WaterStrategyMan
EVK1-CT-2001-00098

MANUAL OF THE INTEGRATED DECISION SUPPORT SYSTEM

Chapter Three

Water Demand Scenarios

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Chapter 3 – Water Demand Scenarios

The Demand Scenarios Module of the DSS produces forecasted time-series of water demand for all the *demand nodes* that are placed on the map of the region, both *site*-type, such as settlements, tourist sites, irrigation, animal breeding and industrial sites, and others such as hydropower plants, exporting and river demands.

Scenarios are generated by specifying appropriate growth rates to the key variables (Drivers) that govern the water demand of the nodes, such as population for the domestic use, cultivable area and livestock for agricultural practices, production growth and energy requirements for industries and hydropower plants respectively. This specification can be done in two ways:

a) at once for all the nodes belonging to the same demand category, by activating the *Create Scenarios/Demand* option in the Navigation Panel, or

b) node by node going through the list on nodes in the Navigation Panel and editing growth rates from the Data Editor Panel.

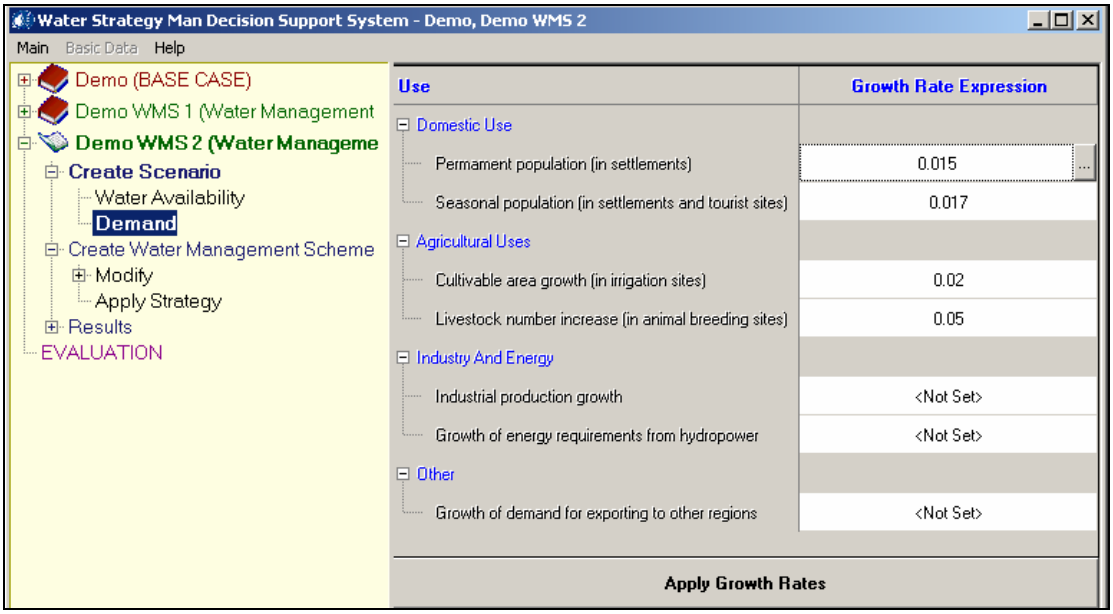


Figure 1. Definition of growth rates from the Create Scenario\Demand Panel (on the right)

In order to assign the same growth rate number or expression to all the nodes of the same water sector, e.g. to all settlement nodes, the user of the DSS activates the Demand Scenarios Panel from the Navigation window and double clicks the <*Not Set*> field corresponding to *Permanent population (in settlements)*. This procedure opens a table where time variant (yearly) or constant rates can be entered. With the *Add* and *Delete* buttons new entries are defined or erased, each one related to a year of the simulation period. The growth rate assigned to a year is implicitly assigned to all the years that follow, which do not have an explicit rate, until another year with a different rate is entered. For example, if growth rates of 1.5, 2.1 and 3% are entered for years 2001, 2004 and 2010 respectively, this means that for the period 2001-2003 the permanent population growth rate will be

1.5%, for the period 2004-2009 it will be 2.1% and from year 2010 up to the end of the scenario horizon, it will be set equal to 3%. With the *Apply Growth Rate* button (located at the bottom of the Demand Panel) the user can apply the growth rate to all the nodes of the sector. The operation overwrites any custom value the end user may have previously entered, even if it has been assigned to a particular node.

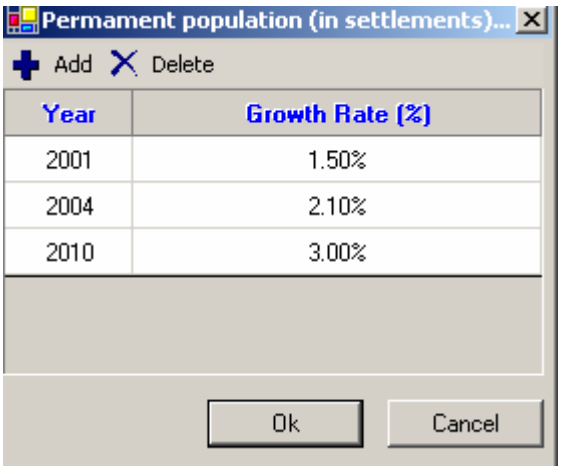


Figure 2. Growth rate form with time-variant rates.

Having confirmed the application of the desired values, it is possible to see graphically what is the influence and effect of any choice over the total water demand of the domestic sector during the simulation period. The yearly sums are displayed in a graph below the Demand Scenario Panel. A tab allows the user to pass from the graph to a table format of the visualized data.

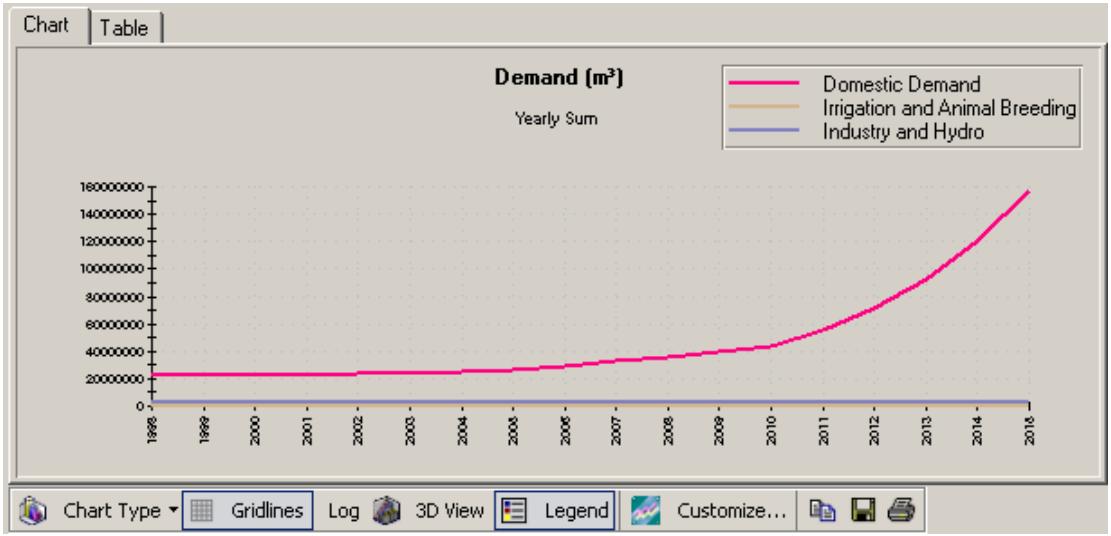


Figure 3. The chart below the Demand Panel displays the Demand Scenarios for each water sectors. Here the effect of three different growth rates for years 2001, 2004 and 2010 is visible.

Alternatively, growth rates for the demand drivers can be entered node-by-node. Data are edited directly in the Data Editor Panel, after having accessed the specific nodes through the Object Manager panel of the DSS. Node by node definition of data

overwrites the one by sector. Table 1 shows for node type, the variables to be assigned a growth factor (or another type of customized expression) and their location in the Data Editor table of attributes.

Table 1. Attributes for building Demand Scenarios on a node level

Node Type	Variables	Data Editor Tab
Animal Breeding Site	Number of Animals	Animal Breeding Activities
Industrial Site	Production	Demand Data
	Consumption Rate	Demand Data
	Share of Consumptive Demand	Demand Data
Irrigation Site	Maximum Cultivable Area	General
	Crop Area Share	Irrigation Activities
Settlement	Residential & Tourist Population	Population Data
	Population Month Variation (optional)	Population Data
	Residential & Tourist Consumption Rate	Demand Data
Tourist Site	Tourist Population	Population Data
	Month Variation (optional)	Population Data
	Tourist Consumption Rate	Demand Data
Exporting	Demand	Demand Data
	Month Variation (optional)	Demand Data
Hydroelectricity	Energy Requirements	Demand Data
	Month Variation (optional)	Demand Data

The *Month Variation* variable, identified in Table 1 as optional, represents the yearly distribution of the increment set by the user to the demand key variable. If not used, the yearly growth is allocated monthly with the same percentage. The month variation entry is supported by a separate window of the DSS, which allows for direct editing of the percentages in a grid or for setting them graphically through a drag and drop operation on a chart. The *Set All Equal to Zero* button helps for a quick reset of variation values.

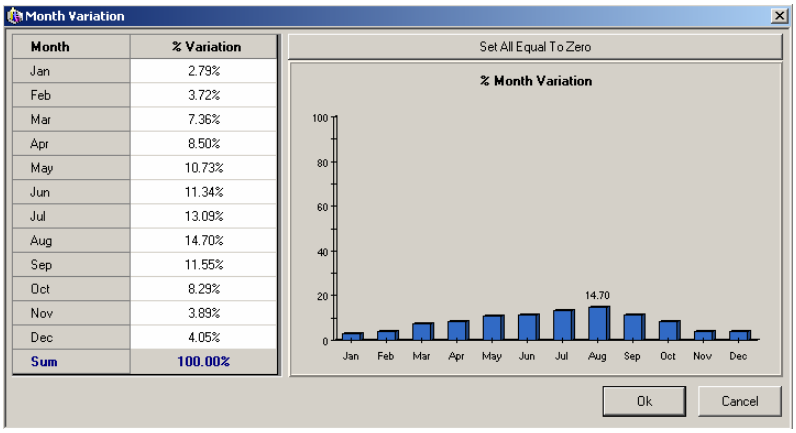


Figure 4. The Month Variation Window

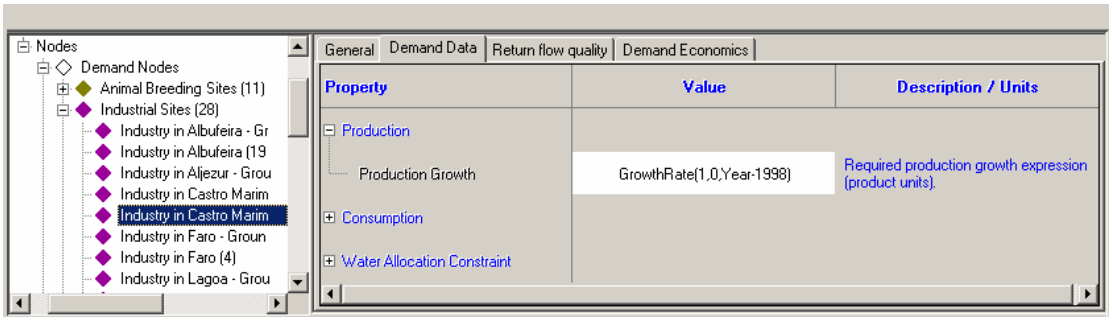


Figure 5. Editing growth rate for a single Industrial Site

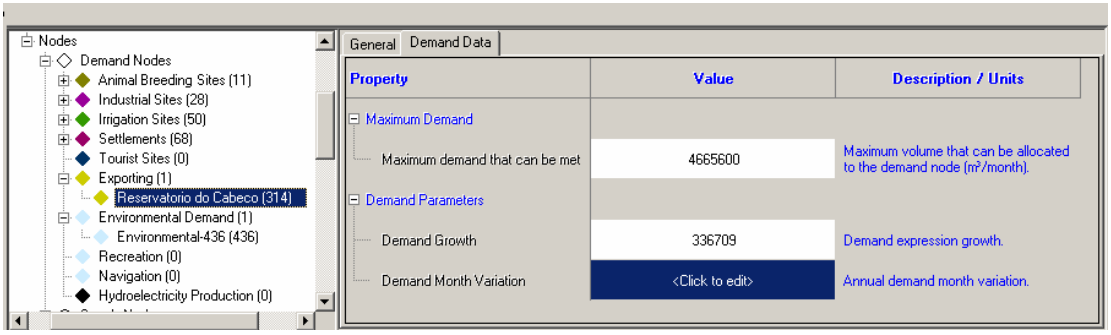


Figure 6. Editing growth rate for a single Export node

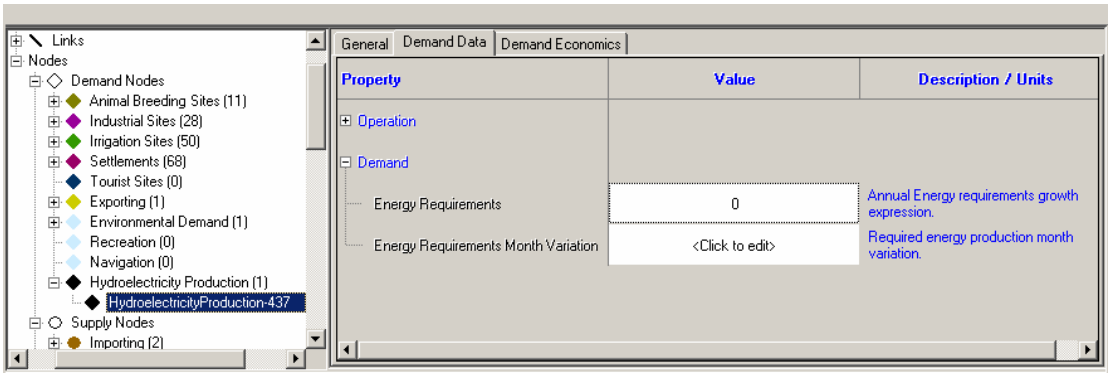


Figure 7. Editing growth rate for a single Hydroelectric Plant

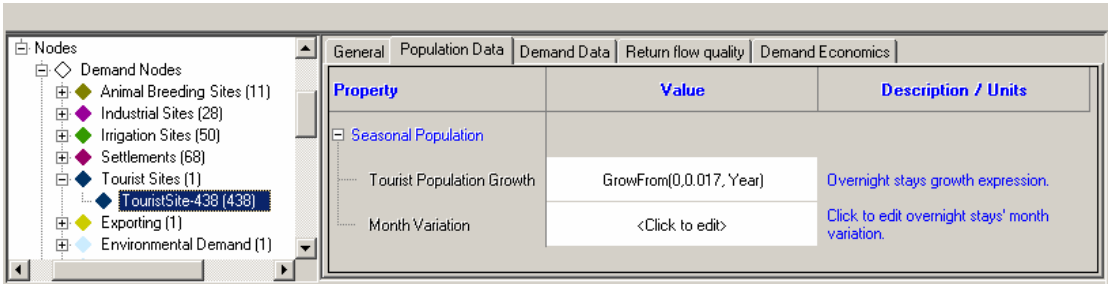


Figure 8. Editing growth rate for a single Tourist Site

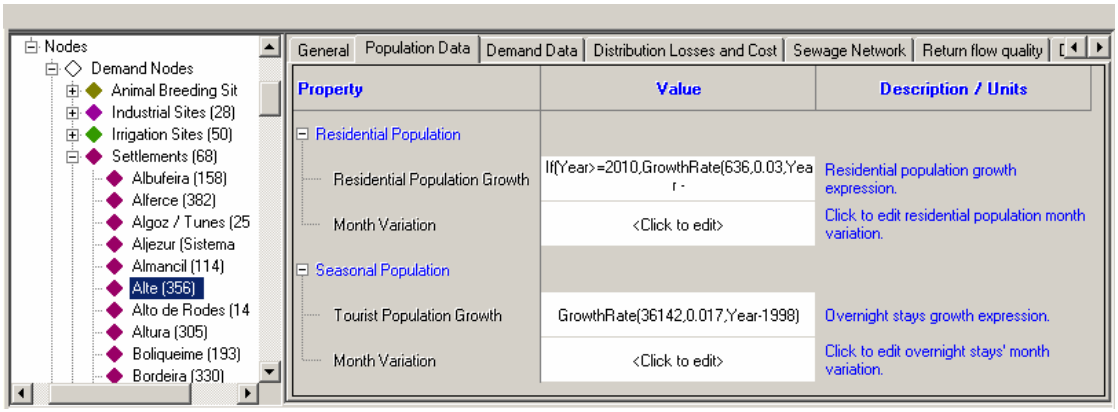


Figure 9. Editing growth rate for a single Settlement

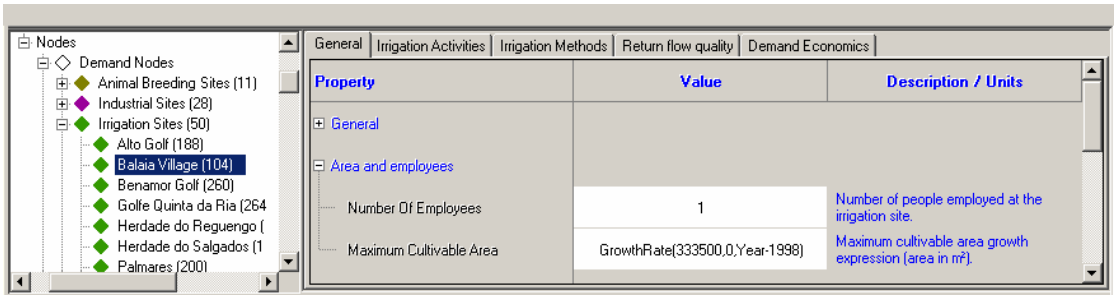


Figure 10. Editing growth rate for a single Irrigation Site

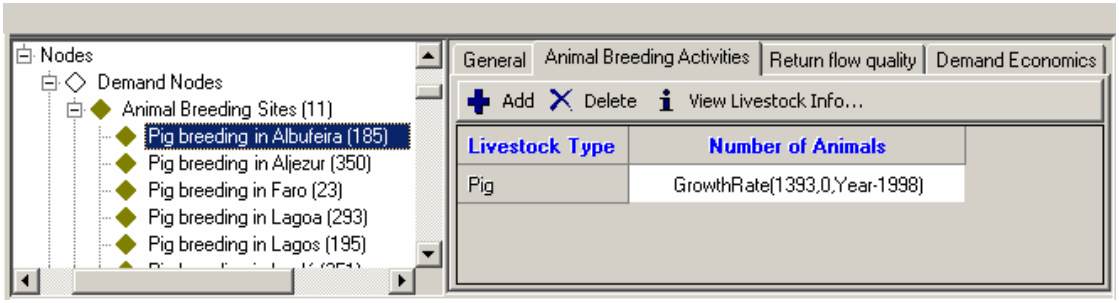
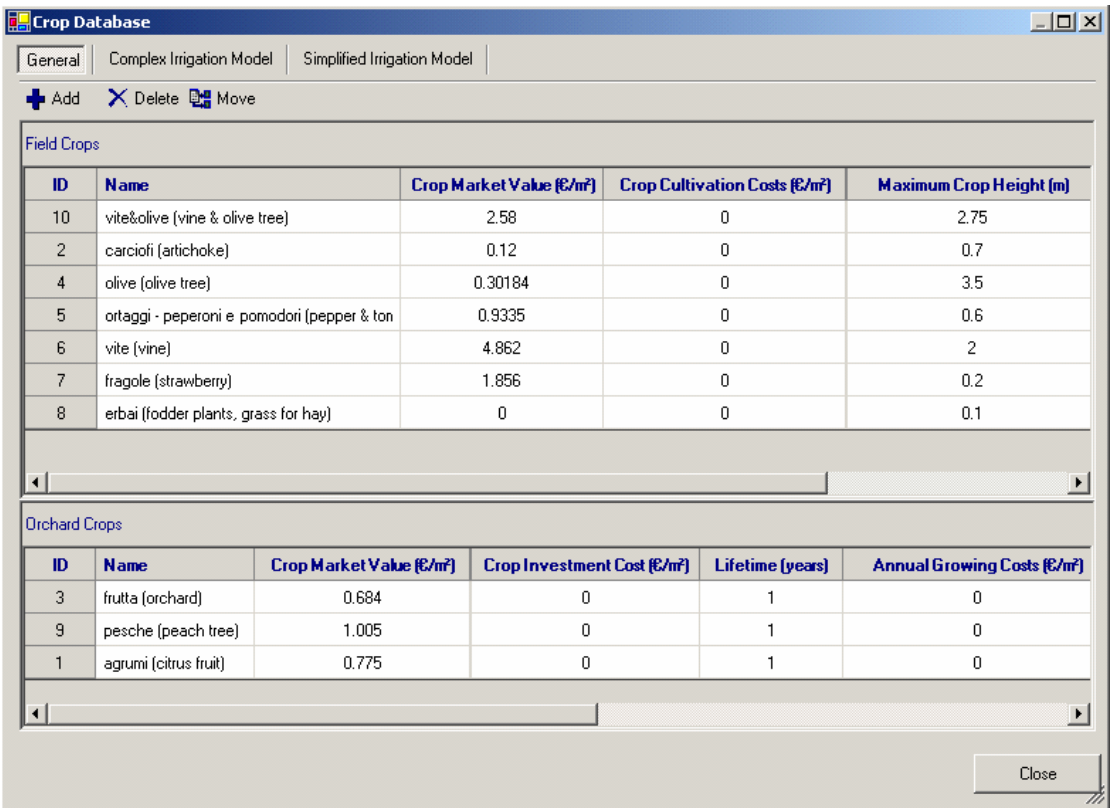


Figure 11. Editing growth rate for a single Animal Breeding Site

The definition and management of data related to agricultural and animal breeding modelling is based on dedicated entry forms. Information about the list of the different crops cultivated in the region and their characteristics is placed in the *Crop Database*, accessed from the interface by the *Basic Data/Demand Database* menu, while the list of animals and their market values are placed in the *Livestock Types Form*, accessed by the *Basic Data/Livestock Types* menu.

In particular, the Crop Database Form presents crop data classified in three sections: the *General,* the *Complex Irrigation Model* and the *Simplified Irrigation Model.* In the General section two tables show a number of economic and crop type data for field and orchard crops respectively. Among the economic information for field crops there are Crop Market Value and Cultivation Costs, whereas maximum crop height and planting date are the crop characteristics. Orchard crops also have some exclusive information, such as Investment Cost, Lifetime, Growth period and Cost. The DSS user can customize his

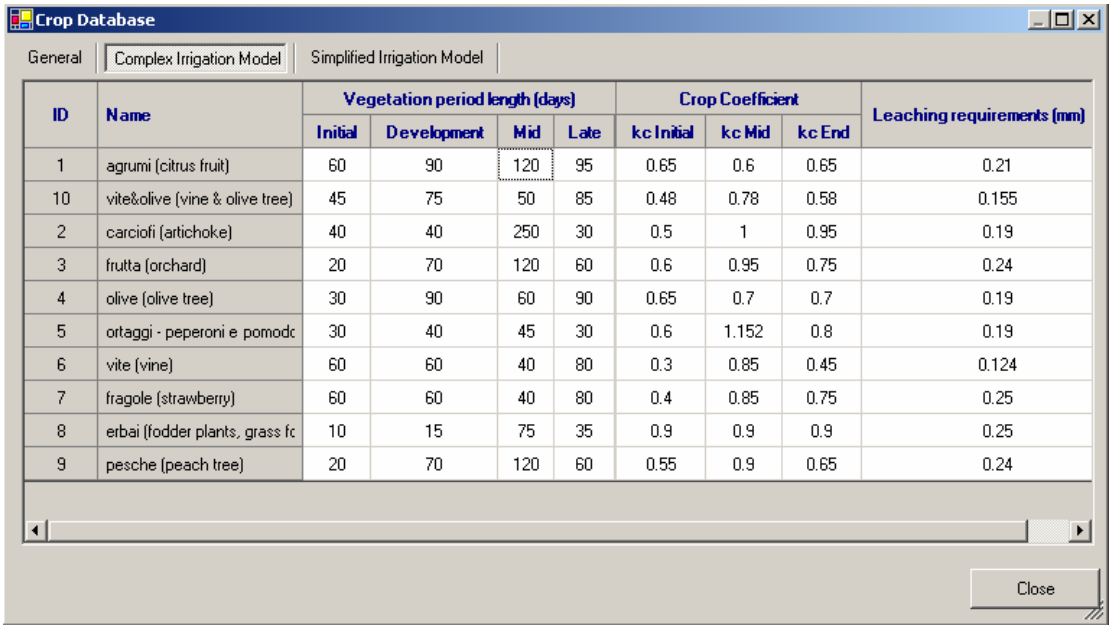
own list of crops by adding new ones or deleting some through the *Add* and *Delete* buttons, and he can also move the crops from the field crop table to the orchard and vice versa by selecting the crop and clicking the *Move* button. The Complex and Simplified sections of the Crop Database Form contain the modelling information that is described in the WSM Approach chapter of this document: vegetation periods, crop factors and leaching, for the complex model, and monthly water requirements for the simplified.



ID	Name	Crop Market Value (€/m²)	Crop Cultivation Costs (€/m²)	Maximum Crop Height (m)
10	vite&olive (vine & olive tree)	2.58	0	2.75
2	carciofi (artichoke)	0.12	0	0.7
4	olive (olive tree)	0.30184	0	3.5
5	ortaggi - peperoni e pomodori (pepper & ton	0.9335	0	0.6
6	vite (vine)	4.862	0	2
7	fragole (strawberry)	1.856	0	0.2
8	erbai (fodder plants, grass for hay)	0	0	0.1

ID	Name	Crop Market Value (€/m²)	Crop Investment Cost (€/m²)	Lifetime (years)	Annual Growing Costs (€/m²)
3	frutta (orchard)	0.684	0	1	0
9	pesche (peach tree)	1.005	0	1	0
1	agrumi (citrus fruit)	0.775	0	1	0

Figure 12. The General Section of the Crop Database



ID	Name	Vegetation period length (days)				Crop Coefficient			Leaching requirements (mm)
		Initial	Development	Mid	Late	kc Initial	kc Mid	kc End	
1	agrumi (citrus fruit)	60	90	120	95	0.65	0.6	0.65	0.21
10	vite&olive (vine & olive tree)	45	75	50	85	0.48	0.78	0.58	0.155
2	carciofi (artichoke)	40	40	250	30	0.5	1	0.95	0.19
3	frutta (orchard)	20	70	120	60	0.6	0.95	0.75	0.24
4	olive (olive tree)	30	90	60	90	0.65	0.7	0.7	0.19
5	ortaggi - peperoni e pomodc	30	40	45	30	0.6	1.152	0.8	0.19
6	vite (vine)	60	60	40	80	0.3	0.85	0.45	0.124
7	fragole (strawberry)	60	60	40	80	0.4	0.85	0.75	0.25
8	erbai (fodder plants, grass fc	10	15	75	35	0.9	0.9	0.9	0.25
9	pesche (peach tree)	20	70	120	60	0.55	0.9	0.65	0.24

Figure 13. The Complex Irrigation Model Section of the Crop Database

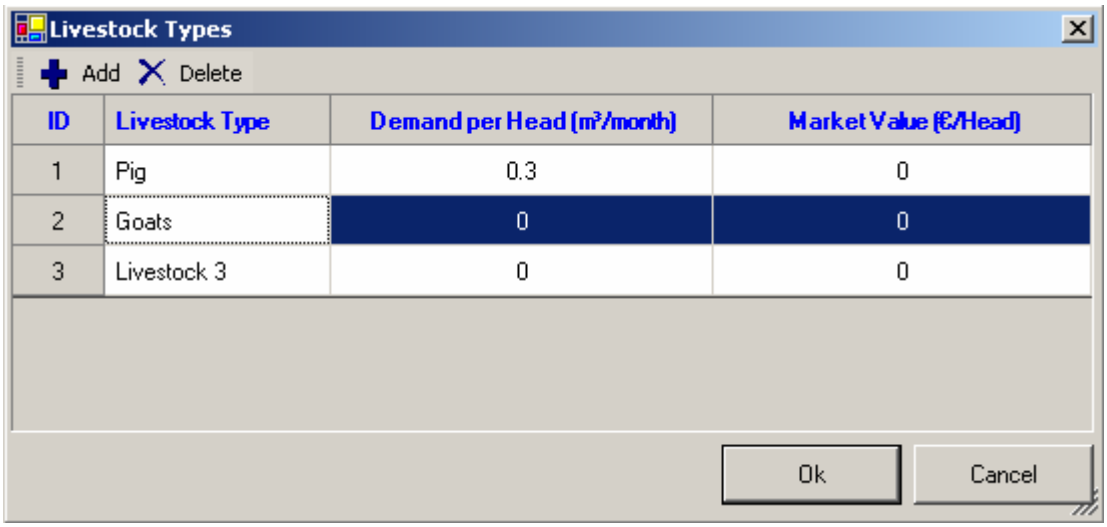


Figure 14. The entry form for livestock data

An additional DSS functionality that characterises the demand scenarios is the Demand Feedback Loop. When enabled by the DSS user in the General Tab of the Data Editor, this option allows for modifying the demand scenarios on the fly, during the simulated water allocation. The variables that drive the scenarios behaviour, such as population for settlements or cultivable area for irrigation sites, are changed according to the demand deficits occurring in a user-defined number of previous years. Such a modelling approach can be used to simulate the demand node reaction and adaptation to deficit conditions. The demand feedback loop option can be activated for every single node, by setting the *Enable* parameter in the General Data Tab of the node equal to *True*. At the same section, the DSS user has to specify the interval of years to be considered in the feedback analysis. The feedback option is currently implemented for Irrigation Sites, Settlements and Animal Breeding and is under development for Tourist, Industrial Sites and Export Nodes.

The irrigation site loop works as follows: the DSS during the feedback interval estimates the actual water that is received by each crop cultivated in the irrigation site (according to the total supply delivered to the irrigation site and the user-defined priority for each crop) and from that the actually irrigated area. In case that the total volume of water received by the crop is less than the theoretical irrigation water requirements during the feedback interval, the DSS estimates the median of actually irrigated area during the interval and uses it to specify an upper limit for the area that can be cultivated with the specific crop.

In the case of settlements, if supply delivered to the settlement is zero during the feedback interval, then permanent and seasonal populations are set to zero for the remaining simulation period; if the total volume of water received is not equal to zero, then the DSS estimates for each month of the interval, an upper limit of overnight stays (seasonal population) that can be sustained with the volume of water delivered. This is performed through the calculation of the median value of overnight stays for that month of the interval that can be sustained with the volume of water delivered.

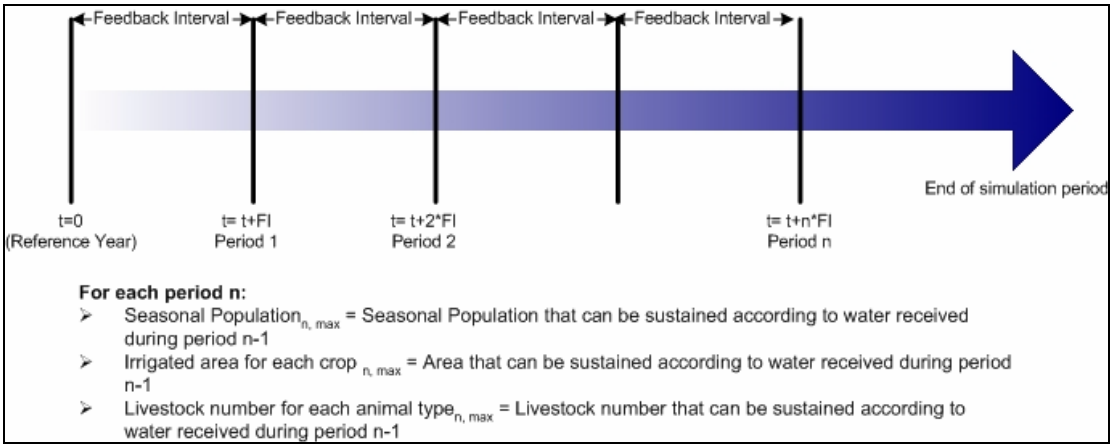


Figure 15. Feedback loop runs every feedback interval in the simulation period

For animal breeding activities the procedure is similar to that applied for irrigation sites. For the Demand Feedback Interval the DSS estimates the actual water that is received by each livestock type specified for the animal breeding site according to the total supply delivered to the site and the market value for the livestock type. In case that the total volume of water received by the animal type during the demand feedback interval is less than its' total water requirements, the DSS estimates the median of the number of animals that can be sustained, and uses it to specify an upper limit for livestock number of the particular type.