European Topic Centre on Air Quality

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AIRBASE:

1997 DEVELOPMENT STATUS & EXTENSIONS FORESEEN

Second European Workshop on Air Quality Monitoring and Assessment Brussels, 22-23 September 1997

This document is also available from the ETC-AQ Web server:
http://www.etcaq.rivm.nl/airbase/wkshp.html

Rob Sluyter, Charlos Potma, Terje Krognes, Mike Petrakis, Patrick van Hooydonk

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EXECUTIVE SUMMARY

This report summarises the current development status and extensions foreseen of the EEA air quality information system AIRBASE. This information system will be used as main source by EEA/ETC-AQ for compiling European air quality assessments.

Data to be included in AIRBASE will be gathered through the EEA EUROAIRNET programme (Larssen et al, 1997) and in the framework of the revised Exchange of Information Decision (97/101/EEC). The Commission and EEA have agreed that EEA/ETC-AQ will be responsible for maintenance and further development of AIRBASE as well as the yearly update of the system with EoI data. In addition, data collected in the framework of the Dobris+3 programme and the Ozone Directive will be stored in AIRBASE.

Currently, information from APIS and GIRAFE has been converted to AIRBASE. The quality of existing meta information is poor and this will seriously hamper the use of the system. To increase quality, data suppliers were provided with a software tool to manage meta information.

A lot of effort was needed to convert all 1995 data series transmitted because countries use deviations from recommended software. In order to smoothen data transmissions, ETC-AQ will develop a Data Exchange Module (DEM), which data suppliers can use for the transmission of both meta information as well as air quality data.

A pilot Web application was developed which gives access to the AIRBASE information system to a wide group of users. In this report, extensions to the Web server are proposed. Extensions to the Web and the DEM will be funded partly by DGXIII and DGIII.

The results of two pilot Java projects are promising and the software developed will be made available on the Web server.

CONTENTS

1. INTRODUCTION

The main task of the European Environment Agency (EEA) is to provide reliable, objective and comparable information in support of environmental policy for those concerned with framing, implementation and further developing European environmental policy, and for the wider European public.

It is the priority for EEA to establish itself as a reliable and independent source of environmental information. As far as air quality is concerned, EEA - through its European Topic Centre on Air Quality (ETC-AQ) - is developing, on the basis of existing national efforts, a pan European air quality monitoring network (EUROAIRNET) to obtain the information needed. Apart from the EEA member countries, PHARE countries also co-operate within the EUROAIRNET programme.

Air Quality Information and data collected through EUROAIRNET will be stored in, and made available through, a multi-level information system called AIRBASE.

In accordance with the new EoI Decision (97/101/EEC), the European Commission and EEA have reached agreement that EEA/ETC-AQ will be responsible for maintenance and further development of the EoI information system (AIRBASE) as well as the yearly update of the system.

At the first European Air Quality Monitoring and Assessment held in Copenhagen (April 1996), representatives (NRCs) of the EEA were informed on the background, objectives and development process of AIRBASE. The AIRBASE workshop position paper (Sluyter et al, 1996) sketched the 3 layer information concept and system contents, designed to serve the needs of different target user groups.

This report, presented at the Second Workshop on Air Quality Monitoring and Assessment (Brussels, 22/23-9-97) intends to give an overview of the 1997 development status of AIRBASE and extensions which are foreseen in the coming year.

1.1 Outline of report

Chapter 2 presents the current status of AIRBASE development including a brief summary of the three layer system concept. Chapter 3 is devoted to the problems encountered with the quality of existing data and the conversion of data transmitted in the framework of the Exchange of Information Decision. Aggregation of data and calculation of statistics according to the new EoI and EUROAIRNET are discussed in Chapter 4. Extensions which are foreseen to be implemented in the coming year are presented in Chapter 5. Two JAVA pilot projects have been carried out by the ETC-AQ. Results are summarised in Chapter 6. The similarities and differences between data exchange in the framework of Decision 97/101/EEC and EUROAIRNET are discussed in Chapter 7.

2. AIRBASE DEVELOPMENT STATUS

This chapter gives an overview of the current status of AIRBASE development (situation summer 1997). First, a brief overview will be given of the AIRBASE three-layer system concept which was presented at the First European Workshop on Air Quality Monitoring and Assessment (for a more detailed description, see: Sluyter et al, 1996). The modules which have been developed during the last year will be presented. The conversion of data from APIS and GIRAFE to AIRBASE and the 1996 Exchange of Information update will be briefly discussed. More detailed information on problems encountered with quality control and conversion of data will be presented in Chapter 3.

2.1 AIRBASE: General overview

The objective of the AIRBASE information system is formulated as:

Offering the facilities needed to collect, validate, evaluate, store and visualise raw air quality data and statistics and (meta) information on air quality monitoring networks and stations, and making these data available on different aggregated levels, for different information users and through different distribution channels.

AIRBASE will be at the service of different target groups:

- EEA
- EU-DGXI
- PHARE countries
- Experts EU Member States
- EEA NFPs and NRCs
- Partners ETC-AQ
- Other ETCs
- EEA's other potential information users: EC Directorates, Council of Ministers, European Parliament, other EU-bodies, national environmental authorities, international organisations, non-governmental organisations, the general public, representatives from sectors such as industry, commerce and agriculture as well as the media.

The variety among these target groups required the new system to provide information that meets the demands of each individual group. This has important consequences for how and where the system can be accessed, for user-interfaces and for the way in which data are presented. A three level database has been proposed, intended to serve optimally the requirements of the different user groups. The three-level concept is outlined in Figure 2.1.

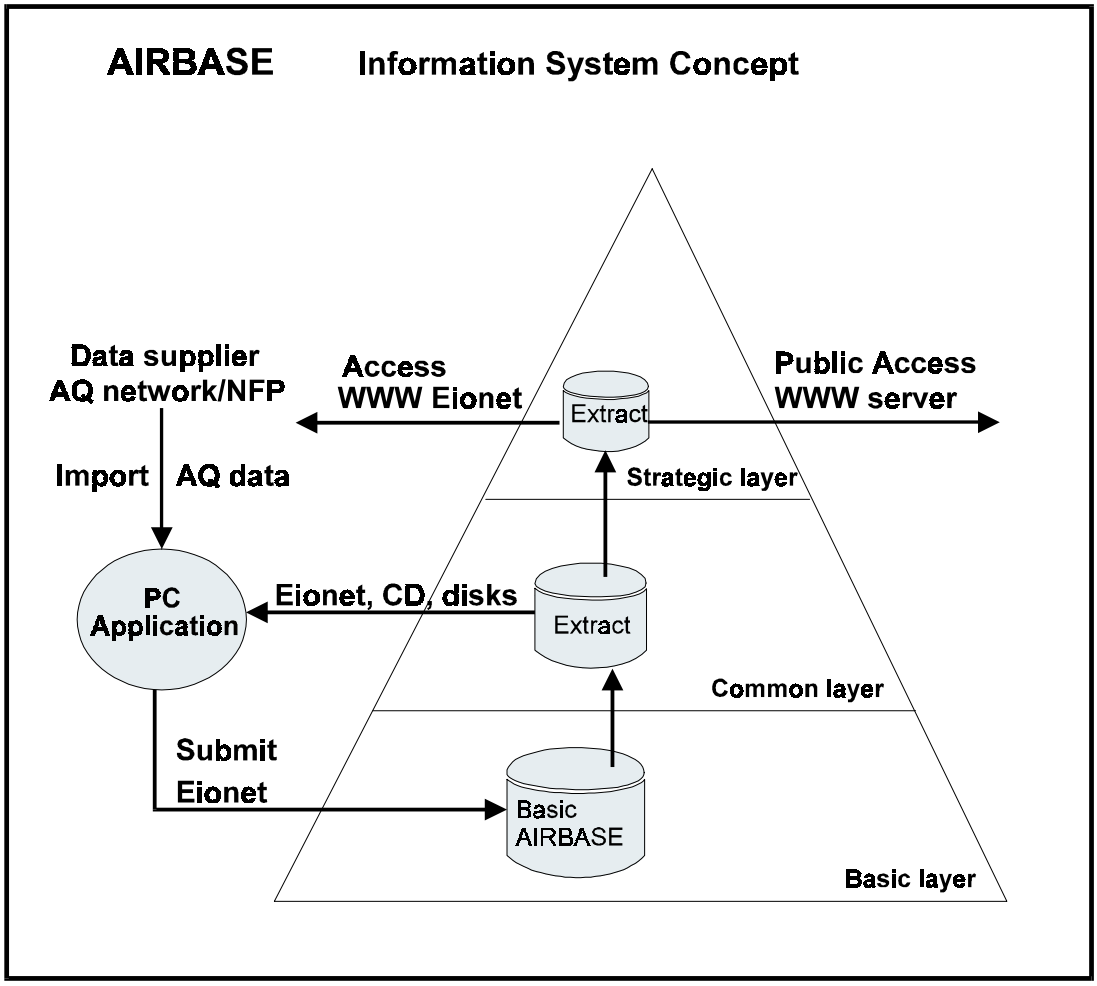

Figure 2.1 The AIRBASE 3 layer information concept

Once all modules have been fully implemented, the different levels of the information system will consist of:

Basic level

A relational ('basic') database in a UNIX environment containing all air quality data and information on networks and stations. The database is updated by data from EEA's member countries or other countries, which come preferably in a format that is generated by a module (part of the common level), which they have at their disposal. The data can be transferred through the EOINET using FTP, Telnet or WWW. EEA, DGXI and the ETC-AQ partners have access to this level, either through the EOINET or copies of the system on their servers. Other persons/organisations can in principle access this level 'on the spot' at one of the above mentioned organisations.

Common level

A relational ('local') database in a PC windows environment containing all air quality data and information on networks and stations. The database can be freely distributed. Data can be approached through a PC-application linked to a map generator. The PC-application includes an import function for single records as well as for bulk data. An export function will generate files in a special data format that can be transmitted to the ETC-AQ to be

implemented in the basic database. The database and applications will be made available on CD-ROM and can also be downloaded from the Internet. The PC-application will be 'Internet-aware'; the application will automatically make contact with the basic database through Internet and transfer updates. This level is especially intended for Experts from EU Member States, NFPs, NRCs, EEA's other potential information users: EC Directorates, national environmental authorities, and international organisations.

Strategic level

A Web application which gives access to the basic level through the Internet. The Web application will give access to general (aggregated) air quality information, statistics and clickable maps. This level can be accessed by everyone but is especially intended to serve the needs of the general public and media.

AIRBASE will contain all air quality data transmitted in the framework of EUROAIRNET, the EU EoI Decision (97/101/EEC), the EU ozone Directive (92/72/EEC), EU daughter directives and additional data collected by EEA (e.g. in the framework of the Dobris programme). Three groups of data can be distinguished which will be physically contained in different database tables:

1. Raw air quality data
2. Statistics (percentiles, averages, min/max, % valid etc.) for all stations mentioned under point 1. In addition, according to the EoI, some stations will only transmit statistics.
3. Exceedances. All information transmitted in the framework of the EU Directives can be entered. This year, the information transmitted in the framework of the EU Ozone Directive will be entered.

2.2 Legal Framework: New EoI Decision adopted

The revised Exchange of Information Decision (97/101/EC) has been adopted by the Council in January 1997. From 1998 on, EU Member States are obliged to transmit air quality data to the Commission and this will end an eight year period in which data was exchanged on a voluntary basis, pending the adoption of the new Decision.

The role of EEA in the framework of the EoI is legally set in article 1 of Dec. 97/101/EC:

> 'In order to benefit from the experience acquired by the European Environment Agency and within its sphere of competence, the Commission shall call upon the Environment Agency, *inter alia*, as regards the operation and implementation of the information system'.

The Commission and EEA agreed that EEA/ETC-AQ will be responsible for maintenance and further development of AIRBASE as well as the yearly update of the system with EoI data. Furthermore, the yearly technical reports

on meta information (Article 4.5) and air quality data (Article 5.6) will be produced by the ETC-AQ.

Procedures for the data exchange between the Commission and EEA have been set. EU Member States will transmit AQ data in the framework of the EoI Decision to the Commission. An advanced copy of the data can be sent directly to the ETC-AQ.

According to Article 5.6 of the new EoI data transmitted in the framework of the EoI will be made available to the public via an information system set up by EEA (AIRBASE Web-application) and data can supplied upon request by EEA.

With respect to Decision 82/459, the new EoI seeks to extend the scope and improve the quality of the data transmitted while ensuring that the procedure to be followed is flexible. The main differences with Decision 82/459 are:

- Information on networks and stations
  Much more detailed information is requested to be transmitted together with the air quality data;
- Components
  The list of components for which data can be exchanged is expanded from 14 pollutants to 37 pollutants;
- Statistics and number of stations
  For some stations, only annual statistics will be exchanged. Under Decision 82/459, only raw air quality data was exchanged. The number of stations for which data will be exchanged is expected to grow.

During the 8 year period in which data exchange was performed on a voluntary basis, some countries transmitted data while other countries stopped the exchange. Article 5.4 of Dec. 97/101/EC states that Member States, as far as possible, shall transmit the information collected from 1989-1996 by the stations which took part in the reciprocal exchange of information established by Decision 82/459/EEC.

2.3 Basic Layer: Ingres database implemented

The AIRBASE data model has been physically built into a RDMS (Ingres) database. The system fully underpins the requirements from the new EoI Decision as far as meta information and AQ data are concerned. Also, requirements evolving from other AQ Directives and from EUROAIRNET can be met.

APIS and GIRAFE contents have been converted to AIRBASE. To be able to do this, conversion software has been written. The problems encountered during this conversion are described in Chapter 3.

Last year the system was updated with 1995 data. An overview of data received and problems encountered with data conversion can be found in Section 2.6.

2.4 Common Layer: AIRBADM

Meta information contained in GIRAFE was outdated, sometimes conflicting with APIS, non-standardised, sometimes partly missing and full of obvious errors (see also Chapter 3).

To ensure that information on networks and stations transmitted to the ETC-AQ is consistent and to provide data suppliers with a user-friendly tool to arrange the requested information, a software module for the administration of meta information ('AIRBADM') was developed and made available to data suppliers[1].

AIRBADM uses simple forms and as much as possible 'pick lists' from which pre-defined selections can be made. The information requested can be divided in three main topics or levels which can be accessed from the main data administration form:

1. Information on air quality monitoring network management and the data supplier;
2. Information on air quality monitoring stations (for all operational stations within a network);
3. Information on air quality monitoring measurement configurations (for every pollutant monitored at a station).

Time and budget constraints made it impossible to prefill AIRBADM with all available (GIRAFE) meta information on networks and stations. Only information on networks was entered.

As an example, Figure 2.3 and 2.4 present two AIRBADM screen shots. The first shows the form in which co-ordinates of stations can be checked. The latter is a typical form for the entry of data, in this case general station information.

[1] AIRBADM software and manual can be downloaded from the ETC-AQ Web site at: http://www.etcaq.rivm.nl/airbase/airbadm.html.

Figure 2.3: AIRBADM form to check station co-ordinates entry

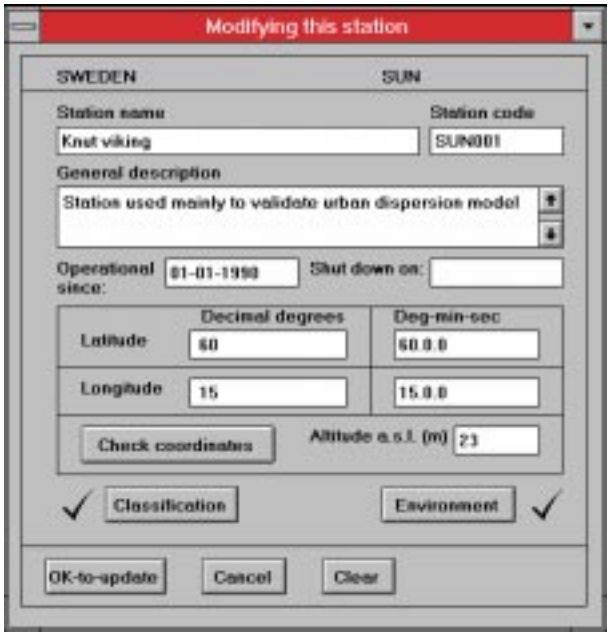

Figure 2.4: Example of AIRBADM form: General station information.

AIRBADM is the pilot version of an input module which also will enable data suppliers to input air quality data and do validation checks on their information before sending it to the ETC-AQ (see also section 5.1: DEM). Together with a future visualisation module, the meta information module will form the AIRBASE PC application.

2.5 Strategic Layer: The AIRBASE pilot Web application

Access to AIRBASE at the moment is only provided through a pilot Web application. The application is located at:

http://www.etcaq.rivm.nl/airbase.htm.

The current application has two entry points for the selection of raw air quality data: 'component' and 'station'. Figure 2.5 presents the selection trees.

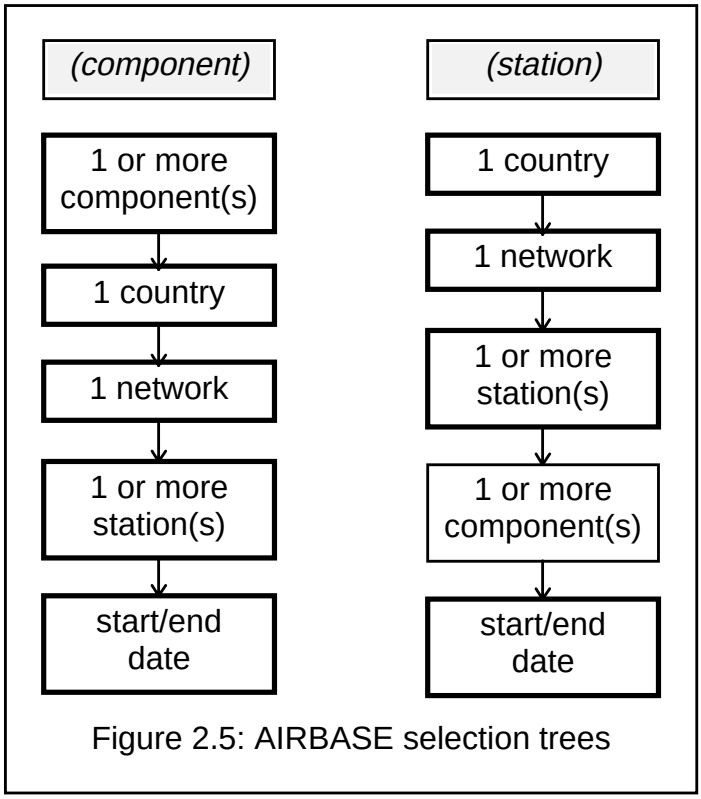

Figure 2.5: AIRBASE selection trees

Output consists of a table on screen which gives all the raw air quality data for the specified station(s), component(s) and year(s). This implies that if both hourly and daily values are available for a station-component relation, both will be listed. The table can be saved to a local computer system as an ASCII file by selecting the 'Save as' button from the browser menu. Alternatively, data can be copied to another PC-application using 'copy' and 'paste' functions.

Apart from the database application, the following information is accessible from the AIRBASE server:

- Background information on AIRBASE (the 1996 Position Paper on AIRBASE presented at the first ETC-AQ workshop in Copenhagen);
- Possibility to download the complete APIS & GIRAFE databases;
- Possibility to download AIRBADM software and manual;
- 'Status of EoI' table giving an overview of the AQ information received from countries and progress made in converting and uploading this data to AIRBASE;
- Overview of problems with meta information encountered while converting GIRAFE to AIRBASE (see also Chapter 3).

2.6 1996 (EoI) update

In the framework of EoI Decision 82/459/EEC, EU Member States were requested to transmit 1995 air quality data. This was done on a voluntary basis, as agreed by the EoI National Expert Working Group, pending the adoption of the new EoI Decision. EEA requested additional EEA Member Countries and PHARE countries to transmit air quality data. Countries were requested to use AIRBADM for the transmission of meta information and use either the ISO-7168 (under revision) or the NASA-Ames 1010 (Gaines & Hipskind, 1992)format for air quality data files.

An overview of the data which was transmitted by countries and the AIRBASE conversion status is presented in Table 2.1.

		1994 AQ data: Number of stations per component										***1995 AQ data: Number of stations per component***										
Country	**Status AIRBADM**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Status 95 update**
Belgium	I	.	28	9	.	4	8	8	4	.	3	.	18	.	.	4	8	4	.	.	.	VI
Denmark	I	2	.	.	2	.	2	2	2	.	2	2	.	.	2	.	2	2	2	.	2	VI
Finland	IV	4	.	.	2	5	2	4	.	2	.	5	.	.	3	11	.	2	1	3		VI
Germany*	IV	78	.	.	54	45	50	68	.	50	.											IV, V
Greece	IV	3	.	3	.	3	.	3	.	3	.	3	.	3	.	3	.	3	.	3	.	VI
Ireland	I	.	5	5	.	.	.	.	.	.	.	.	3	5	.	.	.	.	.	.	.	VI
Italy	I																					II
Netherlands	I	13	.	7	.	17	17	17	.	8	.	13	.	7	.	17	17	17	.	8	.	VI
Sweden	I																					III
United Kingdom	I	14		14	.	.	.	.	.	.	.	13		13								VI
Luxembourg	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Spain	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Portugal	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
France	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Austria	I				.									.	.	.	.	.	.	.	.	III
Iceland	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Norway	IV													.	.	.	.	.	.	.	.	III
Bulgaria	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Estonia	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Lithuania	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Latvia	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Poland	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Czech Republic	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Slovak Republic	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Hungary	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Albania	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Romania	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Slovenia	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Column numbers:

1	SO2	6	NO
2	Strong acidity	7	NO2
3	Black smoke	8	Pb
4	TSP	9	CO
5	O3	10	Other

Data underway, no further information yet

Update Status codes

I	No data received
II	Data known to be underway
III	Data received, not yet converted
IV	Conversion in progress
V	Data partly loaded in AIRBASE
VI	Data loaded in AIRBASE

*see text section 2.6 for additional information on Germany

Table 2.1 shows that not all countries submitted data. It also shows that not all data has been processed by the ETC-AQ. The reasons for not (finalising) processing are:

- Effort needed for conversion by far exceeded the budget which was available for conversion work. The reasons were multiple: the ETC-AQ needed time to learn to work with available Commission software, some countries used deviations from the format they used previously and thus software had to be annotated and for some countries (supplying data for the first time or since many years) new software had to be written;
- Some data came in too late (after 10-12-97 while the deadline was 1-10-97: Norway, Sweden, Austria);
- Italy transmitted data in a non-standardised format and this data was not processed.
- Germany transmitted corrupt files for some years. Unfortunately no back-up was made by the data supplier. New files are currently underway.

More information on problems encountered while converting data can be found in Chapter 3.

2.7 Help Desk

The ETC-AQ maintained a help desk for data suppliers and AIRBASE (Web) users. Contact to the help desk can be made by e-mail (**airbase@rivm.nl**), fax and telephone (use ETC-AQ/RIVM address and telephone/fax numbers). This help desk was used approximately one hundred times, mainly by data suppliers requesting help with uploads of data and the use of AIRBADM. In addition, the complete AIRBASE data model documentation has been provided a couple of times to national database experts who were engaged in updating national database systems.

2.8 Database use

It is not known how many persons made use of the AIRBASE Web application[2].

EEA/ETC-AQ made use of AIRBASE while preparing for the Air pollution in Europe 1997 report (Editors Jol & Kielland, 1997). AIRBASE will also be used for future assessment reports at the European level: "Dobris+3" (1997-98), the three-yearly EEA State of Environment report (1998), the EEA yearly indicator reports (1999 onwards) and follow-up products of the one produced. A second important use of AIRBASE will be as input to the c-Q model proposed for use within the Auto Oil II programme.

[2] A 'hit' counter will be added to the Web application.

3 QUALITY CONTROL AND CONVERSION OF DATA

This chapter focuses on the problems the ETC-AQ encountered while converting APIS/GIRAFE data to AIRBASE and while uploading 1996-EoI data transmitted by countries to AIRBASE. These problems will hamper the use of the database. Only a few problems could be resolved by the ETC-AQ. For most problems, the help of national data suppliers is needed.

Additional information on the problems encountered, such as maps presenting stations with wrong co-ordinates, can be found at the ETC-AQ Web server:

http://www.etcaq.rivm.nl/airbase/problems.htm

3.1 Conversion of APIS and GIRAFE data to AIRBASE

Outdated meta information
Meta information on operational air quality networks and stations available in AIRBASE mainly originates from GIRAFE. This database, which was created in 1990, contains only information for 12 EU Member States. Since then, only Greece and Belgium provided an update of the files (other countries to be added later)[3]. As a result, stations listed in GIRAFE as operational were sometimes already shut down in APIS.

Language
Not only the (preferred) English language was used to enter data. Moreover, a number of database fields were defined as free text. As a result, a number of database fields cannot be used for queries because data entry is not standardised.

Example (measurement technique): 'MVS' has also been entered as 'Medium Volume Sampler', 'MCV', 'M. collector+gravimetry' etc.

Network type
In AIRBASE only the EoI network type classification is used ('geographical coverage'): local industry, town/city, urban area/conurbation, county, region, country. Most of the GIRAFE information is more or less according to this classification, but not all. In the German files for example, entries were found like 'Bremen', or 'Saar river'. As a result, queries cannot be made on 'network type' at the moment.

International networks
Stations taking part in international monitoring programs like the EMEP, GEMS-AIR or TOR programmes, sometimes are defined as part of a separate network ('EMEP'), in other cases this information can only be deduced from a (GIRAFE) comment field. Defining separate networks for these stations is strongly recommended.

[3] A number of countries have provided meta information in the form of AIRBADM files as part of the 1996 EoI (see also Section 2.6 and 3.2).

City names

Sometimes English names were used, sometimes the local name (e.g. Brussels, Bruxelles, Brussel). Moreover, different spelling was used for one entry (e.g. Köln, Koeln). In some cases postal codes or country names were added to the city name. The use of (at least) English names is strongly recommended.

Station names and codes

The local network identifier of a station can consist of a name, a code or a combination of both. In GIRAFE one field was used for name and one for the code. However, sometimes the name field contains both the name and code. In other cases, the station only has a code which is given in both the name and the code field. AIRBADM has two separate fields for station name and station code.

Co-ordinates stations

Missing co-ordinates have been resolved as much as possible using an Atlas and the city where the station is located. Unfortunately this results in all stations within a city having the same co-ordinate. For each country a map has been produced with the location of all operational stations[4]. From these maps it is clear that some stations have obvious wrong co-ordinates because they are plotted in sea or in another country. Note that if a station is plotted in the correct country, this does not imply that co-ordinates were by definition entered correctly. Co-ordinates are regarded as 'critical information' because for reporting purposes in many cases maps will be produced.

Country (EU12 only)	**Nr of missing co-ordinates**
Belgium	7 (3%)
Germany	104 (21%)
Denmark	6 (14%)
Spain	137 (23%)
France	362 (48%)
United Kingdom	99 (22%)
Greece	9 (26%)
Ireland	15 (26%)
Italy	278 (49%)
Luxembourg	0
Netherlands	3 (1%)
Portugal	29 (33%)

Table 3.1 : Number of stations with co-ordinates missing.

[4] You are encouraged to take note of these maps. They can be accessed from the ETC-AQ Web server at: http://www.etcaq.rivm.nl/airbase/.....

Environmental descriptions stations

Both APIS and GIRAFE contained environmental descriptions of cities. GIRAFE codes for the 'local' and 'immediate' environment of the stations sometimes are in conflict with each other. It also seems that there is a conflict between the APIS and GIRAFE descriptive codes for a station (e.g. APIS=traffic heavy, GIRAFE=traffic low). For the time being, all codes are stored. In addition there are 797 stations without any immediate classification, 530 without any local classification and 312 stations with local but without any immediate classification.

Environmental descriptions are regarded as 'critical information' because for report purposes selections of stations will often be based on the 'type' of station.

Measurement configuration

GIRAFE contained a lot of fields with information on the measurement configuration (e.g. monitors used, integration times, calibration). GIRAFE software did not check on data entered and used 'free text' for a number of fields. This resulted in a non standardised database as far as definitions are concerned and a lot of mistakes have been made with data entry (e.g. calibration frequency of 1 second for a manual device). The ETC-AQ was only able to correct the most obvious mistakes. Hopefully, the use of AIRBADM will improve the quality of database contents as far as measurement configurations are concerned.

3.2 1996 EoI update

A number of problems were encountered while processing the data:

- Current data-exchange formats (EoI, ISO, NASA/AMES) are not suitable to load data into Airbase because essential information to load the results is missing (identification station (Airbase has internal codes, names can be written in many ways), monitoring equipment/ sampling analysis, the date measurements started);
- Information received from the countries directly (Through AIRBADM) and the information which came from APIS/Girafe was not compatible. This resulted in (possible) duplication of stations, methods, and measurement sessions.

As a result the status of the database is as follows:

- Stations are not unique in Airbase, some stations (spelled in different ways, or sometimes spelled identically) have more than one identification-code (sn_code), some stations identified with different names have the same identification-code;
- because of the lack of information about starting dates of some measuring sessions a dummy-value is introduced (1/1/1900). In some cases through information from AIRBADM the measuring sessions with the real starting date is stored in Airbase, so one measuring session can be stored twice. When one wants to correct these dates one must correct these in the measuring-configuration table and all result tables;
- the monitoring equipment or sampling analysis information needed to store results into Airbase is in some cases missing or incomplete when loading the data. This resulted also in duplicate measuring sessions by introducing dummy values for these key information. And because of the sometimes correct and sometimes incorrect occurrence of concurrent measurement sessions it is not possible to add results correctly without information about the monitoring equipment/sampling analysis. There are no restrictions for the way this information must be reported, so comparison of these names is also very difficult and can not be done automatically.

4. AGGREGATION OF DATA AND CALCULATION OF STATISTICS

4.1 Introduction

This chapter describes the AIRBASE statistical and data aggregation routines. These statistical functions are simple. Only averages, max/min values and percentiles are involved. The computations are made by a core database process to ensure that they are always performed in the same way. It will be shown below that the computation itself is not trivial, even if the functions are simple.

Before statistical parameters may be computed, the data set must be converted to the desired time resolution. Measurements often are performed at a rather high frequency. Depending on the pollutant and measurement method, samples may be registered every second, every minute, or perhaps every 20 minutes or only once a day. The registered value may in itself be an average or a snap-shot. The data originator may compute 1-hour averages or daily averages before submitting the results to the database. In many cases the data set must undergo further aggregation before use. This is closely related to the statistical functions mentioned above, since the aggregate is an average of two or more values.

Initially, this topic may seem trivial, but there are severe complications. First, a large number of different time resolutions must be handled (both in input and output), and in some cases “moving averages” are needed. Secondly, the input data sets are not complete. When only a few input elements are missing, the aggregates and statistics may be computed with sufficient accuracy. If too many input elements are missing, the output must be defined as missing. There is also an important distinction between missing input elements and undefined input elements. On a day without rain the concentration of pollutants in precipitation is undefined - not missing.

4.2 APIS Compatibility (time series up to 1995)

Only time series were converted from APIS to AIRBASE. Aggregation and statistic calculations were done within AIRBASE. It was required that the AIRBASE computations should be identical to the original APIS algorithm. This could not be achieved throughout, though the results are very close.

ETC-AQ was not in the possession of a document that completely defined the requirements for the APIS software. Instead, parts of the APIS source code had to be decoded. The best (clearest) aggregation routine was found in a program that converted data sets between two versions of the APIS database format, but this routine only covered the case of 1-hour to 1-day resolution. The data completeness limits were converted to percentages and used also for other aggregation cases.

The APIS database stored only integer values, that needed to be scaled before plotting or tabulation. Aggregation and statistical computations were to some extent performed by integer arithmetic on unscaled data. This could

not be copied in AIRBASE, which stores all values in floating point formats. Here, computations had to be performed with floating point arithmetic also.

APIS had three distinct codes for unavailable data, named BLANK, NOVAL, and SPACES. The meaning of the SPACES condition is still unclear. If only one of the input data elements was flagged as SPACES, APIS would flag the output aggregate as SPACES (and not compute a numerical value). A similar construction does not exist in AIRBASE.

Furthermore, APIS used a code REP, which indicated that an element was a repetition of the previous element in the time series. If this was used to report a data set in a finer time resolution than the actual measurements (as when one 24-hour average is reported as 24 identical 1-hour values), the effect will probably not be completely reconstructed in AIRBASE. The code REP is still used in the AIRBASE database, but the values are filled into the data arrays before calling the statistics or aggregation subroutines.

In APIS, if more than 50 % of the input elements were BLANK or NOVAL (in any combination), the aggregate was set to BLANK. In this case, statistic parameters were calculated by the subroutines, but probably not presented to the user. If more than 25 % consecutive input elements were BLANK or NOVAL (in any combination), the results were also discarded, since the data could easily be biased. For example, a one day aggregate is defined as usable if we have 12 hourly values reasonably spread out over the day. If 7 consecutive hours are missing, the maximum or minimum period of the day could be missing in the input data, and a bias could be introduced.

In the APIS database any small negative data value was set to the value zero. This was also done with the 1995 data set. This practice cannot be continued, since some instruments may have negative signal excursions due to normal noise in the signal. If these values are changed, accurate averages can no longer be computed for measurements close to zero. Even if a concentration cannot be negative, the negative noise spikes are significant, and cannot be removed without introducing a bias.

There appear to be some discrepancies between the available definitions for the EoI/APIS procedures and the actual algorithms found in APIS software. Dec. 82/459/EEC declares that an aggregate should be accepted only if

1 not more than 1/6 consecutive BLANK elements
2 not less than 50% measured values
3 not less than 66% with a value not BLANK

Instead of adhering to these definitions, we have used the algorithm found in APIS software, as previously described. There is a clear possibility that several conflicting algorithms have been in use in different modules of APIS, but this is very difficult to verify.

4.3 Algorithms used for time series up to 1995

The *statistic subroutine* accepts REP elements and counts them as valid elements. However, these flags have been substituted with values before the subroutines are called. Elements that contain BLANK or NOVAL are counted as invalid. The number of valid elements and the percentage of valid elements are reported back to the calling program. The maximum number of input elements is declared in the call. The routine sorts the data elements by size, and does not need to know which elements were missing. Even if the data coverage is low, the statistical parameters are always computed, and it is left to the calling programme to use or discard the results. Here, the 95-percentile and higher percentiles are accepted only if the data coverage is 75% or better. For 50-percentile and average, 50% data coverage is accepted. The number of consecutive missing elements is not considered.

The *aggregation subroutine* is somewhat more complex. Data are served from the calling program in arrays that exclude periods with missing data. The subroutine computes the theoretical number of data elements that could have been included between the start time and end time of the input period (also taking into account leap-years where appropriate). All missing data elements are detected, and empty data elements with the BLANK flag are generated. Both original and generated elements are entered into new arrays with continuous progression in time (often referred to as “padded arrays”). Based on the time resolution in the input data and the aggregates to be computed, the subroutine calculates the number of input elements to include in each aggregate. If more than 25% consecutive input elements are flagged BLANK or NOVAL, the aggregate is flagged BLANK. If more than 50% of the input elements are flagged BLANK or NOVAL, the aggregate is flagged BLANK. The aggregates are returned in padded arrays with continuous time progression. The aggregation routine should only be used with original data. A data set that has already been aggregated, should not be re-aggregated to yet another time resolution.

4.4 Proposed changes for 1996 data and future years

Criteria set in the new EoI Decision for aggregation of data and calculation of statistical parameters are similar to those set in earlier EoI Decisions. In addition, data sets may undergo quality control (validation procedures) before aggregation or statistics computations. Suspect data elements will be tagged with a code N (erroneous or doubtful). The new EoI Decision does not give guidance as far as the use of BLANK, NOVAL and REP flags is concerned.

Rules must be developed for how such elements should be treated. Exception flagging within EMEP is more complex. Possibilities for harmonisation may be studied.

The NOVAL flag appears to allow the data originators to define freely if for example they want to produce a measurement every day or every second day. Instead, standard measurement schemes could be implemented. An

originator that does not want to measure every day, should then expect that missing data are flagged as BLANK instead of NOVAL. The use of NOVAL may be restricted to cases where the measurement is undefined (like concentrations in precipitation for days with no rain). This would be a major improvement for harmonisation with the EMEP system.

Small negative values will be defined as valid measurements for concentrations that are monitored with on-line automated instruments. Such monitors may have noise excursions below zero when the actual value is close to zero. Even after some aggregation of the raw data, small negative values may occasionally exist. When aggregated to a longer averaging time, all values should be positive (unless the zero is wrongly adjusted), and the value would be too high if all negative elements had been filtered out before aggregation.

5. AIRBASE EXTENSIONS FORESEEN

The budget needed for extending the functionalities of AIRBASE exceeds the funds EEA can make available as part of the ETC subventions. Subsequently ETC-AQ was requested to seek additional funds. Three routes are being followed:

- ETC-AQ participated in a tender ('IRENIE', DGXIII Telematics for the Environment Applications Programme).
- Seek support through the IDA (DGIII) programme as follow up of a feasibility study on automatic data transfer of ozone data between countries and the Commission
- Seek support through the IDA (DGIII) EEA programme as pilot Eionet application.

Extensions proposed by the ETC-AQ are:

- A Data Exchange Module (section 5.1);
- Extensions to the AIRBASE Web application (section 5.2).

At the time of writing (August 1997) it was not clear which route(s) will be successful and when funds will become available, although the IRENIE proposal has been accepted by the Commission on technical terms. This implies that it is at the moment unclear if DEM and/or extensions to the Web can be realised next year. Other extensions described in this Chapter will be realised as part of the ETC subvention and will be made available before the end of this year.

5.1 Data Exchange Module (DEM)

ETC-AQ Experiences with the 1995 and 1996 EoI updates and ozone data reporting have shown that (see also Chapter 2 and 3):

- data suppliers need a lot of time for transfer because no tailor-made exchange software is available, resulting in;
- countries not using recommended data exchange formats (or use deviations from the formats).
- many errors are made in the data files and poor quality of meta information which in some cases is partly or completely missing.

A substantial effort and budget was needed to process/convert all incoming data and exclude obvious mistakes. Moreover, it is foreseen that the number of countries and amount of data exchanged per country will increase substantially in the coming years (new EoI Dec., Daughter Directives, accession countries) which might result in a rising effort for the yearly update of the database.

The effort needed for updating the information system will be highly reduced and quality of the data improved by using an Data Exchange Module (DEM) which:

- Checks data files against the Commission/ETC-AQ format specifications;
- Links imported data files to station descriptions (meta information).
- Submits files through the Eionet/Internet for inclusion in AIRBASE.

The DEM can be used to exchange AQ information (ozone exceedances, raw data, statistics, meta information on operational networks and stations) in the framework of:

- EUROAIRNET
- Decision 97/101 (EoI)
- Directive 92/72 (Ozone)

The DEM will include all features for management of meta information now offered by AIRBADM (version 1) which was made available to data suppliers last year.

The DEM is the first part of a future PC-AIRBASE application (AIRBASE common layer, see also section 2.1). This future application will also include a Visualisation Module.

5.1.1 Outline of DEM

The Data Exchange Module will enable:

- Adding, modifying and deleting (flagging) of meta information on AQ networks, stations and measurement configurations (includes all features previously offered by ETC-AQ AIRBADM application);
- Selections of station-component combinations for which AQ data is to be exchanged, linking of these combinations to AQ data files, importing of files with extensive error checking;
- Manual entry (in addition to file import) of ozone exceedances and (ozone) statistics;
- Generation of reports giving an overview of information contained in application
- Transmission of database on diskettes or through Eionet/Internet for incorporation in AIRBASE.

The software will be available for download through Eionet/Internet. After incorporation in AIRBASE, data will be available to all countries through the existing but extended WWW application (section 5.2). Data suppliers can upload data using FTP but also by diskette, tape or CD-ROM.

A great advantage of the Data Exchange Module is that data import files can be very simple (identifier, date/time, values) because all meta information is stored in, and handled by the software. File formats like ISO, NASA-Ames and the formats used for transfer of ozone exceedances will not be needed any longer.

The menu structure of the DEM will be a close copy of the data exchange procedures to ensure the clearness of the process. It is expected that this

will result in less errors and the minimalisation of effort needed for ad-hoc support. Apart from the standard help files, 'Cue cards' will be included which will guide the data suppliers through the process of data transmission.

To increase the quality of the database contents, extensive checks will be performed on imported data. Entry of meta data will be 'guided' as much as possible by the use of pick lists.

A read-only version of DEM containing meta information for all participating countries will be made available for download on the ETC-AQ server. This will enable participating countries for example to extract monitoring practices reports from other countries. Only the report module will be active in the read only version of DEM.

The following of DEM screens (Figures 5.1-5.6) present a general overview of planned software functionality.

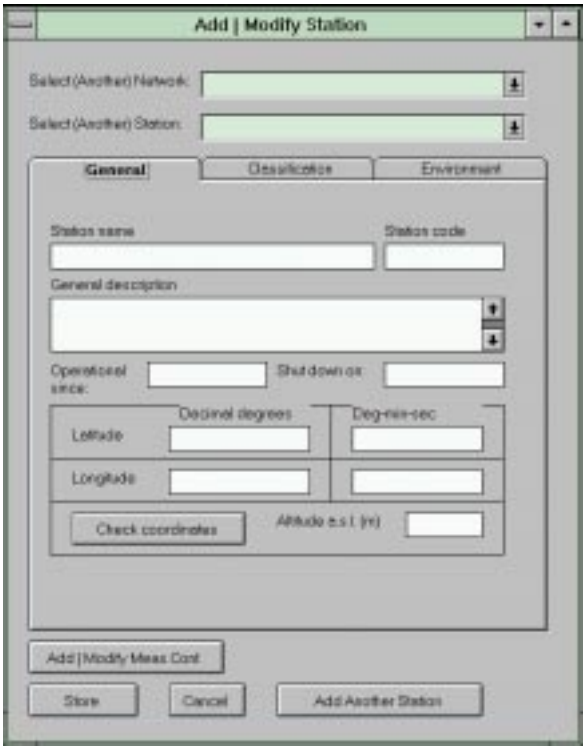

Figure 5.1: *Add/modify*. All meta information related to 'network', 'station' or 'measurement configuration' is presented on one form using tabs.

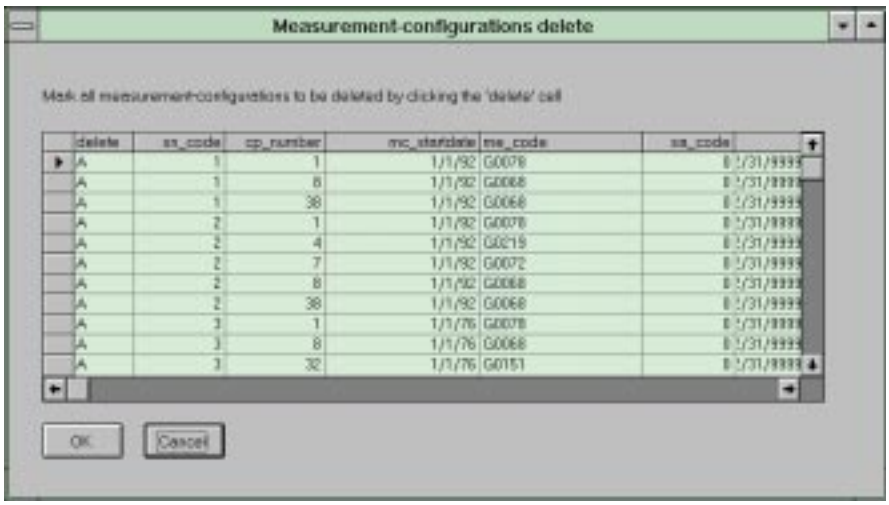

Figure 5.2: *Delete configurations*. Complete networks, stations or measurement configurations can be deleted by clicking from a list.

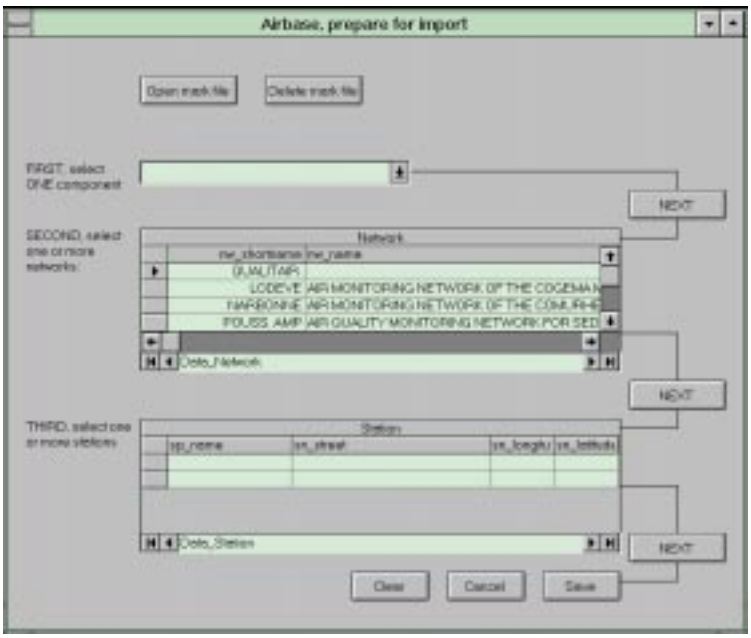

Figure 5.3: *Prepare for data import*. This form will produce (per component) a file ('mark file') containing unique network-station-measurement configuration identification codes. Codes must be placed in the header of the simple data files before importing.

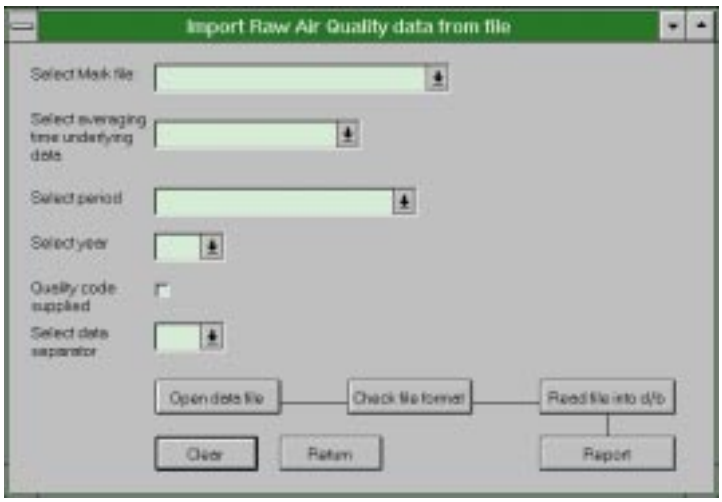

Figure 5.4: *Import data from file*. This form will be used to import data files (raw air quality, statistics or exceedances) using a mark file. Formats will be checked, and after resolving errors (if any) data will be read in to the DEM database (in this example raw air quality data).

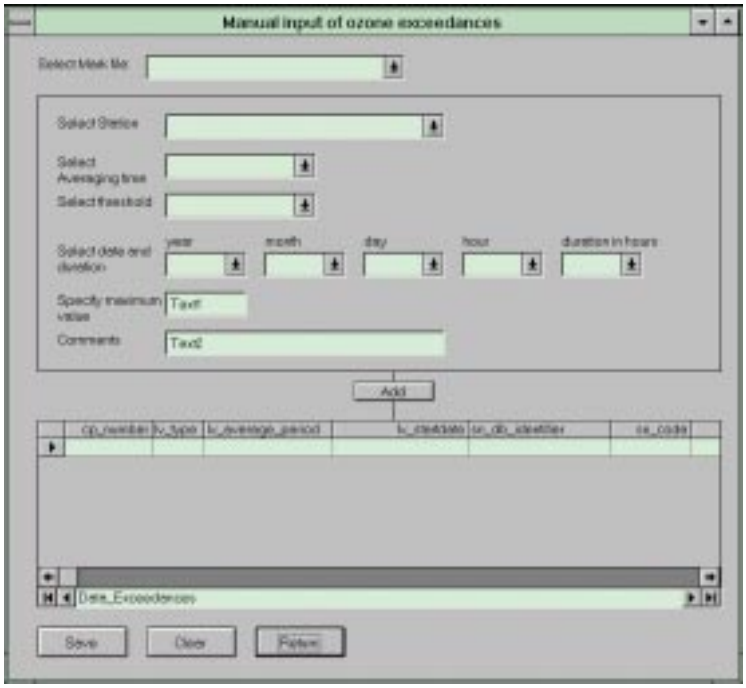

Figure 5.5: *Manual entry of data*. Besides file import, suppliers will be offered the possibility to enter statistics and exceedances (of ozone) manually.

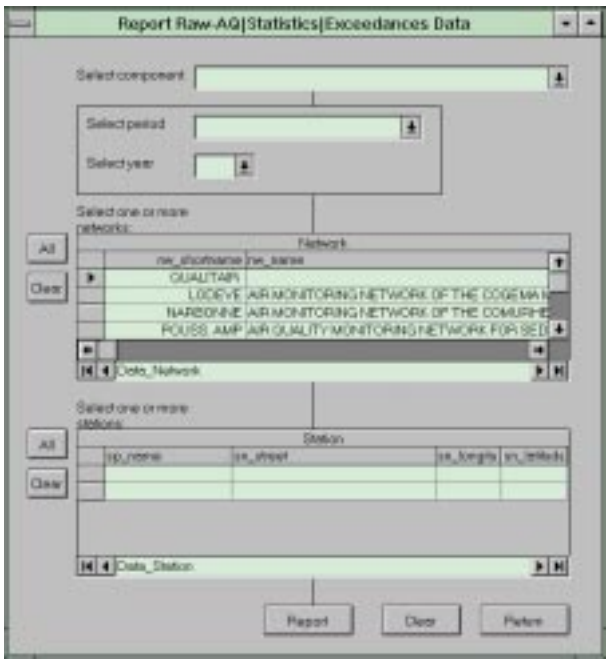

Figure 5.6: D*ata reporting*. The report function will enable suppliers to obtain a hard copy of database information (both meta info and measurement results).

5.2 Extensions to the WWW server

The features of the current AIRBASE Web application have been described in chapter 2.3. The Web application will be extended with the following features during the coming year (providing that necessary funds will come available:

- **Functionality previously offered by APIS**: The current Web application only offers the possibility for simple queries and output in the form of a table listing. These will be extended with the functionality previously offered by APIS;
- **Statistics**: Possibility to generate user defined statistics;
- **Clickable maps**: Users will be offered the possibility to select stations from a clickable map. Maps will be produced for all components. After a station has been chosen, the user will have the possibility to make further selections on meta information or air quality data;
- **Output in the form of maps;**
- **Reports**: Most frequently asked data and information will be made available through reports;
- **'Mail to function'**: to speed up data retrieval, requests from users will be handled as a background process and results will be mailed to the user. In this way, users will not have to wait any longer on the results of a query before they can proceed. Experience learned that the response time was too large in case of complicated queries when numerous users were active on the system;
- **Output in the form of data files**: The user will have the possibility to choose between output in the form of an ASCII file or MS Excel spreadsheet;

- **Component information sheets**: For all the components present in the information system, information sheets will be provided giving general information on emission sources, air quality guidelines, typical concentrations observed and possible adverse (health) impacts to be expected if guidelines are exceeded;
- The 'status of update page' will be automatically updated as soon as incoming data has been uploaded into AIRBASE.

5.3 Implementation of 'Dobris+3' urban air quality statistics

EEA is preparing a Pan-European SER ('Dobris+3') which will assess the progress of the main environmental issues which were addressed by the first 'Europe's Environment (Dobris) report' [lit]. The ETC-AQ is responsible for the urban air pollution paragraph. Questionnaires were sent to 105 major European cities (>500 000 inhabitants or the capital if no such city exists in a country) requesting for 1990 and 1995 urban air quality statistics.

The collected data will be made available through AIRBASE. Because detailed meta information on the stations and monitors in most cases is missing, data will be marked as 'Dobris' data. This flagging is also useful to distinguish the statistical AQ data transmitted by municipal authorities for which algorithms are in most cases not known, from statistics calculated by the ETC-AQ for EoI data series which are based on algorithms set by Decision 97/101/EC. In theory it is even possible that statistics for some cities/stations will be listed twice if data was transmitted both in the framework of the EoI and the Dobris+3 programme.

It is foreseen that EEA will prepare a pan-European SER every three years. Data collection through questionnaires will not be necessary anymore as soon as EURO-AIRNET becomes operational (see Chapter 7). This will also end 'double entries' in AIRBASE because data collection in the framework of EURO-AIRNET and EoI (97/101/EC) will be complementary.

5.4 Implementation of ozone exceedance data

In the framework of Council Directive 92/72/EC on air pollution by ozone, EU Member States transmit validated exceedances of threshold values to the Commission on an annual basis. In addition, annual statistics (average and some percentiles) are also provided to the Commission.

No database existed to store the ozone exceedance data; up till now data was only archived in spread sheets. AIRBASE can handle both the exceedance data as well as the annual statistics and from this year on the data will be stored in the database with (public) access through the Web application.

Stations for which ozone exceedance data are transmitted can also be part of the station set for which time series and/or statistics are transmitted in the framework of the EoI Decision. In order to distinguish between the two sets, annual statistics transmitted in the framework of Directive 92/72/EC will be marked as such in the database.

Apart from ozone exceedance data, AIRBASE can handle other exceedance information, irrespective of components, thresholds and averaging periods.

5.5 New classification scheme for air quality monitoring stations

In order to compile reliable air quality assessments it is important to know in which (emission) environment a station is located, i.e. the 'type of station', Various station classification schemes are in use in Europe at the moment to group stations. Apart from the schemes used in the framework of the new EoI Decision and in the GIRAFE database, countries use their own national classifications which differ from country to country.

Earlier research has shown (MA25 ref) that the environmental description codes used in GIRAFE cannot be used to classify stations, even in simple groups like *traffic stations*, *urban background stations* and *rural stations*. In the opinion of the ETC-AQ, the classification scheme adopted in the new EoI Decision is too restrictive to be used a basis for European air quality assessments.

As part of the development of EUROAIRNET, a station classification scheme has been developed which is proposed to be used in AIRBASE next to the EoI classification. This scheme will satisfy the needs arising from the EUROAIRNET objectives, notably the need to have stations representing a range of well defined exposure situations related to various sources.

The first level classification criteria are presented in Figure 5.7. An in-depth discussion of the scheme and second level criteria can be found in the EUROEAIRNET position paper presented at this workshop (Larssen et al 1997). The classification scheme will be implemented in DEM.

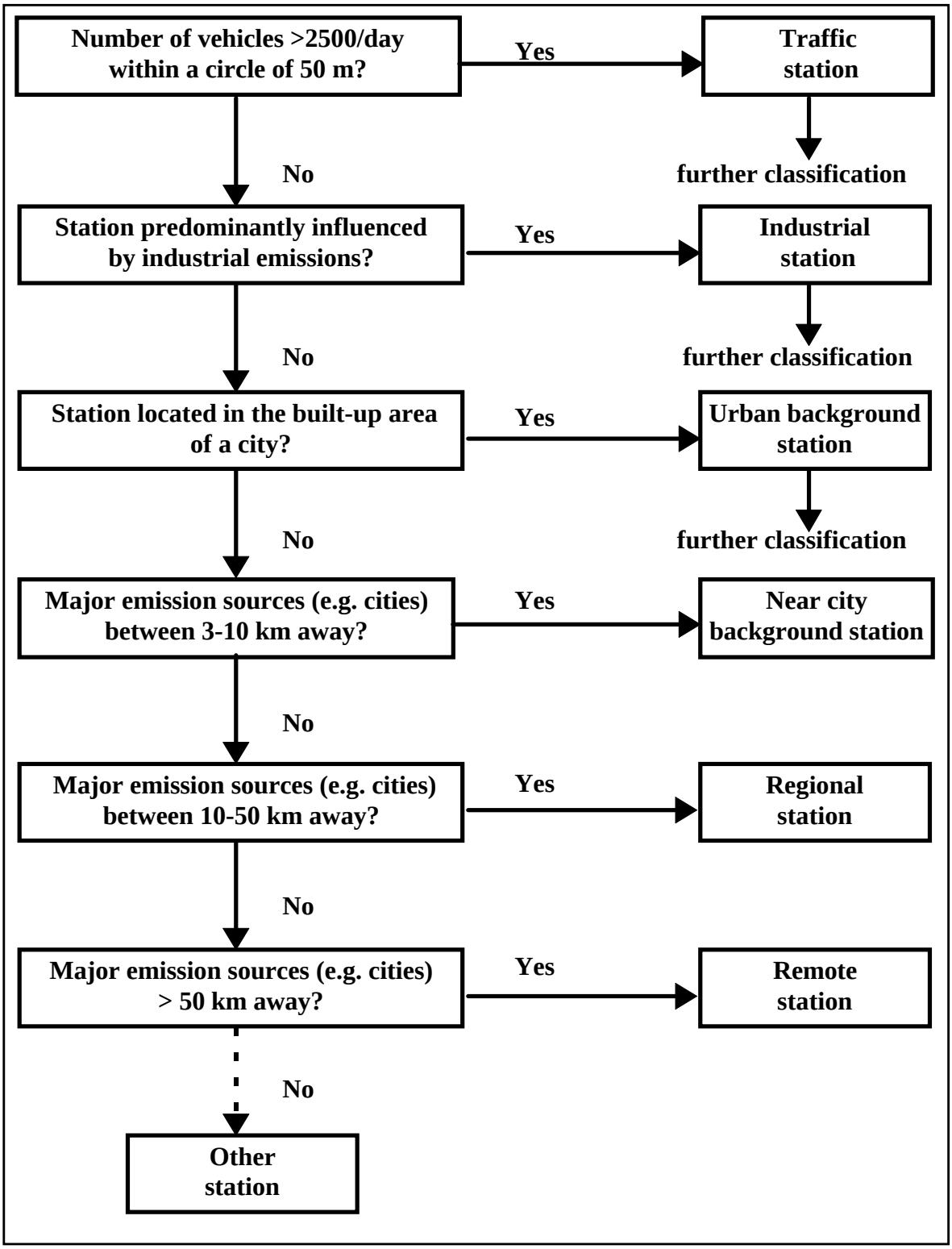

Figure 5.7: First level station classification criteria (Sluyter, 1997)

6. JAVA PILOT PROJECTS

6.1 Introduction

The Java programming language has recently been introduced as an important tool to build Internet applications. This language enables programmers to build small applications, or applets which can be used from within an Internet browser such as Netscape. One of the major advantages of Java is that the applets are platform-independent. Another advantage of using applets is that, once data has been retrieved, all data-processing can be done in the applet and no communication between browser and WWW system is necessary. This feature allows for much more user-interaction with data than is possible with traditional forms-based Internet applications.

In 1997, two pilot projects have been started to evaluate the Java programming language as a tool to build Airbase data selection and visualisation extensions. The first pilot project has been carried out by a group of second-year students of the Utrecht University (UU) and has focused on selection and visualisation of **m**easurement **r**esults. We will call this the MR pilot. The second project is still underway and is being carried out by a Dutch software consultant and is focusing on selection and presentation of Airbase **m**eta-**i**nformation. We will call this the MI pilot.

Note: these pilots are proof of concept projects. They do not result in high-quality software that can seamlessly be integrated into the Airbase WWW system. They will however be made available in the WWW system to enable users to get an impression of the way in which the WWW system may be developed. The results of the pilot projects need to be carefully evaluated and an integrated selection and presentation system must be designed, using software from the pilot projects where possible.

6.2 The MR Java pilot

The MR project has now finished and the end product is either a Java applet object to be contained in a HTML page in the Airbase WWW system, or a stand-alone Java application to be installed at the client side. Figure 6.1 presents the general concept of communication between the Java applet and AIRBASE through Internet.

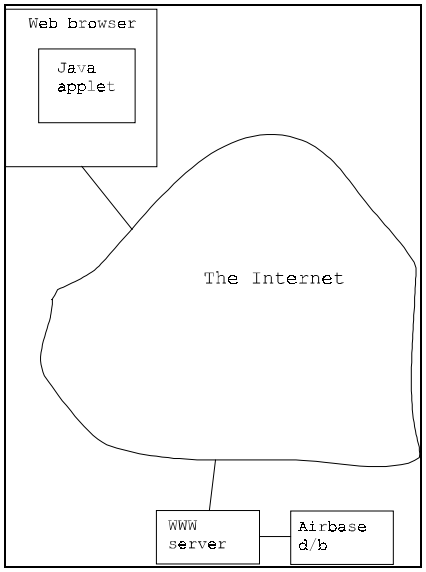

Figure 6.1: General concept of Java-AIRBASE communication

The applet provides the user with a simple menu to make selections of countries, networks, stations, period and presentation type. After selections are made the applet communicates with the Airbase database to retrieve data. Once data is retrieved, the applet locally visualises the data in a simple line-graph, a map or a table. The graph and map presentations are in itself interactive: in a graph, lines can be switched on or off and zooming in on the x-axis is available; in a map, zooming and panning is possible and specific station-info can be requested by clicking on the station position.
Figure 6.2 presents a general overview of the MR applet.

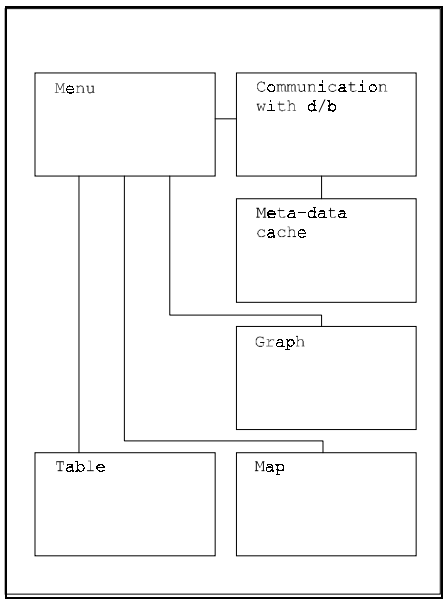

Figure 6.2: MR applet overview

Figure 6.3-6.7 present examples of MR applet windows.

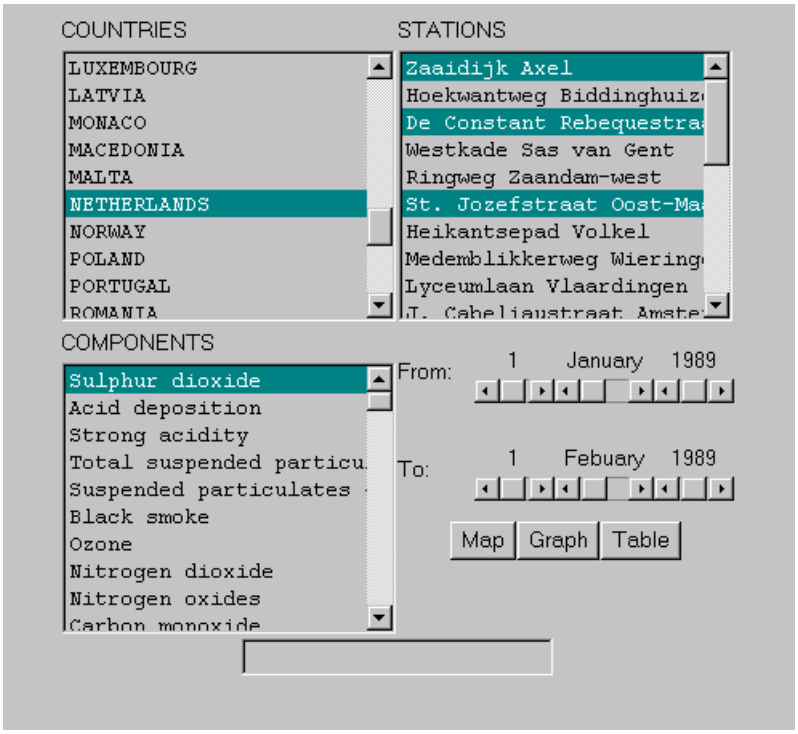

Figure 6.3: MR pilot selection window

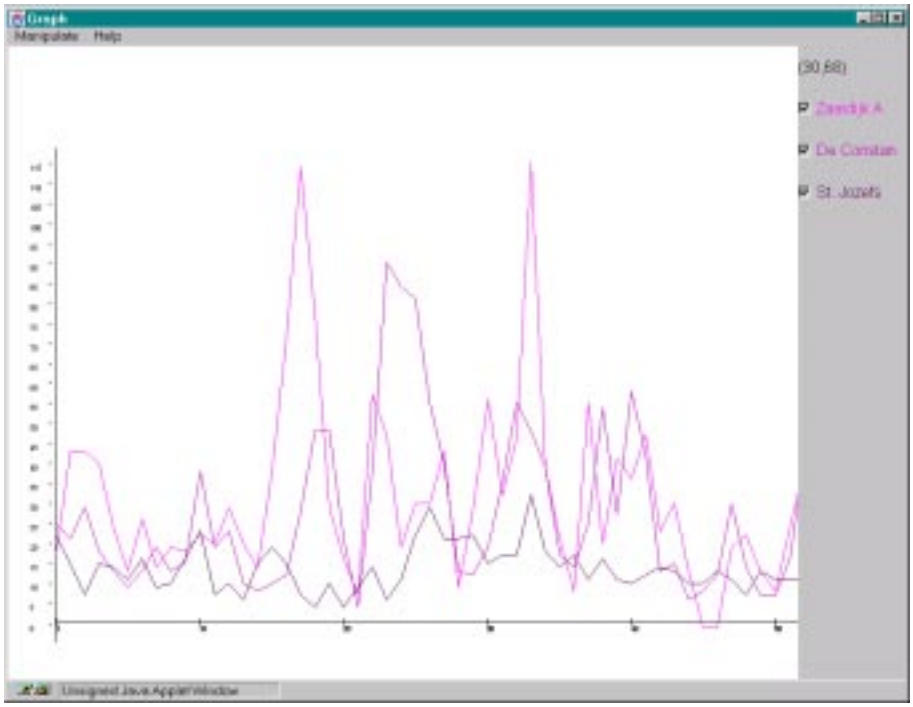

Figure 6.4: MR pilot Graph window

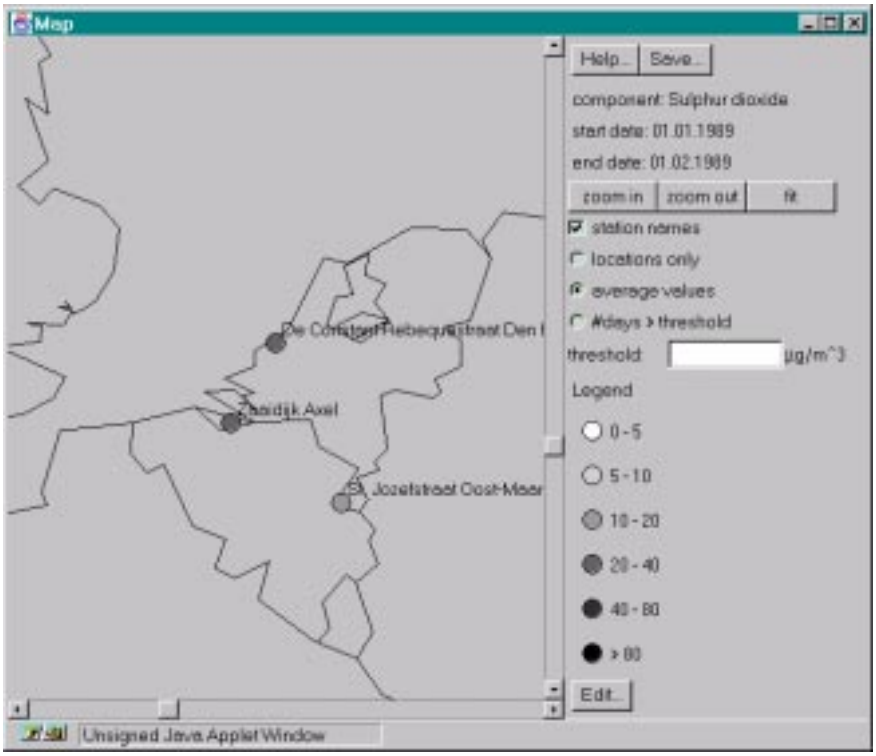

Figure 6.5: MR pilot Map window

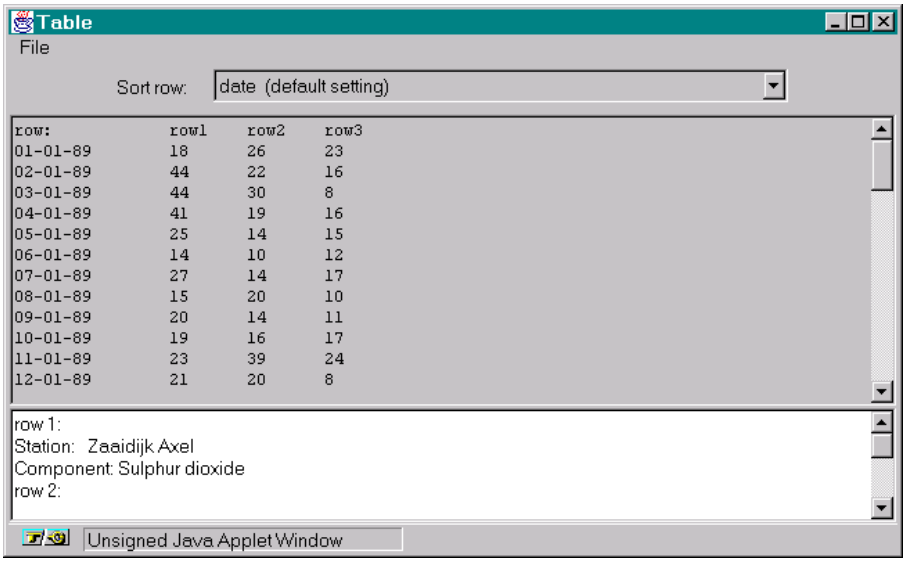

Figure 6.6: MR pilot table window

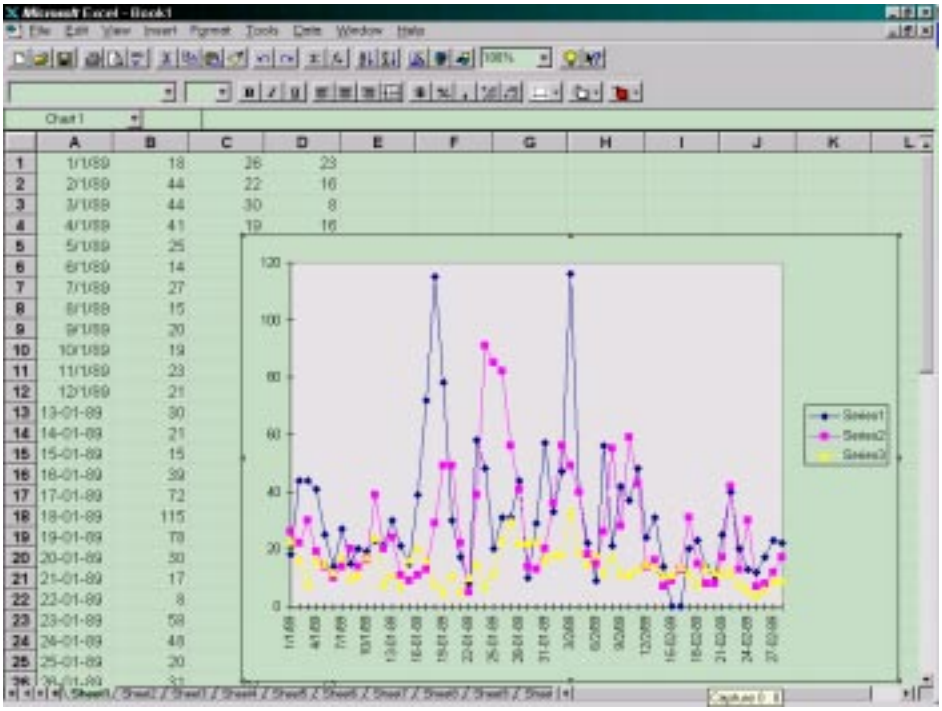

Figure 6.7: Copy/Paste from table to Excel

To make the menu pick-lists dynamic without communication with the Airbase database after each menu choice, the applet starts by requesting from the database a complete meta data list of all country/network/station/ component combinations. This list is stored locally in a cache. If a choice from a pick-list is made, the other, relevant, pick-lists are updated immediately. The advantage of this method is fast interaction in the applet menu, the drawback is, that the database needs time to construct the meta data list each time an applet starts.

6.2 The MI Java pilot.

The MI pilot, which is still underway, focuses on selection and presentation of Airbase meta-data, i.e. descriptions of network, station and component information. Figure 6.8 presents the station selection form. Selected stations are presented on the Query result form (Figure 6.9). From the results form, a station can be selected for which detailed meta information is presented (Figure 6.10).

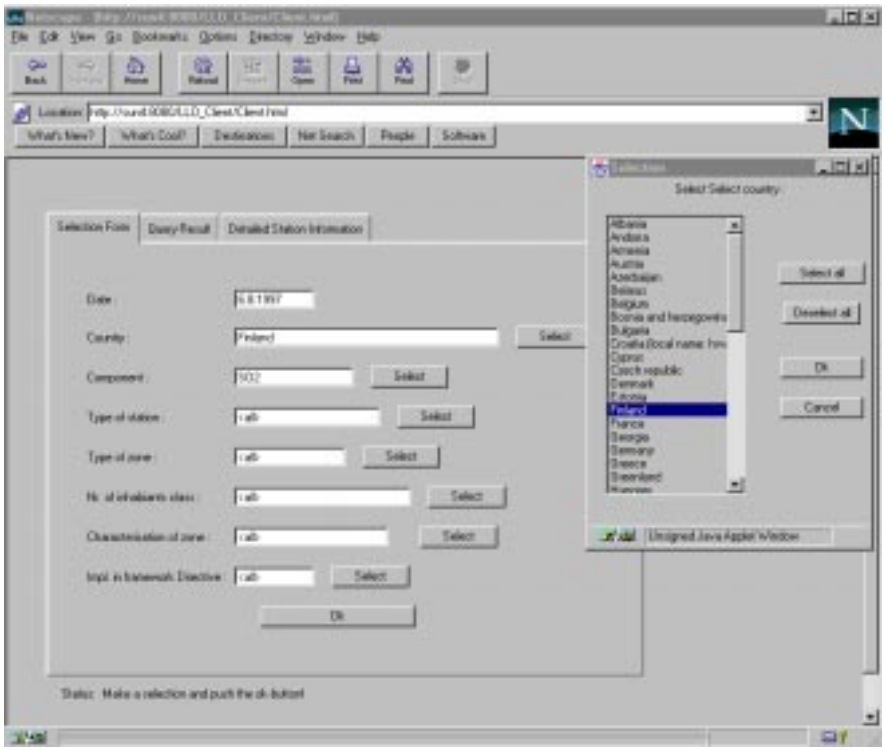

Figure 6.8: MI pilot selection form

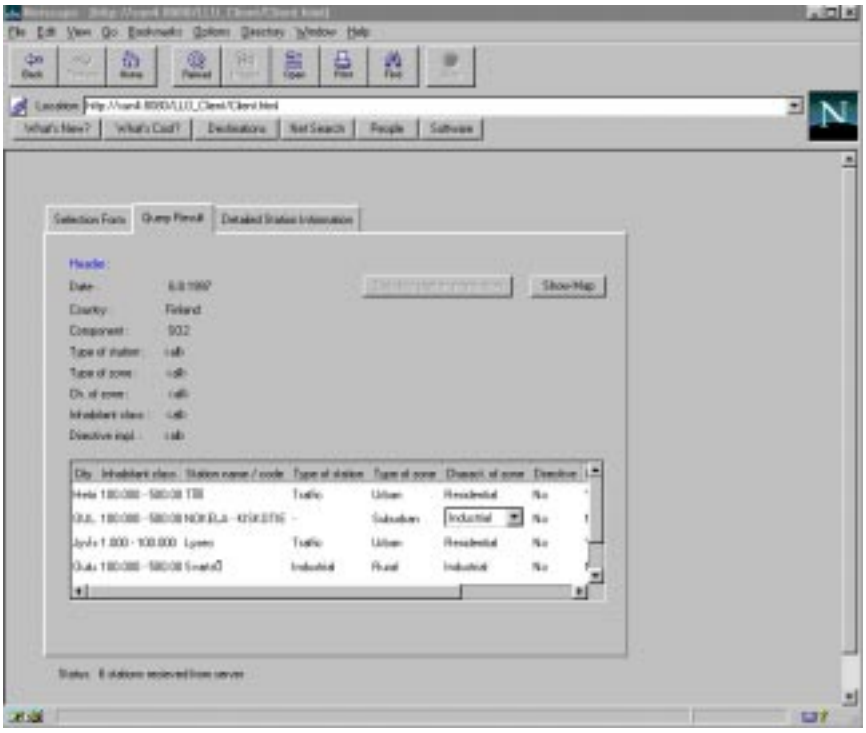

Figure 6.9: MI pilot query result

Figure 6.10: MI pilot detailed station info

7. DATA EXCHANGE: EoI and EUROAIRNET

It is planned to have the Data Exchange Module (see section 5.1) ready in time for next year's reporting in the framework of the EoI Decision and/or EUROAIRNET. However, it must be noted that DEM development is dependent on external funding. If external funds are not made available within the coming months, data suppliers will be asked to keep using AIRBADM to transmit meta information and ISO-7168 or NASA-Ames 1010 to transmit air quality data files.

General procedure for transmitting data in the framework of the EoI, Dir. 92/72/EEC and EUROAIRNET using the DEM:

1. Data suppliers will receive (download from server or through CD-ROM) DEM, loaded with all available meta information on networks, stations and measurement configurations;
2. Suppliers will be requested to check meta info and make annotations where necessary;
3. If data files are to be transmitted, a listing of unique identification codes will be generated by the software, to be used in data files;
4. Suppliers will place identification codes in data files;
5. Data files will be imported into DEM, after extensive error checking[5];
6. Database is transmitted to ETC-AQ/DGXI (diskette, CD-ROM, tape or through Eionet/Internet;
7. DEM data and information ('database') is loaded into AIRBASE. All transmitted data will be made accessible through the AIRBASE Web application.

According to the new EoI Decision, Article 5, EU Member States will transmit data for the calendar year by 1 October of the following year at the latest (first transfer shall cover 1997). In the framework of EUROAIRNET, EEA requires data to be transmitted for the calendar year within 6 months.

In the foreseeable future, it is to be expected that there will be a large overlap (at least for EU Member States) between data transmitted in the framework of the EoI and that of EUROAIRNET[6].

In order to minimise the work load countries have to devote to data transmissions and to avoid that (more or less) the same data arrives twice at the ETC-AQ, it is strongly recommended to transmit data only once before 1 July as combined EoI/EUROAIRNET set. The future Data Exchange Module will make it possible to mark a station as belonging to either EoI and/or EUROAIRNET.

ETC-AQ will offer help in using the DEM to data suppliers through the AIRBASE help desk and with visits, if necessary.

[5] DEM will offer a feature for manual entry of statistics and exceedances of ozone thresholds.
[6] For more information on the selection of stations and components, refer to ....(Larssen et al, 1997) for EUROAIRNET and Decision 97/101/EEC for EoI.

8. CONCLUSIONS AND RECOMMENDATIONS

During the last year, AIRBASE has been implemented and loaded with existing APIS/GIRAFE data. It became clear that network and station meta information (mainly originating from GIRAFE) was outdated, sometimes conflicting with APIS, non standardised, sometimes (partly) missing and full of obvious errors. The poor quality of the information seriously hampers the use of AIRBASE. To increase the quality of meta information, data suppliers were provided with a software tool (AIRBADM) which features standardised meta information entry according to the new EoI requirements.

AIRBADM was already used by a few countries for their 1996 data transmissions. It is strongly recommended data suppliers take notice of the problems with the meta information and start to use AIRBADM to increase the quality of data transfers.

Air quality data files transmitted by countries for loading in AIRBASE were in most cases not according to the recommended formats. The effort needed to convert all data to AIRBASE was far beyond the capacity the ETC-AQ can spend on this task. ETC-AQ strongly recommends to use either the ISO-7168 or NASA/Ames 1010 format for data transfers.

Public access to AIRBASE has been provided through a pilot Web application. Two JAVA pilot projects have been carried out to investigate the possibilities of this technique for implementation in AIRBASE. The results of the pilot projects were very promising and the applets will be made available on the ETC-AQ server.

It is expected that the adoption of the new EoI Decision and EUROAIRNET will increase the number of countries and amount of data reported. In order to ensure smooth and quick transfer of high quality air quality data, the ETC-AQ proposed to build a Data Exchange Module (DEM) which includes all features offered by AIRBADM. DEM can be used for transfer of raw air quality data, statistics and exceedances of thresholds.

Funds needed to build DEM and extensions to the existing Web application cannot be covered by the normal ETC-AQ subventions. ETC-AQ is actively seeking additional funding through the DGXIII Telematics Application Programme, the IDA-Eionet programme and IDA-DGXI programme.

9. REFERENCES

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