

MARSEILLE REPORT PLAN

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MARSEILLE CITY REPORT

Summary of the main findings

Annual daily mean is around $18 \mu\text{g}/\text{m}^3$ for BS and PM_{2.5} and $27 \mu\text{g}/\text{m}^3$ for PM₁₀. Since 1999 PM₁₀ annual mean has never exceeded EC limit values for year 2005 in Marseille.

The main source of air pollution on the Marseille area study is road traffic. The main source of PM₁₀ is traffic but a part seemed due to natural dust (south wind brings particles from Sahara).

The analysis estimated that reduction of the long-term PM_{2.5} pollution to the levels of $15 \mu\text{g}/\text{m}^3$ would reduce mortality in Marseille by 170 deaths in one year, which would save 72 years of expected life for starting year of simulation. If the daily means of PM₁₀ would be kept under $20 \mu\text{g}/\text{m}^3$, 37 deaths and 55 (respectively 79) hospital admissions for cardiac (respectively respiratory) diseases could have been avoided in the year 2000

French policy on air pollution is defined in the law on air and the rational use of energy voted on December 1996. This law requires monitoring of air quality and its effects on health, to define quality objectives and inform the general public. The regional Plan for air quality (PRQA) approved on 2000, sets guidelines to prevent or reduce air pollution. It aims to reduce the levels of pollutant concentrations in a given area to less than the European policies.

Background

The Marseille city is on the Mediterranean seashore at an altitude of 12 metres. It is surrounded by mountains, some of them reaching 800 metres. Marseille has a Mediterranean climate and is very sunny with an average temperature of 11°C to 20°C . There are two types of strong prevailing winds in this area, the “mistral” and the south-east wind, together with moderate winds such as the sea breeze and the inland breeze. Prevailing winds allow the dilution of pollutants, whereas the sea breeze brings the pollution inland.

With five municipalities, the study area of Marseille is 355 km^2 wide and has 856 165 inhabitants. The population is characterised by its slightly higher percentage of 65-75 year olds (18.7%). Population data provides from the last national census in 1999.

French policy on air pollution is defined in the law on air and the rational use of energy voted on December 1996. This law requires monitoring of air quality and its effects on health, to define quality objectives and inform the general public. The regional Plan for air quality (PRQA) approved on 2000, sets guidelines to prevent or reduce air pollution. It aims to reduce the levels of pollutant concentrations in a given area to less than the European policies. The plan for air protection (PPA) which comes with the PRQA is not yet finished.

Sources

The main source of air pollution on the Marseille area study is road traffic. The BS pollution is linked for a large part to exhaust emissions from diesel vehicles. The main source of PM10 is traffic but a part seemed due to natural dust (south wind brings particles from Sahara). For the department, 53 % of NOx emissions are linked to road transport. (CITEPA 1994)

Since 1983, SO2 levels have been decreasing thanks to deindustrialisation in the area study and to the limitation of emissions for factories and heating. For the last ten years, NO2 levels are decreasing slowly since 1990, especially in most polluted areas. PM10 levels increase because of the increase in the number of diesel vehicles (approximately half of the cars).

For the French south area, ozone is the most important air pollutant. Ozone levels are regularly high in summertime resulting in repeated overtaking of the European recommendations. In summer 2003, the air quality monitoring network had measured the highest ozone levels correlated with the most important heat wave for the region.

Exposure data

- **Air quality network**

Air pollutants have been monitored by the Marseille air-quality network AIRMARAIX since 1982. The study area of Marseille is covered by 13 stations measuring 7 different pollutants

BS has been measured since 1982. Currently, two traffic stations and two urban background stations (St Louis and Ste Marguerite) monitor BS. PM10 monitoring sites have been set up progressively since 1998. Currently, PM10 are measured by three urban background stations (St Louis, Cinq Avenues and Thiers/Noailles) and one traffic station. PM2.5 concentrations are measured progressively since 2000 by two urban background stations (St Louis, Cinq Avenues).

BS concentrations are measured by reflectometry method and PM10/PM2.5 concentrations are measured by quartz microbalance method (TEOM) (appendix1).

With regard to last and current measurements, the use of the factor of correction of 1.3 does not seem to allow better to estimate the concentrations in PM10 taking into account the fact that the under valuation varies according to the season and from the geographical localisation. In Marseille, like everywhere else in France, no correction factor is applied to these measurements by the air quality network. However, for the present long-term HIAs, and in order to be homogeneous with the other APHEIS cities, a correction factor of 1.129 was applied only to winter PM10 measures.

A local conversion factor from PM10 to PM2.5 of 0.65 was applied on PM10 measures.

The air quality monitoring network measured continuously others pollutants like urban heavy metals (Cadmium, Lead, Nickel, Arsenic) and volatile organic compounds (VOCs). Actually, the air quality monitoring networks for the PACA region will created a register of regional emissions and will improved expertise on spatial models for air pollution.

- **Data exposure for APHEIS3**

The study period for BS and PM10 is year 2000. For direct PM2.5, the study period is year 2002 because data are not completely available in 2000 for one of the two urban background stations.

The exposure indicator for BS and PM2.5 is the arithmetic mean of two urban monitoring sites and the PM10 indicator corresponds to the arithmetic mean of three urban monitoring sites. Only 24-hour average values of the urban background stations were used for the HIA. For every day, 24-hour average value is validated only if less than 25 % of the hourly values are missing. When one or several daily data were missing from the stations, the method of average seasons, or of linear regression, were used instead depending on how long the data had been missing for.

Table 1 show the distribution of exposure indicators for HIA and number of days when air pollutants exceeded limit levels are presented in Table 2

Table 1: Daily mean levels (SD) and 5th and 95th percentile for air pollutants

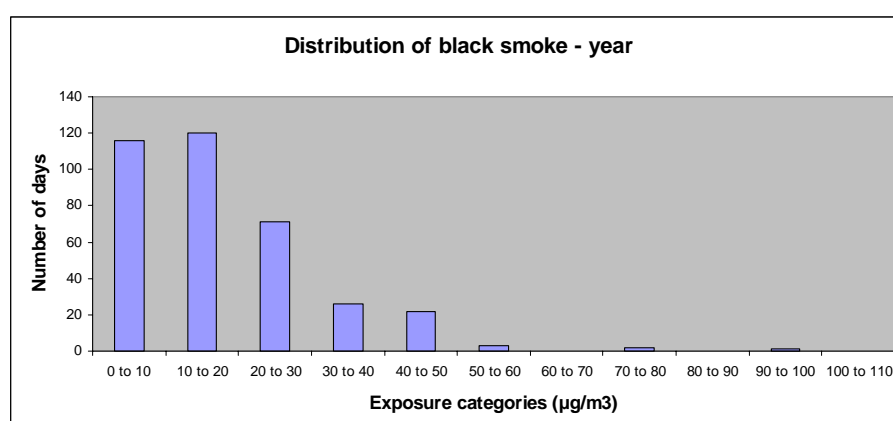
Air pollutant	Number of days for study period	Daily mean (SD)	5 th percentile	95 th percentile
BS	366	18 (13) $\mu\text{g}/\text{m}^3$	5 $\mu\text{g}/\text{m}^3$	43 $\mu\text{g}/\text{m}^3$
PM10	366	27 (10) $\mu\text{g}/\text{m}^3$	13 $\mu\text{g}/\text{m}^3$	42 $\mu\text{g}/\text{m}^3$
PM2.5	365	18 (8) $\mu\text{g}/\text{m}^3$	8 $\mu\text{g}/\text{m}^3$	33 $\mu\text{g}/\text{m}^3$

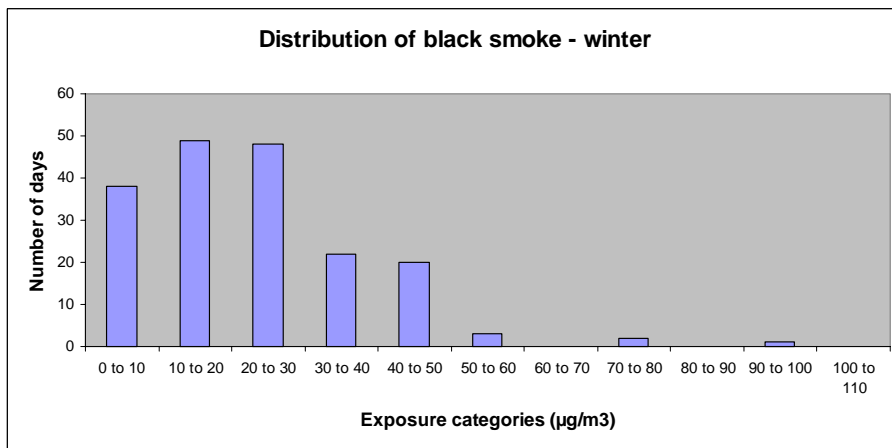
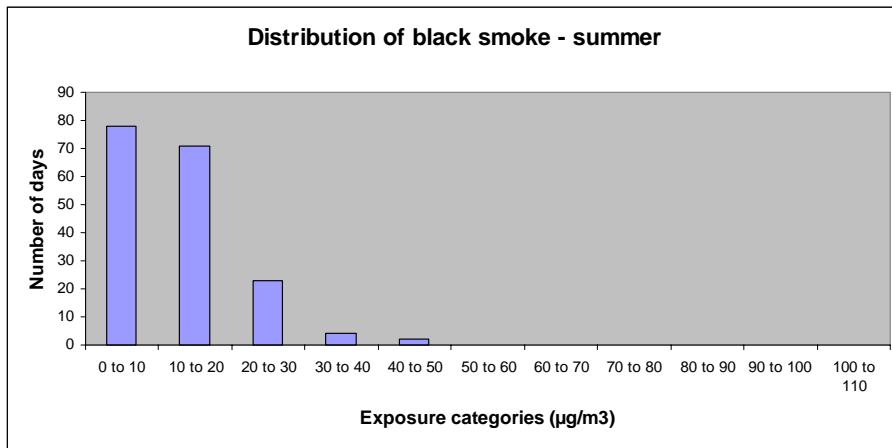
Table 2 .Number of days when air pollutants exceeded limit levels

Air pollutant	Short term		Long term	
	PM ₁₀ /BS	PM _{2.5}	PM ₁₀	PM _{2.5}
Number of days above	20 $\mu\text{g}/\text{m}^3$	14 $\mu\text{g}/\text{m}^3$	20 $\mu\text{g}/\text{m}^3$	15 $\mu\text{g}/\text{m}^3$
	257 / 123	228	257	212
Number of days above	50 $\mu\text{g}/\text{m}^3$	35 $\mu\text{g}/\text{m}^3$	40 $\mu\text{g}/\text{m}^3$	20 $\mu\text{g}/\text{m}^3$
	5 / 6	11	26	131

The following Figures show the distribution of BS, PM10 and PM2.5 by year and seasons.

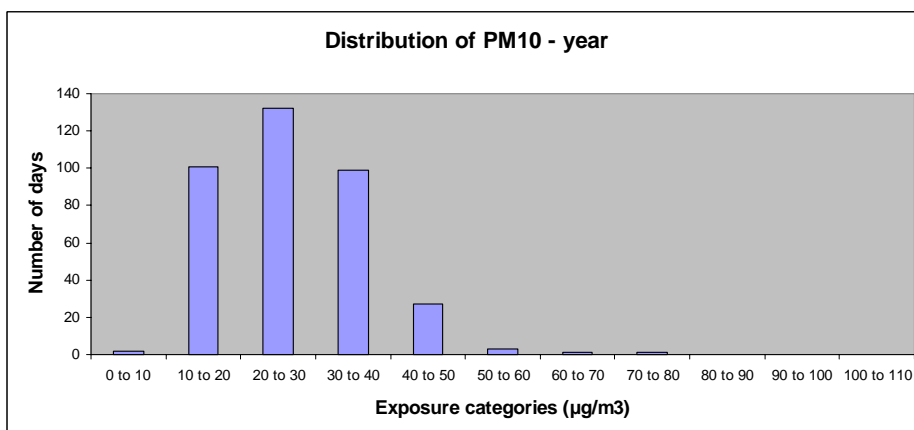
Figures 1,2,3. Distribution of black smoke – year 2000

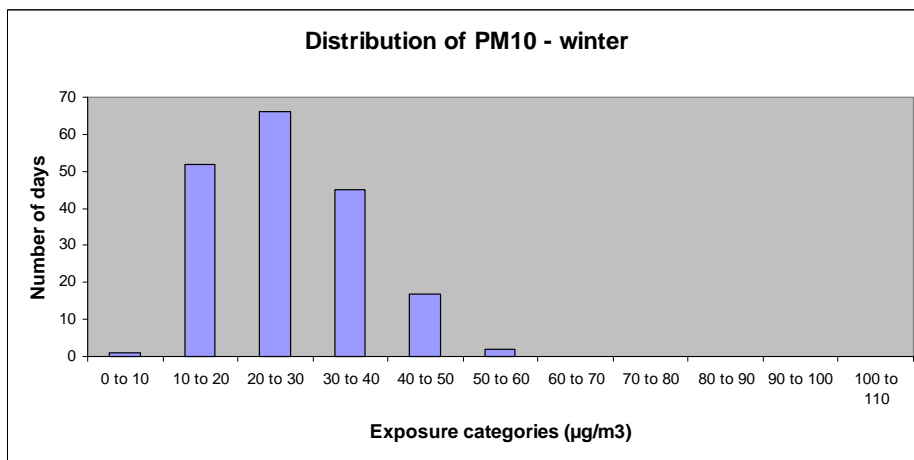
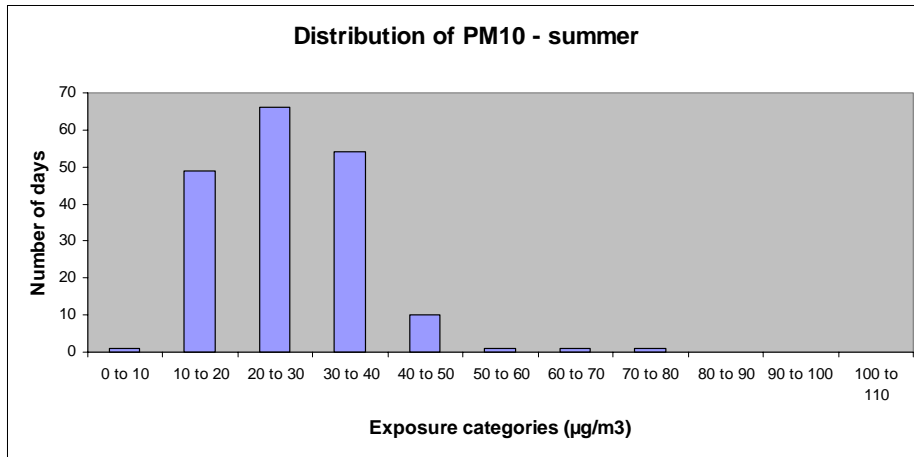




BS levels are more dispersed than the others particles, with a maximum at $98 \mu\text{g}/\text{m}^3$. BS levels are higher in winter because of heating.

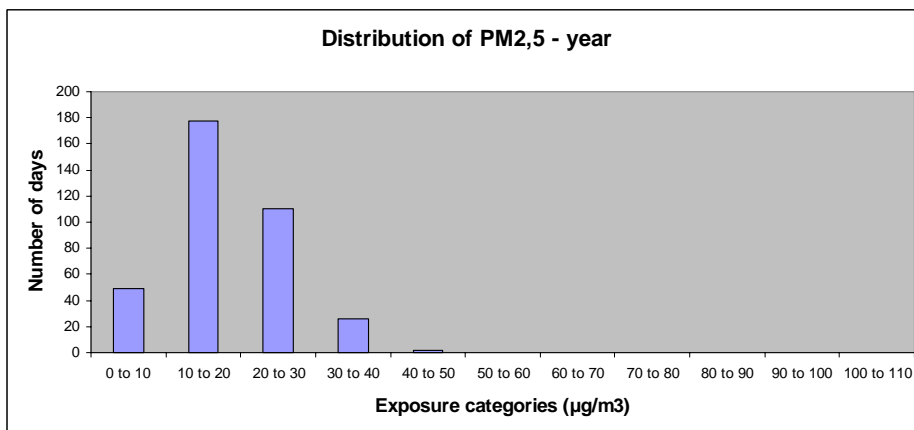
Figures 4,5,6. Distribution of PM10 – year 2000

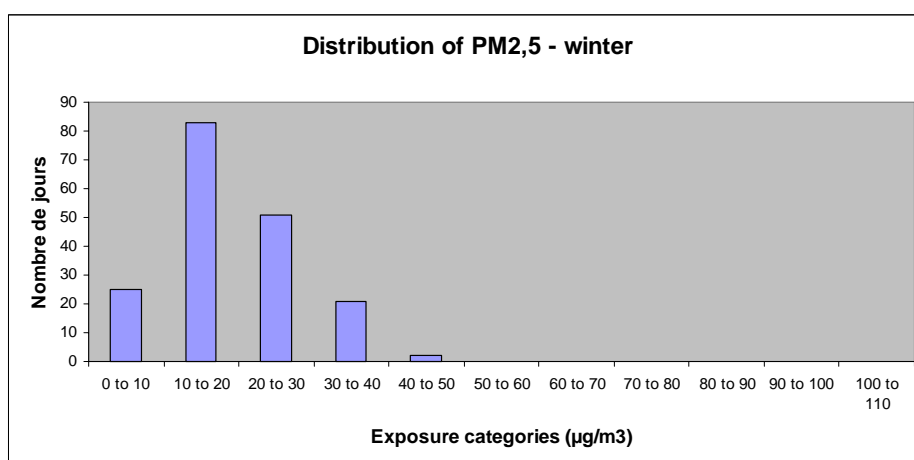
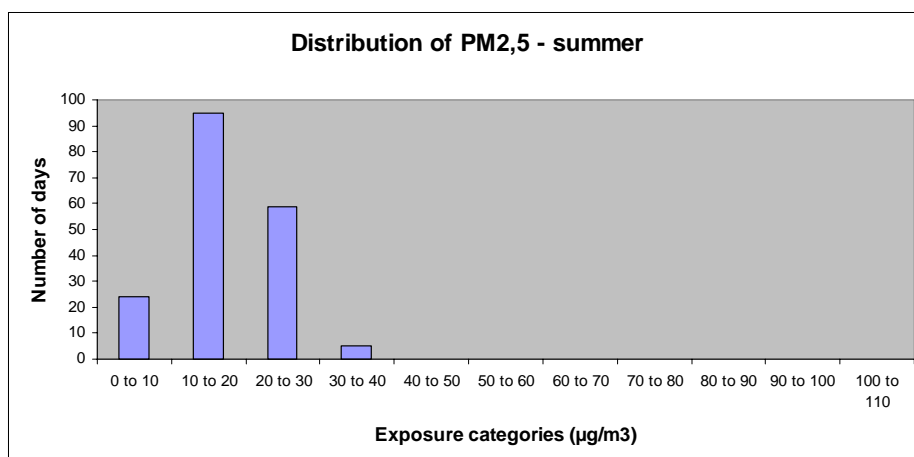




Variation PM10 levels range from 10 to 50 $\mu\text{g}/\text{m}^3$ and no difference by season does exist.

Figures 7,8,9. Distribution of PM2.5 – year 2002





PM2.5 distribution is similar to those for PM10 but levels are smallest.

Health data

- **Data quality assessment.**

The information department specialised in mortality data (CepiDC) use a quality control programme. The completeness of register is verified by crossing two different sources of data. Until year 1999, the codification of deaths with ICD9 was manual.

Data from the hospital information system are coded with ICD10 and concerned total admissions. The completeness is quite 100 % and one quality control per year must be done. Main diagnostic must be coded so there is no missing data on cause admission.

- **Mortality**

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

Age standardised mortality rate using European population was 783 per 100 000 inhabitants.

- **Hospital admissions**

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 Marseille. Respiratory and cardiovascular diseases are coded with ICD10. Data are available for year 2001.

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

Health outcome	ICD9	ICD10	Daily mean number	Number of cases per 100 000
Short term HIA				
All causes mortality*	< 800	A00-Q99	21.63	922.50
Cardiovascular mortality	390-459	I00-I99	7.24	308.60
Respiratory mortality	460-519	J00-J99	1.96	83.75
Cardiac mortality	390-429	I00-I52	4.80	204.75
Cardiac hospital admissions	390-429	I00-I52	33,69	1436,45
Respiratory hospital admissions	460-519	J00-J99	24,42	1041,47
Long term HIA				
Total mortality	0-999	A00-T98	23.24	991.16
Cardiopulmonary mortality	401-440	I10-I70	8.52	363.13
	460-519	J00-J99		
Lung cancer mortality	162	C33-C34	1.21	51.51

* 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 Marseille, 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					
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)	
Complementary ST HIA for some cities reports						
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	
					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/m³ 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 PM_{2.5}, long-term findings are expressed in terms of:

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

1. HIA scenarios

1.1. Short-term scenarios

We used the following scenarios to estimate the acute effects of short-term exposure to BS/PM₁₀ 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 $\mu\text{g}/\text{m}^3$ on all days exceeding this value
- reduction of BS levels to a 24-hour value of 20 $\mu\text{g}/\text{m}^3$ on all days exceeding this value
- reduction by 5 $\mu\text{g}/\text{m}^3$ of all the 24-hour values of BS.

- **Short term HIA scenarios for PM₁₀**

Short-term HIA of PM₁₀ on 0-1 days and cumulative HIA of PM₁₀ 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 $\mu\text{g}/\text{m}^3$ on all days exceeding this value (2005 and 2010 limit values for PM₁₀)
- reduction of PM₁₀ levels to a 24-hour value of 20 $\mu\text{g}/\text{m}^3$ on all days exceeding this value (to allow for cities with low levels of PM₁₀)
- reduction by 5 $\mu\text{g}/\text{m}^3$ of all the 24-hour values (to allow for cities with low levels of PM₁₀)

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 PM₁₀ 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 estimate in the combined (meta-analytic) one.

1.2. 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/m³ (2005 limit values for PM₁₀)
- reduction of the annual mean value of PM₁₀ to a level of 20 µg/m³ (2010 limit values for PM₁₀)
- reduction by 5 µg/m³ in the annual mean value of PM₁₀ (to allow for cities with low levels of PM₁₀)

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

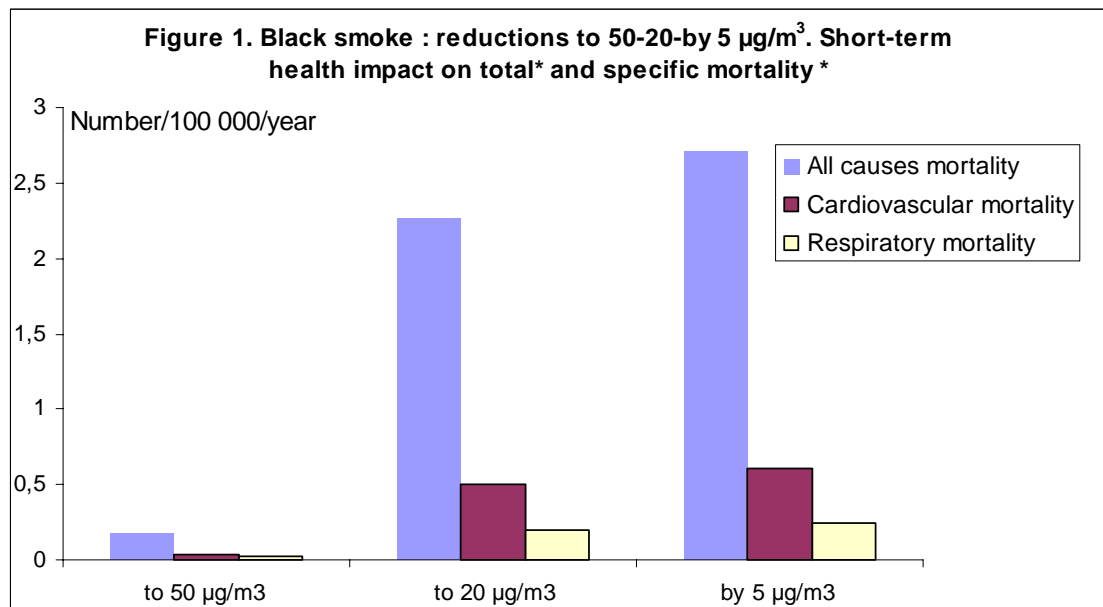
We estimated chronic effects of PM_{2.5} in the Marseille city in population over 30 years old as impacts on mortality due to all causes, due to cardiopulmonary and due to lung cancer deaths.

The following three pollution scenarios were considered:

- reduction of the annual mean value of PM_{2.5} to a level of 20 µg/m³ ²
- reduction of the annual mean value of PM_{2.5} to a level of 15 µg/m³ ²
- reduction by 3.5 µg/m³ in the annual mean value of PM_{2.5} (to allow for cities with low levels of PM_{2.5})

2. BS findings

We estimated the acute effects of short-term exposure to BS on total and specific mortality over one year.

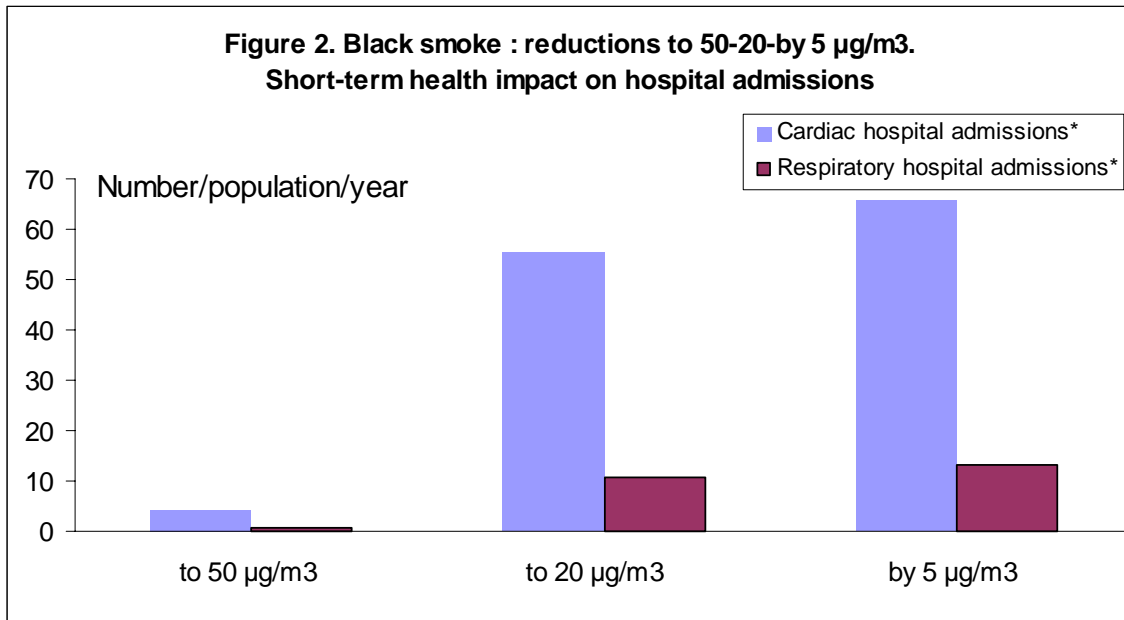


* All causes mortality excluding external causes (ICD9 < 800), cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).

** Black smoke data for 2000, mortality data for 1999

For BS short term exposure, the highest potential benefits for deaths was obtained for a reduction of daily BS levels by 5 $\mu\text{g}/\text{m}^3$. The attributable number of deaths is around 23.2 [IC95: 15.5 – 38.8] for total mortality, 5.2 [IC95: 2.6 - 9.1] for cardiovascular mortality and only to 2.1 [IC95: -0.7 - 5.3] for respiratory admissions, over one year.

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



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

** Black smoke data for 2000, hospital admissions data for 2001

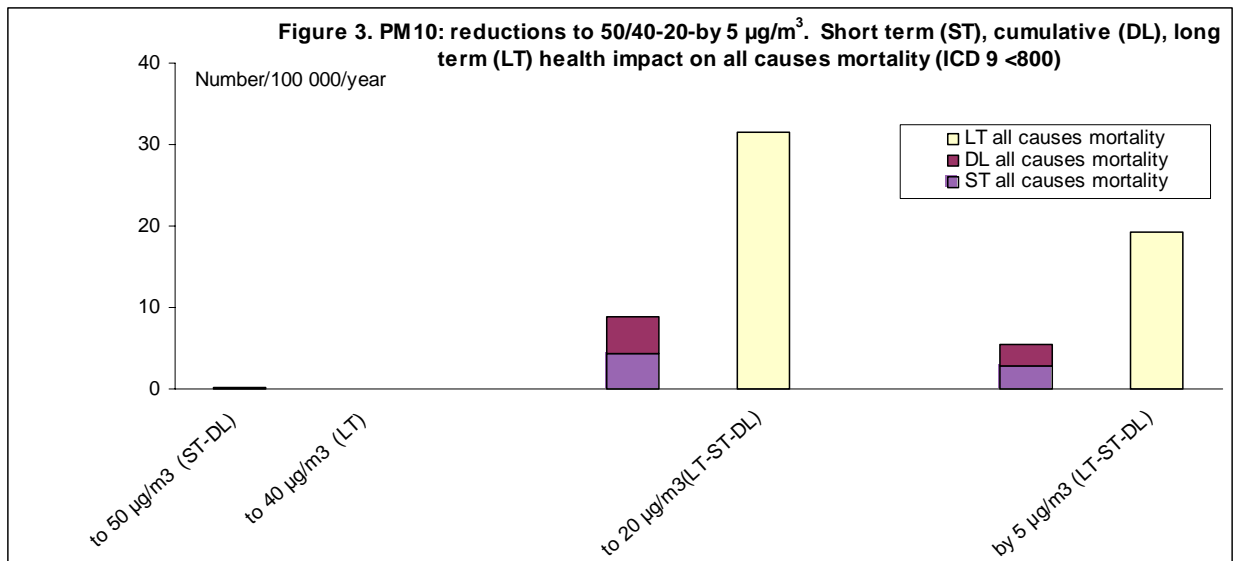
For BS short term exposure, the highest potential benefits for hospital admissions are obtained for a reduction of daily BS levels by 5 $\mu\text{g}/\text{m}^3$. The attributable number of hospital admissions reached to 66 for cardiac diseases and only to 13 for respiratory admissions, over one year.

3. PM10 findings

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

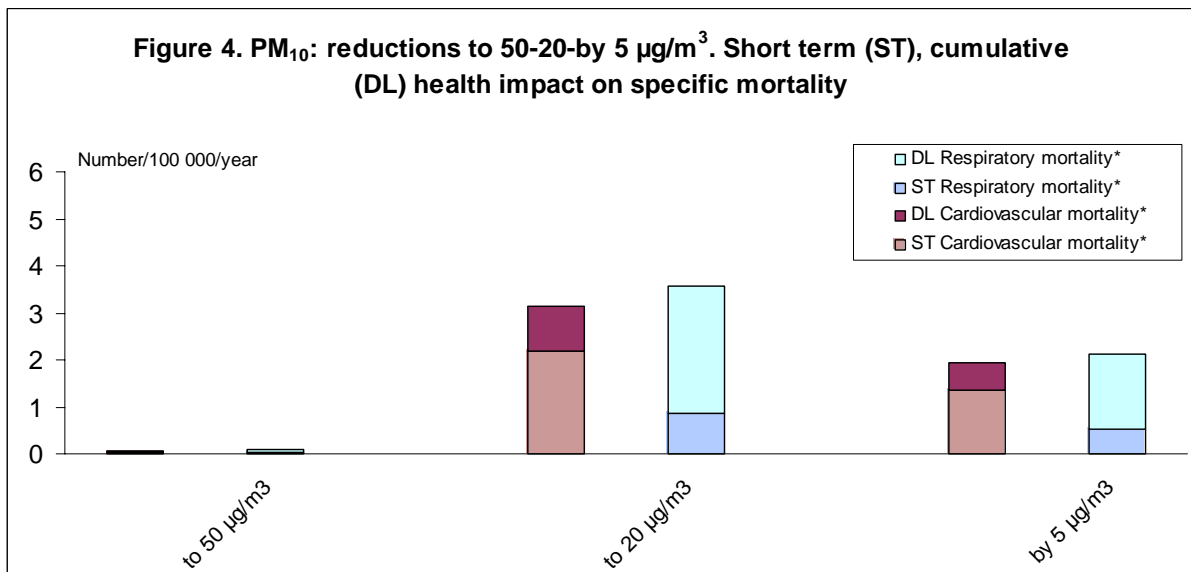
- Mortality findings

The following graphs (Figure 3 and 4) 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 data for 1999

The very short term effect (ST) using a follow up of 2 days is included in the health effect using a follow up of 40 days (DL). For PM₁₀, the highest potential benefits for deaths are obtained for a reduction of daily PM₁₀ levels to 20 µg/m³. The attributable number of total deaths is around 37 for ST health effect, 76 for DL health effect and 270 for LT health effect, over one year.



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

** PM₁₀ data for 2000, mortality data for 1999

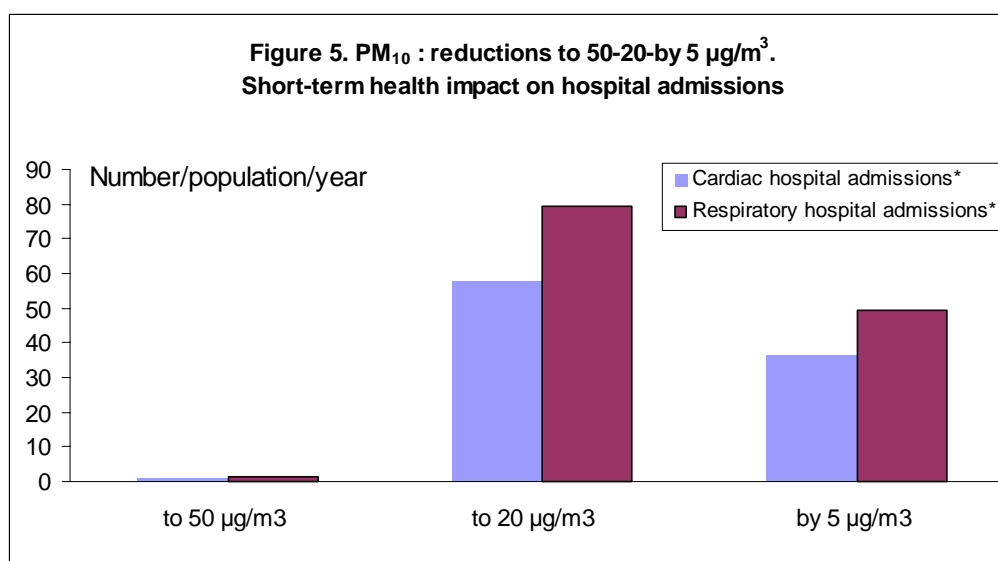
For PM₁₀, the highest potential benefits for specific mortality were obtained for a reduction of daily PM₁₀ levels to 20 µg/m³. The attributable number of cardiac admissions is around 18.6 for ST health effect and 27 for DL health effect. The attributable number of respiratory admissions is around 7.3 for ST health effect and 23.9 for DL health effect.

The attributable number of deaths or hospital admissions is higher when PM10 levels were reduced to $20\mu\text{g}/\text{m}^3$. Potential benefits are closed to zero when PM10 levels were reduced to $50\mu\text{g}/\text{m}^3$ because almost all daily values are under the reference value.

The results for cumulative health effects of PM10 using distributed lag models are systematically higher than results using only two days of follow up. In this case, the potential benefits increased 2 fold for all causes of deaths, 1.5 fold for cardiovascular deaths and 3 fold for respiratory deaths.

- **Hospital admissions findings**

We estimated the acute effects of short-term exposure to PM₁₀ on cardiac and respiratory hospital admissions over one year (Figure 5).



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

The attributable number of hospital admission is higher when PM10 levels were reduced under $20\mu\text{g}/\text{m}^3$. Potential benefits are closed to zero PM10 levels were reduced under $50\mu\text{g}/\text{m}^3$ because almost all daily values are under the reference value.

The attributable number of hospital admissions reached to 79 for respiratory diseases and to 58 for cardiac diseases, over one year. The health impact effect due to PM10 is slightly higher than for BS, especially for respiratory admissions.

4. PM2.5 findings

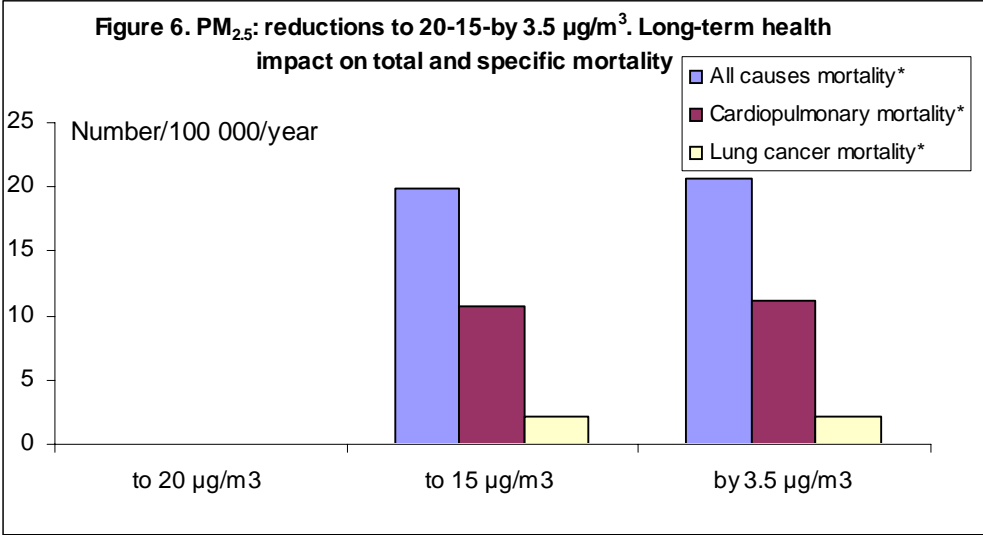
4.1. Long-term attributable cases for PM2.5 measurements

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

For homogeneity among APHEIS cities, the PM2.5 values used for this HIA was obtained by converting PM10 values with a local conversion factor. For APHEIS study only, a conversion factor was applied to measured PM10 values 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/m³. Both reduction to 15µg/m³ and reduction by 3.5µg/m³ scenarios give very similar results, as they correspond to approximately the same decrease in PM_{2.5} concentration in Marseille area."

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

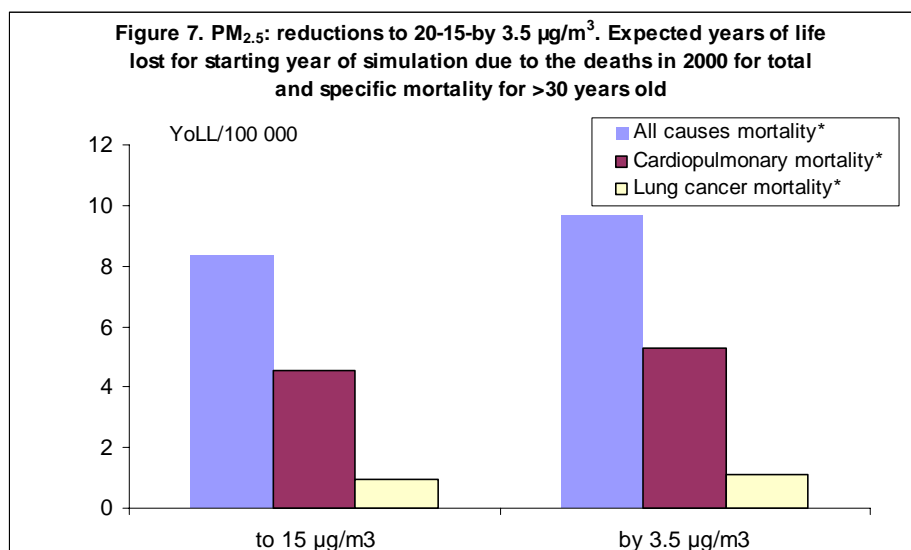


* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162).
 ** PM_{2.5} data for 2000, mortality data for 1999

Reduction of annual mean PM_{2.5} levels by 3.5 µg/m³, would save almost 177 all causes deaths, 96 cardiopulmonary deaths and 19 lung cancer deaths, over one year.

4.2. Years of life lost for PM_{2.5} measurements

We estimated the years of life lost attributable to the chronic effects of PM_{2.5} using the data for year 2000. Figure 7 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 Marseille.



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

** PM_{2.5} data for 2000, mortality data for 1999

For all causes of deaths, all other things being equal, reduction of PM_{2.5} by 3.5 µg/m³ in 2000 would save almost 84 years of expected life for starting year of simulation in people older than 30 years in the city of Marseille. For cardiopulmonary mortality, this number would be around 45 and for lung cancer mortality, around 9.

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/m³ in Marseille

Age	Life expectancy	Expected gain in life expectancy		
		Mean	Low estimate	High estimate
At birth	78.86	0.18	0.05	0.32
30	49.90	0.19	0.05	0.32
65	18.95	0.13	0.04	0.23

In terms of life expectancy, all other things being equal, if annual mean PM_{2.5} levels (18 µg/m³) would be reduced to 15 µg/m³, the 49.90 years of life expectancy in a person of 30 years old would be increased by 0.18 years, due to reduced risk of death from all causes in the city of Marseille.

Interpretation of findings

Potential health benefits should exist when reducing levels of each particulate matter. The short term health impact of PM₁₀ concentrations is slightly higher than with BS.

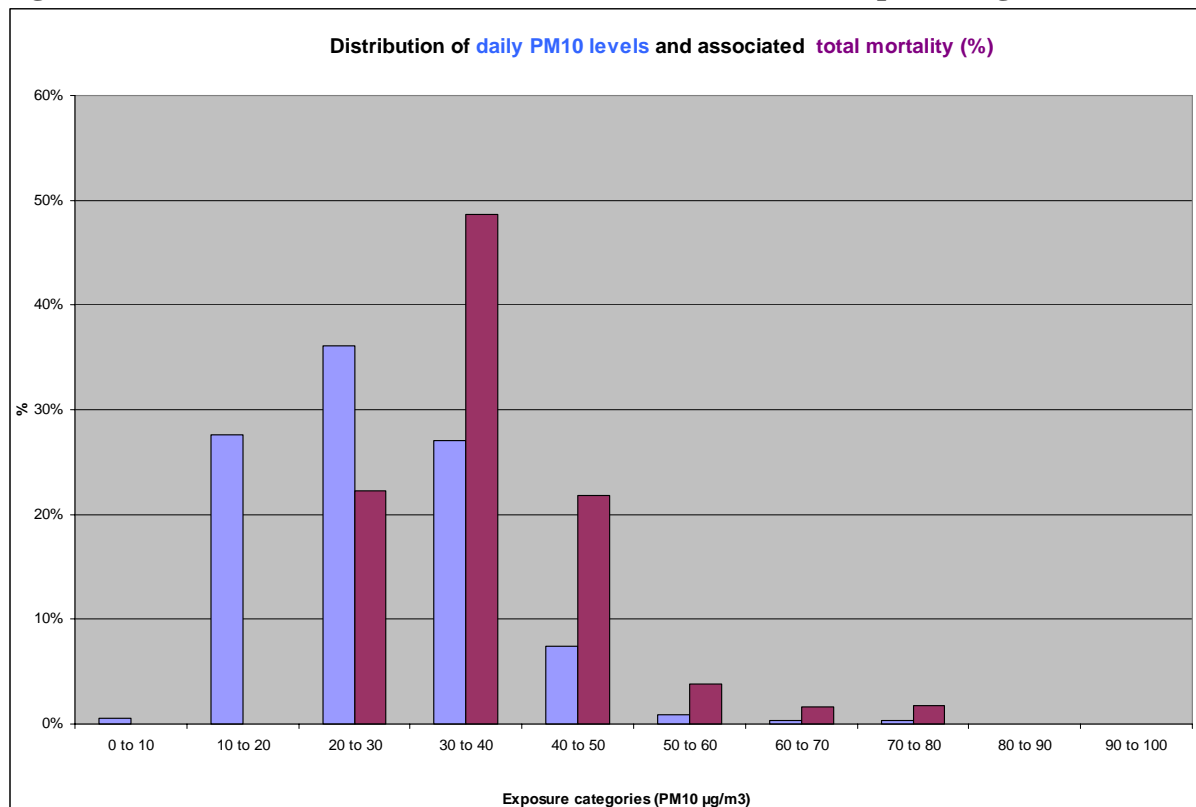
The results for cumulative health effects of PM₁₀ using distributed lag models (DL) are systematically higher than results using only two days of follow up (ST). The difference between DL and ST models is more obvious for respiratory mortality. The effect of PM₁₀ on mortality is probably delayed for respiratory causes and more immediate for cardiac causes.

For a long-term exposure, if PM10 levels were reduced to EC limits for year 2010, 170 all causes deaths would be saved and this saving of life would be more important for a reduction by $3.5 \mu\text{g}/\text{m}^3$.

The increased of expected life for one person seem to be small, but for all the population of Marseille the years of life lost are more important.

For each pair of health/exposure indicators, the most important health effect is due to days with higher levels of air pollution but these days represent few days in one year. In fact, over one year, the health effect of air pollution is due to daily exposure to lower levels. So background pollution is as, or even more dangerous than peaks.

Figure8 : Short term distribution of PM10 levels and associated percentage of cases



General comments

With the French programme PSAS-9, a network of partners who work in the area of air pollution and health has been created. The development of collaborations has been allowing for better communication. The message that background pollution is as, or even more dangerous than peaks is being taken in account by the media and the population.

The short term health effects of air pollution began to be well known. The population and the decisions makers are also very interesting about long term effects and years of life lost. So, the results of APHEIS3 would be important for decisions makers.

Conclusions

All the results show that a potential benefit can be obtained by improvement Air quality, even in cities with pollution levels already below 2005 European recommendations.

At the local level, results of Apehis3 complete the PSAS-9 results (French program for AP effects surveillance) for PM HIA and local policies repercussions of these programs. But, the fact that reports and website information are in English, don't make easy the understanding of Apehis results.

Appendix

1. Questionnaires on the exposure measurement methods and health data

Annex 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: | Marseille |
| 2. | Total area of agglomeration (km ²): | 355 km ² |
| 3. | Area (km ²) covered by the air monitoring network in the city: | 355 km ² |
| 4. | Number of population in this (exposure relevant) area: | 856165 |
| 5. | Total number of PM10 monitoring stations in this area: | 4 |
| 6. | Total number of BS monitoring stations in this area: | 4 |
| 7. | Total number of PM2.5 monitoring stations in this area: | 2 |
| 8. | Number of selected PM10 monitoring stations for HIA: | 3 |
| 9. | Number of selected BS monitoring stations for HIA: | 2 |
| 10. | Number of selected PM2.5 monitoring stations for HIA: | 2 |
| 11. | Measurement interval (please cross) | |
| | PM10 : continuous <input type="checkbox"/> hourly <input type="checkbox"/> BS: 24 hours <input type="checkbox"/> weekly <input checked="" type="checkbox"/> | 2 |
| | weekly <input type="checkbox"/> | |
| 12. | Quality assurance and control (please cross) | |
| | yes <input type="checkbox"/> no <input type="checkbox"/> do not know <input type="checkbox"/> | |
| 13. | Data quality (please cross) | |
| | validated data <input type="checkbox"/> invalidated data <input type="checkbox"/> | |

Annex 2 : Health data

Mortality data

- **Type of source :** Register
- **Year of data:** 1999
- **Quality control program :** yes
- **% of missing data in basic cause death:** 0%
- **Codification (1999)**
 - ICD :** ICD 9
 - Manual :** 100%

Hospital admissions data

- **Type of source :** Register
- **Year of data:** 2001
- **Quality control program :** yes
- **Codification :** ICD 10
- **% of missing data in cause admission :** 0%
- **Type of hospital admissions :** total admissions

2. 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/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 µg/m ³	123	19.33	12.87	29.06	2.26	1.50	3.39
50 µg/m ³	6	1.51	1.00	2.27	0.18	0.12	0.26
By 5 µg/m ³	NA*	23.22	15.49	34.81	2.71	1.81	4.07

*NA: not applicable

Table 2. Cardiovascular deaths (ICD9 390-459) (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 effect of BS

Attributable cases per year							
Scenarios	Number of days per year exceeding 20 and 50 µg/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 µg/m ³	123	4.30	2.15	7.55	0.50	0.25	0.88
50 µg/m ³	6	0.33	0.17	0.58	0.04	0.02	0.07
By 5 µg/m ³	NA*	5.19	2.60	9.08	0.61	0.30	1.06

*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/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 µg/m ³	123	1.75	-0.58	4.42	0.20	-0.07	0.52
50 µg/m ³	6	0.14	-0.05	0.34	0.02	-0.01	0.04
By 5 µg/m ³	NA*	2.11	-0.70	5.26	0.25	-0.08	0.61

*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 $\mu\text{g}/\text{m}^3$, 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 BS

Scenarios	Number of days per year exceeding 20 and 50 $\mu\text{g}/\text{m}^3$	Attributable cases per year		
		N° of deaths central	N° of deaths lower	N° of deaths upper
Hospital admissions for cardiac diseases (all ages)				
20 $\mu\text{g}/\text{m}^3$	123	55.43	20.06	96.30
50 $\mu\text{g}/\text{m}^3$	6	4.39	1.58	7.65
By 5 $\mu\text{g}/\text{m}^3$	NA*	65.78	23.96	113.39
Hospital admissions for respiratory diseases (all ages)				
20 $\mu\text{g}/\text{m}^3$	123	10.88	-5.42	27.28
50 $\mu\text{g}/\text{m}^3$	6	0.84	-0.42	2.11
By 5 $\mu\text{g}/\text{m}^3$	NA*	13.17	-6.59	32.88

*NA: not applicable

3. Tables for PM₁₀ findings

3.1. Health effects of PM₁₀ 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 $\mu\text{g}/\text{m}^3$, 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 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 $\mu\text{g}/\text{m}^3$	257	37.16	24.76	49.58	4.34	2.89	5.79
50 $\mu\text{g}/\text{m}^3$	5	0.72	0.48	0.96	0.08	0.06	0.11
By 5 $\mu\text{g}/\text{m}^3$	NA*	23.42	15.62	31.21	2.74	1.82	3.65

*NA: not applicable

Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Attributable cases per year							
Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	257	18.63	10.33	26.94	2.18	1.21	3.15
50 µg/m ³	5	0.36	0.20	0.53	0.04	0.02	0.06
By 5 µg/m ³	NA*	11.67	6.49	16.84	1.36	0.76	1.97

*NA: not applicable

Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Attributable cases per year							
Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	257	7.29	2.80	11.81	0.85	0.33	1.38
50 µg/m ³	5	0.14	0.06	0.23	0.02	0.01	0.03
By 5 µg/m ³	NA*	4.53	1.75	7.30	0.53	0.20	0.85

*NA: not applicable

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Attributable cases per year				
Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	N° of deaths	N° of deaths	N° of deaths
		central	lower	upper
Hospital admissions for cardiac diseases (all ages)				
20 µg/m ³	257	57.85	28.90	86.86
50 µg/m ³	5	1.12	0.56	1.68
By 5 µg/m ³	NA*	36.46	18.24	54.65
Hospital admissions for respiratory diseases (all ages)				
20 µg/m ³	257	79.55	43.19	116.74
50 µg/m ³	5	1.56	0.85	2.29
By 5 µg/m ³	NA*	49.59	27.00	72.54

*NA: not applicable

3.2. Cumulative health effects of PM₁₀ 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 PM₁₀ 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 PM₁₀

Attributable cases per year							
Scenarios	Number of days per year exceeding 20 and 50 µg/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 µg/m ³	257	75.84	49.99	101.50	8.86	5.84	11.86
50 µg/m ³	5	1.49	0.98	2.00	0.17	0.12	0.23
By 5 µg/m ³	NA*	47.18	31.18	63.00	5.51	3.64	7.36

*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 (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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/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 µg/m ³	257	26.95	18.99	34.97	3.15	2.22	4.08
50 µg/m ³	5	0.54	0.38	0.70	0.06	0.04	0.08
By 5 µg/m ³	NA*	16.51	11.67	21.36	1.93	1.36	2.49

*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 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/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 µg/m ³	257	23.39	6.00	41.71	2.73	0.70	4.87
50 µg/m ³	5	0.50	0.13	0.89	0.06	0.02	0.10
By 5 µg/m ³	NA*	13.69	3.58	23.97	1.60	0.42	2.80

*NA: not applicable

3.3. Long term HIA for PM₁₀

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 µg/m³, and by 5 µg/m³. 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 µg/m ³	269.85	163.41	382.23	31.52	19.09	44.64
40 µg/m ³	0	0	0	0	0	0
By 5 µg/m ³	164.97	100.16	233.02	19.27	11.70	27.22

4. Tables for PM_{2.5} findings

4.1. LT PM_{2.5}: 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/m³, and by 3,5 µg/m³. 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	169.88	44.22	297.70	19.84	5.16	34.77
20 µg/m ³	0	0	0	0	0	0
By 3,5 µg/m ³	177.28	46.13	310.78	20.71	5.39	36.60

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/m³, and by 3,5 µg/m³. 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	91.94	33.01	152.14	10.74	3.86	17.77
20 µg/m ³	0	0	0	0	0	0
By 3,5 µg/m ³	95.92	34.43	158.80	11.20	4.02	18.55

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/m³, and by 3,5 µg/m³. 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	18.39	6.19	30.95	2.15	0.72	3.62
20 µg/m ³	0	0	0	0	0	0
By 3,5 µg/m ³	19.18	6.45	32.30	2.24	0.75	3.77

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 starting year of simulation (ICD9 0-999) (1999). Potential benefits of reducing annual mean values of PM_{2.5} (2000) to levels of 15 and 20 µg/m³, and by 3,5 µg/m³. 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	YoLL	YoLL
	central	lower	upper	per 100 000	per 100 000	per 100 000
15 µg/m ³	71.68	18.93	123.78	8.33	2.20	14.38
20 µg/m ³						
By 3,5 µg/m ³	83.51	22.07	144.07	9.70	2.56	16.74

Table 2. Cardiopulmonary deaths >30 years, male and female, for starting year of simulation (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/m³, and by 3,5 µg/m³. 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	YoLL	YoLL
	central	lower	upper	per 100 000	per 100 000	per 100 000
15 µg/m ³	39.02	14.25	63.38	4.53	1.66	7.36
20 µg/m ³						
By 3,5 µg/m ³	45.42	16.61	73.69	5.28	1.93	8.56

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} (2000) to levels of 15 and 20 µg/m³, and by 3,5 µg/m³. 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	YoLL	YoLL
	central	lower	upper	per 100 000	per 100 000	per 100 000
15 µg/m ³	8.11	2.80	13.28	0.94	0.33	1.54
20 µg/m ³						
By 3,5 µg/m ³	9.43	3.26	15.42	1.10	0.38	1.79