

COST BENEFIT ANALYSIS

INTRODUCTION

The idea of this guide is to provide the basics steps to conduct a Cost Benefit Analysis (CBA) or to modify an existing one. It is assumed that the user is familiar with the terms described here.

IDEAL WORKFLOW

In the following figure we describe an ideal workflow to use the SDSS, and in this guide we will describe the basic steps to conduct cost-benefit analysis (CBA) and the required data and preconditions from other modules in order to use the CBA module correctly.

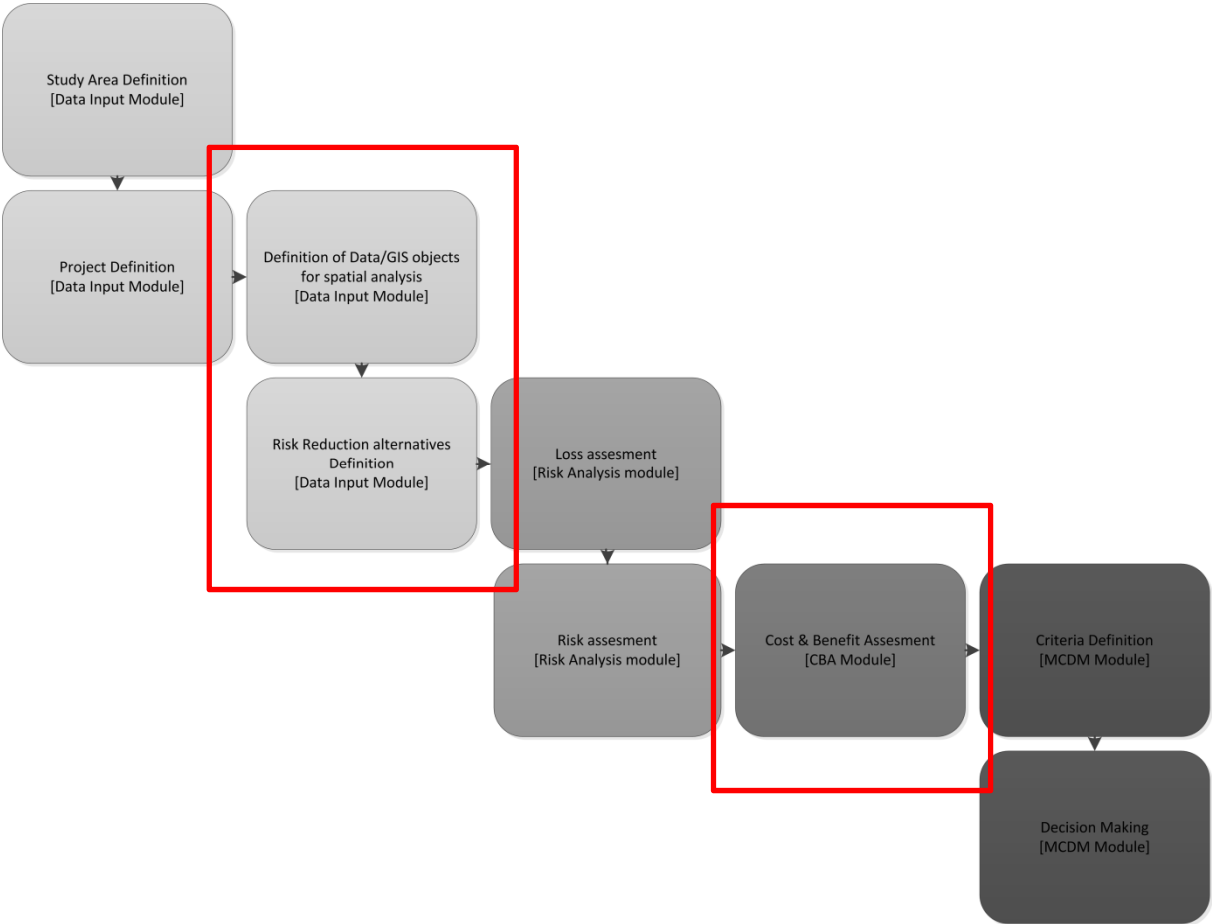


Figure 1 workflow in the SDSS

MANAGING CBA FOR A GIVEN STUDY AREA AND PROJECT

From the menu, press “Conduct Cost Benefit analysis” and the following screen will be displayed:

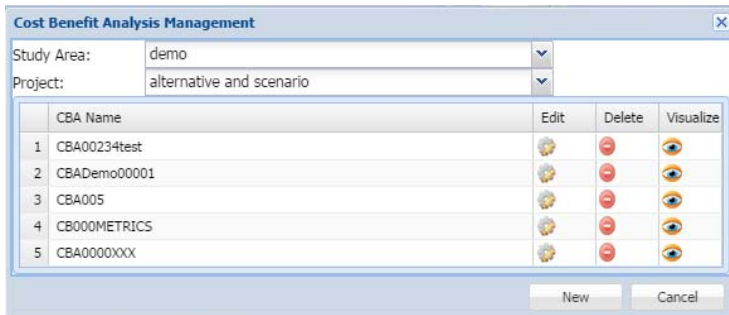


Figure 2 list of CBA calculations

There are two comboboxes, the first one allows you to choose the study area and then the second one a project within the selected study area. First, the user has to select the study area and the project for which a CBA should be conducted or edited.

Once you select these two items, the list will be populated with the currently existing CBA records conducted before for the combination of Study Area/Project. Then you can open an existing one by clicking on the “*Edit*” icon:

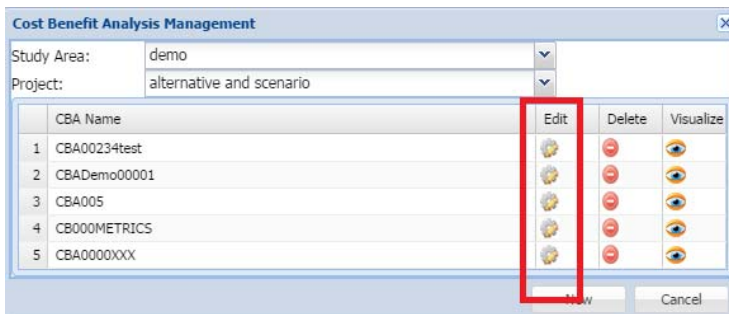


Figure 3 edit existing CBA calculations

You can also delete previously created CBA records by clicking on the delete icon displayed on the record.

Working with the CBA module is an iterative process, because we can have several alternatives plus several scenarios of change, so is better to asses one by one at time and progressively store the results.

DEFINING ALTERNATIVES – GENERAL CONSIDERATIONS

Some information defined in the selected Alternative will be used in while conducting a Cost & Benefit analysis and is important to define it correctly. These are described as follows:

Alternative

Name: engineering solutions
 Keyword: Damn basin
 Description: Construction of new basin/dam in the nochera area

Upload PDF File: Select a file [Browse]
 Upload Shape File: Select a file [Browse]

Alternative Type: Structural

Start Year: 2015
 Lifetime: 0
 When benefits start: [dropdown]
 Allow incremental benefit during investment period:
 Is current situation:

Cost Information

Add Cost									
Item	Sub Type	Start Year	End Year	Recurrent	Qty	Cost/Unit	Total Cost	Delete	
1	Construction	Building & Work Force costs	1	3	R	1	400000.0	400000	[Delete]

Additional Benefits

Add Additional Benefit					
Desc	Start Year	end Year	Recurrent	Yearly benefit	Delete

Hazard Update: [dropdown]

[Save] [Cancel]

Figure 4 information from the Alternative used for CBA

The costs are defined in the alternative and these are loaded in the CBA matrix. Typically the costs refer to the cost of build/implement the alternative and other direct and indirect costs such as construction and maintenance. Also the user can define other costs, which are an indirect consequence of the implementation of the measure like reduction of the tax income, law suits against the government among other side impacts in case of a relocation alternative for example.

For each alternative of mitigation the following information should be entered in order to be properly loaded in the CBA module:

- a) **Start year:** the start year of the construction or implementation of the alternative.
- b) **Lifetime:** the time span in which the risk reduction alternative is effective.
- c) **When the benefits start:** From which year we can start to accrue the full benefits of the measure, in general this is when the measure is in place.
- d) **Allow have incremental benefits:** With this option the user can specify an incremental amount of the expected risk reduction to be accrued, even if the measure is not completed or fully implemented.
- e) **If the alternative is the current situation:** in that case all above described fields are omitted because there is not risk mitigation.

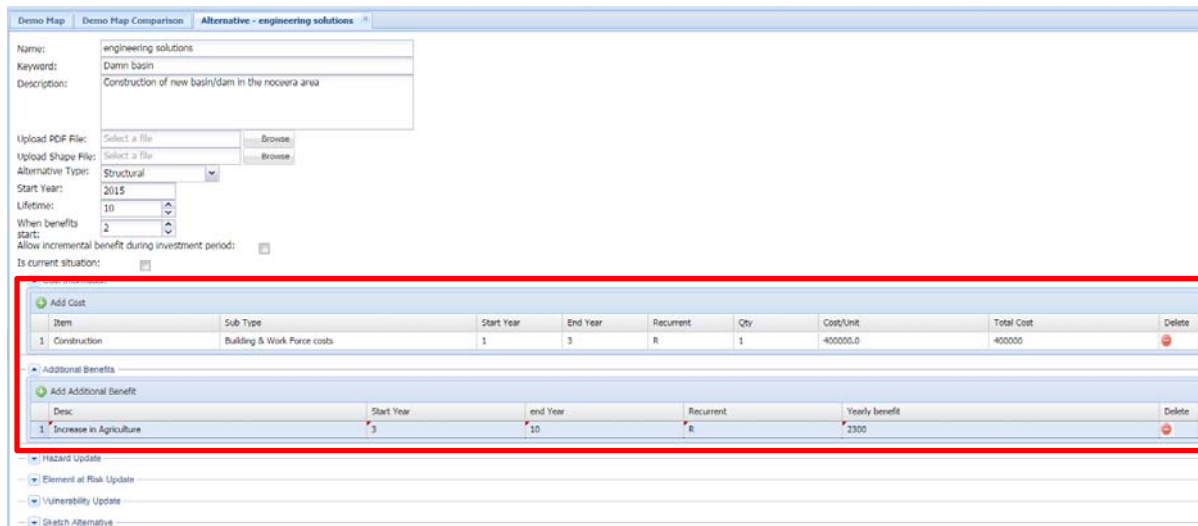


Figure 5 defining cost and benefit items

Then for each cost item, the user has to define the following:

- Item:** The main description of the item in question (i.e. Dam, dike, basin, etc.)
- SubType:** A sub-classification is possible, the user can indicate a subtype (i.e. : Labor, Materials, Expropriations of land, etc.)
- Start Year:** Start year in which the cost is accrued.
- End Year:** End year or end of the period of the cost.
- Recurrent:** This indicates whether the cost is seen as a whole investment amount for the specified period and then is divided by the number of years of the defined period or if it is a recurrent amount per year for the period of validity of the cost.
- Quantity:** The number of the same elements to be taken into account.
- Unit cost:** the unitary cost per item
- Total Cost:** is auto-calculated by taking the unit cost and the quantity.

With this same idea the user can define additional benefits which are the consequence of the implementation of the risk reduction alternative.

CREATING/EDITING A CBA ANALYSIS

The precondition of the module is to have some risk analysis already done for the study area an project selected in the previous step, for both the situation as business as usual (a.k.a. current situation) and the situation with risk mitigation (an alternative to reduce the risk in place). Otherwise you cannot conduct the CBA completely if there is no data.

Once the user has chosen whether to edit or create a new CBA Analysis, the following screen will be displayed in the working area of the application:

Demo Map		Demo Map Comparison		Alternative - engineering solutions		Cost Benefit Analysis - CBA0000XXX					
Start Year:	2015	Number of Years:	60								
Select Risk Analysis:	test3										
Risk Reduction alternative:	relocation										
Scenario:	engineering solutions										
	ecological solutions										
Description	relocation	7	2018	2019	2020	2021	2022	2023	2024		
Benefits											
AAL (current situation)	0.00	0.00	0.00	698560.06	698560.06	698560.06	698560.06	698560.06	698560.06	698560.06	
AAL (Alternative)	0.00	0.00	0.00	942702.23	942702.23	942702.23	942702.23	942702.23	942702.23	942702.23	
Risk Reduction	0.00	0.00	0.00	0.00	0.00	-244142.17	-244142.17	-244142.17	-244142.17	-244142.17	
Costs											
Maintenance	0.00	0.00	0.00	-12000.00	-12000.00	-12000.00	-12000.00	-12000.00	0.00	0.00	
Construction	-368994.00	-368994.00	-368994.00	-368994.00	-368994.00	-368994.00	-368994.00	0.00	0.00	0.00	
Incremental Benefits	-368994.00	-368994.00	-368994.00	-380994.00	-380994.00	-625136.17	-625136.17	-256142.17	-244142.17	-244142.17	

Figure 6 the CBA analysis screen

Description of the controls of the above screen:

- **Start Year:** Defines the start year of the analysis
- **Number of years:** Defines the duration of the analysis.
- **Risk analysis Combo:** Displays the available risk analyses done for the combination of Study Area and Project.
- **Risk reduction alternative combo:** based on the selected risk analysis, only the alternatives for which the risk has been calculated are loaded.
- **Scenario Combo:** based on the selected risk analysis, only the scenarios that were used for calculating the risk are loaded.
- **Load Cost/Risk data:** Loads the data from the risk module for the selected combination of risk analysis, Scenario and alternative.
- **Visualize alternative:** when pressed it displays a popup window with the data of the alternative, the user can add additional costs and additional benefits.

The idea of the workflow is to start working with a given risk analysis and for each alternative and scenario load the risk values into the CBA matrix and add all the relevant additional or collateral costs & benefits:

Demo Map Demo Map Comparison Cost Benefit Analysis - CBA005										
Start Year:	2016		Number of Years: 40							
Select Risk Analysis:	test3									
Risk Reduction alternative:	ecological solutions									
Scenario:	Most realistic									
Load Cost/Risk data										
Description	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Benefits										
AAL (current situation)	0.00	0.00	0.00	0.00	0.00	0.00	666549.16	666549.16	666549.16	
AAL (Alternative)	0.00	0.00	0.00	0.00	0.00	0.00	254631.02	254631.02	254631.02	
Risk Reduction	0.00	0.00	0.00	0.00	0.00	0.00	411918.14	411918.14	411918.14	
Costs										
Maintenance	0.00	0.00	0.00	-291352.00	-291352.00	0.00	0.00	0.00	0.00	
Construction	-538644.00	-538644.00	-538644.00	-538644.00	-538644.00	-538644.00	-538644.00	-538644.00	-538644.00	
Incremental Benefits	-538644.00	-538644.00	-538644.00	-829996.00	-829996.00	-538644.00	-126725.86	-126725.86	-126725.86	

Figure 7 the CBA matrix

In the green upper part of the matrix the benefits are listed. In the bottom red part the costs are listed. And for each time we change the scenario and the selected alternative, the matrix will be filtered, and we can edit and modify the values like a spreadsheet. You can also add additional costs, additional benefits whether in the alternative definition and also by pressing the add item button at the bottom:

Add Cost/Benefit

Select item type: Cost

Description: Maintenance dam

Amount: 23000 EUR

Apply item for a determined period

Select Start year:

Select End Year:

Save Cancel

Figure 8 adding additional costs & benefits

You can decide to add the specific Cost or Benefit for a defined time span by checking the option “Apply item for a determined period”

Add Cost/Benefit

Select item type: Cost

Description: Maintenance dam

Amount: 23000 EUR

Apply item for a determined period

Select Start year: 2020

Select End Year: 2025

Save Cancel

Figure 9 applying item for a defined time span

Demo Map Demo Map Comparison Cost Benefit Analysis - CBA005							
Start Year:	2016	Number of Years:	40				
Select Risk Analysis:	test3						
Risk Reduction alternative:	ecological solutions						
Scenario:	Most realistic	Load Cost/Risk data					
Description	2027	2028	2029	2030	2031	2032	
Benefits							
AAL (current situation)	666549.16	666549.16	666549.16	814884.88	814884.88	814884.88	
AAL (Alternative)	254631.02	254631.02	254631.02	440336.85	440336.85	440336.85	
Risk Reduction	11918.14	11918.14	11918.14	374548.03	374548.03	374548.03	
Costs							
Maintenance	0.00	0.00	0.00	0.00	0.00	0.00	
Construction	0.00	0.00	0.00	0.00	0.00	0.00	
Incremental Benefits	11918.14	11918.14	11918.14	374548.03	374548.03	374548.03	

Figure 10 the CBA matrix

When the risk values change in the future, the new values will be displayed with a different colour. The same happens with the custom items added to the matrix.

SAVING THE RESULTS

The user can see the intermediate results by clicking the button named *“Results & Calculation”*. Here the user can choose an economic metric to see the behaviour of all alternatives through the different defined scenarios:

Save Cost Benefit Analysis				
Name of the analysis:	CBA005	Interest Rate:	1.45	
Calculation & Results				
Economic Metric:				
Alternative	No scenario	Business as usual	Risk informed plan	Most realistic
engineering solutions				
ecological solutions				
relocation				
Confirm Cancel				

Figure 11 saving a CBA analysis

The user chooses one option from the combo named *“Economic Metric”* and then the system conducts the calculation of such metric:

Alternative	No scenario	Business as usual	Risk informed plan	Most realistic
engineering solutions	9577051.43	20127783.40	0	11926420.08
ecological solutions	4030358.23	0	0	11130347.74
relocation	-9207787.07	-9185351.88	0	-9004812.59

Figure 12 applying the economic metric

Then from here the user can save the Analysis either as a new one or an existing one.

CBA AND MCDM

Each time you save the CBA the values of the calculated metrics these are exported to the MCDM. All the metrics can be used as an economic indicator in the MCDM. The CBA module basically saves them in the Indicator table.

APPENDIX 1 – CBA METRICS

The current supported economic metrics are the following:

1. Net Present Value (NPV)
2. Benefit-Cost Ratio (BCR)
3. Internal Rate of Return (IRR)

And these are defined as follows:

$$\text{BCR} = \frac{\sum_{t=0}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=0}^{t=n} \frac{C_t}{(1+i)^t}}$$

$$\text{NPV} = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

$$\text{IRR} = 0 = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

Where:

t = year ,

i = discount rate,

n = threshold,

B = benefit,

C = cost

In the matrix we show the values without applying discounting; we only apply discounting on the calculation of these metrics.