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Scientific Assistance towards a Probabilistic Formulation of Hydraulic Boundary Conditions

Synthetic events software tool Manual

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Synthetic events software tool Manual

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Abstract

The Synthetic Events tool is a Matlab® software packet developed in commission of Flanders Hydraulic Research (FHR). The tool is a standalone executable which facilitates and automates the creation of synthetic events. The tool is part of a suite of software tools to facilitate the probabilistic formulation of hydraulic boundary conditions. This report is a manual for the tool. It assists the user when installing the tool and gives an overview of the workflow. Furthermore it provides an in depth description of the workflow and the functionalities of the tool.

Contents

List of figures

1 Introduction

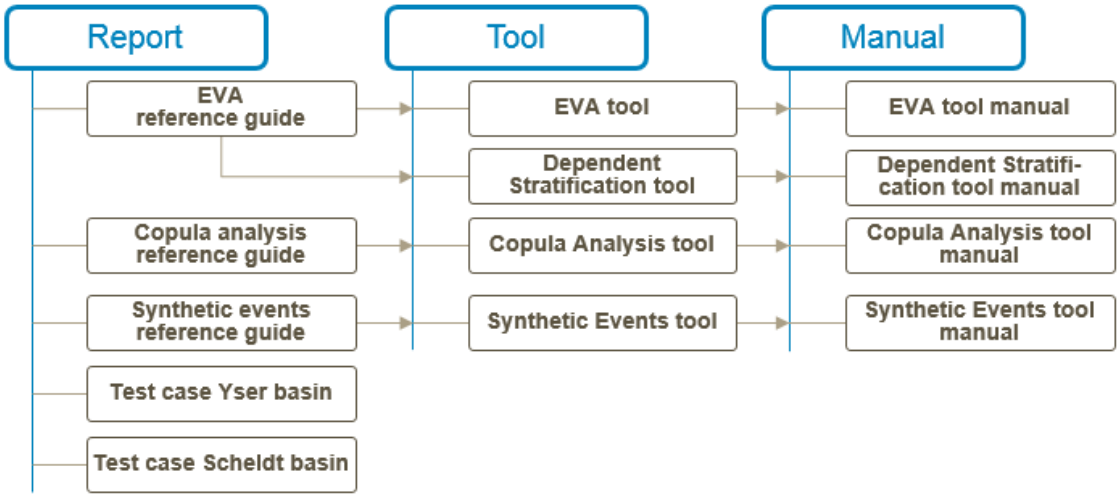
The Synthetic Events tool is a Matlab® software packet developed in commission of Flanders Hydraulic Research (FHR). The tool is a standalone executable which facilitates and automates the creation of synthetic events. A unit profile with confidence interval is calculated based on a selection of events in observed or simulated time series. This profile gives the typical evolution in time of the variable under investigation. By combining the unit profile with the synthetic extremes, synthetic events with a known frequency are obtained.

The tool is part of a suite of software tools to facilitate the probabilistic formulation of hydraulic boundary conditions. An overview of the tools and corresponding reports and manuals is presented in Figure 1-1.

The tool has to be used in combination with the Dependent Stratification tool or the Copula Analysis tool.

The Synthetic Events reference guide gives an overview of the methodology and a summary of the applied formulae.

Figure 1-1: Overview of reports, tools and manuals



2 Software

The Extreme value tool has been developed in a Matlab® environment and compiled into an executable so there are no expensive software licenses required to use the toolbox. The tool consists of three mean visual interfaces which give access to over 50 Matlab® functions.

The user needs to install the Matlab Compiler Runtime (MCR) before the first execution of the Synthetic events tool. The MCR is a Matlab® copy without the graphical interface that can be deployed royalty free and possesses all the strengths of the full Matlab® environment. You must have administrative privileges to install the MCR on a target machine since it modifies both the system registry and the system path. Running the MCRInstaller after the MCR has been set up on the target machine requires only user-level privileges.

2.1 Installation of MCR

The installation of the MCR Installer is guided by an installation GUI which requires following steps. The latest version of the MCR can be downloaded at the Matlab site (http://www.mathworks.nl/products/compiler/mcr/index.html)

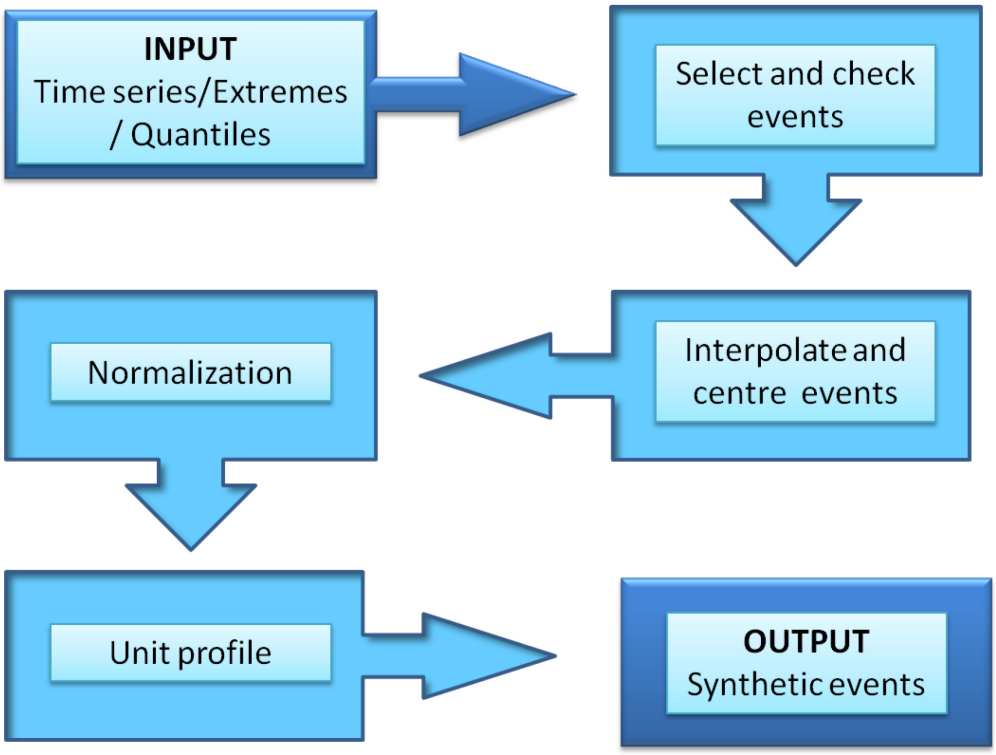
- When the MCR Installer wizard appears, click Next to begin the installation. Click Next to continue.
- In the Select Installation Folder dialog box, specify where you want to install the MCR and whether you want to install the MCR for just yourself or others. Click Next to continue.
- Confirm your selections by clicking Next.
- The installation begins. The process takes some time due to the quantity of files that are installed.

A more detailed explanation of the MCR can be found on Matlab (2011).

3 Workflow

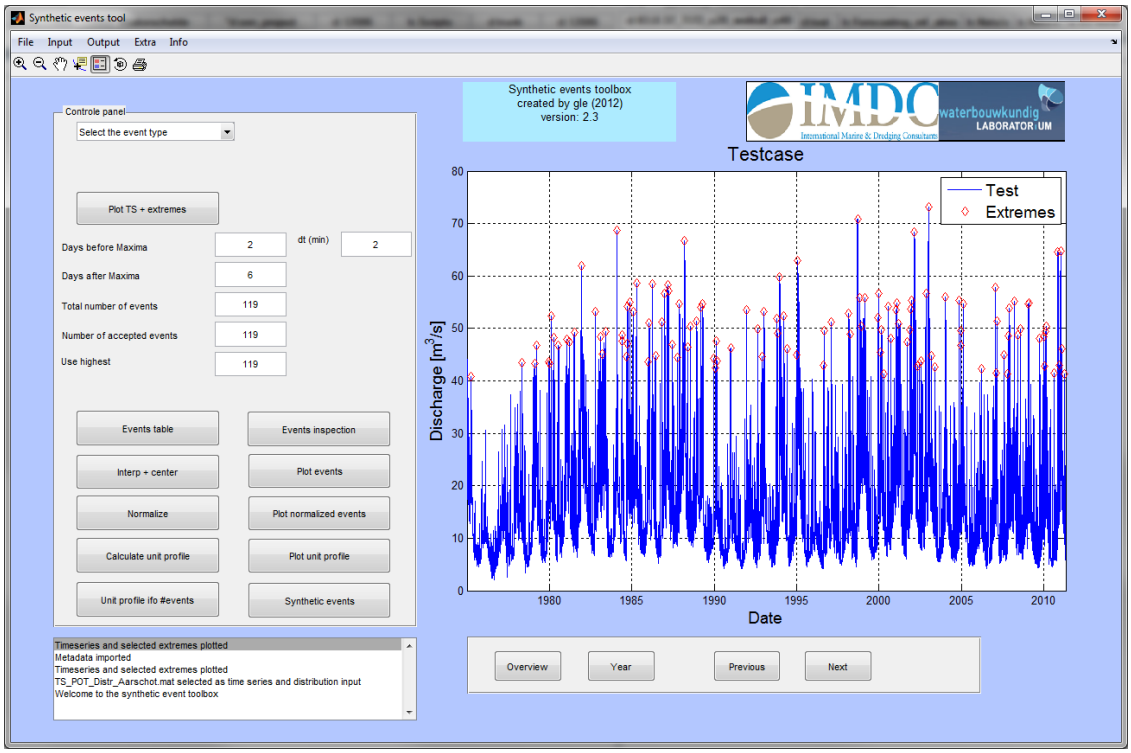
The general workflow of the Synthetic Events tool exists of 6 successive blocks, presented in Figure 3-1, starting with the import of time series, extremes and synthetic extremes. These files are automatically generated by the Dependent Stratification tool or the Copula Analysis tool. The time series can be visualized together with the extremes. The events are selected in the time series by selecting data in a time frame before and after the extreme value. This time frame is user defined. The selected events are visualized, interpolated to a fixed time step and centered around the maximum. During the next step the selected events are normalized, i.e. the values of every event are divided by the corresponding maximum. These normalized events are used to calculate the unity profile with standard deviation. The combination of the unity profile with the synthetic extremes gives a set of synthetic events with known frequency.

Figure 3-1: Workflow of the Synthetic Events tool



In the next sections the menu bar and control panel of the GUI, presented in Figure 3-2, of the tool are described.

Figure 3-2: The GUI of the Synthetic Events tool



3.1 Menu bar

The menu bar contains 5 submenus (Figure 3-3). The File menu contains some functions which facilitate quick access to your work at a later date. Therefore, it is advised to use the ‘save workspace’ function. The entire workspace of the Synthetic Events tool can be saved during every step of the analysis and reloaded at a later time (‘Save workspace’ and ‘Load workspace’). The ‘New project’ function will clear the internal memory of the Synthetic Events tool and reset all the variables to their default values.

The Input menu allows to import data generated by the EVA tool. These input files contain time series and POT values and have a default name ‘TS_POT_Distr_*.mat’. The files can be imported with the “Input Time series and extremes” function. The synthetic extremes generated by the EVA tool, the Copula Analysis tool or the Dependent Stratification tool can be imported with the ‘Input Synthetic quantiles’ function. A third input function is the ‘Input metadata’ which gives the user the possibility to change the title, the ordinate and the name in the legend of the figure (Figure 3-4). Also the trademark in the lower right corner of an exported figure can be changed.

The Output menu can be used to save the current figure in the GUI or to choose a default output directory.

Finally the Info menu gives direct access to this manual.

Figure 3-3: Menu bar and its submenus

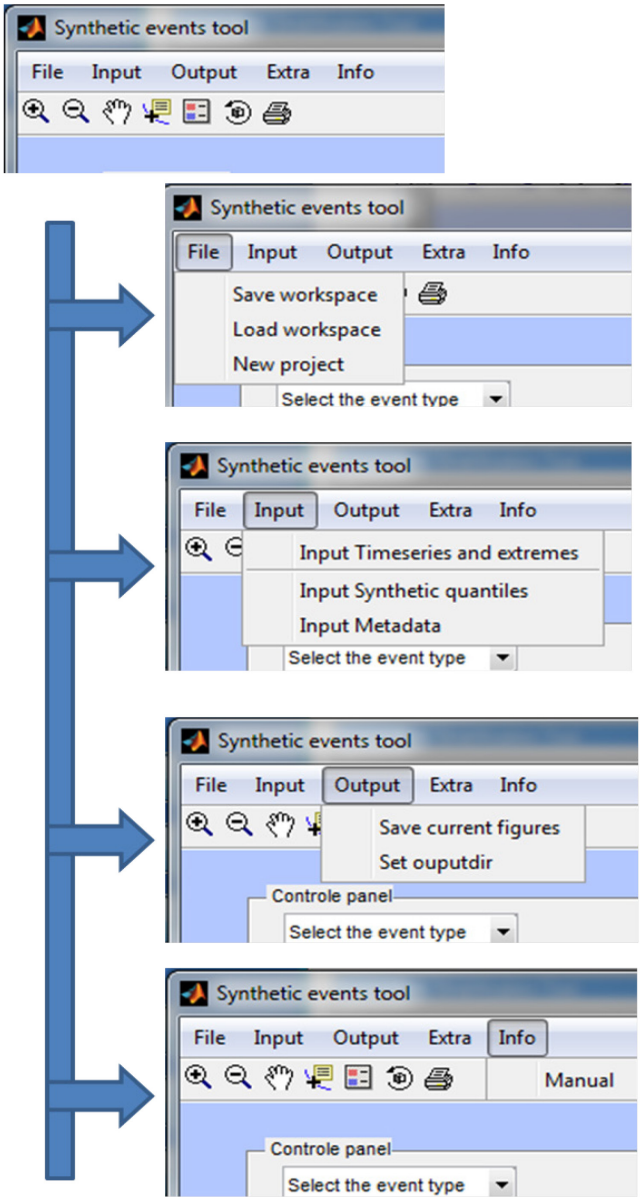
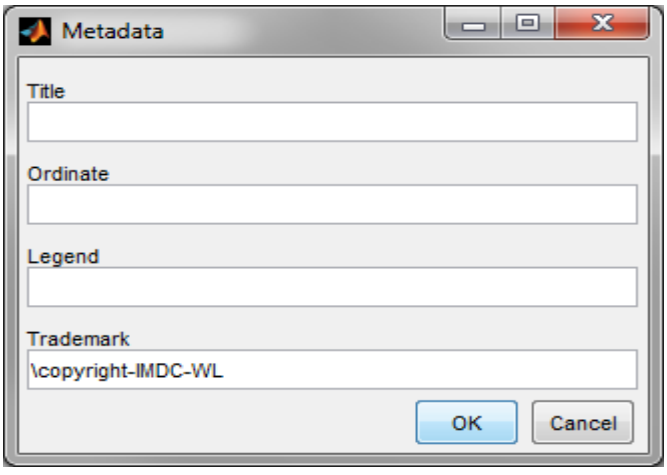


Figure 3-4: Input metadata dialog

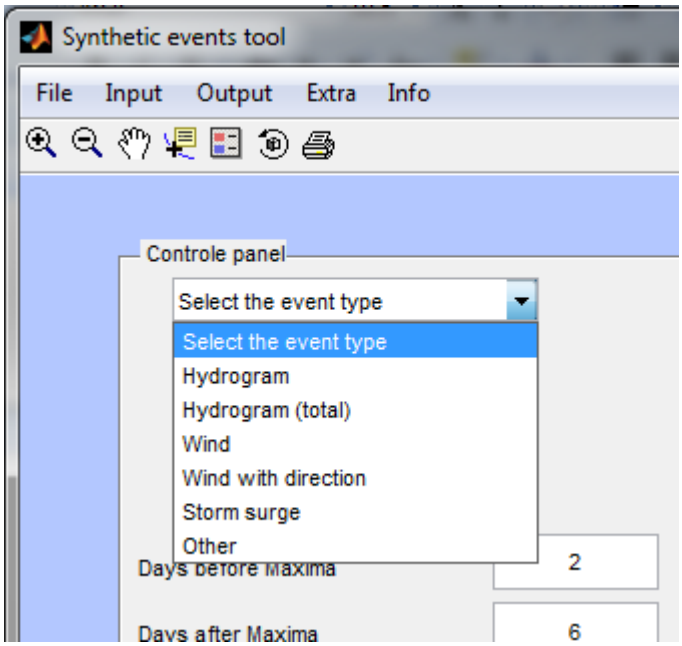


3.2 Control panel

3.2.1 Variables

The tool allows the creation of synthetic events for a range of variables (Figure 3-5). Some special variables like hydrograms and wind events with changing direction are extensively explained in the Synthetic Events Reference Guide (see Figure 1-1). These special cases handle the use of multiple corresponding time series (baseflow and runoff and wind speed and wind direction) and will not be discussed in this manual.

Figure 3-5: Selection of the variables

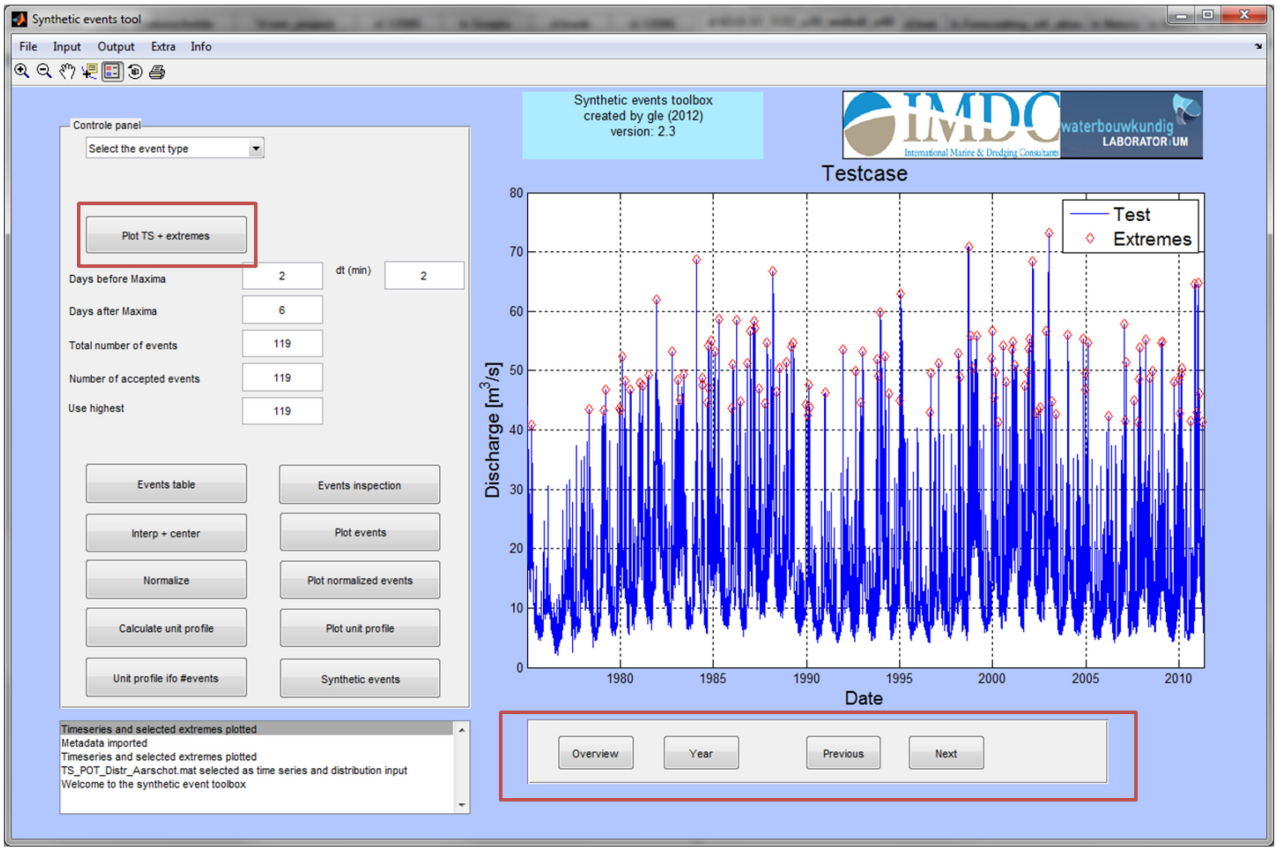


3.2.2 Time series and POT

The imported time series and POT can be plotted in the main figure (Figure 3-6). A tool bar will appear under the figure with the buttons Overview, Year, Previous and Next. These buttons allow a quick check scrolling over the time series with a time frame of one year. The inherent Matlab zoom and pan functions are also available in the upper left corner.

The figure with the time series and POT values is interactive. POT values can be excluded in the further analysis by clicking. A first click will highlight the POT value and give its information in the log box. A second click on a highlighted POT value will exclude it.

Figure 3-6: Time series and POT plot



3.2.3 Input values

The input values to be completed by the user for the selection of extreme events are ‘Days before Maxima’, ‘Days after Maxima’, time interval (dt) and ‘Use highest’ (Figure 3-7). The values ‘Total number of events’ and ‘Number of accepted events’ will be completed by the tool.

The variables ‘Days before Maxima’ and ‘Days after Maxima’ determine the time frame of the selected of events and therefore the time frame of the synthetic events. The days before and after are calculated relative to the time to the peak value. The value ‘dt’ gives the time resolution of the resulting synthetic event. The input value ‘Use highest’ gives the number of real events that will be used to generate the unit profile and the synthetic event.

Figure 3-7: Input values

3.2.4 Event inspection

The events that will be used to generate the unit profile can be inspected by clicking the button 'Events table' (Figure 3-8). This will give a table (Figure 3-9) with all the POT values and a checkbox to include or exclude them in the analysis.

Figure 3-8: Event inspection

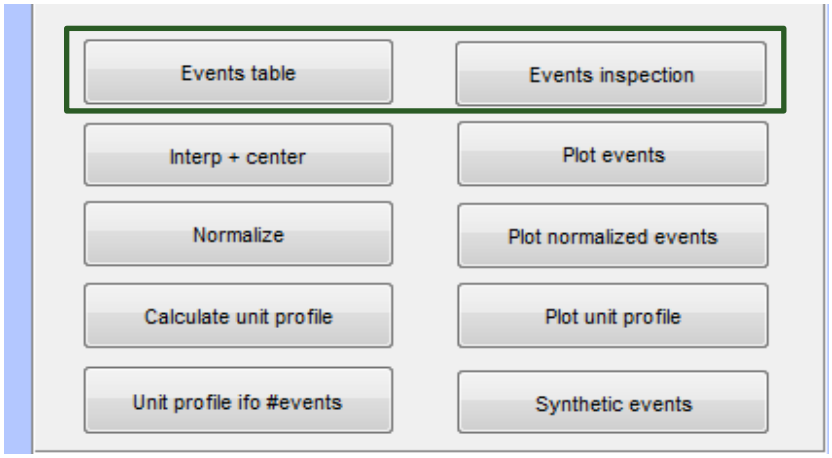
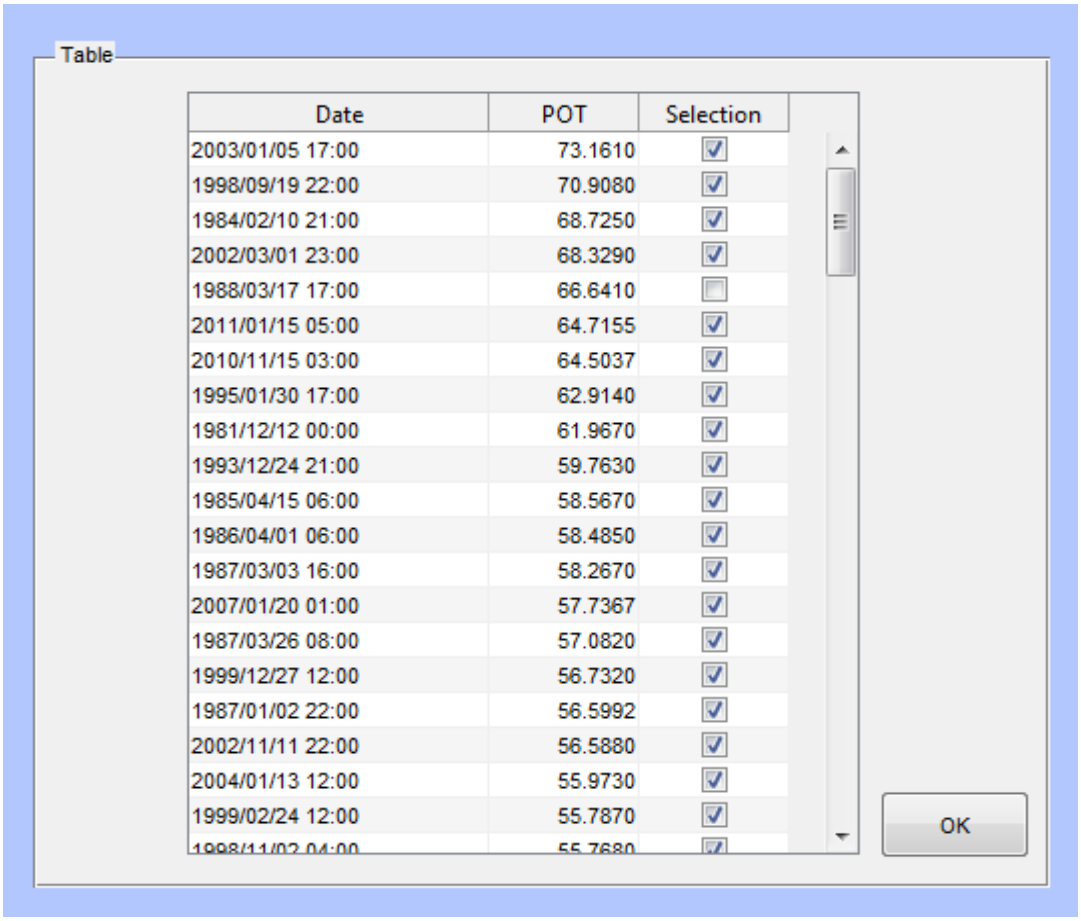


Figure 3-9: Table with all the POT values

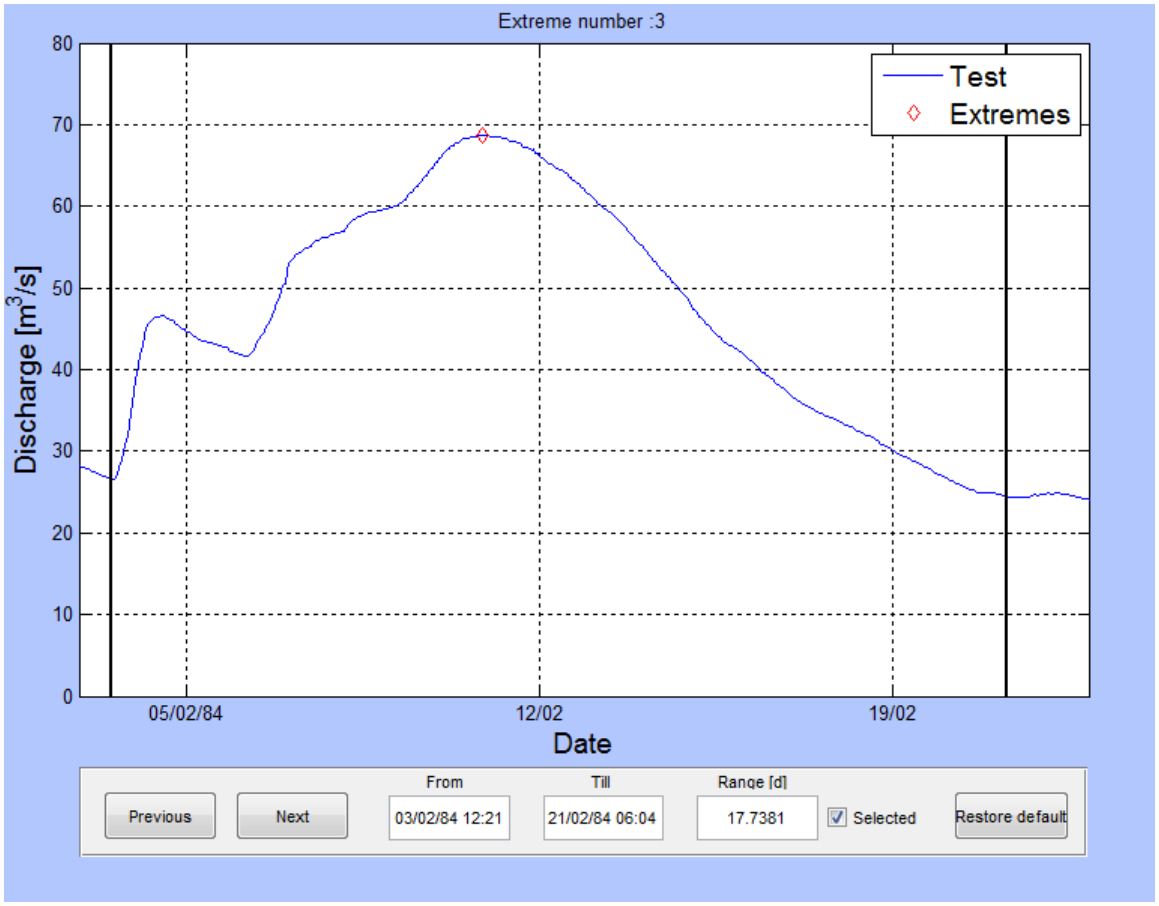


It is important to get the entire time frame of each event. A fixed number of days before and after will be suitable for a number of events, but will cutoff the events that are longer or take multiple events if some events are much shorter. Clicking the 'Events inspection' button (Figure 3-8) will allow the user to scroll through the events for visual inspection and manual adaptation of the time frame.

The events will be sorted from large to small and the default time frame of the input values is given by the black lines (Figure 3-10). These black line are interactive and can be selected by clicking. This turns them into a dotted line. A second click on the wanted location moves the line to that location. A second click on the dotted line will deselect it.

The toolbar under the figure can be used to scroll over the events (Previous and Next). The start date and end date of the selected event are given in editable textboxes. An adaptation in these boxes will also set the date as wanted and update the figure. The checkbox 'Selected' includes or excludes an event in or from the analysis. The 'Restore default' button will set the start and end date to the default values as given by 'Days before Maxima' and 'Days after Maxima' values.

Figure 3-10: Set time frame of the event



3.2.5 Calculation of Unit profile

The calculation of a unit profile consists of 3 steps: the interpolation and centering of the real events, the normalization of the events and finally the calculation of the unit profile (Figure 3-11).

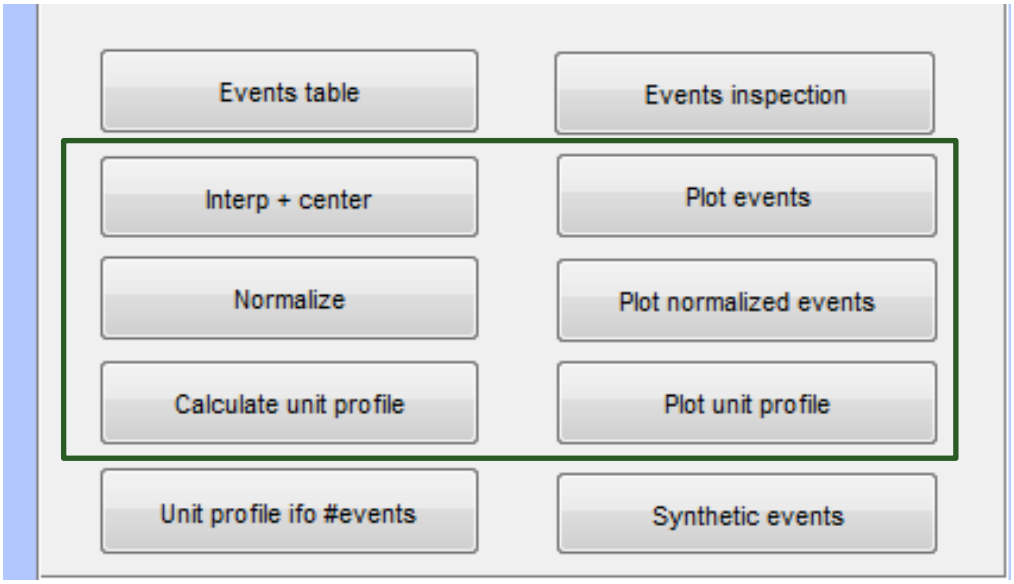
The events are interpolated on a time frame relative to their peak and with a time step defined by 'dt' when clicking the 'Interp + center' button. So a plot will give all the peaks at time t=0. The total time frame is equal to the longest event. Shorter events are extended by a linear interpolation between the end value and the lowest value in the excluded period.

The centered events can be plotted together for visual inspection by clicking the 'Plot events' button. This is once again an interactive figure. An event can be selected by clicking on the event line. The line will turn red when selected and the real date will appear in the log list box. The event can be excluded by a second click on a selected line. After an event is excluded it is important to redo the interpolation and centering calculation (button 'Interp + center').

The events are normalized between 0 and 1 with the button 'normalize'. The normalized events are visualized together with the 'Plot normalized events' button. This plot has the same interactive functionalities as the events plot.

Finally the unit profile is calculated based on the number of highest selected events in the Input Values dialogue (see Figure 3-7).

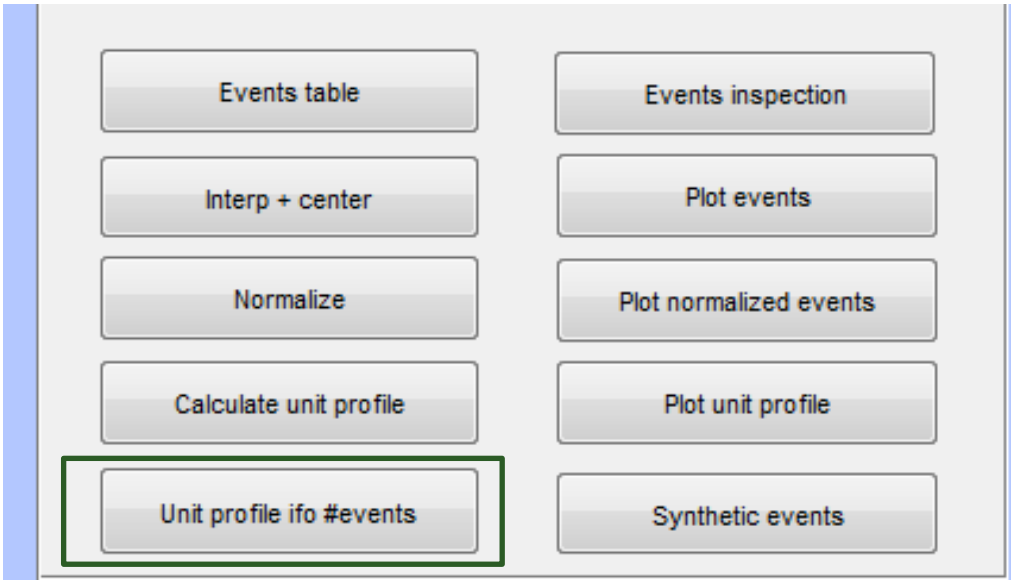
Figure 3-11: Calculation of unit profile buttons



3.2.6 Choice of number of events

The number of events used in the calculation of the unit profile has to be high enough to take the natural variation into account and low enough to get the typical profile of an extreme event. To study the effect of additional events the button 'Unit profile ifo #events' is included (Figure 3-12). This gives the stepwise evolution of the unit profile in function of the number of events.

Figure 3-12: Unit profile in function of the number of events



3.2.7 Output of synthetic events

Finally the unit profile is combined with synthetic extremes (strata) with a known probability of occurrence to get synthetic events (Figure 3-13). The tool will ask for some extra information before generating output files (Figure 3-14).

A time shift can be applied on the entire time series. If the peak discharge of a tributary occurs 1 hour before the peak of the main river, a time shift of -1 hour has to be applied on the synthetic event of the tributary.

The length of the synthetic event is limited to the length of the unit profile. If the synthetic events of multiple variables will be combined in one numerical model, the boundary conditions have to cover the entire simulation period. This can be accomplished with the input variables '#days before time zero' and '#days after time zero' (Figure 3-14, left). The value of the synthetic event in this extended period is also user input.

The synthetic events will be visualized and exported in an Excel file or in dfs0 (Mike by DHI) format (Figure 3-14, right).

Figure 3-13: Output of the synthetic events

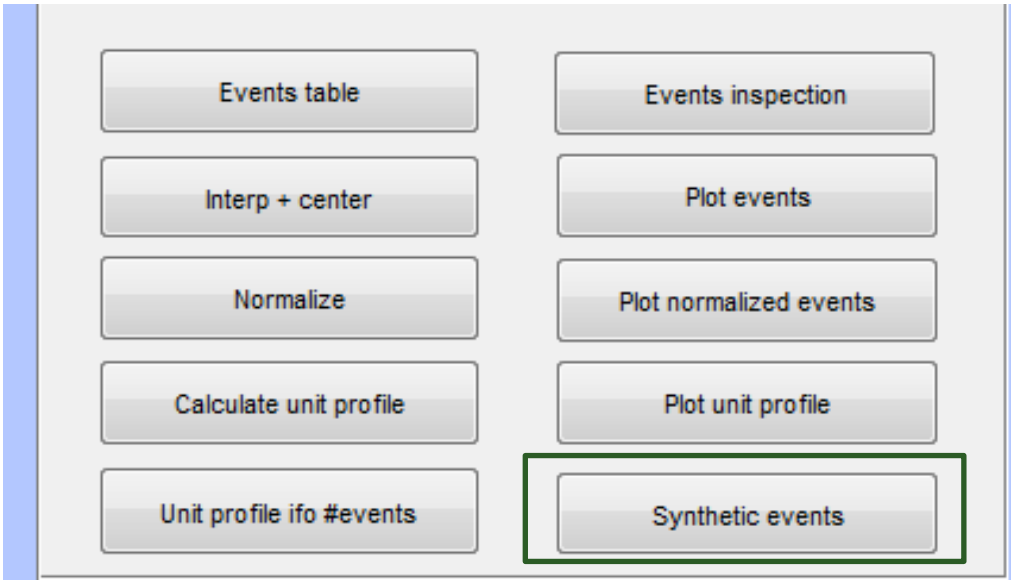
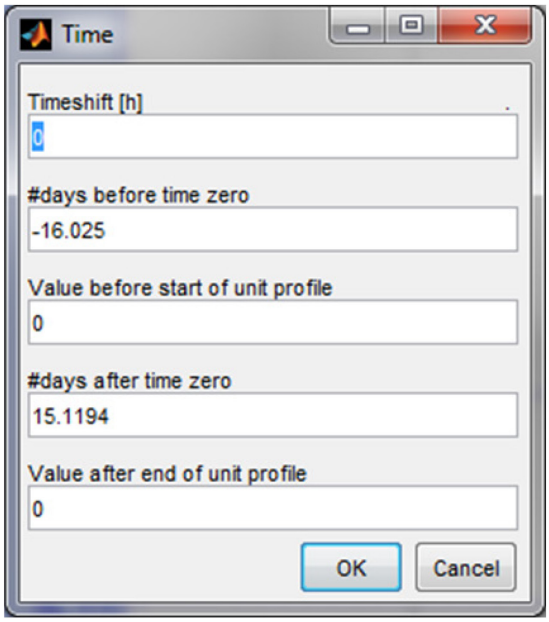
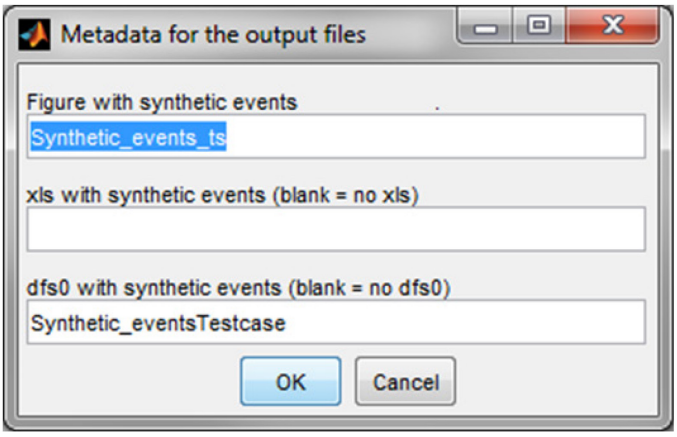


Figure 3-14: Output variables for synthetic events





4 References

Matlab, 2011: http://www.mathworks.com/help/toolbox/compiler/f12-999353.html#br2jauc-33 (retrieved on 15/05/2011).

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