



Nile Basin Decision Support System

Analysis Manager Training Module

Revision History

Version	Date	Revision Description
0.1	1/12/2014	Initial draft
0.2	19/12/2014	Final version for approval
0.3	26/12/2014	Second Final version for approval

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1. Introduction

This document is part of training modules for the Nile Basin Decision Support System (DSS). These modules are developed for use in classroom training that is given to Nile Basin countries and as a self-learning training material that will be made available as part of the DSS helpdesk and knowledgebase.

1.1. Purpose

The purpose of this document is to provide a tutorial to the Analysis Manager. The tutorial starts with the basics and progressively increases in complexity.

1.2. Module pre-requisites

The following prerequisites are needed before taking this tutorial:

Software prerequisites: The Mike by DHI version 2014 and the DSS version 2.0 have to be installed.

User prerequisites: User is expected to be familiar with the DSS User interface and the DSS Indicators, Spreadsheet and Scenario managers.

1.3. Expectations

Upon successful completion of the lessons, exercises and review questions in this document, you will be familiar with most of the 'Analysis' manager functionalities.

1.4. Conventions

The following conventions are followed in this document:



means a tip for the user



means important information

1.5. Module data

The files needed to run this tutorial are located in the `..\AnalysisExp\Data` folder.

1.6. Links to additional resources

Analysis Manager

In addition to the information presented in this module, below are links to additional resources that you can access to obtain further information on the following:

- 'Analysis' manager:
 - The DSS help file

1.7. Problem Reporting Instructions

This document will be updated regularly. Therefore, it is highly recommended to report any spotted problem to helpdesk@nilebasin.org so it can be corrected in future versions. When reporting the problem, you are kindly requested to provide the following:

- Document title
- Document version
- Page number where the problem was spotted
- A description of the problem

2. Lessons

In this section the following lessons (with exercises) are included:

- General: This lesson introduces you to the 'Analysis' manager and also some definitions and concepts that help you understand the process of undertaking a Multi Criteria Analysis (MCA) and/or a Cost Benefit Analysis (CBA) within the DSS.
- CBA pre-requisites: This lesson gives a description of what is required to undertake a CBA in the DSS.
- CBA Setup: This lesson shows the process of setting up a CBA within the DSS through an example.
- CBA results: This lesson shows how you can visualize the CBA results and also explains how you can interpret them.
- MCA pre-requisites: This lesson gives a description of what is required to undertake an MCA in the DSS.
- MCA Setup: This lesson shows the process of setting up an MCA within the DSS through an example.
- MCA results: This lesson shows you how you can visualize the MCA results and also explains how you can interpret them.

After completing the lessons and exercises in this section you will be able to use the "Analysis Manager" to undertake MCA and CBA within the DSS.

2.1. General

Introduction

This lesson introduces you to the 'Analysis Manager' and also some definitions and concepts that help you understand the process of undertaking a Multi Criteria Analysis (MCA) and/or a Cost Benefit Analysis (CBA) within the DSS. If you are familiar with those definitions and concepts you can skip this and move to the next lesson.

Topics covered in this lesson:

- What is the 'Analysis Manager'?
- What is meant by CBA?
- The typical workflow of a CBA process
- What are the CBA pre-requisites?
- What is meant by MCA?
- The typical workflow of a MCA process.
- What are the MCA pre-requisites?

Lesson objectives:

After completing this lesson, you will learn:

- What is the Analysis Manager?
- What are CBA and MCA?
- The typical workflow of CBA and MCA
- The CBA and MCA pre-requisites

What is the 'Analysis' manager?

The 'Analysis' Manager is used in the DSS to undertake Multi-Criteria Analysis (MCA) and Cost-Benefit Analysis (CBA). The analyses are presented as preconfigured spreadsheets that offer required functionality and logic to carry out the MCA and CBA typical workflows. The Analysis Manager is composed of (See Figure 1):

1. An explorer, in which analyses are organized in user defined groups.
2. The data view where the various windows such as MCA or CBA setups, sessions and comparisons are displayed.

Analysis Manager

3. The 'Tools' explorer in which the tools related to CBA and MCA are displayed and accessed.
4. Properties window, in which the properties of the selected object are displayed.

Within the 'Analysis' manager, analyses consist of:

1. Setups (where basic parameters of the analyses are defined)
2. Sessions (where actual analyses are carried out often by varying values of selected parameters)
3. Comparisons (where several analysis sessions can be compared).

The grouping structure of the 'Analysis' manager can, after having included a number of MCAs and CBAs, look similar to Figure 2 below.

Analysis Manager

The screenshot displays the 'Analysis Manager' application window with the following components:

- Analysis Explorer:** A tree view on the left showing the project structure: Database > Oaugadougou Water Supply > Mix of Actions > Average Interest Rates (highlighted).
- Data window:** The main central area displaying a 'Compare CBA Sessions - Tabular' report. It contains three tables comparing 'Future scenario (2020) - Mix of Actions/ High Interest Rates' and 'Future scenario (2020) - Mix of Actions/ Low Interest Rates' across various cost items like Pumping, Loumbilla, and Irrigation.
- Properties window:** A panel on the right showing the 'Comparison sheet' name as 'Average Interest Rates'.
- Tools Explorer:** A panel on the right listing available tools such as 'Compare session', 'Data Export Tool', and 'Script Execute Tool'.

At the bottom of the window, the status bar shows 'admin Connected to: CBA_Training Status: Ready'.

Figure 1: 'Analysis' manager components

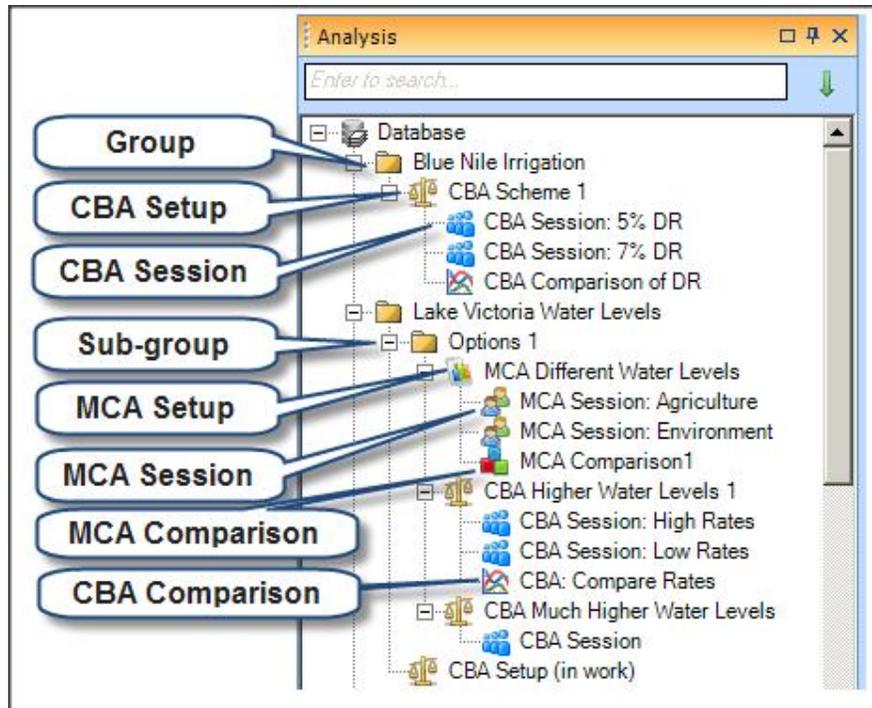


Figure 2: Groups within the 'Analysis' manager

What is meant by CBA?

A Cost Benefit Analysis (CBA) is an assessment of all the costs and benefits of alternative options to evaluate if the benefits outweigh costs. CBA seeks to value the expected performance of an option (i.e. scenario) in monetary terms. These valuations are based on a well-developed economic theory of valuation. This theory can act as a guide to how valuation should be achieved, and as a referee in disputes about valuation. The valuations are based on the willingness to pay of the potential gainers for the benefits they will receive as a result of the option, and the willingness of potential losers to accept compensation for the losses they will incur. In principle, a project is desirable if the benefits exceed the losses (costs), suitably discounted over time.

All cost-benefit studies entail elements which are identified as relevant impacts, but which are not valued. In some circumstances they may be regarded as relatively minor, and so will be listed in the CBA report alongside the overall estimates of those net social benefits which can be valued. They may reinforce the choice ordering implied by the monetary results, or they may not be regarded as sufficient to change this ordering, or sometimes, where the

difference between alternatives implied by monetary valuations is small, they may tip the balance.

Reporting the Results of CBA

CBA typically uses one of several metrics to report findings. Examples are, the benefit-cost ratio, return on investment, and net present value which report the results of a cost-benefit analysis by comparing discounted costs with discounted benefits. In the next section, each metric and the information it conveys for reporting cost-benefit findings are described.

The Benefit-Cost Ratio (BCR) directly compares benefits and costs. To calculate the BCR, divide total discounted benefits by total discounted costs. For example, a program that costs \$3 million and accrues \$8 million in benefits has a BCR of 2.67 (\$8 million divided by \$3 million). A benefit-cost ratio of 2.67 means policymakers can expect \$2.67 in benefits for every \$1 in costs. A BCR greater than 1 means the benefits outweigh the costs and the investment should be considered. If the ratio is less than 1, the costs outweigh the benefits. If the BCR is equal to 1, the benefits equal the costs. BCR values equal or less means the project is not financially viable based on the assumptions and analyses made, but this does not mean automatic exclusion as some of the benefits may have not been considered because of difficulties related to valuation (e.g. restoration of wetlands or forests).

The Return on Investment (ROI) is similar to BCR, but compares the net benefit (total discounted benefits minus total discounted costs) to costs. To calculate the ROI for the previous example, first calculate the net benefits (\$8 million minus \$3 million equals \$5 million). Then divide the net benefits by the total costs (\$5 million divided by \$3 million). The result—1.67—is the ROI, which is typically expressed as a percentage (167 percent). Thus, the investment (i.e., the cost) will generate a return (i.e., net benefit) that amounts to 167 percent of the cost of the investment. The ROI indicates how much of the investment policymakers can expect to receive as a benefit. If the ROI is positive, the benefits exceed the costs and the investment should be considered. A negative ROI means that the costs outweigh the benefits. An ROI of 0 means the benefits equal the costs.

The Net Present Value (NPV) reflects the net benefits of a project in monetary terms. To calculate NPV, subtract the total discounted costs from the total

discounted benefits. The NPV for the previous example is \$5 million (\$8 million minus \$3 million). A positive NPV means that benefits outweigh costs and the investment should be considered. A negative NPV means that the costs outweigh the benefits. An NPV of 0 means the benefits are equal to the costs.

The typical workflow of a CBA process

In General, The following steps are carried out to undertake a CBA:

1. Financial experts provide discount rates, external costs/benefits/funding data
2. Experts calculate expected benefits (and sometimes costs) using models
3. CBAs are created for different scenarios
4. Sensitivity of CBA results with respect to discount rates is assessed
5. CBA results from different scenarios are compared
6. Financially most viable scenario(s) (not necessarily profitable) is(are) identified

The above workflow can be undertaken sequentially but typically has a number of cycles until a decision is reached in particular between steps 2-6.

In the DSS, data for step 1 is assumed to be provided while steps from 2-6 can be carried out as follows:

1. Create Models
2. Define Scenarios for the Models
3. Define Indicators for model outputs
4. Run (at least one) simulation per scenario
5. Review the evaluated Indicators
6. Create a CBA Setup
7. Create one or more CBA Sessions
8. Create a CBA Session Comparison

Steps 1-5 have been presented in other training modules. In this module, the focus is on presenting steps 6-8 which are presented in lessons 2.3 and 2.4.

What are the CBA pre-requisites?

The following steps are mandatory prior to carry out a CBA analysis within the

DSS:

- A model is created for the problem to be analyzed.
- The created model is registered within the DSS.
- At least one scenario is created for the registered model
- One simulation is run successfully for the above scenario
- The Time length of the CBA has to be decided
- Cost and benefits are calculated either based on the simulation results or other sources (e.g. expert judgment)
- The discount rates for the costs and benefits of each of the scenario measures have to be decided.

There are some other optional steps that can also be included within the CBA analysis. These steps are:

- Providing funding data for options (if available) with their discount rates
- Providing benefits minimum level (if required) for the options with their discount rates.

What is meant by MCA?

A Multi Criteria Analysis (MCA) is used for the appraisal of options for policy and other decisions which do not necessarily rely on monetary valuations. MCA establishes preferences between options by reference to an explicit set of objectives that the decision making body has identified, and for which it has established measurable indicators and/or criteria to assess the extent to which the objectives have been achieved. In simple circumstances, the process of identifying objectives and criteria may alone provide enough information for decision-makers. However, where a level of detail broadly similar to CBA is required, MCA offers a number of ways of aggregating the data of individual indicators and/or criteria to provide the overall performance of options to make decisions.

Reporting the Results of MCA

A standard feature of multi-criteria analysis is a decision matrix in which each row describes an option and each column describes the performance of the options against an indicator and/or criterion. The individual performance

assessments are often numerical, but may also be expressed as color coding. An Example of a decision matrix is shown in Figure 3.

← Criteria →

	Costs	Benefit Costs Ratio	Wetlands Area Reduced	Fish Habitat Reduced	Added Crop Production	Water Supply Increase	Additional Floods	Public Acceptance	Overall	
Score	score	score	score	score	score	score	score	score	Score	Rank
Jonglie Canal immediate	0.084	0.027	0.024	0.025	0.171	0.158	0.018	0.032	0.539	2
Jonglie Canal delayed construction (2022)	0.065	0.024	0.024	0.025	0.076	0.158	0.041	0.016	0.429	
Jonglie Canal wide (2015)	0.055	0.025	0.013	0.016	0.214	0.186	0.011	0.024	0.544	1
Jonglie Canal narrow (2015)	0.090	0.024	0.034	0.031	0.095	0.075	0.020	0.024	0.395	

Figure 3: An example of a decision matrix

The typical workflow of an MCA process

In General, The following steps are carried out to undertake an MCA:

1. Establish the decision context. What are the aims of the MCA, and who are the decision makers and other key players?
2. Identify the objectives and criteria that reflect the value associated with the consequences of each option.
3. Generate the Scenarios (or options).
4. Evaluate the performance of each option against the criteria. (If the analysis is to include steps 5 and 6, also 'score' the options, i.e. assess the value associated with the consequences of each option.)
5. 'Weighting'. Assign weights for each of the criteria to reflect their relative importance to the decision. These weights reflect the preferences of the decision makers and/or stakeholders
6. Combine the weights and scores for each of the options to derive and overall value.
7. Examine the results and Conduct a sensitivity analysis of the results to changes in scores or weights.
8. Select acceptable scenario/option: often a (shortlist) of few scenarios are selected and subjected to further evaluations before final decision is made on selection.

The above workflow can be undertaken sequentially but typically has a number of iterations until a decision is reached in particular between steps 4-8 but steps 2 and 3 can also be revisited.

Steps 1, 2 and 3 are assumed to be carried out before using the DSS in meetings or workshops involving the stakeholders. Steps 5-8 are done with the assistance

of the NB DSS but it requires meetings and interaction with stakeholders. Once this is done the rest of the steps can be undertaken as follows:

1. Create Models
2. Define Scenarios for the Models
3. Define Indicators for model outputs
4. Run (at least one) simulation per scenario
5. Review the evaluated indicators
6. Create an MCA Setup
7. Create one or more MCA Sessions
8. Create an MCA Session Comparison

Steps 1-5 have been presented in other training modules. In this module, the focus is on presenting steps 6-8 which are presented in lessons 2.5 and 2.6.

What are the MCA pre-requisites?

MCA compares multiple criteria across multiple scenarios. These scenarios can be based on one or several model setups depending on the differences among those scenarios. The following steps are mandatory prior setting up an MCA within the DSS:

- A model setup or more is created for the problem to be analyzed.
- The created model setup(s) is registered within the DSS.
- Indicators that will be used in the MCA are defined for each model setup.
- Two or more scenarios are created for the registered model(s) either for one setup or several setups
- At least one simulation is run successfully for each of the above scenarios and the values of the indicators are calculated (i.e. scripts required are written and working), reviewed, and error free.
- Criteria to evaluate different options have been decided as well as the normalization and weighting methods to be used. For each criterion, the algorithm for calculation and the desired direction of improvement (i.e. whether higher values or lower values are better off) have been decided.

The groupings of those criteria have been decided upon and the different stakeholders have given their preferences and limits for those criteria.

Review Questions

Analysis Manager

1. What is meant by CBA and MCA?
2. Describe the process of undertaking a CBA in the DSS?
3. Describe the process of undertaking an MCA in the DSS?
4. What are the CBA pre-requisites?
5. What are the MCA pre-requisites?

Answers

1. A Cost Benefit Analysis (CBA) is an assessment of all the costs and benefits of alternative options. CBA seeks to value the expected impacts of an option in monetary terms. These valuations are based on a well-developed economic theory of valuation. A Multi Criteria Analysis (MCA) is used for the appraisal of options for policy and other decisions which do not necessarily rely on monetary valuations. MCA establishes preferences between options by reference to an explicit set of objectives that the decision making body has identified, and for which it has established measurable indicators and/or criteria to assess the extent to which the objectives have been achieved.
2. In the DSS, CBA can be undertaken as follows:
 - Create Models
 - Define Scenarios for the Models
 - Define Indicators for model outputs
 - Run (at least one) simulation per scenario
 - Review the evaluated indicators
 - Create a CBA Setup
 - Create one or more CBA Sessions
 - Create a CBA Session Comparison
3. In the DSS, MCA can be undertaken as follows:
 - Create Models
 - Define Scenarios for the Models
 - Define Indicators for model outputs
 - Run (at least one) simulation per scenario
 - Review the evaluated indicators
 - Create an MCA Setup
 - Create one or more MCA Sessions
 - Create an MCA Session Comparison
4. The following steps are mandatory prior setting up a CBA within the DSS:
 - A model is created for the problem to be analyzed.
 - The created model is registered within the DSS.
 - At least one scenario is created for the registered model
 - One simulation is run successfully for the above scenario

- The Time length of the CBA has to be decided
- Cost and benefits are calculated either based on the simulation results or other sources (e.g. expert judgment)
- The discount rates for the costs and benefits of each of the scenario measures have to be decided.

The following steps are optional prior setting up a CBA within the DSS:

- If funding is available for any the measures that is part of the scenario then it can be also included with their discount rates
- If benefits have a minimum level that needs to be satisfied for any of the measures that is part of the scenario then this can bare level then this included with their discount rates.

5. The following steps are mandatory prior setting up a CBA within the DSS:

- A model is created for the problem to be analyzed.
- The created model is registered within the DSS.
- Indicators that will be used in the MCA are defined.
- Two or more scenarios are created for the registered model
- At least one simulation is run successfully for each of the above scenarios and the values of the indicators are calculated and reviewed.
- Criteria to evaluate different options have been decided

2.2. 'Analysis' Manager Basics

Introduction

This lesson gives an introduction to the Analysis Manager basic operations.

Topics covered in this lesson:

- Activating the Analysis Manager
- Organizing data within the Analysis Manager

Lesson objectives:

By the end of this lesson, it is anticipated that you will be:

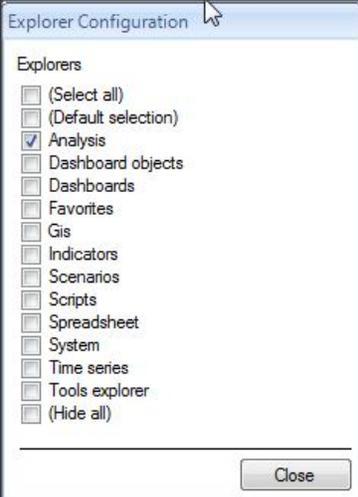
- Familiar with the Analysis Manager basic operations.

Lesson pre-requisites

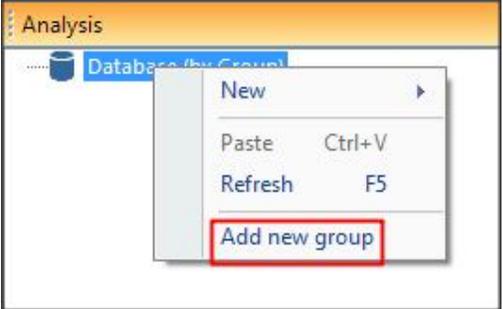
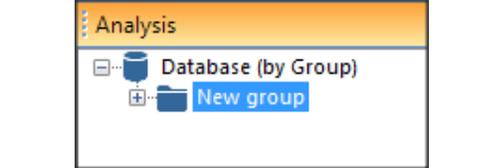
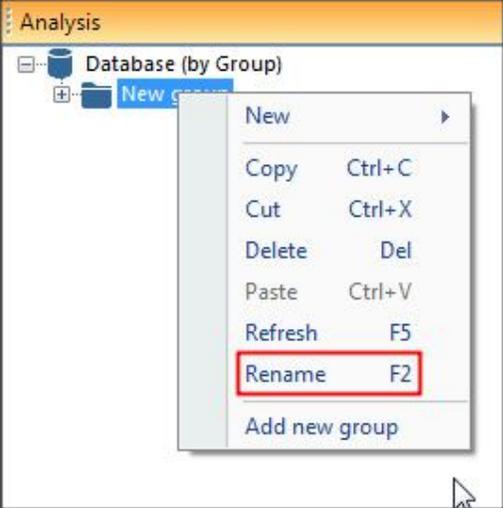
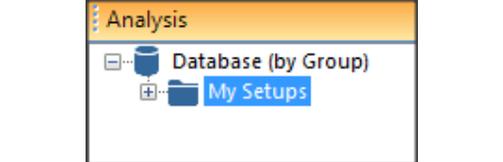
You have to be familiar with the DSS user interface basics to take this lesson.

Exercises

Activating the 'Analysis' manager

<p>1- In the DSS, click on View Menu, click "Explorers..." and the Explorer Configuration box appears. Tick the box next to 'Analysis' explorer.</p>	
<p>2- The 'Analysis' explorer should appear within the DSS window. The explorer has a main group called 'Database'. This main group is created by default when a new DSS database is created. Under this main group user can have 'user defined' groups.</p>	

Adding a new 'user defined' group

<p>1- Within the 'Analysis' explorer, right click on the 'Database' group.</p>	
<p>2- Click on the Add new group option. A new group is added as shown next.</p>	
<p>3- Select the new group and either right click the mouse and select Rename or press the keyboard function Key 'F2' to rename it.</p>	
<p>4- Enter a suitable name (e.g. My Setups).</p>	

Review Questions

1. Explain how the Analysis manager is activated.

Answers

1. In the DSS, click on [View](#) Menu, click “Explorers...” and the Explorer Configuration box appears. Tick the box next to 'Analysis' explorer.

2.3. CBA Setup

Introduction

This lesson gives a description how you can setup a CBA within the DSS.

Topics covered in this lesson:

- A detailed description of how to setup a CBA in the DSS

Lesson objectives:

By the end of this lesson, you will be able to:

- Setup a CBA within the DSS.

Lesson pre-requisites

You have to be familiar with the CBA [concepts](#) to take this lesson.

What is a CBA setup?

In a CBA setup (See Figure 4) within the DSS, you define the following:

- Evaluation Period: The period that is used to assess the viability of an option or a number of options.
- Monetary Units: unified units that are used for the valuation of all costs and benefits (e.g. all costs/benefits are converted to these units)
- Scenario: A future option that has some measures to improve the current situation.
- The costs and benefits data of the scenario measures with their discount rates and units. The units here can be monetary or non-monetary but eventually they need to be converted into the 'Monetary Units' defined above. The costs and benefits data can take one of the following five forms:
 1. Lump sum: One value that is applied at the first year of the evaluation period. An example of this is the initial investment needed at the beginning of the CBA.
 2. Running value: A constant value that is applied annually starting at the first year of the evaluation period until the last year of the same period. An example of this is the operational cost needed along the CBA evaluation period.

3. Yearly values: User defined values that are entered by you into the CBA starting at the first year of the evaluation period until the last year of the same period. An example of this is the annual crop yield.
 4. Yearly value from time series: Annual values from a simulation time series. The selected time series must have no missing data. An example of this is the annual water demands.
 5. Running value from an indicator: An indicator value that is applied annually starting at the first year of the evaluation period until the last year of the same period based. The indicator value is calculated using the simulation results. An example of this is the annual volume of water needed for irrigation.
- Funding and benefits minimum data of the scenario measures with their discount rates and units. The units here can also be monetary or non-monetary but eventually they need to be converted into the 'Monetary Units' defined above. They can also take any of the above five forms described above. Funding are any available funds to cover the costs of implementing a measure and they are typically monetary. Minimum benefits are the lower limits required to consider the solution worthwhile.
 - Conversion factors: These are the factors needed to convert any unit (monetary or non-monetary) to the 'Monetary Units' defined above.

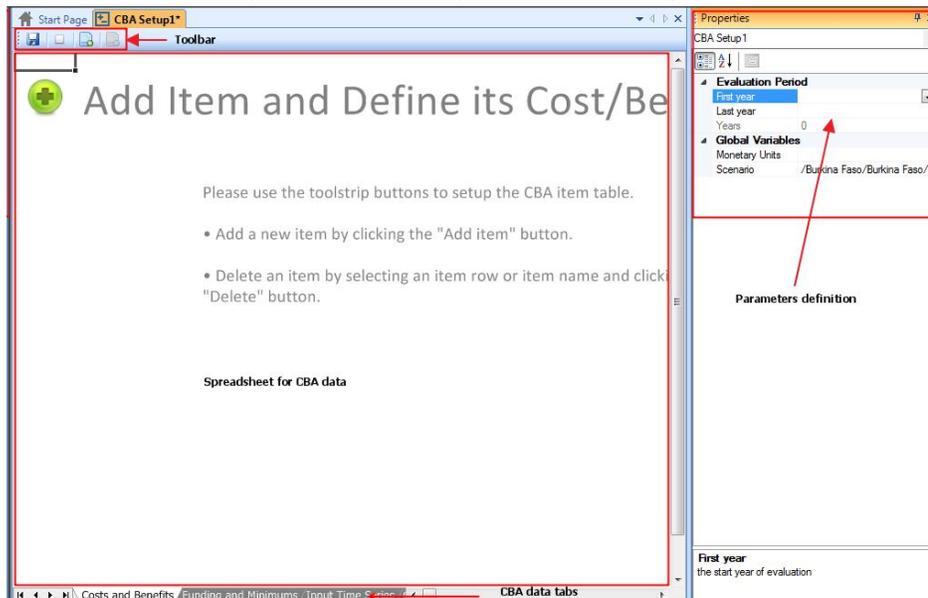


Figure 4: CBA setup window

Some CBA Terminology

Analysis Manager

Here are some CBA terminology definitions to help you in understanding the CBA process.

- **Discount Rate**
The interest rate you could earn on your money. It might vary among CBA costs and/or benefits.
- **Present Value**
Value on a given date of a payment or series of payments made at other times. For example:
 - If you have to pay \$100 today, you need \$100 today to do so
 - If you have to pay \$100 next year, you need approximately \$95 today to do so, assuming you could earn 5% interest on that money in one year
 - If you have to pay \$100 in two years, you need approximately \$91 today to do so, assuming you could earn 5% interest per year on that money

This allows comparing payments and/or benefits that occur in different years
- **Break Even Year**
Year at which aggregate benefits balance or exceed aggregate costs. There is no 'Break Even Year' if the project is not profitable (i.e. benefits are less than the costs)

The CBA problem definition

In the exercises section, the problem of the city of Ouagadougou (Burkina Faso) will be used as an example to demonstrate the use of CBA within the DSS (See Figure 5). The city currently experiencing rapid growth and serious deficits are expected by the year 2020 in its water supply which comes from two reservoirs Ziga, and Loubila. At the same time, increased irrigation is expected for the Lac de Bam area, which will likely strain the water supply for the downstream Ziga Reservoir. Environmental concerns might also restrain the other Ouagadougou water supply diversion at Loubila reservoir as releases there should be increased to protect downstream fish habitat and thus the livelihood of local fishermen.

A study was commissioned to assess the impact of growth in Ouagadougou and the Lac de Bam area on the Ouagadougou city water supply. Historic flow data and

Analysis Manager

estimates of water demands in 2020 were used to establish a number of scenarios to address the expected Ouagadougou water supply shortages.

Following a stakeholders' consultation involving the City of Ouagadougou, Farmers from the Lac de Bam area and an Ouagadougou Environmentalists group, the following scenario was selected as the most widely accepted one:

'Future scenario (2020) – Mix of Actions', which allows lower water levels at Loumbila reservoir in order to increase both the water supply for Ouagadougou and releases for the downstream fishermen. The scenario also restricts some of the irrigation at Lac de Bam, but as much as in other proposed scenarios in order to increase water supply diversions to Ouagadougou.

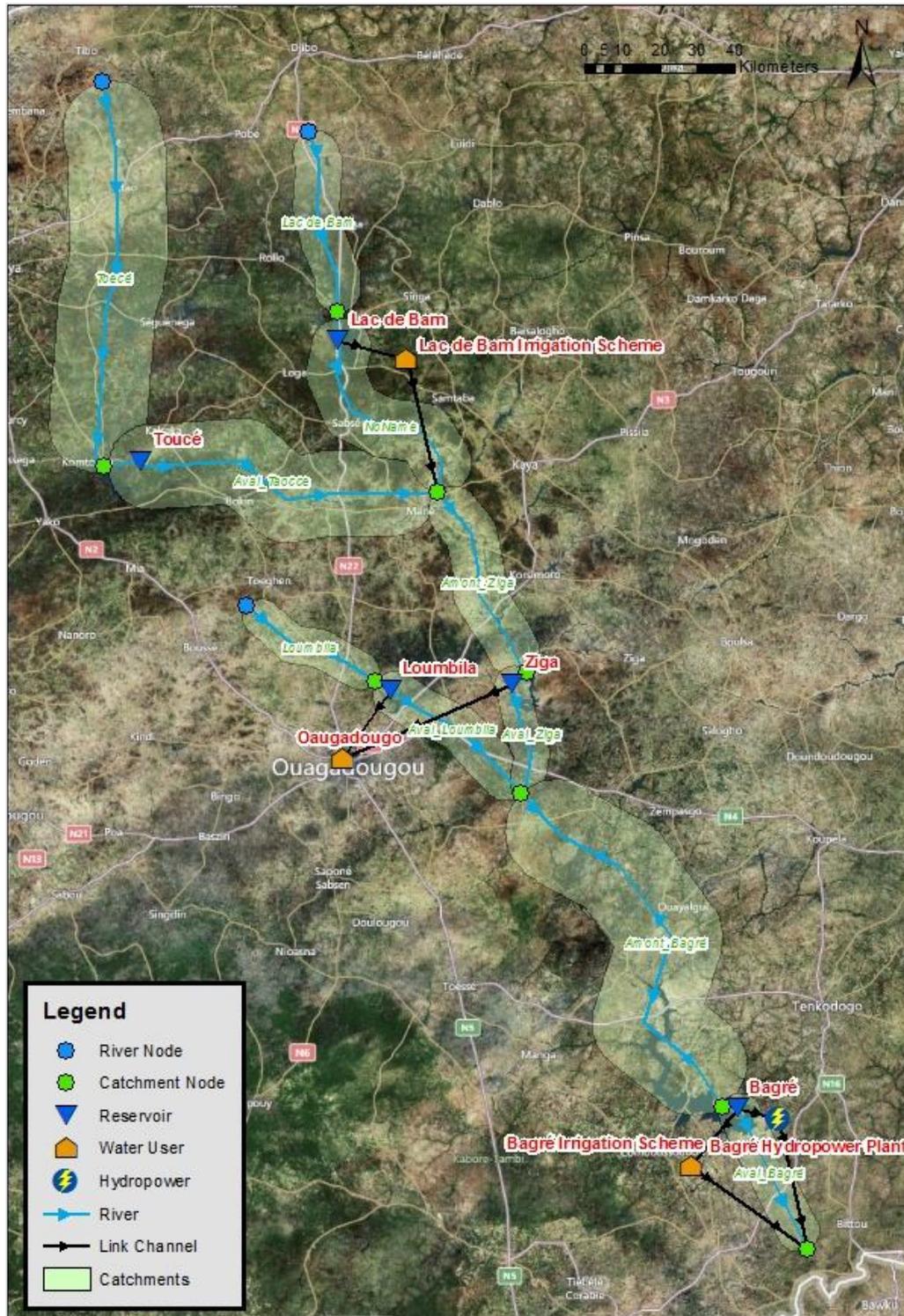


Figure 5: Ouagadougou model schematization

A CBA must now be completed to assess the financial viability of this scenario. All required elements to undertake the CBA have been defined and a simulation has

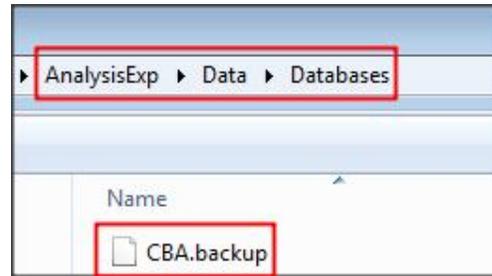
Analysis Manager

been also executed for the selected scenario. Thus, only the NBDSS Analysis Manager will be used for the exercises below and in the next section.

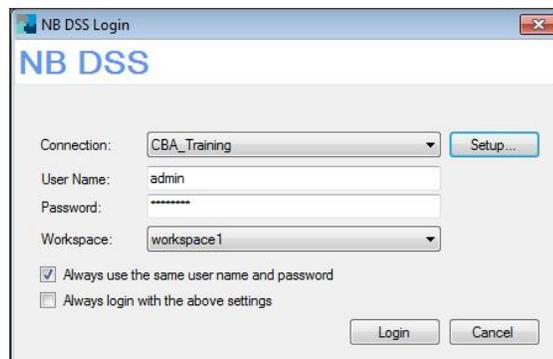
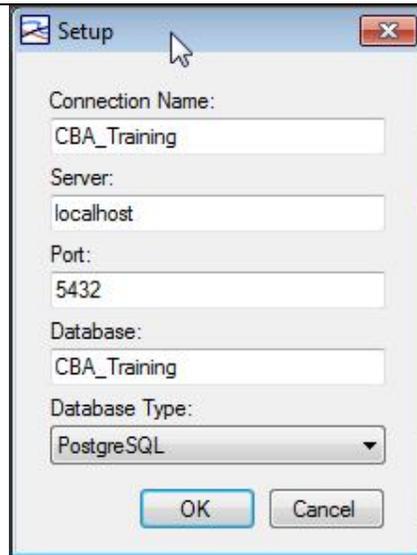
Exercises

Creating a CBA setup

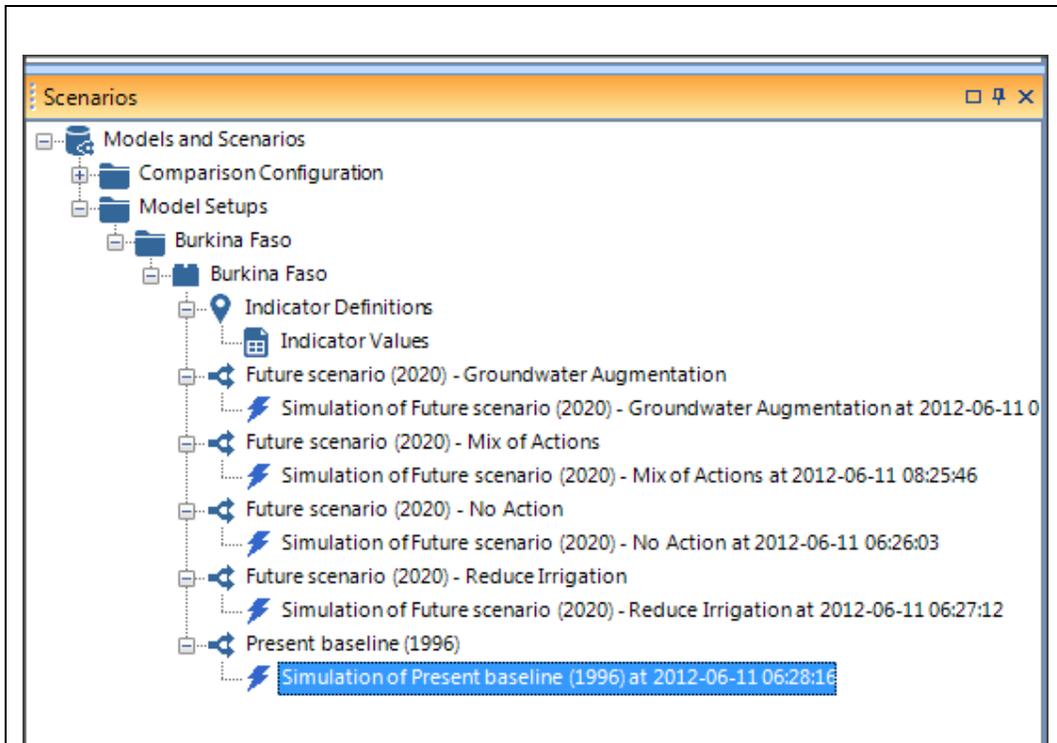
1- Data for the exercises in this section and the next section are supplied in 'CBA' database. Restore the database from **..\AnalysisExp\Data\Databases** folder and call it, for example 'CBA_Training' (For more information on how to restore a database See the Database Manager Utility and System Manager training module).



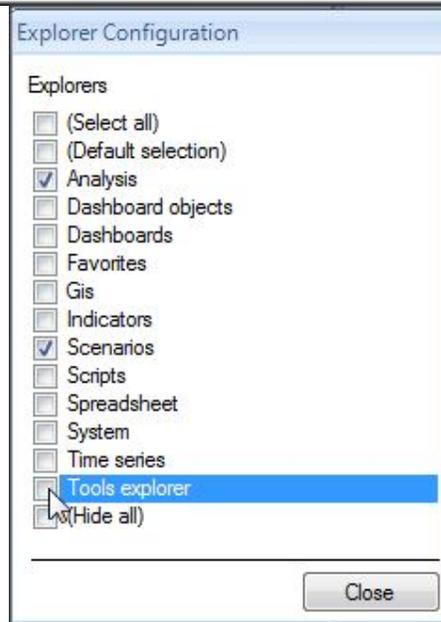
2- Start the DSS and create a setup for the 'CBA_Training' database and then use this setup login to the DSS (For more information on how to create a setup and login See the Database Manager Utility and System Manager training module).



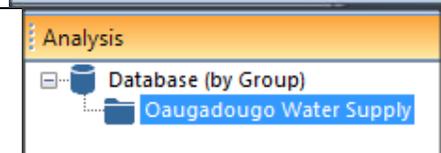
4- This database includes the 'Burkina Faso' model setup with 5 defined scenarios with one simulation each, as shown below.



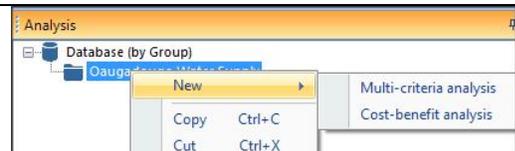
3- In the DSS, click on **View** Menu, click "Explorers...", the Explorer Configuration box appears. Tick the box next to the 'Scenario' and 'Analysis' explorers.

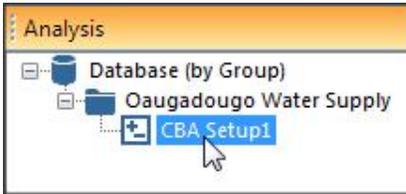
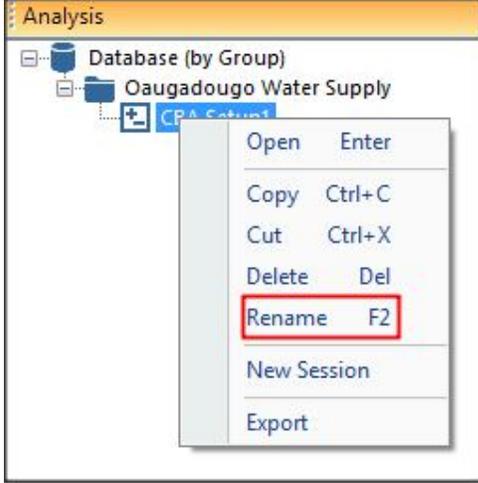
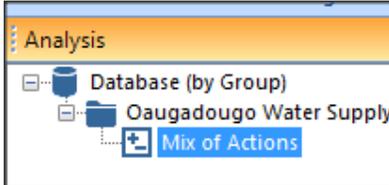
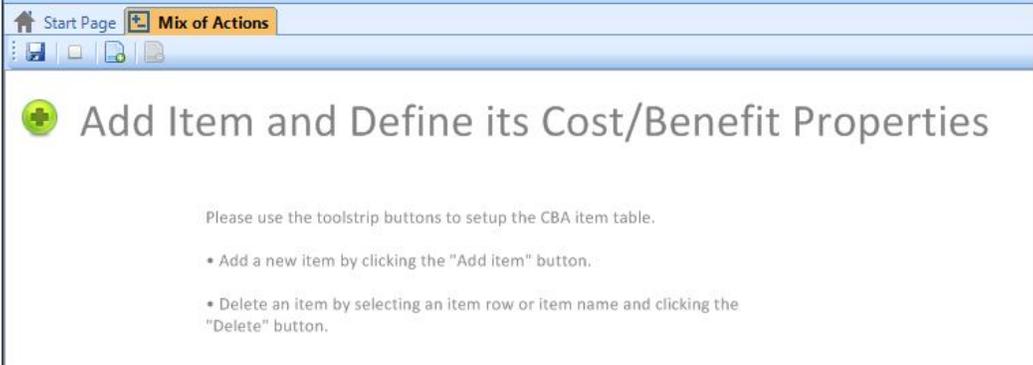


5- In the Analysis Manager, create a new group 'Oaugadougo Water Supply' (See the [adding a new 'user defined' group](#) section for details)



6- In this group, right click and select **New** and then **Cost-benefit analysis** to create a new CBA Setup.



<p>A new CBA setup that is called 'CBA setup1' is created.</p>	
<p>7- Right click on the newly created CBA set up and select Rename. Call the analysis node 'Mix of Actions'.</p>	 
<p>8- Double click on the 'Mix of Actions' group to open it. Once this is done, the window shown below is opened.</p>	
	
<p>In this window you can use the tool bar buttons to:</p> <ul style="list-style-type: none">  Save the setup  Display/ hide the grid 	

 Add a cost item

 Delete a cost item (a cost item has to be selected for this button to function)

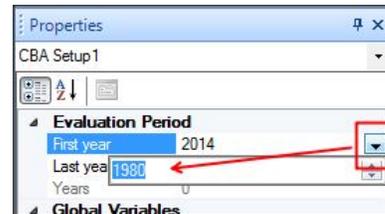
9- Select 'Costs and Benefits' tab, and set the general CBA properties as follows in the 'Properties' windows:

- First year: 1981
- Last year: 1990

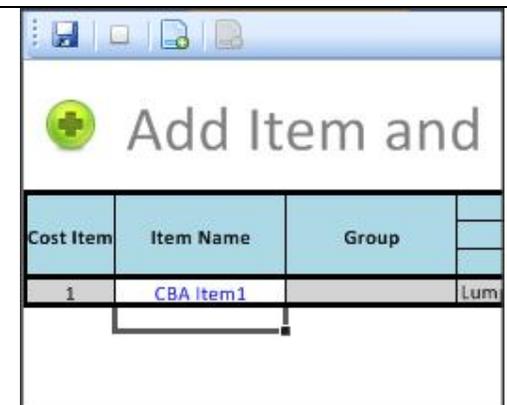
Years can be only typed after clicking the dropdown button in the Properties windows as shown next.

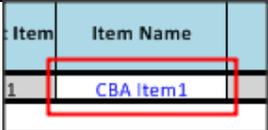
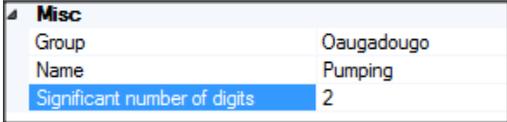
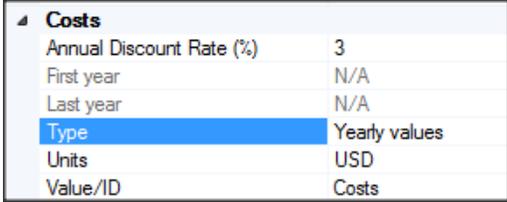
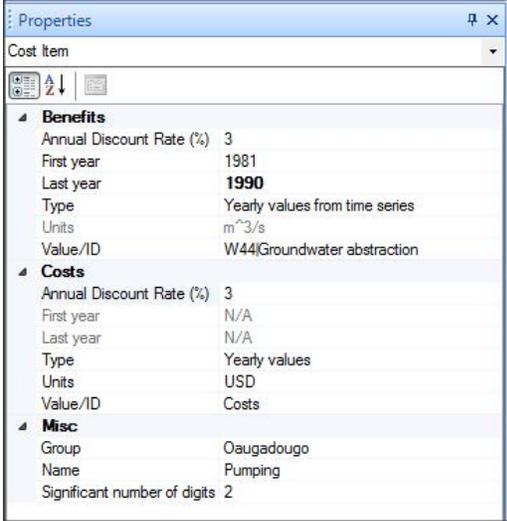
(Note that the 'Years' field is calculated automatically once both the first and last year are entered. This sets the evaluation period of the analysis.)

- Monetary Units: USD
- Scenario: /Burkina Faso/Burkina Faso/Future scenario (2020) - Mix of Actions (use the Dropdown list to select the scenario).



10- Click on the  button to add the first cost item to the setup. A new cost item called 'CBA item1' is added.



<p>11- Click on the cost item cell as shown next. Once this is done, its properties appear in the 'Properties' window. The properties are divided into 3 groups, namely, benefits, costs and misc. These will be filled up in the next steps.</p>	
<p>12- The first cost item is for pumping ground water. Set the Misc data as follows:</p> <ol style="list-style-type: none"> i. Group · Oaugadougo ii. Name · Pumping iii. Significant number of digits · 2 <p>Set the 'Costs' properties to</p> <ol style="list-style-type: none"> i. Annual Discount Rate (%) · 3 ii. Type · Yearly Values iii. Units · USD iv. Value/ID · Costs <p>Note: Values for 'Start year' and 'End year' are not required for type 'Yearly Values'.</p> <p>Set the 'Benefits' properties to</p> <ol style="list-style-type: none"> i. Annual Discount Rate (%) · 3 ii. Type · Yearly values from time series iii. First year · 1981 iv. Last year · 1990 v. Value/ID · W44 Groundwater abstraction (from the dropdown list) <p>Note: the units are picked up from the time series</p>	  
<div style="border: 1px solid black; padding: 10px; display: flex; align-items: center;"> <p>It is a good practice to frequently save your setup as the data is entered using the save button on the toolbar.</p> </div>	

13- Similar to the above step add a 'Increased Releases' CBA Item which represents additional releases to Loumbila as follows:

Set the Misc properties to:

- i. Group · Loumbila
- ii. Name · Increased Releases
- iii. Significant number of digits · 0

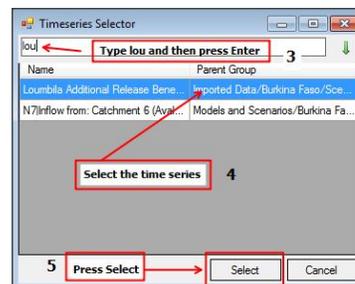
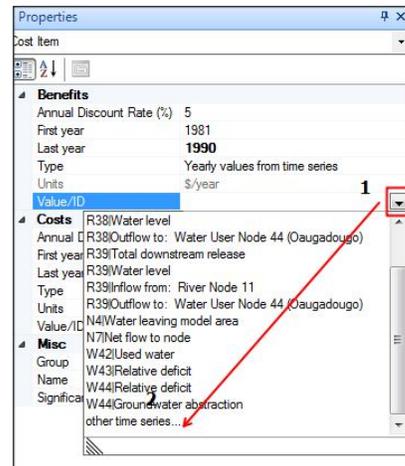
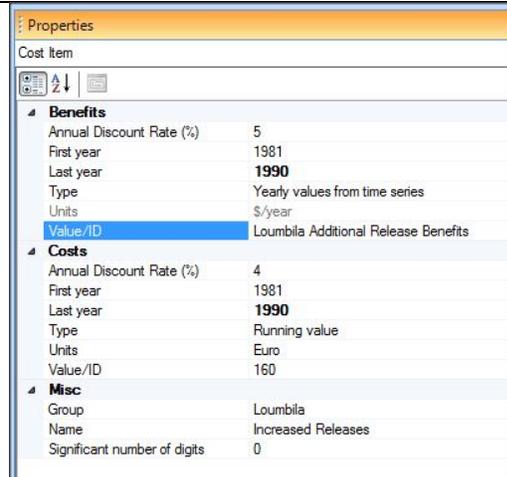
Set the 'Costs' properties to

- i. Annual Discount Rate (%) · 4
- ii. Type · Running value
- iii. First year · 1981
- iv. Last year · 1990
- v. Units · Euro
- vi. Value/ID · 160

Set the 'Benefits' properties to

- i. Annual Discount Rate (%) · 5
- ii. Type · Yearly values from time series

- iii. First year · 1981
- iv. Last year · 1990
- v. Value/ID · Loumbila Additional Release Benefits (... from 'other time series...')



14- Finally, add a CBA item called 'Irrigation' to represent the impact on the Lac De Bam irrigation scheme as follows:

Set Misc. properties

- i. Group · Lac De Bam
- ii. Name · Irrigation
- iii. Significant number of digits · 3

Set the 'Costs' properties to

- i. Annual Discount Rate (%) · 3
- ii. Type · Yearly values from time series
- iii. First year · 1981
- iv. Last year · 1990
- v. Value/ID · Lac de Bam Lost Irrigation Water

(from 'other time series')

Set the 'Benefits' properties to

- i. Annual Discount Rate (%) · 3
- ii. First year · 1981
- iii. Last year · 1990
- iv. Type · Running value
- v. Units · USD
- vi. Value/ID · 0

Properties	
Cost Item	
Benefits	
Annual Discount Rate (%)	3
First year	1981
Last year	1990
Type	Running value
Units	USD
Value/ID	0
Costs	
Annual Discount Rate (%)	3
First year	1981
Last year	1990
Type	Yearly values from time series
Units	m ³ /s
Value/ID	Lac de Bam Lost Irrigation Water
Misc	
Group	Lac De Bam
Name	Irrigation
Significant number of digits	3

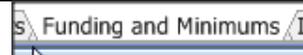


If you enter a year that is not within the evaluation period, a warning message appears asking you to correct the entry.

15-Now we have entered most of the costs and benefits data and the CBA setup should look like the window below.

Cost Item	Item Name	Group	CBA Item Properties							
			Costs/Investments				Benefits			
			Type	ID/Value	Period (Year)	Units	Type	ID/Value	Period (Year)	Units
1	Pumping	Oaugadougo	Yearly values	Costs	N/A	USD	Yearly values from time series	/Models and Scenarios/Burkina Faso/Simulations/Simulation of Future scenario (2020) - Mix of Actions at 2012-06-11 08:25:46/Water User Node 'Oaugadougo' with ID 44/Output/W44 Groundwater abstraction	1981-1990	m^3/s
2	Increased Releases	Loumbila	Running value	160	1981-1990	Euro	Yearly values from time series	/Imported Data/Burkina Faso/Scenarios/Loumbila Additional Release Benefits	1981-1990	\$/year
3	Irrigation	Lac De Bam	Yearly values from time series	/Imported Data/Burkina Faso/Scenarios/Lac de Bam Lost Irrigation Water	1981-1990	m^3/s	Running value	0.000	1981-1990	USD

16- Now move to the 'Funding and Minimums' tab to input some additional cost items that are related to available funding for each item and also minimum costs and benefits.



17 - For the 'Pumping' CBA Item's 'Funding and Minimums' enter for 'Benefit Minimums':
 Annual Discount Rate (%) → 0
 First year → 1981
 Last year → 1990
 Type → Running value
 Units → USD
 Value/ID → 0

Properties

Cost Item

- Benefit Minimums**
 - Annual Discount Rate (%) 0
 - First year 1981
 - Last year 1990
 - Type Running value
 - Units USD
 - Value/ID 0
- Funding**
 - Annual Discount Rate (%) 0
 - First year N/A
 - Last year N/A
 - Type Yearly values
 - Units USD
 - Value/ID Funding
- Misc**
 - Group Oaugadougo
 - Name Pumping
 - Significant number of digits 2



Defining the 'Funding and minimum benefit' is optional. They can be left empty and this has the same effect as setting them to zero.

<p>18- For the 'Increased Releases' CBA Item's 'Funding and Minimums' enter for 'Benefit Minimums':</p> <p>Annual Discount Rate (%) → 0</p> <p>First year → 1981</p> <p>Last year → 1990</p> <p>Type → Running value</p> <p>Units → USD</p> <p>Value/ID → 20</p> <p>For the 'Increased Releases' CBA Item's 'Funding and Minimums' enter for 'Funding':</p> <p>Annual Discount Rate (%) → 0</p> <p>First year → 1981</p> <p>Last year → 1989</p> <p>Type → Running value</p> <p>Units → USD</p> <p>Value/ID → 40000</p>	<p>Properties</p> <p>Cost Item</p> <p>Benefit Minimums</p> <table border="1"> <tr><td>Annual Discount Rate (%)</td><td>0</td></tr> <tr><td>First year</td><td>1981</td></tr> <tr><td>Last year</td><td>1990</td></tr> <tr><td>Type</td><td>Running value</td></tr> <tr><td>Units</td><td>USD</td></tr> <tr><td>Value/ID</td><td>20</td></tr> </table> <p>Funding</p> <table border="1"> <tr><td>Annual Discount Rate (%)</td><td>0</td></tr> <tr><td>First year</td><td>1981</td></tr> <tr><td>Last year</td><td>1990</td></tr> <tr><td>Type</td><td>Running value</td></tr> <tr><td>Units</td><td>USD</td></tr> <tr><td>Value/ID</td><td>40000</td></tr> </table> <p>Misc</p> <table border="1"> <tr><td>Group</td><td>Loumbila</td></tr> <tr><td>Name</td><td>Increased Releases</td></tr> <tr><td>Significant number of digits</td><td>0</td></tr> </table>	Annual Discount Rate (%)	0	First year	1981	Last year	1990	Type	Running value	Units	USD	Value/ID	20	Annual Discount Rate (%)	0	First year	1981	Last year	1990	Type	Running value	Units	USD	Value/ID	40000	Group	Loumbila	Name	Increased Releases	Significant number of digits	0
Annual Discount Rate (%)	0																														
First year	1981																														
Last year	1990																														
Type	Running value																														
Units	USD																														
Value/ID	20																														
Annual Discount Rate (%)	0																														
First year	1981																														
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Units	USD																														
Value/ID	40000																														
Group	Loumbila																														
Name	Increased Releases																														
Significant number of digits	0																														

Analysis Manager

19- For the 'Irrigation' CBA Item's 'Funding and Minimums' enter for 'Benefit Minimums':

Annual Discount Rate (%) → 0

First year → 1981

Last year → 1990

Type → Running value

Units → USD

Value/ID → 0

For the 'Irrigation' CBA Item's 'Funding and Minimums' enter for 'Funding':

Annual Discount Rate (%) → 0

First year → 1981

Last year → 1990

Type → Running value

Units → USD

Value/ID → 100000

Properties	
Cost Item	
Benefit Minimums	
Annual Discount Rate (%)	0
First year	1981
Last year	1990
Type	Running value
Units	USD
Value/ID	0
Funding	
Annual Discount Rate (%)	0
First year	1981
Last year	1990
Type	Running value
Units	USD
Value/ID	100000
Misc	
Group	Lac De Bam
Name	Irrigation
Significant number of digits	3

20- Now the minimum funding and benefits should look like the below window.

Add Item and Define its Funding/Benefit Minimums Properties

Cost Item	Item Name	Group	CBA Item Properties							
			Available Funding				Benefit Minimums			
			Type	ID/Value	Period [Year]	Units	Type	ID/Value	Period [Year]	Units
1	Pumping	Oaugadougo	Yearly values	Funding	N/A	USD	Running value	0.00	1981-1990	USD
2	Increased Releases	Loumbila	Running value	40,000	1981-1990	USD	Running value	20	1981-1990	USD
3	Irrigation	Lac De Bam	Running value	100,000.000	1981-1990	USD	Running value	0.000	1981-1990	USD

21- Now move to the 'Input Time Series' tab to input the yearly data values for the 'Pumping' cost item. Note that all other types are already populated in this tab and the values are not editable (grey cells)

22- For the 'Pumping' CBA Item's 'Input Time Series' enter as 'Costs (actual values)':

Year	Value
1981	500000
1982	12000
1983	12000
1984	12000
1985	12000
1986	12000
1987	12000
1988	12000
1989	12000
1990	12000





Analysis Manager

For the 'Pumping' CBA Item's 'Input Time Series' enter as 'Funding (actual values)':

Year	Value
1981	500000
1982	10000
1983	11000
1984	12000
1985	12000
1986	12000
1987	12000
1988	12000
1989	12000
1990	12000

Year	Pumping Yearly values [USD]
1981	500,000.00
1982	10,000.00
1983	11,000.00
1984	12,000.00
1985	12,000.00
1986	12,000.00
1987	12,000.00
1988	12,000.00
1989	12,000.00
1990	12,000.00

23- Now we have completed the 'Yearly inputs for all of the cost items and data should look like the below window.

Year	Costs (actual values)			Benefits (actual values)			Funding (actual values)			Benefit Minimums (actual values)		
	Pumping Yearly values [USD]	Increased Releases Running value [Euro]	Irrigation Yearly values from time series (Lac de Bam Lost Irrigation Water) [m³/s*]	Pumping Yearly values from time series (W44) Groundwater abstraction [m³/s*]	Increased Releases Yearly values from time series (Lumbila Additional Release Benefits) [\$/year*]	Irrigation Running value [USD]	Pumping Yearly values [USD]	Increased Releases Running value [USD]	Irrigation Running value [USD]	Pumping Running value [USD]	Increased Releases Running value [USD]	Irrigation Running value [USD]
1981	500,000.00	160	0.602	0.00	0	0.000	500,000.00	40,000	100,000.000	0.00	20	0.000
1982	12,000.00	160	0.060	0.00	0	0.000	10,000.00	40,000	100,000.000	0.00	20	0.000
1983	12,000.00	160	0.331	0.00	0	0.000	11,000.00	40,000	100,000.000	0.00	20	0.000
1984	12,000.00	160	-0.015	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1985	12,000.00	160	0.023	1.59	110	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1986	12,000.00	160	0.221	0.80	1,263	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1987	12,000.00	160	-0.044	0.41	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1988	12,000.00	160	1.248	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1989	12,000.00	160	0.248	0.00	29	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1990	12,000.00	160	0.000	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
Total	608,000.00	1,600	2.614	2.80	1,402	0.000	605,000.00	480,000	1,000,000.000	0.00	200	0.000

The star * means "yearly total".

<p>24- Now move to the 'Conversions' tab to input the conversions factors for all items that do not have the same units as the overall CBA (set as USD in step 9). Those are marked by having white editable cells while others are grey non-editable cells.</p>																																	
<p>25- For the 'Increased Releases' CBA Item enter as 'Cost Conversions' 0.70 for all years</p>	<table border="1"> <thead> <tr> <th colspan="2">Cost Conversions</th> </tr> </thead> <tbody> <tr> <td style="background-color: #90EE90;">Increased Releases</td> <td></td> </tr> <tr> <td style="background-color: #90EE90;">Running value</td> <td></td> </tr> <tr> <td style="background-color: #90EE90;">[USD/Euro]</td> <td></td> </tr> <tr> <td></td> <td>0.70</td> </tr> </tbody> </table>	Cost Conversions		Increased Releases		Running value		[USD/Euro]			0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70
Cost Conversions																																	
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<p>26- For the 'Irrigation' CBA Item enter as 'Cost Conversions' 50,000 for all years</p>	<table border="1"> <thead> <tr> <th colspan="2">Irrigation</th> </tr> </thead> <tbody> <tr> <td style="background-color: #90EE90;">Yearly values from</td> <td></td> </tr> <tr> <td style="background-color: #90EE90;">time series</td> <td></td> </tr> <tr> <td style="background-color: #90EE90;">[USD/m³/s]</td> <td></td> </tr> <tr> <td></td> <td>50,000.00</td> </tr> </tbody> </table>	Irrigation		Yearly values from		time series		[USD/m ³ /s]			50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00		50,000.00
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<p>27- For the 'Pumping' CBA Item enter as 'Benefit Conversions' 950,000 for all years</p>	<table border="1"> <thead> <tr> <th colspan="2">Pumping</th> </tr> </thead> <tbody> <tr> <td style="background-color: #90EE90;">Yearly values from</td> <td></td> </tr> <tr> <td style="background-color: #90EE90;">time series</td> <td></td> </tr> <tr> <td style="background-color: #90EE90;">[USD/m³/s]</td> <td></td> </tr> <tr> <td></td> <td>950,000.00</td> </tr> </tbody> </table>	Pumping		Yearly values from		time series		[USD/m ³ /s]			950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00		950,000.00
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Answers

1. In a CBA setup in the DSS you define the various elements that are used to assess the financial viability of a scenario such as costs, benefits, discount rates.

2.4. CBA Sessions and comparisons

Introduction

This lesson shows you how you can visualize the CBA results and also explains how you can interpret and compare them.

Topics covered in this lesson:

- Creating a CBA session
- Cloning a CBA session to vary CBA parameters
- Cloning a CBA setup to vary CBA interventions
- Comparison of CBA results

Lesson objectives:

By the end of this lesson, it is anticipated that you will be able to:

- Create CBA sessions.
- Clone and modify CBA sessions and setups
- Compare CBA session and setup results

Lesson pre-requisites

You have to be familiar with the CBA [setup](#) to take this lesson.

What is a CBA session?

A CBA Session (See Figure 6) is created based upon a CBA setup. It includes the information of the CBA Setup but you can vary certain properties of CBA items such as the discount rates to check the viability of a scenario under different conditions. In the DSS, one CBA Setup can include several CBA Sessions but once a CBA Session is created under a CBA setup, the setup cannot be edited anymore unless all its CBA sessions are deleted. In a session, the CBA metrics are summarized as shown in Figure 7.

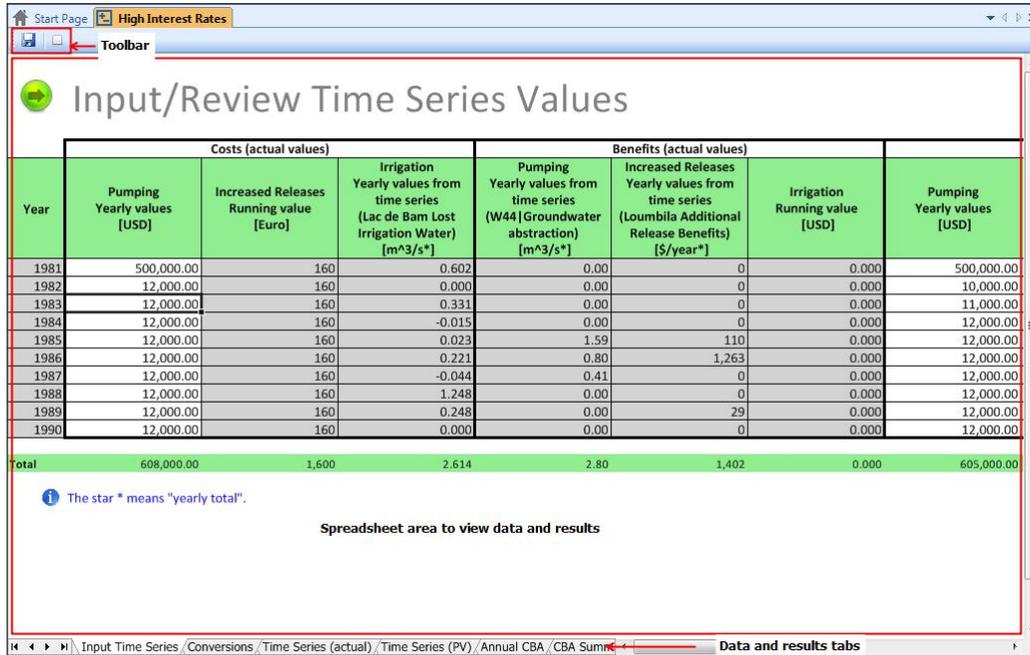


Figure 6: CBA session components

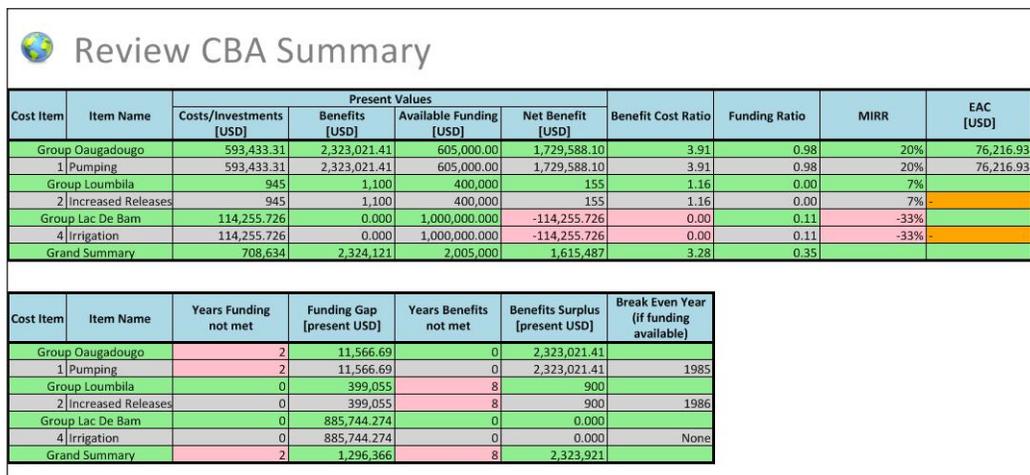


Figure 7: Session summary

What is a CBA comparison?

In a CBA comparison, you can compare a number of CBA sessions. These sessions can be under the same CBA setup or different setups. A comparison is run using the 'Compare sessions' tool from the 'Tools' explorer. In a CBA comparison, you can compare the CBA metrics from different CBA Sessions in tabular or graphical (See Figure 8) formats.

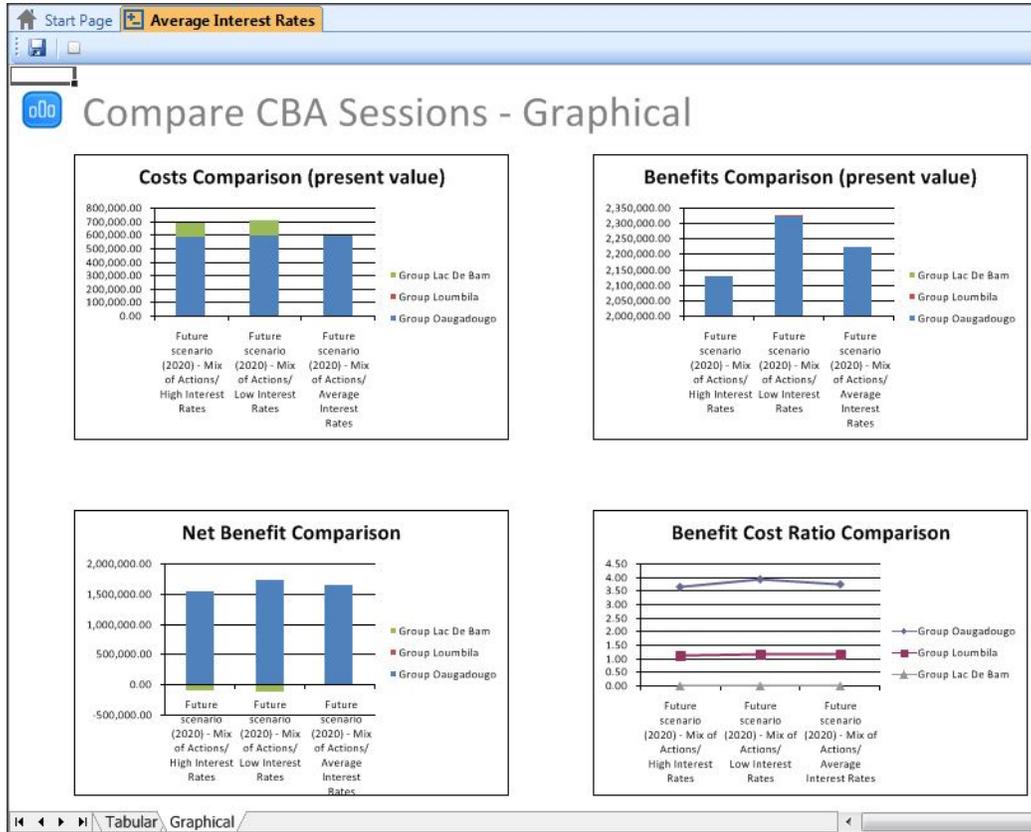
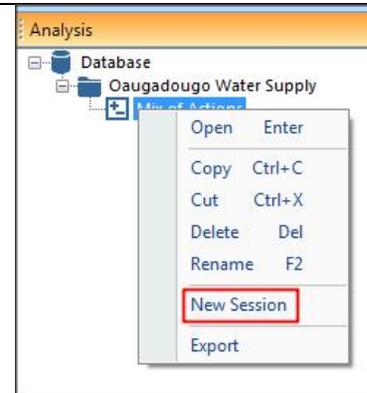


Figure 8: Session comparison in graphical format

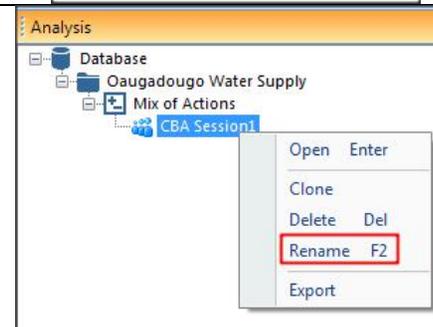
Exercises

Creating a CBA session and visualizing the results

1- Under the 'Oaugadougo Water Supply' group, right click the 'Mix of Actions' CBA Setup and select to **New Session** create a new CBA Session.



2- A new CBA session is created and it is called 'CBA Session1'. Right click the newly created CBA session and select **Rename** to rename it to 'Low Interest Rates'.



Analysis Manager

3- Double click the 'Low Interest Rates' CBA session and review the data in the 'Input Time Series', 'Conversions', and 'Time Series (actual)' tabs. The first two are no different from the CBA setup and third one shows the converted values into 'USD' as shown below.

Year	Costs (actual values)			Benefits (actual values)			Funding (actual values)			Benefit Minimums (actual values)		
	Pumping Yearly values [USD]	Increased Releases Running value [USD]	Irrigation Yearly values from time series (Lac de Bam Lost Irrigation Water) [USD]	Pumping Yearly values from time series (W44) Groundwater abstraction) [USD]	Increased Releases Yearly values from time series (Loumbila Additional Release Benefits) [USD]	Irrigation Running value [USD]	Pumping Yearly values [USD]	Increased Releases Running value [USD]	Irrigation Running value [USD]	Pumping Running value [USD]	Increased Releases Running value [USD]	Irrigation Running value [USD]
1981	500,000.00	112	30,089.565	0.00	0	0.000	500,000.00	40,000	100,000.000	0.00	20	0.000
1982	12,000.00	112	0.000	0.00	0	0.000	10,000.00	40,000	100,000.000	0.00	20	0.000
1983	12,000.00	112	16,534.033	0.00	0	0.000	11,000.00	40,000	100,000.000	0.00	20	0.000
1984	12,000.00	112	-731.806	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1985	12,000.00	112	1,145.945	1,510,448.17	110	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1986	12,000.00	112	11,070.460	760,872.04	1,263	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1987	12,000.00	112	-2,210.728	387,676.38	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1988	12,000.00	112	62,404.133	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1989	12,000.00	112	12,407.372	0.00	29	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1990	12,000.00	112	0.000	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
total	608,000.00	1,120	130,708.981	2,658,996.59	1,402	0.000	605,000.00	400,000	1,000,000.000	0.00	200	0.000

4- Review the data in the 'Time Series (PV)' tab. The present values of costs, benefits, funding and benefits minimum are shown.

★ Review Present Value Time Series

Year	Costs (present values)			Benefits (present values)			Funding (present values)			Benefit Minimums (present values)		
	Pumping Yearly values [USD]	Increased Releases Running value [USD]	Irrigation Yearly values from time series (Lac de Bam Lost Irrigation Water) [USD]	Pumping Yearly values from time series (W44) Groundwater abstraction) [USD]	Increased Releases Yearly values from time series (Loumbila Additional Release Benefits) [USD]	Irrigation Running value [USD]	Pumping Yearly values [USD]	Increased Releases Running value [USD]	Irrigation Running value [USD]	Pumping Running value [USD]	Increased Releases Running value [USD]	Irrigation Running value [USD]
1981	500,000.00	112	30,089.565	0.00	0	0.000	500,000.00	40,000	100,000.000	0.00	20	0.000
1982	11,650.49	108	0.000	0.00	0	0.000	10,000.00	40,000	100,000.000	0.00	20	0.000
1983	11,311.15	104	15,584.912	0.00	0	0.000	11,000.00	40,000	100,000.000	0.00	20	0.000
1984	10,981.70	100	-669.700	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1985	10,661.84	96	1,018.158	1,342,013.64	91	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1986	10,351.31	92	9,549.476	656,334.90	989	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1987	10,049.81	89	-1,851.450	324,672.86	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1988	9,757.10	85	50,740.271	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1989	9,472.91	82	9,794.494	0.00	19	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
1990	9,197.00	79	0.000	0.00	0	0.000	12,000.00	40,000	100,000.000	0.00	20	0.000
Total	593,433.31	945	114,255.726	2,323,021.41	1,100	0.000	605,000.00	400,000	1,000,000.000	0.00	200	0.000

- Which Item has the largest costs and benefits?

5- Review the data in the 'Annual CBA' tab

- In which year is the 'Pumping' CBA Item profitable?

(Hint: Look for years with benefit cost ratio that is equal or more than 1)

- Why are Benefit Cost Ratios for the 'Irrigation' CBA Item not computed for some years? (Hint: Check the costs and benefits in the present value time series)

Year	Benefit Cost Ratio		
	Pumping	Increased Releases	Irrigation
1981	0.00	0.00	0.00
1982	0.00	0.00	-
1983	0.00	0.00	0.00
1984	0.00	0.00	-
1985	125.87	0.95	0.00
1986	63.41	10.75	0.00
1987	32.31	0.00	-
1988	0.00	0.00	0.00
1989	0.00	0.24	0.00
1990	0.00	0.00	-
Total	3.91	1.16	-
Years in violation	7	9	6

6- Review the data in the 'CBA Summary' tab

Review CBA Summary

Cost Item	Item Name	Present Values				Benefit Cost Ratio	Funding Ratio	MIRR	EAC [USD]
		Costs/Investments [USD]	Benefits [USD]	Available Funding [USD]	Net Benefit [USD]				
Group Oaugadougo		593,433.31	2,323,021.41	605,000.00	1,729,588.10	3.91	0.98	20%	76,216.93
1	Pumping	593,433.31	2,323,021.41	605,000.00	1,729,588.10	3.91	0.98	20%	76,216.93
Group Loumbila		945	1,100	400,000	155	1.16	0.00	7%	
2	Increased Releases	945	1,100	400,000	155	1.16	0.00	7%	
Group Lac De Bam		114,255.726	0.000	1,000,000.000	-114,255.726	0.00	0.11	-33%	
4	Irrigation	114,255.726	0.000	1,000,000.000	-114,255.726	0.00	0.11	-33%	
Grand Summary		708,634	2,324,121	2,005,000	1,615,487	3.28	0.35		

Cost Item	Item Name	Years Funding not met	Funding Gap [present USD]	Years Benefits not met	Benefits Surplus [present USD]	Break Even Year (if funding available)
Group Oaugadougo		2	11,566.69	0	2,323,021.41	
1	Pumping	2	11,566.69	0	2,323,021.41	1985
Group Loumbila		0	399,055	8	900	
2	Increased Releases	0	399,055	8	900	1986
Group Lac De Bam		0	885,744.274	0	0.000	
4	Irrigation	0	885,744.274	0	0.000	None
Grand Summary		2	1,296,366	8	2,323,921	

-Is the scenario profitable? (Hint: check the grand benefit cost ratio)

-In which year will 'Pumping' break even? (Hint: check the break even year column)

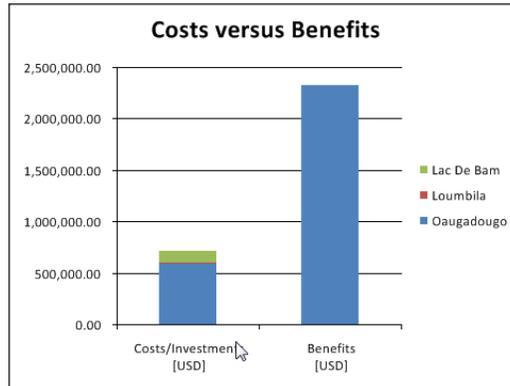
- Are there funding gaps? (Hint: check the funding gap year column)

-In which items are the minimum benefits not met? (check the years benefit not met column)

7- Review the 'CBA Graphs'

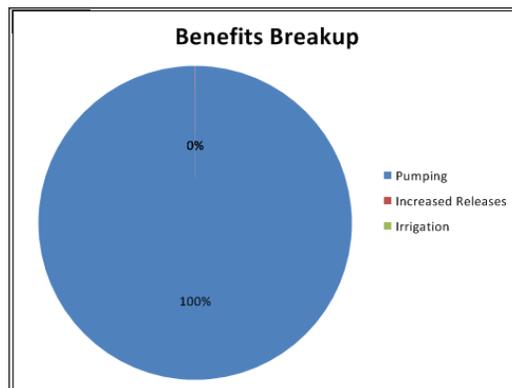
Plot first the 'Cost versus Benefits' from the  tool bar button.

- Are the costs for the 'Increased Releases' (at Loumbila) significant?

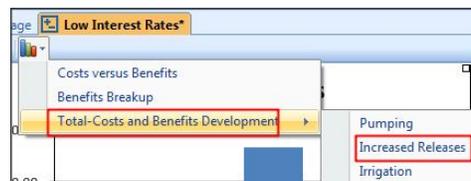


Plot then the 'Benefits Breakup' from the  tool bar button.

-Which benefit dominates?



Let's finally Plot the 'Total costs and Benefits Development' for the 'Increased Releases' from the  tool bar button.



<p><i>- When do the benefits of the 'Increased Releases' exceed the costs?</i></p>	
<p>8- Save the session by clicking the  on the tool bar then close it by clicking the  button as shown next.</p>	

Clone and edit a CBA session

<p>1- To check the impact of varying CBA data (i.e. change of some CBA items Interest rates) on the results, you will need to clone and then edit the 'lowest Interest Rates' session. To do so, right click the 'Low Interest Rates' session and click to clone it.</p>	
<p>2- Rename the cloned CBA Session as 'High Interest Rates' and open it.</p>	
<p>3- Change some discount rates to higher values (e.g. increase by 2 % for all items). To do this select the 'Time Series (PV) tab' then select a cost Item and change the discount rate in the 'Properties' window as shown below.</p>	

Analysis Manager

The screenshot displays the 'High Interest Rates' window in the Analysis Manager. The main table, titled 'Costs (present values)', shows data from 1981 to 1990. The columns are 'Year', 'Pumping Yearly values [USD]', 'Increased Releases Running value [USD]', and 'Irrigation Yearly values from time series (Lac de Bam Lost Irrigation Water) [USD]'. A red box highlights the 'Pumping Yearly values' column, and a red arrow points from it to the 'Annual Discount Rate (%)' field in the 'Properties' panel on the right. The 'Properties' panel shows 'Annual Discount Rate (%)' set to 3, 'Group' as 'Oaugadougo', and 'Name' as 'Pumping'.

Year	Pumping Yearly values [USD]	Increased Releases Running value [USD]	Irrigation Yearly values from time series (Lac de Bam Lost Irrigation Water) [USD]
1981	500,000.00	112	30,089.565
1982	11,650.49	108	0.000
1983	11,311.15	104	15,584.912
1984	10,981.70	100	-669.700
1985	10,661.84	96	1,018.158
1986	10,351.31	92	9,549.476
1987	10,049.81	89	-1,851.450
1988	9,757.10	85	50,740.271
1989	9,472.91	82	9,794.494
1990	9,197.00	79	0.000
Total	593,433.31	945	114,255.726

4- You can also edit if you want the 'Yearly Values' and 'Conversion Factors' as within the 'Input Time Series' and 'Conversions' tabs as done in [creating a CBA setup](#) for a CBA setup.



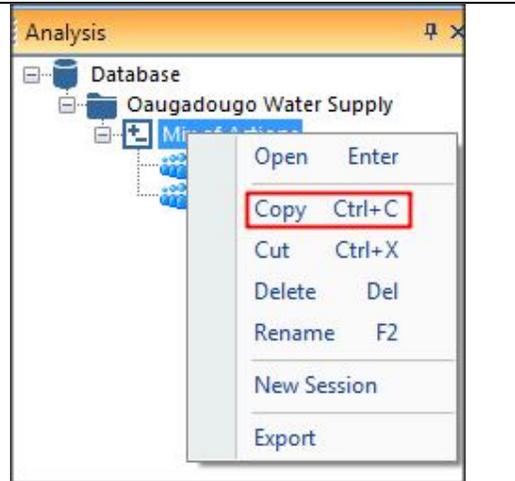
5- Review the results as done in [creating a CBA session and visualizing the results](#).
What do you notice?

6- Save the session by clicking the  on the tool bar then close it by clicking the  button as shown next.

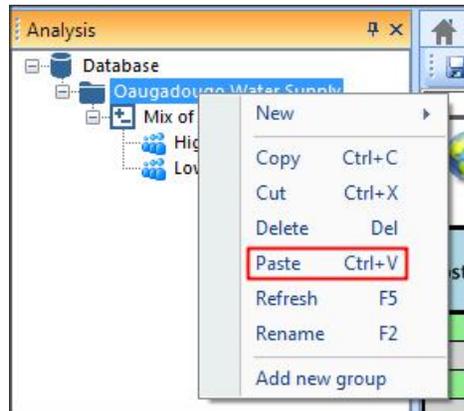


Cloning and modifying a CBA setup

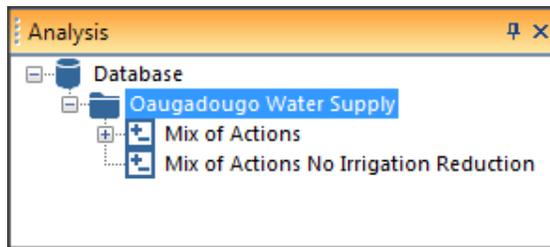
1- To check the impact of varying the CBA Interventions on the CBA results (i.e. removing one intervention), you will need to clone the CBA setup. To clone a CBA setup, first right click the setup and select **Copy**.



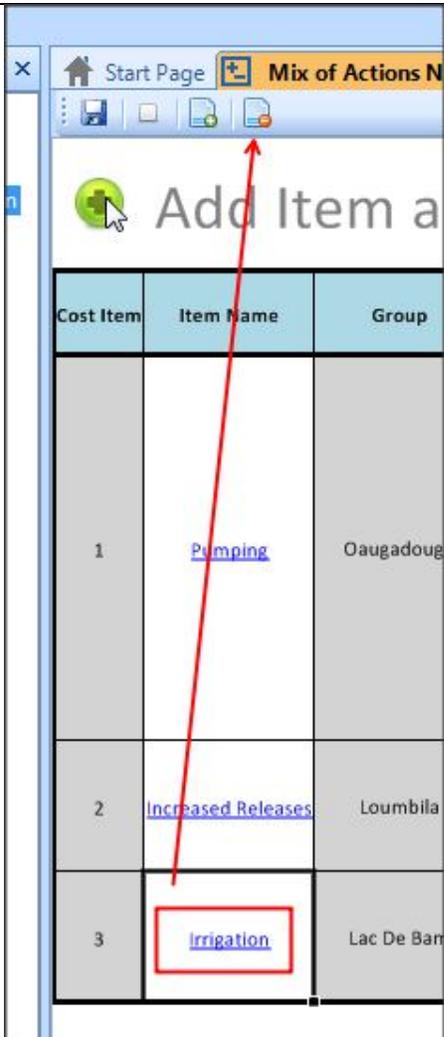
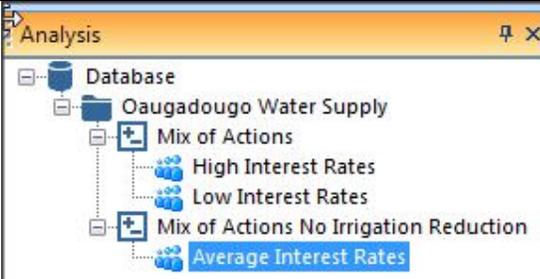
Right click then the 'Database' group or a user defined group and select **Paste**. In this exercise you will clone the setup under the 'Oaugadougo Water Supply' group.



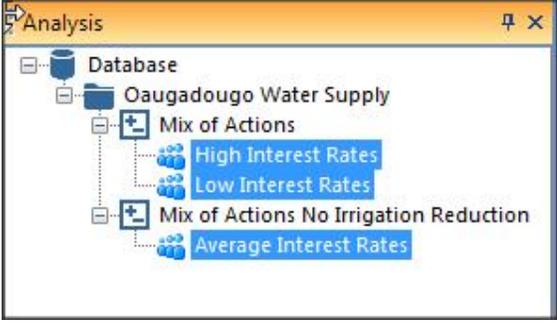
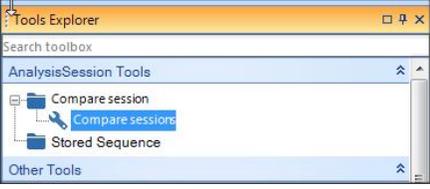
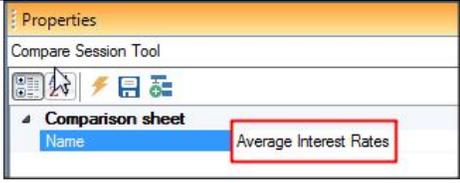
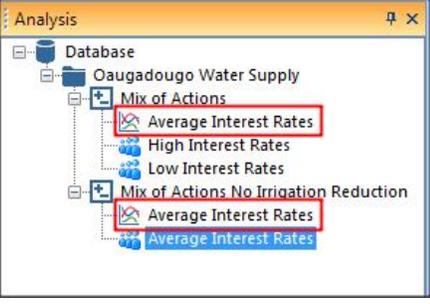
Right click the cloned Setup and rename it to 'Mix of Actions - No Irrigation Reduction'



The new setup contains no sessions.

<p>2- Open the newly created set up and delete the 'Irrigation' Cost Item. This can be done by selecting the cost item and then clicking the  button on the toolbar. Save the setup by clicking the  button.</p>	 <table border="1" data-bbox="878 443 1273 1178"> <thead> <tr> <th>Cost Item</th> <th>Item Name</th> <th>Group</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Pumping</td> <td>Oaugadoug</td> </tr> <tr> <td>2</td> <td>Increased Releases</td> <td>Loumbila</td> </tr> <tr> <td>3</td> <td>Irrigation</td> <td>Lac De Bar</td> </tr> </tbody> </table>	Cost Item	Item Name	Group	1	Pumping	Oaugadoug	2	Increased Releases	Loumbila	3	Irrigation	Lac De Bar
Cost Item	Item Name	Group											
1	Pumping	Oaugadoug											
2	Increased Releases	Loumbila											
3	Irrigation	Lac De Bar											
<p>3. Create a new CBA Session for the CBA Setup 'Mix of Actions - No Irrigation Reduction'. Rename the new CBA Session to 'Average Interest Rates'</p>	 <pre> graph TD Database[Database] --> Oaugadougo[Oaugadougo Water Supply] Oaugadougo --> MixOfActions[Mix of Actions] Oaugadougo --> MixOfActionsNoIrrigation[Mix of Actions No Irrigation Reduction] MixOfActions --> HighInterestRates[High Interest Rates] MixOfActions --> LowInterestRates[Low Interest Rates] MixOfActionsNoIrrigation --> AverageInterestRates[Average Interest Rates] </pre>												
<p>4. Increase the discount rates by 1 % as and save the CBA setup done above.</p>													

Creating a CBA comparison

<p>1- Select all three CBA Sessions that you have created.</p> <p>In the tools explorer select the 'Compare sessions' tool to create a CBA Comparison.</p>	 
<p>2- Once the tool is selected, its properties appear in the 'Properties' explorer. Enter the name of the new CBA Comparison as 'Average Interest Rates'. Then run the tool by clicking the  button.</p>	
<p>3- A CBA comparison is created under each setup (they are identical) showing a comparison between the three sessions that you created.</p>	

4- Double click the CBA comparison to open and review the Tabular data tab.
-which scenario has the largest Net Benefit?

-Do all scenarios break even in the same year?

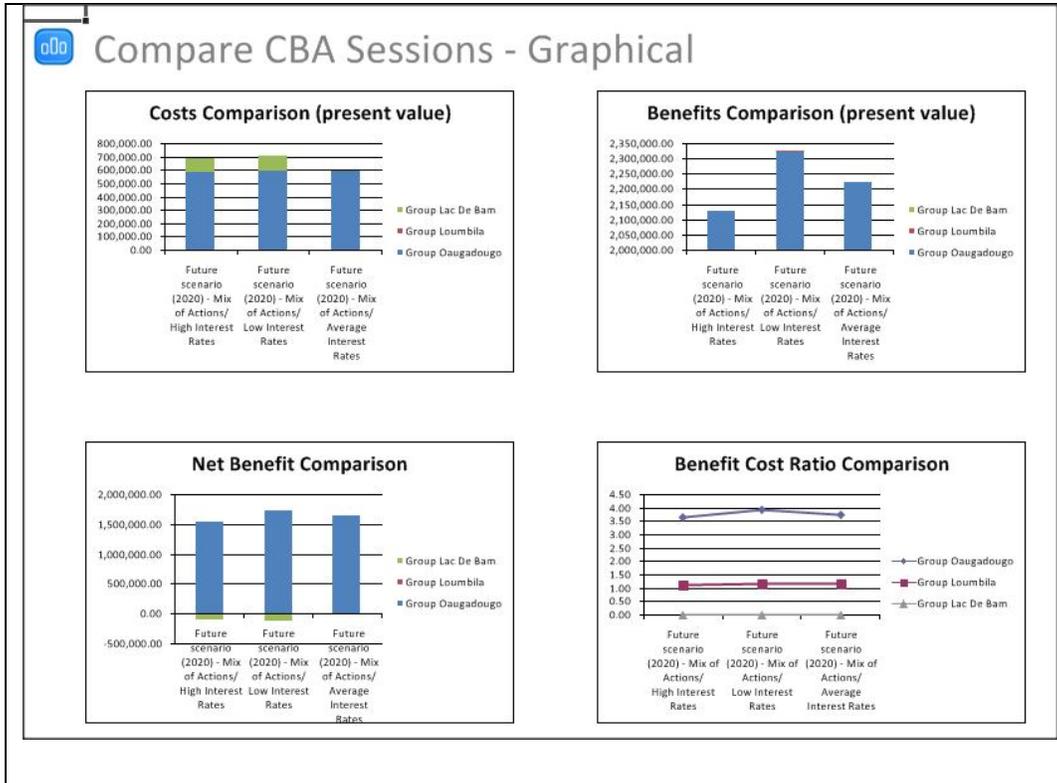
-Which scenario is the most profitable, why?

	Future scenario (2020) - Mix of Actions/ High Interest Rates	Future scenario (2020) - Mix of Actions/ Low Interest Rates	Future scenario (2020) - Mix of Actions/ Average Interest Rates
Present Values			
Net Benefit [USD]			
2	1,542,808.82	1,729,588.10	1,633,681.07
2	1,542,808.82	1,729,588.10	1,633,681.07
1	127	155	141
1	127	155	141
3	-105,168.603	-114,255.726	0
3	-105,168.603	-114,255.726	0
9	1,437,768	1,615,487	1633821.951
	Future scenario (2020) - Mix of Actions/ High Interest Rates	Future scenario (2020) - Mix of Actions/ Low Interest Rates	Future scenario (2020) - Mix of Actions/ Average Interest Rates

	Scenario:	Future scenario (2020) - Mix of Actions/ High Interest Rates	Future scenario (2020) - Mix of Actions/ Low Interest Rates	Future scenario (2020) - Mix of Actions/ Average Interest Rates
Cost Item	Item Name	Break Even Year (if funding available)		
	Group Oaugadougo			
1	Pumping	1985	1985	1985
	Group Loumbila			
2	Increased Releases	1986	1986	1986
	Group Lac De Bam			
4	Irrigation	None	None	
	Grand Summary			

	Scenario:	Future scenario (2020) - Mix of Actions/ High Interest Rates	Future scenario (2020) - Mix of Actions/ Low Interest Rates	Future scenario (2020) - Mix of Actions/ Average Interest Rates
Cost Item	Item Name	Benefit Cost Ratio		
	Group Oaugadougo	3.64	3.91	3.77
1	Pumping	3.64	3.91	3.77
	Group Loumbila	1.15	1.16	1.16
2	Increased Releases	1.15	1.16	1.16
	Group Lac De Bam	0.00	0.00	
4	Irrigation	0.00	0.00	
	Grand Summary	3.08	3.28	3.77

5- Review the Graphical data tab.



Review Questions

1. What is a CBA session?
2. What is a CBA comparison?

Answers

1. A CBA Session is created based upon a CBA setup. It repeats the information of the CBA Setup but you can vary the CBA items such as the discount rates to check the viability of a scenario under different conditions.
2. In a CBA comparison, you can compare a number of CBA sessions. These sessions can be under the same CBA setup or different setups. A comparison is run using the 'Compare sessions' tool from the 'Tools' explorer. In a CBA comparison, you can compare the CBA metrics from different CBA Sessions in tabular or graphical.

2.5. MCA Setup

Introduction

This lesson gives a description how you can setup an MCA within the DSS.

Topics covered in this lesson:

- A detailed description of how to setup an MCA in the DSS

Lesson objectives:

By the end of this lesson, it is anticipated that you will be:

- Able to setup an MCA within the DSS.

Lesson pre-requisites

You have to be familiar with the MCA [concepts](#) to take this lesson.

What is an MCA setup?

In the DSS, an MCA setup (Figure 9) is where you select the scenarios that will be evaluated and indicators that will be used to evaluate the scenarios. Indicators can be based on scenario results (i.e. simulations) or user defined (e.g. cost indicators). Following this a set of criteria that is based on the indicators needs to be defined. This set of criteria needs to be exhaustive and consistent, and in that case they are called non-redundant (i.e. if removing any one single criterion, leads to the remaining criteria no longer being exhaustive or consistent). After defining the criteria, the next step is to normalize them. Normalization is an important process to ensure that the different criteria values are comparable by scaling them to the range between 0 and 1. The four normalization techniques available in the DSS are defined below:

Percentage of Maximum:
$$v_i = \frac{a_i}{\max a_i}$$

Percentage of Range:
$$v_i = \frac{a_i - \min a_i}{\max a_i - \min a_i}$$

Percentage of Total:
$$v_i = \frac{a_i}{\sum a_i}$$

Unit Vector:
$$v_i = \frac{a_i}{\sqrt{(\sum_i a_i^2)}}$$

with:

a : the measurement of a criterion;

a_i : the criterion measurement for any given Scenario; and

v_i : normalized value of a_i .

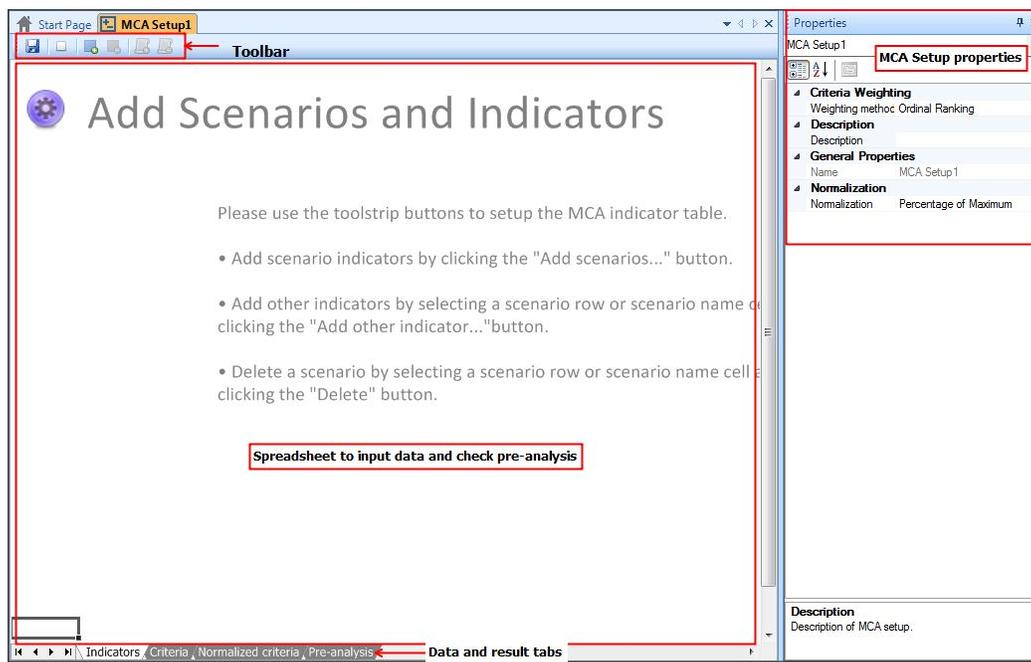


Figure 9: MCA setup components

There is no one single method that can prove to be the globally acceptable approach for normalization. Rather, characteristics of various indicators and parameters have to be evaluated and a normalization process has to be selected that can support comparison of various parameters at a comparable scale. As a general guidance the following recommendations are provided:

- If the normalized values are expected to range between 0 and 1, use 'percentage of range'.
- If the values are expected to sum to one, use 'percentage of total'.
- If the values of the indicators considered should remain constant in the interval [0; 1], the 'unit vector' technique should be used.

Analysis Manager

- If there is no basis for favoring one over the other, use 'percentage of maximum' - it is the most commonly used technique.

The sensitivity of the ranking to the selection of the normalization method is a good way to assess the robustness of the recommendations. Special care should be taken to avoid negative values after normalization (e.g. resulting from criteria that measure the deviation from a baseline)

After normalization, a decision matrix is assembled. This matrix should always be subjected to a simple, structured review before the analysis proceeds. This step is called the pre-analysis. The first step in the pre-analysis is to eliminate redundant criteria that do not vary from one scenario to the next. These criteria, as important as they may be to qualifying a plan, serve no useful purpose in the decision matrix. They do not discriminate among plans and therefore are not essential to the choice of a recommended plan. The next step in the pre-analysis is to eliminate alternatives from the matrix that are dominated by one or more other alternatives. If any one alternative dominates all others, there is no need to proceed with the decision process. The decision has been made, or it is time to go back and formulate more scenarios. In some cases a scenario may dominate one or more but not all other scenarios. In these cases the dominated scenario(s) should be eliminated from the decision matrix or reformulated to avoid domination. Figure 10 shows an example of MCA decision matrix with no redundant criteria or dominant scenario.

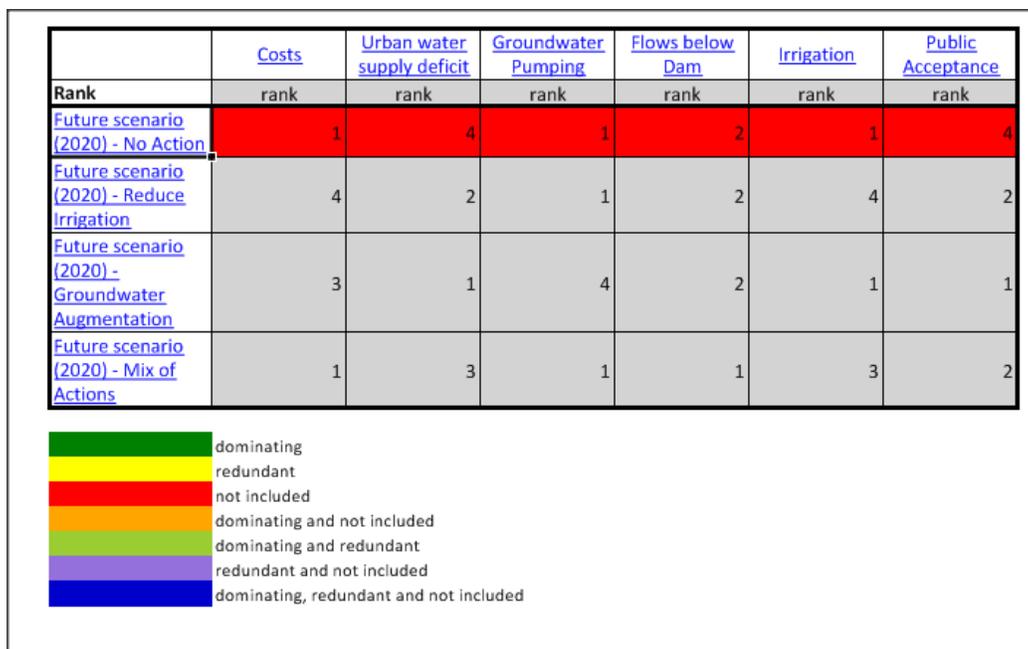


Figure 10: MCA decision matrix

MCA Exercise - problem definition

In the exercises section, the problem of the city of Ouagadougou (Burkina Faso) will be used as an example to demonstrate the use of MCA within the DSS (See Figure 11). The city currently experiencing rapid growth and serious deficits are expected by the year 2020 in its water supply which comes from two reservoirs Ziga, and Loubila. At the same time, increased irrigation is expected for the Lac de Bam area, which will likely strain the water supply for the downstream Ziga Reservoir. Environmental concerns might also restrain the other Ouagadougou water supply diversion at Loubila reservoir as releases there should be increased to protect downstream fish habitat and thus the livelihood of local fishermen.

A study was commissioned to assess the impact of growth in Ouagadougou and the Lac de Bam area on the Ouagadougou city water supply. Historic flow data and estimates of water demands in 2020 were used to establish a number of scenarios to address the expected Ouagadougou water supply shortages. The following scenarios were created by study engineers to assess the impacts of three possible actions:

- 'Future scenario (2020) – Reduce Irrigation', aiming at increasing diversions to Ouagadougou by reducing irrigation at Lac de Bam and modifying operations at Ziga reservoir to allow more water to be diverted to Ouagadougou.
- 'Future scenario (2020) – Groundwater Augmentation', aiming to deliver 50% of the water supply for Ouagadougou through groundwater pumping.

Analysis Manager

- 'Future scenario (2020) – Mix of Actions', which allows lower water levels at Loumbila reservoir in order to increase both the water supply for Ouagadougou and releases for the downstream fishermen. The scenario also restricts some of the irrigation at Lac de Bam, but not nearly as much as in the 'Future scenario (2020) - Reduce Irrigation' scenario in order to increase water supply diversions to Ouagadougou.

The Three stakeholders (City of Ouagadougou, Farmers from the Lac de Bam area and an Ouagadougou Environmentalists group) were invited to perform an MCA and to find a mutually acceptable solution ('Action') that alleviates the expected water supply shortages. The three stakeholders defined the following indicators to assess the impacts of the three scenarios on the stakeholder's interests in a consistent manner:

- Ouagadougou urban water supply - Months above 15% deficit, counting how many months within the model simulation period have a deficit of more than 15% of Ouagadougou's water supply demand. The City of Ouagadougou aims at minimizing the number of months with large water supply deficits.
- Ouagadougou urban water supply - Months at 100% deficit, counting the number of months when no water can be delivered to Ouagadougou. The City of Ouagadougou prefers not to be in this situation and tries to minimize this number of months.
- Releases from Loumbila, computing the average volume of releases from Loumbila reservoir. Larger releases provide better habitat for the local fish population. The Ouagadougou Environmentalists group, which represents the local fishermen, tries to maximize these releases.
- Irrigation at Lac de Bam - Average volume, computing the average volume of irrigation water that can be used in the Lac de Bam area. The farmers from the Lac de Bam area like to maximize this volume.
- Ouagadougou groundwater pumping - Average flows, computing the average volume of groundwater required to meet Ouagadougou's water supply demand. Groundwater pumping is very expensive, and the City of Ouagadougou likes to minimize the volume of pumped groundwater.
- Costs, which were computed for each scenario outside the MIKE Basin model. These costs include construction and maintenance costs for groundwater pumping, lost revenues caused by reduced crop production due to less irrigation water supply, lost revenue by decreasing fish catch and

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general lost productivity due to less available water in Ouagadougou. Costs should be minimized.

Another important aspect in the decision making is public acceptance. During the study, surveys were performed in the stakeholder's areas to gauge the local resident's acceptance of the possible scenarios. Final 'public acceptance' scores are provided to use in the MCA.

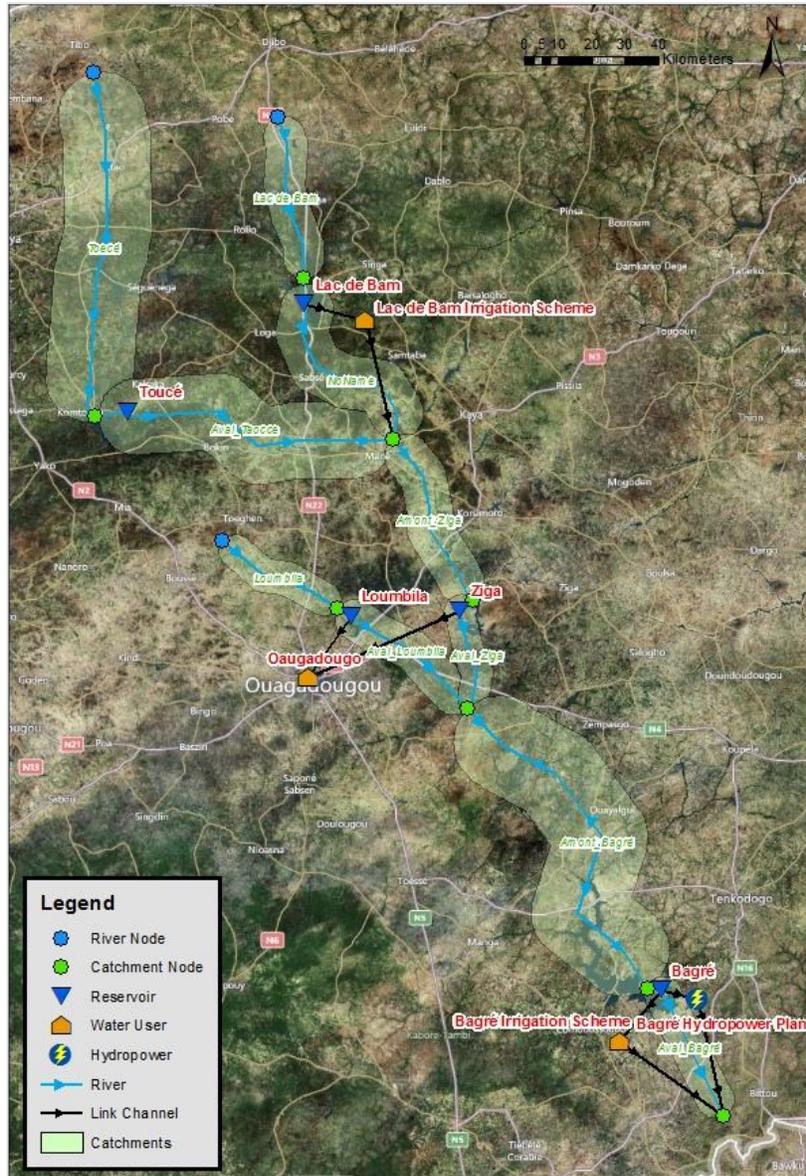
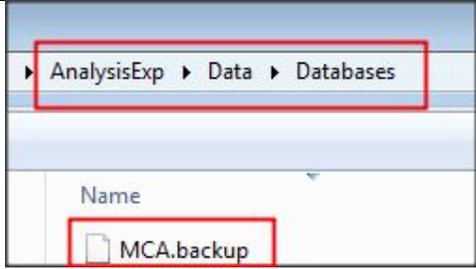
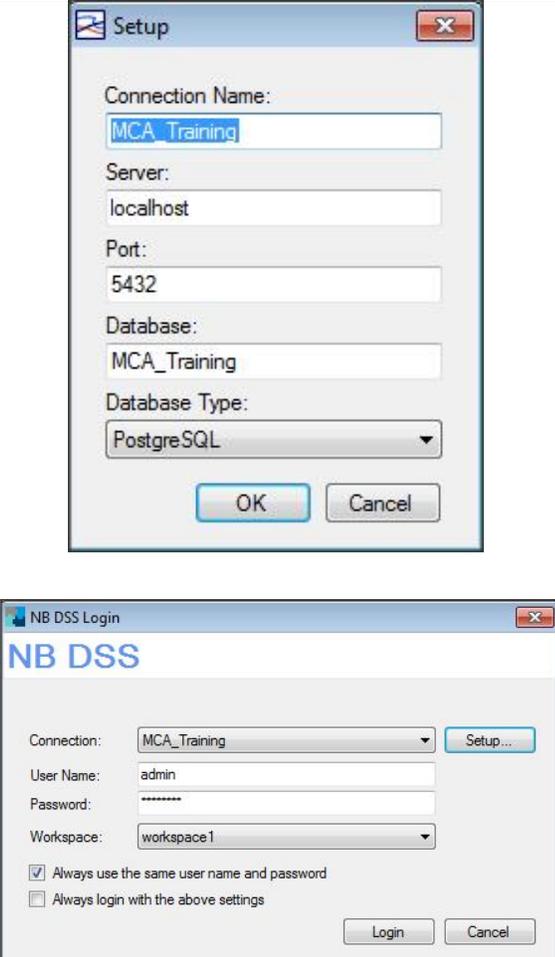


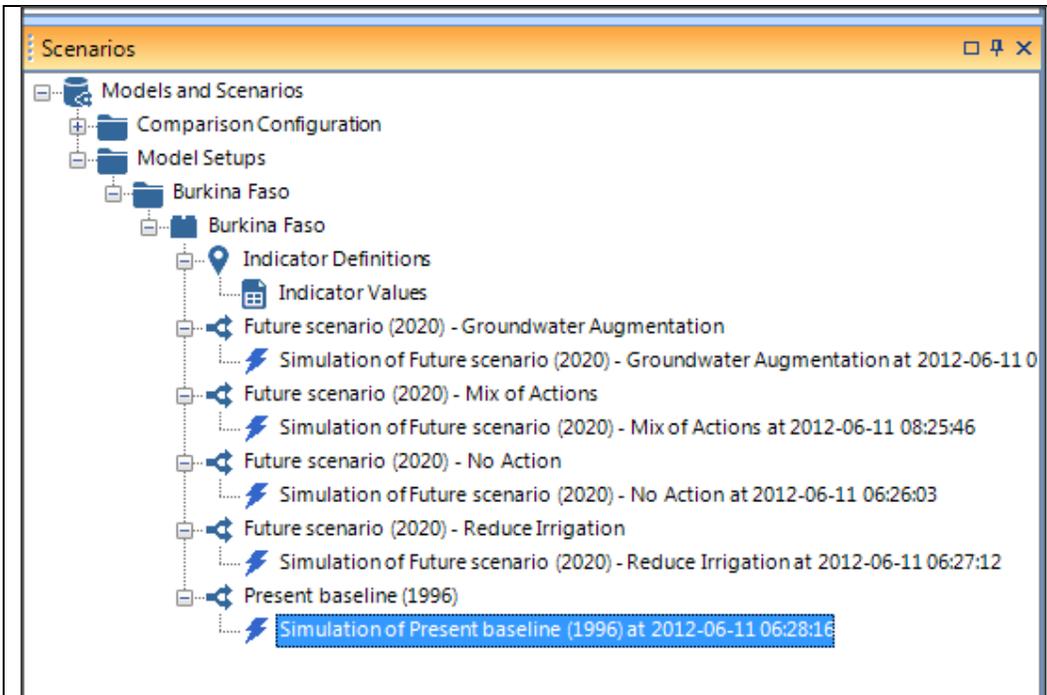
Figure 11: Ouagadougou model for MCA

Exercises

Create an MCA setup

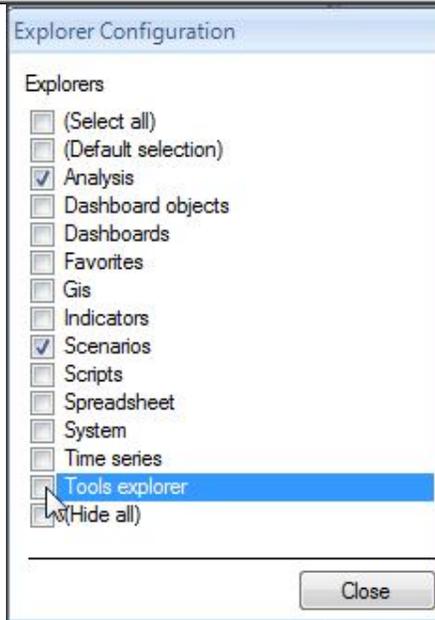
1- Data for the exercises in this section and the next section are

<p>supplied in 'MCA' database. Restore the database from ..\AnalysisExp\Data\Databases folder and call it, for example, 'MCA_Training' (For more information on how to restore a database See the Database Manager Utility and System Manager training module).</p>	
<p>2- Start the DSS and create a setup for the 'MCA_Training' database and then use this setup login to the DSS (For more information on how to create a setup and login See the Database Manager Utility and System Manager training module).</p>	
<p>3- This database includes the 'Burkina Faso' model setup with 4 defined indicators and 5 defined scenarios with one simulation each, as shown below.</p>	

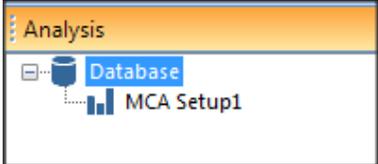
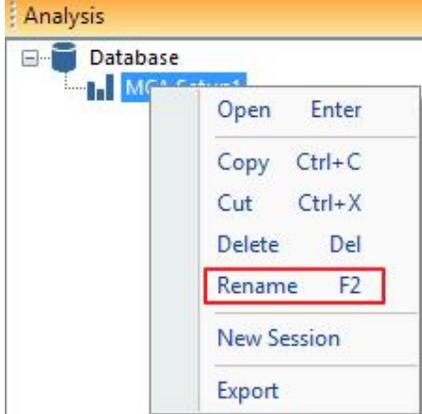
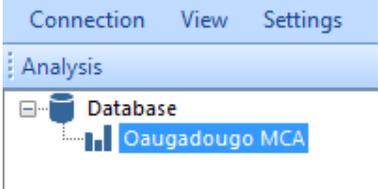


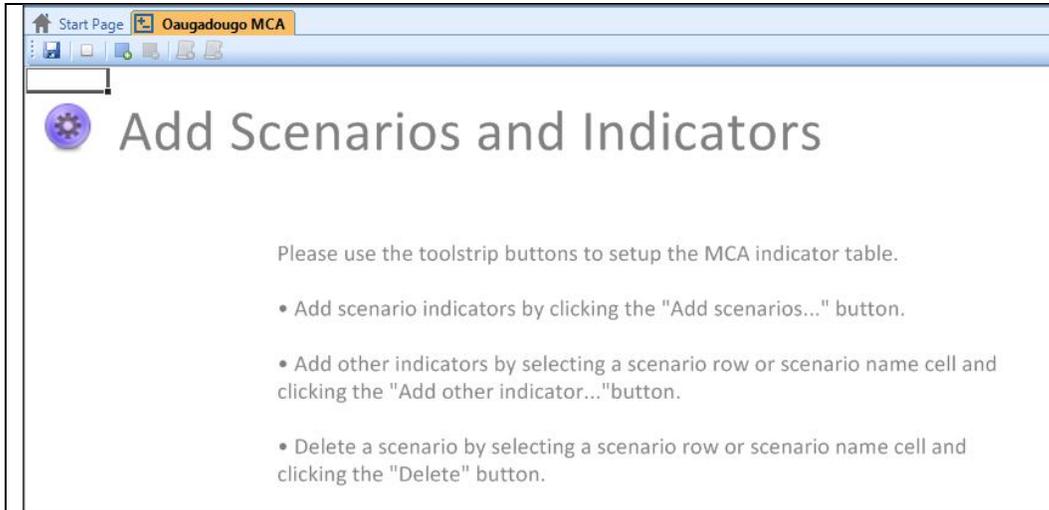
Indicator definitions	
Name	Description
Oaugadougou urban water supply - ...	This indicator counts the number of months with deficits above the specified threshold
Irrigation at Lac de Bam - Average v...	This indicator calculates the average supply for all time steps.
Oaugadougou groundwater pumpin...	This indicator calculates the average pumping for all time steps.
Releases from Loumbila	This indicator calculates the average release for all time steps.

4- In the DSS, click on **View** Menu, click "Explorers..." and the Explorer Configuration box appears. Tick the box next to the 'Scenario' and 'Analysis' explorers.



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<p>5- Right click the 'Database' node in the Analysis Manager and select New and then Multi-criteria analysis to create a new MCA Setup.</p> <p>A new MCA setup that is called 'MCA setup1' is created.</p>	 
<p>6- Right click the newly created MCA setup and select Rename. Call the group 'Oaugadougo MCA'.</p>	 
<p>7- Double click on the 'Oaugadougo MCA' setup to open it. Once this is done, the window shown below is opened.</p>	



Start Page Oaugadougo MCA

Add Scenarios and Indicators

Please use the toolbar buttons to setup the MCA indicator table.

- Add scenario indicators by clicking the "Add scenarios..." button.
- Add other indicators by selecting a scenario row or scenario name cell and clicking the "Add other indicator..." button.
- Delete a scenario by selecting a scenario row or scenario name cell and clicking the "Delete" button.

In this window you can use the toolbar buttons to:



Save the setup



Display/ hide the grid



Add a scenario



Delete a scenario (a scenario has to be selected for this button to function)



Add other indicators (that are not associated to the scenario or calculated outside the DSS)

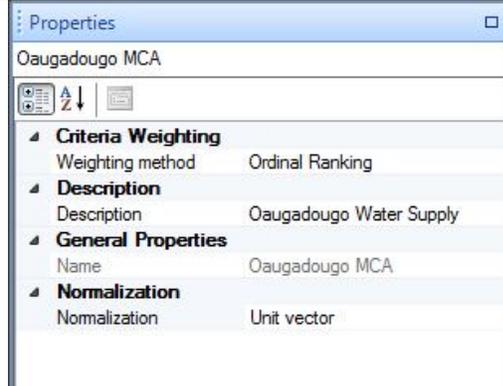


Delete other indicators

8- In the 'Properties' window, set the following MCA properties:

- Weighting Method: Ordinal Ranking
- Normalization Method: Unit Vector

Description: 'Oaugadougo Water Supply'

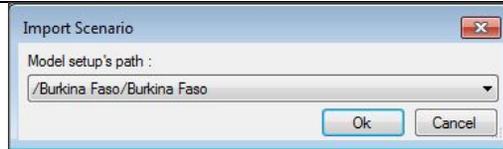


Properties

Oaugadougo MCA

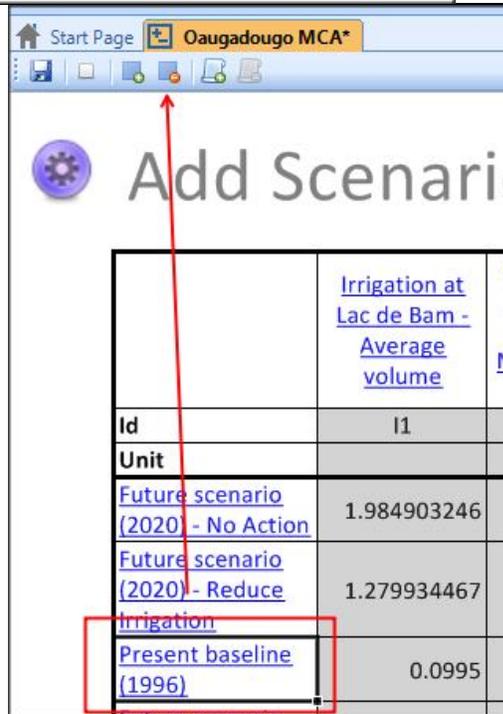
- ▲ **Criteria Weighting**
 - Weighting method: Ordinal Ranking
- ▲ **Description**
 - Description: Oaugadougo Water Supply
- ▲ **General Properties**
 - Name: Oaugadougo MCA
- ▲ **Normalization**
 - Normalization: Unit vector

9- Add the scenarios using the  button from the '/Burkina Faso/Burkina Faso' model. This will populate the table with all scenarios and indicators under this model setup as shown below.



	Irrigation at Lac de Bam - Average volume	Oaugadougo urban water supply - Months above 15% deficit	Oaugadougo groundwater pumping - Average flows	Releases from Loumbila
Id	I1	I2	I3	I4
Unit				Kcms
Future scenario (2020) - No Action	1.984903246	44	0	0.545511329
Future scenario (2020) - Reduce Irrigation	1.279934467	6	0	0.545511329
Future scenario (2020) - Groundwater Augmentation	1.984903246	3	0.022187243	0.545511329
Future scenario (2020) - Mix of Actions	1.806316122	7	0	0.567077103

10- Delete the 'Present baseline (1996)' scenario from the table by selecting it in the scenarios table and then pressing the  button on the toolbar.



11- Add costs indicators for all scenarios. First select the scenario where the indicator will be added. Following this click the  button to import the indicator. In the Import Indicator dialog press the  icon to open the indicator Selector dialog. In the search box enter 'Costs *' and hit return key.

Use the mouse to select the cost indicators one by one and add them to their corresponding scenarios except the one for the base line.

Name	Parent Group
Costs Reduce Irrigation	Models and Scenarios/Burkina Faso/Costs
Costs Baseline	Models and Scenarios/Burkina Faso/Costs
Costs Groundwater Augmentation	Models and Scenarios/Burkina Faso/Costs
Costs Mix of Actions	Models and Scenarios/Burkina Faso/Costs
Costs No Action	Models and Scenarios/Burkina Faso/Costs

12- The table should look like this after adding all indicators.

	Irrigation at Lac de Bam - Average volume	Oaugadougou urban water supply - Months above 15% deficit	Oaugadougou groundwater pumping - Average flows	Releases from Loumbila	Costs No Action	Costs Reduce Irrigation	Costs Groundwater Augmentation	Costs Mix of Actions
Id	I1	I2	I3	I4	I5	I6	I7	I8
Unit								
Future scenario (2020) - No Action	1.984903246	44	0	0.545511329	50000000			
Future scenario (2020) - Reduce Irrigation	1.279934467	6	0	0.545511329		500000		
Future scenario (2020) - Groundwater Augmentation	1.984903246	3	0.022187243	0.545511329			15000000	
Future scenario (2020) - Mix of Actions	1.806316122	7	0	0.567077103				19000000

13- Enter 'Units' for all indicators by clicking the indicator header and entering the unit in the property dialog (Note: Table swapped)

Indicator	Id	Unit
Irrigation at Lac de Bam - Average volume	I1	cms
Oaugadougo urban water supply - Months above 15% deficit	I2	Month
Oaugadougo groundwater pumping - Average flows	I3	cms
Releases from Loumbila	I4	cms
Costs No Action	I5	USD
Costs Reduce Irrigation	I6	USD
Costs Groundwater Augmentation	I7	USD
Costs Mix of Actions	I8	USD

The table should look like this after adding all units.

	Irrigation at Lac de Bam - Average volume	Oaugadougo urban water supply - Months above 15% deficit	Oaugadougo groundwater pumping - Average flows	Releases from Loumbila	Costs No Action	Costs Reduce Irrigation	Costs Groundwater Augmentation	Costs Mix of Actions
Id	I1	I2	I3	I4	I5	I6	I7	I8
Unit	cms	Month	cms	cms	USD	USD	USD	USD
Future scenario (2020) - No Action	1.984903246	44	0	0.545511329	50000000			
Future scenario (2020) - Reduce Irrigation	1.279934467	6	0	0.545511329		500000		
Future scenario (2020) - Groundwater Augmentation	1.984903246	3	0.022187243	0.545511329			15000000	
Future scenario (2020) - Mix of Actions	1.806316122	7	0	0.567077103				19000000



It is a good practice to frequently save your setup as the data is entered using the save button on the toolbar.

14- Now switch to the 'Criteria' tab to add criteria.

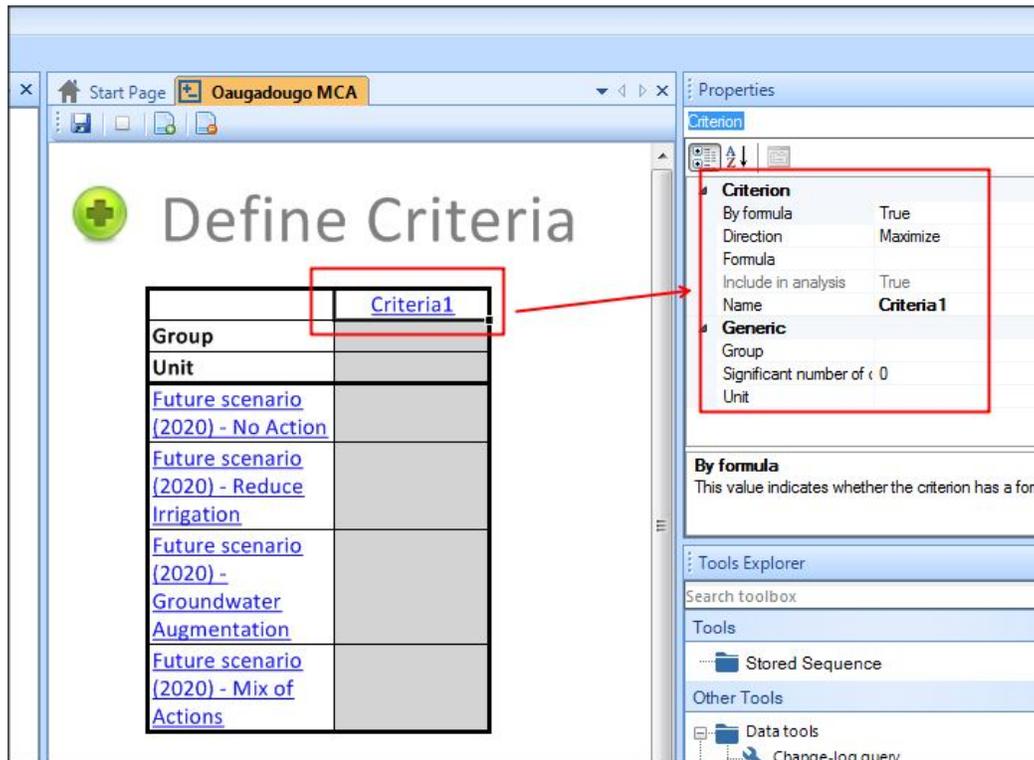


Criteria are added and deleted using the



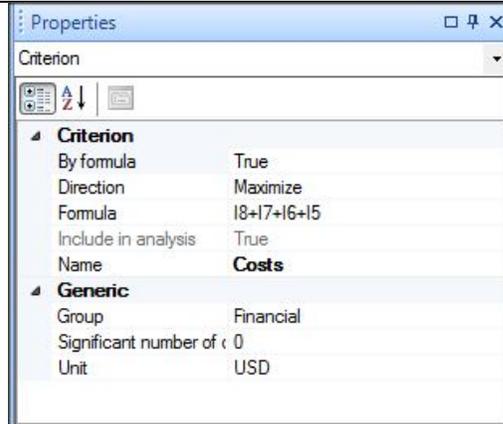
respectively.

15- Click on the  button to add a criterion and fill its properties in the 'Properties' window.



16- Add a 'Costs' criterion and set its properties to:

- By Formula: True
- Direction: Minimize
- Formula: add up the values for all 'Costs' indicators (I5 + I6 + I7 + I8)
The actual cell ID must be typed in manually, I5+I6+I7+I8 or double click in the calculation dialog to add them.
- Group: Financial
- Significant number of digits: 0
- Unit: USD

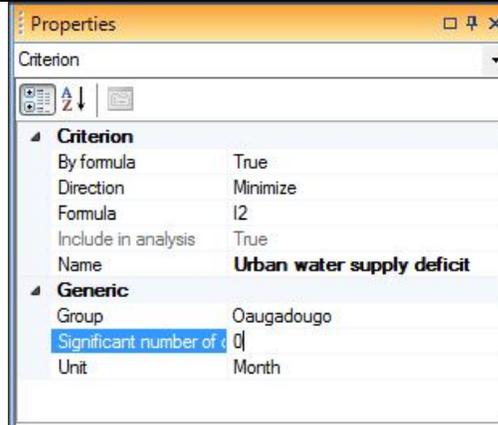




Adding the above criterion will cause a number of red warning statements to appear below the criteria table. These warnings are created because the costs indicators were defined for individual scenarios manually and thus do not have values for all scenarios. These warnings can be ignored.

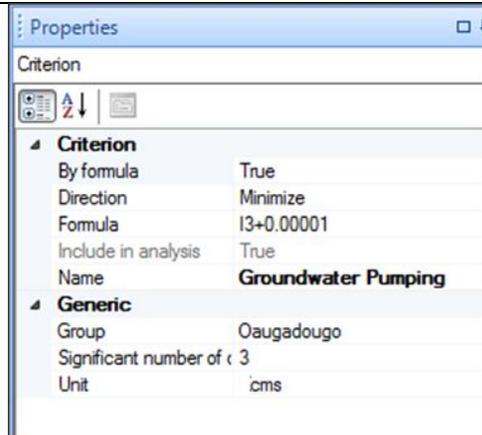
17- Add the 'Urban water supply deficit' criterion and set its properties:

- By Formula: True
- Direction: Minimize
- Formula: based on the 'Oaugadougo urban water supply - Months above 15% deficit' indicator;
- Group: Oaugadougo
- Significant number of digits: 0
- Unit: Months



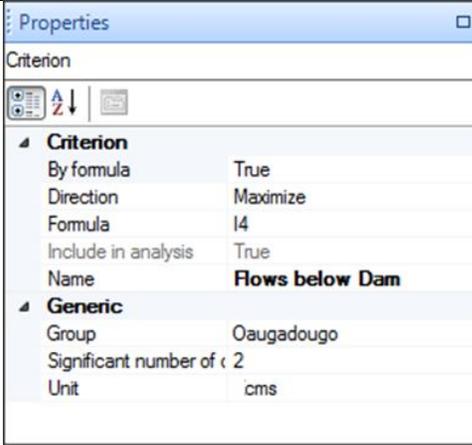
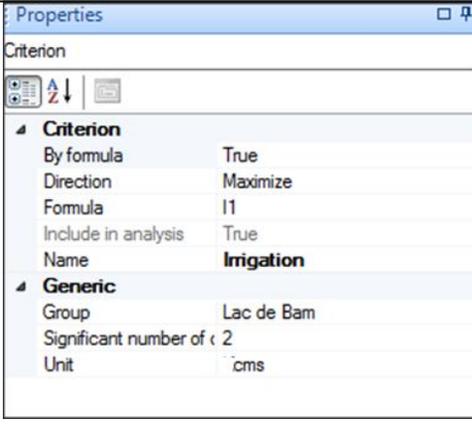
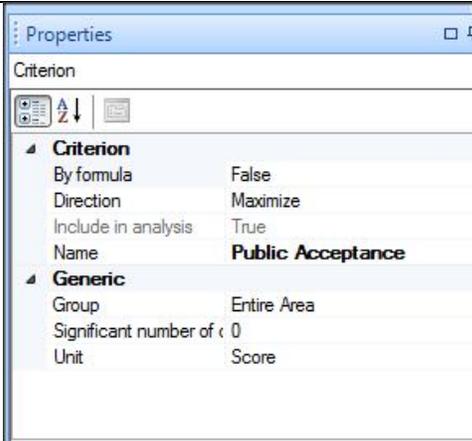
18 - Add the 'Groundwater Pumping' criterion and set its properties:

- By Formula: True
- Direction: Minimize
- Formula: based on the 'Oaugadougo groundwater pumping - Average flows' indicator;
- Note¹: Add 0.00001 to the formula to ensure proper calculation of the normalized criterion values
- Group: Oaugadougo
- Significant number of digits: 3
- Unit: cms



¹ Zeros can cause numerical difficulties when normalizing so this small number is added to avoid this.

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<p>19- Add 'Flows below Dam' criterion and set its properties: By Formula: True Direction: Maximize Formula: based on the 'Releases from Loumbila' indicator; Group: Loumbila Significant number of digits: 2 Unit: cms</p>											
<p>20- Add the 'Irrigation' criterion and set its properties: By Formula: True Direction: Maximize Formula: based on the 'Irrigation at Lac de Bam - Average volume' indicator Group: Lac de Bam Significant number of digits: 2 Unit: cms</p>											
<p>21- Add the 'Public Acceptance' soft criterion and set its properties to:</p> <ul style="list-style-type: none"> - By Formula: False - Direction: Maximize - Group: Entire Area - Significant number of digits: 0 - Unit: Score <p>Set score values for the 'Public Acceptance' soft criteria (in white cells)</p> <table border="1" data-bbox="289 1543 805 1862"> <thead> <tr> <th>Scenario</th> <th>Score</th> </tr> </thead> <tbody> <tr> <td>Future scenario (2020) - No Action</td> <td>1</td> </tr> <tr> <td>Future scenario (2020) - Reduce Irrigation</td> <td>2</td> </tr> <tr> <td>Future scenario (2020) - Groundwater Augmentation</td> <td>4</td> </tr> <tr> <td>Future scenario (2020) - Mix of Actions</td> <td>2</td> </tr> </tbody> </table>	Scenario	Score	Future scenario (2020) - No Action	1	Future scenario (2020) - Reduce Irrigation	2	Future scenario (2020) - Groundwater Augmentation	4	Future scenario (2020) - Mix of Actions	2	
Scenario	Score										
Future scenario (2020) - No Action	1										
Future scenario (2020) - Reduce Irrigation	2										
Future scenario (2020) - Groundwater Augmentation	4										
Future scenario (2020) - Mix of Actions	2										



Non editable cells (which are calculated by formula) are grey.

22- The Criteria tab should now appear as follows (ignore any warnings below the table):

	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance
Group	Financial	Oaugadougo	Oaugadougo	Oaugadougo	Lac de Bam	Entire Area
Unit	USD	Month	cms	cms	cms	Score
Future scenario (2020) - No Action	50000000	44	0.000	0.55	1.98	1
Future scenario (2020) - Reduce Irrigation	500000	6	0.000	0.55	1.28	2
Future scenario (2020) - Groundwater Augmentation	15000000	3	0.022	0.55	1.98	4
Future scenario (2020) - Mix of Actions	19000000	7	0.000	0.57	1.81	2

23- Now switch to the 'Normalized criteria' tab to check normalized criteria values. You should check for negative values and try to reformulate the criteria or chose another normalization method if this happens. In this case normalization looks OK.

	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance
Group	Financial	Oaugadougo	Oaugadougo	Oaugadougo	Lac de Bam	Entire Area
Unit	USD	Month	cms	cms	cms	Score
Future scenario (2020) - No Action	1.000	0.068	1.000	0.962	1.000	0.250
Future scenario (2020) - Reduce Irrigation	0.010	0.500	1.000	0.962	0.645	0.500
Future scenario (2020) - Groundwater Augmentation	0.300	1.000	0.000	0.962	1.000	1.000
Future scenario (2020) - Mix of Actions	0.380	0.429	1.000	1.000	0.910	0.500

24- Now switch to the 'Pre-analysis' tab to check if any criteria redundant? or any scenarios dominating?

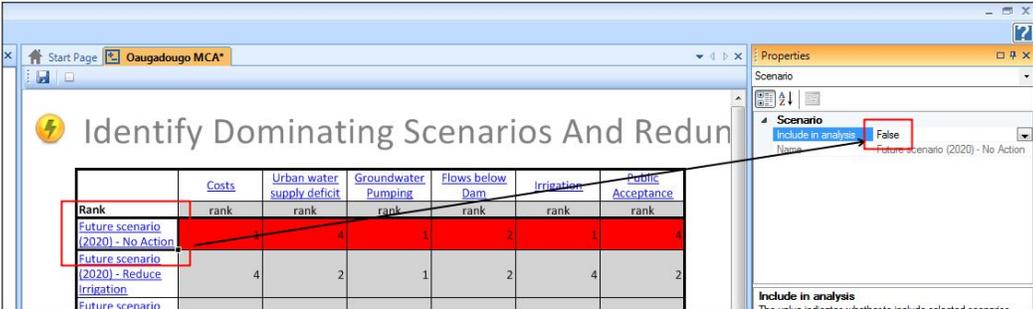
 Identify Dominating Scenarios And Redundant Criteria

	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance
Rank	rank	rank	rank	rank	rank	rank
Future scenario (2020) - No Action	1	4	1	2	1	4
Future scenario (2020) - Reduce Irrigation	4	2	1	2	4	2
Future scenario (2020) - Groundwater Augmentation	3	1	4	2	1	1
Future scenario (2020) - Mix of Actions	2	3	1	1	3	2

	dominating
	redundant
	not included
	dominating and not included
	dominating and redundant
	redundant and not included
	dominating, redundant and not included

In this case, there are no obvious redundant criteria or dominating scenarios. However, in some other cases, you might have dominant scenarios which rank first for all criteria. You might also find redundant criteria that rank the same for all scenarios. These are going to be highlighted in the table. You need to decide what to do in such situation (e.g. eliminate, combine, or revise redundant criteria)

25- Now to demonstrate how to remove a scenario from the analysis, the no-action scenario will be excluded from the analysis. To do this, select the scenario and in the 'Properties' window set 'Included in the analysis' to False. Excluding a scenario is different from deleting it. If a scenario is excluded, its data still remains in the setup and it is still ranked in the pre-analysis. If a scenario is Deleted its data is removed and obviously it is not ranked in the pre-analysis.



The screenshot shows the 'Ougadougou MCA' application window. The 'Properties' pane on the right shows the 'Scenario' section with 'Include in analysis' set to 'False'. The table below shows the ranking data for the 'Future scenario (2020) - No Action' scenario, which is highlighted in red.

Note that we did not really 'delete' the scenario, we just excluded it from the analysis.

27- Now the setup is complete. Save it by clicking the  button.

Review Questions

1. What is normalization?
2. What is meant by a dominant scenario?
3. What is meant by redundant criteria?

Answers

1. After defining the criteria within an MCA setup, they need to be normalized. Normalization is an important process to ensure that the different criteria values are comparable.
2. A dominant scenario ranks first for all criteria.
3. Redundant criteria rank the same for all scenarios.

2.6. MCA Sessions and comparisons

Introduction

This lesson shows you how you can visualize the MCA results and also explains how you can interpret and compare them.

Topics covered in this lesson:

- Creating an MCA session
- Cloning an MCA session to vary MCA parameters
- Cloning an MCA setup to vary MCA interventions/criteria
- Comparison of MCA results

Lesson objectives:

By the end of this lesson, it is anticipated that you will be able to:

- Create MCA sessions.
- Clone and modify MCA sessions and setups
- Compare MCA sessions

Lesson pre-requisites

You have to be familiar with the MCA [setup](#) to take this lesson.

What is an MCA session?

An MCA Session (See Figure 12) is created based upon an MCA setup. One MCA Setup can include several MCA Sessions. Typically, each stakeholder could have his/her own session. Once an MCA Session is created under an MCA Setup, this Setup cannot be edited anymore unless all its MCA Sessions are deleted. In a session, you can have only one set of limits (upper and lower) per criterion. No matter how many stakeholders are there, the set of limits have to be agreed for each session. Scenarios including criteria that violate these limits are not included in the ranking of scenarios and are kept but marked red.

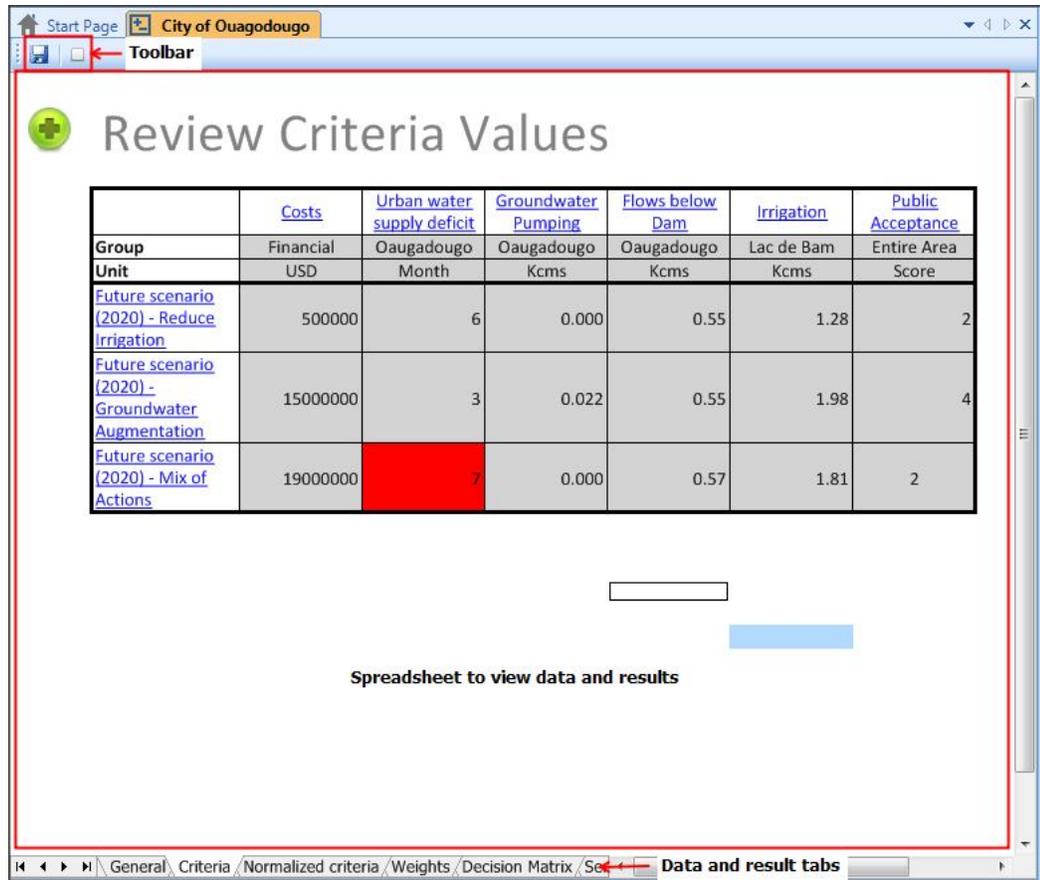


Figure 12: MCA session components

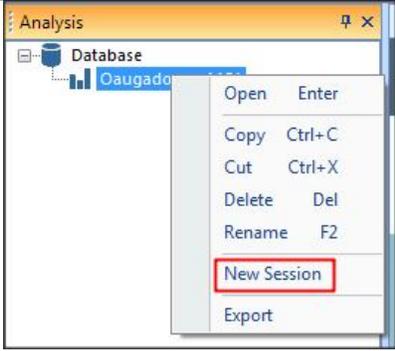
What is an MCA comparison?

In an MCA comparison, you can compare a number of MCA sessions. These sessions have to be under the same MCA setup. A comparison is run using the 'Compare sessions' tool from the 'Tools' explorer. In an MCA comparison, you can compare the ranking of scenarios from different sessions and find the best scenario(s).

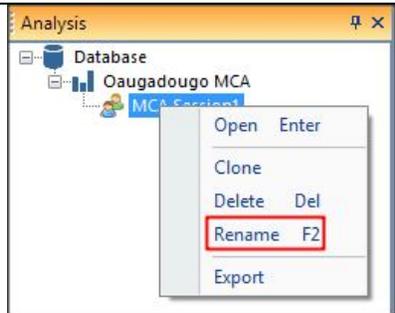
Exercises

Creating an MCA session and visualize the results

1- In this exercise, MCA sessions are created under the 'Oaugadougo MCA' MCA setup for 3 different stakeholders (See below steps for more details). Right click the 'Oaugadougo Water Supply' and select to **New Session** create a new MCA Session.



2- Right click the newly created session and rename to 'City of Ouagodougo'. This session is for stakeholders concerned about deficits in water supply.



3- Double click the session to open and add the below limits for this session in the 'General' tab.

Criteria	Acceptable limits	
	Lower	Upper
Urban water supply deficit		7
Groundwater Pumping		15

4- Repeat steps 1-3 to add two sessions that represent the following stakeholders

- Lac de Bam Farmers (concerned about reductions in Lac de Bam Irrigation) with the following limits

Criteria	Acceptable limits	
	Lower	Upper
Irrigation	1.5	
Public Acceptance		3

- Ouagodougo Environmentalists (concerned with low flows below Loubila and too much groundwater pumping) with the following limits

Criteria	Acceptable limits	
	Lower	Upper
Groundwater Pumping		8
Flows below Dam	0.56	

5- Save all MCA sessions by clicking the  button on the toolbar.

6- For each stakeholder's session, in the 'Criteria' tab, verify that criteria values that are outside the limits specified above are highlighted in red (i.e. excluded). The table below shows this for the 'City of Ouagadougou'.

	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance
Group	Financial	Oaugadougo	Oaugadougo	Oaugadougo	Lac de Bam	Entire Area
Unit	USD	Month	cms	cms	cms	Score
Future scenario (2020) - Reduce Irrigation	500000	6	0.000	0.55	1.28	2
Future scenario (2020) - Groundwater Augmentation	15000000	3	0.022	0.55	1.98	4
Future scenario (2020) - Mix of Actions	19000000	7	0.000	0.57	1.81	2

Now switch to the 'Normalized Criteria' tab and verify that cells corresponding to criteria values that are outside the limits specified above are also highlighted.

	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance
Group	Financial	Oaugadougo	Oaugadougo	Oaugadougo	Lac de Bam	Entire Area
Unit	USD	Month	cms	cms	cms	Score
Future scenario (2020) - Reduce Irrigation	0.026	0.500	1.000	0.962	0.645	0.500
Future scenario (2020) - Groundwater Augmentation	0.789	1.000	0.000	0.962	1.000	1.000
Future scenario (2020) - Mix of Actions	1.000	0.429	1.000	1.000	0.910	0.500

Do the same for the other two sessions.

7- Now move to the 'Weights' tab, enter the following weights for each session as follows:

a. City of Ouagadougou

	Rank
Costs	3
Urban water supply deficit	1
Groundwater Pumping	2
Flows below Dam	4
Irrigation	5
Public Acceptance	6

b. Lac de Bam Farmers

	Rank

Costs	6
Urban water supply deficit	4
Groundwater Pumping	5
Flows below Dam	3
Irrigation	1
Public Acceptance	2

c. Ouagodougo Environmentalists

	Rank
Costs	6
Urban water supply deficit	5
Groundwater Pumping	4
Flows below Dam	1
Irrigation	3
Public Acceptance	2

8- Verify that large normalized weight values correspond with high ranks (rank 1 is the highest). An example of the tables for 'City of Ouagodougo' is given below. The 'Urban water supply deficit' is rank 1 and has the highest weight.



Define Criteria Weights

	Rank
Costs	3
Urban water supply deficit	1
Groundwater Pumping	2
Flows below Dam	4
Irrigation	5
Public Acceptance	6



Normalized Weights Table

Criteria	Weights (0-100)
Costs	19.05
Urban water supply deficit	28.57
Groundwater Pumping	23.81
Flows below Dam	14.29
Irrigation	9.52
Public Acceptance	4.76
Sum of weights (must be 100)	100

9- Now move to the 'Decision Matrix' tab and check whether the highest ranking scenario is consistent with each group's goals or not?

- City of Ouagodougo

Review Scenario Ranks

Rank	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance	Overall	
	rank	rank	rank	rank	rank	rank	Score	Rank
Future scenario (2020) - Reduce Irrigation	3	2	1	2	3	2	0.609	2
Future scenario (2020) - Groundwater Augmentation	2	1	3	2	1	1	0.716	1
Future scenario (2020) - Mix of Actions	1		1	1	2	2	0.804	

- Lac de Bam Farmers

Rank	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance	Overall	
	rank	rank	rank	rank	rank	rank	Score	Rank
Future scenario (2020) - Reduce Irrigation	3	2	1	2		1	0.654	
Future scenario (2020) - Groundwater Augmentation	2	1	3	2	1		0.888	
Future scenario (2020) - Mix of Actions	1	3	1	1	2	1	0.774	1

- Ouagadougou Environmentalists

Review Scenario Ranks

Rank	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance	Overall	
	rank	rank	rank	rank	rank	rank	Score	Rank
Future scenario (2020) - Reduce Irrigation	3	2	1		3	2	0.708	
Future scenario (2020) - Groundwater Augmentation	2	1	3		1	1	0.836	
Future scenario (2020) - Mix of Actions	1	3	1	1	2	2	0.809	1

10- Save all MCA sessions by clicking the  button on the toolbar.

MCA Sensitivity Analysis

1- To see the effect of changing the weights on the MCA results, you need to open an MCA session (e.g. City of Ouagadougou) and select the sensitivity tab.



2- Edit the weights under the sensitivity column but ensure the sum equals to 100. You can use the figures shown next.

Criteria	Calculated (0-100)	Sensitivity (0-100)
Costs	19.05	20.00
Urban water supply deficit	28.57	15.00
Groundwater Pumping	23.81	35.00
Flows below Dam	14.29	15.00
Irrigation	9.52	10.00
Public Acceptance	4.76	5.00
Sum of weights (must be 100)	100	100

3- Now look at the overall score of the scenarios.

Review New Scores

	Costs	Urban water supply deficit	Groundwater Pumping	Flows below Dam	Irrigation	Public Acceptance	Overall	
Score	score	score	score	score	score	score	Score	Rank
Future scenario (2020) - Reduce Irrigation	0.005	0.075	0.350	0.144	0.064	0.025	0.664	1
Future scenario (2020) - Groundwater Augmentation	0.158	0.150	0.000	0.144	0.100	0.050	0.602	2
Future scenario (2020) - Mix of Actions	0.200	0.064	0.350	0.150	0.091	0.025	0.880	

Do you notice any change? (Hint: compare with the ranks in the Decision matrix tab)

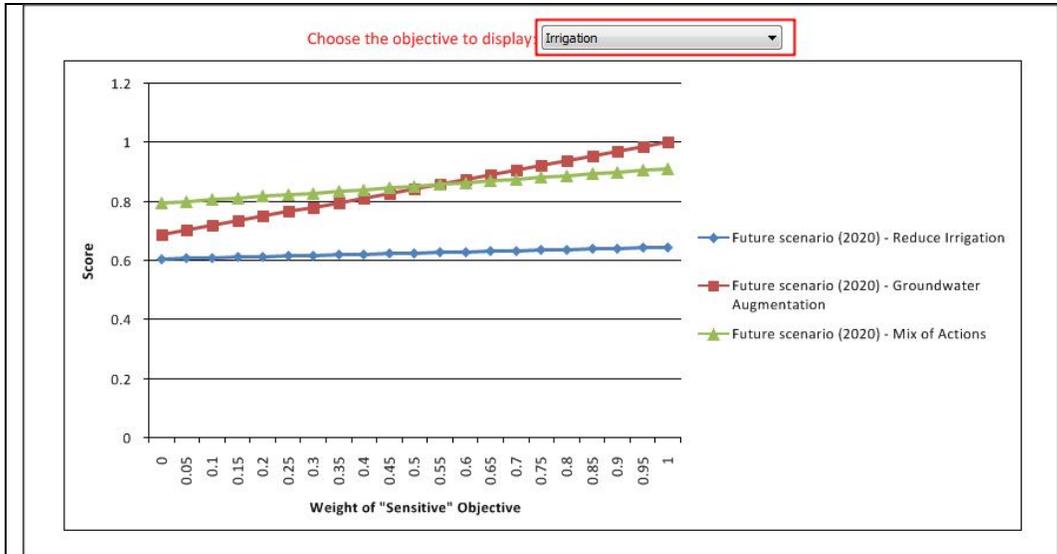
4- Now move to the 'Sensitivity chart' tab. In this tab, You can also see how the total score of a scenario changes with changing weights for this criterion



5- In the top of the spreadsheet, choose the objective to display. In this case, choose 'Irrigation'. Now examine the chart.

What do you notice for the 'Reduce Irrigation' scenario? Its line is almost horizontal.
What does that mean? (Hint: the closer the line slope to horizontal the less sensitive its weight on the scenario score).

Other criteria show an increase in score with increases in weights – this is not always the case as it depends on the direction of improvement of a criterion.

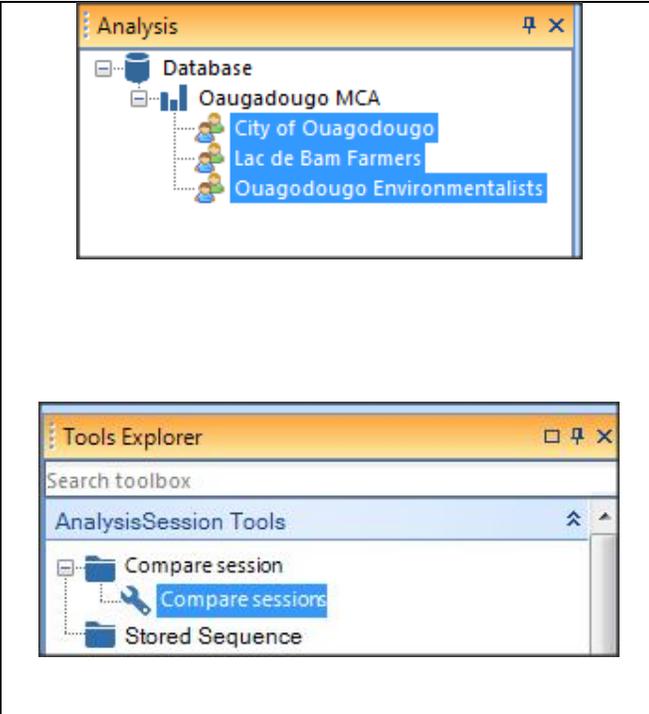


6- Repeat this with other objectives and see how sensitive the scenario score is to weights.

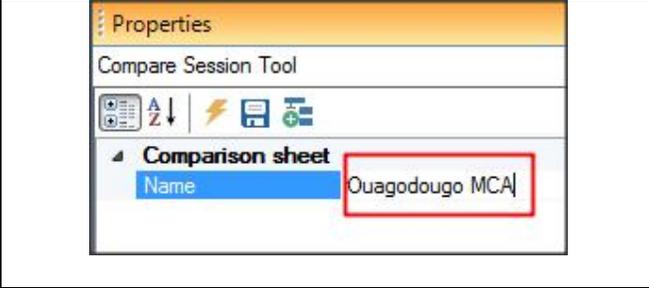
Creating an MCA comparison

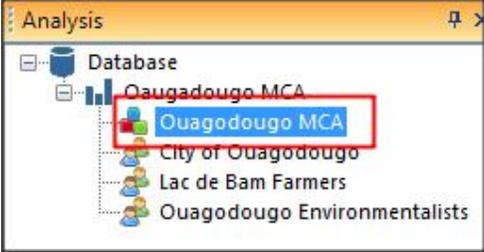
1- Select all three MCB Sessions that you have created.

In the tools explorer select the 'Compare sessions' tool to create a MCA Comparison.

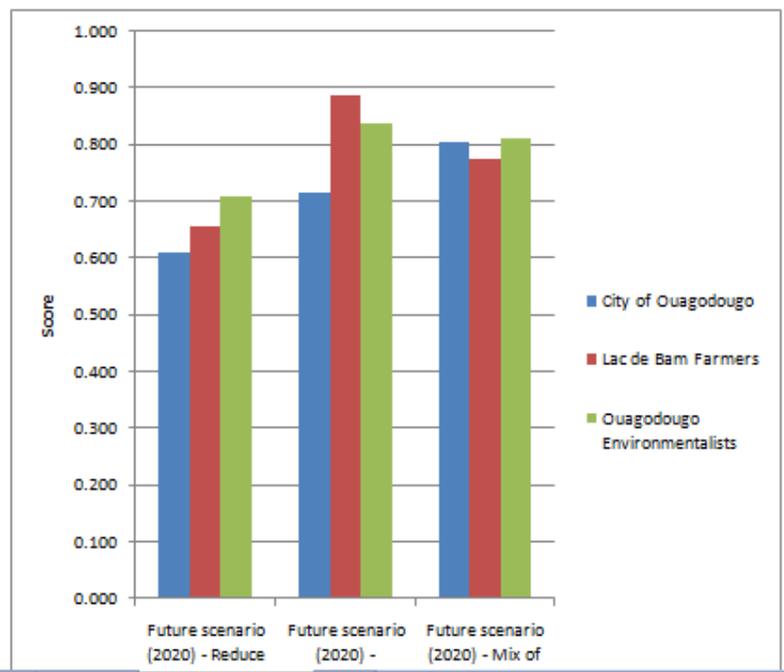


2- Once the tool is selected, its properties appear in the 'Properties' explorer. Enter the name of the new MCA Comparison as 'Ougadougou MCA'. Then run the tool by



<p>clicking the  button.</p>																	
<p>3- An MCA comparison is created under the MCA setup showing a comparison between the three sessions that you created.</p>																	
<p>4- Double click the MCA comparison to open and review the 'Matrix' tab.</p> <ul style="list-style-type: none"> - Which scenario, if any, is suitable? - Which stakeholder could reconsider his criteria limits to resolve the situation? 	<table border="1" data-bbox="732 617 1308 953"> <thead> <tr> <th></th> <th>City of Ouagadougou</th> <th>Lac de Bam Farmers</th> <th>Ouagadougou Environmentalists</th> </tr> </thead> <tbody> <tr> <td>Future scenario (2020) - Reduce Irrigation</td> <td>2</td> <td style="background-color: red;"></td> <td style="background-color: red;"></td> </tr> <tr> <td>Future scenario (2020) - Groundwater Augmentation</td> <td style="background-color: lightgreen;">1</td> <td style="background-color: red;"></td> <td style="background-color: red;"></td> </tr> <tr> <td>Future scenario (2020) - Mix of Actions</td> <td style="background-color: red;"></td> <td style="background-color: lightgreen;">1</td> <td style="background-color: lightgreen;">1</td> </tr> </tbody> </table>		City of Ouagadougou	Lac de Bam Farmers	Ouagadougou Environmentalists	Future scenario (2020) - Reduce Irrigation	2			Future scenario (2020) - Groundwater Augmentation	1			Future scenario (2020) - Mix of Actions		1	1
	City of Ouagadougou	Lac de Bam Farmers	Ouagadougou Environmentalists														
Future scenario (2020) - Reduce Irrigation	2																
Future scenario (2020) - Groundwater Augmentation	1																
Future scenario (2020) - Mix of Actions		1	1														
<p>5- Review the MCA comparison graphs</p> <ul style="list-style-type: none"> - Which scenario score is the highest of all stakeholders? (Hint: check if one scenario scores first for all stakeholders and if none which one scores first for most of the stakeholders) 																	

	City of Ouagodougo	Lac de Bam Farmers	Ouagodougo Environmentalists
Future scenario (2020) - Reduce Irrigation	0.609	0.654	0.708
Future scenario (2020) - Groundwater Augmentation	0.716	0.888	0.836
Future scenario (2020) - Mix of Actions	0.804	0.774	0.809



Review Questions

1. What is an MCA session?
2. What is an MCA comparison?

Answers

1- An MCA Session is created based upon an MCA setup. One MCA Setup can include several MCA Sessions. Typically, each stakeholder could have his/her own session. Once a MCA Session is created under a MCA Setup, it cannot be edited anymore unless all its MCA Sessions are deleted. Within a session, each stakeholder defines his/her criteria limits. Scenarios including criteria that violate these limits are not considered further in the MCA Session.

2- In an MCA comparison, you can compare a number of MCA sessions. These sessions can be under the same MCA setup or different setups. A comparison is run using the 'Compare sessions' tool from the 'Tools' explorer. In a MCA comparison, you can compare the ranking of scenario and find the best scenario(s).

3. References

- Nile Basin Decision Support System help file (DSS Ver. 2.0)
- Nile Basin Decision Support training material (developed in 2013 and 2014)
- DHI training material for the Nile Basin Decision Support (developed in 2012)