP	II	
				TUTOH	1	80	SP	II	
68	LIMBANG	5	78 (85)	LIMBANG	5	78	SP	II	
SABAH	76	INANAM	8	78 (77)	DARAU	1	74	SP	III
					INANAM	3	85	C	II
					LIKAS	2	63	SP	III
					MENGGATAL	2	85	C	II
					76SB	SEMBULAN	2	66 (59)	SEMBULAN
	76	TELIPOK	2	70 (67)	TELIPOK	2	70	SP	III
	85	MOUNAD	2	76 (69)	MOUNAD	2	76	SP	III
	85A	SEGALIUD	2	76 (78)	SEGALIUD	2	76	SP	III
	88	SILABUKAN	2	79 (81)	SILABUKAN	2	79	SP	II
	90	KALUMPANG	5	77 (73)	KALUMPANG	3	85	C	II
PANG BURONG 1					1	56	P	III	
PANG BURONG 2					1	76	SP	III	
95	KALABAKAN	3	78 (78)	KALABAKAN	3	78	SP	II	

Notes :

1. WQI based on 6 major parameters : BOD, COD, SS, pH, DO and NH₃-N
2. River water quality status : C = Clean, SP = Slightly polluted and P = Polluted
3. River class based on NWQS
4. () = Overall WQI for 2005
5. Overall WQI for river basin is calculated by averaging WQI from all sampling stations in each river basin

Table 3.3 Malaysia : Water Quality Status of Polluted River Basins, 2006

STATE	CODE WQR	RIVER BASIN	NO. OF STATIONS	OVERALL WQI	RIVER	NO. OF STATIONS	WQI	RIVER STATUS	CLASS
P. PINANG	06J	JURU	12	54 (46)	ARA	1	47	P	IV
					JURU	2	54	P	III
					KILANG UBI	6	64	SP	III
					PASIR	1	46	P	IV
					RAMBAI	2	44	P	IV
	06PP	PINANG	11	46 (44)	AIR ITAM	5	47	P	IV
					AIR TERJUN	1	91	C	II
					DONDANG	3	45	P	IV
					JELUTONG	1	29	P	V
					PINANG	1	44	P	IV
SELANGOR	17	BULOH	5	57 (51)	BULOH	5	P	III	
JOHOR	28	SEGGET	5	50 (47)	SEGGET	5	50	P	IV
					28D	TEBRAU	11	57 (57)	BALA
		PANDAN	1	44	P				IV
		PLENTONG	1	58	P				III
		SEBULUNG	1	52	P				III
		SENGKUANG	1	43	P				IV
		TAMPOI	1	48	P				IV
		TEBRAU	5	66	SP				III
	28F	DANGA	2	51 (52)	DANGA	2	51	P	IV
	29B	KAW. PASIR GUDANG	5	42 (43)	BULUH	1	32	P	IV
					LATOH	1	60	SP	III
					MASAI	1	62	SP	III
					PEREMBI	1	37	P	IV
TUKANG BATU					1	21	P	V	

Notes :

1. WQI based on 6 major parameters : BOD, COD, SS, pH, DO and NH₃-N
2. River water quality status : C = Clean, SP = Slightly polluted and P = Polluted
3. River class based on NWQS
4. () = Overall WQI for 2005
5. Overall WQI for river basin is calculated by averaging WQI from all sampling stations in each river basin

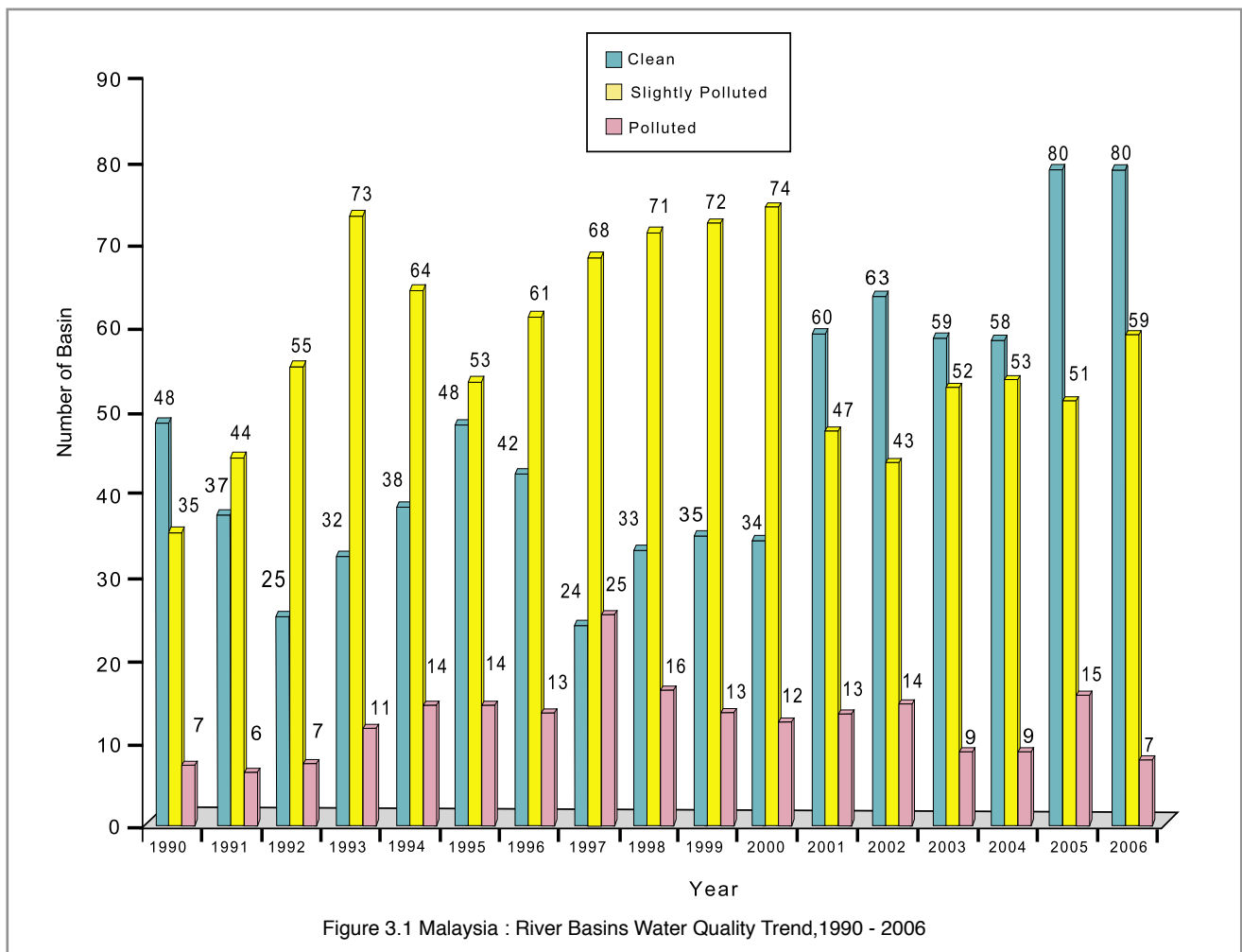


Figure 3.1 Malaysia : River Basins Water Quality Trend, 1990 - 2006

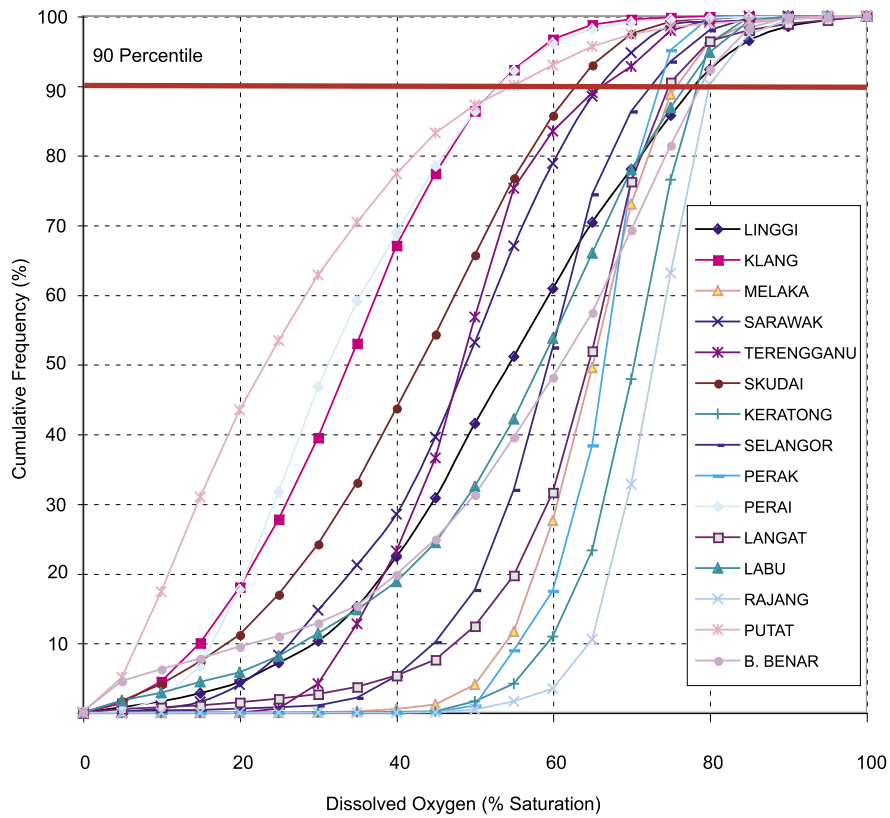


Figure 3.2: Comparison of Cumulative Frequency for 15 CWQM Stations - Dissolved Oxygen : 1 January - 31 December 2006

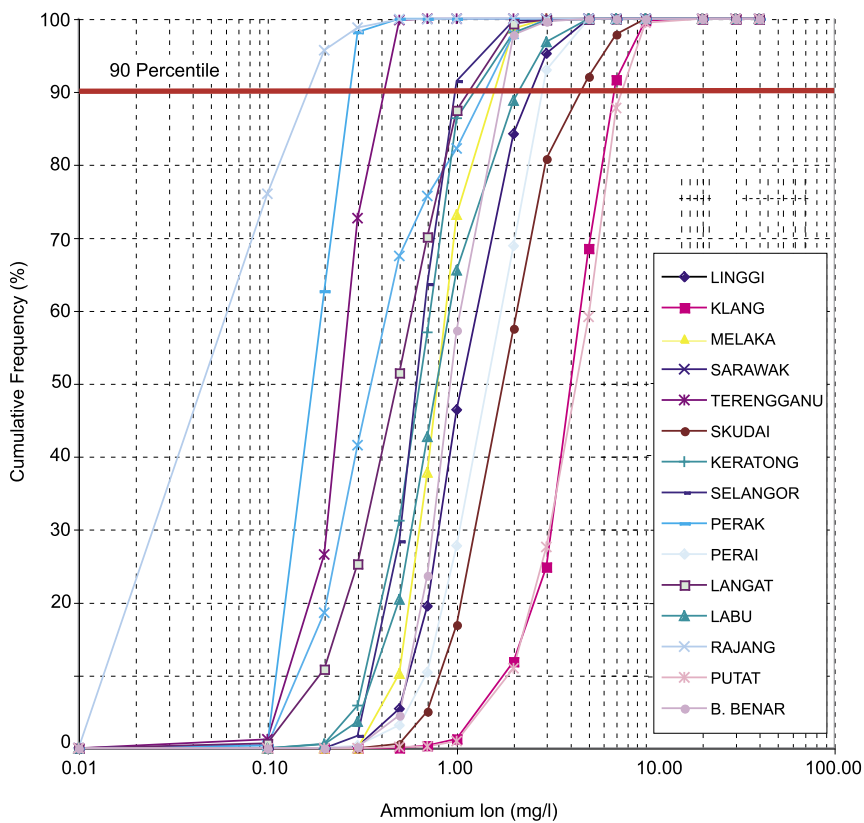


Figure 3.3 : Comparison of Cumulative Frequency for 15 CWQM Stations - Ammonium Ion Concentration : 1 January - 31 December 2006

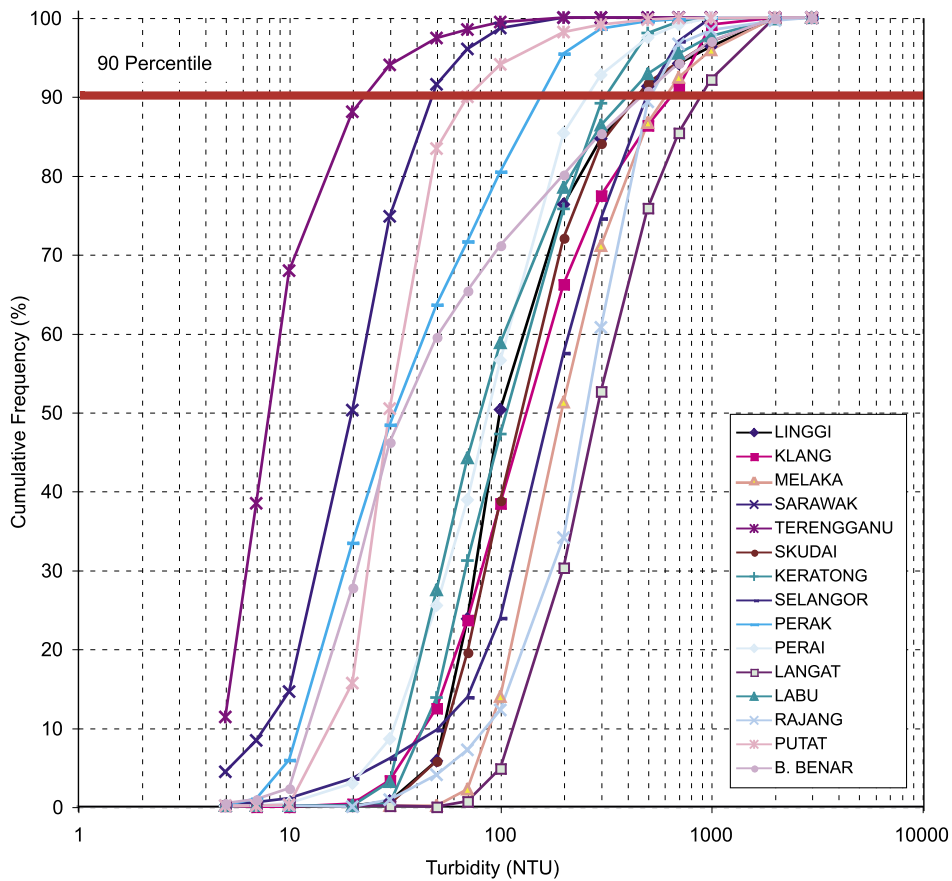


Figure 3.4 : Comparison of Cumulative Frequency for 15 CWQM Stations -
Turbidity : 1 January - 31 December 2006

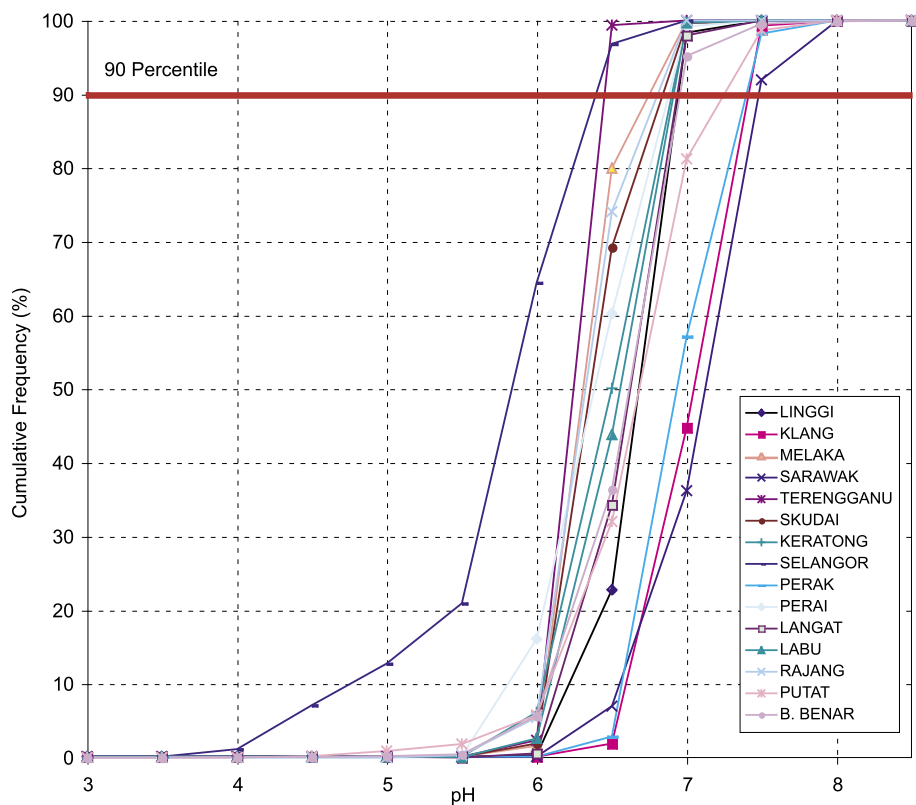


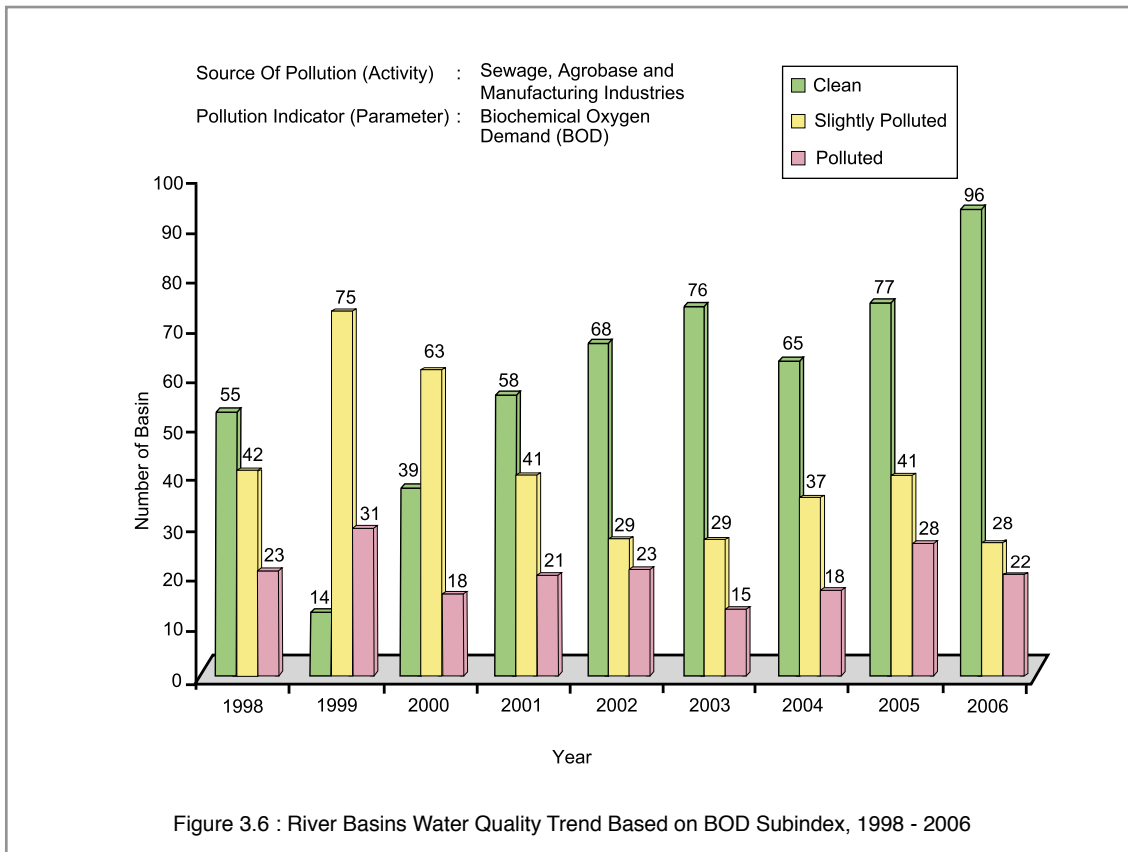
Figure 3.5 : Comparison of Cumulative Frequency for 15 CWQM Stations -
pH Level : 1 January - 31 December 2006

Table 3.4 Malaysia : Pollution Influx Observed at Continuous Water Quality Station

Station	Date	Parameter	Pollution Sources
Sungai Batang Benar	14 Jan `06	NH ₄ : 3.36 mg/l Turbidity : 23.55 NTU	Sewage or latex based industry
Sungai Linggi	23 Jan `06	NH ₄ : 3.79 mg/l Turbidity : 242 NTU	Sewage or earthworks
Sungai Batang Benar	25 Jan `06	NH ₄ : 2.16 mg/l Turbidity : 122.26 NTU	Sewage or latex based industry and industrial discharge
Sungai Melaka	15 Feb `06	NH ₄ : 3.37 mg/l pH : 6.50	Sewage or latex based industry
Sungai Skudai	22 Feb `06	NH ₄ : 7.86 mg/l Turbidity : 714.87 NTU	Sewage or latex based industry
Sungai Selangor	26 Feb `06	NH ₄ : 4.51 mg/l pH : 6.05 NTU	Sewage or latex based industry
Sungai Batang Benar	29 Mar `06	NH ₄ : 2.80 mg/l Conductivity : 214.25 μ S/cm	Sewage or latex based industry
Sungai Batang Benar	11 Apr `06	NH ₄ : 3.09 mg/l DO : 1.55 mg/l	Sewage or latex based industry
Sungai Batang Benar	12 Apr `06	NH ₄ : 2.48 mg/l DO : 2.82 mg/l	Sewage or latex based industry
Sungai Langat	15 Apr `06	NH ₄ : 7.51 mg/l DO : 0.28 mg/l	Sewage or latex based industry
Sungai Batang Benar	15 Apr `06	NH ₄ : 2.05 mg/l DO : 3.45 mg/l	Sewage or latex based industry
Sungai Batang Benar	23 Apr `06	NH ₄ : 3.53 mg/l Turbidity : 863 NTU	Sewage or latex based industry
Sungai Labu	25 Apr `06	NH ₄ : 2.89 mg/l DO : 0.26 mg/l	Sewage or latex based industry
Sungai Batang Benar	2 May `06	NH ₄ : 5.25 mg/l	Sewage or latex based industry
Sungai Batang Benar	29 May `06	NH ₄ : 3.23 mg/l DO : 0.67 mg/l	Sewage or latex based industry
Sungai Batang Benar	13 Jun `06	NH ₄ : 4.05 mg/l Conductivity : 339 μ S/cm	Sewage or industrial discharge
Sungai Labu	11 July `06	NH ₄ : 5.07 mg/l	Sewage or industrial discharge
Sungai Batang Benar	4 Aug `06	NH ₄ : 4.85 mg/l	Sewage or industrial discharge
Sungai Batang Benar	31 Aug `06	NH ₄ : 4.02 mg/l	Sewage or latex based industry
Sungai Keratong	21 Oct `06	NH ₄ : 5.95mg/l	Sewage or industrial discharge
Sungai Batang Benar	10 Nov `06	NH ₄ : 4.14mg/l Conductivity : 242 μ S/cm	Sewage or industrial discharge



Polluted river : Partially treated sewage discharge (DOE photo library)

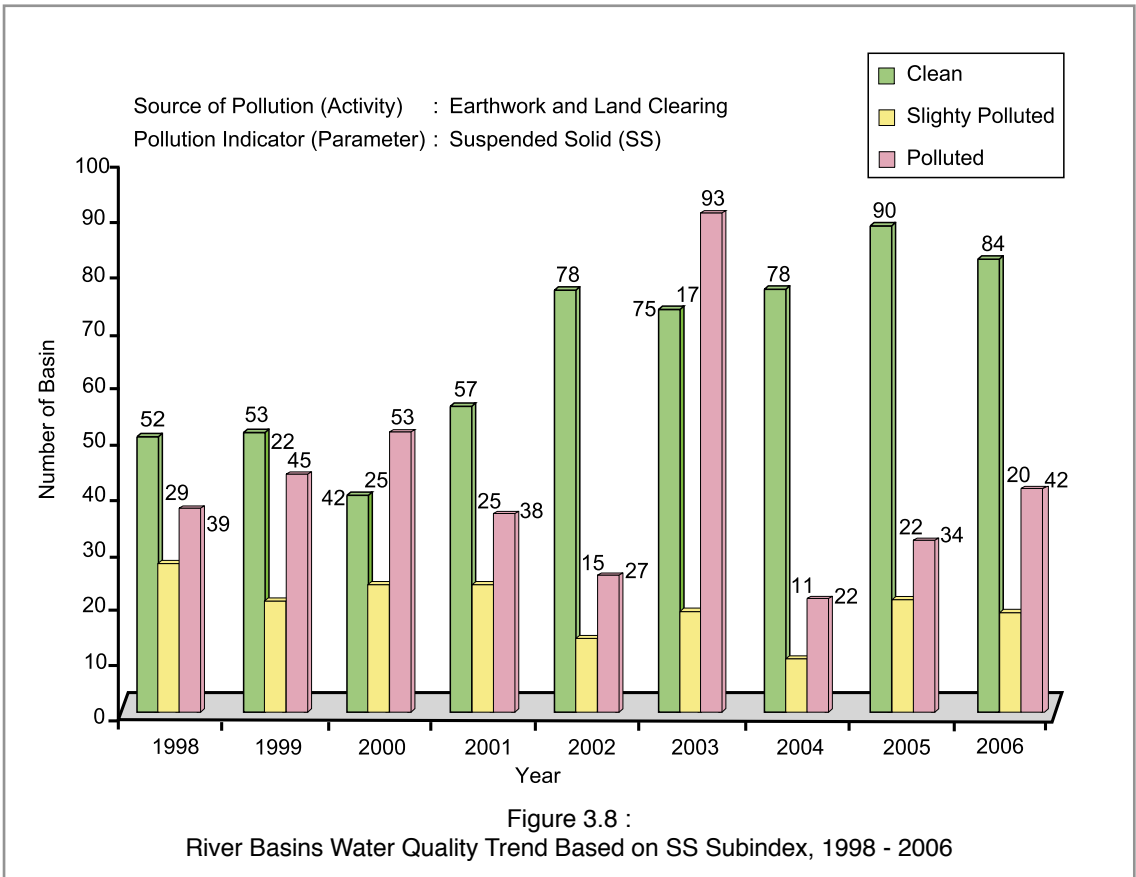
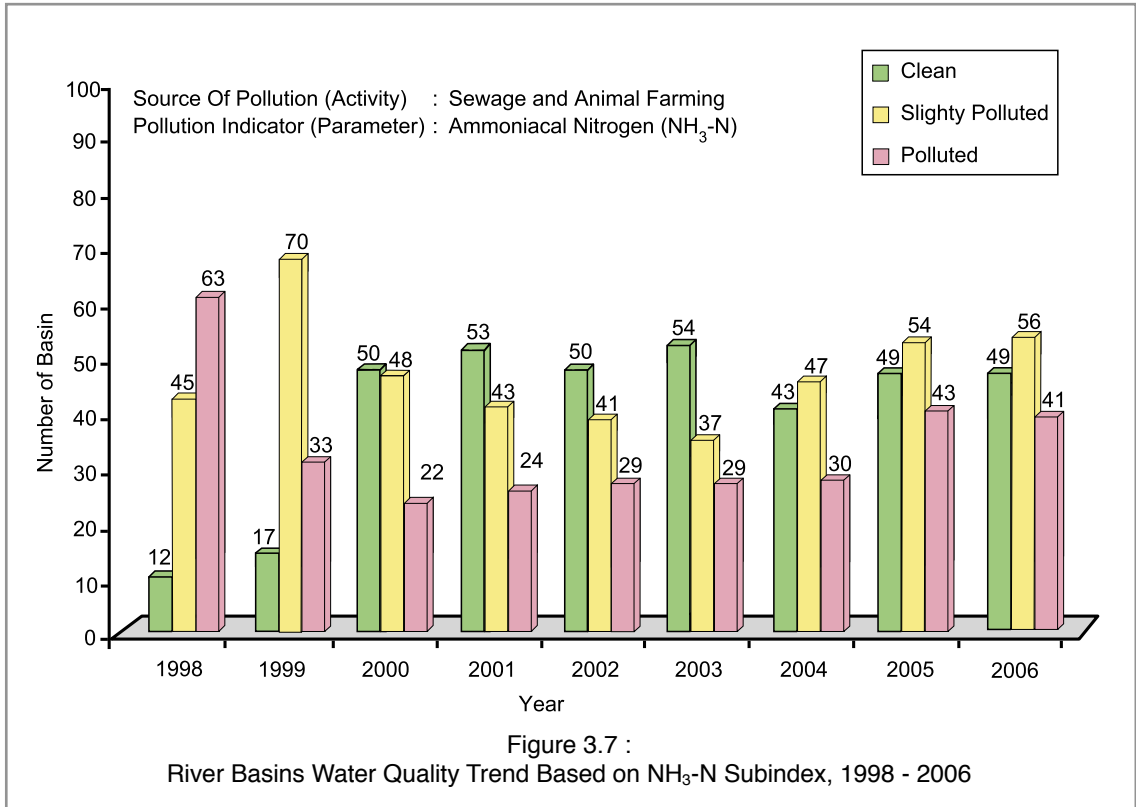


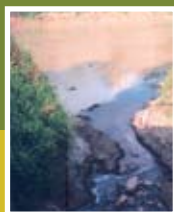
RIVER WATER POLLUTION SOURCES

Figures 3.6, 3.7 and 3.8 illustrate the status of river water quality in relation to the major pollution sources. Based on BOD level, 22 river basins were categorized as polluted, 28 river basins slightly polluted and 96 river basins as clean (Figure 3.6). High BOD was contributed by untreated or partially treated sewage and discharges from agro-based and manufacturing industries. Based on NH₃-N, 41 river basins were categorized as polluted, 56 river basins as slightly polluted and 49 river basins as clean (Figure 3.7). The main sources of NH₃-N were sewage and livestock farming. Meanwhile, 42 river basins were categorized as polluted by SS, 20 river basins as slightly polluted and 84 river basins as clean (Figure 3.8). The sources for SS were earthworks and land clearing activities.

Analysis of heavy metals in 5,613 water samples revealed that almost all samples complied with Class III, National Water Quality Standards for arsenic (As), mercury (Hg), cadmium (Cd), chromium (Cr), lead (Pb) and zinc (Zn), except iron (Fe) with 83 percent compliance.

The trend for river water quality status (1990 to 2006) is as shown in Figure 3.1. In 2006, the number of polluted river basins were 7, slightly polluted river basins 59 and clean river basins 80. The number of polluted river basins in 2006 had decreased from 15 to 7, the slightly polluted had changed from 51 to 59 and the clean maintained at 80. In 2005 these 8 river basins namely Sungai Merbok (WQI 59), Sungai Bayan Lepas (WQI 58), Sungai Klang (WQI 55), Sungai Jejawi (WQI 59), Sungai Merlimau (WQI 58), Sungai Air Baloi (WQI 59), Sungai Kempas (WQI 56) and Sungai Sembulan (WQI 59), the WQI were slightly below the slightly polluted range (WQI 60 to 80). In 2006, these river basins improved in the WQI ranging from 60 to 68. Intensified enforcement efforts and good environmental management practices could also have contributed to the improvement.





CHAPTER 4

GROUNDWATER

QUALITY

Table 4.1 Malaysia : Distribution of Groundwater Monitoring Wells, 2006 •42•

Table 4.2 Malaysia : National Guidelines for Raw Drinking Water Quality (Revised December 2000) •43•

Figure 4.1 Malaysia : Percentage of Non Compliance of Selected Contaminants by Land Used, 2006 •44•

GROUNDWATER QUALITY MONITORING

Recognising the future potential of groundwater as an important alternative source of water, the Department of Environment (DOE) in 1997 initiated the National Groundwater Monitoring Programme. By 2006, 88 monitoring wells had been established at 48 sites in Peninsular Malaysia, 19 wells in

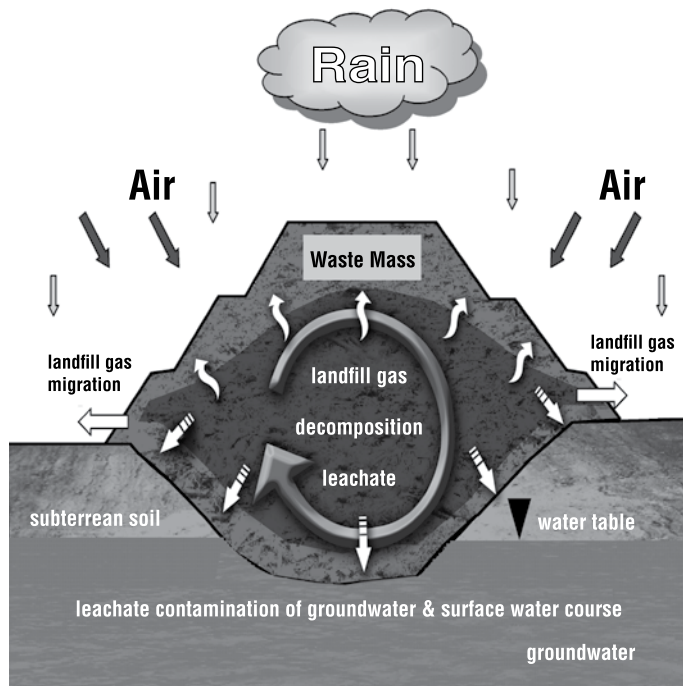
Sarawak and 15 wells in Sabah (**Table 4.1**). The sites were selected and categorized according to the surrounding land use which were agricultural, urban/suburban, rural, industrial, solid waste landfills, golf courses, radioactive landfill, animal burial areas, municipal water supply and ex-mining areas (gold mine).



Untreated leachate discharged from illegal dumping site (DOE photo library)

Table 4.1 Malaysia :
Distribution of Groundwater Monitoring Wells, 2006

Category	Number of Wells
Agricultural Areas	12
Urban/Suburban Areas	12
Industrial Sites	18
Solid Waste Landfills	27
Golf Courses	7
Radioactive Landfill	1
Rural Areas	5
Ex-mining Areas (Gold Mine)	3
Municipal Water Supply	11
Animal Burial Areas	16
Aquaculture Farms	9
Resorts	1
Total	122



Groundwater contamination process by leachate from waste mass decomposition at garbage dumpsite (DOE photo library)



Untreated leachate – contamination of groundwater (DOE photo library)

GROUNDWATER QUALITY STATUS

In 2006, 340 water samples were taken from these monitoring wells compared to 250 in the previous year (2005). The samples were analysed for volatile organic compounds (VOCs), pesticides, heavy metals, anions, bacteria (coliform), phenolic compounds, radioactivity (Gross Alpha and Beta), total hardness, total dissolved solids (TDS), pH, temperature, conductivity and dissolved oxygen (DO). The groundwater quality status was determined based on the National Guidelines For Raw Drinking Water Quality from the Ministry of Health (Revised December 2000) (**Table 4.2**) as the benchmark.

Iron (Fe) levels exceeding the benchmark were recorded in all samples (**Figure 4.1**). Between 30 percent and 100 percent of the samples taken from all sites showed high levels of iron. The sampling results also showed that between 15 percent and 100 percent of samples taken from all areas recorded manganese (Mn) levels exceeding the benchmark. Between 5 percent and 13 percent of samples in rural areas (5%), landfills (5%), municipal water supply (5%), golf courses (7%), agricultural areas (9%) and industrial areas (13%) were found to exceed the nitrate benchmark except in urban/suburban, ex-mining areas and radioactive landfills. Arsenic levels exceeding the benchmark were recorded at radioactive sites (100%), ex-mining areas (67%), solid waste landfill (44%), municipal water supply (36%) and agricultural areas (20%). Other parameters exceeding the acceptable values are shown in **Figure 4.1**.

Table 4.2 Malaysia :
National Guidelines for Raw Drinking Water Quality
(Revised December 2000)

Parameter	Symbol	Benchmark
Sulphate	SO ₄	250 mg/l
Hardness	CaCO ₃	500 mg/l
Nitrate	NO ₃	10 mg/l
Coliform	-	Must not be detected in any 100 ml sample
Manganese	Mn	0.1 mg/l
Chromium	Cr	0.05 mg/l
Zinc	Zn	3 mg/l
Arsenic	As	0.01 mg/l
Selenium	Se	0.01 mg/l
Chloride	Cl	250 mg/l
Phenolics	-	0.002 mg/l
TDS	-	1000 mg/l
Iron	Fe	0.3 mg/l
Copper	Cu	1.0 mg/l
Lead	Pb	0.01 mg/l
Cadmium	Cd	0.003 mg/l
Mercury	Hg	0.001 mg/l

Source : Ministry of Health, Malaysia

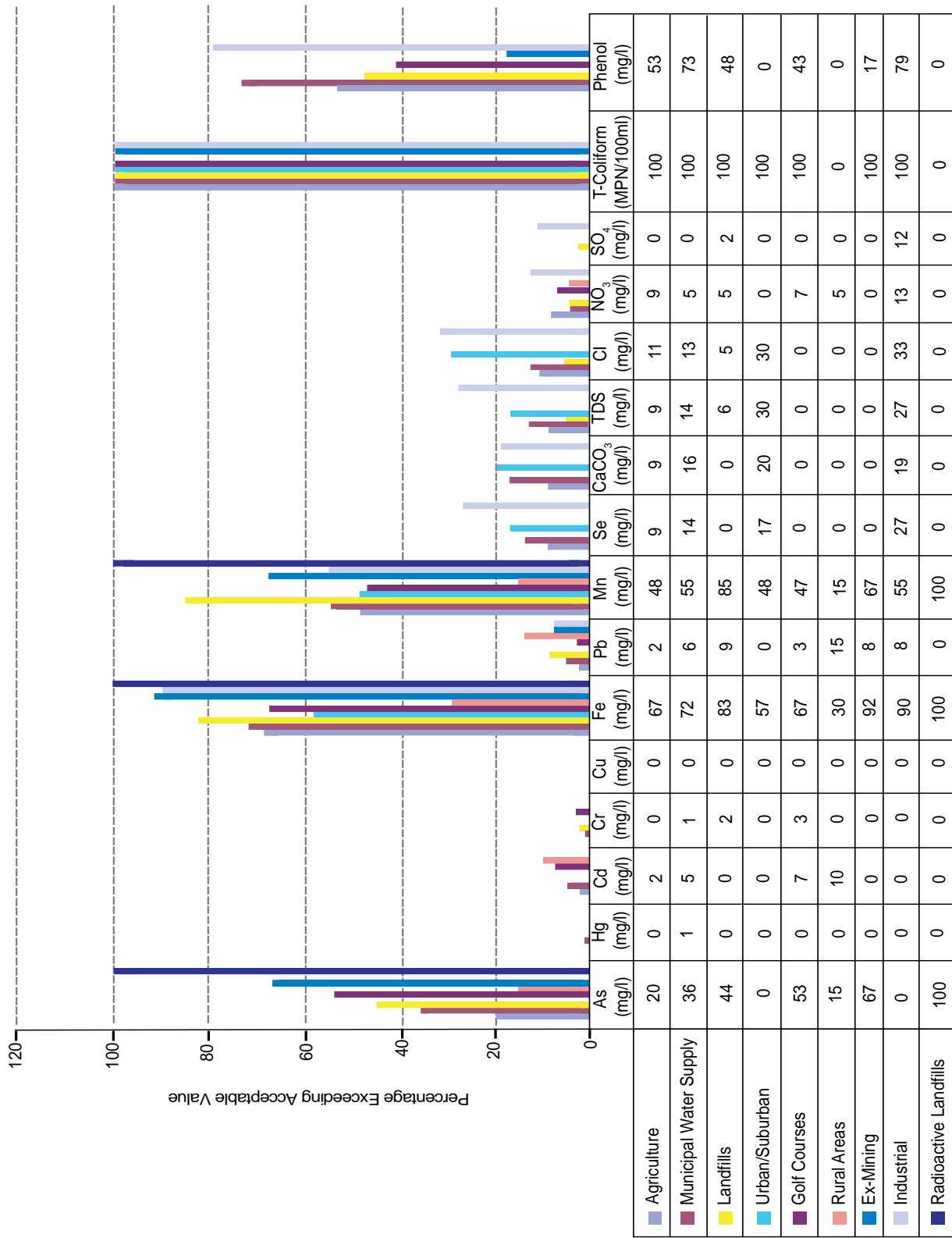


Figure 4.1 Malaysia : Percentage of Non Compliance of Selected Contaminants by Land Use, 2006



CHAPTER 5

MARINE AND

ISLAND MARINE

WATER QUALITY

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MARINE WATER QUALITY MONITORING

Marine water quality monitoring plays an important role in the conservation of marine resources which contribute to the stability and diversity of the marine ecosystem. Pollution from land-based sources as well as from the sea can pose threats to these invaluable resources.

The Department of Environment (DOE) started the marine monitoring programme in 1978 for Peninsular Malaysia and in 1985 for Sabah and Sarawak. The programme included in-situ measurements and laboratory analyses for parameters as listed in **Table 5.1**. The Interim Marine Water Quality Standards (IMWQS) are as shown in **Table 5.2**.

MARINE WATER QUALITY STATUS

A total of 1,035 samples from 229 monitoring stations were analysed in 2006 (**Table 5.3**). As in previous years, the main contaminants of the coastal waters of all States that exceeded the

IMWQS were total suspended solids (75%), *Escherichia coli* (55%) and oil and grease (35%). **Figure 5.1** shows the trend of marine water quality contaminants from 2004 to 2006. Overall comparison showed an increase in *E. coli*, mercury and arsenic levels in marine waters and a decrease in total suspended solids, oil and grease, copper, lead, cadmium and total chromium in 2006 compared to the previous year.

Total suspended solids remained a significant contaminant of marine water with 100 percent of samples from Kedah, Perak and Negeri Sembilan exceeding the IMWQS. Other States recorded levels that exceeded the IMWQS by more than 35 percent, except for Pahang, where the level was 19 percent (**Table 5.3**).

For oil and grease contamination, Terengganu recorded the highest percentage (93%) exceeding the IMWQS, followed by Pahang (80%) and Negeri Sembilan (68%), while Sabah and Labuan was free from oil and grease contamination. *E. coli* contamination was recorded highest in Perlis and Kedah (100%), followed by Negeri Sembilan (83%) and Pulau Pinang (78%).

Table 5.1 Malaysia: Marine Environmental Quality Parameters

In-situ Measurement	Unit	Parameter (Laboratory Analysis)	Unit
Temperature	°C	<i>Escherichia coli</i> (<i>E. coli</i>)	MPN/100ml
pH	-	Oil and grease (O & G)	mg/l
Dissolved oxygen	% Sat	Total suspended solids (TSS)	mg/l
Dissolved oxygen	mg/l	Arsenic (As)	mg/l
Conductivity	µS/cm	Cadmium (Cd)	mg/l
Salinity	ppt	Total Chromium (Cr)	mg/l
Turbidity	NTU	Copper (Cu)	mg/l
Tarball	g/100m	Plumbum (Pb)	mg/l
		Mercury (Hg)	mg/l

Table 5.2 Malaysia: Interim Marine Water Quality Standards

Parameter (Laboratory Analysis)	Unit	Standards
<i>Escherichia coli</i> (<i>E. coli</i>)	MPN/100ml	100
Oil and grease (O & G)	mg/l	0
Total suspended solids (TSS)	mg/l	50
Arsenic (As)	mg/l	0.1
Cadmium (Cd)	mg/l	0.1
Total chromium (Cr)	mg/l	0.5
Copper (Cu)	mg/l	0.1
Lead (Pb)	mg/l	0.1
Mercury (Hg)	mg/l	0.001

Table 5.3 Malaysia : Status of Marine Water Quality Parameters Exceeding Standards (%), 2006

State	No. of Station	No. of Sample	Total Suspended Solids	Oil & Grease	<i>E. Coli</i>	Cadmium	Chromium	Mercury	Lead	Arsenic	Copper
Perlis	2	16	64	43	100	7	0	50	0	0	0
Pulau Langkawi	7	35	94	17	43	0	0	23	0	0	9
Kedah	3	14	100	14	100	0	0	79	14	0	0
Pulau Pinang	25	191	74	10	78	0	2	26	9	0	4
Perak	13	52	100	12	64	0	0	NA	56	0	0
Selangor	14	49	98	54	68	0	0	11	0	0	0
Negeri Sembilan	13	78	100	68	83	0	0	16	0	0	0
Melaka	9	28	92	20	66	0	NA	NA	0	NA	0
Johor	51	122	60	11	49	0	0	10	13	1	9
Pahang	11	80	19	80	10	0	0	0	40	0	0
Terengganu	19	76	74	93	46	11	0	2	86	0	42
Kelantan	10	40	73	59	43	10	0	3	78	10	30
W.P. Labuan	5	20	60	0	25	0	25	NA	0	NA	0
Sabah	26	111	35	0	25	1	0	0	6	NA	3
Sarawak	21	123	78	49	25	0	0	0	2	0	0
Malaysia (Total)	229	1035									
Average (%)			75	35	55	2	2	18	20	1	6

Note :
NA : Not available

Heavy metals pollution was comparatively low with lead (Pb) exceeding the IMWQS by 20 percent, followed by mercury (18%) and copper (6%). Lead contamination was evident in Terengganu (86%), Kelantan (78%) and Perak (56%). Meanwhile, total chromium and cadmium pollution were recorded at two percent and arsenic (As) at one percent was detected in 2006. **Table 5.4** highlights sources of contamination of marine waters.

ISLAND MARINE WATER QUALITY STATUS

The islands monitored are categorised as development islands (3 islands), resort islands (25 islands), marine park islands (38 islands) and protected islands (5 islands). A total of 344 samples were collected and analysed. The major pollutants identified in island marine waters were total suspended solids, *E. coli* and oil and grease.

E. coli was the predominant pollutant recorded in all islands monitored of which 58.3 percent recorded in development islands, 48 percent in marine parks, 47 percent in resort islands and 25 percent in protected

islands exceeded the interim standards (**Figure 5.2**). Development islands and resort islands recorded total suspended solids exceeding the standards by 13.9 and 6.0 percent respectively while protected islands and marine parks recorded no contamination. For development islands, oil and grease samples exceeded the standards by 5.6 percent while 2.5 percent for marine park islands. However no oil and grease contamination was detected for resort and protected islands.

E. coli contamination in Selangor and Pahang island marine waters exceeded the standard of 100 MPN/100 ml by 75 percent, followed by Pulau Pinang (65.9%), Perak and Melaka (50%) (**Figure 5.3**). As for total suspended solids, 31.8 percent of samples analysed in Pulau Pinang exceeded the standard. However, total suspended solids was not detected for islands in Selangor, Johor, Perak, Pahang, Terengganu, Sarawak, Labuan and Sabah. Oil and grease was detected only in Labuan and Johor of which 13.9 percent and 4.7 percent of samples monitored exceeded the interim standards.

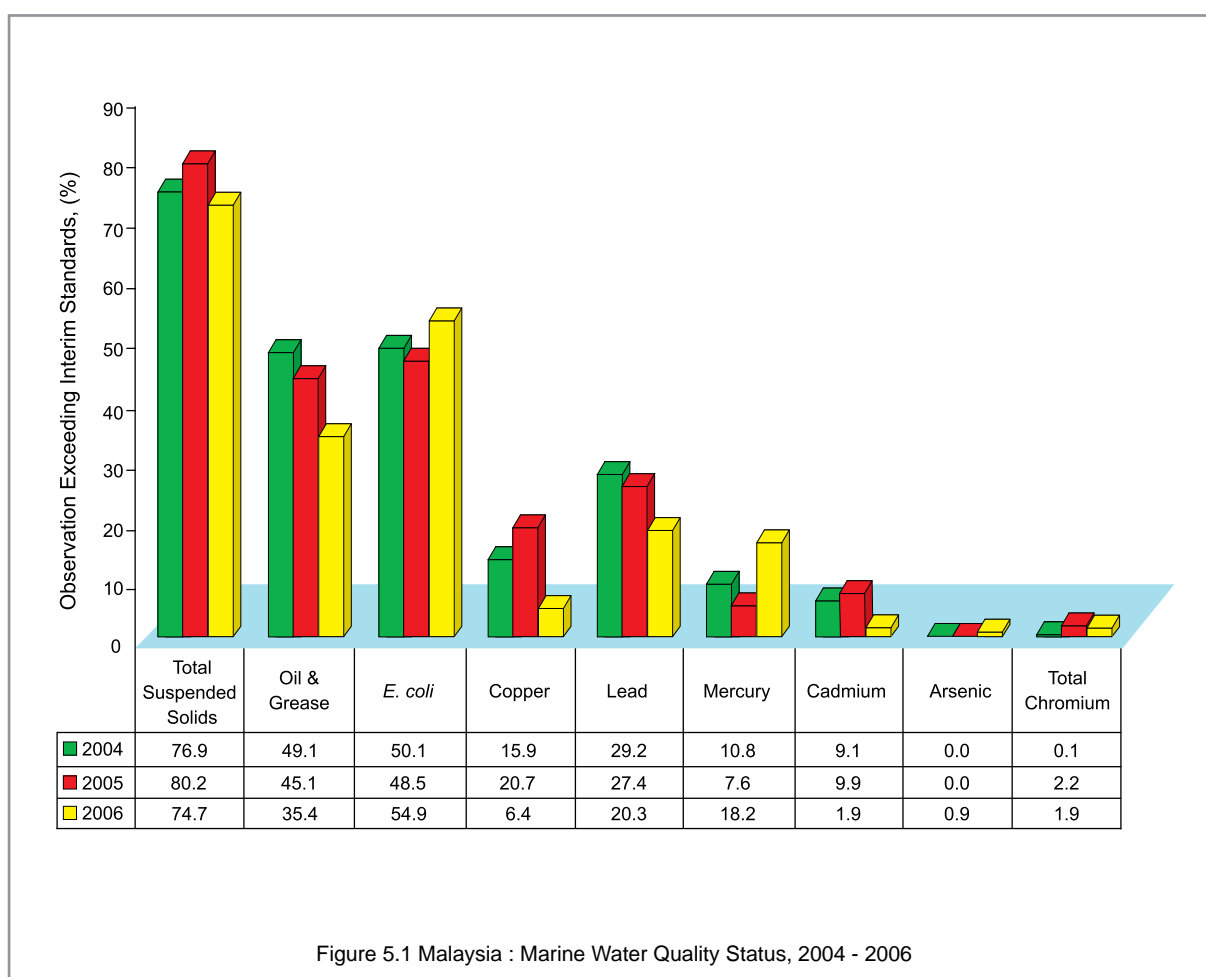


Figure 5.1 Malaysia : Marine Water Quality Status, 2004 - 2006

Table 5.4 Malaysia : Sources of Marine Water Contaminants

Contaminant	Sources
Total suspended solids (TSS)	Agricultural activities, tourism development, coastal reclamation, logging and road construction.
<i>Escherichia coli</i> (<i>E. coli</i>)	Untreated or partially treated domestic and animal wastes.
Oil and grease (O & G)	Discharges from vessels such as tank cleaning, deballasting, bilges and bunkering. Leakages and disposal of engine oil from ferries and boats.
Heavy metals	Industrial development and land-based sources.



Typical coastal mangroves (DOE photo library)

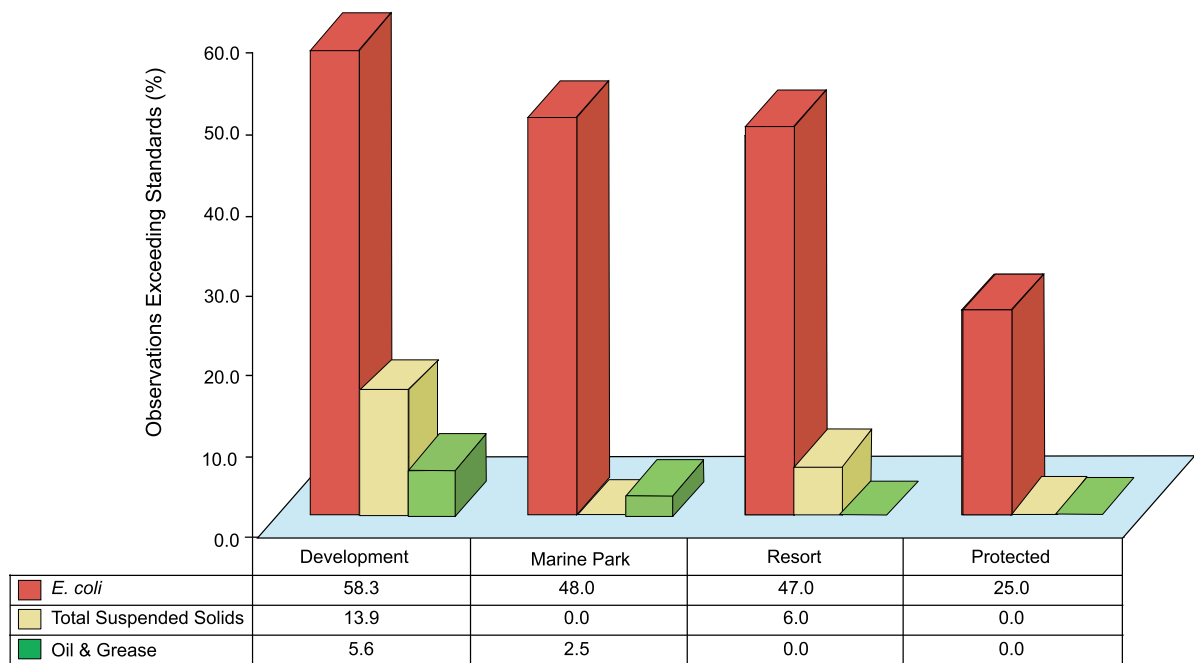


Figure 5.2 Malaysia : Island Marine Water Quality Status, 2006

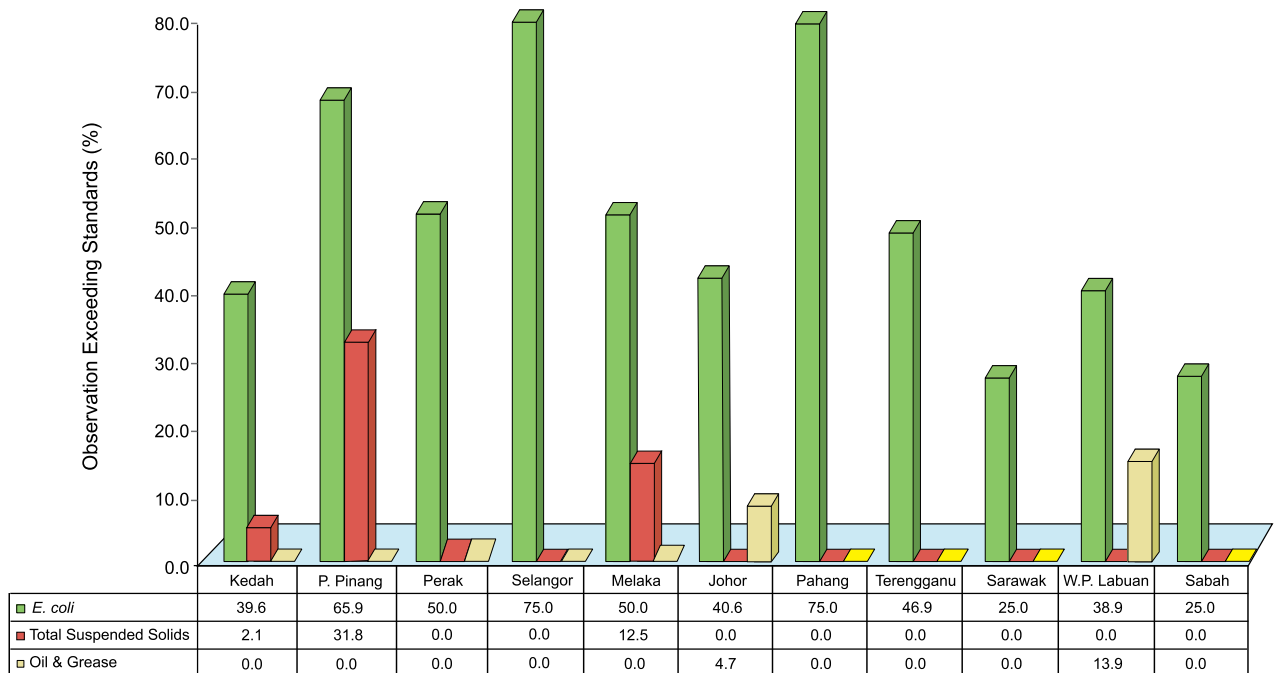


Figure 5.3 Malaysia : Status of Island Marine Water Quality by State, 2006

TARBALL MONITORING

In 2006, there were 133 monitoring stations for tarball. All the beaches were found to be free from tarball

pollution. Tarball residues on beaches, if any were usually caused by oily discharges from fishing boats as well as passing vessel.



Beach polluted by oily residues (DOE photo library)



CHAPTER 6

POLLUTION

SOURCES

INVENTORY

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SOURCES OF WATER POLLUTION

Water pollution is caused by point and non-point sources. Point sources include sewage treatment plants, manufacturing and agro-based industries and animal farms. Non-point sources are defined as diffused sources such as agricultural activities and surface runoffs.

In 2006, the Department of Environment (DOE) registered 18,956 water pollution point sources comprising mainly sewage treatment plants (9,060 : 47.79% inclusive of 601 Network Pump Stations), manufacturing industries (8,543 : 45.07%), animal farms (869 : 4.58%) and agro-based industries (484 : 2.55%) (**Figure 6.1**).

Figure 6.2 represents the distribution of industrial water pollution sources from agro-based and manufacturing industries compiled by the DOE in 2006 through field surveys and questionnaires. A total of 9,027 sources were identified with Selangor having the highest number of water pollution sources (1,850 : 20.49%), followed by Johor (1,774 : 19.65%).

According to statistics compiled by the Veterinary Department of Malaysia, the total standing pig population for 2006 was about 1.67 million, a decrease of 1.76 percent compared to 1.7 million in 2005. Correspondingly, the number of pig farms decreased to 869 farms compared to 898 in the previous year.

The number of sewage treatment plants under the management of Indah Water Konsortium Sdn. Bhd. (IWK) had increased to 9,060 in 2006 compared to 8,782 plants in 2005. Selangor had the largest number of sewage treatment plants (2,563 : 28.3%), Perak (1,343 : 14.8%), Johor (1,010 : 11.1%) and Negeri Sembilan (928 : 10.2%) (**Figure 6.3**).

BOD POLLUTION LOAD

Domestic sewage discharge, in the form of treated sewage and partially treated sewage, remained the largest contributor of organic pollution load with an estimated biochemical oxygen demand (BOD) load of 883,391.08 kg/day. The estimated BOD loading contributed by other major sectors were agro-based and manufacturing industries (76,790.77 kg/day) and pig farming (213,215.00 kg/day). **Table 6.1** indicates the total BOD load in kg/day discharged from sewage treatment plants throughout Malaysia in 2006.



Uncontrolled hill cutting (DOE photo library)

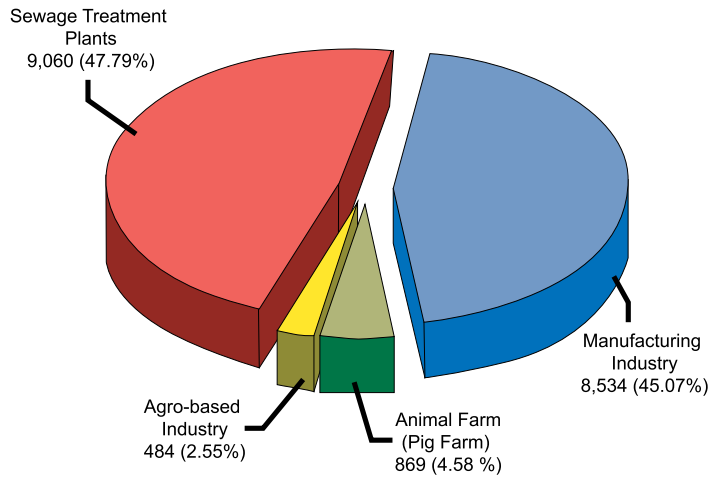


Figure 6.1 Malaysia : Composition of Water Pollution Sources by Sector, 2006

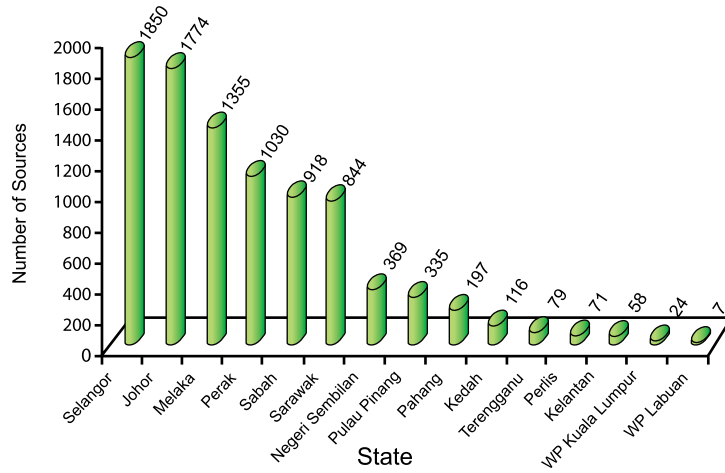


Figure 6.2 Malaysia : Distribution of Industrial Water Pollution Sources (Agro-based and Manufacturing Industries) by State, 2006

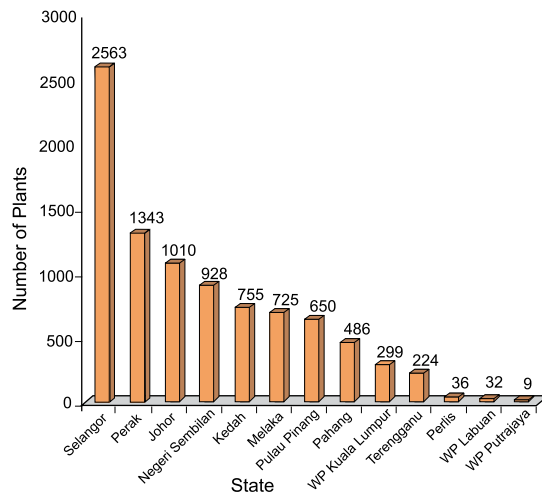


Figure 6.3 Malaysia : Distribution of Sewage Treatment Plants by State, 2006

Table 6.1 Malaysia : Total BOD Load (kg/day) from Sewage Treatment Plants

State	No. of STP	Total PE	Flow (m ³ /day)	BOD Load (kg/day)
Selangor	2,563	5,908,450	1,329,401	332,350.31
Perak	1,343	1,300,430	292,597	73,149.19
Johor	1010	1,198,417	269,644	67,410.96
Negeri Sembilan	928	931,458	209,578	52,394.51
Kedah	755	556,637	125,243	31,310.83
Melaka	725	570,192	128,293	32,073.30
Pulau Pinang	650	2,149,001	483,525	120,881.31
Pahang	486	314,830	70,837	17,709.19
WP Kuala Lumpur	299	2,571,877	578,672	144,668.08
Terengganu	224	75,184	16,916	4,229.10
Perlis	36	16,156	3,635	908.78
WP Labuan	32	39,265	8,835	2,208.66
WP Putrajaya	9	72,833	16,387	4,096.86
Total	9,060	15,704,730	3,533,563	883,391.08

Notes:
 STP = Sewage Treatment Plant
 PE = Population Equivalent
 Source: IWK Sdn. Bhd.

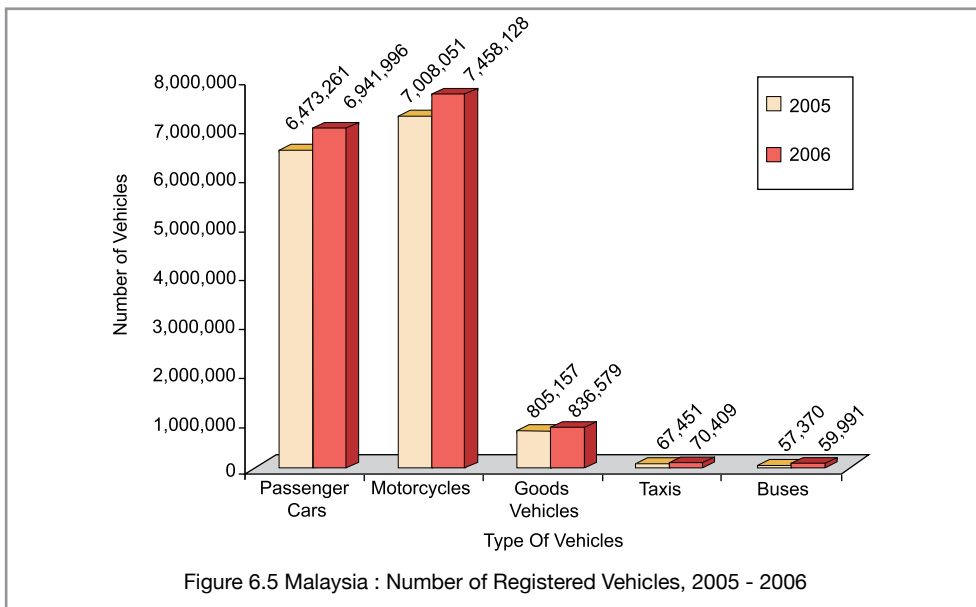
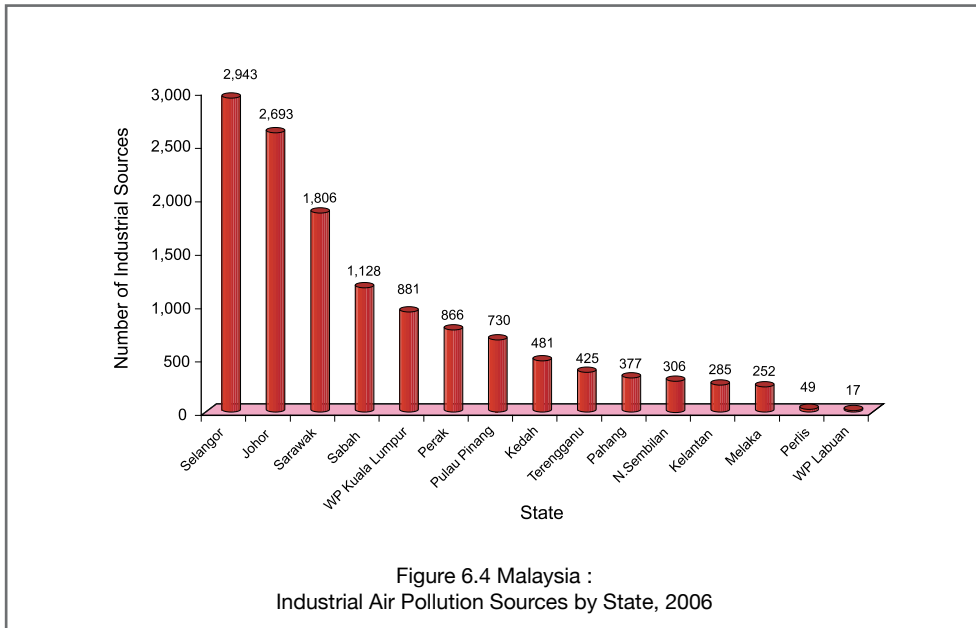
SOURCES OF AIR POLLUTION

Air pollution sources in the country can be divided into three main categories as follows:

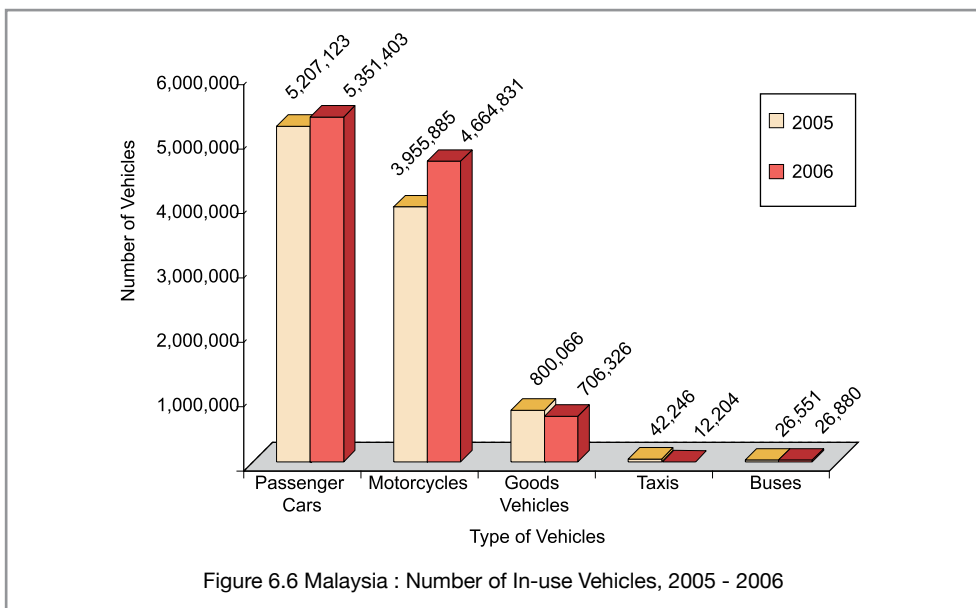
- Industries (including power stations)
- Motor vehicles
- Open burning

The total number of industrial sources identified in 2006 which were subjected to Environmental Quality (Clean Air) Regulations 1978 was 13,239 (**Figure 6.4**), Selangor reported the highest number of stationary pollution sources (2,943 : 22.2%), followed by Johor (2,693 : 20.3%) and Sarawak (1,806 : 13.6%).

Motor vehicles which include passenger cars, taxis, buses, motorcycles, vans and lorries are the major contributors to air pollution in cities. The number of registered vehicles in Malaysia for the year 2005 and 2006 is shown in **Figure 6.5**. In 2006 the number of registered passenger cars increased by 7.24 percent and motorcycles by 6.42 percent. There was a slight increase in the number of good vehicles, taxis and buses in 2006 compared to 2005. The number of in-use vehicles or active vehicles dropped slightly in 2006 compared to 2005 except for passenger cars, motorcycles and buses (**Figure 6.6**).



Source : Road Transport Department, 2006



Source : Road Transport Department, 2006

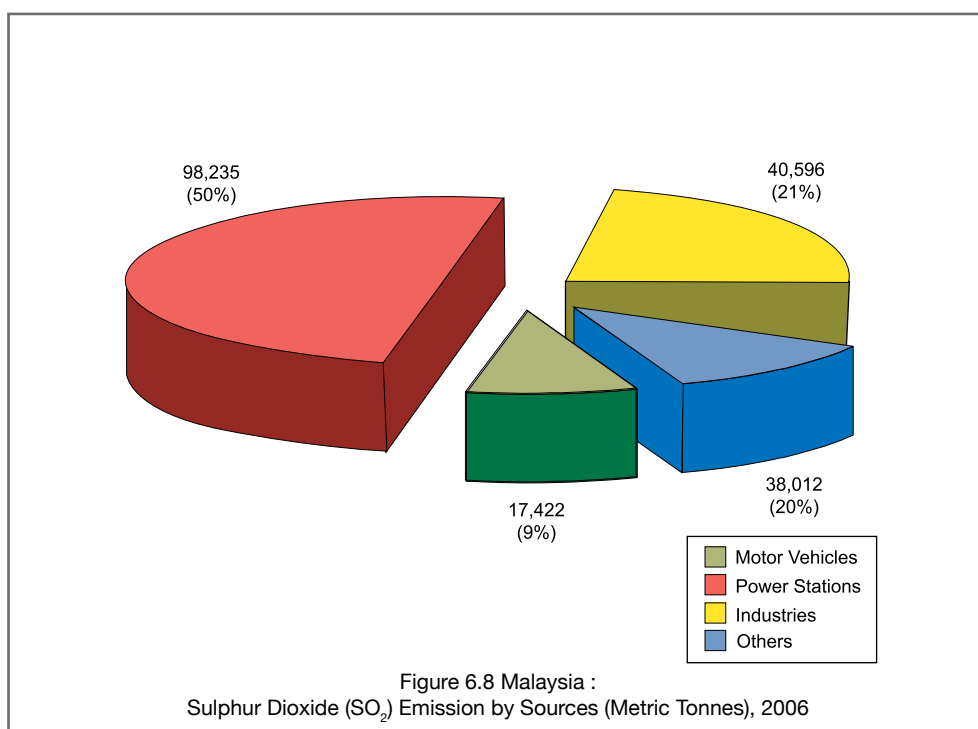
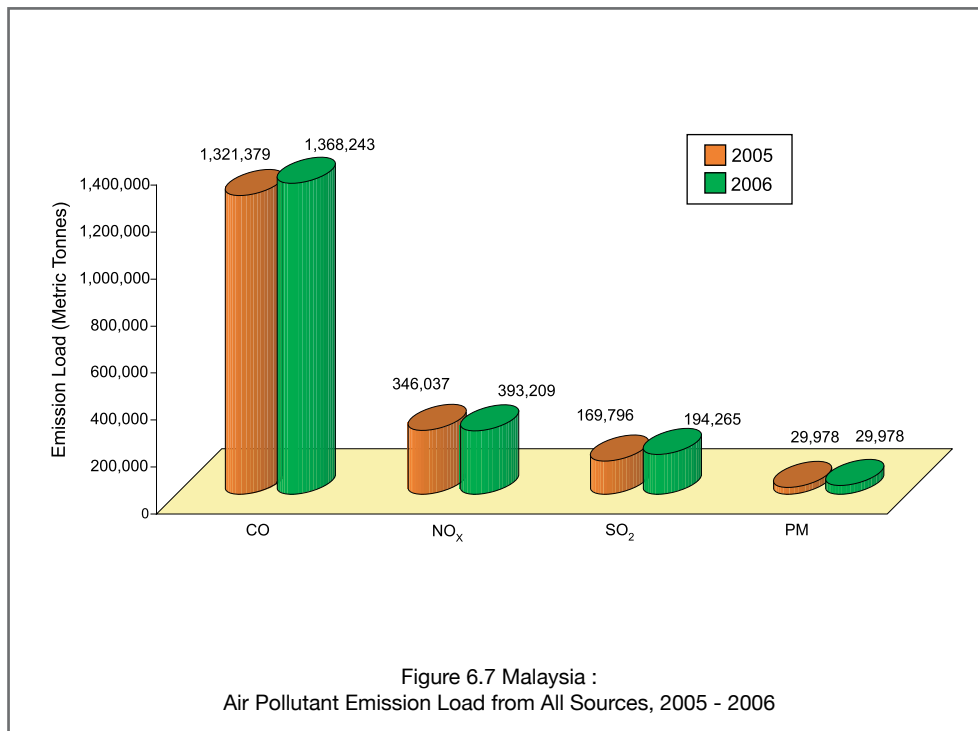
AIR POLLUTANT EMISSION LOAD

The estimated combined air emission load for 2006 was 1,368,243 metric tonnes of carbon monoxide (CO); 393,209 metric tonnes of nitrogen oxides (NO_x), 194,265 metric tonnes of sulphur dioxide (SO₂) and 29,978 metric tonnes of particulate matter (PM). **Figure 6.7** shows the air pollutant emission load from all sources in 2005 and 2006.

Emission load from industries including power stations contributed to 71 percent of the total SO₂ emission load

(**Figure 6.8**) and 69 percent of the total PM emission load (**Figure 6.9**).

Motor vehicles were the main contributors to total NO_x emission load (70%) and CO (98%) emission load (**Figures 6.10, 6.11**). The estimated annual air pollutant emission loads of hydrocarbon (HC), carbon monoxide (CO), particulate matter (PM₁₀), nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) from the road transport sector for 2005 and



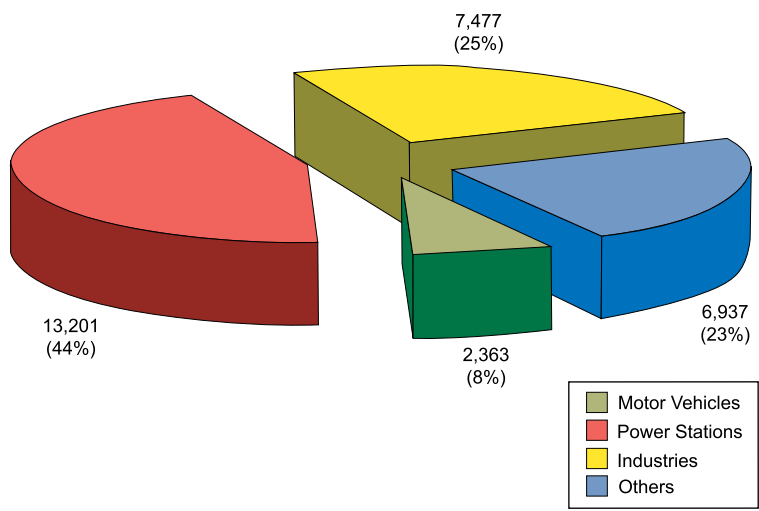


Figure 6.9 Malaysia :
Particulate Matter (PM) Emission by Sources (Metric Tonnes), 2006

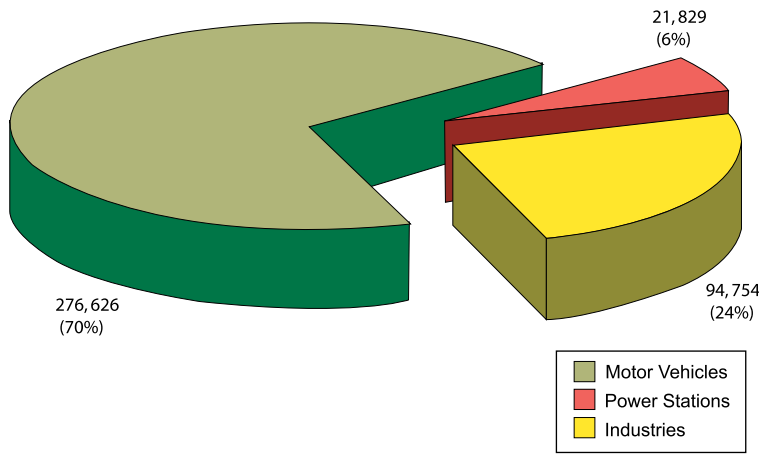


Figure 6.10 Malaysia :
Nitrogen Oxides (NO_x) Emission by Sources (Metric Tonnes), 2006

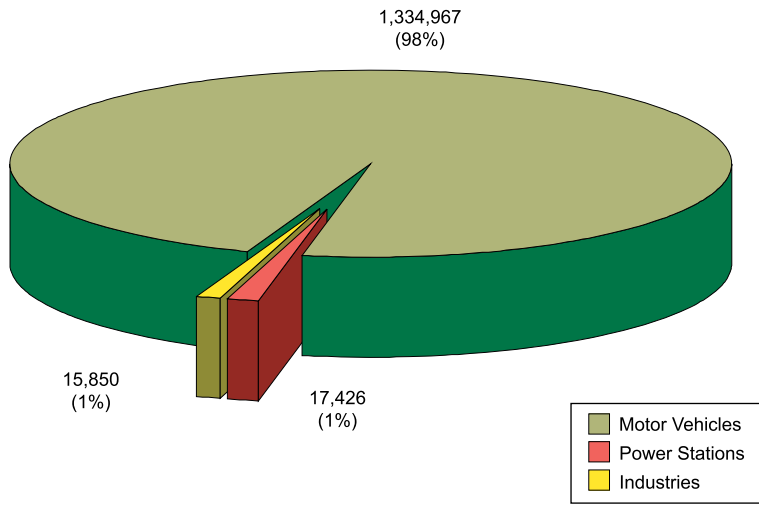


Figure 6.11 Malaysia :
Carbon Monoxide (CO) Emission by Sources (Metric Tonnes), 2006

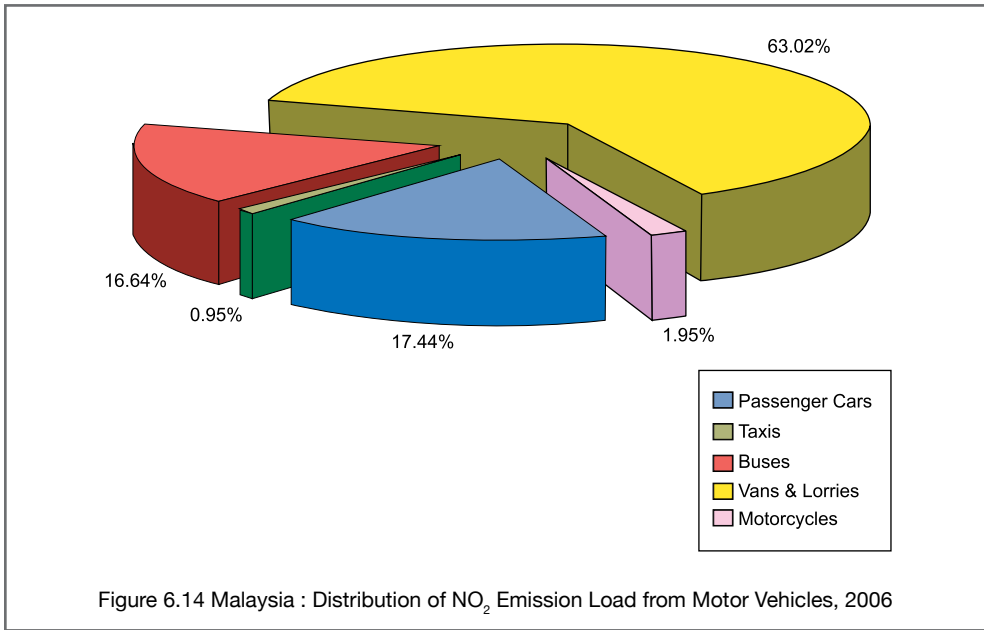
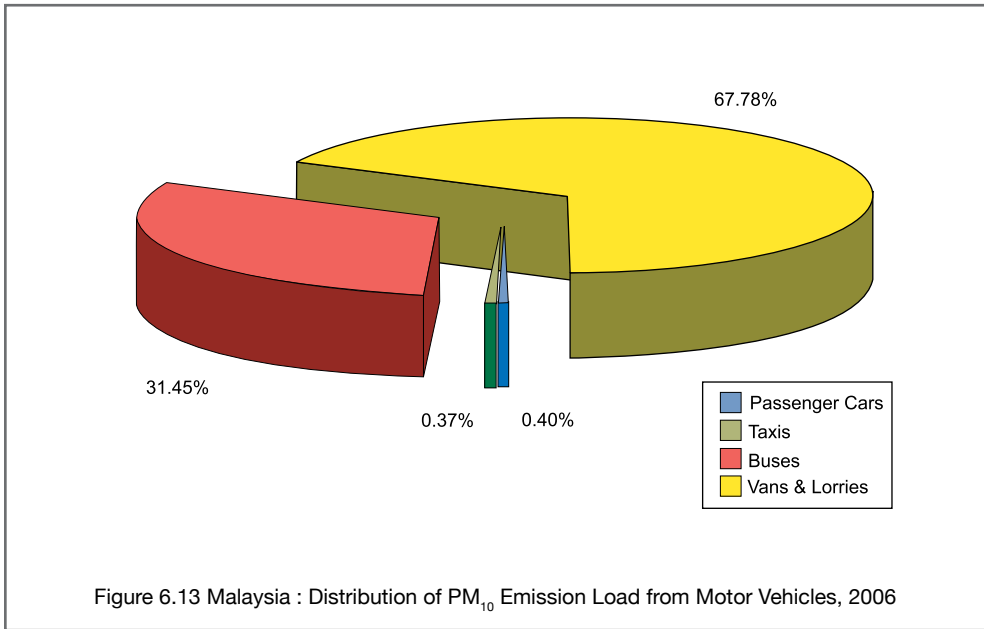
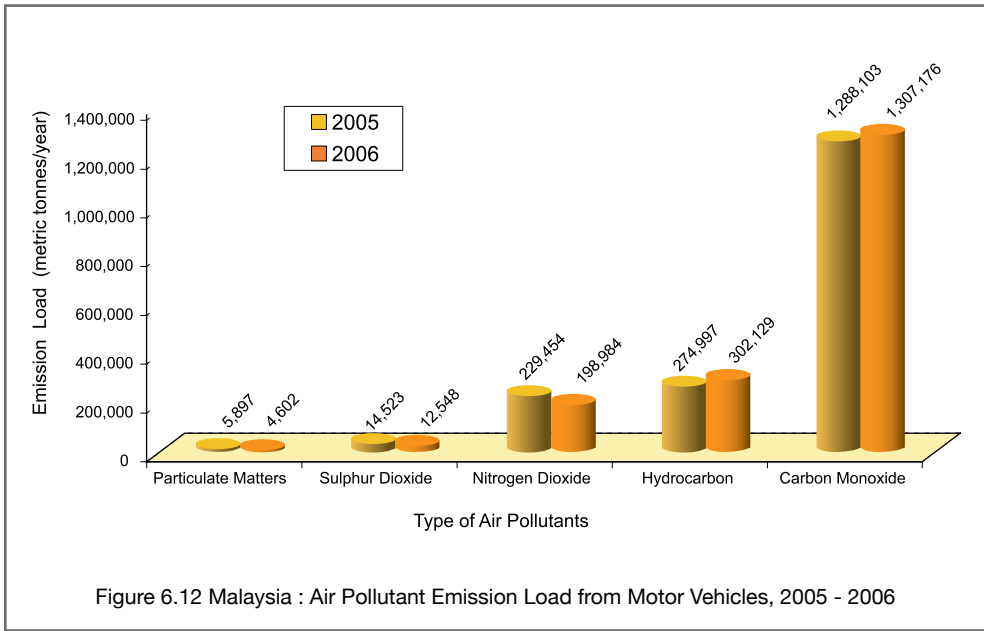


Aerial view of forest fire (DOE photo library)

2006 is shown in **Figure 6.12**. In 2006, the emission loads of HC and CO were estimated to be 302,129 metric tonnes per year and 1,307,176 metric tonnes per year respectively, an increase of 9.86 percent for HC and 1.48 percent for CO emission load in 2006 compared to 2005. However, a decreasing trend was observed in the emission load of PM_{10} , SO_2 and NO_2 in 2006 compared to 2005. Emission load of PM_{10} was 4,602 metric tonnes in 2006 as compared to 5,897 metric tonnes in 2005 (21.96% decrease); SO_2 was 12,548 metric tonnes in 2006 as compared to 14,253 metric tonnes in 2005 (13.60% decrease); and NO_2 was 198,184 metric tonnes as compared to 229,454 metric tonnes in 2005 (13.27% decrease). The increase in HC and CO loads in 2006 was due to the increase in the number of motorcycles and passenger cars.

Figure 6.13 to **Figure 6.17** show the contribution of various categories of vehicle to the respective air pollutant emission load in 2006. It was estimated that 67.78 percent of PM_{10} emission load was contributed by vans and lorries, 31.45 percent from buses, 0.4 percent from taxis and 0.37 percent from passenger cars (**Figure 6.13**).

Figure 6.14 shows that an estimated 63.02 percent of NO_2 emission load was contributed by vans and lorries, 17.44 percent from passenger cars, 16.64 percent from buses, 1.95 percent from motorcycles and 0.95 percent from taxis.





Air pollution from mobile source (DOE photo library)

From the total emission of SO_2 , it was estimated that 60.56 percent was emitted by vans and lorries, 17.92 percent from passenger cars, 15.91 percent from buses, 3.60 percent from motorcycles and 2.01 percent from taxis (**Figure 6.15**).

The higher percentage of NO_2 and SO_2 emitted by vans and lorries was due to the fact that these were diesel engine vehicles. The sulphur content in diesel is 3,000 ppm. The Department is proposing to introduce legislation in 2007 for both diesel and petrol quality to meet EURO 2M standards. Sulphur content for both diesel and petrol will be significantly reduced from 3,000 ppm to 500 ppm and from 1,500 ppm to 500 ppm respectively.

Figure 6.16 shows that motorcycles contributed 60.74 percent of the total HC emissions from motor vehicles, 19.72 percent by passenger cars, 17.23 percent by vans and lorries, while buses and taxis contributed 1.51 percent and 0.80 percent respectively.

Passenger cars contributed 45.35 percent of the total CO emission load from motor vehicles, vans and lorries contributed 35.37 percent, motorcycles 15.34 percent, buses 2.04 percent and taxis 1.90 percent (**Figure 6.17**).

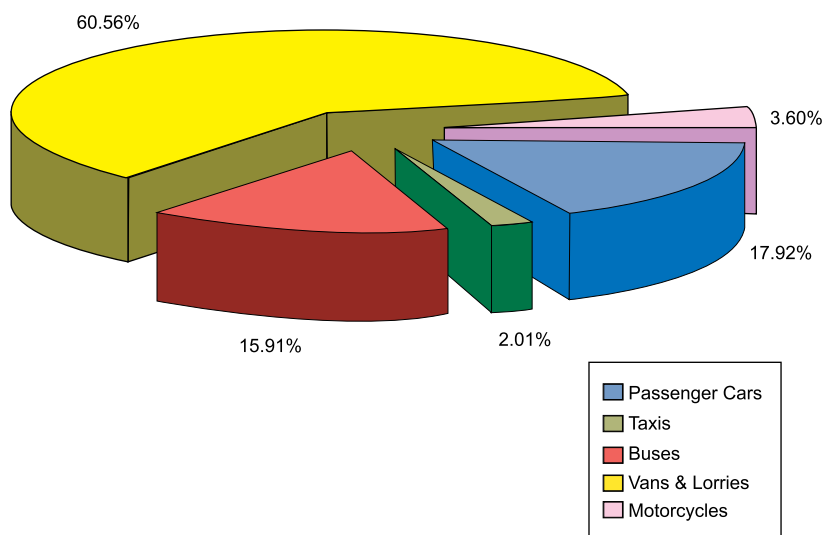


Figure 6.15 Malaysia : Distribution of SO₂ Emission Load from Motor Vehicles, 2006

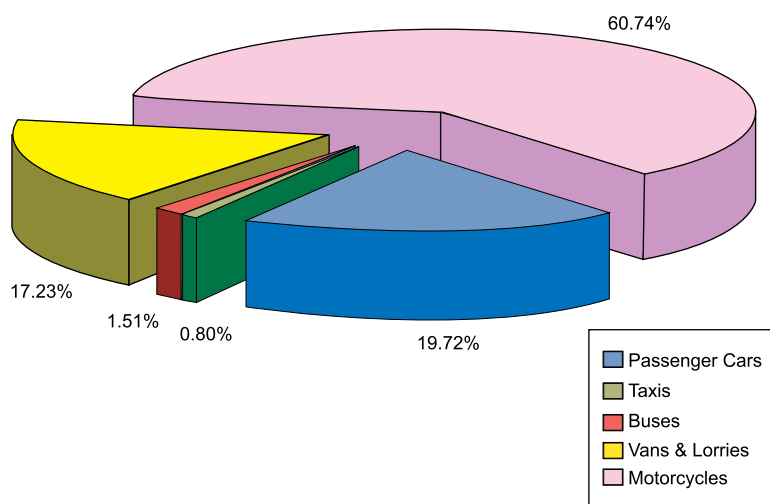


Figure 6.16 Malaysia : Distribution of HC Emission Load from Motor Vehicles, 2006

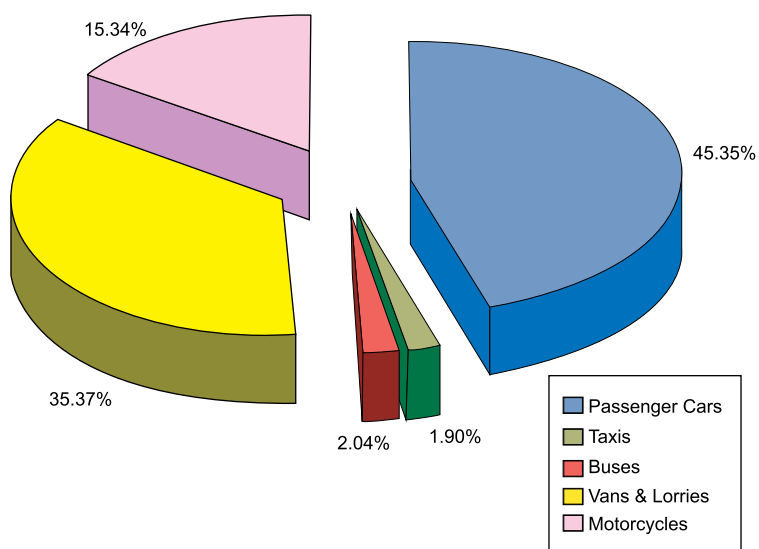


Figure 6.17 Malaysia : Distribution of CO Emission Load from Motor Vehicles, 2006

SCHEDULED WASTES INVENTORY

Based on notification received by the Department of Environment (DOE), a total of 1,103,457.06 metric tonnes of scheduled wastes were generated in 2006 as compared to 548,916.11 metric tonnes in 2005. The sharp increase of waste quantity in 2006 was due to new waste categories such as e-waste introduced and controlled under the Environmental Quality (Scheduled Wastes) Regulations 2005 which came into force on 15 August 2005. In addition, the quantity of gypsum wastes managed on-site by two main generators which were not reported in previous Environmental Quality Reports (EQR) is included in 2006. These amounted to 511,929.38 metric tonnes.

In 2006, gypsum, oil and hydrocarbon, dross, heavy metal sludge, mineral sludge and e-waste were the main categories of waste produced in the country. The breakdown according to waste categories and industry types are as given in **Table 6.2**, **6.3** and **Figure 6.18**, **6.19** respectively.

Of the total wastes produced, 110,814.10 metric tonnes (10.0%) were treated and disposed at Kualiti Alam Sdn. Bhd., 9,360.00 metric tonnes (0.8%) were treated and disposed at Trinekens (Sarawak) Sdn. Bhd., 11,363.88 metric tonnes (1.0%) of clinical wastes were incinerated at licensed off-site facilities; 5,806.00 metric tonnes (0.5%) were exported for recovery purposes, 297,001.41 metric tonnes (26.9%) of scheduled wastes were recovered at off-site facilities and an estimated 495,631.39 metric tonnes (44.9%) were treated on-site and 173,480.28 metric tonnes (15.7%) were stored on-site at waste generators' premises (**Table 6.4**). Three land farms and 15 on-site waste incinerators had been licensed by DOE to allow for on-site treatment and incineration respectively.



New category of scheduled waste under the Environmental Quality (Scheduled Wastes) Regulations 2005 (DOE photo library)



E-waste: End of life mobile phone batteries (DOE photo library)

Table 6.2 Malaysia : Quantity of Scheduled Wastes Generated by Category, 2006

Waste Categories	Quantity of Wastes	
	(Metric Tonnes/Year)	Percentage (%)
Gypsum	411,559.12	37.3
Oil & Hydrocarbon	182,003.35	16.5
Dross/Slag/Clinker	95,593.58	8.7
Heavy Metal Sludge	73,617.71	6.7
Mineral Sludge	48,338.11	4.4
E-Waste	40,275.21	3.6
Clinical/Pharmaceutical	32,270.34	2.9
Spent Solvent	32,079.08	2.9
Ink & Paint Sludge	29,965.79	2.7
Batteries	28,569.31	2.6
Used Containers	26,742.03	2.4
Residue from Treatment/Recovery of Scheduled Wastes	22,329.32	2.0
Acid & Alkali	16,376.65	1.5
Paper & Plastic	14,037.30	1.3
Catalyst	12,712.12	1.2
Mixed Wastes	11,047.07	1.0
Rubber Sludge	7,008.91	0.6
PCB & PCT	6,064.89	0.5
Chemical Waste	4,846.73	0.4
Phenol/Adhesive/Resin	3,872.50	0.4
Asbestos	1,544.84	0.1
Contaminated Filter/Media	1,242.59	0.1
Contaminated Sand	683.07	0.1
Photography	416.85	0.0
Mercury	176.69	0.0
Others	83.91	0.0
Total	1,103,457.06	100.0

Table 6.3 Malaysia : Quantity of Scheduled Wastes Generated by Industry, 2006

Type of Industry	Quantity of Wastes	
	(Metric Tonnes/Year)	Percentage (%)
Chemicals	470,892.50	42.7
Electronic	238,358.25	21.6
Automotive/Workshop	189,948.83	17.2
Metal	78,481.53	7.1
Pharmaceutical	31,847.16	2.9
Batteries	24,664.22	2.2
Industrial Gas	16,246.68	1.5
Rubber & Plastic	16,207.41	1.5
Petroleum/Oleo Chemical	15,329.68	1.4
Licensed Facility	12,667.57	1.1
Others	2,818.73	0.3
Printing & Packaging	2,075.10	0.2
Wood Based	1,808.33	0.2
Resin & Adhesive	1,116.63	0.1
Textile	994.43	0.1
Total	1,103,457.06	100.0

Table 6.4 Malaysia : Facilities Handling Scheduled Wastes, 2006

Type of Industry	Quantity of Wastes	
	(Metric Tonnes/Year)	Percentage (%)
On-site Treatment	495,631.39	44.9
Local Off-site Recovery Facilities	297,001.41	26.9
On-site Storage	173,480.28	15.7
Kualiti Alam Sdn. Bhd.	110,814.10	10.0
Off-site Clinical Wastes Incinerators	11,363.88	1.0
Trinekens (Sarawak) Sdn. Bhd.	9,360.00	0.8
Foreign Facilities	5,806.00	0.5
Total	1,103,457.06	100.0

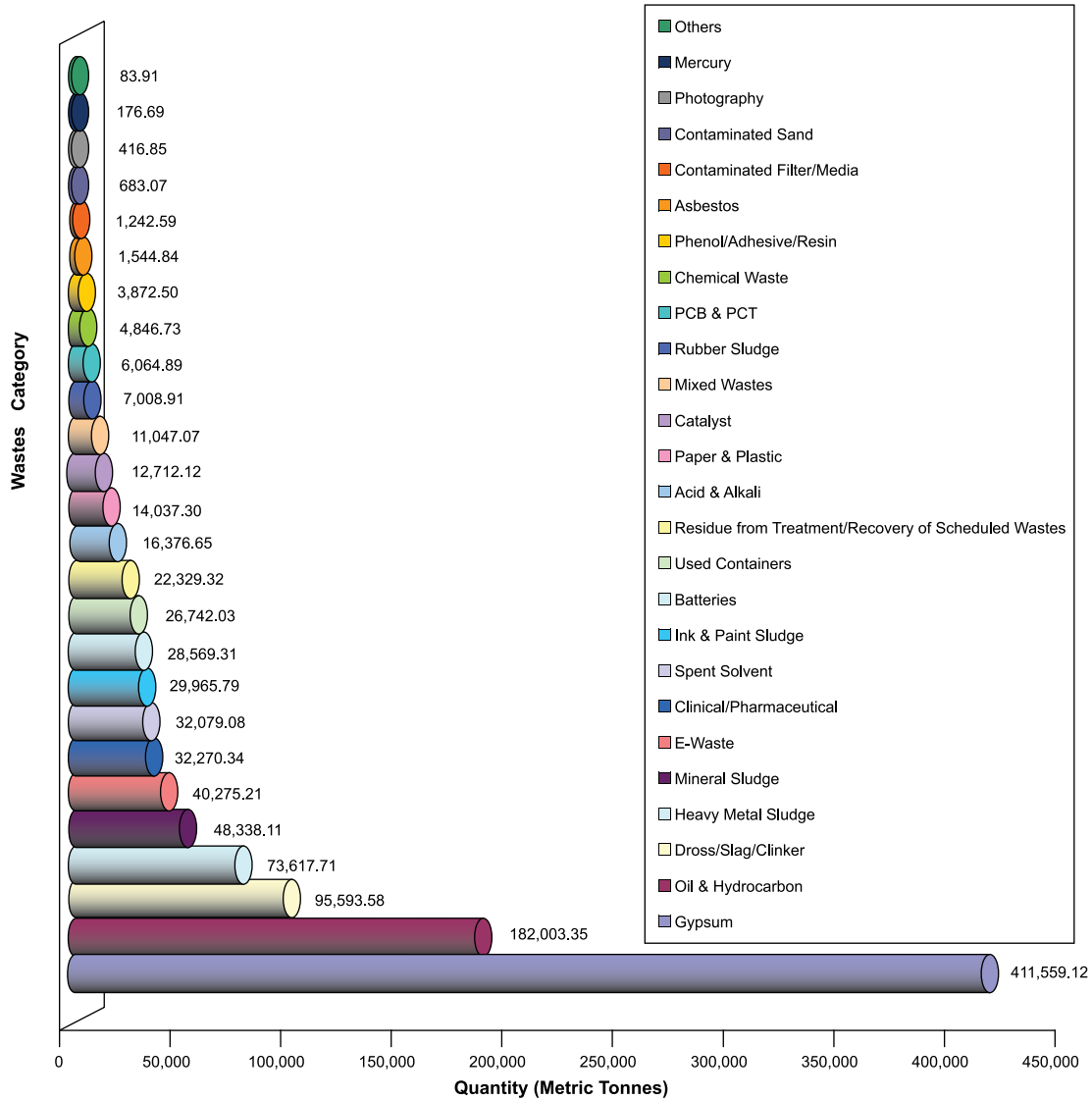


Figure 6.18 Malaysia : Quantity of Scheduled Wastes Generated by Category, 2006

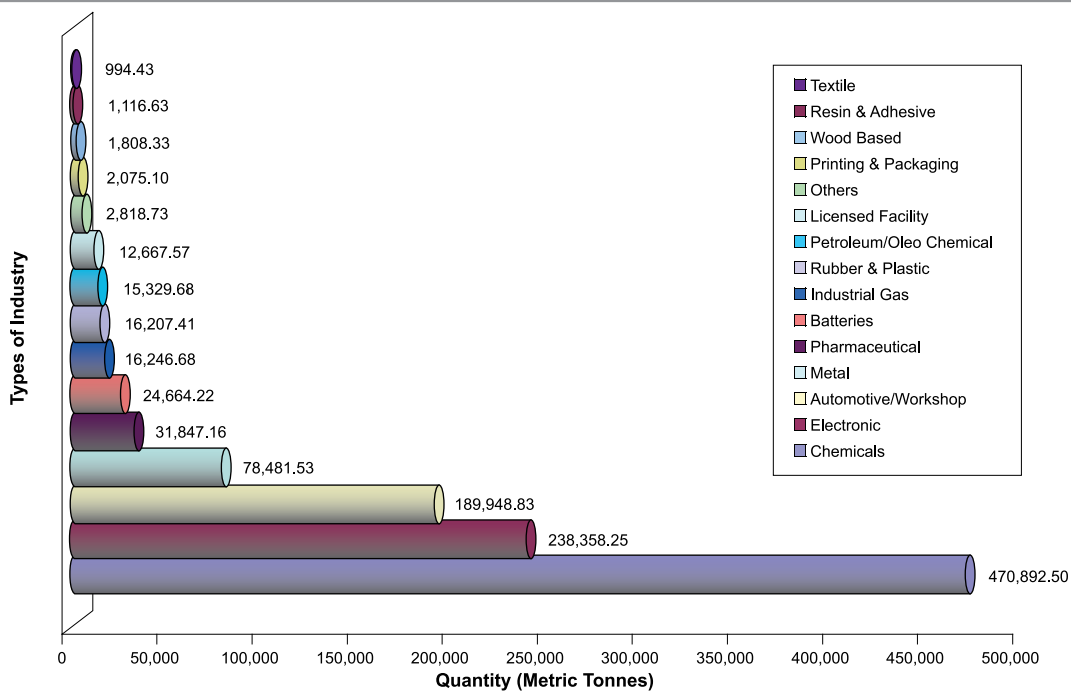


Figure 6.19 Malaysia : Quantity of Scheduled Wastes Generated by Industry, 2006

THE BASEL CONVENTION ON THE CONTROL OF TRANSBOUNDARY MOVEMENT OF HAZARDOUS WASTES AND THEIR DISPOSAL

In 2006, eight Written Approvals were issued for the import of 172,151 metric tonnes of wastes for use as raw materials (Figure 6.20). The wastes comprised of:

- waste gypsum from power plant (132,833 metric tonnes : 77.2%)
- copper slag (33,674 metric tonnes : 19.6%)
- waste glass from cathode ray tube (CRT) (4,628 metric tonnes : 2.7%)
- spent acid (1,016 metric tonnes : 0.6%)

Figure 6.20 illustrates the trend of wastes imported over the past five years (2002 to 2006). Waste gypsum was used as raw materials in cement manufacturing plants, copper slag was used in shipyard blasting operations, spent acid was used as raw material in sulphuric acid recovery process and waste CRT was used as raw material in manufacturing of cathode ray tube.

A total of 5,806 metric tonnes of scheduled wastes were exported in 2006 from 49 waste generators comprised of:

- electrical and electronic wastes (1,925 metric tonnes : 33.2%)
- metal hydroxide sludges containing heavy metals such as silver, nickel and copper (1,769 metric tonnes : 30.5%)
- zinc dross (1,082 metric tonnes : 18.6%)
- spent catalyst (645 metric tonnes : 11.1%)
- wastes of nickel cadmium battery (117 metric tonnes : 2.0%)
- wastes containing formaldehyde (24 metric tonnes : 0.4%)

The wastes were exported for recovery at various countries as shown in Table 6.5. The quantity and type wastes exported between 2002 and 2006 are shown in Figure 6.21.

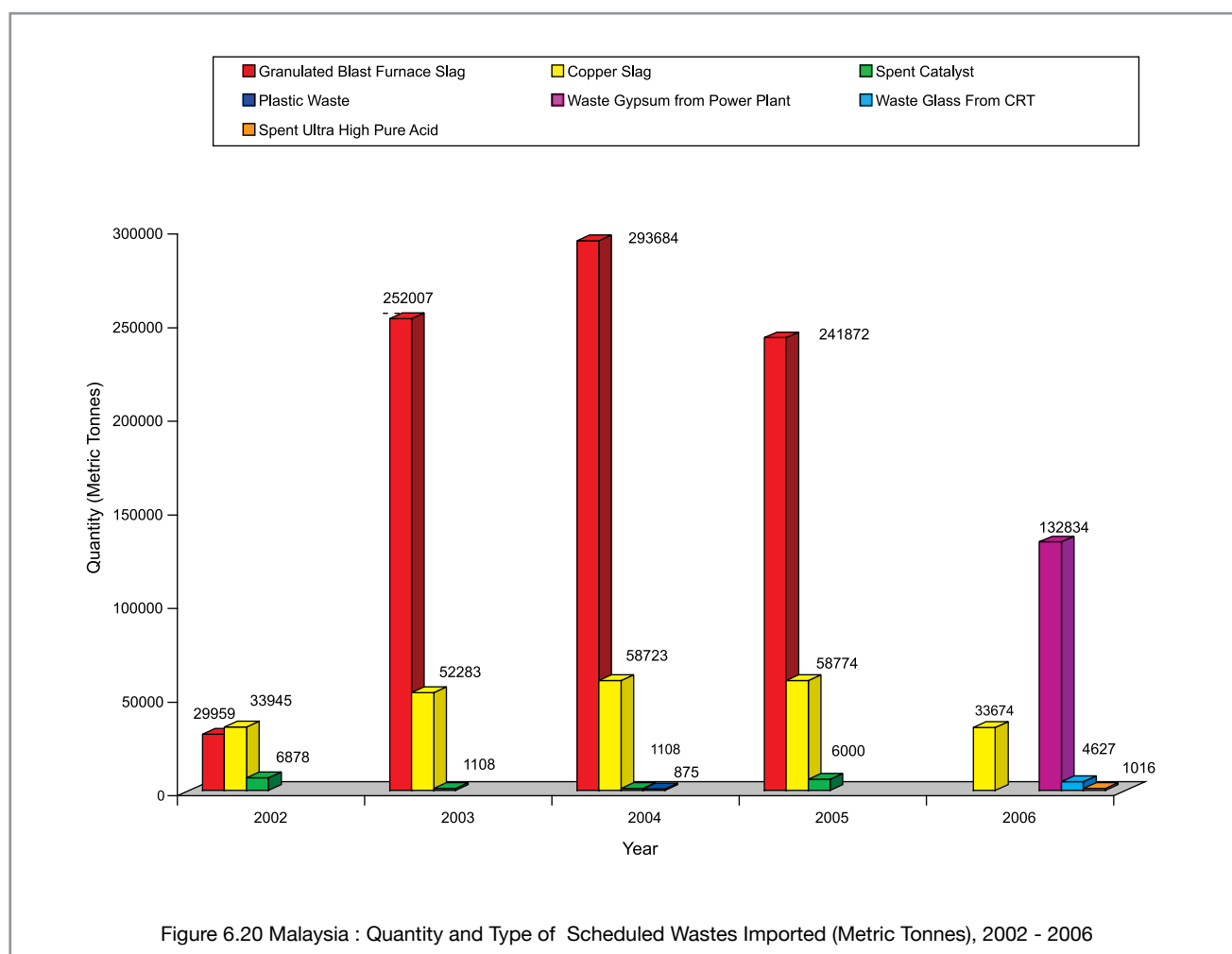


Table 6.5 Malaysia : Quantity and Destination of Scheduled Wastes Exported (Metric Tonnes), 2002 to 2006

Country	2002	2003	2004	2005	2006
Australia	315	209	-	-	-
Germany	128	349	476	492	537
Holland	570	323	294	-	-
Italy	44	28	-	-	98
Japan	1,035	1,006	1,019	1,793	660
Finland	100	23	190	-	381
France	67	98	189	272	-
Philippines	-	-	1,000	1,000	1,280
Singapore	169	-	22	14	10
Thailand	-	-	-	90	233
South Korea	-	118	-	-	117
Sweden	149	7	6	-	21
South Africa	-	-	-	8	424
Belgium	-	140	51	1,555	119
United States of America	533	60	80	-	1,847
China	-	-	-	-	79
Canada	-	-	25	-	-
Total (Metric Tonnes)	3,110	2,361	3,354	5,224	5,806

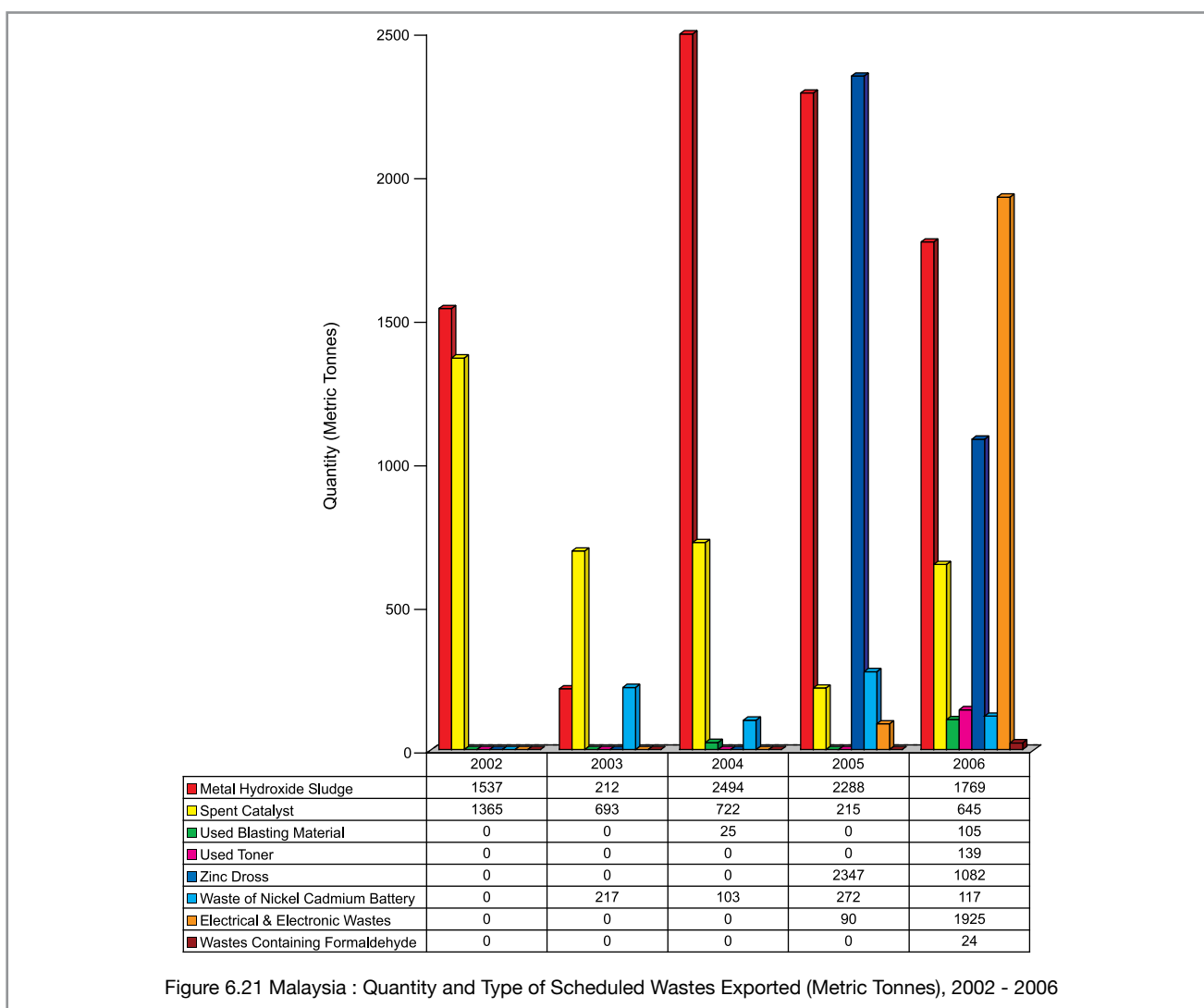


Figure 6.21 Malaysia : Quantity and Type of Scheduled Wastes Exported (Metric Tonnes), 2002 - 2006

ANNEX

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National Water Quality Standards For Malaysia

PARAMETER	UNIT	CLASS					
		I	IIA/IB	III*	IV	V	
Al	mg/l	↑	-	(0.06)	0.5	↑	
As	mg/l		0.05	0.4 (0.05)	0.1		
Ba	mg/l		1	-	-		
Cd	mg/l		0.01	0.01* (0.001)	0.01		
Cr (IV)	mg/l		0.05	1.4 (0.05)	0.1		
Cr (III)	mg/l		-	2.5	-		
Cu	mg/l		0.02	-	0.2		
Hardness	mg/l		250	-	-		
Ca	mg/l		-	-	-		
Mg	mg/l		-	-	-		
Na	mg/l		-	-	3 SAR		
K	mg/l		-	-	-		
Fe	mg/l		1	1	1 (Leaf) 5 (Others)		
Pb	mg/l		0.05	0.02* (0.01)	5		
Mn	mg/l		0.1	0.1	0.2		
Hg	mg/l		N	0.001	0.004 (0.0001)		0.002
Ni	mg/l		A	0.05	0.9*		0.2
Se	mg/l		T	0.01	0.25 (0.04)		0.02
Ag	mg/l		U	0.05	0.0002		-
Sn	mg/l		R	-	0.004		-
U	mg/l		A	-	-		-
Zn	mg/l		L	5	0.4*		2
B	mg/l		L	1	(3.4)		0.8
Cl	mg/l		E	200	-		80
Cl ₂	mg/l		V	-	(0.02)		-
CN	mg/l		E	0.02	0.06 (0.02)		-
F	mg/l		L	1.5	10		1
NO ₂	mg/l		S	0.4	0.4 (0.03)		-
NO ₃	mg/l		O	7	-		5
P	mg/l		R	0.2	0.1		-
Silica	mg/l		A	50	-		-
SO ₄	mg/l		B	250	-		-
S	mg/l		S	0.05	(0.001)		-
CO ₂	mg/l	E	-	-	-		
Gross-α	Bq/l	S	0.1	-	-		
Gross-β	Bq/l	E	1	-	-		
Ra-226	Bq/l	N	< 0.1	-	-		
Sr-90	Bq/l	T	< 1	-	-		
CCE	µg/l		500	-	-		
MBAS/BAS	µg/l		500	5000 (200)	-		
O & G (Mineral)	µg/l		40; N	N	-		
O & G (Emulsified Edible)	µg/l		7000; N	N	-		
PCB	µg/l		0.1	6 (0.05)	-		
Phenol	µg/l		10	-	-		
Aldrin/Dieldrin	µg/l		0.02	0.2 (0.01)	-		
BHC	µg/l		2	9 (0.1)	-		
Chlordane	µg/l		0.08	2 (0.02)	-		
t-DDT	µg/l		0.1	(1)	-		
Endosulfan	µg/l		10	-	-		
Heptachlor/Epoxide	µg/l		0.05	0.9 (0.06)	-		
Lindane	µg/l		2	3 (0.4)	-		
2,4-D	µg/l		70	450	-		
2,4,5-T	µg/l		10	160	-		
2,4,5-TP	µg/l		4	850	-		
Paraquat	µg/l		10	1800	-		

Notes :

* = At hardness 50 mg/l CaCO₃

= Maximum (unbracketed) and 24-hour average (bracketed) concentrations

N = Free from visible film sheen, discoloration and deposits

National Water Quality Standards For Malaysia

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	mg/l	7	5 - 7	5 - 7	3 - 5	< 3	< 1
pH	-	6.5 - 8.5	6 - 9	6 - 9	5 - 9	5 - 9	-
Colour	TCU	15	150	150	-	-	-
Electrical Conductivity*	µS/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	°C	-	Normal + 2 °C	-	Normal + 2 °C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	count/100 ml	10	100	400	5000 (20000) ^a	5000 (20000) ^a	-
Total Coliform	count/100 ml	100	5000	5000	50000	50000	> 50000

Notes :

- N : No visible floatable materials or debris, no objectional odour or no objectional taste
 * : Related parameters, only one recommended for use
 ** : Geometric mean
 a : Maximum not to be exceeded

DOE Water Quality Index Classification

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	-	> 7	6 – 7	5 – 6	< 5	> 5
Total Suspended Solid	mg/l	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index (WQI)		< 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

Water Classes And Uses

CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common, of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above.

DOE Water Quality Classification Based On Water Quality Index

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH ₃ -N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

WQI FORMULA AND CALCULATION

FORMULA

$$WQI = (0.22 * SIDO) + (0.19 * SIBOD) + (0.16 * SICOD) + (0.15 * SIAN) + (0.16 * SISS) + (0.12 * SlpH)$$

where;

SIDO = Subindex DO (% saturation)

SIBOD = Subindex BOD

SICOD = Subindex COD

SIAN = Subindex NH₃-N

SISS = Subindex SS

SlpH = Subindex pH

$$0 \leq WQI \leq 100$$

BEST FIT EQUATIONS FOR THE ESTIMATION OF VARIOUS SUBINDEX VALUES

Subindex for DO (in % saturation)

$$SIDO = 0$$

for $x \leq 8$

$$SIDO = 100$$

for $x \geq 92$

$$SIDO = -0.395 + 0.030x^2 - 0.00020x^3$$

for $8 < x < 92$

Subindex for BOD

$$SIBOD = 100.4 - 4.23x$$

for $x \leq 5$

$$SIBOD = 108 * \exp(-0.055x) - 0.1x$$

for $x > 5$

Subindex for COD

$$SICOD = -1.33x + 99.1$$

for $x \leq 20$

$$SICOD = 103 * \exp(-0.0157x) - 0.04x$$

for $x > 20$

Subindex for NH₃-N

$$SIAN = 100.5 - 105x$$

for $x \leq 0.3$

$$SIAN = 94 * \exp(-0.573x) - 5 * |x - 2|$$

for $0.3 < x < 4$

$$SIAN = 0$$

for $x \geq 4$

Subindex for SS

$$SISS = 97.5 * \exp(-0.00676x) + 0.05x$$

for $x \leq 100$

$$SISS = 71 * \exp(-0.0061x) - 0.015x$$

for $100 < x < 1000$

$$SISS = 0$$

for $x \geq 1000$

Subindex for pH

$$SlpH = 17.2 - 17.2x + 5.02x^2$$

for $x < 5.5$

$$SlpH = -242 + 95.5x - 6.67x^2$$

for $5.5 \leq x < 7$

$$SlpH = -181 + 82.4x - 6.05x^2$$

for $7 \leq x < 8.75$

$$SlpH = 536 - 77.0x + 2.76x^2$$

for $x \geq 8.75$

Note:

* means multiply with