9. AIR

The atmosphere is in constant interaction with soil and water. It plays a crucial role in the water and carbon cycles and is the primary source of oxygen for living organisms. Air is also the receiving body for many pollutants from industries and motor vehicles. Human activities emit several toxic pollutants as well as ozone depleting substances (ODS) and greenhouses gases, which exert significant pressure on air quality. Preserving or restoring air quality is of paramount importance in order to protect public health and the local environment, and to address global environmental concerns. Proper air quality management includes measures to reduce and control pollutant emissions (e.g., environmental standards and cleaner production) and to monitor air quality on a

9.1 Air Quality

Air pollutants are generally grouped into primary and secondary pollutants. The list of primary pollutants generally includes particulate matter (PM_1, $PM_{2.5}$ and PM_{10}), lead, carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and volatile organic compounds (VOCs). Secondary pollutants include by-products of primary pollutants, such as ozone, and are usually country specific. Some air pollutants contribute also to global warming (CO, SO_x, NO_x) while other so-called greenhouse gases are not considered air pollutants, such as methane (CH_4) and carbon dioxide (CO_2).

Continuous measurement and monitoring of key air pollutants (e.g., particulate matter, SO_2, CO, lead) are necessary to determine actual air pollution levels. Continuous air quality monitoring at the national level does not exist in Lebanon. Partial data are becoming available either from local continuous monitoring (e.g., Tripoli, Meteorological Services at Beirut International Airport) or from sporadic monitoring campaigns (e.g., in Beirut, Chekka, along highways).

> The key air pollution hotspots in Lebanon are urban agglomerations (e.g., Beirut, Tripoli), due to exhaust gases from motor vehicles, and the areas near the power plants (e.g., Zouk, Jiyyeh) and the cement plants (e.g., Chekka, Sibline).

9.1.1 Particulate Matter

Particular Matter (PM) is a primary pollutant with significant impacts on human health. Ambient PM levels in Tripoli and Beirut are gradually becoming more available.

<u>Suspended Particulate in Tripoli</u>

The Air Quality Laboratory of the Tripoli Development and Environment Observatory has started measuring suspended particulate matter since April 2000 -- and sulfur dioxide (SO_2) since April 2001. The Laboratory has measured $PM_{2.5}$ (less than 2.5 microns or μ) and SO_2 levels at a fixed location on the roof of the building housing the Municipality of Tripoli (downtown Tripoli). PM_{10} (less than 10 μ) and Total Suspended Particulates (TSP) values were measured in El-Mina, initially at the pumping station roof and since then at the slaughterhouse roof. As indicated in Tables 9.1 and 9.2, average daily values of TSP and PM_{10} exceeded the Lebanese standards of 120 and 80 $\mu g/m^3$ (MoE Decision 52/1 dated 1996) 32 and 56 percent of the time, respectively. Measured average daily values of $PM_{2.5}$ exceeded the US EPA standard of 65 $\mu g/m^3$ 24 percent of the time (Lebanon has no air quality standard for $PM_{2.5}$).

Table 9. 1
TSP Levels Measured in Tripoli in 2001

Month (Year 2001)	*Number of Days Sampled*	*Average daily value ($\mu g/m^3$)*	*Number of Days Exceeding the Lebanese Standard (120 $\mu g/m^3$)*
January	17	85	5
February	12	117	7
March	12	139	8
April	-	-	-
May	-	-	-
June	11	127	5
July	-	-	-
August	10	122	8
September	10	141	7

Source: Data supplied to ECODIT by Tripoli Observatory, 2001

Table 9. 2
PM_{10} Levels Measured in Tripoli in 2001

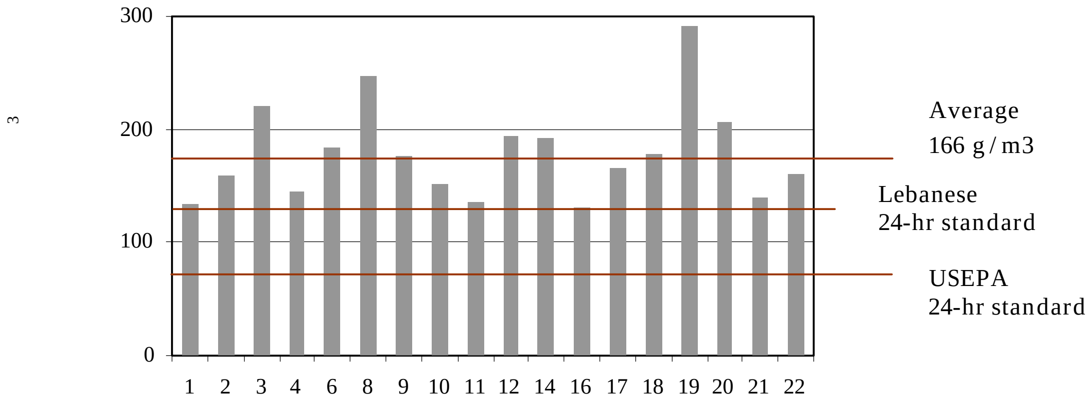
Month (Year 2001)	*Number of Days Sampled*	*Average daily value ($\mu g/m^3$)*	*Number of Days Exceeding the Lebanese Standard (80 $\mu g/m^3$)*
January	18	50	3
February	12	60	2
March	13	85	3
April	-	-	-
May	-	-	-
June	11	55	2
July	-	-	-
August	10	84	8
September	11	100	6

Source: Data supplied to ECODIT by Tripoli Observatory, 2001

Suspended Particulate in Beirut

The daily average concentration of total suspended particles (TSP), measured in Bliss Street, in Beirut between March 1997 and May 1998, fluctuated around 100 $\mu g/m^3$ and peaked several times at levels above the Lebanese standard of 120 $\mu g/m^3$ (Chaaban et al., 2001). These values are higher than WHO standards (60-90 $\mu g/m^3$ for urban regions). Air samples collected from many other locations in Beirut revealed that TSP concentration ^{3} ^{3} (Figure 9.1). In addition to vehicle-induced emissions, the major potential sources of particulate matter are motor vehicles traveling on dusty roads, on-going construction activities, and quarries. Anthropogenic sources coupled with the nature of the dry Lebanese climate, particularly during the summer, results in high dust levels in the atmosphere (METAP / ERM, 1995). While the measurements serve to give a general indication of particulates at various urban junctions, the clear implication is that anthropogenic activities contribute substantially to these levels.

Figure 9. 1
Average Particulates Concentrations at 22 Locations in Beirut



Source: El-Fadel *et al.*, 1999

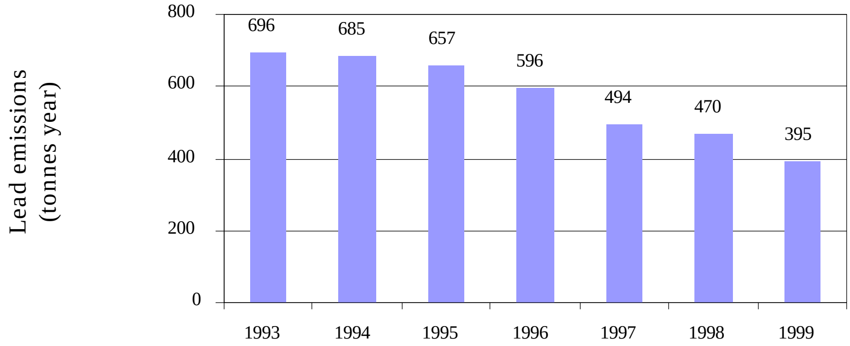
9.1.2 Lead

Lead is a heavy metal toxic to humans, animals, and plants. Food and water intakes and air inhalation are the main sources of contamination for people. Lead tends to accumulate in the blood, especially among children of young age. A high lead level in blood may cause harmful impacts on human health, especially on muscular and nervous systems. Children have less protection against lead contamination than adults and are therefore particularly sensitive to lead exposure. The most comprehensive study of lead exposure in Lebanon has been recently completed at AUB and published in several forms.[1] This study comprises several elements including measurement of lead levels in the air, socio-economic impacts of blood lead level reduction, and policy options for the phase out of lead in gasoline in Lebanon. A brief summary of this study is included below as lifted from the corresponding references.

Lead emissions are continuously decreasing as a result of the introduction of unleaded gasoline in 1993. Annual lead emissions from various gasoline grades were estimated based on gasoline consumption and characteristics (Figure 9.2). As a result, lead levels are expected to be high in various environmental media. Early studies showed a marked increase in lead concentrations in the seawater of Beirut following a rainfall, which was attributed to the use of lead in gasoline (METAP/ERM, 1995). Limited measurements of lead in the air (Chaaban *et al.*, 2001; El Fadel *et al.*, 1999) indicated a range of 0.1 to 0.8 $\mu g/m^3$. To investigate the degree of pollution resulting from the combustion of leaded gasoline, researchers from AUB developed and implemented a sampling program. For this purpose, 16 locations were selected in and around Beirut city: 11 in urban areas at major road intersections (including Sanayeh, Dora, and Tayouneh) and five in suburban areas (including Bsous, Fanar, and Bchamoun).

[1] Hashisho and El-Fadel, 2001a and b; Hashisho, 2000

Figure 9. 2
Estimated Annual Lead Emissions From All Gasoline Grades

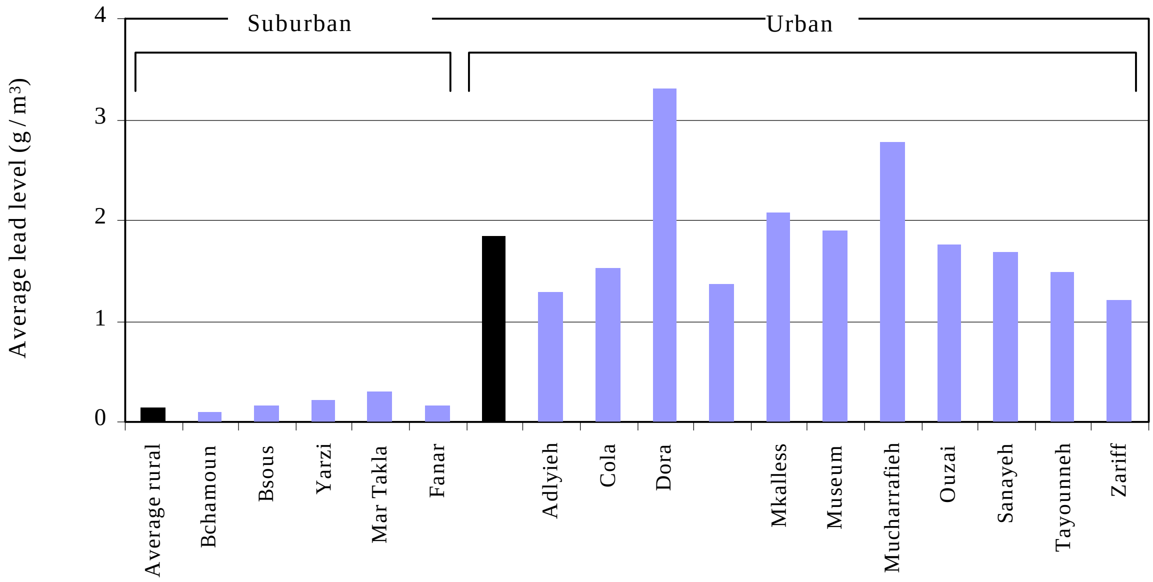


Source: Hashisho and El-Fadel, 2001a

Chemical analysis results

Lead concentrations at monitored urban locations varied from 0.17 to 4.64 µg/m³ with an average value of 1.86 µg/m³. In suburban areas, atmospheric lead concentrations were much lower than those in the heavily traveled urban locations and ranged from 0.052 to 0.295 µg/m³ with an average value of 0.147 µg/m³, which is about 12.7 times lower than the average measured in urban locations (Figure 9.3). These levels are much higher than values reported in countries where *lead has been phased-out from gasoline*: 0.2 µg/m³ in Mexico City (in 1998), 0.03 µg/m³ in Copenhagen (1995), and 0.04 µg/m³ in US Cities (1998).

Figure 9. 3
Average Air Lead Levels at Selected Locations in Beirut



Source: Hashisho and El-Fadel, 2001a

9.1.3 *Other primary pollutants*

Other primary pollutants include CO, SOx, NOx, and NMVOC. Information on the ambient concentration of these pollutants is very sketchy. In the Chekka region, periodic air quality monitoring program indicated elevated levels of SO_2 and NO_2 concentrations exceeding annual and 24-hour average Ambient Air Quality Standards (AAQS) as well as corresponding Lebanese standards at all sampled locations (see Table 9.3). In Tripoli, average daily values of SO_2 exceeded the Lebanese standard of 120 $\mu g/m^3$ 34 percent of the time (Tripoli Observatory).

Table 9. 3
Summary of the Air Quality Monitoring Results in the Chekka Region

Constituent	*Concentration range*	*AAQS*	*3* *(52/1, 1996)*
SO_2 (ppm)	0.45 - 0.7	0.14 (24-hour average) 0.03 (annual average)	120 80
NO_2 (ppm)	6.4 - 10.11	0.053 (annual average)	100
CO (ppm)	0.33	9 (8-hour average)	10,000
PM_{10} ($\mu g/m^3$)	67-316	150 (24-hour average) 50 (annual average)	80 NA

Source: Kobrossi, 1999

The First National Communication on Climate Change estimated total emissions for the base year 1994 as follows (see Section 9.1.5 for emissions of GHG that are not primary pollutants):

Nitrogen Oxides (NO_x)

NO_x emissions (estimated at 54.1 ktonnes in 1994) come from the combustion of fuel (energy and transport sector). Under high temperature conditions, nitrogen and oxygen react to produce nitrogen oxide. Nitrogen monoxide is the most common product of this oxidation and often reverts to nitrogen dioxide (NO_2). Nitrogen dioxide is a very reactive and corrosive gas, and a precursor of ozone (O_3).

Carbon Monoxide (CO)

CO is a poisonous gas that is absorbed by hemoglobins and limits the oxygen-carrying capacity of blood. Carbon monoxide comes primarily from the incomplete combustion of fuels. Energy consumption by transport, industry, and thermal power plants accounted for more than 99.4 percent of all estimated CO emissions in 1994. Agriculture is responsible for most of the rest of CO emissions (0.5 percent).

Non-Methane Volatile Organic Compounds (NMVOC)

Many organic compounds are volatile, i.e., they naturally evaporate at room temperature. Industrial processes are the main sources of volatile organic compounds (VOCs) with 76 percent of NMVOC emissions (see Figure 9.4). NMVOCs from industrial processes come from asphalt roofing production, road paving with asphalt, and glass production. Iron and steel production also contributes to NMVOC emissions (up to 1.25 percent of emissions from the industrial sector). The remainder of NMVOC emissions is related to the consumption of energy, primarily transport (96 percent of the emissions of the energy sector), and the evaporation of fuel from the fuel tanks, fuel injectors and crankcases.

Sulfur Dioxide (SO_2)

SO_2 emissions were estimated at 83 ktonnes in 1994. Fuel combustion for energy production is responsible for 96 percent of sulfur dioxide emissions, while industrial processes produce 4 percent of emissions (see Figure 9.5). Thermal power plants are responsible for more than half of SO_2 emissions from fuel combustion. Energy consumption by industries accounts for 31 percent of SO_2 emissions, of which three industrial branches are the main emitters: production of sulfuric acid, cement industries, and iron and steel mills.

Figure 9. 4
NMVOC Emission Sources

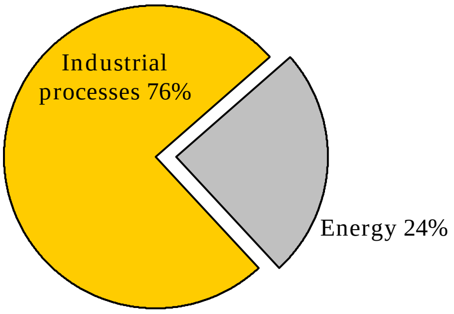
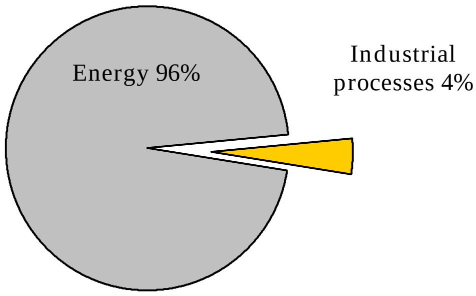


Figure 9. 5
SO_2 Emission Sources

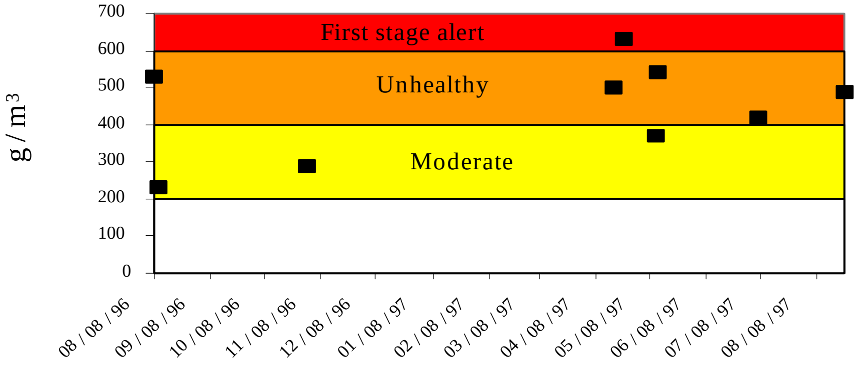


Source: MoE-UNDP, 1999

9.1.4 Secondary pollutants

In the absence of measured data on other secondary pollutants, this section deals only with low-level ozone, which results from the reaction between NOx and hydrocarbons in the presence of sunlight. Low-level ozone is a potential problem in urban areas and can cause eye and skin irritations. Sporadic measurements in Beirut between 1996 and 1997 indicated ozone levels often in the *unhealthy* zone and occasionally in the alert zone, above 600 $\mu g/m^3$ (see Figure 9.6). These values were measured using a calorimetric paper that changes color with a concentration range. Such a method is inaccurate and can be relied on only for screening purposes. More recent measurements conducted using advanced UV Photometric O_3 Analyzer indicated that the O_3 average background level on AUB campus is about 45 ppb (88 $\mu g/m^3$) (El-Fadel et al., 2001c). Certainly, the levels in vehicle-congested areas are expected to be higher.

Figure 9. 6
Ozone Concentration Levels (1996-97)



Source: LEDO Indicator #51

9.1.5 Greenhouse gases and climate change

In June 1992, Lebanon was among 155 countries that signed the United Nations Framework Convention on Climate Change (Rio de Janeiro, 1992). Following its ratification in 1994 (Law 359/94), the GoL prepared the *First National Communication on Climate Change* (MoE-UNDP, 1999). The National Communication Report represents the fruit of a concerted effort among many experts and collaborating institutions (LNCSR) and organizations (UNEP). The work included the preparation of a national inventory of GHG emissions by sources and removal by sinks, with 1994 as a base year. The inventory was developed according to the revised 1996 IPCC[2] guidelines. The GoL secured at the end of 2001 a GEF top-up fund to update
produce its second national communication.

The National Communication Report estimated GHG loads for seven major gases. Four (CO, SOx, NOx, and NMVOC) of those seven gases are primary pollutants and were discussed in Section 9.1.3. The remaining three gases (CO_2, CH_4, and nitrous oxide N_2O) are discussed in this section. CO_2 is by far the most abundant greenhouse gas, with an estimated 13,803 ktonnes of emissions in 1994 (see Figure 9.7).

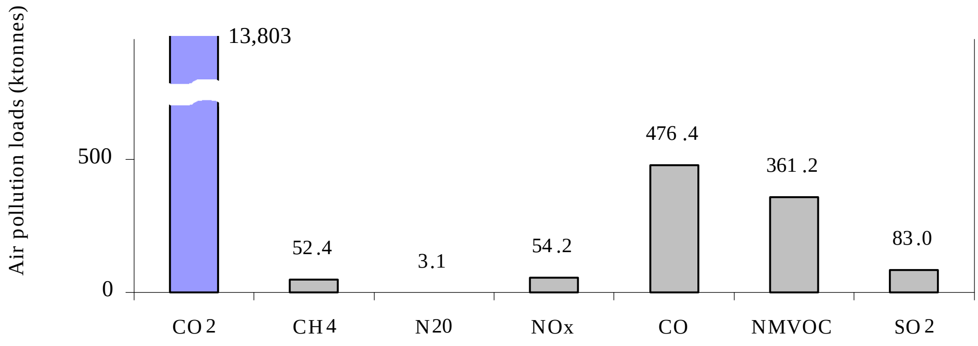
> GHG act as a blanket that retains solar heat in the atmosphere. Elevated concentrations of GHG cause increased atmospheric heat retention, leading to global warming. This process is suspected of having severe environmental repercussions such as coastal zone flooding and desertification. Lebanon is particularly sensitive to both flooding and desertification as it borders arid zones and almost two-thirds of its economic activity is concentrated on a narrow coastal strip.

<u>Carbon dioxide</u>

The combustion of fuel (fossil fuels and wood) is the primary source of CO_2. The consumption of energy accounts for 85 percent of CO_2 emissions while industrial processes emit 14 percent of total CO_2 (see Figure 9.8). Other sources are almost marginal, with land use and forestry contributing only one percent, in addition to negligible emissions from agriculture. Forests are also important GHG sinks.

[2] Intergovernmental Panel on Climate Change

Figure 9. 7
GHG Loads in Lebanon (1994)



Source: MoE-UNDP, 1999

The three largest energy consumers (and CO_2 emitters) are (1) transport, (2) thermal power plants and, (3) construction and manufacturing activities. About 77 percent of CO_2 emissions from the industrial sector come from the cement industry, while another 22 percent are emitted from the steel and iron industry. CO_2 emissions increase proportionally with energy consumption and economic activity. For example, CO_2 emissions due to energy combustion increased 35 percent (from 11,679 ktonnes to 15,777 ktonnes) between 1994 and 1999.

Methane

In 1994, 52.4 ktonnes of methane were emitted. The main source of methane is biogas production from organic waste decomposition (82 percent), followed by agricultural emissions and the energy sector (see Figure 9.9). Methane is a volatile organic compound contributing to the formation of photochemical oxidants like ozone and smog.

Figure 9. 8
CO_2 Emission Sources

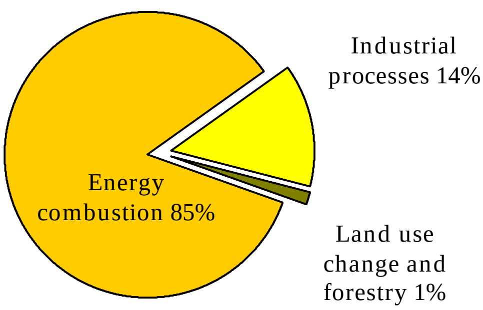
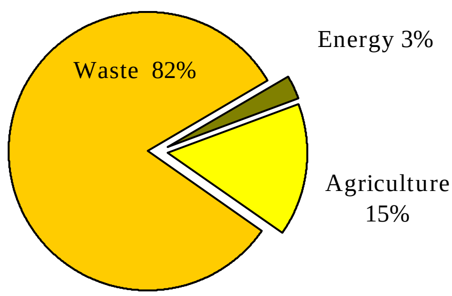


Figure 9.9
Methane Emission Sources



Source: MoE-UNDP, 1999

Nitrous Oxide (N_2O)

N_2O is a final product of the degradation of nitrogen fertilizers. Therefore, this greenhouse gas is primarily emitted by the agriculture sector. Lebanon generated 3.1 ktonnes of N_2O in 1994, 96 percent of which were emitted by agriculture.

9.2 Economic Costs of Air Pollution

Air pollutants cause adverse respiratory health effects, such as episodic or permanent respiratory illnesses and progressive respiratory dysfunction. These health effects have enormous economic implications on society (e.g., cost of illness, reduced productivity, restricted activity days). It is therefore essential to estimate the economic costs of air pollution in order to justify the cost of remedial and/or preventive actions.

9.2.1 Economic costs of particulate matter emissions

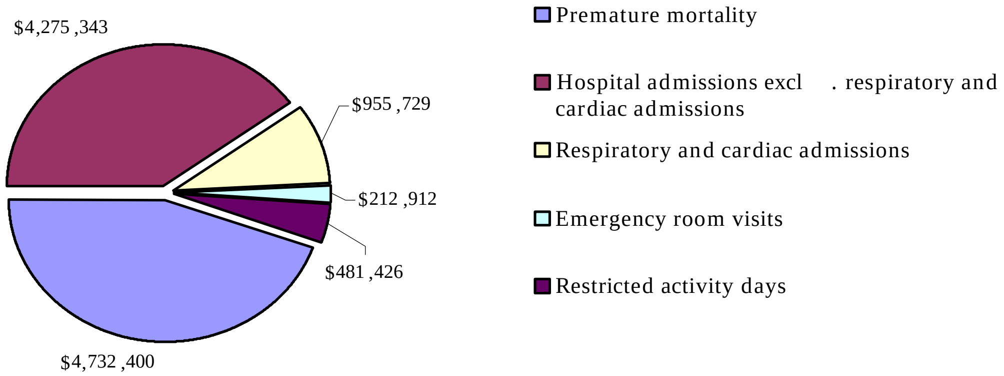
Total Suspended Particulate (TSP) is recognized as the most important air pollutant in terms of human health effects. Numerous epidemiological studies substantiate the intimate association between TSP concentrations in the air and health impacts. Generally, exposure to inhalable TSP can cause an increase in cardiac and respiratory mortality, as well as the impairment of pulmonary lung functions and an increase in daily prevalence of respiratory symptoms.

A 1999 study estimated the cost of TSP on public health in Greater Beirut (Djoundourian et al., 1999). According to the study, an increase of 10 $\mu g/m^3$ in the concentration of particulate results in:

- ❑ 80 excess deaths per year;
- ❑ 3,000 hospital admissions, 400 of which represent respiratory and cardiac conditions;
- ❑ 2,800 emergency room visits; and
- ❑ 14,160 restricted activity days.

The annual cost of these impacts was estimated at US $10,657,811 (see Figure 9.10). Consequently, if the concentration of particulate were to meet the international standard (i.e., reduction by 100 $\mu g/m^3$), then Greater Beirut would save US $106,578,110 annually. This is a conservative estimate (i.e., the true cost of air pollution is likely to be higher) since the study considered only hospitalization expenses. A comprehensive estimate would include the cost of both inpatient and outpatient treatment costs.

Figure 9. 10
Estimated Annual Cost of 10 $\mu g/m^3$ of Particulate in Greater Beirut



Source: Djoundourian et al., 1999

This study, the first reported attempt to quantify the health impacts of air pollution in Lebanon, has several limitations:

- Absence of air quality monitoring stations;
- Presumption that the relationship between pollution concentration and health outcomes in Beirut is the same as that found in the literature reviewed in this study; and
- Level of aggregation in the estimation of treatment cost for various diseases.

A subsequent assessment of the economic health impacts of air pollution has estimated the overall socio-economic impacts of decreasing particulate matter in Lebanese urban areas (El-Fadel and Massoud, 2000). Two economic valuation approaches were followed in this study, namely direct valuation using the human capital and cost of illness approaches for mortality and morbidity, respectively, and the indirect approach via the willingness to pay. Overall, the assessment suggests that potential health and economic benefits due to reduction in particulate matter can be substantial. A summary of the range of economic benefits for the main health endpoints is presented in Table 9.4. Economic benefits are dominated by mortality costs. The number of lives saved per year ^{3} reduction in PM_{10} in Lebanese urban areas is likely to fall between 12 and 617 lives and an economic benefit per case ranging between 55,000 and 705,000 US$ depending on the economic approach adopted (Table 9.4).

Table 9. 4
Economic benefit due to 10 $\mu g/m^3$ reduction in PM_{10}

Endpoint	*Number of cases avoided*	*Total Economic benefit (million US$/yr)*	
		COI[1]	*WTP*[2]
Mortality[3]	11-617	0.27-12.6	3.5-157.9
All COPD	31-441	0.06-0.9	0.98-13.9
All Pneumonia	13-189	0.03-0.4	0.05-0.7
Emergency visits	609-25,578	0.05-1.9	NA[4]
	Total	**0.41-15.8**	**4.53-172.5**

[1] COI = cost of illness
[2] WTP = willingness to pay
[3] Human capital approach
[4] NA = not available

Source: El-Fadel and Massoud, 2000

9.2.2 Economic health benefits of lead phase-out

Switching from leaded to unleaded gasoline would yield health benefits estimated at US$132.2 million per year (Hashisho and El-Fadel, 2001b). This estimate is based on baseline Blood Lead Levels (BLLs) of 15.5 g/dl for men, 9.9 g/dl for women, and 6.6 g/dl for 1-6 year old children in urban areas. This estimate further assumes that the phase-out of leaded gasoline would result in a 77 percent reduction in BLL of children and 78 percent reduction in BLL of men and women.

9.3 Key Policies and Actions

Air pollution is a serious concern that has prompted the MoE to develop new stack emissions standards for industries. Significant progress has been achieved by Lebanese Portland cement factories in reducing emissions, though local inhabitants still complain of excessive air pollution and respiratory problems. The polemic surrounding the sulfur content in imported diesel and fuel oil has not been resolved (see Section 3.3.2 on improving fuel quality). However, an important legal milestone was achieved with the promulgation of Law 341 (6/8/2001) aimed at reducing air pollution from mobile sources (see Section 5.4.2 for a description of the law).

9.3.1 Ambient air quality standards

MoE Decision 52/1 (29/7/1996) provide
air and water quality standards. These standards covered ambient as well as indoor air quality, in addition to noise levels and duration of exposure. In some cases however, the limit values were more stringent than corresponding WHO or USEPA standards. In view of such unrealistic limit values, the MoE developed and released a new set of standards for classified establishments, covering air emissions limit values as well as liquid waste discharge values. Decision 8/1 (2001) replaces all standards under Decision 52/1 (1996) except five, of which two cover air quality (ambient air quality and noise). Table 9.5 shows the ambient air quality standards retained from Decision 52/1 (1996).

Table 9. 5
Ambient Air Quality Standards (Decision 52/1, 1996)

Pollutant	^{3})	*Duration of exposure*
SO_2	350 120 80	1 hour 24 hours one year
NO_2	200 150 100	1 hour 24 hours one year
O_3	150 100	1 hour 8 hours
CO	30,000 12,000	1 hour 8 hours
TSP	120	24 hours
SPM_{10}	80	24 hours
Lead	1,000	1 year
Benzene (ppm)	5 ppm	1 year

9.3.2 Stack air emissions standards for classified establishments

The MoE/SPASI developed National Standards for Environmental Quality (NSEQ) and promulgated these new standards through Decision 8/1 (1/3/2001). The NSEQ set less stringent and more realistic emission levels compared to the previous Decision 52/1 (1996). The NSEQ apply to all sectors of industry and cover stack emissions and wastewater discharges. For stack emissions, the NSEQ include general emissions limit values by group of pollutants and specific regulations for single branches of industry. Refer to Section 3.3.3 on how the NSEQ were developed.

General emission standards

The general emission standards apply to all industrial plants (including power plants) as long as no specific regulations for single branches have been developed. The standards consider both the mass flow of emissions and the concentration of pollutants. For each group of pollutants, the standards define a mass flow threshold value: below the threshold value, there is no concentration emission limit value (ELV) and beyond that threshold, the emission concentration must comply with the limit value of the relevant group. Particulate inorganic pollutants, gaseous inorganic pollutants, gaseous organic pollutants, and cancer causing pollutants were assigned Groups (I to IV), where ELVs for Group I are the most stringent. For example:

- Dust: ELV is 200 mg/m^3 for new facilities and 500 mg/m^3 for existing facilities, provided the dust emissions contain no hazardous compounds.
- Lead (Pb), a particulate inorganic pollutant in Group III: ELV is 30 mg/m^3 for mass flow exceeding 50 g/h; and
- Toluene, a gaseous organic pollutant in Group II: ELV is 100 mg/m^3 for mass flow exceeding 4 kg/h.

Specific regulations for single branches

The following industrial sectors have specific regulations: Energy, power generators operated with fuel > 0.5 MW, Portland cement industry, glass industry, battery manufacturing, electroplating industry, aluminum manufacturing, food industry, and municipal waste incinerators. The standards specify ELVs for pollutants of relevance for each sector and distinguish between existing facilities and new facilities (stricter ELVs). For example, municipal waste incinerators, both new and existing, must comply with an ELV for dust of 30 mg/m^3. In contrast, the general standards define ELVs of 200 and 500 mg/m^3 for dust for new and existing facilities, respectively.

9.3.3 Attempts to comply with national standards

Some evidence of industrial compliance with national standards is becoming available. Compliance is a long and complex procedure which requires a pro-active involvement by the industries, several ministries (e.g., MoE, MoI) and research centers. It may also require modifications in the manufacturing process and costly pollution control measures. Section 3.3 describes on-going institutional and regulatory efforts to implement a national compliance action plan. The following section provides a targeted discussion of policy actions aimed at bringing cement plants into voluntary compliance.

Cement plants have long been recognized as the principle source of particulates (and other pollutants) emissions in their areas (*Chekka* in the North and *Sibline* in the Chouf region). Following mounting public pressure the MoE initiated a gradual dialogue with the concerned cement factories, aimed at reducing the emissions of dust, NO_x, CO, and SO_2 to acceptable limit values, while not burdening the sector. A Guidance Note was prepared by all concerned parties and promulgated by Decision 191/1 (September 1997). This Guidance Note addresses air pollution control, as well as the management of liquid effluents and solid waste that are generated by the cement plants. Specifically, the Guidance Note indicates the need to install appropriate technology for the control of dust and gaseous emissions throughout the production process, such as electrostatic precipitators and bag filters. The document also advocates the use of water sprayers and chemical dust suppressants to control dust emissions from secondary sources, such as the extraction of raw material by blasting, the unloading of trucks, and the storage of clinker.

In accordance with the Guidance Note, all four cement factories began installing various dust and gas emission control equipment in 1998-99. They later installed air emission monitoring equipment and began recording stack emissions on a 24-hour basis (around-the-clock). The MoE began receiving stack emission readings from the cement factories in 2000. These readings have so far indicated that emissions are generally compliant and rarely exceed environmental limit values (ELV) for periods greater than 15 minutes.

Currently, SCL, CN and Sibline monitor dust, NO_x and SO_2 emissions. Only SCL and Sibline are equipped to monitor CO emissions. SLCB monitors only dust emissions. The MoE has required of SLCB to prepare a feasibility for the installation of SO_2 and NO_x monitoring equipment.

When non-compliant emissions last more than 15 minutes, the concerned factory is required to send a report to the MoE explaining the reasons for non-compliance. In the absence of data on emission values before the implementation of pollution control measures, it is difficult to document the improvement in air quality in the region since 1995. Table 9.6 presents the relevant parameters for monitoring stack emissions from cement plants and their corresponding standards. Current ELVs (Decision 8/1) are more lenient than previous standards (Decision 52/1).

Table 9. 6
Environmental Limit Values for Portland Cement Plants

Parameter	*Emission Limit Values (mg/m³)*		
	Ministerial Decision 52/1	Ministerial Decision 8/1	
		New facilities	Existing facilities
Dust (general ELV in mg/m³)	150	200	500
NO_x (mg/m³)	1,200	1,500-2,000	2,500
SO_2 (mg/m³)	500	800	850
CO	Na	Na	Na

Source: MoE Decisions 8/1, 2001 and 52/1, 1996

9.4 Outlook

Several landmark regulatory developments are set to improve ambient air quality in Lebanon in the coming years. First among these is the phase-out of leaded gasoline: according to Law 341/2001 on reducing air pollution from the transport sector, leaded fuel in passenger vehicles will be banned by July 2002 (see Section 5.4.2 for a review of the law). As of January 1st, 2002, there was already a LBP 2,000 price differential in favor of unleaded gasoline (see Section 7.3 on phasing out leaded gasoline). A second landmark regulatory achievement are the new Emission Limit Values promulgated by MoE Decision 8/1 (2001).

To achieve compliance, MoE has developed a Compliance Action Plan (Section 3.3 provides a discussion of CAP). Verifying compliance requires national monitoring of both ambient air quality (continuous) and stack emissions (intermittent and spot checks). MoE has also developed an industry monitoring software (Section 3.3.3 provides a description of that software and its applications).

Continuous monitoring requires considerable technical and human resources, which can only be obtained by pooling resources from various public and private research institutions. The MoE could play an instrumental role in setting the framework for a national air quality monitoring plan (i.e., allocation of resources, data logging and sharing). Some examples of air quality monitoring capabilities follow and a more detailed

Section 12.7.2.

With technical and financial assistance from the city of Barcelona, Spain, the Tripoli Observatory for Environment and Development has established an air quality monitoring laboratory. It is the first such initiative at the local level in Lebanon. The Observatory is equipped to test the compliance of vehicle exhaust gases and to perform continuous air quality monitoring (SPM, SO_2) at fixed locations. It routinely publishes air quality data. The air quality lab in Tripoli, though still understaffed and under-equipped, is an important milestone toward institutionalizing air quality monitoring in Lebanon. Other cities and institutions should capitalize on such an experience and replicate it as appropriate.

Meanwhile, several private institutions are also acquiring valuable equipment and laboratory units for monitoring air quality. For example, with funding from USAID, the AUB Faculty of Engineering and Architecture has acquired a mobile air quality lab. The lab can perform continuous monitoring of select air pollutants (PM_{10}, CO, HC, NO, NO_2, NO_x, O_3 and SO_2) and meteorological parameters (temperature, humidity, wind speed, etc.). While the AUB also has the human resources to implement continuous monitoring, it first needs to synchronize and coordinate its efforts with other public institutions, such as the Meteorological Service of Lebanon, the National Center for Remote Sensing, and possibly other research institutions.