Deltares

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River Basin Simulation Model RIBASIM Version 7.00

User Manual

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River Basin Simulation Model
RIBASIM Version 7.00

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1 Introduction

RIBASIM is a generic model package to simulate the hydrological behaviour of river basins for varying current and future hydrological, climate and anthropogenic conditions. The model is a comprehensive and flexible tool to link the hydrologic water inputs at various locations in a basin to the diverse water-using activities taking place at the same analytical scale. By processing this combination of inputs, RIBASIM can evaluate a large set of system modelling options and outputs, as for example measures related to infrastructure and operational management, changes in water distribution and consumption patterns across sectors, and changes in hydro-meteorological conditions. The model provides an efficient handling and structured analysis of the large amounts of data commonly associated with (complex) water resources systems.

RIBASIM has been developed and fine-tuned at Deltares | DELFT HYDRAULICS in the early 1980's. Countries where the model has been applied include The Netherlands, Belgium, Germany, Greece, Italy, Portugal, Turkey, China, Taiwan, Vietnam, Iran, Iraq, Senegal, Mozambique, Lesotho, Poland, Argentina, Mali, Morocco, Brazil, Ukraine, Trinidad, Canada, Indonesia, Egypt, Kenya, Ethiopia, Poland, Czech Republic, , Nepal, Chile, Colombia, Malaysia, Philippines, Central Asian republics (Aral Sea catchment), Eastern Nile countries (Ethiopia, South Sudan, Sudan, Egypt) and India. In most of these countries a continued use is made of the model by national agencies. The variety of applications available through RIBASIM has resulted in a versatile model. Modeling elements (e.g. reservoir operation, irrigation water use, low flow requirement, etc.) can be selected from a library of options which can easily be expanded to address further user-specific needs.

The current documentation provides a description of RIBASIM in the framework of the so-called *Delft tools*. Delft tools offer a number of MS Windows-based graphical analysis tools which can be used in a flexible way depending on the model application. The complete system enables a quantitative analysis of the various aspects, and it includes systems to structure the required data and to present model calculations.

Figure 1.1 shows the general structure of RIBASIM. Presently the model consists of three subsystems:

- An *information system* containing databases, data files and a database management system;
- A set of *simulation models* (computational framework) containing mathematical (and expert) models to simulate i.e. hydrology, water demand, water allocation and water quality;
- An *analysis system* to define and evaluate management strategies and measures, to perform assessment studies and to evaluate costs of measures.

In the information system all relevant data for analysis, calibration and validation of the mathematical models is stored. The information is generally aligned as a two layered data structure: one layer contains the network of objects (nodes, links), their type and their relations while the second layer contains an object oriented database describing each object. A data quality control procedure may be included in the data entry part of the system to verify the accuracy of the entered data.

The set of simulation models consists of coupled mathematical models to enable a quantitative analysis of the relation between the input of pollutants and the assimilation capacity of the water system. In this set of mathematical models the following aspects are included: hydrology, water demand, water allocation, waste load calculation, pollutant transport, and water quality.

In the analysis system, strategies can be defined and evaluated in order to support the development activities for the river basin.

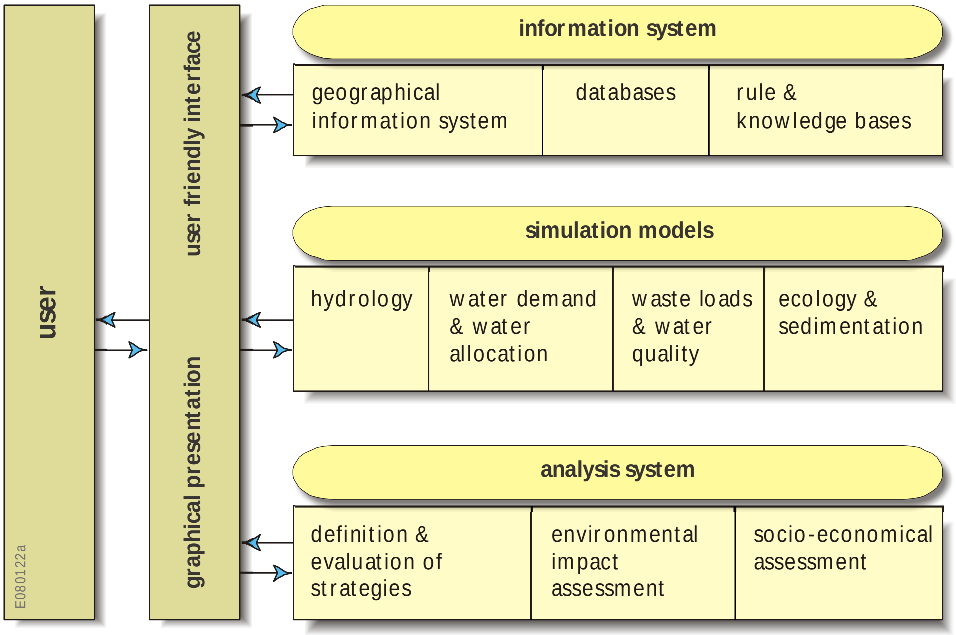

Figure 1.1 General outline of the RIBASIM software.

In many projects the RIBASIM model has been used to generate the flow pattern as a basis for water quality and sedimentation analyses, and special attention has been paid to a flexible transfer of the necessary data to other models. In other cases, the model has been used to perform scenario analysis to assess the impact of changing climate or/and anthropogenic conditions on river hydrology.

<u>When to use RIBASIM?</u>

RIBASIM can be used for several types of assessments. The types of analysis addressed by the model are the following:

- Evaluation of the limits on resources and/or the potential for development in a region or basin:
  Given the available water resources and their natural variations, to what extent can a river basin be developed in terms of reservoirs, irrigation schemes, water supply systems, while avoiding unacceptable shortages for users?
  When and where will conflicts between water users occur?
  Which combination of infrastructure and operational management will provide an optimum use of the available resources?

- Evaluation of measures to improve the water supply or water quality situation:
  - Measures concerning changes in the infrastructure;

- Operational management choices of water allocation and/or water sector infrastructure;
- Sector-specific demand management options;

- Evaluation of the origin of water for every location in the river basin as a first step towards an actual water quality analysis. Without the necessity of having available information with regard to waste loads, waste water discharges and water quality of (upstream) sources the effect of measures on the distribution of water from the various sources in the basin is calculated (influence area of a source of water);

Simulation of the water balance at the basin, regional or transboundary scale forms the basis for such an analysis. RIBASIM provides the means to prepare such system water balance with sufficient detail, taking for example into account re-use of water by different sectors, and providing a comprehensive set of results parameters with which to carry out the final analysis. In this way, RIBASIM results can be used directly for policy development studies, or indirectly as an input for sector specific overviews of water demand and use patterns.

Model schematization

To perform river basin simulations with RIBASIM, a model schematization of the study area is prepared in the form of a *network*, consisting of nodes connected by links. Such a network represents all the features of the basin that play a role in its water balance.

Four main groups of schematization elements are differentiated in the model:

- Infrastructure, both natural and man-made (reservoirs, lakes, rivers, canals, surface water, aquifers and pumping stations, pipelines);
- Water users, or in a wider sense water related activities (e.g. domestic, municipal and industrial water supply, agriculture, hydropower, aquaculture, navigation, recreation, nature, river minimum flows);
- Management of the water resources system (operation rules for surface water reservoirs and diversions, aquifers, water allocation to water users based on priorities, water allocation to crops based on priorities and proportional water allocation to users;
- Hydrology (inflows to the system, inter-basin flows, precipitation, evaporation), geo-hydrology (groundwater), and hydraulic behaviour (e.g. flow level relationship);

The nodes of the network represent structures, water users, in- and outflows boundaries, water use activities, water bodies and so on; the links represent transport of water between the different nodes (interaction between river reaches or surface water reservoirs and aquifers or among aquifers).

Simulations

Simulations are usually made to analyse a specific (current or future) condition over multiple year series of measured or simulated datasets. This is done to cover sequences of dry and wet hydro-meteorological periods. The simulation proceeds in *time steps*, of typically one month, half a month, a decade, a week or even days.

RIBASIM is a water balance model. Within each time step a water balance calculation is performed, in two phases:

- Target setting phase (demand phase).
  Determination of all the water demands, resulting in targets for the releases of water from boundary inflow, reservoir, and aquifer nodes, and diversion flows at weirs and pumping stations.

- Water allocation phase (supply phase).
  Allocation of water over the users according to targets, availability and allocation rules. Computation of flow or water quality composition at each identified location in the basin.

Water allocation to users can be implemented in a variety of ways: in its simplest format water is allocated on a "first come, first serve" principle along the natural flow direction of the river streams. This allocation can be amended by rules which e.g. allocate priority to particular users or which result in an allocation proportional to demand.

On the basis of a set of simulations, usually made for a range of alternative development or management strategies, the performance of the basin is evaluated in terms of water allocation, shortages, supply reliability, (firm and secondary) energy production, pumping energy consumption, overall river basin water balance, crop yields and production costs, flow composition, substances concentrations and other useful parameters..

Model structure

The preparation of input data, running of the model and the processing of output data into graphs, maps of the study area, diagrams and tables takes entirely place via user-friendly menu screens.

RIBASIM distinguishes a number of standard node and link types with which the river basin network can be constructed. Each type of node and link correspond to a particular part of the model that handles the relevant computations for this node or link type. The model contains a library of nodes and links that can easily be expanded to include other activities specific to a particular basin.

A short selection of available "node" and “link” features is presented below:

- irrigation areas: computation of water demand on the network taking into account crop characteristics, irrigation practise parameters, irrigation efficiency rates and actual rainfall;
- conjunctive use of groundwater and surface water for various water users like irrigation and public water supply;
- water balance of groundwater aquifers;
- pumping capacity and maximum groundwater depth for abstraction from an aquifer;
- brackish or fresh water aquaculture: flushing demands;
- minimum flow requirements for sanitation, navigation or ecology;
- loss flow from river stretches to groundwater;
- run-of-river power plants;
- hydropower production requirements at surface water reservoirs: firm (guaranteed) and secondary energy, scheduling;
- computation of pumping energy (from groundwater or surface water to users);
- return flows from users (agriculture, aquaculture, public and industrial water supplies);

- additional (backwater) abstractions from surface water reservoir for various water users;
- surface water reservoir operation rules (firm storage, target storage e.g. for average maximum energy generation, flood control storage);
- sub-catchments which form a hydrological unit from the viewpoint of water supply and demand;
- hydraulic description of (part of) river stretches and partitions of surface water reservoir;
- various hydrologic flow routing methods (2-layered Muskingum, Puls method, Manning, Flow-water level relation);
- routing of flow salinity and computation of flow composition

Input

The required input for RIBASIM includes the following items:

- river basin network schematization: location of surface water reservoirs, aquifers (groundwater reservoirs), irrigation areas, diversion weirs, (river) channels, domestic, municipal and industrial (DMI) demand nodes, sub-catchments comprising a system of nodes and links;
- model data characterizing each node and link in the schematization;
- preferred sources of water for the identified water users in the basin;
- water allocation rules and operation rules for surface water reservoirs, aquifers and diversions;
- hydrologic data (time series of available flow at the system boundaries e.g. river discharge, inflow from inter-basin transfers, open water evaporation, rainfall, general district water demand and discharges, catchment runoff);
- water quality data (lookup tables)

Output

Simulation results can be processed with a number of standard post-processors into graphs, spreadsheets, maps and tables.

For a quick visual interpretation of results a number of graphs can be produced on screen (e.g. during calibration testing). The format of the graphs can be adapted according to the user requirements. Graphs show for example the applied cropping pattern, the water allocation, the occurrence of shortages per user type, the actual surface or groundwater reservoir storage, the overall water balance of the basin and the energy production from reservoirs. Figure 8 provides an example of how results can be visualized directly from the graphical representation of the basin: in the picture, the flow animation of spilling water from the Narmada River in Gujarat (India) is illustrated. The results can be further processed with spreadsheet software like Microsoft Office Excel or directly included in reports produced with for example Microsoft Word.

The available set of report tables that can be generated with RIBASIM spans from summaries of the main results (success rate, allocated amounts of water, water shortages, water utilization rate, failure year percentage and energy production) to user-defined tables containing detailed results identified per time step for specific variables for selected nodes or links.

The following sections inform you what the hardware and software requirements are for the computer on which RIBASIM will be installed and what the installation procedure is. Further the RIBASIM working procedure is outlined in a number of tasks. Each step is described in one or more chapters. For the majority of chapters a number of remarks are listed. It is important that the user understands these remarks before applying RIBASIM on an identified river basin.

2 Hardware and software requirements and installation

2.1 Hardware and software requirements

The installation of RIBASIM requires the following *hardware and software:*

- PC with Intel Pentium or comparable processor;
- MS Windows 95, 98, 2000, NT with package 3, XP, Vista and 7 operating system;
- at least 64 Mbytes of RAM memory;
- free hard disk space of at least 400 Mbytes, but preferably more to have ample storage available for the results of the model simulations;
- a mouse;
- a CD ROM drive;
- a colour monitor;
- a printer

2.2 Installation

Installation of RIBASIM can be easily carried out with the original RIBASIM installation compact disc. The compact disc contains the manuals, the programs and a number of example basins, each stored in a separate directory. The installation of the programs and example basins is described in detail in a separate file README – file on the compact disc. The installation is carried out automatically by starting the execution of the installation program executable under MS Windows.

The installation consists of 3 parts:

1. Installation of the Delft Hydraulics license manager and the RIBASIM license file,
2. Installation of the RIBASIM program;
3. Installation of one or more RIBASIM example models.

Part 1 *Installation of the Delft Hydraulics license manager and the RIBASIM license file*

Open the Start-menu by clicking the left mouse button on the Windows "START" button, select menu item "Run" activate the "Browse" button, browse to the "*Programs*" directory on the RIBASIM cd and select the *Ribasim_install.exe* executable. Execute the installation by activation of button "OK". All required follow-up actions are indicated on the screen for a stand-alone license and listed in table 1.

Table 2.1 Actions to install the Delft Hydraulics license manager and the RIBASIM license file.

At prompt:	Action:
Welcome to the RIBASIM 7.00 installation	Next
Select installation: DHS License Manager	Next
Welcome Delft Software License manager	Next
Choose configuration Options: Stand-alone	Next
Choose destination folder	Next

At prompt:	Action:
Delft software license manager installation	Next
Install the license file (Yes)	Next
Specify license file location	Push button Locate License File > Browse to the "*License*" directory on the RIBASIM cd and select the correct lic-file (license file) > Open
Start installation	Next (the installation may take some time !!!)
Delft Software License Manager Installation	Finish

***Part 2** Installation of the RIBASIM program*

Open the Start-menu by clicking the left mouse button on the Windows "START" button, select menu item "Run" activate the "Browse" button, browse to the "*Programs*" directory on the RIBASIM cd and select the *Ribasim_install.exe* executable. Execute the installation by activation of button "OK". All required follow-up actions are indicated on the screen and listed in Table 2.2. All RIBASIM related programs and data are stored in the main directory RIBASIM7.

Table 2.2 Actions to install the RIBASIM program.

At prompt:	Action:
Welcome to the RIBASIM 7.00 installation	Next
Select installation: Ribasim 7.00	Next
Read Me File	Next
Choose Destination Drive (C:)	Next, if the installation drive is the c-drive else select the drive on which you want to install RIBASIM.
Ready to Start the Ribasim 7.00 Installation	Install

Part 3 Installation of one or more RIBASIM example models

Open the Windows explorer and browse to the "*Examples*" directory on the RIBASIM cd. The directory contains several example models. Each example model is stored in a separate Rbn-directory in the "*RIBASIM7*" directory which is automatically created on the destination drive at the actions for part 2. The actions are as follows:

- If the files in the "*Examples*" directory are Zip-files then Unzip the files to the "*RIBASIM7*" directory on the Destination Drive (see Table 2.2).
- If the files in the "*Examples*" directory are several Rbn-directories then copy each Rbn-directory to the "*RIBASIM7*" directory on the Destination Drive (see Table 2.2).

Remarks:

- Check your Windows regional and language settings: push “Start” button, select "Control Panel", select the "Regional and Language Options" icon, select sheet “Regional Options” and select “English (United States)”. The decimal symbol at numbers must be a point (.).
- At the license manager installation automatically the icon *Delft Hydraulics > DHS License manager (stand alone, server)* is defined with several programs which can be used to install new license files or check the license file.
- At the RIBASIM program installation automatically the icon *Delft Hydraulics > River Basin Simulation Model > RIBASIM Version 7.00* is defined to start RIBASIM.
- If you have a FlexLM hardware key then you have to plug it into the USB port of your pc. You have to restart your pc before using RIBASIM. The license file contains information on:
    - the date till your license is valid and/or
    - the number of the hardware key which belongs to your RIBASIM copy
- At the RIBASIM program item control box the following properties have been filled in to start RIBASIM:
    - Description of the RIBASIM application e.g. "*RIBASIM Version 7.00"*
    - Command to start the RIBASIM application e.g. if programs are stored on the c-drive:
      c:\Ribasim7\Programs\Dsshell\Rbnshell.exe
      c:\Ribasim7\Programs\Dsshell\Dsshell.ini
    - Working directory e.g. if data are stored on the c-drive: *c:\Ribasim7*
- The program and data structure after installation is given in the appendix C.
- The license file (Lic-file) is automatically stored in the “\Program Files\DS_Flex” directory.

3 How to start an application

An ‘application’ is the highest level of the RIBASIM model and consists of the modelling of one or more river basins or parts of river basins. You can start RIBASIM by double clicking the RIBASIM Version 7.00 icon (see Figure 3.1) with the left mouse button. The RIBASIM title screen is shown on the screen.

Figure 3.1 RIBASIM Version 7.00 start icon

3.1 Title screen

Figure 3.2 shows the RIBASIM title screen.

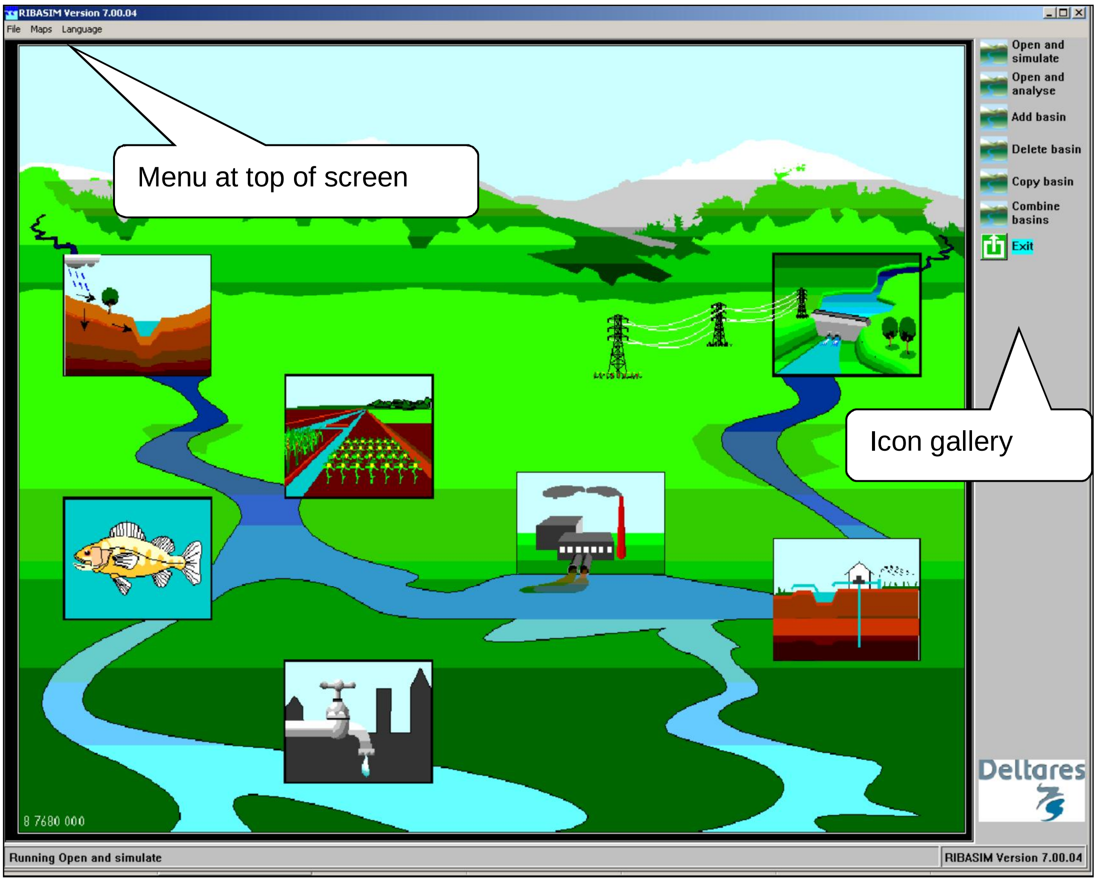

Figure 3.2 RIBASIM title screen

The screen consists of:

- a background picture.
- a menu at the top of the screen
  - **File** and sub-menu item: **Exit** of RIBASIM
  - **Maps**: allows changing the default background map to be used for new applications.
  - **Language:** Switch the language of the screen text from English into Dutch.
- an icon gallery at the right side of the screen showing the following icons:
  - **Open and simulate:** selection of the basin to simulate using the case management tool (CMT).
  - **Open and analyse:** selection of the basin to analyse the simulation results of the various simulation cases using the case analysis tool (CAT). A separate documentation is submitted as User manual for the case analysis tool.
  - **Add basin:** add a new basin.
  - **Delete basin:** selection of a basin to delete.
  - **Copy basin:** selection of a basin to copy.
  - **Combine basin:** combining two or more modelled basin into one new basin.
  - **Exit:** exit RIBASIM.

3.2 Start a previous application

If you want to continue working on an implemented RIBASIM application then the following actions must be carried out:

- Select the icon 'Open and Simulate', then a new window is opened with an overview of all implemented applications (see Figure 3.3)
- Select the application that you want to work on
- Confirm by selection of the 'OK' button

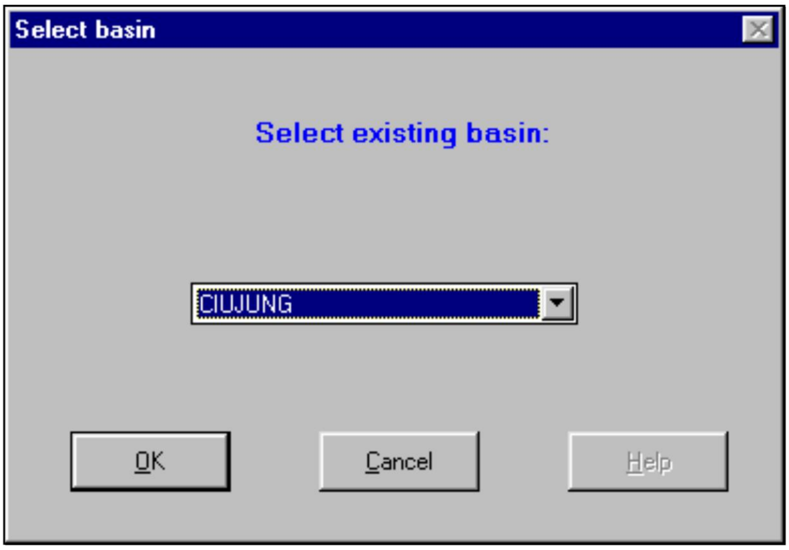

Figure 3.3 Window for selection among all implemented applications or basins

After a correct execution of the above actions the case management tool (CMT) for the selected basin is activated. This is shown in Figure 3.4

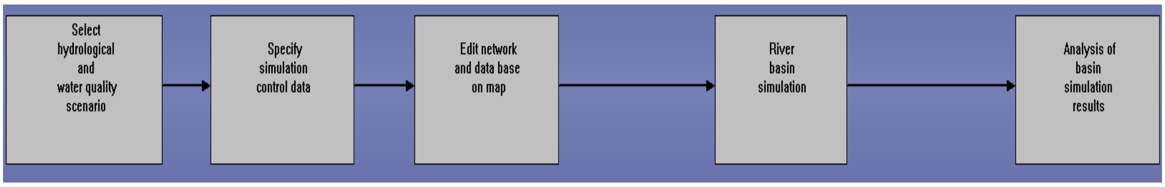

Figure 3.4 Case management Tool (CMT) of RIBASIM

In case that your previous application is set-up with a previous version of RIBASIM then automatically the **update procedure** is started which updates the complete basin application. After the update you can start to work on the application.
The update procedure supports the conversion of applications from RIBASIM Version 6.2 and higher. The update procedure is completed by the screen shown in Figure 3.5.

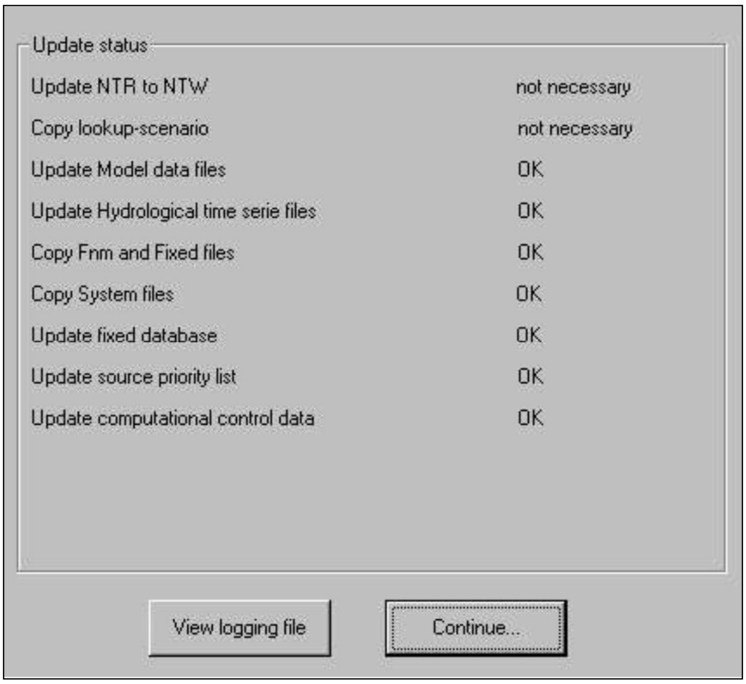

Figure 3.5 RIBASIM update information screen

3.3 Set-up of a new application

Each RIBASIM application has the following characteristics:

- It is represented by an item in the drop-down menu list at the title screen
- It uses an own map
- All data related to one application is stored in one sub-directory of the directory '\Ribasim7'. The file type of the sub-directory is "RBN" (see appendix C) e.g. all data for the Ciujung River basin are stored in the directory '\Ribasim7\Ciujung.Rbn'.

A new RIBASIM application can be set-up in two ways: one by 'adding a basin' and one by 'copying a previous implemented basin'.

Add basin: carry out the following actions

1. Select icon 'Add basin'.
2. Enter the name of the new basin in the new window. The name may be maximal 8 characters e.g. 'Serayu'. The basin name is also used as the directory name of the 'Rbn'-sub-directory, for our example '\Ribasim7\Serayu.Rbn'.
3. Confirm the request 'Do you want to work with this basin?'

Once you have created your new basin application, in the application directory RIBASIM automatically creates a number of sub-directories which the program will use during the modelling and simulation process. An overview of the default sub-directories and files that are automatically created is provided in Figure 3.6. In these sub-directories you find the files needed for the modelling computation. All the sub-directories contain files with default settings. As it will be explained later on, some of these files need to be edited or updated in order for RIBASIM to generate the customized modelling for your river catchment.

Figure 3.6 Default sub-directories of your RIBASIM river application

The contents of the default basin which is stored in the directory '\Ribasim7\Xxxx.Rbn' is copied to the new basin directory, in our example '\Ribasim7\Serayu.Rbn'. The default basin does not contain any map (light blue screen). If a map of the new basin is available then the contents of the MAPS-subdirectory of the new basin must be updated manually (outside RIBASIM).

Copy basin: carry out the following actions

1. Select icon 'Copy basin',
2. A new window is shown (see Figure 3.7). Select the name of the previous implemented basin for example 'NEWLAND' and enter the name of the new basin for

example ‘OLDLAND’. The name may be maximal 8 characters’. The basin name is also used as the directory name of the ‘Rbn’-sub-directory, for our example ‘\Ribasim7\Oldland.Rbn’.

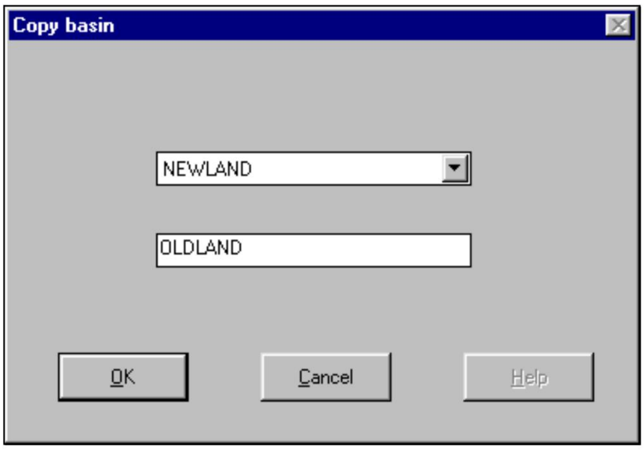

Figure 3.7 Window to select the basin to be copied and to enter the name of the new basin

3. Confirm the request ’Do you want to work with this basin?’

The contents of the previous implemented basin which for our example is stored in the directory ‘\Ribasim7\Newland.Rbn’ is copied to the new basin directory, in our example ‘\Ribasim7\Oldland.Rbn’.

<u>Time step definition</u>

When you start with the implementation of a new basin it is important to decide at the beginning of the implementation for what time step the simulation must be executed. In RIBASIM time is an essential parameter, as the basic task of RIBASIM is to simulate the supply, demand and management of the water resources in a river basin *over time*. RIBASIM operates in time steps; in each time step the water balance is determined, taking into account the data on supply, demand and management as specified in RIBASIM input.

You meet time aspects in all phases of the simulation: in the input data, in the simulation and in the analysis of the results of the simulation.

RIBASIM can simulate in any user defined time step. The most common time step sizes are pre-defined:

Month	Each time step is one month, the number of days per time step depends on the month: 28(29), 30 or 31 days
Half-month	Each time step is half a month; the number of days per time step is always 15 for the first time step in a month, for the second time step it depends on the month: 13(14), 15 or 16 days
Decade	Each time step is 10 days (sometimes indicated as a decade, although this is usually reserved for a period of 10 years), except for the third time step in each month: 8(9), 10 or 11 days
Week	Each time step is 7 days. This time step size is often applied if RIBASIM is used in an operational environment e.g. within a Drought Early

Warning System (DEWS).

Day — The simulation time step is still defined as month, half-month, decade or week which means that the demands are specified or computed for this time step size. But the water allocation is simulated on daily basis.

For the above options *leap-years* are taken into account.

The *choice of the time step seize* is one of the first decisions you have to make when setting up a river basin model with RIBASIM. The choice will depend on the degree of detail in time that is required for the simulation results. However, the same degree of detail will then also apply to the input data. Particularly the hydrological data will often not comply with that requirement. It is worthwhile to spend some time on making this choice, as it will take some time to change later to another number of time steps per year. If you change later to another time step you may have to check the hydrological time series and the model data which are time step dependent such as the demands for public water supply.

There is an option to execute on a daily basis as well. This can be indicated for each time step at the entry of the control data and are stored in the file RUNSIMP.DAT. In the case that you simulate on a daily basis the time series files should contain daily values (see appendix F) and the network schematization should be in accordance with certain rules.

Table 3.1 Example of TIMESTEP.DAT file for monthly time steps

```
ODS 1.00DAT03.00ASC2BIN  6.00
*
* Time step data
*
* - Number of time steps within a year
* - For each time step one record with:
*   1. the number of days within the time step
*   2. the time step name (A12)
*   3. the number of days to add during a leap year
*   4. short time step name (A4) (used in Cropper)
*
  12
      31   'January'      0  'Jan'
      28   'February'     1  'Feb'
      31   'March'        0  'Mar'
      30   'April'        0  'Apr'
      31   'May'          0  'May'
      30   'June'         0  'Jun'
      31   'July'         0  'Jul'
      31   'August'       0  'Aug'
      30   'September'    0  'Sep'
      31   'October'      0  'Oct'
      30   'November'     0  'Nov'
      31   'December'     0  'Dec'
```

To define the time step of your application, you need to update the default values in the TIMESTEP.DAT file with the time step you have chosen for the model simulation. This file is stored in the *Fixed* sub-directory of the newly created ‘Rbn’-directory e.g. *\Ribasim7\Serayu.Rbn\Fixed*. The contents depend on the number of simulation time steps per year. It consists of some header lines followed by the number of days in each successive time step. Examples of TIMESTEP.DAT for each of the options are available in the FIXED directory under the names TIME12_CHRISTIAN.DAT for monthly time steps, TIME24_CHRISTIAN.DAT for half-monthly time steps, TIME36_CHRISTIAN.DAT for decade time steps and TIME53_CHRISTIAN.DAT for week time steps. Table 3.1 shows the file for the monthly time steps. Appendix E.1 contains the time step definition data files for the other time step sizes as well.

The file TIMESTEP.DAT should be set correctly before you start any modelling with RIBASIM. Before you start any tasks in the case management tool (CMT), you must set the desired time step simulation under the right mouse button at the task block “Select hydrological and water quality scenario” (see chapter 5). If needed, you can check the present simulation time step data and change it.

3.4 Combining two or more applications

You can combine two or more previous modelled basins under the icon “*Combine basins*”. The requirements for each of the basins to be combined are:

1. the basins must have the same simulation time step definition;
2. the hydrological time series of the basins must have the same length / time range (or must be updated). The hydrological time series files have the correct TMS-file format (check for any "invisible" control characters at the end of the file and remove those characters / records);
3. the basins use the same background map

When selecting this icon a pop-up window (see Figure 3.8) will appear on the screen. The procedure for combining two or more basins is described in detail under the first menu item of the pop-up window and also in Appendix L.

For the deletion of a previous implemented basin the following actions must be carried out:

1. Select icon ‘Delete basin’.
2. Select the basin from the drop-down list e.g. *Ciujung* for the Ciujung river basin.
3. Activate the ‘OK’ button.
4. Confirm the request ’Are you sure to delete basin: Ciujung?’ e.g. for the Ciujung river basin.

The ‘Rbn’-sub-directory of the selected basin is deleted, for the example this is the directory ‘\Ribasim7\Ciujung.Rbn’.

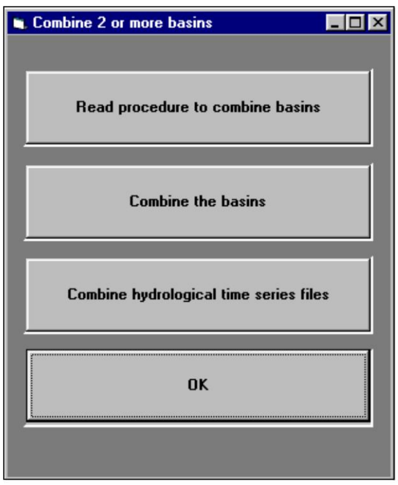

Figure 3.8 Window to combine 2 or more basins

4 Managing the simulation case tools

A simulation case is the combination of possible (current or future) conditions in the basin: this can include different settings for water sector infrastructure, water use, water supply, water management options and climate inputs. Keeping the same hydrological and water demand input constant, a comparison of different simulation cases can provide an overview of the effect of a measure (or a set of measures) on the hydrological conditions of the river system being analysed.

Principles

After confirmation of the selected or new created river basin, the case management tool (CMT) is activated (see Figure 4.1). The screen shows a flow chart of boxes representing the various tasks (through one or several sub-programs) which have to be carried out in a sequential order (indicated by arrows between boxes) to finalise a simulation.

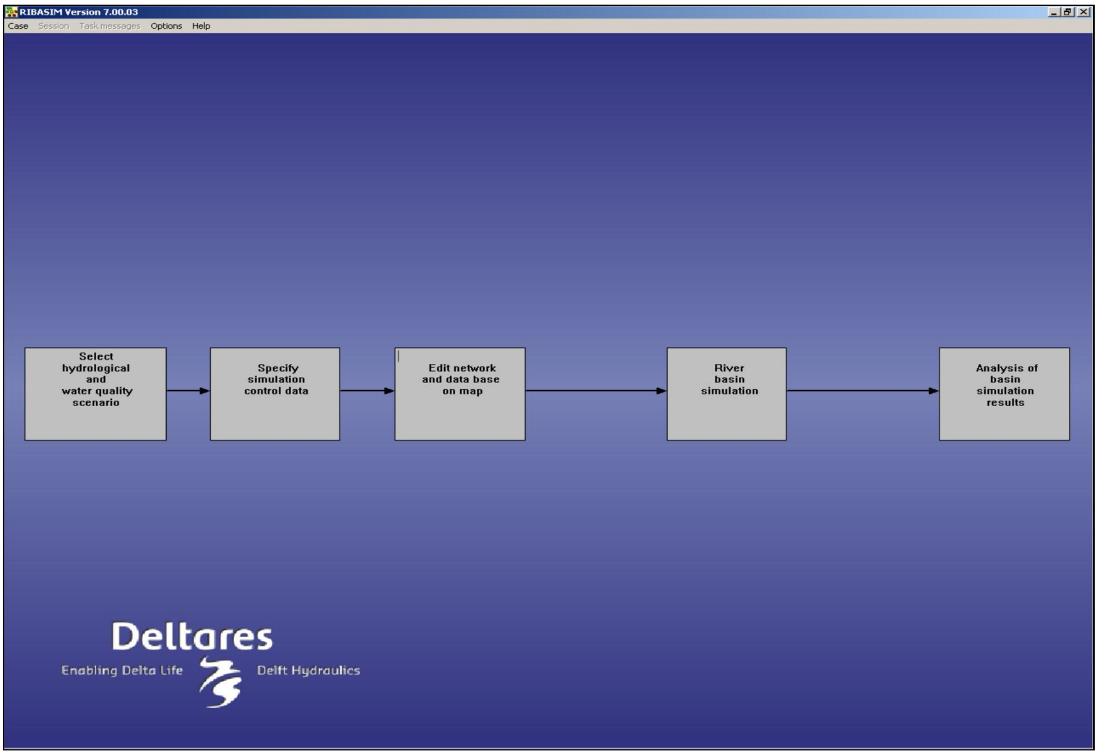

Figure 4.1 Initial case management tool screen with various task blocks

By managing the data files required to execute a RIBASIM simulation, the CMT keeps track of:

- The order of tasks and operations to be performed
- The **status** (to be started, running, or finished) of tasks to be completed

The boxes in the flow chart represent tasks that must be carried out. The arrows in the flow chart indicate the **order** in which the various tasks must be executed. One task cannot start before all previous tasks have been finished. The **status** of each task is indicated by the colour of the boxes in the flow chart (see Figure 4.2):

Colour of task block	Task status
red	Cannot start due to unfinished tasks preceding
yellow	Can start
green	Finished correctly
purple	Still running

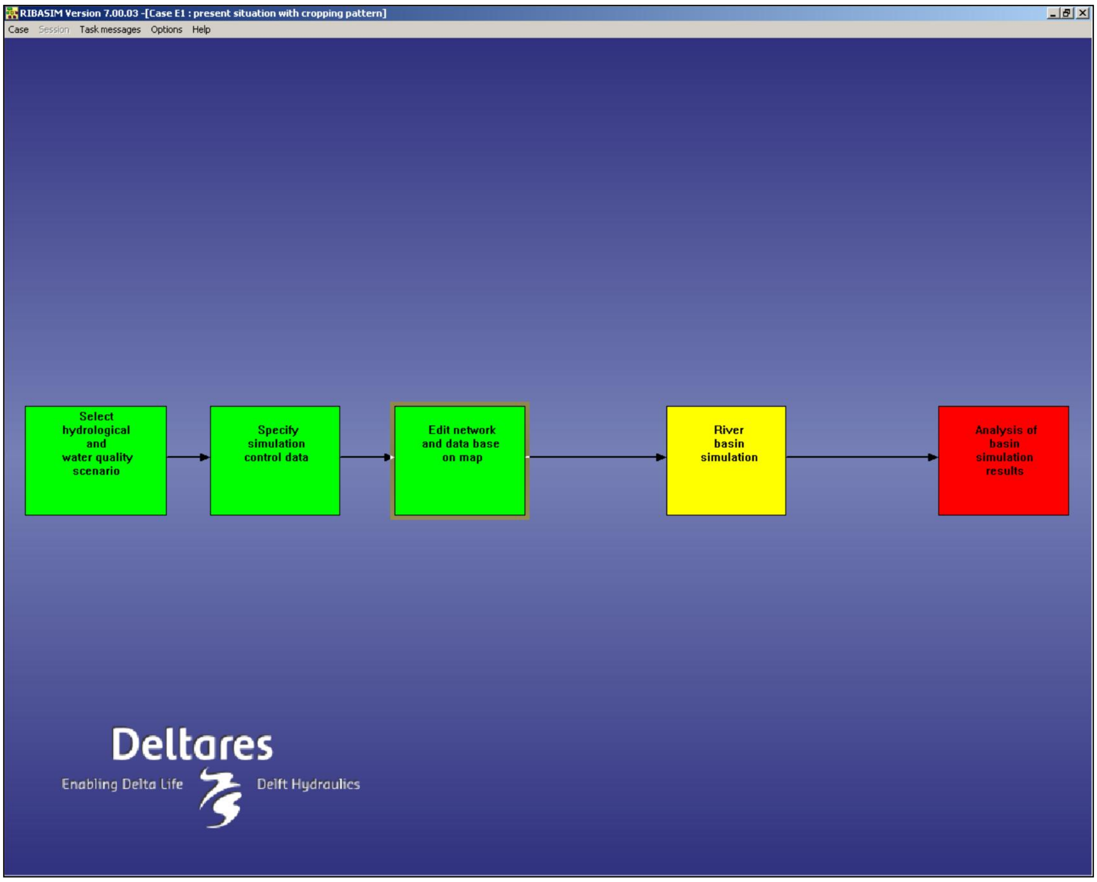

Figure 4.2 Case management tool screenshot of an incomplete river application'

The CMT keeps track of all the files used by Ribasim, this way it is not necessary for the user to know where these files are stored.
With Ribasim, you can open, create and delete simulation cases, store case descriptions, export and import simulation cases. These actions are described in Appendix J.1.

Working with the task boxes diagram (CMT)

At the CMT task boxes flow diagram you can perform the following:

1. You can select a simulation case by selecting from the top Menu the item "Case". A list of all simulation cases is shown in a list box among which a simulation case can be selected. Next you must select one of the following Menu items:

   - "New": An empty case (stored in the directory NEWSTART) will be opened;
   - "Open": The selected simulation cases is loaded and opened, ready to work on;
   - "Open As ...": Here a new case must be specified. The selected simulation case is loaded, opened and ready to work on under the new name

   The opening of simulation case results in a new colour setting of the boxes in the flow chart associated with the selected case.

2. You can now start a task which block is coloured green (for inspection or modification) or yellow (to be finished).

3. When you finish this simulation case session:

   - you should save the case under the same name with the "File" and "Save" commands from the Menu items. With this operation, the previous data files will be overwritten;
   - you can save the case under another name with the "File" and "Save As" menu item. In this case you have to specify the case identification with a short description;
   - you can quit the case without saving by selecting another case or by the "Exit" menu item.

4. If a message box appears that some LOG- and/or other files are erased, you just confirm this message. Those files are temporary files generated by the CMT that have no further use and may be erased.

Under the task boxes in the CMT the following actions are performed (ample details are given in the next chapters):

1. *Select hydrological and water quality scenario*
   Under this task box you can select a hydrological and water quality scenario out of a list of implemented scenarios. Each hydrological scenario and each water quality scenario is stored in a separate directory. E.g. hydrological scenario 1 for the Amu Darya river basin is stored in directory (see appendix C):

   \RIBASIM7\AMUDARYA.RBN**HYDROLOG**\SCENARIO.1

   And the water quality scenario 1 is stored in:

   \RIBASIM7\AMUDARYA.RBN**LOOKUP**\SCENARIO.1

   Further, you can view and edit the agriculture data files that are stored in the **FIXED**-directory (under the right mouse button). Those data are used if one or more “Advanced

irrigation nodes" are part of your river basin schematization. When you create a copy of an existing case, these selections of hydrological, water quality and agricultural settings scenarios are replicated in the new case. As a default procedure, these data are assumed to be valid for all simulation cases within your application. Yet, RIBASIM allows for the user to be able to opt for different scenario selection options. Should this be the case, when opening the new simulation case, the user has to select from the scrolling down menu a different reference directory for the hydrological, water quality and/or agricultural input scenarios. Below an example is given for a different selection of the hydrological input:
\Ribasim7\Amudarya.Rbn**hydrolog**\scenario.3

2. *Specify simulation control data* tool
   This tool box consists of the following items:

   - Run identification;
   - User name
   - Simulation period consisting of start- and end date. The length of this period should be within (therefore not necessarily the same) the range of the time series in the hydrological time series. RIBASIM determines the overlapping time period of the time series in the hydrological time series files.
   - Type of water quality computation: for this selection, the following options are available: no water quality, water quality, default flow composition or user defined flow composition.
   - Other simulation options can be set:
     - apply daily simulation;
     - use the initial state data file;
     - reset initial situation after each year of simulation

3. *Edit network and database on map* tool
   Under this task block the following actions can be carried out:

   - Interactively prepare from the map a river basin schematization through a network of nodes and links, enter the model data for each node- and link type, generate and edit the source preference or priority list, visualize and edit the route from demand node to source node, graphically determine the crop plan for the advanced irrigation nodes, update the model data base, check the network consistency and determine the simulation sequence (order of the nodes from upstream to downstream);
   - Generate and view tables with the network schematization, dimensions of the network elements: nodes, links and the model data of each type of node and link;
   - Specify the node and link renumber options and renumber the nodes and links;
   - Generate and edit the initial state data file;
   - View graphically and export the results of the water demand computation of the crop planning for the "Advanced irrigation nodes";
   - View and edit the control data files that are stored in the Fixed-directory (under the right mouse button). These data are presumed to be valid for all simulation cases within your application

4. *River basin simulation* tool
   With this tool, the input provided for the modelling of the river basin is processed and the water balance computations are performed. At this stage, various activities are carried out automatically one after another:

   - The actual computation of the water demand and allocation, crop yield, crop production costs, flow composition and water quality computation, and water balance for each component within the basin for this specific case and the specified simulation period;
   - The post-processing of the simulation results;
   - Further, the basin simulation control data and frequency analysis data files can be viewed and edited. Those data are stored in the Fixed-directory (under the right mouse button). These data are presumed to be valid for all simulation cases within your application.

5. *Analysis of basin simulation results* tool
   The simulation results can be analysed by means of maps, charts and reports. The results can be exported into various file formats.

Remarks

- **Task execution.** Each of the tools above mentioned can be activated by double clicking the task box with the mouse: the first click will select the task (a double box line appears) and the second click will start the execution of the task. The colour of the box shows the status of the task. Be aware that under MS Windows one window might cover another window(s) (the windows trap!). Aware that you close all windows before you start another task. Hidden windows may slow down the performance of windows and RIBASIM.

- **Error messages, unfinished tasks and Log-files**. If a program module is executed some progress messages appear on the screen like a moving bar. If the program was executed correctly then it will generate a return code equal to 0 and the next program is started automatically. Upon an error the return code different from 0 is generated, the execution window is kept open and a message and/or error code is shown (i.e Task Failed message). At this point the user should close the message window and the CMT task will be interrupted which means that the task block is coloured yellow. You can check the program output and messages in detail in the log-file of the executed program modules. The list of log-files is shown by selecting the right mouse button from the task tool being run and not being completed Figure 4.3 provides an overview of the Log file options available from this selection.

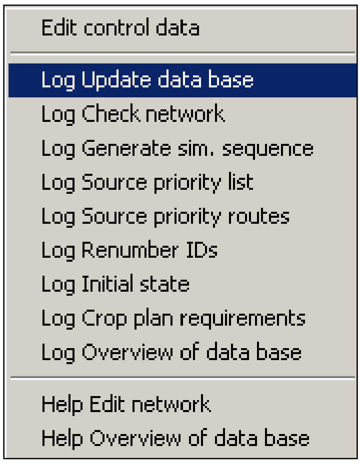

Figure 4.3 List box with Log-files at the task block "Edit network and data base on map"

- **Intermediate saving.** The CMT works with temporary working directories. This means that all data files that are generated during the execution of the various tasks are not registered as long as you do not save the simulation case under the top screen menu item "Case" and "Save" or "Save as". This is also valid if you save your network under the network editor NETTER. Then your network is saved in the temporary working directory of the CMT. It is therefore recommended that you regularly save the simulation case in order to avoid loss of data due to an unexpected power failure or Windows problem.

- **Printing.** The MS Windows programs Notepad, Wordpad, Viewtext and WRITE are used to show and to print the data files. You can print the file directly while viewing the file. Be aware that:
  - it is sometimes better to print in landscape mode (i.e. multiple year time series graphs);
  - you can opt for different graphical format options. For example you can select a character font with a fixed character size like lineprint or courier new. You can change the font by marking the block by dragging the mouse while pushing the left mouse button or select the menu item "View" and "Select all" followed by the selection of the menu items "Character" and "Fonts". You can set the character size even smaller by typing another size value e.g. 6.

  If you wish to print only a part of the file then:
  - make a selection by marking that part of the file as a block by dragging the mouse while pushing the left mouse button; and
  - select at the print dialogue window "Print → Selection".

- **Working directory.** When you are working under the CMT and you are executing the various tasks by double clicking the task boxes all files which are generated during the session are stored in the subdirectory \WORK till you save the case under the top screen menu item "Case" and "Save" or "Save as". When you save the case then the files are stored in the CMT to the various directories with their name equal to a number (see appendix C.2). When you select another case then the directory \WORK is cleaned before the new selected case is loaded.

- **File management.** It is strongly advised not to change or overwrite files in the RIBASIM7 sub-directories from outside the RIBASIM program. This may completely corrupt your work, as the file manager will be unable to keep track of the files and the directory structure. An exception is made for the files in the "fixed data" directory (FIXED). These files are not registered in the CMT and thus may be changed at any time without corrupting the file administration of the CMT.

- **Hard disk space.** When you execute many simulation cases and save the complete results, you may require a lot of hard disk space. In order to avoid this problem, you should save the cases when only the first 3 (left) task blocks are green and the other 2 task blocks are yellow or red. In this situation only a minimum number of files are stored on the hard disk enough to run the simulation case later again.

- **Export and import facility.** One of the menu items of the CMT is the facility to:
  - export simulation cases in order to make a backup; or
  - import a previous exported case into your application

  If you export one or more cases it is advisable to export only a minimum number of files. See item above about saving some hard disk space. Further it is advisable to export first to your hard disk and copy the exported data files from your hard disk to another storing unit (e.g. external hard disk drive). To make sure that all your data has been correctly stored in the new device, after copying you should check if the files have been copied correctly especially the REGISTER.CMT file.

5 Task: Select hydrological and water quality scenario

Under this task you can select:

- the hydrological scenario for which the simulation must be executed;
- the water quality scenario for which the simulation must be executed

Further, under the right mouse button you can activate a pop-up menu (see Figure 5.1) for which you can carry out the following actions:

- Define the simulation time step;
- View and edit the agriculture data related to the node type "Advanced irrigation node";
- View some help info

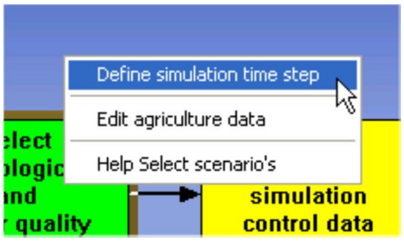

Figure 5.1 Right mouse button pop-up menu at task block "Select hydrological and water quality scenario"

5.1 Sub-task: Selection of hydrological scenario

You can select the scenarios from a drop down list box which shows all the implemented scenarios available (see Figure 5.2).

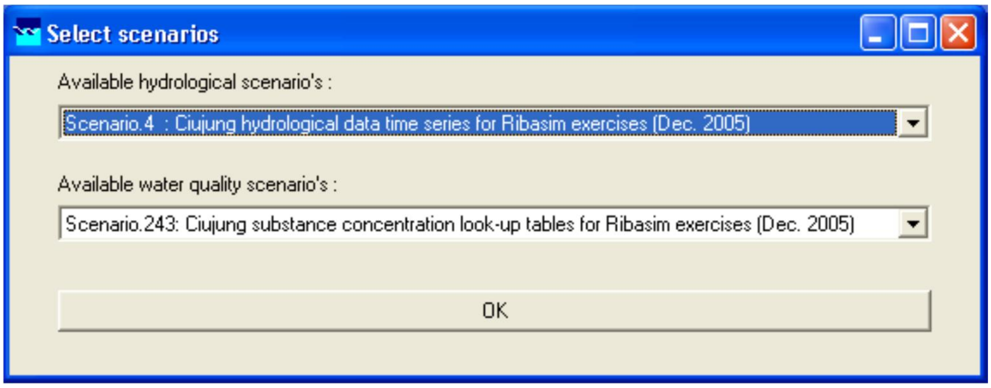

Figure 5.2 Pop-up window for the selection of the hydrological scenario

Hydrological scenario

The *Hydrological scenario is* defined outside RIBASIM by creating a Scenario directory. It is defined by a list of time series files which are outlined in the definition file *HDtimeSr.dat*. This file defines all timeseries files used in the selected hydrological scenario and stored in the sub-directory *Hydrolog* of the Rbn-directory e.g. scenario 1 for the Citarum river basin is stored in sub-directory *\Citarum.Rbn\Hydrolog\Scenario.1.* The *HDtimeSr.dat* file is located in the *Hydrolog\ScenarioX* directory. The format of the file *HDtimeSr.dat* and time series data files are outlined in the appendix F. Time series of the following data are specified in the definition file:

Multiple year time series :	1	Actual inflow data
	2	Loss flow data
	3	Actual rainfall data
	4	Open water evaporation data
	5	General district demand data
	6	General district discharge data
	7	Minimum (environmental) flow data
	8	Monitored (recording) flow data
	9	Potential evapotranspiration data (for Sacramento model)
10 Annual time series :	1	Dependable rainfall data (used by agriculture water demand model)
	2	Dependable river flow data (used by interactive crop planner)
	3	Reference crop evapotranspiration data (used by interactive crop planner and agriculture water demand model)
	4	Expected inflow data

The type and number of hydrological data time series listed in the Scenario directory depends on the type of nodes and links included in the river basin network schematisation. RIBASIM may require multiple year and annual time series. Table 5.1 and Table 5.2 show an overview of the type of data, the node types which require those data, the allowed units and the default file name.

Table 5.1 Overview of multiple year time series files

Data description	**Node type**	**Valid unit(s)**	**Default time series file name**
District demand	General district node	m3/s	DISDEMND.TMS
District discharge	General district node	m3/s	DISDISCH.TMS
Open water evaporation	Surface water reservoir node (1) Fish pond Link storage node(2)	mm/day, mm/time step	EVAPORAT.TMS
Actual rainfall	Surface water reservoir node (1) Link storage node(2) Fish pond Variable irrigation node Advanced irrigation node	mm/day, mm/time step	ACTRAIN.TMS
Loss flow	Loss flow node	m3/s	LOSSFLOW.TMS
Actual inflow (upstream boundary flows)	Variable inflow node	m3/s, mm/day, mm/time step	ACTINFLW.TMS
Minimum (environmental) flow	Low flow node	m3/s	LOWFLOW.TMS
Monitored (recorded) flow	Recording node	m3/s	RECRDFLW.TMS
Potential evapotranspiration	Variable inflow node (3)	mm/day	POTEVAP.TMS

(1) For hydrology data: no use of the annual net-evaporation time series

(2) For routing methods: fixed storage, Manning, Q-h relation and Puls method.

(3) For applied procedure: Sacramento rainfall-runoff model.

Table 5.2 Overview of annual time series files

Data description	**Node type**	**Valid unit(s)**	**Default time series file name**
Dependable rainfall	Advanced irrigation node Variable irrigation node(1)	mm/day, mm/time step	DEPRAIN.TMS
Dependable river flow (used by crop planning component Cropper)	Advanced irrigation node	m3/s	DEPUPFLW.TMS
Reference crop evapotranspiration	Advanced irrigation node	mm/day, mm/time step	REFEVAPO.TMS
Expected inflow	Variable inflow node(2)	m3/s	EXPINFLW.TMS

(1) Used if at Hydrology data theswitch “Apply expected (dependable) rainfall” is on.

(2) Used when surface water reservoir is operated on expected inflows.

<u>Creation of a new hydrological scenario</u>

If you want to add a new hydrological scenario to RIBASIM carry out the following:

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

   \BWRPJAVA.RBN\HYDROLOG\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 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. On the first record you have to mention a short description of the scenario. This record is used and shown in the drop down list box at the selection of the scenario.

4. Update the scenario definition file *HDtimeSr.dat* and the various time series files with file type “Tms”. The format is indicated in the appendix F. Each time series file mentioned in the definition file must be present. The time series files contain time series for the various nodes in your network schematization. If the type of node is not part of your schematization then the time series file can be skipped out of the scenario definition file. At task block "Edit Network and Database on Map" you assign a time series in the time series files to each node by means of a time series index. This means for example that when using the General District node type to represent industrial demand, the Demand/Discharge time series index required to define the Physical characteristics of Industrial node 43 needs to correspond to the same index for that node defined in the DISDEMND.tms and DISDISCH.tms files contained in the Hydrological Scenario directory (see Figure 5.3).

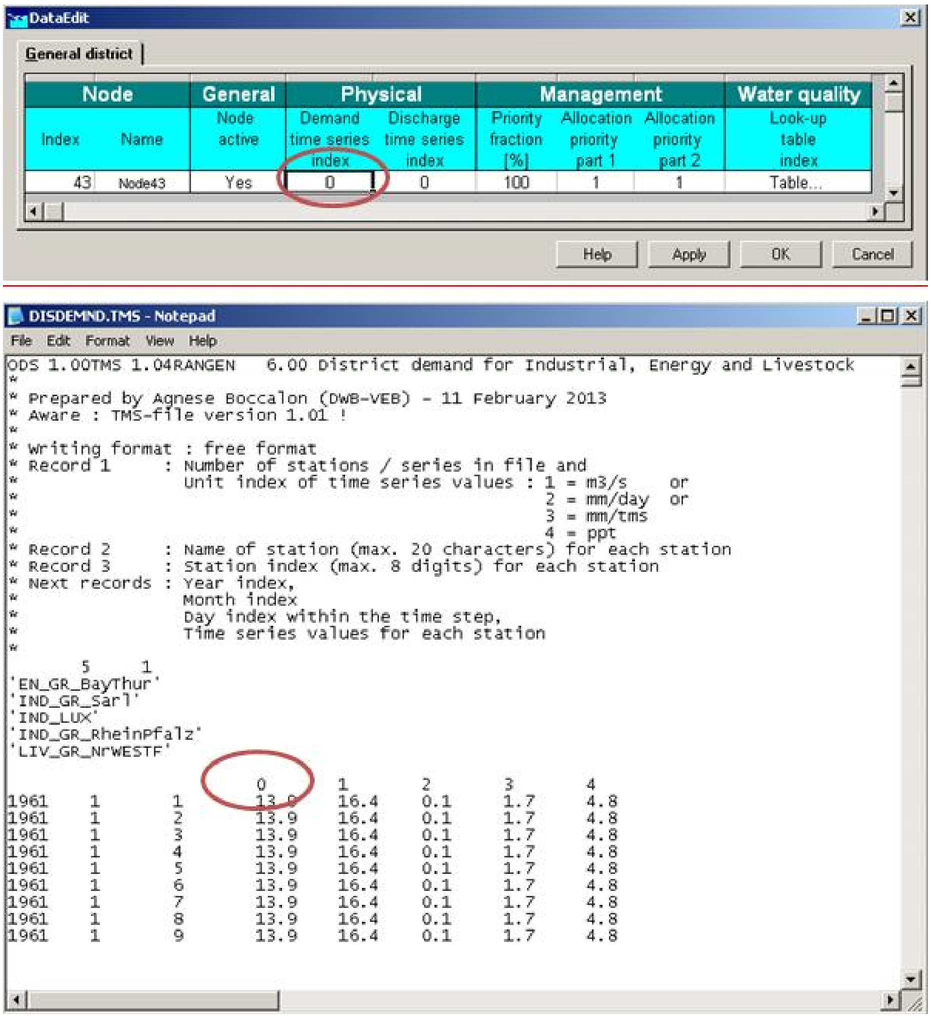

Figure 5.3 Illustration of General district node model data time series index and time series data (tms-) file

Remarks

- You can create or update the time series files (tms files) with Ms Excel. You have to save the spreadsheet as file format “Space delimited”. Next you can fine-tune and edit the file under Notepad or Write. Another way is to select select the time series in the Tms-file and copy / paste it into Excel. By the Data command “Text to columns” all series are stored in the sheet ready for further processing. Finally you select the time series in the Excel sheet and copy / paste it back in the Tms-file. Aware that the header of the file is correct and that each value is separated by at least one space.
- For the creation of multiple year time series files you can use the RIBASIM utility program COMBFILE. COMBFILE combines several time series files into one time series file in the correct format for RIBASIM;
- COMBFILE also produces a table with the names of the time series (station) and the time series index in the newly created file. This list is useful when you have to assign a time series to a node when entering the model data under NETTER. Further it is much easier to handle some smaller files than one big file. In appendix K the use of the COMBFILE utility is outlined.

5.2 Sub-task: Selection of water quality scenario

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

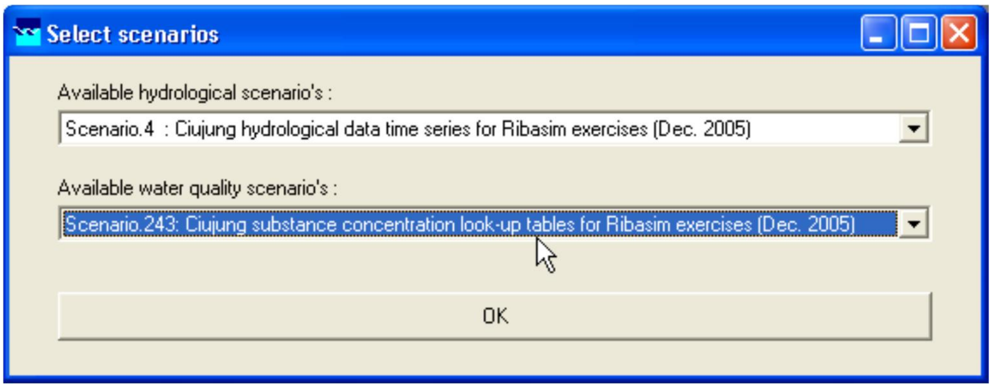

Figure 5.4 Pop-up window for the selection of the water quality scenario.

Water quality scenario

A *water quality scenario* is only used if the "Water quality" or "Flow composition (user defined)" option is switched on at the task block "Specify simulation control data". A water quality scenario is defined outside RIBASIM by creating a different scenario directory. It is defined by a list of substances and associated look-up table files. The substances and look-up tables file names are outlined in the definition file *WQsubsta.dat*. The look-up tables contain the waste loads of the various sources. The waste load can be specified in 3 ways:

- as a concentration;
- as an additional load to the incoming flow;
- as a retention percentage of the incoming concentration

All files are stored in the sub-directory *Lookup* of the Rbn-directory, e.g. Scenario 1 for the Citarum river basin is stored in sub-directory *\Citarum.Rbn\Lookup\ Scenario.1.* The format of the definition file *WQsubsta.dat* and the look-up table files are outlined in the appendix G.

A look-up table definition is as follows:

- for the inflow and groundwater reservoir nodes: the table contains the waste loads of the flows in the downstream links of the node per time step;
- for fixed irrigation, variable irrigation, advanced irrigation, fish pond, public water supply, general district and groundwater district nodes: the table contains the relation between several classes of substance concentrations of the inflow of the node with:
    - o the additional load to the incoming flow: type of data = 1
    - o the substance retention (% of the incoming concentration): type of data = 2
    - o the concentration of the outgoing flow (drainage): type of data = any value except 1 or 2.

The water quality scenarios must be defined and created before you start up RIBASIM. In the section below the procedure how to create a new scenario and to add it to the present scenarios is described.

Creation of a new water quality scenario

The same procedure as for the creation of a hydrological scenario is valid for the creation of a water quality scenario. You can create these scenarios in the “Lookup” sub-directory. Each scenario consists of one substance definition file with associated look-up table files for each substance. To create a new water quality scenario, you are required to carry out the following steps:

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

   \BWRPJAVA.RBN\LOOKUP\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 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. On the first record you have to mention a short description of the scenario. This record is used and shown in the drop down list box at the selection of the scenario.

4. Update the water quality substance definition file *WQSubsta.dat* and the various look-up table files with file type “Lkp”. The format is indicated in the appendix G. A look-up table file must be present for each substance mentioned in the definition file. At task block "Edit Network and Database on Map" you assign a look-up table to each node by means of a look-up table index at the model data.

Remarks

- The number of simulation time steps within a year and the size of each simulation time step is defined and stored in the file TIMESTEP.DAT file in the FIXED - directory. This file must be created before you start any modelling with RIBASIM;
- The time dependent data items at the various nodes, like water demand of public water supply nodes depend on the number of time steps. Most common time steps are monthly, half-monthly, decade and week. The selected time step implicitly defines the structure of the database, hydrological time series and water quality substance look-up table files. So, the time step selection is done at the very beginning of the project.

5.3 Sub-task: Define the simulation time step

If you select menu item “Define simulation time step” from the *Select hydrological and water quality scenario* tool box (right click), then the menu as shown in Figure 5.5 pops up.

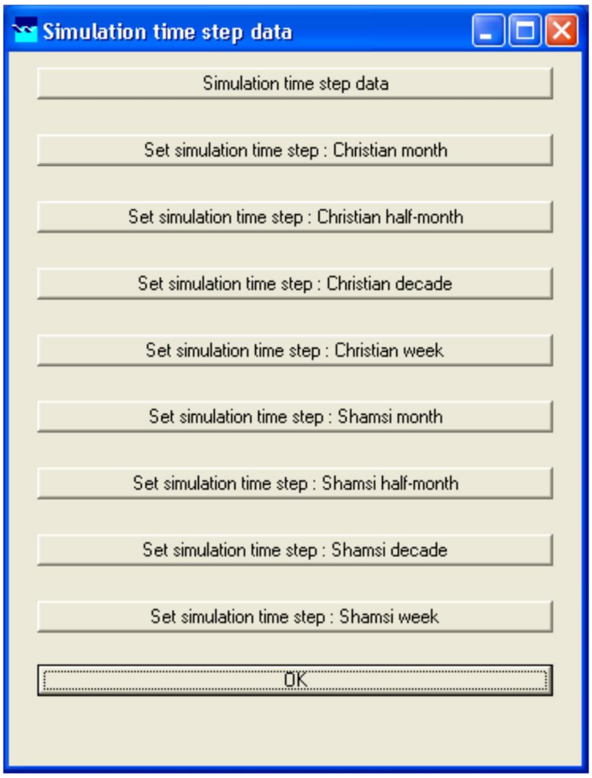

Figure 5.5 Pop-up menu for definition of the simulation time step

Under the menu item “Simulation time step data” you can view the time step definition file which is actually used. Under the other “Set simulation time step: ….” menu items the definition files for the Christian and Shamsi calendar can be set. For example if you want to simulate on a “Christian decade” time step then you click one time on the menu item “Set simulation time step: Christian decade”.

The Christian decade definition file becomes the actual time step definition file (Timestep.dat). You can check this at the first menu item to view the actual time step definition file.

Remarks:

The contents and the layout of the time step definition file are described in appendix E.

5.4 Sub-task: View and edit the agriculture and advanced irrigation data

If you select menu item “Edit agriculture data” from the *Select hydrological and water quality scenario* tool box (right click), then the menu as shown in Figure 5.6 pops up.

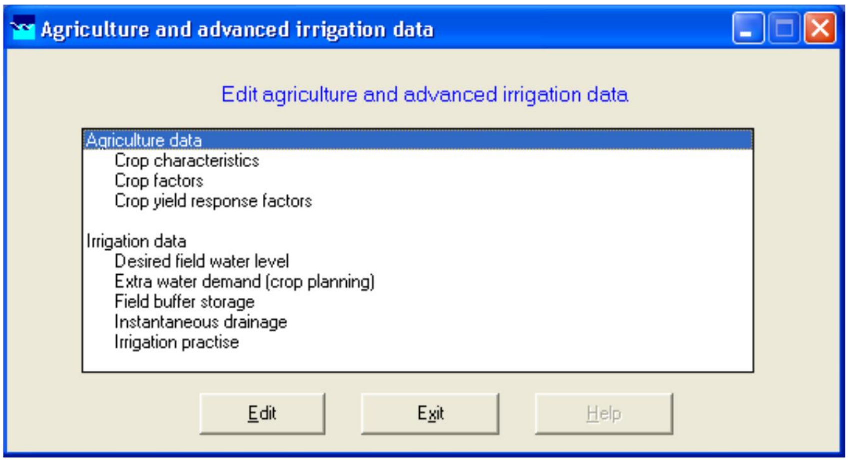

Figure 5.6 Pop-up menu to edit the agriculture and advanced irrigation data.

In Table 5.3 an overview is shown of the contents of the 'fixed' agriculture and irrigation model data files. These files store data, which are defined once for a basin and remain valid for all simulated cases. They describe in effect the agronomy and irrigation practice and their impact on water demand and allocation. The contents of the files are described in the appendix E which also shows some examples. The data are only used if your basin schematization contains nodes of type "Advanced irrigation node".

Table 5.3 Agriculture and irrigation data

Menu item	**File name**	**Agriculture data: description of contents**
Crop characteristics	Cropdata.dat	Crop characteristics
Crop factor	Cropfact.dat	Crop factor per time step in growing season.
Crop yield response factors.	YldRpFct.dat	Crop yield response factors per time step in growing season.
Menu item	**File name**	**Irrigation data: description of contents**
Desired field water level	Deswtlvl.dat	Desired water level on the field per time step in growing season, only relevant for flood basin crops.
Extra water demand (only used for crop planning)	Extwtdmd.dat	Extra water layer demand on the field per time step in growing season, only relevant for flood basin crops. Used in the crop plan editor.
Field buffer storage	FldBfrSt.dat	Field buffer storage per time step in growing season. (mm above desired field water level or soil moisture)
Instantaneous drainage	InstDran.dat	Instantaneous drainage water level on the field per time step in growing season) at the beginning of the time step, only relevant for flood basin crops.
Irrigation practice	Irrpract.dat	Irrigation practise: on - off supply switch per time step in growing season.

6 Task: Specify simulation control data

Under this task the following actions are sequentially carried out:

1. determination of the range of the time series of the selected hydrological scenario;
2. specification of simulation control data

Action 1 is carried out by the program RANGEN at the background and generates a file that is picked up by a dialogue window where you can enter the desired simulation period. If you get error messages from the program RANGEN then it is most likely that your hydrological time series files for the selected hydrological scenario stored in the associated hydrology scenario directory are either incomplete or not in the correct format. You may view the Log-file by using the right mouse button. Check if all time series files of the selected scenario have the format as indicated in appendix F.

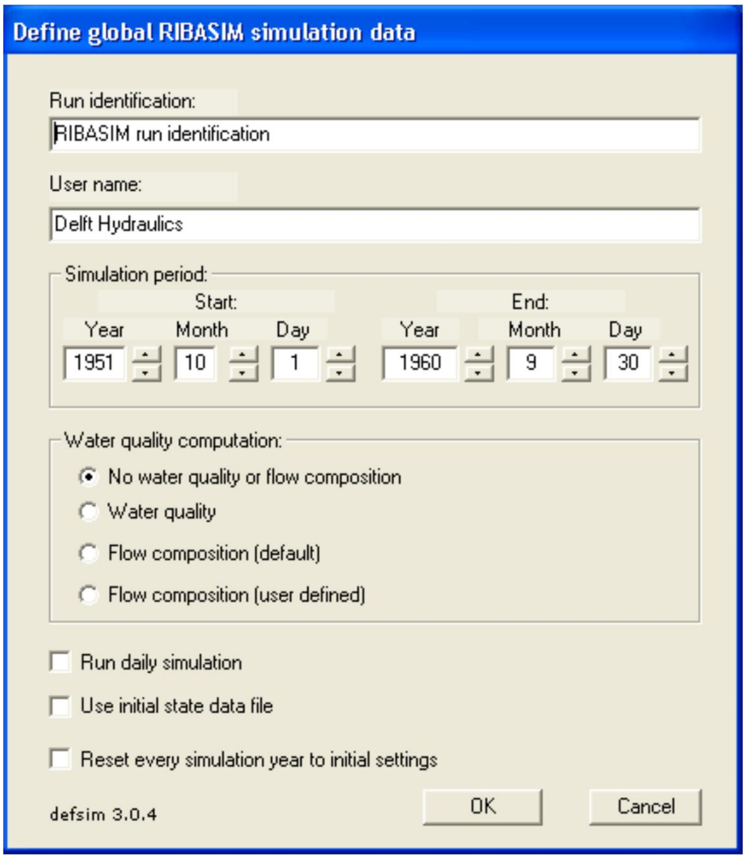

Figure 6.1 Pop-up window for the specification of the simulation control data

At *action 2* you can specify (see Figure 6.1):

- the simulation *run identification* which is used for administrative purposes;
- the *user name* which is used for administrative purpose;
- the *simulation period*: start year, month and day, end year, month and day. The simulation period must fit within the range of the hydrological time series for the

selected hydrological scenario. RIBASIM checks this and replaces the start- and end date step if the simulation period, which you have specified, is out of the time series range. You can view the time series ranges in the Log menu item under the right mouse button (see Figure 6.2Figure 6.2).

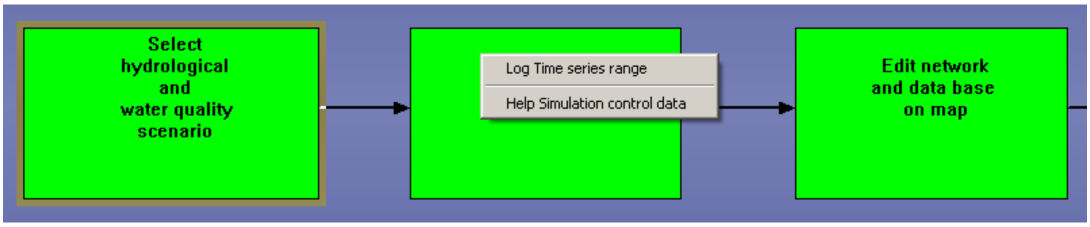

Figure 6.2 Right mouse button pop-up menu at task block "Specify simulation control data"

- Type of water quality computation. Distinction is made here between (simple) water quality computation and flow composition computation. For the water quality computation a number of defined substances are routed through the network schematization and the concentrations are computed at any location in the basin. For the flow composition the contribution of the various sources to the flow at any location in the basin is computed. Sources can be e.g. industrial return flow, surface water reservoir release, groundwater abstraction, boundary virgin catchment inflow, fish pond drainage, etc. So, the fraction of the various upstream sources of water is computed at each location. The sum of all fractions at one location equals to 1. The following options can be selected:

  - Option "No water quality": no water quality or flow composition computation is carried out, only the water demand and allocation simulation is performed;
  - Option "Water quality": water quality computation for the selected water quality scenario is carried out. In the scenario the substances are defined in the water quality substance definition file *WQSubsta.dat* and the associated look-up table files for each substance. The substances are routed through the network;
  - Option "Flow composition (default)": default flow composition computation is carried out. The default substances or flow components are defined in the fixed data file *FlowComp.dat*. No user action is required;
  - Option "Flow composition (user defined)": flow composition is carried out with the substances or flow components defined in the water quality substance definition file *WQSubsta.dat* and the associated look-up table files for each flow component. The "concentration" of the substances or flow components in the look-up table files has value 1.0 for each time step*;*

- Option "Run daily simulation"

  - Option is off: the river basin simulation is executed on time step basis. The time step is defined under task "Select hydrological and water quality scenario: (see chapter 5.3)
  - Option is on: the river basin simulation is executed on daily basis.

- Option "Use initial state data file":

- Option is off: the simulation is executed with the initial state defined at the model data.
- Option is on: the simulation is executed with the initial state defined in the initial state data file. The data file name is Statdata.ini. This file can be generated and edited at task block “Edit network and data base on map”.

* Option "Reset every simulation year to the initial setting".

  - Option is off: the simulation is executed as one continuous time period. This implies that the storage of reservoir, link storage, groundwater reservoir and groundwater district nodes at the beginning of a simulation year, are set equal to the storage at the end of the proceeding simulation year.
  - Option is on: the simulation is executed as a number of separate years. This means that the storage of surface water reservoirs, link storage, groundwater reservoir and groundwater district nodes is reset to the initial storage after each year of simulation.

Remark

The *initial storage, initial level or initial depth* of surface water reservoir, link storage, groundwater reservoir and groundwater district nodes is the value which you specify at the model data or in the initial state data file. If you start your simulation at monthly time step on 1 January then the initial storage is the storage at the beginning of January. If you start at 1 June then the initial storage is the storage at the beginning of June.

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7 Task: Edit network and data base on map

Under this task you can carry out the following activities:

1. Edit fixed data files.
2. Edit network, source priority list and object data on map.
3. Generate overview of data base.
4. View tables of data base.
5. Specify the node- and link-renumber options.
6. Renumber the nodes and links.
7. Generate the initial state data file.
8. Edit the initial state data file.
9. View the results of the crop plan water demand computation.

The first activity is available under the right mouse button. The other two activities can be started from a pop-up window menu after selection of this task (see Figure 7.1).

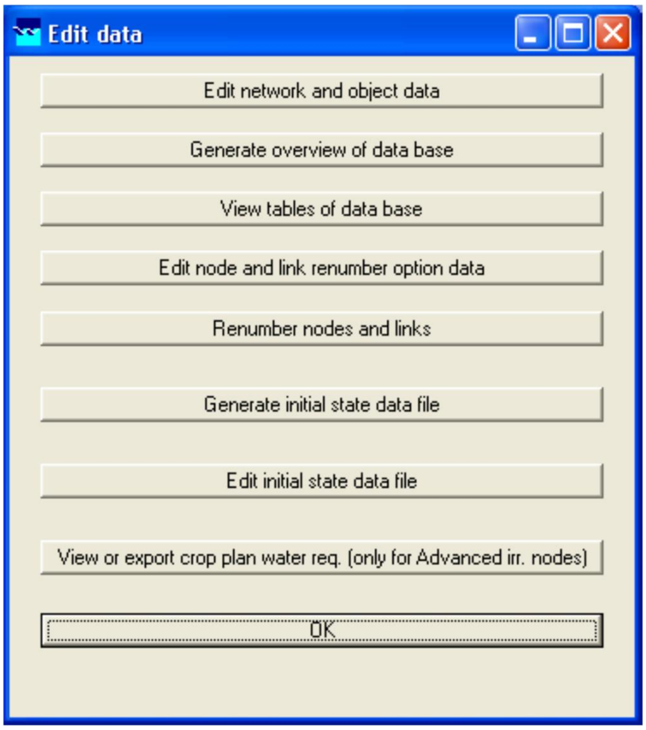


Figure 7.1 Pop-up menu at task block "Edit network and data base on map"

7.1 Sub-task: Edit fixed data files

After pushing the right mouse button while the cursor is pointing to the task block the pop-up menu as shown in Figure 7.2 appears, you can carry out the following actions by selecting the menu items:

- View and edit various control data files. Selecting this menu items shows a new selection window of the various control data files (see Figure 7.3). Table 7.1 shows the names of the fixed files to be shown when selecting one of the menu items. Examples of the files are presented in the appendix E.

- View the log-message files of the various programs which have been executed under this task block. If the task block is coloured yellow after finishing various activities at this task block you can view the Log-files if errors have been detected and an error messages has been generated.
- View some extra help information by using the Help functions.

The default values are for most situations correct.

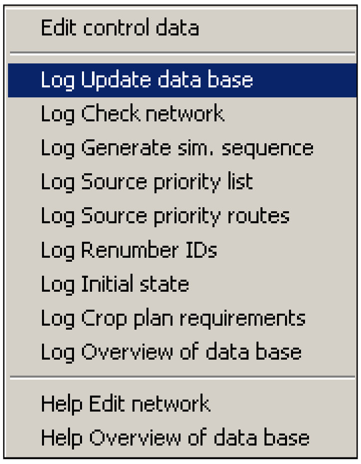


Figure 7.2 Right mouse button pop-up menu at task block “Edit network and data base on map”

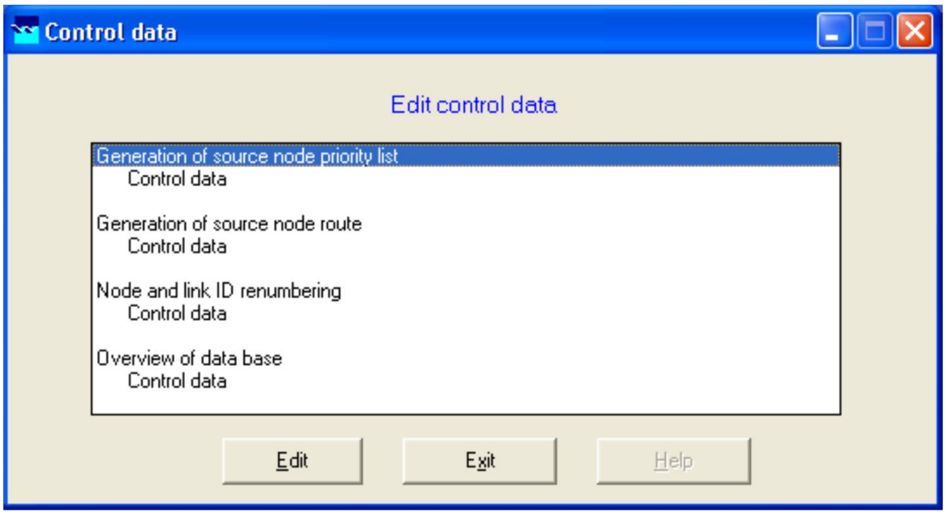


Figure 7.3 Screen for selection of the various control data to be editted

Table 7.1 Control data files for various components

Kind of control data	**Fixed model data file name**
Generation of source node priority list	GenSrcl.dat
Generation of source node route	GenDStrj,dat
Renumber setting for nodes and links	Renumber.dat
Generation of overview of data base	Bin2Prt.dat

7.2 Sub-task: Edit network, source priority list and object data on map

When you select this menu item then the map of the basin will appear with the basin schematization. Figure 7.4 shows an example screen. The actions under this menu item are controlled by the geographical information system (GIS) component of RIBASIM, called NETTER.

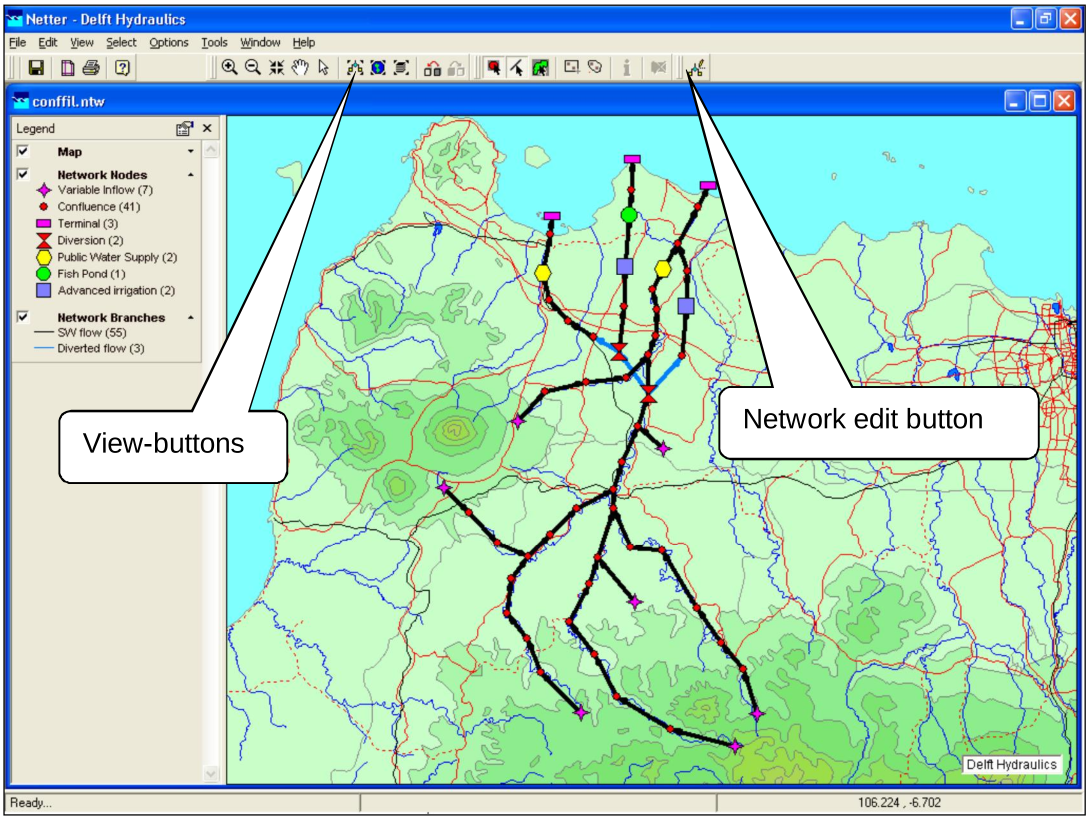


Figure 7.4 Simple river basin network schematization for the Ciujung basin (Indonesia)

Under this task the following actions must be carried out one after another:

1. preparation and adjustment of basin map;
2. preparation of the river basin network schematization;
3. saving your network schematization, generate the default source priority list and the default route from each demand node to each source node;
4. checking the validity of the river basin schematization, update the model data base and generation of the node simulation sequence;
5. entry of node and link model data (the description of the features of the nodes and links representing the basin);
6. where applicable, design interactively and graphically the crop plan for the advanced irrigation nodes;
7. visualize and edit the source priority list and the demand node – source node route.

Action 1: Preparation and adjustment of basin map

When you start a new application then the background map is the default map (most time a blank screen). In order to adjust the map layout you should select menu option

“Option” and “Map option”. At the pop-up window you get an overview of all map layers presently loaded in the map description file. See Figure 7.5. You can do the following:

- import map layer. By pointing to the entry of map layer button you can select a new map layer and add it to the list of map layers. The map layers can be prepared with any commercial GIS software and stored in the MAPS subdirectory. Various vector, image and grid-map layer file types are supported.
- delete map layer. By selecting a map layer and pointing to the button for deleting map layers the selected map layer will be deleted from the map layer list.
- adjust a map layer: make the map layer visible or invisible, change the colour of points, lines or contours, or the background colour, etc.

After changing the map layout, you select OK. You must save the newly created or updated map under the NETTER screen menu item “File”, “Save” and “Map”. The properties of your map are stored in a map file named BASIN.MAP, which is stored in the MAPS subdirectory. For more information you can read the separate manual of the program NETTER.

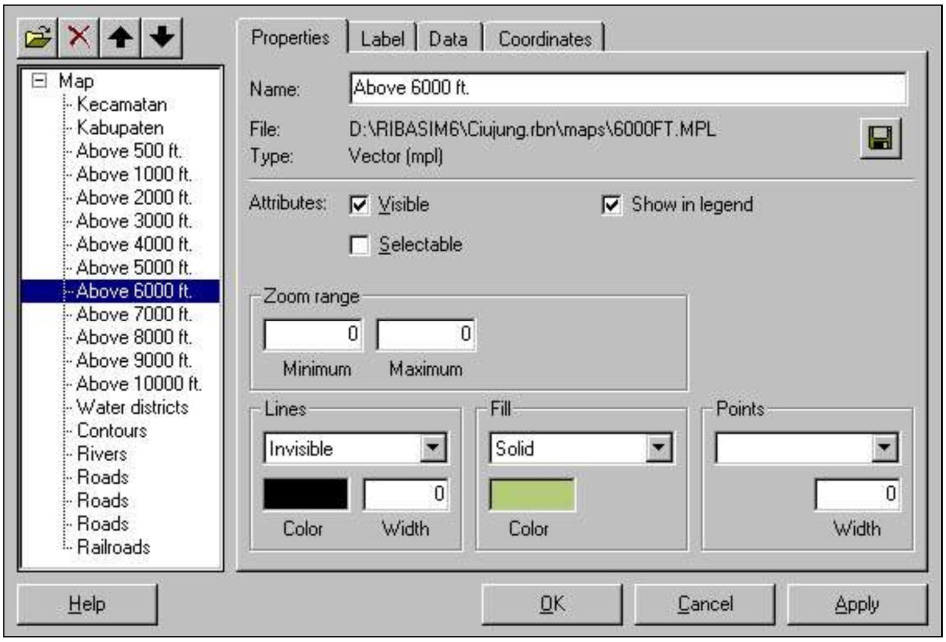


Figure 7.5 Editing of the map properties per map layer

Action 2: Preparation of the river basin network schematization

The river basin is represented by a network of different types of nodes (layout, demand, and control nodes) interconnected through different type of links (surface water flow links, groundwater abstraction links, groundwater recharge links, diverted flow links, etc.). The preparation of the network is facilitated by means of the interactive network editor NETTER (see Figure 7.4).
Upon selection of the menu item "Edit network and data base on map", NETTER is started. The basin map is shown together with the latest network schematization. With NETTER you can perform the necessary map and network operations. The user documentation of NETTER is submitted in a separate documentation.

NETTER uses the last saved map settings data. So, if your screen does not show the river basin schematization network directly on the screen, you select the menu items "View" and "Show full network". NETTER will show the complete network on the screen. You may also select one of the View-buttons (Show full network, Show full map) at the top of the screen.

To start the preparation of a network, or to modify an existing one, you select at the menu at the top of the NETTER screen item "Edit" and in the drop-down list the item "Edit Network'" Your choice is confirmed by a check mark before the selected item "Edit Network". An alternative method is to select the Network-edit button at the top of the screen. After selection four new drop-down buttons are added:

1. Edit operation menu.
    a. General: menu covering several options of which the "Edit setting" described below.
    b. Node: Node edit operation menu
    c. Connection: Link edit operation menu
2. Actual node type for which the node operations are executed.
3. Actual link type for which the link operations are executed.
4. Actual system type for which the system operations are executed.

The window that pops up after the selection of the "Edit setting" menu item is "Edit Network Options" (see Figure 7.6). It offers options for the 'bookkeeping' of the new nodes and links that you add to the network. For nodes and links there are separate windows, to be selected with the corresponding check box. You have a choice between automatic *numbering* and *naming* of nodes and links, or attributing the latter yourself.

For the numbering nodes and links with ID's you are recommended not to use '*Automatic*', unless you have a good reason to do so. You can not change the node and link ID's (numbers) later, only by deleting and adding the node and link again. If you number the nodes and links manually then you may give the nodes and links any number you want and you can skip some values between two adjacent nodes or links in order to keep some values open for possible future additional nodes and links. The node and links ID's (numbers) should be smaller than 32678.

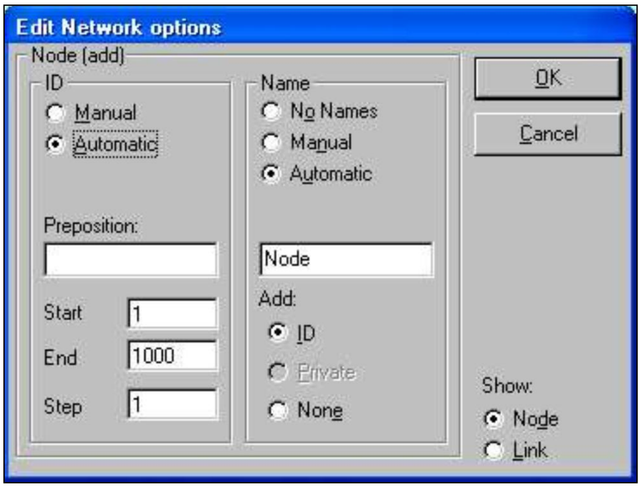


Figure 7.6 Edit setting pop-up window.

You will probably want to give nodes already a name when you add them to the network, so select '*Manual*' under '*Name*'. In contrast to with the ID's you can change the node names easily later from the NETTER operation menu (item '*Rename*'). If you don't want to give specific names or want to add names later, then select '*No names*. In this case nodes will get only an ID number or select '*Automatic'* then the nodes will get a name that consists of a prefix (which can be edited) plus the ID number: this results in names like Node_84 and so on. The same procedure is applied for the naming and numbering of links.

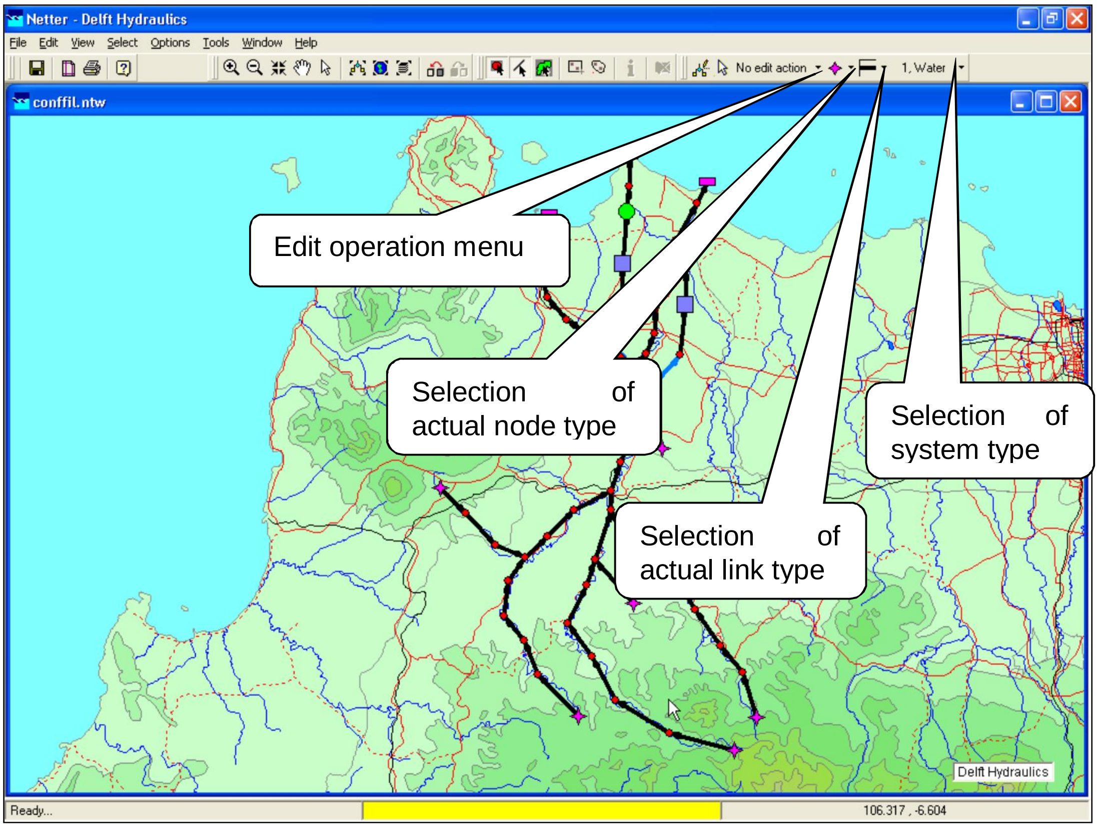


Figure 7.7 Pop-up window for selection of the node and link type

Next you can start to build the network using the node and link edit operation menus, and the selection of actual node and link type (see Figure 7.7).

Table 7.2 gives an overview of the present node- and link types, which can be used to schematise the basin.

Select the node and link type that you want to add to the network by clicking it. Let's assume that the first node of the new network will be a Variable inflow node. Remember that what you have selected *remains the active node type*, until you make another (node type) choice.

Then select in the Edit menu the options for the *Node* and *Link* (*Connection)* operation menu. Two new window pops up, which you can drag down on the screen, with many network operation options (see Figure 7.8).

RIBASIM distinguishes different node and link types. The node types can be split into:

- Lay-out nodes. The nodes serve as elements to complete the configuration. They have no active influence on the system, i.e. not in the sense of regulating the water flows.
- Demand nodes (activity nodes). The nodes represent various water users.
- Control nodes. The nodes pertain to locations where the distribution of flow, production or consumption of energy, or the water quality in space or time is influenced by nature or by manmade works, or in simple words: in control nodes we control the quantity and quality of the water flows in the network with application of predetermined operation policies.

A short description of the node and link types is shown in Table 7.3 till Table 7.6.

Table 7.2 Overview of node- and link types

Node type	Link types
Variable inflow node	Surface water flow link
Fixed inflow node	Groundwater recharge link
Confluence node	Groundwater outflow
Terminal node	Lateral flow link
Recording node	Groundwater abstraction flow link
Surface water reservoir node	Diverted flow link
Groundwater reservoir node	Bifurcated flow link
Run-of-river node	Surface water reservoir backwater flow link
Diversion node	
Low flow node	
Public water supply node	
Fixed irrigation node	
Variable irrigation node	
Advanced irrigation node	
Loss flow node	
Fishpond node	
Bifurcation node	
Pumping node	
General district node	
Groundwater district node	
Link storage node	
Reservoir partition node	
Waste water treatment plant node	
Natural retention node	

Table 7.3 Overview of lay-out nodes types

Node type name	Representation
Fixed and variable inflow node	The upstream boundary of the system where water enters the network. This inflow is specified as a time series. Two types of inflow node are available the “fixed” and “variable”. For the fixed inflow node an annual time series is used for each simulation year. For the variable inflow node
Terminal node	The downstream boundary of the system where water leaves the network. This node may be connected to a (fixed or variable) inflow node representing a delay of one simulation time step and which is used to represent loops.
Confluence node	The location where various river tributaries, canals and/or pipelines join.
Recording node	The flow gauging station in the network.

Table 7.4 Overview of the demand (activity, water user) node types

Node type name	Representation
Fixed, variable and advanced irrigation node	The water demand for irrigated agriculture. Three types are distinguished: the “fixed”, the “variable” and the “advanced” irrigation nodes. The difference consists in the level of detail in which the demand computations are carried out. • At the “fixed” irrigation nodes only the net demand is specified. • At “variable” irrigation nodes the gross demand is specified and the actual rainfall is explicitly taking into account. • At the “advanced” irrigation nodes the most detailed procedure is applied based on the crop plan, crop-, soil- and irrigation practise-characteristics. Beside the water demand and allocation the crop yield and production costs are computed as well.
Fishpond node	The demand for aquaculture activities like fresh and brackish fish ponds.
Public water supply node	The demand for public water supply, generally comprising demands for domestic, municipal and industrial (DMI) purposes.
Loss flow node	Location where water “disappears” from the system else than through a demand or activity node (e.g. by leakage to groundwater). A time series of loss flows is explicitly connected to this node. The loss flow may flow into a groundwater reservoir node.
Low flow node	Location with a minimum flow requirement for example in view of maintaining a certain ambient water quality or a certain minimum water level in a canal (to allow navigation or for the intake of water for irrigation purposes).

General district node	Location where a district's net water extraction and discharge are connected to the network as a time series of demands and discharges computed outside RIBASIM. This node type can be used to represent the water demand and discharge functions of a single sector (i.e. industry), or of multiple sectors together (i.e. industry and energy)
Groundwater district node	District of sub-catchment covering local runoff, public water supply, irrigation and local groundwater storage. This can be represented in more detail using a combination of the following node types: inflow node, public water supply nodes, irrigation node and groundwater reservoir node.

Table 7.5 Overview of the control node types

Node type name	**Representation**
Bifurcation node	The (natural) subdivision of a flow over various downstream links.
Diversion node	Location of an intake structures or gates where water is diverted from a river or a canal to satisfy downstream demands along the downstream diverted flow links.
Surface water reservoir node	Surface water storage facility allowing to store and release water in a controlled way over time for flood control, satisfy downstream water demands (irrigation, DMI, nature, navigation, hydropower generation, etc.) depending gate-levels and -capacities and the reservoir operation rules.
Groundwater reservoir node	Aquifer (groundwater reservoir). Water users withdraw water depending on the groundwater level, pumping-depth and -capacity. Lateral flows may stream from one aquifer to another one. Outflows may stream to surface water (springs). The aquifer is filled up by groundwater recharge and lateral flows.
Link storage node	Storage in a river or canal section as a function of the flow described by the Manning formula, flow-level relation, Muskingum formula, Puls method or Laurenson method. Can also be used to model wetlands and swamps.
Relevant for energy consumption or energy production only	
Pumping node	Pump station where water is pumped from the river to a canal or water user. Only the consumed energy is computed. Capacity constraints must be specified using the diverted flow link or surface water flow link.
Run-of-river node	Hydropower generation facilities without water storage capacity.
Relevant for water quality only	
Surface water reservoir partition node	Part of a surface water reservoir (applied only for reservoir water quality analysis). The total storage of the reservoir is separated over the various partitions.
Waste water treatment plant node	A plant where waste water is purified (artificial purification).
Natural retention node	The natural purification of polluting substances in the basin surface and sub-surface water.

Table 7.6 Overview of the link types

Link type name	**Representation**
Groundwater recharge flow link	A flow into the aquifer which may come from an inflow node or from a loss flow node.
Groundwater abstraction link	A flow directly pumped from the aquifer by water users.
Lateral flow link	A flow between two water bodies represented by a surface water reservoir, groundwater reservoir and/or link storage node. The flow is computed based on Darcy's law, the water level difference between the two linked water bodies, a flow threshold – storage relation, a fixed flow per time step or a groundwater storage relation.
Groundwater outflow link	A flow from the aquifer out of the system or to the surface water network (spring). The flow is a function of the groundwater depth.
Diverted flow link	A flow diverted from a river or canal at a diversion node. The flow depends on the operation of the diversion structure and/or downstream demands (targets).
Surface water flow link	A link between two nodes for surface water flow with limited flow capacity (canal or pipeline) or without any capacity constraint (river).
Reservoir backwater flow link	A flow abstracted directly from a surface water reservoir.
Bifurcated flow link	A downstream flow at a bifurcation node. The flow is a function of the upstream flow.

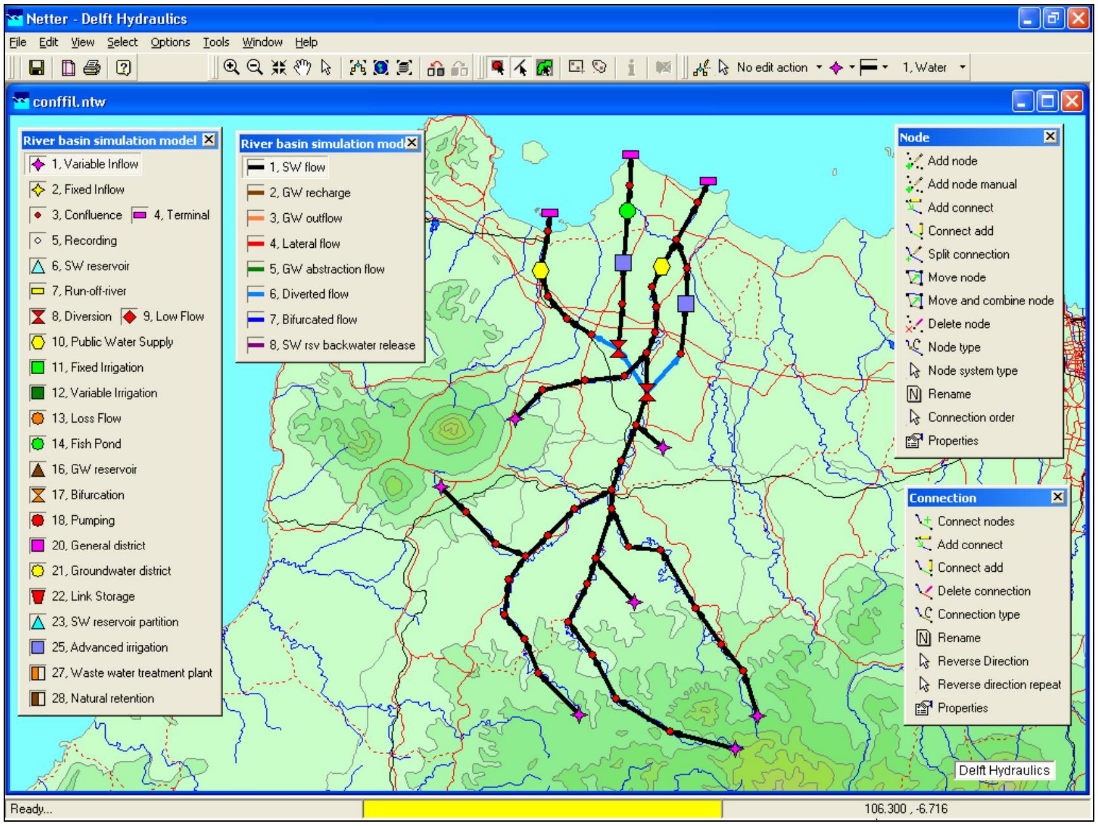


Figure 7.8 Overview of the node and link selection, and the node and link edit operation menus

To see how the network construction works, select "Add node" from the top menu. When you have chosen for manual node names specification, you will be asked to enter the name (maximal 40 characters) for the new node in the "Node definition" window (see Figure 7.9). Next you can point with the cursor on the map to the location where the node must be drawn.

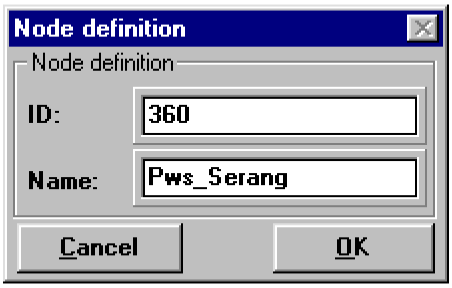


Figure 7.9 Pop-up window for node ID and name specification.

You can continue to build the rest of the network by selecting the various nodes and link types and manipulate your schematization with the node and connection operations. Keep in mind that the direction of the links must be the flow direction. So, when you connect nodes by links you should draw the links from upstream to downstream, to prevent that they initially get the wrong flow direction, which you must then correct later.

Recommendations for network editing

- Before starting to work with your RIBASIM schematization make a sketch of the network with the main items you want to put into your model;
- Start with the fixed or variable inflow nodes, and the terminal nodes, as they will define the boundaries of the network. Make 'Variable inflow node' the active node type and put them on the map. The same you do for the ‘Fixed inflow node’ and 'Terminal node'. The extent of your network is now clear. You can then zoom in, or use the option 'Show full network' to work further. Save this situation with '*Save map*', to keep it for continuation after a break.
- You can now add the other nodes:
  - Type by type, and connect them later with the right type of link; you will probably forget to connect some nodes, however, under the menu option ‘*General’* the menu *'Validate network’* option will check the prepared network. With *ConnectAdd*; work from upstream to downstream so that links get a correct flow direction (with *AddConnect* you will usually have to change the link direction later).
  - With *Split connection* you can add nodes in existing links.

    When connecting nodes please note that certain node types have limitations and requirements on the number and type of upstream and downstream links.

  See Table 7.7,

  Table 7.8, Table 7.9, and Table 7.10 for further details.
- Be aware that in NETTER you can offend these rules without protest until you “Validate network” under the “General” menu or when you exit NETTER. After exiting NETTER a separate program will check the network consistency and report the results in the Log-file. The Log-file can be viewed by pointing the cursor to the task block *Edit Network and Data Base on Map* by pushing the right mouse button.
- When you get error messages caused by a wrong network schematization that is not yet finished or valid, you can still save the network schematization under NETTER and the case under the CMT to continue later.

Table 7.7 Link types and required up- and downstream node types

Link type	Upstream node type	Downstream node type
Bifurcated flow	Bifurcation	Any
Diverted flow	Diversion	Any
Groundwater abstraction	Groundwater reservoir (1)	Confluence (1) Recording (1) Public water supply Fixed irrigation Variable irrigation Advanced irrigation Fish pond General district
Lateral flow	Confluence Groundwater reservoir Surface water reservoir Link storage	Confluence Groundwater reservoir Surface water reservoir Link storage
Groundwater outflow	Groundwater reservoir	Any
Groundwater recharge	Fixed inflow Variable inflow Confluence Recording	Groundwater reservoir
Surface water backwater flow	Surface water reservoir	Any
Surface water flow	Any node except groundwater reservoir node type	Any node except groundwater reservoir node type

(1) Using confluence and recording nodes the route between the groundwater reservoir node and the demand node e.g. the public water supply node can be divided into several links. All the links must be of type "Groundwater abstraction link". Further, the link connected with the groundwater reservoir node must be with flow procedure "Pumping" and the other links must be with flow procedure "Dummy"

Table 7.8 Maximum number of upstream and downstream links per Demand node

Demand node type	Number of upstream links	Number of downstream links	Remarks
Advanced irrigation node	1 or 2	1	If 2 upstream links then one link must be a "Groundwater abstraction flow" link (1).
Fishpond node	1 or 2	1	If 2 upstream links then one link must be a "Groundwater abstraction flow" link (1).
Fixed irrigation node	1 or 2	1	If 2 upstream links then one link must be a "Groundwater abstraction flow" link (1).
General district node	1 or 2	1	If 2 upstream links then one link must be a "Groundwater abstraction flow" link (1).
Groundwater district node	1	1	
Loss flow node	1	1 or 2	If 2 downstream links then one link must be a "Groundwater recharge flow" link (1).
Low flow node	1	1	
Public water supply node	1 or 2	1	If 2 upstream links then one link must be a "Groundwater abstraction flow" link (1).
Variable irrigation node	1 or 2	1	If 2 upstream links then one link must be a "Groundwater abstraction flow" link (1).

(1) If the demand node abstracts from several groundwater reservoir nodes then the groundwater abstraction links from all groundwater reservoir nodes must be connected to one confluence node which is connected to the demand node. Further, the links connected with the groundwater reservoir nodes must be with flow procedure "Pumping" and the other links must be with flow procedure "Dummy". The flow procedure is specified at the link model data.

Table 7.9 Maximum number of upstream and downstream links per Layout node

Layout node type	Number of upstream links	Number of downstream links	Remarks
Confluence node	1 or more	1	
Fixed inflow node	0 or 1	1	Upstream link is only used for loops.
Recording node	1	1	
Terminal node	1	0 or 1	Downstream link is only used for loops.
Variable inflow node	0 or 1	1	Upstream link is only used for loops.

Table 7.10 Maximum number of upstream and downstream links per Control node

Control node type	**Number of upstream links**	**Number of downstream links**	**Remarks**
Bifurcation node	1	2 or more	One downstream link must be of type "Surface water flow", all others must be of type "Bifurcated flow"
Diversion node	1	2 or more	One downstream link must be of type "Surface water flow", all others must be "Diverted flow" links
Groundwater reservoir node	No limitation	1 or more	• Maximum 1 upstream "Groundwater recharge" link. • Other upstream links must be of "Lateral flow" links. • Required is at least 1 downstream "Groundwater outflow" link. • Other downstream links must be "Groundwater abstraction" or "Lateral flow" links.
Link storage node	1 or more	1 or more	• Required is at least 1 upstream and 1 downstream "Surface water flow" link. • Other upstream and downstream links must be "Lateral flow" links.
Natural retention	1	1	
Pumping node	1	1	
Reservoir partition node	1	1	
Run-of-river	1	1	
Surface water reservoir node	1 or more	1 or more	• Required is at least 1 upstream and 1 downstream "Surface water flow" link. • Other upstream links must be "Lateral flow" links. • Other downstream links must be "Backwater flow" or "Lateral flow" links.
Waste water treatment plant	1	1	

Action 3: Saving your network schematization, generate the default source priority list and the default route from each demand node to each source node

When you finish the design of your network schematization, it is highly recommended to save your network and exit Netter. Proceed as follows:

- select menu items: "*File*", "*Save*" and "*Network*".
- select menu items: "*File*" and "Exit".

Each time that you save your network, two programs will be executed at the background: GenSrcL and GenDStrj. The first program generates the default source priority list and the second one determines the route for each demand node – source node combination in the default source priority list. For very large networks this takes a few minutes. These data can be edited at action 7.

If you have not changed the network (river basin schematization) or if you do not want to save the changes you entered then you can exit NETTER without saving.

Action 4: Checking the validity of the river basin schematization, update the model data base and generation of the node simulation sequence

When your schematization is completed and you exit Netter, some other programs will be executed at the background: CHKNTWRK, CLRDBASE and GENSIMSQ are automatically executed, while CHKNTWRK checks if the network is correct. This latter action is prompted by the menu selection *Tools → Validate Network*, through which if the application recognizes a number of inconsistency in the layout of the schematization, an error message will be shown. This validation check is not covering all options. So, a *Task Failed* message can still pop up when the Validate Network option detected no errors in the schematization. As previously mentioned, to spot where the fault in the entered data occurs, make use of the Log files from the right selection of the *Edit Network and Data Base on Map* toolbox.

CLRDBASE erases the model data for the nodes and links that have been removed from the network schematization and fills up the model data with default data for those nodes and links in the network schematization for which no model data have been entered yet. GENSIMSQ determines the order in which the nodes must be simulated, called the *simulation sequence*. This order is basically the upstream to downstream order. If, after execution, the return code of the programs is not equal to 0 then one or more errors have been detected in your network schematization or database.

For debugging you can check the messages in the log-files of the programs which can be shown by selecting the task block with the right mouse button. At the bottom of the log-file error messages may appear. When you get error messages at one of the above, the most likely reason is that your network schematization is not according to the RIBASIM requirements. The required number of upstream and downstream links of the various node types is listed in Table 7.9 to Table 7.10.

When you are entering or updating the downstream links of a diversion or bifurcation node you should be aware which downstream link represents the main downstream link. This must be the “Surface water flow” link. The other downstream links must be of “Diverted flow” or “Bifurcated flow” link type.

Remarks

If an error has been detected due to an incongruence in your schematization it might help to blow up the size of the nodes or move the nodes in Netter. You can change the node size under Netter menu option "Options" and "Network options" (see Figure 7.10). At the "General node size" data entry "Symbol" you can increase the size of the node.

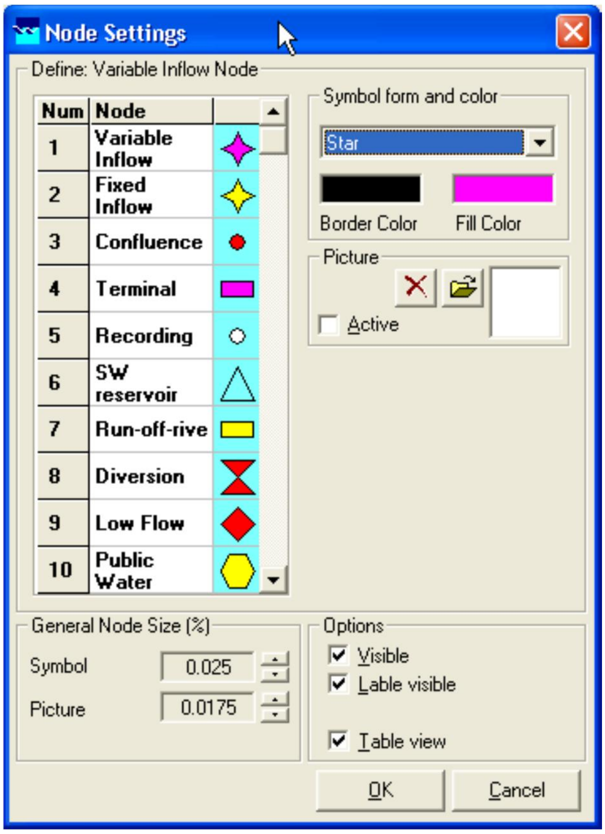


Figure 7.10 Node setting window under menu items "Options" and "Network options"

Action 5: Entry of node and link model data in spreadsheet

With this action the essential features of the nodes and links are defined. RIBASIM has three tools to enter the node and link model data and the source priority list: DATAEDIT, CROPPER and SOURCEDIT. Table 7.11 shows the tool names, the menu items to select one, the associated data to be edited and for which nodes and links data can be edited. All tools are started from NETTER. There are two ways to activate them e.g. the spreadsheet tool DATAEDIT:

- Via the top screen menu. Under the '*Edit network and database on map'* box, at the menu item: "*Edit*" and "*Model data*". A list box is opened with an overview of the nodes of the selected type shown in the list box at the bottom of the dialogue window (see Figure 7.11). Next the item "River basin simulation model" must be selected (see Figure 7.12) for the spreadsheet tool, followed the "Edit" button.

- Direct from the map. Select a node on the map by pushing the left mouse button, next push the right mouse button. Select the menu item "Model data" and "River basin simulation model". The spreadsheet based window for the selected node type will be shown and the data of the selected node will be highlighted (see Figure 7.13).

Table 7.11 Model data edit tools

Menu item	Description	Valid for node and link types	Tool
River basin simulation model	Model data entry by spreadsheet (action 5)	All types	DATAEDIT
Cropping pattern editor	Interactive graphical design of crop plan (action 6)	Advanced irrigation node	CROPPER
Source priority editor	Specification of the actual source node priority list (action 7)	Demand nodes and surface water reservoir nodes	SOURCEDIT

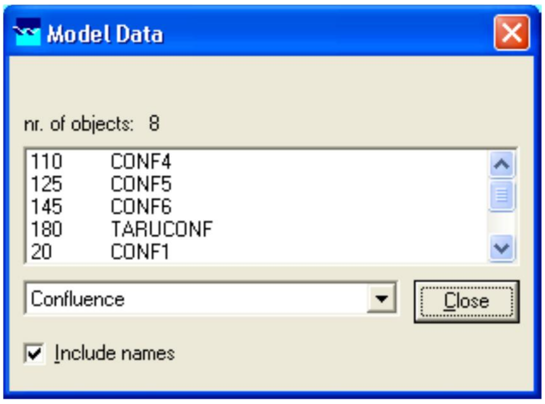


Figure 7.11 Dialogue window for selection of the confluence node type to enter model data

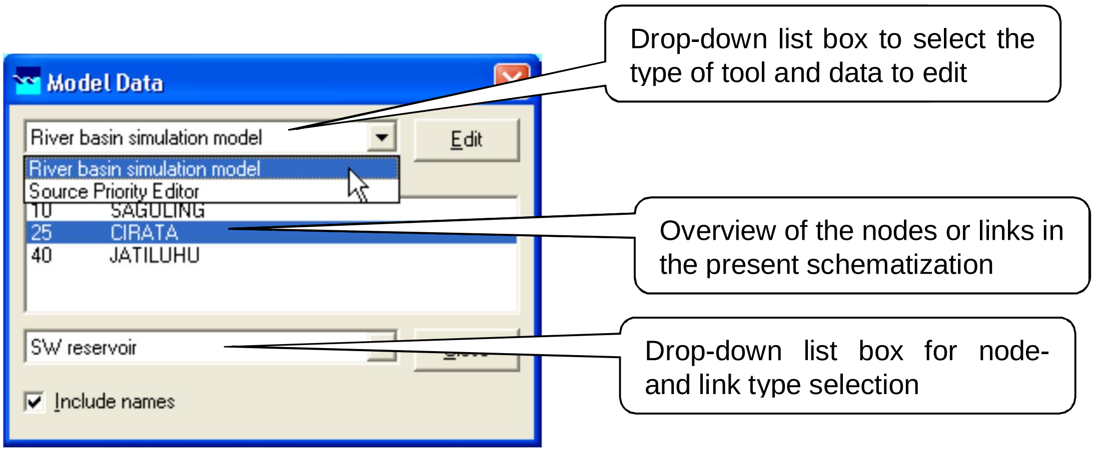


Figure 7.12 Drop-down menu for selection of the model data to be edit: select "River basin simulation data"

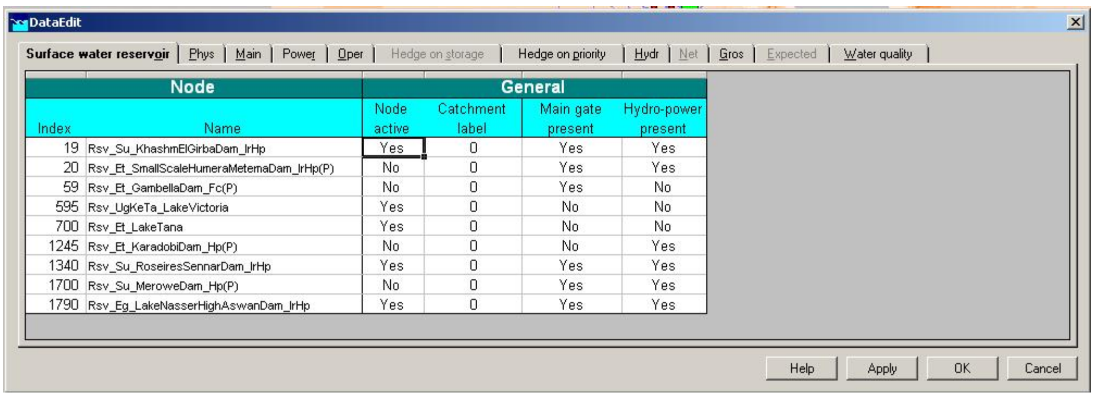


Figure 7.13 Spreadsheet-based window for entry of model data for all 'Surface water reservoir nodes'

The window consists of a number of folders with each folder containing a spreadsheet like hydrology, Soil, Crop plan, Supply, etc. The number and kind of spreadsheets depends on the type of node and link. All spreadsheets together contain the data of the concerning node and link type.

In the appendix H an overview is outlined of the model data of each node and link type. You can enter your data like in a normal spreadsheet. Relations can be graphically verified. The spreadsheets may contain the following data items:

- **Edit**: opens another spreadsheet for specification of the cropping patterns.
- **Table**: open another spreadsheet for specification of relations and time series data.
- **Yes / No**: on - off switch. If you want to change the yes/no switch then you must double click the mouse button. You can not change the values in one column by dragging the Yes/No value of the first item in the column.
- **Numeric value**: real or integer numbers. You can change the values in column and rows by dragging the value of the first item in the column and row.

Further the following buttons are present:

- **Apply**: the data in the spreadsheets are saved and not quit.
- **OK**: the data in the spreadsheets are saved and the program is quit.
- **Cancel:** the data in the spreadsheets are not saved and the program is quit.

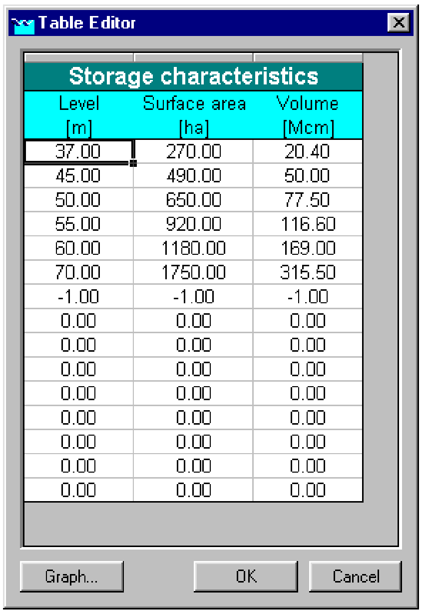
The "Copy", "Select" and "Paste" operations are available under the following key combinations:

Action	**Combination of keys**
Copy a range of cells	Ctrl – C
	Ctrl - Insert
Select a range of cells	Shift - Arrow Up / Down
Paste a selected range of cells	Ctrl – V
	Shift - Insert

The model data are mostly rather straightforward (see appendix H and I for a complete listing). The RIBASIM node types are distinguished in 3 groups of nodes:

- **control node**; the distribution of flow in space or time can be influenced;
- **demand node**; a water use is specified which may be either consumptive e.g. for irrigation or non-consumptive e.g. low flow;
- **layout node**; elements which serve to complete the configuration.

The RIBASIM Technical reference manual covers more details on the model data of each node and link type. The following commentary information may be helpful. First the layout nodes, then the demand nodes, followed by the control nodes and finally the link types. Relations are specified as maximal 15 values. If less than 15 values are entered then the series must be closed with the value –1. Figure 7.14 shows an example.



Storage characteristics		
Level [m]	Surface area [ha]	Volume [Mcm]
37.00	270.00	20.40
45.00	490.00	50.00
50.00	650.00	77.50
55.00	920.00	116.60
60.00	1180.00	169.00
70.00	1750.00	315.50
-1.00	-1.00	-1.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00

Figure 7.14 Specification of a relation in RIBASIM with closing value "-1.0"

Layout nodes

Variable inflow node data: 

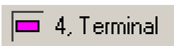
A layout node; the inflow is set for each time step by means of the ACTINFLW.TMS time series file (see chapter 5.1). It is used to represent natural inflow from a river, spring or inter-basin transfer flow. Under the Variable multiple year time series option, this node permit the definition of a local consumption value which is expressed either as percentage of the incoming flow or as an absolute value. If the inflow is specified in mm/day or mm/time step then the catchment area (km2) should be specified. Under the Sacramento option, the variable inflow can also be expressed as resulting from the Rainfall-Runoff transformation computed with Sacramento modelling.

Fixed inflow node data: 

A layout node; the inflow (m3/s) is a constant for each time step within the year. Each year the same flow values are used to represent a reliable inflow from an external source e.g. other basin.

Confluence node data: 

A layout node; no data are required. It represents the confluence of any number of waterways.

Terminal node data: 

A layout node; no data are required for modelling. It represents the downstream outlet boundary of the system.

Recording (dummy) node data: 

A layout node; this node is mainly used for calibration of the model. If a simulation is executed on daily time steps then for the location of the recording nodes the daily-simulated flows are output to the Tms-file DLYQRCRD.TMS and His-file DLYQLINK.HIS.

Demand nodes

Low flow node data: 9. Low Flow

This demand node represents minimum flushing requirements in the network. The requirements are specified as annual time series in the model data or as multiple year time series in the time series file LOWFLOW.TMS (see chapter 5.1). Further, a water management priority must be specified (1=highest) for 2 fractions of the requirements.

Public water supply node data: 10. Public Water Supply

A demand node representing the extraction for public water supply at specific locations within the basin. The definition of public water supply is user-dependent. For example, the node can be used to solely represent the water use function of the domestic sector, or to describe the cumulative water use patterns of public water distributed to multiple sectors (e.g. (domestic, municipal, industrial water supply). This demand is set as fixed time series values for each time step or is computed based on the population and a unit water requirement. Other required data are a water management priority specification (1=highest) which can be given for each of 2 fractions, and a return flow percentage (percentage of the allocated quantity). The demand can be supplied from surface (river, water storage) and/or groundwater.

Fixed irrigation node data: 11. Fixed Irrigation

A demand node with a fixed demand time series for each time step (identical for each year). Required data are the time series for net water requirements (mm/day), irrigated area, irrigation efficiency, return flow percentage and a water management priority specification (1=highest) for 2 fractions. This node is used to represent irrigation schemes where an 'average' rainfall is already taken into account in the computation of (net) water requirements performed by the user outside RIBASIM . The demand can be supplied from surface and/or groundwater.

Variable irrigation node data: 12. Variable Irrigation

A demand node that simulates an irrigation scheme where supply is provided by both the water from the network (river or canal, groundwater aquifer) and rainfall. Required data are the irrigated area, gross irrigation demand for each time step of the year, irrigation efficiency, effective rainfall time series index, actual rainfall time series index in the time series file ACTRAIN.TMS (see chapter 5.1), rainfall effectiveness, and a water management priority specification (1=highest) for 2 fractions. Distinction is made between a dry and a normal year based on the actual rainfall in a defined monitoring period. This node is used to represent irrigation schemes for which the irrigation water demand from the network is online computed based on the actual rainfall. The term gross irrigation demand refers to the demand at field level that will be supplied partly by rainfall (effective rainfall) and partly by irrigation supplies. For the computation of the demand the dependable rainfall can be used. The demand can be supplied from surface and/or groundwater.

Advanced irrigation node data: 25. Advanced irrigation

This demand node represents an irrigation area for which the demands are computed with a high degree of detail. The demand can be supplied from surface and/or groundwater. An agriculture water demand and water allocation is used.
The impact of the water allocation in terms of crop yield and production costs is also computed. The node requires data under the following headings:

- *General* data indicating if the node is active or inactive;

- *Hydrology* data: rainfall time series index of the actual rainfall, dependable rainfall, reference crop evapotranspiration and dependable river flow. All time series files are stored in the selected hydrological scenario directory. Further, the rainfall effectiveness is specified.
- *Soil data:* the soil characteristics of the root zone must be specified: wilting point, field capacity, saturation capacity and the initial soil moisture content.
- *Crop plan data*: a list of cultivated crops with the starting time step of the cultivation, the cultivated area, the percolation and pre-saturation requirements, the number of fields representing the topography of the area and the growing season index is specified.
- *Supply* covering various irrigation efficiencies: the field application efficiency, the distribution efficiency under normal and under drought situations, the conveyance efficiency for surface water and groundwater. Further, it must be indicated if the operation is based on feedback of the field status or not. The water allocation priority (1=highest) for the different crops is specified.
- *Drainage:* the percentage of the total drainage flow to surface water and to groundwater is specified.
- *Management*: A water management priority (1=highest) specification for 2 fraction of demand can be specified.
- *Water quality*: the look-up table index of each substance is specified. All look-up files are stored in the selected water quality scenario.
- *Production:* the parameters for the production costs function are specified. And for each crop the potential crop yield, the price per kg, the potential production costs per hectare and the on-farm yield losses.

Loss flow node data: 

This demand node represents losses from the system due to infiltration, evaporation, illegal abstractions or other reason. The actual loss flow is specified in the time series file LOSSFLOW.TMS (see chapter 5.1). Further, a water management priority must be specified (1=highest) for 2 fractions of the loss flow. If the loss flow node is connected with a groundwater reservoir node by a groundwater recharge link then the allocated loss flow will feed the groundwater reservoir.

Fish pond node data: 

This demand node permits the simulation of fishponds (aquaculture), which require water for flushing. The demand can be supplied from surface (river) and/or groundwater. Required data are the pounded area, flushing requirements (mm/day), actual rainfall time series which are stored in file ACTRAIN.TMS and evaporation time series which are stored in file EVAPORAT.TMS (see chapter 5.1). A water management priority specification (1=highest) for 2 fractions of the flushing requirement can be specified as well.

General district node data: 

This demand node permits to couple a separate district model to RIBASIM. The demands and discharges from the district are specified as time series files: DISDEMND.TMS and DISDISCH.TMS (see chapter 5.1). Dedicated district models generate these time series. The demand can be supplied from surface (river) and/or groundwater. Additional data requirement is the specification of a water management priority specification (1=highest) for 2 fractions of demand. The General District node can be used to represent water use patterns of different sectors (i.e. industry, energy, livestock).

Groundwater district node data (under revision): 

This demand node represents a district with supply from both local ground and surface water, and extraction from irrigated and non-irrigated agriculture and public water supply. A data set is required under the following headings:

- *non irrigated area* data with surface area, soil moisture capacity, initial storage, discharge percentage and percentage of the latter which reaches the aquifer;
- *irrigated area* data with surface area, groundwater pumping capacity and efficiency, irrigation gross demand for each time step of the year and identical for each year, effectiveness of rainfall, groundwater and surface water irrigation efficiency, and irrigation return flow to surface and groundwater. Data specification is similar to that of the variable irrigation node;
- *public and industrial water supply* with groundwater pumping capacity and efficiency, return flow percentage (always to surface water) and PWS water demand;
- *groundwater storage* data with mostly physical data on the aquifer, drainage from groundwater, inflow, rainfall, evaporation and water management procedures and priorities.

Control nodes

Bifurcation node data: 

This node represents the division of an upstream flow in 2 or more separate downstream reaches. The relation between the upstream link flow and the flow in the downstream link is specified at the data for the “bifurcated flow links”.

Diversion node data: 

This node represents the division of the upstream flow in 2 or more separate downstream reaches due to the presence and operation of a weir in a river or canal.

Link storage node data: 

This node represents channels with a variable volume in the channel. Due to the relatively long time-step, the volume difference between the average inflow and outflow will most likely be insignificant as compared with total flow over the time-step period. The link storage node is therefore only meaningful for large river basins and when the fraction simulation or water quality simulation is needed which require channel volumes. Data requirements are structured under the following headings:

- Link storage: selection of the desired routing method.
- Fixed: the storage is kept fixed on the initial volume, only the actual rainfall and evaporation is taken into account.
- Manning: the storage and outflow is computed based on the Manning formula. Data needed are: channel width – water level relation, Manning coefficient (n: from 0.02 to 0.2) and bottom slope, length, initial level and the rainfall and evaporation time series;
- Q-h: the storage and outflow is computed based on the Q-h relation. Data needed are: channel width – water level relation, stage-discharge relation, length, initial level and the rainfall and evaporation time series;
- Muskingum: the storage and outflow is computed based on the 2-layered, multi-segmented Muskingum formula. Data needed are: initial storage, travel time and weighting factor for both layers, layer border discharge and the number of segments.
- Puls: the storage and outflow is computed based on the Puls method. Data needed are: storage – discharge relation, initial storage, storage – area parameter, soil moisture recharge, and the rainfall and evaporation time series.

- Laurenson: the storage and outflow is computed based on the Laurenson's non-linear routing method. Data needed are: initial storage, the storage delay parameter and the non-linearity measure.

The rainfall and open water evaporation time series are stored in the files ACTRAIN.TMS and EVAPORAT.TMS (see chapter 5.1);

Surface water reservoir node data: 

This control node is used to simulate the operation of an existing or planned reservoir, or lake, in the river basin. It requires data under the following headings:

- General: indicate if node is active and presence of a main (releasing on the downstream surface water flow link) and a turbine gate (generating hydro-energy).
- Physical: length of reservoir (for water quality and fraction simulation only), level-area-volume table and spillway characteristics, initial level;
- Main: main gate characteristics; this data is only required if main gate is present.
- Power: turbine intake and tail level, turbine data, firm energy demand, plant capacity factor, auxiliary energy consumption and water allocation priority for firm energy generation; this data is only required if turbine is present.
- Operation: reservoir operation rule curves, detailed operation switches and type of hedging procedure to be applied.
- Hedging on storage: hedging data for the hedging procedure based on water storage in the reservoir;
- Hedging on priority: hedging data for the hedging procedure based on water management priorities of the demands;
- Hydrology: seepage and type of applied time series for evaporation and rainfall and the flood routing period are required;
- Net Series: net evaporation and rainfall time series;
- Gross series: evaporation and rainfall time series index;
- Expected flows: expected inflow relation parameters; the concept of the expected inflow is a procedure to simulate the fact that actual inflow during a time step is not known to the operator at the start of the time step.

Groundwater reservoir node data: 

This control node is used to simulate the behaviour of an aquifer and all flows in and out of the aquifer: this for example includes natural outflow, water user abstractions and lateral flows with other water bodies like reservoir and other aquifers. The node is described by data like the groundwater storage – groundwater depth relation, shallowest groundwater depth, ground surface level, maximum abstraction, initial groundwater depth and the relation between groundwater depth and the outflow via the "Groundwater outflow link".

Relevant for energy consumption or energy generation only:

Run-of-river node data: 

This node model data are similar to the Reservoir node data under the heading 'power'. This node is used to simulate a hydropower station without storage capacity. The output of the node is the generation of hydropower.

Pumping node data: 

This control node simulates a lifting device in the channel. The output of the node is the energy consumption. Data to be specified are the pumping efficiency, as well as the pumping head for each time steps within the year.

Relevant for water quality only:

Surface water reservoir partition node data: 

This control node represents part of a (main) surface water reservoir. Its main use is for water quality analysis that may eventually require the division of reservoirs in several parts each having its separate water balance. The reservoir partition node is always associated with a reservoir node. The following data are required: length of the reach and the width-level relation in a table.

Waste water treatment plant node: 

This control node represents a plant for the artificial purification of waste water.

Natural retention node: 

This control node represents the natural purification of waste water in a river reach.

Link types

Bifurcated link data: 

This link represents a minor downstream branch at a natural split of the main river reach represented with a bifurcation node. The relation between the flow in the upstream link and the bifurcated flow link should be defined in the link.

Diverted flow link data: 

This link represents a canal supplying water users like irrigated agriculture or a canal for an inter-basin transfer of water. The canal is fed via a weir and gate in the river or other canal. The link is a downstream link of a diversion node. The link is described by the maximum flow per time step, the relation between the flow in the link upstream of the diversion node and the flow in the diverted flow link. Further, some operation data is required like the switch to operate the gate on downstream demands and the switch to indicated that the gate is online adjustable.

Surface water flow link data: 

This link represents a river branch (no constraints), canal or pipeline (flow capacity constraint). For the canal or pipeline a flow capacity can be specified per time step.

Surface water reservoir backwater flow link data: 

This link represents secondary outlets at surface water reservoirs. The link is described by the backwater gate intake level (m), the relation between the net head and the gate discharge, an operation switch to indicate that it is online adjustable. Further, it is indicated if the spillway is located on this link.

Groundwater abstraction link data: 

This link is characterised by the pumping depth and the maximum abstraction per time step.

Lateral flow link data: 

This link represents the flow between water bodies like surface water reservoir (surface water reservoir node), river reaches (link storage node) and other aquifers (groundwater reservoir node). Data requirements are structured under the following headings:

- General: selection of the applied flow computation method.
- Dummy: no data required.
- Darcy's law: data consists of the transmissivity (m2/day), the width between water bodies (m) and average length of the flow path in direction of flow (m).
- Q-dH relation: data consists of the relation between the water level difference between the connected water bodies and the flow.
- Flow threshold: data consists of the threshold channel inflow and the storage parameter. This method is often used to model wetland and swamp areas.
- S-Q relation: data consists of the relation between the storage in the upstream node and the flow in the link.

Remarks

- If you get troubles with the entry of data from the map, you might reset your display properties under Windows by activating: 'My computer', 'Control Panel', 'Display', 'Settings and at Colour Palette select "High colour (16 bit)".
- If the real values are not correctly shown in your spreadsheet than you must check and reset the regional setting properties under Windows from: 'My computer', 'Control panel', 'Regional setting'. At the 'Regional setting properties' window the folder 'Numbers' the item 'Decimal symbol' must be a point, and the item 'Digit grouping symbol' a comma.
- You can print the whole network with the network editor NETTER. Zoom in on the network with the "V*iew*" menu item and make a print under the "*File*" - "*Print*" menu.

Action 6: Design interactively and graphically the crop plan for the advanced irrigation nodes

For the Advanced Irrigation nodes you have to specify the following model data: physical data, hydrological data, soil data, crop plan data, supply and drainage characteristics data, water management data and production data. All these data are specified in the spreadsheet data entry tool DATAEDIT as outlined under action 5. For the crop plan data RIBASIM incorporates a useful tool named CROPPER, through which you can interactively design the crop plan with supporting graphics.

A crop plan consists of a table with the actual cultivations defined by:

- Cultivated crops;
- Cultivated area (ha);
- Starting date of the land preparation and transplanting period;
- Percolation rate (mm/day);
- Pre-saturation level (mm);
- Number of fields.

CROPPER is started from NETTER the same way as in action 5 is described for the spreadsheet tool DATAEDIT. There are two ways to activate CROPPER:

- Via the top screen menu. Under the '*Edit network and database on map'* box, at the menu item: "*Edit*" and "*Model data*". Select "Advanced irrigation node" at the list box at the bottom of the dialogue window (see Figure 7.15). Next, the item

"Cropping Pattern Editor" must be selected from the drop-down list box for the interactive graphical crop plan editor tool, followed the "Edit" button (see Figure 7.16).
- Direct from the map. Select an Advanced irrigation node on the map by pushing the left mouse button, next push the right mouse button. Select the menu item "Model data" and "Cropping Pattern Editor".

The interactive graphical crop plan editor tool can be used only when the required input data for the Advanced Irrigation Node have been provided through the Model Data → River Basin Simulation Model selection. Once this data is entered, the Crop Plan Editor starts with a screen with 4 windows:

- Left top window: An overview of all Advanced Irrigation node and cultivated crops.
- Right top window contains 2 folders "Diagram" and "Tables":
  - The "Diagram" folder is shown in Figure 7.18. It shows the crop-time diagram of the crop plan of the selected node. Each cultivated crop in the crop time diagram is represented as a parallelogram as shown in Figure 7.17. On the vertical axis the area is shown and on the horizontal axis the time (one year).
  - The "Table" folder shows the crop plan of the selected node in table form, see Figure 7.19.
- Left bottom window: the cultivation characteristics of the selected cultivation in the crop-time diagram or table.
- Right bottom window: a water balance hydro-graph with the water availability and water demand of the crop plan.

At the determination of the crop plan various constraints, such as maintenance period(s), and overall water availability, are taken into account On-line composition of the crop plan is possible, whereby the water balance hydro-graph is automatically adjusted. An overview of the operations is shown in Table 7.12.

When you want to leave the crop plan editor, you have to select one of the following options:

- **Apply**: the crop plan data are saved and not quit;
- **OK**: the crop plan data are saved and the program is quit
- **Cancel:** the crop plan data are not saved and the program is quit;

Table 7.12 Overview of operations under Cropper

Window	**Allowed operations**
Left top	Select an Advanced irrigation node in the list of nodes
	Select a cultivation among the list of cultivation
Left bottom	Change the characteristics of the selected cultivation
Right top folder “Diagram”	Select a cultivation by pointing the mouse to a parallelogram
	Drag a selected parallelogram over the grid by pushing the left mouse button: this changes the starting time step of the cultivation
	Drag the top line of the parallelogram by pushing the left mouse button: this changes the area of the cultivation
	Open a menu under the right mouse button to add or delete a cultivation or to view the output result tables and Log-file. While viewing the output result tables you can also print them.
Right top folder “Table”	Change the characteristics of all the cultivations
	Add a new cultivation to the crop plan
	Delete a cultivation from the crop plan: select the cultivation and push the Delete-button.
Right bottom	View the water balance hydro-graph with the water demand and water availability. The demand is computed based on the crop plan, agriculture and irrigation characteristics. The water availability is read from the annual time series file DEPUPFLW.TMS in the hydrological scenario.

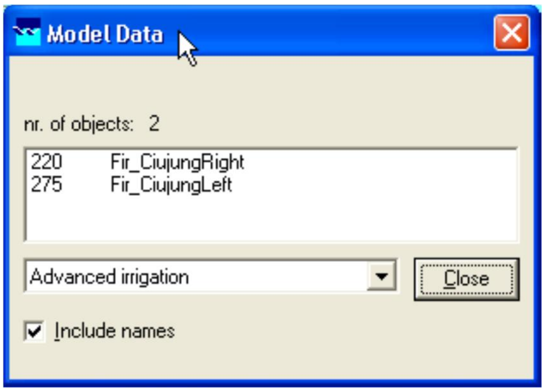


Figure 7.15 Dialogue window for selection of the node type and node to enter model data

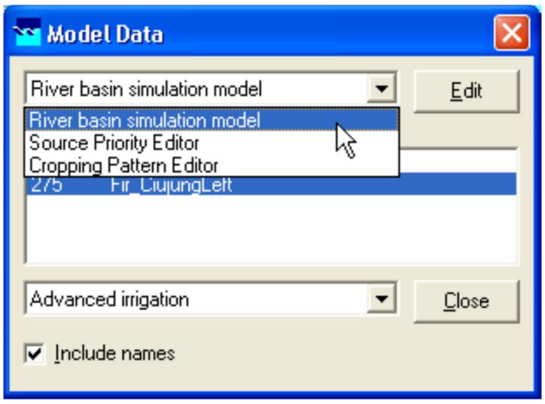


Figure 7.16 Drop-down menu for selection of the model data to be edit: select "River basin simulation data"

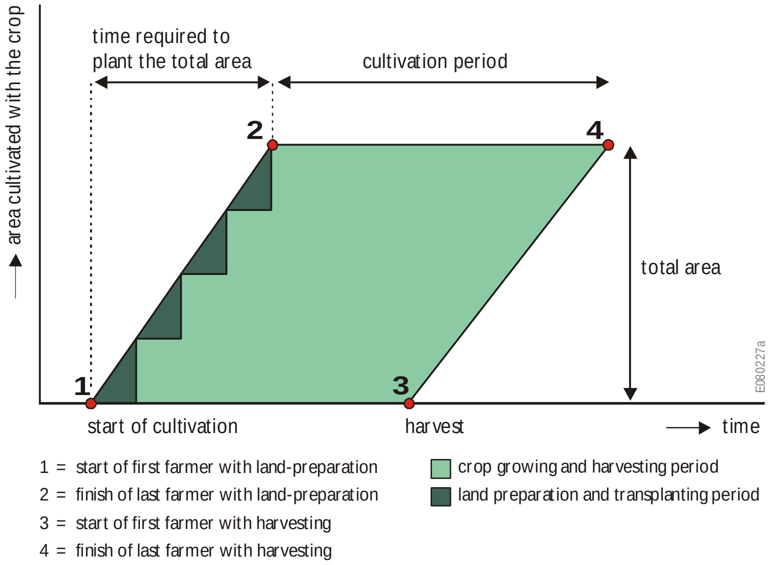


Figure 7.17 Format for presentation of a planned cultivation for a particular area

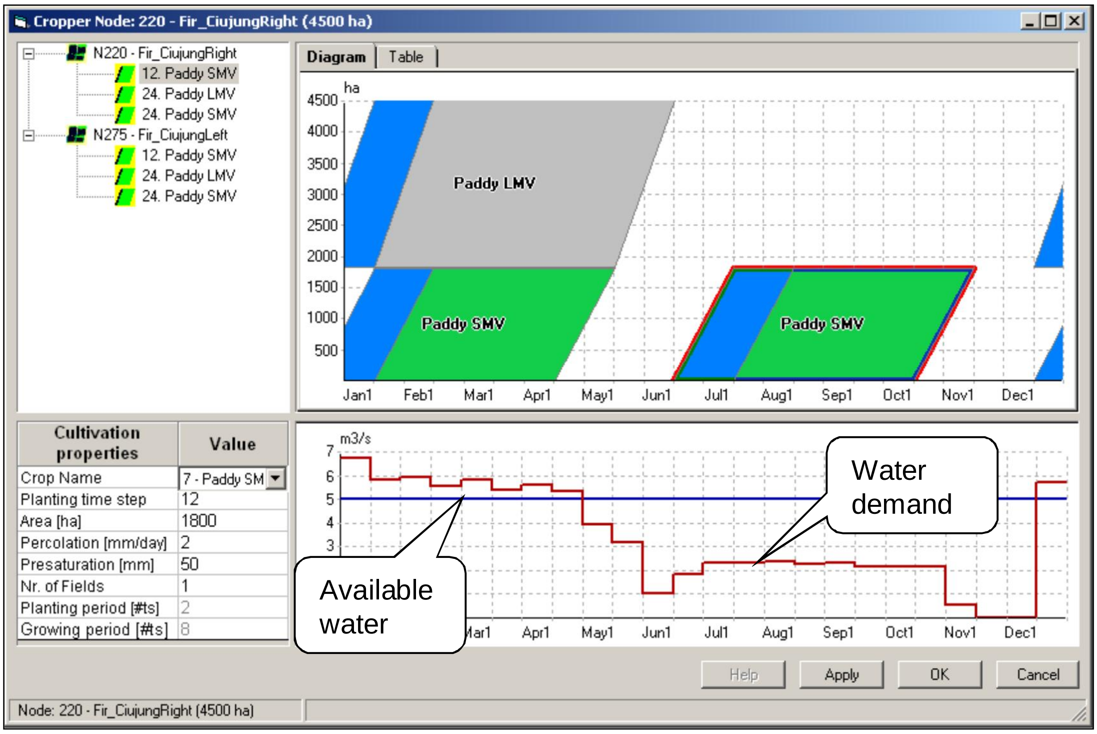


Figure 7.18 Interactive graphical crop plan editor with crop-time diagram

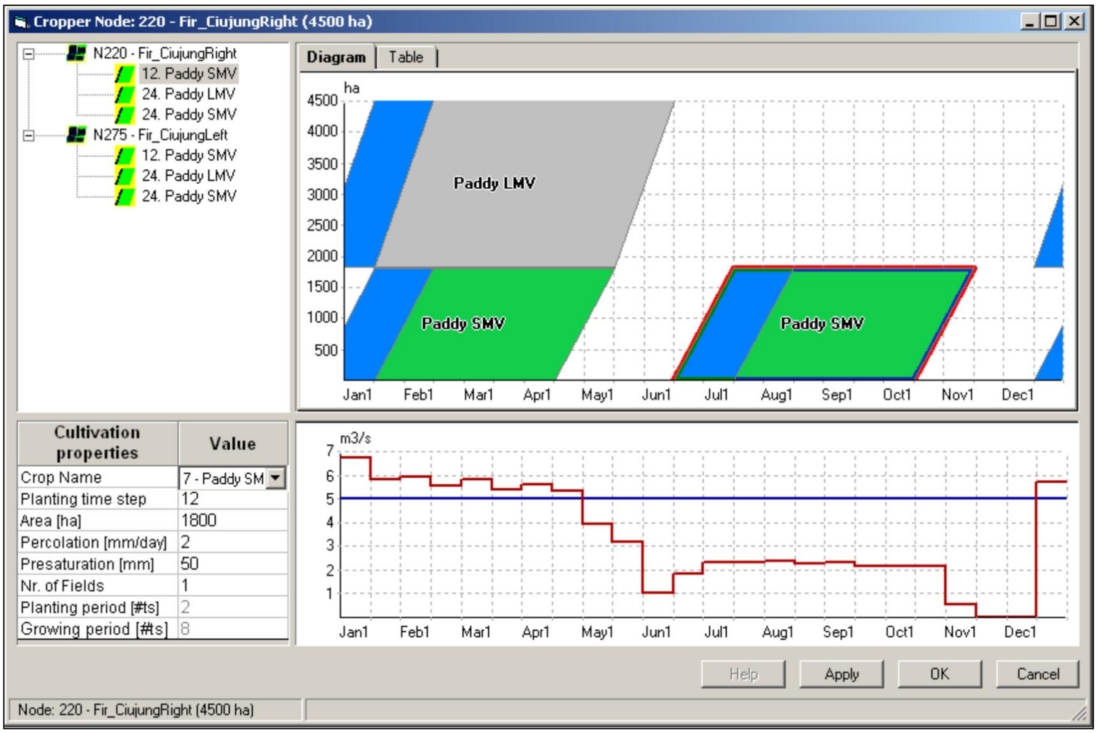


Figure 7.19 Interactive graphical crop plan editor with crop plan table

Remarks

- The annual time series for the water availability in the hydro-graph (blue line) is stored in file specified in the hydrological definition file under the name “Dependable river flow data” (default name DEPUPFLW.TMS, see chapter 5.1).
- If you get an error message when starting the crop planning tool CROPPER e.g. “Error in Totplan.dll” then probably an error has been detected while reading one of the agriculture and irrigation data files and/or hydrological time series data files in the hydrological scenario. You can check the error message at the task block screen under the right mouse button by viewing the Log-file “Log crop plan requirements” (see Figure 4.3) or under the right mouse button at the diagram folder of CROPPER at menu item “View Totplan log”.

Action 7. Visualise and edit the source priority list and the demand node – source node route

For each demand node (e.g. irrigation, PWS, low flow) and surface water reservoir node RIBASIM needs to know from which source (e.g. variable or fixed inflow, reservoir, return flow from irrigation or PWS) the demand can be met. In some cases this will be obvious, as there is only one potential source available for a demand node. However, there are also situations where a demand can be met from several supply nodes. If you want one particular source to be addressed as the first source and a second source next, this can be defined with RIBASIM. If the water demand exceeds the possible supply from the first node then the second identified source is used. For this purpose a *source priority list* is used, which mentions the order of the potential sources for all demand and surface water reservoir nodes. During a simulation the source nodes will be addressed according to their sequence in the list.

The source priority list may contain the source list for the following node types:

- Fishpond node.
- Fixed, variable and advanced irrigation nodes.
- General and groundwater district node.
- Low flow node.
- Loss flow node.
- Public water supply node.
- Surface water reservoir node.

The following node types are potential sources:

- Fixed and variable inflow node.
- Public water supply node (return flow).
- Fixed, variable and advanced irrigation nodes (return flow).
- Fishpond node (return flow).
- General and groundwater district node (discharge).
- Surface water reservoir node (release).
- Groundwater reservoir (abstraction).

RIBASIM contains a program GenSrcL which generates the default source priority list. This list contains all potential sources. Each time that the river basin network is saved under NETTER then the default source list is generated again. The user can specify in the control data if certain potential sources must be excluded from the default source list and also can be specified the order of the potential sources in the default source list. The control data can be edited under the right mouse button.

If a node in the source list is inactive then the source is skipped. Only in the case where the source node is a “Surface water reservoir” node then the source list of the inactive “surface water reservoir” node is used (expansion of the source priority list).

Further, RIBASIM contains a program GenDStrj which determines the water delivery routes (traject, links between the demand and the source node) for each demand node – source node combination in the default source list. The program is executed after the program GenSrcL. If more than one route is identified than the best route is selected based on the following criteria:

1. The number of preferred links in the route. A preferred link is defined as a link with name starting with a certain prefix (3 characters). The prefix is defined in the control data file.
2. If the source node is a surface water reservoir node than the route(s) with last link equal to the downstream link of type surface water flow link is selected.
3. Then the route with the lowest number of diverted flow links is selected.
4. Then the route with the lowest number of bifurcated flow links is selected.
5. Then the route with the lowest number of backwater flow links is selected.
6. Then the route with the minimum length is selected
7. Then the route with the most surface water flow links is selected.

For the last 5 criteria the order can be specified in the control data file.

RIBSIM generates the “default source priority list”. Initially the “actual source priority list” equals to the “default source priority list”. The user can change this “actual source priority list”. There are two ways to activate and use the Source Priority List editor:

- Via the top screen menu. Under the ‘*Edit network and database on map’* box, at the menu item: "*Edit*" and "*Model data*". Select one of the demand node types or the surface water reservoir node type at the list box at the bottom of the dialogue window (see Figure 7.15). Next the item “Source Priority Editor” must be selected from the drop-down list box for the interactive source list editor tool (see Figure 7.20), followed by the selection of the “Edit” button.
- Directly from the map. Select a demand node or a surface water reservoir node on the map by clicking the left mouse button, next click on the right mouse button. Select the menu item “Model data” and “Source Priority Editor”.

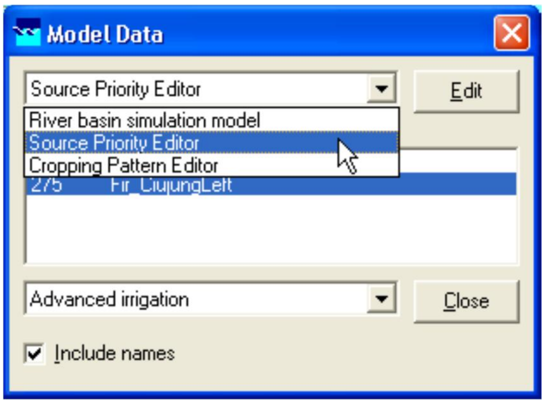


Figure 7.20 Drop-down menu for selection of the model data to be edit: select “Source priority data”.

The SOURCEDIT window shown in Figure 7.21 pops up. The window is split in three parts:

1. the upper window lists all the demand nodes for which a source list can be specified. The selected node on the map or in the list box is the highlighted node;
2. the left window shows all source nodes which are not part of the actual source list;
3. the right window shows the actual source list which will be used in the simulation;

Each node in the three windows is identified by the node ID, the node name, the class and the type of node.

The source nodes in a source priority list are classified as *L* for "*Local*" or *N* for "*Non-local*". During the target setting (demand) phase all demand nodes are first using the "Local" sources. Next all demand nodes are traced again but now the remaining demand can be fulfilled using the "Non-local" sources in the source list. The class of each source is by default "*Non-local*" and can be changed at the source priority list editor (see Figure 7.21). By double clicking on the class the ID will switch from "*L*" to "*N*", or vice versa.

The SOURCEDIT window has the following buttons for "Sources" editing:

1. Arrow left and right: here you can switch source in and out of the actual source list.
2. Arrow up and down: here you can change the order of the source nodes in the actual source list.
3. "Show … ": View the source nodes on the map. The source nodes are highlighted on the map.
4. "Restore": the actual source list is replaced by the default source list for the selected demand node only.
5. "Restore all": the actual source list is replaced by the default source list for all demand nodes.
6. "Class all": change the class of all sources to "*Local*" or "*Non-local*".

The window has the following buttons for "Route" editing which become active after selection of a demand node in the upper window and a source node in the right window (see Figure 7.22):

1. Show route-button: the route from the selected demand node to the selected source node is highlighted on the map (see Figure 7.23).
2. Edit route-button: the route from the selected demand node to the selected source node can be edited on the map. You can (de-)select the links of the shown (highlighted) route by pushing the "Control" key while pointing with the mouse to the links while you push the left mouse button. Three additional buttons related to the pointed route are activated:
    a. Get-button: Get the shown (pointed and edited) route on the map into SOURCEDIT.
    b. Load-button: Load the last saved (actual) route in SOURCEDIT
    c. Load default: Restore the default route generated by the program GenDStrj.

You finish your edit session or exit SOURCEDIT by the one of the following buttons:

1. Save-button: the actual source priority list and actual demand node - source node route are saved.
2. Cancel-button: exit SOURCEDIT while not saving any list.
3. OK-button: exit SOURCEDIT.

When you want to finish your edit session, exit NETTER under the File-menu item at the top of the screen. If a new Delwaq water quality schematization has been prepared the program will prompt you when this schematization must be saved.

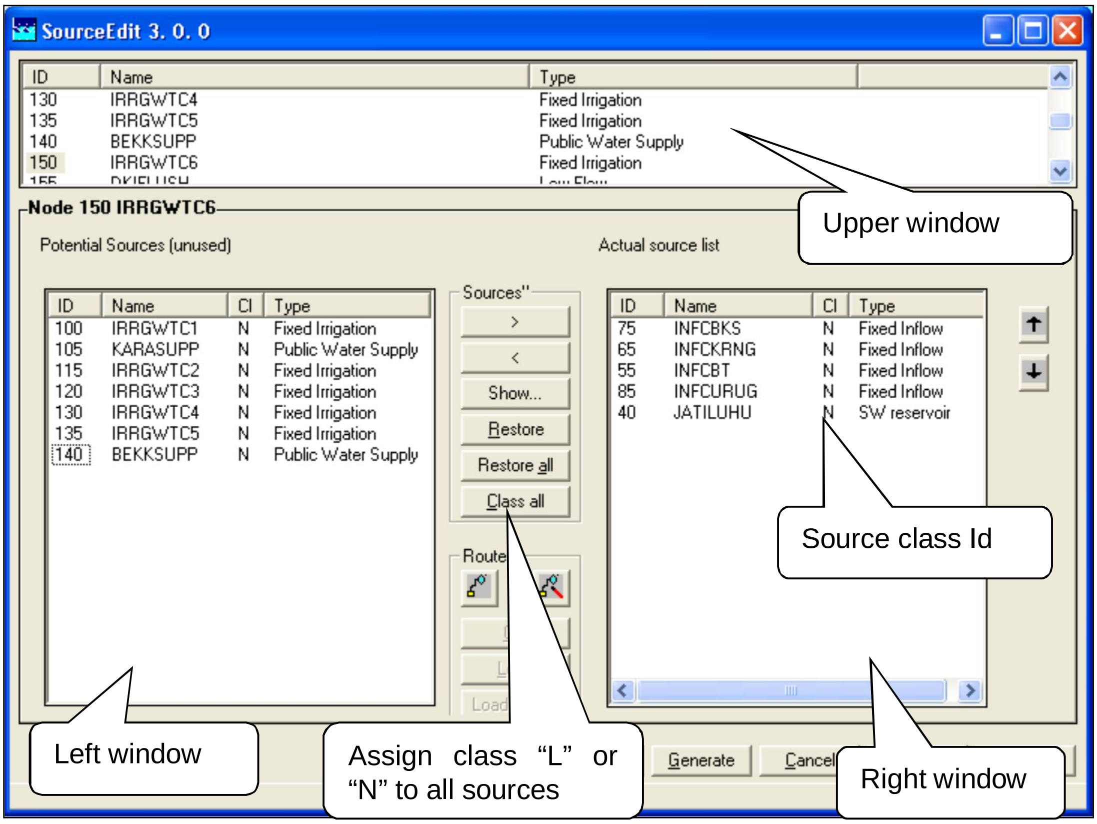


Figure 7.21 Window for editing the source priority list and demand - source node route.

Remarks

- Usually the automatically generated default source priority list is correct and sufficient for further simulation. However, you should always verify if the actual source priority list is correct, as this list may have a decisive impact on the actual water allocation in the basin. Special attention is required for the demand nodes with more than one source.
- When you have updated your previous network schematization, then the default source priority list is generated after saving the schematization. Also the actual source priority list is updated which means that non-existing nodes are deleted from the list. If you want to use the complete default source priority list as the actual source priority list then you must select the "Restore all" button at the SOURCEDIT window.
- If during the execution of a program inconsistencies among the various data items are discovered then the task block will stay yellow. The program will generate an error message and/or warning at the end of the Log-file of the program that

detected the error. You can view the Log-files of the programs by selecting the task block with the right mouse button.

- When you have changed your schematization e.g. added some new source and/or demand nodes, then you have to check the source priority list of the new demand node but also the demand nodes which might use the newly added source node. The new source node is put into the actual source priority list as a potential (unused) source. So, you have to check and update the actual source priority list yourself else the new source node is not used as a source. If your actual source priority list was the default source priority list then you can update all directly by pushing the “Restore all” button.
- If you have changed the fixed source priority control data file *Gensrcl.dat* then you have to generate a new source priority list again. Carry out the following actions:
  - Edit the network under NETTER e.g. move one node to another location on the map.
  - Save network. Then automatically some programs will be executed at the background which generate the new source priority list,
  - Activate the source priority editor for one of the demand nodes under NETTER,
  - In the SOURCEDITOR still the old generated source priority list is shown. Update the list by clicking on the “Restore all” button.

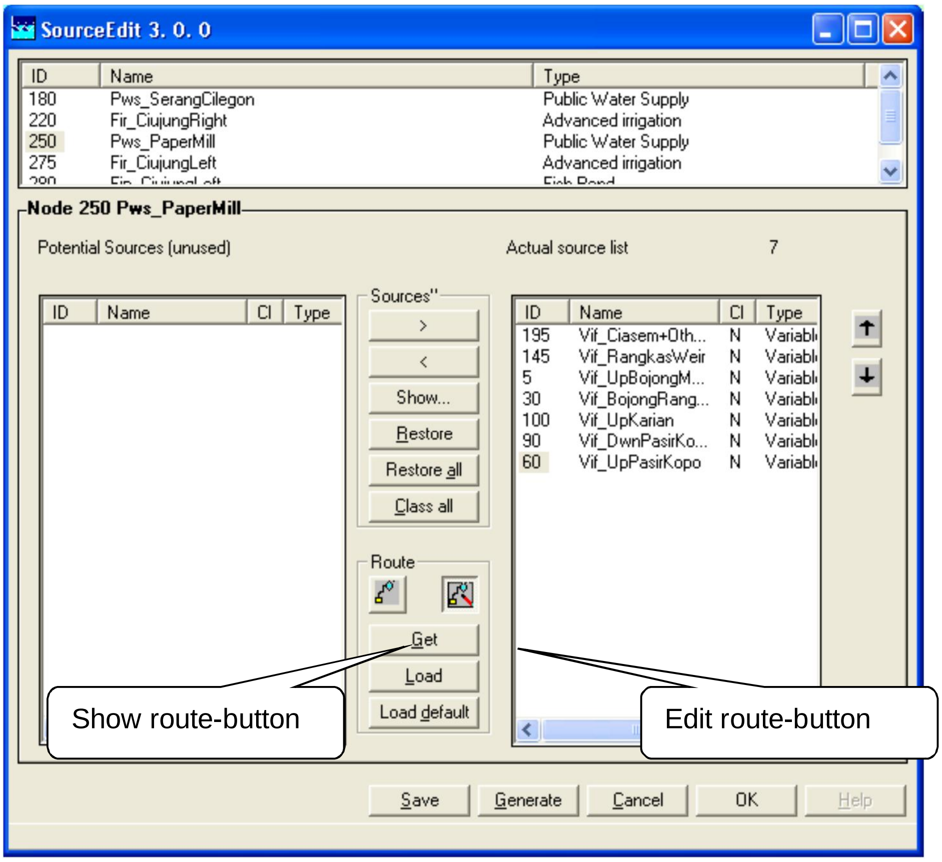


Figure 7.22 Window for editing water delivery route (Demand node - Source node route)

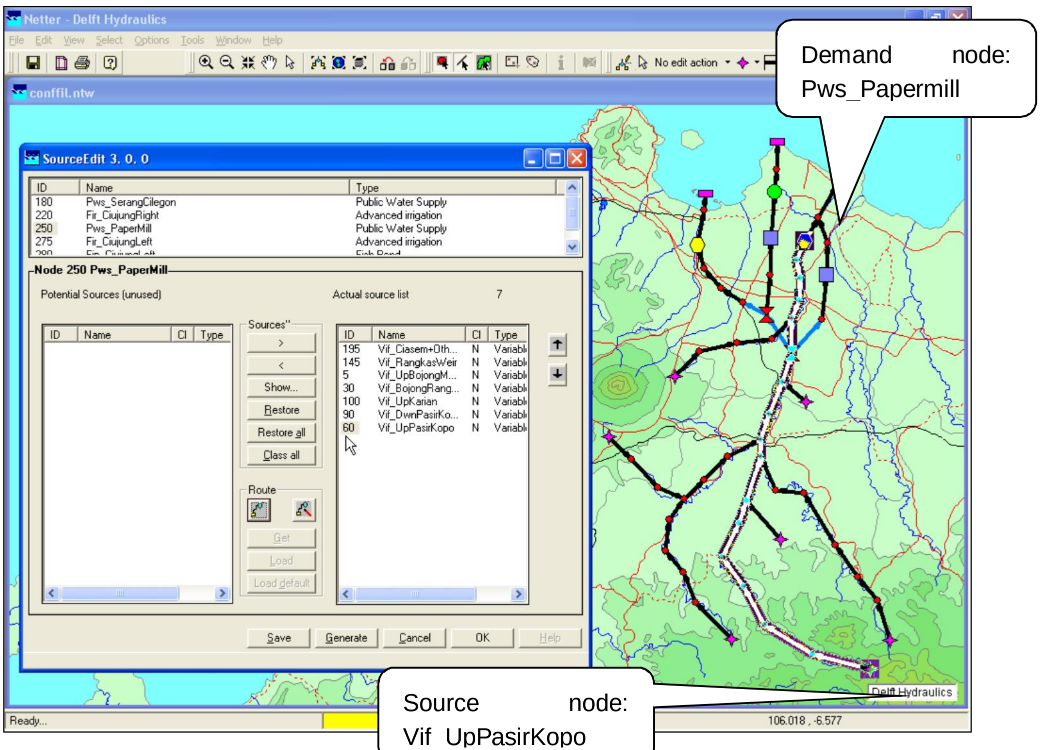


Figure 7.23 SOURCEDIT shows demand node - source node route on map by highlighted links

7.3 Sub-task: Generate overview of the data base

By double clicking on the *Edit Network and Data Base on Map* tool, you can access to a number of options. When you execute the task *Generate overview of the data base*, the Log-file RIB2PRT.LOG is generated. This file contains tables of all network and network related data, and model data of all nodes and links. The number of output tables depends on:

- The node and link types in your network schematization;
- The “Overview of data base” control data in the file Bin2Prt.dat (see task 7.1). You can edit this file directly. Table 7.13 gives an overview of the various output tables;

The Log-file can be viewed and printed (partly) directly after generation by selecting the printing option from the File menu.

Table 7.13 Example overview of the various output tables with model data

Table index	Description
1.0	Dimension of the present schematization
2.1	Configuration data
2.2	Water allocation priority data
2.3	Simulation sequence
2.4.1	(Updated) source priority list
2.4.2	Original source priority list (if updated)
2.4.3	(Updated) source traject list
2.4.4	Original source traject list (if updated)
2.5	Left open intentionally
2.6	Parallel sequences of surface water reservoir and run-of-river nodes
3.1	Data for variable inflow nodes
3.2	Data for fixed inflow nodes
3.3	Left open intentionally
3.4	Left open intentionally
3.5	Data for recording nodes
3.6	Data for surface water reservoir nodes
3.7	Data for run-of-river nodes
3.8	Data for diversion nodes
3.9	Data for low flow nodes
3.10	Data for public water supply nodes
3.11	Data for fixed irrigation nodes
3.12	Data for variable irrigation nodes
3.13	Data for loss flow nodes
3.14	Data for fish pond nodes
3.15	Left open intentionally
3.16	Data for groundwater reservoir nodes
3.17	Data for bifurcation nodes
3.18	Data for pumping nodes
3.19	Left open intentionally
3.20	Data for general district nodes
3.21	Data for groundwater district nodes
3.22	Data for link storage nodes
3.23	Data for surface water reservoir partition nodes
3.24	Left open intentionally
3.25	Data for advanced irrigation nodes

3.26	Left open intentionally
3.27	Data for waste water treatment plant nodes
3.28	Data for natural retention nodes
4.1	Data for surface water flow links
4.2	Left open intentionally
4.3	Left open intentionally
4.4	Data for lateral flow links
4.5	Data for groundwater abstraction flow links
4.6	Data for diverted flow links
4.7	Data for bifurcated flow links
4.8	Data for surface water reservoir backwater flow links
5	Data of time series files
6	Data of output variables for each type of node
7	Dimension of present RIBASIM version

Remarks

If during the generation of the tables inconsistencies among the various data items are discovered then the program will generate an error message and/or warning among the various tables at the specific node or link. At the end of the file a message is shown if any error has been detected. You can check the messages in the Log-files of the program by selecting the task block with the right mouse button. You can search the Log-file for the text “error” or “warning”.

7.4 Sub-task: View tables of data base

When you activate this task you can view and print the whole or part of the Log-file RIB2PRT.LOG which is generated at the task "*Generate overview of data base*" (see previous chapter). This file contains an overview of network, node and link related data. The program VIEWTEXT is used for this action. You can print the whole file or select a particular table to be printed.

Remarks

- Here you can check all data which are used for the river basin simulation with the exception of the hydrological time series, the water quality lookup tables and some of the fixed model data.
- If during the generation of the tables inconsistencies among the various data items are discovered then warning or error messages are output among the various tables at the specific node or link for which the message is meant. At the end of the file a message is shown if any warning or error messages were output. You can search the Log-file for the text “warning” or “error”.

7.5 Sub-task: Edit node and link renumber option data

Ribasim offers the feature to renumber systematically all node ID’s and link ID’s. This option updates the whole data base (program RENUMID) including the source priority. The program offers three different options for numbering the nodes and links, which can be set under this menu item. When you select this task, Figure 7.24 is shown. At this window you can select which one out of the 3 renumbering options you prefer and some additional data which depends on your selected renumber option. Those options are:

1. Number the nodes and links in **downstream order** as outlined in the simulation sequence. For this option you have to specify the basin index (value 0-2). As explained later, the option of numbering the basin can be useful when more RIBASIM applications are combined (e.g. merging of 2 basins). Once you have defined the basin index, this task attributes a sequential value to the nodes and links as provided in the following examples:

   Link ID: any number smaller than 32678 and format: "xyyyy"
   With:

x	basin index (0-2) (input at the window)
yyyy	sequence index over all links within the basin (0-9999)

   Example
   20150 a link in basin 2 and the 150-th link in this schematization (defined by program)

   Node ID: any number smaller than 32678 and format "xyyyy"
   With:

x	basin index (0-2) (input at the window)
yyyy	sequence index over all nodes within the basin (0-9999)

   Example
   11145 a node in basin 1 and the 1145-th node in this schematization (defined by program)

2. Number the nodes and links in **downstream order** as outlined in the simulation sequence. For this option you have to specify the basin index (value 0-31).

   Link ID: any number smaller than 32678 and format: "xxyyy"
   With:

xx	basin index (0-31) (input at the window)
yyy	sequence index over all links within the basin (0-999)

   Example
   2150 a link in basin 2 and the 150-th link in this schematization (defined by program)

   Node ID: any number smaller than 32678 and format "xxyyy"
   With:

xx	basin index (0-31) (input at the window)
yyy	sequence index over all nodes within the basin (0-999)

   Example
   11145 a node in basin 11 and the 145-th node in this schematization (defined by program)

3. Number the nodes and links **based on node types**. For this option you have to specify the basin index (value 0-31) and a node type index (value 0-9), see Figure 7.25. At the renumbering the following rules are applied:

Link ID: any number smaller than 32678 and format: "xxyyy"
With:

xx	basin index (0-31) (input at the window)
yyy	sequence index over all links within the basin (0-999)

Example

2050	a link in basin 2 and the 50-th link in this schematization (defined by program)

Node ID: any number smaller than 32678 and format "xxyzz"
With:

xx	basin index (0-31) (input at the window)
y	**type of node index (0-9) (input at the window)**
zz	sequence index over all nodes of the concerning type (0-99)

Example

6722	a node in basin 6 and node type 7 (defined in this file) and the 22-th node of node type 7 in this schematization (defined by program)

Remarks

- Actually you are editing the node and link renumbering control data file RenumID.dat. This file can also be edited directly under task 7.1.
- The renumbering option is often used after finalizing a new schematization. Then it is practical to have the ID’s numbered systematically e.g. in a downstream order.
- The node and link renumbering is most time required when you want to combine two or more basins. Before combining you have to renumber each basin so there are no overlapping node and link ID’s among the combined basins.

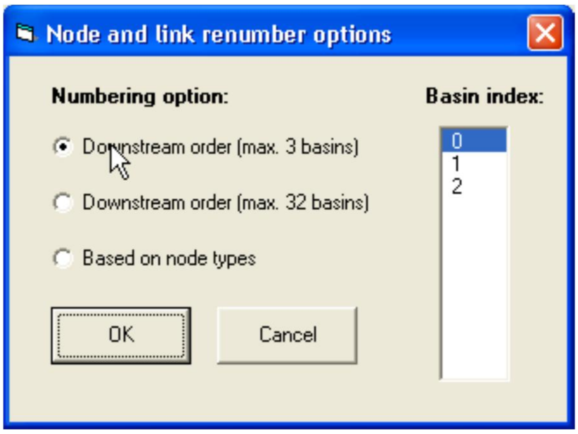


Figure 7.24 Window to select one of the three renumbering node and link ID’s options

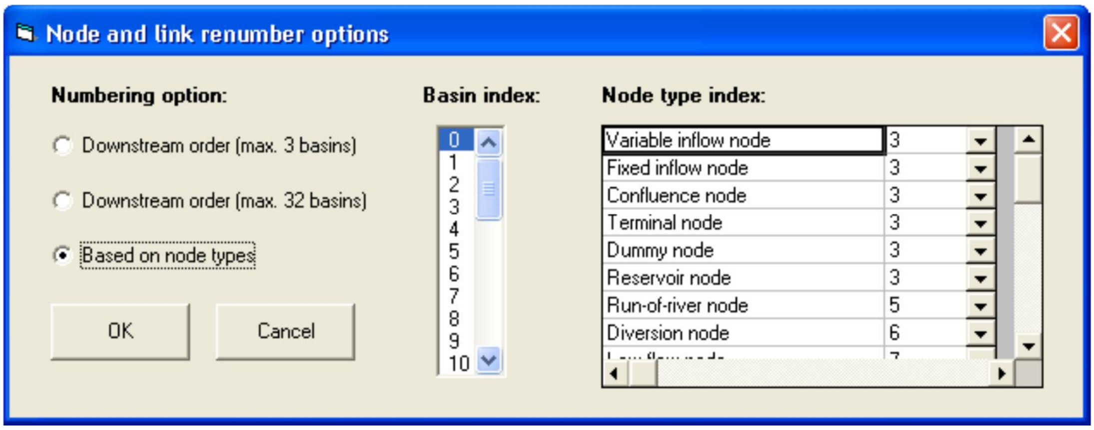


Figure 7.25 Window to specify the additional data for renumber option 3 which is based on node types

7.6 Sub-task: Renumber nodes and links

When you select this task then the actual renumbering will be carried out according to the option which you have selected and defined in the previous task. This option automatically renumbers the node and link ID's and updates the whole data base (program RENUMID) including the source priority list. During the execution a Log-file is generated which can be viewed under the right mouse button while pointing to the task block "Edit network and data base on map".

7.7 Sub-task: Generate the initial state data file

At the chapter 6 at the specification of the control data you can switch on the option "Use initial state data file". If this option is *on* then the simulation is executed with the initial state defined in the initial state data file. At this task you can generate the initial state data file with the initial state values defined in the model data. At the next task you can edit this initial data file. Table 7.14 shows for each node type the initial data items in the initial state data file.

7.8 Sub task: Edit the initial state data file.

At the chapter 6 at the specification of the control data you can switch on the option "Use initial state data file". If this option is *on* then the simulation is executed with the initial state defined in the initial state data file. At this task you can edit under Ms Notepad the initial state data file which is generated at the previous task. You can specify new initial values for the items shown in Table 7.14.

Table 7.14 Overview of initial data items in initial state data file for various node types

Node type	**Data**
Surface water reservoir	Initial level (m)
	Initial concentration for each substance
Groundwater district	Actual rainfall in last NacTim (=3) time steps
	Initial groundwater depth (m)
	Initial soil moisture level (mm)
Groundwater reservoir	Initial groundwater depth (m)
	Initial concentration for each substance
Link storage node	
Fixed routing	Initial storage (Mcm)
Manning	Initial level (m)

Flow-level	Initial level (m)
2-layered Muskingum	Initial storage (Mcm)
	Initial flow in upstream link per segment and layer (m3/s)
	Initial flow in downstream link per segment and layer (m3/s)
Puls method	Initial storage (Mcm)
Laurenson non-linear "lag and route" method	Initial storage (Mcm)

7.9 Sub-task: View or export crop plan water requirements

Under sub-task 0 action 6 you can interactively and graphically design a crop plan for the Advanced irrigation nodes in your network schematization using the tool CROPPER. The computational results of this activity can be graphically presented and exported using the ODS_VIEW graph and export tool. This concerns the following results per time step:

- Net irrigation requirement (Mcm, m3/s, l/s/ha, mm/day).
- Gross irrigation requirement (Mcm, m3/s, l/s/ha, mm/day).
- Dependable river flow (Mcm, m3/s, l/s/ha, mm/day).
- Shortage (= Gross requirement – Dependable river flow, in Mcm, m3/s, l/s/ha, mm/day).
- Dependable rainfall (mm/day).
- Reference evapotranspiration (mm/day).
- Cultivated area for each crop and fallow (ha).

An example graph is shown in Figure 7.26 with a graph of the stacked cultivated area over time for the crop plan of the Advanced irrigation node AirCiujung_Left. In the figure, 2 paddy cultivations are shown (green and grey) combined with fallow (orange).

Remark

You can customize the graph layout via the left and right mouse-button.

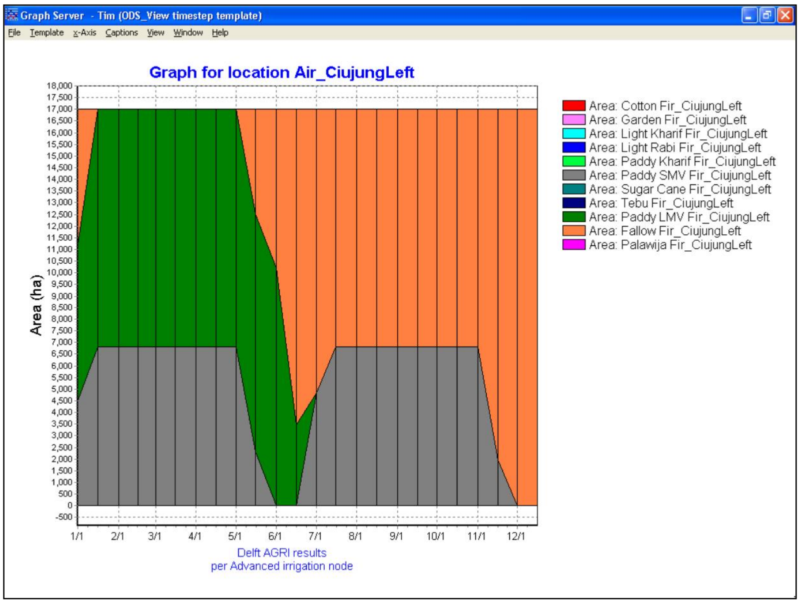


Figure 7.26 Graph with the stacked cultivated area for the crop plan consisting of crops Paddy SMV and Paddy LMV

8 Task: River basin simulation

Under this task you can carry out the following activities:

1. Edit fixed (control) data files and view Log-files.
2. Execute the river basin simulation.

The first activity is available under the right mouse button. The other activity can be started by double-clicking the task block.

8.1 Sub-task: Edit fixed data files and view Log-files

After pushing the right mouse button while the cursor is pointing to the task block the pop-up menu as shown in Figure 8.1 appears, you can carry out the following actions by selecting the menu items:

- View and edit various control data files. Selecting this menu items shows a new selection window of the various control data files (see Figure 8.2). Table 8.1 shows the names of the fixed files to be shown when selecting one of the menu items. Examples of the files are presented in the appendix E.
- View the log-message files of the various programs which have been executed under this task block. If the task block is coloured yellow after finishing various activities at this task block you can view the Log-files if errors have been detected and an error messages has been generated.
- View some help info.

Figure 8.1 Right mouse button pop-up menu at task block “River basin simulation”

The items contained in Table 8.1 are recorded in RIBASIM with a .dat format. If for example you want to change the default level of accuracy of the computation to a customized format, you can then change the values provided in the file by editing the default values provided (red rectangle in Figure 8.3).

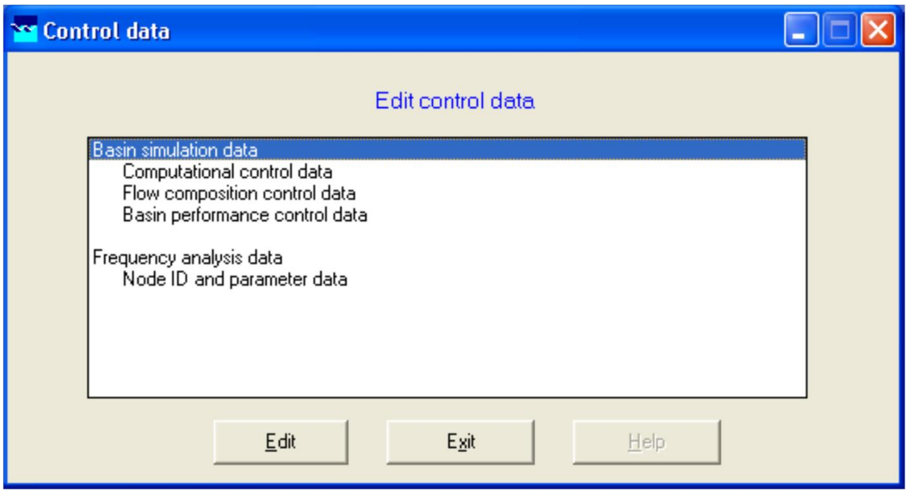


Figure 8.2 Screen for selection of the various control data to be editted

Table 8.1 Control data files for various components

Kind of control data	Description	Fixed model data file name
Computational	Basin simulation computational control data for basin simulation component (Simproc)	Simproc.dat
Flow composition	Definition of flow components for the default flow composition computation	FlowComp,dat
Basin performance	Basin performance parameter control data for post-processing components (Summary and Rib2His)	Summary.dat
Frequency analysis: Node ID and parameter data	List of variables for frequency interval analysis (see Table 8.2)	SelVrbl.dat

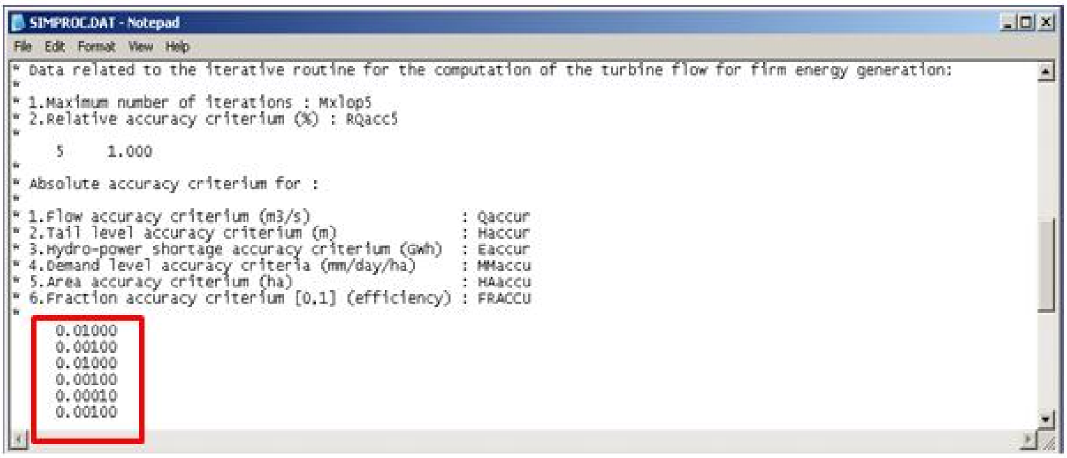


Figure 8.3 Location of input change for the absolute accuracy criterion (example)

Table 8.2 Overview of output variables per node type (unit is Mcm unless mentioned otherwise)

Node type	Variable index	Output variable
Variable inflow	1	Downstream flow
	2	Miscellaneous use consumption
	3	Shortage to miscellaneous use
	4	Variable inflow
	5	Upstream link flow of previous time step
	6	Potential virgin area (km^2)
	7	Actual virgin area (km^2)
	8	Total fixed irrigation node area in catchment (km^2)
	9	Total variable irrigation node area in catchment (km^2)
	10	Total advanced irrigation node area in catchment (km^2)
	11	Total fish pond node area in catchment (km^2)
	12	Total surface water reservoir area in catchment (km^2)
	13	Total link storage node area in catchment (km^2)
	14	Total groundwater district node area in catchment (km^2)
Fixed inflow	1	Downstream flow
	2	Fixed inflow
	3	Upstream link flow of previous time step
Confluence	1	Downstream flow
Terminal	1	End flow
Recording	1	Downstream flow
	2	Recorded flow
Reservoir	1	Flow into the reservoir
	2	Net evaporation
	3	Reservoir level at the end of the simulation time step (m)
	4	Reservoir volume at the end of the simulation time step
	5	Downstream flow
	6	Spillway flow
	7	Turbine flow
	8	Main gate flow
	9	Generated energy (GWh)
	10	Non-hydro target release
	11	Evaporation
	12	Rainfall
	13	Water surface area at end of simulation time step (m2)
	14	Seepage
	15	Firm energy release target
	16	Tailrace level (m)
	17	Head loss (m)
	18	Hydroelectric power generation efficiency (%)
	19	Net or effective head for hydro power generation (m)
	19+N	Substance concentration at end of time step with N = number of defined substances in water quality scenario.
Run-of-river	1	Flow into the run-of-river node
	2	Generated energy (GWh)
	3	Spilling flow
	4	Tailrace level (m)
	5	Head loss (m)
	6	Hydroelectric power generation efficiency (%)
	7	Net or effective head for hydro power generation (m)
Diversion	1	Target diverted flow
	2	Allocated diverted flow
	3	Downstream flow

Node type	Variable index	Output variable
	4	Upstream link flow
Low flow	1	Realized downstream flow
	2	Minimum flow requirement
Public water supply	1	Demand
	2	Shortage
	3	Return flow to surface water
	4	Downstream flow
	5	Allocated surface water
	6	Allocated groundwater
	7	Return flow to groundwater
Fixed irrigation	1	Target flow
	2	Shortage (Target flow - Allocated flow)
	3	Consumed (Allocated flow - return flow)
	4	Return flow to surface water
	5	Downstream flow
	6	Allocated surface water
	7	Allocated groundwater
	8	Return flow to groundwater
	8+N	Substance balance at end of time step with N = number of defined substances in water quality scenario.
Variable irrigation	1	Target flow from network
	2	Shortage (Target flow - Allocated flow)
	3	Consumed (Water from rainfall and surface water=Effective rainfall + allocated flow from network)
	4	Rainfall (mm/day)
	5	Return flow (Part from surface water supply and part from rainfall)
	6	Downstream flow
	7	Rainfall "inflow" (Total rainfall on irrigated area)
	8	Field water requirements
	9	Field water allocation from network and rainfall
	10	Allocated surface water
	11	Allocated groundwater
	12	Irrigated area (ha)
	13	Return flow to groundwater
	14	Surplus rainfall to surface water
	15	Expected rainfall
	16	Surplus rainfall to groundwater
	17	Net groundwater allocation
	18	Effective rainfall
	18+N	Substance balance at end of time step with N = number of defined substances in water quality scenario.
Loss flow	1	Downstream flow
	2	Allocated loss flow (to groundwater)
	3	Desired loss flow
Fishpond	1	Gross demand based on conveyance efficiency of last source type
	2	Allocated Gross shortage based on conveyance efficiency of last source type
	3	Consumed flow (= total allocated flow - return flow)
	4	Downstream flow
	5	Return flow to surface water
	6	Allocated surface water
	7	Allocated groundwater

Node type	Variable index	Output variable
	8	Net supply from surface water
	9	Net supply from groundwater
	10	Return flow to groundwater
	11	Evaporation
	12	Rainfall
	13	Net demand for flushing
	14	Net spilling
	15	Fish pond area (ha)
Groundwater reservoir	1	Depth at end of time step (m)
	2	Volume at end of time step
	3	Direct return flow from users
	3+N	Substance concentration end of time step with N = number of defined substances in water quality scenario.
Bifurcation	1	Target flow in downstream link 1 (surface water flow link)
	2	Target flow in downstream link 2 (bifurcated flow link))
	3	Downstream flow in downstream link 1 ((surface water flow link)
	4	Downstream flow in downstream link 2 (bifurcated flow link)
	5	Upstream link flow
Pumping	1	Downstream flow
	2	Pumping energy (GWh)
General district	1	District demand flow
	2	Allocated flow
	3	Shortage flow
	4	District discharge flow
	5	Downstream flow
	6	Allocated surface water
	7	Allocated groundwater
Groundwater district	1	PWS: Demand
	2	PWS: Demand from surface water
	3	PWS: Allocated water from surface water
	4	PWS: Allocated water from groundwater
	5	PWS: Return flow to surface water
	6	NIR: Rainfall on non-irrigated area
	7	NIR: Soil moisture storage at the end of time step
	8	NIR: Soil moisture level at the end of the time step (mm)
	9	NIR: Evaporation from non-irrigated area
	10	NIR: Flow from soil moisture to surface water
	11	NIR: Percolation from soil moisture to groundwater
	12	NIR: Runoff from soil moisture to surface water (caused by saturated soil moisture)
	13	IRR: Desired net demand for irrigated area
	14	IRR: Rainfall on irrigated area
	15	IRR: Return flow from rainfall to
	16	IRR: Return flow from rainfall to groundwater
	17	IRR: Effective rainfall
	18	IRR: Desired gross demand for irrigated area from surface water
	19	IRR: Allocated flow for irrigated area from surface water
	20	IRR: Return flow from irrigated surface water-flow to surface water
	21	IRR: Return flow from irrigated surface water-flow to groundwater
	22	IRR: Allocated flow for irrigated area from groundwater
	23	IRR: Return flow from irrigated groundwater-flow to surface water
	24	IRR: Return flow from irrigated groundwater-flow to groundwater
	25	GW: Fixed inflow to groundwater from neighbouring layers
	26	GW: Variable inflow to groundwater from neighbouring layers

Node type	Variable index	Output variable
	27	GW: Groundwater-storage at the end of time step
	28	GW: Groundwater-level at the end of time step (m)
	29	GW: Internal drainage from GWh to surface water
	30	GW: External drainage from groundwater to surface water
	31	GW: Forced drainage from groundwater to surface water (caused by full groundwater storage)
	32	GW: Accumulated rainfall of last time steps (mm)
	33	Used energy for paws pumping (GWh)
	34	Used energy for irrigated area pumping (GWh)
	35	Downstream flow
	36	Field water allocation from rainfall, surface water and groundwater
Link storage	1	Target downstream flow
	2	Target upstream flow
	3	Downstream flow
	4	Volume at end of time step
	5	Rainfall
	6	Evaporation
	7	Soil moisture recharge
	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+N	Substance concentration at end of time step with N = number of defined substances in water quality scenario.
Reservoir partition	1	Net evaporation
	2	Reservoir level at the end of the simulation time step (m)
	3	Reservoir volume at the end of the simulation time step
	4	Downstream flow
	5	Evaporation
	6	Rainfall
	7	Water surface area at end of simulation time step (m2)
	8	Seepage
Advanced irrigation	1	Demand
	2	Allocated surface water
	3	Allocated groundwater
	4	Return flow to surface water
	5	Downstream flow
	6	Return flow to groundwater
	6+N	Substance balance at end of time step with N = number of defined substances in water quality scenario.
Waste water treatment plant	1	Downstream flow
Natural retention	1	Downstream flow

8.2 Sub-task: Execute the river basin simulation

If you activate this task the actual river basin simulation is executed. This simulation is defined by:

- the hydrological time series and water quality look-up tables in the scenario directories which you selected at task "*Select hydrological and water quality scenario*";
- the simulation time period and the control switches which you have specified at task "*Specify simulation control data*"; and
- the network, the model data incl. crop plan and the source priority list which you have created at task "*Edit network and data base on map*".

Some progress messages appear on the screen e.g. at each simulation time step. After the simulation several post-processing programs with the following purpose are available:

- Prepare a table with the overall average annual river basin water balance over the whole simulation period (component RIBALANS).
- Prepare a table with the flows in the links for each time step (component DISCHRG).
- Prepare summary tables with the basin performance parameters of all demand nodes and hydro-power generation nodes (component SUMMARY).
- Carry out a frequency interval analysis for the selected variables specified in the frequency control data file (see previous chapter, file SelVrbl.dat) (component FREQINT).
- Prepare a history output time series file (his-file) for each node- and link type and for the overall river basin water balance over the whole simulation period to be used for presentation purpose on map and graph and or the export of results (component RIB2HIS). The graphical Delft tools NETTER and ODS_VIEW use these files as input files for the presentation of the simulation results.

Remarks

If the task block stays yellow then an error has been detected. You must push the right mouse button and check the error message at the bottom of the Log-files. If you get error messages during the simulation, it is likely that the values in the time series files, look-up table files or your model data files especially the fixed data files, which you have prepared manually, are not correct. In that case you must check the format of the files (see appendix E, F and G). A first check is to view all tables with model data in the menu item task "View tables of data base".

9 Task: Analysis of basin simulation results

The selection of this task will open a menu window as shown in Figure 9.1. You can analyze the results:

- From map using the Delft tool component NETTER.
- From charts and export results using the Delft tool component ODS_VIEW.
- In standard generated reports.

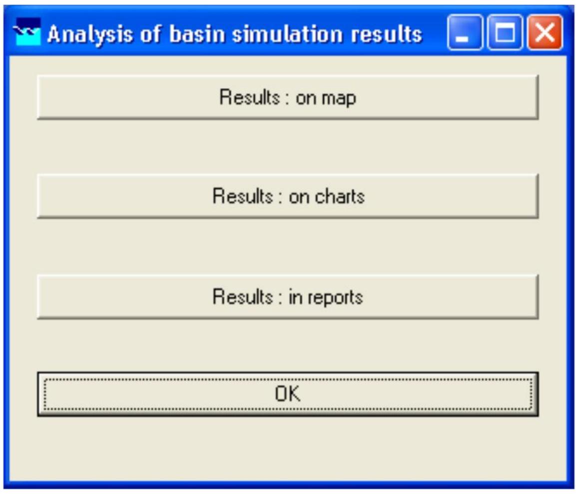


Figure 9.1 Menu window for the analysis of simulation results

9.1 Sub-task: Analyse simulation results on map

Under this selection a map of the basin is shown with the basin schematization. Here you can explore links and nodes results on the map. The link flows (m3/s) are shown by default. You can move to node type information by selecting the node type from the left menu options on the screen as shown in Figure 9.2. By opting for a different selection from the left menu, the item displayed in the View Data window will automatically change, and you can select the parameter that you want to assess by using the drop down list available from the window.

Should you wish to produce graphs of the data being shown, first select the type of node or link you want to explore, then the parameter to be measured for the link/node type, and eventually in the map point to the node(s) or link(s) you are interested in. RIBASIM will produce a graphical overview of the behaviour of the identified parameters only for those nodes you have selected.

The program NETTER is used for the graphical representation of results. .

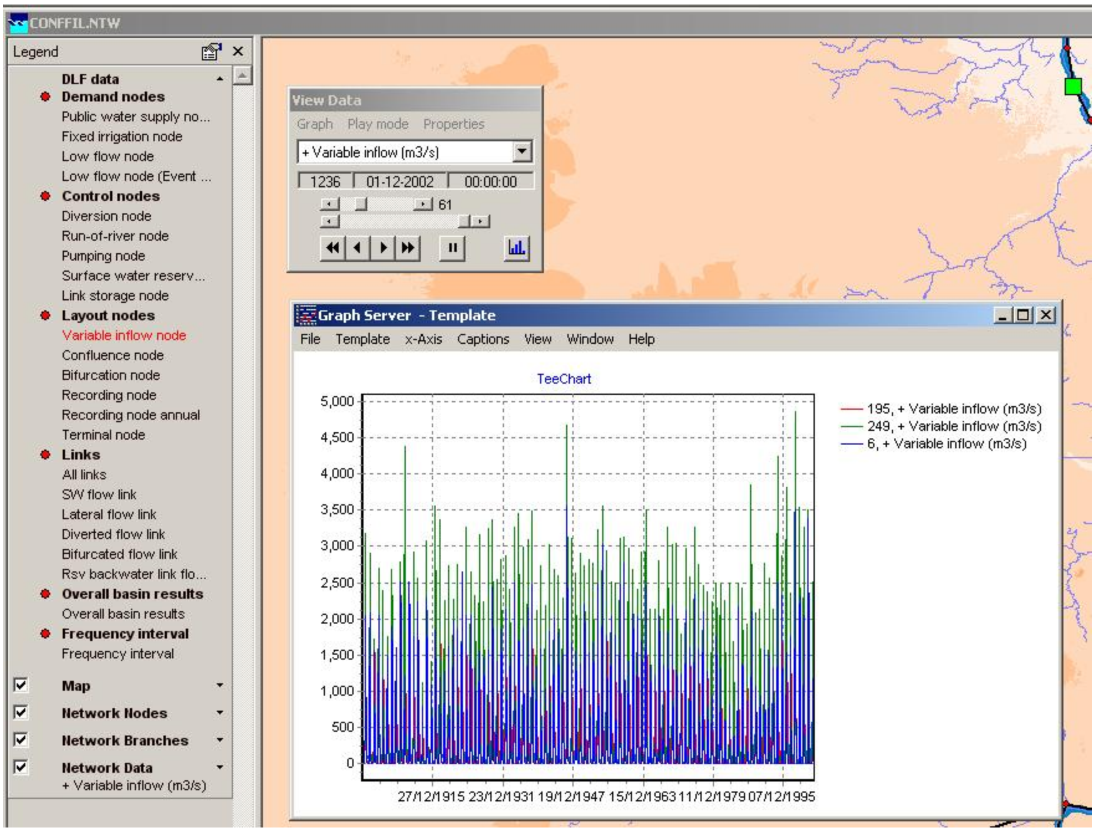


Figure 9.2 Overview of left menu selection options for Results on Map

Remarks

- An elegant facility that NETTER offers is to carry out an animation of the flow in the network (see Figure 9.3). With the selection set on the Link type option, select the following menu options "*Options*", "*Options*", "*Data*" and set the "*Show branch data*" options "*Colour*" off and "*Width*" on. The size of flow is shown as the width of the links. You can browse through the simulation period by moving the time bar at the “View data window”.
- When you select a link of the network on the map the “Graph button will appear. Selecting this button will generate a graph of the flow is shown in Figure 9.3 and Figure 9.4.
- You can show node and link results on the map. There are 2 ways:
  - Via the top screen menu: select menu items “File” and “Open data”. You will get a pop-up window (see Figure 9.5) with an overview of the type of nodes and links in your network schematization. The simulation results of the selected node type or link type are shown on the map.
  - Via the active legend: You can switch on the active legend under the menu option “Option” and “Active legend”. From the active legend you can directly access the result of the node type and link type as shown in Figure 9.6.
- The parameters per node and link type are outlined in Table 9.1, Table 9.2, Table 9.3 and Table 9.4.
- You can also generate an animation video file using the three video buttons at the top of the screen (see Figure 9.6) as follows:
  - Define in your own directory an Avi-file and select a compressor (advisable is the MicroSoft Video 1).

- Switch on the recorder: screen dumps are written to the Avi-file each time that you browse through the simulation period.
- Switch off the recorder.

The generated Avi-file can be used directly for presentation and demonstration.

- All simulation results are shown in graphs starting at the first of the month.
- The flows refer to “flow over the simulation time step” and storage results e.g. surface water reservoir storage and level refer to the “end of the time step”.
  There is one exception on the above item for the computed flows in the links (file Tak.His). These results are shifted one time step which means that the flows are shown at the “end of the time step” (beginning of next time step). This is needed for the flow composition computation simulation using the DELWAQ model.
- Tool at model calibration. When you want to compare a certain monitored time series with a time series computed by RIBASIM e.g. reservoir levels or flows, then the graph server provides a nice feature. A requirement is that you store your monitored data as a defined table in a Ms Excel file. Under Ms Excel you define a table with the menu options “Insert”, “Name” and “Define”. The table is a certain selection of your spreadsheet with the first column as format “Date” and the other columns as your monitoring data. Further the first row contains the name for each column. Then under the RIBASIM graph server perform the following actions:
  - Add new graph e.g. line graph under “Chart” and “Series”.
  - Select one after another “Series”, “Data Source”, “ODBC Database”, “New”, “Data Source”, “Excel files” and select your prepared Ms Excel file with monitoring data. Then select as X column the “Date” formatted column and Y column e.g. the column with reservoir levels named “S-level”. Then you get a nice graph with the combined monitoring data and model results while the dates are scheduled.
  - You can save the whole graph including the data in a file with file type Tee.

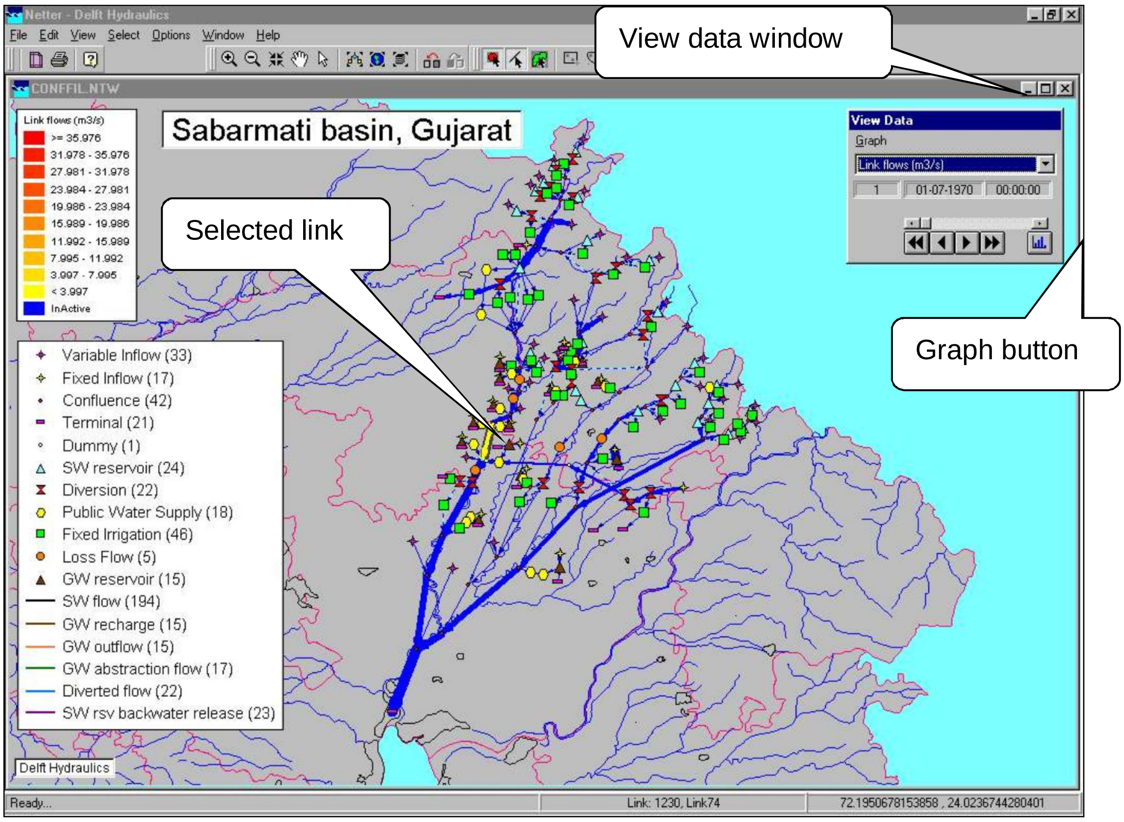


Figure 9.3 Animation of the flow in the basin and selection of link for showing graph

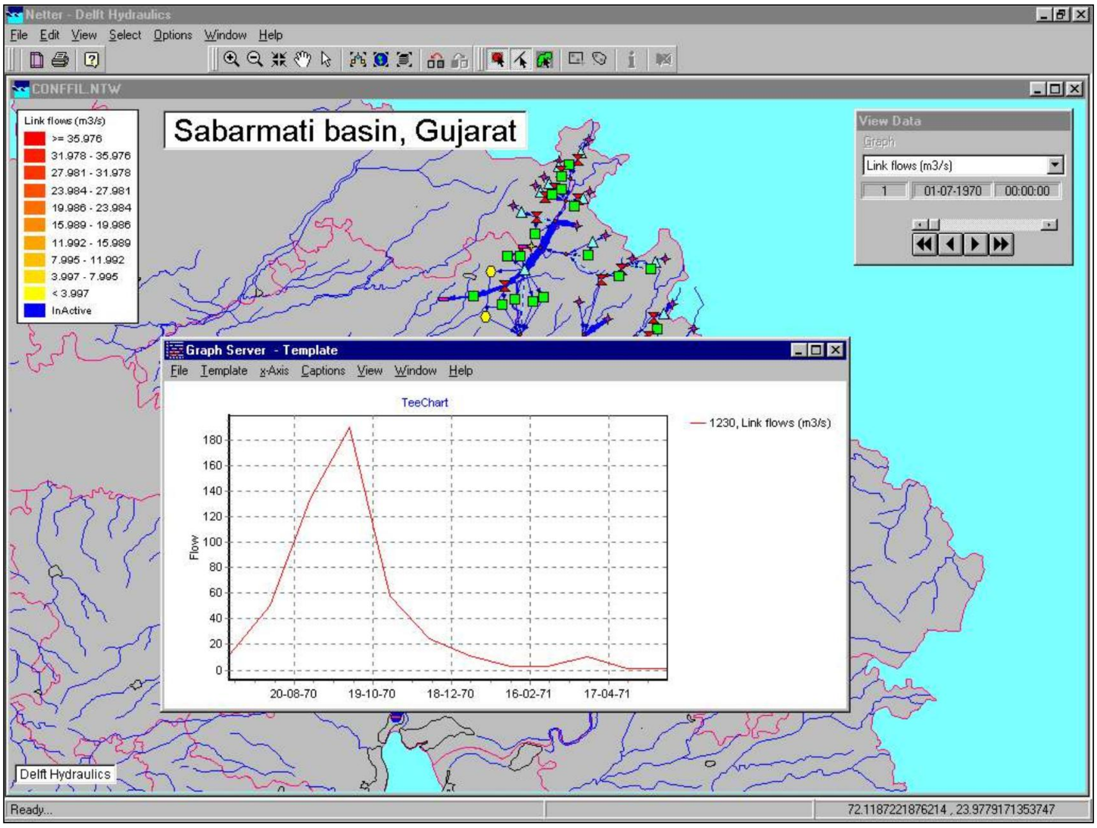


Figure 9.4 Graph of the flow in a selected link

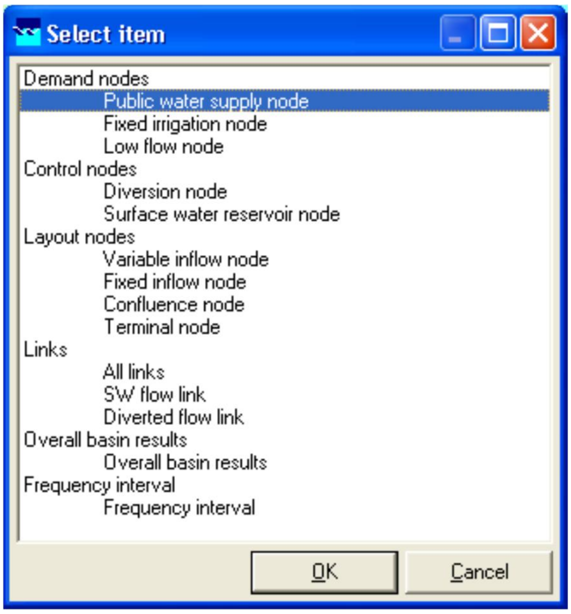


Figure 9.5 Overview of node and link types for which the results can be shown on the map

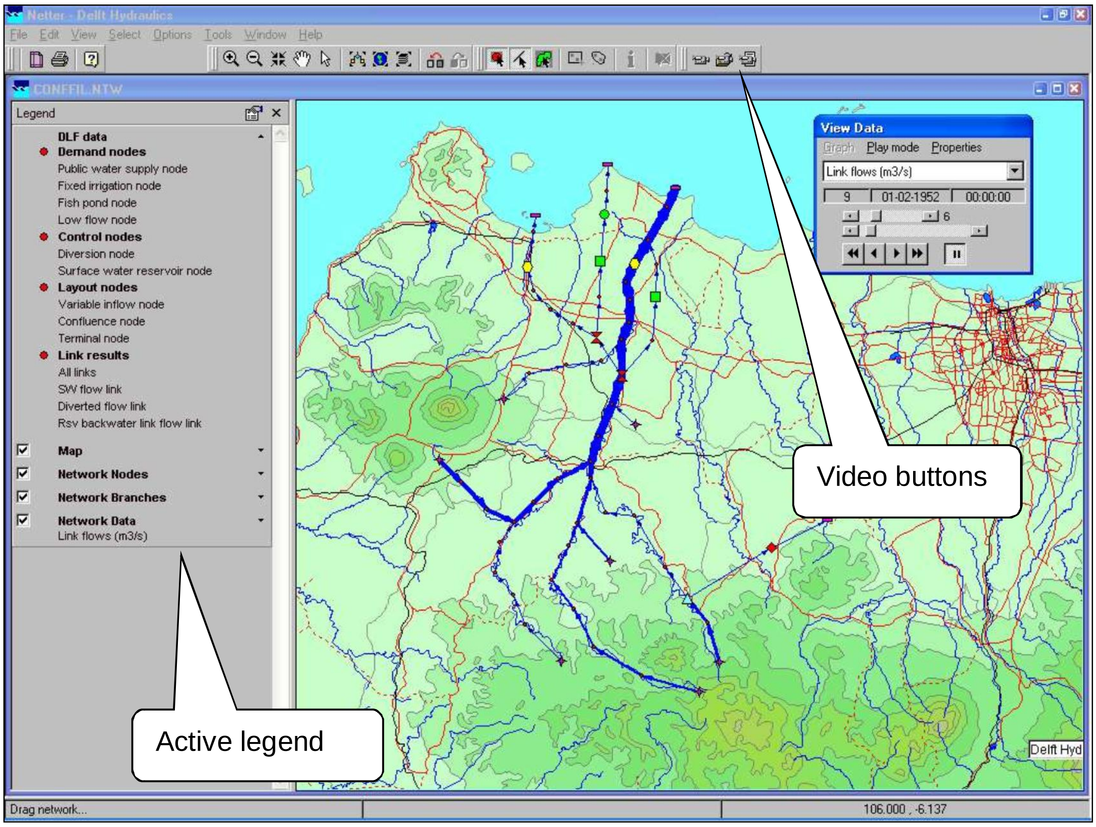


Figure 9.6 Active legend and video recording options

9.2 Sub-task: Analyse results on charts

Under this button a menu is shown with all type of results:

- Demand nodes, result parameters are shown in Table 9.1
- Control nodes, result parameters are shown in Table 9.2
- Layout nodes, result parameters are shown in Table 9.3
- Links, result parameters are shown in Table 9.4
- Agriculture, result parameters are shown in Table 9.5
- Overall basin results, result parameters are shown in Table 9.6
- Frequency interval, result parameters are shown in Table 9.7

If you select one of the results then the graphics and export tool ODS_VIEW is activated with which you can prepare any kind of graph and export data into a desired format. ODS_VIEW works on the result files with file type “his”. The time step indication in the “his”-file is the first day of the time step.

If the simulation is executed on a daily basis then:

- a daily time series file is generated with link flows, named Dlylink.His.
- a daily time series file, named DlyQrcrd.Tms (in Tms-file format), is generated with the flow at each recording node. This file can be used as a hydrological flow time series file e.g. for a variable inflow or low flow node.

If the simulation is carried with a user defined or default flow composition computation then for each link a flow composition graph can be produced. The various flow components are parameters in the results file for all links, see Table 9.4. Figure 9.8 shows 2 example stacked area graphs representing the flow composition at two locations.

Figure 9.9 and Figure 9.10 show the overall river basin water balance over time in a stacked area graph. In Table 9.6 the various overall basin parameters are outlined. The sum of all sources is equal to the sum of all use of water. Figure 9.11 shows an example graph of the frequency analysis.

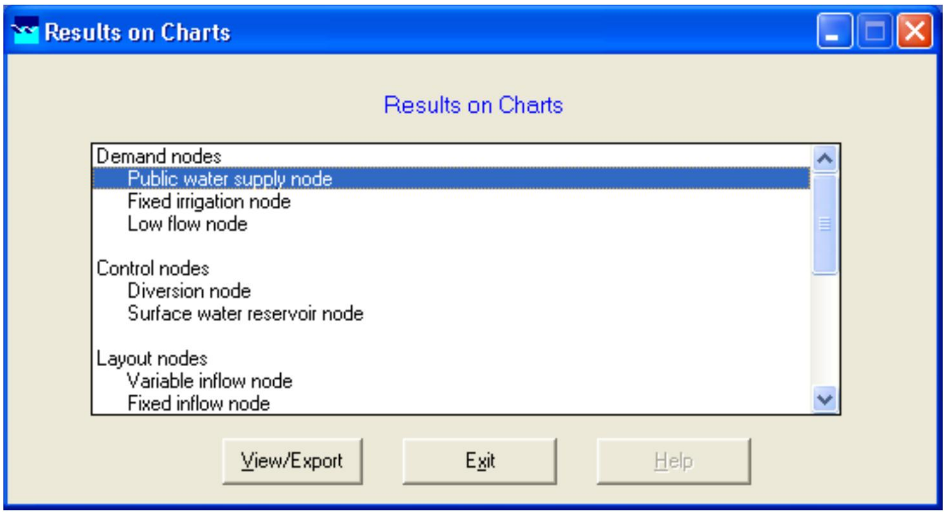


Figure 9.7 Screen for selection of the node types, link types, overall basin or frequency interval results

Table 9.1 Result parameters of the demand nodes

Demand node (file name)	**Index**	**Parameter**	**Unit**
Public water supply (Pwsupply.His)	1	Supply	m3/s
	2	Demand	m3/s
	3	Supply-Demand ratio	%
	4	Downstream flow	m3/s
	5	Shortage	m3/s
	6	Number of time steps with shortage (# of time steps)	-
	7	Number of time steps with shortage	%
	8	- Return flow to surface water	m3/s
	9	Population	-
	10	+ Allocated surface water	m3/s
	11	+ Allocated groundwater	m3/s
	12	- Return flow to groundwater	m3/s
	13	- Consumed flow	m3/s
	14	Balance check (must be 0.0)	m3/s
Fixed irrigation (Fixirrig.His)	1	Supply	m3/s
	2	Demand	m3/s
	3	Supply-Demand ratio	%
	4	- Return flow to surface water	m3/s
	5	Downstream flow	m3/s
	6	Shortage	m3/s
	7	Number of time steps with shortage (# of time steps)	-
	8	Number of time steps with shortage	%
	9	+ Allocated surface water	m3/s
	10	+ Allocated groundwater	m3/s
	11	Irrigated area	ha
	12	- Return flow to groundwater	m3/s
	13	- Consumed flow	m3/s
	14	Balance check (must be 0.0)	m3/s
	14+N	Substance balance at end of time step with N = number of defined substances in water quality scenario.	-
Variable irrigation (Varirrig.His)	1	Supply from network	m3/s
	2	Demand from network	m3/s
	3	Supply-Demand ratio	%
	4	Rainfall	mm/day
	5	Total return flow (to surface and groundwater)	m3/s
	6	Downstream flow	m3/s
	7	Net +: Crop water requirements	mm/day
	8	Net -: Effective surface water allocation	mm/day
	9	Shortage	m3/s
	10	Number of time steps with shortage (# of time steps)	-
	11	Number of time steps with shortage	%
	12	+ Allocated surface water	m3/s
	13	+ Allocated groundwater	m3/s
	14	Irrigated area	ha
	15	+ Total rainfall	m3/s
	16	- Effective rainfall	m3/s
	17	- Surplus rainfall to surface water	m3/s
	18	Expected rainfall	mm/day
	19	Rainfall effectiveness	%
	20	- Return flow to surface water excl. R surplus	m3/s
	21	- Return flow to groundwater excl. R surplus	m3/s
	22	- Surplus rainfall to groundwater	m3/s
	23	- Effective supply from surface and groundwater	m3/s
	24	- Other consumed water from surface and groundwater	m3/s
	25	- Surplus rainfall to other	m3/s

Demand node (file name)	Index	Parameter	Unit
	26	Balance check gross (must be 0.0)	m3/s
	27	Net -: Effective groundwater allocation	mm/day
	28	Net -: Effective rainfall	mm/day
	29	Net -: Shortage	mm/day
	30	Balance check net (must be 0.0)	mm/day
	30+N	Substance balance at end of time step with N = number of defined substances in water quality scenario.	-
Advanced irrigation (Advirrig.His)	1	Supply from network	m3/s
	2	Demand from network	m3/s
	3	Supply-Demand ratio	%
	4	Downstream flow	m3/s
	5	Shortage	m3/s
	6	Number of time steps with shortage (# of time steps)	-
	7	Number of time steps with shortage	%
	8	- Return flow to surface water	m3/s
	9	+ Allocated surface water	m3/s
	10	+ Allocated groundwater	m3/s
	11	- Return flow to groundwater	m3/s
	12	- Consumed flow	m3/s
	13	+ Rainfall	m3/s
	14	Balance check (must be 0.0)	m3/s
	14+N	Substance balance at end of time step with N = number of defined substances in water quality scenario.	-
Fish pond (Fishpond.His)	1	Supply	m3/s
	2	Demand	m3/s
	3	Supply-Demand ratio	%
	4	Downstream flow	m3/s
	5	- Return flow to surface water	m3/s
	6	Shortage	m3/2
	7	Number of time steps with shortage (# of time steps)	-
	8	Number of time steps with shortage	%
	9	+ Allocated surface water	m3/s
	10	+ Allocated groundwater	m3/s
	11	Fish pond area	ha
	12	- Return flow to groundwater	m3/s
	13	- Evaporation	m3/s
	14	+ Rainfall	m3/s
	15	Balance check gross (must be 0.0)	m3/s
	16	Net + Allocated surface water	mm/day
	17	Net + Allocated groundwater	mm/day
	18	Net + Rainfall	mm/day
	19	Net - Actual flushing	mm/day
	20	Net - Evaporation	mm/day
	21	Net - Spilling	mm/day
	22	Flushing requirements	mm/day
	23	Net + Storage reduction	mm/day
	24	+ Storage reduction	m3/s
	25	Balance check net (must be 0.0)	mm/day
Low flow (Lowflow.His)	1	Demand flow	m3/s
	2	Realised flow	m3/s
	3	Supply - demand ratio	%
	4	Shortage	m3/s
	5	# times shortage (# of time steps)	-
	6	# times shortage	%
		EF:length of event occurrence window	# of tmst

Demand node (file name)	Index	Parameter	Unit
		EF:length per. since last demand year	# of tmst
		EF:demand year switch (0/1)	-
		For each low flow node which applies the event driven flushing procedure the following output parameters are generated for each year:	
		EF total demand	Mcm
		EF total allocated flow	Mcm
		EF supply - demand ratio	-
Loss flow	1	Supply	m3/s
(Lossflow.His)	2	Demand	m3/s
	3	Supply - demand ratio	%
	4	Downstream link flow	m3/s
	5	Shortage	m3/s
	6	# times shortage (# of time steps)	-
	7	# times shortage	%
General district	1	Surface water supply	m3/s
(Gnrldist.His)	2	Demand	m3/s
	3	Supply - demand ratio	%
	4	Discharge	m3/s
	5	Downstream link flow	m3/s
	6	Shortage	m3/s
	7	# times shortage (# of time steps)	-
	8	# times shortage	%
	9	Allocated surface water	m3/s
	10	Allocated groundwater	m3/s
Groundwater district	1	Total surface water supply	m3/s
(Grwdist.His)	2	Total surface water demand	m3/s
	3	Surface water supply-demand ratio	%
	4	PWS surface and groundwater supply	m3/s
	5	PWS surface and groundwater demand	m3/s
	6	PWS surface and groundwater ratio	%
	7	Irr. surface and groundwater supply	m3/s
	8	Irr. surface and groundwater demand	m3/s
	9	Irr. surface and groundwater ratio	%
	10	PWS consumed pump energy	GWh
	11	Irr. consumed pump energy	GWh
	12	Downstream link flow	m3/s
		Public water supply	
	13	PWS desired demand	m3/s
	14	PWS desired demand from surface water	m3/s
	15	PWS desired demand from groundwater	m3/s
	16	PWS allocated water from surface water	m3/s
	17	PWS allocated water from groundwater	m3/s
	18	PWS return flow	m3/s
		Non-irrigated area	
	19	NIR rainfall	m3/s
	20	NIR soil moisture storage	Mcm
	21	NIR soil moisture level	mm
	22	NIR evaporation	m3/s
	23	NIR flow from soil moisture to surface water	m3/s
	24	NIR flow from soil moisture to groundwater	m3/s
	25	NIR runoff soil moisture to surface water	m3/s

Demand node (file name)	Index	Parameter	Unit
		Irrigated area	
	26	IRR field water requirements	m3/s
	27	IRR rainfall	m3/s
	28	IRR flow from rain to surface water	m3./s
	29	IRR flow from rain to groundwater	m3/s
	30	IRR effective rainfall	m3/s
	31	IRR demand from surface water	m3/s
	32	IRR allocated water from surface water	m3/s
	33	IRR return flow from surface water allocation to surface water	m3/s
	34	IRR return flow from surface water allocation to groundwater	m3/s
	35	IRR allocated water from groundwater	m3/s
	36	IRR return flow from groundwater allocation to surface water	m3/s
	37	IRR return flow from groundwater allocation to groundwater	m3/s
	38	IRR field water consumption aquifer	m3/s
	39	GW fixed flow from neighbouring layers	m3/s
	40	GW variable flow from neighbouring layers	m3/s
	41	GW storage at end of time step	Mcm
	42	GW level at end of time step	m
	43	GW internal drainage	m3/s
	44	GW external drainage	m3/s
	45	GW forced drainage	m3/s
	46	GW accumulated rainfall of last 3 time steps	mm
		Public water supply	
	47	PWS Shortage	m3/s
	48	PWS # of time steps with water shortage	-
	49	PWS # of time steps with water shortage	%
		Irrigated area	
	50	Irr.Shortage	m3/s
	51	Irr.# of time steps with water shortage (# of time steps)	-
	52	Irr.# of time steps with water shortage	%

Remarks

- The ‘# of times shortage’ is the number of times that there was a water shortage for each time step within the year. If you make a graph of this parameter for the last whole year of the simulation period you get a graph over the one-year period with for each time step the number of times that there was shortage during the whole simulation period. The number of times with shortage can be maximal the number of simulated years. A water shortage is defined if the difference between demand and supply is bigger than the margin defined in the fixed data file Summary.Dat.
- The + and – characters before the parameter name indicate that it relates to an incoming (+) or outgoing (-) water balance component of the node.
- The parameter “Balance check (must be 0.0)” must be equal to 0.0 else some computational errors had occurred.

Table 9.2 Result parameters of the control nodes

Control node (file name)	Index	Parameter	Unit
Bifurcation (Bifurcat.His)	1	Target flow in link 1	m3/s
	2	Target flow in link 2	m3/s
	3	Downstream flow in link 1	m3/s
	4	Downstream flow in link 2	m3/s
	5	Upstream link flow	m3/s
Diversion (Diversn.His)	1	Upstream flow	m3/s
Run-of-river (Runofrvr.His)	1	+ Downstream flow	m3/s
	2	- Turbine flow	m3/s
	3	- Spillway flow	m3/s
	4	Generated energy	GWh
	5	Tailrace level	m
	6	Head loss	m
	7	Power generation efficiency	%
	9	Power generation nethead	m
Pumping (Pumping.His)	1	Downstream flow	m3/s
	2	Consumed pumping energy	MWh
Groundwater reservoir (Gwresvr.His)	1	Depth at end of time step	m
	2	Volume at end of time step	Mcm
	3	Shallowest groundwater depth	m
	4	Full groundwater storage	Mcm
	5	Dead storage level	m
	6	Dead storage	Mcm
	7	Recharge flow	m3/s
	8	Outflow	m3/s
	9	Sum of abstractions	m3/s
	10	Sum of lateral flows	m3/s
	11	+ GW recharge flow	Mcm
	12	+ Return flow from users previous time step	Mcm
	13	+ Sum lateral inflows	Mcm
	14	+ Decrease of storage	Mcm
	15	- Base outflow	Mcm
	16	- Spilling outflow	Mcm
	17	- Sum abstractions	Mcm
	18	- Sum lateral outflows	Mcm
	19	- Increase of storage	Mcm
	20	Balance check (must be 0.0)	Mcm
	20+N	Substance concentration at the end of the time step with N = number of defined substances in water quality scenario.	-
Surface water reservoir partition (Rsvrpart.His)	1	Net evaporation	m3/s
	2	Level at end of time step	m
	3	Volume at end of tim estep	Mcm
	4	Downstream flow	m3/s
	5	Evaporation	m3/s
	6	Rainfall	m3/s
	7	Surface area at end of time step	ha
	8	Seepage	m3/s
Link storage (Linkstor.His)	1	Rainfall	m3/s
	2	Evaporation	m3/s
	3	Average water depth	m
	4	Volume at end of time step	Mcm
	5	Downstream flow	m3/s

Control node (file name)	Index	Parameter	Unit
	6	Soil moisture recharge	m3/s
	7	Surface area	ha
	8	Average width	m
	9	Average cross sectional area	m2
	10	Wb: + Flow into link	Mcm
	11	Wb: + Rainfall	Mcm
	12	Wb: + Sum lateral inflows	Mcm
	13	Wb: + Decrease of storage	Mcm
	14	Wb: - Evaporation	Mcm
	15	Wb: - Soil moisture recharge	Mcm
	16	Wb: - Flow outof link	Mcm
	17	Wb: - Sum lateral outflows	Mcm
	18	Wb: - Increase of storage	Mcm
	19	Balance check (must be 0.0)	Mcm
	19+N	Substance concentration at the end of the time step with N = number of defined substances in water quality scenario.	-
Natural retention (NatReten.His)	1	Downstream flow	m3/s
Surface water reservoir (Reservoi.his)	1	Flow: into reservoir	m3/s
	2	Flow: net evaporation	m3/s
	3	Flow: evaporation	m3/s
	4	Flow: rainfall	m3/s
	5	Flow: seepage	m3/s
	6	Flow: downstream	m3/s
	7	Flow: downstream target	m3/s
	8	Flow: full reservoir spilling	m3/s
	9	Flow: turbine	m3/s
	10	Flow: main gate	m3/s
	11	Flow: backwater gate 1	m3/s
	12	Flow: backwater gate 2	m3/s
	13	Flow: backwater gate 3	m3/s
	14	Flow: backwater gate 4	m3/s
	15	Flow: backwater gate 5	m3/s
	16	Level: actual at end of time step	m
	17	Level: full reservoir	m
	18	Level: flood control	m
	19	Level: target	m
	20	Level: turbine intake	m
	21	Level: backwater gate 1	m
	22	Level: backwater gate 2	m
	23	Level: backwater gate 3	m
	24	Level: backwater gate 4	m
	25	Level: backwater gate 5	m
	26	Level: firm	m
	27	Level: hedging 1	m
	28	Level: hedging 2	m
	29	Level: hedging 3	m
	30	Level: hedging 4	m
	31	Level: hedging 5	m
	32	Level: dead	m
	33	Storage: actual at end of time step	Mcm

Control node (file name)	**Index**	**Parameter**	**Unit**
	34	Storage: full reservoir	Mcm
	35	Storage: flood control	Mcm
	36	Storage: target	Mcm
	37	Storage: turbine intake	Mcm
	38	Storage: backwater gate 1	Mcm
	39	Storage: backwater gate 2	Mcm
	40	Storage: backwater gate 3	Mcm
	41	Storage: backwater gate 4	Mcm
	42	Storage: backwater gate 5	Mcm
	43	Storage: firm	Mcm
	44	Storage: hedging 1	Mcm
	45	Storage: hedging 2	Mcm
	46	Storage: hedging 3	Mcm
	47	Storage: hedging 4	Mcm
	48	Storage: hedging 5	Mcm
	49	Storage: dead	Mcm
	50	Storage: Filling percentage	%
	51	Area: Surface at end of time step	ha
	52	Energy: Generated	GWh
	53	Energy: Firm demand	GWh
	54	Energy: Firm shortage	GWh
	55	Energy: Firm production-Demand ratio	%
	56	Energy: Number of time steps with firm shortage (# of time	-
	57	steps)	%
	58	Energy: Number of time steps with firm shortage	m
	59	Energy: Tailrace level	m
	60	Energy: Tail head loss	m
	61	Energy: Power generation nethead	%
	62	Energy: Power generation efficiency	m3/s
	63	Flow: Sum of backwater gate flows	m3/s
	64	Flow: Sum of lateral inflows	m3/s
	65	Flow: Sum of lateral outflows	Mcm
	66	Wb: + Flow into reservoir	Mcm
	67	Wb: + Rainfall	Mcm
	68	Wb: + Sum lateral inflows	Mcm
	69	Wb: + Decrease of storage	Mcm
	70	Wb: - Evaporation	Mcm
	71	Wb: - Seepage	Mcm
	72	Wb: - Main gate	Mcm
	73	Wb: - Turbine	Mcm
	74	Wb: - Full reservoir spilling	Mcm
	75	Wb: - Sum backwater gate flows	Mcm
	76	Wb: - Sum lateral outflows	Mcm
	77	Wb: - Increase of storage	Mcm
	77+N	Balance check (must be 0.0)	-
		Substance concentration at the end of the time step with N = number of defined substances in water quality scenario.	
Waste water treatment plant (WasteWtp.His)	1	Downstream flow	m3/s

Remarks

- The + and – characters before the parameter name indicate that it relates to an incoming (+) or outgoing (-) water balance component of the node.
- The parameter "Balance check (must be 0.0)" must be equal to 0.0 else some computational errors had occurred.

Table 9.3 Result parameter of the layout nodes

Layout node (file name)	Index	Parameter	Unit
Variable inflow	1	+ Variable inflow	m3/s
(Varinfl.His)	2	- Downstream flow	m3/s
	3	Desired miscel, consumption	m3/s
	4	- Actual miscel. consumption	m3/s
	5	Miscellaneous consumption ratio	%
	6	+ Upstr.link flow prev.time stp	m3/s
	7	Balance check (must be 0.0)	m3/s
	8	Area Potential virgin	km2
	9	Area Actual virgin	km2
	10	Area fixed irrigation	km2
	11	Area variable irrigation	km2
	12	Area advanced irrigation	km2
	13	Area fishpond	km2
	14	Area surface water reservoir	km2
	15	Area link storage	km2
	16	Area groundwater district	km2
	17	Downstream flow	mm/ts
	18	Downstream flow	mm/dy
		For each Sacramento model segment:	
		Sg1: Area Pot.	km2
		Sg1: Area Act.	km2
		Sg1: UZTWM Capacity upper zone tension water	mm
		Sg1: UZFWM Capacity upper zone free water	mm
		Sg1: LZTWM Capacity lower zone tension water	mm
		Sg1: LZFSM Capacity lower zone supplementary free water	mm
		Sg1: LZFPM Capacity lower zone primary free water	mm
		Sg1: UZTWC Content upper zone tension water	mm
		Sg1: UZFWC Content upper zone free water	mm
		Sg1: LZTWC Content lower zone tension water	mm
		Sg1: LZFSC Content lower zone supplementary free water	mm
		Sg1: LZFPC Content lower zone primary free water	mm
		Sg1: EDMND Potential evapotranspiration	mm
		Sg1: STOR Storage at end of time step	mm
		Sg1: ADIMC Contents of area which when saturated produces direct runoff and evaporation	mm
		Sg1: FLOBF Base flow	mm
		Sg1: FLOIN Interflow	mm
		Sg1: ROIMP Runoff from impervious or water-covered area	mm
		Sg1: SSOUTACT Actual subsurface outflow along stream channel	mm
		Sg1: Wb + PLIQ Rainfall	mm
		Sg1: Wb + Decrease of storage	mm
		Sg1: Wb - EUSED Actual evapotranspiration	mm

		Sg1: Wb - FLOBS Subsurface flow Sg1: Wb - QF Runoff Sg1: Wb - Increase of storage Sg1: Wb Balance check (must be 0.0)	mm mm mm
Fixed inflow (Fixinfl.His)	1 2 3 4	- Downstream flow + Fixed inflow + Upstream link flow previous time step Balance check (must be 0.0)	m3/s m3/s m3/s m3/s
Confluence (Confluen.His)	1	Downstream flow	m3/s
Recording (Dummy.His)	1 2	Simulated flow Monitored flow	m3/s m3/s
Recording annual (DumAvAnl.His)	1 2	Annual flow Delta annual flow : difference with the annual flow of the upstream recording node with lower order index.	Mcm Mcm
Terminal (Terminal.His)	1	End flow	m3/s

Remarks

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

Table 9.4 Result parameters of all link and per link type

Link types	***Index***	**Parameter description**	**Unit**
All link types (Tak.His)	1 1+N	Link flows Substance concentration at end of time step with N = number of defined substances in water quality scenario.	m3/s -
Bifurcated flow (Bifurclk.his)	1 2	Actual bifurcated flow Target bifurcated flow	m3/s m3/s
Diverted flow (DivertLk.his)	1 2	Actual diverted flow Target diverted flow	m3/s m3/s
Surface water flow (Swlink.his)	1	Flow	m3/s
Groundwater outflow (GwoutfLk.his)	1 2 3	Groundwater outflow Base outflow Spilling outflow	m3/s m3/s m3/s
Groundwater recharge (Gwrechlk.his)	1	Groundwater recharge flow	m3/s
Lateral flow (Gwltrllk.his)	1 2	Lateral flow Head difference	m3/s m
Groundwater abstraction flow *(Gwabstlk.his)*	1 2 3 4 5	Abstraction flow Target flow Maximum abstraction Pumping head Pumping energy	m3/s m3/s m3/s m GWh
Surface water reservoir backwater flow (Rsvbcklk.His)	1 2	Actual backwater flow Target flow	m3/s m3/s

Table 9.5 Agriculture result parameter related to Advanced irrigation node type

Agriculture results (file name)	Index	Parameter	Unit
Agriculture demand per advanced irrigation node (AirAgDmd.his)	1	Field crop water requirements	mm/day
	2	Field crop water requirements	l/s/ha
	3	Shortage per time step (# of time steps)	-
	4	Shortage per time step	%
	5	Supply-demand ratio	%
	6	Effective rainfall	Mcm
	7	Effective supply	Mcm
	8	Overall irrigation efficiency	%
	9	Area cultivated potential	ha
	10	+ Gross water supply	Mcm
	11	+ Actual rainfall	Mcm
	12	+ Decrease root zone soil moisture + field storage	Mcm
	13	- Actual evapotranspiration	Mcm
	14	- Drainage from fields	Mcm
	15	- Increase root zone soil moisture + field storage	Mcm
	16	- Actual percolation	Mcm
	17	Water balance term (must be 0.0 during growing.season)	Mcm
	18	Demand to network	m3/s
	19	Supply from network	m3/s
	20	Area cultivated actual	ha
	21	Rainfall effectiveness	%
Agriculture production per advanced irrigation node (AirAgPro.his) (1)	1	FB: Potential field level production	kg
	2	FB: Potential farm gate level prod.	kg
	3	FB: Potential field level production.	Mon.unit
	4	FB: Potential farm gate level production.	Mon.unit
	5	FB: Potential production costs	Mon.unit
	6	FB: Actual field level production.	kg
	7	FB: Actual farm gate level production.	kg
	8	FB: Actual field level production.	Mon.unit
	9	FB: Actual farm gate level production.	Mon.unit
	10	FB: Actual production costs	Mon.unit
	11	DL: Potential field level production.	kg
	12	DL: Potential farm gate level production.	kg
	13	DL: Potential field level production.	Mon.unit
	14	DL: Potential farm gate level production.	Mon.unit
	15	DL: Potential production costs	Mon.unit
	16	DL: Actual field level production	kg
	17	DL: Actual farm gate level production	kg
	18	DL: Actual field level production.	Mon.unit
	19	DL: Actual farm gate level production.	Mon.unit
	20	DL: Actual production costs	Mon.unit
	21	SM: Potential field level production.	kg
	22	SM: Potential farm gate level production.	kg
	23	SM: Potential field level production.	Mon.unit
	24	SM: Potential farm gate level production.	Mon.unit
	25	SM: Potential production costs	Mon.unit
	26	SM: Actual field level production.	kg
	27	SM: Actual farm gate level production.	kg
	28	SM: Actual field level production.	Mon.unit
	29	SM: Actual farm gate level production.	Mon.unit
	30	SM: Actual production costs	Mon.unit
Agriculture production per cultivation (CltAgPro.his) (1)	1	Pot.evapotranspiration	Mcm
	2	- Actual evapotranspiration	Mcm
	3	- Actual percolation	Mcm

	4	- Increase root zone soil moisture + field storage	Mcm
	5	Decrease root zone soil moisture + field storage	Mcm
	6	+ Actual rainfall	Mcm
	7	Survival fraction	-
	8	Cult.water balance term (must be 0.0 during grow.season)	Mcm
	9	Cultivation area	ha
	10	Potent.field level production	kg
	11	Potent.farm gate production	kg
	12	Potent.field level production	Mon.unit
	13	Potent.farm gate production	Mon.unit
	14	Potent.production costs	Mon.unit
	15	Actual field level production	kg
	16	Actual farm gate production	kg
	17	Actual field level production	Mon.unit
	18	Actual farm gate production	Mon.unit
	19	Actual production costs	Mon.unit

(1) FB refers to flood basin cultivations (rice),

DL refers to dry-land cultivations,

SM refers to the sum of flood basin and dry-land cultivations.

Table 9.6 Result parameters of the overall basin parameters (Mcm)

Sources of water (In)	**Use of water (Out)**
Fixed node inflow	End node outflow
Variable node inflow	Variable inflow miscellaneous consumption
Rainfall on surface water reservoir surface	Evaporation from reservoir surface
Delta surface water reservoir storage (-)	Delta surface water reservoir storage (+)
Rainfall in link storage nodes	Evaporation from links storage nodes
Delta storage in link storage node (-)	Delta link storage node (+)
Fixed irrigation excess return flow	Consumption in fixed irrigation
Rainfall in variable irrigation	Consumption in variable irrigation
Fish pond excess return flow	Consumption in fish pond node
General district node discharge	Consumption in general district node
Groundwater district surface water discharge	Groundwater district surface water consumption
Rainfall in reservoir partition node	Consumption in public water supply node
Delta reservoir partition node storage (-)	Consumption in loss flow node
Delta groundwater reservoir storage (-)	Evaporation in reservoir partition node
Advanced irrigation excess return flow	Delta reservoir partition node storage (+)
Groundwater reservoir inflow: return flows from previous time step	Delta groundwater reservoir storage (+)
	Consumption in advanced irrigation
	Link storage soil moisture recharge
	Return flow to groundwater from Public water supply
	Return flow to groundwater from fixed irrigation
	Return flow to groundwater from variable irrigation
	Return flow to groundwater from advanced irrigation
	Return flow to groundwater from fish pond node

Table 9.7 Result parameters of the frequency analysis

Description	***Index***	**Parameter description**	**Unit**
Number of values within the different frequency interval s (Freqint.His) (1)	1	<= 0%	-
	2	0% - 10%	-
	3	10% - 20%	-
	4	20% - 30%	-
	5	30% - 40%	-
	6	40% - 50%	-
	7	50% - 60%	-
	8	60% - 70%	-
	9	70% - 80%	-
	10	80% - 90%	-
	11	90% -100%	-
	12	> 100%	-

(1) The minimum (0%) and maximum interval (100%) is defined in the Frequency analysis control data file "SelVrbl.dat" or is determined by the program as the minimum and maximum value of the parameter over the whole simulation period.

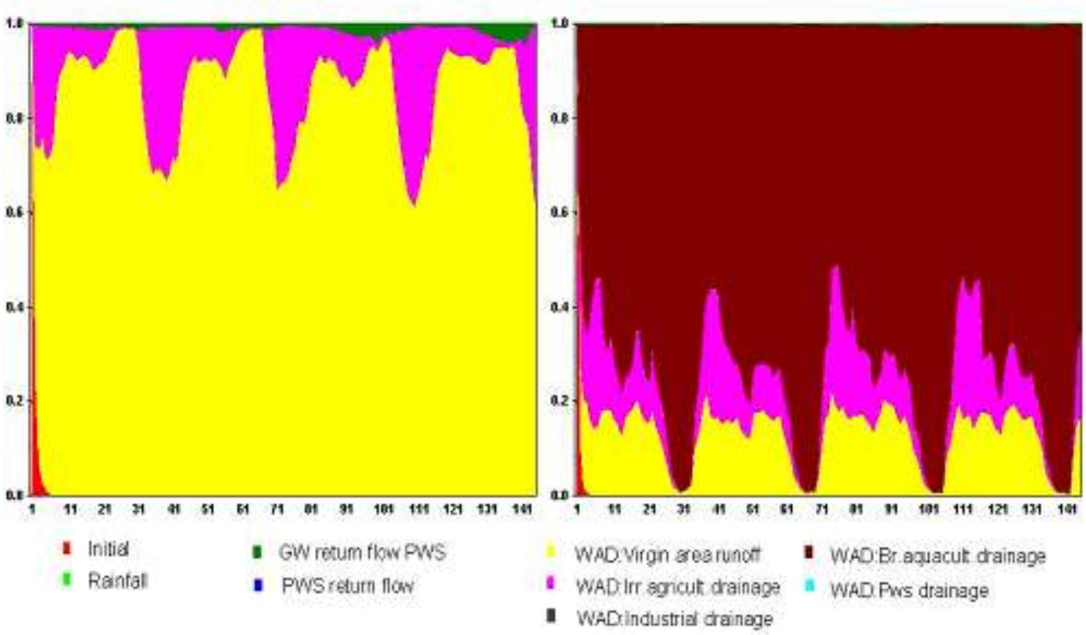


Figure 9.8 Two example stacked area graph of the flow composition at selected locations in the basin (the fraction of water from each source).

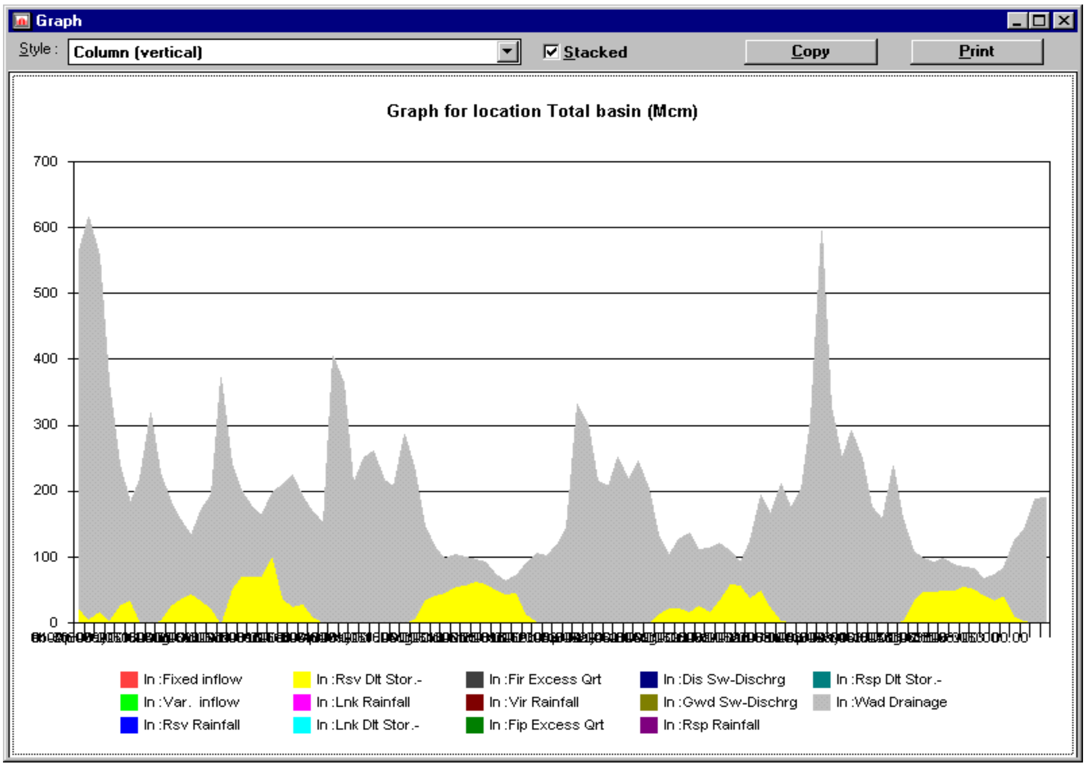


Figure 9.9 Stacked area graph of the overall river basin: water sources.

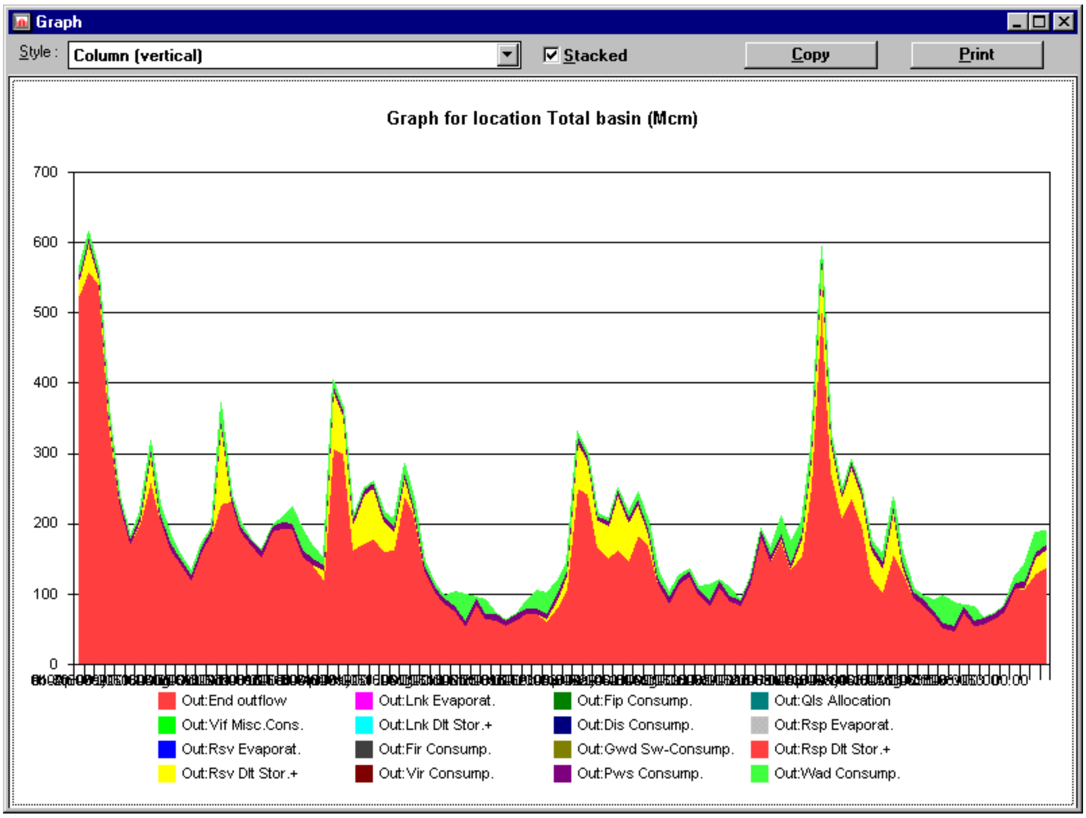


Figure 9.10 Stacked area graph of the overall river basin: water use.

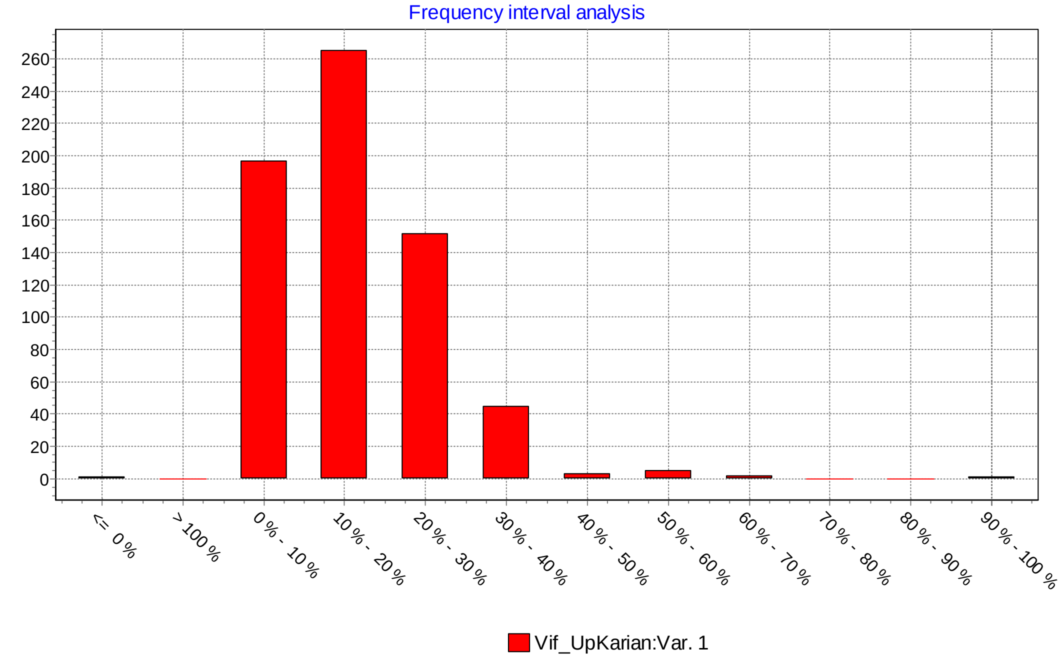


Figure 9.11 Example frequency analysis graph for the flow at variable inflow node "Vif_UpKarian"

9.3 Sub-task: Analyse simulation results in reports

Under this option a menu is shown with an overview of the standard reports which have been generated during the simulation (see Figure 9.12). If you select one of the reports, the tool VIEWTEXT is activated with which you can view and print the report. The following standard reports are generated:

Report	**Description of report content**
Flows in the links	Table with the flows in all links
Overall river basin water balance	Tables with the annual river basin water balance over the whole simulation period. Table 9.8 and Table 9.9 show the description of each water balance component: water sources and water consumption.
Advanced irrigation water balance	Tables with the sources of water and the use of water for the advanced irrigation nodes.
Summary of results	Tables with a summary of the basin performance over the whole simulation period.
Frequency intervals	Tables with the frequency interval analysis results.

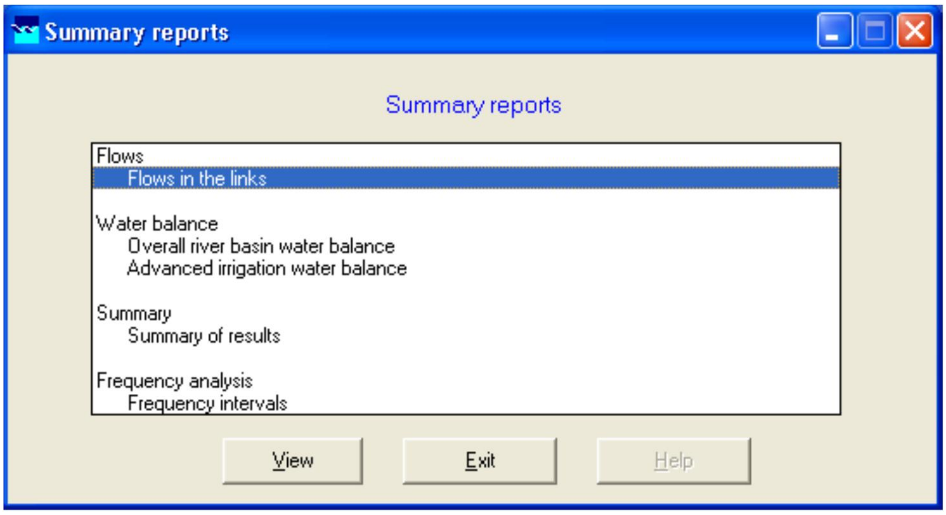


Figure 9.12 Screen for selection of reports with simulation results

The **summary** table contains the average annual results over the simulation period. The hydrological year starts at the first time step of the simulation period e.g. if the monthly first time step is 10 then the hydrological year start in October.

The cumulative substance balance in the summary report is only generated if water quality computation is carried out. The substance balance shows the amount of substance which flushed out (negative value) or built-up in the irrigation area (positive value) over the whole simulation period.

The shortage margins and definition of failure time step and failure year are defined in the “Basin performance control data” file which can be edited under the right mouse button at task block “River basin simulation” (file name is Summary.Dat in Table 8.1).

Table 9.8 Specification of the source part of the annual river basin water balance

Table specification	**Description of source**
Fixed inflow	Inflow as specified in the input
Variable inflow	Inflow as specified in flow time series
Surface water rainfall	Rainfall on surface area of surface water reservoir
Surface water reservoir storage change (-)	If initial storage greater than final storage then initial storage minus final storage at surface water reservoir
Surface water reservoir storage change (-)	If initial storage greater than final storage then initial storage minus final storage at surface water reservoir partition
Groundwater reservoir storage change (-)	If initial storage greater than final storage then initial storage minus final storage at groundwater reservoir
Public water supply	Return flow
Fixed irrigation	Return flow
Variable irrigation	Return flow including rainfall on the irrigated area
Advanced irrigation	Return flow
Fish ponds	Return flow
District discharge	Drainage from general district nodes and groundwater district nodes
Link storage (-)	If initial storage greater than final storage then initial storage minus final storage
Link storage rainfall	Rainfall on the storage area

Table 9.9 Specification of the consumption part of the annual river basin water balance

Table specification	**Description of consumption**
Variable inflow	Miscellaneous extraction
Fixed irrigation	Extraction from surface and groundwater
Variable irrigation	Extraction from surface and groundwater
Advanced irrigation	Extraction from surface and groundwater
Public water supply	Extraction from surface and groundwater
Surface water reservoir evaporation	Evaporation from surface area of reservoirs and partition of reservoirs
Surface water reservoir Seepage	Seepage from reservoirs and partition of reservoirs
Surface water reservoir storage change (+)	If final storage greater than initial storage then final storage minus initial storage at reservoir
Surface water reservoir storage change (+)	If final storage greater than initial storage then final storage minus initial storage at reservoir partition
Groundwater reservoir storage change (+)	If final storage greater than initial storage then final storage minus initial storage at groundwater reservoir
Terminal	Outflow at terminal nodes
Loss	Outflow at loss nodes but not the flows to the groundwater reservoir
Fish ponds	Extraction from surface and groundwater
District extraction	Extraction for general districts and groundwater districts
Link storage (+)	If final storage greater than initial storage then final storage minus initial storage at link storage
Link storage evaporation	Evaporation from the storage area
Link storage soil moisture recharge	Soil moisture recharge if surface area increases

10 References

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Verhaeghe R.J., van der Krogt W.N.M., "Estimation of demands and balancing of resources at basin level, ICID, Cairo, Egypt, 1996

Verhaeghe R.J., van der Krogt W.N.M., "Decision support system for river basin planning, Hydroinformatics 96, Zurich, Switzerland, 1996

Verhaeghe R.J., van der Krogt W.N.M., Patnaik R.K. and Singh Samant B.B., "Developments in River Basin Planning", Int. R&D conference Water&Energy 2001, Delhi, 1995

Verhaeghe R.J. van der Krogt W.N.M., van de Most H.,"Simulation and optimisation analysis of the water resources of the Tana river basin, Kenya", IAHR congress on WRM, Kyoto, Japan, 1988.

Various Delft Hydraulics project reports.

A RIBASIM Version 7.00 extensions

RIBASIM Version 7.00 has the following new features:

- The **source nodes in a source priority list are classified as "Local" resp. "Non-local".** During the target setting (demand) phase all demand nodes are first using the "Local" sources. Next all demand nodes are traced again but now the remaining demand can be fulfilled using the "Non-local" sources in the source list.

- The **groundwater distribution network** has been extended to support confluence, diversion and bifurcation nodes. Further surface and groundwater flow can be mixed to supply various users. For irrigation the groundwater irrigation efficiency, which is entered at the irrigation node, is used only if all links in the route from the groundwater reservoir node to the irrigation node have type "Groundwater abstraction link".

- The **Surface water links** have two types:
  - Canal or pipeline: limited flow capacity per time step (constraint).
  - River: no data required and no constraints.

- The **Lateral flow links** have six types of applied flow procedures. There are three new flow procedures added especially related to the lateral flow from the groundwater reservoir node. The newly added flow procedures are:
  - Fixed flow specified per time step.
  - Flow-storage relation (Q-S relation) : flow based on the storage of the upstream storage body.
  - Dummy: no data required.

- A route of lateral flow links between two storage bodies consists of any number of lateral flow links. The first link defines the applied flow procedure. All other links are of type flow procedure "Dummy".

- At the **Public Water Supply (PWS) nodes** the user can specify a "Distribution loss percentage".

- The Groundwater abstraction link has two types:
  - Dummy: no data are required
  - Pumping: the pump characteristics are specified (capacity and efficiency).

- A route of Groundwater abstraction flow links between a Groundwater reservoir node and a water demand node e.g. PWS node consists of any number of groundwater abstraction links. The first link must have type "Pumping". All other links have type "Dummy".

- Several output parameters have been added:

Node or link type	**New output parameter**
Variable inflow node	Variable inflow (read from hydrological time series file)
	Flow from upstream link (circuit)
Fixed inflow node	Fixed inflow (read from node model data)
	Flow from upstream link (circuit)
GW reservoir node	GW base outflow

	GW spilling outflow
GW outflow link	GW base outflow
	GW spilling outflow
Public water supply node	Return flow to groundwater
Fixed irrigation node	Return flow to groundwater

- **Labelling of Groundwater reservoir nodes**. At the groundwater reservoir (GWR) nodes a new input item is added the “GWR node label”. This is a number which is used to identify the GWR node at the model data of other node types independent from the node ID and node name. The label is used at the Fixed Variable and Advanced irrigation and Public water supply nodes to specify that the groundwater return flow is input of the GWR node. There is one time step delay, which means that the ground water return flow at time step t will enter the GWR node at time step t+1.

- **Groundwater return flow at Fixed Variable and Advanced irrigation and Public water supply nodes**. The return flow of those node types can be specified for surface water and for groundwater as a percentage of the allocated water or computed drainage flow. The surface water return will enter the system at the downstream link of the node. The sink of the groundwater return flow can be indicated as follows:
  - using the GWR node label (value # 0). The return flow will enter the GWR node in the next time step.
  - with the value 0. The return flow is out of the system.

- **Water balance of the Groundwater reservoir nodes**. The components of the water balance of the GWR nodes are explicitly generated in the GWR node result file (His-file) available for preparation of a graph or for export to Excel.
  Table A.1 outlines the various components.

Table A.1 Groundwater reservoir node water balance components (Mcm)

Inflow components	Outflow components
Groundwater recharge flow	Base outflow
Return flow to groundwater from users in previous time step	Spilling outflow
Sum of the lateral inflows	Sum of the abstractions
Decrease of storage	Sum of the lateral outflows
	Increase of storage

- **Water balance of the Surface water reservoir (RSV) nodes**. The components of the water balance of the surface water RSV nodes are explicitly generated in the RSV node result file (His-file) available for preparation of a graph or for export to Excel.

Table A.2 Reservoir node water balance components (Mcm).

Inflow components	Outflow components
Flow into reservoir node from upstream links excl. lateral flow links	Evaporation
Rainfall	Seepage
Sum of the lateral inflows	Main gate outflow
Decrease of storage	Turbine outflow
	Full reservoir spilling flow

	Sum of the backwater gate flows
	Sum of the lateral outflows
	Increase of storage

- **Water balance of the Link storage (LST) nodes**. The components of the water balance of the LST nodes are explicitly generated in the LST node result file (His-file) available for preparation of a graph or for export to Excel.

Table A.3 Links torage node water balance components (Mcm).

Inflow components	Outflow components
Flow into link storage node from upstream links excl. lateral flow links	Evaporation
Rainfall	Soil moisture recharge
Sum of the lateral inflows	Flow outof link storage node into downstream surface water flow link
Decrease of storage	Sum of the lateral outflows
	Increase of storage

- **Overall basin water balance**. The components of the water balance of the overall basin is extended with the following components:
    - In : GWR nodes. Return flows fromPWS and FIR nodes to groundwater of previous time step.
    - Out : PWS nodes. Return flow to groundwater.
    - Out : FIR nodes. Return flow to groundwater.

- **Editing of node as well as link model data** under the task block “Analysis of result” from map is allowed.

- An **default and user defined flow composition** computation has been included as new option beside the water quality simulation. The flow composition is an interesting method for a first water quality assessment of the basin.

- **Recording node** as location of the computation of the annual average flow and difference with the flow at the upstream recording node.

- **Monitored or recording time series** can be connected to a recording node for direct calibration using the ODS-View component.

- **Environmental minimum flow time series** part of the hydrological scenario can be specified at the low flow node.

- For the water quality simulation the waste loads can be specified beside in concentrations als by **additional loads and retention percentage** using the look-up table in the water quality scenario.

- At the Variable inflow nodes a “**Catchment label**” can be defined. At each "space using node" like an irrigation area or surface water reservoir this label can be specified indicating that the water user like irrigation area or the reservoir is located in the catchment.

- During the simulation the actual virgin catchment area is online computed by subtracting the actual area of all "space using nodes" from the potential virgin catchment area.

- The "**Advanced irrigation node**" type has been changed. The agriculture water demand model AGWAT and the crop yield and production costs model WADIS has been replaced by a new agriculture water demand, water allocation, crop yield and production costs model **DelftAGRI** which is fully integrated in the RIBASIM model. This model is activated if the "Advanced irrigation node" type is part of the basin schematization. The model is online connected to the water allocation module of RIBASIM and computes the actual field soil moisture status. So, for instance a shortage in the full water allocation is taking into account for the demand during the next time step. The fixed data base files and the model data describing the new "Advanced irrigation node" have been changed. The agriculture water balance of the irrigation nodes can be analysed on 4 levels: field, strip, cultivation and irrigation areas.

- **Interactive graphical crop plan editor**. For the "Advanced irrigation nodes" a new graphical tool CROPPER has been developed for the interactive design and entry of the crop plan. The model data can be entered in 2 different ways: using the standard spreadsheet-based RIBASIM data editor and via the new interactive graphical crop plan editor.

- The "**Water district node**" type has been skipped. This node type can be represented in more detail by a combination of the following nodes types: inflow node, advanced irrigation node, fish pond node and public water supply node.

- The "**Brackish fish pond node**" type as well as the brackish fish pond model FISHWAT has been skipped. The brackish aquaculture water users can be represented with the node type "Fish pond node".

- The number of task blocks at the **Case Management Tool** screen for managing the simulation cases has been reduced.

- The standard procedure for Deltares | Delft Hydraulics software license has been implemented.

B RIBASIM Version 7.00 dimensions

RIBASIM allows applications within the certain dimensions. The actual dimensions for your RIBASIM version are outlined in the “Overview of data base” which may differ from the ones below. The tables below give an indication.

Network elements	**Maximum number**
nodes	2500
links	2500
Node types	**Maximum number**
Advanced irrigation	100
Bifurcation	200
Recording (dummy)	500
Diversion	250
Fishpond	50
Fixed inflow	500
Fixed irrigation	500
General district	200
Groundwater district	50
Groundwater reservoir	80
Link storage	300
Loss flow	500
Low flow	200
Public water supply	250
Pumping node	50
Surface water reservoir	200
Surface water reservoir partition	50
Run-of-river	30
Terminal (end)	800
Variable inflow	500
Variable irrigation	100
Link types	**Maximum number**
Bifurcated flow	300
Diverted flow	600
Groundwater abstraction	700
Lateral flow	200
Groundwater outflow	80
Groundwater recharge flow	300
Surface water flow	1500
Surface water reservoir backwater flow	100
Parameter	**Maximum number**
Time steps within a year	53
Parameter	**Maximum number**
Substances	25

Water district related parameters	**Maximum number**	**Remarks**
Crops	20	
Crop types	2	flood basin crop like rice, and dry land crop like vegetables and sugar cane
Cultivations	1200	

C Directory structure and contents

All programs and data are stored in the \Ribasim7-directory, only the Windows related files (DLL, OCX, etc) are stored in the Windows system32 directory. Below the sub-directories of the \Ribasim7 directory are outlined and their contents.

C.1 Program directory

The programs which form the RIBASIM software are stored in the sub-directory of directory \Ribasim7\Programs. Below all sub-directories are outlined:

\Casedef	All the files related to the menu selection tool box program Casedef.
\Caseman	All the files related to the case management tool program Caseman.
\Cat	All the files related to the case analysis tool program CAT.
\ComBasin	All the files related to the program ComBasin.
\CombFile	All the files related to the program CombFile.
\Dsshell	Programs and files of the title screen program.
\Fixed	Some fixed data files for the DELFT DSS programs like the icon-files (ICO), bitmap files (BMP) and Windows meta files (WMF).
\FlexLM	Hardware protection key programs
\Mapset	All files related to the program Mapset for setting of the default map
\Netter	All NETTER (program for interactive network editing and presentation of simulation results from maps) program related system files and programs.
\Ods_View	All the files related to the graphics and export tool Ods_View.
\Pictures	Background pictures
\RenumId	All the files related to the program RenumId.
\Runlist	All the files related to the program Runlist for the background running of programs without DOS windows.
\Selapps	All the files related to the river basin selection tool Selapps.
\Showpict	All the files related to the program Showpict.
\Showlist	All files related to the program Showlist
\Sourcedit	All files related to the source list editor program SourcLstEdit.
\Ribasim	All RIBASIM Version 7.00 model related system files and programs.
\Ribasim\fixed	All spreadsheet template files used by the model data editor RibDataEdit and icons.
\Ribasim\system	All system files and programs (EXE) part of Ribasim.
\UpdateRibasim	All files related to the update utility program.

C.2 Data directories

The data for a river basin implementation are organized as follows. All basins are stored in sub-directories under the directory \Ribasim7 with type 'Rbn'. For each (sub) basin a dedicated sub-directory is created to store the data related to that specific river basin.

The name of the sub-directory is maximal 8 characters long and is specified when the icon ‘Add basin’ is selected at the title screen menu. Examples are:

River basin name	Directory
SWS Citarum basin	\Ribasim7\SWSTarum.Rbn
SWS Ciujung - Ciliman basin	\Ribasim7\CjngClmn.Rbn
SWS Jrantunseluna	\Ribasim7\Jrtnsln.Rbn

Below a complete outline is given of all subdirectories for the SWS Ciujung-Ciliman basin as example

\CjngClmn.Rbn\Maps

Map related data consisting of all map layer files (file type MPL, SHP, BIL, etc) and one file which defines the map layers into one basin map (file type MAP). Those data are used by NETTER (Basin.MAP). MPL-file can be generated manually from standard GIS-formatted files using the utility program Maplink or automatically generated by Netter.

For this specific example application the map of Java is included in the file Java.Map which is equal to the used map file Basin.Map. So each basin on Java can be modelled without changing the map. If an application must be set-up with another map than the contents of this directory must be replaced. For the case that no map is required an empty map is already included in file Empty.Map. If you copy this file to Basin.Map then the empty map is used. If you want to return to the Java map then copy file Java.Map again back to file Basin.Map.

\CjngClmn.Rbn\Fixed

Fixed data for SWS Ciujung - Ciliman basin for all simulation cases. The contents of the various files in this directory are described in the appendix E.

\CjngClmn.Rbn\Hydrolog

All data for the hydrological scenario’s. A scenario is defined by a definition file and associated time series files as described in appendix F.

\CjngClmn.Rbn\Hydrolog\Scenario.1

The scenario definition file and all hydrological time series defining hydrological scenario 1. Within RIBASIM a hydrological scenario can be selected at the task "Select hydrological and water quality scenario". Scenarios are defined by the user and each scenario is stored in a separate directory with names : Scenario.2, Scenario.3, etc. The name of the scenario is specified in the *Dirinfo*-file in the scenario directory.

\CjngClmn.Rbn\Lookup

All data for the water quality scenario’s. A scenario is here defined a definition file and associated look-up table.

\CjngClmn.Rbn\ Lookup\Scenario.1

The scenario definition file and all look-up table files defining water quality scenario 1. Within RIBASIM a water quality scenario can be selected at the task "Select hydrological and water quality scenario". Scenarios are defined by the user and each scenario is stored in a separate directory with names : Scenario.2, Scenario.3, etc. The name of the scenario is specified in the *Dirinfo*-file in the scenario directory.

\CjngClmn.Rbn\Newstart

All files required to start a new case in the CMT menu.

\CjngClmn.Rbn\System

Initialisation files, batch and Pif-files

\CjngClmn.Rbn\Work

Working directory of the case management tool. Here the case related files are stored while working on this river basin. This is temporary storage space and the files are permanently stored when the case is saved.

\CjngClmn.Rbn\Cmtwork

Working directory where the case management tool stores the non-case related temporary files.

\CjngClmn.Rbn\Fnm

All files with file names of the models and programs, which can be executed under the case management tool.

\CjngClmn.Rbn\1
\CjngClmn.Rbn\2
\CjngClmn.Rbn\3
...

Stored data related to the simulation cases. Each simulation case and the description of the case is stored in a subdirectory with the name equal to a number. The CMT controls those directories. It will create and delete the directories with name equal to a number. The description of a case in terms of the case identification and the files, which are used, for the case are stored in a separate data file *Casedesc.Cmt*. The case description files are also stored in the subdirectory with the name equal to a number.

Directory **\Ribasim7\XXXX.Rbn** contains the default basin data, which is copied to a new implemented basin.

D Map data

D.1 Map description file

In RIBASIM the use of a map is optionally. Also without a map of your study area you can still use RIBASIM with a blue empty screen as background. The map is used for reference background purposes while setting up interactively the river basin network schematization or to present simulation results on map.

The RIBASIM map is stored in the sub-directory \MAPS (see appendix C.2) and consists of a number of map layers. Each map layer is stored in a separate file with file type MPL, SHP, BIL, etc. All map layer files are combined into one map. The description of a map is stored in a file with name BASIN.MAP. The map layer files are made with GIS packages like MAPINFO, ArcView, ARC GIS,etc. Each map layer can be selected and adjusted e.g. visible or invisible, assign a color, line width, etc. This is done under the interactive network editor NETTER.

D.2 Print the map

You can print the whole map on a number of pages under NETTER and if you fit those pages together then you have an excellent working map. Carry out the following actions under Netter:

1. Show the full map under menu item: *View - Full map*.
2. Zoom in on e.g. a part of the map under menu item: *View - Zoom* in. Do not zoom in too much because the more you zoom in the more pages are required to print the map.
3. Make a print of the full map under the menu: *File - Print*. At the dialogue window you have to select the option "Full Map". On the right top of the dialogue window you can see how many pages are used to print the complete map. You can also specify a margin of e.g. 5 % which means that part of the pages is overlapping which makes it easier to fit them together as one whole map.

E Fixed data

In the fixed directory a number of files are stored which under normal cases does not change from one simulation case to another. Before the user starts the RIBASIM implementation of a new river basin the data files in the "Fixed"-directory should be checked or updated using a normal text editor like Ms Windows Notepad or Wordpad. The files can be edited under the right mouse button at the case management tool task blocks.

An overview of the files in the *Fixed* directory is shown in the Table E.1, Table E.2 and Table E.3. The files are used by the various models and programs of RIBASIM. The time step data file and the control data files are always used, but the agriculture and irrigation data files are only used if the Advanced irrigation node is part of the network schematization.

Table E.1 Simulation time step definition data

File name	**Description of contents**
Timestep.dat	Actual time step definition file
Time53_Shamsi.dat	Time step definition file for weekly time steps in Shamsi calendar
Time53_Christian.dat	Time step definition file for weekly time steps in Christian calendar
Time36_Shamsi.dat	Time step definition file for decade time steps in Shamsi calendar
Time36_Christian.dat	Time step definition file for decade time steps in Christian calendar
Time24_Shamsi.dat	Time step definition file for half-monthly time steps in Shamsi calendar
Time24_Christian.dat	Time step definition file for half-monthly time steps in Christian calendar
Time12_Shamsi.dat	Time step definition file for monthly time steps in Shamsi calendar
Time12_Christian.dat	Time step definition file for monthly time steps in Christian calendar

Table E.2 Control data.

File name	**Description of contents**
Bin2Prt.dat	Specification of desired output tables at overview of model data
FlowComp.dat	Definition of flow components for the default flow composition computation
GenDStrj.dat	Generation of default demand - source traject - control data
RenumId.dat	Renumbering of nodes and links control data
Selvrbl.dat	Variables for which a frequency interval analysis is done.
Simproc.dat	Basin simulation computational control data
Summary.dat	Basin performance parameter control data.
GenSrcL.dat	Generation of default source priority list - control data

Table E.3 Agriculture and irrigation data.

File name	Description of contents
Cropdata.dat	Crop data.
Cropfact.dat	Crop factor per time step in growing season.
DelftAGRI.dat	Specification for daily output on field level.
Deswtlvl.dat	Desired water level on the field per time step in growing season., only relevant for flood basin crops.
Extwtdmd.dat	Extra water layer demand on the field per time step in growing season., only relevant for flood basin crops. Used in the crop plan editor.
FldBfrSt.dat	Field buffer storage per time step in growing season. (mm above desired field water level or soil moisture).
InstDran.dat	Instantaneous drainage water level on the field per time step in growing season at the beginning of the time step, only relevant for flood basin crops.
Irrpract.dat	Irrigation practise : on - off supply switch per time step in growing season.
YldRpFct.dat	Yield response factors per time step in growing season.

Remarks

The Timestep.Dat file defines the number of simulation time steps within a year and the number of days within each time step. For the case that the year is divided into 12, 24, 36 or 53 time steps the example Timestep.Dat file is included in this directory under the names outlined in Table E.1. You can copy the related file to Timestep.dat under the task block “Select hydrology and water quality scenario” menu item “Define simulation time step”.

The format and the set-up of most "Fixed" files follow the following guidelines:

- The first record of the file contains a header, which is used by the programs to determine what kind of data file it is. The header is compulsory.
- After the header a number of records are used to describe the contents of the file. Each comment record start with an asterisk (*) in the first column. Intermediate comment records are sometimes included to describe the contents of the next record(s). Comment records are optional. Any number of comment records is allowed.
- After the comment records the data part of the file starts. The data should be typed in the correct order and separated by at least one space. The data items are read in free format. Data items consisting of text should be enclosed by a single quote (‘).

Below an example of each of the "Fixed" data files is shown. The agriculture and irrigation data example files refer to a half-monthly simulation time step (24 time steps per year). The comment records in the files outline the various data items.

E.1 Example simulation time step definition data files

Timestep.dat: Time step definition file

For **monthly** time steps:

```
ODS 1.00DAT 3.00ASC2BIN  6.00
*
* Time step data
*
* - Number of time steps within a year
* - For each time step one record withe:
*   1. the number of days within the time step
*   2. the time step name (A12)
*   3. the number of days to add during a leap year
*   4. short time step name (A4) (used in Cropper)
*
  12
      31   'January'      0  'Jan'
      28   'February'     1  'Feb'
      31   'March'        0  'Mar'
      30   'April'        0  'Apr'
      31   'May'          0  'May'
      30   'June'         0  'Jun'
      31   'July'         0  'Jul'
      31   'August'       0  'Aug'
      30   'September'    0  'Sep'
      31   'October'      0  'Oct'
      30   'November'     0  'Nov'
      31   'December'     0  'Dec'
```

For **half-monthly** time steps:

```
ODS 1.00DAT 3.00ASC2BIN  6.00
*
* Time step data
*
* - Number of time steps within a year
* - For each time step one record withe:
*    1. the number of days within the time step
*    2. the time step name (A12)
*    3. the number of days to add during a leap year
*    4. short time step name (A4) (used in Cropper)
*
  24
      15  'January 1'      0   'Jan1'
      16  'January 2'      0   'Jan2'
      15  'February 1'     0   'Feb1'
      13  'February 2'     1   'Feb2'
      15  'March 1'        0   'Mar1'
      16  'March 2'        0   'Mar2'
      15  'April 1'        0   'Apr1'
      15  'April 2'        0   'Apr2'
      15  'May 1'          0   'May1'
      16  'May 2'          0   'May2'
      15  'June 1'         0   'Jun1'
      15  'June 2'         0   'Jun2'
      15  'July 1'         0   'Jul1'
      16  'July 2'         0   'Jul2'
      15  'August 1'       0   'Aug1'
      16  'August 2'       0   'Aug2'
      15  'September 1'    0   'Sep1'
      15  'September 2'    0   'Sep2'
      15  'October 1'      0   'Oct1'
      16  'October 2'      0   'Oct2'
      15  'November 1'     0   'Nov1'
      15  'November 2'     0   'Nov2'
      15  'December 1'     0   'Dec1'
      16  'December 2'     0   'Dec2'
```

For **decade** time steps:

```
ODS 1.00DAT 3.00ASC2BIN  6.00
*
* Time step data
*
* - Number of time steps within a year
* - For each time step one record withe:
*   1. the number of days within the time step
*   2. the time step name (A12)
*   3. the number of days to add during a leap year
*   4. short time step name (A4) (used in Cropper)
*
  36
      10   'January 1'      0  'Jan1'
      10   'January 2'      0  'Jan2'
      11   'January 3'      0  'Jan3'
      10   'February 1'     0  'Feb1'
      10   'February 2'     0  'Feb2'
       8   'February 3'     1  'Feb3'
      10   'March 1'        0  'Mar1'
      10   'March 2'        0  'Mar2'
      11   'March 3'        0  'Mar3'
      10   'April 1'        0  'Apr1'
      10   'April 2'        0  'Apr2'
      10   'April 3'        0  'Apr3'
      10   'May 1'          0  'May1'
      10   'May 2'          0  'May2'
      11   'May 3'          0  'May3'
      10   'June 1'         0  'Jun1'
      10   'June 2'         0  'Jun2'
      10   'June 3'         0  'Jun3'
      10   'July 1'         0  'Jul1'
      10   'July 2'         0  'Jul2'
      11   'July 3'         0  'Jul3'
      10   'August 1'       0  'Aug1'
      10   'August 2'       0  'Aug2'
      11   'August 3'       0  'Aug3'
      10   'September 1'    0  'Sep1'
      10   'Septmeber 2'    0  'Sep2'
      10   'September 3'    0  'Sep3'
      10   'October 1'      0  'Oct1'
      10   'October 2'      0  'Oct2'
      11   'October 3'      0  'Oct3'
      10   'November 1'     0  'Nov1'
      10   'November 2'     0  'Nov2'
      10   'November 3'     0  'Nov3'
      10   'December 1'     0  'Dec1'
      10   'December 2'     0  'Dec2'
      11   'December 3'     0  'Dec3'
```

For **weekly** time steps:

```
ODS 1.00DAT 3.00ASC2BIN  6.00
*
* Time step data
*
* - Number of time steps within a year
* - For each time step one record withe:
*   1. the number of days within the time step
*   2. the time step name (A12)
*   3. the number of days to add during a leap year
*   4. short time step name (A4) (used in Cropper)
*
  53
       7   'Week  1'        0  'Wk 1'
       7   'Week  2'        0  'Wk 2'
       7   'Week  3'        0  'Wk 3'
       7   'Week  4'        0  'Wk 4'
       7   'Week  5'        0  'Wk 5'
       7   'Week  6'        0  'Wk 6'
       7   'Week  7'        0  'Wk 7'
       7   'Week  8'        0  'Wk 8'
       7   'Week  9'        0  'Wk 9'
       7   'Week 10'        0  'Wk10'
       7   'Week 11'        0  'Wk11'
…

       7   'Week 40'        0  'Wk40'
       7   'Week 41'        0  'Wk41'
       7   'Week 42'        0  'Wk42'
       7   'Week 43'        0  'Wk43'
       7   'Week 44'        0  'Wk44'
       7   'Week 45'        0  'Wk45'
       7   'Week 46'        0  'Wk46'
       7   'Week 47'        0  'Wk47'
       7   'Week 48'        0  'Wk48'
       7   'Week 49'        0  'Wk49'
       7   'Week 50'        0  'Wk50'
       7   'Week 51'        0  'Wk51'
       7   'Week 52'        0  'Wk52'
       7   'Week 53'        0  'Wk53'
```

E.2 Example control data files

Bin2Prt.dat : Specification of desired output tables at overview of model data

```
ODS 1.00DAT 1.01Handmade 6.00
*
* Overview of model data - control data
* =====================================
*
* Used by        : program Bin2Prt
* Reading format : free format
*
* Per record :
* - Switch to indicate generation of associated table : 0 = no, 1 = yes
*
* Switch Table description
* ------ -----------------
    1    Table 1. Dimension of the present schematization
    1    Table 2. Network related data (outline below)
    1    Table 3. Data per node type   (outline below)
    1    Table 4. Data per link type   (outline below)
    1    Table 5. Data of time series files
    1    Table 6. Data of output variables for each type of node
    1    Table 7. Dimensions of present Ribasim version
*
* Sub-tables 2 for network related data
*
* Switch Sub-table description
* ------ ---------------------
    1    2.1. Configuration data
    1    2.2. Water allocation priority data
    1    2.3. Simulation sequence
    1    2.4.1 (Updated) source priority list
    1    2.4.2 Original source priority list (if updated)
    1    2.4.3 (Updated) source traject list
    1    2.4.4 Original source traject list (if updated)
    1    2.5. Expected source priority list
    1    2.6. Parallel sequences of SW reservoir and run-of-river nodes
*
* Sub-tables 3 with model data per node type
*
* Switch Node type description
* ------ ---------------------
    1     1. Variable inflow nodes
    1     2. Fixed inflow nodes
    1     3. Confluence nodes (no model data present)
    1     4. Terminal node (no model data present)
    1     5. Recording (dummy) node
    1     6. Surface water reservoir nodes
    1     7. Run-of-river nodes
    1     8. Diversion nodes
    1     9. Low flow nodes
    1    10. Public water supply nodes
    1    11. Fixed irrigation nodes
    1    12. Variable irrigation nodes
    1    13. Loss flow nodes
    1    14. Fish pond nodes
    1    15. Intentionally not used
    1    16. Groundwater reservoir nodes
    1    17. Bifurcation nodes
    1    18. Pumping nodes
    1    19. Intentionally not used
    1    20. General district nodes
    1    21. Ground water district nodes
    1    22. Link storage nodes
    1    23. Surface water reservoir partition nodes
```

```
    1    24. Intentionally not used
    1    25. Advanced irrigation nodes
    1    26. Intentionally not used
    1    27. Waste water treatment plant nodes
    1    28. Natural retention nodes
*
* Sub-tables 4 with model data per link type
*
* Switch Link type description
* ------ ---------------------
    1     1. Surface water flow links
    1     2. Groundwater recharge links (no model data present)
    1     3. Groundwater outflow links  (no model data present)
    1     4. lateral flow links
    1     5. Groundwater abstraction flow links
    1     6. Diverted flow links
    1     7. Bifurcated flow links
    1     8. Surface water reservoir backwater flow links
    1     9. Intentionally not used
```

FlowComp.dat: Definition of flow components for the default flow composition computation

```
ODS 1.00DAT 1.00XXXXXXXX 1.00
*
* Definition of flow components for the default flow composition
* computation
* ==============================================================
*
* Reading format : free format
*
* Number of defined flow components (maximum 25)
*
   14
*
* Flow component / "substance" index and name of flow components /
* "substances" (between quotes, max. 40 characters)
*
  1 'Variable inflow runoff'
  2 'Fixed inflow runoff'
  3 'Public water supply return flow'
  4 'Fixed irrigation return flow'
  5 'Variable irrigation return flow'
  6 'Advanced irrigation return flow'
  7 'Fish pond return flow'
  8 'GW district return flow'
  9 'General district discharge'
 10 'SW reservoir rainfall'
 11 'Link storage rainfall'
 12 'Init. storage SW reservoir'
 13 'Init. storage Link storage'
 14 'Init. storage GW reservoir'
*
* Specify the flow component / "substance" index for the 14 default flows
* computed in RIBASIM:
*
* Ix Flows computed in RIBASIM
* -- -----------------------------
   1 'Vif node : inflow runoff (1)'
   2 'Fif node : inflow runoff (2)'
   3 'Pws node : return flow (3)'
   4 'Fir node : return flow (4)'
   5 'Vir node : return flow (5)'
   6 'Air node : return flow (6)'
   7 'Fip node : return flow (7)'
   8 'Gwd node : return flow (8)'
   9 'Dis node : discharge (9)'
  10 'Rsv node : rainfall (10)'
  11 'Lst node : rainfall (11)'
  12 'Rsv node : init. storage (12)'
  13 'Lst node : init. storage (13)'
  14 'Gwr node : init. storage (14)'
```

GenDStrj.dat : Generation of default demand - source traject - control data

```
ODS 1.00DAT 1.00Handmade 6.00
*
* Generation of default demand - source traject - control data
* ============================================================
*
* Used by        : program GenDStrj
* Reading format : free format
*
* - Link name prefix to indicate that link is a "preferred link".
*   Preferred links are used first.
*
    'Prf'
*
* During the "best" traject selection procedure the following
* criteria are used in the order specified below :
*
* - selection order (1 is highest, 5 is lowest)
*
* Selection
* order index  Description of criterium
* -----------  --------------------------------------------------
          1    'Minimum number of diverted flow links'
          2    'Minimum number of bifurcated flow links'
          3    'Minimum number of reservoir backwater flow links'
          5    'Minimum number of surface water flow links'
          4    'Minimum number of links'
```

RenumId.dat : Renumbering of nodes and links control data

```
ODS 1.00DAT 1.02SelRenumOpt 1
*
* Renumbering of nodes and links
* ------------------------------
* The program RenumId will renumber the nodes and links according to one
* of the following options :
*
* Option 1. Number the nodes and links in downstream order as
* ========  outlined in the simulation sequence
*           Link index : any number smaller than 32678 and format: "xyyyy"
*                        With x    = basin index (0-2)
*                             yyyy = sequence index over all links
*                                    within the basin (0-9999)
*                             e.g. link 20150 is a link in basin 2
*                                  (defined in control data file) and
*                                  the 150-th link in this schematization
*                                  (defined by program)
*           Node index : any number smaller than 32678 and format "xyyyy"
*                        With x    = basin index (0-2)
*                             yyyy = sequence index over all nodes within
*                                    the basin (0-9999)
*                             e.g. node 11145 is a node in basin 1 (defined
*                                    in control data file) and
*                                    the 1145-th node in this
*                                    schematization (defined by program)
*
* Option 2. Number the nodes and links in downstream order as outlined
*           in the simulation sequence
* ========
*           Link index : any number smaller than 32678 and format: "xxyyy"
*                        With xx  = basin index (0-31)
*                             yyy = sequence index over all links within
*                                   the basin (0-999)
*                             e.g. link 2150 is a link in basin 2
*                                  (defined in this file) and
*                                  the 150-th link in this schematization
*                                  (defined by program)
*           Node index : any number smaller than 32678 and format "xxyyy"
*                        With xx  = basin index (0-31)
*                             yyy = sequence index over all nodes within
*                                   the basin (0-999)
*                             e.g. node 11145 is a node in basin 11
*                                   (defined in this file) and
*                                   the 145-th node in this schematization
*                                   (defined by program)
*
* Option 3. Number the nodes and links according to the following rules:
* ========
*           Link index : any number smaller than 32678 and format: "xxyyy"
*                        With xx  = basin index (0-31)
*                             yyy = sequence index over all links within
*                                   the basin (0-999)
*                             e.g. link 2050 is a link in basin 2
*                                  (defined in this file) and
*                                  the 50-th link in this schematization
*                                  (defined by program)
*           Node index : any number smaller than 32678 and format "xxyzz"
*                        With xx = basin index (0-31)
*                             y  = type of node index (0-9)
*                             zz = sequence index over all nodes of the
*                                  concerning type (0-99)
*                             e.g. node 6722 is a node in basin 6
*                                  (defined in this file) and
*                                  node type 7 (defined in this file) and
*                                  the 22-th node of node type 7 in this
*                                  schematization (defined by program)
*
```

```
* This file is read in free format.
*
* Numbering option to be applied : 1 or 2 or 3 (see above)
*
  1
*
* Required for numbering option 1 and 2 and 3.
* ============================================
* Basin index : for option 1 (0-2) and for option 2 and 3 (0-31)
*
 0
*
* Required for numbering option 3 only.
* =====================================
* Type of node index (0-9) to be used in the node number for the following
* node types:
*
 3 : Variable inflow node
 3 : Fixed inflow node
 3 : Confluence node
 3 : Terminal node
 3 : Recording node
 3 : Reservoir node
 5 : Run-of-river node
 6 : Diversion node
 7 : Low flow node
 8 : Public water supply node
 9 : Fixed irrigation node
 9 : Variable irrigation node
 8 : Loss flow node
 0 : Fish pond node
 0 : Natural lake node (under development)
 0 : Groundwater reservoir node
 6 : Bifurcation node
 0 : Pumping node
 0 : Not used
 0 : General district node
 0 : Ground water district node
 4 : Link storage node
 0 : Reservoir partition node
 0 : Not used
 0 : Advanced irrigation node
 0 : Not used
 0 : Waste water treatment plant node
 0 : Natural retention node
```

Selvrbl.dat : Variables for which a frequency interval analysis is done.

```
ODS 1.00DAT 1.00HANDMADE 6.00
*
* Variables for frequency interval analysis
* =========================================
*
* Aware : The required data is Node ID dependent !
*
* Format : free format
*
* - Node index,
* - Variable index and
* - Range of values : minimum and 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.
*   Aware that range values of flows should be specified in m3/s.
*
* Node  Variable Minimum     Maximum
* index index    range value range value
* ----- -------- ----------- -----------
     5        1        -1.0        -1.0
    10        1        -1.0        -1.0
    15        1        -1.0        -1.0
```

Simproc.dat : Basin simulation computational control data (floating point precision condition)

```
ODS 1.00DAT 1.05UpFxDbs  6.00
*
* Basin simulation computational control data
*
* Free format
*
* Data related to the iterative reservoir operation simulation routine:
*
* 1.Maximum number of iterations: Mxlop1
* 2.Reservoir storage step size : Salfa1 (0,1]
* 3.After Mxlop1 iterations, an additional number of iterations : MxLop2
* 4.At the additional MxLop2 iterations an adapted res. storage step size:
*   Salfa2 (0,1]
*
     5     1.000
    20     0.500
*
* 5.Relative iteration criteria for water availability at reservoir
*   gate(s) (m3/s) :
*   flow fraction (Qalfa) (0,1]
*   This value also fixes the iteration citeria for storages (10**6 m3) :
*   24*60*60*Ndays*Qalfa/1000000.
*
     0.010
*
* Data for iterative routine for comp. of maximum rsv turbine flow:
*
* 1.Maximum number of iterations : Mxlop3
* 2.Hydro-power net or effective head step size : Halfa3 (0,1]
* 3.After Mxlop3 iterations, an additional number of iterations : MxLop4
* 4.At the additional MxLop4 iterations an adapted hydro-power net or
* effective head step size : Halfa4 (0,1]
*
     5     1.000
    20     0.500
*
* Data related to the iterative routine for the computation of the
* turbine flow for firm energy generation:
*
* 1.Maximum number of iterations : Mxlop5
* 2.Relative accuracy criterium (%) : RQacc5
*
     5     1.000
*
* Absolute accuracy criterium for :
*
* 1.Flow accuracy criterium (m3/s)                 : Qaccur
* 2.Tail level accuracy criterium (m)              : Haccur
* 3.Hydro-power shortage accuracy criterium (GWh)  : Eaccur
* 4.Demand level accuracy criteria (mm/day/ha)     : MMaccu
* 5.Area accuracy criterium (ha)                   : HAaccu
* 6.Fraction accuracy criterium [0,1] (efficiency) : FRACCU
*
     0.01000
     0.00100
     0.01000
     0.00100
     0.00010
     0.00100
*
* Relative accuracy criterium (%) for  :
*
* 1.Storage accuracy criterium                : RSaccu
*   (used at reservoir operation)
```

```
* 2.Nethead accuracy criterium                : RNHacc
*   (used at maximum turbine flow)
*
     0.01000
     0.01000
*
* Data related to the iterative link storage simulation routine:
*
* 1.Maximum number of iterations: Mxlop6
* 2.Link storage step size : LSalf1 (0,1]
* 3.After Mxlop6 iterations, an additional number of iterations : MxLop7
* 4.At the additional MxLop7 iterations an adapted link storage
*   step size : LSalf2 (0,1]
* 5.Link storage accuracy criterium (%) : RLSacc
*
     5     1.00000
    50     0.50000
           0.10000
```

Table E.4 Short description of computational parameters.

Reservoir operation iteration	
MxLop1, MxLop2, Salfa1, Salfa2	Maximum number of iteration to simulate the reservoir operation (end storage, releases). After maximal MxLop1 with storage step size Salfa1 then maximal MxLop2 times storage step size Salfa2 is implemented.
Rsaccu	Relative end storage criteria for iteration to simulate the reservoir operation.
Qalfa	Relative criteria for computation of the available reservoir water per gate based on the total outflow.
Link storage computation	
MxLop6, MxLop7, LSalf1, LSalf2	Maximum number of iteration to simulate the link storage operation (end storage, releases). After maximal MxLop6 with storage step size LSalf1 then maximal MxLop7 times storage step size LSalf2 is implemented.
RLSaccu	Relative end storage criteria for iteration to simulate the link storage operation.
Online target setting and demand iteration	
MxLop1	Maximum number of iteration that a demand node asks online for extra water from a certain source e.g. a reservoir.
Maximum turbine flow iteration	
MxLop3, MxLop4, Halfa3, Halfa4	Maximum number of iteration to compute the maximum turbine flow. After MxLop1 with reservoir level step size Halfa3 then MxLop4 times level step size Halfa4 is implemented.
RNHacc	Relative nethead criteria for iteration to simulate the maximum turbine flow.
Required firm energy turbine flow iteration	
MxLop5	Maximum number of iteration to compute the turbine flow for the firm energy generation.
RQacc5	Relative turbine flow criteria for the computation of the firm energy turbine flow.
Taillevel iteration	
Haccur	Absolute criteria for the taillevel computation from two reservoirs and/or run-of-river in series.
Floating point precision criteria	
Qaccur	Flow (m3/s) and storage (Mm3) variables.
Haccur	Level (reservoir, groundwater depth) (m) variables.
Eaccur	Hydro-energy (GWh) variables.
Mmaccu	Agriculture and fish pond demand and supply variable (mm/day over area).
Haaccu	Area variables (ha).
FRaccu	Fraction variables (-) e.g. water allocation fraction and irrigation efficiency.

Summary.dat : Basin performance parameter control data.

```
ODS 1.00DAT 1.03HANDMADE 6.00
*
* Basin performance parameter control data (for program Summary
* and Rib2His)
* --------------------------------------------------------------
*
* Format      : free format
*
* General district node
* ---------------------
* 1. Definition of failure time step : percentage of demand above
*    which water shortage
*    is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
*
* Groundwater district node
* -------------------------
* 1. Definition of failure time step : percentage of demand above
*    which water shortage is accounted as a failure time step for
*    irrigation and public water supply (2 values, % of demand)
* 2. Definition of failure year : the minimum number of failure
*    time steps within a year needed to define the year as a failure
*    year for irrigation and public water supply (2 values, -)
*
     0.1    0.1
       1      1
*
* Fixed, variable and advanced irrigation node
* --------------------------------------------
* 1. Definition of failure time step : percentage of demand above
*    which water shortage is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
*
* Loss flow node
* --------------
* 1. Definition of failure time step : percentage of demand above which
*    water shortage is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
*
* Fish pond node
* --------------
* 1. Definition of failure time step : percentage of demand above which
*    water shortage is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
*
* Public water supply node
* ------------------------
* 1. Definition of failure time step : percentage of demand above which
*    water shortage is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
```

```
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
*
* Low flow node
* -------------
* 1. Definition of failure time step : percentage of demand above which
*    water shortage is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
*
* Firm energy at reservoirs
* -------------------------
* 1. Definition of failure time step : percentage of demand above which
*    water shortage is accounted as a failure time step (% of demand)
* 2. Definition of failure year : the minimum number of failure time steps
*    within a year needed to define the year as a failure year (-)
*
     0.1
       1
```

GenSrcL.dat : Generation of default source priority list - control data

```
ODS 1.00DAT 1.00Handmade 6.00
*
* Generation of default source priority list - control data
* =========================================================
*
* Used by        : program GenSrcL
* Reading format : free format
*
* Per record :
* 1. Index of node type which can be a source (defined by Ribasim)
* 2. Group index : if = 0 then node type is not included in source list
*                    > 0 then order in the source list
*                        e.g. 1 for 'Groundwater reservoir node'
*                        means that GW reservoir nodes are the first
*                        source in the source priority list
* 3. Node type name (not used here)
*
* Node
* type  Group
* index index Node type description
* ----- ----- ----------------------------
      1     3 'Variable inflow node'
      2     3 'Fixed inflow node'
      6     4 'SW reservoir node'
     10     2 'Public water supply node'
     11     2 'Fixed irrigation node'
     12     2 'Variable irrigation node'
     14     2 'Fish pond node'
     16     1 'Groundwater reservoir node'
     20     2 'General district node'
     21     2 'Ground water district node'
     25     2 'Advanced irrigation node'
```

E.3 Example agriculture and irrigation data files

Cropdata.dat : Crop data (half monthly time step).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Crop data
* =====================
*
* Reading format : free format
*

* Number of crops
*
     6
*
* Description of the data
* -----------------------
* Cr Ix              = Crop index. Crop index must be in sequence !!!!
* Crop name          = Name of crop (max. 20 characters)
* Kd cr              = Kind of crop water demand model :
*                      1 = flood basin crop demand model e.g. for paddy
*                      2 = dry land crop demand model e.g. for vegetables
* Plt. per.          = Planting period to cover the whole cultivated area
*                      with the crop [# of time steps].
* Grow. seas.        = Length of growing season excluding land preparation
*                      (which is one time step) [# of time steps].
* Root zone depth    = Depth of the modelled soil layer [mm]
*
*                                         Root
*                             Plt.  Grow. zone
*Cr                        Kd per.  seas. depth
*ix Crop name              cr [#ts] [#ts] [mm]
*-- ---------------------- -- ----- ----- -----
  1 'Paddy Kharif        '  1     1    11  400.
  2 'Light Kharif        '  2     1     9  600.
  3 'Light Rabi          '  2     1     9  600.
  4 'Cotton              '  2     2    14 1000.
  5 'Sugar Cane          '  2     1    22 1000.
  6 'Garden              '  2     1    22  600.
```

Cropfact.dat : Crop factor per time step in growing season (half monthly time step). Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Crop factors data
* =============================
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data per column
* ----------------------------------
* Ts Ix        = Time step index within growing period (excl. land
*                preparation)
* Crop factors = Kc - values for each time step in growing season and crop
*                (in the order as defined in Cropdata.drn file) [-].
*
* Ts  Crop factors for each time step in growing season and crop (in the
*     order as defined in Cropdata.dat file) (-).
*
* Length of growing period (time steps) defined in Cropdata-file :
*
*         11     9     9    14    22    22
*
* ix       1     2     3     4     5     6     7     8     9    10
*----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----
     1  1.10  0.45  0.70  0.30  0.40  0.80
     2  1.10  0.45  0.70  0.30  0.40  0.80
     3  1.10  0.80  1.00  0.75  0.75  0.80
     4  1.10  0.80  1.00  0.75  0.75  0.80
     5  1.05  1.15  1.15  0.75  0.95  0.80
     6  1.05  1.15  1.15  0.75  0.95  0.80
     7  1.05  0.90  0.90  1.20  1.10  0.80
     8  1.05  0.90  0.90  1.20  1.10  0.80
     9  0.95  0.90  0.90  1.20  1.25  0.80
    10  0.95  0.00  0.00  1.20  1.25  0.80
    11  0.00  0.00  0.00  0.95  1.25  0.80
    12  0.00  0.00  0.00  0.95  1.25  0.80
    13  0.00  0.00  0.00  0.90  1.25  0.80
    14  0.00  0.00  0.00  0.90  1.25  0.80
    15  0.00  0.00  0.00  0.00  1.25  0.80
    16  0.00  0.00  0.00  0.00  1.25  0.80
    17  0.00  0.00  0.00  0.00  0.95  0.80
    18  0.00  0.00  0.00  0.00  0.95  0.80
    19  0.00  0.00  0.00  0.00  0.70  0.80
    20  0.00  0.00  0.00  0.00  0.70  0.80
    21  0.00  0.00  0.00  0.00  0.70  0.80
    22  0.00  0.00  0.00  0.00  0.70  0.80
```

DelftAGRI.dat : Specification for daily output on field level.

```
ODS 1.00DRN 2.00XXXXXXXX 1.00
*
* DelftAGRI control data if connected to module Simproc
* =====================================================
*
* Reading format : free format
*
* DelftAGRI Operation mode : 0 = stand alone
*                             1 = Ribasim pre-processor
*
        1
*
* For stand-alone operation mode
* ==============================
*
* 1. DelftAGRI simulation period : - starting year and time step
*                                  - end      year and time step
* 2. Cutback percentage [%] : Reduction on the full supply at water
*                              allocation phase
*                              <  0.0 : Allocation is computed by Ribasim
*                                       module Simproc
*                              >= 0.0 : Allocation = Demand * (1. – Cutback
*                                       percentage // 100.)
*
   1951 1 1951 24
      50.0
*
* For both operation modes
* ========================
*
* Switch to generate daily output His-files :
*
* 11.Irrigation block results     :dlyblkrslt.his
* 12.Cultivation results          :dlycltrslt.his
* 13.Cultivation strip results    :dlystrrslt.his
* 14.Strip field results          :dlyfldrslt.his
*
* = 1 then output files are generated
* = 0 then no output files are generated
*
           0
```

Deswtlvl.dat : Desired water level on the field per time step in growing season., only relevant for flood basin crops (half monthly time step). Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Desired water level on the field (only relevant for flood
* basin crops)
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data
* -----------------------
* Ts Ix               = Time steps within growing period (excl. land prep)
* Desired water level = The desired water layer on the field for flood
*                       basin crops like paddy for
*                       each crop and time step in growing season [mm
*                       above soil saturation capacity].
*                       For dry land crop the desired soil moisture equals
*                       to the field capacity.
*
* Length of growing period (time steps) defined in Cropdata-file :
*         11     9     9    14    22    22
*
*  Ts  Desired water layer on the field for flood basin crops like paddy
*      for each time step in growing season and crop (in the order as
*      defined in Cropdata.dat file).
*  ix      1     2     3     4     5     6     7     8     9    10
*----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----
     1  30.0   0.0   0.0   0.0   0.0   0.0
     2  30.0   0.0   0.0   0.0   0.0   0.0
     3  50.0   0.0   0.0   0.0   0.0   0.0
     4  50.0   0.0   0.0   0.0   0.0   0.0
     5  50.0   0.0   0.0   0.0   0.0   0.0
     6  50.0   0.0   0.0   0.0   0.0   0.0
     7  30.0   0.0   0.0   0.0   0.0   0.0
     8  30.0   0.0   0.0   0.0   0.0   0.0
     9  20.0   0.0   0.0   0.0   0.0   0.0
    10   0.0   0.0   0.0   0.0   0.0   0.0
    11   0.0   0.0   0.0   0.0   0.0   0.0
    12   0.0   0.0   0.0   0.0   0.0   0.0
    13   0.0   0.0   0.0   0.0   0.0   0.0
    14   0.0   0.0   0.0   0.0   0.0   0.0
    15   0.0   0.0   0.0   0.0   0.0   0.0
    16   0.0   0.0   0.0   0.0   0.0   0.0
    17   0.0   0.0   0.0   0.0   0.0   0.0
    18   0.0   0.0   0.0   0.0   0.0   0.0
    19   0.0   0.0   0.0   0.0   0.0   0.0
    20   0.0   0.0   0.0   0.0   0.0   0.0
    21   0.0   0.0   0.0   0.0   0.0   0.0
    22   0.0   0.0   0.0   0.0   0.0   0.0
```

Extwtdmd.dat : Extra water layer demand on the field per time step in growing season., only relevant for flood basin crops. Used in the crop plan editor (half monthly time step). Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* Extra water layer demand on the field (only relevant for flood basin
* crops) for crop planning (Cropper)
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data
* -----------------------
* Ts Ix                    = Time steps within growing period (excl. land
*                            preparation)
* Extra water layer demand = The extra demand for a water layer on
*                            the field for flood basin crops for
*                            each time step in growing season [mm]
*                            like paddy. This usually occurs during the
*                            first time step of the growing season or
*                            after 1 or 3 months for application of
*                            fertilizer. The values should be equal to
*                            the positive changes in water layer.
*                            Aware that the extra demand at the first
*                            time step is also an extra demand at the
*                            land-preparation time step above the
*                            pre-saturation requirement.
*
* Length of growing period (time steps) defined in Cropdata-file :
*
*         11     9     9    14    22    22
*
* Ts   Extra water layer demand for each time steps within growing period
*      and crop (in the order as defined in Cropdata.dat file) [mm]
* ix       1     2     3     4     5     6     7     8     9    10
*----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----
     1  50.0   0.0   0.0   0.0   0.0   0.0
     2   0.0   0.0   0.0   0.0   0.0   0.0
     3   0.0   0.0   0.0   0.0   0.0   0.0
     4   0.0   0.0   0.0   0.0   0.0   0.0
     5   0.0   0.0   0.0   0.0   0.0   0.0
     6   0.0   0.0   0.0   0.0   0.0   0.0
     7   0.0   0.0   0.0   0.0   0.0   0.0
     8   0.0   0.0   0.0   0.0   0.0   0.0
     9   0.0   0.0   0.0   0.0   0.0   0.0
    10   0.0   0.0   0.0   0.0   0.0   0.0
    11   0.0   0.0   0.0   0.0   0.0   0.0
    12   0.0   0.0   0.0   0.0   0.0   0.0
    13   0.0   0.0   0.0   0.0   0.0   0.0
    14   0.0   0.0   0.0   0.0   0.0   0.0
    15   0.0   0.0   0.0   0.0   0.0   0.0
    16   0.0   0.0   0.0   0.0   0.0   0.0
    17   0.0   0.0   0.0   0.0   0.0   0.0
    18   0.0   0.0   0.0   0.0   0.0   0.0
    19   0.0   0.0   0.0   0.0   0.0   0.0
    20   0.0   0.0   0.0   0.0   0.0   0.0
    21   0.0   0.0   0.0   0.0   0.0   0.0
    22   0.0   0.0   0.0   0.0   0.0   0.0
```

FldBfrSt.dat : Field buffer storage per time step in growing season (mm above desired field water level or soil moisture) (half monthly time step). Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Field buffer storage (mm above desired field water level or
* soil moisture)
*
* Storage above the desired field water level or soil moisture from where
* drainage will start to the next field [mm].
* 1. For flood basin crops the desired field water level is specified in
*    the file Deswtlvl.dat.
* 2. For dry-land crops the desired soil moisture equals to the soil field
*    capacity [% of RZ] specified at the advanced
*    irrigation node model data.
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data
* -----------------------
* Ts Ix               = Time steps within growing period (excl. land
*                       preparation)
* Desired water level = Field buffer storage for each crop (in the order as
*                       defined in Cropdata.dat file) at each time step
*                       within growing period (excl. land preparation) [mm]
*
* Length of growing period (time steps) defined in Cropdata-file :
*         11     9     9    14    22    22
*
* Ts  Field buffer storage for each time steps within growing period and
*     crop (in the order as defined in Cropdata.dat file) [mm]
* ix       1     2     3     4     5     6     7     8     9    10
*----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----
     1   0.0   0.0   0.0   0.0   0.0   0.0
     2   0.0   0.0   0.0   0.0   0.0   0.0
     3   0.0   0.0   0.0   0.0   0.0   0.0
     4   0.0   0.0   0.0   0.0   0.0   0.0
     5   0.0   0.0   0.0   0.0   0.0   0.0
     6   0.0   0.0   0.0   0.0   0.0   0.0
     7   0.0   0.0   0.0   0.0   0.0   0.0
     8   0.0   0.0   0.0   0.0   0.0   0.0
     9   0.0   0.0   0.0   0.0   0.0   0.0
    10   0.0   0.0   0.0   0.0   0.0   0.0
    11   0.0   0.0   0.0   0.0   0.0   0.0
    12   0.0   0.0   0.0   0.0   0.0   0.0
    13   0.0   0.0   0.0   0.0   0.0   0.0
    14   0.0   0.0   0.0   0.0   0.0   0.0
    15   0.0   0.0   0.0   0.0   0.0   0.0
    16   0.0   0.0   0.0   0.0   0.0   0.0
    17   0.0   0.0   0.0   0.0   0.0   0.0
    18   0.0   0.0   0.0   0.0   0.0   0.0
    19   0.0   0.0   0.0   0.0   0.0   0.0
    20   0.0   0.0   0.0   0.0   0.0   0.0
    21   0.0   0.0   0.0   0.0   0.0   0.0
    22   0.0   0.0   0.0   0.0   0.0   0.0
```

InstDran.dat : Instantaneous drainage water level on the field per time step in growing season) at the beginning of the time step, only relevant for flood basin crops (half monthly time step). Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Instantaneous drainage water level on the field (only
* relevant for flood basin crops) at the beginning of the time step
* =================================================================
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data
* -----------------------
* Ts Ix               = Time step index within growing period (excl. land
*                       preparation) [-]
* Desired water level = The desired water layer on the field for flood
*                       basin crops after instantaneous drainage at
*                       the beginning of the time step for each time step
*                       in growing season [mm above soil saturation
*                       capacity]. If value equals to -1.0 then value is
*                       skipped.
*
* Length of growing period (time steps) defined in Cropdata-file :
*        11     9     9    14    22    22
*
* Ts   Desired water level for each time step index within growing period
*      and crop (in the order as defined in Cropdata.dat file) [mm above
*      soil saturation capacity]
* ix      1     2     3     4     5     6     7     8     9    10
*----- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ----
     1    -1    -1    -1    -1    -1    -1
     2    -1    -1    -1    -1    -1    -1
     3    -1    -1    -1    -1    -1    -1
     4    -1    -1    -1    -1    -1    -1
     5    -1    -1    -1    -1    -1    -1
     6    -1    -1    -1    -1    -1    -1
     7    -1    -1    -1    -1    -1    -1
     8    -1    -1    -1    -1    -1    -1
     9    -1    -1    -1    -1    -1    -1
    10    -1    -1    -1    -1    -1    -1
    11    -1    -1    -1    -1    -1    -1
    12    -1    -1    -1    -1    -1    -1
    13    -1    -1    -1    -1    -1    -1
    14    -1    -1    -1    -1    -1    -1
    15    -1    -1    -1    -1    -1    -1
    16    -1    -1    -1    -1    -1    -1
    17    -1    -1    -1    -1    -1    -1
    18    -1    -1    -1    -1    -1    -1
    19    -1    -1    -1    -1    -1    -1
    20    -1    -1    -1    -1    -1    -1
    21    -1    -1    -1    -1    -1    -1
    22    -1    -1    -1    -1    -1    -1
```

Irrpract.dat : Irrigation practise : on - off supply switch per time step in growing season (half monthly time step). M Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Irrigation practise : on - off supply switch during growing
* period
* ======================================================================
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data
* -----------------------
* Ts Ix         = Time step index within growing period (excl. land
*                 preparation) [-]
* On-Off switch = On - off supply indication for each crop and time step in
*                 growing season :
*
*                 0 : Supply off
*                 1 : Supply on
*
* Length of growing period (time steps) defined in Cropdata-file :
*
*         11     9     9    14    22    22
*
* Ts    On-off indication for each time step index within growing period
*       and crop (in the order as defined in Cropdata.dat file).
* ix       1     2     3     4     5     6     7     8     9    10
*----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----
     1     1     1     1     1     1     1
     2     1     1     1     1     1     1
     3     1     1     1     1     1     1
     4     1     1     1     1     1     1
     5     1     1     1     1     1     1
     6     1     1     1     1     1     1
     7     1     1     1     1     1     1
     8     1     1     1     1     1     1
     9     1     1     1     1     1     1
    10     1     1     1     1     1     1
    11     1     1     1     1     1     1
    12     1     1     1     1     1     1
    13     1     1     1     1     1     1
    14     1     1     1     1     1     1
    15     1     1     1     1     1     1
    16     1     1     1     1     1     1
    17     1     1     1     1     1     1
    18     1     1     1     1     1     1
    19     1     1     1     1     1     1
    20     1     1     1     1     1     1
    21     1     1     1     1     1     1
    22     1     1     1     1     1     1
```

YldRpFct.dat : Yield response factors per time step in growing season (half monthly time step). Maximum growing period is 22 for crops sugar cane and garden (crop 5 and 6).

```
ODS 1.00DAT 2.00XXXXXXXX 1.00
*
* DelftAGRI : Yield response factors data
* ========================================
*
* Reading format : free format (file version in header must be 2.0)
*
* Description of the data
* -----------------------
* Ts Ix        = Time step index within growing period (excl. land
*                preparation) [-]
* Crop factors = The Ky - values for each time step in growing season [-].
*
* Length of growing period (time steps) defined in Cropdata-file :
*
*         11     9     9    14    22    22
*
* Ts  Yield response factors for each time steps within growing period and
*     crop (in the order as defined in Cropdata.dat file) [-]
* ix       1     2     3     4     5     6     7     8     9    10
*----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----
     1  1.10  0.45  0.70  0.30  0.40  0.80
     2  1.10  0.45  0.70  0.30  0.40  0.80
     3  1.10  0.80  1.00  0.75  0.75  0.80
     4  1.10  0.80  1.00  0.75  0.75  0.80
     5  1.05  1.15  1.15  0.75  0.95  0.80
     6  1.05  1.15  1.15  0.75  0.95  0.80
     7  1.05  0.90  0.90  1.20  1.10  0.80
     8  1.05  0.90  0.90  1.20  1.10  0.80
     9  0.95  0.90  0.90  1.20  1.25  0.80
    10  0.95  0.00  0.00  1.20  1.25  0.80
    11  0.00  0.00  0.00  0.95  1.25  0.80
    12  0.00  0.00  0.00  0.95  1.25  0.80
    13  0.00  0.00  0.00  0.90  1.25  0.80
    14  0.00  0.00  0.00  0.90  1.25  0.80
    15  0.00  0.00  0.00  0.00  1.25  0.80
    16  0.00  0.00  0.00  0.00  1.25  0.80
    17  0.00  0.00  0.00  0.00  0.95  0.80
    18  0.00  0.00  0.00  0.00  0.95  0.80
    19  0.00  0.00  0.00  0.00  0.70  0.80
    20  0.00  0.00  0.00  0.00  0.70  0.80
    21  0.00  0.00  0.00  0.00  0.70  0.80
    22  0.00  0.00  0.00  0.00  0.70  0.80
```

Deltares

F Hydrological scenario

F.1 Definition of a hydrological scenario

A hydrological scenario is defined by a list of time series files which are outlined in the definition file *HDtimeSr.dat*. This file defines all time series files used in the hydrological scenario and are stored in the sub-directory *Hydrolog* of the Rbn-directory e.g. scenario 1 for the Citarum river basin is stored in sub-directory *\Citarum.Rbn\Hydrolog\Scenario.1.* The format of the file *HDtimeSr.dat* 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.
- One record with the number of files names, presently this must be 12.
- Some comment records: records with an asterisk (*) in the first column.
- The actual names of the time series files with following data :

  1. Actual inflow data
  2. Loss flow data
  3. Actual rainfall data
  4. Open water evaporation data
  5. General district demand data
  6. General district discharge data
  7. Minimum (environmental) flow data
  8. Monitored (recording) flow data
  9. Dependable rainfall data
  10. Dependable river flow data (used at the crop planning only)
  11. Reference crop evapotranspiration data
  12. Expected inflow data
  13. Potential evapotranspiration data (for Sacramento model)

Example:

```
ODS 1.00DAT 1.01XXXXXXXX 6.00
*
* Hydrological time series data
* =============================
*
* This files defines all time series files used in the hydrological scen.
*
* Reading format : Free format
*
* Number of files
*
     12
*
* For each type of hydrological time series the following data :
*
* 1. Index type of hydrological time series (integer value).
*
*    Long time series   :  1 = Actual inflow data
*                          2 = Loss flow data
*                          3 = Actual rainfall data
*                          4 = Open water evaporation data
*                          5 = General district demand data
*                          6 = General district discharge data
*                          7 = Low (environmental) flow data
*                          8 = Monitored (recording) flow data
*                         13 = Potential evapotranspiration
*                              data (for Sacramento model)
*
*    Annual time series :  9 = Dependable rainfall data
*                         10 = Dependable river flow data
*                              (used only by crop plan editor Cropper)
*                         11 = Reference crop evapotranspiration data
*                         12 = Expected inflow data
*
* 2. Hydrol. time series file name (between quotes, max. 20 characters)
*    The following file types are accepted:
*
*    TMS = ASCII standard RIBASIM time series format
*    SWD = ASCII file format defined in Hydrology Project (India)
*    HIS = Delft Hydraulics binary time series file format (in rpogress)
*    XML = Standard XML file format for Delft FEWS / DEWS (in progress)
*
*  1          2
*---   --------------------
   1   'Actinflw.tms'
   2   'Lossflow.tms'
   3   'Actrain.tms'
   4   'Evaporat.tms'
   5   'Disdemnd.tms'
   6   'Disdisch.tms'
   7   'Lowflow.tms'
   8   'Recrdflw.tms'
   9   'Deprain.tms'
  10   'Depupflw.tms'
  11   'Refevapo.tms'
  12   'Expinflw.tms'
  13   'PotEvapo.tms'
```

F.2 Hydrological time series files

The type and number of hydrological data time series depends on the type of nodes which are included in the river basin network schematisation. RIBASIM may require multiple year (long) and annual time series. Table F.1 and Table F.2 show an overview of the type of data and the node types which require those data.

Table F.1 Overview of multiple year time series files.

Data description	**Node type**	**Valid unit(s)**	**Default time series file name**
District demand	General district node	m3/s	DISDEMND.TMS
District discharge	General district node	m3/s	DISDISCH.TMS
Open water evaporation	Surface water reservoir node (1) Fish pond Link storage node(2)	mm/day, mm/time step	EVAPORAT.TMS
Actual rainfall	Surface water reservoir node (1) Link storage node(2) Fish pond Variable irrigation node Advanced irrigation node	mm/day, mm/time step	ACTRAIN.TMS
Loss flow	Loss flow node	m3/s	LOSSFLOW.TMS
Actual inflow (upstream boundary flows)	Variable inflow node	m3/s, mm/day, mm/time step	ACTINFLW.TMS
Minimum (environmental) flow	Low flow node	m3/s	LOWFLOW.TMS
Monitored (recorded) flow	Recording node	m3/s	RECRDFLW.TMS
Potential evapotranspiration	Variable inflow node (3)	mm/day	POTEVAP.TMS

(1) For hydrology data: no use of the annual net-evaporation time series

(2) For routing methods: fixed storage, Manning, Q-h relation and Puls method.

(3) For applied procedure: Sacramento rainfall-runoff model.

Table F.2 Overview of annual time series files.

Data description	**Node type**	**Valid unit(s)**	**Default time series file name**
Dependable rainfall	Advanced irrigation node Variable irrigation node(1)	mm/day, mm/time step	DEPRAIN.TMS
Dependable river flow (used by crop planning component Cropper)	Advanced irrigation node	m3/s	DEPUPFLW.TMS
Reference crop evapotranspiration	Advanced irrigation node	mm/day, mm/time step	REFEVAPO.TMS
Expected inflow	Variable inflow node(2)	m3/s	EXPINFLW.TMS

(1) Used if at Hydrology data the switch “Apply expected (dependable) rainfall” is on.

(2) Used when surface water reservoir is operated on expected inflows.

F.3 Format of multiple year time series files

The multiple year time series data as shown in Table F.1 must be stored in a Tms- or SWDes- equidistant file format.

TMS-file Version 1.01 and 1.04 format

The multiple year time series data which are stored in a TMS-file format may have 2 versions supported:

1. Version 1.01 on time step basis, or
2. Version 1.04 on daily calendar basis.

The formats are outlined below.

The **TMS-file Version 1.01** format is based on the simulation time step as follows (an example is shown below) :

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

  ODS 1.00TMS 1.01XXXXXXX 6.00

- Some comment records: records with an asterisk (*) in the first column.
- One record with two integer values indicating:
  - o the number of time series in the file, and
  - o the unit index of the time series values:

Unit index	Unit
1	m3/s
2	mm/day
3	mm/time step

- One or more records with for each time series the name of the station (max. 20 characters) between single quotes (') and separated by at least one space or a comma.
- One or more records with for each time series the index of the station (max. 8 digits) and separated by at least one space or a comma.
- One record for each time step with values for all time series in free format, which means that the data items must be separated by at least one space or a comma. The record contains the following items:

Data item	Description
1	Year index e.g. 1956
2	Time step index e.g. if time step is monthly then value 1 to 12.
3	Day index within the time step If day index = 0 then value for the whole time step. If day index > 0 then value for the day
4	Time series values for each time series in the unit as specified in previous record.

Example of time series TMS-file Version 1.01 for a half-monthly simulation time step:

```
ODS 1.00TMS 1.01XXXXXXX  6.00
      4     1
'Inflow series 1     '
'Inflow series 2     '
'Inflow series 3     '
'Inflow series 4     '
                     1         2         3         4
1999   1   0   124.300   116.600     9.900     0.000
1999   2   0   110.000   105.600     8.800     0.000
1999   3   0   149.600   139.700    11.000     0.000
1999   4   0   185.900   169.400    12.100     0.000
1999   5   0    51.700    56.100     6.600     0.000
1999   6   0    34.100    41.800     0.000     0.000
1999   7   0    30.800    39.600     5.500     0.000
1999   8   0    25.300    34.100     5.500     0.000
1999   9   0    17.600    26.400     5.500     0.000
1999  10   0    26.400    35.200     4.400     0.000
1999  11   0    50.600    56.100     6.600     0.000
1999  12   0   115.500   110.000     8.800     0.000
1999  13   0   122.100   116.600    16.500     0.000
1999  14   0    99.000   139.700     4.400     0.000
1999  15   0   158.400    37.400   118.800     0.000
1999  16   0   198.000   106.700    84.700     0.000
1999  17   0   193.600   183.700     5.500     0.000
1999  18   0    70.400    72.600     6.600     0.000
1999  19   0    33.000    40.700     0.000     0.000
1999  20   0    28.600    36.300     0.000     0.000
1999  21   0    20.900    29.700     0.000     0.000
1999  22   0    49.500    53.900    47.300     0.000
1999  23   0   154.000   143.000     0.000     0.000
1999  24   0   122.100   115.500     0.000     0.000
2000   1   0    69.300    48.400     7.700     0.000
2000   2   0   189.200    83.600    16.500     0.000
2000   3   0    68.200    68.200     8.800     0.000
2000   4   0    51.700    60.500     6.600     0.000
2000   5   0   113.300    79.200    12.100     0.000
2000   6   0    89.100    92.400    11.000     0.000

etc
```

The **TMS-file Version 1.04** format is based on calendar days as follows (an example is shown below):

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

  ODS 1.00TMS 1.04XXXXXXX 6.00

- Some comment records: records with an asterisk (*) in the first column.
- One record with two integer values indicating :
- the number of time series in the file, and
- the unit index of the time series values :

Unit index	Unit
1	m3/s
2	mm/day
3	mm/time step

- One or more records with for each time series the name of the station (max. 20 characters) between single quotes (') and separated by at least one space or a comma.
- One or more records with for each time series the index of the station (max. 8 digits) and separated by at least one space or a comma.
- One record for each time step with values for all time series in free format, which means that the data items must be separated by at least one space or a comma. The record contains the following items:

Data item	Description
1	Year index e.g. 1956
2	Time step index e.g. if time step is monthly then value 1 to 12.
3	Day index within the time step If day index = 0 then value for the whole time step. If day index > 0 then value for the day
4	Time series values for each time series in the unit as specified in previous record.

Example of time series TMS-file Version 1.04:

```
ODS 1.00TMS 1.04RANGEN   6.00Recordflow
*
* Aware : Tms - file version 1.04 = calendar days
*
* Writing format : free format
* Record 1     : Number of stations / series in file and
*                Unit index of time series values : 1 = m3/s    or
*                                                   2 = mm/day  or
*                                                   3 = mm/tms
* Record 2     : Name of station (max. 20 characters) for each station
* Record 3     : Station index (max. 8 digits) for each station
* Next records : Year index,
*                Month index (1=Jan, 2=Feb, 3=Mar. etc),
*                Day index within the month,
*                Time series values for each station
*
       4     1
'Record flow series 1     '
'Record flow series 2     '
'Record flow series 3     '
'Record flow series 4     '
                   1         2         3         4
1958  1  1   124.300   116.600     9.900     0.000
1958  1  2   110.000   105.600     8.800     0.000
1958  1  3   149.600   139.700    11.000     0.000
1958  1  4   185.900   169.400    12.100     0.000
1958  1  5    51.700    56.100     6.600     0.000
1958  1  6    34.100    41.800     0.000     0.000
1958  1  7    30.800    39.600     5.500     0.000
1958  1  8    25.300    34.100     5.500     0.000
1958  1  9    17.600    26.400     5.500     0.000
1958  1 10    26.400    35.200     4.400     0.000
1958  1 11    50.600    56.100     6.600     0.000
1958  1 12   115.500   110.000     8.800     0.000
1958  1 13   122.100   116.600    16.500     0.000
1958  1 14    99.000   139.700     4.400     0.000
1958  1 15   158.400    37.400   118.800     0.000
1958  1 16   198.000   106.700    84.700     0.000
1958  1 17   193.600   183.700     5.500     0.000
1958  1 18    70.400    72.600     6.600     0.000
1958  1 19    33.000    40.700     0.000     0.000
1958  1 20    28.600    36.300     0.000     0.000
1958  1 21    20.900    29.700     0.000     0.000
1958  1 22    49.500    53.900    47.300     0.000
1958  1 23   154.000   143.000     0.000     0.000
1958  1 24   122.100   115.500     0.000     0.000
1958  1 25    69.300    48.400     7.700     0.000
1958  1 26   189.200    83.600    16.500     0.000
1958  1 27    68.200    68.200     8.800     0.000
1958  1 28    51.700    60.500     6.600     0.000
1958  1 29   113.300    79.200    12.100     0.000
1958  1 30    89.100    92.400    11.000     0.000
1958  1 31   104.500   116.600    14.300     0.000
1958  2  1    18.700    19.800     2.200     0.000
1958  2  2    12.100    12.100     1.100     0.000
1958  2  3    11.000    17.600     2.200     0.000
1958  2  4    53.900    81.400     7.700     0.000
1958  2  5   127.600   123.200    15.400     0.000

etc.
```

SWDes-equidistant file format

Each time series SWDes-file (Surface water Dat Entry Software-file defined for Hymos4) may have many blocks of data, each block is a series with specified series ID and start date. The file contains a file header record followed by data blocks. Each block must contain a header and lines with data. The file has the following format:

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

  ODS 1.00SWD 1.00XXXXXXX 6.00UnitId=1

  With the unit ID is the same as defined for the Tms-files:

Unit index	Unit
1	m3/s
2	mm/day
3	mm/time step

- Layout of the block:
  - Some comment records: records with an exclamation sign (!) in the first column.
  - One lines with the following information. A comma is used as separator between the different items.
    - Time interval unit: 1=Year, 2=Month, 3=Day, 4=Hour (defined Hymos date index)
    - Time interval divider,
    - Basic unit interval,
    - Replicator,
    - Number of series,
    - Number of data values,
    - Starting date
- One lines with the following information. A comma is used as separator between the different items.
  - Station ID,
  - Parameter ID.
- The data lines are values separated by a comma.

Example:

```
ODS01.00SWD01.00XXXXXXXx06.00UnitId=1
!
! SWDES Equidistant data.
!
! UnitId in header : 1 = m3/s    or
!                    2 = mm/day  or
!                    3 = mm/tms
!
! Record 1:
!  Time interval unit : 1=Year, 2=Month, 3=Day, 4=Hour (Hymos date index)
!  Time interval divider
!  Basic time unit interval
!  Replicator
!  Number of series
!  Number of data values
!  Starting date (yyyy-mm-dd)
!
! Records 2 per series:
!  Station ID (no spaces)
!  Parameter ID (no spaces)
!
! Following records: Data values
!
2,2,0,0,4,48,1999-01-01
Inflow_Series_1,HH
Inflow_Series_2,HH
Inflow_Series_3,HH
Inflow_Series_4,HH
 124.3 116.6   9.9   0.0
 110.0 105.6   8.8   0.0
 149.6 139.7  11.0   0.0
 185.9 169.4  12.1   0.0
  51.7  56.1   6.6   0.0
  34.1  41.8   0.0   0.0
  30.8  39.6   5.5   0.0
  25.3  34.1   5.5   0.0
  17.6  26.4   5.5   0.0
  26.4  35.2   4.4   0.0
  50.6  56.1   6.6   0.0
 115.5 110.0   8.8   0.0
 122.1 116.6  16.5   0.0
  99.0 139.7   4.4   0.0
 158.4  37.4 118.8   0.0
 198.0 106.7  84.7   0.0
 193.6 183.7   5.5   0.0

etc
```

F.4 Format of annual time series files

The annual time series data as shown in Table F.2 must be stored in a TMS-file format. There are 2 versions supported:

- Version 2.00 on time step basis, or
- Version 3.00 on daily basis.

The formats are outlined below.

The **TMS-file Version 2.00** is as follows (an example is shown below):

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

  ODS 1.00TMS 2.00HANDMADE 1.00

- Some comment records: records with an asterisk (*) in the first column.
- One record with two integer values indicating :
  - o the number of time series in the file, and
  - o the unit index of the time series values :

Unit index	Unit
1	m3/s
2	mm/day
3	mm/time step

- One or more records with for each time series the name of the station (max. 20 characters) between single quotes (') and separated by at least one space or a comma.
- One or more records with for each time series the index of the station (max. 8 digits) and separated by at least one space or a comma.
- One record for each time step with values for all time series in free format, which means that the data items must be separated by at least one space or a comma. The record contains the following items:

Data item	Description
1	Time step index e.g. if simulation time step is monthly then value 1 to 12.
2	Time series values for each time series in the unit as specified in previous record.

Example of annual time series TMS-file Version 2.00 for a half-monthly simulation time step:

```
ODS 1.00TMS 2.00HANDMADE 1.00
*
* Dependable river time series (used for Cropper / Totplan)
* =========================================================
*
* Reading format : free format
*
* Description of layout
* =====================
* Record 1     : Number of series in file
*                Unit index of time series values : 1 = m3/s    or
*                                                   2 = mm/day  or
*                                                   3 = mm/tms  or
* Record 2     : Name of series (max. 20 characters)
* Record 3     : Series index
* Next records : Time step index.
*                Values for each time series.
*
       3     1
'Intake 1'
'Intake 2'
'Intake 3 '
           1      2      3
    1   5.00  10.00  15.00
    2   5.00  10.00  15.00
    3   5.00  10.00  15.00
    4   5.00  10.00  15.00
    5   5.00  10.00  15.00
    6   5.00  10.00  15.00
    7   5.00  10.00  15.00
    8   5.00  10.00  15.00
    9   5.00  10.00  15.00
   10   5.00  10.00  15.00
   11   5.00  10.00  15.00
   12   5.00  10.00  15.00
   13   5.00  10.00  15.00
   14   5.00  10.00  15.00
   15   5.00  10.00  15.00
   16   5.00  10.00  15.00
   17   5.00  10.00  15.00
   18   5.00  10.00  15.00
   19   5.00  10.00  15.00
   20   5.00  10.00  15.00
   21   5.00  10.00  15.00
   22   5.00  10.00  15.00
   23   5.00  10.00  15.00
   24   5.00  10.00  15.00
```

The **TMS-file Version 3.00** is as follows (an example is shown below) :

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

  ODS 1.00TMS 3.00HANDMADE 1.00

- Some comment records: records with an asterisk (*) in the first column.
- One record with two integer values indicating:
  - the number of time series in the file, and
  - the unit index of the time series values:

Unit index	Unit
1	m3/s
2	mm/day
3	mm/time step

- One or more records with for each time series the name of the station (max. 20 characters) between single quotes (') and separated by at least one space or a comma.
- One or more records with for each time series the index of the station (max. 8 digits) and separated by at least one space or a comma.
- One record for each time step with values for all time series in free format, which means that the data items must be separated by at least one space or a comma. The record contains the following items:

Data item	Description
1	Day index within year
2	Day index within month
3	Month index
4	Daily time series values for each time series in the unit as specified in previous record.

- If you simulate on a weekly time step then the annual TMS Version 3.00 time series file must have 371 daily records (53 * 7 days). You can continue the counting of the days from 366 till 371 e.g. for 2 time series

```
 ......
 366   32   12    5.19    4.44
 367   33   12    4.20    4.03
 368   34   12    4.20    4.03
 369   35   12    4.13    3.80
 370   36   12    4.19    3.81
 371   37   12    4.20    4.03
```

Example of annual time series TMS-file Version 3.00:

```
ODS 1.00TMS 3.00HANDMADE 1.00
*
* Aware : Tms - file version 3.00 = calendar days
*
* Dependable river time series (used for Cropper / Totplan)
* ==========================================================
*
* Description of layout
* =====================
* Record 1     : Number of series in file
*                Unit index of time series values : 1 = m3/s    or
*                                                   2 = mm/day  or
*                                                   3 = mm/tms
* Record 2     : Name of series (max. 20 characters)
* Record 3     : Series index
* Next records : Day index within year.
*                Day index within month.
*                Month index.
*                Daily values for each time series.
*
       3     1
'Intake 1'
'Intake 2'
'Intake 3'
                      1       2       3
    1     1   1     5.0    10.0    15.0
    2     2   1     5.0    10.0    15.0
    3     3   1     5.0    10.0    15.0
    4     4   1     5.0    10.0    15.0
    5     5   1     5.0    10.0    15.0
    6     6   1     5.0    10.0    15.0
    7     7   1     5.0    10.0    15.0
    8     8   1     5.0    10.0    15.0
    9     9   1     5.0    10.0    15.0
   10    10   1     5.0    10.0    15.0
   11    11   1     5.0    10.0    15.0

……………………………………

  347    13  12     5.0    10.0    15.0
  348    14  12     5.0    10.0    15.0
  349    15  12     5.0    10.0    15.0
  350    16  12     5.0    10.0    15.0
  351    17  12     5.0    10.0    15.0
  352    18  12     5.0    10.0    15.0
  353    19  12     5.0    10.0    15.0
  354    20  12     5.0    10.0    15.0
  355    21  12     5.0    10.0    15.0
  356    22  12     5.0    10.0    15.0
  357    23  12     5.0    10.0    15.0
  358    24  12     5.0    10.0    15.0
  359    25  12     5.0    10.0    15.0
  360    26  12     5.0    10.0    15.0
  361    27  12     5.0    10.0    15.0
  362    28  12     5.0    10.0    15.0
  363    29  12     5.0    10.0    15.0
  364    30  12     5.0    10.0    15.0
  365    31  12     5.0    10.0    15.0
```

G Water quality scenario

The definition of a water quality scenario is only used if the water quality computation or the “Water quality” or “Flow composition (user defined)” is switched on at the task block “Specify simulation control data”. Water quality scenarios are defined outside RIBASIM by creating different Scenario directories.

G.1 Definition of a water quality scenario

A water quality scenario is defined by a list of substances and associated look-up table files which are outlined in the definition file *WQsubsta.dat*. The look-up tables contain the waste loads of the concerned source. The waste load can be specified in 3 ways:

- as a concentration;
- as an additional load to the incoming flow; and
- as a retention percentage of the incoming concentration.

All files are stored in the sub-directory *Lookup* of the Rbn-directory e.g. scenario 1 for the Citarum river basin is stored in sub-directory *\Citarum.Rbn\Lookup\ Scenario.1.* The format of the file *WQsubsta.dat* 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.
- One record with the number of substances (maximal 25).
- Some comment records: records with an asterisk (*) in the first column.
- One record for each substance with the following data:
  - Substance index (integer value)
  - Full substance name and unit (between quotes, max. 40 characters)
  - Look-up table file name (between quotes, max. 20 characters)

Example:

```
ODS 1.00DAT 1.00XXXXXXXX 6.00
*
* Water quality substances definition data
* ========================================
*
* This files contains all computed water quality substances.
*
* Reading format : Free format
*
* Number of substances (max. 25)
*
     3
*
* For each substance the following data :
*
* 1. Substance index (integer value)
* 2. Full substance name and unit (between quotes, max. 40 characters)
* 3. Look-up table file name (between quotes, max. 20 characters)
*
* 1                        2                                 3
*---  ----------------------------------------   --------------------
  1  'Nitrogen [mg/liter]                     ' 'Nitrogen.Lkp       '
  2  'Posphorus [mg/liter]                    ' 'Posphorus.Lkp      '
  3  'BOD [mm/liter]                          ' 'BOD.Lkp            '
```

G.2 Format of the Look-up table files

The look-up tables for each substance must be stored in the LKP-file format. There are 2 versions supported:

- Version 1.00 on time step basis in concentration only, or
- Version 1.01 on time step basis in concentrations, additional loads and retention percentage.

The formats are outlined below.

The **LKP-file Version 1.00** format is based on the waste load as concentration only, and is as follows (an example is shown below) :

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

  ODS 1.00LKP 1.00XXXXXXX 6.00

- Some comment records: records with an asterisk (*) in the first column.
- For each look-up table the following records:

  - One record with two integer values indicating:
    - o the look-up table index which is specified at the model data of the nodes,
    - o the number of incoming concentration classes

  - If the number of classes is 2 or more then
    - o one record with the boundary values of the incoming concentration classes.
    - o one record for each time step with the outgoing concentration for each class.

Example of look-up table LKP-file Version 1.00 for a monthly simulation time step:

```
ODS 1.00LKP 1.00XXXXXXX  6.00
*
* Ribasim input data file with all salt concentration look-up tables.
*
* All concentration values in gram/liter.
*
* Reading format : free format
*
* A look-up table is defined by a block of the following records :
* 1. Look-up table index, number of concentration classes (NsltCl)
* 2. Upper boundary of each incoming concentration class (NsltCl-1 values)
* 3. for each time step a record with:
*    - time step index
*    - outgoing concentration per concentration classe (NsltCl values)
*
* Look-up table 101
*
   101  1
   1    0.5
   2    0.5
   3    0.5
   4    0.5
   5    0.5
   6    0.5
   7    0.5
   8    0.5
   9    0.5
  10    0.5
  11    0.5
  12    0.5
*
* Look-up table 501
*
   501  8
        0.5  1.0  1.5  2.0  2.5  3.0  3.5
   1    0.7  1.4  2.1  2.8  3.5  4.2  4.9  5.6
   2    0.7  1.4  2.1  2.8  3.5  4.2  4.9  5.6
   3    0.7  1.4  2.1  2.8  3.5  4.2  4.9  5.6
   4    0.8  1.5  2.2  2.9  3.6  4.3  5.0  5.7
   5    0.8  1.5  2.2  2.9  3.6  4.3  5.0  5.7
   6    0.8  1.5  2.2  2.9  3.6  4.3  5.0  5.7
   7    0.9  1.6  2.3  3.0  3.7  4.4  5.1  5.8
   8    0.9  1.6  2.3  3.0  3.7  4.4  5.1  5.8
   9    0.9  1.6  2.3  3.0  3.7  4.4  5.1  5.8
  10    0.9  1.6  2.3  3.0  3.7  4.4  5.1  5.8
  11    0.8  1.5  2.2  2.9  3.6  4.3  5.0  5.7
  12    0.7  1.4  2.1  2.8  3.5  4.2  4.9  5.6
```

Explanation of the above look-up table definitions is as follows:

- for fixed inflow-, variable inflow and groundwater reservoir nodes: the table contains the salt concentration (waste loads) in the downstream links of the node per time step. For example look-up table 101 above.

- for the demand nodes like the irrigation and public water supply nodes : the table contains the relation between several classes of salt concentrations of the inflow of the node with the salt concentration of the drainage flow out of the node per time step. For example look-up table 501 above. The table defines 8 classes of incoming salt concentrations and associated outgoing salt concentration. It is defined as follows:

Class	Class definition of incoming salt	Outgoing salt concentration

	concentration	**for t=1**
1	C_in[t] < 0.5	0.7
2	0.5 <= C_in[t] < 1.0	1.4
3	1.0 <= C_in[t] < 1.5	2.1
4	1.5 <= C_in[t] < 2.0	2.8
5	2.0 <= C_in[t] < 2.5	3.5
6	2.5 <= C_in[t] < 3.0	4.2
7	3.0 <= C_in[t] < 3.5	4.9
8	C_in[t] >= 3.5	5.6

The **LKP-file Version 1.01** format is based on the waste load as concentration, additional waste load or retention percentage, and is as follows (an example is shown below) :

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

  ODS 1.00LKP 1.01XXXXXXX 6.00

- Some comment records: records with an asterisk (*) in the first column.
- For each look-up table the following records:
  - One record with three integer values indicating :
    - the look-up table index which is specified at the model data of the nodes,
    - the number of incoming concentration classes, and
    - index 0, 1 or 2 indicating the type of data in the look-up tables:
      - 0 for concentration of the incoming flows
      - 1 for additional loads to the incoming flows
      - for retention percentage (% of the incoming concentration)

  - If the number of classes is 2 or more then
    - one record with the boundary values of the incoming concentration classes.
    - one record for each time step with the outgoing concentration for each class.

Example of look-up table LKP-file Version 1.01 for a half-monthly simulation time step:

```
ODS 1.00LKP 1.01XXXXXXX  6.00
*
* Biological oxygen demand (BOD) look-up tables (Ribasim input data)
*
* A look-up table is defined by a block of the following records :
* 1. Look-up table index,
*    number of concentration classes (NsltCl),
*    Type of data in look-up tables : 1 = Additional loads to incoming
*                                         flows
*                                     2 = Retention (% of incoming
*                                         concentration)
*                                  other = Outgoing WQ substance
*                                           concentration
* 2. Upper boundary of each incoming concentration class (NsltCl-1 values)
* 3. for each time step a record with:
*    - time step index
*    - dependent of type of data (see above), values per incoming
*      concentration class (NsltCl values)
*
* Look-up table 1 : all concentration values in mg/liter.
*
   1      1     0
   1    3.0
   2    2.0
   3    3.0
   4    2.0
   5    3.0
   6    3.0
   7    3.0
   8    1.0
   9    3.0
  10    4.0
  11    5.0
  12    4.0
  13    3.0
  14    2.0
  15    3.0
  16    2.0
  17    3.0
  18    3.0
  19    3.0
  20    1.0
  21    3.0
  22    4.0
  23    5.0
  24    4.0
*
* Look-up table 2 : all retention values in %.
*
   2      1     2
   1    40.0
   2    30.0
   3    40.0
   4    40.0
   5    50.0
   6    50.0
   7    50.0
   8    30.0
   9    40.0
  10    50.0
  11    60.0
  12    50.0
  13    40.0
  14    30.0
  15    40.0
  16    40.0
```

```
  17    50.0
  18    50.0
  19    50.0
  20    30.0
  21    40.0
  22    50.0
  23    60.0
  24    50.0
*
* Look-up table 3 : all retention values in %.
*
   3      8    2
        0.5  1.5  2.5  40.0  60.0  80.0 100.0
   1    30.0  40.0  50.0  60.0  70.0  90.0  90.0  90.0
   2    20.0  30.0  40.0  60.0  70.0  90.0  90.0  90.0
   3    30.0  30.0  30.0  60.0  70.0  90.0  90.0  90.0
   4    20.0  30.0  40.0  60.0  70.0  90.0  90.0  90.0
   5    30.0  30.0  50.0  60.0  70.0  90.0  90.0  90.0
   6    30.0  30.0  40.0  60.0  70.0  90.0  90.0  90.0
   7    30.0  30.0  30.0  60.0  70.0  90.0  90.0  90.0
   8    10.0  40.0  40.0  60.0  70.0  90.0  90.0  90.0
   9    30.0  40.0  40.0  60.0  70.0  90.0  90.0  90.0
  10    40.0  40.0  30.0  60.0  70.0  90.0  90.0  90.0
  11    50.0  50.0  20.0  70.0  70.0  90.0  90.0  90.0
  12    40.0  50.0  10.0  70.0  70.0  90.0  90.0  90.0
  13    30.0  40.0  50.0  60.0  70.0  90.0  90.0  90.0
  14    20.0  30.0  40.0  60.0  70.0  90.0  90.0  90.0
  15    30.0  30.0  30.0  60.0  70.0  90.0  90.0  90.0
  16    20.0  30.0  40.0  60.0  70.0  90.0  90.0  90.0
  17    30.0  30.0  50.0  60.0  70.0  90.0  90.0  90.0
  18    30.0  30.0  40.0  60.0  70.0  90.0  90.0  90.0
  19    30.0  30.0  30.0  60.0  70.0  90.0  90.0  90.0
  20    10.0  40.0  40.0  60.0  70.0  90.0  90.0  90.0
  21    30.0  40.0  40.0  60.0  70.0  90.0  90.0  90.0
  22    40.0  40.0  30.0  60.0  70.0  90.0  90.0  90.0
  23    50.0  50.0  20.0  70.0  70.0  90.0  90.0  90.0
  24    40.0  50.0  10.0  70.0  70.0  90.0  90.0  90.0
*
* Look-up table 4 : all retention values in %.
*
   4      6     2
        1.5  3.5  4.5  5.5  80.0
   1   -30.0 -40.0 -50.0 -60.0 -90.0 -90.0
   2   -20.0 -30.0 -40.0 -70.0 -90.0 -90.0
   3   -30.0 -30.0 -30.0 -80.0 -90.0 -90.0
   4   -20.0 -30.0 -40.0 -90.0 -90.0 -90.0
   5   -30.0 -30.0 -50.0 -70.0 -90.0 -90.0
   6   -30.0 -30.0 -40.0 -80.0 -90.0 -90.0
   7   -30.0 -30.0 -30.0 -90.0 -90.0 -90.0
   8   -10.0 -40.0 -40.0 -80.0 -90.0 -90.0
   9   -30.0 -40.0 -40.0 -80.0 -90.0 -90.0
  10   -40.0 -40.0 -30.0 -80.0 -90.0 -90.0
  11   -50.0 -50.0 -20.0 -70.0 -90.0 -90.0
  12   -40.0 -50.0 -10.0 -70.0 -90.0 -90.0
  13   -30.0 -40.0 -50.0 -60.0 -90.0 -90.0
  14   -20.0 -30.0 -40.0 -70.0 -90.0 -90.0
  15   -30.0 -30.0 -30.0 -80.0 -90.0 -90.0
  16   -20.0 -30.0 -40.0 -90.0 -90.0 -90.0
  17   -30.0 -30.0 -50.0 -70.0 -90.0 -90.0
  18   -30.0 -30.0 -40.0 -80.0 -90.0 -90.0
  19   -30.0 -30.0 -30.0 -90.0 -90.0 -90.0
  20   -10.0 -40.0 -40.0 -80.0 -90.0 -90.0
  21   -30.0 -40.0 -40.0 -80.0 -90.0 -90.0
  22   -40.0 -40.0 -30.0 -80.0 -90.0 -90.0
  23   -50.0 -50.0 -20.0 -70.0 -90.0 -90.0
  24   -40.0 -50.0 -10.0 -70.0 -90.0 -90.0
```

H Node model data

In this section you will find for each node type the data that RIBASIM requires for input. These data are prepared with a menu (task: “Edit network and database on map”). In the Technical reference manual you will find detailed information on the meaning of each input parameter.

Relations between 2 or more parameters are specified as maximal 15 interpolation values. If less than 15 values are entered then the series of values must be closed with a value –1. For example to specify the relation between the surface water reservoir level, area and volume the following values are entered:

Level [m]	Area [ha]	Volume [Mcm]
85.00	202.00	22.10
95.00	396.00	53.40
100.00	522.00	76.40
105.00	627.00	105.10
110.00	758.00	139.70
115.00	897.00	181.20
-1.00	-1.00	-1.00

H.1 Variable inflow node data

The catchment for which the runoff is modeled with the Sacramento model is schematized as a Variable inflow node. The catchment is subdivided in a number of segments (see Sacramento manual). Each Variable inflow node can have maximal 5 segments (each segment refers to an input folder, see Figure 10.1). If more than 5 segments are needed to model a catchment then additional inflow nodes must be included in the schematization. The model data which must be specified are:

- Node ID
- Active mode: on-off switch
- Catchment label (any integer number)
- Apply variable inflow long time series: on-off switch *
- Apply Sacramento rainfall - runoff model : on-off switch *
- Water quality concentration look-up table index

* Only one of the options is used.

<u>If switch “Apply variable inflow long time series” is on</u>

- Index of the actual inflow time series. The name of the time series file is specified in the file *HDtimeSr.dat*. The default file name is *Actinflw.tms.*
- Index of the expected inflow time series. The name of the time series file is specified in the file *HDtimeSr.dat*. The default file name is *ExpInflw.tms.* If the time series index equals to 0 then the actual inflow values are used at the target setting.
- Local consumption unit index: 1 [%], 2 [m3/s]
- Local consumption value [% or m3/s]
- Virgin catchment area [km2]

- Index of water quality look-up table per substance. The substances are defined in the file *WQsubsta.dat*. The look-up tables are stored in the look-up table file of each substance.

<u>If switch “Apply Sacramento rainfall - runoff model” is on</u>

For each segment:

- Segment area [km2]
- Index of the rainfall time series. The name of the time series file is specified in the file *HDtimeSr.dat*. The default file name is *ActRain.tms.*
- Index of the potential evapotranspiration time series. The name of the time series file is specified in the file *HDtimeSr.dat*. The default file name is *PotEvapo.tms.*
- Reservoirs capacity (mm) and initial values (mm):
  - Upper zone tension water
  - Upper zone free water
  - Lower zone tension water
  - Lower zone supplementary free water
  - Lower zone primary free water
- Model parameters:
  - UZK Upper zone drainage rate [1/day]
  - LZSK Lower zone drainage rate supplementary free water [1/day]
  - LZPK Lower zone drainage rate primary free water [1/day]
  - ZPerc Percolation parameter [-]
  - RExp Percolation parameter [-]
  - PFree Fraction of percolated water direct to LZ [-]
  - Rserv Fraction of lower zone unavailable for evaporation [-]
  - PctIm Permanently impervious fraction contiguous to stream [-]
  - AdImp Percentage additional impervious area [-]
  - Sarva Fraction of the basin covered by streams, lakes, etc [-]
  - Side Ration unobserved portion of base flow [-]
  - Ssout All runoff above this value is surface runoff [mm/dt]
- Unit hydrograph ordinates (maximal 36 values)
- Rainfall intensity variation:
  - PM Time interval increment parameter
  - PT1 Lower rainfall threshold
  - PT2 Upper rainfall threshold

The meaning of the various model data for the Sacramento model is described in detail in the Sacramento user manual.

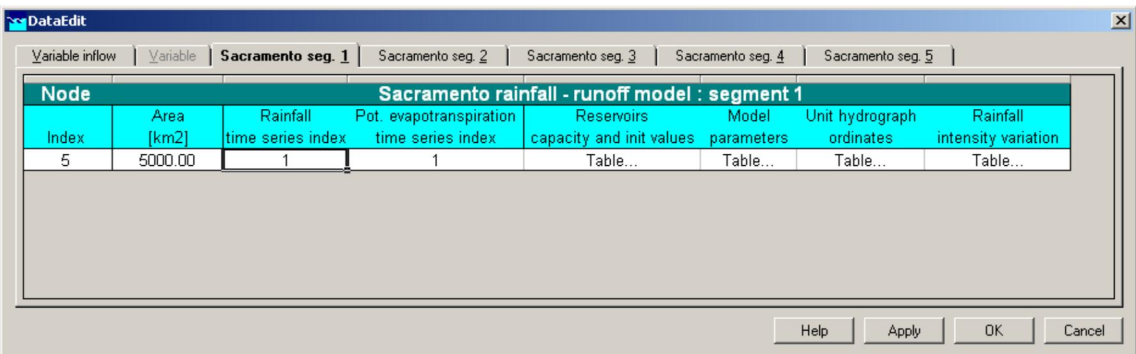

Figure 10.1 Variable inflow model data entry window.

H.2 Fixed inflow node data

- Node ID
- Active mode: on-off switch
- Inflow values [m3/s]: annual time series.
- Index of water quality look-up table per substance. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.

H.3 Confluence node data

No data required.

H.4 Terminal node data

No data required.

H.5 Recording node data

- Node ID
- Active mode: on-off switch
- Order index outlining the order in which the annual flow difference between the recording nodes is computed.
- Index of the monitored flow time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is *RecrdFlw.tms.*

H.6 Surface water reservoir node data

- Node ID
- Active mode : on-off switch
- Catchment label of the variable inflow node in which the irrigation node is located.
- Main gate present : on-off switch
- Power station present : on-off switch
- Level [m] - area [ha] - volume [Mcm] relation : 3 x max. 15 values
- Length of reservoir [m] optionally
- Initial storage level [m]
- Spillway or full reservoir level (m)
- Spillway net head [m] - discharge [m3/s] relation: 2 x max. 15 values
- Use net-evaporation time series : on-off switch
- Seepage loss (1000 m3/day)
- Flood routing period [days] (only relevant for daily simulation).
- Operation rule curves:
  - Flood control storage level [m]: constant time series (per time step)
  - Target storage level [m] for maximum energy generation : constant time series (per time step)
  - Firm storage level [m] : constant time series (per time step), a value for each time step within a year.
- Operation options :
  - On-off operation switch : apply hedging based on storage (default : on)
  - On-off operation switch : filling up till firm storage level (lowest priority) (default : off)
  - On-off operation switch : on-line adjustable gate settings (default : on)
  - On-off operation switch : operation on expected inflow (default : on)
- Initial concentration of the water in the reservoir for each substance

- Index of water quality look-up table per substance for rainfall. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.
- Index of water quality look-up table per substance for reservoir node. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.

<u>If switch “Main gate present” is on</u>
- Main gate level (m)
- Main gate net head [m] - discharge [m3/s] relation: 2 x max. 15 values

<u>If switch “Power station present” is on</u>
- Minimum level for power generation [m] (turbine gate outlet level)
- Plant load factor [%]
- Auxiliary hydro-energy consumption [%]
- Turbine gate net head [m] - power capacity [MW] relation : 2 x max. 15 values
- Turbine gate net head [m] - power efficiency [%] relation : 2 x max. 15 values
- Turbine discharge [m3/s] - hydraulic loss [m] relation : 2 x max. 15 values
- Turbine discharge [m3/s] - minimum tail level of power plant [m] relation : 2 x max. 15 values
- Firm energy demand [GWh]: constant time series (per time step)
- Firm energy (water allocation) priority

<u>If switch “Apply hedging based on storage” is on</u>
- Hedging rules specification :
  - 4 values [%] indicating the definition of 5 hedging zones between the firm storage level and the dead storage level
  - 5 values [%] indicating the percentage of the target release in the 5 hedging zones.

<u>If switch “Apply hedging based on storage” is off</u>
- Hedging per priority (%) : per water allocation priority the percentage of the release target that will be released.

<u>If switch “Use net-evaporation time series” is on</u>
- Net evaporation (evaporation – rainfall) [mm/day] : annual time series (per time step).

<u>If switch “Use net-evaporation time series” is off</u>
- monitored flow Time series index of the open water evaporation in time series file (specified in the HDtimeSr.dat file). The default file name is *Evaporat.tms.*
- Time series index of the actual rainfall in time series file (specified in the HDtimeSr.dat file). The default file name is *ActRain.tms.*

<u>If switch “Operation on expected inflow” is on</u>
- Expected flow related data (only relevant if operation is carried out on expected flows):
  - a value for each time step within a year for parameters A(t) of the linear relation of the sum of the flow in the downstream links of the nodes in the expected source list and the expected inflow in the reservoir for the next time step : constant time series (per time step).
  - a value for each time step within a year for parameters B(t) of the linear relation of the sum of the flow in the downstream links of the nodes in the expected

source list and the expected inflow in the reservoir for the next time step : constant time series (per time step).

The reservoir level is specified with reference to the basin reference level which is used for all specified level e.g. ground-surface level at groundwater reservoir node, link storage level at link storage node, etc.

H.7 Run-of-river node data

- Node ID
- Active mode: on-off switch
- Fixed intake level [m]
- Plant load factor [%]
- Auxiliary hydro-energy consumption [%]
- Turbine gate net head [m] - power capacity [mw] relation: 2 x max. 15 values
- Turbine gate net head [m] - power efficiency [%] relation: 2 x max. 15 values
- Turbine discharge [m3/s] - hydraulic loss [m] relation: 2 x max. 15 values
- Turbine discharge [m3/s] - tail race level [m] relation: 2 x max. 15 values

H.8 Diversion node data

No data required

H.9 Low flow node data

- Node ID
- Active mode: on-off switch
- Apply fixed flushing annual time series : on-off switch *
- Apply variable flushing long time series : on-off switch *
- Apply event driven flushing : on-off switch *
- Water management priority specification:
- definition of part 1 of demand [%] (part 2 is the remaining demand)
- priority for part 1 of the demand
- priority for part 2 of the demand

* Only one of the options is used.

<u>If switch “Apply fixed flushing annual time series” is on</u>

- Minimum flow requirements [m3/s]: annual flow time series

<u>If switch “Apply variable flushing long time series” is on</u>

- Index of the minimum flow time series. The name of the time series file is specified in the file *HDtimeSr.dat*. The default file name is *Lowflow.tms.*

<u>If switch “Apply event driven flushing” is on</u>

- Length of event occurrence window (number of time steps).
- Start time step of event window.
- Length of event window (number of time steps, maximal 12).
- Event flow for each time step within the event window (m3/s).
- Demand year water allocation threshold (% of total demand).
- Natural year water allocation threshold (% of total demand).

H.10 Public and industrial water supply node data

- Node ID
- Active mode: on-off switch
- Apply explicit demand : on-off switch *
- Apply demand based on population: on-off switch *
- Distribution losses [%]
- Return flow to surface water [% of supply]: annual time series.
- Return flow to groundwater [% of supply]: annual time series.
- Water management priority specification:
  - definition of part 1 of demand [%] (part 2 is the remaining demand)
  - priority for part 1 of the demand
  - priority for part 2 of the demand
- Index of water quality look-up table per substance for the waste loads by the return flow. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.
- Label of groundwater reservoir node where the groundwater part of the return flow will go.

* Only one of the options is used.

<u>If switch “Apply explicit demand” is on</u>
- Explicit demand (m3/s) or Unit demand (litre/capita/day): annual time series.

<u>If switch “Apply demand based on population” is on</u>
- Population (-)
- Unit demand (l/cap/day): annual time series.

H.11 Fixed irrigation node data

- Node ID
- Active mode: on-off switch
- Catchment label of the variable inflow node in which the irrigation node is located.
- Irrigated area [ha]: annual time series (per time step)
- Net demand [mm/day]: annual time series (per time step)
- Surface water irrigation efficiency [%]
- Groundwater irrigation efficiency [%]
- Return flow to surface water [% of supply]
- Return flow to groundwater [% of supply]
- Groundwater reservoir label
- Water management priority specification:
  - definition of part 1 of demand [%] (part 2 is the remaining demand)
  - priority for part 1 of the demand
  - priority for part 2 of the demand
- Index of water quality look-up table per substance for waste load by the the return flow. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.
- Label of groundwater reservoir node where the groundwater part of the return flow will go.

H.12 Variable irrigation node data

- Node ID

- Active node: on-off switch
- Catchment label of the variable inflow node in which the irrigation node is located.
- Irrigated area for year type 1 (dry year) [ha] : annual time series.
- Irrigated area for year type 2 (normal year) [ha] : annual time series.
- Crop water requirements [mm/day] for year type 1(dry year) : annual series.
- Crop water requirements [mm/day] for year type 2 (normal year) : annual time series.
- Surface water irrigation efficiency [%] for year type 1 (dry year)
- Groundwater irrigation efficiency [%] for year type 1 (dry year)
- Surface water irrigation efficiency [%] for year type 2 (normal year)
- Groundwater irrigation efficiency [%] for year type 2 (normal year)
- Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is *ActRain.tms.*
- Apply dependable rainfall: on-off switch
- Effectiveness of expected rainfall [%]
- Start of growing season [time step index]
- Length of monitoring period [number of time steps] used to define year type
- Year type criteria: total rainfall in monitoring period [mm] below which it is a year type 1 (dry year) and above it is a year type 2 (normal year).
- Return flow of allocated water to surface water [% of allocated water]
- Return flow of allocated water to groundwater [% of allocated water]
- Return flow of unused rainfall to surface water [% of unused rainfall]
- Return flow of unused rainfall to groundwater [% of unused rainfall]
- Water management priority specification:
  - definition of part 1 of demand [%] (part 2 is the remaining demand)
  - priority for part 1 of the demand
  - priority for part 2 of the demand
- Index of water quality look-up table per substance for waste load by the the return flow. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.
- Label of groundwater reservoir node where the groundwater part of the return flow will go.

<u>If switch “Apply dependable rainfall” is on</u>

- Index of the dependable rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The dependable rainfall is used as the expected rainfall. The default file name is *DepRain.tms.*

<u>If switch “Apply dependable rainfall” is off</u>

- The actual rainfall is used as the expected rainfall. No additional data required.

H.13 Loss flow node data

- Node ID
- Active mode : on-off switch
- Index of the loss flow time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is *LossFlow.tms.*
- Water management priority specification:
  - definition of part 1 of demand [%] (part 2 is the remaining demand)
  - priority for part 1 of the demand
  - priority for part 2 of the demand

H.14 Fish pond node data

- Node ID
- Active mode: on-off switch
- Catchment label of the variable inflow node in which the fish pond node is located.
- Fish pond area [ha]
- Flushing requirements (demand) [mm/day] : annual time series
- Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is *ActRain.tms.*
- Index of the open water evaporation time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is Evaporat*.tms.*
- Water management priority specification:
  – definition of part 1 of demand [%] (part 2 is the remaining demand)
  – priority for part 1 of the demand
  – priority for part 2 of the demand
- Index of water quality look-up table per substance for waste load from return flow. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.
- Surface water conveyance efficiency [%].
- Groundwater conveyance efficiency [%].
- Return flow to surface water [% of total drainage]
- Return flow to groundwater [% of total drainage]
- Label of groundwater reservoir node where the groundwater part of the return flow will go.

H.15 Groundwater reservoir node data

- Node ID
- Active mode: on-off switch
- Groundwater reservoir label
- Groundwater depth [m] - groundwater storage (Mcm) relation: 2 x max. 15 values
- Shallowest groundwater depth (at capacity) [m]
- Initial groundwater depth [m]
- Groundwater outflow [m3/s] - groundwater depth [m] relation: 2 x max. 15 values
- Ground surface level [m]
- Maximum groundwater abstraction [m3/s]
- Initial concentration of the water in the groundwater reservoir for each substance
- Index of water quality look-up table per substance for groundwater reservoir node. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.

Depth is specified with reference to the ground surface level. The ground surface level is specified with reference to the basin reference level which is used for all specified level e.g. at surface water reservoir level, link storage level, etc. Those specified levels are used for the computation of the lateral flow based on the level difference between two water bodies.

H.16 Bifurcation node data

No data required.

H.17 Pumping node data

- Node ID
- Active mode: on-off switch

- Pumping efficiency [%]
- Pumping head [m] : annual time series.

H.18 General district node data

- Node ID
- Active mode: on-off switch
- Index of the district demand time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is *DisDmnd.tms.*
- Index of the district discharge time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is *DisDisch.tms.*
- Water management priority specification:
  - definition of part 1 of demand [%] (part 2 is the remaining demand)
  - priority for part 1 of the demand
  - priority for part 2 of the demand
- Index of water quality look-up table per substance for the waste loads from district drainage. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.

H.19 Ground water district node data

This node is under revision. It can be represented in more detail using a combination of the following node types: inflow node, irrigation node, public water supply node, groundwater reservoir node.

- Node ID
- Active mode: on-off switch
- Non-irrigated area data:
  - Area [ha]
  - Capacity of soil moisture storage (mm)
  - Initial soil moisture storage (mm)
  - Soil moisture discharge percentage [% of soil moisture contents]
  - Percentage of soil moisture discharge that flows to ground water [%] (other part flows to surface water)
  - Evaporation [mm/day]: annual time series
- Irrigated area data:
  - Area [ha]
  - Ground water pumping capacity [m3/s]
  - Ground water pumping efficiency [%]
  - Crop water requirements [mm/day]: annual time series
  - Effectiveness of rainfall [%]
  - Ground water irrigation efficiency [%]
  - Surface water irrigation efficiency [%]
  - Irrigation return flow percentage [%] (to ground water and surface water)
  - Percentage of return flow to ground water (percolation) [%] (the other part flows to surface water)
- Public water and industrial water supply data:
  - Ground water pumping capacity [m3/s]
  - Ground water pumping efficiency [%]
  - Return flow percentage [%] (flows always to surface water)
  - Public and industrial water supply demand : annual time series
- Ground water storage data (level below surface) :
  - Depth [m] - storage [Mcm] relation : 2 x 15 values

- Smallest depth [m]
- Critical depth for public water supply pumping [m]
- Initial depth [m]
- Critical depth for irrigation water pumping [m]
- Groundwater depth [m] - internal drainage from ground water [m3/s] relation : 2 x 15 values
- Groundwater depth [m] - external drainage from ground water [m3/s] relation : 2 x 15 values
- Cumulative rainfall in the last three time steps [mm/time step] - ground water inflow [m3/s] relation : 2 x 15 values
- Ground water storage inflow values [m3/s] : constant time series (per time step)
- Actual rainfall [mm/time step] in the three time steps before the first simulation time step: 3 values

• Index of actual rainfall time series. The time series are stored in the series file as specified in the HDtimeSr.dat file. The default file name is ActRain.*tms.*
• Management data:
  - Priority for irrigation from surface water (else ground water) : on/off switch
  - Priority for public and industrial water supply from surface water (else ground water): on/off switch
  - Water management priority specification:
    - definition of part 1 of demand [%] (part 2 is the remaining demand)
    - priority for part 1 of the demand
    - priority for part 2 of the demand

H.20 Link storage node data

• Node ID
• Active mode: on-off switch
• Catchment label of the variable inflow node in which the link storage node is located.
• Switch to indicate which routing method must be applied*:
  - Fixed storage,
  - Manning formula,
  - Q-h relation (flow – water level relation),
  - 2-layered multi segmented Muskingum,
  - Puls method, or
  - Laurenson non-linear routing method.
• Initial concentration of the water in the link storage for each substance
• Index of water quality look-up table per substance for rainfall. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.
• Index of water quality look-up table per substance for link storage node. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.

* Only one of the routing methods is used.

<u>Depending on the switch which is on the routing method data are:</u>

• For Fixed storage
  - Initial surface area [ha]
  - Initial storage [Mcm]
  - Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is ActRain.tms.

    - Index of the open water evaporation rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is Evaporat.tms.
- For Manning formula:
    - Manning coefficient
    - Bottom slope [m/m]
    - Length [m]
    - Channel width on water surface [m] - water level [m] relation : 2 x max. 15 values
    - Initial water level [m]
    - Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is ActRain.tms.
    - Index of the open water evaporation rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is Evaporat.tms.
- For Q-h relation (flow – water level relation):
    - Length [m]
    - Channel width on water surface [m] - water level [m] relation : 2 x max. 15 values
    - Initial level [m]
    - Flow [m3/s] - level [m] relation: 2 x max. 15 values
    - Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is ActRain.tms.
    - Index of the open water evaporation rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is Evaporat.tms.
- For 2-layered multi segmented Muskingum:
    - Initial storage
    - Travel time for layer 1 [days]
    - Weighting factor X for layer 1
    - Travel time for layer 2 [days]
    - Weighting factor X for layer 2
    - Two layer border discharge [m3/s]
    - Number of segments
- For Puls method:
    - Storage [Mcm] - Discharge [m] relation: 2 x max. 15 values
    - Time delay [# of time steps]
    - Initial storage [Mcm]
    - Storage - area parameter [m]
    - Soil moisture recharge [mm]
    - Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is ActRain.tms.
    - Index of the open water evaporation rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is Evaporat.tms.
- For Laurenson non-linear routing method:
    - Initial storage [Mcm]
    - Storage delay parameter k [days]
    - Non-linearity parameter m [-]

The water level is specified with reference to the basin reference level which is used for all specified level e.g. ground surface level at the groundwater reservoir node, surface water reservoir level at the surface water reservoir node, etc.

H.21 Surface water reservoir partition node data

- Node ID
- Active mode: on-off switch
- Length [m]
- Channel width on water surface [m] - level [m] relation: 2 x max. 15 values

H.22 Advanced irrigation node data

- Node ID
- Active mode: on/off switch
- Catchment label of the variable inflow node in which the irrigation node is located.
- Total area of irrigation scheme [ha]

Hydrology data
- Index of the actual rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is ActRain.tms.
- Index of the dependable rainfall time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is DepRain.tms.
- Index of the reference crop evapotranspiration time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is RefEvapo.tms.
- Index of the dependable river flow time series. The time series are stored in the time series file as specified in the HDtimeSr.dat file. The default file name is DepUpFlw.tms.
- Rainfall effectiveness [% of the dependable rainfall]

Soil
- Wilting point [% of root zone]
- Field capacity [% of root zone]
- Saturation capacity [% of root zone]
- Initial soil moisture content [% of root zone]

Crop plan : for each cultivation:
- Cultivated crop
- Start time step of cultivation
- Cultivated area [% of total area]
- Percolation [mm/day]
- Pre-saturation requirements [mm]
- Number of fields [-]
- Growing season index [-]
- Stacking area [% of total area] (filled in by crop planning program Cropper)

Supply
- Field application efficiency [%]
- Normal distribution efficiency [%]
- Drought period distribution efficiency [%]
- SW conveyance efficiency [%]
- GW conveyance efficiency [%]

- Feedback on actual field water level: on/off switch
- Water allocation priority per crop

Drainage
- Return flow to surface water [% of total drainage]
- Return flow to groundwater [% of total drainage]
- Label of groundwater reservoir node where the groundwater part of the return flow will go.

Water management
- Water management priority specification:
- definition of part 1 of demand [%] (part 2 is the remaining demand)
- priority for part 1 of the demand
- priority for part 2 of the demand

Water quality
- Index of water quality look-up table per substance for waste load from drainage. The substances are defined in the WQsubsta.dat file. The look-up tables are stored in the look-up table file of each substance.

Production
- Per crop :
- Potential crop yield [kg/ha],
- price [Mon.unit/kg],
- potential production costs (Mon.unit.ha) and
- on-farm yield losses [%].
- Production costs function parameters : minimum survival fraction at full costs [%] and minimum costs at no survival [% of potential production costs].

The data of the crop plan can be interactively graphically edited with the crop plan editor Cropper.

H.23 Natural retention node data

- Node ID
- Active mode: on-off switch
- Retention per substance [%]

H.24 Waste water treatment plant node data

- Node ID
- Active mode: on-off switch
- Plant capacity [m3/s]
- Retention per substance [%]

I Link model data

In this section you will find for each link type the data that RIBASIM requires for input. These data are prepared with a menu (task: “Edit network and database on map”). Surface water flow links, groundwater recharge links and groundwater outflow links do not need any input data. In the Technical reference manual you will find detailed information on the meaning of each input parameter.

Relations are specified as maximal 15 interpolation values. If less than 15 values are entered then the series of values must be closed with a value –1.

I.1 Surface water flow link data

- Link ID
- Apply river link (no constraints) : on-off switch *
- Apply canal or pipeline link : on-off switch *

* Only one of the options is used.

<u>If switch “Apply canal or pipeline” is on</u>

- Flow capacity : annual time series [m3/s]

I.2 Groundwater recharge link data

No data required.

I.3 Groundwater outflow link data

No data required.

I.4 Lateral flow link data

- Link ID
- Switch to indicate which flow procedure must be applied*:
  - Apply Dummy
  - Apply Darcy's law
  - Apply Q-dH relation (flow – water level difference relation)
  - Apply Flow threshold - storage relation
  - Apply Fixed lateral flow
  - Apply storage - lateral flow relation

* Only one of the procedure is used

<u>Depending on the switch, which is on, the flow procedure data are:</u>

- For Darcy's law:
  - Transmissivity [m2/day]
  - Width between water bodies [m]
  - Average length of flow path in direction of flow [m]
- For Q-dH relation:
  - Lateral flow [m3/s] - Head difference between water bodies (m): 2 x max. 15 values
- For Flow threshold:
  - Threshold channel inflow [m3/s]

  - Storage parameter alfa
- For Fixed lateral flow:
  - Lateral flow [m3/s] : annual time series
- For storage - lateral flow relation:
  - Storage at upstream water body [Mcm] – Lateral flow [m3/s] : 2 x max. 15 values

I.5 Groundwater abstraction flow link data

- Link ID
- Switch to indicate which routing method must be applied:
  - Apply Dummy*
  - Apply Pump capacity*

* Only one of the options is used

<u>If switch “Apply Pump capacity” is on:</u>
- Maximum pumping depth [m]
- Pumping capacity or maximum groundwater abstraction: annual time series [m3/s]
- Pumping efficiency [%]

I.6 Diverted flow link data

- Link ID
- Active mode: on-off switch
- Maximum diverted flow [m3/s]: annual time series
- Online adjustable gate settings: on-off switch
- Operate on downstream demand: on-off switch
- Relation between the flow in link upstream of diversion node [m3/s] - maximum divertable flow [m3/s]: 2 x max. 15 values.

I.7 Bifurcated flow link data

- Link ID
- Active mode: on-off switch
- Relation between the flow in upstream link of bifurcation node [m3/s] - flow in the bifurcated flow link [m3/s] : 2 x max. 15 values

I.8 Surface water reservoir backwater flow link data

- Link ID
- Active mode: on-off switch
- Back water gate intake level {m]
- Backwater gate nethead [m] – backwater gate discharge [m3/s] relation: 2 x max. 15 values
- Online adjustable gate settings: on-off switch
- Spillway on link: on-off switch

J Backup procedures

The backup procedure can be carried out on the following levels :

- Export and import a simulation case.
- Backup and restore a whole RIBASIM application ("Rbn" - directory).

J.1 Export and import a simulation case

If you want to backup a certain simulation case you can do that under the CMT with the "Export" option under menu item "File". The CMT collects all files which are used by this simulation case and copied them together with a number of other files to a diskette or other destination. Optionally you can specify if the "general application files" as well as the "general files" must be copied as well. You can restore a backup case under the CMT with the "Import" option under menu item "File".

J.2 Backup and restore a RIBASIM application

Backup an application

If you want to make a backup of an implemented application or basin, which has been modelled and implemented, you must make a back up of the whole river basin "Rbn" directory. If you want to backup e.g. the SWS Ciujung-Ciliman then you must copy the contents of the whole "\Ribasim7\CujgClmn.Rbn" sub-directory to diskette including all files and subdirectories.

Remark

You must never back up only part of the "\Ribasim7\CujgClmn.Rbn" sub-directory. The case management tool cmt is based on a consistent set of sub-directories and data files. If you change files and/or sub-directories you may disturb the function of the case management tool permanently.

Restore an application

If you want to restore a basin from a backup then you should copy the whole basin "\Ribasim7\CujgClmn.Rbn" sub-directory : all files and all subdirectory. For example if you want to restore the SWS Ciujung-Ciliman then copy the whole directory "\Ribasim7\CujgClmn.Rbn" your backup diskettes to your computer.

Remark

You must not mix up a backup of a basin and its current implementation on your computer because all files in the case management tool cmt are registered in its own "Rbn" directory.

K RIBASIM utility program combfile

The Ribasim utility program COMBFILE combines a number of (ASCII) files with time series e.g. generated with HYMOS into one time series file to be used by Ribasim. This utility can be used to generate any time series file of Ribasim : inflow, rainfall, evaporation, district demand, district drainage, loss flow and water district runoff. COMBFILE is a program which runs under MS Windows.

Command to start COMBFILE : COMBFILE <File with file names>

e.g. COMBFILE COMBFILE.FNM

The input files are:

11 A file with input- and output file names
12 A number of time series files which must be combined.

The output files are:

13 A file with messages
14 A file with all time series combined to be used by Ribasim.

Description of the input files

The file with file names:

Part I: Output file names
- Some comment records : an asterisk (*) in position 1 of the record
- One record with: Name of the output file with messages
- One record with: Name of the output file with all time series combined e.g. file actinflw.tms. This file has the "Header version 1.01" - format (see appendix F.3)

Part II: Input file names
- Some comment records : an asterisk (*) in position 1 of the record
- A number of records equal to the number of files that must be combined: for each time series file one record with the file name.

Example file with file names for combination of inflow time series :

```
*
* Output files for COMBFILE Version 1.0
*
*------------------------------|----------------------------------------
 1.Print file                   :COMBFILE.PRT
 2.Time series output file      :STARTFL1.TMS
*
* Input files for COMBFILE Version 1.0
*
*------------------------------|----------------------------------------
 1.Time series file 1           :TELFL.TMS
 2.Time series file 2           :RSMHFL.TMS
 3.Time series file 1           :ONGFL.TMS
 4.Time series file 2           :IBFL.TMS


Example file with file names for combination of rainfall time series :

*
* Output files for COMBFILE Version 1.0
*
*------------------------------|----------------------------------------
 1.Print file                   :COMBFILE.PRT
 2.Time series output file      :RAINFIL1.TMS
*
* Input files for COMBFILE Version 1.0
*
*------------------------------|----------------------------------------
 1.Time series file 1           :TELRAIN.TMS
 2.Time series file 2           :RSMHRAIN.TMS
 3.Time series file 1           :ONGRAIN.TMS
 4.Time series file 2           :IBRAIN.TMS
```

The accepted formats of the input files with time series are described below. The time series files are read in free format, so all items must be separated by a space or a comma.

Format 1 : No header - format (free format)

Record	Content
1	The number of time series in the file.
2	One or more records with for each time series the name of the station (max. 20 characters) between single quotes (') and separated by at least one space or a comma.
3	One or more records with for each time series the index of the station (max. 8 digits) and separated by at least one space or a comma. Other records: Time step data with for each time step one record in the free format as described in table G1 below.

Format 2: Header version 1.00 - format (free format)

Record	Content
1	The header which looks as follows : ODS 1.00TMS 1.00XXXXXXX 6.00
2	Some comment records : records with an asterisk (*) in the first column.
3	The number of time series in the file.
Other	Time step data with for each time step one record in the free format as described in table G1 below.

Format 3: Header version 1.01 - format (free format)

Record	Content
1	The header which looks as follows : ODS 1.00TMS 1.01XXXXXXX 6.00
2	Some comment records: records with an asterisk (*) in the first column.
3	One record with two integer values indicating : • the number of time series in the file, and • the unit index of the time series values : – means values in m3/s or – means values in mm/day or – means values in mm/time step
4	One or more records with for each time series the name of the station (max. 20 characters) between single quotes (') and separated by at least one space or a comma.
5	One or more records with for each time series the index of the station (max. 8 digits) and separated by at least one space or a comma.
Other	Time step data with for each time step one record in the free format: • Year index e.g. 1956 • Time step index (if time step is monthly then value 1 to 12) • Day index within the time step If day index = 0 then value for the whole time step. If day index > 0 then value for the day • Inflow values for time step in m3/s, mm/day or mm/time step • Loss flow, district abstraction or discharge values for each time series in m3/s • Rainfall or evaporation values in mm/day

Format 4 : Header version 1.02 - format (fixed format)

Record	Content
1	The header which looks as follows : ODS 1.00TMS 1.02XXXXXXX 6.00
2	Some comment records: records with an asterisk (*) in the first column.
3	The number of time series in the file
Other	Time step data with for each time step one record in the fixed format as described table below. Time step data with for each time step one record in the fixed format as described in table below.

Data item	Format	Description
1	I4	Year index e.g. 1956
2	1X	One space
3	I2	Time step index (if time step is monthly then value 1 to 12)
4	1X	One space
5	I2	Day index within the time step If day index = 0 then value for the whole time step. If day index > 0 then value for the day
6	11F6.0	Maximal 11 values or time series in one file for : • Inflow values for time step in m^3/s, mm/day or mm/time step • Loss flow, district extraction or discharge values for each time series in m^3/s • Rainfall or evaporation values in mm/day

Example COMBFILE input data file with time series data in **"No header format" :**

```
'INF-MP' 'INF-TALS'   'INF-X' 'INF-SARF'   'INF-Z'  'CAT-BHE'  'INF-XX'  'INF-SAN'  'INF-LAM'
                4582     75     781     66     2900     305     2420     484     410
1964 01  0      4.87   0.06    0.65   0.06     2.43    0.26     2.14    0.40    0.38
1964 02  0      5.57   0.06    0.63   0.07     3.10    0.33     2.77    0.49    0.40
1964 03  0      1.69   0.02    0.22   0.02     0.86    0.09     0.74    0.14    0.13
1964 04  0      5.10   0.06    0.64   0.07     2.83    0.26     2.24    0.53    0.31
1964 05  0      3.48   0.05    0.51   0.04     1.83    0.21     1.54    0.26    0.20
1964 06  0     65.17   0.83    8.33   0.60    30.35    3.36    28.25    7.94    4.90
1964 07  0    704.27   9.49   94.60   0.70   314.21   40.94   295.36   77.28   51.24
1964 08  0    663.74   8.20   84.14   7.23   304.65   35.08   295.71   70.41   51.94
1964 09  0    308.55   3.58   37.69   3.91   143.33   16.20   129.43   31.07   25.39
1964 10  0     59.18   0.68    7.17   0.78    27.05    3.06    24.20    5.95    5.02
1964 11  0     16.54   0.20    0.11   0.21     7.92    0.88     6.94    1.57    1.32
1964 12  0      7.57   0.09    0.98   0.09     3.68    0.40     3.21    0.71    0.59
```

Example COMBFILE input data file with time series data in **"Header version 1.00 format":**

```
ODS 1.00TMS 1.00XXXXXXX  6.00
*
* Ribasim input data file with hydrological time series
*
* Reading format : free format
*            - first record : number of series in file
*            - next records with the following values :
*              Year index,
*              Time step index,
*              Day index within the time step,
*              Time series values
*
9
1964 01  0      4.87   0.06    0.65   0.06     2.43    0.26     2.14    0.40    0.38
1964 02  0      5.57   0.06    0.63   0.07     3.10    0.33     2.77    0.49    0.40
1964 03  0      1.69   0.02    0.22   0.02     0.86    0.09     0.74    0.14    0.13
1964 04  0      5.10   0.06    0.64   0.07     2.83    0.26     2.24    0.53    0.31
1964 05  0      3.48   0.05    0.51   0.04     1.83    0.21     1.54    0.26    0.20
1964 06  0     65.17   0.83    8.33   0.60    30.35    3.36    28.25    7.94    4.90
1964 07  0    704.27   9.49   94.60   0.70   314.21   40.94   295.36   77.28   51.24
1964 08  0    663.74   8.20   84.14   7.23   304.65   35.08   295.71   70.41   51.94
1964 09  0    308.55   3.58   37.69   3.91   143.33   16.20   129.43   31.07   25.39
1964 10  0     59.18   0.68    7.17   0.78    27.05    3.06    24.20    5.95    5.02
1964 11  0     16.54   0.20    0.11   0.21     7.92    0.88     6.94    1.57    1.32
1964 12  0      7.57   0.09    0.98   0.09     3.68    0.40     3.21    0.71    0.59
```

Example COMBFILE input data file with time series data in **"Header version 1.01 format"** :

```
ODS 1.00TMS 1.01XXXXXXXX 6.00
*
* Aware : TMS-file version 1.01 !!!
*
* Reading format : free format
* Record 1     : Number of series in file and
*                 Unit index of time series values : 1 = m3/s      or
*                                                     2 = mm/day  or
*                                                     3 = mm/tms
* Record 2     : Name of station (max. 20 characters)
* Record 3     : Station index (max. 8 digits)
* Next records : Year index,
*                  Time step index
*                  Day index within the time step,
*                  Time series values
*
9  1
'INF-MP' 'INF-TALS'   'INF-X' 'INF-SARF'   'INF-Z'  'CAT-BHE'   'INF-XX'  'INF-SAN'  'INF-LAM'
               4582     75     781     66      2900    305     2420     484     410
1964 01  0     4.87   0.06    0.65   0.06      2.43   0.26     2.14    0.40    0.38
1964 02  0     5.57   0.06    0.63   0.07      3.10   0.33     2.77    0.49    0.40
1964 03  0     1.69   0.02    0.22   0.02      0.86   0.09     0.74    0.14    0.13
1964 04  0     5.10   0.06    0.64   0.07      2.83   0.26     2.24    0.53    0.31
1964 05  0     3.48   0.05    0.51   0.04      1.83   0.21     1.54    0.26    0.20
1964 06  0    65.17   0.83    8.33   0.60     30.35   3.36    28.25    7.94    4.90
1964 07  0   704.27   9.49   94.60   0.70    314.21  40.94   295.36   77.28   51.24
1964 08  0   663.74   8.20   84.14   7.23    304.65  35.08   295.71   70.41   51.94
1964 09  0   308.55   3.58   37.69   3.91    143.33  16.20   129.43   31.07   25.39
1964 10  0    59.18   0.68    7.17   0.78     27.05   3.06    24.20    5.95    5.02
1964 11  0    16.54   0.20    0.11   0.21      7.92   0.88     6.94    1.57    1.32
1964 12  0     7.57   0.09    0.98   0.09      3.68   0.40     3.21    0.71    0.59
```

Example COMBFILE input data file with time series data in **"Header version 1.02 format" :**

```
ODS 1.00TMS 1.02XXXXXXX  6.00
*
* Ribasim input data file with hydrological time series
*
* Reading format : fixed format
*
* - first record : number of series in file (maximal 11 series)
* - next records with the following values : I4,1X,I2,1X,I2,11f6.0
*   Year index,
*   Time step index,
*   Day index within the time step,
*   Time series values
*
   11
1959  1  0  0.62  1.49  0.78  1.09  0.83  0.12  0.09  0.59  0.13  0.33   1.92
1959  2  0  0.50  1.20  0.63  0.88  0.67  0.11  0.07  0.53  0.10  0.33   1.92
1959  3  0  0.49  1.20  0.62  0.87  0.67  0.11  0.07  0.47  0.10  0.33   2.10
1959  4  0  0.49  1.19  0.62  0.86  0.66  0.27  0.18  0.50  0.10  0.33   2.81
1959  5  0  0.52  1.27  0.66  0.93  0.71  0.41  0.28  0.65  0.11  0.33   3.77
1959  6  0  0.77  1.86  0.97  1.35  1.03  0.60  0.40  0.85  0.16  0.33 10.89
1959  7  0  0.51  1.23  0.64  0.89  0.68  0.11  0.07  0.60  0.10  0.33   7.20
1959  8  0  0.40  0.97  0.51  0.71  0.54  0.05  0.04  0.51  0.08  0.33   4.61
1959  9  0  0.38  0.93  0.48  0.68  0.52  0.06  0.04  0.39  0.08  0.33   3.22
1959 10  0  0.45  1.09  0.57  0.80  0.61  0.08  0.05  0.33  0.09  0.33   2.53
```

L Procedure for combining two or more basins

Procedure for combining two or more basins is described in this appendix. The requirements for the combined basins:

1 the basins have the same simulation time steps.
2 the basins use the same background map.
3 the ID's of the node and links are different.
4 the time series indexes and look-up table indexes are different.
5 the hydrological time series of the basins must have the same unit and a common time period range.

Procedure to combine two or more basins:

Step 1. Renumber the node and links of the basins so all have a different ID.
Step 2. Add a new basin.
Step 3. Combine the network and data files of the basins.
Step 4. Combine the hydrological time series files.
Step 5. Combine the water quality look-up table files.
Step 6. Setup a new case for the new basin.

Step 1. Renumber the node and links of the basins so all have a different ID.

Renumber the node and link id's for each basin (case) which must be combined. This can be carried out under the Case Management Tool (CMT) task block "Edit network and database on map". Before you renumber, select the renumber option you want to apply under menu item "Edit node and link renumber option data".

For example: we combine the following 3 basins

a. the Baitarani basin which are stored in directory : \Ribasim7\Baitaran.Rbn
b. the Mahanadi basin which is stored in the directory: \Ribasim7\Mahanadi.Rbn
c. the Nagavali basin which is stored in the directory : \Ribasim7\Nagavali.Rbn

Step 2. Add a new basin.

1 Create/add a new basin for the combination of basins. This can be done under the start screen.

   For our example we call the new combined basin : CombOris
   This all data are stored in the directory : \Ribasim7\CombOris.Rbn

2 Set simulation time step. Define the simulation time step of the new combined basin equal to the simulation time step of the original basins which will be combined. This can be done directly by using the right mouse button at the task block "Edit network and database on map". Select at the menu item "Simulation time step" one of the set menu options. For our example : we select basin CombOris and at right mouse button menu at task block "Edit network and database on map" we set the correct simulation time step. After this return to the start screen.

3 Map data : copy using Windows Explorer all map files from one of the basins which must be combined to the map directory of the new combined basin.

4 For our example : we copy / overwrite all files from the directory \Ribasim7\Baitaran.Rbn\maps to the directory \Ribasim7\CombOris.Rbn\maps

Step 3. Combine the network and data files of the basins.

1 Under Windows Explorer determine the name of the directory (is equal to a number) in which the data are stored of the cases to combine. You can find the list of case names and directory names (number) in the file "Caselist.Cmt" of each basin.

For example the directories:

a. Baitarani basin data is stored in directory 12: \Ribasim7\Baitaran.Rbn\12
b. Mahanadi basin data is stored in directory 5: \Ribasim7\Mahanadi.Rbn\5
c. Nagavali basin data is stored in directory 34: \Ribasim7\Nagavali.Rbn\34

2 Copy using Windows Explorer the simulation time step file Timestep.Dat from the fixed directory of the new combined basin to the working directory \Ribasim7\ComBasin

For our example:

copy file \Ribasim7\CombOris.Rbn\Fixed\Timestep.Dat to directory \Ribasim7\ComBasin

3 Combine under the network files and data files using the program ComBasin as follows:

a. At the start screen activate icon "Combine basins".
b. Select the menu item "Combine the basin".
c. Select the menu item "Copy default file with filenames".
The default file with filenames is copied to the working directory \Ribasim7\ComBasin. The name of the file is ComBasin.Fnm.

The default file with filenames looks as follows:

```
ODS 1.00FNM 1.07XXXXXXXX 7.00
*
* Default file with filenames to combine basin related data files
* ==============================================================
*
* Action : overwrite the input directory names at the bottom
* of this file and delete the remaining default names.
*
*-------------------------------|--------------------------------
* Output files
*-------------------------------|--------------------------------
 1.Print file                   :ComBasin.Log
 2.Return code file             :ComBasin.rtn
*-------------------------------|--------------------------------
*
*  Input files which are combined for the basins stored in the
directories
* indicated in the lowest part of this file (incl. some Dat-files).
*
*-------------------------------|--------------------------------
 1.Intentionally left open
 2.Configuration data file (1)  :conffil.ntw
```

```
 3.Time step data file          :\Ribasim7\combasin\timestep.dat
 4.Variable inflow node data    :varinfl.bin
 5.Fixed inflow node data       :fixinfl.bin
 6.Recording node data          :record.bin
 7.Reservoir node data          :reservoi.bin
 8.Run-off-river node data      :runofrvr.bin
 9.Intentionally left open
10.Low flow node data           :lowflow.bin
11.Public water supply node data:pwsupply.bin
12.Fixed irrigation node data   :fixirrig.bin
13.Variable irrigation  node dat:varirrig.bin
14.Loss flow node data          :lossflow.bin
15.Fish pond node data          :fishpond.bin
16.Intentionally left open
17.Pumping node data            :pumping.bin
18.Greek district node data     :grkdist.bin
19.General district node data   :gnrldist.bin
20.Ground water district node dt:grwdist.bin
21.Link storage node data       :linkstor.bin
22.Rsv partition node data      :rsvrpart.bin
23.Natural lake node data       :natlake.bin
24.Intentionally left open
25.Intentionally left open
26.Groundwater reservoir node dt:gwresrvr.bin
27.Groundwater lateral flow link:gwlatral.bin
28.Diverted flow link           :divlink.bin
29.Bifurcated flow link         :biflink.bin
30.Rsv backwater flow link      :rbwlink.bin
31.Source priority list         :srcprior.dat
32.Intentionally left open
33.Groundwater abstr.flow link  :gwabstr.bin
34.Advanced irrigation node data:advirrig.bin
35.Intentionally left open
36.Intentionally left open
37.Default source priority list :defprior.dat
38.Waste water treatment plant  :wastewtp.bin
39.Natural retention node data  :natreten.bin
40.SW flow link                 :swflow.bin
*-------------------------------|--------------------------------
*
* Directory name of the combined basin.
*
*-------------------------------|--------------------------------
 1.Output directory name        :..\Combasin\
*-------------------------------|--------------------------------
*
* Directory names of the basins to be combined (2 or more).
*
*-------------------------------|--------------------------------
1.Input directory             :\Ribasim7\Default.Rbn\1\
  2.Input directory             :\Ribasim7\Default.Rbn\1\
  3.Input directory             :\Ribasim7\Default.Rbn\1\
  4.Input directory             :\Ribasim7\Default.Rbn\1\
  5.Input directory             :\Ribasim7\Default.Rbn\1\
  6.Input directory             :\Ribasim7\Default.Rbn\1\
  7.Input directory             :\Ribasim7\Default.Rbn\1\
  8.Input directory             :\Ribasim7\Default.Rbn\1\
  9.Input directory             :\Ribasim7\Default.Rbn\1\
 10.Input directory             :\Ribasim7\Default.Rbn\1\
```

d. Select the menu item "Specify basins to combine". Edit the file with file names of the ComBasin-program. Enter at the bottom of the file the names of the case directories which have been determined in step 3.1. You must delete the remaining records at the bottom of the file. And be sure that no empty records are left at the end of the file.

For our example the bottom of the file with filenames is as follows:

```
*------------------------------|--------------------------------
*
* Directory names of the basins to be combined (2 or more).
*
*------------------------------|--------------------------------
 1.Input directory             :\Ribasim7\Baitaran.Rbn\12\
 2.Input directory             :\Ribasim7\Mahanadi.Rbn\5\
 3.Input directory             :\Ribasim7\Nagavali.Rbn\34\
```

e. Select the menu item "Merge the basin files". The program ComBasin is executed.

f. Check the messages in the program Log-file at menu item "View Log-file".

Step 4. Combine the hydrological time series files.

Prepare a new hydrological scenario consisting of the combined hydrological time series. Combining the hydrological time series files (file type Tms) of the combined basins can be done:

- manually with Excel or editor, or
- using the Ribasim utility program CombFile for the multiple year time series under menu item "Combine hydrological time series files". Aware that the unit of the data in the files to combine must be the same. The description is outlined below.

Step 5. Combine the water quality look-up table files.

If you have applied the water quality computation of Ribasim then you must prepare a new water quality scenario consisting of the combined look-up tabes. Combining the look-up tabe files (file type Lkp) of the combined basins can be done:

- manually with Wordpad, Notepad or other editor.

Step 6. Setup a new case for the new basin.

1 Copy the files with file type Ntw, Bin and Dat from the working directory \Ribasim7\ComBasin to the Newstart subdirectory of the in step 2 created combined basin directory.

   For our example : we copy the files from the directory \Ribasim7\ComBasin to the directory \Ribasim7\CombOris.Rbn\Newstart

2 Start Ribasim7, select icon "Open ans simulate" and select the new basin in our example CombOris.

   a. Select menu item "Case" then item "New". A new case is defined with the combined network and model data from the Newstart-directory.
   b. At task block "Select hydrological and water quality scenario": Select the in step 4 created hydrological scenario and the in step 5 created water quality scenario.
   c. Select the task "Edit network and model data" and carry out the following tasks under the network editor Netter:

- Check the interbasin connections. Change the network for those locations: remove or change the node type into a confluence node of the demand and/or end nodes representing the export flow and the inflow node representing the import of flow, and contact the two remaining nodes (aware of the link number).
- Check the time series index of the various nodes and the water quality look-up table indexes.
- Save the network (automatically the new source priority list is generated), check and update the source priority list of the various demand and reservoir nodes from map.

d. Select the task "Specify simulation control data". At this task block Ribasim will determine the length of each hydrological time series and determines the common time period range. If an error message occurs then check the log-file (by clicking the right mouse button while the cursor is on the task block). The log-file shows the name of the files, which have been read. At the last mentioned file the error has occurred. Check this time series file: most time at the end of the time serie file some (invisible) characters are present, which must be erased completely (Use preferably the editor Wordpad which shows the invisible characters on the screen).

3 Save your case under a new case name at the menu items "Case" and "Save as".

4 Erase all files in the work directory \Ribasim7\Combasin

Description of utility program Combfile

If you want to use the utility program CombFile, select the menu item "Combine hydrological time series files". The time series files must be in the Tms-file format. The Tms-file format is described in the Ribasim User manual appendix F.2.

1 At the pop-up menu select the menu item "Copy default file with filenames". The default version of the file with filenames are copied from the directory \Ribasim7\Programs\CombFile to the work work directory \Ribasim7\Combasin. The names of the deafult files are:

CombRecrdflw.FNM
CombActInflw.FNM
CombActRain.FNM
CombEvaporat.FNM
CombLossflow.FNM
CombDisdisch.FNM
CombDisdemnd.FNM
CombLowflow.FNM

2 Select menu item "Combine actual inflow time series files", a new pop-up menu appears.

a. select menu item "Specify actual inflow time series to combine". Edit the default file with file names (see below) of the various time series files. At the bottom of the file you must specify all time series file names incl. the directory name. Only the last few records must be editted. You can add or delete records at the bottom of the file. And be sure that no empty records are left at the end of the file.

For our example after editting the file with filenames for the actual inflow time series (named CombActInflw.Fnm) is as follows :

```
ODS 1.00FNM 1.00XXXXXXXX 6.00
*
* Default file with filenames to combine time series files with
* Tms-file format
*
* Action : overwrite the input file names below and delete the
*             remaining default names.
*
* For description of Tms-file format see Ribasim User manual
*
*-------------------------------|---------------------------------
* Output files
*-------------------------------|---------------------------------
 1.Print file                   :\Ribasim7\ComBasin\CombActInflw.Log
 2.Time series output file      :\Ribasim7\ComBasin\ActInflw.Tms
*-------------------------------|---------------------------------
* Input files
*-------------------------------|---------------------------------
 1.Time series file 1           :\Ribasim7\Baitaran.Rbn\Hydrolog\Scenario.2\ActInflw.Tms
 2.Time series file 2           :\Ribasim7\Mahanadi.Rbn\Hydrolog\Scenario.1\ActInflw.Tms
 3.Time series file 3           :\Ribasim7\Nagavali.Rbn\Hydrolog\Scenario.2\ActInflw.Tms
```

b Select menu item "Merge actual inflow time series files". The program CombFile is executed. The combined time series result file ActInflw.Tms is stored in the work directory \Combasin

c Check the messages in the program Log-file in the menu item "View Log-file".

All actions 2a-2c must be done for all Tms-files.

M Indicators of Hydrologic Alteration

The Indicators of Hydrologic Alteration (IHA) is a software program developed by The Nature Conservancy and provides useful information for those trying to understand the ecological implications of a particular flow pattern or water management scenario. This software program examines over 67 ecologically relevant statistics derived from daily hydrologic data. These parameters are subdivided into 2 groups, the Indicators of Hydrologic Alteration (IHA) parameters and the Environmental Flow Component (EFC) parameters. For instance, the IHA software can calculate the timing and maximum flow of each year's largest flood or lowest flows, then calculates the mean and variance of these values over some period of time. The program is used to assess how current flow patterns in a particular river, lake, or groundwater aquifer differ from the system's natural flow regime.

The main IHA webpage from where the software and manuals can be downloaded is:

http://www.nature.org/initiatives/freshwater/conservationtools/art17004.html

The daily input time series for the IHA software can be generated by RIBASIM as follows:

1 Make a daily RIBASIM simulation of your basin. In this case the result flow file "DlyQlink.His" is generated containing the daily link flows.
2 Prepare a Csv-file (Comma Separated Value-file) of the flows. At the task block "Analysis of basin simulation results" and sub-task "Results : on charts" (see chapter 9.2) you can start the ODS_VIEW program. At this program you can find and open the file "DlyQlink.His". After selection of the flow parameter, one link name and the time period you must export the results to a Csv-file e.g. IHAFlows.Csv and store this file in your own result sub-directory.
3 Edit the Csv-file. First you must remove the header lines and second you have to remove the time "00:00:00" indication in all records.

Finally the file looks like:

```
1977-01-01, 1.5
1977-01-02, 1.6
1977-01-03, 1.7
1977-01-04, 1.6
1977-01-05, 1.3
1977-01-06, 1.0
…
```

The Csv-file can directly be imported in the IHA software for further analysis.

N List of abbreviations

Abbreviation	Description
AGWAT	Irrigated agriculture water demand model in previous RIBASIM versions
ASCII	Standard code for characters
BNA	ASCII based standard format for graphical pictures (GIS)
CAT	Case Analysis Tool (a Delft tool)
CD	Compact disk
CMT	Case Management Tool, program Caseman (a Delft tool)
CMT_PROJ	Tool to create and delete RIBASIM river basin implementations (a Delft tool)
COMBFILE	Combine time series (TMS) files (a Ribasim utility program)
CROPPER	Interactive , graphical crop plan editor, part of Ribasim
DATAEDIT	Spreadsheet based data entry tool, part of Ribasim
DelftAGRI	Delft agriculture water demand, water allocation, crop yield and production costs model, part of RIBASIM
DMI	Domestic, municipal and industrial water supply
DSSHELL	Tool to present a title page and select menu and icon options (a Delft tool)
FISHWAT	Brackish water fish pond water demand model in previous RIBASIM versions
GIS	Geographical information system
golongan	Number of geographical units of irrigated areas that start the field operation at the same time or within a limited period of time. In this way a better distribution of water demands in time is promoted.
GWh	Gigawatt-hour (1,000,000,000 Watt)
ha	hectare (10,000 m2)
HIS	Delft Hydraulics standard history format used for time series files
kg	kilogram
km	kilometre
kW	Kilowatt
kWh	Kilowatt-hour
l	litre
m	meter
MAPPER	Map manipulator (a Delft tool)
MAPLINK	Map linker for conversion of GIS file format like BNA into the NETTER map layer MPL-format (a Delft tool)
MPL	Map layer file type
MRp	Million rupiah (currency unit)
MW	Megawatt (1,000,000 Watt)
Mcm	million cubic metre
NETTER	Network editor (a Delft tool)
NOTEPAD	Ms` Windows text processor
ODS_VIEW	Open Data Structure conversion to Excel format and other file formats including graphical presentation (a Delft tool)
palawija	A on crop water requirement characteristics defined “average” crop covering e.g. maize, soy beans, ground nuts, mung beans, pigeon pea, vegetables and sweet potatoes (used in Indonesia).
ppm	parts per million
ppt	parts per thousand
PWS	Public Water Supply including domestic, municipal and industrial water
RIBASIM	River basin simulation model
Rp	Rupiah (currency unit)
s	second
SVGA	Super VGA
tebu	Sugar cane (Indonesian terminology)
VGA	Video Graphics Adapter
WADIS	Crop yield and production costs model in previous Ribasim versions
Wordpad	Ms Windows word processor
WRITE	Ms Windows word processor