



# **Pollution in Lebanon**

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Pollution is caused by the need to dispose of waste, which may be defined as any gaseous, solid, or liquid material that is discarded because it has no further apparent use for the owner, industrial processor or manufacturer (34, 35). If not properly managed, its impact on the environment is seen as a change in the composition of air, water and soil in ways that are to some extent harmful to living things, irreversible, and that have already in places reached disastrous proportions.

Despite the fact that current population estimates vary widely from one source to another, ranging from 2.7 million, to nearly 4 million, there is a strong case for believing that the total current population in Lebanon lies between 3.5 and 4.0 million, including non-Lebanese (36), and they are unevenly distributed. Lebanon is a small country, and yet has a high population density of 365 persons/Km, and showing sharp regional variations reaching 1,600 persons/Km in the coastal areas, which contain 60% of the total population (4). These high coastal counts resulted from the combined effects of socioeconomic change and forced internal migration which originated from the urban areas of Mount-Lebanon (62%) and South-Lebanon (24%), and destined the peri-urban centers of Mount-Lebanon and the Greater Beirut Area (GBA) (27). Most of these lived in accommodations not originally designed for dwelling units, such as factories and offices. So, the population growth outstripped the provision of environmental services, from solid waste management to other element of urban life, and led to increase in the sources and types of pollutants that affected drastically the environment of the country and even surrounding countries. The impact focused on the air, water and even soil quality and caused the pollutants to enter the local ecological food chain of the inhabitants, and thus returning to humans in various harmful forms.

The major impact resulting from this over population is the wastewater management and its effect on the supply of water. The war caused severe damage to sewerage systems in the country. Large portions of the networks were badly damaged and there is widespread clogging or silting. Many of the sewerage systems are undersized in relation to the population that they now serve, representing 50%, following population growth and demographic shift.

The coastal zone is severely stressed as a result of the city, and tourist resort sewerage systems which, have either short outlets (Beirut, and southern suburbs), or are undersized (Ghadir, North Metn), or are old (Tripoli, Akkar), and empty their contents in rivers and the sea. Individual systems serve inland communities which discharge raw sewage into local streams. This chaotic sewage disposal is polluting, and contaminating the rivers (39) and the adjacent coastal area (22), especially around the ports, stressing strongly the marine life (23). In addition, at sea ports the discharge and disposal of ballast waters, the effect of dredging, and petroleum pollution from accidental spills from tankers, increase the pollutants and their concentration.

Water quality showed that Nahr Antelias, Nahr el Kalb, Nahbel Laban are believed to have high bacterial concentrations along its course, and source. The Naba'El Assal, a major domestic water source for Kesrouan, is known to be polluted by wastewater infiltration from uphill communities. The Bay of Jounieh and the Kesrouan coastal areas are considered unacceptable bathing waters because the bacterial content exceeds the WHO limit of 100 fecal coli/100ml (30).

In Tripoli and Akkar, the systems are old, and terminate with relatively short outfalls resulting in the diversion of part of the sewage to the open storm water channels from which it is used for irrigation, and contaminate the Akkar soil with Nitrate, which find its way to ground water (5). Six of the seven communities in the caza of Bcharre provided with sewer networks discharge their sewage into Kadisha/Abu Ali River whose waters are tapped by lower altitude communities. Part of the sewer networks serving the Koura and Zgharta communities are made of open channels. These channels often flood their contents contaminating the surrounding areas and exposing the inhabitants to potential risk of acquiring endemic diseases.

In 1993 the MoE collected data on bacterial contamination at 38 sites along the coast of North Lebanon from river outlets. The bacterial count ranged from 35 at Ras el Saker to 1100 in Jbail and Al Buhsas, to 11,000 at the Ramlet EL Baydah (19).

The sewer system in Jezzine terminates at a water outfall on the Aariye River, which provides water used for irrigation. Individual cesspools and percolation pits in the area contribute to pollution of local springs that are used for domestic supply. In Saida, discharge sewage along the shoreline at

more than 15 locations, stressing and contaminating the healthy marine life. Sour, is served by a separate sewer system that was constructed about 30 years ago leading to a single discharge output. The system is reported to be undersized, and lift station is not in operation at present, leading to frequent sewage overflows onto the street of the city and exposing its inhabitants to contamination.

Raw sewage from Baalbek is discharged to Ras El Ain stream. Some of the sewers are purposely blocked to allow sewage to be diverted for irrigation. Raw sewage from Zahle and other nearby villages discharge their sewage into the Berdaouni River which flows through a tourist area (WadiEL Arayesh) with many restaurants along its banks (31).

This extensive channeling of the sewage to the water system leads back to humans, in various forms in their diets as part of the food chain, where the pollutants find their way through water to plants, to animals, and to humans. The viable sector affected by the chaotic sewage management is the water supply, both from ground and surface water. Surface water provides 65% of potable water, differing between seasons, and if contaminated affects a large portion of the citizens. Water authorities, in addition, use some 208 springs for domestic supply. The major ones are Jeita, Kachkouch, Habb, Nabaa, El Kadi Dalle, Afqa, Mar Semaan, El Madiq, Kfaroue, Nabaa El Tasseh, Rayan and Chamsine. Some authorities, such as Batroun, Metn, Bcharre, Jbail, Nabaa El Kadi, Kesrouan, and Chamsine, rely almost completely on surface water, which are Mostly contaminated by the sewage system, and other sources.

Of the 352 wells (32) used for potable water supplies, only 28 were provided with operating chlorinates in 1992, today the figures are much more encouraging. Eight of the water authorities, supplying 23% of the total population, undertake no disinfecting. In addition, service connections are not routinely maintained and constitute a major source of water losses, and contamination from nearby sewage channels. Repairs only take place at request of subscribers. Furthermore, civilians performed connections with no adherence to construction standards during the war, and estimated at 30% of the total connections.

The non-hazardous wastes liquid effluent and slurries containing a range of organic and inorganic chemicals generated from industrial manufacturing (12) add another variety of pollutants to the water system in the country. The

1994 Census identified 23,517 industrial units in the country, the size distribution varies by sector, with nearly half of the largest enterprise concentrated in food processing and beverages, clothing, cement and associated building products (11, 14, 17). The number of units by Mohafaza clearly indicates that there is a strong concentration of industries in the Mount-Lebanon and Greater Beirut Area (GBA) which together comprise 57% of industrial units and 70% of the industrial workforce (16), and found within residential areas, especially in the southern suburbs of Beirut.

### **Spatial Distribution of Industry in the Lebanon**

Mouhafaza	No Industrial units	Workforce
GBA	2849	16,766
Mount-Lebanon	10,532	81,033
North Lebanon	4585	18163
Bekaa	2260	9780
South Lebanon	2054	8383
Nabatiyeh	1237	5588
<b>Total</b>	<b>23,517</b>	<b>139,713</b>

MoIP. census of industries, 1994.

This phenomenon is also distributed mainly along the coastal strip from Beirut to Sour, and from Beirut to Tripoli; in the region of Zahle and central Bekaa; and along the road Rayak-Baalbek, and Chtoura-Syrian border (25,26).

Unfortunately, industrial waste is disposed off, untreated, through municipalities, in addition to other disposal routes include informal on-site incineration, disposal to wells, and informal dumping concentrated on the western slopes and foothills of Mount-Lebanon, leading to additional

contamination of ground and surface water. Also many industrial processes use water for cooling purposes leading to thermal pollution when heated cooling water is released into streams and lakes, and changing the basic viable conditions for the survival of the marine life (20).

Although the impact of industrial discharges is focused on the coastal zone, the Litani river and Karaoun lake are seriously threatened by industrial run off from Zahle, Chtoura and Rayak, centers of agro processing (dairy products, wineries, food processing), the sugar beet factory at Anjar, Tanneries and Glue factories at Machghara, which discharge non-grading heavy metals such as chrome and arsenic (18,36). Today the river risks a complete drought.

Agricultural pollution comes indirectly from irrigation, and directly from organic wastes produced from farms in the form of manure slurries, silage effluent, and dairy washings, which end up returning to man if tracked by the food chain (1). The size of this pollution resulted from the small agricultural enterprise runned by relatively non-professional agriculturists. This is reflected in the irrigation systems, techniques, and the use of agrochemicals. Application rate for irrigation is very high compared with crop demand, at around 14,000m<sup>3</sup>/ha compared with a median value of 6000-7000m<sup>3</sup>/ha (10,15). About one quarter of cultivated land is irrigated by basin flooding; most of that is in the Bekaa resulting in substantial system losses from damaged and traditional networks (about 40%). This system leads to extremely low efficiency in use, long term soil salination, and break down of soil structure.

Use of agrochemicals represents a direct polluting factor affecting the agricultural sector, and its concern is related to the excessive use of pesticides for irrigated crops. During the harvest season, when sprays are regularly required in green house and on irrigated lands, farmers rarely conform to the specified waiting period, and use of out-dated coarse sprays for application of pesticides, which encourages over use and poses health risks to consumers of crops (2,3). The current unregulated use of pesticides caused considerable levels of pesticides to enter the food chain, through contamination of ground and surface water as well as direct contamination of food product, and marine life.

Fertilizers are widely used in particular areas where agriculture is intensive, available at relatively low cost, distributed irregularly by the private sector.

Its use is considered excessive, and detrimental to the country's calcareous soils as well as contaminating water supplies (ground water) with nitrates. In addition, rainfall encourages the nitrate leaching which promote it's movement to ground water (25). These poses potential health risks to children and babies if the water is used as a drinking source (28).

Other impact originating from this over population is the gaseous polluting emission, which originate mainly from transportation, and industrial sectors. Emission from vehicles seems to be one of the greatest contributors, concentrated in and around the great cities (37). Traffic congestion in urban areas constrains economic productivity, damages people's health, and worsens their quality of life. It is estimated that there are 320 vehicles/1000 people, which sum up to 62% of the domestic sector owning a car (6).

#### **Emission Level in GBA**

Pollutant type	Daily emissions (tons)	Average Annual Emissions (Tons)
NOx	45	30115
HC	54	36135
CO	225	150577
Lead	20.5	13731

Ministry of Environment (Transport Sector) 1998

The major gaseous emission from the transportation sector is CO, and is substantially higher than the WHO guide lines (22ppm) (7). This high concentration leads to a decrease in the oxygen-carrying capacity of people's blood living in the area. NOx is released from the exhaust into the atmosphere, in the form of NO, reacts with ozone to form NO<sub>2</sub>, a respiratory irritant that exacerbate asthma, and increase susceptibility to infections. It also reacts with Hydrocarbons (HC) to form ozone, an eye irritant, which are released into the atmosphere, and observed on a sunny summer day as smog in locations where the air mass has previously collected emissions of HC and NO<sub>2</sub>. It may persist for several days and be transported to long distances from the source, and thus affect the rural areas.

Unleaded fuel is not widely spread in the Lebanon, so the emission of lead and its compounds could be a threat to the human health. The GBA area shows total vehicle lead emission around 720 Kg/day (38). The estimates of lead in the atmosphere represent significant quantities and suggest that in heavily trafficked regions, lead can cause health problems, especially to children's IQ living and learning in those areas (28).

Atmospheric dust concentrations in the coastal areas are likely to be high because of the dry climate, whereas in the mountains they are lower where the soil is less dry. In addition, vehicle movement over unpaved roads, and agricultural activities contribute significantly to the ambient concentration of particulate matter, and especially in rural areas. Winds from the Arab dessert, especially from Egypt, offers its share to this climate stress during the springtime via the Khamasine winds hitting the coastal regions. In addition, Lebanon is believed to be affected by the fission products released into the atmosphere in large quantities by nuclear-bomb tests from Europe and the former Soviet Union; knowing that these products are concentrated between latitudes 30 and 60 degrees in both hemispheres, and that the country is hit by a succession of distributed cyclonic conditions from that continent in winter (35).

The industrial sector contributes another set of pollutants to the pollution profile of the country. The emissions covered are consequently those associated with the combustion processes. These include CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and total suspended particulate (TSP). The major industries of Lebanon include electricity, petroleum products, cement, chemicals, rubber, plastics, paper, ceramics, foodstuffs, textiles, and garments, and metal products. Emissions from the cement plants depend on the fuel used to fire the Kiln, and consist of the four pollutants of combustion, in addition particulate emission originating from the final product for the handling of the raw material. These dust emissions led to significant deteriorating effects in and around the plants. Selaata Fertilizer Factory (Chekka) produces, in addition to the four pollutants of combustion, triple super phosphate, simple super phosphate, and fluoride, which is a harmful gas to humans and animals. Winds from the south and west sectors predominate, but the foothills of Mount-Lebanon just inland may present a barrier to dispersion and emissions from the plant, thus affecting the ambient concentration of these pollutants in Batroun and nearby areas.



Sugar-beet Factory located in Majdel-Anjar, in south Bekaa plain represent a major emitter of combustion pollutant to this area, in addition to the sugar dust from the dry mill. The mountains to the north represent a barrier and emissions are channeled along the plain, to the northeast (14,11,17).

CFCs, gases commonly found in urban areas, and originate from the refrigerators and air-conditions, were extensively used for recharge of equipment, foam making, over stocking, and fire fighting. The ozone layer over the Middle East has become fragile, as a result of the petroleum combustion gases released during the gulf war (8). This pushed the government to ban the further import of halons, and replaced their use by non-ODS substitutes (13).

Sources of CH<sub>4</sub> in the Lebanon other than combustion have not been quantified. One relatively important source is the municipal waste landfill sites, of which there are two major ones in Beirut and a large one in Tripoli. Annual methane production from Beirut sites is likely to be approximately 5000 tons for the next ten years as of 1994, relative to the global warming effect of CO<sub>2</sub>, over the next 100 years, considering CH<sub>4</sub> is 21 times more potent.

The fuel oil for power generation in the Lebanon contains a maximum of 2.5% sulfur by wt. Most of the sulfur in the fuel is emitted as sulfur dioxide, with small proportion being emitted as sulfur trioxide (SO<sub>3</sub>), from Jieh TTH (fuel oil), Zouk TTH (Fuel oil), Zouk TG (Gas oil), and Hrayche TTH (fuel oil). Zouk TTH is the largest emitter of SO<sub>2</sub>. Jieh TTH emits about half the SO<sub>2</sub> emitted by Zouk TTH. The Jieh stacks are only 43m, and consequently will result in maximum ground level concentration approximately twice that attributable to Zouk TTH. Furthermore, the maximum annual average concentration will occur at a distance of 1 km in case of Jieh TTH, compared with 3-5km in the case of Zouk TTH. So the impact of the SO<sub>2</sub> emissions on air quality from the shorter stacks at Jieh may well be greater than the impact of the taller stacks at Zouk TTH, knowing that SO<sub>2</sub> is a corrosive gas and form acid rain with water vapor in the atmosphere. This effect is not pronounced due to the relatively alkaline soil of the country (9).

The burning of the heavy fuel oil in power stations for the generation of electricity is by far the major contributor to overall CO<sub>2</sub> emissions. The annual emission of CO<sub>2</sub> constitute only 0.037% of global emissions of

greenhouse gases. This is considered to be of no significant global importance, nor a priority policy area for national government.

Residential consumers use also, privately generated power, and so does the industrial sector. Private generators do not have any emission control devices and so present a far less efficient and more polluting option for power generation compared to EDL. It is likely that the majority of this emissions were in the GBA and to a lesser extent, Tripoli, and El-Mina. Today with the rehabilitation of the power sector, use of private generators has declined sharply.

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