ROUEN CITY REPORT

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Summary of the main findings

Air pollution levels and trends compared to EC limit values : daily and annual means of PM10 are under the EC limit values for 2005 (50 µg/m^3 not to be exceeded more than 35 times per calendar year for 24h-levels) in Rouen. Therefore, the levels (daily and annual mean) remain a little bit above the limit values for 2010 (50 µg/m^3 not to be exceeded more than 7 times per calendar year for 24h-levels and 20 µg/m^3 for annual mean).

The analysis estimated that reduction of the long-term PM pollution to the levels of PM2.5 of 15 µg/m^3 would reduce mortality in Rouen by 37 deaths in one year, which would save 20 years of expected life for starting year of simulation. If the daily means of PM10 would be kept under 20 µg/m^3, 8 deaths and 32 hospital admissions could have been avoided in the year 2001.

Main causes of air pollution in the city are industry and traffic, and planned actions to reduce it are reduction measures of industrial emissions.

Background

The city of Rouen is located 120 km to the North-west of Paris. It covers an area of 320 km^2 and, according to the 1999 census, has a population of approximately 435 000 inhabitants (15% 65 years +). The study area include 38 municipalities.
The city has a large industrial area along the Seine. Sources of pollution are mainly industrial, particularly sulphur dioxide (93% of emissions are due to industrial activities). Rouen is situated in a basin surrounded by hills that, added to weak winds and/or thermal inversion phenomena, limit the dispersion of the air pollutants. There are mainly Southwest dominant winds, which push the air pollution of the industrial area towards the centre of the town. The morning fogs are rather frequent. The minimum and maximum temperatures average 6.2°c and 14.4°c, respectively. In 2002, the temperature was close to that realised over 30 years.

In Rouen, there are two political framework for public air quality management: the regional plan for air quality (PRQA) approved in December 2001 and the plan for air protection (PPA) which is in progress. PPA aims to take the necessary measures in order to follow the European policy on regulated pollutants such as SO_2, NO_2, PM10, O_3.

Summary of local data and findings in Apheis second year (HIA)
For Apheis 2, only BS were measured in 1998. The daily mean level of BS is 9.8 µg/m3 (14.0). Only the short-term Health Impact Assessment could be carried out on mortality and hospital admissions for respiratory diseases, over one year. No data were available for cardiac admissions.

Potential benefits of reducing daily BS	attributable case per year (SD)	rates per 100 000 inhabitants (SD)
death		
reduction of BS levels above 50 to 50 µg/m^3	1.4 (0.7-1.9)	0.3 (0.2-0.4)
reduction above 20 to 20 µg/m^3	5.1 (2.5-6.8)	1.2 (0.6-1.6)
reduction by 5 µg/m3	10.5 (6.1-14.8)	2.4 (1.4-3.4)

hospital admissions for respiratory diseases	
reduction of BS levels above 50 to 50 µg/m^3	0.1 (0.0-0.8)
reduction above 20 to 20 µg/m^3	0.3 (0.0-2.9)

Objectives for Apheis 3
The objectives for APHEIS 3 are to complete the PSAS-9 and APHEIS 2 results. It calculate absolute number of attributable deaths or hospital admissions to estimate again the short term impact of Black smoke (BS) and to estimate the health impact of short and long term exposure to air pollution from new indicators of particulate pollution (PM10, PM2.5 and BS). The health impacts of long term exposure to air pollution were estimated by calculate Years of life lost or reduction in life expectancy.

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:

Table 1. Main sources of air pollution

Source (year)	Road (%)	Heating (%)	Industry (%)
SO2	3.3%	3.2%	93.5%
NOx	45.5%	7.2%	46.5%
COVNM	31.8%	13%	53.8%

The city of Rouen's share of regional air pollution emissions is estimated at 16 % for sulphur dioxide (SO2) and 11 % for nitrogen dioxide (NO2). 93 % of Rouen's SO_2 emissions are due to industry. Road traffic and industry share the responsibility for the NOx emissions (CITEPA 1994).

Exposure data

A permanent automated air pollution network (Air Normand) provided air pollution data. The agglomeration is covered by 14 fixed stations including 4 urban. The two measuring sites of PM2.5 were established during the year 2001 and PM10 are measured since April 2000 by two stations. All measuring sites of BS have been changed since APHEIS II.

The exposure indicator was constructed by calculating the arithmetic mean of daily concentrations recorded by stations selected in the city area, which answer to the following criteria: the ambient urban stations had to be correlated (correlation >= 0.70) and to present close mean levels of pollution. For BS, 3 urban stations were selected and for PM10 and PM2.5, 2 urban stations were selected.

Black smoke (BS) concentrations were measured by reflectometry.
PM10 and PM2.5 were measured by automatic analyser TEOM (Tapered Element Oscillating Microbalance).
After consultation of the reference laboratory in France for methods of measuring PM10, we used two correction factors for long term HIA calculations:

- in winter (increased levels of PM) : 1.22
- in summer (moderate levels of PM) : 1

These factors were based on comparative locally measurements between gravimetric and TEOM methods.

A conversion factor is used to converted PM2.5 from PM10 : 0.7

Exposure data for Apheis 3 :

- Year of air pollution data : 2001 for BS and PM10 ; 2002 for PM2.5 measured.

- Daily mean levels of PM10/BS/PM2.5 and SD :
  -Daily mean levels (SD) of PM10 were 21 (9) µg/m^3.
  -Daily mean levels (SD) of BS were 8 (7) µg/m^3.
  -Daily mean levels (SD) of PM2.5 were 15 (8) µg/m^3.

- P5 and P95:

- The levels of PM10 reached during the 18 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 12 µg/m3 and 38 µg/m3.
- The levels of BS reached during the 18 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 3 µg/m3 and 24 µg/m3.
- The levels of PM2.5 reached during the 18 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 7 µg/m3 and 29 µg/m3.

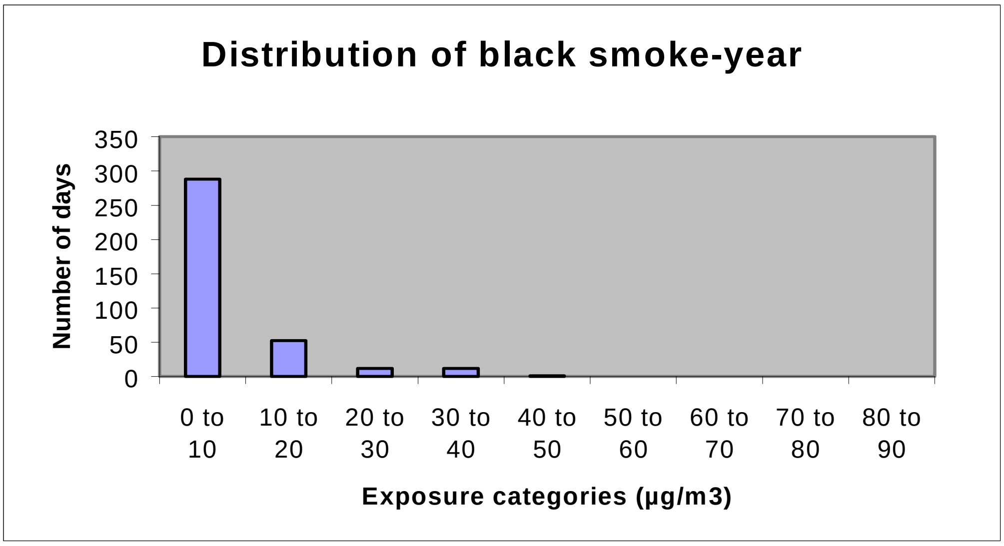
- Number of days when air pollutants exceeded limit levels:

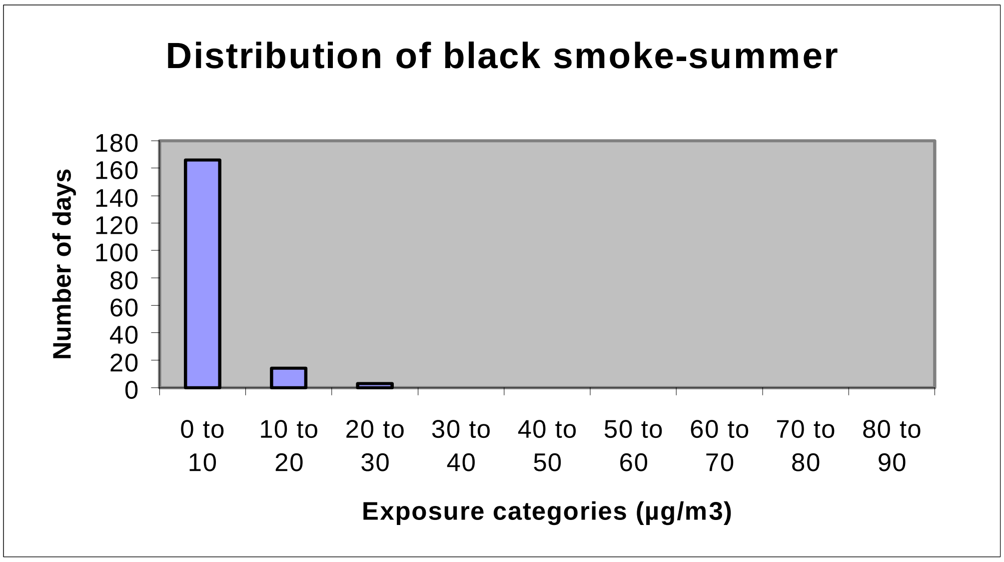
Table 2. Number of days when air pollutants exceeded limit levels

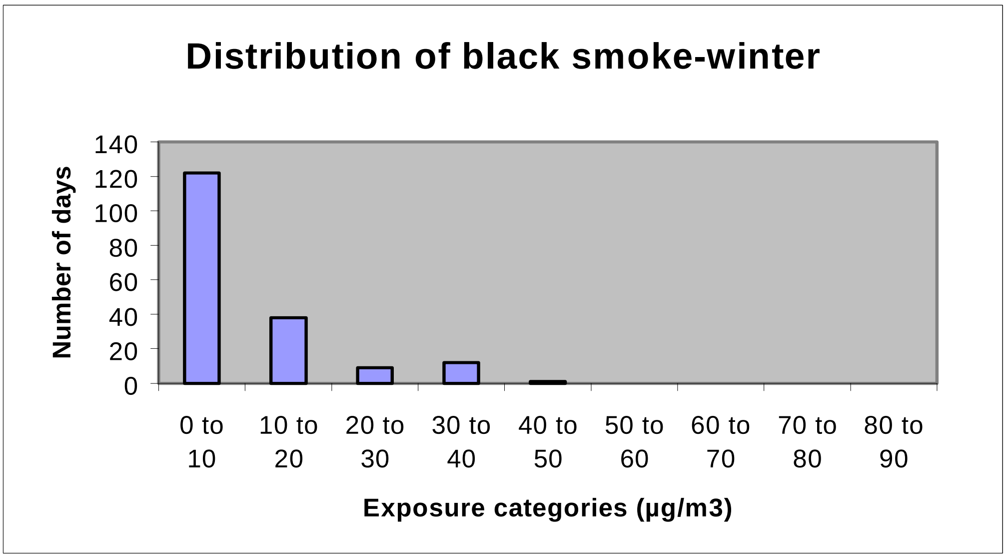
	Short term	
Air pollutant	**PM_{10}**	**BS**
Number of days above	20 µg/m^3	20 µg/m^3
	173	25
Number of days above	50 µg/m^3	50 µg/m^3
	17	1

The 3 following figures show distributions of BS, PM10 and PM2.5 for year, summer and winter. The distributions patterns are not very different between winter and summer but the highest levels are measured in winter.

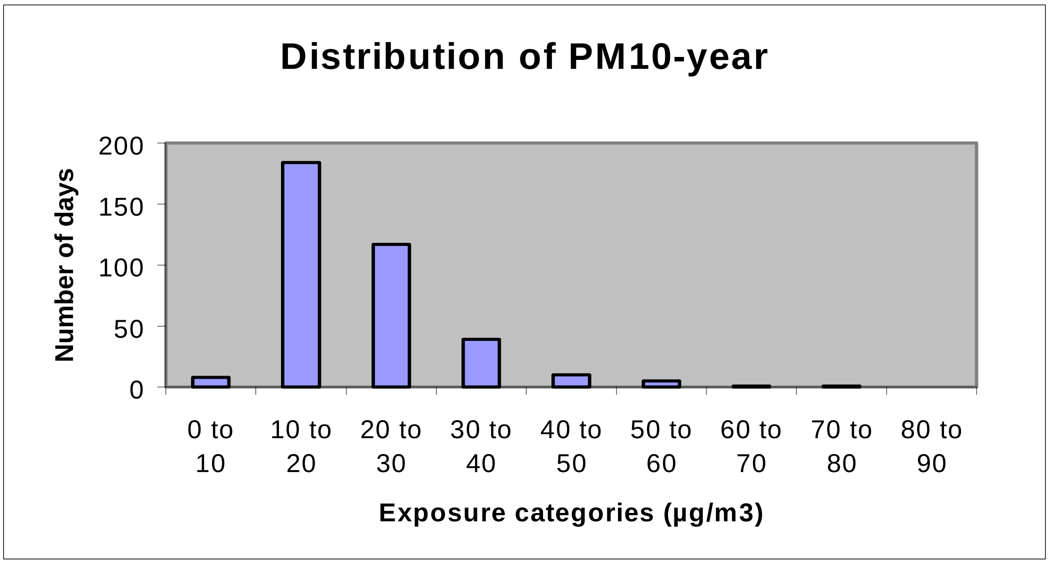
Figure 1,2,3. Distribution of Black smoke for 2001

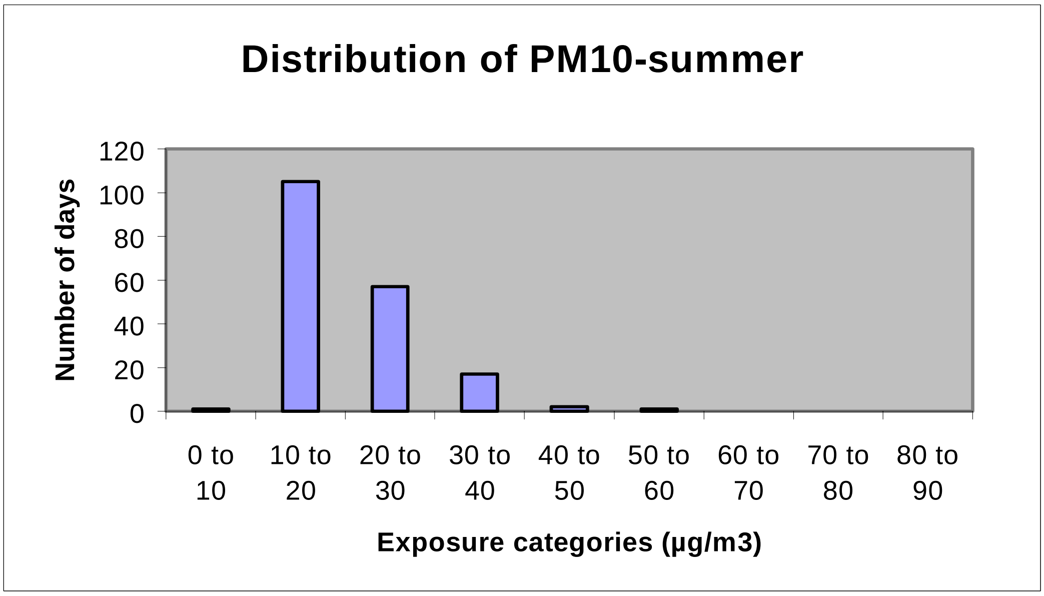


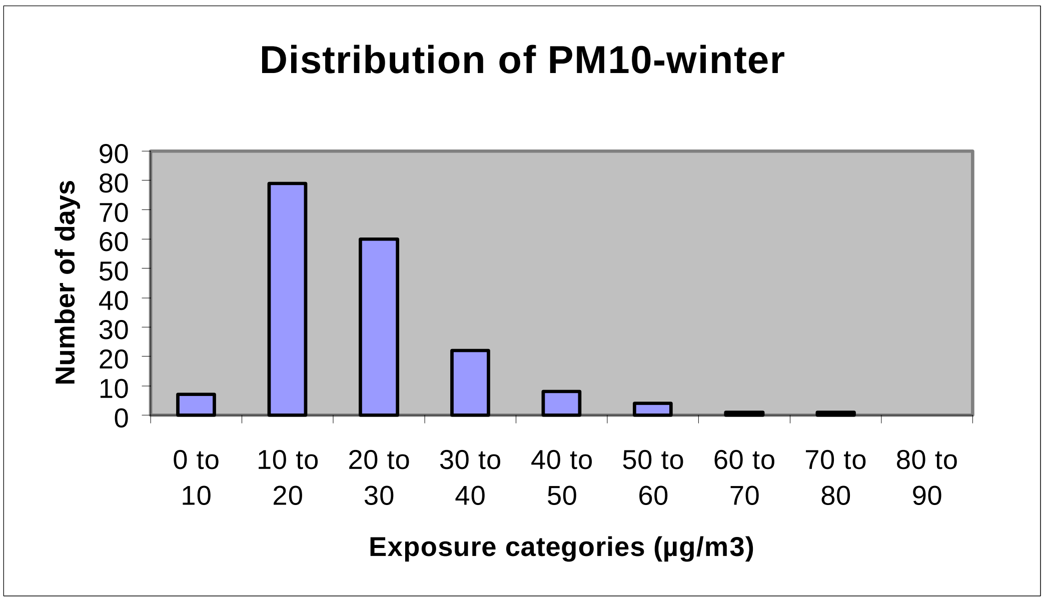




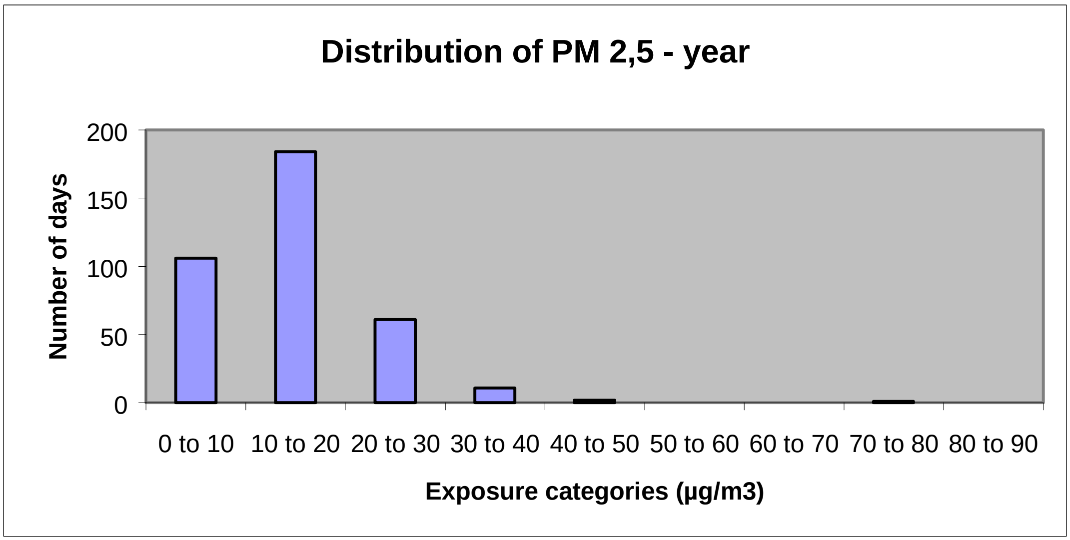
Figures 4,5,6. Distribution of PM10 for 2001

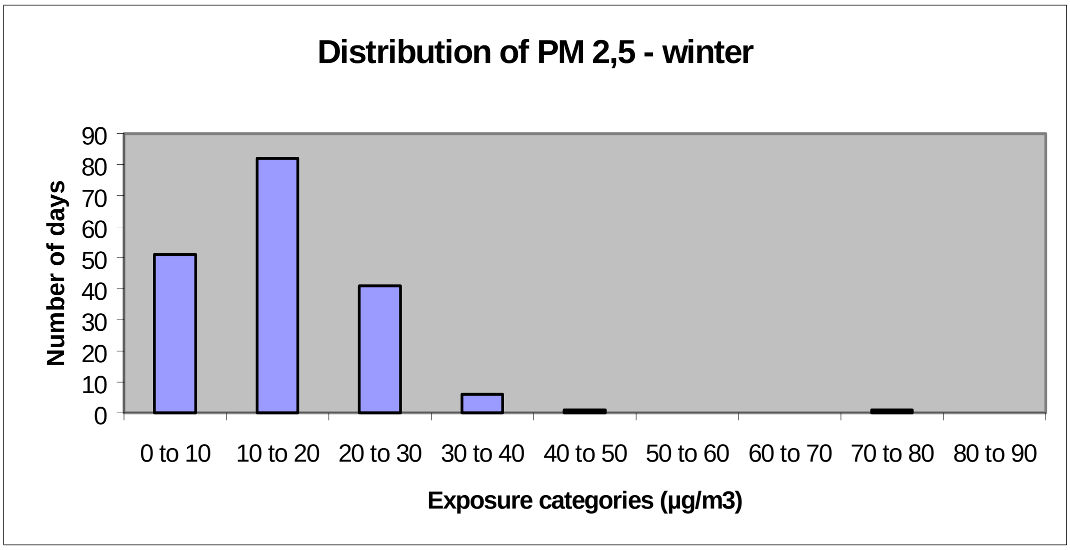


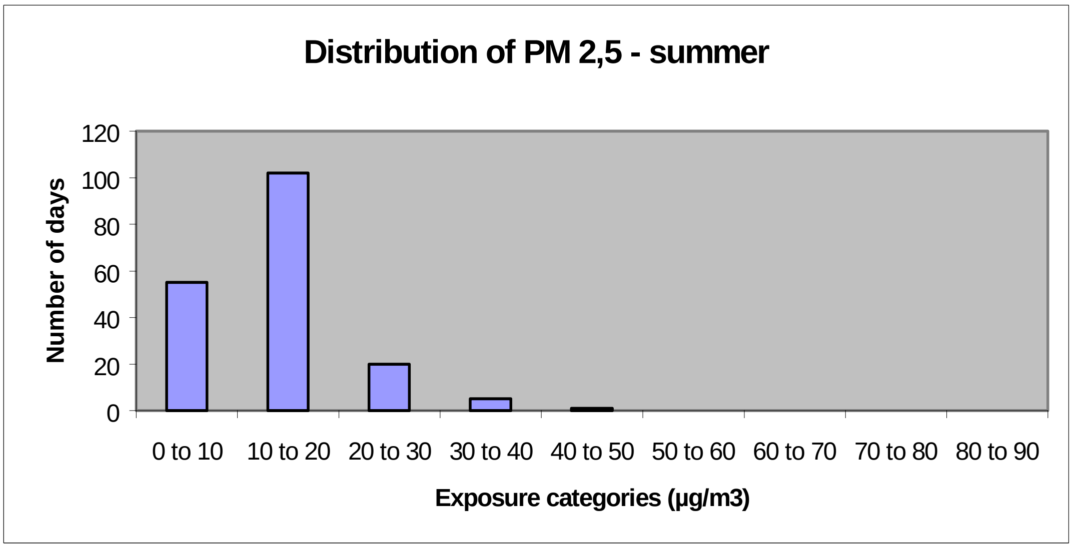




Figures 7,8,9. Distribution of PM2.5 for 2002







Health data

Mortality data were provided by the Information Department specialised in mortality data (CepiDC) at the National Health and Medical Research Institute (INSERM) for year 1999.

Data on hospitalisations for respiratory and cardiovascular diseases are provided by the Hospital Information Technical Agency (ATIH) from the hospital information system PMSI (Programme de médicalisation des systèmes d'information) for public and private hospitals in Rouen. Respiratory and cardiovascular diseases are coded with ICD10. Only one private establishment was taken into account, the "clinique Saint Hilaire" (The most important for cardiac disease). The data are available for year 2000 and results are presented in Table3.

Quality controls are carried out on hospital admissions and mortality data.

Age standardised mortality rate using European population was 784 per 100 000 inhabitants. Total European population (both sexes combined): 727 304 (in thousands) for year 2000 [1].

Table 3. Daily mean number and annual rate per 100 000 of deaths (1999) and hospital admissions (2000)

Health outcome	ICD9	ICD10	Daily mean or annual count number (SD)	Number of cases per 100 000 (daily or annual rate)
Short term HIA				
All causes mortality (excluding external causes)*	< 800	A00-R99	9.07 (3.16)	2.1(daily rate)
Cardiovascular mortality	390-459	I00-I99	2.94 (1.87)	0.7(daily rate)
Respiratory mortality	460-519	J00-J99	0.70 (0.86)	0.2(daily rate)
Cardiac hospital admissions	390-429	I00-I52	13.4	2.9(daily rate)
Respiratory hospital admissions	460-519	J00-J99	12.8	3.1(daily rate)
Long term HIA				
All causes mortality	0-999	A00-Y98	3621 (annual count)	832.7 (annual rate)
Cardiopulmonary mortality	401-440 460-519	I10-I70 J00-J99	1235 (annual count)	284.0 (annual rate)
Lung cancer mortality	162	C33-C34	206 (annual count)	47.4 (annual rate)

* For short and long term scenarios

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

Health impact assessment

Different scenarios were used to evaluate short and long-term exposure to particulate pollution. In the city of Rouen, 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/m^3 increase
Attributable cases		**ICD9**	**ICD10**		
		ST HIA for all cities report			
	All ages, all causes mortality (excluding external causes)	< 800	A00-R99		WHO, 2003: 1.006 (1.004 - 1.008)
	All ages, cardiovascular mortality	390-459	I00-I99		WHO, 2003: 1.009 (1.005 - 1.013)
	All ages, respiratory mortality	460-519	J00-J99		WHO, 2003: 1.013 (1.005 - 1.021)
	All ages, cardiac hospital admissions	390-429	I00-I52	French PSAS-9	Le Tertre et al. 2002: 1.006 (1.003 - 1.009)
PM10	All ages, respiratory hospital admissions	460-519	J00-J99	Excel spreadsheet	Apheis 3: 1.0114 (1.0062 - 1.0167)
	All ages, all causes mortality (excluding external causes)	< 800	A00-R99		WHO, 2003: 1.006 (1.004 - 1.009)
	All ages, cardiovascular mortality	390-459	I00-I99		WHO, 2003: 1.004 (1.002 - 1.007)
	All ages, respiratory mortality	460-519	J00-J99		WHO, 2003: 1.006 (0.998 - 1.015)
	All ages, cardiac hospital admissions	390-429	I00-I52	French PSAS-9	Le Tertre etal. 2002:1.011 (1.004 - 1.019)
BS	All ages, respiratory hospital admissions	460-519	J00-J99	Excel spreadsheet	Apheis 3: 1.0030 (0.9985 -1.0075)
	All ages, all causes mortality (excluding external causes)	< 800	A00-R99		Zanobetti et al. 2002: 1.01227 (1.0081 - 1.0164)
PM10 Distributed lag	All ages, cardiovascular mortality	390-459	I00-I99	French PSAS-9	Zanobetti et al. 2003: 1.01969 (1.0139 - 1.0255)
(40 days)	All ages, respiratory mortality	460-519	J00-J99	Excel spreadsheet	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 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 PM10 on 0-1 days and cumulative health effects of PM10 up to 40 days on all causes (excluding external causes), cardiovascular and respiratory mortality over one year:

- reduction of PM10 levels to a 24-hour value of 50 µg/m^3 on all days exceeding this value (2005 and 2010 limit values for PM10)
- reduction of PM10 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 PM10)
- reduction by 5 µg/m^3 of all the 24-hour values (to allow for cities with low levels of PM10)

Long-term scenarios

Long-term HIA scenarios for PM10

We used three scenarios to estimate the chronic effects of long-term exposure to PM10 on all mortality causes (excluding external causes) over one year:

- reduction of the annual mean value of PM10 to a level of 40 µg/m^3 (2005 limit values for PM10)
- reduction of the annual mean value of PM10 to a level of 20 µg/m^3 (2010 limit values for PM10)

- reduction by 5 µg/m^3 in the annual mean value of PM10 (to allow for cities with low levels of PM_{10})

Long term HIA for PM2.5

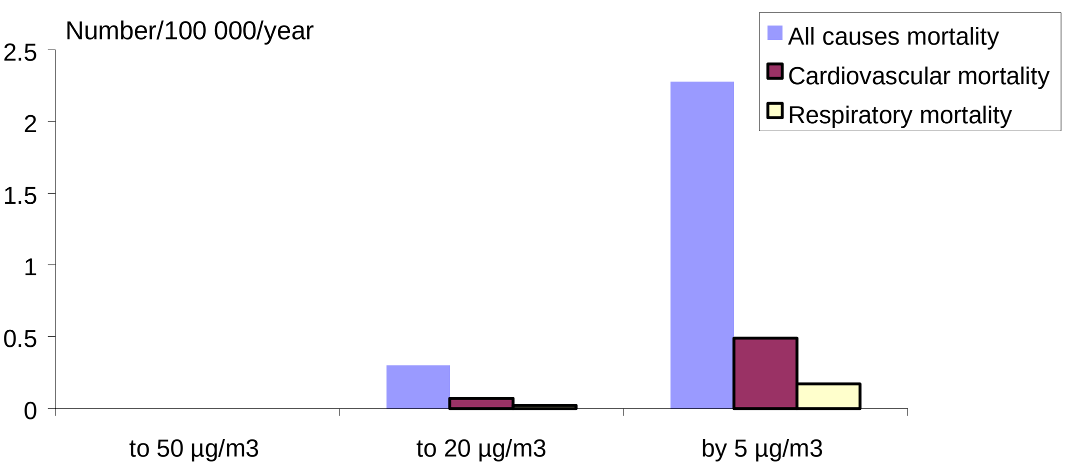
We estimated chronic effects of PM2.5 on the Rouen's population over 30 years old as impacts on mortality due to all causes, cardiopulmonary and lung cancer deaths.

The following three pollution scenarios were considered:
- reduction of the annual mean value of PM2.5 to a level of 20 µg/m^3
- reduction of the annual mean value of PM2.5 to a level of 15 µg/m^3
- reduction by 3.5 µg/m^3 in the annual mean value of PM2.5 (to allow for cities with low levels of PM2.5)

BS findings

The following graph shows the health impact of BS on all causes of mortality (excluding external causes), cardiovascular mortality and respiratory mortality.

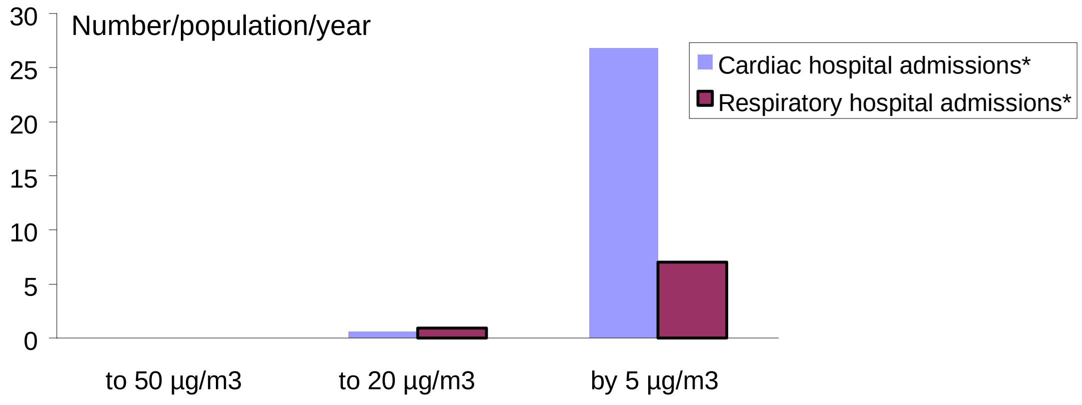
Figure 2. Black smoke : reductions to 50-20-by 5 µg/m^3. Short-term health impact on total* and specific mortality *



* 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 2000

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 2000

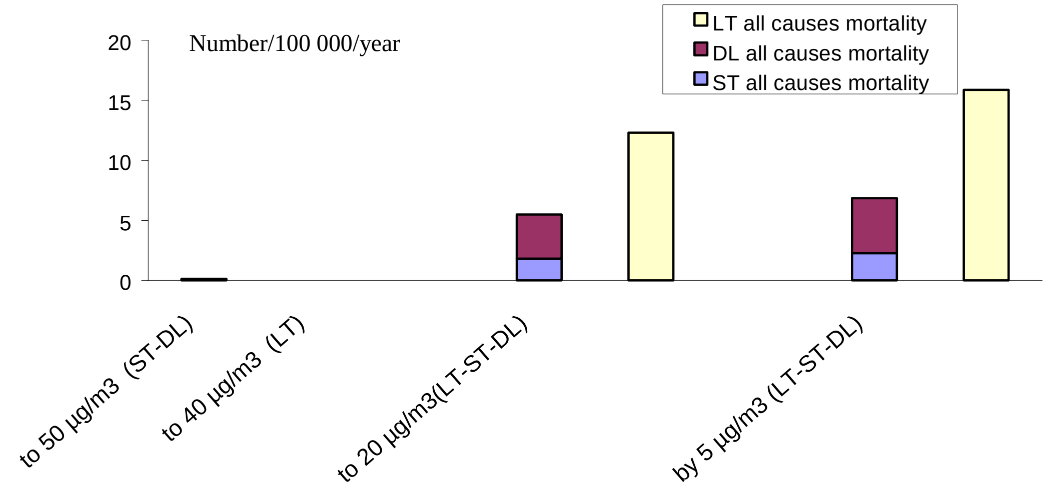
PM10 findings

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

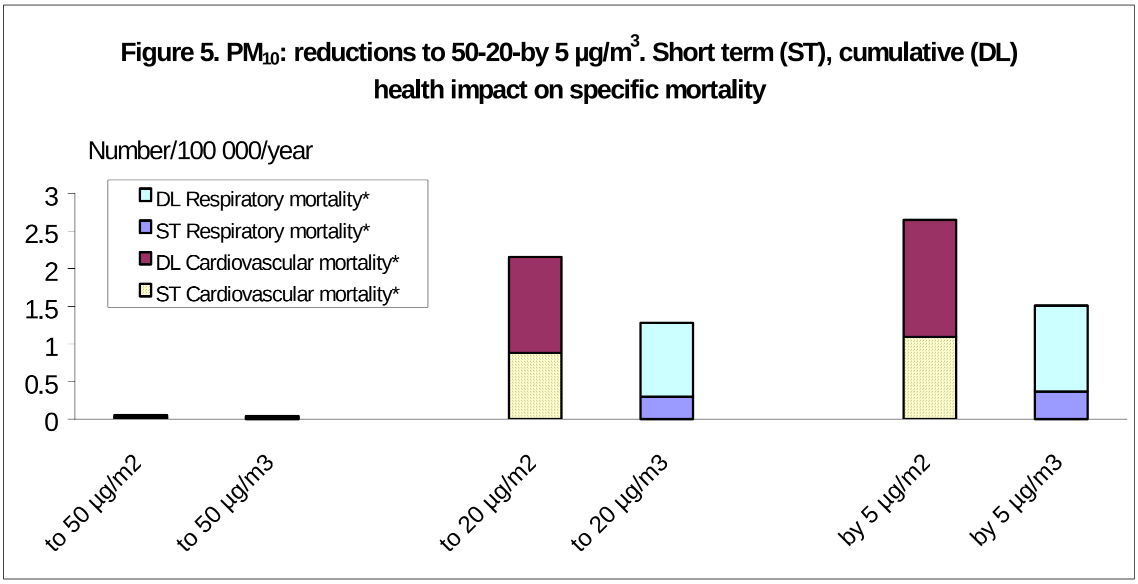
1.1. Mortality findings

The following graphs show the health impact of PM10 on mortality for different lags: short-term ST (0-1 days 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/m^3. Short term (ST), cumulative (DL), long term (LT) health impact on all causes mortality (ICD 9 <800)



* PM10 data for 2000, mortality data for 2000

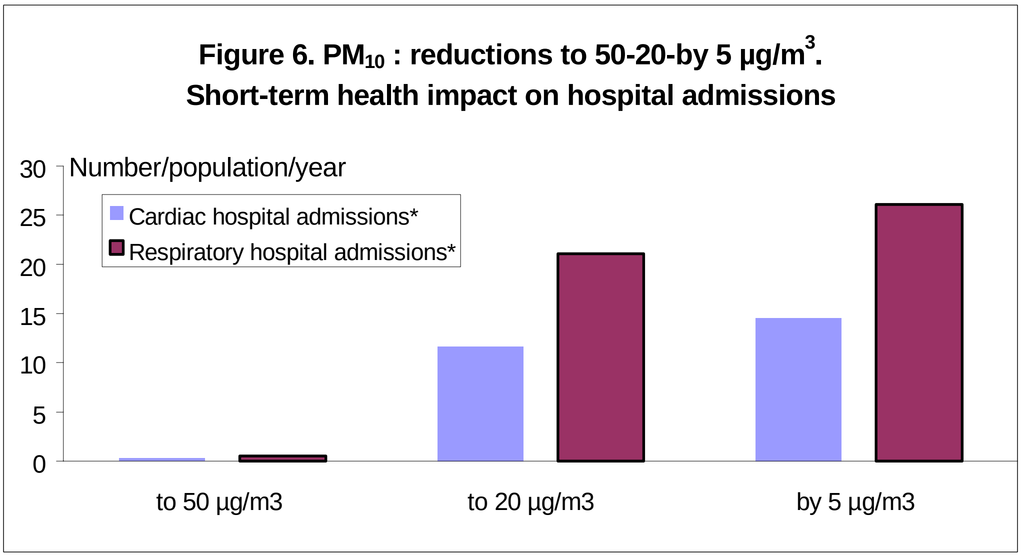


*Cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).
** PM10 data for 2000, mortality data for 2000

Comments:
The first scenario (to 50 µg/m^3) health impact is very slight according to the moderate air pollution levels in Rouen.
The results show the cumulative health effects is more than twice that the health effects of PM10 calculated on 0-1 days. Health impact is more intense when the considered exposure duration is longer and effects are cumulative in time. The long term impact on mortality is twice the DL impact.

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.



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

Comments :
The health impact is more important for respiratory admissions because of a higher baseline frequency of them comparatively to the cardiac admissions. As in the precedent graphs, the first scenario health impact (to 50 µg/m^3) is negligible due to the moderate observed PM10 levels.

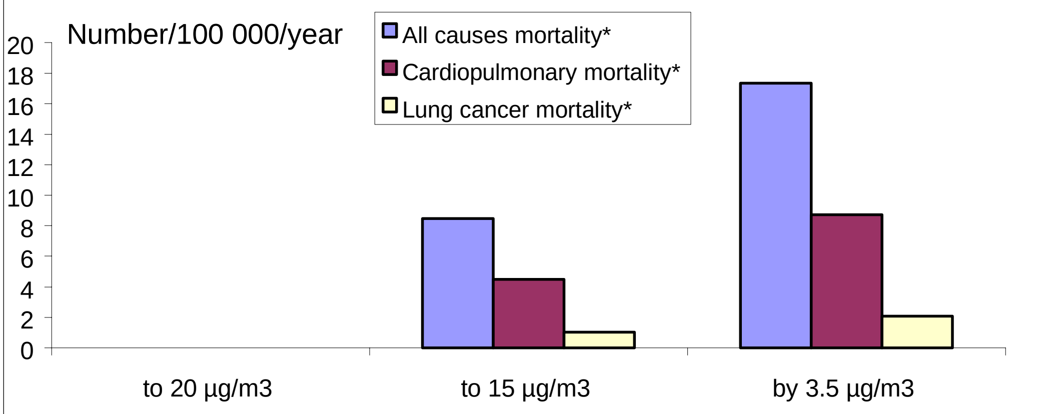
PM2.5 findings

1. Number of attributed cases

We also used three scenarios to estimate the chronic effects of long-term exposure to PM2.5 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



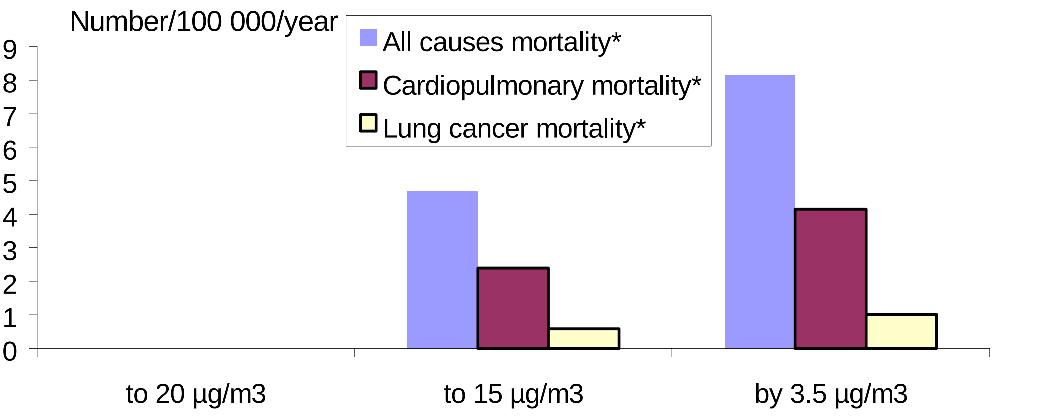
* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162).
** PM2.5 data for 2000, mortality data for 2000

The health impact for the second scenario (to 15 µg/m^3) is lower than for the third scenario (by 3.5 µg/m^3) because the PM2.5 annual mean used for HIA (i.e. converted from corrected PM10 for TEOM measurements) is closed to 15 µg/m^3: 17 µg/m^3.

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. PM2.5 data were converted from corrected PM10 data.
Figure 9 presents the years of life lost for all causes, cardiopulmonary and lung cancer deaths for 30 years of age or older in Rouen and its suburbs.

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 2000

Comments:
For all causes of deaths, all other things being equal, reduction of PM2.5 by 3.5 µg/m^3 in 2000 would save almost 36 years of expected life for starting year of simulation in people older than 30 years in the city of Rouen and its suburbs (434 830 inhabitants). For cardiopulmonary mortality, this number would be around 18 and for lung cancer mortality, more than 4 years.

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 µg/m^3 in Rouen

		Expected gain in life expectancy		
Age	Life expectancy	Mean	Low estimate	High estimate
At birth	78.71	0.13	0.03	0.22
30	49.63	0.13	0.03	0.23
65	19.34	0.09	0.02	0.16

Comments:
In terms of life expectancy, all other things being equal, if annual mean PM2.5 levels (17 µg/m^3) would be reduced to 15 µg/m^3, the 49.6 years of life expectancy in a person of 30 years old would increase by 0.13 year, due to reduced risk of death from all causes in the city of Rouen and its suburbs.

Interpretation of findings

Some comments can be made :

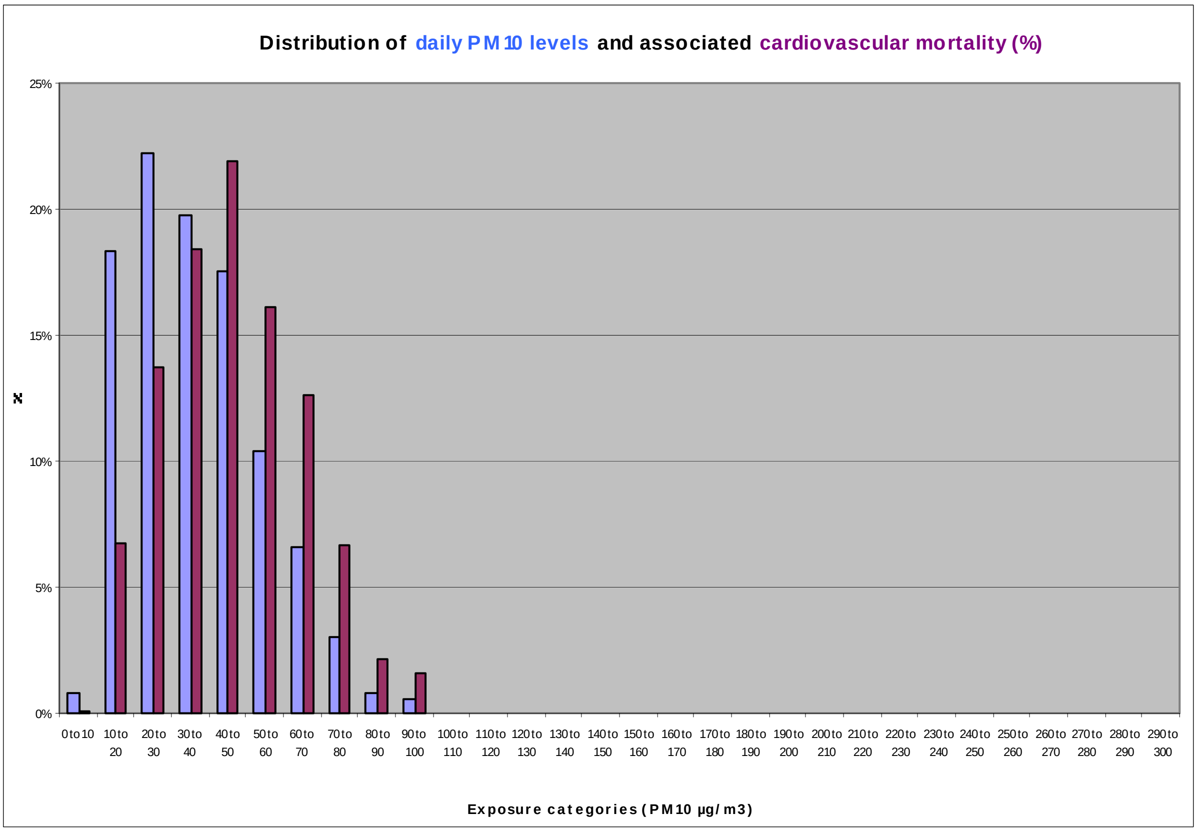
- Exposure assessment: In order to decrease potential exposure misclassification, the study area was defined using population exposure homogeneity criteria. First, this area does not present any discontinuance in urbanization. Second, the work place of the majority of working inhabitants was located in the area. Third, air pollution data homogeneity (closed means and high correlation coefficients) was checked on multi-sites measurements time series for PM and BS.

- Health outcomes : The principal lack of health data stay in hospital admission data. Indeed these data correspond to total admissions and not only emergency admissions due to the registry organisation. This fact can overestimate the ST health impact assessment because included planned admissions cannot be related to ST exposure. Furthermore, admissions data for some private hospital are missed.

- Findings :
  For Rouen, daily concentrations were above the value of 20 et 50 µg/m^3 for PM10 and BS and of 15 µg/m^3 for PM2.5. Also, a reduction of levels during these days leads a small decrease in the number of attributable case.
  For PM10 ,the results showed that health impact increases according to the exposure duration taken into account : LT impact is more important than DL impact which is more important than ST impact.
  The results show that, in spite of moderate levels of air pollution, potential health benefits can be obtained by air quality improvement, seeing result for reducing annual mean values of PM2,5 by 3,5 µg/m^3. These findings are even more visible on the years of life lost results.
  The air quality management consequence is that a long term air pollution decrease, even minimal, seems to be more effective than only air pollution peaks remove in term of health impact.

  This next figure illustrates the relative impact importance of air pollution peaks during a few days compared to daily exposure to lower levels of air pollution over longer periods. In this example, only 4% of the associated health impact is attributable to levels of PM10 higher than 80 µg/m3. Ninety six percent of the health impacts are observed for lower levels of PM10.

Short term distribution of PM10 levels and associated percentage of cases



General comments

These results complete those described in APHEIS II report for Rouen with health impact of PM10 and PM2.5. It confirms that potential health benefits can be obtained by air quality improvement even in cities with moderate levels of air pollution

Because the Atmospheric Protection Plan is in progress, it is still too early to truly assess the impact of results. A health working group has been created to take into account public health aspects. The HIA results of PSAS-9 and APHEIS are mentioned in this document, but no management decisions have been taken up by now.

Conclusions

In conclusion, the HIA results and their interpretation will bring to the decision makers quantitative medical data elements and thus will clarify their choice of reduction and prevention policies of the risks having to be implemented.
For the PPA ,the communication of air pollution's health impact to the general public will be developed and HIA results will be used.

Appendix

1. Exposure measurement methods

Harmonised compilation of information indicating the exposure relevant area of the city, number of PM10, PM2.5 or BS monitoring sites, and the type, sampling and measurement characteristics of stations selected for the HIA of APHEIS.

1.	City:	Rouen
2.	Total area of agglomeration (km²):	320 km^2
3.	Area (km²) covered by the air monitoring network in the city:	320 km^2
4.	Number of population in this (exposure relevant) area:	434 830
5.	Total number of PM10 monitoring stations in this area:	2
6.	Total number of BS monitoring stations in this area:	7
7.	Total number of PM2.5 monitoring stations in this area:	2
8.	Number of selected PM10 monitoring stations for HIA:	2
9. q	Number of selected BS monitoring stations for HIA:	3
10.	Number of selected PM2.5 monitoring stations for HIA:	2

11. Measurement interval (please cross)

PM10/PM2.5 : continuous ⊗ hourly BS : 24 hours ⊗ weekly

12. Quality assurance and control (please cross)

yes ⊗ no do not know

13. Data quality (please cross)

validated data ⊗ invalidated data

14. Name, classification and sampling characteristics of the monitoring site (traffic, kerbside, building line, commercial, urban residential, sub-urban, rural, industrial, others)

Name	PM10/BS/PM2.5	Classification
Val de la Haye – Ecole	BS	industrial
Petit Couronne	BS	industrial
Parc Expositions	BS	urban
Bois Guillaume	BS	sub-urban
Sotteville S[t] Etienne	PM10/ BS/PM2.5	urban
Guillaume le Conquérant	PM10/BS	traffic
Air Normand-Rouen	BS	urban
Rouen-Palais de justice	PM10/PM2.5	urban

15. Measurement method / Type of instrument

BS: reflectrometric

PM10 manual:____
automated: Quartz microbalance with a TEOM (Tapered Element Oscillating Microbalance) instrument
probe temperature (in °C): 50°C
optical:____

PM2.5 manual:____
automated: Quartz microbalance with a TEOM (Tapered Element Oscillating Microbalance) instrument
probe temperature (in °C): 50°C
optical:____

16. Using PM10 data for your city HIA calculation, did you used a conversion factor in order to compensate losses of volatile particulate matter?

no

yes ⊗ if yes, a) which factor: 1 for summer and 1.221 for winter.

b) is it a default factor? yes no

or c) derived from own parallel measurements
(reference method vs. TEOM or beta attenuation) yes ⊗ no
(cf: report of Ecole des Mines de Douai, there factors have been transmitted by Souad Bouallala to Mchal Krzyzanowsky)

17. If your PM2.5 data have been calculated from your PM10 data, what conversion

factor did you use? factor: 0.7 (default factor)

2. health data caracteristics

2.1 Mortality data

Type of source	Year	Source	Quality control programme	% Missing data in basic cause death	Codification		
					ICD	Manual	Automatic
Register	1999	Institut National de la Santé et de la Recherche Médicale (CepiDC)	Yes	0%	ICD9	100%	

2.2 Hospital admissions data

Type of source	Year	Source	ICD	Quality control	Completeness (%)	% Missing data cause admission	Type of H. admissions	
							Total	Emergency
Register	2000	PMSI	10	Yes	100	0	X	

3. 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 (2001) 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 BS

		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	25	1.31	0.88	1.97	0.30	0.20	0.45
50 µg/m^3	1	0.00	0.00	0.00	0.00	0.00	0.00
By 5 µg/m^3	NA*	9.90	6.60	14.84	2.28	1.52	3.41

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily BS levels (2001) 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 effect of BS

		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	25	0.28	0.14	0.50	0.07	0.03	0.11
50 μg/m^3	1	0.00	0.00	0.00	0.00	0.00	0.00
By 5 μg/m^3	NA*	2.14	1.07	3.74	0.49	0.25	0.86

**NA: not applicable*

Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily BS levels (2001) 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 BS

		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	25	0.10	-0.03	0.25	0.02	-0.01	0.06
50 μg/m^3	1	0.00	0.00	0.00	0.00	0.00	0.00
By 5 μg/m^3	NA*	0.76	-0.25	1.89	0.17	-0.06	0.44

**NA: not applicable*

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions(2000). Potential benefits of reducing daily BS levels (2001) 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 BS

		Attributable cases per year		
Scenarios	**Number of days per year exceeding 20 and 50 μg/m^3**	**N° of admissions central**	**N° of admissions lower**	**N° of admissions upper**
Hospital admissions for cardiac diseases (all ages)				
20 μg/m^3	25	3.59	1.30	6.21
50 μg/m^3	1	0.00	0.00	0.00
By 5 μg/m^3	NA*	26.79	9.76	46.18
Hospital admissions for respiratory diseases (all ages)				
20 μg/m^3	25	0.92	-0.46	2.31
50 μg/m^3	1	0.00	0.00	0.00
By 5 μg/m^3	NA*	7.00	-3.50	17.47

**NA: not applicable*

4. Tables for PM_{10} findings

4.1. 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 (2001) 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	173	7.86	5.24	10.48	1.81	1.20	2.41
50 µg/m³	17	0.20	0.13	0.26	0.05	0.03	0.06
By 5 µg/m³	NA*	9.82	6.55	13.09	2.26	1.51	3.01

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM_{10} levels (2001) 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	173	3.82	2.12	5.52	0.88	0.49	1.27
50 µg/m³	17	0.10	0.05	0.14	0.02	0.01	0.03
By 5 µg/m³	NA*	4.74	2.64	6.84	1.09	0.61	1.57

**NA: not applicable*

Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM_{10} levels (2001) 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	173	1.31	0.50	2.12	0.30	0.12	0.49
50 µg/m^3	17	0.03	0.01	0.05	0.01	0.00	0.01
By 5 µg/m^3	NA*	1.61	0.62	2.60	0.37	0.14	0.60

**NA: not applicable*

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2000). Potential benefits of reducing daily PM_{10} levels (2001) 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 admissions central	N° of admissions lower	N° of admissions upper
Hospital admissions for cardiac diseases (all ages)				
20 µg/m^3	173	11.63	5.81	17.46
50 µg/m^3	17	0.29	0.15	0.44
By 5 µg/m^3	NA*	14.54	7.28	21.79
Hospital admissions for respiratory diseases (all ages)				
20 µg/m^3	173	21.09	11.45	30.95
50 µg/m^3	17	0.54	0.29	0.79
By 5 µg/m^3	NA*	26.07	14.20	38.14

**NA: not applicable*

4.2. 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 PM10 up to 40 days and all causes of deaths (ICD 9 < 800) (1999).Potential benefits of reducing daily PM_{10} levels (2001) 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 PM10

		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	173	16.09	10.61	21.54	3.70	2.44	4.95
50 µg/m^3	17	0.41	0.27	0.55	0.09	0.06	0.13
By 5 µg/m^3	NA*	19.86	13.12	26.51	4.57	3.02	6.10

**NA: not applicable*

Table 6. Cumulative health effects of PM10 up to 40 days and cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM10 levels (2001) 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 PM10

		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	173	5.58	3.93	7.25	1.28	0.90	1.67
50 µg/m^3	17	0.15	0.10	0.19	0.03	0.02	0.04
By 5 µg/m^3	NA*	6.78	4.80	8.77	1.56	1.10	2.02

**NA: not applicable*

Table 7. Cumulative health effects of PM10 up to 40 days and respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM10 levels (2001) 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 PM10

		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	173	4.26	1.09	7.60	0.98	0.25	1.75
50 µg/m^3	17	0.12	0.03	0.21	0.03	0.01	0.05
By 5 µg/m^3	NA*	4.94	1.29	8.65	1.14	0.30	1.99

**NA: not applicable*

4.3. Long term HIA for PM10

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 PM10 (2001) 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 PM10

	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	53.44	32.48	75.41	12.29	7.47	17.34
40 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 5 µg/m^3	68.99	41.89	97.45	15.87	9.63	22.41

5. Tables for $PM_{2.5}$ findings

5.1. 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 $PM_{2,5}$ (2001) 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	36.94	9.65	64.49	8.49	2.22	14.83
20 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 3,5 µg/m^3	75.44	19.63	132.25	17.35	4.51	30.41

Table 2. Cardiopulmonary deaths (ICD9 401-440 and 460-519) (1999). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2001) 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	**N° of deaths**	**N° of deaths**	**N° of deaths per 100 000**	**N° of deaths per 100 000**	**N° of deaths per 100 000**
	central	**lower**	**upper**	**central**	**lower**	**upper**
15 µg/m^3	18.65	6.73	30.72	4.29	1.55	7.07
20 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 3,5 µg/m^3	38.00	13.64	62.91	8.74	3.14	14.47

Table 3. Lung cancer deaths (ICD9 162) (1999). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2001) 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	**N° of deaths**	**N° of deaths**	**N° of deaths per 100 000**	**N° of deaths per 100 000**	**N° of deaths per 100 000**
	central	**lower**	**upper**	**central**	**lower**	**upper**
15 µg/m^3	4.40	1.49	7.36	1.01	0.34	1.69
20 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 3,5 µg/m^3	8.94	3.01	15.05	2.06	0.69	3.46

4.1. 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 starting year of simulation (ICD9 0-999) (1999). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2001) 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	20.46	5.39	35.40	4.68	1.23	8.10
20 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 3,5 µg/m^3	35.65	9.42	61.49	8.16	2.16	14.67

Table 2. Cardiopulmonary deaths >30 years, male and female, for starting year of simulation (ICD9 401-440 and 460-519) (2001). Potential benefits of reducing annual mean values of $PM_{2,5}$ (1999) 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	10.43	3.80	17.0	2.39	0.87	3.89
20 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 3,5 µg/m^3	18.14	6.63	29.44	4.15	1.52	6.74

Table 3. Lung cancer deaths >30 years, male and female, for starting year of simulation (ICD9 162) (1999). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2001) 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	2.55	0.88	1.19	0.58	0.20	0.96
20 µg/m^3	0.00	0.00	0.00	0.00	0.00	0.00
By 3,5 µg/m^3	4.42	1.53	7.22	1.01	0.35	1.65