Appendix 2

Health Impact Assessment of Outdoor Air Pollution

Exposure Assessment

The Apheis Programme

(Air Pollution and Health – European Information System)

UPDATE ON GUIDELINES ON EXPOSURE ASSESSMENT

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HELP FOR STUDY AREA DEFINITION AND MONITORING STATIONS SELECTION FROM THE PSAS-9 STUDY

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1. Introduction

In this chapter, the exposure assessment strategy developed under APHEA will be discussed and revised in the light of recent developments in WHO and EU air quality policies, in order to make recommendations for the APHEIS programme.

2. APHEA Guidelines on Exposure Assessment

During the first meeting of the APHEIS programme, it was suggested that the exposure assessment strategy, i.e. the establishment of the most appropriate exposure indicators for epidemiological surveillance and health impact assessment in particular, should be based on the APHEA2 protocol (APHEA2, 1st meeting, Munich, 14 February 1998). The following strategy was proposed in this protocol:

2.1. Air quality indicators

- Sulphur dioxide: 24-hour average
- Nitrogen dioxide: maximum 1-hour daily value
- BS, TSP, PM10: 24-hour average
- Carbon monoxide: maximum 8-hour average (based on 8 hour moving average)
- Ozone: maximum 8 hour (preferably calculated as 8 hour moving average and, if possible, 8 hour average from 9 am to 5 pm), and maximum 1 hour daily value.

This means that for each city five series for gaseous pollutants plus as many as available particles data.

2.2. Site selection criteria

The APHEA2 protocol defines that only diffuse sources are to be considered. Daily air pollutants measurements should be provided by the monitoring networks established in each participating town. Measurements done at stations located in limited access highways should be excluded from the analysis. Since only urban air pollution is going to be studied, air pollution monitoring sites situated outside urban areas will not be used, except for O_3 (due to its special pattern of spread).

2.3. QA/QC of air quality data

"There was no quality assurance or quality control programme within APHEA to ensure comparability of air pollution measurements" (Katsouyanni et al., 1996).

Concerning the data quality objectives, the APHEA2 protocol refers to the following:

Completeness criteria

For the calculation of 24 hour NO_2 and SO_2 and maximum one hour NO_2 values, it is required to have at least 75% of the one hour values on that particular day. For the maximum one hour O_3 values, 75% of the hourly values from 6am to 7pm have to be available, since the maximum O_3 levels always occur during day-light. For the eight hour value of O_3, it was decided to take the 9am to 5pm average (since O_3 peaks at or immediately after mid-day and this eight hour average is probably identical or very close to the maximum), and to calculate

this, at least six hourly values have to be available. If a station has more than 25% of the values missing for the whole period of analysis it is excluded. In some centres a station may have been closed for a long period. If a nearby station is operating, measurements may be substituted. In this situation, care is taken not to introduce systematic error, because in some cases a nearby (in geographic terms) station, may give systematically different values. In such a case an adjustment may be done (for example if the levels of the substitute station are systematically higher by 25% they are multiplied by 0.8).

Missing data

For each pollutant, a series consisting of the arithmetic mean of daily values of all monitoring stations that fulfill the inclusion criteria, will be constructed. Despite the completeness criteria, there will still be missing values in the air pollutants series for some days (usually for a small proportion of days). Missing air pollution data will be filled in accordance with the following procedure. The value in a day with missing data in a monitoring station *j* in the year *k* will be replaced by the weighted average of the values of the rest of the monitoring stations, i.e.

$$\dot{x}_{ijk} \; ? \; \overline{x}_{i.k} * (\overline{x}_{.jk} / \overline{x}_{..k})$$

For days with missing values in all used monitoring stations, the resulting series will also have a missing value on that date, but this should be a small percentage of the time series. Provided this is less than 5%, the final decision taken during the last Santorini Workshop was to replace these days by using the average of the value of the pollutant of the previous day (to the one with the missing value) and the next day, if these are not missing as well. In case there are consecutive days with missing values they will not be filled in.

3. Recent Developments in WHO and EU Air Quality Policies

3.1 WHO Air Quality Guidelines

The first edition of the WHO Air Quality Guidelines for Europe was published in 1987. This publication comprised health risk evaluations for 27 pollutants. It was the aim of the Guidelines as stated in the first edition to provide a basis for protecting public health from adverse effects of environmental pollutants and eliminating or reducing to a minimum exposure to those pollutants that are known or likely to be hazardous to human health or well-being. Although health effects were the major consideration in establishing the Guidelines, ecologically based Guidelines for preventing adverse effects on terrestrial vegetation were also considered, and guideline values for vegetation protection for nitrogen- and sulphur oxides and ozone have been established.

The Guidelines are intended to provide background information and guidance to national or international authorities in making risk assessment and risk management decisions. In providing pollutant levels below which exposure, for lifetime or for a given

period of time, does not constitute a significant public health risk, the guidelines form a basis for setting (inter)national standards or limit values for air pollutants.

In general, the guidelines address single pollutants, whereas in real-life exposure to mixtures of chemicals occur, with additive, synergistic or antagonistic effects. Although the WHO Air Quality Guidelines are considered to be protective to human health they are by no means a "green light" for pollution and it should be stressed that attempts should be made to keep air pollution levels as low as practically achievable.

The Guidelines do not differentiate between indoor and outdoor air exposure because, although the site of exposure is determining the type and concentration of air pollutants, it does not directly affect the exposure-response relationship.

It should be emphasized, however, that the Guidelines are health based or based on environmental effects and are not standard per se. In setting legally binding standards also other considerations such as prevailing exposure levels, technical feasibility, source control measures, abatement strategies, as well as social, economic and cultural conditions must be taken into consideration. Consequently (inter)national standards may be above or below the health-based WHO Air Quality Guidelines.

Since the publication of the first edition of the WHO Air Quality Guidelines new scientific data in the field of air pollution toxicology and epidemiology have emerged and new developments in risk assessment methodology have taken place. These developments have necessitated updating and/or revision of the existing Guidelines. The WHO European Centre for Environment and Health has undertaken the process of amending, updating and extending the existing Guidelines. This process was carried out in close cooperation with the International Programme of Chemical Safety (IPCS) and the European Commission (DG XI). The update and revision of the WHO Air Quality Guidelines were undertaken in several Working Groups between 1993 and 1996. They are published at the homepage of the WHO European Centre for Environment and Health Bonn Office (http://www.euro.who.int/air/activities/20050223_3).

3.2. WHO Publication on Health Impact Assessment

Recent efforts have been made in a WHO project (WHO, 1999) to define the features of monitoring networks that allow their use in assessing the potential exposure of the population to ambient air pollution. Most air quality monitoring systems do not fully address population exposure to toxic air pollution. The principles outlined are intended to promote progressive modification of the air quality monitoring networks to improve their usefulness for health impact assessment. Also parts of this work provides guidance which should practically be implemented into the APHEIS project.

3.3. EC Air Quality Framework Directive (Council Directive 96/62/EC)

The Air Quality policy of the EC started in the mid-seventies, with the development of the directive on air pollution by sulphur dioxide and particulate matter, and the later directives for lead and nitrogen dioxide. The implementation of these early directives was often troublesome and sometimes ineffective. Mainly the poor comparability of air quality data obtained from different Member States caused major problems: incomplete data sets, poor data quality, different criteria for network design were so many reasons to call for a revision of these directives. The Directive on Air Quality Assessment and Management, also called the Air Quality Framework directive was therefore developed by the European Commission and adopted by the Council of Ministers in 1996. This directive defines the basic principles of an European strategy for the protection of human health and the environment as a whole. This directive constitutes the framework for the development of specific Daughter Directives for a series of pollutants.

Already with the development of the ozone directive in 1992, but definitely with the Framework Directive and the coming Daughter Directives, the philosophy of the directives changed in many ways, with important consequences for the assessment philosophy, in particular. Where the assessment objectives in earlier directives mainly concerned the control of compliance with limit values, these are now extended to the information of the public, the full assessment in terms of areas of exceedance and population exposed, the implementation of abatement measures and the control of their efficiency.
Special provisions are contained in the Framework Directive, that will ensure a better comparability of air quality data among the Member States: criteria for network design (siting criteria, member of sites), standardized and validated reference measurement methods and data quality objectives, requirements for the agreement of measurement systems (laboratories, methods, instruments), recommendations for the QA/QC of the measurements.

3.4. EC Daughter Directives

The first Daughter Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air (attached as 1DDt-99-30.pdf file) has been adopted by the Council of Ministers in June 1999 and has been brought into force the national regulations and ordinances of the EU Member States by July 2001. The second Daughter Directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air was adopted in November 2000 and turned into force in December 2000 (http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_313/l_31320001213en00120021.pdf). The third Daughter Directive of February 2002 regulates the target values of ozone concentration in ambient air (http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_067/l_06720020309en00140030.pdf).
It is important to note that the limit values of the Daughter Directives are based on the revised WHO Air Quality Guidelines for Europe (1997). In addition, the results of the APHEA and PEACE studies have been similarly determining in the establishment of these limit

values. Due to this, the health impact of air pollutants are better considered than ever before in the EC directives. **The Advisory Group on Exposure Assessment therefore highly recommends to take over parts of the guidelines of the first and third Daughter Directive into the exposure assessment strategy of the APHEIS project.**
The directives are formulated on the basis of Position Papers prepared by the EC with the support of European air quality experts. These documents present a state of the art on the knowledge for each single air pollutant, and contain relevant and information to the APHEIS project, in particular concerning origin and fate of the pollutants, risk assessment and measurement strategy.

4. Approach to Measurement Strategies under WHO and EU policies

4.1. WHO Policy

Chapter two of WHO, 1999 deals comprehensively with the relationship between information on air quality and population exposure. Herein it is mentioned that “Air quality assessment in general and specifically air quality monitoring should produce information that can be interpreted to indicate population exposure. Correctly determining population exposure requires knowing the population distribution and location of air monitoring stations to identify the population concentrations to which the population and different population subgroups in particular are exposed. Not only hot spots or areas where maximum concentrations are expected but also representative community sites where most of the population lives should be monitored. Monitoring ambient air quality that means outdoor air, and the monitoring sites are more or less fixed at selected locations. The population moves into, out of and across the community every day. The exposure estimated by using the ambient air concentration levels is the potential exposure of the population”. Various methods to assess population exposure using ambient air quality monitoring data are described in this WHO monograph too (WHO, 1999).

Chapter three of WHO, 1999 reviews comprehensively some of the requirements regarding design, operation and quality assurance and control (QA/QC) of monitoring networks for assessing population exposure to ambient air pollution. Harmonisation of measurement quality – at both a national and international level – should be promoted through national QA/QC co-ordination, laboratory accreditation and international validation programmes (WHO, 1999).

WHO Intercomparison Workshops on Air Quality Monitoring for SO2, NO/NO2, CO and O3 gave first indications on the comparability of measuring methods (manual and automatic) used by air monitoring network authorities in Western, Central and Eastern Europe, but under laboratory conditions only (Mücke et al. 1999 and 2000).
The definition of clear data quality objectives is essential to enable networks to be optimally designed, priority pollutants and measurements methods to be selected and requirements for

data management and reporting to be identified. With regard to the recommendations of WHO, 1999 following requirements are to be achieved: measurement accuracy and precision, adaptable to metrology standards, temporal completeness (data capture), spatial representativity and coverage, consistency from site to site over time, international comparability and harmonisation.

4.2. EC Policy

Air Quality Indicators

- SO2 (1h, 24h, 1 year)
- NO, NO2 (24h, 1year)
- PM10 (24h, 1 year), PM2.5 (24h, 1 year)
- Lead (1 year)
- CO (8h)
- O3 (1h, 8h)
- Benzene (1 year).

Further directives proposals for Heavy Metals (Cd, Ni, As, Hg) and Poly-Aromatic Hydrocarbons have recently been developed.

Site selection criteria

As part of the provisions of the Framework Directive to ensure the comparability of air quality data, the Daughter Directives contain harmonised criteria for the design of the measurement networks.
Annex VI of EC Council Directive 1999/30/EC *(see annexed directive)* determines the location of sampling points for the measurement of SO2, NO2/NOx and PM10 in ambient air.
With regard to the protection of human health, fixed measurements should be sited such as:

(i) to provide data on the areas within zones and agglomerations where the highest concentrations occur to which the population is likely to be directly or indirectly exposed for a period which is significant in relation to the averaging period of the limit and target value(s);

(ii) to provide data on levels in other areas within the zones and agglomerations which are representative of the exposure of the general population.

The sites to be selected should be representative of the exposure of population and take into account the time scale of their effects on health: for pollutants with acute effects (e.g. SO2) also peak values in hot spots should be considered, whereas for pollutants with long-term effects (e.g. benzene), only background levels are of relevance.

Number of stations

Annex VII of EC Directive 1999/30/EC *(see annexed directive)* gives further criteria for determining the minimum number of sampling points for fixed measurements. Annex VII has to be seen in context with the Annex V of EC Council Directive 1999/30/EC *(see annexed directive)* specifying requirements for the assessment of concentrations of SO2, NO2/NOx and PM10 within a zone or agglomeration.

Measurement Methods

Annex IX of EC Council Directive 1999/30/EC *(see annexed directive)* commits to reference methods for sampling and analysis for assessment of concentrations of SO2, NO2/NOx and PM10/PM2.5. The reference methods of the directives are currently being standardised by the European Standardisation Committee (CEN) in the framework of EC mandates. Besides the reference measurement methods proposed by the directives for each single pollutant, the Member States are allowed to use whatever other method provided they can demonstrate the method to produce equivalent results or to show a consistent relationship to the reference method. Equivalence is obtained if all the data quality requirements established for each single pollutant and expressed in terms of accuracy, data coverage and data availability are respected.

Assessment of population exposure

For the assessment of population exposure, a combination of the spatial distribution of both air quality and population density are required. If most of the monitoring networks are able today to assess the air quality in the single stations of the monitoring network, the mapping of air pollutants over an area of interest, constitute a new challenging task. In order to fulfil this task, two approaches are possible: the use of screening techniques for the experimental assessment of the pollutant distribution, or the use of mathematical models. The Guidance Document on Preliminary Assessment of the EC provides different methodologies for the spatial assessment of the air pollutants.

Data Quality Objectives

The technical annexes of the EC directives define more extensive data quality objectives for the required accuracy of assessment methods, for minimum data capture (data completeness) and time coverage. These various requirements are laid down for the selection of the most appropriate assessment methods and to guide the quality assurance programmes.

Accreditation of laboratories

The EC directives require that the laboratories responsible for the assessment of the air quality be approved in accordance with, inter alia, the requirements of European quality assurance standards. This refers to the EN 45000 standards concerning the accreditation of

laboratories. In application of these standards a laboratory may obtain a formal recognition of its competencies to perform a certain activity by an independent accreditation body. Accreditation is the formal recognition, authorisation and registration of a laboratory that has demonstrated its capability, competence and credibility to carry out the tasks it is claiming to be able to do. Accreditation is granted by an independent body and relies on the recognition of the competence by peers, i.e. people of the same profession. This competence is expressed in organisational terms as well as in terms of technical skill. Moreover, a laboratory is never accredited as a whole, but only for a set of well defined and validated methods. An accredited laboratory is able to demonstrate and document the technical training of staff, traceability of measurements and traceability of data and documents.

QA/QC of the measurements

In order to ensure a harmonised implementation of EU Air Quality directives, the European Commission (DGXI) has carried out Quality Assurance programs for the pollutants Sulphur Dioxide, Black Smoke (1984-1988), Nitrogen Dioxide (1992-1996) and is currently organising a similar programme for PM10 and Ozone (1994-1998). These programmes are implemented by the European Reference Laboratory of Air Pollution (ERLAP) of the Joint Research Centre in Ispra (Italy) in collaboration with the EU Member States (Payrissat et a. 1997, Borowiak et al. 2000). These programmes include different activities, such as:

- the validation of sampling, calibration and analysis methods in laboratory and field conditions;
- the participation to ISO and CEN activities for the standardisation of measurement methods;
- the organisation of inter-comparisons to test the calibration methods implemented in the national central laboratories;
- the organisation of quality controls of air quality measurements in the EU monitoring networks;
- the organisation of pilot studies for the design and optimisation of the monitoring networks;
- the publication of guidance documents on monitoring strategies for network managers and operators.

With the new directives, Member States are requested to participate to the inter-laboratory exercises regularly organised by the Commission. These exercises are organised by the JRC in collaboration with the national reference laboratories with the objective to control the quality and the comparability of the measurement methods implemented in the Member States. Since 1999, these exercises are organised on a routine basis simultaneously for sulphur dioxide, nitrogen oxides, ozone and carbon monoxide. From the year 2000 on, these programmes have been extended to the countries currently in the accession phase. Similar activities will be initiated in the next future for the other pollutants covered by the new Daughter Directives, i.e. for benzene, PM10 and PM2.5, poly-aromatic Hydrocarbons and heavy metals (Pb, Cd, Ni, As, Hg).

5. Data Availability

AIRBASE

AirBase is the air quality information system of the EEA. It contains a database carrying information submitted by participating countries from across Europe. This information comprises air quality data for a selection of stations and a number of components, and meta information on air quality monitoring networks and stations. The two preceding EU databases APIS (Air Pollution Information System; air quality data) and GIRAFE (meta information on air quality networks and stations) have been included and replaced. The AirView web-application facilitates free access to all information contained in AirBase. The current database contains information which was transmitted by EIONET partner states in the framework of 'Exchange of Information' (EoI) Decisions, or as part of Euro Airnet. To this end the Data Exchange Module (DEM) was designed to facilitate data transmission. The AirBase information system further contains a web-application to facilitate free access to all information contained in the database (AirView), and a Model Documentation System (MDS) providing access to model characteristics for potential model users.
The AirBase information system is developed and maintained by the European Topic Centre on Air Quality on behalf of the European Environment Agency. More information on the AirBase database can be downloaded from the ETCAQ web-site (http://www.etcaq.rivm.nl/databases/airbase.html).

EUROAIRNET

The main goal behind the establishment of the Europe wide air quality monitoring and information network of the EEA (EUROAIRNET) is to improve significantly the reporting of air quality data in Europe, with a coverage that makes possible comprehensive assessments of European air quality within a year or a little more after the end of a monitoring year.
The aim of EUROAIRNET is to provide information to support and to facilitate the assessments of air quality to be produced by EEA. The information is available in such a form that it is suitable to:

- facilitate a general description of air quality across Europe, and its development over time (trend);
- enable comparison of air quality across Europe;
- produce estimates of exposure of the European population, and of materials and ecosystems;
- estimate health effects;
- quantify damage to materials and vegetation;
- produce emissions/exposure relations and exposure/effect relations;
- support development of cost-effective abatement strategies;
- support the framing and implementation of legislation (in relation to air quality directives);
- influence/inform/assess effectiveness of future/previous policy.

The assessments is based upon concentration fields (space-time fields) produced by the monitoring and information network or by a combination of monitoring and modelling, and covers local as well as regional scales. The modelling efforts are essential in forming the links between emissions on the one hand and exposure and effects on the other hand.
The EUROAIRNET information system is developed and maintained by the European Topic Centre on Air Quality on behalf of the European Environment Agency. More information on the EUROAIRNET database can be downloaded from the EEA web-site (http://eea.eu.int).

6. Proposal for APHEIS Exposure Assessment Strategy

Based on the above considerations, for the definition of the APHEIS exposure assessment strategy, it is advised to take advantage of the general provisions developed under the WHO and EC policies with respect to human health.

Also, the most important issue for HIA is that exposure has to be measured in the same way in each centre.

In addition, the following specific requirements are proposed for the APHEIS exposure assessment:

6.1. Air quality indicators

With regard to the air quality indicators, the selected parameters should be easily available, be indicative of the health risk to the population and relevant to the time scale of the pollutants effect.
The new EC directives will begin to be implemented in 2001, in the meanwhile, the APHEA criteria on AQ stations completeness and on procedures to impute missing values were agreed upon *(see above section 2 APHEA2 methodology*).
After discussion at the Ispra meeting (June 2000) and update, the following parameters can be proposed in general, more specific indications will be given for each particular HIA:

- **Sulphur dioxide** (SO2): short-term effects, urban background levels, 24h average (1 hour as optional indicator where available)
- **Nitrogen dioxide** (NO2): short-term effect, urban background levels, 24h average (Nitrogen monoxide 24h average and NO2 1h as optional indicators where available)
- **PM10:** urban background levels, short-term effects (24h average); long term effects (annual mean value) ; **PM2.5:** where available; **Black smoke:** 24h average was recommended by the Epi AG should be optional.
- **Ozone** (O3): short-term effects, urban background levels, 1 hour maximum concentration and 8h maximum of daily moving average.
- **Carbon monoxide** (CO): short-term effects, urban background levels, 8h running average.

?? **Benzene**: short and long-term effects, urban background levels, daily and yearly average.

6.2. Site selection criteria

Only measurements performed in areas representative of the exposure of urban population at large will be considered and take into account the time scale of their effects on health. Typically this limits the measurement stations to urban background locations, excluding sites in the direct vicinity of traffic (hot spots) or of industrial sources. However, for pollutants with acute effects (e.g. SO2) also peak values in hot spots need to be considered, whereas for pollutants with long-term effects (e.g. benzene), only background levels are of relevance. For Apheis, the decision on selection of sites should finally be taken with the advice of the air quality monitoring expert who knows which stations are representative of the population exposure at large without any direct influence of a particular source of pollution (industry or other).

For the selection criteria of APHEIS it is recommended to use the site selection requirements established under the EC Directives:

Annex VI of EC Council Directive 1999/30/EC *(see annexed directive)* determines the location of sampling points for the measurement of SO2, NO2/NOx and PM10 in ambient air. With regard to the protection of human health, fixed measurements should be sited such as:

(i) to provide data on the areas within zones and agglomerations where the highest concentrations occur to which the population is likely to be directly or indirectly exposed for a period which is significant in relation to the averaging period of the limit value(s);

(ii) to provide data on levels in other areas within the zones and agglomerations which are representative of the exposure of the general population.

Annex IV of EC Council Directive 2002/3/EC *(see annexed directive)* determines the location of sampling points for the assessments of ozone concentrations in ambient air. With regard to protect the health of city population respectively, fixed measurements (representative for a few km²) should be sited at residential and/or commercial areas, parks (away from trees), big streets or squares with very little or no traffic, open areas characteristic of educational, sports or recreational facilities.

Site modifications in air monitoring networks following, for example an improvement of the air quality situation, may raise problems for the selection of monitoring sites for studies in the long run. For the selection of measurement sites , it was suggested at the first APHEIS meeting (Paris, February 2000), to select monitoring sites which are foreseen for a long-term run by the air monitoring network operating authorities.

The first APHEIS meeting also suggested that when changing the measurement method at a measurement site it is important to run concurrent measurements for one year to evaluate the impact of changes.

6.3. Number of stations

Criteria for determining the minimum number of exposure relevant sampling points for fixed measurements should take into account:

- the area to be covered
- the spatial variability of pollutants
- the availability of resources

Because health monitoring requires large populations in order to generate sufficient counts of health events , single monitors may be insufficient to assess the population exposure. It is strongly recommended that a number of monitoring stations is used to reflect the exposure of the population at risk. These stations should comply with the site selection criteria described under 6.2.

6.4. Measurement methods

The measurement methods used for sampling and analysis of air quality measurements should be reported by each centre (i.e. UV Fluorescence, Chemiluminescence, UV Absorption, Beta absorption, TEOM, Gravimetric, Reflectometry, for Black smoke the type of reflectometer and the filter type)*.*

6.5. Data quality

The data quality requirements developed under the EC Air Quality directives are proposed. Air quality data are in general available from the national air quality agencies. They are also available on-line from the EEA databases (AIRBASE and EUROAIRNET). These data are usually validated and of known and documented quality.

Whenever other sources of air quality are considered, for example from local networks, the following requirements apply:

Data quality objectives

The essential requirements on data quality to be met by the local networks are :

- Known measurement uncertainty
- Data completeness (minimum capture rate)
- Spatial representativity and coverage
- Consistency from site to site and over time
- National and International comparability and harmonisation

Quality assurance and control

The objective of quality assurance and control should be:

- Measurements accurate, , comparable and traceable
- Data representative of ambient conditions
- Measurements consistent over time and space
- Rate of data capture high

The major components of quality assurance are:

- Well defined monitoring and and data quality objectives
- Well defined criteria for network design and site selection
- Selection and evaluation of measurement methods and equipment
- Management of the laboratory and training of personnel

The major components of quality control are:

- Controlling routine site operations
- Establishing a chain of calibration and traceability
- Internal and external audits (inter-calibration and inter-comparisons)
- Maintaining and supporting systems
- Reviewing and managing data

6.6. Assessment of population exposure (mapping)

Mapping air pollutants over an area of interest is a new challenge. Two approaches are possible: a) use of screening techniques for the experimental assessment of the pollutant distribution, and b) mathematical models. The future collaboration between APHEIS and EUROHEIS projects (UK) will help dealing with this issue.

7. Transfer of exposure data

The new European Directive states in Article 8 'Public information' of 1999/30/EC:' Member States shall ensure that up-to-date information on ambient concentrations … is routinely made available (on at least a daily basis) to the public as well as to appropriate organisations, such as relevant health-care bodies by means of e.g. computer-network services'

The EU new directives will begin to be implemented in 2001. However, it should be noted that historical time series of air quality data collected under the EC APIS and GIRAFE programmes are available on the EEA databases.

8. Storing of exposure data

The exposure data collected by each centre will be stored first at the local APHEIS centre, then it will be transferred to the APHEIS coordinating centre to allow data analysis.

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THE APHEIS PROGRAMME

(Air Pollution and Health – European Information System)

HELP FOR STUDY AREA DEFINITION AND MONITORING STATIONS SELECTION FROM THE PSAS-9 STUDY

Sylvie Cassadou

Objective :

In order to guarantee the applicability of the exposure / response functions, the definition of the study area aims at the best homogeneity of population exposure as possible and air pollution measurements have to be representative of this exposure.
Indeed, the exposure / response functions used in HIA make the underlying hypothesis that the global exposure calculated with ambient air pollution measurements is an un-biased proxy of the mean of all the individual exposures for the entire population studied.

The procedures below aim at helping concretely Apheis centres to define their study area and then select their monitoring stations with this objective.

I – Study area definition (multi-municipalities agglomeration is supposed)

Useful data and information :

- if available, administrative definition, in terms of municipalities, of the agglomeration (list of these municipalities)
- Precise and recent map of agglomeration (scale1/25,000) with topographic curves and urbanization indications
- Knowledge of dominant winds
- Inventory of the main industrial plants emitting air pollution and mapping their location
- Inventory of all the urban background and suburban air monitoring stations and mapping their locations
- As part of the routinely collected air quality data, data of eventual measurements campaign on the agglomeration (on sites different from those of fixed monitors) and/or mapping of annual levels of air pollution (obtained from measurements or modelling)
- Population data for each municipality of the agglomeration and the part of 65 years and older people for each of these municipality
- Data on population displacements between home and work location
- Inventory of hospitals with cardiovascular and/or respiratory activity and mapping their location

Initial area : agglomeration defined on administrative criteria

Step 1 : Identify urban and peri-urban monitoring sites and hospitals location on a general agglomeration map

Step 2 : Use the precise map (scale 1/25 000) to outline a zone 1 around the centre city, following administrative limits of the municipalities[1] and according to :

[1] Generally imposed by the collect of health data

- Topographic characteristics (in case of an important relief, a zone may be excluded of the study area)
- Urbanization density

Step 3 : Use population data to outline a zone 2 around the centre city (following also administrative limits of municipalities) with the following criteria :

- More than 20% of the population of each municipality come in centre city to work
- The percentage of people of 65 years and older in each municipality is lower than the mean of this percentage in all the agglomeration

By this step, we can take into account municipalities whose a big part of the population is daily exposed to the centre city pollution

Step 4 : outline a zone 3, intersection of zones 1 and 2.

For example : zone 1 = municipalities a, b, c, d
Zone 2 = municipalities a, b, c, e
Zone 3 = municipalities a, b, c

Step 5 : In order to define the final zone, confront the zone 3 with :

- the main industrial areas emitting air pollution : some peri-centre municipalities may be excluded
- the dominant winds : the study area around the centre city has to be consistent with them
- the results of eventual measurements campaign of air pollution on the zone 3 : the levels registered have to be consistent with those of the fixed monitoring sites
- the results of eventual mapping of annual levels of air pollution (modelling) on agglomeration

Remarks :

- All these last criteria(step 5) are not in “all or nothing” : the judgment of the epidemiologist should be based on the first objective of this procedure
- For any doubt, please take advice with the metrologists of the air quality monitoring network of the area.

II – Monitoring station selection

In order to reach the objective presented at the beginning of this procedure, several criteria have to be used for monitoring stations selection :

- as written in the Apheis guidelines for exposure assessment, urban background station or suburban background station for Ozone can be selected
- as well written in the guidelines, the stations selected have less than 25% of missing data for the study period

Other procedures can be applied on air pollution data in order to check homogeneity of exposure measurements.

Step 1 : for each station and each pollutant, calculate data distribution for the study period. Distribution parameters can be :

- mean
- standard error
- variation coefficient
- minimum
- percentile 5
- percentile 25
- median
- percentile 75
- percentile 95
- maximum

If inter-quartile of data of one station do not overlap the inter-quartile of the other, that means that this station represents an other exposure and may be excluded.

Step 2 : for each pair of station and each pollutant, calculate correlation coefficients between data for the study period.

For example, stations a, b, c are available, matrix of correlation can be calculate

	a	b	c
a	1	r(a,b)	r(a,c)
b		1	r(b,c)
c			1

If one station is badly correlated with the others, that means that this station measures an other exposure and may be excluded

Remarks: if these criteria cannot be fulfilled, the decision to select or not a station depends on the total number of available stations and on the spatial representativity of these stations. In all the cases, advices of local metrologists can help for this decision.