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EVA

Extreme Value Analysis

User Guide

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CONTENTS

1 Setup

1.1 Introduction

The EVA editor consists of a *Tree view*, a *Data view* and an *Error message view* (see Figure 1.1). The *Tree view* controls the content of the *Data view*. The *Data view* is used to display the property pages for the *Setup* and the *Output*.
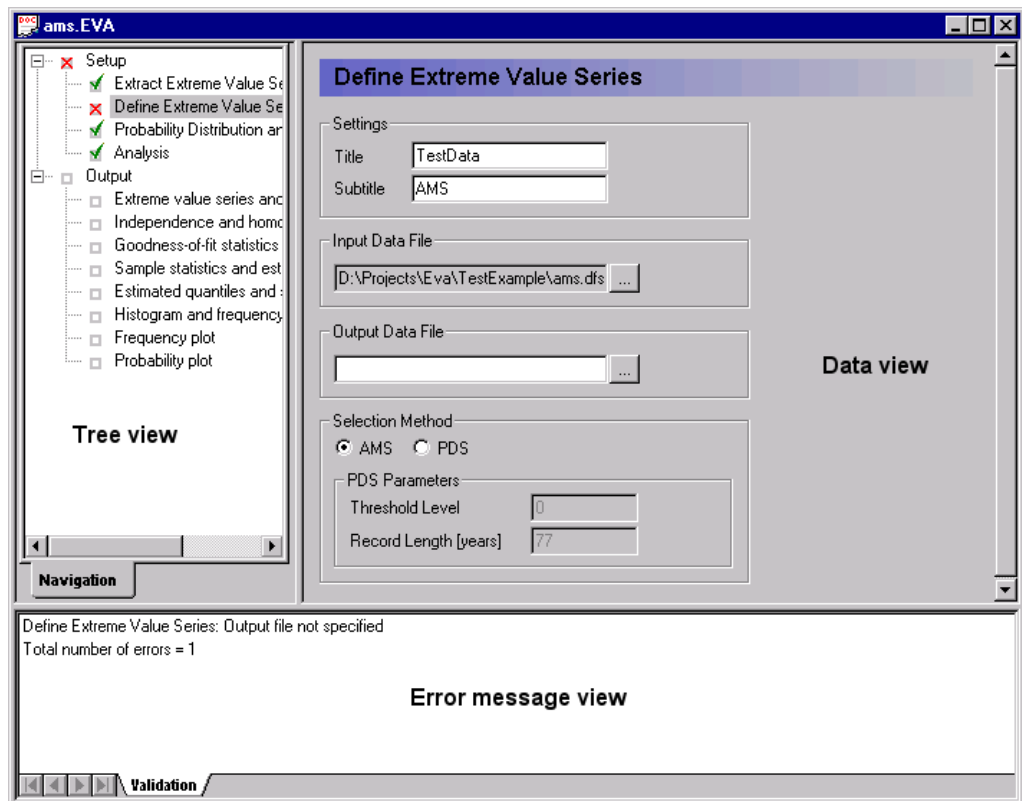
Figure 1.1   EVA editor structure and user interface

The input is automatically validated and input errors are written in the *Error message view*. If a page has been visited and contains invalid input, it will be marked with an *Invalid data* icon in the tree view. If all input fields are filled in correctly, the page will be marked with a *Valid data* icon (see Figure 1.1).

The EVA setup consists of 4 pages:

● Extract Extreme Value Series

- Define Extreme Value Series
- Probability Distribution and Estimation Method
- Analysis

The contents of these pages is explained in this section. The EVA output pages are described in Section 2.

1.2   Extract Extreme Value Series

The *Extract Extreme Value Series* page is used for extraction of the extreme value series from a time series file (see Figure 1.2). The page is optional. If the extreme value series is defined, the different settings are specified directly in the *Define Extreme Value Series* page. When the extreme value series has been extracted, the specifications from this page are automatically transferred to the *Define Extreme Value Series* page.

Figure 1.2   Extract Extreme Value Series page

1.2.1   Input data file

The time series to be analysed is specified in the *Input Data File* field. The time series is defined as an item in a Dfs time series file (file type *.dfs0 or *.dt0).

1.2.2 Output data file

The extracted extreme value series is saved in the *Output Data File* (Dfs time series file type *.dfs0 or *.dt0).

1.2.3 Selection method

Two different extreme value analysis methods are supported by EVA. The Annual Maximum Series (*AMS*) method and the Partial Duration Series (*PDS*) method. The method to be used for extraction of the extreme value series is specified.

1.2.4 AMS parameters

In the AMS method the maximum value in each analysis year is extracted for the extreme value analysis. In this case, the *Start Date* of the analysis year must be specified.

Depending on the dates of the first and last data points in the time series, the first and last analysis year may not include a whole year of data points. Furthermore, large gaps may exist in the record. In such cases one should be careful in interpreting the extracted value as the annual maximum value (e.g. if only data from the dry season are included in the analysis year).

1.2.5 PDS parameters

For the PDS method the *Record Length* is specified. This value is used for calculation of the average annual number of extracted data points in the extreme value series.

Two different methods are available for defining the PDS. If the *Threshold Level* is specified, all exceedances above this level are extracted. If the average annual number of exceedances (*Avg. Annual No Exc.*) is specified, the *n* largest exceedances in the record are extracted where *n* is the record length times the average annual number of exceedances.

To ensure independent exceedances in the PDS restrictions on the time and the level between two successive events can be specified. If the *Inter Event Time* is specified, two successive events are extracted only if the time between the two events is larger than the specified interevent time criterion. If the time between the two events is smaller than the specified interevent time criterion, only the largest event is extracted. Besides the interevent time criterion, an *Inter Event Level* criterion (value between 0 and 1) can be specified. In this case two successive events are extracted only if the time between the two events is larger than the specified interevent time criterion and the level between the two events becomes smaller than the specified interevent level

criterion times the lower of the two events. If both criteria are not fulfilled, only the largest event is extracted.

1.2.6 Seasonal analysis

If the extreme value analysis should consider only extremes in part of the year (e.g. rainfall extremes in the monsoon season or runoff extremes in the snow melt season), this can be performed by specifying the season to be analysed (*Start* and *End* date of the season). In this case the analysis year for the AMS method is the specified season.

1.2.7 Extraction

When the various settings have been specified, the extraction program is ready for execution, and the *Extract* button is activated. When the extraction is completed, the message box in Figure 1.3 is shown.

Figure 1.3   Message box when extraction is completed
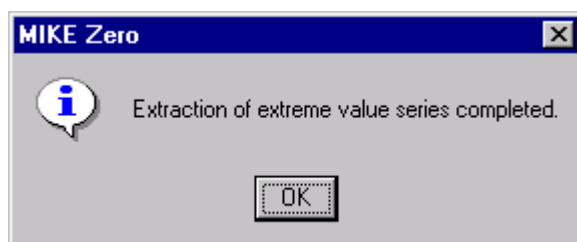
1.3 Define Extreme Value Series

The *Define Extreme Value Series* page is used for specification of the basic settings of the extreme value series to be analysed (see Figure 1.4). If the extreme value series has been extracted, the specifications of the *Selection Method* from the *Extract Extreme Value Series* are transferred to the *Define Extreme Value Series* page.

Figure 1.4   Define Extreme Value Series page

1.3.1   Settings

A *Title* and a *Subtitle* can be specified for the output pages.

1.3.2   Input data file

The extreme value time series file is specified in the *Input Data File* field (Dfs time series file type *.dfs0 or *.dt0).

1.3.3   Output data file

The *Output Data File* contains the results of the EVA analysis (EVA result file type *.RES). The result file is referred to in the EVA editor file (*.EVA). Thus, when an EVA editor file is opened that contains a result file from a previous run, the results from this run can be seen in the output pages (see Section 2).

1.3.4   Selection method

The applied extreme value series model is specified: *AMS* (annual maximum series model) or *PDS* (partial duration series model). In the case of *PDS* the *Threshold Level* and the *Record Length* are specified. If the threshold level is not used in the estimation of the distribution parameters, i.e. the location parameter is estimated from the data (see Section 1.4), the *Threshold Level*

is set to a dummy value. The record length is used for calculation of the average annual number of exceedances in the PDS.

1.4 Probability Distribution and Estimation Method

The *Probability Distribution and Estimation Method* page (see Figure 1.5) is used for specification of the different combinations of statistical distribution and estimation method to be analysed. The specified distribution and estimation method combinations are shown in the *D/E Combinations* list box.
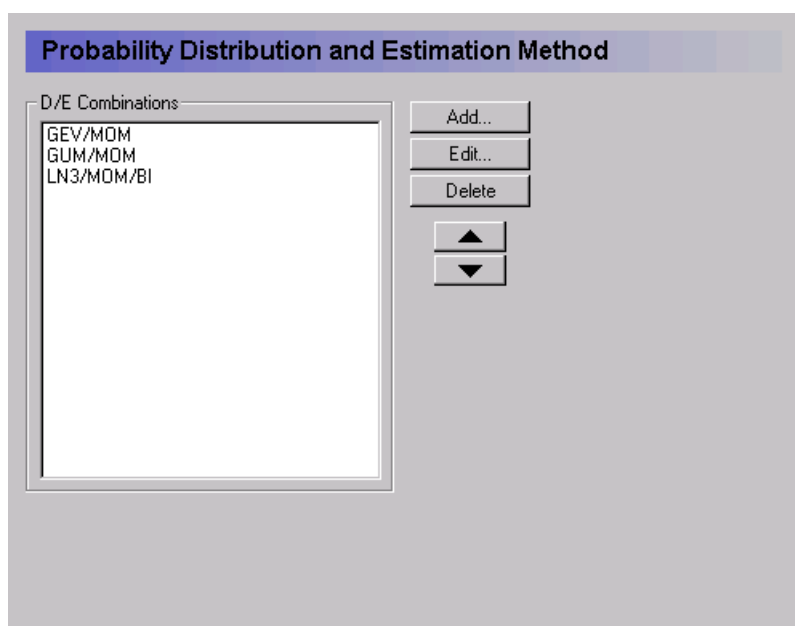
Figure 1.5   Probability Distribution and Estimation Method page

1.4.1 D/E combinations

Add
To add a new D/E combination to the list press the *Add*... button to open the D/E combination specification page (see Figure 1.6 and Figure 1.7).

Edit
To edit a D/E combination, mark the D/E combination in the list box and press the *Edit...* button to open the D/E combination specification page (Figure 1.6 and Figure 1.7).

Delete
To delete a D/E combination, mark the D/E combination in the list box and press the *Delete* button.

Change order

To change the order of the D/E combinations in the list box, use the up and down buttons to move a marked D/E combination up or down in the list.

1.4.2   Specify D/E combination for AMS

Figure 1.6   Specify D/E combination for AMS page

For specification of the distribution and estimation methods two pages are available, depending on the applied extreme value model. The *Specify D/E Combination for AMS* page is shown in Figure 1.6.

Distribution

For AMS, 9 different probability distributions are available as shown in the distribution list box in Figure 1.6. To select a distribution mark the distribution name in the list box.

Estimation method

In general, three different estimation methods are available: *Method of Moments*, *Maximum Likelihood* method, and *Method of L-moments*. However, not all estimation methods are available for the various distributions. For the selected distribution the available estimation methods will be highlighted in the *Estimation Method* list.

Name

A default name for the selected distribution and estimation method is specified in the *Name* field box. The default name can be changed by ticking the *Name* field and writing the new name in the box. The name is shown in the

D/E Combinations list box on the *Probability Distribution and Estimation Method* page. The specified name is used on the output pages (see Section 2).

Log-normal distribution

For the Log-normal distribution different specifications are required. If the *Estimate Location Parameter* is ticked, a three-parameter log-normal distribution is selected. Otherwise the two-parameter version of the log-normal distribution is assumed with a location parameter equal to zero.

For the three-parameter log-normal distribution, 4 different *Method of Moments* estimation methods are available:

- *Bias correction of skewness I*: Correction of the sample skewness using the Ishihara and Takase method

- *Bias correction of skewness II*: Correction of the sample skewness using the Bobée-Robitaille formula

- *Lower bound quantile method I*: Lower bound quantile estimator proposed by Iwai

- *Lower bound quantile method II*: Lower bound quantile estimator proposed by Stedinger

Log-Pearson Type 3 distribution

For the log-Pearson Type 3 distribution, two different *Method of Moments* estimation methods are available:

- *Moments in Log Space*: The parameters are estimated using the moments calculated from the logarithmic transformed data values

- *Moments in Real Space*: The parameters are estimated using the moments calculated from the real data values

Gumbel distribution

For the Gumbel distribution a *Sample Size Correction* can be applied for the *Method of Moments* estimation.

1.4.3   Specify D/E combination for PDS

The *Specify D/E Combination for PDS* page is shown in Figure 1.7.

Figure 1.7   Specify D/E Combination for PDS page

Distribution
For PDS, 7 different probability distributions are available as shown in the distribution list box in Figure 1.7. To select a distribution mark the distribution name in the list box.

Estimation method
In general, three different estimation methods are available: *Method of Moments*, *Maximum Likelihood* method, and *Method of L-moments*. However, not all estimation methods are available for the various distributions. For the selected distribution the available estimation methods will be highlighted in the *Estimation Method* list.

Name
A default name for the selected distribution and estimation method is specified in the *Name* field box. The default name can be changed by ticking the *Name* field and writing the new name in the box. The name is shown in the *D/E Combinations* list box on the *Probability Distribution and Estimation Method* page. The specified name is used on the output pages (see Section 2).

Location parameter
For the various PDS distributions, except the log-Pearson Type 3 distribution, two different versions are available. If a *Fixed Location Parameter* is selected, the *Threshold Level* specified on the *Define Extreme Value Series* page is used as location parameter, and the remaining parameters are estimated from the series of threshold exceedances (data values subtracted the threshold level). If *Estimate Location Parameter* is selected, the location parameter is estimated from the data values along with the other parameters.

Log-normal distribution

For the three-parameter log-normal distribution (*Estimate Location Parameter* option selected), 4 different *Method of Moments* estimation methods are available:

- *Bias correction of skewness I*: Correction of the sample skewness using the Ishihara and Takase method

- *Bias correction of skewness II*: Correction of the sample skewness using the Bobée-Robitaille formula

- *Lower bound quantile method I*: Lower bound quantile estimator proposed by Iwai

- *Lower bound quantile method II*: Lower bound quantile estimator proposed by Stedinger

Log-Pearson Type 3 distribution

For the log-Pearson Type 3 distribution, two different *Method of Moments* estimation methods are available:

- *Moments in Log Space*: The parameters are estimated using the moments calculated from the logarithmic transformed data values

- *Moments in Real Space*: The parameters are estimated using the moments calculated from the real data values

1.5 Analysis

Figure 1.8   Analysis page

The *Analysis* page (see Figure 1.8) is used for specifying various settings related to the analysis of the extreme value series and the specified distribution and estimation methods.

1.5.1 Independence and homogeneity tests

For testing independence and homogeneity of the observed extreme value series, three different test are available:

- *Run Test*: General non-parametric test for testing independence and homogeneity of a time series

- *Test for Trend*: Mann-Kendall test for testing monotonic trend of a time series

- *Test for Shift in Mean*: Mann-Whitney test for testing shift in the mean between two subsamples defined from the time series

Define subsamples
When applying the *Test for Shift in Mean* the two subsamples must be defined. The *Define Subsamples* dialog box is shown in Figure 1.9.

Figure 1.9   Define Subsamples dialog box

Three different options are available for defining the two subsamples:

- *Split sample test*: The time series is split in two subsamples according to the specified *Split Date*

- *Seasonal test*: When testing for seasonal differences (e.g. monsoon vs. non-monsoon extreme rainfalls or snowmelt vs. non-snowmelt runoff events), a seasonal test can be adopted. In this case the season (*Start* and *End* date) for defining the first subsample is specified

- *Custom*: In the general case, the two subsamples can be defined in the table. In the table the periods (*Start Date* and *End Date*) of the two sub-samples (*Sample* = 1 and *Sample* = 2) are specified. When filling in the table, the *End Date* for a specified sub-period of a sample is automatically taken as the *Start Date* for the next sub-period of the other sample. The *Tab* key is used to navigate in the table

1.5.2 Goodness of fit statistics

For comparing the goodness-of-fit of the selected distribution and estimation method combinations, six *Goodness of Fit Statistics* are provided by EVA:

- *Chi-squared*: Chi-squared test statistic
- *Kolmogorov-Smirnov*: Kolmogorov-Smirnov test statistic
- *SLSC*: Standardised least squares criterion
- *PPCC I*: Probability plot correlation coefficient based on the correlation between the ordered observations and the corresponding order statistics
- *PPCC II*: Probability plot correlation coefficient based on the correlation between the ordered reduced variate and the corresponding order statistic
- *Log-likelihood*: Log-likelihood measure

For the SLSC, PPCC I, and PPCC II statistics a *Plotting Position Method* must be specified. Five different plotting position formulae are available as shown in the list box in Figure 1.8.

1.5.3 Uncertainty calculations

Two different methods are available for evaluating the uncertainty of quantile estimates:

- *Monte Carlo*: Monte Carlo simulation
- *Jackknife*: Jackknife resampling

1.5.4 Evaluated return periods

The return periods (in years) for which quantile estimation has to be performed are specified in the *Evaluated Return Periods* table. The return periods are automatically sorted in ascending order. The *Tab* key is used to navigate in the table. To add return periods activate the tick box and mark the header of the retun period table then press the tab key on the keyboard to add additional rows in the table.

In the case of PDS an *Annual Return Period* option can be chosen corresponding to the *T*-year event definition for the annual maximum series. If this option is not chosen, the general PDS *T*-year event definition is applied.

1.5.5 Run program

When the various settings have been specified, the program is ready for execution, and the *Run* button is activated. If the computations are completed successfully, the message box in Figure 1.10 is shown.
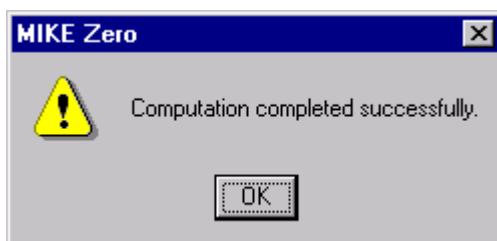
Figure 1.10   Message box when computations are completed successfully

If errors or warnings have occurred during the computation, the message box in Figure 1.11 is shown. Error and warning messages are written in the log file **EVA.log**.
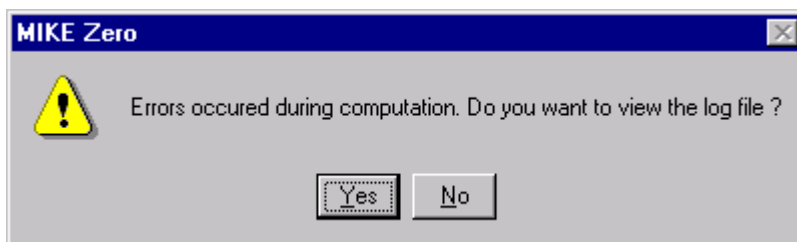
Figure 1.11   Message box when errors are given in the log file

1.6 Analysis of DFS2 Data Files

EVA also allows extreme value analysis of time series in a DFS2 file. For this option additional input that is not supported by the EVA editor has to be specified in the EVA specification file.

1.6.1 Input specifications

The setup of EVA with the DFS2 data file is done in two steps:

1. Setup of general EVA specifications for the extreme value analysis in the EVA editor in MIKE Zero. These settings are saved in the EVA specification file (.EVA).

    Note that you need a DFS0 file to setup the EVA specification file. You can extract this DFS0 file from your DFS2 file in the MIKE Zero Toolbox prior to running EVA.

2. Setup of DFS2 input in the EVA specification file (see Figure 1.12) using a text editor.

```
[Dfs2Input]
   UseDfs2Input = true
   Dfs2InputFile = |.\wa1981-1986nm27.dfs2|
   Dfs2ItemNo = 1
   X_Range_And_Interval = 0, 10, 1
   Y_Range_And_Interval = 0, 10, 1
   Time_Range_And_Interval = 0, 43824, 1
   Dfs2OutputFile = |.\waout1.dfs2|
   UncertaintyCal = true
   SaveEVS = true
EndSect  // Dfs2Input
```

Figure 1.12   Input specifications for the DFS2 option in the EVA specification file (.EVA)

In the DFS2 input section the following parameters are specified:

UseDfs2Input
This parameter is set to true if the DFS2 input option is used.

Dfs2InputFile
File name of the DFS2 file to be analysed.

Dfs2ItemNo
No. of the item in the DFS2 file to be analysed.

X_Range_And_Interval
Specification of the x-coordinate range of the sub-area of the DFS2 file to be analysed (x-coordinate of first point, x-coordinate of last point, frequency).

Y_Range_And_Interval
Specification of the y-coordinate range of the sub-area of the DFS2 file to be analysed (y-coordinate of first point, y-coordinate of last point, frequency).

Time_Range_And_Interval

Specification of the time range of the DFS2 file to be analysed (first time step, last time step, frequency).

Dfs2OutputFile

File name of output file.

UncertaintyCal

This parameter is set to true if uncertainty calculations are to be conducted. Note that these calculations can be very time consuming, especially if the Monte Carlo uncertainty analysis option is chosen.

SaveEVS

This parameter is set to true if the extracted extreme value series should be saved. In this case the extreme value series are saved in DFS0 files in the folder ExtremeValueSeries, which is created when EVA is executed. The files are given the name: Dfs2OutputFile_i_j.dfs0 where Dfs2OutputFile is the name of the DFS2 output file as specified in the .EVA file, and (i,j) refers to the grid point in the DFS2 input file.

1.6.2   Model execution

The EVA programme with DFS2 input can be executed from e.g. a command prompt using the following command:

> *evadfs2.exe MyModel.EVA*

where MyModel.EVA is the name of the .EVA specification file.

When EVA is running, temporary time series files are generated and saved on disk in the Windows Temporary folder (note that this operation may require large disk space). After completion the temporary files are deleted.

1.6.3   Output

The following output are saved as items in the output file:

- Moment estimates: Mean, standard deviation, skewness, and kurtosis
- L-moment estimates: L-CV, L-skewness, and L-kurtosis
- Estimated parameters for each analysed distribution (D/E combination) as specified in the .EVA file
- Goodness-of-fit statistics (if selected in the .EVA file) for each analysed distribution (D/E combination)
- Estimated quantiles and associated uncertainty estimates for the return periods specified in the .EVA file for each analysed distribution (D/E combination)

2 Output

2.1 Introduction

The output from EVA is written to an EVA result file (file type *.RES). The output is displayed in the *Output* pages in the EVA editor. Three different types of output are given:

- Text: Output is given as text, describing the results of the analysis.
- Table: Output values are ordered in a table.
- Graphics: Output is given as graphical charts/plots.

Eight different output pages are provided

- Extreme value series and plotting position
- Independence and homogeneity tests
- Goodness-of-fit statistics
- Sample statistics and estimated parameters
- Estimated quantiles and standard errors
- Histogram and frequency function
- Frequency plot
- Probability plot

Besides these pages, details of some of the analysis results are provided in text files. The output is described in detail below.

Different options are available for the output pages. When pressing the right mouse button in the *Data view*, an options dialog box will be opened. The dialog boxes for the text and table output and the graphical output are shown in Figure 2.1 and Figure 2.2.
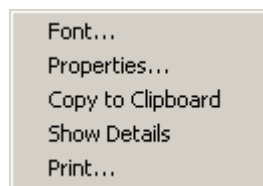
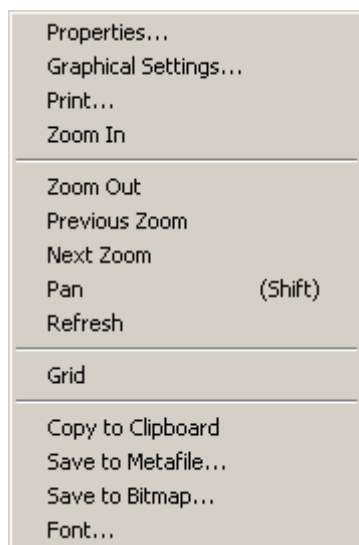Figure 2.1   Options dialog box for text and table output

Figure 2.2   Options dialog box for graphical output

Font
The font used in text and table output can be changed. The selected font is used for the entire output page.

Properties
Various settings that are used to display the results can be changed. The specific settings for the different output pages are described below.

Copy to Clipboard
Output displayed in the text and table output pages can be copied to the clipboard and imported directly into other programs. The text to be copied is marked with the mouse. If no text is marked, the entire content of the output page will be copied.

Copy to metafile
The graphical chart/plot is copied to a metafile (enhanced metafile type *.emf).

Print
The output page is sent to the printer.

Show details
The text file with details of the analysis is opened in a text editor. The content of the text files is described below.

Row height and column width
The row height and column width in the table output can be changed by dragging the row and column boundaries.
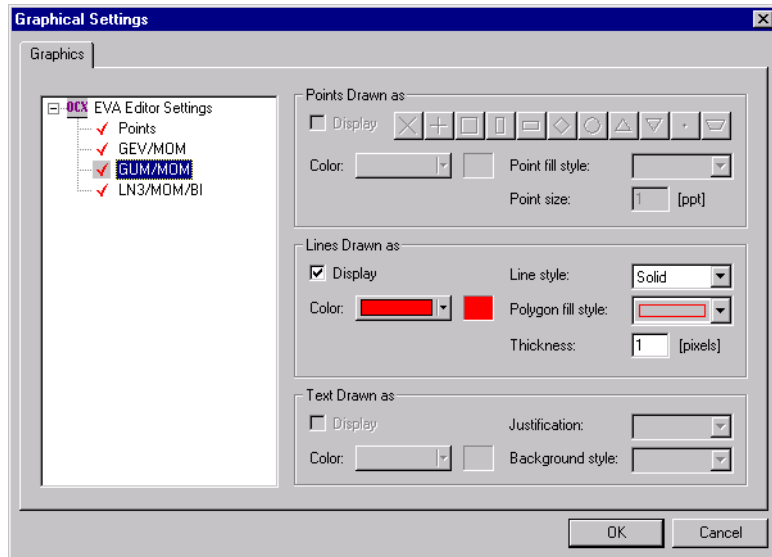
Figure 2.3   Graphical Settings dialog box

Graphical settings

For the graphical plots various settings can be changed. The graphical settings dialog box is shown in Figure 2.3.

Zoom

For the graphical plots different zoom functions are available.

Grid

On/off function for displaying the grid in the graphical plot.

2.2   Extreme Value Series and Plotting Position

In the *Extreme value series and plotting position* page the ordered extreme value series and the corresponding empirical exceedance probabilities are shown (see Figure 2.4). Five different plotting position formulae are supported for calculation of the exceedance probabilities.

		Plotting position (exceedance probability)				
Rank	**Data**	**Weibull**	**Hazen**	**Gringorten**	**Blom**	**Cunnane**
1	165.000	0.013	0.006	0.007	0.008	0.008
2	146.000	0.026	0.019	0.020	0.021	0.021
3	140.500	0.038	0.032	0.033	0.034	0.034
4	138.000	0.051	0.045	0.046	0.047	0.047
5	130.000	0.064	0.058	0.059	0.060	0.060
6	124.000	0.077	0.071	0.072	0.073	0.073
7	120.500	0.090	0.084	0.085	0.086	0.085
8	115.500	0.103	0.097	0.098	0.099	0.098
9	115.000	0.115	0.110	0.111	0.112	0.111
10	111.200	0.128	0.123	0.124	0.125	0.124
11	110.680	0.141	0.136	0.137	0.138	0.137
12	110.390	0.154	0.149	0.150	0.150	0.150
13	110.000	0.167	0.162	0.163	0.163	0.163
14	109.500	0.179	0.175	0.176	0.176	0.176
15	106.000	0.192	0.188	0.189	0.189	0.189
16	106.000	0.205	0.201	0.202	0.202	0.202
17	103.740	0.218	0.214	0.215	0.215	0.215
18	102.700	0.231	0.227	0.228	0.228	0.228
19	96.000	0.244	0.240	0.241	0.241	0.241
20	95.600	0.256	0.253	0.254	0.254	0.254
21	95.200	0.269	0.266	0.267	0.267	0.267

TestData — AMS

Figure 2.4   Extreme value series and plotting position output page

The settings for the page are shown in Figure 2.5. It is possible to specify which of the plotting positions to be displayed in the table output. Furthermore, the number precision (number of decimal places) can be specified.
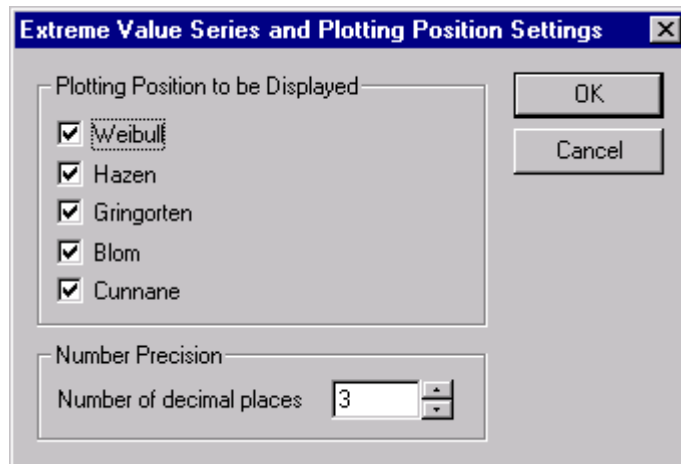
Figure 2.5   Extreme value series and plotting position settings

2.3   Independence and Homogeneity Tests

In the *Independence and homogeneity tests* output page the results of the applied independence and homogeneity tests are shown (see Figure 2.6). The calculated test statistic and the corresponding level of significance are shown.

The settings for the page are shown in Figure 2.7. It is possible to specify which of the results to be displayed on the output page.

```
TestData
AMS

Run test:
Test statistic = -0.23
Accepted at a 81.85% level of significance

Test for trend:
Test statistic = 0.56
Accepted at a 57.49% level of significance

Test for shift in mean:
Test statistic = -0.34
Accepted at a 73.18% level of significance
```
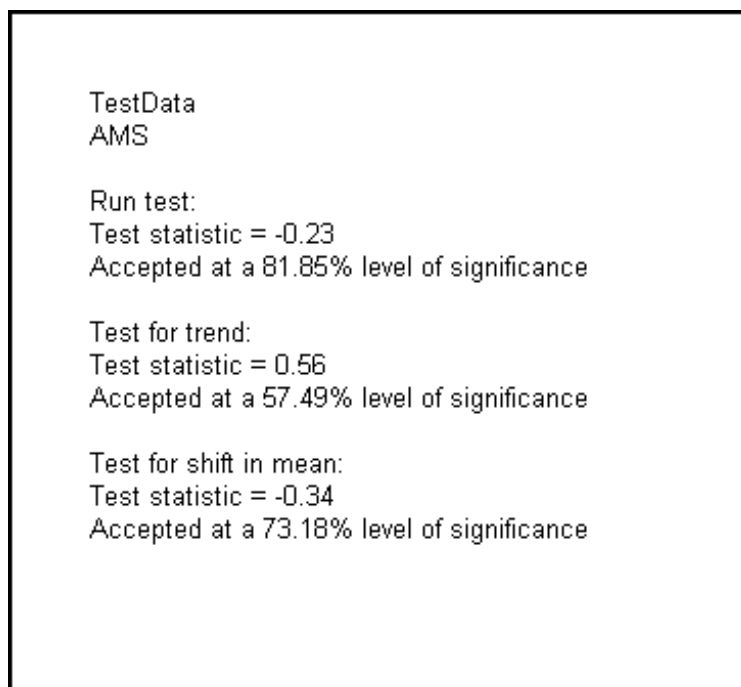
Figure 2.6   Independence and homogeneity tests output page
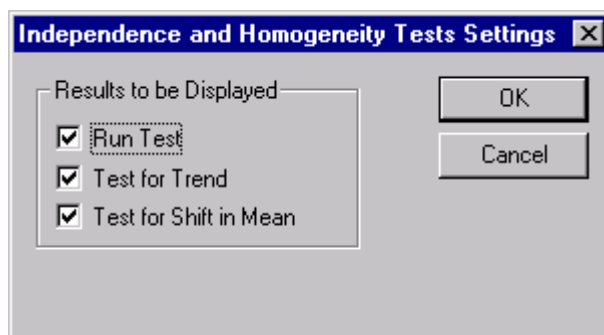
Figure 2.7   Independence and homogeneity tests settings

2.4   Goodness-of-fit Statistics

In the *Goodness-of-fit statistics* output page the calculated goodness-of-fit statistics for the selected distribution and estimation method combinations are shown (see Figure 2.8):

- *Chi-squared*: Chi-squared test statistic

- *Kolmogorov-Smirnov*: Kolmogorov-Smirnov test statistic

- *SLSC*: Standardised least squares criterion

- *PPCC1*: Probability plot correlation coefficient based on the ordered observations

- *PPCC2*: Probability plot correlation coefficient based on the reduced variate

- *Log-likelihood*: Log-likelihood measure

For the Chi-squared and the Kolmogorov-Smirnov tests also the corresponding level of significance is shown.

TestData			
AMS			
D/E Combination	Statistic	Value	Level of significance [%]
GEV/MOM	Chi-squared	6.766	34.301
	Kolmogorov-Smirnov	0.066	25.000
	SLSC	0.023	
	PPCC1	0.997	
	PPCC2	0.995	
	Log-likelihood	-361.894	
GUM/MOM	Chi-squared	10.403	16.688
	Kolmogorov-Smirnov	0.097	25.000
	SLSC	0.025	
	PPCC1	0.994	
	PPCC2	0.994	
	Log-likelihood	-363.422	
LN3/MOM/BI	Chi-squared	6.766	34.301
	Kolmogorov-Smirnov	0.067	25.000
	SLSC	0.019	
	PPCC1	0.997	
	PPCC2	0.997	
	Log-likelihood	-361.929	

Figure 2.8   Goodness-of-fit statistics output page

The settings for the page are shown in Figure 2.9. It is possible to specify which of the distribution and estimation method combinations and test statistics to be displayed on the output page. Furthermore, the number precision (number of decimal places) can be specified.
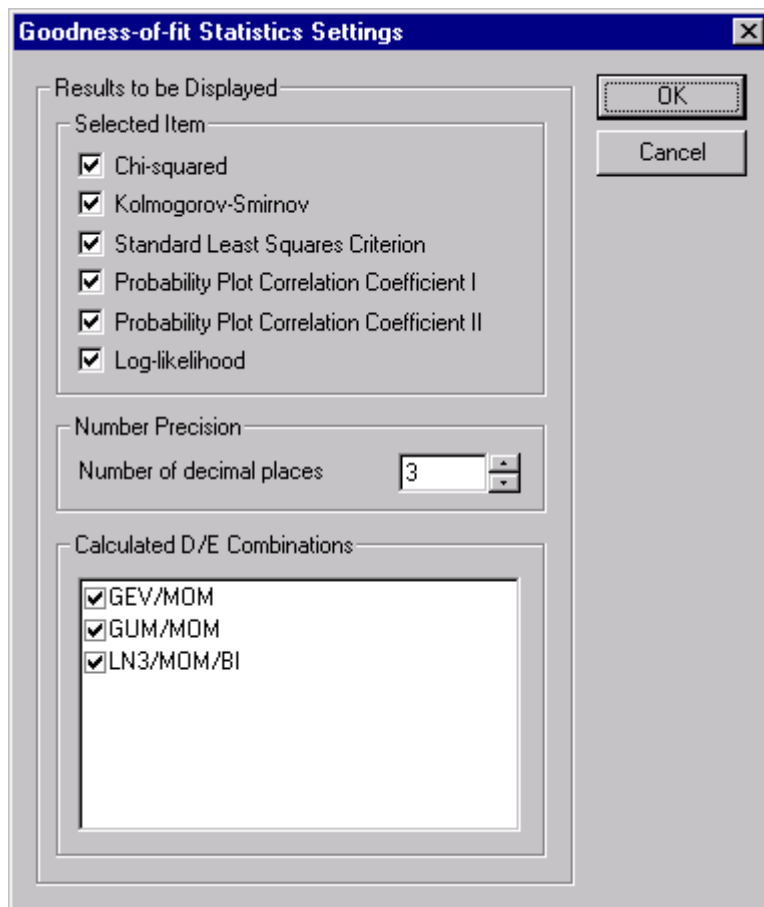
Figure 2.9   Goodness-of-fit statistics settings

Details of the calculation of the SLSC, PPCC1, and PPCC2 statistics are given in the file **EVAout1.txt** (see Figure 2.10). For the SLSC statistic, results for applying different formulae of the reduced variate are shown. These are denoted SLSC1, SLSC2 etc. according to the formulae given in the Scientific Documentation. The SLSC statistic on the EVA output page (Figure 2.8) corresponds to the SLSC1 formula.

Figure 2.10   Text file containing details of the calculation of the goodness-of-fit statistics

2.5   Sample Statistics and Estimated Parameters

The *Sample statistics and estimated parameters* output page is shown in Figure 2.11. The calculated sample statistics include:

- Sample size
- Average annual number of exceedances (in the case of PDS)
- Ordinary moments
- Probability weighted moments
- L-moments

For each of the chosen distribution and estimation method combinations, the estimated parameters are shown. The parameter names correspond to the nomenclature used in the Scientific Documentation.

The settings for the page are shown in Figure 2.12. It is possible to specify which of the calculated distribution and estimation method combinations to be displayed.

```
TestData
AMS

Sample statistics:

   Sample size                = 77

Ordinary moments:
   Mean      = 82.082
   Variance  = 758.566
   Skewness  = 0.527
   Kurtosis  = 3.135

Probability weighted moments:
   Beta-0    = 82.082
   Beta-1    = 48.803
   Beta-2    = 35.350
   Beta-3    = 27.945

L-moments:
   L-1       = 82.082
   L-2       = 15.523
   L-Skewness  = 0.088
   L-Kurtosis  = 0.125

Estimated parameters:

GEV/MOM
   Location parameter = 70.614
   Scale parameter = 24.678
   Shape parameter = 0.127
```

Figure 2.11   Sample statistics and estimated parameters output page
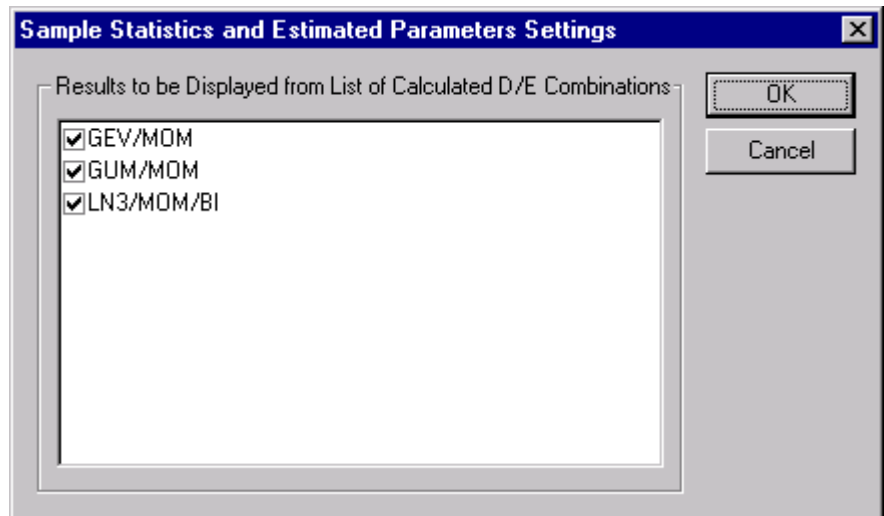
Figure 2.12   Sample statistics and estimated parameters settings

2.6   Estimated Quantiles and Standard Errors

The *estimated quantiles and standard errors* output page is shown in Figure 2.13. The output page contains for each distribution and estimation method combination the estimated quantiles together with the average quantiles and standard deviations obtained from the uncertainty calculations. Furthermore, the calculated goodness-of-fit statistics are shown in the table:

- *CHISQ*: Chi-squared test statistic

- *KS*: Kolmogorov-Smirnov test statistic

- *SLSC*: Standardised least squares criterion based on the SLSC1 formula

- *PPCC1*: Probability plot correlation coefficient based on the ordered observations

- *PPCC2*: Probability plot correlation coefficient based on the reduced variate

- *LLM*: Log-likelihood measure

TestData				
AMS				
		D/E Combination		
	Return Period [years]	**GEV/MOM**	**GUM/MOM**	**LN3/MOM/BI**
Estimated quantile	2.00	79.452	77.557	79.442
	5.00	104.325	101.897	103.925
	10.00	118.933	118.012	118.418
	20.00	131.699	133.470	131.361
	50.00	146.584	153.478	147.072
	100.00	156.642	168.472	158.265
	200.00	165.816	183.411	169.045
Average quantile	2.00	79.740	77.635	79.368
	5.00	104.352	101.812	103.609
	10.00	118.656	117.820	118.135
	20.00	131.094	133.174	131.249
	50.00	145.560	153.049	147.367
	100.00	155.340	167.943	158.998
	200.00	164.286	182.782	170.324
Standard deviation	2.00	3.310	2.877	3.357
	5.00	4.243	4.827	4.235
	10.00	5.213	6.505	5.354
	20.00	6.582	8.205	7.061
	50.00	9.014	10.467	10.128
	100.00	11.251	12.186	12.970
	200.00	13.758	13.911	16.210
Goodness-of-fit statistics	CHISQ	6.766	10.403	6.766
	KS	0.066	0.097	0.067
	SLSC	0.023	0.025	0.019
	PPCC1	0.997	0.994	0.997
	PPCC2	0.995	0.994	0.997
	LLM	-361.894	-363.422	-361.929

Figure 2.13   Estimated quantiles and standard errors output page

The settings of the page are shown in Figure 2.14. It is possible to specify which of the calculated distribution and estimation method combinations and goodness-of-fit statistics to be displayed. Furthermore, the number precision (number of decimal places) can be specified.
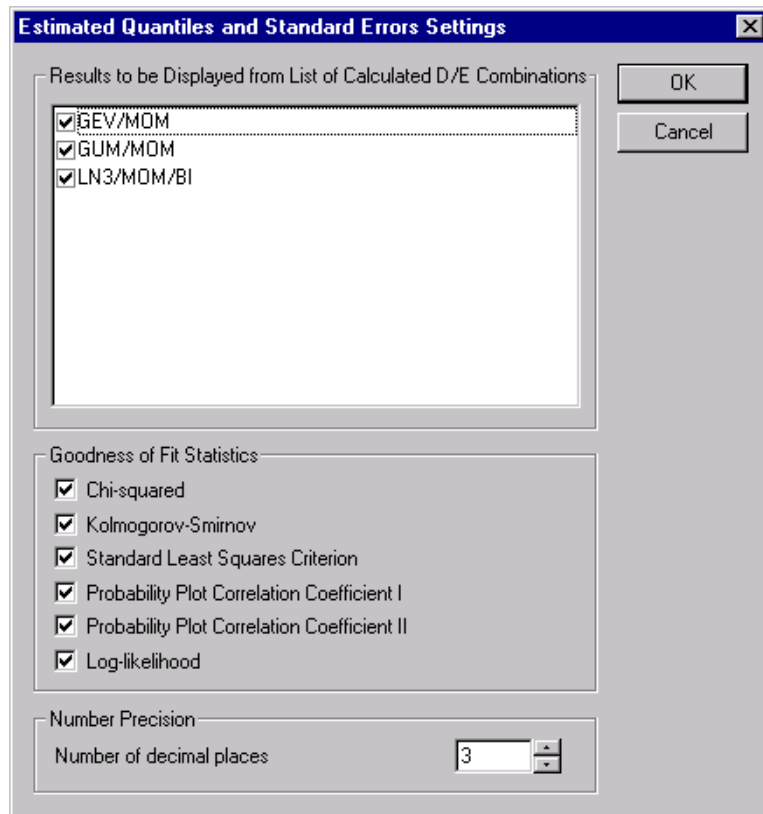
Figure 2.14   Estimated quantiles and standard errors settings

Details of the uncertainty calculations are given in the file **EVAout2.txt**. In the case of Monte Carlo simulation, the file contains information about the number of evaluated samples in the analysis (see Figure 2.15). The number of randomly generated samples is 10,000. In some cases, however, samples may be generated from which distribution parameters cannot be estimated or which result in unreasonable quantile estimates, implying fewer than 10,000 evaluated samples (see the Reference Manual for further information on this subject). In the case of Jackknife resampling the file contains information about the estimated quantiles for each of the evaluated subsamples (see Figure 2.16).

Figure 2.15   Text file containing details of the Monte Carlo simulation analysis

Figure 2.16   Text file containing details of the Jackknife resampling

2.7   Histogram and Frequency Function

The *Histogram and frequency function* output page is shown in Figure 2.17. In the table, the histogram as well as the estimated frequency for the selected distribution and estimation method combinations are shown.

The settings of the page are shown in Figure 2.18. It is possible to specify which of the selected distribution and estimation method combinations to be displayed. In addition, the number precision can be specified.

TestData				
AMS				
Histogram		Estimated Frequency		
Interval	Frequency	GEV/MOM	GUM/MOM	LN3/MOM/BI
32.00 - 52.00	0.00714	0.00545	0.00448	0.00540
52.00 - 72.00	0.00974	0.0134	0.0159	0.0134
72.00 - 92.00	0.0169	0.0144	0.0149	0.0146
92.00 - 112.00	0.0104	0.00940	0.00828	0.00944
112.00 - 132.00	0.00325	0.00449	0.00373	0.00436
132.00 - 152.00	0.00195	0.00170	0.00155	0.00160
152.00 - 172.00	0.000649	0.000511	0.000624	0.000505

Figure 2.17   Histogram and frequency function output page

Histogram and Frequency Distribution Settings

Results to be Displayed from List of Calculated D/E Combinations

☑ GEV/MOM
☑ GUM/MOM
☑ LN3/MOM/BI

OK
Cancel

Number Precision

Number of decimal places   3

Figure 2.18   Histogram and frequency function settings

2.8   Frequency Plot

The *Frequency plot* output page is shown in Figure 2.19. In this plot, the histogram is shown together with the estimated frequency functions for the selected distribution and estimation method combinations.

The settings of the page are shown in Figure 2.20. It is possible to specify which of the selected distribution and estimation method combinations to be displayed. The colour, style and thickness of the lines can be specified in the Graphical Settings (see Figure 2.3).
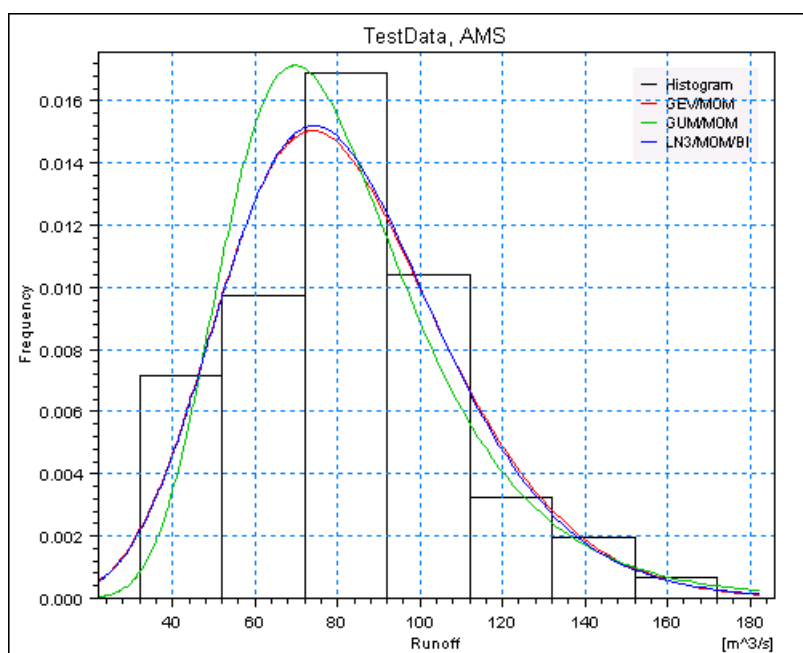

Figure 2.19   Frequency plot output page
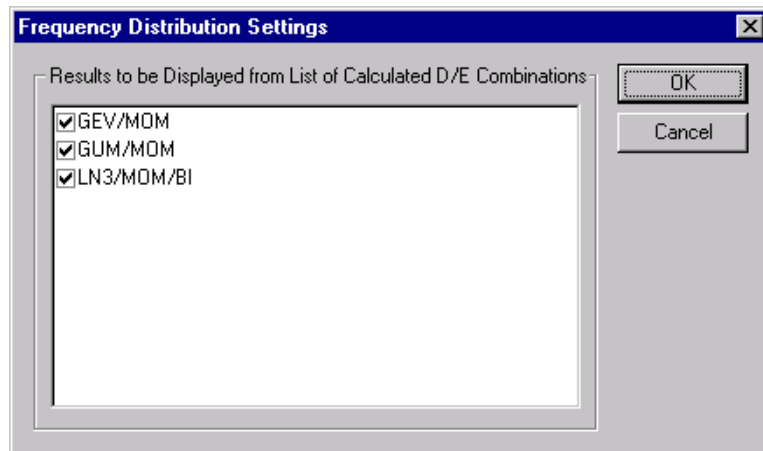
Figure 2.20　Frequency plot settings

2.9　Probability Plot

The *Probability plot* output page is shown in Figure 2.22. In this plot, the empirical probability distribution is compared to the estimated probability distributions for the selected distribution and estimation method combinations. The settings for the page are shown in Figure 2.21. Besides these settings, the colour, style and thickness of the lines can be specified in the Graphical Settings (see Figure 2.3).

Figure 2.21   Probability plot settings

Plotting position

The empirical probability distribution is plotted using a plotting position formula. The applied formula is specified in the *Plotting Position* list.

Probability paper

For plotting, three different probability papers are available:

- *Gumbel*: data points are plotted versus the Gumbel reduced variate. The Gumbel distribution is a straight line is this plot

- *Log-normal*: the logarithmic transformed data points are plotted versus the standard normal variate. The two-parameter log-normal distribution is a straight line in this plot

- *Semi-logarithmic*: data points are plotted versus the exponential reduced variate. The exponential distribution is a straight line in this plot

Confidence limits

The confidence limits of the estimated distributions can be shown by ticking *Display standard error of estimate* and specifying the *Frequency factor*. The confidence limits are calculated as $\tilde{x}_T \pm q s_T$ where $\tilde{x}_T$ is the mean value of the *T*-year event estimate, s_T is the corresponding standard deviation, and *q* is the frequency factor. Approximate 68% and 95% confidence limits correspond to *q* = 1 and *q* = 2, respectively.

Y-axis settings

Three different y-axis can be specified:

- *Probability*: non-exceedance probabilities

- Return period

- *Reduced variate*: Gumbel reduced variate, standard normal variate, or exponential reduced variate, depending on the selected probability paper
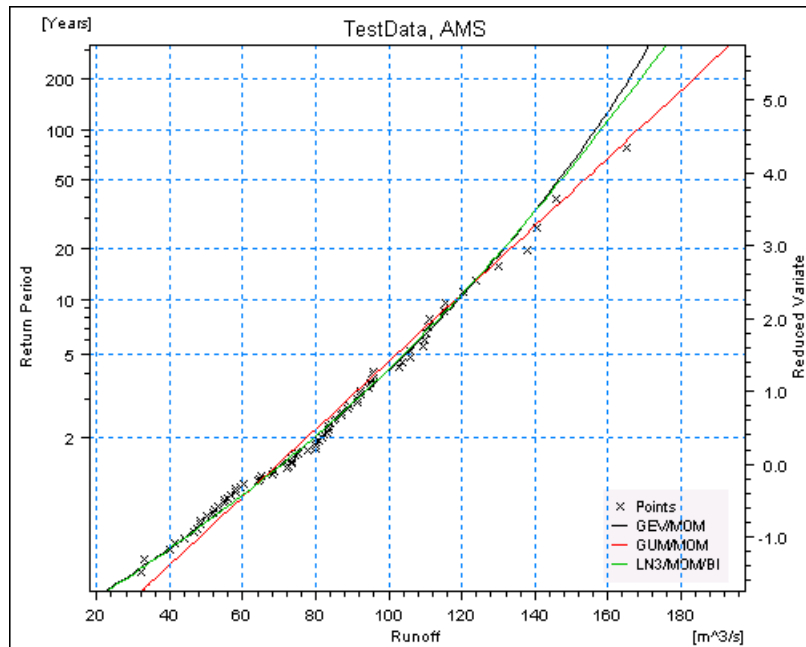

Figure 2.22   Probability plot output page

INDEX