CELJE CITY REPORT

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Summary of the main findings

The analysis estimated that reduction of the long-term PM pollution to the levels of $PM_{2,5}$ of 15 µg/m^3 would reduce mortality in Celje by 122 deaths in one year, which would save 194 years of expected life. If the daily means of PM_{10} would be kept under 20 µg/m^3 11 deaths and 18 hospital admissions could have been avoided in the year 2000.

Principal sources of air pollution were described in detail in the previous Apheis city report last year (www.apheis.org). There is no important new point source. Transportation is still the main source of air pollution in mostly because of public transport in the city. We do not expect any major changes refer to sources of pollution in incoming years.

Background

The city of Celje had a population of 48 943 in year 2000. The number of people over 65 years was 7 286 (14,9 %).

Due to its location it is one of the coolest towns in the country. It has a climate that is transition between continental and alpine, with prevailing weak local winds, influenced by urban heat island. Celje is located in basin with regular temperature inversions. The height of temperature inversion is varied. To the north and to the west of the basin the inversion is initially a bottom inversion at a height of about 10 – 20 m; towards the south and east it reaches 140 m. Volume of air trapped under inversion is small. It has been proved that in winter the warm air above the town rises and is replaced by the cool (polluted) air from the surrounding areas. The meteorological conditions are unfavourable and contribute to build up of pollution. The average wind speed is below 1 m/s and average yearly daily temperature was 11,4 °C.

Sources

The main sources of air pollution are industrial sources and traffic. The greatest industrial sources are; the production of titanium white based on sulphate procedure (1 % of the world production), sulphuric acid production, ironworks, enamel factory and ceramic industry.
In the city centre road traffic is the denominating source. In some residential areas poor oil burning is important too. The local heating plants are using gas. In a past only poor quality coal was used and represented the most important source of SO_2 and BS. In last ten years coal was almost completely substituted by gas. The result is dramatic decrease in SO_2 and BS emissions.

Table 1. Main sources of air pollution

Source (year)	**Road (%)**	**Heating (%)**	**Industry (%)**	**Other sources (specify)**
2000	70	20	10	/

Medium – range transported particles from coal power stations contribute a fraction to the total concentration in the urban background. The main sources of pollution are industry and traffic. The most important vehicle category is diesel vehicles (trucks and buses). There is also a dense transit traffic going through part of the town and which contributes a lot to traffic air pollution, more than local traffic.

There are two important air pollution point sources; titanium production plant and ironwork. The pollution due to production of titanium has improved in last five years, new cleaning systems were introduced and further reduction is expected. The sore point is still ironwork. There are plans to introduce cleaning systems in next two years.

Small domestic furnaces were important source of BS and SO_2 in a past. Almost ten years ago The clean action plan was introduced with aim to reduce pollution. The levels of BS were much higher, the reduction is mostly due to introduction of gas in almost all the parts of the city. In last ten years more than 45 km of gas pipeline network was built, the price of gas is subsidized by local authorities, bank loans available at low interest rate so that individuals can connect to the gas pipeline network. With further reduction of BS level we could save few lives per year and decrease a number of hospital admissions for cardiovascular diseases for a few cases. The main potential for BS reduction is further introduction of gas.

The levels of PM_{10} are of much greater concern. The annual daily mean level of PM_{10} is not decreasing and was 35,8 µg/m3 in 2000. The main sources of PM_{10} pollution are industry and traffic. The traffic air pollution is partly due to transit traffic at the edge of the city. Local public transport is with diesel buses and part of the vehicle fleet is not kept in a good condition.

The ban of traffic in city centre is already in place, a large number of pedestrian zones is already introduced, more activities to reduce the traffic in broader area are already going on. City transport policy needs to recognise that it cannot only focus on the demand for roads but must make walking, cycling and public transport real and accessible choices. There are attempts to introduce cycling paths. Public Health and Health Promotion is going to play a

major role in developing these strategies and in their cross-sectoral implementation through Green Transport Plans, local Transport Plans and through improving access to public transport.

A program is going to be prepared to reduce traffic emissions. The main point is to limit traffic in the city and offer cheap parking lots out of the city. The point stays in detouring the transit traffic out of the edge of the city centre. There are already plans for new traffic flow.

The fact is that Celje faces extremely unfavourable meteorological conditions (weak winds, temperature inversion), therefore the only solution is reduction of emissions. The data on air quality are displayed in city centre and accessible by phone and in a close future by web site. During the air pollution peaks, citizens are warned not to go out, and asked not to use motor vehicles.

It is of vital importance to first inform inhabitants of the city about air quality. The problem of air pollution should get more important role within city problems. The people should be properly informed and authorities should take more active role in promoting health and environmental friendly transport such as walking and cycling.

APHEIS program will encourage decision makers, policy makers to accelerate process to adopt new measures that will prevent and reduce air pollution in the city. The first important measure should be adoption of new local transport policy, more efficient control of certain industrial emission sources.

Exposure data

PM 10 Monitoring cite	*Type*
Celje center	Urban background

BS Monitoring cite	*Type*
Celje center	Urban background

Daily mean levels for year 2000 were:
- daily mean levels (SD) of BS were 13,6 µg/m^3
- daily mean levels (SD) of PM_{10} were 35,8 µg/m^3
- daily mean levels (SD) of $PM_{2,5}$ were 25,1 µg/m^3.

Data for $PM_{2,5}$ were converted from data for PM_{10} by conversion factor 0,7. For purpose of health impact assessment (long term calculation with data for PM_{10} and $PM_{2,5}$) we used conversion factor 1,3.

The levels of BS reached during 335 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 1,0 µg/m^3 and 47,0 µg/m^3.

The levels of PM_{10} reached during the 352 days with the lowest (5th percentile) the highest (95th percentile) levels were respectively 10,7 µg/m^3 and 70,3 µg/m^3.

The levels of $PM_{2,5}$ reached during the 352 days with the lowest (5th percentile) and the highest (95th percentile) levels were respectively 7,5 µg/m^3 and 49,2 µg/m^3.

Meteorological data were provided by Agency for Environment too. The data includes, on a daily basis minimum, mean, maximum temperature and relative humidity.

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

	Short term		**Long term**	
Air pollutant	**PM_{10} / BS**	**$PM_{2,5}$**	**PM_{10}**	**$PM_{2,5}$**
Number of days above	20 µg/m^3	14 µg/m^3	20 µg/m^3	15 µg/m^3
	284 / 66	**284**	**315**	**310**
Number of days above	50 µg/m^3	35 µg/m^3	40 µg/m^3	20 µg/m^3
	65 / 13	**65**	**188**	**264**

The levels of BS were much higher in the winter because of heating. Same parts of city still use for heating poor quality coal. The levels of PM_{10} and $PM_{2,5}$ correlate and there is no difference in pollution levels between summer and winter.

We do not expect any major changes in air pollutants levels in incoming years. Most of classical emission sources are already removed and not much improvement can be expected from this side. It all depends of new traffic policy.

Health data

National Institute of Public Health provides mortality and hospital admission data.

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

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	**1,53**	213,1
Cardiovascular mortality	390-459	I00-I99	**0,70**	96,9
Respiratory mortality	460-519	J00-J99	**0,18**	25,1
Cardiac hospital admissions	390-429	I00-I52	**1,32**	988,9
Respiratory hospital admissions	460-519	J00-J99	**1,94**	1452,7
Long term HIA				
All causes mortality	0-999	A00-Y98	**1,69**	234,3
Cardiopulmonary mortality	401-440 460-519	I10-I70 J00-J99	**0,85**	117,7
Lung cancer mortality	162	C33-C34	**0,09**	12,2

* For short and long term scenarios

Slight decrease of number of births expected. Independent research institutions do predict a slight decrease, but it also depends on number of newly come immigrants.

Health impact assessment

Different scenarios were used to evaluate short and long-term exposure to particulate pollution. In the city of Celje, these scenarios were built for three indicators of this particulate pollution: BS, PM_{10} and $PM_{2,5}$. Different tools and different estimates were used for evaluating the short- and long-term impacts of this particulate pollution on health.

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/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/m³ Reduction to 20 µg/m³ Reduction by 5 µg/m³
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/m³ Reduction to 15 µg/m³ Reduction by 3.5 µg/m³
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/m³ Reduction to 15 µg/m³ Reduction by 3.5 µg/m³
			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 PM_{10}, 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 in one year.

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 µg/m^3 on all days exceeding this value
- reduction of BS levels to a 24-hour value of 20 µg/m^3 on all days exceeding this value
- reduction by 5 µg/m^3 of all the 24-hour values of BS.

Short term HIA scenarios for PM_{10}

- **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 µg/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 µg/m^3 on all days exceeding this value (to allow for cities with low levels of PM_{10})
- reduction by 5 µg/m^3 of all the 24-hour values (to allow for cities with low levels of PM_{10})

- **Combined local and meta-analytic estimates for short-term HIA of PM_{10}**

We used the same scenarios than above and combined local and meta-analytic estimates to calculate the acute health effects of PM_{10} 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.

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 $PM_{2,5}$

We estimated chronic effects of $PM_{2,5}$ in the Celje 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 $\mu g/m^3$ [2]
- reduction of the annual mean value of $PM_{2,5}$ to a level of 15 $\mu g/m^3$ [2]
- reduction by 3,5 $\mu g/m^3$ in the annual mean value of $PM_{2,5}$ (to allow for cities with low levels of $PM_{2,5}$)

BS findings

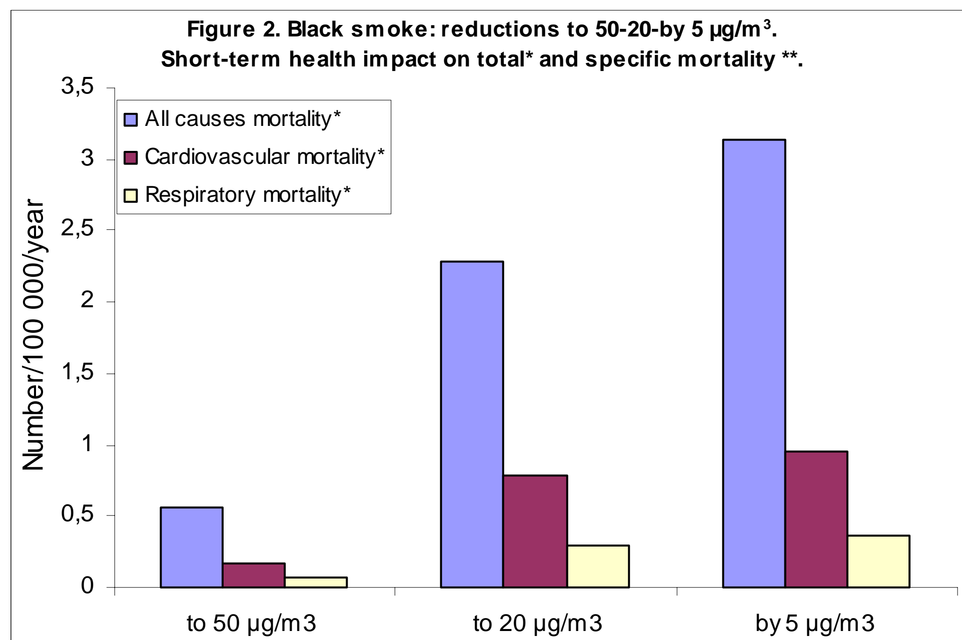
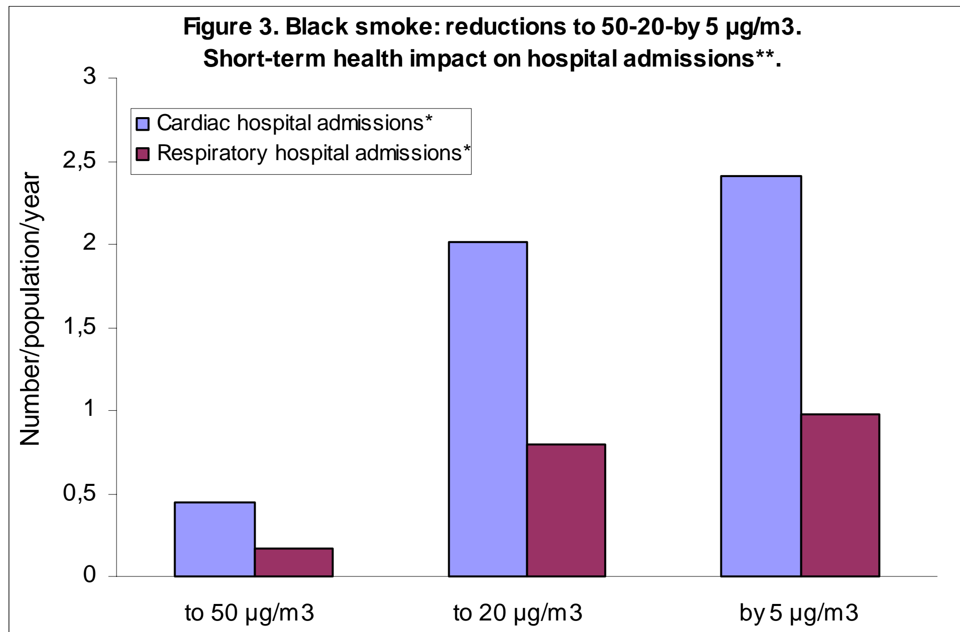


Figure 2. Black smoke: reductions to 50-20-by 5 µg/m³. Short-term health impact on total* and specific mortality **.

* All causes mortality excluding external causes (ICD9 < 800), cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).
** Black smoke data for 2000, mortality data for 2000.

Reduction of short term BS exposure by 5 µg/m^3 would be the most significant and would reduce total mortality by 3 persons, mortality due to cardiopulmonary diseases by approximately 1 person and mortality due to lung cancer by 0,4 person.



* Cardiac (ICD9 390-429) and respiratory hospital admissions (ICD9 460-519).
** Black smoke data for 2000, hospital admissions data for 2000.

Again, reduction of short term BS exposure by 5 µg/m^3 would be the most significant and would reduce cardiac hospital admissions by 2,4 person and respiratory hospital admissions by 1 person.

PM_{10} findings

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

1.1. Mortality findings

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).

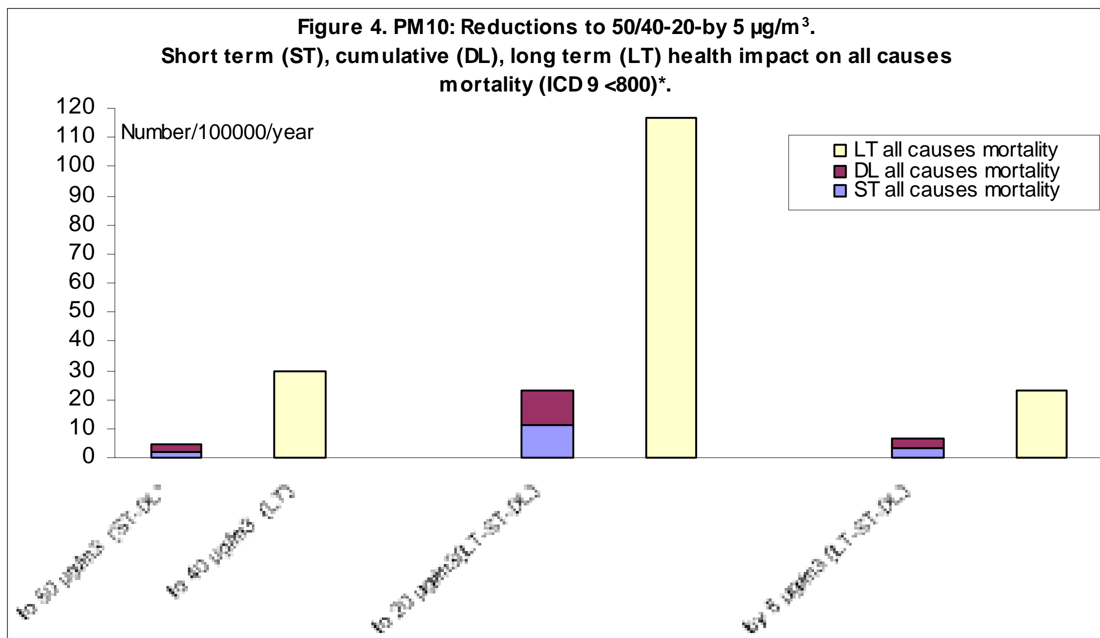


Figure 4. PM10: Reductions to 50/40-20-by 5 µg/m³. Short term (ST), cumulative (DL), long term (LT) health impact on all causes mortality (ICD 9 <800)*.

* PM_{10} data for 2000, mortality data for 2000

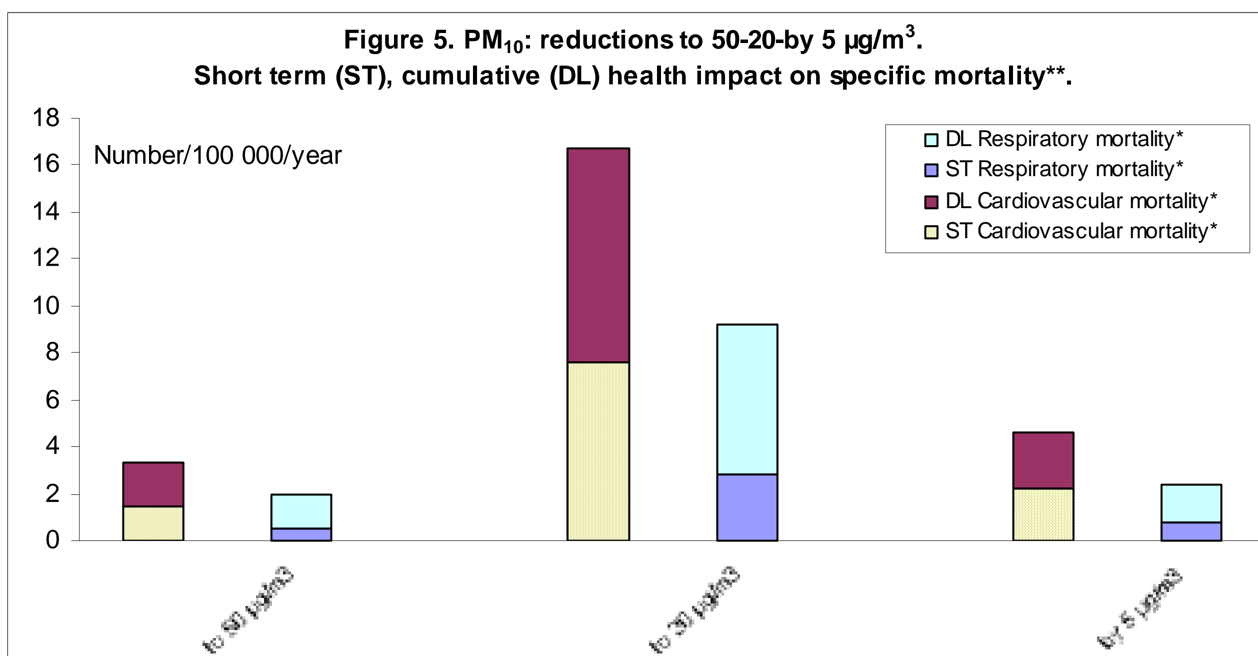


Figure 5. PM_{10}: reductions to 50-20-by 5 µg/m³. Short term (ST), cumulative (DL) health impact on specific mortality.**

* Cardiovascular mortality (ICD9 390-459), respiratory mortality (ICD9 460-519).
** PM_{10} data for 2000, mortality data for 2000.

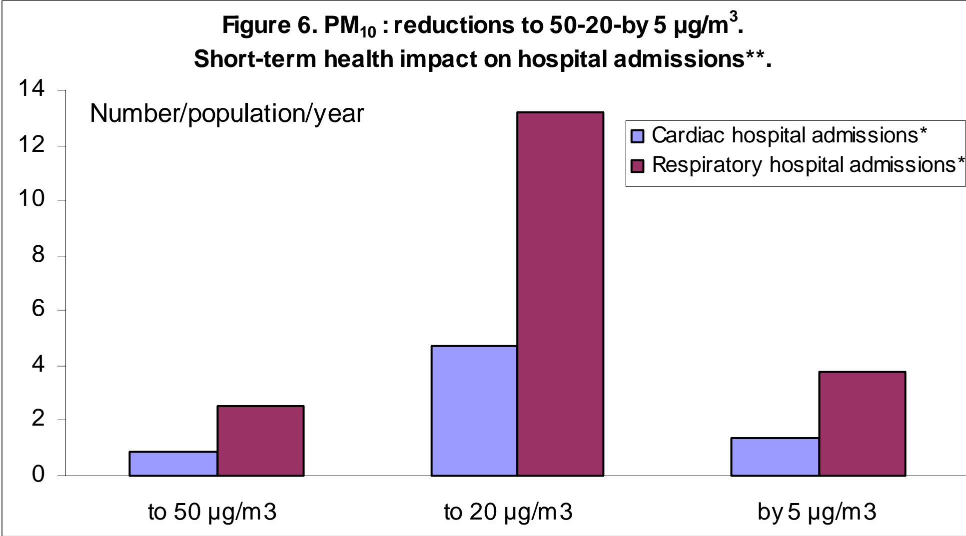
There is a difference in attributable cases between LT, ST and DL for PM_{10} on mortality. It seems that larger effect can be evenly ascribed to short and long term exposure. The effect is most pronounced in medium exposure. Thus it would most effective to reduce PM_{10} to 20 µg/m³. Benefits of reducing are most clearly shown when studying long term (LT) health impact on all causes mortality: reduction to the levels of 20 µg/m³ would reduce total mortality in Celje by 117 deaths. The same reduction would reduce total mortality by 11 in case of short term health impacts and by 23 in case of cumulative health impacts.

Cumulative (DL) health impacts on all causes mortality and on specific mortalities are all approximately two times higher than short term (ST) assessments. Reduction of short term

PM_{10} exposure to 20 µg/m^3 would reduce mortality due to cardiovascular diseases by 8 persons and mortality due to respiratory diseases by approximately 3 persons. In cumulative case reduction to 20 µg/m^3 would reduce mortality due to cardiovascular diseases by 17 persons and mortality due to respiratory diseases by more than 9 persons.

1.2. Hospital admissions findings

We estimated the acute effects of short-term exposure to PM_{10} on cardiac and respiratory hospital admissions over one year.



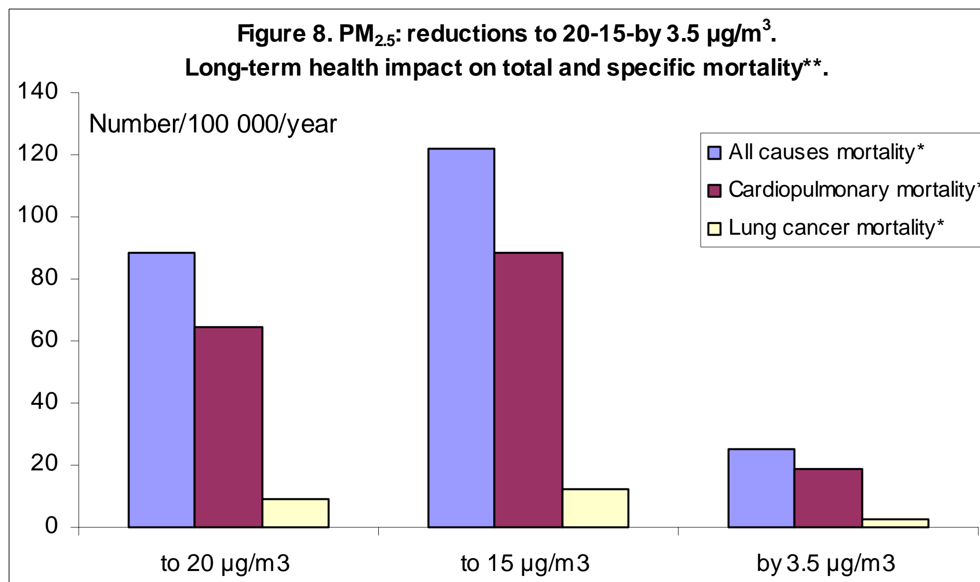
* Cardiac (ICD9 390-429) and respiratory hospital admissions (ICD9 460-519)
** PM10 data for 2000, mortality data for 2000

Reduction to 20 µg/m^3 would mean a significant reduction of hospital admissions in Celje: by 5 patients in case of cardiac and by 13 patients in case of respiratory hospital admissions.

$PM_{2,5}$ 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).
** $PM_{2,5}$ data for 2000, mortality data for 2000

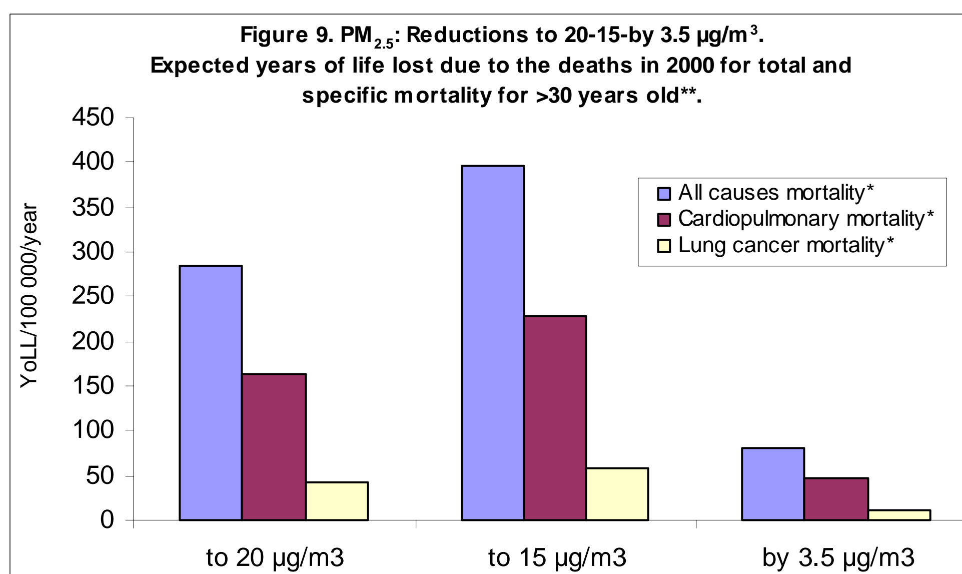
Reduction of long term $PM_{2,5}$ exposure to 20 $\mu g/m^3$ would reduce total mortality by 88 persons, mortality due to cardiopulmonary diseases by 65 persons and mortality due to lung cancer by 9 persons.

Reduction of long term $PM_{2,5}$ exposure to 15 $\mu g/m^3$ would reduce total mortality by 122 persons, mortality due to cardiopulmonary diseases by 89 persons and mortality due to lung cancer by 13 persons.

Reduction of long term $PM_{2,5}$ exposure by 3,5 $\mu g/m^3$ would reduce total mortality by 25 persons, mortality due to cardiopulmonary diseases by 19 persons and mortality due to lung cancer by 3 persons.

2. Years of life lost

We estimated the years of life lost attributable to the chronic effects of PM2,5 using the data for year 2000. Figure 9 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 Celje.



* 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 2000

For all causes of deaths, all other things being equal, reduction of $PM_{2,5}$ by 3,5 $\mu g/m^3$ in 2000 would save around 80 years of expected life in people older than 30 years in the city of Celje. For cardiopulmonary mortality, this number would be around 46 and for lung cancer mortality 12 years.

For all causes of deaths, all other things being equal, reduction of $PM_{2,5}$ to 15 $\mu g/m^3$ in 2000 would save 397 years of expected life in people older than 30 years in the city of Celje. For cardiopulmonary mortality, this number would be around 227 and for lung cancer mortality 57 years.

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 $\mu g/m^3$ in Celje.

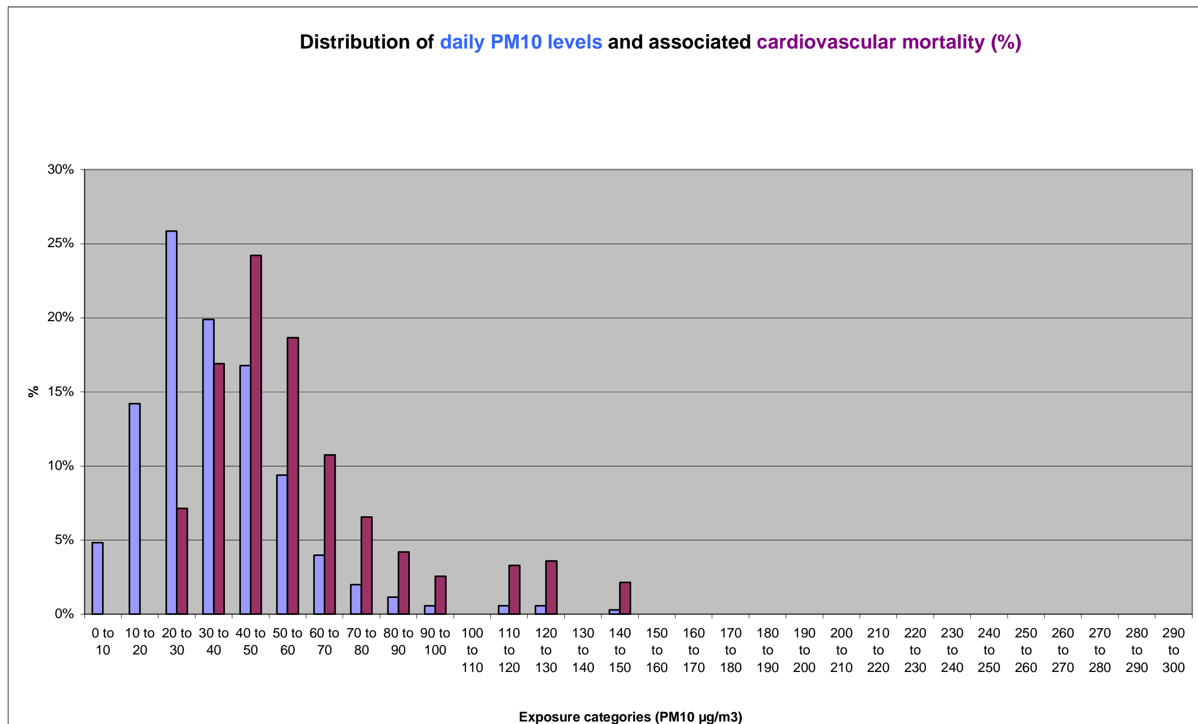
		Expected gain in life expectancy		
Age	Life expectancy	Mean	Low estimate	High estimate
At birth	73,15	1,04	0,27	1,81
30	44,70	1,07	0,28	1,86
65	14,48	0,76	0,20	1,33

In terms of life expectancy, all other things being equal, if annual mean $PM_{2,5}$ levels (25,1 $\mu g/m^3$) would be reduced to 15 $\mu g/m^3$, almost 45 years of life expectancy in a person of 30 years old would be increased by approximately one year, due to reduced risk of death from all causes in the city of Celje. And approximately 15 years of life expectancy in a person of 65 years old would be increased by almost one year.

Interpretation of findings

Relative importance of air pollution peaks during a few days compared to daily exposure to lower levels of air pollution over longer periods have much larger impact on mortality.

Short term distribution of PM10 levels and associated percentage of cases



General comments

Imposing a ban on traffic in city centre and going for electrification of public transport are ideas already in place long time. The main obstacles to realize them is usually lack of money and nonreadiness – even of responsible stakes to give up personal transport – cars.
The stakes are members of City council and public. Public Health Sector is asked to prepare a health assessment of present levels of air pollution. From this respect APHEIS program is extremely valuable. APHEIS program results are presented to members of city council to all decision makers and their advisors. They were given a very comprehensive information, a full APHEIS report.

At local level which is really the most important a network of cycling paths will be more extensively planned. There is a kind of reluctance about imposing ban on traffic in city centre. I did not get right answer why this is like that. The information was given on to services that usually do planning and development and to general public. While the information was presented to city council media was in place The access to information is given to anybody. The quality of information was never questioned by anybody. Information about air pollution and health impact was fully accepted and considered scientific.

There is aim to inform all the relevant stakeholders and get involved as much of interested public as possible.

Conclusions

We intend to run on Apheis surveillance system and inform stakeholders and public about our findings. City air pollution policy should follow recommendations and findings. We would you like to develop Apheis communications tools if Apheis develop the appropriate templates. We would certainly well come HIA developments of water pollution and noise pollution programs and would you like to include them in the future besides air pollution.

Appendix

1. **Add the questionnaires for your city on the exposure measurement methods and health data**

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) (2000). Potential benefits of reducing daily BS 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 BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m^3	66	1,26	0,84	1,90	2,28	1,71	3,88
50 µg/m^3	13	0,27	0,18	0,41	0,56	0,37	0,84
By 5 µg/m^3	NA*	1,53	1,02	2,29	3,13	2,09	4,69

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (2000). Potential benefits of reducing daily BS 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 effect of BS

		Attributable cases per year					
Scenarios	Number of days per year exceeding 20 and 50 µg/m^3	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
20 µg/m^3	66	0,38	0,19	0,67	0,78	0,39	1,37
50 µg/m^3	13	0,08	0,04	0,14	0,17	0,08	0,29
By 5 µg/m^3	NA*	0,46	0,23	0,81	0,95	0,48	1,66

**NA: not applicable*

Table 3. **Respiratory deaths (ICD9 460-519) (2000). Potential benefits of reducing daily BS 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 BS**

		Attributable cases per year					
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**	**N° of deaths per 100 000 central**	**N° of deaths per 100 000 lower**	**N° of deaths per 100 000 upper**
20 µg/m^3	66	0,15	-0,05	0,38	0,30	-0,10	0,77
50 µg/m^3	13	0,03	-0,01	0,08	0,07	-0,02	0,17
By 5 µg/m^3	NA*	0,18	-0,06	0,45	0,37	-0,12	0,92

**NA: not applicable*

Table 4. **Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2000). Potential benefits of reducing daily BS 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 (95% confidence limits) attributable to the acute effects of BS**

		Attributable cases per year		
Scenarios	**Number of days per year exceeding 20 and 50 µg/m^3**	**N° of deaths central**	**N° of deaths lower**	**N° of deaths upper**
Hospital admissions for cardiac diseases (all ages)				
20 µg/m^3	66	2,01	0,73	3,52
50 µg/m^3	13	0,44	0,16	0,77
By 5 µg/m^3	NA*	2,41	0,88	4,15
Hospital admissions for respiratory diseases (all ages)				
20 µg/m^3	66	0,79	-0,39	2,00
50 µg/m^3	13	0,17	-0,08	0,43
By 5 µg/m^3	NA*	0,97	-0,49	2,43

**NA: not applicable*

3. Tables for PM_{10} findings

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

Tables 1, 2, 3 present the attributable number of all causes, cardiovascular and respiratory deaths expressed as absolute numbers and as rates per 100 000 inhabitants. Table 4 presents the results for cardiac and respiratory hospital admissions.

Table 1. Deaths all causes (ICD9 < 800) (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	284	5,48	3,65	7,33	11,20	7,45	14,98
50 µg/m^3	65	1,04	0,69	1,39	2,13	1,42	3,85
By 5 µg/m^3	NA*	1,59	1,06	2,11	3,24	2,16	4,32

**NA: not applicable*

Table 2. Cardiovascular deaths (ICD9 390-459) (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	284	3,74	2,06	5,43	7,63	4,22	11,09
50 µg/m^3	65	0,72	0,40	1,04	1,47	0,81	2,13
By 5 µg/m^3	NA*	1,07	0,60	1,55	2,19	1,22	3,16

**NA: not applicable*

Table 3. Respiratory deaths (ICD9 460-519) (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	284	1,40	0,53	2,28	2,85	1,08	4,66
50 µg/m^3	65	0,27	0,10	0,44	0,55	0,21	0,91
By 5 µg/m^3	NA*	0,40	0,15	0,64	0,81	0,31	1,30

**NA: not applicable*

Table 4. Cardiac (ICD9 390-429) and respiratory (ICD9 460-519) hospital admissions (2000). Potential benefits of reducing daily PM_{10} levels (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 (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
Hospital admissions for cardiac diseases (all ages)				
20 μg/m^3	284	4,73	2,36	7,13
50 μg/m^3	65	0,90	0,45	1,36
By 5 μg/m^3	NA*	1,37	0,68	2,05
Hospital admissions for respiratory diseases (all ages)				
20 μg/m^3	284	13,19	7,12	19,47
50 μg/m^3	65	2,55	1,38	3,77
By 5 μg/m^3	NA*	3,75	2,04	5,49

**NA: not applicable*

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

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

Table 5. Cumulative health effects of 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	284	11,20	7,35	15,06	22,89	15,02	30,77
50 μg/m^3	65	2,17	1,42	2,92	4,44	2,91	5,97
By 5 μg/m^3	NA*	3,18	2,10	4,24	6,49	4,29	8,67

**NA: not applicable*

Table 6. Cumulative health effects of PM_{10} up to 40 days and cardiovascular deaths (ICD9 390-459) (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	284	8,16	5,71	10,66	16,68	11,68	21,78
50 µg/m^3	65	1,62	1,13	2,12	3,31	2,31	4,32
By 5 µg/m^3	NA*	2,26	1,60	2,93	4,62	3,27	5,98

**NA: not applicable*

Table 7. Cumulative health effects of PM_{10} up to 40 days and respiratory deaths (ICD9 460-519) (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	284	4,50	1,12	8,34	9,20	2,28	17,05
50 µg/m^3	65	0,96	0,24	1,78	1,96	0,48	3,64
By 5 µg/m^3	NA*	1,16	0,30	2,04	2,38	0,62	4,16

**NA: not applicable*

3.4. **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					
	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	57,1	34,0	82,2	116,6	69,5	167,9
40 µg/m^3	14,7	8,9	20,8	30,0	18,2	42,5
By 5 µg/m^3	11,2	6,8	15,9	23,0	13,9	32,4

4. Tables for PM2,5 findings

4.1. LT PM2,5: Attributable Cases

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

Table 1. Deaths all causes (ICD9 0-999) (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 PM2,5.

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	59,6	15,0	107,9	121,7	30,7	220,4
20 µg/m^3	43,3	11,0	77,5	88,4	22,5	158,3
By 3,5 µg/m^3	12,36	3,22	21,7	25,3	6,57	44,3

Table 2. Cardiopulmonary deaths (ICD9 401-440 and 460-519) (2000). Potential benefits of reducing annual mean values of PM2,5 (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 PM2,5.

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	43,3	14,9	74,8	88,5	30,5	152,9
20 µg/m^3	31,7	11,1	53,9	64,8	22,6	110,1
By 3,5 µg/m^3	9,17	3,29	15,19	18,74	6,73	31,03

Table 3. Lung cancer deaths (ICD9 162) (2000). Potential benefits of reducing annual mean values of PM2,5 (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 PM2,5.

	Attributable cases per year					
	N° of deaths central	N° of deaths lower	N° of deaths upper	N° of deaths per 100 000 central	N° of deaths per 100 000 lower	N° of deaths per 100 000 upper
15 µg/m^3	6,15	1,95	11,02	12,56	3,98	22,5
20 µg/m^3	4,54	1,47	7,95	9,27	3,00	16,25
By 3,5 µg/m^3	1,34	0,45	2,25	2,73	0,92	4,59

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 one year (ICD9 0-999) (2000). Potential benefits of reducing annual mean values of PM2,5 (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 PM2,5.

	Years of life lost					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m³	194,04	51,63	332,44	396,47	105,50	679,23
20 µg/m³	139,67	37,02	240,26	285,37	75,64	490,90
By 3,5 µg/m³	39,17	10,31	67,88	80,04	21,06	138,70

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 PM2,5 (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 PM2,5.

	Years of life lost					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m³	111,25	41,53	176,78	227,31	84,85	361,19
20 µg/m³	80,41	29,76	128,88	164,30	60,80	263,32
By 3,5 µg/m³	22,71	8,28	36,98	46,40	16,91	75,55

Table 3. Lung cancer deaths >30 years, male and female, for one year (ICD9 162) (2000). Potential benefits of reducing annual mean values of PM2,5 (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 PM2,5.

	Years of life lost					
	YoLL central	YoLL lower	YoLL upper	YoLL per 100 000 central	YoLL per 100 000 lower	YoLL per 100 000 upper
15 µg/m³	28,18	10,30	43,69	57,57	21,05	89,26
20 µg/m³	20,46	7,34	32,32	41,81	14,99	66,04
By 3,5 µg/m³	5,83	2,02	9,54	11,92	4,12	19,49