

# USE OF SELMAGIS FOR PREPARATION OF AIR QUALITY ACTION PLANS

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**Abstract:** Municipal environmental protection officers have to survey local and regional air quality. Supplementary to air quality monitoring, modelling systems are gaining more and more an importance. Lohmeyer GmbH & Co. KG provides the graphical user interface SELMAGIS, able to accommodate the locally used air quality models. It is completely implemented into ESRI's geographical information system ArcGIS. Thus the user is able to use his specific air quality models and at the same time all functionalities of the GIS (e.g. intersection of data, interfaces to data bases etc.). SELMA<sup>GIS</sup> is a modular system, presently containing different dispersion models as AUSTAL2000, PROKAS, MEMO/MUSE, NERI's OML-Highway being presently implemented. Depending on the individual task, i.e. regional, urban or micro scale modelling, the user is able to choose the adequate dispersion model on a common data base and a common display of the results.

SELMA<sup>GIS</sup> is used in different European countries.

The presentation will show the application and advantages of the SELMA<sup>GIS</sup> procedure for the preparation of the air quality action plan for the German coastal city of Rostock. The determination of the concentrations resulting from the main emission sources industry/harbour, maritimetraffic and road traffic was executed on a meso-scale and an urban scale. The German regulatory model AUSTAL2000, the Gaussian dispersion model PROKAS and its street canyon module have been used, providing the results to be used by the standard tools of ArcGIS.

By calculating the contribution of each emission source it was possible to identify the main polluters and to get a first hint on the hotspots in the city of Rostock. At these hotspots the concentrations were calculated in more detail with the prognostic microscale flow and dispersion model WinMISKAM, which also has an interface to GIS formats.

Using this analysis for the air quality in Rostock it was possible to trade off actions for reducing PM10 or NO<sub>2</sub> concentrations and to prepare the air quality action plan for Rostock..

**Key words:** *Dispersion modeling, Geographical Information System (GIS), ArcGIS, Air Quality Action Plan.*

## 1. INTRODUCTION

Municipal environmental protection officers have to survey local and regional air quality. Supplementary to air quality monitoring, modelling systems are gaining more and more an importance. Lohmeyer GmbH & Co. KG provides the graphical user interface SELMA<sup>GIS</sup>, able to accommodate the locally used air quality models SELMA<sup>GIS</sup> is in use in different European countries and has also been applied for the air quality action plan Rostock city.

## 2. DESCRIPTION OF SELMA<sup>GIS</sup>

SELMA<sup>GIS</sup> is a system for calculating and displaying air pollutant concentrations. The preparation of air quality action plans includes analyzing the actual situation of air quality and identifying the main pollutants as well as pollution hotspots. Based on this, it is possible to define measures to reduce the emissions in order to ensure the fulfilment of limit values defined by EU directives. For analysing and determining reducing measures it is necessary to translate different scenarios into dispersion models.

The type of the applied dispersion model depends, among other things, on the spatial resolution, the type of emission sources, and the chemical components which will be considered. It is possible that different dispersion models should be applied in combination. SELMA<sup>GIS</sup> tries to establish unique tools for controlling different types of dispersion models. This makes it easy for the user to operate different types of dispersion models.

SELMA<sup>GIS</sup> is completely implemented into ESRI's geographical information system ArcGIS. Thus the user is able to use his specific air quality models and at the same time all functionalities of the GIS. Using GIS makes it possible to work under the same graphical user interface (GUI) for administrating input and output data, preparing input data (e.g. digitizing emission sources), run the dispersion models, evaluate and display results (Figure 1). Using GIS has the advantage that various possibilities of interfaces to geographical data bases exist, e.g. emission inventories, street maps and interfaces to other file formats. By this it is possible to get input data from different administrative data bases.

SELMA<sup>GIS</sup> consists of different modules, which have interfaces to each implemented dispersion model. The following modules are implemented:

- Digitizing Tool: Defines emission sources (point, line, area and volume sources). The spatial location and dimension and emissions parameters can be defined and stored as emission files (ESRI shape file format).
- Emission Factory: Based on the emission parameters of the emission files, emissions can be calculated and time series can be produced.
- Meteorology Factory: Implements a conversion tool to generate and display dispersion category statistics from meteorological measurement data.
- Terrain Factory: Receptor points and the boundary of the model calculation can be defined.

- Navigator for Dispersion Model: The navigator is a GUI to gather all input data and define control settings of the dispersion model. The dispersion model can be started directly or all input and control files can be prepared to migrate to another computer. This is needed for long time calculations on special high-performance computers.
- Evaluation and Visualisation: The results of the dispersion calculation can be imported and converted into GIS format. The results can be displayed in coloured maps. All standard evaluation and calculation tools of ArcGIS can also be applied to the results.

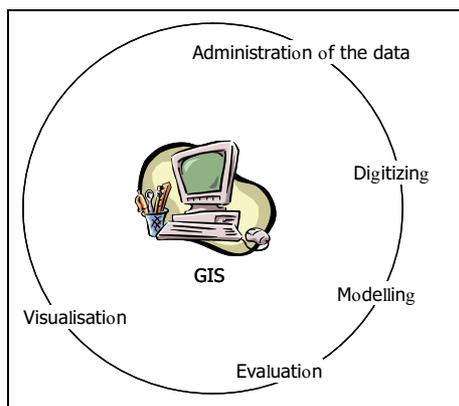


Figure 1. Work environment of SELMA<sup>GIS</sup> in a GI-System.

Depending on the individual task, i.e. regional, urban or micro scale modelling, the user is able to choose the adequate dispersion model on a common data base and a common display of the results. SELMA<sup>GIS</sup> contains different dispersion models such as

- AUSTAL2000: The official German Federal Environmental Agency air pollution dispersion model. It is a 3-dimensional Lagrangian particle model according to the German guideline VDI (3945 sheet 3).
- PROKAS: A Gaussian Screening model for street sources. It can consider street canyons as well. For that PROKAS is using parameterized scaling factors, which are calculated with MISKAM (Eichhorn, 2005) for typical street canyons.
- MEMO/MUSE (Moussiopoulos): MEMO is a prognostic mesoscale model which allows describing the air motion and the dispersion of inert pollutants over complex terrain. MUSE is a multilayer dispersion model for reactive species in the local-to-regional scale.
- Presently NERI's OML-Highway is being implemented, which is a Gaussian model for highways.

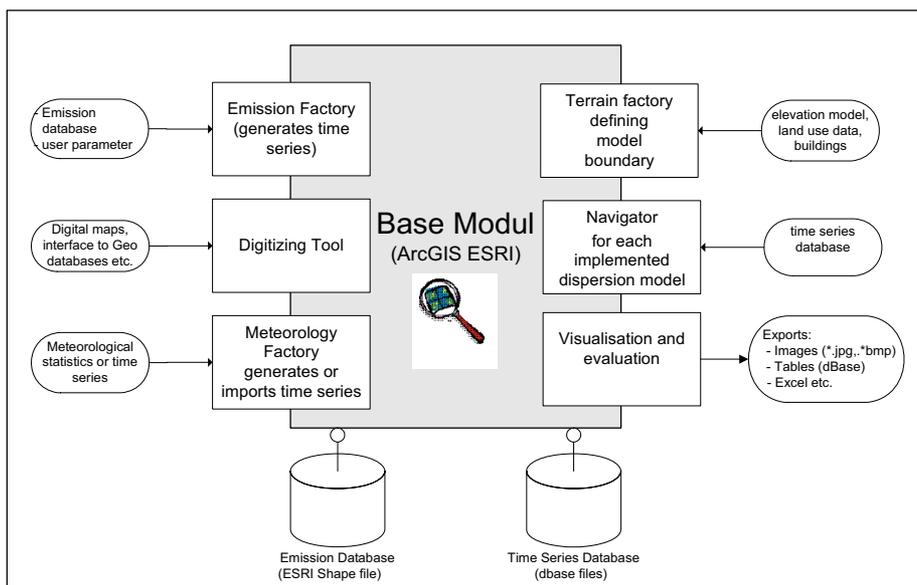


Figure 2. SELMA<sup>GIS</sup> Modules.

### 3. DISPERSION MODELLING WITH SELMA<sup>GIS</sup> FOR THE AIR QUALITY PLAN ROSTOCK CITY

Rostock is located in North-East Germany nearly centrally on Mecklenburg-Vorpommern's Baltic Sea coast. The city is crossed by the river Warnow. The seaside part of Rostock, Rostock-Warnemünde, which also hosts the overseas port is located north of the historic city centre. The city of Rostock has about 200 000 inhabitants.

The air quality action plan has been made in 2007 and 2008. Dispersion calculations have been made – managed with SELMA<sup>GIS</sup> – for different scenarios (actual situation and prediction 2010). The dispersion calculation has been managed with SELMA<sup>GIS</sup>.

The dispersion modelling was separated into the following steps:

- Gathering emission data for the industrial point and area sources (industry/harbour), traffic sources (maritime traffic and road traffic). For that, existing data bases have been used. The location, spatial dimension and emission rates for industrial sources have been taken from the Mecklenburg-Vorpommern's emission inventory. The municipality of Rostock supplied the geometry of the road network as ESRI shape file and the traffic data. Information about the maritime traffic was supplied by the Rostock harbour society. With the digitising tool of SELMA<sup>GIS</sup> the data could be prepared for the dispersion models.
- Deriving background concentration from measurement stations. The state of Mecklenburg-Vorpommern operates a network of concentration measurement stations. For deriving background concentrations, the data from the measurement station Stuthof has been used.
- The information about the metrological situation in Rostock has been agglomerated out of a teen years measurement data set.
- The determination of the concentrations resulting from the main emission sources industry/harbour, maritime and road traffic was executed on a meso-scale and an urban scale. The German regulatory model AUSTAL2000 has been used for the industrial and harbour sources. The emitted concentrations of the maritime and road traffic sources have been calculated with the Gaussian dispersion model PROKAS (Fig. 3).

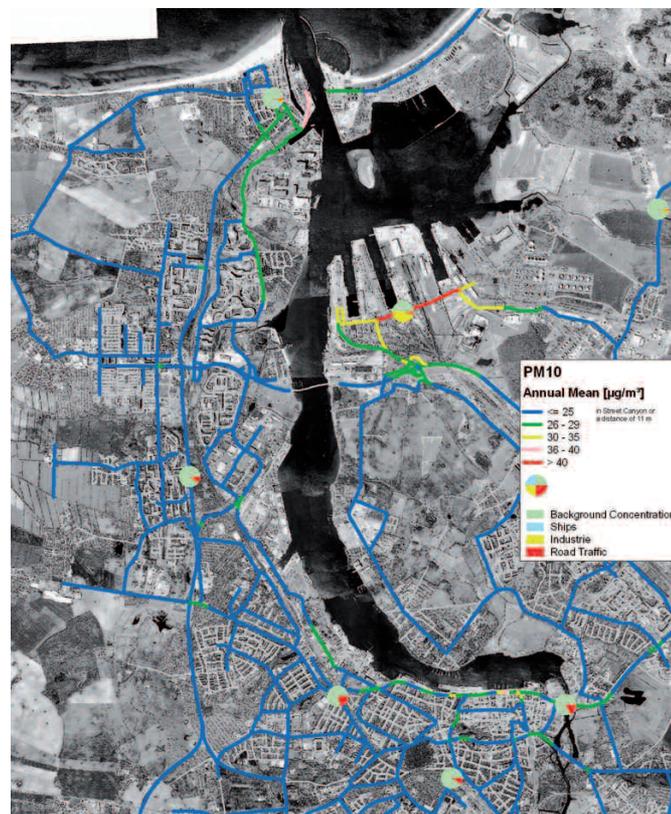


Figure 3. PM10 Screening of the City of Rostock and distribution of the concentration results of different source types.

- The resulting concentration fields of background concentrations and concentration of each emission source have been intersected and added. For that the standard tools of ArcGIS have been applied.

- By calculating the contribution of each emission source it was possible to identify the main polluters and to get a first hint on the hotspots in the city of Rostock. At these hotspots the concentrations were calculated in more detail with the prognostic microscale flow and dispersion model WinMISKAM, which also has an interface to GIS formats (Fig. 4).
- Using this analysis for the air quality in Rostock it was possible to trade off actions for reducing PM10 or NO<sub>2</sub> concentrations and to prepare the air quality action plan for Rostock.

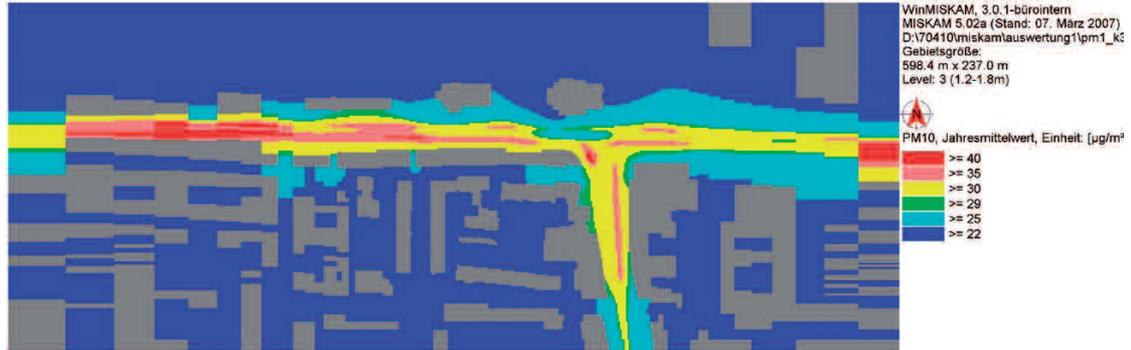


Figure 4. PM10 annual mean at one hotspot. Calculated with MISKAM.

## REFERENCES

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- Moussiopoulos: MEMO and MUSE are models from the Laboratory of Heat Transfer and Environmental Engineering, Aristotle University Thessaloniki, Greece. Head Director of the Laboratory is Prof. Dr.-Ing. Nicolas Moussiopoulos. <http://www.envirocomp.org/html/meetus/moussio.htm>
- VDI (3945 sheet 3): VDI = Verein Deutscher Ingenieure (German Association of Engineers), For a summary see: <http://www.vdi.de/vdi/vrp/richtliniendetails/index.php?ID=9078307>