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IER

User's Manual

EcoSense

Brazil/Latin America

Version 1.0

Acknowledgment

The implementation of the *EcoSense* software is based on the methodological approach developed in the ExternE-Project on External Costs of Energy, funded by the European Commission, DG XII, JOULE Programme. The development of *EcoSense* would not have been possible without the input of many experts involved in the ExternE project, including Fintan Hurley (IOM), Mike Hornung (ITE), Mike Holland and Jacquie Berry (ETSU), Nick Eyre (EEE), Anil Markandya (University of Bath), Ari Rabl (ARMINES) and many others. The implementation of the EcoSense model in Brazil/Latin America was supported by the International Atomic Energy Agency.

The windrose trajectory model which is implemented in *EcoSense* is a HTM-like atmospheric model (HTM = Harwell Trajectory Model, developed by Derwent and co-workers at AEA Technology, Harwell Laboratory, UK). It is configured to resemble results of a 1991 FORTRAN version of HTM, but program design and implementation are quite different from the FORTRAN HTM, and it contains no code written by AEA Technology. Dr. Colin Johnson, at that time (1993) AEA Technology, encouraged the use of the model by various ExternE teams, provided the 1991 FORTRAN version of the HTM, literature on the model, and a one-week training on concepts and application of HTM at Harwell Laboratory. He also approved that IER would develop a model interpreter based on the windrose approach of HTM and give this interpreter to the public. Dr. David Lee, AEA Technology, provided help on details of the chemical mechanism, and approved that IER employs a HTM-like windrose trajectory model in the *EcoSense* software for application in the ExternE project.

The emission inventory for Latin America was derived from the Emission Database for Global Atmospheric Research (EDGAR), Version 2.0.

EcoSense has been developed within the Section of Technology Assessment at the Department of Technology Assessment and Environment (TFU), IER, with contributions from

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University of Stuttgart 1999

Content

1 INTRODUCTION/GENERAL REMARKS

EcoSense is an integrated computer system developed for the assessment of environmental impacts and resulting external costs from electricity generation systems and other industrial activities. Based on the impact pathway approach established in the ExternE-Project on External Costs of Energy funded by the European Commission, *EcoSense* provides relevant data and models required for an integrated impact assessment related to airborne pollutants.

The European version of the *EcoSense* model, which was developed under the ExternE and GARP II (Green Accounting Research Project II) projects, has been used successfully in a large number of research projects and policy advise studies as a standard tool for the assessment of environmental externalities in Europe. The implementation of the *EcoSense* package in Brazil/Latin America is a first step to make the tools that support the well established ExternE methodology applicable also in other regions of the world. Compared to the European version, the implementation of *EcoSense* Brazil/Latin America Version 1.0 led to a major revision of the underlying database system (e.g. adaptation of the basic grid system, compilation of data relevant for Brazil/Latin America), while the calculation procedure is similar to the European version, and thus represents the ExternE methodology. However, due to the limited availability of data, and also the limited resources available for the implementation, *EcoSense* Brazil/Latin America Version 1.0 does not completely cover the full functionality of the European version. The present version provides data for Brazil in a rather high spatial resolution, while for other countries only national average data are available.

The development of *EcoSense* Brazil/Latin America was supported by the International Atomic Energy Agency (IAEA) with the objective of linking the assessment of environmental impacts and external costs from power generation to the DECADES modeling framework developed by the IAEA.

1.1 Structure of the *EcoSense* system

Figure 1-1 shows the general structure of the *EcoSense* system. The main modules are

- a database system comprising several sub-modules,
- air transport models completely integrated into the system,
- impact assessment modules, and
- tools for the evaluation and presentation of results.

From a user's perspective, the structure of the system appears to be quite different from the technical structure (see Figure 1-2). An important feature of the system design was the strict separation between the database module and the air transport modeling/impact assessment modules in order to guarantee consistency among the various levels of data (input data, intermediate results, final results). If for instance the user modifies the SO_2-emission factor of a facility specified in the reference technology database, the system automatically deletes all related intermediate (e.g. results from air transport modeling) and final results (e.g. physical impacts) from the database.

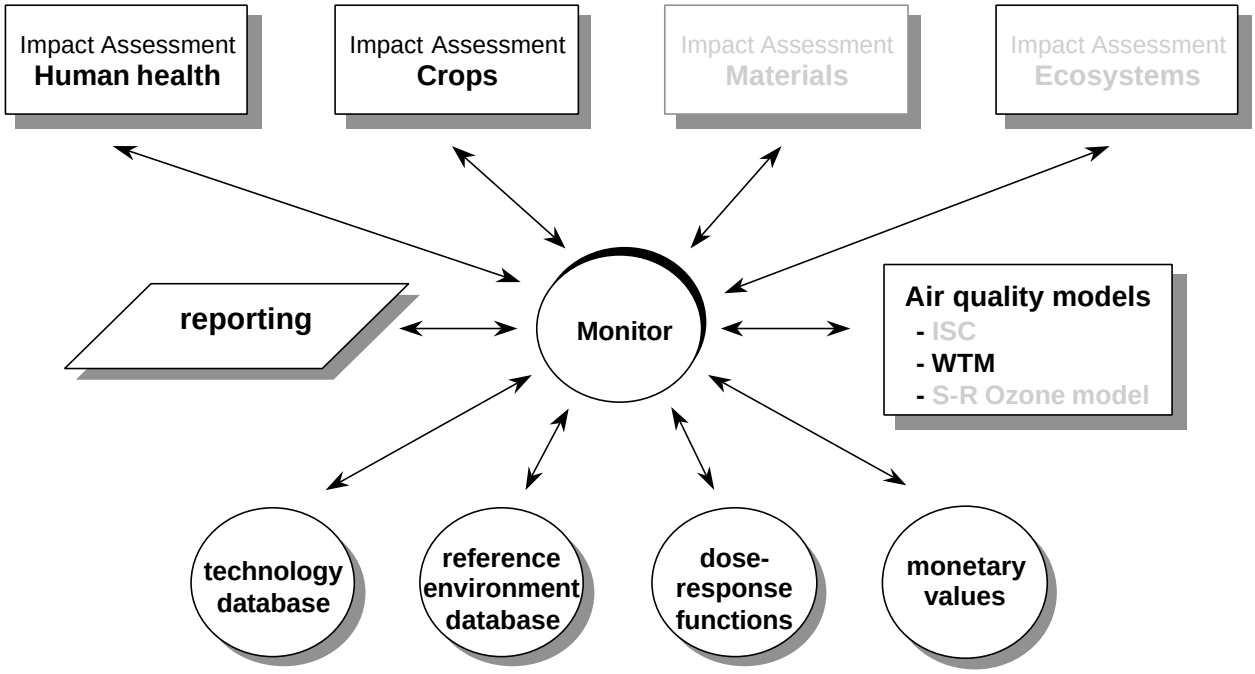


Figure 1-1 Modular structure of the *EcoSense* model (items printed in gray are only available in the European version of *EcoSense*)

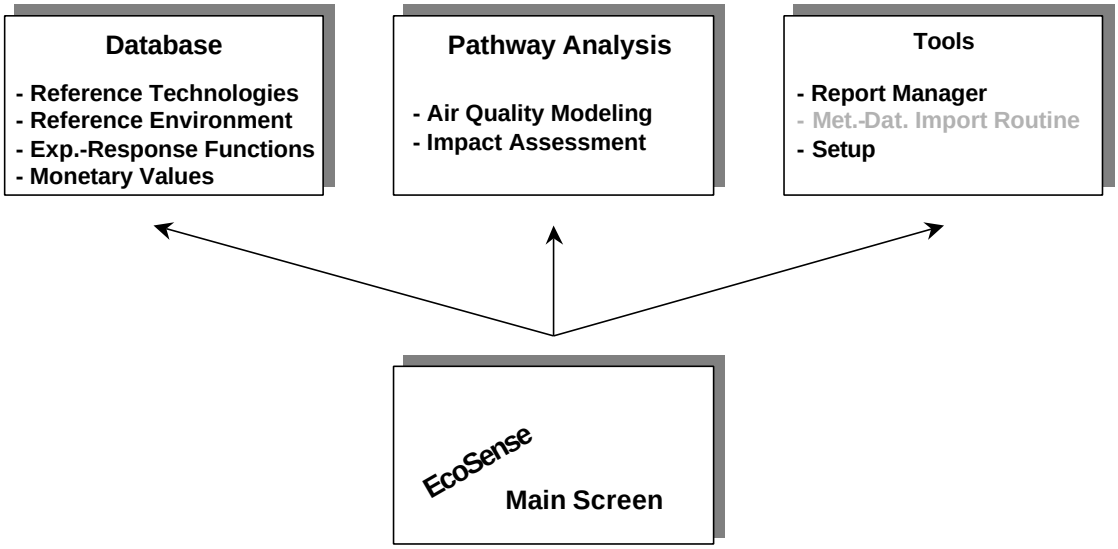


Figure 1-2 The *EcoSense* modules from a user's perspective

1.2 Software used

The following software has been used for the implementation of the *EcoSense* system:

- Microsoft Visual C++ 1.52 for Windows
- Borland Paradox
- Borland Paradox Engine

The use of a high level programming language in combination with a relational database system seems to be an appropriate technical solution for processing and managing large amounts of data required for impact assessment. The Paradox Engine organizes the transfer of data between the database tables and the C-Program.

1.3 Air quality modeling

The *Windrose Trajectory Model (WTM)* included in the *EcoSense* package is a user-configurable trajectory model based on the windrose approach of the Harwell Trajectory Model developed at Harwell Laboratory, UK. For current applications, the WTM is configured to resemble the atmospheric chemistry of the Harwell Trajectory Model, other mechanisms can be adopted as well.

1.4 Reference Environment Database

The reference environment database provides an emission inventory, receptor data and meteorological data on administrative units (except of meteorological data) to facilitate the user's access to the data, and on a regular grid system (gridded data are used as an input for air quality modeling and impact assessment). The system automatically organizes the transfer of data between administrative units and the grid system. The grid system is based on geographical longitude and latitude with a gridcell size of 0.5^o x 0.5^o. The modeling domain covers an area from 33.5^o West to 96° West, and 42° South to 12° North.

In the Version 1.0 of *EcoSense* Brazil/Latin America, receptor data are available for population, and the production of various crop types. The database provides meteorological data (wind speed, wind direction, precipitation) which are required by the Windrose Trajectory Model.

Table 1-1 Reference environment data included in the *EcoSense* database

	Source
Receptor distribution	
Population	
Production of barley, potatoes, sugar beets, wheat	FAO
Meteorological data	
Wind speed	US NCAR
Wind direction	US NCAR
Precipitation	Global Precipitation Climatology Centre (GPCC)
Emissions	
SO_2, NO_x, NH_3	Emission Database for Global Atmospheric Research (EDGAR)

1.5 Structure of the Manual

The *EcoSense* User's Manual does not provide any information on methodological aspects. For a full discussion of the methodological framework the reader should refer to

> *European Commission, DG XII, Science, Research and Development, JOULE. ExternE - Externalities of Energy. Volume 2 Methodology, EUR 16521, 1995*
>
> *and*
>
> *European Commission, DG XII, Science, Research and Development, JOULE. ExternE Externalities of Energy., Volume 7: Methodology 1998 update, EUR 19083, 1999.*

A comprehensive set of reports produced within the ExternE project is available at the ExternE homepage: http://ExternE.jrc.es/

The following sections give a description of how to use the *EcoSense* system, following the logical way of doing a complete impact assessment procedure, i. e.

- installation,
- specification of a power plant/emission scenario,
- defining exposure response functions,
- assigning monetary values to physical impact categories,
- air transport modeling,
- impact assessment, and
- evaluation of results.

For a standard application, in which the user relies on predefined exposure-response functions and monetary values, the sections 4.1 (Emission database), 5 (Pathway Analysis), and 6 (Report Manger) are the most relevant ones.

2 INSTALLATION

2.1 Hardware requirement

EcoSense runs on an IBM-compatible PC with a 486 processor (or higher) and with 32 bit MS-Windows. 8 MB RAM are required, and to install and run the system you should have >85 MB free on your hard disk.

2.2 Installation

To install *EcoSense* Brazil/Latin America 1.0, insert the *EcoSense* CD into your CD-ROM drive, and start `ECOB1INS.EXE` from Windows. The installation program asks for a directory on your hard disk where *EcoSense* will be installed. Enter a directory path and click the "Unzip" button. The installation program copies all files and tables necessary to run *EcoSense* except CTL3DV2.DLL. If CTL3DV2.DLL is not yet installed on your system, copy the file CTL3DV2.DLL to your Windows System directory where several other .DLL files may be located.

3 THE *ECOSENSE* MAIN SCREEN

After starting the *EcoSense* system, the *EcoSense* main screen (further referred to as the main screen) appears. You start any activity from the main screen's menu. The menu structure is as follows:

- *System*
  - *Pathway Analysis* — Start your impact pathway analysis (including air transport modeling and impact assessment). Note that you should have specified a power plant or an emission scenario before in the database module.
  - *Database*
    - *Emission Database*
      - *Reference Technology Database*
        - *New data* — Define a new power plant
        - *Edit data*: — Edit data of a previously defined power plant
      - *Emission Scenario Manager* — Define a new or edit an existing emission scenario.
    - *Reference Environment Database* — Edit receptor data (based on administrative units).
    - *Exposure Response Functions*
      - *Crops* — Define/edit an exposure response function
      - *Human Health* — Define/edit an exposure response function
    - *Monetary Values* — Assign monetary values to impact categories
  - *Exit* — Close the *EcoSense* System
- *Tools*
  - *Report Manger* — Generate a report of the results
- *Setup*
  - *Reference Technology Database*
    - *Tech. Data Min/Max* — Define minimum and maximum values for the input controller
  - *Reference Environment Database*
    - *Risk Group Fractions* — Specify the fraction of specific risk groups within the total population
  - *Currency*
    - *Exchange Rates* — Specify exchange rates
    - *Consumer Price Index* — Specify consumer price index

4 THE DATABASE INTERFACE

4.1 The Reference Technology Database

Open the Reference Technology database to define a new reference facility. Select the items <System> <Database> <Reference Technology Database> <New data> from the main screen's menu.

The purpose of the first dialogue (Figure 4-1) is to specify some general characteristics of the reference facility. Use the mouse or the tab/shift-tab key to move around in the window.

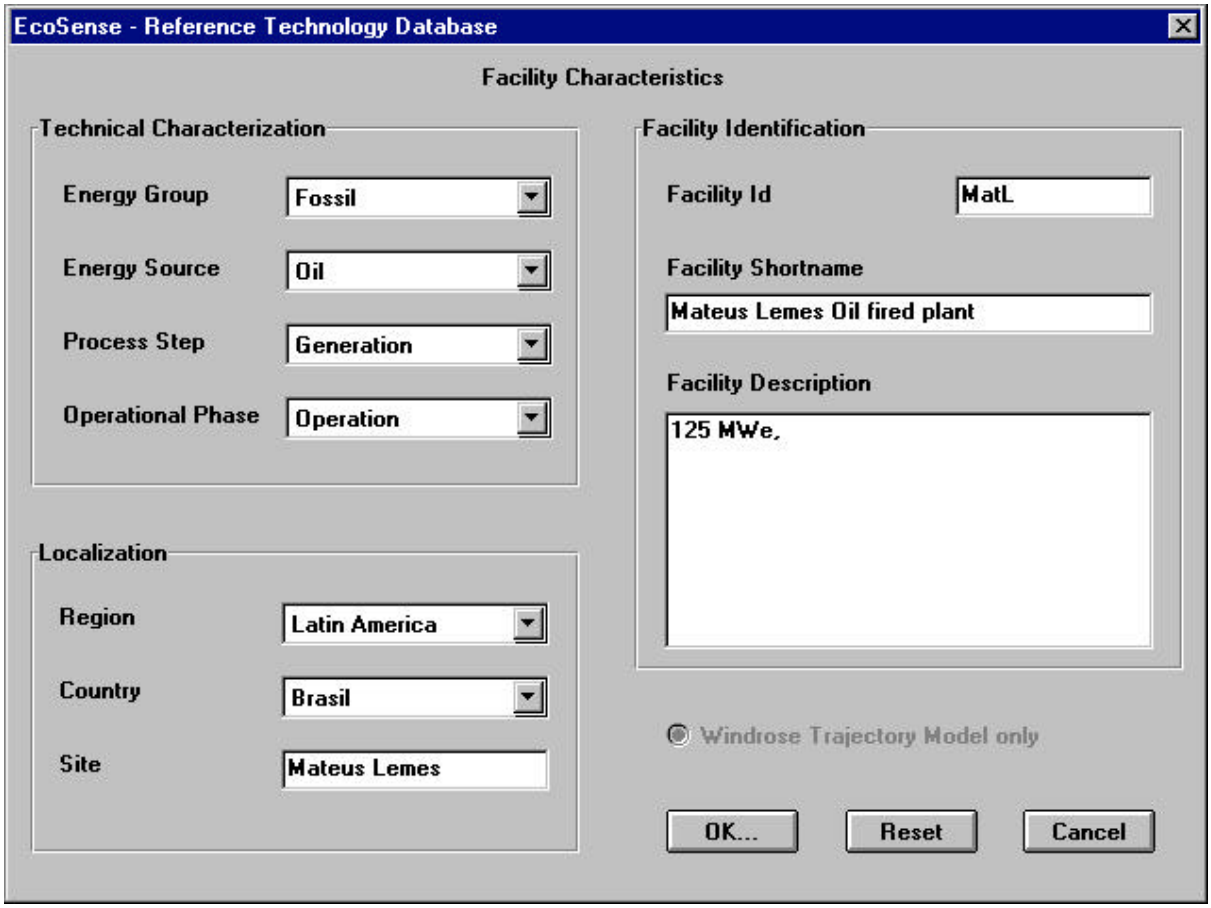


Figure 4-1 Specification of a facility's general characteristics

Technical Characterization

Specify the energy group, energy source, process step, operational phase and mode of the facility by selecting one of the options offered in the list boxes.

Localization

Select the country from the Country List-Box, and write the facility's site into the *Site*-Edit-field.

Facility Identification

Enter an alpha-numeric facility-identification flag (maximum 4 characters) into the *Facility Id* edit-field. Although the program needs the facility-id for internal use only, some of the temporary files use the facility-id as filename, so that a descriptive filename is helpful. The program ensures that the Id is unique.

Write an alpha-numeric short-name of the facility (maximum 32 characters) into the *Facility Shortname* edit-field. The short name should be descriptive, it is used in several other screens, mainly for the identification and selection of the facility. The program ensures that the facility shortname is unique.

For the purpose of documentation, you might add (optional) a brief description of the facility's main characteristics (maximum 255 characters).

After clicking on the *OK* button, the dialogue with the technical data sheet shown in Figure 4-2 appears. Fill in all the technical data you are asked for. Use the mouse or the tab/shift-tab key to move around. The range of values that is accepted by the system is defined in the *EcoSense*-Setup (see section 7.1). Clicking the *OK* button, the current data are stored in the Reference Technology Database.

Note The ISC model, which currently is included only in the European Version of EcoSense, requires more data than the Windrose Trajectory Model. The data fields that are related to the ISC model only are de-activated in the current version.

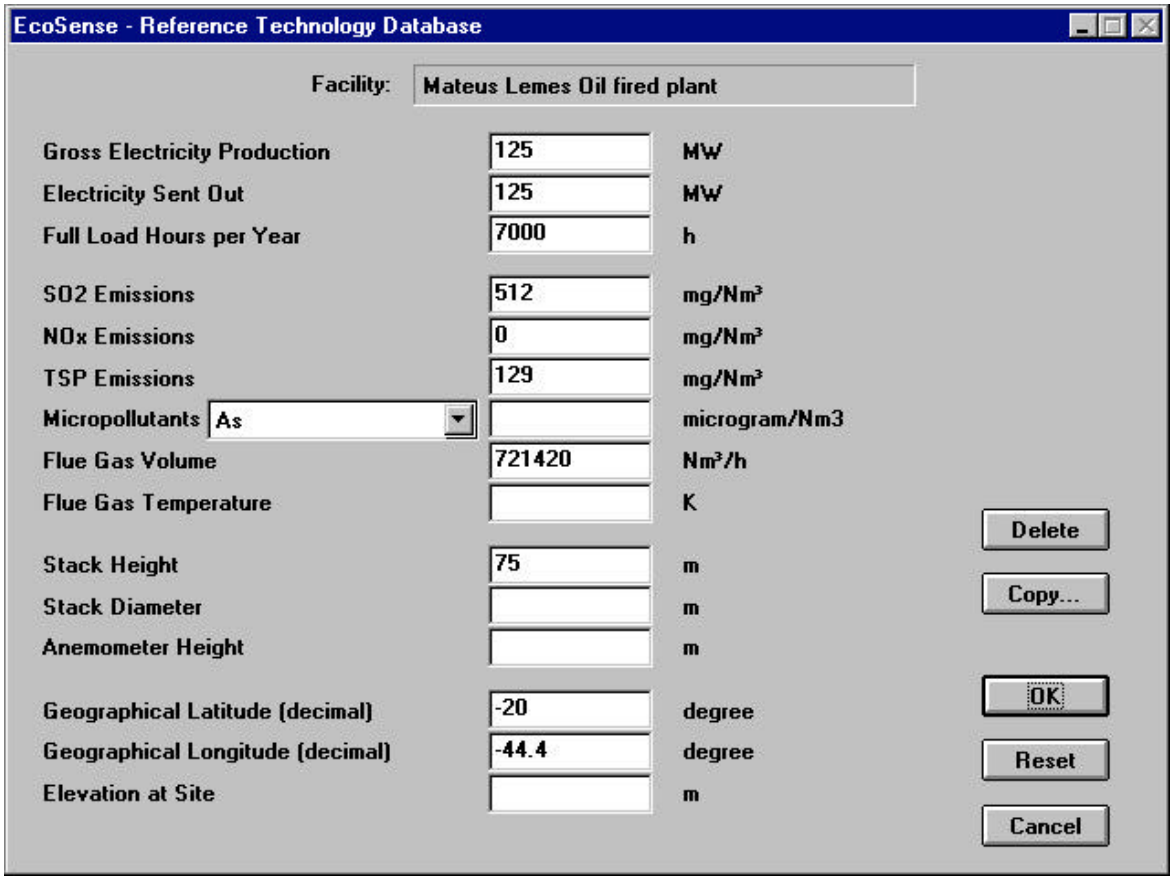


Figure 4-2 Reference Technology Database interface

To edit data of a previously specified facility select the items <System> <Database> <Reference Technology Database> <Edit Data> from the main screen's menu. Select the facility that you want to modify from the *Facility* list-box. After the selection of a facility, all edit-fields are filled with the current values. Use the mouse or the tab key to select the value you want to modify. After editing this value, use the mouse or the tab key to go to the next field, thus confirming the modification. After clicking the *OK* button, the new data will be stored in the database, and all intermediate and final results that depend on the previously modified value are deleted (after confirmation from the user) in the database system to ensure consistency between the technical data and the results. Click the *Delete* button to remove all data (technical data as well as all results) related to the selected facility from the database.

In the case you want to perform a sensitivity analysis and change specific parameters without loosing all the related results, you can copy the technical data of the selected facility to a new facility and then modify the technical characteristics of the new facility. After clicking the *Copy* button, the dialogue shown in Figure 4-3 pops up. The user is asked for the *Facility Id*,

Facility Shortname and *Facility Description* of the new power plant. After clicking the *OK* button, the previous screen for editing technical data appears again, showing the same set of technical data now for the new facility, which can be modified without loosing any results.

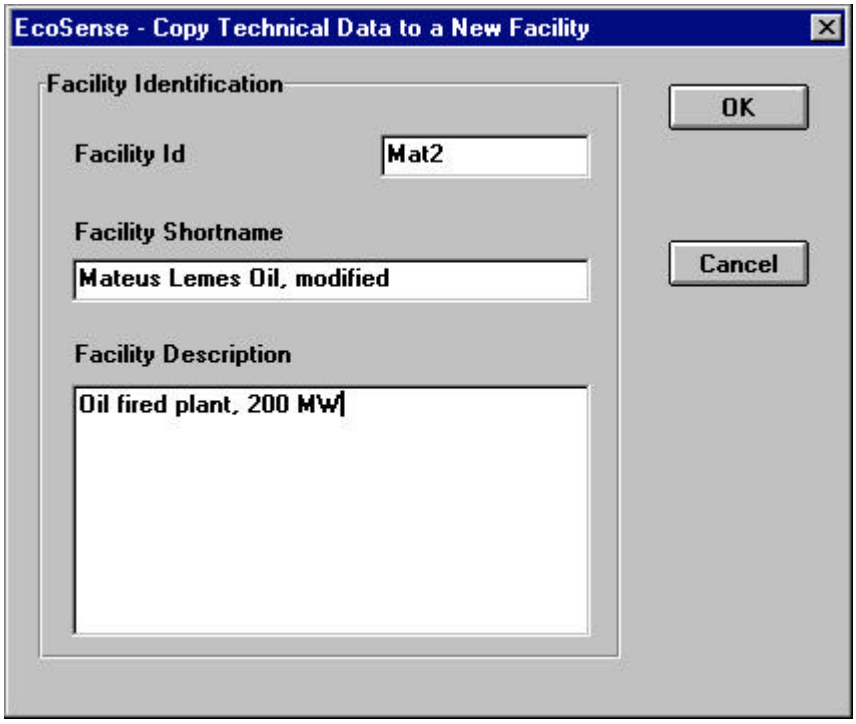


Figure 4-3 Copy technical data to a new facility

4.2 The Emission Scenario Manager

The Emission Scenario Manager is a tool to set up new emission inventories to be used as an input to air quality modeling and impact assessment. The starting point for new emission scenarios is the so called 'BRAZIL 90 Reference (EDGAR)' inventory, which was derived from the world wide emission inventory provided by the Emission Database for Global Atmospheric Research (EDGAR) for the year 1990. The system provides different 'template scenarios' that are based on the 'BRAZIL 90 Reference (EDGAR)' inventory, and which should be used to create new emission scenarios. The different template scenarios provide emission data on different levels of aggregation with respect to administrative units and industry sectors.

Based on the data format used in the EDGAR database, emission data are available according to the following categorization of source sectors:

Table 4-1 Categorization of source sectors

Industry Sector		
Level 1	Level2	
1		Industry (excluding coke ovens, refineries, etc.)
2		Power generation (public and autoproduction; including cogeneration)
3		Other transformation sectors (refineries, coke ovens, gas works)
4		Residentials, commercials and other sectors
5		Transport (including international shipping)
5	1	Road
5	4	Rail, inland shipping, other/non-specified (land non-road)
5	8	International shipping
10		Land use and waste treatment
10	1	Agriculture
10	2	Animals (ruminant/waste)
10	3	Biomass burning
10	4	Waste treatment
11		Natural sources
11	1	Natural soils
11	4	Oceans
11	6	Wild animals
11	7	Human population

The system currently supports three different levels of administrative units for Brazil (country, state, municipal), while for all other countries only national average data are available.

4.2.1 Create a new emission scenario

Start the Emission Scenario Manager by selecting <Database><Emission Scenario Manager> from the menu of the main screen. The 'Edit Scenario' dialogue shown in Figure 4-1 appears. Select one of the template emission inventories from the *Scenario name* list box.

Note The computing time for the transformation of emission data from administrative units to the regular grid increases by using higher levels of sectoral/spatial resolution. It is therefore recommended to always use the highest reasonable aggregation level.

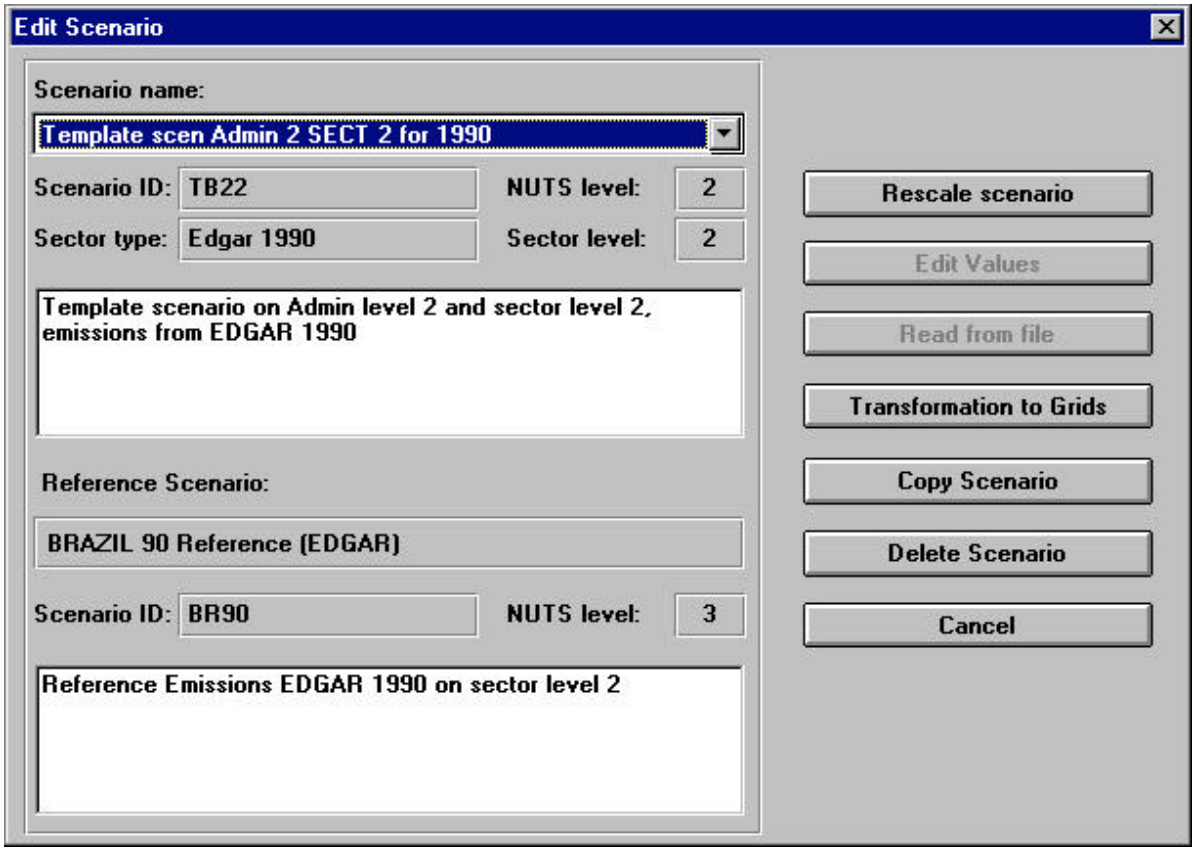


Figure 4-1 The *Edit Scenario* dialogue

After selecting one of the template inventories, click the *Copy Scenario* button to copy the emission data from the template inventory to a new scenario. The dialogue shown in Figure 4-2 appears, asking the user for the scenario identification code (maximum 4 characters) in the *New Scenario ID* edit field, a scenario name in the *New Scenario Name* edit field, and (optional) a brief description of the scenario in the *Comment* edit field. After clicking the *OK* button, the previously selected template emission inventory is stored under the new scenario name in the database. Go back to the *Edit Scenario* dialogue by clicking on the *Exit* button, select the new defined scenario by clicking on the new scenario name in the *Scenario name* list box, and then click the *Rescale Scenario* button. Now the emission data for the new emission scenario can be specified in the 'Rescale Scenario' dialogue (Figure 4-3).

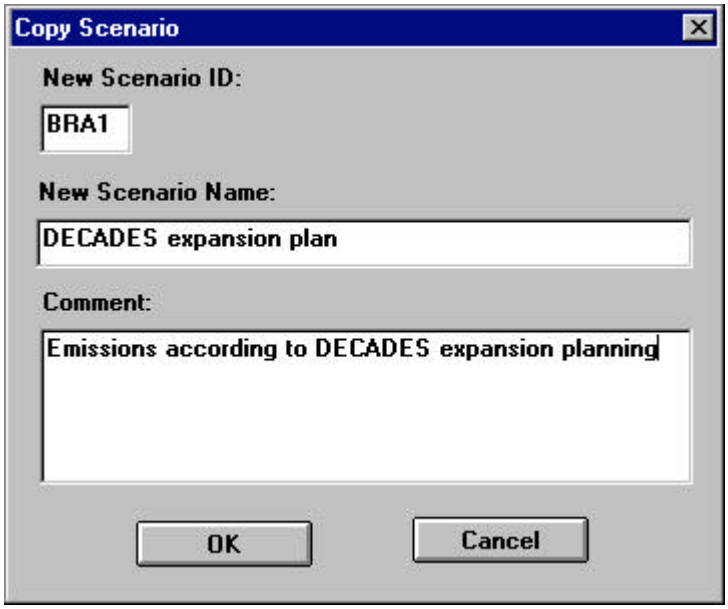
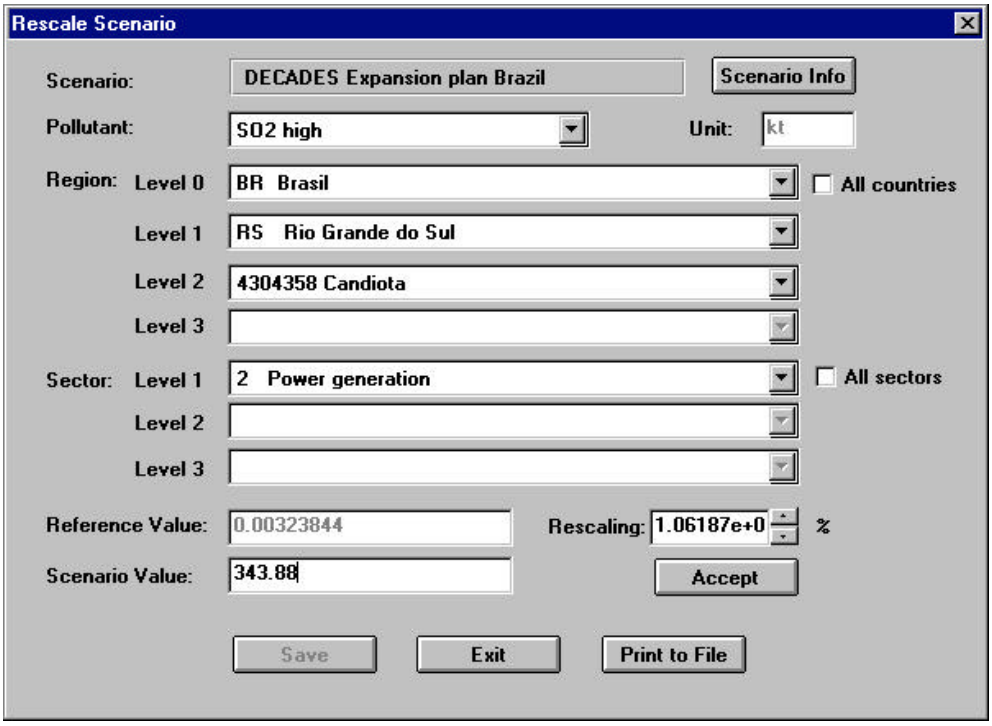


Figure 4-2 Specification of the new scenario name

In the *Rescale Scenario* dialogue, select the pollutant to be modified from the *Pollutant* list box. The system differs between 'high' emission sources (stack height > 100 m) and 'low' emission sources (stack height < 100 m), as emissions from 'low' and 'high' stacks are treated differently in the Windrose Trajectory Model.



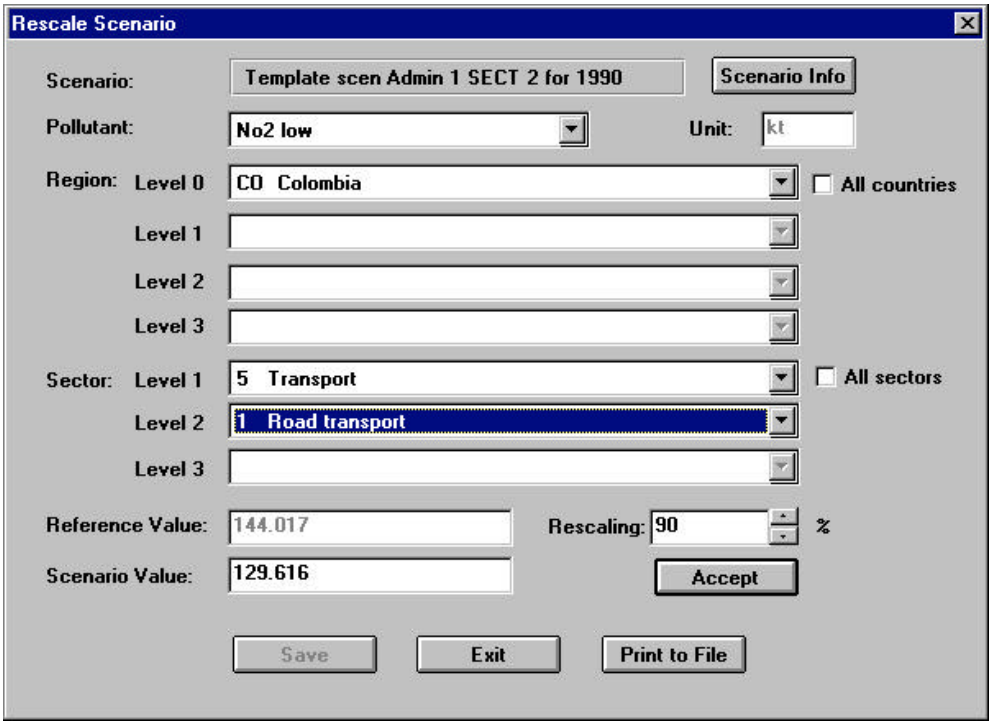


Figure 4-3 Definition of new emission scenarios. Example 1: Additional SO_2-emissions in the municipal of Candiota, Rio Grande do Sul, Brazil, due to new power capacity. Example 2: Reduction of NO_x-emissions from road transport in Colombia by 10%.

The user can now successively select the administrative units (*Region* list boxes) and the source sectors (*Sector* list boxes) to be modified. The number in the *Reference Value* text field gives the annual emissions from the selected region/sector combination in the original 'BRAZIL 90 Reference (EDGAR)'. To change this value, the user can either write a new absolute number into the *Scenario Value* edit field, or use the up/down buttons of the *Rescaling* field to specify the new amount of annual emissions as a given percentage of the *Reference Value*. After confirming the new value by clicking on the *Accept* button, the user might select further region/sector combinations to modify emission data for the same pollutant. Before selecting another pollutant in the *Pollutant* list box, click on the *Save* button to write the modified emission data to the database. After saving data for one pollutant, the user might modify emission data for other pollutants within the same scenario. The definition of a new emission scenario is finished by clicking the *Exit* button, the system goes back to the *Edit Scenario* dialogue (Figure 4-1) dialogue.

Before using the new emission scenario as an input to air quality modeling and subsequent impact assessment, the new emission data have to be transferred from the administrative units to the regular grid system. Start the transformation procedure by selecting the scenario in the *Scenario name* list box, and then click the *Transformation to Grids* button. Note that the transformation is a complex task which needs some computing time!

A scenario can be deleted by selecting it from the *Scenario name* list box, and then click on the *Delete Scenario* button. The system deletes several database tables related to the selected scenario from the database.

Return to the main menu by clicking on the *Cancel* button.

Note The EDGAR database does not provide any emission data for particles. To allow the re-scaling of particle emissions (which is not possible for 'zero'-emissions), the 'low' and 'high' particle emissions in each country are set to 1E-18.

4.3 The Reference Environment Database

The Reference Environment Database interface supports the display and editing of receptor data according to administrative units. The module organises the transfer of data between administrative units and the grid system.

Select the items <System> <Database> <Reference Environment Database> <Edit data> from the main screen's menu. In the dialog box shown in Figure 4-1, select the receptor to be edited from the *Receptor*-list box. After selecting a receptor, a list of all 'NUTS 0' administrative units (countries) appears in the *NUTS 0*-list box. Select the adminstrative unit you want to edit by stepwise clicking through the *NUTS 0*, *NUTS 1*, and *NUTS 2* - list boxes. After confirming the selection by clicking the *OK*-button, the dialogue shown in Figure 4-2 appears, which –as far as applicable - contains a list of subregions of the region selected in the previous dialog box. In this dialog you can edit the numerical value for each subregion.

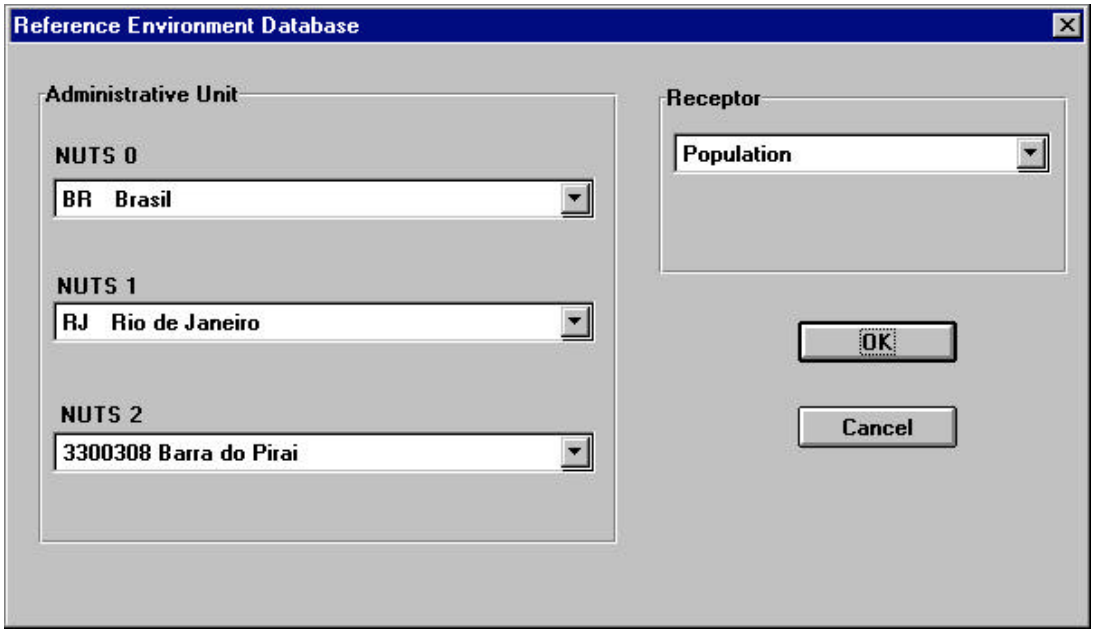


Figure 4-1 Reference Environment Database Dialog box 1.

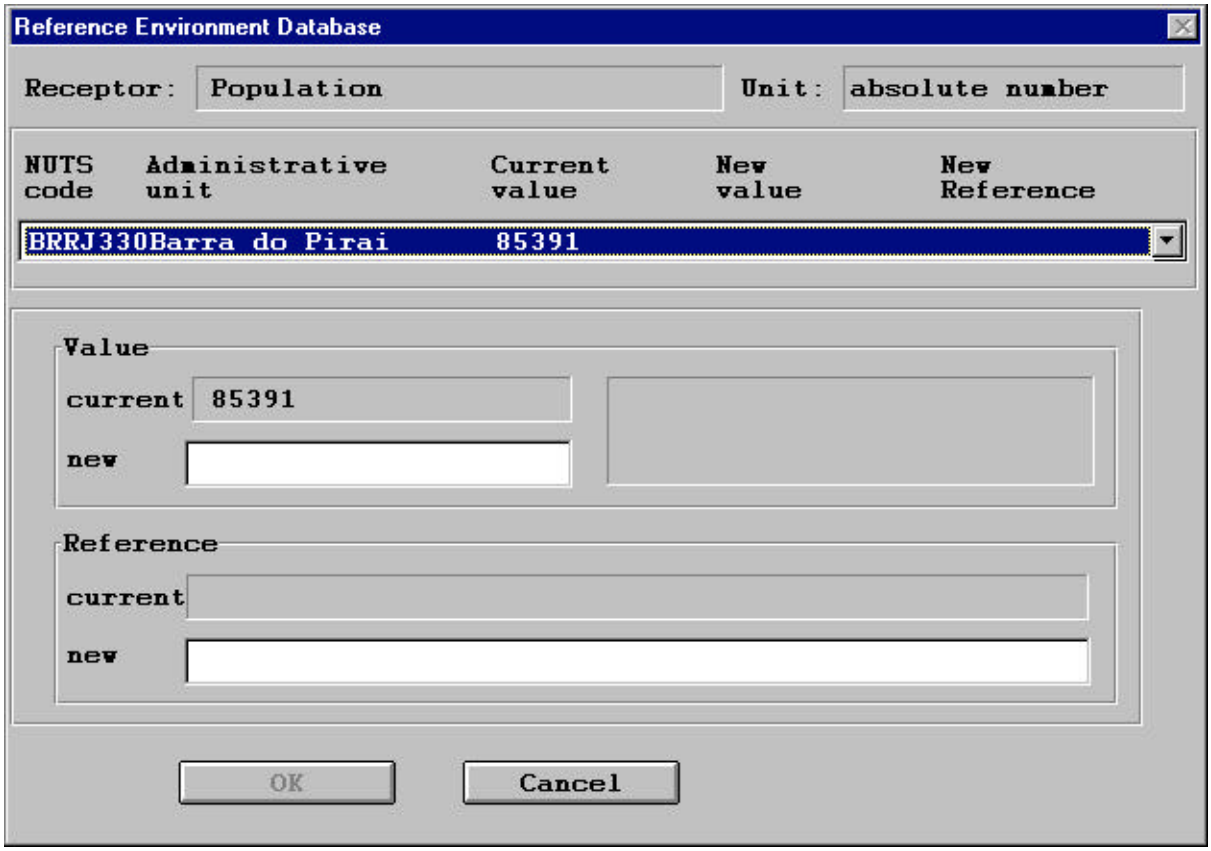


Figure 4-2 Reference Environment Database Dialog box 2 (Edit dialog).

The lists box shows the NUTS code, the name of the administrative unit and the current value for the selected receptor. In the column „Current value“ one of the following entries may be displayed:

Current value	Meaning
(a number)	A value exists already in the database for exactly this administrative unit
..	A value exists in the region covering all administrative units in the list. In this case changes are accepted only if you edit **all** entries in order to keep the coverage of the region complete. The value of the covering region will be deleted then.
- - >	Values exist in smaller subregions of the administrative unit. If you enter a new value for this line and push OK, all entries in the subregions subdividing this administrative unit will be deleted.
(empty)	No value was found, the current value is assumed to be zero.

Select the administrative unit you wish to edit and enter a new value and a new reference string into the edit boxes below. After clicking the *OK*- button, all changes are stored in the database and the input is transformed to the grid system. The calculation of the grid transformation may take some time.

Note You can edit values on any NUTS level you want. But the way down to smaller regions must be taken step by step. For example, if the current database has one entry on NUTS level 0 (i.e. one value for the whole of the country) you cannot enter new values for NUTS level 3 (the finest resolution). Instead, first you have to give values for NUTS level 1, then NUTS level 2, then NUTS level 3. This is because the program always expects a unique coverage for the countries.

Be careful when editing a field with the sign „- - >“. This sign indicates that values for the region exist already in subregions. If you enter a new value for this line, all entries in the subregions will be deleted.

4.4 Exposure Response Functions

4.4.1 Add a new exposure response function

To define a new exposure response function, select the items <System> <Database> <Exposure Response Function> <Human Health> (or other receptors), and <New Data> from the main menu, leading to the screen shown in Figure 4-1. Use the *Receptor sub-group* list-box, *Impact* list-box and *Pollutant* list-box to specify the receptor sub-group (e.g. children, asthmatics), the impact and the pollutant the new exposure response function refers to by clicking on one of the items in each list-box.

Use the edit-field to enter the exposure response function as a mathematical expression. The *Constant/Variables* list-box provides a list of constants and variables for which numerical values are available in the system and thus can be used to build up the exposure response function. To get some information on units etc. of the constants and variables offered in the list-box, click on the *Explain*-button after selecting on of the items in the *Constants/Variables* list-box. Items from the list-box are copied into the edit-field by clicking on the *Select*-button.

Besides of the basic mathematical operations (+,-,*,/), a set of mathematical functions listed in the *Math. Functions* list-box is supported. Click on a function in the list-box to copy it into the edit-field, and insert text between the brackets. Click the *Accept*-button to confirm the exposure response function after writing it into the edit field. The syntax of the function is checked, and in the case of syntax errors an error message appears.

Low, mid and high estimate

To take into account information on confidence intervals for calculating a possible range of results, the user can define three different functions representing a low, mid and high estimate. Click the *low*, *mid* or *high* radio-button before writing the respective function into the edit-field.

Define a threshold

To define an exposure response function with threshold (i.e. no effects at concentrations below the threshold), click the *Threshold* check-box at the bottom of the screen and enter the numerical value into the related edit-field. Note that you can define a single threshold value only for a set of related low/mid/high functions.

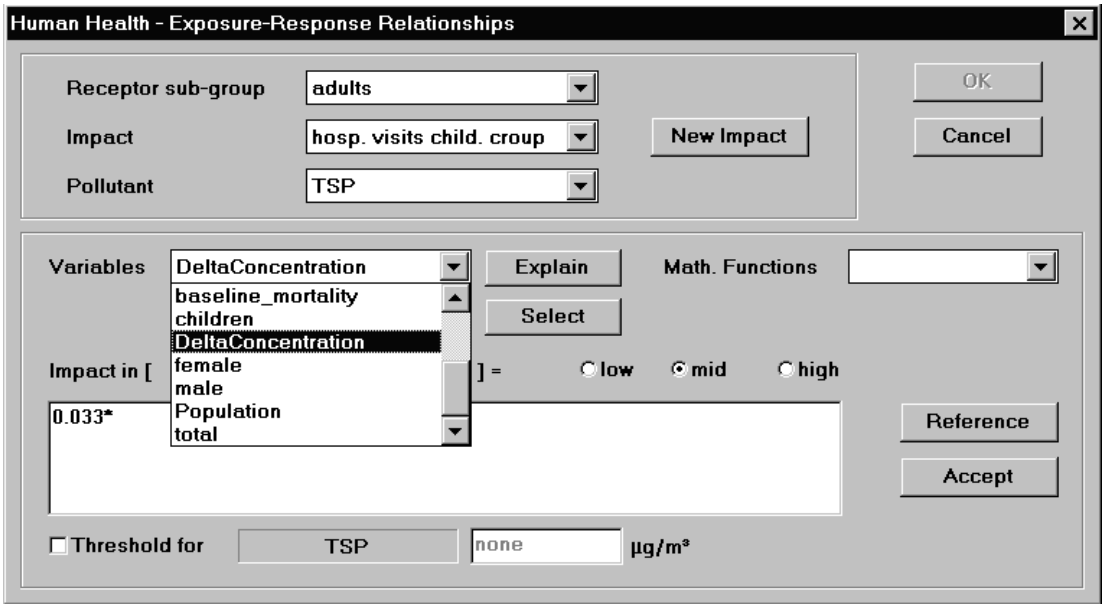


Figure 4-1 Add a new exposure response function

Note Clicking one of the low/mid/high radio buttons before you terminate the editing of a function by clicking the *Accept*-button leads to a loss of the current content of the edit-field.

The current version requires the definition of a function for the low, mid and high case. If you want to work with a single function only, save the same function as a low, mid and high function. (Use the Windows clipboard functions to copy a function: mark the expression you want to copy with the mouse (left button down), press the <Ctrl> and <Ins> keys to copy the expression into the clipboard, click the low, mid or high radio-button, click the edit field to make it active and then press the <Shft> and <Ins> keys to copy the expression from the clipboard into the edit-field.)

Reference

Click on the *Reference*-button to open the *Function Reference* dialogue (Figure 4-2). Enter the reference and comments into the respective edit-fields. Click the *OK*-button to confirm and to go back to the previous screen. Note that the reference entry is used for the identification of the exposure response function in various list-boxes in other modules of the system.

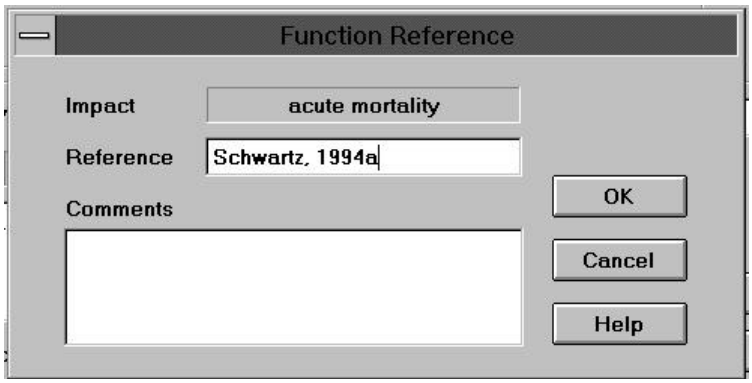


Figure 4-2 Specification of a reference related to an exposure-response function

Define a new impact

In the case the exposure response function to add is related to a physical impact that is not yet included in the *Impact* list-box, click the *New Impact* button to define a new impact in the *New Impact* dialogue (Figure 4-3). Enter the type of impact, the unit to measure the impact and comments into the respective edit-fields. Click the *OK*-button to confirm and to go back to the previous screen.

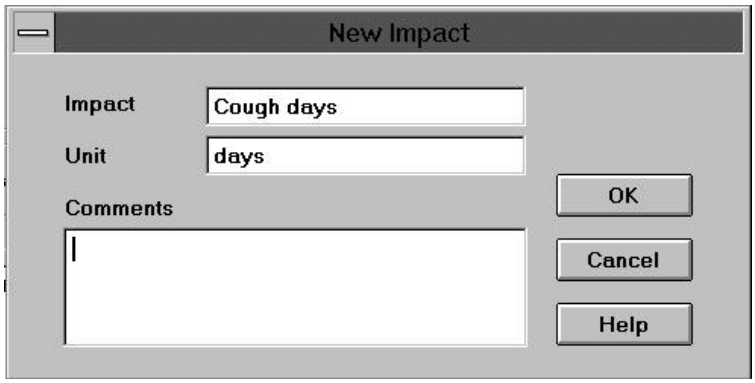


Figure 4-3 Define a new impact

4.4.2 Edit existing exposure response functions

Select the items <System> <Database> <Exposure Response Functions> <Human Health> (or other receptors) and <Edit Data> from the main menu to modify previously defined exposure response functions (Figure 4-1). After selecting one of the items in the *Function* list-box by clicking on it, the corresponding receptor sub-group, impact, and pollutant is displayed in the respective text-fields, and the mathematical function is shown in the edit-

field. Delete the function by clicking on the *Delete*-button, or edit the mathematical expression in the edit field. Editing a function is similar to the procedure of defining a new exposure response function described above. After confirming the modifications by clicking the *OK*-button, all intermediate and final results related to the modified or deleted function are deleted from the database system.

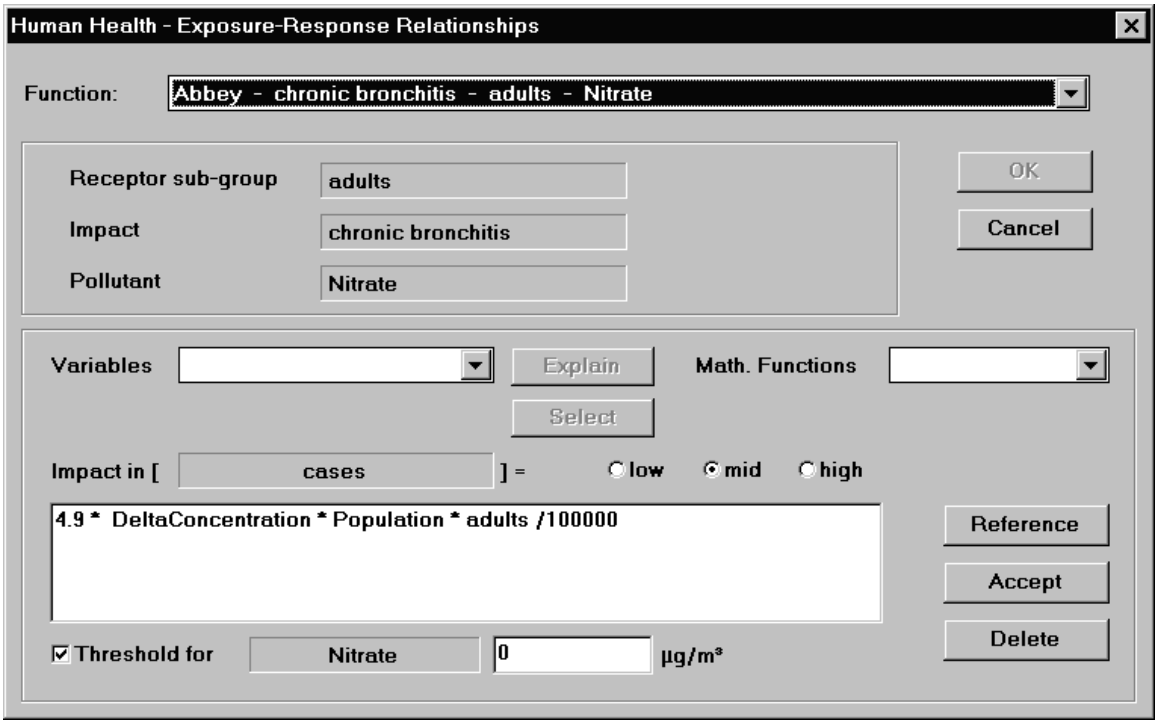


Figure 4-1 Edit a previously defined exposure-response function

4.4.3 Standard functions and Operators in *EcoSense* Formulas

You can define your own functions at the beginning of the formula. An expression may be preceded by one or more definitions like

{ funcname(parameter,...) = subst_expression }

Funcname and each parameter must not be defined yet. You cannot define a function that starts with a known name. "expe(x)" will cause an error at the `e', since "exp" is a predefined function. Any character is allowed except of "(),+*-/;" and white space. Avoid characters other than A-Z, a-z, 0-9, and _ (underscore).

Parameters are separated by commas. The list may be empty, but the surrounding parentheses are still necessary.

The subst_expression may use these parameters like variables. After the `}', all parameters become invalid. You can reuse these names for another definition. From now on up to the end of this expression you can use the function like any other function.

Examples: { invert (x) = if x=0 then 0 else 1/x } invert (max(1.5,Conc))
{ f(x)=x*x+1 } { g(x) = f(f(x))-1 } f(g(g(g(Variable))))

Note A function definition does not increase evaluation speed. This feature is implemented to increase readability.

Table 4-1: Standard functions and operators supported by *EcoSense*

Name	Description
+ - * /	Addition,Subtraction,Multiplication,Division with standard rules
^	Power. Associativity: a^b^c = (a^b)^c, a*b^c = a*(b^c)
Sqrt()	Square root
Sqr()	Square sqr(x)=x^2
Ln()	Natural logarithm, ln, is the logarithm with base exp(1) = 2.71828..
Log10()	Logarithm with base 10
Exp()	Exponential function
Relative(,)	Relative deviation from x due to y. relative(x,y) = (x-y) / y
If then else	A special function is "IF expr <|=|> expr THEN expr ELSE expr". Each expr may be another expression, including IF's. The result is the value of the expr after THEN, if the condition holds. Otherwise, the function returns the value of the expr after ELSE. Conditions other than <, =, and > are not available. Use parentheses, if you want to continue after an if-expression. For example the following construction is allowed: sqrt (if x>0 then x else -x) - 1
Min(,)	Minimum of the two arguments
Max(,)	Maximum of the two arguments
Theta()	Heaviside function. theta(x) means: if x>=0 then 1 else 0. This function can be used to include thresholds, for example „theta(TotalConcentration-0.2)*x“ yields x if TotalConcentration exceeds 0.2, otherwise the result is 0.
Range(,,)	range(x,a,b) means: if x in interval [a,b] then 1 else 0.

4.5 Monetary Values

To add or modify monetary values select the items <System> <Database> and <Monetary Values> from the main menu. Use the *Receptor* list-box, *Sub-group* list-box and *Impact* list-box in the *Impact Specification* panel to select the physical impact related to the monetary value you want to add or edit (Figure 4-1). After selection, the left-hand edit-field in the *Monetary Valuation* panel shows a list of the monetary values related to the selected impact that are currently available in the database.

Note Monetary values can be defined only for impacts for which an exposure response function has been defined before.

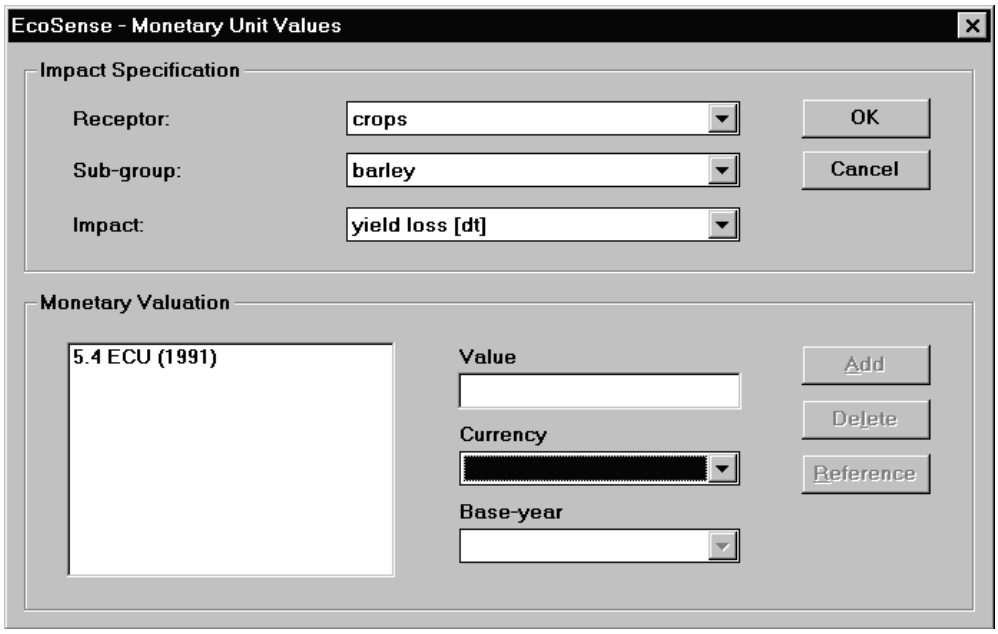


Figure 4-1 Add/edit monetary values

Add a new monetary value

To add a new monetary value, enter the numerical value into the *Value* edit-field and select the related currency and base year in the *Currency* and *Base-year* list box. After clicking the *Add*-button, the new value is added to the list of monetary values shown in the edit-field.

Click on the *Reference*- button to open the dialogue shown in Figure 4-2. Enter reference and comments into the respective edit-fields. Click the *OK*-button to confirm and to go back to the previous screen.

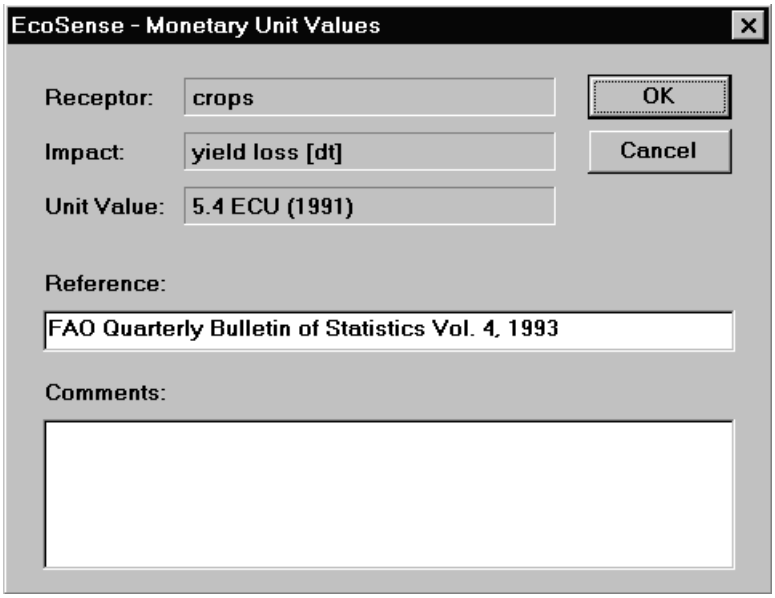


Figure 4-2 Specification of a reference related to a monetary value

Delete a monetary value

Mark the monetary value that you want to delete by clicking on it in the left-hand edit-field of the *Monetary Valuation* panel and then click on the *Delete*-button. Note that all intermediate and final results related to the deleted monetary value are deleted from the database system.

Click on the *OK* or *Cancel* button to confirm/cancel the modifications and to go back to the main menu.

5 PATHWAY ANALYSIS

After defining the reference facility, the user can now start the impact assessment procedure by selecting the items <System> <Pathway Analysis> from the main screen. Note that once you have started the impact pathway module, for the purpose of consistency, you cannot edit any of the data previously specified in the database module.

5.1 Selector

After selecting <Pathway Analysis> from the main screen, the *Selector* dialogue appears (Figure 5-1). In the Selector, the user selects the 'emission scenario' for which external costs shall be calculated, and the 'reference scenario'. The reference scenario specifies the background conditions against which the emission scenario is compared. The difference in concentration and deposition between the emission scenario and the reference scenario is the basis for the impact assessment.

Emission scenarios are defined via the interface to the emission database (see section 4.1), either by defining a single power plant (the 'scenario' is created by adding the emissions from a point source to an existing emission inventory), or by using the Emission Scenario Manager which allows to set up more complex emission scenarios. Basically, every emission scenario stored in the database can be used also as a reference scenario. (This is different from the *EcoSense* Europe Version 2.0, which uses a pre-defined default reference scenario as a background.)

Scenario panel

Choose the emission scenario to be analyzed from the *Emission Scenario* list box. The *Emission Scenario* list box shows all the emission scenarios (power plants and/or complex scenarios created with the Emission Scenario Manager) which have been defined in a previous step, and which are stored in the database.

In the *Reference Scenario* list box all emission scenarios appear for which air quality modeling has been carried out, so that the related concentration and deposition fields can be used as a reference.

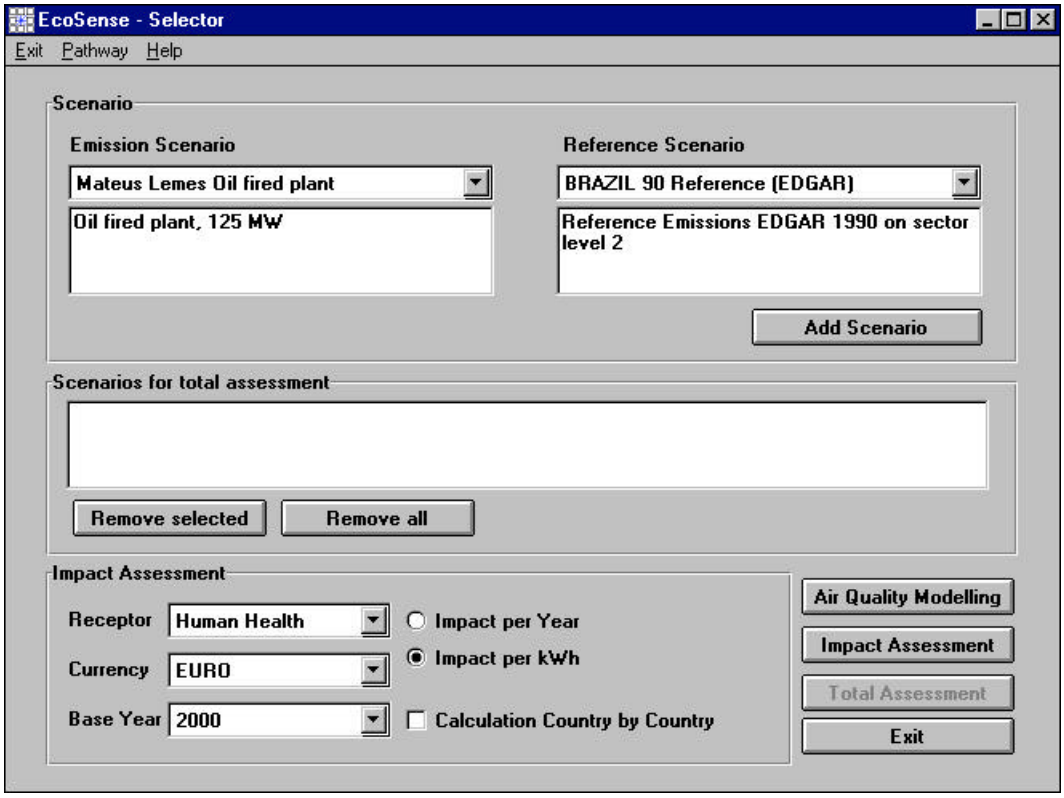


Figure 5-1 The Selector dialogue

Scenarios for total assessment panel

A selected emission scenario/reference scenario combination can be added to the list of *Scenarios for total assessment* by clicking on the *Add Scenario* button in the Emission Scenario panel. The 'total assessment' feature allows the user to carry out a full impact assessment automatically for several emission scenario/reference scenario combinations (see below). Scenarios can be removed from the list by using the *Remove selected* or *Remove all* buttons.

Impact Assessment panel

The user specifies which impacts are evaluated in the *Receptor* list box. In the current version the impact pathways related to human health and crop losses are supported. The item 'All pathways' in the list box can be used to evaluate 'all' pathways (i.e. human health and crops) automatically in the total assessment mode (see below).

The currency and the related base year in which external costs will be presented are specified in the *Currency* and *Base Year* list boxes. (Ensure that exchange rate and consumer price index for the selected currency/base year combination is available in the database. If not, add relevant data to the

database by using the interface available under the <Setup><Currency> menu from the main screen (see sections 7.3 and 7.4).

According to the status of the *Impact per Year* and *Impact per kWh* radio buttons, impacts and external costs are calculated as impacts per year, or as impacts per kWh (The calculation of impacts per kWh are not possible for emission scenarios defined with the Emission Scenario Manager.)

If the *Calculation Country by Country* check box is checked, the system calculates the impacts in each individual country within the modeling domain in addition to the total impacts. Note that this mode significantly increases the space requirement for writing results to the hard disk.

Air Quality Modelling button

Clicking on the *Air Quality Modelling* button starts the Windrose Trajectory Model for the emission scenario selected in the *Emission Scenario* list box. (It is not possible to automatically start consecutive WTM runs for several scenarios.)

Impact Assessment button

Clicking on the *Impact Assessment* button starts the selected impact assessment module (see section 5.3). In the impact assessment module, the user can evaluate individual dose-response functions, has access to intermediate results and maps showing e.g. concentration fields. The *Impact Assessment* button is de-activated if the 'All Pathways' is selected in the *Receptor* list box.

Total Assessment button

The *Total Assessment* button is active only if

- at least one emission scenario/reference scenario combination is added to the list of scenarios for total assessment, and
- 'All Pathways' is selected in the *Receptor* list box.

In the 'Total Assessment' mode, the impact assessment modules (human health and crops) consecutively run in the background for all emission scenario/reference scenario combinations previously added to the list of *Scenarios for total assessment*. The system automatically calculates impacts and external costs for *all* dose-response functions and monetary values available in the database, and writes results into the database. The 'Total Assessment' mode allows to evaluate several scenarios without any actions required from the user.

5.2 Atmospheric Modeling

In contrast to the European version of *EcoSense*, the version 1.0 of *EcoSense* Brazil/Latin America includes only the Windrose Trajectory Model for air quality modeling. As a consequence, there is no extra dialogue required to operate different air quality models in this version. The Windrose Trajectory Model and the relevant pre- and postprocessors are directly started from the 'Selector' dialogue by clicking on the *Air Quality Modelling* button (see section 5.1).

5.3 Impact Assessment Modules

In the following, only the human health impact pathway is described in detail. Other impact pathways have a similar structure.

The impact assessment module offers two different approaches:

- A step-by-step analysis for each single combination of pollutant and exposure-response relationship, with the possibility of presenting detailed intermediate results (e.g. maps showing incremental air pollution concentrations).
- A *Full Assessment Procedure* performing an automised impact assessment of selected combinations of pollutant/exposure-effect relationships.

5.3.1 Step-by-step analysis

The dialogue (Figure 5-1) is organized according to the logical structure of the impact pathway (environmental burden, air quality modeling, impact assessment, valuation) .

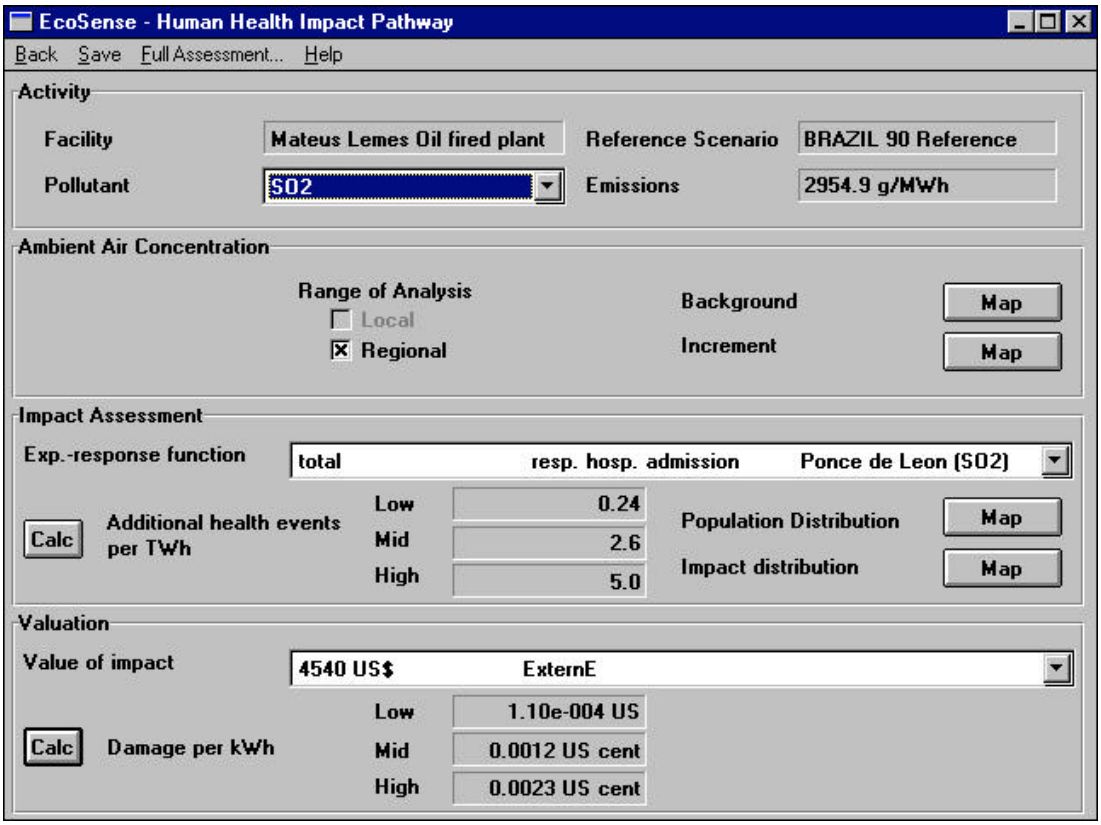


Figure 5-1 The *Human Health Impact Pathway* dialogue

Activity panel

Select the pollutant to be analyzed in the *pollutant* list-box.

Note Only pollutants, for which both exposure-response functions and air transport modeling results are available in the database are included in the list.

Ambient Air Concentration panel

The *Range of Analysis* boxes indicate whether results from air transport modeling are available on the local or/and the regional range (box checked = data available). As version 1.0 of *EcoSense* Brazil/Latin America does not include a detailed local air quality model, the 'local' check box is not active.

By clicking on one of the *map* buttons, you can display the background concentration as well as the increment in concentration of the previously selected pollutant.

Note The map buttons are only active after performing at least one impact assessment calculation (the system loads the relevant data into memory for calculation only).

No data on background concentrations for particulates are currently available in the database.

Impact Assessment panel

Select an exposure-response function from the *Exp.-response function* list box. Only functions related to the previously selected pollutant are included in the list. Click the *Calc* button to start the physical impact quantification.

Valuation panel

Select a monetary value from the list box. Only monetary values related to the impact specified by the previously selected exp.-response function are included in the list. Click the *Calc* button to start the calculation of costs.

Note After specifying the exp.-response function, you can immediately select a monetary value in the Valuation panel and then start the calculation of both physical impacts and economic damage at the same time by clicking the *Calc* button in the Valuation panel.

Use the <Save> item from the menu to save the current results to the database.

5.3.2 Full Assessment procedure

While the step-by-step analysis described above provides a high degree of transparency, it is not very comfortable to carry out a full fuel cycle evaluation. Thus, the Full Assessment procedure has been implemented, allowing a more automised analysis of impacts. Start the Full Assessment procedure by selecting the <Full Assessment> item from the menu (Figure 5-1).

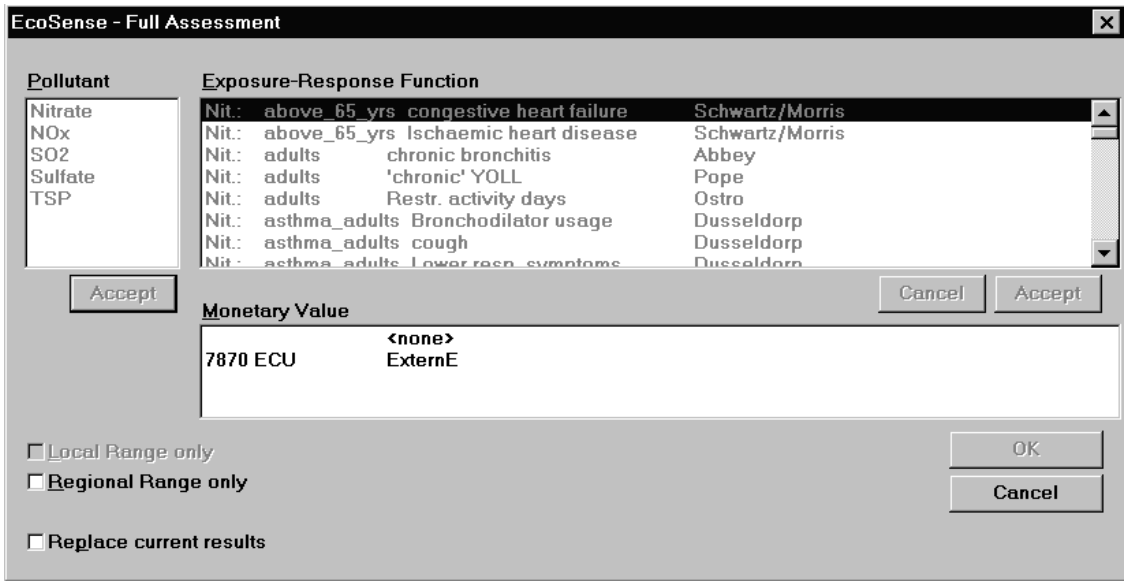


Figure 5-1 The *Full Assessment* dialogue

In the *pollutant* field a list of pollutants for which exp.-response functions and air transport modeling results are available is displayed. Select those pollutants that you wish to include in your full assessment by clicking on them with the mouse. Confirm the selection by clicking the *Accept* button.

After clicking the *Accept* button of the *pollutant* field, a list of exp.-response functions related to the selected pollutants is displayed in the *Exposure Response Function* field. Select those functions that you want to include in your full assessment by clicking on them with the mouse. Confirm the selection by clicking the *Accept* button. Note that the structure of the database system allows results to be stored only with **one** monetary value for each of the possible exposure-response functions. Thus, immediately after selecting one of the exposure-response functions, the *Monetary Value* field becomes active and you have to select one of the related monetary values.

The Full Assessment procedure automatically saves results to the database. In the case you have not checked the *Replace current results* box, you are asked for each single result before overwriting existing results from previous model runs. Click the *OK* button to start the calculation of physical impacts and economic damages.

6 THE REPORT MANAGER

EcoSense supports the evaluation of results by generating two different types of reports:

- an ASCII text file in a 'readable' format with the extension .rpt, and
- an ASCII file pre-formatted for import into spreadsheet programs like Microsoft-Excel with the extension .tab.

Select the <Tools> < Report Manger> items from the main screen's menu to start the report manager (Figure 6-1).

Note You can generate a report only if you have performed an impact pathway analysis and saved results to the database before.

Results are presented in the report according to a user-defined 'aggregation scheme'. As in most cases the user is interested in aggregated information rather than in detailed results for all impact indicators, the use of the aggregation scheme helps to present results on the level of aggregation required. The aggregation scheme defines for which impacts and impact categories aggregated results are presented in the report.

Report Specification panel

In the *Report Specification* panel the user specifies for which emission scenario a report is generated, and how results are presented. The emission scenario/reference scenario combination for which a report shall be generated is selected in the *Emission Scenario* and *Reference Scenario* list boxes. Only those scenario combinations appear in the list boxes for which results are available in the database.

The selection of an aggregation scheme in the *Aggregation Scheme* list box specifies the way how results are presented in the report. By selecting a currency and the related base year in the *Currency* and *Base-Year* list boxes, the user specifies the currency in which monetary values are reported.

To present impacts and external costs occurring within individual countries, click on the *Individual Countries* radio button, and select the countries to be included in the report from the list box. The report will present results for individual countries in addition to the total impacts/external costs. If the *All*

Countries radio button is checked, only the total impacts/external costs occurring in the whole modeling area are reported.

Note The reporting of results for individual countries is possible only if the impact assessment was carried out in the 'Calculation Country by Country' mode (see Selector, section 5.1).

As in Version 1.0 of *EcoSense* Brazil/Latin America only the Windrose Trajectory Model is included for air quality modeling, results are presented only on the 'regional' scale (which includes the 'local' impacts!), so that the separate presentation of local or global impacts is not supported.

The low, mid or high estimates of the results are included in the report if the related *Low*-, *Mid*- and *High*-Estimate check boxes are checked. The low, mid and high values refer to the respective low, mid and high estimates of the exposure-response functions (see section 4.4).

Depending on the calculation mode under which the impact assessment was carried out, results might be available for different reference units (e.g. impacts per year or impacts per kWh). In such a case the user should select one of the options to be considered in the report by checking the relevant radio button.

Options panel

The Options panel provides some further options to format the report:

- Impacts and resulting external costs are reported for every individual exposure-response function that was included in the impact assessment if the *Detailed Results* check box is checked
- A summary of aggregated results for the impact categories defined in the selected aggregation scheme is included in the report if the *Aggregation by Impact Category* check box is checked.
- A summary of aggregated results for the impact categories defined in the selected aggregation scheme is included for the individual countries selected in the *Individual Countries* list box in the report if the *Agg. Damages of Ind. Countries* check box is checked. (This check box becomes visible only if a country has been selected previously.)

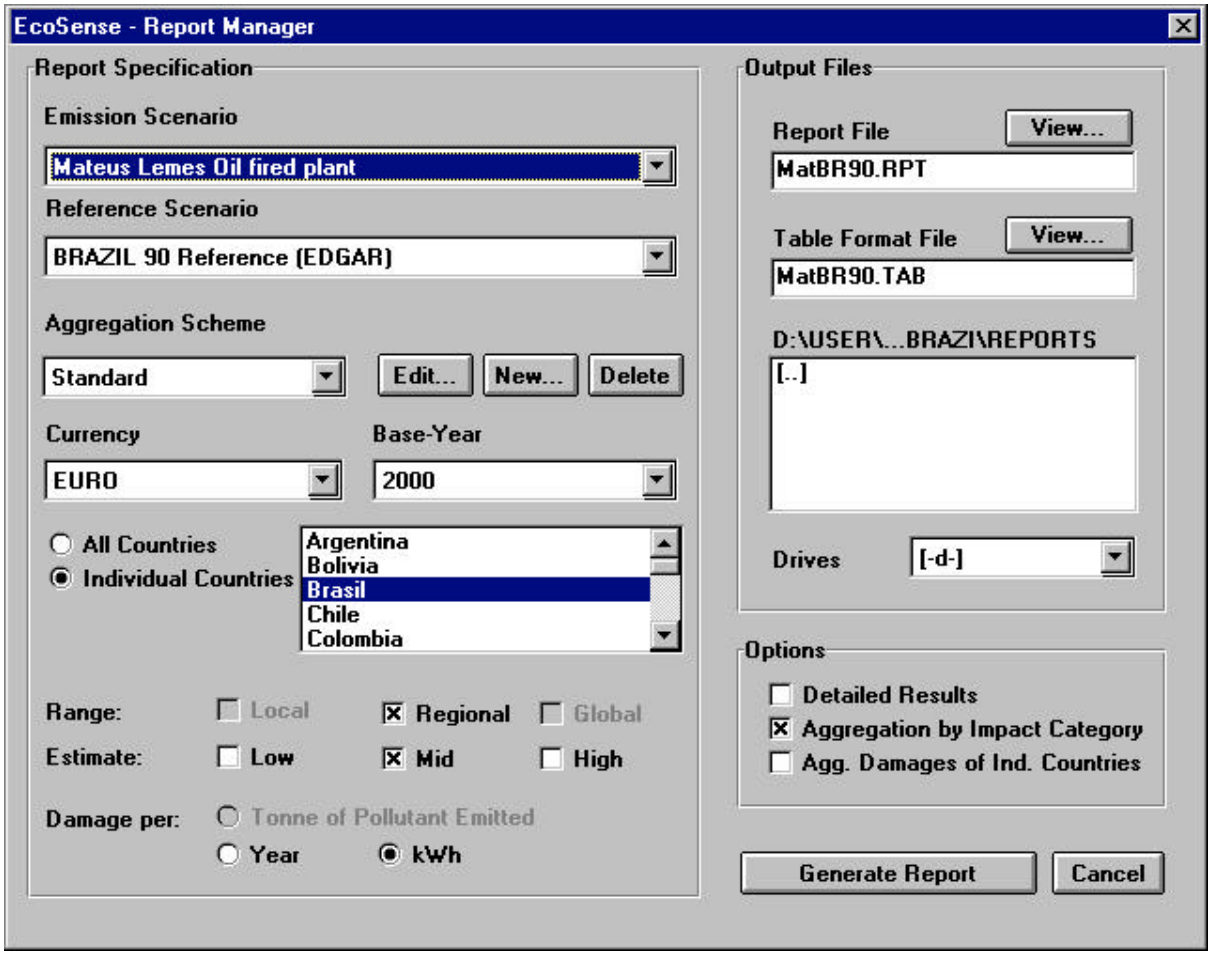


Figure 6-1 The *Report Manager* dialogue

Output Files panel

In the *Output Files* panel the user specifies the names of the report files, and the directory to which the reports are written. As a default, the system uses a combination of the (maximum 4-character) identification of the emission scenario, and the (maximum 4-character) identification of the reference scenario to build the filenames. The filenames might be modified by the user.

Use the *Directories* and *Drives* list-boxes to specify the directory to which the reports are written. The default directory is the `...\reports` directory.

Click on the *Generate Report* button to start the generation of the report. By clicking the *View* buttons, you can directly browse or print the report files after generating them.

6.1 Create and Edit an Aggregation Scheme

Click on the *New...* button in the *Report Specification* panel of the Report Manger dialogue to start the definition of a new aggregation scheme. The dialogue shown in Figure 6-1 appears. Enter a name for the new aggregation scheme, and (optional) a brief description of the scheme. To copy impact categories from an existing scheme into the new scheme check the *Copy impact categories from existing scheme* check box. This might simplify the definition of a new scheme.

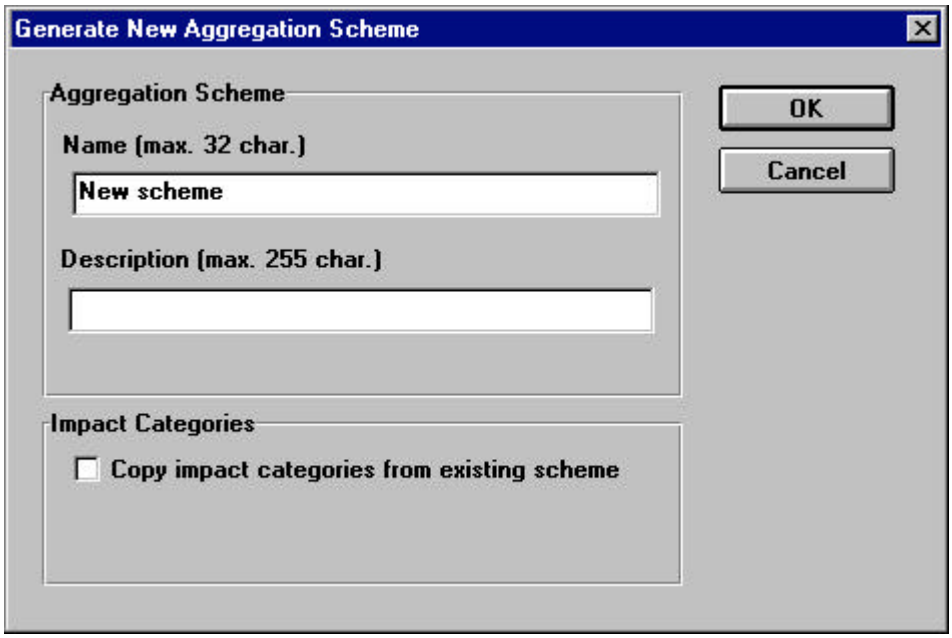


Figure 6-1: Definition of a new aggregation scheme

After clicking the *OK* button, the Aggregation Scheme Editor pops up (Figure 6-2). The list of *Available Impact Categories* on the right hand side of the dialogue shows all the impact categories that have been defined earlier and thus can be used to build up a new aggregation scheme (for the creation of a new impact category see section 6.2). Use the arrow buttons to copy impact categories to the list of *Impact Categories Included* on the left hand side of the dialogue. The impact categories that are listed under the *Impact Categories Included* are elements of the new aggregation scheme. Click on the *OK* button to confirm the selection and finish the definition of the aggregation scheme.

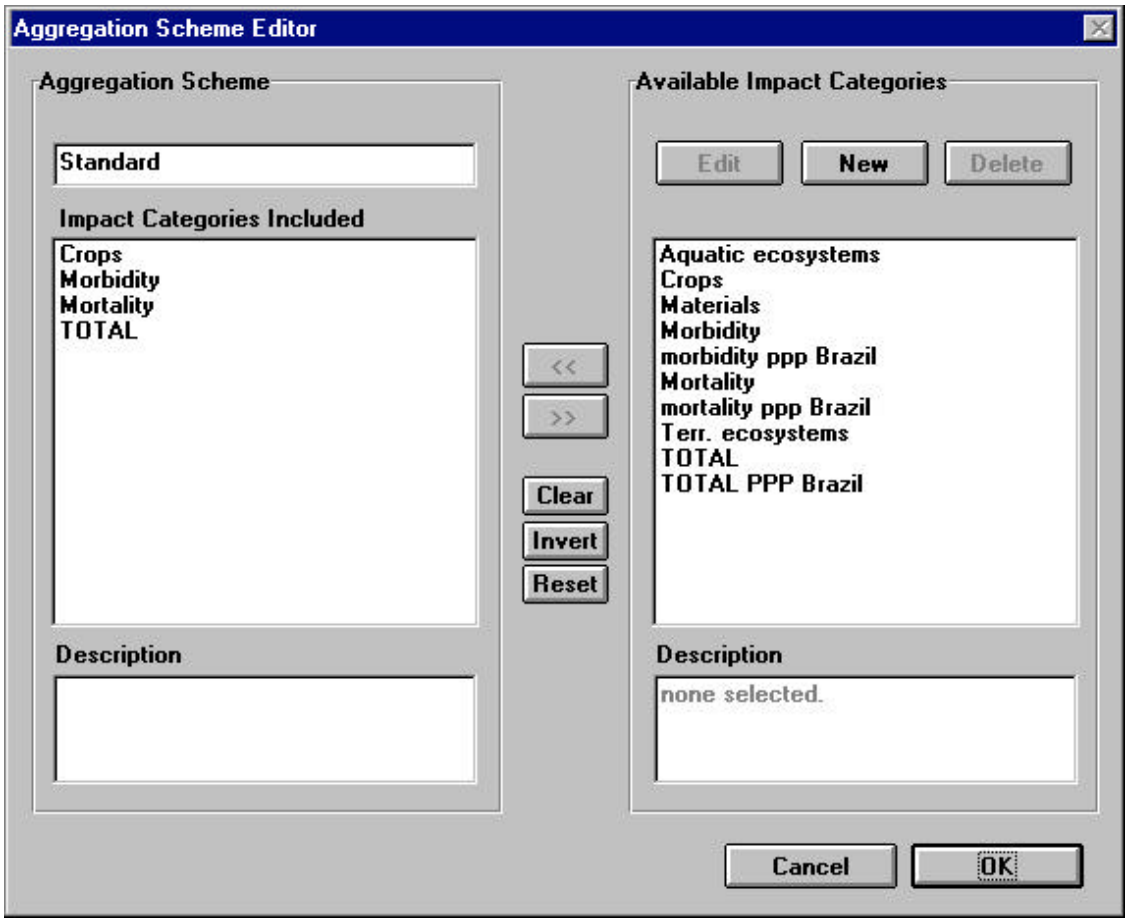


Figure 6-2: The Aggregation Scheme Editor

To edit an existing aggregation scheme, select the aggregation scheme to be edited from the *Aggregation Scheme* list box of the Report Manger dialogue (Figure 6-1), and click on the *Edit...* button. The Aggregation Scheme Editor appears, and the aggregation scheme can be modified by removing or adding impact categories to or from the list of *Impact Categories Included*.

An aggregation scheme can be deleted by selecting it from the *Aggregation Scheme* list box of the Report Manger dialogue (Figure 6-1), and then clicking on the *Delete* button.

6.2 Create and Edit Impact Categories

The impact categories are the basic elements of an aggregation scheme. The impact category is the level on which individual impacts are aggregated to a single number. A new impact category can be defined by clicking on the *New* button in the Aggregation Scheme Editor (Figure 6-2). The dialogue shown in Figure 6-1 pops up, asking for the name and (optional) a description of the new impact category. Like in the case of aggregation schemes, it is possible to copy data from existing impact categories by checking the *Copy impact data from existing category* check box to simplify the definition of a new category.

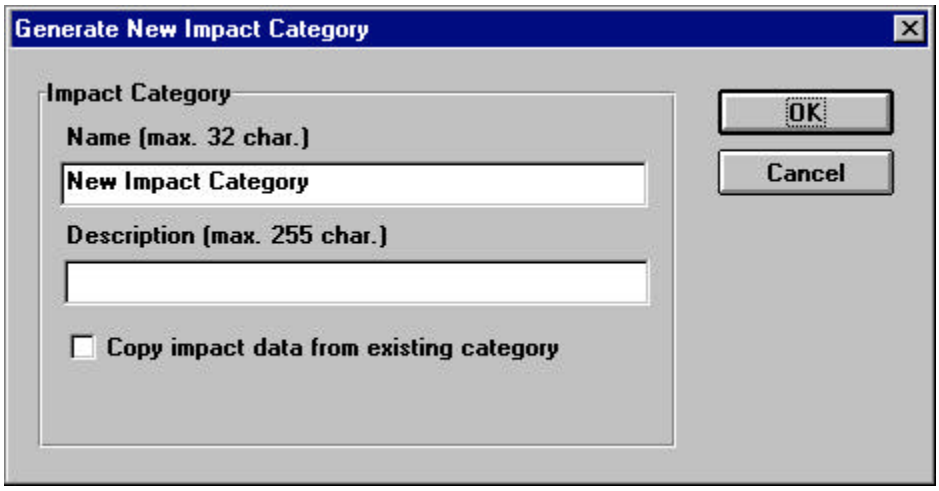


Figure 6-1: Definition of a new impact category

After clicking the *OK* button, the Impact Category Editor (Figure 6-2) appears. The user consecutively selects the receptor, the pollutants, the exposure-response functions and monetary values that shall be included in the new impact category by clicking on the entries in the respective list boxes. After selecting a receptor in the *Receptor* list box, and confirming the selection by clicking the *Accept* button, the *Pollutant* list box is filled with those pollutants available in the exposure-response database that are linked to the selected receptor. After selecting pollutants from the list, and confirming the selection by clicking on the *Accept* button, the *Exposure-Response Function* list box shows all the exposure response functions available in the database that are related to the selected receptor and the selected pollutants.

Immediately after selecting one of the exposure response functions from the list by clicking on it, the *Monetary Value* list box becomes active, showing

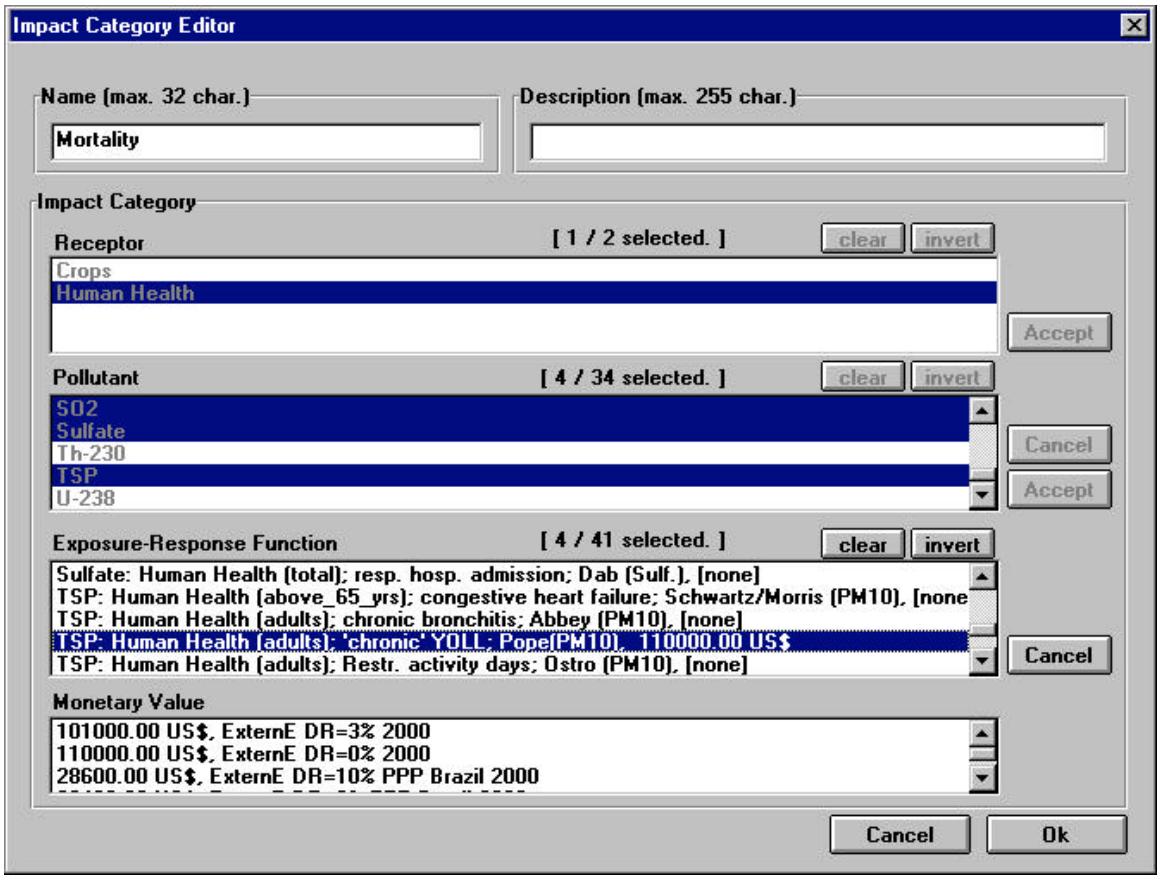


Figure 6-2: The Impact Category Editor

the monetary values available in the database that are related to the impact defined by the previously selected exposure response function. After selecting one of the monetary values, the *Exposure-Response Function* list box becomes active again, so that further functions can be selected. The selection process is finished by clicking the *OK* button, the system goes back to the Aggregation Scheme Manager.

To edit an existing impact category, the user first selects the impact category from the list of *Available Impact Categories* in the Aggregation Scheme Editor. After clicking the *Edit* button the Impact Category Editor opens, and the existing selections can be modified. After clicking the *OK* button, the modified impact category is saved to the database.

An impact category can be deleted by selecting the impact category from the list of *Available Impact Categories* in the Aggregation Scheme Editor, and then clicking on the *Delete* button.

7 SETUP

The Setup option in the main menu can be used to modify some of the default values used by the system.

7.1 Reference Technology Database input controller

Open a list of minimum and maximum values that are used by the input controller of the Reference Technology Database interface by selecting <Setup> <Reference Technology Database> <Tech. Data Min/Max> from the main menu. Use the mouse or the <Tab> key to move around in the screen. Click the *OK*-button to confirm modifications and to go back to the main screen.

7.2 Human health risk groups

Some of the exposure response functions related to human health impacts refer to specific risk groups (e.g. children, asthmatics) within the total population. You can add risk groups or modify risk group fractions in the screen shown in Figure 7-1 after selecting <Setup> <Reference Environment Database> <Risk Group Fractions> from the main menu. To change a given risk group fraction, select the risk group in the *Risk group* list-box and edit the numerical value in the *Percentage of total population* edit-field. After confirming a modification by clicking the *Accept*-button, you can select a new item from the *Risk group* list-box. The set of new values is written to the database after clicking on the *OK*-button.

To add a new risk group, write the risk group's name into the *Risk group* list-box and specify the numerical value in the *Percentage of total population* edit field. Confirm by clicking the *Accept* and *OK*-button.

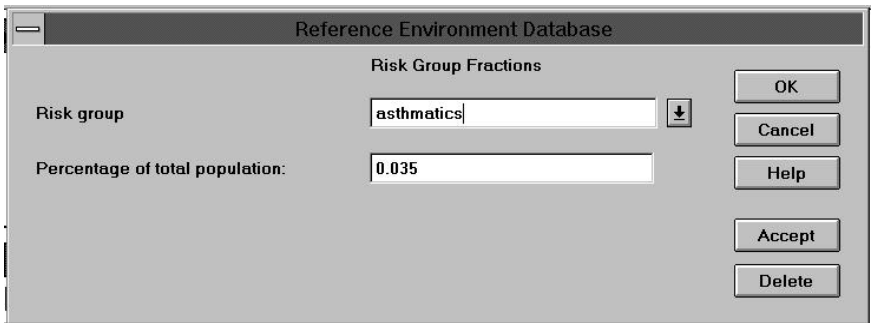


Figure 7-1 Add/edit risk group fractions within the total population

7.3 Exchange Rates

Select the base year in the list box. Select the currency in the *Currency* list box. Write the exchange rate between the selected currency and the EURO into the text field.

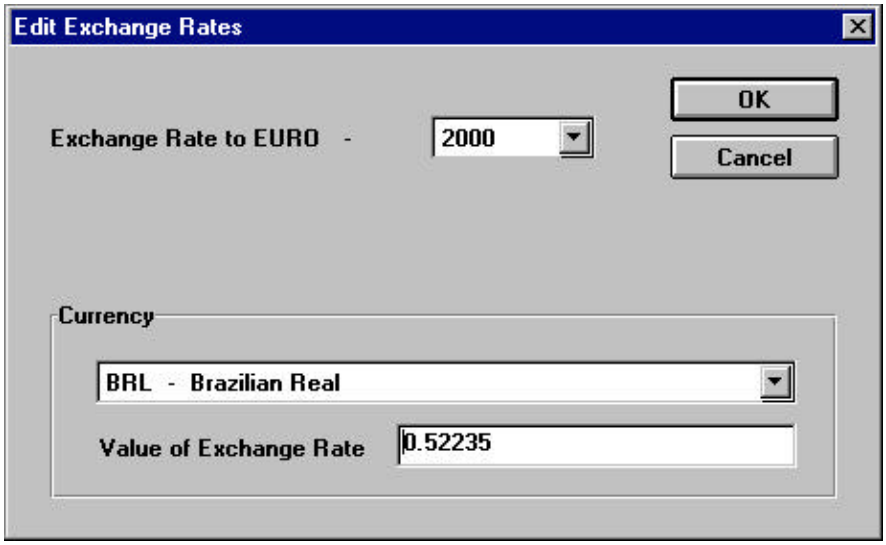


Figure 7-1: Dialogue for editing exchange rates

7.4 Consumer Price Index

The consumer price index is used to transfer monetary values between different base years.

Select the base year from the list box. Select the currency in the *Currency* list box. Write the consumer price index for the selected base year into the text field. In the current version of the model, the consumer price index is set to 100 for the year 2000.

Figure 7-1: Dialogue for editing the consumer price index