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Recommendations on spatial assessment of air quality resulting from the FP6 EU project Air4EU

Bruce Denby[1], Steinar Larssen[1], Peter Builtjes[2], Menno Keuken[2], Ranjeet Sokhi[3], Nicolas Moussiopoulos[4], John Douros[4], Carlos Borrego[5], Ana Margarida Costa[5], Thomas Pregger[6]

[1]Norwegian Institute for Air Research (NILU), Kjeller, Norway
[2]TNO, Environmental Quality Department, Apeldoorn, The Netherlands
[3]University of Hertfordshire, Hatfield, United Kingdom
[4] Aristotle University, Thessaloniki, Greece
[5] CESAM & Department of Environment and Planning, University of Aveiro, Portugal
[6] Institute of Energy Economics and the Rational Use of Energy (IER), University of Stuttgart, Germany

Norwegian Institute for Air Research

6th Framework Programme- Policy oriented Research Priority 8.1 Topic 1.5 Task 2

Introduction
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Introduction

- Aim and scope of the project
- Methodology
- Products

Structure of the recommendations

- Spatial scales
- Methods for spatial assessment
- Levels of recommendations

Example recommendations

- Network design and quality control
- General model types and applications
- Emissions
- Combining monitoring and modelling
- Uncertainty analysis

Conclusions

Aim

- **Provide recommendations on methodologies for carrying out the spatial assessment of air quality on all scales**
- **The major application is for regulatory purposes (EU directives) and the emphasis is on methodologies that combine monitoring and modelling**

Users

Authorities, policy makers and researchers involved in air quality assessment at city, regional, national and European level.

Air4EU methodology

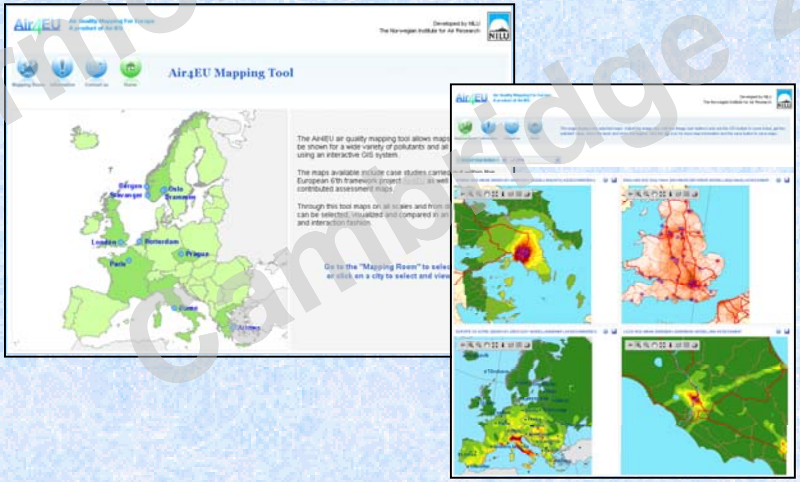
6 research institutes and 7 city partners, coordinated by TNO

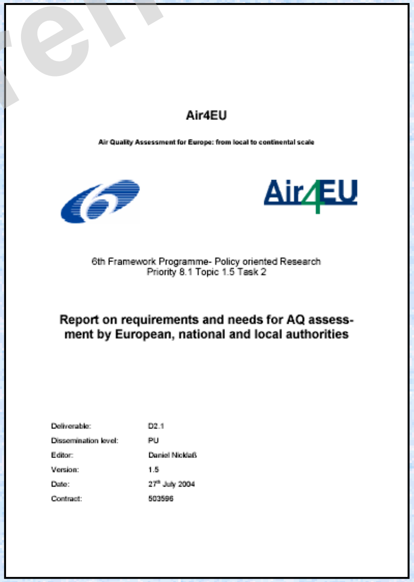
- **Reviews** of city and policy needs and current methodologies
- Examine and discuss **methodologies** through **cross-cutting issues**
- Provide **initial recommendations**
- Test and examine selected recommendations through **case studies**
- **Final recommendations**
- Convey results through mapping tool, reports, workshops and conferences

Products of Air4EU

In total 36 documents delivered

- **Reviews of city needs and current practices on local, urban and regional scales**
- **14 case studies and reports**
- **5 cross-cutting issue reports**
- **Air4EU mapping tool (www.air4eumaps.info)**




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

Report on requirements and needs for AQ assessment by European, national and local authorities

Deliverable:	D2.1
Dissemination level:	PU
Editor:	Daniel Nickláß
Version:	1.5
Date:	27th July 2004
Contract:	503596

- **Recommendation documents on local, urban and regional scales**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Air Quality Assessment for Europe: from local to continental scale

6th Framework Programme- Policy oriented Research
Priority 8.1 Topic 1.5 Task 2

Final recommendation documents

Deliverable:	D6.2
Dissemination level:	PU
Editor:	Bruce Denby
Version:	7.0
Date:	March 2007
Contract:	503596

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Structure of the recommendations

Recommendation topics divided into 3 different scales, focussing on the most relevant compounds for each scale

Local (PM_{10}, NO_2)

Urban (PM_{10}, NO_2, O_3)

Regional (PM_{10}, O_3)

Within each scale the methodologies are examined

Monitoring *e.g. network design, monitoring methods,representativeness*

Modelling *e.g. meteorology, emissions, model processes, scale interactions*

Combining monitoring and modelling *e.g. data assimilation*

Uncertainty *e.g. model assessment, representativeness, spatial mapping*

Recommendations are divided into

a) Basic requirements

b) Best practices

c) Scientific recommendations

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Structure of the recommendations

Introduction

Structure

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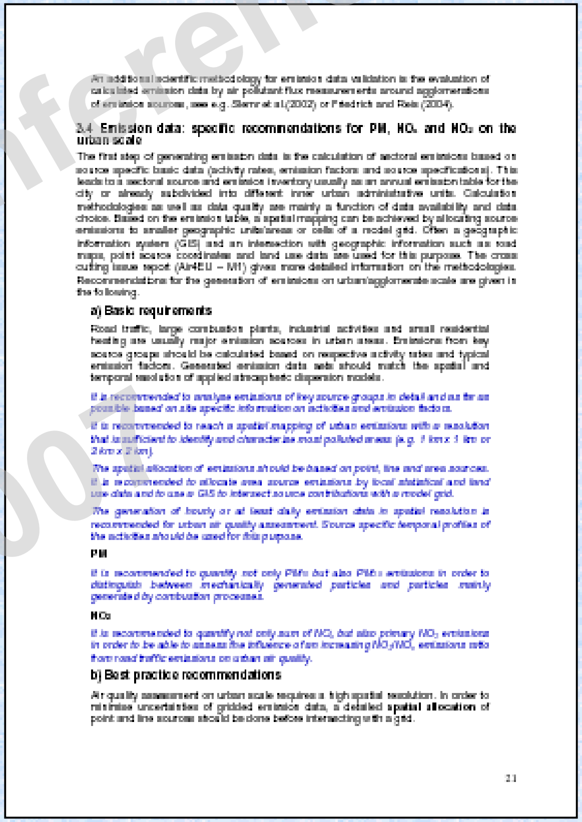
Cross-cutting issues

- Emissions
- Uncertainty analysis
- Representativeness
- Scale interactions
- Data assimilation

Case studies

14 case studies were carried out

Reported individually and also summarised in the 3 recommendation documents



An additional scientific methodology for emission data validation is the evaluation of calculated emission data by air pollutant flux measurements around agglomerations of emission sources, see e.g. Slemr et al.(2002) or Friedrich and Reis (2004).

3.4 Emission data: specific recommendations for PM, NO_x and NO_2 on the urban scale

The first step of generating emission data is the calculation of sectoral emissions based on source specific basic data (activity rates, emission factors and source specifications). This leads to a sectoral source and emission inventory usually as an annual emission table for the city or already subdivided into different inner urban administrative units. Calculation methodologies as well as data quality are mainly a function of data availability and data choice. Based on the emission table, a spatial mapping can be achieved by allocating source emissions to smaller geographic units/areas or cells of a model grid. Often a geographic information system (GIS) and an intersection with geographic information such as road maps, point source coordinates and land use data are used for this purpose. The cross cutting issue report (Air4EU – M1) gives more detailed information on the methodologies. Recommendations for the generation of emissions on urban/agglomerate scale are given in the following.

a) Basic requirements

Road traffic, large combustion plants, industrial activities and small residential heating are usually major emission sources in urban areas. Emissions from key source groups should be calculated based on respective activity rates and typical emission factors. Generated emission data sets should match the spatial and temporal resolution of applied atmospheric dispersion models.

It is recommended to analyse emissions of key source groups in detail and as far as possible based on site specific information on activities and emission factors.

It is recommended to reach a spatial mapping of urban emissions with a resolution that is sufficient to identify and characterise most polluted areas (e.g. 1 km x 1 km or 2 km x 2 km).

The spatial allocation of emissions should be based on point, line and area sources. It is recommended to allocate area source emissions by local statistical and land use data and to use a GIS to intersect source contributions with a model grid.

The generation of hourly or at least daily emission data in spatial resolution is recommended for urban air quality assessment. Source specific temporal profiles of the activities should be used for this purpose.

PM

It is recommended to quantify not only PM_{10} but also $PM_{2.5}$ emissions in order to distinguish between mechanically generated particles and particles mainly generated by combustion processes.

NO_2

It is recommended to quantify not only sum of NO_x but also primary NO_2 emissions in order to be able to assess the influence of an increasing NO_2/NO_x emissions ratio from road traffic emissions on urban air quality.

b) Best practice recommendations

Air quality assessment on urban scale requires a high spatial resolution. In order to minimise uncertainties of gridded emission data, a detailed spatial allocation of point and line sources should be done before intersecting with a grid.

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In total 517 recommendations

	Local	Urban	Regional
Basic	59	91	40
Best practice	58	108	33
Scientific	33	60	35

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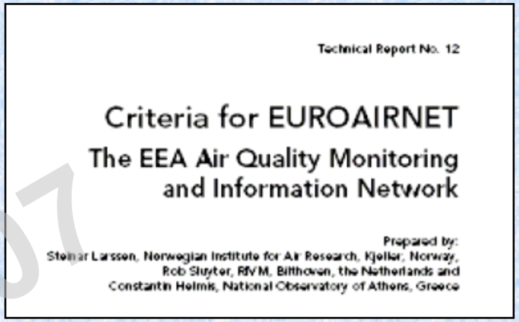
Example recommendations

Network design and quality control and assurance

Monitoring is the best established method for carrying out assessment and it is recommended to consult key documents on air quality monitoring methods when undertaking monitoring programmes

Best practice

The requirements for a complete QA/QC plan have been described in the EUROAIRNET recommendations (***Larssen et al.*, 1999; Chapter 4.5.6**)


Technical Report No. 12

Criteria for EUROAIRNET

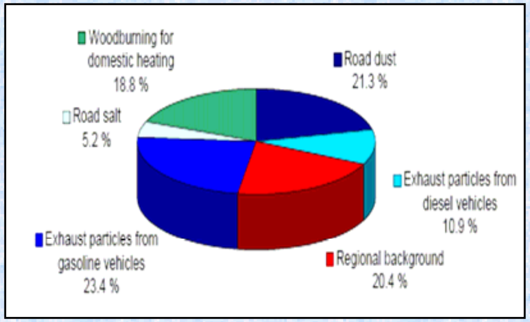
The EEA Air Quality Monitoring and Information Network

Prepared by:
Steinar Larssen, Norwegian Institute for Air Research, Kjeller, Norway,
Rob Sluyter, RIVM, Bilthoven, the Netherlands and
Constantin Helmis, National Observatory of Athens, Greece

The use of station pairs or triplets is highly recommended for an improved understanding of the regional scale contributions to the urban and local air quality.

Science

It is recommended to carry out proper source apportionment (SA) studies using receptor models, by sampling PM at, at least, one of the stations according to SA procedures. See e.g. **Watson and Chow (2004)** for a review. The US EPA also provides some guidance on receptor modelling (**www.epa.gov/scram001/receptorindex.htm**)



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Example recommendations

Introduction

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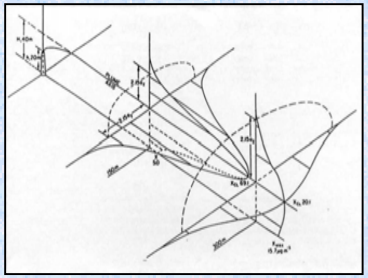
General model types and applications

An atmospheric dispersion model should be appropriate for the intended application in terms of it validity and limitations. It is important to justify the use of any particular model and understand these limitations.

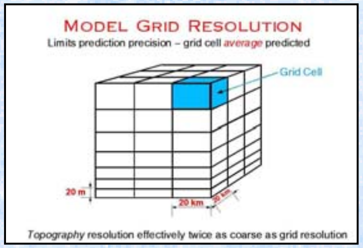
Basic

Gaussian models are suitable for screening purposes when generating urban air quality maps. They are recommended for long-term applications when applied to the urban scale or for hourly calculations where meteorology is spatially homogenous.



Best practice

The vertical resolution of a Eulerian model may have significant influence on the near surface concentrations, depending on the effective height of the emissions. The sensitivity of Eulerian models to vertical resolution should be assessed for the differing source categories.



Science

When modelling near road dispersion of traffic emissions more research is required to establish the effect of traffic induced turbulence on the initial dispersion of these pollutants.

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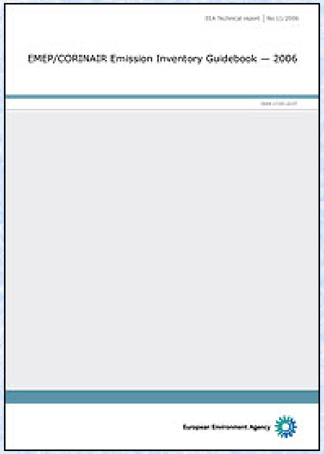
Example recommendations

Emissions

Basic

Uncertainties of calculated emission data should be assessed and analysed. Basic procedures recommended are: transparent documentation, data archiving, cross checking of plausibility and completeness, external reviews and emission factor quality ratings (e.g. EMEP/CORINAIR, **http://reports.eea.europa.eu/EMEPCORINAIR4**).



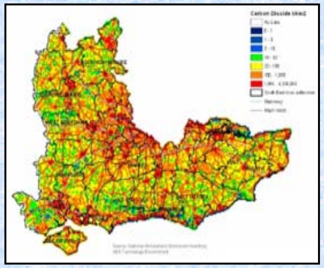
EMEP/CORINAIR Emission Inventory Guidebook — 2006

European Environment Agency

Best practice

As far as possible and reasonable, local data and methodologies should be harmonised with already existing inventories on regional or national level.

If possible, a bottom-up approach and local data/information should be used for emission and scenario calculations on local and urban scale.



Science

A further examination of fugitive PM emissions e.g. from agriculture, construction, material handling, industrial vents, barbecues and road dust suspension should be done.

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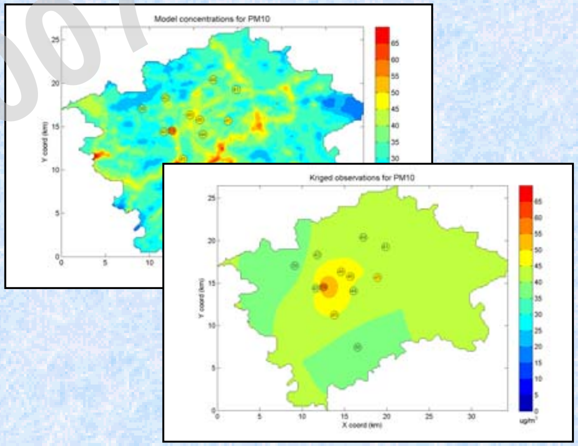
Example recommendations

Combining models and monitoring

Combining model results with measurements can reduce uncertainties inherent in both, and is strongly recommended in order to achieve a better depiction of the real situation in the area of interest.

Basic

When model results are poor, in relation to the evaluation process, or with strong bias then it is not recommended to carry out data assimilation but rather to improve the model description.



Best practice

Urban air quality has a spatial variation that is much higher than the distance between stations. Interpolation methods, such as kriging, will not capture this variation. These should only be applied in combination with models that can represent the spatial variation.

Science

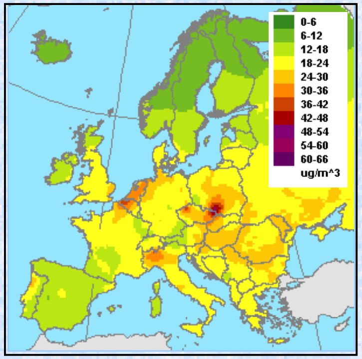
More research is required into how to best characterize and estimate the representativeness of point-like observations compared to spatial averages from grid models.

Uncertainty analysis

An assessment of known model error or estimated uncertainty is always required when modelling results are presented.

Basic

For the application of the Quality Objectives of the Air Quality Framework Directive it is recommended to use the alternative model error Relative Percentile Error (RPE) when dealing with percentiles.



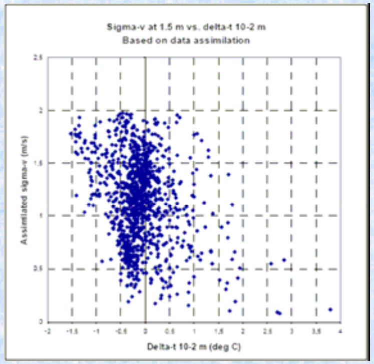
When plotting contour or gridded maps using colour coding it is recommended to use a contour spacing that reflects the estimated uncertainty.

Best practice

The recommended technique for assessing uncertainty when using data assimilation is cross-validation. RMSE is a recommended measure.

Science

For the estimation of uncertainty related to input data a sensitivity analysis (e.g. on Monte Carlo simulations) to input parameters (like initial and boundary conditions, meteorological parameters, emissions, land use and topography) is recommended.



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Concluding comments

- There is much to be considered when carrying out air quality assessment
- The recommendation documents provided by Air4EU should serve as a guide to both city users of air quality assessments and the institutes carrying them out
- As such, these recommendations are intended to steer decisions that need to be made on how assessment is carried out
- This will help achieve the best assessment of air quality and also improve the understanding of the causes and effects that lead to the current and future air quality situation

- There are always real world limitations that will not allow all of the best practice recommendations to be carried out, nor indeed some of the basic requirements
- Documents and systems cannot replace expert advice and assessment

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Conclusions

Air4EU home page

www.air4eu.nl

Reports, presentations, posters, workshops etc. available at

⇨ **Results/downloads**

- ⇨ **Reports and products**
- ⇨ **Dissemination**

Air4EU mapping tool

www.air4eumaps.info