Time Series Manager Training Module

Revision History

Version	Date	Revision Description
0.1	8/5/2014	Initial draft
0.2	17/06/2014	Updated version to take into account new manager design agreed with NBI-SEC on 12/06/2014
0.3	19/06/2014	Updated based on the comments received from WRMD team on 17-18/6/2014.
0.4	1/8/2014	Draft final version
0.5	11/9/2014	Updated version taking into account comments received from Nile-SEC team. To complete this version, information is needed from Nile-SEC team. This is all highlighted in the document.
0.6	27/12/2014	Final version for approval

Contents

1. Introduction

This document is part of training modules for the Nile Basin Decision Support System (DSS). These modules are developed for use in classroom training that is given to Nile Basin countries and as a self-learning training that will be available as part of the DSS helpdesk and knowledgebase.

1.1. Purpose

The purpose of this document is to provide a tutorial to the DSS Time Series Manager and its associated components and tools. The tutorial starts with the basics and progressively increases in complexity.

1.2. Module pre-requisites

The following prerequisites are needed before taking this tutorial:
Software prerequisites: The Mike by DHI version 2014 and the DSS version 2.0 have to be installed.
User prerequisites: User is expected to be familiar with or have taken the tutorial of the following:

- Database Manager Utility and System Manager
- The GIS Manager

1.3. Expectations

Upon successful completion of the lessons, exercises and review questions in this document, you will be familiar with most of the Time Series Manager functionalities.

1.4. Conventions

The following conventions are followed in this document:

 means a tip for the user

 means important information

1.5. Module data

The files needed to run this tutorial are located in the **..\timeseries\data** folder.

1.6. Links to additional resources

In addition to the information presented in this module, below are links to additional resources that you can access to obtain further information on the following:

- Time Series Manager tools:
  - The DSS help file
- Ensembles:
  - http://en.wikipedia.org/wiki/Climate_ensemble
  - http://en.wikipedia.org/wiki/Statistical_ensemble_(mathematical_physics)
- XML Schema:
  - Definition of standard types http://www.w3.org/2001/XMLSchema
  - Editing and validating schema (www.xmlfox.com/)

1.7. Problem reporting instructions

This document will be updated regularly. Therefore, it is highly recommended to report any spotted problem to helpdesk@nilebasin.org so it can be corrected in future versions. When reporting the problem, you are kindly requested to provide the following:

- Document title
- Document version
- Page number where the problem was spotted
- A description of the problem

2. Lessons

In this section, the following lessons are included:

- General: This lesson introduces definitions and concepts that apply to all lessons. It also shows the list of tools that are available for use with time series.
- Time Series Manager basics: This lesson introduces you to the manager's components and basic tasks such as activating the manager, organizing data within the manager and adding a new time series.
- Time series data handling and visualization: This lesson introduces you to data handling tasks within the manger such as importing, moving, removing (deleting) and exporting data. It also describes assigning quality control flags to the data. It concludes with describing the methods to visualize the time series data in the DSS.
- Linking time series data to GIS features: This lesson shows how to link (or associate) time series data to a GIS feature (e.g. gauge point).
- Handling changes and metadata: This lesson introduces you to the change log and metadata sections of each time series. It also shows how they can be used.
- Time series calculation and processing tools: This lesson describes how to apply the DSS time series calculation and processing tools on time series data. The tools include basic tools such as the calculation of the basic statistics of time series data (e.g. Mean and standard deviation). They also include other statistics tools such as calculation of a duration curve and data processing tools such as resampling and data extraction.
- Time series data analysis tools: This lesson describes applying the DSS time series data analysis tools on time series data. The tools include advanced statistics tools such as the calculation of the moving average and fitting data to a probability distribution. This module also covers applying statistical tests on time series data.
- Working with ensembles: This lesson presents the ensembles concepts followed by handling ensembles (e.g. importing, exporting and generating) and visualizing them in the DSS.

2.1 General

Introduction

This lesson describes some definitions and concepts used in Nile Basin DSS. If you are familiar with those definitions and concepts, you can skip this and move to the next lesson.

Topics covered in this lesson:

- Definition of a time series.
- Definitions of time series value and Time series time (axis) types within the DSS context.
- A description of the available time series tools within the DSS.

Lesson objectives:

After completing this lesson, you will be able to understand the following:

- What is a time series?
- What are the available time series value and time axis types within the DSS
- What are the available time series tools that in the DSS and their functions

Definitions

Below are some definitions to assist you in following the lessons and exercises given later in this document. If you are familiar with those definitions, you can skip this section.

Time series: is a sequence of data points (X, Y), measured typically at successive points in time spaced at uniform or non-uniform time intervals (X-Axis). An example of time series is the annual flow volume of a river at specific location.

Time series value types: In the DSS, the data can represented in different ways, which are called time series value types (e.g. Y-axis value types). These types are:

- Step accumulated: Data is accumulated for each time step and assigned to the next time step. Units can be mm.
- Accumulated: Data is accumulated for each time step and also all preceding time steps and assigned to the next time step.

- Mean step accumulated: Same as step accumulated but data is averaged across the time step and assigned to the next time step. Units can be mm/hour.
- Reverse Mean step accumulated: Same as Mean step accumulated but data is assigned to the present (actual) time step. Units can be mm/hour.

An example of the above types is given in below:

Table 1: Time Series value type examples

	Step Accumulated	Accumulated	Mean Step Accumulated	Reverse Mean Step Accumulated
Unit	mm	mm	mm/h	mm/h
1/1/2001 9:00				0.5
1/2/2001 9:00	12	12	0.5	0.25
1/3/2001 9:00	6	18	0.25	0.125
1/4/2001 9:00	3	21	0.125	0
1/5/2001 9:00	0	21	0	0
1/6/2001 9:00	0	21	0	1
1/7/2001 9:00	24	45	1	2
1/8/2001 9:00	48	93	2	0.5
1/9/2001 9:00	12	105	0.5	0.25
1/10/2001 9:00	6	111	0.25	0
1/11/2001 9:00	0	111	0	

1) For Step Accumulated, Accumulated and Mean step Accumulated, the first time step should be empty as a value represents the period from previous to present (Actual) time step

2) For Reverse Mean Step Accumulated, the last time step should be empty as a value represents the period from present (actual) to the next time step

In addition to the above types, an 'Instantaneous' value type time series exists in the DSS. In this value type, data represent values at one precise instant at the given time. For example, the measured discharge or water level at gauge location is an instantaneous value.

Time series time (axis) types: In the DSS, the time data can represented in two ways which are called time series time axis types (i.e. X-axis types). These types are:

- Equidistant calendar: Data is equally spaced in time. An example of this is a daily rainfall time series data where the time step between data points is one day.
- Non-equidistant calendar: Data is not equally spaced in time. An example of this is a monthly rainfall time series data where the time step between data point is one month (so time step can be 28, 29, 30 or 31 days). The same applies to yearly data.

Time Series Manager Tools

A number of tools are incorporated with the DSS to process, manipulate and analyze time series data. Those tools are object sensitive (i.e. when an object is selected such as a time series, only those tools which are applicable to this object appears in tools list. The table below shows a list of tools available for time series.

Category: Basic statistics	
Tool	**Function**
Accumulation	Calculates the accumulation of all values in a time series for one or more time series.
Annual maximum series (seasonal)	Extracts the maximum value in each year of the record for use in extreme value analysis for one or more time series.
Average	Calculates the average of a time series for one or more time series.
Count	Calculates the number of time steps that contain values in a time series for one or more time series.
Count per year (Average)	Calculates the average number of time steps per year that contain values for one or more time series.
Distribution	Plots the probability distribution of the values in a time series for one or more time series.
Maximum	Obtains the maximum value of one or more time series.
Minimum	Obtains the minimum value of one or more time series.
Monthly statistics	Calculates statistics for a specified month or Months for one or more time series.
Ordinary moments	Calculates the ordinary moments of one or more time series. The ordinary moments are: - Mean - Variance - Skewness - Kurtosis

Category: Basic statistics	
Tool	**Function**
Period statistics	Calculates statistics for a specified period for one or more time series.
Standard deviation	Calculates the standard deviation of one or more time series.
Sum	Calculates the sum of all values in a time series for one or more time series.

Category: Advanced statistics	
Tool	**Function**
Auto correlation	Calculates the auto correlation coefficient of a time series.
Cross correlation	Calculates the cross correlation coefficient(s) of two or more time series.
Coverage	Plots the coverage of a time series making it easy to mark missing values/periods for one or more time series.
Data quantile	Calculates the data quantile for one or more time series. The data quantile is the value that a specified fraction of all raw data are less than. For a fraction of 0.5 the data quantile equals the median.
Drought duration and volume	
Duration curve	Calculates the exceedence probability for the range of values found in the time series being analyzed for one or more time series.
Ensemble statistics	Calculates a user specified statistic (e.g. Mean) for each input ensemble time series.
Exceedance duration and volume	

Category: Advanced statistics	
Tool	**Function**
L-Moments	Calculates the L-moments of one or more time series. L-moments are statistics used to summarize the shape of a probability distribution. They are analogous to ordinary moments in that they can be used to calculate quantities analogous to standard deviation, skewness and kurtosis, termed the L-scale, L-skewness and L-kurtosis respectively (the L-mean is identical to the conventional mean). L-moments differ from conventional moments in that they are calculated using linear combinations of the ordered data; the "L" in "linear" is what leads to the name being "L-moments".
Mann-Kendall test	Tests the existence of trend in a time series for one or more time series using the Mann-Kendall procedure.
Mann-Whitney test	Tests the existence of a shift in the mean between two sub-samples defined from a time series for one or more time series using the Mann-Whitney procedure.
Mode	Calculates the mode for one or more time series. The mode is the value that occurs the most frequently in a sample.
Period statistics charts	Plots the statistics for a specified period for one or more time series.
Residual mass	
Run test	Tests the independence and homogeneity of a time series for one or more time series using the Mann-Kendall statistics.
Statistics map	Calculates a selected time series statistics and plots results on a map for one or more time series.

Category: Advanced statistics	
Tool	**Function**
Time series index tool	Calculates the stream flow index for one or more time series.
Time series threshold tool	Calculates the time series index for one or more time series.
Within-year statistics	

Category: Extreme value extraction	
Tool	**Function**
Annual maximum	Extracts the maximum value in each year of the time series record for the extreme value analysis for one or more time series.
Annual n-day minimum	
Partial duration series	
Partial duration series (seasonal)	

Category: Probability distribution	
Tool	**Function**
Empirical CDF	
Fit to distribution	Fits the time series data to a probability distribution and estimates the distribution parameters for one or more time series.
Histogram	Produces a histogram for one or more time series.

Category: Time series processing	
Tool	**Function**
Append	Appends a time series or a value to an existing time series.
Check time series tool	Checks the values of one or more time series, according to a specified criterion, and returns back a boolean with the result of the check.

Category: Time series processing	
Tool	**Function**
Create time series	Creates a new time series using an existing time series as template.
Extract ensemble members	Produces a single item series for each member of an ensemble. Can be applied to one or more ensemble time series.
Flag outliers	Adds a user specified flag to the values in a time series that falls within a specified criterion. Can be applied to one or more time series.
Moving average	Calculates the moving average for a user specified window width for one or more time series.
Quality flag filter	Processes the flagged values (Remove value, delete record or insert a constant) for one or more time series.
Rate of change	Calculates the slope (rate of change) for one or more time series.
Replace value tool	Replaces any given value or a range of values in a time series with a new value for one or more time series.
Resample	Changes the time step of a time series into a user specified time step for one or more time series. It is possible to resample into larger or smaller time steps.
Synchronize	Resamples two or more time series into a common time axis.
Time shift	Calculates the shifted values of the X-axis and the lagged values of the Y-axis of a time series for one or more time series.
Time series calculator	Performs time series math calculations on one or more time series using syntax commonly found in spreadsheet programs.

Category: Time series processing	
Tool	**Function**
Unit conversion	Converts time series values to a specified unit for one or more time series.
Value type conversion	Converts the value type of the input time series for one or more time series.

Category: Weather generator	
Tool	**Function**
Nearest neighbour resampling	Generates daily time series ensembles of weather variables based on historical time series. Can be applied to one or more time series.

Category: Soil erosion	
Tool	**Function**
Rainfall erosivity (R) (Extended)	Calculates rainfall erosivity (R) for the RUSLE soil erosion equation from 'raw' rainfall data.

Category: Import tools	
Tool	**Function**
Append values	Appends an existing time series to another time series

Category: Output tools	
Tool	**Function**
To chart	Displays one or more time series in a chart.
To file	Exports one or more time series to files on the disk.
To database	Saves one or more time series to the database.
To feature class	Calculates scalar values according to the “Tool to apply” property and adds the results to all features that are associated with input time series

Review Questions

1. Give other examples of time series data.
2. Can a rating curve be considered a time series?
3. Give examples of the different time series value types
4. Data can be equally or not equally spaced in time in real life and with the DSS
   - True
   - False
5. List the main time series tool categories and give an example tool for each one.

Answers

1. Other examples of time series data are daily water levels at a gauge location, annual hydropower generated at a dam or power plant or monthly evaporation of a lake.
2. No. (because a rating curve is relationship between water level and discharge, i.e. the x-axis is not time)
3. Rainfall and Evapotranspiration (e.g. in mm) are usually specified as step accumulated (monthly or daily totals) but can also be specified as a rate (e.g. in mm/hr) and in such case it will be (Reverse) Mean Step Accumulated. Discharge is usually (Reverse) Mean Step Accumulated but can be instantaneous if it is in-situ measurement. Water levels are usually instantaneous.
4. True
5. Basic statistics (Average), Advanced statistics (Duration curve), Extreme value extraction (Annual maximum), Probability distribution (Histogram), Time series processing (Moving average), Soil erosion (Rainfall erosivity (R) (Extended)), Import (Append values), Output (To file) and Weather generator (Nearest neighbour resampling).

2.2. Time Series Manager Basics

Introduction

The Time Series Manager deals with time series data within the DSS. This data can be from several sources such as project reports, modeling studies or DSS simulations. All of them are stored in the DSS database and can be accessed for further processing within the Time Series Manager. This section introduces you to the components of the manager with some basic tasks such as activating the manager and organizing data within the manager.

Topics covered in this lesson:

- Time Series Manager components
- Activating the Time Series Manager
- Organizing data within the Time Series Manager

Lesson objectives:

After completing this lesson, you will be able to:

- Explore the Time Series Manager components
- Activate the Time Series Manager
- Organize data within the Time Series Manager

Lesson pre-requisites

You have to be familiar with the DSS user interface basics to take this lesson.

Using the Time Series Manager

In order to use a manager within the DSS, it has to be activated. Activation is done through the DSS view menu. Once a manager is activated its window is added within the DSS user interface. It can then be used to handle its corresponding objects (e.g. Time series for the Time Series Manager).

Time Series Manager components

Each manager in the DSS has four user interface components. These components are used to carry out operations on objects related the concerned manager (e.g.

view a time series for the Time Series Manager). For Time Series Manager these are:

1. *The Time Series Explorer:* where time series data are organized in user defined groups and subgroups.
2. *The 'Data View Area:* where the time series data is viewed.
3. *Tools Explorer:* where the tools that are relevant to time series data are accessed.
4. *The Properties Window:* where the selected time series and tools properties are displayed, property values are set and selected tools are executed.

The components of the Time Series Manager are shown in the figure below.

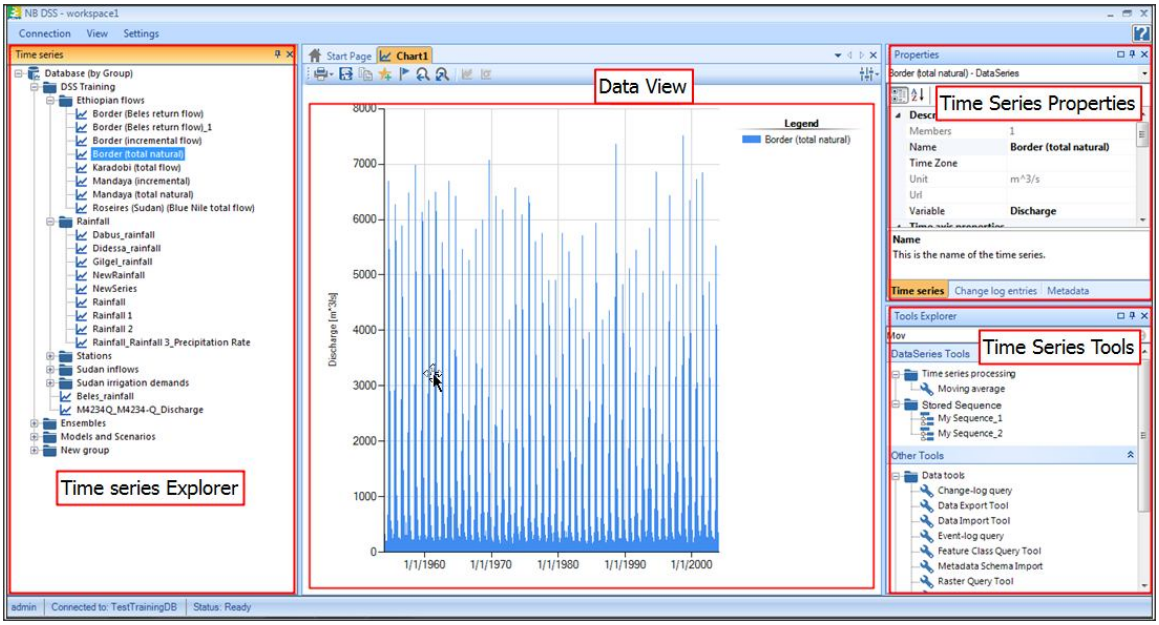


Figure 1: Time Series Manager components

Data Organization within Time Series Manager

Data in the Time Series Manager is listed within the explorer window. The explorer has a tree structure where groups (or folders) can be created and data is organized in groups so they can be easily identified and found. An example of such a structure is given below.

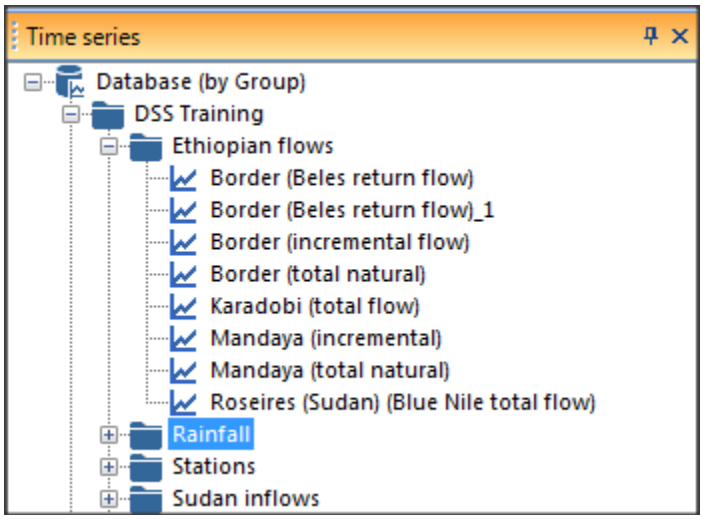
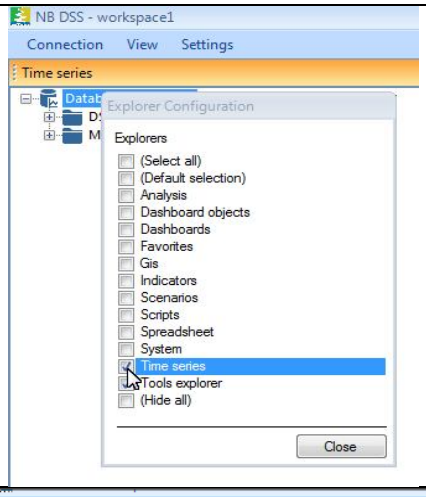
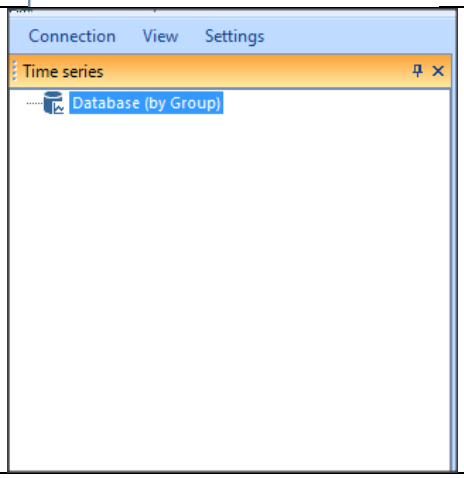


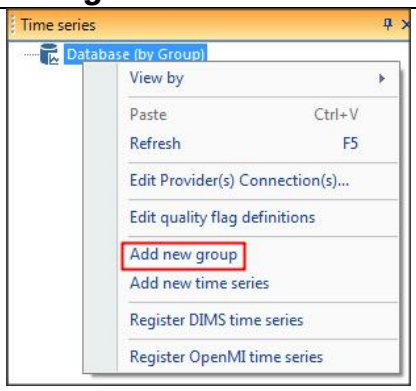
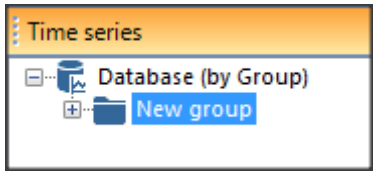
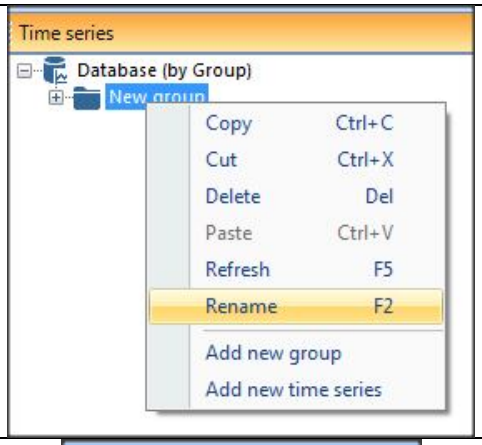
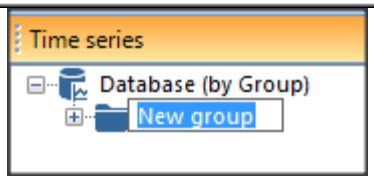
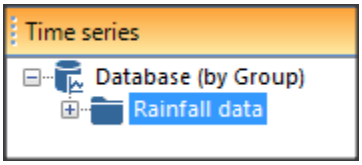
Figure 2: Organizing data within the Time Series Manager

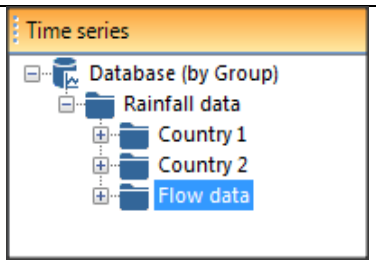
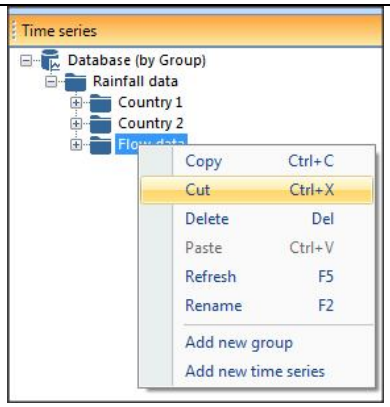
Exercises

Activating the Time Series Manager

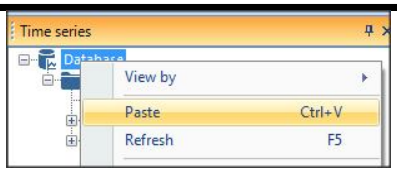
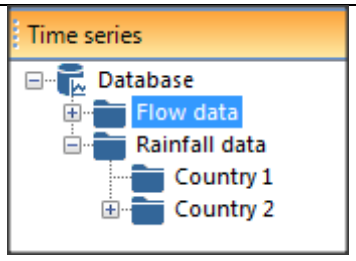
1- In the DSS, click on View Menu, click "Explorers…" and the Explorer Configuration box appears. Tick the box next to Time Series explorer and also ensure that the Tools Explorer box is ticked to be able to use the time series tools.	
2- Time Series Explorer should appear within the DSS window. The explorer has a main group called 'Database'. This main group is created by default when a new DSS database is created. Under this main group user can have 'user defined' groups (See organizing data within the Time Series Manager).	

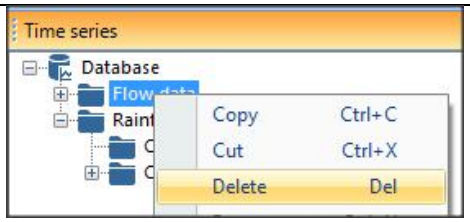
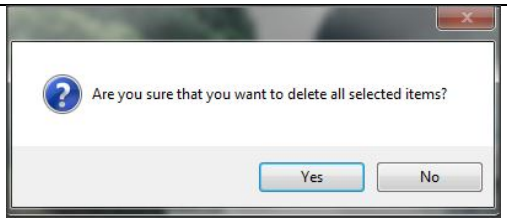
Organizing data within Time Series Manager

1- To organize data within the Time Series manager, user defined groups have to be added to the time series explorer. To add a new group, right click 'Database' group. The context menu shown next appears. Click 'Add new group'. A new group called 'New group' is added to the explorer.	 
2- To rename the new group, right click the group or select it and press the keyboard function key 'F2'. The context menu shown next appears. Select 'Rename'	
3- Type in the group name (e.g. Rainfall data). Press 'Enter' or Click outside the naming box. Now the group has been renamed	 

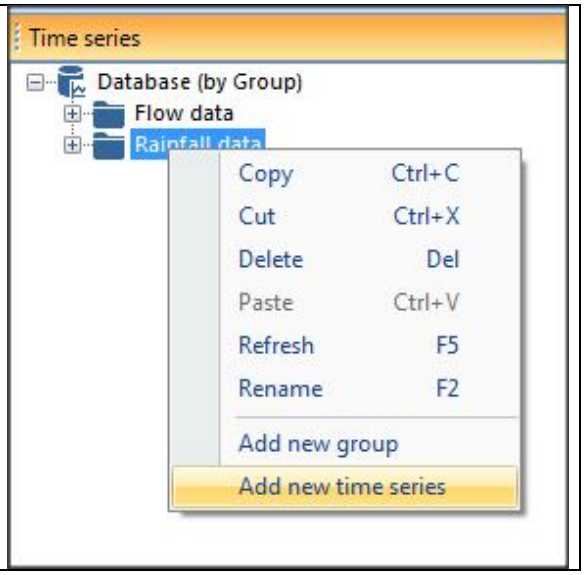
4- Create more groups as shown. Please note that the 'Flow data' group has been added under the 'Rainfall data' group.	
5- Groups can be moved from one level to another by cutting and pasting them at the right level. Now right-click the 'Flow data' group. The context menu shown next appears. Select 'Cut'. You can alternatively select the group and press the 'Ctrl+x' buttons on the keyboard.	

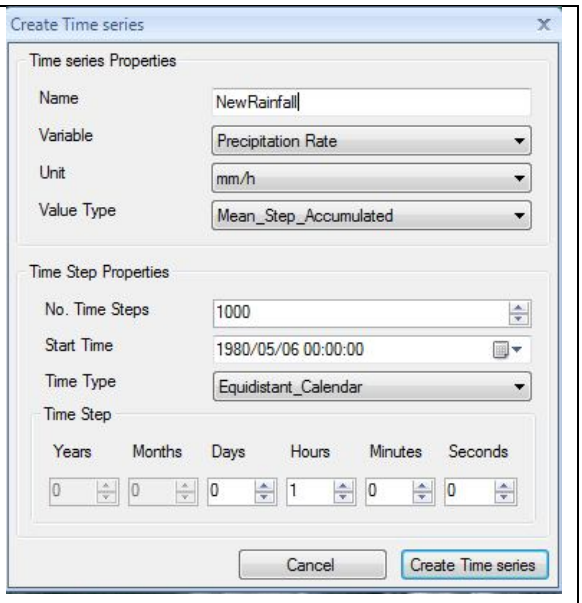
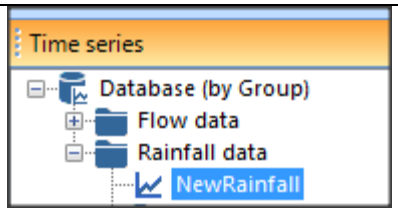
Drag and drop can also be used to move groups.

6- Right click the 'Database' group. The context menu shown next appears. Select 'Paste'. You can alternatively select the group and press the 'Ctrl+v' buttons on the keyboard.	
9- Now the 'Flow data' group moved under the 'Database' group. In the same way, a group can also be copied between groups by copying and pasting them.	

10- Finally to delete a group, right click the 'Flow data' group to get the context menu shown. Click 'delete'. You can alternatively select the group and press the ‘Delete’ buttons on the keyboard.	
11- The next confirmation box appears. Click 'Yes' to delete the group. Deleting a group deletes all sub-groups and time series it contains.	

Adding a new Time Series

1- Within the Time Series explorer, right click either the 'Database' node or a group (e.g. Rainfall data) to view the context menu	

2- Click the Add new time series item. The 'Create Time series' dialog appears. Fill the dialog as shown with the following: - **Name:** give your series any representative name - **Variable:** select data type from the list - **Unit**: select data units – depends on the selected variable above - **Value type**: select from the list - See the 0Introduction section for details - **No. Time Steps:** input how many time steps to create, i.e. length of your time series - **Start date**: enter the start date – you may use the calendar button - **Time type**: Whether equidistant or not-equidistant - See the 0Introduction section for details - **Time step**: Fill in the respective boxes At the end click the Create Time series button to create the new series.	
3- The New Time Series 'NewRainfall' is added under the 'Rainfall data' Group. This is an empty time series – only the time series is filled according to your inputs. To input the data values, see editing time series data section.	

Review Questions

1. What are the components of the Time Series Manager?
2. The 'Tools' explorer is not part of the Time Series Manager Components.
   - True
   - False

3. What are the pre-created groups of the Time Series Manager.
4. Give two operations that are used to organize data in time series explorer.
5. DSS users cannot create an empty time series
   - True
   - False
6. A new time series can only be created inside a user defined group
   - True
   - False

Answers

1. The Time Series explorer, 'Data view', 'Properties' and 'Tools Explorer'.
2. False.
3. The 'Database' group.
4. Add a new group and rename a group or a time series
5. False
6. False (Can also be created under the ‘Database’ group)

2.3. Time series data handling and visualization

Introduction

This lesson introduces you to data handling tasks within the Time Series Managera.
Topics covered in this lesson:

- Getting time series data into the DSS
- Viewing time series data
- Marking, editing and exporting time series data

Lesson objectives:
After completing this lesson, you will be able to:

- Import time series data into the DSS
- View time series data
- Move or remove time series
- Mark, edit and export time series data

Lesson pre-requisites

You have to be familiar with the Time Series basics to take this lesson.

Getting Time Series data into the DSS

There are a number of methods to import time series into the DSS. Each depends on the data format and quantity and is accessible from the Tools Explorer. The DSS can import ASCII, DSF0 (format used in Mike DHI products), GRIB, NETCDF and excel files. The import methods are:

- Import a single file with a generic format (file can contain one or a number of time series)
- Import a single file with a specific format (file can contain one or a number of time series)
- Import multiple files with a specific format from a folder
- Import multiple files with a specific format in batch mode

In the Importing Time Series into the DSS section, each import method is presented.

Time series data visualization

Once the time series data is added or imported into the explorer component of the Time Series Manager, users might need to view the data to check, for example, that it has been added or imported correctly. There are a few ways to do so on the DSS. Data can be viewed in a chart or as a table (See Figure 3).

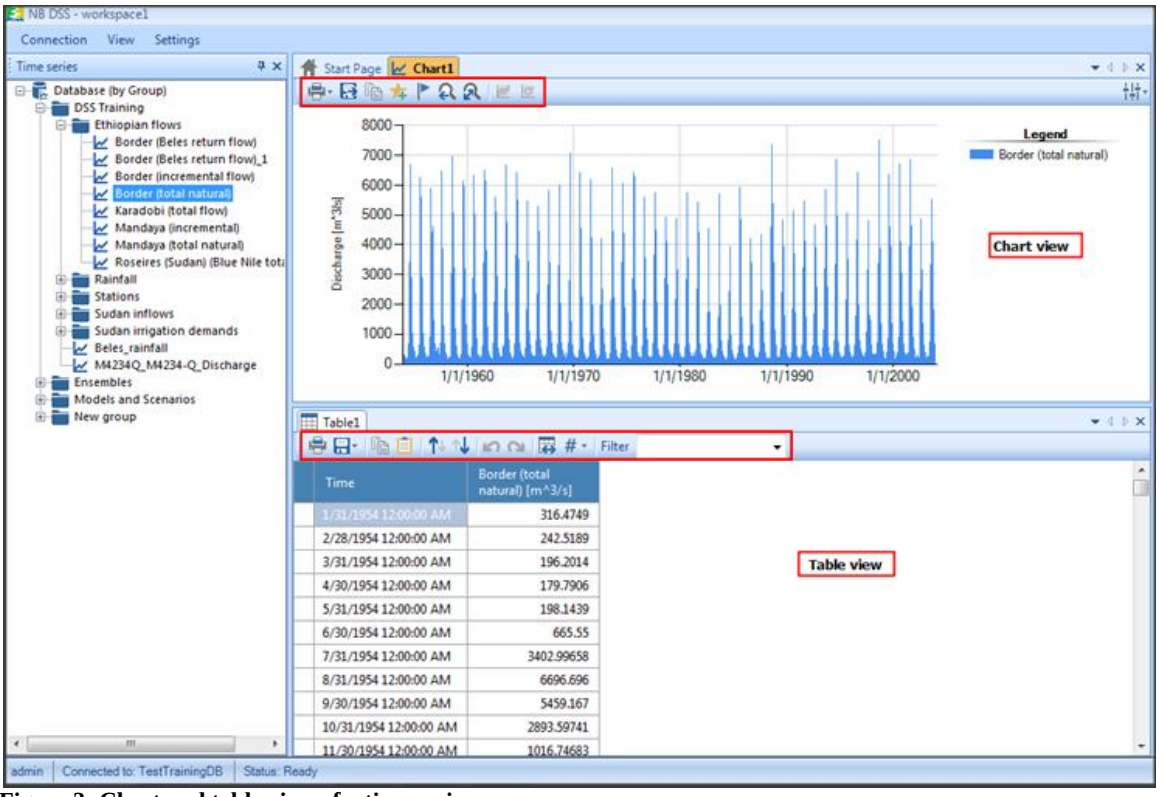


Figure 3: Chart and table view of a time series

As can also be seen in Figure 3, each view has a tool bar that helps you to undertake frequent tasks (e.g. save, zoom in and zoom out). The chart view tool bar allows you to do the following tasks:

 Print, setup the print page or preview the print page.

 Export the chart to a graphic file

 Copy the chart to clipboard

 Add the chart to favorites (Favorites can be viewed within the 'Favorites' explorer)

 Show / hide data flags (See Using Time Series flags for details)

 Zoom to previous extent

 Zoom to full extent

 Display the range and standard deviation for an ensemble data series (See Plotting ensembles for details – these buttons will only be active if an ensemble is plotted)

 Display options to the following:

- Synchronize zoom: zooms in and out synchronously between different chart areas (if there is more than one) – uncheck to zoom in the selected chart area only
- Box zoom mode: zooms in both axes (as one draws a box) - unchecked to zoom on the x-axis only
- Template manager: Shows available chart templates and allows their management
- Save chart as a template: Adds the active chart to the template manager
- Apply a template: Applies a saved template to the active chart

The table view tool bar allows you to do the following tasks:

 Print the table

 Save or save as the table (to the database)

 Copy part or the entire table as selected

 Paste copied records

 Sort data in ascending or descending order respectively.

 Undo or redo edits respectively

 Fit column width to view

 Change number format

Filter data according to flags (only if flags are defined – see next section)

In the Viewing time series data section, data viewing methods are described.

Marking, Editing and exporting time series data

The DSS user interface allows the user to mark, edit and export the time series data. Time series flags are used to mark individual values in a time series to indicate, for example, data quality issues associated with them. Flags are defined by an integer ID, a color and a description. Once defined, they can be used to flag, for example, issues with time series data.

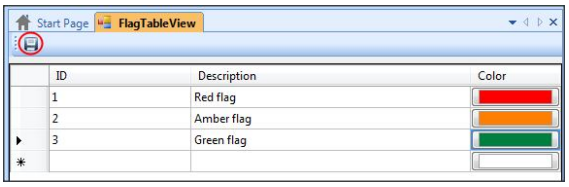


Figure 4: Time series flags

Once time series data is imported into the DSS, you might need to edit (i.e. modify) its values. Editing can be done when data is viewed as a table. Data values can be edited by typing directly into the table cells. Once editing is complete, data needs to be saved using the  button.

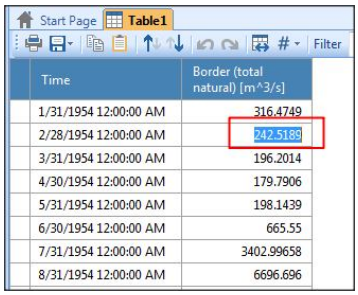


Figure 5: Editing values

The DSS also allows you to export data to ASCII, DSF0 (format used in Mike DHI products), and excel file formats. This is done using the 'To file' output tool from the Tools explorer.

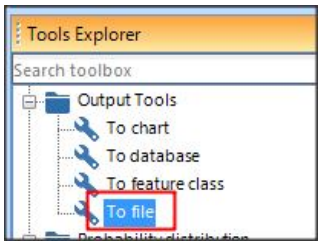
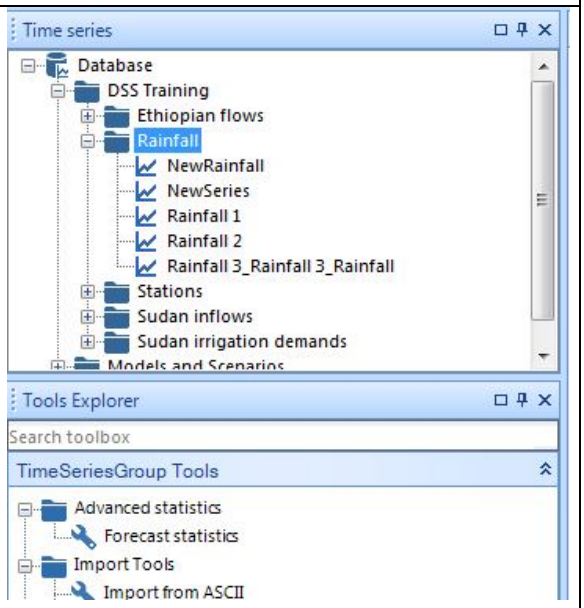
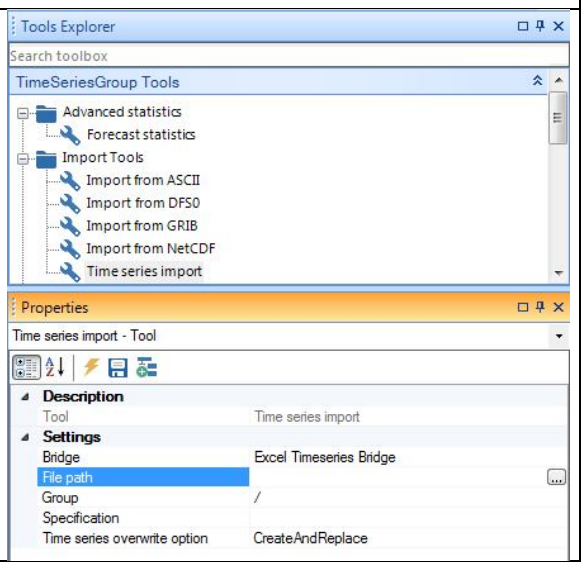


Figure 6: To file output tool

Exercises

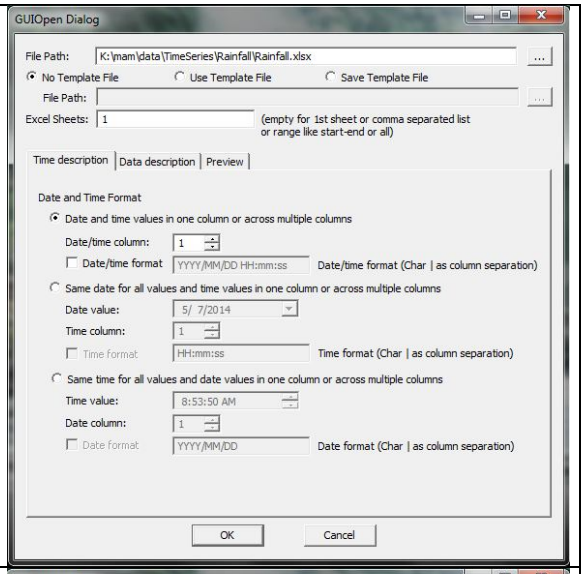
Importing Time Series into the DSS

- Import a single file with a generic format

1- Restore the 'Training' database from the **..\TimeSeriesExp\Data\Database** folder (See restoring a database section in the Database Manager Utility training module for more details).	
2- Within the Time Series explorer, Select either the 'Database' or a Group (e.g. Rainfall). Look for the 'Import Tools' within the Tools explorer and Select 'Time series import'.	
3- Once the 'Time series import' tool is selected, its properties appear in the 'Properties' explorer. First, select the file format or the 'Bridge' as shown next and then click the browse button (i.e. the ... button). For more information on the Excel format import see Annex 1.	

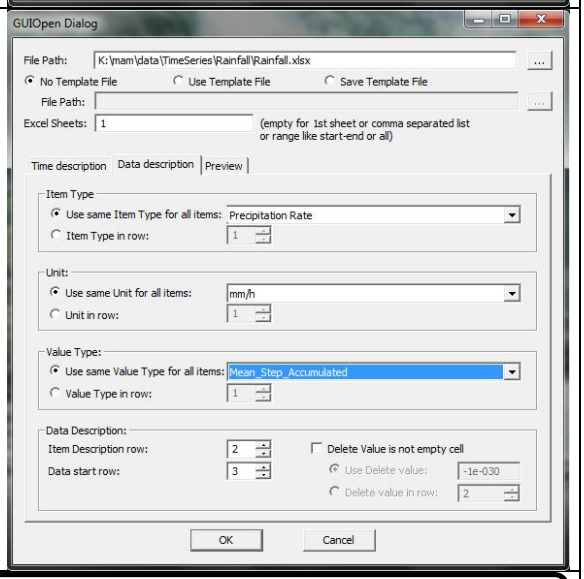
4- After clicking the ... button, the dialog box shown next appears. Set the file path by clicking the ... button next to the file path text box. Browse to the **..\TimeSeriesExp\Data\Rainfall** folder and select the Rainfall.xlsx file.

- The data to be imported is located in sheet number 1. For more details on the import dialog see Annex 2.



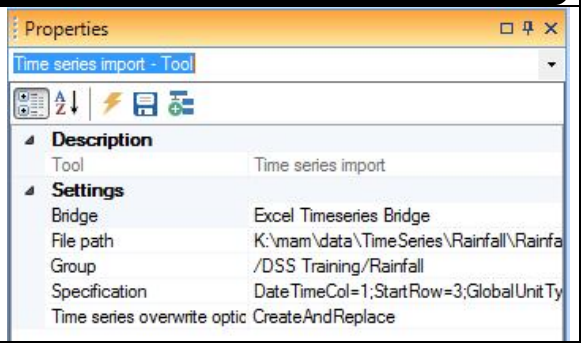
5- Move to the Data description tab and fill the data as below:

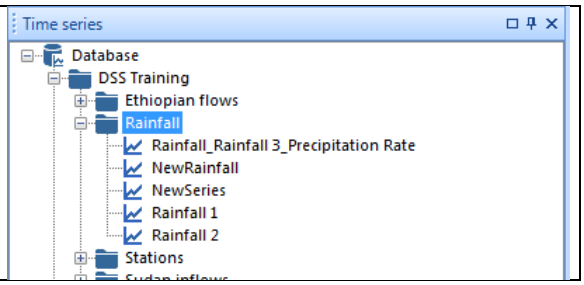
- **Item type** is 'Precipitation Rate'
- **Unit** is mm/h
- **Value type** is Mean_Step_Accumulated



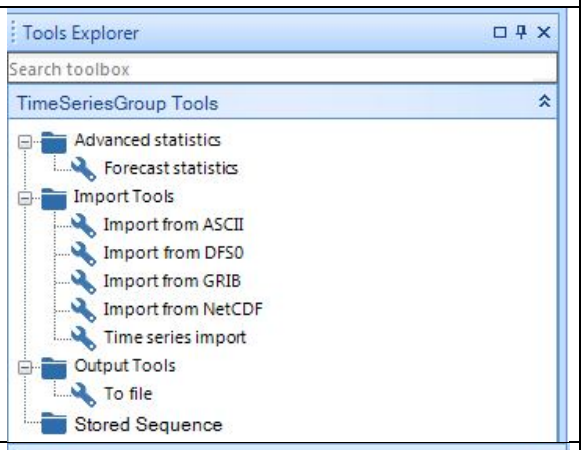
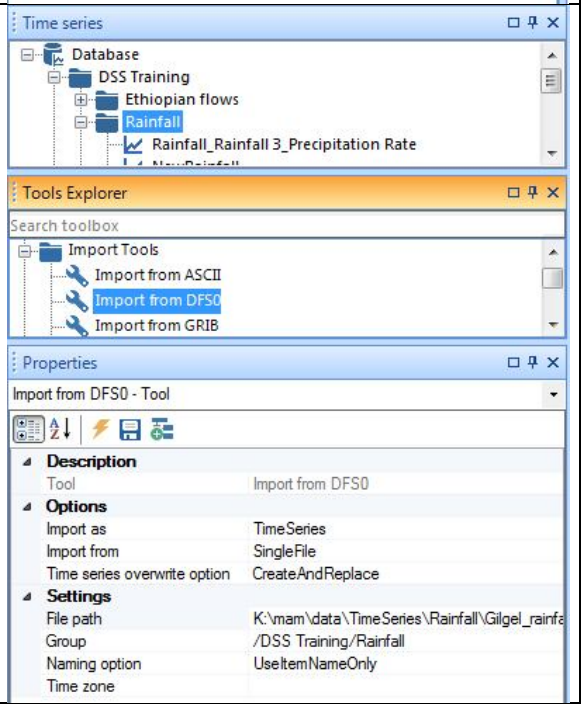
To see how the imported data looks move to the Preview tab. It is recommended to check whether the data is read correctly

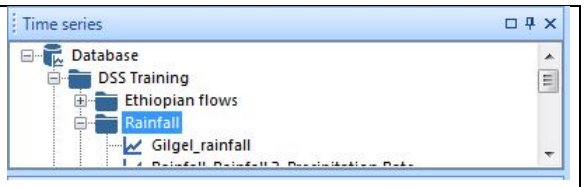
6- Click the OK button and get back to the 'Properties' explorer. Now you can notice that the 'File path' and 'Specification' fields are filled based on the above inputs.



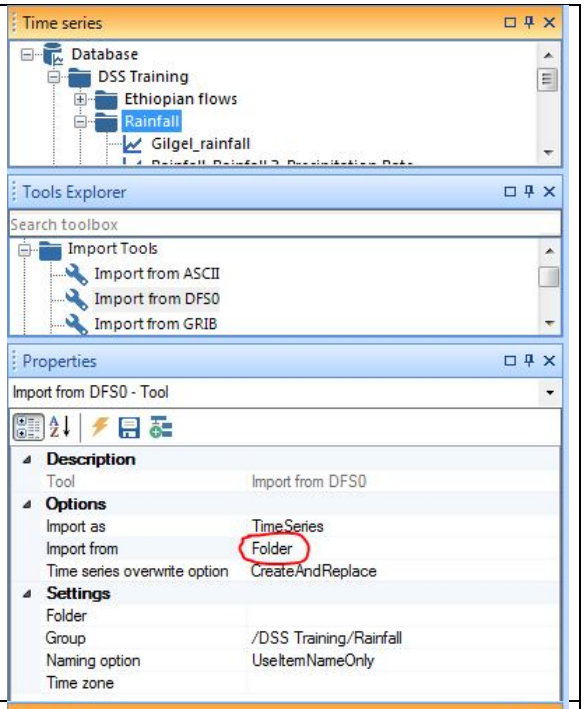
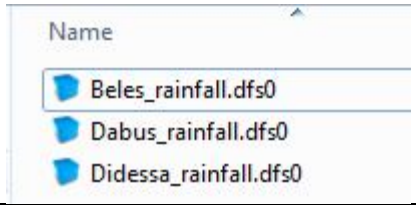
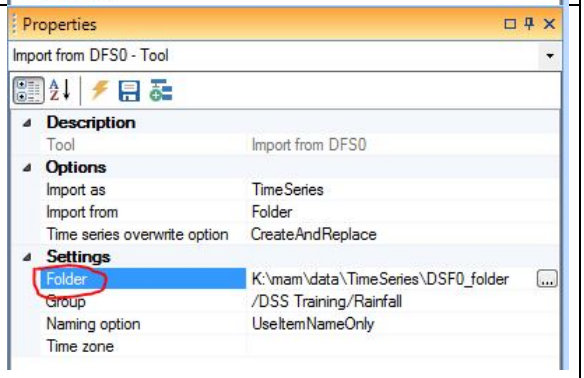
7- Click then the button to run the tool. The rainfall series has now been imported under the 'Rainfall' group (See Rainfall_Rainfall 3_Precipitation Rate).	

- Import a single file with a specific format

1- Within the Time Series explorer, Select either the 'Database' or a Group (e.g. Rainfall).	
2- Look for the ' Import Tools' within the Tools explorer. There are some other import tools for ASCII, DFS0, GRIB and NETCDF formats. For this exercise, Select 'Import from DFS0' tool.	
3- Once the 'Import from DFS0' tool is selected, its properties appear in the 'Properties' Explorer. First click the file path button (i.e. the ... button) to select the location of the file. - Set the file path by clicking the ... button next to the file path text box. Browse to the **..\TimeSeriesExp\Data\Rainfall** folder and select '**Gilgel_rainfall.dfs0**' file.	

4- Click then the  button to run the tool. The rainfall series has now been imported under the 'Rainfall' group (See Gilgel_rainfall).	

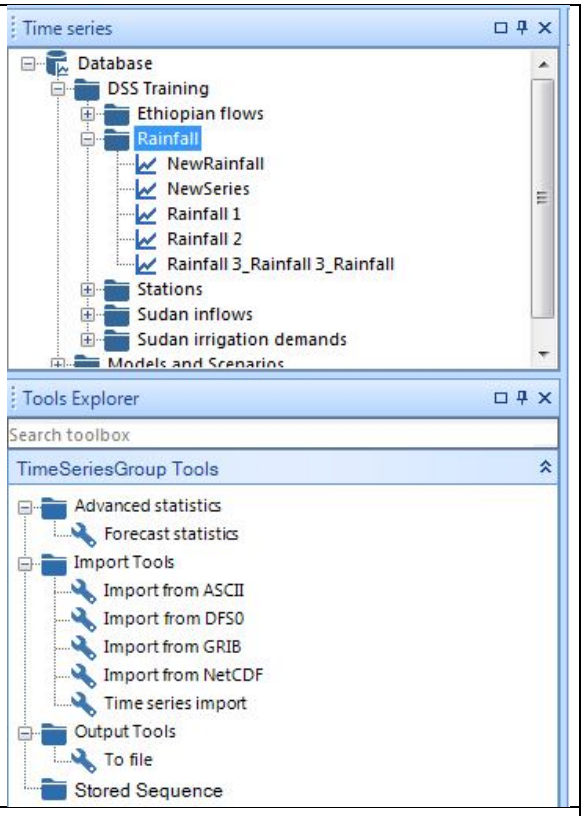
- Import multiple files with a specific format from a folder

1- In some cases your data files are many and exist in a folder and you need to import all of them into the DSS. This can be done using the 'Import Tools' for the ASCII, DFS0, GRIB and NETCDF data formats. In this exercise importing multiple DFS0 from a folder will be shown. Select either the 'Database' or a Group (e.g. Rainfall) and then select 'Import from DFS0' tool. Make sure in the 'Import from' field is 'Folder'.	
2- In the 'Folder' field click at the  button and select the folder location **..\TimeSeriesExp\Data\DSF0_folder.** This folders contains the following 3 DSF0 files: 	
3- Click then the  button to run the tool. The 3 DSF0 rainfall files have now been imported under the 'Rainfall' group.	

- Import multiple files with a specific format in batch mode

1- When you need to import data files that are many and not stored in one folder, it may be faster to provide the import settings in a text file (.csv), and then load them into the wizard, instead of manually entering them one by one.

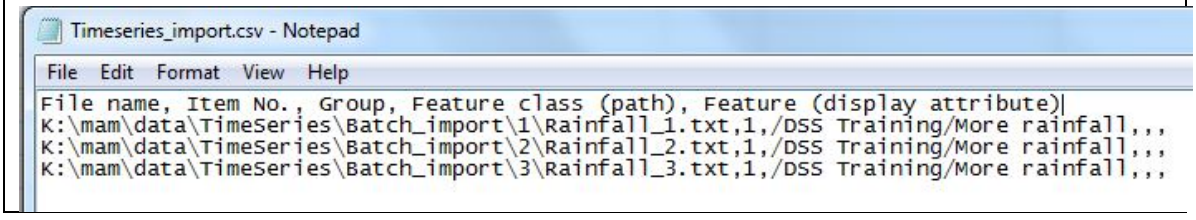
This exercise shows how this can be done. The specifications file is given in the Timeseries_batch_import.csv file that can be found at the **..\TimeSeriesExp\Data\Batch_import** folder.

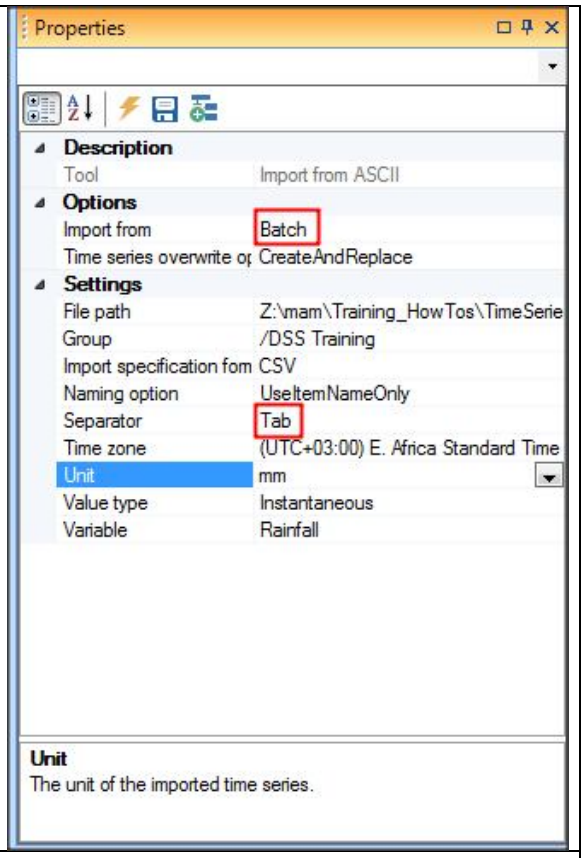


2- The specifications file is an ascii file (to be opened in Notepad) that looks as shown below. It has to contain as a minimum the following:

- File names with full path (required)
- Item number (optional)
- Group that the data will be imported into (with the DSS) (required)
- FeatureClass: full path of feature class (optional)
- Feature Name: Name of the associated feature (optional)

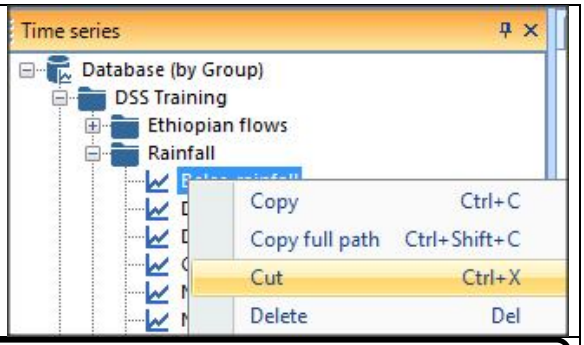
So based on the above files three ASCII files will be imported into a group called /DSS Training/More rainfall into the Time Series Explorer.



3- Select either the 'Database' or a Group (e.g. Rainfall) and under the Tools Explorer, select 'Import from ASCII' tool. Make sure in the 'Import from' field is 'Batch'. In the 'File path' field click on the ... button and select the Timeseries_import.csv file from the **..\TimeSeriesExp\Data\Batch_import** folder. In the 'Separator' field select 'Tab'. All fields in the property window must be filled as shown next. The group is to be read from the specifications file You will need to edit the paths in the specification file for the files as to reflect the absolute paths on your machine.	

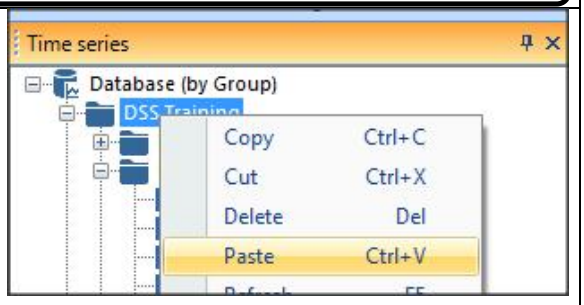
Moving a Time series

1- To move a time series, right click the time series and then click 'Cut'. You can alternatively select the time series and press the 'Ctrl+x' buttons on the key board.

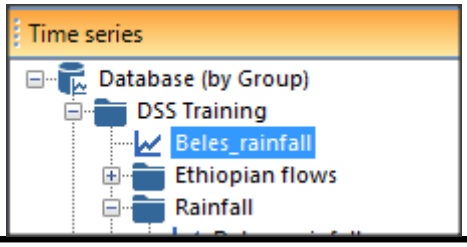


Drag and drop can also be used to move a time series. It can be applied to folders or multiple selections using the Ctrl+ and Shift keys while clicking.

2- Right click the group where the time series will be moved to and then click 'Paste'. You can alternatively select the time series and press the 'Ctrl+v' buttons on the keyboard



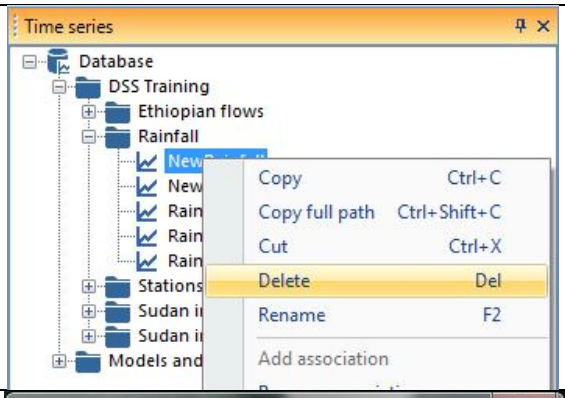
Time series has now been moved.



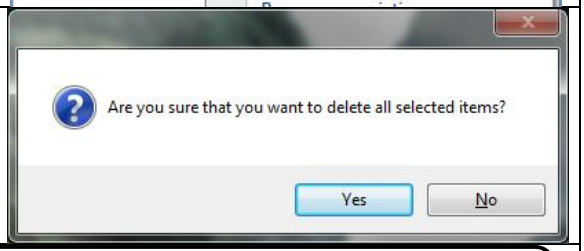
Time series data can also be copied using the 'Copy' command in the context menu. The properties of the new series can be viewed in the 'Properties' Explorer which can be activated from the View menu.

Removing (deleting) a Time series

1- To remove (delete) a time series, right click the time series and then click 'Delete'. You can alternatively select the time series and press the 'Del' button on the keyboard. The above can also be applied to multiple selections and to whole folders.



2- Confirm the message by clicking 'Yes' then the time series will be deleted



The delete operation is undoable. Once a time series is deleted, it cannot be recovered.

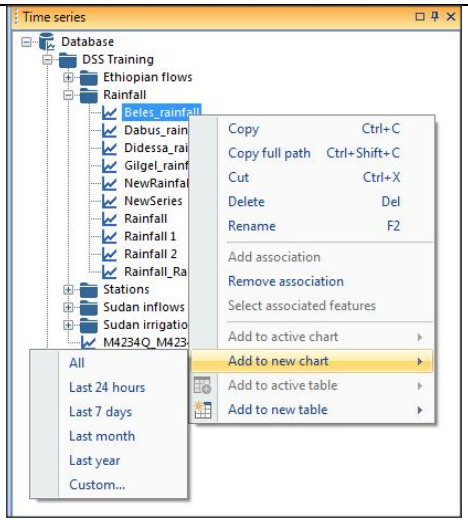
Viewing a time series data

Viewing data in a chart

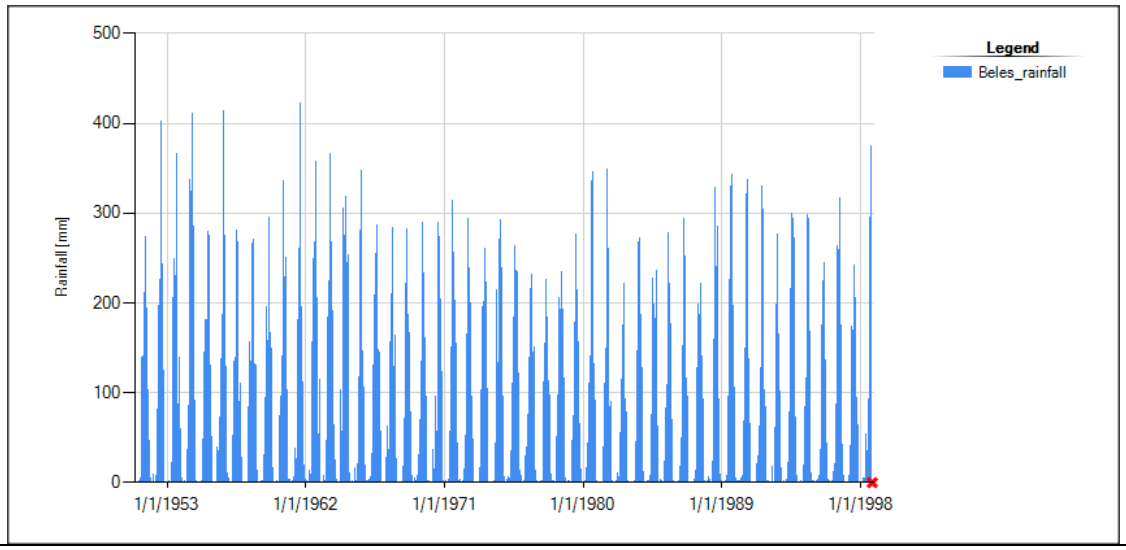
1- Right click the time series and then click ' Add to new chart ' option. Another menu will appear with the following options:

- **All**: all data is viewed
- **Last 24 hours, 7 days, month , year**: these show the data as specified
- **Custom**: allows the user to customize what the period to be viewed.

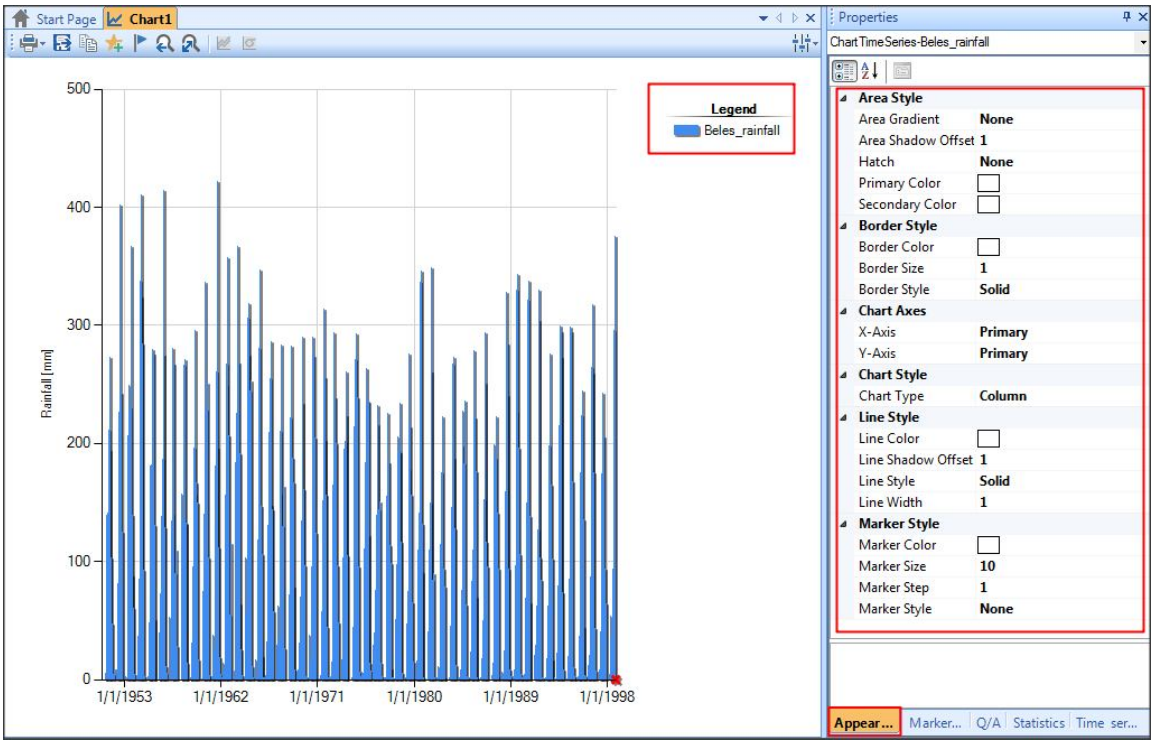
For this exercise, select 'All' to view all the data.



The selected time series is now added to a new chart as shown next. As can be noted in the figure below, there is a red tick mark at the end of the record. This red mark indicates that data is missing.



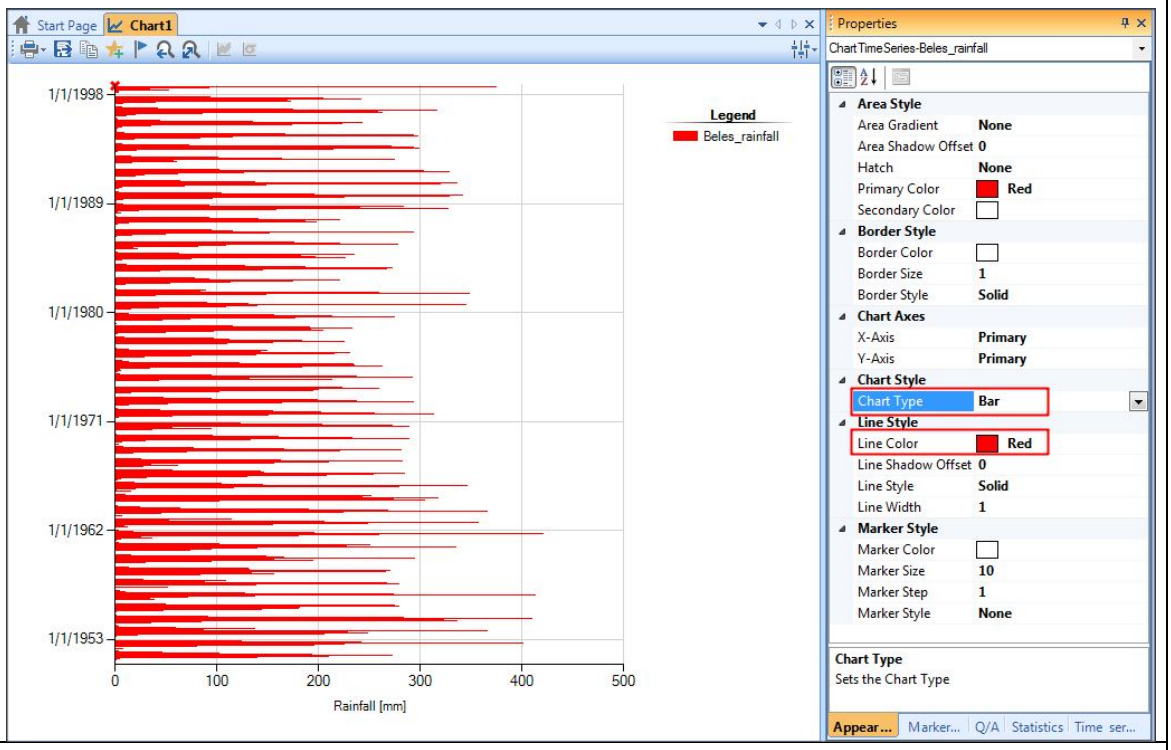
2- To edit the appearance of a chart series, click on a chart series in a legend area. This will make the properties of the chart series appear in the properties explorer as shown below. Note that the properties may have several tabs.



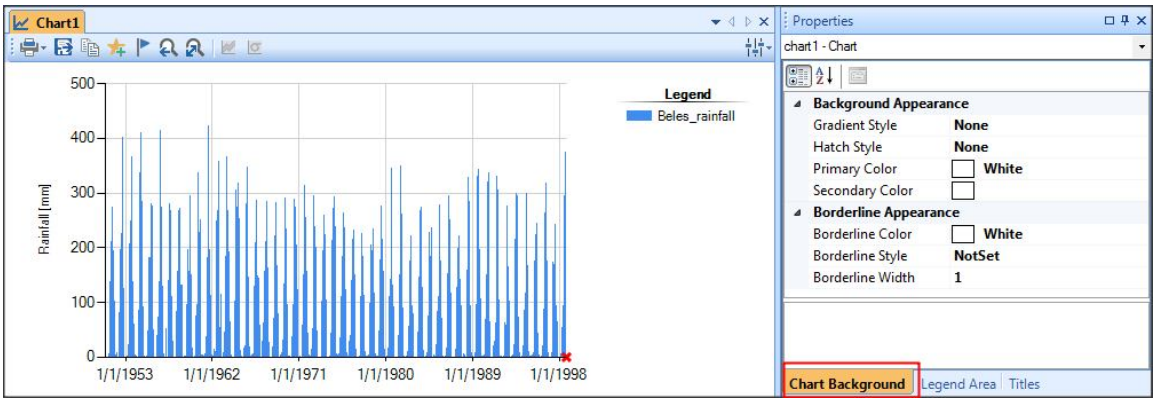
You can change the time series data color by changing the 'Line Color' under the 'Line Style' group. You can also change the chart type by changing the 'Chart Type' under the 'Chart Style' group. Use the arrow beside the group to expand/collabse the group.

The figure below shows the chart after changing the line color to 'Red' and the chart type to 'Bar'.

You are encouraged to explore the rest of the apearance optionesss

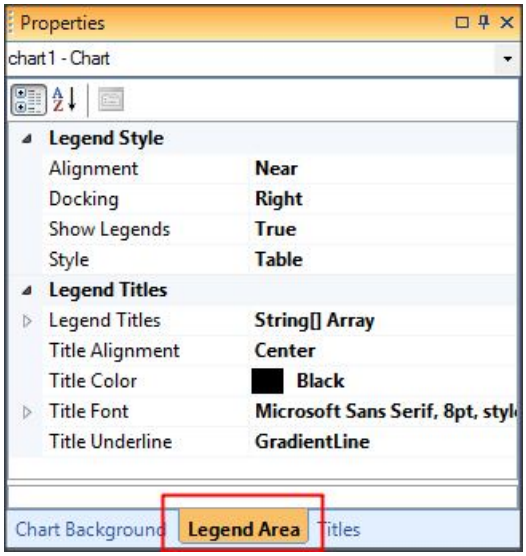


3- To edit the appearance of the chart area including the legend, click on a chart area. This will make the properties of the chart area appear in the property window as shown below.



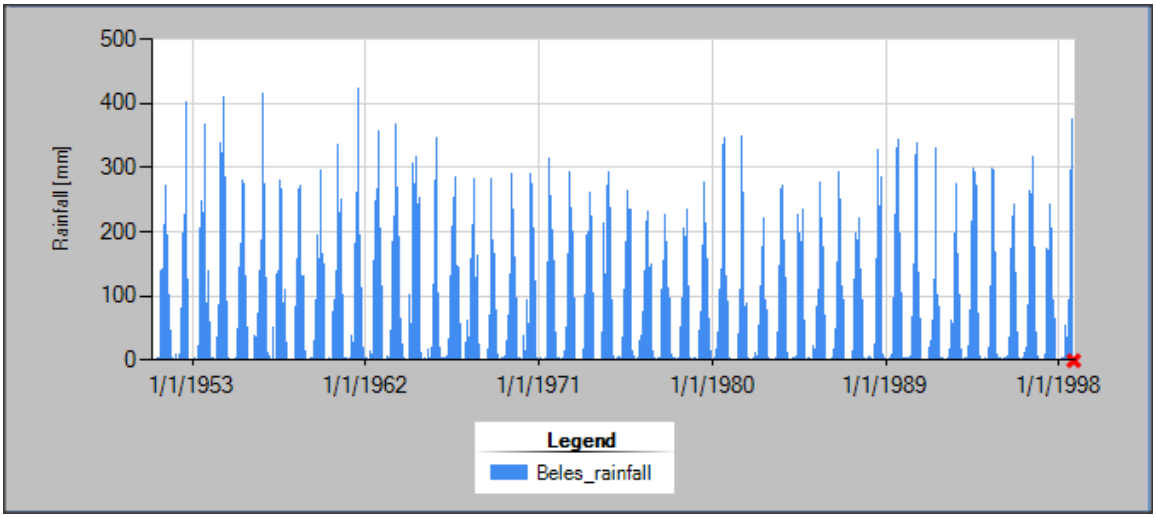
You can change the background color by changing the 'Primary Color' under the 'Background Appearance' group.

To edit the legend of the chart click on the 'Legend Area' Tab. Legend properties appears as shown below.



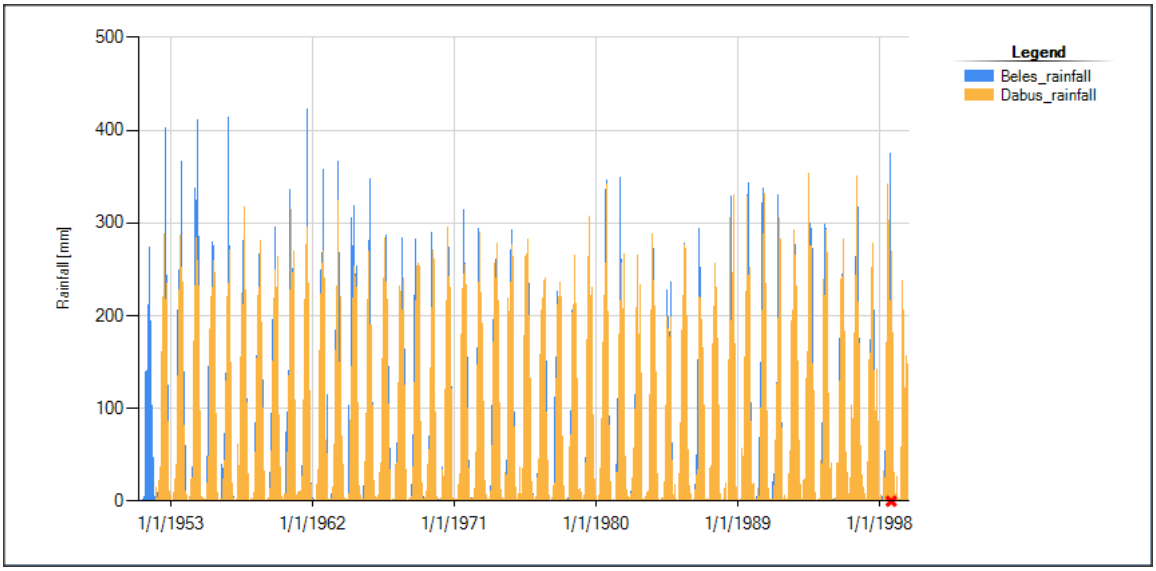
You can change the legend position and alignment by changing the 'Docking' and 'Alignment' options under the 'Legend Style' group.

The figure below shows the chart after changing the background color to 'Sliver' and the legend position and alignment to 'Bottom' and 'Center' respectively.

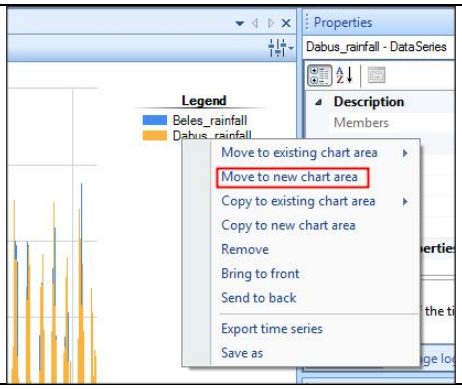


You are encouraged to explore the rest of the options to familiarize yourself with them.

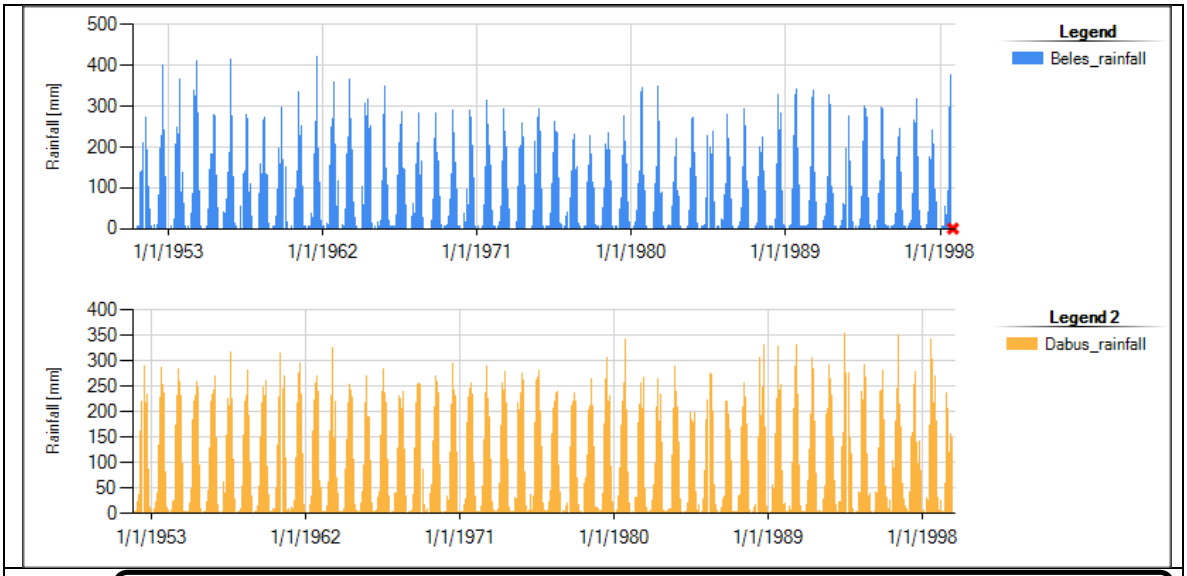
4- To add one more series to the chart, simply drag the series from the explorer to the chart area, and release (or alternatively, double click on the time series or right-click and select 'add to existing chart')



5- If charts are plotted in one area, they can be separated by right-clicking the legend and selecting 'Move to new chart area'.
You are encouraged to explore other options on the context menu (e.g. remove).



6- To add a time series to a new chart area inside an existing chart, drag the time series to the chart, but drop it somewhere outside the existing chart area. The series is added to a new chart area in the existing chart.



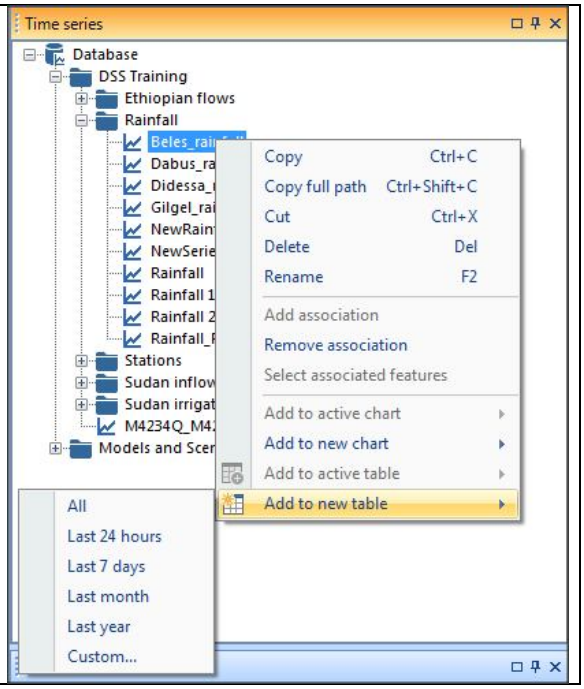
More than two time series can be added to an existing chart area for comparison either as a new chart or to the existing chart.

View data in a table

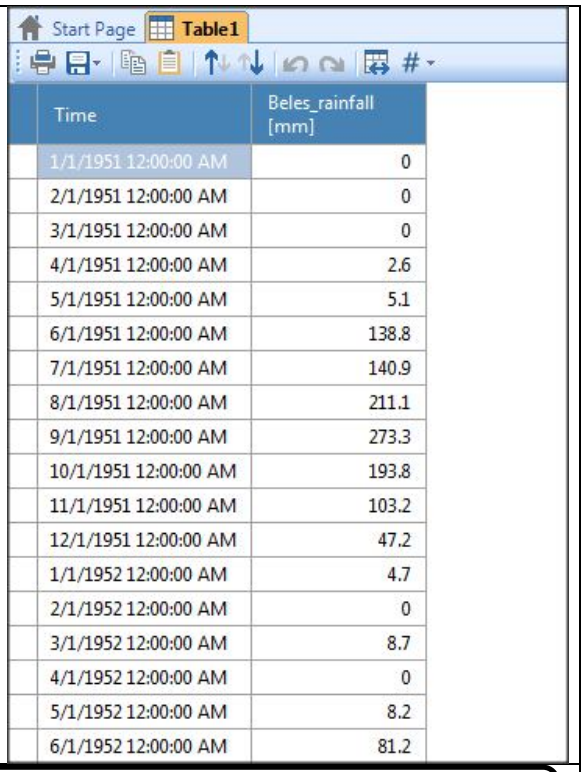
1- Right click the time series and then click Add to new table option. Another menu will appear with the following options:

- **All**: all data is viewed
- **Last 24 hours, 7 days, month , year**: these show the data as specified
- **Custom**: allows the user to customize what period to view.

For this exercise, select 'All' to view all the data.



2- The selected time series is now added to a new table as shown next.



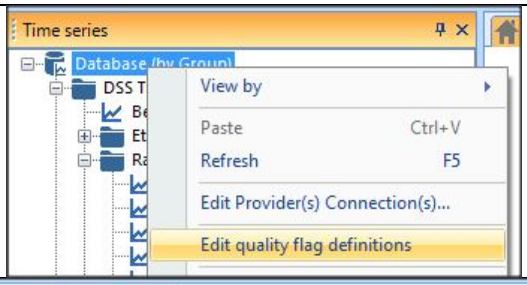
Time	Beles_rainfall [mm]
1/1/1951 12:00:00 AM	0
2/1/1951 12:00:00 AM	0
3/1/1951 12:00:00 AM	0
4/1/1951 12:00:00 AM	2.6
5/1/1951 12:00:00 AM	5.1
6/1/1951 12:00:00 AM	138.8
7/1/1951 12:00:00 AM	140.9
8/1/1951 12:00:00 AM	211.1
9/1/1951 12:00:00 AM	273.3
10/1/1951 12:00:00 AM	193.8
11/1/1951 12:00:00 AM	103.2
12/1/1951 12:00:00 AM	47.2
1/1/1952 12:00:00 AM	4.7
2/1/1952 12:00:00 AM	0
3/1/1952 12:00:00 AM	8.7
4/1/1952 12:00:00 AM	0
5/1/1952 12:00:00 AM	8.2
6/1/1952 12:00:00 AM	81.2

More than two time series of the same time step can be added to an existing table area for comparison using the Add to active table option.

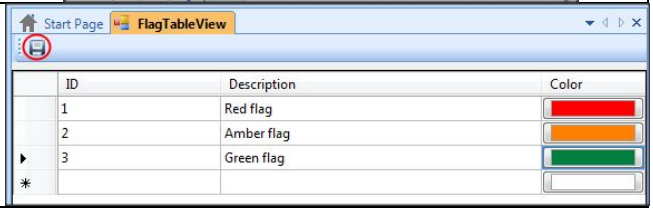
Using Time Series flags

Defining Time Series flags

1- To add a flag definition, right-click on the 'Database' group of the Time Series explorer and select “Edit quality flag definitions”.



2- Add a few flags as shown, and click the button. You may close the view.

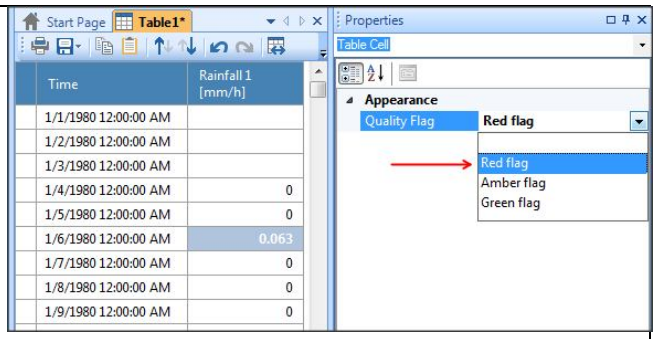


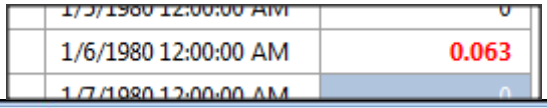
ID	Description	Color
1	Red flag	
2	Amber flag	
3	Green flag	

3- Open a time series in a table (See View data in a table).

Select a value cell, and assign it a flag in the properties window as shown.

When the flag is assigned, the cell value takes the color of the flag.

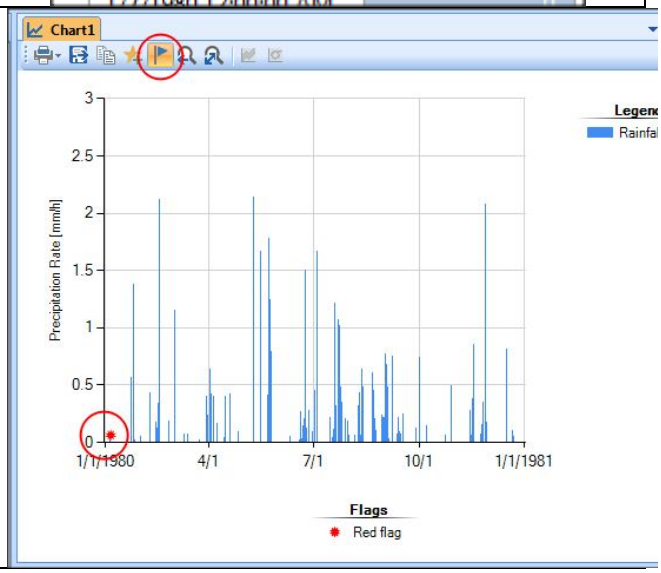




4- Save the changes using the button, and add the time series to a chart (See View data in a chart).

Make sure that display of flags is enabled (button).

The flagged values are now displayed in the chart.



Editing time series data

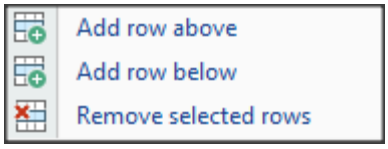
1- Table view (See view data in a table) allows the DSS user to:

- Edit the values directly in the grid

	Time	Beles_rainfall [mm]
	1/1/1951 12:00:00 AM	0
	2/1/1951 12:00:00 AM	0
	3/1/1951 12:00:00 AM	0

	Time	Beles_rainfall [mm]
	1/1/1951 12:00:00 AM	0.5
	2/1/1951 12:00:00 AM	2
	3/1/1951 12:00:00 AM	2.1
	4/1/1951 12:00:00 AM	2.6
	5/1/1951 12:00:00 AM	5.1

- Add or delete data rows from the row context menu (this menu appears when a row is selected and then the mouse is right clicked).

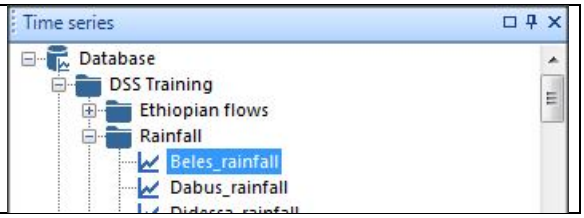


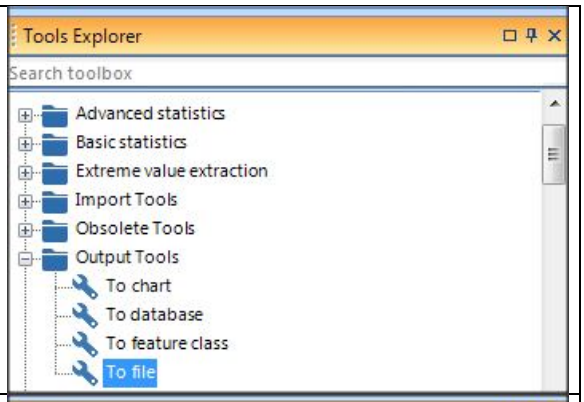
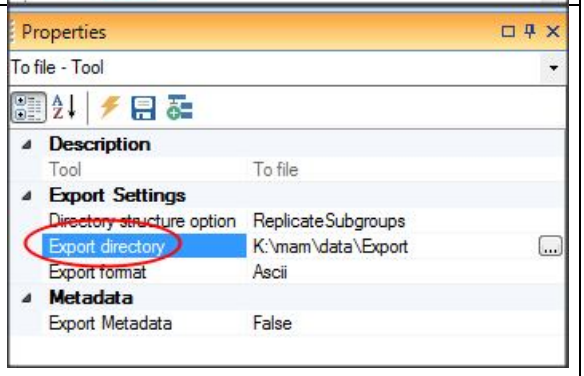
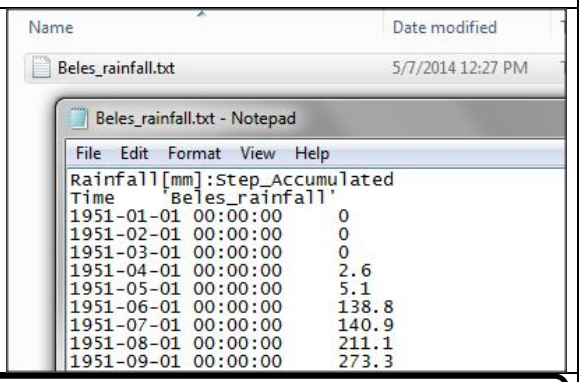
- When user completes the editing, changes are saved using either the save or save under the  button.

You are not encouraged to edit multiple Time Series data of different time step or length in the same table. Erroneous entries can cause undesirable change in Time Series data length or irregularities in the time step.

Exporting time series data

1- Within the Time Series explorer, Select what you need to export.



2- Look for the 'Output Tools' within the Tools explorer and Select 'To file'.	
3- Once the 'To file' tool is selected, its properties appear in the 'Properties' Explorer. First, click the 'Export directory button (i.e. the ... button) to select the location where the file will be exported. Leave 'Export format' as ASCII (or set it to ASCII if it is otherwise). Then click the ⚡ button to run the tool.	
4- Open the exported time series in Notepad or any other text editor and looks as shown next when exported.	

In the above exercise data was exported to ASCII format. The 'To file' tool can also export data to Excel and DSF0 formats.

Review Questions

1. List the main formats that the DSS can import from and export to.
2. What are time series quality flags? Give two examples of their use.
3. List 3 chart types that can be used to visualize time series.

4. Several time series with different time steps can be edited and saved in the same table
   - True
   - False
5. Which tool would you use to import many files that are in several folders?

Answers

1. The DSS can import from the ASCII, DSF0 (format used in Mike DHI products), GRIB, NETCDF and excel file formats and export to the ASCII, DSF0 and excel file formats.
2. Time series flags are used to mark individual time step values in a time series to indicate, for example, data quality issues associated with them such as missing or outlier values.
3. Chart types are:
    - Bar
    - Column
    - Line
4. True
5. Batch Import

2.4. Linking time series to GIS data

Introduction

This lesson introduces you to the concept of linking GIS feature data to time series data.

Topics covered in this lesson:

- Associating GIS feature data with time series data

Lesson objective:

After completing this lesson, you will be able to:

- Associate GIS feature data to time series data:

Lesson pre-requisites

You have to be familiar with the GIS vector data and Time series basics to take this lesson.

Time series and geospatial data

The representation of hydrologic or hydraulic phenomena in a Geographic Information System (GIS) requires the integration of geospatial data with time series data. Rainfall, stream flow, nutrient loading, and stage are examples of parameters that exhibit high spatial and temporal variability and, therefore, must be described with both spatial and temporal data. In the DSS, not only representation and visualization of geospatial hydrologic or hydraulic data in GIS is available but also linking temporal and geospatial data (i.e. Time Series can be linked or associated to feature data) where time series describes the traditional, non-spatial use of time series and feature data describes stationary features.

Associated time series can then be selected by clicking on a map (e.g. a station) as shown in Figure 7. This is a big advantage as data is directly linked therefore it can be viewed, processed and analyzed in relation to its spatial feature.

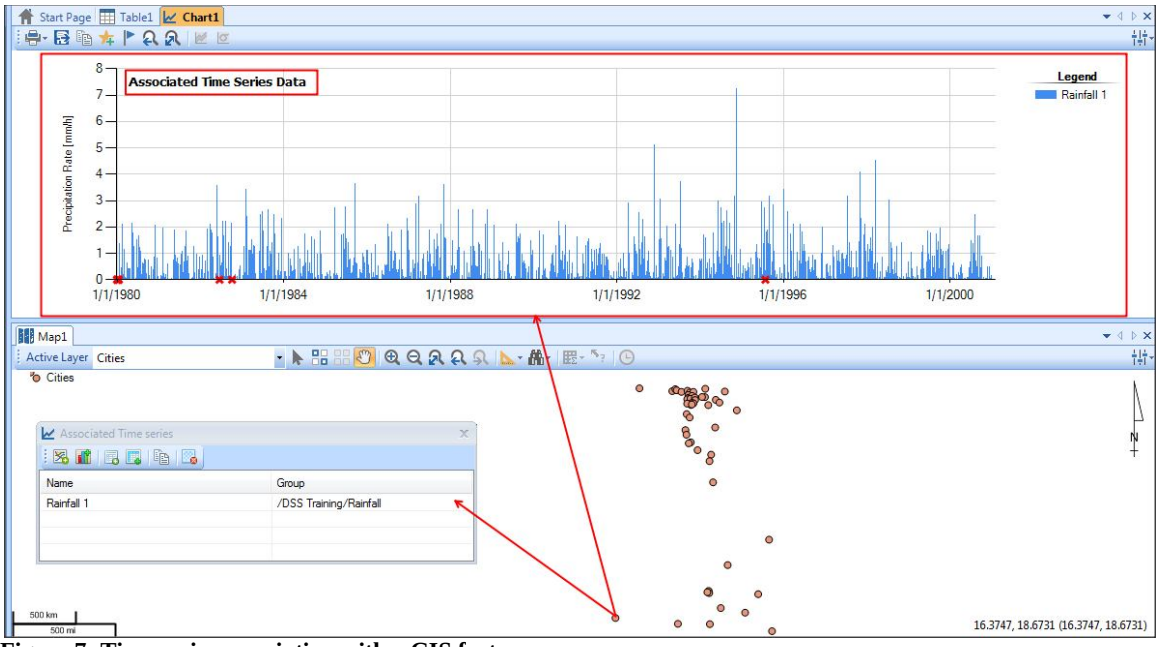


Figure 7: Time series association with a GIS feature

Associated Time series dialog toolbar

The toolbar within the 'Associated Time series' dialog (See bottom window in Figure 7) assist you in undertaking the following tasks on one or more selected time series:

 Add to a new chart

 Add to active chart

 Add to a new table

 Add to active table

 Copy to clipboard

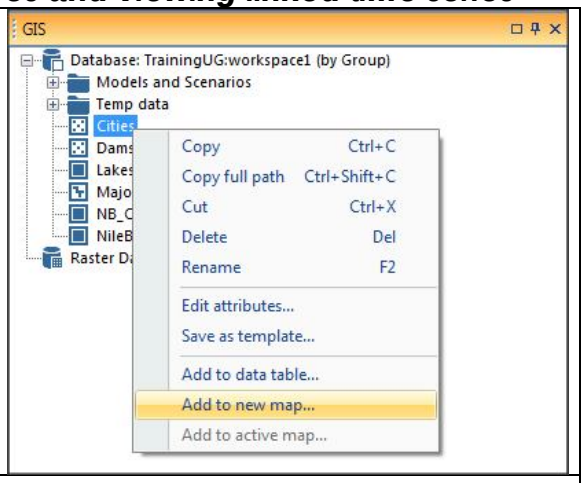
 Remove association

In the next sections linking time series data to GIS data is presented.

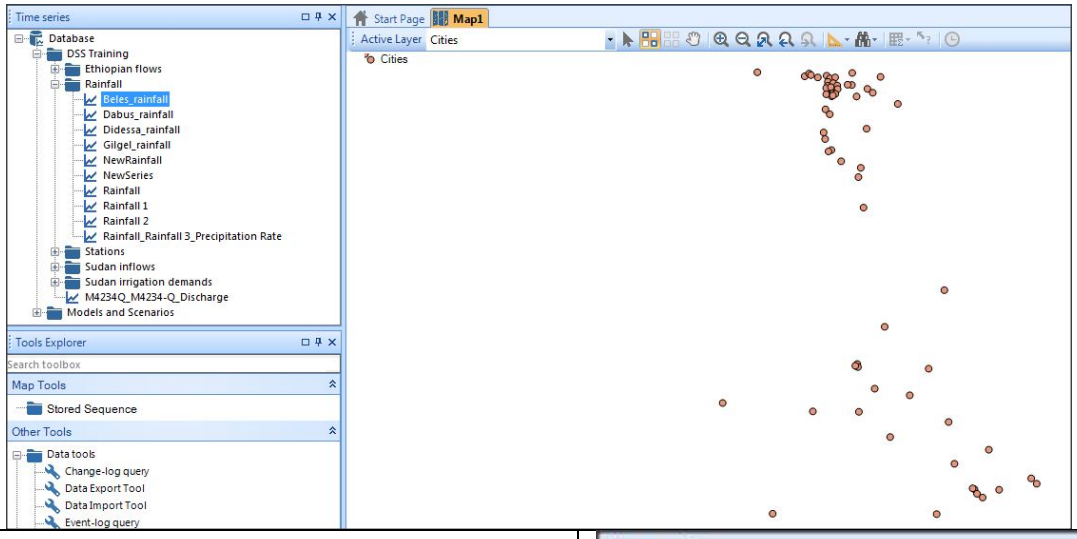
Exercises

Linking time series to geospatial features and viewing linked time series

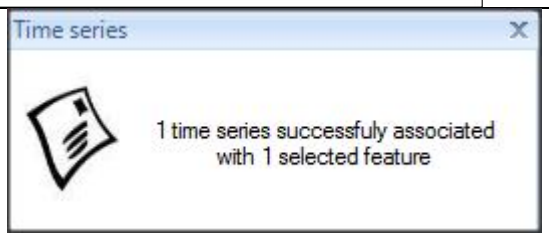
1- In the GIS Explorer, add the 'Cities' layer to a new map.

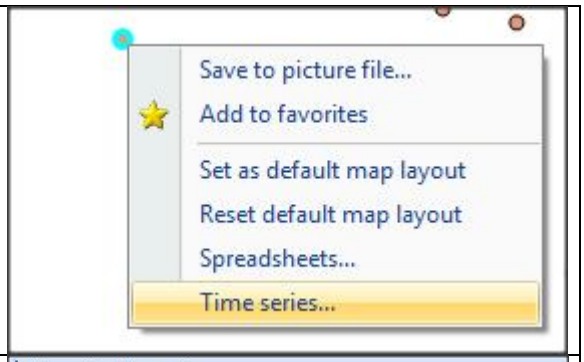
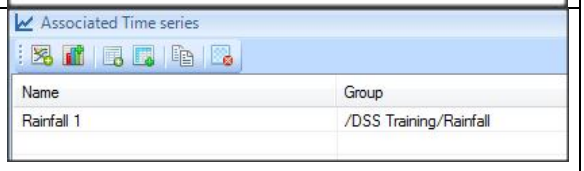


2- Navigate to the Time Series Explorer (you need to have the 'Cities' map view and the Time Series Explorer active at the same time as shown below).



3- Select a time series (e.g. Rainfall 1) and drag and drop it on a point on the map. The point will flash and you should be informed that you have created a spatial association.



4- To check which data series is linked to a GIS feature, select the feature and right click and select Time series... option.	
5- The dialog box shown next appears with all associated time series (Rainfall 1 in this case). You can directly view the time series in chart or table from this dialog	

More than one time series can selected and then dragged and dropped into a feature class to associate a number of time series to a feature class at once.

Review Questions

1. Give two examples of linking time series data to geospatial features
2. Only one time series can be linked to a GIS feature
   - True
   - False
3. Time series can be linked to raster data
   - True
   - False

Answers

1. Water levels or flow time series data to a gauge location and Rainfall data to a catchment.
2. False (More than one time series can be linked to a GIS feature)
3. False (Time series can only be linked to features – it will be difficult to designate a pixel to associate to)

2.5. Handling time series data changes and metadata

Introduction

This lesson introduces you to the handling of time series data changes and metadata within the DSS.

Topics covered in this lesson:

- Examining the change log entries for time series data
- Importing and editing time series metadata

Lesson objective:

After completing this lesson, you will be able to:

- Understand the change log entries for each time series data
- Handle time series metadata

Lesson pre-requisites

You have to be familiar with the Time Series basics to take this lesson.

Time series data changes and metadata

One of the main challenges to data users is to keep a log of the changes made to a data set and also save and keep its metadata updated. The DSS solves this problem though an innovative solution. When a time series data is added to the Time Series manager, The DSS monitors all operations that is carried out on this series noting the time and date of this operation, and who carried it out. For example, when a time series is added, an entry is added to the ‘Change log’ of this time series to show the time and date of adding this time series and also a description of the operation as shown in the below figure.

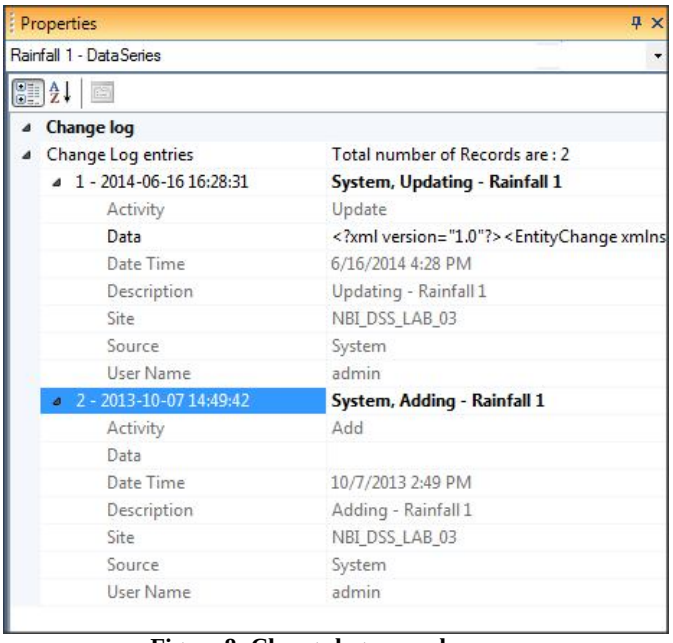


Figure 8: Change log example

Similarly, the DSS allows the users to import time series metadata through an xml schema. Once this schema is within the DSS, it is saved and linked to all time series where the metadata can be entered and updated by the users as needed.

To define the metadata properties an agreement on a common set of metadata properties has to be made. At a technical level the metadata properties must be expressed as an XML schema. An example of a simple schema is given below:

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema attributeFormDefault="unqualified" elementFormDefault="qualified"
xmlns:xs="http://www.w3.org/2001/XMLSchema">
<xs:element name="metadata" > <!--Root node -->
<xs:complexType>
<xs:sequence>
<xs:element name="identification" minOccurs="0" > <!--Category -->
<xs:complexType>
<xs:sequence>
<xs:element name="originator" type="xs:string" minOccurs="0" />
<xs:element name="publicationdate" type="xs:dateTime" minOccurs="0" />
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
```

The above simple schema defines one property, `identification`, which is optional (i.e. minoccurs=0) and consists of two (also optional) values, `originator` and `publicationdate`. The first is a string, while the latter is a date-time. Note in addition to 'string' and 'datetime' data types, 'decimal' types are also used. Data types of properties in such a schema should be kept to standard types as defined by `http://www.w3.org/2001/XMLSchema`

You are encouraged to read more about the xml schema in the 'Data Quality Assurance Guideline: Data Processing, Quality Assurance and Metadata' report that was published as part of the 'Data Compilation and Pilot Application of the Nile Basin Decision Support System (NB-DSS)' study (Water Resources Planning and Management project Work Package 2: Stage 2).

Free software is available and can help create/edit XML schemas. One such software is XMLFox which can be downloaded from http://www.xmlfox.com/. It shows the schema as a tree (Figure 9) and allows easy editing. It creates the XML tags automatically.

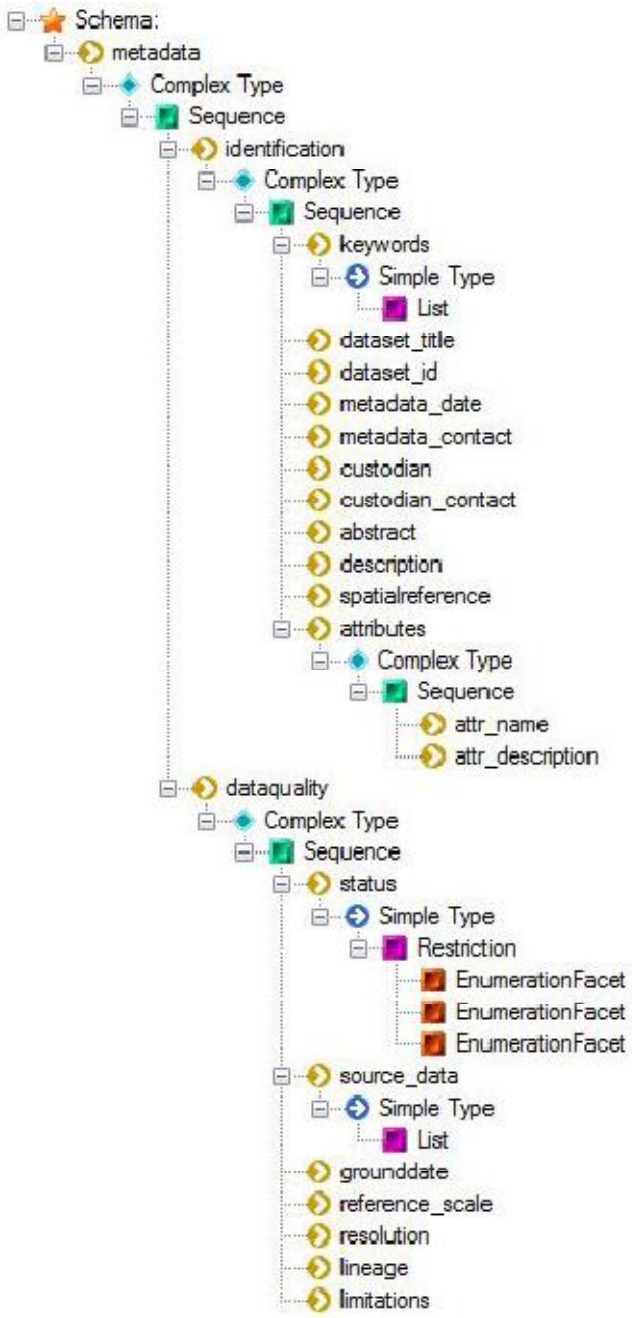
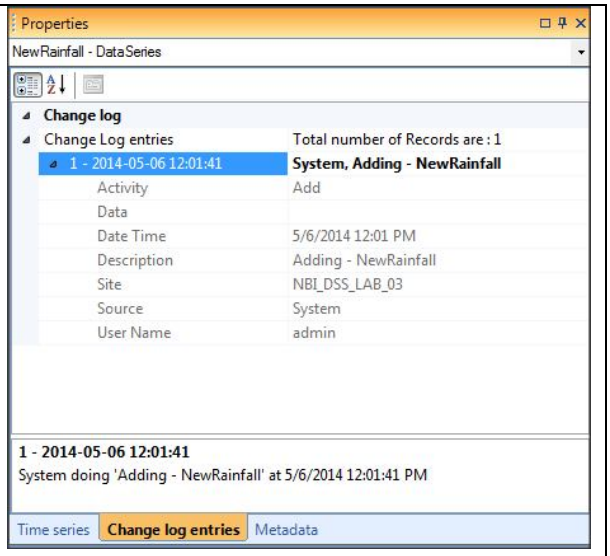
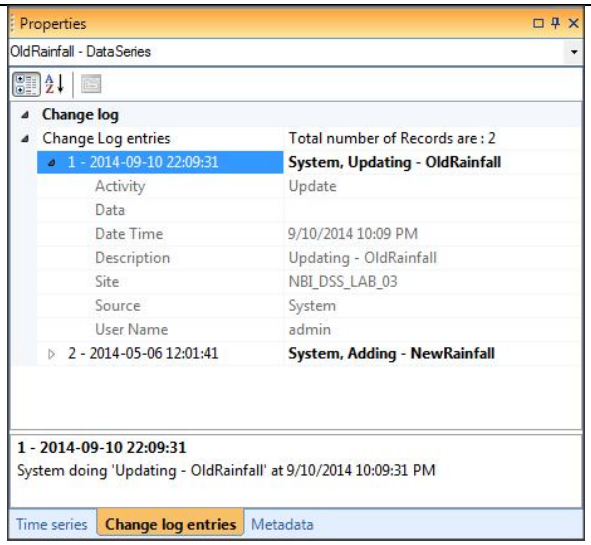


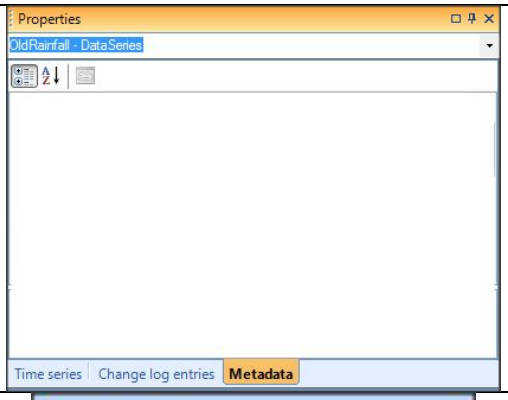
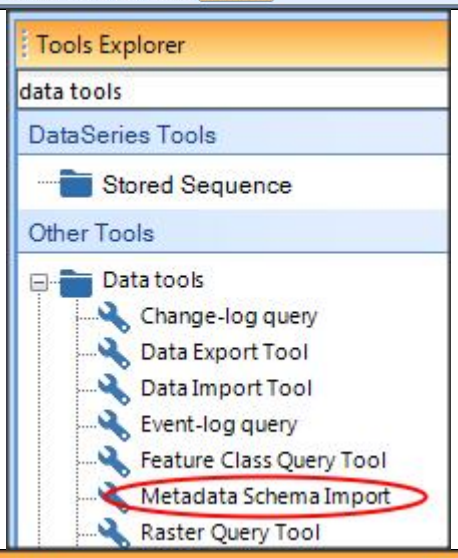
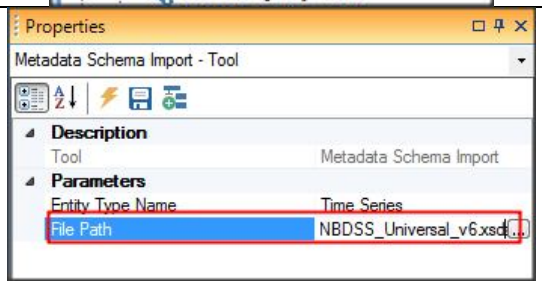
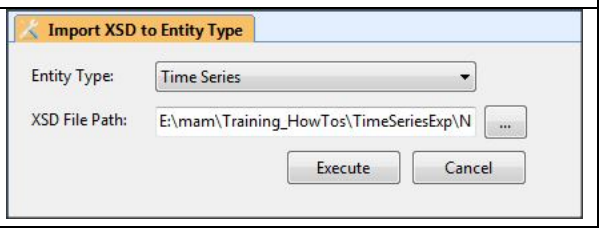
Figure 9 NB DSS Universal Metadata Schema in XMLFox

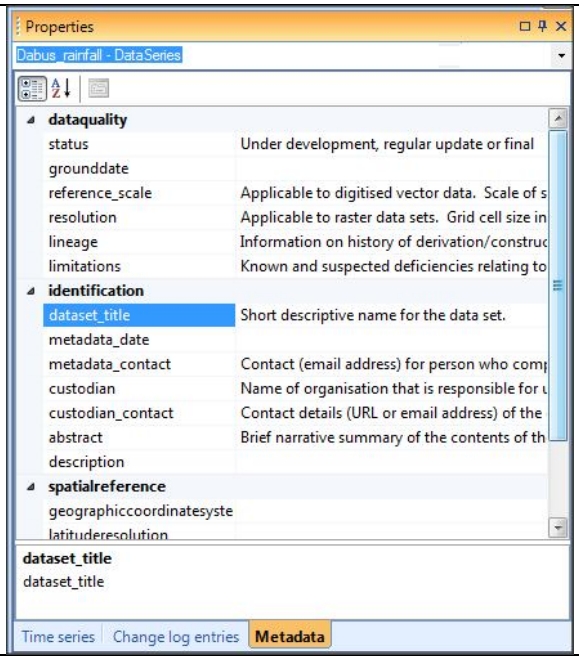
Exercises

Handling time series change Log

1- Repeat the steps carried out to import a single time series into the Time Series Manager (See Importing Time Series into the DSS for details). Give the time series a name such as 'NewRainfall' Check the 'Change log entries' tab after the import. You will notice that there is one entry in the change log. The entry shows that the time series was added to the database. Double click the entry to expand. You can see more details such as the activity type, date and time, User who carried out the activity.	
2- Rename the time series and check again the 'Change log entries' tab. What did you notice? Write down your observations. (Hint: compare what you see against the next figure).	
3- Edit the data (See editing time series data section for details), and save the changes. Check the Change log entries again	

Handling Metadata

1- Switch to the third tab of the time series properties called “metadata”. For the ‘OldRainfall’ data series no metadata fields exist.	
2- If metadata fields do not exist, a schema needs to be imported using the ‘Metadata Schema Import’ tool under the ‘Data tools’ category. To use the tool, select ‘Metadata Schema Import’ from the ‘Data tools’ category.	
3- Once the tool is selected, its properties appear in the ‘Properties’ window. Two parameters need to be entered for this tool. The first is the DSS entity type to which the template should be applied (i.e. Time Series in this case’) and the second is the ‘File Path’ to the metadata schema file. Select the **'NBDSS_Universal_v6.xsd'** file that is located in the **'..\TimeSeriesExp\Data\metadata'** folder.	
4- Click the  button. The next dialog box appears. Confirm that both entity type and XSD file path are correct and then click the Execute button.	

5- The metadata are imported into the 'Meta data' tab. Select a time series and go to the metadata tab to familiarize yourself with the content, the template contains descriptions of the various fields. You can start entering metadata for any time series.	

Review Questions

1. Explain how time series metadata is imported and maintained with the DSS.
2. The DSS keeps track of all the operations made on a time series.
   - True
   - False
3. How can a user customize metadata for time series that are specific to a study?

Answers

1. The DSS allows the users to import time series metadata through an xml schema using the ‘Metadata Schema Import’ tool. Once this schema is within the DSS, it is saved and linked to the time series. Metadata can also be entered and updated directly by the users as needed.
2. True
3. A user can edit the metadata schema (using XMLFox or any other tool) and modify or add fields as required then import the schema into the DSS.

2.6. Time Series Calculation and Processing Tools

The DSS includes various tools to process, analyze and extract time series data. These tools are divided into the following categories (See the Time Series Manager Tools section for details):

- Basic statistics
- Advanced statistics
- Extreme value extraction
- Time series processing
- Probability distribution

In this lesson, a number of the time series calculation and processing tools under the 'Basic statistics' and 'Time series processing' categories are presented.

Topics covered in this lesson:

- Carrying out simple calculations on a Time Series such as calculation of the average
- Applying time processing tools on time series data such as the resample tool.

Lesson objective:

After completing this lesson, you will be able to:

- Carrying out simple calculations on a Time Series such as calculation of the average
- Process time series data using the data processing tools within the DSS.

Lesson pre-requisites

You have to be familiar with the Time Series Manager Basics and time series data handling and visualization to take this lesson.

Time series simple calculations

It is quite often needed to undertake simple calculations on a time series such as simple statistics (e.g. Average). This can also be done within the DSS using the 'Tools' Explorer. Tools under the 'Basic statistics' category allows the user to undertake a number of simple calculations on time series such as average,

minimum, maximum, count and standard deviation. For more details on this and a list of all available tools see the Time Series Manager Tools section.

Time series processing

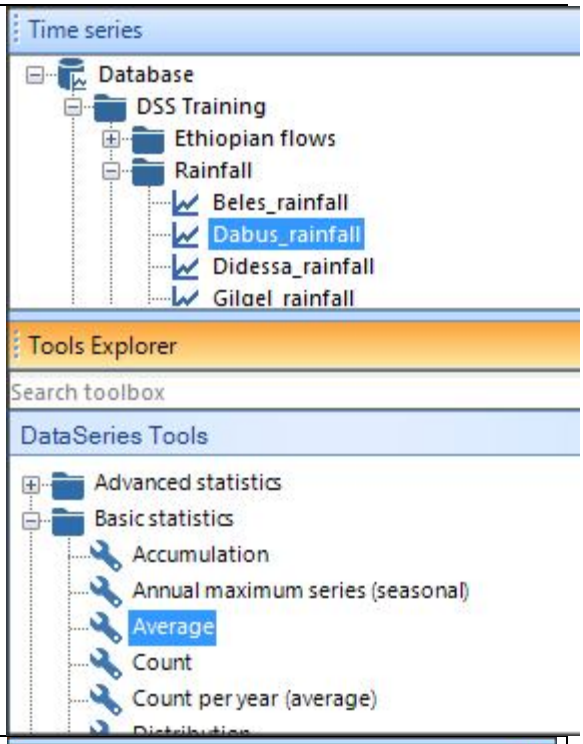
Common time series data processing operations can be undertaken within the DSS. For a full of list see the Time Series Manager Tools section. The following tools are presented in the exercises section:

- Resample tool: is used to change the time step of a time series into a user specified time step. It is possible to resample into larger or smaller time steps.
- Moving Average tool: is used to calculate the moving average which is the average value of the variable over a specific number of preceding periods. It provides trend information that a simple average of all historical data would mask.
- Extract time period tool: is used to extract a specified period from the input time series.
- Value type conversion tool: is used to convert a time series value type from one type to another (See the General lesson for details).

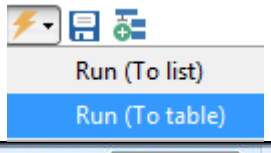
Exercises

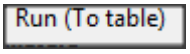
Carrying out simple calculations on a Time Series

1- In this exercise, you will calculate the average of a rainfall time series. Select a rainfall time series (e.g. Dabus_rainfall). In the Tools Explorer click on the 'Average' tool under the 'Basic statistics' category to select it.

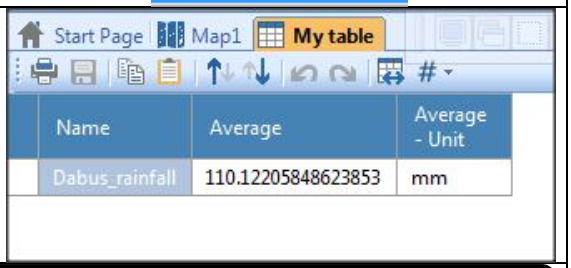


2- Once the 'Average' tool is selected, its properties appear in the 'Properties' Explorer.



3- Click on the  button and then the 

option. The tool produces the average in a table as shown next.

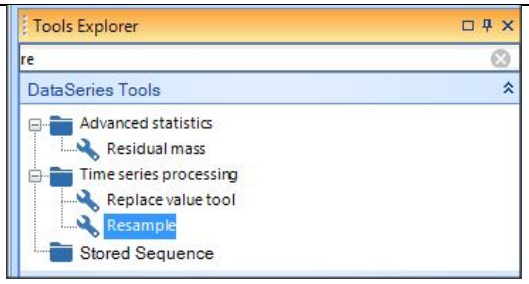


Other basic statistics such as count, minimum, maximum and sum can be calculated in the same way as the 'Average' tool. Those tools can also be applied to a number of time series simultaneously.

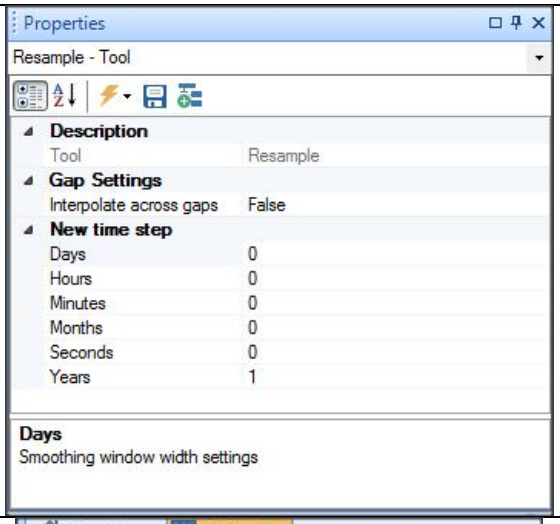
Time series processing

Resampling a time series

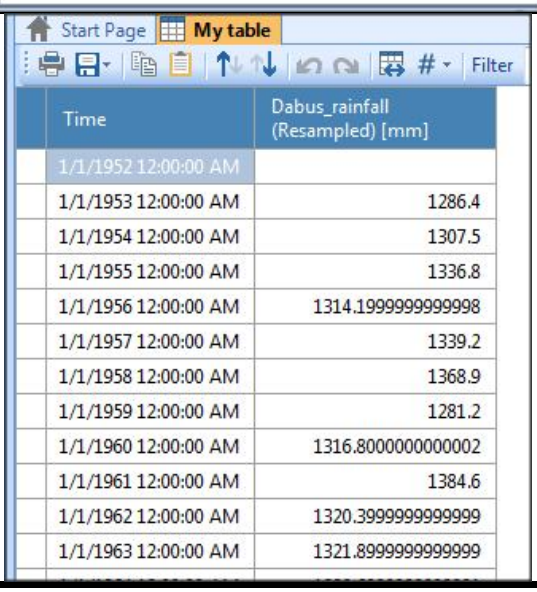
1- In this exercise, you will resample a rainfall time series from monthly to yearly time step. Select a rainfall time series (e.g. Dabus_rainfall). In the Tools Explorer click on the 'Resample' tool under the 'Time series processing' category.



2- Once the ' Resample' tool is selected, its properties appear in the 'Properties' Explorer. In the 'New time step' parameter, set all values to 'zero' except 'Year to 'one'.



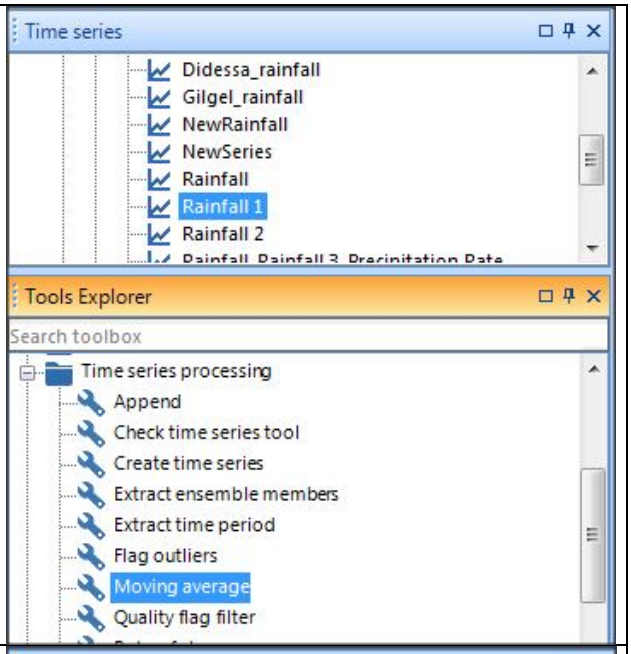
3- Click on the button and then the Run (To timeseries table) option. The tool produces the resampled time series in a table as shown next.



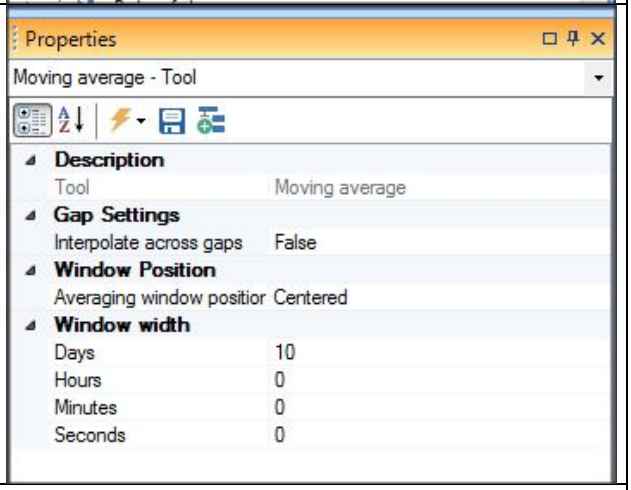
The output of the time processing tools can also be to a chart using the Run (To chart) option.

Calculating moving average

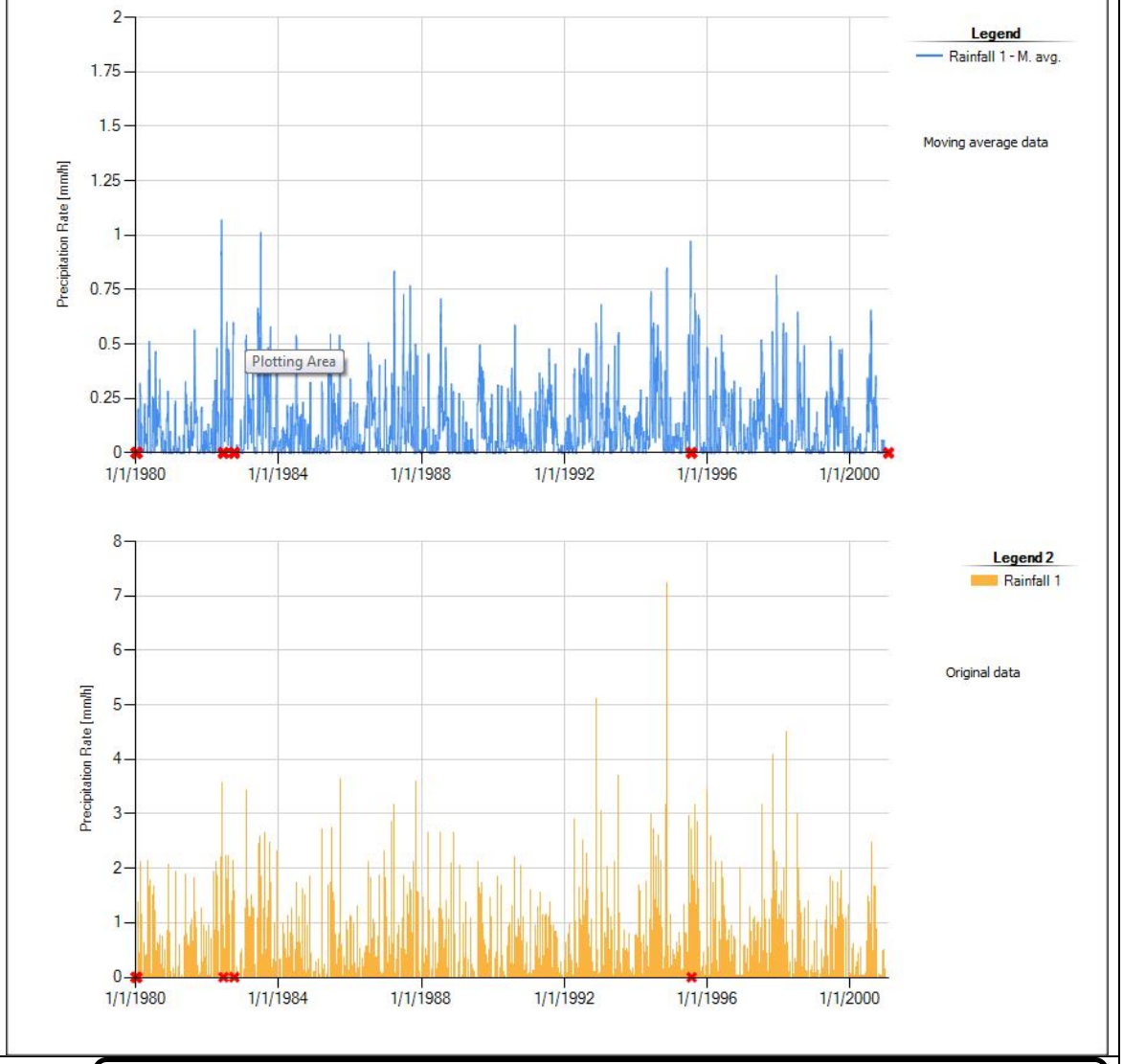
1- In this exercise we will calculate the moving average of a rainfall time series. Select a rainfall time series (e.g. Rainfall 1 – which has a daily time step). In the Tools Explorer click on the 'Moving average' tool under the 'Time series processing' category.



2- Once the 'Moving average' tool is selected, its properties appear in the 'Properties' Explorer. Fill the moving average 'Window width'. In this case since the data is daily, we will calculate the moving average based on a 10 days window, i.e. the moving average will be calculated using a 10 day window



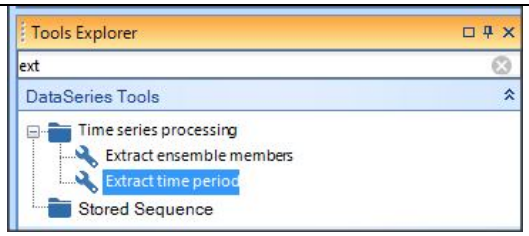
3- Click on the  button and then the Run (To chart) option. The tool produces the moving average in a chart as shown below (original data was also added at the bottom for comparison).



The moving average tool cannot be applied on time series of value types 'Accumulated' and 'Step Accumulated'. Trying to do so will produce an error message.

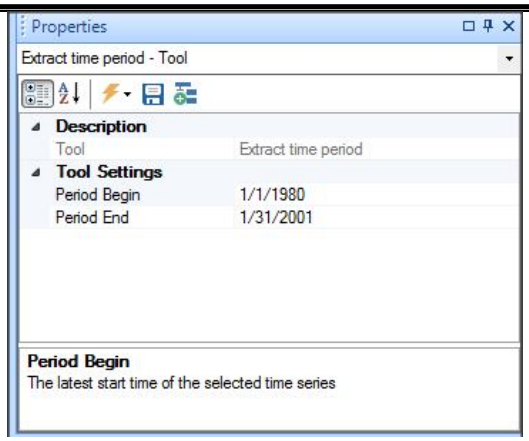
Extracting subsets from a Time Series

1- In this exercise, you will extract a time period from a rainfall time series. Select a rainfall time series (e.g. Rainfall 1). In the Tools Explorer click on the 'Extract time period' tool under the 'Time series processing' category.

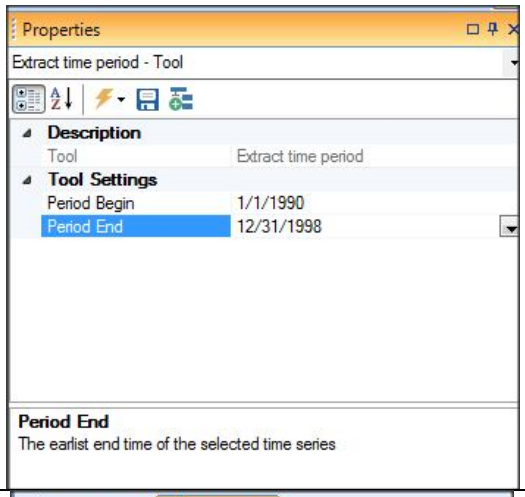


To quickly find a tool, type the first two or 3 letters of its title in the Tools explorer search bar. This makes the explorer to show those tools that start with those letters so you easily pick the tool you look for.

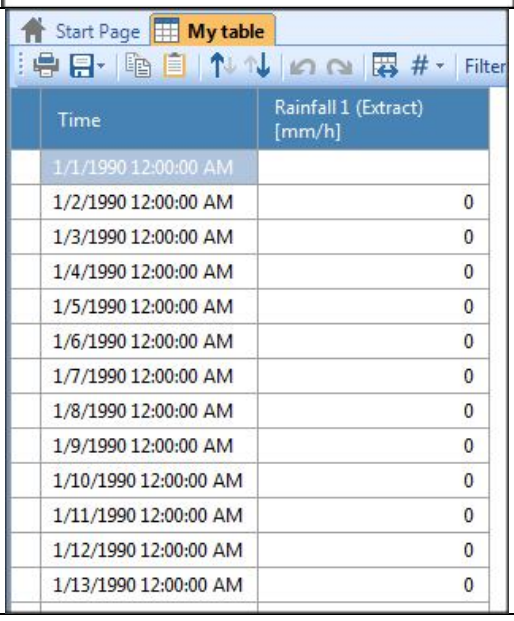
2- Once the 'Extract time period' tool is selected, its properties appear in the 'Properties' Explorer. In the 'Tool Settings', the full period is initially populated in the 'Period Begin' and 'Period End' fields.



Change them to 1/1/1990 and 12/31/1998 respectively.

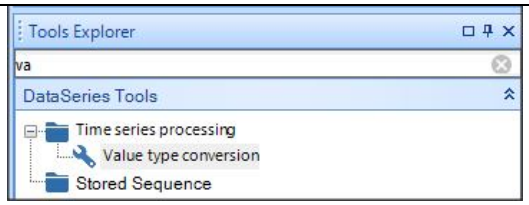


3- Click on the button and then the Run (To timeseries table) option. The tool produces the subset time series in a table as shown next. The subset time series can be saved using the button.

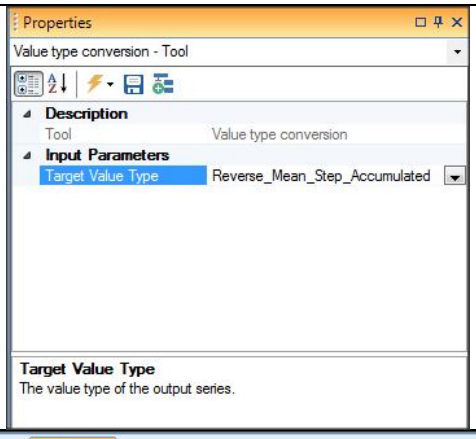


Making a value type conversion

1- In this exercise we will convert a time series value type from 'Mean_Step_Accumulated' to 'Reverse_Mean_Step_Accumulated'. Select a rainfall time series (e.g. Rainfall 1). In the Tools Explorer click on the 'Value type conversion' tool under the 'Time series processing' category.

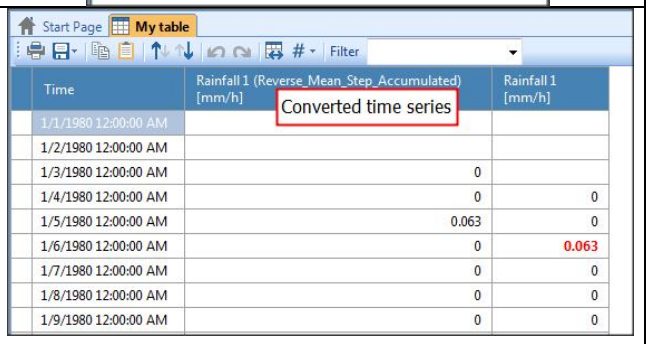


2- Once the 'Time series processing' tool is selected, its properties appear in the 'Properties' Explorer. In the 'Input parameters', the value type is initially populated with 'Instantaneous'. Change this to 'Reverse_Mean_Step_Accumulated'.



3- Click on the  button and then the Run (To timeseries table) option. The tool produces the updated time series in a table as shown next.

Original time series has been added manually next to the converted data to see the difference between the original and converted time series.



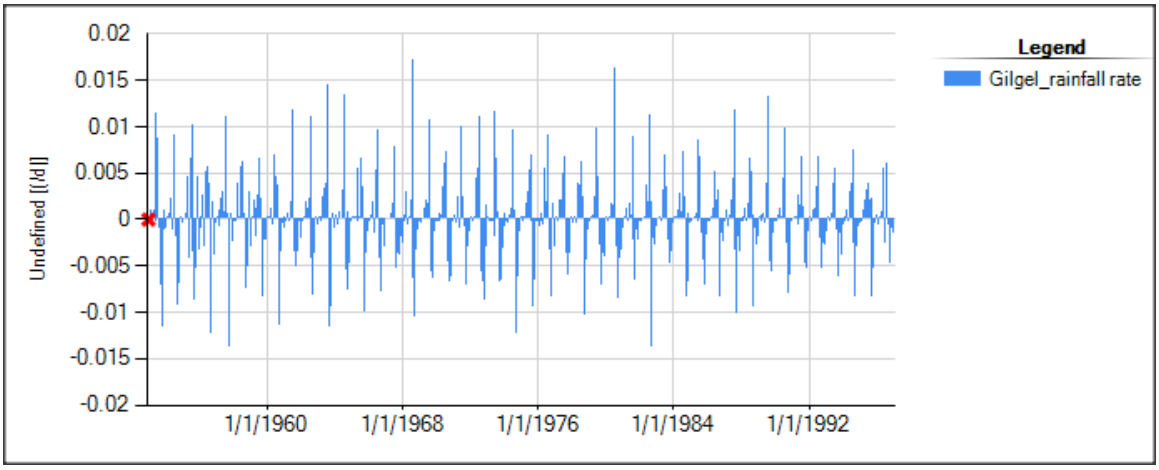
The method described above is the right way to change the value type. Changing it through the Properties window is incorrect.

Review Questions

1. Calculate the minimum and the maximum values of the ' Dabus_rainfall' time series.
2. The resample tool can only resample data to larger time steps
   - True
   - False
3. Define the moving average.
4. Plot the daily 'Rate of change' of the 'Gilgel_rainfall' time series. (hint: use the rate of change tool)

Answers

1. The minimum is 0.0 mm and the maximum is 352.8 mm.
2. False.
3. The moving average is the average value of the variable over a specific number of preceding periods (i.e. time steps). This calculation is repeated for all time steps resulting in a new time series.It highlights trend and long-term cycles in the series by smoothing short-term fluctuations of the data.
4. The daily rate of change plot is shown below.



2.7. Time Series Data Analysis Tools

Introduction

The DSS includes various tools to analyze time series data. These are mainly under the tools of the following categories:

- Advanced statistics
- Extreme value extraction
- Probability distribution
-

In this lesson, a number of the time series data analysis tools under those categories are presented. For more details on this and a list of all available tools see the Time Series Manager Tools section

Topics covered in this lesson:

- Producing a duration curve
- Fitting time series data to probability distribution
- Applying Mann Kendall test on a time series
- Calculation of the cross correlation between two time series

Lesson objective:

After completing this lesson, you will be able to:

- Produce duration curves for time series data.
- Fit time series data to a probability distribution.
- Apply Mann Kendall test on a time series.
- Calculate the cross correlation between two time series.

Lesson pre-requisites

You have to be familiar with the Time Series Manager Basics and time series data handling and visualization to take this lesson.

Advanced calculations on Time Series

More advanced calculations can be performed on a time series in the DSS. These can, for example, be:

- Calculation of a duration curve which shows the range of data values found in the time series as a function of the exceedence probability. An exceedence probability of one means that the value is exceeded at all times and a value of zero indicates that the value is not exceeded in the time span covered by the time series.
- Fitting a probability distribution to the data,
- Performing a Mann Kendall test which is used for testing the existence of a trend in a time series.

  In the exercise section, carrying out those calculations on a time series in the DSS is presented.

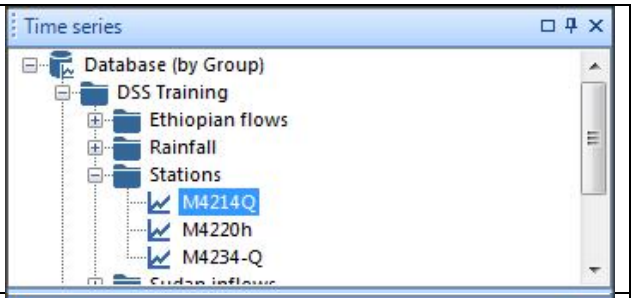
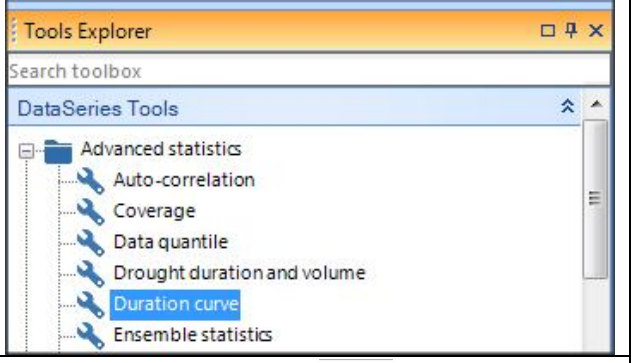
Using tools on more than one time series

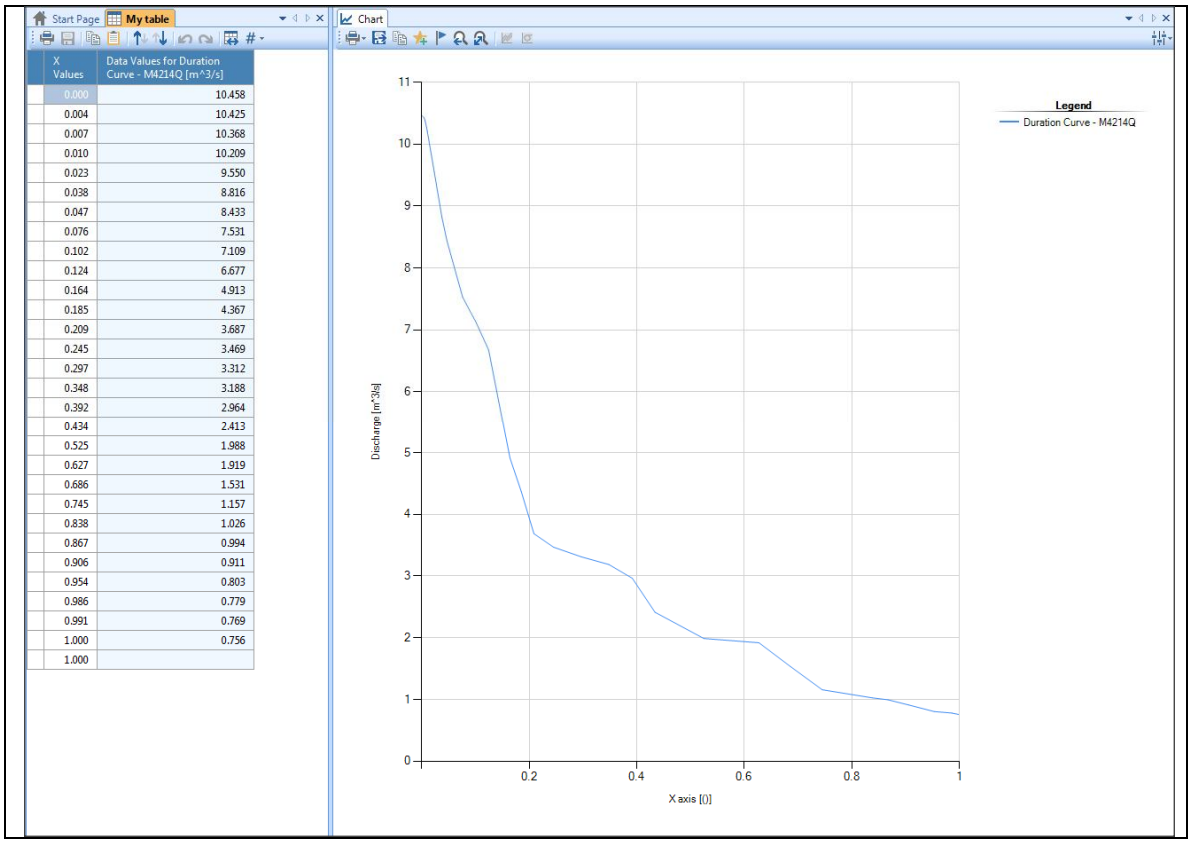
Many of the time series tools can work on more than one time series. But, this is optional. However a number of tools in the DSS require two or more time series as input. On example of those tools is the 'Cross correlation' tool, which, measures the relationship (i.e. strong or weak) between two (random) variables.

Exercises

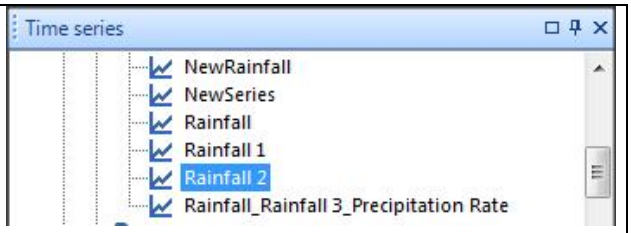
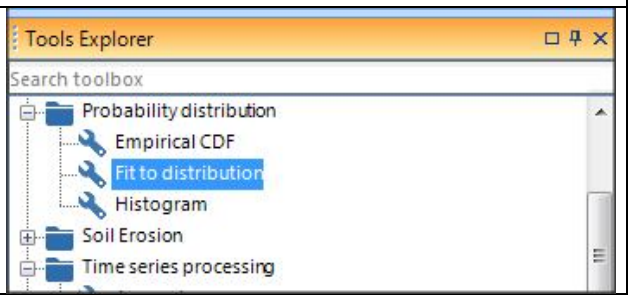
Carrying out advanced calculations on Time Series

Producing a duration curve

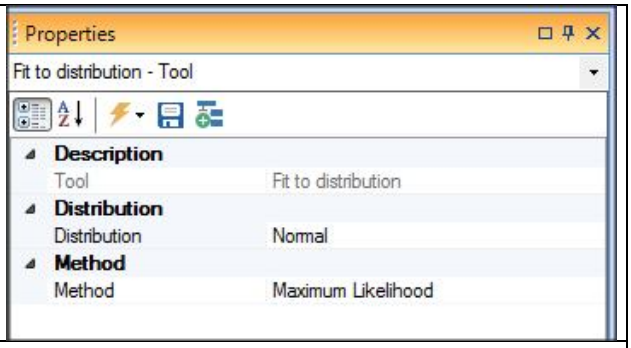
1- In this exercise we will produce a duration curve for a time series data. Select a flow time series (e.g. M4214Q) under the 'Stations' Group.	
2- In the Tools Explorer click on the 'Duration curve' tool under the Advanced statistics' category. Once the 'Duration curve' tool is selected, its properties appear in the 'Properties' Explorer. This tool has no properties to fill.	
3- Click on the  button and then the Run (To chart). Click the  again and then Run (To table). The tool produces the 'Duration curve' as shown below in a chart and a table. They have been put side by side for viewing purposes. Refer to xxx in the UI module on how to do that.	



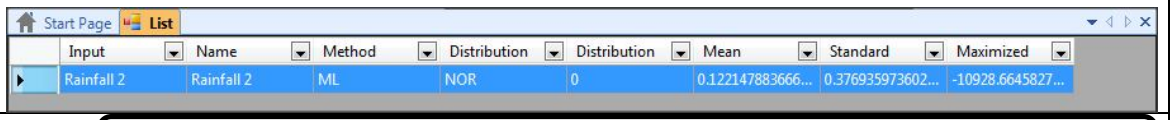
Fitting data to a probability distribution

1- In this exercise we will fit a time series data to a probability distribution. Select a rainfall time series (e.g. Rainfall 2).	
2- In the Tools Explorer click on the 'Fit to distribution' tool under the 'Probability distribution' category.	

3- Once the 'Fit to distribution' tool is selected, its properties appear in the 'Properties' Explorer. Fill the properties as shown.



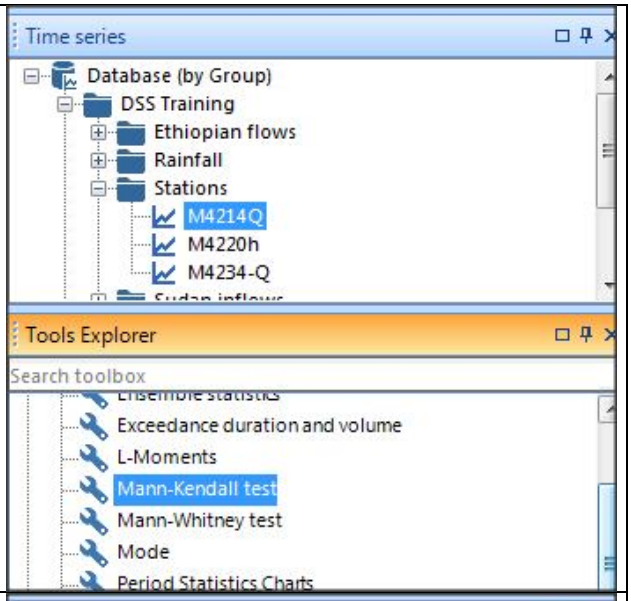
3- Click on the  button and then the Run (To list) option. The tool calculates the mean and the standard deviation of the distribution as shown below.



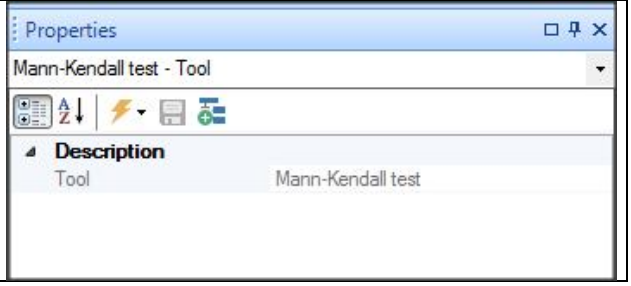
Time series value type can restrict probability distribution fitting. Probability distributions cannot be fitted to accumulated and step-accumulated value types.

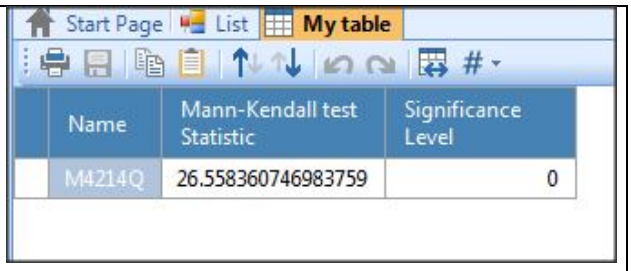
Performing a Mann Kendall test

1- In this exercise we will perform a Mann Kendall test on a time series data (testing the existence of a trend in the data). Select a flow time series (e.g. M4214Q) under the 'Stations' Group. In the Tools Explorer click on the 'Mann Kendall Test' tool under the Advanced statistics' category.



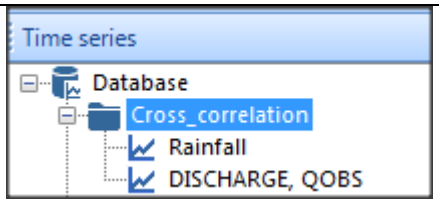
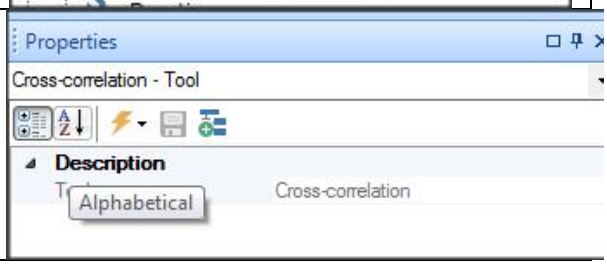
2- Once the 'Mann Kendall Test' tool is selected, its properties appear in the 'Properties' Explorer. There are no input parameters required here.



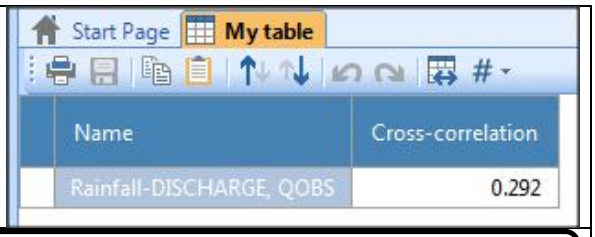
3- Click on the  button and then the Run (To table) option. The tool produces the Mann Kendall test outputs with a significance level of zero which means a trend exists in the data. The positive value of the statistic means the trend is positive.	

Using tools requiring more than one time series

Calculating the cross-correlation between two time series

1- In this exercise we check the cross correlation between two time series. First import the two dsf0 files in the '**..\TimeSeriesExp\Data\Cross_correlation**' folder in a newly created group called ' Cross_correlation'.	
2- Select the 'Rainfall' and 'Discharge, QOBS' time series. In the Tools Explorer click on the 'Cross-correlation' tool under the Advanced statistics' category.	
3- Once the 'Cross-correlation' tool is selected, its properties appear in the 'Properties' Explorer. This tool has no additional properties to fill.	

4- Click on the button and then the Run (To table) option. The tool calculates a cross correlation coefficient of 0.292 between the two time series.



The Cross correlation tool can be only applied on time series with equidistant intervals and with no missing values.

Review Questions

1. What is a Mann Kendall test?
2. Apply the Mann Whitney test to the same data of the Mann Kendall test and show the results (use default parameter values)
3. Define cross correlation.
4. What is a duration curve?
5. The Cross correlation tool can be applied on time series with missing values
   - True
   - False

Answers

1. A Mann Kendall test is used for testing the existence of a trend in a time series.
2.

Name	Mann-Kendall test Statistic	Significance Level
M4214Q	-20.171490034550377	0

3. Cross correlation measures the relationship between two (random) variables. Variables that have high (cross) correlation are strongly related than those with weak cross correlation.
4. A duration curve shows the range of data values found in the time series as a function of the exceedence probability.
5. False.

2.8. Using tools in a sequence

Introduction

This lesson introduces you to the use of the DSS tools in a sequence.

Lesson pre-requisites

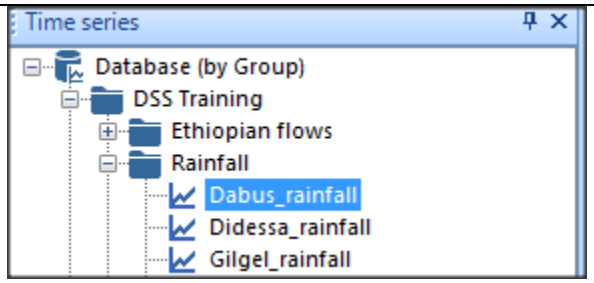
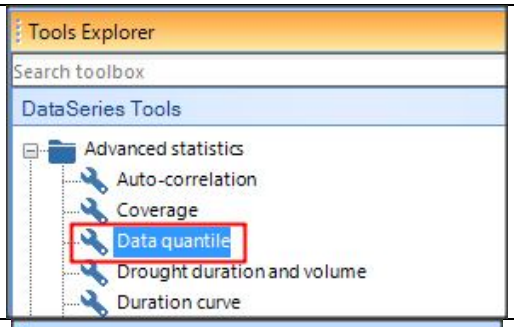
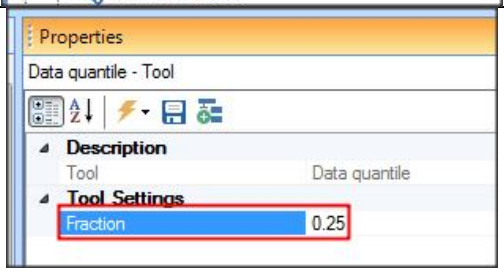
You have to be familiar with the Time Series Manager Basics and time series data handling and visualization to take this lesson.

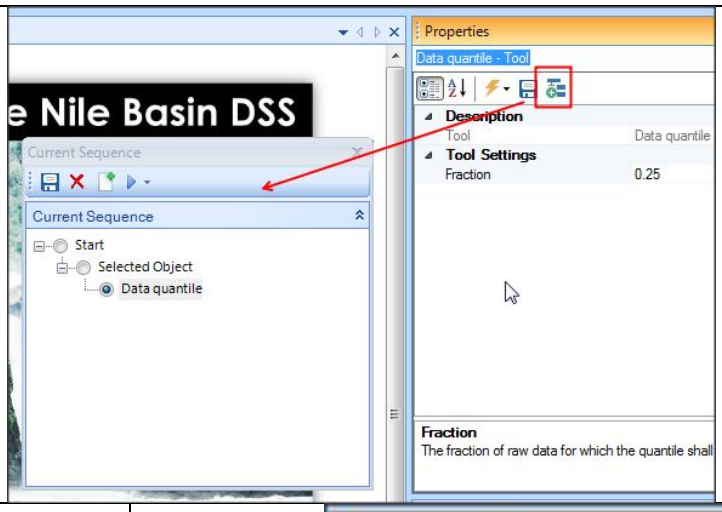
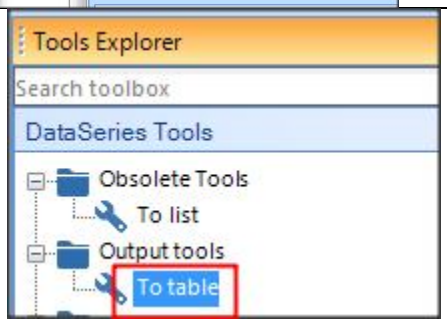
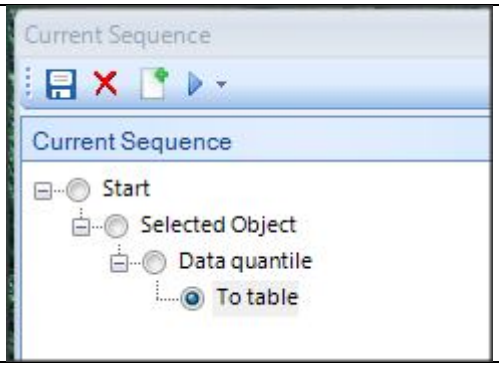
Time series and sequences

A sequence is number of steps that are executed sequentially. Each step includes instruction to execute a tool or another sequence on one or more time series. Sequences can be helpful when a number of tools need to be repeatedly applied to one or more time series. In that case those tools are added to a sequence which is saved for repetitive or future use. The use of tools in sequence is presented in the next section.

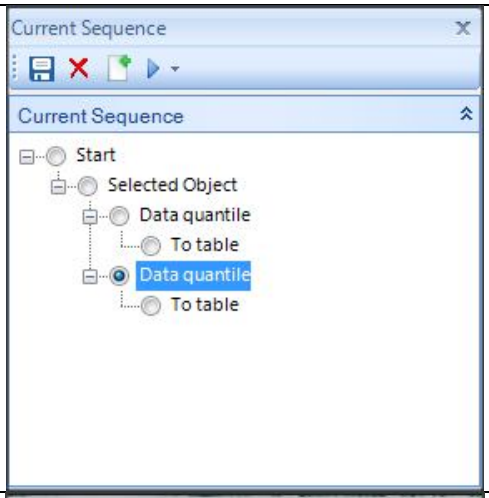
Exercises

Using tools in a sequence

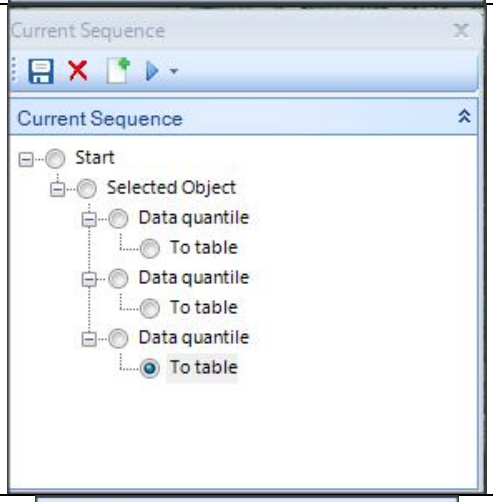
1- In this example, The 25, 50 and 75 % quantiles are calculated in a sequence using the data quantile tool. To do this first select a time series in the Time series explorer. (e.g. 'Dabus_rainfall').	
2- Select the 'Data quantile' tool from the Advanced Statistics category under the Tools explorer.	
3- Once the tool is selected. Its properties appear in the properties window. Set the tool properties (fraction = 0.25).	
4- Click the  button on the toolbar of the properties window. A dialogue box called 'current sequence' appears as shown below. Note that a 'Data quantile' line is added in the sequence for the tool.	

<table>
<tr><td></td><td colspan="2"> 
</td></tr>
<tr><td>5- Click the ‘to table’ tool from the output tools category (available output tools will depend on the selected tool). The properties of that appears in the properties window</td><td colspan="2"> 
</td></tr>
<tr><td>6- Add the tool to the sequence as done above. Note that a new line is inserted for the 'To table' tool.</td><td colspan="2"> 
</td></tr>
</table>

7- Click the 'selected Object' node in the Current Sequence dialog and:
- Repeat steps 2 – 3 but using fraction = 0.5
- Repeat steps 4 – 6



8- Repeat 7 but using fraction = 0.75



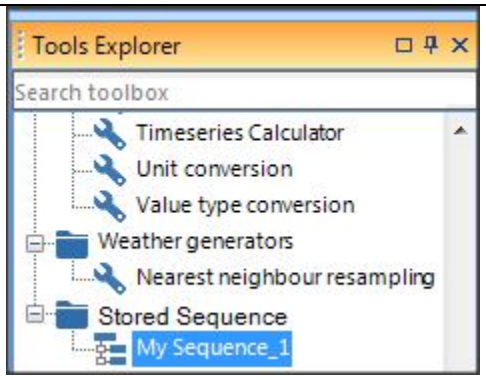
9- Use the  button on the toolbar of the 'Current Sequence' dialog and select 'run Entire sequence'. A table should appear with the results as shown below.

Start Page | My table

Name	Data quantile (0.25)	Data quantile (0.25) - Unit	Data quantile (0.5)	Data quantile (0.5) - Unit	Data quantile (0.75)	Data quantile (0.75) - Unit
Dabus_rainfall	8.3250000000...	mm	70.25	mm	216.725	mm

10- Save the sequence using the button on the 'Current Sequence' toolbar – it will be added to the tools under 'Stored Sequences' group (rename as necessary). You may close the 'Current Sequence' dialog window.

11- To run a stored sequence, select another time and select the sequence from 'Stored Sequences' group in the Tools explorer. Run it as you do with any other tool (i.e. using the button)



12- To edit the sequence, double-click. This brings the 'Current Sequence' dialog. Click on the first and last 'Data quantile' lines and change the fractions to 10 and 90 quantiles. Save and run the sequence as done above (See results below for 'Dabus_rainfall').

Start Page | My table

Name	Data quantile (0.1)	Data quantile (0.1) - Unit	Data quantile (0.5)	Data quantile (0.5) - Unit	Data quantile (0.9)	Data quantile (0.9) - Unit
Dabus_rainfall	1.0600000000000009	mm	70.25	mm	256.71000000000004	mm

Review Questions

1. What is a sequence?
2. What is the benefit of creating and saving sequences?
3. Can a sequence be a part of another sequence?

Answers

1. A sequence is number of steps that are executed sequentially. Each step includes instruction to execute a tool or another sequence on one or more time series.
2. To perform repetitive tasks more efficiently.
3. Yes, it can be considered as a tool and used to compose more complex sequences.

2.9. Working with Ensembles

Introduction

In this lesson you are introduced to ensembles. The lesson shows what are they, their uses and how they are generated in real life. It then focuses on handling them within the DSS.

Topics covered in this lesson:

- What are ensembles? and their uses.
- How are ensembles generated in the DSS?
- Handling ensembles in the DSS (e.g. import, visualize and export)
- Calculating ensemble statistics in the DSS.

Lesson objective:

After completing this lesson, you will be familiar with:

- Ensembles, their uses in practice
- Importing, visualizing and exporting ensembles within the DSS.
- Calculating ensemble statistics in the DSS

Lesson pre-requisites

You have to be familiar with the Time Series Manager Basics and time series data handling and visualization to take this lesson.

What are Ensembles?

In the context of the DSS, an ensemble is a set of time series having some statistical similarity that are handled together. They are generated through some probabilistic techniques. Basically it is a group of possible behaviors of the system that reflect the inherent or external uncertainties due to initial conditions, parameters, or forcing of the system.

What are the uses of ensembles?

Ensembles are used extensively in climate science, weather prediction, hydrological forecasting, climate change studies, etc. Any member of the ensemble is sometimes

called a trace. Individual traces are not usually important; it is the statistics of these traces that is important. This is one aspect of the “handled together” attribute of an ensemble. This togetherness also implies that the model will automatically run for all ensemble members and produces the output as an ensemble as well. However, in some cases, the output ensemble members can be generated separately and then grouped to form the ensemble.

When a model is forced with an ensemble input, the results are basically an ensemble of outputs which are analyzed statistically, i.e. statistics like the ensemble mean or median gives us an idea of the average system behavior while the range or standard deviation across the ensemble give us the uncertainty range in the output. The main reason to use ensembles is that we are not certain about the behavior of the system under consideration.

How are ensembles generated?

Ensembles can be generated in many different ways:

- Using different initial conditions, e.g. different initial lake water levels, one can generate an ensemble of lake outflows; different initial weather conditions can be used to generate an ensemble of different future weather predictions; etc.
- Using different model parameters, or even parameterization (i.e. process representation), one can generate an ensemble of model results, e.g. different hydrological parameters that produce similar performance in terms of calibration criteria (Bias, R^2, etc.) can be used to generate an ensemble of catchment runoffs. One can use several calibrated hydrological models to generate an ensemble across models which will vary due to the different process representations in each model (e.g. single soil layer rainfall-runoff model vs. a more complex 4 layer model that are both calibrated to the same data will perform differently and they can be used to generate an ensemble)
- Using different forcing, e.g. an ensemble of climate scenarios can be used to force a model to calculate the impacts of these scenarios.
- Mixing more than one aspect of the above when generating the ensemble input leads to an ensemble of ensembles, which is sometime termed, a grand ensemble. For example, if one runs a weather generator with different initial

conditions and different model parameters, the result will be a grand ensemble reflecting both factors.

Handling ensembles in the DSS

Importing and exporting ensembles data

Similar to importing time series data, The DSS can import ensembles that are in ASCII, DSF0 (format used in Mike DHI products), GRIB, NETCDF and excel file formats. Importing can be from a single file (i.e. ensemble data is stored in one file) or multiple files. DSS users can also extract the traces within an ensemble and then export them individually as shown above for a time series, or as an ensemble (i.e. a group of time series).

Using ensembles in modeling

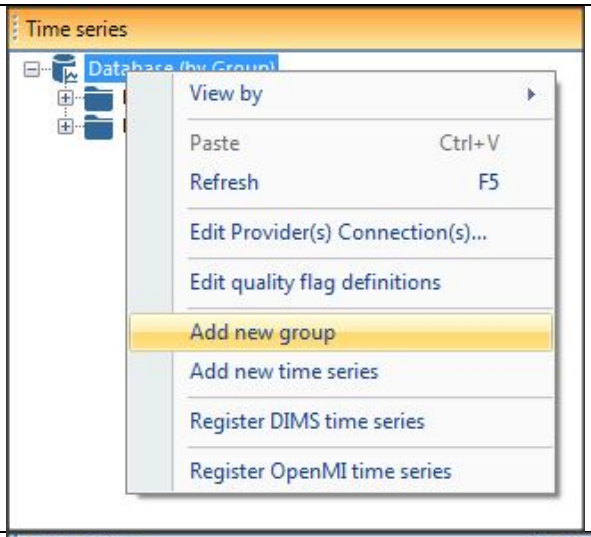
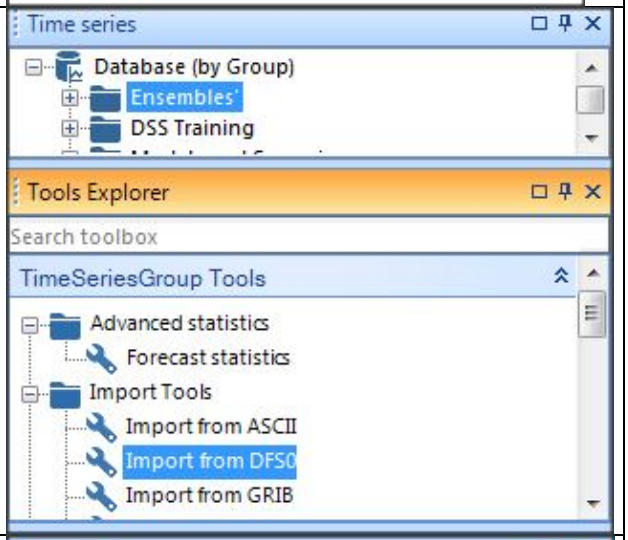
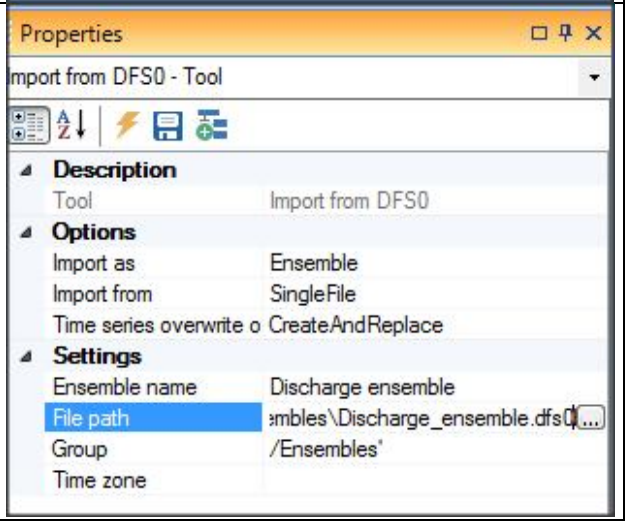
The 'Weather shuffler' tool can be used to generate an ensemble of, for example, rainfall time series that represents the main input to a rainfall-runoff model (e.g. NAM). The output of such model will then be an ensemble of catchment runoffs translating the uncertainty in rainfall to the corresponding uncertainty in runoff. One could do this by preparing these different rainfall traces, running the rainfall-runoff model individually for each, organizing the outputs in a way that will enable calculating the statistics across the ensemble members rather than along the time axis. Using the ensemble features in the DSS will save time and effort to set up and run the model as well as in analyzing the results. More details on this are shown in the 'Running simulation with ensembles' section of the Scenario manager training module.

Ensemble visualization and statistics

The DSS is also capable of plotting the ensemble mean, range and standard deviation. Ensemble statistics such as mean, minimum, maximum and quantiles can be calculated using the 'Advanced statistics' category tools.

Exercises

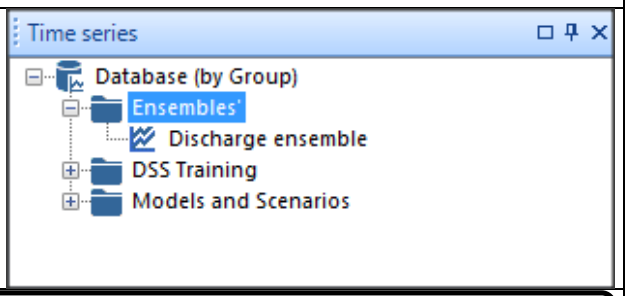
Importing an ensemble from a single file

1- Select the 'Database' Group. Create a new group in the Time Series Explorer by right clicking the mouse and selecting the 'Add new group' option. Rename the group to 'Ensembles' and select the group.	
2- Find and select the tool called 'Import from dfs0' in the 'Tools' Explorer.	
3- Once the tool is selected, its properties appear in the 'Properties Explorer'. By default the tool is configured to import ordinary single item time series. Change the 'Import as' field to 'Ensemble'. Click the 'File Path' button (i.e. the ... button) to select the location where the ensemble file is stored. Select the	

'Discharge_ensemble.dfs0' file that is located in **..\TimeSeriesExp\Data\Ensembles** folder.

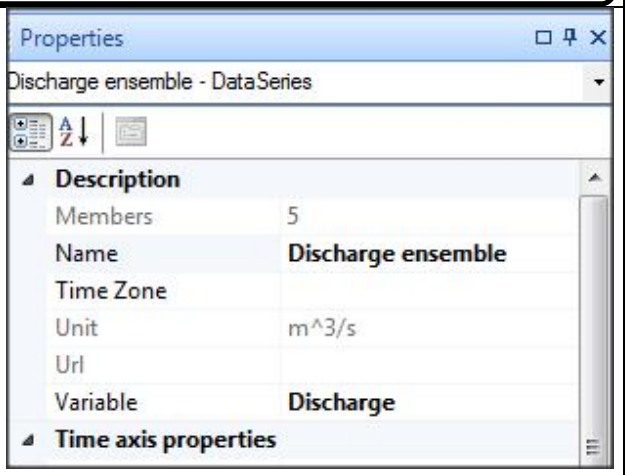
Provide a name for the imported ensemble (e.g. Discharge ensemble).

4- Click on the button to run the tool. The dfs0 file is imported to the DSS as a single ensemble time series.



The Ensemble time series has a slightly different icon than an ordinary time series. It indicates that an ensemble time series has multiple members.

5- Select the ensemble time series and take a look at the properties. Notice that the only difference between the properties of an ordinary, single item time series and an ensemble time series is that the Members property is higher than 1. All ensemble members share the same time axis.

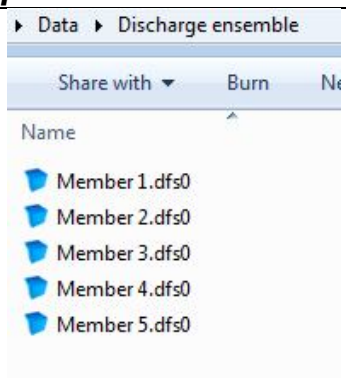


Importing an ensembles from multiple files

1- In this exercise, the same ensemble shall be imported again, but this time from a number of single item dfs0 files located in the same folder.

Browse to the **..\TimeSeriesExp\Data\Ensembles\Discharge ensemble** folder on the disk.

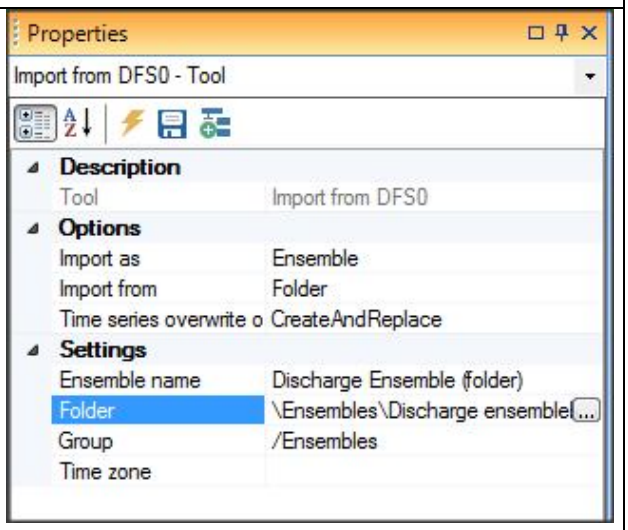
It contains five dfs0 files, each containing a single item.



2- Select the 'Ensembles' group again, select the 'Import from DFS0' tool, and this time configure the tool to import from a folder by setting the 'Import from' Field to 'Folder'.

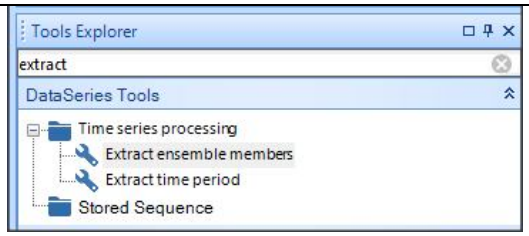
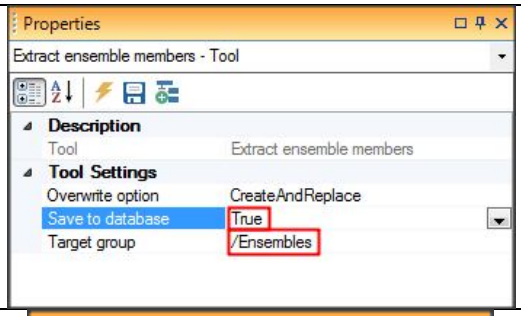
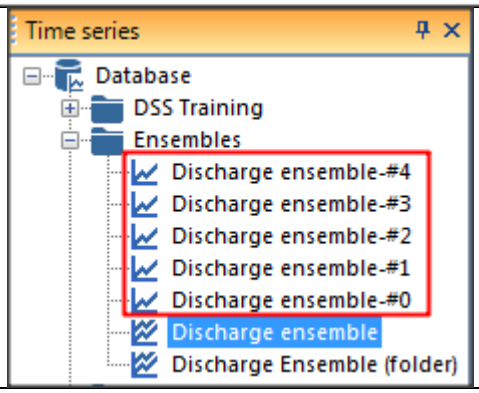
Click the 'Folder' button (i.e. the ... button) to select the location where the ensemble files are stored. Select the **..\TimeSeriesExp\Data\Ensembles\Discharge ensemble** folder.

For the Ensemble name, provide a different name for the ensemble (e.g. Discharge Ensemble (folder)).



3- Click on the  button to run the tool. The five dfs0 files are imported as a single, ensemble time series.	

Exporting ensemble traces

1- Exporting ensemble traces (members) is a two-step process. First traces need to be saved to the DSS database and then they can be exported as done for single time series in the Exporting time series data section. To save traces to the database, select the ensemble data and then select the 'Extract ensemble members' tool under the 'Time series processing' category.	
2- Make sure the 'Save to database' is set to 'True' and the 'Target group' is set to '/Ensembles'.	
3- Run the tool by clicking the  icon. Traces are now extracted as shown as single time series. Follow the steps under the Exporting time series data section to export them.	

The average of the ensemble traces can be exported using the ‘To file’ tool under the 'Output Tools' category.

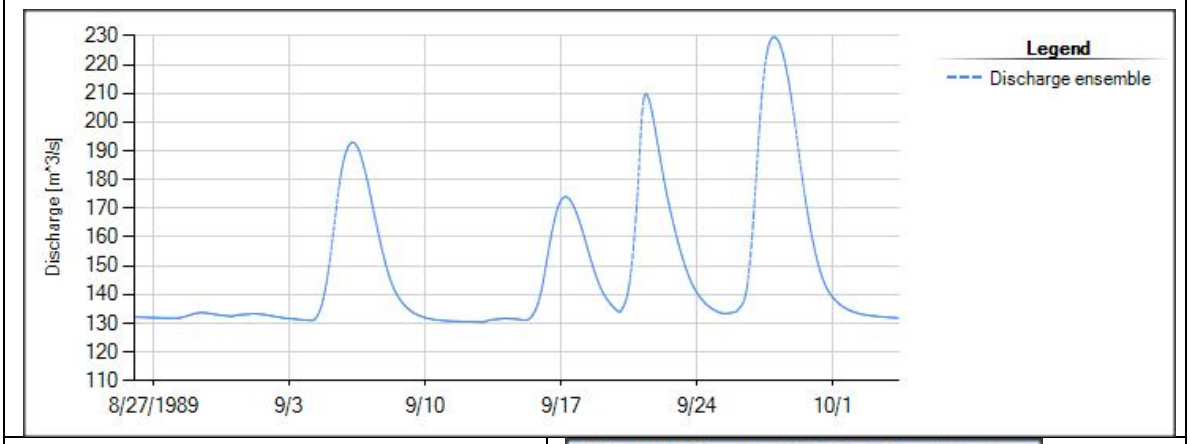
Ensembles Change Log and Metadata

The ensemble change log entries and metadata are used in same way as for a time series (See Time Series Change Log and Metadata for details). The only difference is that the user needs to select ‘Ensembles’ as the DSS entity type for metadata when using the ‘Metadata Schema Import’ tool.

Plotting ensembles

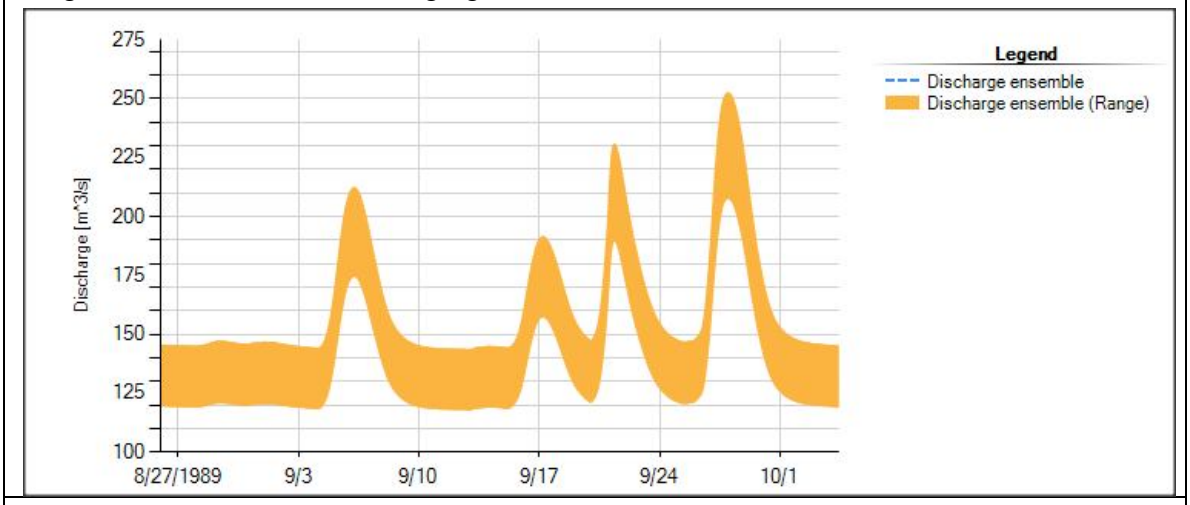
1- Ensemble time series are added to a chart as done above (See View data in a chart). By default, only the ensemble mean is plotted (the mean of all members for each time step).

The ensemble mean is plotted with a dashed line to distinguish it from normal time series.

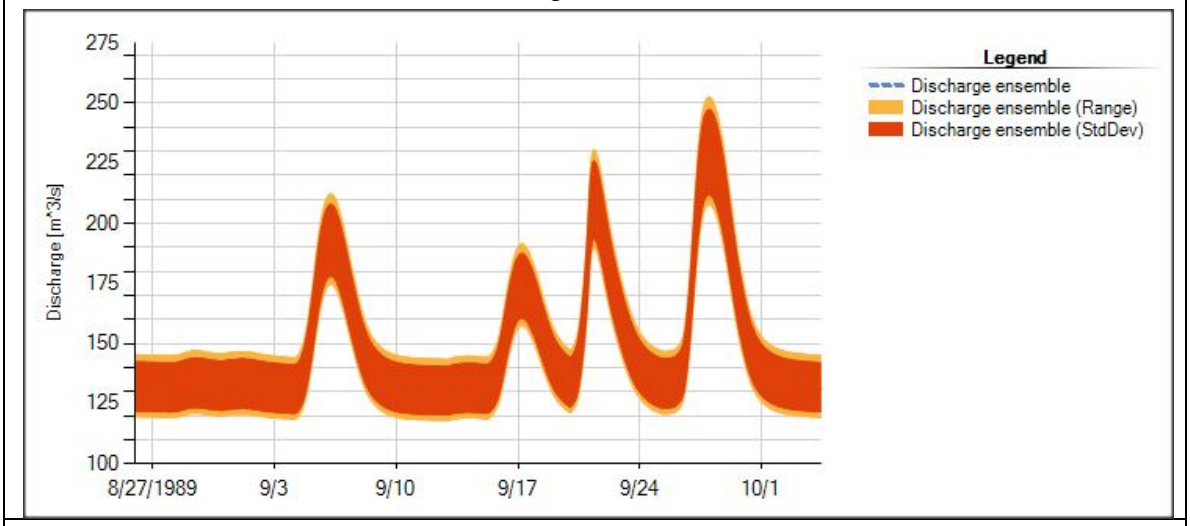


2- Select the ensemble series in the chart legend to enable the range and the standard deviation buttons on the toolbar as shown next.

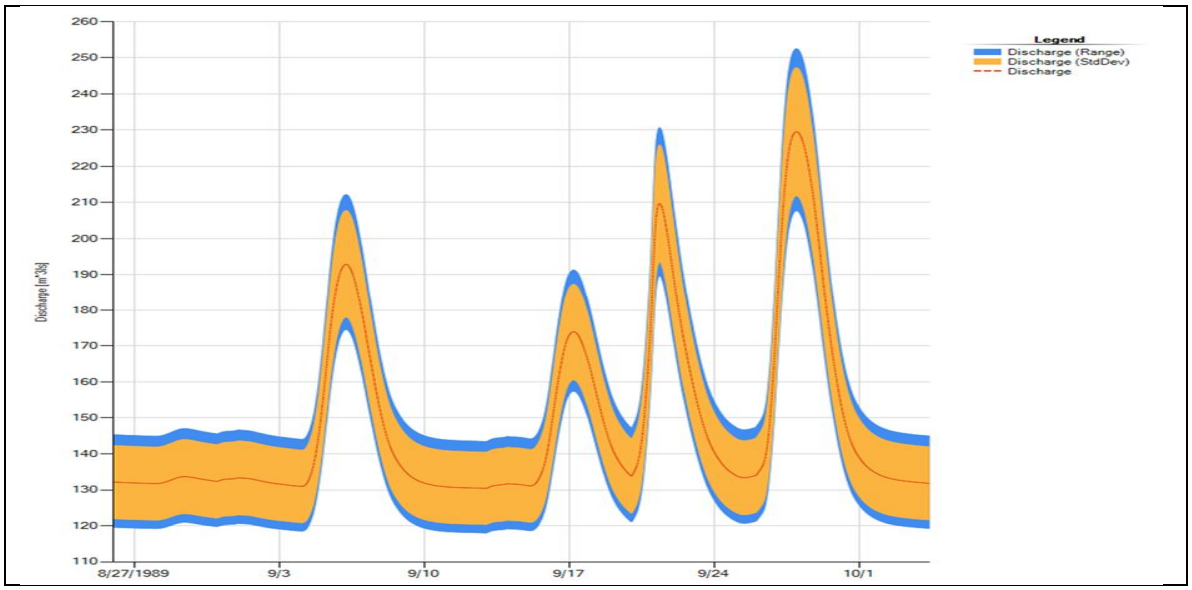
3- Click the Range button to get maximum and minimum of the ensemble plotted as a range chart. Notice that the range gets added as a new series in the same chart.



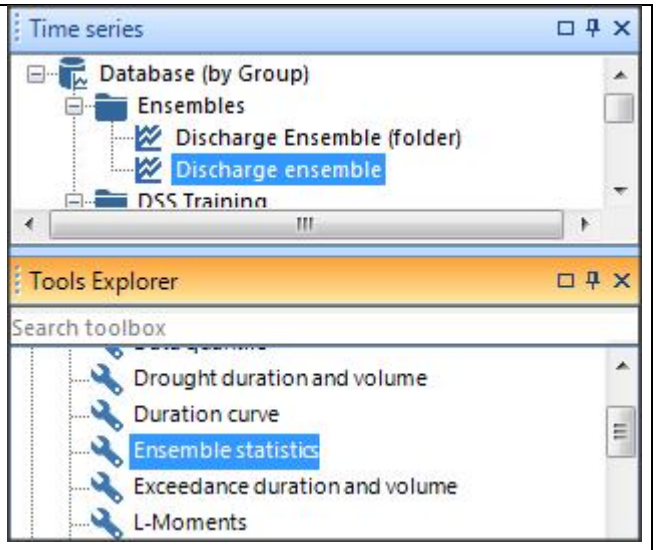
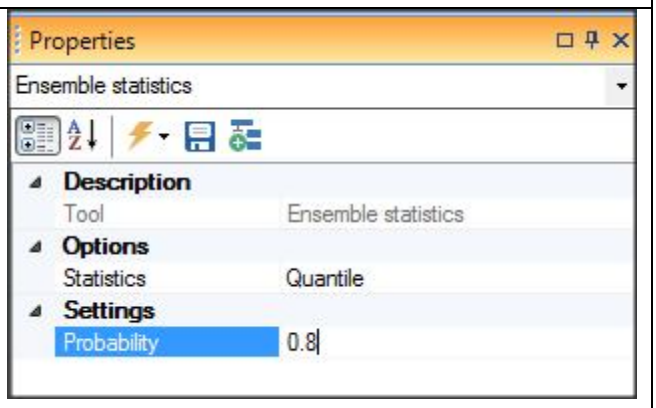
4- To get the mean +/- one standard deviation plotted, click the Standard deviation button. The new series is added to the legend.



5- The mean is not shown because it is hidden under the two other series. Right-click it in the legend area and remove it, then add it again from the time series explorer to get it on top as shown below (Note that colors get reassigned when the time series is removed).

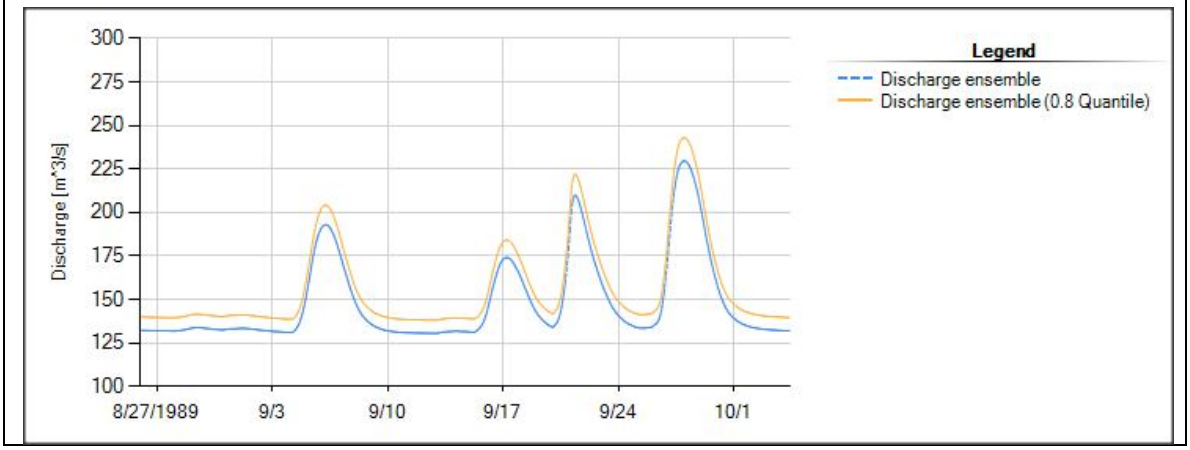


Calculating Ensemble statistics

1- Ensembles statistics (time series) are calculated using the 'Ensemble statistics' tool under the 'Advanced statistics' category. This tool becomes available in the toolbox when an ensemble time series is selected.	
2- Once the tool is selected, its properties appear in the 'Properties Explorer'. The tool can be configured to calculate a number of statistics such as mean, maximum, minimum and quantiles. The tool output is provided as a single-member time series containing the selected statistics.	

Set the tool to produce the 80% quantile as shown	

3- Run the tool to a chart and add the ensemble mean to the same chart. The below figure shows a comparison between what the tool produce (80% quantile) against the ensemble mean.



Review Questions

1. What is the difference between an ensemble and a time series?
2. What are the uses of an ensemble?
3. How ensembles are generated in the DSS?
4. Can you plot ensemble members in the DSS? and how?

Answers

1. An ensemble is a collection of time series.
2. Ensembles are used extensively in climate science, weather prediction, hydrological forecasting and climate change
3. Using the weather generation tools
4. Yes by extracting them using the 'Extract ensemble member' tool and then plotting them.

3. References

- Nile Basin Decision Support System help file (DSS Ver. 2.0)
- Nile Basin Decision Support training material (developed in 2013 and 2014)
- DHI training material for the Nile Basin Decision Support (developed in 2012)
- Wikipedia web site - http://en.wikipedia.org/wiki/Main_Page (last accessed on 8/5/2014)
- WP2 Report: NB-DSS WP2 Stage 2 'Data Processing, Quality Assurance and Metadata' report (2012)

4. Annexes

Annex 1: Excel sheet DSS import format

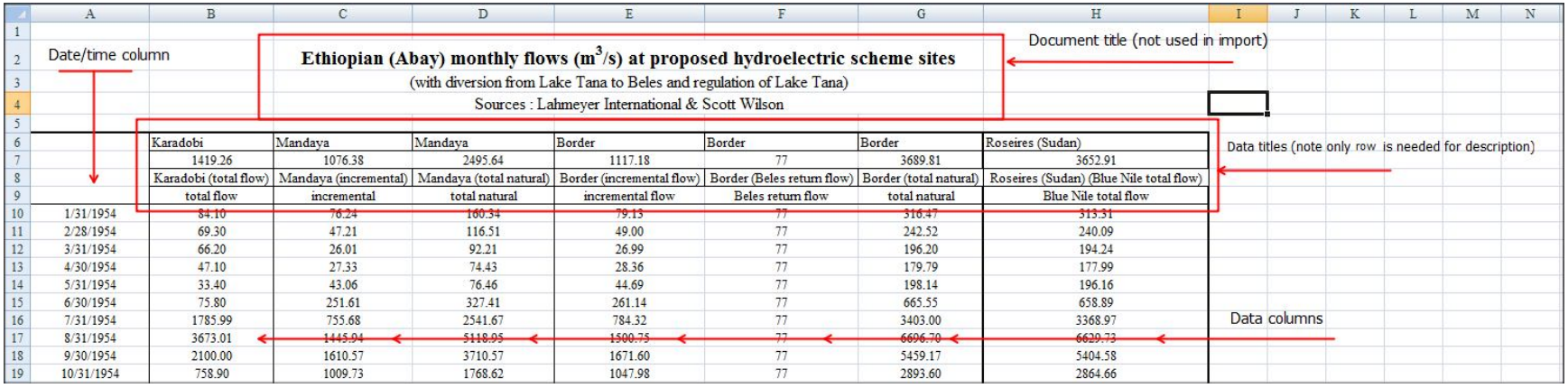
1- You can have at the top as many rows as you wish for a document title (optional). These are not used in the import.

2- Below the document title, data is arranged in columns.

3- First column(s) should have the date and/or time data (mandatory to have at least one). The column(s) can also have their own titles and can be for one time series or all.

4- Columns next to the date/time column(s) should include the data (e.g. flow data) and can be one or more (Mandatory to have at least one). The column(s) can also have their own titles such as Item type (e.g. discharge), units (e.g. m^3/s), value type (e.g. instantaneous) and description, each in a separate row. The description title is mandatory while other titles can be specified at import time.

An example is given below for a number of flow time series with one date/time column.



		Karadobi	Mandaya	Mandaya	Border	Border	Border	Roseires (Sudan)
		1419.26	1076.38	2495.64	1117.18	77	3689.81	3652.91
		Karadobi (total flow)	Mandaya (incremental)	Mandaya (total natural)	Border (incremental flow)	Border (Beles return flow)	Border (total natural)	Roseires (Sudan) (Blue Nile total flow)
		total flow	incremental	total natural	incremental flow	Beles return flow	total natural	Blue Nile total flow
	1/31/1954	84.10	76.24	160.34	79.13	77	316.47	313.31
	2/28/1954	69.30	47.21	116.51	49.00	77	242.52	240.09
	3/31/1954	66.20	26.01	92.21	26.99	77	196.20	194.24
	4/30/1954	47.10	27.33	74.43	28.36	77	179.79	177.99
	5/31/1954	33.40	43.06	76.46	44.69	77	198.14	196.16
	6/30/1954	75.80	251.61	327.41	261.14	77	665.55	658.89
	7/31/1954	1785.99	755.68	2541.67	784.32	77	3403.00	3368.97
	8/31/1954	3673.01	1445.04	5118.05	1500.75	77	6696.70	6629.73
	9/30/1954	2100.00	1610.57	3710.57	1671.60	77	5459.17	5404.58
	10/31/1954	758.90	1009.73	1768.62	1047.98	77	2893.60	2864.66

Annex 2: Import time series dialog box

File name and excel sheet inputs

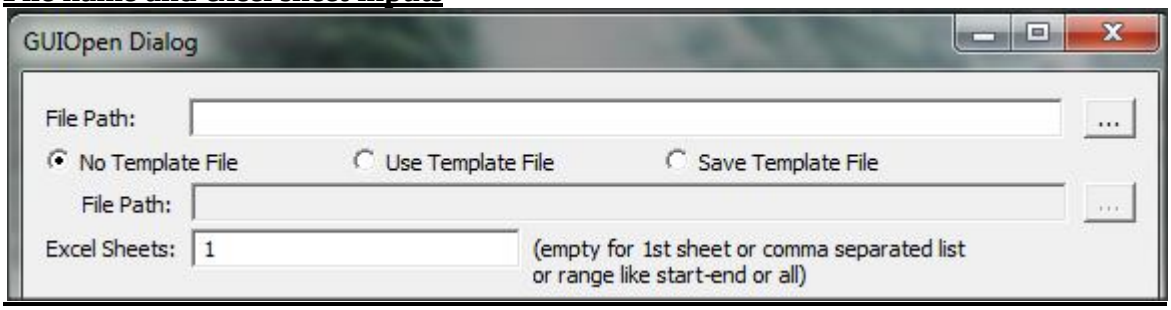


Figure 10: File name and excel sheet inputs

File path: Path to the file that includes the data that will be imported.
The import dialog has 3 template options:

- No Template File: data is imported as specified by the user using the Time and Data description tabs (See details below).
- Use Template File: If a template file exists for the data then this option should be used. User does not need to describe the data in the Time and Data description tabs.
- Save Template File: If the data is going to be imported from several files with identical structure then it save time to save a template file the first time the data is imported. Following this the template file can be used for all subsequent files.

Excel sheet: Here the user specifies in which sheet(s) in an excel file the data exists. If data is in the first sheet this box can be empty. If more than sheet has data then sheets can be separated by a comma (i.e. 1,2,3).

Time description tab

In this tab the format of the date and time part of the data is defined. There are three options:

- Data and time is in one column or across multiple consecutive columns (See Box 1 in Figure 11). In this option, the user needs to define date\time column number. If the data is across multiple columns then the 'Date/Time format' option should be checked and the format is defined with the '|' character as the separator between columns. For formatting YYYY is used for years, MM for Month, DD for days, HH for hours, mm for minutes and ss for seconds.
- Same date for all values and time values is in one column or across multiple consecutive columns (See Box 2 in Figure 11). In this option user, the user needs to select the date value that is identical for all data values then s/he needs to define time column number. If the time data is across multiple columns then the 'Time format' option should be checked and the format is defined with the '|' character as the separator between columns. For formatting HH is used for hours, mm for minutes and ss for seconds.
- Same time for all values and date values is in one column or across multiple consecutive columns (See Box3 in Figure 11). In this option user, the user needs to select the time value that is identical for all data values then s/he needs to define date column number. If the time data is across multiple columns then the 'Time format' option should be checked and the format is defined with the '|' character as the separator between columns. For formatting YYYY is used for years, MM for Month and DD for days,

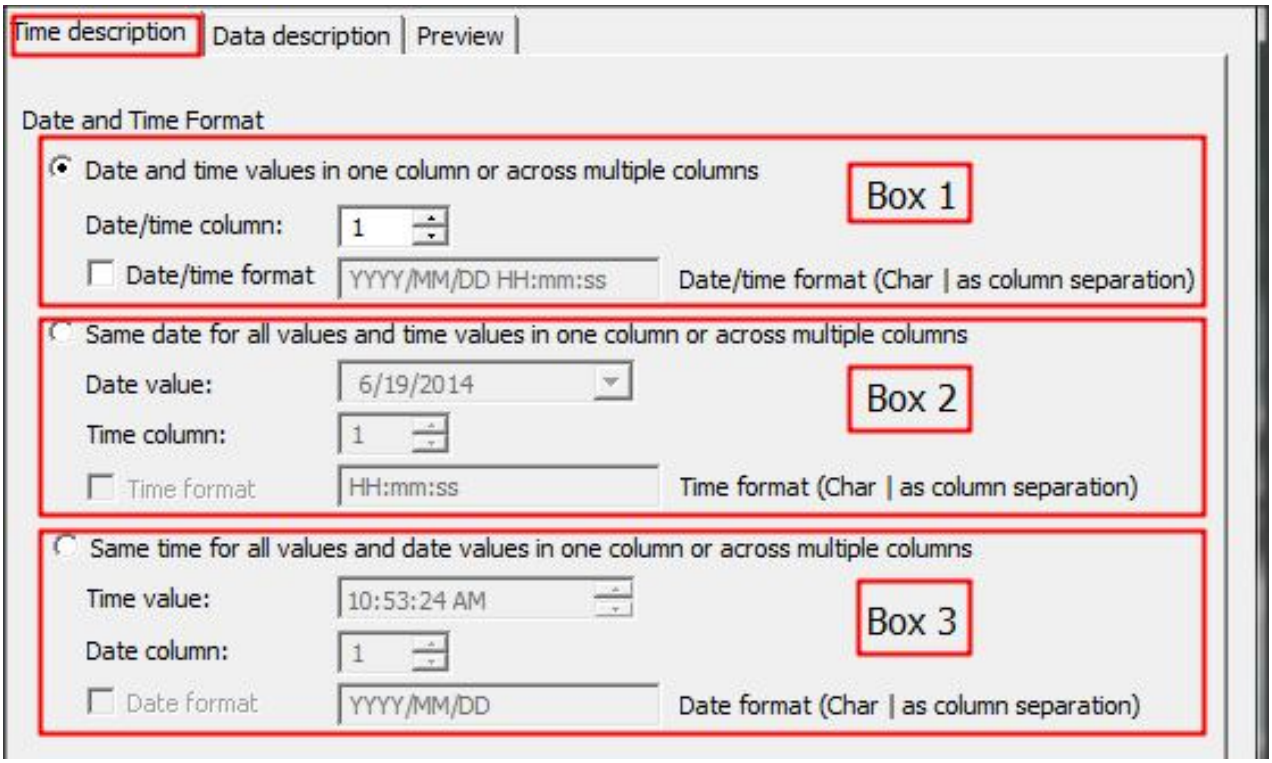


Figure 11: Time description tab

Data description tab

In this tab the description of the data is defined as follows:

- Item type (See Box 1 in Figure 12): Here the data type is defined. This can be picked up from the list or it can be defined in the file that will be imported. In the second case the row number where the type is specified in the file has to be entered.
- Units (See Box 2 in Figure 12): Here the data unit is defined. This can be picked up from the list or it can be defined in the file that will be imported. In the second case the row number where the unit is specified in the file has to be entered.
- Value type (See Box 3 in Figure 12): Here the data value type is defined (e.g. Instantaneous). This can be picked up from the list or it can be defined in the file that will be imported. In the second case the row number where the value type is specified in the file has to be entered.
- Data Description (See Box 4 in Figure 12): Here the data description text is defined (e.g. Gauge or station name Instantaneous). The row number where this description specified in the file has to be entered. The row where the actual data starts has also to be specified here.

In Box 4 in Figure 12, there is an option to deal with missing values which is called 'Delete value is not empty cell this relates to'. If not this option is not checked, blank cells in the sheet will be considered as missing values. If it is checked, there are two options. The first is to give a value for those cells directly (e.g. -1e-30 as shown in Figure 12), or specify the row to pick the missing value from as done with item type, units, etc.

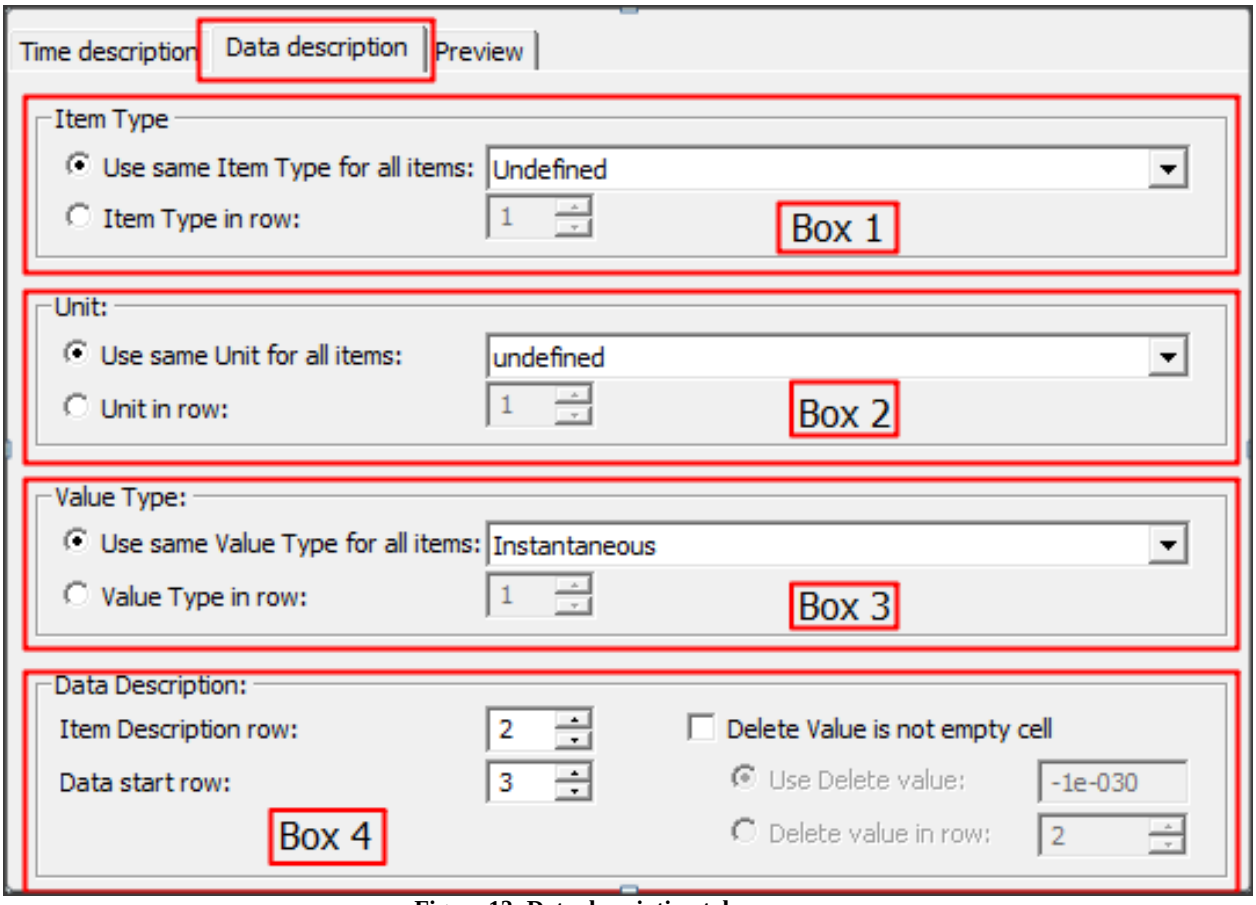


Figure 12: Data description tab

Preview tab

In this tab (See Figure 13), a preview of the data that is read from the excel file and the way it looks after importing are shown. User needs to check that the imported data is correctly read by the DSS before importing time series into the DSS.

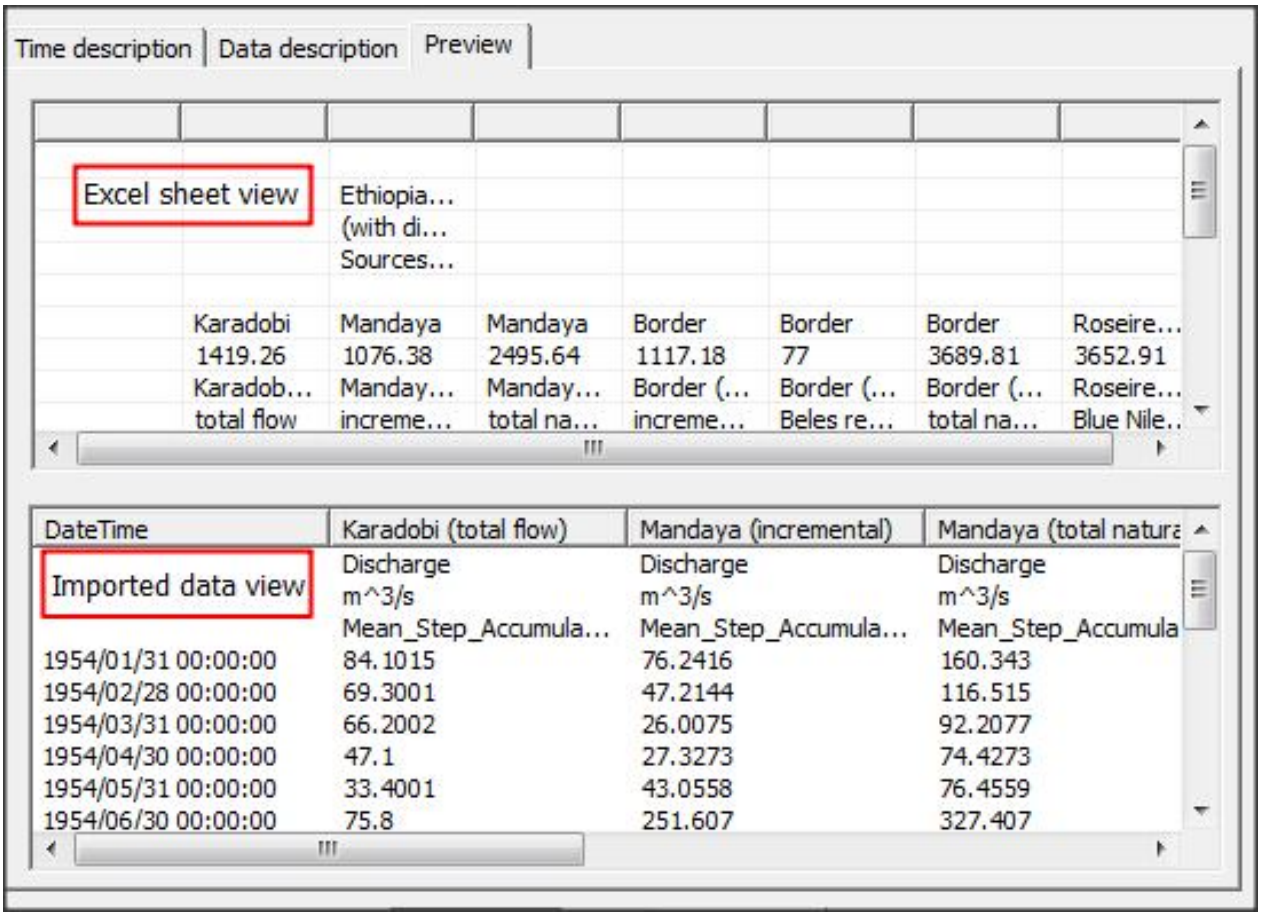


Figure 13: The data preview