

# TOULOUSE CITY REPORT

## Summary of the main findings

Daily and annual means of PM10 are under the EC limit values for 2005 in Toulouse. Therefore, the levels remains above these limit values for 2010.

The analysis estimated that reduction of the long-term PM pollution to the levels of PM2.5 of  $15 \mu\text{g}/\text{m}^3$  would reduce mortality in Toulouse by 60 deaths in one year, which would save 28 years of expected life for starting year of simulation. If the daily means of PM10 would be kept under  $20 \mu\text{g}/\text{m}^3$ , 15 deaths and 39 hospital respiratory admissions could have been avoided in the year 2000.

Main cause of air pollution in the city is traffic and actions planned to reduce it are urban transport management improvement.

## Background

As described in the city report Aphis second year, Toulouse is situated in the plain of the south-west of France, influenced by the two Oceanic and Mediterranean climates. The city is swept by a cool and wet, West wind, and by the strong and dry Autan wind (SE). Many rainfalls are brought in from the ocean : 650 mm of water on average for 715 hours of rain in a year. The minimum and maximum temperatures are on average  $9.6^\circ\text{C}$  and  $18.7^\circ\text{C}$ . Minimum relative humidity is 53.5%.

The study area includes 62 municipalities, that is 690 162 inhabitants (1999 census) with 13.5% older than 65 years on a  $635 \text{ km}^2$  area. This study area was defined on AP exposition homogeneity criteria. It therefore has a low population density compared to other urban centres. It is also characterised by heavy traffic between the suburbs and the town centre, mainly with the use of private cars. In 1996, out of 2.5 million journeys, 63% is done by car. Nevertheless, between 1990 and 1996, this percentage seems to be stabilising, probably thanks to the new subway that opened in 1993.

In Toulouse, as in other French urban areas of more than 250 000 inhabitants, the main political framework for public air quality management is the plan for air protection (PPA) which is in progress. This plan completes the regional plan for air quality (PRQA) initiated in 1999 within the framework on the law on air and rational use of energy voted in 1997.

PPA aims to take the necessary measures in order to follow the European policy on regulated pollutants such as  $\text{SO}_2$ ,  $\text{NO}_2$ , PM10, CO, Pb, HCl,  $\text{O}_3$ ,  $\text{C}_6\text{H}_6$ . Yet, if necessary, local policies on regulated pollutants may be more restrictive than the European policies and new measures on non-regulated pollutants may also be taken.

At the local level, results of Aphis3 complete the PSAS-9 results (French program for AP effects surveillance) for PM HIA and local policies repercussions of these programs.

## Sources

The previous Apehis city report presented in 2002 the relative part of the various types of emission sources based on a list, established in 1997, of data from 1994 ([www.apheis.org](http://www.apheis.org)).

Recently, the Regional Observatory of Air Quality (ORAMIP) updated this list with data from 1999 and 2000. Table 1 presents the evolution of the relative part of the various emission sources between these two periods.

**Table 1. Main sources of air pollution (in ton/year except for CO<sub>2</sub> in kton/year)**

	SO <sub>2</sub>		NO <sub>x</sub>		COV		CO		NH <sub>3</sub>		CO <sub>2</sub>	
	1994	1999/2000	1994	1999/2000	1994	1999/2000	1994	1999/2000	1994	1999/2000	1994	1999/2000
Industry,	26.5	37.7%	15.7%	17.5%	29.7%	33.1%	1.1%	1.2%	98.8%	100%	29.1%	21.7%
Energy and waste management	836	1026	1617	2102	5656	5516	827	756			896	884
Residential , commerce	31.3%	43.4%	7.7%	8.4%	20.2%	31.9%	20.5%	32.3%	0%	0%	36%	34.9%
	987	1180	793	1009	3847	5310	15443	21208			1108	1420
Transport (road, planes, trains)	42.2%	18.9%	76.6%	74.1%	49.6%	35%	78.3%	67%	1.2%		34.9%	43.4%
	1331	514	7889	8892	9446	5831	58984	43700			1074	1769
Total emissions	3154	2720	10299	12003	19044	16658	75332	66663	1610	1502	3078	4073

Particles are not listed in this table but it can be observed that among all the pollutants taken into account, traffic remains the main source of emissions, except for SO<sub>2</sub>, whether it is in 1994 or in 2000.

## Exposure data

Concerning particulate matter, Black Smoke have never measured in the city of Toulouse.

PM10 have been measured since August 1999 by 3 stations : 2 urban background stations (Jacquier and Berthelot) and one traffic station (CCIT). One of the background stations was destroyed by the explosion of the AZF factory in September 2001 and was not replaced until January 2003. In the same time, a third background station (Mazades) was installed.

PM2.5 have been measured since August 1999 by 2 stations : one urban background station (Berthelot) and one traffic station (CCIT).

The two stations Berthelot (urban) and CCIT (traffic) were used for Apehis 3. We checked that mean level measured by these two stations were closed and daily concentrations series were correlated.

PM10 and PM2.5 are measured by 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) : 1.2
- in summer (moderate levels of PM) : 1

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

Moreover, a local conversion factor from PM10 to PM2.5 was locally established from comparative PM10 and PM2.5 measurements on the same sites. An HIA sensibility analysis with PM10, PM2.5 measured and PM2.5 converted from PM10 data was locally also carried out. This conversion factor is : 0,65.

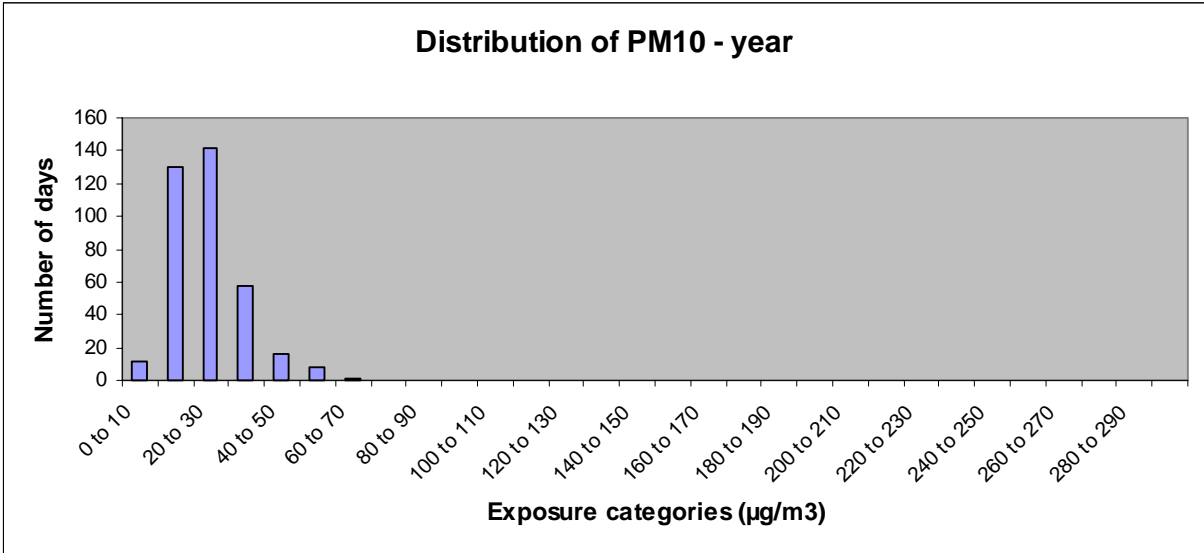
**Exposure data for Apehis 3:**

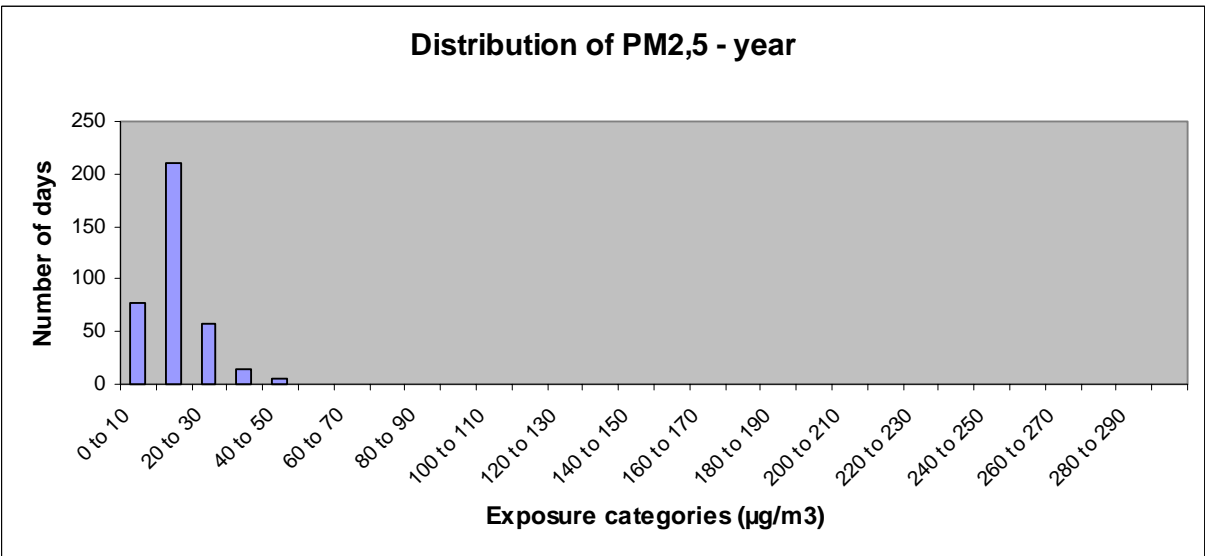
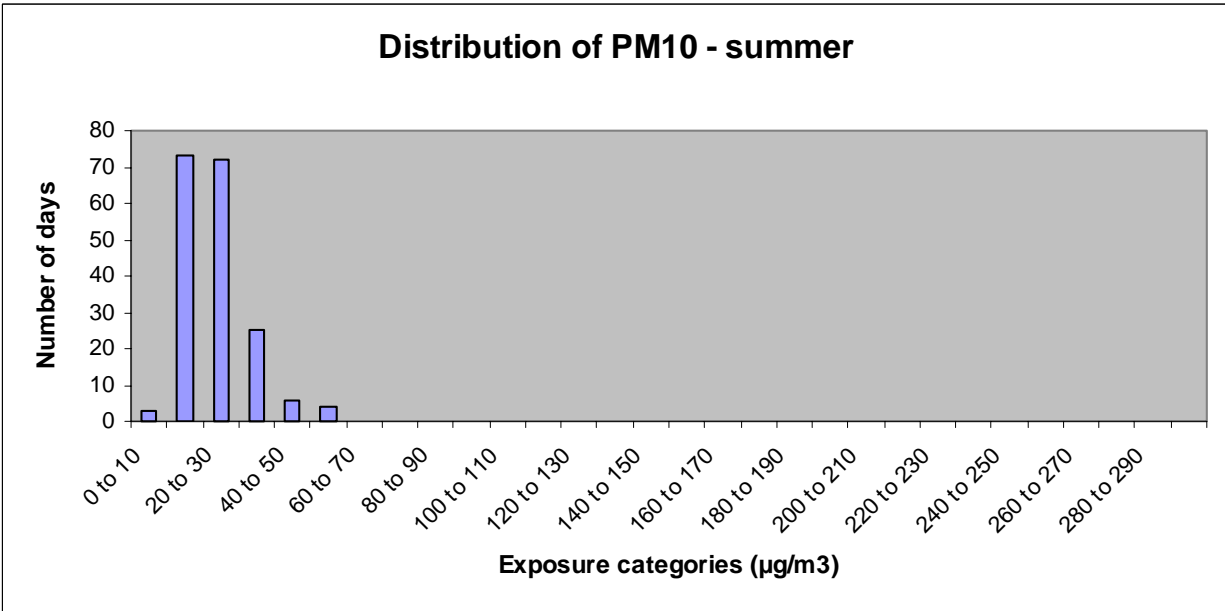
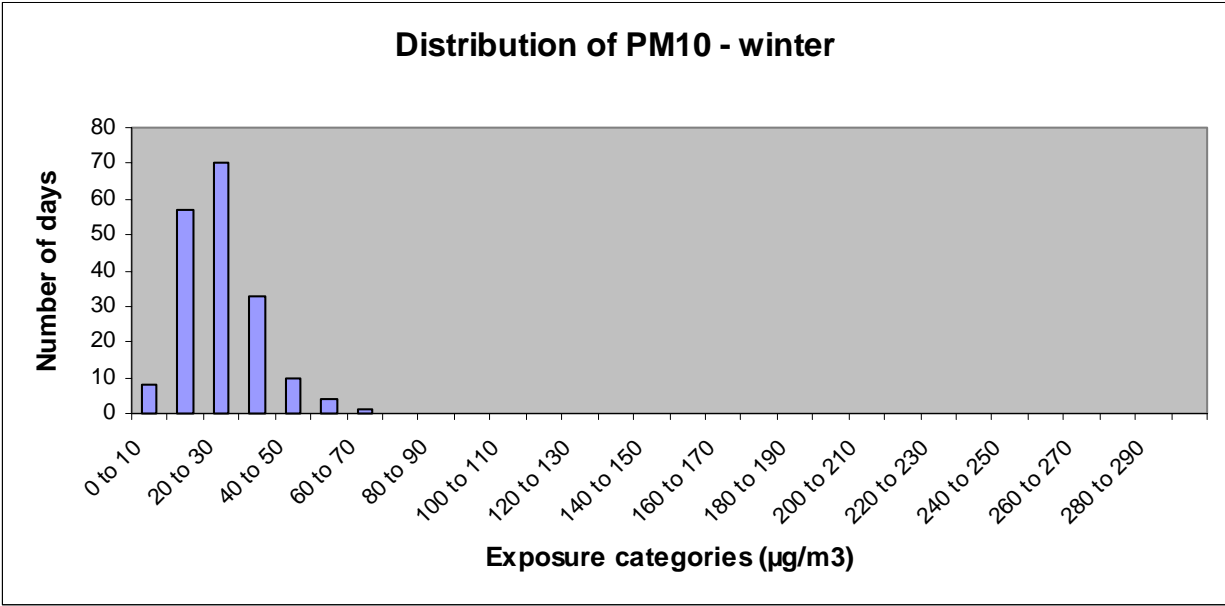
- Year of air pollution data was 2000
- Daily mean levels (SD) of PM10 and PM2.5 were respectively (direct measurements) 24,0 (10,0)  $\mu\text{g}/\text{m}^3$  and 15,7 (7,1)  $\mu\text{g}/\text{m}^3$ .
- P5 and P95: The levels of PM10 reached during the 18 days with the lowest (5<sup>th</sup> percentile) and the highest (95<sup>th</sup> percentile) levels were respectively 11  $\mu\text{g}/\text{m}^3$  and 44  $\mu\text{g}/\text{m}^3$ . The levels of PM2.5 reached during the 18 days with the lowest (5<sup>th</sup> percentile) and the highest (95<sup>th</sup> percentile) levels were respectively 7 $\mu\text{g}/\text{m}^3$  and 30 $\mu\text{g}/\text{m}^3$ .
- Number of days when air pollutants exceeded limit levels:

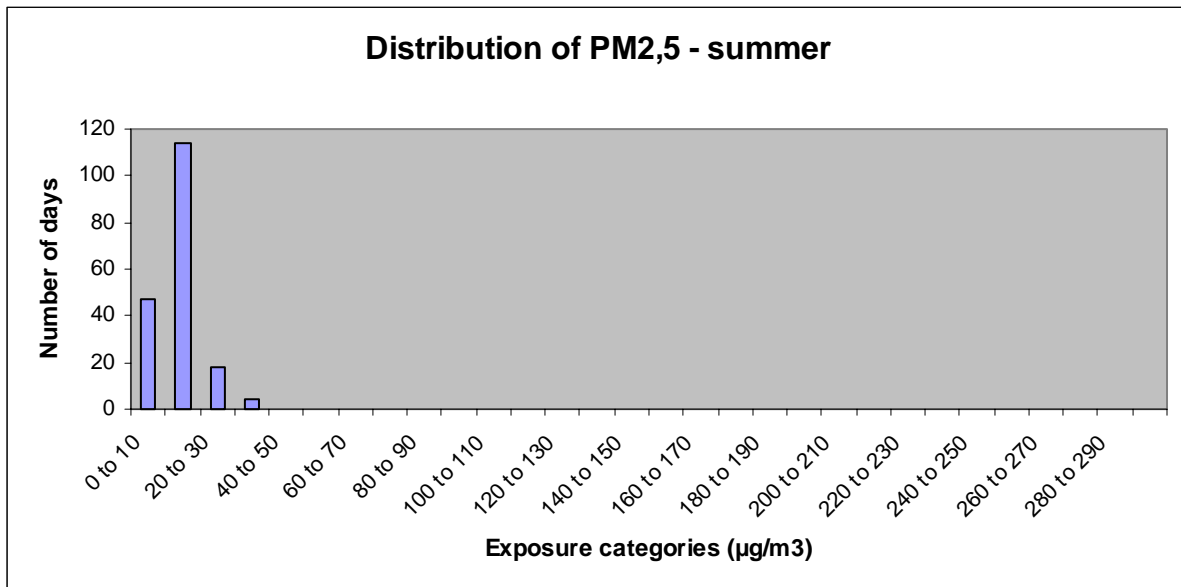
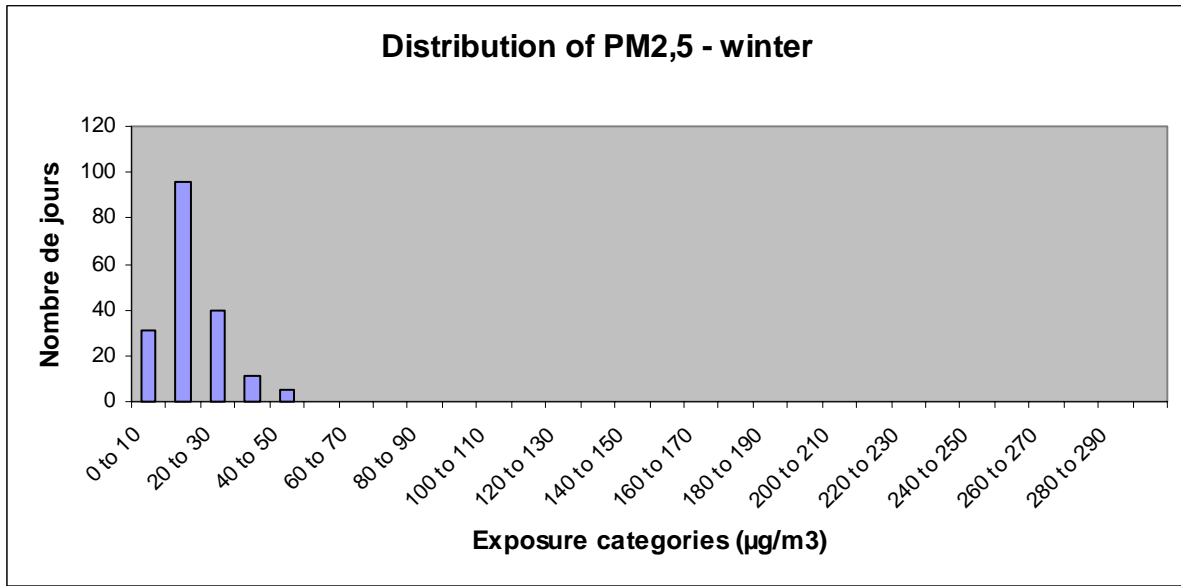
**Table 2. Number of days when air pollutants exceeded limit levels**

Air pollutant	Short term	
	PM10	PM2.5
Number of days above 20 $\mu\text{g}/\text{m}^3$	225	185
Number of days above 50 $\mu\text{g}/\text{m}^3$	9	6

The 3 following figures show distributions of PM10 and PM2.5 for year, for summer and for winter : the distributions patterns are not very different between winter and summer but the highest levels are measured in winter either for PM10 or PM2.5. For PM10, the majority of daily means are between 10 and 30  $\mu\text{g}/\text{m}^3$ . For PM2.5, most of the daily means are between 10 and 20  $\mu\text{g}/\text{m}^3$ .







In the context of the local urban transport plan and choices made for local transport management, ORAMIP studied the urban background air pollution evolution (PM10, NO<sub>2</sub>). The results were concentrations maps and the global conclusions of the study were an increase of the traffic in 2008 but a decrease of the background air pollution due to the improvement of vehicles. Actually, a second study is carrying out in order to model the annual mean of background PM10. These results will permit taking into account these evolutions in the HIA.

## Health data

- The information department specialised in mortality data collection (Cepi DC) at the National Health and Medical Research Institute (INSERM) provides medical causes of death based on the international classification of diseases (CIM9). The more recent available data were for year 1999 coded with CIM 9<sup>th</sup> revision.
- Data on hospital admissions concerned public and private hospitals and were extract for year 2000 by the hospital information technical agency (ATIH) from the Information Systems Medicalisation Program (PMSI).
- Quality controls are carried out on hospital admissions and mortality data.
- Annual age-standardised total mortality rate (CIM9 = [000-999]) was 456 per 100 000 inhabitants, using the European population as a reference<sup>1</sup>.

Table 3 presents daily mean number and standard deviation, and **annual** number of cases per 100 000.

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

Health outcome	ICD9	ICD10	Daily mean number (SD)	Number of cases per 100 000
<b>Short term HIA</b>				
All causes mortality (excluding external causes)*	< 800	A00-R99	11,74(daily mean)	1,7 (daily rate)
Cardiovascular mortality	390-459	I00-I99	3,82(daily mean)	0,55(daily rate)
Respiratory mortality	460-519	J00-J99	0,88(daily mean)	0,13(daily rate)
Cardiac hospital admissions	390-429	I00-I52	17,54(daily mean)	2,54(annual rate)
Respiratory hospital admissions	460-519	J00-J99	15,56(daily mean)	2,25(annual rate)
<b>Long term HIA</b>				
All causes mortality	0-999	A00-Y98	4552(annual count)	657(annual rate)
Cardiopulmonary mortality	401-440	I10-I70	1574(annual count)	226(annual rate)
Lung cancer mortality	162	C33-C34	232(annual count)	657(annual rate)

\* For short and long term scenarios

The birth number is not expected to change dramatically in Toulouse for the future years. In an other hand, the population trend is increasing because of migrations from other French regions.

<sup>1</sup> 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 Toulouse, these scenarios were built for two indicators of this particulate pollution : 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 relative risk (RR) estimates were used to evaluate the short- and long-term impacts of this particulate pollution on health according to the pollutant, the health indicator and the city (Table 4).

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

	Health indicator	ICD		Tool	RR (95% IC) For 10 µg/m <sup>3</sup> increase	
Attributable cases		ICD9	ICD10			
		<b>ST HIA for all cities report</b>				
PM10	All ages, all causes mortality (excluding external causes)	< 800	A00-R99	French PSAS-9 Excel spreadsheet	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		Le Tertre et al. 2002: 1.006 (1.003 - 1.009)	
	All ages, respiratory hospital admissions	460-519	J00-J99		Apheis 3: 1.0114 (1.0062 - 1.0167)	
BS	All ages, all causes mortality (excluding external causes)	< 800	A00-R99	French PSAS-9 Excel spreadsheet	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		Le Tertre et al. 2002: 1.011 (1.004 - 1.019)	
	All ages, respiratory hospital admissions	460-519	J00-J99		Apheis 3: 1.0030 (0.9985 - 1.0075)	
PM10 Distributed lag (40 days)	All ages, all causes mortality (excluding external causes)	< 800	A00-R99	French PSAS-9 Excel spreadsheet	Zanobetti et al. 2002: 1.01227 (1.0081 - 1.0164)	
	All ages, cardiovascular mortality	390-459	I00-I99		Zanobetti et al. 2003: 1.01969 (1.0139 - 1.0255)	
	All ages, respiratory mortality	460-519	J00-J99		Zanobetti et al. 2003: 1.04206 (1.0109 - 1.0742)	
<b>Complementary ST HIA for some cities reports</b>						
PM10 with shrunken estimates	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	
					<b>RR</b>	
					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)

<b>Table 4 (cont), Summary LONG-TERM Health impact assessment (HIA)</b>						
	<b>Health indicator</b>	<b>ICD 9</b>	<b>ICD10</b>	<b>Tool</b>	<b>RR (95% IC) For 10 µg/m<sup>3</sup> increase</b>	<b>Scenarios</b>
<b>Long term HIA for all-cities report</b>						
<b>Attributable cases</b>						<b>Annual mean</b>
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 <sup>3</sup> Reduction to 20 µg/m <sup>3</sup> Reduction by 5 µg/m <sup>3</sup>
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 <sup>3</sup> Reduction to 15 µg/m <sup>3</sup> Reduction by 3.5 µg/m <sup>3</sup>
<b>YoLL</b>						<b>Annual mean</b>
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 <sup>3</sup> Reduction to 15 µg/m <sup>3</sup> Reduction by 3.5 µg/m <sup>3</sup>
<b>Complementary LT HIA for some cities report</b>						
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 (non available for Toulouse)
- 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 PM10 on mortality and hospital admissions over one year:

### **Short-term HIA of PM<sub>10</sub> on 0-1 days and cumulative HIA of PM<sub>10</sub> up to 40 days**

We used three scenarios to estimate the acute health effects of PM<sub>10</sub> 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 PM<sub>10</sub> levels to a 24-hour value of 50 µg/m<sup>3</sup> 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<sup>3</sup> on all days exceeding this value (to allow for cities with low levels of PM10)
- reduction by 5 µg/m<sup>3</sup> 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 causes mortality (excluding external causes) over one year:

- reduction of the annual mean value of PM10 to a level of 40 µg/m<sup>3</sup> (2005 limit values for PM10)
- reduction of the annual mean value of PM10 to a level of 20 µg/m<sup>3</sup> (2010 limit values for PM10)
- reduction by 5 µg/m<sup>3</sup> in the annual mean value of PM10 (to allow for cities with low levels of PM10)

### **Long term HIA for PM2.5**

We estimated chronic effects of PM2.5 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 PM2.5 to a level of 20 µg/m<sup>3</sup>
- reduction of the annual mean value of PM2.5 to a level of 15 µg/m<sup>3</sup>

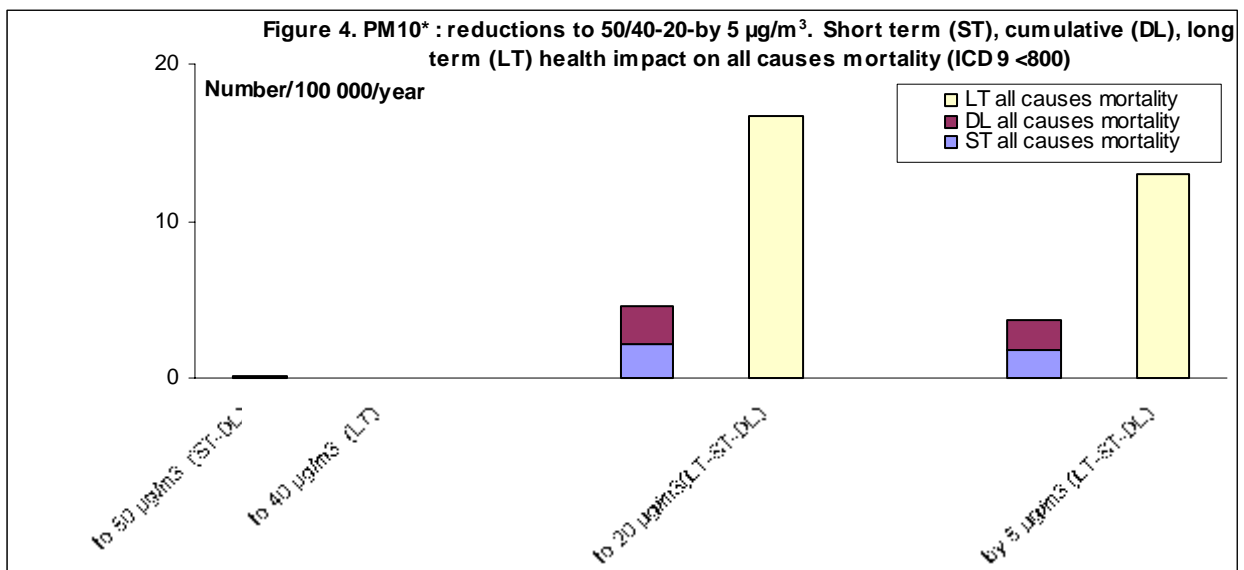
- reduction by  $3.5 \mu\text{g}/\text{m}^3$  in the annual mean value of  $\text{PM}_{2.5}$  (to allow for cities with low levels of  $\text{PM}_{2.5}$ )

## PM10 findings

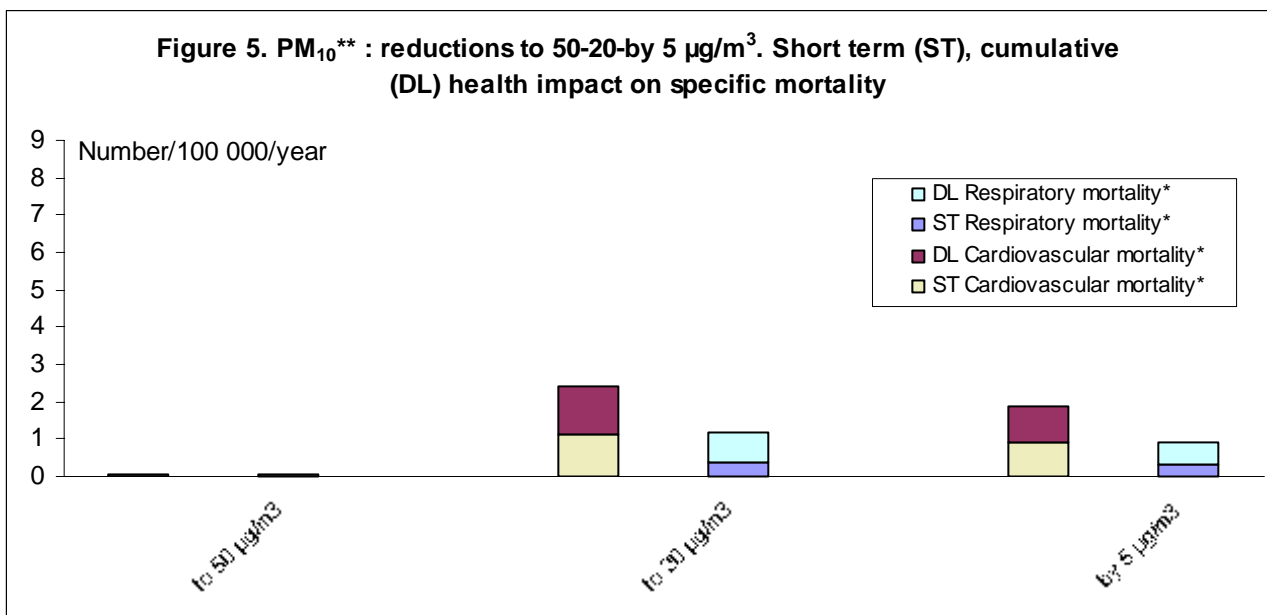
### 1. Short-term HIA of PM10 on 0-1 days, cumulative HIA of PM10 up to 40 days, and long term HIA of PM10

#### 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).



\* PM10 data for 2000, mortality and population data for 1999



\*Cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).

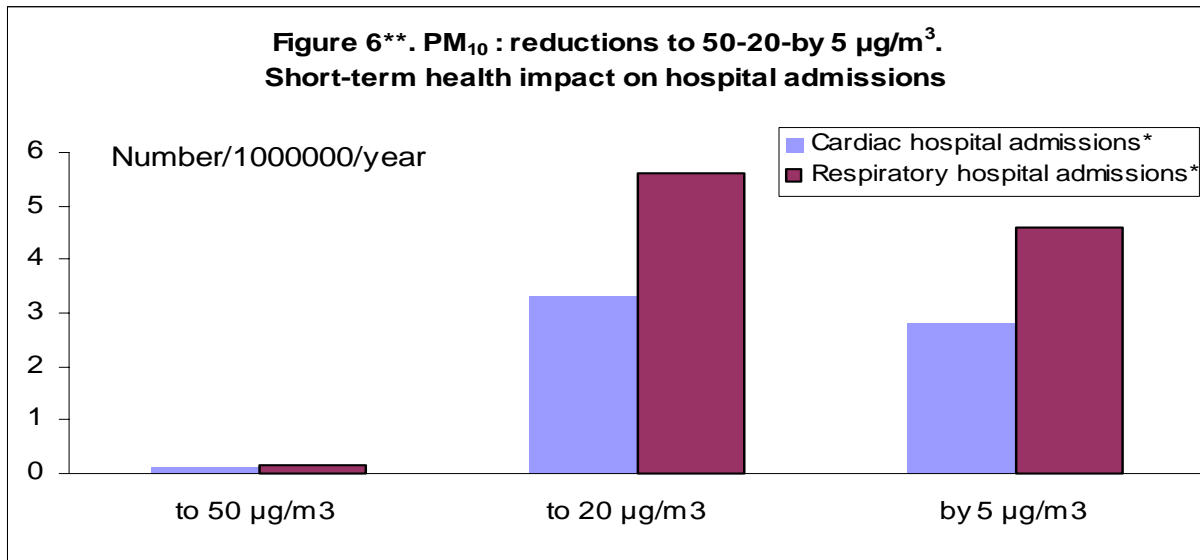
\*\* PM10 data for 2000, mortality and population data for 1999

First, these graphs show that the first scenario (to 50  $\mu\text{g}/\text{m}^3$ ) health impact is negligible according to the moderate air pollution levels registered in Toulouse. Second, for the two other scenarios, the graphs show 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.

If the daily means of PM10 would be kept under 20  $\mu\text{g}/\text{m}^3$ , 15 deaths could have been avoided in the year 2000 (ST impact). If the annual mean would be kept under 20  $\mu\text{g}/\text{m}^3$ , 115 deaths could be avoided in one year (LT impact).

## 1.2. Hospital admissions findings

We estimated the acute effects of short-term exposure to PM10 on cardiac and respiratory hospital admissions over one year.



\* Cardiac (ICD9 390-429) and respiratory hospital admissions (ICD9 460-519).

\*\* PM10 and data hospital admissions for 2000, population data for 1999.

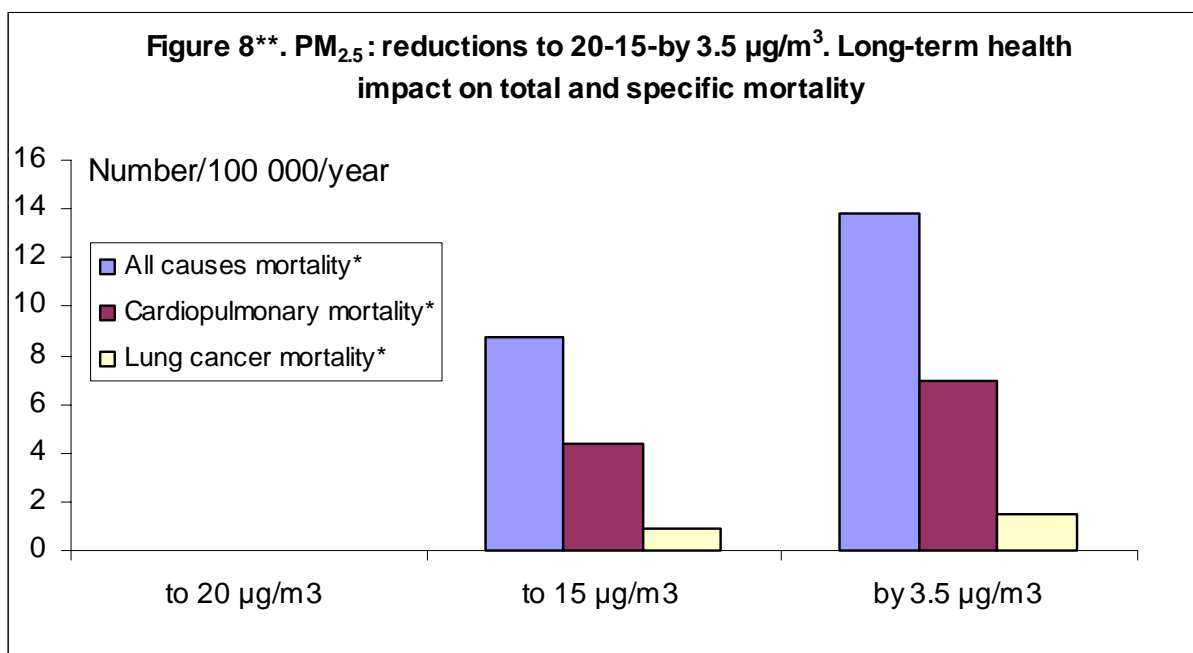
The health impact is more important for respiratory admissions because of a bigger baseline frequency of them comparatively to the cardiac admissions. As in the precedent graphs, the first scenario health impact (to 50  $\mu\text{g}/\text{m}^3$ ) is negligible due to the moderate PM10 levels observed.

## 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.



\* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162).

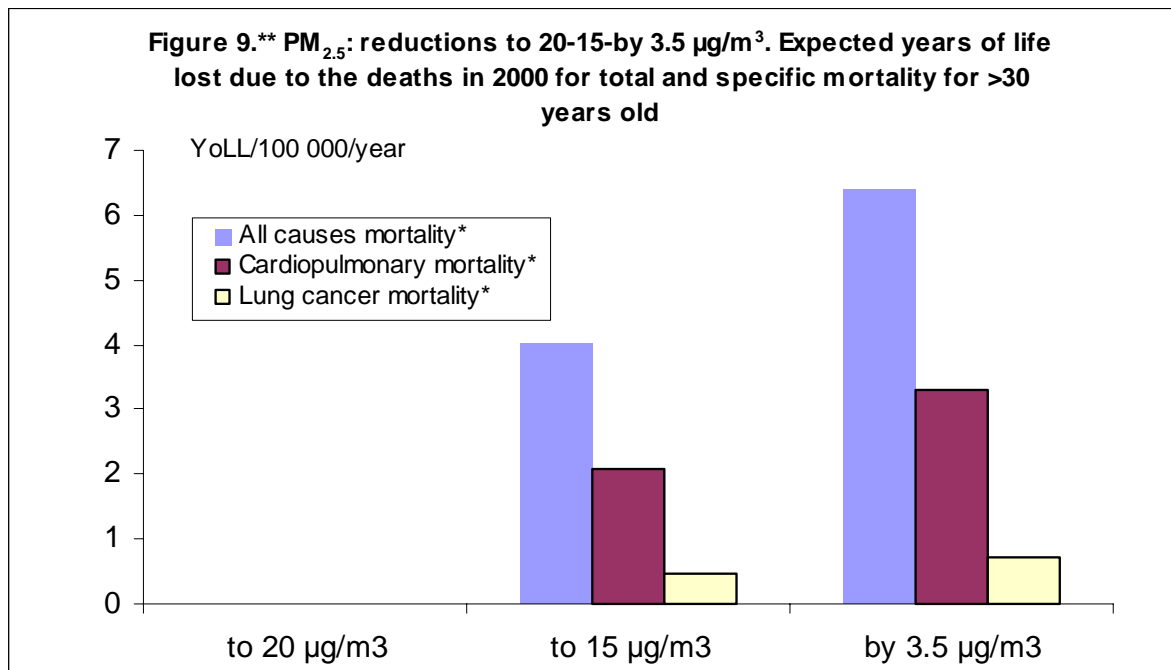
\*\* PM<sub>2.5</sub> data for 2000, mortality and population data for 1999.

The reduction of the long-term PM pollution to the levels of 15 µg/m<sup>3</sup> and by 3,5 µg/m<sup>3</sup> would reduce total mortality in Toulouse respectively by 60 and 95 deaths in one year. The health impact is lower for the second scenario (to 15 µg/m<sup>3</sup>) than for the third scenario (by 3.5 µg/m<sup>3</sup>) because the PM<sub>2.5</sub> annual mean used for HIA (i.e. converted from corrected PM<sub>10</sub> for TEOM measurements) is closed to 15 µg/m<sup>3</sup> in Toulouse : 17.2 µg/m<sup>3</sup>.

## 2. Years of life lost

We estimated the years of life lost attributable to the chronic effects of PM<sub>2.5</sub> using the data for 2000. PM<sub>2.5</sub> data were converted from corrected for TEOM PM<sub>10</sub> data.

Figure 9 presents the years of life lost for all causes, cardiopulmonary and lung cancer deaths for 100,000 inhabitants 30 years of age or older of Toulouse.



\* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162).

\*\* PM<sub>2.5</sub> data for 2000 converted from PM<sub>10</sub> (corrected for TEOM), mortality data for 1999

This graph has to be interpreted as following : for all causes of deaths, all other things being equal, reduction of PM<sub>2.5</sub> by 3.5 µg/m<sup>3</sup> in 2000 would save 6 years of expected life for 100,000 inhabitants older than 30 years in the city of Toulouse for starting year of simulation (i.e. 45 years of expected life for the total population). For cardiopulmonary mortality, this number would be around 3 and for lung cancer mortality, around 1.

As the attributable cases numbers results, this third scenario is the more effective because of the annual mean observed in this city.

The following table 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<sup>3</sup> in Toulouse.**

Age	Life expectancy	Expected gain in life expectancy		
		Mean	Low estimate	High estimate
At birth	80.88	0.13	0.03	0.22
30	51.73	0.13	0.03	0.22
65	19.93	0.10	0.03	0.17

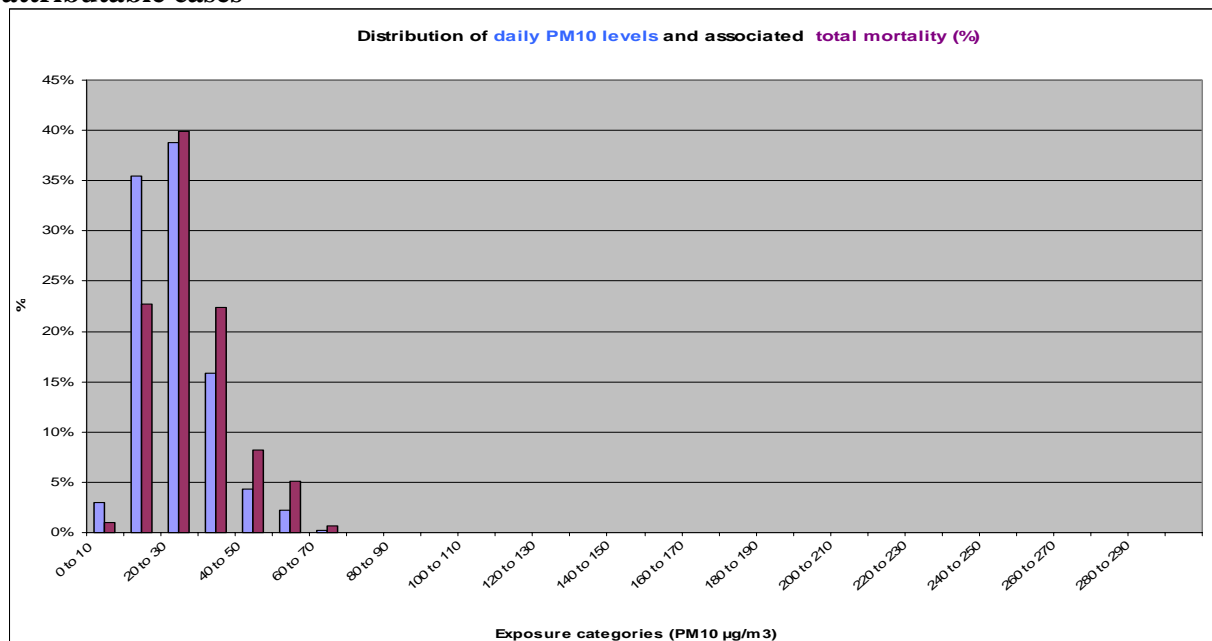
This table has to be interpreted as following : In terms of life expectancy, all other things being equal, if annual mean PM<sub>2.5</sub> levels (17.2 µg/m<sup>3</sup>) would be reduced to 15 µg/m<sup>3</sup>, the 52 years of life expectancy in a person of 30 years old would be increased by 0.13 years, due to reduced risk of death from all causes in the city of Toulouse.

## Interpretation of findings

Comments and discussion can be made on the results reliability relatively to several issues :

- Exposure assessment : In order to decrease potential exposure misclassification, the Toulouse 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 but also for other urban pollutants (NO<sub>2</sub>).
- Health outcomes : The health data principal lack stay in hospital admission data. Indeed these data correspond to total admissions and not only emergency admissions due to the registry organization. This fact can overestimate the ST health impact assessment because included planned admissions cannot be related to ST exposure.
- 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. These findings are consistent with mortality patterns observed in the historic air pollution major episodes (London, 1952 and other) and cohort studies results. The air quality management consequence is that a long term air pollution decreasing, even minimal, seems to be more effective than only air pollution peaks removing in term of health impact (figure 10).  
This fact is also illustrated by the YoLL findings for PM<sub>2.5</sub> : in Toulouse, a minimal annual mean decrease of 2,2 µg/m<sup>3</sup> (17,2 to 15 µg/m<sup>3</sup> – see table 5) could give an expected gain in life expectancy equal to 0.13 year or around 50 days.

**Figure 10 : Daily distribution of PM10 levels and associated percentage of ST attributable cases**



## **General comments**

These results confirm those described in APHEIS2 report for Toulouse. Potential health benefits can be obtained by air quality improvement even in cities with moderate levels of air pollution like Toulouse.

When the first PSAS-9 (French program for air pollution effects surveillance) results were published in 1999, together with the PRQA, decision-makers first became aware of the issue on air and health.

It is too early to assess the real impact of the information provided by HIA (Apheis and PSAS-9) to the Atmospheric Protection Plan in Toulouse where, for the first time, HIA results can be taken into account in management decisions. Yet, one can expect that decisions on air quality management will take into account public health aspects, thanks to the numerous discussions between the different partners and the PSAS-9/Apheis epidemiologist about articulation between the HIA results and the actions to be taken.

It is clear that epidemiologists must remain attentive to the various decision-makers' request in order to improve health impact quantification tools and develop partnerships. For example, these tools are still locally insufficient for the specific problems encountered in a specific area or population.

## **Conclusions**

In conclusion, the HIA results and their interpretation begin to be better understood by the local partners and decision makers locally. The communication to the general public has now to be developed in order to help them understand personal issues of the public decisions.

# Appendix 1 : exposure measurements methods and health data characteristics

## 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:   | <b>Toulouse</b>                     |
| 2.  | Total area of agglomeration (km <sup>2</sup> ):   | 713 km <sup>2</sup>                 |
| 3.  | Area (km <sup>2</sup> ) covered by the air monitoring network in the city:  | 635 km <sup>2</sup>                 |
| 4.  | Number of population in this (exposure relevant) area:  | 690 162 inhabitants                 |
| 5.  | Total number of PM10 monitoring stations in this area:  | 3 since May 1999, 6 since July 2003 |
| 6.  | Total number of BS monitoring stations in this area:  | zero                                |
| 7.  | <b>Total number of PM2.5 monitoring stations in this area:</b>  | <b>2 since August 1999</b>          |
| 8.  | Number of selected PM10 monitoring stations for HIA:<br>(located in the same site than the two PM2.5 stations in order to carry out the sensibility analysis) | 2 for year 2000                     |
| 9.  | Number of selected BS monitoring stations for HIA:  | zero                                |
| 10. | <b>Number of selected PM2.5 monitoring stations for HIA:</b>  | <u>    2    </u>                    |
| 11. | Measurement interval (please cross)   |                                     |
|     | continuous <input checked="" type="checkbox"/> hourly      24 hours      weekly      2 weekly   |                                     |
| 12. | Quality assurance and control (please cross)  |                                     |
|     | yes <input checked="" type="checkbox"/> no      do not know   |                                     |
| 13. | Data quality (please cross)   |                                     |
|     | validated data <input checked="" type="checkbox"/> invalidated data   |                                     |

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

<u>Name</u>	<u>PM10/BS/PM2.5</u>	<u>Classification</u>
Lycée Berthelot	PM10/PM2.5	urban
CCIT	PM10/PM2.5	trafic

Before using CCIT measurements, the correlation coefficient between the two daily series and the two distributions were checked (year 2000) :

- Correlation coefficient between Berthelot and CCIT = 0,9
- Distribution parameters :

	Berthelot	CCIT
<b>mean</b>	22	26
<b>Standard dev.</b>	10	10
<b>coef de var.</b>	0,5	0,4
<b>médiane</b>	21	25
<b>pc25</b>	15	18
<b>pc75</b>	27	31
<b>min</b>	5	8
<b>max</b>	67	64
<b>pc98</b>	52	53

The two interquartiles overlap each other.

15. Measurement method / Type of instrument

BS: \_\_\_\_\_

PM10 manual: \_\_\_\_\_  
 automated: TEOM  
 probe temperature (in °C): \_\_\_\_\_ 50 \_\_\_\_\_  
 optical: \_\_\_\_\_

PM2.5 manual: \_\_\_\_\_  
 automated: TEOM  
 probe temperature (in °C): \_\_\_\_\_ 50 \_\_\_\_\_  
 optical: \_\_\_\_\_

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

no

yes

if yes, a) which factor:

local factors in Toulouse are (report of Ecole des Mines de Douai, JL Houdret, December 2002) :

Summer : 1.0 Winter : 1.2

b) is it a default factor? Yes no

or c) derived from own parallel measurements

(reference method vs. TEOM or beta attenuation) yes  no

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

The local conversion factor used (checked on the data) was : 0.65.

## 2. Health Data

### 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	

## Appendix 2 : Tables for PM10 findings

### 1. Health effects of PM<sub>10</sub> 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 PM10 levels (2000) above 20 to 20 µg/m<sup>3</sup>, above 50 to 50 µg/m<sup>3</sup> and all days by 5 µg/m<sup>3</sup>. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM10**

Scenarios	Number of days per year exceeding 20 and 50 µg/m <sup>3</sup>	Attributable cases per year					
		N° of deaths		N° of deaths per 100 000		N° of deaths per 100 000	
		central	lower	upper	central	lower	upper
20 µg/m <sup>3</sup>	225	15.39	10.25	20.54	2.2	1.5	2.9
50 µg/m <sup>3</sup>	9	0.39	0.26	0.52	0.06	0.04	0.08
By 5 µg/m <sup>3</sup>	NA*	12.73	8.49	16.96	1.8	1.2	2.5

\*NA: not applicable

**Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM10 levels (2000) above 20 to 20 µg/m<sup>3</sup>, above 50 to 50 µg/m<sup>3</sup> and all days by 5 µg/m<sup>3</sup>. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM10**

Scenarios	Number of days per year exceeding 20 and 50 µg/m <sup>3</sup>	Attributable cases per year					
		N° of deaths		N° of deaths per 100 000		N° of deaths per 100 000	
		central	lower	upper	central	lower	upper
20 µg/m <sup>3</sup>	225	7.51	4.17	10.86	1.1	0.6	1.6
50 µg/m <sup>3</sup>	9	0.19	0.11	0.28	0.03	0.02	0.04
By 5 µg/m <sup>3</sup>	NA*	6.17	3.43	8.91	0.9	0.5	1.3

\*NA: not applicable

**Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM10 levels (2000) above 20 to 20  $\mu\text{g}/\text{m}^3$ , above 50 to 50  $\mu\text{g}/\text{m}^3$  and all days by 5  $\mu\text{g}/\text{m}^3$ . Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM10**

Scenarios	Attributable cases per year						
	Number of days per year exceeding 20 and 50 $\mu\text{g}/\text{m}^3$	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
20 $\mu\text{g}/\text{m}^3$	225	2.50	0.96	4.05	0.4	0.1	0.6
50 $\mu\text{g}/\text{m}^3$	9	0.06	0.02	0.10	0.008	0.003	0.014
By 5 $\mu\text{g}/\text{m}^3$	NA*	2.04	0.78	3.28	0.3	0.1	0.5

\*NA: not applicable

**Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2000). Potential benefits of reducing daily PM10 levels (2000) above 20 to 20  $\mu\text{g}/\text{m}^3$ , above 50 to 50  $\mu\text{g}/\text{m}^3$  and all days by 5  $\mu\text{g}/\text{m}^3$ . Absolute number (95% confidence limits) attributable to the acute effects of PM10**

Scenarios	Attributable cases per year			
	Number of days per year exceeding 20 and 50 $\mu\text{g}/\text{m}^3$	N° of deaths	N° of deaths	N° of deaths
		central	lower	upper
<b><i>Hospital admissions for cardiac diseases (all ages)</i></b>				
20 $\mu\text{g}/\text{m}^3$	225	22.9	11.48	34.53
50 $\mu\text{g}/\text{m}^3$	9	0.58	0.29	0.87
By 5 $\mu\text{g}/\text{m}^3$	NA*	19.01	9.51	28.50
<b><i>Hospital admissions for respiratory diseases (all ages)</i></b>				
20 $\mu\text{g}/\text{m}^3$	225	38.75	21.03	56.87
50 $\mu\text{g}/\text{m}^3$	9	0.99	0.54	1.46
By 5 $\mu\text{g}/\text{m}^3$	NA*	31.68	17.25	46.35

\*NA: not applicable

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

Scenarios	Number of days per year exceeding 20 and 50 µg/m <sup>3</sup>	Attributable cases per year					
		N° of deaths		N° of deaths per 100 000		N° of deaths per 100 000	
		central	lower	upper	central	lower	upper
20 µg/m <sup>3</sup>	225	31.47	20.74	42.12	4.6	3.0	6.1
50 µg/m <sup>3</sup>	9	0.81	0.53	1.08	0.12	0.07	0.15
By 5 µg/m <sup>3</sup>	NA*	25.68	16.97	34.29	3.7	2.5	5.0

\*NA: not applicable

**Table 6. Cumulative health effects of PM<sub>10</sub> up to 40 days and cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM<sub>10</sub> levels (2000) above 20 to 20 µg/m<sup>3</sup>, above 50 to 50 µg/m<sup>3</sup> and all days by 5 µg/m<sup>3</sup>. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM<sub>10</sub>**

Scenarios	Number of days per year exceeding 20 and 50 µg/m <sup>3</sup>	Attributable cases per year					
		N° of deaths		N° of deaths per 100 000		N° of deaths per 100 000	
		central	lower	upper	central	lower	upper
20 µg/m <sup>3</sup>	225	16.43	11.57	21.32	2.4	1.7	3.1
50 µg/m <sup>3</sup>	9	0.43	0.30	0.56	0.06	0.04	0.08
By 5 µg/m <sup>3</sup>	NA*	13.20	9.33	17.07	1.9	1.4	2.5

\*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 (2000) above 20 to 20  $\mu\text{g}/\text{m}^3$ , above 50 to 50  $\mu\text{g}/\text{m}^3$  and all days by 5  $\mu\text{g}/\text{m}^3$ . Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM10**

Scenarios	Number of days per year exceeding 20 and 50 $\mu\text{g}/\text{m}^3$	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
20 $\mu\text{g}/\text{m}^3$	225	8.08	2.07	14.42	1.2	0.3	2.1
50 $\mu\text{g}/\text{m}^3$	9	0.22	0.06	0.39	0.03	0.01	0.06
By 5 $\mu\text{g}/\text{m}^3$	NA*	6.20	1.62	10.85	0.9	0.2	1.6

\*NA: not applicable

### 3. Long term HIA for PM<sub>10</sub>

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

**Table 8. Deaths all causes (ICD9 < 800) (1999). Potential benefits of reducing annual mean values of PM10 (2000) to levels of 20 and 40  $\mu\text{g}/\text{m}^3$ , and by 5  $\mu\text{g}/\text{m}^3$ . 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	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
20 $\mu\text{g}/\text{m}^3$	115.35	69.95	163.13	16.7	10.1	23.6
40 $\mu\text{g}/\text{m}^3$	0	0	0	0	0	0
By 5 $\mu\text{g}/\text{m}^3$	89.51	54.34	126.42	13.0	7.9	18.3

## Appendix 3 : Tables for PM2.5 findings

### 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. PM2.5 data used are obtained by PM10 conversion (factor = 0.65). These PM10 data are corrected for measurements method.

**Table 1. Deaths all causes (ICD9 0-999) (1999). Potential benefits of reducing annual mean values of PM2,5 (2000) to levels of 15 and 20  $\mu\text{g}/\text{m}^3$ , and by 3,5  $\mu\text{g}/\text{m}^3$ . Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM2,5**

	Attributable cases per year					
	N° of deaths		N° of deaths per 100 000		N° of deaths per 100 000	
	central	lower	upper	central	lower	upper
15 $\mu\text{g}/\text{m}^3$	60.03	15.67	104.94	8.7	2.3	15.2
20 $\mu\text{g}/\text{m}^3$	0	0	0	0	0	0
By 3,5 $\mu\text{g}/\text{m}^3$	95.09	24.74	166.69	13.8	3.6	24.2

**Table 2. Cardiopulmonary deaths (ICD9 401-440 and 460-519) (1999). Potential benefits of reducing annual mean values of PM2,5 (2000) to levels of 15 and 20  $\mu\text{g}/\text{m}^3$ , and by 3,5  $\mu\text{g}/\text{m}^3$ . Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM2,5**

	Attributable cases per year					
	N° of deaths		N° of deaths per 100 000		N° of deaths per 100 000	
	central	lower	upper	central	lower	upper
15 $\mu\text{g}/\text{m}^3$	30.70	11.06	50.64	4.4	1.6	7.3
20 $\mu\text{g}/\text{m}^3$	0	0	0	0	0	0
By 3,5 $\mu\text{g}/\text{m}^3$	48.54	17.42	80.36	7.0	2.5	11.6

**Table 3. Lung cancer deaths (ICD9 162) (1999). Potential benefits of reducing annual mean values of PM<sub>2,5</sub> (2000) to levels of 15 and 20 µg/m<sup>3</sup>, and by 3,5 µg/m<sup>3</sup>. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM<sub>2,5</sub>**

	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 <sup>3</sup>	6.44	2.18	10.79	0.9	0.3	1.6
20 µg/m <sup>3</sup>	0	0	0	0	0	0
By 3,5 µg/m <sup>3</sup>	10.16	3.42	17.11	1.5	0.5	2.5

## 2. LT PM<sub>2.5</sub>: Years of Life Lost

Tables 4, 5, 6 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. PM<sub>2.5</sub> data used are obtained by PM<sub>10</sub> conversion (factor = 0.65). These PM<sub>10</sub> data are corrected for measurements method.

**Table 4. Deaths all causes >30 years, male and female, for one year (ICD9 0-999) (1999). Potential benefits of reducing annual mean values of PM<sub>2,5</sub> (2000) to levels of 15 and 20 µg/m<sup>3</sup>, and by 3,5 µg/m<sup>3</sup>. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM<sub>2,5</sub>**

	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 <sup>3</sup>	28.08	7.40	48.57	4.03	1.06	6.97
20 µg/m <sup>3</sup>	0	0	0	0	0	0
By 3,5 µg/m <sup>3</sup>	44.51	11.77	76.78	6.39	1.69	11.02

**Table 5. 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<sub>2,5</sub> (2000) to levels of 15 and 20 µg/m<sup>3</sup>, and by 3,5 µg/m<sup>3</sup>. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM<sub>2,5</sub>**

	Years of life lost					
	YoLL	YoLL	YoLL	YoLL	YoLL	YoLL
	central	lower	upper	per 100 000	per 100 000	per 100 000
15 µg/m <sup>3</sup>	14.55	5.30	23.70	2.09	0.76	3.40
20 µg/m <sup>3</sup>	0	0	0	0	0	0
By 3,5 µg/m <sup>3</sup>	23.03	8.42	37.36	3.31	1.21	5.36

**Table 6. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (1999). Potential benefits of reducing annual mean values of PM<sub>2,5</sub> (2000) to levels of 15 and 20 µg/m<sup>3</sup>, and by 3,5 µg/m<sup>3</sup>. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM<sub>2,5</sub>**

	Years of life lost					
	YoLL	YoLL	YoLL	YoLL	YoLL	YoLL
	central	lower	upper	per 100 000	per 100 000	per 100 000
15 µg/m <sup>3</sup>	3.15	1.08	5.18	0.45	0.16	0.74
20 µg/m <sup>3</sup>	0	0	0	0	0	0
By 3,5 µg/m <sup>3</sup>	4.97	1.72	8.13	0.71	0.25	1.17