RIBASIM Version 7.01 User Manual Addendum

Contents

Appendices

1 Introduction

This document is supplemental to the User and Technical Reference manual for RIBASIM Version 7.00 and describes the new features of RIBASIM Version 7.01:

1. Works on Windows7 64 bits.
2. No limitation on the number of nodes and links (dynamic memory allocation for all network elements).
3. Maximum number of crops increased from 50 to 100.
4. The nodes in the source priority list within the same priority group are put in the source priority list based on the length of the demand-source node route: the number of links in the route. Now the sources near the demand nodes are used first.
5. The inactive source nodes in a source priority list are replaced by the source priority list of the inactive node. Now this updated list is also rearranged by applying the procedure outlined in the previous item.
6. Link with Delft water quality process model Delwaq, specification of waste load scenarios and use of the waste load estimation model.
7. Specification of climate change scenarios (change in runoff, rainfall, evaporation).
8. Specification of agriculture scenario's (change in crop plan).
9. Specification of land-use and population scenario’s (link with spatial planning) .
10. Explicitly definition of measures and management actions (strategies, interventions, combination of measures).
11. Flow statistics in post-processing: minimum flow, average flow, maximum flow, standard deviation, one or more dependable flow and simulated flow per calendar year
12. Annual results for various parameters
13. Standard histogram for time step and annual output parameters
14. Cumulative distribution function for annual output parameters

RIBASIM Version 7.01 is combined with the water quality process library and computation model DELWAQ and a waste load estimation model. With this version a solid water quality analysis in the river basin can be carried out. Thru DELWAQ the following water quality features become available for the RIBASIM user.

- A water quality library which offers more than 30 years of collective water quality modeling experience world-wide.
- DELWAQ models almost any water quality variable and its related water quality processes
- Highly flexible due to the many standard options and user-defined options available
- Uses a library of 900 processes and substances, including eutrophication, adsorption, desorption, nutrients, bacteria, oxygen, phytoplankton, heavy metals and micro-pollutants
- The processes are defined by selection of the desired water quality variables and processes.
- Pre-defined sets of water quality variables and processes can be used for particular problems or following the standard set of rules and regulations for specific regions
- State-of-the-art numerical schemes use a finite volume approach and display mass balances.
- Fully integrated with the standard user interface, which means that standard network, editing, animations, graphs and other post-processing facilities of RIBASIM are used.

- Automated link to the RIBASIM, which allows you to view water quality in an integrated river basin modeling context

Various options are available to avoid the tedious job of defining your boundary conditions. For example defining default boundary values for clusters of inflow locations. The possibility to overwrite these defaults for specific locations, and the option to link your own ASCII input file with boundary data.

In chapter 2 the setup of the RIBASIM Version 7.01 is outlined. In chapter 3 the changes to the interface is described. In chapter 4 the new DMI demand option under the Public water supply node is described. In chapter 5 and 6 the specification of the various scenario's and management actions is explained. The link with the water quality process model DELWAQ and waste load estimation model is described in chapter 7. Chapters 8, 9 and 10 describe the new output options of annual results, histograms and cumulative distribution function. In the attachments file formats are described in detail and example files are shown.

2 Setup of RIBASIM7

The RIBASIM7 with and without Delwaq model is setup based on:

1. **Model data base** in which all data are stored describing the modeled river basin for the base year and all potential elements. It consist of:
   a. The river basin network schematization of various nodes and links representing existing and potential (inactive) infrastructure or water users, and associated source priority list.
   b. The characteristics of all nodes and links including water allocation priorities.

2. **Historical and alternative hydrological data base** of time series of runoff, flow, rainfall and evaporation stored in hydrological scenarios.

Various future and potential situations and system configurations can be modeled by selecting scenarios and management actions (strategies, interventions). The following selections can be carried out:

1. **Hydrological scenarios.** This scenario type covers multiple year and annual time series of runoff, flow, rainfall and evaporation.

2. **Climate change scenarios**. This scenario type contains the percentage change of the hydrological variables defined in the hydrological scenarios due to climate changes.

3. **Land-use and population scenarios**. This socio-economic scenario type contains the percentage change in irrigated area, population numbers and industrial (explicit Public water supply) demand per catchment of base year (stored in the model data base) for future demand years.

4. **Agriculture scenarios**. This scenario type contains the alternative future crop plans per catchment. These scenarios might be generated by the agriculture sector models.

5. Water quality scenarios. Depending on the run mode one of the following scenarios are used:
   a. **Basic water quality scenario**. This scenario type is used in the run mode without Delwaq and contains the definition of substances and associated waste load lookup tables.
   b. **Delwaq water quality scenario**. This scenario type is used in the run mode with Delwaq and contains the waste load related data like emission factors and treatment efficiency. The data is used by the waste load estimation model to compute the industrial, domestic and agriculture waste loads.

6. **Measure and strategy data.** This management action or intervention type contains a list of strategies consisting of combinations of defined potential measures.

Figure 2.1 and Figure 2.2 show the input and output data flows of RIBASIM7 without and with Delwaq.

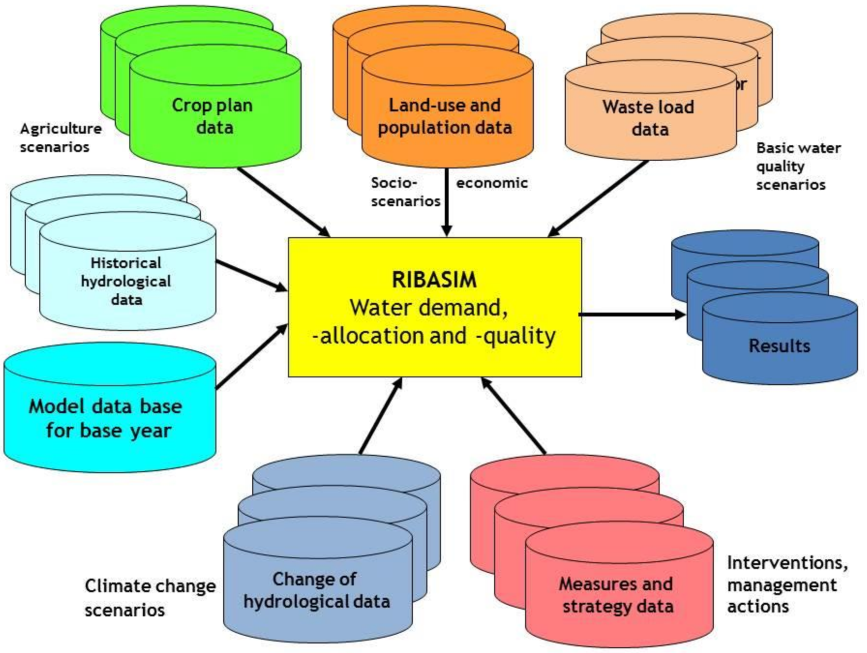

Figure 2.1 Input- and output structure of RIBASIM7.

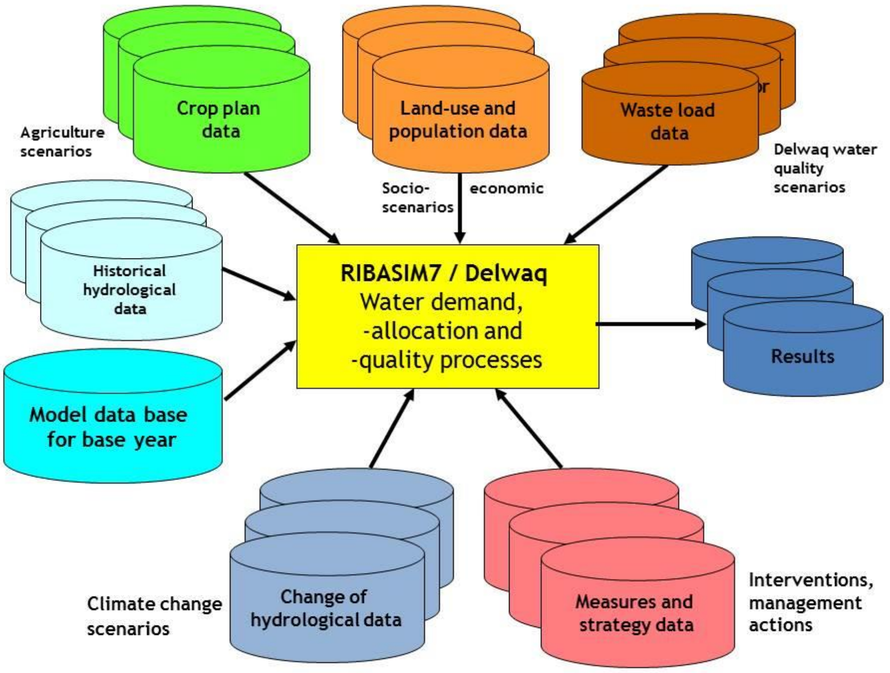

Figure 2.2 Input- and output structure of the RIBASIM7 with Delwaq model, a water resources analysis DSS.

Usually with RIBASIM7 a large number of simulation cases will be executed for the evaluation of all types of measures and strategies in the context of the preparation of basin plans. Basically the following cases are defined and executed:

1. “Base case” representing the present situation for which the model is calibrated and / or verified e.g. Base case 2010.

2. “Reference cases” representing the situation with the present and already scheduled new infrastructure and changed future water demands e.g. for 2030 and 2050.

3. Cases to analyze the effect of various measures and strategies (combination of measures, management actions, interventions)

3 Interface

RIBASIM Version7.01 has 2 run modes:

1. **RIBASIM7 only** covering: water demand, water allocation, flow composition and basic water quality
2. **RIBASIM7 with DELWAQ** covering: water demand, water allocation, flow composition and water quality process computation using Delwaq.

Each running mode has a separate start icon, see Figure 3.1

Figure 3.1 RIBASIM Version 7.01 icons to start "RIBASIM7 only" and the "RIBASIM7 with DELWAQ" run mode.

When the "RIBASIM7" icon is activated then the original case management screen is shown as outlined in Figure 3.2. The data for these applications are stored in the Rbn-directories.

When the "RIBASIM7 - DELWAQ" icon is activated then the more extended case management screen as shown in Figure 3.3 is shown with 3 additional task blocks. The data for these applications are stored in the Rbd-directories. The 3 new task blocks are:

1. Edit Delwaq water quality process configuration.
2. Delwaq water quality process computation
3. Analysis of water quality process results

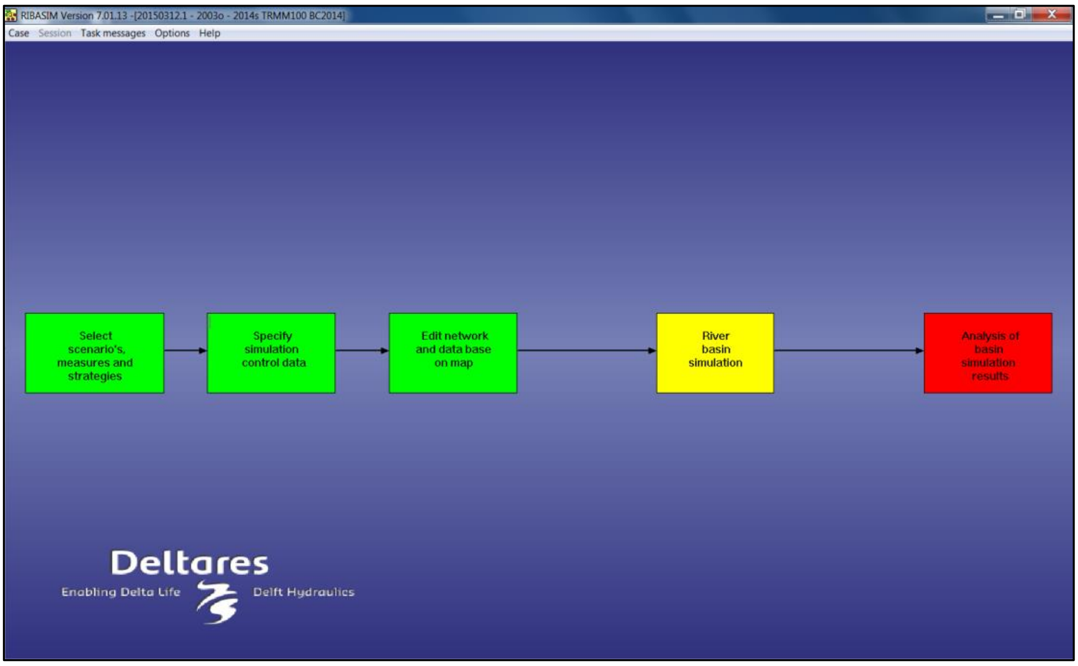

Figure 3.2 Task block screen for RIBASIM Vesrion 7.01" without Delwaq.

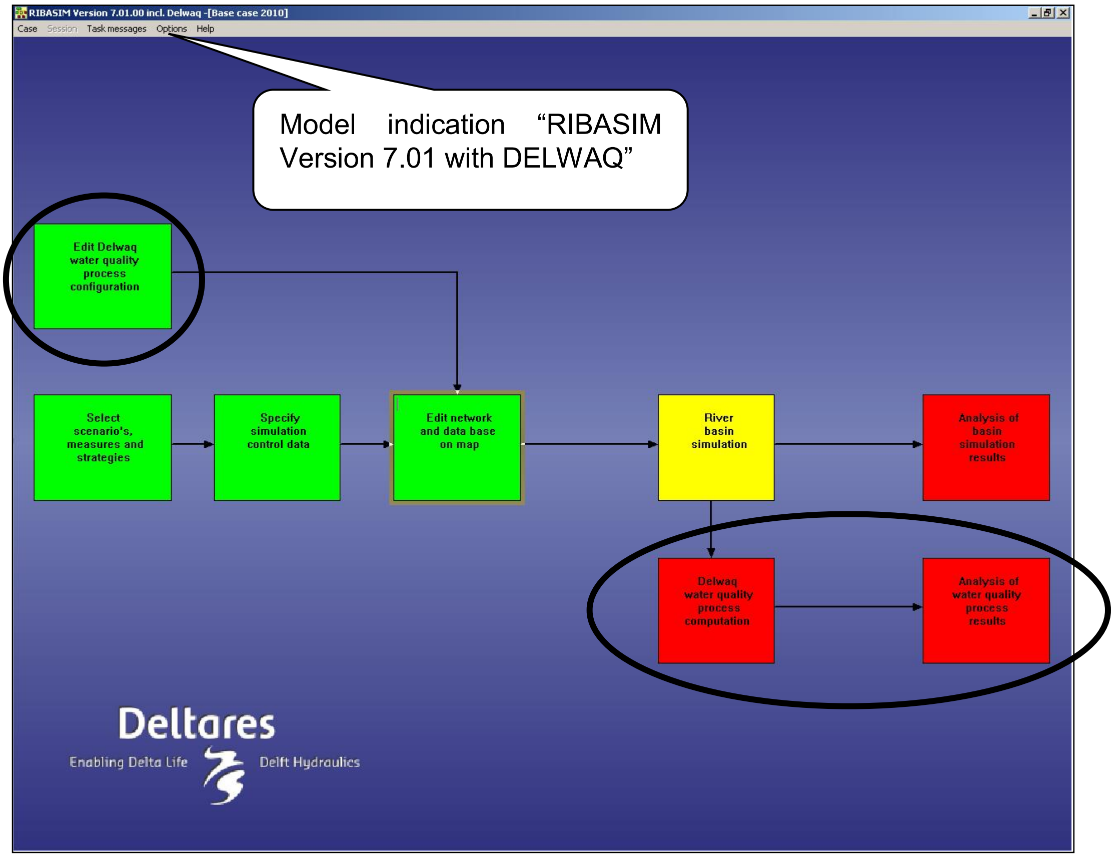

Figure 3.3 Task block screen for “RIBASIM Version 7.01 with DELWAQ” with the 3 newly added task blocks.

4 Domestic, Municipal and Industrial water demand computation

The Public water supply node type is used for the modeling domestic, municipal and industrial purpose, livestock demand, etc. There are 3 options for computation of the demand:

1. Explicit demand. The demand is explicitly specified as an annual time series of demand values per time step (m3/s).
2. Unit demand. The demand is computed based on the size of the population and the annual unit water demand per time step (liter/capita/day).
3. DMI demand. This is a new option and the demand is computed based on the number of people per population type, unit water demand and parameters describing the industrial and municipal sectors.

4.1 Explicit demand

The net demand is explicitly specified as an annual time series.

$$Dnet[t] = Dex[t]$$

With:

Dnet[t]	Net public water supply demand (m3/s)
Dex[t]	Explicit demand (m3/s) (I)

4.2 Unit demand

The net demand is computed based on the population size and unit water demand per capita per day which is specified as an annual time series. The equations are:

$$Dnet[t] = c * Ndays[t] * P * Dun[t]$$

With:

Dnet[t]	Net public water supply demand (m3/s)
P	Population (Number of inhabitants) (I)
Dun[t]	Unit demand (litre/capita/day) (I)

Ndays[t]	Number of days in time step t (-) (I)
c	Conversion factor

4.3 DMI demand: computational concept

Adequate water supply should be provided to support a growing population and its economic activities; projections of this population and its activities and estimation of the associated water demand forms a primary step in basin water resources planning.

Scenarios for the economic and demographic development of the region and spatial planning reservations and regulations form the basis for projection of future activity levels. A general methodology for the projection is schematized in the flow diagram in Figure 4.1. The method uses projected population as the main input parameter and assumes a particular equilibrium between population and economic activities expressed by coefficients. Determination of the demand on surface water is determined by a mode split between groundwater and surface water use while technical coefficients, describing the losses during transport and treatment, further describe the transformation from raw water to drinking water at the tap. Those coefficients depend on the applied level of technology, maintenance and management. Reduction of losses forms a main target for improvement in the framework of demand management.

The method to estimate industrial water requirements outlined in Figure 4.1 is fairly general and does not make a differentiation for different industries (for long term projections usually such information is not available). If however more information is available on particular types of industry and their location, then more specific localized information should obviously be used.

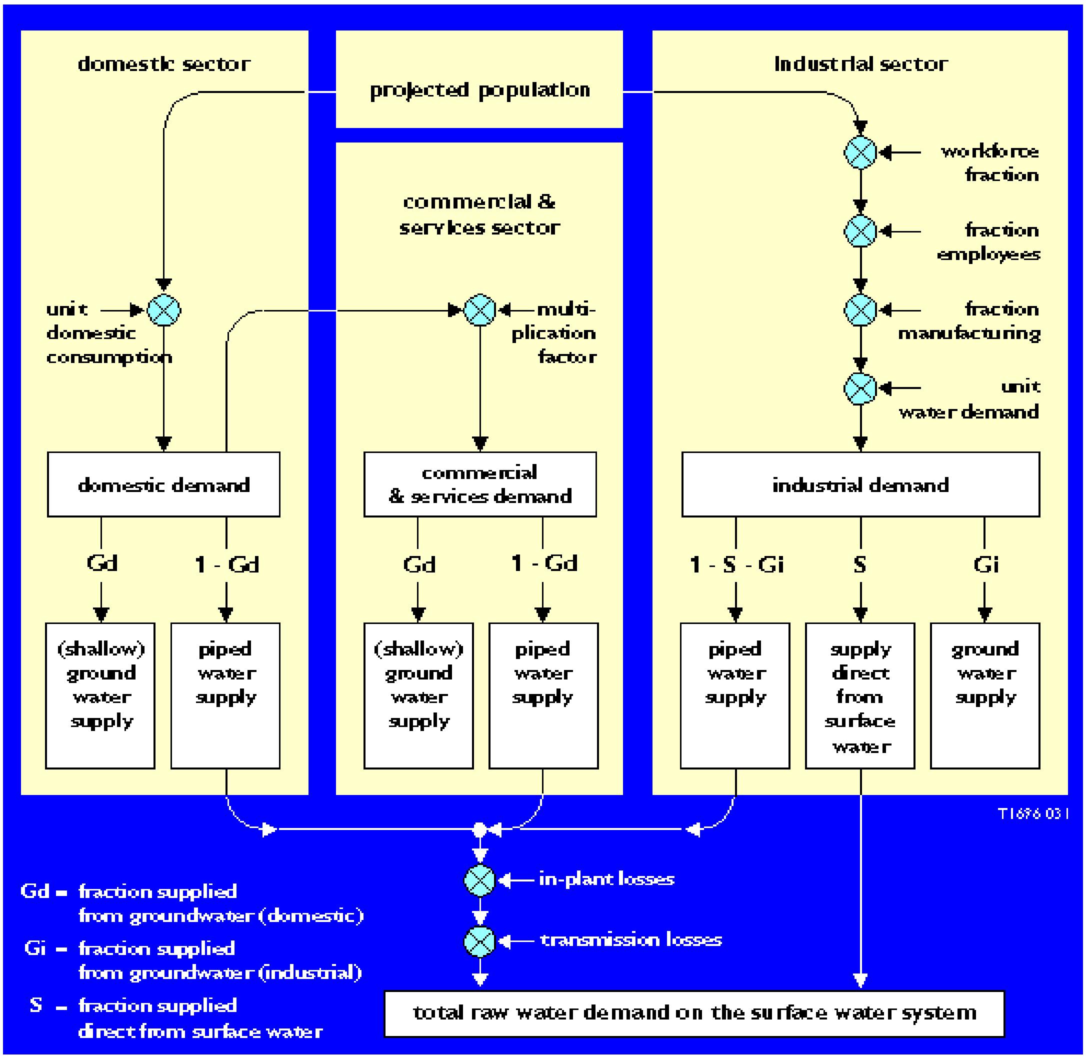

Figure 4.1 General methodology for DMI water demand projection.

Detailing part of the flow diagram in Figure 4.1, Figure 4.2 further illustrates the flow of water and the operational losses from the source to the actual point of consumption. Direct use of local groundwater constitutes the most effective use, however a high level of development characterized by a high intensity of water use, needs to be supported by a high coverage level with piped water supply in order to avoid over-use of local sources. From the viewpoint of efficient allocation of resources and conservation of groundwater, a certain minimum coverage rate should be established. The actual realized coverage rate will be the result of many aspects and influences, including the availability of piped water, regulation and the willingness to connect based on aspects such as water quality, costs and supply reliability. Reaching a particular coverage rate forms an important target for water resources development.

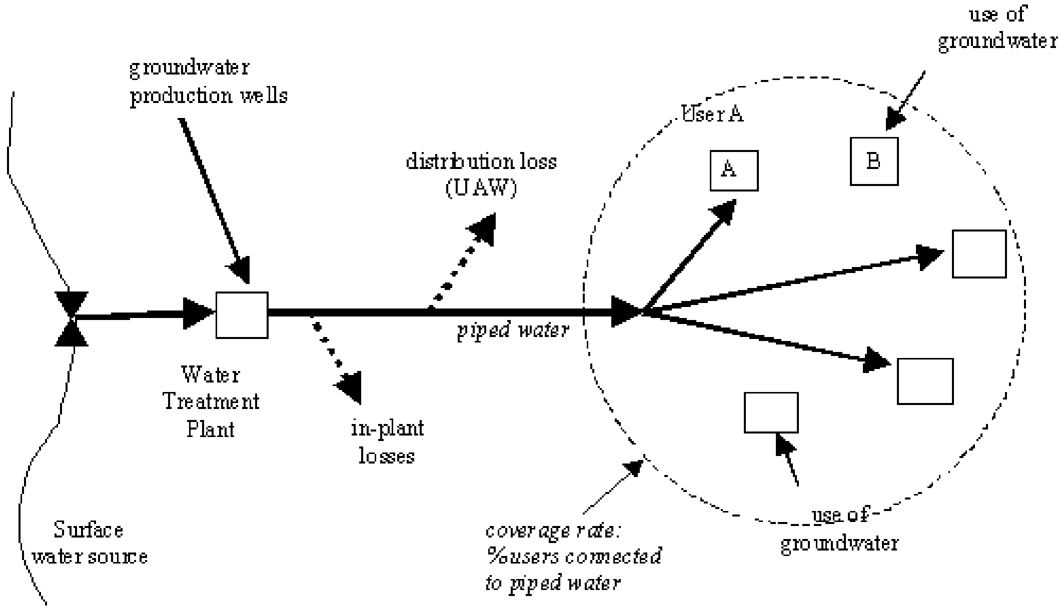

Figure 4.2 Illustration of losses and use of local water in DMI water supply.

Targets for municipal and industrial water demand and environmental conditions at various stages in the future form a main input to planning. Those target demands are based on a projection of the population and its activities. A variety of measures, ranging from construction of facilities to changing the behaviour of the users can be employed to reach those targets. Demand management can be defined as composing the set of measures that influences the level or distribution pattern (space or time) of the demand and consequently the design of the water supply infrastructure.

The net demand *Dnet* is computed as follows for each time step t the same value:

$Ddomes = Sum\ (\ PudPws_{Ipopul} * PudPop_{Ipopul}\ /\ c\ )$ *Over all population types Ipopul*

$Ninhab = Sum\ (\ PudPop_{Ipopul}\ )$ *Over all population types Ipopul*

*DdomGw = Ddomes * Gd / 100.*

DdomPw = Ddomes - DdomGw

*Dcmsrv = Ddomes * MFactor*

*DcmsGw = Dcmsrv * Gd / 100.*

DcmsPw = Dcmsrv - DcmsGw

*Dindus = Ninhab * Fw * Fe * Fm * IudPws / c*

*DindGw = Dindus * Gi / 100.*

*DindSw = Dindus * S / 100.*

DindPw = Dindus - DindGw - DindSw

Dnet[t] = DdomPw + DcmsPw + DindPw

with:

C	Conversion factor from litre/day to m3/s
Gd	Fraction of domestic, commercial and services sector water use supplied from groundwater (%)
Gi	Fraction of industrial sector water use supplied from groundwater (%)
Ipopul	Population types defined in fixed data file *Populat.dat* (see Annex A)
$PudPws_{Ipopul}$	Number of inhabitants of population type Ipopul (-)
$PudPop_{Ipopul}$	Unit water demand of population type Ipopul (litre/capita/day) defined in fixed data file *Populat.dat*
IudPws	Unit industrial demand (litre/capita/day)
Ddomes	Domestic water demand (m3/s)
DdomGw	Domestic demand from groundwater (m3/s)
DdomPw	Domestic demand from piped water supply (m3/s)
Dcmsrv	Municipal (commercial and services) water demand (m3/s)
MFactor	Commercial and services sector multiplication factor (-)
DcmsGw	Municipal water demand from groundwater (m3/s)
DcmsPw	Municipal water demand from piped water (m3/s)
Fw	Workforce (fraction of population, %)
Fe	Employee (fraction of workforce, %)
Fm	Manufacturing (fraction of employee, %)
S	Fraction of industrial sector water use supplied directly from surface water (%)
Dindus	Industrial water demand (m3/s)
DindGw	Industrial water demand from groundwater (m3/s)
DindSw	Industrial water demand supplied directly from surface water (m3/s)
DindPw	Industrial water demand from piped water (m3/s)
Dnet*[t]*	Net public water supply water demand for each time step (m3/s)

4.4 Losses, gross demand and demand from network

Losses in the plant and distribution system are taken into account in order to compute the gross demand DQPws*[t]*.

$$DgrsDs[t] = Dnet[t] * 100. / (100. - Ld)$$

$$LossDs[t] = DgrsDs[t] - Dnet[t]$$

$$LossPl[t] = DgrsDs[t] * 100. / (100. - Li) - DgrsDs[t]$$

$$DQgross[t] = Dnet[t] + LossDs[t] + LossPl[t] + DindSw[t]$$

If Operation switch “Operate on demand” is on: *DQPws[t]* = Min. (*DQgross[t]*, PlCap)

If Operation switch “Operate on demand” is off: *DQPws[t]* = PlCap

with:

Li	In-plant loss (%) (I)
Ld	Distribution loss and unaccounted water (%) (I)
LossDs*[t]*	Distribution loss and unaccounted water (m3/s)
LossPl*[t]*	In-plant loss (m3/s)
DQgross[t]	Gross demand incl. losses from network (m3/s)
PlCap	Plant capacity (m3/s) (I)
DQPws*[t]*	Water public water supply demand from network (m3/s)

4.5 DMI demand: model input data

The General model data are (see Figure 4.3):

- Node index (via interactive network editor Netter)
- Node name (via interactive network editor Netter)
- Active mode: on-off switch
- Plant capacity (m3/s)
- Catchment label (any integer number).
- Demand option switch “Apply explicit demand” *
- Demand option switch ”Apply unit demand (based on population)” *
- Demand option switch “Apply DMI demand (based on population)” *
- Priority fraction (%) which split the demand into 2 parts with different water allocation priorities (next item).
- Water allocation priority of part 1 of the demand.
- Water allocation priority of part 2 of the demand.
- Water quality look-up table index.

* Only one of the 3 demand options must be switched on.

If switch “Apply explicit demand” is on then the following model data are required:

- Explicit demand (m3/s): annual time series.

If switch “Apply unit demand” is on then the following model data are required:

- Population (-)
- Unit demand (litre/capita/day): annual time series.

If switch “Apply DMI demand” is on then the following model data are required (see Figure 4.4 and Figure 4.5):

- Node index (via interactive network editor Netter)
- Population (-) per type. The population types and the unit water requirement per capita are defined in the fixed data file *Populat.dat* (see annex A).
- Workforce as a fraction of the population (%)
- Employee as a fraction of the workforce (%)
- Manufacturing as a fraction of the employee (%)
- Industrial unit demand (lire/capita/day)
- Commercial and services sector multiplication factor (-)
- Fraction of domestic, commercial and services sector water use supplied from groundwater (%)
- Fraction of industrial sector water use supplied from groundwater (%)
- Fraction of industrial sector water use supplied directly from surface water (%)

The Operation model data which must be specified are (see Figure 4.6):

- In-plant losses (%)
- Distribution losses (%)
- Operation switch “Operate on demand”:

  Yes : demand = Minimum(Computed or explicit demand, Plant capacity)

  No : demand = Plant capacity
- Return flow to surface water time series (% of allocation): annual time series
- Return flow to ground water time series (% of allocation): annual time series
- Ground water reservoir label

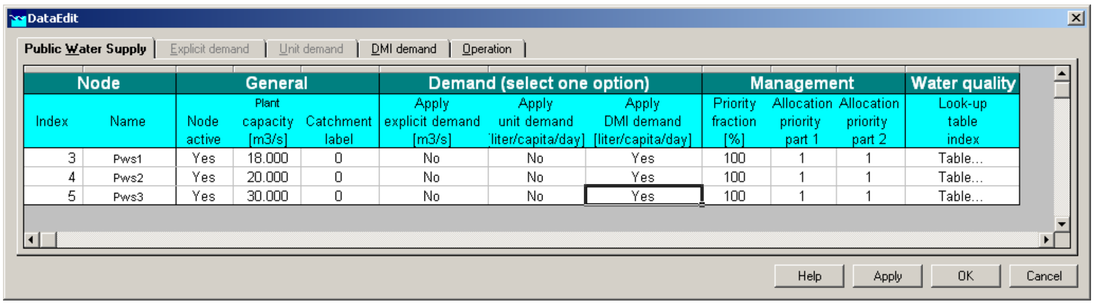

Figure 4.3 Specification of General data at Public Water Supply node.

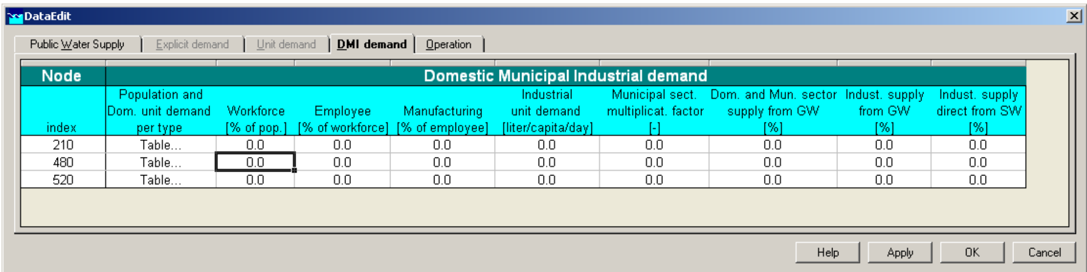

Figure 4.4 Public water supply node model data entry window for "DMI demand" option.

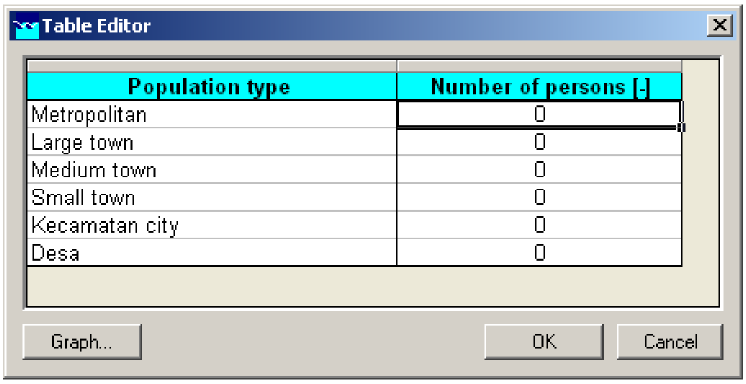

Figure 4.5 Entry of number of persons per population type.

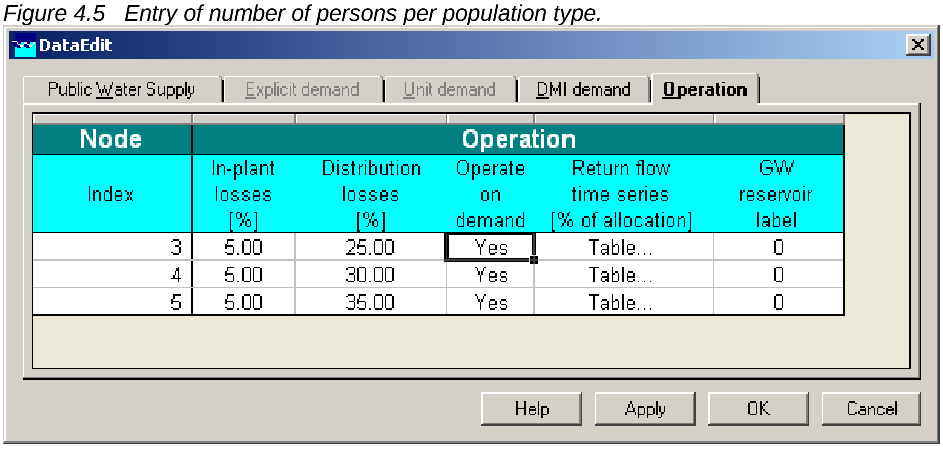

Figure 4.6 Entry of operation data.

4.6 DMI demand: result output parameters

The following output parameters are generated and can be presented graphically or exported for further processing with Ms Excel:

- Consumed flow (m3/s)
- Return flow to GW (m3/s)
+ Allocated groundwater (m3/s)
+ Allocated surface water(m3/s)
Balance check (must be 0.0)
Balance check Dm (must be 0.0)
Dm - Gross demand incl. losses (m3/s)
Dm + Losses distribution (m3/s)
Dm + Losses In-plant (m3/s)
Dm + Net demand - Explicit (m3/s) (only for demand option ”Apply explicit demand”)
Dm + Net demand - Unit based (m3/s) (only for demand option ”Apply unit demand”)
Dm + Sect. Domestic - Piped (m3/s) (only for demand option ”Apply DMI demand”)
Dm + Sect. Industrial - direct from SW (m3/s) (only for demand option ”Apply DMI demand”)
Dm + Sect. Industrial - Piped (m3/s) (only for demand option ”Apply DMI demand”)
Dm + Sect. Municipal - Piped (m3/s) (only for demand option ”Apply DMI demand”)
Downstream flow (m3/s)
Employees in manufacturing (-)
Net demand (Sum of all piped demand) (m3/s)
Number (%) of time steps with shortage
Number (-) of time steps with shortage
Population (-)
Return flow to SW (m3/s)
Sect. Domestic - GW supply (m3/s) (only for demand option ”Apply DMI demand”)
Sect. Domestic demand (m3/s) (only for demand option ”Apply DMI demand”)
Sect. Industrial - GW supply (m3/s) (only for demand option ”Apply DMI demand”)
Sect. Industrial demand(m3/s) (only for demand option ”Apply DMI demand”)
Sect. Municipal - GW supply (m3/s) (only for demand option ”Apply DMI demand”)
Sect. Municipal demand(m3/s) (only for demand option ”Apply DMI demand”)
Shortage from network (m3/s)
Supply from network (m3/s)
Ratio supply-demand from network (%)
Gross demand incl. losses from network (m3/s)
Plant capacity (m3/s)
Average gross demand incl. losses (Mcm)

Remarks:

- The + and – character before the parameter indicate that it relates to an incoming (+) or outgoing (-) water balance component.
- The “Dm +” and “Dm -” characters before the parameter relates to the composition of the gross demand.
- The parameters “Balance check (must be 0.0)” and “Balance check Dm (must be 0.0)” must be equal to 0.0 else some computational errors had occurred.

5 Specification of scenarios

In RIBASIM Version 7.01 the task block for the selection of scenarios has been extended with 4 other scenario types. Table 5.1 shows the present distinguished scenarios and run mode for which it is active: RIBASIM7 (R7) and/or RIBASIM7/Delwaq (R7/D). Figure 5.2 shows the selection window for RIBASIM7/Delwaq.

Table 5.1 Overview of the type of scenarios and management actions, and the run mode.

Scenarios and management action	**Description**	**Active in run mode**
Hydrological	The set of hydrological time series input like inflow, rainfall, evaporation, etc is selected.	R7 and R7/D
Climate change	The change in hydrological parameters due to climate change is selected.	R7 and R7/D
Land-use and population	The size of the population and irrigation area change is selected.	R7 and R7/D
Agriculture	The applied crop plan per catchment (sub-basin) is selected	R7 and R7/D
Basic water quality	The set of substances and associated waste loads (in lookup table format) is selected. This scenario is only required if the basic water quality computation is used, so without DELWAQ.	R7
DELWAQ water quality	The Delwaq boundary and dry waste loads is selected. This scenario is only required for the Delwaq water quality process modeling.	R7/D

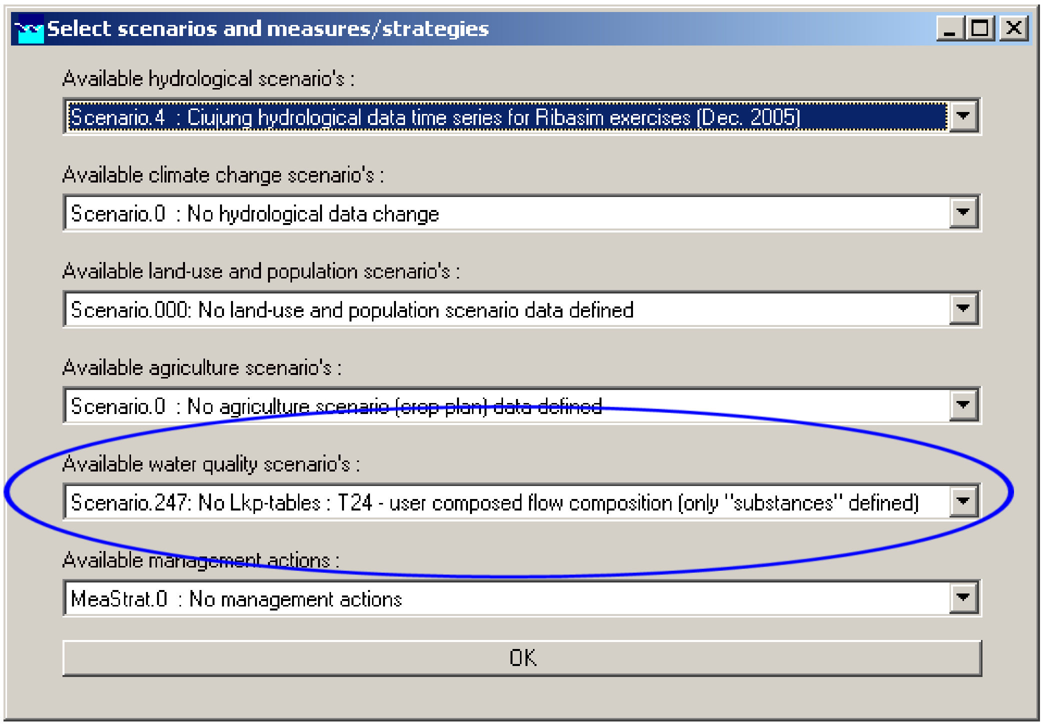

Figure 5.1 Pop-up window for the selection of the scenarios and management actions for the run mode RIBASIM7.

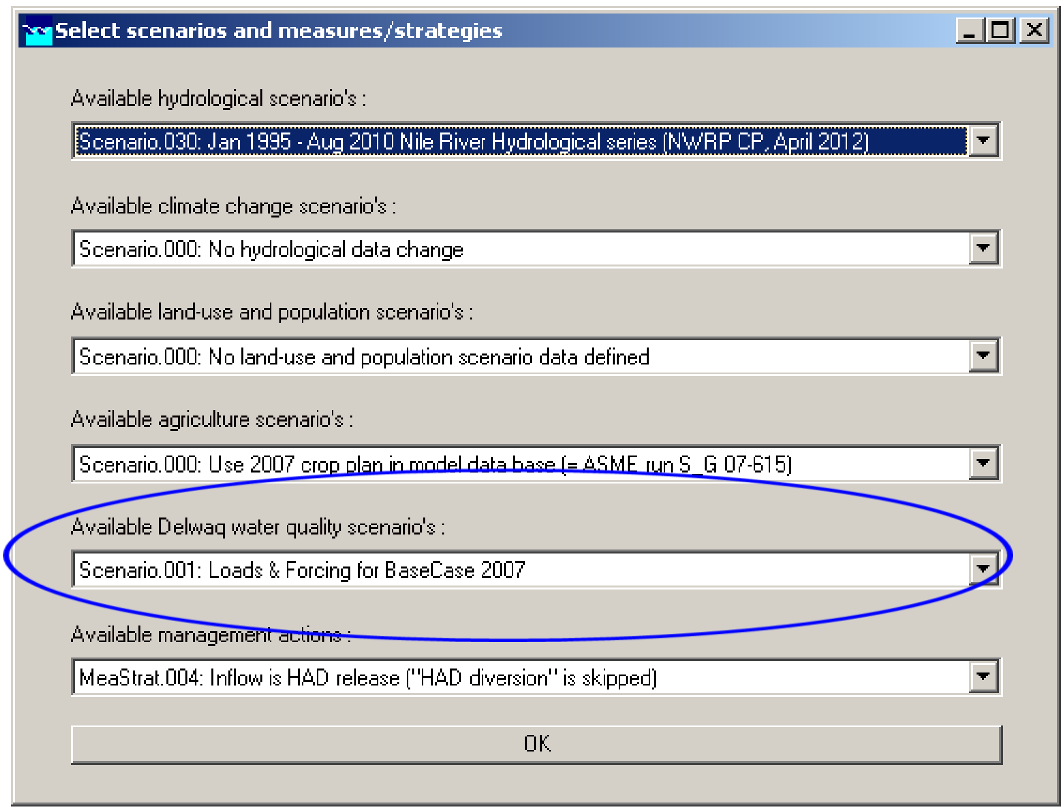

Figure 5.2 Pop-up window for the selection of the scenarios and management actions for the run mode RIBASIM7/Delwaq.

5.1 Hydrological scenarios

The definition of hydrological scenarios is outlined in chapter 5.1 of the RIBASIM Version 7.00 User manual.

5.2 Climate change scenarios

You can select the scenarios from a drop down list box which shows all the implemented scenarios (see Figure 5.3).

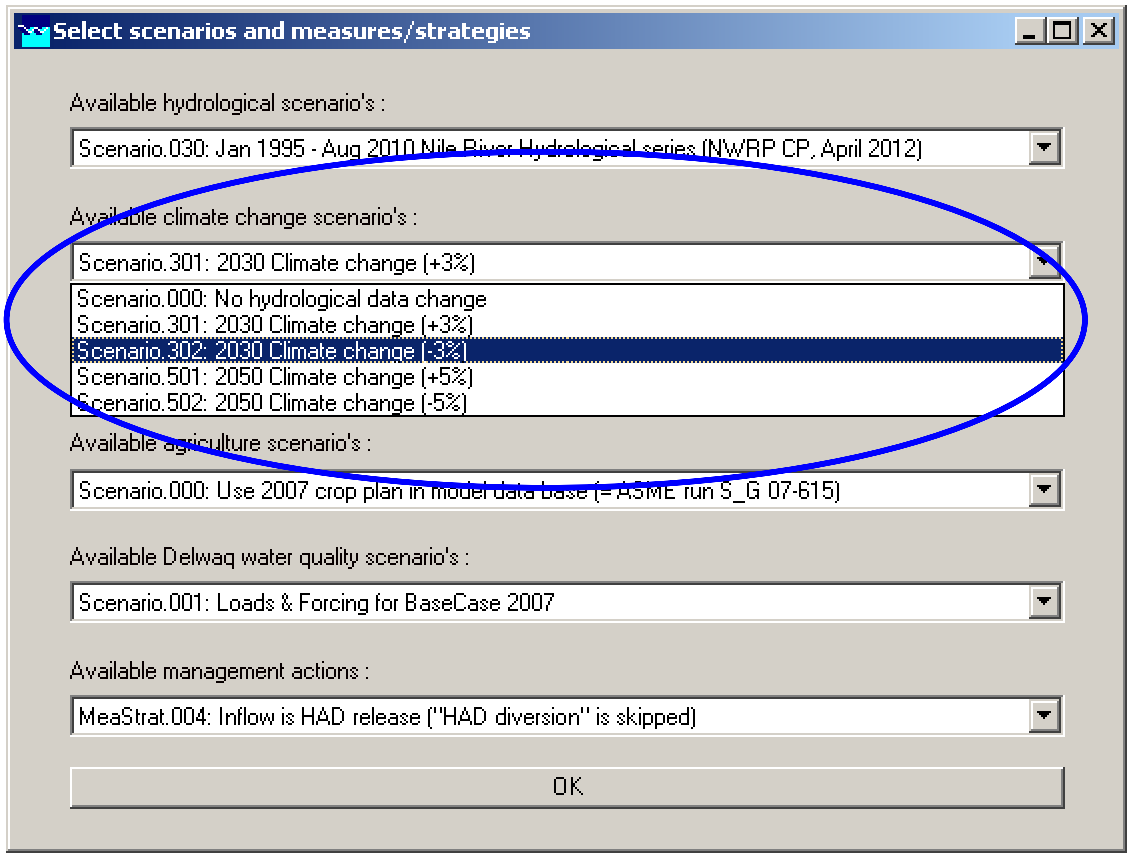

Figure 5.3 Drop-down list box for the selection of the climate change scenario.

The annual and multiple year time series for rainfall, evaporation, discharge, drainage and runoff are stored in a hydrological scenario, as described in the appendix F of the “RIBASIM Version 7.00 User manual”. Climate change can be interpreted as a variation on those hydrological time series. Different scenarios for climate change can be defined and modeled by the creation of a “Climate change scenario” in the directory “Climate” e.g. “\Climate\Scenario.301”. At the task block “Select scenarios, measures and strategies” the desired Climate change scenario can be selected.

An climate scenario is defined outside RIBASIM7 by creating a scenario in the directory *Climate* of the Rbd- or Rbn-directory e.g. Climate change scenario 1 for the Citarum river basin is stored in sub-directory \Citarum.Rbd\Climate\Scenario.001. A scenario consists of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The definition file *ClimDef.dat* with the name of the climate change data file, and
- The climate change data file, an Ini-file. The climate change data file contains the percentage (%) of increase or decrease of the hydrological parameters in de hydrological scenario. For example if for the actual rainfall a change of +10% is specified then the rainfall values which are read from the selected hydrological scenario will be increased with 10%.

The format of the definition file *ClimDef.dat* and the climate change data file (*Ini*-file) are outlined in the attachment B.

The scenarios must be defined and created outside the RIBASIM7 interface. Below the procedure is described how to create a new scenario and how to add it to the present scenarios. You have to carry out the following steps:

1 Create a new scenario directory in the *Climate* directory of your Rbd – or Rbn- river basin directory e.g. for your Citarum river basin application you define a third scenario then you create subdirectory:

\Ribasim7\Citarum.Rbd\Climate\Scenario.003

You can further create more scenarios in sub-directories Scenario.004, Scenario.005, etc.

2 Most convenient is to copy all files from a previous climate change scenario into the new scenario-directory.

3 Update the file DIRINFO with an editor, the Ms Windows Notepad or Wordpad. In this file you can store some administrative information about the newly created scenario. The name or a short description of the scenario must be specified at the first record of the file. This record is shown in the drop down list box at the selection of the scenario (see Figure 5.3).

4 Update the definition file *Climdef.dat* and the climate change data file with file type "*Ini*". The format of the file is indicated in the attachment B. In the Climate change data file the percentage increase (+) or decrease (-) of the hydrological parameters of the hydrological scenario are specified.

5.3 Land-use and population scenarios

You can select the scenarios from a drop down list box which shows all the implemented scenarios (see Figure 5.4).

A *land-use and population scenario* influences the following node types in the river basin network schematization:

- Public water supply nodes, and/or
- Fixed, Variable and Advanced irrigation nodes.

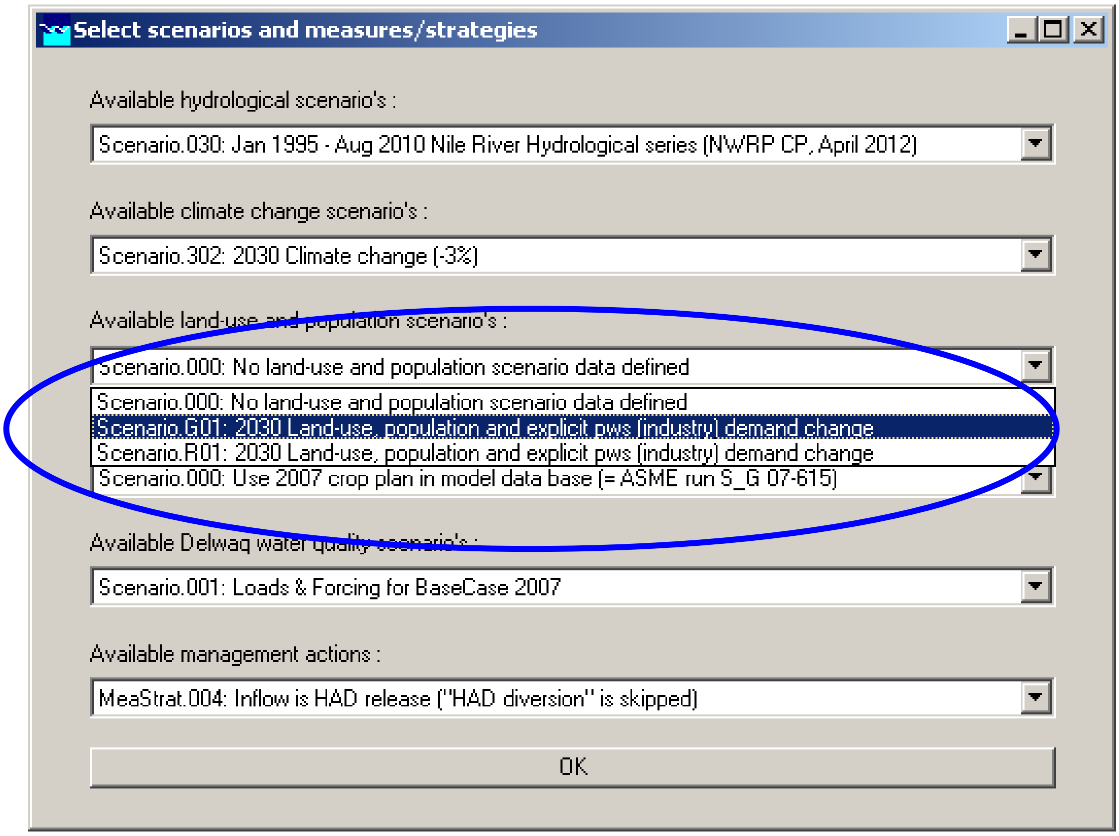

Figure 5.4 Drop-down list box for the selection of the land-use and population scenario.

A land-use and population scenario is defined outside RIBASIM by creating a different scenario in the directory *Landuse* of the *Rbd*- or Rbn-directory e.g. Scenario 1 for the Citarum river basin is stored in sub-directory \Citarum.Rbd\Landuse\Scenario.001. A scenario consists of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The definition file *LuPopDef.dat* outlining the name of the *Lpm*-file, and
- The land-use and population model data file, an *Lpm*-file. The land-use and population model data file contains for each catchment the change (%) of the following parameters:
  - the land-use cq irrigation area
  - the population

- the explicit public water supply demand

  The area of all fixed, variable and advanced irrigation nodes in the catchment will be updated with the specified change (%). Also the number of inhabitants (population) and explicit demand values of all public water supply nodes in the catchment will be updated with the specified change (%). For example in the model data base it is outlined that Public water supply node "Delft" is located in catchment with label 1 and that the number of inhabitants of the population is 200,000. Further in the land-use and population scenario the change of population in catchment with label 1 is specified an increase of 10 %, then in the simulation the model uses 220,000 inhabitants for Delft at the computation of the public water supply demand.

The sub-division of the basin into catchments is determined by the user. Most time each variable inflow node is related to a catchment. The label of the catchment (an integer value) is defined by the user. All Public water supply nodes, Fixed, Variable and Advanced irrigation nodes are located in one of the defined catchments. The catchment label is a model input data item for various node types like variable inflow, fixed, variable and advanced irrigation nodes.

The format of the definition file *LuPopDef.dat* and the land-use and population model data file (*Lpm*-file) are outlined in the attachment C.

The scenarios must be defined and created before you start up RIBASIM. Below the procedure is described how to create a new scenario and how to add it to the present scenarios. You have to carry out the following steps:

1. Create a new scenario directory in the *Landuse* directory of the *Rbd* – or *Rbn*- river basin directory e.g. you define a second scenario then you create subdirectory:

   \Ribasim7\Nile001.Rbd\Landuse\Scenario.002

   You can further create more scenarios in sub-directories scenario.003, scenario.004, etc.

2. Most convenient is to copy all files from a previous land-use and population scenario into the new scenario-directory.

3. Update the file DIRINFO with an editor, the Ms Windows Notepad or Wordpad. In this file you can store some administrative information about the newly created scenario. A short description of the scenario must be specified at the first record of the file. This record is shown in the drop down list box at the selection of the scenario (see Figure 5.4).

4. Update the definition file *LuPopDef.dat* and the land-use change and population change table files with file type "*Lpm*". The format of the file is indicated in the attachment C. In the land-use and population file table the land-use change and population change per catchment is outlined.

5.4 Agriculture scenarios

You can select the scenarios from a drop down list box which shows all the implemented scenarios (see Figure 5.5).

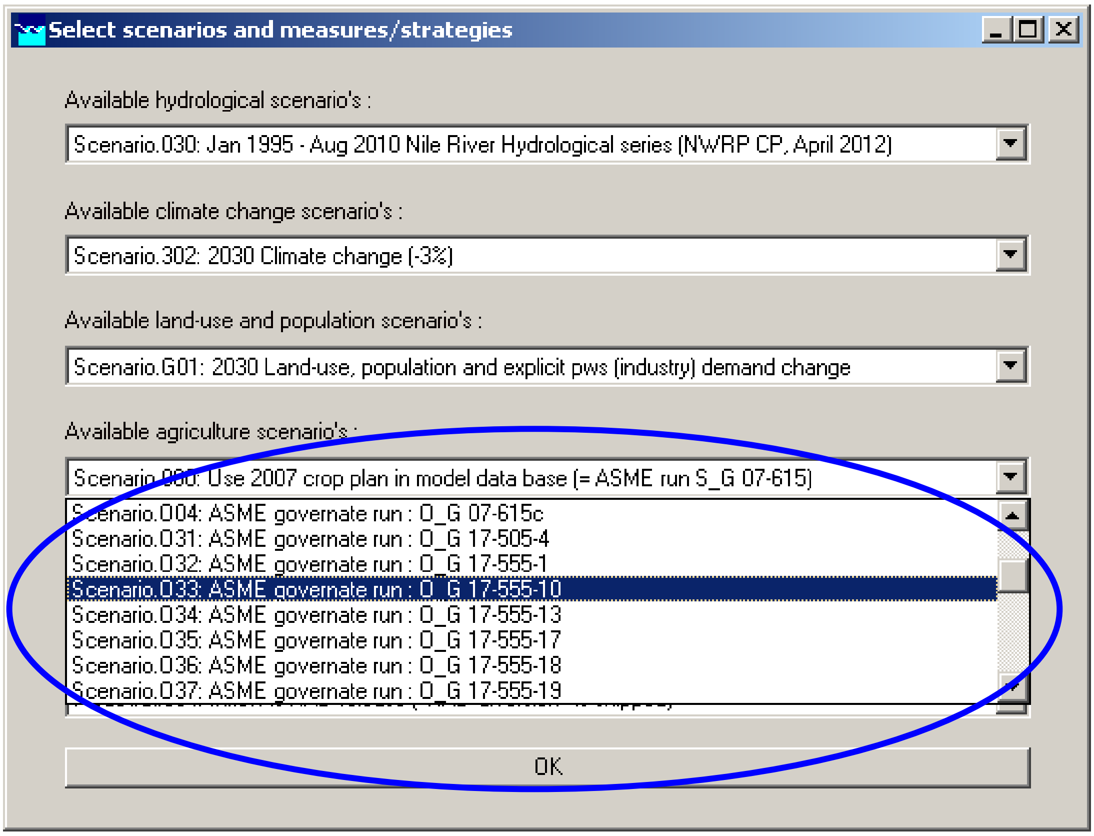

Figure 5.5 Drop-down list box for the selection of the agriculture scenario.

An agriculture *scenario* is only used if the river basin network schematization contains one or more "Advanced irrigation nodes".

An agriculture scenario is defined outside RIBASIM by creating a different scenario in the directory *Agricult* of the Rbd-directory e.g. Scenario 1 for the Citarum river basin is stored in sub-directory \Citarum.Rbd\Agricult\Scenario.1. A scenario consists of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The definition file *AgriDef.dat* outlining the name of the Asm-file, and
- The agriculture sector model data file, an *Asm*-file. The Agriculture sector model data file contains the crop plan per catchment. The crop plan is the list of cultivations adopted by each Advanced irrigation node within the catchment. So the crop plan of the Advanced irrigation nodes stored in the model data base is overwritten by the crop plan of the agriculture scenario.

The sub-division of the basin into catchments is determined by the user. Most time each variable inflow node is related to a catchment. The label of the catchment (an integer value) is defined by the user. All Advanced irrigation nodes are located in one of the defined catchments. The catchment label is a model input data item for various node types like variable inflow, advanced, variable and fixed irrigation nodes.

The format of the definition file *AgriDef.dat* and the Agriculture sector model data file (*Asm*-file) are outlined in the attachment D.

The scenarios must be defined and created before you start up RIBASIM. Below the procedure is described how to create a new scenario and how to add it to the present scenarios. You have to carry out the following steps:

1. Create a new scenario directory in the *Agricult* directory of the Rbd - river basin directory e.g. you define a second scenario then you create subdirectory:

   \Ribasim7\Nile001.Rbd\Agricult\Scenario.2

   You can further create more scenarios in sub-directories scenario.3, scenario.4, etc.

2. Most convenient is to copy all files from a previous agriculture scenario into the new scenario-directory.

3. Update the file DIRINFO with an editor, the Ms Windows Notepad or Wordpad. In this file you can store some administrative information about the newly created scenario. The name or a short description of the scenario must be specified at the first record of the file. This record is shown in the drop down list box at the selection of the scenario (see Figure 5.5).

4. Update the definition file *Agridef.dat* and the Agriculture sector model data file with file type “Asm”. The format of the file is indicated in the attachment C. In the Agriculture sector model data file the crop plan per catchment is outlined.

5.5 Basic water quality scenarios

The definition of (basic) water quality scenarios is outlined in chapter 5.2 of the “RIBASIM version 7.00 User manual”. This *scenario* is only used in the run mode RIBASIM7 only, thus without Delwaq.

5.6 DELWAQ water quality scenarios

You can select the scenarios from a drop down list box which shows all the implemented scenarios (see Figure 5.6).

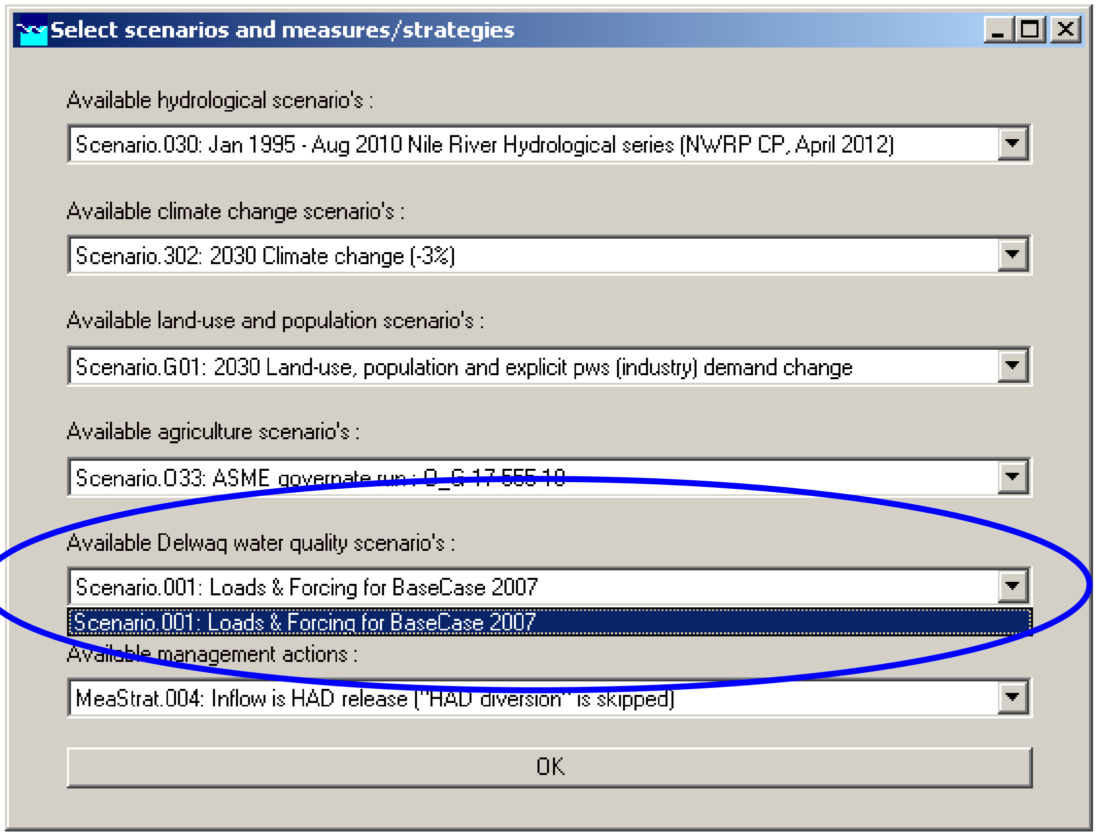

Figure 5.6 Drop-down list box for the selection of the DELWAQ water quality scenario.

A Delwaq water quality *scenario* is only used in the run mode RIBASIM7 with Delwaq.

An Delwaq water quality scenario is defined outside RIBASIM by creating a different scenario in the directory *BounLoad* of the Rbd-directory e.g. Scenario 1 for the Citarum river basin is stored in sub-directory \Citarum.Rbd\BounLoad\Scenario.001. A scenario consists of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The definition file *DlwqSet.dat* outlining the name of the various files, and
- A set of files as listed in the file *DlwqSet.dat.*

The format of the definition file *DlwqSet.dat* and the various data files are outlined in the attachment F.

The scenarios must be defined and created before you start up RIBASIM. Below the procedure is described how to create a new scenario and how to add it to the present scenarios. You have to carry out the following steps:

1. Create a new scenario directory in the *BounLoad* directory of the Rbd - river basin directory e.g. you define a second scenario then you create subdirectory:

   \Ribasim7\Nile001.Rbd\ BounLoad\Scenario.002

   You can further create more scenarios in sub-directories scenario.003, scenario.004, etc.

2. Most convenient is to copy all files from a previous Delwaq water quality scenario into the new scenario-directory.

3. Update the file DIRINFO with an editor, the Ms Windows Notepad or Wordpad. In this file you can store some administrative information about the newly created scenario. The name or a short description of the scenario must be specified at the first record of the file. This record is shown in the drop down list box at the selection of the scenario (see Figure 5.6).

4. Update the definition file *DlwqSet.dat* and the various data files. The format of the file is indicated in the attachment F.

6 Specification of Management actions

RIBASIM7 has a **measure and strategies (M&S) data base** in which all management actions are defined which need to be simulated for the basin analysis. At the task block "Select Scenario's, measures and strategies" one of the management actions in the M&S data base can be selected for the simulation case e.g. the measure to “Increase the Cirata dam height” is defined in the M&S data base. For the simulation case in which the effect of the increase of the Cirata dam height must be analyzed, this management action is selected in the user interface at the task block "Select Scenario's, measures and strategies” (see *Figure* 3.3). When the simulation is executed at task block “River basin simulation” first the data from the Model data base 2010 are read and next the data from the selected management action which consists here of a new set of Cirata dam and reservoir characteristics. Those data are overwriting the previous read data from the Model data base 2010 and are thus used for the simulation.

The M&S data base must be filled outside the RIBASIM7 interface. It consists of a number of Ini-files to be created in specific sub-directories (comparable with the hydrological scenarios definition, climate change scenarios definition, land-use change and population scenarios definition, agriculture sector scenarios definition).

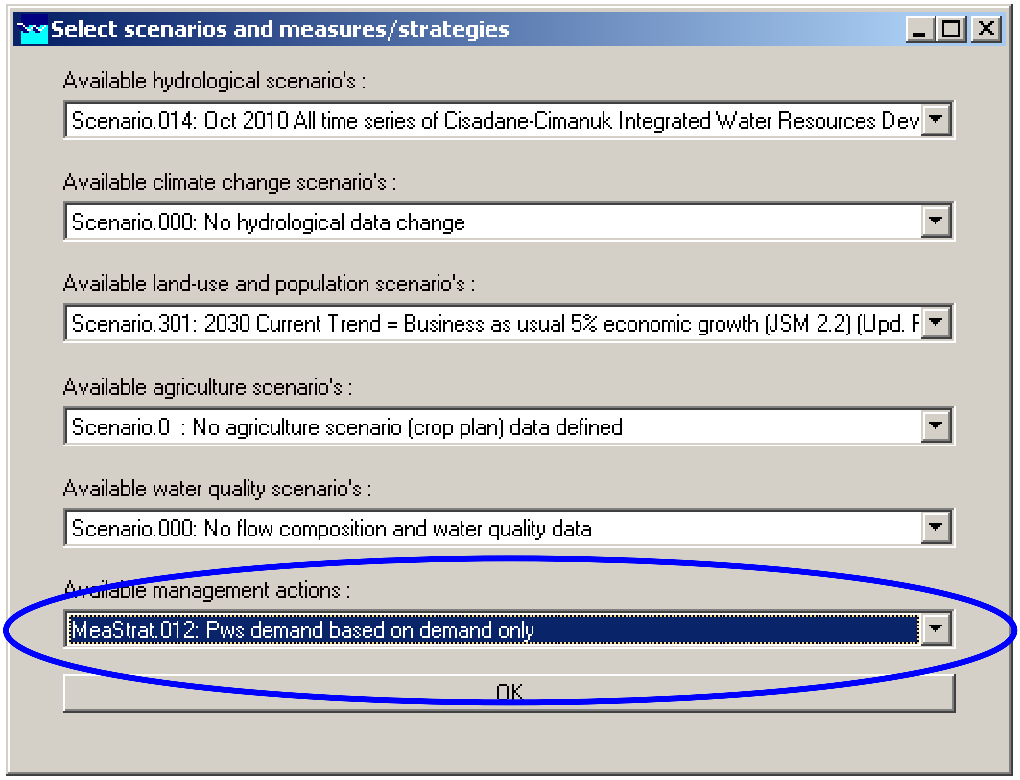

Figure 6.1 Selection menu at task block "Select Scenario's, measures and strategies".

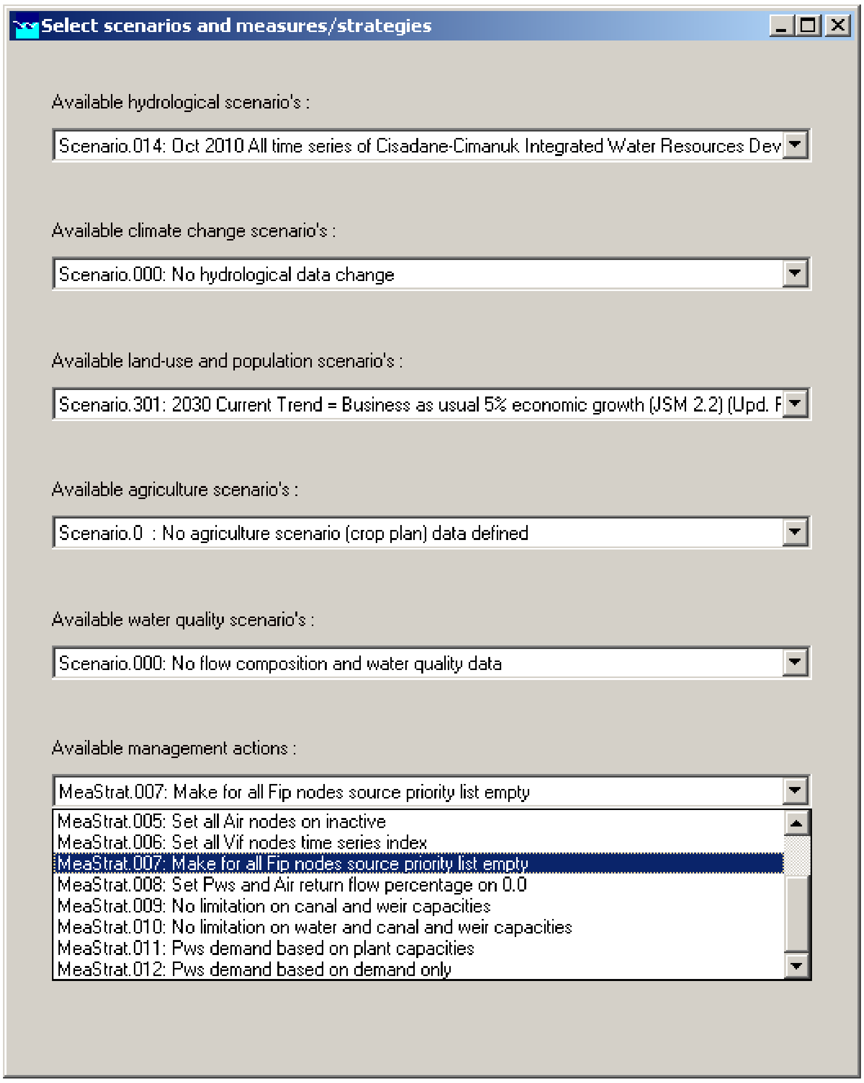

Figure 6.2 Selection of the management action from drop-down menu to simulate in the case.

The M&S data base is defined and stored in the sub-directory "*Actions*" of the Rbn- or Rbd-directory e.g. in the directory *\6Cis006.Rbn\Actions* all measures and strategies of the "*6Ci006*" model are defined. The following sub-directories are further present:

- One "*Measures*" sub-directory in which all measures are defined.
- One or more "*MeaStrat*" sub-directories in which the management actions (interventions, strategies) are defined.

The format of the measure and management action definition file is specified in Annex G and H.

The working procedure with RIBASIM is that the user starts with the setup of the model data base which may include all potential and future developments. For the base case which usually is the calibrated present situation, those potential and future developments are inactive. The data describing this case are stored in the RIBASIM model data base. When scenarios, measures and strategies must be analyzed this model data will change e.g. if the effect of a new (potential) reservoir must be analyzed then the reservoir must be activated.

This means that the node representing this reservoir which is initially set on “inactive” must be switched to “active”. The data which must be changed to make the measure or strategy effective is stored in the measure definition data file, a file with file type “Mes”.

If you want to define one or more management actions you must carry out the following tasks outside RIBASIM:

1. Create one or more measure Mes-files in the sub-directory “Measures” in which you define your measures. Easiest way is to start with one of the example Mes-files and edit the file in a normal text editor (Notepad, Textpad, Xedit, etc). You can also prepare Mes-files with Ms Excel.

2. Create a new “MeaStrat.xxx” sub-directory with xxx = the sequence index. Copy the files of a previous MeaStrat directory and edit those files.

When you want to execute a simulation case with the new created management action then under RIBASIM:

1. At task block “Select scenario’s, measures and strategies” you select the new management action from the drop-down menu.

2. At task block “Edit network and data base on map” you select first the menu item “Generate overview of data base” and next “View tables of data base” and check if the model data has been changed according to your measure definition.

Aware that the data in the model data base which you enter, update and check from map via spreadsheet tool at the network editor Netter is always the data in the model data base **without** the selected management actions

7 Link with water quality process model DELWAQ

For the conceptual and computational details of the Delwaq model a separate User and Technical reference manuals Delwaq is available.

7.1 Case management screen

For the use of DELWAQ three newly added task blocks.

- Edit Delwaq water quality process configuration
- Delwaq water quality process computation
- Analysis of water quality process results

7.1.1 Task block “Edit Delwaq water quality process configuration”

RIBASIM/DELWAQ requires the selection of a certain type of model. This selection concerns:

- the list of modelled substances;
- the list of modelled processes;
- the initial conditions to be applied;
- the model parameters;
- the meteorological and hydraulic forcing functions to be applied;
- the available output variables (in addition to the modelled substances).

In the user interface, you select the type of model from a list of available types (see Figure 7.1).

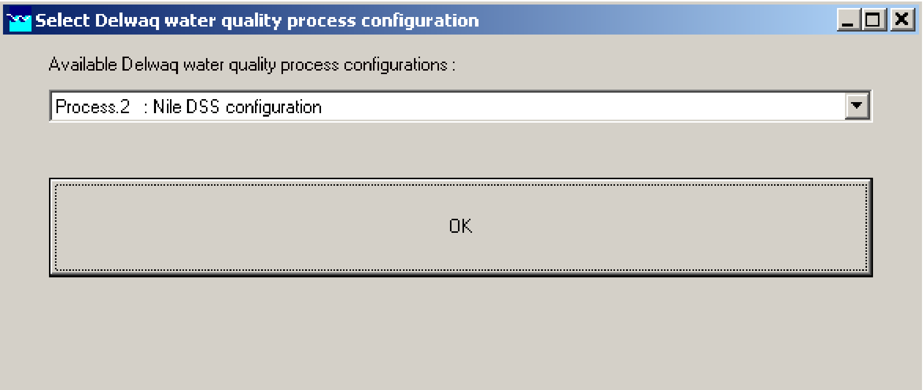

Figure 7.1 Selection of type of model

The available types have been prepared by the model developer. The files holding the relevant information are stored in:

```
\Ribasim7\zzzzzzzz.Rbd\Quality\Process.1\*.*
\Ribasim7\zzzzzzzz.Rbd\Quality\Process.2\*.*
```

```
etc …
```

where zzzzzzzz equal to the name of the model or basin (maximal 8 characters) e.g. Niledlt1.Rbd.

Each one of these folders is supposed to contain the following files:

• Dirinfo	description of type in first line
• ProcDef.dat	definition of file names
• initials.dwq	initial conditions
• substanc.dwq	substances
• process.dwq	processes
• constant.dwq	parameters & meteo & hydraulics
• outputm.dwq	extra output variables (maps)
• outputh.dwq	extra output variables (charts

The files are all ASCII files and allows for easy inspection and editing. A description of their format has still to be prepared.

7.1.2 Task block “Delwaq water quality process computation”

At this task block the water quality process computations are executed based on the water balance results of the task block “River basin simulation”.

7.1.3 Task block “Analysis of water quality process results”

At this task block data and results of the Delwaq water quality process computations can be analysed. There are 3 options:

- Results on map
- Results on charts
- Results in reports

Results on map and charts

Under these menu items the following Delwaq input data and results can be shown on map, in graphs or can be exported to an external file or Ms Excel:

Delwaq input data	**File name**
Node area (m2) and volume (m3) for all segments	Nodes.his
Node boundary flows	Nodeboun.his
Public water supply nodes emissions	WL_pws.his
Advanced irrigation nodes emissions	WL_air.his
Link flows (m3/s)	Links.his
Delwaq output : segment results	
Substance concentrations	Wq_rib.his

Table 7.1 lists a potential list of substances for public water supply nodes emissions. And Table 7.2 lists a potential list of substances for advanced irrigation nodes emissions. Table 7.3 lists a potential list of substances for which concentrations are computed for all segments.

Results in reports

Under this menu items the following waste load model (WLM) and Delwaq output reports can be viewed:

WLM output reports	**File name**
Waste load model debug output	nepwlm.lst
Delwaq output reports	
File Input Report	wq_rib.lst
File Processes Library Report	wq_rib.lsp
File Mass Balances	wq_rib.bal

Table 7.1 Example list of substances for public water supply nodes.

NH4 (g)	BOD (g)	Cd (g)	Tot_P (g)	TColi (g)
NO3 (g)	COD (g)	Cu (g)	PO4 (g)	TSS (g)
Norg (g)	Cl (g)	Zn (g)	Pb (g)	

Table 7.2 Example list of substances for advanced irrigation nodes.

Tot_N (g)	BOD (g)	TSS (g)	Cu (g)	Pb (g)
Tot_P (g)	TDS (g)	Cd (g)	Zn (g)	

Table 7.3 Example list of substances for which Delwaq computes the concentrations.

AAP	DetC	GREEN	LimSidiat	Surf
AAPS1	DetCS1	IM1	MrtToTColi	TColi
AlgDM	DetN	IM1S1	NH4	TDS
AlgN	DetNS1	IM2	NO3	Temp
AlgP	DetP	IM2S1	OXY	TIM
AlgSi	DetPS1	KjelN	Pb	TotN
BOD5	DetSi	LimDLdiat	PbS1	TotP
CBODu	DetSiS1	LimDLGreen	Phyt	TotSi
Cd	DIAT	LimNdiat	PO4	Volume
CdS1	DIN	LimNgreen	POC	Vwind
Chlfa	DO	LimNutDiat	Rad	Zn
Continuity	ExtVl	LimNutGree	RCRear	ZnS1
Cu	ExtVlBak	LimPdiat	SaturOXY	Surf
CuS1	ExtVlISS	LimPgreen	Si	TColi
DayL	ExtVlOSS	LimRadDiat	SOD	TDS
Depth	ExtVlPhyt	LimRadGree	SS	Temp

7.2 Schematization issues

The steps to create a Delwaq segment schematization based on a RIBASIM node-link network schematization are:

1. Design a RIBASIM node – link network schematization
2. Generate and edit Delwaq segments under the network editor Netter: *Edit* > *Edit Delwaq segments.* Next at the pop-up window: *Auto* > *File* > *Close.* At this step the Delwaq pointer table is generated.
3. At Netter save the RIBASIM node – link network: *File* > *Save* > *Network*
4. Exit Netter: *File* > *Exit.*
    a. When Netter is closing a pop-up window appears with the message "*Delwaq network has been changed. Do you want to save the changes?*". You must select: *Yes*.
    b. At the background the program NtrDlwq is executed which updates the Delwaq pointer table (Poi-file) which generated at step 2.

The generated Delwaq schematization can be shown under Netter menu item: *Options* > *Options* > *Delwaq* folder > Set switch "*Show Delwaq*" on. Figure 7.2 an example river basin node-link and associated segment schematization.

The Delwaq segment ID's can be shown under the Netter menu item: *Options* > *Options* > *Node* folder > Set switch "*Delwaq ID*" on.

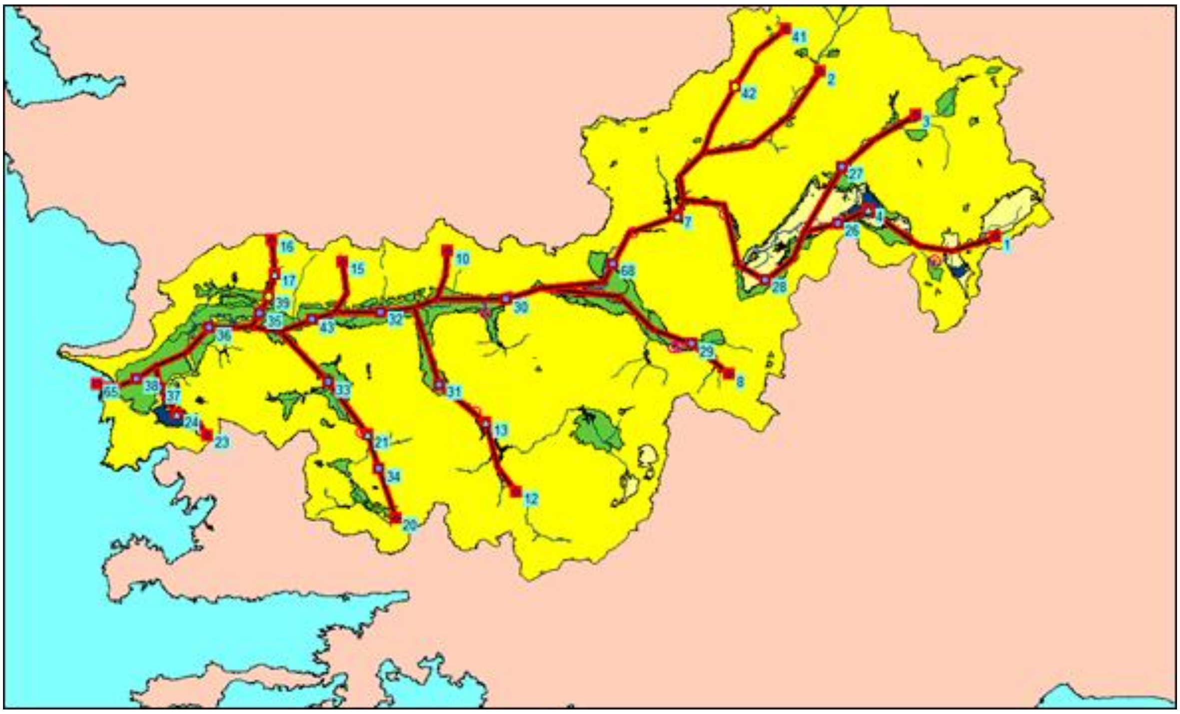

Figure 7.2 Example Delwaq segment schematization based on a RIBASIM node-link network schematization (Buyuk Menderes basin, Turkey).

8 Flow statistics

The new option on link flow statistics is available under the task block “Result: on charts” called “All links statistics”. The option shows the annual flows over the simulated time period for the parameters:

- Minimum flow
- Average flow
- Maximum flow
- Standard deviation
- One or more dependable flow
- Simulated flow per calendar year

Standard deviation

The (corrected) standard deviation s is:

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \overline{x})^2}.$$

With:

X_i Simulated flow values for time step i

$\overline{x}$ Average flow

N Number of flow values

Control data

The file “*Dischrg.dat*” controls the number of dependable flow computations and is stored in the “Fixed” sub-directory. The file can directly be edited by pushing the right mouse button at task block “River basin simulation” and by selecting menu item “Dependable flow control data”. The content of the file is outlined in Table 8.1. An example file is shown below.

Table 8.1 Contents of file with dependable flow computation data.

Records	Description
1	The header must be as follows: ODS 1.00DAT 1.00HANDMADE
2	Some comment records : records with an asterisk (*) I first column
3	Dependable flow computation method index : * 1 = Normal distribution method 2 = Empirical method
4	Some comment records : records with an asterisk (*) in the first column
5	One or more values (> 0.0) representing: 1. If method index = 1 then value = standard normal variable obtained

	from normal distribution table (z = 0.70 for 75% likelihood) 2. If method index = 2 then value = likelihood of exceedance e.g. 0.75 for a 75% dependable time series value

* There are 2 methods to compute the dependable flow: the normal distribution method and the empirical method.

Example input data file for the computation of the dependable flow.

```
ODS 1.00DAT 1.00HANDMADE
*
* Program Dischrg control data file
* --------------------------------
*
* Dependable flow computation method index :
*
* 1 = Normal distribution method
* 2 = Emperical method
*
      2
*
* One or more values (> 0.0) representing:
*
* 1. If method index = 1 then value = standard normal variable obtained from normal distribution table
*     (z = 0.70 for 75% likelihood)
* 2. If method index = 2 then value = likelihood of exceedance e.g. 0.75 for a 75% dependable time
*     series value
*
     0.90
     0.50
     0.20
```

Use of new option

The new option can be used to get more insight in the water balance. The statistics values can be shown graphically under Ods_view. An example of the final result is shown in Figure 8.1.

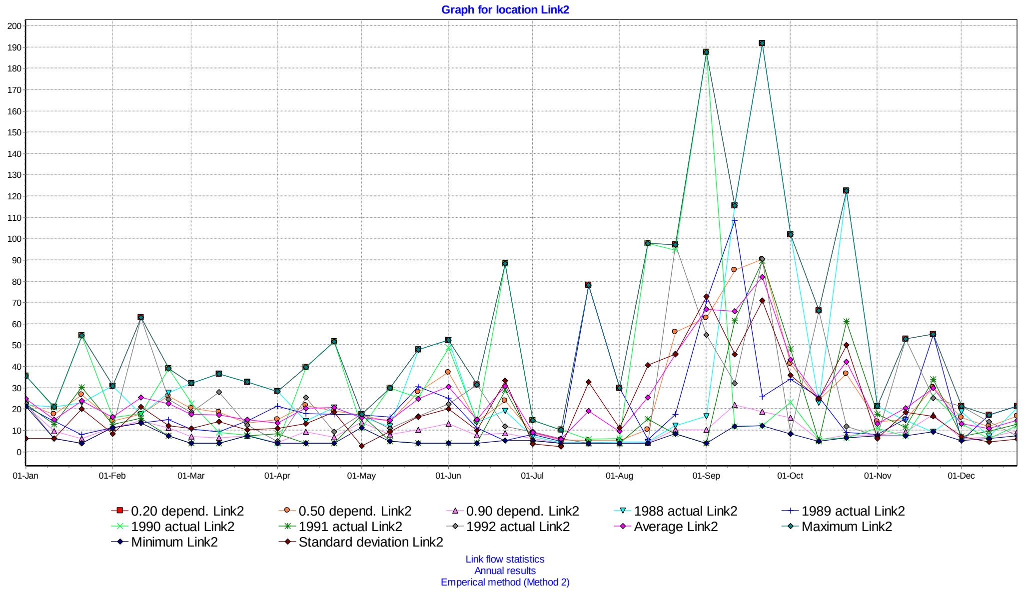

Figure 8.1 Example graph of the link flow statistics parameters for a decade time step (36 time step per year).

9 Annual results and cumulative distribution function

Introduction

RIBASIM Version 7.01 has been extended with several extra output parameters:

1. Annual results and
2. Cumulative distribution function (CDF).

The parameters are generated by the post-processing program Rb2HisAn. The annual results are output in:

1. table form in the log-file Rb2HisAn.log. The desired tables can be specified in the fixed control data file Rb2HisAn.dat. An example file is shown in annex A.
2. His-file format in the annual result His-files of each node and link type. With Ods_View this file can be picked up to make a graph or export the values to Ms Excel.

Control data

The user can specify in the control data file *Rb2HisAn.dat* which tables must be produced. This file is stored in the directory *Fixed*. An example is shown below.

```
ODS 1.00DAT 1.00HANDMADE
*
* Control data file
* -----------------
*
* Used by        : program Rib2HisAn
* Reading format : free format
*
* Cumulative distribution function computation method index :
*
* 1 = Normal distribution method (not implemented yet)
* 2 = Emperical method
*
      2
*
* Number of Likelihood of exceedance variables
*
      41
*
* Per record :
*
* - Switch to indicate generation of associated table : 0 = no, 1 = yes
*
* Switch Table description
* ------ -----------------
    1    Table 1.  Annual link results
    1    Table 2.  Annual surface water reservoir node results
    1    Table 3.  Annual run-of-river node results
    1    Table 4.  Annual low flow node results
    1    Table 5.  Annual public water supply node
    1    Table 6.  Annual fixed irrigation node results
    1    Table 7.  Annual variable irrigation node results
    1    Table 8.  Annual advanced irrigation node results
    1    Table 9.  Annual fish pond node results
    1    Table 10.  Annual loss flow node results
    1    Table 11.  Annual general district node results
    1    Table 12.  Annual ground water district node results
    1    Table 13.  Annual pumping node results
    1    Table 14.  Annual gw abstraction link results
```

Annual results

Table 9.1 and Table 9.2 and outline the annual output parameters per node and link type. The computation of the annual value starts with the first simulation time step. For example if the simulation period is from September 1991 till August 2000 then there are 10 complete years from September till August.

Table 9.1 Annual output parameters per node type.

Node type	**Annual output parameters**
Reservoir	Annual generated energy (GWh) Annual firm energy demand (GWh) Annual firm energy shortage (GWh) Average annual generated energy (GWh) Deviation from average (GWh)
Run-of-river	Annual generated energy (GWh) Average annual generated energy (GWh) Deviation from average (GWh)
Low flow Public water supply Fixed irrigation Variable irrigation Advanced irrigation Fish pond Loss flow General district Groundwater district	Annual demand (Mcm) Annual shortage (Mcm)
Pump	Annual pumped energy (MWh)

Table 9.2 Annual output parameters per link type.

Link type	**Annual output parameters**
All	Annual flow (Mcm) Average flow (Mcm) Deviation from average flow (Mcm)
Groundwater abstraction	Annual pumped energy (MWh)

Cumulative distribution function (CDF)

The cumulative distribution function is computed for a number of annual output parameters. Table 9.3 outlines the annual output parameters for which a CDF is computed and the node and link types involved. The CDF is output in a His-file format.

Table 9.3 Annual output parameters per link type.

Annual output parameters	**Network component**
Annual flow (Mcm)	All link types
Generated energy (GWh)	Run-of-river node Reservoir node
Consumed energy (MWh)	Groundwater district node Pump node Groundwater abstraction link
Demand (Mcm)	Low flow node Public water supply node Fixed irrigation node Variable irrigation node Advanced irrigation node Fish pond node Loss flow node General district node Groundwater district node
Shortage (Mcm)	Low flow node Public water supply node Fixed irrigation node Variable irrigation node Advanced irrigation node Fish pond node Loss flow node General district node Groundwater district node

Computation of the CDF

The computation of the CDF is described below. The CDF is computed for a fixed defined number of exceedance A multiple year of simulation results is available on a time step basis. The CDF is computed as follows:

Step 1 The annual values are computed starting from the first simulation time step. The result is a time series of N annual values.
Step 2 The N values are sorted in increasing order.

Probability of exceedance of the i-th value = (N + 1 - i) / (N + 1)

Step 3 For each of the desired CDF probability values the actual annual value is computed by linear interpolation.

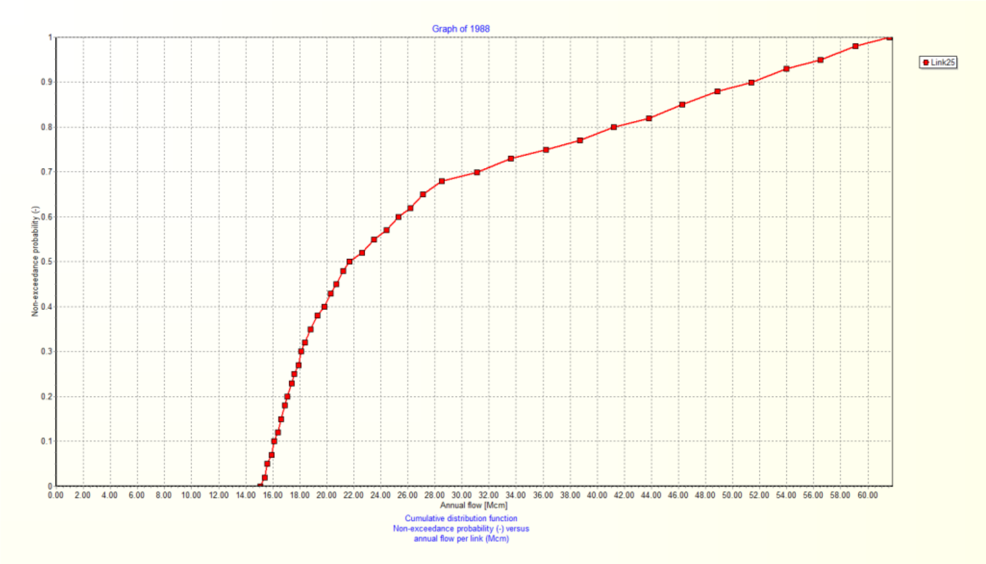

Figure 9.1 Example CDF graph for annual link flow (Mcm).

10 Annual results and histogram

Introduction

With RIBASIM the results can be shown in a histogram. This is a graphical representation of the distribution of data and an estimation of the probability distribution of the results. It is a representation of tabulated frequencies over discrete intervals (bins) with an area equal to the frequency of the results (observations) in the interval. RIBASIM Version 7.00 already included the generation of histograms for selected variables. RIBASIM Version 7.01 has been extended with:

1. extra histogram output parameters:
    a. Annual parameters:
        i. firm energy shortage (GWh) for each reservoir node with hydro-power and
        ii. water supply shortage (Mcm) for each demand node.
    b. Time step parameters:
        i. link flows (m3/s),
        ii. firm energy shortage (GWh) and
        iii. water supply shortage (Mcm) for each demand node.
2. evaluation of the performance of the annual basin firm energy shortage for each reservoir with hydro-power and the water supply shortage for the following demand nodes:
    a. Surface water reservoir
    b. Low flow
    c. Public water supply
    d. Fixed irrigation
    e. Variable irrigation
    f. Advanced irrigation
    g. Fish pond
    h. Loss flow
    i. General district
    j. Groundwater district

The parameters are generated by the post-processing program *Freqint*.

Control data

There are 2 input data files stored in the directory *Fixed* to control the data processing:

1. Control data file *Freqint.dat*
2. Data file *Selvrbl.dat*

File *Freqint.dat* contains the following data (example file is shown below):

1. on-off switches to indicate the desired output tables to the log-file *Freqint.log* and
2. annual firm energy and water supply shortage performance criteria per node type. This consists of 3 criteria values:

    a. maximum annual shortage for shortage year (% of annual demand). The year is a shortage year if the annual shortage is higher than this value.

b. maximum annual shortage (% of annual demand). A “Warning” is specified in output Table 7.2 of the log-file *Freqint.log* if the maximum annual shortage is bigger than this value. Annex D includes an example.
c. maximum annual shortage frequency (% of the simulated years). A “Warning” is specified in Table 7.2 of log-file Freqint.log file if the percentage of shortage years (= 100 * number of shortage years / number of simulated years) is higher than this value. A shortage year is defined with criteria value a. An example of this table is shown below.

```
ODS 1.00DAT02.00Handmade 6.00
*
* Control data
* ============
*
* Used by        : program Freqint
* Reading format : free format
*
* for record :
*
* - Switch to indicate generation of associated table : 0 = no, 1 = yes
*
* User action: Change switch to 0 or 1 (the order of tables is fixed)
*
* Switch Table description
* ------ -----------------
    1    Table 1.1 Boundary values for selected data series (% of target value)
    1    Table 1.2 Frequency distribution for selected data series
    1    Table 2.1 Boundary values for link flow series (% of maximum value)
    1    Table 2.2 Frequency distribution for link flow series
    1    Table 3.1 Boundary values for water shortage series (% of demand)
    1    Table 3.2 Frequency distribution for water shortage series
    1    Table 4.1 Boundary values for firm energy shortage series (% of demand)
    1    Table 4.2 Frequency distribution for firm energy shortage series,
    1    Table 5.1 Boundary values for annual shortage series (% of annual dmnd)
    1    Table 5.2 Frequency distribution for annual water shortage series
    1    Table 6.1 Boundary values for an. firm energy shortage series (% of an. dmd)
    1    Table 6.2 Frequency distribution for annual firm energy shortage series
    1    Table 7.1 Annual firm energy shortage performance evaluation
    1    Table 7.2 Annual water shortage performance evaluation
*
* Annual firm energy and water supply shortage performance criteria per node type:
*
* 1. Maximum annual shortage for shortage year (% of annual demand)
* 2. Maximum annual shortage (% of annual demand)
* 3. Maximum annual shortage frequency (% of simulation years)
*
* User action: change values of "% of annual demand" and "% of sim.years"
*             (the order of node types is fixed)
*
* Max. annual shortage                        Max. annual
* for shortage year     Max. annual shortage  shortage freq.
* (% of annual demand)  (% of annual demand)  (% of sim.years) Node type
* --------------------  --------------------  ---------------- ---------
                100.0                 100.0            100.0 Sw rsvoir (firm enrgy)
                100.0                 100.0            100.0 Low flow
                 10.0                   0.5              0.5 Public water supply
                 15.0                  50.0             20.0 Fixed irrigation
                100.0                 100.0            100.0 Variable irrigation
                100.0                 100.0            100.0 Advanced irrigation
                100.0                 100.0            100.0 Fish pond
                100.0                 100.0            100.0 Loss flow
                100.0                 100.0            100.0 General district
                100.0                 100.0            100.0 Groundwater district
```

Example output table 7.2 of log-file Freqint.log.

Table 7.2 Annual water shortage performance evaluation

Annual shortage frequency is in % of simulated years
Maximum and average annual shortage is in % of annual demand

Node index	Node name	An. short. freq. Criteria	An. short. freq. Actual	Max. an. shortage Criteria	Max. an. shortage Actual	Average annual shortage	Remark
72	Tr1_Lks_AEPZoneCotiereFrmBgeSmir	100.00	0.00	100.00	0.00	0.0	
73	Tr2_Lks_AEPZoneCotiereFrmBgeMHBElMehdi	100.00	0.00	100.00	0.00	0.0	
74	Tr3_Lks_AEPZoneCotiereFrmBgeMartil(P)	100.00	0.00	100.00	0.00	0.0	
76	Tr4_Lks_AEPZoneCotiereFrmBgeNakhla	100.00	0.00	100.00	0.00	0.0	
77	Tr1_Lks_AEPAlHoceimaFrmBgeRhiss(P)	100.00	0.00	100.00	0.00	0.0	
12	Aep_Oer_RuralElJadida:P5	0.50	0.00	0.50	0.00	0.0	
13	Aep_Oer_Azemmour	0.50	4.55	0.50	16.62	0.5	Warning
147	Aep_Lks_ChefchaouenEtRural(P)	0.50	0.00	0.50	0.00	0.0	
175	Aep_Brg_Tamesna	0.50	1.52	0.50	46.99	0.7	Warning
222	Aep_Lks_RuralDarKhrofa(P)	0.50	0.00	0.50	0.00	0.0	
285	Aep_Seb_Bouhouda	0.50	0.00	0.50	0.00	0.0	
310	Aep_Seb_Taounate	0.50	1.52	0.50	8.64	0.1	Warning
425	Aep_Seb_Taza	0.50	0.00	0.50	0.00	0.0	
485	Aep_Seb_TifletKhemisset	0.50	0.00	0.50	0.00	0.0	
680	Aep_Lks_DarChaoui	0.50	1.52	0.50	25.61	0.4	Warning
850	Aep_Lks_TetouanZoneCotiere	0.50	0.00	0.50	0.00	0.0	
885	Aep_Lks_Targuist	0.50	0.00	0.50	0.00	0.0	
15	Irr_Brg_PMHAinKoreima:Bou9	20.00	100.00	50.00	100.00	91.9	Warning
55	Irr_Brg_PMHSidiAmar:Bou23(P)	20.00	0.00	50.00	0.00	0.0	
59	Irr_Seb_PMHSaiss(P)	20.00	0.00	50.00	0.00	0.0	
70	Irr_Brg_PMHSidiOmar:Bou33(P)	20.00	0.00	50.00	0.00	0.0	
82	Irr_Seb_PMHBabOuender(P)	20.00	0.00	50.00	0.00	0.0	
95	Irr_Brg_PMHKhannoussa:Bou31(P)	20.00	0.00	50.00	0.00	0.0	
103	Irr_Seb_TTIE2Z6	20.00	0.00	50.00	14.56	0.2	
106	Irr_Seb_GHTTIZ3Z4Z5(P)	20.00	0.00	50.00	0.00	0.0	
122	Irr_Lks_PMHLoukkosRiveGauche	20.00	0.00	50.00	0.00	0.0	
132	Irr_Lks_PMHMartil(P)	20.00	0.00	50.00	0.00	0.0	
135	Irr_Brg_PMHRouidat:Bou8	20.00	65.15	50.00	97.60	31.7	Warning
148	Irr_Lks_GHMoulayBouchta(P)	20.00	0.00	50.00	0.00	0.0	
179	Irr_Lks_PMHLaou	20.00	4.55	50.00	22.10	2.1	
202	Irr_Lks_PMHAyacha(P)	20.00	0.00	50.00	0.00	0.0	
223	Irr_Lks_GHDarKhrofa(P)	20.00	0.00	50.00	0.00	0.0	
250	Irr_Seb_UPAOuerghaAmont	20.00	0.00	50.00	5.20	0.3	
355	Irr_Seb_PMHZelloul(P)	20.00	0.00	50.00	0.00	0.0	
380	Irr_Seb_PMHMikkes	20.00	0.00	50.00	1.59	1.2	
395	Irr_Seb_PMHLebene	20.00	100.00	50.00	94.36	68.6	Warning
1275	Irr_Oer_PMHTessaoutIntermediare:I13	20.00	0.00	50.00	8.21	0.2	
1300	Irr_Oer_GHTessaoutAmont:I14	20.00	56.06	50.00	79.76	25.1	Warning
1340	Irr_Oer_GHDir:I2	20.00	100.00	50.00	92.43	54.2	Warning
1515	Irr_Oer_PMHAmontTadla:I24	20.00	0.00	50.00	0.00	0.0	
1630	Irr_Oer_GHBeniAmir:I1	20.00	25.76	50.00	80.85	12.4	Warning
1660	Irr_Oer_GHTessaoutAvalT2:I6	20.00	43.94	50.00	99.98	29.8	Warning

Data file *Selvrbl.dat* the user can specify selected variables for which a histogram must be generated and the histogram characteristics. An example file is shown below. The list of selected variables per node type is shown below.

```
ODS 1.00DAT02.00RANGEN   6.00UpFxDbs
*
* Series for frequency interval analysis
* ======================================
*
* Format : free format
*
* - Frequency analysis index : 1 = one analysis for the whole simulation period
*                              2 = separate analysis for each time step
     1
*
* - Node index,
* - Variable index
* - Range type definition index : 1 = Minimum value - maximum value
*                                 2 = Minimum value - interval size value
* - 2 values depending the range type definition :
*   Type 1 : Minimum value, maximum value.
*            The range will be divided into 10 frequency intervals. If both
*            values equal to -1.0 then program uses the minimum and maximum
*            value of within the whole time series range.
*   Type 2 : Minimum value, interval size.
*            Values must not be equal to -1.0.
*
*   Aware that range values of flows should be specified in m3/s.
*
* Node    Variable Range Minimum        Maximum value or
* index   index    type  value          Interval size
* ------- -------- ----- -------------- --------------
       30        1     1         2.0000        10.0000
       30        2     1        -1.0000        -1.0000
       30        3     1        -1.0000        -1.0000
       30        4     1        -1.0000        -1.0000
       30        5     1        -1.0000        -1.0000
      107        1     1         0.0000       100.0000
      107        2     1        -1.0000        -1.0000
      107        3     1        -1.0000        -1.0000
```

The list of the selected variables per node type are below.

```
 Tp ix   = Node type index
 Var inx = Ouput variable index
 Unt     = Unit
 Nwqsub  = Number of water quality substances defined in file WQsubsta.dat

                  Tp Var
 Type of node     ix inx Output variables description
 ---------------- -- --- ---------------------------
 Variable inflow   1   1 Downstream flow (Mcm)
                       2 Miscellaneous consumption (Mcm)
                       3 Shortage to miscellaneous users (Mcm)
                       4 Variable inflow (Mcm)
                       5 Upstream link flow of previous time step (Mcm)
                       6 Potential virgin area (km2)
                       7 Actual virgin area (km2)
                       8 Total fixed irrigation node area in catchment (km2)
                       9 Total variable irrigation node area in catchment (km2)
                      10 Total advanced irrigation node area in catchment (km2)
                      11 Total fish pond node area in catchment (km2)
                      12 Total sw reservoir area in catchment (km2)
                      13 Total link storage node area in catchment (km2)
                      14 Total gw district node area in catchment (km2)

                      For each Sacramento model segment (maximal 5) the following parameters:

                      15 Actual segment area (km2)
                      16 UZTWC = Upper zone tension water content (mm)
                      17 UZFWC = Upper zone free water content (mm)
                      18 LZTWC = Lower zone tension water content (mm)
                      19 LZFSC = Lower zone supplementary free water content (mm)
                      20 LZFPC = zone primary free water content (mm)
                      21 PLIQ  = Actual rainfall (mm)
                      22 EDMND = Potential evapotranspiration (mm)
```

```
                        23 EUSED = Actual evapotranspiration (mm)
                        24 QF    = Total runoff (mm)
                        25 STOR  = Storage at end of time step (mm)
                        26 ADIMC = Contents of area which when saturated produces direct runoff(mm)
                        27 FLOBF = Base flow (mm)
                        28 FLOIN = Interflow (mm)
                        29 FLOBS = ???, (mm)
                        30 ROIMP = Runoff from impervious or water-covered area (mm)
                        31 SSOUTACT = Actual surface runoff ? (mm)

Fixed inflow       2     1 Downstream flow (Mcm)
                         2 Fixed inflow (Mcm)
                         3 Upstream link flow of previous time step (Mcm)

Confluence         3     1 Downstream flow (Mcm)

Terminal           4     1 End flow (Mcm)

Recording          5     1 Downstream flow (Mcm)
                         2 Recorded flow (Mcm)

Reservoir          6     1 Flow into sw reservoir (Mcm)
                         2 Net evaporation (Mcm)
                         3 Level at end of time step (m)
                         4 Volume at end of time step (Mcm)
                         5 Downstream flow (Mcm)
                         6 Spillway flow (Mcm)
                         7 Turbine flow (Mcm)
                         8 Main gate flow (Mcm)
                         9 Generated energy (GWh)
                        10 Non-hydro target (Mcm)
                        11 Evaporation (Mcm)
                        12 Rainfall (Mcm)
                        13 Water surface area at end of time step (m2)
                        14 Seepage (Mcm)
                        15 Firm energy release target (Mcm)
                        16 Tailrace level (m)
                        17 Head loss (m)
                        18 Hydro electric power generation efficiency (%)
                        19 Net or effective head for for hydro power generation (m)
                 19+Nwqsub WQ substance concentration at end of time step (-)

Run-of-river       7     1 Flow into the run-of-river (Mcm)
                         2 Generated energy (GWh)
                         3 Spilling flow (Mcm)
                         4 Tailrace level (m)
                         5 Head loss (m)
                         6 Hydro electric power generation efficiency (%)
                         7 Net or effective head for hydro power generation (m)

Diversion          8     1 Target diverted flow (Mcm)
                         2 Allocated diverted flow (Mcm)
                         3 Downstream flow (Mcm)
                         4 Upstream flow (Mcm)

Low flow           9     1 Realised downstream flow (Mcm)
                         2 Demand downstream flow (Mcm)
                         3 Length of period since last EF demand year (# of time steps)
                         4 EF demand year switch (0 or 1)

Public wtr supply 10     1 Gross demand incl. all losses (Mcm)
                         2 Shortage (Mcm)
                         3 Return flow to SW (Mcm)
                         4 Downstream flow (Mcm)
                         5 Allocated surface water (Mcm)
                         6 Allocated groundwater (Mcm)
                         7 Return flow to GW (Mcm)
                         8 Domestic sector demand (Mcm)
                         9 Domestic sector - GW supply (Mcm)
                        10 Domestic sector - Piped water supply (Mcm)
                        11 Commercial and services sector demand(Mcm)
                        12 Commercial and services sector - GW supply (Mcm)
                        13 Commercial and services sector - Piped water supply (Mcm)
                        14 Industrial sector demand(Mcm)
                        15 Industrial sector - GW supply (Mcm)
                        16 Industrial sector - supply direct from SW (Mcm)
                        17 Industrial sector - Piped water supply (Mcm)
                        18 Net demand (m3/s) (Sum of piped water demand for all sectors) (Mcm)
                        19 Distribution losses (Mcm)
                        20 In-plant losses (Mcm)
                        21 Explicit net demand (m3/s)
                        22 Unit based net demand (m3/s)
                        23 Gross demand incl. all losses from network (Mcm)
```

```
Fixed irrigation  11   1 Gross demand based on irrig. efficiency of last source type (Mcm)
                       2 Gross shortage based on irrig. efficiency of last source type (Mcm)
                       3 Consumed flow (= total allocated flow - return flow) (Mcm)
                       4 Return flow to SW (Mcm)
                       5 Downstream flow (Mcm)
                       6 Allocated surface water (Mcm)
                       7 Allocated groundwater (Mcm)
                       8 Return flow to GW (Mcm)
                8+Nwqsub WQ substance balance (-)

Variable irrig.   12   1 Gross demand based on irrig. efficiency of last source type (Mcm)
                       2 Gross shortage based on irrig. efficiency of last source type (Mcm)
                       3 Consumed flow (= total allocated flow - return flow) (Mcm)
                       4 Rainfall (mm/timestep)
                       5 Return flow to SW (Mcm)
                       6 Downstream flow (Mcm)
                       7 Effective rainfall (Mcm)
                       8 Crop water requirements (mm/time step)
                       9 Net SW allocation (mm/time step)
                      10 Allocated surface water (Mcm)
                      11 Allocated groundwater (Mcm)
                      12 Irrigated area (ha)
                      13 Return flow to GW (Mcm)
                      14 Surplus rainfall to SW (Mcm)
                      15 Expected rainfall (mm/time step)
                      16 Surplus rainfall to GW (Mcm)
                      17 Net GW allocation (mm/time step)
                      18 Effective rainfall (mm/time tep)
               18+Nwqsub WQ substance balance           -

Loss flow         13   1 Downstream flow (Mcm)
                       2 Allocated loss flow (to GW) (Mcm)
                       3 Desired loss flow (Mcm)

Fish pond         14   1 Gross demand based on convey.efficiency of last source type (Mcm)
                       2 Gross shortage based on convey.efficiency of last source type (Mcm)
                       3 Consumed flow (= total allocated flow - return flow) (Mcm)
                       4 Downstream flow (Mcm)
                       5 Return flow to SW (Mcm)
                       6 Allocated surface water (Mcm)
                       7 Allocated groundwater (Mcm)
                       8 Net supply from surface water (Mcm)
                       9 Net supply from groundwater (Mcm)
                      10 Return flow to GW (Mcm)
                      11 Evaporation (Mcm)
                      12 Rainfall (Mcm)
                      13 Net demand for flushing (Mcm)
                      14 Net spilling (Mcm)
                      15 Fish pond area (ha)

Natural lake      15   1 Not defined yet (Mcm)

Groundwater rsv   16   1 Depth at end of time step (m)
                       2 Volume at end of time step (Mcm)
                       3 Direct return flow from users (Mcm)
                3+Nwqsub WQ substance concentration at end of time step (-)

Bifurcation       17   1 Target downstream flow link 1 (Mcm)
                       2 Target downstream flow link 2 (Mcm)m
                       3 Downstream flow link 1 (Mcm)
                       4 Downstream flow link 2 (Mcm)
                       5 Upstream flow (Mcm)

Pumping           18   1 Downstream flow (Mcm)
                       2 Pumping energy (GWh)

General district  20   1 Demand (Mcm)
                       2 Total allocation (Mcm)
                       3 Shortage (Mcm)
                       4 Discharge (Mcm)
                       5 Downstream flow (Mcm)
                       6 Allocated surface water (Mcm)
                       7 Allocated groundwater (Mcm)

Ground wtr dist.  21     User : Public water supply
                         --------------------------
                       1 Demand (Mcm)
                       2 Demand from surface water (Mcm)
                       3 Allocated water from surface water (Mcm)
                       4 Allocated water from groundwater (Mcm)
                       5 Return flow to surface water (Mcm)
```

```
                          User : Non-irr. agriculture
                          ---------------------------
                        6 Rainfall on non-irrigated area (Mcm)
                        7 Soil moisture storage at the end of time step (Mcm)
                        8 Soil moisture level at the end of the time step (mm)
                        9 Evaporation from non-irrigated area (Mcm)
                       10 Flow from soil moisture to surface water (Mcm)
                       11 Percolation from soil moisture to groundwater (Mcm)
                       12 Runoff from soil moistureto surface water (caused by saturated soil
moisture) (mcm)

                          User : Irrigated agriculture
                          ----------------------------
                       13 Field water requirements or desired net demand supplied from rainfall,
surface water and groundwater (Mcm)
                       14 Rainfall on irrigated area (Mcm)
                       15 Return flow from rainfall to surface water (Mcm)
                       16 Return flow from rainfall to groundwater (Mcm)
                       17 Effective rainfall (Mcm)
                       18 Desired gross demand from surface water (Mcm)
                       19 Allocated flow from surface water (Mcm)
                       20 Return flow from irrigated surface water flow to surface water (Mcm)
                       21 Return flow from irrigated surface water flow to groundwater (Mcm)
                       22 Allocated flow from groundwater (Mcm)
                       23 Return flow from irrigated groundwater-flow to surface water (Mcm)
                       24 Return flow from irrigated groundwater-flow to groundwater (Mcm)

                          Storage : Groundwater
                          ---------------------
                       25 Fixed inflow to groundwater from neighbouring layers (Mcm)
                       26 Variable inflow to groundwater from neighbouring layers (Mcm)
                       27 Groundwater-storage at the end of time step (Mcm)
                       28 Groundwater-level at the end of time step (m)
                       29 Internal drainage from groundwater to surface water (Mcm)
                       30 External drainage from groundwater to surface water (Mcm)
                       31 Forced drainage from gw to sw (caused by full gw storage) (Mcm)
                       32 Accumulated rainfall of last number of time steps (mm)

                          Other :
                          -------
                       33 Used energy for pws pumping (GWh)
                       34 Used energy for irr.area pumping (GWh)
                       35 Downstream flow (Mcm)

                          User : add. irrigated agriculture
                          ---------------------------------
                       36 Field water allocation from rainfall, surface water and groundwater (Mcm)

 Link storage      22   1 Target downstream flow (Mcm)
                        2 Target upstream flow (Mcm)
                        3 Downstream flow (Mcm)
                        4 Volume at end of time step (Mcm)
                        5 Rainfall (Mcm)
                        6 Evaporation (Mcm)
                        7 Soil moisture recharge (Mcm)
                        8 Water surface area at end of time step (m2)
                        9 Average depth at end of time step (m)
                       10 Average width at end of time step (m)
                       11 Average cross sectional area at end of time step (m2)
                11+Nwqsub WQ substance concentration at end of time step (-)

 Reserv. partition 23   1 Net evaporation (Mcm)
                        2 Level at end of time step (m)
                        3 Volume at end of time step (Mcm)
                        4 Downstream flow  (Mcm)
                        5 Evaporation  (Mcm)
                        6 Rainfall  (Mcm)
                        7 Water surface area at end of time step (m2)
                        8 Seepage  (Mcm)

 Advanced irrig.   25   1 Demand (Mcm)
                        2 Allocated surface water (Mcm)
                        3 Allocated groundwater (Mcm)
                        4 Return flow to SW (Mcm)
                        5 Downstream flow (Mcm)
                        6 Return flow to GW (Mcm)
                 6+Nwqsub WQ substance balance (-)

 Waste water
   treatment plant 27   1 Downstream flow (Mcm)
                        2 Treated flow (Mcm)
```

```
Natural retention 28    1 Downstream flow (Mcm)
```

Results

The results are output in:

1. Table form in the log-file Freqint.log.
2. Histogram His-file format to view or export with Ods_View. Figure 10.1 shows an example.
3. His-file format with annual parameters to view or export with Ods_View:
    a. Firm energy demand and shortage (GWh) and
    b. Water demand and shortage (Mcm).

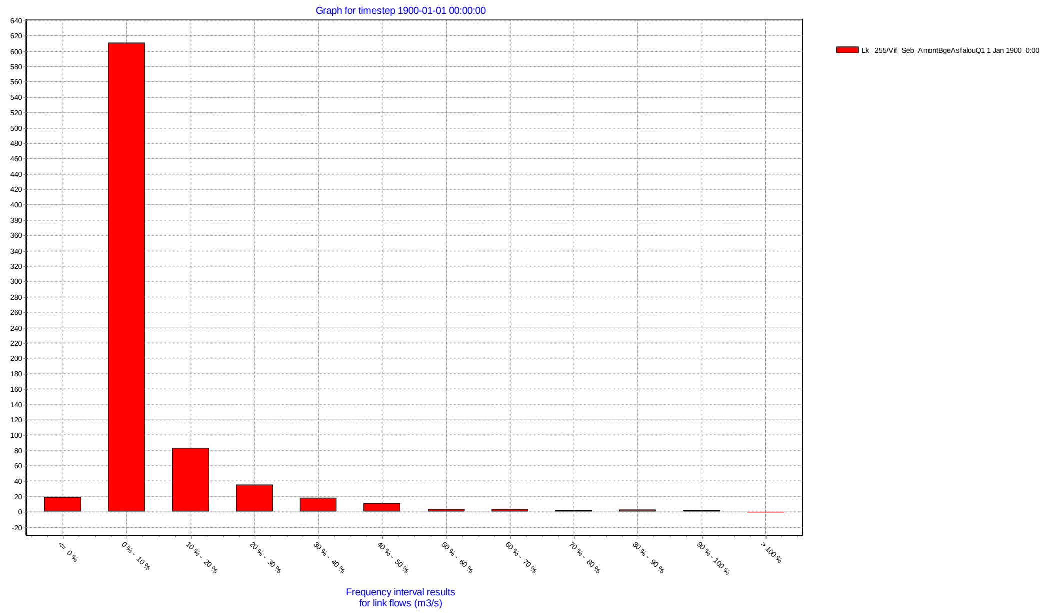

Figure 10.1 Example histogram of link flow (Mcm).

Annual results

Table 9.1 outlines the annual output parameters per node type. The computation of the annual value starts with the first simulation time step. For example if the simulation period is from September 1991 till August 2000 then there are 10 complete years from September till August.

Table 10.1 Annual output parameters per node type.

Node type	**Annual output parameters**
Reservoir	Annual firm energy demand (GWh) Annual firm energy shortage (GWh)
Low flow Public water supply Fixed irrigation Variable irrigation Advanced irrigation Fish pond Loss flow General district Groundwater district	Annual demand (Mcm) Annual shortage (Mcm)

Histogram

The histogram is computed for a number of parameters on time step and annual basis. Table 9.3 outlines the histogram output parameters and the node and link types involved. The histogram data is output in a His-file format. All histograms have 12 equal size intervals. The definition of the boundary values of the intervals depends on the parameter (see Table 10.2) and are output in the log-file *Freqint.log*.

Table 10.2 Histogram output parameters.

Histogram output parameters	**Network component**	**Interval boundaries**
Selected variables	All node types	Defined in the data file Selvrbl.dat
Link flow (m3/s)	All link types	Percentage between minimum and maximum value
Firm energy shortage (GWh)	Reservoir node	Percentage of the maximum demand
Water shortage (Mcm)	Low flow node Public water supply node Fixed irrigation node Variable irrigation node Advanced irrigation node Fish pond node Loss flow node General district node Groundwater district node	Percentage of the maximum demand
Annual firm energy shortage (Gwh)	Reservoir node	Percentage of the maximum annual demand
Annual water shortage (Mcm)	Low flow node Public water supply node Fixed irrigation node Variable irrigation node Advanced irrigation node Fish pond node Loss flow node General district node Groundwater district node	Percentage of the maximum annual demand

A Population type definition file Populat.dat

The population types, which are used for the computation of the DMI water demand at the Public water supply nodes, and the associated unit water demand are defined in the fixed data file *Populat.dat.* The file is an ASCII file in free format, which means that each data is described on a separate record and at least one space is between the various values. The file description is as follows:

Record	Data description
1	The fixed header which looks as follows : ODS01.00DAT02.00XXXXXXXX
2	Optionally one or more comment records. A comment record must have an asterisk (*) in the first column.
3	Number of population types (maximal 20 types)
4	Optionally one or more comment records. A comment record must have an asterisk (*) in the first column.
5	One record for each population type with following data:
	• Sequence type index
	• Population type name (maximal 20 characters between quotes)
	• Unit water demand of the population type (Liter/capita/day)

An example file is shown below.

```
ODS01.00DAT02.00XXXXXXXX
*
* Population type data (used for Pws node model data)
* ====================
*
* Reading format : free format
*
* Number of types (max. 20)
*
    6
*
* Description of the data
* -----------------------
* Tp Ix              = Type index.
* Type name          = Name of population type (max. 20 characters)
* Unit demand        = Unit domestic demand (litre/capita/day)
*
* Type
* indx  Population type name    Unit demand
* ----  ----------------------  -----------
     1 'Metropolitan         '       200.0
     2 'Large town           '       150.0
     3 'Medium town          '       100.0
     4 'Small town           '        75.0
     5 'Kecamatan city       '        50.0
     6 'Desa                 '        25.0
```

B Climate change scenario

Climate change scenario is defined by a combination of the following 3 files:

1. *Dirinfo* : scenario name for selection menu
2. *Climdef.dat* : climate change scenario definition data
3. *ClimateChange.ini* : climate change data

File "Dirinfo"

This file may contain any information relevant for the user. For the execution of the model only the **first record** of the file is used as this is the scenario name which appears in the drop-down selection menu at the task block "Select scenarios, measures and strategies".

File "Climdef.dat"

This file contains the name of the file with climate change data. An example is shown below. The format of the file is as follows:

- A fixed header record, which is used by the program to determine which file format, is used. The header looks as follows:

```
ODS01.00DAT01.00XXXXXXXX
```

- Some comment records: records with an asterisk (*) in the first column.
- The name of the climate change data file between quotes (')

File "ClimateChange.ini"

This file contains the data which defines the increase (+) or decrease (-) of the hydrological time series data stored in the hydrological scenarios. The file has an Ini-file format. This means that the content of the file is described by "Chapters" and "Properties" which are defined by their names. Chapter names must be written between square brackets e.g. chapter "Hydrological data change" makes "[Hydrological data change]". The value(s) of the property must be outlined after the property name and the "=" sign e.g. the value of property "Actual inflow (%)" makes "Actual inflow (%) = 3.0". The names of the chapters and properties are case insensitive. For each chapter and property one record is used. The file may contain comment lines at the top of the file. A comment line starts with an asterisk (*) in the first column of the record. The contents of the file is as follows:

Chapter name Property name	Type of data	Description
General		
FileType	String (max. 3 characters)	Must be “INI”
Version	String (max. 10 characters)	Must be “ 1.00”
ClimateChangeName	String (max. 80 characters)	Name of the climate change scenario which will be shown in the output files
Hydrological data change		
Actual inflow (%)	Real	Increase (+) or decrease (-) of the actual inflow data (%)
Actual rainfall (%)	Real	Increase (+) or decrease (-) of the actual rainfall data (%)
Open water evaporation (%)	Real	Increase (+) or decrease (-) of the open water evaporation data (%)
Dependable rainfall (%)	Real	Increase (+) or decrease (-) of the dependable rainfall data (%)
Dependable river flow (%)	Real	Increase (+) or decrease (-) of the dependable river flow data (%)
General district demand (%)	Real	Increase (+) or decrease (-) of the general district demand data (%)
General district discharge (%)	Real	Increase (+) or decrease (-) of the general district discharge data (%)
Low flow (%)	Real	Increase (+) or decrease (-) of the low flow data (%)
Expected inflow (%)	Real	Increase (+) or decrease (-) of the expected inflow data (%)
Loss flow (%)	Real	Increase (+) or decrease (-) of the loss flow data (%)
Potential evapotranspiration (%)	Real	Increase (+) or decrease (-) of the potential evapotranspiration data (%)
Monitored flow (%)	Real	Increase (+) or decrease (-) of the monitored flow data (%)
Reference crop evapotranspiration	Real	Increase (+) or decrease (-) of the reference

(%)		evapotranspiration data (%)

Example of definition file “ClimDef.dat”

```
ODS01.00DAT01.00XXXXXXXX
*
* Climate change scenario definition file
*
* This file contains the definition of the climate change scenario.
*
* Reading format : Free format
*
* Name of file with the climate change data
*
'ClimateChange.ini'
```

Example of data file “ClimateChange.ini”:

```
*
* RIBASIM climate change data file (Ini-file format)
*

[General]
FileType=INI
Version=1.00
ClimateChangeName= 2050 climate change

[Hydrological data change]
Actual inflow (%) = -5.0
Actual rainfall (%) = -7.5
Open water evaporation (%) = 10.0
Dependable rainfall (%) = -7.5
Dependable river flow (%) = -5.0
General district demand (%) = 0.0
General district discharge (%) = 0.0
Low flow (%) = 0.0
Expected inflow (%) = 0.0
Loss flow (%) = 0.0
Potential evapotranspiration (%) = 0.0
Monitored flow (%) = 0.0
Reference crop evapotranspiration (%) = 0.0
```

C Land-use and population scenario

Land-use and population scenario is defined by a combination of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The scenario definition file *LuPopDef.dat* outlining the name of the *Lpm*-file, and
- The land-use, population and explicit demand change model data file, an *Lpm*-file. The data file contains:

  - the land-use change (%) for the fixed, variable and advanced irrigation nodes;
  - the population change (%) for the public water supply nodes with demand type “Unit demand”.
  - the explicit demand change (%) for the public water supply nodes with demand type “Explicit demand”.

  The base irrigation area, population and explicit demand data are stored in the model data base. For example in the model data base it is outlined that at Public water supply node “Delft” the number of inhabitants of population type “Large town” is 200,000 people and in the scenario the change value is 10 %, then in the simulation the model uses 220,000 people for the computation of the DMI demand of “Delft”.

The *Lpm*-file is an ASCII file in free format, which means that each data is described on a separate record and at least one space is between the various values. The file description is as follows:

Record	Data description
1	The fixed header which looks as follows : ODS01.00LPM01.00Manual
2	Optionally one or more comment records. A comment record must have an asterisk (*) in the first column.
3	One record for each change with following data: • Type of data : o “L” for land-use change at Irrigation nodes o “P” for population change at Public water supply nodes o “E” for explicit demand change at Public water supply nodes • Catchment label • Change value (%) (can be + or -): o Land-use change at irrigation nodes o Population change at Public water supply nodes with demand type “Unit demand” or “DMI demand” o Explicit demand change at Public water supply nodes with demand type “Explicit demand”

Remarks:

- The “Catchment label” is defined by the user at the variable inflow nodes and are also specified at each Fixed, Variable and Advanced irrigation and Public water supply node. Nodes which are located in the same catchment get the same label.

Example of file *LuPopDef.dat* :

```
ODS01.00DAT01.00XXXXXXXX
*
* File Version 1.00 !!!
*
* Land-use and population scenario definition file
* ================================================
*
* This file contains the definition of the Land-use and population scenario
*
* Reading format : Free format
*
* Name of the Land-use and Population scenario data file (output of a LPM - model)
*
*
'2030.lpm'
```

Example of Lpm-file e.g. *2030.Lpm* :

```
ODS01.00LPM01.00Manual
*
* Land-use and population scenario data file (free format)
*
* For each catchment a record with
*
* 1. Type of data : "L"   for land-use change for irrigation nodes
*                      "P"   for population change for Pws nodes
*                      "E"   for explicit demand change for Pws nodes
* 2. Catchment label
* 3. Change (%) (can be + or -)
*
"L"     1       10.00
"L"     2       -12.00
"L"     3       14.00
"L"     4       -16.00
"L"     5       18.00
"L"     6       -20.00
"L"     7       22.00
"L"     8       -24.00
"L"     9       26.00
"P"     1       10.00
"P"     2       -12.00
"P"     3       14.00
"P"     4       -16.00
"P"     5       18.00
"P"     6       -20.00
"P"     7       22.00
"P"     8       -24.00
"P"     9       26.00
"E"     1       15.00
"E"     2       -18.00
"E"     3       21.00
"E"     4       -24.00
"E"     5       27.00
"E"     6       -30.00
"E"     7       33.00
"E"     8       -36.00
"E"     9       39.00
```

D Agriculture scenario

An agriculture scenario is defined by the combination of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The definition file *AgriDef.dat* outlining the name of the Asm-file, and
- The agriculture sector model data file, an *Asm*-file. The Agriculture sector model data file contains the crop plan per catchment. The crop plan is the list of cultivations adopted by each Advanced irrigation node within the catchment. So the crop plan of the Advanced irrigation nodes stored in the model data base is overwritten by the crop plan of the agriculture scenario.

The *Asm*-file is an ASCII file in free format, which means that each cultivation is described on a separate record and at least one space is between the various values. The file description is as follows:

Record	Data description
1	The fixed header which looks as follows : ODS01.00ASM01.00ASME
2	Optionally one or more comment records. A comment record must have an asterisk (*) in the first column.
3	One record for each cultivation:
	• Catchment label
	• Crop index
	• Start time step index
	• Cultivation area (% of total irrigation area)
	• Percolation (mm/day)
	• Pre-saturation (mm)
	• Number of fields
	• Growing season index

Remarks:

- The “Catchment label” is defined by the user at the variable inflow nodes and are also specified at each Fixed, Variable and Advanced irrigation and Public water supply node. Nodes which are located in the same catchment get the same label.
- The value for “Number of fields” can be set by default on 1.
- The value of the growing season index must be 1, 2 or 3 for first, second or third season e.g. wet, dry1 and dry2 season. The value can be set by default on 1.

Example of file *AgriDef.dat* :

```
ODS 1.00DAT 1.00XXXXXXXX 6.00
*
* Agriculture scenario definition file
* ====================================
*
* This file contains the definition of the Agriculture scenario
* based on the Agriculture Sector Model for Egypt (ASME) output file (Asm-file).
*
* Reading format : Free format
*
* Name of file with the crop plan file
*
*
'2030.asm '
```

Example crop plan data Asm-file:

```
ODS01.00ASM01.00ASME
*
* Crop plan data file (free format)
*
* For each cultivation a record with
*
* 1. Catchment label
* 2. Crop index
* 3. Start time step index
* 4. Cultivation area (% of irrigation area)
* 5. Percolation (mm/day)
* 6. Pre-saturation (mm)
* 7. Number of fields
* 8. Growing season index
*
 1      1       27       14.71   2.0     100.0   1       1
 1      1       29       10.35   2.0     100.0   1       1
 1      2       27       24.05   2.0     100.0   1       1
 1      2       28       22.20   2.0     100.0   1       1
 1      4       6        14.71   2.0     100.0   1       2
 2      4       7        13.77   2.0     100.0   1       2
 2      5       12       50.20   2.0     100.0   1       2
 2      6       30       82.50   2.0     100.0   1       1
 3      7       8        35.88   2.0     200.0   1       2
 3      7       11    15.35      2.0     200.0   1       2
 5      8       13        44.35  2.0     100.0   1       2
 7      9       29       15.35   2.0     100.0   1       1
 7      10      27        55.30  2.0     100.0   1       1
 7      1       27       44.71   2.0     100.0   1       1
 8      1       29       86.35   2.0     100.0   1       1
 9      2       27       14.05   2.0     100.0   1       1
 10     2       28       22.20   2.0     100.0   1       1
 11     4       6        74.71   2.0     100.0   1       2
```

E DELWAQ water quality scenario

A DELWAQ water quality scenario is defined by the combination of the following files:

- The info file *Dirinfo* which contains the name of the scenario (first record).
- The definition file *DlwqSet.dat* outlining the names of the emission factors, treatment, boundary concentration and meteo data files, and
- The Waste load estimation model data file for boundary condition, meteo, load and treatment data.

File "Dirinfo"

This file may contain any information relevant for the user. For the execution of the model only the first record of the file is used as this is the scenario name which appears in the drop-down selection menu at the task block "Select scenarios, measures and strategies".

File "DlwqSet.dat"

This file contains the names of the waste load estimation model data files with emission factors, treatment, boundary concentration and meteo data. An example is shown below. The format of the file is as follows:

- A fixed header record, which is used by the program to determine which file format, is used. The header looks as follows:

```
ODS 1.00DAT 1.00XXXXXXXX 6.00
```

- Some comment records: records with an asterisk (*) in the first column.
- The name of the following files between quotes (')

File name	Description
air.cft	Emission factors for Advanced irrigation nodes (kg/fed/year in model converted to g/ha/s)
air.use	Substance conversion data for Advanced irrigation nodes
all.trt	Treatment efficiency (% removal)
boundwq.dat	Boundary concentration per substance over time (various units)
boundwq.typ	Empty file
ind.cft	Emission factors for industrial Public water supply nodes (g/m3)
ind.use	Substance conversion data for industrial Public water supply nodes
loadswq.dat	Empty file
loadswq.typ	Empty file
meteo.dwq	Time series fof meteo parameters Temp and Rad.
nodes_sectors.wlm	Definition of the industrial sectors for the Public water supply nodes that represent industry
nodes_treatment.wlm	Definition of the treatment of emission sources (most time Public water supply nodes)
pws.cft	Emission factors for domestic Public water supply node

	(g/cap/day)
pws.use	Substance conversion data for domestic Public water supply nodes

Example of file *DlwqSet.dat* :

```
ODS 1.00DAT 1.00XXXXXXXX 6.00
*
* Delwaq Water quality substance set definition data
* ==================================================
*
* This files contains all Delwaq required data for a selected set of substances.
*
* Reading format : Free format
*
* Names of the following files:
*
* 1. boundary type   default
* 2. boundary object default
* 3. dry waste loads type   default
* 4. dry waste loads object default
*    see also DIRINFO
*
'loadswq.typ'
'loadswq.dat'
'boundwq.typ'
'boundwq.dat'
'pws.cft'
'pws.use'
'air.cft'
'air.use'
'ind.cft'
'ind.use'
'all.trt'
'nodes_sectors.wlm'
'nodes_treatment.wlm'
'meteo.dwq'
```

Various Waste load estimation model data files

The content of the files mentioned in the definition file "*DlwqSet.dat"* are described below.

Emission Factors file (*.cft)

This file defines the emission factors related to a certain emission variable for a series of substances. Optionally, different sectors with different emission values can be defined. The file is of the space delimited ascii type:

- Spaces are separating the different fields.
- Strings need to be placed between single quotes (‘).
- A header may be added with the ‘#’ sign in the first position.
- Under the header, you provide the data lines.
- The columns are as follows:
    - Column 1: defines the emission variable.
    - Column 2: defines the sector (default is ‘none’).
    - Column 3 and following provide emission factors for individual substances.

The example below (*ind.cft*) demonstrates the optional use of sectors, in this case for industrial return flows. Note that in the example below, lines have been truncated to three substances only, for clarity.

```
# Emission factors for PWS node (industry type)
# Derived from file INDUSTRY.CFT in DSS
# Emission factors are expressed in g/m3
# Sectors introduced since nodes represent clusters of industries
# EV                 Sector               NH4     NO3     Norg
'Return flow to SW'   'Textile'            5.0     50.0    1.0
'Return flow to SW'   'Metal'              1.0     10.0    1.0
'Return flow to SW'   'Mining'             1.0     10.0    1.0
'Return flow to SW'   'Engineering'        1.0     10.0    1.0
'Return flow to SW'   'Chemical'           30.0    20.0    5.0
'Return flow to SW'   'Food'               50.0    60.0    20.0
```

Substance conversion file (*.use)

This file is used to convert the parameters used in the emission factors file to the model state variables. The format of the file is described above under *Aliases for Substances*. An example is provided below for the *Public Water Supply* nodes:

```
USEFOR 'NH4' 'NH4'
USEFOR 'NO3' 'NO3'
USEFOR 'DetN' 'Norg'
USEFOR 'PO4' 'Tot_P' * 0.2
USEFOR 'AAP' 'Tot_P' * 0.6
USEFOR 'DetP' 'Tot_P' * 0.2
USEFOR 'OOC' 'BOD' * 0.375
USEFOR 'Cl' 'Cl'
USEFOR 'TColi' 'TColi'
USEFOR 'IM1' 'TSS'
USEFOR 'Cd' 'Cd'
USEFOR 'Cu' 'Cu'
USEFOR 'Zn' 'Zn'
USEFOR 'Pb' 'Pb'
```

Note that the first column of substances are the DELWAQ state variables. The second column of substances needs to correspond to the parameters defined in the .cft files.

Treatment file (all.trt)

This file is used to define the efficiency of a certain type of treatment to remove pollutants. The file is of the space delimited ascii type (see above). The treatment types mentioned in this file should agree with the treatment types used in the NodesTreatmentFile below. Note that in the example below, lines have been truncated to three substances only, for clarity.

```
# Treatment efficiency file
# Derived from file WWTPCFT.CFT in DSS
# Expressed as % removal
# Treatment                                NH4     NO3     Norg
'Primary settling'                         5       5       25
'Activated sludge'                         80      20      80

Etc..
```

Definition of sectors at nodes (nodes_sectors.wlm)

This file is used to subdivide the return flow from nodes representing industry over various sectors, each having their own emission factors. Per sector, the share in the total return flow should be defined (in %). The sum of all shares at one node should be 100%. In the case that no sectors are defined, the default sector is ‘none’ (100%).

The file is of the space delimited ascii type (see above).

```
#   This file defines the industrial sectors for the PWS industry nodes
#   Default sector is 'none'
#   It is possible to define multiple sectors each with a different share
#   Missing value (< 0) for the share is interpreted as 100%
#   Total of shares needs to be 100%
#
# NODE-NAME                                    Sector           Share(%)
'Ind_WDL_ALX_Alex'                             'Chemical'       25
'Ind_WDL_ALX_Alex'                             'Food'           31
'Ind_WDL_ALX_Alex'                             'Textile'        12
'Ind_WDL_ALX_Alex'                             'Engineering'    14
'Ind_WDL_ALX_Alex'                             'Mining'         5
'Ind_WDL_ALX_Alex'                             'Metal'          13
etc
```

Definition of treatment at nodes (nodes_treatment.wlm)

This file is used to define the treatment of emission sources, mostly of the PWS type. Multiple types of treatment can be defined, each with their own relative capacity (in %). The sum of the capacities of all treatment types defined for one node should not exceed 100%. In the case that it is < 100%, the remaining part of the waste flow is assumed untreated.

The file is of the space delimited ascii type (see above).

```
#   This file defines the applicable treatment type and
#   capacity for individual nodes
#   Default treatment is 'none'
#   It is possible to define multiple treatment types for one node,
#   with a different capacity
#   Treatment capacity can be < 100%, remaining part will be assumed untreated
#
# Node                                   Treatment               Capacity(%)
'Dom_UEG_ASW_Aswan1'                     'Trickling filter'      33
'Dom_UEG_ASW_Aswan1'                     'Oxidation pond'        17
etc
```

Definition of extra volumes and surfaces at links (volumes.prn)

This file is used to define optional extra volumes and surfaces at RIBASIM links, to allow DELWAQ to take into account the residence time and the effect of water quality processes.

The file is of the space delimited ascii type (see above).

```
# Link       Name                                      Volume           Surface
"25"         "Swf_XXX_YYY_Link25"                      525860           262930
"1405"       "Swf_XXX_YYY_WestNagHamCanal80"           142262           71131
"2325"       "Swf_XXX_YYY_Link2325"                    97799            48899
"2560"       "Dvf_MEG_GIZ_int_effl.reuse"              35758            17879
```

F Measure (Mes) – file description

The “*Measure*” sub-directory contains the measure definition files for all measures to simulate with the RIBASIM model. A measure definition or Mes-file has the format of an Ini-file. The file is setup with “chapters” and “properties” within the chapters. Chapter names must be written between square brackets e.g. chapter “General” makes “[General]”. The value(s) of the property must be outlined after the “=” sign e.g. the value of property “Link name” makes “Link name = Dvf_CCC_Cidanau”. For each chapter and property one record is used. The file may contain comment lines at the top of the file. A comment line starts with an asterisk (*) in the first column of the record. The various chapters in the Mes-file are outlined in Table F.10.3. Each node and link type chapter may contain a number of properties. This annex outlines the node and link type chapters.

Table F.10.3 Desciption of the Mes-file chapters.

Chapter name	**Description**
[General]	Define the file type and version, and the measure (strategy) name
[Variable inflow node]	Variable inflow node model data
[Fixed inflow node]	Fixed inflow node model data
[Recording node]	Recording node model data
[Reservoir node]	Surface water reservoir node model data
[Run of river node]	Run-of-river node model data
[Low flow node]	Low flow node model data
[Public water supply node]	Public water supply node model data
[Fixed irrigation node]	Fixed irrigation node model data
[Variable irrigation node]	Variable irrigation node model data
[Loss flow node]	Loss flow node model data
[Fish pond node]	Fish pond node model data
[Groundwater reservoir node]	Groundwater reservoir node model data
[Pumping node]	Pumping node model data
[General district node]	General district node model data
[Groundwater district node]	Groundwater district node model data
[Link storage node]	Link storage node model data
[Reservoir partition node]	Surface water reservoir partition node model data
[Advanced irrigation node]	Advanced irrigation node model data
[Waste water treatment plant node]	Waste water treatment plant node model data
[Natural retention node]	Natural retention node model data
[Surface water flow link]	Surface water flow link model data
[Lateral flow link]	Lateral flow link model data
[GW abstraction flow link]	Groundwater abstraction flow link model data
[Diverted flow link]	Diverted flow link model data
[Bifurcated flow link]	Bifurcated flow link model data
[Reservoir backwater flow link]	Surface water reservoir backwater flow flow link model data

The following rules are valid for the node and link type chapters:

- The General chapter is compulsory, the other chapters are optional.
- Node and link names may not contain spaces.
- For all chapter and property names the following rules are valid: the names are case insensitive and all spaces are skipped before the evaluation.
- If the property “Node name” equals to “All nodes” then the specified properties will be given to all nodes of the node type. If the property name equals to a node name in the network schematization then only the property data will be given to that specific node.
- If the property “Link name” equals to “All links” then the specified properties will be given to all links of the link type. If the property name equals to a link name in the network schematization then only the property data will be given to that specific link.
- The set of property data for the node with name outlined at property “Node name” can be copied for any number of nodes. All properties refer to the node with name outlined at property “Node name”. If there is no node in the network schematization with the specified node name then the data is skipped and a message is given in the Log-file. Only the model data for the identified nodes are changed.
- The set of property data for the link with name outlined at property “Link name” can be copied for any number of links. All properties refer to the link with name outlined at property “Link name”. If there is no link in the network schematization with the specified link name then the data is skipped and a message is given in the Log-file. Only the model data for the identified links are changed.
- If the property description contains “(t)” then a value must be specified for each time step separated by a comma or space, so for monthly time step 12 values, for half-monthly 24 time steps, for decade time steps 36 values and for weekly time steps 53 values.
- If the property refers to a relation then always 15 values must be specified separated by a comma or space. If the relation is set by less than 15 value then it must be closed with the value -1.0 and the remaining values set on 0.0.
- Not all properties are required. The chapter must include only those properties which must be changed and all other properties will keep the value as stored in the model data base.

F1. Mes-file: General chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
General		
FileType	String (max. 3 characters)	Must be "Mes"
Version	String (max. 10 characters)	Must be " 1.00"
MeasureStrategyName	String (max. 80 characters)	Name of the measure or strategy
NtimYr	Integer, optional	Number of time steps per year. Must be the same as outlined in the time step definition file Timestep.dat.

F2. Mes-file: Variable inflow node chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Variable inflow node		
Node name	String	Name of node as specified in the network configuration or "All nodes"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Local consumption unit index (1=%, 2=m3/s)	Integer: 1 or 2	Switch to indicate type of local consumption specification: 1 = % of inflow value, 2 = flow in m3/s
Local consumption value	Real	Local consumed flow (correction on the inflow value) as % of inflow value or flow in m3/s
Virgin catchment area (km2)	Real	Size of the virgin catchment area (km2)
Actual inflow time series index	Integer	Index of actual inflow time series in hydrological scenario file Actinflw.tms

F3. Mes-file: Fixed inflow node chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Fixed inflow node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Inflow (t) (m3/s)	Real	Inflow per time step (m3/s)
Inflow (m3/s)	Real	Inflow applied for all time steps (m3/s)

F4. Mes-file: Recording node chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Recording node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node

F 5. Mes-file: Reservoir node chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Reservoir node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Level-Area-Storage relation 1 (m)	Real (15x)	Level of Level-Area-Storage relation (m)
Level-Area-Storage relation 2 (ha)	Real (15x)	Surface area of Level-Area-Storage relation (ha)
Level-Area-Storage relation 3 (Mcm)	Real (15x)	Storage of Level-Area-Storage relation (Mcm)
Length (m)	Real	Length of reservoir (m)

Initial level (m)	Real	Initial reservoir level at start of simulation (m)
Full reservoir level (m)	Real	Full reservoir level or spillway level (m)
Nethead - Spillway flow relation 1 (m)	Real (15x)	Net head of Nethead - Spillway flow relation (m)
Nethead - Spillway flow relation 2 (m3/s)	Real (15x)	Spillway flow of Nethead - Spillway flow relation m3/s)
Nethead - Main gate flow relation 1 (m)	Real (15x)	Net head of Nethead - Main gate flow relation 1 (m)
Nethead - Main gate flow relation 2 (m3/s)	Real (15x)	Main gate flow of Nethead - Main gate flow relation m3/s)
Main gate level (m)	Real	Main gate level (m)
Turbine gate level (m)	Real	Turbine gate level (m)
Plant load factor (%)	Real	Plant load factor (%)
Auxiliary energy consumption (%)	Real	Auxiliary energy consumption (%)
Nethead - Hydro power capacity relation 1 (m)	Real (15x)	Nethead of Nethead - Hydro power capacity relation (m)
Nethead - Hydro power capacity relation 2 (MW)	Real (15x)	Hydro-power capacity of Nethead - Hydro power capacity relation (MW)
Nethead - Power efficiency relation 1 (m)	Real (15x)	Nethead of Nethead - Power efficiency relation (m)
Nethead - Power efficiency relation 2 (%)	Real (15x)	Power efficiency of Nethead - Power efficiency relation (%)
Turbine discharge - Hydraulic loss relation 1 (m3/s)	Real (15x)	Turbine discharge of Turbine discharge - Hydraulic loss relation (m3/s)
Turbine discharge - Hydraulic loss relation 2 (m)	Real (15x)	Hydraulic loss of Turbine discharge - Hydraulic loss relation (m)
Turbine discharge - Tail race level relation 1 (m3/s)	Real (15x)	Turbine discharge of Turbine discharge - Tail race level relation (m3/s)
Turbine discharge - Tail race level relation 2 (m)	Real (15x)	Tail race level of Turbine discharge - Tail race level relation (m)
Firm energy demand (t) (GWh)	Real	Firm energy demand per time step (GWh)
Firm energy demand (GWh)	Real	Firm energy demand for all time steps (GWh)
Firm energy water allocation priority	Integer	Firm energy water allocation priority
Flood control storage operation rule (t) (m)	Real	Flood control storage level per time step (m)
Flood control storage operation rule (m)	Real	Flood control storage level for all time steps (m)
Target storage operation rule (t) (m)	Real	Target storage level per time step (m)
Target storage operation rule (m)	Real	Target storage level for all time steps (m)

Firm storage operation rule (t) (m)	Real	Firm storage level per time step (m)
Firm storage operation rule (m)	Real	Firm storage level for all time steps (m)
Apply hedging based on storage (Yes / No)	Yes or No	Switch to apply hedging below firm storage level based on storage (Yes) or water allocation priority (No)
Apply special reservoir operation (Yes / No)	Yes or No	Switch to apply special reservoir operation rules (Yes) or not (No)
Online adjustable gate (Yes / No)	Yes or No	Switch to apply online adjustable gate setting (yes) or not (No)
Operate on expected inflow (Yes / No)	Yes or No	Switch to apply operation based on expected inflow time series (Yes) or not (No)
Hedging zone lower boundary (%)	Real (5x)	Lower boundary of hedging zone (% between firm and dead storage) for hedging based on storage : 5 values
Hedging zone water allocation (%)	Real (5x)	Water allocation per hedging zone (% of target release) for hedging based on storage : 5 values
Hedging per water allocation priority zone boundary (%)	Real	Boundary between upper and lower zone below firm storage for hedging based on water allocation priority (% between dead (=0%) and firm storage (=100%))
Hedging per water allocation priority zone 1 (%)	Real (10x)	Hedging per water allocation priority for upper zone (zone 1) in case of hedging based on water allocation priority (% of target release) : 10 values
Hedging per water allocation priority zone 2 (%)	Real (10x)	Hedging per water allocation priority for upper zone (zone 2) in case of hedging based on water allocation priority (% of target release) : 10 values
Use net evaporation time series (Yes / No)	Yes or No	Switch to use annual net evaporation (open water evaporation - rainfall) time series (Yes) or multiple year open water and actual rainfall time series in the hydrological scenario (No)
Seepage loss (1000 m3/day)	Real	Seepage loss (1000 m3/day)
Flood routing period (days)	Integer	Length of flood routing period (days). If length of the simulation period is smaller than this value then the Nethead - Spillway flow relation is used.
Net evaporation (t) (mm/day)	Real	Net evaporation (open water evaporation - rainfall) per time step (mm/day)
Actual rainfall time series index	Integer	Actual rainfall time series index

Open water evaporation time series index	Integer	Open water evaporation time series index
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F 6. Mes-file: Run of river node chapter

This chapter may contain the following properties.

Chapter name / **Property name**	**Type of data**	**Description**
Run of river node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Intake level (m)	Real	Fixed intake level (m)
Plant load factor (%)	Real	Plant load factor (%)
Auxiliary energy consumption (%)	Real	Auxiliary energy consumption (%)
Nethead - Hydro power capacity relation 1 (m)	Real (15x)	Net head of Nethead - Hydro power capacity relation (m)
Nethead - Hydro power capacity relation 2 (MW)	Real (15x)	Hydro-power capacity of Nethead - Hydro power capacity relation (MW)
Nethead - Power efficiency relation 1 (m)	Real (15x)	Net head of Nethead - Power efficiency relation (m)
Nethead - Power efficiency relation 2 (%)	Real (15x)	Power efficiency of Nethead - Power efficiency relation (%)
Turbine discharge - Hydraulic loss relation 1 (m3/s)	Real (15x)	Turbine discharge of Turbine discharge - Hydraulic loss relation (m3/s)
Turbine discharge - Hydraulic loss relation 2 (m)	Real (15x)	Hydraulic loss of Turbine discharge - Hydraulic loss relation (m)
Turbine discharge - Tail race level relation 1 (m3/s)	Real (15x)	Turbine discharge of Turbine discharge - Tail race level relation (m3/s)
Turbine discharge - Tail race level relation 2 (m)	Real (15x)	Tail race level of Turbine discharge - Tail race level relation (m)

F 7. Mes-file: Low flow node chapter

This chapter may contain the following properties.

Chapter name / **Property name**	**Type of data**	**Description**
Low flow node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node

Apply fixed flushing time series procedure (Yes / No)	Yes or No	Switch to set flushing as fixed annual time series
Apply variable flushing time series procedure (Yes / No)	Yes or No	Switch to set flushing as multiple year time series specified in hydrological scenario time series file
Apply event driven flushing procedure (Yes / No)	Yes or No	Switch to set flushing as event driven.
Water allocation priority fraction (%)	Real	Fraction to split the demand into 2 parts with different water allocation priority (%)
Water allocation priority priority of part1	Integer	Water allocation priority of part 1
Water allocation priority priority of part2	Integer	Water allocation priority of part 2
Flushing requirements (t) (m3/s)	Real	Flushing requirements per time step (m3/s)
Flushing requirements (m3/s)	Real	Flushing requirements for all time steps (m3/s)
Flushing time series index	Integer	Time series index in the hydrological scenario time series file
Length of event occurence window	Integer	Length of event occurence window
Start time step of event window	Integer	Start time step of event window
Length of event window (# of time steps)	Integer	Length of event window (# of time steps)
Event flow per time step (t) (m3/s)	Real	Event flow per time step (m3/s)
Event flow per time step (m3/s)	Real	Event flow used for all time steps (m3/s)
Demand year water allocation threshold (% of total demand)	Real	Demand year water allocation threshold (% of total demand)
Natural year water allocation threshold (% of total demand)	Real	Natural year water allocation threshold (% of total demand)
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F8. Mes-file: Public water supply node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Public water supply node		
Node name	String	Name of node as specified in the network configuration or "All nodes"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Plant capacity (m3/s)	Real	Plant capacity (m3/s)
Apply explicit demand (Yes / No)	Yes or No	Switch to set demand option on explicit demand
Apply unit demand based on population (Yes / No)	Yes or No	Switch to set demand option on unit demand based on population
Apply DMI demand based on population (Yes / No)	Yes or No	Switch to set demand option on DMI demand based on population

Water allocation priority fraction (%)	Real	Fraction to split the demand into 2 parts with different water allocation priority (%)
Water allocation priority of part1	Integer	Water allocation priority of part 1
Water allocation priority of part2	Integer	Water allocation priority of part 2
Explicit demand (t) (m3/s)	Real	Explicit demand per time step (m3/s)
Explicit demand (m3/s)	Real	Explicit demand for all time steps (m3/s)
Population (-)	Integer	Number of inhabitants (-)
Unit demand (t) (liter/capita/day)	Real	Unit demand per time step (t) (litre/capita/day)
Unit demand (liter/capita/day)	Real	Unit demand used for all time steps (litre/capita/day)
Population per type (-)	Integer (Npop)	Number of inhabitants per type (-)
Workforce (fraction of population (%)	Real	Workforce (fraction of population, %)
Employee (fraction of workforce (%)	Real	Employee (fraction of workforce, %)
Manufacturing (fraction of employee (%)	Real	Manufacturing (fraction of employee, %)
Industrial unit demand (liter/capita/day)	Real	Industrial unit demand (liter/capita/day)
Commercial and services sector multiplication factor (-)	Real	Commercial and services sector multiplication factor (-)
Fraction of domestic, commercial and services sector water use supplied from GW (%)	Real	Fraction of domestic, commercial and services sector water use supplied from ground water (%)
Fraction of industrial sector water use supplied from GW (%)	Real	Fraction of industrial sector water use supplied from ground water (%)
Fraction of industrial sector water use supplied directly from SW (%)	Real	Fraction of industrial sector water use supplied directly from surface water (%)
In-plant losses (%)	Real	In-plant losses (%)
Distribution / transmission losses (%)	Real	Distribution / transmission losses (%)
Operate on demand (Yes / No)	Yes or No	Switch to operate on demand (Yes) or on capacity only (No)
Return flow to SW (% of allocation)	Real	Return flow to SW (% of allocation)
Return flow to GW (% of allocation)	Real	Return flow to GW (% of allocation)
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F 9. Mes-file: Fixed irrigation node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Fixed irrigation node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
GW conveyance efficiency (%)	Real	Groundwater conveyance efficiency (%)
Irrigated area (ha)	Real	Irrigated area (ha) for all time steps
Irrigated area (t) (ha)	Real	Irrigated area (ha) per time step
Net demand (mm / day)	Real	Net demand used for all time steps (mm /

		day)
Net demand (t) (mm / day)	Real	Net demand per time step (mm / day)
Return flow to groundwater (% of allocation)	Real	Return flow to groundwater (% of allocation)
Return flow to surface water (% of allocation)	Real	Return flow to surface water (% of allocation)
Return flow to gw (% of allocation)	Real	Return flow to groundwater (% of allocation)
Return flow to sw (% of allocation)	Real	Return flow to surface water (% of allocation)
SW conveyance efficiency (%)	Real	Surface water conveyance efficiency (%)
Water allocation priority fraction (%)	Real	Fraction to split the demand into 2 parts with different water allocation priority (%)
Water allocation priority of part 1	Integer	Water allocation priority of part 1
Water allocation priority of part 2	Integer	Water allocation priority of part 2
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F10. Mes-file: Variable irrigation node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Vraiable irrigation node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Irrigated Area for year type 1 (ha)	Real	Irrigated area for all time steps for year type 1 (ha)
Irrigated Area for year type 1 (t) (ha)	Real	Irrigated area per time step for year type 1 (ha)
Irrigated Area for year type 2 (ha)	Real	Irrigated area for all time steps for year type 2 (ha)
Irrigated Area for year type 2 (t) (ha)	Real	Irrigated area per time step for year type 2 (ha)
Crop water requirements for year type 1 (mm/day)	Real	Crop water requirements for all time steps for year type 1 (mm/day)
Crop water requirements for year type 1 (t) (mm/day)	Real	Crop water requirements per time step for year type 1 (t) (mm/day)
Crop water requirements for year type 2 (mm/day)	Real	Crop water requirements for all time steps for year type 2 (mm/day)
Crop water requirements for year type 2 (t) (mm/day)	Real	Crop water requirements per time step for year type 2 (t) (mm/day)
Actual rainfall time series index	Integer	Actual rainfall time series index
Apply dependable rainfall (Yes / No)	Real	Switch to set dependeable rainfall as

		hydrological scenario time series (Yes) or based on actual rainfall (No)
Rainfall effectiveness (%)	Real	Rainfall effectiveness (%)
Dependable rainfall time series index	Integer	Dependable rainfall time series index
Start of growing season (time step index)	Integer	Start of growing season (time step index)
Monitoring period (# of time steps)	Integer	Length of monitoring period (# of time steps)
Year type criteria (mm rainfall in monitoring period)	Real	Year type criteria: year type 1 if total actual rainfall in monitoring period is lower, else year type 2 (mm rainfall in monitoring period)
SW irrigation efficiency for year type 1 (%)	Real	Surface water irrigation efficiency for year type 1 (%)
SW irrigation efficiency for year type 2 (%)	Real	Surface water irrigation efficiency for year type 2 (%)
GW irrigation efficiency for year type 1 (%)	Real	Groundwater irrigation efficiency for year type 1 (%)
GW irrigation efficiency for year type 2 (%)	Real	Groundwater irrigation efficiency for year type 2 (%)
Return flow of allocation to SW (%)	Real	Return flow of allocated water supply to surface water (%)
Return flow of unused rain to SW (%)	Real	Return flow of unused rain to surface water (%)
Return flow of allocation to GW (%)	Real	Return flow of allocation to groundwater (%)
Return flow of unused rain to GW (%)	Real	Return flow of unused rain to groundwater (%)
Water allocation priority fraction (%)	Real	Fraction to split the demand into 2 parts with different water allocation priority (%)
Water allocation priority of part 1	Integer	Water allocation priority of part 1
Water allocation priority of part 2	Integer	Water allocation priority of part 2
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F11. Mes-file: Loss flow node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Loss flow node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Loss flow time series index	Integer	Loss flow time series index
Water allocation priority fraction (%)	Real	Fraction to split the demand into 2 parts with different water allocation priority (%)

Water allocation priority of part1	Integer	Water allocation priority of part 1
Water allocation priority of part2	Integer	Water allocation priority of part 2
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F12. Mes-file: Fish pond node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Fish pond node		
Node name	String	Name of node as specified in the network configuration or "All nodes"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Fish pond area (ha)	Real	Fish pond area (ha)
Flushing requirements (t) (mm/day)	Real	Flushing requirements per time step (mm/day)
Flushing requirements (mm/day)	Real	Flushing requirements for all time steps (mm/day)
Actual rainfall time series index	Real	Actual rainfall time series index
Open water evaporation time series index	Real	Open water evaporation time series index
Water allocation priority fraction (%)	Real	Fraction to split the demand into 2 parts with different water allocation priority (%)
Water allocation priority of part 1	Integer	Water allocation priority of part 1
Water allocation priority of part 2	Integer	Water allocation priority of part 2
SW conveyance efficiency (%)	Real	Surface water conveyance efficiency (%)
GW conveyance efficiency (%)	Real	Groundwater conveyance efficiency (%)
Return flow to surface water (% of total drainage)	Real	Return flow to surface water (% of total drainage)
Return flow to groundwater (% of total drainage)	Real	Return flow to groundwater (% of total drainage)
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F13. Mes-file: Groundwater reservoir node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**

Groundwater reservoir node		
Node name	String	Name of node as specified in the network configuration or "All nodes"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Groundwater reservoir label	Integer	Groundwater reservoir label
Groundwater depth - Groundwater storage relation 1 (m)	Real (15x)	Groundwater depth of the groundwater depth - groundwater storage relation (m)
Groundwater depth - Groundwater storage relation 2 (Mcm)	Real (15x)	Groundwater storage of the groundwater depth - groundwater storage relation (Mcm)
Shallowest groundwater depth (m)	Real	Shallowest groundwater depth (m)
Initial groundwater depth (m)	Real	Initial groundwater depth (m)
Ground surface level (m)	Real	Ground surface level (m)
Groundwater depth - Groundwater outflow relation 1 (m)	Real (15x)	Groundwater depth of the groundwater depth - groundwater outflow relation (m)
Groundwater depth - Groundwater outflow relation 2 (m3/s)	Real (15x)	Groundwater outflow of the groundwater depth - groundwater outflow relation (m3/s)
Maximum groundwater abstraction (m3/s)	Real	Maximum groundwater abstraction for all time steps (m3/s)
Maximum groundwater abstraction (t) (m3/s)	Real	Maximum groundwater abstraction per time step (m3/s)

F14. Mes-file: Pumping node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Pumping node		
Node name	String	Name of node as specified in the network configuration or "All nodes"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Pumping efficiency (%)	Real	Pumping efficiency (%)
Pumping head (t) (m)	Real	Pumping head per time step (m)
Pumping head (m)	Real	Pumping head for all time steps (m)

F15. Mes-file: General district node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
General district node		
Node name	String	Name of node as specified in the network

		configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Demand time series index	Integer	Demand time series index
Discharge time series index	Integer	Discharge time series index
Water allocation priority fraction (%)	real	Fraction to split the demand into 2 parts with different water allocation priority (%)
Water allocation priority of part 1	Integer	Water allocation priority of part 1
Water allocation priority of part 2	Integer	Water allocation priority of part 2
Make source priority list empty (Yes/No)	Yes or No	Switch to make the source priority list of node empty (Yes)

F16. Mes-file: Ground water district node chapter

Not applicable

F17. Mes-file: Link storage node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Link storage node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node

F18. Mes-file: Reservoir partition node chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Reservoir partition node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node

F19. Mes-file: Advanced irrigation node chapter

This chapter may contain the following properties. *Ncrop* in the column "Type of data" means that the number of crops times a value must be specified. The number of crops is defined in the fixed data file with the crop data.

Chapter name / **Property name**	**Type of data**	**Description**
Advanced irrigation node		
Node name	String	Name of node as specified in the network configuration or "All nodes"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Actual rainfall time series index	Integer	Actual rainfall time series index
Dependable rainfall time series index	Integer	Dependable rainfall time series index
Dependable river flow time series index	Integer	Dependable river flow time series index
Drainage to GW (% of total drainage)	Real	Drainage to groundwater (% of total drainage)
Drainage to SW (% of total drainage)	Real	Drainage to surface water (% of total drainage)
Drought period distribution efficiency (%)	Real	Drought period distribution efficiency (%)
Feedback on field status (Yes / No)	Yes or No	Switch to indicate feedback on field status (Yes) or not (water demand computed by program Totplan)
Field application efficiency (%)	Real	Field application efficiency (%)
GW conveyance efficiency (%)	Real	Groundwater conveyance efficiency (%)
Irrigated area (ha)	Real	Irrigated area (ha)
Normal distribution efficiency (%)	Real	Normal distribution efficiency (%)
On-farm yield losses (%)	Real (Ncrop)	On-farm yield losses per crop (% of the actual yield)
Potential crop yield (kg/ha)	Real (Ncrop)	Potential yield per crop (kg/ha)
Potential production costs (Mon.unit / ha)	Real (Nrcrop)	Potential production costs per crop (monetary unit per hectare)
Price (Mon.unit / kg)	Real (Ncrop)	Price per crop (monetary unit e.g Rp per kilogram)
Rainfall effectiveness (%)	Real	Rainfall effectiveness (%)
Reference evapotranspiration time series index	Integer	Reference evapotranspiration time series index
SW conveyance efficiency (%)	Real	SW conveyance efficiency (%)
Water allocation priority fraction (%)	Real	Priority fraction (%)
Water allocation priority of part 1	Integer	Priority of part1
Water allocation priority of part 2	Integer	Priority of part2
Water allocation priority per crop	Integer	Water allocation priority per crop
Make source priority list empty (Yes/No)	Yes or No	Make the source priority list of node empty
Wilting point (% of RZ)	Real	Set wilting point (% of rootzone)
Field capacity (% of RZ)	Real	Set field capacity (% of rootzone)
Saturation capacity (% of RZ)	Real	Set saturation capacity (% of rootzone)
Initial soil moisture (% of RZ)	Real	Set initial soil moiture (% of rootzone)

F20. Mes-file: Waste water treatment plant node chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Waste water treatment plant node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node
Plant capacity (m3/s)	Real	Plant capacity (m3/s)

F21. Mes-file: Natural retention node chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Natural retention node		
Node name	String	Name of node as specified in the network configuration or “All nodes”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate node

F22. Mes-file: Surface water flow link chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Surface water flow link		
Link name	String	Name of link as specified in the network configuration or “All links”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate link
Apply river branch (Yes / No)	Yes or No	Switch to set river branch (link has no constraints)
Apply canal or pipeline link (Yes / No)	Yes or No	Switch to set canal or pipeline link (link has flow capacity constraint)
Flow capacity (t) (m3/s)	Real	Capacity constraint per time step (m3/s)
Flow capacity (m3/s)	Real	Capacity constraint used for each time step (m3/s)

F23. Mes-file: Lateral flow link chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Lateral flow link		
Link name	String	Name of link as specified in the network configuration or "All links"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate link

F24. Mes-file: GW abstraction flow link chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
GW abstraction link		
Link name	String	Name of link as specified in the network configuration or "All links"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate link
Apply Dummy flow procedure (Yes / No)	Yes or No	Switch to set dummy flow procedure
Apply pumping procedure (Yes / No)	Yes or No	Switch to set pumping flow procedure
Maximum pumping depth (m)	Real	Maximum pumping depth (m)
Pumping capacity (t) (m3/s)	Real,	Pumping capacity per time step (m3/s)
Pumping capacity (m3/s)	Real	Pumping capacity for all time steps (m3/s)
Pumping efficiency (%)	Real	Pumping efficiency (%)

F25. Mes-file: Diverted flow link chapter

This chapter may contain the following properties.

Chapter name Property name	Type of data	Description
Diverted flow link		
Link name	String	Name of link as specified in the network configuration or "All links"
Status active (Yes / No)	Yes or No	Switch to activate or inactivate link
Maximum diverted flow	Real	Maximum diverted flow for all time steps (m3/s)
Maximum diverted flow (m3/s)	Real	Maximum diverted flow for all time steps (m3/s)
Maximum diverted flow (t)	Real	Maximum diverted flow per time step (m3/s)

Maximum diverted flow (t) (m3/s)	Real	Maximum diverted flow per time step (m3/s)
Maximum diverted flow relation 1	Real (15x)	Upstream link flow of the maximum diverted flow relation (m3/s)
Maximum diverted flow relation 2	Real (15x)	Maximum diverted flow of the maximum diverted flow relation (m3/s)
Online adjustable gate settings (Yes / No)	Yes or No	Switch to set the online adjustable gate setting
Operate on downstream demand (Yes / No)	Yes or No	Switch to set the gate operation on downstream demand
Upstream flow - Maximum diverted flow relation 1 (m3/s)	Real	Upstream link flow of the upstream link flow - maximum diverted flow relation (m3/s)
Upstream flow - Maximum diverted flow relation 2 (m3/s)	Real	Maximum diverted flow of the upstream link flow - maximum diverted flow relation (m3/s)

F26. Mes-file: Bifurcated flow link chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Bifurcated flow link		
Link name	String	Name of link as specified in the network configuration or “All links”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate link
Upstream flow - bifurcated flow relation 1 (m3/s)	Real (15x)	Upstream link flow of the upstream flow - bifurcated flow relation (m3/s)
Upstream flow - bifurcated flow relation 2 (m3/s)	Real (15x)	Bifurcated flow of the upstream flow - bifurcated flow relation (m3/s)

F27. Mes-file: Reservoir backwater flow link chapter

This chapter may contain the following properties.

Chapter name **Property name**	**Type of data**	**Description**
Reservoir backwater flow link		
Link name	String	Name of link as specified in the network configuration or “All links”
Status active (Yes / No)	Yes or No	Switch to activate or inactivate link
Backwater gate intake level (m)	Real	Intake level (m)
Nethead - Backwater gate flow relation 1 (m)	Real	Nethead of Nethead - backwater gate flow relation(m)

Nethead - Backwater gate flow relation 2 (m3/s)	Real	Backwater gate flow of Nethead - backwater gate flow relation (m3/s)
Online adjustable gate settings (Yes / No)	Yes or No	Switch to set the online adjustable gate setting
Spillway on link (Yes / No)	Yes or No	Switch to indicate that spillway is on the backwater flow link (Yes)

Example Mes-file 1

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
Version=1.00
MeasureStrategyName=Set all public water supply on active 5 m3/s.

[Public water supply node]
Node name=All nodes
StatusActive(Yes/No)=Yes
Explicit demand (m3/s)=  5.0
```

Example Mes-file 2

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
Version=1.00
MeasureStrategyName=Set all irrigation, public water supply and infrastructure nodes on inactive.

[Public water supply node]
Node name=All nodes
StatusActive(Yes/No)=No

[Fixed irrigation node]
Node name=All nodes
StatusActive(Yes/No)=No

[Low flow node]
Node name=All nodes
StatusActive(Yes/No)=No

[Reservoir node]
Node name=All nodes
StatusActive(Yes/No)=No
```

Example Mes-file 3

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
Version=1.00
MeasureStrategyName=Set hedging rules based on water allocation priority for all reservoir nodes

[Reservoir node]

Node name=Bge_Lks_TferDam(P)
Hedging per water allocation priority zone boundary (%)=50
Hedging per water allocation priority zone 1 (%)=100,75,50,25,0,0,0,0,0,0
Hedging per water allocation priority zone 2 (%)=80,25,10,10,0,0,0,0,0,0
Node name=Bge_Lks_MartilDam(P)
Hedging per water allocation priority zone boundary (%)=50
Hedging per water allocation priority zone 1 (%)=100,75,50,25,0,0,0,0,0,0
Hedging per water allocation priority zone 2 (%)=80,25,10,10,0,0,0,0,0,0
Node name=Bge_Lks_MoulayBouchtaDam(P)
Hedging per water allocation priority zone boundary (%)=50
Hedging per water allocation priority zone 1 (%)=100,75,50,25,0,0,0,0,0,0
Hedging per water allocation priority zone 2 (%)=80,25,10,10,0,0,0,0,0,0
Node name=Bge_Lks_RhissDam(P)
```

```
Hedging per water allocation priority zone boundary (%)=50
Hedging per water allocation priority zone 1 (%)=100,75,50,25,0,0,0,0,0,0
Hedging per water allocation priority zone 2 (%)=80,25,10,10,0,0,0,0,0,0
Node name=Bge_Lks_KharoubDam(P)
Hedging per water allocation priority zone boundary (%)=50
Hedging per water allocation priority zone 1 (%)=100,75,50,25,0,0,0,0,0,0
Hedging per water allocation priority zone 2 (%)=80,25,10,10,0,0,0,0,0,0
```

Example Mes-file 4

The Mes-file below refers to a case with 6 crops defined in the fixed data file with crop data.

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
Version=1.00
MeasureStrategyName=Set potential crop yield for all irrigation nodes

[Advanced irrigation node]
Node name=All nodes
Potential crop yield (kg/ha) =  7000.0, 3500.0, 4000.0, 45000.0, 5000.0, 3500.0
```

Example Mes-file 5

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
AsmVersion=1.00
MeasureStrategyName=Transfer project Phase 1: from Ouergha River basin via SMBA reservoir to Al
Massira reservoir

[Low flow node]
Node name=Nst_Seb_FromBgeKoudietBornaToPointL(P)
StatusActive(Yes/No)=Yes
Flushing requirements (m3/s)=  30.0

Node name=Nst_Brg_FromBgeSMBAbdellahToBgeMassir(P)
StatusActive(Yes/No)=Yes
Flushing requirements (m3/s)=  30.0

[Pumping node]
Node name=Pmp_Seb_SP3(P)
StatusActive(Yes/No)=Yes

Node name=Pmp_Seb_SP5(P)
StatusActive(Yes/No)=Yes

Node name=Pmp_Brg_SP6(P)
StatusActive(Yes/No)=Yes

Node name=Pmp_Brg_SP7(P)
StatusActive(Yes/No)=Yes

[Diverted flow link]
LinkName=Dvf_Seb_KoudiatElBorna(P)
StatusActive(Yes/No)=Yes
Maximum diverted flow (m3/s)= 30.0

[Reservoir backwater flow link]
LinkName=Rbw_Brg_BgeSMBAbdellahToBgeMassir(P)
StatusActive(Yes/No)=Yes
```

Example Mes-file 6

The Mes-file below refers to a case with monthly time steps.

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
Version=1.00
MeasureStrategyName=Set potential Renaissance dam with FSL 640 m, node 1305, Rsv_Et_GrandRenaissanceDam_Hp(P)

[Reservoir node]
Node name=Rsv_Et_GrandRenaissanceDam_Hp(P)
StatusActive(Yes/No)=Yes

Full reservoir level (m)=640.0
Main gate level  (m) = 610.0
Turbine gate level (m) = 610.0
Initial level (m)= 630.0

Flood control storage operation rule (t) (m)=640, 640, 640, 640, 640, 640, 640, 640, 640, 640, 640, 640.0
Target storage operation rule (t) (m)=640, 640, 640, 640, 640, 640, 640, 640, 640, 640, 640, 640.0
Firm storage operation rule (t) (m)=610.0, 610.0, 610.0, 610.0, 610.0, 610.0, 610.0, 610.0, 610.0, 610.0, 610.0, 610.0

Nethead - Hydro power capacity relation 1 (m)=0.0, 100.0, -1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
Nethead - Hydro power capacity relation 2 (MW)=2800.0, 2800.0, -1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0

Firm energy demand (t) (GWh)=1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0, 1175.0
```

Example Mes-file 7

The Mes-file below refers to a case with monthly time steps.

```
*
* RIBASIM measure and strategy-file (Ini-file format)
*

[General]
FileType=MES
Version=1.00
MeasureStrategyName=Set all irrigation nodes for 2020

[Fixed irrigation node]

Node name=Irr_Brg_PMHAinKoreima:Bou9
StatusActive(Yes/No)=Yes
Irrigated area (t) (ha) =200,200,200,200,200,200,200,200,200,200,200,200
Net demand (t) (mm / day) =0.561,0.648,1.317,2.332,3.325,3.605,4.361,3.972,2.785,1.706,1.166,0.410
Node name=Irr_Brg_PMHSidiAmar:Bou23(P)
StatusActive(Yes/No)=Yes
Irrigated area (t) (ha) =1000,1000,1000,1000,1000,1000,1000,1000,1000,1000,1000,1000
Net demand (t) (mm / day) =0.561,0.648,1.317,2.332,3.325,3.605,4.361,3.972,2.785,1.706,1.166,0.410
Node name=Irr_Brg_PMHSidiOmar:Bou33(P)
StatusActive(Yes/No)=Yes
Irrigated area (t) (ha) =1000,1000,1000,1000,1000,1000,1000,1000,1000,1000,1000,1000
Net demand (t) (mm / day) =0.561,0.648,1.317,2.332,3.325,3.605,4.361,3.972,2.785,1.706,1.166,0.410
```

G Management action

Management action is defined by a combination of the following 2 files

1. *Dirinfo* : name of the management action.
2. *ActDef.dat* : Management action definition file.

File “Dirinfo”

File “Dirinfo” has on the first record the name of the management action. The remaining part of the file can be used to enter some info. The name is shown in the drop down selection menu (see Figure 6.1).

File “ActDef.dat”

This file contains a list of measures which become active. The list may contain all measures defined in the sub-directory “*Measures*” and a switch per measure to indicate that the measure must be on (=1) or off (=0). Table outlines the file format. The file is read in free format so between each data item at least one space must be included and the character strings like file names must be between quotes or double quotes. Examples are shown below.

Table G.1. Format of management action definition file Actdef.dat.

Record	Description
1	The header must be as follows: ODS01.00DAT01.00XXXXXXXX
2	Some comment records: records with an asterisk (*) in the first column.
3	One record for each measure defined in the “Measures” sub-directory with: 1. Index to identify the status of the measure: 1 = active 0 = inactive 2. The name of the measure definition Mes-file in the “Measures” sub-directory between quotes (max. 60 characters)

Example of the management action definition file "ActDef.dat".

```
ODS01.00DAT01.00XXXXXXXX
*
* Management actions definition file
* ==================================
*
* This file describes the management actions: one or more active measures
* and/or strategies. The required data for each measure or strategy is:
*
* 1. Status of the measure or strategy : 1 = active, 0 = inactive
* 2. The file in which the measure or strategy is defined (max. 60 characters)
*
* Reading format : Free format
*
* Status File name
* ------ ------------------------------------------------------------
        1       "M001_EmptySourceList.mes"
        0       "I002_SetGumeraProjects.mes"
        0       "I003_SetRibbProjects.mes.mes"
        0       "I004_SetMegechPumpingAndGravityProject.mes"
        0       "I005_SetNesheProject.mes"
        0       "I006_SetArjoDidessaRiverProject.mes"
        0       "I007_SetNegesoRiverProject.mes"
        0       "I008_SetAngarRiverProject.mes"
        0       "I009_SetRahad2Project.mes"
        0       "I010_SetUpperBelesProject.mes"
        0       "I011_SetGreatKenanaProject.mes"
        0       "I012_SetHumeraProject.mes"
        0       "I013_SetRumelaProject.mes"
        0       "I014_SetLowerBelesProject.mes"
        0       "I015_SetUpperDinderProject.mes"
        1       "I016_SetRumelaAndUpperAtbaraProject.mes"
        0       "H001_SetKaradobiDam.mes"
        0       "H002_SetBekoAboLowDam.mes"
        0       "H003_SetBekoAboHighDam.mes"
        0       "H004_SetMandayaDam.mes"
        0       "H005_SetMandayaUpperDam.mes"
        0       "H006_SetRenaissance620Dam.mes"
        0       "H007_SetRenaissance640Dam.mes"
        0       "H008_SetUpperBelesDam.mes"
        0       "H009_SetHighRoseiresDam.mes"
        0       "H010_SetRumelaDam.mes"
        0       "H011_SetJongleiCanal.mes"
        1       "H012_SetRumelaAndDurbanaDams.mes"
        0       "G001_SetAllInfrastructureAndUsersInactive.mes"
        0       "G002_SetAllPotentialIrrigationProjectsActive.mes"
```