Deltares

Enabling Delta Life

RIBASIM Version 7.01 User Manual Addendum 2

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RIBASIM Version 7.01 User Manual Addendum 2

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Contents

1 Introduction

This document is supplemental to the User and Technical Reference manual for RIBASIM Version 7.00 and 7.01 and describes the new features of RIBASIM Version 7.01.20. The new features are:

1. Extension of the option “Reset to initial setting” and related post-processing of results.
2. Use of “Time conditional measures” for surface water reservoirs.
3. Use of measures for “Site conditional reservoir operation rules”.

Each chapter describes one of the new features.

2 Reset to initial setting

This chapter describes the extension of the option to reset to the initial status.

2.1 How to reset initial setting?

In previous RIBASIM versions it was possible to switch on the “Reset to initial settings” at the simulation control data and task block 2 (see User manual, chapter 6). Then the initial status is reset each year. So, the length of the reset period is fixed to 1 year. Now, the length of the reset period has been made variable and can be specified by the user. See Figure 2.1 where the reset period is specified as 25 years so after each 25 years of simulation the initial status is reset. This means that the storage of the surface water reservoir, groundwater reservoir and link storage nodes are reset to the initial values.

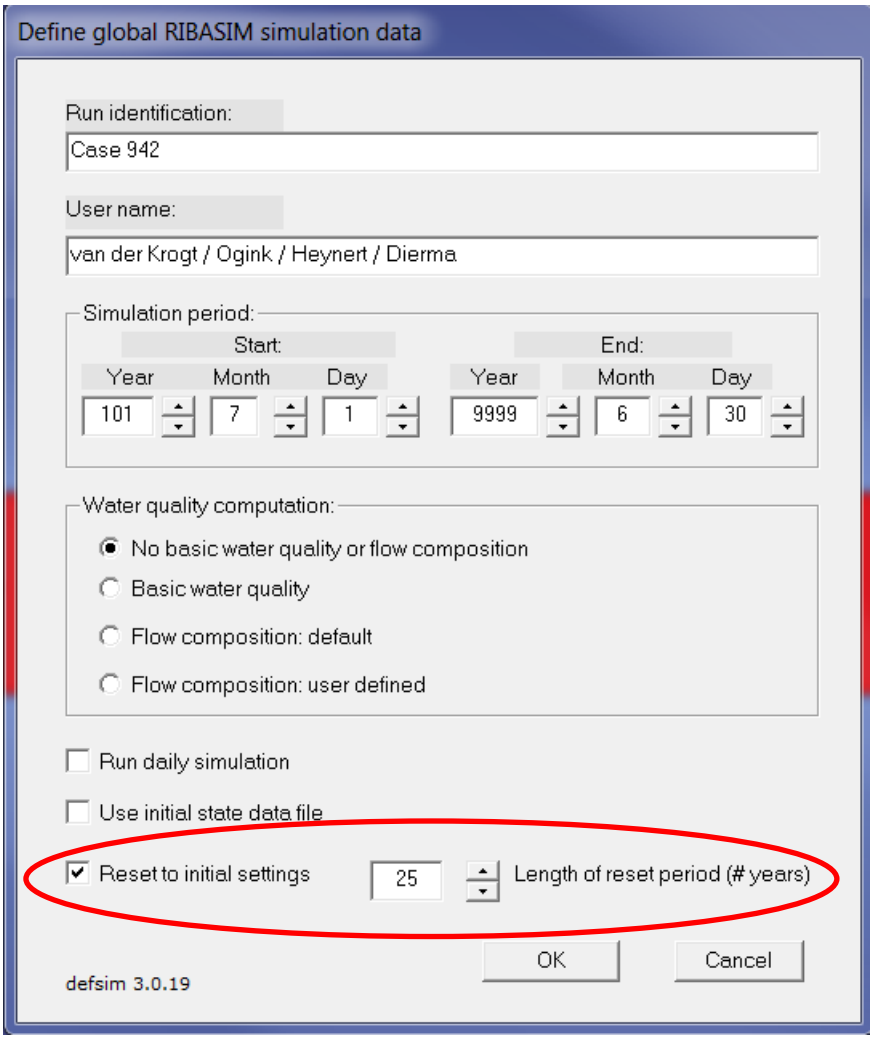

Figure 2.1 Specification of the length of the reset period in number of years.

2.2 How can you check the initial setting?

The reset to initial settings data can be checked at task block 3 “Edit network and data base on map” and menu item 3 “View tables of data base”. In Table 1.3 the initial settings data is shown. For example:

If switch is off:

Initial status ..... : No reset of initial status

If switch is on with length of reset period is 25 years:

Reset initial status with reset period (# of years) ..... : 25

2.3 How does RIBASIM process?

The initial level, storage and/or depth can be set on 3 ways:

1. in the model data from map (Dataedit spreadsheet, see User manual chapter 7 at the description of Action 5),
2. in the measure files and
3. in the initial status file which can be generated and edited at Task block 3.

RIBASIM processes all model data, management actions (measures) and initial status files before the simulation starts. At the first simulation time step RIBASIM saves the initial storage of the surface water reservoir, groundwater water reservoir and link storage nodes. RIBASIM will reset the initial storage of surface water reservoir, groundwater water reservoir and link storage nodes after simulating the number of years specified as reset period.

For example, if

1. the simulation period is 1 July 101 till 30 June 9999,
2. the switch “reset to initial settings” is on, and
3. the length of the reset period is 25 years.

then

1. After 25 simulation years at the start of July in year 126 the initial storage is reset.

Progress messages are written to the log file of the simulation (Simproc.log) when the simulation is running at task block 4 “River basin simulation”. The log-message “Reset of initial status” is written to the log file at the simulation time step that the initial status has been reset.

Aware that the initial soil moisture storage in the Advanced irrigation nodes are not saved and not reset.

2.4 What is the related output?

Two extra output features are available at task block 5 “Analysis of basin simulation results” menu item 2 “Results on charts” to analyse the simulation results of the surface water reservoirs for each reset period in one graph. First the desired reservoir output parameter

"level" or "release" must be selected, see Figure 2.2. Next the following selections must be done, see Figure 2.3:

- Parameter: some statistical values and the simulated initial reset periods
- Locations: the reservoirs
- Time steps: the length of the initial reset period e. g. 25 years of monthly time steps is 300 plus 1 for the initial storage level. The shown year index starting at 1901 is not relevant. Only the length is relevant.

Figure 2.4 and Figure 2.5 show example graphs of the reservoir level and release for each initial reset period. Each graph represents a simulation of 1 initial reset period of 25 years.

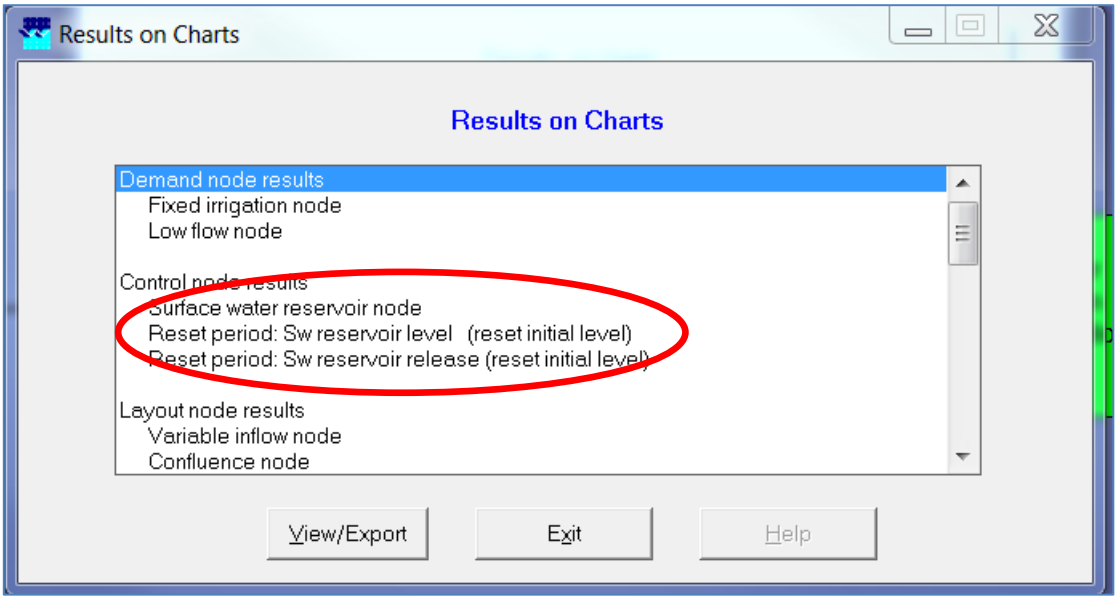

Figure 2.2 Two reservoir output parameters to show the results per initial reset period.

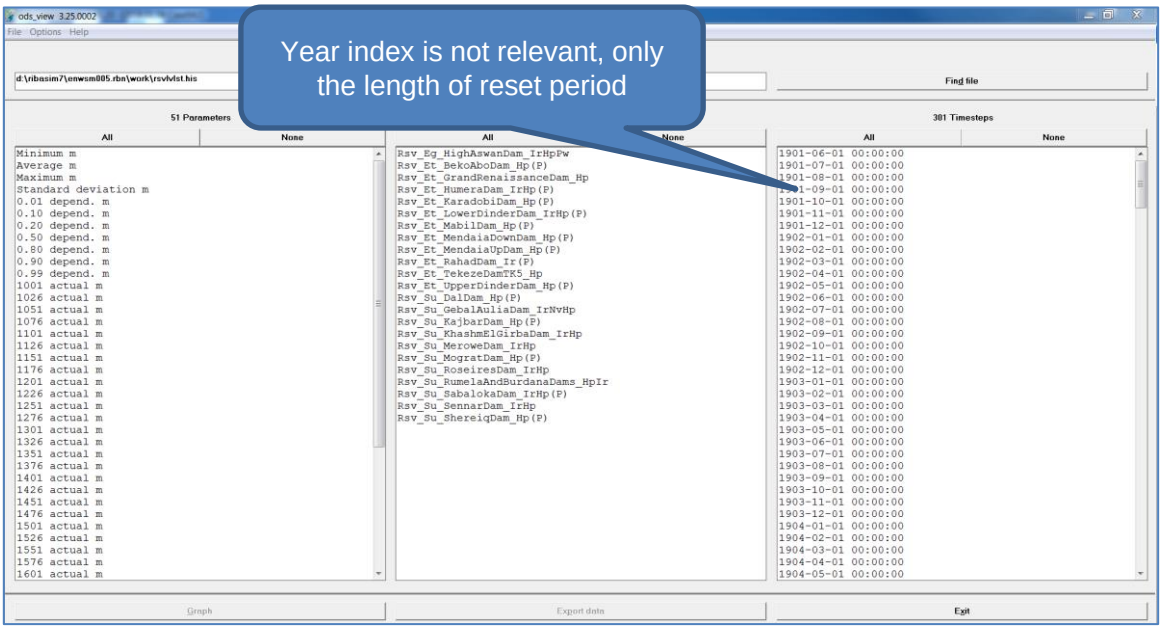

Figure 2.3 Selection screen.

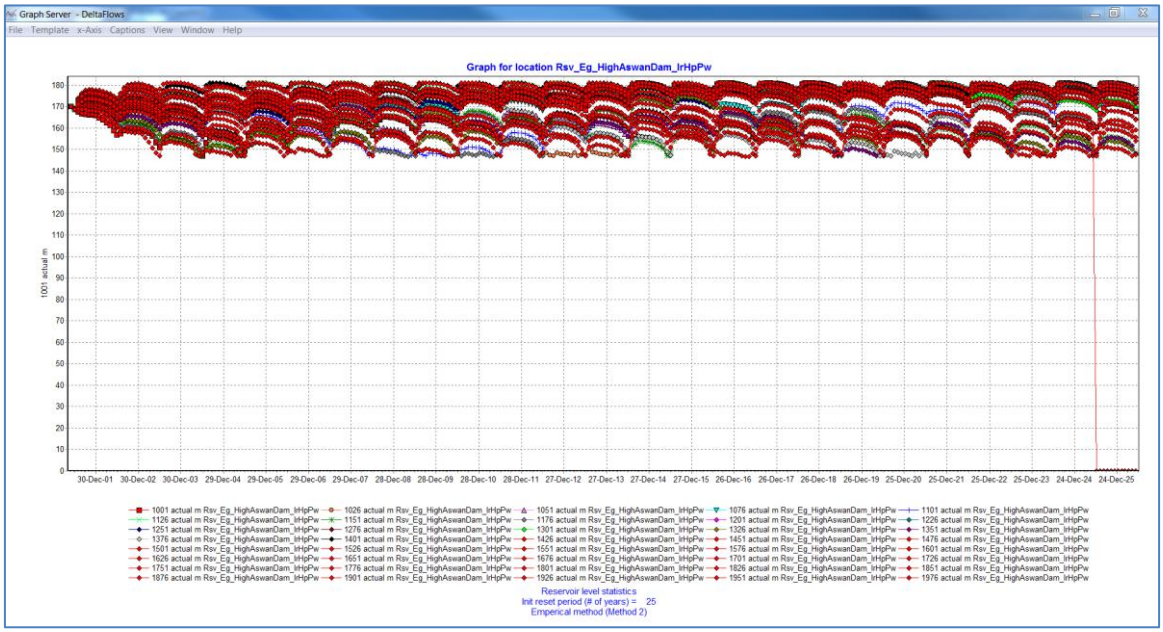

Figure 2.4 Reservoir level for all initial reset periods of 25 years (m).

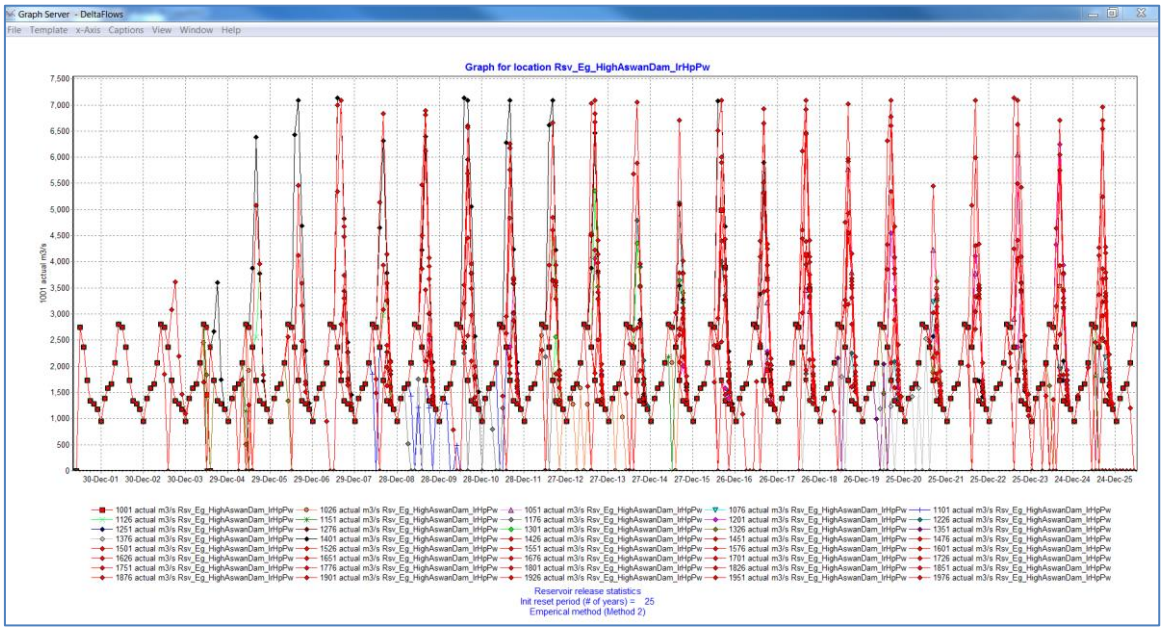

Figure 2.5 Reservoir release for all initial reset periods of 25 years (m3/s).

3 Time conditional measure

It may occur that we have to simulate the situation that the infrastructure e.g. reservoir dimensions change over time. In that situation the model data during the simulation time period has to be updated. There must be an option to change the model data at a specified time step or after simulating a number of years. This can be implemented by defining a “Time conditional measure”.

Aware: in RIBASIM Version 7.01.20 and 7.01.21 the time conditional measures are only valid for the surface water reservoir nodes.

3.1 How to define a time conditional measure?

Measures and combinations of measures (strategies, management actions) can be defined and simulated in RIBASIM, see RIBASIM Version 7.01 User Manual addendum. Figure 3.1 gives an overview of the RIBASIM input data flows and type of data, scenarios and management actions (measures). When make a measure time conditional by adding a time stamp to the measure data. The time stamp indicates the number of years after the start of the simulation that the measure becomes active.
The data of the measures without a time stamp (normal measures) are read and checked on its consistency in the program that generates the overview of the model data (Bin2prt). The time conditional measures with a time stamp are skipped here. The normal measures are directly activated at the start of the simulation. The time conditional measure data are read and checked on its consistency during the execution of the simulation at the year that the measure is implemented and activated. In the log file with progress messages under the right mouse button at task block “River basin simulation” the user can check if the time conditional measure has been activated. Error messages are also shown in the Log-file.

The property name indicating the time stamp that must be added to the chapter of the concerning node type is “Implementation year (sequence index of simulated year) =”. An example basin schematization is shown in Figure 3.2. Table 3.1 shows a time conditional measure indicating the increase of reservoir Rsv_A and Rsv_B1 to 540 meter including changes of operation after 5 simulation years and another increase to 560 meter including operation rules after 10 years.

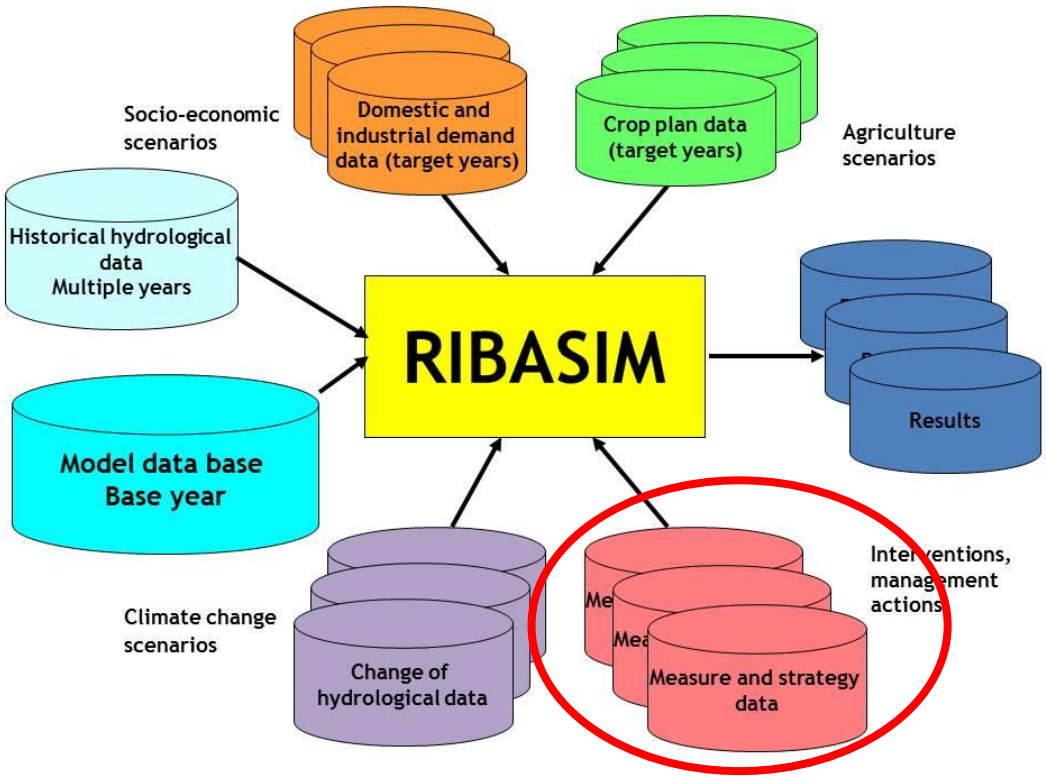

Figure 3.1 RIBASIM in- and output diagram.

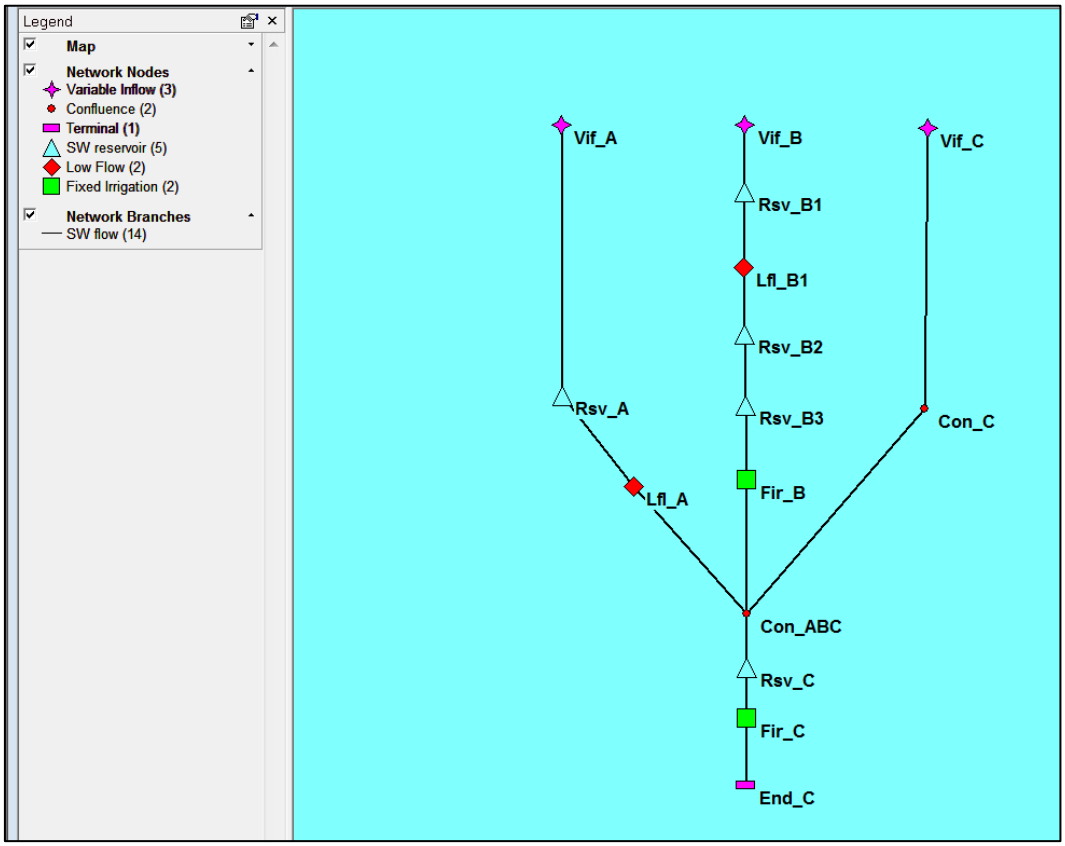

Figure 3.2 Example network schematization (RsvGrp01.rbn).

Table 3.1 Example time conditional measure.

```
[General]
FileType=MES
Version=1.00
MeasureStrategyName=Time conditional measure

[Reservoir node]
Node name = Rsv_B1
Implementation year (sequence index of simulated year) = 5
Full reservoir level (m) =540
Flood control storage operation rule (m)= 540
Target storage operation rule (m)=540

Implementation year (sequence index of simulated year) = 10
Full reservoir level (m) =560
Flood control storage operation rule (m)= 560
Target storage operation rule (m)=560

Node name = Rsv_A
Implementation year (sequence index of simulated year) = 5
Full reservoir level (m) =540
Flood control storage operation rule (m)= 540
Target storage operation rule (m)=540

Implementation year (sequence index of simulated year) = 10
Full reservoir level (m) =560
Flood control storage operation rule (m)= 560
Target storage operation rule (m)=560
```

3.2 How to check the time conditional measure is correctly processed?

The user can check if the time conditional measure is correctly processed in RIBASIM at the following 2 locations:

1. In the report: tables of data base which can be viewed under the right mouse button of task block 3 “Edit network and data base on map” and at menu item 3 “View tables of data base”. At the end of table 5 in the report (file Bin2prt.log) the measures and the start year are listed.
2. In the basin simulation log file under the right mouse button at task block 4 “River basin simulation” a message is shown at the time step that the measure becomes active. All model data are written to the log-file.

When the “reset to initial settings” option is on (see Figure 2.1) then the year counter for the time conditional measures is reset to 0.

4 Site conditional reservoir operation rule

Reservoirs, lakes and dams with or without hydro-power station and their operation are modelled in RIBASIM. Figure 4.1 shows the general geometry of a reservoir in RIBASIM. The actual reservoir release is computed for each simulation time step taking into account the following parameters:

1. Initial water volume in the reservoir
2. Hydrological in- and output components: rainfall, evaporation, seepage, inflow
3. Release targets for downstream users at main, backwater and / or turbine gate (if present) for:
   a. non-hydro power release targets like irrigation, domestic municipal and industrial water supply, flushing, fish ponds, environment, inter-basin transfer, etc
   b. hydro-power release targets for generation of firm energy
4. Gate capacities
5. Reservoir operation rules: flood control, maximum annual energy production, firm storage and hedging. Figure 4.2 and Figure 4.3 show the standard reservoir operation rules in RIBASIM and their associated actions.

The above listed parameters allow the user to define a standard way of reservoir operation. This normal operation is described in the RIBASIM technical reference manual chapter 6.5.

In some situation for example when reservoirs are located parallel and in series (see Figure 4.4) the operation of an upstream reservoir is determined by the status of a downstream reservoir. In this case explicitly defined “Site conditional operation rules” might be needed to simulate the actual and desired situation. This chapter describes various types of site specific operation rules which are implemented in RIBASIM.

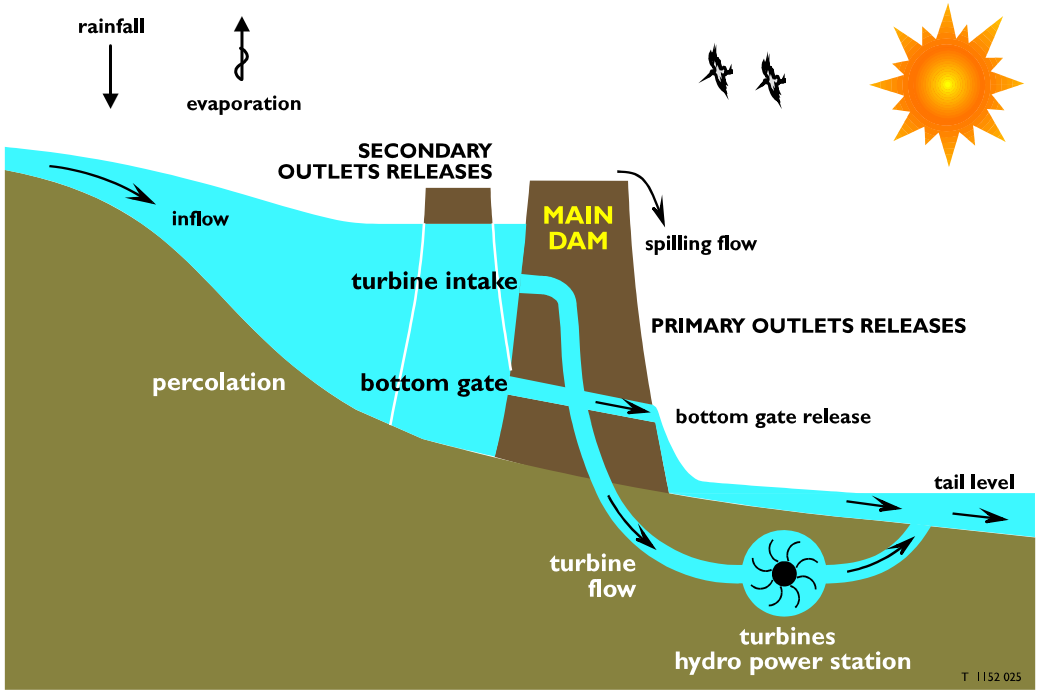

Figure 4.1 Geometry of surface water reservoir in RIBASIM.

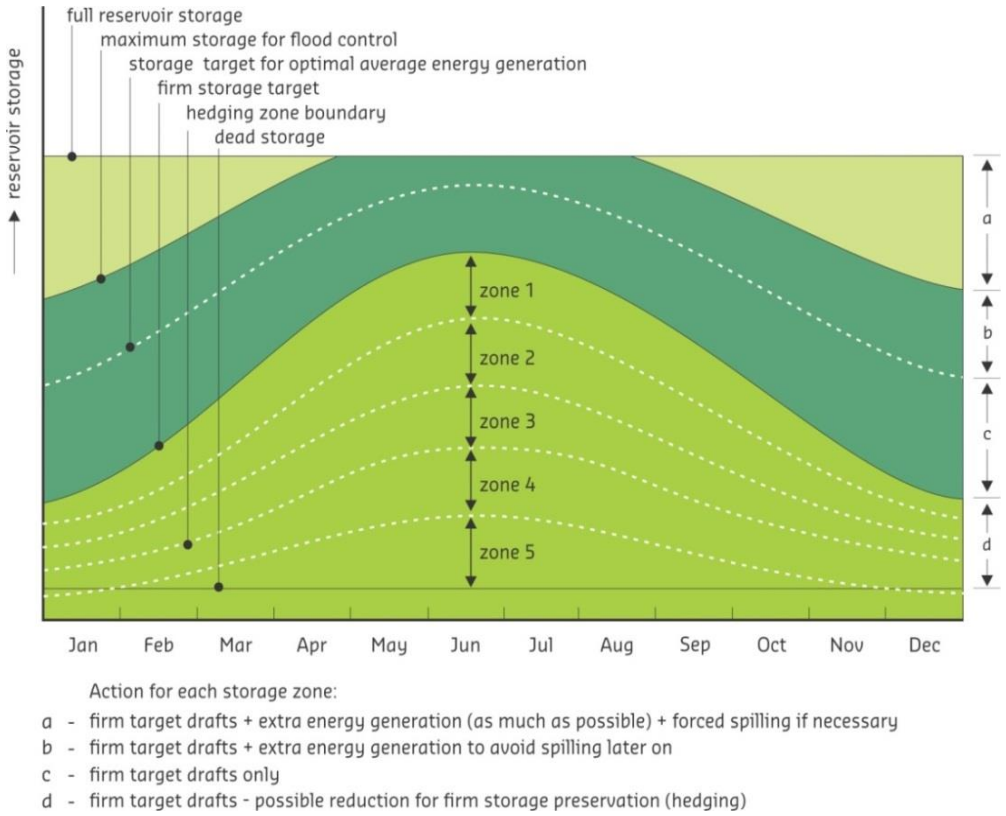

Figure 4.2 Annual reservoir operation rules with hedging based on storage.

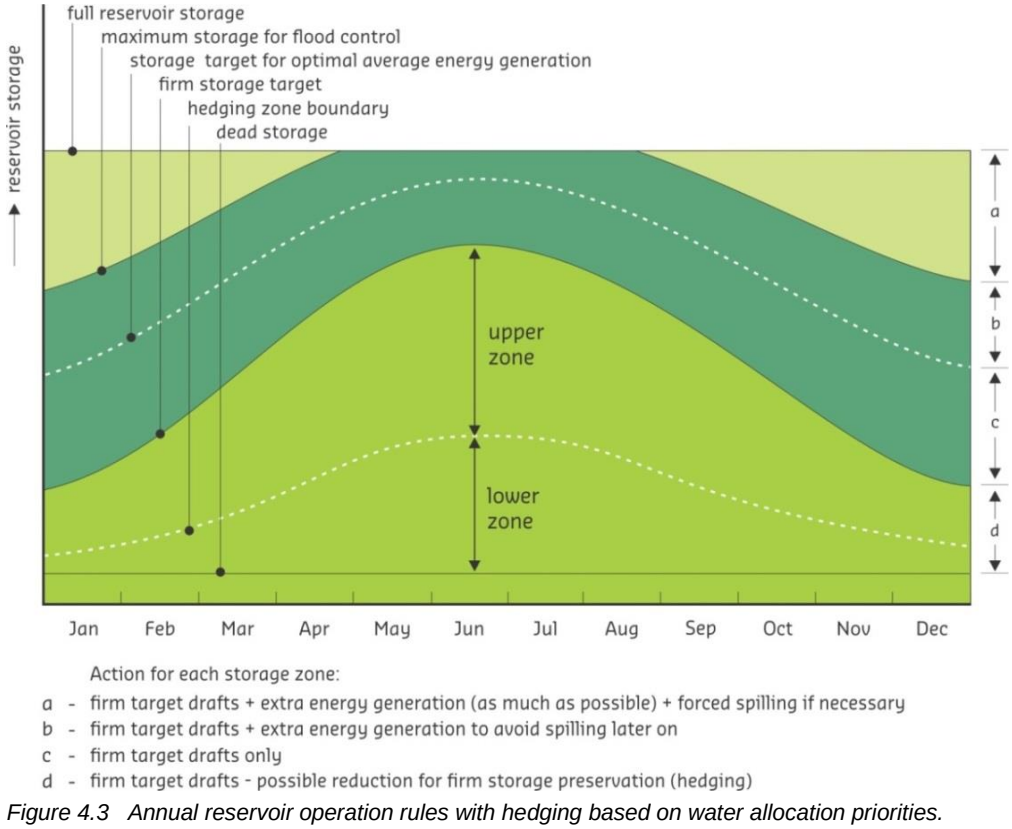

Figure 4.3 Annual reservoir operation rules with hedging based on water allocation priorities.

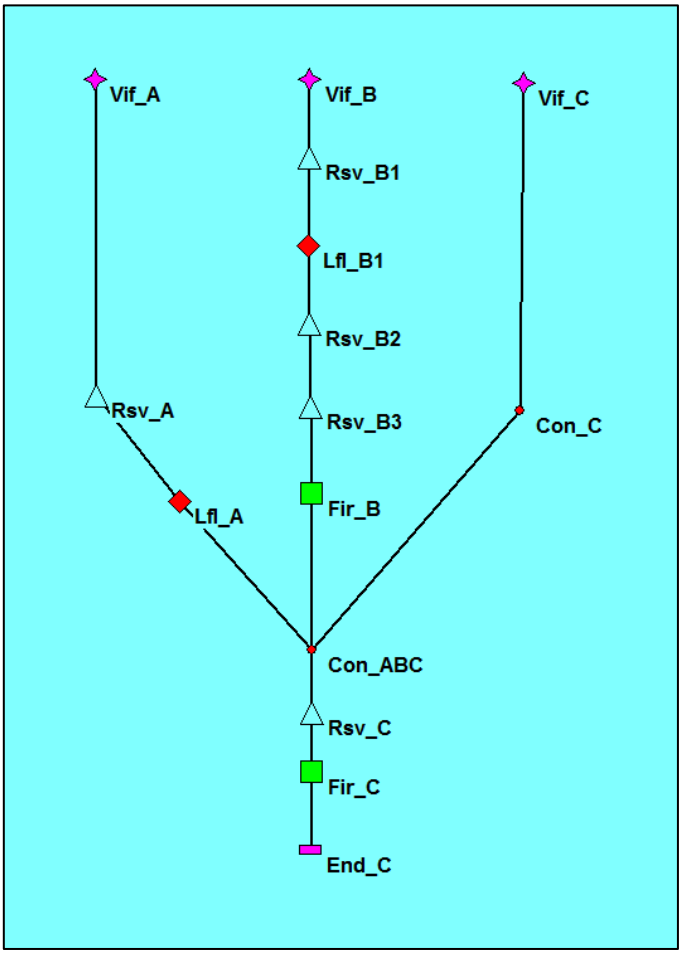

Figure 4.4 Example configuration with reservoirs parallel and in series.

4.1 How to define a site conditional reservoir operation rule?

The “Site conditional reservoir operation rules” are additional to the standard annual reservoir operation rules. The “site conditional reservoir operation rules” are defined and modelled in RIBASIM using the measure files, see Figure 3.1. The definition and use of measures are described in the “RIBASIM Version 7.01 User manual Addendum”. The measure is defined in the chapter of the surface water reservoir with chapter name [Reservoir node]. The measure defines:

1. the condition that activates the operation rule. Condition is a critical reservoir level.
2. the action to be taken. Actions can be defined for 1 or more upstream reservoirs. The action is an additional release target of the action reservoir node. The release target is at the downstream surface water link of the reservoir and is not at the backwater flow link, if present.

RIBASIM simulates the reservoir operation using the normal operation rules for each time step. At the end of the simulation for each time step the status of the reservoir is tested with the defined condition in the “Site condition measure” and if needed the additional release target at the action reservoir is computed. Finally RIBASIM starts the simulation at the action reservoir.

RIBASIM supports 3 types of site conditional reservoir operation rules described below. The property names used to define the site conditional reservoir operation rules in the measure file (Mes-file) are listed in Table 4.1.

Aware, the rules for the definition of the measures:

1. **The maximum number of site conditional measures equals to the number of reservoirs (for the time being).**
2. **The route between the site conditional reservoir and the action reservoir is via the main river. The water is not supplied via a diverted flow link.**

Table 4.1 Overview of the chapter and property names for the site conditional measures.

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”
Site conditional operation rule type	Integer	Value is 1, 2 or 3.
Action reservoir name	String	Rule type 1, 2 and 3: Name of the reservoir node for which the operation must be changed.
Demand factor (-)	Real	Rule type 1 and 3: demand factor to compute the additional release target.
Additional release (m3/s)	Real	Rule type 2: Additional release from the action reservoir for all time steps (m3/s)
Additional release (t) (m3/s)	Real	Rule type 2: Additional release from the action reservoir per time step (m3/s)
Critical reservoir level (m)	Real	Rule type 2 and 3: Critical reservoir level for all time steps (m)
Critical reservoir level (t) (m)	Real	Rule type 2 and 3: Critical reservoir level per time step (m)

Site conditional reservoir operation rule type = 1

Type 1 defines the operation rule: if the reservoir level is below the firm storage level then an additional site conditional demand D is computed which is equal to the volume of water below the firm storage level. This demand D is multiplied by a demand factor to compute the additional release target for each action reservoir. Demand factor represent the intermediate losses between the 2 reservoirs and may differ per action reservoir. The additional release target at each specified action reservoir may be released thru the turbine and/or main gate within each gate capacity. Table 4.2 shows an example type 1 measure.

Table 4.2 Example measure of a site conditional operation rule type 1.

[Reservoir node]

Node name = Rsv_C
Site conditional operation rule type = 1
Action reservoir name= Rsv_A
Demand factor (-) = 0.45
Action reservoir name= Rsv_B1
Demand factor (-) = 0.55

Site conditional reservoir operation rule type = 2

Type 2 defines the operation rule: if the reservoir level is below a specified critical level then a specified additional target release is requested to the specified action reservoirs. At this rule type the user explicitly specifies the critical level and the additional release target (action). The values can vary per time step. Table 4.3 shows an example type 2 measure. Table 4.4 shows another example measure with values varying per time step.

Table 4.3 Example measure 1 of a site conditional operation rule type 2.

[Reservoir node] **Node name** = Rsv_C Site conditional operation rule type = 2 Critical reservoir level (m) = 120.0 Action reservoir name= Rsv_A Additional release (m3/s) = 10.0 Action reservoir name= Rsv_B1 Additional release (m3/s) = 10.0

Table 4.4 Example measure 2 of a site conditional operation rule type 2.

[Reservoir node] **Node name** = Rsv_C Site conditional operation rule type = 2 Critical reservoir level (t) (m) =120, 120, 120, 115, 115, 115, 110, 110, 110, 115, 115, 115 Action reservoir name= Rsv_A Additional release (t) (m3/s) = 35, 35, 35, 30, 30, 30, 30, 30, 30, 35, 35, 35 Action reservoir name= Rsv_B1 Additional release (t) (m3/s) = 25, 25, 25, 20, 20, 20, 20, 20, 20, 25, 25, 25

Site conditional reservoir operation rule type = 3

Type 3 defines the operation rule: if the reservoir level is below the specified critical reservoir level then an additional site conditional demand D is computed which is equal to the volume of water below the critical storage level. This demand D is multiplied by a demand factor to compute the additional release target for each action reservoir. Demand factor represent the intermediate losses between the 2 reservoirs and may differ per action reservoir. The additional release target at each specified action reservoir may be released thru the turbine and/or main gate within each gate capacity. Table 4.5 shows an example type 3 measure. Table 4.6 shows another example measure with values varying per time step.

Table 4.5 Example measure 1 of a site conditional operation rule type 3.

[Reservoir node]

Node name = Rsv_C
Site conditional operation rule type = 3
Critical reservoir level (m) = 120
Action reservoir name= Rsv_A
Demand factor (-) = 0.45
Action reservoir name= Rsv_B1
Demand factor (-) = 0.55

Table 4.6 Example measure 2 of a site conditional operation rule type 3.

[Reservoir node]

Node name = Rsv_C
Site conditional operation rule type = 3
Critical reservoir level (t) (m) = 120, 120, 120, 125, 125, 125, 125, 125, 125, 120, 120, 120
Action reservoir name= Rsv_A
Demand factor (-) = 0.45
Action reservoir name= Rsv_B1
Demand factor (-) = 0.55

4.2 How to check if all measure data has been correctly processed?

The user can check if the site conditional reservoir operation rule is correctly processed in RIBASIM at the following 2 locations:

1. In the report: tables of data base which can be viewed under the right mouse button of task block 3 “Edit network and data base on map” and at menu item 3 “View tables of data base”. At the end of table 3.6 an table is added with the site conditional data. Table 4.7 shows an example table.
2. In the basin simulation log file under the right mouse button at task block 4 “River basin simulation” the message is shown at the time step that the measure becomes active:

```
Measures with site conditional operation rules processed
```

Table 4.7 Example overview of the site conditional reservoir operation rules.

```
Data related to the site conditional reservoir rules defined in the measures
-----------------------------------------------------------------------

Number of site conditional reservoir rule type 1 =  0 (based on actual and firm storage and demand factor)
                                       type 2 =  0 (based on critical storage and specified additional release)
                                       type 3 =  1 (based on actual and critical storage and demand factor)

Site conditional reservoir rule type 3 data

        Site conditional reservoir node                 Action reservoir node
Rule    ------------------------------------------------ ------------------------------------------------ Demand
index   index   name                                     index   name                                     factor (-)
------- ------- ---------------------------------------- ------- ---------------------------------------- ----------
      1      50 Rsv_C                                         10 Rsv_A                                          0.450
                                                              30 Rsv_B1                                         0.550

        Site conditional
Rule    reservoir node   Critical level at site conditional reservoir (m) for each time step (12 time steps per line)
index   index                 1        2        3        4        5        6        7        8        9       10       11       12
------- ---------------- -------- -------- -------- -------- -------- -------- -------- -------- -------- -------- -------- --------
      1               50   120.00   120.00   120.00   125.00   125.00   125.00   125.00   125.00   125.00   120.00   120.00   120.00
```