SESAMO_SHARE_v3.0

User Manual

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SHARE - Sustainable Hydropower in Alpine Rivers Ecosystems
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Summary

Short Description
This document is an update of the previous User Manual written for version 7 of SESAMO software, to describe all new features developed for the version 8.0 of SESAMO. SESAMO is a Decision Support System based on the methodology of Multi-Criteria Analysis (MCA) that allows you to manipulate in a graphical way all the objects of the MCA itself (criteria and alternatives, utility functions and weights), to get the final ranking of the alternatives and to analyze the composition of the results.

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Introduction

SESAMO is a Decision Support System based on the methodology of Multi-Criteria Analysis (MCA). This manual assumes that you are already familiar with this type of methodology and general concepts relating to decision-making processes.

The program deals with the MCA and allows the user to manipulate in a graphical way all the objects of the MCA itself, including, for example:

- criteria and alternatives;
- utility functions;
- weights.

This tool allows you to get the final ranking of the alternatives and to analyze the composition of the results.

This report describes the software and the procedure that allows to create decision project.

Below, is a list of abbreviations that will be used hereafter referred

- L-Click = A single click with the left mouse button;
- R-Click = A single click with the right mouse button;
- 2L-Click = double click the left mouse button

SESAMO: SetUp

The SESAMO setup consists of a compressed self-exploding archive.
By starting the executable file, an input form appears that shows the installation path of SESAMO.
A SESAMO folder will be created by the installation procedure, generating some files and some sub-folders, including the "Project" folder.

System Requirements

Minimum Hardware Recommended: Pentium IV – 2,4 GHz or equivalent , 512 MByte RAM.

Software OS: Windows 98, 2000, XP.

Platform: Java Runtime Environment 1.6 or forward (1.6.0_03). The JRE is downloadable for free from the website http://www.java.com/it/download/index.jsp.

Starting the Program

To launch the application, double click on batch file *"Dss.bat"*.
Note that for the proper execution of the application, it is required that the Java Runtime Environment is properly installed on the computer. If the software doesn't start, probably the path to the Java software is not correctly defined. In this case, run the batch file *"DssEsteso.bat"* which contains the absolute path for the Java program. This allows the Java software to run and the SESAMO application to start.

SESAMO: User manual

The SESAMO program operates on projects. A project is an independent entity that contains all the data and structures that are related to the description of a decision-making process applied to a specific problem.
Each project is stored in a single file that can reside anywhere on the hard disk of the user's machine. Within the program, projects are managed through a Multiple Document Interface, in which each project is opened and maintained in a dedicated window.

Starting the program

SESAMO will be started by launching the batch program Dss.bat, that is located inside the installation folder.
In the loading phase of SESAMO, an image appears (a splash screen) with the project logos, as in the following picture:

Fig.1: Splash screen

Creating a project

For creating a new project you will choose *"New Project ..."* from the Project Manager Menu. You will be asked the name of the new project and the storage location path on the disk. The proposed path is the default Projects folder within the installation directory of the program.

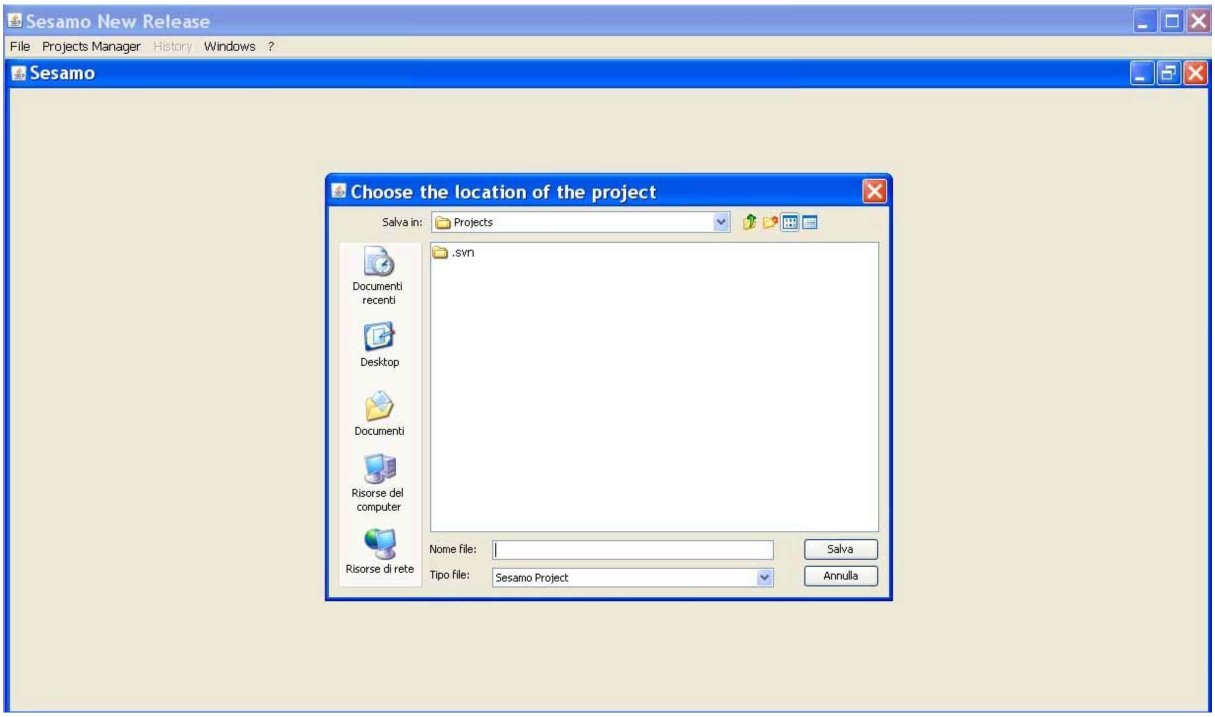


Fig.2: Choosing the name and location to save a new project.

After entering the name of the new project, in a few moments, the following form has been shown to the user for entering login and password.

Fig.3: Authentication form.

The user is able to decide if protecting or not the project with credentials.
If the user wants to unlock the newly created project, he can simply choose the item "*Unlock project*" in the Project Manager Menu and he can avoid entering login credentials to open the project in the next work session. Otherwise he can lock the project and enters login and password.

After the credentials, the program creates a "skeleton" of empty project. From now on, it is possible to organize the evaluation criteria in a hierarchical structure, called the evaluation tree.

It is now possible to omit the credentials for the projects that are managed in local mode.

User-Interface Structure

All the stages of an evaluation process are reproduced in the program by means of panels which can be opened simply by L-clicking on the name of the panel.

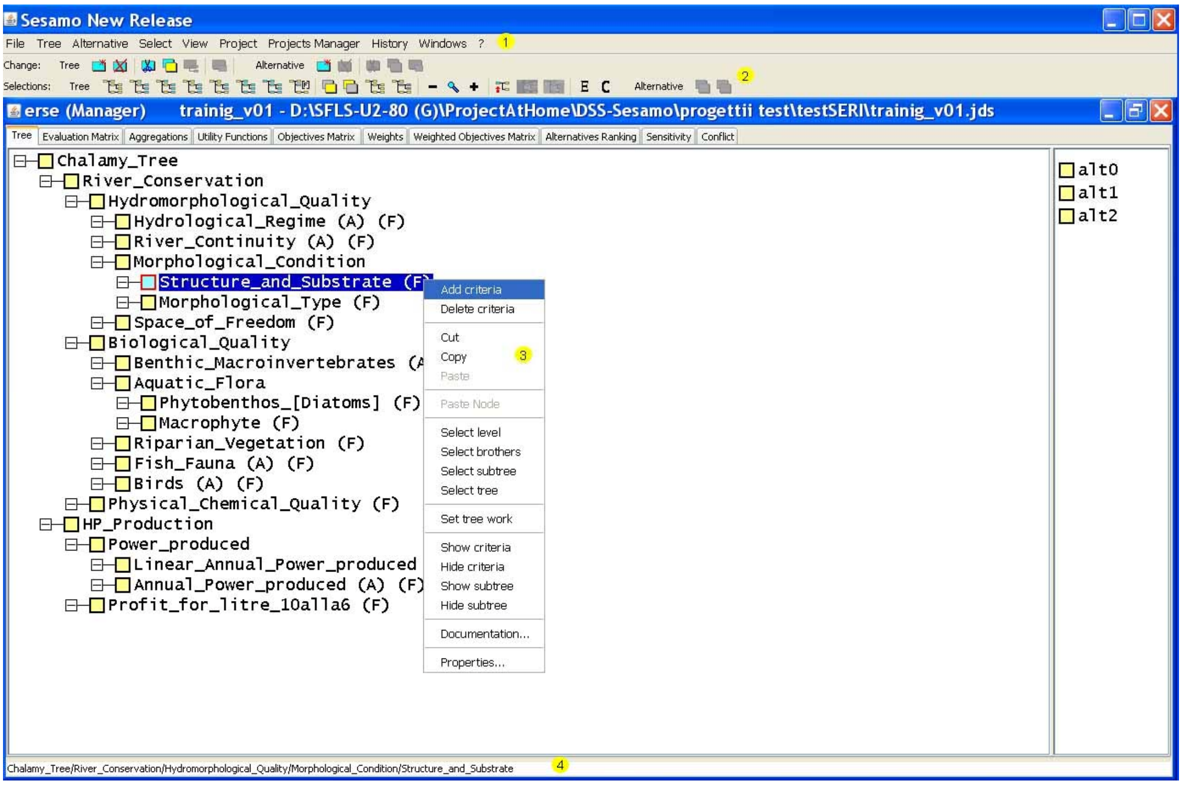


Fig.4: Interface design: evaluation tree.

The user-interfaces of the panels have some common characteristics that affect the selection mechanism, the presence of menu (1), toolbars (2) and context menus (3); at the bottom of the window (in the 6th version), there is a status bar (4) that contains a description of the object that currently you are focused on.
In other words, in the status bar it is possible to read the path that leads to the primary receiver of all actions carried out through menu items or commands in the toolbars.

Commands Redundancy

All the operations available for an object within a panel are usable through three types of structure:

1. **Menu bar**: in the main menu bar, specific items are available related to the panel in which the user is operating. Some of these items are also represented by commands for the management of open projects within the program.

2. **Toolbar**: in the toolbars, commands are available for the current panel in the form of buttons with an icon representative of their functionality. Moreover, stopping for a moment the mouse over a button, you will see a short text description of its function.

3. **Contextual menu**: by R-Clicking on an object, it will appear a contextual menu containing all operations that can be applied to the selected object.

Except for some cases that will be highlighted in the description of the specific panels, the three listed structures are equivalent and can perform all operations on the focused object.

Selections

The selection mechanism within the panels works similarly to other Windows applications.
The selections of the objects are performed by L-Clicking on the items themselves. This operation has the effect of:

- delete previous selections;
- select the object and give it the focus.

The object that holds the focus will be drawn with a red border, while in general the selected objects have a blue background.
Unless otherwise noted, in the description of individual panels, to select multiple objects you can use the SHIFT or CTRL+ L-Click combination.
While holding down these buttons during the selection you will respectively select a range of values (SHIFT), or simply maintain the previous selections (CTRL).

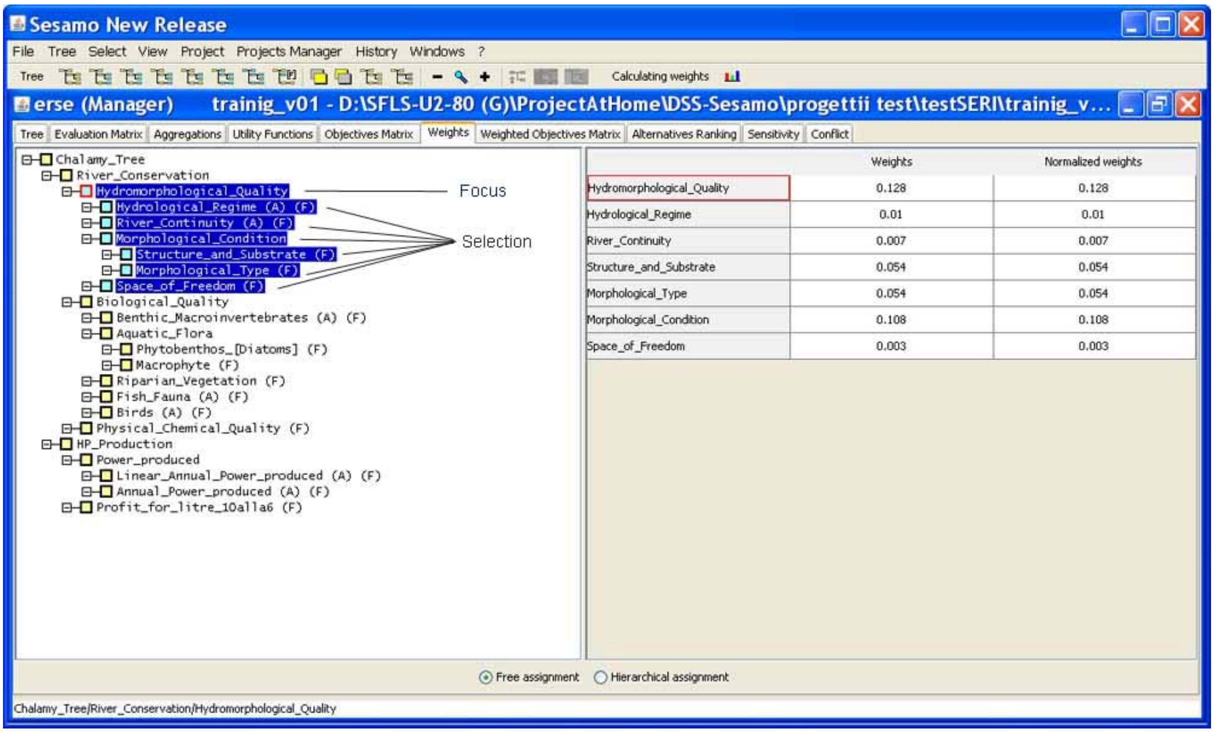


Fig.5: Selection on the tree.

Documentation Opportunity

It is possible to associate documentation to each object in the project. Through documentation, the user can enter text useful for understanding all the operations that he is performing on a specific node of the decision tree.
The documentation of an object is set through the mask shown in Fig.6.

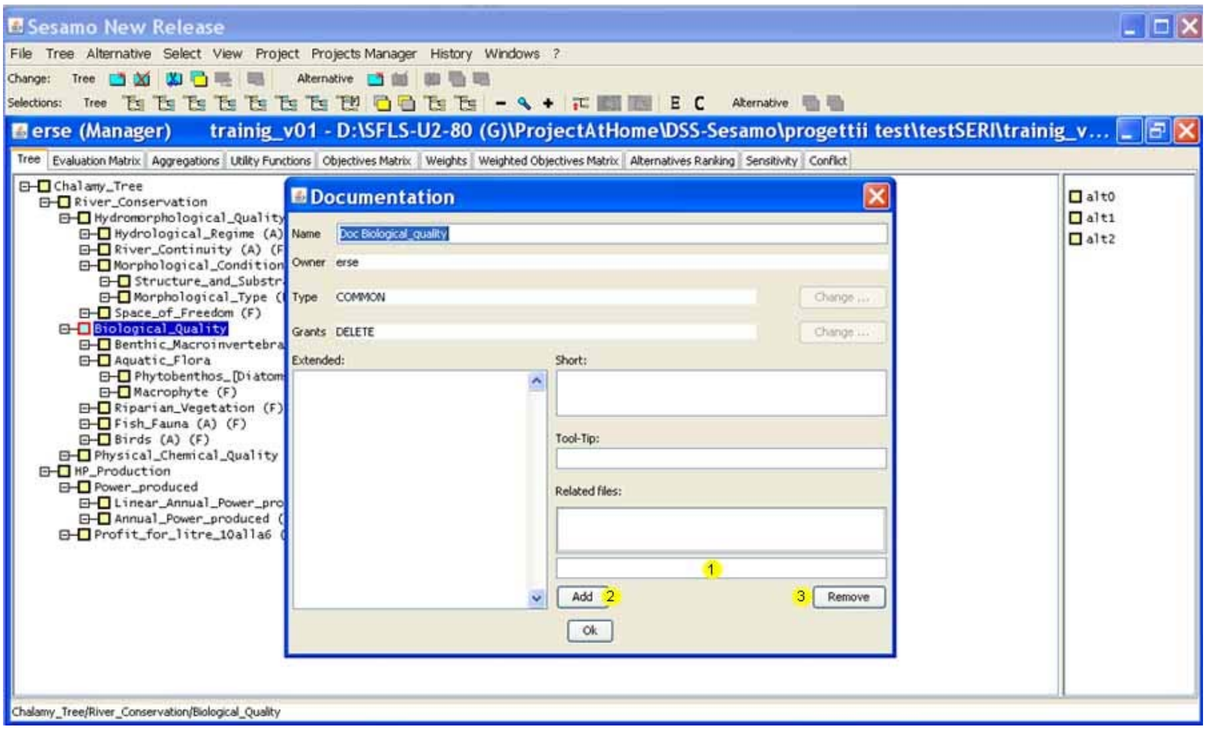


Fig.6: Documentation window.

The mask for entering documentation provides users with different fields, for a full description of this object.

1. **Extensive Documentation**: it contains the actual text of the document;
2. **Short Documentation**: it should include a brief summary of the extensive documentation;
3. **Tool Tip**: it contains a description of the object, in a line appearing when the mouse passes over the object itself;
4. **Linked files:** a list of paths to files with a further description (such as a map that represents the soil concentration of a particular pollutant).

References are added by typing the text in the field (1) and pressing the button (2). To delete a reference you must select it from the list and press the button (3).

Link to external documents/programs

In the properties form of the node there is the opportunity to enclose external documents, web pages or programs (as an Indicator Database, for example) related to the selected node.
This has been allowed through the field *"External Link"*, as shown in the next Figure.

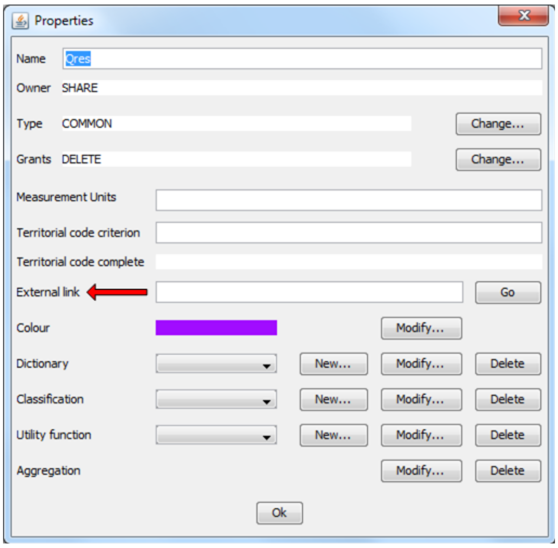


Fig.7: External Link field

The information entered in this field may be the name of a file or a URL (Uniform Resource Locator). By clicking the Go button, the system opens the specified file or in case of a hyperlink, the web browser address.

Evaluation tree representation

There is the evaluation tree in many panels of the application, then in this section we give a brief initial description of the meaning of some aspects. We are giving you a description of more specific aspects while describing each step of the MCA procedure.

Because of the tree structure, in this manual the terms **criterion** and **node** are considered synonyms, although the latter is used mainly when you talk about the structure of the evaluation tree.

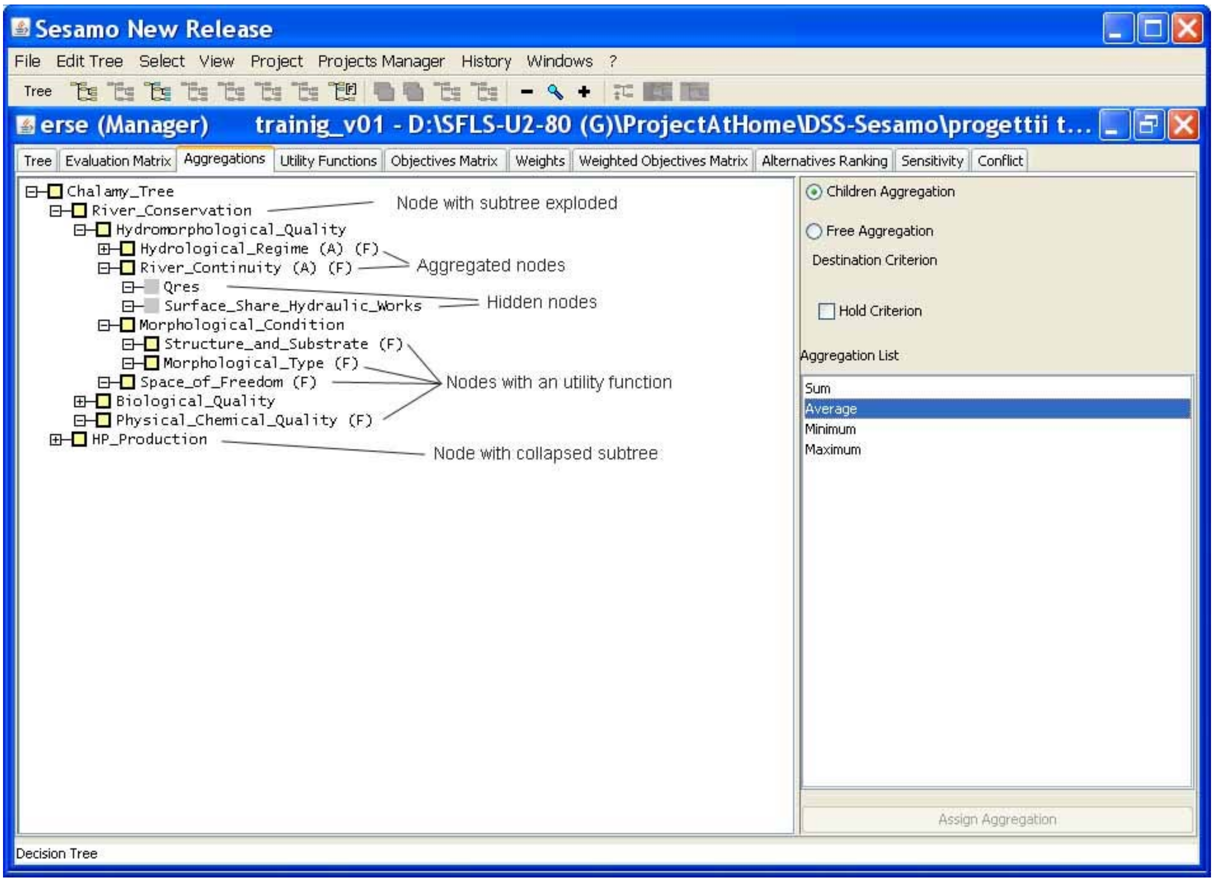


Fig.8: Description of evaluation tree.

As you can see in Fig.8, the structure of the tree is very similar to the structure used in the tool Windows "Explorer". On the left side of each node there is a symbol that can explode or collapse the structure of a sub-tree.
Immediately after the criterion name, information about some components of the state of that criterion are brackets: the presence of (A) indicates that the node has been aggregated, while the symbol (F) indicates that the node has been associated with a utility function.
The presence of a red (A) indicates that the aggregation concerns children whose structure has not yet been defined.

To make it convenient for the user to manage very complex trees, the program provides a mechanism to hide certain parts of the tree. Viewing or masking of the nodes are activated through the menu option "Show hidden items" in the "View" Menu, as shown in Fig.9.

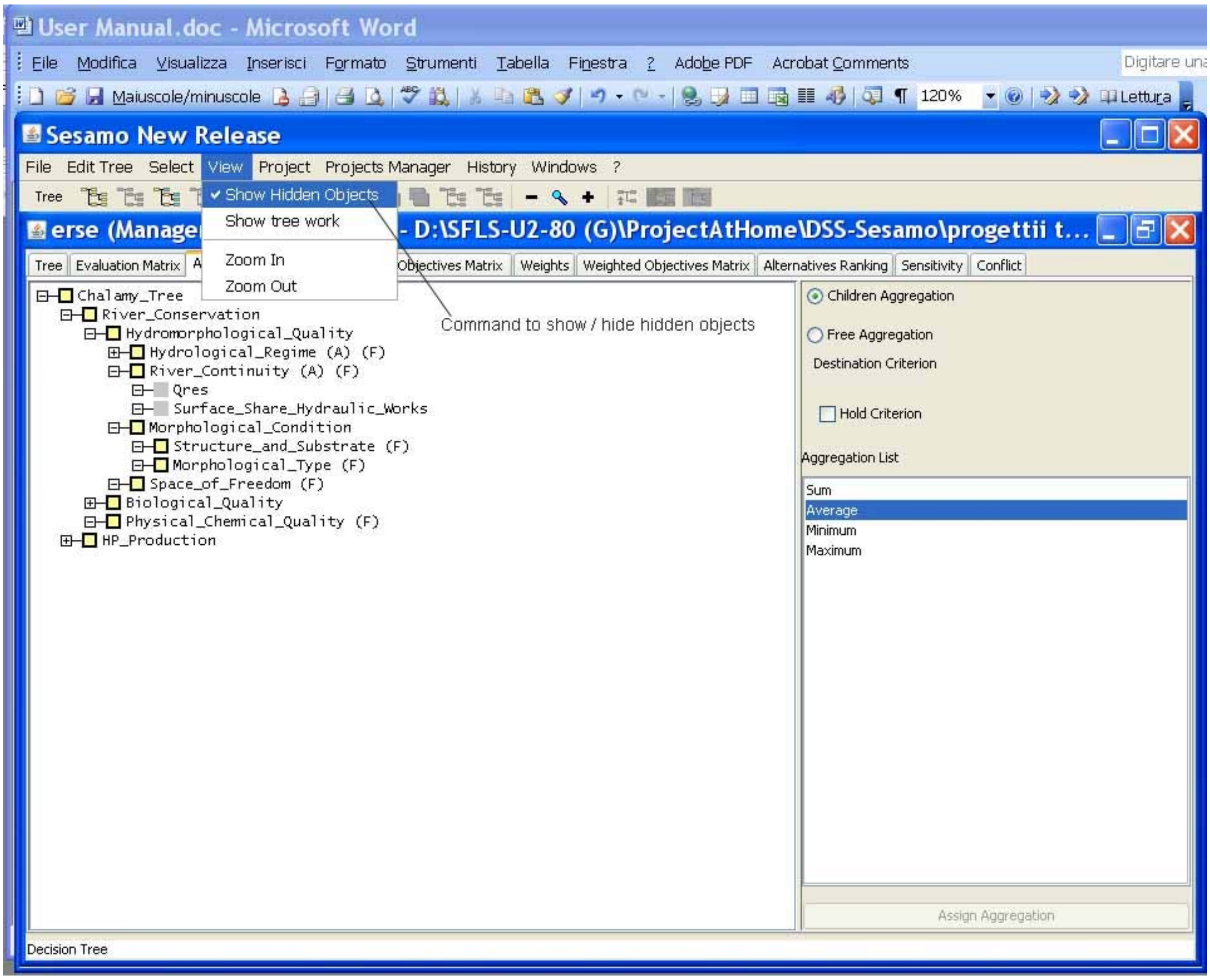


Fig.9: Showing Hidden objects.

Construction of the project

This section describes in detail all the steps that you must follow to build an evaluation process, since the editing of criteria and alternatives, up to the ranking of the same alternatives, according to their performances and to an examination of the parameters that influenced the results through sensitivity analysis.

Construction of evaluation tree and project alternatives

The tree panel allows the construction of the evaluation tree and the entering of project alternatives. In this panel there are two types of commands: those for changing criteria tree and alternatives and those that allow you to make short selections on these structures.

Construction and editing commands

For a description of construction and edit commands, refer to Fig.10.

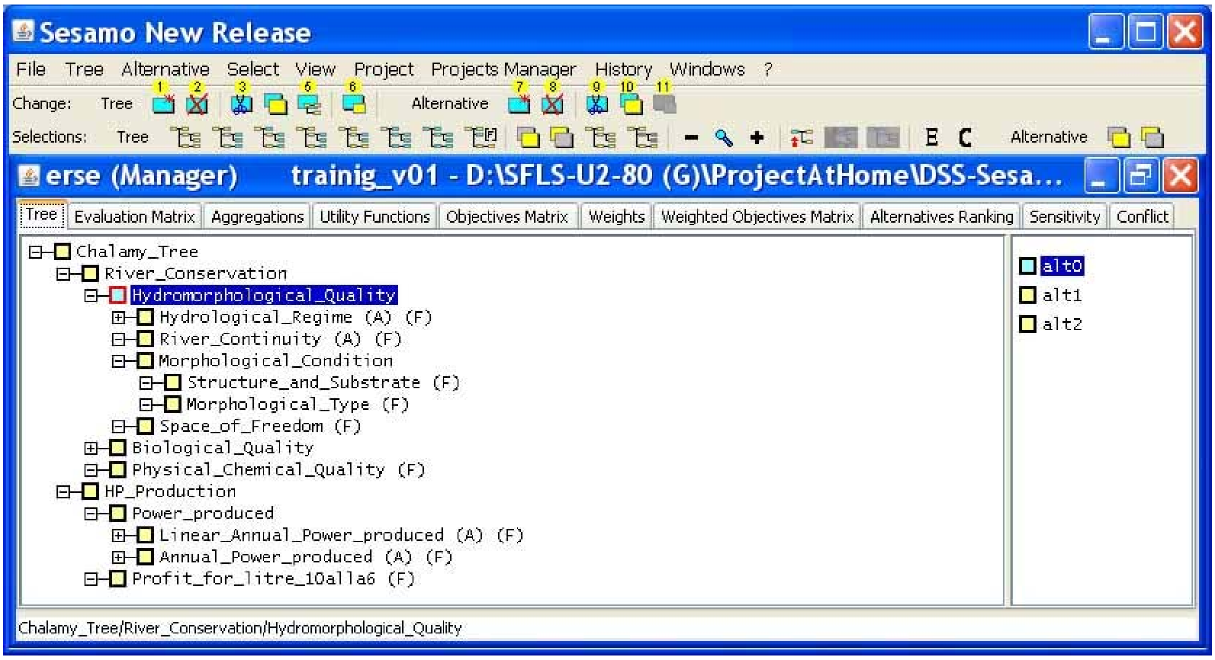


Fig.10: Commands for building tree and alternatives.

Add node (1)
For each selected node, it adds a new child node. The nodes added with this command have a default name that matches the name of the father, followed by a growing number.

Delete node (2)
It deletes the selected nodes from the tree.

Cut Node (3)
It cuts the selected nodes and copy them to clipboard. The cut nodes retain the hierarchical structure of their sub-tree.

Copy node (4)
It copies the selected nodes to the clipboard. The copied nodes retain the hierarchical structure of their sub-tree.

Paste sub-tree (5)
It adds the nodes contained in the clipboard to the selected nodes. All the nodes contained in the clipboard will be added as children to the selected nodes, thus the nodes will become brothers, independently of their initial position within the tree.

Paste node (6)
It adds the nodes contained in the clipboard to the selected nodes. Unlike what happens with the *Paste sub-tree* command, in this case the nodes are added removing the hierarchical structure of their sub-tree.

Add alternative (7)
It adds an alternative to the list of the project alternative.

Delete alternative (8)
It deletes the selected alternatives by the project.

Cut alternative (9)
It cuts the selected alternatives and copy them to the clipboard.

Copy Alternate (10)
It copies the selected alternatives to the clipboard.

Paste Alternative (11)
It adds the alternatives contained in the clipboard to the project.

Rename node
In the 7th version , it is also possible to change the name of a criterion or indicator by double clicking the left mouse button on the node itself.
By doing this, you will get a dialog form where you can insert the new name.

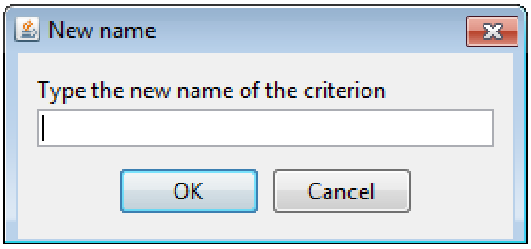


Fig.11: Rename node dialog form

Selection commands
For a description of the selection commands, refer to Fig.12.

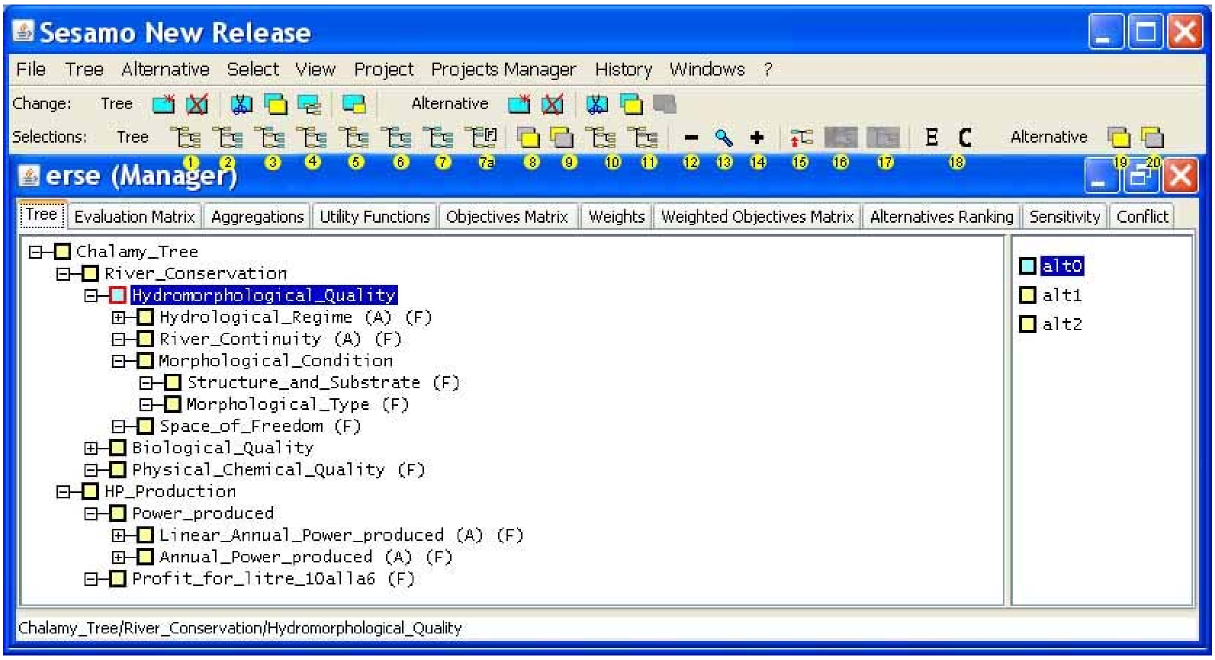


Fig.12: Commands for the selection of criteria and alternatives.

Delete selections (1)
It deletes all the active selections on the tree.

Invert Selection (2)
It inverts the selection state of the nodes that belong to the sub-tree of the selected nodes.

Select leaves (3)
It selects all the leaves of the tree.

Select level (4)
It selects all the nodes that have the same hierarchical level than currently selected node.

Select brothers (5)

It selects all the brothers of the currently selected nodes.

Select sub-tree (6)
It selects all the nodes that belong to the sub-trees of the actually selected nodes and it deselects the root node.

Select tree (7)
It selects all the nodes that belong to the sub-tree of the currently selected nodes.

Show criterion (8)
It makes the selected criteria visible, if they were hidden.

Hide criterion (9)
It hides the selected criteria.

View sub-tree (10)
It makes the sub-tree's criteria that belongs to the selected nodes visible.

Hide subtree (11)
It hides the criteria that belong to the sub-tree of the selected nodes.

Zoom out(12)
It decreases the zoom level used for displaying the tree and the alternatives.

Zoom Normal (13)
It shows the zoom level to the default level.

Zoom in (14)
It increases the zoom level used to display the tree and the alternatives.

Set working tree (15)
Through this command, the user can choose to see only a portion of a evaluation tree (later on, the working tree). The focused node is chosen as the root of the working tree.

Show working tree (16)
If a working tree has been set, this command allows you to switch between viewing the whole tree and viewing the working tree.

See all nodes in the tree (17)
If a working tree has been set, this command allows you to switch between viewing the working tree and viewing the whole tree.

Collapse / Explode tree (18)
It collapses [C] / explodes [E] all the nodes of the tree.

Alternative View (19)
It makes the selected alternative visible, if it was hidden.

Hide alternative (20)
It hides the selected alternatives.

Alternatives order and visualization

In the Tree panel, two buttons placed just above the alternatives list allow the user to modify the alternatives visualisation; the new order is reflected in all the other panel of the software. The new order is automatically reflected to all the alternatives either those visible and those hidden.

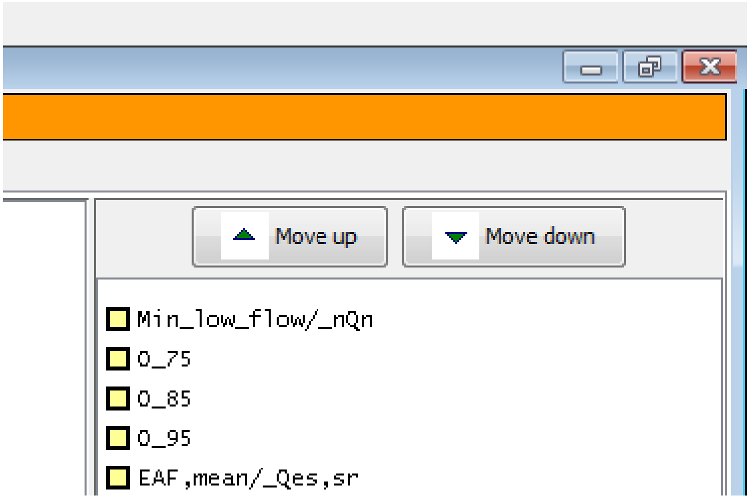


Fig. 13: Buttons to change the alternatives order of visualization

Save and print commands

There are two items in the File Menu for saving and printing the evaluation tree.

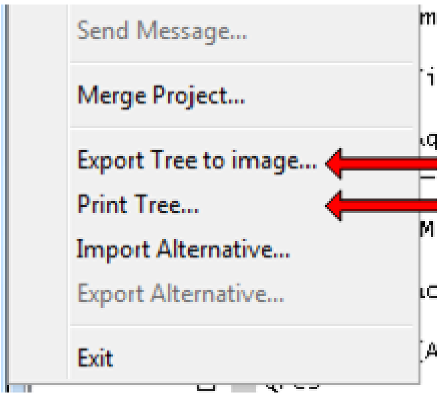


Fig. 14: Commands for saving and printing the tree.

"Export Tree to image" allows to export the evaluation tree as an image, in different types of graphic formats: BMP, GIF, JPEG, PNG.

"Print Tree" allows printing the evaluation tree in textual mode.

In textual mode, the tree is represented using only ASCII alphanumeric characters and symbols. Nodes are represented with their name, while the hierarchy is represented by dotted lines, as you can see in the example below.

```
|-- Ekološki_kriteriji/_Ecologic_criteria
|    |
|    |-- Fizikalno_kemijska_kvaliteta/_Physical_chemical_quality
|    |    |
|    |    |-- Makrodeskriptorji/_Macrodescriptors__LIM_
|    |         |
|    |         |-- Qres
|    |
|    |-- Bioloska_kvaliteta/_Biological_quality
|    |    |
|    |    |-- Bentoski_makroinvertebrati/_Benthic_macroinvertebrates
|    |    |    |
|    |    |    |-- Zima/_Winter
|    |    |    |    |
|    |    |    |    |-- Qres
```

Fig.15: Textual representation of the evaluation tree.

Visualizing parent-child relationships commands

To make more evident the parent-child relations between nodes in complex trees, two features have been introduced on the user interface of the 7th version of Sesamo: the first one is on the status bar, the second one is on the modules containing the evaluation tree representation.
The status bar has been moved up, magnified and highlighted with an orange background color. The root node and the deeper node were highlighted with bold font.

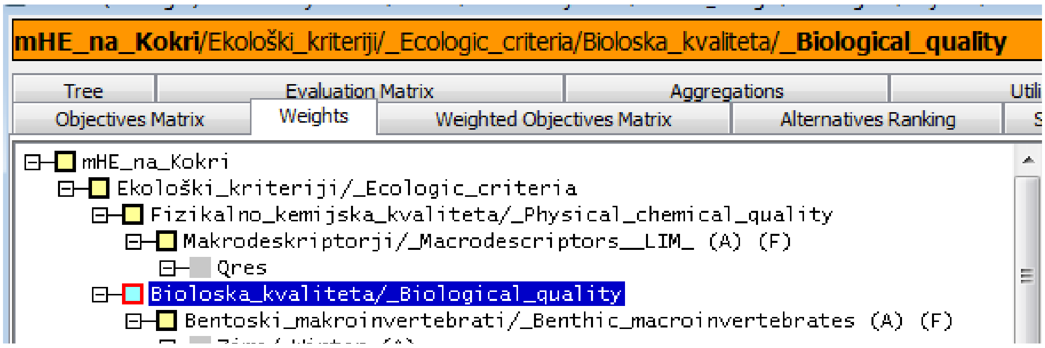


Fig.16: Status bar

The second functionality allows you to color a specific area of the evaluation tree in a different way.
In the following picture, you can see how it has been highlighted the relationship between the selected node "Qres" and the node "Aquatic_flora" that is two levels higher up the hierarchy.

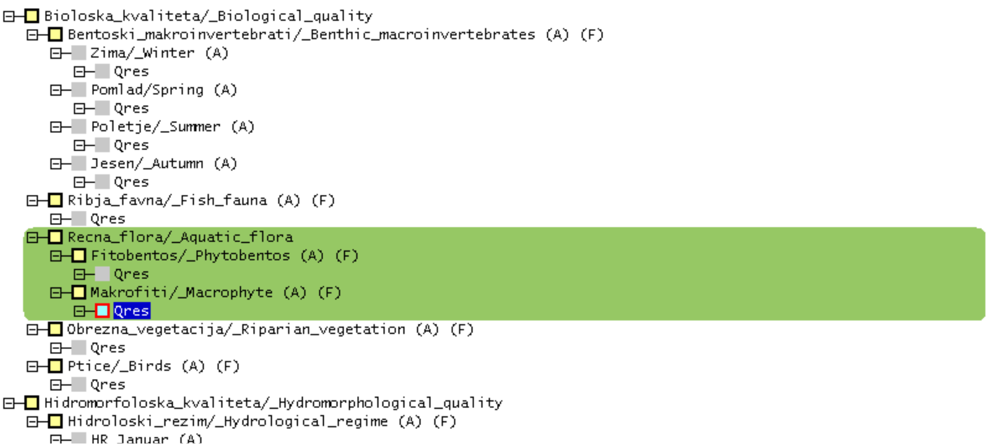


Fig.17: Highlighted relationship

To enable this feature you can select the item *"Highlight hierarchy"* in the contextual menu of the node; it will be then opened the dialog form shown in the figure below, through which you can define the area to be highlighted:

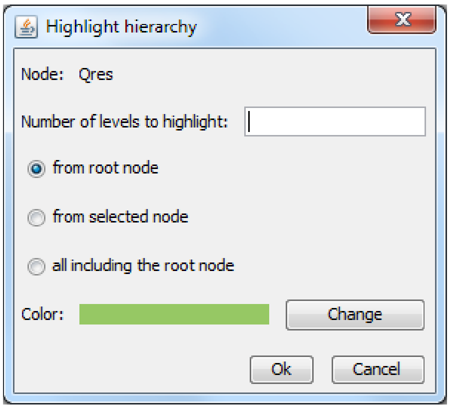


Fig.18: Highlight hierarchy dialog form

The first way: you can count the levels you entered in the field "*Number of levels to highlight*" starting from the root and after that the area will be highlighted till the selected node.

The second way: you will highlight the hierarchy levels you entered in the filed, but starting from the selected node.

The third way: the field is disabled because the number of levels is not necessary anymore: all levels of the hierarchy will be highlighted starting from the root to the selected node.

The highlighted area will remain visible until the considered node is visible or until the user decides to remove it using the button added in the toolbar.

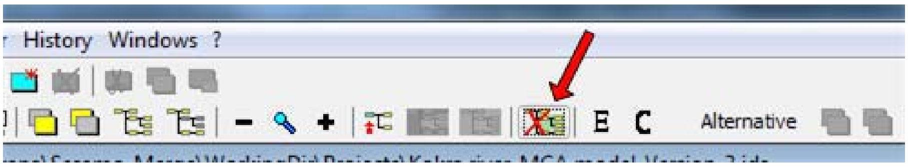


Fig.19: Remove button

Opening the SHARE database

Sesamo is linked to an indicators database.
When you introduce an indicator or criterion into the evaluation tree, you can find in the SHARE database its textual report with all related information about that indicator. Otherwise, you can choose the indicator you think most appropriate for your tree, browsing among records inside this database.

A text field in the properties mask of the selected criterion allows you to input the identity code of the corresponding criterion contained in the SHARE database. If the correct identity code has been set, the button "Open database" allows the opening the selected criterion record page inside the SHARE database.

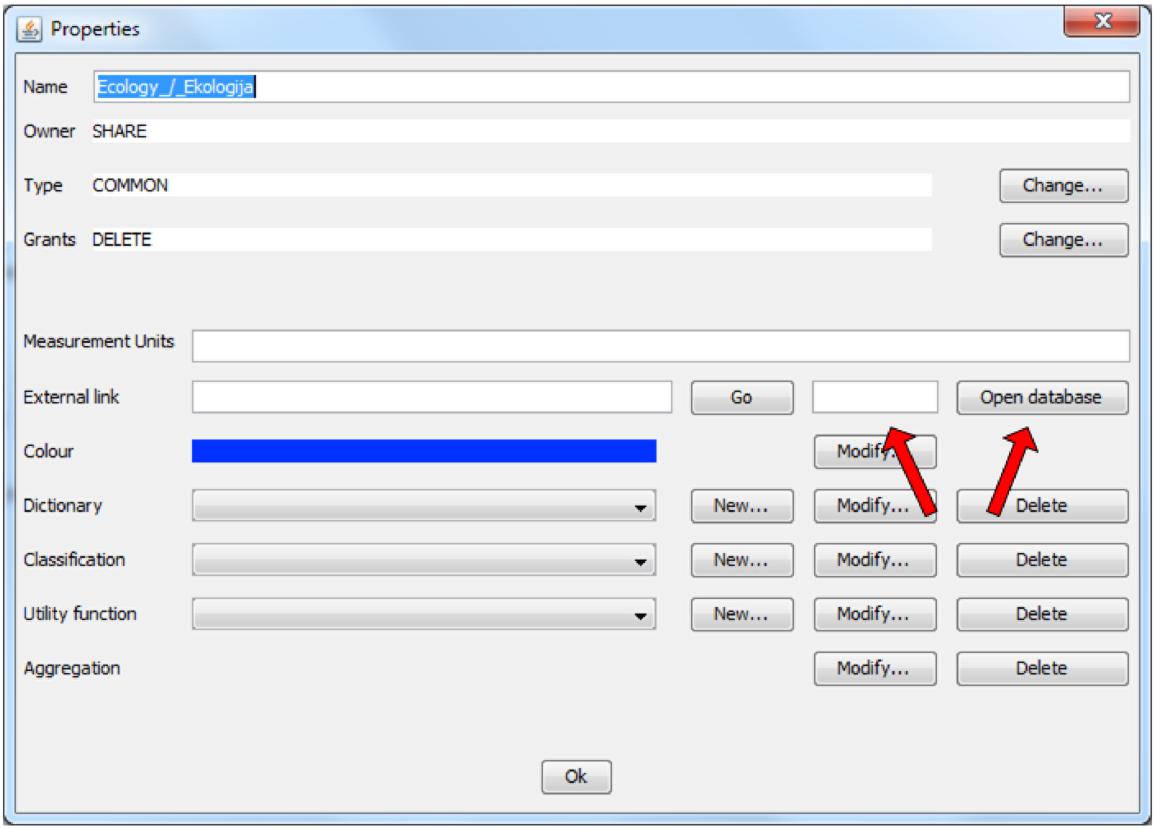
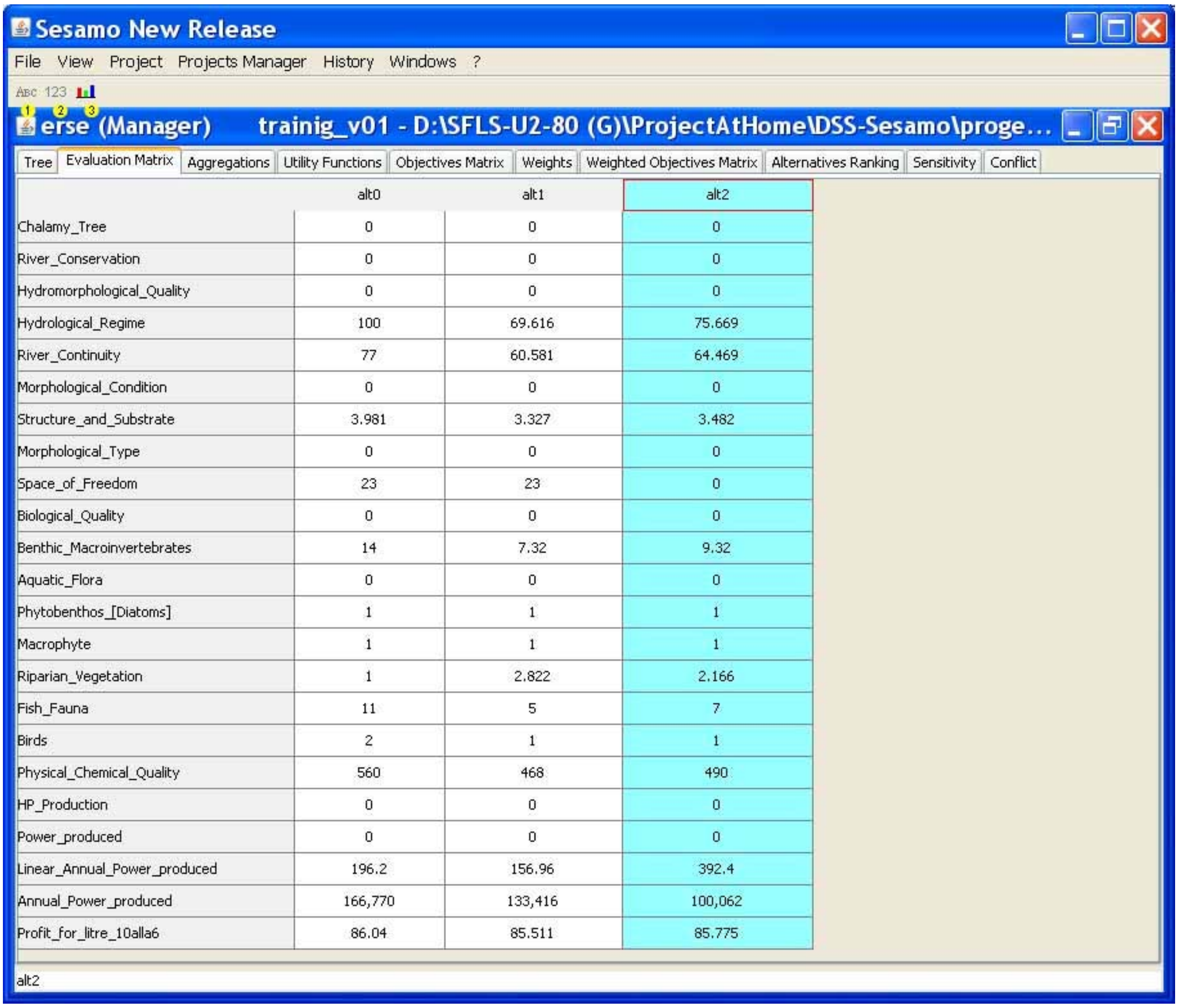


Fig. 20: Code field and button to open the SHARE Database

If no code is present into the specified field, the SHARE database will open on its default start form.

Entering data in the evaluation matrix

The evaluation matrix panel contains the visualization of the evaluation matrix. If a selection is active, in this panel you will see only the criteria and alternatives selected in the tree panel.
In this way the user can work only on a subset of criteria and alternatives that he can handle more easily than the complex matrix, which can contain many rows and columns.
The evaluation matrix panel is shown in Fig.21.



	alt0	alt1	alt2
Chalamy_Tree	0	0	0
River_Conservation	0	0	0
Hydromorphological_Quality	0	0	0
Hydrological_Regime	100	69.616	75.669
River_Continuity	77	60.581	64.469
Morphological_Condition	0	0	0
Structure_and_Substrate	3.981	3.327	3.482
Morphological_Type	0	0	0
Space_of_Freedom	23	23	0
Biological_Quality	0	0	0
Benthic_Macroinvertebrates	14	7.32	9.32
Aquatic_Flora	0	0	0
Phytobenthos_[Diatoms]	1	1	1
Macrophyte	1	1	1
Riparian_Vegetation	1	2.822	2.166
Fish_Fauna	11	5	7
Birds	2	1	1
Physical_Chemical_Quality	560	468	490
HP_Production	0	0	0
Power_produced	0	0	0
Linear_Annual_Power_produced	196.2	156.96	392.4
Annual_Power_produced	166,770	133,416	100,062
Profit_for_litre_10alla6	86.04	85.511	85.775

Fig.21: Evaluation matrix.

The first column on the left lists the selected criteria, while the other columns represent the selected alternatives.
Selections are made on the matrix as explained above; in addition, by L-Clicking on the name of a criterion, all the cells in the row will be selected. In the same way, if the name of an alternative is selected, the selection will be extended to the correspondent column.

Within the evaluation matrix, you can enter both quantitative and qualitative values, through the use of vocabularies and classifications that will be introduced in the next section. Through the commands shown in Fig.21, you can switch to display only quantitative values (2) or both quantitative and qualitative values associated with (1).
Through the command (3) is offered the chance to see a graphical representation of the values of evaluation matrix. The values represented in the chart are those of the selected cells (see Fig.22).

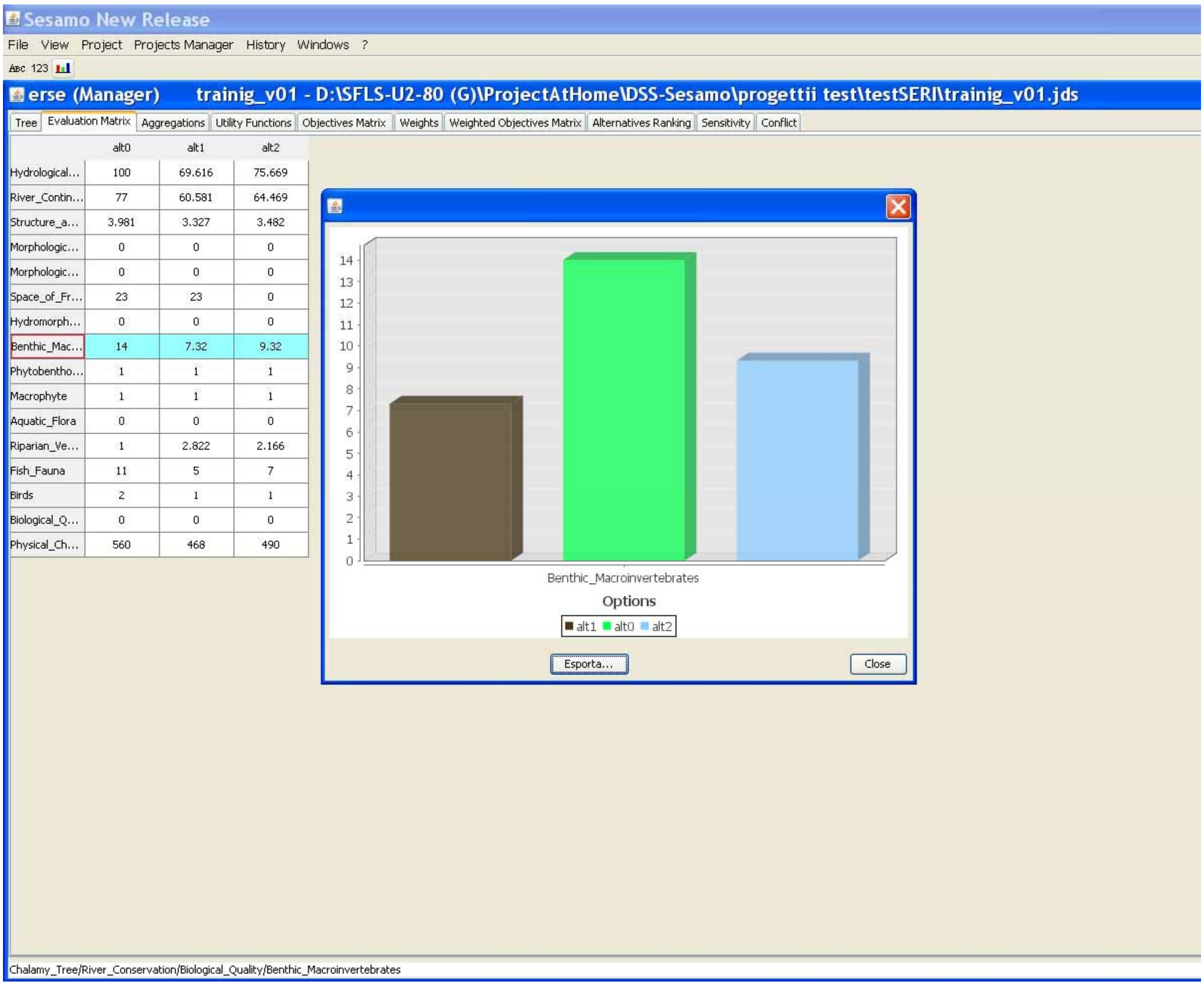


Fig.22: Graphical representation of the values.

Through this type of representation, the user can change the zoom area of the values represented by holding down the left mouse button on a bar graph and dragging vertically.
In addition to the driven mechanism for zooming, you can use two shortcuts. Holding down the Shift key and making an L-Click on a column, the value is returned to its original value, that is indicated by the gray column. Pressing CTRL and L-Click on a column, the value is set to zero.

Importing data of evaluation matrix

A menu item of the File menu allows the user to import the evaluation matrix from file. The procedure imports the criteria tree too, just as happens for the single alternatives import.

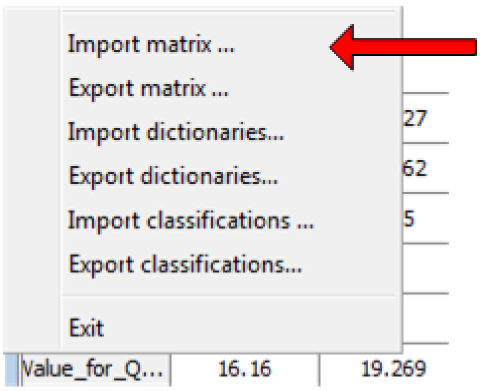


Fig. 23: Import matrix menu item

The format of the import file is the same used for the matrix export file. It is a CSV file where the separator character is ';' and the columns contains the values of the matrix, besides the first columns which contains the full path of the criterion; the first row contains the name of the alternatives.

Exporting data of the evaluation matrix

You can export data, in CSV format, by clicking on a button; this button will be available at the bottom of each table inside the SESAMO application.
The separator used to columns of data is the ";" (semicolon).

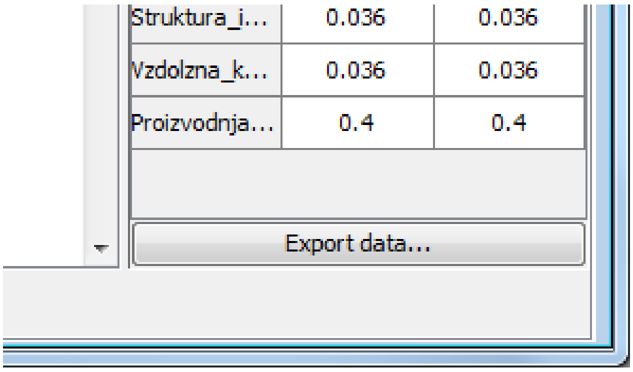


Fig.24: Export data button.

Data in CSV format can be imported and exported in/to Excel program

Dictionaries and classifications

The dictionaries and classifications are modules that allow you to associate numerical values to certain user-specified strings, to insert in the evaluation matrix qualitative values for criteria.
The difference between dictionaries and classifications is that while the former represents an association of 1-1, as a string is a numeric value, the classifications associates a range of values to a qualitative value.
The assignment of a dictionary or a classification with a criterion occurs through the properties windows of the criterion itself.

Defining a dictionary

The procedure for the definition of a dictionary is shown in Fig.25.

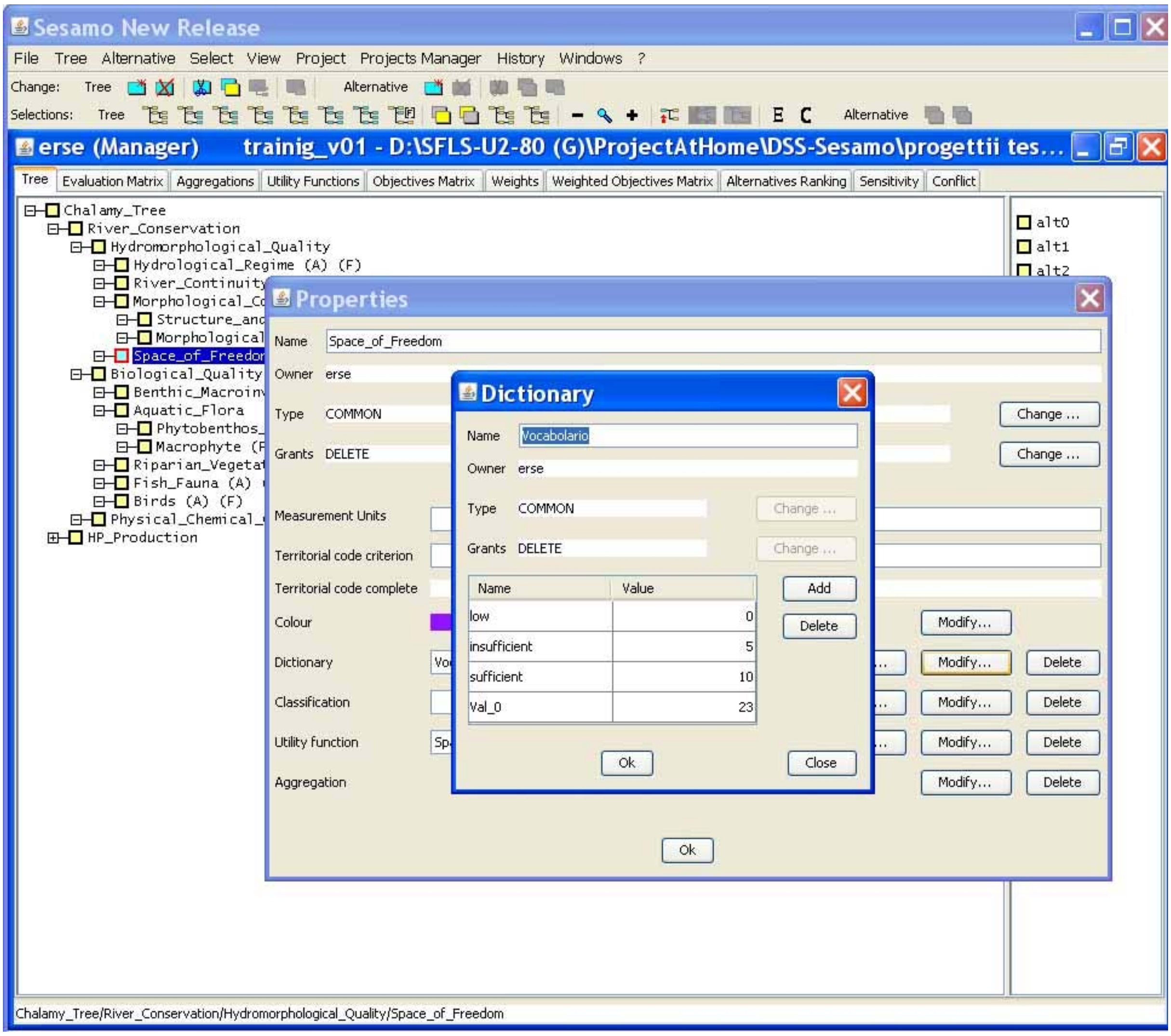


Fig.25: Creating a dictionary.

The form defining a default dictionary takes all the values of the criterion in the evaluation matrix and generates as many entries as these values, associating them with a conventional name that is the position occupied within the same dictionary.
The user is free to change the string associated with a value, add a few words or remove them.
The only rule to be observed is that there are not two words equal.

Defining a classification

The procedure for defining a classification is shown in Fig.26.

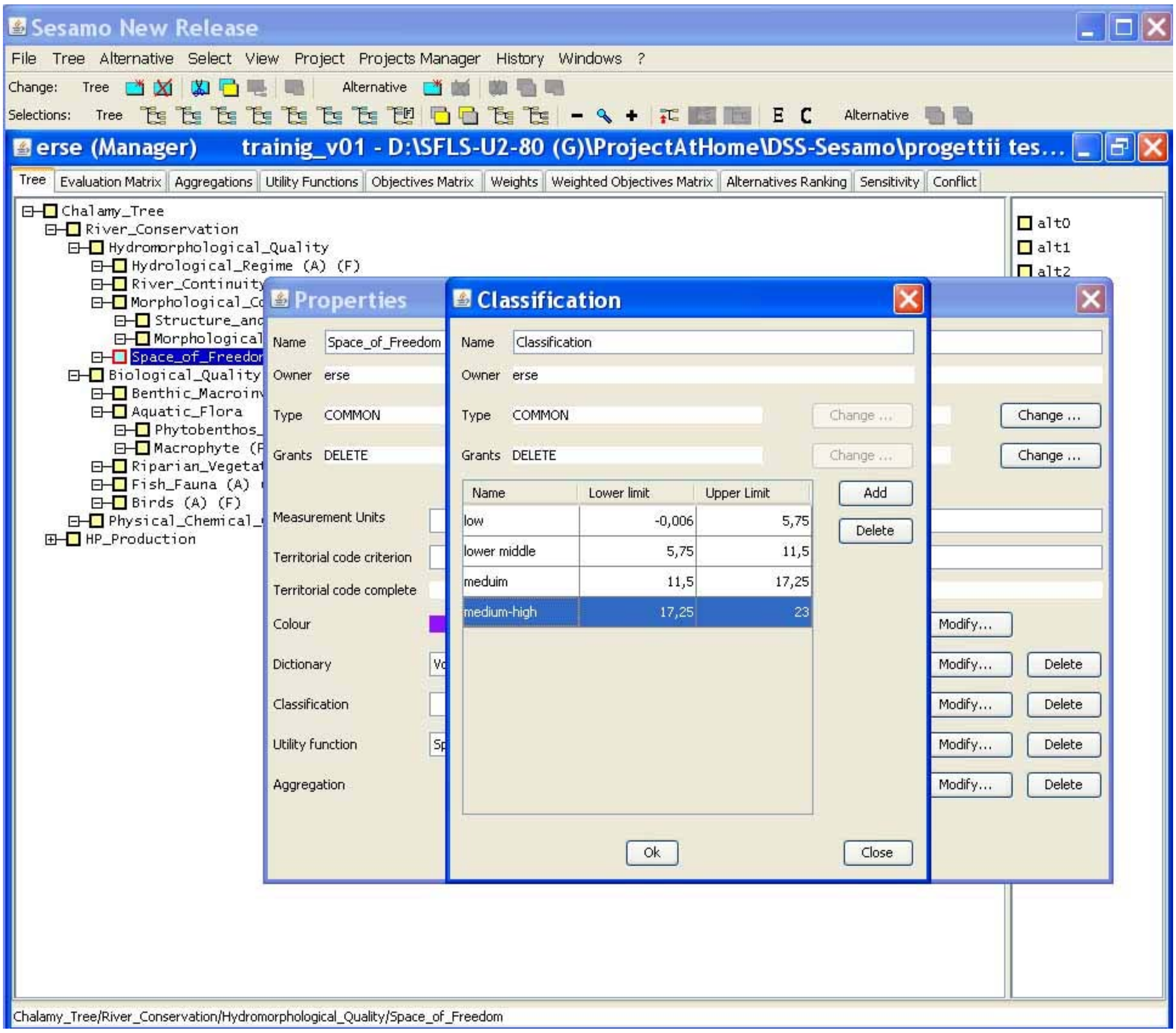


Fig.26: Creating a classification.

To define a classification, the program initially prompts you to insert the number of classes that are to be created from the values contained in the evaluation matrix. Then, it displays the form shown in Fig.26 which contains the definition of the required classes, based upon the values of the criterion.
Intervals defined for a class are open for the lower limit and closed for the upper one.
As for dictionaries, even for the definition of a classification the user can freely change the name of a class of values, add or remove classes.
There cannot be two classes with the same name, nor there can be overlapping among the intervals defining the classes.

Creating aggregations

The aggregations panel (Fig.27) allows the creation of aggregations among the nodes of the evaluation tree.

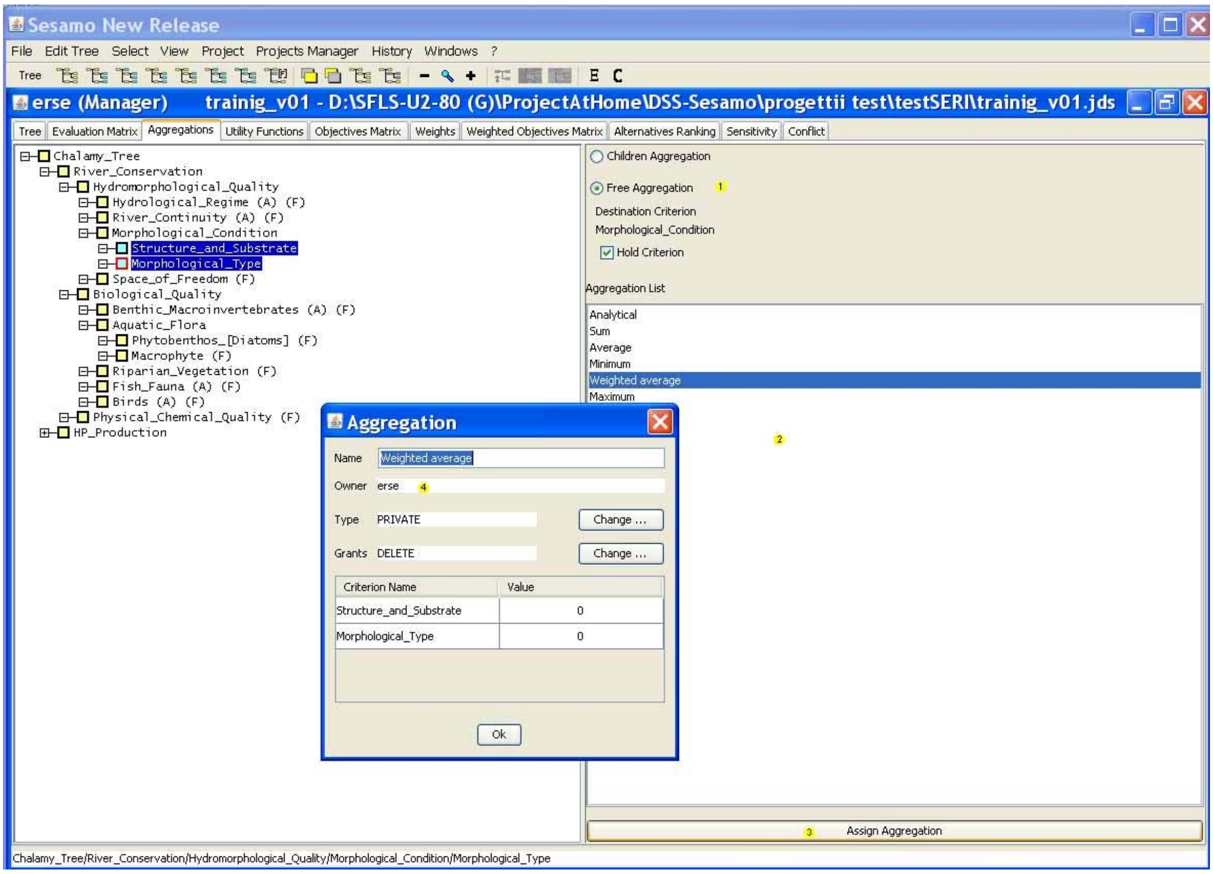


Fig.27: Creating an aggregation.

Creating an aggregation allows you to assign a criterion (criterion of destination) the value resulting from an operation of aggregation of values given by other criteria (criteria source).
Aggregations are divided into two categories (1), called the *Children Aggregations* and *Free Aggregations* that have slightly different way of creation.
The list of types available for both categories is shown in Fig.27, in the list (2).

It has been introduced a new category of aggregation function but only to allow the definition and the visualization of causal relations to be applied to children, as described in the dedicated subchapter.

Children aggregations

This category includes all the aggregations that are applied to the children of a destination node and are independent of the number of children that are going to be aggregated. For example, the average operation is independent of the number of children: whatever it is, the program will always be able to follow the definition of aggregation by averaging the values of children of the destination node.
To create aggregations of this type, simply select the criterion target, the aggregation type from the list (2) and assign the aggregation through the button (3).

Free Aggregations

The term free aggregations means an aggregation that, unlike the previous one, is tied to the tree structure.
In this category of aggregations you have to select all source nodes, which are object of the aggregation and thus, if the tree is modified at a later time (such as removing certain criteria), there is the possibility that the aggregation defined above is no longer valid.
An example of this type of aggregation is shown in Fig.27, namely “weighted average”. In the form that is presented here, in fact, the user must assign a weight to each of the sources listed. If any of the criteria is lacking source (as a result of a change in the structure of the tree), aggregation is no longer valid.

In this case, you could see a red (A) to indicate that the aggregation concerns children whose structure has been modified.

To create a free aggregation you must follow these steps:

- select the target criterion, to which the result of the aggregation will be assigned;
- set the checkbox "Block Criterion";
- select the source criteria;
- select the type of aggregation to be applied;
- set the parameters of the form that is shown.

Causal relations

A new typology of functions has been added to the list of aggregation functions.
This kind of function allows the definition of the causal relationship to be applied to children.

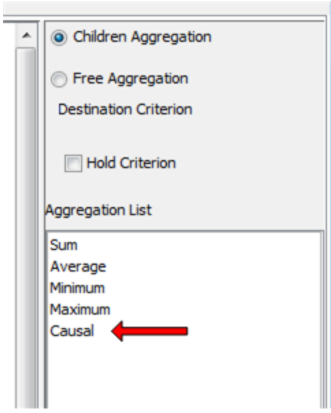


Fig.28: Creating a causal relation.

Causal aggregation can be applied to nodes that have only one child.
By selecting this aggregation you will be able to build a function with the same wizard used for the Utility Functions.

Assign utility functions

In the Utility Functions panel, shown in Fig.29, the user has the ability to assign Utility Functions to the criteria for a evaluation tree.

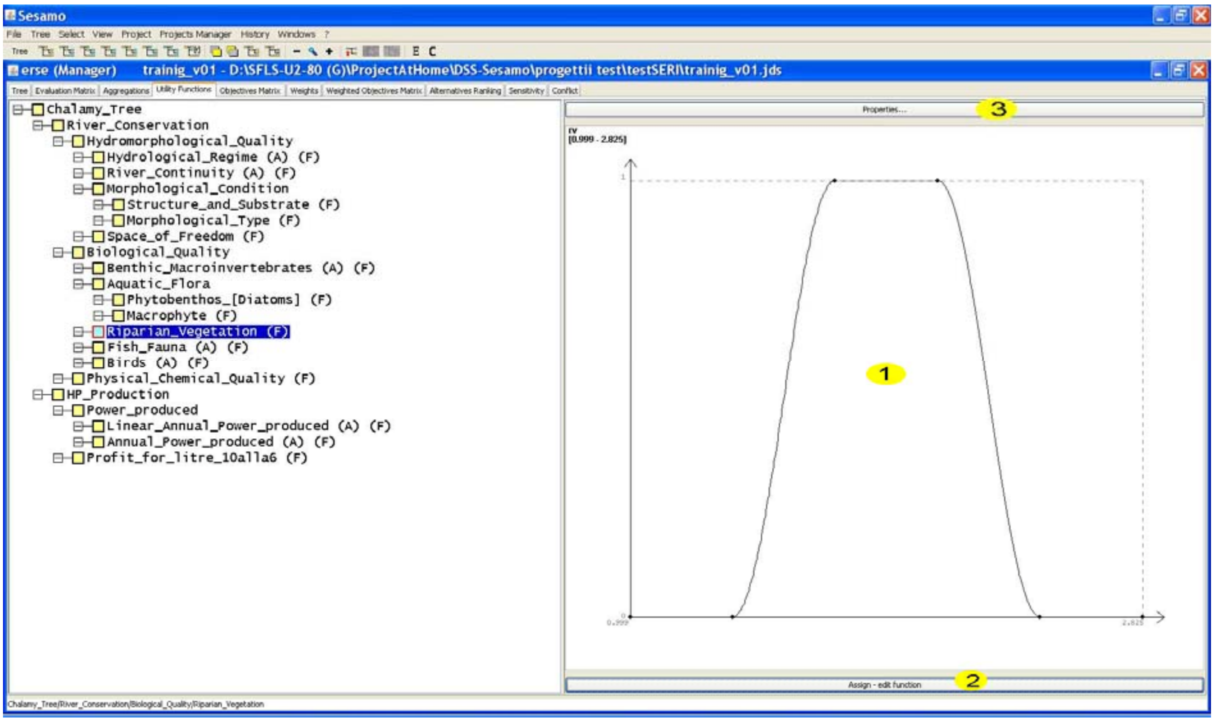


Fig.29: Utility Functions.

In the panel shown in Fig.29, the user can view the function assigned to the criterion selected in the right side of the screen (1); in the top there is a button to open the properties of the function (3). To assign a function to a new criterion or modify an already assigned one, you need to click (2). This action activates a wizard that allows you, step by step, to set all the features of the function.

Defining the name and the domain

In the first step of the procedure for assigning the utility function, shown in Fig.30 you define the function name (1) and the lower limit (2) and the upper one (3) of its domain.

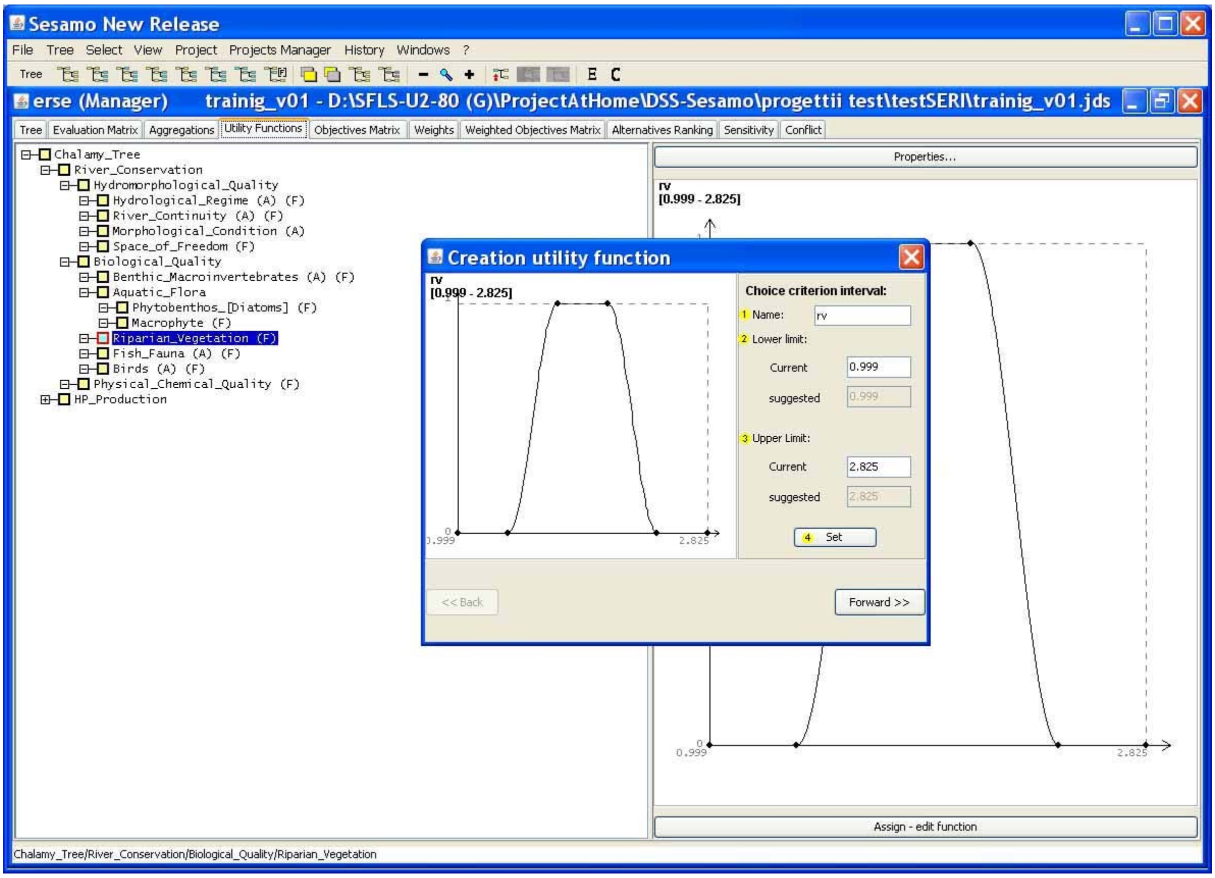


Fig.30: Creating a function - Setting up domain.

Pressing the "Set" button (4), all changes are made effective and the new limits are represented on the chart at the left side of the window.
Pressing the button "Next" takes you to the next step.

Defining the function type

In this second step (Fig.31), the user must choose the type of function that he wants to create.
The program provides four main categories of functions: for points, parametric, analytical, standard.

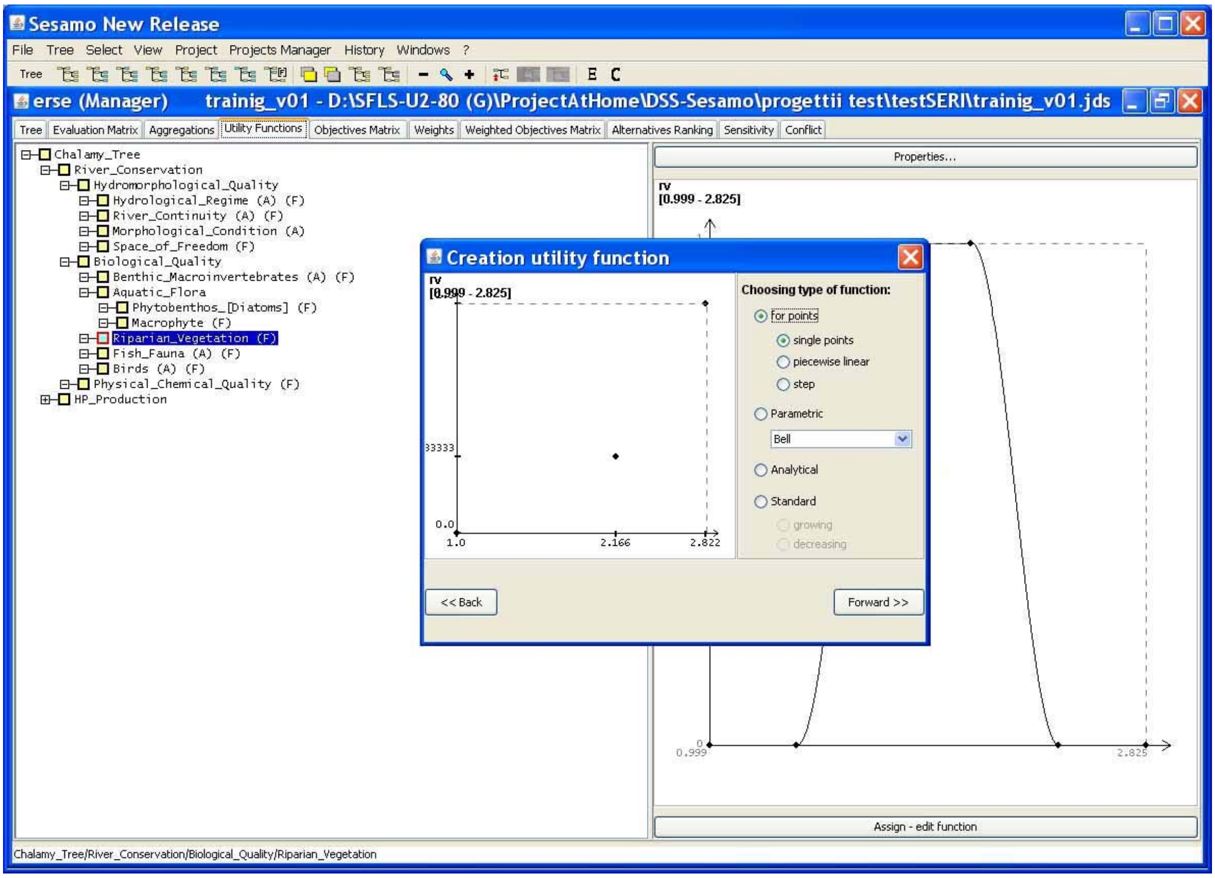


Fig.31: Creating a function - function for points

Functions for points

This category includes all functions that can be built by defining the coordinates of the points that compose it. The subtypes of the functions for points differ in behaviour between a point and another:

- single points function: the function is defined only at the specified points and elsewhere it is not defined;
- piecewise linear function: the points that define the function are joined through segments;
- step function: in the interval between two points, the function takes the value of the left point.

Parametric function

This type of functions is characterized by having a shape that depends on a small number of parameters. In Fig.32 there is an example.

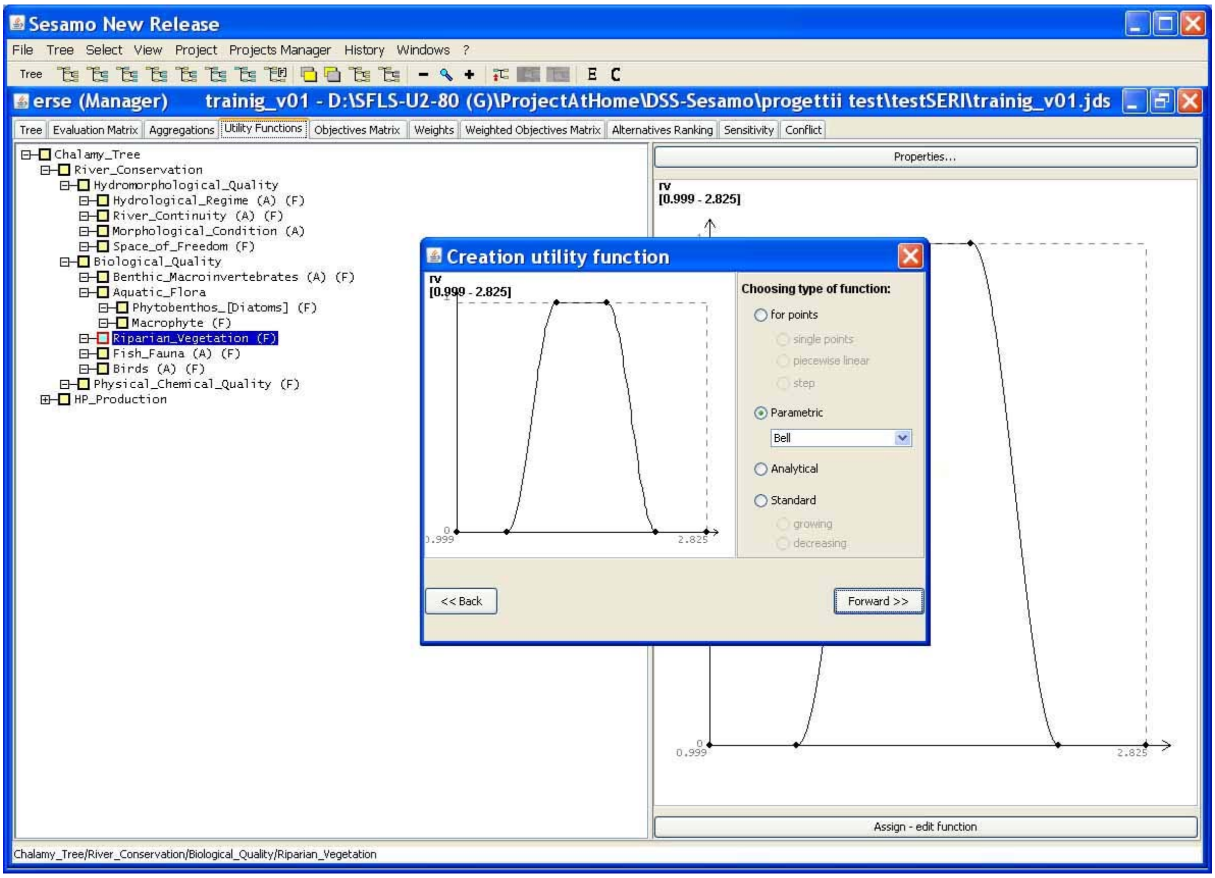


Fig.32: Creating a function - Parametric Function.

Analytic function

This category contains those functions that the user can compose using the basic functions of mathematical analysis.

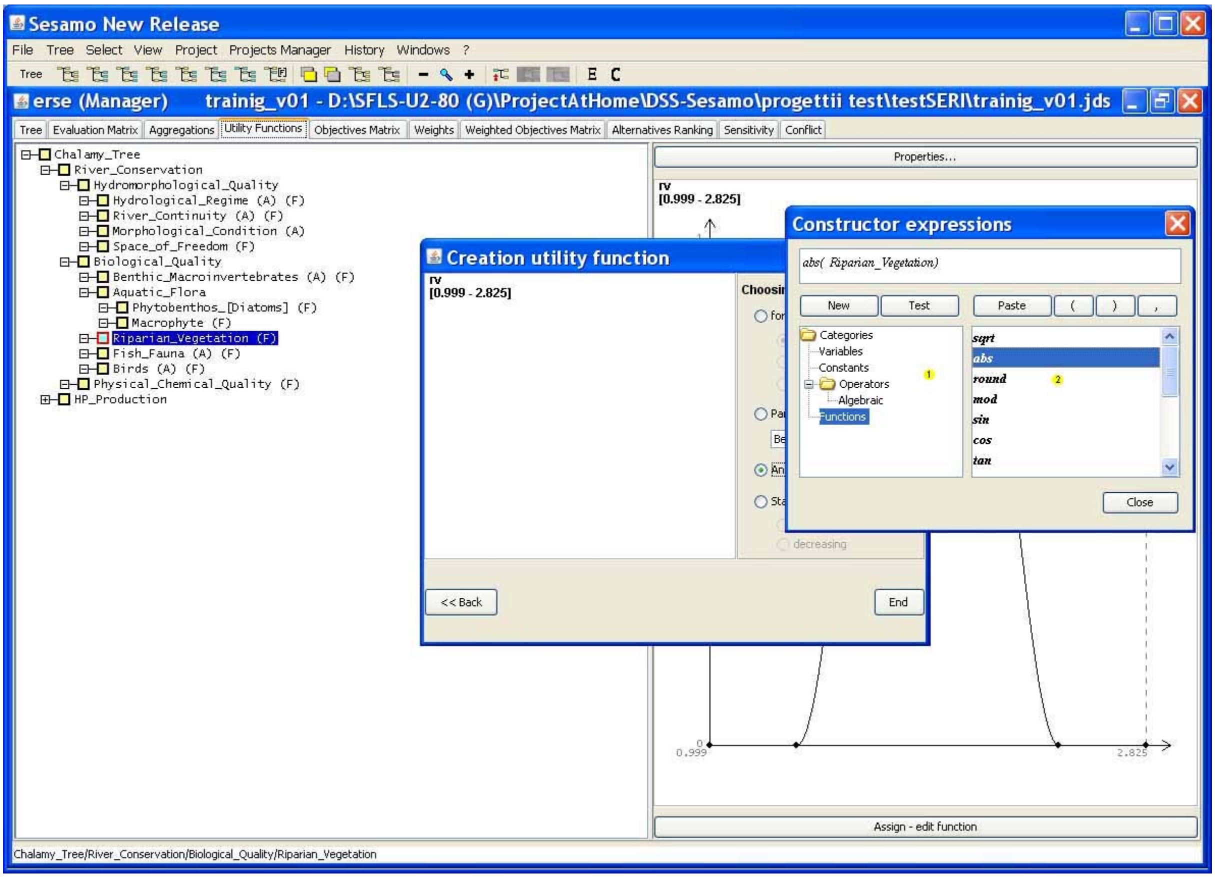


Fig.33: Creating a function - Analytic function.

In the form shown in Fig.33, the user can type the function directly in the field that he wants (3), or he can compose the function itself using the basic functions provided by the program. These are organized in the categories shown in the lower left of the form (1); by selecting a category on the right side (2), the user will see a list of all the functions belonging to it.
By L-Clicking on a feature or selecting it and pressing the "Paste" button, it is added to the text field (3).
After the insertion of the function, through the "Verify" button you can check the syntactic correctness of the function itself; in case there are not errors you will receive a verification success, otherwise you will be notified of any errors.

You can export the graph of the Utility Functions. To do this, you have simply to click the right mouse button on the graph you want to save. The exported image has the same size of the representation of the graph on the screen. Image file formats available are: BMP, GIF, JPEG, PNG.

Standard function

The term standard function indicates an ascending or descending linear function of the type shown in Fig.34.

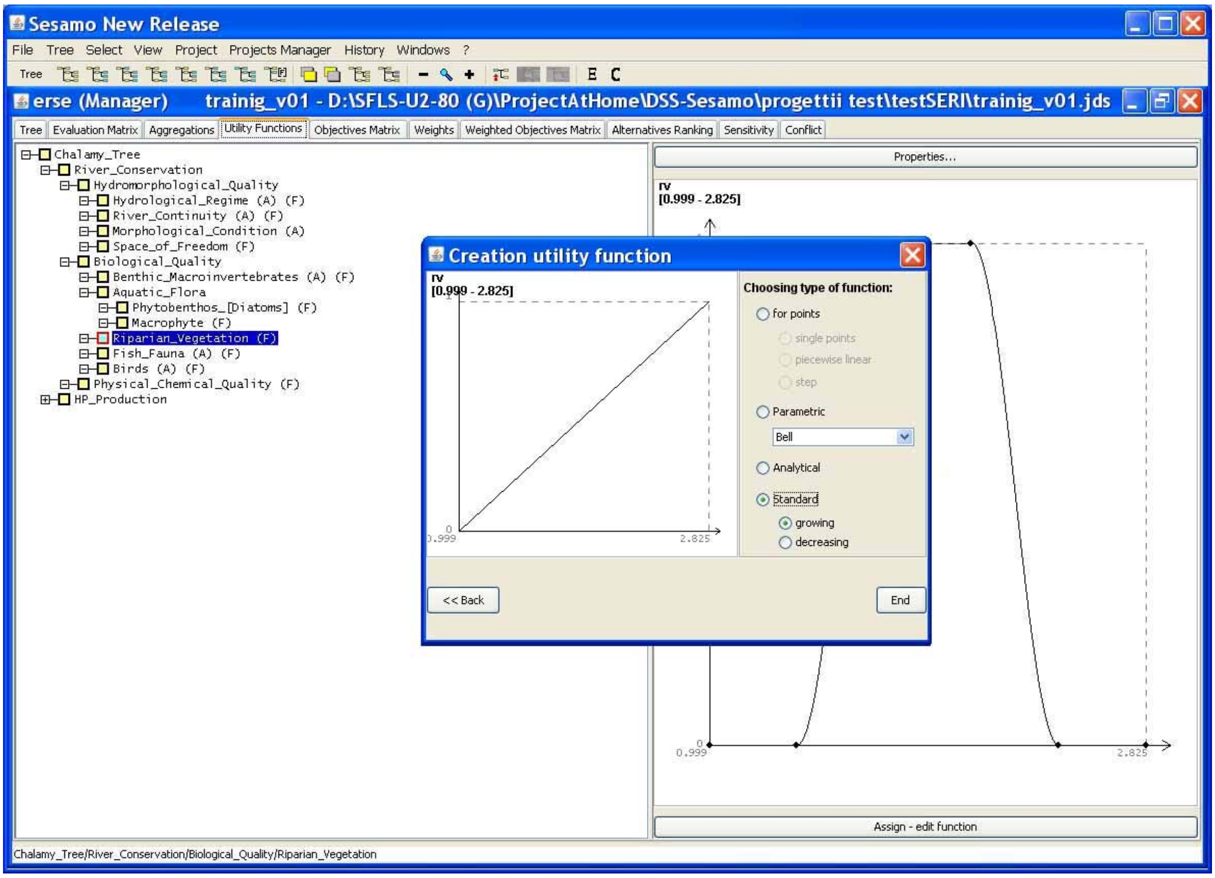
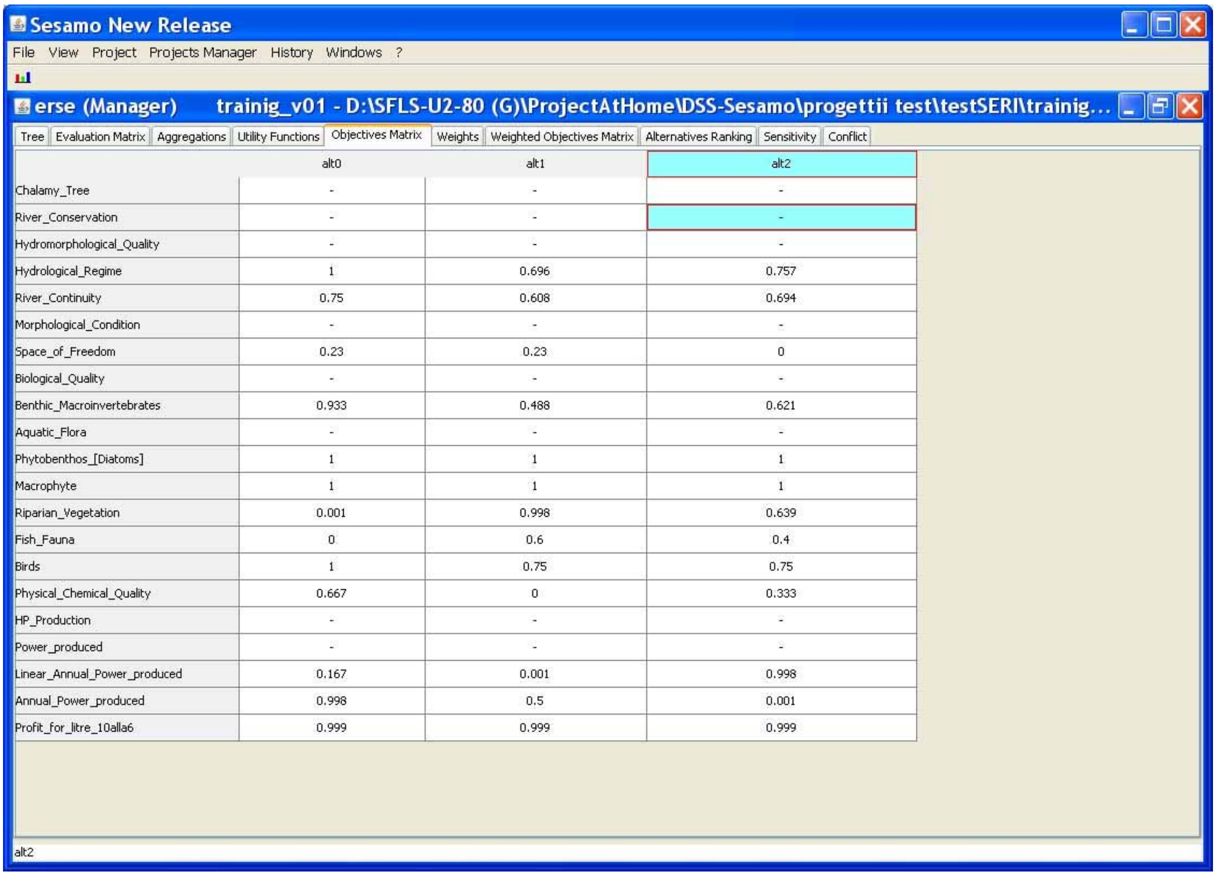


Fig.34: Create a function - Standard Function

In many cases, the decision maker has no clear idea of the form that the utility function should have for a particular criterion, but he only knows that its performance is increasing (e.g. in the case of income) or decreasing (e.g. in the case of the concentration of a pollutant).
This type of function gives the user a quick way to resolve the situation without force him to define a function through points.

Control the objectives matrix

The objectives matrix panel (Fig.35) is very similar to the evaluation matrix panel, but in this case the cell contains the values that the criteria assume after the application of the utility functions.
For this reason, all the values contained in the objective matrix varies between zero and one.



	alt0	alt1	alt2
Chalamy_Tree	-	-	-
River_Conservation	-	-	-
Hydromorphological_Quality	-	-	-
Hydrological_Regime	1	0.696	0.757
River_Continuity	0.75	0.608	0.694
Morphological_Condition	-	-	-
Space_of_Freedom	0.23	0.23	0
Biological_Quality	-	-	-
Benthic_Macroinvertebrates	0.933	0.488	0.621
Aquatic_Flora	-	-	-
Phytobenthos_[Diatoms]	1	1	1
Macrophyte	1	1	1
Riparian_Vegetation	0.001	0.998	0.639
Fish_Fauna	0	0.6	0.4
Birds	1	0.75	0.75
Physical_Chemical_Quality	0.667	0	0.333
HP_Production	-	-	-
Power_produced	-	-	-
Linear_Annual_Power_produced	0.167	0.001	0.998
Annual_Power_produced	0.998	0.5	0.001
Profit_for_litre_10alla6	0.999	0.999	0.999

Fig.35: Objectives Matrix

The criteria and the alternatives represented in the objective matrix are those that have been selected in the tree panels.
A dash in an objective matrix cell represent the fact that no valid utility function has been associated to the correspondent criterion.

Since this is a matrix of values obtained through a calculation based on the evaluation matrix and utility functions, it is not possible for the user to change the values here represented. Again there is the possibility to display the values through a bar chart.

Assigning weights

In the Weights panel the user can assign weights to the criteria of the evaluation tree.

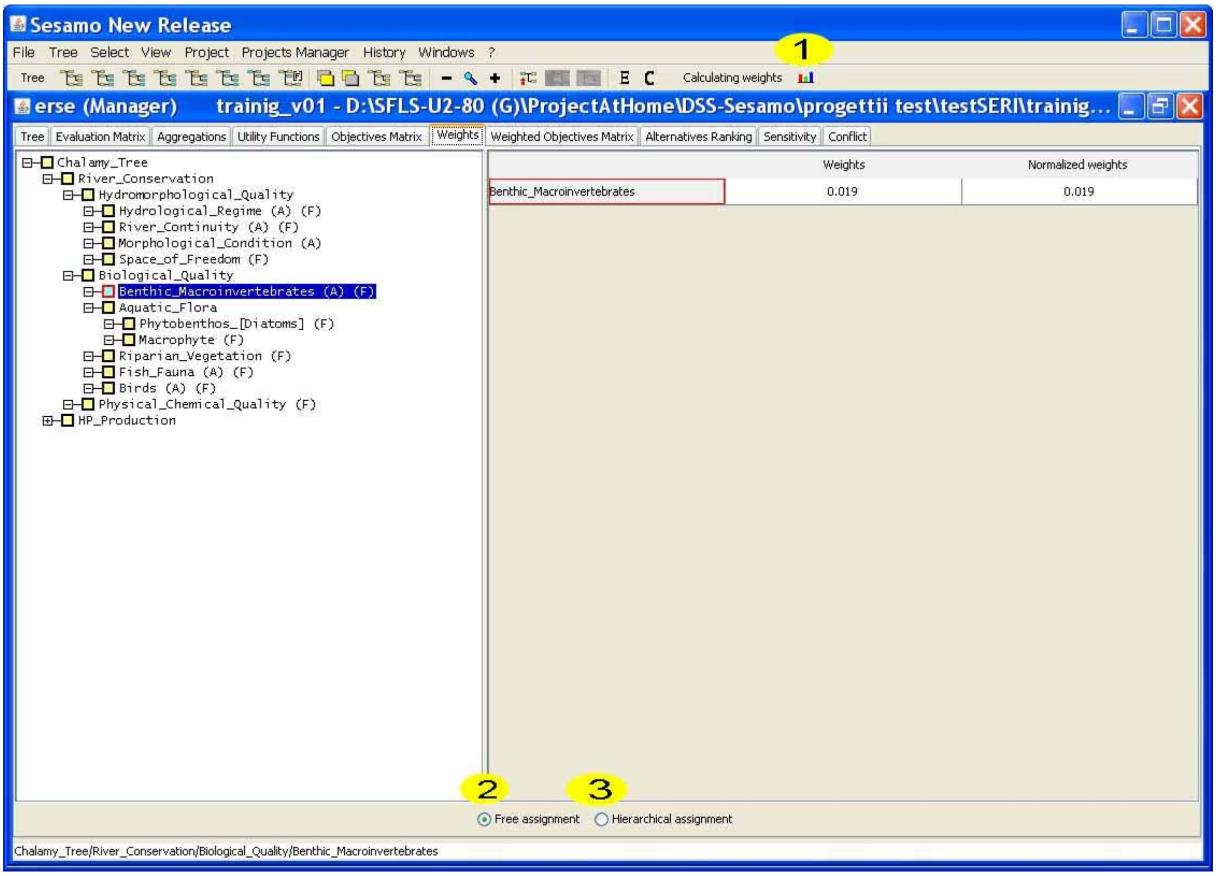


Fig.36: Procedure of entering weights.

In Fig.36 through commands (1) you can view a chart that allows you to change the vector via the graphics mode already described in the panel of the evaluation matrix.
The weights can be assigned in two ways (2) and (3):

1. **Free assignment**: the user selects on the tree criteria and assigns a weight to them directly, as shown in Fig.36. The numbers must be included in the column "Weights".
2. **Hierarchical assignment**: in this mode, the user does not directly determine the weights of the criteria, but give each criterion a coefficient of relative importance, the assignment is done in a group for all sons of selected node, as shown in Fig.37.

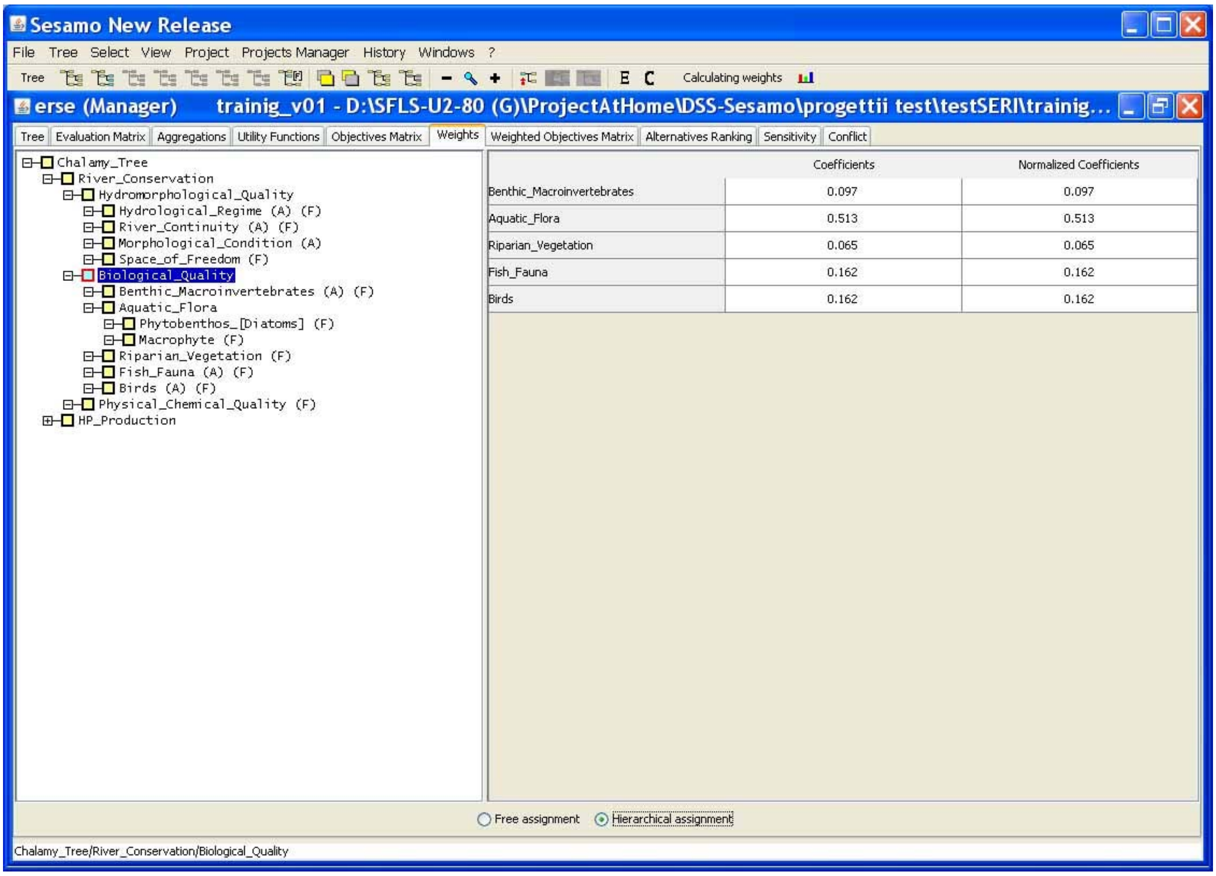
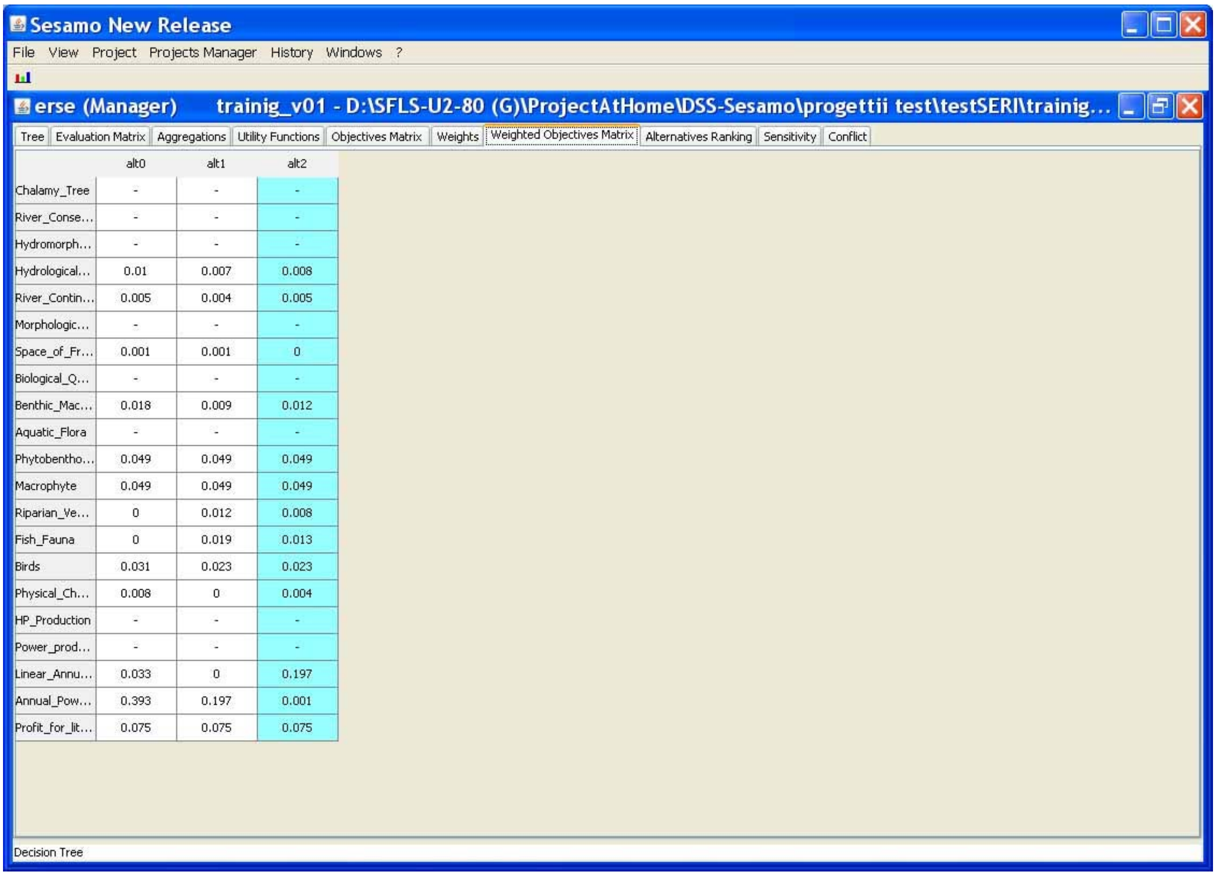


Fig.37: Assigning hierarchical weights.

In the example represented above, the user chooses the criterion “Biological_Quality” and on the right the tool automatically shows its children. The criteria were assigned their coefficients of relative importance.

Weighted Objectives Matrix

In this type of representation, you can see the value of each objective multiplied by the weight that you have previously assigned.



	alt0	alt1	alt2
Chalamy_Tree	-	-	-
River_Conse...	-	-	-
Hydromorph...	-	-	-
Hydrological...	0.01	0.007	0.008
River_Contin...	0.005	0.004	0.005
Morphologic...	-	-	-
Space_of_Fr...	0.001	0.001	0
Biological_Q...	-	-	-
Benthic_Mac...	0.018	0.009	0.012
Aquatic_Flora	-	-	-
Phytobentho...	0.049	0.049	0.049
Macrophyte	0.049	0.049	0.049
Riparian_Ve...	0	0.012	0.008
Fish_Fauna	0	0.019	0.013
Birds	0.031	0.023	0.023
Physical_Ch...	0.008	0	0.004
HP_Production	-	-	-
Power_prod...	-	-	-
Linear_Annu...	0.033	0	0.197
Annual_Pow...	0.393	0.197	0.001
Profit_for_lit...	0.075	0.075	0.075

Fig.38: Panel of weighted objectives matrix.

In the table shown in the panel, at the parents node, you'll see a dash instead of the final value (weighted sum of objectives).

Creating the rank of alternatives

Fig.39 shows the Alternatives Ranking panel, which displays the evaluation results, or the ranking of the performance of the alternatives, both in tabular and in graphical form.

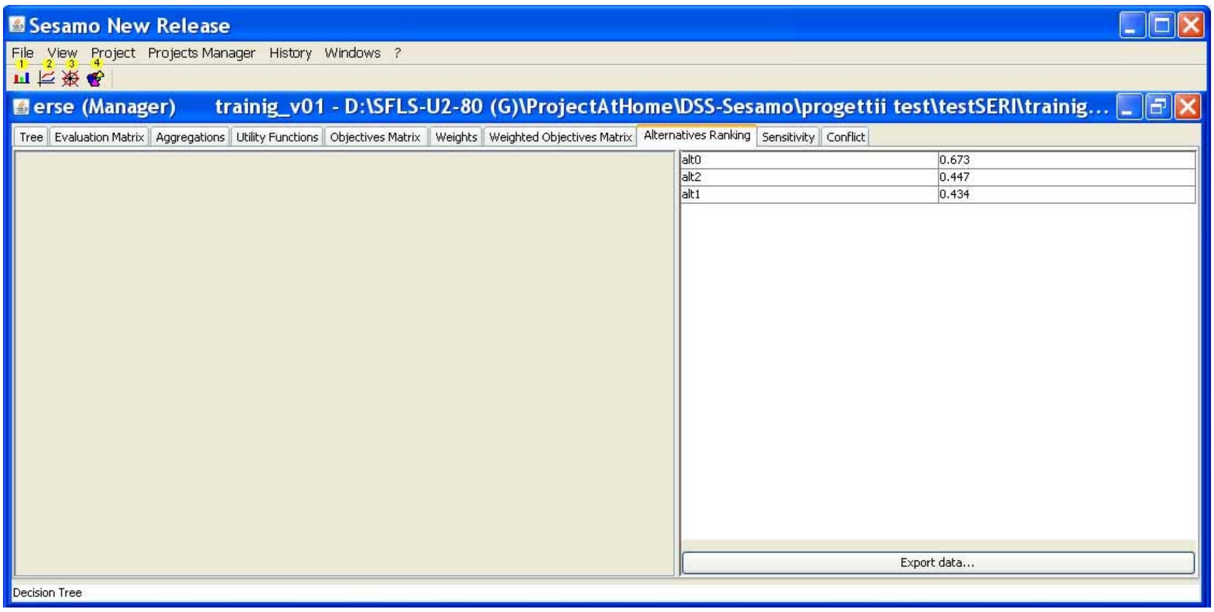


Fig.39: Ranking of alternatives.

In the toolbar, there are commands for four types of graphical representation of the results:

- bar chart (1);
- line chart (2);
- radar chart (3).
- pie chart(4).

Besides these, there are also available buttons for zoom control of the graphics; zoom is active only in the bar graph and in the line one.
While in the table of the ranking there are represented performances of all the alternatives, graphics contain only a representation of the criteria and alternatives which are selected.

Bar Graph

Each alternative is represented by a column (bar) whose value is the sum of the contributions of the selected criteria (Fig.40).

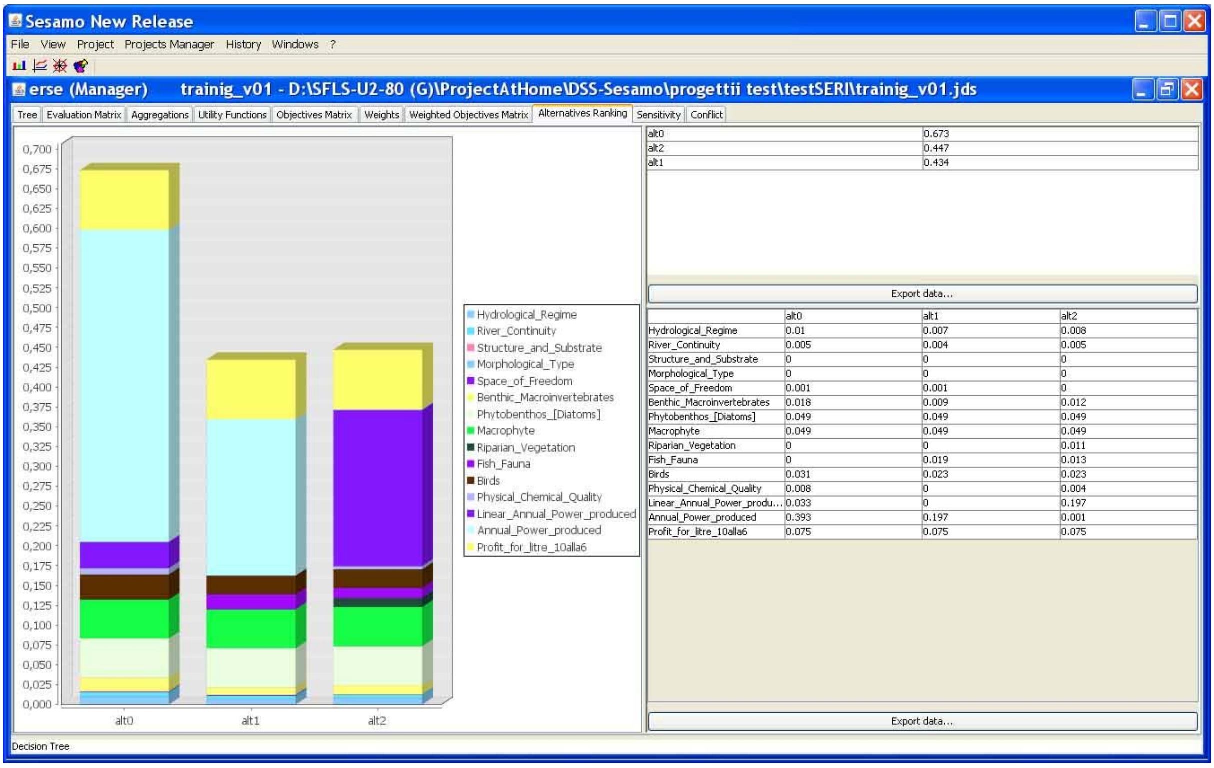


Fig.40: Rank of alternatives - Bar graph.

Since, as mentioned above, the table on the right shows the overall performances of the alternatives, in general the value represented in the chart will be different from that shown in the table.
The main purpose of this kind of representation is to highlight which of the selected criteria gives the biggest contribution to the final result.

Pie chart

This type of graph is shown in Fig.41.

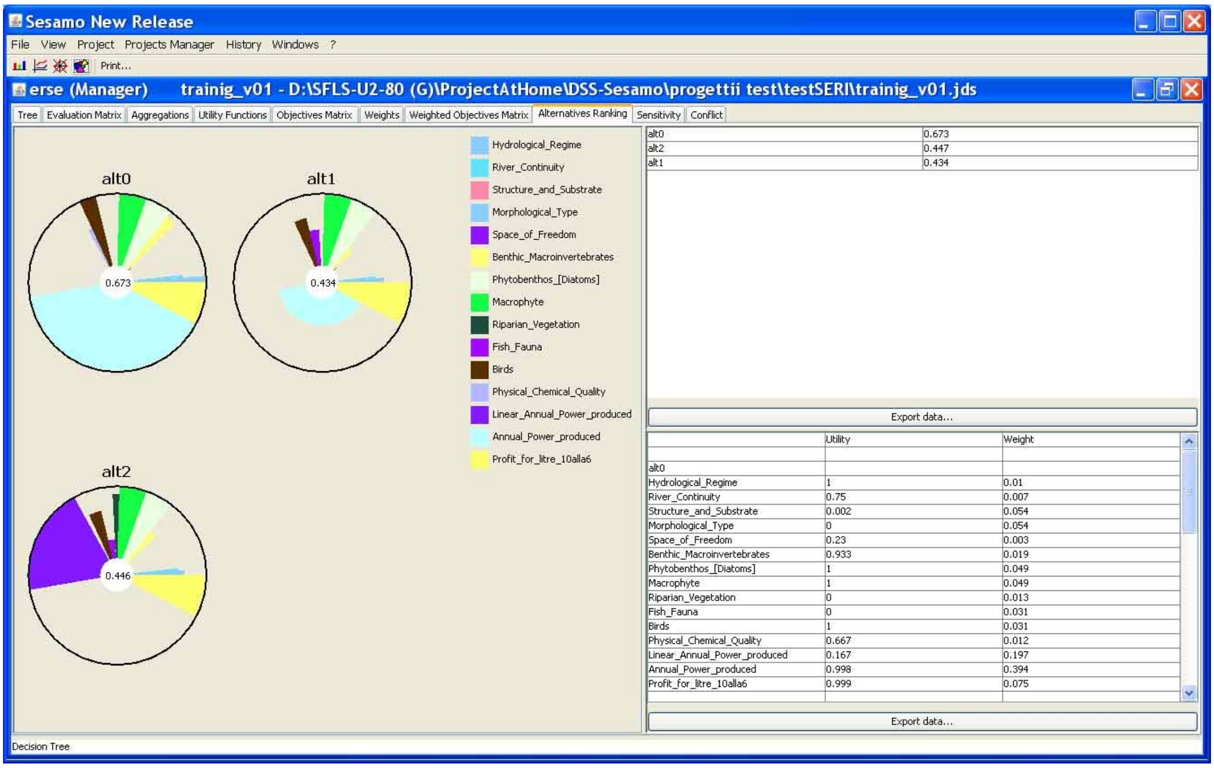


Fig.41: Rank of alternatives - pie chart.

The graph represents the overall performance of the selected alternatives, calculated considering all criteria. In this representation, the radius represents the utility value, while the angle represents the weight.

Line Chart

The representation given in this graph is dual to the one concerning the bar graph (Fig.42).

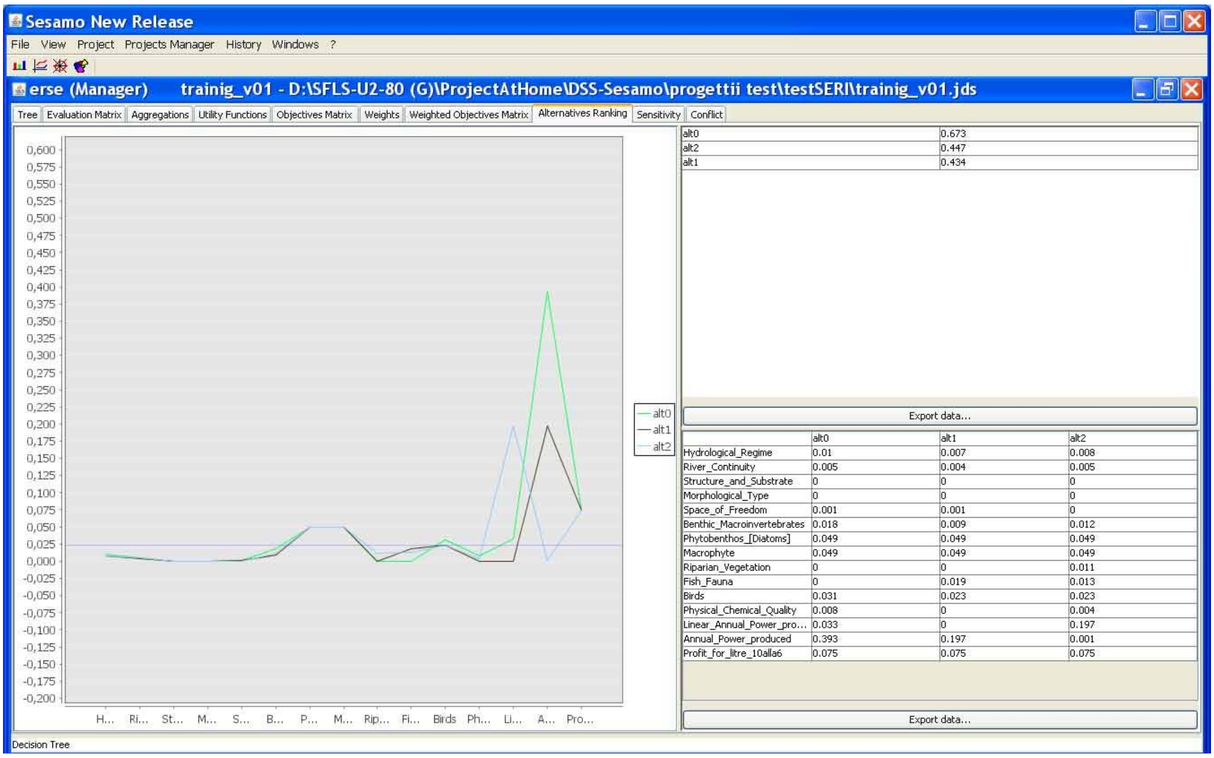
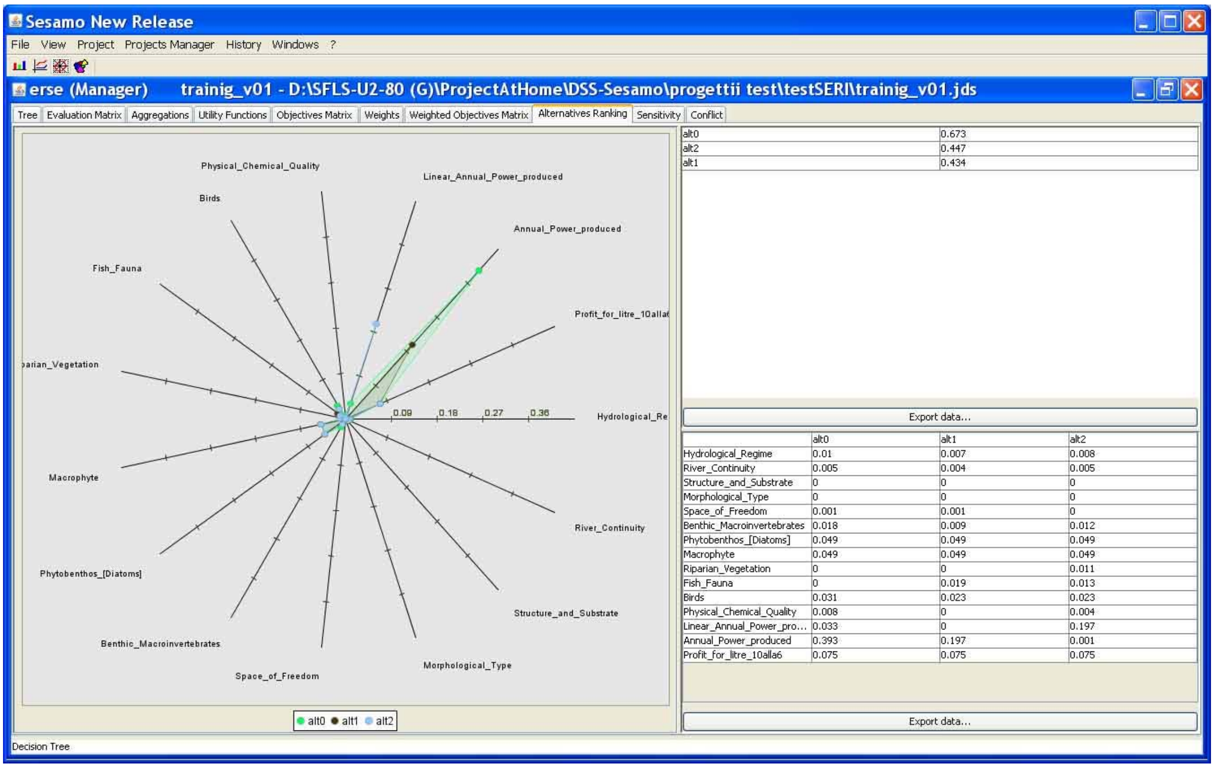


Fig.42: Rank of alternatives – line chart.

In this case, the criteria are represented in the abscissa while the ordinate shows the objective value of the same.
The main purpose of this type of representation is to demonstrate the behaviour of selected alternatives against criteria. This way you will have an immediate perception of what criterion contributes most to the difference between the performances of alternatives.

Radar Chart

This type of representation is conceptually very similar to that offered by the line chart in the previous section (Fig.43).



	alt0	alt1	alt2
Hydrological_Regime	0.01	0.007	0.008
River_Continuity	0.005	0.004	0.005
Structure_and_Substrate	0	0	0
Morphological_Type	0	0	0
Space_of_Freedom	0.001	0.001	0
Benthic_Macroinvertebrates	0.018	0.009	0.012
Phytobenthos_[Diatoms]	0.049	0.049	0.049
Macrophyte	0.049	0.049	0.049
Riparian_Vegetation	0	0	0.011
Fish_Fauna	0	0.019	0.013
Birds	0.031	0.023	0.023
Physical_Chemical_Quality	0.008	0	0.004
Linear_Annual_Power_pro...	0.033	0	0.197
Annual_Power_produced	0.393	0.197	0.001
Profit_for_litre_10alla6	0.075	0.075	0.075

Fig.43: Rank of the alternatives - radar chart

In this case, however, you have a better perception of the extent of dominance between alternatives.

Sensitivity analysis

The sensitivity panel allows you to develop the sensitivity analysis in relation to the criteria and alternatives selected in the panel of the tree. In other words, in this panel it is possible to analyse how robust the ranking of the alternatives is, in relation to the given vector of weights.
By clicking on the name of the panel, a series of four panels appears that can be opened in the same way as the main panel and allows to study the sensitivity in four different ways.
Any changes to the vector of weights assigned by the decision makers within these panels have no effect outside of the panel.

Analysis of Rank Reversal

The “Rank Reversal Vectors” panel (Fig.44) identifies, if any, the vectors of weights that change the ranking of the performances achieved by the alternatives.

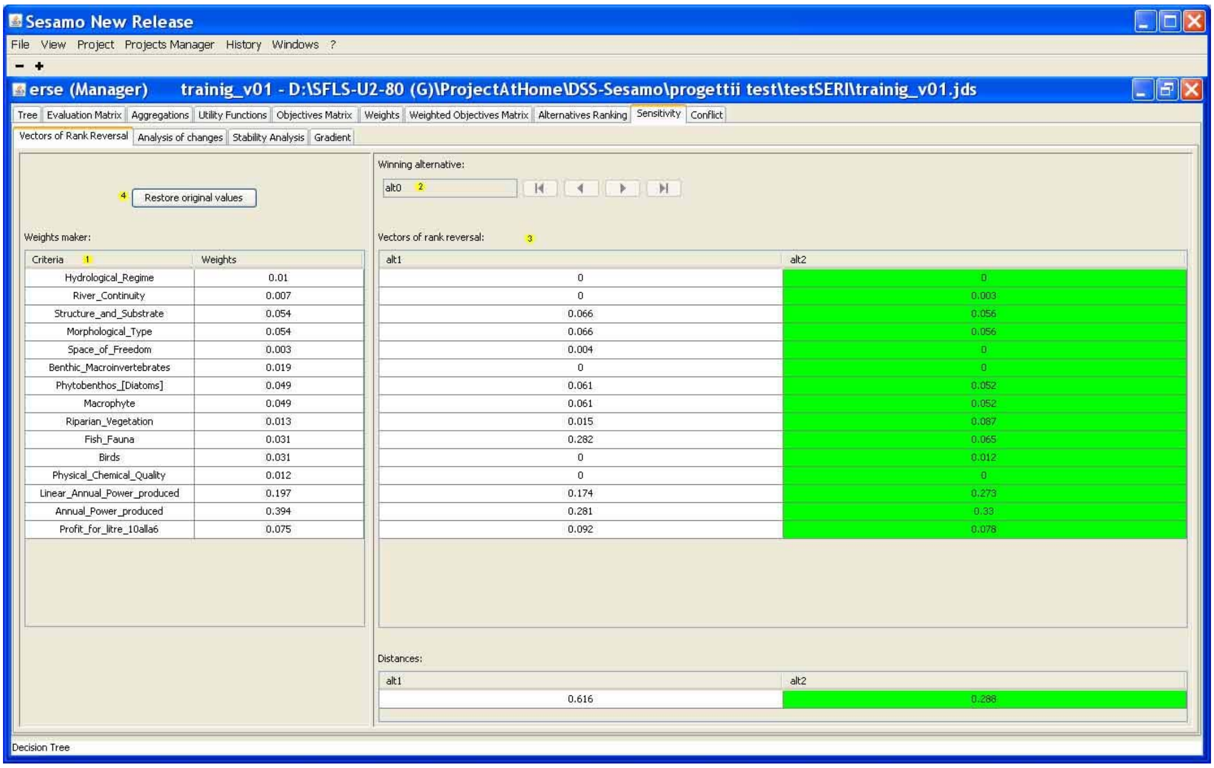


Fig.44: Panel Sensitivity - Vectors Rank Reversal.

The table in Fig.44 (1) shows the selected criteria and, initially, the weights assigned to criteria by the decision maker. Controls (2) display and allow you to select one of the winning alternatives, given the weight vector (1). The table (3) consists of many columns as the number of the selected alternatives, except for the winning alternative. Each column represents a vector of weights, with the following properties:

- it makes the alternative corresponding to this vector and the winning alternative (2) equivalent with each other;
- it has the same Euclidean norm of the vector (1);
- among all vectors satisfying the first two properties, it is the closest in terms of Euclidean distance to the vector (1).

Note that each of these vectors exists and is unique, unless the corresponding alternative is dominated by the winning one (2). In this case, each cell of the vector contains a hyphen ("-").
Among all vectors calculated, the one highlighted in green is the closest to the vector (1).
Button (4) can restore in the table (1) the values of weights that the decision maker has assigned before starting the sensitivity analysis.
A <shift>L-Click on a column of the table (2) brings up a dialog box (Fig.45).

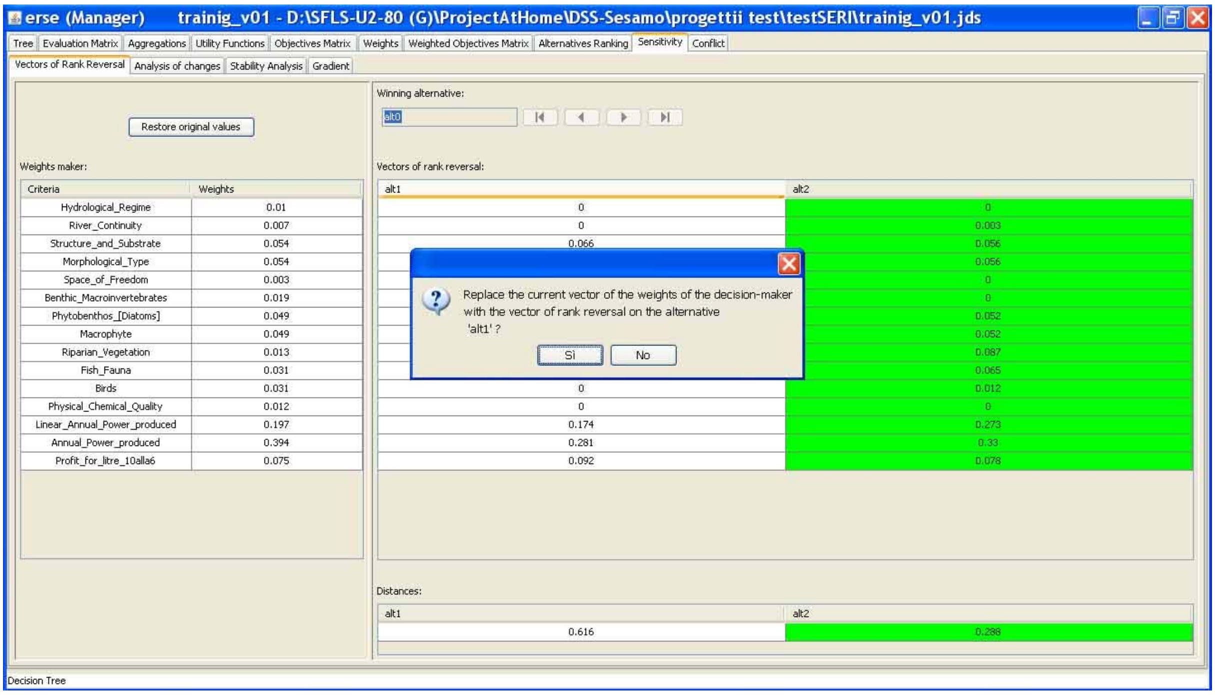


Fig.45: **Sensitivity Panel - Vectors Rank Reversal: replacement of the weight vector of reference.**

Responding with a yes, the vector of weight2 (1) becomes the one selected with the L-Click and both winning alternatives and vectors of rank reversals are recalculated.
The vector introduced in the weights panel by the decision maker is not altered by this operation.

Analysis of the changes of weights

The "analysis of changes" panel, shown in Fig.46, allows you to change as you like (keeping constant the sum) the weights set by the decision maker to observe the effect of these changes on the ranking of the alternatives.

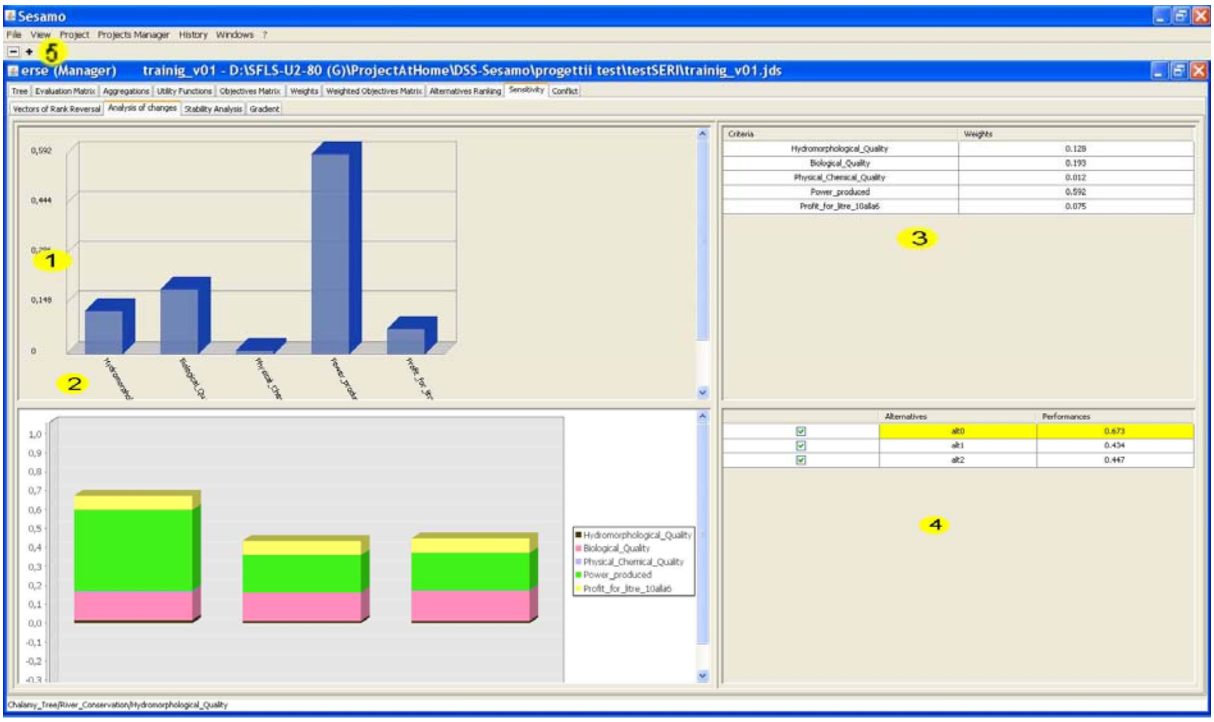


Fig.46: Sensitivity Panel - Analysis of changes.

The weights' vector initially equal to that given during the assigning weights step, is represented both graphically (1) and numerically (3). The graph (2) shows the performance of alternatives with the contribution of each criterion, and the table (4) shows the performance of alternatives in terms of numbers. The winning alternatives are highlighted in yellow.
Using the buttons on the upper left (5), you can zoom-in/zoom out horizontally the two graphs.

On the chart (1) you can change the weights both individually and in groups, with drag and drop with the mouse. You select the weights to be modified (which appear highlighted in green) with a L-Click on each, but you can select a group of weights to maintain fixed (which appear highlighted in red) by a R-Click on each. Deselecting a weight, this can be carried out with a new L-Click, if the weight is in the group to be changed or a new R-Click if the weight is in the group to keep fixed.

After performing the selection operations as you want, you can drag up or down to change the weights (those coloured in green), which would increase or decrease their values, each for the same amount. The other weights are calculated by the software so that the total amount remains constant (of course the weights marked in red are left unchanged). An example is illustrated in Fig.47.

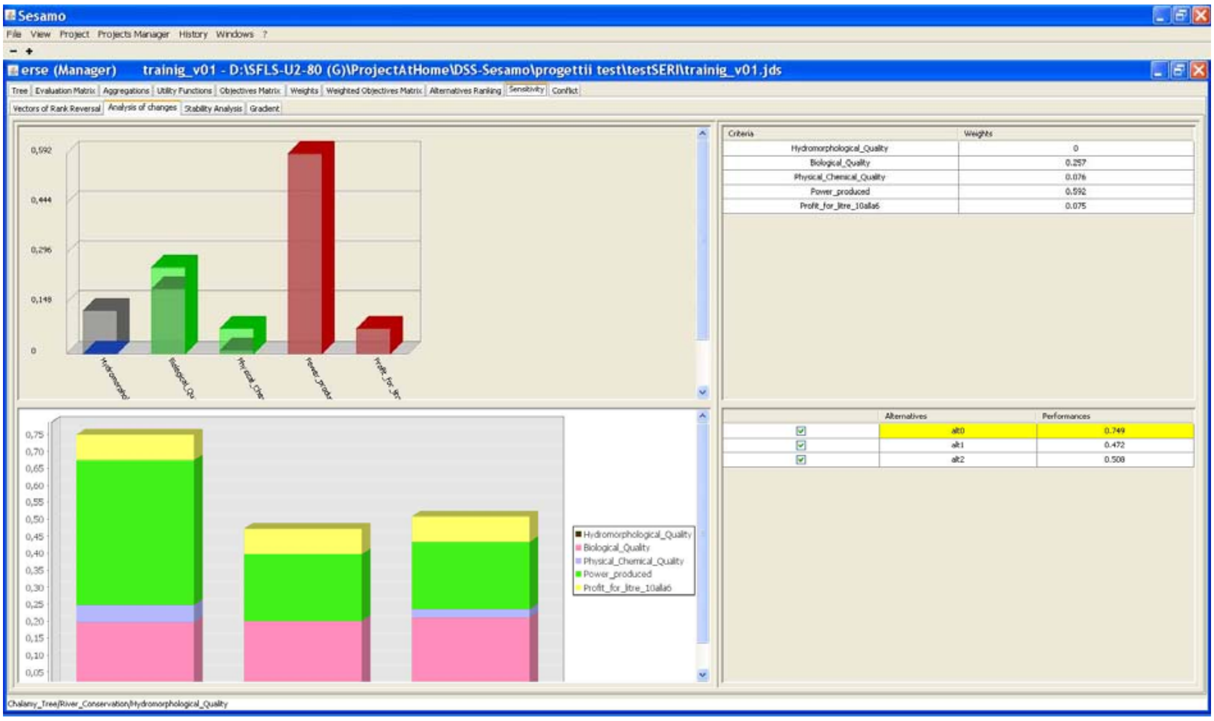


Fig.47: Sensitivity Panel - Analysis of changes: example of changing the weights

Note that overlapped to the modified values of weights, it is possible to see also the starting values of each bar (darker bars if the starting value was lower than the final one or coloured in gray if the starting value was higher than the final one).
All the changes affect only the weights inside the panel on the analysis of variations: you will not have any disruption of the weights assigned by decision makers in the dedicated step of the process.

Stability Analysis

Stability analysis panel (Fig.48) enables to assess the minimum amount of changes in individual weights that disturbs the ranking of alternatives generated by the weight vector being introduced in the assigning weights step.

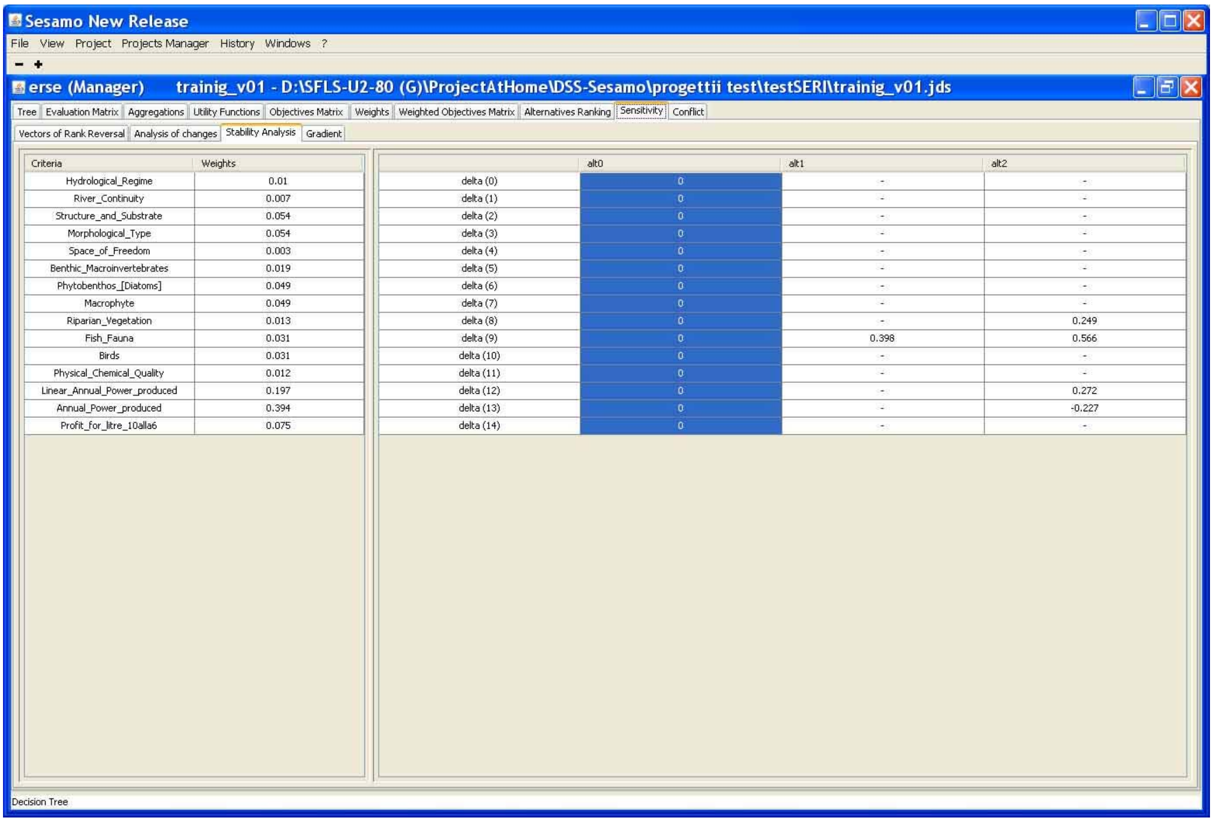


Fig.48: Sensitivity Panel - Stability Analysis

Gradient

The Gradient panel (Fig.49) allows you to see how the value of an objective varies by changing its weight.

You have to select the objective in the left table and you will see in the right chart for each alternative (coloured lines) the variation of the objective value (ordinate) with varying the associated weight (abscissa).

In this way, you can figure out what is the weight for that objectives that changes the ranking of alternatives.

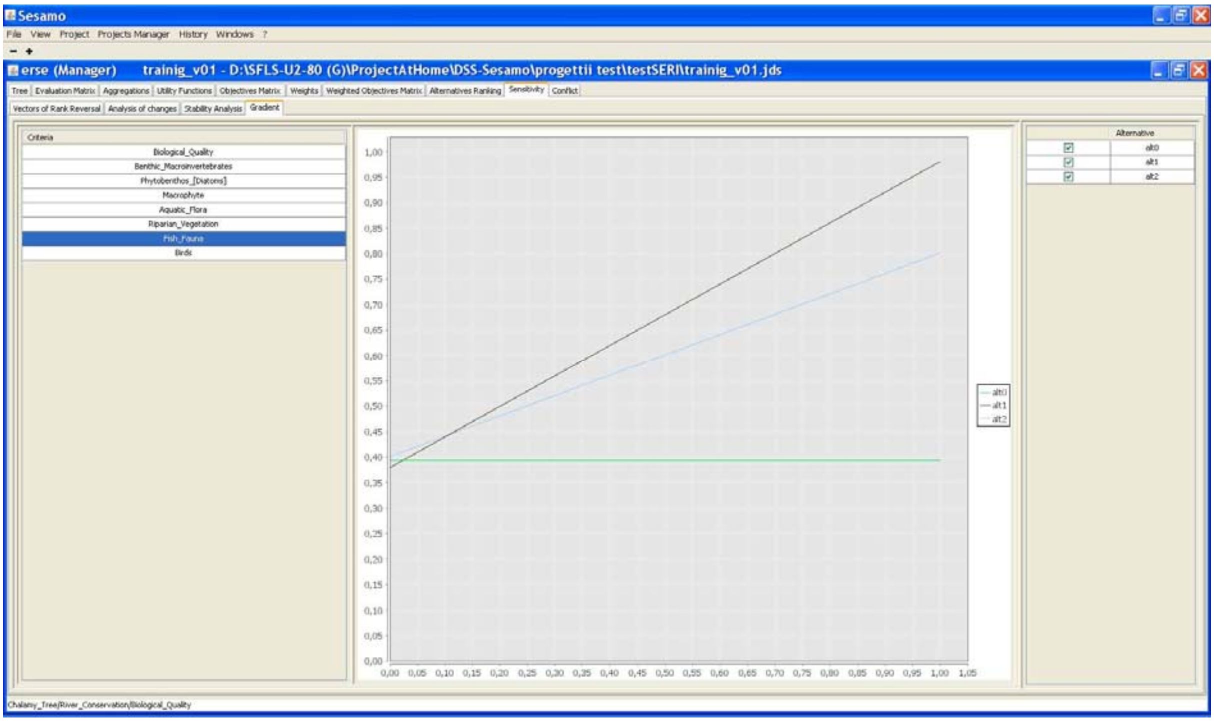


Fig.49: Sensitivity Panel – Gradient

Dashboard representation

A new panel dedicated to the visual representation of the sensitivity analysis on criteria weights has been added.
This new panel provides a more efficient and pleasant visualisation of the sensitivity analysis on the criteria weights, mainly acting on simple and well customized controls.
The panel is logically separated into 3 sections (see Fig. 50):

- a section on the lower right, where the alternative list takes place;
- an upper section, where visual controls take place, each one related to a selected alternative (the maximum number of controls available at the same time is correlated to the screen resolution);
- a section below the visual controls, where a set of mixer sliders represents the weights of the criteria selected.

Fig. 50: Dashboard representation panel of the Analysis of correlations

Each control of the upper panel is a synthetic representation of two different kinds of data: the performance of the selected alternative and the exact objective value of the selected criteria for that alternative. In order to aggregate in such a control this information it has been considered to use a diagram consisting of:

- a major scale spanning from 0 to 1 representing the normalized ranking of the selected alternative;
- each sector inside the main control represent the weight (angle of the sector) and the value of the criteria within the objective matrix (radius of the sector);
- the number inside is the actual value of the alternative ranking.

Each "mixer slider" represents the weight value of the criteria selected on the panel "Tree" and it is used to change the height (i.e. the weight value) of it in relation with the other criteria. The way it coordinate the weight values is exactly the same used in the graph of the "weights variation analysis" panel.

Moving the sliders makes the software automatically recalculate the alternatives ranking and refresh the gauge controls of the upper panel. In this way, the user can immediately see the effects of the variations applied to the criterion weights.

The button in the bottom right of the panel allows the user to export the results of the analysis.