HelmholtzZentrum münchen
German Research Center for Environmental Health

Scientific Highlight Mai 2013

☒ co-ordinated with the Director of the Institute / Research Unit

Institute of Epidemiology II / Environmental Exposure Assessment

PSP-Element:
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Title of the highlight:
Ambient Air Quality in 36 European Areas – Results of the ESCAPE Project.

Keywords:
ESCAPE study, air pollution, long term exposure, spatial variation, Land Use Regression modelling

Central statement of the highlight:
The highly standardized measurements across Europe show great variations of exposure across Europe and within study regions. Ambient air quality standards may be exceeded more frequently than indicated by routine monitoring.

Text of the highlight:
Spatially resolved measurements of NO_2 and NO_x were performed in 36 study areas across Europe. PM_{10}, $PM_{2.5}$, soot and elemental content of $PM_{2.5}$ were measured for estimating annual average concentrations in 16 of these areas.

Substantial spatial variability of annual average concentrations within and between study areas for $PM_{2.5}$, PM_{10}, NO_2 and NO_x was observed. In most study areas EU limit values were exceeded, particularly for NO_2. This result indicates a clear need for immediate action. For most pollutants the concentrations were higher in Southern Europe and lower in Northern Europe.

The annual average concentrations were used to develop Land Use Regression (LUR) models by means of a standard procedure. LUR modelling utilizes the measured levels of pollutant as dependent variable and potential predictors (such as population density, land use, physical geography and various traffic-related variables) as independent variables in a multivariate regression model. Levels of pollution may then be predicted for any location, such as individual homes, using the parameter estimates derived from the regression model.

Measurements and modelling procedures were highly standardized. They are documented in the ESCAPE study manual, the exposure assessment manual, the

standard operating procedures for monitoring of PM and NO_2 / NO_x and the manuals for back-extrapolation of concentrations to the year of recruitment.

The results were published in four manuscripts due to the large amount of information. The distribution of NO_2 and NO_x concentrations in 36 areas is presented by Cyrys et al. (2012), whereas the distribution of $PM_{2.5}$ / PM_{10} concentrations in 20 areas is described by Eeftens et al. (2012a). Also, the manuscripts on the LUR models were published: Eeftens et al. (2012b) for $PM_{2.5}$ / PM_{10} and Beelen et al. (2013) for NO_2 /NO_x. All four papers describe the exposure assessment methodology as applied in the ESCAPE study and form the basis for the epidemiological research within the framework of this study.

Publications:

Cyrys, J., M. Eeftens, **J. Heinrich**, C. Ampe, A. Armengaud, R. Beelen , T. Bellander, T. Beregszaszi, M. Birk, G. Cesaroni, M. Cirach, K. de Hoogh, A. De Nazelle, F. de Vocht, C. Declercq, A. Dédelé, K. Dimakopoulou, K. Eriksen, C. Galassi, R. Gražulevičiené, G. Grivas, O. Gruzieva, A. Hagenbjörk Gustafsson, B. Hoffmann, M. Iakovides, A. Ineichen, U. Krämer, T. Lanki, P. Lozano, C. Madsen, K. Meliefste, L. Modig, A. Mölter, G. Mosler, M. Nieuwenhuijsen, M. Nonnemacher, M. Oldenwening, **A. Peters**, S. Pontet, N. Probst-Hensch, U. Quass, O. Raaschou-Nielsen, A. Ranzi, D. Sugiri, E. G. Stephanou, P. Taimisto, M.-Y. Tsai, É. Vaskövi, S. Villani, M. Wang, B. Brunekreef, G. Hoek: Variation of NO2 and NO concentrations between and within 38 European study areas: results from the ESCPAE study. Atmospheric Environment. 62, 374-390, 2012.

Eeftens, M., M-Y. Tsai, C, Ampe, B. Anwander, R. Beelen, T. Bellander, G. Cesaroni, M. Cirach, **J. Cyrys**, K. de Hoogh, A. De Nazelle, F. de Vocht, C. Declercq, A. Dédelé, K. Eriksen, C. Galassi, R. Gražulevičiené, G. Grivas, **J. Heinrich**, B. Hoffmann, M. Iakovides, A. Ineichen, K. Katsouyanni, M. Korek, U. Krämer, T. Kuhlbusch, T. Lanki, C. Madsen, K. Meliefste, A. Mölter, G. Mosler, M. Nieuwenhuijsen, M. Oldenwening, A. Pennanen, N. Probst-Hensch, U. Quass, O. Raaschou-Nielsen, A. Ranzi, E. Stephanou, D. Sugiri, O. Udvardy, É. Vaskövi, G. Weinmayr, B. Brunekreef, G. Hoek: Variation of PM2.5, PM10, PM2.5 absorbance and PMcoarse concentrations between and within 20 European study areas – results of the ESCAPE project. Atmospheric Environment. 62, 303-317, 2012a.

Beelen, R., G. Hoek, D. Vienneau, M. Eeftens, K. Dimakopoulou, X. Pedeli, M.-Y. Tsai, N. Künzli, T. Schikowski, A. Marcon, K.T. Eriksen, O. Raaschou-Nielsen, E. Stephanou, E. Patelarou, T. Lanki, T. Yli-Tuomi, C. Declercq, G. Falq, M. Stempfelet, **M. Birk**, **J. Cyrys**, **S. von Klot**, G. Nádor, M. János Varró, A. Dédelé, R. Gražulevičiené, A. Mölter, S. Lindley, C. Madsen, G. Cesaroni, A. Ranzi, C. Badaloni, B. Hoffmann, M. Nonnemacher, U. Krämer, T. Kuhlbusch, M. Cirach, A. de Nazelle, M. Nieuwenhuijsen, T. Bellander, M. Korek, D. Olsson, M. Strömgren, E. Dons, M. Jerrett, P. Fischer, M. Wang, B. Brunekreef, K. de Hoogh: Development of NO_2 and NO_x land use regression models for estimating air pollution exposure in 36 study areas in Europe - The ESCAPE project. Atmospheric Environment 72, 10-23, 2013.

Eeftens, M., R. Beelen, K. de Hoogh, T. Bellander, G. Cesaroni, M. Cirach, C. Declercq, A. Dédelé, E. Dons, A. de Nazelle, K. Dimakopoulou, K. Eriksen, G. Falq, P. Fischer, C. Galassi, R. Gražulevičiené, **J. Heinrich**, B. Hoffmann, M.

B. Brunekreef, and G. Hoek: Development of Land Use Regression Models for PM2.5, PM2.5 Absorbance, PM10 and PMcoarse in 20 European Study Areas; Results of the ESCAPE Project. Environmental Science Technology 46, 11195−11205, 2012b.

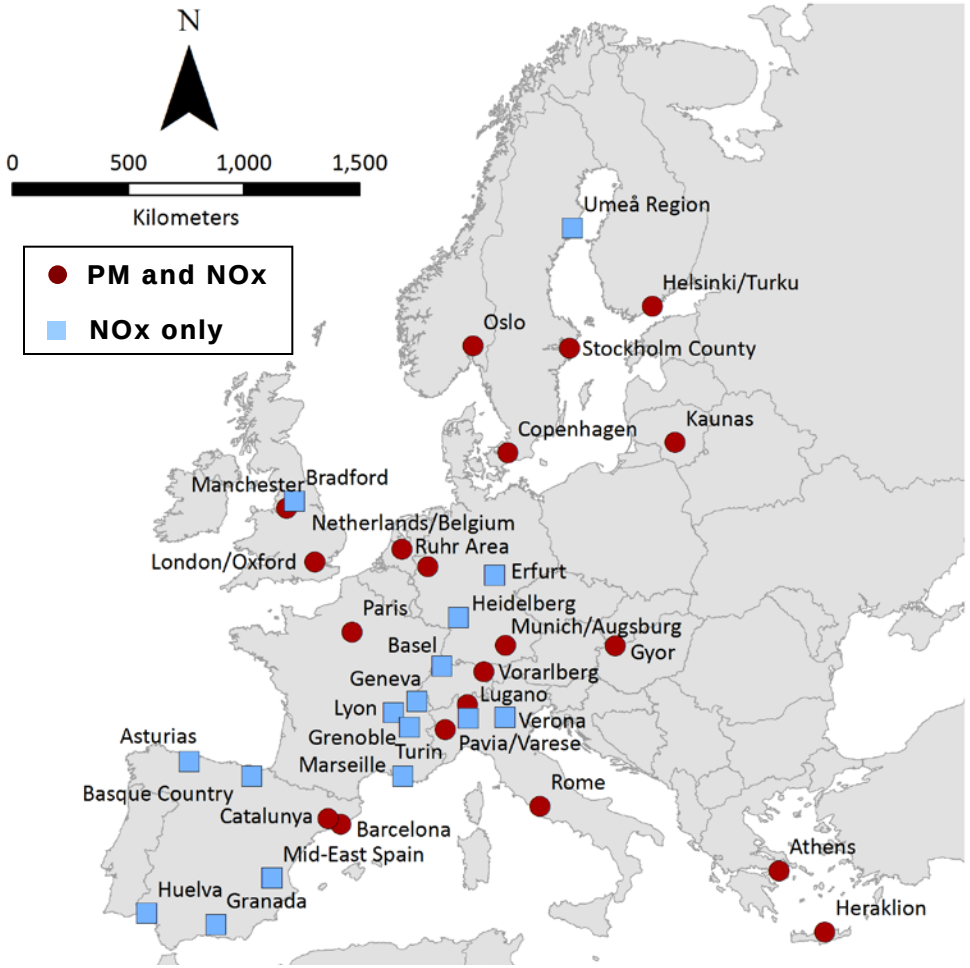
Taking account of the HMGU mission:
The results provide starting point for epidemiological research filling the critical data need identified when the European Union revised the Air Quality Directive in the 2005-2008 period.

The internal HMGU co-operation partners with whom the highlight was compiled, if appropriate:
Institute of Epidemiology I

European Study of Cohorts for Air Pollution Effects
ESCAPE

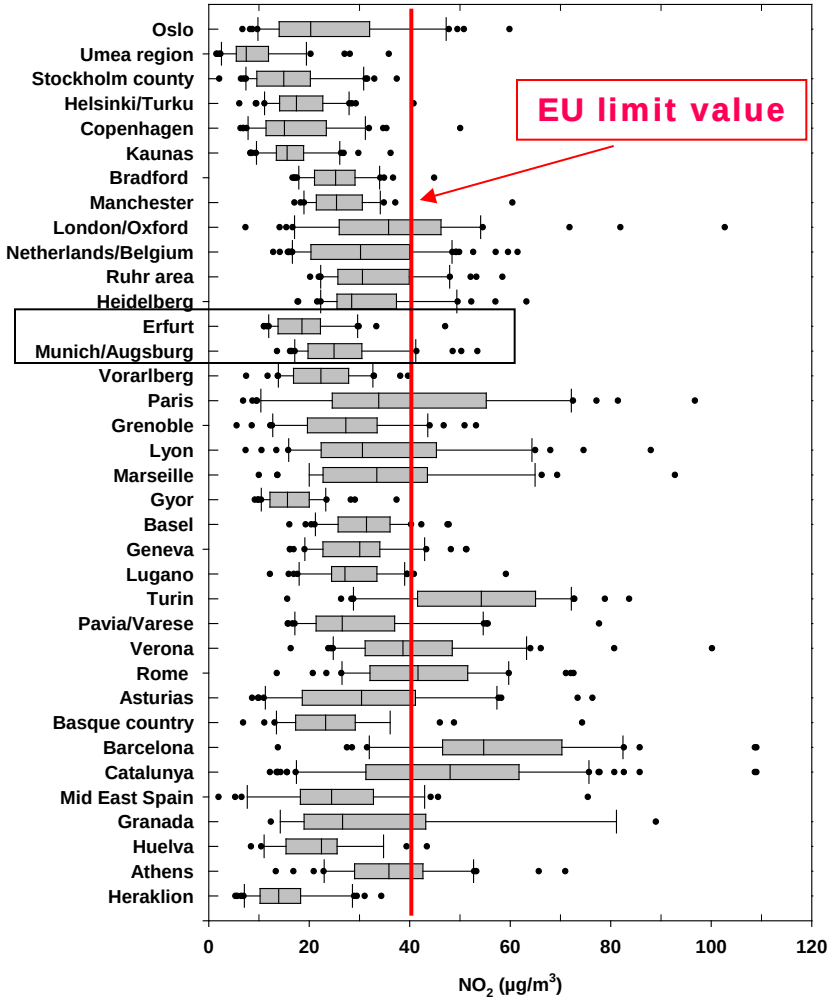
EPI II

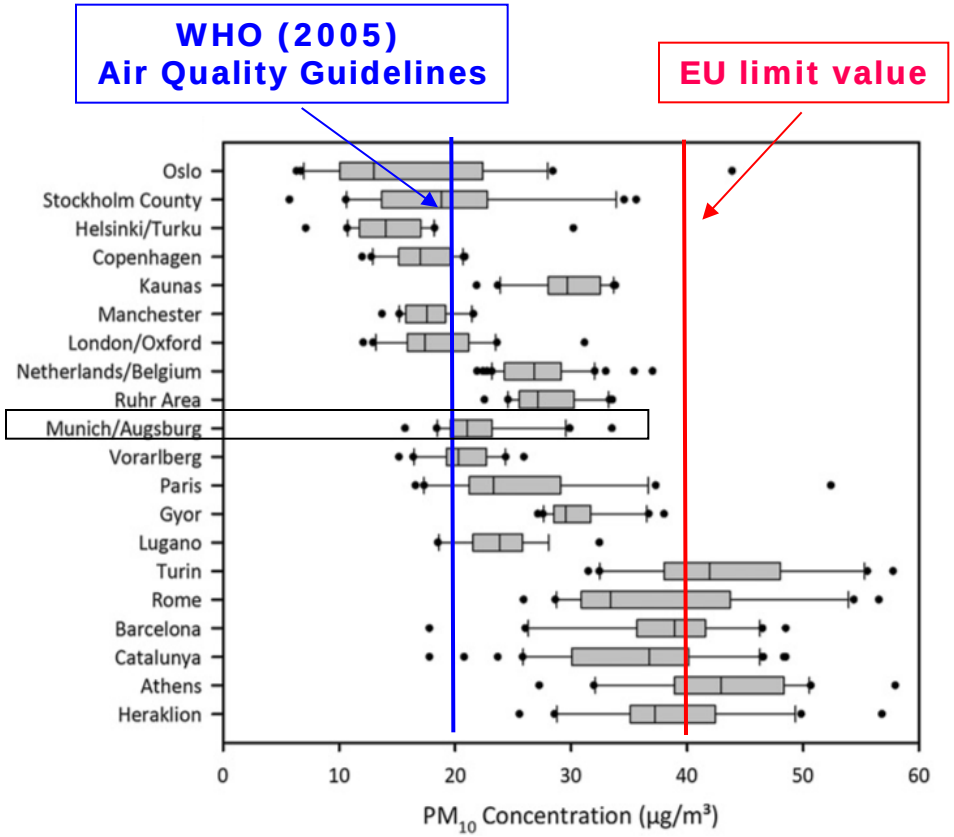
- Exposure assessment in 36 regions
- Health data from 30 cohorts
- 24 universities and research institutes from Europe involved



Comparison of the within area variability for NO_2 and $PM_{2.5}$

EPI II





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Adapted from Cyrys et al., 2012, Eeftens et al., 2012a

HELMHOLTZ ASSOCIATION

Modeling of exposure at the individual level by a land use regression model

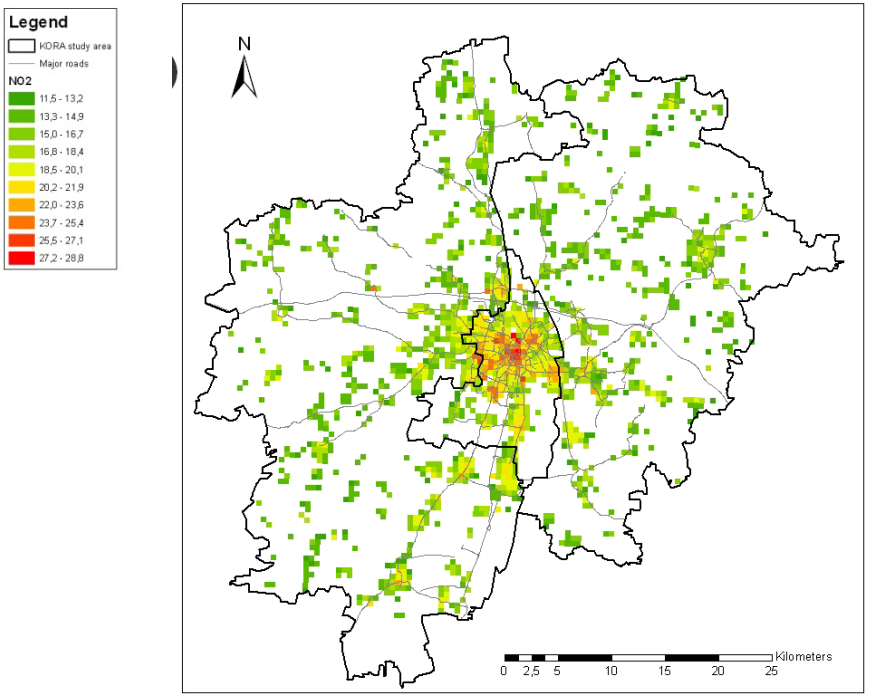
EPI II

- Air pollution measurements conducted at selected sites
- Collecting of input data (information on land use, address density, traffic intensity etc) for these sites using Geographic Information System (GIS)
- Development of a regression model for the monitoring sites based on the relevant input data
- Estimation of the ambient air concentrations at the home-addresses based on the regression model

Estimated NO_2 and PM_{10} concentrations for the KORA cohort in Augsburg

EPI II

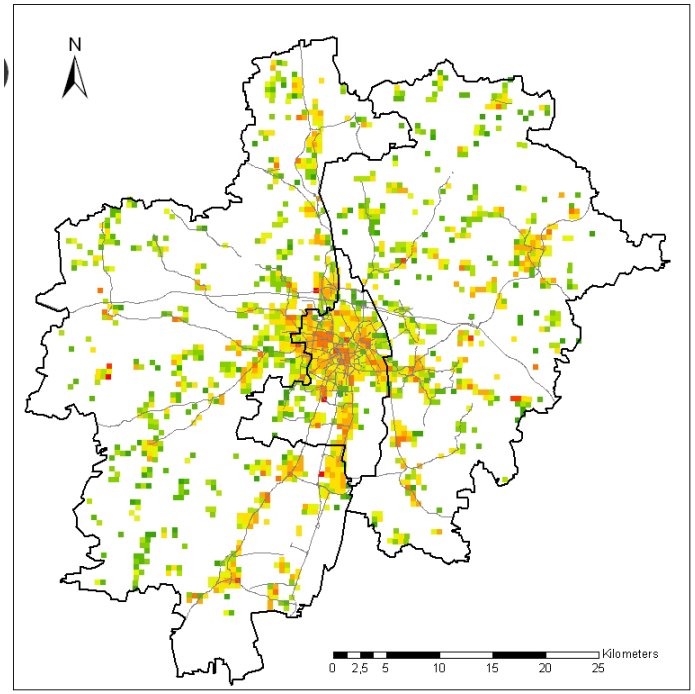
NO_2



LUR model NO_2	R^2
7.43 + 1.98E-6*TRAFLOAD_50 + 1.35E-3*INTMAJOR INVDIST + 2.37E-2*ROADLENGTH_50 + 1.47E-5*POP_5000 + 4.15E-2*MAJORROADLENGTH_50d + 9.85*HLDRES_500d	0.86

Beelen et al., 2013

PM_{10}



LUR model PM_{10}	R^2
18.47 + 3.89E-2*MAJORROADLENGTH_504–56.65* NATURAL_1004 + 2.07E-2*ROADLENGTH_504	0,83

Eeftens et al., 2012b