AirQUIS: A Modern Air Quality Management Tool

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A complete Air Quality Management Strategy (AQMS) system contains modules for Air Quality Assessment, Abatement Measure Assessment, Cost/benefit analyses and Optimum Abatement Strategy identification. Norwegian institute for Air Research, NILU, has developed professional management software for such work, AirQUIS.

AirQUIS represents a main tool for establishing and integrating the different components of the AQMS. The system has been established and operated in more than 20 cities and urban areas world-wide. It received the European IT prize in 1998, and is being further developed and improved for a variety of applications.

Main objective

A main objective of the modern environmental management system is to enable direct data and information transfer and obtain a remote quality control of the data collection. The system must:

- Provide information on how much pollution the population is exposed to,
- Establish a basis for strategies to reduce pollution,
- Estimate environmental impacts from present and future developments.

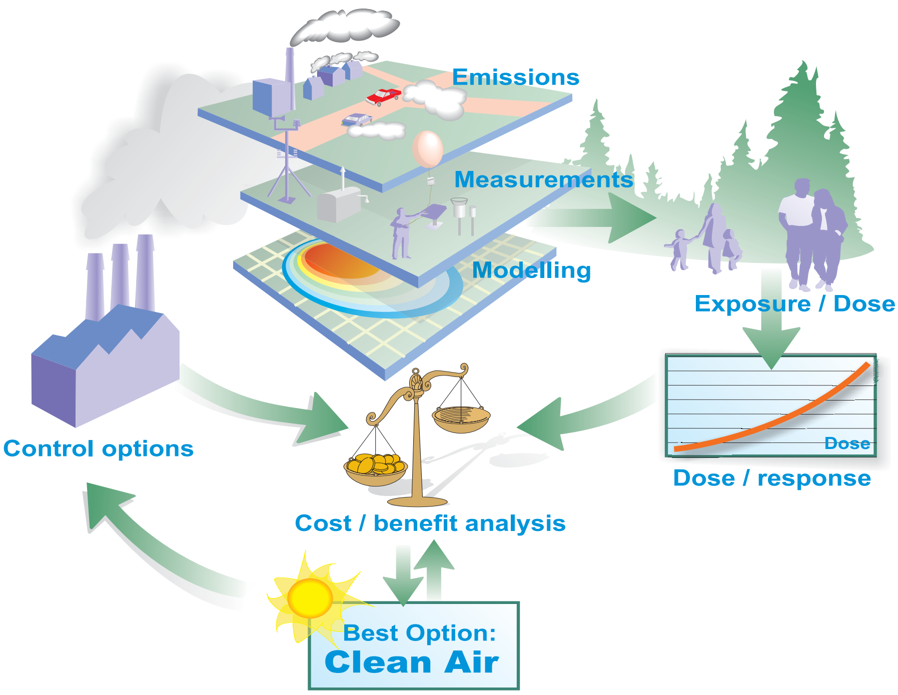

Figure 1. A modern Air Quality Management System integrates all necessary elements.

One of the main challenges in today's society is to have timely and appropriate access to relevant and good quality environmental data. The aim is to enable actions whenever environmental requirements and limits are violated. These were the challenges that a group of scientists faced when a new generation of GIS based monitoring and planning system was to be developed in Norway.

The AirQUIS technologies are now being used in environmental management to support integrated pollution prevention and control. It can also be part of an emergency management system to support actions and crisis management during emergencies and accidents of various kinds.

The environmental information system will have to combine the latest sensor and monitor technologies with data acquisition; data base developments, quality assurance, statistical and numerical models and advanced computer platforms for data processing, as well as distribution and dissemination of data and model results.

The AirQUIS components

AirQUIS consists of six components and makes use of an Oracle database. The system has integrated forms and maps developed in VisualBasic and MapObject (GIS):

- A manual data entering application,
- An on line monitoring system,
- A module for online data acquisition and quality control,
- A measurement data base for meteorology and air quality,
- A modern emission inventory data base with emission models,
- Numerical models for transport and dispersion in air of pollutants,
- A module for exposure estimates and population exposure assessment,
- Statistical treatment and graphical presentation of measurements and modelling results.

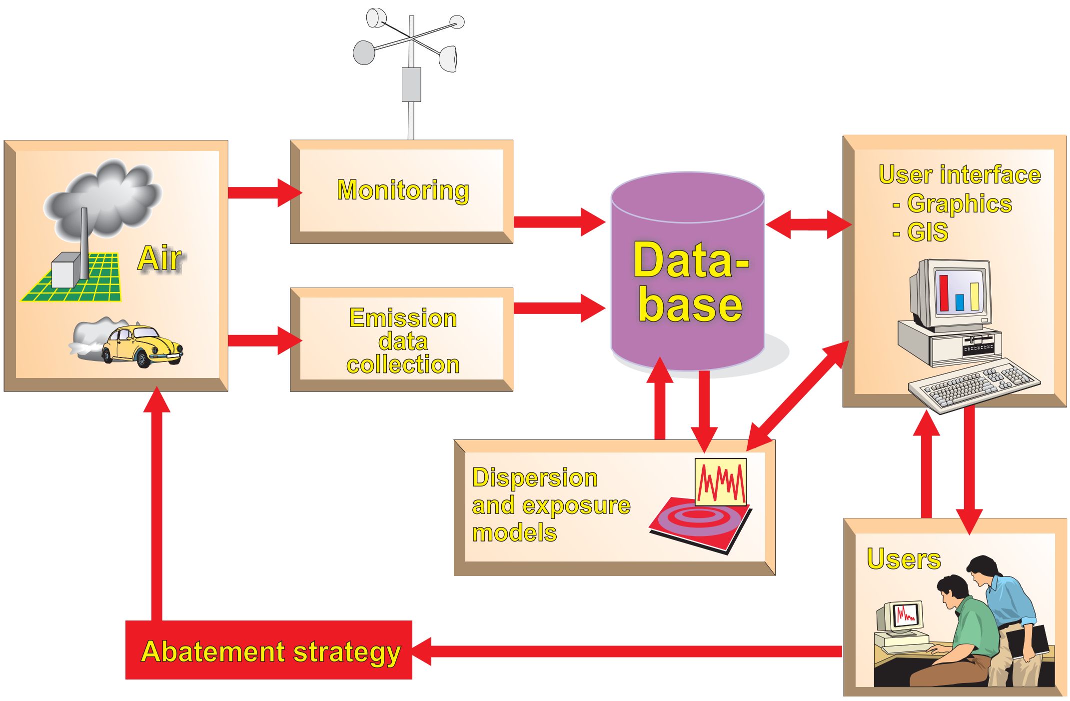

Figure 2. AirQUIS can be used as a management tool for planners, as an information tool for the public and as an expert system for specialists.

All objects described above are integrated in a map and menu oriented user-friendly interface with direct link to the databases for measurements, emissions, modelling results and presentation tools. Advanced import/export wizards allow the user to transfer data easily to and from the AirQUIS system.

The GIS based air quality planning system

Based on a Geographical Information System (GIS) platform AirQUIS has been developed to handle air pollution problems. The main objective of a modern environmental surveillance platform of this kind is to enable direct data and information transfer and obtain a remote quality control of the data collection. The system combine monitoring, data presentation and modelling in one package, which enable the user not only to present and evaluate the present situation, but also to undertake environmental planning for a sustainable future. The GIS platform, on which the system is operated, provides easy access to the data and gives a perfect and easily understandable data presentation tool.

The GIS Functionality

The GIS (Geographical Information System) functionality of the AirQUIS system is designed to offer several possibilities for understanding the problems of air pollution.

- The GIS makes it easier to place the air pollution sources at the correct location, for example by making it easy to display and edit the total network of road links in a city.

- GIS presentation of area-distributed consumption of fossil fuels and direct emissions gives a good overview of where to expect high impact of air pollution.

- Viewing the measurement stations on a map with the pollution sources will give an idea of what concentrations one may expect to find at the stations for a given wind direction.

- The GIS makes it possible to search for geographically linked data in the database.

Information on all map related data such as area use, traffic density and emissions can be accessed through the map by selecting an area. Displaying results of model calculations as a map can be used for public information on pollution levels at different parts of a city.

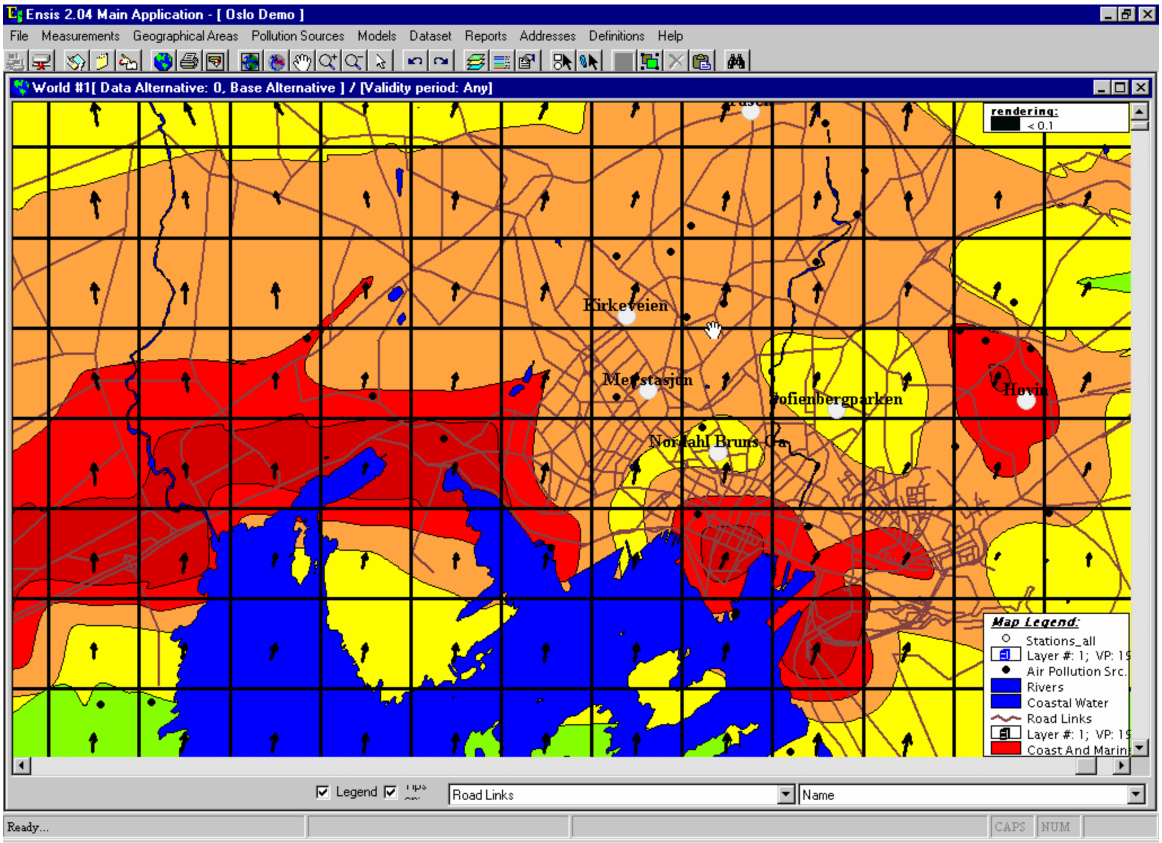

Figure 3. GIS-functionalities combined with a windows based standardized interface makes AirQUIS very user friendly.

The models

A major part of the AirQUIS system is the dispersion models for emission inventories, concentration and exposure estimates. The models covers air pollution on all scales; traffic in street canyons and along roads, industrial emissions and gridded pollution from household etc. within the urban areas and on a regional scale.

The NILU developed source oriented numerical dispersion model EPISODE calculates spatial distribution of hourly concentration of selected indicators, such as SO_2, NO_2 and suspended particles. The NILU models ROADAIR and CONTI-LENK are used to estimate sub grid concentrations close to roads within the square grid. A puff-trajectory part of the model is used to calculate the influence of point sources.

To obtain a good description of the wind field in a complex terrain, NILU has included a terrain influenced wind field model. This model is fast and can on hourly basis perform inhomogeneous wind fields as input to the dispersion models for emissions to the atmosphere.

Numerical air quality and episode forecast

Numerical forecast models have been developed to combine estimated wind and turbulence with numerical dispersion models to forecast air quality into the next 24 or 48 hours. At NILU the forecasted wind fields have been used as input to the AirQUIS air pollution dispersion modelling system to estimate concentration distributions for the next 24 and 48 hours.

An improved modelling system for air pollution forecasting have been developed and tested for the 5 cities participating in the "Better City" programme. The new models involve a combination of numerical forecast models and numerical air pollution dispersion models. The development has been a co-operation between NILU and the Norwegian Meteorological Institute (DNMI).

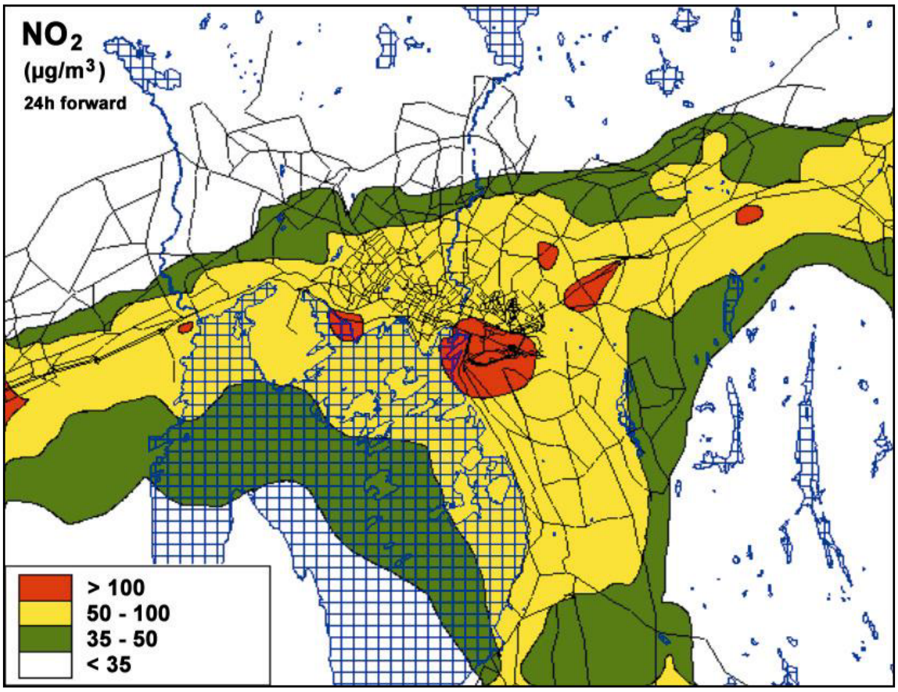

Figure 4. Forecasted concentrations of NO_2 in Oslo 24 hours ahead are the basis for exposure estimates, which again is used for decisions on immediate actions to reduce air pollution emissions for traffic.

Weather forecasts

The numerical weather forecast model HIRLAM50 with 50-km resolution has been used to estimate and forecast the weather conditions such as wind and turbulence for the next 24 hours. The results from the HIRLAM model is then used as input to the MM5 model to produce a more detailed wind field. The input to the AirQuis dispersion models is given in a 1 km grid. The procedure requires large computer capacities and is thus fairly cost consuming for routine and daily operations.

Typical for most of the urban areas of Norway are the topographically complex surroundings with rather complicated wind patterns and local/mesoscale circulations. This lead to the necessity of enabling weather forecast modelling on a very fine scale compared to the normal synoptic scale weather prediction models. For the Norwegian cities Oslo and Bergen, which were the first cities to test the models, the grid size selected was 1 km. The weather prediction models are estimating three-dimensional wind and turbulence fields which are then fed automatically into the NILU "Episode" air pollution dispersion model.

Information to the public

Information of air quality in urban areas has been issued to the public on a daily basis described in terms of “very good”, “good”, “poor” etc. Many European cities already provide this type of information.

The EU-project EN 4002 IRENIE has been coordinated by NILU. The project wants to provide European-wide information services for the European Environment Agency (EEA) and its customers such as the European Commission (EC), national environmental protection authorities and for the public, and to demonstrate and evaluate the telematic options for increasing the efficiency of flows of data and information at the local, national and international level.

NILU also participates in the European research project APNEE. The main objective of this project is to establish user-friendly information services for the citizens and communities to improve the quality of life in Europe. Modern information systems as AirQUIS will be the basis for enabling citizens to easier access and exchange of information about air pollution in urban regions. Information will be distributed by mobile telecommunication system such as SMS, WAP and Voice. It is also real- time information, early warning and forecasting system for of air pollution across borders.

Figure 5. Information to the public is given to the public as text, graphs, maps, SMS-messages, e-mail etc, and updated on half hour or hourly basis.

The Technical Platform

Hardware

AirQUIS has the following *minimum* recommendations:

PC/Clients:
- PC Pentium II 400 MHz
- 128 MB RAM
- 1.0 GB hard disk
- CD player
- 19” monitor
- Graphic adaptor with 8 Mb RAM, 1024 x 786 dpi screen and 65536 colours

PC/Server:
- PC Pentium II 400 MHz
- 256 MB RAM
- 3 x 4 GB hard disks
- Monitor
- CD player
- Backup unit

Software

AirQUIS is a user-friendly system, integrating forms and maps in the same application. The system is developed in VisualBasic and MapObject (as GIS).

To fulfill a successful installation the following additional software must be available:

- Windows NT version 4.0 (version 3.51 is possible) on all PC’s
- ORACLE version 7.3.4 or higher on server
- ODBC Merant 3.5
- Communication software between the server and client(s)
- Seagate Crystal Reports version 6.0 Professional

AirQUIS installations:

Norway:
- Oslo
- Bergen,
- Drammen
- Sarpsborg
- Fredrikstad
- Trondheim
- Grenland area

Sweden:
- Stockholm

China:
- Yantai
- Guangzhou
- Heiliongjiang

Botswana:
- Dept. of Mines

Saudi Arabia:
- SEC Electric comp.

Israel:
- Haifa

EU programmes/Europe:
- Interreg
- EEAA, Eionet
- Wood Assess
- Irenie
- Reach
- Apnee