Chapter 1
Air Quality

Air Quality

Introduction

The Arab Republic of Egypt is committed to invariables that are an inherent right of the Egyptian citizen including environment preservation. Health and living standards of citizens come at the top of government priorities for creating a better work production environment and increasing investments. Overpopulation, establishment of many factories, widening many activities and increased number of vehicles over the last three decades have led to the increase of air polluting emissions. The State, represented in the Egyptian Environmental Affairs Agency (EEAA), is continuously supporting the environment monitoring network through its development and increasing the numbers of monitoring stations at the level of all governorates. Air quality is monitored in Egypt for compliance in accordance with air quality standards at the local level and with Environment law No. 4 of 1994. The Air Quality Monitoring Network enjoys special significance and plays an influential and effective role through evaluating the Air Pollutants Control Policy, development of the strategy followed by (EEAA) to reduce emissions form different sources and development of detailed list of the concentrations of air pollutants not only all the year round but also over 24 hours daily.

Sources of Pollution

Egypt's population now is approximately 77 millions. Some current studies refer that 25% of Egyptian population lives in Greater Cairo with population of over 20 millions. These figures clearly show a high population density in Greater Cairo and some other areas all over Egypt as the population concentrates in 6% of the total area of Egypt, consequently affecting air quality.

There are several sources of industrial pollution including power stations, oil refineries as well as other industries such as iron and steel, fertilizers, textiles, bricks, cement and food industries and other sources of industrial pollution. This is in addition to mobile sources such as vehicles, which are considered one of the most important pollution sources due to their environmentally polluting emissions. The accumulation of wastes and increased quantities of municipal wastes as a result of the rapid increase in population and the limited capacity of municipalities in dealing with them have led to increased open burning of such wastes and the consequent air polluting emissions, with exacerbated risk due to their proximity to residential areas. Expansion in cultivating rice has also led to increased rates of rice straw production and consequent increased rates in its open burning in Delta regions resulting in the release of dense fumes that pollute air during Autumn periods. Added to all above is another natural source of pollution, which is the desert, where seasonal winds transfer dusts from the desert resulting in higher concentrations of dusts during certain times of the year (Khamasin phenomenon). Egypt’s climate is also considered one of the most important factors increasing the feeling of air pollution due to its dryness with rare rainfall. Surface winds are also inactive most times of the year. The thermo reflection phenomenon is thus repeated resulting in the trapping of pollutants in the layer near the surface of the earth, hence the occurrence of severe air pollution episodes, particularly during Autumn each year; a phenomenon known by the term “Black Cloud”.
Studies show that emissions from factories, vehicle exhausts and open burning of wastes

(household and agricultural wastes) help largely in increasing the concentrations of several pollutants in Greater Cairo, at the top of which are particulate matters (chest dusts). Some pollutants interact with each other in atmospheric air under certain conditions producing secondary pollutants leading to increased pollution rates as in the case of the reaction of ozone with Nitrogen Oxides and volatile organic compounds and the reaction of ammonia with sulfates and nitrates.

Air Pollution Harmful Impacts

The Ministry of Health and Population (Environmental Monitoring and Work Environment Studies Centre) in cooperation with Ain Shams University (Community and Environment Medicine and Industries Medicine Departments) have conducted consecutive studies since 1995 for exploring the relation between air pollution and mortality rates as a result of cardiac and respiratory diseases in Egypt. These studies have shown the existence of a direct relation between increased suspended matter pollution rates (Sulphur Dioxide and fumes) and mortality rates resulting from cardiac and respiratory diseases.

Air Quality

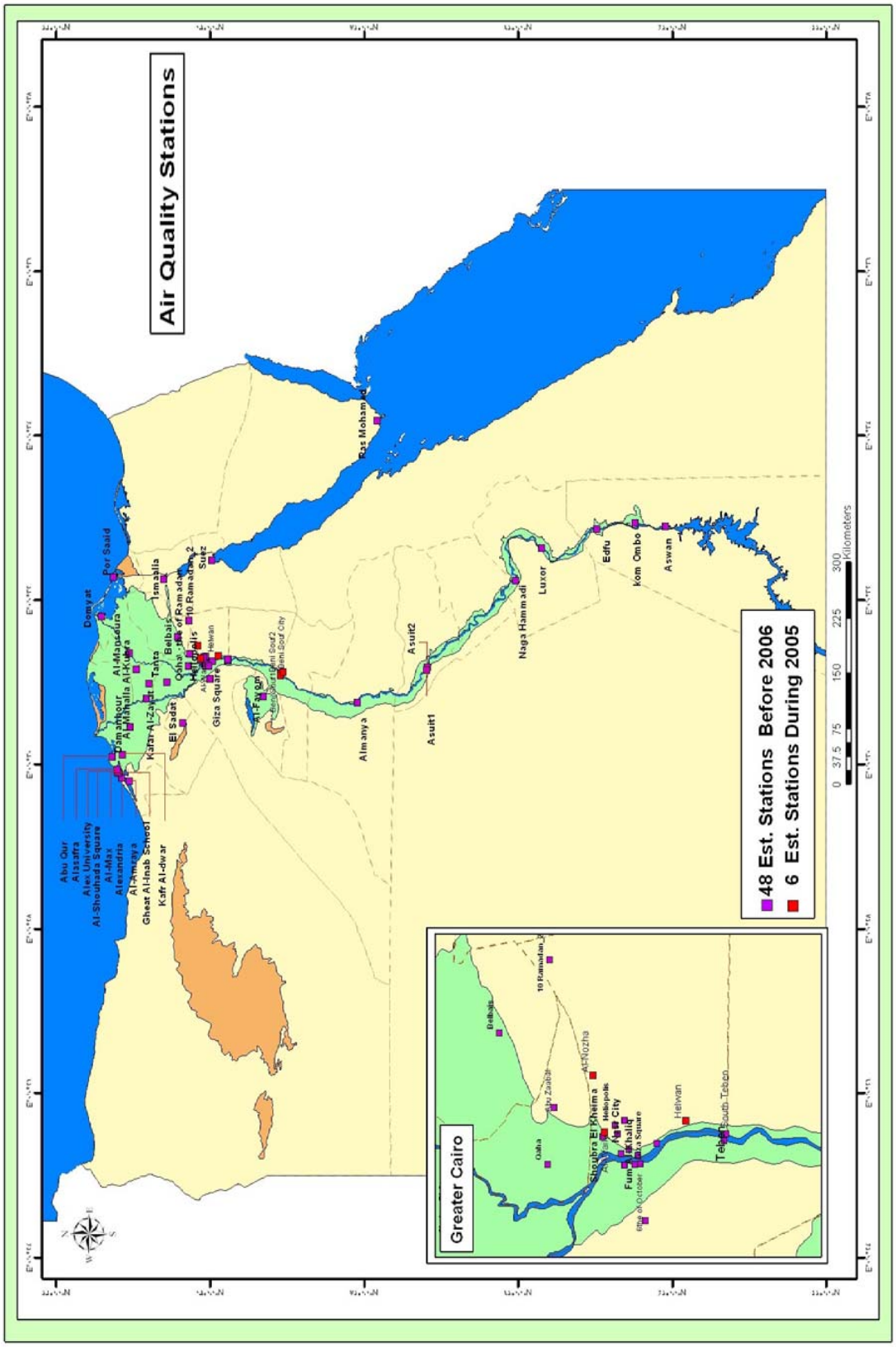
Air pollutants in the Arab Republic of Egypt are monitored through EEAA monitoring network which covering Greater Cairo area and most parts of Egypt. Table (1.1) shows the number and distribution of the network stations, while Map (1.1) shows their geographical distribution.

Table (1.1): Numbers and Topography of Network Stations

Distribution of Operational Stations

Source Type	Cairo	Alexandria	Delta	Upper Egypt	Sinai and Canal Cities	
Industrial areas	**7**	**3**	**3**	**3**		**16**
Urban areas	**9**	**1**	**4**	**7**		**21**
Residential areas	**4**	**2**	**2**	**2**		**10**
Traffic areas	**7**			**1**		**8**
Remote areas	**4**	**1**	**1**	**1**	**2**	**9**
Mixed uses areas	**10**	**1**	**2**	**1**		**14**
Total	**41**	**8**	**12**	**15**	**2**	**78**

Map (1.1) Air Quality Monitoring Station Sites in Egypt



Currently, there are 78 air pollutants monitoring and measurement stations. Air quality measurement sites are spread in many sites such as industrial, residential, urban and remote areas. The network measures all different air pollutant indicators such as Particulate Matters less than10 microns (PM_{10}), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Nitric Oxide (NO), Carbon Monoxide (CO), Ozone (O_3), Lead (Pb) and Smog.

Air Quality Indicators in Egypt

Pollutants measured by environmental monitoring networks are divided into: basic pollutants (primary) emitted as a result of industrial production processes or traffic density such as sulphur oxides, nitrogen oxides, particulate matters, carbon monoxide, and subordinate pollutants resulting from the interaction between primary pollutants or between primary pollutants and some chemical compounds found in air such as ozone gas.
Following are some results related to air quality indicators related results during 2007 according to monitoring results collected from the monitoring stations.

1. Sulphur Dioxide (SO_2)

Sulphur Dioxide gas (SO_2) is primarily generated as a result of oxidizing sulfur residues in liquid oil fuel during combustion whether in fixed sources, such as power stations and factories, or mobile sources particularly gas oil operated vehicles. Air quality indicators with respect to sulphur dioxide have shown the following:

- Sulphur dioxide concentration has not exceeded its permissible maximum exposure limit for one hour (350 microgram/m^3) except for few periods of time in 2007.
- Sulphur dioxide annual average concentrations in all monitoring sites countrywide did not exceed the permissible level except in two sites in Greater Cairo (Fom El Khalig and Qulaly), which are two highly dense traffic areas due to their location downtown Cairo. Control of sulphur dioxide gas concentrations - not exceeding Environment Law 4/94 maximum limits in most monitoring stations, despite economic growth, particularly in the industrial sector, as well as the resulting increase in fuel consumption rates, increased demand for means of transportation, increased number of vehicles - is due to MSEA's efforts, in coordination with concerned agencies, to limit the use of mazot as fuel in residential areas, especially in power generation plants, which were transformed to run on natural gas, as well as to the tight control on industrial and vehicular emissions.
- Figure (1.1) shows sulphur dioxide concentrations in some Egyptian governorates such as Shebeen El Koom, Belbeis, Suez and some parts in Alexandria, where results indicate that the annual average concentration of sulphur dioxide (SO_2) measured in these areas is less than the permissible limits (60 µg/m^3) stated in Environment Law. Noteworthy, 2007 has witnessed increased concentrations monitored in some sites compared to previous years especially in Mansoura and Suez stations due to increased industrial emissions in such stations located in proximity to industrial zones (Tlkha fertilizer factory in Mansoura and oil refineries in Suez).

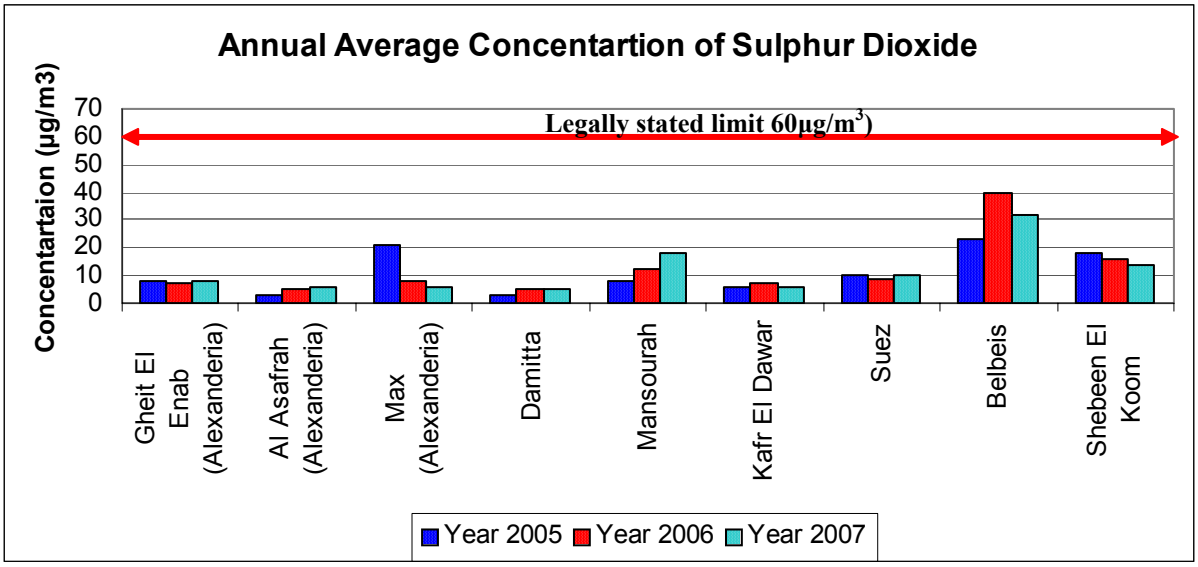


Figure (1.1): Annual average Concentration of SO_2 in some locations in governorates during the past three years

- Figure (1.2) shows SO_2 Concentration in some Upper Egyptian cities such as Aswan, Kom Ombo, Luxor and Assuit where SO_2 annual average measured in these cities was less than the permissible limits defined by the Executive Regulations. Note worthy, SO_2 concentration in Kom Ombo city has decreased by 50% during 2007 compared to past years due to EEAA efforts in combating industrial pollution and applying cleaner production technology. It is observed that the annual average concentration of SO_2 in Luxor did not exceed 30µg/m^3; an indicator of good air quality appropriate for the tourist nature of this city.

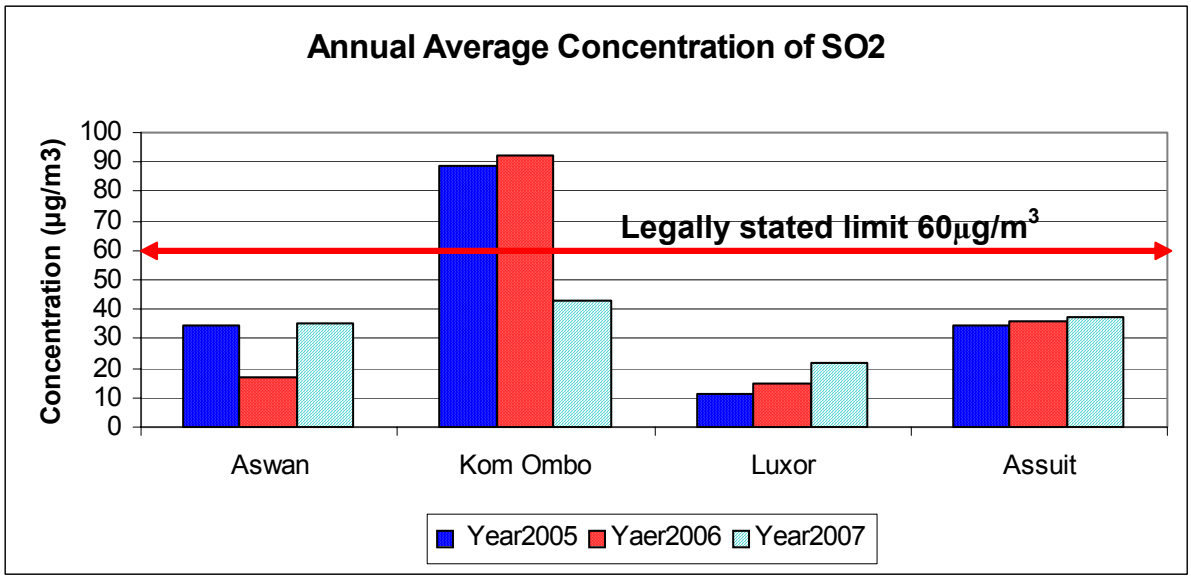


Figure (1.2): SO_2 gas annual average concentration in some locations in the south of Egypt during the past three years.

- Comparing SO_2 monitoring results in Greater Cairo during 2007 with the results of the past two years, figure (1.3) shows gradual decrease of SO_2 during recent years in some areas such as Shoubra EL Kheima , Maadi and Cairo University due to several factors as we have previously mentioned, most significant is the continuous operation of power stations using natural gas instead of fuel oil.

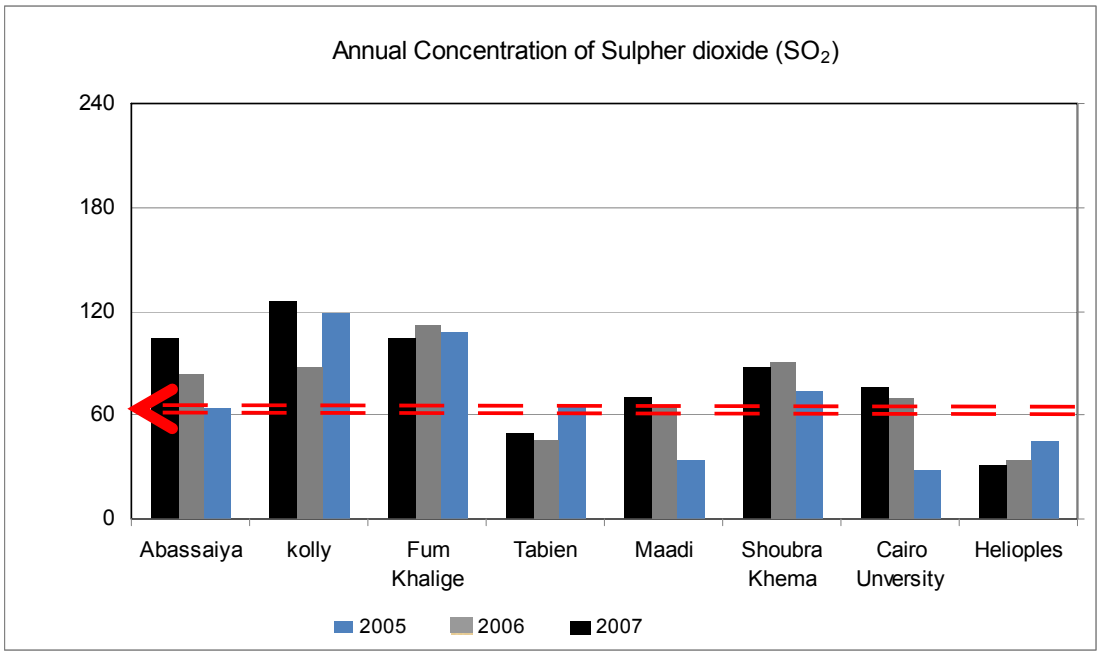


Figure (1.3): Annual average of SO_2 Concentration in some locations in Cairo during the past three years

- Figure (1.4) illustrates the monthly average of SO_2 Concentration in some locations in Cairo and Giza during 2007. From the figure, it is observed that monthly average concentration had not exceeded 60 µg/m^3 for most months of the year except in the two locations of Qulaly and Fom El Khalig where concentrations of SO_2 have increased especially during Autumn and generally in the second half of the year. This is attributed to the different weather factors that lead to the concentration and non spread of pollutants during Autumn. Monthly average concentration rises to exceed 100 µg/m^3 during severe pollution episodes in these two locations owing to the accumulation of pollutants resulting from vehicular fuel combustion and other sources during such severe pollution episodes. This is also due to increased activities and special habits as people tend to spend as much time as possible outdoors, particularly during summer, consequently creating highly dense traffic most of the day.

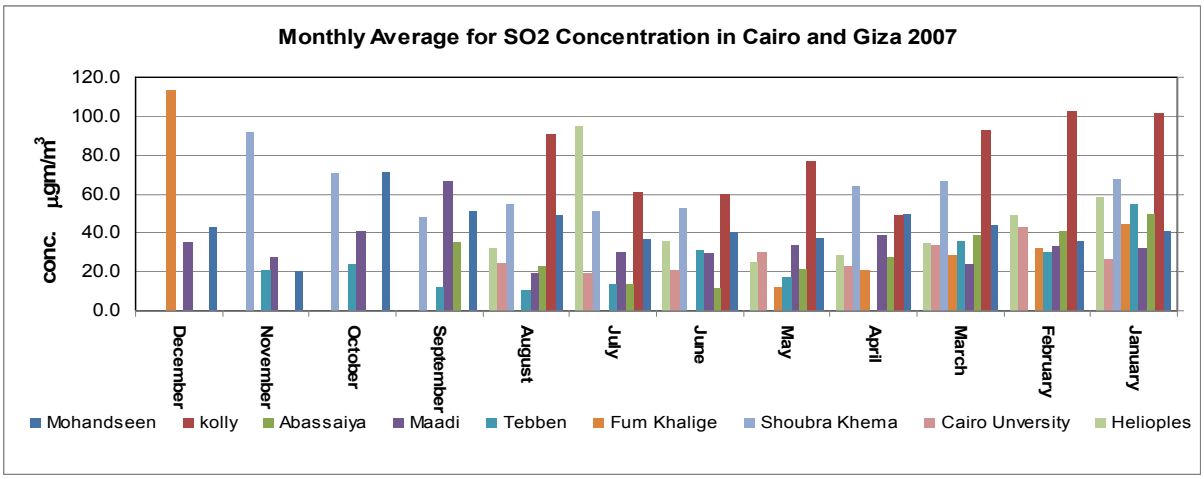


Figure (1.4): the monthly average of SO_2 concentration in Cairo and Giza during 2007

*Cairo university and Heliopolis monitoring stations is nonoperational as of September 2007 and have been under maintenance since then.

2. Nitrogen Dioxide Gas (NO_2)

NO_2 is produced from all fuel combustion processes under high temperatures. No annual limit of NO_2 gas is provided for in the Executive Regulations of law No.4 of 1994 on Environment Protection but taking the annual limit of 40 µg/m^3 imposed by World Health Organization (WHO) as a guideline, we find that 12 out of 15 NO_2 monitoring locations have exceeded this permissible guiding annual limit during 2007. Table (1.2).

Table (1.2): the annual average concentration of NO_2 during the past three years (µg/m^3)

Location	Year 2005	Year 2006	Year 2007
Giza		98.8	119.3
Nasr City	117.8	83.6	48.8
Koulaly	150.1	146.3	154.7
Maadi	79.8	102.6	119.7
Tebin	39.9	43.7	39.1
Fum El khaleeg	110.2	159.6	154.3
Ciro University	108.3	70.3	85.4
Qaha	68.4	70.3	87.3
Mohandseen			82.4
Suez			79.5
Assuit			89.5
Beni Sweef City	57.8	36.1	42.6
Beni Sweef Governorate	31.3	31.4	36.3
El Goumhoria	52.8	58.9	65.1
Heliopolis			30.4

Also, it is clear that this problem continues with the rise in numbers of vehicles during the past years; a matter that led to the increase of fuel combustion rates and consequently to the increase in NO_2 average annual concentrations to exceed the internationally permissible guideline.

Air quality indicators of NO_2 gas have shown the following:

- NO_2 concentrations measured for an average exposure of one hour did not exceed the permissible limit prescribed in the Egyptian Environment Protection Law (400µg/m^3 – for one hour exposure) in most stations during 99% of year days.
- NO_2 annual average in some locations in governorates did not exceed the annual guidline limit, such as in Gheit El-Enab and El-Max in Alexandria and Kafr El-Zayata; figure (1.5), whereas it had increased Kaha, Suez, Assuit and Abo Keer stations to exceed the guiding limit as a result of increased industrial emissons in these loactions which are classified as industrial cities.
- During 2007, the annual average concentration of NO_2 exceeded the WHO maximum annual limit (40 µg/m^3) in all monitoring loactions in Greater Cairo.

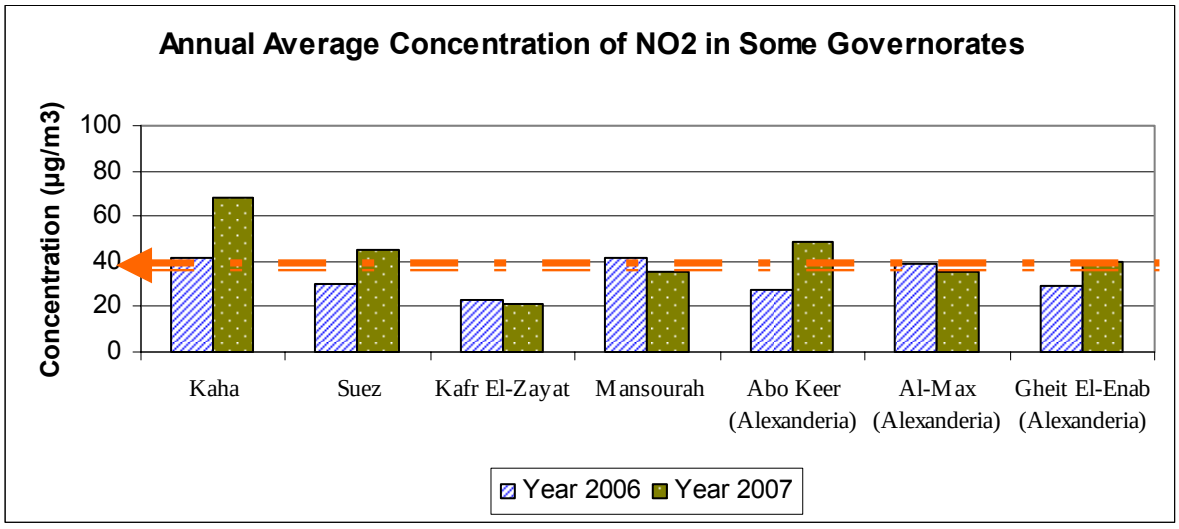


Figure (1.5) NO_2 annual average concentration in some locations in Egypt during 2006 and 2007

- There was an increase in NO_2 gas concentrations in highly dense traffic locations brought about by the combustion of huge amount of fuel especially during traffic congestion periods.
- Figure (1.6) illustrates the monthly average of NO_2 concentration in some locations in both Cairo and Giza. Monthly concentrations exceed 40µg/m^3 in most locations, and exceed 70µg/m^3 in severe pollution episodes in Autumn.
- Fum El– Khaleeg and Koulaly stations are still recording annual pollution levels higher than the guideline as these stations are located in highly dense traffic areas leading to increased NO_2 concentrations.

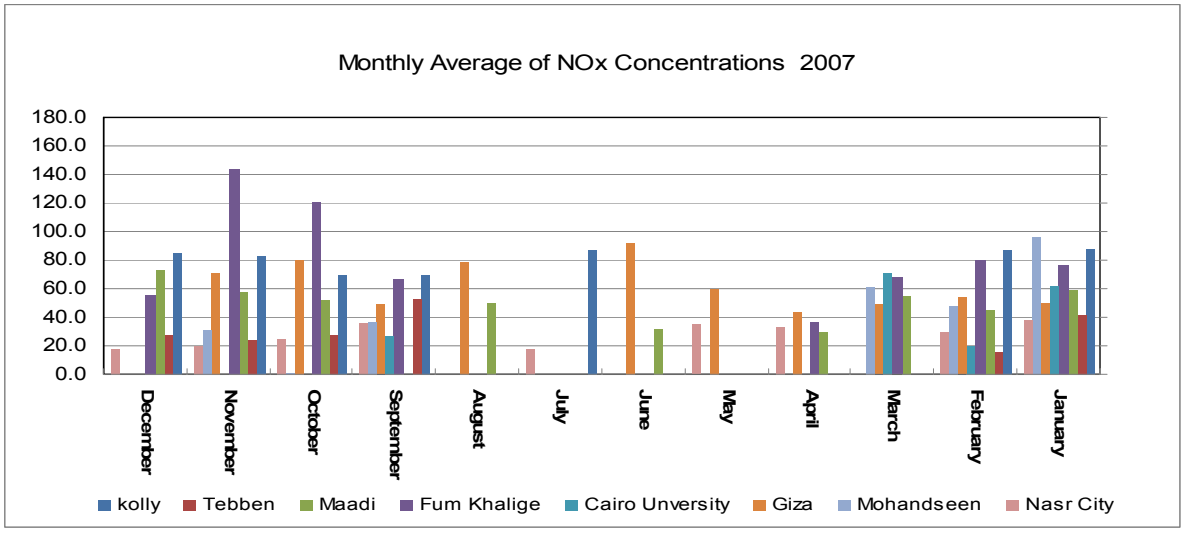


Figure (1.6): NO_2 concentration monthly average in Cairo and Giza (µg/m^3).

3. Particulate matters (PM_{10})

Particulate matters are considered a major pollution problem in the Arab Republic of Egypt particularly in Greater Cairo region owing to the multiplicity of pollution sources. In recent years, focus has been directed towards monitoring suspended particles especially the concentrations of particulate matters less than 10 micron PM_{10} suspended in the air that are of grave risk to public health as they are significantly inhaled and settle in the lungs causing subsequent health problems. Figure (1.3) shows the annual average of PM_{10} concentrations in Greater Cairo and some other areas such as Belbeis and Shebin El-Kom during recent years (1999-2007).

Table (1.3) Annual Average concentration of Particulate matters (PM_{10}) (Chest Dust) (µg/m3) in some location in Greater Cairo and Governorates from 1999—2007

Location	Type	1999	2000	2001	2002	2003	2004	2005	2006	2007
El Qulaly	Traffic	239	197	165	172	172	194	165	167	160
Kobry El Quba	Residential	160	157	193	141	171	170	163	151	148
Maadi	Residential	158	160	188	143	163	166	131	126	151
Giza (Faculty of Agriculture)	Traffic	166	162	183	155	148	149	139	132	149
6th of October City	Residential	136	127	135	122	106	116	97	93	122
El Moqatam	Residential	152	161	194	154	143	160	131	138	136
Shopra El Khema	Industrial	232	214	212	191	199	206	162	168	179
El Sahel	Industrial	280	236	245	200	209	206	167	156	152
El Mataria	Residential	184	180	195	161	163	160	145	147	144
El Wayli	Industrial/Residential	167	206	199	177	176	169	140	149	141
Embaba	Residential	161	173	193	161	160	148	123	131	127
Qaha	Remote	137	146	153	128	141	136	128	129	122
El Basateen	Industrial/Residential	216	197	234	183	187	189	142	147	153
Tahrir Square	Traffic	155	172	182	151	152	164	133	130	137
Zamalik	Residential	147	179	162	154	154	154	137	140	134
Helwan	Residential	167	193	212	160	179	210	143	154	133
Maasara	Industrial/Residential	219	235	268	182	195	223	184	176	169
Masr El Gadida	Residential	149	154	163	119	122	130	116	135	134
Abou Zaabal	Industrial		268	325	161	168	195	150	150	144

Air quality indicators of suspended particulate matters (chest dusts) have shown the following:

- There is a relative improvement compared to previous years as a result of the use of dust filters by industrial facilities (e.g. cement factories) as well as EEAA efforts. However, concentrations measured in 2007 were higher than those monitored in 2006 as a result of noticeably increased severe traffic congestions in Greater Cairo, consequently leading to augmented traffic air polluting emissions, in addition to prolonged times of dormant wind and greenhouse gases during 2007 compared to weather conditions in 2006.
- On comparing PM_{10} monitoring results in some other monitoring locations nationwide in 2007 with past years (since 1999), a relative improvement in particulate matters are noticeable in some areas. For example, we observe average improvement amounting to 22.2% in some monitoring locations as from1999 till 2007.
- Despite the relative improvement in suspended particulate matters concentrations, average annual concentrations of PM_{10} during 2007 are still recording high rates in a large percentage of monitoring sites nationwide.
- Abo Zaabal monitoring site witnessed a noticeable improvement decrease in particulate matters by 59%. PM_{10} concentrations have also decreased by 35% in the industrial parts of El-Sahel, Helwan and Massara, in additional to their residential areas. This indicates that the strategy developed for addressing pollutants, industrial pollution prevention and industrial modernization has proven successful for this indicator from 1999 till 2007; (Table 1-3).
- Figure (1.7) illustrates the monthly average of particulate matters concentration in some locations in Cairo and Giza. The month of April for example has recorded concentrations higher than Autumn months in some locations owing to the Khamaseen phenomenon. It has been observed that particulate matters concentrations during June till December have recorded nearly the same levels in the illustrated locations. This indicates a multiplicity of pollution sources and that particulate matters pollution sources, whether in dense traffic, residential or industrial areas, though may be different, however, they are the persistent source of pollution and contribute differently to such a problem in the respective locations depending on their proximity to the source of pollution.

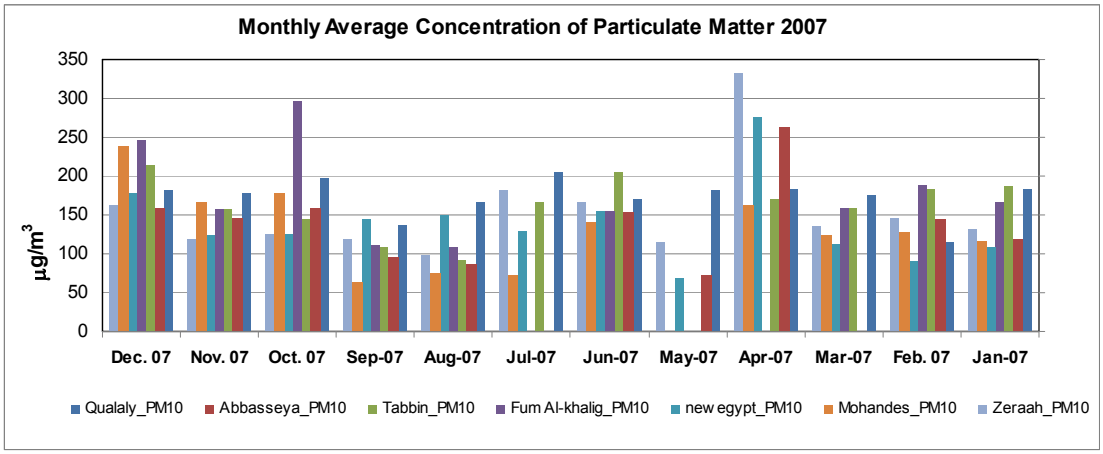


Figure (1.7) Monthly average concentration of particulate matters in some areas in Cairo

4. Lead

Human exposure to Lead pollution is taking different forms whether through air inhalation or taking in Lead- or Lead-derivatives- polluted food. Most important of such forms is inhaling lead in the form of suspended air particles or dusts, leading to the accumulation of such poisonous element in human blood through the respiratory system. Lead badly affects both digestive and immunity systems as well as the kidneys, liver and blood vessels . It has also been proven that children's bodies highly absorb Lead much more than adults' and hence posing high risks. Lead monitoring results showed that all Lead measurements monitored in residential areas did not exceed the permissible limit provided for in the Environment Protection Law Executive Regulations as shown in table (1.4). This was attributed to the strict enforcement to the Environment Protection Law and amendments introduced by EEAA to its Executive Regulations for the purpose of reducing the Lead permissible level in both residential and industrial areas to 0.5µg/m^3 and 1.5µg/m^3 respectively instead of 1µg/m^3 in all areas alike whether residential or industrial.

- Table (1.4) illustrates Lead concentrations during the past years. Comparing lead concentrations monitored during the first monitoring years starting from 2001, averaging higher than the Executive Regulations permissible levels, we find that Lead concentrations in residential areas were 1.01µg/m^3, while they currently do not exceed 0.37µg/m^3. whereas concentrations in industrial areas were 2.31µg/m^3 in 2001, however, they have currently reached down to 1.04 µg/m^3. Comparing Lead average concentrations during the years preceding 2007, we find a general tendency towards a decrease in Lead concentrations level due to Lead concentrations reduction efforts.

Table (1.4) Annual Lead Concentration from 2001 till 2007 (µg/m^3)

Location	Type	2001	2002	2003	2004	2005	2006	2007
El Qulaly	Traffic	1.44	1.46	1.36	1.07	0.88	0.48	0.27
Kobry El Quba	Residential	1.02	1.28	1.00	1.22	1.15	0.41	0.41
Maadi	Residential	1.02	1.04	1.16	1.08	1.02	0.65	0.35
Giza (Faculty of Agriculture)	Traffic	1.06	1.03	1.02	1.09	1.16	0.67	0.38
6th of October City	Residential	1.01	0.70	0.86	0.85	0.86	0.77	0.27
El Moqatam	Residential	1.18	0.94	1.06	0.98	0.83	0.39	0.33
Shopra El Khema	Industrial	5.79	6.19	0.93	1.05	1.09	0.72	0.33
El Sahel	Industrial	3.98	6.00	1.99	1.35	1.66	1.06	1.04
El Mataria	Residential	1.33	1.55	1.40	1.11	1.17	0.72	0.26
El Wayli	Industrial/Residential	1.41	1.58	1.04	0.93	1.00	0.52	0.28
Embaba	Residential	1.16	1.12	0.83	0.94	1.02	0.41	0.23
Qaha	Remote	1.09	0.76	0.96	0.94	1.21	0.44	0.39
El Basateen	Industrial/Residential	1.07	1.29	1.25	1.12	1.29	0.59	0.27
Tahrir Square	Traffic	1.35	1.23	1.32	1.08	1.09	0.71	0.26
Zamalik	Residential	1.22	1.21	0.97	0.95	1.02	0.53	0.26
Helwan	Residential	1.32	0.98	1.00	0.99	0.76	0.68	0.35
Maasara	Industrial/Residential	0.95	0.93	1.01	1.06	1.17	0.56	0.27
Masr El Gadida	Residential	1.05	0.90	0.90	0.80	0.99	0.48	0.25
Abou Zaabal	Industrial	1.30	1.35	1.29	3.78	2.60	2.39	1.20

- Figure (1.8) illustrates Lead concentrations in residential and traffic areas during the last three years, showing clear decrease in Lead concentrations in such areas. Figure (1.9) also shows Lead concentrations in industrial areas in the first half of 2007.

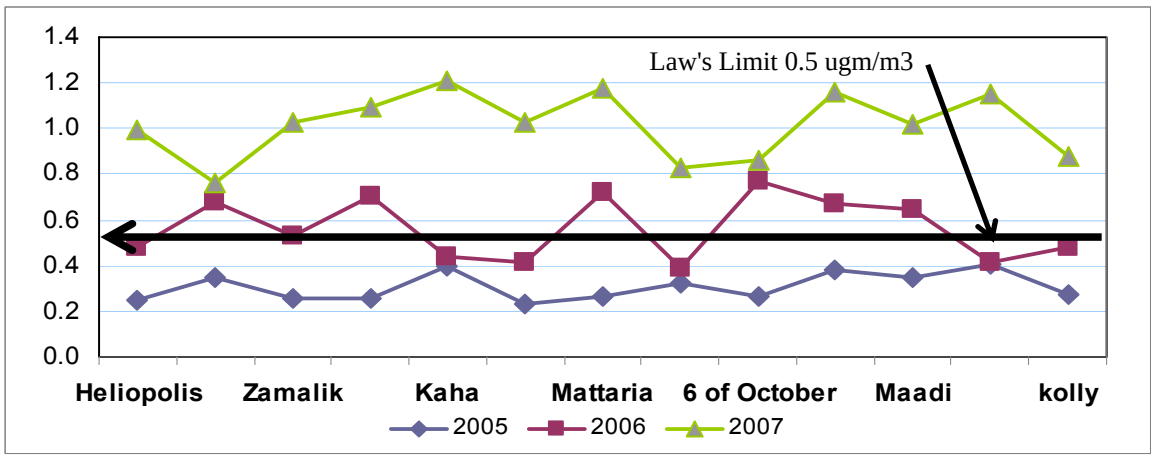


Figure (1.8): Lead concentrations in residential and traffic areas during the last three years (µg/m^3)

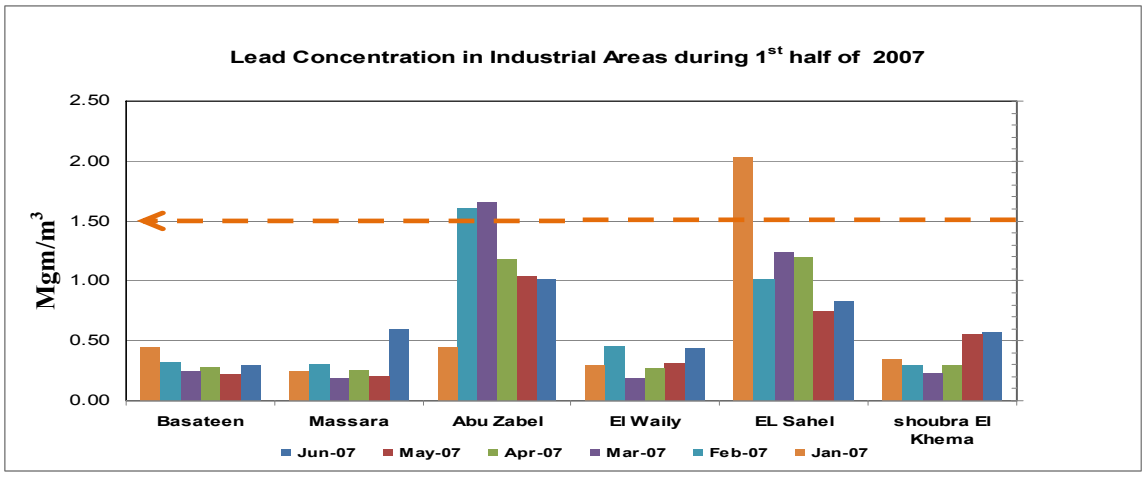


Figure (1.9): Lead concentrations in the industrial areas during the first half of 2007 (µg/m^3)

- Results show that Lead concentrations have decreased in residential areas to below the permissible limit. Concerning concentrations in industrial areas, they are within the permissible limits; a good indication of environmental improvement in Lead pollution prevention.
  - Residential areas such as Matareya, Imbaba and Zamalek as well as other areas have Lead concentrations less than the permissible levels provided for in Environment Law No.4 of 1994. This also applies to areas such as Abo Zaabal and Shoubra El-Kheima.
  - The average Lead concentration decreased by about 70% during 2007 compared to 2001. The highest decrease was in Shoubra El–Kheima (an industrial area) with clear improvement reaching 95%. The annual average concentration of Lead in Shoubra El-Kheima during 2001 was 5.79µg/m^3, while the annual average concentration of Lead in 2007 was 0.33µg/m^3 as illustrated in table (1.4). This decrease is a good indicator on implementing a successful Lead pollution reduction strategy.

- Residential areas such as Maadi, Giza and Heliopolis witnessed a decrease in Lead concentrations not less than 60% compared to 2001, which is an indicator of decreased lead concentrations during the past years and an indicator to improved public health.
- Lead concentrations reduction in Shoubra El-Kheima is owed to EEAA efforts. In co-operation with the United States Agency for International Development (USAID) within the framework of Shoubra El-Kheima Lead Pollution Prevention Project (LIFE), EEAA was able to clean up seven Lead-polluted sites, two schools and a medical center and the relocation of polluting Lead smelters outside Shubra El-Kheima city residential agglomerates to El Safaa industrial zone in Abo Zaabal using modern eco-friendly technologies.

5. Carbon Monoxide (CO)

Carbon monoxide (CO) is emitted from vehicular emissions and from burning coal or wood in heaters. It is considered one of the most hazardous and toxic air pollutants affecting both human beings and animals. CO reacts with hemoglobin forming carboxi-hemoglobin preventing oxygen from combining with hemoglobin, depriving the body from oxygen resulting in suffocation. The Environment Law executive regulation stipulates that the maximum permissible limit of CO exposure for one hour and eight hours is 30 mg/m^3 and 10 mg/m^3 respectively. Figure (1.10) shows the annual average of CO concentrations during 2005 - 2007 in the three operational CO monitoring stations in Egypt, showing relatively stable concentrations. CO concentrations during an eight-hour exposure have sometimes exceeded permissible limits in different months of the year. However, they did not exceed the permissible limits in the one-hour exposure at any time of the year.

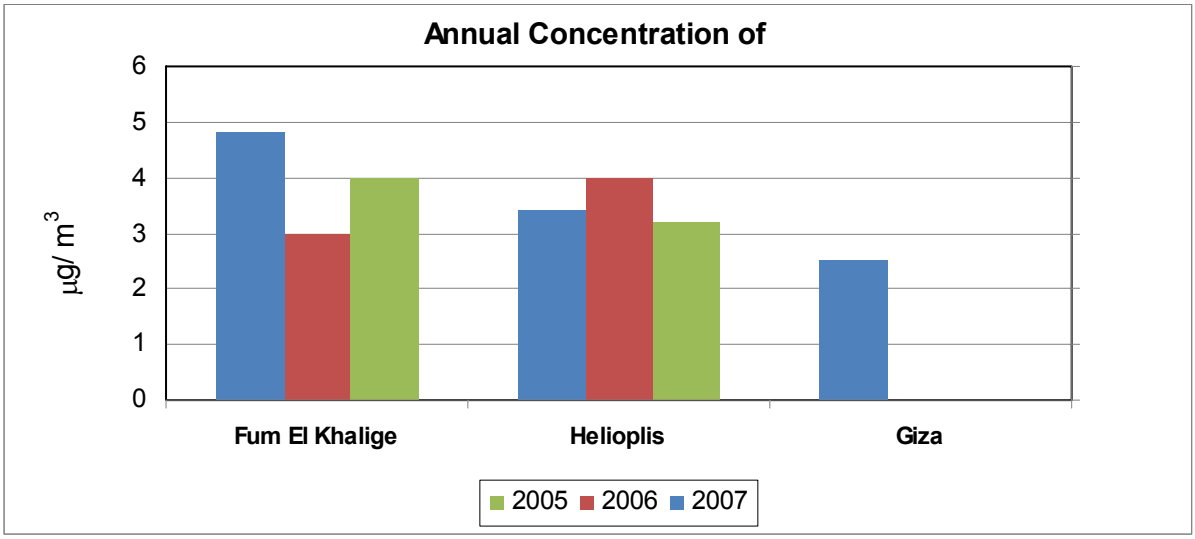


Figure (1.10): CO concentration 2005 - 2007 (mg/m^3)

6. Ozone

Ozone is formed in the troposphere as a result of the interaction of pollutants emitted from transportation means or appliances containing hydrocarbons (Freon) used in manufacturing refrigerators, A/Cs, and many other industries. Ozone is considered a hazardous component to human health.

Environment Law executive regulations specify the maximum limit of exposure to surface Ozone by one hour and not to exceed 200 µg/m^3. Permissible limit during 8 hours should not exceed 120 µg/m^3. Figure(1.11) shows a relative but ineffective increase in Ozone concentration in both Abbasseya and Aswan monitoring sites. For a reasonable judgment on Ozone concentrations and impacts it is required to increase the number of Ozone monitoring stations. In Qaha and Giza monitoring stations, ozone concentrations significantly increased mostly due to high traffic density in these areas being in proximity to road networks and due to weather factor prevailing at that time of the year (Summer), leading an increase in the percentage of surface Ozone formation.

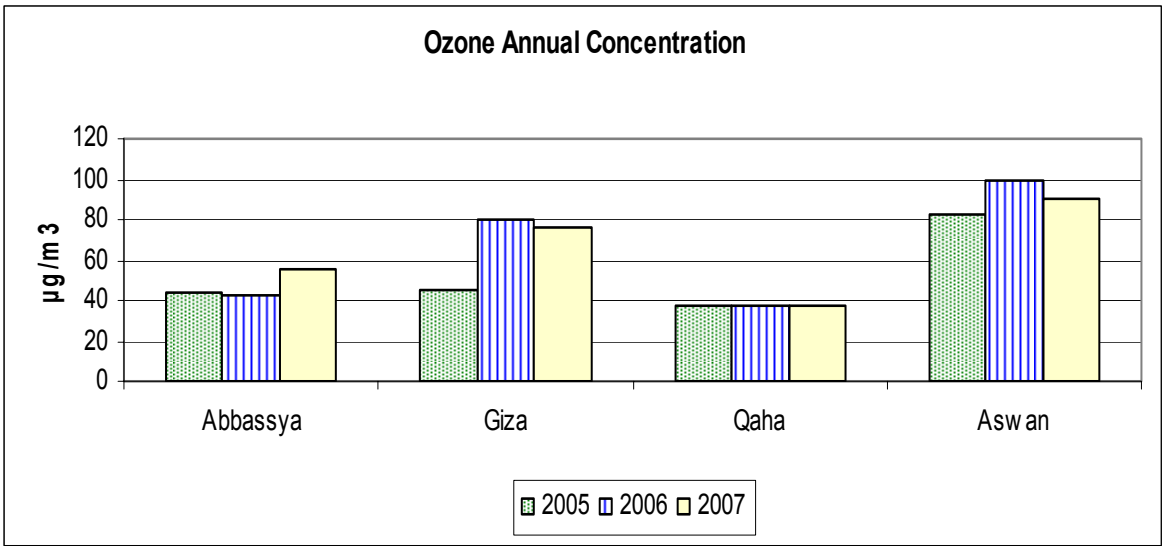


Figure (1.11): Ozone concentration since 2005 till 2007 (µg/g^3).

Causes of Severe Air Pollution Episodes

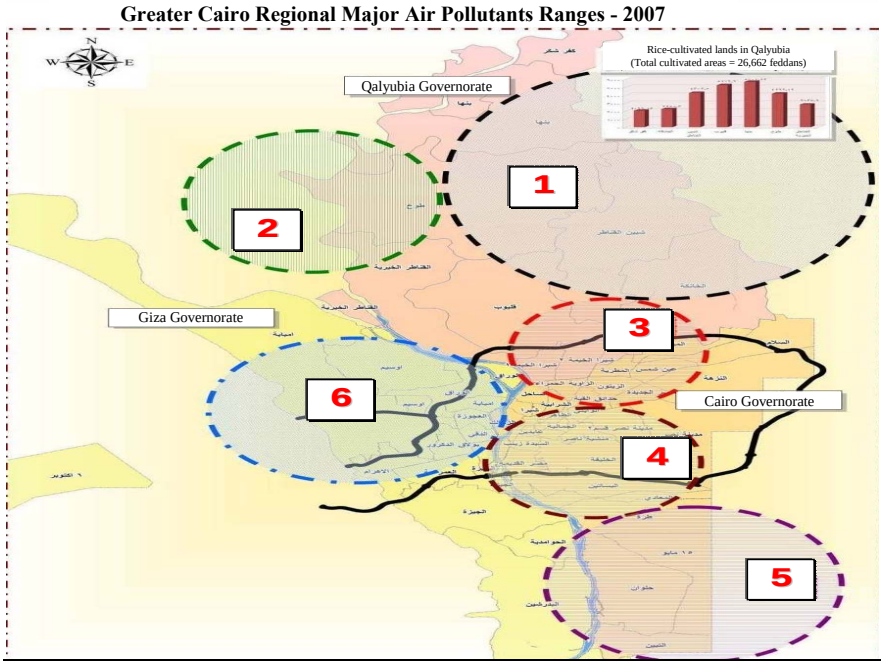
The Black Cloud is one of the most significant environmental phenomena that have nearly become chronic since 1999 particularly in the skies of Cairo. The severity of this phenomenon increased during night hours after sunset and in the early morning with varying cloud density year on year.

Studies and analyses by EEAA and different research bodies professionals and experts the Black Cloud was found to occur due to several main factors:

- Increased quantities of air pollutants in Cairo.
- Occurrence of certain atmospheric phenomenon known as “Thermal Reflection”.
- Cairo Topography.

Air Quality

- The existence of many different air pollution sources in Greater Cairo, Map (1.2), such as industrial pollution, pollution generated by the different means of transportation and solid wastes open burning.



Map (1.2) sources of pollution in Greater Cairo and its data mentioned in table (1.5)

Table (1.5): Pollution Sources in Greater Cairo

Range	Facilities							Total
	Kilns	Potter-ies	Smelt-ers	Brick Facto-ries	Crush-ers & Lime Ovens	Quar-ries	Large Indus-tries	
1	34	10	200	10	-	1	5	**260**
2	113	-	-	-	-	-	-	**113**
3	8	-	143	-	-	-	15	**166**
4	-	179	550	-	-	-	8	**737**
5	-	-	-	220	273	50	12	**555**
6	-	-	35	33	-	-	3	**71**
Total	**155**	**189**	**928**	**263**	**273**	**51**	**43**	**1902**

We will review the most important sources causing pollution in Cairo Governorate as follows:

A. **Industry:** 52% of factories in Egypt are in Cairo and most industries are centered in both Helwan and Shoubra El-Kheima. Industries in Cairo include iron and steel, textiles, cars, cement, chemicals, oil refining, bricks, refractories and metallic and non-ferrous metals industries specially foundries. The number of registered factories in Greater Cairo is estimated by 13608 including 13084 small and medium industrial establishments and about 524 huge establishments (with investment of L.E 20 million and more).

B. **Means of transport:** micro-/mini-buses are the major transportation in Cairo and they release emissions including carbon monoxide, nitrogen oxides and smog. The numbers of vehicles working in Cairo have increased to reach about 2.1 million vehicles in 2007.

C. **Other sources of air pollution in Cairo:** include burning the municipal solid wastes which are estimated in Greater Cairo by approximately one million ton per year as well as the waste burned to be used as fuels in some small industries and workshops. In addition, wind coming from the North Carries pollutants resulting from industries in the northern areas starting from Mostorod to Abo-Zaabal as well as burning the agricultural wastes specially during the periods of time when rice straw is burnt.

- **The greenhouse effect phenomenon**

In ordinary meteorological conditions Earth's near-surface air temperature is increased by heat emitted from the earth as it is warmed by sun rays declining on the earth and Earth's near-surface warm air goes up carrying the existing pollutant amounts and subsequently help spreading and carrying the pollutants away from the earth's surface. This situation identifies the pollutant prevailing ;levels measured all along the year under ordinary meteorological conditions. But when an area exposes to high pressure in which , air moves in reverse cyclones, air currents sometimes slowly fall downward which led to the feeling of the accumulation of pollutants. When the falling air meets the air ascending and emitted from the earth, the temperature of the later becomes lower than that of the earlier and subsequently a layer is formed between the two air masses called the greenhouse effect area. This air layer constitutes a cover under which the ascending air is held and as a result the pollutants are withheld and restrained from spreading above; a matter leads to the high concentration of the pollutants and these conditions are called " sever air pollution episodes". The greenhouse effect phenomenon occurs in different times of the year but largely felt in autumn which is a transitional season between summer and winter and some times has different weather changes.

- **Cairo Topography**

It is known that both Cairo and Giza cities are located in a rectangular depression on the two sides of the Nile extending from Shoubra in the north to Helwan in the South and when air is calm and still the accumulation of the pollutants on such a depression is increased and the topography of Cairo is therefore a cause of the Black Cloud occurrence. Accordingly, it is obvious that the black cloud is caused by the "greenhouse effect layer" existing over Greater Cairo in which high pollutant concentrations are basically trapped into the air and consequently are more felt specially after sunset and in the early morning.

Data analysis of September, October and December 2007 shows the following:

1. Prevailing wind blew from the north of the northern east part in most days of the year and with some northern west wind some times led to the decrease of these severe pollutants.
2. The average wind speed in 2006 and 2007 was 1-7 m/s.
3. The number of hours recorded concentrations higher than 300µg/m^3 decreased from 362 hours during October 2006 to 265 hours in 2007 and from 205 in November 2006 to 107 in 2007. table (1.6) shows the number of hours in which concentrations exceeded 300µg/m^3 in November.

Table(1.6): The number of hours in which the PM Concentrations exceeded 300µg/m^3 in some monitoring stations in Cairo

Site	2005	2006	2007
Abbassya	18	44	17
El Qulaly	33	64	27
Fom El Khalig	120	27	106
Teebin	89	90	60
Roxy	***	12	16
Giza	***	11	12
Mohandessin	24	47	16

*** The station was not operational that year

4. The thickness of the greenhouse effect layer during 2005-2007 was close 20-2700m as illustrated in figure(1.12).

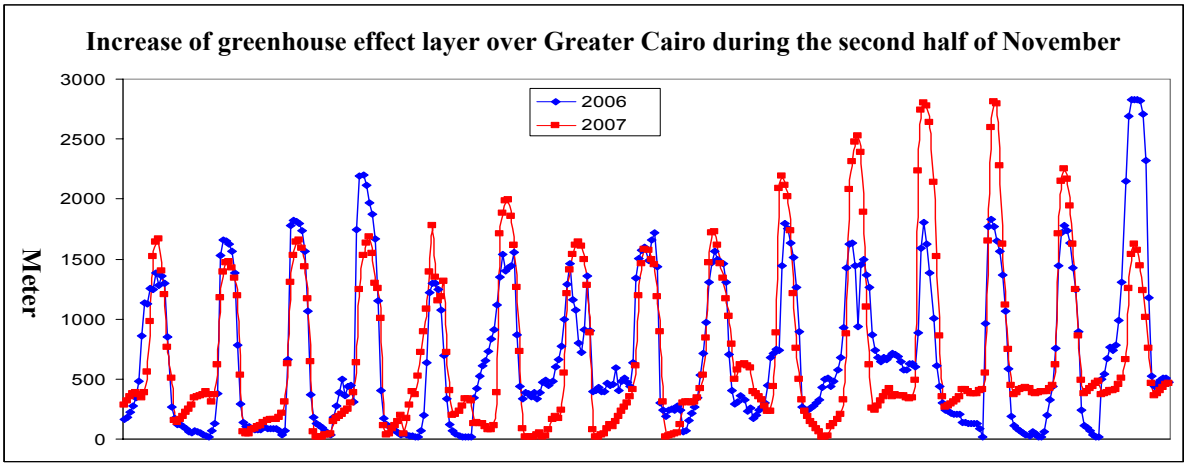


Figure (1.12): the thickness of the greenhouse effect layer over Greater Cairo during the second half of November 2006-2007

5. Similarity of weather conditions contributed to citizens feeling of increased pollutant concentrations but on the contrary, the PM concentration levels in some areas were

higher in 2006 than in 2007 as illustrated in figures (1.13) and (1.14).

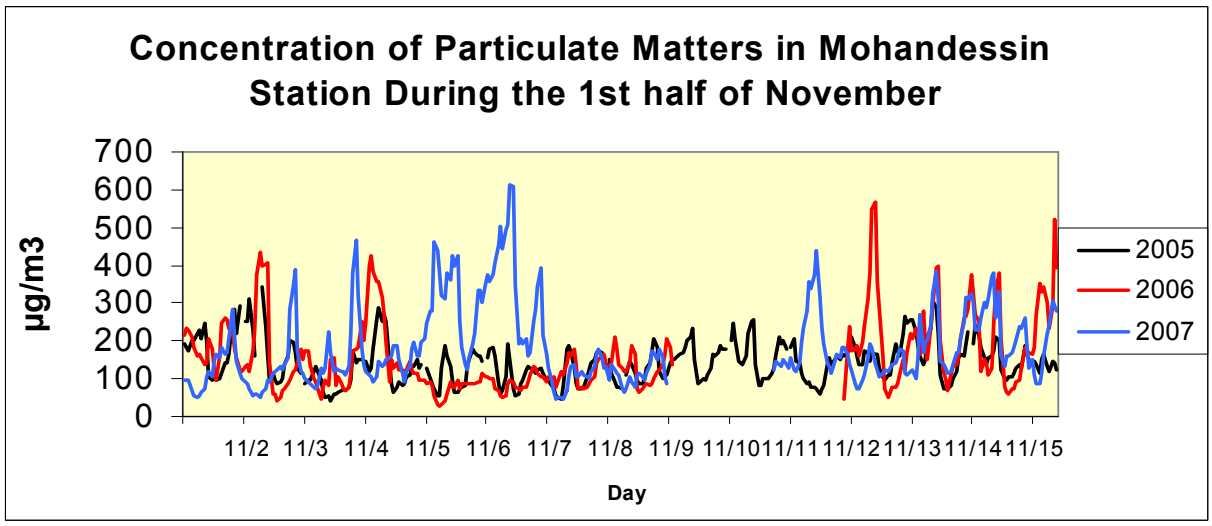


Figure (1.13): the concentration of particulate matters in Mohandseen

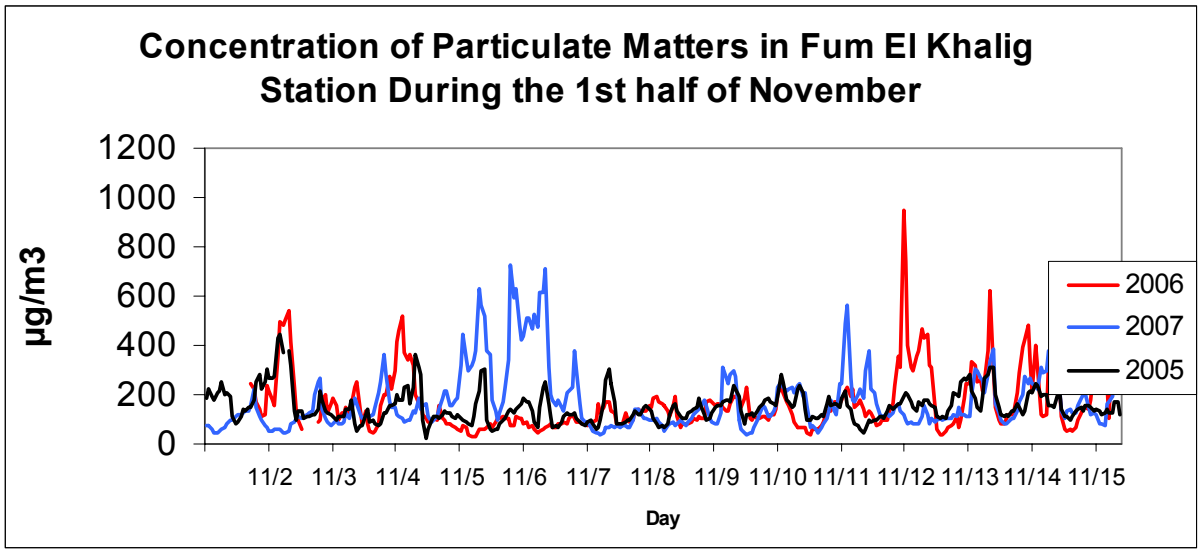


Figure (1.14): PM concentrations in Fum El-Khaleeg during November 2007.

Accordingly:

1. The general average of suspended particulate matters in November 2007 reached 165µg/g^3 whereas it was in 2006 and 2005 163µg/g^3 and 172µg/g^3 respectively.
2. Decrease of sever pollution in some areas indicates the successful strategy for tightly controlling the open burning of the municipal and agricultural wastes especially in Greater Cairo and the surroundings as well as lifting up the long-time accumulation of wastes.

3. Slight increase of the general average suspended PM in November 2007, in comparison with the concentrations monitored in November 2006, resulted from increase of traffic emissions in 2007 as well as the weather conditions prevailed in that period of time.

Efforts made by MSEA during 2007 for improving Air Quality

1. Cement factories

EEAA pays attention to monitoring the emissions from all major industrial sources as one of the most important preliminary steps to control and limit the harmful effects of those pollutants. Accordingly, a national network for monitoring emissions from factories and cement companies was established through electronically connecting self-monitoring networks of these companies with EEAA as the emissions are constantly monitored.

Cement industry in Egypt represents an important part of Egyptian economy. It is characterized by abundance of production and raw material sources. This industry has witnessed great developments during the last decades. Cement plants increased from 4 factories in 1975, with 4 million tons/year production capacity, to 15 factories by December 2006, with more than 35 million tons/year total production capacity. These plants cover wide areas in Egypt, in addition to investments intended to be directed to establishing new cement companies which, if approved, are expected to double production capacity.

The study on identifying the sources of each pollutant shows that current cement companies in Greater Cairo are responsible for about 6% of PM_{10} pollutant concentration in Greater Cairo generally. This ratio reaches 30% in the surroundings of these plants and companies.

Cement companies shifting from wet process to dry process with the purpose of rationalizing energy, water consumption, and maximizing production led to the problem of emitted dusts and By-Pass dusts appeared. These dusts are estimated at hundred thousands tons per year, which gives a kind of warning of significant problems in production sites as well as environmental problems in the surrounding areas (it is well-known that the dry process produces tripled amount of dust compared to the wet process). Currently a study on how to benefit from by-pass in terms of environment and economy is being conducted.

Cement plants monitoring results indicators during 2007

Daily round-the-clock monitoring for ensuring emission compliance with maximum levels stipulated in Law 4/1994 has shown the following:

1. 707 violations were recorded due to dust emissions from some cement plant stacks, which exceeded maximum limits stipulated in the Executive Regulations of Environment Law 4 /1994 all the year round (2007).

2. Highest number of violations (88% of violations) was recorded at the end of 2007, during September, October, and December, due to the development of the networks for monitoring dust emissions from cement plant chimneys by the end of 2007 which led to accurate monitoring of violations. Companies within Greater Cairo recorded the largest number of violations (65% of total number of violations).

comparing cement plants monitoring results in 2006 versus those of 2005, the Following was found:

Total number of emission violations of cement companies monitored in 2007 was 707 which decreased than those of 2006 which were 1024 by 31% as a result of monitoring efforts as well as the implementation of several industrial pollution control projects for the purpose of reaching high efficiency of emission control systems (filters)

2. Vehicle exhaust fumes

Vehicle exhaust fumes are the major source of air pollution in big cities with high traffic density specially in Greater Cairo which suffers from traffic jam problems as a result of the increase of vehicles number amounted to 2.1 million vehicles in 2007 which is more than road capacity. A study prepared by the National Institute for Transportation in cooperation with Japanese International Cooperation Agency (JICA) showed that an average of speeds of cars in Greater Cairo reached 11 km/h.

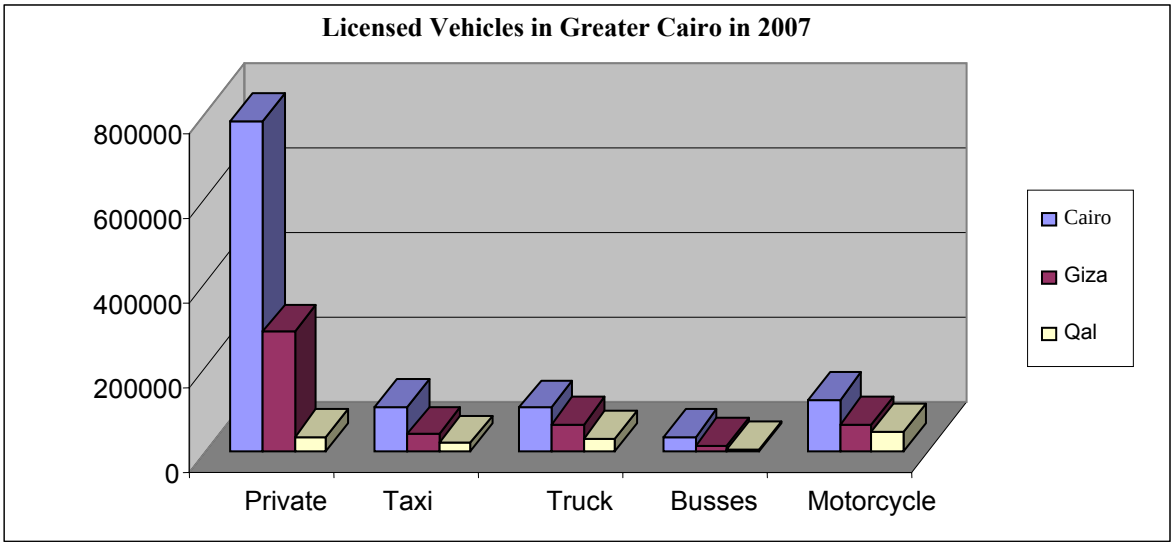


Figure (1.15): number of licensed vehicles in Greater Cairo in 2007

Results illustrate emissions from vehicle monitoring (gasoline -diesel– motorbikes) in Greater Cairo during 2005, 2006 and 2007. Hydrocarbons and Carbon monoxides are the most important source of pollution from vehicles in Greater Cairo as illustrated in figure (1.16)

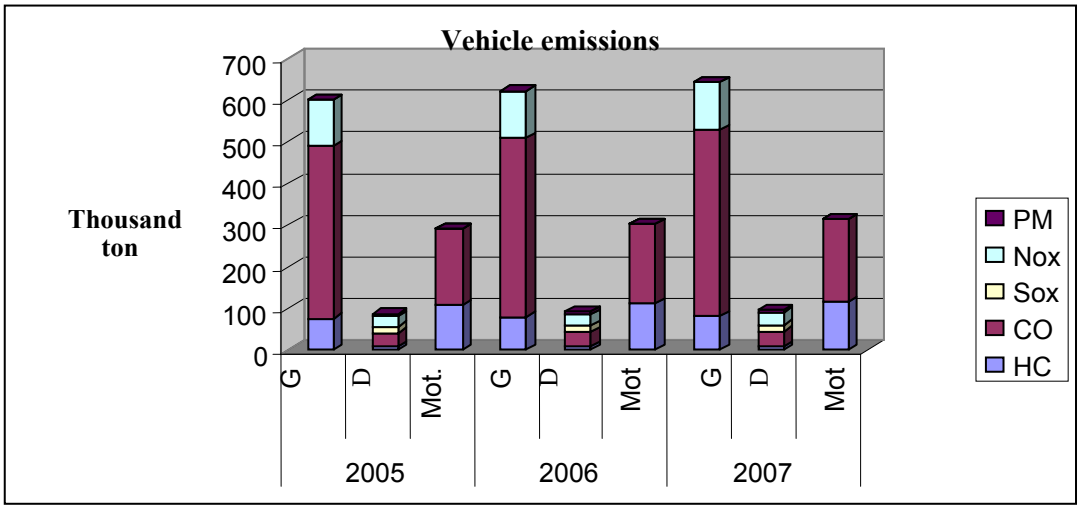


Figure (1.16): vehicle emission rates in Greater Cairo during 2005, 2006 and 2007.

Note : G = gasoline , D = Diesel, mot = motorcycles

The most important Programs implemented to Control Pollution from vehicle exhausts

1. Old Taxis Replacement Projects.
2. Vehicle exhausts testing program in traffic units
3. Vehicle exhaust testing on the road.
4. Natural gas use promotion program.
5. Environment protection from motorbike exhausts.
6. Garage relocation projects.

Old taxi replacement project

A. MSEA studies have indicated that car exhausts contribute to 26% of total PM_{10} pollution loads in Greater Cairo, more than 90% of Carbon monoxide pollution loads, 90% of Hydrocarbon pollution loads and 50% of Nitrogen oxides pollution loads. These non-environmental gases are harmful to the Environment and public Health.

B. Transportation sector is the main consumer of oil substances as it consumes oil fuel by 38 % of total fuel consumption in Egypt. The amount of gas oil annually consumed by the transportation sector is 7.2 million tons representing 84% of total gas oil consumption in Egypt (according to statistics of Ministry of Petroleum in 2005)

C. The problem of air pollution with car exhausts becomes severe as car fleet becomes very old and the aging of cars decreases their efficiency and highly consuming fuels compared with new cars. Subsequently, the emission of harmful gases from these cars increases.

D. Cars of more than 35 years represent 11% (three hundred twenty seven thousand cars) of the total number of licensed cars in Egypt while cars between 25 and 35 years represent 21% (605000 cars). These cars are very old models and lack new technology applied in modern ones, which raise the fuel consumption efficiency and reduces exhaust emitted.

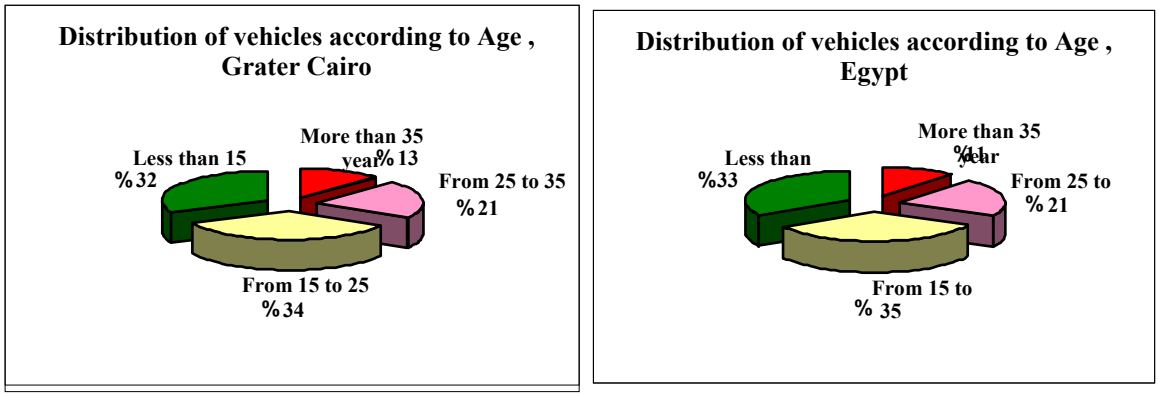


Figure (1.17): proportional distribution of these cars according to their age

E. During 2007, EEAA implemented an experimental project for replacing 100 old taxis of more than 35 years in age in Greater Cairo with new modern taxis work with natural gas. To cover the price of these new cars, the car owners are provided through Nasser Social Bank with a six-year loan with annual interest rate of 6% of the total loan. The banking interest due on the loan was incurred by EEAA to stimulate the old taxi owners to scrap their old cars and replace them with new ones. The cost of transforming cars to work using natural gas was also incurred by EEAA.

F. Based on the success of this experimental project as well as the old cars owners` embarking on participating in this project, this project first phase for replacing 1000 old taxis of 1960-1979 models was implemented in cooperation with both MSEA and Ministry of Finance through providing the taxis` owners with financial incentives amounted tens thousand Egyptian pounds for each taxi to be replaced. A cooperation protocol with the National Bank of Egypt was signed for the purpose of funding this project phase as well as providing soft loans for those taxis` owners.

G. Due to the importance of this national project, MSEA, in coordination with other stakeholders, has conducted a study for estimating environmental and economic bene-

fits that can be gained from expanding the application of this project over all taxis of more than 29 years of operation (up till 1979 models) in Greater Cairo (40,000 taxis).

H. In addition to environmental, economic and social benefits gained from this project , it is expected to promote auto market and increase sales, specially for new cars.

Table (1.7): the distribution of numbers of vehicles in Greater Cairo according to the type of license, and vehicle age.

Type of licensing	More than 35 years	From 25 to 35 years	From 15 to 25 years	Less than 15	Total
Private cars	114082	185054	265407	406726	971269
Taxis	23474	17097	21587	22752	84910
microbuses	7658	5456	6042	10153	29309
transportation	13004	31085	106896	23326	174311
busues	28044	76207	112426	8839	225516
Total	186262	314899	512358	471796	1485315
Percentage	%13	%21	%34	%32	%100

2. Inspection of vehicle exhausts as part of vehicle licensing:

In continuation of MSEA plans to link vehicle licensing to exhaust inspection and measurement, stage 4 of the program was implemented in 2007 in 6 governorates: Qena, Red Sea, Minya, Sohag, Faiyum, and Beheira. Accordingly, 95% of vehicles in Egypt have been covered till the end of 2007.

Figure (1.18)

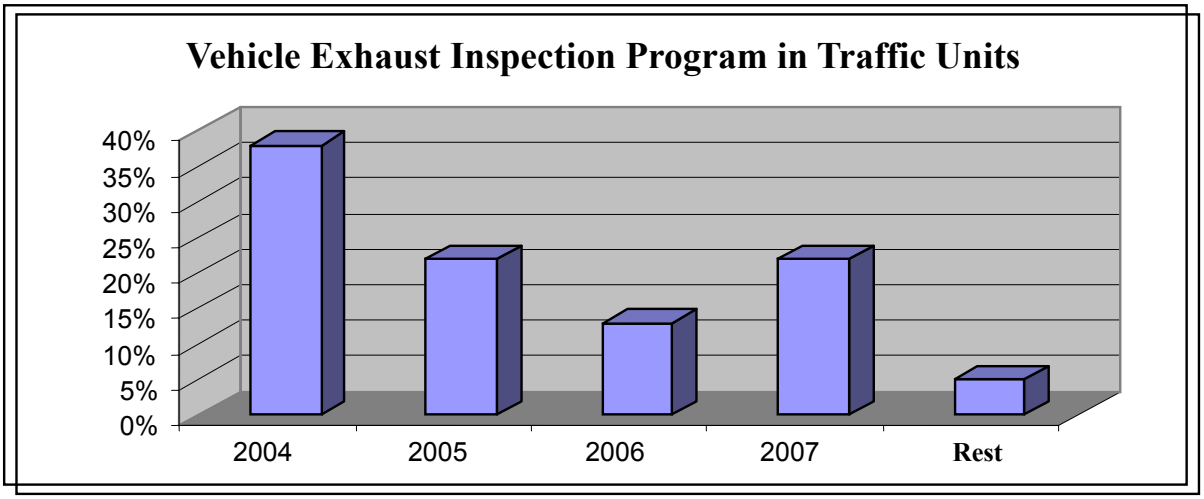


Figure (1.18): Developing Vehicle Exhaust Inspection Program in Traffic Units

3. On-The-Road Vehicle Exhaust Inspection:

During 2007, technical inspection of vehicle exhaust on roads was implemented in several Greater Cairo areas for 54,972 vehicles (gasoline- and diesel-powered) while 56,430 vehicles (gasoline- and diesel-powered) were tested in 2006, through joint campaigns by traffic departments in governorates and EEAA. Results indicate that almost 72% of the vehicles passed the test during 2006 and 2007, whereas the licenses of 28% of these vehicles were withdrawn because emissions released exceeded the limits stated in the Executive Regulations of Law No.4 of 1994, and owners of such vehicles were obliged to make necessary repairs and conduct re-inspection to ensure the compliance of exhausts with the limits stated in the said Law before re-licensing.

4. Cairo Transport Authority (CTA) Bus Inspection Program

A program for inspecting CTA buses was conducted in garages in 2007. Results indicated that exhaust from almost 36% of the total number of CTA and Greater Cairo Co. buses comply with the limits stated in the Law. Accordingly, coordination was made with Cairo Governorate and CTA officials to implement an integrated program for maintaining and environmentally re-inspect violating vehicles in order to ensure they are compliant with standards stated in Environment Law. Figure (1.19)

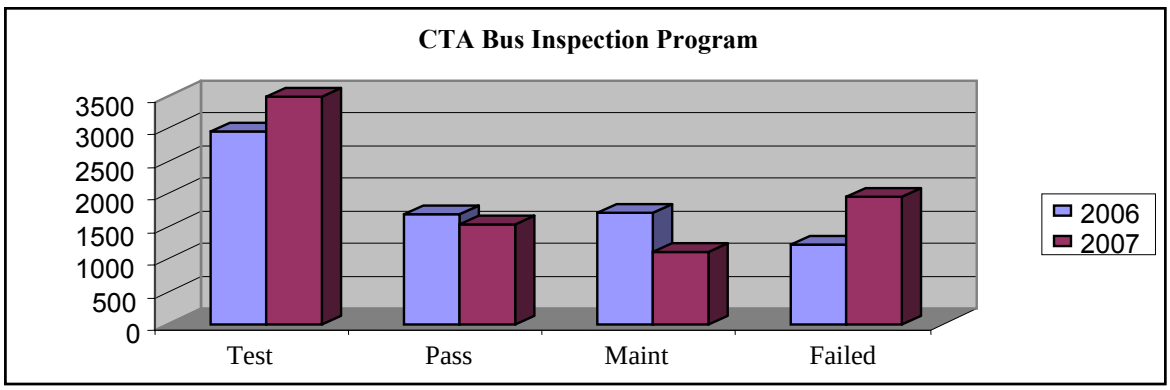


Figure (1.19): CTA Bus Inspection Program

5. Reducing Pollution from Motorcycles:

Studies conducted worldwide concluded that hydrocarbons emitted from one two-stroke motorcycle are equal to emissions from 10 – 15 gasoline-operated cars.

In Egypt, there are 730,000 motorbikes, more than 95% of which have two-stroke engines. In Greater Cairo alone, there are 300,000 motorbikes exhausting 150,000 tons of air pollutants per annum; thus, adversely impacting air quality.

In order to reduce motorcycle exhausts, production and importation of all motorcycles with two-stroke engines in all types and size have been prohibited as of 31/12/2007.
Concerning Tuktuk vehicles (rickshaws), EEAA in cooperation with the General Department for Traffic has conducted field studies on the nature of these vehicles and places where they spread in Daqahlia. Results showed that such three-wheel vehicles are compliant with environmental standards as they are powered by four-stroke engines and do not impose danger in comparison with two-stroke engine motorbikes.

6. Project for Garage Relocation Outside Residential Blocks

In collaboration among Cairo and Giza Governorates, CTA, General Organization for Physical Development (GOPP), a project for garage relocation outside residential blocks was studied based on the proposal by MSEA. Economic, environmental, and urban studies were developed for the project and new proposed relocation sites for submission to the Ministerial Committee for Utilities. Garages proposed for relocation are Teraa, Amoun, Athar al-Nabi, and Fom al-Khalig in Cairo, and Giza, Imbaba, and Tiba in Giza.

A: Proposed Sites in Cairo:

- The 52,000-sqm Al-Salam for relocating Teraa and Amoun garages; 305 vehicles.
- The 50,000-sqm Al-Qawmeya Cement (Tebbeen District) for future increase.

B: Proposed sites in Giza:

- The 130,000-sqm 6th October site, of which 90,000 sqm will be used as a garage (1000 buses), 40,000 sqm as a driver training center (360 vehicles). This site can accommodate future expansions of CTA services.
- The 30,000-sqm, 200-vehicle capacity Berqash site as an alternative for Giza, Imbaba, and Tiba garages.

Objectives of the Five-year Plan (2007-2012)

Continuing education, training and capacity building activities with a focus on the main causes of ambient air pollution and addressing internal air quality issues through implementing the following programs:

1. Fuel quality improvement and use of more environment-friendly fuel alternatives.
2. Vehicle exhaust management in rural and urban areas.
3. Expansion of old vehicle replacement project and developing standards and criteria for produced and imported cars.
4. Mitigating air pollution from existing industries.
5. Implementing the National Strategy for Safe Municipal Waste Handling.
6. Safe disposal of agricultural wastes and prevention of open burning.

References

(1) 2006Air Quality Monitoring Report, EIMP, Environment Quality Sector.

(2) 2005Air Quality Monitoring Report, EIMP, Environment Quality Sector.

(3) 2005Air Quality Monitoring Report, Environmental Monitoring Center, MOHP

(4) Air Quality Monitoring Stations, EEAA.

(5) Law 4 of 1994 and its Executive Regulations.