

# MIKE 11

## River and Channel Modelling

### Short Introduction - Tutorial



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# CONTENTS

## MIKE 11 River and Channel Modelling Short Introduction - Tutorial

<b>1</b>	<b>Background.....</b>	<b>1</b>
<b>2</b>	<b>Before You Begin .....</b>	<b>3</b>
2.1	Product Support.....	3
2.2	THE ACADEMY by DHI Training Courses .....	4
2.3	Comments and Suggestions.....	4
<b>3</b>	<b>Welcome to MIKE 11 .....</b>	<b>5</b>
3.1	Introduction.....	5
3.2	Short Description of MIKE 11 .....	5
3.3	MIKE 11.....	6
3.4	What's New.....	6
<b>4</b>	<b>Getting Started .....</b>	<b>7</b>
4.1	Hardware Requirements.....	7
4.2	Installation of MIKE 11 .....	7
4.3	How to Start MIKE 11 .....	7
4.4	MIKE 11 Online Help.....	8
<b>5</b>	<b>Working with the MIKE 11 User Interface.....</b>	<b>9</b>
5.1	MIKE Zero Project Files.....	9
5.2	MIKE 11 Editor Files.....	9
5.2.1	File handling.....	9
5.2.2	File types .....	12
5.3	Integrating Editors – the Simulation Editor .....	12
5.4	Working with the Network Editor.....	13
5.4.1	Graphical view .....	14
5.4.2	Tabular view.....	16
5.5	Working with the Cross-section Editor .....	23
5.5.1	Raw data view.....	24
5.5.2	Processed data view .....	27
5.6	Working with the Boundary Editors.....	28
5.6.1	Time series editor.....	28
5.6.2	Boundary editor.....	31
5.7	Working with Parameter File Editors.....	31
5.7.1	HD parameter editor .....	31
5.7.2	AD parameter editor .....	35
5.7.3	ST parameter editor .....	38
5.7.4	WQ simulation parameters (MIKE ECO Lab).....	41

<b>6</b>	<b>Setting Up a Simulation.....</b>	<b>43</b>
6.1	Using the Simulation Editor.....	43
6.2	Simulation Editor File – also a Simulation-Log.....	45
<b>7</b>	<b>MIKE 11 Tutorial .....</b>	<b>47</b>
7.1	What Will I Learn? .....	47
7.2	Network Editor – Basic Facilities.....	47
7.3	Cross-section Editor .....	54
7.4	Boundary and Time Series Editor .....	56
7.5	HD Parameter Editor .....	60
7.6	Running the Simulation.....	60
<b>8</b>	<b>MIKE View Tutorial .....</b>	<b>65</b>
8.1	MIKE View in General.....	65
8.2	What Will I Learn in the MIKE View Tutorial? .....	66
8.3	Before You Begin .....	66
8.4	About MIKE 11 and MOUSE Result Files.....	66
8.5	What Are We Going to View .....	67
8.6	Loading Results.....	67
8.7	Exploring the MIKE View Screen .....	68
8.8	Viewing System Data.....	69
8.9	Viewing Results.....	71
8.10	Viewing Results in a Longitudinal Profile.....	73
8.11	Viewing Time Series.....	74
<b>9</b>	<b>Demo Set-ups Included in the Installation .....</b>	<b>77</b>
9.1	Introduction .....	77
9.2	How to Use the Demonstration Set-ups .....	77
9.3	Cali River.....	78
9.4	Vida.....	80

## 1 Background

MIKE 11, developed by DHI, is a software package for simulating flows, water quality and sediment transport in estuaries, rivers, irrigation channels and other water bodies.

This manual provides a short description of MIKE 11 with emphasis on the basic features and usage of the fully Windows integrated Graphical User Interface of MIKE 11. Additionally, a tutorial is provided to introduce MIKE 11 to users with no or very little experience with MIKE 11 and guide them through the set-up and simulation of a simple river system.

Presentation of results from MIKE 11 is carried out with MIKE View. MIKE View is a Windows based result presentation and reporting tool for MIKE 11. A tutorial is described in order to familiarise MIKE 11 users with the features and usage of MIKE View.

More detailed description of MIKE View is supplied in a separate MIKE View manual.

The MIKE 11 User Guide and MIKE 11 Reference Manual complements the present manual and the Online Help with essential information on conceptual and algorithmic implementation of the main processes treated by MIKE 11, as well as descriptions of applied modelling techniques.

To help you to learn using MIKE 11 efficiently, the online help and the present manual can be used to guide you through the facilities of MIKE 11.





## 2 Before You Begin

### 2.1 Product Support

If you have questions concerning MIKE 11 or problems with the MIKE 11 software, please consult the present manual, the MIKE 11 User Guide, MIKE 11 Reference Manual or the online help.

If you have access to the Internet, You may also have a look under 'Frequently Asked Questions' (FAQ), User Forum or 'Tips & Tricks' in the Support section of the MIKE Powered by DHI's home page:  
<http://www.mikepoweredbydhi.com/>

If you cannot find the answer to your queries, please contact your local MIKE Powered by DHI support centre.

In countries where no local MIKE Powered by DHI support centre is present you may contact DHI headquarters directly, by mail, phone, fax or e-mail:

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If you wish to upgrade or purchase additional modules on an existing installation, please contact your local MIKE Powered by DHI support centre or DHI headquarters.

The most efficient way of communicating is by e-mail, allowing us to optimise services to our clients. Under normal circumstances, all e-mail messages received at DHI will be answered within 24 hours.

When contacting your local MIKE Powered by DHI support centre or the MIKE Powered by DHI support centre at DHI headquarters, you should have the following information at the ready:

- The version number of your MIKE 11 installation.
- The exact wording of any message that appears on the monitor (in case of software problems).
- A description of what happened and what you were trying to do when the problem occurred.
- A description of how (if at all) you tried to solve the problem.
- The type of hardware you are using including available memory.
- If you contact DHI by e-mail, please attach the set up that causes problems.

## 2.2 THE ACADEMY by DHI Training Courses

MIKE Powered by DHI software is often used to solve complex and complicated problems, which require a good perception of modelling techniques and the capabilities of the software. Therefore, THE ACADEMY by DHI offers a wide range of standard courses in the use of our MIKE software products.

The courses are advertised through THE ACADEMY by DHI's home page:

<http://www.theacademybydhi.com/courses-and-events-calendar>.

THE ACADEMY also offers tailored training courses based upon your own data and designed according to your specific needs

If you have any questions about our standard courses or any request for a tailored course, please do not hesitate to contact us: [courses@dhigroup.com](mailto:courses@dhigroup.com).

## 2.3 Comments and Suggestions

Success in perception of the information presented in this document, together with the user's general knowledge of river systems, hydrology, hydrodynamics and experience in numerical modelling is essential for getting a maximum benefit from MIKE 11. This implies that the quality of the documentation, in terms of presentation style, completeness and scientific competence, constitutes an important aspect of the software product quality. DHI will, therefore, appreciate any suggestion that will contribute to the improved overall quality of the future editions of MIKE 11.

Please give us your contribution by e-mail to [mike@dhigroup.com](mailto:mike@dhigroup.com).

## 3 Welcome to MIKE 11

### 3.1 Introduction

MIKE 11 is part of the MIKE Powered by DHI software products based on the MIKE Zero platform, comprising a fully Windows integrated Graphical User Interface, which conforms to the evolving standards for Windows based software. MIKE 11 contains the mature, well-known and well-tested computational core, which has formed the basis for the long history of MIKE 11 releases. MIKE 11 is a true 64-bit application securing fast computational speed or number crunching in comparison with earlier MIKE 11 versions.

By applying MIKE 11 it is possible to answer questions such as:

- The exceedance levels in case of flooding – and at which locations will flooding occur?
- The implications of introducing e.g. flood control measures?
- The long-term environmental impact affected by changing pollution loadings?
- Where is the sediment deposited in the river system - and what are the overall morphological changes?
- The peak concentrations of pollutants at specific locations after e.g. heavy polluted loadings from urban catchments, CSO's (combined sewer overflow) or industry plants?

And much more...

### 3.2 Short Description of MIKE 11

MIKE 11 is a professional engineering software package for the simulation of flows, water quality and sediment transport in estuaries, rivers, irrigation systems, channels and other water bodies.

MIKE 11 is a user-friendly, fully dynamic, one-dimensional modelling tool for the detailed analysis, design, management and operation of both simple and complex river and channel systems. With its exceptional flexibility, speed and user friendly environment, MIKE 11 provides a complete and effective design environment for engineering, water resources, water quality management and planning applications.

The Hydrodynamic (HD) module is the nucleus of the MIKE 11 modelling system and forms the basis for most modules including Flood Forecasting, Advection-Dispersion, Water Quality and Non-cohesive sediment transport modules. The MIKE 11 HD module solves the vertically integrated equations for the conservation of continuity and momentum, i.e. the Saint Venant equations.

Applications related to the MIKE 11 HD module include:

- Flood forecasting and reservoir operation
- Simulation of flood control measures
- Operation of irrigation and surface drainage systems

- Design of channel systems
- Tidal and storm surge studies in rivers and estuaries

The primary feature of the MIKE 11 modelling system is the integrated modular structure with a variety of add-on modules each simulating phenomenon related to river systems.

In addition to the HD module described above, MIKE 11 includes add-on modules for:

- Hydrology
- Advection-Dispersion
- Models for various aspects of Water Quality
- Cohesive sediment transport
- Non-cohesive sediment transport

### 3.3 MIKE 11

The present generation of MIKE 11 combines the features and experiences from the previous MIKE 11 generations, with the powerful Windows based user interface including graphical editing facilities and improved computational speed gained by the full utilisation of 64-bit technology.

On the input/edit side MIKE 11 features:

- graphical data input/editing
- simultaneously input/editing of various data types
- copy & paste facility for direct import (export) from e.g. spread sheet programs
- fully integrated tabular and graphical windows
- importing of river network and topography data from ASCII text files
- user defined layout of all graphical views (colours, font settings, lines, marker types etc.)

On the output side, advanced presentation facilities are available, including:

- coloured horizontal plan graphics for the system data and results
- animated presentation of results in horizontal, longitudinal and time series plot
- synchronised animation of results
- presentation of external time series
- copy & paste facility for exporting result tables or the presentation graphics into other applications (spread sheet, word processing or others)

### 3.4 What's New

Every new release of MIKE 11 comprises new modules, new features and/or corrections to problems or significant inconsistencies discovered in previous releases.

Release Notes on every MIKE product are prepared with every new release and new features and other general improvements are described in these.

## 4 Getting Started

### 4.1 Hardware Requirements

MIKE 11 is available for PCs with Microsoft Windows based operating systems. For specifications on supported Windows versions, please refer to the release notes. Using dynamic memory allocation the required RAM in MIKE 11 varies depending on the actual set-up and model domain. As a general guideline we usually recommend minimum 2 GB RAM and similarly at least 2 GB of free disk space.

### 4.2 Installation of MIKE 11

To install MIKE 11 safely please follow the instructions given below:

1. If you have a previous version of any MIKE Zero product installed, you must uninstall this version initially.

To uninstall MIKE Zero products, use the 'Control Panel → Add/Remove Programs'. Occasionally, you will find some files remaining in your installation folder after the uninstall procedure, e.g.:

'C:\Program Files (x86)\DHI\2020\MIKE Zero\bin' or  
'C:\Program Files (x86)\DHI\2020\MIKE Zero\bin\x64'

Make a backup of any personal files or directories you might have placed in this directory, and then delete everything. Especially, make sure that the 'bin' directory is completely empty.

2. It is strongly recommended that you exit all Windows programs you may have running before running the set up program.
3. To install MIKE 11 Release 2022, please download and unpack the installation package from our home page:

<https://www.mikepoweredbydhi.com/download/MIKE-2022>

The installation program automatically installs all necessary MIKE 11 files and folders to your PC. Additionally, a 'MIKE Zero 2022' group is created, from which you can start the 'MIKE Zero' application. MIKE 11 are accessible as a product type inside the MIKE Zero platform.

### 4.3 How to Start MIKE 11

To start MIKE 11, select the 'MIKE Zero 2022' folder from the Start menu and start the 'MIKE Zero' application.

Starting MIKE 11 without a DHI configured Software Key and a valid license file, causes the program to run in Demo mode. If this happens, a message box will inform you during program initialisation. Running in Demo mode, MIKE 11 supplies full access to all editors, input files and editing facilities. However, restrictions apply on the number of items allowed, when saving input files and performing computations.

**PLEASE NOTE:**


The User Interface of MIKE Zero/MIKE 11 is designed such that a monitor with a minimum of Super VGA resolution (1024x768) is required to view the full contents of all dialogs.

It is indeed possible to run MIKE 11 on a monitor with smaller resolution, but parts of the dialogs can then only be viewed, if the specific window is moved manually by using the mouse.

## 4.4 MIKE 11 Online Help

Following the standards of true Windows application, MIKE 11 utilises integrated online Help supplying descriptive information on each of the editors, dialogs and property pages within the system. The online Help supplies explanations on how to operate a specific dialog as well as descriptions of the parameters present in the specific page.

The online Help can be activated in several ways, depending on the user's requirement:

1. Use the Help button:  To see the description of a specific functionality, press the Help button and move the '?' to point and click in an editor page or on one of the edit buttons available in the editor.

Please note that this help feature is only available in the network editor.

2. <F1> key seeking help on a specific activated editor page;  
To access the help associated with a specific editor property page press the <F1> key on the keyboard after opening the editor and activating the specific property page.
3. Open the online Help system for scrolling manually after a specific help page;  
Open the online Help system by selecting Help in the main menu bar.

## 5 Working with the MIKE 11 User Interface

### 5.1 MIKE Zero Project Files

On-line help exist for all products and modules inside MIKE Zero and help documents can be accessed for further details through the 'MIKE Zero Documentation Index' which is also located and accessible from the MIKE Zero 2022 folder in the Windows Start menu.

### 5.2 MIKE 11 Editor Files

#### 5.2.1 File handling

With respect to file handling, MIKE 11 is operated just like any other Windows application. That is, all file-related operations are performed through the File menu on the Main Menu bar. Please note that the content of the File menu will change depending on which MIKE 11 editor is in focus at the time where the File menu is opened. An example of the File menu is shown in Figure 5.1.

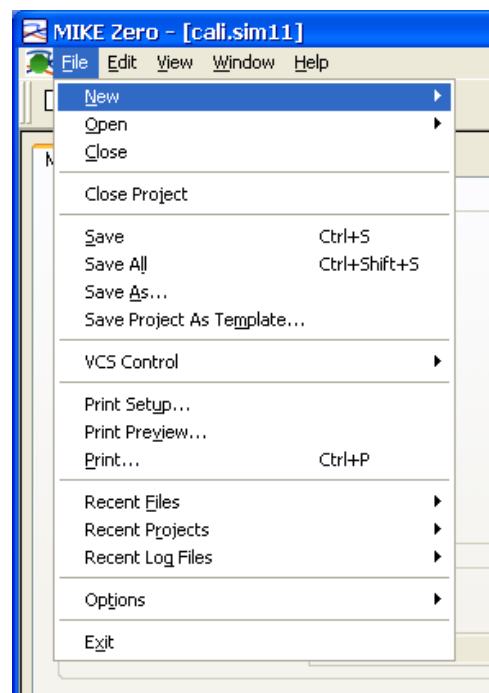


Figure 5.1 File menu from MIKE 11 Main Menu bar

#### Creating new editor files

To create a new editor file, select File from the main menu bar and choose New → File to open the 'New' dialog (alternatively press Ctrl+N), see Figure 5.2. Expand the tree view in the dialog by clicking '+' or double-clicking the MIKE Zero and MIKE 11 icons. The tree view in the 'New' dialog shows a list of available Data editors in the MIKE Zero environment.

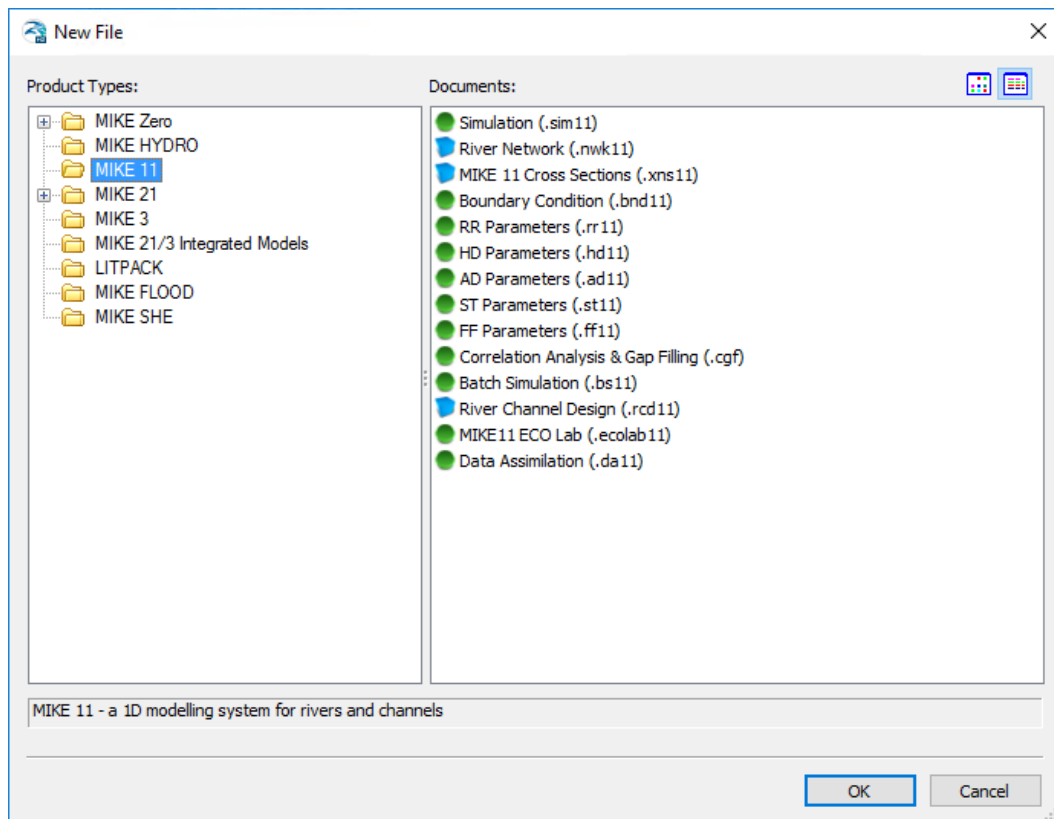


Figure 5.2 'New File' dialog for generating a new MIKE 11 input file

Select the type of file you wish to create and press the OK button or double-click the specific icon. Selecting an item from the 'New' dialog automatically opens the specific editor and data input can commence.

### Open existing editor files

To open an existing editor file, select File → Open → File from the Main Menu bar to activate the standard Windows 'Open file' dialog (alternatively press Ctrl+O). Activate the file type combo box by clicking the arrow button in the 'Files of Type' field and select the type of file you wish to open, see Figure 5.3.



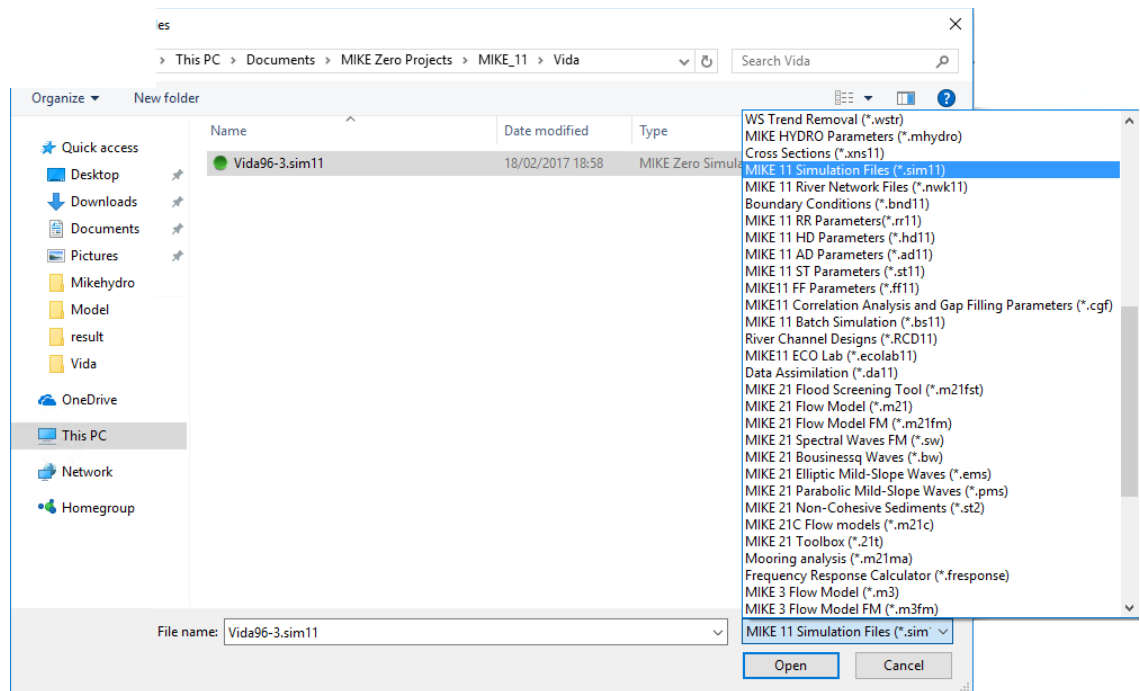


Figure 5.3 File open dialog including file type selection combo box

After selection of the editor file to open, the corresponding editor will be automatically opened with the content of the selected editor file. The content of the loaded data file can now be modified.

Upon termination of an input editing session, the editor file is saved by selecting File + Save from the main menu bar. You are automatically prompted to specify an editor filename.

**IMPORTANT NOTICE:**

When saving editor files, please specify the full filename including the specific extension for the editor file used. It is essential that all input files are saved with the correct extension before a simulation is performed. (Example: saving a Network editor file with the name 'TEST', you should specify 'TEST.NWK11' to ensure that all files holds the right extension as this is a must in order for the simulation part of MIKE 11 to work properly!

## 5.2.2 File types

MIKE 11 includes multiple editors each operating on different types of data. Data from these editors must be saved in separate editor files – utilising the default MIKE 11 file extensions as listed below.

MIKE 11 Editor	File Extension
Network editor	*.NWK11
Cross-section editor	*.XNS11
Boundary editor	*.BND11
Time series files	*.DFS0
HD parameter file	*.HD11
AD parameter file	*.AD11
MIKE ECO Lab parameter file (WQ)	*.ECOLab11
ST parameter file	*.ST11
FF parameter file	*.FF11
Rainfall Runoff parameter file	*.RR11
Simulation editor	*.SIM11
Result files	*.RES11

## 5.3 Integrating Editors – the Simulation Editor

MIKE 11 comprises a number of different editors in which data can be implemented and edited independently of each other. As a consequence of the system of separated editor-files, no direct linkage exists between the different editors if they are opened individually. That is, it will not be possible to e.g. view the locations of cross-sections specified in the cross-section file in the Graphical view of the network editor (Plan plot) if these editors are opened individually.

The integration and exchange of information between each of the individual data editors is achieved by use of the MIKE 11 Simulation editor. The Simulation Editor serves two purposes:

1. It contains simulation and computation control parameters and is used to start the simulation.
2. It provides a linkage between the graphical view of the network editor and the other MIKE 11 editors as illustrated in Figure 5.4.

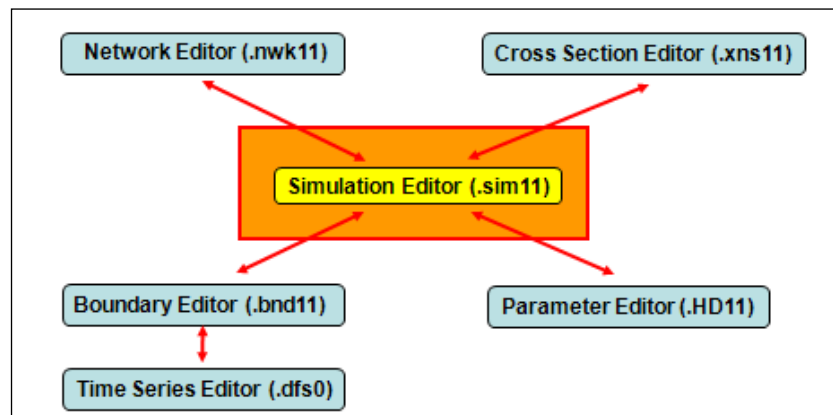


Figure 5.4 The MIKE 11 Simulation editor

Editing of cross-sections could be a typical example, where cross-sections can be selected from the graphical view in order to open the cross-sections for editing in the cross-section editor.

The linkage requires a file name to be specified for each of the editors. File names are specified on the Input Property Page of the simulation editor.

Once the editor filenames are specified on the Input page, the information from each of the editors is automatically linked. That is, you will be able to display and access all data from the individual editors (such as cross-sectional data, boundary conditions and different types of parameter file information) on the graphical view of the river network editor.

## 5.4 Working with the Network Editor

The Network editor is a very central unit in the MIKE 11 Graphical User Interface. From the graphical view (the plan plot) of the network editor, it is possible to display information from all other data editors in MIKE 11. The Network editor consists of two views, a tabular view, where the river network data are presented in tables, and a graphical view, where graphical editing of the river network can be performed as well as data from other editors can be accessed for editing, etc.

The main functions of the network editor are:

- To provide editing facilities for data defining the river network, such as
  - digitisation of points and connection of river branches,
  - definition of weirs, culverts and other hydraulic structures,
  - definition of catchments connecting the river model to a rainfall run-off model.
- To provide an overview of all data included in the river model simulation. Overview is provided via the possibility of presenting items from the different data editors on the plan plot, graphical view. The different items can be presented using symbols and lines of different colours and size – all controlled by the user via the 'Settings', 'Network' dialog from the graphical view.

The tabular and the graphical view of the Network editor are shown in Figure 5.5.

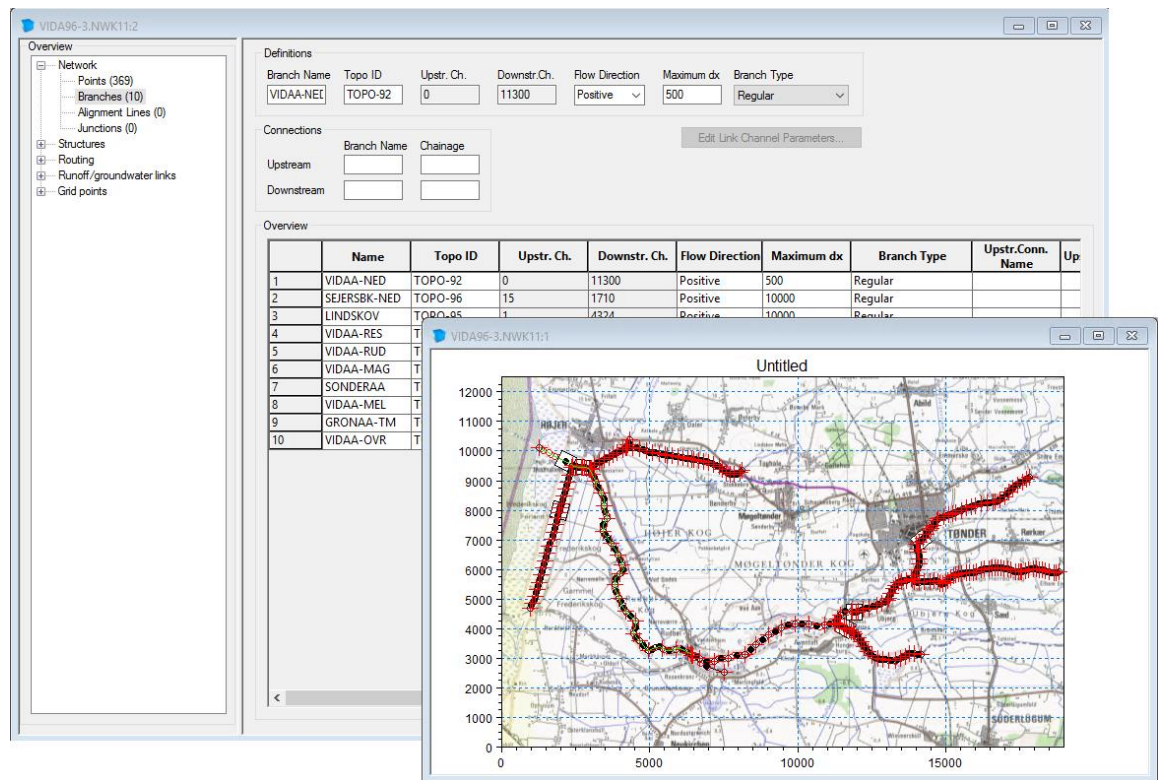


Figure 5.5 Network editor, Tabular and Graphical view

### 5.4.1 Graphical view

The graphical view is opened as default when a river network file is opened or created. Additional graphical views can be opened using the 'New window' facility in the Window Menu in the Main menu bar. When creating a new network file, the user is prompted to define Area Co-ordinates. These define the co-ordinate system of the plan in which the river system will be digitised.

The Graphical editor of MIKE 11 provides a large number of facilities for editing and presentation of the river network.

The main features comprise:

- **Network toolbar for graphical editing.**



The tools necessary for creating or editing the river network can be accessed from the network toolbar. That is, tools can be selected for digitising single or multiple points, connecting points and branches, merging or cutting branches, deleting points or branches etc.

- **Right mouse pop-up menu.**

From the graphical window, it is possible to activate a number of editing facilities from the editor's right mouse pop-up menu.

To edit an object through the pop-up menu, place the cursor at a network component

(e.g. a point, a branch or any other symbol) and press the right mouse button to activate the menu.

Selecting 'Edit...' gives a possibility of editing any object in the vicinity of the selected point.

Use the 'Insert' entrance to insert a new object at the selected point in the network. Selecting an entrance from one of the Insert's sub-menus will open the corresponding editor.

'Point properties' gives a possibility for changing the selected point's co-ordinates and chainage (if chainage type is selected as 'User Defined').

- **Zoom functions.**

Zoom functions (zoom in, out and previous zoom) can be activated from the zoom toolbar buttons or from the right mouse pop-up menu. To zoom in, click and drag until the zoom selection square covers the area in the horizontal plan, which should be enlarged.

Please note that the shape of the zoom-in selection area is identical to the shape of the graphical view window.

- **User-defined settings for display of river network components.**

The drawing style, size and colours of points, branches and other network components presented in the graphical view can be controlled from the 'Graphical Settings' page in the Network Dialog. The Network dialog is activated from the Settings Menu in the Main menu bar

- **Background images.**

Using the Layers menu from the Main menu bar, it is possible to import one or more images as a background map for the river network. Image-files must be saved in either GIF- or BMP-format.

Location of the image(s) in the horizontal plan can be modified by selecting the image (a red square appears around the image when selected), activate the 'Image Co-ordinates' entry from the right mouse pop-up menu, and it will then be possible to alter the co-ordinates of the specific image.

Thereby, it is also possible to import multiple images of selected areas within the same river network file.

- **Auto functions.**

In the 'Network' menu under the Main menu bar you can activate facilities for auto generating network components. E.g. automatic connection of branches following logical user-defined specifications, automatic generation of boundary conditions at all open ends and automatic update of chainages in the entire network in case points have been added, moved or deleted.

- **Longitudinal profile.**

The Longitudinal profile feature is only available if the network file has been opened through a simulation editor where a cross-section file is associated. It is required to associate information on cross-sections, as the bed- and bank-levels are presented in the longitudinal profile.

Activate the Longitudinal feature in the 'View' menu from the Main menu bar. Place

the cursor at a branch and click with the left mouse button to select the upper branch in the profile (notice that the branch is highlighted and the cursor changes symbol when a branch can be selected). Secondly, place the cursor at the branch which should be the end branch in the profile and click with the mouse button.

MIKE 11 investigates the number of possible profiles following the path from the first branch to the last and if more than one possibility exists, a profile selection dialog will appear. Select a profile from the dialog to present the longitudinal profile in a separate window.

If only one path exists from the first to the last selected branch, a window containing the longitudinal profile will appear immediately.

- **Metafile options.**  
The river network can be saved in a Windows Metafile format for use in e.g. word processors. The metafile feature is activated through the 'View' menu in the Main menu bar. Metafile can be copied to the clipboard for immediate pasting in to other programmes or it can be saved to a file on the disk.
- **Import of network co-ordinates from ASCII files.**  
Branch and point (cross-section) data can be imported from ASCII text-files. File format is described in the On-line Help system.

## 5.4.2 Tabular view

The tabular view is opened manually by selecting the 'Tabular View...' item in the View Menu (hotkey combination is CTRL+T) or automatically, when editing an existing network object through the right mouse Pop-up menu.

The dialog for the tabular view contains a number of property pages. A short description of the content and purpose of each property page is given below. For a more comprehensive description on some of the items reference is made to the On-line Help system:

### Points

The points' property page offers a possibility of editing co-ordinates and river chainages of the points digitised in the graphical view (horizontal plan plot).

Important to notice on this property page is the column; 'Chainage type' where two options are available: 'System Defined' and 'User Defined' chainage:

- **'System Defined' chainage** means that MIKE 11 automatically calculates the chainage from the digitisation (distance from neighbouring points calculated from the plan plot co-ordinates).
- **'User Defined' chainage** means that the user can manually specify fixed chainages for specific reference points (e.g. hydraulic structures, bridges etc., which have been surveyed and found to have a specific location and chainage).

Additionally, it is recommended always to specify the first and last point in each branch as User defined, as this will ensure that the length of the river system is exactly as required.

**PLEASE NOTE:**

The points' information in this property page only includes digitised points. Digitised points are not used in the computation – only for presentation of the plan plot of the river system.

Computational points (grid points) used in the computation can be presented in the 'Grid Points' property page.

## Branches

In the 'branches' page, specifications are made on the river branches included in the set-up. Initially, a River name must be specified in the 'Name' column. Afterwards, the remaining columns must be edited:

- **Topo ID.**

Topo ID is a 'topographical identifier', which gives the user a possibility of distinguishing between different surveys for the same river system.

Topographical surveys from different years can be stored in the same cross-section file if only the Topo ID parameter differs. Therefore, the Topo ID specified must correspond to a Topo ID defined in the cross-section file used in the computation – otherwise, cross-section data for the simulation cannot be located.

- **Flow direction.**

The standard notation of MIKE 11 is that flow direction is positive with increasing chainages. This typically requires that the starting point (zero chainage) is defined as the upper part and the end the point of the river system are defined in the downstream part of the river system.

However, in many surveys, the downstream point (e.g. the river mouth at the sea) is the starting point for the river survey, and this point is therefore required to be the starting point (zero chainage) for the river model as well. Therefore, in these cases, it is required to specify the flow direction as 'Negative', as the increasing chainages will then be opposite to the standard notation used internally in MIKE 11.

- **Maximum dx.**

The maximum selected distance between two neighbouring h-points in the computational grid.

- **Branch type.**

The branch type can be selected as one of two:

- Regular:

The regular branch is the standard branch of MIKE 11 comprising water level points at both the up- and downstream end, and an alternating grid of water level and discharge points.

- Link Channel:

When a branch has been defined as a Link channel type, the 'Edit Link Channel Parameters...' button is made active. Press the button to open the 'Link Channel Parameters' dialog where Link channel parameters can be specified.

*Important notice:*

*After specification of the link channel parameters, it is required to press the 'Calculate Q/h relations' button in order to calculate the link channels Q-h table, which is used in the computation.*



*After each modification of any of the link channel parameters, it is required to update the Q-h table by pressing the button.*

Short description of Link channels:

Link channels are ideal for modelling the flow paths between e.g. river and floodplains. They play an important role in modelling floodplain inundation and drainage.

Also, floodplain cells can be attached to one end of a link channel. The cell is represented as a flooded area versus elevation curve based on the additional flooded area column of a cross-section in the MIKE 11 cross-section file.

A link channel can be defined to represent an embankment, a natural levee or a tributary. Flow paths can be lumped together to reduce the model size, i.e. several tributaries and a river levee may be represented in one link.

Link structures are similar to a long open culvert. Bed levels at the upstream and downstream ends, length, bed resistance and head loss coefficient can be specified. The cross-section shape is fixed along the entire length and is defined by a depth-width table. There is no need for upstream and downstream cross-sections (as is the case with other structures).

Each link is treated as a short branch (two h-points and one Q-point).

- Routing:  
No cross sections are required. Only the flow is calculated, no water levels.
- Kinematic Routing:  
Kinematic Routing can be used to model the hydraulics of upstream tributaries and secondary river branches, where the main concern is to route the water to the main river system. The Kinematic Routing method does not facilitate the use of structures at Kinematic Routing branches. Moreover the method does not account for backwater effects. At kinematic Routing branches, it is possible to run the model without information on cross sections. In turn, this indicates that Kinematic Routing branches cannot be used to model a looped part of a river network. Employment of Kinematic Routing branches requires that all branches located upstream of a Kinematic Routing branch are defined in the same way.
- Stratified:  
Used when a multilayer description is required.
- **Connections.**  
Upstream and/or downstream branch connections must be specified by River name and Chainage, respectively.

## Weirs

Data on broad-crested weirs, special weirs (utilising user-defined Q-h relations), Weir Formula 1 and Weir Formula 2 (Honma) are entered in this page. These data comprise the location of the weir and the geometry of the weir (that is, a level-/width-table describes the geometry).

Valve regulations can be selected to include e.g. flap gates descriptions allowing flow in only one direction.

Additionally, it is possible to select the weir geometry from a cross-section defined in the cross-section file. Hence, you must select the 'Geometry Type' as 'Cross-section DB' and



ensure that a cross-section exists at exactly the same location (river name and chainage) in the associated cross-section file.

From the entered data, MIKE 11 will calculate Q-h relations for critical flow conditions at the weir. In order to compute the Q-h relation, the nearest upstream and downstream cross-sections are used. Hence, the user needs to ensure that the Topo ID specified in the Branches dialog corresponds to the definitions in the cross-section file.

Please note that:

1. If no cross-section file is associated to the network file through a simulation editor, it is not possible to calculate the Q-h relations for any structure.
2. If changes are made in the nearest upstream or downstream cross-section – or in the weir-descriptions, it is required to perform a re-computation of the Q-h table prior to the simulation.

## Culverts

Data on culverts must be specified in this page.

The page is very similar to the weir page and offers the same options for specifying valve regulations and geometry from a cross-section file.

However, some of the variables are specific for the definition of culverts:

- **Invert upstream (U/S) and downstream (D/S) elevation.**  
Elevation is the invert elevation at the upstream and downstream end respectively. These levels must be higher than the bed level of the cross-sections immediately up- or downstream of the culvert,
- **Length.**  
Specifies the length of the culvert,
- **Manning's n.**  
Specifies the roughness (material) of the culvert,
- **No. of Culverts.**  
Specifies the number of parallel culverts at the same location (using same geometry)

After entering the Culvert data, press the 'Calculate Q-h...' button to calculate Q-h relations for the culvert. The Q-h relations are given as Q-y relations (where y is the depth above invert). Other parameters are given in the 'Hydraulic Parameters' page. If desired, the orifice flow coefficients can be edited as discussed below.

When calculating the Q-h relation, the types of flow occurring are also listed:

- **No Flow.**  
No flow occurs at the first level ( $y=0$ ) and when the valve regulation flag prohibits flow in one direction.
- **Inlet C.**  
The flow at the inlet is critical.
- **Outlet C.**  
The flow at the outlet is critical. A backwater curve using a fine resolution is calculated to relate the discharge to the upstream water level in the river.

- **Orifice.**  
The flow at the culvert inlet has an orifice type information. The discharge is based on the orifice coefficients shown in the menu. These coefficients can be edited, added or deleted, if required. The Q-h relation must be re-calculated after editing the coefficients.
- **Full Culvert.**  
The culvert is fully wet with a free discharge at the outlet.

## Bridges

Eight types of bridges may be implemented:

- FHWA WSPRO bridge method
- USBPR bridge method
- Fully submerged bridge
- Arch Bridge (Biery and Delleur)
- Arch Bridge (Hydraulic Research (HR))
- Bridge Piers (D'Aubuisson's formula)
- Bridge piers (Nagler)
- Bridge piers (Yarnell)

## Pumps

Data on pumps operated using start and stop levels must be specified on this page. The pumps can discharge either internally or externally, and the discharge can be fixed or tabulated as a function of the water level difference across the pump.

## Regulating

The regulating page offers a possibility for specifying the discharge at a certain point (e.g. a structure) as a function of time or as a function of hydraulic conditions elsewhere in the river system.

Two regulating types are available:

- **Function of Time.**  
The discharge through the structure is specified as a function of time (e.g. if two channels are connected to a pump or a turbine). The equation of momentum in the specified Q-point in the computational grid is replaced by a discharge/time function.

The actual discharge time series must be specified in the Hydrodynamic Property Page using the Boundary Editor.

- **Function of h and/or Q.**  
Special forms of river regulation can be defined in this page. This structure type is applied where discharge through a dam is to be regulated as a function of the water level, and the inflow into the reservoir. The location of the structure and the location

of the control points (J1 and J2) must be defined together with the regulating functions.

The discharge through the dam/structure is calculated as a given factor times the discharge or water level as a function of  $h$  or  $Q$  at two locations (J1 and J2) in the river model:  $Q = f(J2) * J1$

### Control Structures (HD Add-on module)

Control structures may be used whenever the flow through or above a structure is to be regulated by the operation of a movable gate, which forms part of the structure.

For detailed descriptions on how to use the Control Structures module, please refer to the MIKE 11 User Guide.

The gate position (operation) during the computation can be saved in the HD Additional Output file. To activate this output feature, you must select 'Velocities in Structures' output in the HD Parameter file, Add. output page.

### Dam Break Structures (HD Add-on module)

The dam break module is used to simulate breach development in a dam structure due to overtopping or pipe failure.

The specification of a dam break requires the user to define relevant information from each of the following categories:

- **Geometric specification.**  
Specify the dam's crest level and length (perpendicular to the river flow),
- **Limit for breach development.**  
Regardless of which shape and mode a breach development has been defined, a limiting section can be applied. The geometry of the limiting section is specified in the cross-section file.

The limiting section allows an irregular shape to be used to define the breach limits. This is a useful feature, which allows the natural shape of the river section at the dam site to be modelled. Only the section of the dam breach lying inside the limiting section is used for calculating the hydraulic parameters.

- **Failure moment and mode.**  
Failure moment can be specified to commence:
  - As a given number of hours after the start of simulation,
  - At a specified time,
  - At a specific reservoir water level. In this case the dam failure will occur when the reservoir water level reaches the specified level. The reservoir water level is defined as the water level in the grid point immediately upstream of the dam break structure.

Failure mode can be defined as either of the following:

- 'Time dependent'  
A known geometry of the breach development is specified as a function of time.

The increase in breach dimensions is specified as time series of; Breach width, Breach level and Breach slope.

- 'Erosion based'  
The increase in the breach depth is calculated from a sediment transport formula (Engelund-Hansen). The increase in breach depth multiplied by the side erosion index. If an erosion based failure is specified, further information is necessary. This information is entered in a separate dialog, which is activated by pressing the 'Erosion Parameters...' button.

## User defined Structures

User defined structures is available to create customised structures in MIKE 11. When activated, the user defined structure will access a DLL (Dynamic Link Library) written by the user. In addition, the DLL can access any variable in MIKE 11 through several records.

## Tabulated Structures

Tabulated Structures may be used whenever the flow is determined by a user defined relation between the discharge through the structure and the up- and downstream water level. The relation is entered in a table. The relation can be expressed in three ways:

- The discharge at the structure is given as a function of up- and downstream water level.
- The upstream water level is given as a function of the discharge and the downstream water level.
- The downstream water level is given as a function of the discharge and the upstream water level.

## Energy Loss

The Energy Loss property page is used to define energy losses associated with local flow obstructions such as sudden flow contractions or expansions and gradual or abrupt changes in the river alignment. Further, a user defined energy loss coefficient can be defined.

## Routing

Kinematic routing can be used to model upstream tributaries and secondary river branches, where the main concern is to route the water to the main river system. The Kinematic Routing method does not facilitate the use of structures at Kinematic Routing branches. Moreover, the method does not account for backwater effects. Please check the User Guide for details.

## MIKE SHE links

MIKE SHE links are used to link MIKE 11 with the groundwater simulation software package MIKE SHE. Details of how to establish such a link is described in the User Guide.

## Catchments

Catchment discharge can be calculated by the Rainfall Runoff Module and included as lateral inflows to the hydrodynamic module. The property page is used to specify the locations of catchments in the river network. Lateral catchment inflow can be included in either one single point (upstream and downstream chainage must have the same value) or distributed along a reach of a river branch.

## Grid Points

The grid points' property page has two specific purposes:

1. The page presents summary information on the computational network (or grid) points prior to the simulation. Press the 'Generate Grid Point' button to generate the computational grid, which corresponds to the grid used in the computation.
2. The page can be used to limit the number of computational points saved in result files. (e.g. for large models it is desirable to save only those grid points required and to discard remaining results thus preventing result files from becoming too large).

The page has no influence on the simulation results and is only for information purposes (i.e. the user is not required to press the Generate Grid Points button prior to a simulation).

Each of the property pages provides access to relevant information pertaining to the page. The property pages are designed such that the top of each page contains a complete item description, where data for each item are specified, while the lower half of the page contains an overview of data specified for each item, presented in a single row.

Selecting an object from the overview grid control, automatically changes the content of all edit fields on the upper part of the page in order to view all details specified on the actual data item. Parameters can be edited in both the detailed and the overview sections of each property page.

Please note that the 'Settings' + 'Network' dialog provides a possibility of specifying settings for 'Highlight object'. That is, the object being edited in the tabular view can be highlighted in the Graphical View by a user-defined symbol.

## 5.5 Working with the Cross-section Editor

River cross-section data comprises two data sets, the raw and the processed data. The raw data describes the physical shape of a cross-section using (x, z) co-ordinates, typically obtained from a river bed survey.

The processed data is calculated from the raw data and contains corresponding values for level, cross-section area, flow width, hydraulic/resistance radius. The processed data table is directly applied in the computational module.

Each cross-section is uniquely identified by the following three keys:

- River name: String of any length.
- Topo ID: String of any length. (topographical identification)
- Chainage: Real number.

### 5.5.1 Raw data view

The raw data view is the default view when a cross-section file is opened or created. An example of the cross-section raw data editor is shown in Figure 5.6.

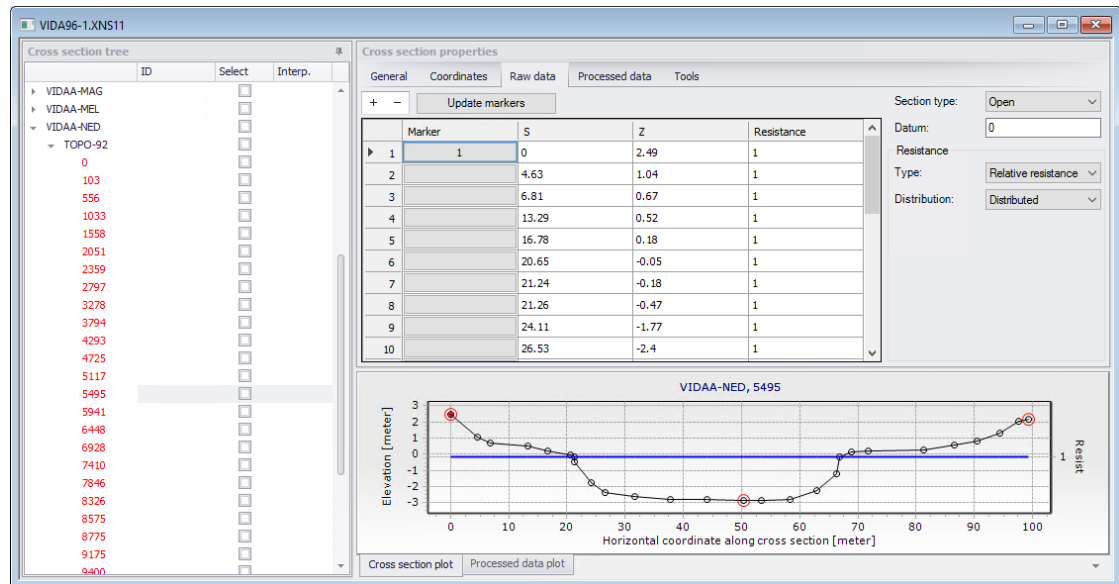


Figure 5.6 Cross-section, raw data editor

The raw data section contains different 'views':

- **Tree View**

The tree view provides a list of all cross-sections in the cross-section file.

The tree includes three levels, where the upper level defines the rivers names, the middle contains the Topo-ID(s) for the specific river and the lower provides a list of chainages of the cross-sections defined for the actual Topo-ID in the specific river.

Selecting a cross-section from the tree by clicking the left mouse button will immediately update the tabular and graphical views, as all three views are fully integrated in order to present the data of the selected section automatically.

Selecting a section chainage, river name or Topo-ID of a cross-section with the right mouse button opens a pop-up menu from which it is possible to make changes to the existing content of the cross-section file (e.g. insert, delete, copy and rename of sections, rivers and/or Topo-ID's).

- **Tabular View**

The tabular view contains the raw cross-section data selected from the tree view.

S- and Z-co-ordinates and relative resistance factors can manually be edited in the table.

The resistance (relative resistance) in each row of the tabular view has a default value of 1, indicating a constant value of the roughness across the section. If the roughness is not constant across the entire section, e.g. on a flood plain or in a composite channel cross-section, the variation in roughness can be included by entering a relative resistance different from 1 for a part of the section. The resistance

is normally given relative to that of the main riverbed. A relative resistance greater than 1.0 indicates higher roughness and vice versa.

The marker column lists the location of marker one, two and three each representing the river's left bank, bed and right bank respectively. It is important to notice that only the part of a section, which lies between marker 1 and 3, is included when calculating the processed data. That is, parts of a section can be omitted from the computation by adjusting the location of markers (e.g. if a flood plain is included in the cross-section data).

The user can modify the location of markers.

- **Graphical View**

The graphical view displays the raw cross-section selected in the tree view.

Depending on the current settings in the 'Change Options' page (opened from the Cross-section item in the Settings menu), the graphical view will overlay multiple cross-sections with previous selections displayed as a 'watermark'.

Selecting 'clear' in the local pop-up menu (right mouse button) clears the history graphical display.

Apart from the river name, topo-ID and chainage, it is required to consider whether some of the other variables identifying each cross-section should be altered. These are:

- **Section type**

Section type can be defined as open (default), closed irregular, closed circular or closed rectangular. In case of a closed section the hydraulic radius using total area is always used, and MIKE 11 automatically introduces a Preissman slot when calculating the processed data table in order to allow the computation of pressurised flow.

- **Datum**

Datum adjustment will be added to all z-co-ordinates and all levels when calculating the processed data. In this way it is possible to link a local datum with a global datum or to correct for benchmark errors in the raw data.

- **Resistance**

In this section of the raw data window the user chooses to how to deal with bed resistance.

Two choices have to be made:

- *Distribution (Transverse distribution)*. This defines description of the resistance across the cross section. There are three choices:

*Uniform*: A single resistance number will be applied throughout the cross section.

*High/Low flow zones*: Three resistance numbers are to be specified: 1) Left high flow resistance applying between marker 1 and 4. 2) Right high flow resistance applying between marker 5 and 3, and 3) Low flow resistance applying between marker 4 and 5. If marker 4 and 5 do not exist, the low flow resistance number will apply throughout.

*Distributed:* The resistance number is to be specified for each X,Z data set.

- *Type.* There are the following choices for type of resistance number:

*Relative resistance:* The resistance is given relative to the resistance number specified in the .hd11 file (HD parameter file). Resistance numbers higher than one always corresponds to higher physical resistance than specified in the .hd11 file (i.e. independent of the choice of resistance number type in the .hd11file).

*Manning's n:* The resistance number is specified as Manning's n in the unit s/m(1/3). Resistance numbers specified in the .hd11 file do not apply.

*Manning's M:* The resistance number is specified as Manning's M in the unit m(1/3)/s. Resistance numbers specified in the .hd11 file do not apply.

*Chezy number:* The resistance number is specified as Chezy number in the unit m(1/2)/s. Resistance numbers specified in the .hd11 file do not apply.

Other features of the Cross-section, raw data editor comprise:

- **Computation of processed data**

The computation of processed data is required after entering raw data, as the processed data tables must be used in the computation.

Two options are available for computation of processed data:

- The '*Recompute all*' feature in the 'Cross-sections' menu in the Main menu bar re-computes the processed data for all cross-sections in the cross-section file in one operation. This is a very useful feature e.g. when a large number of new sections have been entered or many of the existing sections have been modified.
- Press the '*View processed data...*' button. This will compute the processed data for the selected cross-section and automatically open the processed data editor. This feature, however, is only active if the 'Update processed data automatically' check box is activated.

- **Update Markers**

The update of markers feature is a facility in MIKE 11 to automatically place the markers 1, 2 and 3 in case a cross-section has been modified or a new section introduced to the cross-section file. Markers will automatically (per default) be located at the first x, z co-ordinate (Marker 1), at the lowest z-value (Marker 2 at the bottom) and at the very last x,z co-ordinate (Marker 3).

However, only the markers activated in the 'Cross-section...' ('change options for...') dialog will be automatically updated.

Two options are available for updating the location of markers:

- The '*Update Raw data Markers*' in the 'Edit properties for multiple Cross-sections' tool in which updates or marker location for all cross-sections in the cross-section file can be done in one operation.
- Press the '*Update Markers button*'. This will update the markers for the selected cross-section.



## 5.5.2 Processed data view

The Processed data view is opened by pressing the 'View Processed Data...' button in the Raw Data View

The Processed data view also contains a tree view (as described above), a tabular and a graphical view, see Figure 5.7. The graphical display can be altered by selecting the desired parameter from the pop down list at the top of the page.

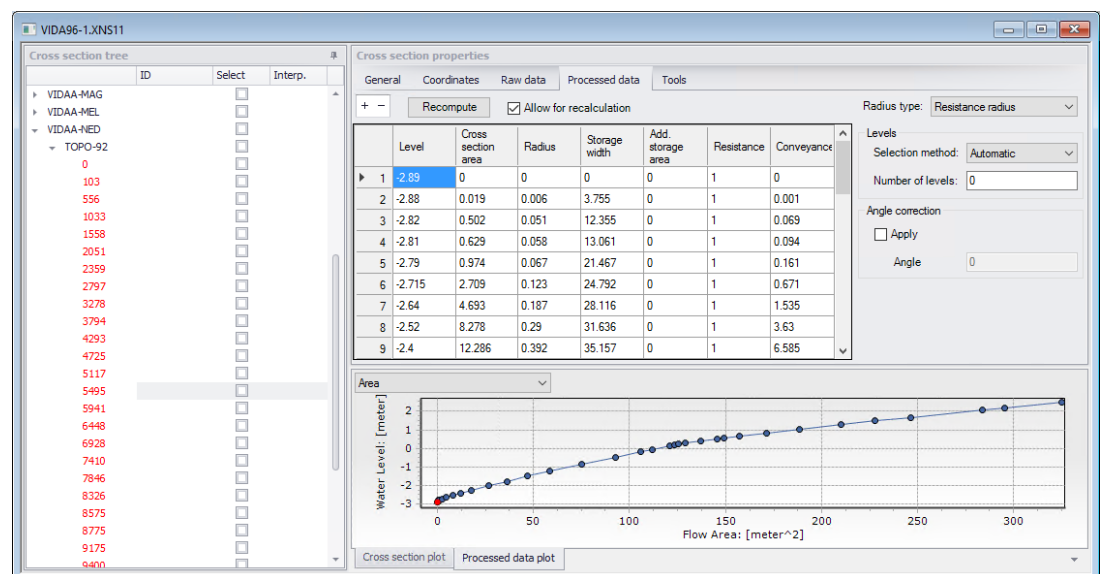


Figure 5.7 Cross-section processed data editor view

The tabular view contains processed data automatically calculated from the raw data. The processed data contains corresponding values of Water level, Cross-sectional area, Radius, Storage width and conveyance.

Additional storage area (surface area) can also be specified as a function of the water level.

If data has been altered, and it is required to keep the data unchanged in future, it is possible to protect the processed data for specific sections by activating the 'Protect Data' check box.

Please note that the 'Data Status' group is not an editable field. The value of the data status is only an information to the user, whether the data has been edited or updated during the period where the processed data editor has been activated.

Additional features of the processed data editor comprise:

- Radius type**  
 The user must define which method to apply when calculating the hydraulic radius in the processed data table. Three methods are available; Resistance radius, Hydraulic radius using the total flow area and Hydraulic radius using the effective flow area. The effective flow area is the calculated area where the effect of altered relative resistance values is included.

- Modification of levels in processed data table**  
 If the number of levels and or the level values must be modified this is possible in the 'Levels for Processed data' dialog, activated by pressing the 'Levels...' button. Select the level selection method, the min and max level and number of levels and press the 'Recompute' button to determine the new levels for the processed data. If the levels are satisfying, press the 'OK' button to close the Levels dialog.

## 5.6 Working with the Boundary Editors

Boundary conditions in MIKE 11 are defined by combined use of time series data prepared in the Time Series editor and specifications made on locations of boundary points and boundary types, etc. in the Boundary editor.

That is, the 'boundary editors' comprise the Time series editor and the Boundary editor. Both editors are necessary to activate in order to specify a MIKE 11 boundary condition.

### 5.6.1 Time series editor

The appearance of the Time series editor differs if you create a new (blank) time series compared to opening an existing (dfs0) file.

Creating a new time series requires specification of properties for the time series file, and the File Properties dialog is therefore opened in this case, cf. Figure 5.8.

If you are opening an existing dfs0-file, the data are immediately presented in the Time series data dialog where data can be viewed and edited both in a graphic and a tabular view. In this case, if you wish to change the file already defined file properties, it is required to open the File Properties dialog from the graphical view.

### File Properties dialog

File Properties

General Information

Title:

Axis Information

Axis Type:

Start Time:

Time Step:  [days]  
 [hour:min:sec]  
 [fraction of sec.]

No. of Timesteps:  Axis Units:

Item Information

	Name	Type	Unit
1	M4220h	Water Level	meter




Buttons: OK, Cancel, Help, Insert, Append, Delete, Item Filtering...

Figure 5.8 Time Series Editor, File properties dialog

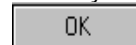
In the File Properties dialog, you must specify information on the time series axis and information on the items (series) which should be present in the specific dfs0-file. The axis information comprises:

- axis type: Equidistant or non-equidistant intervals, calendar axis or time relative to a specified start-time or plot of X-Y data
- start time (date-format follows the standard definition of Windows)
- time step (given in days, hours, min, sec)
- number of time steps (must always be larger than one!)

Item information comprises:

- Name of each time series item
- Item type (e.g. water level, discharge, concentration etc.)
- Item Unit (e.g. meter, m<sup>3</sup>/s, g/m<sup>3</sup> etc.)
- The 'TS Type' column is used to define different type of time series for different DHI software packages. However, MIKE 11 does not utilise the 'TS Type' settings in the simulations so this field can just be left unchanged from default
- The 'Min', 'Max' and 'Mean' columns are not editable to the user. Values to these columns are automatically inserted based on the actual time series data
- The  ,  and  buttons are used to modify the content of the Item information table. That is, Items can be appended to the bottom of the table, deleted from the table or inserted at a selected position by use of these buttons

When you have concluded the definition of axis and item information, press the



button to activate the Time series data dialog.

## Time Series Data dialog

The Time Series Data dialog consists of two views, a tabular view and a graphical view (see Figure 5.9).

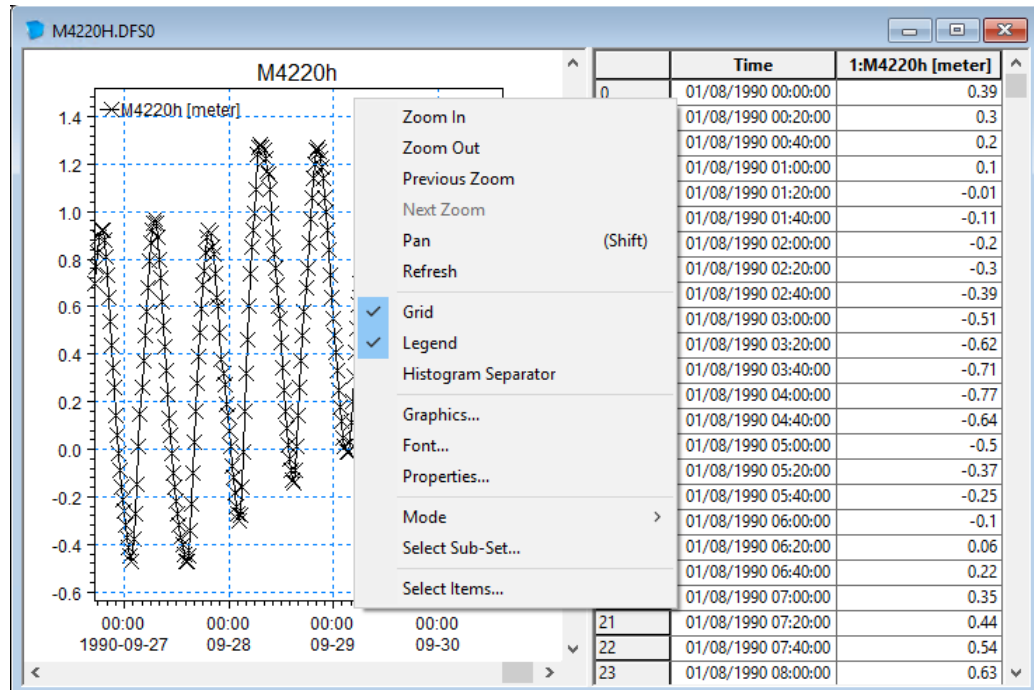


Figure 5.9 Time series editor; Time Series Data dialog

- **Tabular view:**
  - Presents the time series data in tabular form
  - Copy & Paste functions are available (e.g. copy and paste series from Excel)
  - The time format is determined from the selected default Windows format
- **Graphical view:**
  - Data can be edited graphically by selecting one of the editing modes; Select, Move, Insert or Delete
  - When opening a time series file, all items contained in the file are plotted by default. The file title specified in the file properties dialog is used as a header on the graphical view, while the item names are displayed in the upper left corner of the plot
  - To activate the pop-up menu as shown on Figure 5.9 place the cursor in the graphical view and press the right mouse button

From the pop-up menu you have multiple options, like activation of zoom and refresh facilities, entrances to modify the appearance of the graphical view (enable or disable grid and legends, changing colour and styles etc.).

Additionally, it is possible to open the File Properties dialog from the pop-up menu by selecting the 'Properties...' entry. Thereby, it is possible to alter previous property specifications of a specific file (e.g. if you want to add an additional item to the file, it must be done through the File Properties dialog!).


## 5.6.2 Boundary editor

The boundary editor dialog is where boundary conditions are specified for hydrodynamic, advection-dispersion/water quality and sediment transport calculations.


The definition of a Boundary condition requires the following actions to be performed - in the order as listed:

1. Specify the location of the boundary point and the boundary description and type.

Location is defined by the river name and the chainage. The boundary description (e.g. open, point source etc.) is selected from a combo box activated by pressing the right side of the edit field. The boundary type (e.g. water level, discharge, concentration etc.) is selected from the 'Boundary Type' combo-box.

2. Use the  button to select a time series (dfs0).

After defining the location of the boundary point, you must associate a time series to be applied at the boundary. The time series are kept in separate time series files (DFS0) and it is required to browse and select a time series file for each boundary definition.

The  button is used to open the selected dfs0 file for a specific boundary condition (name of the selected file is listed in the 'Time series File' field). That is, the 'Edit' button is a quick way to open a selected dfs0-file in the time series editor.

**Please note** that if the 'Time series file' field is empty (no file has been selected), it will not be possible to use the 'Edit' button. Nothing happens if the button is activated.

## 5.7 Working with Parameter File Editors

The MIKE 11 parameter file editors are comprised of the Hydrodynamic, Advection-Dispersion, Water Quality, Sediment Transport and Rainfall Runoff editors. The Parameter editors contains information on variables related to the selected type of computation, e.g. the HD Parameter Editor contains information on the bed resistance as a significant variable for the hydraulic computations.

All parameter editors are designed as dialogs containing a number of property pages in which specific data can be entered. Clicking the corresponding 'tab' in the editor dialog will activate a property page.

### 5.7.1 HD parameter editor

To run a hydrodynamic computation it is required to create a HD Parameter file. The HD parameter editor offers a possibility of specifying user-defined values for a number of variables used during the hydrodynamic computation. The HD parameter editor is shown in Figure 5.10.

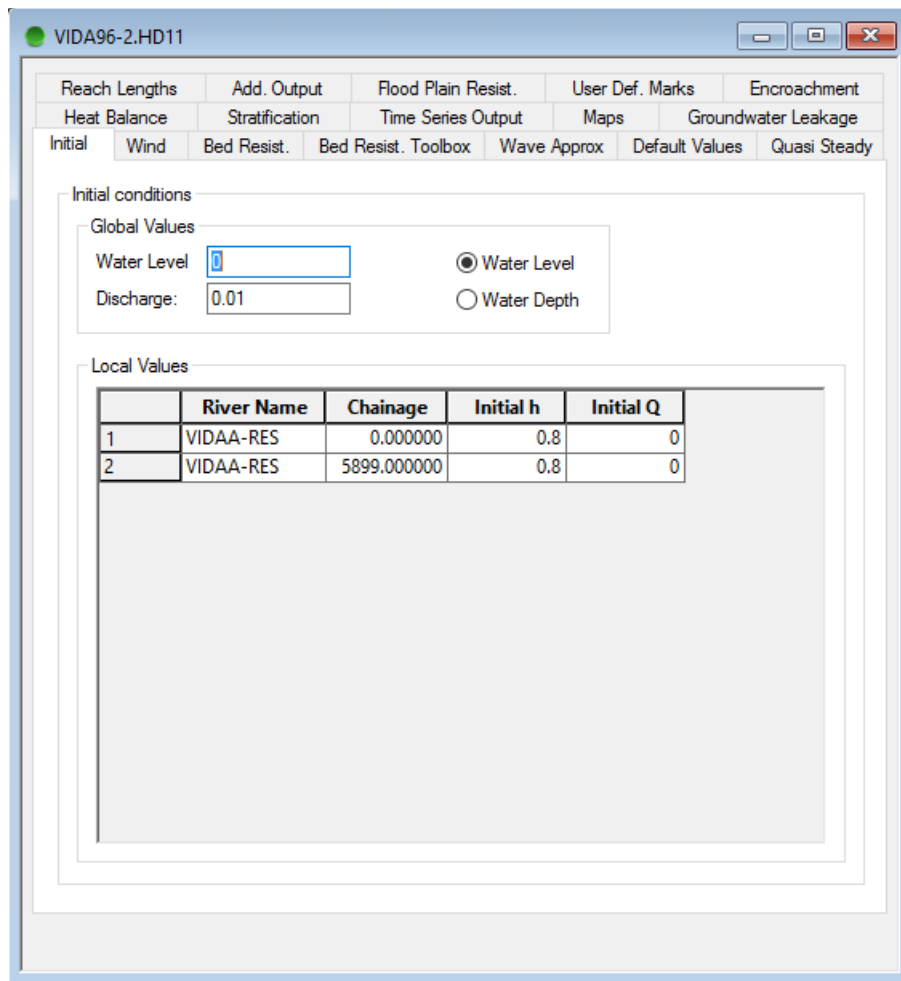


Figure 5.10 HD Parameter Editor

## Initial

Before starting a computation, the user must select how the initial conditions will be specified. MIKE 11 can automatically compute a steady-state profile in the river or the channel network compatible with the given boundary conditions at the specific computation start time in the simulation editor. Alternatively, the initial conditions may be obtained either from an existing result file (a so-called 'Hotstart') or from manually specified initial conditions of corresponding values for Water levels and Discharges in the entire network at the start time of the computation.

A global initial condition (water level and discharge) can be entered. This global condition is applied throughout the model, unless otherwise specified. It is possible to specify a number of river reaches or channel reaches; 'Local values', where initial values of water level and discharge different from the global values are to be applied. The values entered for the initial water levels can also be interpreted as water depths by using the radio bottom.

Figure 5.10 shows an example of such a specification. A global water level of 2.5 m and a global discharge of 12 m<sup>3</sup>/s have been specified. In the branch 'RIVER 1' between chainage 0 m and 2500 m, alternative conditions are given. These indicate that the initial

water level varies linearly between 2.3 m and 2.5 m and the discharge between 10 m<sup>3</sup>/s and 12 m<sup>3</sup>/s in the specified river reach.

## Wind

If the user wishes to include Wind shear stress, it is required that a time variable boundary condition for Wind Field is included in the simulation. The Wind Field boundary condition consists of specifications for Wind direction (towards North) and the Wind velocity.

In the Wind page of the HD Parameter dialog, the user can activate the usage of Wind field in the computation by activating the 'Include Wind' check box.

The time varying boundary condition defines the wind field, but local variations must often be taken into consideration. This can be done by specifying a topographic wind factor (topo factor), and if a topo factor is defined for a particular reach, the wind velocity used in the computations will be applied as the velocity multiplied by the topo factor.

## Bed Resistance

The resistance number must be specified in this page. The resistance number can have one of three different forms, of which Manning's M is default:

- Manning's n
- Manning's M ( $M = 1/n$ )
- Chezy number

Two approaches exist: Uniform Section and Tripple Zone. When the Uniform Section approach is selected the specified resistance number will be valid all over the section. If the Tripple Zone approach is selected the cross sections are divided into three zones and a resistance number must be specified for each zone.

The resistance number specified on this menu is multiplied by the resistance factor specified for a given cross-section (and water level) in the processed data of the Cross-section file during computations.

Global and local values for the resistance number can be defined. During a calibration exercise, typically, the resistance number is the most significant variable to adjust, and therefore, you will typically need to specify (a number of) local values to account for local variations in the topography, vegetation etc.

## Bed Resistance Toolbox

The bed resistance toolbox offers a possibility to make the program calculate the bed resistance as a function of the hydraulic parameters during the computation by applying a Bed Resistance Equation. The equations are designed to simulate the influence of vegetation on the resistance during varying flow conditions. Details on the equations can be found in the User Guide.

## Wave Approx

It is possible to specify which wave approximation should be used in the computation, viz Kinematic, Diffusive or one of two fully dynamic wave approximations.

Default is the dynamic wave.

## Default Values

In this page it is possible to alter the value for a number of parameters connected to the hydrodynamic computations.

Parameters should not be altered, unless the user is familiar with the effect on the results. A more detailed explanation of the various parameters is given in the MIKE 11 On-line help system and MIKE 11 Reference manual.

## Quasi Steady

A number of Quasi-Steady Control parameters connected with the Quasi steady computations are entered in this page. Detailed description can be found in the MIKE 11 On-line Help and MIKE 11 Reference manual.

### Time Series Output

On this property page request is made for time series output files to be generated during the simulation. This output is in addition to the regular and the additional .res11 output file. Time series output can be saved in .dfs0 or ASCII files.

## Maps

On this property page request is made for that MIKE 11 produces two dimensional maps based on the one-dimensional simulations. The maps are constructed through interpolation in space of the grid point results. Thus the maps constructed in this way should be viewed as a two dimensional interpretation of results from a one -dimensional model

## Reach Lengths

This can only be used in connection with Quasi Steady simulations, see above. Detailed description can be found in the MIKE 11 On-line Help and MIKE 11 User manual.

## Add. Output

Additional output can be produced upon request by the user. This extra facility is available as a supplement to the hydrodynamic result file. The additional output is stored in a file with a similar name as the HD result-file name. Only difference is that an additional string 'HDADD' is added to the filename of the HD result-file name.

**Example:** If the HD result filename is 'HDRES1.RES11', the name of the additional output file would be; 'HDRES1HDADD.RES11'

To activate the additional output, the user must activate the check-box in front of the item to save to the additional output result-file.

## Flood Plain Resistance

Normally, the resistance numbers on flood plains are included through editing the relative resistance factors above 'Level of Divide' in the Cross-section editor, Raw data specifications. Hence, it is possible to reduce the effective flow area as a function of the



water level. Another possibility of changing flood plain resistance numbers is to edit the Resistance Factor in the Processed Data in the cross-section editor.

However, if the modelling task does not require a water level dependent resistance on flood plains, an overall Flood Plain Resistance number can be specified in this page. Please note that flood plain resistance numbers are only applied above the 'Level of Divide'. Hence, it is required also to modify the cross-section data in order to activate this feature.

A global resistance number on the flood plains in the model can be specified. This is applied on all flood plains unless local values are specified. Local specified values are linearly interpolated. Giving the value '-99' as resistance number indicates that the flood plain resistance number should be calculated from the raw data in the cross-section file.

## User Def. Marks

The User Defined Markers page offers a possibility for the user to define items in the modelling area, which they would like to present on a longitudinal profile from MIKE View, (e.g. gauging stations, bridges etc.). Markers can be defined as single points at a specific chainage or as a marker with a certain length between two chainages in the same river stretch.

## Encroachment

The Encroachment module of MIKE 11 can be used to make analysis of the effect on making encroachment on floodplains. The necessary information is specified on this property page. Details are given in the User Guide.

## Heat Balance

It is possible to include detailed descriptions of the heat exchange between the water and the atmosphere in MIKE 11. The necessary data must be entered here. Details are given in the User Guide.

## Stratification

When one or more of the branches in the MIKE 11 set up have been selected as 'Stratified' the data necessary to run the stratified model must be entered here. Please see the User Guide for more details.

### 5.7.2 AD parameter editor

The AD Parameter file is required in order to run an Advection-Dispersion (and a Water Quality) simulation. The AD parameter file contains information on each of the pollutant components included in the simulation. The AD parameter editor is shown in Figure 5.11.

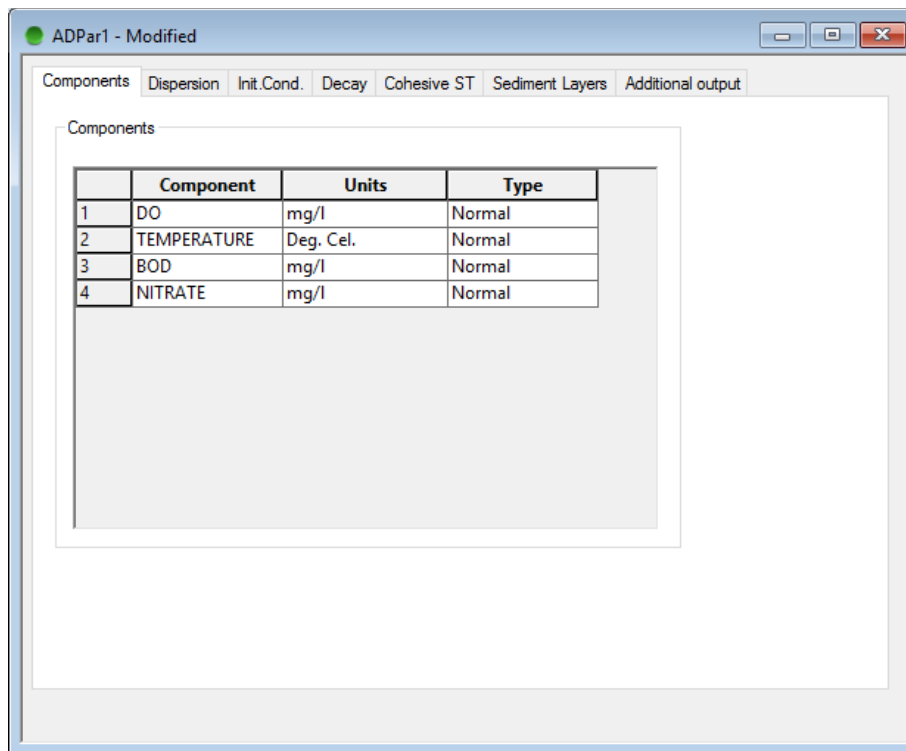


Figure 5.11 AD Parameter Editor

## Components

In this page, the name, unit and component type must be specified for each of the substances (components) to be included in the Advection-Dispersion computations.

Unit and component type (Normal, Single Layer Cohesive, Multi Layer cohesive or Non-cohesive) must be selected from the corresponding combo-box. To activate the combo-box activate e.g. the unit field and press the 'down-arrow' appearing after the field has been selected.

The 'Fill WQ Components' button can be used to automatically define the WQ model to be used in a WQ computation. After selection of the WQ-model type and level, the component table is automatically filled with the component names, units and order of components. The order of components is very important if you are performing a WQ-simulation.

## Dispersion

The dispersion coefficient and factors are specified in this page. Dispersion can be specified as a function of the flow velocity calculated by the following expression:

$$D = f \cdot V^{ex},$$

where:

- $D$  is the dispersion coefficient
- $V$  is the flow velocity
- $f$  is the dispersion factor
- $ex$  is a dimensionless exponent

Minimum and maximum dispersion coefficient values are specified to limit the range over which the calculated dispersion coefficient may vary.

## Init. Cond.

Initial conditions, i.e. initial concentrations of each component are specified in this page.

In the Component column, select from a combo-box the component for which you wish to specify initial conditions. The combo-box in the component column lists the components specified in the 'Components' page and a specific component can be selected from the list.

In the Concentration column specify the initial concentration of the component in the unit selected in the Components page.

Both global and local initial conditions can be specified for the same component. If you wish to specify local variations in initial conditions de-activate the 'Global' check-box and specify the location (river name and chainage) of the initial condition for the specific component. The global value will be used everywhere except in those reaches where additional local values have been specified. If no value is entered for a component, a global concentration of zero will be applied automatically.

## Decay

It is possible to specify one or more non conservative components, i.e. the concentration is assumed to decay according to the first order expression:

$$dC/dT = K*C$$

where:

K is the decay coefficient

C is the concentration

If the data entered are used in connection with a water quality computation, the user should not specify the decay coefficients, as the special water quality model computes these coefficients.

## Boundary

This property page is not in use anymore. The information previously entered here should now be entered in the boundary editor. The property page is visible so set ups made in previous releases can be inspected and converted properly when updating to the present version.

## Cohesive ST

Data used for the cohesive sediment transport models are entered on this page. When using the cohesive sediment transport models (either the simple or the advanced) all components specified in the AD editor must be defined as 'Single layer cohesive' or 'Multi layer cohesive' in the Components dialog.

The cohesive sediment transport parameters can only be accessed when a component type on the 'Components' page is defined as either single or multi layered. Global and local parameter values can be specified as required.

## Sediment Layers

Initial conditions for the sediment layers are defined on the Sediment Layers page. Selection combo-boxes are available for the component types 'Single cohesive', 'Multi cohesive' or 'Non cohesive'.

When the single layer model is used only one sediment layer is displayed. When a multi-layer cohesive model is applied, three layers, upper, middle and lower are displayed. Parameters must be specified for each layer on three separate rows.

## Non-Cohesive ST

This page contains input parameters for Non-Cohesive components. A non-cohesive component is defined using the data section at the bottom of the page.

## Additional Output

The additional output page contains check-boxes, which can be used to store internal model parameters in an additional AD result file. The name of the additional AD result file is similar to the AD result-file name. Only difference is that an additional string 'ADADD' is added to the filename of the AD result-file name.

**Example:** If the AD result filename is 'ADRES1.RES11', the name of the additional output file would be; 'ADRES1ADADD.RES11'

### 5.7.3 ST parameter editor

To run a non-cohesive sediment transport simulation it is required to give specifications on e.g. sediment grain size (grain diameters) to calculate the correct transport and eventual morphological changes.

MIKE 11 permits the computation of non-cohesive sediment transport capacities together with corresponding accumulated erosion/sedimentation rates, using several different transport and calculation models.

The MIKE 11 sediment transport model operates in two 'modes':

- **Explicit sediment transport model**  
In the explicit model the sediment transport computations are based either on the results from an existing HD result file or from a HD computation made in parallel using characteristic transport parameters. Sediment transport is calculated in time and space as an explicit function of the hydrodynamic parameters (i.e. discharge, water levels etc.), previously calculated. There is no feedback from the sediment transport computations to the hydrodynamics.
- **Morphological sediment transport model**  
The sediment transport computations are made in parallel with the HD computation. The sediment transport is calculated in time and space as an explicit function of the

corresponding values of the HD parameters calculated in tandem. The resistance number may be updated and the bottom level is updated so that changes in flow resistance and hydraulic geometry due to the sediment transport can be included in the HD computations.

This model requires sediment or bottom level boundary conditions at all inflow boundaries.

Variables for the sediment transport model are specified in the ST parameter editor, see Figure 5.12.

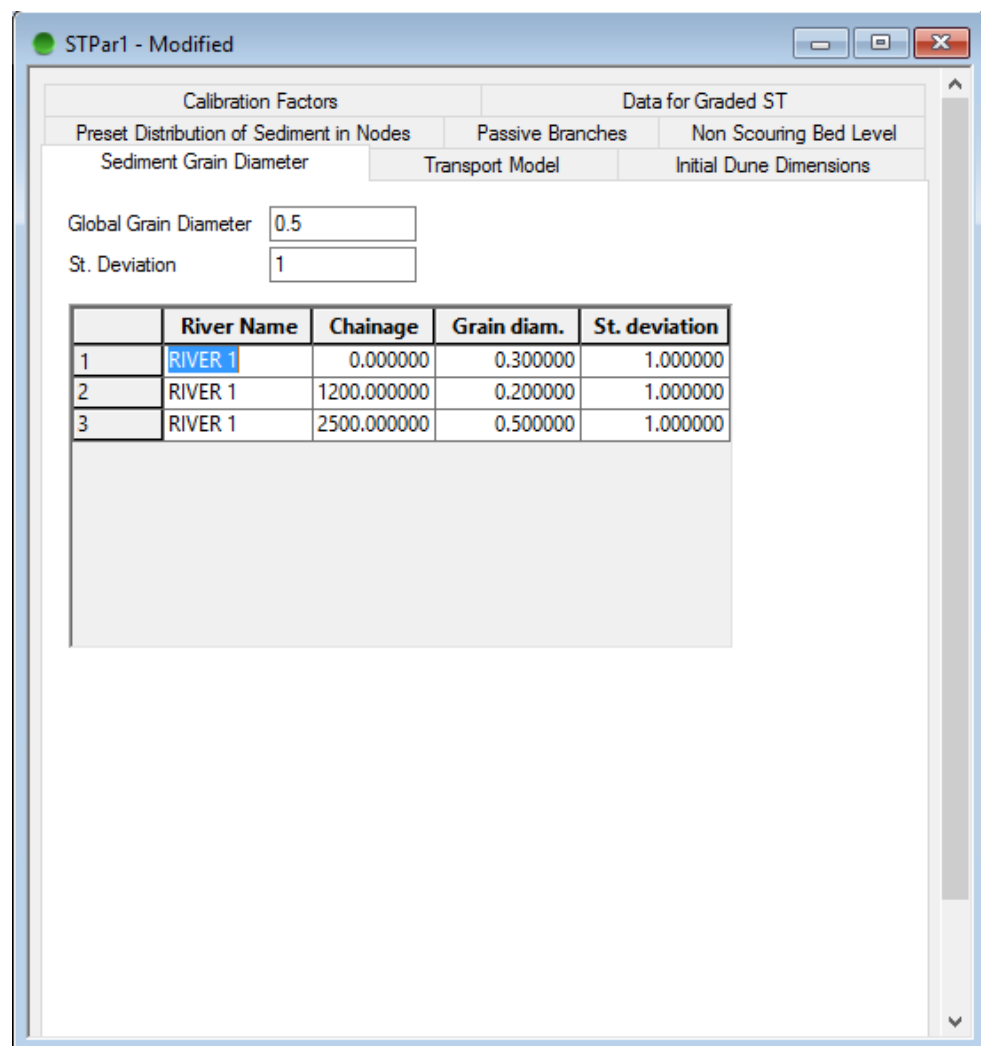


Figure 5.12: ST Parameter Editor

### Sediment Grain Diameter

Sediment Grain diameter and standard deviation to be used in the ST computation are specified in this page. Grain size and standard deviation may be specified as being applicable globally and locally.

## Transport Model

Selection of transport model to use and specification of parameters and constants for the specific transport model must be given in this page.

The transport model is selected by the 'Model Type' combo-box.

A detailed description of the parameters of this page can be found in the MIKE 11 On-line help. One variable to mention here though, is the check-box for 'Calculation of Bottom Level'. This check-box differs between the two sediment transport modes; explicit and morphological such that if the check-box is activated, MIKE 11 will operate in a morphological mode and therefore, the ST computation must be made in parallel with a HD computation.

## Calibration Factors

The factors; 'Factor1' and 'Factor2' can be applied to the calculated transport rates as correction factors. Bed load transport is multiplied with 'Factor1' and Suspended load transport is multiplied with 'Factor2'.

If the sediment transport is calculated as total load 'Factor1' is applied. These factors can be applied globally and locally.

## Data for Graded ST

Input data for the simulation of graded sediment transport and sediment sorting are specified in this page.

The bed material is represented by two layers, an active layer overlying an inactive, passive layer. Each layer is divided into an equal number of fractions (or classes) specified by the user. A mean grain size (mm) for each fraction and the percentage distribution for both the active and the passive layer must be specified.

The fraction mean grain sizes are global but the initial percentage size distributions may be specified globally or locally.

The sum of the initial percentage distributions for both the active and the passive layers must equal 100%.

Shielding of particles can be included by activating the 'Shielding of particles' check-box, and additionally, the user can select the percentage contribution and transport rate of each fraction to be saved to the ST result file by activating the corresponding check-box.

## Preset distribution of Sediment in nodes

The default distribution of sediment at a node is carried out according to the ration of flow discharges. A user-defined distribution can be specified in this menu by giving the distribution coefficients and exponents (K and n variables in the distribution relationship - please refer to the MIKE 11 On-line help for more detailed information).

## Passive Branches

Branches, in which sediment transport should not be calculated, are specified by giving the river name as well as the upstream and the downstream chainage. Sediment can be transported into a passive branch, but no sediment can be transported out of a passive branch.

## Initial dune dimension

Only used together with the Engelund-Fredsoe transport model. This property page is used for specification of the initial dune length and height.

## Non Scouring Bed Level

This property page is used to define a level – both globally and/or locally – at which the bed is no longer erodible. It can also be used to define the thickness of the active layer used in the Graded Sediment Model.

### 5.7.4 WQ simulation parameters (MIKE ECO Lab)

Water quality simulations in MIKE 11 is undertaken by use of the so-called MIKE ECO Lab system using pre- or user-defined 'Templates' describing the actual processes to investigate. A number of pre-defined MIKE ECO Lab templates for the more standard or common water quality aspects are developed by DHI and enclosed in the installation package. These include simple BOD-DO relations to Eutrophication and Heavy Metals etc. For more details on Templates available and their specific content, please refer to the MIKE 11 User Manual on Water Quality modelling

To run a water quality simulation, the user must define WQ parameters in a separate parameter file with the extension '.ECOLab11', which contains a reference to a selected MIKE ECO Lab model template (where all equations and processes are defined) and the user defined values of specific parameters involved in the selected water quality model.

Figure 5.13 presents the front page of the WQ parameter editor in which the MIKE ECO Lab Template model file should be selected.

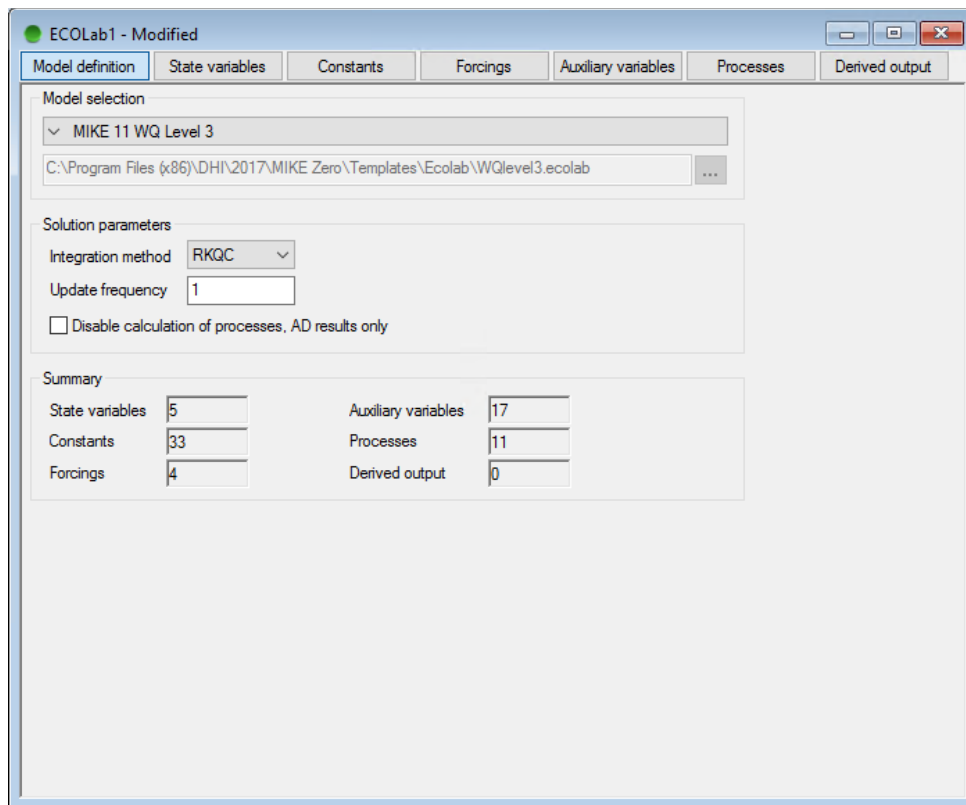


Figure 5.13: MIKE 11 WQ simulation file (.ECOLab11)

The contents of the '.ECOLab11' file should be saved and the name of the file should be specified on the Input page of the simulation editor.



## 6 Setting Up a Simulation

### 6.1 Using the Simulation Editor

The Simulation Editor combines all information necessary for MIKE 11 to perform a simulation. This information comprises type of model to run, name and location of input data files, simulation period, time step etc. and name of result files.

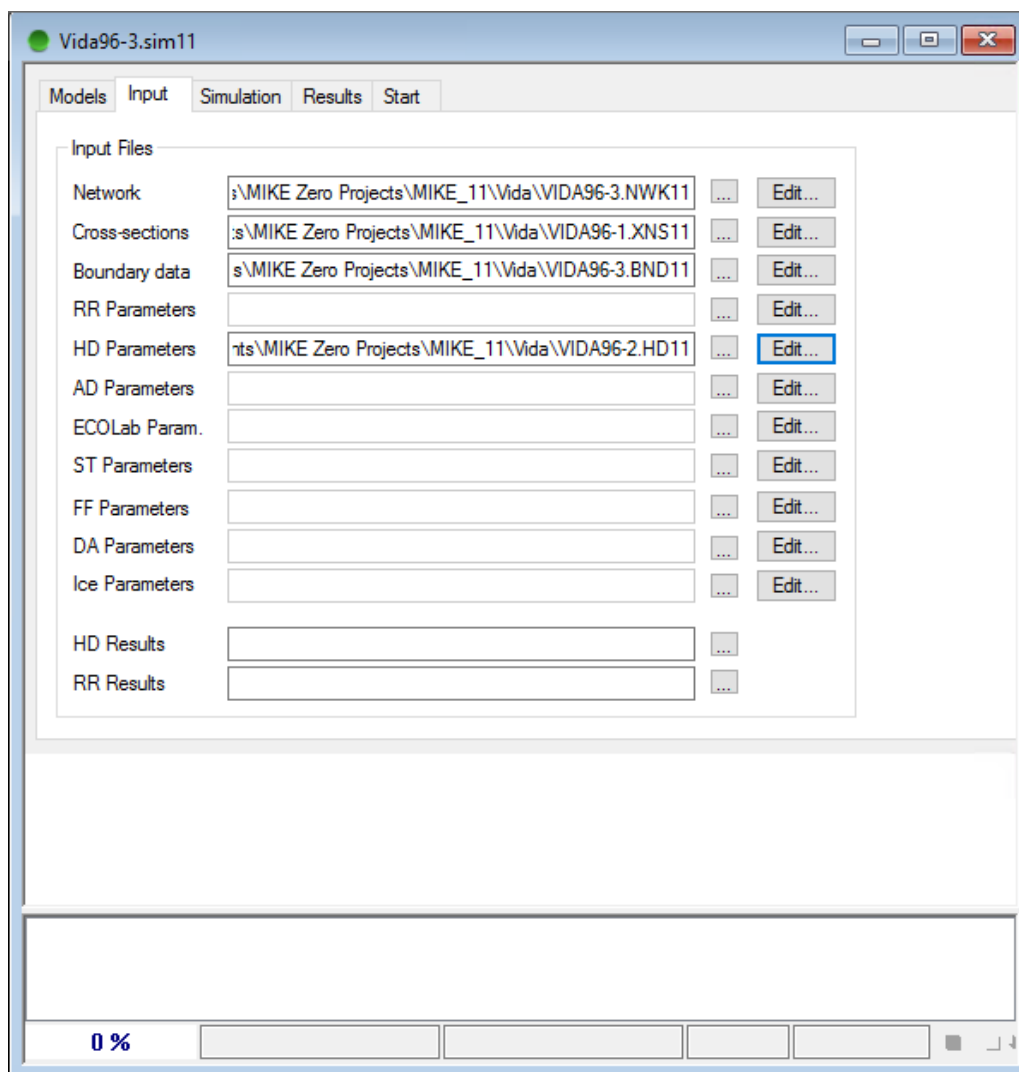


Figure 6.1 Simulation Editor of MIKE 11

The Simulation editor contains 5 property pages in which data must be specified.


#### Models property page


Select the models (HD, AD, ST, WQ etc.) to be included by activating the checkbox for the specific simulation model,

Additionally, you must select the simulation mode (Unsteady or Quasi steady simulation). If an encroachment simulation is to be made the encroachment checkbox must be checked.

## Input property page

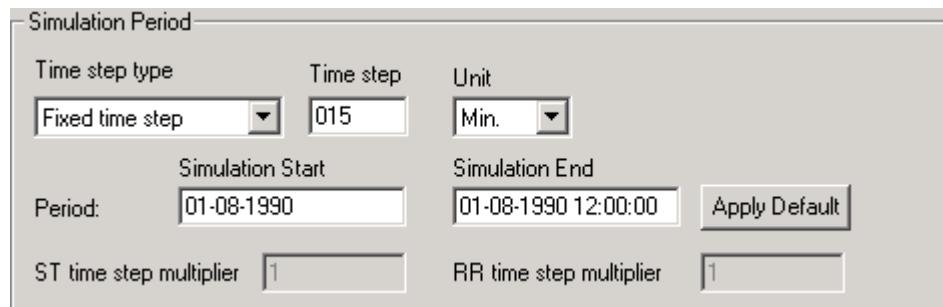
Specify the location of input files to be used in the simulation. The type of input files necessary for the simulation is identified by the colour of the edit fields. If the field is white the field can be edited and a file must be selected. If the field is grey ('dimmed') it is a non-editable field and the specific input file is not required for the simulation. One exception though, is the edit field; 'RR Results (\*.RES11)' which is used to specify an input file from the Rainfall Runoff simulation only. If you do not require any runoff input from a Rainfall Runoff simulation, this field should just be left blank.

Input files can be located in any directory on the disk. Use the  button to browse a specific input file in a file selection box.


If a filename has been specified in a filename field, you can use the  button to open the file in its corresponding editor

## Simulation property page

In the Simulation property page, information on the simulation period, time step and type of initial condition must be specified. Further the user can select if a fixed time step, a tabulated time step or an adaptive time step should be used or



There are two ways of specifying the simulation period:

1. Specify manually the simulation start and end time respectively. The date-format to be used for the simulation start and end time must be the same as Windows utilises (e.g. yyyy-mm-dd hh-mm-ss)
2. Press the  button to let MIKE 11 automatically determine the minimum and maximum date and hour where all time series (defined in the boundary file) have common periods. The date and hour for start and end time respectively are then automatically inserted in the field.

If no common period exists for the time series defined in the boundary files, nothing happens and the value in the Start and End date fields are not modified.

After specifying the simulation period, the simulation time step must be defined. Specify a value for the time step and select the unit (days, hour, min, sec).

The Time Step multiplier for Rainfall Runoff (RR) and Sediment Transport (ST) modules can also be specified in case one of these models is selected.

The Time step multipliers are used to adjust the time step applied for these models. E.g. in ST-simulations it will often be necessary to run the Hydrodynamic model using a much smaller time step than required in the ST model. That is, the time step used in the RR and/or ST model is therefore the multiplier-value multiplied the simulation time step.

Finally, specify the type of initial condition to use (steady state, hotstart, parameter file)

Type of Initial conditions:

- **Steady State**  
MIKE 11 calculates automatically a steady state profile for the entire model
- **Hotstart**  
Initial conditions are read from results of previous simulation (define a result-file)
- **Parameter File**  
Initial conditions are read from Input Parameter file (e.g. HD Parameter file)

## Results property page

Specify the filename for results from the simulation.

Storing frequency can be used to decrease the size of result-files by reducing the number of time steps saved. (e.g. Storing frequency specified as 10 means that results are saved in the result-file for every 10 time-step only).

## Start property page

In the Start property page you will find two validation groups. One group informing on the status of the simulation (are all input files required for the simulation specified? do the time series files used for boundary conditions have a common period – and is the simulation period within this period?).

If a problem exists, a red light symbol is displayed in the validation group and it will not be possible to start the simulation. If all input files are satisfactory, a green light symbol is displayed and pressing the Start button starts the simulation.

## 6.2 Simulation Editor File – also a Simulation-Log

All information specified in the Simulation editor are saved in a Simulation editor file (\*.sim11). The sim11 file is – as most of the other editor files in MIKE 11 – an ASCII text-file. It is therefore possible to view the content of these input files in any word processing program (like Notepad, Works, Word, etc.).

Occasionally, it is required to go back in time and investigate results and/or input from previous projects, and it is therefore necessary to keep a log of the simulations performed (input files used, time step, etc.). If you are running several simulations (e.g. using different input files or simulation periods) it is therefore advisable to save the input for each simulation in a separate Simulation editor file.

Saving each simulation in separate simulation file you do not have to keep an additional, separate log of each individual simulation. Simply specify a name for the simulation files, which identifies the content of the file and eventually the purpose of the simulation.

## 7 MIKE 11 Tutorial

### 7.1 What Will I Learn?

Following the instructions given in this tutorial users with no experience with MIKE 11, will be guided through the set-up of a simple river network, cross-sections, boundary conditions, HD parameters and simulation parameters as well as presentation of simulation results.

#### Contents

1. Network Editor. Basic Facilities
2. Cross-section Editor
3. Boundary and Time Series Editor
4. HD Parameter Editor
5. Running a Simulation
6. MIKE View

### 7.2 Network Editor – Basic Facilities

The aim of this exercise is to introduce the basic facilities of the network editor, i.e. how a system of branches is defined and connected.

Start MIKE 11 to produce the MIKE Zero base screen. The MIKE 11 river network file is created here using the File menu by selecting New from the menu and choosing MIKE 11 and River Network. A MIKE 11 river network screen is created with default area co-ordinates. The size and position of both the MIKE 11 window and the river network window may be changed to allow for easier viewing of river branches defined later in this tutorial.


#### Defining a branch

Defining and editing a river network is mainly undertaken using the river network toolbar:



Figure 7.1 Network toolbar

More details on the functionality of each of the buttons can be found in the help system under the topic 'Graphical Editing Toolbar'.

To define the branch shown below you should select the  button in the toolbar and define the branch by clicking the left mouse button once at the position of each river point. Start at the upstream end of the river branch (which is assumed here, to be in the upper part of the window). The last point in the branch should be defined by a double click.

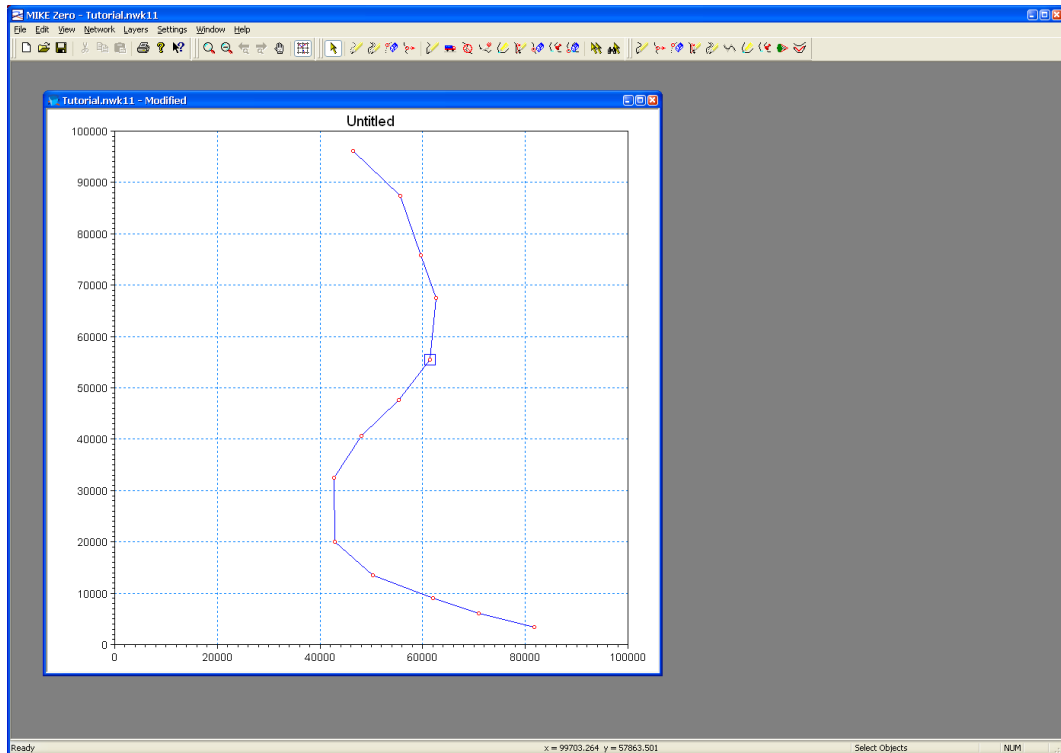


Figure 7.2 Plan plot, one digitised branch

## Chainage in points

Once a branch is defined the chainage of each point is calculated automatically based on the distance between the digitised points. The default chainage of the first point in a branch is zero. See the topic 'Chainages in Points' in the help system for more details. The calculated chainages may not be optimal and the user may wish to set the chainage manually. This can be done in two ways:

### Option 1)

Click with the right mouse button at the point for which the chainage is to be changed and a Pop-Up Menu will be displayed as shown below. See the topic Pop-Up Menu in the help system for more details.

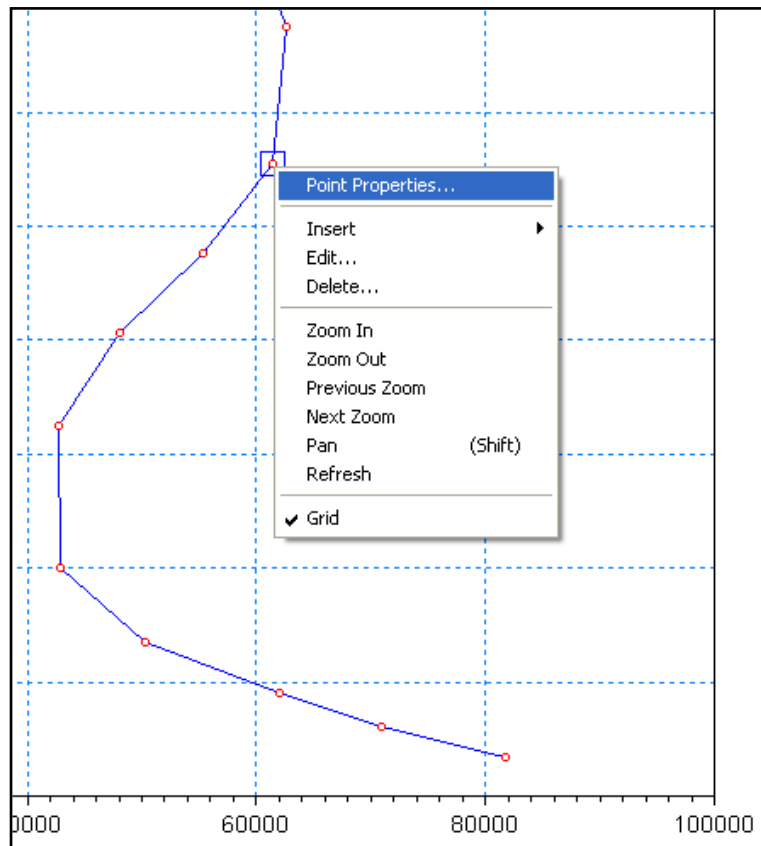


Figure 7.3 Network editor, Right mouse Pop-up menu

When selecting the item Point Properties in the Pop-Up Menu the following dialog will show up. The user can then set the chainage manually by setting the chainage type to User Defined and then entering the desired chainage value. When clicking the OK button the chainages in all remaining points within the river branch will be recalculated accordingly.

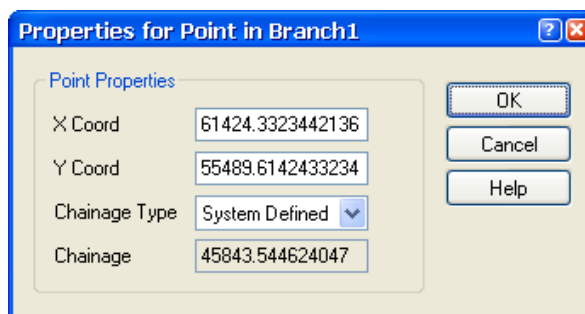


Figure 7.4 Point properties dialog

**Option 2)**

Select the item Tabular View in the View menu and change to the Points page of the tabular view as shown below:

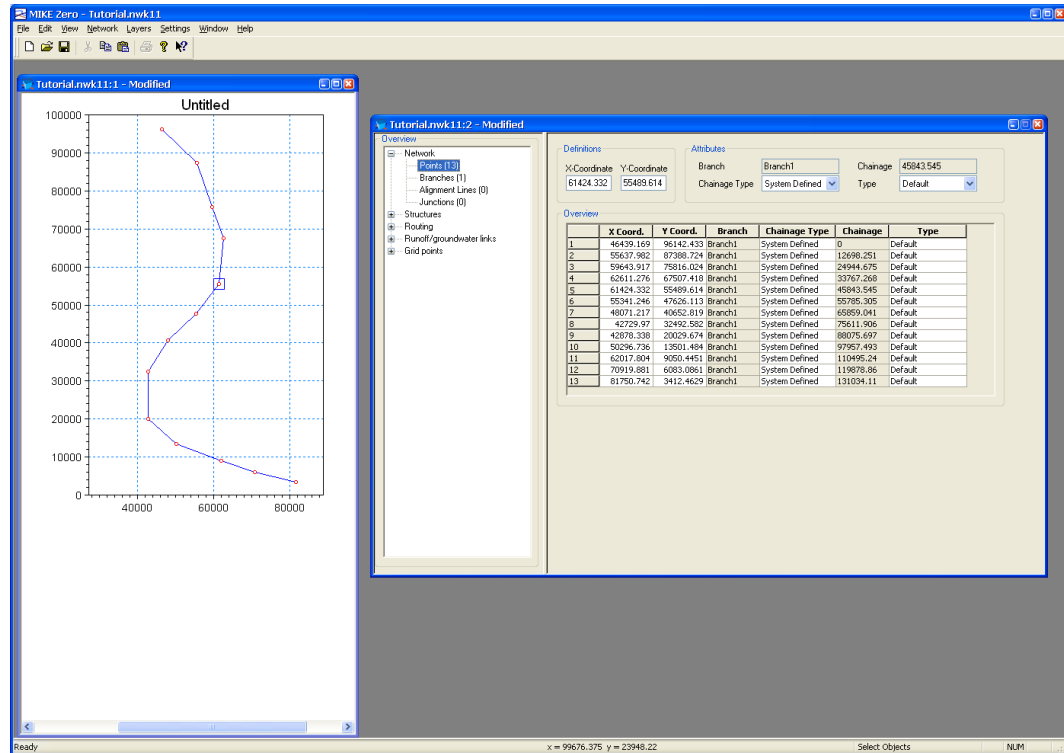


Figure 7.5 Graphical and Tabular view, Network editor

This page contains information about each point and allows the user to change the chainage type and value. The graphical and tabular views are linked such that the highlighted points in the each of the views are always the same.

In the above river system the chainage type should be set to user defined for the first and last points of the river branch with the chainage assumed to be 0 and 100000, respectively.

**Display of objects**

When a branch is defined a label indicating the name and chainage from upstream to downstream may be displayed adjacent to the branch. The display of these labels, as well as any other object shown in the graphical view of the river network editor, can be controlled through the Network Settings dialog shown below. This dialog is activated by selecting the item Network in the Settings menu. See the topic 'Graphical Settings Property Page' in the help system for more details.



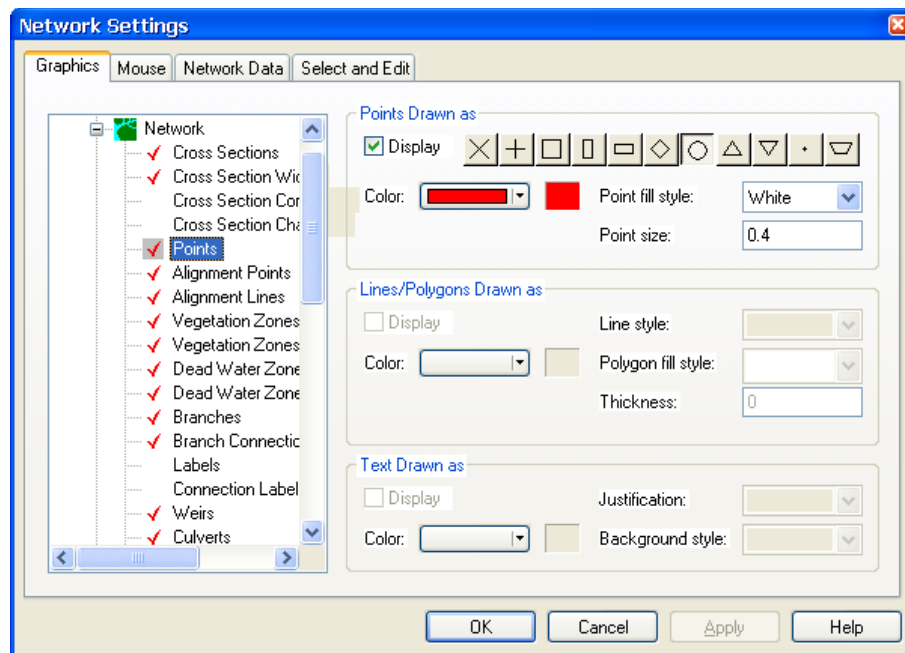







Figure 7.6 Network settings dialog

### Defining and connecting additional branches

The  tool can be used to create the points and branch in one operation. Alternatively the points can be defined in one operation and the branch in another by using the  tool followed by one of the tools  or .

In Figure 7.7, eight points in a tributary have been digitised using the  tool.

Note that the points appear in the list of points in the tabular view, but there is yet no information on which branch the points belongs to.

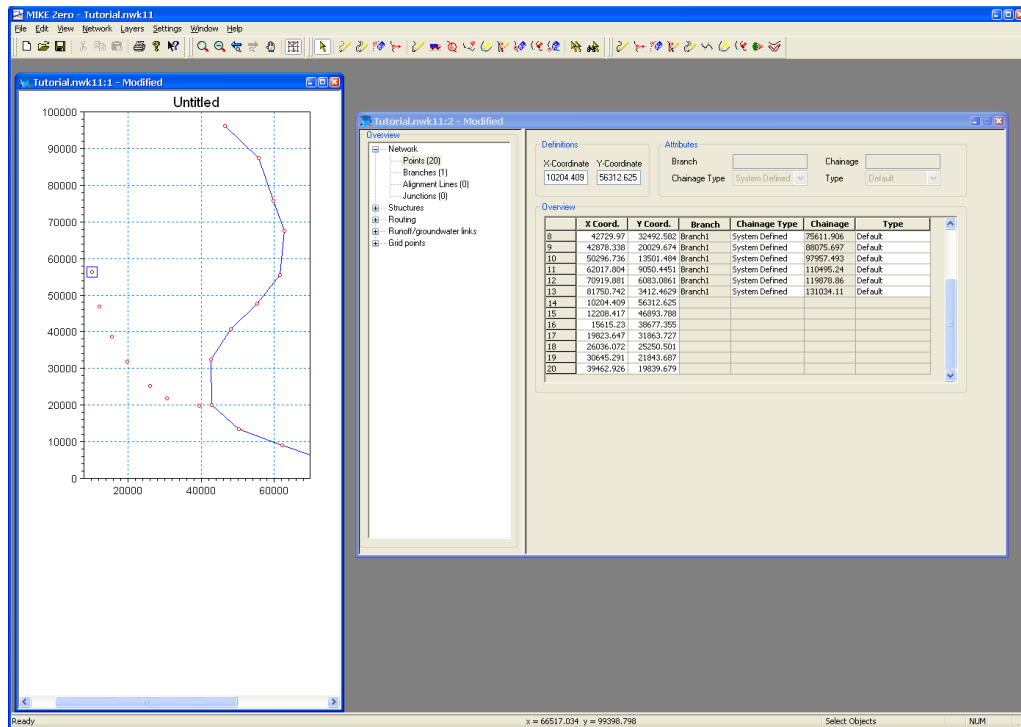




Figure 7.7 One branch defined, second branch digitised

To connect the eight points the tool  or  can be used (start at the left most point) and when the connection is done the screen should look similar to the following.

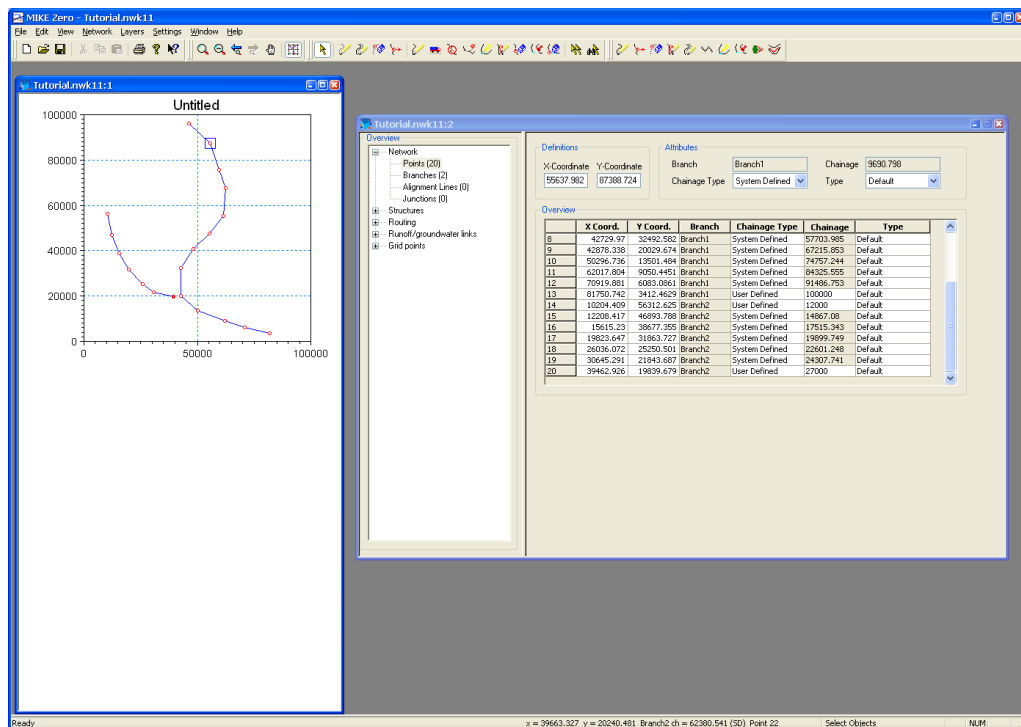


Figure 7.8 Two branches defined with user-defined chainages in up- and downstream points

Note that the branch information is now available in the list of points in the tabular view. The chainage type should be set to user defined in the first and last point and the chainages set to 12000 and 27000, respectively.

Before connecting the two branches each should be given identification names. This is done on the branch page of the tabular view where the river names are changed to 'Main' and 'Trib' as shown below. For both rivers the Topo ID should be set to 1997.

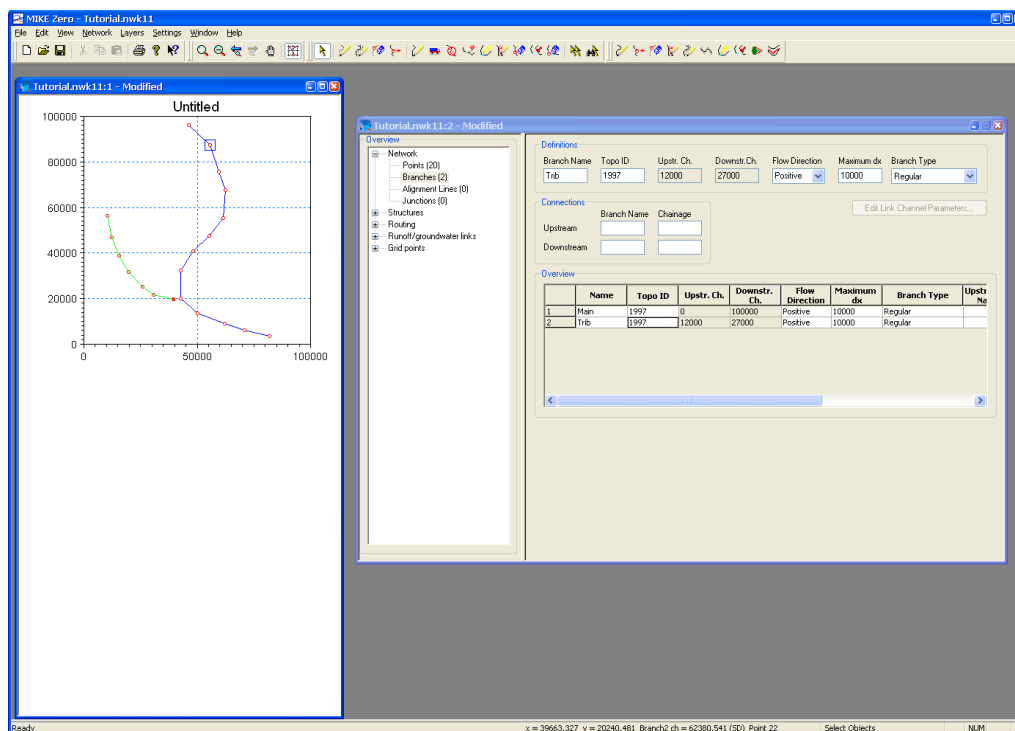



Figure 7.9 River Names defined as 'Main' and 'Trib'

To connect the tributary to the main river the  button should be used. Point at the downstream end of the tributary and while clicking and holding the left mouse button move the cursor to the point on the main branch you wish to connect and then release the mouse button. The connection is indicated by a line as shown below:

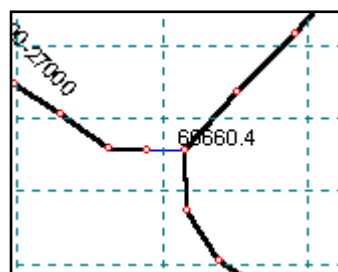


Figure 7.10 Connection of river branches

The contents of the network editor should now be saved by selecting the Save item in the File menu.


## 7.3 Cross-section Editor

The aim of this exercise is to show how cross-sections are created and then to establish links between the network editor, the cross-section editor and other editors.

The latter requires the use of the simulation editor, which in general serves two purposes:

1. It allows the user to specify a range of simulation parameters such as file names and time step and it allows a simulation to be started.
2. It enables the network editor to communicate with other editors. This communication could for instance be to receive from the cross-section editor a list of locations with cross-sections. Another example is when the network editor instructs the cross-section editor to insert a cross-section at a specific location. Such communication requires that a file name for each of the editors is specified. This takes place in the Input Property Page of the simulation editor.

In the simulation editor file names for both the network and cross-section files are required, and to do so an empty cross-section file needs to be created. This is done by selecting New on the File menu followed by Save and then Close. Similarly an empty simulation file has to be created and saved.

The simulation file is loaded and on the Input page of the simulation file editor the name of the network file and the empty cross-section file is specified using the  button. The network file can now be accessed using the Edit button on the simulation file menu.

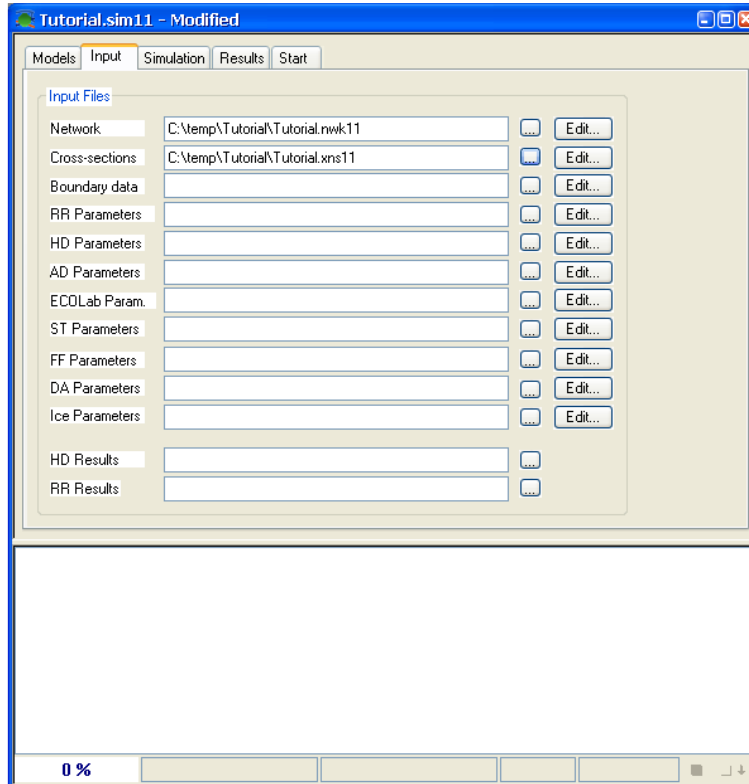


Figure 7.11 Simulation editor after selection of network and cross section file

Cross-section is required to be inserted at upstream and downstream end of both branches. This is done using the right-click Pop-Up Menu. Point at the upstream end of the Main branch and click at the right mouse button and select Insert, Network, Cross-section, as shown below:

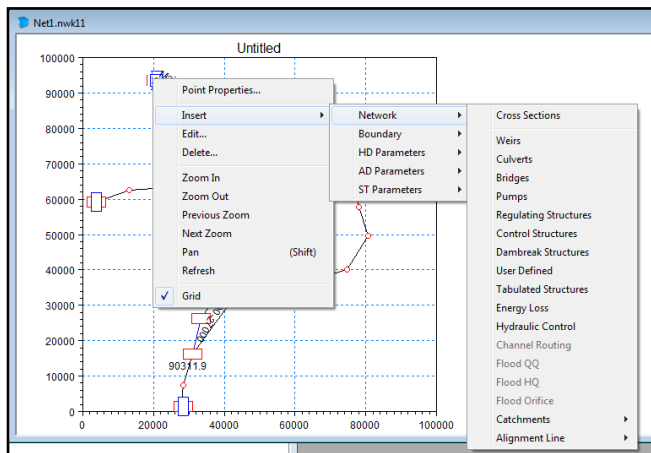


Figure 7.12 Using the Right mouse pop-up menu to insert new cross-section

The cross-section editor will appear and the data for the cross-section can be entered as shown. The name of the branch and the chainage will be automatically transferred to the cross-section editor. Modify the Z-value to 10.0 for Marker 1 and Marker 3 in the table.

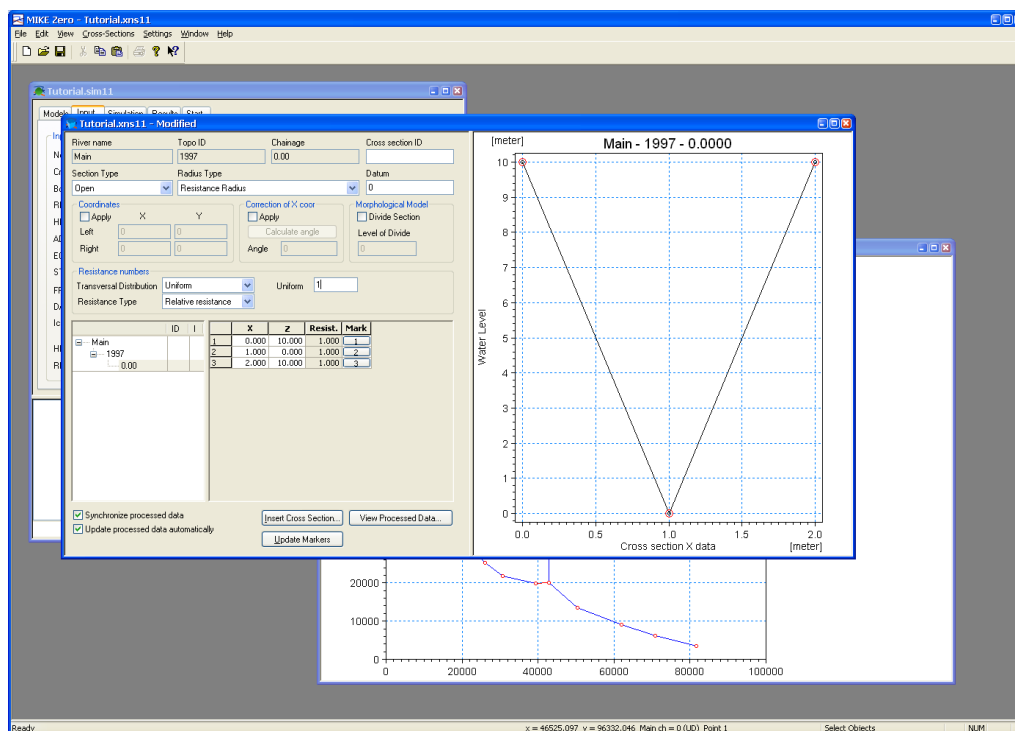


Figure 7.13 Cross-section editor, raw data editor

Once the raw data has been entered the button View Processed Data should be pressed to display the processed data tables.

The processed data will be calculated when the Recompute button is pressed.

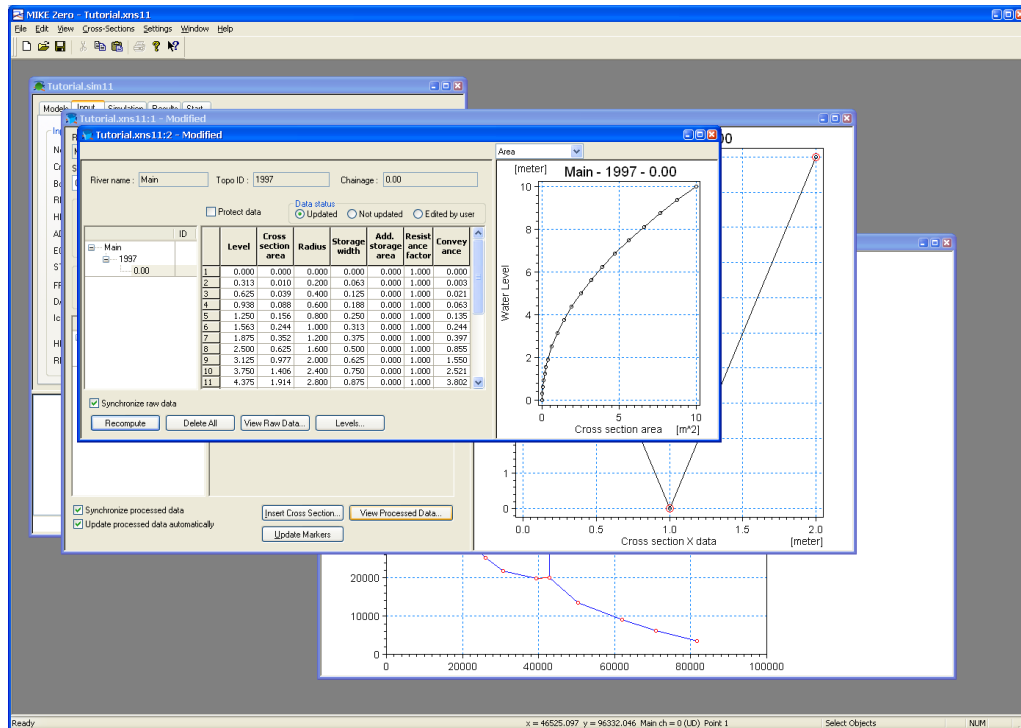


Figure 7.14 Cross-section editor, Processed data editor

Similar cross-sections should now be inserted at the downstream end of Main branch and at both ends of Trib branches. Modify here the Z-values for Marker 1 and Marker 3 as well.

The cross-section file is now saved and closed.

## 7.4 Boundary and Time Series Editor

The aim of this exercise is to create time series and boundary conditions.

The boundary condition at the upstream ends is zero discharge and at the downstream end the water level varies between 5 and 6 meters. First the file containing the variation in time of the water level and the discharge must be defined and to do so a new time series file is created from the New item on the File menu. The properties for the file should be entered as follows:

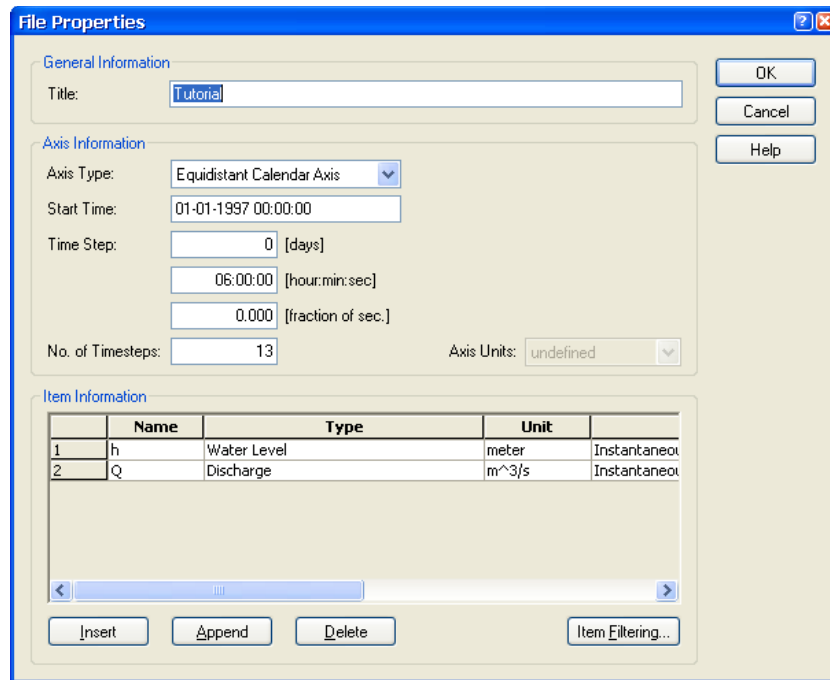


Figure 7.15 Time series 'File Properties' dialog

The format of the start time follows the standard windows format, which depending on the configuration of your PC might be different from the above shown.

Once the OK button is pressed the time variation of the water level can be entered as follows. The discharge values are to be kept as zeroes.

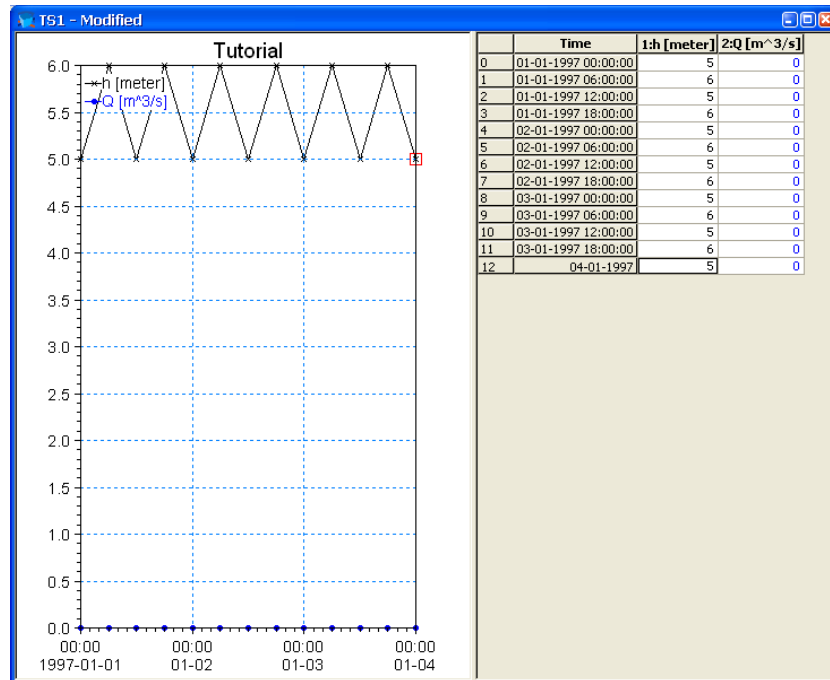


Figure 7.16: Time series editor, two items included in time series file

The content of the time series editor should be saved and closed using the File menu.

An empty boundary file must now be created, similar to the way in which an empty cross-section file was created earlier in this tutorial. The name of the file should be specified on the Input page of the simulation editor.

The location and type of boundaries can now be specified through the network editor where the Pop-Up Menu is used to insert the boundary at the downstream end of Main. The boundary editor now pops up and the location of the boundary is automatically transferred as shown below:

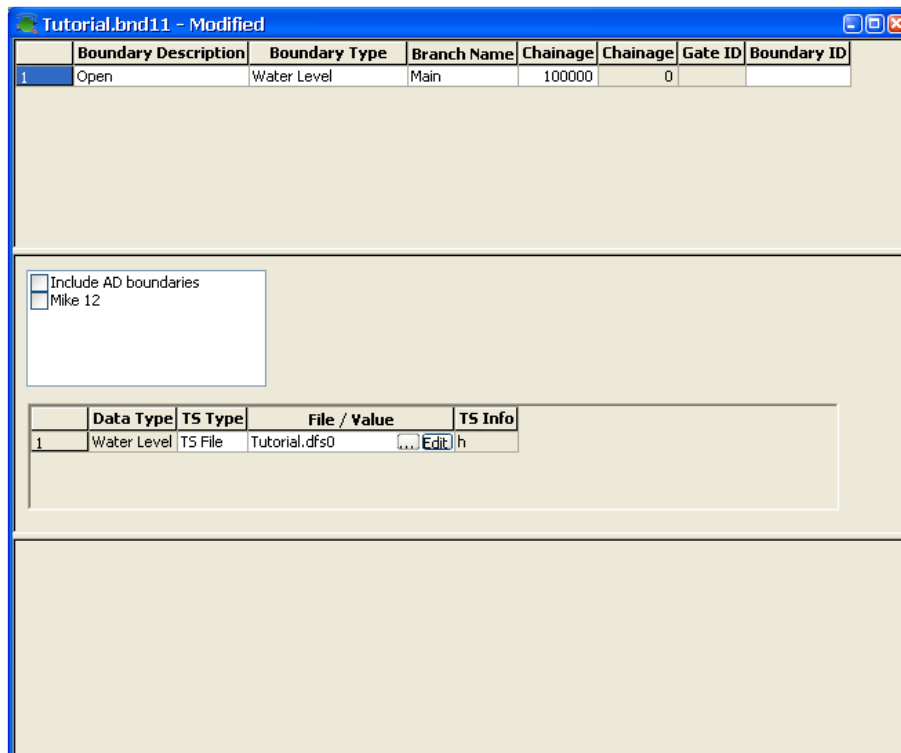


Figure 7.17 Boundary editor, defining downstream boundary condition

The time series file and item must be selected using the Browse button (...). This will open the file and item selector as shown in Figure 7.18.



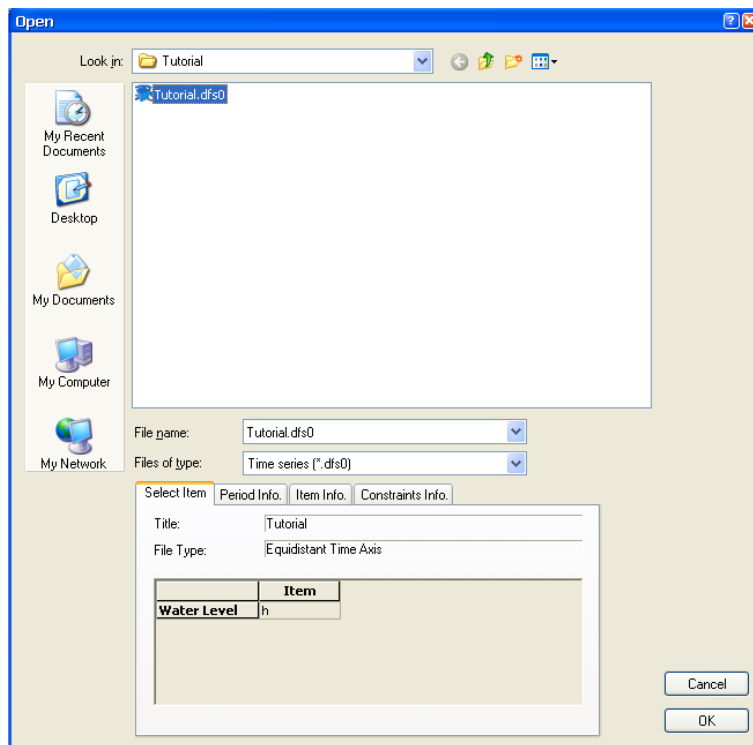


Figure 7.18 Time series, Item selector dialog. 'Green button Items' can be selected

In a similar manner the discharge boundaries at the upstream of both Main and Trib must be inserted and the correct file and item has to be selected. The boundary editor should now have the following content:

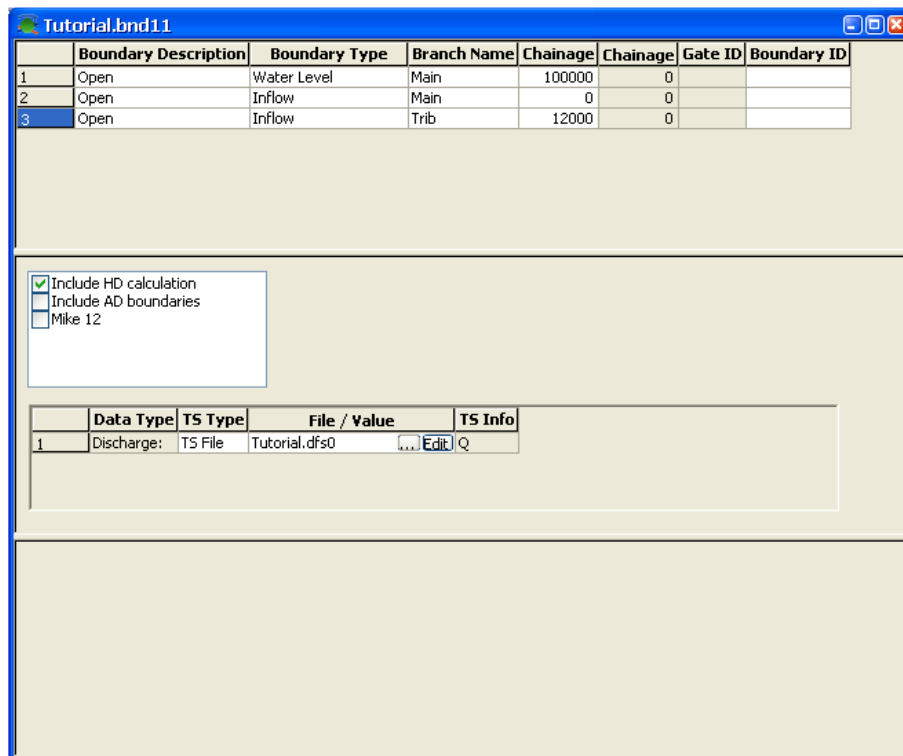


Figure 7.19: Boundary conditions for the tutorial set-up

The content of the boundary editor can now be saved and the editor closed using the File menu.

## 7.5 HD Parameter Editor

The final data required to run a simulation is the HD parameters, and to define those, a HD Parameter File is created through the File menu. The only parameter to be changed from the default values in this tutorial are the initial water levels. This is specified on the left most page of the HD Parameter file as shown. The initial water level should be 5 metres.

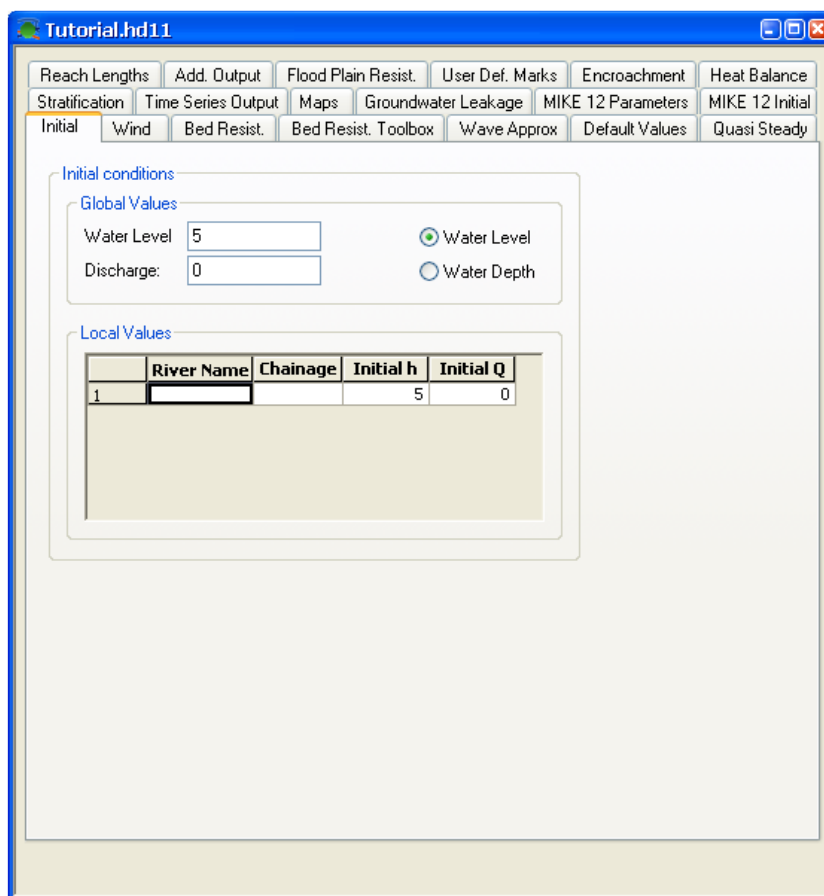


Figure 7.20 HD Parameter file, Initial conditions

The contents of the file should be saved and the name of the file should be specified on the input page of the simulation editor.

## 7.6 Running the Simulation

In order to run the simulation the pages of the simulation editor must be set-up as shown in the following diagrams.

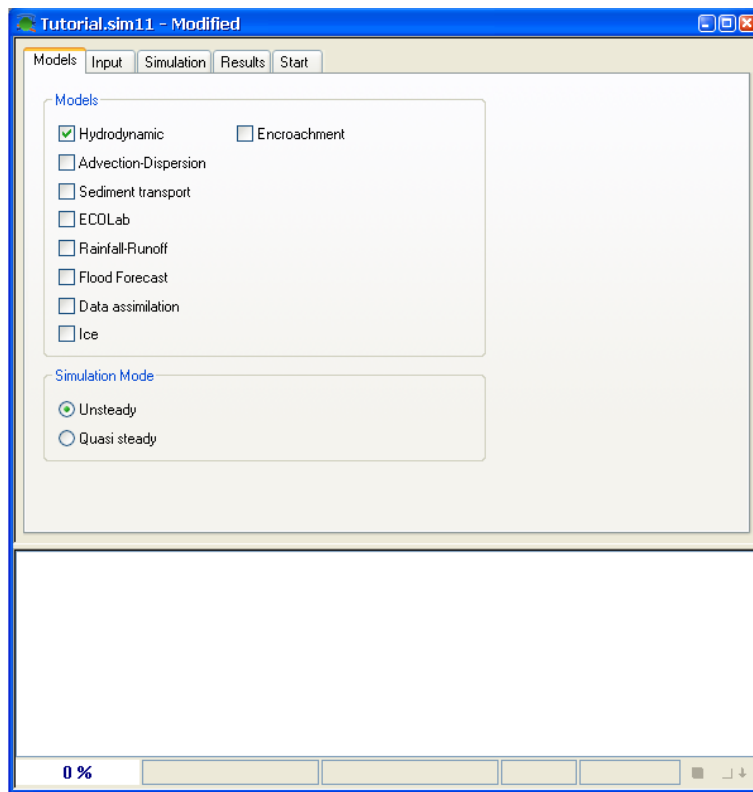


Figure 7.21 Simulation editor, Models selection page

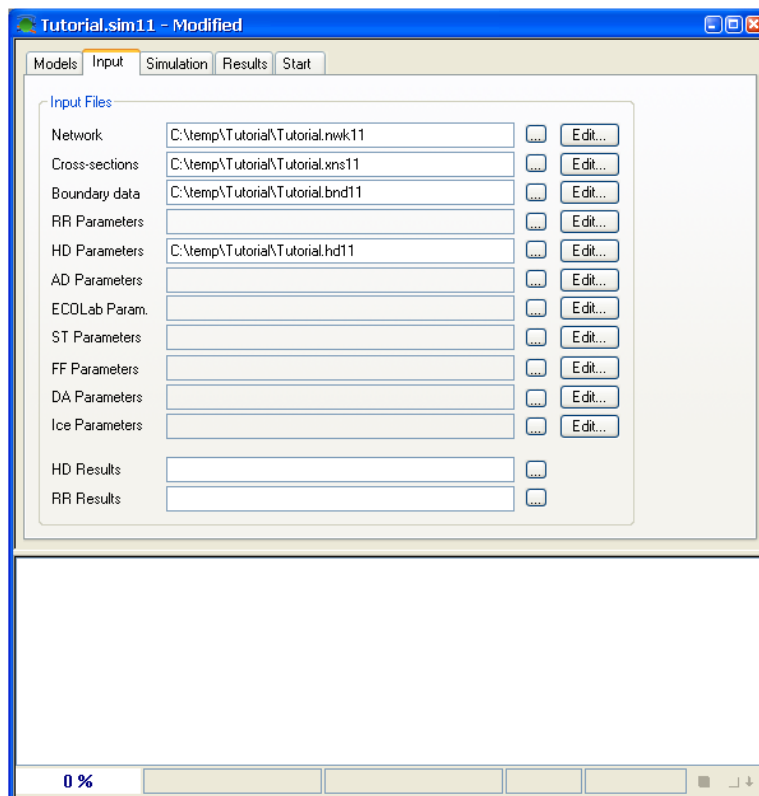


Figure 7.22 Simulation editor, selection of input files for simulation

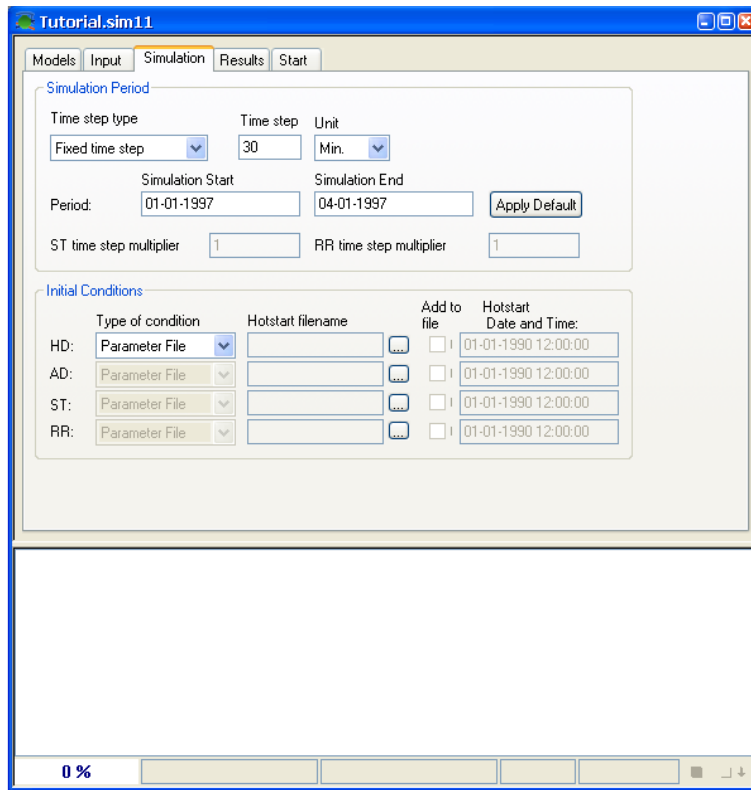


Figure 7.23 Simulation period, time step and initial condition selection for simulation

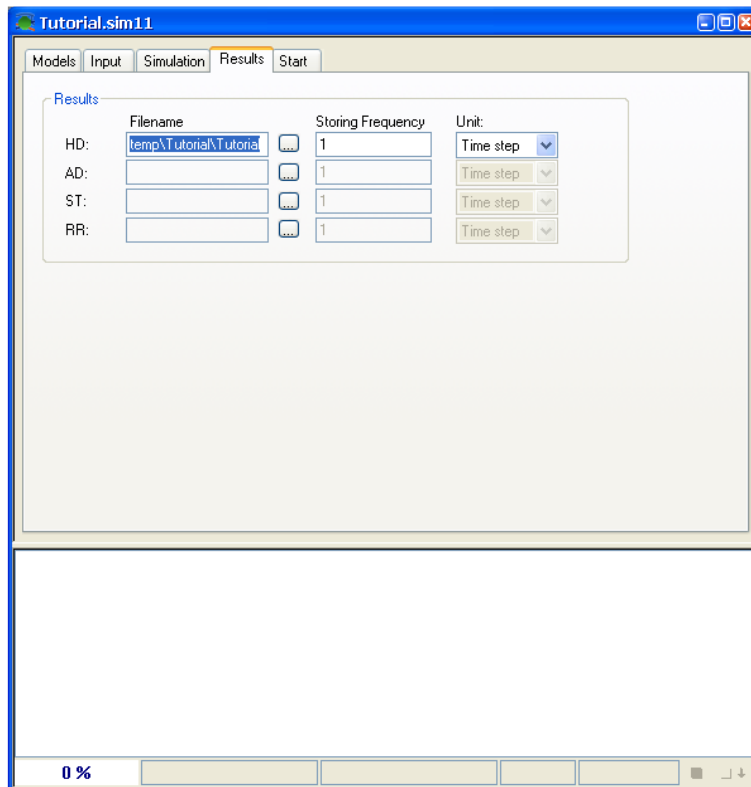


Figure 7.24 Specify the result-file name

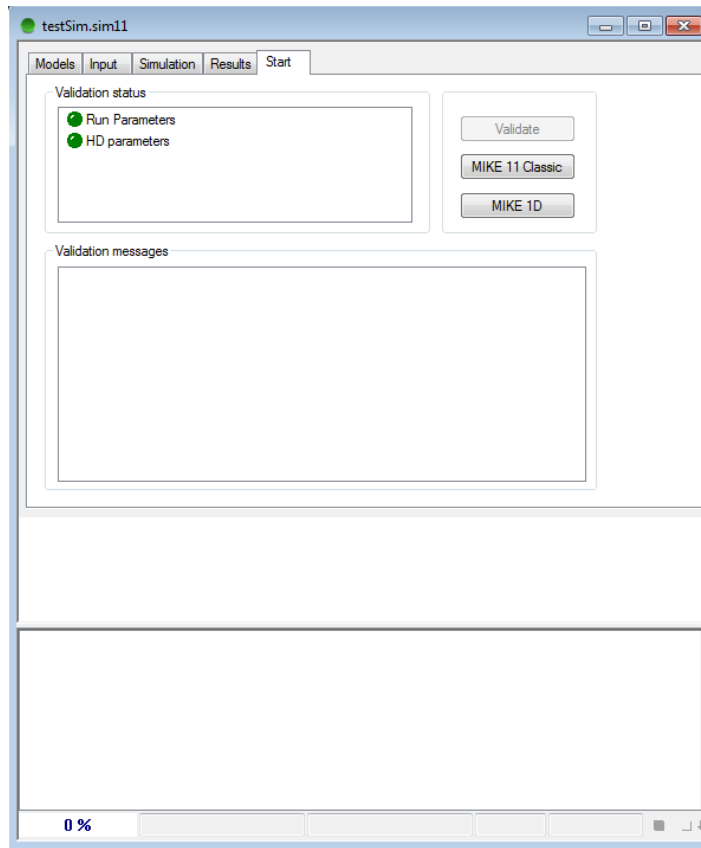


Figure 7.25 Ready to start the simulation – press the ‘Start’ button

When the start button is pressed the simulation will start and the progress of the simulation will be shown in the lower part of the simulation editor:

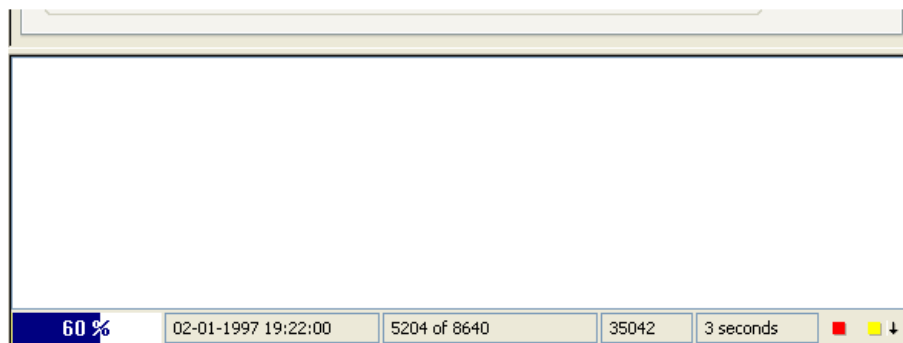


Figure 7.26 Simulation progress dialog

Once the simulation is complete the window will disappear and the results of the simulation can be inspected using MIKE View.



## 8 MIKE View Tutorial

### 8.1 MIKE View in General

The MIKE View program has been adopted as the result viewer for MIKE 11. In the current release MIKE View has not been integrated into the MIKE 11 structure and therefore, must be started as a stand-alone program.

MIKE View offers a variety of functions and features for viewing and analysing simulation results produced by the MIKE 11 system. The main presentation features comprise:

- Colour plan plot of the river network
- Longitudinal profiles
- Time series plot (Several events can be presented on the same plot).
- Animation of water level in cross-sections
- Results from several result-files can be included for comparison.
- Plot of Q-h relations
- Animation of user-specified result items (plan plot, longitudinal profiles and time series).
- Zoom facility in all windows
- Scanned images of background maps can be loaded
- Hard copy of all plots

One of the most interesting options in MIKE View is the 'show synchronised' feature. This feature allows the user to play back the results of one or more simulations while viewing the results from several types of display windows, all fully synchronised. This option opens the possibilities of:

- Viewing a plan view (e.g. with water levels or concentrations) together with a longitudinal section, one or more time series and a Q-h relation plot, for a single simulation fully synchronised in time.
- Viewing two sets of plan views, time series etc. for two alternative simulations, shown together and fully synchronised.
- Viewing synchronised output from MIKE 11 and the DHI Urban Sewer modelling product; MOUSE, showing Combined Sewer Overflow (CSO's) from MOUSE which pass into the river, the resulting hydrodynamic impacts and the effects on river Water Quality parameters.

More detailed information on the use of MIKE View can be found in the 'MIKE View User Manual' and the integrated on-line Help available within MIKE View. Descriptions and useful information on the dialogs and other available features are well described within the on-help system.

## 8.2 What Will I Learn in the MIKE View Tutorial?

This tutorial will guide you step by step through the basic features of MIKE View. The result file included in this tutorial is a MIKE 11 result file (originates from the Vida demonstration example enclosed with the MIKE 11 Installation), but the main principles shown here are also applicable for the viewing of MOUSE result files. MOUSE is the DHI system for modelling of Urban Sewer Systems.

When going through the tutorial, you will get the feeling of the most important features of MIKE View. With the help of the MIKE View Manual and the MIKE View online Help you should be able to get optimal results in your work with MIKE View.

## 8.3 Before You Begin

You can work with this Tutorial without any prior experience with MIKE View. However, at this stage MIKE View should be properly installed and you should be able to start the program, otherwise refer to the MIKE View User Manual, before you begin.

Please note that even though MIKE View is a user-friendly presentation tool for urban drainage systems, rivers and canal networks, the successful usage of the program requires some basic understanding of the respective hydraulic engineering areas.

A copy of the result file used by this tutorial is automatically installed on your computer. It is located in the 'Vida' directory under 'Examples\Mike\_11'.

## 8.4 About MIKE 11 and MOUSE Result Files

MIKE 11 and MOUSE produce several types of result files which all have one thing in common: they contain time series for various variables in the system.

The result files from the two types of models are distinguished by the file extension. Each result file type can contain only certain types of time series, which depends on the actual process treated by the model (e.g. runoff, sewer network flow, river flow, pollution transport, etc.).

From the MIKE View point of view, the result files are hierarchically divided in two groups:

- Files including the network geographical information:
  - MIKE 11 DSF result file (\*.RES11),
  - MOUSE HD result file (PRF)
  - MIKE 11 HD result file (RRF), MIKE 11 version 3.2 and previous versions – and not to be confused with MOUSE Runoff result files which also has the extension RRF but cannot be opened, only added
- Files without the network geographical files, e.g. Advection-Dispersion result file generated with MIKE 11 version 3.2 or previous releases (TRF).

The files from the first group establish a platform for the result viewing in MIKE View, since MIKE View is a map-based presentation tool. These files can be loaded into MIKE View through the <Open> function.



The files from the second group can be loaded into MIKE View with the <Add> function, being associated with the relevant (already loaded) file from the first group. Of course, the added file has to be fully consistent with its associated MIKE 11 or MOUSE file.

## 8.5 What Are We Going to View

The river network related to the result file in this tutorial consists of the following elements:

- 10 River branches including one main river and several tributaries feeding the main stream,
- 8 hydraulic structures of which 7 are regular broad-crested weirs and one is a controllable structure with a movable gate controlled by the water-level conditions in a gauging point upstream of the movable gate.

We are going to examine the details of the network layout throughout the exercise.

## 8.6 Loading Results

Start MIKE View by choosing 'MIKE View' in the 'MIKE 11' program group.

At start-up, MIKE View opens the File Open view. This facility makes it possible to navigate through the accessible drives, and you can easily find the data directory with your result file.

Examine the possible choices of result file types by clicking on the 'Files of Type' field. Select the 'MIKE 11 DFS Files (\*.Res11)' option, i.e. the MIKE 11 Result file.

All DFS11-files available in the Vida directory are listed. Select the 'VIDA96-3.Res11' file.

Some result files can be rather large, being hard work even for a fast PC. It is often sufficient to load the data from a result file selectively, so that your hardware is used in a more rational way. MIKE View gives you a chance to discard the unnecessary data types or irrelevant simulation periods, or to reduce the level of time resolution of the displayed data. You simply switch ON or OFF certain data types, redefine the time interval for loading, and select the appropriate step-loading factor.

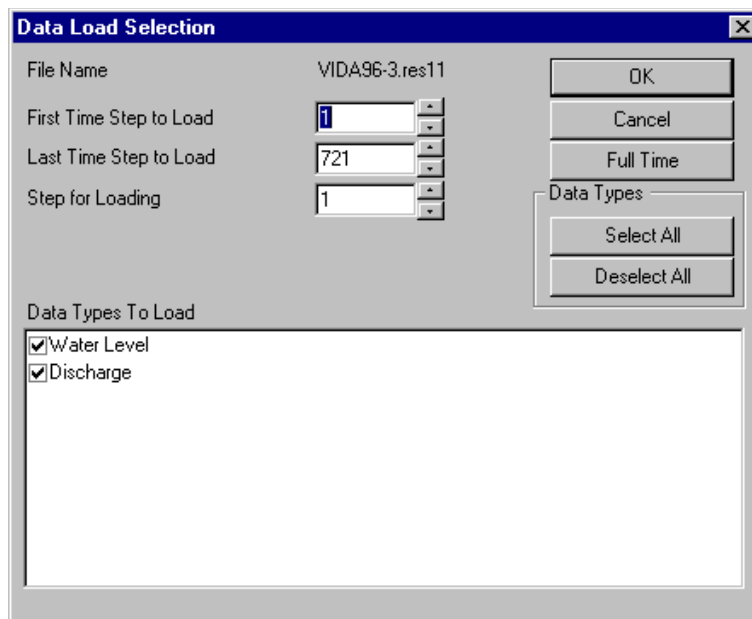


Figure 8.1 The Data Load Selection View. As default, MIKE View proposes the complete result file to be loaded

The tutorial result file is fairly small, and you should simply confirm the default selection by clicking on the <OK> button. After a short while, the file is loaded and MIKE View opens two new windows.

## 8.7 Exploring the MIKE View Screen

MIKE View has opened two windows:

- Horizontal Plan window
- Plan Overview window

**Please note:**

If your MIKE View ‘remembers’ some other settings from the previous session, the Palette window may also be on the screen, and the Horizontal Plan will be coloured.

The Horizontal Plan window dominates MIKE View. It displays the layout of the sewer network. If you select the Horizontal Plan window it becomes the active window, and the Horizontal Plan toolbar appears under the main menu.

When you move the cursor within the Horizontal Plan window, the co-ordinates of the current position are displayed in the status bar, located in the bottom left corner. The status bar also provides useful information on the program mode, help text, etc.

The Overview Plan window contains an outline of the network Horizontal Plan. It makes it easier to see where in the network you are while zooming. Try to arrange the size and position of the MIKE View windows, until you get them in a desired layout.

## 8.8 Viewing System Data

The best way to get a closer look at the Horizontal Plan is through playing with the various options available.

The Horizontal Plan Options View is activated by clicking on the Options tool in the toolbar, or by activating the Horizontal Plan local menu (press the right mouse button, while in the window).

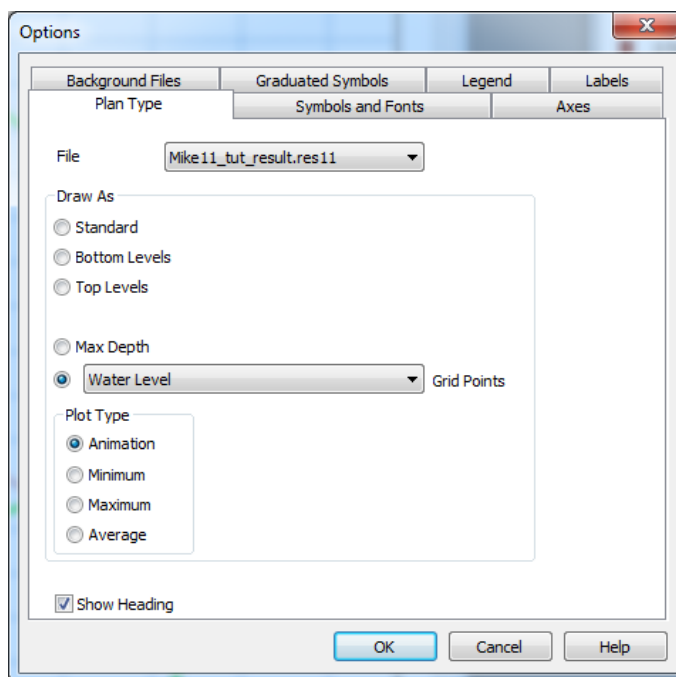


Figure 8.2 Horizontal Plan Options View

Let's first try to understand the modelled network. The various options available in MIKE View have been designed exactly to facilitate this activity.

Try the different options from the Plan Type group. Select one of the drawing modes featuring the system information, e.g. by selecting 'Slope'. This may give you a first impression of the topographical layout of the network: the slopes of the links will be displayed as a palette of colours. Furthermore, you may select 'Slope' under the 'Symbols and Fonts' group, which will add arrows to the links, indicating the direction of the slopes (works only if 'Slope' has been selected under 'Plan Type'). Similarly, if you select 'Bottom Levels', the colour palette will illustrate the bottom level of the Riverbed.

Under the 'Symbols and Fonts' group, you may adjust the size of symbols and the thickness of links and select your preferred font type and size.

Further, the system can be explored by selecting and viewing the longitudinal profiles along various selected paths.

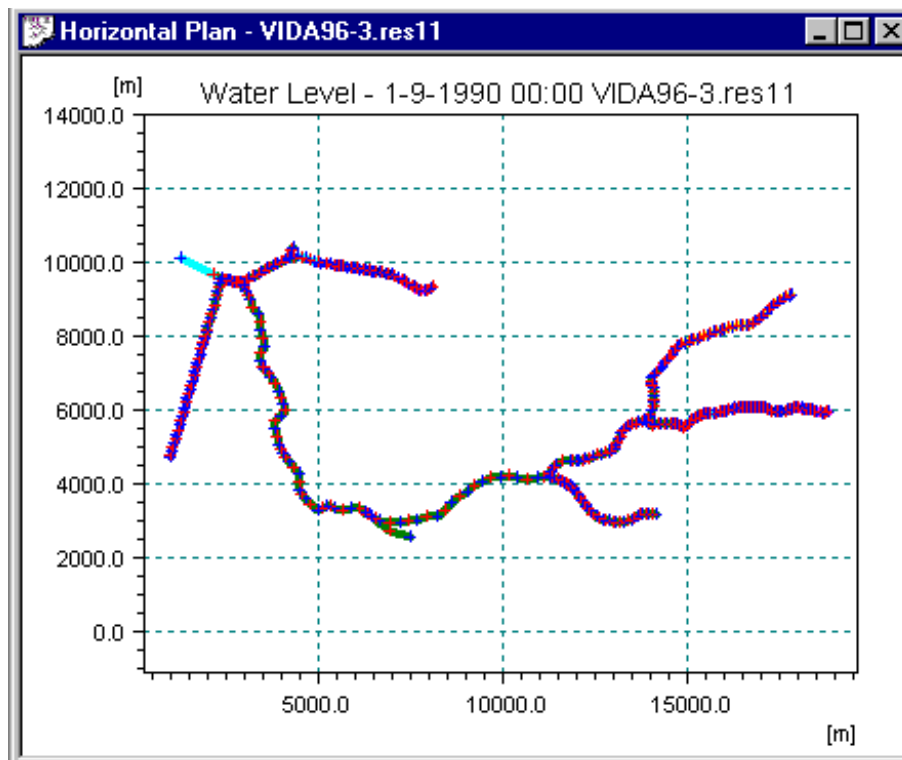


Figure 8.3 The network plan plot

## Zooming

The zoom function is available in all of the MIKE View graphical presentation windows. It is activated by choosing the various zoom tools in the toolbar, or by selecting <Zoom In>, <Zoom Out> or <Zoom Previous> in the local menu.

If you choose 'Zoom In' the cursor changes to a magnifying glass symbol. Move it to the location on the plan plot, which should be one of the corners of the zoomed-in frame. Then press the mouse button and drag the cursor across the Horizontal Plan. The cursor has again changed shape, and the zoom frame rectangle indicates the area, which will be included into the zoomed Horizontal Plan window. Continue the dragging until you are satisfied with the area included. Release the mouse button, and the displayed part of the network Horizontal Plan reduces to the framed area only.

The scroll bars of the Horizontal Plan window make it possible to 'pan' the zoomed frame over the network area. Also, you can drag the zoom frame rectangle in the Overview window over the network area to the desired position.

If you would like to see the whole network again, use <Zoom Out> or <Zoom Previous>

## 8.9 Viewing Results

### Selecting result variable and plot type

Under the Horizontal Plan <Options><Plan Type> select one of the result variables. You may notice that the result variables are divided into two groups: some variables are attached to network nodes, and others are attached to links.

At first, if you have more than one result file loaded into MIKE View, you should select the desired file. Then, you select a desired variable from the list of the available variables.

Finally, you select a mode for the presentation. The results may be viewed as animation, as minimum results or as maximum results. Selection of 'Min' or 'Max' results in the lower or upper envelope for the selected variable being displayed as static Horizontal Plan plot. If you select Animation, the selected variable will be displayed dynamically, as a replay of the simulation through time. We will choose the animation.

The only file available (i.e. loaded in MIKE View) is the TUTOR1.PRF. Choose the group of variables related to links, and select 'Discharge Branches' (i.e. Links). Check if 'Animation' is selected as the plot type.

When you are done, click <OK>. MIKE View now displays the discharges in the Horizontal Plan, corresponding to the start time of the simulation.

Note the date and time indicator in the upper part of the Horizontal Plan (the 'Clock'). The 'tape recorder' buttons in the toolbar have been activated, too.

### Animation in the horizontal plan

If you click on the run button, the animation will start. You may notice that the time elapses in the 'Clock', and that the colours on the plan plot are changing, following the discharge dynamics.

Try the other animation functions: Pause, Stop, Step Forward and Step Backward. The functionality is the same as controlling a tape recorder.

Under the Main menu <Animation><Advanced>, you can adjust the speed of the animation and some other parameters. Try and see the difference.

### Flooding and depth

MIKE 11 computes absolute water levels. However, it may be of a particular interest to see where flooding occurs in the system. MIKE View can compute the flooding as a new variable, which you can view as any other result variable.

In the Main menu choose <Tools><Compute><Flood>. As soon as you click with the mouse, the flooding is computed for the whole system, and added on the list of the available variables (in the Options View).

Go back to the Horizontal Plan window and select 'Flood' in links under <Options> of the local menu. Change the plan type to 'Max' and click <OK>. Your Horizontal Plan now displays the upper envelope of the flooding, which occurred during the simulated event. You can also view the dynamics of the flooding, simply by switching to the plot type 'Animation' and pressing the 'run' tool.

Additionally, the actual water depth of a certain location can be of interest. Compute also depth in the system. Show these variables as 'Max' and as 'Animation', see Figure 8.4.

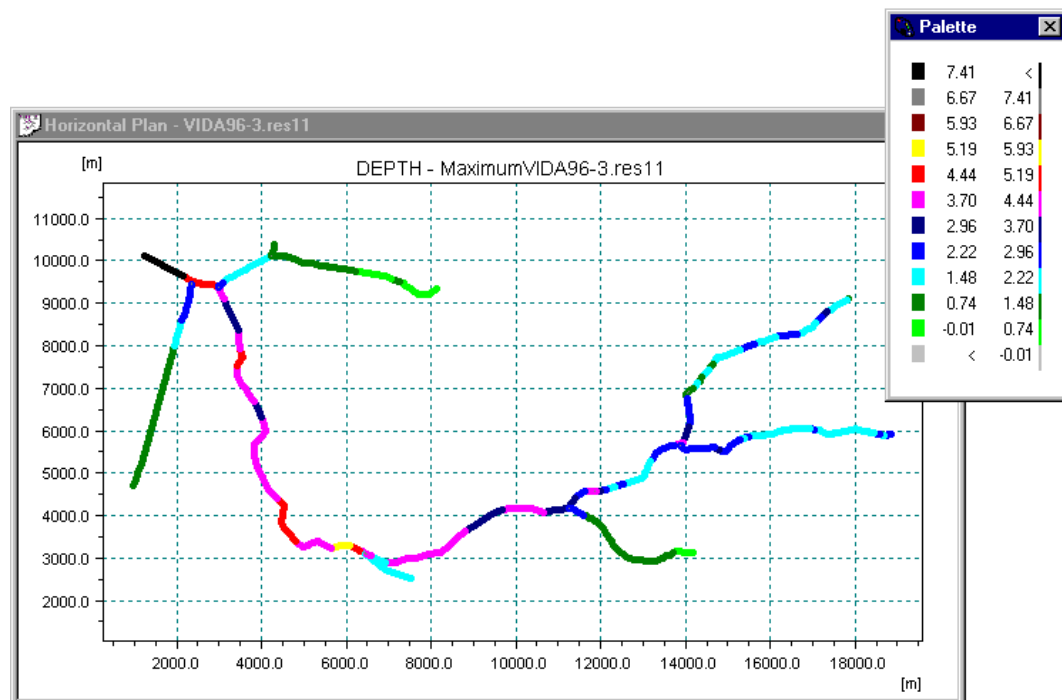


Figure 8.4 Maximum Depth for the simulated event

### Adjusting Min/Max range and colour palette

In reality, you are not interested in seeing the 'negative' flooding displayed, i.e. the situation where the water levels are contained within the surface levels as specified in the MIKE 11 model. This problem can be easily solved, by adjusting the 'Min' and 'Max' of the displayed range.

Activate the <Change Palette Intervals> function in the Horizontal Plan local menu, and change the 'Min' to zero. You may also change the 'Max' value to be some round number. Confirm your settings and have a look at the plan plot: Initially, the whole network is grey, indicating that there is no flooding. When you start the simulation, only those parts of the system where the flooding actually occurs changes colours, according to the palette.

The palette may be controlled in many ways. Click the right mouse button while in the palette window, and examine the possibilities.

If you do not like the colours on the palette, you may change them with the palette editor. Just double-click on the colour you want to change, and the editor opens. Similarly, if the range intervals are not suitable for your presentation, double click on the value, which you want to edit.

It is recommended that you spend some time playing with the palette. It will pay-off when you can efficiently apply your new experience in future work. Moreover, if you create a custom palette of a more general applicability, or if you want to have it at hand next time you work with MIKE View, just save the palette settings into a PAL file. Next time, load it and your own palette will be there again.

## Exporting the horizontal plan

You will often be in a situation, where you want to include some of the MIKE View graphs into your text report. With MIKE View there is nothing easier.

Of course, your word processor should be a true Windows application with Copy and Paste facilities, e.g. Word. Start it, and open your report document (or create a new one for the exercise).

Return back to MIKE View, adjust the Horizontal Plan to fit your needs in the report, and activate the local menu. Simply click on the <Copy Graphics > option. Apparently, nothing happens, but actually, the content of your Horizontal Plan has been copied to the Windows Clipboard.

Switch again to the text editor, position the cursor at the desired location, and activate the standard <Edit><Paste> function. The MIKE View plot is pasted into your document as a fully vectorised graphical image, which opens the possibilities for resizing and editing.


This facility works for any graphical window in MIKE View.

## 8.10 Viewing Results in a Longitudinal Profile

The Horizontal Plan is the working area where items may be selected for all the other presentation modes: longitudinal profile, time series, Q-H relations and Cross-section animations.

### Selecting a longitudinal profile

Let's assume that we want to have a look at the longitudinal profile of the main stream starting from upstream point and down to the boundary point where the river has its connection with the sea.

Click on the Longitudinal Profile tool in the toolbar  and point with the cursor in the vicinity of the upstream point of VIDAA-OVR (ch 108 m). When the cursor changes to an arrow, it means that you can start the selection of the longitudinal profile.

Click on the branch, and the VIDAA-OVR branch changes colour to green. Continue the selection by clicking at each branch (or in the direction) along the desired path. MIKE View paints your selections bold green. When you arrive to the last branch, MIKE View recognises the end of the path and proposes that the selection is closed. Confirm and choose the type of variable, which you would like to show in the longitudinal profile. The default selection is 'Water Levels'.

Note:

If you have selected a wrong branch, 'deselect' the last selected branch by clicking on the mouse button and pressing the Shift key at the same time (or simply press Backspace).

## Animating a longitudinal profile

At first, resize and reposition the Longitudinal Profile window, until you are satisfied with the appearance. You can also, as in the Horizontal Plan, zoom-in, zoom-out and control various display options by opening the Options View from the local menu.

The animation is started in exactly the same way as in the Horizontal Plan: Just click on the 'Run' tool in the toolbar.

## Synchronising animations

If you want, the animation in two or more windows can be fully synchronised. This means that the animation in each of the open Horizontal Plan and Longitudinal Profile windows will elapse synchronously and that you can follow the system dynamics from several 'angles' simultaneously.

You can only have one Horizontal Plan window opened with each of the result files loaded. But, if you load more result files (e.g. one from MIKE 11 and the other from MOUSE or two MIKE 11 result files), a synchronised animation can be made also for two Horizontal Plan windows.


To make sure that your windows are 'synchronised' select <Animation><Synchronize All Plots>. Next time you start the animation, all windows will be in motion.

Each of the windows can individually be excluded from the synchronised animation. This switch is available under the local menu of the window.

## 8.11 Viewing Time Series

Time series graphs are usually the most relevant graphs for the system analyses. MIKE View allows you to see any of the existing time series from the loaded result files, to view them in combination with the measured data, and to create time series graphs with all possible time series combinations.

### Selecting a time series

Let's assume that the water level is of our primary interest. Click the  button; 'Select Gridpoint' in the toolbar and select 'Water Level' as the variable. Select the RES11 file (in case you have multiple files added to the current project), and either point the cursor to a point in the horizontal plan or press the 'List' button to select the Time series location from a table. Please note that if you select the point from the plan plot, you are kept informed in the info bar (lower left corner of the MIKE View window) on which point you are actually pointing at.

The cursor changes to an arrow if you are pointing at a point equal to the item you have just selected (= Water level) indicating that here data are available. After clicking with the mouse, MIKE View opens a window with a graph showing the Water level for the actual point.

Try also to select a Time Series from the Time Series List selection window.



Similarly, as in the longitudinal profile window, you can control the appearance of this window in many ways with the right mouse pop-up menu. Try to open the 'TS Settings...' under 'Options' in the pop-up menu. Here, you can change the thickness, colours and other settings for appearance of individual series in the actual window.

## Adding items to a time series graph

You can complement any time series graph with as many other time series of the same data type as you wish (e.g. Water Level). Additionally, you can add data of a different data type to the same windows – max 2 data type area allowed within a Time Series window. These may come from the same result file, from some other loaded result file, from a separate DFS0-file, from the MIKE 11/MOUSE time series databases, from the Clipboard or from a text file.

Just for the exercise, let's view the water level in a specific point in combination with a discharge time series from an external DFS0-file.

Press the Time Series tool button, select 'Water Level' and press the List button. In the list of calculation points go down to the point 'VIDAA-OVR 4822.00' and select this point by activating the check mark in the first column. Press the 'Draw Graph' button to draw the Time Series in a new Windows. After this, open the right mouse pop-up menu and choose <External TS>, in order to open the External Time Series View.

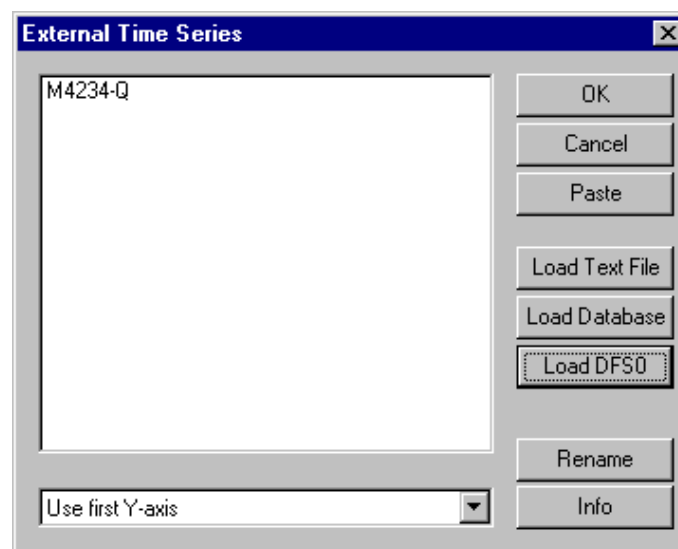


Figure 8.5 The External Time Series View

Click on the <Load DFS0> button and find the file; M4234-Q.DFS0. Select the file and MIKE View are loading the time series, which can then be used for comparison with the simulated series

In order to get the time series displayed in the graph, you should select it by clicking with the mouse on the time series identifier. Before confirming your selection with <OK>, select 'Use second y-axis' from the list. This will cause the Water level and the discharge to be shown with each their y-axis.



## 9 Demo Set-ups Included in the Installation

### 9.1 Introduction

Setting up a river model – especially for new users of MIKE 11 – typically introduces some initial problems on how to schematise the natural river in the mathematical model, which input data are required, how to combine the measured series of hydrometric data and topographical surveys etc. etc. To reduce the amount of initial difficulties in the process of setting up a river model for the first time, it is often beneficial to obtain experience from already existing river set-ups.

Included in the MIKE 11 installation, you will find examples of river model set-ups including all required data input files to perform simulations with MIKE 11. The two basic examples comprises a set-up for a Danish stream (small river) named 'Vida' and a reduced set-up for a river in Bangladesh named 'Cali'.

Input files for the demonstration set-ups are automatically installed to your computer when installing MIKE 11. Input data comprises files for the River Network, Cross-sections (River topography), Boundary definitions, hydrometric time series data and HD parameters.

After installing MIKE 11, the demonstration set-ups are located in the installation folder in the following directories:

'...\MIKE Zero Projects\MIKE_11\Vida'	(Vida Stream)
'...\MIKE Zero Projects\MIKE_11\Demo'	(Cali River)

Additionally there are three examples of using the auto-calibration feature of MIKE 11:

'...\MIKE Zero Projects\MIKE_ZERO\AutoCa\MIKE_11\Example1'	(target: Resistance)
'...\MIKE Zero Projects\MIKE_ZERO\AutoCa\MIKE_11 Example2'	(target: RR)
'...\MIKE Zero Projects\MIKE_ZERO\AutoCa\MIKE_11 Example3'	(target: AD)

### 9.2 How to Use the Demonstration Set-ups

A source of inspiration for own projects, or an exercise for inexperienced users to familiarise themselves with the various editor features and functions of MIKE 11. This could be some of the achievements for users when examining and working with the demonstration set-ups.

MIKE 11 works both as a Demo version (without a software key and valid license files) and as a Full version (with software key and valid license files). If MIKE 11 works as Demo version, several limitations apply compared to the Full version. All editors are accessible and operate as in a full version, but restrictions apply for the number of data objects allowed when saving editor data files.

Limitations for a Demo version are:

- max 50 grid points in the river set-up,
- max 3 river branches,
- max 1 hydraulic structure,

- max 1 Q/h boundary,
- max 1 NAM catchment,
- max 10 cross-sections,
- max 3 time series items containing max 50 time steps

The enclosed two set-ups differ from each other primarily by the number of data objects included in the set-up;

The Cali river set-up has been reduced from the original size in order to comprise the limitations of the MIKE 11 Demo version. It is therefore possible to modify and save input data, perform simulations and view results from simulations which means that also users working with the Demo version can use the Cali set-up as an exercise to familiarise themselves with MIKE 11 and eventually make a set of 'what-if' scenarios.

For example, what happens if I change the Manning number globally? What happens if I change the boundary conditions? What happens if I change the shape of cross-sections? Etcetera, etcetera.

The Vida river set-up comprises a fully, non-reduced river set-up. The amount of data and number of data objects significantly exceeds the limitations of MIKE 11 Demo version, and therefore, it is not possible to modify and save the content of the data files in the Vida set-up if you are working with the Demo version. In this case, it is only possible to open the data files, view the content and obtain knowledge on how the river system is defined – the data files cannot be re-saved due to the large amount of data.

### 9.3 Cali River

The enclosed Cali River set-up has been modified to reduce the original number of input elements (cross-sections and river branches) to keep within the limitations of MIKE 11 Demo version.

The set-up comprises 3 river branches and 10 cross-sections. The boundaries consist of a single recorded upstream inflow and two downstream water levels conditions. A plan plot of the Cali River set-up is presented in Figure 9.1.

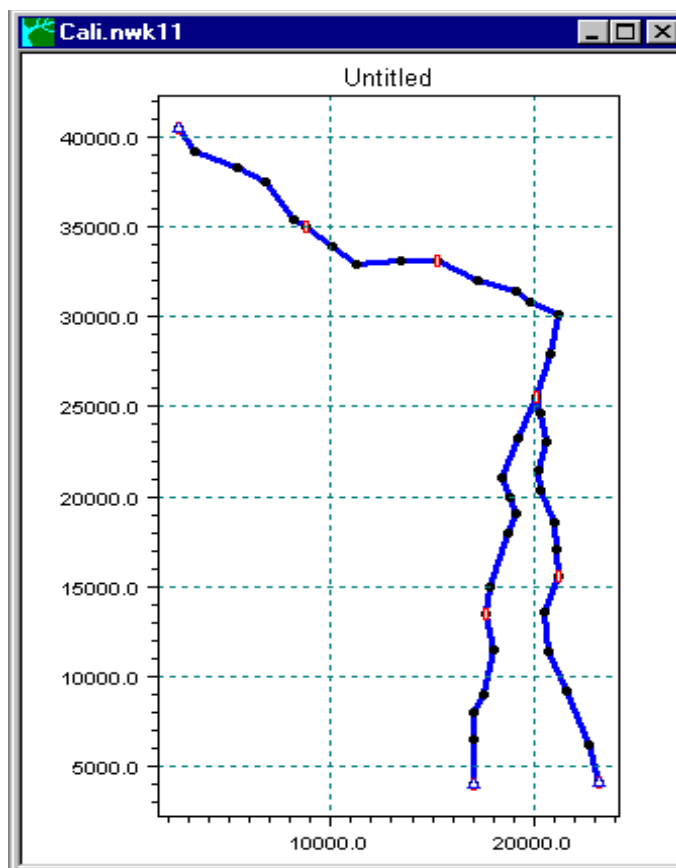


Figure 9.1 Cali River, plan plot of MIKE 11 set-up

The input files are all located in the ‘...\\Examples\\Mike\_11\\Demo’ directory. To load the files select File Open (Ctrl+O), change directory to Examples\\Mike\_11\\Demo in the File selection box and select the file type you wish to load (e.g. Time series file, simulation file, network file, etc.).

When integrating information from the pre-defined editor files, you should initially open the simulation editor file (Cali.Sim11). Select the ‘Input’ property page and open a specific editor by pressing the ‘Edit...’ button.

Please note that two boundary files are enclosed. The two files illustrate two different methods for defining boundary conditions (i.e. by extracting time series items from either one or several Time series files).

1. ‘CALI1.BND11’  
The three boundary conditions are defined by extracting time series items from three different Time series files (\*.Dfs0). Each time series file contains only one item.
2. ‘CALI2.BND11’  
The three boundary conditions are defined by extracting time series items from only one Time series file. The current Time series file contains three items.

Using the pre-defined settings in the Simulation editor for input files the simulation period and time step, it is possible to perform a simulation and view the results in the result presentation programme, MIKE View.

## 9.4 Vida

The second example is a set-up from a stream (small river) in Denmark, named 'Vid-Å'. The set-up was developed by DHI for a project conducted in 1997.

The Vida set-up comprises a main river branch with several smaller tributaries feeding into the main river. Boundary conditions are defined as inflow hydrographs on all upstream boundaries and a downstream tidal boundary at the sea. The downstream boundary is defined by applying measured water levels covering a large number of tidal periods.

Input files for the Vida set-up are located in '..\Examples\Mike\_11\Vida'. All input files required to perform the hydrodynamic computation are present. Additionally, two graphical files (.GIF) are enclosed each containing a scanned map of the study area. The scanned images are provided as high and low resolution (200 dpi or 400 dpi).

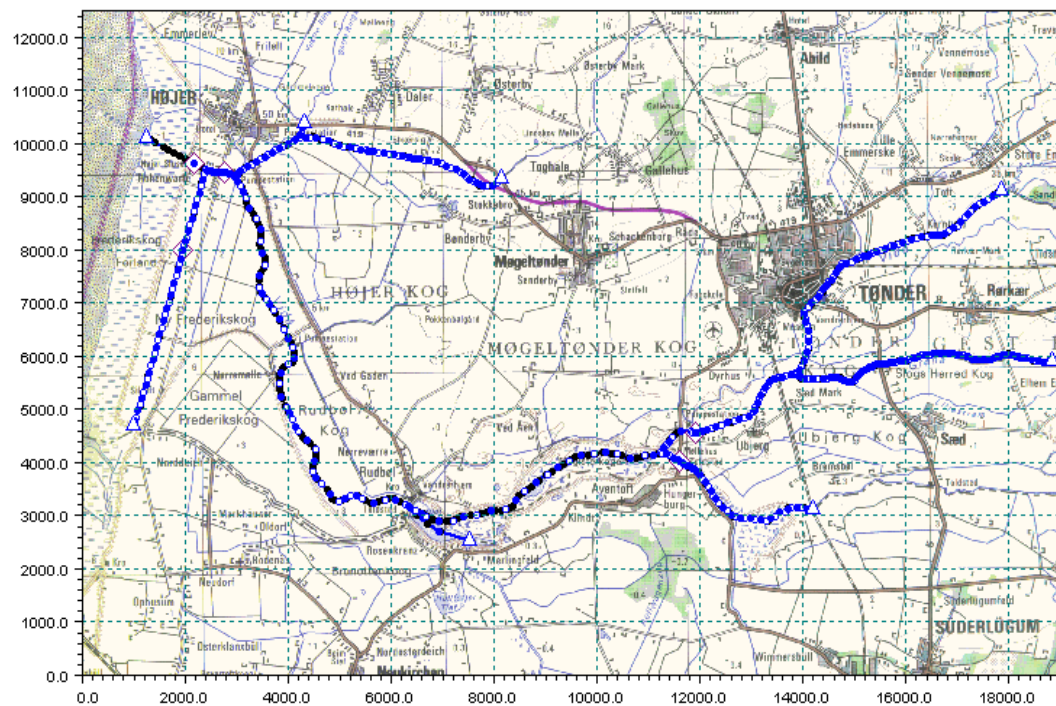


Figure 9.2 Vida, plan plot of MIKE 11 set-up including background map