USE OF ATMOSPHERIC DISPERSION MODELS FOR URBAN AIR QUALITY MANAGEMENT IN POLAND AND OTHER CEE COUNTRIES

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INTRODUCTION

The Air Quality Framework Directive sets out the philosophy, principles and techniques for the assessment and management of air quality. Where concentrations may exceed the legally binding limits, Member States must implement air quality management plans to ensure compliance with the relevant limit value. Many Member States are experiencing difficulty to comply with PM_{10} limit values which entered into force on 1 January 2005. Exceedances of daily PM_{10} have been reported in 39% of all zones in EU25 for 2005 (Kobe, 2006). Nine Member States reported PM_{10} exceedances in more than 90% of their zones. Serious problem of non-compliance concerns also the ozone and NO_2 concentrations.

CURRENT STATE OF URBAN AIR QUALITY MANAGEMENT PRACTICES IN POLAND AND SELECTED OTHER CEE COUNTRIES

Air quality management in Poland is focused on the annual assessment and resulting action plans for the zones where the air quality limits are exceeded. The process of air quality action plans (AQAPs) preparation has been developing since 2002 when EU Air Quality Framework Directive was implemented. The number of zones requiring AQAPs increased from 13 (first assessment for 2002) up to 96 according to the last available official assessment for 2005 (IOS, 2006). The main pollutant exceeding the limit values is PM_{10} (79 zones with exceedances in 2005 assessment). Other pollutants specified in 2005 assessment are ozone (27 zones), NO_2 (2 zones), SO_2 (1 zone) and benzene (1 zone). The regional authorities responsible for action plans completed the air quality management projects only in the part of indicated zones. The AQAPs were prepared for the zones in Warsaw, Lodz, Cracow and Katowice regions. For some others the process of AQAPs preparation is on-going.

In the Czech Republic in 2005 the limit value for PM_{10} daily concentration was exceeded in 35% of the territory where more than 65% of the population live (Ostatnicka, 2006). The situation was worse than in previous year especially in the Moravian-Silesian region. In this industrial region the special integrated programme of emission reduction was set up by the authorities.

Very interesting transboundary air quality management system was introduced in the Boundary Bulgarian-Romanian region (IEM, 2005). Joint air quality monitoring system was established and air quality management programs were developed in four pairs of cities in Bulgaria and Romania: Silistra – Calarasi, Rousse – Giurgiu, Nikopol – Turnu Magurele and Svishtov – Zimnicea.

The models used for urban air quality management systems in CEE zones include recognised foreign solutions like ADMS-Urban, AIRVIRO, OML and OSPM models as well as local tools like Czech ATEM and SYMOS'97 models, Estonian AEROPOL model or Polish AMOT model. For example Swedish AIRVIRO dispersion model was applied in Prague, Riga, Vilnius and Tallinn. It consists of four sub-models: street canyon model, Gaussian plume model, Eulerian grid model and heavy gas dispersion model. AIRVIRO was also used as an air quality management system to collect and process emissions data as well as to generate reports for decision makers and information for public use. Sometimes a combination of different dispersion models is used for air quality management. In Prague, where AIRVIRO was used, other dispersion models were also applied (ATEM and SYMOS'97).

CRITERIA OF MODEL SELECTION

One of the main factor considered is the model accuracy. Polish regulations set up the required accuracy depending on the pollutant and concentration averaging time.

Table 1. Model accuracy requirements in Polish regulations

Pollutant	Averaging time	Required accuracy
PM_{10}	24 h	50%
SO_2, NO_2	24 h	50%
SO_2, NO_2	annual	30%

Other requirements concern the output format, the spatial range of modelling and use of particular meteorological data. It is also very important for the model to be listed in the guidelines issued by the Ministry of Environment (Lobocki, 2003).

Some authorities responsible for air quality management specify the requirements clearly indicating use of particular models or group of models. For instance the requirement of regional meteorological parameters spatial distribution calculation prefers application of CALMET/CALPUFF category of models. On the other hand the same authorities would like to obtain detailed air quality modelling results for the urban areas including the concentrations at individual streets. Such mix of criteria leads to the considerable difficulties for the selection of right modelling tools. The above example shows the local authorities are not fully aware of existing modelling tools, their functions and applications ranges. It may happen that the criteria of model selection are not coherent and do not take into account the main objectives of urban air quality modelling.

CASE STUDY ON MODEL APPLICATION AND VERIFICATION

One of the major air quality management projects in Poland was carried out in 2005 and 2006 by ATMOTERM company in Cracow region. Air quality action plans were prepared for five zones located in this region. In 2003 and 2004 air pollution measurements showed PM_{10} air quality limit values exceedances in each zone. NO_2 and SO_2 air quality limit values was exceeded only in Cracow city.

After the consultation with local authorities ADMS-Urban system was chosen for the modelling tasks of the project. For each zone model verification has been made with application of ADMS-Urban short term calculation option. Good results of verification have been obtained. Example of concentration time-series for the town of Skawina is shown at figure 1. Although some peaks are not achieved the general levels and concentration changes of modelling results are in agreement with measurements. The difference between summer and winter season clearly indicates the nature of sources responsible for high concentrations.

The source apportionment analysis confirmed that the main contribution to PM_{10} pollution in this zone comes from area sources.

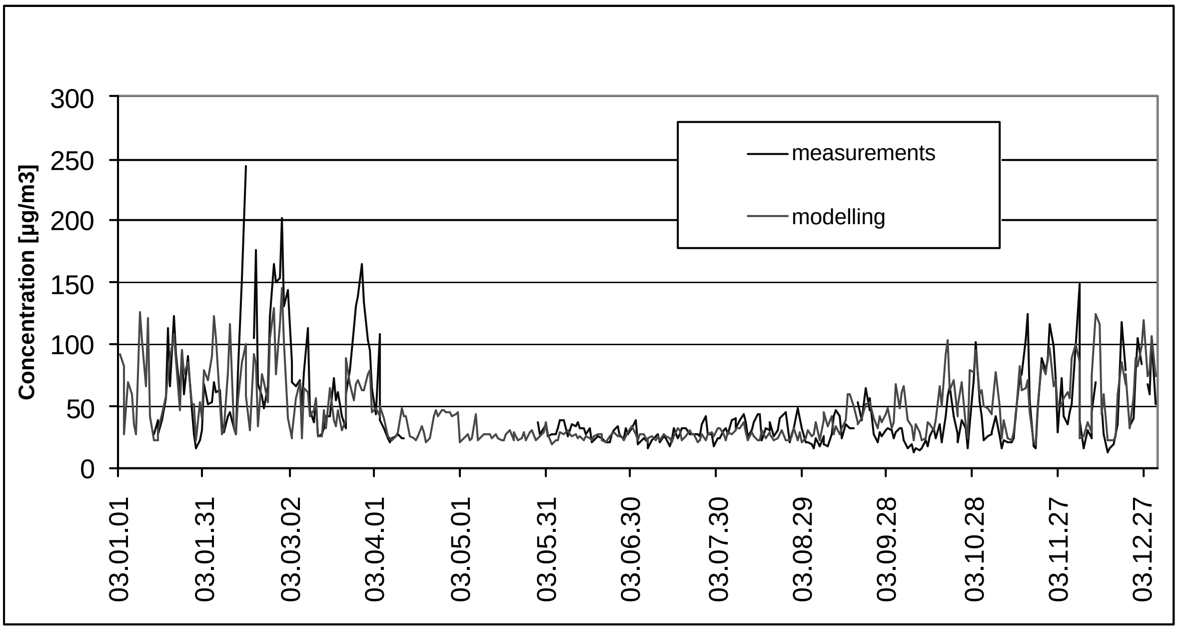

Fig. 1; PM_{10} daily concentrations in Skawina, Poland, 2003. Comparison of monitoring and modelling results.

More difficult situation was in the city of Cracow, where modelling results had to match with multi-point monitoring network data and considerable contribution of road sources was observed. However also in that case the results of verification were satisfactory for local authorities.

PROCEDURES APPLIED TO ENSURE HIGH QUALITY OF MODELLING

The quality of modelling in complex urban area depends not only on the model itself but also on the quality of input data. Collecting the precise data on the various types of emission is the key factor for the process.

The procedures applied to ensure high quality of emission data include the following:

- field emission inventory activities,
- emission database development and maintenance,
- emission scenarios creation and
- use of emission changes patterns correlated with sequential meteorological data.

Existing data on industrial air emissions are dispersed but generally quite well available. Public records of air emissions, IPPC permits and mandatory reporting systems are not perfect but give the amount of information which is satisfactory in terms of urban air quality modelling. The real difficulties lie at the side of area and road emission sources. Usually there are no available inventories of domestic and commercial heating so for each individual air quality zone the database has to be prepared. The methodology is based on the heating energy demand and fuel use spatial distribution evaluation. In the countries like Poland there is still high use rate of hard coal for residential heating and this is why the detailed inventory of area emission sources is so important. To calculate road emissions traffic flows must be also included and supplemented by the updated emission factors.

For the daily concentrations modelling it is very important to evaluate emission changes in time. Depending on the type of emission source long-term (monthly) and short-term (hourly) emission changes patterns are used.

ATMOTERM company developed a software package for air quality management (SOZAT-WKE) that includes special functions for road and area emission sources and provides useful tools for emissions forecasts and simulations. It allows transfer of emission data to the selected air quality model as well as presentation of obtained results. SOZAT-WKE is fully compatible with Polish guidelines on emission inventory.

ROLE OF MODELLING FOR DECISION MAKING PROCESS

Results of modelling give the picture which is the basis for decision making process. However the decision makers are usually not fully aware of the air quality modelling details. This is a role of professional consulting to assess the quality of modelling and to ensure the decision maker his decision is taken basing on relevant information. Application of harmonised assessment methodology would be very useful in this task.

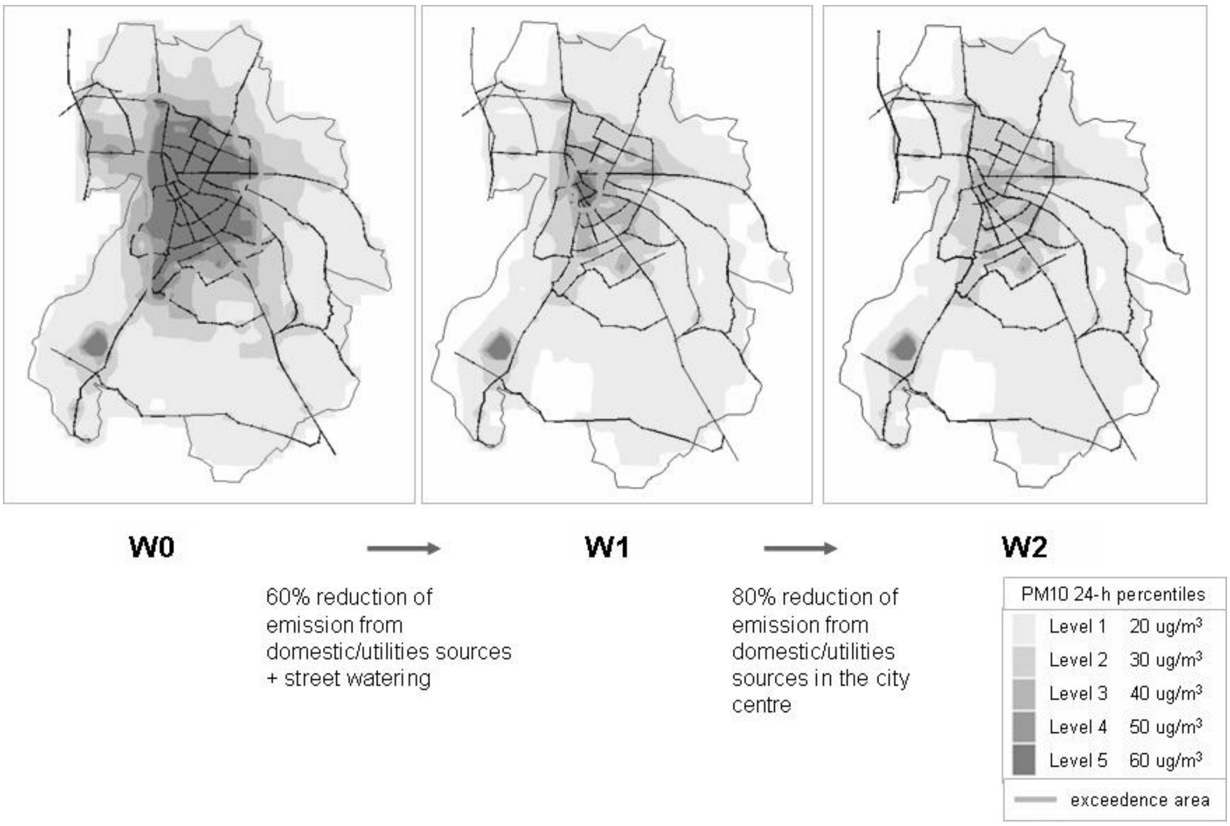

Fig. 2; PM_{10} air quality improvement plan for Nowy Sacz, Poland – summary of measures and their effects.

At the figure 2 the PM_{10} emission reduction measures for one of the zones within Cracow project are presented together with the maps of daily concentrations showing the effects of the measures on the PM_{10} pollution. It was discovered that planned 60% reduction of area emissions was not enough for the very centre of the town, where the highest density of old coal-fired buildings occurs (scenario W1). Thus an additional reduction was proposed for this area (scenario W2), which could solve the problem of PM_{10} exceedances. Each additional percent of emission reduction means the considerable costs and difficulties in the action plan implementation. For the decision maker the value of modelling in this case is of highest importance.

CONCLUSIONS

Air quality management projects in Poland and other CEE countries have been developing since couple of years. The number of zones which require action plans is high, particularly for PM_{10}. In the near future, after implementation of CAFE Directive the number of AQAPs can be even higher as the new requirements connected with $PM_{2.5}$ will enter into force.

Within the air quality management projects complex mathematical modelling tools are used by local authorities for different tasks that lead to decision making – set up of long-term improvement plans and implementation of short-term actions. It is crucial to ensure the proper reliability of these tools. There is a real need to develop harmonised set of parameters which describe the air quality models in terms of accuracy, verification record and applicability to urban areas. Such set of parameters would be very useful for both decision makers and consultants involved in the air quality management.

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