BUCHAREST CITY REPORT

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Summary of the main findings

Air pollution levels and trends compared to EC limit values:

According to the Romanian legislation that is transposing the EC Directives for air pollution the mean annual limit value for PM10 till 1st Jan 2005 is 60 μg/m3/year . This value derives from the mean annual limit value of 40 μg/m3/year plus a margin of tolerance of 50 % till 1st Jan. 2005. This margin of tolerance will be gradually reduce in such way that on the 1st Jan 2007 the limit value to be met will be 40 μg/m3/year as recommended by EC legislation. Staring with 1st Jan 2007 the limit value for PM10 will be 20 μg/m3/year plus a 50% margin of tolerance (that means 30 μg/m3/year) to be reduced till 1st Jan 2010 to 20 μg/m3/year.

The annual mean value of PM 10 in 2000 for Bucharest (data from the network of the Ministry of Health) was 61 μg/m3/year. PM10 is derived from TSP measurements at a transformation rate of 0.6 . At present the air pollution concentrations for PM10 in Bucharest can be considered being at the upper limit. Taking into account the decreasing trend of the limit values, measures have to be taken to reduce the air pollution concentrations.

PM2.5 values used in this report for long term estimations of health effects are derived from PM10 measurements at a conversion rate of 0.7.

The analysis estimated that reduction of the long-term PM pollution to the levels of PM2.5 of 15 ug/m3 would reduce mortality in Bucharest by 167/ 100 000 inh. deaths in one year.

Main causes of air pollution in the city, and actions implemented / planned to reduce it:

The main cause of air pollution in Bucharest, for particles is represented at present by the increasing traffic in the city.

In order to reduce air pollution in Romania, legislation (Governmental Order) are currently prepared for establishing national action plans for air pollution surveillance and reduction.

Background

As described in the AHEIS second year report, Bucharest is the capital city of Romania, situated in Eastern Europe it's co-ordinates corresponding to a latitude of 44.45^{o} and a longitude of 26.17^{o} . Its altitude is 85 meters above see level. It covers an area of 238 km2 with a population density of 8,521 inhabitants/km2. In 2000 the mid year population as of 1st of July was 2.009.200 inhabitants with a proportion of 13.6% of people older than 65 years. The city is divided in 6 administrative sectors (1-6).

The objective of the third year study is to update the Health Impact assessment for 2000 with the latest available scientific dose – response functions (RR) and to extend the impact assessment from attributable cases due to air pollution to Years of Life Lost (YLLo).

Sources of air pollution

Principal sources of air pollution were described in detail in the previous Apheis city report last year (www.apheis.org).

In the past, there were several industrial sites in the outskirts of Bucharest that were heavily polluting.
Yet, in the past ten years, as production declined and some of the industrial areas shut down, the main source of pollution became traffic and the combustion plants for central heating, as well as individual heating systems. The percentage of emissions from industry/heating and traffic in 1996 were respectively 27%, 32% and 41% (source: Ministry of Environment).

Exposure data

The pollution indicators provided are measured by the Network of the Ministry of Health and Family. For 2000, measurements were performed by this network at five locations. Four of them are represented in the Apheis study, these being generally a combination of background and traffic measurements. The monitoring stations are geographically representative of the study area. 24 hours TSP was measured. TSP was converted to PM10 using on a conversion factor of 0.6. Measurements are 24h, gravimetric, four days a week, Monday to Thursday, and there are no measurements on Fridays and weekends. This can lead to an overestimated yearly mean air pollution level, as during weekends air pollution levels tend to be lower due to reduced traffic and industrial activity in the city. The PM2.5 values are estimated from PM10 at a conversion rate of 0.7 of PM10.

According to the PEACE project 1), PM10 levels generally vary little between weekdays and weekends, on the order of –5% to -7%. But during PM10 European measurement campaigns, experts consider that the PM10 concentration on weekends (Saturdays and Sundays) is 30% lower than from Mondays to Fridays. For Bucharest the annual mean for TSP in 2000 is 76.9 $\mu g/m^3$ (measurements from Monday to Thursday) for 208 days. According to the experts, because Fridays should also be considered (due to industrial and pre-weekend traffic activities on Fridays) the "weekend reduction" should be smaller, around 20% to 25%, which means that the missing values should be replaced by 55 µg/m3. Instead, we replaced PM10 missing values by an average value of 40 µg/m3, applying an "at least" conservative approach. Replacing all the days with missing values by an average value of 40 µg/m3 the air pollution levels as done in APHEIS second year report

1) Hoek G, Forsberg B, Borowska M, Hlawiczka S, Vaskövi H, Welinder H, Branis M, Benes I, Kotesovec F, Hagen LO, Cyrus J, Jantunen M, Roemer W, Brunekreef B. Wintertime PM_{10} and Black smoke concentrations across Europe: results from the PEACE study *Atmospheric Environment* 1997;31:3609-3622.

Exposure data used in APHEIS 3

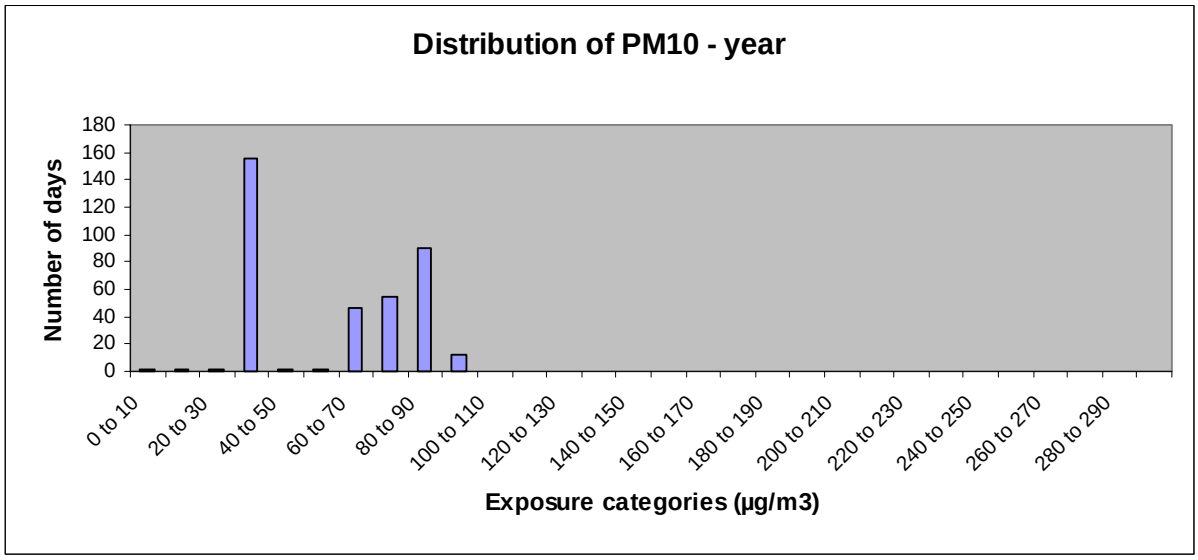
- Air quality network used for APHEIS 3 is the same as for APHEIS 2
- Number and type of stations used for APHEIS 3 are the same as for APHEIS 2
- Methods of measuring PM10/PM2.5 : PM10 is derived from TSP measurements at a conversion rate of ***0.6*** and PM2.5 from PM10 at a conversion rate of ***0.7***
  TSP is measured by gravimetric methods, manually for Monday to Friday

- Use of correction factor for automatic measurements of PM10: none
- Use of conversion factor from PM10 to PM2.5: ***0.7***

- Year of air pollution data : 2000
-
- Daily mean levels of PM10/PM2.5 and SD: Daily mean levels (SD) of PM10 were 61 (SD : 20) *µg/m3/year and PM2.5 were 43 (SD: 14) µg/m3/year*.
- The levels of PM10 reached during the 366 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 40 µg/m^3 and 88 µg/m^3.
- The levels of PM2.5 reached during the 366 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 28 µg/m^3 and 62 µg/m^3.
- Number of days when air pollutants exceeded limit levels of 75 µg/m^3/day (limit value for Romania : 50µg/m^3 limit value plus 50% margin of tolerance) : 136 days in 2000

Number of days when air pollutants exceed certain levels

	Short term		
Air pollutant	**PM_{10}**	**BS**	**$PM_{2.5}$**
Number of days above	20 µg/m^3	20 µg/m^3	14 µg/m^3
	364		
Number of days above	50 µg/m^3	50 µg/m^3	35 µg/m^3
	205		



Health data

The mortality and morbidity data are for 2000 and in some cases for 1999[§] and 1997[#] provided by the National Institute for Statistics and by the Medical Statistics Center of the Ministry of Health and Statistic Department of the Public Health Direction Bucharest. The codes are based on the international classification of diseases (ICD10).

Due to differences with the health care system, hospital admissions can not be used for comparative purposes across countries and are not reported in this study.

Age-standardised mortality rate 1050 (per 100 000 inhabitants). Total European population (both sexes combined): 727 304 (in thousands) for year 2000 [1]

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

Health outcome	ICD9	ICD10	Daily mean number (SD)	Number of cases per 100 000
Short term HIA				
All causes mortality*	< 800	A00-R99	57	1038
Cardiovascular mortality	390-459	I00-I99	33	601
Respiratory mortality	460-519	J00-J99	3	55
Cardiac mortality	390-429	I00-I52	18 §	329
Cardiac hospital admissions	390-429	I00-I52		
Respiratory hospital admissions	460-519	J00-J99	135 §	2438
Long term HIA				
Total mortality	0-999	A00-Y98	60	1086
Cardiopulmonary mortality	401-440 460-519	I10-I70 J00-J99	33.3 §	599
Lung cancer mortality	162	C33-C34	2.8 #	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 Bucharest, these scenarios were built for three indicators of this particulate pollution: PM10 and PM2.5. The estimated health impacts of these indicators may overlap, and caution is recommended in the interpretation of findings: under no circumstances should we add findings of these indicators because they represent the same type of pollution.

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

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

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

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

Also different approaches were used to describe the impacts:

For PM10, short and long-term findings are expressed in terms of number of attributed deaths per year

For PM2.5, long-term findings are expressed in terms of:
- number of attributed deaths per year
- number of expected years of life lost for starting year of simulations

Short-term scenarios

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

Short term HIA scenarios for PM10

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

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

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

Long-term scenarios

Long-term HIA scenarios for PM10

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

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

Long term HIA for PM2.5

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

The following three pollution scenarios were considered:

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

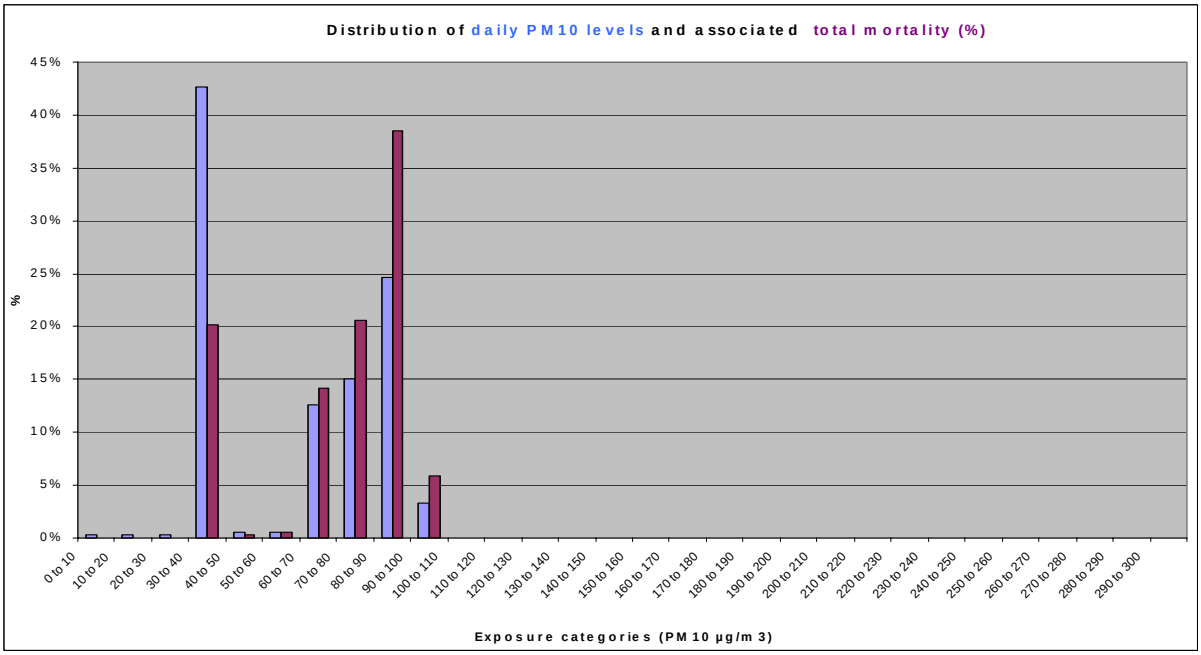
PM10 findings

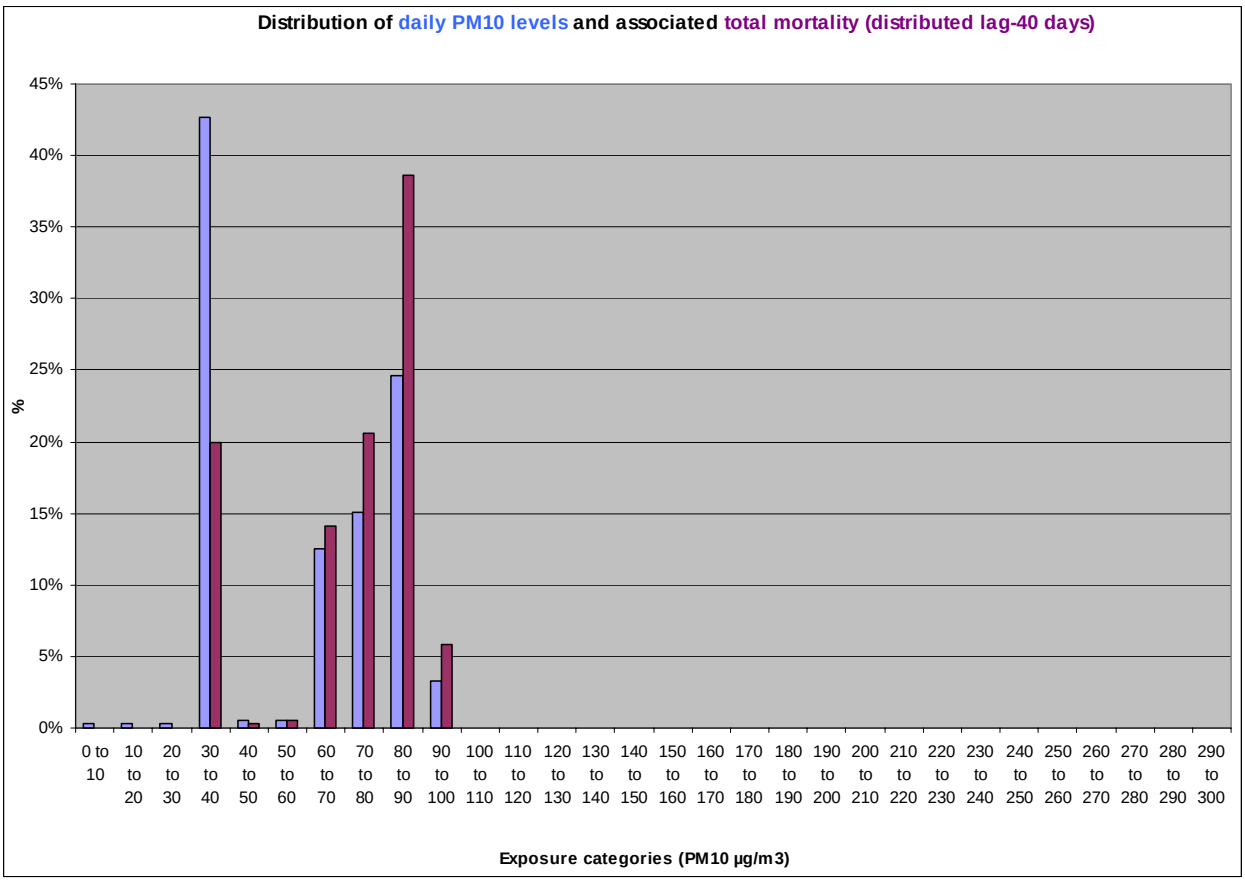
1. Short-term HIA of PM10 on 0-1 days and cumulative HIA of PM10 up to 40 days, and long term HIA of PM10

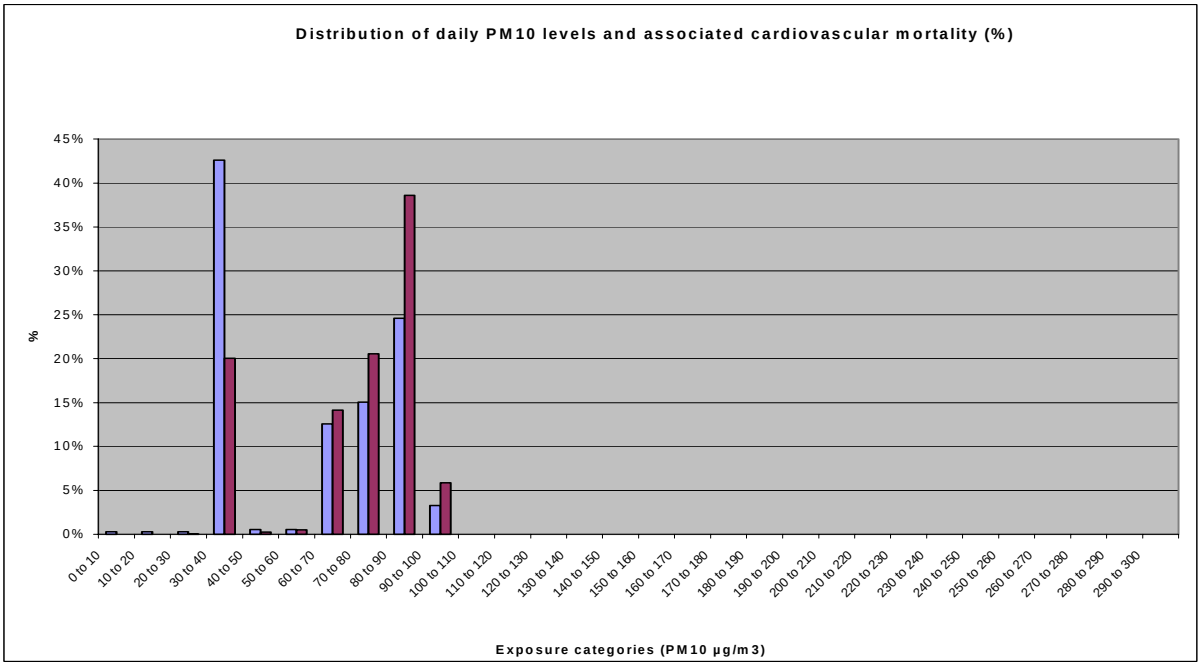
1.1. Mortality findings

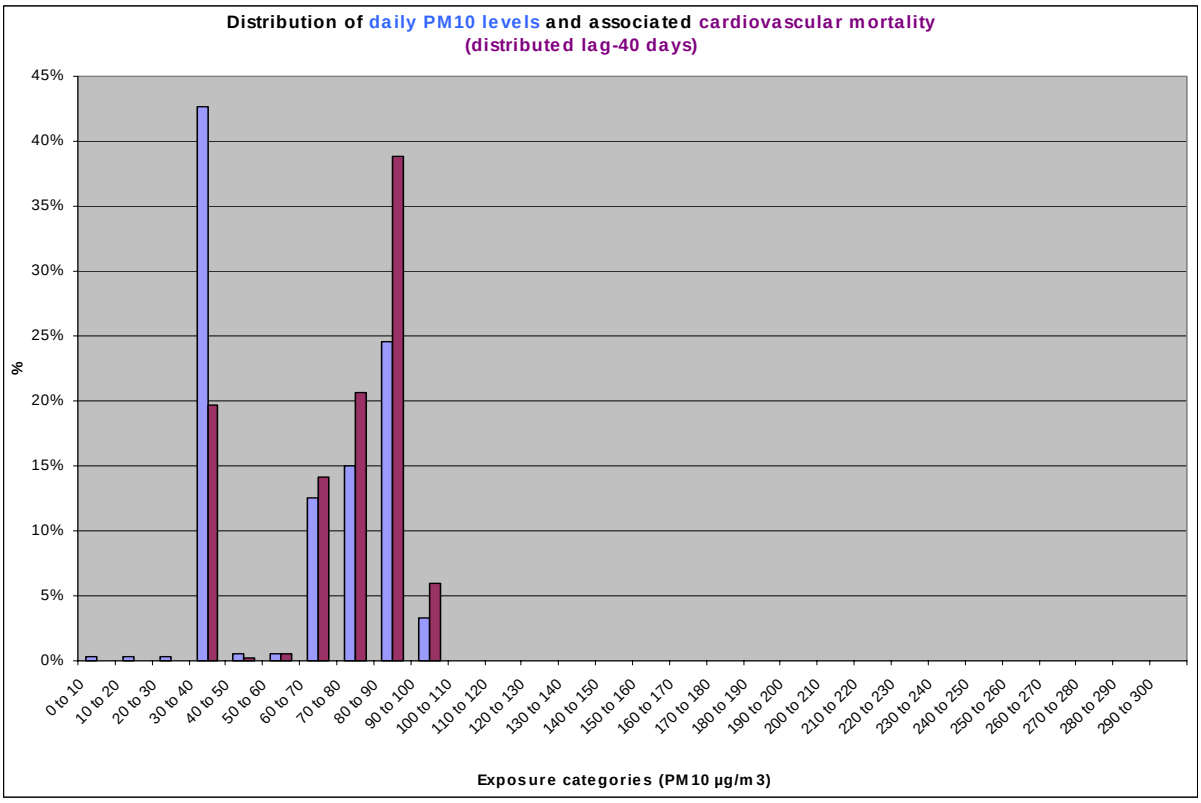
The following graphs show the health impact of PM10 on mortality for different lags: short-term-ST (0-1 day lag), cumulative effect –DL-distributed lag (up to 40 days lag)

Short term distribution of PM10 levels and associated percentage of cases




Distribution of daily PM10 levels and associated total mortality (distributed lag-40 days)
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
%
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
90 to 100
100 to 110
110 to 120
120 to 130
130 to 140
140 to 150
150 to 160
160 to 170
170 to 180
180 to 190
190 to 200
200 to 210
210 to 220
220 to 230
230 to 240
240 to 250
250 to 260
260 to 270
270 to 280
280 to 290
290 to 300
Exposure categories (PM10 µg/m3)


Distribution of daily PM10 levels and associated cardiovascular mortality (%)
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
%
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
90 to 100
100 to 110
110 to 120
120 to 130
130 to 140
140 to 150
150 to 160
160 to 170
170 to 180
180 to 190
190 to 200
200 to 210
210 to 220
220 to 230
230 to 240
240 to 250
250 to 260
260 to 270
270 to 280
280 to 290
290 to 300
Exposure categories (PM10 µg/m3)


Distribution of daily PM10 levels and associated cardiovascular mortality (distributed lag-40 days)
%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
90 to 100
100 to 110
110 to 120
120 to 130
130 to 140
140 to 150
150 to 160
160 to 170
170 to 180
180 to 190
190 to 200
200 to 210
210 to 220
220 to 230
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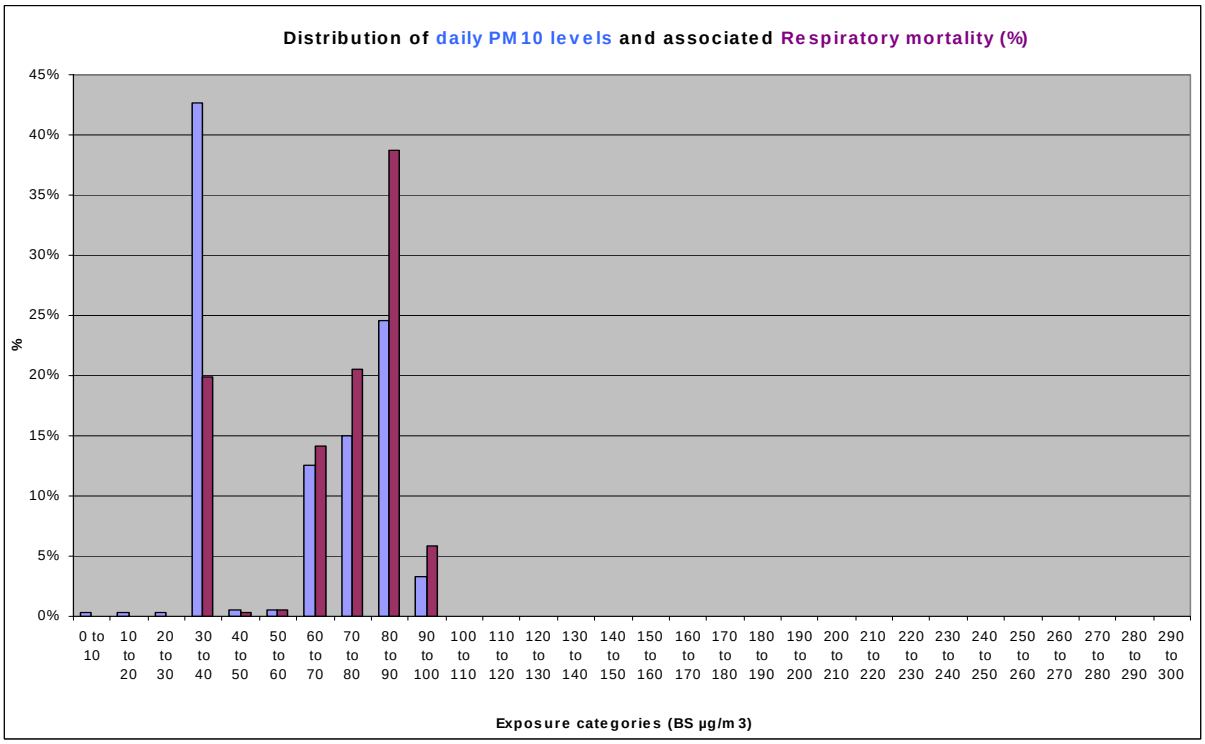
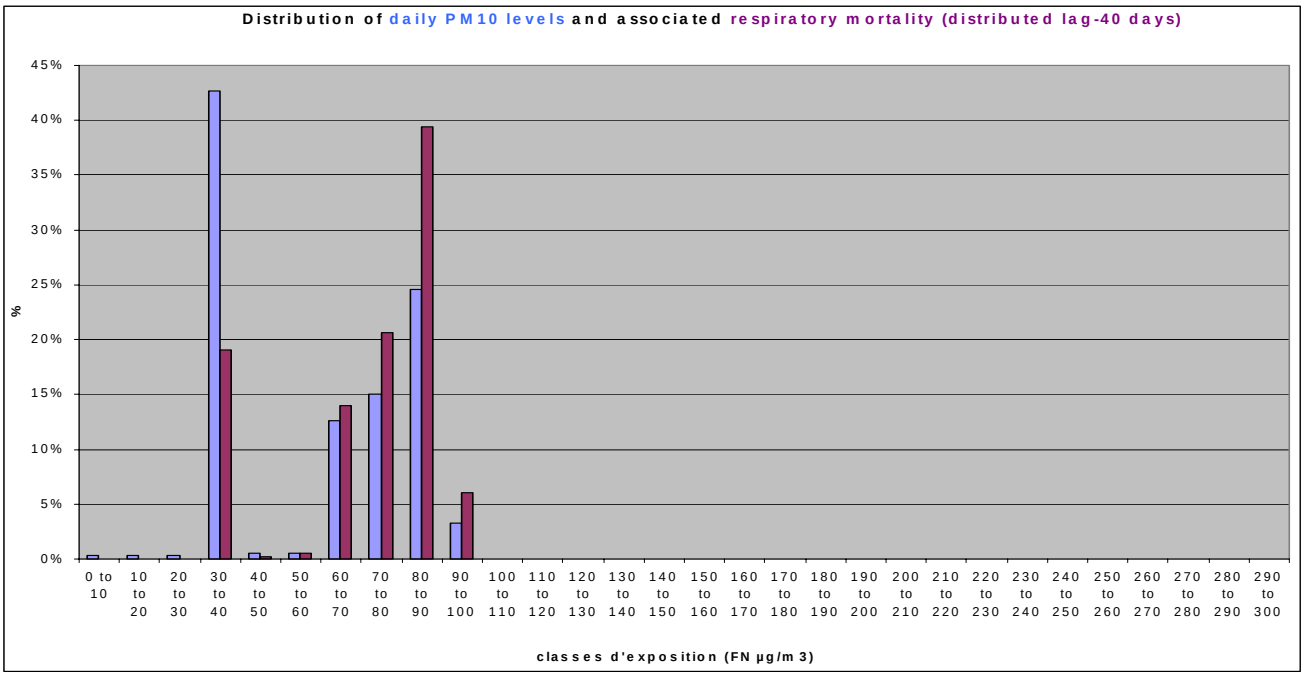
240 to 250
250 to 260
260 to 270
270 to 280
280 to 290
290 to 300
Exposure categories (PM10 µg/m3)


Distribution of daily PM10 levels and associated Respiratory mortality (%)
%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
70 to 80
80 to 90
90 to 100
100 to 110
110 to 120
120 to 130
130 to 140
140 to 150
150 to 160
160 to 170
170 to 180
180 to 190
190 to 200
200 to 210
210 to 220
220 to 230
230 to 240
240 to 250
250 to 260
260 to 270
270 to 280
280 to 290
290 to 300
Exposure categories (BS µg/m3)

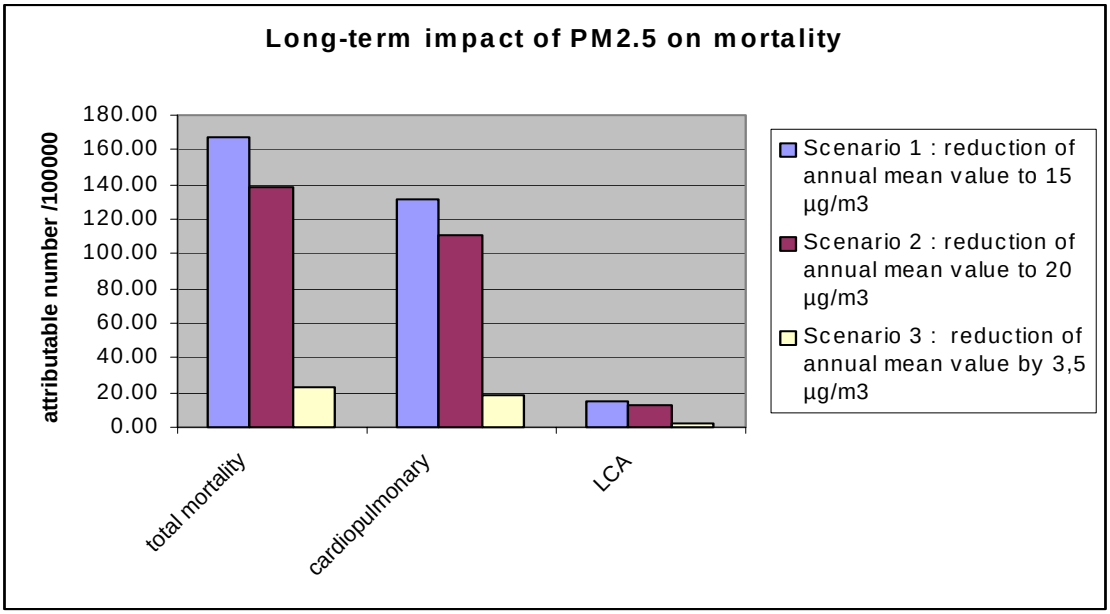


PM2.5 findings

1. Number of attributed cases

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

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



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

** PM2.5 data for 2000, mortality data for 2000

Life expectancy and its possible increase by reduction of air pollution to 15 ug/m3 in Bucharest

		Expected gain in life expectancy		
Age	Life expectancy	Mean	Low estimate	High estimate
At birth	71.61	2.10	0.55	3.62
30	45.88	2.27	0.6	3.92
65	15.44	1.81	0.47	3.14

Comments: In terms of life expectancy, all other things being equal, if annual mean PM2.5 levels (43 μg/m^3) would be reduced to 15 μg/m^3, the 45.88 years of life expectancy in a person of 30 years old would be increased by 2.27 years, due to reduced risk of death from all causes in the city of Bucharest.

General comments

Air pollution remains a public health problem in Bucharest. We assigned a 40 μg/m3 value to the days with missing values using an "at least approach", which is conservative but gives an idea of what the potential "at least" health benefits would be of reducing PM10 levels in Bucharest, allowing an "at least" comparison with the other Apheis cities.
In the last years special attention was paid to assessing the health impact of air pollution on health through the National Environmental Health Action Plans (NEHAPs). Legislative activity has also been taking place in the last few years towards a harmonisation of the European Union (EU) environmental legislation with Romania's national legislation as part of Romania's intergration with the European Union.
HIA will be one of the important activities that will support this process and of which aim is to improve air quality in Bucharest.

Bucharest partners

Dr. Emilia Maria Niciu – Institute of Public Health Bucharest – coordinator

Dr. Vasile Frunza, Chem. Gabriela Mitroi, Chem. Irina Roman

Collaborating institutes:

Directia de Sanatate Publica Bucuresti (Public Health Direction Bucharest) – Dr. Maria Zurini,
Dr. Balaceanu, Chem.Marilena Padureanu, Chem. Cezar Ionescu

Medical Statistics Center of the Ministry of Health and Family – Dr Liviu Botezat

Further contacts: Ministry of Environment and water management, Municipality of Bucharest, Environmental Protection Inspectorate Bucharest, National Institute of Hydrology and Meteorology.

Appendix

1. **Questionnaires for exposure assessment**

1. A. EXPOSURE MEASUREMENT METHODS
YEAR OF DATA : 2000

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:	BUCHAREST
2.	Total area of agglomeration (km²):	238
3.	Area (km²) covered by the air monitoring network in the city:	approx. 3/4 of 238
4.	Number of population in this (exposure relevant) area:	2,009,200
5.	Total number of PM10 monitoring stations in this area:	_____
6.	Total number of BS monitoring stations in this area:	_____
7a.	Total number of TSP monitoring stations in this area:	_____5_____
7b.	**Total number of PM2.5 monitoring stations in this area:**	**_____**
8.	Number of selected PM10 monitoring stations for HIA:	_____
9.	Number of selected BS monitoring stations for HIA:	_____
10a.	Number of selected TSP monitoring stations for HIA:	_____4_____
10b.	**Number of selected PM2.5 monitoring stations for HIA:**	**_____**

11. Measurement interval (please cross)

continuous hourly 24 hours X(4 days a week) weekly 2 weekly

12. Quality assurance and control (please cross)

yes X (partially) no do not know

13. Data quality (please cross)

validated data X invalidated data

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

Name	PM10/BS/TSP	Classification
ISPB	TSP	RESIDENTIAL
POLICOLOR	_TSP	RESID+TRAFFIC + INDUSTRIAL

SINTOFARM_____TSP_____ RESID +TRAFFIC +INDUSTRIAL

ROMAERO_____TSP_____ RESID + TRAFFIC

Please note that Romania is now in the process of harmonising the National legislation with the EU,
and monitoring sites are at this moment not fully complying with the EU regulations

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15. Measurement method / Type of instrument

TSP: GRAVIMETRIC
manual, 4 days a week (Monday to Thursday)

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

no X
yes if yes, a) which factor: _____

b) is it a default factor? yes no
or c) derived from own parallel measurements
(reference method vs. TEOM or beta attenuation) yes no

Not applicable : PM10 converted from TSP at a conversion factor of 0.6

17. If your PM2.5 data have been calculated from your PM10 data, what conversion factor did you use? factor:_____0.7_____

2. TABLES FOR PM_{10} FINDINGS

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

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

Table 1. Deaths all causes (ICD9 < 800) (2000). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100 000

inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m³**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m³	364	505.41	335.56	676.66	25.15	16.70	33.68
50 µg/m³	205	195.62	130.15	261.36	9.74	6.48	13.01
By 5 µg/m³	NA*	60.43	40.31	80.54	3.01	2.01	4.01

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m³**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m³	364	441.55	243.30	643.07	21.98	12.11	32.01
50 µg/m³	205	171.90	95.11	243.32	8.56	4.73	12.41
By 5 µg/m³	NA*	52.20	29.03	75.33	2.60	1.44	3.75

**NA: not applicable*

Table 3. Respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m³, above 50 to 50 µg/m³ and all days by 5 µg/m³. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m³**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m³	364	56.83	21.50	93.33	2.83	1.07	4.65
50 µg/m³	205	22.30	8.51	36.31	1.11	0.42	1.81

By 5 µg/m^3	NA*	6.62	2.55	10.67	0.33	0.13	0.53

**NA: not applicable*

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

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

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

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3		1020.64	668.02	1375.85	50.80	33.25	68.48
50 µg/m^3		399.87	26285	536.71	19.90	13.08	26.71
By 5 µg/m^3	NA*	119.17	78.75	159.12	5.93	3.92	7.92

**NA: not applicable*

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

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3	364	945.78	659.73	1239.68	47.07	32.84	61.70
50 µg/m^3	205	375.82	263.74	489.60	18.70	13.13	24.37

By 5 µg/m^3	NA*	107.37	75.91	138.85	138.85	3.78	6.91

**NA: not applicable*

Table 7. Cumulative health effects of PM_{10} up to 40 days and respiratory deaths (ICD9 460-519) (1999). Potential benefits of reducing daily PM_{10} levels (2000) above 20 to 20 µg/m^3, above 50 to 50 µg/m^3 and all days by 5 µg/m^3. Absolute number and number per 100 000 inhabitants (95% confidence limits) attributable to the acute effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3	364	173.91	42.25	328.28	8.66	2.10	16.34
50 µg/m^3	205	72.02	18.08	131.27	3.58	0.90	6.53
By 5 µg/m^3	NA*	18.14	4.74	31.76	0.90	0.24	1.58

**NA: not applicable*

Long term HIA for PM_{10}

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

Table 9. Deaths all causes (ICD9 < 800) (2000). Potential benefits of reducing annual mean values of PM_{10} (2000) to levels of 20 and 40 µg/m^3, and by 5 µg/m^3. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of PM_{10}

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 40 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3		3308.50	1948.72	4825.16	164.67	96.99	240.15
40 µg/m^3		1766.44	1058.29	2530.23	87.92	52.67	125.93
By 5 µg/m^3	NA*	434.57	263.85	613.81	21.63	13.13	30.55

**NA: not applicable*

2. Tables for $PM_{2.5}$ findings

LT PM2.5: Attributable Cases

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

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

	Attributable cases per year					
Scenarios	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
15 µg/m^3	3371.64	830.56	6251.94	167.81	41.34	311.17
20 µg/m^3	2804.07	698.70	5138.06	139.56	34.78	255.73
By 3,5 µg/m^3	457.51	119.05	802.03	22.77	5.93	39.92

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

	Attributable cases per year					
Scenarios	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
15 µg/m^3	2671.50	893.05	4759.14	131.73	44.04	234.67
20 µg/m^3	2237.01	759.08	3923.15	110.31	37.43	193.45
By 3,5 µg/m^3	375.01	134.60	620.84	18.49	6.64	30.61

Table 3. Lung cancer deaths (ICD9 162) (1997). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3,5 µg/m^3. Absolute number of deaths and number of deaths per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2,5}$

	Attributable cases per year					
Scenarios	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	306.71	92.83	576.51	15.1	4.6	12.4
20 µg/m^3	259.02	80.17	475.41	12.8	4.0	23.4
By 3,5 µg/m^3	44.94	15.11	75.67	2.2	0.7	3.7

LT PM2.5: Years of Life Lost for starting year of simulations

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

Table 1. Deaths all causes >30 years, male and female, for one year (ICD9 0-999) (2000). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3,5 µg/m^3. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2,5}$

	Years of life lost for starting year of simulations					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m^3	1489.35	414.44	2443.01	73.73	20.52	120.93
20 µg/m^3	1240.77	341.71	2055.72	61.42	16.92	101.76
By 3,5 µg/m^3	199.6	52.77	344.25	9.88	2.61	17.04

Table 2. Cardiopulmonary deaths >30 years, male and female, for one year (ICD9 401-440 and 460-519) (2000). Potential benefits of reducing annual mean values of $PM_{2,5}$ (1999) to levels of 15 and 20 µg/m^3, and by 3,5 µg/m^3. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2,5}$

	Years of life lost for starting year of simulations					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m^3	1231.06	480.81	1873.07	60.94	23.80	92.72
20 µg/m^3	1032.56	398.00	1590.97	51.11	19.70	78.76
By 3,5 µg/m^3	170.68	62.41	276.86	8.45	3.09	13.71

Table 3. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (1997). Potential benefits of reducing annual mean values of $PM_{2,5}$ (2000) to levels of 15 and 20 µg/m^3, and by 3,5 µg/m^3. Years of life lost (YoLL) and YoLL per 100 000 inhabitants (95% confidence limits) attributable to the chronic effects of $PM_{2,5}$

	Years of life lost for starting year of simulations					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m^3	127.43	48.63	189.81	6.31	2.41	9.40
20 µg/m^3	107.77	40.34	163.43	5.33	2.00	8.09
By 3,5 µg/m^3	18.43	6.38	30.13	0.91	0.32	1.49