MALAYSIA ENVIRONMENTAL QUALITY REPORT 2003

Department of Environment
Ministry of Natural Resources and Environment
Malaysia
(formerly Ministry of Science, Technology and the Environment)

DEPARTMENT OF ENVIRONMENT, MALAYSIA

Printed on Recycled Paper

Edited by
Publication Section,
Strategic Communications Division
Department of Environment

ISSN 0127-6433

Design & printed by
Sasyaz Kreatif Sdn Bhd.(154747K)
29, Jalan PJU 3/48, Sunway Damansara
Technology Park, 47810 Petaling Jaya, Selangor. Malaysia
Tel : 603-7803 3754 Fax : 603-7804 8245

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Foreword

In compliance with Section 3 (1) (i) of the Environmental Quality Act (EQA), 1974, the 2003 Environmental Quality Report is hereby presented.

I am pleased to report that in 2003 the environmental quality monitored by the Department of Environment continued to improve. The ambient air quality was relatively cleaner based on the increasing number of days with good air quality. Five (5) river basins that were categorised as being polluted all this while have improved compared to the previous years, which bring about the reduction in the number of polluted river basins to 9. This improvement could only be attributed to the effectiveness of enforcement actions, increased awareness and the strong support and cooperation from various stakeholders, the private sector as well as non-governmental organisations (NGOs).

With the establishment of new DOE Branch Offices at the State level and the deployment of additional manpower, efforts are being strengthened to prevent and mitigate environmental problems at the ground level. Notwithstanding the manpower increase, the cooperation and support of the public are essential to achieve common and mutually supportive objectives that take into account the interrelationship between people, resources, environment and development.

`Alam Sekitar Milik Kita:
Amanah Bersama'
`Our Environment,
Our Possession: Our Mutual Trust'

With Best Wishes,

Hajah Rosnani Ibarahim
Director-General of Environmental Quality, Malaysia

30 August 2004

CHAPTER 1

Air Quality

CHAPTER 1

AIR QUALITY

AIR QUALITY MONITORING

In 2003, an additional continuous air quality monitoring station was established at Precinct 1 of the Federal Government Administrative Centre in Putrajaya, bringing the total to 51 stations throughout the country. These stations were operated continuously to detect any significant change in the air quality which may be harmful to human health and the environment. These stations are strategically located according to specific monitoring objectives as shown in Map 1a and 1b. Most of the stations were located in residential areas to monitor population exposure to air pollution, while others were located within industrial areas.

The National Air Quality Monitoring Network is also supplemented by manual air quality monitoring stations (High Volume Samplers) located at 25 different sites. At these sites, total suspended particulates, particulate matter (PM_{10}) and several heavy metals such as lead were measured once in every six days.

AIR QUALITY STATUS

The air quality status for Malaysia is reported based on the Air Pollutant Index (API) as shown in Table 1. The overall air quality for Malaysia throughout the year 2003 improved slightly compared to 2002 especially with regard to the PM_{10} parameter. Generally the air quality was between good to moderate most of the time except for several unhealthy days recorded at various locations in Selangor and Penang. The slight deterioration of air quality in Selangor was mainly due to the increase of ground level ozone concentration in the ambient air which was formed by the reaction of volatile organic compounds (VOCs) and NO_x in the presence of heat and sunlight. Hence, the maximum ozone concentration detected in Klang Valley usually occurred between 1400 hrs to 1500 hrs. On the other hand, the unhealthy air quality status in Penang, specifically in Seberang Perai, was mainly due to sulphur dioxide and PM_{10} due to intensive industrial activities in the area. No other serious air pollution incident was detected throughout 2003. Particulate Matter (PM_{10}) and ozone remained the prevailing pollutants throughout the country.

Air Quality in the Klang Valley

Due to its physical geographical siting, industrial and commercial activities, population and vehicle density, the Klang Valley is more prone to air pollution than other areas.

In 2003, the Klang Valley experienced more than 70 percent of moderate and several unhealthy air quality days. However the number of unhealthy air quality days recorded was lesser as compared to the previous year. The unhealthy days recorded ranged between 9 to 56 days, compared to 17 to 67 days last year, measured at 7 different locations (Figure 1). Ozone which was normally formed between 1400 hrs to 1500 hrs remained the main pollutant which contributed to the unhealthy air quality days in Shah Alam, Kajang, Gombak and Kuala Lumpur. In other areas, the

Photo 1 : Putrajaya Automatic Air Quality Monitoring Station (DOE Photo Library)

Photo 2 : Instruments Used to Analyse Air Pollutants (DOE Photo Library)

air quality was moderate with PM_{10} as the main pollutant. Figure 2 shows the overall air quality status in the Klang Valley.

Air Quality in the 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 except in the Prai area. More than 70 percent of the time, the air quality in Langkawi and Alor Setar was good, while Kangar and Sungai Petani experienced good air quality 55 and 52 percent of the time respectively. Moderate air quality was experienced for the rest of the days throughout the year in those areas.

Prai is a heavily industrialised area. In Prai, the air quality was moderate more than 90 percent of the time. Figure 3 shows a slight increase in the number of unhealthy days recorded at the Seberang Perai station in 2003 as compared to the year before. Sulphur dioxide (SO_2) remained the main pollutant of concern in the area due to industrial activities in the vicinity. On the other hand, the air quality station located in Universiti Sains Malaysia in Minden, Penang, recorded moderate air quality around 50 percent of the time and good the remaining days.

In Perak, more moderate air quality days were experienced in 2003 except in Taiping and Tg. Malim which experienced more than 60 percent of good air quality throughout the year. In Sri Manjung, Ipoh and Tasek about 70 percent of the time, the air quality was moderate with only one unhealthy day recorded in Tasek. Being an industrial area, the air quality in Tasek was moderate 83 percent of the time, good for 16 percent of the time and with only one unhealthy day recorded. The air quality status in the Northern Region as well as the whole of the West Coast of Peninsular Malaysia is described in Figure 4.

Air Quality in the Southern Region

Similarly, the status of air quality observed in the southern region of the West Coast of Peninsular Malaysia, which covers 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. Seremban and Nilai recorded two and three unhealthy air quality days respectively. Ozone was the main pollutant that contributed to the unhealthy days in both of these areas.

In Bandaraya Melaka, more than 60 percent of the time the air quality was moderate, while in Bukit Rambai, the air quality was moderate 99 percent of the time. Bukit Rambai is an industrial air quality station located within the wood-based industrial zone. All four stations in Johor, recorded several unhealthy air quality days in 2003 except for a station in Muar. Ozone was the main pollutant that contributed to the unhealthy days in both of these areas. Muar, Johor Bahru and Pasir Gudang experienced between 60 to 80 percent of moderate air quality throughout the year. Meanwhile, Larkin experienced less than 40 percent of moderate air quality, a number of unhealthy days, and the remaining time of good air quality (Figure 4).

Air Quality in the East Coast

As in the previous years, the air quality in the East Coast of Peninsular Malaysia was good most of the time. Areas such as Kuantan, Jerantut, Paka, Kota Bharu, Kemaman and Pengkalan Chepa experienced good air quality more than 70 percent of the time, while Kemaman, Pengkalan Chepa, Kuala Terengganu and Balok Baru experienced more moderate than good air quality throughout 2003. No unhealthy air quality was recorded (Figure 5).

Air Quality in Sabah, Wilayah Persekutuan Labuan and Sarawak

The air quality in Sandakan, Kota Kinabalu and Keningau, Sabah was good more than 70 percent of the time, while in Tawau more moderate than good air quality was recorded. Sandakan and Keningau recorded one and two unhealthy days respectively. In Labuan, the air quality was good 80 percent of the time with the remaining 20 percent of moderate air quality.

In Sarawak, the overall air quality improved significantly compared to 2003. Most stations in Sarawak experienced more than 80 percent of good air quality in 2003. In Kapit more than 60 percent of the time the air quality was good (Figure 6). Only Bintulu in Sarawak experienced more moderate than good air quality days compared to other places. Bintulu is a heavy industrial area in Sarawak.

AIR QUALITY TREND

Six criteria pollutants namely Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Ozone (O_3), Sulphur Dioxide (SO_2) and Particulate Matter (PM_{10}) were monitored continuously at 51 locations, while Lead (Pb) concentration was measured once in every six days at three locations from 1996 to 2003. The air quality trend was computed by averaging direct measurements from the monitoring sites on a yearly basis. The averaging times used in the calculations are directly related to the Malaysian Ambient Air Quality Guidelines (Table 2).

Particulate Matter (PM_{10})

Particulate Matter (PM_{10}) is the general term used to describe respirable particles less than 10 micron in size, mainly from stationary and mobile sources as well as from natural sources. They may be directly emitted from motor vehicle exhaust, heat and power generation, industrial processes and open burning activities. Particulate matter may also be formed in the atmosphere by the transformation of precursor emissions such as SO_2 and NO_x (to form Sulfates and Nitrates). In addition, significant amount of fine particulates from uncontrolled biomass burning activities were transported into the country by southwesterly winds (transboundary pollution).

Photo 3 : Mobile Sources of Urban Air Pollution (DOE Photo Library)

Photo 4 : Open Burning at Illegal Solid Waste Dumping Site (DOE Photo Library)

Accumulation of this pollutant in the respiratory system is associated with numerous health effects related to respiratory diseases, decreased lung function and causes eye and throat irritation. Sensitive groups such as the elderly, individuals with asthma, cardiopulmonary disease and children are at great risk to such health effects.

Particulate Matter (PM_{10}) can also cause undesirable impact to the environment. Presence of high levels of PM_{10} in the atmosphere is also a major cause of reduced visibility, which results in hazy conditions especially during the dry season. Other environmental impacts occur when particles are deposited onto soil, plants, water or materials. Depending on their chemical composition, when deposited in sufficient quantities, particulate matter may change the nutrient balance and acidity in soil, interfere with plant metabolism and damage materials.

PM_{10} remained the prevalent pollutant in many areas of Malaysia. The annual average levels of PM_{10} concentration in the ambient air between 1996 to 2001 were just slightly below the Malaysian Ambient Air Quality Guideline value, except for 1997 when the country experienced severe haze episodes and in 2002 when the annual average concentration of PM_{10} was equivalent to the Malaysian Ambient Air Quality Guideline. Figure 7 shows a decrease of 13 percent in the annual average value of PM_{10} concentrations across the country between 2002 to 2003. Figure 7(a) describes the breakdown of the annual average levels of the PM_{10} for various categories of land use. Generally, higher levels of PM_{10} concentration were recorded in urban and industrial areas due to the presence of more sources in these areas.

Sulphur Dioxide (SO_2)

Sulphur Dioxide is a colourless pungent, irritating, water-soluble and reactive gas. This gas is formed when fuel containing sulphur (e.g. oil and coal) is burned during the combustion process mainly from industrial activities. High concentration of SO_2 in the atmosphere increases the risk of adverse symptoms in asthmatic patients and irritates respiratory system. Other effects associated with long-term exposure to high concentrations of SO_2, coupled with high levels of particulate matter include respiratory illnesses, alterations in lung functions and aggravation of existing cardiovascular diseases.

There are also environmental concerns associated with high concentrations of SO_2. Sulphur dioxide (SO_2) along with NO_x is a major precursor to acidic deposition which contributes to the acidification of soils, lakes and streams and can cause adverse impact on the ecosystem. Sulphur dioxide (SO_2) can also be harmful to plant life and accelerates the corrosion of buildings and monuments.

The annual average levels of the sulphur dioxide in the ambient air between 1996 and 2003 (Figure 8) were well below the Malaysian Ambient Air Quality Guideline. Figure 8(a) shows the annual average concentrations of sulphur dioxide for different categories of land use. The concentration of SO_2 was consistently higher in industrial areas where main sources of emissions were located.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that is formed in the ambient air through the oxidation of nitric oxide (NO). Nitrogen oxides (NO_x) is the term used to describe the sum of NO, NO_2 and other oxides of nitrogen. The major sources of man-made NO_x emissions are high-temperature combustion processes, such as those occurring in power plants and automobiles. Most of the NO_x (95 percent) from combustion processes is emitted as NO, and the remaining as NO_2. Nitrogen monoxide (NO) is readily converted to NO_2 in the environment.

Short term exposure to NO_2 may lead to changes in airway responsiveness and lung function in individuals with pre-existing respiratory illness and increases respiratory illness in children. Long term exposure may increase susceptibility to respiratory infection and cause alteration in lung functions. Nitrogen oxides also react in the air to form ground-level ozone and fine particle pollution which are both 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 increases in levels of toxins harmful to fish and other aquatic life.

For the period of 1996 to 2003, the annual average concentrations of NO_2 in the ambient air in Malaysia as shown in Figure 9 and Figure 9(a), were well below the Malaysian Ambient Air Quality Guideline; a downward trend in NO_2 concentration from 1996 to 2000, a 14.7 percent increase in 2001 from the year before, while in 2003, the NO_2 concentration was at the same level as in 2002. Nitrogen dioxide (NO_2) concentrations were high in urban and industrial areas, mainly due to emissions from automobiles and combustion processes.

Photo 5 : Open Burning Near Residential Area (DOE Photo Library)

Ground Level Ozone (O_3)

Ozone is not emitted directly into the air but is formed by the reaction of Volatile Organic Carbon (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 other sources of combustion. Changes in the weather pattern contribute to yearly differences in ozone concentrations. Ozone and the precursor pollutants that form ozone also can be transported hundreds of kilometres away depending on wind directions.

Exposures to high concentration of ground-level ozone have been linked to a number of health effects. Repeated exposures 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, reduces growth and survivality of tree seedlings, and increases plant susceptibility to diseases, pests, and other environmental stresses. In long-lived species, these effects may become evident only after several years or even decades, thus having the potential for long-term effects on forest ecosystems.

Figure 10 shows the annual average daily maximum 1-hour ozone concentration in the ambient air between 1996 to 2003. There were fluctuations in the trend observed throughout this period. The highest level was recorded in 1997. This pattern can be explained by the meteorological conditions during that year where the whole region experienced prolonged dry and hot weather as a result of the El-Nino phenomenon. In 2003, the annual average daily maximum 1-hour ozone concentration decreased by 7..6 percent from the previous year. Figure 10(a) describes the breakdown of ozone concentrations at various land use categories throughout those years. Higher levels of Ozone were consistently recorded in urban areas, due to the presence of the precursor ozone gases, namely NO_x, emitted from motor vehicles.

Photo 6 : Air Pollution From Peatland Fire (DOE Photo Library)

Photo 7 : Air Pollution From Traditional Brick Kiln (DOE Photo Library)

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. Carbon monoxide is emitted mainly by motor vehicle exhausts, while other sources of CO emissions include industrial processes and open burning activities. Carbon monoxide enters the bloodstream through the lungs and reduces oxygen delivery to organs and tissues. 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 capacity and poor learning ability are among the health effects associated with exposure to elevated CO levels.

The annual 8-hourly average concentrations of carbon monoxide throughout the country measured between 1996 to 2003 were well below the Malaysian Ambient Air Quality Guideline (Figure 11). The concentration of CO is consistently higher in urban areas where the main sources of emissions were motor vehicles. Figure 11(a) shows CO concentrations at the various categories of land use.

Lead Concentration (Pb)

Excessive exposure to lead may cause neurological impairment, such as mental retardation and behavioural disorders. Even at low doses, lead exposure is associated with damage to the nervous systems of foetuses and young children resulting in learning deficits and lowered IQ.

In the past, motor vehicles had been the main source of lead (Pb) emission in to the atmosphere. The lead levels monitored in the atmosphere were high in the eighties. However, as the result of the Government's effort in promoting the use of unleaded petrol since 1991 and the total phase-out of leaded petrol in 1998, the lead level in the atmosphere had declined significantly. In 2003, the average level of atmospheric lead monitored in the Klang Valley remained low as in the previous years (Figure 12).

Map 1a Malaysia : Location of Continuous Air Quality Monitoring Stations, 2003

Map 1b Malaysia : Location of Continuous Air Quality Monitoring Stations, 2003

Table 1: Malaysia Air Pollutant Index

API	Air Quality Status
0 - 50	Good
51 - 100	Moderate
101 - 200	Unhealthy
201 - 300	Very Unhealthy
> 300	Hazardous

Table 2: Malaysian Ambient Air Quality Guidelines

Pollutant	Averaging Time	Malaysian Guidelines	
		ppm	(ug/m³)
Ozone	1 Hour 8 Hours	0.10 0.06	200 120
Carbon Monoxide	1 Hour 8 Hours	30 9	35 10
Nitrogen Dioxide	1 Hour 24 Hours	0.17 0.04	320
Sulphur Dioxide	1 Hour 24 Hours	0.13 0.04	350 105
Particulate Matter (PM_{10})	24 Hours I Year		150 50
Total Suspended Particulate (TSP)	24 Hours I Year		260 90
Lead	3 Months		1.5

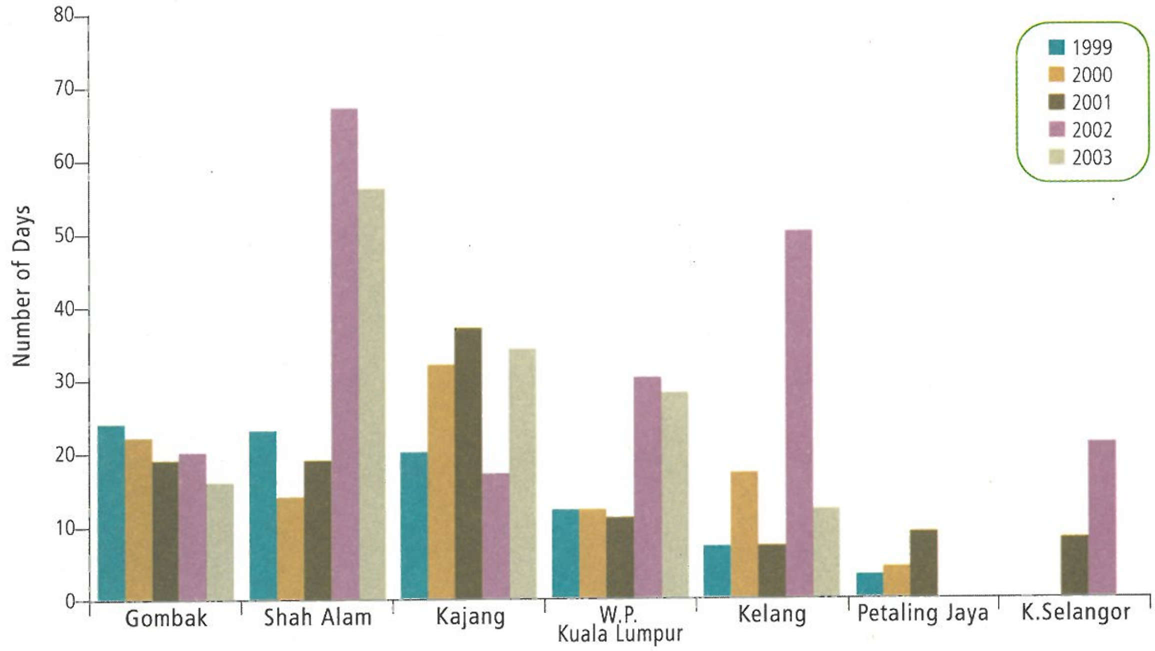


Figure 1 Malaysia: Number of Unhealthy Days, Klang Valley,1999-2003

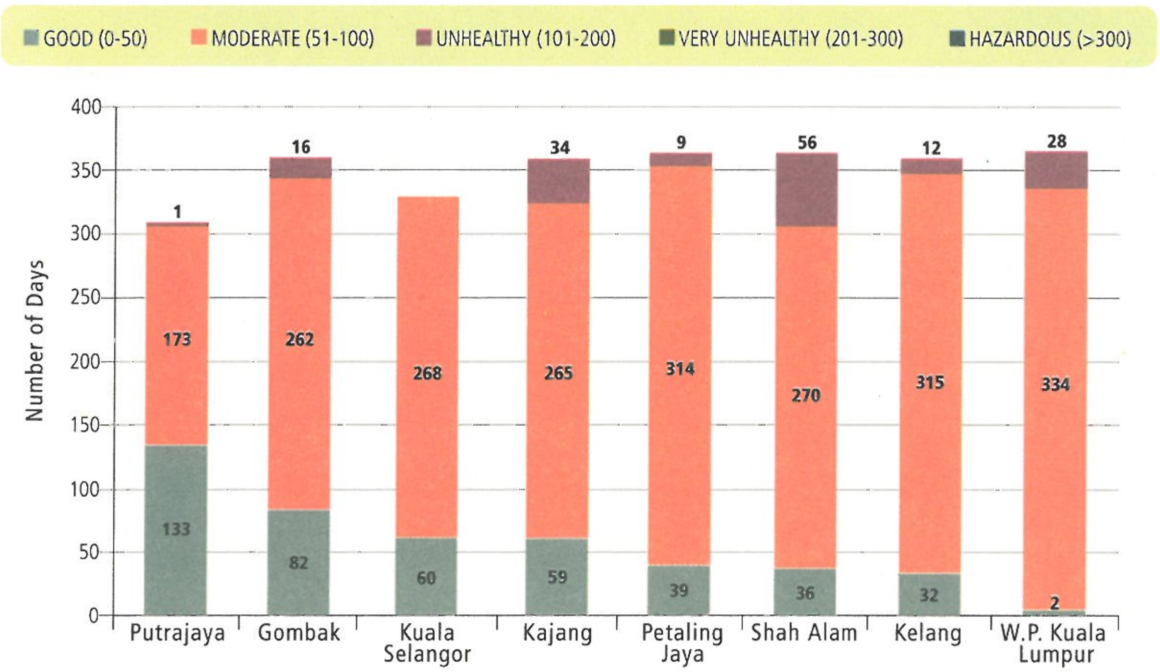


Figure 2 Malaysia: Air Quality Status, Klang Valley, 2003

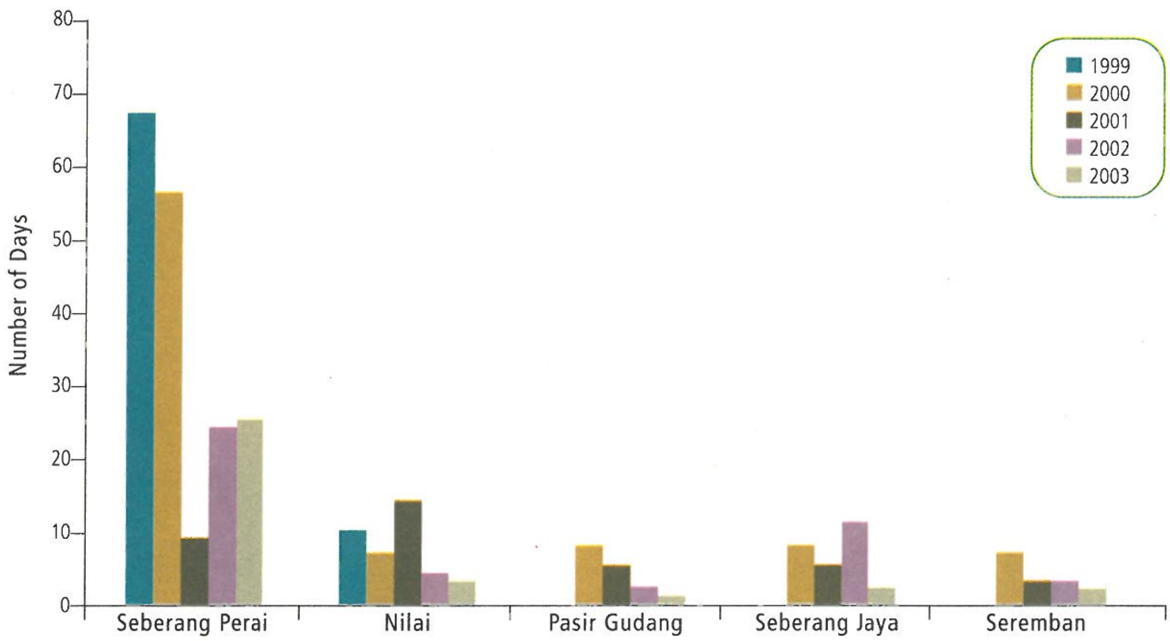


Figure 3 Malaysia: Number of Unhealthy Days, West Coast Peninsular Malaysia,1999-2003

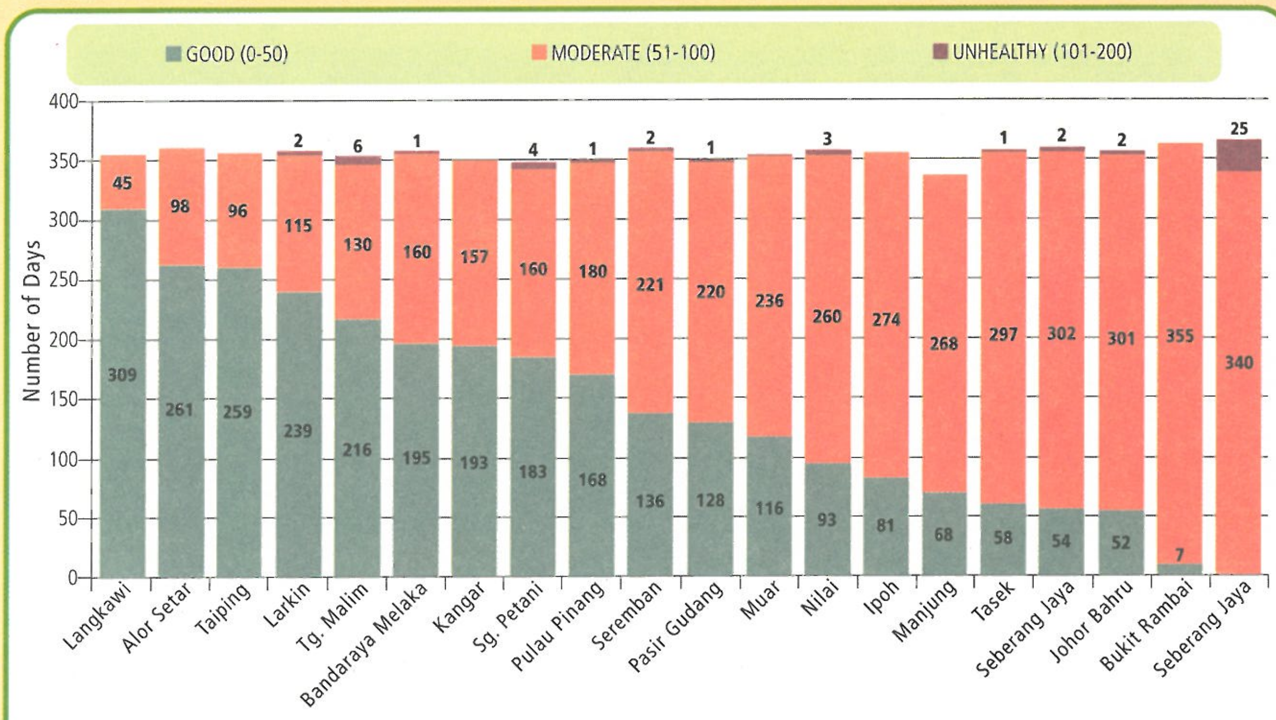


Figure 4 Malaysia: Air Quality Status, West Coast Peninsular Malaysia, 2003

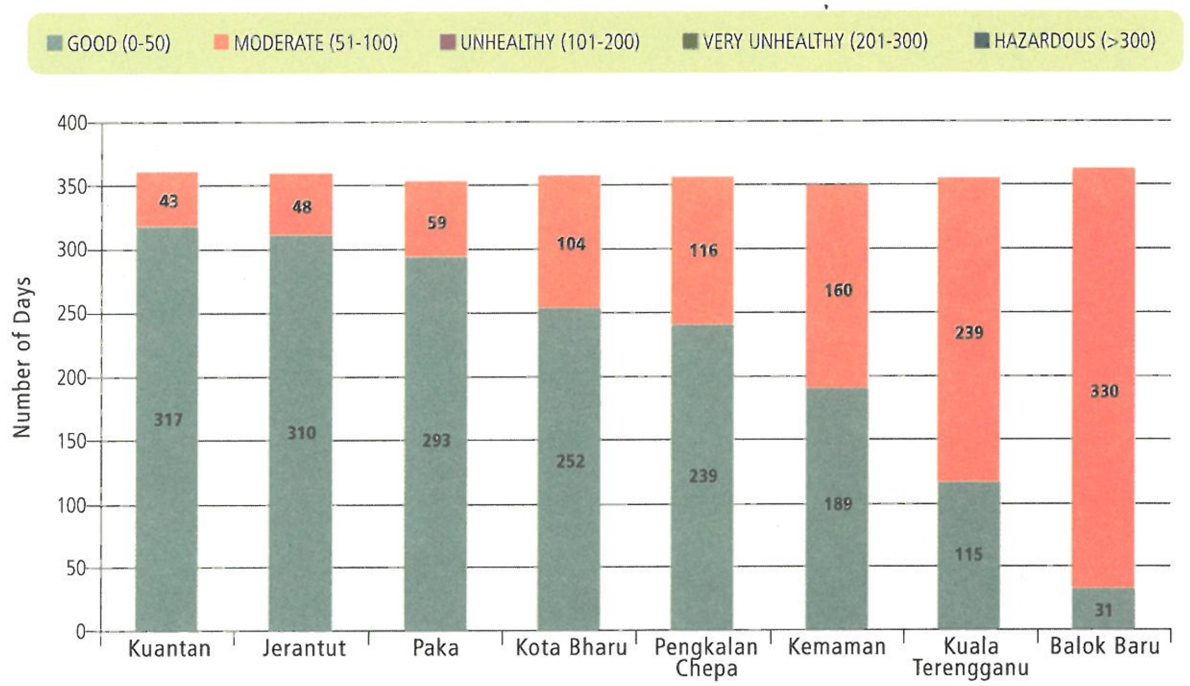


Figure 5 Malaysia: Air Quality Status, East Coast Peninsular Malaysia, 2003

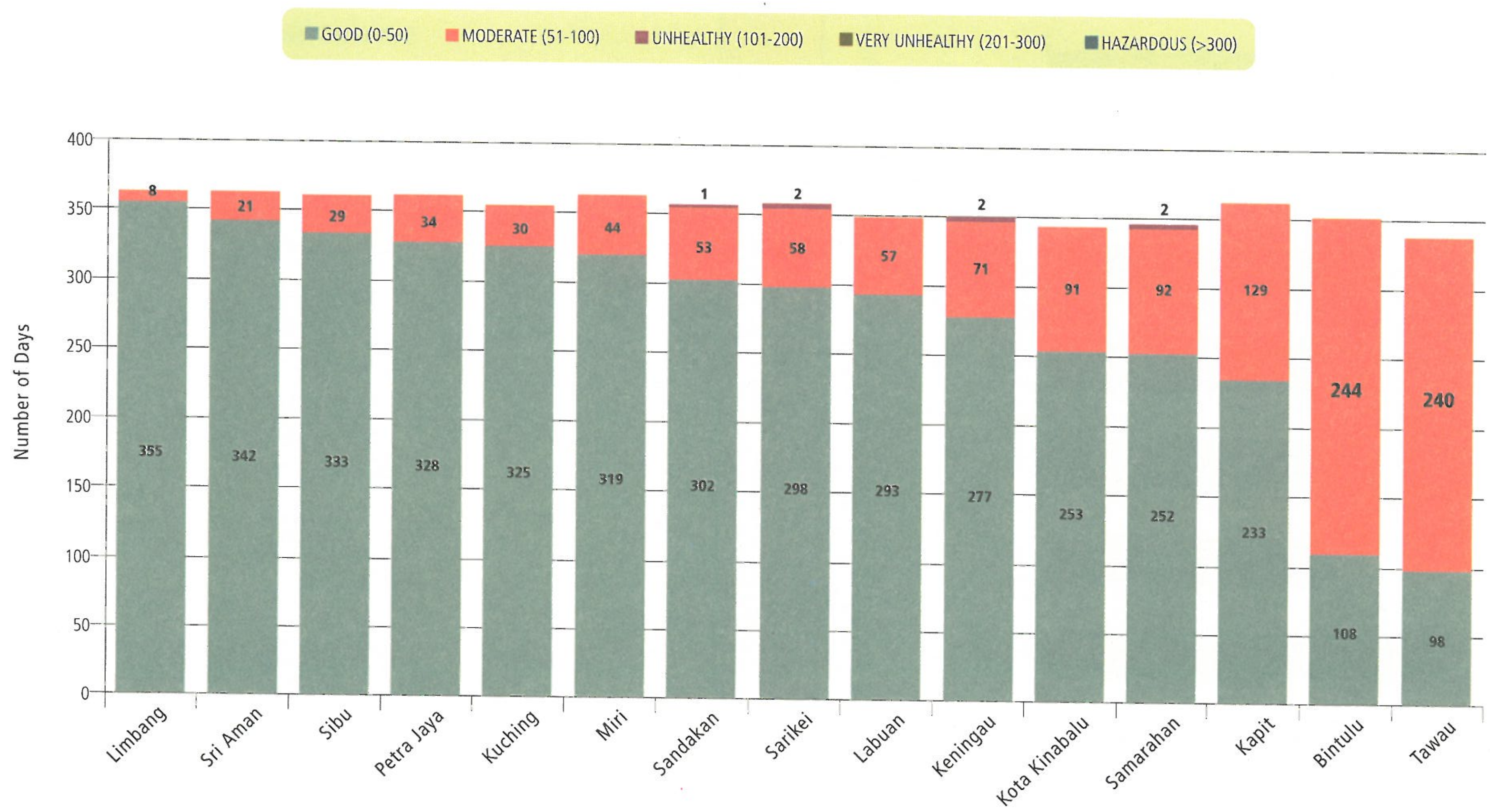
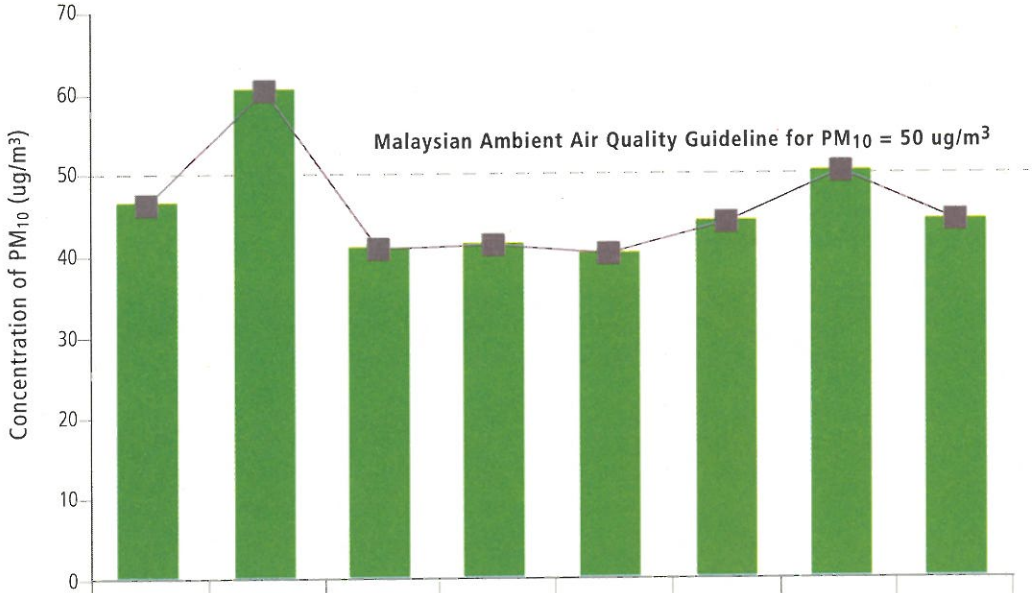
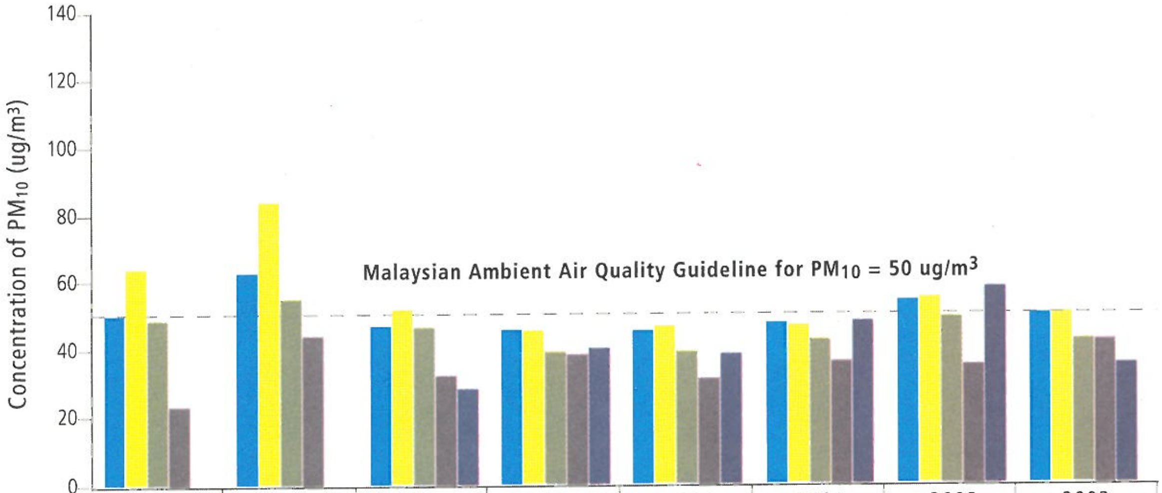


Figure 6 Malaysia: Air Quality Status, Sabah and Sarawak, 2003



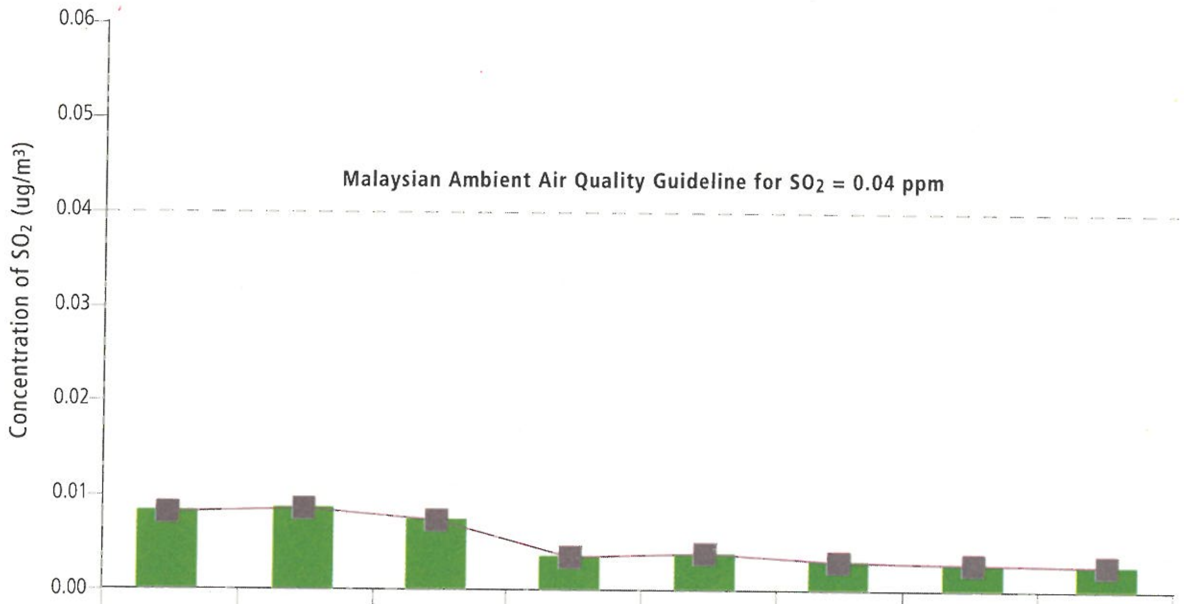
	1996	1997	1998	1999	2000	2001	2002	2003
No. of sites	13	27	37	45	50	50	50	51

Figure 7 Malaysia: Annual Average Concentration of Particulate Matter (PM_{10}), 1996-2003



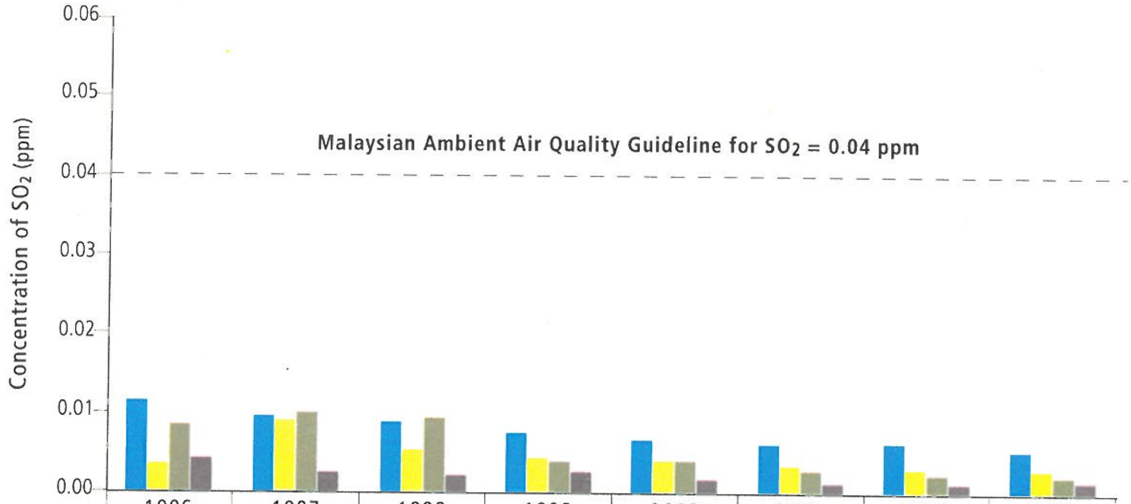
	1996	1997	1998	1999	2000	2001	2002	2003
Industrial	50	62	47	45	45	47	54	50
Urban	64	83	51	45	46	46	55	50
Sub Urban	49	54	46	39	39	42	49	42
Background	23	44	32	38	31	36	35	42
Rural			28	40	38	48	58	35

Figure 7(a) Malaysia: Annual Average Concentration of Particulate Matter (PM_{10}) by Land Use, 1996-2003



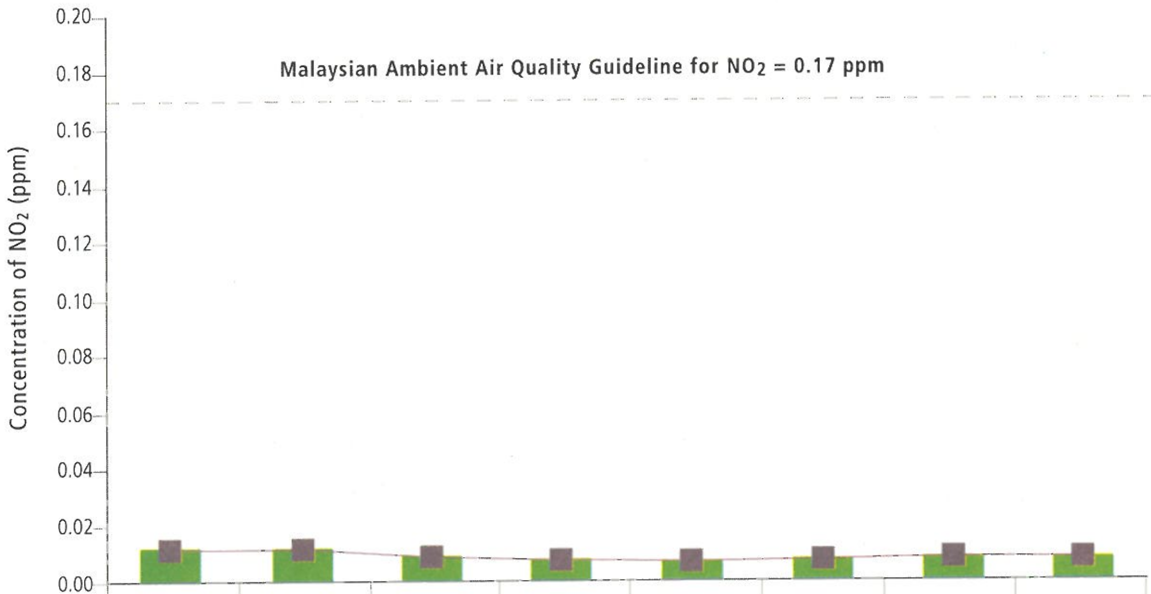
	1996	1997	1998	1999	2000	2001	2002	2003
No. of sites	13	27	33	39	43	43	43	44

Figure 8 Malaysia: Annual Average Concentration of Sulphur Dioxide (SO_2),1996-2003



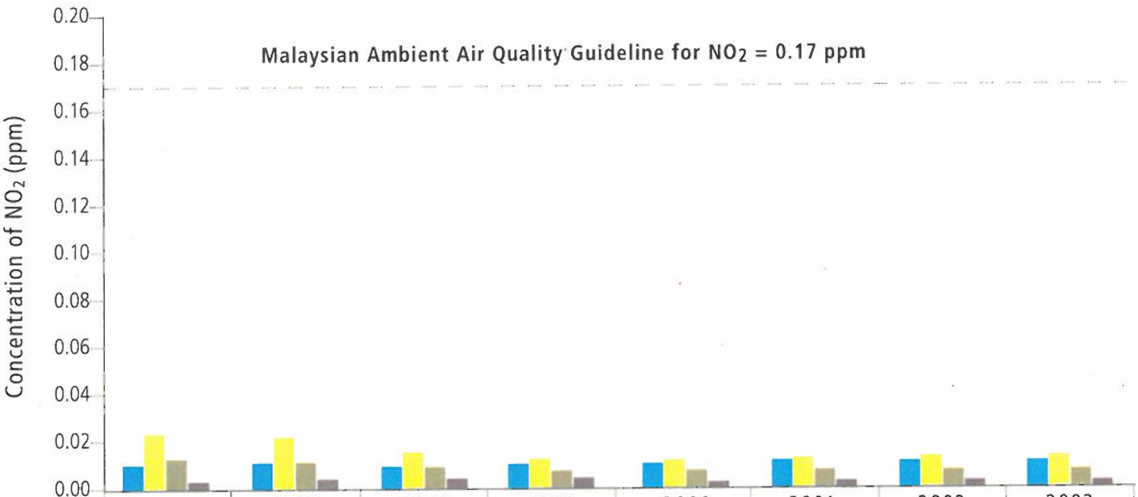
	1996	1997	1998	1999	2000	2001	2002	2003
Industrial	0.0112	0.0093	0.0087	0.0073	0.0064	0.0057	0.0058	0.0050
Urban	0.0033	0.0089	0.0052	0.0039	0.0037	0.0030	0.0027	0.0026
Sub Urban	0.0082	0.0097	0.0090	0.0036	0.0038	0.0024	0.0020	0.0018
Background	0.0040	0.0022	0.0017	0.0022	0.0013	0.0009	0.0009	0.0010

Figure 8(a) Malaysia: Annual Average Concentration of Sulphur Dioxide (SO_2) by Land Use, 1996-2003



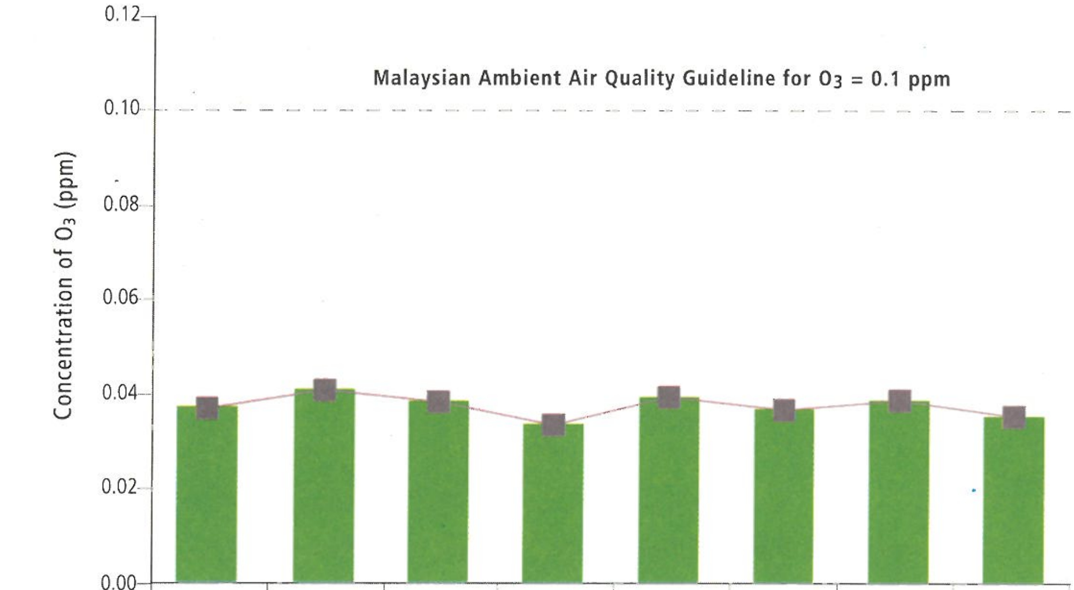
	1996	1997	1998	1999	2000	2001	2002	2003
No. of sites	13	27	33	39	43	43	43	44

Figure 9 Malaysia: Annual Average Concentration of Nitrogen Dioxide (NO_2), 1996-2003



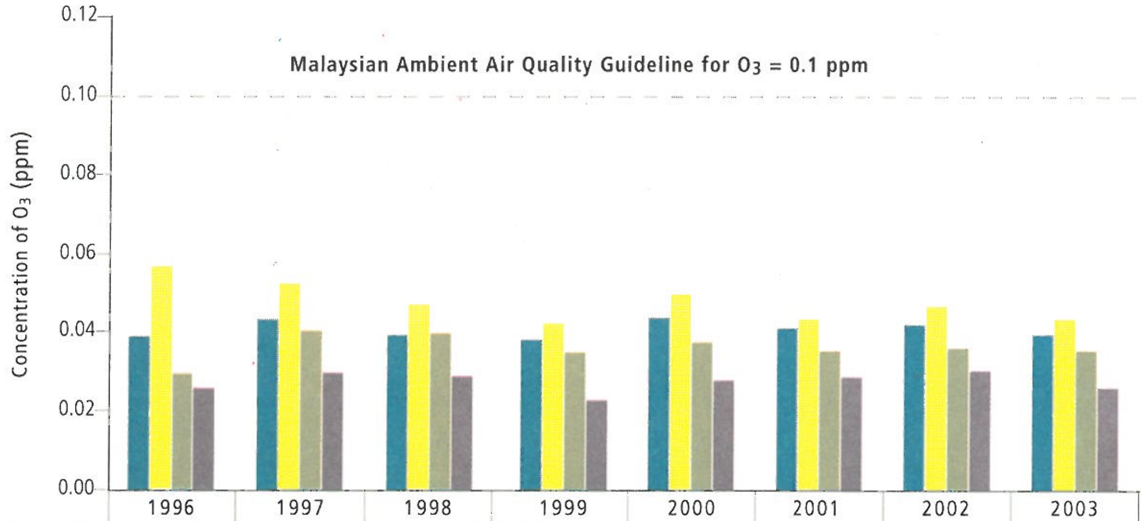
	1996	1997	1998	1999	2000	2001	2002	2003
Industrial	0.0096	0.0100	0.0089	0.0096	0.0093	0.0105	0.0106	0.0104
Urban	0.0221	0.0210	0.0141	0.0112	0.0104	0.0113	0.0122	0.0123
Sub Urban	0.0123	0.0108	0.0084	0.0062	0.0062	0.0062	0.0065	0.0066
Background	0.0025	0.0033	0.0031	0.0030	0.0014	0.0013	0.0018	0.0017

Figure 9(a) Malaysia: Annual Average Concentration of Nitrogen Dioxide (NO_2) by Land Use, 1996-2003



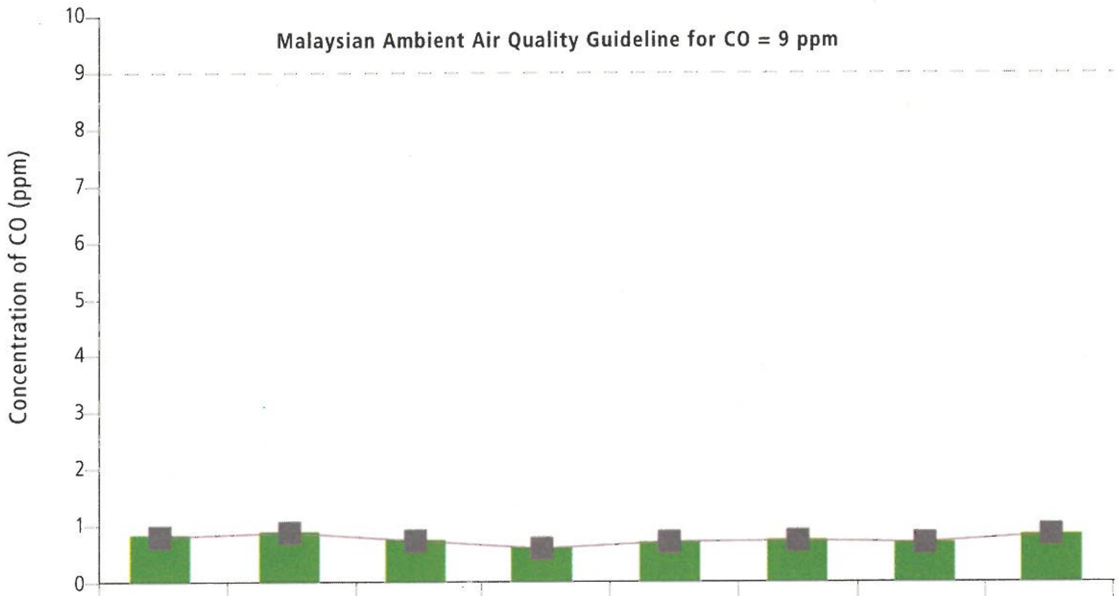
	1996	1997	1998	1999	2000	2001	2002	2003
No. of sites	12	21	27	35	39	39	39	41

Figure 10 Malaysia: Annual Average Daily Maximum 1 Hour Concentration of Ozone (O_3), 1996-2003



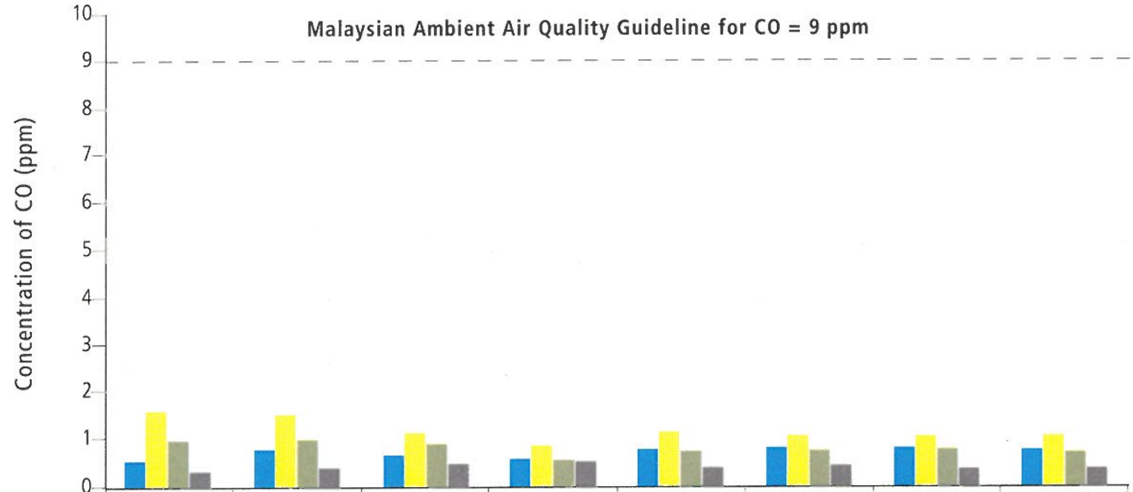
	1996	1997	1998	1999	2000	2001	2002	2003
Industrial	0.038	0.043	0.039	0.038	0.043	0.0405	0.0413	0.0389
Urban	0.056	0.051	0.046	0.041	0.049	0.0426	0.0461	0.0428
Sub Urban	0.029	0.040	0.039	0.034	0.037	0.0348	0.0355	0.0345
Background	0.025	0.029	0.028	0.022	0.027	0.0279	0.0298	0.0250

Figure 10(a) Malaysia : Annual Average Daily Maximum 1 Hour Concentration of Ozone (O_3) by Land Use, 1996-2003



	1996	1997	1998	1999	2000	2001	2002	2003
No. of sites	12	21	27	35	39	39	39	41

Figure 11 Malaysia: Annual Average Concentration of Carbon Monoxide (CO), 1996-2003



	1996	1997	1998	1999	2000	2001	2002	2003
Industrial	0.501	0.726	0.627	0.555	0.739	0.7614	0.7676	0.7405
Urban	1.541	1.475	1.067	0.822	1.071	1.0091	0.9934	0.9981
Sub Urban	0.922	0.975	0.845	0.520	0.689	0.7169	0.7187	0.6768
Background	0.255	0.330	0.436	0.448	0.347	0.3978	0.3182	0.3060

Figure 11(a) Malaysia: Annual Average Concentration of Carbon Monoxide (CO) by Land Use, 1996-2003

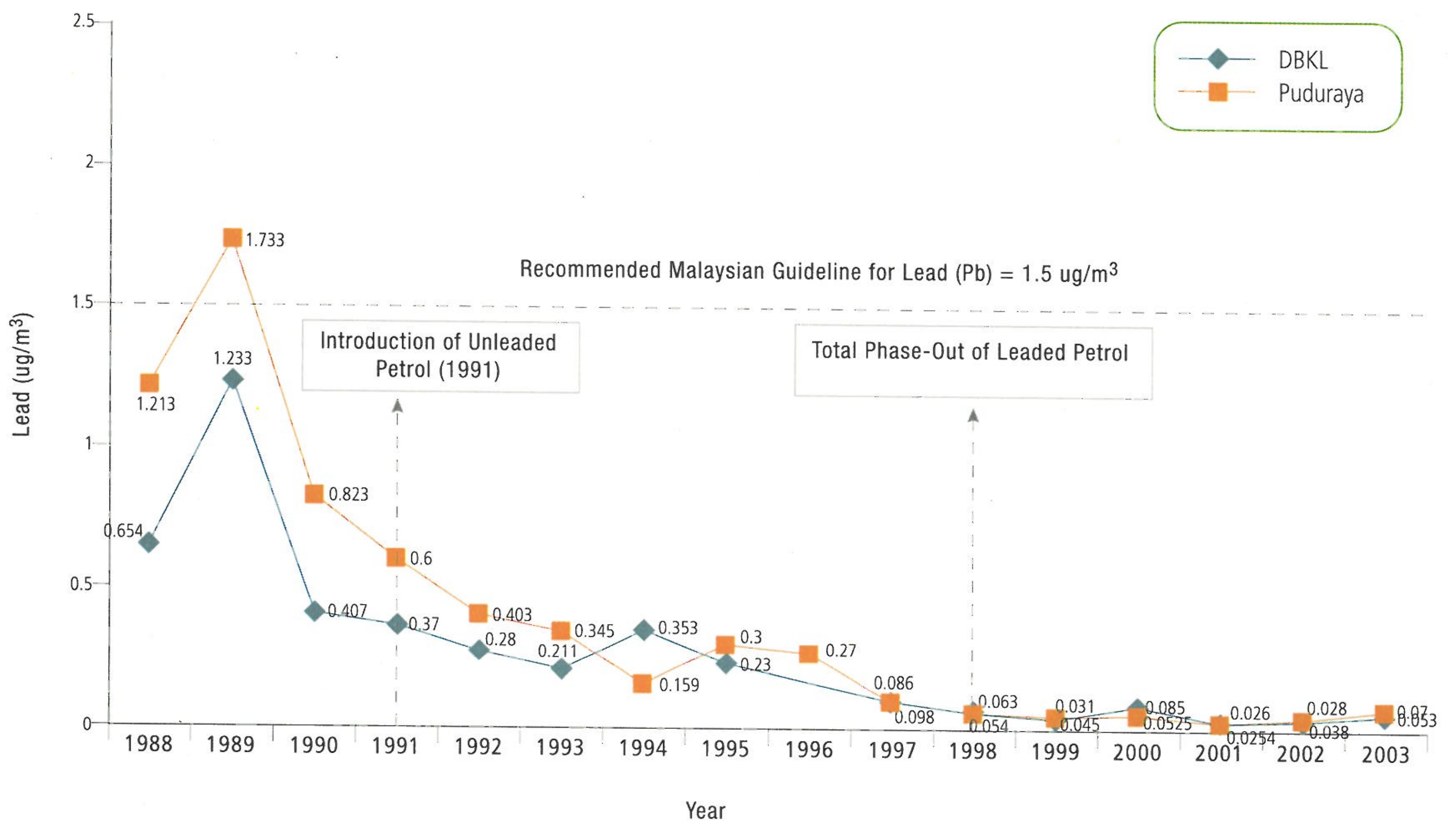
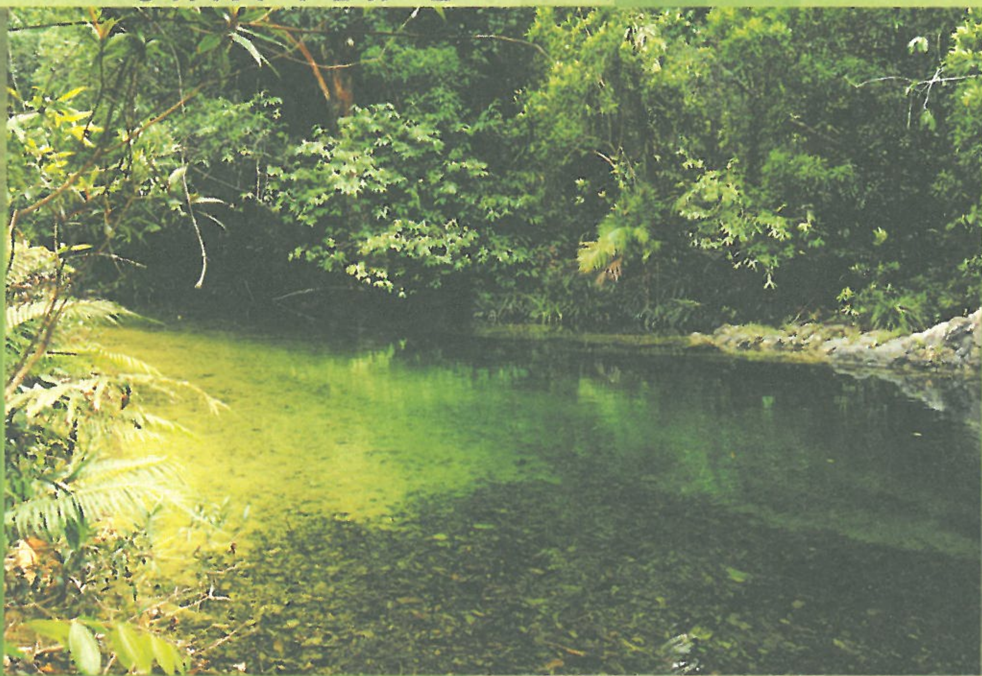


Figure 12 Malaysia: Air Quality Trend : Ambient Lead Concentration, Klang Valley, 1988 - 2003

CHAPTER 2



River Water Quality

CHAPTER 2

RIVER WATER QUALITY

Photo 8 : A Clean River Meandering Through Endau Rompin National Park (DOE Photo Library)

RIVER WATER QUALITY MONITORING

The importance of establishing baselines for water quality and to detect changes prompted the Department of Environment to begin monitoring river quality in 1978. This has since been extended to identify pollutions sources as well. Since then samples are regularly collected at predetermined stations for *in situ* and laboratory analysis and data interpretation in terms of physico-chemical and biological characteristics. The Water Quality Index (WQI) is used to appraise the river water quality consisting of parameters such as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (NH_3N), Suspended Solids (SS) and pH. The WQI serves as a basis for environmental assessment of a watercourse in relation to pollution load categorisation and designation of classes of beneficial uses as provided for under the Interim National Water Quality Standards for Malaysia (INWQS) (ANNEX).

RIVER WATER QUALITY STATUS

In 2003, a total of 926 water quality monitoring stations located within 120 river basins were monitored. Out of these 926 monitoring stations, 412 (44.5%) were found to be clean; 448 (48.4%) slightly polluted and 66 (7.1%) polluted (Table 4.0(a), (b) & (c)). Stations located upstream were generally clean, while those downstream were either slightly polluted or polluted. In terms of water quality on the basis of river basins, 59 river basins (49.2%) were clean compared to 63 river basins in 2002; 52 (43.3 %) slightly polluted compared to 43 in 2002; and 9 (7.5 %) polluted compared to 14 in 2002 (Figure 13).

Cumulative water quality data compiled from the water quality data accumulated from the 15 continuous water quality monitoring (CWQM) stations are presented in Figures 14, 15, 16 & 17. Based on the 90-percentile values, low dissolved oxygen levels were most frequent in Sg. Klang (51% Saturation), followed by Sg. Perai (51.1% Saturation) and Sg. Putat (60.4% Saturation) (Figure 14). High ammonium levels were recorded more frequently in Sg. Klang (7.89 mg/l), followed by Sg. Putat (7.36 mg/l) and Sg. Batang Benar (5.34 mg/l) (Figure 15). High turbidity levels were most frequently detected in Sg. Langat (1000 NTU), followed by Sg. Rajang (954 NTU) and Sg. Linggi (887 NTU) (Figure 16). Meanwhile pH value of 6.03 was recorded in Sg. Selangor, pH 6.46 in Sg. Terengganu and pH 6.59 in Sg. Melaka (Figure 17).

The most important and significant use of the continuous monitoring data is the early detection of pollution influx. Over the years, a number of pollution incidences had been observed at many of the continuous monitoring stations. For the period from January to December 2003, eleven river water conditions exerting distinctive pollution influx were observed (Table 3).

Figure 18 illustrates the status of river water quality in relation to major pollution sources: 13% of the river basins were polluted by Biochemical Oxygen Demand (BOD) due to sewage and discharges from agro-based and manufacturing industries; 24% of the river basins were polluted by ammoniacal nitrogen (NH_3-N)

Table 3: Malaysia Pollution Influx Observed at Eleven Continuous Water Quality Monitoring (CWQM) Stations, 2003

Station	Date	Parameter	Potential Source
Sg. Putat	2nd July	DO: 0.11 mg/L Cond: 921 uS/cm NH_4: 10.5 mg/L	Sewage or latex-based and industrial
Sg. Labu	24th Sept	Cond: 448 uS/cm NH_4: 6.32 mg/L	Sewage or latex-based and industrial
Sg. Labu	24th Oct	Cond: 791 uS/cm	Industrial
Sg. Putat	2nd Oct	Cond: 498 uS/cm NH_4: 11.65 mg/L	Sewage or latex-based and industrial
Sg. Putat	9th Oct	DO: 1.08 mg/L Cond: 564 uS/cm NH_4: 9.2 mg/L	Sewage or latex-based and industrial
Sg. Batang Benar	24th Oct	DO: 0.08 mg/L Cond: 266 uS/cm NH_4: 6.96 mg/L	Sewage or latex-based
Sg. Batang Benar	24th Nov	DO: 1.6 mg/L Cond: 180 uS/cm NH_4: 4.42 mg/L	Sewage or latex-based
Sg. Batang Benar	25th Nov	DO: 0.31 mg/L Cond: 114 uS/cm NH_4: 7.37 mg/L	Sewage or latex-based
Sg. Langat	28th Dec	Cond: 124 uS/cm NH_4: 2.53 mg/L	Sewage or latex-based
Sg. Langat	31st Dec	Cond: 135 uS/cm NH_4: 2.36 mg/L	Sewage or latex-based
Sg. Putat	29th Dec	Cond: 104 uS/cm NH_4: 3.19 mg/L	Sewage or latex-based

Photo 9 : River Water Quality Manual Measurement (DOE Photo Library)

Photo 10 : Automatic River Quality Monitoring Station (DOE Photo Library)

from sewage that include livestock farming and domestic sewage; and 23% of river basins by suspended solids (SS) due to earthworks and land-clearing activities. The corresponding figures in 2002 were 18%, 24% and 23% for BOD, NH_3-N and SS respectively.

Analysis of heavy metals in 5,639 water samples revealed that almost all samples complied with Class III Interim National Water Quality Standards for arsenic (As), mercury (Hg), cadmium (Cd), chromium (Cr), lead (Pb) and zinc (Zn), except for iron (Fe) with 71% compliance.

As shown in Figure 13, the number of polluted river basins in 2003 had decreased from 14 to 9 while the slightly polluted basins increased from 43 in 2002 to 52 in 2003. This general improvement could be due to the fact that the three river basins namely Sg. Pontian Besar, Sg. Rambah (Johor) and Sg. Landas (Terengganu) that became slightly polluted (WQI ≥ 60) were already marginally in the polluted category (WQI 56-59) over the past several years. This improvement could be attributed to several contributing factors such as better environmental management of land activities, awareness programmes and intensified enforcement efforts.

Table 4 (a) Malaysia: Water Quality Status within Clean River Basins, 2003

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
KEDAH	01PL	MELAKA	3	88 (84)	KISAP	1	91	C	II
					MELAKA	1	83	C	II
					PETANG	1	91	C	II
	03	KEDAH	6	82 (82)	KEDAH	1	61	SP	III
					PADANG TERAP	3	86	C	II
					PEDU	1	92	C	II
					TEKAI	1	84	C	II
KEDAH / P.PINANG	05	MUDA	9	86 (87)	JERUNG	2	77	SP	II
					KETIL	1	89	C	II
					MUDA	4	87	C	II
					TAWAR	2	88	C	II
PERAK	09	KURAU	5	82 (82)	ARA	1	92	C	II
					KURAU	4	79	SP	II
	10T	TEMERLOH	2	89 (84)	TEMERLOH	2	89	C	II
	11	BERUAS	4	84 (82)	BRUAS	2	79	SP	II
					ROTAN	2	89	C	II
SELANGOR	16	SELANGOR	9	84 (84)	BATANG KALI	1	90	C	II
					KANCING	1	90	C	II
					KERLING	1	91	C	II
					SELANGOR	4	83	C	II
					SEMBAH	1	65	SP	III
					SERENDAH	1	86	C	II
JOHOR/ NEGERI SEMBILAN	25	MUAR	43	81 (78)	GEMENCHEH	3	89	C	II
					JUASSEH	2	87	C	II
					KELAMAH	2	78	SP	II
					LABIS	4	84	C	II
					MERBUDU	1	75	SP	III
					MERLIMAU	1	69	SP	III
					MUAR	16	82	C	II
					P. MENKUANG	1	88	C	II
					PALONG	4	85	C	II
					SEGAMAT	1	88	C	II
					SENARUT	2	64	SP	III
					SEROM	1	63	SP	III
					SPG. LOI	2	80	SP	II
					TEMARONG	1	91	C	II
					TENANG	2	81	C	II
JOHOR	30A	SEDILI BESAR	13	84 (84)	AMBAT	2	86	C	II
					DOHOL	1	89	C	II
					MUPUR	1	74	SP	III
					SEDILI BESAR	5	81	C	II
					SEMANGGOT KANAN	1	90	C	II
					SEMANGGOT KIRI	1	90	C	II
					TEMUBOR KANAN	2	84	C	II
	30C	PALOI	2	82 (82)	PALOI	2	82	C	II
	31A	MERSING	1	91 (91)	MERSING	1	91	C	II
PAHANG	32AE	ANAK ENDAU	2	87 (87)	ANAK ENDAU	2	87	C	II
	33	ROMPIN	18	85 (86)	AUR	1	86	C	II
					BAKAR	1	72	SP	III
					JEKATIH	2	91	C	II
					JERAM	1	91	C	II
					KEPASING	1	79	SP	II
					KERATONG	4	86	C	II
					PUKIN	3	90	C	II
					REKOH	1	77	SP	II
					ROMPIN	4	84	C	II
	34	BEBAR / MERCHONG	8	83 (83)	BEBAR	1	75	SP	III
					KELAYAT	1	88	C	II
					MERBA	1	87	C	II
					MERCHONG	1	71	SP	III
					SERAI	2	89	C	II
					TEMIANG	2	83	C	II
PAHANG	35B	BERA	5	85 (82)	BERA	3	84	C	II
					TASIK BERA	1	82	C	II
					TRIANG	1	90	C	II
	35CH	BERTAM	10	85 (87)	BERTAM	2	86	C	II
					BURUNG	1	88	C	II
					HABU	1	86	C	II
					LENGGOK	1	87	C	II
					RINGLET	1	85	C	II
					TELOM	2	80	SP	II
					TERLA	1	88	C	II
					TRINGKAP	1	86	C	II
	35L	LEPAR	10	87 (83)	ANAK SG. LEPAR	1	73	SP	III
					BELAYAR	1	92	C	II
					BERKAPOR	2	89	C	II
					CHINI	1	80	SP	II
					LEPAR	3	90	C	II

Table 4 (a) Malaysia: Water Quality Status within Clean River Basins, 2003 (Continued)

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
PAHANG	35L	LEPAR	10	87 (83)	T. PAYA BUNGOR	1	89	C	II
					TASIK CHINI	1	88	C	II
	35M	MENTIGA	2	84 (82)	MENTIGA	2	84	C	II
	35P	PAHANG	53	88 (88)	BATU	1	73	SP	III
					BENTONG	4	89	C	II
					BENUS	2	91	C	II
					BILUT	1	86	C	II
					JELAI	2	87	C	II
					JEMPOL	2	90	C	II
					JENGKA	2	83	C	II
					KELAU	2	89	C	II
					KERTAM	1	85	C	II
					KOYAN	1	90	C	II
					KUNDANG	1	80	SP	II
					LIPIS	3	87	C	II
					LUIT	1	88	C	II
					MARAN	2	85	C	II
					PAHANG	9	88	C	II
					PENJURING	1	93	C	I
					PERTANG	2	85	C	II
					PERTING	1	92	C	II
					SEMANTAN	3	88	C	II
					SERTING	2	82	C	II
					SIAM	1	89	C	II
					TANGLIR	1	91	C	II
					TEKAL	1	85	C	II
					TEKAM	2	89	C	II
					TELANG	1	86	C	II
					TELEMONG	2	91	C	II
					TERANUM	1	94	C	I
					TERAS	1	93	C	I
	36	KUANTAN	11	81 (82)	BELAT	1	85	C	II
					CHARU	1	90	C	II
					GALING BESAR	1	50	P	IV
					GALING KECIL	1	61	SP	III
					KENAU	1	91	C	II
					KUANTAN	4	88	C	II
					PINANG	1	79	SP	II
					RIAU	1	83	C	II
TERENGGANU	38	KEMAMAN	10	81 (80)	CHERUL	2	91	C	II
					KEMAMAN	2	91	C	II
					NERAM	2	78	SP	II
					PERASING	2	89	C	II
					RANSAN	2	55	P	III
	39K	KERTIH	2	88 (88)	KERTIH	2	88	C	II
	40	PAKA	10	85 (84)	BESUL	2	90	C	II
TERENGGANU	40	PAKA			PAKA	4	88	C	II
					RASAU	2	82	C	II
					RENGAT	2	75	SP	III
	41	DUNGUN	4	89 (90)	DUNGUN	2	91	C	II
					TELEMBOH	2	87	C	II
	42I	IBAI	3	82 (83)	IBAI	3	82	C	II
	42M	MARANG	5	84 (83)	KERAK	2	82	C	II
				(83)	MARANG	1	83	C	II
					TEMALA	2	85	C	II
	43	TERENGGANU	9	87 (87)	BERANG	2	89	C	II
					NERUS	3	88	C	II
					PUEH	2	86	C	II
					TERENGGANU	2	86	C	II
	44	SETIU	3	84 (77)	SETIU	1	91	C	II
					TAROM	2	81	C	II
	46	BESUT	4	89 (91)	BESUT	2	92	C	II
					JERTIH	2	86	C	II
KELANTAN	47K	KEMASIN	1	83 (80)	KEMASIN	1	83	C	II
	48	KELANTAN	38	88 (88)	ARING	2	87	C	II
					BELATOP	2	84	C	II
					BER	1	92	C	II
					BEROK	2	87	C	II
					BETIS	1	88	C	II
					CHIKU	2	90	C	II
					GALAS	1	88	C	II
					KELANTAN	4	86	C	II
					KELESA	2	91	C	II
					KERAK	2	92	C	II
					KERILLA	2	91	C	II
					KETIL	2	90	C	II
					NAL	3	90	C	II
					PEHI	2	90	C	II
					PENGKALAN CHEPA	1	75	SP	III
					PENGKALAN DATU	3	82	C	II
					PERGAU	2	91	C	II

Table 4 (a) Malaysia: Water Quality Status within Clean River Basins, 2003 (Continued)

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
	48	KELANTAN	38	88 (88)	PERTOK	2	87	C	II
					RELAI	2	88	C	II
	49	GOLOK	4	89 (85)	GOLOK	2	91	C	II
					TASIK GARU	2	87	C	II
SARAWAK	50	KAYAN	4	85 (86)	KAYAN	3	83	C	II
					SEMATAN	1	89	C	II
	52	SADONG	6	81 (83)	KARANGAN	1	79	SP	II
					SADONG	3	76	SP	III
					TARAT	2	90	C	II
	53	LUPAR	7	83 (84)	AI	1	86	C	II
					LUPAR	3	79	SP	II
					SEKERANG	1	89	C	II
					SETERAP	1	80	SP	II
					UNDUP	1	89	C	II
	54	SARIBAS	2	82 (82)	RIMBAS	1	89	C	II
					SARIBAS	1	75	SP	III
	55	KERIAN	3	81 (80)	KERIAN	2	81	C	II
				(80)	SEBLAK	1	82	C	II
	56	RAJANG	18	82 (80)	BINATANG	1	89	C	II
					JULAU	1	89	C	II
					MERADONG	1	87	C	II
					RAJANG	14	81	C	II
					SARIKEI	1	84	C	II
	61	KEMENA	3	81 (81)	KEMENA	2	81	C	II
					SIBIU	1	80	SP	II
	62	SIMILAJAU	1	88 (89)	SIMILAJAU	1	88	C	II
	68	LIMBANG	5	83 (82)	LIMBANG	5	83	C	II
SARAWAK	69	TRUSAN	1	81 (87)	TRUSAN	1	81	C	II
	70	LAWAS	2	88 (85)	LAWAS	2	88	C	II
SABAH	71	MENGGALONG	3	88 (88)	LAKUTAN	1	88	C	II
					LINGKUNGAN	1	90	C	II
					MENGGALONG	1	87	C	II
	72	PADAS	7	90 (88)	BUNSIT	1	93	C	I
					LIAWAN	1	92	C	II
					PADAS	3	87	C	II
					PANGATAN	1	89	C	II
					TANDULU	1	93	C	I
	73	MEMBAKUT	1	85 (82)	MEMBAKUT	1	85	C	II
	75	PAPAR	2	91 (89)	PAPAR	2	91	C	II
	77	DAMIT/TUARAN	6	90 (90)	DAMIT	2	89	C	II
					SONG SAI	1	93	C	I
					TUARAN	3	89	C	II
	78	KEDAMAIAN	3	91 (91)	TEMPASUK	2	92	C	II
					TENGHILAN	1	88	C	II
	80	BENGKOKA	1	83 (86)	BENGKOKA	1	84	C	II
	83	SUGUT	6	92 (92)	BONGKUD	1	92	C	II
					LOHAN	2	90	C	II
					MERALI	1	91	C	II
					SUGUT	2	93	C	I
	84	LABOK	8	89 (89)	KINIPIR	2	90	C	II
					LIWAGU	2	89	C	II
					MALIAU	1	93	C	I
					SAPI	2	83	C	II
					SUALONG	1	94	C	I
	85	KAYA	1	84 (84)	MOUNAD	1	83	C	II
	86	KINABATANGAN	4	82 (83)	KINABATANGAN	2	83	C	II
					KOYAH	1	85	C	II
					TENEGANG BESAR	1	79	SP	II
	87	SEGAMA	1	87 (85)	SEGAMA	1	87	C	II
	89	TINGKAYU	1	81 (87)	TINGKAYU	1	81	C	II
	91	TAWAU	5	86 (85)	APAS	1	92	C	II
					BALUNG	1	86	C	II
					TAWAU	3	84	C	II
	93	UMAS-UMAS	1	86 (90)	UMAS-UMAS	1	86	C	II
	94	BRANTIAN	1	86 (85)	BRANTIAN	1	86	C	II

NOTE:
1. WQI BASED ON 6 MAJOR PARAMETERS:BOD, COD, SS, PH, DO, NH_3-N
2. RIVER WATER QUALITY STATUS: C: CLEAN, SP: SLIGHTLY POLLUTED, P: POLLUTED
3. RIVER CLASS BASED ON INWQS
4. ( ) Overall WQI for 2002

Table 4 (b) Malaysia: Water Quality Status within Slightly Polluted River Basins, 2003

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
PERLIS	1	PERLIS	10	77 (77)	ARAU	1	74	SP	III
					JARUM	1	82	C	II
					JERNIH	2	74	SP	III
					KOK MAK	1	80	SP	II
					NGULANG	1	72	SP	III
					PERALIT	1	89	C	II
					PERLIS	1	67	SP	III
					SERAI	1	79	SP	II
					TASOH	1	80	SP	II
KEDAH	04	MERBOK	10	64 (54)	BAKAR ARANG	1	61	SP	III
					BATU	1	37	P	IV
					BONGKOK	1	77	SP	II
					BUKIT MERAH	1	79	SP	II
					KOROK	1	57	P	III
					MERBOK	1	74	SP	III
					PETANI	1	54	P	III
					TOK PAWANG	2	76	SP	III
					TUPAH	1	56	P	III
P. PINANG/KEDAH	06P	PERAI	22	66 (61)	AIR MELINTAS	1	45	P	IV
					JARAK	6	71	SP	III
					KELADI	1	71	SP	III
					KEREH	4	58	P	III
					KUBANG SEMANG	2	60	SP	III
					KULIM	3	85	C	II
					PERAI	2	68	SP	III
					SELUANG	1	55	P	III
					SELUANG BAWAH	2	56	P	III
PULAU PINANG	07	JEJAWI	5	60 (53)	CEMPEDAK	1	48	P	IV
					JAWI	3	65	SP	III
					JUNJONG	1	56	P	III
P. PINANG/PERAK	08	KERIAN	10	75 (71)	KECHIL	3	75	SP	III
					KERIAN	4	79	SP	II
					SELAMA	2	65	SP	III
					SERDANG	1	77	SP	II
PERAK	10	SEPETANG	10	75 (69)	BATU TEGUH	2	79	SP	II
					JANA	1	92	C	II
					LARUT	1	70	SP	III
					LIDIN	1	54	P	III
					MALAI	1	59	P	III
					SEPETANG	3	78	SP	II
					TUPAI	1	82	C	II
	12	RAJA HITAM/ MANJONG	6	68 (69)	DERHAKA	2	61	SP	III
					MANJONG	2	75	SP	III
					RAJA HITAM	2	67	SP	III
	12W	WANGI/DERALIK	4	64 (64)	DERALIK	2	69	SP	III
					WANGI	2	59	P	III
	13	PERAK	53	80 (78)	BATANG PADANG	3	87	C	II
					BIDOR	3	81	C	II
					CHENDERIANG	2	91	C	II
					CUAR	2	87	C	II
					KAMPAR	2	84	C	II
					KANGSAR	2	86	C	II
					KEPAYANG	2	67	SP	III
					KERDAH	2	68	SP	III
					KINTA	6	76	SP	III
					KLAH	2	88	C	II
					KLIAN BARU	2	81	C	II
PERAK	13	PERAK			KUANG	1	88	C	II
					PARI	2	68	SP	III
					PELUS	2	87	C	II
					PERAK	8	87	C	II
					PINJI	2	63	SP	III
					RAIA	2	89	C	II
					SELUANG	1	80	SP	II
					SEROKAI	2	60	SP	III
					SUNGKAI	2	88	C	II
					SUNGKAI MATI	2	70	SP	III
					TUMBOH	1	67	SP	III
PERAK/ SELANGOR	14	BERNAM	10	80 (82)	BERNAM	6	74	SP	III
					SLIM	2	88	C	II
					TEROLAK	2	89	C	II
SELANGOR	15	TENGI	2	79 (80)	TENGI	2	79	SP	II
	19	LANGAT	28	71 (66)	ANAK CHUAU	1	79	SP	II
					BALAK	1	62	SP	III
					BATANG BENAR	2	67	SP	III
					BATANG LABU	2	79	SP	II

Table 4 (b) Malaysia: Water Quality Status within Slightly Polluted River Basins, 2003 (Continued)

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
SELANGOR					BATANG NILAI	2	48	P	IV
					BERANANG	1	85	C	II
					BUAN	1	76	SP	III
					CHUAU	2	85	C	II
					JIJAN	1	88	C	II
					LANGAT	8	69	SP	III
					LIMAU MANIS	1	45	P	IV
					LUI	1	92	C	II
					PAJAM	1	82	C	II
					RINCHING	1	76	SP	III
					SEMENYIH	3	79	SP	II
	20	SEPANG	3	74 (73)	SEPANG	3	74	SP	III
NEGERI SEMBILAN	20J	LUKUT	1	74 (77)	LUKUT	1	74	SP	III
	21	LINGGI	15	76 (75)	BATANG PENAR	1	55	P	III
					CHEMBONG	1	84	C	II
					KEPAYONG	1	75	SP	III
					KUNDUR BESAR	1	89	C	II
					LINGGI	6	72	SP	III
					PEDAS	1	87	C	II
					REMBAU	2	82	C	II
					SIMIN	1	71	SP	III
					TEMIANG	1	77	SP	II
MELAKA	22	MELAKA	17	73 (69)	BTG.MELAKA	2	87	C	II
					DURIAN TUNGGAL	1	82	C	II
					MELAKA	9	72	SP	III
					PUTAT	2	61	SP	III
					REMBIA	2	68	SP	III
					TAMPIN	1	89	C	II
	23	DUYONG	3	72 (72)	DUYONG	3	72	SP	III
	24	KESANG/MERLIMAU	8	75 (71)	CHOHONG	2	87	C	II
					KESANG	3	79	SP	II
					MERLIMAU	3	64	SP	III
JOHOR	26	BATU PAHAT	23	75 (75)	AMRAN	2	75	SP	III
					BATU PAHAT	1	55	P	III
					BEKOK	4	82	C	II
					BERLIAN	2	80	SP	II
					CHAAH	2	85	C	II
					LENIK	1	82	C	II
JOHOR	26	BATU PAHAT			MEREK	2	85	C	II
					MERPO	2	86	C	II
					SEMBERONG	2	68	SP	III
					SIMPANG KANAN	2	54	P	III
					SIMPANG KIRI	3	64	SP	III
	27B	BENUT	7	77 (78)	BENUT	4	72	SP	III
					PT. HAJI YASSIN	2	79	SP	II
					ULU BENUT	1	90	C	II
	28A	PONTIAN BESAR	5	61 (59)	AIR HITAM	1	60	SP	III
					AYER MERAH	1	46	P	IV
					PONTIAN BESAR	3	67	SP	III
	28B	PONTIAN KECIL	2	75 (65)	PONTIAN KECIL	2	75	SP	III
	28C	SKUDAI	11	70 (68)	MELANA	2	66	SP	III
					SKUDAI	9	70	SP	III
	28D	TEBRAU	5	77 (72)	PLENTONG	1	62	SP	III
					TEBRAU	4	80	SP	II
	28G	RAMBAH	2	63 (57)	RAMBAH	2	63	SP	III
	29	JOHOR	44	80 (81)	ANAK SG. SAYONG	3	68	SP	III
					BERANGAN	2	81	C	II
					BKT. BESAR	2	69	SP	III
					CHEMANGAR	1	77	SP	II
					JOHOR	4	84	C	II
					LAYANG	1	91	C	II
					LAYAU KIRI	2	82	C	II
					LEBAM	2	83	C	II
					LINGGIU	1	85	C	II
					PENGGELI	2	86	C	II
					REMIS	2	83	C	II
					SANTI	1	83	C	II
					SAYONG	4	83	C	II
					SEBOL	2	83	C	II
					SEMANGER	1	87	C	II
					SEMENCHU	2	84	C	II
					SENING	2	80	SP	II
					SERAI	2	73	SP	III
					TELOR	2	89	C	II
					TEMON	2	86	C	II
					TIRAM	4	72	SP	III
	30B	SEDILI KECIL	5	74 (74)	ANAK SEDILI KECIL	1	50	P	IV
					BAHAN	2	82	C	II
					SEDILI KECIL	2	78	SP	II
	31B	JEMALUANG	2	80 (83)	JEMALUANG	2	80	SP	II

Table 4 (b) Malaysia: Water Quality Status within Slightly Polluted River Basins, 2003 (Continued)

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
JOHOR	32	ENDAU	29	79 (76)	A.S. SEMBERONG	2	83	C	II
					DENGAR	2	85	C	II
					ENDAU	1	86	C	II
					JEBONG	1	79	SP	II
					LENGA	2	63	SP	III
					LENGGOR	2	84	C	II
					MAMAI	2	85	C	II
					MELANTAI	2	74	SP	III
					MENGKIBOL	3	77	SP	II
					PALOH	2	86	C	II
					PAMOL	1	57	P	III
					SEMBERONG	5	82	C	II
					SINGOL	2	70	SP	III
					TAMOK	2	88	C	II
PAHANG	32/33	PONTIAN	3	78 (80)	PONTIAN	2	87	C	II
					SEPAYANG	1	59	P	III
	35	SERTING	5	78 (77)	MOKEK	2	80	SP	II
					SERTING	3	76	SP	III
	37	BALOK/TONGGOK	5	79 (77)	BALOK	2	76	SP	III
					TONGGOK	3	82	C	II
	37A	CERATING	1	78 (79)	CERATING	1	78	SP	II
TERENGGANU	39C	CHUKAI	5	79 (86)	CHUKAI	1	85	C	II
					IBOK	2	88	C	II
					RUANG	2	66	SP	III
	42L	LANDAS	2	60 (58)	LANDAS	2	60	SP	III
KELANTAN	47S	SEMERAK	2	78 (83)	SEMERAK	2	78	SP	II
SARAWAK	51	SARAWAK	15	80 (80)	KUAP	2	76	SP	III
					MAONG KIRI	1	70	SP	III
					SANTUBONG	1	76	SP	III
					SARAWAK	6	84	C	II
					SARAWAK KANAN	1	84	C	II
					SARAWAK KIRI	1	86	C	II
					SEMENGGOH	2	73	SP	III
					TABUAN	1	76	SP	III
	51BS	SAMARAHAN	2	76 (77)	SAMARAHAN	2	76	SP	III
	57	OYA	3	75 (81)	OYA	3	75	SP	III
	58	MUKAH	4	77 (79)	MUKAH	4	77	SP	II
	59	BALINGIAN	2	80 (82)	BALINGIAN	2	80	SP	II
	60	TATAU	1	76 (82)	TATAU	1	76	SP	III
	63	SUAI	1	78 (84)	SUAI	1	78	SP	II
	64	NIAH	5	73 (70)	NIAH	2	83	C	II
					SEKALOH	3	66	SP	III
	65	KABULOH	6	77 (75)	KABULOH	2	72	SP	III
					KEJAPIL	1	84	C	II
					SATAP	1	80	SP	II
					SIBUTI	2	77	SP	II
	66	MIRI/LUTONG	7	66 (67)	ADONG	1	62	SP	III
					DALAM	1	60	SP	III
					LUTONG	2	70	SP	III
					MIRI	2	63	SP	III
					PADANG LIKU	1	79	SP	II
	67	BARAM	4	75 (77)	BARAM	4	75	SP	III
SABAH	76	MOYOG	11	79 (80)	INANAM	3	82	C	II
					LIKAS	1	57	P	III
					MENGGATAL	2	79	SP	II
					MOYOG	3	90	C	II
					TELIPOK	2	68	SP	III
	79	BINGKONGAN	3	68 (76)	BANDAU	1	93	C	I
					MENGGARIS	1	35	P	IV
					TANDEK	1	75	SP	III
	88	SILABUKAN	2	80 (82)	SILABUKAN	2	80	SP	II
	90	KALUMPANG	5	77 (78)	INTAN	1	86	C	II
					KALUMPANG	2	91	C	II
					PANG BURONG 1	1	62	SP	III
					PANG BURONG 2	1	56	P	III
	95	KALABAKAN	2	78 (80)	KALABAKAN	2	78	SP	II

NOTE: 1. WQI BASED ON 6 MAJOR PARAMETERS:BOD, COD, SS, PH, DO, NH_3-N
2. RIVER WATER QUALITY STATUS: C: CLEAN, SP: SLIGHTLY POLLUTED, P: POLLUTED
3. RIVER CLASS BASED ON INWQS
4. ( ) Overall WQI for 2002

Table 4 (c) Malaysia: Water Quality Status within Polluted River Basins, 2003

STATE	CODE WQR	RIVER BASIN	NUMBER OF STATIONS	OVERALL WQI	RIVER	NUMBER OF STATIONS	WQI	RIVER STATUS	CLASS
PULAU PINANG	06J	JURU	8	51 (44)	ARA	1	45	P	IV
					JURU	1	48	P	IV
					KILANG UBI	2	52	P	III
					PASIR	1	48	P	IV
					RAMBAI	3	55	P	III
	06PP	PINANG/KLUANG	12	53 (44)	AIR ITAM	5	55	P	III
					AIR TERJUN	1	92	C	II
					DONDANG	3	54	P	III
					JELUTONG	1	30	P	V
					KLUANG	1	65	SP	III
					PINANG	1	41	P	IV
SELANGOR	17	BULOH	5	58 (56)	BULOH	5	58	P	III
	18	KLANG	24	58 (53)	AMPANG	1	57	P	III
					BATU	2	54	P	III
					DAMANSARA	3	57	P	III
					GOMBAK	3	74	SP	III
					JINJANG	1	53	P	III
					KERAYONG	1	52	P	III
					KEROH	1	54	P	III
					KLANG	10	55	P	III
					KUYOH	1	62	SP	III
					PENCALA	1	48	P	IV
JOHOR	27A	AIR BALOI	3	54 (47)	AIR BALOI	3	54	P	III
	28	SEGGET	5	54 (46)	SEGGET	5	54	P	III
	28E	KEMPAS	2	44 (45)	KEMPAS	2	44	P	IV
	28F	DANGA	2	52 (52)	DANGA	2	52	P	III
	29B	KAW. PASIR GUDANG (TUKANG BATU)	5	47 (45)	BULUH	1	35	P	IV
					LATOH	1	62	SP	III
					MASAI	1	64	SP	III
					PEREMBI	1	48	P	IV
					TUKANG BATU	1	26	P	V

NOTE:
1. WQI BASED ON 6 MAJOR PARAMETERS:BOD, COD, SS, PH, DO, NH_3-N
2. RIVER WATER QUALITY STATUS: C: CLEAN, SP: SLIGHTLY POLLUTED, P: POLLUTED
3. RIVER CLASS BASED ON INWQS
4. ( ) Overall WQI for 2002

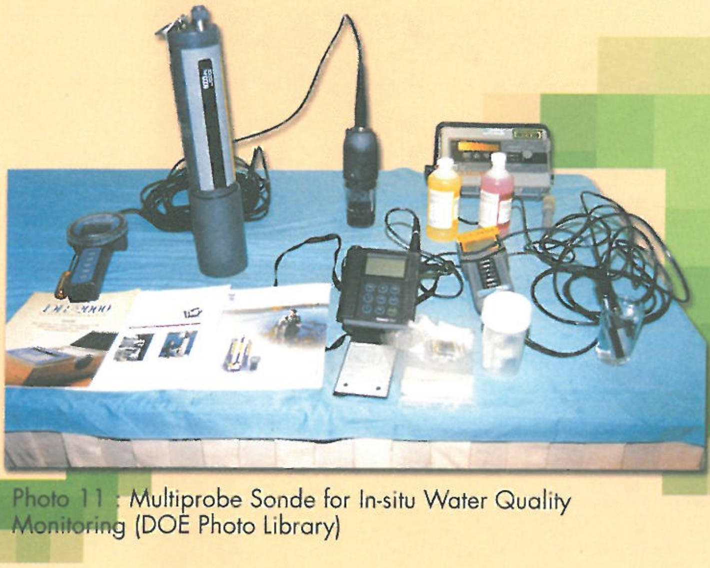


Photo 11 : Multiprobe Sonde for In-situ Water Quality Monitoring (DOE Photo Library)

Photo 12 : Continuous River Water Quality Monitoring Station (DOE Photo Library)

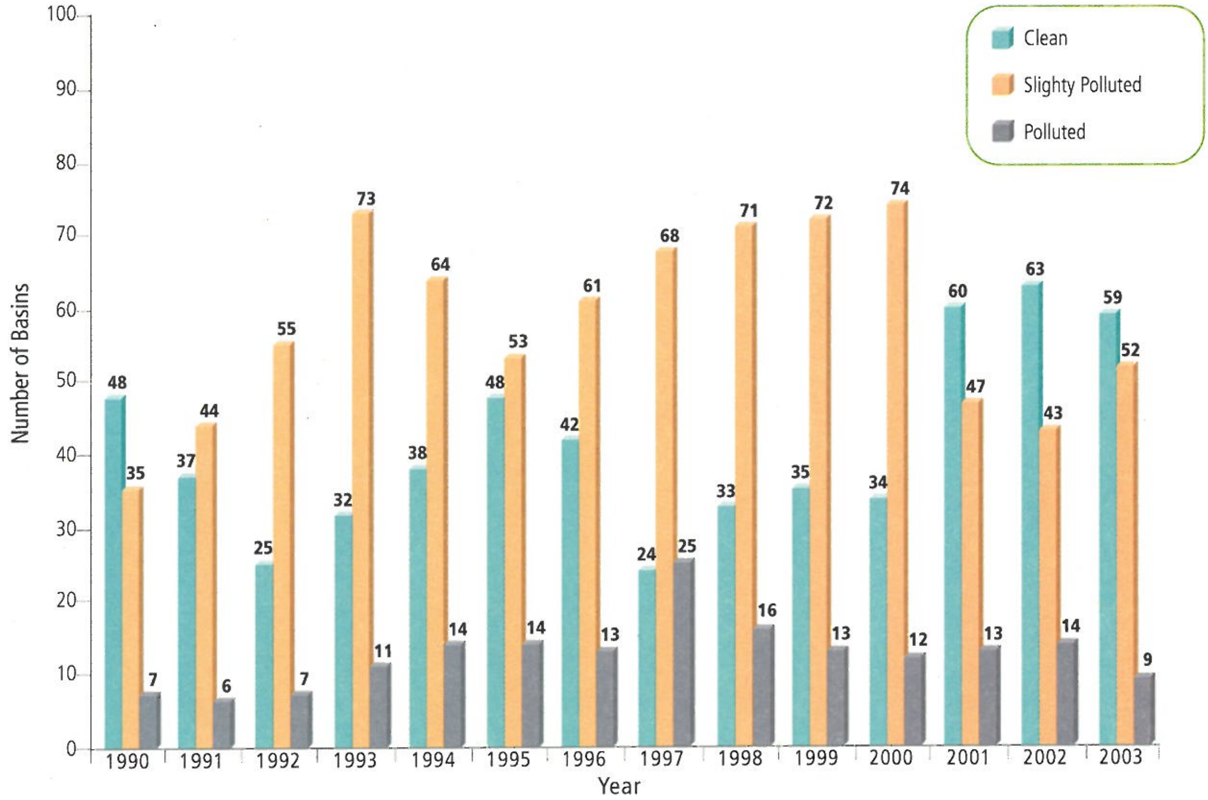


Figure 13 Malaysia: River Basins Water Quality Trend (1990-2003)

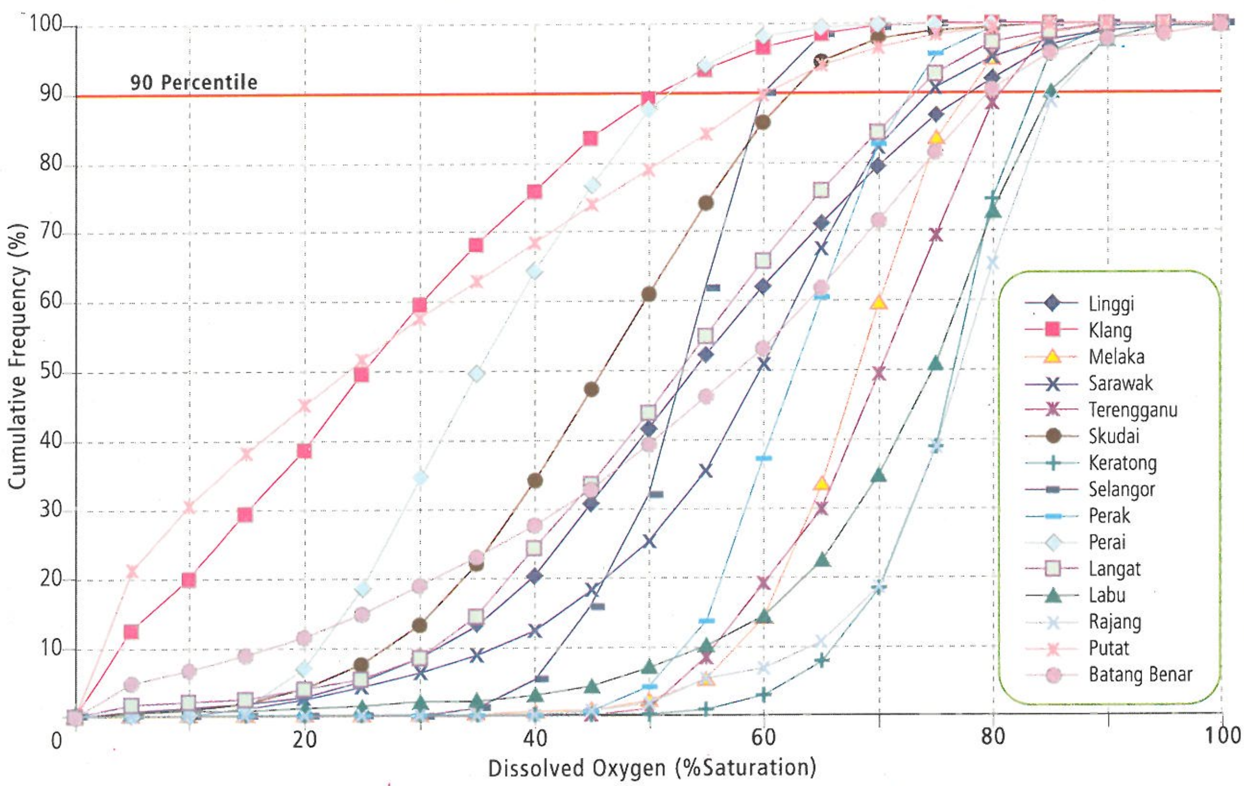


Figure 14 Malaysia: Comparison of Cumulative Frequency for 15 CWQM Stations - Dissolved Oxygen : 1 January-31 December 2003

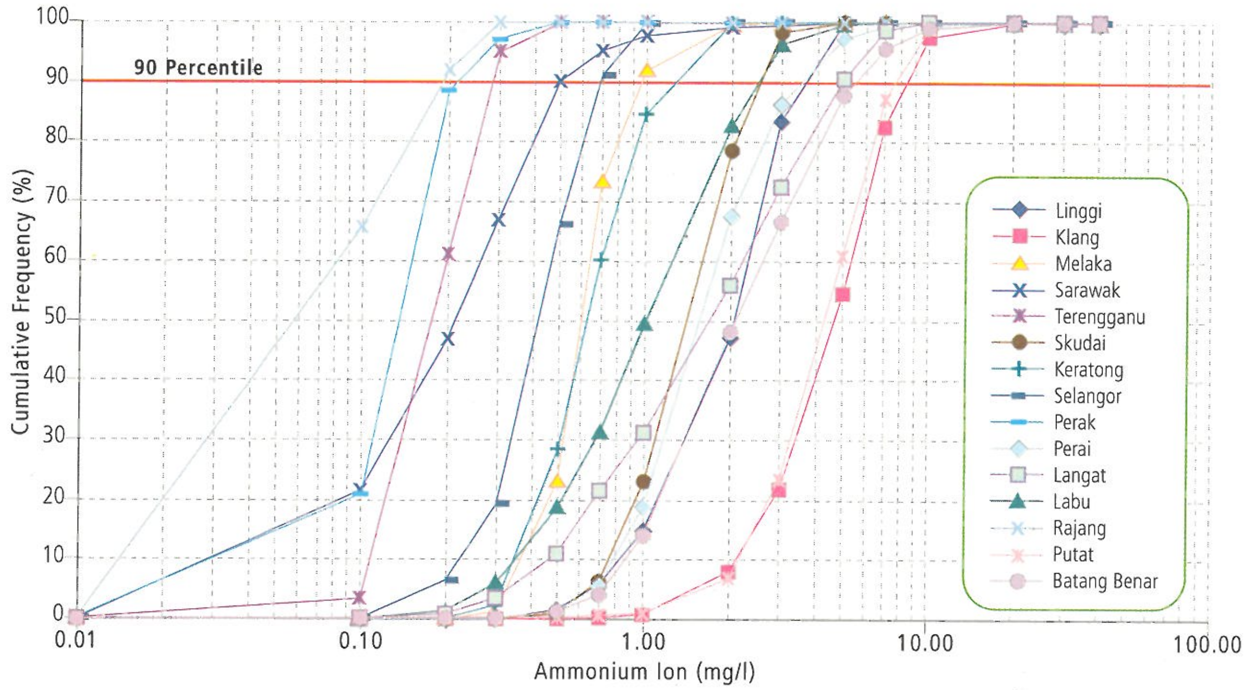


Figure 15 Malaysia: Comparison of Cumulative Frequency for 15 CWQM Stations - Ammonium Ion Concentration:1 January-31 December 2003

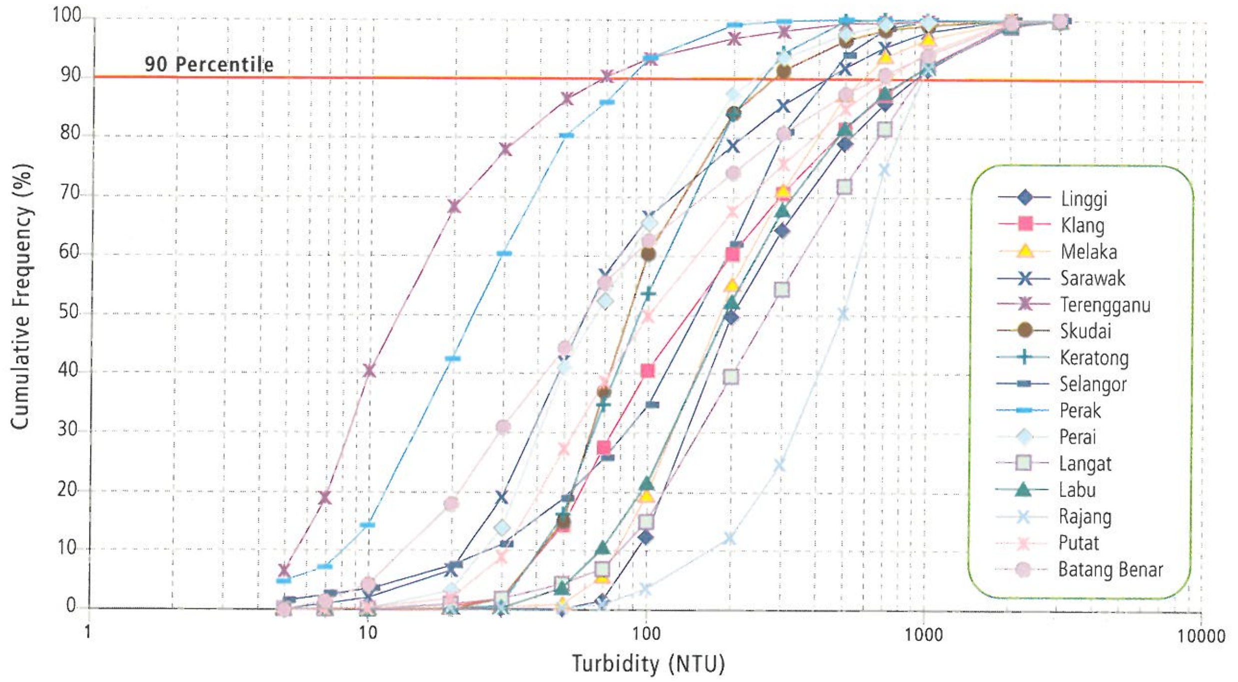


Figure 16 Malaysia: Comparison of Cumulative Frequency for 15 CWQM Stations - Turbidity: 1 January-31 December 2003

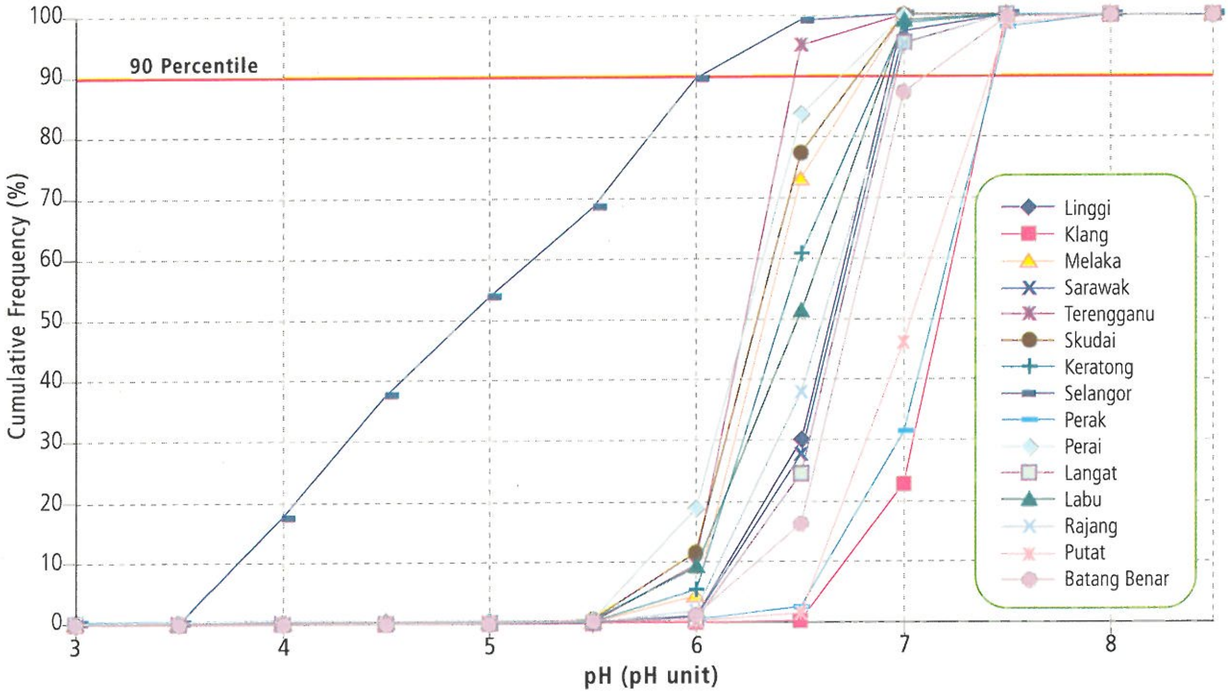


Figure 17 Malaysia: Comparison of Cumulative Frequency for 15 CWQM Stations - pH Level: 1 January-31 December 2003

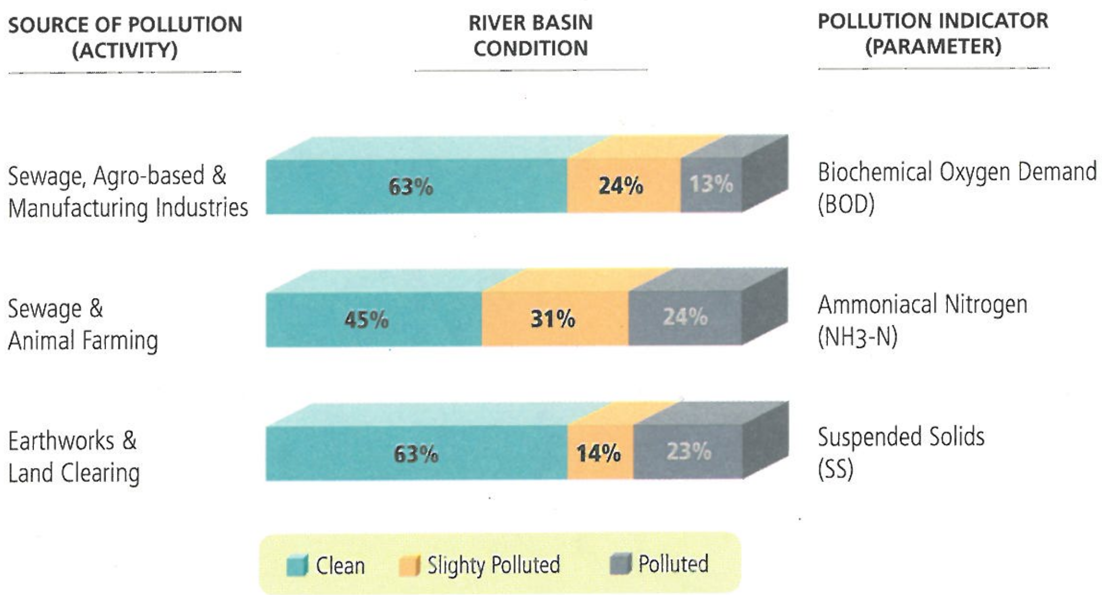


Figure 18 Malaysia: Status of River Basin Water Quality, 2003

NOTE:-
Number of River Basins Monitored = 120
Number of Monitoring Stations = 926

CHAPTER 3

Groundwater Quality

CHAPTER 3

GROUNDWATER QUALITY

Photo 13 : Suburban Groundwater Monitoring Station (DOE Photo Library)

GROUNDWATER QUALITY MONITORING

Groundwater is water that exists in the pore spaces and fissures in rock and sediment beneath the Earth's surface. It originates from rainfall or snow, and then moves through the soil. Groundwater is stored in, and moves slowly through, moderately to highly permeable rocks called aquifers.

Recognising the potential of groundwater as an important alternative source of water, the Department of Environment initiated the national groundwater monitoring programme in 1997. By 2003, 94 monitoring wells had been established at 48 sites in Peninsular Malaysia, 19 wells in Sarawak and 15 wells in Sabah (Table 5). The sites were selected and categorised according to the surrounding landuse such as agricultural, urban/suburban, rural, industrial, solid waste landfills, golf courses, radioactive sites, animal burial areas, municipal water supply and ex-mining (gold mine) areas.

GROUNDWATER QUALITY STATUS

In 2003, 226 water samples were taken from these monitoring wells compared to 177 samples the previous year. The samples were analysed for volatile organic compounds (VOCs), pesticides, heavy metals, anions, bacteria, phenolic compounds, radioactivity (Gross Alpha and Beta), total hardness, total dissolved solids (TDS), pH, temperature, conductivity and dissolved oxygen. The National Guidelines for Raw Drinking Water Quality from the Ministry of Health (Revised Dec 2000) was used as the benchmark for determining the groundwater quality status (Table 6).

The percentage of non-compliance of selected contaminants is shown in Figure 19a and 19b. Iron (Fe) levels exceeding the standard were recorded in all samples. Between 11% to 100% of the samples taken at respective sites showed high levels of iron. The sampling results also showed that between 6% to 100% of samples taken in all areas recorded manganese (Mn) levels exceeding the benchmark. Between 2% to 25% of samples were found to exceed the nitrate benchmark in all areas except in radioactive sites, ex-mining, municipal water supply and urban/suburban areas.

Arsenic levels exceeding the benchmark were recorded at radioactive sites (100%), ex-mining (100%), solid waste landfill (55%), industrial areas (29%), agricultural areas (29%) and rural areas (11%). Other parameters exceeding the acceptable values are shown in Figure 19a & 19b. Samples taken in industrial, landfill and agricultural areas were found to have more parameters exceeding the acceptable values.

Table 5 Malaysia : Distribution of Groundwater Monitoring Wells, 2003

Category	Number of Wells
Agricultural Areas	12
Urban/Suburban Areas	14
Industrial Sites	17
Solid Waste Landfills	27
Golf Courses	7
Radioactive Sites	1
Rural Areas	4
Ex-Mining	3
Municipal Water Supply	11
Animal Burial	16
Aquaculture farm	15
Resorts	1
Total	**128**

Table 6 Malaysia : National Guidelines for Raw Drinking Water Quality Benchmark for Groundwater in Malaysia (Revised December 2000)

PARAMETER	SYMBOL	BENCHMARK
SULPHATE	SO4	250 mg/l
HARDNESS	CaCO3	500 mg/l
NITRATE	NO3	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 mg/l
LEAD (PLUMBUM)	Pb	0.01 mg/l
CADMIUM	Cd	0.003 mg/l
MERCURY	Hg	0.001 mg/l

Source : Ministry of Health, Malaysia

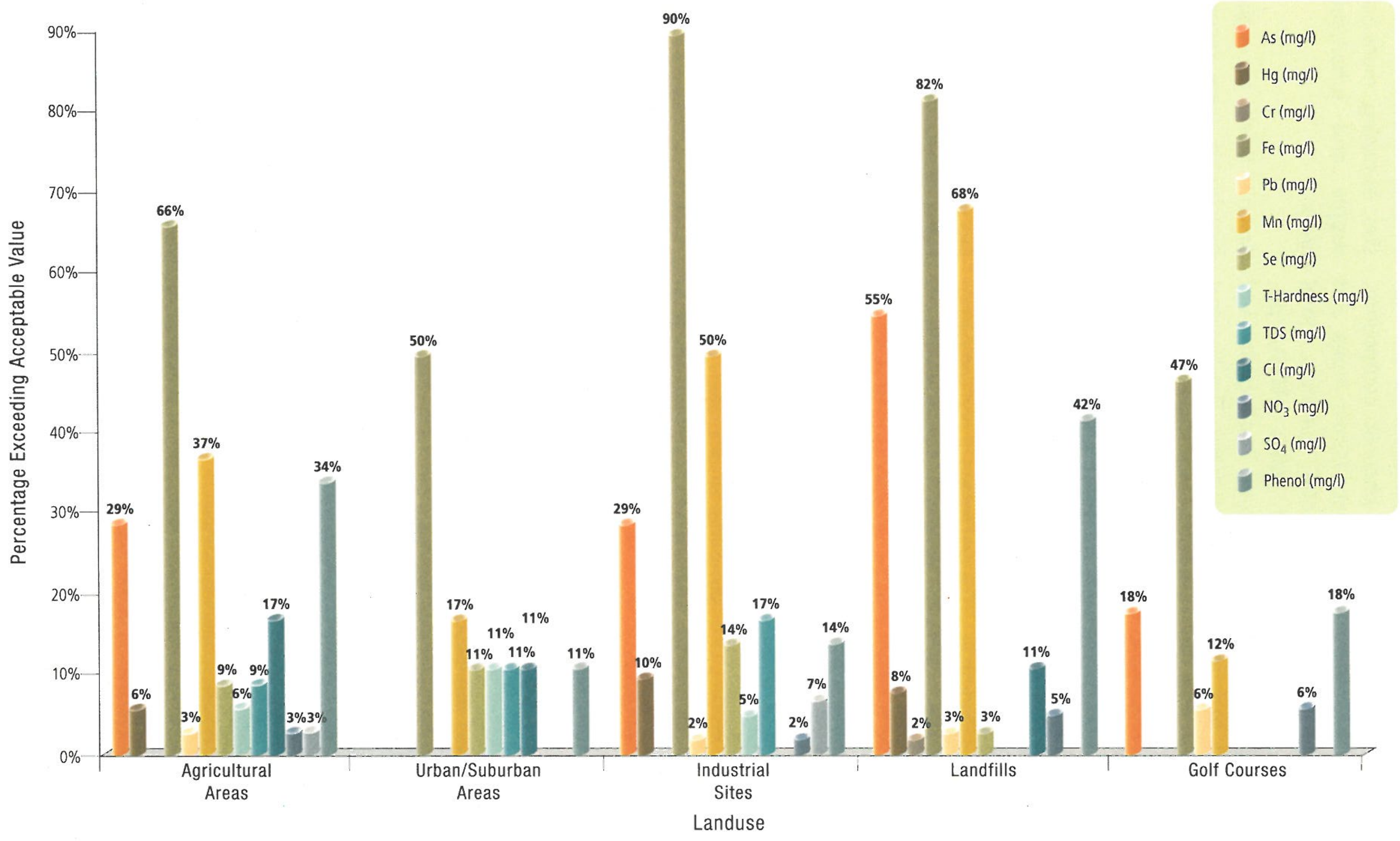


Figure 19(a) Malaysia: Percentage of Non-Compliance of Selected Contaminants by Landuse, 2003

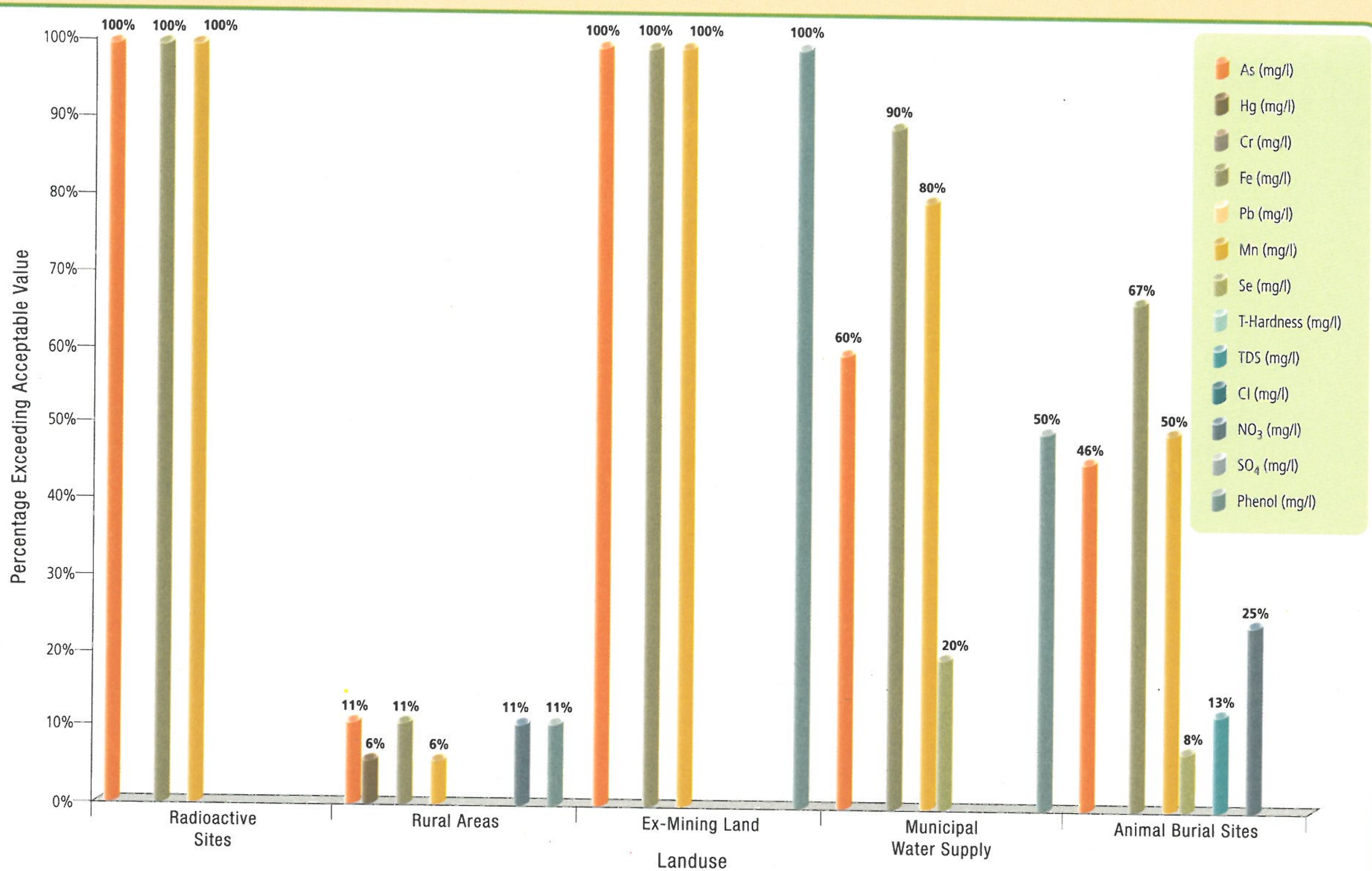


Figure 19(b) Malaysia: Percentage of Non-Compliance of Selected Contaminants by Landuse, 2003 (continued)

CHAPTER 4

Marine Environmental Quality

CHAPTER 4

MARINE ENVIRONMENTAL QUALITY

MARINE ENVIRONMENTAL QUALITY

MARINE ENVIRONMENTAL QUALITY MONITORING

Marine Environmental Quality (MEQ) has a direct social and economic impact on the coastal zone. A marine ecosystem can be altered by both natural and human activities which affect its physical, biological and chemical characteristics. The Department of Environment (DOE) started the MEQ monitoring programme in 1978 for Peninsular Malaysia and in 1985 for Sabah and Sarawak which included *in-situ* measurements and laboratory analysis (Table 7).

In 2003, a total of 972 samples were collected from 219 monitoring stations. DOE also embarked on the island marine water quality monitoring for 71 islands in the country. The proposed Interim Standards for Marine Water Quality (IMWQS) is as shown in Table 8.

Photo 13 : Marine Water Quality Grab Sampling (Van Dorn Sampler) (DOE Photo Library)

MARINE ENVIRONMENTAL QUALITY STATUS

The marine quality status is summarised in Table 9. As in the previous years, the main contaminants of the coastal waters in all States exceeding their Interim Marine Water Quality Standards (IMWQS) were total suspended solids (72.1%), oil and grease (34.7%) and *Escherichia coli* (48.2%). Figure 20 shows the trend of marine water quality contaminants for the years 2001 to 2003. Overall comparison showed a steady increase in E.coli, cuprum and cadmium levels in marine waters, while there was an improvement in the marine water quality in terms of total suspended solids.

Oil & grease remained a significant contributor to the contamination of marine water quality (Table 9) due to sea transportation and land based activities. As for *E.coli* contamination, Pulau Pinang recorded the highest percentage exceeding the IMWQS (89%), followed by Johor (77%), Selangor (75%), Negeri Sembilan (72%) and Sarawak (71%). The prevalence of *E.coli* in coastal waters could be attributed to untreated or partially treated discharge of domestic sewage and animal wastes.

Heavy metal pollution in the marine waters of Malaysia was considerably low with cadmium (Cd), chromium (Cr), mercury (Hg) and arsenic (As) exceeding the IMWQS at 6.7%, 0.2%, 12.7% and 0.5% respectively. However, there was a significant increase in the levels of lead (16.1%) and cuprum (30.0%) analysed for 2003. The observations where cuprum formed significant pollutants were in Pulau Langkawi, Pulau Pinang, Kedah, Kelantan and Terengganu with percentages ranging from 58%-92% exceeding the IMWQS.

Table 7 Malaysia : Marine Environmental Quality Parameters

in-situ measurements	Unit	Laboratory analysis	Unit
Temperature (Temp)	°C	*Escherichia coli* (E.coli)	MPN/100ml
pH	unit	Oil & Grease (O&G)	mg/l
Dissolved Oxygen (DO)	% Sat	Total Suspended Solids (TSS)	mg/l
Dissolved Oxygen (DO)	mg/l	Arsenic (As)	mg/l
Conductivity (Cond)	mS/cm	Cadmium (Cd)	mg/l
Salinity (Sal)	ppt	Chromium (Cr) Total	mg/l
Turbidity (Tur)	NTU	Cuprum (Cu)	mg/l
Tarball	g/100m	Plumbum (Pb)	mg/l
		Mercury (Hg)	mg/l

Table 8 Malaysia : Interim Marine Water Quality Standards

Parameter (lab)	Unit	Interim standards
Escherichia coli (E.coli)	MPN/100ml	100
Oil & 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
Chromium (Cr) Total	mg/l	0.5
Cuprum (Cu)	mg/l	0.1
Plumbum (Pb)	mg/l	0.1
Mercury (Hg)	mg/l	0.001

ISLAND MARINE WATER QUALITY

A total of 364 samples were collected from 85 monitoring stations off 71 islands in 2003. The islands were categorized as development islands (3), resort islands (25), marine park islands (38) and protected islands (5). In general, the islands' marine water quality for 2003 remained relatively unpolluted (Figure 21). The main pollutants were *E.coli*, total suspended solids and oil & grease.

E.coli was recorded as the highest pollutant exceeding 5.8% of the interim standards for development islands, 1.1% for marine park islands and 2.6% for resort islands. For development islands, Pulau Pinang and Wilayah Persekutuan Labuan recorded the highest *E.coli* pollution levels of 4.1% and 3.6% respectively exceeding the interim standards (Figure 22). Marine water quality status for resort islands and marine park islands showed that *E.coli* remained the major pollutant with 2.6% and 1.1% respectively exceeding the IMWQS. On the other hand, excellent marine water quality was recorded for the protected islands with none of the parameters measured exceeding the interim standards.

Photo 14 : Marine Water Samples Preparation for Analysis (DOE Photo Library)

TARBALL MONITORING

Beaches along the island and coastal areas were also monitored for tarball contamination. In 2003, most coastal beaches were found to be free from tarball contamination, except at Kuala Sg. Kerteh (observed on 11 Mar), Pantai Rantau Abang (observed on 12 Mar), Pantai KIPC Tengah (observed on 11 Mar) and Pantai KIPC Selatan

Table 9 Malaysia : Status Of Marine Water Quality, 2003

State	No. of Station	No. of Sample	Parameter Exceeding Interim Standard (%)								
			Total Suspended Solids	Oil and Grease	Escherichia coli	Cadmium	Chromium	Mercury	Lead	Arsenic	Cuprum
Perlis	2	24	100	71	0	0	0	25	13	0	42
Pulau Langkawi	7	42	95	57	35.7	0	0	12	0	0	81
Kedah	3	12	92	83	-	0	0	0	0	0	92
Pulau Pinang	23	136	90	67	89	0	0	13	1	1	82
Perak	13	52	100	3	69	0	0	5	33	0	0
Selangor	14	69	88	24	75	0	0	4	0	0	0
N. Sembilan	13	77	100	24	72	0	0	7	0	0	0
Melaka	9	54	96	11	67	0	0	0	4	6	0
Johor	45	151	21	15	77	0	0	0	1	0	0
Pahang	11	80	14	34	13	0	0	0	1	0	1
Terengganu	19	76	65	57	51	58	1	18	70	0	58
Kelantan	10	30	67	43	53	43	0	0	73	0	63
W.P. Labuan	5	15	67	0	0	0	0	-	-	-	-
Sabah	26	65	73	2	3	0	2	94	13	0	0
Sarawak	19	89	15	29	71	0	0	0	16	0	3
Malaysia (Total)	**219**	**972**									
Average (%)			**72.1**	**34.7**	**48.2**	**6.7**	**0.2**	**12.7**	**16.1**	**0.5**	**30.0**

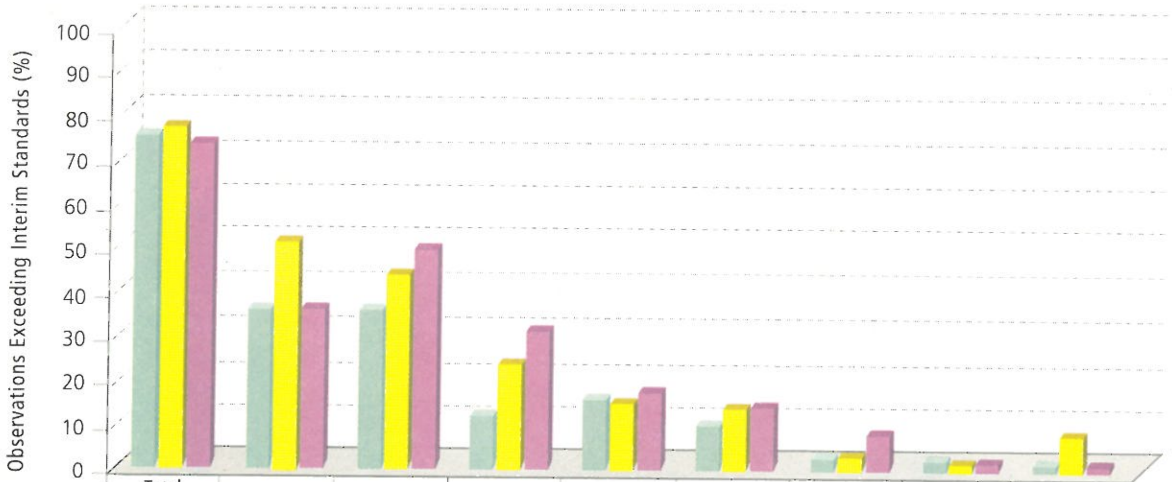
(observed on 11 Mar). The amount of tarballs quantified were 4.5, 4.5, 13.0 and 2.3g/100m strip respectively. Tarball residues found on beaches could be due to the oily discharges from fishing boats and passing vessels.

Island tarball monitoring on 43 accessible beaches showed three (3) tarball sightings. The beaches were in the resort islands of Pulau Pemanggil, Pulau Aur and Pulau Tinggi, each with one tarball sighting (Table 10).

Photo 15 : Beach Tar Monitoring (DOE Photo Library)

Table 10 Malaysia: Island Tarball Monitoring 2003

Island Category	No. of Beaches Monitored	No. of Tarball Sightings
Protected	3	0
Development	5	0
Resort	17	3
Marine Park	18	0
TOTAL	**43**	**3**



Year	Total Suspended Solids	Oil & Grease	*Escherichia coli*	Cuprum	Lead	Mercury	Cadmium	Arsenic	Chromium
2001	74.3	34.7	34.7	11.1	14.6	8.7	1.7	1.0	0.1
2002	75.7	50.5	42.6	22.4	13.6	12.6	1.9	0.1	6.7
2003	72.1	34.7	48.2	30	16.1	12.7	6.7	0.5	0.2

Figure 20 Malaysia : Marine Water Quality Status, 2001-2003

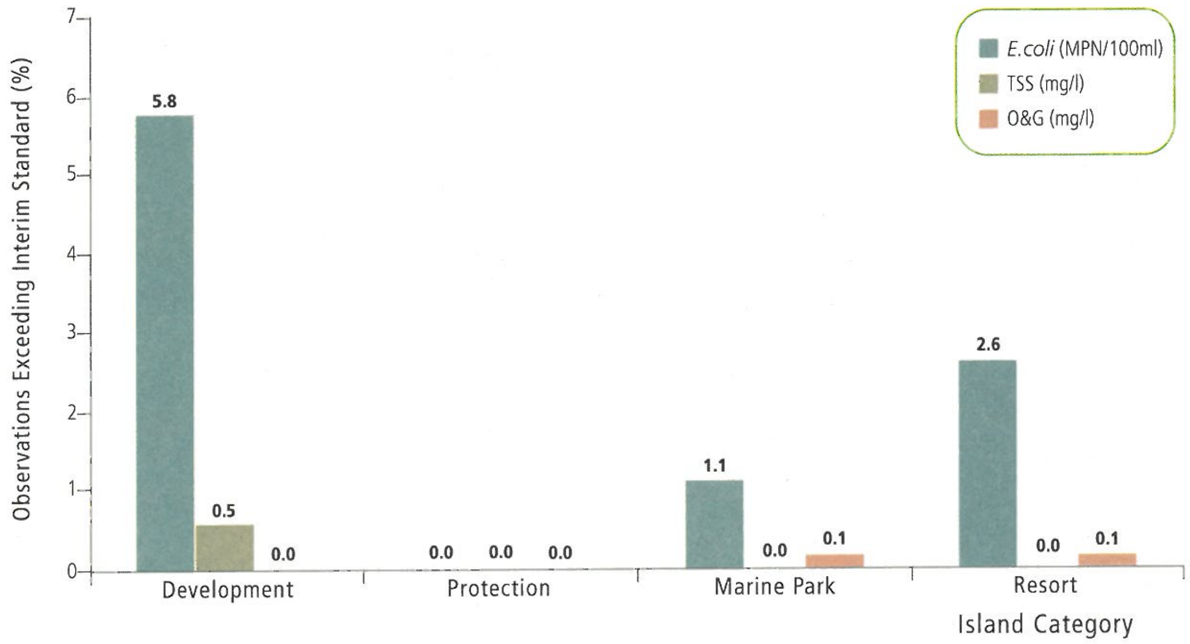


Figure 21 Malaysia: Observations Exceeding Interim Standard of Island Marine Water Quality

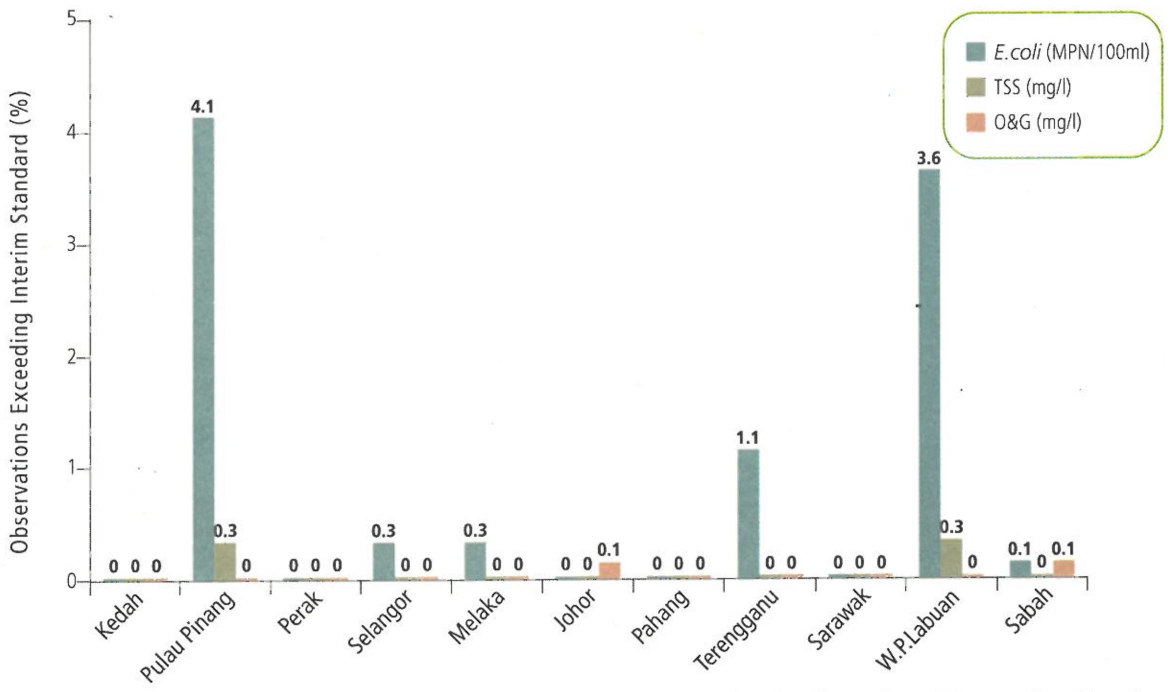


Figure 22 Malaysia: Observations Exceeding Interim Standard of Marine Water Quality by State, January-November 2003

CHAPTER 5

Pollution Sources Inventory

CHAPTER 5

POLLUTION SOURCES INVENTORY

Photo 16 : River flowing Through An Urban Area (DOE Photo Library)

SOURCES OF WATER POLLUTION

Two main sources of water pollution identified in Malaysia are point-sources and non-point sources. Point sources include sewage treatment plants, manufacturing and agro-based industrial plants and animal farms. Non-point sources, on the other hand, come from many diffused sources such as agricultural activities and surface runoff. The runoff collects and carries along natural and man-made pollutants, before finally depositing them into the surface water bodies and underground water.

Photo 17 : Oil Pollution on River Surface (DOE Photo Library)

The estimated number of water pollution sources for 2003 was 14110 comprising mainly of sewage treatment plants, agro-based industries, manufacturing industries and animal farms (Figure 23). About 53.3% of the total number of sources were domestic sewerage facilities (7,519 sources), followed by 37.1% manufacturing industries (5,233), 6.7% pig farms (950) and the remaining 2.9% agro-based industries (408).

Figure 24 represents the distribution of agro-based and manufacturing industries compiled by the DOE in 2003 based on field surveys and returned questionnaires. A total of 5,641 sources were identified. In the year 2003, Johor recorded the highest number of water pollution sources (1,670 sources), followed by Selangor (1,546 sources).

Statistics by the Veterinary Department of Malaysia shows that the total standing pig population for 2003 was about 1.7 million, an increase of 12.6% from 1.5 million in 2002. Correspondingly, the number of pig farms in 2003 increased to 950 farms compared to 807 farms the previous year.

Meanwhile, the number of sewage treatment plants under the management of Indah Water Consortium Sdn. Bhd. identified in 2003 increased to 7,519 plants as compared to 7,126 plants in 2002. Selangor had the largest number of these sewage treatment plants (2,066;27.5%), followed by Perak (1,159;15.4%), Johor (805;10.7%) and Negeri Sembilan (796;10.6%) (Figure 25)

BOD POLLUTION LOAD

Domestic sewage discharges remain the largest contributor of organic pollution load with an estimated biochemical oxygen demand (BOD) load of 2071.5mt/day, in the form of treated and partially treated sewage. The estimated BOD loading contributed by other major sectors were agro-based and manufacturing industries (81.2mt/day) and pig farming (19.2 mt/day). Table 11 indicates the total BOD load in kg/day discharged from sewage treatment plants throughout Malaysia in 2003.

Table 11: Malaysia Total BOD Load (kg/day) from Sewage Treatment Plants of Respective States.

State	No. of STP's	Total PE	Flow (m^3/d)	BOD Load (kg/day)
Johor	805	926212	208,398	52,099.43
Kedah	639	395450	88,976	22,244.06
Melaka.	621	437521	98,442	24,610.56
Negeri Sembilan	796	764563	172,027	43,006.67
Pahang	378	238050	53,561	13,390.31
Perak	1,159	1080610	243,137	60,784.31
Perlis	31	12090	2,720	680.06
Pulau Pinang	565	1335184	300,416	75,104.10
Selangor	2,066	4884961	1,099,116	274,779.06
Terengganu	200	58711	13,210	3,302.49
WP Kuala Lumpur	235	1600282	360,063	90,015.86
WP Labuan	23	23874	5,372	1,342.91
WP Putrajaya	1	64595	14,534	3,633.47
Total	**7,519**	**11,822,103**	**2,659,973.18**	**664,993.29**

STP = Sewage Treatment Plant
PE = Population Equivalent

**(Source: IWK Sdn. Bhd.)*

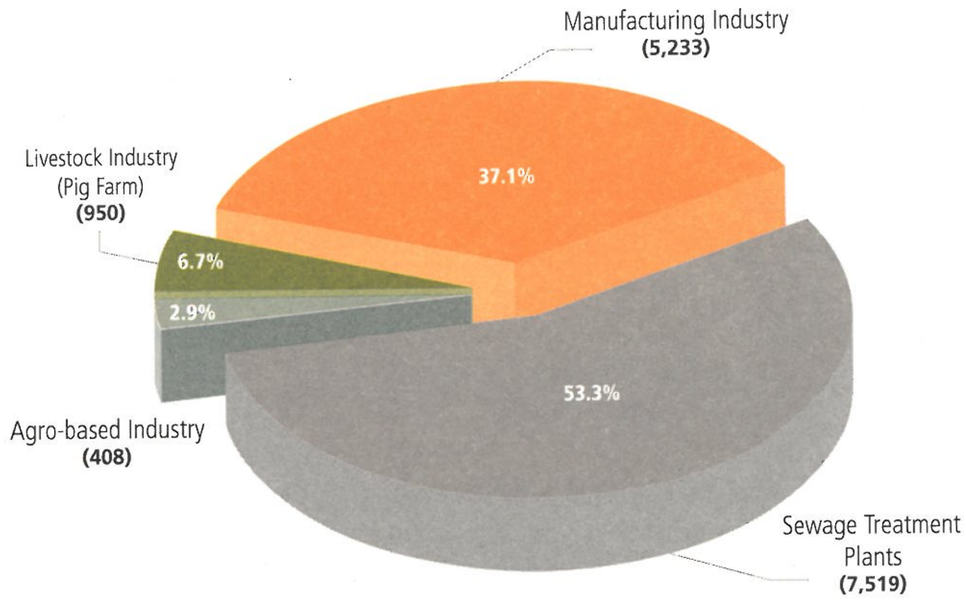


Figure 23 MALAYSIA: Distribution of Water Pollution Sources by Sector, 2003

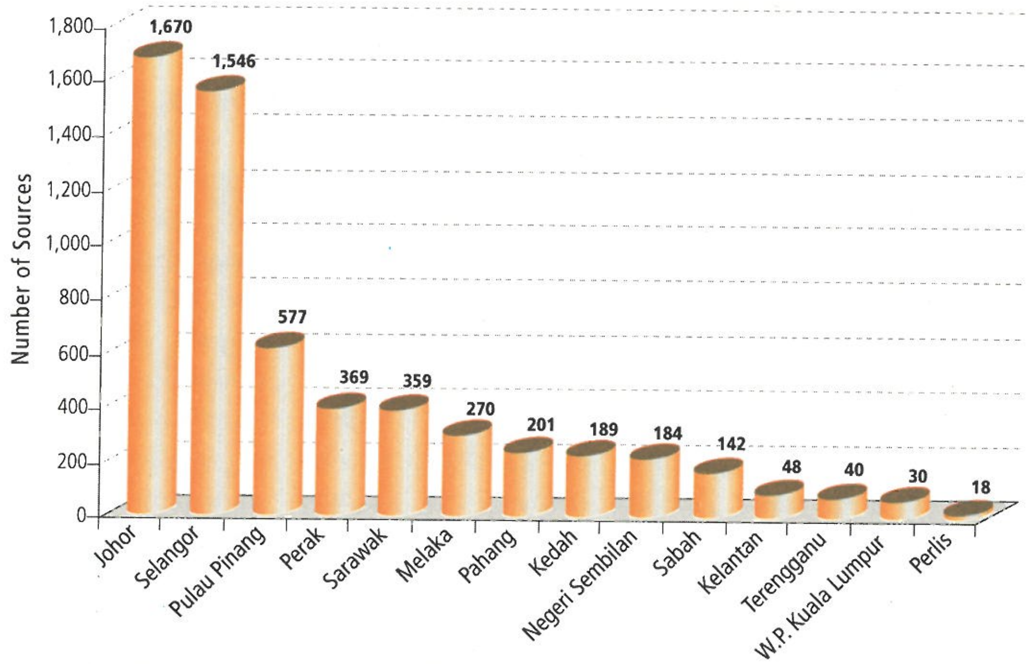


Figure 24 Malaysia: Distribution of Industrial Water Pollution Sources (Agro-based & Manufacturing Industries) by State, 2003

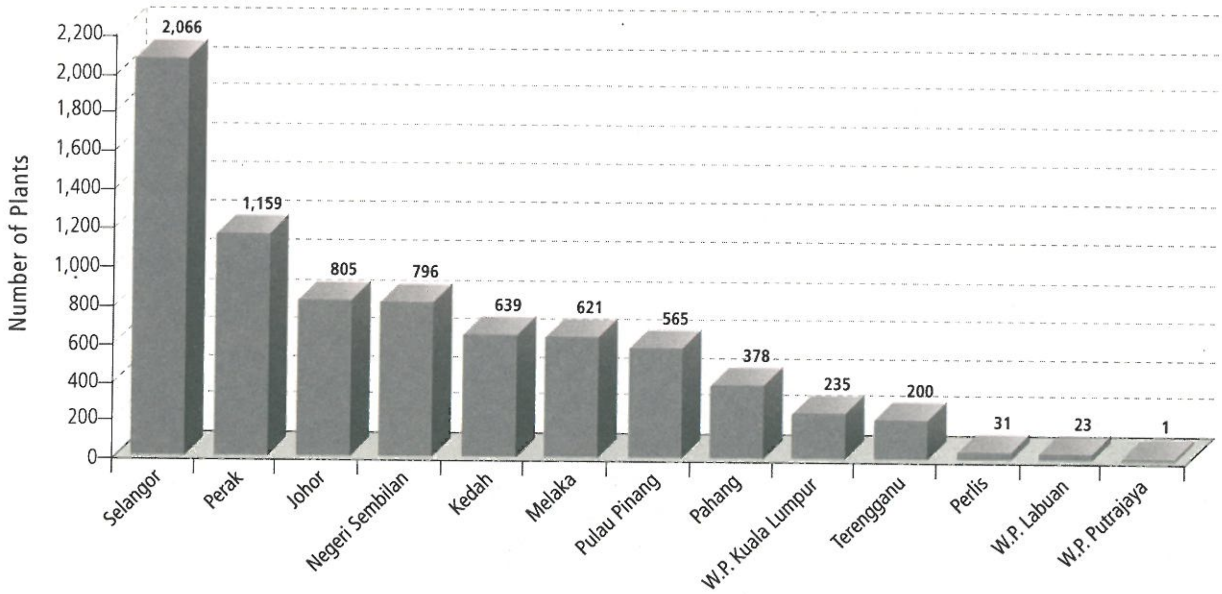


Figure 25 Malaysia: Distribution of Sewage Treatment Plants by State, 2003

AIR POLLUTION SOURCES AND EMISSION LOAD

The main sources of air pollution in Malaysia can be divided into four main categories as follows:

- Mobile sources
- Stationary sources
- Open burning
- Transboundary pollution

Emissions from mobile and stationary sources and open burning activities remained the most significant sources of air pollution in the country throughout the year. In addition, Malaysia was occasionally affected by transboundary pollution of fine particles arising from biomass burning activities transported by wind into the country from external sources during certain months of the year depending on the meteorological factors such as prevailing wind pattern of the year.

Air Pollution from Stationary Sources

Stationary sources comprise emissions from industrial sectors including power stations. The total number of stationary air pollution sources identified in 2003 was 10,286 (Figure 26). Selangor reported the highest number of stationary sources (3,330), followed by Sarawak (2,049), and Perak (1,335).

Emission Load from Stationary Sources

The estimated combined air emission load for 2003 was about 1,455,840 metric tonnes of carbon monoxide (CO); 324,415 metric tonnes of oxides of nitrogen (NO_X); 264,413 metric tonnes of sulphur dioxide (SO_2) and 20,453 metric tonnes of particulate matter. Out of these, the industrial sector and power stations contributed 57% of the total SO_2 emission load and 64% of particulate emission load (Figures 27 & 28). On the other hand, the mobile sources were the main contributor to NO_x (83%) and CO (93%) emission load (Figures 29 & 30). Apart from stationary and mobile sources, open burning activities also contributed significantly to the particulate emission load. However, the total emission load estimated in this report did not include those from open burning activities.

Photo 18 : Black Smoke from Industry (DOE Photo Library)

Air Pollution from Mobile Sources

Mobile sources include passenger cars, taxis, buses, motorcycles, vans and lorries. Due to the large numbers of vehicles on the road, mobile sources remained the major contributors to air pollution especially in major cities. The number of in-use vehicles in Malaysia for the year 2002 and 2003 is shown in Figure 31. In 2003, the number of passenger cars increased by 6.3%, motorcycles 2.6% and taxis by 10.5% compared to 2002. However, the number of vans/lorries and buses decreased by 4.1% and 2.0% respectively.

Emission Load from Mobile Sources

Estimated annual air pollutant emission load of pollutants namely hydrocarbon (HC), carbon monoxide (CO), particulate matters (PM_{10}), nitrogen dioxide (NO_2) and

Photo 19 : Vehicular Black Smoke (DOE Photo Library)

sulphur dioxide (SO_2) from the road transport sector for 2002 and 2003 is shown in Figure 32. In 2003, the emission load of HC and CO was estimated to be 283,311 metric tonnes/year and 1,354,910 metric tonnes/ year respectively. There is an increase of 2.5% of HC emission load and 3.6% of CO emission load in the year 2003 as compared to 2002. On the other hand, a decreasing trend was observed in the emission load of PM_{10}, SO_2 and NO_2 in 2003 compared to 2002. Emission load of PM_{10} was 7,266 metric tonnes in 2003 as compared to 8,221 metric tonnes in 2002 (11.6% decrease); SO_2 was 16,984 metric tonnes in 2003 as compared to 18,297 metric tonnes in 2002 (7.2% decrease); and NO_2 was 269,963 metric tonnes as compared to 291,937 tonnes in 2002 (7.5% decrease).

Figure 33 to 37 show the contribution of various categories of vehicles to the overall air pollutant emission load. It was estimated that 70% of PM_{10} emission load was contributed by vans and lorries, 27% from buses and 3% from taxis (Figure 33).

It was also estimated that 68% of NO_2 emission load was contributed by van and lorries, 19% from buses, 11% from passenger cars and 1% each from motorcycles and taxis (Figure 34).

From the total emission of SO_2, it was estimated that 66% of emission load emitted was from vans and lorries, 18% from buses, 11% from passenger cars, 3% from motorcycles and 2% from taxis (Figure 35).

Figure 36 shows that motorcycles contributed 59% of the total HC emissions from mobile sources, 23% by vans and lorries, 15% by passenger cars, and buses and taxis both contributed 1% each to the total HC emission load.

Vans and lorries contributed 45% of the total CO emission load from mobile sources; passenger cars contributed 35%, motorcycles 15%, buses 3% and taxis 2% (Figure 37).

Photo 20 : Urban Air Pollution From Mobile Sources (DOE Photo Library)

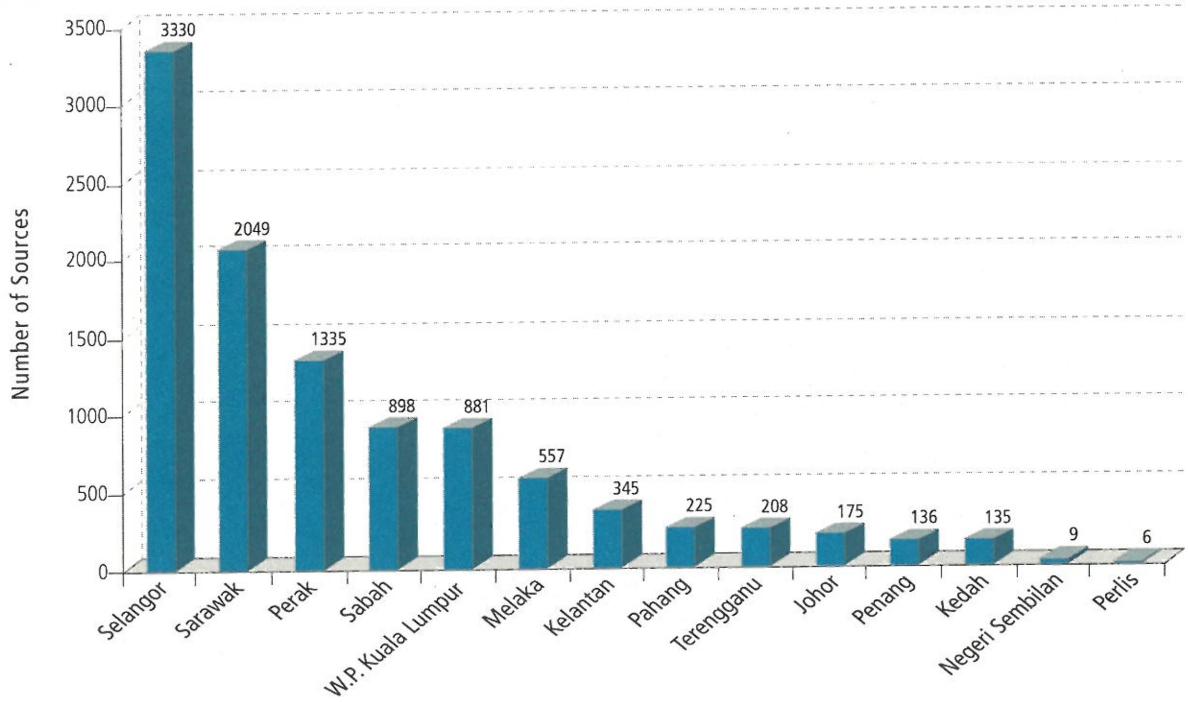


Figure 26 Malaysia: Distribution of Industrial Air Pollution Sources by State, 2003

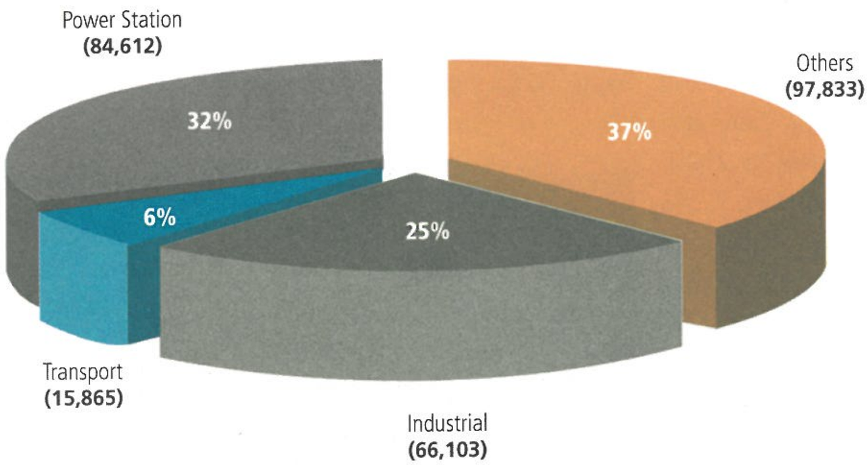


Figure 27 Malaysia: Combined SO_2 Emission by Sources (tonnes), 2003

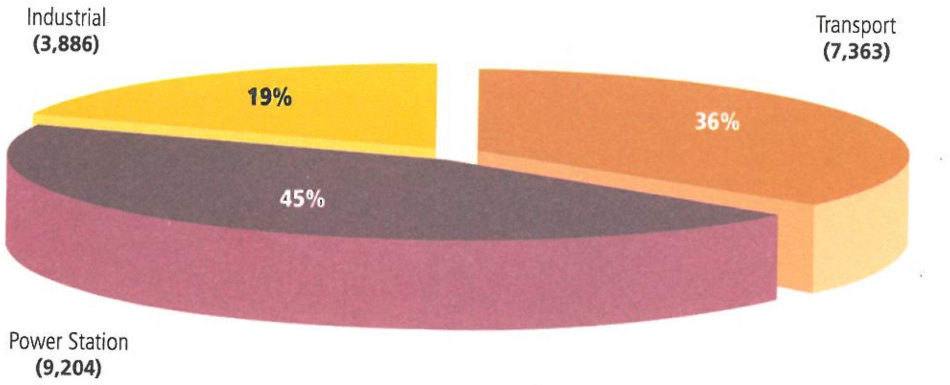


Figure 28 Malaysia: Combined Particulate Matter Emission by Sources (tonnes), 2003

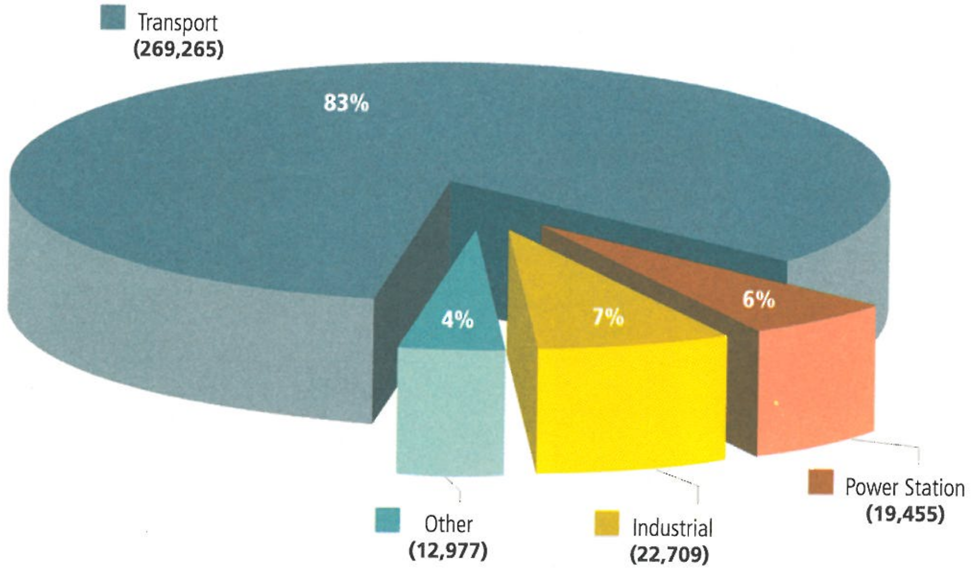


Figure 29 Malaysia: Combined Nitrogen Oxides (NO_x) Emission by Sources (tonnes), 2003

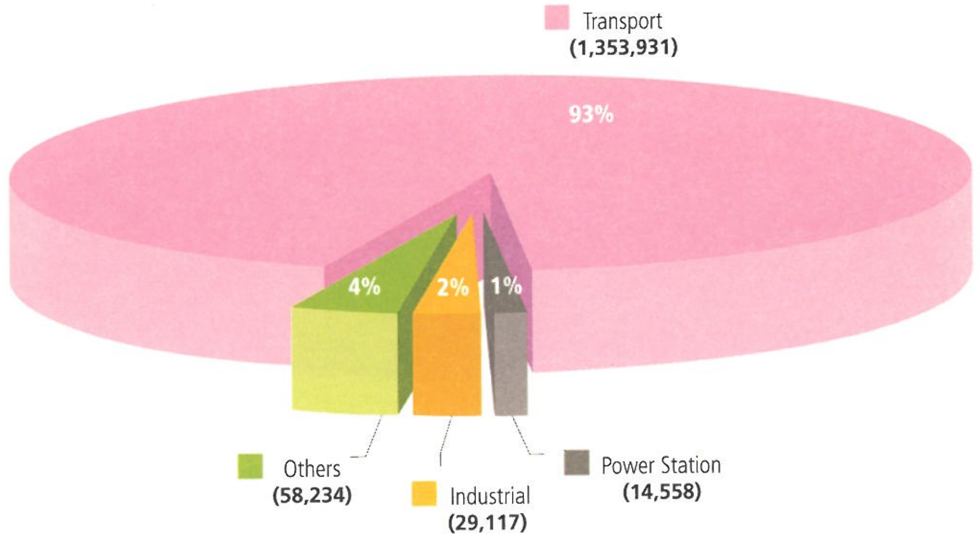


Figure 30 Malaysia: Combined Carbon Monoxide (CO) Emission by Sources (tonnes), 2003

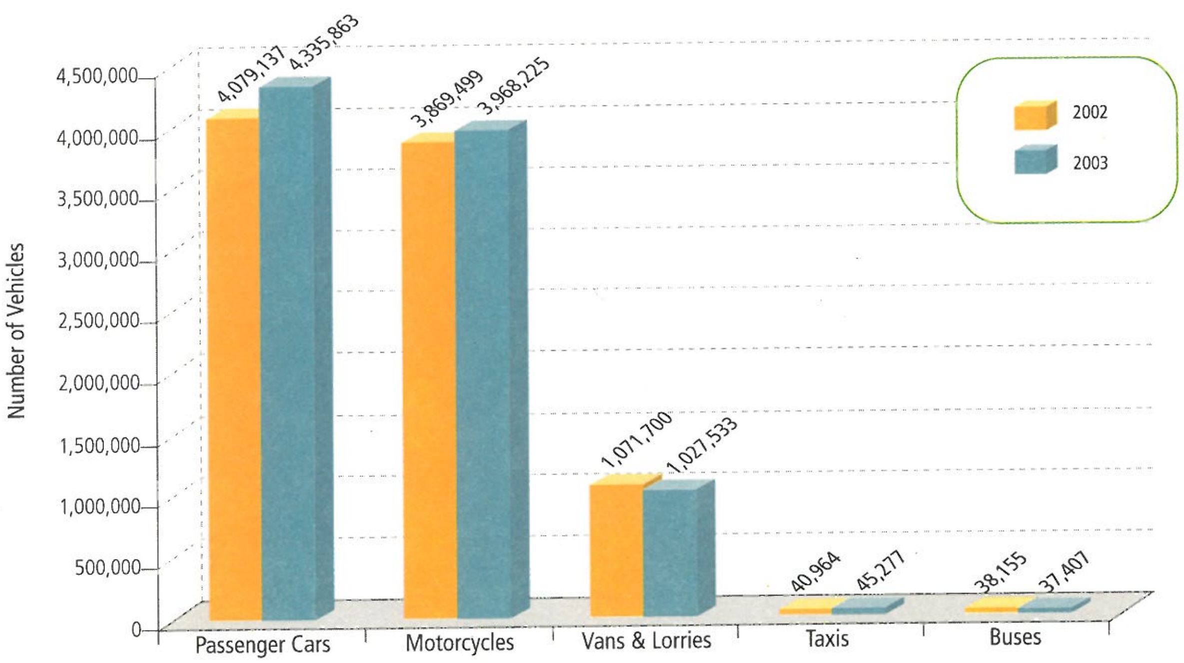


Figure 31 Malaysia: Number of In-Use Vehicles, 2002-2003

**Source : Road Transport Department, Malaysia, 2003*

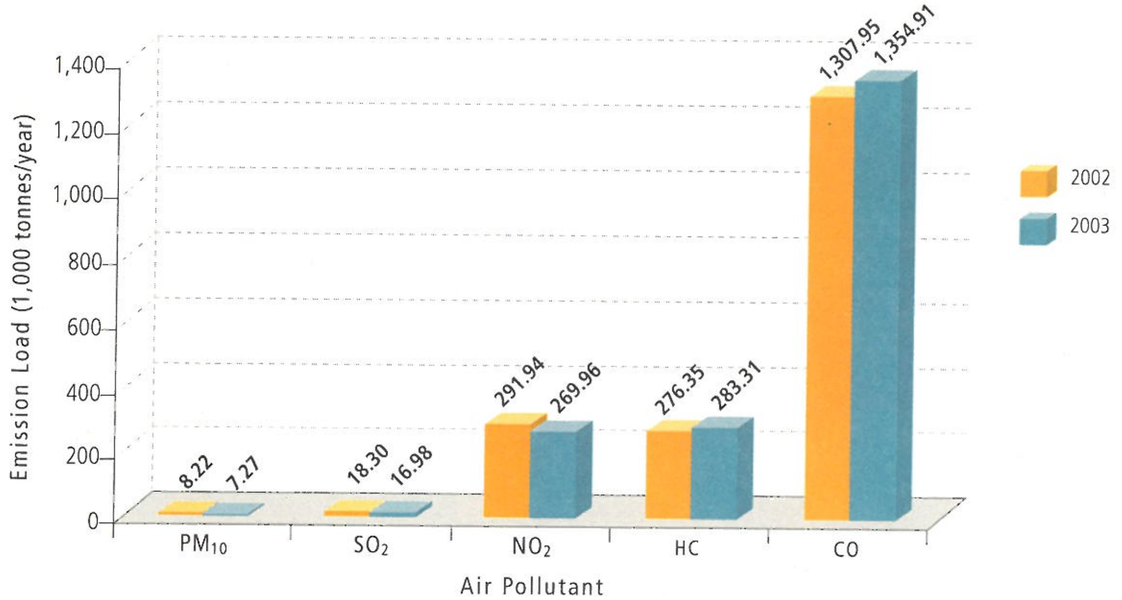


Figure 32 Malaysia: Air Pollutant Emission Load from Mobile Sources, 2002-2003

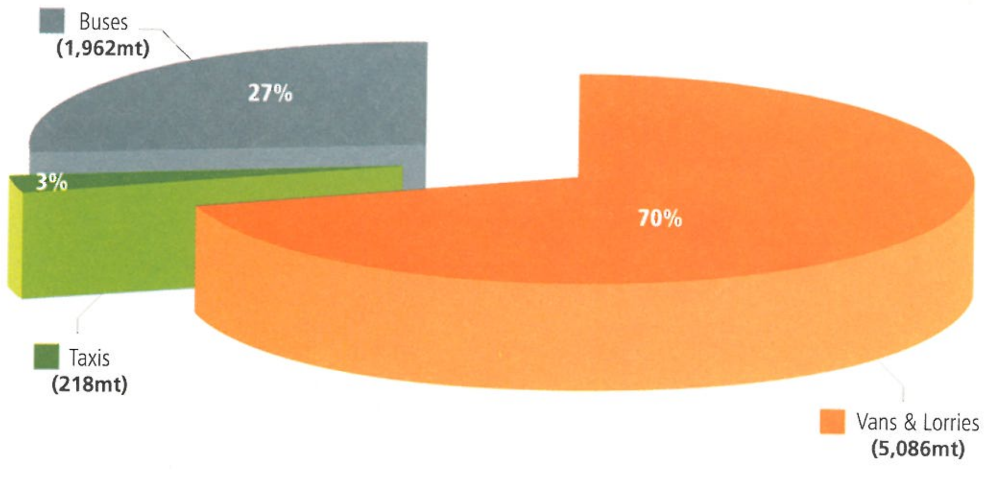


Figure 33 Malaysia: Total PM_{10} Emission by Vehicle Categories, 2003

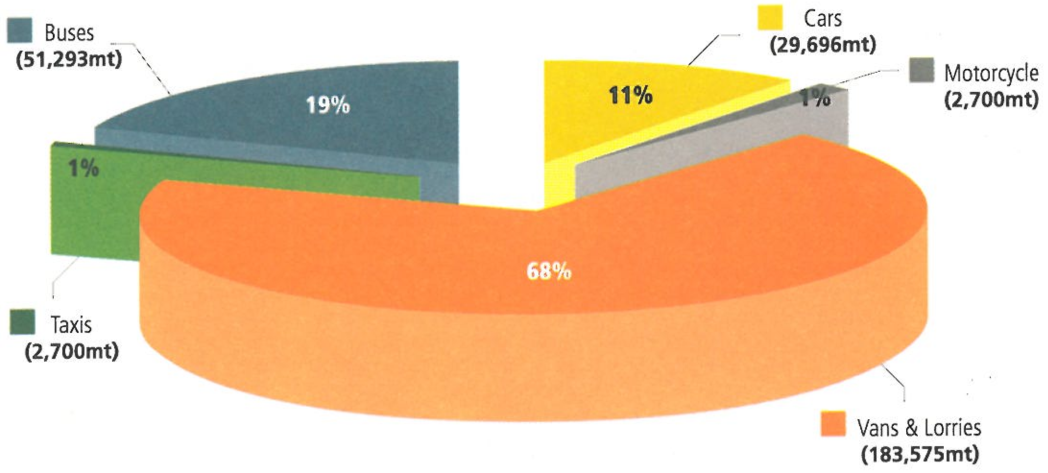


Figure 34 Malaysia: Total NO_2 Emission by Vehicle Categories, 2003

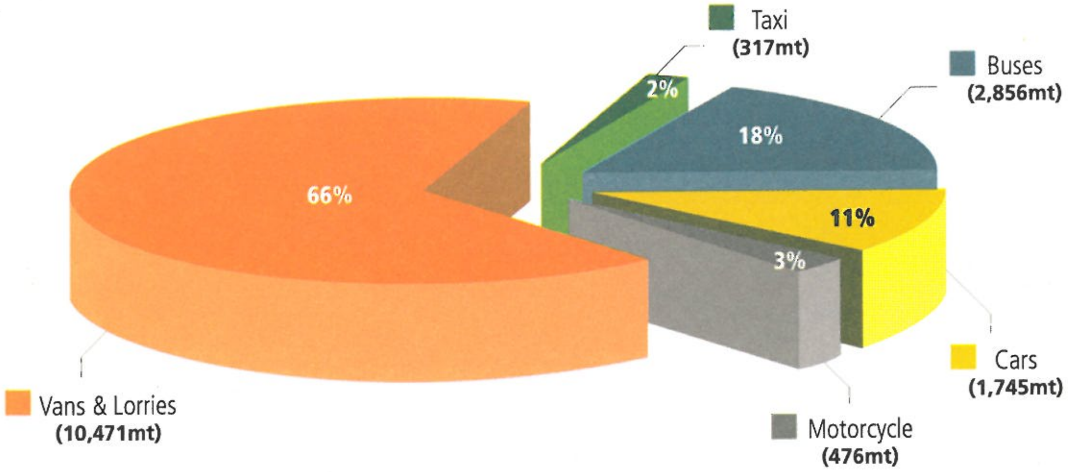


Figure 35 Malaysia: Total SO_2 Emission by Vehicle Categories, 2003

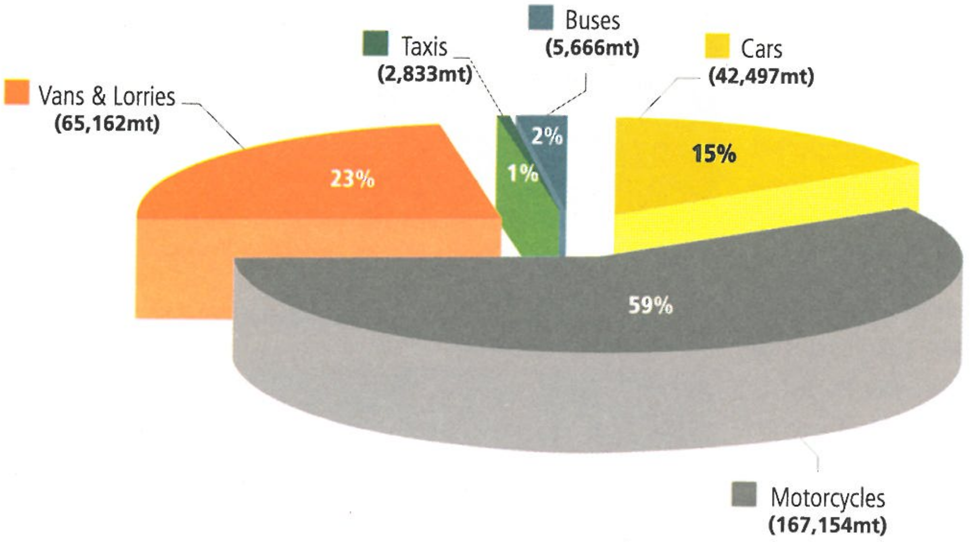


Figure 36 Malaysia: Total HC Emission by Vehicle Categories, 2003

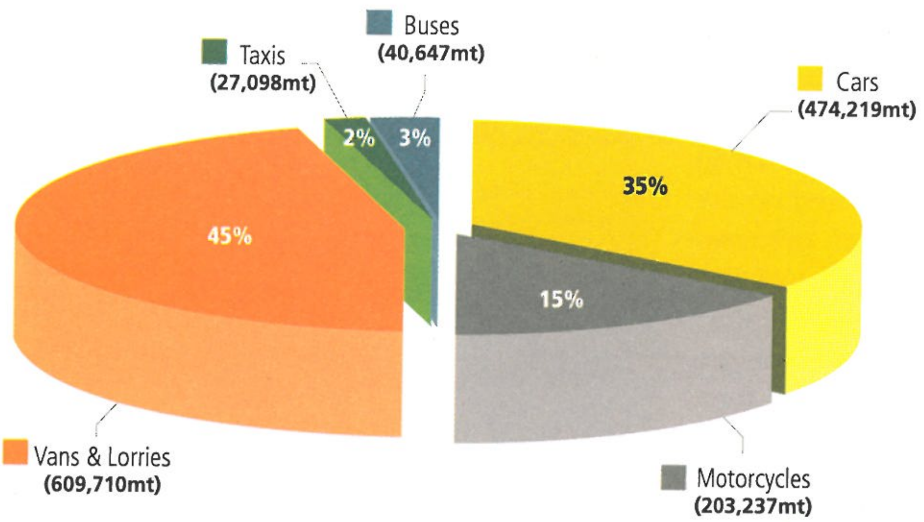


Figure 37 Malaysia: Total CO Emission by Vehicle Categories, 2003

SCHEDULED WASTES INVENTORY

Based on notifications received by DOE, a total of 460,865.74 tonnes of scheduled wastes were reported by 5,139 waste generators in 2003 as compared to 363,017 tonnes generated by 4,079 generators in 2002. Heavy metal sludge, mineral sludge and dross/slag/clinker made up the main categories of wastes produced in the country. The breakdown according to waste categories and industry type are given in Table 12 and 13 and Figure 38 and 39 respectively.

Of the total wastes produced, 81,358.82 tonnes (17.7%) were treated and disposed at the Kualiti Alam Treatment Disposal Facility; 5,239.42 tonnes (1.1%) of clinical wastes were incinerated at licenced off-site facilities; 2,361.88 tonnes (0.5%) were exported for recycling purposes; 250,260.45 tonnes (54.3%) of scheduled wastes were recycled at off-site local facilities and an estimated 121,645.17 tonnes (26.4%) were treated and stored on-site at waste generators premises (Table 14). Six landfarms and 35 on-site waste incinerators were licenced by DOE for on-site treatment and incineration respectively. The on-site facilities handled an estimated 68,052.93 tonnes (14.8%) of the total wastes produced in the country.

Photo 21 : Aerial view of Improper Scheduled Wastes Storage (DOE Photo Library)

Table 12 Malaysia : Quantity of Scheduled Wastes Generated by Industries, 2003

Industry	Quantity of Wastes	
	(MT/Year)	Percentage (%)
Oleochemical	167.65	0.04
Wood-based	551.28	0.12
Printing & Packaging	809.00	0.18
Rubber & Plastic	5,613.31	1.22
Petroleum	7,437.91	1.61
Pharmaceutical	8,793.24	1.91
Industrial Gas	42,380.12	9.20
Chemical	67,268.50	14.60
Electronic	76,914.20	16.68
Others	100,366.61	21.78
Metal	150,563.92	32.67
TOTAL	**460,865.74**	**100.00**

Table 13 Malaysia : Quantity of Scheduled Wastes Generated by Category, 2003

Category of Waste	Quantity of Wastes	
	(MT/Year)	Percentage (%)
Photographic	150.54	0.03
Paint/ Ink/ Dye Solvent	752.15	0.16
Ink/ Paint/ Dye Sludge	1,072.45	0.23
Halogenated Solvent	1,057.90	0.23
Paper & Plastic	1,669.88	0.36
Phenol/ Adhesive/ Resin	4,275.69	0.93
Acids/Alkalis	5,731.40	1.24
Rubber & Latex	5,786.66	1.26
Catalyst	7,047.39	1.53
Non Halogen Solvent	8,603.94	1.87
Clinical	8,793.24	1.91
Others	18,810.38	4.09
Containers	44,932.18	9.75
Oil & Hydrocarbon	66,522.14	14.43
Dross/ Slag/ Clinker	77,179.35	16.75
Mineral Sludge	78,876.87	17.11
Heavy Metal Sludge	129,603.58	28.12
TOTAL	**460,865.74**	**100.00**

Table 14 Malaysia : Handling of Scheduled Wastes, 2003

Facility	Tonnes	Percentage (%)
Kualiti Alam Sdn. Bhd.	81,358.82	17.65
Export to Foreign Facilities	2,361.88	0.51
Delivered to Local Off-site Recovery Facilities	250,260.45	54.30
Off-site Clinical Waste Incinerators	5,239.42	1.14
On-site Treatment	68,052.93	14.77
On-site Storage	53,592.24	11.63
TOTAL	**460,865.74**	**100.00**

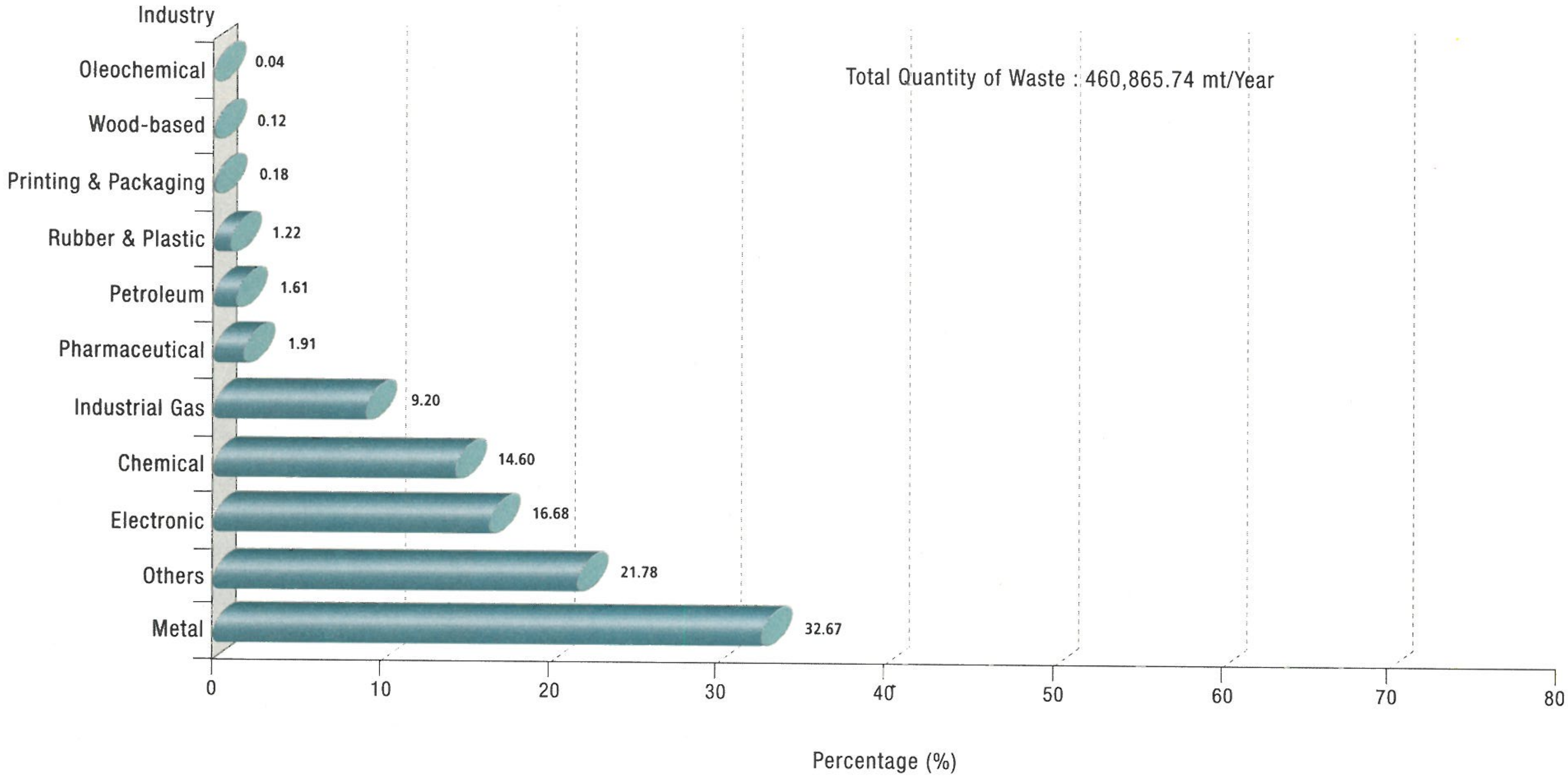


Figure 38 Malaysia: Quantity of Scheduled Wastes Generated by Industries, 2003

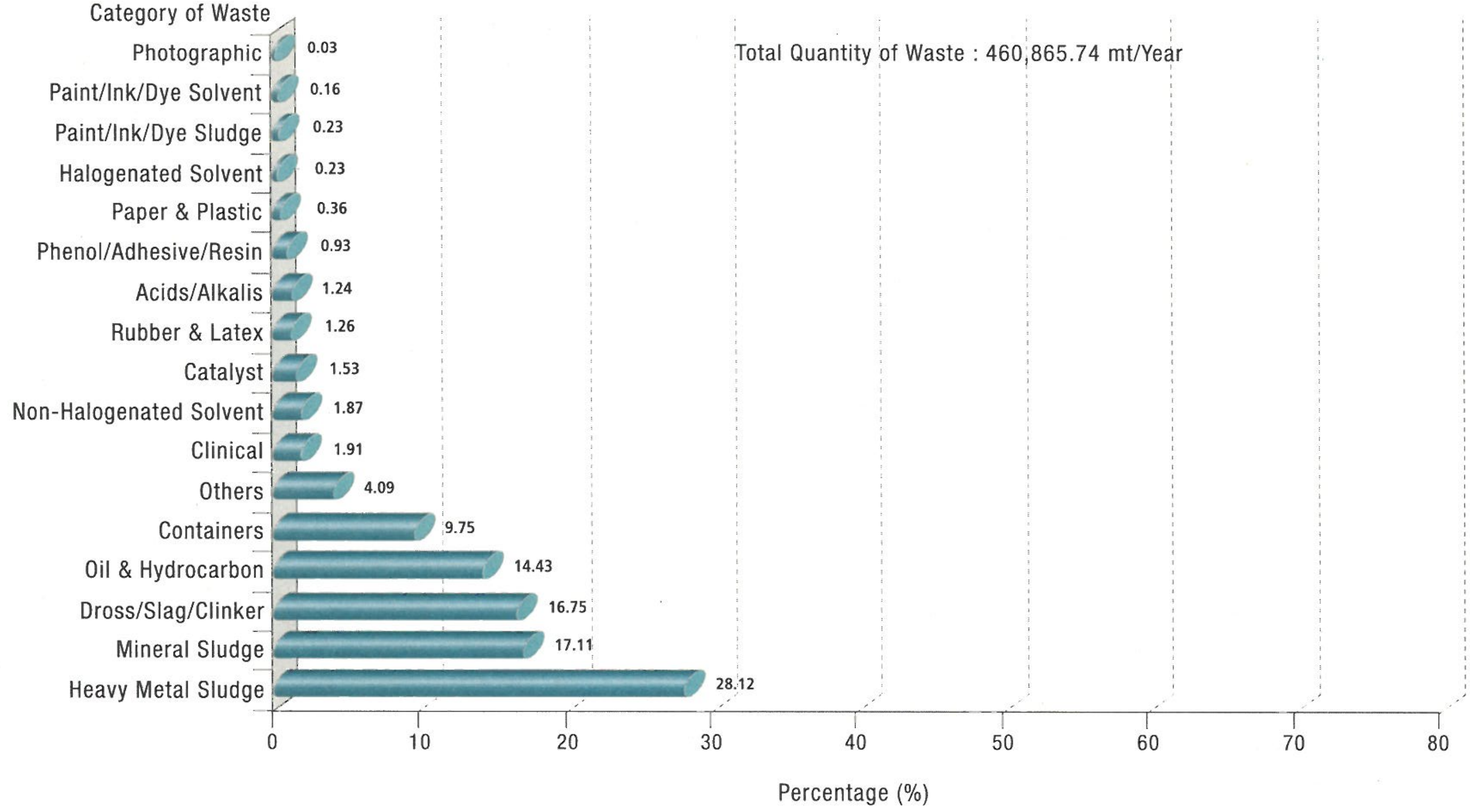


Figure 39 Malaysia: Quantity of Scheduled Wastes Generated by Category, 2003

Photo 22 : Illegal Disposal of Scheduled Wastes (DOE Photo Library)

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

In 2003, 12 Written Approvals were issued for the import of 305,398 tonnes of wastes for use as raw materials. The wastes comprised of granulated blast furnace slag (252,007mt, 82.5%), copper slag (52,283 mt, 17.1%) and spent fluid cracking catalyst (1,108mt, 0.4%). Figure 41 illustrates the quantities of wastes imported over the past five years (1999-2003). The spent catalysts and blast furnace slag were used as raw materials in cement manufacturing plants, while the copper slag was used in sand-blasting operations.

A total of 2,362 tonnes of scheduled wastes were exported. The exported wastes were derived from 42 waste generators and comprised of copper oxide sludges (1209mt, 51.2%), spent industrial catalysts (693mt, 29.4%), nickel cadmium battery (217mt, 9.2%), metal hydroxide sludges (212mt, 8.9%) and cadmium nickel oxide sludges (30mt, 1.3%). The wastes were exported for recovery in various countries as shown in Table 15. The quantity and type of wastes exported between 1999 and 2003 is shown in Figure 40.

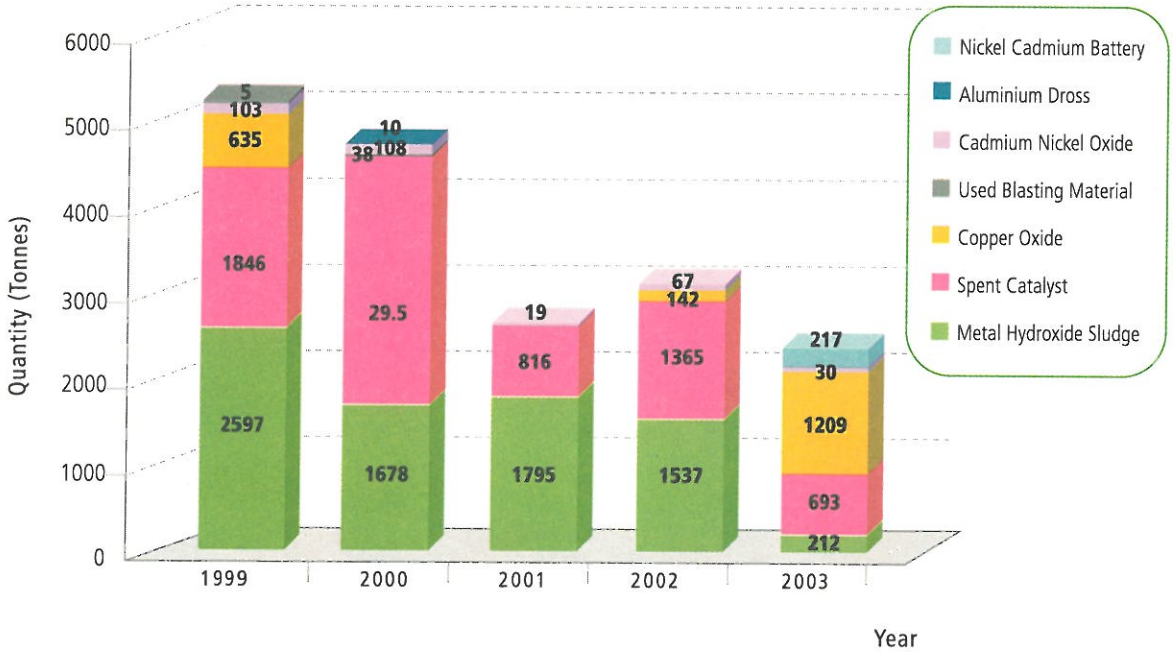


Figure 40 Malaysia: Quantity and Type of Wastes Exported (tonnes), 1999-2003

Table 15 Malaysia : Quantity of Scheduled Wastes Exported (tonnes), 1999-2003

Country	1999	2000	2001	2002	2003
Australia	280.00	69.00	-	315.00	208.500
Germany	80.00	470.00	159.00	128.00	349.488
Holland	1266.00	1234.00	487.00	569.58	322.770
Italy	-	-	107.00	44.10	27.520
Japan	1103.00	1530.00	68.00	1,034.96	1006.891
Finland	-	-	-	100.00	23.000
France	80.00	108.00	-	66.61	98.751
Philippines	1073.00	-	532.00		-
Singapore	27.00	500.00	-	170.00	-
South Africa	45.00	-	-		-
South Korea	23.00	-	-		117.900
Sweden	102.00	203.00	27.00	149.00	7.000
Switzerland	-	10.00	-		-
Belgium	-	-	-	-	140.000
USA	1107.00	753.00	1295.00	532.90	59.660
Total	**5,186.00**	**4,878.00**	**2,675.00**	**3,110.15**	**2,361.876**

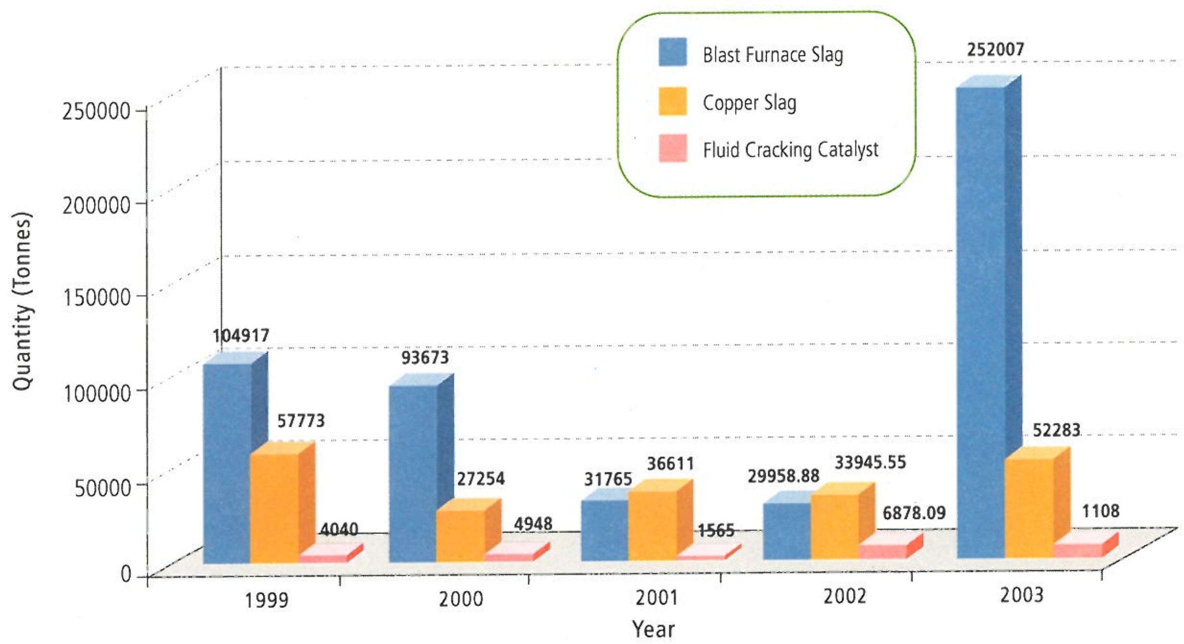


Figure 41 Malaysia: Quantity and Type of Wastes Imported (tonnes), 1999-2003

INTERIM NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

PARAMETERS	UNIT	CLASS				
		I	IIA / IIB	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	N	-	-	-	L
Mg	mg/l	A	-	-	-	E
Na	mg/l	T	-	-	3 SAR	V
K	mg/l	U	-	-	-	E
Fe	mg/l	R	1	1	1 (Leaf) 5(Others)	L
Pb	mg/l	A	0.05	0.02* (0.01)	5	S
Mn	mg/l	L	0.1	0.1	0.2	
Hg	mg/l		0.001	0.004 (0.0001)	0.002	A
Ni	mg/l	L	0.05	0.9*	0.2	B
Se	mg/l	E	0.01	0.25 (0.04)	0.02	O
Ag	mg/l	V	0.05	0.0002	-	V
Sn	mg/l	E	-	0.004	-	E
U	mg/l	L	-	-	-	
Zn	mg/l	S	5	0.4 *	2	IV
B	mg/l		1	- (3.4)	0.8	
Cl	mg/l		200	-	80	
Cl2	mg/l			- (0.02)	-	
CN	mg/l		0.02	0.06 (0.02)	-	
F	mg/l		1.5	10	1	
NO2	mg/l		0.4	0.4 (0.03)	-	
NO3	mg/l		7	-	5	
P	mg/l		0.2	0.1	-	
Silica	mg/l		50	-	-	
SO4	mg/l		250	-	-	
S	mg/l		0.05	- (0.001)	-	
CO2	mg/l			-	-	
Gross - alfa	Bq/L		0.1	-	-	
Gross - beta	Bq/L		1	-	-	
Ra - 226	Bq/L		<0.1	-	-	
Sr - 90	Bq/L		<1	-	-	
CCE	ug/l		500	-	-	-
MBAS/BAS	ug/l		500	5000 (200)	-	-
O & G (Mineral)	ug/l		40 ; N	N	-	-
O & G (Emulsified edible)	ug/l		7000 ; N	N	-	-
PCB	ug/l		0.1	6 (0.05)	-	-
Phenol	ug/l		10	-	-	-
Aldrin/Dieldrin	ug/l		0.02	0.2 (0.01)	-	-
BHC	ug/l		2	9 (0.1)	-	-
Chlordane	ug/l		0.08	2 (0.02)	-	-
t - DDT	ug/l		0.1	(1)	-	-
Endosulfan	ug/l		10	-	-	-
Heptachlor / Epoxide	ug/l	OR	0.05	0.9 (0.06)	-	-
Lindane	ug/l		2	3 (0.4)	-	-
2,4 -D	ug/l	A	70	450	-	-
2,4,5 - T	ug/l	B	10	160	-	-
2,4, 5 - TP	ug/l	S	4	850	-	-
Paraquat	ug/l	E	10	1800	-	-
		N				
		T				

* = At hardness 50 mg/l CaCO3
# = Maximum (unbracketed) and 24 - hour average (bracketed) concentrations
N = Free from visible film sheen, discoloration and deposits

Interim National Water Quality Standards for Malaysia

PARAMETERS	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	>2.7
BOD	mg/l	1	3	3	6	12	>12
COD	mg/l	10	25	25	50	100	>100
DO	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	-	-	-
Elec. Conductivity *	umhos/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)	C	-	Normal +2C		Normal +2C	-	-
Turbidity (NTU)	NTU	5	50	50	-	-	-
Faecal Coliform **	counts/100mL	10	100	400	5000 (20000)a	5000 (20000)a	-
Total Coliform	counts/100mL	100	5000	5000	50000	50000	>50000

Notes

N : No visible floatable materials or debris, No objectionable odour; No objectionable taste

* : Related parameters, only one recommended for use

** : Geometric mean

a : Maximum not to be exceeded

Class	Uses
CLASS I	Conservation of natural environment Water Supply 1 - practically no treatment necessary. Fishery 1 - 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

Malaysia : DOE Water Quality Index Classification

PARAMETERS	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 Oksigen	mg/l	> 7	5 - 7	3 - 5	1 - 3	< 1
pH	mg/l	> 7.0	6.0 - 7.0	5.0 - 6.0	< 5.0	> 5.0
Total Suspended Solids	mg/l	< 25	25 - 50	50 - 150	150 - 300	> 300
Water Quality Index		> 92. 7	76.5 - 92.7	51.9 - 76.5	31.0 - 51.9	< 31.0

Malaysia : DOE Water Quality Classification Based on Water Quality Index

PARAMETER	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH3-N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69