



Meso-level eco-efficiency indicators to assess technologies and their uptake in water use sectors

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**Economic Value chain Analysis Tool –
EVAT**

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Abstract

The Economic Value chain Analysis Tool (EVAT) is described as a flexible tool to perform economic assessments across the analyzed value chains. EVAT focuses on the economic component of the eco-efficiency indicators and on the analysis of potential distributional effects among the actors involved in the studied systems.

The finalized version of the EVAT was released in Month 25 of the EcoWater Project (November 2013). The tool can be downloaded by all registered users from the EcoWater Toolbox web site:

<http://environ.chemeng.ntua.gr/EWToolbox/Toolbox/Resources.aspx>

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1 Introduction

The Economic Value chain Analysis Tool (EVAT) is a tool which extends the information included in a SEAT model incorporating economic data. It supports the assessment of the economic performance of alternative technological configurations of a meso-level water use system and provides the monetary flows that can be used for estimating the economic performance of the system.

EVAT allows the development of a representation of the value chain, the various actors involved and their interactions. The actors are divided into directly and indirectly involved, and emphasis is placed on their role/function. Each directly involved actor is responsible for the operation, maintenance and investment decisions for at least one stage, whereas indirectly involved actors (e.g. river basin management authorities, government agencies etc.), intervene through the setting of rules/standards, the offer of incentives, etc. The value chain monitors the added value to the final product due to water use from stage to stage and can be described using monetary quantities (i.e. €).

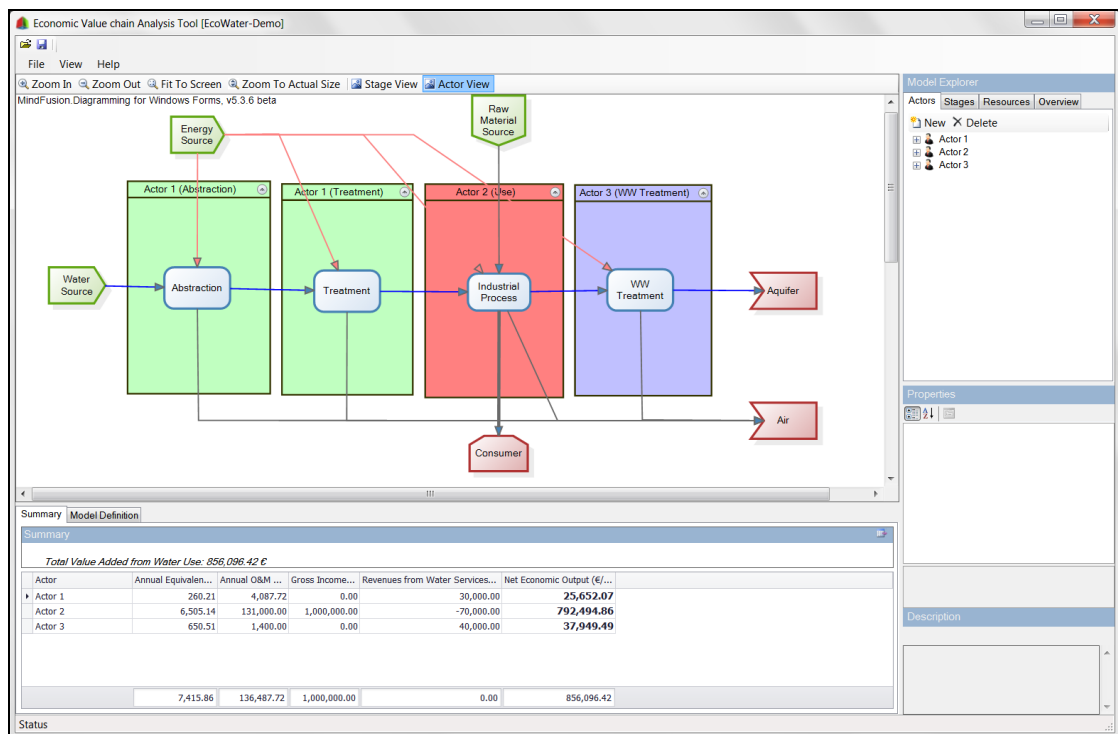


Figure 1. The EVAT modeling environment

1.1 Functionalities

The main functionalities of EVAT are:

- Management of the relevant actors
The user specifies the actors involved in the water service system and assigns the relevant stages to each actor.
- Categorization of resources

All resources are categorized, according to their type, into one of the following categories: (i) Water service related materials, (ii) productive inputs, (iii) emissions and (iv) products/services and by-products.

- Specification of financial costs and revenues
The user specifies the financial costs incurred in the system's processes and the incomes generated from products or services.
- Analysis of economic interactions among actors
All interactions and costs of services between actors are identified.
- Calculation, presentation and reporting of the results
The software calculates the Total Added Value from water use to the product and the Net Economic Output per actor. All results are presented either per stage or per actor.

The following sections briefly present the main methodological concepts used in EVAT and its main functionalities. More information can be found in the tutorials (presentation and video) available at the EcoWater Toolbox web site:

<http://environ.chemeng.ntua.gr/EWToolbox/Toolbox/Help.aspx>

1.2 System Requirements

EVAT is a Windows Applications developed with the Visual Basic .NET programming language. The software requirements are:

- a. Microsoft® Windows XP Service Pack 2 (32bit or 64bit), Microsoft® Windows Vista (32bit or 64bit) or Microsoft Windows 7 (32bit or 64bit) and
- b. NET framework 4.0.

2 Concepts

The economic performance indicator used in EVAT is the **Total Value Added** (TVA) to the product due to water use, expressed in monetary units per period, usually per year (€/year). It is estimated as:

$$TVA = EVU + VP_{BP} - TFC_{WS} - TFC_{WW} - FC \quad (1)$$

where:

- EVU* Total economic value from water use;
- VP_{BP}* Income generated from any by-products of the system;
- TFC_{WS}* Total financial cost related to water supply provision for rendering the water suitable for the specific use purpose;
- TFC_{WW}* Total financial cost related to wastewater treatment; and
- FC* Annual equivalent future cash flow generated from the introduction of new technologies in the system.

The **Economic Value from Water Use** (*EVU*) refers to the total benefits from direct use of water. The approach followed for estimating *EVU* depends on whether the water is used as a resource in a production process (e.g. water use in industrial and agricultural sectors), or delivers a service to the customers (e.g. water use in urban sector).

In the first case, *EVU* is estimated using the **residual value approach**:

$$EVU = TVP - EXP_{NW} \quad (2)$$

where

$$TVP = \sum_p f_p \times p_p \quad (3)$$

is the **Total Value of Products**, and

$$EXP_{NW} = \sum_r f_{r,3} \times c_r + \sum_e f_{e,3} \times c_e \quad (4)$$

are the **Non-Water Expenses** representing the expenses for all the non-water inputs as well as the costs related to emissions in the water use stage.

In the second case the estimation of the economic value from water used is based on the customers' willingness to pay for the water services. Based on the assumption that the level of water services provided will not change as a result of technology implementation (i.e. the application of a technology or management practice will not result in supply interruptions or render the quality of water unsuitable for the specific purpose) and that the total utility (the overall satisfaction of wants and needs) does not change between scenarios, the economic value from water use can be estimated by:

$$EVU = EVU^{bl} = WTP \times f_{w,2-3}^{bl} \quad (5)$$

where:

WTP The consumers' willingness to pay for the services provided (defined as the maximum amount a consumer would be willing to pay in order to receive a reliable and adequate water supply).

$f_{w,2-3}^{bl}$ The total quantity of water supplied to the processes of water use stage in the baseline case, as denoted by the superscript *bl*.

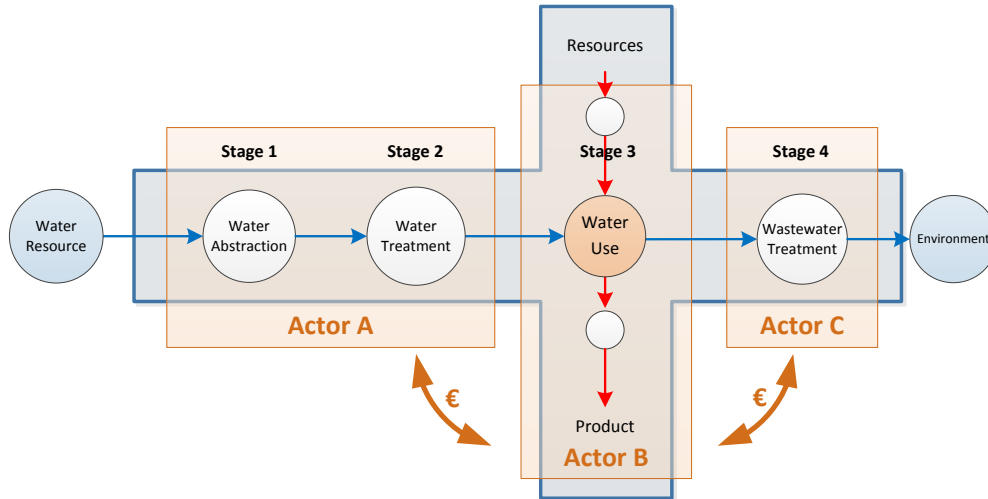


Figure 2: The meso-level water use system.

The **Total Financial Cost related to Water Supply** (TFC_{WS}) represents the expenses in the processes of water abstraction and water treatment stages (stages 1 and 2):

$$TFC_{WS} = \left(\sum_r f_{r,1} \times c_r + \sum_e f_{e,1} \times c_e \right) + \left(\sum_r f_{r,2} \times c_r + \sum_e f_{e,2} \times c_e \right) \quad (6)$$

and the **Total Financial Cost related to Wastewater Treatment** (TFC_{WW}) represents the expenses in the processes of wastewater treatment stage (stage 4):

$$TFC_{WW} = \sum_r f_{r,4} \times c_r + \sum_e f_{e,4} \times c_e \quad (7)$$

3 User Interface Elements

The main EVAT user interface elements (Figure 3) are the following:

(a) Menu Toolbar

It provides access to the most important functions of the program and consists of seven sub-menus:

- File menu: Provides the option for creating, opening, saving and managing a model, as well giving access to printing and exporting operations of both the model diagram and the model definition report.
- View menu: Allows altering the model diagram area, by toggling the grid, enlarging and decreasing the size of the diagram and setting the background color.
- Help menu: Gives access to the EVAT help system.

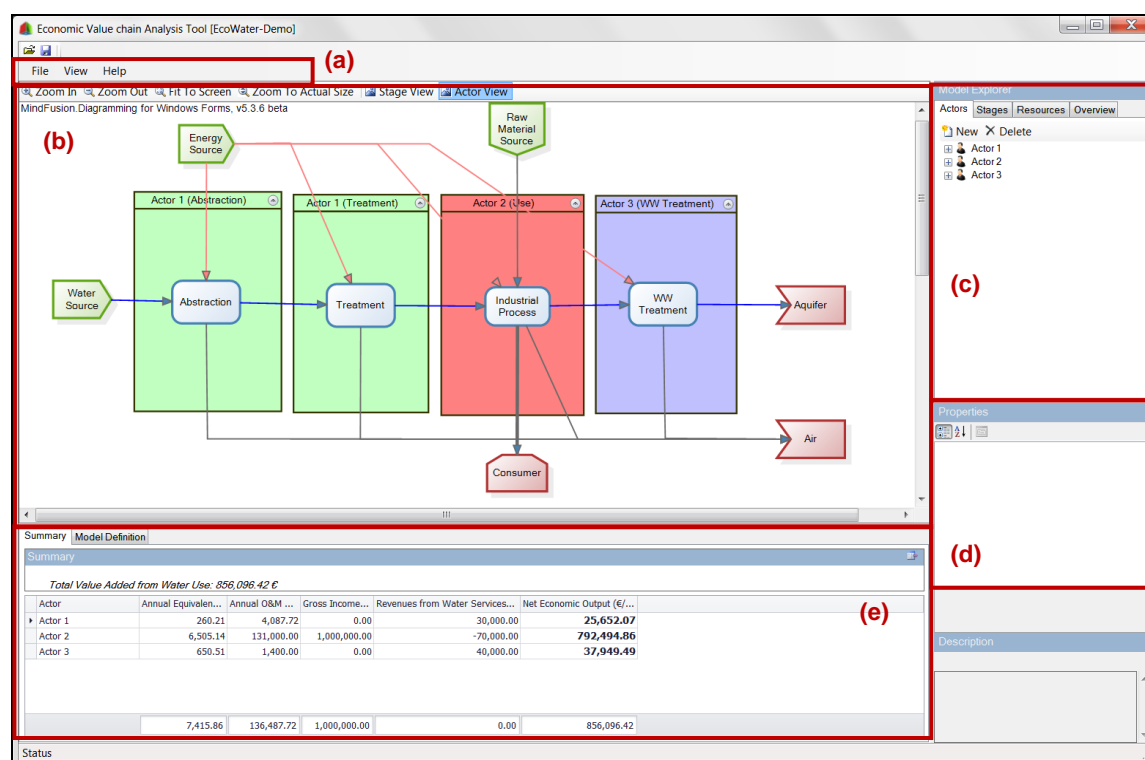


Figure 3. User Interface Elements

(b) Graphical Model Explorer

It is the main screen of EVAT, where the water value chain is presented. It allows the user to toggle between the “Stage View” and the “Actor View”.

(c) Model Explorer

It is located in the upper right corner of EVAT. The model explorer area is an active window which basically gathers all the model information. It contains four individual tabs, each serving a distinct purpose:

- The “Actor” tab, presenting all the actors of the system and allowing the user to add, edit or delete an actor.
- The “Stages” tab, presenting all the stages of the system as well as information for the responsible actor for the investment and the operation of each stage.
- The “Resources” tab, presenting all the resources of the model and allowing the user to categorize them according to their type to one of the following categories: (i) water service related materials, (ii) productive inputs, (iii) emissions and (iv) products/services and by-products.
- The “Overview” tab, showing an overview of the system model.

(d) Properties Editor

It presents all the properties of the model element that is selected either in the graphical model editor or in the model explorer.

(e) Model Specification Area

It includes four different categories of tabs:

- “Actor” Specification Tab
- “Cost Specification” Tabs
- “Results” Tabs and
- “Model Definition” Tab.

4 Managing Actors & Resources

4.1 Creating and Editing Actors

The creation of a new actor is achieved by navigating to the Actor Tab of the Model Explorer and pressing the “New” Button. Editing an actor involves the navigation to the Properties Editor and changing its name and its color (Figure 4).

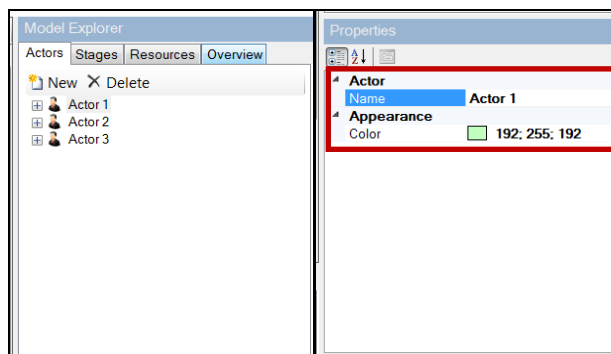


Figure 4. Creating and editing an actor

An actor responsible for the investments and for the operation and maintenance for each stage should be assigned.

For the selected stage in the Graphical Model Explorer, the user selects the relevant actor from the drop-down list in the “Specification” Tab (Figure 5).

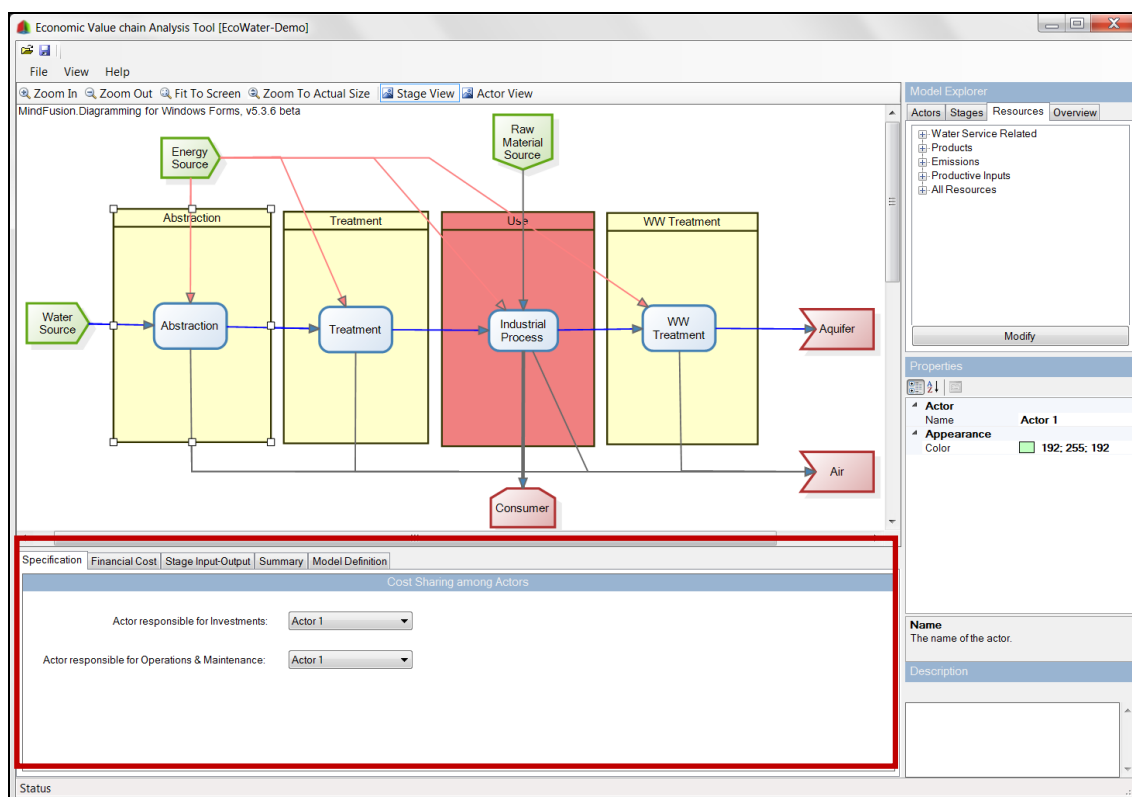


Figure 5. Assigning actors to the stages

4.2 Editing Resources

EVAT uses the resources defined by the user when creating the model in SEAT. In order to complete the economic analysis of the system, the user should classify all the resources in one (or more) of the following categories:

- Water service related resources
- Productive inputs
- Emissions and
- Products/services and by-products.

The screenshot displays the MindFusion Diagramming software interface. The main window shows a process flow diagram with stages: Abstraction, Treatment, Use, and WW Treatment. Resources are represented by boxes: Energy Source, Raw Material Source, and Water Source. A 'Resource Type Management' dialog box is open, allowing the user to assign categories to resources. The dialog box has two columns: a list of resources (Water, Energy, CO2, Product, Raw Material, Intermediate Product, Waste Water) and a list of categories (Water, Product, Emission, Productive Input) with checkboxes. The 'Water' category is checked for the 'Water' resource. The background shows a summary table with the following data:

Stage	Annual Equivalen...	Annual O&M ...	Annual Gross ...	Net Cash Flow (€/yr)
Abstraction	130.10	1,754.39	0.00	-1,884.49
Treatment	130.10	2,333.33	0.00	-2,463.44
WW Treatment	650.51	1,400.00	0.00	-2,050.51
Use	6,505.14	131,000.00	1,000,000.00	862,494.86
	7,415.86	136,487.72	1,000,000.00	856,096.42

Figure 6. Categorizing the resources

In order to categorize the resources, the user should navigate to the “Resources” Tab of the Model Explorer and press the “Modify” button. In the pop-up screen, a category should be assigned to each resource (Figure 6).

5 Specifying Costs

5.1 Specifying financial costs

In order to specify the financial costs, the unit cost for all the input and output flows of each stage must be defined in the Financial Cost Tab. Furthermore, the user may define an annual fixed operation & maintenance cost as well as one (or more) investment cost, with the respective lifetime and the interest rate.

The screenshot displays the Economic Value chain Analysis Tool (EcoWater-Demo) interface. The main window shows a process flow diagram with four stages: Abstraction, Treatment, Use, and WW Treatment. The 'Use' stage is highlighted in red and contains an 'Industrial Process' actor. Inputs include 'Water Source', 'Energy Source', and 'Raw Material Source'. Outputs include 'Aquifer' and 'Air'. A 'Consumer' actor is also shown. The 'Financial Cost' tab is active, showing investment and operations & maintenance costs.

Cost (€)	Lifetime (yrs)	Interest Rate (%)	Annual Investment Cost ...	Del
2,000.00	30.00	5.00	130.10	X

Operations & Maintenance Cost

Fixed cost (€/yr): 0

Cost of Productive Inputs:

Resource	From Node	To Node	Flow	Unit	Unit Cost (€/u...)	Cost (€/yr)
Energy	Energy Source	Abstraction	17,543.86	kWh	0.10	1,754.39

Figure 7. Specifying financial costs

5.2 Specifying income

By navigating to the Income Tab, the user can define the income generated from products, by-products or services for the selected stage.

5.3 Specifying cost of services between actors

In order to fully specify the economic data of a given system, the user must also specify the revenues and expenditures of each actor from selling and/or buying water service related materials. These data can be entered in the Water Service Tab of the selected actor, available in the Actor View of EVAT (Figure 8).

There are two different options for defining the unit price of each resource:

- Using a flat rate and/or
- Using a fixed or block volumetric rate

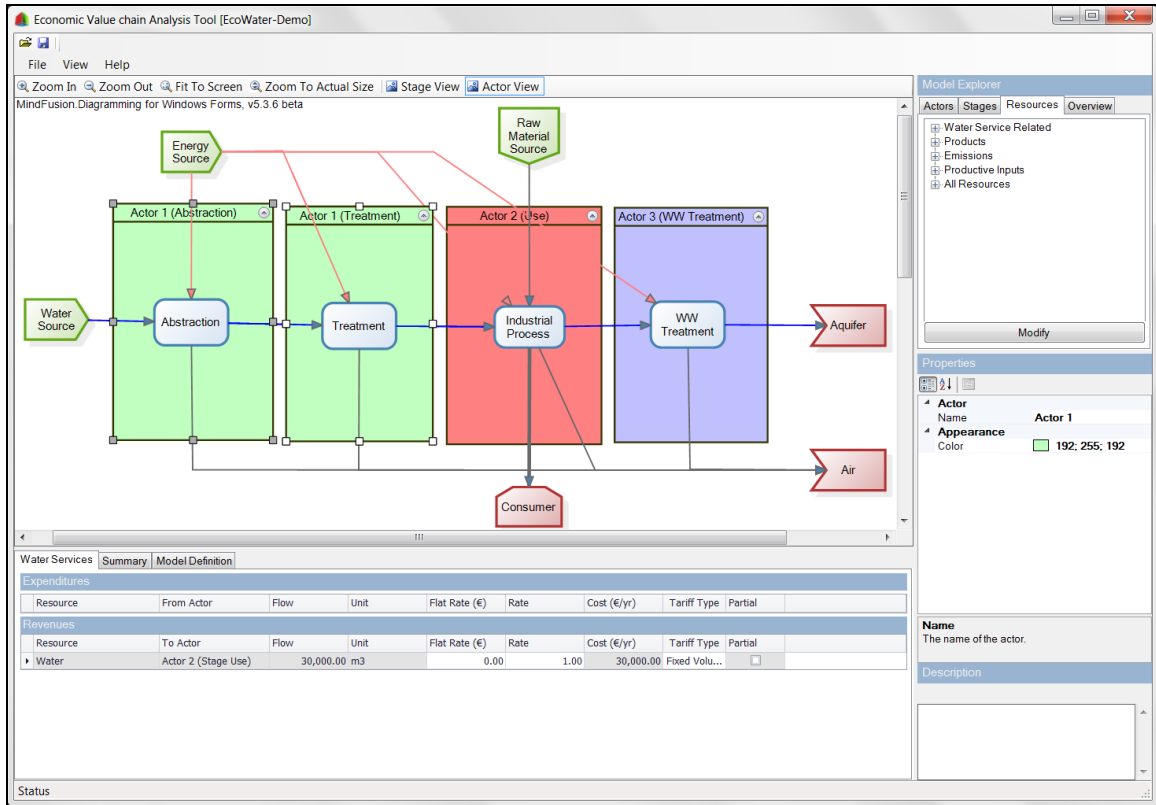


Figure 8. Specifying cost of services between actors

6 Results

The tool automatically calculates the Total Value Added from water use to the final product, the Net Economic Output per actor and the Net Cash Flow per stage.

The results tabs consist of two different tables:

- Summary per Stage (Figure 9). Presents the annual equivalent investment cost, the annual operation and maintenance cost, the annual gross income and the net cash flow for each stage and the Total Value Added for the system.
- Summary per Actor (Figure 10). Presents the annual equivalent investment cost, the annual operation and maintenance cost, the annual gross income, the revenues from water services and the net economic output for each actor as well as the Total Value Added for the system.

Both tables can be exported in a spreadsheet file, in a comma-separated value file or in a text file by clicking the button located in the upper right corner of the respective tab.

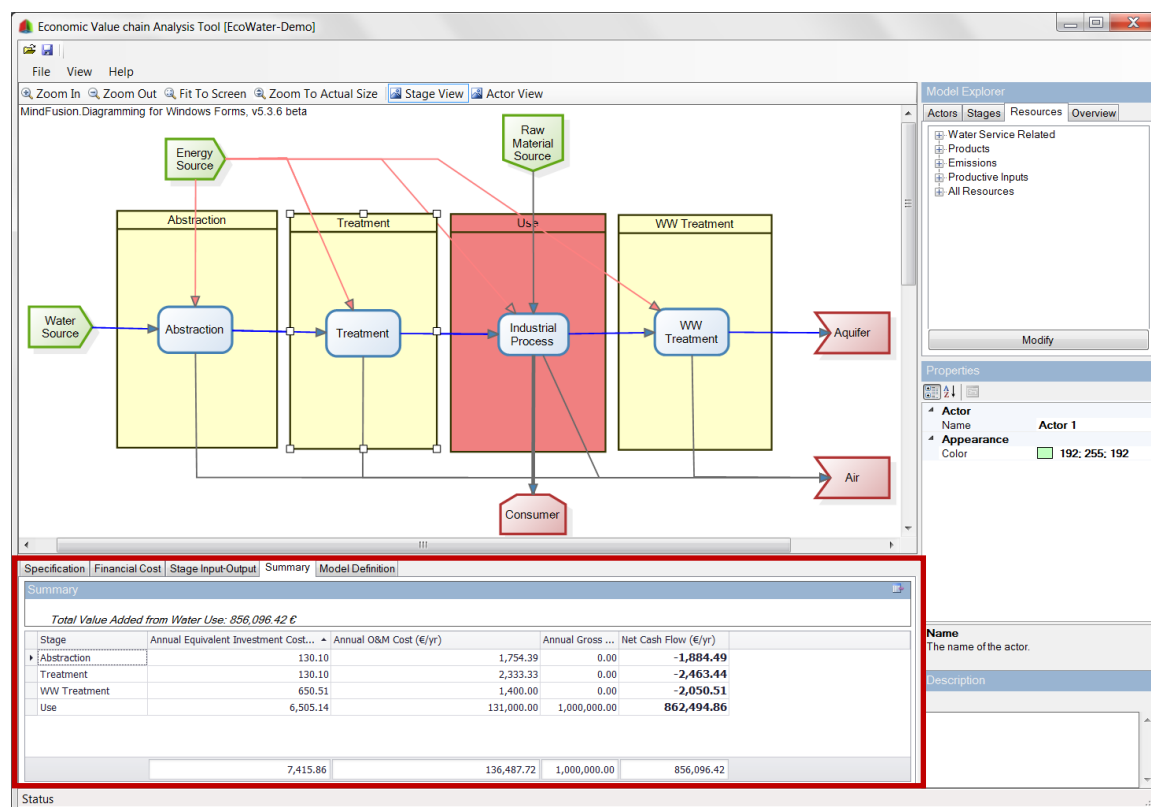


Figure 9. Summary per Stage

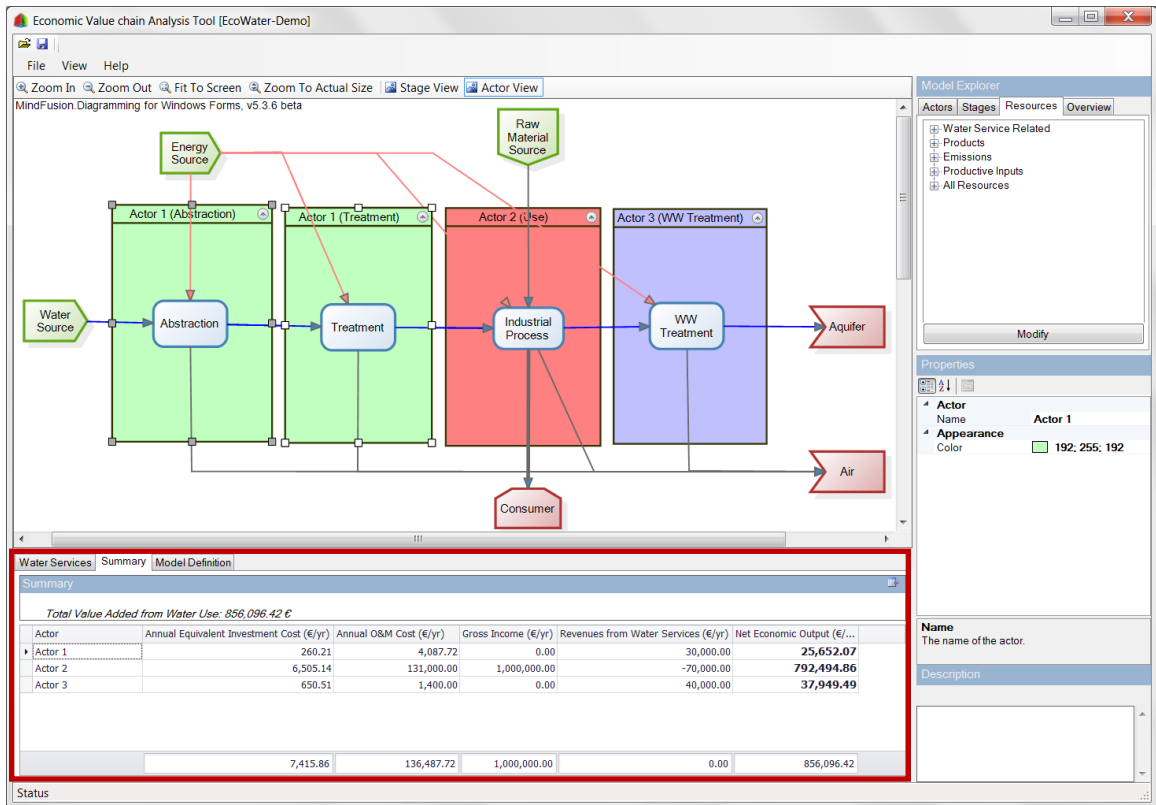


Figure 10. Summary per Actor