

## **D23.3 USER GUIDE AND SYSTEM DOCUMENTATION**

### **ESS valuation software framework**

**DHI, May 2017**



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## USER GUIDE AND SYSTEM DOCUMENTATION

D23.3: USER GUIDE AND SYSTEM DOCUMENTATION  
ESS valuation software framework

### SUMMARY

This deliverable documents the ESS valuation software framework (DESSIN D23.2) developed as part of DESSIN WP23. The documentation is also accessible within the software, either by clicking on the help icon, or by pressing F1.

### DELIVERABLE NUMBER

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## 1 ESS Tool

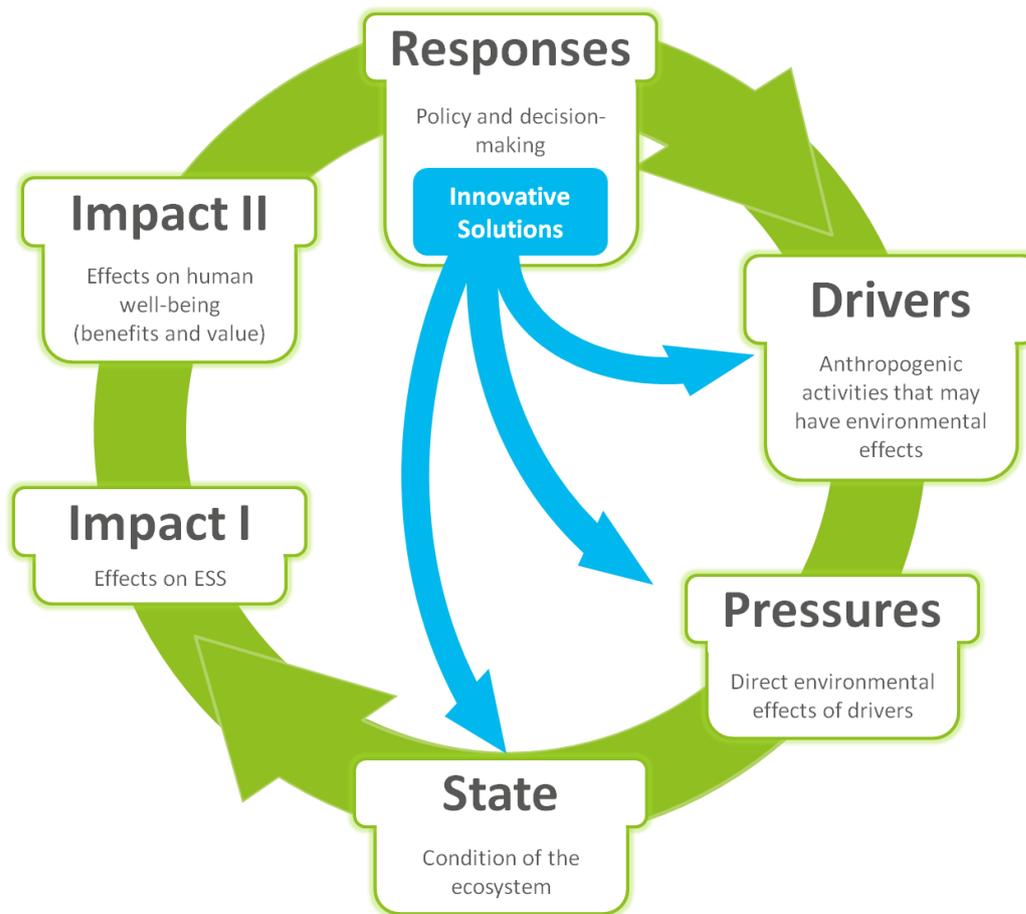
The overall goal of the DESSIN ESS software tool is to support users implementing the DESSIN ESS Evaluation Framework and sustainability assessment, as described in the DESSIN Cookbook (DESSIN Deliverable 11.2).

The DESSIN ESS Evaluation Framework is a structured approach to measuring changes in ecosystem services (ESS). The main purpose of running an evaluation using this framework is to facilitate the application of the ESS Approach in the appraisal of innovative technical and management measures that have impacts on freshwater ecosystems and their services. The framework is described in the DESSIN Cookbook, which presents the practical steps that the user should follow to apply the DESSIN ESS Evaluation Framework. The DESSIN Cookbook is accompanied by the DESSIN Cookbook Companion Document, which provides more detailed background information on the concepts presented in the Cookbook.

### 1.1 Background

The DESSIN ESS Evaluation Framework helps its users evaluate changes in ESS by linking biophysical, economic, and sustainability assessments sequentially. It was developed on the basis of the Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin, 2011) and the DPSIR (Drivers, Pressures, State, Impact, Responses) adaptive management cycle (EEA, 1999). The former is a standardized system for the classification of ESS developed by the European Union to enhance the consistency and comparability of ESS assessments. The latter is a well-known approach used to separate the biophysical and social aspects of a system under study. As part of its analytical component, the DESSIN framework also integrates elements of the Final Ecosystem Goods and Services-Classification System (FEGS-CS) (Landers and Nahlik, 2013) of the US Environmental Protection Agency (USEPA).

In the DPSIR scheme as applied in DESSIN, innovative measures to be tested are considered Responses that may have influence on Drivers (anthropogenic activities with environmental effects), Pressures (the direct effects of such activities) and States (the conditions of the ecosystems under study). From the resulting changes in an ecosystem's State, the changes in the provision of ESS (Impact I) and the use of ESS (Impact II) are estimated. The Impact II assessment includes an assessment of changes in economic values. The estimated changes can then contribute to decision-making on whether to implement a proposed solution (Responses), closing the circle of the workflow. The figure below outlines the DPSIR scheme as applied in DESSIN.



## 1.2 Structure of the tool

The DESSIN framework consists of 5 parts: Study description; problem characterization; response capabilities and potential beneficiaries; impact evaluation; and sustainability assessment. The software tool is also organized into five parts, duplicating this structure.

In Part I of the evaluation, the environmental system of interest (e.g. a surface or ground water body, sub-catchment or catchment), i.e. the ecosystem, is defined and described and the local stakeholders must be identified. Furthermore, administrative details and objectives of the assessment are defined.

Parts II-IV are based on the DPSIR scheme. In Part II, Drivers and Pressures are identified. The claimed/expected capabilities of the proposed measure(s) (i.e., of the Responses) are examined in Part III to estimate how the measure(s) might impact on Drivers, Pressures, and States, or a combination of these. The expected impacts on States are then used to identify case-relevant ESS, along with potential beneficiaries. In Part IV, changes in ESS resulting from the proposed measures are estimated.

The DESSIN sustainability assessment (SA) is carried out in Part V. The SA examines the wider social, environmental, and governmental impacts (e.g. economic impact and job creation, resources use and life cycle emissions, compliance with relevant regulations, stakeholder involvement) of proposed measures and facilitates comparison between different alternatives.

The interface of the software tool is organized using a tabbed structure, with the upper layer of tabs

corresponding to the five parts of the framework. The second layer of tabs divides each part into coherent sub-sections. The rest of the documentation describes the functionality located in each part and sub-section in the order in which the user completes the various parts of the workflow when undertaking an ESS evaluation and sustainability assessment. A screen capture of the tabbed interface is presented below.

1 Study Description	2 Problem Characterization	3 Responses and Beneficiaries	4 Impact Evaluation	5 Sustainability Assessment		
1.1 General Information	1.2 System Boundary	1.3 Population Data	1.4 Economic Data	1.5 Employment Data	1.6 Overview of Study Area	1.7 Stakeholders
<b>General Information</b>						
Assessment name	Aarhus_test2					
Objective	Test the DESSIN tool with three different measures.					
Target audience	The DESSIN user group.					
Entities carrying out assessment	DHI					
Entities providing information	Aarhus Vand					
Entities funding the assessment	European Commission, Danish Ministry for Research and Development					

Users of the software tool are referred to the DESSIN Cookbook and Companion Document for further information about the ESS Framework and sustainability assessment.

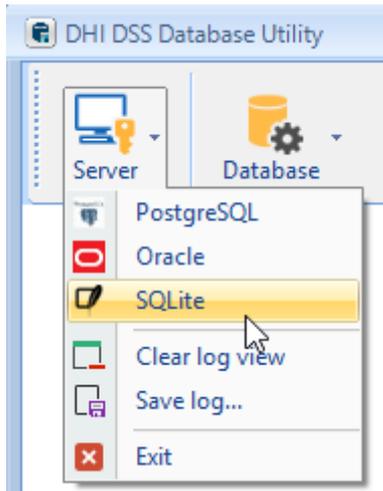
### 1.3 Creating a new database

The DESSIN tool is a component of MIKE Workbench, which is a front-end database software that requires creation of an underlying database to store data and maintain relationships between different data types. MIKE Workbench is installed either as part of MIKE OPERATIONS (which requires a software license) or MIKE INFO (which does not).

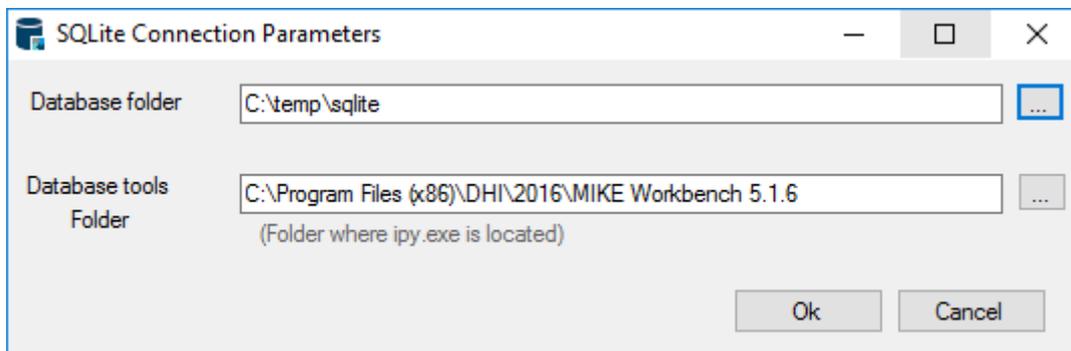
MIKE Workbench can work with different database types. It is recommended that users of the DESSIN tool work with SQLite. SQLite is a single file database (similar to MS Access) which does not require installation of a database service like PostgreSQL.

To use this type of database, make a designated folder on disk to hold the files. You can use any folder and even separate folders for each database, but to make it simple we assume c:\temp\sqlite as your database folder.

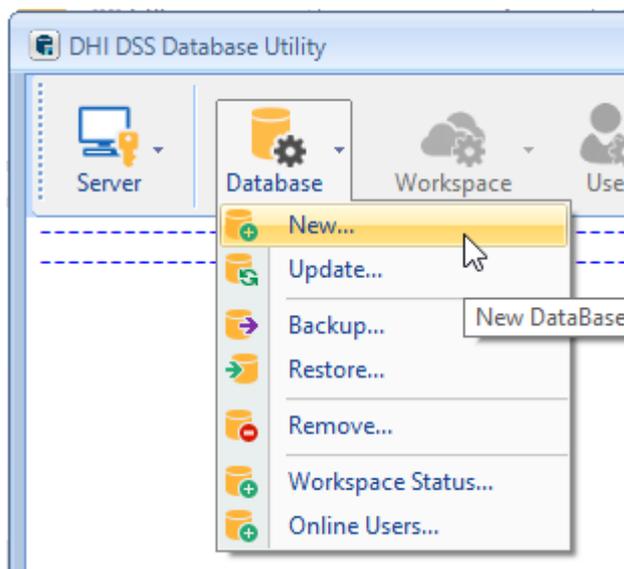
Start the Database Manager Utility of either MIKE OPERATIONS or MIKE INFO and connect to SQLite.



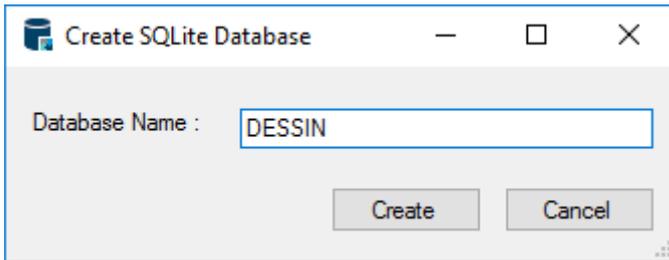
Specify the folder of the SQLite database files and press Enter.



You can now create a new database.



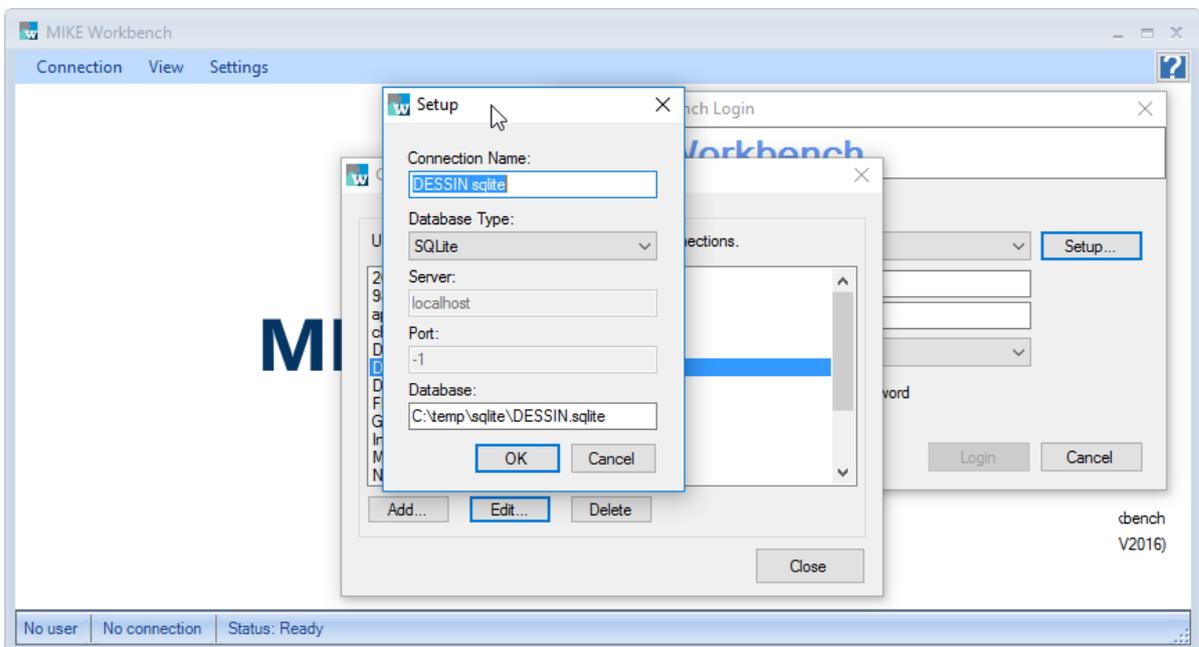
After creating a new database, the user is prompted to give the database a name.



After this, you are ready to start MIKE Workbench and connect to your database.

## 1.4 Starting MIKE Workbench

Start MIKE Workbench and on the Login dialog press “Setup” to create a connection to your SQLite database. Give it a name of your choice, select the database type “SQLite” and provide the full path to the SQLite database file.



Click OK and Close and on the Login dialog provide the default account details: user=admin, password=dssadmin

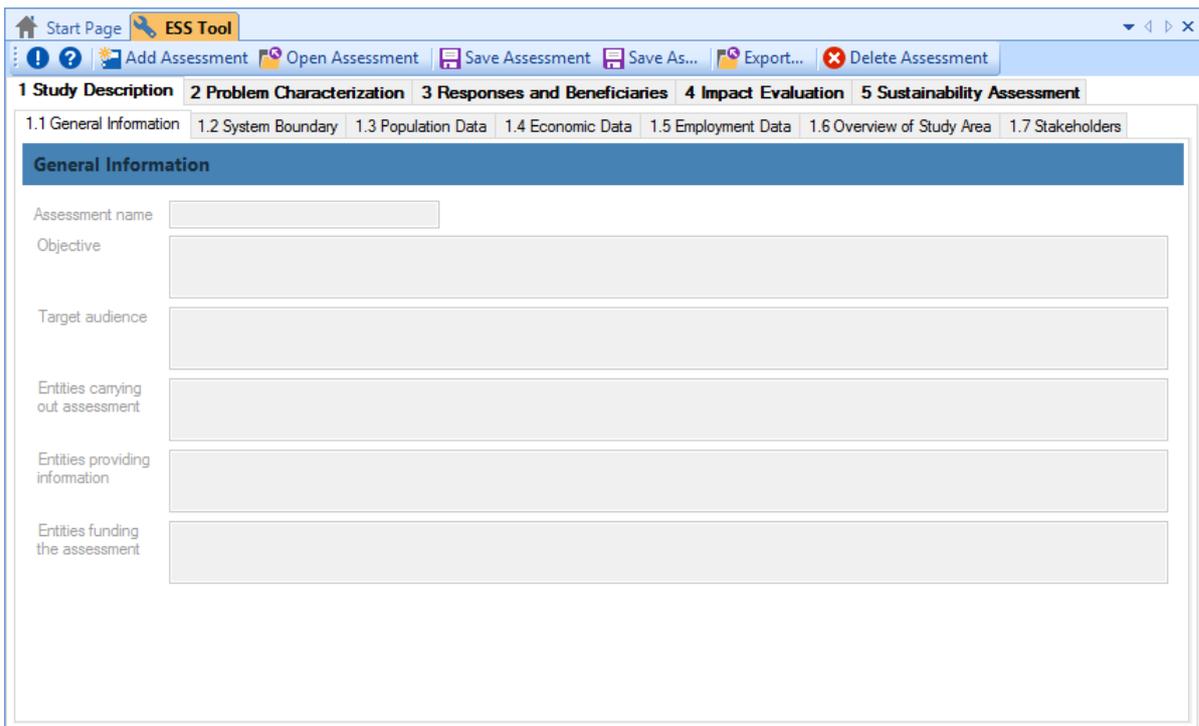
Once the login sequence and application load has completed you should be ready to start the ESS Tool.

## 1.5 Starting the ESS Tool

Locate the ESS Tool in the Tools Explorer and start it with the Run right-click menu.

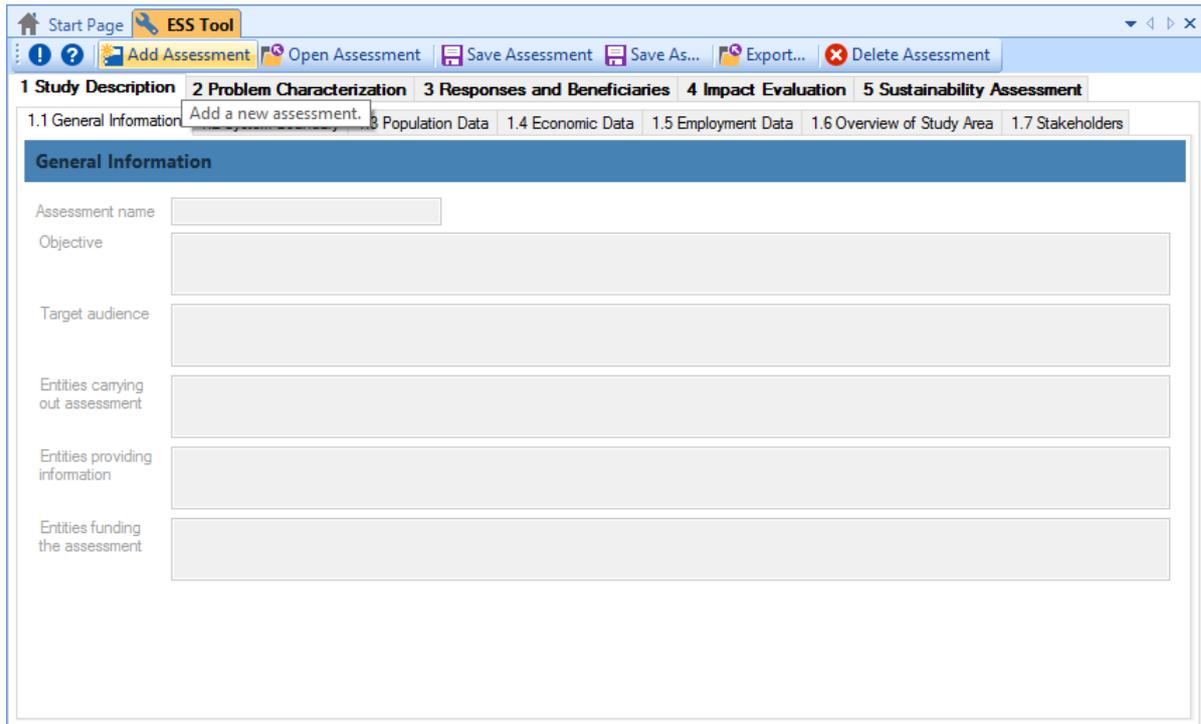


You are now ready to start using the tool.



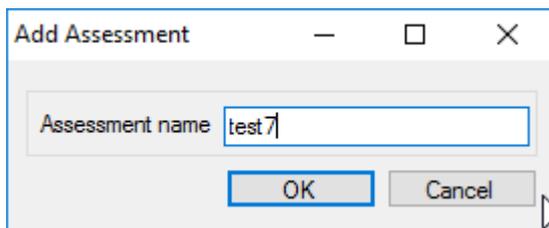
## 1.6 Adding a new assessment

To add a new assessment, click on the "Add Assessment" button.



The screenshot shows the ESS Tool interface with the 'Add Assessment' dialog box open. The dialog box is titled 'Add Assessment' and contains a text input field for 'Assessment name' with the text 'test 7' entered. Below the input field are 'OK' and 'Cancel' buttons. The background interface shows the 'General Information' section of the assessment tool, with fields for 'Assessment name', 'Objective', 'Target audience', 'Entities carrying out assessment', 'Entities providing information', and 'Entities funding the assessment'.

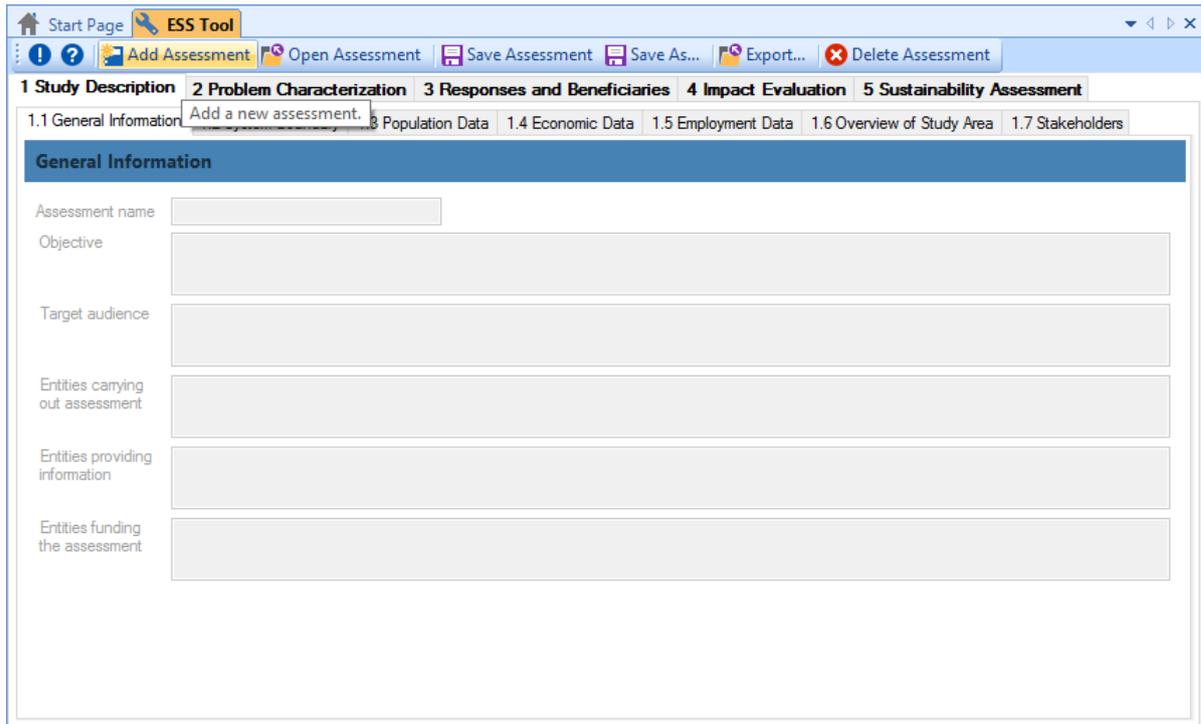
Give the assessment a name in the pop-up box and click “OK”.



This is a close-up screenshot of the 'Add Assessment' dialog box. The 'Assessment name' field contains the text 'test 7'. The 'OK' button is highlighted with a blue border, and the 'Cancel' button is also visible.

## 1.7 Opening an existing assessment

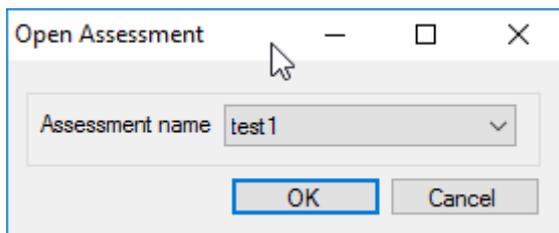
To open an existing assessment, click on the “Open Assessment” button.



The screenshot shows the 'ESS Tool' application window. The main menu includes 'Add Assessment', 'Open Assessment', 'Save Assessment', 'Save As...', 'Export...', and 'Delete Assessment'. The interface is divided into five main sections: 1 Study Description, 2 Problem Characterization, 3 Responses and Beneficiaries, 4 Impact Evaluation, and 5 Sustainability Assessment. Under '1 Study Description', there are sub-sections: 1.1 General Information, Add a new assessment, Population Data, 1.4 Economic Data, 1.5 Employment Data, 1.6 Overview of Study Area, and 1.7 Stakeholders. The 'General Information' section is active and contains the following fields:

- Assessment name:
- Objective:
- Target audience:
- Entities carrying out assessment:
- Entities providing information:
- Entities funding the assessment:

The assessment can then be selected from saved assessments using a drop-down menu.



The 'Open Assessment' dialog box is shown with the following elements:

- Title: Open Assessment
- Assessment name:  (with a drop-down arrow)
- Buttons: OK, Cancel

An assessment can be saved at any time by clicking on the “Save Assessment” button.

## 1.8 Exporting assessment results

Although the DESSIN ESS Tool provides functionality for viewing results, users may be interested in exporting results to Excel or other software tools for additional visualization and/or post-processing.

To export results from an assessment, click on the “Export” button. This will create an Excel spreadsheet that duplicates the tabular organization of the DESSIN ESS tool.

The screenshot displays the 'ESS Tool' web application interface. The top navigation bar includes a 'Start Page' button and a menu with options: 'Add Assessment', 'Open Assessment', 'Save Assessment', 'Save As...', 'Export...', and 'Delete Assessment'. Below the navigation bar, there are five main tabs: '1 Study Description', '2 Problem Characterization', '3 Responses and Beneficiaries', '4 Impact Evaluation', and '5 Sustainability Assessment'. Under the '1 Study Description' tab, there are five sub-sections: '1.1 General Information', '1.2 System Boundary', '1.3 Population Data', '1.4 Economic Data', and '1.5 Employment Data'. The '1.1 General Information' sub-section is currently active and contains a form with the following fields: 'Assessment name', 'Objective', 'Target audience', 'Entities carrying out assessment', 'Entities providing information', and 'Entities funding the assessment'. A tooltip is visible over the 'Export...' button, stating 'Export the assessment to an Excel file'. The 'Delete Assessment' button is also visible in the top navigation bar.

It is possible to delete an assessment using the "Delete Assessment" button.

## 2 Study Description

The purpose of Part I, the study description, is to prepare the evaluation by describing general basic characteristics of the study area, including: the geographical location and spatial extension; the intended audience and expected results of the assessment; and other information.

The DESSIN ESS Tool also provides functionality that enables retrieval of demographic, economic, and employment information from the EUROSTAT database.

### 2.1 General Information

The General Information tab provides text entry fields for general information about the assessment, including the following:

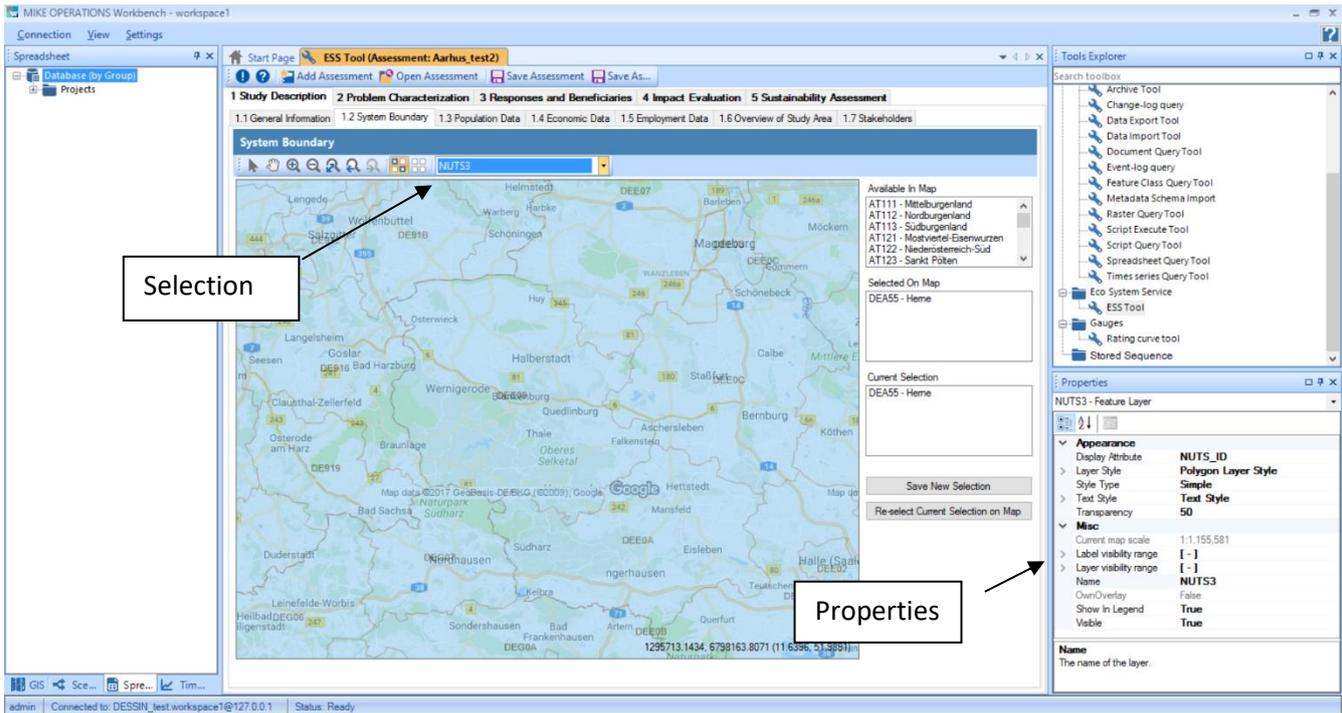
- objective of the assessment
- target audience
- entities carrying out the assessment
- entities providing information for the assessment
- entities funding the assessment

### 2.2 System Boundary

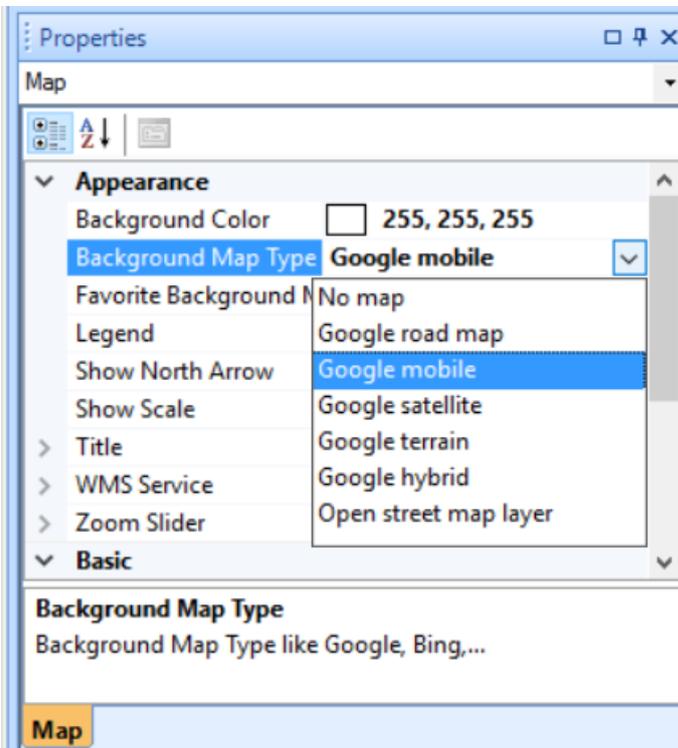
The System Boundary tab provides functionality for retrieving information from the EUROSTAT database. The tab provides a GIS interface that allows users to select one or more NUTS (Nomenclature of territorial units for statistics) 3 zones; data are then retrieved for these zones and displayed on following tabs. NUTS is a hierarchical system for dividing up the territory of the EU for the collection, development, and harmonization of European regional statistics. The NUTS 3 level is the smallest level and includes 1342 regions in Europe as of the most recent classification in 2013. The DESSIN tool provides information at this level because the tool is targeted towards users in urban settings for which data from larger regions may not be appropriate.

The system boundary tab displays NUTS regions and a background map. It is possible to change how the NUTS regions are displayed, and also the display of the background map. In addition, it is possible to select from a number of background maps.

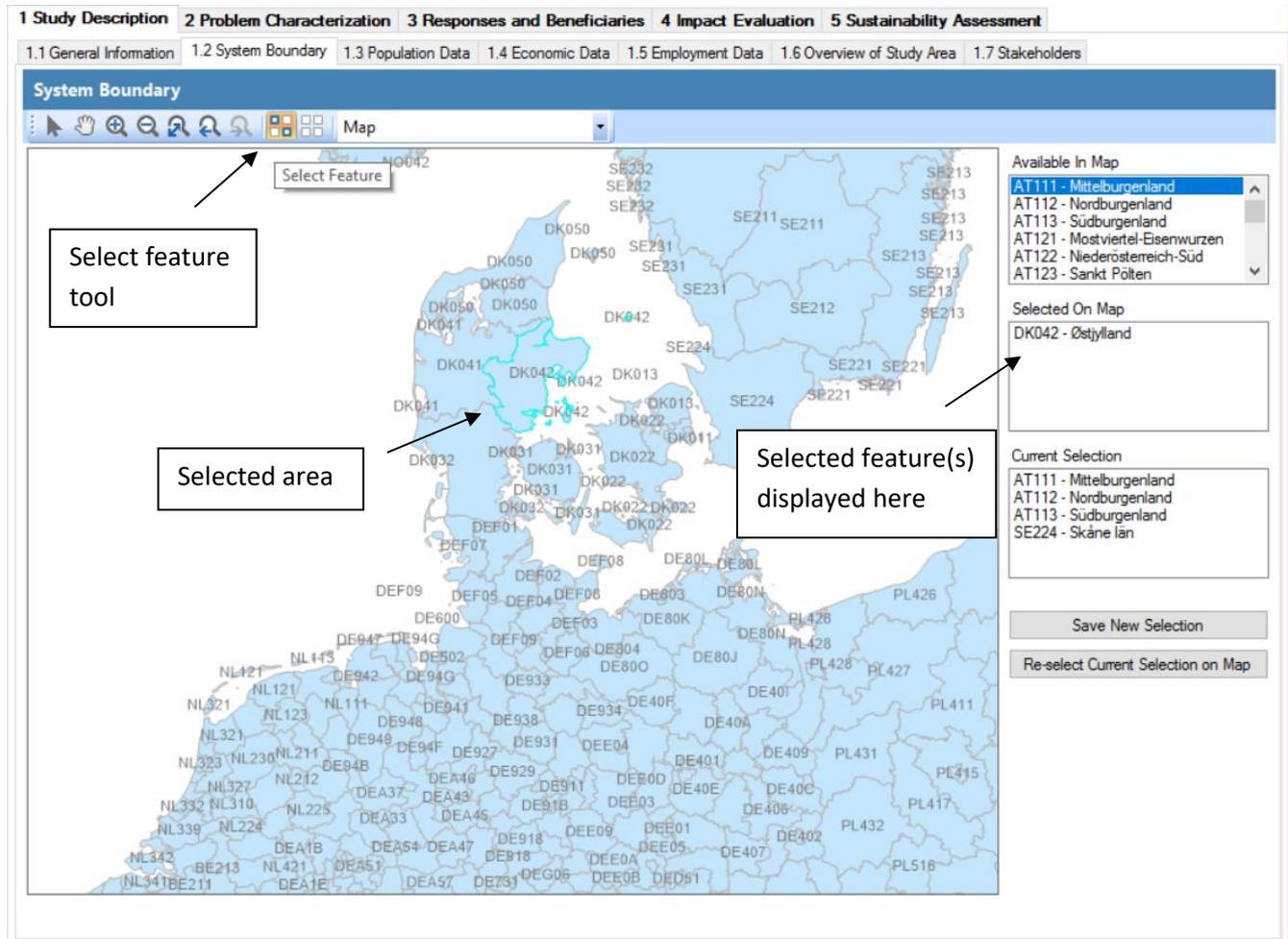
Properties of the NUTS 3 layer and background map can be modified in the Properties View of MIKE Workbench. Properties of either the NUTS 3 layer or the background map are displayed depending on the selection in the GIS toolbar that appears above the map display.



If “Map” is selected in the GIS toolbar at the top of the map view, then it is possible to select a background map for display. A number of options from Google are available, as well as a background map from Open Street Map. It is also possible to remove the background map display.



There are two ways to select one or more NUTS 3 zones. NUTS 3 zones may be selected from the map view using the select feature tool. After selection, the zone name(s) will appear in the field with the title “Selected On Map”. Multiple zones can be selected either by clicking and dragging over more than one zone, or by pressing the “shift” key while selecting zones individually.



Alternatively, it is possible to select from the list of NUTS 3 zones displayed in the field, “Available in Map”. Zones can be selected from this field by double-clicking on a zone name. The selected zones will be displayed in the field “Selected On Map”.

1 Study Description 2 Problem Characterization 3 Responses and Beneficiaries 4 Impact Evaluation 5 Sustainability Assessment

1.1 General Information 1.2 System Boundary 1.3 Population Data 1.4 Economic Data 1.5 Employment Data 1.6 Overview of Study Area 1.7 Stakeholders

System Boundary

Map



Available In Map

- AT111 - Mittelburgenland
- AT112 - Nordburgenland
- AT113 - Südburgenland
- AT121 - Mostviertel-Eisenwurzen
- AT122 - Niederösterreich-Süd
- AT123 - Sankt Pölten

Selected On Map

- AT111 - Mittelburgenland
- DK042 - Østjylland

Current Selection

- AT111 - Mittelburgenland
- AT112 - Nordburgenland
- AT113 - Südburgenland
- SE224 - Skåne län

Save New Selection

Re-select Current Selection on Map

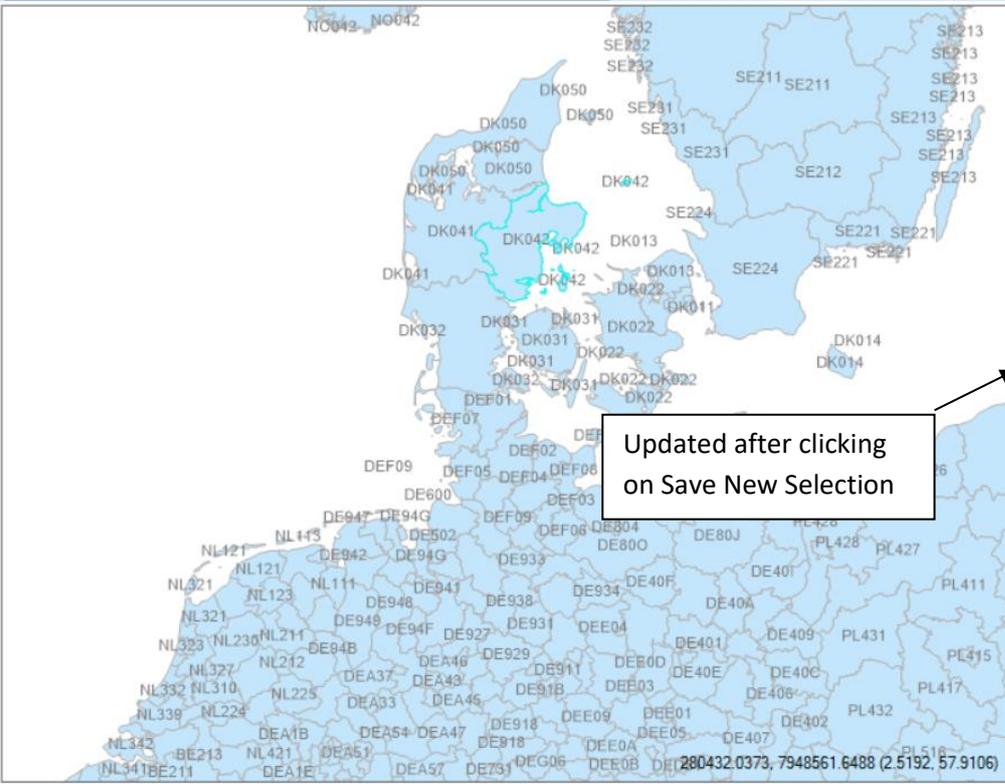
Retrieval of data from EUROSTAT is initiated by clicking on the button “Save New Selection”. This transfers the zones displayed in the field “Selected On Map” to the field “Current Selection”. Zones displayed in the “Current Selection” field are used to populate the “Population Data”, “Economic Data”, and “Employment Data” tabs, as described in the sections below.

1 Study Description 2 Problem Characterization 3 Responses and Beneficiaries 4 Impact Evaluation 5 Sustainability Assessment

1.1 General Information 1.2 System Boundary 1.3 Population Data 1.4 Economic Data 1.5 Employment Data 1.6 Overview of Study Area 1.7 Stakeholders

**System Boundary**

Map



Updated after clicking on Save New Selection

Available In Map

- AT111 - Mittelburgenland
- AT112 - Nordburgenland
- AT113 - Südburgenland
- AT121 - Mostviertel-Eisenwurzen
- AT122 - Niederösterreich-Süd
- AT123 - Sankt Pölten

Selected On Map

AT111 - Mittelburgenland  
DK042 - Østjylland

Current Selection

AT111 - Mittelburgenland  
DK042 - Østjylland

Save New Selection

Re-select Current Selection on Map

If the zones displayed in the “Current Selection” field are different from the zones selected in the map, it is possible to refresh the map selection with the zones in the “Current Selection” field by clicking on the button “Re-select Current Selection on Map”.

## 2.3 Population Data

The Population Data tab displays population data for the NUTS 3 zones selected in the System Boundary tab. The Population Data tab is refreshed by clicking on the button, “Retrieve Data”. Before clicking on “Retrieve Data”, the user must select a year from the “Show year” drop-down menu. Not all data types may be available for all zones and years.

## 2.4 Economic Data

The Economic Data tab displays population data for the NUTS 3 zones selected in the System Boundary tab. The Economic Data tab is refreshed by clicking on the button, “Retrieve Data”. Before clicking on “Retrieve Data”, the user must select a year from the “Show year” drop-down menu. Not all data types may be available for all zones and years.

## 2.5 Employment Data

The Employment Data tab displays population data for the NUTS 3 zones selected in the System Boundary tab. The Employment Data tab is refreshed by clicking on the button, “Retrieve Data”. Before clicking on “Retrieve Data”, the user must select a year from the “Show year” drop-down menu. Not all data types may be available for all zones and years.

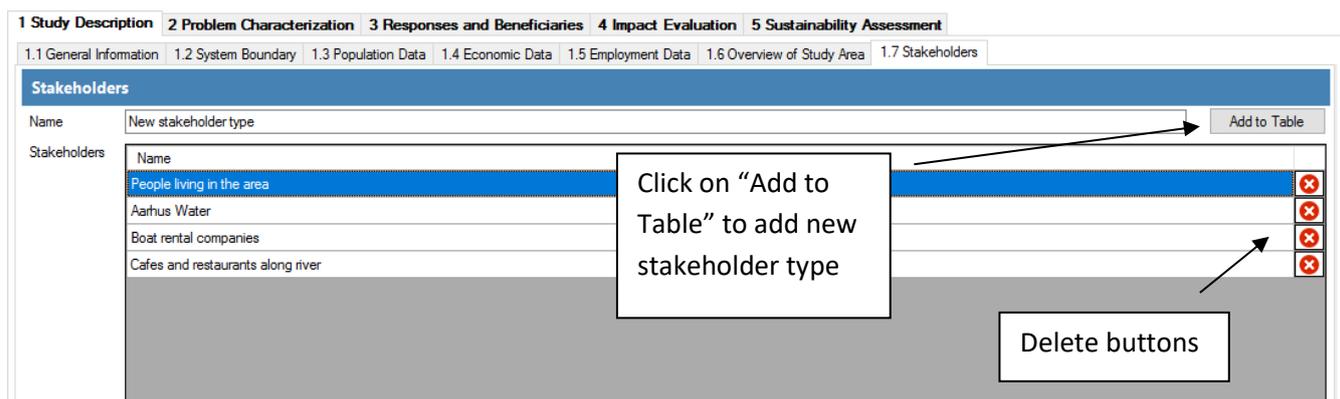
## 2.6 Overview of Area

The Overview of Area tab provides text-entry fields for description of the following aspects of the study area, including:

- environmental attributes (e.g. climate type, topography, water quality levels, water availability)
- economic activities taking place in the area (e.g. land use, land use transitions, comparison of activities by share of GDP)
- socio-economic profile (e.g. population density, average household income, age profile)
- socio-cultural aspects (e.g. value systems, role of landscape and land use in identity formation for local communities).

## 2.7 Define Stakeholders

The Define Stakeholders tab is used to populate a list of stakeholder types in the study area. The populated list of stakeholder types is used later in the workflow to identify ESS with beneficiaries. A new stakeholder type is entered by typing a name in the “Name” field and then clicking on the button, “Add to Table”. Stakeholder types can also be removed from the list by clicking on the delete button.



### 3 Problem Characterization

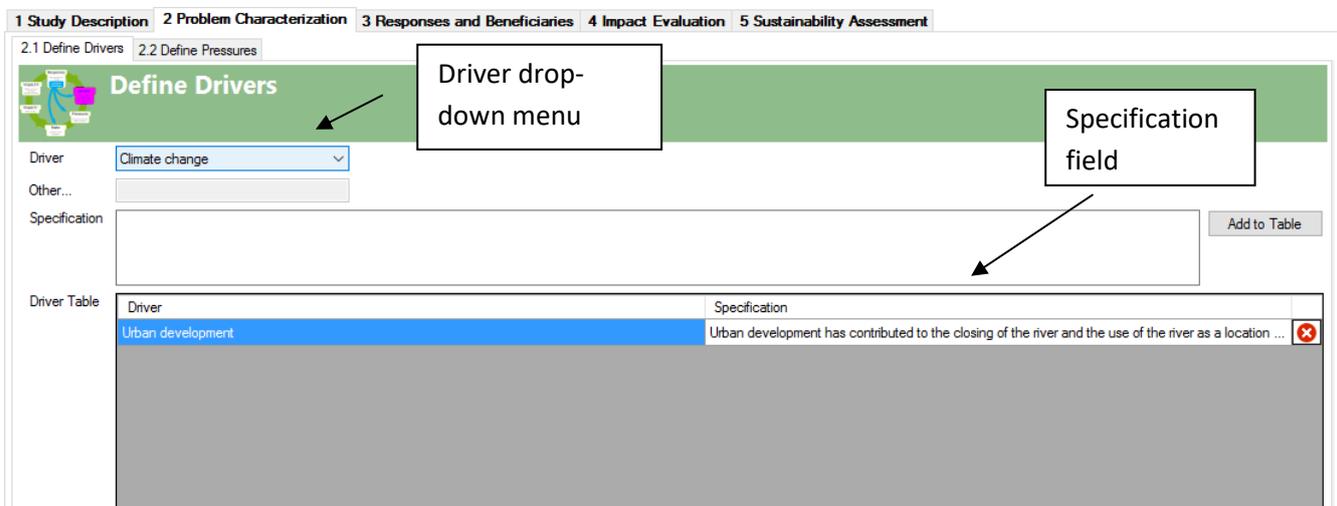
Part II-Problem Characterization represents the first step in the core evaluation and is the entry point to the DPSIR cycle. In this section, relevant Drivers and Pressures are identified in order to understand why technical or management intervention measures may be needed. This step can also help the user to identify important Pressures and appropriate measures.

The aim of this part is to produce a qualitative overview of the Drivers present in the study area, relate these to resulting Pressures, and describe the latter. In specific cases where the proposed measures are expected/found to influence Pressures, then changes in those Pressures should be quantified. For more detailed information see Chapter 3 of the DESSIN Cookbook Companion Document.

#### 3.1 Define Drivers

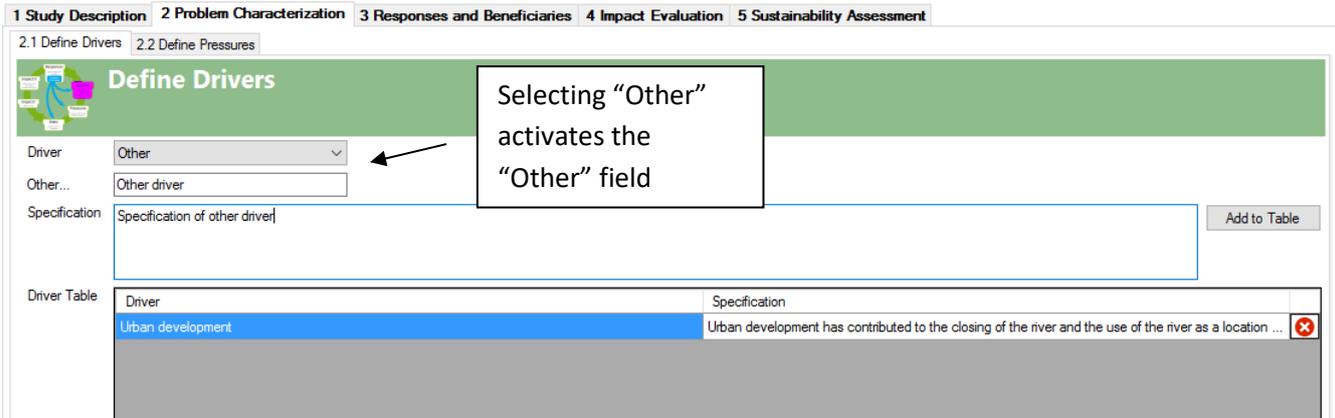
The Define Drivers tab provides a list of typical drivers affecting water supply and water quality in urban areas. Drivers are defined as human activities that lead to environmental impacts (i.e., pressures) on ecosystems. Functionality is also provided for defining other Drivers besides the ones available from list. More information about the list of drivers is available in the DESSIN Cookbook and the DESSIN Cookbook Companion Document.

Drivers can be selected from the “Driver” drop-down list. After selection, a brief description of main characteristics must be provided in the “Specification” field. The description should address spatial and temporal features of the driver (e.g., does the driver vary in space and time).



Once defined, a driver and specification are added to the table below by clicking on the “Add to Table” button.

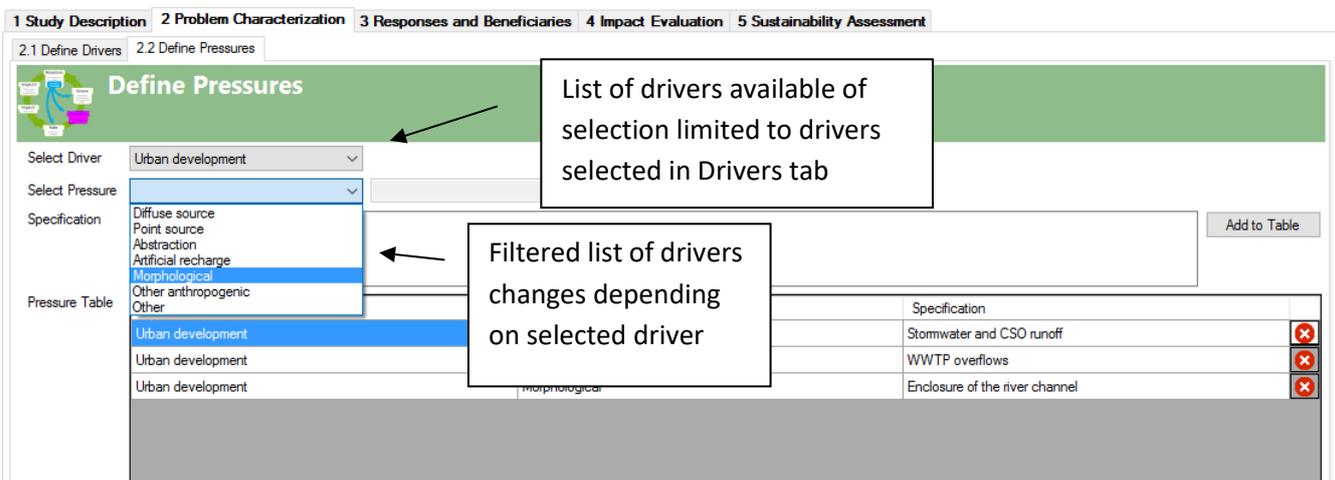
It is possible to add a user-defined driver by selected “Other” from the “Driver” drop-down menu. If “Other” is selected, the “Other” field becomes active and it is possible to enter a user-defined driver name in this field.



### 3.2 Define Pressures

The Define Pressures tab enables the user to identify relevant pressures in the study area. A pressure is defined as the direct environmental effect of the driver, such as an effect that causes a change in water flow or a change in water chemistry.

The selection of pressures is related to the selection of drivers made on the Drivers tab. A single driver can be selected from the subset of drivers identified in the Drivers tab using the “Select Driver” drop-down menu. After selection of a driver, the user is presented with a list of pressures in the “Select Pressure” drop-down menu that is filtered based on the selected driver.



Pressures can be added to a list of selected pressures by clicking on the “Add to Table” button. As with drivers, it is necessary to provide a description of the pressure in the “Specification” field. It is also possible to define a user-defined pressure by selecting “Other” in the “Select Pressure” drop-down menu and then entering the name of the pressure in the text field to the right of the “Select Pressure” drop-down menu.

Pressures can be selected more than once, if the same pressure is related to two or more drivers. Each selected driver-pressure combination is displayed in the “Pressure Table” field.

## 4 Responses and Beneficiaries

The aim of Part III-Responses and Beneficiaries is to describe the Responses (i.e., the proposed measures) under consideration to address the problems in the study area that were identified in Part II. In Part III, the user is also prompted to identify the case-relevant ESS (i.e., ESS that may be affected by the proposed measures). Finally, ESS are linked to beneficiaries in order to categorize case-relevant ESS as final ESS or intermediate ESS. Final ESS have direct impact on human welfare that are possible to measure using economic valuation methods. Intermediate services may not impact on human welfare directly, but play an important role supporting other services (for example, natural purification processes that contribute to the availability of clean water for drinking) and therefore may be of interest to decision makers.

A response is defined as a measure taken to address drivers, reduce pressures and/or improve the state of the ecosystem under study. Beneficiaries include any persons, organizations, households, or firms whose interests are positively or negatively affected by either the direct use or presence of an ESS affected by a proposed measure.

### 4.1 Create Measures

The Create Measures tab is used to define the measures under consideration in a study and assign some basic properties to each measure.

To create a new measure, the name of the measure should be typed in the “Name” field. After this, the measure should be categorized as either a technical (e.g., installation of new equipment) or management measure (e.g., a new regulation for industrial discharges), using the “Type” drop-down menu. Finally, an expected lifetime should be provided in the “Lifetime” field.

New measures are added to the list of measures by clicking on the “Add to Table” button. After a measure has been added to the table, it is still possible to edit the lifetime field.

### 4.2 Define Capabilities

The Define Capabilities tab is used to provide a qualitative description of each measure that were defined on the Create Measures tab.

Measures are selected from the list created on the Create Measures tab using the “Select Measure” drop-down menu. After selecting a measure, the name of the capability is defined in the “Name of Capability” field. The capability is defined as either theoretical or tested using the “Type” drop-down menu. Finally, a qualitative description is provided in the “Description of Capability” field.

A new capability is added to the list of capabilities by clicking on the “Add to Table” button. It is possible to define more than one capability for each measure.

### 4.3 Select Drivers

The Select Drivers tab is used to identify drivers affected by proposed measures. The Select Drivers tab is only relevant if one or more management measures have been defined in the Create

Measures tab, as technical measures do not affect drivers. It is required to identify drivers in order to determine whether it is necessary to estimate impacts of measures on drivers and resulting effects on pressures and/or states.

To select a driver, the measure affecting the driver must first be selected from the “Select Measure” drop-down list. The drop-down list will be empty if no management measures have been defined. If one or more management measures have been defined, then the capabilities of the measures will be displayed for reference in the text area to the right of the “Select Measure” drop-down list.

The list of drivers defined on the Define Drivers tab is displayed in the “Select Drivers” field. To associate drivers with a measure, check the box next to each driver associated with the selected measure and then click on “Add to Table”. It is possible to associate a driver with more than one measure.

#### 4.4 Select Pressures

The Select Pressures tab is used to identify pressures affected by proposed measures. Both technical and management measures can affect pressures. It is required to identify pressures in order to determine whether it is necessary to estimate impacts of measures on pressures and resulting effects on states.

To select a pressure, the measure affecting the pressure must first be selected from the “Select Measure” drop-down list. The capabilities of the measures are displayed for reference in the text area to the right of the “Select Measure” drop-down list.

The list of pressures defined on the Define Pressures tab is displayed in the “Select Pressures” field. To associate pressures with a measure, check the box next to each pressure associated with the selected measure and then click on “Add to Table”. It is possible to associate a pressure with more than one measure.

1 Study Description 2 Problem Characterization 3 Responses and Beneficiaries 4 Impact Evaluation 5 Sustainability

3.9 Select ESS For Further Analysis

3.1 Create Measures 3.2 Describe Capabilities 3.3 Select Drivers 3.4 Select Pressures 3.5 Select State Parameters

Capabilities display changes in selection of measure.

### Select pressures

Select Measure: RTC system plus opening river

Name	Capabilities
Reduction in overflows	Reduction in overflows
Improved disinfection	Reduction in overflows
Opening of river	Improvement in water quality

Select pressures and then click on Add to Table to add to list.

Select Pressures

Driver	Pressure	Specification
<input checked="" type="checkbox"/> Urban development	Diffuse source	Stormwater and CSO runoff
<input checked="" type="checkbox"/> Urban development	Point source	WWTP overflows
<input checked="" type="checkbox"/> Urban development	Morphological	Enclosure of the river channel

Relevant drivers

Measure	Driver	Pressure
Opening river	Urban development	Morphological
RTC system plus opening river	Urban development	Diffuse source
RTC system plus opening river	Urban development	Point source
RTC system plus opening river	Urban development	Morphological

## 4.5 Select State Parameters

The Select State Parameters tab is used to identify ecosystem state parameters affected by the proposed measure. Both technical and management measures can affect state parameters. It is necessary to identify affected state parameters because this information is used to link proposed measures to changes in ESS.

To select a state parameter, the measure affecting the state parameter must first be selected from the “Select Measure” drop-down list. The capabilities of the measures are displayed for reference in the text area to the right of the “Select Measure” drop-down list.

A list of state parameters is displayed in the “Select Affected State Parameters” field. To associate state parameters with a measure, check the box next to each state parameter associated with the selected measure and then click on “Add to Table”. It is possible to associate a state parameter with more than one measure.

User-defined state parameters can be added by providing a name in the “State Parameter” field and a description in the “Description” field. A description is required for any user-defined parameters. User-defined parameters are added to the list of state parameters by clicking on the “Add to Table” button.

1 Study Description | 2 Problem Characterization | 3 Responses and Beneficiaries | 4 Impact Evaluation | 5 Sustainability Assessment

3.9 Select ESS For Further Analysis

3.1 Create Measures | 3.2 Describe Capabilities | 3.3 Select Drivers | 3.4 Select Pressures | 3.5 Select State Parameters | 3.6 Case-relevant ESS | 3.7 Identify Beneficiaries | 3.8 Categorize Stakeholders

**Select state parameters**

Select Measure: Opening river

Name of capability	Description of capabilities
Opening of river	Improved aesthetics due to opening of river channel.

Select Affected State Parameters

Category	SubCategory	State parameter
<input type="checkbox"/> Biological	Aquatic animals	Composition and abundance of benthic invertebrate fauna
<input type="checkbox"/> Biological	Aquatic animals	Composition, abundance and age structure of fish fauna
<input type="checkbox"/> Biological	Aquatic animals	Composition and abundance of zooplankton species

State Parameter: test

Description:

Use "State Parameter" and "Description" to add user-defined state parameters

Measure	State Parameter	IsAdditional	
Opening river	Depth and width variation	<input type="checkbox"/>	✖
Opening river	Structure of the water body shoreline	<input type="checkbox"/>	✖
RTC system plus opening river	Quantity and dynamics of water flow	<input type="checkbox"/>	✖
RTC system plus opening river	Water residence time	<input type="checkbox"/>	✖
RTC system plus opening river	Depth and width variation	<input type="checkbox"/>	✖
RTC system plus opening river	Structure of the water body shoreline	<input type="checkbox"/>	✖
RTC system plus opening river	Odor	<input type="checkbox"/>	✖
RTC system plus opening river	Thermal conditions	<input type="checkbox"/>	✖
RTC system plus opening river	Oxygenation conditions	<input type="checkbox"/>	✖
RTC system plus opening river	Nutrient conditions	<input type="checkbox"/>	✖
RTC system plus opening river	Pollution by other substances identified as being discharged	<input type="checkbox"/>	✖
RTC system	Odor	<input type="checkbox"/>	✖
RTC system	Quantity and dynamics of water flow	<input type="checkbox"/>	✖
RTC system	Water residence time	<input type="checkbox"/>	✖
RTC system	Thermal conditions	<input type="checkbox"/>	✖
RTC system	Oxygenation conditions	<input type="checkbox"/>	✖
RTC system	Nutrient conditions	<input type="checkbox"/>	✖
RTC system	Pollution by other substances identified as being discharged	<input type="checkbox"/>	✖

## 4.6 Case-relevant ESS

The Case-relevant ESS tab is used to make associations between measures and ESS and therefore lies at the core of the ESS assessment. ESS that are affected by measures under consideration in an assessment are referred to as “case-relevant” ESS.

To identify case-relevant ESS, the user begins by selecting a measure using the “Select Measure” drop-down menu. The user is then presented with a list of state parameters associated with the selected measure on the Select State Parameters tab. The selection of a state parameter from this list then filters a list of CICES ESS classes that is presented in the “Select CICES ESS” drop-down menu.

The filtered list of CICES ESS classes is based on links between ESS state parameters and CICES classes established in the DESSIN Cookbook. Readers are referred to the DESSIN Cookbook and Cookbook Companion Document for more information on these links.

To add a CICES class to the list of case-relevant ESS, the user selects a class from the “Select CICES ESS” drop-down menu and then provides a name in the “User-defined name”. Once a name has been given, it is possible to associate the same name with different measures. It is also possible to associate more than one state parameter with the same measure/ESS combination.

An example table is shown below. The table is populated with the CICES section associated with each class. Only one entry is possible per item for all fields except the “State Parameters” field, for which multiple entries are possible.

1 Study Description | 2 Problem Characterization | 3 Responses and Beneficiaries | 4 Impact Evaluation | 5 Sustainability Assessment

3.9 Select ESS For Further Analysis

3.1 Create Measures | 3.2 Describe Capabilities | 3.3 Select Drivers | 3.4 Select Pressures | 3.5 Select State Parameters | 3.6 Case-relevant ESS | 3.7 Identify Beneficiaries | 3.8 Categorize Stakeholders

**Case-relevant ESS**

Select Measure: Opening river

Select State Parameter: Depth and width variation - Opening river

Select CICES ESS: Mass stabilisation and control of erosion rates | Depth and width variation

User-defined ESS Name:  Add to Table

Measure	State Parameters	CICES Class	CICES Section	ESS Name	
RTC system plus opening river	Quantity and dynamics of water flow	Hydrological cycle and water flow maintenance	Regulation & Maintenance	Hydrological cycle	✗
RTC system	Quantity and dynamics of water flow	Hydrological cycle and water flow maintenance	Regulation & Maintenance	Hydrological cycle	✗
RTC system plus opening river	Quantity and dynamics of water flow Water residence time	Dilution by atmosphere, freshwater and marine ecosystems	Regulation & Maintenance	Dilution	✗
RTC system	Quantity and dynamics of water flow Water residence time	Dilution by atmosphere, freshwater and marine ecosystems	Regulation & Maintenance	Dilution	✗
RTC system plus opening river	Quantity and dynamics of water flow Odor Pollution by other substances identified as being discharged in significant quantities into the body of water	Physical use of land-/seascapes in different environmental settings	Cultural	Physical use	✗
RTC system	Odor Quantity and dynamics of water flow Pollution by other substances identified as being discharged in significant quantities into the body of water	Physical use of land-/seascapes in different environmental settings	Cultural	Physical use	✗
Opening river	Depth and width variation Structure of the water body shoreline	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Experiential use	✗
RTC system plus opening river	Quantity and dynamics of water flow Depth and width variation Structure of the water body shoreline Odor	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Experiential use	✗
RTC system	Odor Quantity and dynamics of water flow	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Experiential use	✗
RTC system plus opening river	Oxygenation conditions Nutrient conditions	Chemical condition of freshwaters	Regulation & Maintenance	Chemical conditions	✗
RTC system	Oxygenation conditions Nutrient conditions	Chemical condition of freshwaters	Regulation & Maintenance	Chemical conditions	✗
Opening river	Depth and width variation	Buffering and attenuation of mass flows	Regulation & Maintenance	Attenuation	✗
RTC system plus opening river	Water residence time Depth and width variation	Buffering and attenuation of mass flows	Regulation & Maintenance	Attenuation	✗
RTC system	Water residence time	Buffering and attenuation of mass flows	Regulation & Maintenance	Attenuation	✗

## 4.7 Identify Beneficiaries

On the Identify Beneficiaries tab, case-relevant ESS are associated with potential beneficiaries. This is also a central part of the assessment because it is used to determine whether an economic value should be assigned to an ESS.

ESS that are provided by an ecosystem but not directly used or appreciated by humans are considered intermediate ESS (e.g., natural water purification processes are considered intermediate

ESS), while those ESS that are directly used or otherwise appreciated by humans are final ESS (e.g., the use of water for drinking). The distinction is made by identifying beneficiaries, which are defined as persons, organizations, households, or firms whose interests are positively or negatively affected by the direct use or presence of the ESS. ESS classified as final are monetized using economic valuation methods in Part IV of the assessment.

To associate an ESS with a beneficiary, the ESS should be selected using the “Select case-relevant ESS” drop-down menu. This populates the “CICES Class” and “CICES Section” fields with the associated section and class. Beneficiaries can then be selected for the selected ESS by checking boxes in the “Select beneficiary types.....” checkbox list.

The “Select beneficiary types.....” checkbox list contains four fields: Type, Sub-Type, Example, and Final ESS. Only the Type field is used elsewhere in the workflow. The other fields are for informational purposes only and are provided to help the user to decide if the beneficiary type can be associated with the selected ESS.

The user can add beneficiary types to the list of selected types by clicking on the button “Add to Table”. Both the beneficiary type and sub-type are added the table, and it is possible to associate more than one sub-type with a single type. Although the sub-type does not have a functional purpose elsewhere in the assessment, sub-type associations may be useful for selecting economic valuation methods in Part IV of the assessment, and are carried forward to this part of the assessment in order to assist users with the selection of appropriate methods.

ESS Tool (Assessment: Aarhus\_test2)

1 Study Description 2 Problem Characterization 3 Responses and Beneficiaries 4 Impact Evaluation 5 Sustainability Assessment

3.8 Categorize Stakeholders 3.9 Select ESS For Further Analysis

3.1 Create Measures 3.2 Describe Capabilities 3.3 Select Drivers 3.4 Select Pressures 3.5 Select State Parameters 3.6 Case-relevant ESS 3.7 Identify Beneficiaries

### Identify beneficiaries

Select case relevant ESS: [dropdown]

CICES Class: [text input]

CICES Section: [text input]

Select beneficiary type: AGRICULTURE, FORESTRY AND FISHING

Select beneficiary subtype: Irrigators

Example: Irrigators interact with aquatic environments, as they consume water from aquatic environments for maintaining crops, often moving water through ditches and canals. Note that Farmers and Irrigators are different beneficiaries.

Final ESS: water for growing and maintaining crops

Add to Table

CICES Classes and Associated Beneficiaries	ESSName	CICESName	CICESSection	BeneficiaryTypeName	BeneficiarySub TypeNam	
	Dilution	Dilution by atmosphere, fres...	Regulation & Maintenance	WATER SUPPLY; SEWER...	Sewerage	✖
	Experiential use	Experiential use of plants, a...	Cultural	Real estate activities	Residential property o...	✖
	Experiential use	Experiential use of plants, a...	Cultural	RECREATIONAL	Experiencers and view...	✖
	Hydrological cycle	Hydrological cycle and wate...	Regulation & Maintenance	NON-USE	People who care (exist...	✖
	Hydrological cycle	Hydrological cycle and wate...	Regulation & Maintenance	NON-USE	People who care (opti...	✖
	Physical use	Physical use of land-/seasc...	Cultural	RECREATIONAL	Boaters	✖
	Physical use	Physical use of land-/seasc...	Cultural	RECREATIONAL	Experiencers and view...	✖
	Physical use	Physical use of land-/seasc...	Cultural	RECREATIONAL	Waders, Swimmers an...	✖

## 4.8 Categorize Stakeholders

The Categorize Stakeholders tab is used to link stakeholders to beneficiaries. The purpose of this part to the tool is to help users determine whether potential ESS beneficiaries are represented among local stakeholder groups.

To associate a stakeholder with one or more beneficiary types, a stakeholder must first be selected from the “Select Stakeholder” drop-down menu. The stakeholder can then be associated with different beneficiary types by clicking on one or more boxes in the “Select beneficiary types for stakeholder” drop-down list. As was the case on the Identify Beneficiaries tab, both the Beneficiary Type and Beneficiary Sub-Type fields are added to list of stakeholders when the user clicks on the button “Add to Table”.

ESS Tool (Assessment: Aarhus\_test2)

1 Study Description 2 Problem Characterization 3 Responses and Beneficiaries 4 Impact Evaluation 5 Sustainability Assessment

3.1 Create Measures 3.2 Describe Capabilities 3.3 Select Drivers 3.4 Select Pressures 3.5 Select State Parameters 3.6 Case-relevant ESS 3.7 Identify Beneficiaries  
3.8 Categorize Stakeholders 3.9 Select ESS For Further Analysis

### Categorize stakeholders

Select Stakeholder:

Select beneficiary type:

Select beneficiary subtype:

Example: Irrigators interact with aquatic environments, as they consume water from aquatic environments for maintaining crops, often moving water through ditches and canals. Note that Farmers and Irrigators are different beneficiaries.

Final ESS:

Stakeholders and Associated Beneficiaries

Stakeholder Name	Beneficiary Type	Beneficiary Sub-Type	
People living in the area	NON-USE	People who care (existence)	<input type="checkbox"/>
People living in the area	NON-USE	People who care (option/bequest)	<input type="checkbox"/>
People living in the area	Real estate activities	Residential property owners	<input type="checkbox"/>
People living in the area	RECREATIONAL	Anglers	<input type="checkbox"/>
People living in the area	RECREATIONAL	Boaters	<input type="checkbox"/>
People living in the area	RECREATIONAL	Experiencers and viewers	<input type="checkbox"/>
People living in the area	RECREATIONAL	Waders, Swimmers and divers	<input type="checkbox"/>

## 4.9 Select ESS For Further Analysis

The final tab in Part III, Select ESS for Further Analysis, is used to select a sub-set of ESS for further analysis in Part IV.

All of the ESS selected on the Case-relevant ESS tab are presented in a checkbox list that includes the associated CICES class and section for each ESS. If the ESS has been associated with a beneficiary, then the associated beneficiary type is also displayed in the list. If the associated beneficiary type has been associated with a stakeholder, then the associated stakeholder type is also displayed. If an ESS is associated with both a beneficiary AND a stakeholder, then the ESS is classified as final. Otherwise, the ESS is classified as intermediate.

The user can select an ESS for further analysis in Part IV by clicking on the checkbox next to that ESS. Both final and intermediate ESS can be selected for further analysis.

## 5 Impact Evaluation

The purpose of Part IV-Impact Evaluation is to carry out the rest of the DPSIR analysis cycle (as adapted for DESSIN) using the relationships established in PART III.

In Part IV-Impact Evaluation, the user estimates how proposed measures will affect the system under study by estimating the impact of measures on the state of the ecosystem (State), the provision of ESS (Impact I-Provision), and the use of ESS (Impact II-Use). The Impact II-Use assessment is limited to ESS that have been classified as final in Part III. The user is further prompted to estimate economic values for changes in the use of these services.

Changes in State, Impact I and Impact II are measured using indicators. An indicator is defined as an observed value representative of a phenomenon under study. Indicators are defined for each state parameter associated with the selected ESS, as well as the provision and use of ESS.

Indicators are estimated for a baseline scenario that represents the system before any measures have been implemented. These are compared to indicators that estimate the impact(s) of one or more proposed measures.

### 5.1 State Indicators

Indicators are defined for state parameters on the State Indicators tab. An indicator can be defined for every combination of Measure, ESS, and State parameter.

The user can select a measure, ESS, and state parameter combination using drop-down lists. A list of suggested state indicators that can be used to measure the selected state parameter is provided in the “Add State Indicator” drop-down list.

It is also possible to create a user-defined state indicator by selecting “Other” from the list. This activates the text field below the drop-down list, which can then be used to enter the name of the indicator. Indicators are added to the “State Indicators” list by clicking on the “Add to Table” button.

1 Study Description 2 Problem Characterization 3 Responses and Beneficiaries 4 Impact Evaluation 5 Sustainability Assessment

4.1 State Indicators 4.2 Impact I Indicators 4.3 Impact II - Use Indicators 4.4 Economic Valuation Studies 4.5 Economic Valuation 4.6 Before/After Configuration 4.7 Before/After Comparisons (2)

**State Indicators**

Select Measure: Opening river

Select ESS: Attenuation (Buffering and attenuation of mass flows, Regulation & Maintenance)

Select State Parameter: Depth and width variation - Opening river (Hydromorphological, Morphology)

Add State Indicator: area and length of water body (from: Scholz et al., 2012)

State Indicators:

Measure	ESS	State Parameter	State Indicator	Indicator Value		
RTC system	Experiential use	animals and land-/seascapes in different environmental settings	Cultural	Odor	% of analysis period that concentration of BOD exceeds 10 mg/L	✗
RTC system plus opening river	Experiential use	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Odor	% of analysis period that concentration of BOD exceeds 10 mg/L	✗
RTC system plus opening river			Regulation & Maintenance	Depth and width variation	area and length of water body	✗
Opening river			Regulation & Maintenance	Depth and width variation	area and length of water body	✗
Opening river			Cultural	Structure of the water body shoreline	Degree of naturalness (hemeroby)	✗
RTC system plus opening river			Cultural	Structure of the water body shoreline	Degree of naturalness (hemeroby)	✗
Opening river	Experiential use	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Depth and width variation	Length of restored river section	✗
RTC system plus opening river	Experiential use	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Depth and width variation	Length of restored river section	✗
RTC system plus opening river	Experiential use	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Quantity and dynamics of water flow	Minimum daily average flow	✗
RTC system	Experiential use	Experiential use of plants, animals and land-/seascapes in different environmental settings	Cultural	Quantity and dynamics of water flow	Minimum daily average flow	✗
RTC system plus opening river	Attenuation	Buffering and attenuation of mass flows	Regulation & Maintenance	Water residence time	quantity and temporal variability of the water (avg. flows, flood levels)	✗
RTC system	Attenuation	Buffering and attenuation of mass flows	Regulation & Maintenance	Water residence time	quantity and temporal variability of the water (avg. flows, flood levels)	✗

List of proposed state indicators, with option to create user-defined indicator by clicking on "Other"

## 5.2 Impact I Indicators

Indicators for the provision of ESS (Impact I) are defined on the Impact I Indicators tab. An indicator can be defined for every combination of measure and ESS.

The user can select a measure and ESS combination using drop-down lists. A list of suggested indicators that can be used to measure the provision of the selected ESS is provided in the "Add Impact I Indicator" drop-down list.

It is also possible to create a user-defined Impact I indicator by selecting "Other" from the list. This activates the text field below the drop-down list, which can then be used to enter the name of the indicator. Indicators are added to the Impact I Indicators list by clicking on the "Add to Table" button.

### 5.3 Impact II Indicators

Indicators for the use of ESS (Impact II) are defined on the Impact II-Use Indicators tab. An indicator can be defined for every combination of measure and ESS, as long as the ESS has been classified as a final ESS in Part III.

The user can select a measure and ESS combination using drop-down lists. A list of suggested indicators that can be used to measure the use of the selected ESS is provided in the “Add Impact II-Use Indicator” drop-down list.

It is also possible to create a user-defined Impact II indicator by selecting “Other” from the list. This activates the text field below the drop-down list, which can then be used to enter the name of the indicator. Indicators are added to the Impact II Indicators list by clicking on the “Add to Table” button.

### 5.4 Economic Valuation Studies

The Economic Valuation Studies tab provides access to a database of economic valuation studies that can be used for guidance in the assignment of economic values to the use of ESS (Impact II). The economic valuation database is intended to be advisory and choices made on this tab do not impact other parts of the workflow.

The economic valuation database provides summary information about 71 studies that have been disseminated in the recent literature. It is possible to filter the list by CICES Class and by economic valuation type. The list of CICES classes used to filter the database is limited to ESS that have been identified as final ESS in Part III.

Individual studies are selected using the “Authors” drop-down list, which displays the authors and publication year for each study. Changing the selection in this field changes the information displayed in the fields below, which show the study title, journal name, and also an abstract.

It is possible to view more information about the selected study by clicking on the button “View all article properties”. This causes a pop-up box to appear with further information.

In some cases, two or more valuation methods were applied in a single study. In these cases, two or more columns (with the heading, “Estimate”) will appear in the pop-up box, with each column containing information about a single valuation method.

### 5.5 Economic Valuation

The Economic Valuation tab is used to assign economic valuation methods to ESS. The assignment of economic valuation methods is independent of any selections made on the Economic Valuation Studies tab, which is intended to be advisory only.

An economic valuation method should be assigned to each combination of measure and ESS. Different combinations of measures and ESS can be selected using drop-down lists.

After selection of an ESS, the “Select Beneficiary” fields are updated with beneficiary types and sub-types. However, the information in these fields is provided for informational purposes only to help the user identify an appropriate economic valuation type.

A valuation method is assigned to an ESS by entering the name of the valuation method in the “Valuation Method” field. It is also possible to provide information about assumptions and other comments in the optional “Assumptions/comments/references” field.

## 5.6 Before/After Configuration

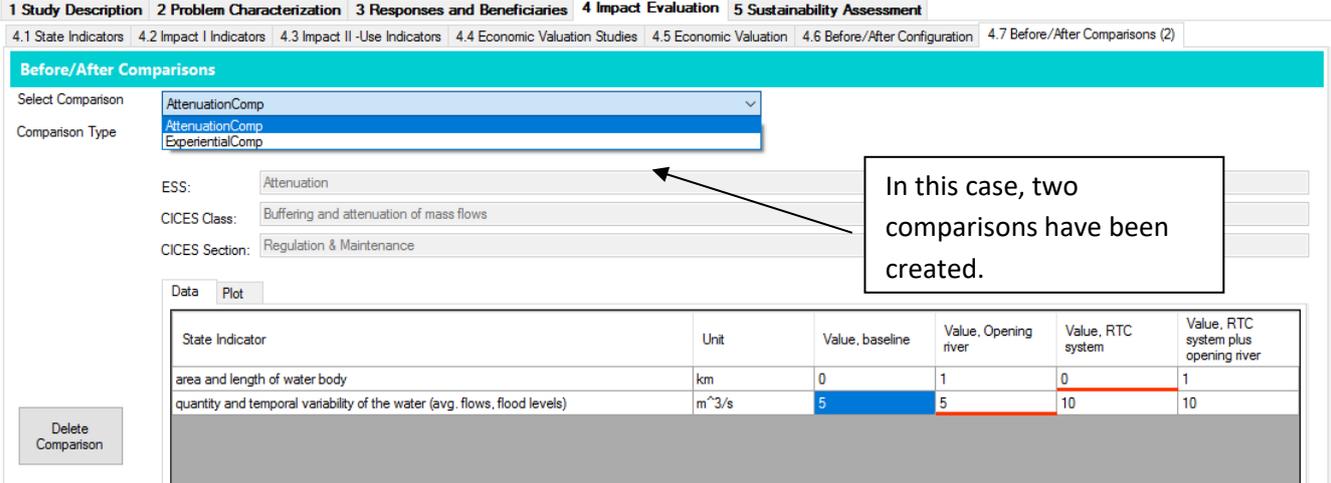
The Before/After Configuration tab is used to set up a comparison of indicator values for an ESS. The ESS for which indicators will be compared is selected using the “Select ESS” drop-down menu. Selection of an ESS also updates the CICES section and class names to the right of the drop-down menu.

Measures to be included in the comparison are selected by clicking on boxes in the “Select Measures to include in Comparison” checkbox list. After the comparison is given a name in the “Comparison Name” field, the comparison is created by clicking on the “Create Comparison” button. This creates a new comparison on the Before/After Comparisons tab. There is no limit to the number of comparisons that can be created.

## 5.7 Before/After Comparisons

The Before/After Comparisons tab provides a template for comparison of indicator values based on choices made in other tabs of Part IV-Impact Evaluation.

All of the comparison created using the Before/After Configuration tab are available for selection using the “Select Comparison” drop-down menu.

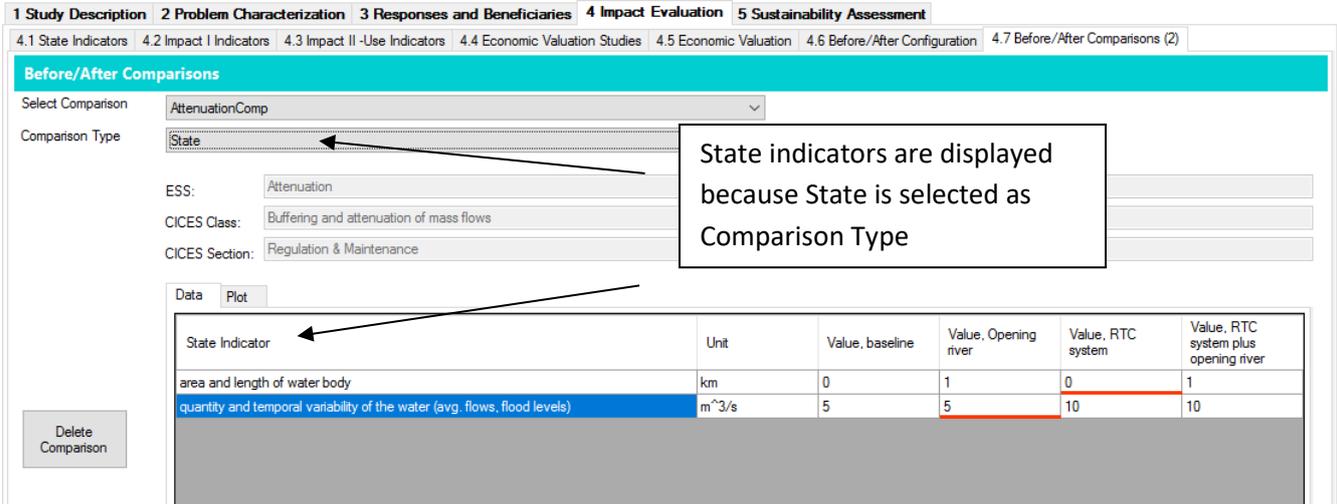


The screenshot shows the 'Before/After Comparisons' tab in a software interface. It includes a 'Select Comparison' dropdown menu with 'AttenuationComp' selected, a 'Comparison Type' dropdown with 'AttenuationComp' and 'ExperientialComp' options, and fields for 'ESS: Attenuation', 'CICES Class: Buffering and attenuation of mass flows', and 'CICES Section: Regulation & Maintenance'. A callout box points to the ESS field with the text: 'In this case, two comparisons have been created.' Below these fields is a table with 'Data' and 'Plot' tabs. The table has columns for 'State Indicator', 'Unit', 'Value, baseline', 'Value, Opening river', 'Value, RTC system', and 'Value, RTC system plus opening river'. The data rows are:

State Indicator	Unit	Value, baseline	Value, Opening river	Value, RTC system	Value, RTC system plus opening river
area and length of water body	km	0	1	0	1
quantity and temporal variability of the water (avg. flows, flood levels)	m <sup>3</sup> /s	5	5	10	10

After selecting a comparison, the ESS Name, CICES Class, and CICES Section are displayed in the fields below.

Indicator values are compared in a table. The type of indicator displayed depends on the selection in the “Comparison Type” field. All four indicator types (State, Impact I-Provision, Impact II-Use, and Economic valuation) can be displayed for ESS that have been classified as Final. Only State and Impact I-Provision indicators can be displayed for ESS that have been classified as Intermediate.

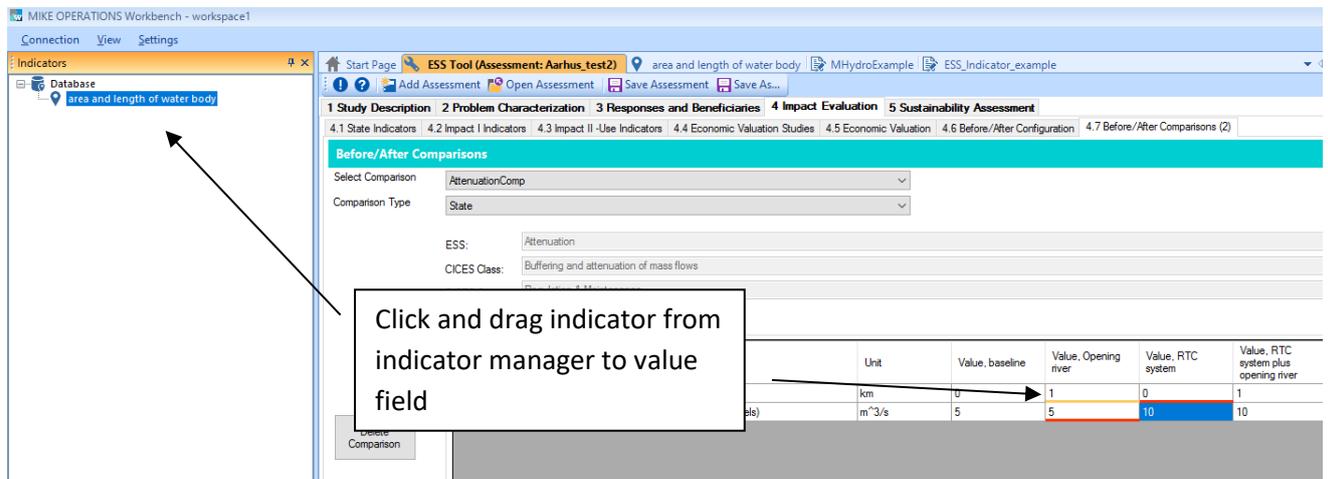


State Indicator	Unit	Value, baseline	Value, Opening river	Value, RTC system	Value, RTC system plus opening river
area and length of water body	km	0	1	0	1
quantity and temporal variability of the water (avg. flows, flood levels)	m <sup>3</sup> /s	5	5	10	10

The comparison includes both Data and Plot tabs. The Data tab displays the name of indicators or economic valuation methods that were selected in earlier sections of the Part IV workflow. The other fields in the table must be filled out by the user. The Unit field is filled out by the user using text entry. The Value field displays indicator values for a baseline scenario and for the alternatives that were selected when the comparison was created on the Before/After Configuration tab.

Values can be inserted in the Value fields by text entry or by using indicators that have been defined using the MIKE Workbench indicator manager. The second option is only available if using the MIKE Operations version of MIKE Workbench, which requires a license.

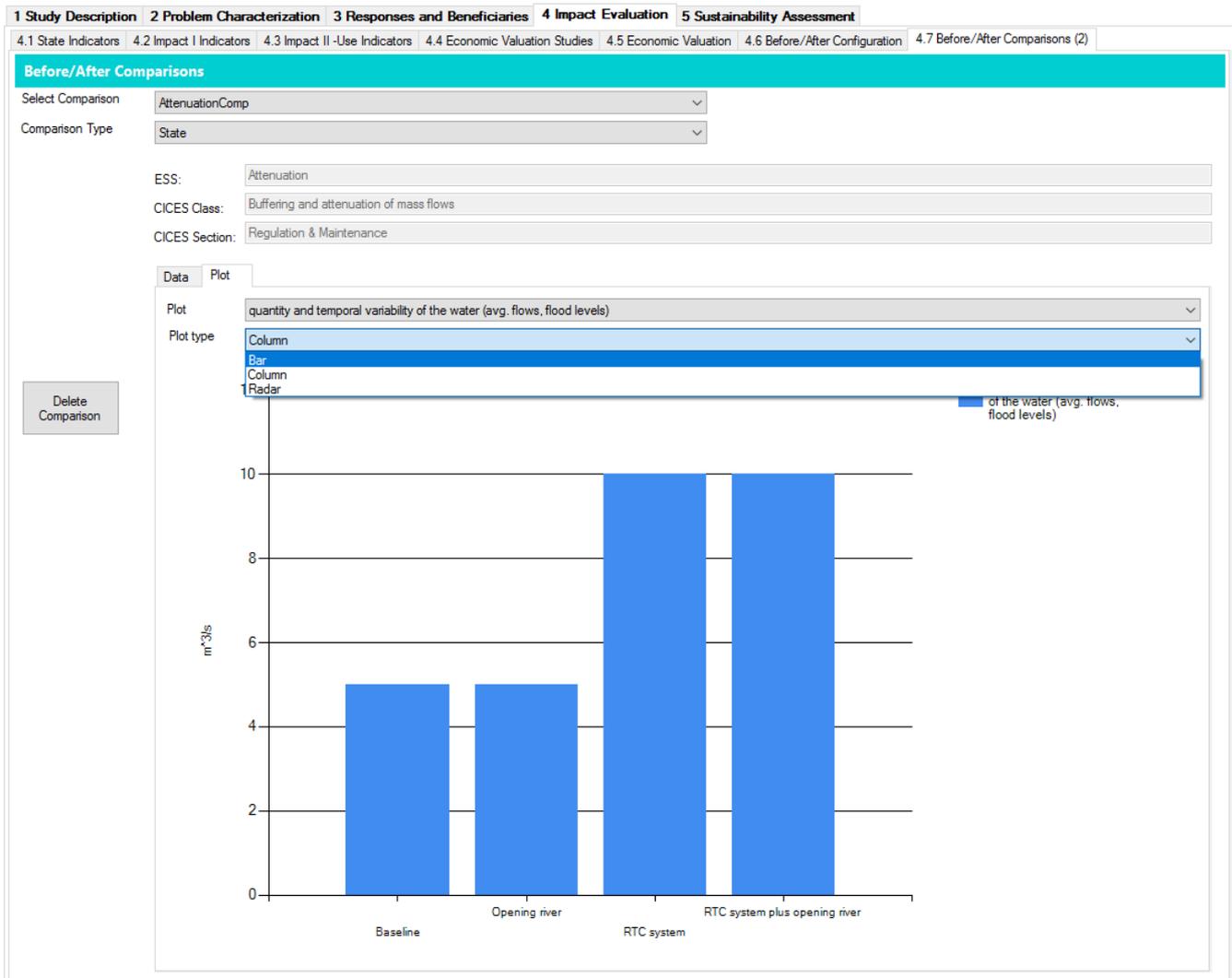
To link an indicator value to an indicator that has been defined using the MIKE Workbench indicator manager, click and drag the indicator from the indicator manager to the value field. The value field will be highlighted in yellow, which indicates a link to the indicator manager.



Unit	Value, baseline	Value, Opening river	Value, RTC system	Value, RTC system plus opening river
km	0	1	0	1
m <sup>3</sup> /s	5	5	10	10

If an indicator was not defined for a particular measure, then the value field for that indicator/measure combination is highlighted in red. Indicators values that are not defined are set to the baseline value for that indicator, which is based on the assumption that the measure does not affect the value of the indicator.

The Plot tab enables visual comparison of indicator values. Bar, Column, and Radar plot types are available. It is only possible to compare one indicator at a time. The indicator to be compared is selected from the “Plot” drop-down menu.



A comparison can be deleted by clicking on the “Delete Comparison” button. This will cause the comparison to be removed from the “Select Comparison” drop-down list.

## 6 Sustainability Assessment

The DESSIN Sustainability Assessment (SA) supplements the ESS evaluation by broadening the analysis to put the evaluated changes in ESS into perspective by considering multiple dimensions. These multiple dimensions include wider social, environmental, financial, governmental, and asset performance aspects of the alternatives under consideration. This allows for the consideration of potential disadvantages like costs and environmental effects (e.g. additional greenhouse gas emissions) together with advantages such as benefits expected from implementing a measure.

### 6.1 Configuration

The Configuration tab is used to define basic characteristics of the SA. The proposed measures must be categorized as either water supply or wastewater measures using the “System Type” radio buttons. A brief description of the system in which the measures will be deployed is provided in the “Description” field. The start year for the assessment is provided in the “Start year” field. Future time points for which SA indicator values will be estimated can be specified in the “Snapshot Times in years” field. There is no limit to the number of future snapshot times that can be defined. Measures to be included in the SA are selected using the “Measures” checkbox list.

### 6.2 Time scales

The Time scales tab is used to specify start-up times for each of the measures included in the SA. Start-up times are entered manually in the “Start Time” field.

The purpose of specifying start-up time is informational only and exists to help the user maintain consistency in comparing measures at different points in time. Start-up times are not used anywhere else in the SA workflow.

### 6.3 Indicators

The Indicators tab is used to select indicators that will be used in the SA. The Indicators tab is also used to specify indicator properties that affect how indicator values are displayed and compared in other parts of the Part V workflow.

SA indicators are selected from the SA indicators list, which was developed as part of the DESSIN Cookbook. The SA indicators list groups indicators into five dimensions: Assets, Environmental, Financial, Governance, and Social. Each dimension is further subdivided into “objectives” and “criteria”. More information about the SA indicators and indicator categories is available in the DESSIN Cookbook and Cookbook Companion Document.

Indicators are selected from the “Select/Specify Indicator” drop-down menu. The list of available indicators changes depending on the selections in the “Select Dimension”, “Select Objective”, and “Select Criterion” fields. It is also possible to create a user-defined indicator by selecting “Other”. If “Other” is selected, the “Metric”, “Indicator”, and “Unit” fields become active and the user must provide values for these fields.

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**Indicators**

Select Dimension: Assets (A)

Select Objective: A1 - Technology/Solution reliability, adequacy, resilience, and safety (A1)

Select Criterion: A11 - Technology / solution reliability, adequacy, resilience and safety

Select/Specify Indicator: Other - -

Metric:  Data available:  Yes  No

Indicator:  Regulatory threshold:

Unit:  Target value:

Dimensio	Objective	Criterion	Id	Metric	Indicator	System	Unit	Threshold	Type	Target Value
Social (S)	S1 - Quality of life enhancem	S12 - Economic impact creation	S121	Economic impact (incl. Indirect and induced impacts) derived from initial spending for the solution itself	(Economic impact - initial spending) / economic impact	WW/WS	{-}	<input checked="" type="checkbox"/>		1000000
Governan (G)	G1 - Complianc	G11 - Complianc with relevant regulatio	G111	Compliance improvement w/ relevant EU standards (WFD, BWD)	water status reached / water status level required	WW/WS	{-}	<input type="checkbox"/>		
Social (S)	S1 - Quality of life enhancem	S11 - Health and Safety	S111	Presence of microbial pathogens		WW/WS	{-}	<input checked="" type="checkbox"/>	0.05	Maximum

Metric, Indicator, and Unit fields become active when Other is selected

After an indicator is selected, properties must be specified that affect how indicators are displayed and compared later in the SA workflow. The “Data available” radio buttons are used to indicate whether data are available for quantifying indicator values. If Yes is selected, then the indicator is included in the Quantitative Assessment while if No is selected, the indicator becomes part of the Qualitative Assessment. The “Regulatory threshold” and “Target value” fields are used to normalize indicator values for comparing different indicators on the Compare Indicators tab. If a regulatory threshold (i.e., a minimum or maximum) exists for an indicator, then the threshold value should be provided and users should indicate whether the threshold is a minimum or a maximum using the accompanying radio buttons. If a target value exists, then that value should be given in the “Target value” field. Details of how these values are used to normalize indicators are provided in the documentation of the Compare Indicators tab.

New indicators are added to the “Indicators” list by clicking on the “Add to Table” button.

## 6.4 Quantitative Assessment

The Quantitative Assessment tab is used to compare indicators for which data are available to support quantitative estimation of indicator values.

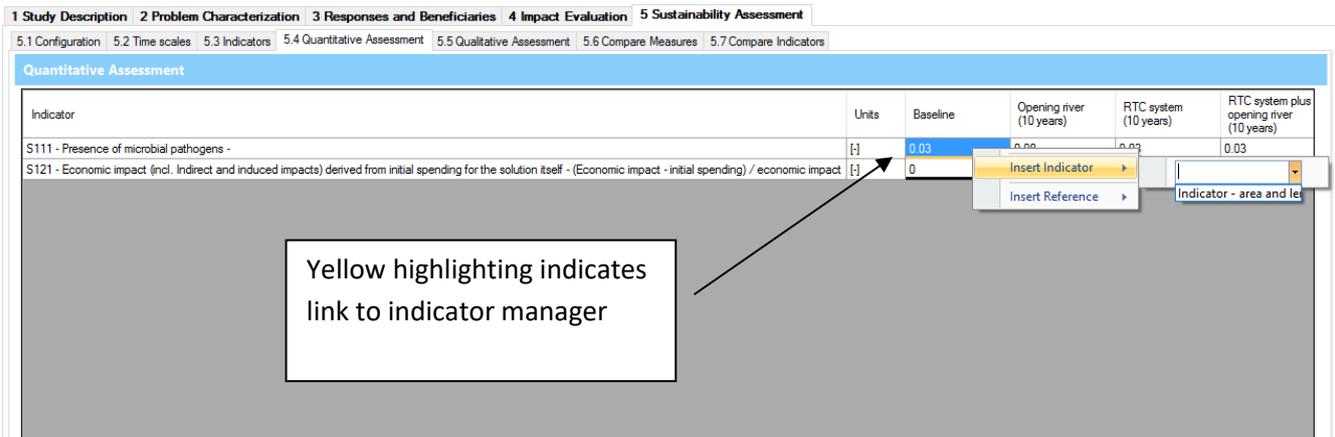
Indicators values are compared in a table. The table displays the name of indicators that were selected on the Indicators tab. The Unit field is carried over from the Indicators tab. The Value must be filled out by the user.

The Value field displays indicator values for a baseline scenario and for the alternatives that were selected when the comparison was created on the Configuration tab. In addition, indicator values are displayed for each of the snapshot times defined in the Configuration tab. Snapshot time refer

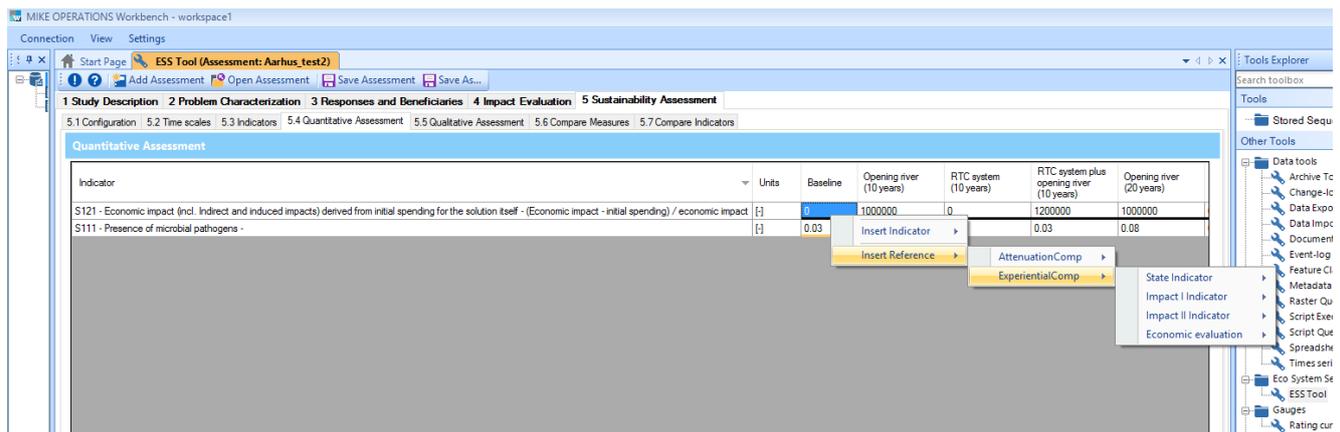
to the time since start-up (defined on the Time scales tab), and not the time since the beginning of the assessment (defined on the Configuration tab).

Values can be inserted in the Value fields in three ways: by text entry; by using indicators that have been defined using the MIKE Workbench indicator manager; or by linking to indicators that were defined in Part IV-Impact Evaluation. The second option is only available if using the MIKE Operations version of MIKE Workbench, which requires a license.

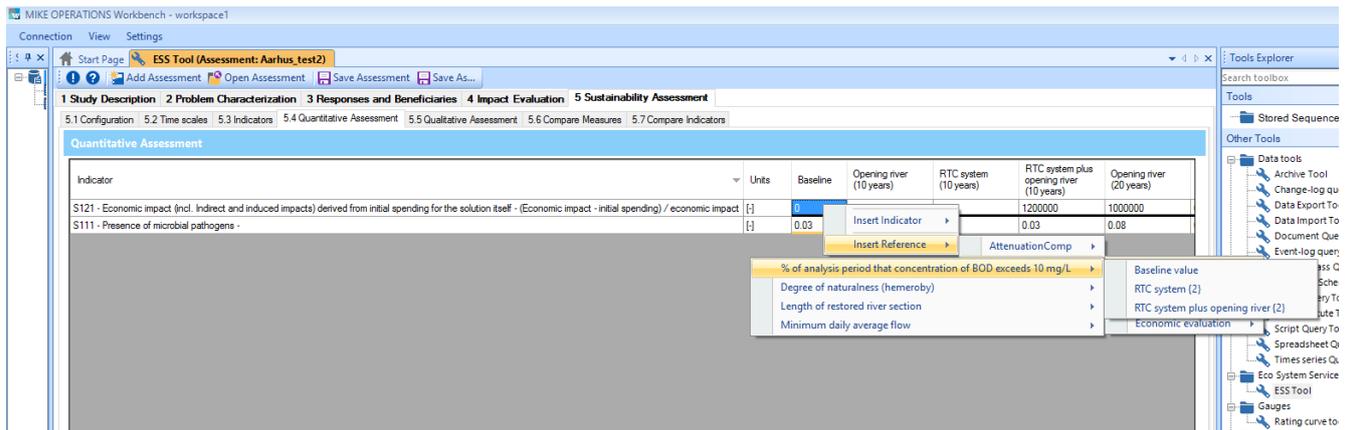
To link an indicator value to an indicator that has been defined using the MIKE Workbench indicator manager, right-click in the value field and select “Insert Indicator”. A drop-down menu will appear with a list of indicators available for selection. The value field will be highlighted in yellow, which indicates a link to the indicator manager.



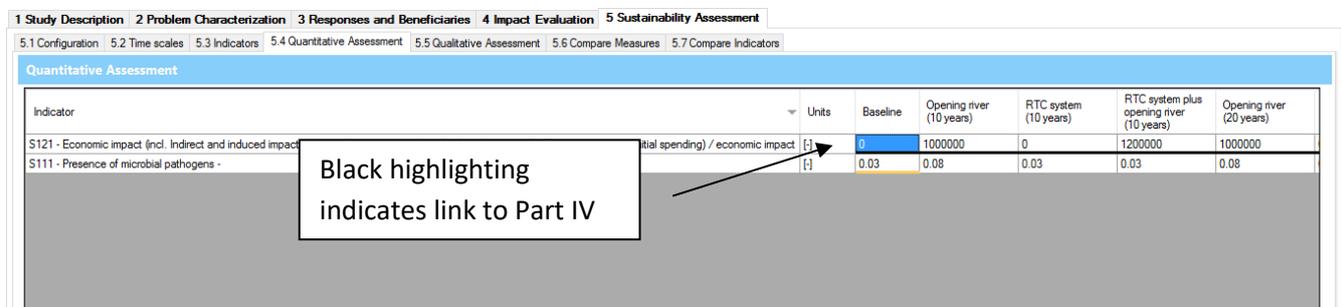
To link an indicator value to an indicator that was defined in Part IV-Impact Evaluation, right-click in the value field and select “Insert Reference”. A drop-down menu will appear with a list of comparisons that were created on the Before/After Configuration tab. If a comparison is selected, another drop-down menu will appear with the different types of indicators available for selection.



Selecting an indicator type will open another context menu with list of indicator types. Selecting an indicator type will open a final context menu with a list of available values, which can be either the baseline value or a value defined for a particular measure. It is possible to link to any of these values.



Linking to a value from Part IV-Impact Evaluation will cause the value field to be highlighted in black.



## 6.5 Qualitative Assessment

The Qualitative Assessment tab is used to compare indicators for which data are not available to support a quantitative analysis.

The qualitative assessment is different from the quantitative assessment in that qualitative indicators are not scalar values. Instead, qualitative indicator categories are distributed over the study area.

To assign qualitative indicator values, the user should click on one of the qualitative indicator fields. This will cause a pop-up window to appear displaying five qualitative categories: Strong Negative, Negative, Neutral, Positive, and Strong Positive. To the right of each category label is a text-entry field in which the user is prompted to enter the percentage of the study area that should be assigned to each category. The sum of the five entries must add up to 100.

The Qualitative Assessment tab also provides a text entry field immediately to the right of the indicator definition that allows the user provide more information about the indicator and/or the area of the system over which the qualitative indicators are defined.

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Qualitative Assessment

Indicator	Opening river (10 years)	RTC system (10 years)	RTC system plus opening river (10 years)	Opening river (20 years)	RTC (20 years)
G111 - Compliance imp...	StrongNegative: 20 Negative: 40 Neutral: 40 Positive: 0 StrongPositive: 0	StrongNegative: 5 Negative: 10 Neutral: 85 Positive: 0 StrongPositive: 0	StrongNegative: 5 Negative: 10 Neutral: 85 Positive: 0 StrongPositive: 0	StrongNegative: 20 Negative: 40 Neutral: 40 Positive: 0 StrongPositive: 0	StrongNegative: 20 Negative: 40 Neutral: 40 Positive: 0 StrongPositive: 0

Quality Value Editor

Edit the percentages - must add up to 100

Strong Negative (%)

Negative (%)

Neutral (%)

Positive (%)

Strong Positive (%)

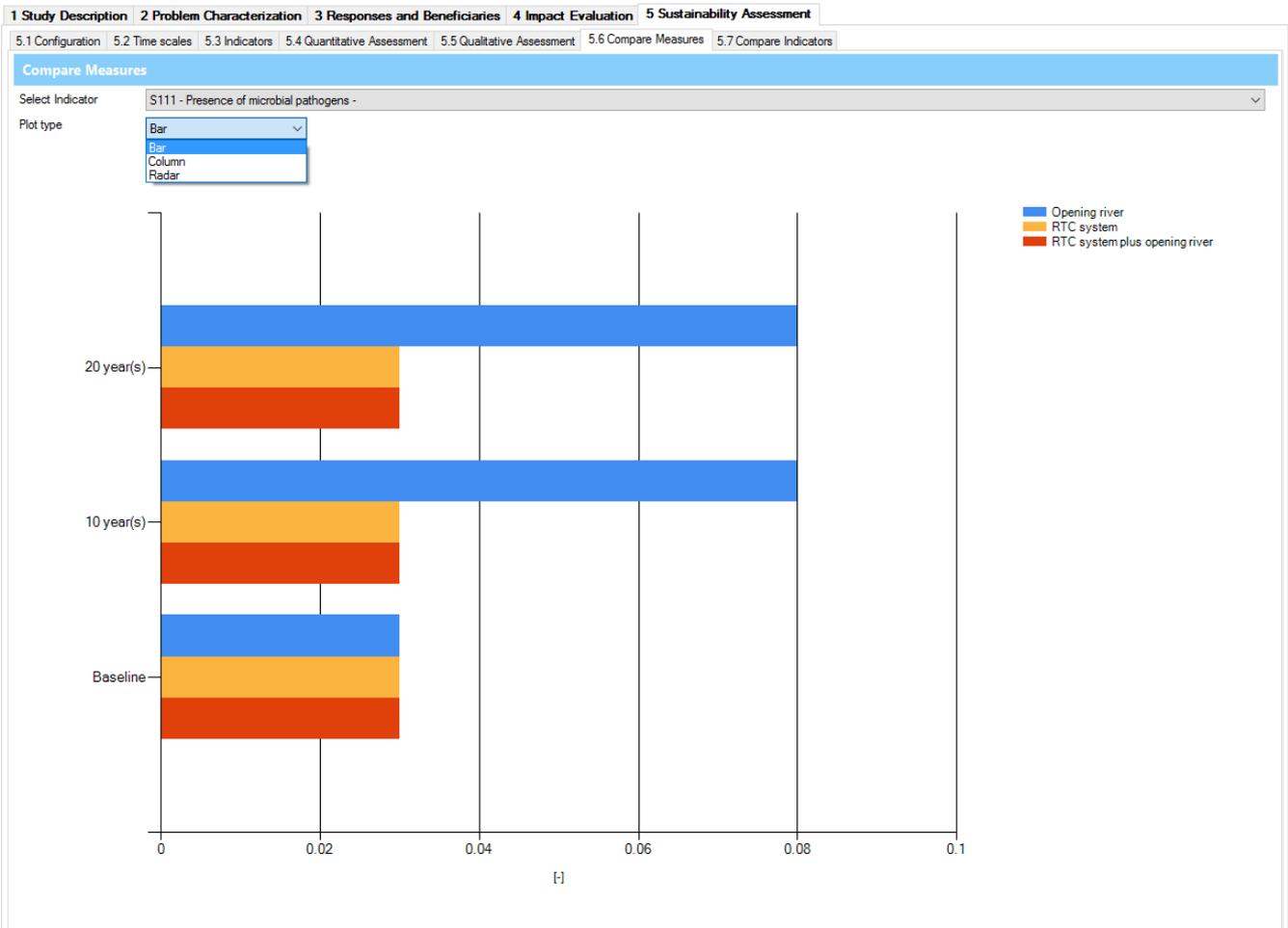
OK Cancel

Sum of entries must add up to 100

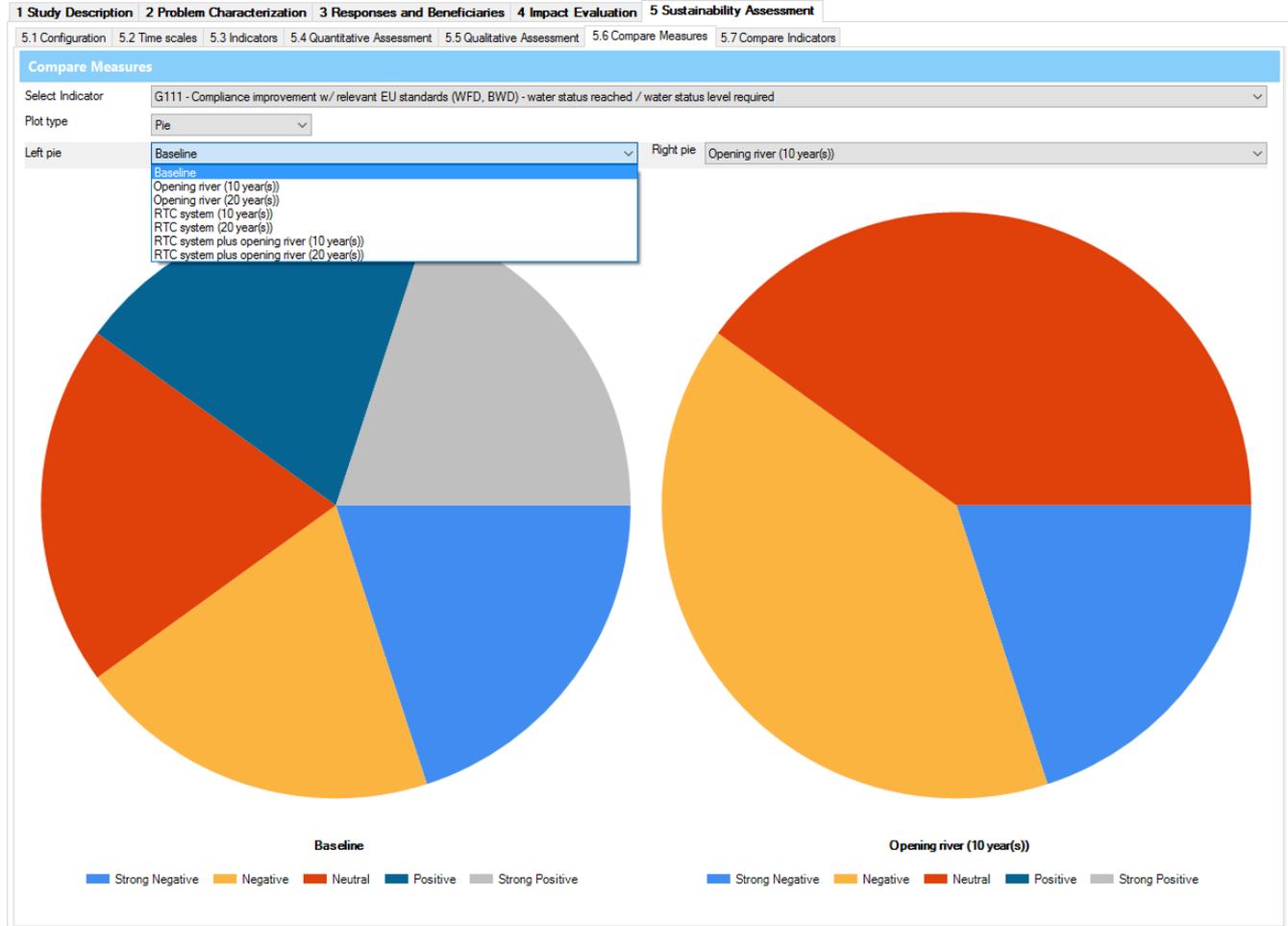
## 6.6 Compare Measures

The Compare Measures tab is used for visual comparison of indicator values. The tools available for comparison change depending on whether quantitative or qualitative indicators are being compared.

If a quantitative indicator is selected, bar, column, and radar plots are available for comparing values.



If a qualitative indicator is selected, then pie or doughnut charts are available for displaying results. It is only possible to display two charts at once. Results to display in each pie/doughnut chart are selected from the drop-down menus labeled “Left pie” and “Right pie”.

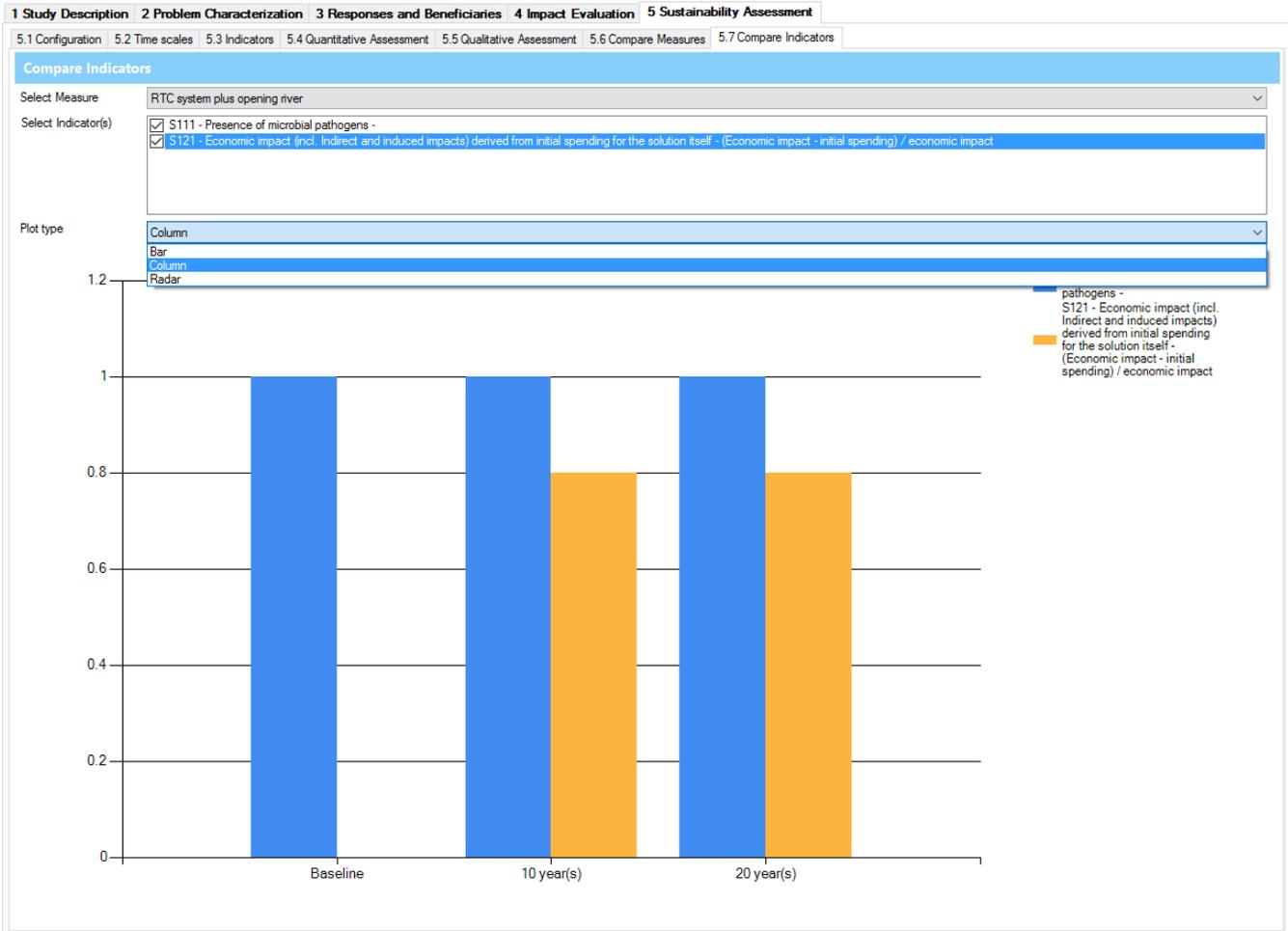


## 6.7 Compare Indicators

The Compare Indicators tab provides functionality for comparing different indicator types. Only quantitative indicators can be compared.

Comparison of different indicator types requires normalization to a common scale. The proposed approach normalizes values to either a regulatory threshold or a target value. If both a regulatory threshold and a target value are defined for a particular indicator, then the target value is used in the normalization.

Indicators can be compared using bar, column, and radar plots.



### 6.7.1 Normalization to a regulatory threshold

A regulatory threshold can be either a minimum or a maximum value. If the threshold is a maximum, then the indicator is computed as follows:

*Let  $X$  = set of indicator values*

*Let  $x_i$  = value of indicator  $i$*

*Let  $x_{reg}$  = regulatory threshold*

*Let  $X^*$  = subset of  $X$  with values greater than  $x_{reg}$*

*Let  $x_{max}^*$  = maximum value of  $X^*$*

*Let  $x_{norm,i}$  = normalized indicator value for indicator  $i$*

$$\text{Then } x_{norm,i} = \frac{x_{max}^* - x_i}{x_{max}^* - x_{reg}} \text{ if } x_i \in X^*, 1 \text{ otherwise}$$

If the threshold is a minimum, then the indicator is computed as follows:

*Let  $X$  = set of indicator values*

*Let  $x_i$  = value of indicator  $i$*

*Let  $x_{reg}$  = regulatory threshold*

*Let  $X^*$  = subset of  $X$  with values lesser than  $x_{reg}$*

*Let  $x_{min}^*$  = minimum value of  $X^*$*

*Let  $x_{norm,i}$  = normalized indicator value for indicator  $i$*

*Then  $x_{norm,i} = \frac{x_i - x_{min}^*}{x_{reg} - x_{min}^*}$  if  $x_i \in X^*$ , 1 otherwise*

### 6.7.2 Normalization to a target value

If a target value has been defined, then the indicator is estimated as follows:

*Let  $X$  = set of indicator values*

*Let  $x_i$  = value of indicator  $i$*

*Let  $x_{tar}$  = target value*

*Let  $x_{max}$  = member of  $X$  with maximum absolute distance from  $x_{tar}$*

*Let  $x_{norm,i}$  = normalized indicator value for indicator  $i$*

*Then  $x_{norm,i} = 1 - \frac{|x_i - x_{tar}|}{|x_{max} - x_{tar}|}$*



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