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European Commission funded program on the impact of air pollution on population health: the example of HEalth Risk from Environmental Pollution Levels in Urban Systems (HEREPLUS Project)

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Abstract

HEalth Risk from Environmental Pollution Levels in Urban Systems (HEREPLUS) project has been thought and carried out to fill some of the identified gaps in the evidence base and develop and apply an integrated methodology for assessing and quantifying the health risk associated to outdoor pollution exposure and for investigating the potential mitigating role of urban green. Results of HEREPLUS have demonstrated that these are no watertight compartments and that some issues should be tackled in an integrated approach. For instance, benefits from a proper selection of vegetation species in a city could be assessed in terms of load of pollutants removed from the atmosphere, and furthermore this data translated into health benefits. Additionally, health outcomes could be better interpreted in terms of a spatial analysis that previously had defined the high risk areas associated to a specific pollutant and, in consequence, action plans can be defined taking into account this geo-referenced information.

Keywords: *air pollution; population health; urban green; mitigation; risk mapls.*

Project background

In EU countries, environmental impact assessment has been implemented as part of planning control, with the implementation of Directives 85/337/EEC, 97/11/EC, and the Air Quality Directive (2008/50/EC). Guidelines for health impact assessment have been produced in several countries. During the past three decades, more and more research findings have pointed to urban green spaces as a resource in promoting public health [1]. In fact, the so called "ecosystem goods and services" [2] are known to sustain human health and well-being and, in their turn, are affected by the relationship between ecosystem functioning, stability and biodiversity [3]. Despite it is known from years that vegetation plays an important role in the photochemistry of atmospheric pollutants, as a source of biogenic volatile compounds, precursors of ozone, none of the criteria applied for urban green management relate to air pollution [3].

In this contest HEREPLUS (HEalth Risk from Environmental Pollution Levels in Urban Systems) project has been thought and carried out to fill some of the identified gaps in the evidence base and develop and apply an integrated methodology for assessing and quantifying the health risk associated to outdoor pollution exposure and for investigating the potential mitigating role of urban green [4].

The final objective of the project is the provision of guidelines for urban managers and administrators responsible for urban environmental management measures aiming at minimizing the health cost of urban air pollution.

EU-project HEREPLUS

The common methodology developed has been applied in four cities in EU (Rome, Athens, Madrid and Dresden) during 2003-2004. Seasonal air pollutants distribution maps (PM_{10} and ozone) have been produced for each city. Cardiovascular and respiratory events were collected using hospital discharge data: ICD-10 codes J00 to J99 and ICD-10 codes I00 to I99.

The outcomes variables were daily respiratory or cardiovascular morbidity and mortality among persons residing in the four cities across the study period. The GIS (Geographic Information System) approach allowed to produce risk maps of the estimated absolute number of cases (aggregated on municipalities) attributed to the exposure to the studied pollutants.

Results achieved

- Review of the scientific literature (478 papers) on methods used to monitor the link between air pollution and health and environmental data. The results have been used to frame and underpin data collection and analysis, and for developing air pollution, vegetation and epidemiological models.

- Integrated databases, arranged on a geographical basis for each of the four cities, and covering the period 2003-2005 with climatic and pollution data, individual epidemiological data (mortality and morbidity potentially associated to O3 and PM pollution), the distribution and covered area of urban parks and gardens, eco-physiological data of the main woody species representing the urban vegetation. The databases have a relational structure, and contain geo-referenced data.
- Modelling simulations of the response of human health to O3 and PM concentrations, encompassing both collating the best available epidemiologically-derived concentration-response models, and adapting existing models to local situations (sanitary districts).

- Modelling simulations of O3 **(Figure 1)** and PM uptake/deposition **(Figure 2)** dynamics by woody vegetation in the different conditions. The daily amount of O3 and PM10 depositions to urban vegetation of Rome and Madrid have been estimated, by applying the MOCA-Flux and CHIMERE models, which have been parameterized by local vegetation data (geographic position, structure and function of the main woody species), previously collected and included in the database.

- Production of distribution maps of O3, PM10 and environmental variables, by using geo-statistical approaches, atmospheric modelling or a combination of both. On the basis of these maps, the quantification of the vegetation sink capacity for O3 and PM10 is under completion for each sanitary district.

- Involvement of Stakeholders, which participated to 2 of the meetings and led to a report confirming their interest in potentially applying project outputs to the routine management practice of urban quality policies.

- Integrated health risk maps, in GIS environment, for the urban areas (Rome, Madrid, Athens, Dresden).

- Operational manual based on the assessment of risk maps and targeted to local public bodies.

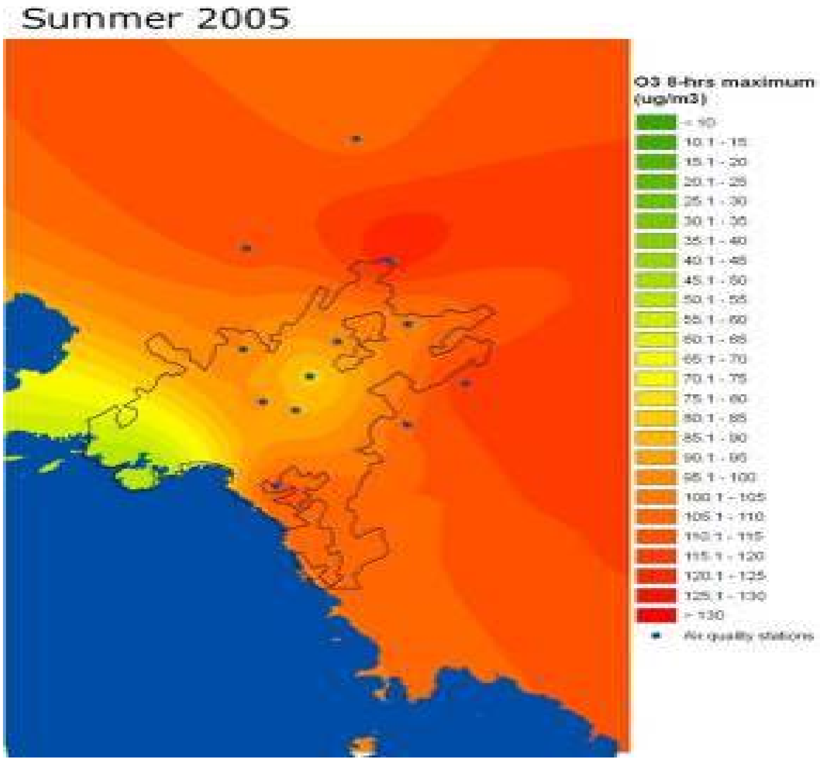

Figure 1 - Kriging model of O3 8-hrs maximum daily average seasonal distributions in the Greater Athens Area during summer 2005.

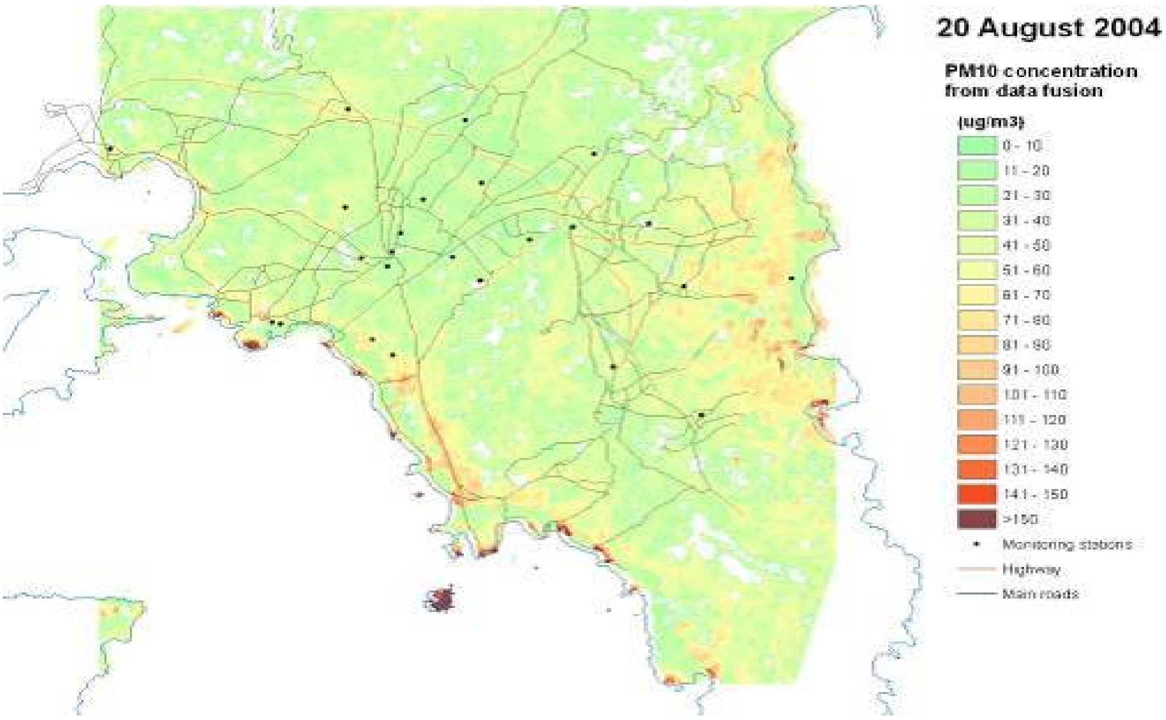

Figure 2 - High resolution map of ambient air PM10 concentration filed in Athens on August 20th 2004 (black dots denote the location of the ground monitors).

Contributions of HEREPLUS

Results of HEREPLUS have demonstrated that these are no watertight compartments and that some issues should be tackled in an integrated approach [5].

For instance, benefits from a proper selection of vegetation species in a city could be assessed in terms of load of pollutants removed from the atmosphere, and furthermore this data translated into health benefits.

Additionally, health outcomes could be better interpreted in terms of a spatial analysis that previously had defined the high risk areas associated to a specific pollutant and, in consequence, action plans can be defined taking into account this geo-referenced information [3].

In summary:

- Urban green spaces as a multifunctional system are significant for sustainable development, providing substantial ecosystems services for human well-being.
- A deeper knowledge on the role of different vegetation types is crucial to ameliorate detrimental environmental conditions (e.g. poor air quality) and health-related quality of life.
- The main motivation for conserving urban biodiversity can be summarized as follows:
    - to provide ecosystem services to improve human health and well-being in a global change context
    - to preserve important local biodiversity and ecological corridors
    - to provide environmental education

- There is the need for assessing abandoned urban sites, both built an non built, to be included in restoration planning aimed at increasing vegetation cover and maintaining local biodiversity structure and functions.
- There is the need to coordinate the activities among the environment, health and mobility decision-makers, to better transfer the scientific knowledge obtained by multidisciplinary studies related to GIS analysis of green areas in urban environment, and in elaborating plans for improving the quality of citizens living in urban areas.

This study might be affected by the following limitations. Health outcomes, mortality and morbidity endpoints studied in the HEREPLUS project are grouped outcomes, including the whole group of respiratory diseases and the entire cardiovascular diseases group.

More specific respiratory and cardiovascular outcomes such as infarction, asthma, bronchitis, lung cancer, etc. might allow a more precise relative risk estimation (if the statistical power of the study was high enough). The risk estimations have not been carried out by age groups, but in the whole all-ages population. The study of the effect of air pollutants on vulnerable groups like children, elderly or patients with preexisting diseases would be useful for a more precise relative risk estimation (if the statistical power of the study was high enough).

Another limitation is it should be pointed out that the air pollutants concentrations assigned to an area are not real values, but theoretical values obtained by calculating the means of air pollutants concentration values coming from different stations in each defined area.

Outlook

Best practice recommendations cover primarily two aspects:

1) Improvement of air quality monitoring networks, for a better assessment of the spatial extent of urban air pollution and its impacts on public health;

2) Better management of urban forests to enhance their pollution removal capacity, also through the conservation of local biodiversity, with its structural and functional traits adapted to site-specific climatic and environmental conditions.

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