Trend analysis of air pollution exposure in Oslo 1995, 1998 and 2001.

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Norwegian Institute for Air Research (NILU) has performed trend analysis of exposure to air pollution for Oslo, the capitol of Norway, in the period 1995 – 2001. In this period, the number of persons exposed to concentrations of PM_{10} above the Norwegian guideline for good air quality, were reduced with approx. 100 000 (31%). Similar, the reduction related to NO_2 was 45 000 (77%). The improved impact of air pollution was mainly due to reduced use of studded tyres (PM_{10}) and more cars using3-way catalytic converter (NO_2).

The air quality management system AirQUIS

AirQUIS is a menu oriented, user friendly air quality management system containing several modules :

- Modules for manual and online data acquisition and quality control,
- On line monitoring system with data base for meteorology and air quality,
- An emission data base with emission models for selected source categories
- Numerical models for line, point and area sources for dispersion calculations of air pollutants,
- A module for exposure estimates and population exposure assessment,
- Statistical and graphical presentation of measurements and modelling results.

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.

Background

The NILU developed air quality management system AirQUIS has been used to calculate hour by hour concentrations and exposure fields in Oslo in 1995, 1998 and 2001 for selected source categories such as industry, traffic and private consumption of fossil fuels and indoor wood burning. The impact of air pollution is divided into user specified source categories and the exposure calculation can be performed in specified building points or as average for a grid square.The results has been compared to recommended Norwegian air quality guidelines of nitrogen dioxide (NO_2) and particles (PM_{10}).

Emissions to air

The main sources to emissions to air of PM_{10} and NO_2 in Norwegian cities are traffic and indoor wood burning. Other sources such as industry, public buildings and harbour activities are limited. In some few specific regions also industrial areas might impact urban areas

Traffic
The number of vehicle driven kilometres in Oslo has increased by 22% from 1995 to 2001. In the same period, the fraction of cars using studded tyres have been reduced from approx. 70% to 20% due to implementation of taxes for using studded tyres in Oslo. This has lead to about 60% reduction of resuspended particles caused by vehicle driven turbulence. Emission of nitrogen oxides from traffic have been reduced by approx. 33% due to increased use of 3-way catalytic converters in the cars.

Indoor wood combustion
The private use of wood for heating in stoves or open fire places is commonly used in Norwegian houses during the winter period. Next to traffic, this is the major source to emission to air of particles. The emissions to air from wood burning has been reduced by approx. 33% due to a combination of reduced use of wood burning and improved technology in the stoves.

Other sources
Other sources of emissions to air such as industry, public buildings, harbour activities and heating by fossil fuels are limited and only small changes have occurred in the period.

Norwegian recommended air quality guidelines
The recommended Norwegian air quality guidelines of PM10 and NO2 are based on the same concept as the EU Directives.These are :

- **NO_2** : 150 ug/m3 as 8. highest hourly averaged value
- **PM_{10}** : 50 ug/m3 as 7. highest daily averaged value

Concentration distributions

The results of the dispersion calculations for Oslo from 1995 – 2001 shows reduced concentrations levels for both NO_2 and PM_{10}, giving the highest reductions for PM_{10}. The 8. highest daily average concentration distribution of PM_{10} for the year 1995 and 2001 is given in figure 1 and figure 2.

Figure 1 : Concentration distribution of the 8. highest daily averaged gridded PM_{10} value in Oslo 1995

Figure 2 : Concentration distribution of the 8. highest daily averaged gridded PM_{10} value in Oslo 2001

Exposure
Personal exposure of NO2 and PM10 has been calculated by a combination of exposure calculations in building points along major roads and for each model grid square. The number of persons exposed to exceedances of the recommended guidelines for 1995 and 2001 is given in figure 3 and 4, respectively. These gives that the number of persons exposed to exceedances of PM_{10} is reduced from 320 000 persons to 220 000 persons, while the reduction for NO_2 was from 58 500 persons to 13 500 persons.

Figure 3 : Number of people exposed to exceedance of the recommended air quality guideline for PM_{10} in Oslo in 1995

Figure 4 : Number of people exposed to exceedance of the recommended air quality guideline for PM_{10} in Oslo in 2001

Source contribution
The situations where exceedances of recommended air quality guidelines occur are related to cold, calm days with atmospheric inversions and poor dispersion conditions. The typical source contribution of the main source classes to the impact of NO_2 and PM_{10} according to the guidelines is given in figure 5 and 6. This clearly shows that the major source category for emissions to air of nitrogen oxides during these episodes are traffic with approx. 90% of the emissions. Similar, the main source categories to emissions of PM_{10} in the centre of Oslo are wood burning and traffic with approx. 60% and 30%, respectively.

Figure 5 : Typical source contribution for emissions to air of nitrogen oxides in Oslo.

Figure 6 : Typical source contribution for emissions to air of particles (PM_{10}) in Oslo.

Conclusions and recommendations
The situations where exceedances of recommended Norwegian air quality guidelines occur are related to cold, calm days with atmospheric inversions and poor dispersion conditions.
The major source to the impact of NO_2 according to the guidelines are traffic with approx. 90% of the NOx-emissions. Similar, the main source categories to emissions of PM_{10} in the centre of Oslo are wood burning and traffic with approx. 60% and 30%, respectively.

The trend analysis of air pollution impact in Oslo in the period 1995 – 2001 shows a reduction in number of people exposed to exceedances of recommended air quality guidelines for PM_{10} and NO_2 by 100 000 and 45 000, respectively. The main reason for this is reduced use of studded tyres and wood for house heating and the introduction of 3-way catalytic converter in cars.

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