



# USER MANUAL

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RAT is a Microsoft Excel based tool for quantitative risk analysis for natural hazards (or other types of hazards where multiple magnitudes of the hazard are considered) and for evaluation of alternative risk mitigation strategies using Cost Benefit Analysis (CBA). The methodology of risk assessment and CBA utilized in RAT is described in document *RAT – methodology*. Document *RAT – Examples* provides example applications of the software.

*RAT – User Manual* provides basic guidance how to use the three modules of RAT:

- Risk estimation
- Cost estimation
- Evaluation of alternative mitigation strategies using Cost Benefit analysis (CBA)

It is important that all data are entered or changed by using the buttons and dialogues, i.e. it is not recommended to enter or change values directly in the cells by hand.

By clicking on the information button  additional advices and hints are provided in RAT.

## **1. Before using RAT for the first time, Software requirements**

RAT requires MS Excel version 2013 or newer. Macros must be enabled to use RAT. This is done in Excel as following:

- click on the 'File' tab
- click on 'Options', select the 'Trust Center' category
- click on 'Trust Center Settings' and click on 'Macro Settings'
- set a tick to activate all macros

In older versions of the MS Office and in MS Office for Mac, RAT is not fully functional.

## 2. “General Information” – sheet

**General Information**

**General Information**

Project name

Company / Institution

Author

Date

**Planning details**

Planning horizon [years]

Discount rate

Currency

Currency unit

**RAT** Risk Analysis Tool

Figure 1: “General Information” sheet

On this sheet the general information of the project are defined or edited. After clicking on the “Edit” button, the dialog from Figure 2 appears, which enables the user to insert and edit basic information on the project. Before the input mask is closed, the changes have to be saved by clicking on the ‘Save’ button. Otherwise new information won’t be adopted. After defining or editing all desired information, the dialogue can be closed by clicking on the ‘Close’ button.

**General Information**

General Information

Project name:

Company / Institution:

Author:

Date:

Planning Details

Planning horizon [years]:

Discount rate:

Currency

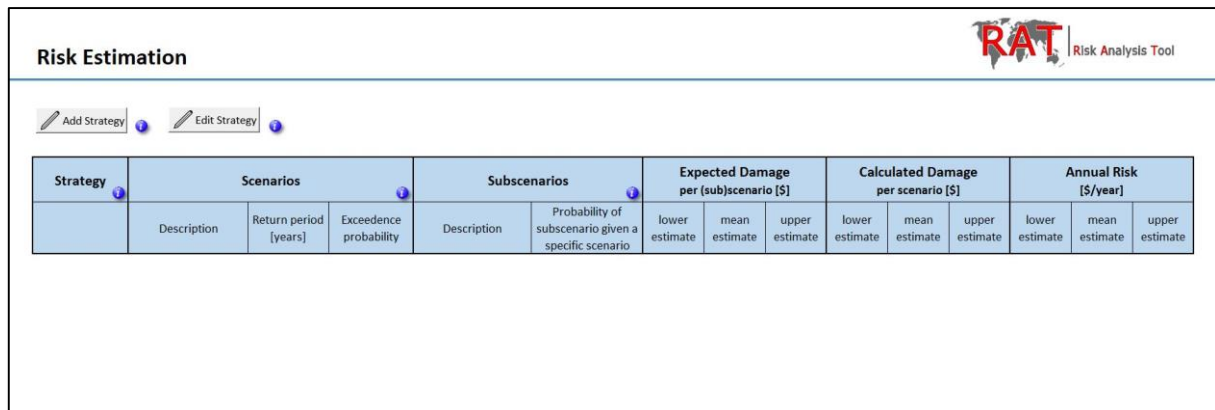
Currency Unit

Save Close

Figure 2: Dialog for inserting information to “General Information” sheet

### 3. “Risk Estimation” sheet

Risk mitigation sheet allows inserting the inputs for calculation of risk (expected damage). The risk is calculated separately for each mitigation strategy (i.e. combination of risk mitigation measures).

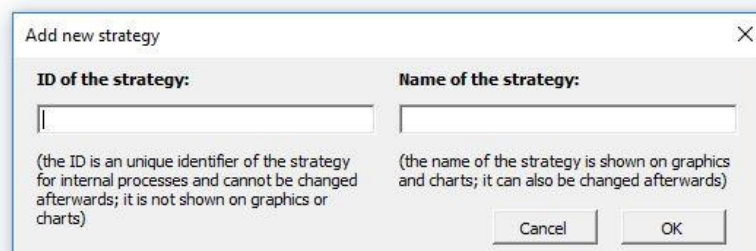


Strategy	Scenarios			Subscenarios		Expected Damage per (sub)scenario [\$]			Calculated Damage per scenario [\$]			Annual Risk [\$ / year]		
	Description	Return period [years]	Exceedence probability	Description	Probability of subscenario given a specific scenario	lower estimate	mean estimate	upper estimate	lower estimate	mean estimate	upper estimate	lower estimate	mean estimate	upper estimate

Figure 3: “Risk Estimation” sheet

#### 3.1. Add a new risk mitigation strategy, calculating the risk

Risk mitigation strategies can be added by clicking on the “Add Strategy” button. In the dialogue that appears (Figure 4) the unique ID and the name of the new strategy can be defined. The selected ID is a unique identifier of each strategy that doesn’t show up in graphics or charts but it is important for internal processes. The ID of a strategy cannot be changed later and it is not allowed to use the same ID twice.



**ID of the strategy:**


(the ID is an unique identifier of the strategy for internal processes and cannot be changed afterwards; it is not shown on graphics or charts)

**Name of the strategy:**


(the name of the strategy is shown on graphics and charts; it can also be changed afterwards)

Figure 4: Dialogue to define the unique identifier (ID) and name of a new strategy

After confirming the name of the strategy by clicking on OK, a dialogue shown in Figure 5 appears that allows the user to define the inputs for calculation of risk for the given strategy. In this dialogue, individual scenarios can be inserted, that are characterized by their return period, and the associated damages. The appropriate selection of scenarios is discussed in Section 2.1 of the RAT - Methodology.

Figure 5: Dialog for inserting inputs risk estimation for a given risk mitigation strategy.

The dialog for adding a new scenario shown in Figure 5 has following features:

- **1** – name of the strategy which is edited
- **2a** - name of the selected scenario
- **2b** - the return period of the selected scenario
- **2c** - damages associated with the selected scenario. There are three input boxes for the damage: for the mean, lower and upper estimate of the damages. It is mandatory to define the mean estimate of the damage (it can also be 0), while defining the upper and lower estimate of the damage is optional.
- **3** - list of existing scenarios. Here the scenario which shall be edited can be selected. The selected scenario is highlighted by a blue bar.
- **4** – buttons “Add scenario”, “Delete scenario” allow adding/deleting the selected scenario
- **5** - button “Save changes”. **The inputs or changes must be saved with the ‘Save changes’ button before a new scenario is added, another scenario is selected or the dialog is closed, otherwise the changes are lost.**
- **6** - button ‘Delete current strategy’ allows the user to delete the current strategy including all scenarios.
- **7** – button “Close” for closing the dialog.

The annual risk of the defined strategy is calculated automatically when the dialogue is closed. The result of the annual risk as well as all defined details of the strategy are automatically listed in a table on the “Risk Estimation” - sheet.

### 3.2. Including subscenarios

Subscenarios can be used to account for the fact that a hazard scenario (e.g. 100-year flood event) can have significantly different consequences depending on the actual situation in the analyzed area. This should be reflected in estimating the damage for the given scenario. For example, the consequences of a 100-year flood event would be negligible, if the dike protection system stays intact, but can reach very high values in case that the system fails. The methodology for selection and evaluation of the subscenarios is described in Section 2.3 of the RAT - Methodology.

Adding subscenarios to selected scenario is optional. The user can add subscenarios by selecting their number in field **2e** in **Error! Reference source not found.** shows. **Error! Reference source not found.** shows the same dialogue as Figure 5 with the difference that the selected scenario contains subscenarios. The dialog now has following additional features:

- **2d** – area showing the details of each subscenario
- **2f** - name/description of the subscenario
- **2g** –probability of occurrence of the scenario **conditionally on the main scenario** (e.g. if the probability of a bridge blockage during a 300-year flood event is 40%, 0.4 should be entered for subscenario “bridge blockage” and 0.6 to scenario “no bridge blockage”). **The conditional probabilities of the evaluated subscenarios must sum up to 1!!!**
- **2h** - damage associated with the occurrence of the subscenario). Defining the damages of scenarios containing subscenarios is similar to scenarios without subscenarios: defining mean estimates for each subscenario is obligatory while lower and upper estimates of the damages are optional.

When the subscenarios are inserted, the RAT tool automatically calculates the expected damage for the relevant basic scenario as the “weighted average” of the subscenarios.

Dialog box titled "Edit Strategy: Sample Strategy".

**Strategy Section:**

- Strategy Name:

**Scenario Section:**

Existing Scenarios: 

Existing Scenarios	Return Period
New Scenario	100

Description of the Scenario:  Return Period [years]:

Number of Subscenarios:  **2e**

**Subscenarios Table:**

Description of Subscenario	Probability of Subscenario	Damage (lower estimate) [€]*	Damage (mean estimate) [€]	Damage (upper estimate) [€]*
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Red boxes highlight: **2f** (Description of Subscenario 1), **2g** (Probability of Subscenario 1), **2h** (Damage (upper estimate) [€]\* for Subscenario 1), and **2d** (Damage (upper estimate) [€]\* for Subscenario 5).

Buttons: Add scenario, Delete scenario, Save changes \*\*, Delete current strategy, Close.

Footnote: \* optional input  
 \*\* every time you have added a scenario or changed one or several details of a scenario, you have to save the changes

Figure 6: Dialogue to define scenarios and subscenarios of a strategy (here the selected scenario contains subscenarios)

### 3.3. Editing an existing risk mitigation strategy

Previously defined risk mitigation strategies can be edited by clicking on the button “Edit Strategy” on the “Risk Estimation” sheet. The strategy which shall be edited can be selected from a drop-down list.

After confirming the selected strategy by clicking on OK, the scenarios and subscenarios of the selected risk mitigation strategy can be edited. The dialogue to edit the scenarios and subscenarios corresponds to the one described in the previous sections.

## 4. “Risk Curves” - sheet

In the “Risk Curves” sheet, the results of the annual risk estimation are available in form of risk curves (damage-probability curves) – see Section 2 of the RAT - Methodology. No additional user input is required. By clicking on the button “Update”, a chart with risk curve for each strategy (which was previously defined at the “Risk Estimation” - sheet) is created which represents the risk curve (Figure 7). As the required data are adopted from the “Risk Estimation” – sheet, **it is necessary to use the “Update” button again if the inputs for the risk estimation have been changed in the “Risk Estimation” - sheet.**

The button “Save Chartes” can be used to save all the charts in the sheet as .jpg files.

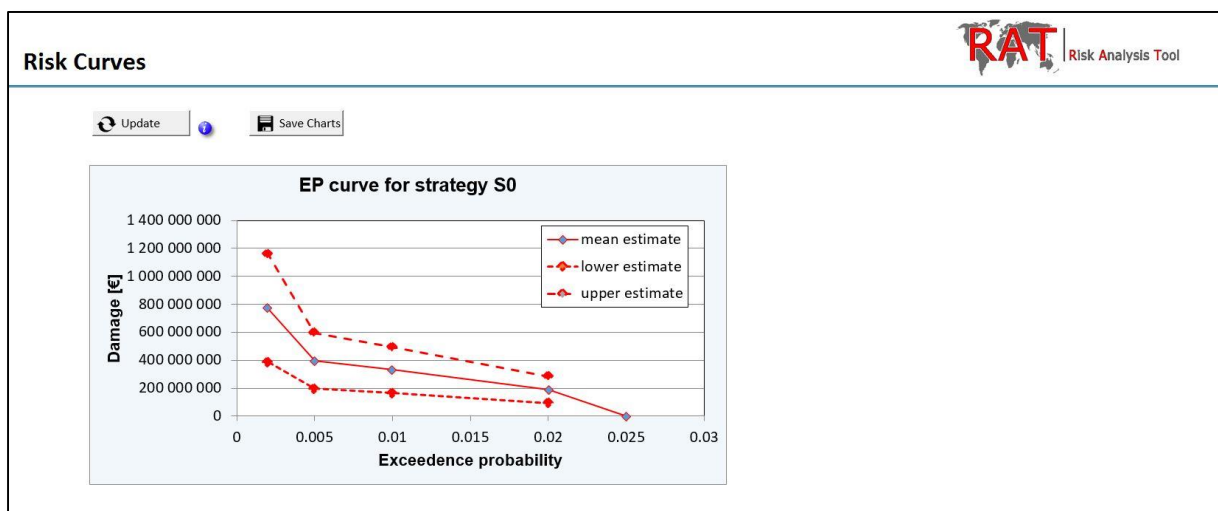


Figure 7: “Risk Curves” - sheet, showing a risk curve of an example strategy



## 5. “Risk Discounting” - sheet

In the “Risk Discounting” sheet (Figure 8), the annual risk is distributed over the planning horizon and the Net Present Value (NPV) of the sum of lifetime risk is calculated following the procedure described in Section 4 of the RAT - Methodology.

No additional user input is required, the values are automatically taken over from the “Risk Estimation” and “General Information” - sheets. After clicking on the “Update” button, two charts for the graphical representation of the annual discounted and undiscounted risks of each strategy are created. In addition the values of the discounted annual risks as well as the sum of the discounted risk over the whole planning horizon are listed in an extra table for each strategy. **It is necessary to use the “Update” button again every time the inputs for the risk estimation have been changed.**

The charts can be saved as a .jpg file by clicking on the “Save Chart” button.

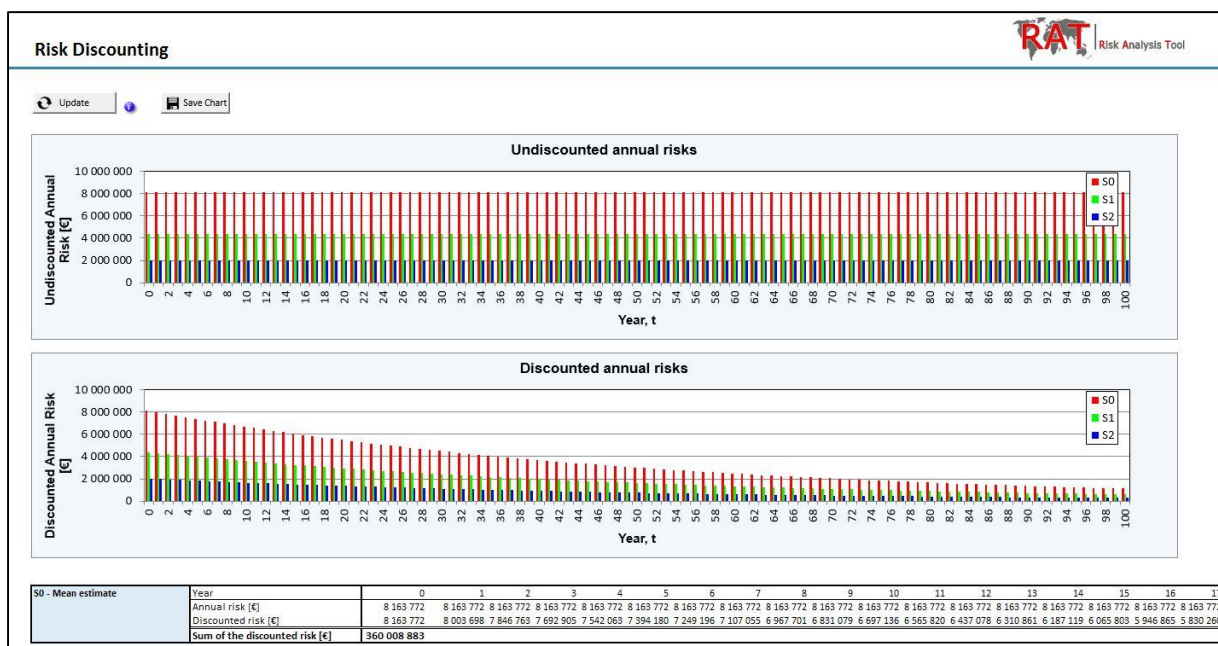


Figure 8: "Risk Discounting" - sheet, including the data of three example strategies

## 6. “Cost Estimation” – sheet

The “Cost Estimation” sheet allows the user to insert information on costs associated with each risk mitigation strategy (see Section 3 of the RAT – Methodology for more information). The charts representing the distribution of costs over the planning horizon are then created and the Net Present Value (NPV) of the sum of lifetime costs is calculated.

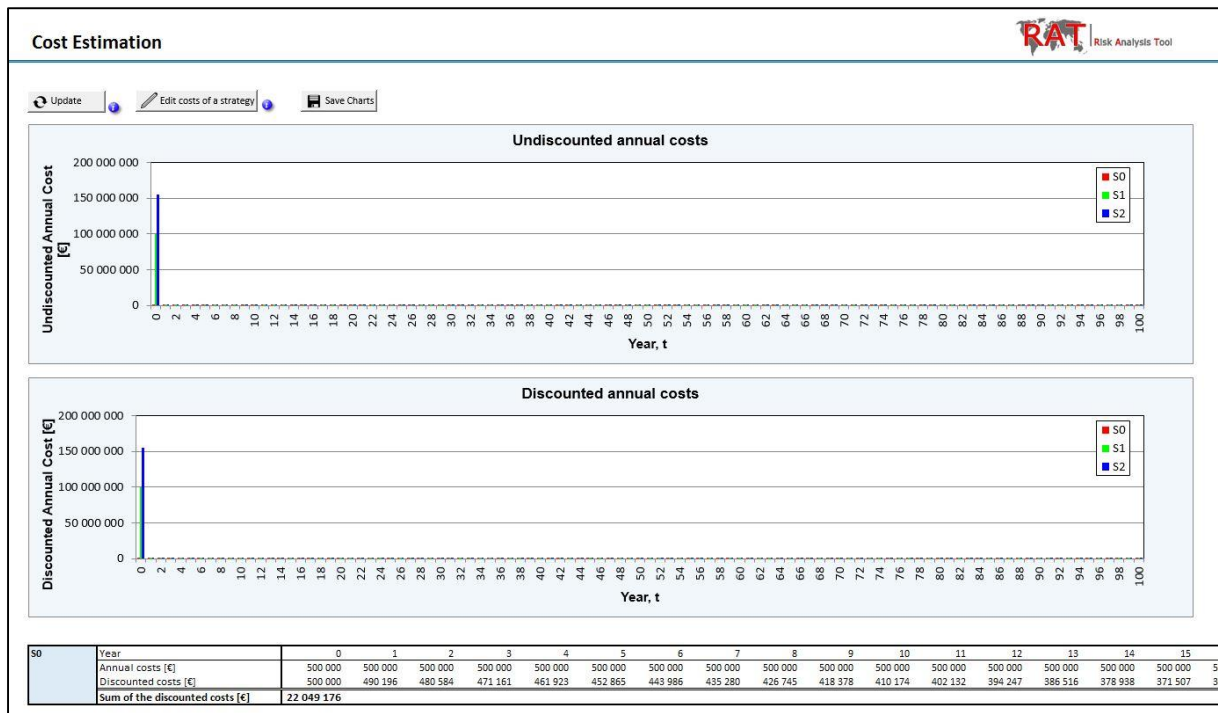


Figure 9: “Cost Estimation” - sheet, including the data for three example strategies

Use button “Edit costs of a strategy” to insert or edit the inputs on costs. The strategy whose costs shall be defined or edited can be selected in the drop-down list of the dialogue that appears (Figure 10). The costs of the selected risk mitigation strategy are inserted using two different dialogues: First dialog allows inserting the **one time costs** (i.e. costs that only apply once over the planning horizon such as the investment costs) and after clicking on “Next” button, a second dialog appears that can be used for inserting **continuous costs** that repeat in regular intervals (e.g. every year).

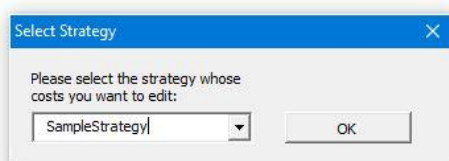


Figure 10: Dialogue to select the strategy whose costs shall be defined/edited

By clicking the “Update” button two charts are created (Figure 9). First represents the undiscounted annual costs for all strategies over the whole planning horizon, the second represents the discounted annual costs for all strategies over the whole planning horizon. In addition to these two charts, a table which lists the annual discounted costs as well as the sum of the annual discounted costs over the whole planning horizon is created for each strategy (which has been previously defined at the “Risk Estimation” – sheet). The strategies are adopted from the “Risk Estimation” – sheet while the planning horizon as well as the discount rate is adopted from the “General Information” – sheet. **It is necessary to use the “Update” button again very time when the inputs in “Risk Estimation” – sheet and “General Information” – sheet have been changed.**

By clicking on the “Save Charts” button both charts are saved as .jpg files.

The dialogue for defining/editing one time costs (Figure 11) has the following features:

- **1** – list of all defined one-time costs. Here the cost input which shall be edited is selected. The cost input which is selected at the moment is highlighted by a blue bar.
- **2a** – hight/amount of the selected one time costs
- **2b** - year when the selected cost are to be spent.
- **2c** - button for saving the inputs. New or changed cost inputs need to be saved before closing the dialog or choosing other cost input.
- **2d** - button for deleting the selected cost input.
- **3** – Button for adding a new cost input
- **4** - button for deleting all one-time cost inputs of the current strategy.
- **5** - Next’ button for confirming the on-time cost inputs and opening the dialog for continuous costs.

Figure 11: Dialogue to define and edit one time costs of a previously selected strategy

The dialogue for defining/editing continuous costs (Figure 12) has the following features:

- **1** – list of all defined continuous costs. Here the cost input which shall be edited is selected. The cost input which is selected at the moment is highlighted by a blue bar.
- **2a** – hight/amount of each payment
- **2b** – interval between the payments in years
- **2c** - time of the first payment (year)
- **2d** - button for saving the inputs. New or changed cost inputs need to be saved before closing the dialog or choosing other cost input.
- **2f** - button for deleting the selected cost input.
- **3** – Button for adding a new cost input
- **4** - button for deleting all one-time cost inputs of the current strategy.
- **5** – “Finish” button for confirming the cost inputs.

The screenshot shows a software dialog box titled "Continuous cost inputs". It contains a table with three columns: "Amount [\$]", "Period [Year]", and "Starting at year:". The first row of the table has values 0, 1, and 1, and is highlighted with a blue background. To the right of the table is a section titled "Details of the selected cost input" which contains three input fields for "Amount [\$]", "Period [Year]", and "Starting at year:", each with the same values as the selected row in the table. Below these fields are two buttons: "Save cost input \*" and "Delete cost input". At the bottom of the dialog are three buttons: "Add new cost input", "Delete all cost factors", and "Finish". Red numbers 1 through 5 are placed next to the corresponding UI elements: 1 next to the table, 2a, 2b, and 2c next to the detail input fields, 2d next to the "Save cost input" button, 2f next to the "Delete cost input" button, 3 next to the "Add new cost input" button, 4 next to the "Delete all cost factors" button, and 5 next to the "Finish" button. A red box labeled "2" encompasses the entire "Details of the selected cost input" section.

Figure 12: Dialogue to define and edit continuous costs of a previously selected strategy

After confirming the dialogue, the data will automatically be considered in the charts representing the costs as well as in the calculation of the sum of the annual discounted costs.

## 7. “Evaluation” – sheet

The “Evaluation” sheets summarizes the final results of the Cost Benefit Analysis comparing the defined risk mitigation strategies following the procedure described in Sec. ## of the RAT – Methodology. No additional user input is required.

By clicking on the “Update” button a table is created which lists the information (discounted lifetime risk, discounted lifetime costs and the sum of both) for each strategy. In addition a Risk vs. Cost chart is created which compares the strategies graphically. **It is necessary to use the “Update” button again every time when the inputs in “Risk Estimation” – sheet, “General Information” – sheet or “Cost Estimation” – sheet have been changed.**

By clicking on the “Save Chart” button, the chart is saved as .jpg file.

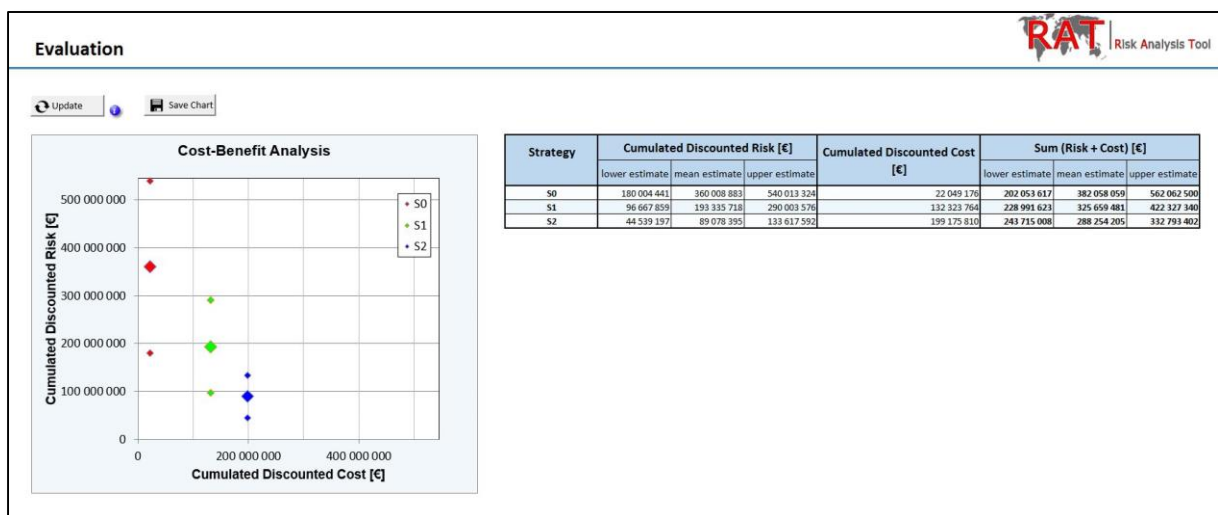


Figure 13: "Evaluation" - sheet, showing results of an example project