Air4EU

Air Quality Assessment for Europe: from local to continental scale

6th Framework Programme- Policy oriented Research

Priority 8.1 Topic 1.5 Task 2

Publishable final activity report

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Organisation:	**TNO**

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Executive Summary

Air4EU has addressed policy-oriented research on integrated air quality (AQ) assessment by combining monitoring and modelling at different temporal and spatial scales. The spatial scales are the local/ hot spot scale, the urban scale and the regional/continental scale. Due to the strong involvement of the City-partners in AIR4EU, the focus has been on the regulated compounds PM_{10}, NO_2 and O_3. The combination of modelling and monitoring leads to internally consistent and comprehensive air quality concentrations maps with an uncertainty which is less than the uncertainty of monitoring and modelling separately.

AIR4EU in its aim to support the Clean Air for Europe-CAFÉ-programme, has strengthened the links between research and policy, and has developed recommendations for best methods and techniques for conducting air quality assessments. To ensure the policy relevance of the recommendations a high-level expert group comprising also Directorate General Environment has been established.

AIR4EU has produced two major results:

- **A guidance document on best practices/recommendations:** in fact Best Available Technology-for the combined use of monitoring methods and models to assess AQ in Europe from hot spot/street level, via urban to continental scale.
- **Maps of air quality-A Mapping Tool:** based on available data sets and best technique of assessment. These maps are an illustration of the application of the recommendations.

The products developed by AIR4EU directly benefit EU stakeholders including policy makers and city, national and regional users. Research objectives in AIR4EU were directed to review the benefits and drawbacks of existing modelling and monitoring methods for different spatial and temporal scales. Criteria for the review are parameters such as accuracy, input requirements and representativeness of the data. These parameters were evaluated against the requirements for different policy purposes. This has resulted in recommended methods for AQ assessment with emphasis on the combined use of monitoring and modelling. AIR4EU has also prepared AQ maps at different scales in Europe based upon available data sets and the recommended methods.

AIR4EU facilitated the co-operation of European scientists with complementary skills in the field of AQ assessment with relevant stakeholders. The cooperation of researchers from six member states representing four universities and two research institutes, as well as eight user partners supported the establishment of the European Research Area.

In the project the City-partners/ users have been consulted about their requirements for AQ-assessment, including the specific needs of their city. Subsequently, the wide variety of existing methods, both monitoring and modelling, and its combination, by which AQ-assessment is carried out has been reviewed for the three scales involved, hot spot, urban and regional.

Important so-called Cross Cutting issues have been addressed and analysed which are vital for an adequate AQ-assessment: Emissions and data needs, Uncertainty of models and modelling, Representativeness of model outputs and monitoring data, Scale interactions and Data assimilation.

Based on the performed reviews and the specifically addressed issues, first recommendations have been formulated for the combined use of monitoring and modelling on the three scales. These recommendations have been tested and improved upon, as far as possible, in 14 Case Studies which have been performed in close cooperation with the City users. All these resulted in the guidance document on best recommendations, and in a mapping tool to illustrate the applications.

All the produced documents, the 14 Deliverable Reports, the 14 Case Study Reports, the 3 Topic Reports and the 5 Cross Cutting Issue Reports, and the presentations given about AIR4EU at different workshops and meetings are available on the AIR4EU web-page: www.air4eu.nl, which also contains a link to the mapping tool. In the course of the project two open workshops have been held to present and discuss the AIR4EU results; in Athens in June 2005 and in Prague in November 2006. The results of the project have been evaluated and commented by a high-level expert group, for this purpose a specific workshop has been held in June 2006 in Brussels

The final results and different aspects of AIR4EU will be presented in about 15 oral presentations at different conferences in 2007, and about 5-8 double refereed papers will be written and submitted during 2007.

1 Project execution

1.1 Project objectives

The overall aims/objectives of the project AIR4EU have been:

- To formulate a guidance document on best practices for the combined use of monitoring methods and models to assess air quality in Europe from hotspot/street level to continental level for various users on local, national, regional and European level and for various purposes
- To prepare maps of air quality in Europe based on the available European wide data sets and best technique of assessment.

The focus in the study has been to develop and apply the combined use of monitoring and modelling, which should lead to AQ-assessment with a smaller uncertainty than the uncertainty of AQ-assessment based on monitoring or modelling separately. In order to achieve these overall aims, a set of operational measurable objectives have been specified, each linked to one or more of the work packages and contributing to one or more of the project products and deliverables.

1.2 Partnership

The project facilitated the co-operation of European scientists with complementary skills in the filed of air quality assessment and users on the city- and regional level. The project comprised 14 partners from 9 European countries. Six partners were mainly driving the research in Air4EU, eight were acting as users on the city and regional level. The project was coordinated by TNO and was supported by Heich Consult from Germany. In addition, a high level expert group was established and regularly consulted to review the progress aiming to enhance the applicability of the results.

Research Partners

The scientific work has mainly carried out by the six research partners comprising two research institutes: TNO – The Netherlands Research Organisation and NILU – Norwegian Institute for Air Research; and four universities: Aristotle University Thessaloniki (GR), University of Stuttgart (DE), University of Hertsfordshire (UK) and the University of Aveiro (PT)

City/regional users

Next to these six research organisations, seven so-called City Users were partners in the project: Airparif-Paris, STA/ATAC-Rome, EA-London and UK, URM-Prague, ENVECO-Athens, DCMR-Rotterdam/Rijnmond and OPHA-Oslo.

High-level Expert group

The expert group comprised delegates from seven organizations: Joint research Center (IT), European Environment Agency (DK), EMEP (NO), European Topic Centre Air and Climate change (NL), European Commission DG ENV (BE), Municipality of Berlin (DE), Council of European Municipalities and Regions (BE).

1.3 Project structure

The project was broken down into eight work packages and five cross-cutting issues to address the various scientific topics in an appropriate way. Figure 1 depicts the project elements and their interrelation. This structure took account of the complexity of the project and ensured, together with a flexible and iterative working method, that good quality results have been delivered. The key element of the project structure was the establishment of the five cross-cutting issues Emissions, Uncertainties, Representativity, Scale Interactions and Data Assimilation. Together with the WPs 3, 4 and 5 who are addressing the different spatial scales an efficient matrix structure was developed and successfully implemented throughout the project lifetime. The project-structure with (horizontal) Work Packages and (vertical) Cross Cutting Issues has the advantage that specific issues, like emissions, are treated coherently over all three spatial scales. However, this matrix-structure also leads to duplications, and required more interactions and close coordination.

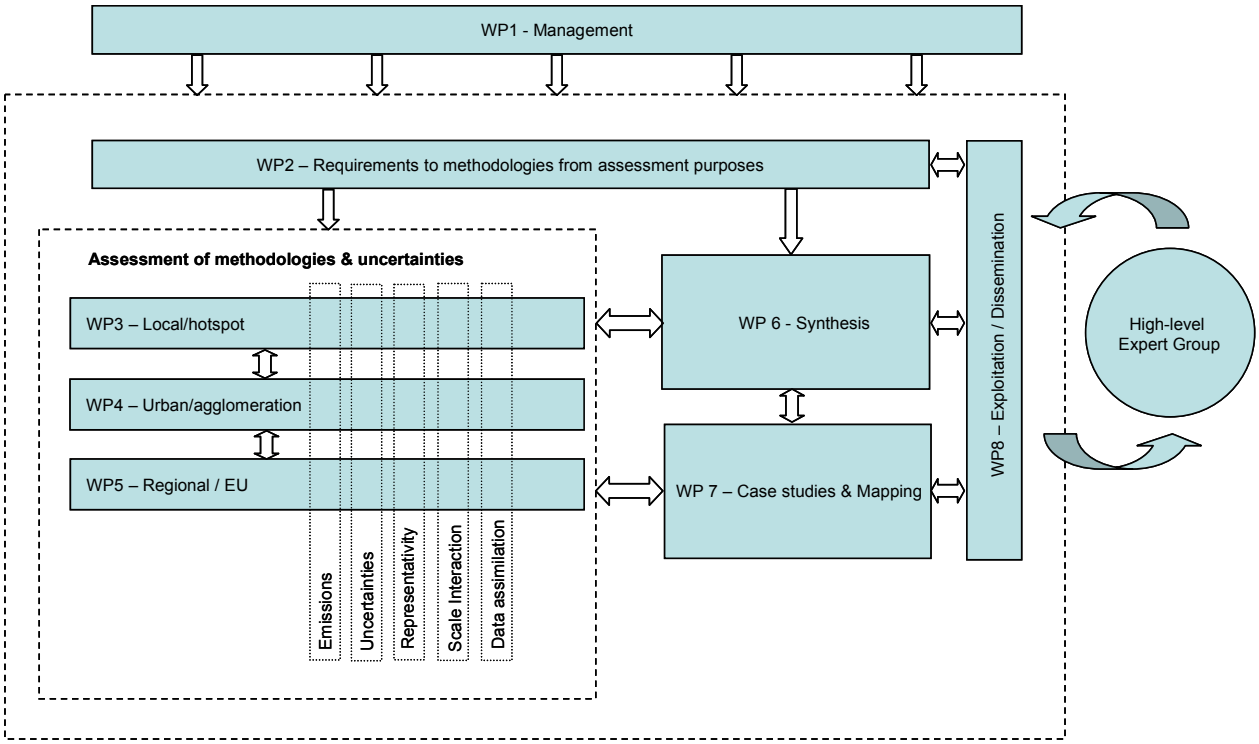

Figure 1: Air4EU structure

1.4 Work performed

The work was broken down into several, subsequent work steps. The matrix structure involving spatial aspects as well as the cross-cutting issues provided the backbone of the work sequence.

It should be noted that the involvement of city-users in this research project has been essential in achieving the final results of AIR4EU. There was a clear tendency by the research partners to produce results that where too scientific, and not applicable by the city-users, notwithstanding that the cities involved where all quite advanced in AQ-assessments. To address this bias, the recommendations have been divided into basic recommendations, best practice recommendations and scientific recommendations.

The various steps are described below. However, the complexity of the project made several iterations between the work steps necessary.

User analysis & policy framework

The research started with an analysis to define the user needs and the policy framework. The investigations have been done in close co-operation with the city/regional users and by consulting the members of the expert group. The outcome of this work was a report on requirements and user needs for air quality assessment by European, national and local authorities including the relevant features (e.g. accuracy, representativeness, quality control) of air quality data for different policy purposes.

Detailed reviews

Subsequently a detailed review has been carried out of monitoring and modelling methods on the three spatial scales: the hot spot scale, the urban scale and the regional/continental scale. One review for each of the spatial scales has been carried out separately. The reviews examined the most frequently used modeling approaches employed for air quality assessments, introduces practical examples of such applications, reflected on the use of emission-, meteorological and topographical data and considered the repesentativeness and uncertainty aspects.

The review clearly indicated that both monitoring as well as modelling methods are quite advanced, however that the combination of modelling and monitoring is still in its infancy, although clear progress has been made over the last years.

Three reports (D3.1; D4.1; D5.1) describing the findings in detail are available.

Cross-cutting issues

In parallel to and in interaction with these reviews five so-called cross cutting issues have been studied namely

- Emissions and Data needs,
- Uncertainty of models and monitoring,
- Representativeness of models and monitoring,
- Scale interactions, and finally
- Data assimilation.

These five issues formed the scientific back-bones of the project ensuring that these aspects are adequately addressed for each spatial scale. Even more, after the reviews the cross-cutting issues continued their work and provided valuable input to the development of the final recommendations as well as to the case studies. For each cross-cutting issues a so-called Milestone report (M6.4 to M6.8) has been prepared.

First recommendations

Combining the reviews with the information from the cross cutting issues, and analysing the results obtained led to the formulation of first recommendations for best methods and techniques for conducting air quality assessments at the three different spatial scales. These first recommendations have been separated in three categories. First the basic requirements which are requirements which has to be fulfilled in any AQ-assessment which will be carried out. Without these basic requirements no adequate AQ-assessment can in fact be carried out. The second level are the so-called best practice recommendations. These recommendations are in fact the key recommendations originating from the project. The idea is that in case users would follow these recommendations, they would be able to perform much better and reliable AQ-assessment then they have performed until now. These best practice recommendations have been tested further in the study in so-called case studies. The third level are the scientific recommendations. These recommendations are directed to the scientific community and are meant as a research agenda for the coming years.

Case studies

Based on an analysis and integration of the best practice recommendations, discussions have been held with the cities to come to the set-up of case studies in which these best practice recommendations could be tested. In total 14 case studies have been carried out. Two case studies in Rotterdam, one in Paris and one in Rome; three in Oslo and one in Prague; two in London and one in South-East England, one in Athens, and two on the European scale, and finally one in Berlin. Although Berlin was not a partner in the project, a Berlin Case study has been carried out in view of the large experience in Berlin with AQ-assessment studies.

Final recommendations

In parallel to the analysis of the Case-Study results in which the best practice recommendations were tested, and in case necessary modified, the final recommendations have been developed (D6.2).

This guidance document provides recommendations of best methods for carrying out the spatial assessment of a number of regulated pollutants. It provides recommendations on basic requirements, best practices and further scientific research. Recommendations are provided for the various methodologies used to achieve spatial assessment including monitoring, modelling and methods for combining models and monitoring. A number of particular issues are also dealt with such as emissions and uncertainty analysis. The intended result of the spatial assessment and uncertainty analysis described is the production of maps. The recommendations are intended as guidance for authorities involved in air quality assessment at city, national and European level. They are intended to aid good assessment practice and to highlight areas that require further development.

Mapping tool

As one of the major deliverables in the project, a mapping tool has been developed in close cooperation with the cities who have been providing maps of both monitoring and modelling results of their city. These maps, including maps which show a combination of modelling and monitoring, form a clear illustration of the results obtained in AIR4EU. The maps are available under http://www.air4eumaps.info/

Due to the rather complicated interaction between the workpackages and the Cross-cutting issues, real results, both scientific and overall results have been produced quite late in the project, with as result that presentations at conferences and double refereed papers will mostly appear after the end of the project, in 2007.

1.5 Main achievements

The main scientific achievements of the project have been the study of the uncertainty in modelling and monitoring and the development of a methodology for uncertainty analysis, and the development and application of data assimilation methods to combine monitoring and modelling.

The main overall achievements of the project have been the set-up of a mapping tool, and the guidance document with the basic and best practice recommendations.

All reports and presentations of AIR4EU can be found at www.air4eu.nl

2 Dissemination and use

Following the guidelines for project reporting in FP6 Air4EU has to report on the dissemination of knowledge. The following table provides an overview about the dissemination activities the AIR4EU project has undertaken from the commencement date until the end of the project.

Date	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
April 2004	Project dissemination website	General public and research community	all	n/a	TNO and core partners
June 2004	Conference paper	Research community	EU	400	TNO
Sept. 2004	Scientific workshop	Research community	EU	25	TNO
Dec. 2004	1st.Project newsletter	Research community, Cities and regions	AT, BE, DK, FI, FR, DE, GR, IE, IT, NL, NO, PT, ES, SE, UK,	520	TNO and core partners
June 2005	Project Workshop	Research community, Cities and regions	AT, BE, BG, CZ, CY, DE, DK, EE, FR, GR, I, NL, NO, PT, SE, UK	49	All project partners
Sept. 2005	2nd Project newsletter	Research community, Cities and regions	AT, BE, DK, FI, FR, DE, GR, IE, IT, NL, NO, PT, ES, SE, UK,	520	TNO and core partners
Nov. 2006	Final Conference	Research community, Cities and regions	DE, PT, CZ, NL, SK, SI, NO, DK, UK, BE, CH, LV, LU, PL, GR, AL, I, ES, FR, HR, USA	63	All project partners
Dec. 2006	3rd Project newsletter	Research community, Cities and regions	AT, BE, DK, FI, FR, DE, GR, IE, IT, NL, NO, PT, ES, SE, UK,	600	TNO and core partners
March 2007	Conference papers (See details below)	Research community	EU and beyond	-	TNO
May 2007	8 Conference papers (See details below)	Research community	EU and beyond	-	TNO, AUT, IER, UAVR, UH
May 2007	3Posters (See details below)	Research community	EU and beyond	-	IER, NILU, Airparif
2-5th July 2007	Conference paper (See details below)	Research community	EU and beyond	-	AUT
Spring 2007	3Publications (See details below)	Research Community	Worldwide	-	IER, UH

Table 1: Dissemination and use – Overview table

Date	Paper name / poster / Article	Conference/ Scientific magazine	Partner
29/30th March 2007	Assessment of the Air Quality concerning PM, Results of the AIR4EU-project	KAPA-GS Conference	TNO
27/28th March 2007	Boundary conditions and their impact on urban scale CTM simulations	UAQ2007	AUT
27/28th March 2007	Estimation of modelling uncertainty for air quality assessment: the AIR4EU Berlin case	UAQ2007	UAVR
27/28th March 2007	Simple Curves For Estimating Nitrogen Dioxide In Industrial Plumes	UAQ2007	UH
27/28th March 2007	Performance of Models-3/CMAQ for a summer O3 and NO2 episode in Southeast of England, UK	UAQ2007	UH
27/28th March 2007	Investigation of Metal Concentrations within PM10 and PM2.5 Particles Using Tunnel Sampling Techniques	UAQ2007	UH
27/28th March 2007	Trend analysis of NO2 urban background concentrations: Importance of direct NO2 emissions versus Ozone/NOx equilibrium -An AIR4EU case study in Rotterdam	UAQ2007	TNO
27/28th March 2007	Assessment of non-exhaust PM emissions by road traffic in urban areas - An Air4EU case study in Rome, London, Oslo and Rotterdam	UAQ2007	TNO
27/28th March 2007	A web based mapping tool for the harmonised intercomparison of air quality maps in Europe	UAQ2007	
27/28th March 2007	Poster: Methodologies and recommendations for emission calculation in the frame of AIR4EU	UAQ2007	IER
27/28th March 2007	Poster: Application of data assimilation in air pollution line source modelling	UAQ2007	NILU
27/28th March 2007	Poster: Air4EU case study: Paris – comparisons of data assimilation methods at urban scales	UAQ2007	Airaprif
2-5th July 2007	Data assimilation within the Air4EU project"	HARMO11	AUT
Spring 2007	Effective emission height of point sources	Atmospheric environment	IER
Spring 2007	Performance of Models-3/CMAQ for a summer O3 and NO2 episode in Southeast of England, UK – to be submitted to Atmospheric Environment	Atmospheric environment	UH
Spring 2007	Contribution of non-exhaust particulate matter emissions to street level air quality in Rome, London, Oslo and Rotterdam – to be submitted to Atmospheric Environment	Atmospheric environment	UH

Table 2: Dissemination and use – Details for 2006/2007