WaterStrategyMan
EVK1-CT-2001-00098

MANUAL OF THE INTEGRATED DECISION SUPPORT SYSTEM

Chapter Six

Water Allocation and Simulation Results

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The *Simulation* menu in the tree view of water management schemes, in the Manager Panel, is made up of three sub-menus: Overview, Cost Analysis and Detailed Results. By clicking on one of them, without distinction, the simulation of the WSM DSS runs, thus allocating the available water from resources to connected demand nodes. Then, according to the selected menu, a different simulation window opens.

The *Detailed Results* menu opens a window showing the results of the allocation in terms of indicators, each type of node or link having its own, which are both plotted and presented in tabular form. The Detailed Results window comprises of four panels which allow the DSS user to navigate among the indicators and network elements: 1) the navigation panel, 2) the map of the region, 3) the list of indicators and 4) the graphical and tabular view where results are presented.

Since the simulation runs at a monthly time step, most indicators are computed on a monthly basis. However, for many network elements they can be displayed either as monthly time series or as yearly aggregated values.

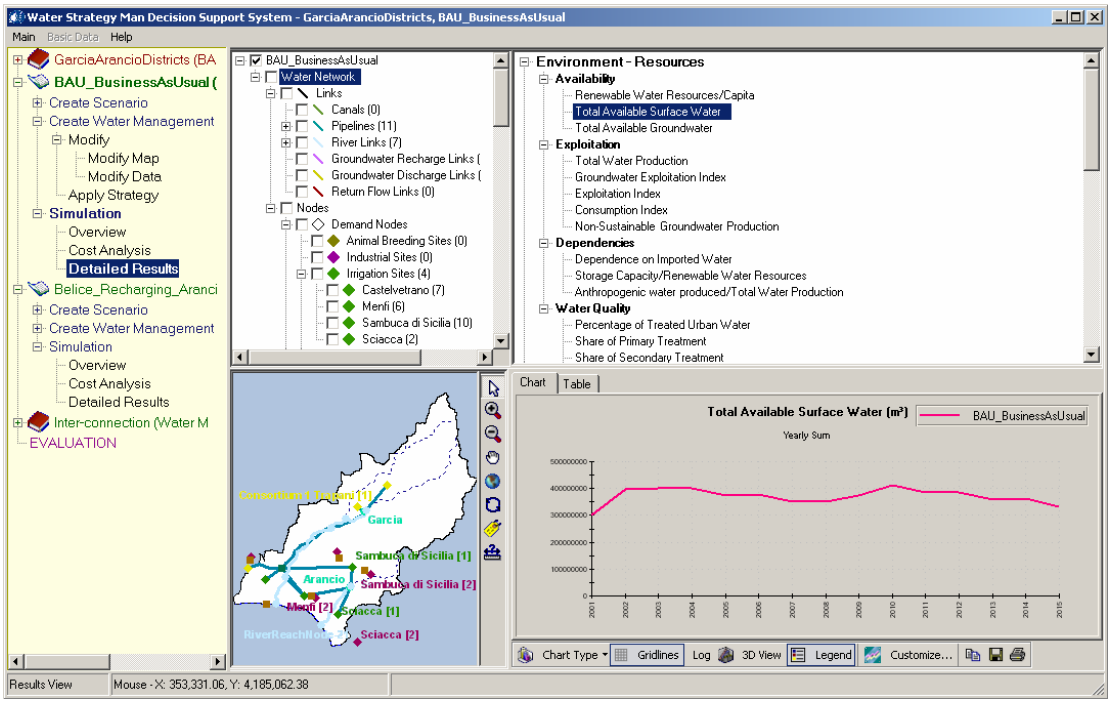

Figure 1. Opening the Detailed Results View

The list of indicators that are associated to a specific node or link is shown once the element has been checked on the Object Manager panel. Each indicator in the list can be plotted just for one node at a time or for some or for all the nodes of the same type that exist in the case study region. This is useful for comparing the same simulation output for different demand nodes of same category; for instance the time series of unmet demands for all the irrigation sites, or the BOD concentrations in some subsequent river reaches.

A list of indicators aggregated yearly and at regional level is also available, by checking the name of the current water management scheme at the top of the Object Manager panel. These regional indicators are divided into three main groups. *Environment and Resources* includes indicators about water availability, exploitation, dependencies on imported water and water quality, *Social Indicators* refer to consumption indices or abstractions per capita (being the pressures over the system), and to deficits, and finally the *Cost-Revenues* section address the economic results, such as direct and environmental costs, benefits on water use and rate of cost recovery. As far as the node-specific indicators are concerned, they are usually divided into the three classes of Water Quantity, Quality and Cost.

The *Chart Panel* of the Result View has some useful functionalities that permit the customization of the plot of indicators: it is possible to change the graph type, from lines to bars, or to use a logarithmic scale, or a 3D view, and the legend and gridlines of the graph can be put to visible or not. The *Customize* button has an important role as it modifies the time steps plotted: the DSS user can decide to show the detailed simulation output, monthly time series, or show yearly aggregation only. In case he is making an analysis for a particular season or for one-two months only, he can select them in the customize dialog box and decide also to view this information for the entire duration of the scenario or for preferred years only.

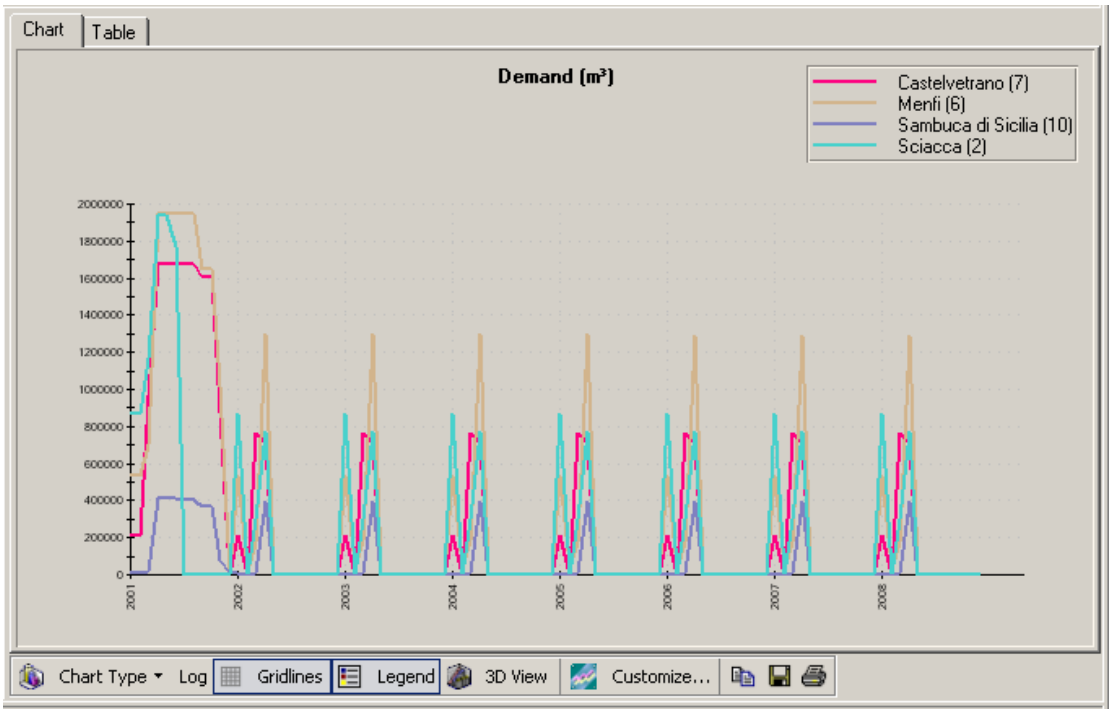

Figure 2. The Chart View displaying indicators

At the right side of the graphical tools, three buttons allow to copy the graph to the Windows clipboard, to save it as a JPEG image or to print it. These copy, save and print options can be useful in the analysis of the case study, mostly when there is the need to investigate results in many network users, to find inter-relations and causal effects

between them, and it is important to look simultaneously at the behaviour of many indicators.

The *Table Panel* of the Result View displays in a table the data plotted in the Chart View. Time steps are the columns of the table and the selected nodes are the rows. The two Chart and Table views are loaded as tabs in the same interface block and the DSS user can pass from one to the other by selecting the *Chart* or *Table* tab. The Customise option operates on the tabular data as well.

Once the chart and table have been customized, either the graph types and the time steps to be visualized, the format remains the same while the Result View is open, whatever indicator is loaded, so an overall analysis of a targeted period can be performed just by selecting the different simulation outputs.

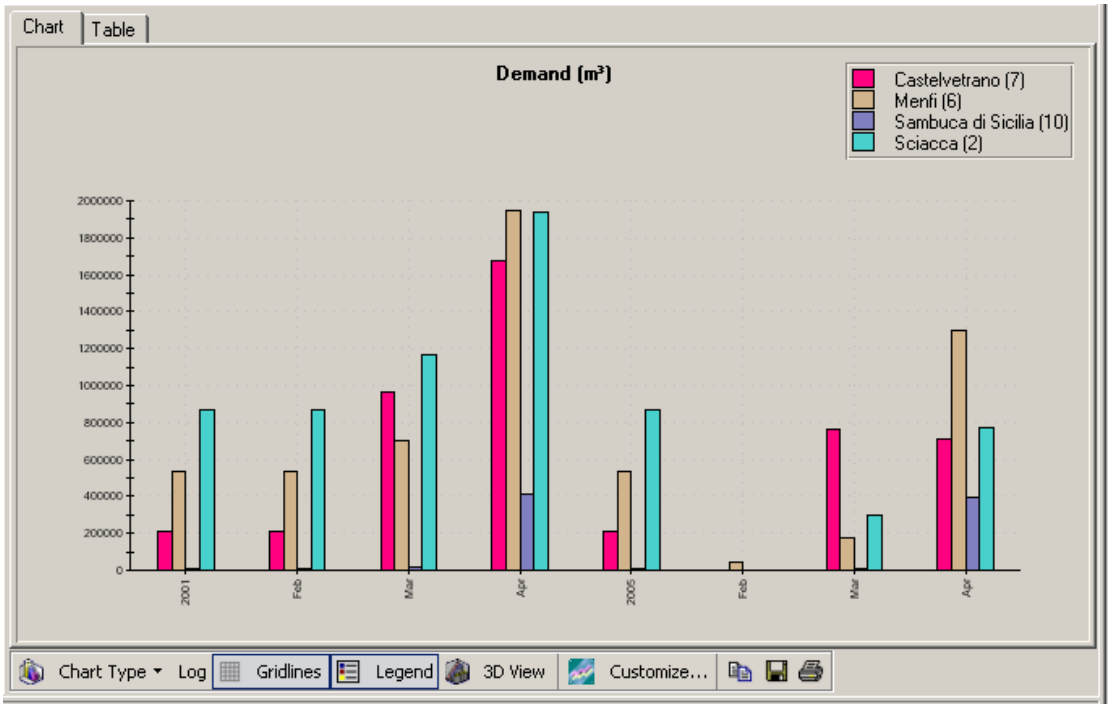

Figure 3. The Customize functionality: comparing results for January-April seasons of years 2001 and 2005

The *Simulation-Overview* menu of WSM DSS interface displays in the same window the four graphs relating water demands, unmet demands, freshwater abstractions and cost/benefits data, aggregated yearly and over water uses or water resource types in the region. The yearly water demands and the unmet demands are both displayed aggregated on domestic use, summing over all the settlement nodes, on irrigation and animal breeding, and on industries and hydropower stations. The freshwater abstractions are aggregated over all surface or groundwater resources. Finally the Costs and Benefits graph shows aggregated direct costs, benefits from water use and environmental costs.

Chart | Table

Demand (m³)

	2001				2005			
	Jan	Feb	Mar	Apr	Jan	Feb	Mar	Apr
Castelvetrano (7)	207,956.74	207,956.74	968,693.14	1,678,423.0	207,956.74	0.000	760,736.40	709,729.92
Menfi (6)	539,236.14	539,236.14	704,751.93	1,951,147.5	539,236.14	40,138.197	179,723.13	1,294,171.8
Sambuca di Sicilia (10)	8,058.775	8,058.775	17,646.823	412,520.44	8,058.775	1,395.817	10,146.376	397,461.22
Sciacca (2)	870,737.27	870,737.27	1,167,738.1	1,935,859.3	870,737.27	0.000	297,000.89	768,121.20

Customize...

Figure 4. The Table View shows the data that are plotted in the Chart View

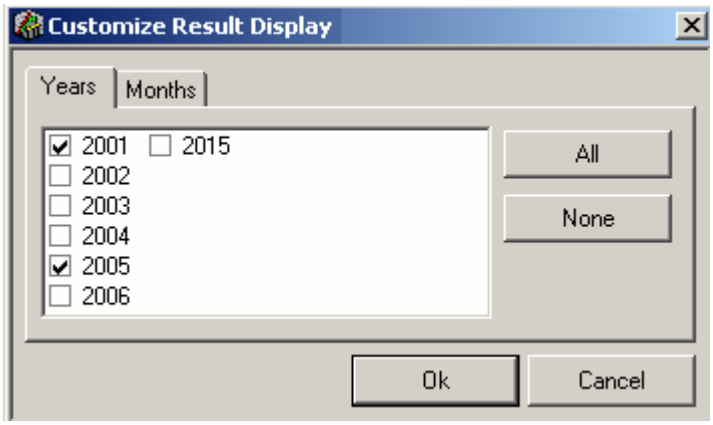

Figure 5. The Customize Dialog Box

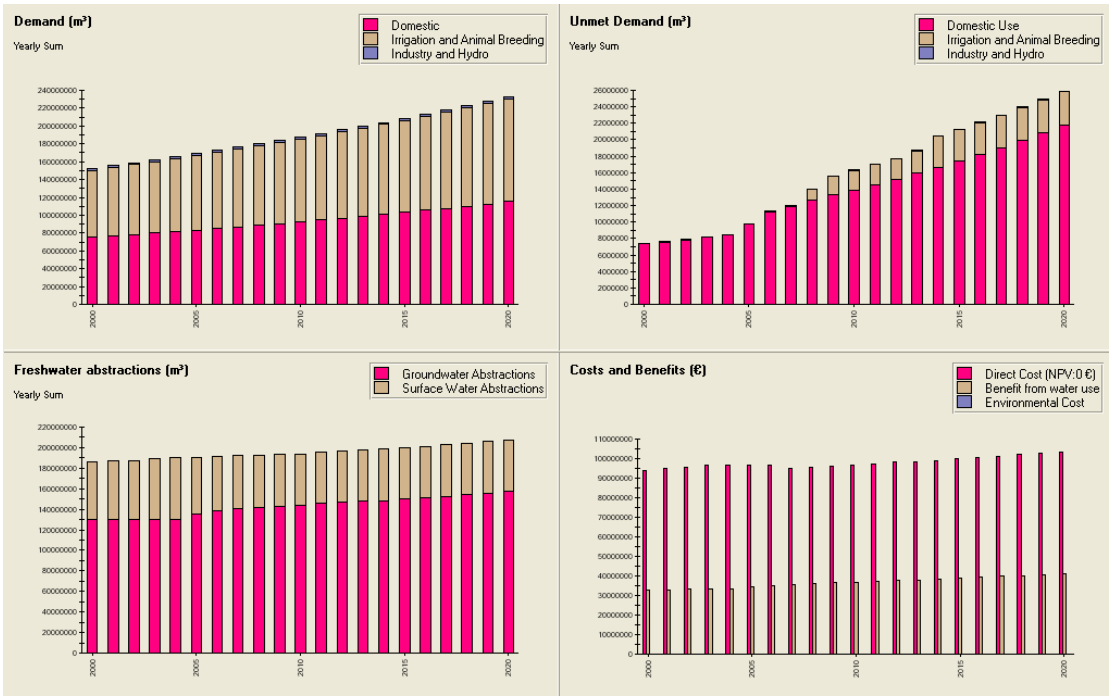

Figure 6. The Overview window of the WSM DSS

The economic analysis is performed by the DSS together with the water allocation and the calculation of the resulting indicators. However, the economic parameters involved in the estimation of the full water cost can be modified in the Cost Analysis Window, and

the costs can be updated as freestanding, without the need of running again the water allocation. The Cost Analysis Window is reachable from the homonymous sub-menu of the generic water management scheme (Navigation Panel). The user is allowed to navigate the different costs in a dedicated panel and to change or enter the specific parameters for the selected cost in the top-right panel. He can for example change the Discount Rate of the direct cost, or choose the way the environmental cost is obtained, either relating aquifer abstractions or using the charge model, or set the water selling price for each water use in the region, namely domestic, agricultural and industrial, or finally decide to generate a rate of cost recovery by including or not the resource and the environmental costs.

By pressing the *Calculate* button, costs are updated and their annual time series can be investigated either in tabular form or plotted on a graph.

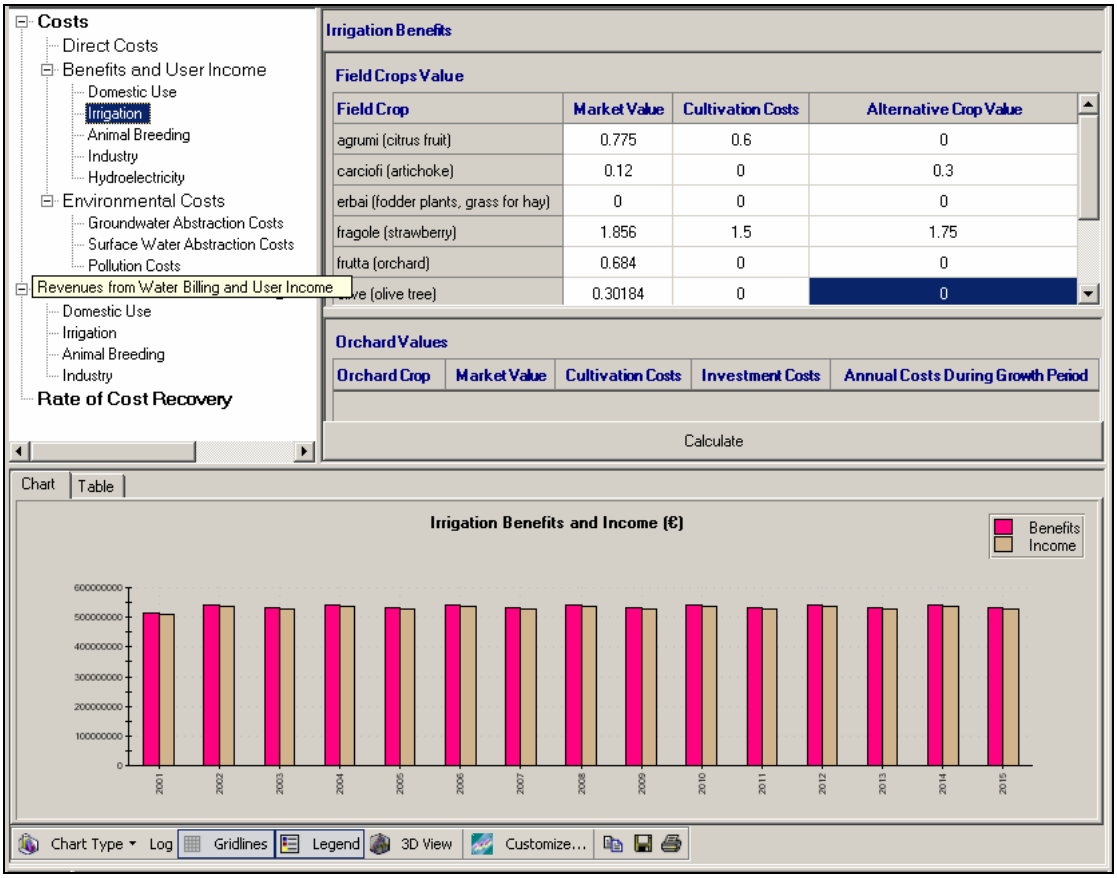

Figure 7. Setting the Benefits and Income data for irrigation in the Cost Analysis Window

As a sort of appendix to the simulation chapter, a table is presented, which lists all the indicators computed in the DSS, the category they belong to and the types of node or link they are computed for.

Table 1. Indicators Implemented in the WSM DSS

Category	Indicator	Network Element
Exploitation	Total Water Production	Region
	Groundwater exploitation index	Region
	Consumption index	Region
	Non-sustainable production index	Region
Dependencies	Dependence on imported water	Region
	Anthropogenic water produced over total water production	Region
Water Quality	Percentage of Treated urban water	Region
	Share of Primary Treatment	Region
	Share of Secondary Treatment	Region
	Share of Tertiary Treatment	Region
	Concentrations of quality variables	Pipelines, River Links, River Reach Nodes, Canal, GW Recharge/Discharge Link, Return Flow, Importing, Lake, Small Reservoir, Storage Reservoir, Fossil GW
	Concentrations of quality variables in inflows and return flows	Irrigation, Settlement, Exporting (only inflow), Waste Water Treatment Plant, Industry, Tourist, Environmental + Navigation + Recreational(only inflow), Hydroelectricity Production (only inflow), Drinking Plant
Pressures	Agricultural demand per hectare	Region
	Tourists per inhabitant	Region
	Water abstractions per capita	Region
Deficits	Specific Water use Deficit as a percentage of the specific water use demand	Region
Cost/Revenues	Total Direct Cost	Region, Irrigation, Settlement, Industry, Tourist, Hydroelectricity Production
	Total Benefit from water use	Region, Irrigation, Settlement, Industry, Tourist, Hydroelectricity Production
	Total Income	Region, Irrigation, Settlement, Industry, Tourist, Hydroelectricity Production
	Environmental Costs for	Region Irrigation,

Category	Indicator	Network Element
	abstractions and pollution	Settlement, Industry, Tourist
	Revenues	Region
	Overall Rate of Cost Recovery	Region
	Rate of cost recovery without Environmental costs	Irrigation, Settlement, Industry, Tourist
	Rate of cost recovery with Environmental costs	Irrigation, Settlement, Industry, Tourist
	Annualized Capital Costs	Pipelines, River Reach, Waste Water Treatment Plant, Network Reservoir, Canal, Importing, Lake, Small Reservoir, Storage Reservoir, Fossil GW, Renewable GW, Desalination, Drinking Plant
	Total Water Transfer Costs	Pipelines, Canal
	Running Cost	Pipelines, River Reach, Waste Water Treatment Plant, Network Reservoir, Canal, Importing, Lake, Small Reservoir, Storage Reservoir, Fossil GW, Renewable GW, Desalination, Drinking Plant
	Total Supply cost	River Reach, Importing, Lake, Small Reservoir, Storage Reservoir, Fossil GW, Renewable GW
	Total Treatment Costs	Waste Water Treatment Plant, Desalination, Drinking Plant
Irrigation	Cultivated Area	Irrigation
Livestock Number	Livestock Number	Animal Breeding
Industry	Industrial Production	Industry
Water Quantity	Inflow	Pipelines, Network Reservoir, Canal
	Outflow	Pipelines, Canal
	Losses	Pipelines, Canal
	Flow	River Link, GW Recharge/Discharge Link, Return Flow
	Demand	Irrigation, Settlement, Exporting, Animal Breeding, Industry, Tourist, Environmental, Navigation,

Category	Indicator	Network Element
		Recreational, Hydroelectricity Production
	Supply Delivered	Irrigation, Settlement, Exporting, Animal Breeding, Industry, Tourist, Environmental, Navigation, Recreational, Hydroelectricity Production
	Unmet Demand	Irrigation, Settlement, Exporting, Animal Breeding, Industry, Tourist, Environmental, Navigation, Recreational, Hydroelectricity Production
	Losses	Irrigation, Settlement, Animal Breeding, Industry, Tourist
	Return Flow Volume	Irrigation, Settlement, Animal Breeding, Industry, Tourist, Lake, Small Reservoir, Storage Reservoir, Renewable GW
	Abstraction	River Reach, Importing, Small Reservoir, Lake, Storage Reservoir, Fossil GW, Renewable GW
	Total Run-off	River Reach, Lake, Storage Reservoir
	Groundwater recharge	River Reach
	Groundwater discharge	River Reach
	Return flows	River Reach
	Volume of Water Treated	Waste Water Treatment Plant, Drinking Plant
	Available supply	Importing
	Storage	Lake, Small Reservoir, Storage Reservoir, Fossil GW, Renewable GW
	Evaporation Losses	Lake, Small Reservoir, Storage Reservoir
	Seepage Losses	Lake, Small Reservoir, Storage Reservoir
	Natural Recharge	Renewable GW
	Discharge	Renewable GW
	Drinking Water Production	Desalination
Hydroelectricity	Electricity Production	Hydroelectricity Production
Population	Permanent Population	Settlement
	Seasonal Population	Settlement, Tourist
	Total Population	Settlement