



BAB  
CHAPTER 1

## KUALITI UDARA / AIR QUALITY



### PENGAWASAN KUALITI UDARA

Pengawasan status kualiti udara dilaksanakan oleh Jabatan Alam Sekitar (JAS) melalui 52 stesen pengawasan kualiti udara yang ditempatkan di seluruh Negara. Stesen-stesen pengawasan kualiti udara tersebut ditempatkan di lokasi yang strategik iaitu di kawasan bandar, sub- bandar dan perindustrian (**Peta 1.1 dan Peta 1.2**) bertujuan untuk mengesan sebarang perubahan ketara ke atas kualiti udara yang mungkin memberi kesan berbahaya kepada kesihatan dan alam sekitar.

Rangkaian Stesen Pengawasan Kualiti Udara Kebangsaan turut dilengkapi stesen pengawasan kualiti udara secara manual yang ditempatkan di 14 kawasan yang berbeza. Pengawasan udara di stesen manual ini melibatkan pengukuran parameter-parameter seperti kumin pepejal, habuk halus bersaiz kurang dari 10 mikron ( $PM_{10}$ ) dan beberapa parameter logam berat termasuk plumbum. Bagi stesen manual

### AIR QUALITY MONITORING

The Department of Environment (DOE) monitors the country's ambient air quality through a network of 52 continuous monitoring stations. These monitoring stations are strategically located in urban, sub urban and industrial areas (**Map 1.1 and Map 1.2**) to detect any significant changes in the air quality which may be detrimental to human health and the environment.

The National Air Quality Monitoring Network is also complemented by manual air quality monitoring stations located at 14 different sites. At these sites, total suspended particulates, particulate matter ( $PM_{10}$ ) and heavy metals such as lead are measured at interval of six (6) days using High Volume Samplers.

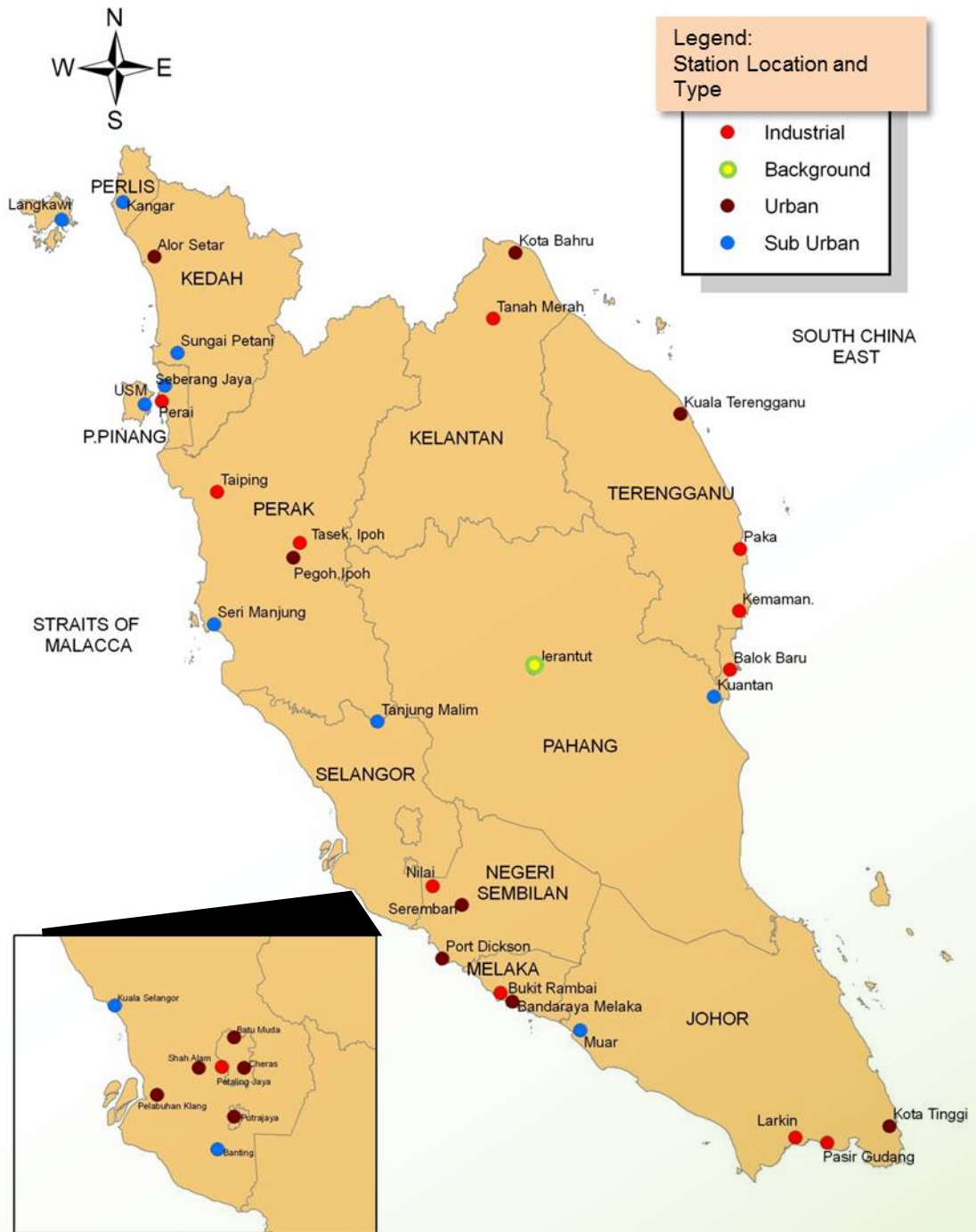
ini, pengukuran dibuat sekali bagi tempoh enam (6) hari dengan menggunakan alat “High Volume Sampler”.

Status kualiti udara dilaporkan dalam bentuk Indeks Pencemar Udara (IPU). IPU dikira berdasarkan kepekatan lima (5) bahan pencemar utama iaitu ozon di permukaan bumi ( $O_3$ ), karbon monoksida (CO), nitrogen dioksida ( $NO_2$ ), sulfur dioksida ( $SO_2$ ) dan kuman pepejal yang kurang dari 10 mikron ( $PM_{10}$ ). IPU ini dikategorikan sebagai baik, sederhana, tidak sihat, sangat tidak sihat dan berbahaya seperti yang dinyatakan dalam **Jadual 1.1**.

The air quality status is reported in terms of Air Pollution Index (API). The API is calculated based on concentration of five (5) major pollutants which are ground level ozone ( $O_3$ ), carbon monoxide (CO), nitrogen dioxide ( $NO_2$ ), sulphur dioxide ( $SO_2$ ) and particulate matter of less than 10 microns in size ( $PM_{10}$ ). The API is categorized as good, moderate, unhealthy, very unhealthy and hazardous as presented in **Table 1.1**.

API / IPU	STATUS KUALITI UDARA / AIR QUALITY STATUS
0 – 50	Baik / Good
51 – 100	Sederhana / Moderate
101 – 200	Tidak Sihat / Unhealthy
201 – 300	Sangat Tidak Sihat / Very Unhealthy
> 300	Berbahaya / Hazardous

**Jadual 1.1 Malaysia : Indeks Kualiti Udara (IPU)**  
**Table 1.1 Malaysia : Air Pollutant Index (API)**



**Peta 1.1 Malaysia: Lokasi Stesen Pengawasan Kualiti Udara Automatik, 2013 di Semenanjung Malaysia**  
**Map 1.1 Malaysia: Location of Continuous Air Quality Monitoring Stations in Peninsular Malaysia, 2013**



Peta 1.2 Malaysia: Lokasi Stesen Pengawasan Kualiti Udara Automatik Di Sabah & Sarawak, 2013

Map 1.2 Malaysia: Location Of Continuous Air Quality Monitoring Stations In Sabah And Sarawak,2013

## STATUS KUALITI UDARA

Malaysia telah mengalami episod jerebu yang singkat pada 15 hingga 27 Jun 2013 yang disebabkan oleh pencemaran merentas sempadan. Kebanyakan kawasan di Semenanjung Malaysia terjejas dan kualiti udara merosot ke tahap yang tidak sihat dan berbahaya. Kawasan yang paling teruk terjejas adalah tiga (3) negeri di Semenanjung Malaysia iaitu Johor, Melaka dan Negeri Sembilan. Semasa episod jerebu, bacaan IPU tertinggi yang dicatatkan adalah di Daerah Muar, Johor iaitu melebihi paras 500. Berikutan itu, pada 23 Jun 2013, YAB Perdana Menteri Malaysia telah mengisytiharkan keadaan Darurat Bencana Jerebu bagi seluruh Daerah Muar dan Daerah Ledang pada 23 Jun 2014. YAB Perdana Menteri pada 24 Jun 2013 telah menarik balik pengisytiharan keadaan Darurat Bencana Jerebu berikutan penurunan bacaan IPU di bawah paras 300 dan jarak penglihatan bertambah baik. Selain daripada episod jerebu ini, tiada kejadian pencemaran udara lain yang teruk berlaku pada tahun 2013.

Selain daripada bahan pencemar  $PM_{10}$ ,  $O_3$  juga merupakan parameter pencemar yang menjadi perhatian yang terhasil akibat keadaan atmosfera dan pelepasan ekzos daripada kenderaan bermotor di bandar-bandar besar. Ini menyebabkan berlakunya beberapa hari yang tidak sihat di beberapa lokasi di Lembah Klang dan di Negeri Perak, Negeri Sembilan, Johor, Kedah dan Pulau Pinang.

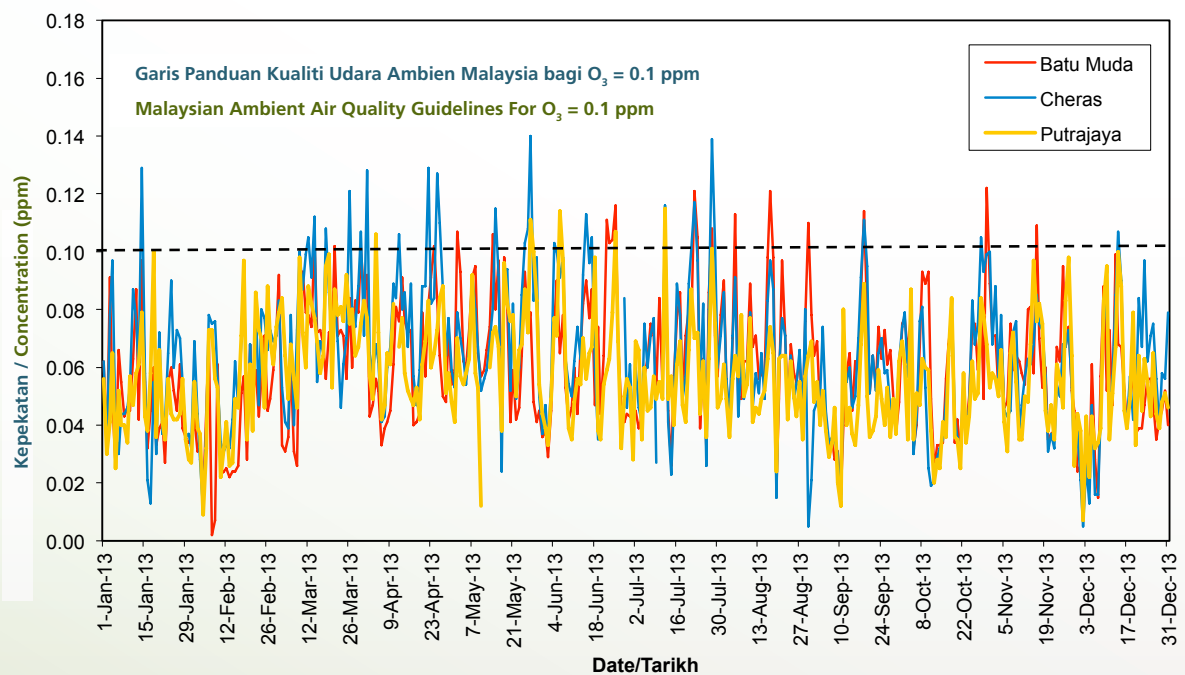
## AIR QUALITY STATUS

From 15 to 27 June 2013, Malaysia had experienced short periods of severe haze episodes due to trans-boundary pollution. Most parts of Peninsular Malaysia were adversely affected when the air quality deteriorated to unhealthy and hazardous levels. The most severely affected areas in Peninsular Malaysia were Johor, Melaka and Negeri Sembilan. During the haze episodes, the highest API readings were recorded in Muar District, Johor, where it exceeded more than 500. Consequently, a haze emergency was declared by the Hon. Prime Minister on 23 June 2013, in Muar and Ledang Districts, Johor, and was subsequently lifted on 24 June 2013, after the API levels in both areas dropped to below 300, further improving visibility. Apart from this haze episode, there were no other serious air pollution incidences in 2013.

Besides  $PM_{10}$ ,  $O_3$  remained the pollutant of concern due to favourable atmospheric conditions and emission from motor vehicles in urban areas. These resulted in several unhealthy days being recorded at various locations in the Klang Valley and in the States of Perak, Negeri Sembilan, Johor, Kedah and Pulau Pinang.

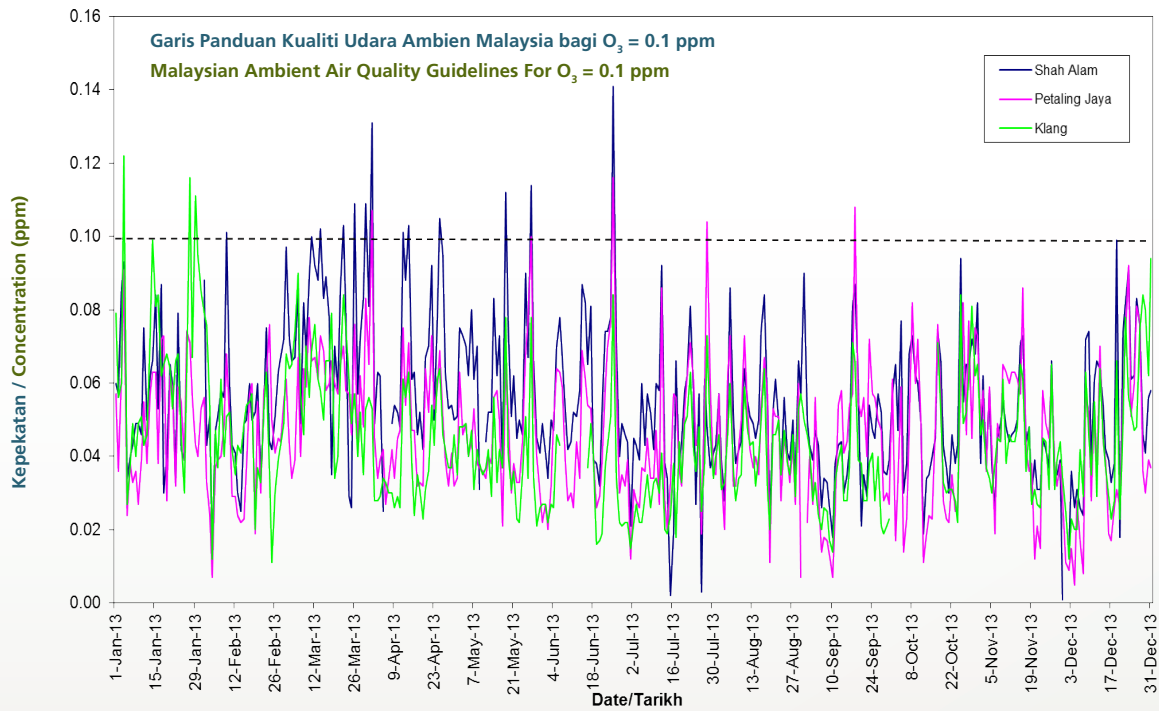
Kadangkala, kepekatan maksimum harian bagi parameter  $O_3$  dalam tempoh 1 jam adalah melebihi Garis Panduan Kualiti Udara Ambien Malaysia terutamanya di beberapa kawasan di Lembah Klang, Perak, Negeri Sembilan dan Kedah seperti yang ditunjukkan dalam **Rajah 1.1 (a)**, **Rajah 1.1 (b)** dan **Rajah 1.1 (c)**. Keadaan ini menyebabkan beberapa hari yang tidak sihat dicatatkan di kawasan-kawasan pusat perniagaan yang tinggi kepadatan trafik.

Occasionally, the daily maximum 1-hour concentration of  $O_3$  exceeded the Malaysian Ambient Air Quality Guidelines in several stations in the Klang Valley, Perak, Negeri Sembilan and Kedah, as shown in **Figure 1.1(a)**, **Figure 1.1(b)** and **Figure 1.1(c)**. These conditions, which created several unhealthy days, affected a few high traffic volume business areas.

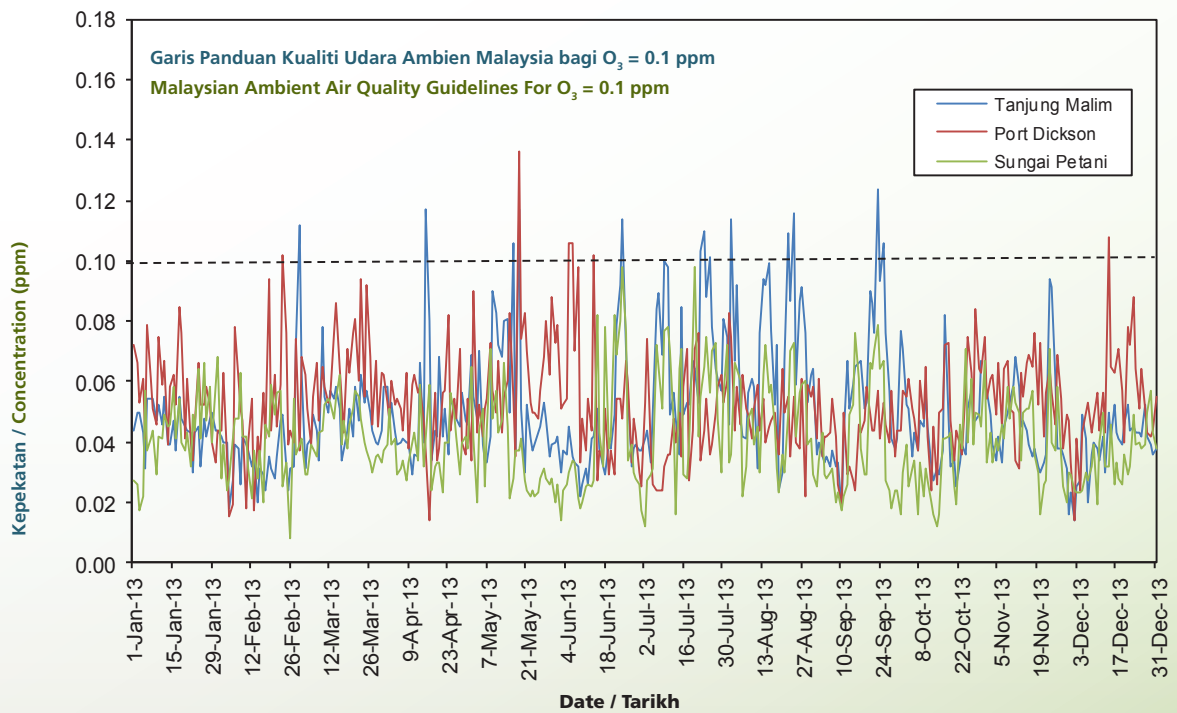


**Rajah 1.1 (a) Malaysia : Tren Kepekatan maksimum Harian Ozon ( $O_3$ ) 1 Jam, Lembah Klang, 2013**

**Figure 1.1 (a) Malaysia: Trend of Daily Maximum 1- hour Concentration of Ozone ( $O_3$ ), Klang Valley 2013**



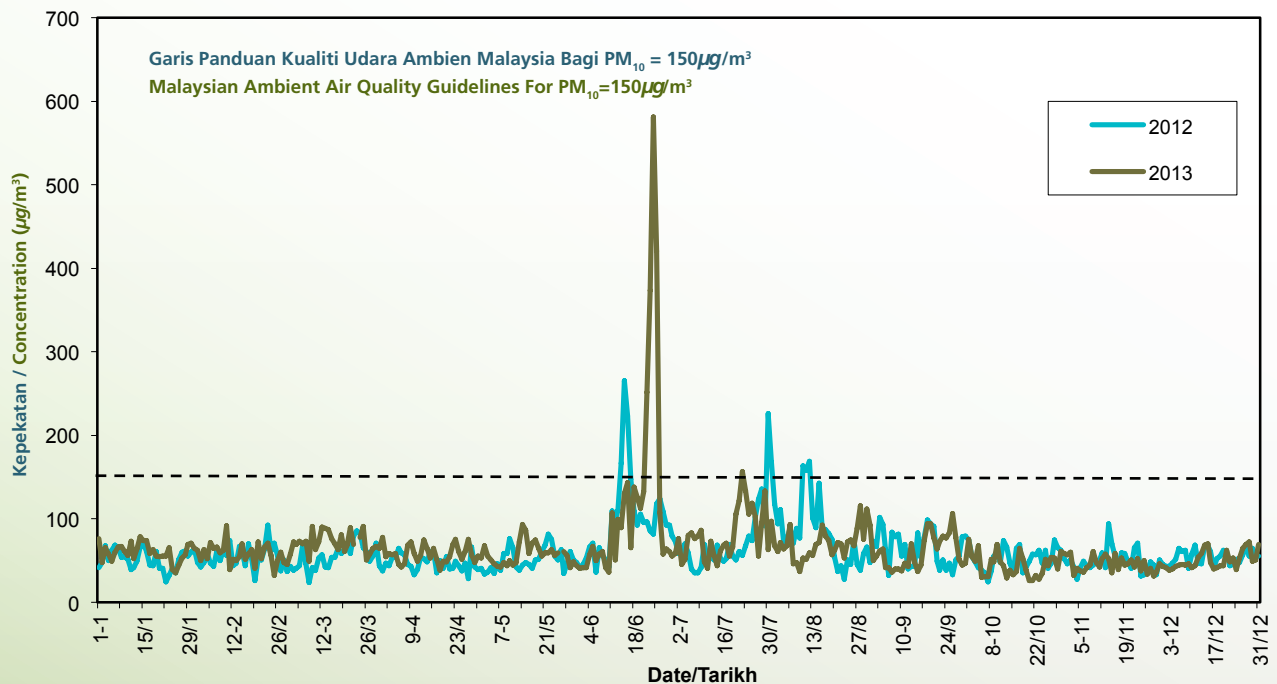
**Rajah 1.1 (b) Malaysia : Tren Kepekatan maksimum Harian Ozon (O<sub>3</sub>) 1 Jam, Lembah Klang, 2013**  
**Figure 1.1 (b) Malaysia: Trend of Daily Maximum 1- hour Concentration of Ozone (O<sub>3</sub>), Klang Valley 2013**



**Figure 1.1 (c) Malaysia : Tren Maksimum Harian Ozon (O<sub>3</sub>) dalam tempoh 1 jam, Tanjung Malim, Port Dickson dan Sungai Petani, 2013**  
**Figure 1.1 (c) Malaysia : Trend of Daily Maximum 1-hour Concentration of Ozone (O<sub>3</sub>), Tanjung Malim, Port Dickson and Sungai Petani, 2013**

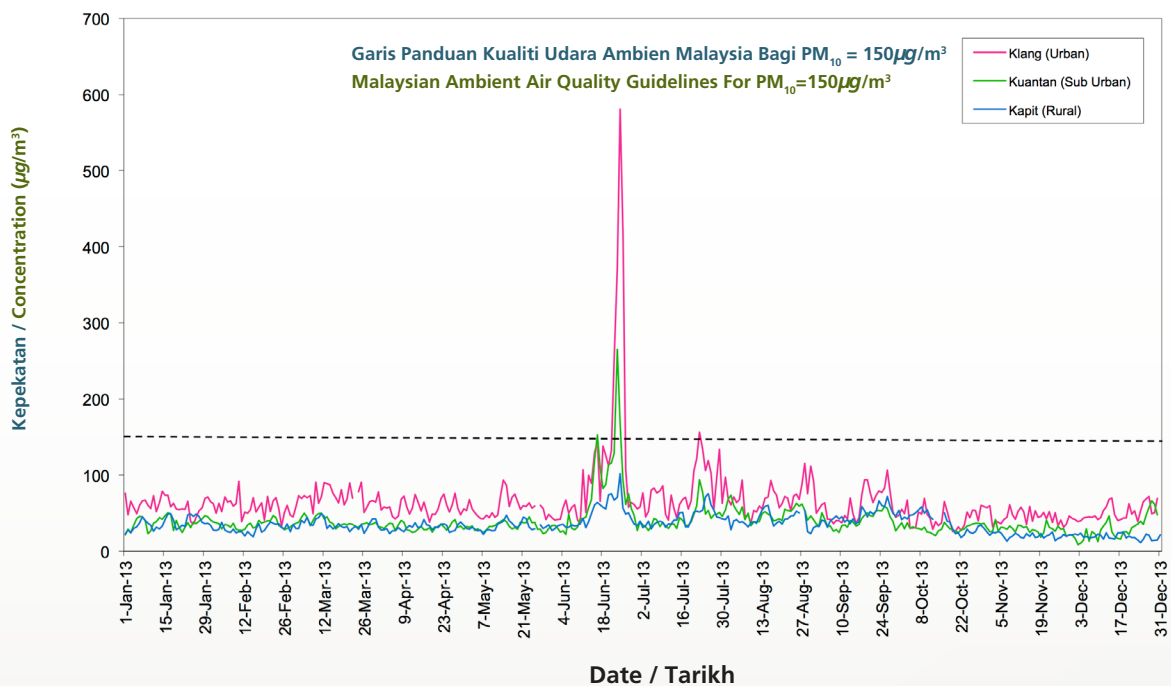
Secara keseluruhan, terdapat sedikit kemerosotan tren kualiti udara di Lembah Klang pada tahun 2013 berbanding tahun 2012 seperti yang ditunjukkan dalam **Rajah 1.1 (d)**.  $PM_{10}$  merupakan pencemar utama yang menyebabkan kualiti udara menjadi tidak sihat berikutan musim panas dan kering yang dialami semasa Monsun Barat Daya. Status kualiti udara tidak sihat di Lembah Klang sepanjang tempoh ini adalah disebabkan oleh pencemaran merentas sempadan. **Rajah 1.1 (e)** menunjukkan kepekatan harian  $PM_{10}$  bagi Klang secara perbandingan dengan beberapa stesen terpilih di kawasan-kawasan sub-bandar dan luar bandar dengan paras  $PM_{10}$  yang lebih rendah. Nilai kepekatan kumin pepejal ( $PM_{10}$ ) di Klang (kawasan bandar) adalah lebih tinggi berbanding dengan kawasan-kawasan sub-bandar dan luar bandar.

Overall, in 2013, there had been a slight deterioration in the trend of air quality in the Klang Valley, as compared to the previous year, as shown in **Figure 1.1(d)**.  $PM_{10}$  was the predominant pollutant that had caused unhealthy conditions during the dry period, as a result of the Southwest Monsoon. The unhealthy days in the Klang Valley during this period was due to trans-boundary pollution. **Figure 1.1(e)** shows the daily concentrations of  $PM_{10}$  for Klang, in comparison with other selected stations in sub-urban and rural areas which recorded lower levels of  $PM_{10}$ . The concentration of particulate matter ( $PM_{10}$ ) in Klang (urban area) was significantly higher compared to other suburban and rural areas.



**Rajah 1.1 (d) : Tren Kepekatan 24 jam bagi Kumin Pepejal ( $PM_{10}$ ), Klang, 2012 dan 2013**

**Figure 1.1 (d) : Trend of 24-hour Concentration of Particulate Matter ( $PM_{10}$ ), Klang, 2012 and 2013**



Rajah 1.1 (e) : Tren Kepekatan 24 jam bagi Kumin Pepejal ( $PM_{10}$ ), Klang, 2012 dan 2013

Figure 1.1 (e) : Trend of 24-hour Concentration of Particulate Matter ( $PM_{10}$ ), Klang, 2012 and 2013

## Status Kualiti Udara di Pantai Barat

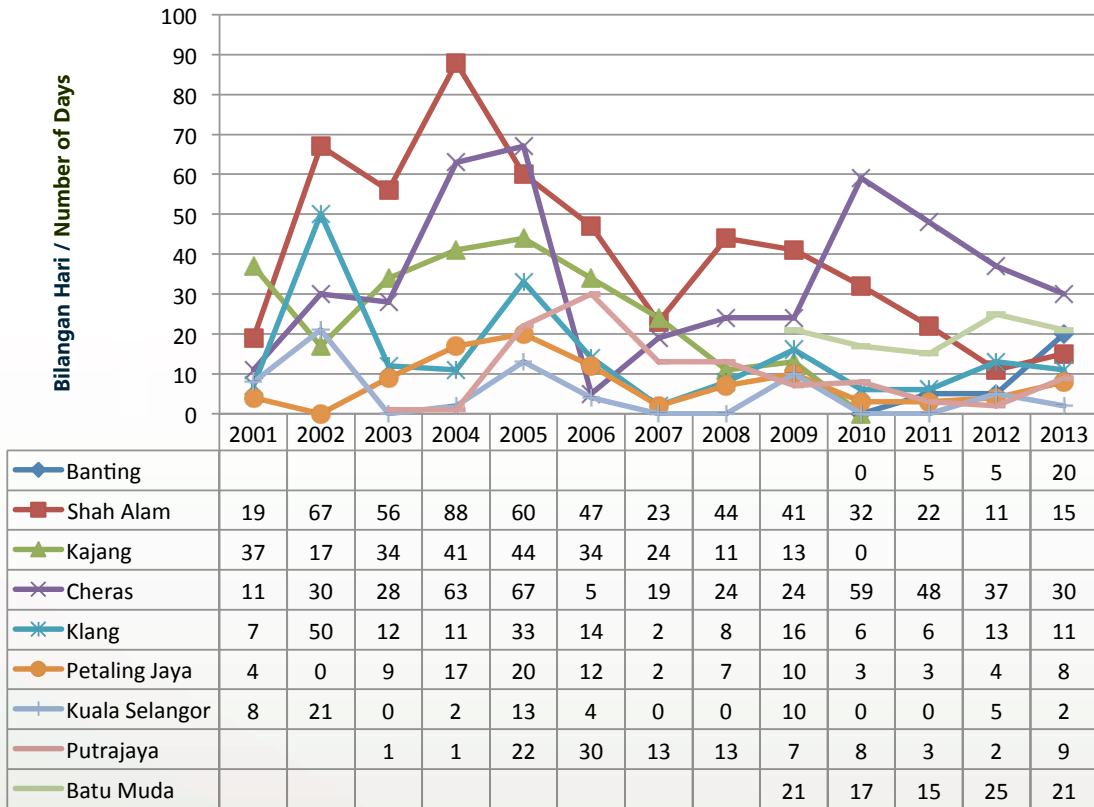
### Lembah Klang

Pada tahun 2013, status kualiti udara di Lembah Klang mencatatkan 67 peratus baik, 28 peratus sederhana dan baki lima (5) peratus tidak sihat. Bilangan hari di mana status kualiti udara mencatatkan paras tidak sihat yang tertinggi adalah di Cheras, Kuala Lumpur (30 hari) (**Rajah 1.1**). Status kualiti udara tidak sihat yang dicatatkan adalah disebabkan oleh ozon di permukaan bumi ( $O_3$ ). Di Klang, status kualiti udara tidak sihat adalah sebahagian besarnya disebabkan oleh kumin pepejal ( $PM_{10}$ ) akibat pencemaran merentas sempadan semasa musim Monsun Barat Daya. Status kualiti udara di Lembah Klang secara keseluruhannya ditunjukkan seperti di **Rajah 1.2**.

## Air Quality Status in the West Coast

### Klang Valley

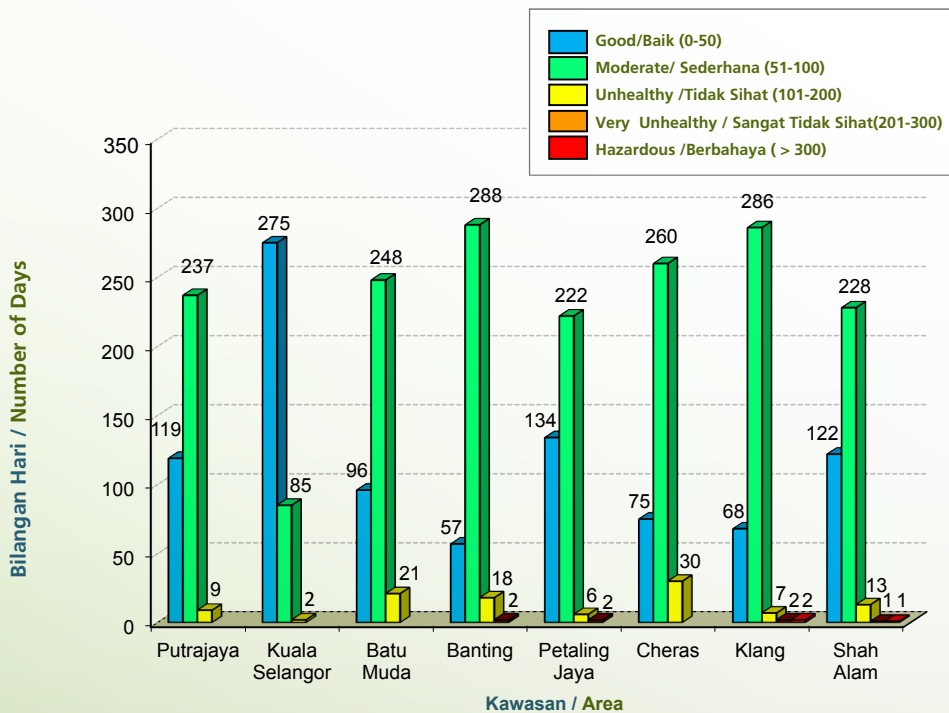
In 2013, the air quality in the Klang Valley was good for about 67 percent of the time, was moderate for about 28 percent of the time and the remaining five (5) percent recorded unhealthy levels. The highest number of unhealthy days was recorded in Cheras, Kuala Lumpur (30 days) (**Figure 1.1**). The unhealthy days recorded were due to ground level ozone ( $O_3$ ). In the Klang area, the unhealthy days were caused by particulate matter ( $PM_{10}$ ) mainly from trans-boundary pollution during the Southwest Monsoon. The overall air quality status in the Klang Valley is as shown in **Figure 1.2**.



Rajah 1.1 Malaysia : Bilangan Hari Tidak Sihat, Lembah Klang, 2001-2013

Figure 1.1 Malaysia : Number of Unhealthy Days, Klang Valley, 2001 - 2013

Nota: Bacaan adalah berdasarkan IPU Maksimum Harian  
 Note: Reading based on daily Maximum API



Rajah 1.2 Malaysia : Lembah Klang, Status Kualiti Udara, 2013

Figure 1.2 Malaysia : Klang Valley Air Quality Status, 2013

Nota: Bacaan adalah berdasarkan IPU Maksimum Harian  
 Note: Reading based on daily Maximum API

## Wilayah Utara

Secara keseluruhan, status kualiti udara di utara Pantai Barat Semenanjung Malaysia yang meliputi Negeri Perlis, Kedah, Negeri Pulau Pinang dan Perak adalah baik dan sederhana sepanjang masa. Walau bagaimanapun, Manjung mencatatkan satu (1) hari status kualiti udara berbahaya dan lima (5) hari status kualiti udara tidak sihat, Tanjung Malim mencatatkan 16 hari status kualiti udara tidak sihat, Taiping mencatatkan tiga (3) hari status kualiti udara tidak sihat, Sungai Petani mencatatkan satu (1) hari status kualiti udara tidak sihat, USM dan Perai masing-masing mencatatkan dua (2) hari status kualiti udara tidak sihat dan di Seberang Jaya, Tasek serta Ipoh mencatatkan empat (4) hari status kualiti udara tidak sihat. Pencemar-pencemar utama adalah ozon di permukaan bumi ( $O_3$ ) dan  $PM_{10}$ . **Rajah 1.3** menunjukkan status kualiti udara keseluruhan bagi wilayah utara di Pantai Barat Semenanjung Malaysia.

## Wilayah Selatan

Kualiti udara di wilayah selatan Pantai Barat Semenanjung Malaysia (Negeri Sembilan, Melaka dan Johor) adalah baik dan sederhana pada kebanyakan masa, kecuali terdapat beberapa hari yang mencatatkan status kualiti udara berbahaya iaitu di Bukit Rambai empat (4), Melaka dua (2), Muar dua (2), Pasir Gudang dua (2) dan Kota Tinggi dua (2), manakala hari yang sangat tidak sihat dicatatkan di Melaka dua (2), Muar dua (2), Pasir Gudang satu (1) dan Larkin dua (2).

## Northern Region

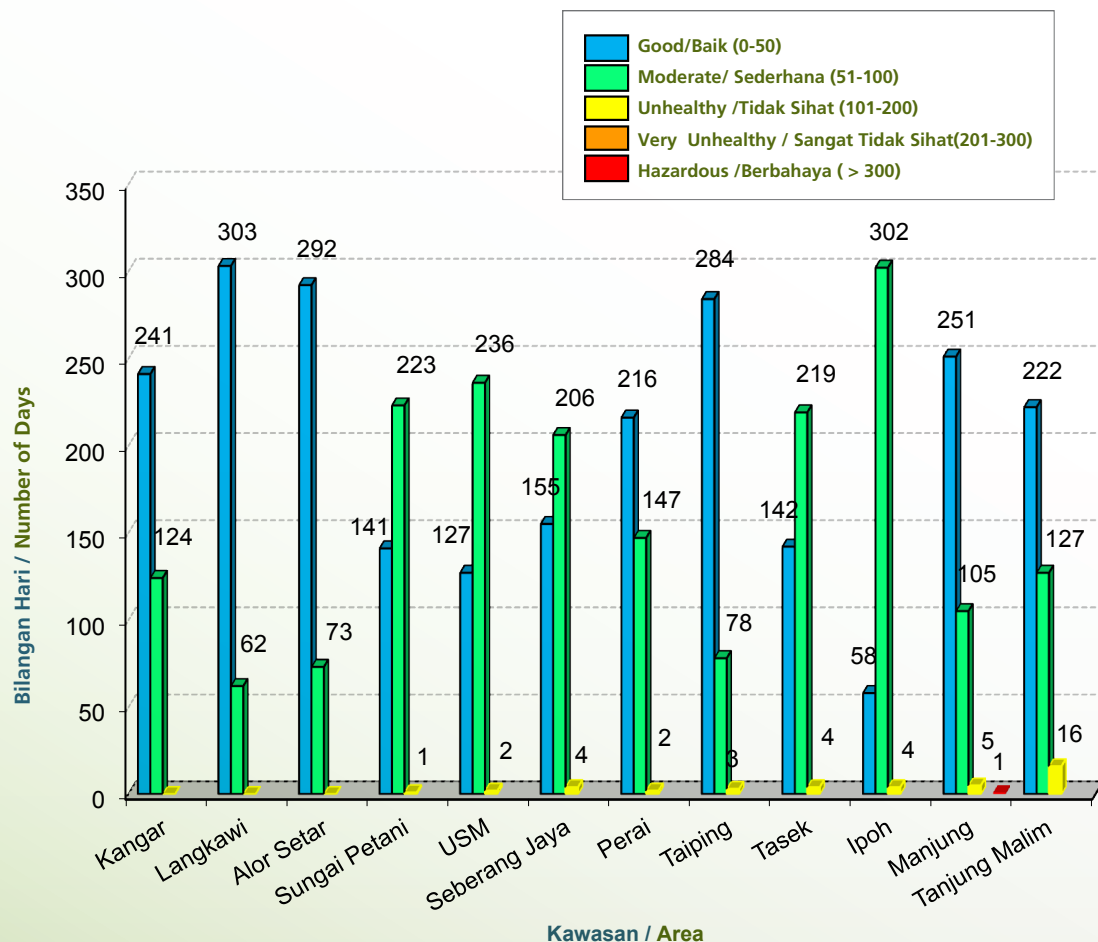
The overall air quality of the northern region, of the West Coast of Peninsular Malaysia, covering Perlis, Kedah, Pulau Pinang and Perak, were between moderate to good most of the time. However, Manjung recorded one (1) hazardous day and five (5) unhealthy days, Tanjung Malim recorded 16 unhealthy days, Taiping recorded three (3) unhealthy days, Sungai Petani recorded one (1) unhealthy day, USM and Perai recorded two (2) unhealthy days, whereas four (4) unhealthy days were recorded at Seberang Jaya, Tasek and Ipoh, respectively. The main pollutants were ground level ozone ( $O_3$ ) and  $PM_{10}$ . **Figure 1.3** indicates the overall air quality status for the northern region of the West Coast of Peninsular Malaysia.

## Southern Region

In the southern region of the West Coast of Peninsular Malaysia (Negeri Sembilan, Melaka and Johor), the air quality hovered between moderate to good most of the time, with the exception of a few hazardous days in Bukit Rambai (4 days), Melaka (2 days), Muar (2 days), Pasir Gudang (2 days) and Kota Tinggi (2 days). Very unhealthy days were recorded in Melaka (2 days), Muar (2 days), Pasir Gudang (1 day) and Larkin (2 days). Apart from that, unhealthy days were

Selain daripada itu, terdapat juga hari yang mencatatkan status kualiti udara tidak sihat iaitu di Nilai sembilan (9), Seremban (18), Port Dickson (11), Bukit Rambai (15), Melaka sembilan (9), Muar lapan (8), Pasir Gudang lapan (8), Larkin tujuh (7), dan Kota Tinggi sembilan (9). Terdapat sedikit kemerosotan kualiti udara bagi wilayah selatan dengan sedikit peningkatan dari segi jumlah hari yang tidak sihat berbanding tahun 2012. Ini disebabkan oleh pencemar  $PM_{10}$  daripada pencemaran merentas sempadan. **Rajah 1.4** menunjukkan status kualiti udara secara keseluruhan bagi wilayah selatan di Pantai Barat Semenanjung Malaysia.

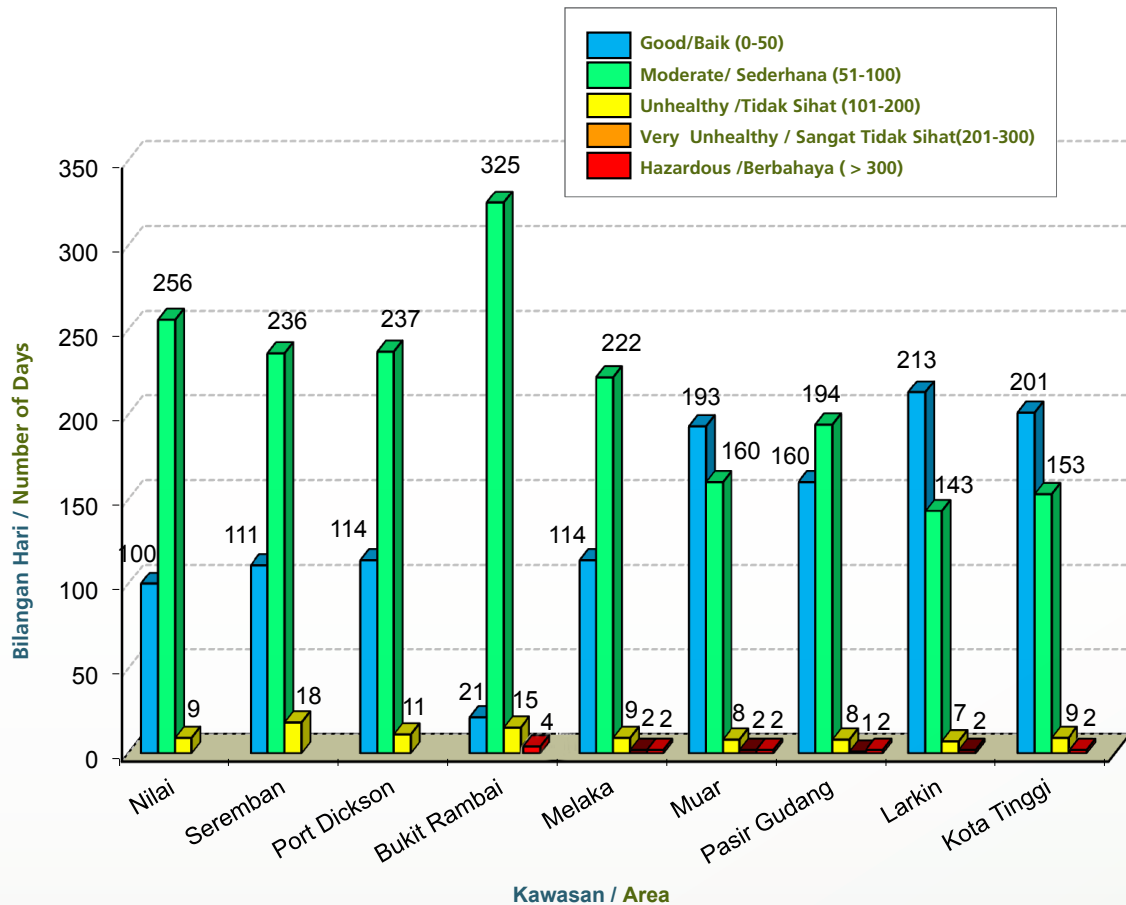
also recorded in Nilai (9 days), Seremban (18 days), Port Dickson (11 days), Bukit Rambai (15 days), Melaka (9 days), Muar (8 days), Pasir Gudang (8 days), Larkin (7 days), and Kota Tinggi (9 days). A slight deterioration was seen in the overall air quality for the southern region with a slight increase in the number of unhealthy days compared to 2012. This is due to high levels of  $PM_{10}$  caused by trans-boundary pollution. **Figure 1.4** shows the overall air quality status for southern region of the West Coast of Peninsular Malaysia.



**Rajah 1.3 Malaysia : Status Kualiti Udara, Wilayah Utara Pantai Barat Semenanjung Malaysia, 2013**

**Figure 1.3 Malaysia : Air Quality Status, Northern Region of The West Coast Peninsular Malaysia, 2013**

*Nota: Bacaan adalah berdasarkan IPU Maksimum Harian*  
*Note: Reading based on daily Maximum API*



Rajah 1.4 Malaysia : Status Kualiti Udara, Wilayah Selatan Pantai Barat Semenanjung Malaysia, 2013

Figure 1.4 Malaysia : Air Quality Status, Southern Region of The West Coast Peninsular Malaysia, 2013

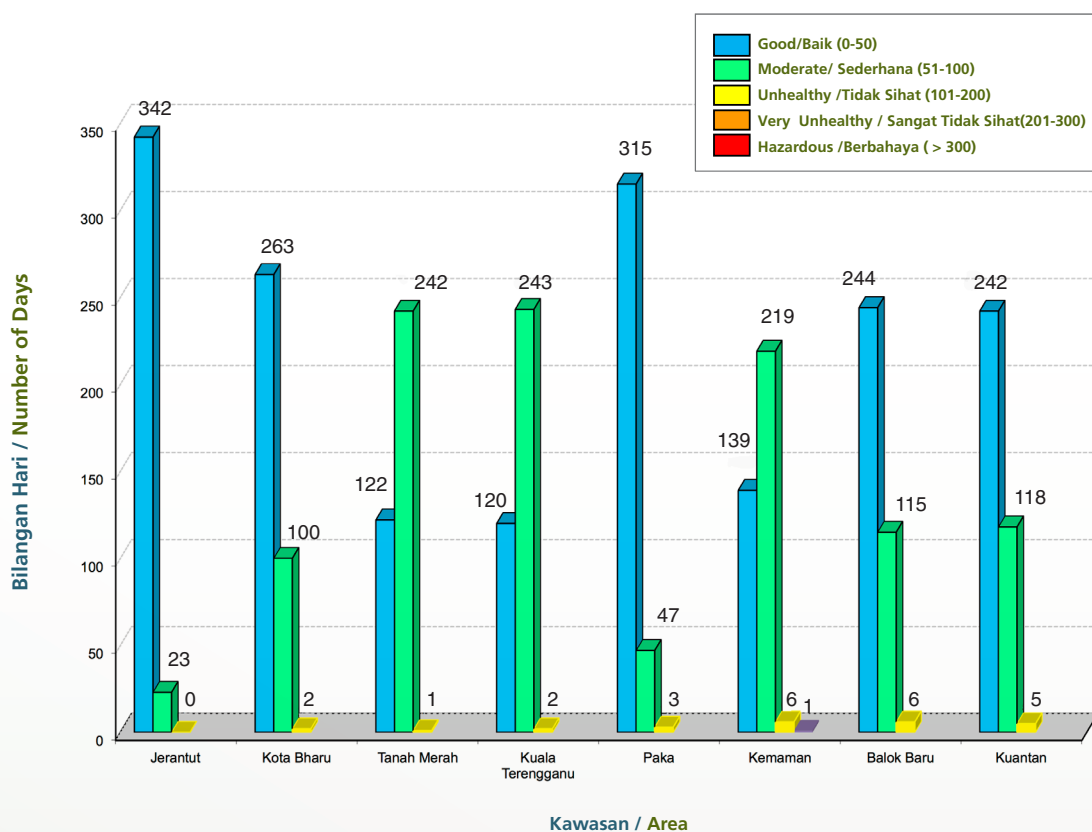
*Nota: Bacaan adalah berdasarkan IPU Maksimum Harian*  
*Note: Reading based on daily Maximum API*

### Status Kualiti Udara di Pantai Timur

Kualiti udara di Pantai Timur Semenanjung Malaysia (Pahang, Terengganu, Kelantan dan timur Johor) kekal berstatus baik dan sederhana pada kebanyakan masa, kecuali terdapat beberapa hari yang mencatatkan status kualiti udara tidak sihat semasa musim kering iaitu pada bulan Jun hingga September iaitu di Jerantut (18), Kota Bharu dua (2), Tanah Merah satu (1), Kuala Terengganu dua (2), Paka tiga (3), Kemaman enam (6), Balok Baru enam (6) dan Kuantan lima (5). Kemaman, Terengganu mencatatkan satu (1) hari status kualiti udara berbahaya iaitu

### Air Quality Status in the East Coast

In the East Coast of Peninsular Malaysia (Pahang, Terengganu, Kelantan and East Johor), the air quality remained between moderate to good most of the time, with the exception of a few unhealthy days during the dry period, from June to September. The readings shown were Jerantut (18 days), Kota Bharu (2 days), Tanah Merah (1 day), Kuala Terengganu (2 days), Paka (3 days), Kemaman (6 days), Balok Baru (6 days) and Kuantan (5 days). One (1) hazardous day was also recorded in Kemaman, Terengganu, in June 2013. The overall air quality status in



Rajah 1.5 Malaysia : Status Kualiti Udara, Pantai Timur Semenanjung Malaysia, 2013

Figure 1.5 Malaysia : Air Quality Status, East Coast Peninsular Malaysia, 2013

*Nota: Bacaan adalah berdasarkan IPU Maksimum Harian*  
*Note: Reading based on daily Maximum API*

pada bulan Jun 2013. Status kualiti udara di Pantai Timur Semenanjung Malaysia secara keseluruhan adalah seperti di **Rajah 1.5**

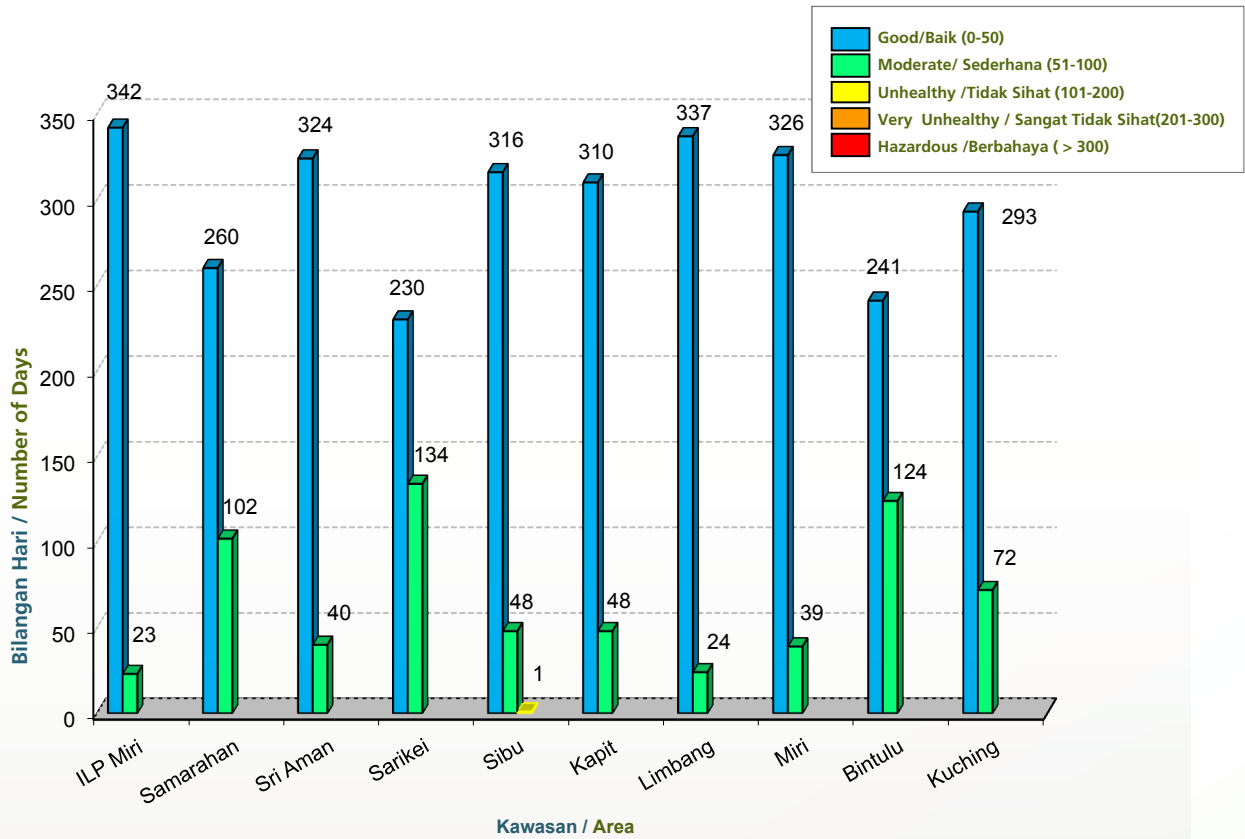
### Status Kualiti Udara di Sabah, Labuan Sarawak Sarawak

Kualiti udara di Sabah, Labuan dan Sarawak kekal berstatus baik dan sederhana di kebanyakan masa. Hanya Sibu, Sarawak dan Keningau, Sabah masing-masing merekodkan satu (1) hari status kualiti udara tidak sihat. Status kualiti udara di Sarawak secara keseluruhan ditunjukkan dalam **Rajah 1.6** dan di Sabah dan Labuan ditunjukkan dalam **Rajah 1.7**.

the East Coast of Peninsular Malaysia is as shown in **Figure 1.5**.

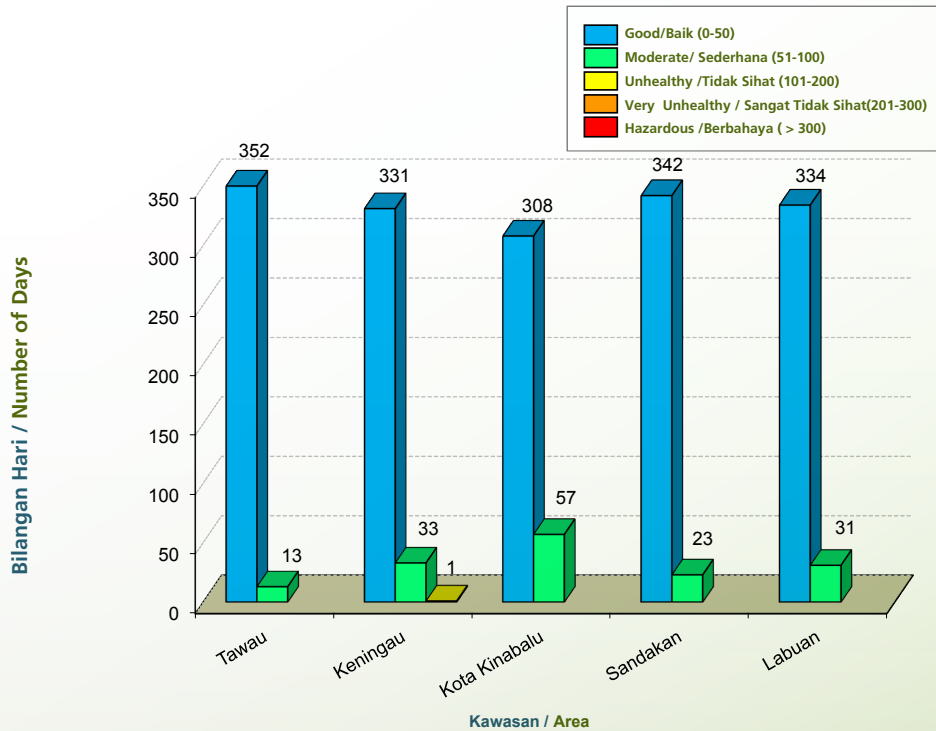
### Air Quality Status in Sabah, Labuan and Sarawak

The air quality in Sabah, Labuan and Sarawak remained between moderate to good most of the time. Only Sibu, Sarawak, and Keningau, Sabah, recorded one (1) unhealthy day, respectively. The overall air quality status in Sarawak is as shown in **Figure 1.6** while **Figure 1.7** shows the overall air quality in Sabah and Labuan.



Rajah 1.6 Malaysia : Status Kualiti Udara, Sarawak, 2013  
 Figure 1.6 Malaysia : Air Quality Status, Sarawak, 2013

Nota: Bacaan adalah berdasarkan IPU Maksimum Harian  
 Note: Reading based on daily Maximum API



Rajah 1.7 Malaysia : Status Kualiti Udara, Sabah dan Labuan, 2013  
 Figure 1.7 Malaysia : Air Quality Status, Sabah and Labuan, 2013

Nota: Bacaan adalah berdasarkan IPU Maksimum Harian  
 Note: Reading based on daily Maximum API

## TREN KUALITI UDARA

Lima (5) pencemar udara iaitu kumin pepejal ( $PM_{10}$ ), ozon permukaan bumi ( $O_3$ ), sulfur dioksida ( $SO_2$ ), nitrogen dioksida ( $NO_2$ ) dan karbon monoksida (CO) dipantau secara berterusan di 52 buah lokasi. Tren kualiti udara dari tahun 1999 hingga 2013 ditentukan dengan mengambil kira purata data kualiti udara tahunan daripada stesen-stesen pengawasan dan merujuk kepada Garis Panduan Kualiti Udara Ambien Malaysia seperti yang ditunjukkan dalam **Jadual 1.2**.

## AIR QUALITY TREND

Five (5) air pollutants consisting of particulate matter ( $PM_{10}$ ), ozone ( $O_3$ ), sulphur dioxide ( $SO_2$ ), nitrogen dioxide ( $NO_2$ ) and carbon monoxide (CO) were monitored continuously at 52 locations. The air quality trend for the period of 1999 to 2013 was computed by taking the yearly average measurement from the monitoring sites and cross-referencing with Malaysia Ambient Air Quality Guidelines as shown in **Table 1.2**.

Bahan Pencemar / Pollutant	Masa Purata / Averaging Time	Garis Panduan Malaysia / Malaysia Guidelines	
		ppm	( $\mu\text{g}/\text{m}^3$ )
Ozon / Ozone	1 Hour	0.10	200
	8 Hours	0.06	120
Karbon Monoksida / Carbon Monoxide	1 Hour	30.0	35**
	8 Hours	9.0	10**
Nitrogen Dioksida / Nitrogen Dioxide	1 Hour	0.17	320
	24 hours	0.04	
Sulfur Dioksida / Sulphur Dioxide	1 hour	0.13	350
	24 Hours	0.04	105
Pepejal Terampai ( $PM_{10}$ ) / Particulate Matter ( $PM_{10}$ )	24 Hours		150
	12 Months		50
Jumlah Pepejal Terampai / Total Suspended Particulate (TSP)	24 Hours		260
	12 Months		90
Plumbum / Lead	3 Months		1.5

**Jadual 1.2 Malaysia : Garis Panduan Kualiti Udara Ambien Malaysia**

**Table 1.2 Malaysia : Ambient Air Quality Guidelines**

Nota / Note: \*\*  $\text{mg}/\text{m}^3$

### Kumin Pepejal (PM<sub>10</sub>)

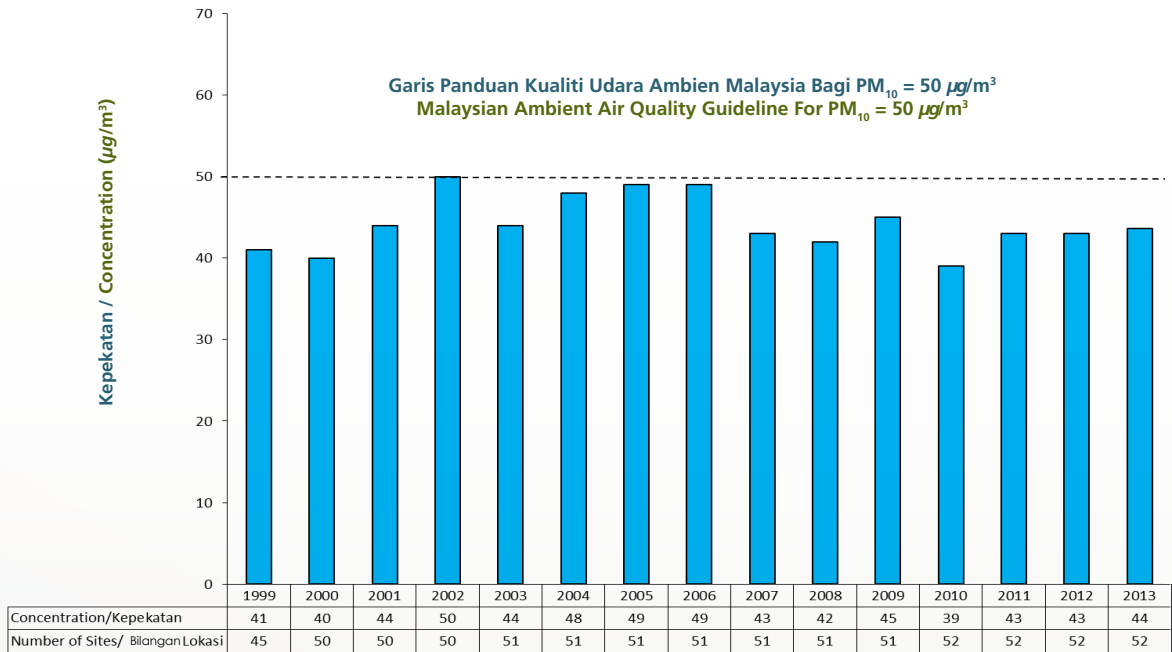
Pada tahun 2013, nilai purata tahunan PM<sub>10</sub> dalam udara ambien adalah 44 µg/m<sup>3</sup> iaitu di bawah had yang ditetapkan dalam Garis Panduan Kualiti Udara Ambien Malaysia iaitu sebanyak 50 µg/m<sup>3</sup>. Kepekatan PM<sub>10</sub> bagi tahun 2013 menunjukkan sedikit peningkatan iaitu sebanyak dua (2) peratus berbanding tahun 2012. Kejadian kebakaran tanah gambut dalam negara dan jerebu merentas sempadan telah menyumbang kepada bacaan PM<sub>10</sub> yang tinggi dicatatkan di beberapa kawasan di Johor, Melaka dan Negeri Sembilan dari bulan Jun hingga September 2013.

Tren purata tahunan kepekatan PM<sub>10</sub> dalam udara ambien antara tahun 1999 hingga 2013 didapati mematuhi Garis Panduan Kualiti Udara Ambien Malaysia seperti yang ditunjukkan dalam **Rajah 1.8**. Berdasarkan kategori guna tanah, nilai kepekatan PM<sub>10</sub> adalah mematuhi Garis Panduan Kualiti Udara Ambien Malaysia seperti yang ditunjukkan dalam **Rajah 1.8 (a)**.

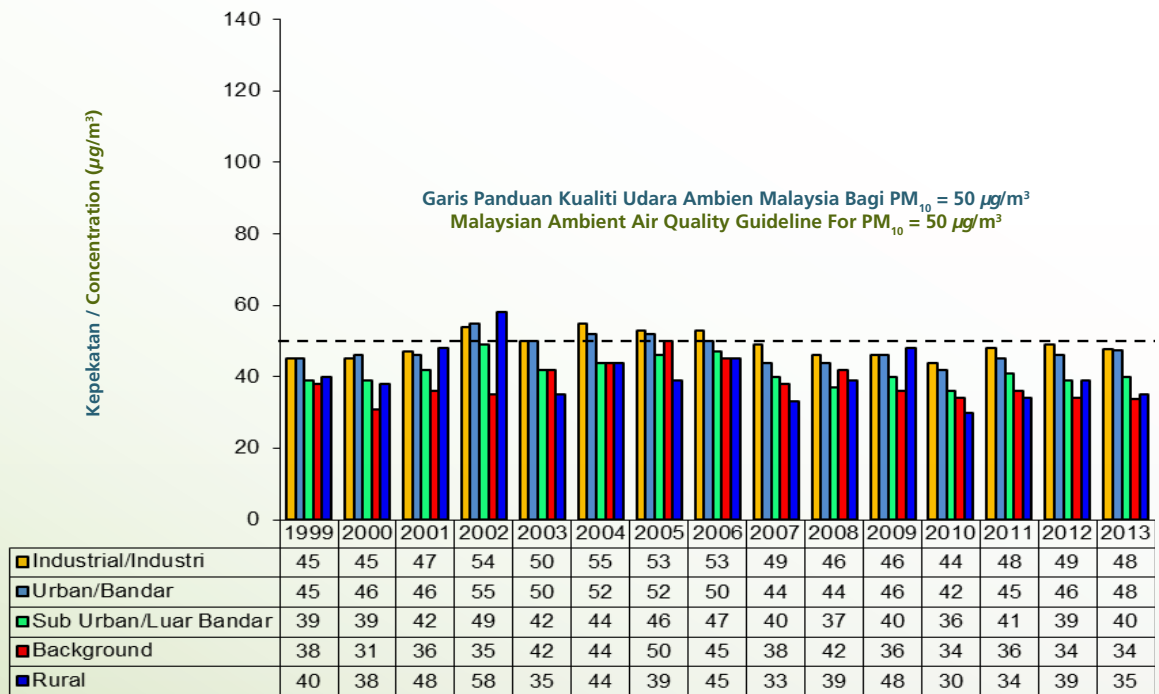
### Particulate Matter (PM<sub>10</sub>)

In 2013, the annual average value of PM<sub>10</sub> in the ambient air was 44 µg/m<sup>3</sup>, which is below the Malaysian Ambient Air Quality Guidelines value of 50 µg/m<sup>3</sup>. The concentrations for 2013 increased slightly by two (2) percent compared to 2012. Incidences of local peat land fires and trans-boundary smoke haze had contributed to the higher PM<sub>10</sub> recorded intermittently in several areas in Johor, Melaka and Negeri Sembilan from June to September 2013.

The trend of the annual average levels of PM<sub>10</sub> concentration in the ambient air between 1999 and 2013 is in accordance with the Malaysian Ambient Air Quality Guidelines as shown in **Figure 1.8**. Based on land use categories, PM<sub>10</sub> concentration was in compliance with the Malaysian Ambient Air Quality Guidelines as shown in **Figure 1.8(a)**.



**Rajah 1.8 Malaysia: Purata Kepekatan Tahunan Kumin Pepejal (PM<sub>10</sub>) 1999 -2013**  
**Figure 1.8 Malaysia: Annual Average Concentration of Particulate Matter (PM<sub>10</sub>) 1999 -2013**



**Rajah 1.8(a) Malaysia: Purata Kepekatan Tahunan Kumin Pepejal (PM<sub>10</sub>) Mengikut Guna Tanah, 1999 - 2013**  
**Figure 1.8(a) Malaysia: Annual Average Concentration of Particulate Matter (PM<sub>10</sub>) by Land Use, 1999 - 2013**

### Ozon Permukaan Bumi (O<sub>3</sub>)

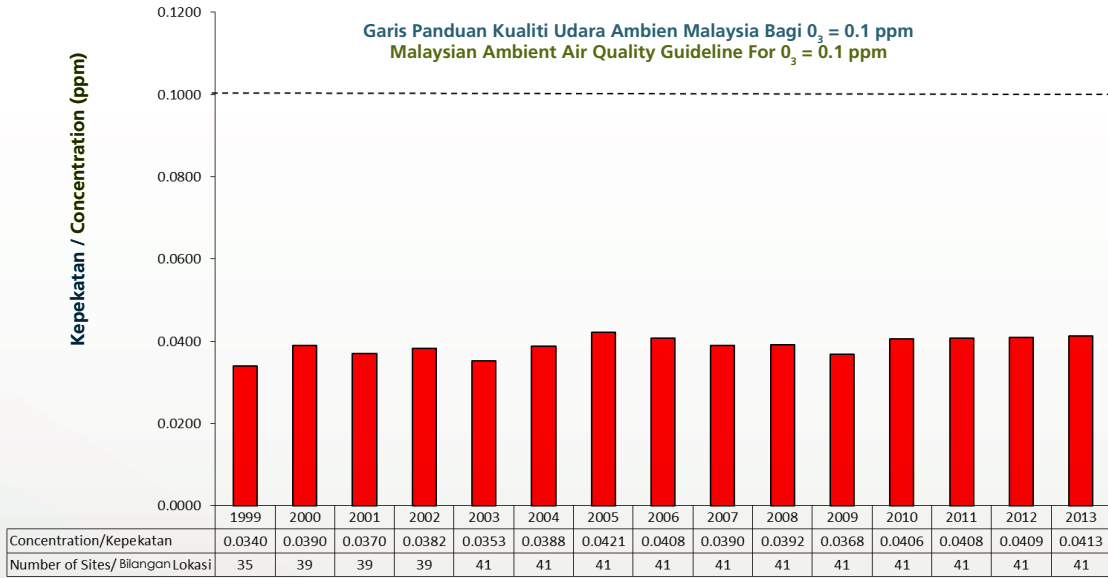
Pada tahun 2013, purata tahunan kepekatan maksimum harian ozon adalah meningkat sebanyak dua(2) peratus berbanding tahun 2012. Walau bagaimanapun, tren keseluruhan purata tahunan kepekatan maksimum ozon dalam udara ambien dari tahun 1999 hingga 2013 adalah mematuhi had sebanyak 0.1 ppm seperti yang ditetapkan dalam Garis Panduan Kualiti Udara Ambien Malaysia dan tren tersebut adalah seperti yang ditunjukkan dalam **Rajah 1.9**.

**Rajah 1.9(a)** menunjukkan kepekatan ozon untuk pelbagai kategori guna tanah dari tahun 1999 hingga 2013. Kawasan bandar mencatatkan bacaan ozon lebih tinggi disebabkan oleh jumlah trafik yang lebih tinggi dan keadaan atmosfera yang kondusif menyebabkan pembentukan ozon. Pencemaran ozon juga ketara di beberapa kawasan bandar dan sub-bandar disebabkan oleh pergerakan angin yang membawa pencemar ozon yang terhasil daripada tindakbalas oksid-oksida nitrogen (NO<sub>x</sub>) dan sebatian organik meruap (VOC) daripada kenderaan bermotor dan industri.

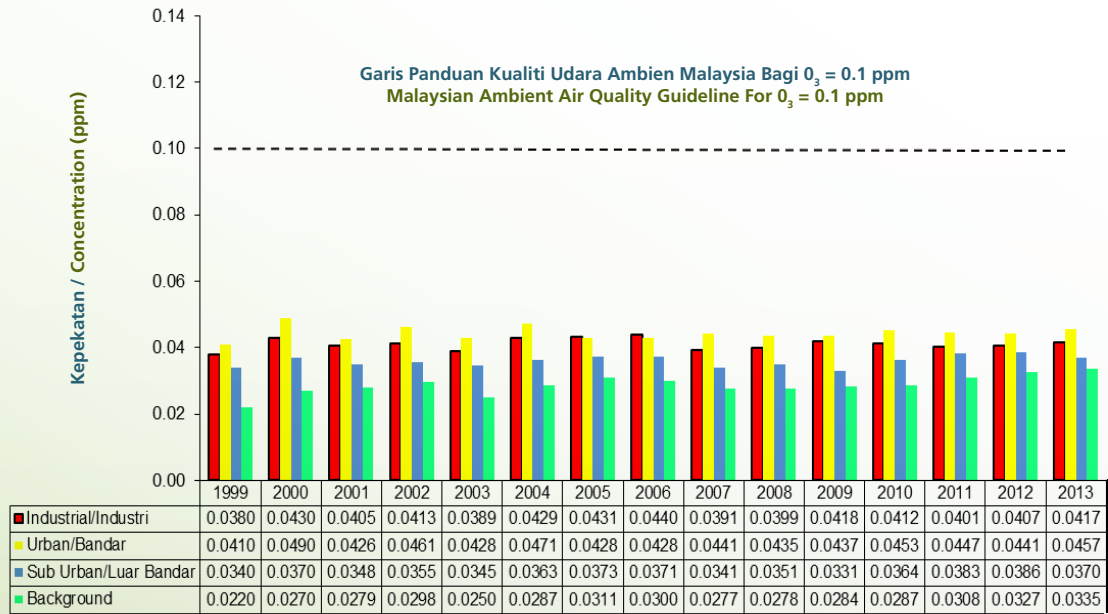
### Ground Level Ozone (O<sub>3</sub>)

In 2013, the annual average daily maximum one-hour ozone concentrations increased slightly by two (2) percent compared to 2012. However, the overall trend on the annual average daily maximum one-hour ozone concentrations in ambient air from 1999 to 2013 were well below the limit of 0.1 ppm as stipulated in the Malaysian Ambient Quality Guidelines and the trend is as shown in **Figure 1.9**.

**Figure 1.9(a)** shows the ozone concentration for various land use categories between 1999 and 2013. Urban areas recorded higher levels of ozone due to higher traffic volume and conducive atmospheric conditions, resulting in its formation. Ozone pollution was also dominant in some rural and sub urban areas due to downwind effect transporting ozone pollution from the sources of ozone precursors namely nitrogen oxides (NO<sub>x</sub>) and volatile organic compound (VOC) emitted from motor vehicles and industries.



**Rajah 1.9 Malaysia: Purata Kepekatan Tahunan Ozon (O<sub>3</sub>)1999 -2013**  
**Figure 1.9 Malaysia: Annual Average Concentration of Ozone (O<sub>3</sub>)1999 -2013**



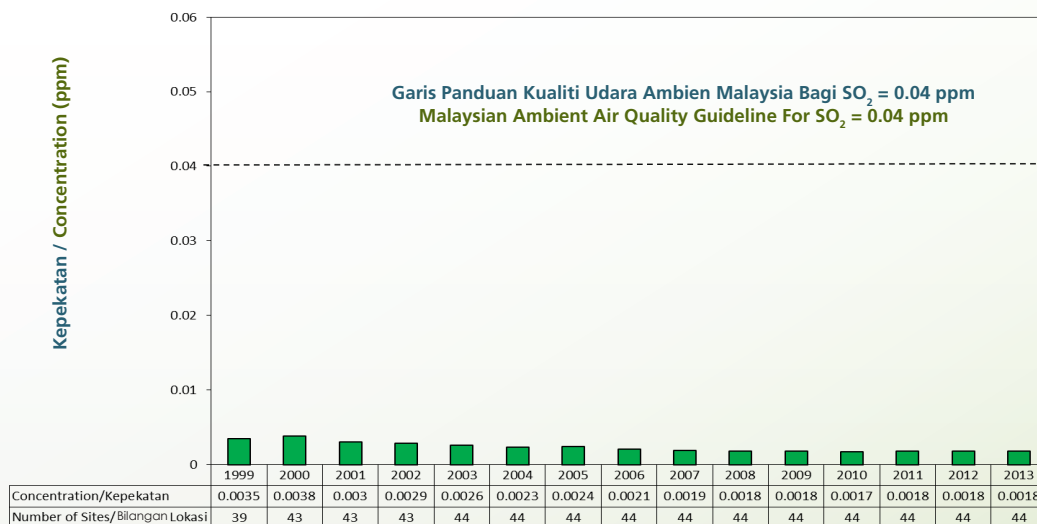
**Rajah 1.9(a) Malaysia: Purata Kepekatan Tahunan Ozon (O<sub>3</sub>)1999 -2013**  
**Figure 1.9(a) Malaysia: Annual Average Concentration of Ozone (O<sub>3</sub>)1999 -2013**

## Sulfur Dioksida (SO<sub>2</sub>)

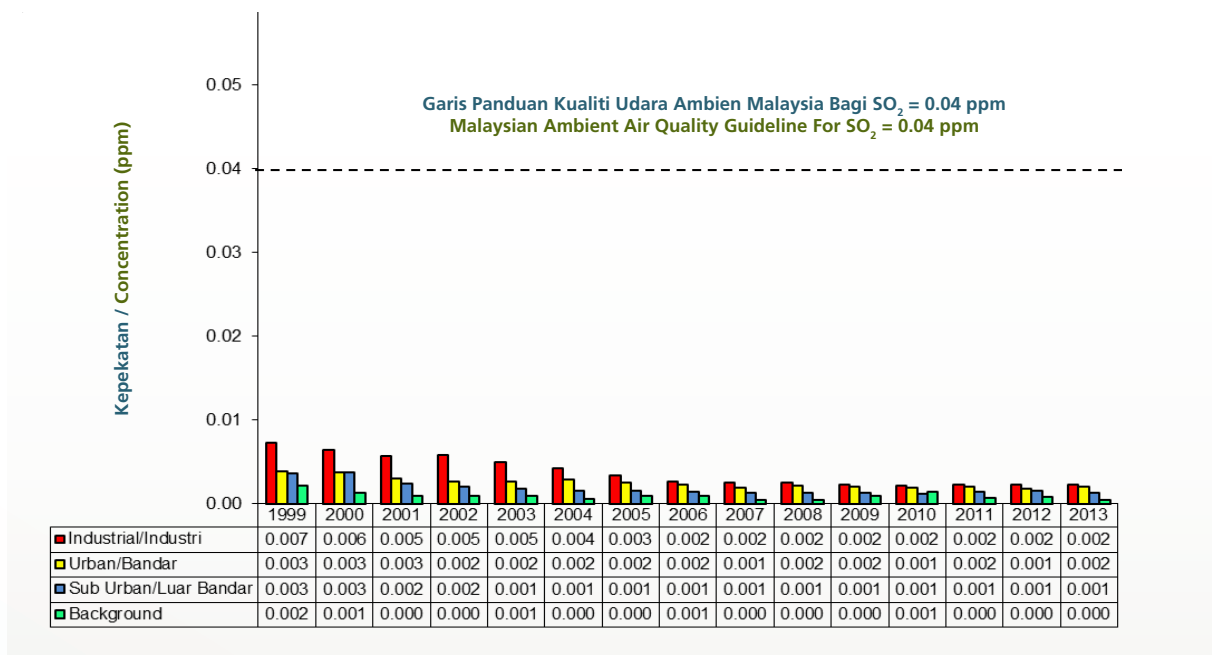
Secara umumnya, purata kepekatan tahunan SO<sub>2</sub> menunjukkan tren penurunan dari tahun 1999 hingga 2013 (**Rajah 1.10**) dan ia adalah jauh di bawah had sebanyak 0.04 ppm seperti yang ditetapkan dalam Garis Panduan Kualiti Udara Ambien Malaysia. Ini adalah disebabkan oleh penggunaan bahan api berkualiti EURO-2M yang lebih baik di negara ini bermula dari bulan September 2009 dan penguatkuasaan yang lebih ketat oleh JAS serta penggunaan gas asli secara meluas dalam proses industri dan kegunaan kenderaan. **Rajah 1.10 (a)** menunjukkan kepekatan purata tahunan bagi sulfur dioksida mengikut kategori guna tanah.

## Sulphur Dioxide (SO<sub>2</sub>)

Generally, the annual average SO<sub>2</sub> concentration shows a declining trend between 1999 and 2013 (**Figure 1.10**) and it is well below the limit of 0.04 ppm as stipulated in the Malaysian Ambient Air Quality Guidelines. This was attributed by the use of better fuel quality EURO-2M in this country starting from September 2009 and also stricter enforcement by DOE as well as the wide use of natural gas for industrial combustion process and vehicles. **Figure 1.10(a)** shows the annual average concentrations of sulphur dioxide coming from different categories of land use.



**Rajah 1.10 Malaysia: Purata Kepekatan Tahunan Sulfur Dioksida (SO<sub>2</sub>), 1999 - 2013**  
**Figure 1.10 Malaysia: Annual Average Concentration of Sulphur Dioxide (SO<sub>2</sub>), 1999 - 2013**



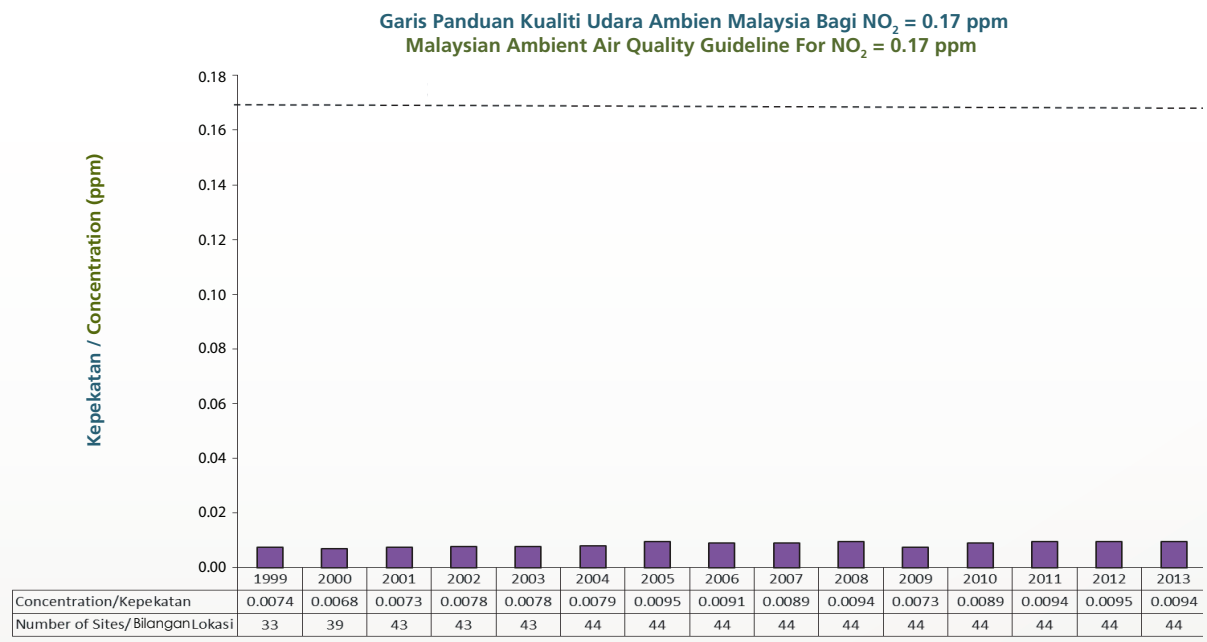
**Rajah 1.10(a) Malaysia: Purata Kepekatan Tahunan Sulfur Dioksida Mengikut Guna Tanah (SO<sub>2</sub>), 1999 - 2013**  
**Figure 1.10(a) Malaysia: Annual Average Concentration of Sulphur Dioxide (SO<sub>2</sub>) by Land Use, 1999 - 2013**

## Nitrogen Dioksida (NO<sub>2</sub>)

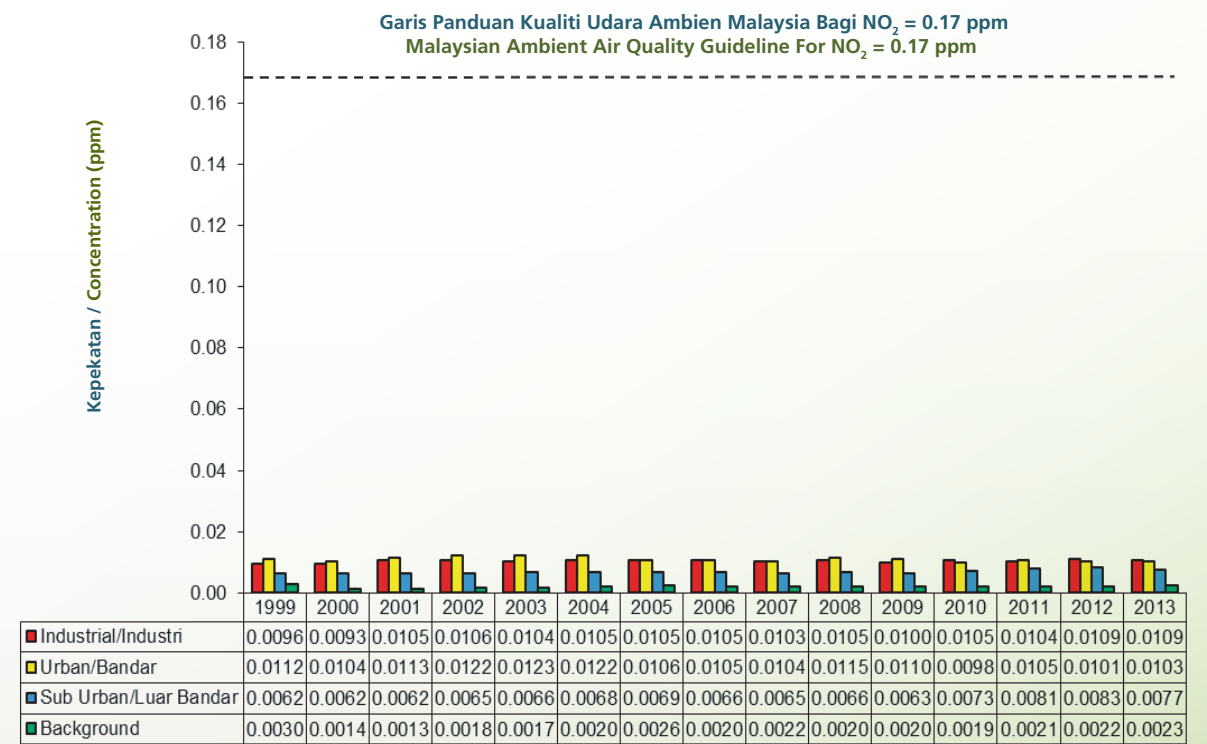
Pada tahun 2013, tiada sebarang perubahan yang ketara bagi NO<sub>2</sub> berbanding tahun 2012. Kepekatan NO<sub>2</sub> kekal tinggi di kawasan bandar dan perindustrian disebabkan oleh peningkatan yang ketara dalam bilangan kenderaan bermotor dan proses pembakaran. Anggaran beban pelepasan NO<sub>2</sub> menunjukkan sebanyak 61% adalah daripada loji janakuasa, 26% daripada pelepasan kenderaan bermotor, 6% daripada industri dan 7% daripada lain-lain sumber. Kepekatan purata tahunan NO<sub>2</sub> dalam udara ambien dari tahun 1999 hingga 2013 adalah stabil dan jauh berada di bawah had yang ditetapkan dalam Garis Panduan Kualiti Udara Ambien Malaysia. **(Rajah 1.11 dan Rajah 1.11 (a))**

## Nitrogen Dioxide (NO<sub>2</sub>)

In 2013, there was no significant change of NO<sub>2</sub> concentration compared to the 2012 levels. The NO<sub>2</sub> concentrations remain high in urban and industrial areas largely due to a significant increase in the number of motor vehicles and combustion processes. Estimates on NO<sub>2</sub> emission load indicate 61% was from power plants while 26% from motor vehicles, 6% from industries and 7% from other sources. The annual average concentration of NO<sub>2</sub> in the ambient air from 1999 to 2013 remains almost constant and well below the Malaysia Ambient Air Quality Guidelines. **(Figure 1.11 and Figure 1.11(a))**



**Rajah 1.11 Malaysia: Purata Kepekatan Tahunan Nitrogen Dioksida (NO<sub>2</sub>), 1999 - 2013**  
**Figure 1.11 Malaysia: Annual Average Concentration of Nitrogen Dioxide (NO<sub>2</sub>), 1999 - 2013**



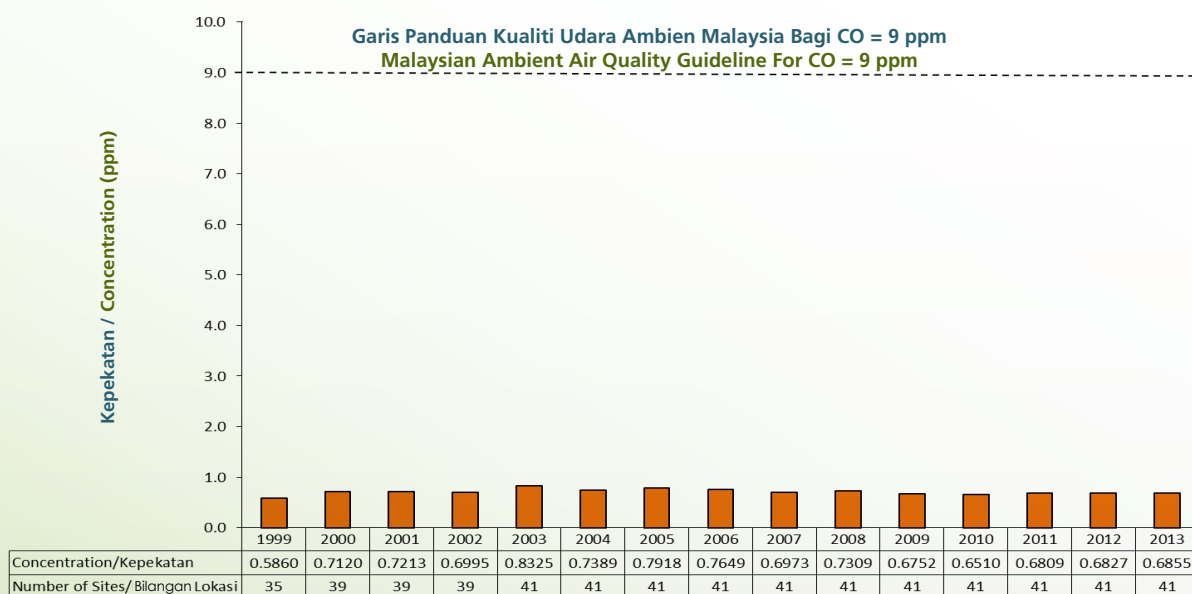
**Rajah 1.11(a) Malaysia: Purata Kepekatan Tahunan Nitrogen Dioksida (NO<sub>2</sub>), 1999 - 2013**  
**Figure 1.11(a) Malaysia: Annual Average Concentration of Nitrogen Dioxide (NO<sub>2</sub>), 1999 - 2013**

## Karbon Monoksida (CO)

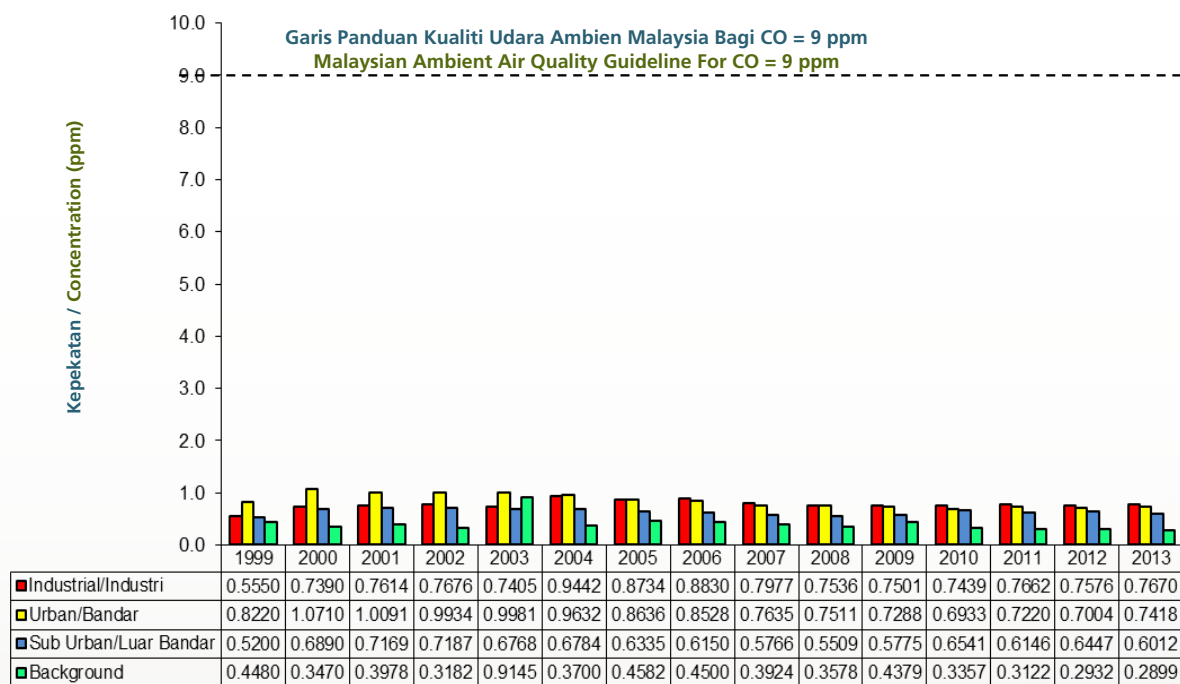
Terdapat sedikit peningkatan iaitu sebanyak 0.4% tahap kepekatan CO pada tahun 2013 berbanding dengan tahun 2012. Walau bagaimanapun, tren kepekatan CO dari tahun 1999 hingga 2013 adalah stabil. Tahap kepekatan yang dicatatkan juga mematuhi Garis Panduan Kualiti Udara Ambien Malaysia (Rajah 1.12). Di kawasan bandar, kepekatan CO adalah lebih tinggi yang berpunca daripada pelepasan kenderaan bermotor dengan menyumbang sebanyak 95% daripada beban pelepasan CO pada tahun 2013. Rajah 1.12 (a) menunjukkan kepekatan CO untuk pelbagai kategori guna tanah.

## Carbon Monoxide (CO)

There was a slight increase of 0.4% CO level in 2013, as compared to 2012. However the trend of CO concentration from 1999 to 2013 remains almost constant. The levels recorded were in compliance to the Malaysian Ambient Air Quality Guidelines (Figure 1.12). In urban areas, the concentration of CO was higher where the main source of emission was motor vehicles, which contributed to 95% of CO emission load in 2013. Figure 1.12(a) shows CO concentrations for various categories of land use.



**Rajah 1.12 Malaysia: Purata Kepekatan Tahunan Karbon Monoksida (CO), 1999 - 2013**  
**Figure 1.12 Malaysia: Annual Average Concentration of Carbon Monoxide (CO), 1999 - 2013**



**Rajah 1.12(a) Malaysia: Purata Kepekatan Tahunan Karbon Monoksida (CO), 1999 - 2013**  
**Figure 1.12(a) Malaysia: Annual Average Concentration of Carbon Monoxide (CO) by Land Use, 1999 - 2013**

