

## Methodology for measuring environmental health within Europe. Health Risk from Environmental Pollution Levels in Urban Systems (HEREPLUS)

Anja Zscheppang<sup>1</sup>, Fausto Manes<sup>2</sup>, Giuseppe La Torre<sup>3</sup>, Antonio Boccia<sup>3</sup>, Stephen Trueman, Dimosthenis Sarigiannis<sup>4</sup>, Kalabokas Pavlos<sup>5</sup>, Begoña Artíñano<sup>6</sup>, Cinzia Perrino<sup>7</sup>, Rosalía Fernández Patier<sup>8</sup>, Michael Rigby<sup>9</sup>, Slavenka Jankovic<sup>10</sup>, Wilhelm Kirch<sup>1</sup>

<sup>1</sup>Research Association Public Health, Institute of Clinical Pharmacology, Technische Universität Dresden, Germany; <sup>2</sup>Department of Plant Biology, University "La Sapienza", Italy; <sup>3</sup>Department of Experimental Medicine, Sapienza University of Rome, Italy; <sup>4</sup>Joint Research Centre, Italy; <sup>5</sup>The Academy of Athens, Greece; <sup>6</sup>Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Atmospheric Pollution Unit, Spain; <sup>7</sup>National Research Council Italy, Institute of Atmospheric Pollution, Institute of Agro-Environmental and Forest Biology, Italy; <sup>8</sup>Spanish National Institute for Health Carlos III - Air Pollution Division, Spain; <sup>9</sup>Keele University - Centre for Health Planning and Management, United Kingdom; <sup>10</sup>Faculty of Medicine University of Belgrade, Serbia

Correspondence to: Anja Zscheppang, Research Association Public Health, Institute of Clinical Pharmacology, Technische Universität Dresden, Fiedlerstraße 33, 01307 Dresden. E-mail: anja.zscheppang@tu-dresden.de

### Abstract

**Background:** The European Commission funds a European research project titled "Health Risk from Environmental Pollution Levels in Urban Systems" (HEREPLUS) that focuses on environmental health within Europe. The HEREPLUS project was presented at the 16th EUPHA conference in Lisbon in November 2008 within a workshop named "The assessment of the effect of air pollution on population and environmental health: the integration of epidemiology and geographical information system (GIS)".

**Methods:** The HEREPLUS project aims to measure the correlation between air pollution (especially ozone and particulate matter), meteorology, vegetation and human health in four European cities (Rome, Madrid, Athens and Dresden) by using a Geoinformation System to develop risk maps and subsequently guidelines to reduce air pollution and number of diseases.

**Results:** The project started in September 2008 and a large, structured, relational database has been developed and completed. A literature review including national as well as international scientific literature goes on and will be completed in April 2009. Final results will be presented and published in 2011.

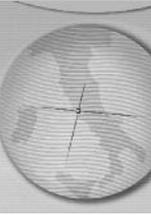
**Conclusions:** Detailed scientific knowledge is important and needed to implement environmental programmes with the overall aim to protect human population against environmental related diseases.

*Key words: environmental health, HEREPLUS, air pollution*

### Background

Air pollution is still a global problem affecting nearly all European countries. It is of particular importance to know that air quality affects human health in urban as well as in rural areas and that high level of air pollutants such as ozone and particulate matter may cause various diseases. Humans living in and near big cities are especially at high risk for becoming ill because air pollution concentration is, mostly, highest in urban areas. These people are considered to be vulnerable for falling ill with environmental related diseases such as different kinds of cardiovascular and

respiratory diseases. Only a small number of persons living in Europe were not resident in urban areas between the years 1997 and 2006. Most people were resident in cities for 1 to 25 days a year, as well as 25 days and more, whereas in 2003, more than 50 percent spent more than 24 days of their time in cities (EEA member countries: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain,



Sweden, Switzerland, Turkey, United Kingdom). In 2004, 25% of the total population from 362 cities resided in cities (whereas 321 cities are EU-27 cities, and 41 are non-EU cities from Norway, Switzerland, Croatia, and Turkey) [1]. The high number of days that people spent in urban areas emphasises the need for good air quality not only in rural areas but also in large cities.

Environmental reports published by the European Environmental Agency show ozone exposure in Europe during summer 2007 by illustrating the number of days, that exceed the long-term objective for the protection of human health, during summer 2007 [2]. Highest ozone concentration was found in Southern and Eastern Europe. In contrast, ozone concentration was not a problem in the northern part of Europe. To enhance the air pollution situation in Europe, the European Commission initiated and passed a European legislation on ozone that aims at protecting health against environmental related diseases [3]. Therefore, a target value of  $120\mu\text{g}/\text{m}^3$  as a maximum daily 8 hour average shall not be exceeded on more than 25 days per year [3]. Experts state that up to this value a health risk does not exist. But ozone concentration in Europe frequently exceeded this threshold, with big cities recording very high concentrations [3]. In Southern and Eastern Europe ozone concentration exceeded the target value on more than 25 days a year, whereas the target value was not exceeded on any day in Scandinavia. Target values as well as European Directives also exist for further air pollutants such as particulate matter, sulphur dioxide as well as nitrogen dioxide [4].

Health in connection with air pollution can be measured with different methods which can include epidemiological approaches, clinical studies or laboratory research. A strong correlation between air pollution and respiratory diseases as well as between air pollution and cardiovascular diseases has been confirmed by many research projects [5]. The strength of association between air pollution and respiratory diseases is very likely and ranges between 90-99 percent [6]. Important health effects associated with air pollution exposure were additionally shown in a WHO project titled "Systematic Review of Health Aspects of Air Pollution in Europe" [7]. Short term exposure to ozone and particulate matter may affect numerous diseases including lung inflammatory reactions, respiratory symptoms, adverse effects on cardiovascular system, increased medication usage, a higher number of hospital admissions and mortality. Effects of long time exposure to ozone is a

reduction in lung function development. Long time exposure to particulate matter may lead to a rising number of lower respiratory symptoms and chronic obstructive pulmonary diseases, and further may cause a reduction in lung function in adults, in children and in life expectancy.

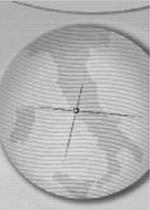
All of these described facts led to the initial project proposal for a European research project titled "Health Risk from Environmental Pollution Levels in Urban Systems" (HEREPLUS) that was approved by the European Commission within the Seventh Framework Programme.

### Aim and Method

HEREPLUS is a European research project that is funded by the European Commission, it started in September 2008 and will finish in February 2011. Project partners come from six European countries: Italy, Spain, Greece, Germany, United Kingdom, and Serbia. The working group is made up of ten institutions located in Europe (Consorzio Sapienza Innovazione, Italy; University of Rome "La Sapienza", Italy; Technische Universität Dresden, Germany; Joint Research Centre - Institute for Health and Consumer Protection, Italy; The Academy of Athens - Research Centre for Atmospheric Physics and Climatology, Greece; Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Spain; Faculty of Medicine University of Belgrade, Serbia; Keele University - Health Policy and Professional Practice, United Kingdom; National Research Council Italy, Italy; Spanish National Institute for Health Carlos III - Air Pollution Division, Spain).

The current air pollution situation and resulting health status in Europe emphasises the need for additional research that should aim to study the correlation between meteorology, air pollution, vegetation, urban structures, mortality and morbidity. Geographic Information Systems enable us to illustrate air pollution and health situation with risk maps by linking air pollution, such as ozone and particulate matter, to the main cardio-respiratory diseases at the local level. Risk maps will be developed for four European cities, Rome, Madrid and Athens, which are very large metropolises in South Europe, as well as for Dresden, which represents a large city in Central Europe. Subsequently, guidelines will be delivered addressing municipal managers, administrators, stakeholders as well as environmental agencies at both national and European levels.

HEREPLUS follows an international multidisciplinary approach that is called for in particular by the following two Actions of the European Environment & Health Action Plan [8].



Action 4 of the European Environment & Health Action Plan enhances coordination and joint activities on environment and health. Action 7 highlights the necessity to develop methodological systems to analyse interactions between environment and health. To achieve these aims, the use of time series statistics as well as information about spatial distribution of risk factors and geographic variation of diseases are inevitable, firstly to cover pollution health risks, secondly to research the association between air pollution and health and thirdly to increase the knowledge about the association between exposure and health outcome.

The project is divided into essential and important tasks including a literature review and the development of a database, followed by data entry, data analysis and the construction of risk maps. A decision-support system will be created leading to the dissemination of results and an Operational Manual.

One of the first tasks is a systematic review of national and international scientific literature that focuses on current methods of monitoring the link between air pollution and population health. Various methods are used to develop the risk map assessment. These methods are explored for comparison. Common points between methods are extracted from the literature making it possible to share the same methodology in all of the project countries.

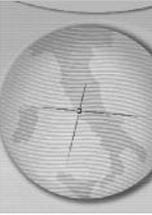
At the same time a large structured standardised relational database is being developed, which is compliant with GIS technology with the aim to produce standardised risk maps. The database and the risk maps make it possible to increase the knowledge on the pollutant concentration in urban areas and their relationship with mortality and morbidity. With the help of the database the role of green areas can be characterised. To describe the association between air pollution and health spatial information (geo-referenced data), temporal information (time series), epidemiological, air pollution, meteo-climatic, vegetation, and ancillary data (such as population density) are measured. Time series are the best way to reproduce changes over time. Data are collected for the years 2003, 2004 and 2005 including the heavy summer of 2003 [9]. The project does not survey its own data but uses existing quantitative data for the previous years collected by public agencies and ministries and available from official statistics. Data that are collected rather than surveyed makes it possible to produce risk maps in a very short time. State Ministries, such as Environment Departments, have

data available for green and non-green areas, for climate and air pollution, whereas epidemiological data can be obtained from hospital discharge documents or hospital statistics. All causes of diseases and causes of mortality excluding accidents are considered such as lung cancer, cerebrovascular diseases (stroke), cardiovascular and respiratory diseases (such as acute and chronic bronchitis and asthma in children and adults).

Air pollution data, meteo-climatic data, vegetation data, epidemiological data and other data are integrated into the database. All of the data is supplied to the GIS as it is a valuable tool for processing, analysing and visualizing spatial and temporal data. Health problems can be identified, while influences of spatial patterns and short and long-term influences on health in local positions can be verified.

Previous research shows that acute/ chronic respiratory and heart diseases are associated with air pollutants such as ozone and particulate matter. Research further clarifies that mortality and morbidity data increase with an increase in air pollution concentration [10, 11]. The HEREPLUS project aims at proving the association between environmental risks and the presence of cardio-respiratory diseases for each of the four local urban areas (Rome, Madrid, Athens, and Dresden) by integrating pollution distribution with mortality/morbidity distributions and density of the local population. Risk maps can determine the geographic relation between environmental risk and exposure as well as between exposure and the occurrence of environmental related cardiovascular and respiratory diseases. Currently, there is a lack of maps pertaining to the risks for many large European cities. Additionally, the project wants to develop and use new epidemiological and statistical approaches, for example, to take in consideration potential confounding factors, such as missing data.

From the risk maps developed for four large European cities located in different environmental conditions a decision-support system can be created. The project will develop guidelines and best practices in the form of an Operational Manual with the overriding objective of minimizing sanitary and societal costs. From the beginning on, local experts will be involved in the decision-support analysis process. Results will be presented in four national and one European workshop as well as on the project's website. The above-mentioned Operational Manual will be disseminated to policy makers, public administrators, territorial operators, etc. at local, national and European levels.



## Results

Results in the form of robust correlations of air pollution and climate data with morbidity and mortality data will clarify how the environment influences human health in the cities of Rome, Madrid, Athens and Dresden as well as in general.

## Conclusions

The HEREPLUS project is characterised is innovative. It provides data for Central as well as for South Europe. Data for South Europe (Madrid, Rome, and Athens) can be compared with data for Central Europe (Dresden), and furthermore these four large cities can be compared with each other in terms of air pollution and health conditions. The project therefore follows a transnational dimension. Researchers with different scientific backgrounds, for example epidemiologists, statisticians, GIS experts, environmental scientists and sociologists, from six European countries allows for an interdisciplinary and multiprofessional approach.

In summary, data concerning urban pollution, climate and the health situation for different time periods are extremely relevant. Consolidated and extensive knowledge about the causal association between air pollution and adverse health effects should form the basis for action. However until now, there has been a gap in our knowledge base.

It should be the substantial aim to reduce air pollutant concentrations for our future, in order to reduce long-term effects and chronic diseases. It is necessary to initiate laws and regulations as well as actions that will lead to cleaner air and therefore better health status, as it is of the utmost importance to protect human health.

## References

- 1) European Commission. Kommission zieht „Bilanz der Lebensqualität“ in 321 europäischen Städten [The Commission draws “balance of life quality” in 321 European cities]. IP/08/1387. 2008;09.
- 2) European Environment Agency. Air pollution by ozone across Europe during summer 2007. Technical Report 5. Copenhagen, 2008.
- 3) Directive 2002/3/EC of the European Parliament and of the Council of 12. February 2002 relating to ozone in ambient air, 2002 (2).
- 4) European Environment Agency. Air pollution in Europe 1990-2004. EEA Report No 2. Copenhagen, 2007.
- 5) Cai QC, Lu J, Xu QF, Guo Qet al. Influence of meteorological factors and air pollution on the outbreak of severe acute respiratory syndrome. *J Royal Inst Pub Health* 2007;4:258-65.
- 6) European Environment Agency. Environment and Health; Report No 10. Copenhagen, 2005.
- 7) WHO Regional Office for Europe, editor. Systematic Review of Health Aspects of Air Pollution in Europe 2004. No. 2121.
- 8) Commission of the European Communities. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee. “The European Environment & Health Action Plan 2004-2010”, 2004(SEC):729.
- 9) Meusel D, Menne B, Kirch W, Bertollini R. Public Health Responses to extreme weather and climate events - a brief summary of the WHO meeting on this topic in Bratislava on 9 - 10 February 2004. *J Pub Health* 2004;12:371-81.
- 10) Liang WM, Wei HY, Kuo HW. Association between daily mortality from respiratory and cardiovascular diseases and air pollution in Taiwan. *Environ Res* 2009;109(1):51-8.
- 11) McKone TE, Ryan PB, Ozkaynak H. Exposure information in environmental health research: current opportunities and future directions for particulate matter, ozone, and toxic air pollutants. *J Expo Sci Environ Epidemiol* 2009;19(1):30-44. Epub 2008, Apr 2.