1.4 Urban Air Pollution: Problems and Trends in Latin America

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Introduction

The total population of Latin America approximates 450 million. The annual increase of 2.3% exceeds that in Europe, North America and Russia though it is lower than in Africa (2.8%).

While population densities are moderate or low, 40 per km^2 in Mexico and 11 per km^2 in Argentina, the degree of urbanisation is high. This is 70% of the total population in Peru, Mexico and Brazil and reaches 85% in Argentina, Chile, Uruguay and Venezuela. In 1985 twelve Latin American cities had populations exceeding 2.5 million, and four of the world's largest conurbations are Latin America; Mexico City, Buenos Aires, São Paulo and Rio de Janeiro. Annual growth rates are high and by the year 2000 populations may reach 26 million in Mexico City and 24 million in São Paulo.

Total energy consumption and specific consumption by fuel type and by sector or socio-economic activity are important facts in air pollution. The per capita consumption of commercial energy approximates 30 GJ, low compared with a world-wide average of 60 GJ. Coal, the most polluting fuel, represents only 6%, liquid fuels 65%, gas 20% and primary electricity (mainly hydroelectric) 9% of commercial energy production. The major contribution to air pollution comes from liquid fossil fuels especially when used in motor transport. Latin America has 60% of the automobiles in all developing countries and annual growth rates are high, eg. 11% in Brazil compared with 2% in the USA.

A high degree of urbanisation, heavy motor traffic, with high vehicle emission rates due to poor technology and maintenance and low quality fuels combined with adverse meteorological conditions (sunlight, inversion, stagnation) mean that pollution problems are unavoidable. This will be illustrated by considering the metropolitan areas of Mexico City and São Paulo.

Air Quality Guidelines and Standards

National Air Quality Standards in the cities under investigation are summarised in Table 1 together with the corresponding guidelines of the WHO.

Table 1. National Air Quality Standards and WHO Guidelines (in µg/m^3)

Pollutant	t_{av}	Brazil	Mexico	WHO
SO_2	24h	365	350	100-150*
	AAM	80	-	40-60
SPM	24h	240	275	150-230*
	AAM	-	-	60-90
	AGM	80	-	-
Inh. Part. (<10 µm)	24h	150	150	-
	AAM	50	-	-
Smoke	24h	150	-	100-150*
	AAM	60	-	40-60
CO	1h	40.000	-	30.000
	8h	10.000	15.000	10.000
O_3	1h	160	220	150-200
NO_2	1h	320	400	400
	24h	-	-	150
	AAM	100	-	-
HC-CH_4	1h	-	160	-
Pb	3m	-	1.5	-
	AAM	-	-	0.5-1.0

t_{av}: Averaging time

AAM: Annual Arithmetic Mean

AGM: Annual Geometric Mean

* : 98th-percentile of daily averages for 1 year

SPM: Suspended particle matter

Air Pollution in Mexico City

The Metropolitan Area of Mexico City (MAMC) is situated in the Mexican Basin at an average altitude of about 2240 m. It covers an area of some 2500 km^2 surrounded by high mountains. Two valley channels, located in the North East and North West tend to funnel (contaminated) air to the centre and the South West of the city.

The local climate is subtropical with high average monthly temperatures around 15°C (12°C as lowest in January, 17°C as highest in May). Precipitation mainly occurs in the period June - September and totals 725 mm on a yearly basis. Due to the particular geographical characteristics and the light winds, ventilation is poor with a high frequency of surface as well as upper air inversions during winter time (on average 25 days/month in the period November - May).

The population approaches 20 million with an annual growth rate over 3%. The population density is almost 7000/km^2 in the centre to some 500/ km^2 in the least populated zones.

MAMC is the political, administrative and economic centre of Mexico with one third of the country's GDP, some 30,000 industries and 3 million motor vehicles moving slowly, responsible for 44% of the total energy consumption in MAMC and continuously loading the stagnant air with soot, SO_2, NO_2, CO, hydrocarbons and lead.

Air pollution monitoring in Mexico City began in the 1950s and by 1972, a 17-stations manual network for SPM (Hi-Vol) and SO_2 was functioning on a daily basis. In 1985 an automatic network with 25 stations for SO_2, CO, O_3, NO_x and hydrocarbons (HC) became operational as well. Despite this long history information is still incomplete.

In the late sixties and early seventies annual average SO_2 levels were in the range 40 - 190 mg/m^3, with daily maxima occasionally as high as 500 - 900 mg/m^3. Over the years the situation has not improved much and average SO_2 levels (50 - 160 mg/m^3) are still above WHO guidelines (Table 1).

Average SPM levels (Hi-vol gravimetric determination) were between 60 and 150 mg/m^3 by the end of the sixties and yearly average levels are now 150 mg/m^3 with daily maxima exceeding the 1000 mg/m^3 level.

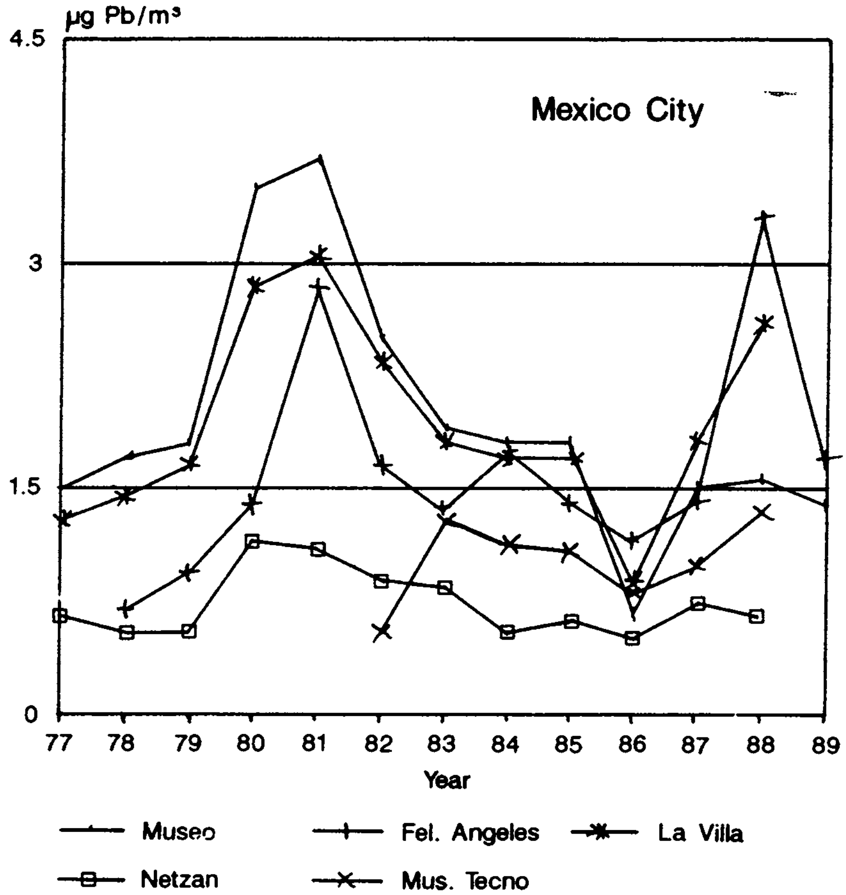
While the lead content of gasoline has officially been lowered from 3.5 ml/gallon before 1981 to 0.64 in 1986, lead-free gasoline is still not available locally. Consequently average lead levels are still too high though some overall improvement has been noted over past years as illustrated by Figure 1.

Ozone is undoubtedly Mexico City's air pollution problem number one, especially in the SW region. Hourly levels exceed 160 mg O_3/m^3 a couple of times (on the average 4 hours) during 70% or more of the days. Hourly peak values have been reported reaching 700 mg O_3/m^3. Recent reports (1) show a deterioration since 1986/87 when gasoline was reformulated with a lower lead content.

CO levels have been reported as surprisingly low (1) despite the extremely advance local conditions. However, a systematic overview of the actual CO measurements in Mexico City seems hard to find. The same applies to nitrogen oxides.

In conclusion it can be stated that the MAMC has very serious air pollution problems, mainly linked to local motor traffic.

Figure 1. Average Lead Levels in Mexico City



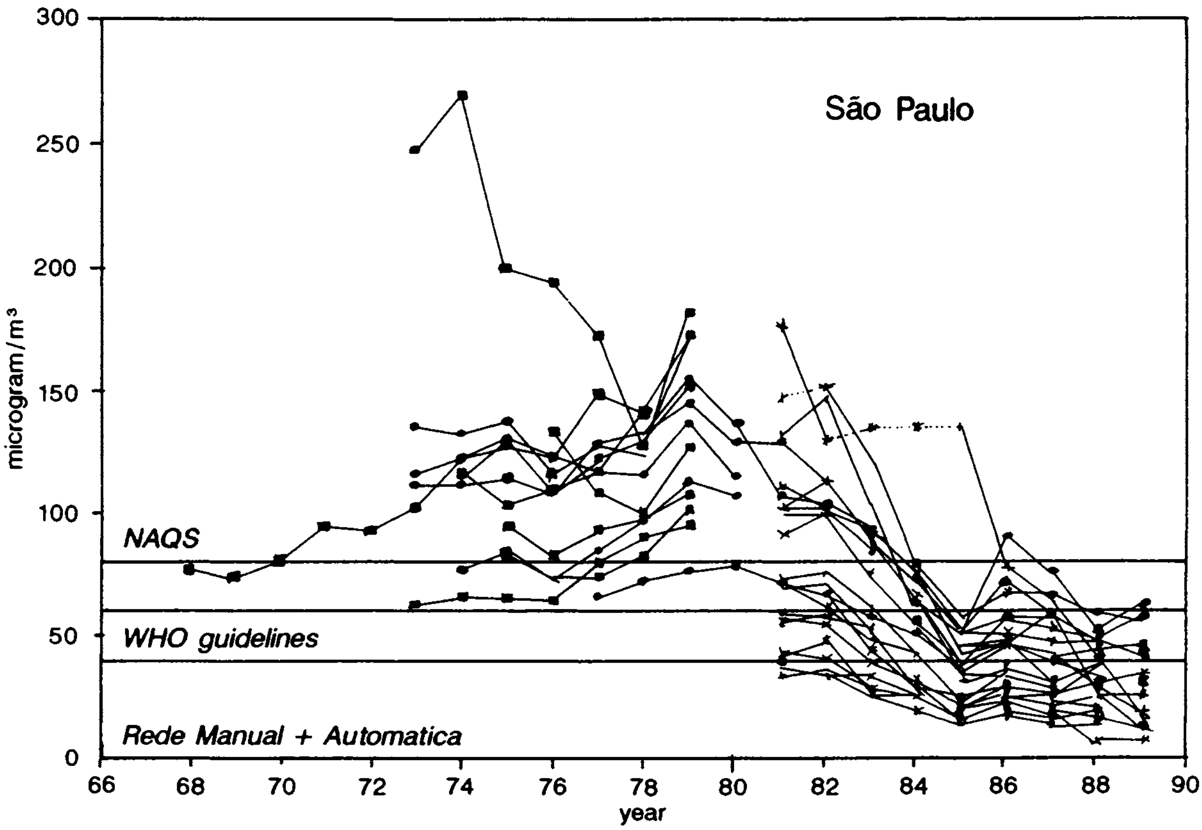
Air Pollution in São Paulo

The economically most important region in Brazil is the so-called Greater São Paulo Area (GSPA). The total area is close to 8000 km^2 with a complicated topography dominated by 650 m to 1200 m high hills. Some 5000 km^2 of GSPA is urbanised. The total population is approximately 17 million and continues to increase.

The local climate can be summarised as a dry winter (minimum temperature 8°C) followed by a wet summer (maximum temperature 30°C). In winter time subsidence inversions frequently occur with 'unfavourable dispersion conditions' 50% of the time. With almost 4 million motor vehicles major air pollution problems are a likely risk.

Air pollution monitoring started in 1968 with the measurement of the daily average SO_2 and smoke levels at one site. In 1981 CETESB (2) started a telemetric monitoring network with 25 fixed sites. SO_2 pollution showed an increase in the 1970s, a significant decrease in 1980-85 and a stationary situation afterwards (figure 2a). NAQS levels were met at all sites by the end of the 1980s and all average SO2 levels were within WHO guidelines.

Figure 2a. Yearly SO_2 Average in Manual and Automatic Network

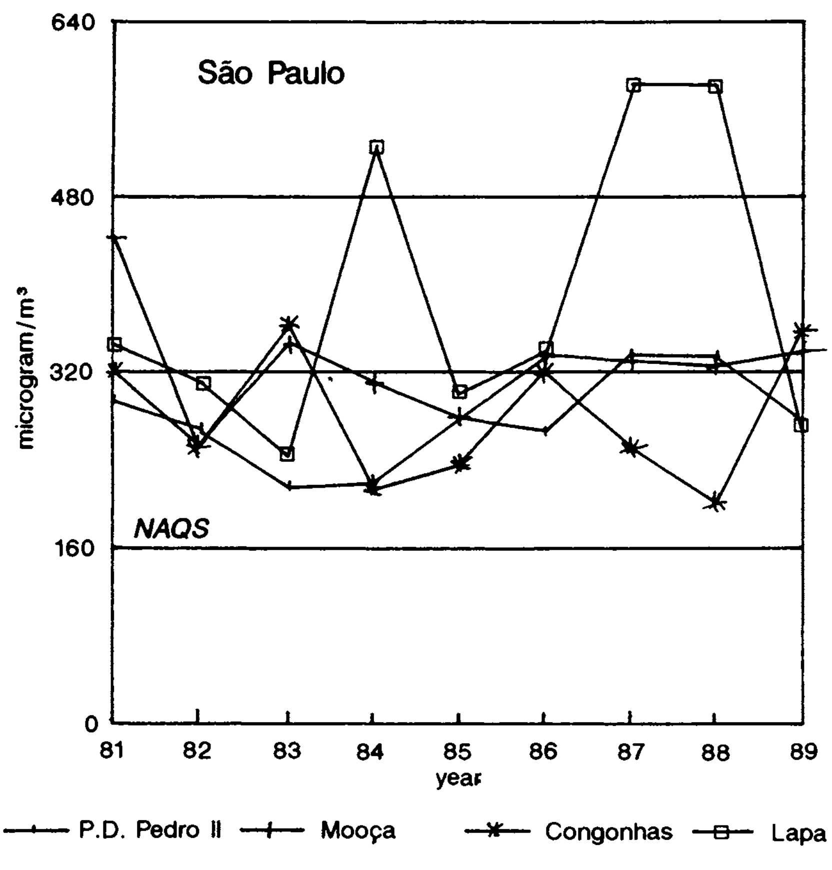


Measurements of Suspended Particle Matter (SPM) showed only a minor downward trend over six years. Major efforts to reduce ambient smoke levels have been less successful than for SO_2. WHO guidelines and NAQS standards are frequently exceeded at certain sites, particularly in winter. The enormous fleet of badly maintained diesels is the most probable cause of this problem.

The CO situation in São Paulo is really worrying and no improvement has been noticed over the past years. WHO guidelines and NAQS standards are exceeded in 4 out of 5 monitoring sites. In order to address this problem, and other traffic related problems such as NO_x, HC and O_3, the National Environmental Council enacted on 6 May 1969 an automobile emission control programme under which emission limits become progressively more stringent.

Nitrogen oxides, volatile organic compounds, high ambient temperature and intense solar radiation are ideal for ozone production at ground level. All these conditions are frequently met in São Paulo. The seriousness of the problem is illustrated in Figure 2b.

Figure 2b. Maximum Hourly Ozone Levels in Four Different Sites



The results of systematic monitoring of the daily lead levels at different sites show figures below WHO guidelines (Table 2). This reduction with time has occurred despite the rapid increase in vehicle numbers from 1.5 million in 1976 to over 4 million in 1990. The National Alcohol Programme launched in 1975 to reduce oil imports has been responsible for this by the introduction of gasohol (gasoline with 13 to 22% anhydrous ethanol) and the introduction of alcohol-based Otto engines; by 1990 more than 90% of the new cars will have alcohol-based engines.

Table 2. Three Monthly Average Pb-Levels (μg Pb/M^3) in São Paulo

Site	1978	1983	1987
1	0.8-1.4		
2	0.9-1.2		
3		0.1-0.3	0.2-0.4
4		0.2-0.6	0.1-0.4
5		0.1-0.2	0.1-0.2
6	0.8-1.6	0.2-0.4	0.4-0.5

Acknowledgement

Collecting and analysing air pollution data for Latin America has been a slowly moving process over the past years. Although still incomplete, the first results are beginning to emerge. To a large extent this is due to the information obtained from many different local agencies and individuals and the help and support from the Monitoring and Assessment Centre (MARC) in London, the World Health Organisation (WHO) in Geneva and the United Nations Environmental Programme (UNEP) in Nairobi.

References

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