

ATHENS CITY REPORT PLAN

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ATHENS CITY REPORT

Summary of the main findings

According to the EU, daily levels for PM₁₀ in 2001, must not exceed the limit of 70 µg/m³ more than 35 days and the annual levels must not exceed the limit of 46.4 µg/m³. In Athens, both daily and annual limits were exceeded in 5 out of 6 stations, as we can see in Table 1

<i>Station</i>	<i>No. of days above 70 µg/m³</i>	<i>Annual levels (µg/m³)</i>
Aristotelous	71	55.4
Goudi	51	49.8
Lykovrisi	101	59.7
Marousi	81	55.4
Peiraias	71	57.4
Zografou	14	34.4

The analysis estimated that reduction of the long-term PM pollution to the levels of PM_{2.5} of 15 µg/m³ would reduce mortality in Athens by 2704 deaths in one year, which would save 1277 years of expected life for starting year of simulation. If the daily means of PM₁₀ would be kept under 20 µg/m³, 5066 deaths could have been avoided in the year 2001

The main causes of pollution are traffic, heating and industrial and construction activity. The main actions are related to improvement of fuel quality, changing the fuel for buses from diesel to natural gas and new road systems.

Background

The city of Athens has a population of more than 3 million inhabitants, 15% of whom are over 65 years old. Athens lies in a valley totalling 350 km² surrounded by three mountains and the sea. The major axis of the valley runs from the north-east to the south-west for about 30 kilometres. Most industries lie close to the sea and the harbour of Piraeus in the south-western part of the city. The climate of Athens is typically Mediterranean. The mean daily temperature during the winter months is 9.9°C and the minimal daily temperature falls below zero only few times per year. During the summer months the mean daily temperature is 25.8°C and the mean value of the maximum daily temperature slightly exceeds 31°C. Insolation is strong with average daily values on the order of 22 MJm⁻² in the summer and 8 MJm⁻² in the winter. The prevailing wind direction is north-north-east at the end of summer, in autumn and in the winter and south-south-west in spring and the beginning of the summer.

Because of the topography, the climate and the size of the population, air pollutants easily reach high concentrations in the Athens Basin. The main problems are the high ozone and particles concentrations.

Sources

The main sources of air pollution are traffic, heating (in the winter) and industrial activity. The Ministry of Environment, Planning and Public Works, Division of Air Pollution and Noise Control (PERPA) indicates that about 70% of PM_{10} comes from vehicles (a large proportion from diesel-powered) and 30% from heating/industry.

Exposure data

The Ministry of Environment, Planning and Public Works has been responsible for monitoring air pollution in the Athens area since 1982. The monitoring network has recently been restructured and modernised and since year 2000, PM_{10} concentration is measured on a daily basis. For the year 2001 we used BS measurements from 2 stations that fulfilled the completeness criteria, Athinas and Patisision which are both traffic. For PM_{10} six station were used: Aristotelous (traffic), Goudi (traffic), Lykovrisi (suburban), Marousi (traffic), Peiraias (traffic) and Zografou (suburban background).

Black smoke was measured using reflectometry and PM_{10} using beta attenuation (correction factor for automatic measurements of PM_{10} was 1.3). $PM_{2.5}$ direct measures are not available and are calculated from PM_{10} using conversion factors that differ between months and range from 0.30 to 0.63, based on co-located monitors.

For 2001, daily mean levels (SD) of BS were $77.02(36.80)\mu\text{g}/\text{m}^3$, of PM_{10} were $52.12(19.23)\mu\text{g}/\text{m}^3$ and of $PM_{2.5}$ were $24.03(10.73)\mu\text{g}/\text{m}^3$. The lowest (5th percentile) and the highest (95th percentile) levels of pollutants were respectively:

- BS: $27.50 \mu\text{g}/\text{m}^3$ - $147.00 \mu\text{g}/\text{m}^3$,
- PM_{10} : $24.83 \mu\text{g}/\text{m}^3$ - $86.67 \mu\text{g}/\text{m}^3$,
- $PM_{2.5}$: $10.41 \mu\text{g}/\text{m}^3$ - $43.44 \mu\text{g}/\text{m}^3$.

The number of days when air pollutants exceeded limit levels are presented in Table 2

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

Air pollutant	Short term		
	PM_{10}	BS	$PM_{2.5}$
Number of days above	$20 \mu\text{g}/\text{m}^3$	$20 \mu\text{g}/\text{m}^3$	$14 \mu\text{g}/\text{m}^3$
	354	360	321
Number of days above	$50 \mu\text{g}/\text{m}^3$	$50 \mu\text{g}/\text{m}^3$	$35 \mu\text{g}/\text{m}^3$
	178	273	47

In Figures 1a,b,c and 2a,b,c the distribution of black smoke and PM_{10} for the whole year and by season are shown. We see that black smoke concentrations are higher in the winter but this is not true for PM_{10}

Figure 1. Distribution of black smoke

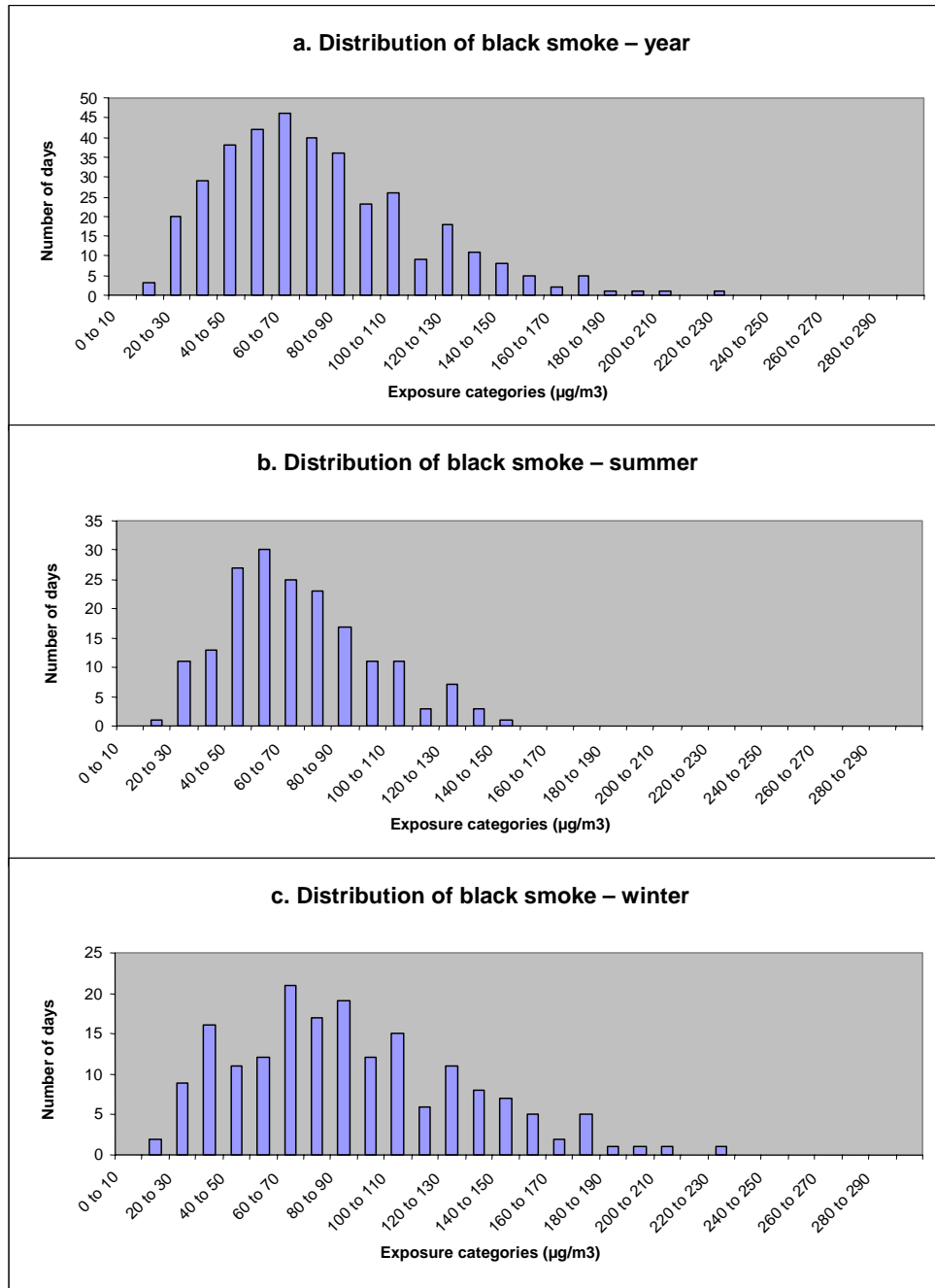
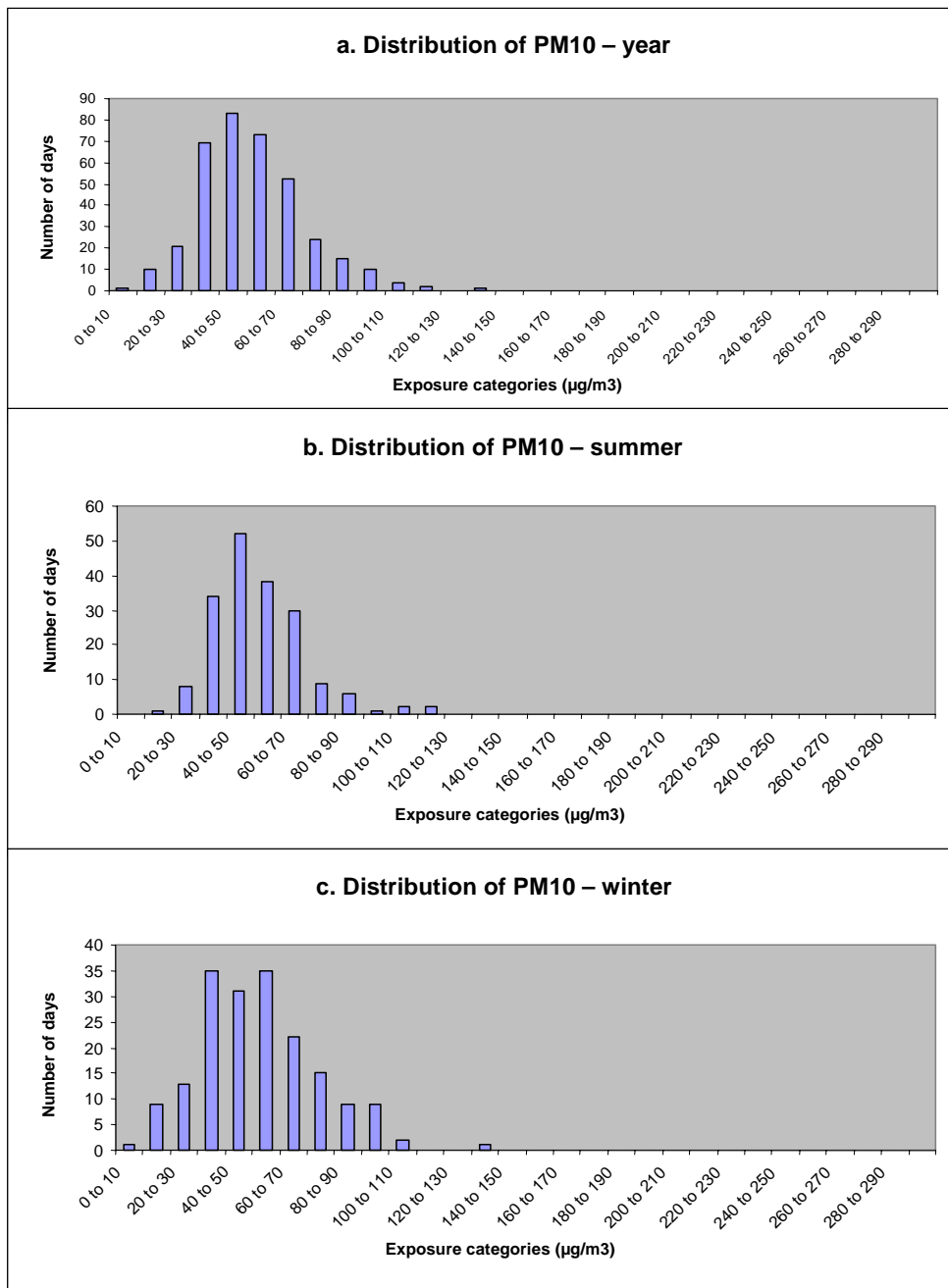


Figure 2. Distribution of PM10



We only had one common station (Patision) with black smoke measurements both in 1996 and in 2001.

BS:

2001: mean (5th percentile - 95th percentile) 102.6 (34-197)

1996: mean (5th percentile - 95th percentile) 95.1 (32-188)

We see that black smoke level slightly increased

Health data

All cause and cause-specific mortality data were provided by the National Statistical Service of Greece, following a specific request. Daily mean number, standard deviation and annual number of cases per 100 000 are presented in Table 3

Table 3. Daily mean number and annual rate per 100 000 of deaths (2001)

Health outcome	ICD9	ICD10	Daily mean Number (SD)	Number of cases per 100 000
Short term HIA				
All cause mortality (excluding external causes)*	< 800	A00-R99	76 (11.0)	873
Cardiovascular mortality	390-459	I00-I99	38 (7.6)	441
Respiratory mortality	460-519	J00-J99	6 (2.8)	72
Long term HIA				
All cause mortality	0-999	A00-Y98	80 (-)	912
Cardiopulmonary mortality	401-440	I10-I70	44 (-)	500
Lung cancer mortality	162	C33-C34	4 (-)	50

* For short and long term scenarios

The age-standardised mortality rate for Athens using the European population for year 2000 as a reference, is 854 per 100 000 inhabitants (all cause mortality).

Health impact assessment

Different scenarios were used to evaluate short and long-term exposure to particulate pollution. In the city of Athens, these scenarios were built for three indicators of this particulate pollution: BS, PM₁₀ and PM_{2.5}. 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 for starting year of simulation.

Black smoke findings

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/m³ on all days exceeding this value
- reduction of BS levels to a 24-hour value of 20 µg/m³ on all days exceeding this value
- reduction by 5 µg/m³ of all the 24-hour values of BS.

Tables 5, 6 and 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. Deaths all causes (ICD9 < 800) (2001). Potential benefits of reducing daily BS 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 BS

Scenarios	Attributable cases per year						
	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	360	943.08	624.24	1429.95	29.58	19.58	44.85
50 µg/m ³	273	508.62	337.15	769.54	15.95	10.57	24.14
By 5 µg/m ³	NA*	79.80	53.23	119.61	2.50	1.67	3.75

*NA: not applicable

Table 6. Cardiovascular deaths (ICD9 390-459) (2001). Potential benefits of reducing daily BS 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 effect of BS

Scenarios	Attributable cases per year						
	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	360	319.00	158.37	564.27	10.01	4.97	17.70
50 µg/m ³	273	171.26	85.15	302.29	5.37	2.67	9.48
By 5 µg/m ³	NA*	27.28	13.65	47.71	0.86	0.43	1.50

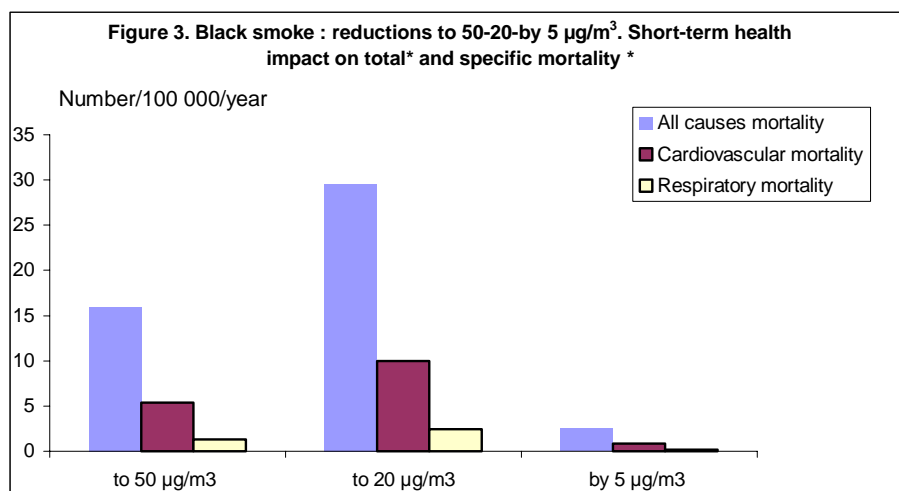
*NA: not applicable

Table 7. Respiratory deaths (ICD9 460-519) (2001). Potential benefits of reducing daily BS levels (2001) 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 BS

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 per 100 000		
		central	lower	upper	central	lower	upper
20 $\mu\text{g}/\text{m}^3$	360	77.97	-25.26	201.37	2.45	-0.79	6.32
50 $\mu\text{g}/\text{m}^3$	273	42.05	-13.70	107.90	1.32	-0.43	3.38
By 5 $\mu\text{g}/\text{m}^3$	NA*	6.60	-2.20	16.46	0.21	-0.07	0.52

*NA: not applicable

The following graph shows the health impact of BS on mortality



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

Black smoke data for 2001, mortality data for 2001

PM₁₀ findings

1. Health effects of PM₁₀ on 0-1 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 PM_{10})

Tables 8, 9 and 10 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 8. Deaths all causes (ICD9 < 800) (2001). Potential benefits of reducing daily PM_{10} levels (2001) 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 PM_{10}

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 per 100 000		
		central	lower	upper	central	lower	upper
20 $\mu\text{g}/\text{m}^3$	354	534.58	355.19	715.17	16.77	11.14	22.43
50 $\mu\text{g}/\text{m}^3$	178	143.98	95.80	192.35	4.52	3.00	6.03
By 5 $\mu\text{g}/\text{m}^3$	NA*	81.00	54.03	107.94	2.54	1.69	3.39

*NA: not applicable

Table 9. Cardiovascular deaths (ICD9 390-459) (2001). Potential benefits of reducing daily PM_{10} levels (2001) 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 PM_{10}

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 per 100 000		
		central	lower	upper	central	lower	upper
20 $\mu\text{g}/\text{m}^3$	354	403.32	222.56	586.51	12.65	6.98	18.40
50 $\mu\text{g}/\text{m}^3$	178	109.37	60.52	158.62	3.43	1.90	4.97
By 5 $\mu\text{g}/\text{m}^3$	NA*	60.49	33.64	87.28	1.90	1.06	2.74

*NA: not applicable

Table 10. Respiratory deaths (ICD9 460-519) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	Attributable cases per year					
		N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	354	94.76	35.96	155.17	2.97	1.13	4.87
50 µg/m ³	178	25.93	9.90	42.23	0.81	0.31	1.32
By 5 µg/m ³	NA*	14.02	5.40	22.60	0.44	0.17	0.71

*NA: not applicable

2. Cumulative health effects of PM₁₀ up to 40 days

Tables 11, 12 and 13 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 11. Cumulative health effects of PM₁₀ up to 40 days and all causes of deaths (ICD 9 < 800) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	Attributable cases per year					
		N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	354	1082.99	709.92	1457.66	33.97	22.27	45.72
50 µg/m ³	178	295.89	194.52	397.11	9.28	6.10	12.46
By 5 µg/m ³	NA*	160.61	106.14	214.45	5.04	3.33	6.73

*NA: not applicable

Table 12. Cumulative health effects of PM₁₀ up to 40 days and cardiovascular deaths (ICD9 390-459) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	868.55	607.16	1136.01	27.24	19.04	35.63
50 µg/m ³	178	241.31	169.37	314.34	7.57	5.31	9.86
By 5 µg/m ³	NA*	125.59	88.78	162.41	3.94	2.78	5.09

*NA: not applicable

Table 13. Cumulative health effects of PM₁₀ up to 40 days and respiratory deaths (ICD9 460-519) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	294.20	72.30	548.91	9.23	2.27	17.22
50 µg/m ³	178	85.88	21.57	156.60	2.69	0.68	4.91
By 5 µg/m ³	NA*	39.41	10.29	69.00	1.24	0.32	2.16

*NA: not applicable

3. Combined local and meta-analytic estimates for the health effects 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 estimates in the combined (meta-analytic) one.

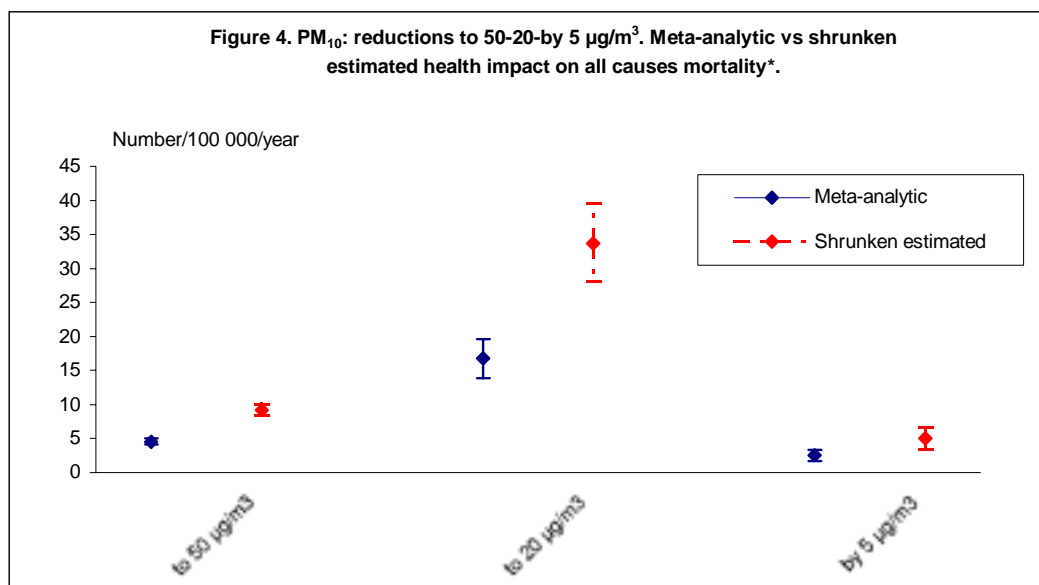
Table 14 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 14. Combined local and meta-analytic estimates for the health effects of PM₁₀ and all causes of deaths (ICD9 < 800) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Attributable cases per year						
	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	354	1074.94	670.25	1487.68	33.72	21.02	46.66
50 µg/m ³	178	293.63	183.66	405.09	9.21	5.76	12.71
By 5 µg/m ³	NA*	159.47	100.31	218.76	5.00	3.15	6.86

*NA: not applicable

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



* All causes mortality excluding external causes (ICD9 < 800)
PM₁₀ data for 2001, mortality data for 2001

4. Long term HIA 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)

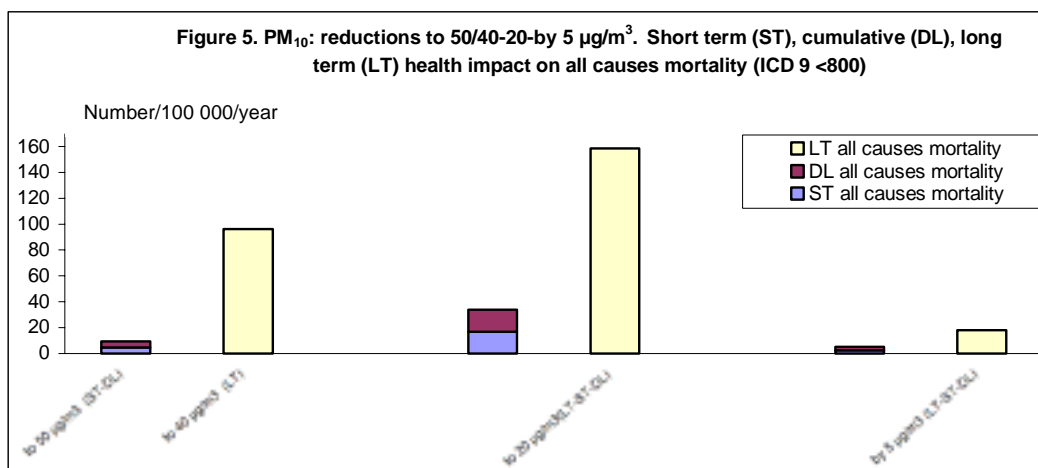
- reduction by 5 $\mu\text{g}/\text{m}^3$ in the annual mean value of PM_{10} (to allow for cities with low levels of PM_{10})

Table 15 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

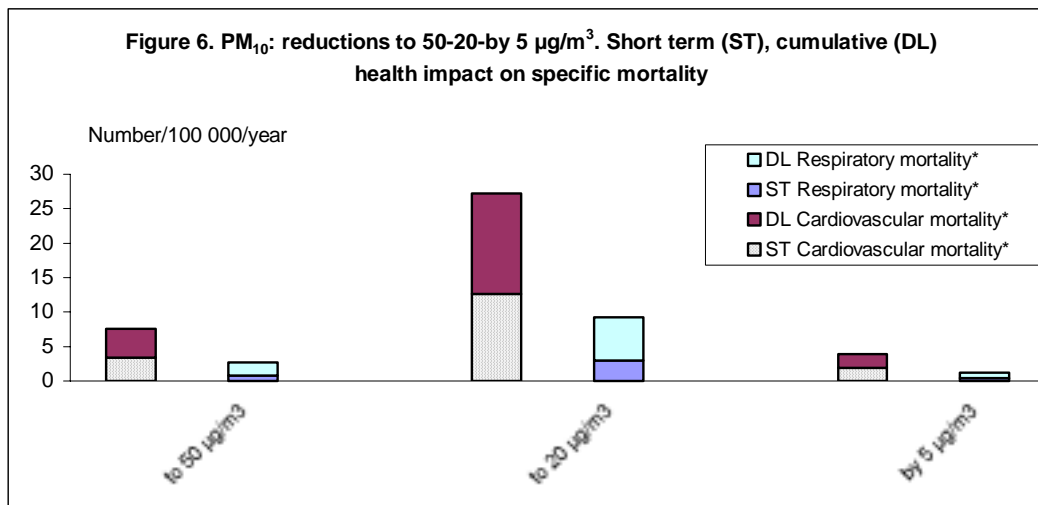
Table 15. Deaths all causes (ICD9 < 800) (2001). Potential benefits of reducing annual mean values of PM_{10} (2001) to levels of 20 and 40 $\mu\text{g}/\text{m}^3$, and by 5 $\mu\text{g}/\text{m}^3$. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM_{10}

	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 $\mu\text{g}/\text{m}^3$	5066.30	2966.75	7434.75	158.90	93.05	233.19
40 $\mu\text{g}/\text{m}^3$	3068.02	1827.64	4421.10	96.23	57.32	138.67
By 5 $\mu\text{g}/\text{m}^3$	579.36	351.77	818.33	18.17	11.03	25.67

The following graphs show the health impact of PM_{10} 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).



PM_{10} data for 2001, mortality data for 2001



* Cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).
PM₁₀ data for 2001, mortality data for 2001

PM_{2.5} findings

1. LT PM_{2.5}: Attributable Cases

We estimated chronic effects of PM_{2.5} in Athens 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/m³²
- reduction of the annual mean value of PM_{2.5} to a level of 15 µg/m³²
- 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})

Tables 16, 17 and 18 present the attributable number of all causes, cardiopulmonary and lung cancer deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 16. Deaths all causes (ICD9 0-999) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	2704.22	683.81	4880.56	84.82	21.45	153.08
20 µg/m ³	1899.66	485.81	3389.16	59.58	15.24	106.30
By 3,5 µg/m ³	605.30	157.51	1061.12	18.99	4.94	33.28

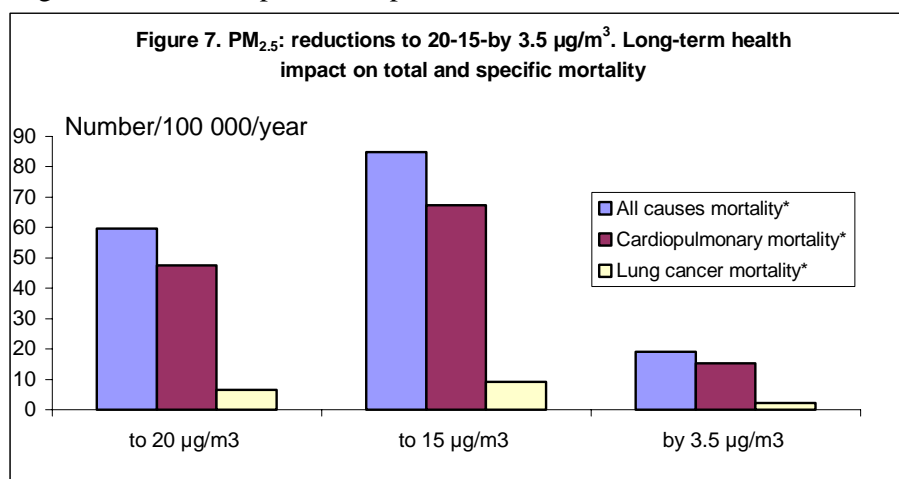
Table 17. Cardiopulmonary deaths (ICD9 401-440 and 460-519) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) to levels of 15 and 20 µg/m³, and by 3,5 µg/m³. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic 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	2148.30	743.06	3693.48	67.38	23.31	115.84
20 µg/m ³	1519.79	533.42	2573.92	47.67	16.73	80.73
By 3,5 µg/m ³	489.66	175.75	810.65	15.36	5.51	25.43

Table 18. Lung cancer deaths (ICD9 162) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	291.94	92.97	520.01	9.16	2.92	16.31
20 µg/m ³	208.38	67.81	362.91	6.54	2.13	11.38
By 3,5 µg/m ³	68.09	22.90	114.66	2.14	0.72	3.60

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 2001, mortality data for 2001

2. LT PM_{2.5}: Years of Life Lost

We estimated the years of life lost attributable to the chronic effects of PM_{2.5} for starting year of simulation, using the data for 2001. The same pollution scenarios were considered:

Tables 19, 20 and 21 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 19. Deaths all causes >30 years, male and female, for one year (ICD9 0-999) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	1276.97	346.44	2146.88	39.87	10.82	67.03
20 µg/m ³	895.18	240.39	1520.22	27.95	7.51	47.46
By 3,5 µg/m ³	285.81	75.55	493.05	8.92	2.36	15.39

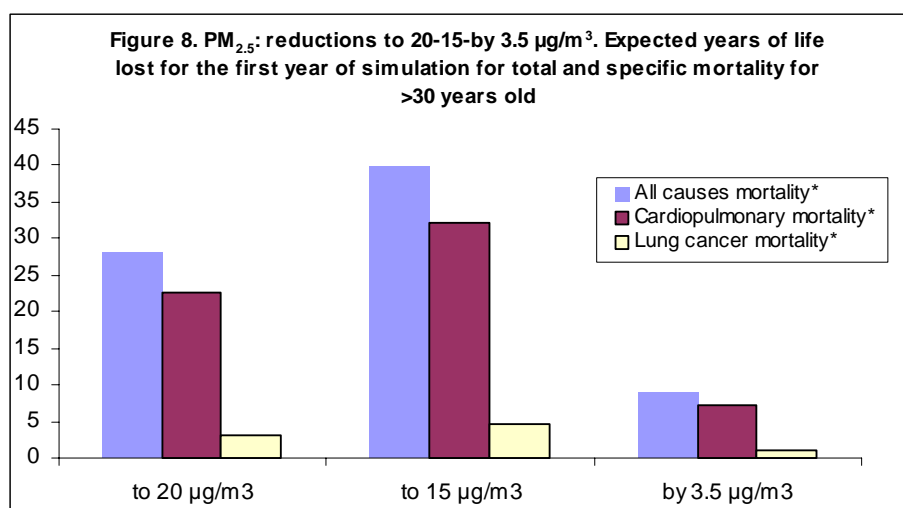
Table 20. Cardiopulmonary deaths >30 years, male and female, for one year (ICD9 401-440 and 460-519) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) to levels of 15 and 20 µg/m³, and by 3,5 µg/m³. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence 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	1028.67	388.98	1614.50	32.12	12.14	50.41
20 µg/m ³	726.05	270.95	1154.36	22.67	8.46	36.04
By 3,5 µg/m ³	234.29	85.66	380.15	7.32	2.67	11.87

Table 21. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	144.47	52.65	224.69	4.51	1.64	7.02
20 µg/m ³	102.92	36.76	163.17	3.21	1.15	5.09
By 3,5 µg/m ³	33.70	11.66	55.10	1.05	0.36	1.72

Figure 8 presents the years of life lost for all causes deaths for 30 years of age or older in the population of Athens for starting year of simulation.



* All causes mortality (ICD9 0-999), cardiopulmonary mortality (ICD9 401-440 and 460-519), lung cancer mortality (ICD9 162). PM_{2.5} data for 2001, mortality data for 2001

For all causes of deaths, all other things being equal, reduction of PM_{2.5} by 3.5 µg/m³ in 2001 would save almost 100 years of expected life for starting year of simulation, in people older than 30 years in the city of Athens. For cardiopulmonary mortality, this number would be around 65 and for lung cancer mortality, 15.

Table 22. Life expectancy and its possible increase by reduction of air pollution to 15 $\mu\text{g}/\text{m}^3$ in Athens

Age	Life expectancy	Expected gain in life expectancy		
		Mean	Low estimate	High estimate
At birth	78.41	0.93	0.24	1.62
30	49.48	0.95	0.25	1.65
65	17.79	0.73	0.19	1.28

In terms of life expectancy, all other things being equal, if annual mean $\text{PM}_{2.5}$ levels ($31.2 \mu\text{g}/\text{m}^3$) would be reduced to $15 \mu\text{g}/\text{m}^3$, the 49 years of life expectancy in a person of 30 years old would be increased by almost 1 year, due to reduced risk of death from all causes in the city of Athens.

Interpretation of findings

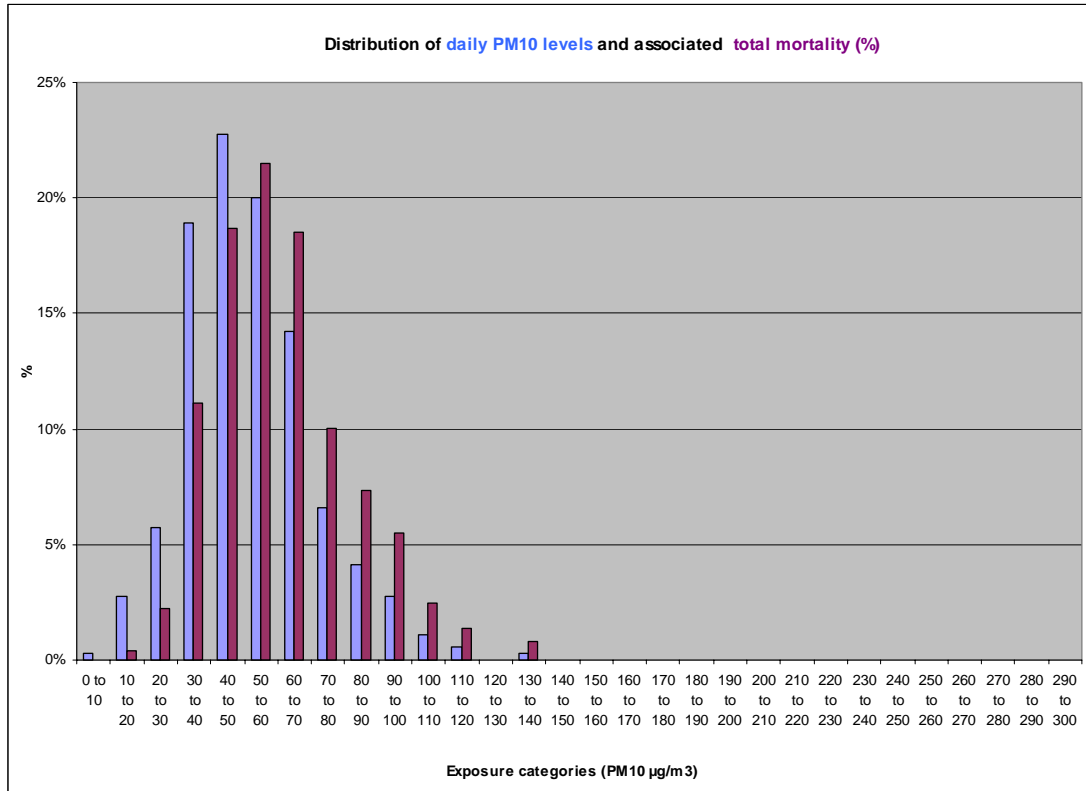
In Athens, exposure to PM_{10} in 2001 exceeded the standards set by the daughter Directive of the EC of 1999 and the mean annual values exceeded the limit in 5 out of 6 stations. Compared to the previous APHEIS report (data of 1996) black smoke levels are slightly higher in 2001 in the one monitoring station for which we had data for both periods. Black smoke levels display a seasonal pattern, with peaks in the winter. In contrast, PM_{10} concentrations do not display a pronounced seasonal pattern.

In Athens only mortality data are available. The avoidable number of deaths for short-term effect estimates is considerable. For PM_{10} effects it is almost all explained by CVD and respiratory deaths. For BS total mortality effects are more than just the sum of CVD and respiratory. Using estimates weighted by the local parameter vs. using combined (meta-analytic) ones makes a big difference: The weighted local estimates yield much larger number of deaths.

Long term effects were estimated based on $\text{PM}_{2.5}$ concentrations. Since $\text{PM}_{2.5}$ is not measured in Athens we used conversion factors to derive $\text{PM}_{2.5}$ from PM_{10} . The conversion factors were based on co-located monitors, which operated for a whole year and were specific for each month. The longer term effects are more important in terms of numbers of avoidable deaths but the effect estimates are based on fewer studies from other countries. In terms of years of life lost, considerable gain (almost 300 YOLL for starting year of simulation) will occur just by reducing annual $\text{PM}_{2.5}$ average concentrations by $3,5 \mu\text{g}/\text{m}^3$ and substantially more by further reductions.

In Athens, the topography and climate lead to relatively high mean levels of air pollution associated with relatively low emissions. The percentage % of attributable deaths is about 10% for the highest PM_{10} concentration category ($>90\text{mg}/\text{m}^3$), 57% for exposures between 50 and $90 \mu\text{g}/\text{m}^3$, 30% for exposures between 30 and $50 \mu\text{g}/\text{m}^3$ and about 3% for the lowest exposure category. Therefore, reducing 24 hour concentrations to $90 \text{mg}/\text{m}^3$ would avoid 10% of premature deaths, whilst reducing down to 50 would avoid 67% (figure 9). The distributions are similar for PM_{10} concentrations and other outcomes.

Figure 9. Short term distribution of PM₁₀ levels and associated percentage of cases



General comments

Several ministries and municipal authorities are interested and implement policies for pollution reduction, but so far they seem to have other priorities and we did not manage to involve them in APHEIS in an organized way.

Conclusions

The APHEIS surveillance system for Athens is very useful and interesting, as Athens has special characteristics which make the air pollution problem a prominent potential public health issue. The problem will attract additional interest in view of 2004 Olympic games to be held in August, a time with high ozone and PM₁₀ concentrations. We believe that air pollution will attract further interest after the Olympic games.

Appendix

1. Exposure data

- *Air quality network and possible changes in the air pollution network that may affect exposure data for Apheis 3:* Since year 2000, PM₁₀ concentration is measured in daily basis.
- *Number and type of stations used for Apheis 3:* For year 2001 we had BS measurements from 2 stations that fulfilled the completeness criteria, Athinas and Patisision which are both traffic. For PM₁₀ six station were used: Aristotelous (traffic), Goudi (traffic), Lykovrisi (suburban), Marousi (traffic), Peiraias (traffic) and Zografou (suburban background).
- *Methods of measuring PM₁₀/BS/PM_{2.5}:* BS was measured using reflectometry and PM₁₀ using beta attenuation. PM_{2.5} direct measures are not available and it is converted from PM₁₀.
- *Use of correction factor for automatic measurements of PM₁₀:* We used correction factor 1.3
- *Use of conversion factor from PM₁₀ to PM_{2.5}:* The conversion factor from PM₁₀ to PM_{2.5} differs between months and ranges from 0.30 to 0.63.
- *Exposure data for Apheis 3:*
 - o Year of air pollution data: The air pollution data are for year **2001**
 - o Daily mean levels of PM₁₀/PM_{2.5} and SD: Daily mean levels (SD) of **BS** were **77.02 (36.80)**, of **PM₁₀** were **52.12 (19.23)µg/m³** and **PM_{2.5}** were **24.03 (10.73)µg/m³**
 - o P5 and P95: The levels of pollutant reached during the 366 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively: **BS: 27.50µg/m³** and **147.00µg/m³**, **PM₁₀: 24.83µg/m³** and **86.67µg/m³**, **PM_{2.5}: 10.41µg/m³** and **43.44µg/m³**
 - o Number of days when air pollutants exceeded limit levels:

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

Air pollutant	Short term		
	PM ₁₀	BS	PM _{2.5}
Number of days above	20 µg/m ³ 354	20 µg/m ³ 360	14 µg/m ³ 321
Number of days above	50 µg/m ³ 178	50 µg/m ³ 273	35 µg/m ³ 47

2. Health data

- *Source and year of mortality:* National Statistical Service of Greece, year 2001
- *Age-standardised mortality rate (per 100 000 inhabitants) using the European population for year 2000¹:* 854(per 100 000, all causes mortality)
- *Daily mean number and standard deviation, and **annual** number of cases per 100 000:*

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

Table 3. Daily mean number and annual rate per 100 000 of deaths (2001)

Health outcome	ICD9	ICD10	Daily mean number (SD)	Number of cases per 100 000
Short term HIA				
All causes mortality (excluding external causes)*	< 800	A00-R99	76 (11.0)	873
Cardiovascular mortality	390-459	I00-I99	38 (7.6)	441
Respiratory mortality	460-519	J00-J99	6 (2.8)	72
Long term HIA				
All causes mortality	0-999	A00-Y98	80 (-)	912
Cardiopulmonary mortality	401-440 460-519	I10-I70 J00-J99	44 (-)	500
Lung cancer mortality	162	C33-C34	4 (-)	50

* For short and long term scenarios

1. Tables for black smoke findings

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

Table 1. Deaths all causes (ICD9 < 800) (2001). Potential benefits of reducing daily BS 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 BS

Scenarios	Attributable cases per year						
	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	360	943.08	624.24	1429.95	29.58	19.58	44.85
50 µg/m ³	273	508.62	337.15	769.54	15.95	10.57	24.14
By 5 µg/m ³	NA*	79.80	53.23	119.61	2.50	1.67	3.75

*NA: not applicable

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

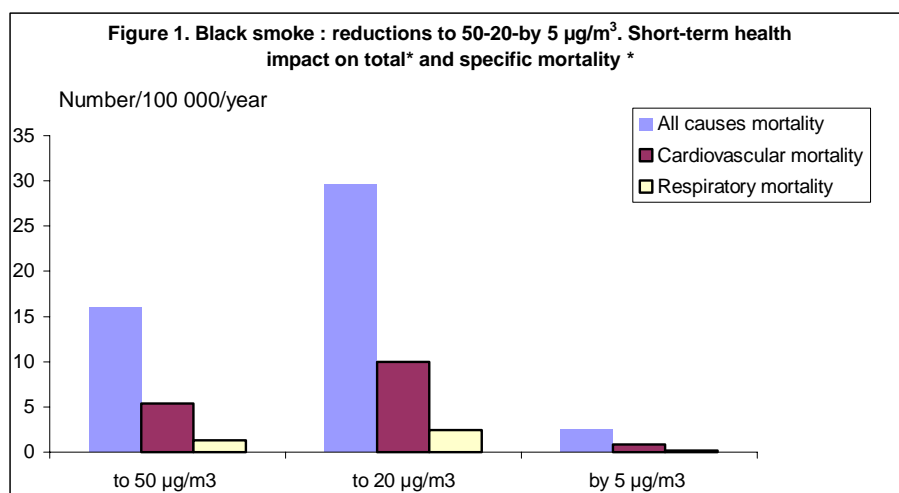
Scenarios	Attributable cases per year						
	Number of days per year exceeding 20 and 50 µg/m ³	N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	360	319.00	158.37	564.27	10.01	4.97	17.70
50 µg/m ³	273	171.26	85.15	302.29	5.37	2.67	9.48
By 5 µg/m ³	NA*	27.28	13.65	47.71	0.86	0.43	1.50

*NA: not applicable

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

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 per 100 000		
		central	lower	upper	central	lower	upper
20 $\mu\text{g}/\text{m}^3$	360	77.97	-25.26	201.37	2.45	-0.79	6.32
50 $\mu\text{g}/\text{m}^3$	273	42.05	-13.70	107.90	1.32	-0.43	3.38
By 5 $\mu\text{g}/\text{m}^3$	NA*	6.60	-2.20	16.46	0.21	-0.07	0.52

*NA: not applicable



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

** Black smoke data for 2001, mortality data for 2001

2. Tables for PM_{10} findings

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

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

Table 1. Deaths all causes (ICD9 < 800) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	534.58	355.19	715.17	16.77	11.14	22.43
50 µg/m ³	178	143.98	95.80	192.35	4.52	3.00	6.03
By 5 µg/m ³	NA*	81.00	54.03	107.94	2.54	1.69	3.39

*NA: not applicable

Table 2. Cardiovascular deaths (ICD9 390-459) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	403.32	222.56	586.51	12.65	6.98	18.40
50 µg/m ³	178	109.37	60.52	158.62	3.43	1.90	4.97
By 5 µg/m ³	NA*	60.49	33.64	87.28	1.90	1.06	2.74

*NA: not applicable

Table 3. Respiratory deaths (ICD9 460-519) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	94.76	35.96	155.17	2.97	1.13	4.87
50 µg/m ³	178	25.93	9.90	42.23	0.81	0.31	1.32
By 5 µg/m ³	NA*	14.02	5.40	22.60	0.44	0.17	0.71

*NA: not applicable

3.2. Cumulative health effects of PM₁₀ up to 40 days

Tables 4, 5 and 6 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 4. Cumulative health effects of PM₁₀ up to 40 days and all causes of deaths (ICD 9 < 800) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	1082.99	709.92	1457.66	33.97	22.27	45.72
50 µg/m ³	178	295.89	194.52	397.11	9.28	6.10	12.46
By 5 µg/m ³	NA*	160.61	106.14	214.45	5.04	3.33	6.73

*NA: not applicable

Table 5. Cumulative health effects of PM₁₀ up to 40 days and cardiovascular deaths (ICD9 390-459) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	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 ³	354	868.55	607.16	1136.01	27.24	19.04	35.63
50 µg/m ³	178	241.31	169.37	314.34	7.57	5.31	9.86
By 5 µg/m ³	NA*	125.59	88.78	162.41	3.94	2.78	5.09

*NA: not applicable

Table 6. Cumulative health effects of PM₁₀ up to 40 days and respiratory deaths (ICD9 460-519) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	Attributable cases per year					
		N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	354	294.20	72.30	548.91	9.23	2.27	17.22
50 µg/m ³	178	85.88	21.57	156.60	2.69	0.68	4.91
By 5 µg/m ³	NA*	39.41	10.29	69.00	1.24	0.32	2.16

*NA: not applicable

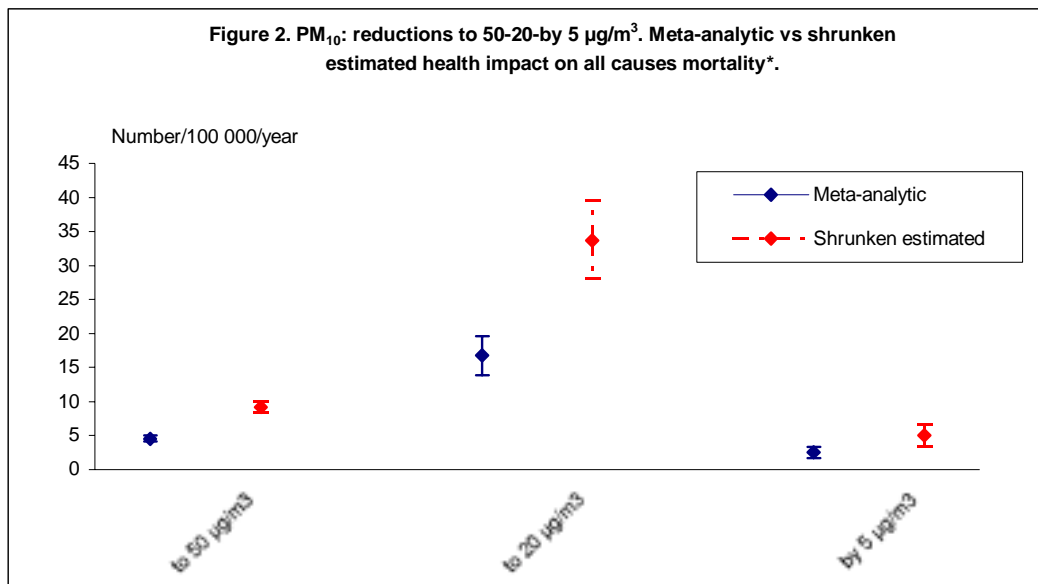
3.3. Combined local and meta-analytic estimates for the health effects of PM₁₀

Table 7 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 7. Combined local and meta-analytic estimates for the health effects of PM₁₀ and all causes of deaths (ICD9 < 800) (2001). Potential benefits of reducing daily PM₁₀ 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 PM₁₀

Scenarios	Number of days per year exceeding 20 and 50 µg/m ³	Attributable cases per year					
		N° of deaths			N° of deaths per 100 000		
		central	lower	upper	central	lower	upper
20 µg/m ³	354	1074.94	670.25	1487.68	33.72	21.02	46.66
50 µg/m ³	178	293.63	183.66	405.09	9.21	5.76	12.71
By 5 µg/m ³	NA*	159.47	100.31	218.76	5.00	3.15	6.86

*NA: not applicable



* All causes mortality excluding external causes (ICD9 < 800)

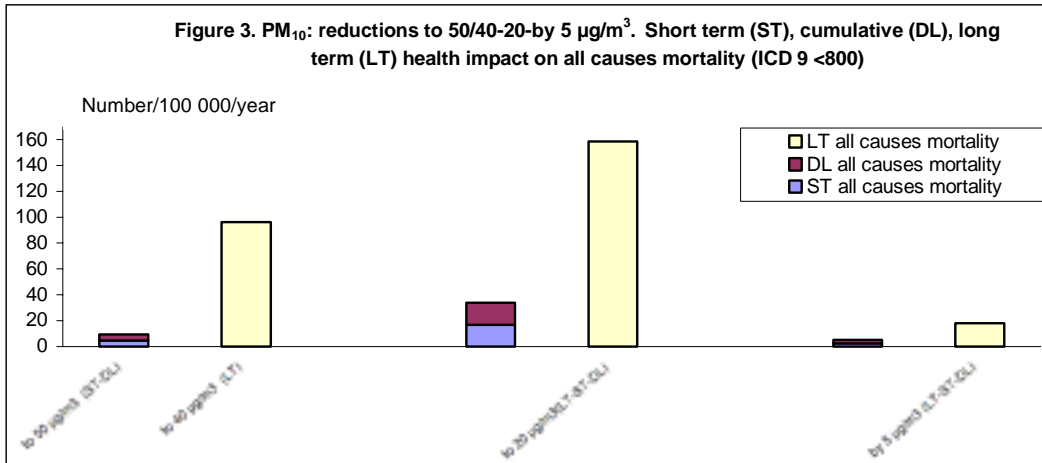
** PM₁₀ data for 2001, mortality data for 2001

3.4. Long term HIA for PM₁₀

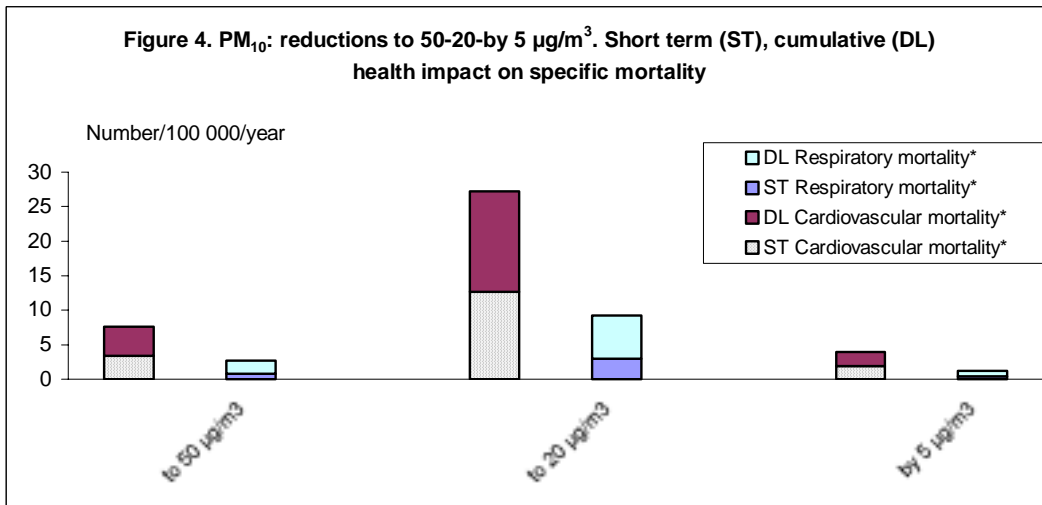
Table 8 presents the attributable number of all causes of deaths expressed as absolute numbers and as rates per 100 000 inhabitants.

Table 8. Deaths all causes (ICD9 < 800) (2001). Potential benefits of reducing annual mean values of PM₁₀ (2001) 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 per 100 000		N° of deaths per 100 000	
	central	lower	upper	central	lower	upper
20 µg/m ³	5066.30	2966.75	7434.75	158.90	93.05	233.19
40 µg/m ³	3068.02	1827.64	4421.10	96.23	57.32	138.67
By 5 µg/m ³	579.36	351.77	818.33	18.17	11.03	25.67



* PM₁₀ data for 2001, mortality data for 2001



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

** PM₁₀ data for 2001, mortality data for 2001

4. Tables for PM_{2.5} findings

4.1 LT PM_{2.5}: Attributable Cases

Tables 1, 2 and 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) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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}

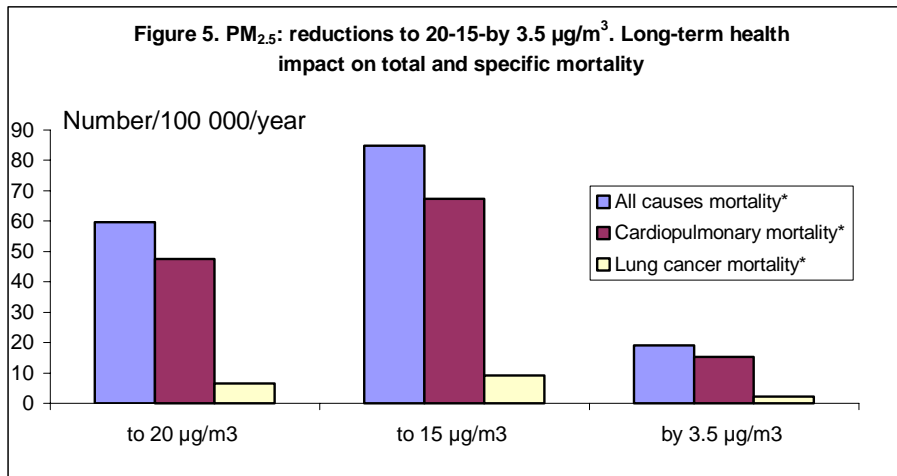
	Attributable cases per year					
	N° of deaths	N° of deaths	N° of deaths	N° of deaths per 100 000	N° of deaths per 100 000	N° of deaths per 100 000
	central	lower	upper	central	lower	upper
15 µg/m ³	2704.22	683.81	4880.56	84.82	21.45	153.08
20 µg/m ³	1899.66	485.81	3389.16	59.58	15.24	106.30
By 3,5 µg/m ³	605.30	157.51	1061.12	18.99	4.94	33.28

Table 2. Cardiopulmonary deaths (ICD9 401-440 and 460-519) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	2148.30	743.06	3693.48	67.38	23.31	115.84
20 µg/m ³	1519.79	533.42	2573.92	47.67	16.73	80.73
By 3,5 µg/m ³	489.66	175.75	810.65	15.36	5.51	25.43

Table 3. Lung cancer deaths (ICD9 162) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	291.94	92.97	520.01	9.16	2.92	16.31
20 µg/m ³	208.38	67.81	362.91	6.54	2.13	11.38
By 3,5 µg/m ³	68.09	22.90	114.66	2.14	0.72	3.60



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

** PM_{2.5} data for 2001, mortality data for 2001

4.2 LT PM_{2.5}: Years of Life Lost

Tables 4, 5 and 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.

Table 4. Deaths all causes >30 years, male and female, for one year (ICD9 0-999) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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}

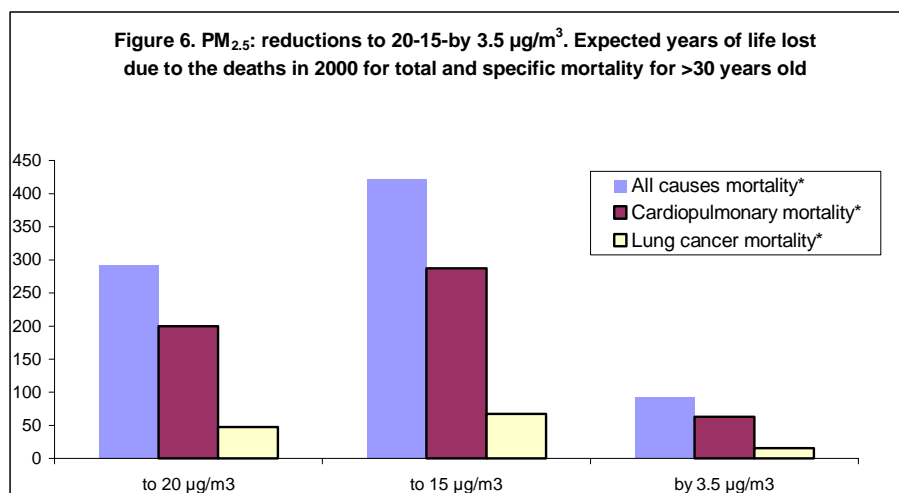
	Years of life lost					
	YoLL	YoLL	YoLL	YoLL	YoLL	YoLL
	central	lower	upper	per 100 000	per 100 000	per 100 000
15 µg/m ³	1276.97	346.44	2146.88	39.87	10.82	67.03
20 µg/m ³	895.18	240.39	1520.22	27.95	7.51	47.46
By 3,5 µg/m ³	285.81	75.55	493.05	8.92	2.36	15.39

Table 5. Cardiopulmonary deaths >30 years, male and female, for one year (ICD9 401-440 and 460-519) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	1028.67	388.98	1614.50	32.12	12.14	50.41
20 µg/m ³	726.05	270.95	1154.36	22.67	8.46	36.04
By 3,5 µg/m ³	234.29	85.66	380.15	7.32	2.67	11.87

Table 6. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (2001). Potential benefits of reducing annual mean values of PM_{2.5} (2001) 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	144.47	52.65	224.69	4.51	1.64	7.02
20 µg/m ³	102.92	36.76	163.17	3.21	1.15	5.09
By 3,5 µg/m ³	33.70	11.66	55.10	1.05	0.36	1.72



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

** PM_{2.5} data for 2001, mortality data for 2001

For all causes of deaths, all other things being equal, reduction of PM_{2.5} by 3.5 µg/m³ in 2001 would save almost 100 years of expected life in people older than 30 years in the city of Athens. For cardiopulmonary mortality, this number would be around 65 and for lung cancer mortality, 15.

Table 7. Life expectancy and its possible increase by reduction of air pollution to 15 µg/m³ in Athens

Age	Life expectancy	Expected gain in life expectancy		
		Mean	Low estimate	High estimate
At birth	78.41	0.93	0.24	1.62
30	49.48	0.95	0.25	1.65
65	17.79	0.73	0.19	1.28

In terms of life expectancy, all other things being equal, if annual mean PM_{2.5} levels (31.2 µg/m³) would be reduced to 15 µg/m³, the 49 years of life expectancy in a person of 30 years old would be increased by almost 1 year, due to reduced risk of death from all causes in the city of Athens.