PARIS CITY REPORT

Agnès Lefranc
Benoît Chardon

Regional Observatory of Health

Paris

France

PARIS CITY REPORT

Table of contents

PARIS CITY REPORT

Summary of the main findings

Air pollution levels and trends compared to EC limit values:
In Paris metropolitan area, the level of air pollution globally shows a trend toward a decrease over the last years.
The annual mean level of **nitrogen dioxide** in 2002 was 44µg/m^3, which is slightly higher than the European limit value for 2010 (40µg/m^3). For this pollutant, the levels are decreasing since 1997 (annual mean level in 1997 was 57µg/m^3).
The annual mean level of **black smoke** (BS) in 2002 was 17µg/m^3. The levels of BS have been decreasing for years in Paris metropolitan area: annual mean level was about 150µg/m^3 at the end of the 50's. Over the last four years, the levels are stable.
The annual mean level of **fine particulate matter** (PM10) in 2002 was 22µg/m^3, which is slightly higher than the European limit value for 2010 (20µg/m^3), but lower than the limit value for 2005 (40µg/m^3). Over the past five years, the levels of PM are stable.

The analysis estimated that reduction of the long-term PM pollution to the levels of PM2.5 of 15 ug/m3 would reduce mortality in Paris by about 850 deaths in one year, which would save about 410 years of expected life for starting year of simulation. If the daily means of PM10 would be kept under 20 ug/m3, about 100 deaths and 140 hospital admissions for cardiovascular causes could have been avoided in the year 2000.

Main causes of air pollution in the city, and actions implemented / planned to reduce it:
The region witnessed relatively high industrial emissions before the plants were relocated and their emissions therefore reduced, and were then replaced by high emissions from traffic. Today, most actions aiming at reducing air pollution levels are hence directed toward traffic emissions.

Background

- In the previous APHEIS report, similar HIAs were conducted. Exposure and health data were obtained from the same sources. In the previous report, exposure and health (mortality and hospital admissions) data used were the ones of year 1998. The results showed that compliance with the 2010 limit value for particulate matter could potentially induce a rather large public health benefit (decrease of about 800 long-term deaths per year).
- In general, results of the ERPURS, PSAS-9 and APHEIS studies are often used as a good argument in favour of the measures taken to reduce emissions, or more generally speaking in favour of the prevention policies taken to reduce current pollution levels. Hence the results of APHEIS3 may be used in this context in Paris metropolitan area.
- Air quality is really a concern for both general public and decision makers in Paris metropolitan area, even if the levels of air pollution are almost compliant with European limit values for 2010.

- In this report, the analyses have been done using year 2000 data for air pollution exposure, year 1999 data for mortality and population size and year 2001 data for hospital admissions

Sources

Principal sources of air pollution were described in detail in the previous Apheis city report last year (www.apheis.org). This is an update of the main sources of air pollution. The most recent inventory of air pollution sources was made in 2003, during the preparation of the Ile-de-France plan for protection of air quality. Table 1 presents some of the results of this inventory

Table 1. Main sources of air pollution (2003 PPA inventory)

Pollutant	Road	Heating	Industry	Other sources (transportation other than road, incineration of garbage…)
PM	36.9%	4.9%	46.3%	11.8%
NO_2	49.4%	15.5%	20.6%	14.5%

Transportation is the main source of NOx: road transportation itself contributes to 49.4% of the NOx emissions, and other transportation contributes to 10% of the emissions. Concerning PM, the pattern is less decided: road represent 36.9% of the emissions and the remaining 63.1% are produced by burning of fossil fuels in generating stations, industry, factories, office buildings, and homes and by the incineration of garbage.

Exposure data

Air pollution indicators are monitored by AIRPARIF, which is the agency entitled to monitor air quality within metropolitan Paris.
Measurements from urban background monitoring stations, which are representative of the study area and not directly influenced by sources of air pollution have been selected.
PM10 are measured since 1995, and in 2000, there were 7 background-monitoring stations within the study area. PM2.5 are measured since 1998, and there was a single background monitoring station within the study area in 2000. The measurement of PM are performed with TEOM instruments. In Paris, as everywhere else in France, no correction factor is applied to these measurements for the purpose of air quality monitoring. However, for the present long-term HIAs, and in order to be homogeneous with the other APHEIS cities, a correction factor of 1.37 was applied to winter PM10 measures.

Concerning Black Smoke (BS), the network is very old, and there were 10 background-monitoring stations within the study area in 2000.

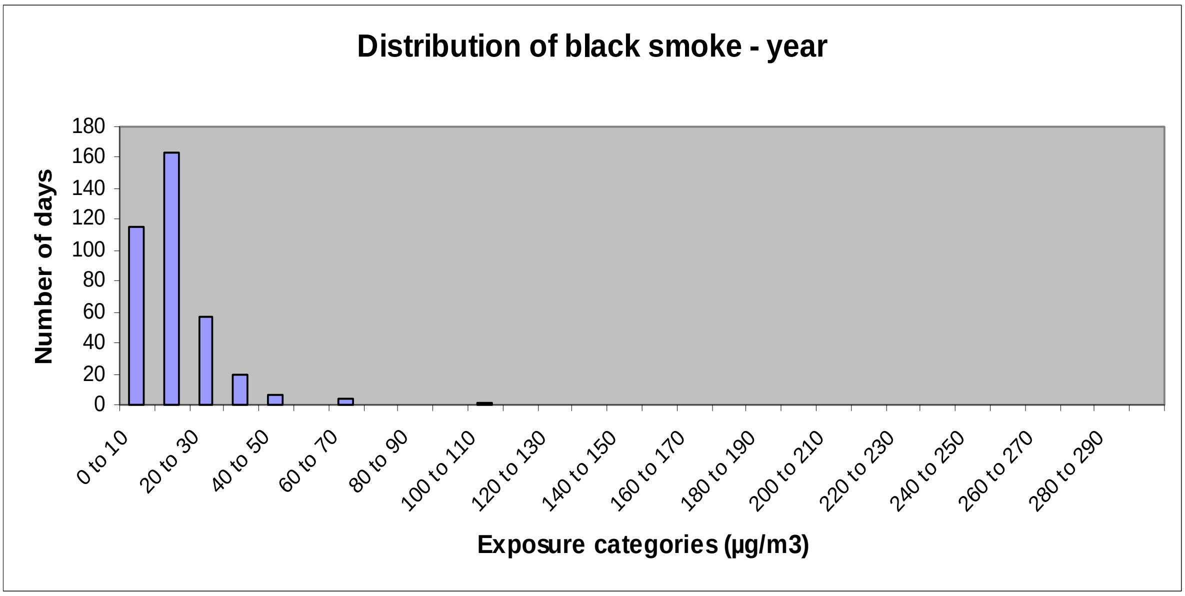
For 2000,
- daily mean level (SD) of measured **PM10** was 22µg/m^3 (9.3)
- The level of PM10 reached during the 18 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 12µg/m^3 and 37µg/m^3

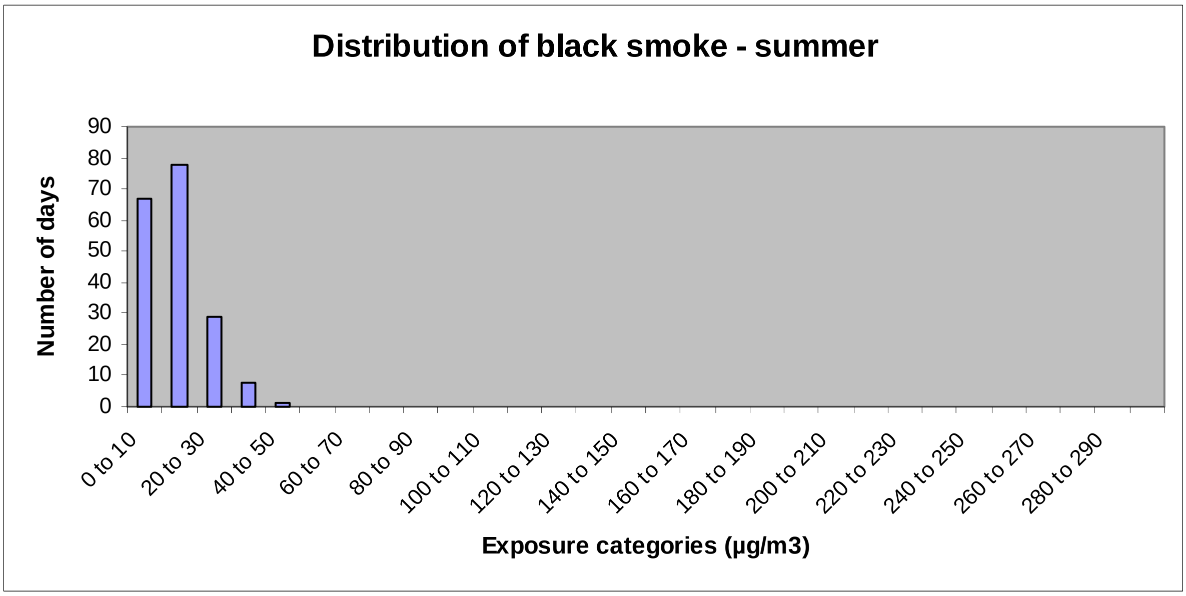
- daily mean level (SD) of measured **PM2.5** was 14µg/m^3 (6.9)
- The level of PM2.5 reached during the 18 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 7µg/m^3 and 26µg/m^3

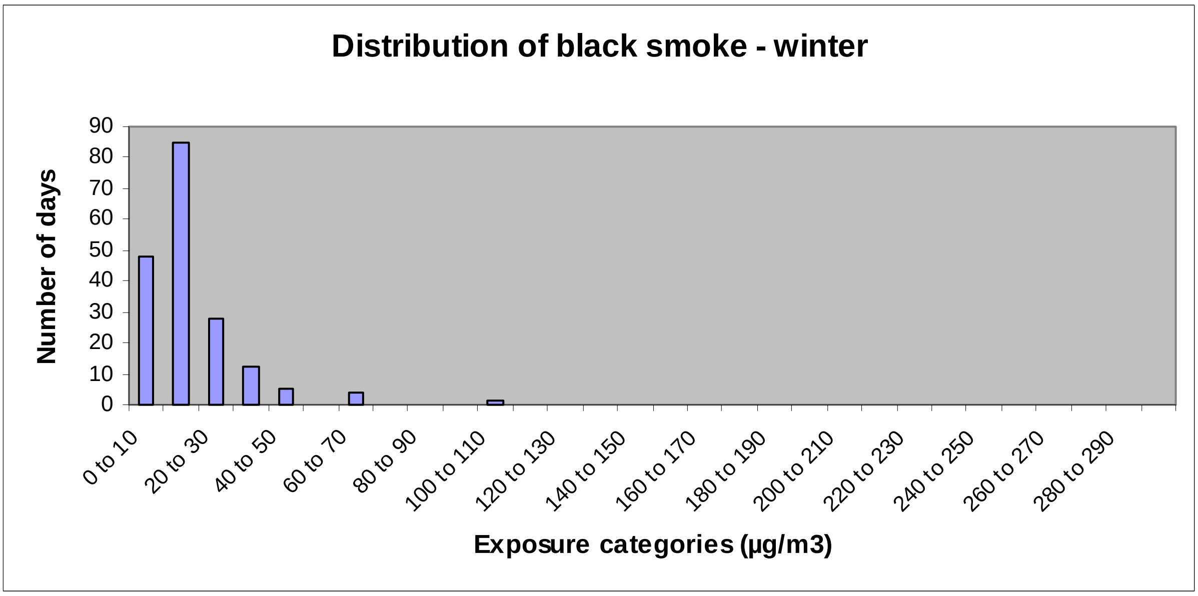
- daily mean level of **BS** was 16µg/m^3 (10.6)
- The level of BS reached during the 18 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 6µg/m^3 and 34µg/m^3.

Table 2 .Number of days when air pollutants exceeded limit levels

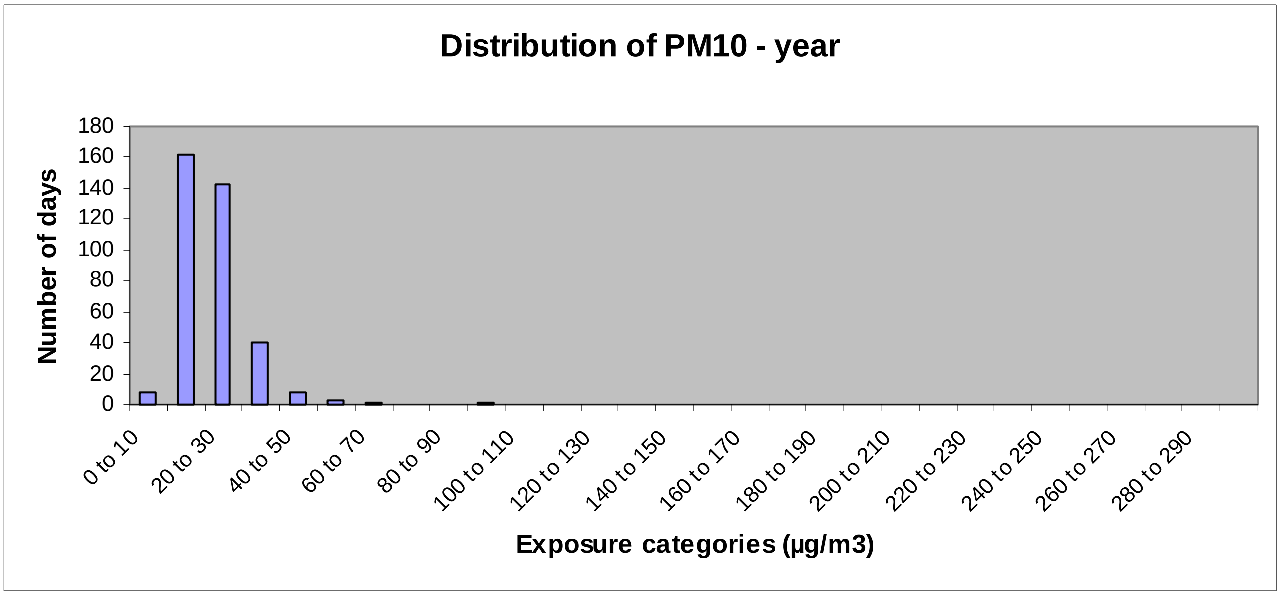
	Short term		
Air pollutant	**BS**	**PM_{10}**	**$PM_{2.5}$**
Number of days above	20 µg/m^3	20 µg/m^3	14 µg/m^3
	87	196	152
Number of days above	50 µg/m^3	50 µg/m^3	35 µg/m^3
	5	5	3

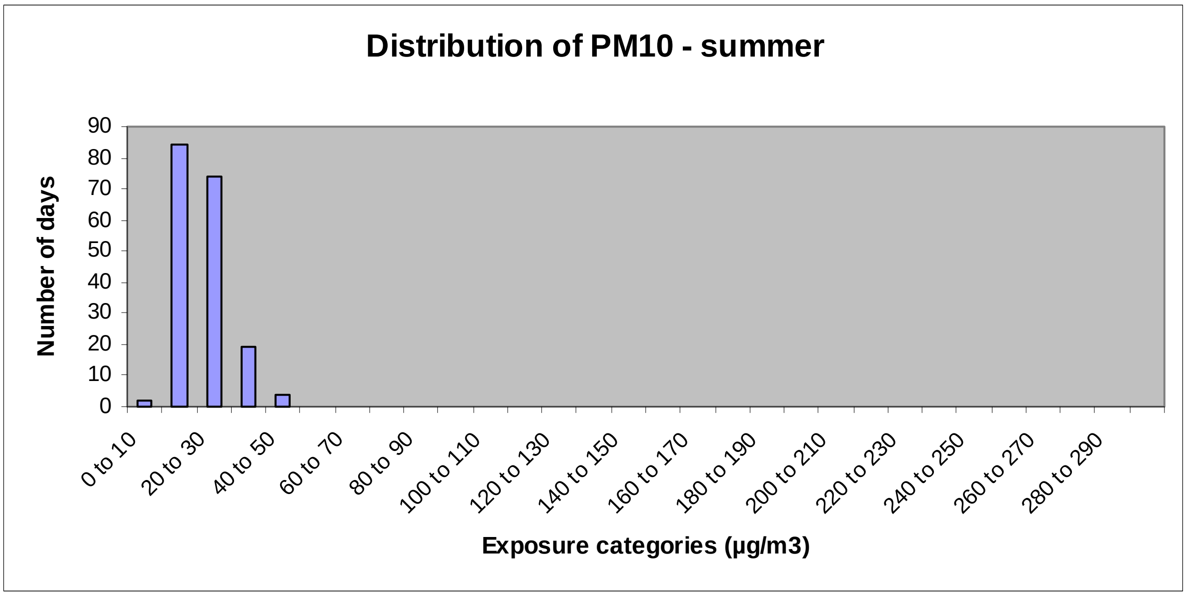

Distribution of black smoke - year
Number of days
180
160
140
120
100
80
60
40
20
0
0 to 10
20 to 30
40 to 50
60 to 70
80 to 90
100 to 110
120 to 130
140 to 150
160 to 170
180 to 190
200 to 210
220 to 230
240 to 250
260 to 270
280 to 290
Exposure categories (µg/m3)

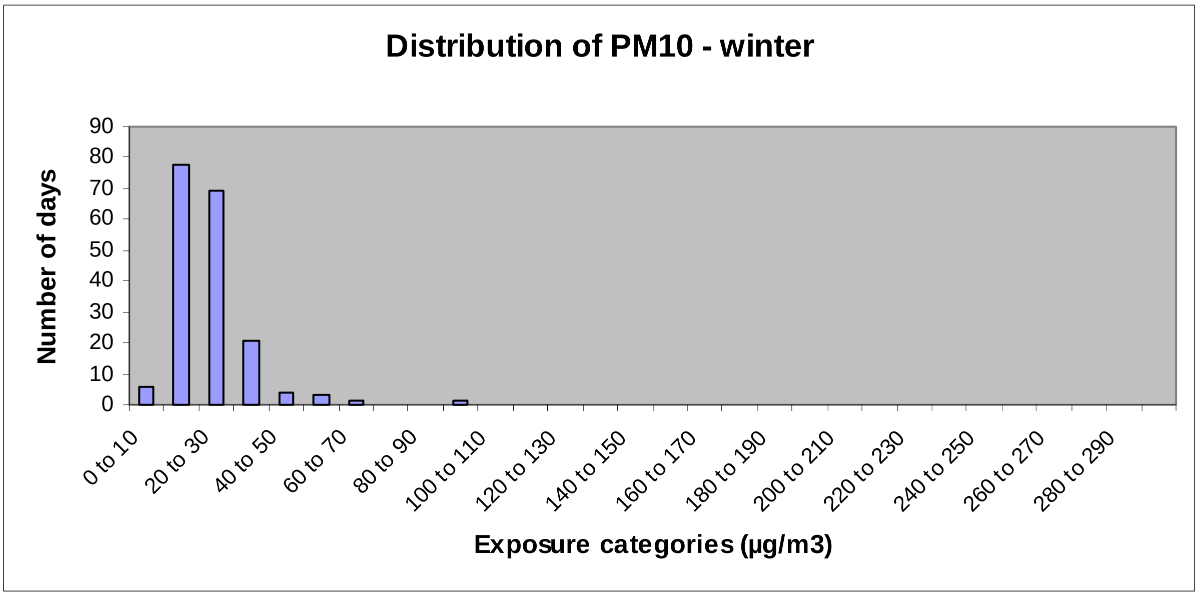

Distribution of black smoke - summer
Number of days
90
80
70
60
50
40
30
20
10
0
0 to 10
20 to 30
40 to 50
60 to 70
80 to 90
100 to 110
120 to 130
140 to 150
160 to 170
180 to 190
200 to 210
220 to 230
240 to 250
260 to 270
280 to 290
Exposure categories (µg/m3)



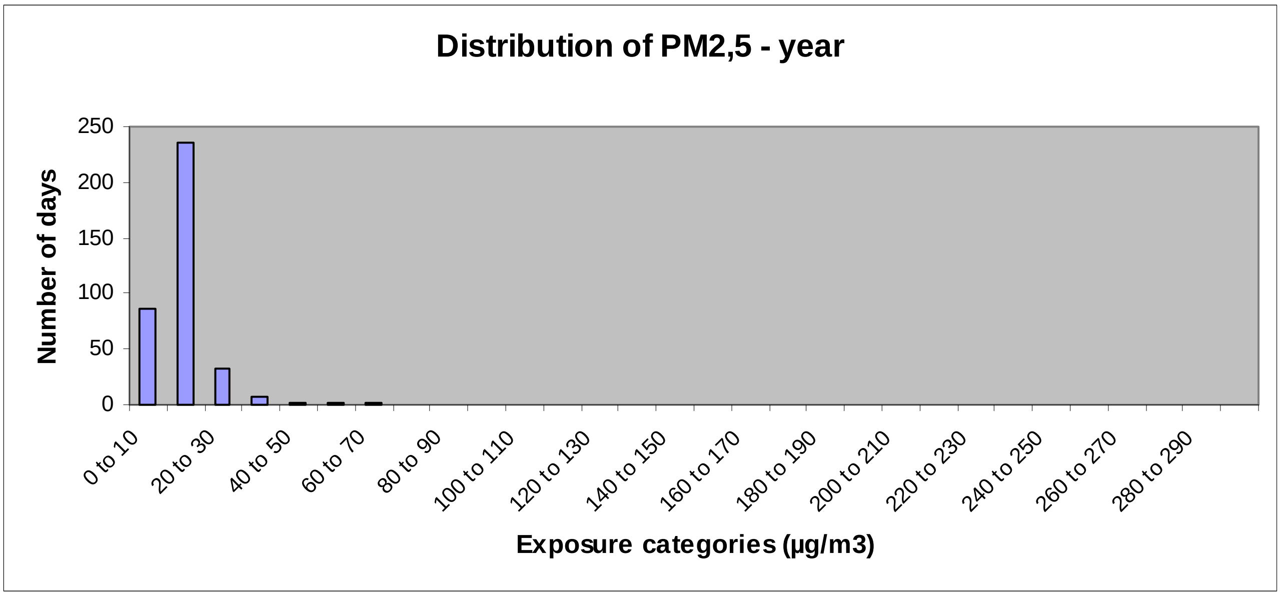
Levels of black smoke are very low for a large number of days in Paris metropolitan area. Daily level was higher than 100µg/m^3 during only one day (during the winter 2000), and the days with levels lower than 20µg/m^3 represent more than the two thirds of the year.

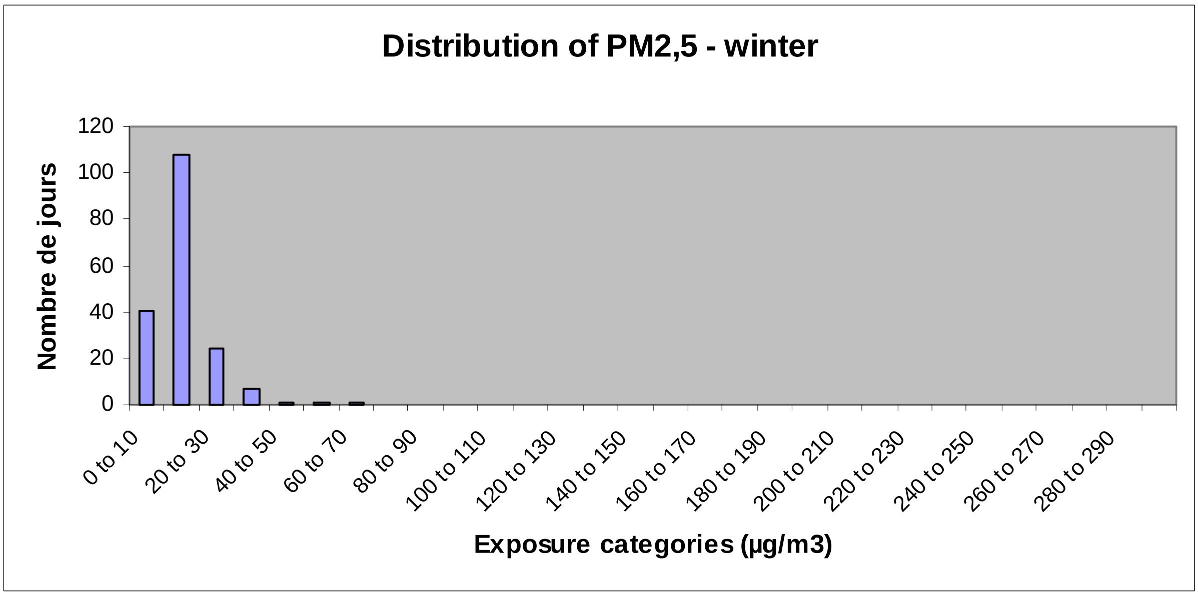


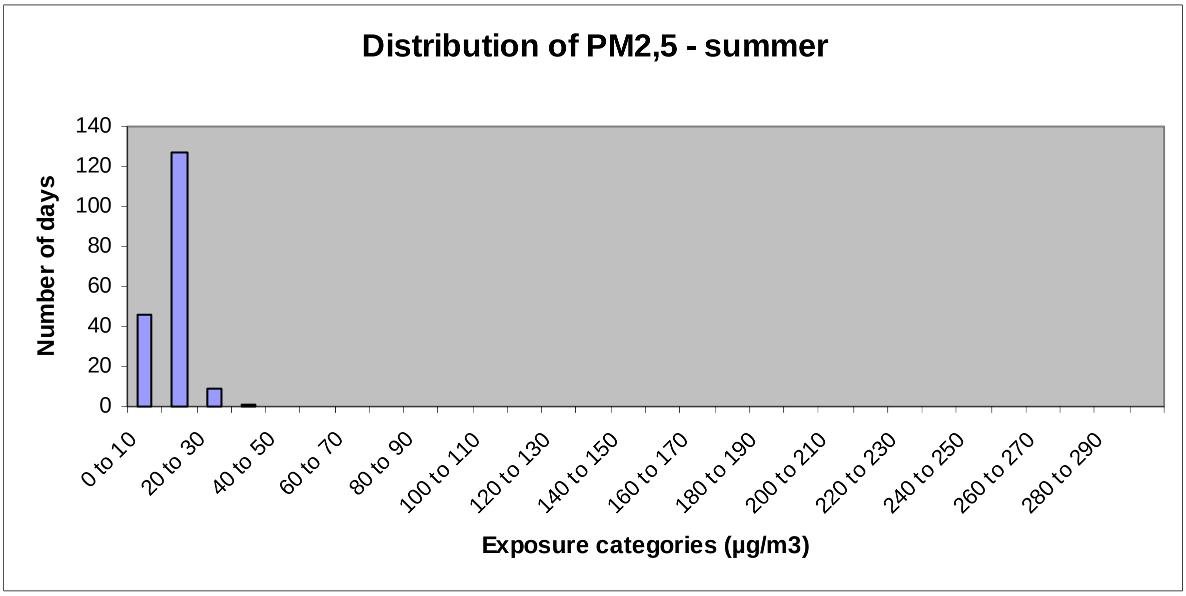




More than 300 days corresponded to concentrations ranging from 10 to 30 µg/m^3. Very high concentrations of PM10 occur only during the winter (2 days with concentrations higher than 60µg/m^3), whereas during the summer, concentrations are always lower than 50µg/m^3.





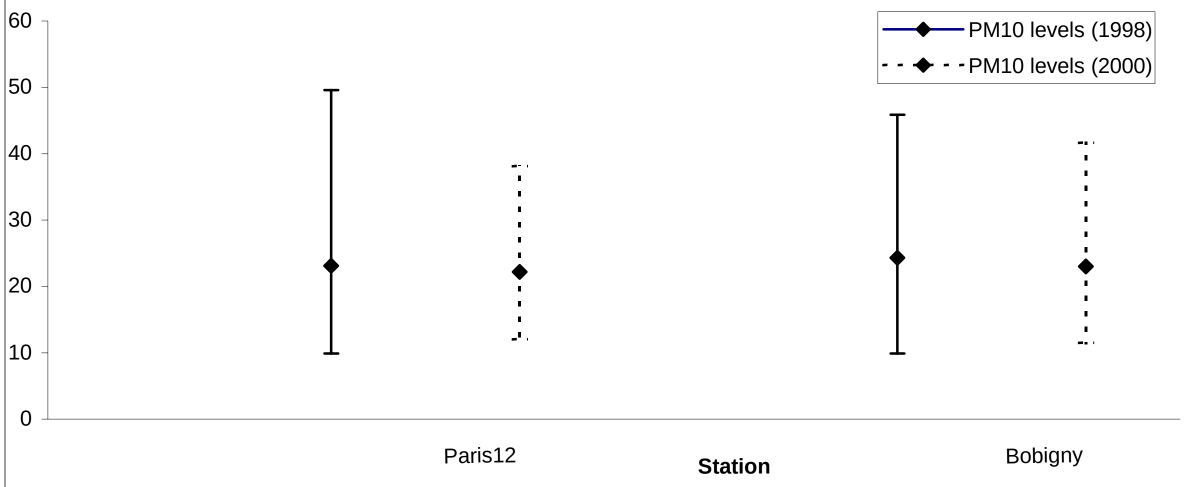


More than 300 days correspond to concentrations lower than 20µg/m^3. High concentrations of

PM2.5 occur mainly during the winter (3 days with concentrations higher than 40µg/m^3), whereas during the summer, concentrations are always lower than 40µg/m^3.

The following graph represents the annual mean levels and the percentile of the distribution of pollutants for the two stations that are present in both the APHEIS2 and APHEIS3 analysis. For APHEIS3, another five others monitoring stations were used for assessing the exposure to air pollution.

Figure 1. Annual mean levels and 5th and 95th percentiles of the distribution of PM_{10} by station in Apheis 2 and 3.



For these two stations, annual mean levels of PM10 did not differed greatly between 1998 and 2000. The size of the distribution range seems to have decreased from 1998 to 2000.

Health data

The information department specialized in mortality data (CépiDC) at the National Health and Medical Research Institute (INSERM) provides medical causes of death based on the international classification of diseases (ICD9). The latest year available for mortality data was 1999.

Age-standardised mortality rate (per 100 000 inhabitants) was 702[1].

Data on hospitalizations for respiratory and cardiac admissions were obtained from the PMSI information system of the Assistance Publique - Hôpitaux de Paris (AP-HP). Hospital admissions taken into account in these data are hence admissions in one of the 27 public hospitals of the AP-HP, which represent a subset of all hospital admissions in the study area. Rates per 100000 and daily mean numbers of hospital admissions are hence an underestimation of the actual rates and numbers of hospital admissions in this area. The year used for hospital admissions data was 2001.

[1] UNITED NATIONS. Population Division Department of Economic and Social Affairs. World Population Prospects: The 2000 Revision.

Table 3. Daily mean number and annual rate per 100 000 of deaths and hospital admissions

Health outcome	ICD9	ICD10	Daily mean number (SD)	Number of cases per 100 000
Short term HIA				
All causes mortality*	< 800	A00-Q99	114	674
Cardiovascular mortality	390-459	I00-I99	33	195
Respiratory mortality	460-519	J00-J99	9	53
Cardiac mortality	390-429	I00-I52	23	134
Cardiac hospital admissions	390-429	I00-I52	153	909
Respiratory hospital admissions	460-519	J00-J99	180	1070
Long term HIA				
Total mortality	0-999	A00-T98	121	718
Cardiopulmonary mortality	401-440 460-519	I10-I70 J00-J99	39	232
Lung cancer mortality	162	C33-C34	7	39

* For short and long term scenarios

Health impact assessment

Different scenarios were used to evaluate short and long-term exposure to particulate pollution. In the city of Paris, these scenarios were built for three indicators of this particulate pollution: BS, PM10 and PM2.5. The estimated health impacts of these indicators may overlap, and caution is recommended in the interpretation of findings: under no circumstances should we add findings of these indicators because they represent the same type of pollution.

Different tools and different estimates were used to evaluate the short- and long-term impacts of this particulate pollution on health. (Table 4).

Table 4. Summary SHORT-TERM Health impact assessment (HIA)

	Health indicator	ICD		Tool	RR (95% IC) For 10 μg/m³ increase
Attributable cases		**ICD9**	**ICD10**		
		ST HIA for all cities report			
PM10	All ages, all causes mortality (excluding external causes) All ages, cardiovascular mortality All ages, respiratory mortality All ages, cardiac hospital admissions All ages, respiratory hospital admissions	< 800 390-459 460-519 390-429 460-519	A00-R99 I00-I99 J00-J99 I00-I52 J00-J99	French PSAS-9 Excel spreadsheet	WHO, 2003: 1.006 (1.004 - 1.008) WHO, 2003: 1.009 (1.005 - 1.013) WHO, 2003: 1.013 (1.005 - 1.021) Le Tertre et al. 2002: 1.006 (1.003 - 1.009) Apheis 3: 1.0114 (1.0062 - 1.0167)
BS	All ages, all causes mortality (excluding external causes) All ages, cardiovascular mortality All ages, respiratory mortality All ages, cardiac hospital admissions All ages, respiratory hospital admissions	< 800 390-459 460-519 390-429 460-519	A00-R99 I00-I99 J00-J99 I00-I52 J00-J99	French PSAS-9 Excel spreadsheet	WHO, 2003: 1.006 (1.004 - 1.009) WHO, 2003: 1.004 (1.002 - 1.007) WHO, 2003: 1.006 (0.998 - 1.015) Le Tertre etal. 2002:1.011 (1.004 - 1.019) Apheis 3: 1.0030 (0.9985 -1.0075)
PM10 Distributed lag (40 days)	All ages, all causes mortality (excluding external causes) All ages, cardiovascular mortality All ages, respiratory mortality	< 800 390-459 460-519	A00-R99 I00-I99 J00-J99	French PSAS-9 Excel spreadsheet	Zanobetti et al. 2002: 1.01227 (1.0081 - 1.0164) Zanobetti et al. 2003: 1.01969 (1.0139 - 1.0255) Zanobetti et al. 2003: 1.04206 (1.0109 - 1.0742)
		Complementary ST HIA for some cities reports			
PM10 with shrunken stimates	All ages, all causes mortality (excluding external causes)	< 800	A00-R99	French PSAS-9 Excel spreadsheet	Apheis 3: RRs and 95% CI of the shrunken estimate for each city
					RR
				Athens	1,012 (1,008-1,017)
				Barcelona	1,009 (1,005-1,012)
				Budapest	1,005 (0,999-1,011)
				Cracow	1,004 (0,998-1,009)
				London	1,007 (1,004-1,010)
				Madrid	1,006 (1,002-1,010)
				Paris	1,005 (1,001-1,009)
				Rome	1,011(1,006-1,015)
				Stockholm	1,006 (0,999-1,013)
				Tel-Aviv	1,006 (1,002-1,011)

Table 4 (cont), Summary LONG-TERM Health impact assessment (HIA)						
	Health indicator	**ICD 9**	**ICD10**	**Tool**	**RR (95% IC) For 10 μg/m^3 increase**	**Scenarios**
			Long term HIA for all-cities report			
Attributable cases						**Annual mean**
PM10	All causes mortality (excluding external causes)	< 800	A00-R99	French PSAS-9 Excel spreadsheet	Kunzli et al, 2000 1.043 (1.026 -1.061)	Reduction to 40 μg/m^3 Reduction to 20 μg/m^3 Reduction by 5 μg/m^3
PM2.5	All causes mortality Cardiopulmonary mortality LCA	0-999 401-440 and 460-519 162	A00-Y98 I10-I70 and J00-J99 C33-C34	French PSAS-9 Excel spreadsheet	CA III Pope, 2002 1.06 (1.02 - 1.11) 1.09 (1.03 - 1.16) 1.14 (1.04 - 1.23)	Reduction to 20 μg/m^3 Reduction to 15 μg/m^3 Reduction by 3.5 μg/m^3
YoLL						**Annual mean**
PM2.5	All causes mortality Cardiopulmonary mortality LCA	0-999 401-440 and 460-519 162	A00-Y98 I10-I70 and J00-J99 C33-C34	WHO AirQ software	CA III Pope, 2002 1.06 (1.02 - 1.11) 1.09 (1.03 - 1.16) 1.14 (1.04 - 1.23)	Reduction to 20 μg/m^3 Reduction to 15 μg/m^3 Reduction by 3.5 μg/m^3
			Complementary LT HIA for some cities report			
Prospective scenarios on air pollution, prospective scenarios on birth numbers	Local choice	–	–	WHO AirQ software	–	–

Also different approaches were used to describe the impacts:
For BS, short-term findings are expressed in terms of number of attributed deaths per year
For PM10, short and long-term findings are expressed in terms of number of attributed deaths per year
For PM2.5, long-term findings are expressed in terms of:

- number of attributed deaths per year
- number of expected years of life lost for starting year of simulation.

Short-term scenarios

We used the following scenarios to estimate the acute effects of short-term exposure to BS/ PM_{10} on mortality and hospital admissions over one year:

Short term HIA scenarios for BS

We used three scenarios to estimate the acute health effects of BS on all causes (excluding external causes), cardiovascular and respiratory mortality over one year:

- reduction of BS levels to a 24-hour value of 50 µg/m^3 on all days exceeding this value
- reduction of BS levels to a 24-hour value of 20 µg/m^3 on all days exceeding this value
- reduction by 5 µg/m^3 of all the 24-hour values of BS.

Short term HIA scenarios for PM10

- **Short-term HIA of PM_{10} on 0-1 days and cumulative HIA of PM_{10} up to 40 days**

We used three scenarios to estimate the acute health effects of PM_{10} on 0-1 days and cumulative health effects of PM_{10} up to 40 days on all causes (excluding external causes), cardiovascular and respiratory mortality over one year:

- reduction of PM_{10} levels to a 24-hour value of 50 µg/m^3 on all days exceeding this value (2005 and 2010 limit values for PM_{10})
- reduction of PM_{10} levels to a 24-hour value of 20 µg/m^3 on all days exceeding this value (to allow for cities with low levels of PM_{10})
- reduction by 5 µg/m^3 of all the 24-hour values (to allow for cities with low levels of PM_{10})

- **Combined local and meta-analytic estimates for short-term HIA of PM10**

We used the same scenarios than above and combined local and meta-analytic estimates to calculate the acute health effects of PM_{10} on all causes of death (excluding external causes) over one year. This sensitivity analysis was done to study the interest of including the weight of a local estimates in the combined (meta-analytic) one.

Long-term scenarios

Long-term HIA scenarios for PM10

We used three scenarios to estimate the chronic effects of long-term exposure to PM_{10} on all causes mortality (excluding external causes) over one year:

- reduction of the annual mean value of PM_{10} to a level of 40 µg/m^3 (2005 limit values for PM_{10})
- reduction of the annual mean value of PM_{10} to a level of 20 µg/m^3 (2010 limit values for PM_{10})
- reduction by 5 µg/m^3 in the annual mean value of PM_{10} (to allow for cities with low levels of PM_{10})

Long term HIA for PM2.5

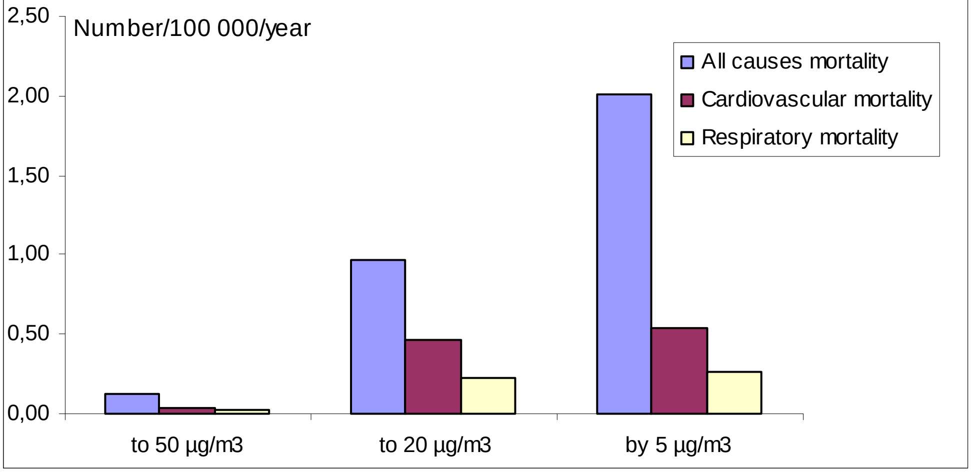
We estimated chronic effects of $PM_{2.5}$ in the Paris metropolitan area in population over 30 years old as impacts on mortality due to all causes, due to cardiopulmonary and due to lung cancer deaths.

The following three pollution scenarios were considered:
- reduction of the annual mean value of $PM_{2.5}$ to a level of 20 µg/m^3 [2]
- reduction of the annual mean value of $PM_{2.5}$ to a level of 15 µg/m^3 [2]
- reduction by 3.5 µg/m^3 in the annual mean value of $PM_{2.5}$ (to allow for cities with low levels of $PM_{2.5}$)

BS findings

The following graph shows the BS effects on all causes mortality (excluding external causes), cardiovascular mortality and respiratory mortality:

Figure 2. Black smoke : reductions to 50-20-by 5 µg/m³. Short-term health impact on total* and specific mortality *

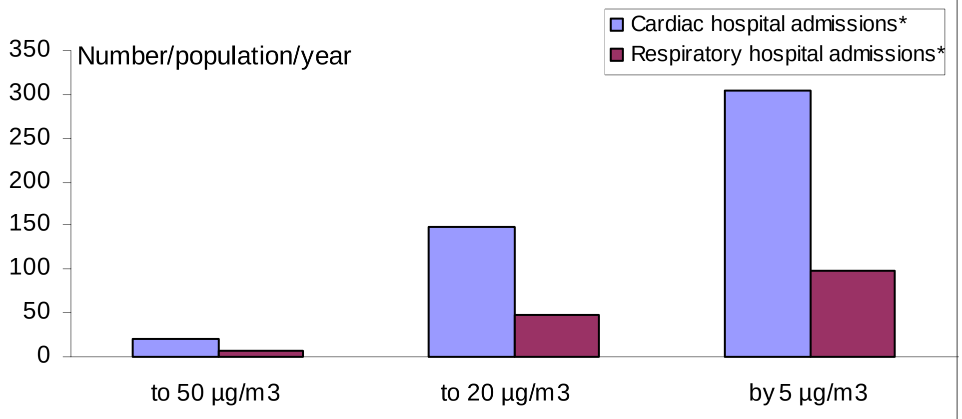


* All causes mortality excluding external causes (ICD9 < 800), cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).
** Black smoke data for 2000, mortality data for 1999

The number of attributable cases / 100 000 inhabitants is higher for cardiovascular mortality than for respiratory mortality. However, the relative risk linking black smoke levels to respiratory mortality is higher than the one linking black smoke levels to cardiovascular mortality. The higher number of attributable cases observed for cardiovascular mortality hence has to be related to the very important number of cardiovascular deaths in Paris metropolitan area (195 / 100 000 inhabitants in 1999) when compared to the number of respiratory deaths (53 / 100 000 inhabitants in 1999).

The following graph shows BS effects on cardiac and respiratory hospital admissions:

Figure 3. Black smoke : reductions to 50-20-by 5 µg/m3.
Short-term health impact on hospital admissions



* Cardiac (ICD9 390-429) and respiratory hospital admissions (ICD9 460-519)
** Black smoke data for 2000, mortality data for 1999

Similarly, the number of attributable cases is higher for cardiac hospital admissions than for respiratory hospital admissions.

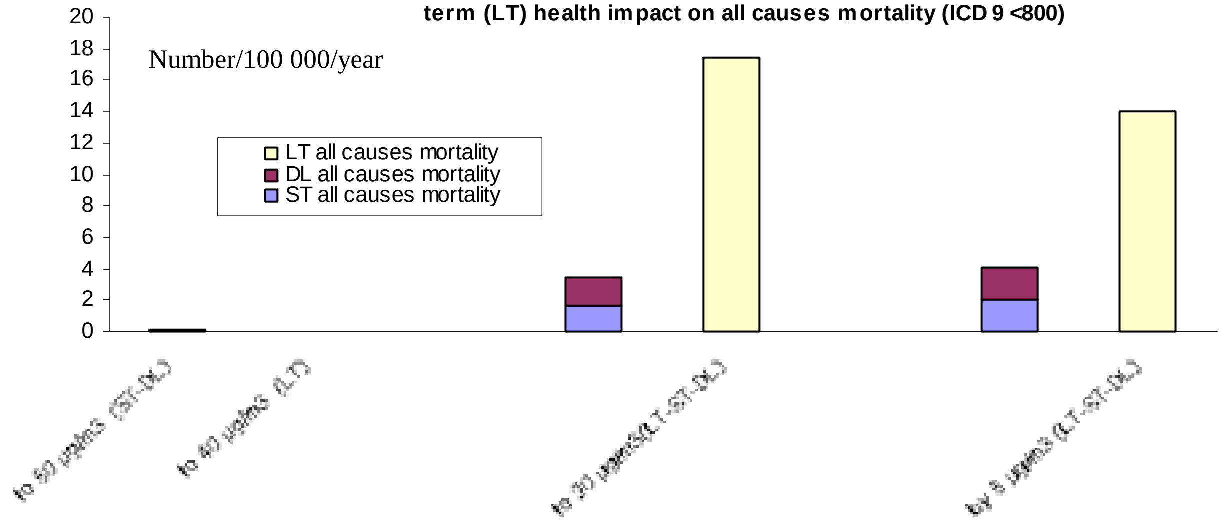
PM10 findings

1. Short-term HIA of PM10 on 0-1 days and cumulative HIA of PM10 up to 40 days, and long term HIA of PM10

1.1. Mortality findings

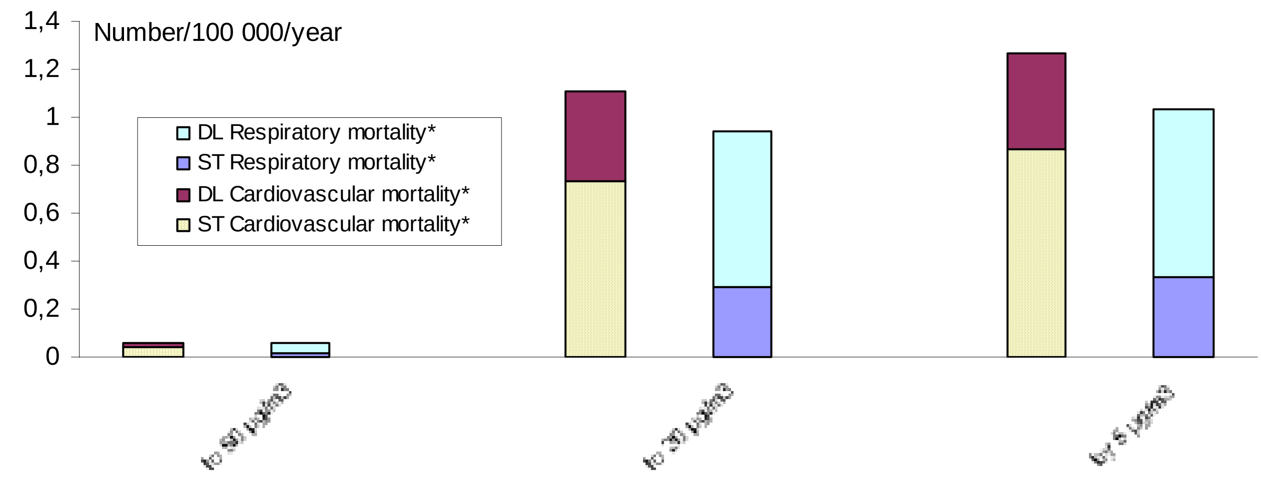
The following graphs show the health impact of PM10 on mortality for different lags: short-term-ST (0-1 day lag), cumulative effect –DL-distributed lag (up to 40 days lag) and long-term LT (years).

Figure 4. PM10: reductions to 50/40-20-by 5 µg/m³. Short term (ST), cumulative (DL), long term (LT) health impact on all causes mortality (ICD 9 <800)



* PM10 data for 2000, mortality data for 1999

Figure 5. PM_{10}: reductions to 50-20-by 5 µg/m³. Short term (ST), cumulative (DL) health impact on specific mortality



*Cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).
** PM10 data for 2000, mortality data for 1999

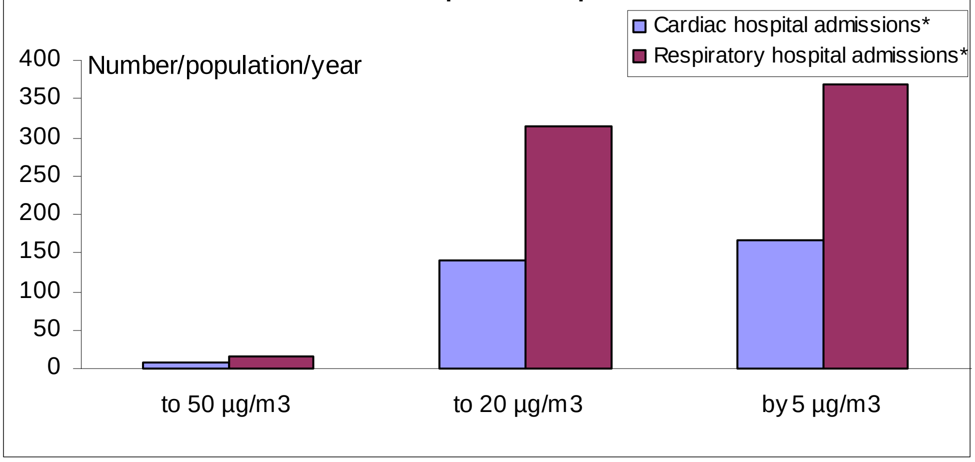
Effects of PM10 on mortality estimated for DL or LT are always more important than effects estimated for ST. ST effects only take into account deaths within a day or two of exposure.

The difference between ST and DL or LT estimates hence certainly corresponds to the deaths occurring with a lag of more than 2 days between exposure and death. This difference between ST and DL estimates is more important for respiratory mortality than for cardiovascular mortality. Hence it seems that cardiovascular deaths attributable to air pollution are concentrated within the two days following exposure, whereas there can be a larger lag between exposure and death for respiratory deaths.

1.2. Hospital admissions findings

We estimated the acute effects of short-term exposure to PM_{10} on cardiac and respiratory hospital admissions over one year.
The following graph represents the short-term effects of PM10 on cardiac and respiratory admissions:

Figure 6. PM_{10} : reductions to 50-20-by 5 µg/m³.
Short-term health impact on hospital admissions



* Cardiac (ICD9 390-429) and respiratory hospital admissions (ICD9 460-519)
** PM10 data for 2000, hospital admissions data for 2001

There are more attributable cases for respiratory hospital admissions than for cardiac hospital admissions.

2. Combined local and meta-analytic estimates for the health effects of PM_{10}

We combined local and meta-analytic estimates (shrunken estimates-SE) to calculate the acute health effects of PM_{10} on all causes of death (excluding external causes) over one year.

The following figure compares the HIA of PM10 on 0-1 days and that of the combined estimate (SE).

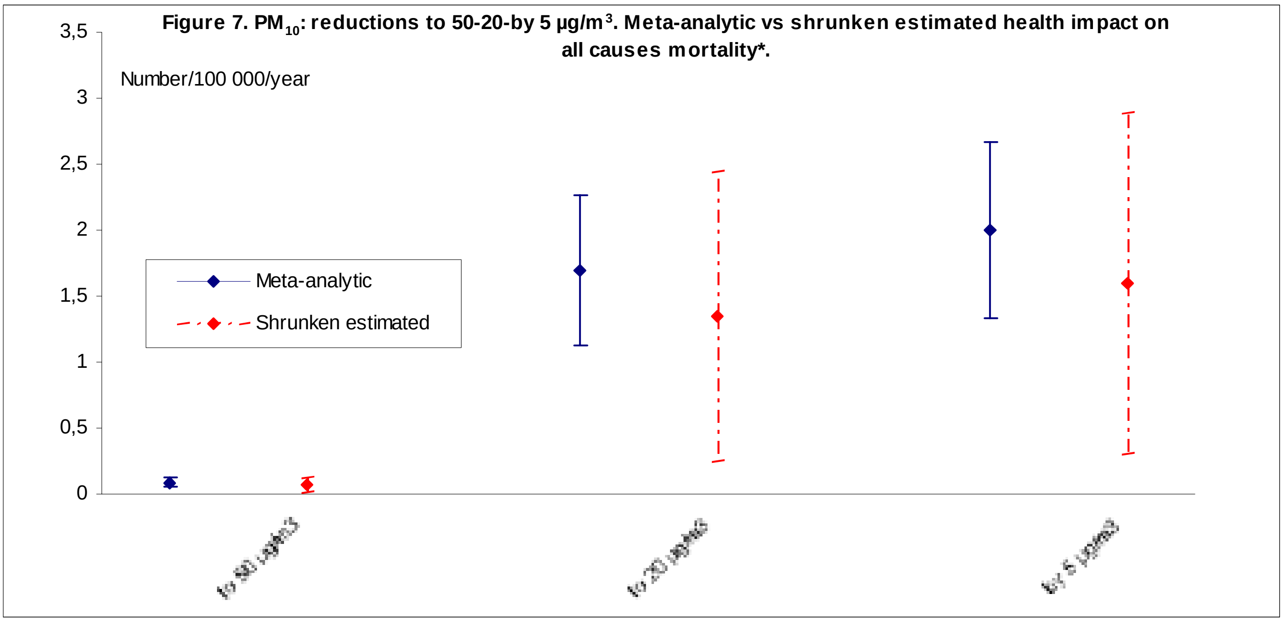


Figure 7. PM_{10}: reductions to 50-20-by 5 µg/m^3. Meta-analytic vs shrunken estimated health impact on all causes mortality*.

* All causes mortality excluding external causes (ICD9 < 800)
** PM10 data for 2000, mortality data for 1999

PM10 attributable cases are slightly higher when obtained with meta-analytic estimates on 0-1 days when compared to the ones obtained with combined local and meta-analytic estimates (SE).

<u>PM2.5 findings</u>

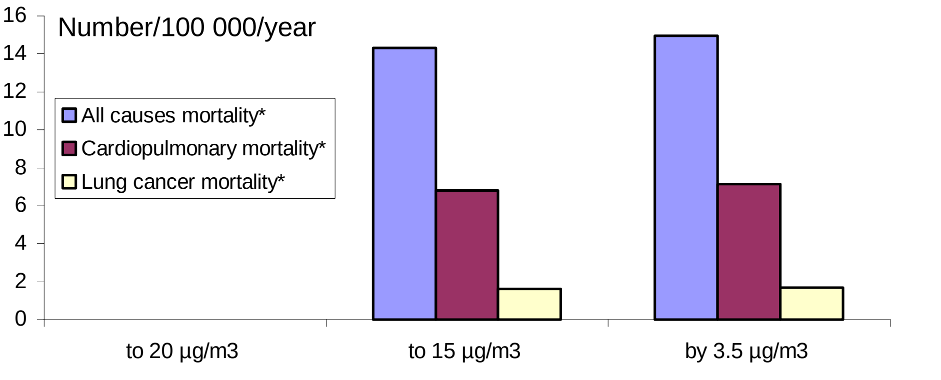
The annual mean concentration for PM2.5 measured with TEOM in Paris is 14µg/m^3. However, for homogeneity among APHEIS cities, the annual mean concentration of PM2.5 used for this HIA was obtained by converting concentrations of PM10, themselves obtained by applying a conversion factor to measured PM10 in order to take into account the possible underestimation due to the use of TEOM. The annual mean PM2.5 concentration obtained with this method was 18µg/m^3.

1. Number of attributed cases

We also used three scenarios to estimate the chronic effects of long-term exposure to $PM_{2.5}$ on mortality over one year.

The following graph presents the attributable number of all causes, cardiopulmonary and lung cancer deaths expressed as per 100 000 inhabitants.

Figure 8. $PM_{2.5}$: reductions to 20-15-by 3.5 µg/m^3. Long-term health impact on total and specific mortality



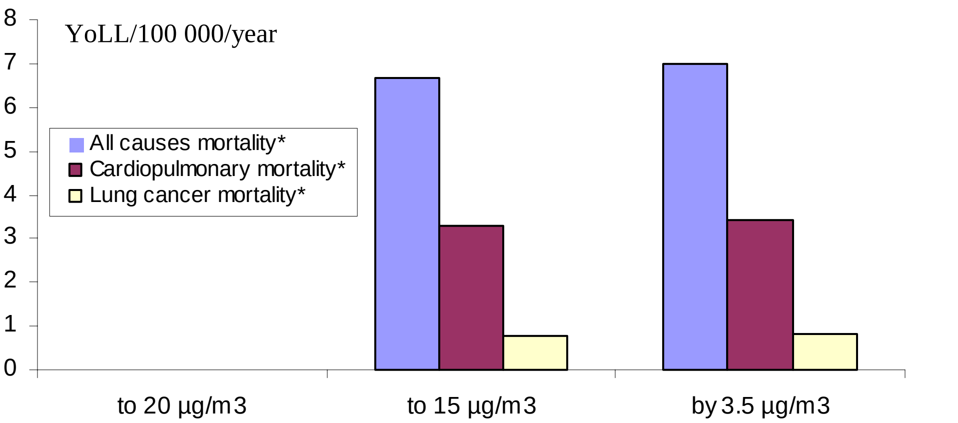
* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162).
** PM2.5 data for 2000, mortality data for 1999

In Paris metropolitan area, the annual mean value of PM2.5 concentration is lower than 20µg/m^3, hence there are no attributable deaths for this scenario. Both reduction to 15µg/m^3 and reduction by 3.5µg/m^3 scenarios give very similar results, as they correspond to approximately the same decrease in PM2.5 concentration in Paris metropolitan area.
Both scenarios would result into a decrease of the death rate per 100000 per year of about 15 for all causes long-term deaths, about 7 for cardiopulmonary deaths, and less than 2 for lung cancer deaths.

2. Years of life lost

We estimated the years of life lost attributable to the chronic effects of $PM_{2.5}$ using the data for 2000
Figure 9 presents the years of life lost for all causes, cardiopulmonary and lung cancer deaths for 30 years of age or older in the population of Paris metropolitan area.

Figure 9. $PM_{2.5}$: reductions to 20-15-by 3.5 µg/m^3. Expected years of life lost for the first year of simulation for total and specific mortality for >30 years old



* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162).
** PM2.5 data for 2000, mortality data for 1999

In Paris metropolitan area, the annual mean value of PM2.5 concentration is lower than 20µg/m^3, hence there are no attributable deaths for this scenario. Both reduction to 15µg/m^3 and reduction by 3.5µg/m^3 scenario give very similar results, as they correspond to approximately the same decrease in PM2.5 concentration in Paris metropolitan area.
For all causes of deaths, all other things being equal, reduction of $PM_{2.5}$ by 3.5 µg/m^3 in 2000 would save about 7 years of expected life per 100 000 in people older than 30 years in Paris metropolitan area. For cardiopulmonary mortality, this number would be around 3 and for lung cancer mortality, more or less one.

The following figure presents the findings in terms of life expectancy.

Table 5. Life expectancy and its possible increase by reduction of air pollution to 15 ug/m3 in Paris

		Expected gain in life expectancy		
Age	Life expectancy	Mean	Low estimate	High estimate
At birth	79.9	0.20	0.05	0.36
30	50.9	0.21	0.06	0.36
65	19.9	0.15	0.04	0.26

In terms of life expectancy, all other things being equal, if annual mean PM2.5 levels would be reduced to 15 µg/m^3, the 50.9 years of life expectancy of a 30 years old person would be increased by 0.2 years, due to reduced risk of death from all causes in the city of Paris.
.

Interpretation of findings

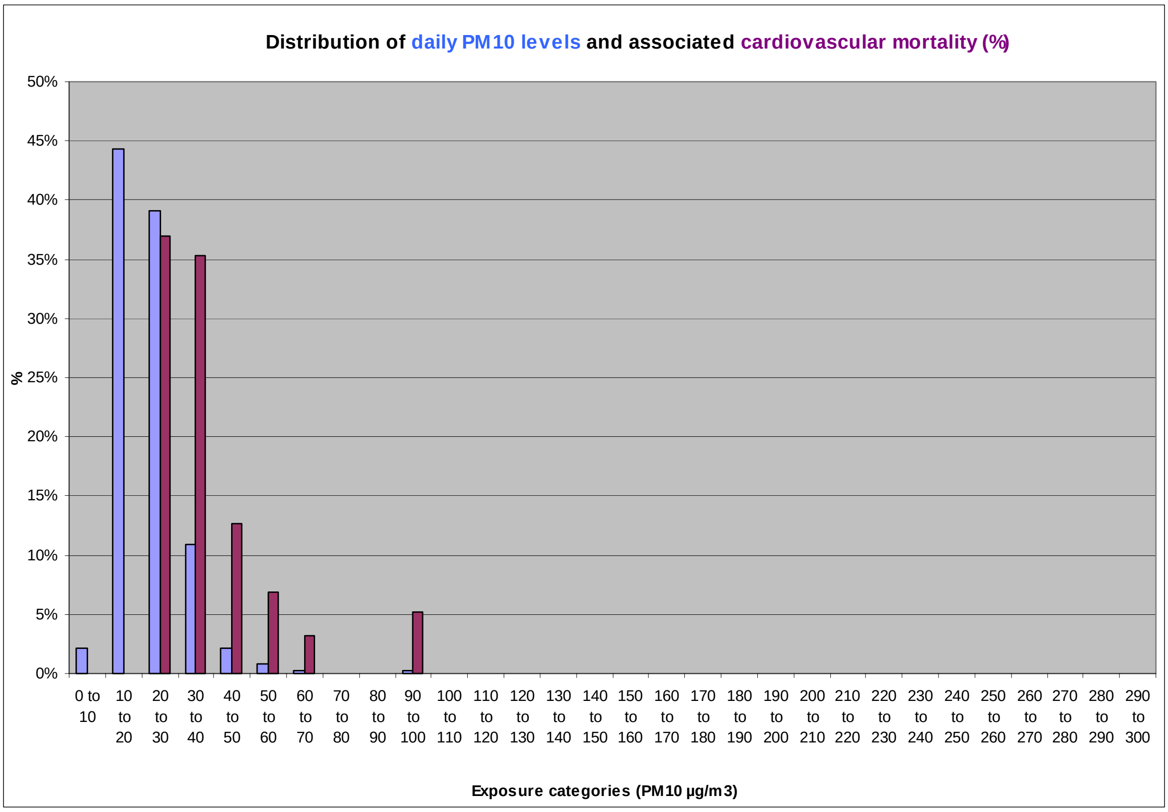
In Paris metropolitan area, the measures of particulate matter (both PM10 and PM2.5) was done using automated stations (TEOM). In order to be homogeneous with other APHEIS cities, a conversion factor was applied to PM10 values for long-term HIAs. The conversion factor differed according to the season. However, using this conversion factor certainly added some uncertainty to the evaluation of exposure for long term HIAs concerning both PM10 and PM2.5 (converted from PM10 using a constant conversion factor).

Hospital admissions data represent only a subset of the hospitals in Paris metropolitan area. This subset represents a large part of all hospital admission, but HIAs concerning hospital admissions hence certainly represent an underestimation of the total number of attributable cases for each scenario and each pollutant.

In Paris metropolitan area, as shown by the following graph, the largest number of attributable cases (more than 70%) corresponds to days when pollutant concentration is lower than 40µg/m^3 (the European limit value for 2005). However, a single day with a very high level of particular air pollution is responsible for more than 5% of the total number of attributable cardiovascular deaths.

These results concerning short-term deaths for all causes show that more than picks of pollution, it is daily pollution levels that are responsible for most of the health effects. Similar trends are found for other health outcomes (cardiovascular and respiratory deaths, hospital admissions for cardiac and respiratory diseases) and other pollutants (black smoke and PM2.5).

Short term distribution of PM10 levels and associated percentage of cases



General comments

All HIAs show that a relatively large number of deaths (about 900 long-term deaths) and hospital admissions (about 300 hospital admissions for respiratory causes) could be avoided in Paris metropolitan area if the European limit value for PM10 in 2010 (20µg/m^3) was reached. The benefit of less aggressive action, such as reduction of daily PM10 above 50µg/m^3 to 50µg/m^3 would only reduce the number of short-term deaths by 5 (0-1 days effects) or 11 (40 days cumulative effects).

Even if much uncertainty certainly surrounds these numbers, they indicate that there are still some significant health effects of air pollution in Paris metropolitan area at the current concentrations, and that public health benefits could be obtained by reducing air pollution levels.

Pollution is a concern in Paris metropolitan area for a relatively long time. In Paris, there have been monitoring networks since the 60s which were first operated by the laboratories of the city of Paris and Paris police headquarters. Thanks to the creation of the association AIRPARIF in 1979, this network has been developed and extended to the Paris region and its suburbs. Yet air pollution became a political issue only since the 90s with, among others, a strong involvement of the Regional Council which was created in 1982 with the new law on decentralisation.

The Prefect and the President of the Regional Council showed an interest in the effect of air pollution on health and initiated the ERPURS programme in 1990, following the high pollution peaks in 1989 and a lack of knowledge on the effects of air pollution on health in the area.

Since then, there has been a renewed interest with the creation of the “Air and Health” group, when the regional Action for air quality was developed, and the request that the Observatoire Régional de Santé participates in various working groups (Action for air protection, Ile-de-France sitting for a charter on environment, paper following the regional Action for air quality).

The current redaction of the plan for air protection (PPA), during which the results from the health impact assessment have clearly been taken into account, provides the opportunity to propose a set of measures aiming at reducing pollutant emissions, and more generally at making every inhabitant of the region more aware of the potential health effects of air pollution and how they can modify their behaviour in order to participate to the amelioration of air quality in Paris metropolitan area.

Today, Paris metropolitan area main source of air pollution is traffic. Reducing traffic emissions require a behaviour modification, and one of the ways of obtaining it is to objectively inform people about the effects of air pollution.

Appendix

1. Add the questionnaires for your city on the exposure measurement methods and health data

1. City: Paris et petite couronne (départements 75,92,93,94)
2. Total area of agglomeration (km²): 762
3. Area (km²) covered by the air monitoring network in the city: 762
4. Number of population in this (exposure relevant) area: 6 164 418
5. Total number of PM10 monitoring stations in this area: 7
6. Total number of BS monitoring stations in this area: 10
7. Total number of PM2.5 monitoring stations in this area: 1
8. Number of selected PM10 monitoring stations for HIA: 7
9. Number of selected BS monitoring stations for HIA: 10
10. Number of selected PM2.5 monitoring stations for HIA: 0 (PM2.5 converted from PM10)
11. Measurement interval: hourly measurements
12. Quality assurance and control : yes
13. Data quality: validated data

14. Name, and classification of the monitoring site

1.PM10
Paris12(75),urban
Bobigny(93),urban
Genevilliers (93), urban
Issy les Moulineaux, urban
Paris 18, urban
Tremblay en France, urban
Vitry sur Seine, urban

2. BS
Paris 18 (75), urban
Paris Tour st Jacques(75), urban
Paris 7(75), urban
Paris 8 (75) urban
Paris 14(75),urban
Gennevilliers (92),urban
Ivry (94),urban
Vitry (94), urban
Montreuil(93),urban
Saint Denis(93), urban

15. Measurement method / Type of instrument
- BS: Réflectance du dépôt de poussière recueilli lors du passage de l’air échantillonné à travers un papier filtre pour déterminer un indice de fumées ,noires dans l’air ambiant.
- PM10 automated : TEOM.
- PM2.5 automated: TEOM

16. Using PM10 data for your city HIA calculation, did you used a conversion factor in order to compensate losses of volatile particulate matter?
Yes, Winter: 1.37; Summer: 1. These factors are derived from local parallel measurements (reference method vs. TEOM or beta attenuation)

17. If your PM2.5 data have been calculated from your PM10 data, what conversion factor did you use? 0.7

1. Tables for black smoke findings

Tables 1, 2, 3 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants. Table 4 presents the results for cardiac and respiratory hospital admissions.

Table 1. Deaths all causes (ICD9 < 800) (1999). Potential benefits of reducing daily BS levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m³	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m³	87	60	40	90	1	0.6	1.5
50 µg/m³	5	8	5	12	0.1	0.08	0.19
By 5 µg/m³	NA*	124	82	185	2	1.3	3

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily BS levels above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effect of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m³	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m³	87	11	6	20	0.2	0.09	0.3
50 µg/m³	5	1	0.7	3	0.02	0.01	0.04
By 5 µg/m³	NA*	24	12	42	0.4	0.2	0.7

**NA: not applicable*

Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily BS levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m³	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m³	87	5	-2	12	0.08	-0.02	0.2
50 µg/m³	5	0.6	-0.2	1.5	0.01	-0.003	0.02
By 5 µg/m³	NA*	10	-3	24	0.2	-0.05	0.4

**NA: not applicable*

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2001). Potential benefits of reducing daily BS levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number (95% confidence limits) attributable to the acute effects of BS

Scenarios	Number of days per year exceeding 20 and 50 µg/m³	Attributable cases per year: N° of deaths central	N° of deaths lower	N° of deaths upper
Hospital admissions for cardiac diseases (all ages)				
20 µg/m³	87	148	54	258
50 µg/m³	5	20	7	34
By 5 µg/m³	NA*	304	111	523
Hospital admissions for respiratory diseases (all ages)				
20 µg/m³	87	47	-24	118
50 µg/m³	5	6	-3	15
By 5 µg/m³	NA*	99	-49	246

**NA: not applicable*

2. Tables for PM_{10} findings

3.1. Health effects of PM_{10} on 0-1 days

Tables 1, 2, 3 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants. Table 4 presents the results for cardiac and respiratory hospital admissions.

Table 1. Deaths all causes (ICD9 < 800) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

Scenarios	Number of days per year exceeding 20 and 50 µg/m³	Attributable cases per year: N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m³	196	104	69	139	1.7	1.1	2.3
50 µg/m³	5	5	4	7	0.09	0.06	0.1
By 5 µg/m³	NA*	123	82	164	2	1.3	2.7

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3	196	45	25	66	0.7	0.4	1.1
50 µg/m^3	5	2	1	3	0.04	0.02	0.06
By 5 µg/m^3	NA*	53	30	77	0.9	0.5	1.2

**NA: not applicable*

Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3	196	18	7	29	0.3	0.1	0.5
50 µg/m^3	5	1	0.4	1.6	0.02	0.01	0.025
By 5 µg/m^3	NA*	21	8	33	0.3	0.1	0.5

**NA: not applicable*

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2001). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year		
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper
Hospital admissions for cardiac diseases (all ages)				
20 µg/m^3	196	141	70	211
50 µg/m^3	5	7	4	11
By 5 µg/m^3	NA*	166	83	249
Hospital admissions for respiratory diseases (all ages)				
20 µg/m^3	196	315	171	462
50 µg/m^3	5	17	9	25
By 5 µg/m^3	NA*	368	200	538

**NA: not applicable*

3.2. Cumulative health effects of PM_{10} up to 40 days

Tables 5, 6, 7 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 5. Cumulative health effects of PM_{10} up to 40 days and all causes of deaths (ICD 9 < 800) (1999).Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m^3	196	214	141	286	3.5	2.3	4.6
50 µg/m^3	5	11	7	15	0.2	0.1	0.25
By 5 µg/m^3	NA*	249	164	322	4	2.7	5.4

**NA: not applicable*

Table 6. Cumulative health effects of PM_{10} up to 40 days and cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m³**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m³	196	68	48	88	1.1	0.8	1.4
50 µg/m³	5	4	3	5	0.06	0.04	0.08
By 5 µg/m³	NA*	78	55	101	1.3	0.9	1.6

**NA: not applicable*

Table 7. Cumulative health effects of PM_{10} up to 40 days and respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m³**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m³	196	58	15	104	0.9	0.2	1.7
50 µg/m³	5	3	1	6	0.06	0.01	0.1
By 5 µg/m³	NA*	63	17	111	1	0.3	1.8

**NA: not applicable*

3.3. Combined local and meta-analytic estimates for the health effects of PM_{10}

Table 8 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 8. Combined local and meta-analytic estimates for the health effects of PM_{10} and all causes of deaths (ICD9 < 800) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m^3	196	83	16	151	1.4	0.2	2.4
50 µg/m^3	5	4	1	8	0.07	0.01	0.1
By 5 µg/m^3	NA*	98	19	178	1.6	0.3	2.9

**NA: not applicable*

3.4. Long term HIA for PM_{10}

Table 9 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 9. Deaths all causes (ICD9 < 800) (1999). Potential benefits of reducing annual mean values of PM_{10} to levels of 20 and 40 µg/m^3, and by 5 µg/m^3. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM_{10}

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m^3	1072	650	1515	17.4	10.5	24.6
40 µg/m^3	-	-	-	-	-	-
By 5 µg/m^3	866	526	1222	14	8.5	19.8

4. **Tables for $PM_{2.5}$ findings**

4.1. LT PM2.5: Attributable Cases

Tables 1, 2, 3 present the attributable number of all causes, cardiopulmonary and lung cancer deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 1. Deaths all causes (ICD9 0-999) (1999). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	881	229	1545	14.3	3.7	25
20 µg/m^3	-	-	-	-	-	-
By 3.5 µg/m^3	922	240	1617	15	3.9	26.2

Table 2. Cardiopulmonary deaths (ICD9 401-440 and 460-519) (1999). Potential benefits of reducing annual mean values of $PM_{2.5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	420	151	695	6.8	2.4	11.3
20 µg/m^3	-	-	-	-	-	-
By 3.5 µg/m^3	439	158	727	7.1	2.6	11.8

Table 3. Lung cancer deaths (ICD9 162) (1999). Potential benefits of reducing annual mean values of $PM_{2.5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	99	33	166	1.6	0.5	2.7
20 µg/m^3	-	-	-	-	-	-
By 3.5 µg/m^3	103	35	174	1.7	0.6	2.8

4.2. LT PM2.5: Years of Life Lost

Tables 1, 2, 3 present the years of life lost of all causes, cardiopulmonary and lung cancer deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 1. Deaths all causes >30 years, male and female, for one year (ICD9 0-999) (1999). Potential benefits of reducing annual mean values of $PM_{2.5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Years of life lost					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m^3	414.00	109.40	714.39	6.69	1.77	11.55
20 µg/m^3						
By 3.5 µg/m^3	433.64	114.63	748.03	7.01	1.85	12.10

Table 2. Cardiopulmonary deaths >30 years, male and female, for one year (ICD9 401-440 and 460-519) (1999). Potential benefits of reducing annual mean values of $PM_{2.5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Years of life lost					
	YoLL	YoLL	YoLL	YoLL per 100 000	YoLL per 100 000	YoLL per 100 000
	central	lower	upper	central	lower	upper
15 µg/m^3	203.72	74.76	330.62	3.29	1.20	5.35
20 µg/m^3						
By 3.5 µg/m^3	213.33	78.01	346.07	3.45	1.26	5.60

Table 3. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (1999). Potential benefits of reducing annual mean values of $PM_{2.5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3.5 µg/m^3. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2.5}$

	Years of life lost					
	YoLL	YoLL	YoLL	YoLL per 100 000	YoLL per 100 000	YoLL per 100 000
	central	lower	upper	central	lower	upper
15 µg/m^3	48.67	16.84	79.64	0.79	0.27	1.29
20 µg/m^3						
By 3.5 µg/m^3	50.96	17.64	83.31	0.82	0.29	1.35