NEWSLETTER

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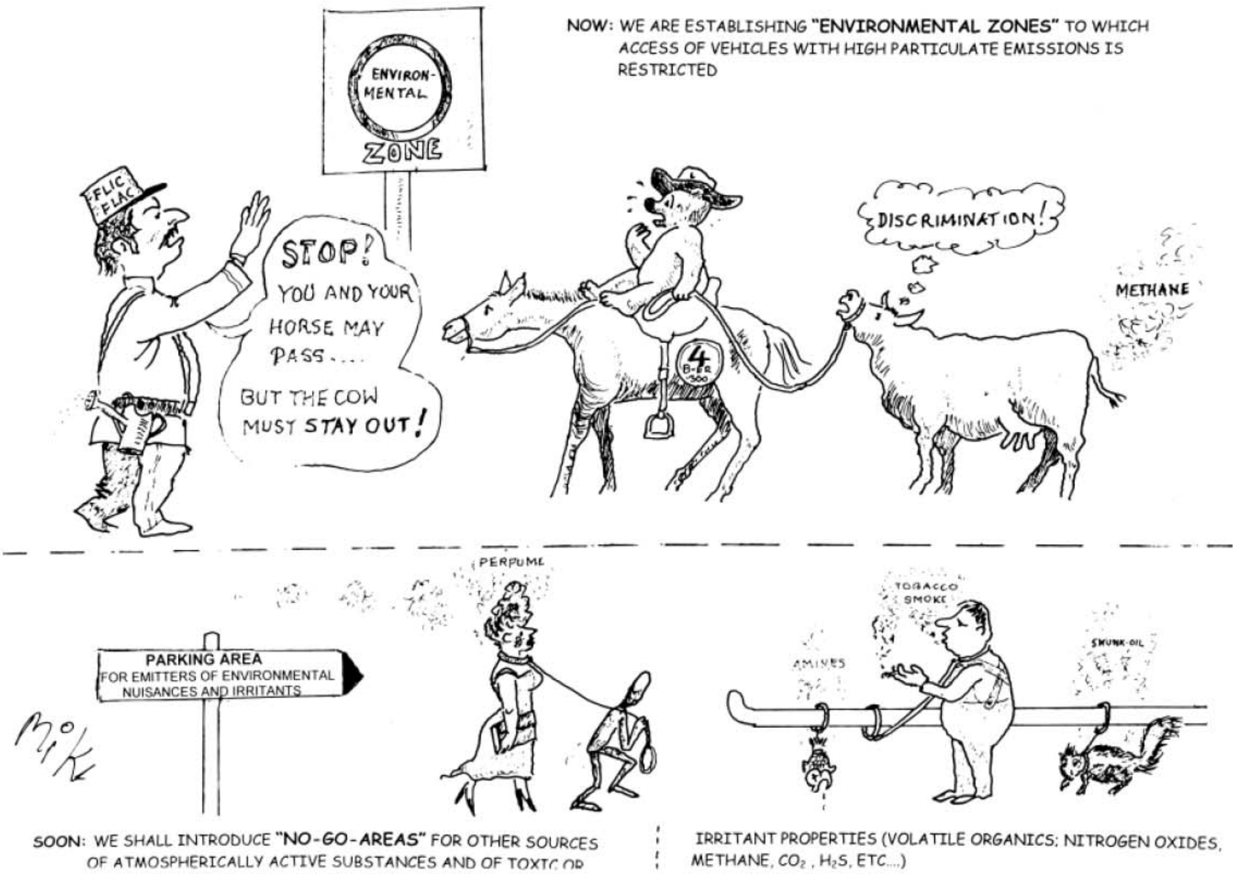

THE RELATION BETWEEN TEMPERATURE, OZONE AND MORTALITY IN NINE FRENCH CITIES DURING THE HEATWAVE 2003

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Introduction

During August 2003, record high temperatures were observed across Europe. France was the most affected country (InVS 2003). Between 1 and 18 August, more than 60% of the meteorological stations recorded temperatures above 35°C and in 15% of the stations temperature reached 40°C and more. A report (Hémon and Jougla 2003) estimated that about 15,000 excess deaths occurred between 1 and 20 August. During the same period, elevated ozone concentrations were measured all over the country (European Environment Agency 2003). Ozone is a photochemical air pollutant and several studies have shown that daily variations in its concentration levels are associated with daily variations in number of deaths after adjusting for the independent effect of temperature (Basu and Samet 2002).

Questions have been raised concerning the contribution of air pollution to the health impact of summer heat wave 2003. Some European authors have estimated the number of deaths attributable to ozone exposure during summer 2003. In the Netherlands they showed an excess of 400 to 600 air pollution related deaths (Fischer et al. 2004). Others also carried out a health impact assessment in UK (Stedman 2004). However, the authors applied pre-existing exposure-response functions defined in usual conditions of temperature and ozone levels and did not take into account the exceptional meteorological conditions of summer 2003.

The aim of this study was, first to estimate a new exposure-response function and the consequent health impact assessment between ozone and the risk of mortality in nine French cities, taking into account the particular period in 2003 and compare the results with previous estimates (excluding the heat wave) in the same cities (Le Tertre et al. 2002). The second objective was to estimate, for the heat wave period, the relative contribution of ozone in the joint excess risk of mortality related to temperature and ozone in each of the nine French cities.

Methods

Study area and environmental data

The nine cities involved in this study (Figure 1) are those participating to the French surveillance programme for health risks related to urban air pollution (PSAS-9).

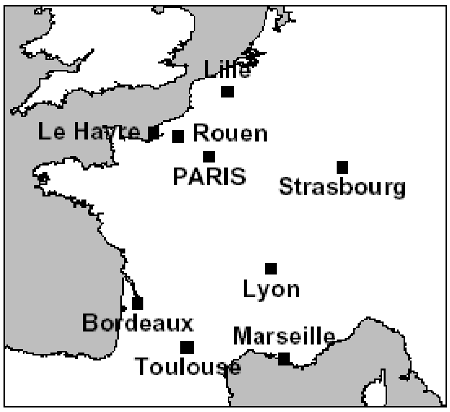

Figure 1: Localization of the nine cities

In each city of the PSAS-9 programme (InVS 2002), a study area was defined according to the localization of air pollution monitoring stations and daily population displacements. Air pollution data were obtained from local air monitoring networks, which measured ozone levels since 1996. Urban or suburban monitoring stations (France has a national standardized classification system for air quality monitoring stations) used for the development of the ozone indicator were selected according to the following criteria: the values measured by each station must be sufficiently correlated and close to the ones measured by every other station (correlation coefficient higher than 0.6, 75th percentile of the distribution of the values recorded by a station higher than the 25th percentile of the distribution of the values recorded by every other station). For each day of the 1996-2003 period we constructed daily exposure indicators by calculating the arithmetic mean of the 8 hours maximum concentrations recorded by each station selected. Then, the mean of these values was calculated to obtain the daily indicator. Meteorological data (daily minimum and maximum temperature and relative humidity) were provided by Météo-France.

Health Data

The National Institute of Statistics and Economic Studies (INSEE 2005) provided mortality data. We considered daily counts of deaths in each study area during 1996-2003 period. Influenza data were provided by the teleprocessing national network of monitoring and information on the transmissible diseases (Valleron and Garnerin 1992), except for Paris metropolitan area, where the influenza indicator was defined, during influenza epidemics (as defined by the Regional Group for the Observation of Influenza – GROG) (Cohen et al. 2005), as the daily number of doctor’s house calls for influenza symptoms, recorded by SOS-Medecins, an emergency doctor house calls system (SOS-Medecins 2005).

Statistical analysis

We used a time series design to analyze short-term effects of temperature and ozone pollution on mortality. Counts of deaths were regressed on temperatures and ozone levels controlling for possible confounders: long-term trends, season, influenza outbreaks, day of the week and bank holidays effects. Poisson regression models were used allowing for over-dispersion and autocorrelated data. To characterize health effect of temperature and ozone, the weather and air pollution variables included in models captured the expected effects, independent of the heat wave, of these variables on daily mortality. Temperature variables were modelled using penalised cubic regression spline. Temperature terms were modelled using three degrees of freedom for each (minimum temperature and maximum temperature).

Thin plate regression splines were used to allow for potentially non-linear effects and interactions between the variables. The degree of smoothing by the spline function was chosen to remove seasonal and long-term temporal trends and to minimize autocorrelation in the residuals. In order to compare the excess risks with our previous results, ozone-8h mean of the current and the previous days (0-1 day lag) was introduced as a linear term, following the APHEA-2 (Air Pollution and Health: an European Approach) methodology (Touloumi et al. 2004). We tested same-day, 1-day, 2-day and 3-day temperature lags and their second degree interactions to allow for a potential delay in temperature effects. The choice of temperature variables (minimum, maximum), lags (1 to 5 days) and interactions was based on Akaike criteria (Akaike 1973). Potential interaction between ozone-8h and temperatures variables was also tested.

For comparison with the nine cities previous results, pooled excess risk was calculated using a random effect approach (InVS 1999). Nevertheless, according to heterogeneity observed between the nine cities, excess of risk were also estimated using an empirical Bayes approach (shrunken estimates; Post et al. 2001). In the presence of heterogeneity, city-specific estimates vary about the overall effect estimate for two reasons: a) due to the true heterogeneity in the estimates, and b) due to additional stochastic error. A city-specific estimate reflects the first source of variation, but not the second which is then required. The use of these shrunken estimates allows reducing the stochastic variability of the local estimates. All analysis was done using R (R Development Core Team 2004). For each of the nine cities, the mean of daily excess risk (shrunken estimates) was calculated from 3 to 17 August 2003 for ozone-8h and temperatures together using as baseline ozone-8h and temperatures levels for the same period of the three previous years.

In this joint excess risk, the contribution of ozone-8h was calculated as the ratio between logarithm of ozone-8h relative risk and logarithm of joint ozone-8h and temperatures relative risk. The ozone-8h excess risk during 3 to 17 August 2003 was also used to assess the health impact of ozone exposure during this period, according to the health impact assessment methodology described elsewhere (Pascal et al. 2003).

Results

The study population consisted of about 11 million people as indicated by the 1999 census. Table 1 presents population sizes and mean daily counts of deaths for each city. Ozone levels and temperature measured during summer 2003 are also described. The 50th percentile of the ozone-8h average ranged from 80 µg/m^3 in Lille to 123 µg/m^3 in Marseille.

The daily mean of maximum temperature ranged from 36.3°C in Le Havre to 40.7°C in Bordeaux. For minimum temperature, the daily mean ranged from 12.7°C in Lille to 19.8°C in Marseille (Table 1). In each city, the excess risk (ER) of mortality associated with a 10 µg/m^3 increase in the ozone-8h (0 to 1 day lag) is presented in Table 2 for the current study period (1996-2003) and the previous one (1990-1997) (InVS 2002).

For the 1996-2003 period, we observe a positive association between an increase in ozone levels and mortality in each city except in Lyon. The relationship is significant except for Bordeaux, Lyon and Le Havre. The pooled excess risk of death is significant (1.01%; 95 % confidence interval = 0.58 to 1.44) for an increase of 10 µg/m^3 of ozone levels for the nine cities. In comparison with previous results obtained on the same cities and using the same analysis design, the pooled excess risk increased moderately between the two periods. However, local excess risks variations between the two periods differed according to the city: they increased in Le Havre, Lille, Rouen (becoming significant), and particularly in Toulouse. They decreased in Marseille and Lyon and remained stable in Paris and Strasbourg. Globally, local excess risks were more heterogeneous between cities during the second period (1996-2003) than during the first period (1990-1997).

Table 1: Population size, mortality, ozone and temperature in nine French cities during summer 2003 (1 June – 30 September)

		Summer 2003					
City	Population	Daily deaths	Ozone (8h mean) in µg/m^3			Temperature (daily means) in °C	
	Number	Mean (SD)	P25	P50	P75	Minimum	Maximum
Bordeaux	584 164	13.6 (5.0)	80	92	116	14.3	40.7
Le Havre	254 585	5.6 (2.7)	69	82	100	15.3	36.3
Lille	1 091 156	21.8 (5.3)	67	80	104	12.7	36.6
Lyon	782 828	19.4 (9.7)	87	112	136	17.3	39.9
Marseille	856 165	23.8 (5.8)	104	123	137	19.8	37.6
Paris	6 164 418	137.0 (107.0)	70	93	122	16.3	39.3
Rouen	434 924	10.8 (4.4)	72	88	111	12.8	37.9
Strasbourg	451 133	9.5 (3.6)	86	119	148	14.5	38.4
Toulouse	690 162	13.3 (4.3)	95	114	135	18.0	40.4

Table 2: Local, pooled and shrunken excess risks (%) of mortality (all ages) for a 10 μg/m³ increase in ozone levels in the nine cities for the periods 1990-1997 and 1996-2003

City	1990-1997 study period	1996-2003 study period	
	Local ER[a] [IC95%][b]	Local ER [IC95%]	Shrunken ER [IC95%]
Bordeaux[c]		0.58 [-0.37; 1.54]	0.72 [-0.07; 1.51]
Le Havre	0.61 [-0.56 ; 1.79]	1.17 [-0.29; 2.55]	1.09 [0.12; 2.07]
Lille	0.27 [-0.59 ; 1.14]	0.96 [0.30; 1.61]	0.97 [0.37; 1.56]
Lyon	0.16 [-0.55 ; 0.87]	-0.02 [-0.71; 0.67]	0.19 [-0.43; 0.80]
Marseille	1.89 [0.90 ; 2.89]	1.08 [0.46; 1.72]	1.07 [0.50; 1.65]
Paris	0.44 [0.17 ; 0.71]	0.55 [0.28; 0.83]	0.57 [0.30; 0.84]
Rouen	0.82 [-0.14 ; 1.79]	1.35 [0.28; 2.42]	1.22 [0.38; 2.07]
Strasbourg	1.08 [0.33 ; 1.83]	1.12 [0.36; 1.88]	1.09 [0.43; 1.76]
Toulouse	0.74 [-0.22 ; 1.70]	3.12 [2.09; 4.17]	2.38 [1.55; 3.21]
Pooled excess risk	0.66 [0.34 ; 0.97]	1.01 [0.58; 1.44]	*NA*[d]

[a] Excess risk; [b] 95% confidence interval; [c] Not available for the first period ; [d] Not applicable

For the 3 to 17 August 2003 period, the excess risk of deaths linked to ozone-8h and temperatures together ranged from 10.6 % in Le Havre to 174.7 % in Paris (Table 3). When we compared the relative contributions of ozone and temperature to this joint excess risk, we observed that the contribution of ozone to mortality varied according to the city, ranging from 2.5% in Bordeaux to 85.3% in Toulouse. In Paris, Lyon and Bordeaux, the temperature had a major effect during 3 to 17 August and the relative contribution of ozone was low (less than 8 %). In Rouen, the temperature effect was also slightly more important (67 %). Inversely, the part of ozone was greater in Strasbourg and Toulouse (more than 75 %). On the whole, we observed heterogeneity between the nine cities not only for the joint effect of ozone-8h and temperatures, but also for the relative contribution of each factor.

In each city, the daily distribution of ozone-8h and temperatures effects did not vary during the period. However, the daily variation of the excess risk linked to ozone and temperature together showed a temporal and spatial variability according to the city (Figure 2, page 6). In two cities (Rouen and Le Havre) variations showed two peaks of excess risk. In other cities (Paris, Lyon), we observed an increase between 3 and 7 August and then stability of excess risks until 15 August. For Bordeaux and Toulouse, excess risks were constant until 13 August and decreased afterwards. For Strasbourg and Marseille, excess risks were stable during the entire period. The rate of deaths attributable to ozone exposure between 3 to 17 August 2003 ranged from 0.9 (Lyon) to 5.5 (Toulouse) for 100,000 inhabitants, leading to a total of 379 short-term attributable deaths during this period for the nine cities.

Table 3: Excess risk (%) between 3 and 17 August, 2003 linked to ozone and temperature, percentage of ozone and temperature (%) in nine French cities

	All ages mortality		
City	ER Ozone and Temperature (%)	Ozone (%)	Temperature (%)
Bordeaux	25.00	2.46	97.54
Le Havre	10.58	58.00	42.00
Lille	13.97	44.61	55.39
Lyon	87.74	2.57	97.43
Marseille	11.19	50.30	49.70
Paris	174.68	7.33	92.67
Rouen	35.24	32.60	67.40
Strasbourg	11.75	75.95	24.05
Toulouse	17.98	85.34	14.66

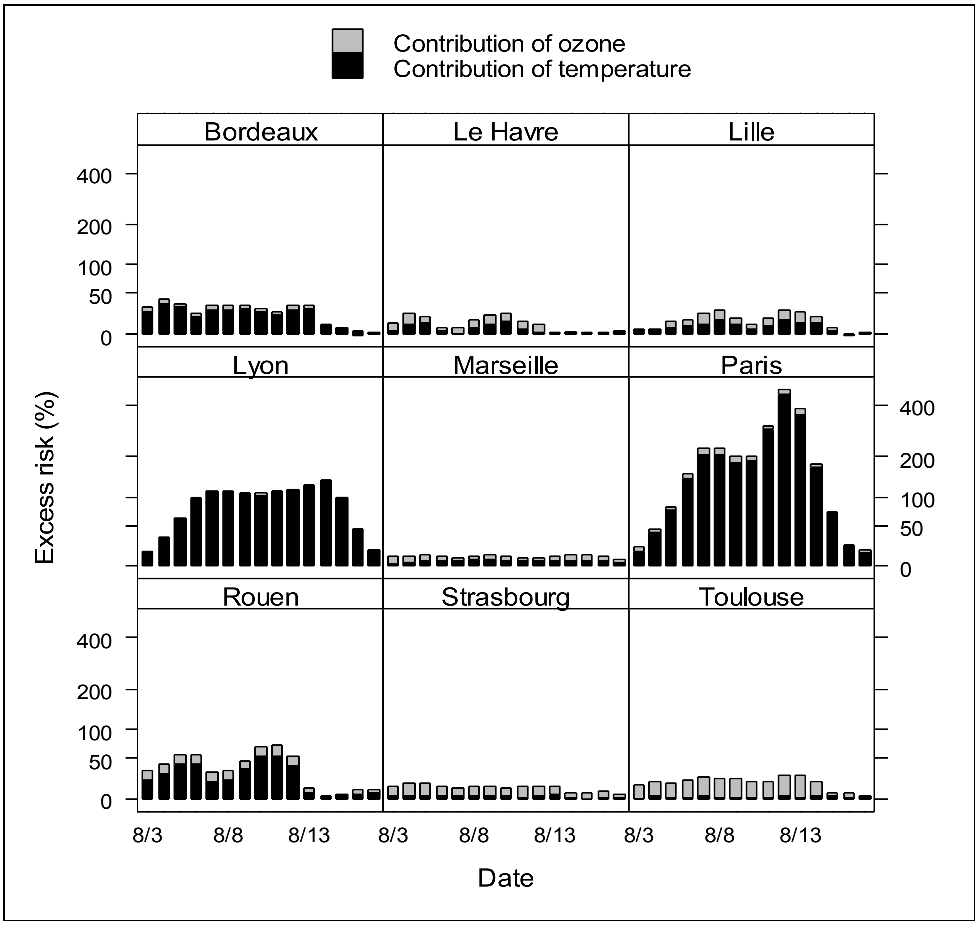

Figure 2: Daily values of excess risk of deaths linked to ozone and temperature and percentage of these two factors in all ages population for nine French cities, August 2003

Discussion

Our findings show a non-negligible impact of ozone during the heat wave: 379 short-term attributable deaths for the nine cities using as baseline ozone-8h levels for the same period of the three previous years. Our analysis also showed a global significant relationship between ozone and excess risk of deaths in the nine cities combined for the 1996-2003 period including the heat wave. In comparison with previous results on these cities (InVS 2002), the pooled estimate remained stable but local estimates varied differently according to the city.

Several hypotheses could explain these variations between the two studies. First, the study periods were different. The second study included the 2003 heat wave period and also more recent data sets provided by more monitors than for the first period. Second, for the current analysis, we introduced two to four temperature variables and their interactions in order to capture their effects as much as possible. On the other hand, the previous models included only two temperature variables for controlling confounding effect of these factors. In the same time, ozone was similarly taken into account in the two analyses: a linear term, mean of ozone levels for the current and previous days. The consequence of the new approach is a probable under estimation of ozone excess risks due to the *a priori* shape attributed to the relationship. Third, our analysis applied more strict convergence criteria than in previous analysis, as suggested by Dominici et al. (2002). Also, to avoid the underestimation of parameters variance, we used R Programming Environment for Data Analysis and Graphics (R Development Core Team 2004). Finally, according to the recent discussions about optimal smoothing method, thin plate regression splines were used instead of LOESS smoothers used for previous analysis.

The correlation between ozone and temperature was quite high during the heatwave but according to our statistical method, we have separated the respective effects. The observed correlations between ozone and minimum and maximum temperature, each adjusted on season and weekdays effect, were respectively equal to 0.71 and 0.89 during the heatwave. These correlations are too high to separate the specific effect of each covariate. But on the previous years, we also observed days with the same levels of ozone and not necessarily the same levels of temperature. The correlations are now respectively equal to 0.6 and 0.7 when we only select the days exceeding 108 $\mu g/m^3$ of ozone-8h (average level during the heatwave). These correlations are still high but not so dramatic in terms of estimation.

Numerous studies have shown associations between ozone levels and mortality. Short-term effects were the most studied and typically, an overall estimate (based on a meta-analysis) is provided. A recent meta-analysis (Anderson et al. 2004) is based on 15 European studies published between 1999 and 2002 about the effect of ozone on all causes mortality. The pooled excess risk of death in all ages population for an increase of 10 $\mu g/m^3$ of ozone was 0.3 % (95% confidence interval = 0.1 to 0.4). The more recent results of APHEA-2 project (Gryparis et al. 2004) showed similar values: in summer, pooled estimates for the increase in the total daily number of deaths associated with ozone-8h increases of 10 $\mu g/m^3$ (average of lags 0 and 1) was 0.34 and 0.31 respectively for fixed effects and random effects (95% confidence intervals were respectively 0.27 to 0.50 and 0.17 to 0.52). Our pooled excess risk is larger than these estimates: the issue of the impact of extreme levels of ozone and temperature on the results, even scarce, should be addressed.

As part of the APHEIS programme (APHEIS Group 2004), an analysis was conducted to address the issue of using alternatively city-specific estimates: local estimate, shrunken estimate, estimate adjusted on effects modifiers and overall estimate. This analysis was conducted on PM_{10} exposure but its conclusion seems to be extensible to other pollutants exposure. The use of the local estimate seems to be subject to too much noise to be really effective. On the other hand, applied to a single city, the overall estimate could not adequately reflect the heterogeneity present in the data. The two other derived city-specific estimates seem to give similar results. We preferred the shrunken one, as it does not make any inference on the relation with potential effect modifiers.

Regarding the health effect of heat waves, there are also numerous studies showing adverse effects of high temperatures. Basu and Samet (2002) have done a review of epidemiologic evidence and reported that a number of studies have shown that mortality is increased during heat waves. They observed that temperature at lag times of 0 to 3 days have been observed to produce the maximum effect of mortality following heat waves.

During the period with high temperature, our results show that the health effects are different according to the city. These differences are coherent with previous results observed in France (Vandentorren et al. 2004) showing the same trend of mortality according to geographical area. Different factors may be responsible to these results. McGeehin and Mirabelli (2001) reported that the elderly and young children are particularly vulnerable to heat waves. Other risk factors including poverty, social isolation, and certain medication associated with aging were associated to an excess of death during heat waves (McGeehin and Mirabelli 2001, Semenza et al. 1996). Characteristics of the population of each city could hence explain some of the differences observed in our results.

Moreover, environmental characteristics of each city, like heat island effect, may also explain the heterogeneity of the results. Heat islands have been consistently shown to be associated with urban density. A strong relation exists between the size (population) of a city, and the temperature encountered in its dense center (Oke 1973, WHO Europe 2004). The urban heat island effect influences the relation between the temperature measured in meteorological monitoring stations (data used in our models), and the temperature to which city inhabitants are really exposed. Hence, this could contribute to the difference in temperature effects observed across the nine participating cities.

In conclusion, these results confirmed that in urban areas ozone levels have a non negligible impact in terms of public health, even if this impact is low in terms of individual risks. Our findings also showed that the relative contribution of ozone and temperature in the joint excess of mortality during the heat wave 2003 was heterogeneous between cities according to local specific characteristics.

Abbreviations

ER: excess risk
ozone-8h: arithmetic mean of the 8 hours maximum concentrations of ozone
PM_{10}: particulate matter less than 10 µm of diameter
SD: standard deviation
P25: 25^{th} percentile of the distribution of ozone
P50: 50^{th} percentile of the distribution of ozone
P75: 75^{th} percentile of the distribution of ozone

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COST ACTION 633 PARTICULATE MATTER – PROPERTIES RELATED TO HEALTH EFFECTS

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In March 2008, the COST Action 633 (co-chairs: Regina Hitzenberger, Austria and Janja Tursic, Slovenia) held its final workshop "Particulate matter and health in 2020 - Are we on the right track? Challenges of the changing particulate air pollution in Europe: what we know and what we should know in the future". At that time, the Action had been running for five and a half years. Although this article is on the results of the workshop, I would like to give an overview over the background of the Action and its main activities. As not everyone will be aware of the rules for COST Actions, there will also be a few words on this respect. The Action was initiated in the late 1990's, when the need of multidisciplinary studies became apparent. The importance of particulate matter (PM) for human health had already been recognized, but the studies performed then had their focus either on PM measurements or on health effects (epidemiology or toxicology). The Action was designed to bring together experts from the fields of research in PM, epidemiology, toxicology, emission inventory, source apportionment, exposure and integrating assessment modelling.

The objective of the Action was to look for heterogeneities in Europe from the point of view of: chemical and physical properties of PM, particle sources, and influence of PM on health. We set ourselves the tasks to review existing data and methods (PM, health), to identify gaps in knowledge (e.g. gaps in methodology, find regions without prior studies, relevant target substances, etc.), to consolidate and expand emission inventories, to further develop source apportionment and integrated assessment models and to propose future research activities. As COST Actions do not receive research funding, but only funding for meetings and some "short-term scientific missions" mainly for early career scientists to visit another institution for a few weeks, we could not perform new research within the Action. However, all members of the management committee were nominated by their countries because they do have research projects related to this topic.

Three working groups consisting of experts in the different fields were established. Working group I (co-chairs: Jean-Philippe Putaud, JRC and Axel Berner, Austria) dealt with PM measurements, measurement techniques and artefacts. Working Group II (co-chairs: Raimo Salonen, Finland and Wolfgang Kreyling, Germany) focused on health effects (epidemiology, toxicology and exposure). Working Group III (co-chairs: Thomas Kuhlbusch, Germany and Markus Amann, Austria) concentrated on modelling of PM and health issues. Joint meetings of the working groups were held to identify existing knowledge as well as research needs for the future. In these joint meetings, knowledge of the experts was pooled to create synergies between the different fields. Full information on the Action and the working groups, the objectives and tasks as well as a list of members of the Action and the working groups is available at our website http://cost633.dmu.dk. Apart from the more future-oriented activities, the working groups compiled a collection of data on PM in Europe made available by the members of the Action, which is hosted by JRC in Ispra, a collection of past and running projects on PM and Health including info on contact persons, and a collection of information on existing models (ranging from source apportionment through emission inventories to integrating assessment models).

COST 633 always was active in disseminating its results and getting input both from the scientific community and from stakeholders. In April 2006, COST 633 organized a conference in Vienna (the conference report can also be found on the Action website) where we addressed topics in multidisciplinary discussion groups. The consensus was that although there had been an immense increase of knowledge in the field since the start of the Action, the complexity of the subject was becoming more and more fully recognized. A need for new metrics was recognized as well as a need for a better understanding of source contributions. Knowledge gaps were identified and a suggestion was made for integrated approaches (e.g. for urban super regions). An article about this conference was published in WHO Newsletter No. 38, December 2006, page 6. We held a public workshop in Lausanne, Switzerland, in May 2007 where we invited the Swiss community as well as international scientists to discuss the relevance of PM and health issues from a Swiss perspective, and a special session on COST 633 at the European Aerosol Conference in Salzburg, in September 2007 (http://www.gaef.de/EAC2007/).

In the final workshop in Brussels, Belgium, (13–14 March 2008; presentations and extra material are available at the Action website), the main results of our action were presented to the scientific public as well as to stakeholders and policy makers. The workshop was held in the context of the current scientific and legislative background in the EU. The revised European Union air quality directive is now on track after the numerous legislative and implementation efforts made in the last few years. During the revision and discussion of this directive, several important issues especially related to particulate matter (PM) were taken up within the Clean Air for Europe programme. In the revision process, not all issues could be addressed due to lack of scientific data. There are still major uncertainties and important gaps in the current scientific knowledge that need handling before the next evaluation of the air quality directive in 2013. Stakeholders, policy-makers and decision-makers need further information about the changing PM situation in Europe. Much more emphasis should be put on the dual impact of PM on health and climate change. We aimed the workshop at providing guidance for dealing with the current heterogeneities and future changes in Europe-wide PM levels and characteristics, as well as the health implications of air pollution and climate change. The legislation on air quality regulates outdoor PM concentrations at fixed sites. However, large differences can exist between these concentrations and the concentrations that people are really exposed to. We know that the distribution of PM over Europe is heterogeneous with regard to mass concentration, physical and chemical characteristics, contributing sources, and related health effects, so there might not be a single way to deal with the situation. In the scientific presentations on day 1 (all presentations are available at the Action website), we concentrated on what is known about PM in Europe and its health effects by members for our action.

Two discussion groups were set up to discuss open questions, such as the problem of changing source patterns and emission characteristics with regard to modelling and source apportionment and for assessing short-term and long-term health effects, the value of alternative metrics or indicators for PM mass such as black smoke, elemental carbon, particle number, and an oxidative stress index; and whether we are able to monitor these indicators and, maybe most importantly, where we should go in European PM research and collaboration. The consensus of the discussions was that new sources have to be included in the models continuously as they change continuously. Changing sources need also continuously updated emission inventories, as there are still many uncertainties. We need models to formulate abatement strategies and we need new metrics for pollution control. The prime target should be to reduce health effects in the most effective way. The issues of air quality, health and climate change are interlinked, and policy makers need markers for both health and climate effects. Future abatement strategies have to be oriented towards both effects.

For the second day, we invited stakeholders and policy makers to participate and to show their view, and finished the workshop with a podium discussion among the presenters of this day (Tuomo Karjalainen, EU, Peter Bruckmann, Germany, Bert Brunekreef, the Netherlands, and Thomas Kuhlbusch and Raimo Salonen, both for COST 633) with contributions from other workshop participants. At the end of the Action, we are in an interesting situation. We do know a lot more than we did when we started, but we now also have a list of new questions. During the workshop, policy makers told us that scientists should not always talk about what they do not know, and they are right. Well, scientists tend to concentrate on what is unknown, and not on what we do know. During the Action, knowledge really has increased enormously, which becomes even more apparent when we compare what we know today with what was put down in the Memorandum of Understanding of COST 633. When we look at where we want to be in 2020, however, of course we see new questions to investigate. Sources are changing, and emission patterns are changing as well. Climate change will also lead to changes in the air quality situation, both by itself (secondary organic aerosol production, photochemical smog) and through measures set to mitigate climate change (changing fuel mix from fossil to biogenic). The role of ultra-fine particles is becoming more apparent, and we do not have emission inventories for them. As the emphasis in the past has been on ambient PM, the relation between indoor air (including special environments, e.g. subways) and health effects is still unresolved. Long-term health effects will also become an increasingly important study topic. Traffic is predicted to increase further. Wood smoke is expected to become a large contribution to ambient PM with the shift to biofuels.

PM has been a very valuable tool to identify the link of PM and health effects. Investigations of PM_{10} and $PM_{2.5}$ drove toxicological research in the field. Today, however, we see the need for new metrics, which was substantiated in the scientific presentations. Source patterns are changing, and as they change, parts of our existing emission inventories will become outdated. This situation has to be kept in mind when using emission inventories, and source apportionment models have to be improved and linked to assessment of abatement strategies. Models need to be validated in the various study areas over Europe, and extensive sets of measurements of old and new metrics for air pollution (particulate as well as some gases) should be performed in some regions as well. Exposure assessment models should be included in epidemiological studies, and exposure assessment and source apportionment models need to be linked. Suggested new metrics for PM (e.g. particle number concentration, number size distributions, elemental carbon, black smoke) and health effects (oxidative stress index) have to be tested as well. It is crucial to demonstrate with carefully designed studies, which is the relevant metric and address policy makers after this has been done. Integrated research platforms would be a way to deal with all these issues, so that we can keep track of the changing situation and keep improving air quality for as many citizens of the European Union effectively in a cost effective way.

So, at the end of COST 633, we know that we know a lot, and it is a lot more than what we started with, but we also know what we should study in future research, so that the health of citizens can be protected from adverse effects of PM in an effective and sustainable manner.

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NOTES AND NEWS

Harmonization of Material Emission Labelling Schemes in the EU

Growing awareness about requirements for healthy indoor air has resulted in a demand for products demonstrated to be safe for use in indoor environments. Emissions from construction products have been identified as a significant source of indoor air pollution since the beginning of the 1980's. Different approaches to evaluate construction products have emerged over time, and considerable practical experience has been gained during recent years. In some markets, emissions originating from indoor construction products have been noticeably reduced by developing quality criteria and labelling systems. A detailed review of the existing labelling schemes was compiled in 2005 in the European Collaborative Action (European Commission, Report 24 (http://www.inive.org/medias/ECA/ECA_Report24.pdf).

In 2007, under German EU presidency an EU-wide discussion process was initiated on the different existing approaches and possible ways forward. Consequently, a two-day conference on "Construction products and Indoor Air Quality – Emissions reduction in the EU" was held in Berlin, June 2007. The conference was designed to provide a platform for dialogue and discussion about the different approaches used to measure and assess the indoor air related quality of construction products. It also aimed to exchange experience regarding the reduction of emissions in practice.

The main conclusion of this conference was that reducing emissions from building products is necessary and feasible and the need for an EU-wide harmonized approach to evaluate harmful emissions from building products has become obvious. The necessary step forward recognised is the development of a harmonised evaluation concept.

Representatives of the Danish and Finish labelling systems and the German evaluation system have combined to form a small working group with additional input from some national testing laboratories. The goal of the working group is to propose a harmonized labelling scheme based on the experience gained through the national schemes.

The working group agreed to start with a practical comparison by testing and evaluating the same material according to their "own" criteria. The results were encouraging and challenging: the material was unanimously rejected by the three labelling schemes. However, the rejection was due to different parameters.

A common understanding is emerging in the working group that emission testing should include two tests (day 3 and 28) for Total Volatile Organic Compounds (TVOC) and carcinogens (EU Categories 1 and 2). A limitation should also be set for the total amount of Semi Volatile Organic Compounds (SVOC) and Very Volatile Organic Compounds (VVOC), at least for formaldehyde and other relevant aldehydes. As a basic requirement of a health related assessment, single substances (VOC) should be evaluated by comparing the emitted amount in the chamber with their respective Lowest Concentration of Interest (LCI) value.

The importance of sensory evaluation of the emission is confirmed although current practices differ and the development of an ISO standard is at an early stage.

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Federal Environment Agency
Berlin, Germany

Final Adoption of the new EU Air Quality Directive

The European Commission welcomed the adoption of the directive on ambient air quality and cleaner air for Europe finally agreed on 14 April 2008 (IP/08/570). It establishes ambitious, cost-effective targets for improving human health and environmental quality up to 2020. The directive merges four directives and one Council decision into a single directive on air quality. It sets standards and target dates for reducing concentrations of fine particles, which together with coarser particles known as PM_{10} already subject to legislation, are among the most dangerous pollutants for human health. Under the new air quality directive EU Member States are required to reduce exposure to $PM_{2.5}$ in urban areas by an average of 20% by 2020 based on 2010 levels. It obliges them to bring exposure levels below 20 $\mu g/m^3$ by 2015 in these areas. Throughout their territory Member States will need to respect the $PM_{2.5}$ limit value set at 25 $\mu g/m^3$. This value must be achieved by 2015 or, where possible, already by 2010.

The new directive introduces new objectives for fine particles $PM_{2.5}$ but does not change existing air quality standards. It does, however, give Member States greater flexibility in meeting some of these standards in areas where they have difficulty complying. Meeting PM_{10} limit values is proving challenging for 25 of the 27 EU Member States which are exceeding these limits in at least one part of their territory (IP/07/1537).

The deadlines for complying with the PM_{10} standards can be postponed for three years after the directive's entry into force (mid-2011) or by a maximum period of five years for nitrogen dioxide and benzene (2010-2015) provided that the relevant EU legislation such as industrial pollution prevention and control (IPPC, see MEMO/07/441) is fully implemented, and that all appropriate abatement measures are being taken. The directive provides a list of measures that need to be considered.

CAIR4HEALTH

The project CAIR4HEALTH is a two year specific support action (SSA) under the Sixth Framework Programme of the European Commission/DG Research. It was launched in February 2007.

It is recognised that exposure to air pollutants can lead to adverse health effects. As pollution levels in urban areas are growing, for example, due to rising traffic levels, health effects in cities are of particular concern. CAIR4HEALTH aims to provide an overview of the latest research findings on air pollution and health studies, such as research and policy-related outputs from clusters, networks, projects and expert groups including those represented by other projects, e.g. CLEAR and AIRNET, in order to support European sustainable development action plans and strategies. These include the Environment and Health Action Plan, the Environmental Technologies Action Plan and the Thematic Strategy on Urban Environment. CAIR4HEALTH will aid the review and horizon scanning process for key action plans including the Environment and Health Action Plan.

The main partners of CAIR4HEALTH are the six following research institutes: University of Hertfordshire/UK, Netherlands Organisation for Applied Research/NL, Finnish Meteorological Institute/FIN, Joint Research Centre/EU, Aristotle University of Thessaloniki/GR and University of Utrecht/NL. More information on the aims, structure and action plan of the CAIR4HEALTH project can be obtained from the web-portal: http://www.cair4health.eu.

MEETINGS AND CONFERENCES

5th Warwick Healthy Housing Conference 17-19 March 2008 in Coventry, UK

The fifth Warwick Healthy Housing Conference took place between 17 and 19 March at the University of Warwick in the historical city of Coventry, UK. Specialists from several countries talked about their concerns and experiences. During these three days a very broad range of topics was discussed concerning healthy housing, from social, cultural and political aspects towards heating and energy efficiency, chemical compounds used in building products and potential health damages.

The Conference was structured with plenary and parallel sessions which unfortunately do not allow us to report on all presented topics, but in the following we summarize some of them. Some works, e.g. presented by experts from New Zealand, show that private initiative and better housing can work if common interests are found, like the investment of energy companies in the insulation of houses from families with low-income presented by Howden-Chapman (Department of Public Health, New Zealand).

Others, like the study of Zurlyte (Lithuania State Environmental Health Centre) pointed out that there is still a long way to go to lower the injury rates from home accidents, but that can be improved if policies and regulations are established, enforced and communicated.

A greatly discussed topic was the presence of lead in old houses and demolition sites, as well as some recent cases of children poisoning in France and the US. Both countries are building databases on the subject and seeking for solutions to avoid further poisonings. Jacobs (National Center for Healthy Housing, USA) presented a study of dustfall sampled during the demolition of houses likely to contain lead-based paint in two big American cities. It demonstrated that the planned demolition in a dust suppressing way presents very good results to protect the workers, the neighboring houses and the environment from lead contaminated dust.

Braubach (World Health Organization, Europe) showed that tools like the Local Housing and Health Action Plans (LHHAP) developed in Portugal can provide information to identify and analyze data and translate them into actions to eradicate substandard housing, reducing injuries and health problems. The data collection provides a link between the survey tools, the field visits and the already existing data. The software questionnaires can be downloaded soon from www.euro.who.int/housing .

Other interesting aspects on healthy housing literature were discussed at the conference. Smith (University of Illinois, USA) commented on the difficulties to find surveys which combine measures of both health and housing. Thomson (MRC Social & Public Health Sciences Unit, UK) made a systematic review of housing intervention studies and showed the need to improve the amount and quality of papers showing correlation between health impacts and housing improvement. Due to the broad range of topics that healthy housing involves, the articles are scattered in many different magazines. A good attempt to facilitate the search of such studies is a newsletter containing recent articles elaborated by the World Health Organization (WHO) and the German State Health Office of Baden-Württemberg. It is electronically available at www.landesgesundheitsamt.de .

Studies from Lansley (University of Reading, UK) and Burton (Oxford Brookes University, UK) showed that it is not enough to provide elderly people with disabilities adapted housing for their well-being. The well-being is also connected with the neighborhood and its social and practical structures, like availability of shopping facilities, green areas, transportation system, noise level and security. This wide number of variable parameters requires, in addition to the elderly people themselves, an equally wide range of specialists in planning these houses. For the purpose of stimulating research and involvement from academics in the field of ageing-related housing research, the Extend Quality Life (EQUAL) initiative and the Strategic Promotion of Ageing Research Capacity (SPARC) are successful examples.

Allergies caused or severed by indoor air pollutants were also discussed in several sessions. Jones (GAIA Group, UK) commented on the amount of chemicals present in construction materials and showed examples of houses which are built by avoiding at least partially the use of materials containing substances that could be harmful to people. He also presented a Green House design based on the best available knowledge, which not only takes into account energy efficiency but also the total use of low-allergen materials and the reduction/prevention of dust mites as well as moisture regulation and ventilation strategies. Salares (Canada Mortgage and Housing Corporation) explored this topic by several examples of environmentally hypersensitive individuals which “abandon” their houses in search for a healthier place to live. Her study included the example of houses successfully built for these individuals.

A method for the calculation of mould growth in houses was presented by Cunningham (BRANZ, New Zealand). A simple empirical model was developed which only includes two outdoor climates and two building factors, all describing wall conditions and two behavioral factors. This method was suitable to quantify mould growth in large scale housing studies and to estimate mould growth reduction by retrofitting of houses.

A contribution by Zöllner (State Health Office, Germany) discussed the correlation of Particulate Matter (PM_{10}) in indoor air and the people’s activities and highlighted the importance of producing guidelines for the measurement of indoor particulate matter. The still present existing danger of CO poisoning in dwellings and the prevention strategies were shown in posters by Ezratty (EDF – Gaz de France)/Ormandy (University of Warwick) and Myers/Maynard (Department of Health, UK).

Furthermore, research on housing related childhood asthma morbidity was reported for several countries. Rudnai (National Institute of Environmental Health, Hungary) presented an epidemiological study carried out in Hungary. Here, strong determinants of asthma and allergy were identified as indoor exposure to coal and wood heating, air conditioners, mould and tobacco smoke as well as emissions from local industries, traffic and pesticide sprays. Another study on this subject carried out in Winnipeg was reported by Polyzois (University of Manitoba, Canada). The results of a questionnaire survey and measurements of indoor climate and air quality showed a causal relationship between mould and children’s respiratory infections and asthma. In New Zealand, Howden-Chapman reported that the insulation of houses and replacement of unflued gas heaters and plug-in electrical heaters with more effective heaters increased indoor temperature, reduced NO_2 levels and lowered significantly levels of children’s asthma symptoms.

The next Warwick Healthy Housing Conference is planned to take place in two or three years and we are looking forward to it.

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PUBLICATIONS

WHO

Health risks of heavy metals from long-range transboundary air pollution

WHO Regional Office for Europe, Copenhagen, Denmark 2007, 130 pages, ISBN 978 92 890 7179 6, also available through the web:
http://www.euro.who.int/document/E91044.pdf.

The heavy metals cadmium, lead and mercury are common air pollutants, emitted mainly as a result of industrial activity. Even low atmospheric levels contribute to build-up in soils, where they persist in the environment and accumulate in the food-chain both on land and in water. Heavy metals are associated to different degrees with a wide range of conditions, including kidney and bone damage, developmental and neurobehavioural disorders, elevated blood pressure and potentially even lung cancer.

This report, based on contributions from an international group of experts, reviews the available information on the sources, chemical properties and spatial distribution of environmental pollution with cadmium, lead and mercury caused by long-range transboundary air pollution, and evaluates the potential health risks in Europe.

Development of WHO Guidelines for indoor air quality: dampness and mould

WHO Regional Office for Europe, Copenhagen, Denmark 2008, 12 pages, EUR/07/5067585, only available through the web:
http://www.euro.who.int/Document/E91146.pdf.

Report on a working group meeting in Bonn, Germany, 17-18 October 2007. Microbial pollution is one of the key constituents of indoor air pollution. It consists of hundreds of species of bacteria and fungi, and in particular filamentous fungi (moulds) growing indoors when sufficient moisture is available. Health problems associated with moisture and biological agents include increased prevalence of respiratory symptoms, allergies, and asthma as well as perturbation of the immunological system.

Based on the extensive review of the scientific evidence, this WHO working group identified the main health risk due to excess moisture, associated with microbial growth and contamination of indoor spaces. It also formulated WHO guidelines for protecting public health, recommending that persistent dampness and microbial growth on interior surfaces and in building structures should be prevented (or minimized) as they may lead to adverse health effects.

Protecting Health in Europe from climate change

B. Menne, F. Apfel, S. Kovats and F. Racioppi, WHO Regional Office for Europe, Copenhagen, Denmark 2008, 50 pages, ISBN 978 92 890 7187 1, also available through the web:
http://www.euro.who.int/Document/GCH/Protecting_health.pdf.

This publication intends to stimulate debate and support an active response by providing up-to-date information on the health effects of climate change, as well as practical guidance on specific actions that decision-makers at different levels in health and other sectors can take now. As long as climate change is not too rapid or strong, many of the health effects can be controlled by strengthening health systems. This can include strengthening preparedness, public health services and health security, advocating action in other sectors to benefit health, better informing citizens and leading by example. Health systems need to strengthen their capacity to assess potential climate-related health effects, to review their capacities to cope, and develop and implement adaptation and mitigation strategies, and to strengthen a range of key areas of work – from disease surveillance and control to disaster risk reduction – that are essential for rapid detection of and action against climate-related risks.

Heat-health action plans

F. Matthies, G. Bickler, N. Cardenosa Marin and S. Hales, WHO 2008, 45 pages, ISBN 978 92 890 7191 8, available through the web:
http://www.euro.who.int/Document/E91347.pdf.

Climate change is leading to variations in weather patterns and an apparent increase in extreme weather events including heat-waves. Recent heat-waves in Europe have led to a rise in related mortality but the adverse health effects of hot weather and heat-waves are largely preventable. Prevention requires a portfolio of action at different levels, including meteorological early warning systems, timely public and medical advice, improvements to housing and urban planning and ensuring that health care and social systems are ready to act. These actions can be integrated into a defined heat-health action plan. This guidance results from the EuroHEAT project on improving public health responses to extreme weather/heat-waves, co-funded by the European Commission. It explains the importance of the development of heat-health action plans, their characteristics and core elements, with examples from several European countries that have begun their implementation and evaluation.

OTHERS

Air pollution in Europe 1990-2004
EEA Report No. 2/2007

European Environment Agency and Office for Official Publications of the European Communities, Copenhagen, Denmark 2007, ISBN 978 92 9167 964 5, EUR 25.00, also available through the web: http://reports.eea.europa.eu/eea_report_2007_2/en/Air_pollution_in_Europe_1990_2004.pdf.

The report 'Air pollution in Europe 1990–2004' analyses changes in air pollutant emissions and their possible health or ecosystem impacts in Europe. The report covers the period 1990–2004. In the 32 EEA member countries measured concentrations of particulate matter and ozone in the air have not shown any improvement since 1997, despite a decrease in emissions. Fine particulate matter ($PM_{2.5}$) is now generally recognised to be the main threat to human health from air pollution. As sulphur emissions have fallen, ammonia emitted from agricultural activity and nitrogen oxides from combustion processes have become the predominant acidifying and eutrophying agents affecting ecosystems.

Reporting on Ambient Air Quality Assessment – Preliminary Results for 2006

F. de Leeuw, E. Vixseboxse, European Topic Centre on Air and Climate Change, Bilthoven, The Netherlands 2007, Technical Paper 2007/5, 22 pages, also available through the web: http://air-climate.eionet.europa.eu/reports/docs/ETCACC_TP2007_5_anlalysis_AQQ2006.pdf.

EU Member States have submitted annual reports on air quality in 2006 to the European Commission under the Air Quality Framework Directive (96/62/EC). The reports were provided in the form of a predefined questionnaire. The present report gives a preliminary overview and analysis of the submitted information.
This report is based on information available at the European Topic Centre on Air and Climate Change on 27 November (that is, nearly 2 months after the official submission deadline). By that date, questionnaires from Luxembourg, Malta and of several regions within Italy were missing.

The analyses indicate that the designation of zones seems to be incomplete in a number of Member States. Zones designated for the protection of human health should cover the whole territory and the total population of a Member State. A nearly complete coverage is in general found for sulphur dioxide, nitrogen dioxide, PM_{10} (with exceptions for Belgium and Estonia) and ozone (except France).

Lower coverages are found in the case of lead, benzene and carbon monoxide. The number of zones where an exceedance of the limit or target values has been observed in 2006 does not differ strongly from the numbers observed in 2005. The limit values of PM_{10} (daily and annual) and nitrogen dioxide (annual) and the target value of ozone are the most frequently exceeded. Exceedances of the limit value of sulphur dioxide (both hourly and daily), carbon monoxide and lead are observed in a small number of zones (less than 5%).

The monitoring information on $PM_{2.5}$ concentrations is still limited: 20 Member States report data for 294 stations which is similar to the situation in 2005. Exceedances of the limit value of 25 $\mu g/m^3$ as annual mean are observed in 12 of the 20 Member States on reporting $PM_{2.5}$.

German Environmental Survey for Children 2003/06 (GerES IV): Human Biomonitoring. Levels of selected substances in blood and urine of children in Germany.

K. Becker et al., Federal Environment Agency (Umweltbundesamt), Dessau-Roßlau, Germany, WaBoLu-Hefte 01/2008, 85 pages, ISSN 1862-4340, also available through the web: http://www.umweltbundesamt.de/gesundheit-e/survey/index.htm.

GerES is a large scale population study to determine the exposure of the general population in Germany. 1.790 representatively chosen children from 150 sampling locations took part. The report provides the basic information on the human biomonitoring part of the survey by showing the levels of selected environmental pollutants or their metabolites in blood and urine of children in Germany.

Blood specimens were analyzed for lead, cadmium, mercury, polychlorinated biphenyls (PCB), dichlorodiphenyldichloroethylene (DDE), hexachlorobenzene (HCB) and hexachlorocyclohexane (HCH). In urine specimens, the levels of arsenic, cadmium, mercury, nickel, nicotine and cotinine, pentachlorophenol (PCP) and other chlorophenols as well as the metabolites of polycyclic aromatic hydrocarbons (PAHs), organophosphates and pyrethroids were determined. The report presents the statistical data also for sub-groups of children in Germany. This stratification which refers to variables like gender, age, social and migrant status provides, *inter alia*, valuable data for a national and international data comparison.

COMING EVENTS

2008

June 2008

11th InterNational Inhalation Symposium (INIS): Benefits and Risks of Inhaled Engineered Nanoparticles
11-14 June, Hannover, Germany.
For more information, see: http://www.inis-symposium.com/index.html.

17th International Symposium: Transport and Air Pollution
16-17 June, Graz, Austria.
For more information, see: http://vkm-thd.tugraz.at/tuengl/TAP08/TAP08_CallForPapers.pdf.

Air & Waste Management Association's 101st Annual Conference & Exhibition
24-27 June, Portland, Oregon, USA. For more information, see: http://www.awma.org/ACE2008/.

August 2008

Indoor Air 2008 – 11th Int. Conference on Indoor Air Quality and Climate
17-22 August, Copenhagen, Denmark.
For more information, see: www.idoorair2008.org.

European Aerosol Conference 2008
24-29 August, Thessalonoki, Greece. For more information, see: http://www.eac2008.org/.

September 2008

14th Conference on Urban Transport 2008
1-3 September, Malta. For more information, see: http://www.wessex.ac.uk/conferences/2008/urban08/index.html.

Air Pollution 2008 - 16th International Conference on Modelling, Monitoring and Management of Air Pollution
22-24 September, Skiathos, Greece.
For more information, see:
http://www.wessex.ac.uk/conferences/2008/air08/.

Inhaled Particles X Conference 2008
23-25 September, Sheffield, United Kingdom.
For more information, see:
http://www.bohs.org/newsArticle.aspx?newsItem=50.

October 2008

20th Conference of the International Society for Environmental Epidemiology (ISEE): Exposure and Health in a Global Environment
12-16 October, Pasadena, California, USA.
For more information, see:
http://www.iseepi.org/conferences/current.html.

International Public Health Symposium on Environment and Health Research
20-22 October, Madrid, Spain.
For more information, see:
http://www.euro.who.int/envhealth/policy/20080102_1.

2009

March 2009

Seventh International Conference on Air Quality – Science and Application (formerly Urban Air Quality Conference)
24-29 March, Istanbul, Turkey. For more information, see: http://www.airqualityconference.org/.

July 2009

Air Pollution 2009 – 17th International Conference on Modelling, Monitoring and Management of Air Pollution
20-22 July, Tallinn, Estonia. For more information, see: http://www2.wessex.ac.uk/09-conferences/air-pollution-2009.html.

August 2009

21st Conference of the International Society for Environmental Epidemiology (ISEE) – Food and Global Health
25-28 August, Dublin, Ireland.
For more information, see: http://www.isee2009.ie.

September 2009

Healthy Buildings 2009
13-17 September, New York, USA.
For more information, see: http://hb2009.org/.

EDITORS' NOTE

We appreciate submissions to NOTES AND NEWS regarding programmes and projects within the field. Notes (100-500 words) should be sent directly to the WHO Collaborating Centre for Air Quality Management and Air Pollution Control.

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http://www.umweltbundesamt.de/whocc/titel/titel21.htm