HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

LOCAL CITY REPORT

Budapest

Summary of main findings for Budapest

In 2001- the PM_{10} annual mean (SD) was 22(11) µg/m^3, above the 1999/30/EC Directive limit value for 2010 (20 µg/m^3), and below that established for 2005 (40 µg/m^3). For the summer period of the same year, the mean (SD), P5 (5th percentile) and P95 of the maximum daily 8-hour moving average concentration of ozone (O_3) were 74(21), 42 and 113 µg/m^3.

Regarding children, infant mortality in Europe is quite low and consequently, the expected attributable number of deaths related to air pollution is also very low. All other things being equal, the reduction of the annual average levels of PM_{10} to 20 µg/m^3 would prevent 0.93 total postneonatal deaths.

As far as short-term effects of O_3 in summer are concerned, all other things being equal, each reduction by 10 µg/m^3 of the daily maximum 8-hour moving average concentrations would delay 35.1deaths per year in the general population in the study area, 26.9 from cardiovascular diseases, and 3.7 from respiratory causes.

Summary of HIA of outdoor air pollution in Budapest in ENHIS-1

Health outcome	Population	Pollutant	Period	Mean type	RR (for 10 µg.m^3 increase)	*References*	Number of attributable cases by scenario[1]	
Mortality							**Ozone: Reduction by 10 µg.m^3**	**PM10: Reduction by 5 µg/m^3**
Total mortality excluding external causes (ICD9 < 800 - ICD10 A00-R99)	All ages	O_3 8h max	Summer[2]	Daily	1.0031 (1.0017-1.0052)	Gryparis et al 2004	35.1	
Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99)					1.0046 (1.0022-0.0073)		26.9	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		3.7	
Total postneonatal mortality	1 month- 1 year	Corrected PM_{10}[3]	Year	Annual	1.048 (1.022-1.075)	Lacasaña et al 2005		2.13
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.216 (1.102-1.342)			0.19
Postneonatal Sudden Infant Death Syndrom Mortality (ICD9 798.0 - ICD10 R95)					1.12 (1.07-1.17)	Woodruff 1997		0.06
Morbidity								
Emergency room visits for asthma (ICD-9 codes 493, ICD-10 codes J45, J46)	< 18 years	O_3 1h max	Year	Daily	1.0115 (1.0067-1.0163)	CARB 2004	not available	
Cough	< 18 years	Measured PM_{10}			1.0407 (1.0202-1.0511)	Ward and Ayres 2004		not available
Lower respiratory symptoms LRS	< 18 years	Measured PM_{10}			1.0407 (1.0202 -1.617)	Ward and Ayres 2004		not available
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	< 15 years	Measured PM_{10}			1.010 (0.998-1.021)	Anderson et al 2004		not available
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	15 - 64 years	**O_3 8h max**	Summer		1.001 (0.991-1.012)		not available	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	> 64 years				1.005 (0.998-1.012)		not available	

[1] For ozone: absolute reduction by 10 µg/m^3. For PM_{10} absolute reduction by 5 µg/m^3.

[2] Definition of summer period : 01 April – 30 September

[3] PM_{10} reference papers for HIA on postneonatal mortality use gravimetric methods to measure PM_{10}. If the local air quality network uses automatic methods (TEOM or other) a correction factor is required to compensate for loss of volatile compounds: if available, a local correction factor recommended by the air quality network or, by default, the European factor 1.3.

- Introduction

The mean particulate matter concentration showed a decreasing tendency, in 1992 TSP concentration started from 71 µg/m^3, in 1997 it was 58 µg/m^3, in 1998 it decreased to 51 µg/m^3. This decrease was partly due to the decreasing tendency of particulate emissions of industrial origin. The major source of air pollution in Budapest is nowadays traffic, especially heavy trucks and also private cars. Public transportation is very well developed, but only approximately 80% of the buses are environmental friendly (catalysers and no diesel engines). There was no significant improvement in the electronically driven public vehicles in the last 15 years, and no new metro lines were built joining the outskirts to the city centre.

There are medium and long term plans to improve the structure of transport in Budapest, the building of the new metro line joining West and East outskirts of Buda and Pest will start in 2 years. A new bridge over the Danube between the West and East part of the M0 highway will be built in the near future.

The overall mortality of adult population is very high in Hungary as well as in **Budapest**, the leading causes are cardiovascular (687.7 /100 000 in 2001 in Budapest) and cancer mortality (395.9/100 000). Respiratory mortality was very low (40.0/100 000). Infant mortality was 880/100 000, the main causes were related to perinatal complications, are inborn errors, deformations and chromosomal aberrations. Respiratory diseases as death causes, as well as sudden infant death were very rare.

Budapest took part in the previous APHEIS studies. The results of the health impact assessment based on the air quality data of 1999 showed the benefits of reducing particulate matter exposure. Although the PM_{10} yearly mean concentration was 29.5 ug/m^3, and on 289 days it exceeded 20 µg/m^3, and this was associated with more than 170 excess of short-term deaths per year that could be prevented. The benefits were much higher for long-term exposure to PM_{10}. It was shown that even a PM_{10} reduction of 5µg/m^3 would lead to a decrease in the number of long-term deaths by more than 500 per year, of which more than 80 were short-term deaths.

The results of the 2nd APHEIS study showed that PM_{10} pollution did not decrease in the year 2000 compared to the previous year, but the number of days when PM_{10} concentration exceeded short-term vs. long-term limit values were somewhat less (284 days vs. 289 days in 1999). The average concentration of classical chemical pollutants showed a constant decrease from 1992 to 2000. The strongest decrease was observed in the case of NO_2 and particulate matter.

The health impact assessment using air quality data of the years 2000 estimated that reduction of the long-term PM pollution to the levels of $PM_{2.5}$ of 15 µg/m3 would reduce mortality in Budapest by 1702,7 deaths in one year, which would save 421 years of expected life for starting year of simulation. If the daily means of PM_{10} would be kept under 20 µg/m^3, 146,2 deaths and 292,4 cardiac hospital admissions could have been avoided in the year 2000.

The health impact assessment was carried out according to the description in the main part of the report. In Budapest TSP was measured by 8 on-line stations. PM_{10} was calculated by conversion: using 0.58 as local conversion factor. O_3 concentration was calculated as the mean of 2 online stations.

In the health impact assessment we analysed the effects of PM_{10} on postneonatal mortality (total and respiratory mortality and Sudden Infant Death Syndrome). We could not assess the impact on morbidity because of the lack of data availability. The impact of exposure to ozone on premature mortality (total, respiratory and cardiovascular mortality) in the general population was also carried out.

- This work has been carried out within the framework of work package WP5 on health impact assessment of ENHIS-1 project (www.enhis.net).

Sources of air pollution

Principal sources of air pollution were described in detail in the Apheis2 city report (www.apheis.org). This is an update of the main sources of air pollution:

Main sources of air pollution				
Source (year)	**Road (%)**	**Heating (%)**	**Industry (%)**	**Other sources (%)**
2000	18	33	44	5

Exposure data

The classical air pollutants were monitored by the Municipal Institute of Public Health Service, Capital Budapest. The network of online monitoring system was established in 1992. It consisted of eight stations, 5 out of them measured residential-commercial type pollution, three measured residential type of pollution. Each station measured TSP, the average of the concentration of the eight stations was used in this analysis.

TSP was monitored by eight on-line automatic stations (the method of measurement was beta-ray). SO2, NO2, CO were measured by eight automatic stations, and O3 was measured by two automatic stations. The methods of measurement were UV fluorescence (SO2), chemilumniscence (NO2), infrared rays spectrometry (CO) and O3 UV absorption.

Air pollution network is given in the table below.

	List of monitoring stations	Station type	type of zone	characteristic
1	Laborc street	background	urban	residential
2	Szena square	traffic	urban	residential/ commertial
3	Déli street	industrial	urban	residential/ commertial
4	Baross Square	traffic	urban	residential/ commertial
5	Kosztolanyi Square	traffic	urban	residential/ commertial
6	Erzsebet Square	traffic	urban	residential/ commertial
7	Gergely Square	background	urban	residential
8	Ilosvai Square	background	urban	residential

PM_{10}: daily exposure indicator has been calculated as the arithmetic mean of the daily concentrations of the stations.

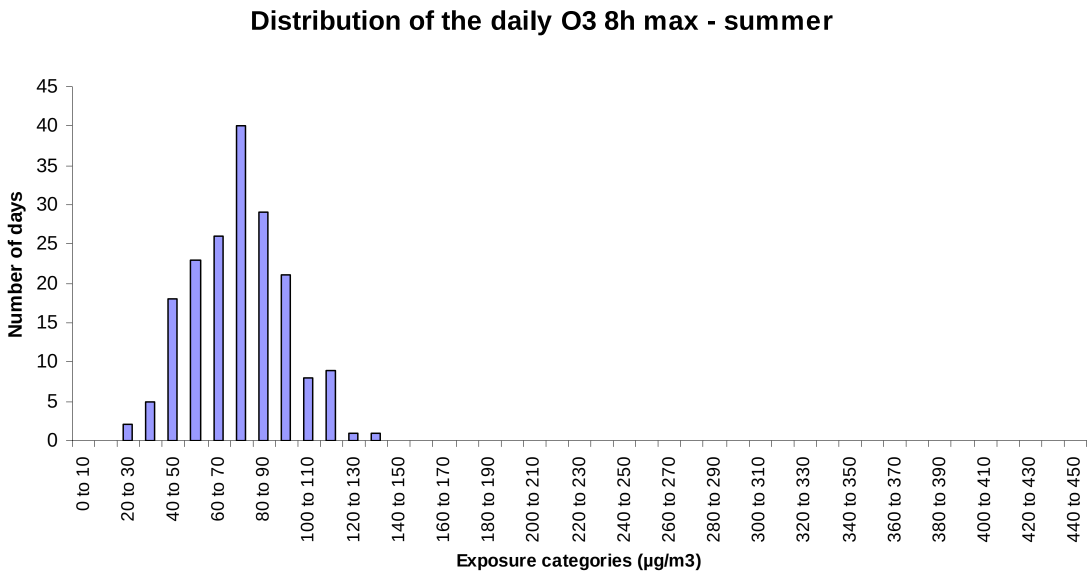
Ozone: The daily maximum 1-hour indicator has been calculated as the arithmetic mean of the 1-hour maximum of the stations. The daily maximum 8-hour moving average of each day have been calculated as the arithmetic mean of the maximum 8-hour moving averages of the stations for the summer period (1st April to 30th September) .

AP data description: The annual mean level (SD) of PM_{10} in Budapest was 22(11) µg/m^3, and P5 and P95 of the daily mean values were, respectively, 10 µg/m^3 and 43 µg/m^3. The mean (SD) , P5 and P95 of the daily maximum 8-hour moving average concentrations of O_3 were, respectively, 74(21), 42 and 113 µg/ m^3, and those of the daily maximum 1-hour concentrations 58(29), 17 and 107 µg/m3 (Table 1 and figures 1-3)

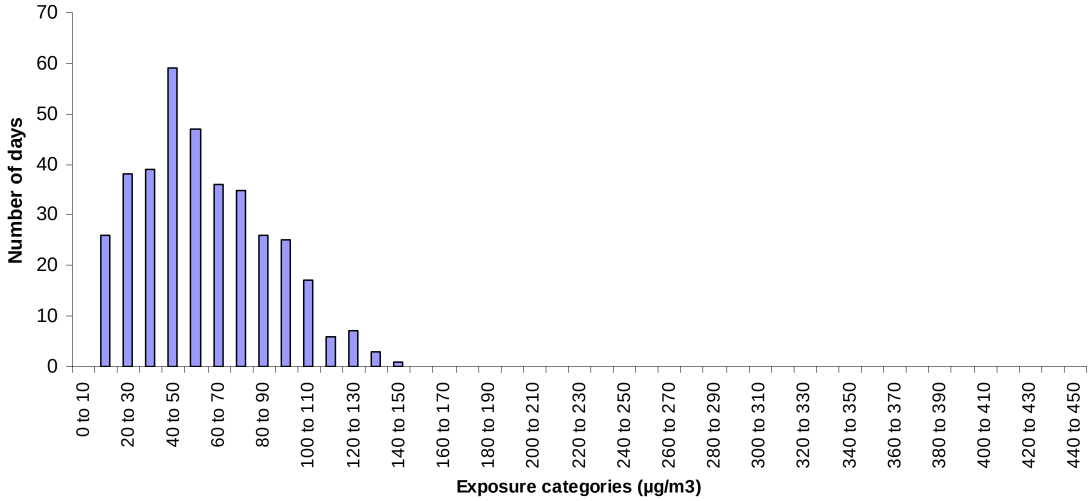
In Budapest the 8 hour maximum of 03 concentration is almost normally distributed, the concentration was between 60-70µg/m^3 in the majority of the days in summer. Concentration more than 130µg/m^3 was measured only on 1 day. As regards the daily 1 hour maximum O3 concentration it was between 40-60µg/m^3 in 60 days, there were only 1-2 days over 120µg/m^3. As regards PM_{10} concentration, it fell between 10-20 ug/mg3 in 160 days, there were around 10 days when PM_{10} was over the limit value.

Table 1. Descriptive statistics for ozone and PM_{10} levels in Budapest, 2001

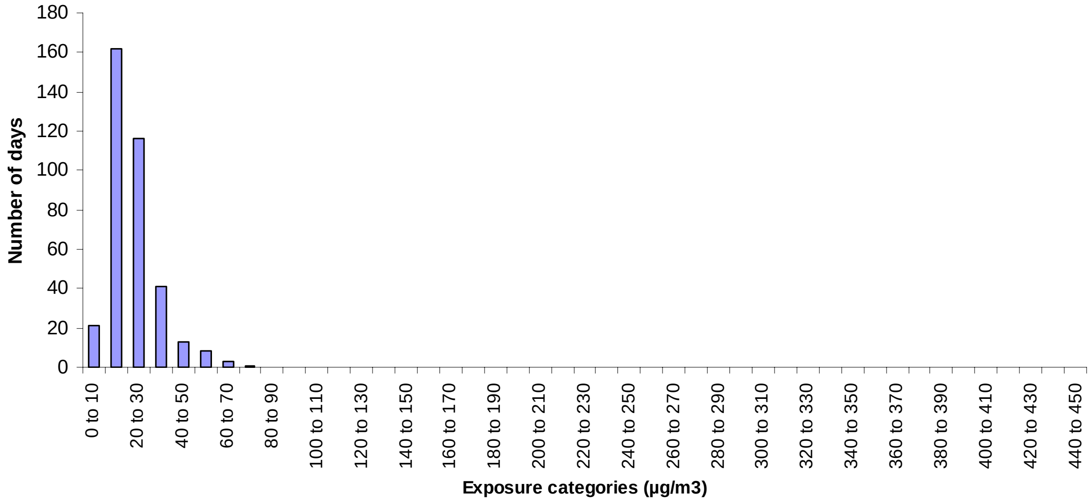
	O3 8h - summer	O3 1h max - year	PM10 - year
Number	183	365	365
Minimum	27	11	6
Percentile 5	42	17	10
Percentile 25	59	36	15
Median	75	54	20
Percentile 75	89	79	26
Percentile 95	113	107	43
Percentile 98	117	127	55
Maximum	140	149	72
Daily mean	74	58	22
standard error	21	29	11
% missing values	0	0	0



Distribution of the daily O3 1h max - in Budapest area, 2001 summer



Distribution of the daily PM 10 - in Budapest area, 2001



Health data

The mortality data were gained from the Central Statistical Office for the year 2001 for the permanent inhabitants of Budapest, died in the capital. The data are 100% complete, there is a manual control concerning coding at the Central Statistical Office. ICD10 is used for coding the death cases. Morbidity data were not analyzed because of the lack of standardized central data collection system for emergency room visits and the lack of coding emergency hospital admissions in the database.

In Budapest, the number of postneonatal death due to respiratory diseases was very low, 2 cases, which equaled 14.4 /100 000. Sudden infant death occurred only in one case. The mortality of the total population is very high among European cities, the daily mean number was 63.1 cases. More than half of the total mortality was due to cardiovascular diseases, and the underlying cause was respiratory disease only in 3% of the cases. It should be mentioned that this phenomena can partly be explained by coding habits.

Table 2. Descriptive statistics for health outcomes in Budapest, 2001

Health outcome	ICD9	ICD10	Annual deaths	Annual rate (per 100 000)	Daily mean (SD)	Daily rate (per 100 000)	Annual incidence rate (per 100 000)
POSTNEONATAL MORTALITY							
Total			92	663.6			
Respiratory *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	2	14.4			
Sudden infant death syndrome *ICD9 798.0 – ICD10 R95*	798.0	R95	1	7.2			
GENERAL POPULATION MORTALITY							
Total mortality all causes *ICD9 <800 ICD10 A00-R99*	<800	A00-R99			63.1(9.0)	3.6	
Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99*	390-459	I00-I99			32.9(6.4)	1.9	
Respiratory mortality *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99			1.9(1.4)	0.1	
MORBIDITY							
Cough					not available		
Lower respiratory symptoms LRS					not available		
Emergency room visits for asthma - Age < 18 years *ICD9 493, ICD10 J45 J46*	493	J45-J46			not available not available	not available not available	
Hospital respiratory admissions - Age < 15 years *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99					not available
Hospital respiratory admissions - Age 15 -64 years	460-519	J00-J99					not available
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99					not available

Health Impact Assessment

Methodology

Health impact of air pollution (AP) has been calculated as the annual number of health events attributable to AP in the target population. A causal relationship between AP and the effects is assumed, and therefore HIA can only be performed for those outcomes with sufficient evidence of causality. Once the effects with sufficient evidence of causal relationship with AP have been determined, the next step is to find the best exposure-response functions (ERFs) for each of the selected outcomes. Table 3 shows the result of a systematic review on these issues carried out by the Bilbao Apheis team[1] for WP5 of ENHIS-1. This table summarizes the health outcomes and ERFs deemed suitable for HIA according to the criteria established by WP5 with the advice of the air pollution experts of WP5[2].

[1] Cambra K, Alonso E, Cirarda FB, Martínez-Rueda T. Bilbao APHEIS group. Selection of outcomes and exposure response functions for health impact assessment of particles and ozone. Review of the evidence. ENHIS project. WORK PACKAGE 5. Bilbao, February 2005. Http:

[2] Ferran Ballester: Valencian School of Health Studies, Valencia, Spain; Sylvie Cassadou: National Institute of Public Health Surveillance, InVS, Toulouse, France; Fintan Hurley: Institute of Occupational Medicine, Edinburgh, Scotland, UK; Nino Künzli: University of Southern California, Division of Occupational and Environmental Health, Los Angeles, CA, USA; Odile Meckel: Institute of Public Health NRW (LOEGD), Bielfeld, Germany; Hans-Guido Mücke: WHO Collaborating Center (Air)-Federal

Table 3. Health outcomes and Exposure-response functions (ERFs) selected for health impact assessment

	OUTCOME	POLLUTANT	ERFs	ORIGINAL SOURCE
CHILDREN - PARTICLES				
	Total postneonatal mortality (1 month-1 year)	PM_{10} Annual Mean	RR=1.048 (1.022-1.075) ↑10μg/m^3	Lacasaña et al 2005
	Postneonatal respiratory mortality ICD9 460-519 ICD10 J00-J99	PM_{10} Annual Mean	RR=1.216 (1.102-1.342) ↑10μg/m^3	Lacasaña et al 2005
	Postneonatal Sudden Infant Death Syndrome (SIDS) mortality (normal birth weight ≥2500g) ICD9 798.0 –ICD10 R95	PM_{10} Annual Mean	Adjusted Odds Ratio AOR=1.12 (1.07-1.17) ↑10μg/m^3	Woodruff et al. 1997
	Cough	PM_{10} Daily Mean	OR=1.041 (1.020-1.062) ↑10μg/m^3	Ward & Ayres 2004
	Lower respiratory symptoms LRS	PM_{10} Daily Mean	OR=1.041 (1.020-1.051) ↑10μg/m^3	Ward & Ayres 2004
CHILDREN – OZONE				
	Emergency room visits for asthma <18 Y ICD9 493, ICD10 J45 J46	Ozone Maximum 1 h	RR=1.0116 (1.0067-1.0165) ↑10μg/m^3	CARB 2004
ADULTS/GENERAL POPULATION				
	Total mortality all causes ICD9 <800 ICD10 A00-R99	Ozone Maximum 8 h Summer	RR= 1.0031 (1.0017-1.0052) ↑10μg/m^3	Gryparis et al 2004 (APHEA 2)
	Respiratory mortality ICD9 460-519 ICD10 J00-J99	Ozone Maximum 8 h Summer	RR= 1.0113 (1.0074-1.0151) ↑10μg/m^3	Gryparis et al 2004 (APHEA 2)
	Cardiovascular mortality ICD9 390-459 ICD10 I00-I99	Ozone Maximum 8 h Summer	RR= 1.0046 (1.0022-1.0073) ↑10μg/m^3	Gryparis et al 2004 (APHEA 2)

To be coherent with mortality findings, it was decided, with the experts' advice, to include RRs of hospital admissions in the health impact assessment calculations, even if they were not statistically significant. More concretely, it was decided that if there was not any new RR published by the time of making the calculations, the RRs for respiratory hospital admissions from Anderson's meta-analysis could be used, although they were not statistically significant (see Table 2). The rationale for that is that if there is sufficient evidence to accept a causal relationship between air pollution and respiratory mortality -both in children-PM and adults-O_3- we should easily accept that there will also be an impact on hospital admissions.

Table 4. Complementary Exposure-response functions (ERFs) for health impact assesment on respiratory hospital admissions for children (particles) and adults (ozone)

	OUTCOME	POLLUTANT	RR	SOURCE
CHILDREN - PARTICLES				
	Respiratory hospital admissions 0-14 Y ICD9 460-519 ICD10 J00-J99	*PM_{10}* Daily Mean	*RR= 1.010 (0.998-1.021) ↑10μg/m^3*	*Anderson 2004*
ADULTS/GENERAL POPULATION				

Environmental Agency, Berlin, Germany; Nikolaos Stilianakis: Institute for Environment and Sustainability, European Commission – JRC, Ispra, Italy.

	Hospital respiratory admissions 15-64 Y ICD9 460-519 ICD10 J00-J99	*Ozone Maximum 8 h*	*RR=1.001 (0.991-1.012) ↑10µg/m³*	*Anderson et al 2004*
	Hospital respiratory admissions >64 Y ICD9 460-519 ICD10 J00-J99	*Ozone Maximum 8 h*	*RR=1.005 (0.998-1.012) ↑10µg/m³*	*Anderson et al 2004*

Finally, HIA needs defining the evaluation scenarios, i.e. the hypothetical scenario with which we want to compare the current air pollution situation. We calculate the impact on health of the (current) air pollution levels in the city that are above the pollution level of the evaluation scenario. In other words, the attributable number of health events (deaths, hospital admissions…) calculated for each scenario represents the number of events that would be prevented if, all other things being equal, air pollution levels were reduced to the evaluation scenario level. These evaluation scenarios are based on the objectives and limits established in 1999/30/CE, and 2002/3/CE Directives.

HIA scenarios

1 - HIA scenarios for PM_{10}

1.1.- Scenarios for HIA on **short-term** effects of PM_{10} and **cough, lower respiratory symptoms** in people under 18 year (<18), and **hospital respiratory admissions** in people under 15 year (< 15)

1.1.1 Reduction of PM_{10} levels to a 24-hour value of **50 µg/m³** in all days exceeding this value (Limit of 1999/30/CE Directive)

1.1.2. Reduction of PM_{10} levels to a 24-hour value of **20 µg/m³** in all days exceeding this value

1.1.3 Reduction **by 5 µg/m³** of all the 24-hour values

1.2.- Scenarios for HIA on **long-term** effects of PM_{10} and **postneonatal mortality** (total, respiratory and sudden infant death syndrome-SIDS)

1.2.1 Reduction of the annual mean value of PM_{10} to a level of **40 µg/m³** (Limit of 1999/30/CE Directive for 2005)

1.2.2 Reduction of the annual mean value of PM_{10} to a level of **20 µg/m³** (Limit of 1999/30/CE Directive for 2010)

1.2.3 Reduction **by 5 µg/m³** of the annual mean value of PM_{10}

2.- HIA scenarios on short-term effects of Ozone

1.2.1 Daily maximum 1-hour concentration and **emergency room visits for asthma** in people under 18 year (< 18)

1.2.1.1 Reduction of O_3 daily maximum 1-hour concentrations to a level of **180 µg/m³** in all days exceeding this value (Information threshold of 2002/3/CE Directive)

1.2.1.2 Reduction **by 10 µg/m³** of the daily maximum 1-hour concentrations

1.2.2 Daily maximum 8-hour moving average concentration and **mortality** in general population

1.2.2.1 Reduction of O_3 daily maximum 8-hour moving average concentrations to **120 µg/m³** in all days exceeding this value (Limit for health protection of 2002/3/CE Directive)

1.2.2.2 Reduction **by 10 µg/m³** in the daily maximum 8-hour moving average concentrations.

Findings

The annual number of postneonatal deaths attributable to PM_{10} levels higher than 20 µg/m^3 was 0.93 (95%CI: 0.43-1.44), which is equivalent to an annual rate of 6.73 deaths per 100 000 (95%CI: 3.11-10.42).

Table 5. Potential benefits of reducing PM_{10} levels. Absolute numbers and rates (per 100 000 children) (95% confidence limits) attributable to the health effects of PM_{10}.

	PM10 reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
POSTNEONATAL MORTALITY	**Annual mean levels**		
Total	by 5 µg/m^3	2.13 (0.98-3.31)	15.37(7.09-23.86)
	to 20 µg/m^3	0.93 (0.43-1.44)	6.73 (3.11-10.42)
	to 40 µg/m^3	-	-
Respiratory	by 5 µg/m^3	0.19 (0.09-0.29)	1.34 (0.64-2.07)
	to 20 µg/m^3	0.08 (0.04-0.13)	0.6 (0.29-0.91)
	to 40 µg/m^3	-	-
SIDS	by 5 µg/m^3	0.06 (0.03-0.08)	0.39 (0.23-0.55)
	to 20 µg/m^3	0.02 (0.01-0.03)	0.17 (0.10-0.24)
	to 40 µg/m^3	-	-
MORBIDITY	**Daily levels**		
Cough <18 y	by 5 µg/m^3	not available	not available
	to 20 µg/m^3	not available	not available
	to 50 µg/m^3	not available	not available
LRS <18 y	by 5 µg/m^3	not available	not available
	to 20 µg/m^3	not available	not available
	to 50 µg/m^3	not available	not available
Hospital respiratory admissions <15 y	by 5 µg/m^3	not available	not available
	to 20 µg/m^3	not available	not available
	to 50 µg/m^3	not available	not available

Regarding short-term effects of O_3, each reduction by 10 µg/m^3 of daily maximum 8-hour moving average concentrations would delay 35.09 (95%CI: 19.24-58.86) deaths per year in the study area, 26.89 (95%CI: 12.86-42.67) from cardiovascular diseases, and 3.65 (95%CI: 2.39-4.88) from respiratory causes.

Table 6. Potential benefits of reducing ozone daily levels. Absolute numbers and rates (per 100 000 inhabitants) (95% confidence limits) attributable to the health effects of ozone.

	OZONE reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
MORTALITY	**Daily 8-h max**		
Total excluding external causes	by 10 µg/m^3	35.09 (19.24-58.86)	253.1 (138.8-424.5)
	to 120 µg/m^3	0.42 (0.23-0.76)	3.00 (1.65-5.05)
Cardiovascular	by 10 µg/m^3	26.89 (12.86-42.67)	193.9 (92.7-307.8)
	to 120 µg/m^3	0.33 (0.16-0.52)	2.34 (1.12-3.72)
Respiratory	by 10 µg/m^3	3.65 (2.39-4.88)	26.36 (17.26-35.23)
	to 120 µg/m^3	0.05 (0.03-0.06)	0.34 (0.22-0.46)
MORBIDITY	**Daily 1-h max**		
Emergency room visits for asthma <18 y	by 10 µg/m^3	not available	not available
	to 180 µg/m^3	not available	not available
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3	not available	not available
	to 120 µg/m^3	not available	not available
Hospital respiratory admissions > 64 y	by 10 µg/m^3	not available	not available
	to 120 µg/m^3	not available	not available

Discussion

The level of air pollution due to PM_{10} decreased a little compared to the previous year (29µg/m^3). The 03 concentration did not change over the years, the 8 hours moving average concentration was between 70 and 80µg/m^3 in the majority of summer days. Concentration over 120µg/m^3 occurred only in 2 days during the summer 2001.

The postneonatal total mortality is quite low. The majority of infant deaths occur in the first month after birth, and the main causes are related to perinatal circumstances as well as inborn errors, deformations and chromosomal aberrations (around 70% of all death cases. Communicable diseases, parasites, malignant diseases and external causes and "other causes" are responsible for the remaining 30% of infant mortality. Air pollution is not a major risk factor in infant mortality. However we can not estimate the effect of air pollution on morbidity because of the lack of centrally collected, standardized database. In the future it would be necessary to improve the data collection concerning hospital admission due to emergency causes as well as emergency room visits.

As regards the effect of air pollution on adults, the role of particulate matters was assessed in the previous APHEIS studies. The benefit of reduction of particulate matter emission was proven, the reduction of the yearly average concentration would result a higher potential benefit than the short term improvement of air quality. The reduction of PM_{10} concentration has a benefit in reduction of postneonatal mortality, however this effect is very small, because of the small number of postneonatal death cases. The impact of O3 on the health state of the general population could be improved by reducing the O3 8 hour maximum concentration. A reduction by 10µg/m^3 would save the lives of 253 persons dying from all causes, 194 – dying from cardiovascular causes and 27 – dying from respiratory causes. The reduction of the concentration to 120µg/m^3 would save the lives of only 3 persons.

Conclusion

The 3rd health impact assessment for Budapest showed a small improvement in the air quality. The number of days with very high concentration of O3 and PM is few. In spite of this favourable results of air quality, it is necessary to continue the programs aiming at reducing traffic related exposure in Budapest. First of all the highway ring around Budapest should be completed. In the present situation heavy traffic reaching the capital from North-East direction should pass through the city to cross the Danube and to continue the way towards the West. The suburban train network should be improved – the building of the 4th metro line would help to solve the traffic jams during rush hours in the city. This will reduce the concentration of PM and O3. Public transportation should be made more popular.

The impact of air pollution on postneonatal mortality is low. However the assessment of air pollution on the health state of children is only partial because of the lack of assessment using morbidity data. The benefit on mortality of adult population is detectable, more information is needed for the entire assessment.

The results of environmental health impact assessment of the APHEIS studies have been communicated with the decision makers year by year. These communications definitely help the short term, medium and long term planning of the traffic system of Budapest.

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