WP 4 MASURIN

The Urber Tool

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Summary

The aim of the URBER-tool development is to have a tool for environmental assessment of the current situation and the situation after the revitalising process. The tool addresses air and water quality and noise, and is based on existing tools used for assessing urban environmental situation.

ENSIS is a management and decision support system for environmental issues that includes the parts ENSIS AirQUIS for air quality topics and ENSIS WaterQUIS for water quality topics. The system can be used as a management tool for planners, an information tool for the public and an expert system for specialists.

The ENSIS system contains in addition to AirQUIS and WaterQUIS common modules that are shared by air and water specific parts of the programme system. Important common parts are the measurement database, and the graphical user interface including the GIS (geographical information system).

The user interface is to a large extent a map interface from which spatial distribution of pollution sources, monitoring stations, measurements, model results and other geographically linked objects can be presented. The map interface can also be used as an entrance for making queries to the database.

The database is designed to be a tool for storing all the necessary data for conducting an environmental survey or impact analysis for a city or region. For air quality this means that the ENSIS database takes care of emission related data, such as fuel consumption, emission factors, physical description of stacks and processes, dynamic traffic data etc. It also takes care of ambient air measurements and meteorological data, including descriptions of the methods and the measured values. The results of the emission, dispersion and exposure model calculations are also stored in the database.

For water quality, the database includes discharge data for industry, domestic wastewater plants and municipal sewage and information on area sources as run off from agriculture. Other important data for the water quality management are general information on the watershed and information on the water resources. Especially for the EU Water Framework Directive (EU-WFD), management on a watershed scale is required, and here the water part of URBER tool is designed to cover all aspects in the directive. Also water quantity and quality measurements for surface water, groundwater and coastal waters are stored in the database, depending on what is available for the actual management area.

The ENSIS database is prepared to receive and store a wide range of environmental information, such as monitoring data to asses the status of the environment, data about the pollution sources that causes pressure to human beings and the environment, and information related to the water resources.

Both emissions, measurements and model results are geographically linked and can be viewed through the GIS interface. The use of a commonly built database

ensures consistency of the data. Data are entered into the database via standard graphical menus, or special import functions.

The AirQUIS models include an air emission calculation model, a meteorological model, an air dispersion model and different ways of calculating population exposure. The WaterQUIS models include a water pollution budget model and a water quality model. The models provide the possibility of identifying the results of alternative planning scenarios as well as describing the present situation. The contribution to the air pollution from different source categories, such as industry, traffic and domestic heating can be calculated based on emission or fuel consumption data. In the same way contributions from different sources to the water pollution may be calculated, and the resulting water quality displayed. In this way the system can be used as a tool for evaluating and comparing different measures to reduce pollution as a basis for cost-effectiveness ranking.

ENSIS has tools for graphical presentation and control of data, and tables for numerical presentation of data and statistical summaries. The information system provides a report generator and the possibility of exporting data and map images.

URBER

URBER is a tool where the user will be able to:

- analyse the present environmental status with respect to causes and effects,
- identify problems of concern,
- set the environmental objectives,
- identify measures and the environmental effects of the measures and
- support the responsible authority in producing relevant information for other stakeholders involved including the public, in order to stimulate the participation of these in the planning process and secure ownership to the plan.

The new features developed in the MASURIN project is the abatement module, where the user will be able to perform abatement measures and simulate the effects of the measures on the air and water quality. A key issue has been to develop this tool so that the system is user friendly.

Noise

The principal appropriation of the module is the evaluation of the impact of noise emitted from different sources on the acoustic climate of the environment. It can also be used as a module for supporting the process of decision taking in the question of environmental protection against the excessive noise. By applying in the assumed model of computation the different variants and scenarios of actions, it is a tool that facilitates planning and performing simulations. The noise sources included in the model is divided into traffic noise, industrial noise and municipal noise.

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1 Introduction the URBER TOOL

The aim of the URBER-tool development is to have a tool for environmental assessment of the current situation and the situation after the revitalising process. The tool addresses air and water quality and noise, and is based on existing tools used for assessing urban environmental situation.

1.1 Description of the System

ENSIS is a management and decision support system for environmental issues that includes the parts ENSIS AirQUIS for air quality topics and ENSIS WaterQUIS for water quality topics. The system can be used as a management tool for planners, an information tool for the public and an expert system for specialists.

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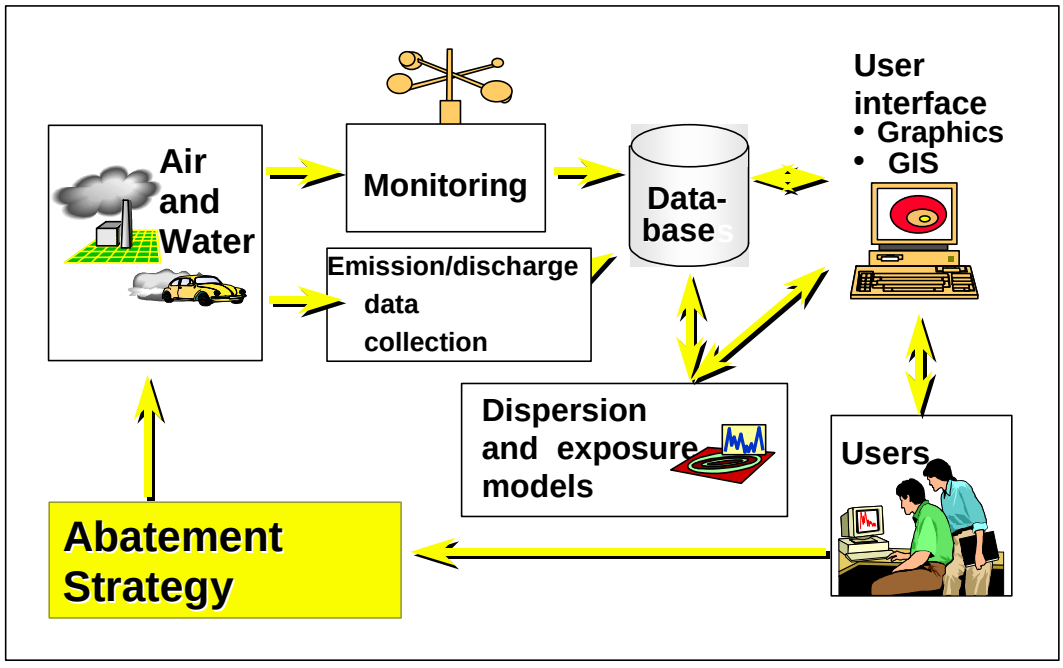

Figure 1: The ENSIS concept.

The user interface is to a large extent a map interface from which spatial distribution of pollution sources, monitoring stations, measurements, model results and other geographically linked objects can be presented. The map interface can also be used as an entrance for making queries to the database.

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The ENSIS database is prepared to receive and store a wide range of environmental information, such as monitoring data to asses the status of the environment, data about the pollution sources that causes pressure to human beings and the environment, and information related to the water resources.
Both emissions, measurements and model results are geographically linked and can be viewed through the GIS interface. The use of a common database ensures consistency of the data. Data are entered into the database via standard graphical menus, or special import functions.

The AirQUIS models include an air emission calculation model, a meteorological model, an air dispersion model and different ways of calculating population exposure. The WaterQUIS models include a water pollution budget model and a water quality model. The models provide the possibility of identifying the results of alternative planning scenarios as well as describing the present situation. The contribution to the air pollution from different source categories, such as industry, traffic and domestic heating can be calculated based on emission or fuel consumption data. In the same way contributions from different sources to the water pollution may be calculated, and the resulting water quality displayed. In this way the system can be used as a tool for evaluating and comparing different measures to reduce pollution as a basis for cost-effectiveness ranking. ENSIS has tools for graphical presentation and control of data, and tables for numerical presentation of data and statistical summaries. The information system provides a report generator and the possibility of exporting data and map images.

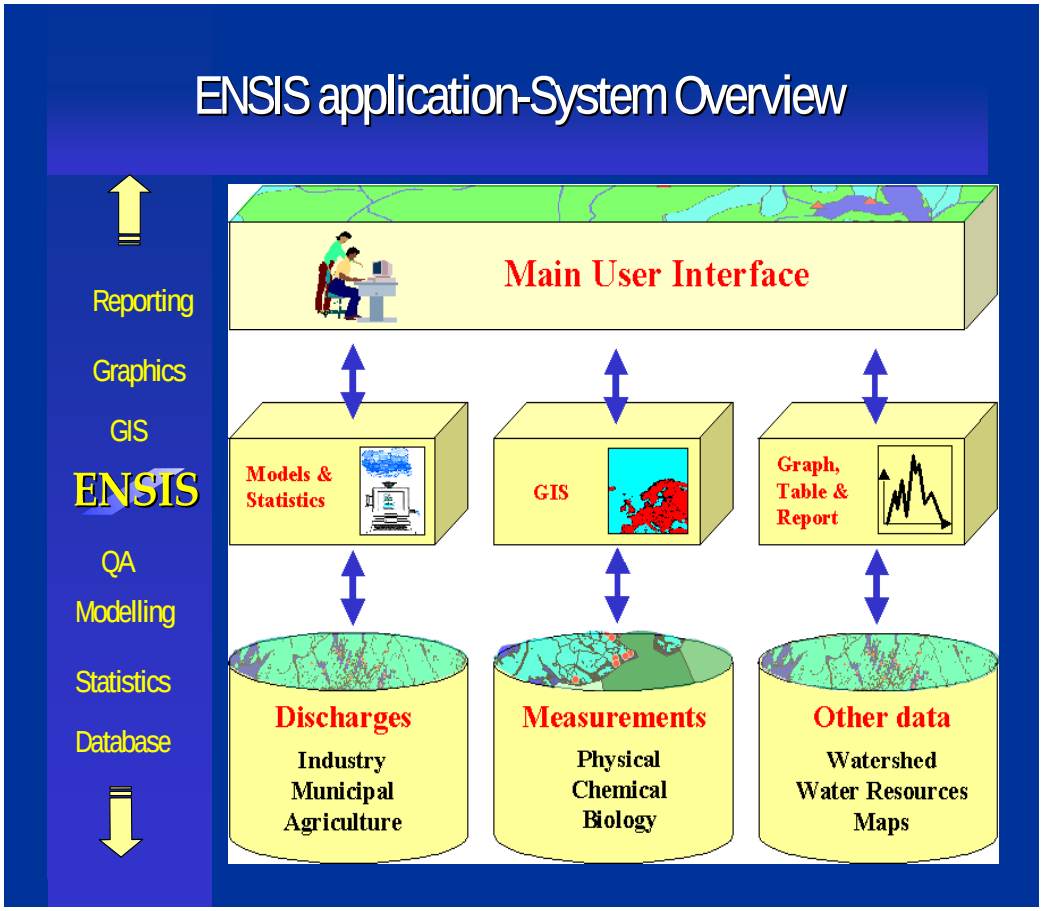


Figure 2: ENSIS application system overview.

1.2 The GIS Functionality

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

- The GIS shows all geographically defined elements such as, for example, monitoring stations, industries, rivers, lakes and coastal areas.
- The GIS makes it easier to place the air pollution sources at the correct location, for example by displaying 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 gives an idea of what concentrations one may expect to find at the stations for a given wind direction.
- The GIS makes it easier to search for geographically linked data in the database.
- Displaying results of model calculations as a map can be used for public information on pollution levels at different parts of a city.
- Displaying results of water classification after grade of pollution produces relevant information for other stakeholders involved, including the public.

- The GIS makes it easier to interpret the data and identify problems of concern.

There are three types of data that can be displayed on the map: shape themes, ENSIS themes and data set.

1.2.1 Shape Themes

The Shape Themes are themes that are not connected to data in the ENSIS database. Examples of shape themes may be coastlines, lakes, parks, borders, or anything that will make the map look better and be easier to understand. The user decides which shape themes to display by selecting from a list of available themes. The available themes may be different for different projects. This is organised through the User Manager.

1.2.2 ENSIS Themes

The ENSIS Themes are the GIS representation of the data in the ENSIS database, for example administrative regions, air and water pollution sources, road links, river links, stations, receptor points. The user decides which themes to display by selecting from a list of all ENSIS themes. All ENSIS themes will be available for all projects, and may be shown on the map, provided they contain data.

1.2.3 Data Set

All data sets in the database can be viewed on the map. This may be data distributed on administrative or user defined regions (region data set), data distributed in grids (field data set), data distributed on lines (line data set) or data distributed in points (point data set). The data set may have been entered into the database manually or by import, or the data set may be results of model calculations.

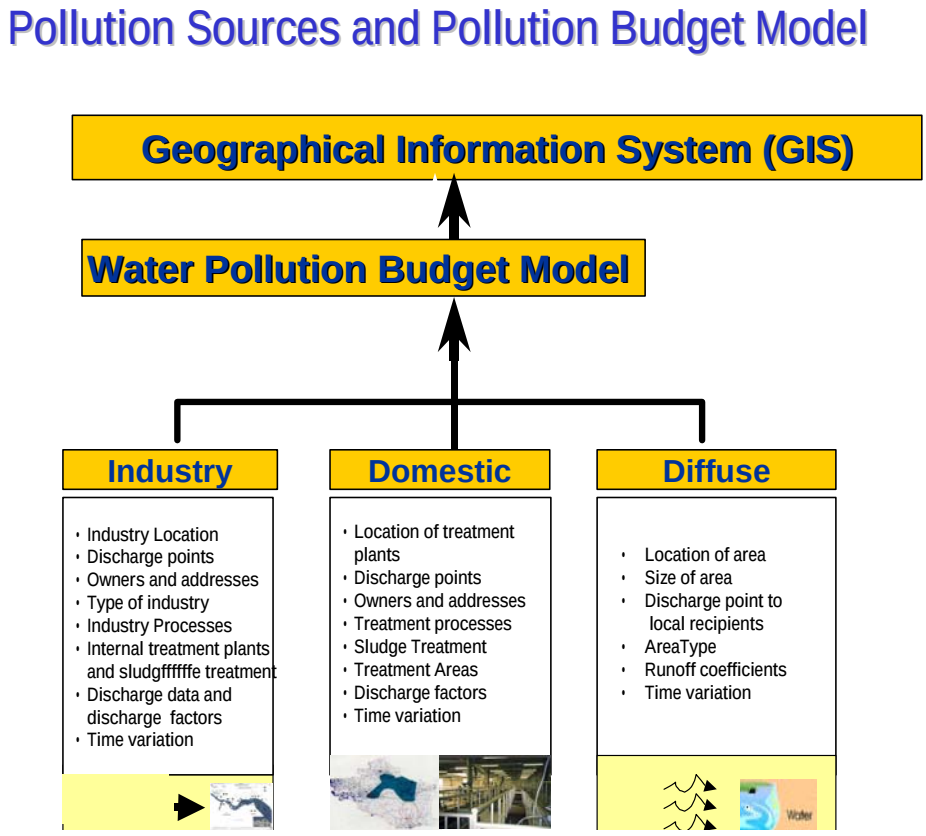


Figure 3: Pollution Sources and pollution budget model.

1.3 Measurements

The measurement module is used to store, retrieve and organise measurements of meteorology, air and water quality. The user can carry out different analyses on data stored in the database, like statistical calculations, aggregation of time series, quality assurance tests and classification of water quality according to classification systems defined in the system. Data can also be viewed graphically, exported to other programs, saved to file, and printed directly to a hard copy.

Data stored via the measurement module can be linked to other types of data stored in ENSIS, like municipal wastewater plants and industries.

1.4 Emission/Discharge Database

Information about the sources that causes pressure to the environment can also be stored in the database. Pollution sources that may be defined in the database are industries, discharges of domestic wastewater through treatment plants, or direct discharges, and all types of diffuse sources (area sources), as well as traffic. The system can hold administrative information about the sources like contact persons, addresses and telephone numbers, which might be used in the case of accidental spill. Discharge information can also be registered and be used for the pollution load modelling, in order to find the main polluters and hence the target sources. The discharge information can be registered at different levels of detail, depending at what level the information is available. It might vary from direct

measurements, aggregated data (i.e. monthly averages) to theoretical coefficients. For industries, discharge factors based on production or consumption can be used together with production or consumption data. For the diffuse sources, area run-off coefficients can be entered for the individual areas. The pollution sources must be linked to either a recipient or to a treatment facility, in order for the system to keep track of the pollution and the risk for the environment.

The sources of air pollution are in the same way divided in three categories, see Figure 4. Emissions from single activities of some size, like industries, energy production, etc., that are linked to single stacks, are treated as point sources. Emissions from home heating, public and private services, agricultural activities, etc. are treated as area sources. Emissions from road traffic are treated as line sources in the emission database.

Regardless of being point, line or area distributed, emission data can be found either as emission data for different components, or as a set consisting of consumption data and emission factors for the components for different fuels and activity types.

The emission data usually comes as yearly data, and a time factor is used to find the fraction of the yearly value that is valid for a specific period within the year.

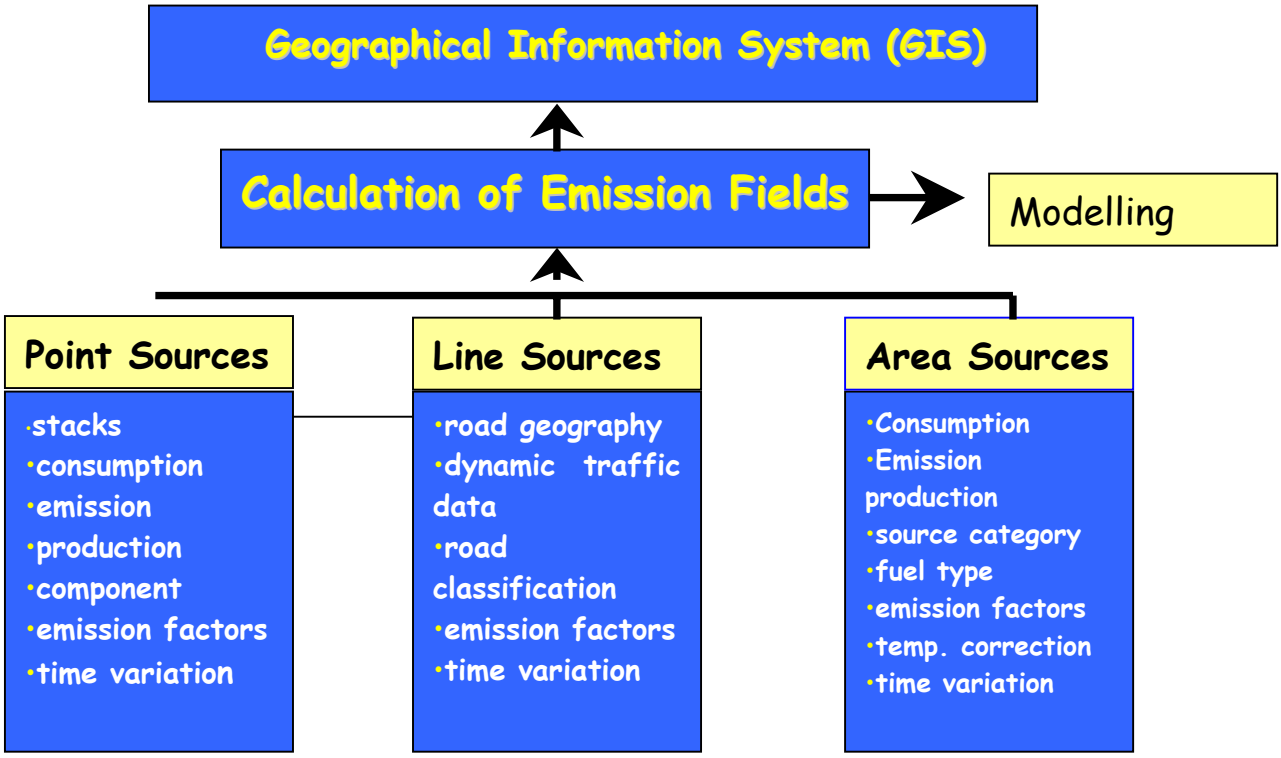


Figure 4: Air Emission/Water Discharge Databases.

1.5 The Models

Both air and water models shall be included in the URBER tool to better plan and manage the revitalisation process of urban industrial sites.

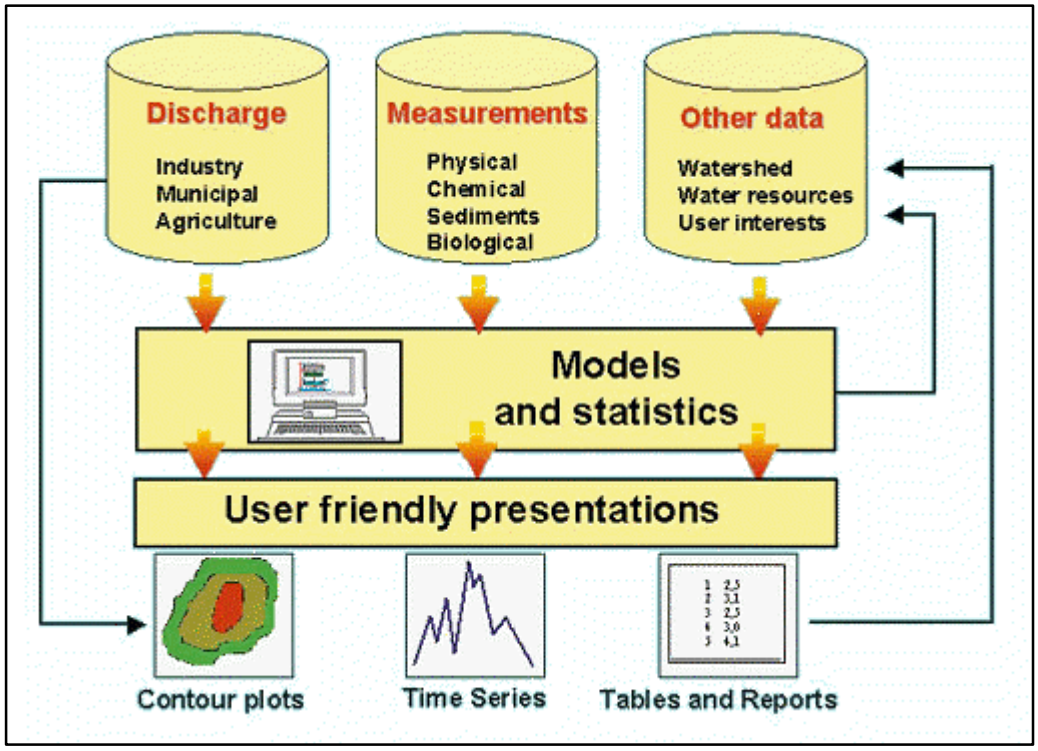


Figure 5: The ENSIS concept, with special focus on water.

1.5.1 AirQUIS Models

1.5.1.1 Emission model

Calculates hourly emissions from area, line and point sources. Stores results as field, line or point data set.

1.5.1.2 Wind field model (MATHEW)

Calculates 3-dimensional hourly wind fields using measurements of wind direction, wind speed, temperature, temperature gradient and a topography field. The wind field generated is necessary to run the Air Dispersion Model.

1.5.1.3 The Dispersion model EPISODE, output

The EPISODE model is a combined 3D Eulerian/Lagrangian air pollution dispersion model for urban and local-to-regional scale applications.

The model may be used to calculate air pollution in an area from several simultaneous emission sources such as road traffic (line sources), domestic or home heating (area sources) and individual industry sources (point sources).

The model produces ground level hourly averaged concentrations as gridded data (using a user-defined grid) and/or at individually placed receptor points.

Since the output from the model consist of hourly data, the results may also be used to calculate different long-term max, average and percentiles.

1.5.1.4 The Exposure models, output

Exposure estimates can be used to describe how many people are exposed to air pollution above air quality guidelines. They can also calculate the number of hours and persons exposed to pollution in user defined concentration intervals.

1.5.2 The WaterQUIS Models

A principle drawing for the modelling work in WaterQUIS is shown in figure 6. The included models are described in the following text.

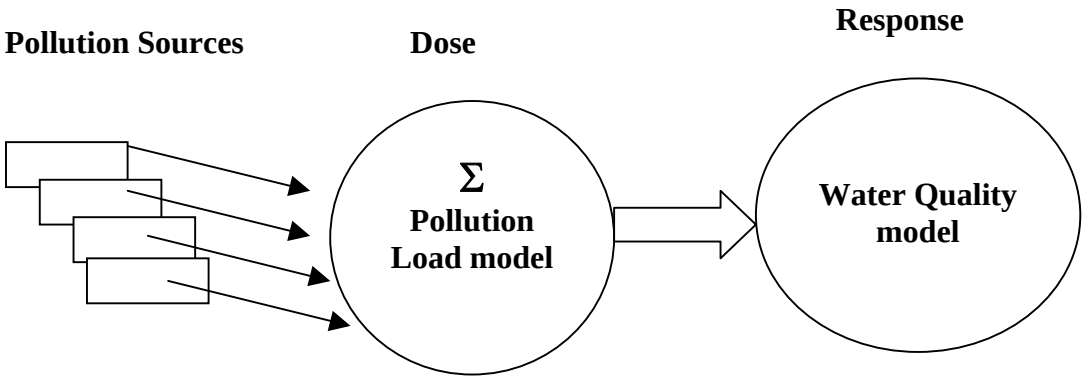


Figure 6: The WaterQUIS modelling concept

1.5.2.1 The Pollution Budget Model

As a basis for the modelling work, information about the sources that causes pressure to the environment must be collected and stored in the database. Pollution sources that may be defined in the database are industries, discharges of domestic wastewater through treatment plants, or direct discharges, and all types of diffuse sources (area sources) as agriculture, aquaculture or user defined sources. Discharge information must be registered for the pollution load modelling in order to find the main polluters and hence the target sources. The discharge information can be registered at different levels of detail, depending at what level the information is available. It might vary from direct measurements, aggregated data (i.e. monthly averages), or theoretical coefficients. For industries discharge factors based on production or consumption can be used together with production or consumption data. For the diffuse sources area run-off coefficients can be entered for the individual areas. The pollution sources must be linked to either a recipient or to a treatment facility in order for the system to keep track of the pollution and the risk for the environment.

The modelling tool provides the possibility of identifying the consequences of different planning scenarios. The contribution of water pollution from different source categories, such as municipal wastewater, industry and agriculture can be

calculated by using the Pollution Budget Model. The pollution load model includes calculation of all pollution sources discharging to water recipients directly or to recipients through a municipal sewerage system. This model consider the pollution contribution for each source until it reaches the recipients, including calculations for retention on the way to the recipient, but it does not take into consideration the fate of the pollution in the water system (routing, decay, etc). This means that the model calculates the total pollution load to the recipient (the dose).

Different measures to reduce water pollution can be evaluated, and a priority list of measures can be developed taking into account both the costs and the benefits of the selected measures. The figure below shows for instance the improvement of the water quality over time in a river stretch.

1.5.2.2 Water Quality Model

Calculates the ambient water quality based on pollution load (mass/time), description of water elements, and processes . This is a water quality model calculating the concentration (mass/volume) as a response of pollution discharges.

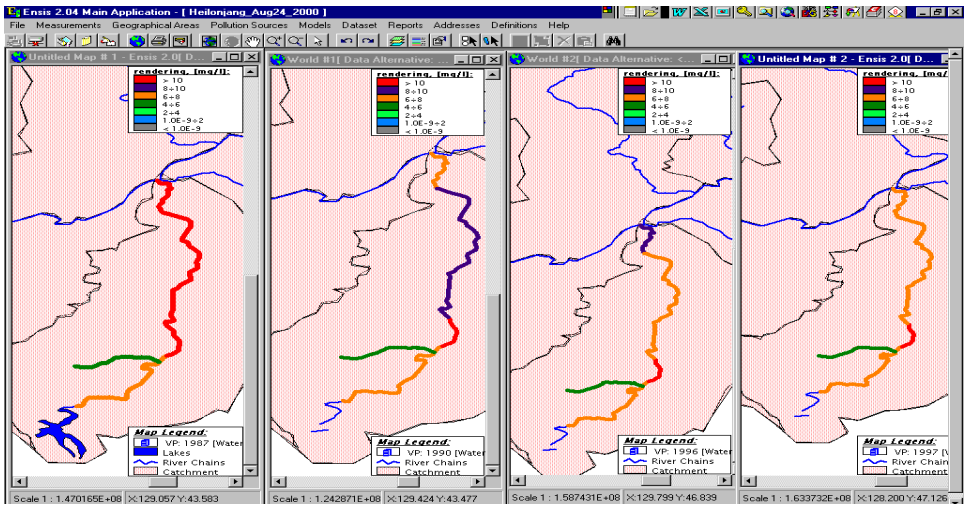


Figure 7: Example of improvement of the water quality over time in a river stretch.

1.5.2.3 Water Pollution Budget Model, output

In order to manage water and implement and enforce environmental actions, it is an important task to monitor the water quality properly and to detect the sources which contribute to pollution. A pollution load model that calculates the contribution from different pollution sources can base its calculations on monitoring of discharges or/and theoretical calculations based on the use of raw material, production and process information.

The output from the Pollution Load/Pollution Budget modelling work in ENSIS, is the contribution to pollution from different sources of pollution: 1) Industry, 2) Domestic Waste Water, 3) Diffuse sources.

1.5.2.4 Water Quality Model, output

The need for reduction in pollution to obtain a certain water quality will be the difference between the present water quality and the future water quality objectives. To undertake a complete abatement strategy analysis, the Pollution Load model needs to be connected to a Water Quality model, which simulates the effect of the pollution on the receiving waters.

The Water Quality model is used to simulate the necessary pollution reduction for the sources of pollution in order to determine when the objectives for the receiving waters are met.

2 Masurin required functionality

In order to make URBER to a planning tool, scenario analysis must be in place. The system shall be able to simulate different scenarios for causes (Discharges/ Emissions) and effects (resulting Water and Air Quality).

The URBER tool has also been extended to integrate a Noise Module, in order to be able to perform assessment of noise for urban and industrial areas.

2.1 Abatement module

The key objective for developing the abatement functionality for the URBER tool is to make the system user friendly for abatement scenarios. This functionality will ease the use and handling of numerical models to undertake abatement scenario calculations by non-expert users. This will enable a municipality to perform such studies as to the effect of different measures themselves. The users will be able to perform abatement scenario calculations by changing the emission/discharge sources by the following options:

- Selection of emission sources (point and area) for abatement measures by region.
- Selection of emission sources (point and area) for abatement measures by polygon selection.
- Selection of individual industries for abatement measures.
- Selection of emission sources (point and area) for abatement measures by source sector, fuel type and emission type.
- Abatement measures on line sources; change in annual daily traffic, speed and vehicle distribution by region, road class and vehicle classes.
- Abatement measures in river and lakes/water-bodies by change in discharge to recipients.

2.1.1 Abatement functionality in AirQUIS

AirQUIS is GIS based system and the geographical elements such as regions, model grids, roads, industrial plants, etc. are included in the infrastructure of the system.

The area is defined as administrative regions. A common way is to divide the area of interest into smaller units with use of regions like countries, provinces, municipalities, cities and/or sub city regions. In addition, the user is able to select an area based on user-defined polygons, independently of the defined regions. The polygon will be described by drawing on the map. The user is also able to select individual sources (line, area and point) in a table for individual abatement measures.

Placement in the menu
The new functionality is located under 'Model' – 'Emission', with the menu name 'Abatement Scenario' (see figure below).

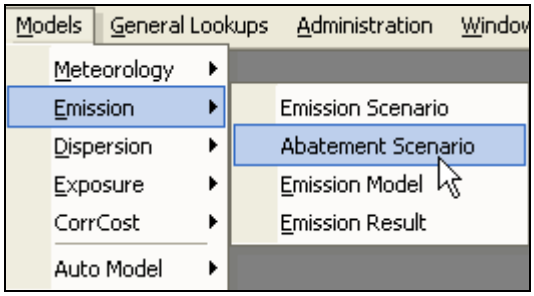


Figure 8: Placement of the abatement functionality in the menu.

Abatement scenarios entering form
The Abatement Scenario functionality requires a lookup form that can store all the different set of scenarios methods that have been defined. Only the ID and the Name of the abatement scenario will be showed in the lookup form.

When clicking on the 'Abatement Scenario' in the menu, the form below will appear:

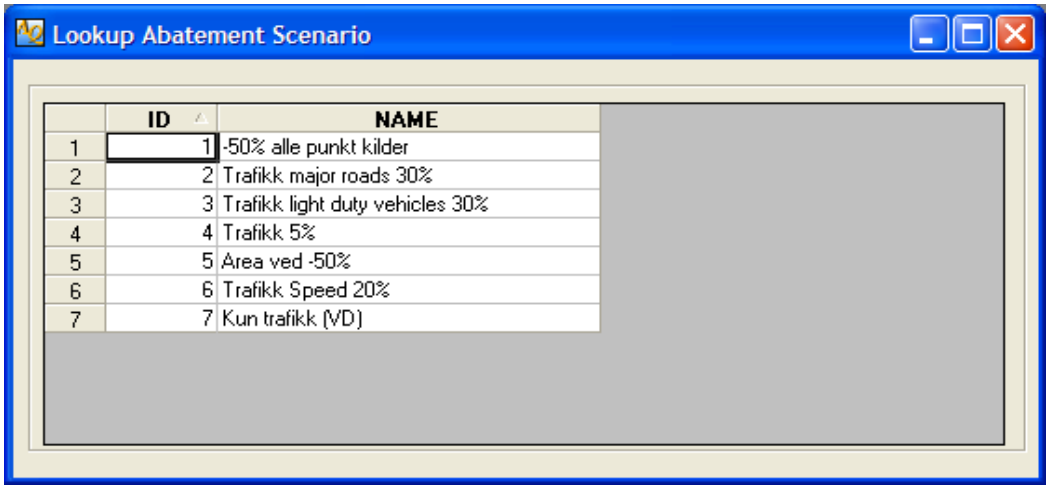


Figure 9: Lookup abatement scenario form.

A double click on the chosen abatement scenario opens the abatement scenario definition itself form, illustrated in Figure 10.

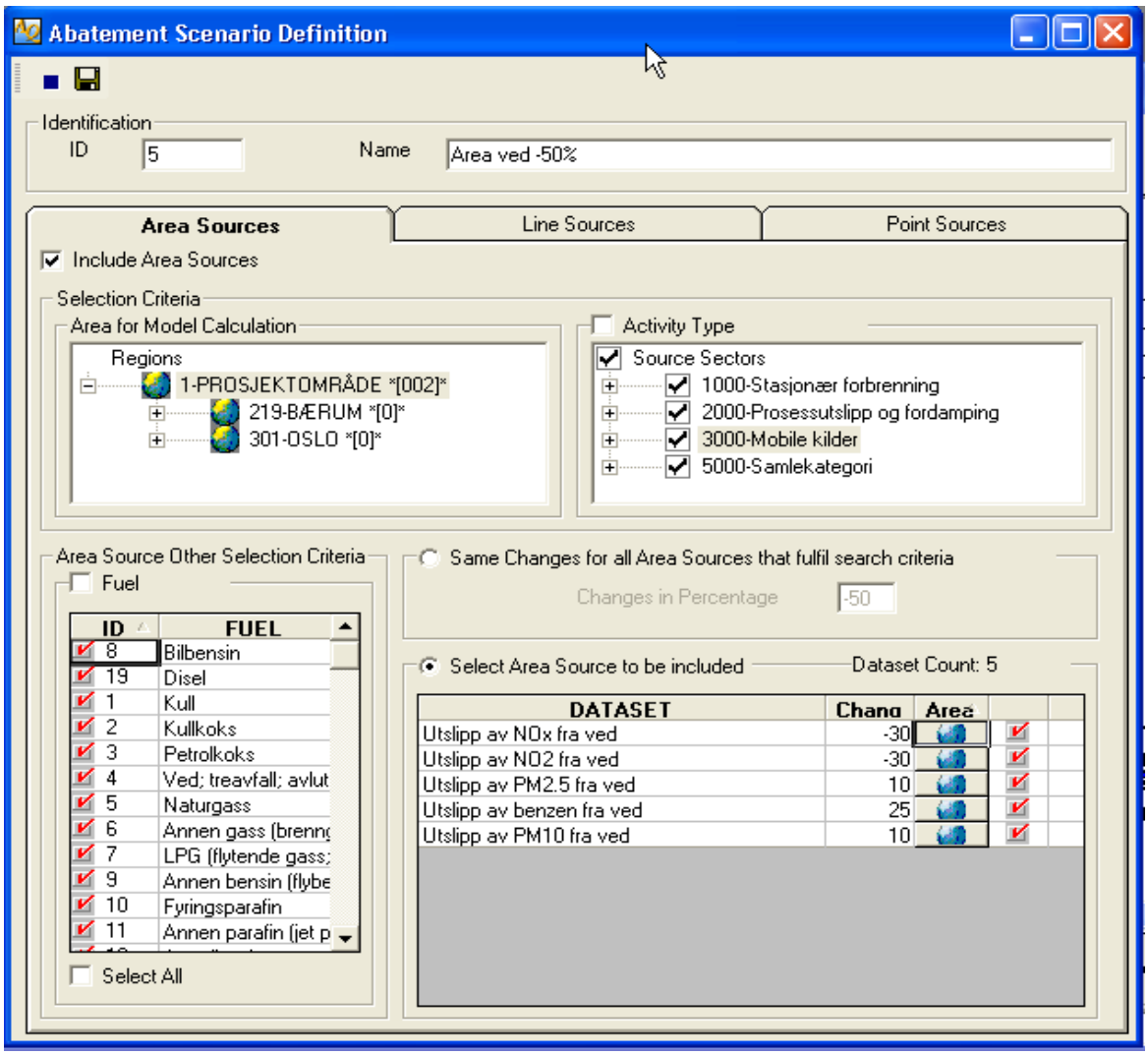


Figure 10: 'Abatement Scenario Definition' form, where 'Tab' for area sources is selected.

This form contains:

ID: Unique ID number.

Name: Unique Scenario Name

Further the form contains a 'TabStrip' controller with three tabs. The tabs are grouped in the same manner as in the 'Air Emission Scenario' form, namely:

- Area Sources
- Line Sources (Traffic data/Ships)
- Point Sources (Industry data)

2.1.1.1 Abatement on Source sectors, fuels and emissions

Source sector is one of the necessary factors for classifying data from point, line and area sources. There are several classification systems for source sector, and each country normally have their own way of grouping emissions. Source sector is often hierarchy defined according to the processes.

In AirQUIS, the fuel types are registered in a lookup table. Fuel types are properties for industry processes, area dataset and traffic data in the emission inventory database.

The user can carry out abatement studies on consumption or emissions from:

- in user defined regions
- a specific fuel type
- in source sectors

2.1.1.2 Abatement on Area Sources

By selecting 'Source sector and Fuel Types' one can select out different datasets that the user want to perform control measures on, Figure 9. If the user wants to make the same changes for all the datasets that fulfil the given search criteria, the user select option 'Same changes for all Area Sources that fulfil search criteria'. The change number should be given in percentage (for example –20 %, which means that the emission is reduced with 20 percent when running the model compared to the basic results). By clicking on the 'Map' button the user can draw the boundary of the area, in which the changes should apply for. The 'Abatement Area Boundary' form is illustrated in Figure 11, if the 'Map' button is not pushed then the changes will apply for the whole area:

- When clicking the "map" command button in the Abatement Area Boundary form one will activate the GIS system. By applying the **'Draw shape on map'**, which already exist in the system today, one is enabled to draw the required polygon. When the user is satisfied with the created polygon area, (s)he clicks on the **'Paste shape'** button.

- If the region already exists as administrative region or as a user defined region, the user should be enabled to easily select this region instead of drawing it.

- This procedure must be done for all of the numbers of specific dataset selected.

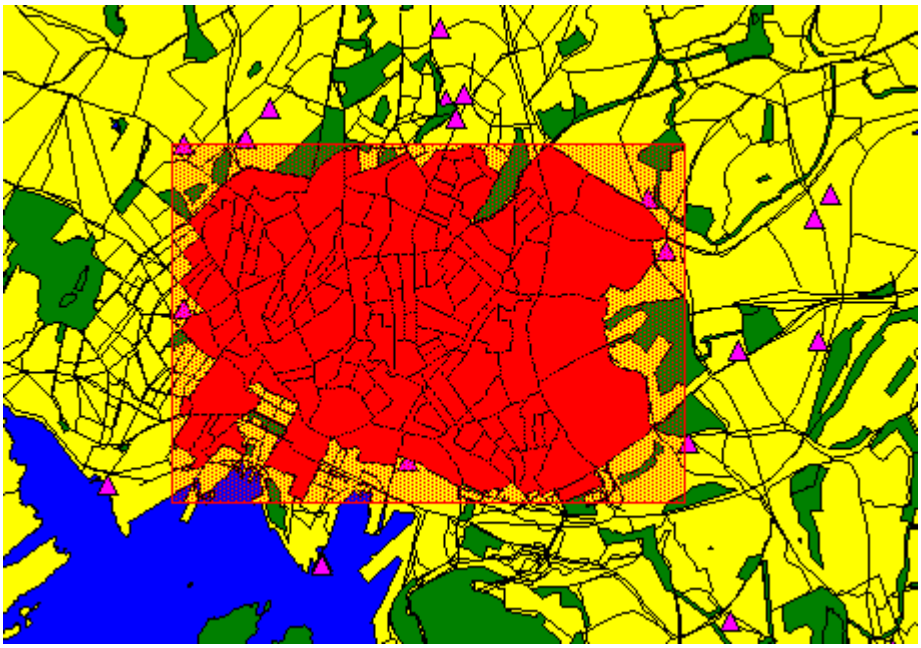


Figure 11: Example of polygon defined by the user to mark the area where changes in emissions apply for.

If the user has different control measures on different datasets then (s)he can select the option 'Choose from the list below'. This list will include all dataset that fulfil the search criteria on left-hand-side in form. By checking out the dataset to modify (s)he can enter the change/reduction number in text boxes, and click on the belonging Map button. When clicking on this map button the Abatement Area Boundary form will appear. The functionality will work in the same manner as described above. All dataset checked out will each have its own boundary area the control measure is valid for. The check boxes on the right-hand-side will be set by the system when defined a area boundary. If the 'Map' button is not pushed then the changes will apply for the whole area, and the check box on the right-hand-side will not be checked out.

2.1.1.3 Abatement on Line Sources

This functionality works more or less in the same manner as the 'Include Area Sources' functionality. The user can select the specific Abatement Area the changes should apply for.

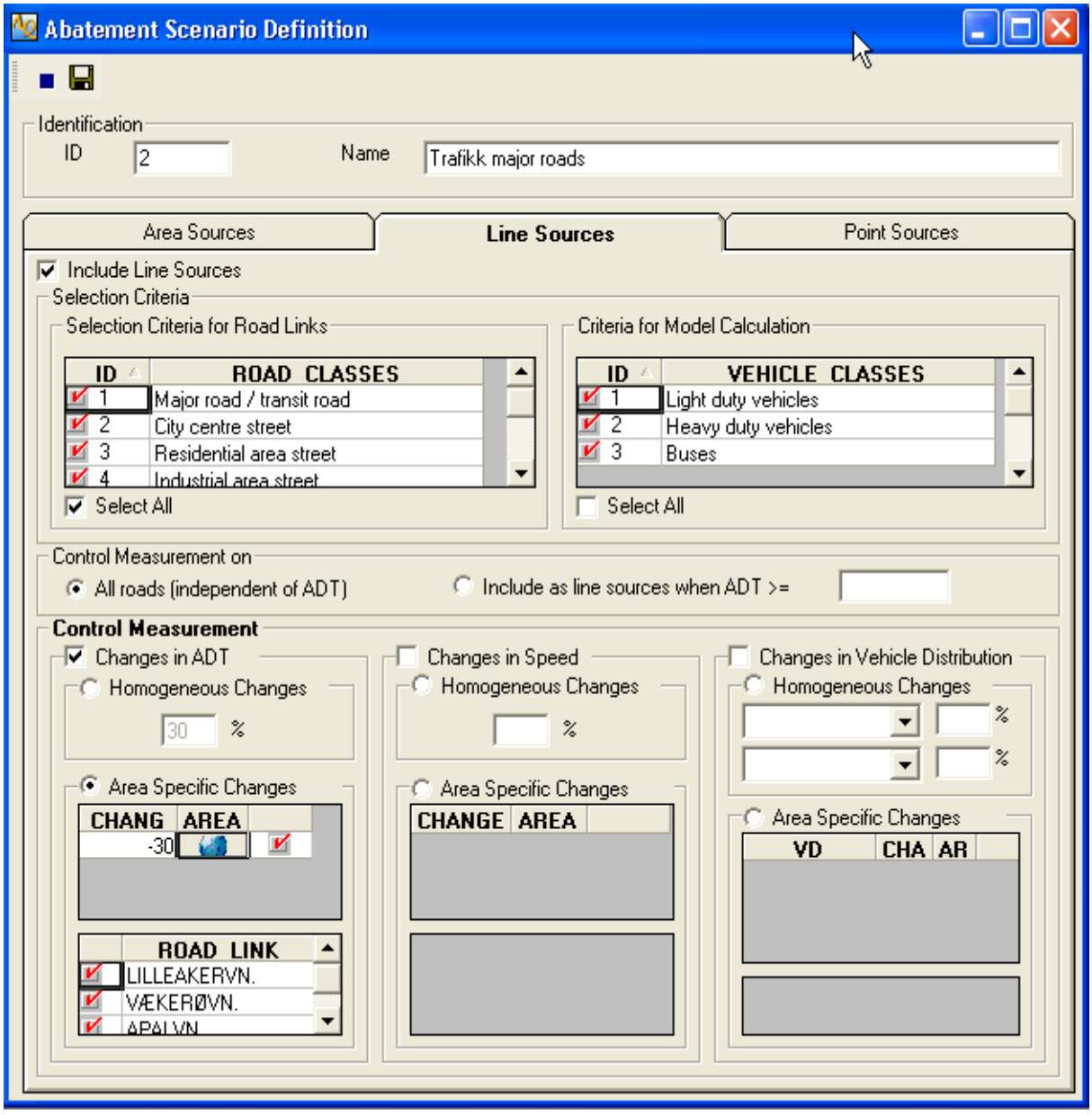


Figure 12: 'Abatement Scenario Definition' form, where 'TabStrip' for line sources is selected.

The user can make control measures on:

- ADT (Annual Daily Traffic)
- Speed (Free flow Speed)
- Vehicle Distribution

The Selection of the Road Links to be included in the abatement scenario can be controlled by the Road Class definition (as default all is included), ADT limit, and inside an area boundary. In the case where the Road Links are not fully covered by the selected area, the user has to decide whether or not to include the road link in the area by clicking the specific road link off or on.

Vehicle Distribution Changes:

When the user wants to carry out control measures on the vehicle distribution, for example percentage reduction of heavy traffic on city roads inside a city area, (s)he must compensate the distribution percentage with other vehicles. This control measure functionality is only vehicle distribution (which should sum up to 100%), and not the amount of traffic. If the user wants to remove all heavy traffic in the example above, then (s)he must combine this functionality with reduction in ADT.

2.1.1.4 Abatement on Point Sources

This functionality works also more or less in the same manner as the 'Include Area Sources' functionality. The user can select the specific Abatement Area Boundary the changes should apply for. The functionality is illustrated in the form below:

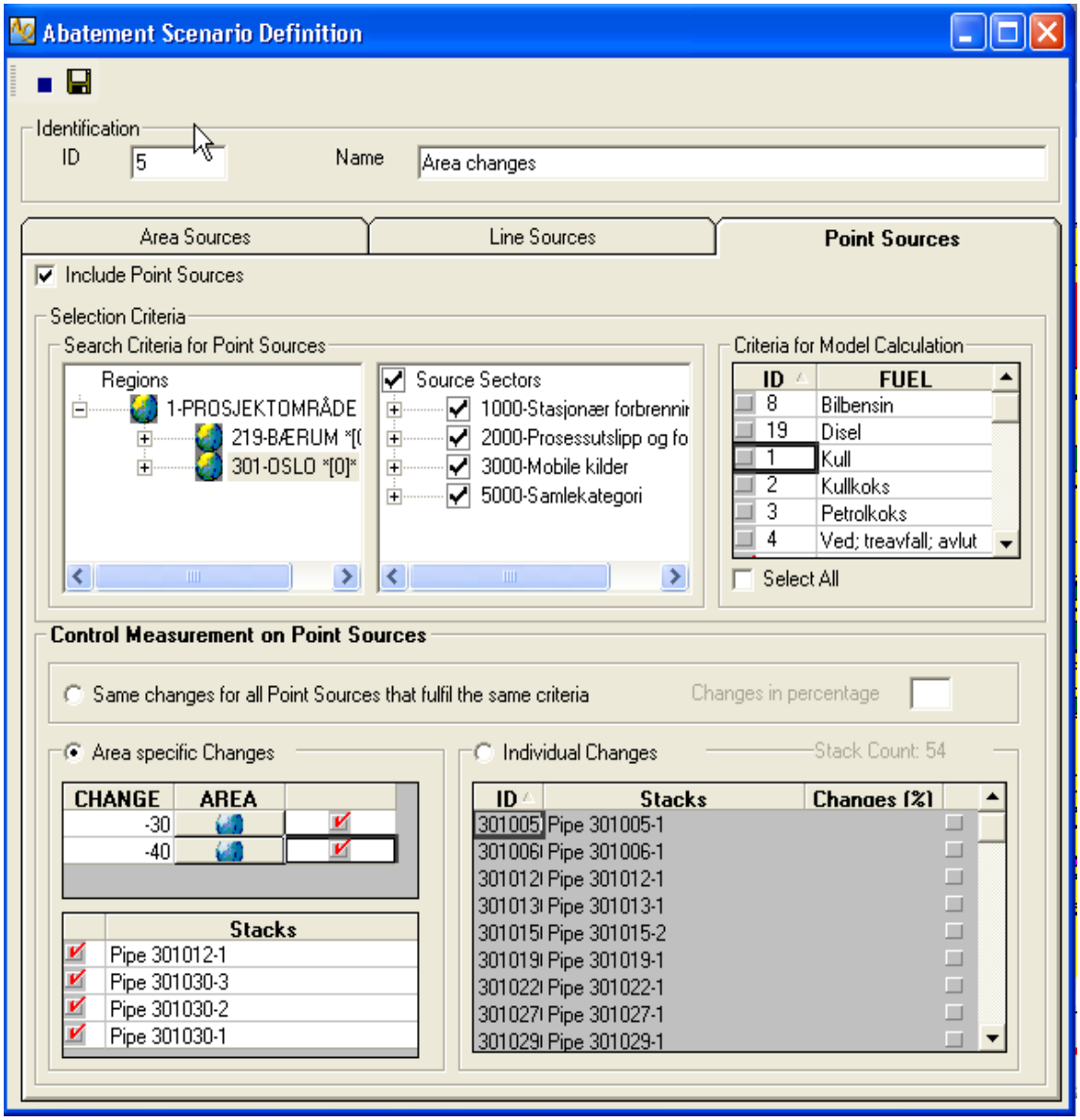


Figure 13: 'Abatement Scenario Definition' form, where 'Tab' for point sources is selected.

The user can specify which source sector(s) and fuel(s) the measures are to include.

In additional to the same functionality as for Area Sources the user can make modification on each Point Source individually without specifying the boundary

area. The user may also specify the area in which all stacks within shall experience the same percentage change.

2.1.2 Model Calculations

When the user has specified the abatement scenario, this needs to be included in the emission model scenario. In the form in Figure 15 the emission scenario is presented. The user can then choose to include an abatement scenario in the emission scenario definition. It is important that the user in this definition includes all sources, as it is the abatement scenario that defines where and on what the measures are to be done. In the example underneath the user wishes to perform model calculations where the effect of abatements on industrial sources only, is to be investigated.

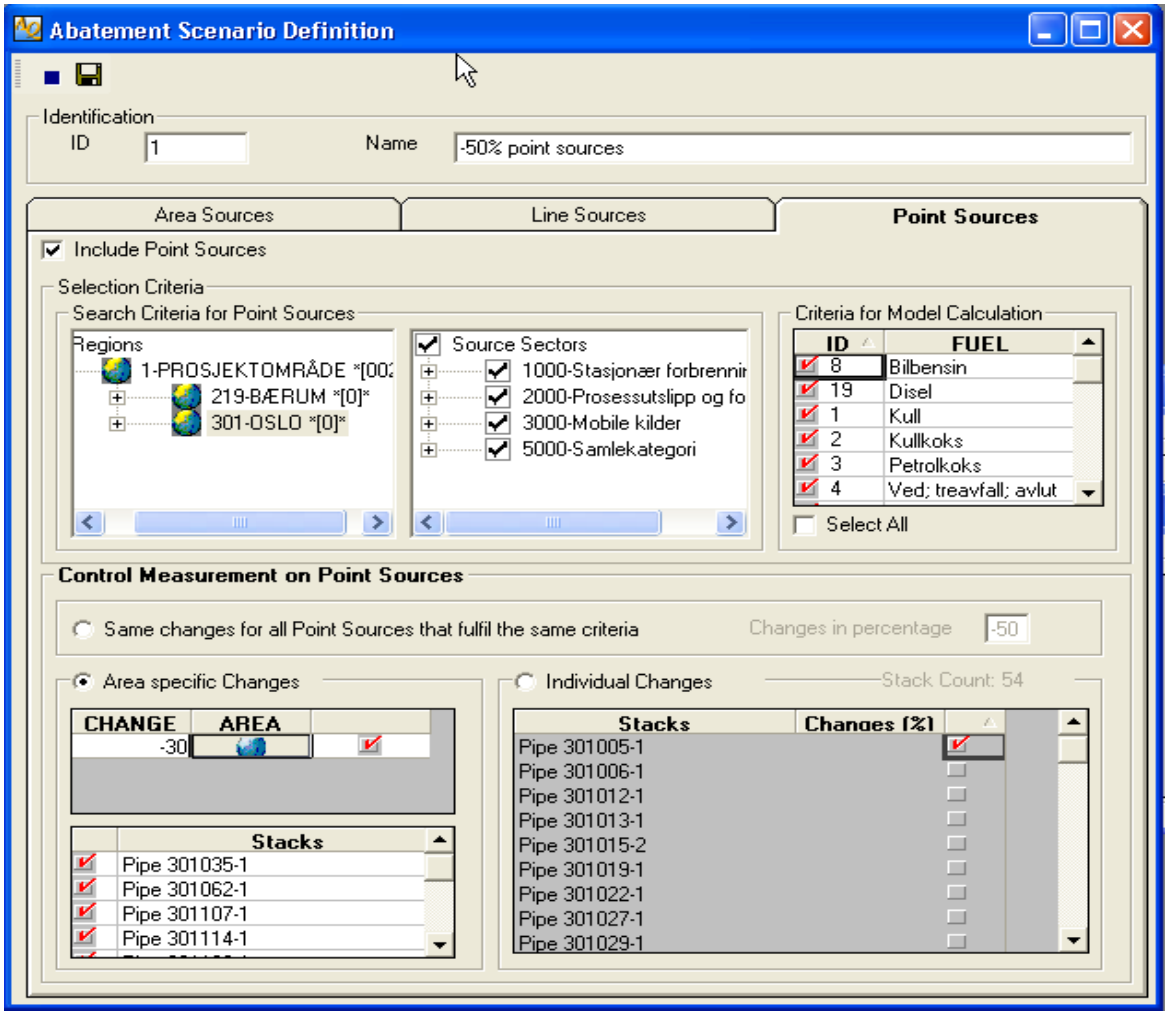


Figure 14: Example of defining an abatement scenario where the specific measures on industry are set.

The user will first define an abatement scenario definition where the specific measures on industry are set, Figure 14. The user can then define the emission scenario itself where all point sources are included, Figure 15.

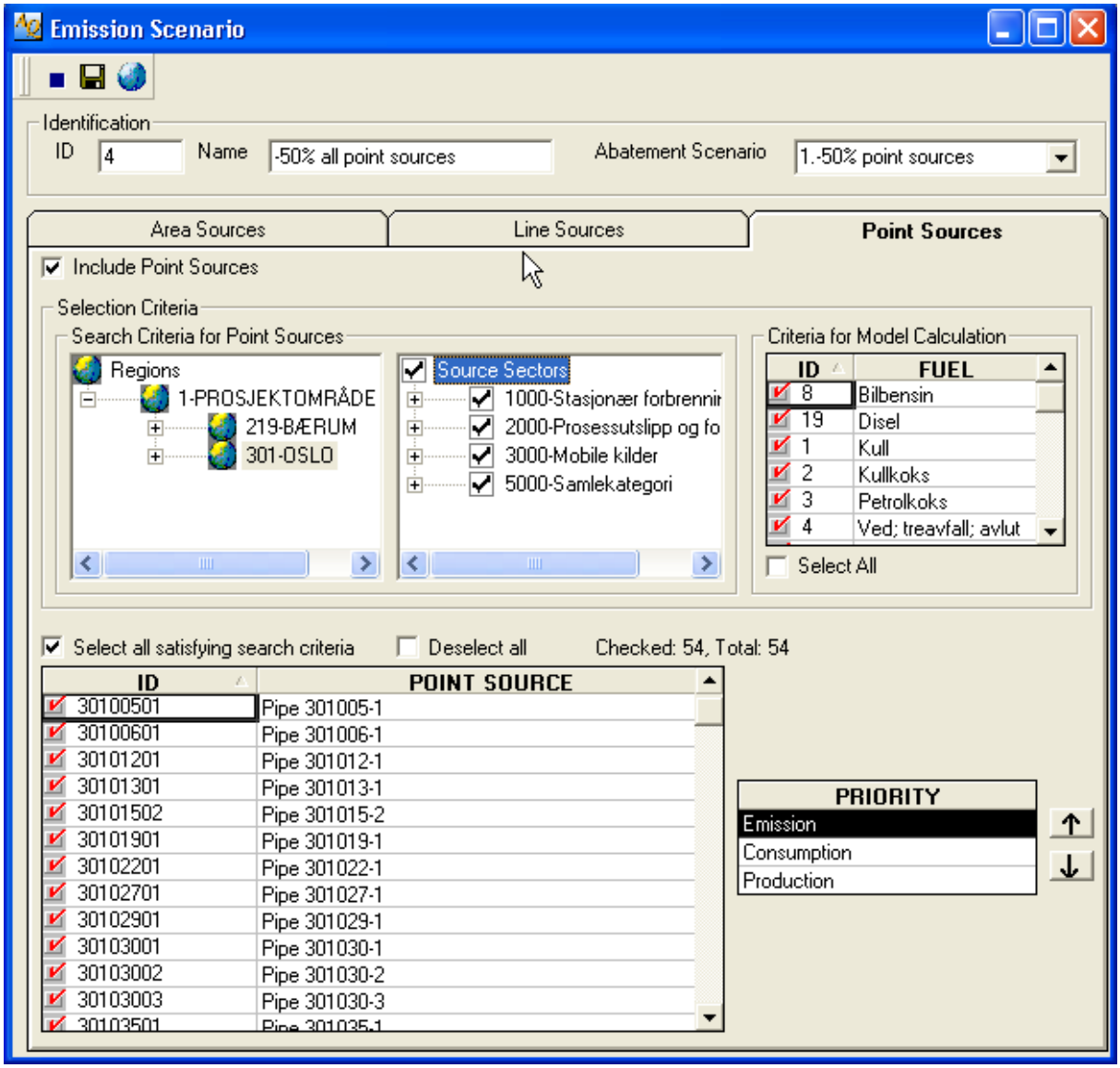


Figure 15: Example of defining the emission scenario itself, where all point sources are included.

This emission scenario can then be used to perform emission model runs (Figure 16), or be included as the emission composition when performing a dispersion model run (Figure 17).

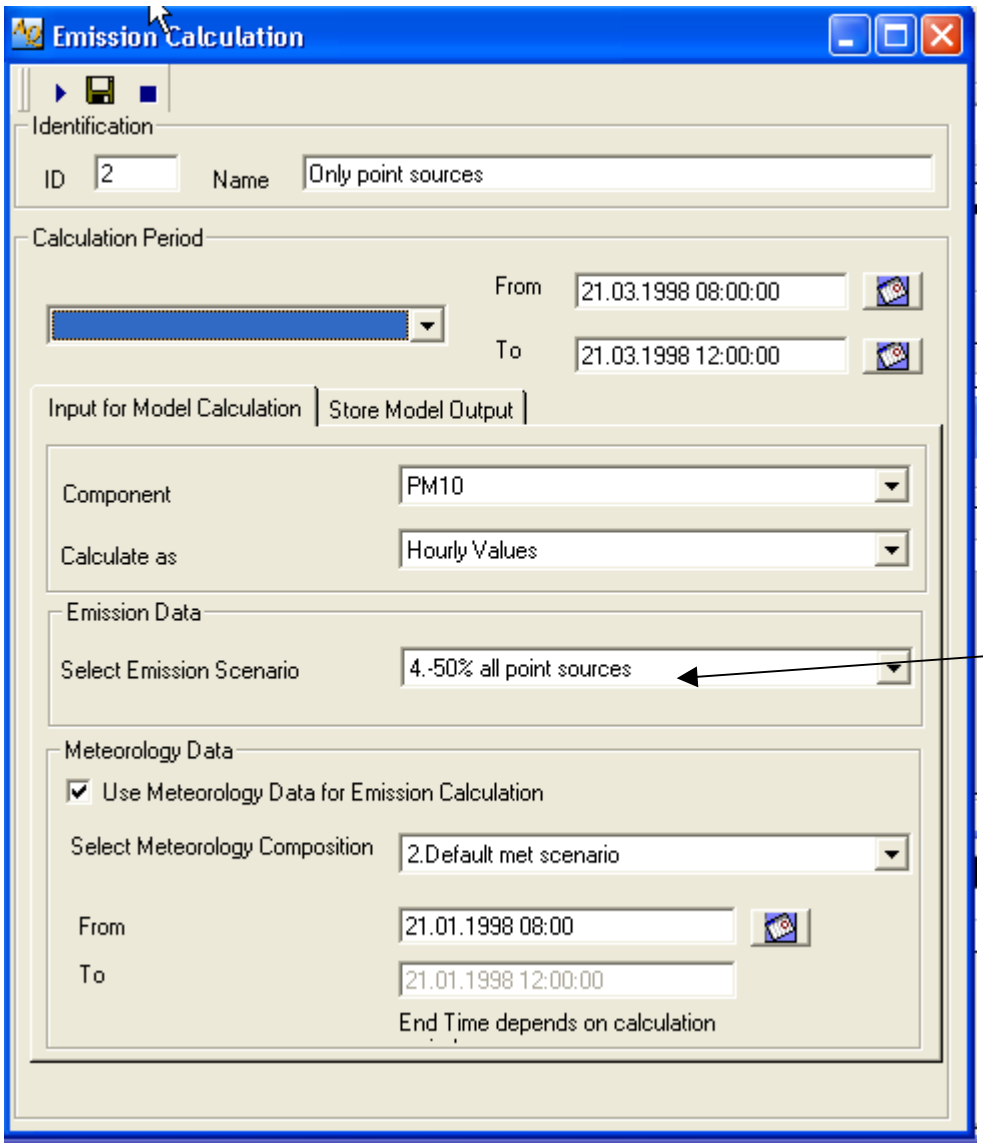


Figure 16: Emission calculation form, to run the emission model.

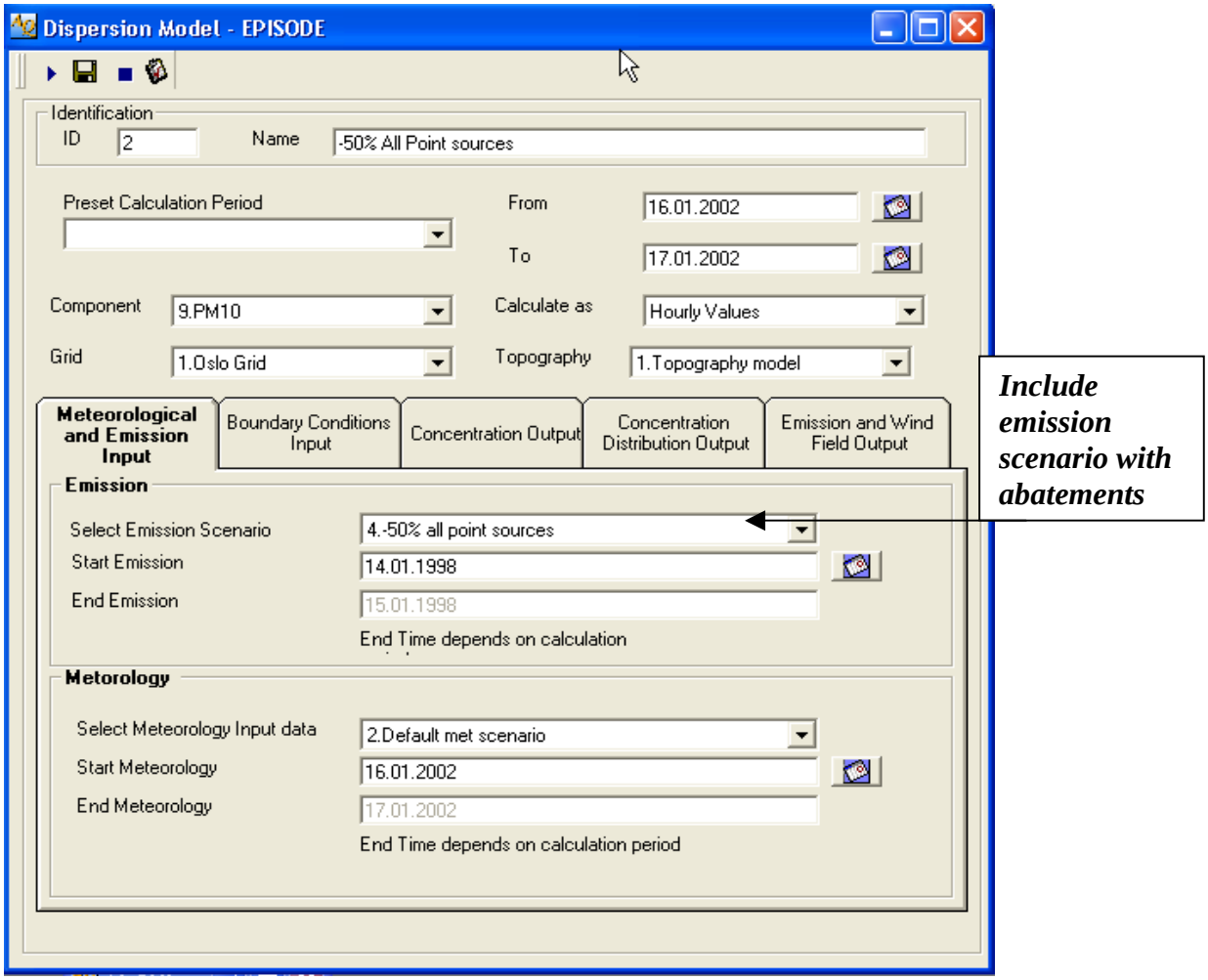


Figure 17: Dispersion calculation form, to run the dispersion model EPISODE.

The AirQUIS can perform emission and dispersion calculations for all predefined air quality components if emission data or emission factors for the selected component exist in the emission inventory database. The necessary meteorological data must also have been imported to the measurement database.

Results of the emission calculations for point, line and area emissions can be viewed by selecting the “Emission result” option from the AirQUIS tool bar.

The user can select the time period of the result dataset (s)he wants to investigate and choose to view this on the GIS or as a time graph for a specific stack, road or region. The dispersion model results can be displayed for the three different types of data. i.e. receptor point (chosen geographical points), building points and field (gridded) data.

In Figure 18 the line source emissions are displayed for all line sources as colour coded lines in the GIS display. An example of a field data set results from the dispersion model EPISODE is shown in Figure 19. By running the models with different inputs of emission, e.g. abatement scenarios the user can compare the results using the GIS or the graph functionality in the system and be able to

analyse the impact of the change in emissions for the area in question. The output of such scenarios can then indicate effects of the revitalising strategies simulated, which the municipalities can use in the pursuit of finding optimised strategies for the improvement of the environment.

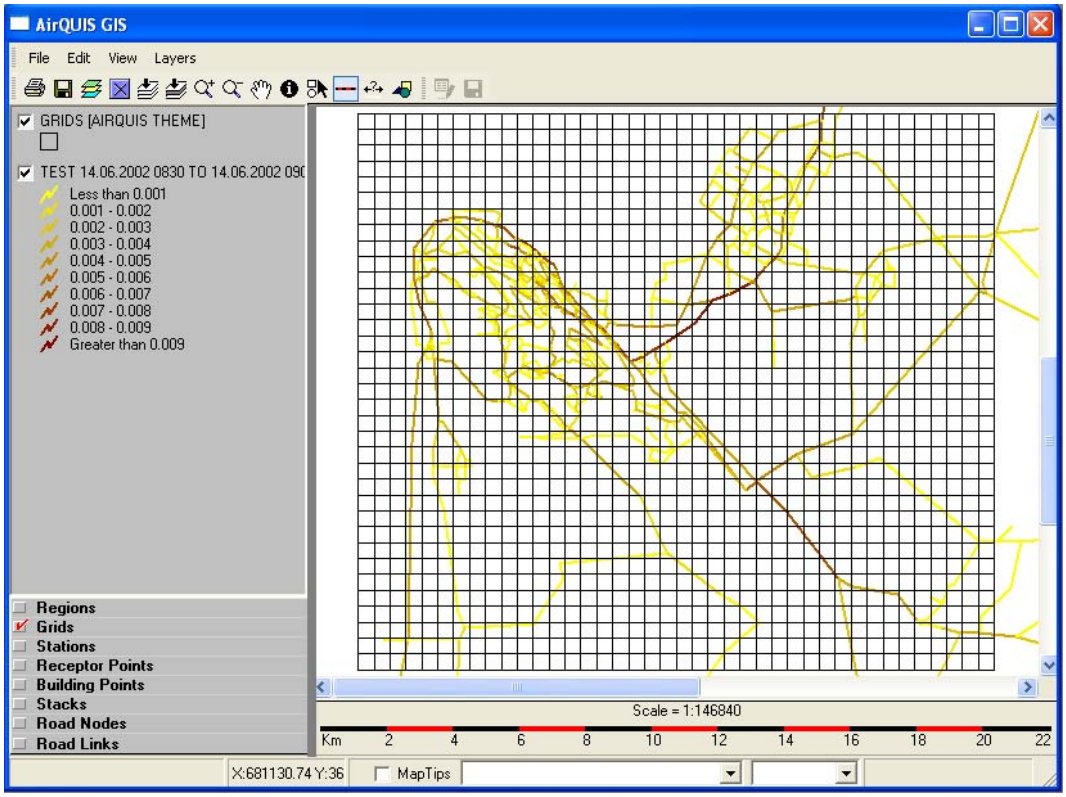


Figure 18: GIS display of line source emission calculation.

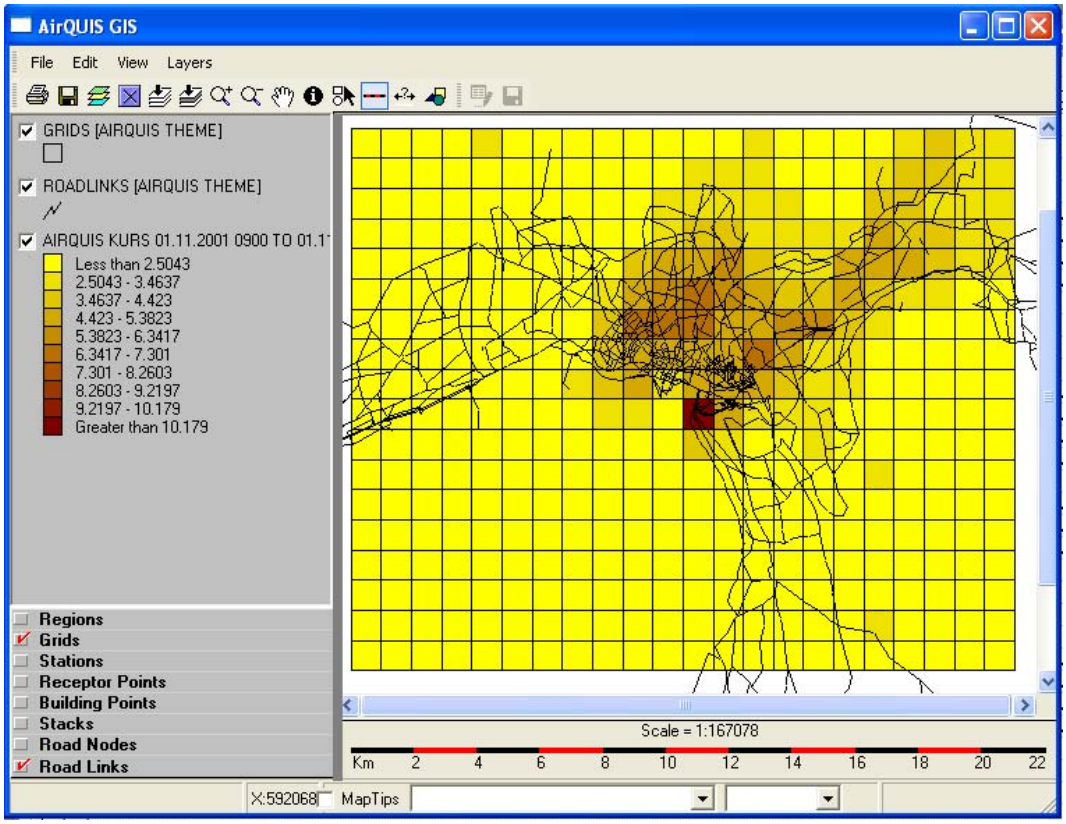


Figure 19: EPISODE dispersion calculation field results displayed on the GIS with grids and road links.

2.1.3 Abatement functionality and model calculations in WaterQUIS

2.1.3.1 Introduction

The Pollution Budget Model operates based on measurement data stored in the measurement module, and discharge data stored in the pollution sources module of ENSIS. Figure 19 describes the Pollution Budget Model. The Pollution Budget Model can be divided in 3 main parts; Source composition, Model scenario and Model Configuration.

Abatement evaluations/calculations are feasible by model scenarios with possibilities for manipulating data in different ways. A model scenario is a definition of a specific source composition and the alternative for sources where "true data" (original data) are manipulated to reflect a specific and possible change (reduced discharge, improvement of treatment technology, future scenario, etc).

2.1.3.2 Source composition

Source composition is a way of selecting what kind of pollution sources to include in the Pollution Budget Model. One source composition is defined by ID, name and link to one or several model configurations. One source composition can be used in different pollution models with different scenarios.

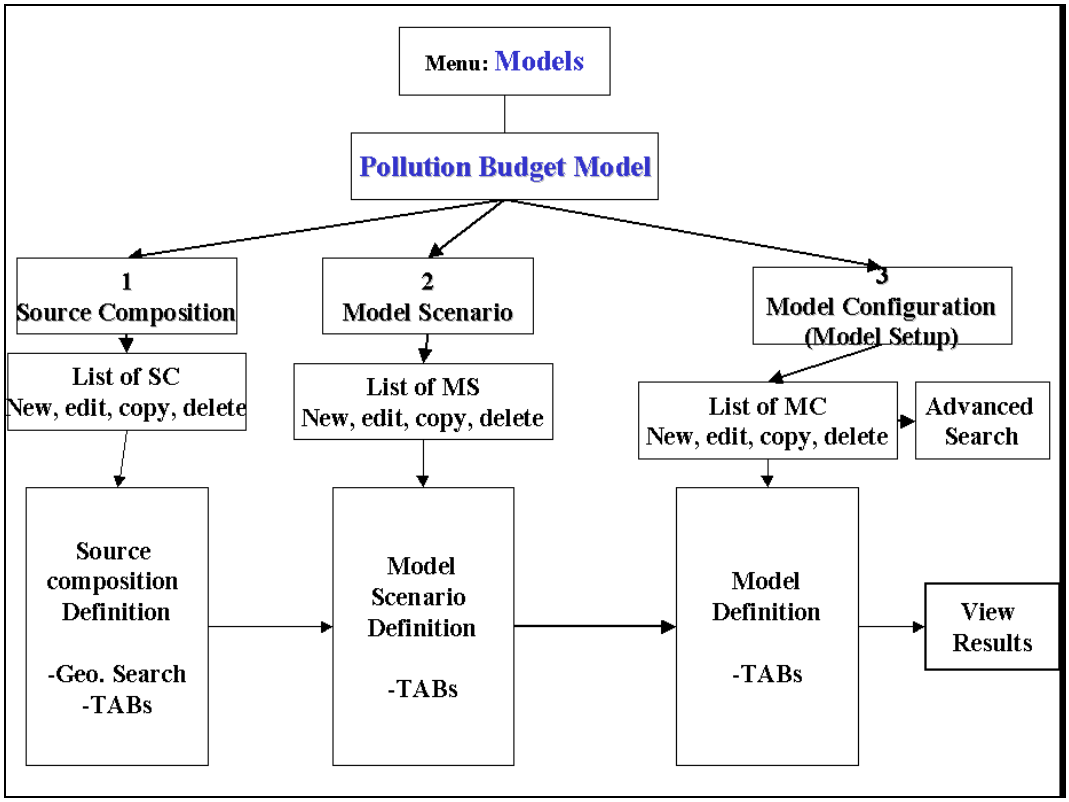


Figure 20. Sketch of the Pollution Budget Model

Each source compositions form have 5 different tabs where the user can select different sources among all pollution sources stored in the database. The following tabs to extract data are implemented:

- Domestic WWTP (WasteWater Treatment Plant)
- Industry
- Point sources
- Domestic wastewater (WW) activities
- Diffuse source

All the tabs have a check box in the upper left corner (similar to the air emission source composition) that indicates if this type of source is included or not. Figure 20 shows how this form will appear.

Source composition form consists of 4 main parts. Firstly the identification of source composition by ID, name and link to the pollution model configuration. Secondly some global settings on how these selected sources should be handled. The third part is a global search criteria and gives the user the possibility to search for sources based on GIS. The last part of the form is where pollution sources are selected. All different kinds of sources can be selected, and each pollution source have more accurate search criteria in their tab.

Figure 21 shows the form for source composition definition and the tab for selecting domestic wastewater treatment plants (wwtp). As can be seen, wwtp can

be searched for based on wwtp method, slude treatment method, totatl PE load or based on certain measurement data that are measured at the source.

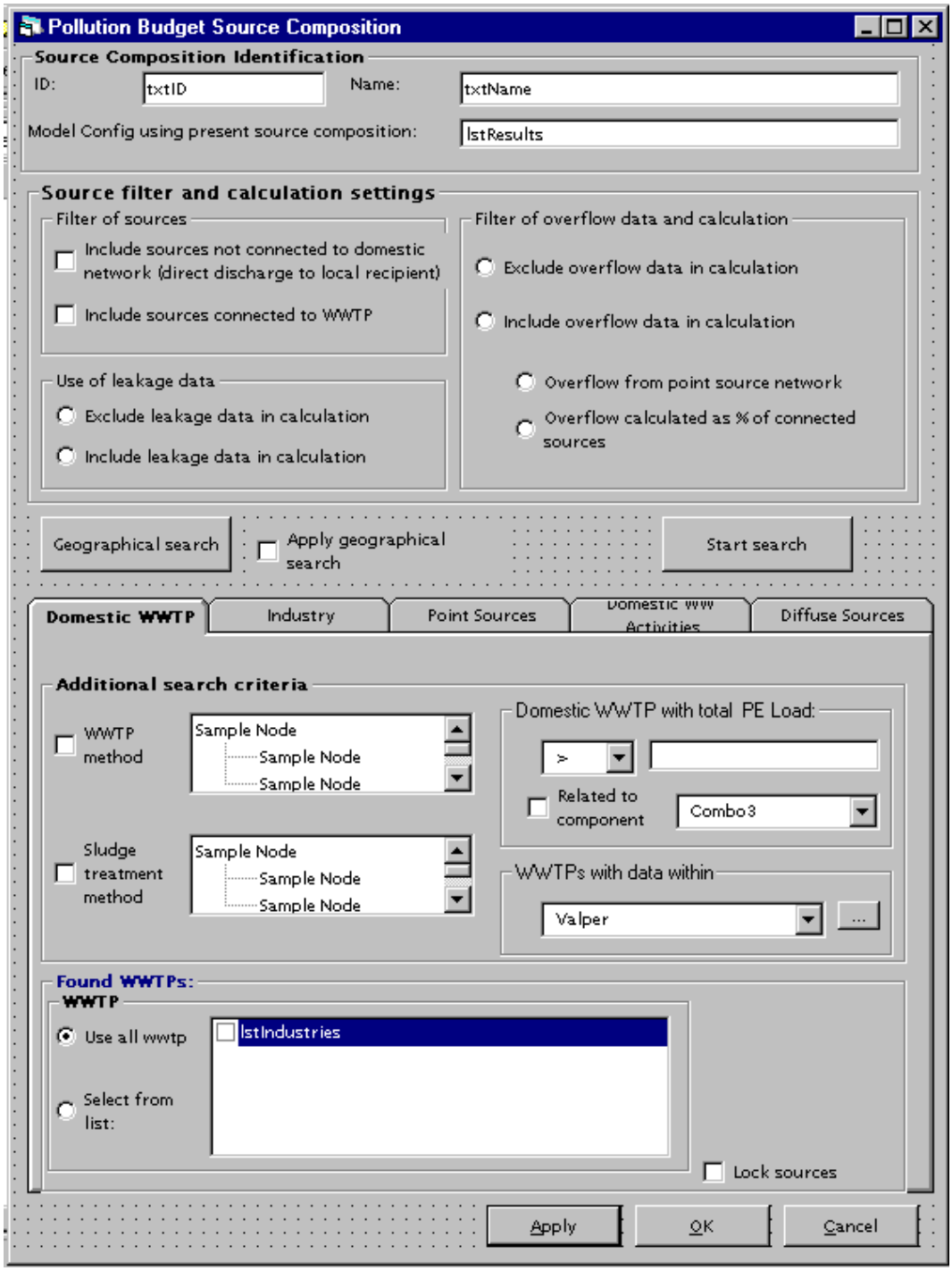


Figure 21. The form for source composition registration and the tab for selecting domestic wastewater plants (WWTP).

There is a check in the lower right on all the tabs saying if the sources are locked or not. This is to ensure that additional sources are not included, or some are taken away when the user has finished the preparation of one source and edits another one. If the user has prepared a composition of domestic wwtp sources, he will be

encouraged (by a message coming up) to lock this part of the source composition (check the lock sources), before he goes to the next type of source (eg. industry). When the user goes back to the domestic wwtp tab again, he must uncheck the lock before he can change the domestic wwtp part of the source composition.

Each source composition can be stored, edited or deleted. The tab for source composition for industry is shown in Figure 22.

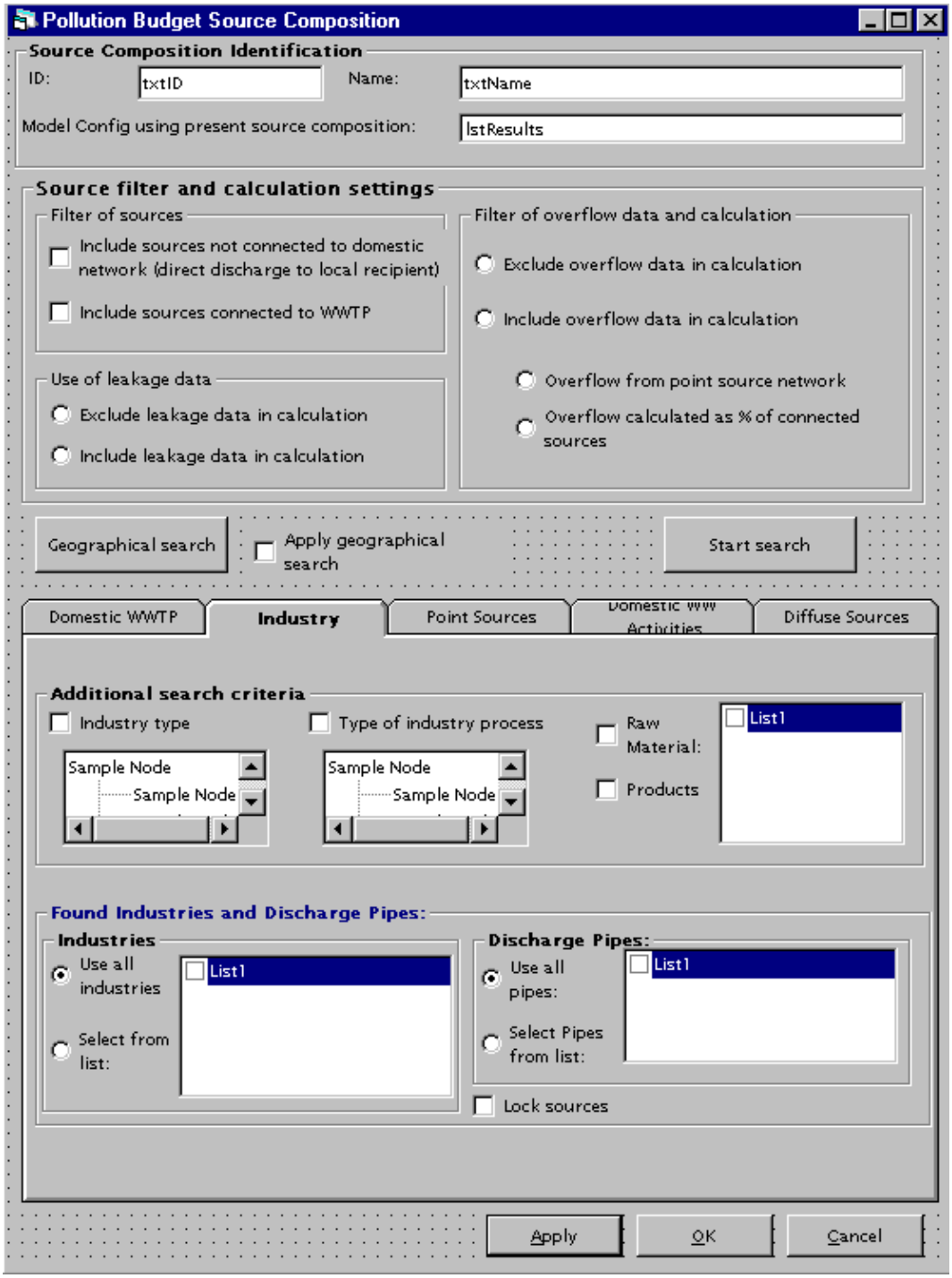


Figure 22: Source composition form and tab for Industry.

2.1.3.3 Model scenario

The list of defined model scenarios for the Pollution Budget Model is shown in Figure 23. There is a copy button on this form, coping everything, except for ID, name, Source composition and registration level to/from the selected model scenario into a new definition form.

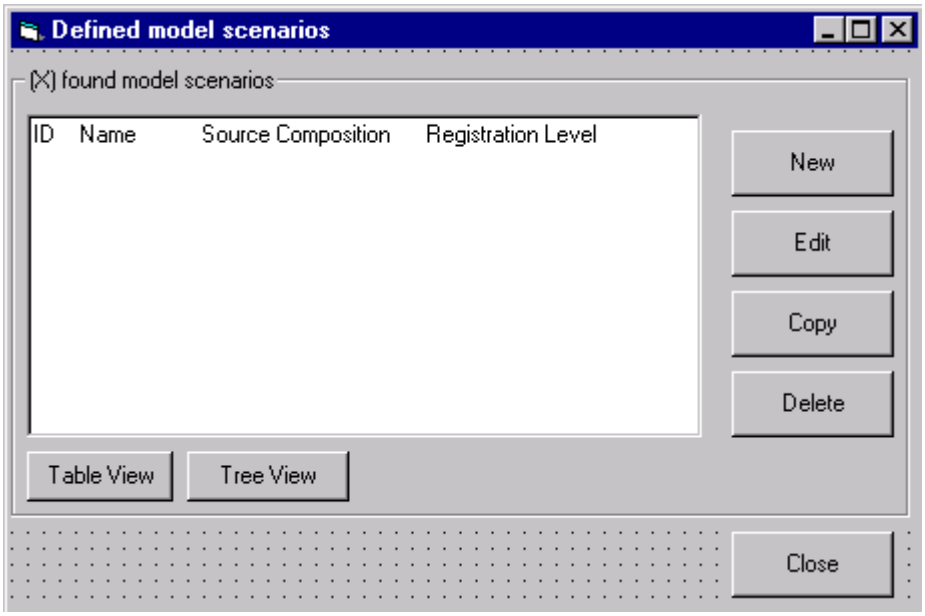


Figure 23: The list of defined models.

Model scenario definition is given in Figure 24. This is build in the same way as Source composition with the 5 different tabs. This is the form where the user can manipulate the source composition (adjust discharges, etc) for analytical purpose. The tabs are analogue to the tabs of the source composition.

Each scenario is identified by an id, name and a selected parent scenario. The scenario must be linked to a source composition.

Select source composition: The user must select which source composition to adjust the discharge for. As soon as this is selected, the five tabs will be automatically filled out with the sources defined to be included in the calculation.

There are a field for description in the middle of the form. This is for information only. Figure 24 shows the model scenario tab domestic wwtp.

The changes the user can do are to adjust the sources defined in the selected source composition by a certain percentage. 0 % means no change, -100% means no discharge, and 100 % means doubled discharge. The sources can be adjusted globally for the whole tab, or individual for the defined pollution sources.

The field Model runs linked to Model scenario gives information about pollution budget models that are using this specific model scenario and the name of source composition.

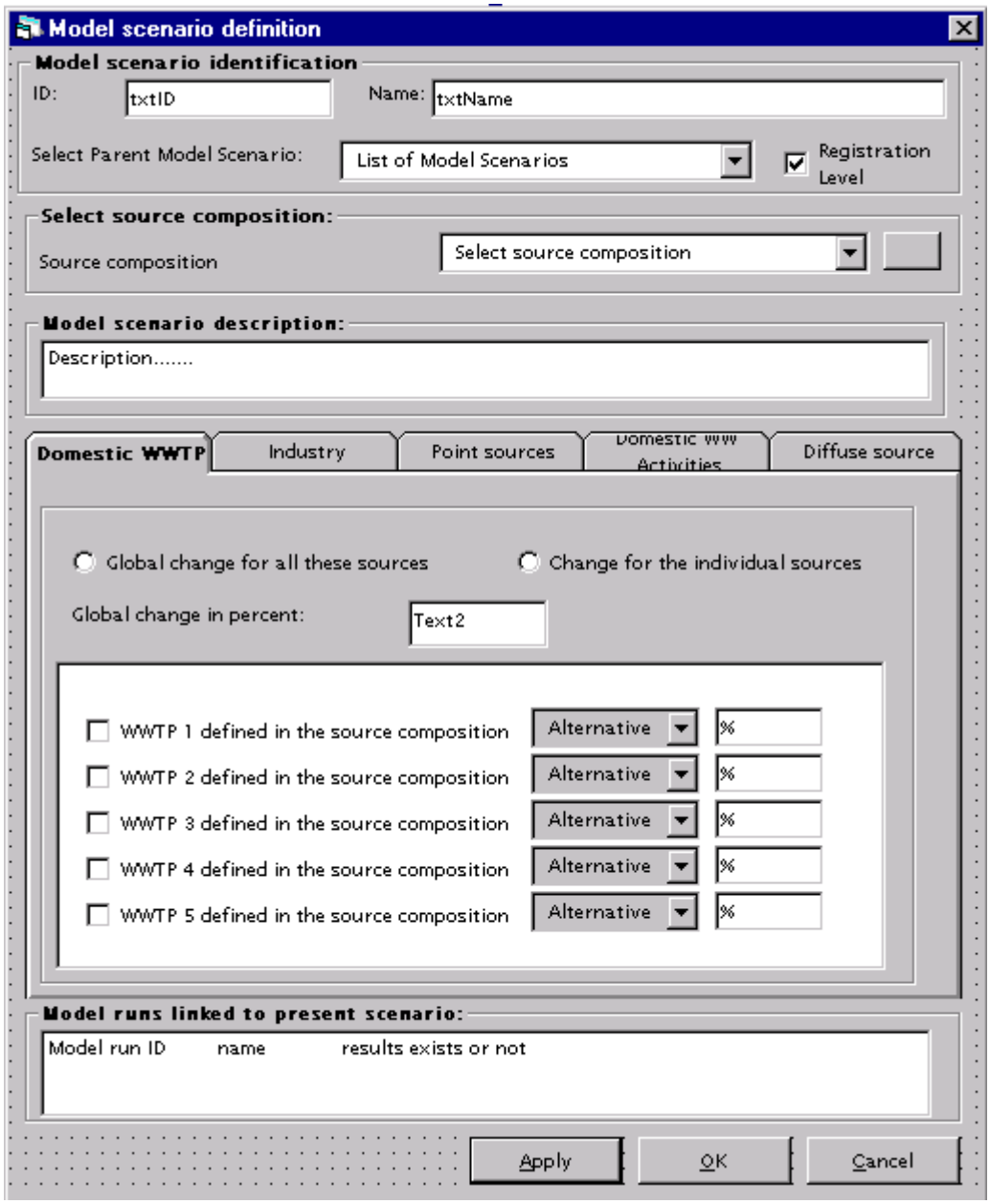


Figure 24: Model scenario definition form for manipulation of the source composition.

2.1.3.4 Pollution Budget Model - Model Configuration

To run the Pollution Budget Model a Configuration of the model must be made. Figure 25 shows the configuration form in ENSIS. Each model is stored by ID and name. If the model already exists and there are results available, a message is given.

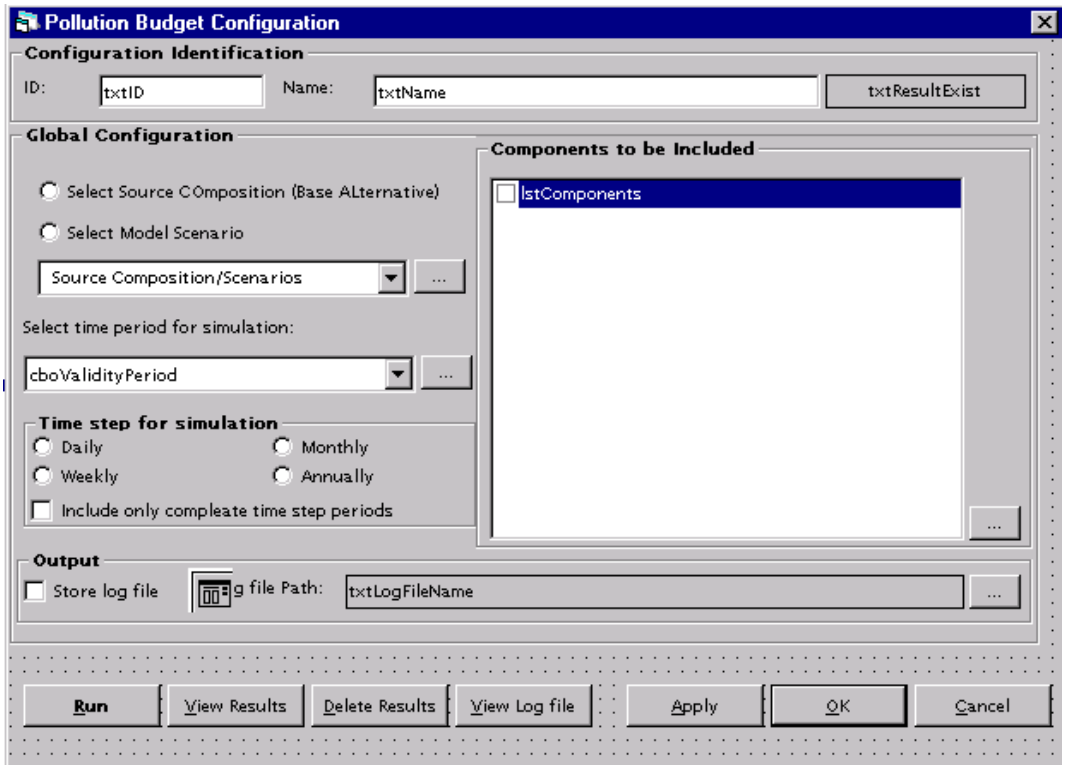


Figure 25: Configuration form for the Pollution Budget Model.

Firstly a source composition must be selected and then a model scenario. Additional information like time period, time step for simulation and how the output should be presented must be given.

2.1.3.5 Pollution Budget Model - presentation of results

There are two different strategies to present model results. The first is the source oriented. It is focused on the pollution sources (industry, diffuse, etc), and compares the different sources at the location. The second strategy is to look at the recipients (lakes, rivers, and coastal areas) and compare the load to the different recipients called recipient oriented presentation. The option buttons on the top of the form determines if the user selects to present data source oriented or recipient oriented. Selection of the source oriented presentation disables everything inside the frame "Recipient oriented presentation". When the option button Recipient oriented presentation is selected, everything within the frame labelled Source oriented presentation is disabled. Figure 26 shows the recipient oriented presentation.

If recipient oriented presentation is selected, the user is able to select which recipients (lakes, rivers, and coastal areas, and also to net node and WWTP) he wants to look upon the discharge to. The user can select one or several recipients, and then the system shall analyse which sources that go to the selected recipient/wwtp/net node, and calculate the load to the selected objects for each time step. One or several components can be selected when recipient oriented presentation is selected.

If only one component is selected, the user shall be able to see contribution from the 5 different categories. This shall be shown as 5 bars beside each other for each of the recipients included in the presentation.

The options net node and wwtp are only relevant when the choice "Include sources connected to WWTP" is selected both in the source composition and in the presentation form.

Presentation of results can be given in table views, graphical views or GIS views.

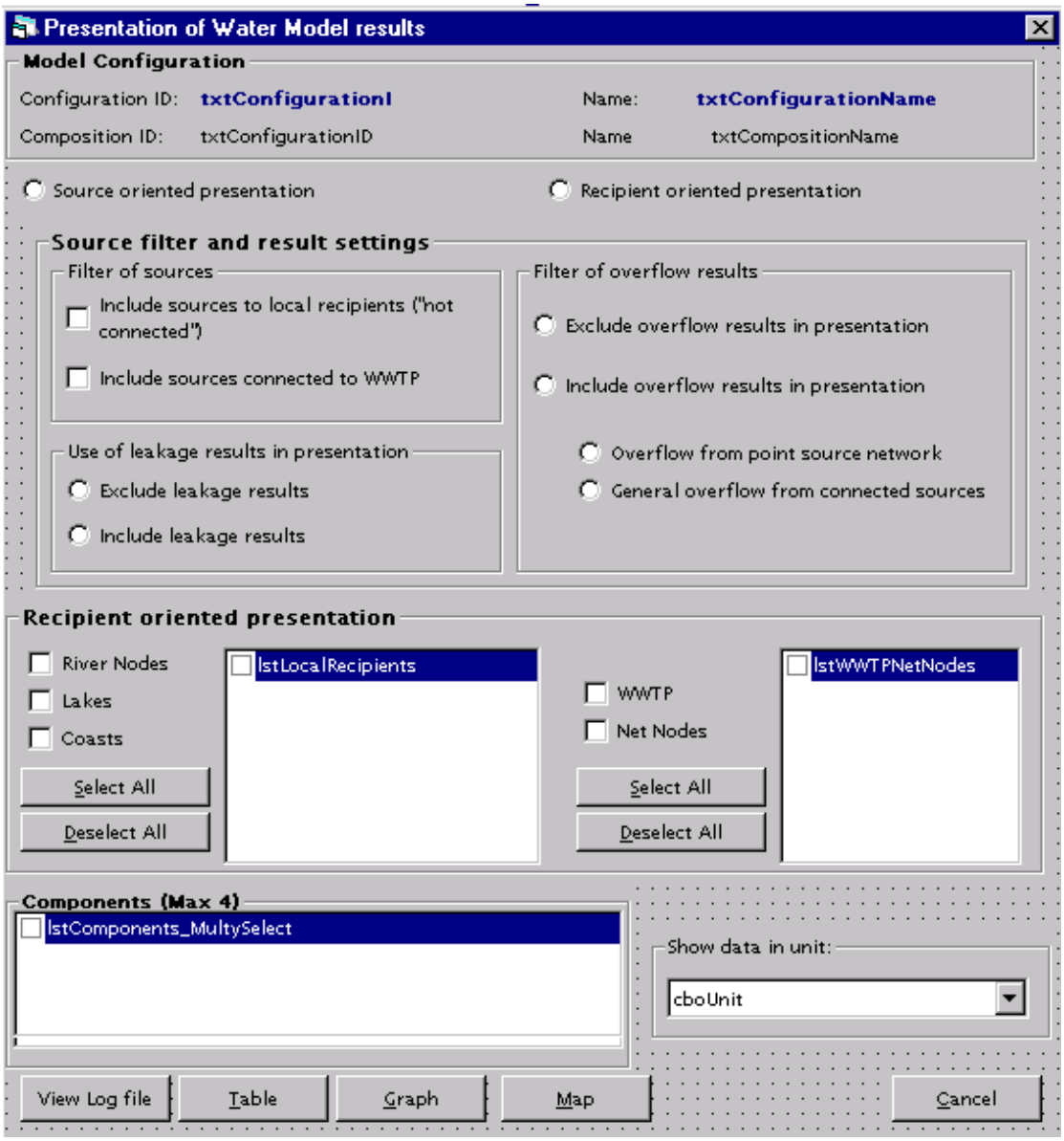


Figure 26: The form for recipient oriented presentation.

Regarding the GIS/map presentation, if source oriented presentation is selected, the results shall be shown at the location of the source, but if recipient oriented presentation is selected, the results shall be fetched to the recipient they discharge to.

If recipient oriented presentation is selected, it requires calculation by the system when extracting data from the database. The system sums up all the sources discharging to the selected recipient/net node/wwtp for each time step

If a lake or coastal area are among the recipients to be presented, the user will be able to present these recipients with colours (the same as the point dataset colour), covering the entire polygon. This function can be called "Representative for area". An example is shown in Figure 27.

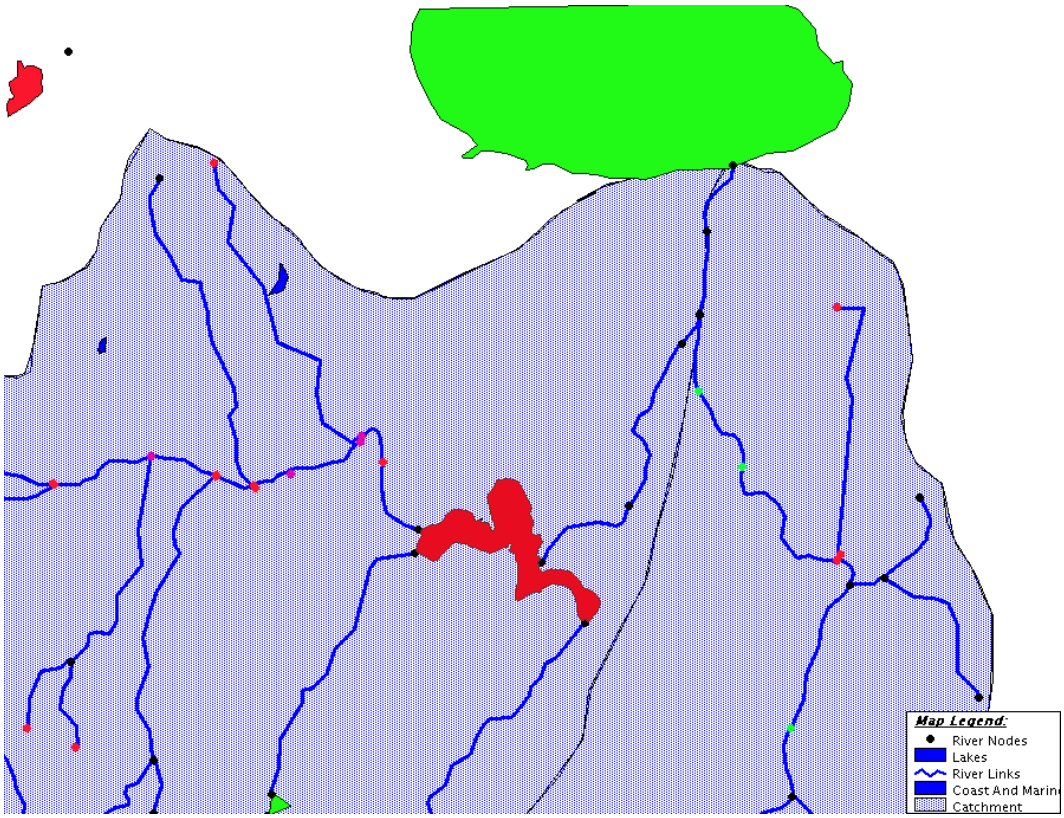


Figure 27: This example shows how recipient oriented presentation with "Representative for area" can look like. River nodes are given colour according to the value, and the lakes and coastal area in a similar way, but the values are made representative for the entire polygon.

Presenting the discharge from different sources gives the possibility to view on the map what is the origin of the discharge to the recipient/net node/wwtp. The discharge will be grouped in 7 categories, which reflect the 5 tabs from the source composition, and overflow at the source and leakage if included.

It will be possible to view the amount of discharge both as the real number, and as a percentage shall be possible to switch on directly on the map. The division between the categories of sources will, of course, be the same. Example of presentation is given in Figure 28.

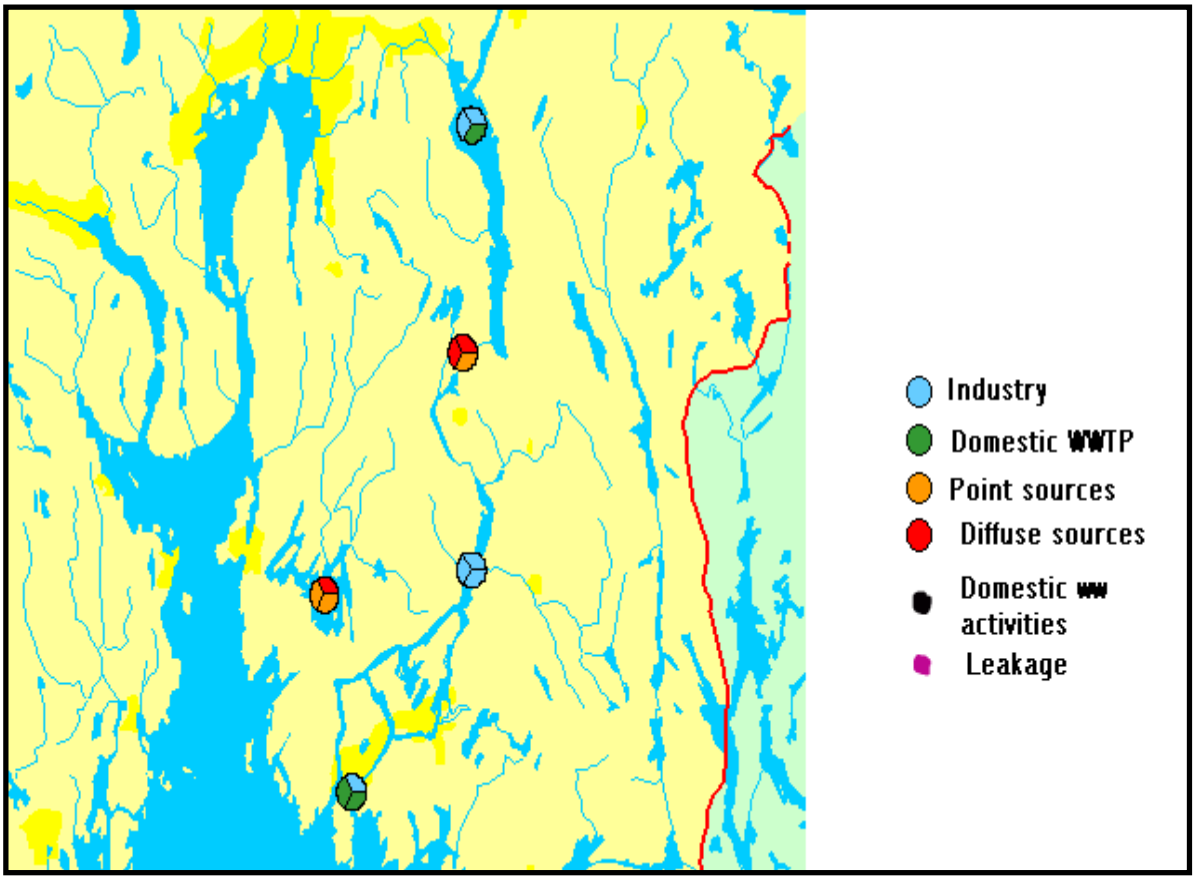


Figure 28: This example shows how the pie presentation looks like. The size of the sector shall reflect the amount of discharge for each sector. In a similar way, it is possible to present results from each of the categories as bars.

It is possible to export the prepared maps to other programs.

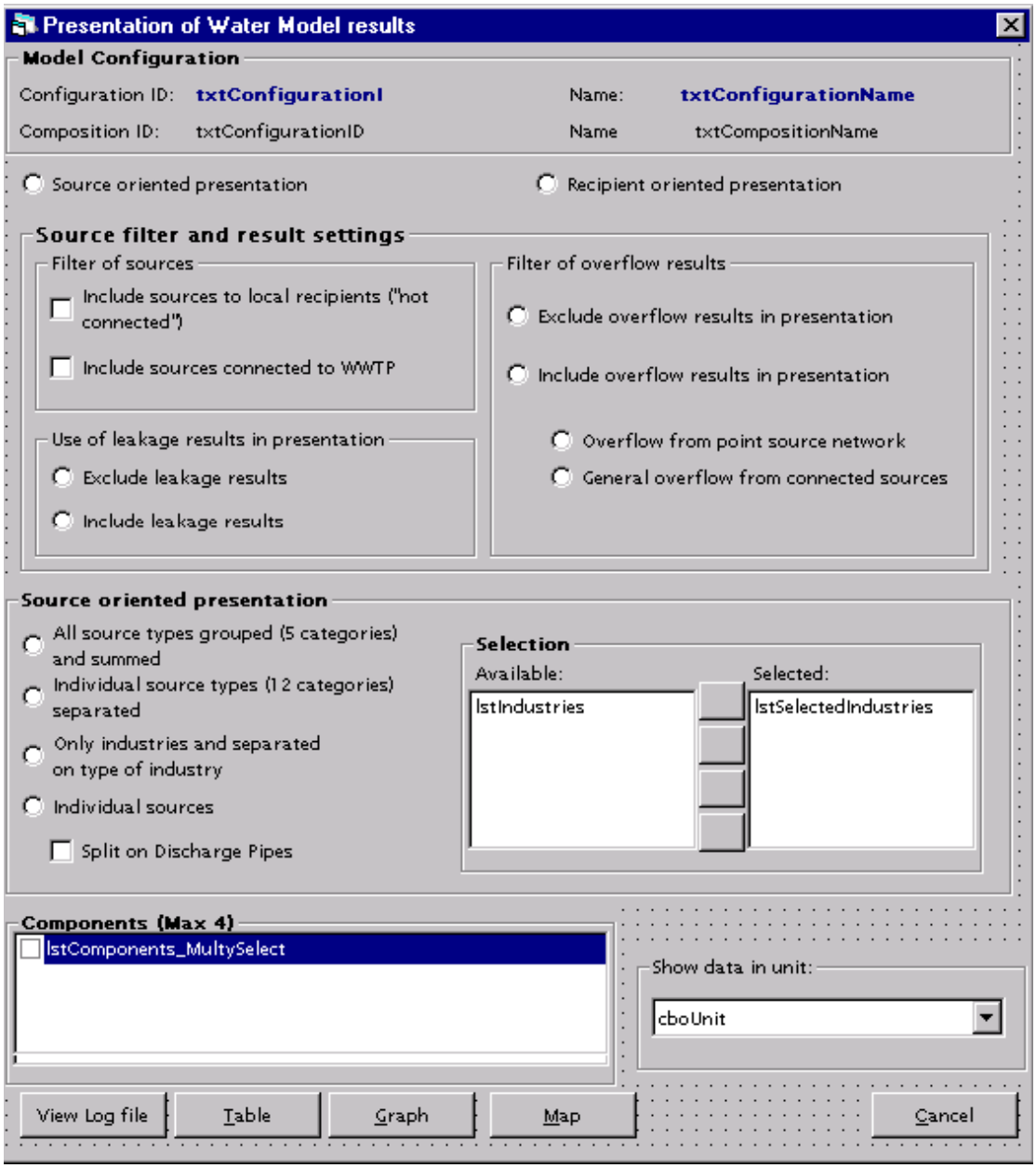


Figure 29: Form where the presentation of results from the complete water pollution budget model is determined.

2.2 The noise module

2.2.1 Identification of the sources of noise occurring in the urbanised areas

Noise, in accordance with the definitions functioning in the acoustic environment is composed of all the undesirable, unpleasant or simply harmful mechanical vibrations of an elastic medium, and influencing, through the atmosphere, the hearing organ and other senses and elements of the human organism.

In respect of the environment, in which it exists, and the sources that generate them is divided into:

- traffic noise resulting from the means of transport, both on road and railway,
- industrial noise - produced by industrial plants and individual machines and equipment localised in their preemies
- municipal noise, the sources of which are localised inside the apartment buildings, for instance, thermal centres, boiler rooms, transformer stations, water and sewage installations, lifts, rubbish chuets, and such ones when they are located in the outer environment, e.g. restaurants with entertainment activities, shops, sound signals activated by privileged vehicles (ambulances, fire brigade cars, police cars), and signals from alarm installations and mobile trade points, etc. The classification in respect of the form of noise sources in presented in Figure 30.

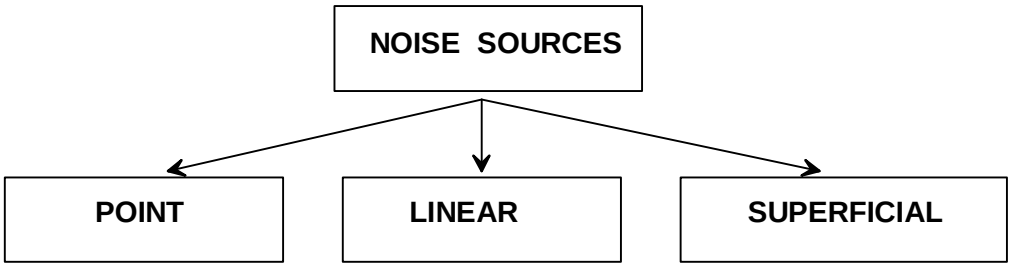


Figure 30: Division of noise sources including their shape.

Into the category of point sources, emitting acoustic energy in the outer environment, depending on their own directional characteristics, the following are counted, as an example: individual cars, machines and small industrial plants.

The linear noise sources are characterised by the domination of one of their dimensions over the others and constitute a set of point sources poisoned along a single line. The source of this land can emit acoustic energy both through its entire surface, and from a number of point sources located so close one to the other that the front surface of the wave emitted together by all the sources is close to a cylindrical or semi cylindrical surface. This type of the sources are for instance, transport routes with heavy traffic, belt conveyor flights or machines and equipment localised in one string.

The superficial noise sources are the areas with a distributed set of point and linear sources of external noise. Particularly, most industrial plants evaluated with the view of their environmental impact are the superficial noise sources. Point or linear types of this kind of noise are principally machines and equipment and technological processes.

The above - mentioned sources are distantly differentiated in relation to their acoustic parameters.

Therefore, a part of them will produce a hazard by reason of the level of emitted noise, another part by reason of its type, while the other by reason of a large of their impact.

This range, that is the level and characteristics of noise in the observation point, situated at a great distance from the source, depends on many factors. The principal of them are:

- acoustic power of the source
- emission characteristics of the source;
- -value of noise atternation by the atmosphere and earth surface
- -sound level A including the location of the source (s) of noise in the area (land of development planning),
- type of noise emitted by the source (continuous, interrupted, variable)
- atmospheric conditions taking place in the course of performing the measurements (in that the direction and power of the wind, atmospheric precipitation, humidity)
- method of land development of the considered area (including, first of all, the phenomena of screaming and atternation by the natural and artificial urbanisation elements)
- phenomena of acoustic wave amplification in consequence of reflection from the earth surface, water reservoirs or other natural and artificial barriers having a very low sound absorption capacity,
- method of encasing the source (if such one exists),
- location and sort of the areas subject to acoustic protection,
- time of the day in which the measurements are performed.

In ideal conditions, the method of determining the sound level at a given distance from the source is based on the principal assumption that noise propagates through the open space with no interference, and a change in the noise level is affected only by the distance of the observation (measurement) point from the source of noise.

2.2.2 Principle of operation of the module

The principal appropriation of the module is the evaluation of the impact of noise emitted from different sources on the acoustic climate of the environment. It can also be used as a module for supporting the process of decision taking in the question of environmental protection against the excessive noise. By applying in the assumed model of computation the different variants and scenarios of actions, it is a tool that facilitates planning and performing simulations.

The most important element of the module is the CadnaA programme. It makes possible to collect very different data. The program has a graphical interface, and most operations are performed on the visible map base. Extensive import and export parts make possible to transfer the information from and to other systems.

The database of the CadnaA programme, being its integral part, is prepared for storing the data, both acoustic and non- acoustic. A part of the data is only of informative character, but most of them are used in the course of computation. The information is entered into the system twofold. The first of these methods, manual one, when the user manually enters all the data, refers only to small models. For the larger ones, there is a possibility of automatic transfer of data from the GIS systems or CAD programmes.

In the discussed module, the computations are performed with the use of the CADNA A programme, version 3.2, developed by DataKustik. The programme version used (the so- called SIP+ BMP version) contains the packages for computation of industrial, railway, and traffic noise, and the computational models applied in the programme are compatible with the European recommendations included, for instance, in the Directive 2002/49/EC, and the PN ISO 9613 standard.

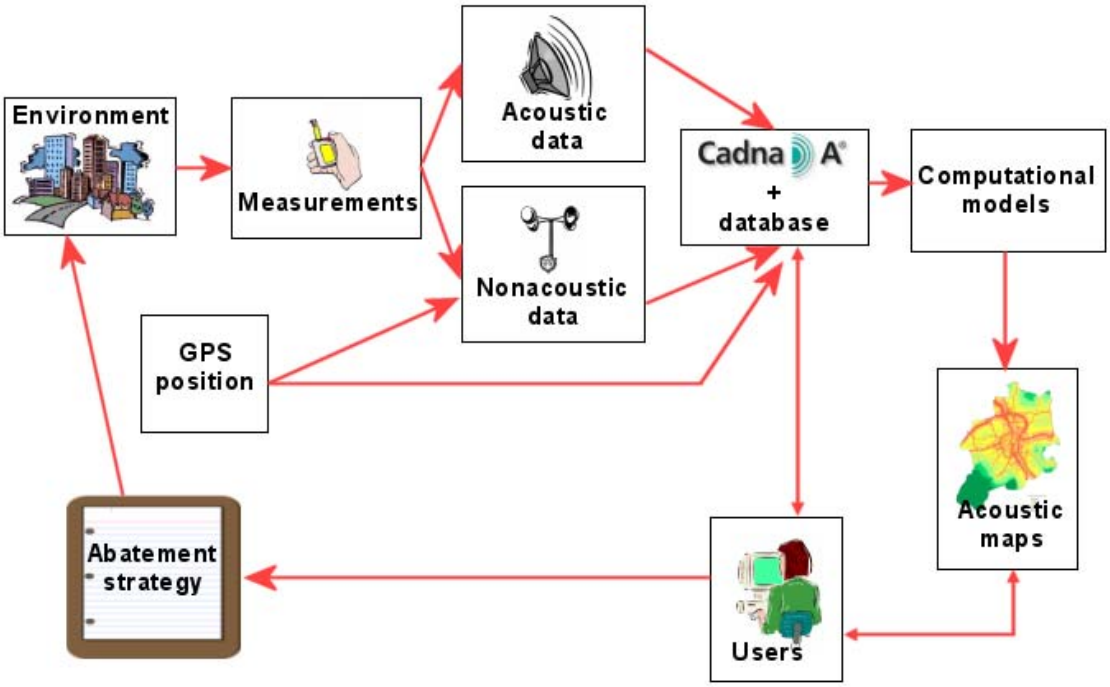


Figure 31: Block diagram of the module operation.

The programme operates on the basis of the principal value that characterises the source of noise, that is on the level of emitted acoustic power.

Noise coming from the sources of either linear or superficial character, is represented by a set of substitute, equivalent point sources with a definite acoustic power and direction of propagation.

The computational results are represented in a graphical form as an acoustic map with visible cartographic base, and in a tabular form. The module enables to generate the reports based on the templates prepared earlier. The export module of tabular data and acoustic maps into other programmes is also extensive, including the graphical file format.

2.2.3 Co - operation of the CadnaA Software with the software operating within the URBER tool

The programme for computations makes use of the information collected in its own database. A number of tools localised in the programme enables to import the data from the GIS systems (including ArcView, MapInfo), CAD Systems and other formats.

After performing the computations or simulation, the data (results) are saved in CadnaA programme database, or are exported to other formats. The export relates not only to the results obtained, but to the whole information collected in the database, such as Oracle, SQL Server, DB2 or others.

2.2.4 Global positioning system (GPS)

The modern methods of land development planning and preparing the assessments of impacts on the environment, need linking the measurement data and computational methods applied with the maps of the investigated region. Within this scope, the GIS (Geographical Information System) is used, which links the cartographic maps with the databases (which apply the GPS system), enabling to perform an exact localisation of spatial, linear resources, and precise determination of the places in which the measurements or observations were made.

2.2.5 Examples of application of the software

The considered software was used, among the other things, in the course of creating an acoustic map of a medium - size town, and in the assessment of acoustic annoyance in the project of a thermal - electric power station modernisation.

- Acoustic map of a medium-size town

In the year 2003, an acoustic map was prepared using this programme, of a town located in south Poland. The town has a population of 180 thousand inhabitants, with an average population density being 1450 inhabitants per 1 km2. The town area is 12.5 thousand hectares.

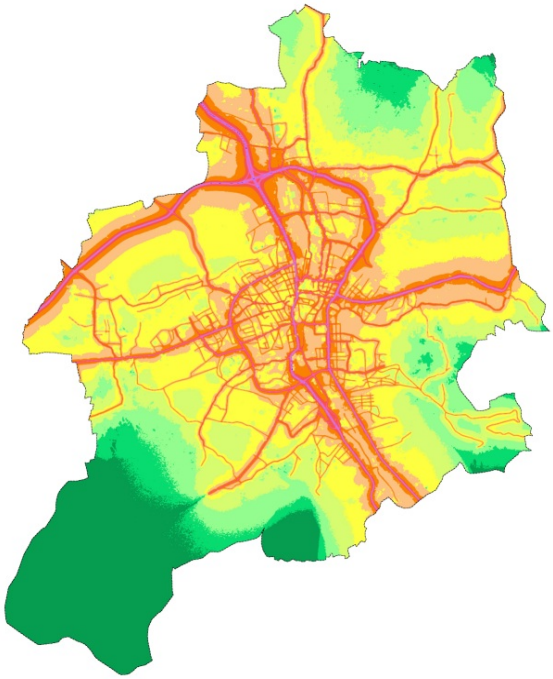


Figure 32: Emission map of the road traffic noise.

Before the computations have been started, the data of the road traffic, railway and industrial noise were entered. Then, the required non - acoustic parameters were determined (location of building, heights, meteorological conditions, shape of the area, localisation of reference measuring points, etc.).

The result of computations conducted is the acoustic map which describe the current state (Figure 32), and the emission maps of individual noise sources (Figure 33).

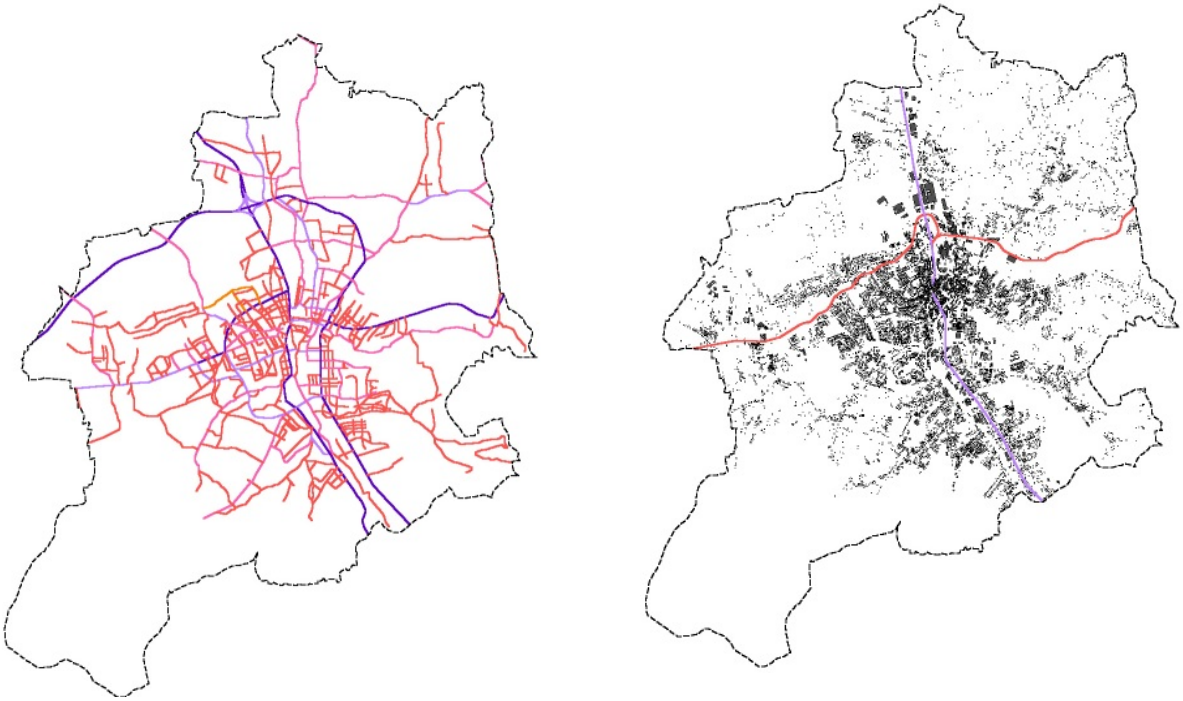


Figure 33: Emission map of road traffic and railway noise.

2.2.6 Evaluation of acoustic annoyance of the thermal - electric power station after modernisation

The work was aimed at performing the assessment of acoustic annoyance of the thermal-electric power station, and analysing the distribution of noise after its modernisation, comprising the replacement and change of localisation of the cover being a part of this industrial plant. The new location and other type of the cooling equipment is related to origination, at the station premises, of new operational conditions of noise sources, which has been adequately modelled in the system. To determine the degree of influence of the planned investment on the external environment, the simulations were carried out for various locations of the new coolers. To this end, a model was used which exactly reflected the investigated area (plant premises and adjacent areas). The use of simulation enabled to answer the question how the acoustic climate condition would change at a change of defined parameters (location and power of two coolers). A fragment of the acoustic map of the power station and neighbouring areas, reflecting one of the scenarios referring to given parameters of the noise source is presented in Figure 34.

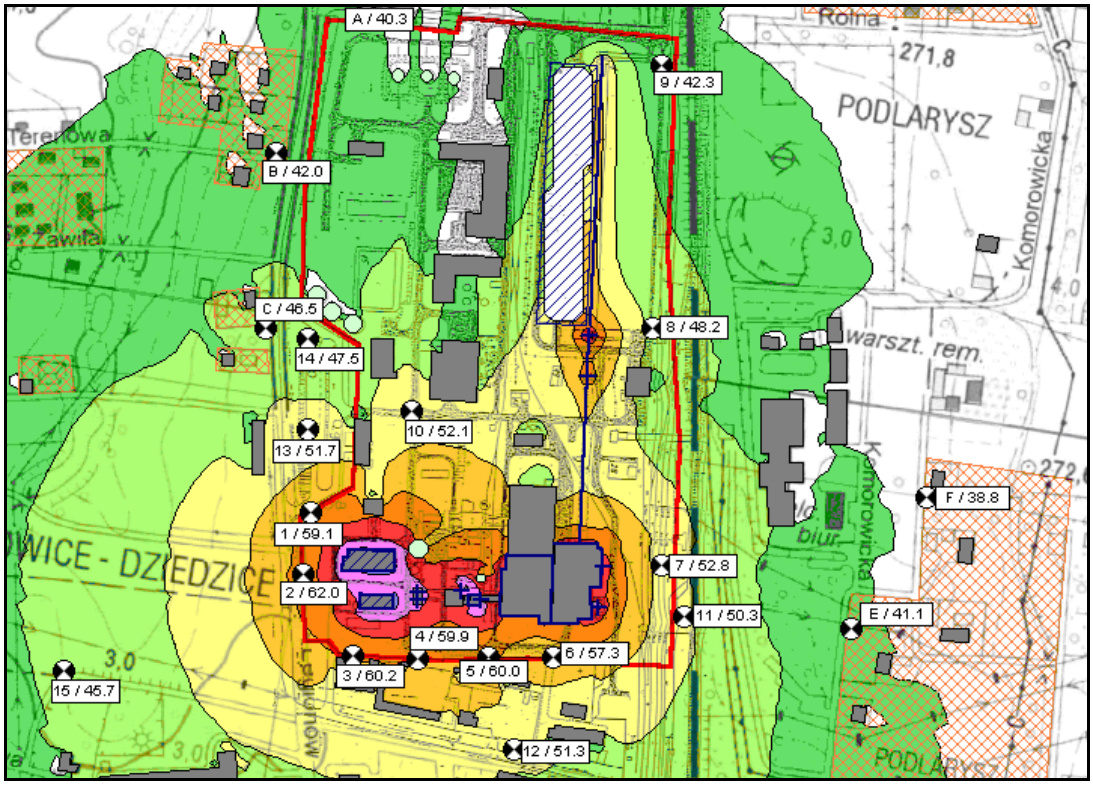


Figure 34: Emission map of the planned thermal - electric power station.

2.2.7 Methods of the environment formation- scenarios of the actions

As mentioned above, the system, apart from the analyses of current acoustic annoyance, makes possible to model various scenarios of the actions. the process of modelling of the environment and its surroundings, enables to introduce various changes and assets the process of decision taking, whether or not these changes improve or worsen the acoustic climate in a given area.

In the model prepared for simulation, the following changes can be introduced:

- change of meteorological conditions (temperature, humidity, wind direction, etc.),
- change of road traffic parameters (intensity of vehicle movement, proportion of heavy vehicles, velocity of vehicles),
- planning of new objects, roads, railway lines,
- change of railway line parameters (type, number and velocity of passing trains, material for making track ballast, length of train),
- construction of acoustic screens,
- changes in shaping of the area (e.g. embankments along the railway lines or motorways),
- change of acoustic parameters of industrial noise sources (emitted power, size of industrial buildings),
- change of parameters of point and linear sources (power, direction of propagation, height).

The results of computations for different variants can be compared in tables, which makes tracking the effects of individual simulations easier. An example of noise propagation for various scenarios is presented in Figure 35.

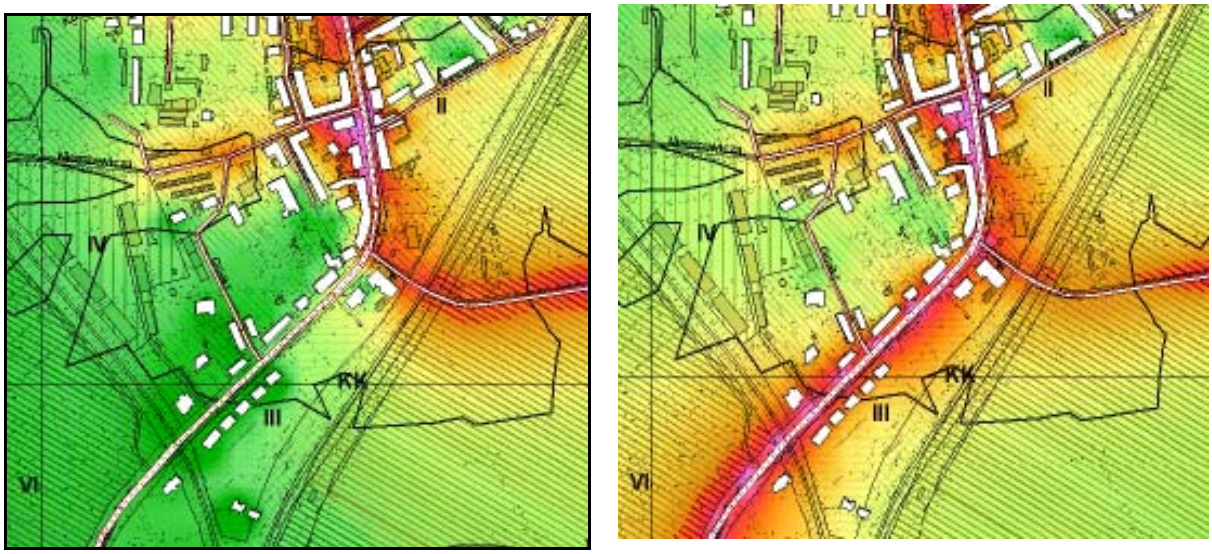


Figure 35: Emission map of the area before and after closing the road section.

In the example in Figure 35, the situation of Bytom- Bobrek district was modelled. In this situation, the road leading southwards has been closed and the traffic shifted to the road running eastwards. One can see that the houses localised along the south road are not more located in the noise- hazard zone.

View of the entire Bytom-Bobrek district, seen from flight of bird, in shown in Figure 36.

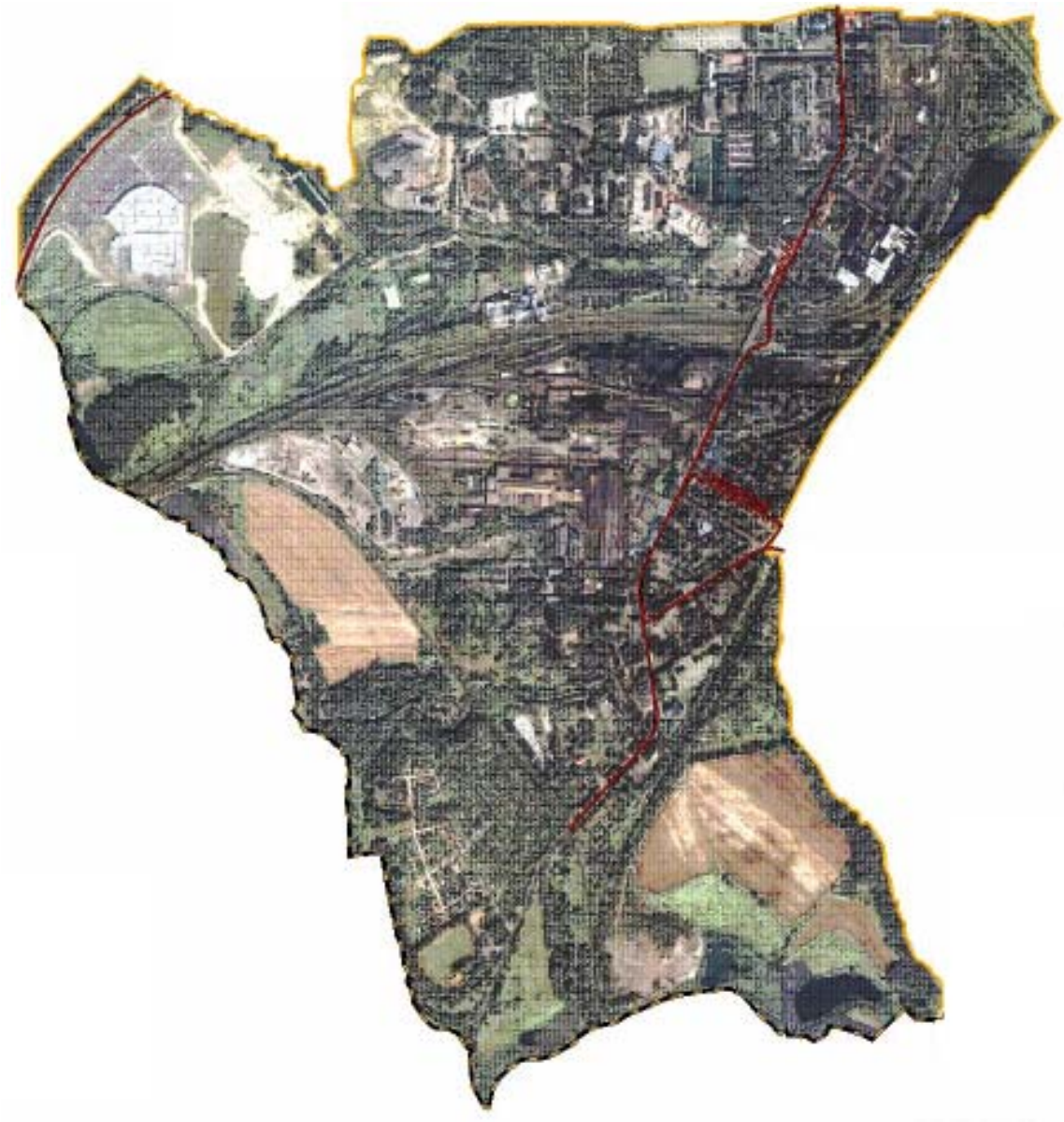
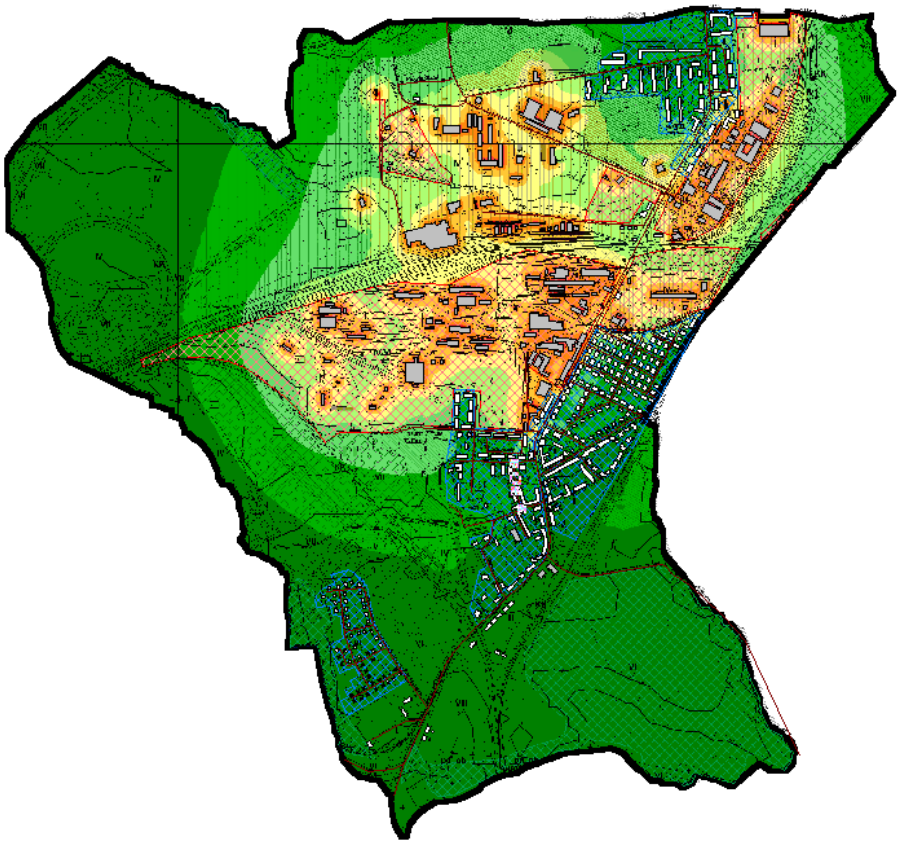
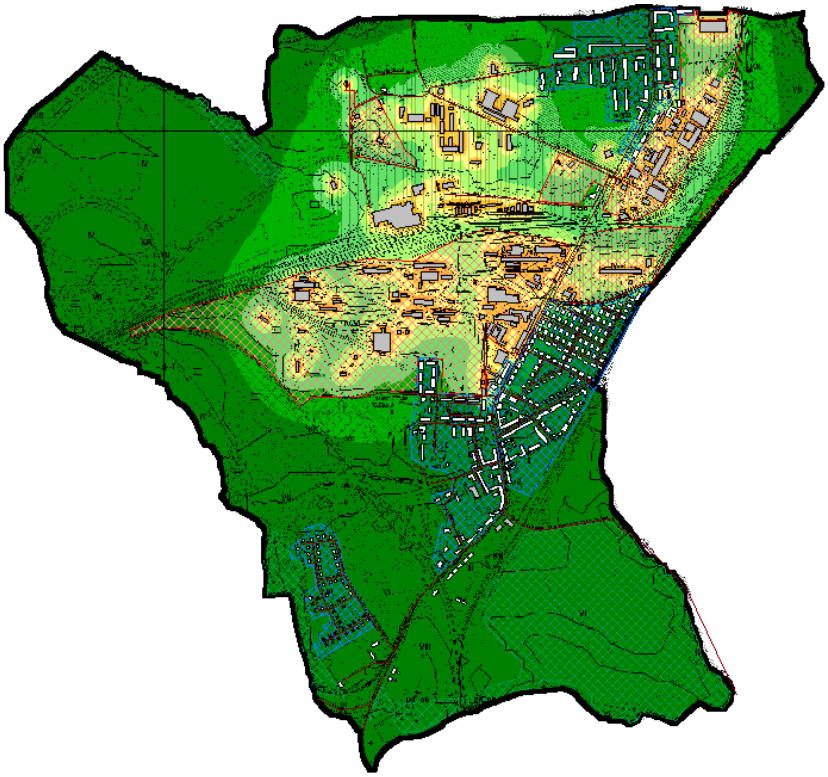


Figure 36: Bytom-Bobrek district map.

Next paragraph describe possibilities of creating scenarios in CadnaA software. In the first model we assumed that every industry building (marked with grey colour in Figure 37) have indoor level of sound equals 85dB and sound reduction of buildings walls is 15 dB. Industry noise was the only one type of source. In the second model we enlarge the acoustic insulationess to 20dB. All remaining parameters stayed without any change. Emission maps, calculated in this two various models are presented in Figure 37a and Figure 37b.



a)



b)

Figure 37 a, b: Two models with different sound reduction of buildings walls.

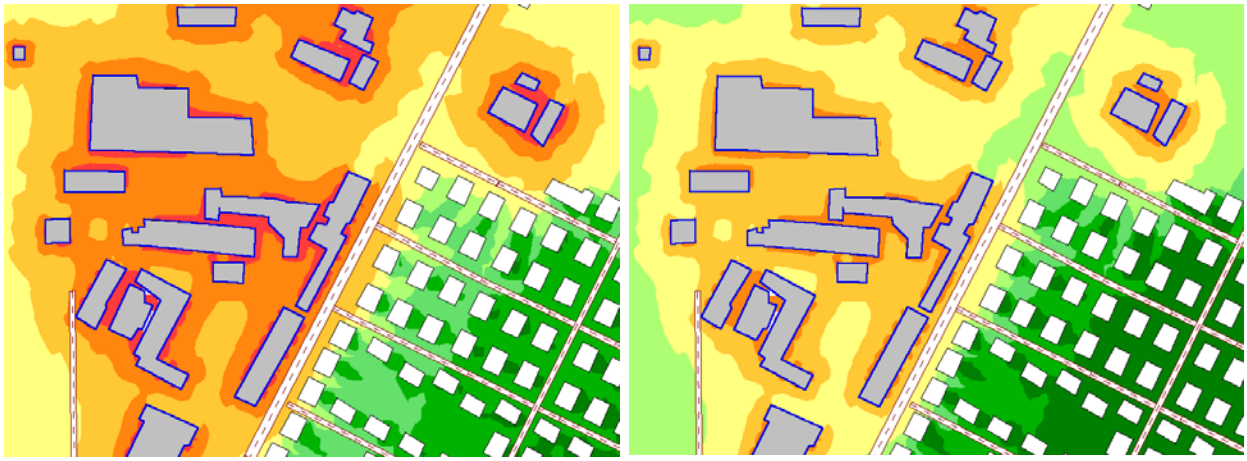


Figure 38: Result of computations of the noise for the present state and the state after a modernisation.

In the result of the increase only of acoustic insulationess in 5 dB, the lessening of the noise hazard zone is very noticeable – Figure 38.

2.2.8 Functionality of the computational programme

At present, various methods of mathematical modelling are used for the acoustic field that occurs in the surroundings of typical noise sources in the area of large urban agglomerations. The available CADNA A programme is adapted for preparing the acoustic maps of towns. It contains the modules for computation of road, railway and industrial noise in accordance with the EU directives. These methods are compatible, among the other things, with the requirements included in the ISO 9613-2 standard, and are based on the French computational standard (*NMBP*) which is applied in all modern computational procedures of noise.

The software package enabling to prepare the acoustic maps includes the following:

- modules for calculation of road, railway and industrial noise in accordance with the EU recommendations,
- possibility to co- operate (export and import of data) with the GIS (Map- Info, ArcView,.?.), and the GPS system,
- collection of the base of acoustic and non- acoustic data which enable to perform acoustic computations,
- preparation of map bases in a given scale and their digitalisation,
- creation of a database for measurement results,
- performing the computations for the whole area under consideration, propagation or road traffic, railway and industrial noise for night and day time,
- making assessment of the current condition, separation of individual noise types through preparing:
    - strategic emission and Emission maps,
    - maps of noise- hazard area the ones in which the admissible threshold levels were exceeded,

  - maps of the areas where the admissible levels were exceeded in relation to the local land development plan,
  - maps of the distribution of the index which characterises the value of overstepping the admissible limit, and the number of inhabitants present in the health-hazard area,
- evaluation of the number of inhabitants subject to noise over the admissible level,
- determination of the index which characterises the value of overstepping the admissible noise level and the number of inhabitants in the area, defined in the following way

$$M = 0{,}1\ m\ (10^{0{,}1\Delta L} - 1)$$

where:

M - index value,
ΔL - value of overstepping the admissible noise level, dB,
m - number of inhabitants in the area with exceeded admissible level.

In addition, the software enables to:
- perform automatic scaling of maps,
- perform computations for large areas (e.g. towns over 250 thousand inhabitants)
- perform computations at different heights, including fronts of buildings,
- calculate other indices of annoyance and harmfulness of noise.

2.2.9 Compatibility with GIS systems.

To storing information about objects and their attributes CadnaA uses a special database format. It's not a typical Geographical Information System, but the program offers a useful tool to move data to and from ArcView which is very popular GIS system. The entire process of moving data is based on ODBC (Open Database Connection) technology, implemented in every Windows operating system.

To execute a calculation on select area of city recorded in system ArcView, users should do the following things:

1. Import data from ArcView (ArcView stores data in two files: shape file format and dBase format)
   - in ODBC Data Source Administrator make a new User DSN source with dBase driver,
   - in CadnaA select option import to get a specify data (only file with shp extension – information about shapes of objects),
   - make a data source definition in CadnaA (to object like: roads, point sources, buildings,…) and ascribe selected attributes form dbf file through ODBC connector,
   - update existing object.
2. Execute suitable calculation
3. Export results to ArcView format.

- in export option type a file name and click button: Export. After that CadnaA create new file (new layer in ArcView) witch contains lines of equal sound level (Iso-dB-lines) as polygon.

Besides this CadnaA can also export data to formats like: AutoCAD DXF, Bitmap, Immis-Luft, Lima, Text Files. Using ODBC technology user can export and import data to other format, but one condition must be fulfil: a proper ODBC driver registered in Windows operating system.

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ABSTRACT

The aim of the URBER-tool development is to have a tool for environmental assessment of the current situation and the situation after the revitalising process. The tool addresses air and water quality and noise, and is based on existing tools used for assessing urban environmental situation. URBER is a tool where the user will be able to:

- analyse the present environmental status with respect to causes and effects,
- identify problems of concern,
- set the environmental objectives,
- identify measures and the environmental effects of the measures and
- support the responsible authority in producing relevant information for other stakeholders involved including the public, in order to stimulate the participation of these in the planning process and secure ownership to the plan.

The new features developed in the MASURIN project is the abatement module, where the user will be able to perform abatement measures and simulate the effects of the measures on the air and water quality. A key issue has been to develop this tool so that the system is user friendly.

NORWEGIAN TITLE

KEYWORDS		
Abatement	Industry	Emission

ABSTRACT (in Norwegian)

** Classification* *A* *Unclassified (can be ordered from NILU)*
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