



Software Package for Water Sciences

---

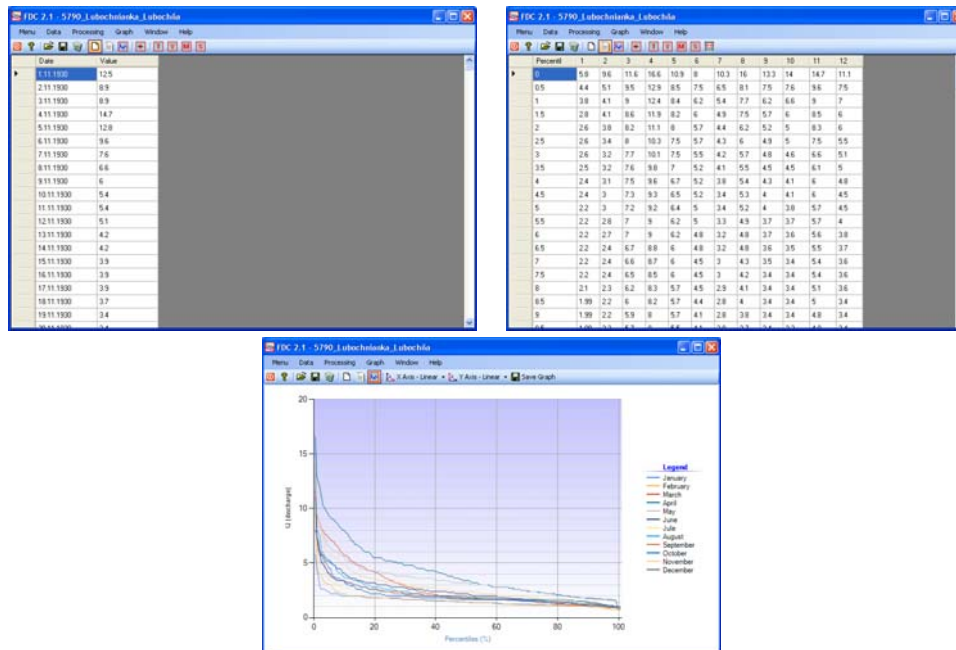
# FDC 2.1

## User's Manual

---

By Miloš Gregor

---



---

2010

---

<b>Product Name: FDC 2.1</b>
<b>Version: 2.1</b>
<b>Build: 6</b>
Author: <a href="#">Miloš Gregor</a> <sup>1,2,3</sup>
<sup>1</sup> Department of Hydrogeology, Faculty of Natural Science, Comenius University, Bratislava, Slovakia
<sup>2</sup> Department of Hydrogeology and Geothermal Energy, Geological Survey of Slovak Republic, Bratislava
<sup>3</sup> <a href="http://hydrooffice.org/">http://hydrooffice.org/</a> ( <a href="mailto:milos.gregor@hydrooffice.org">mailto:milos.gregor@hydrooffice.org</a> )
© Miloš Gregor, 2010-2020

## CONTENTS

INTRODUCTION.....	4
INPUT DATA.....	5
DATA PROCESSING.....	6
TABLE RESULT.....	7
GRAPH RESULT.....	10
BULK DATA PROCESSING.....	11
CONCLUSION.....	13
REFERENCES.....	13

## INTRODUCTION

This manual was created for the use of the FDC 2.1 module (build 6) for [HydroOffice 2010](#). The manual describes the functionality and limits of module use.

The FDC 2.1 module serves for the calculation and analysis of flow duration curves. This application was created primarily to deal with the analysis of hydrological drought in the author's work. The methodology is based on publication **Tallaksen & van Lannen (2004)**.

The primary impetus for the development of this module was the need for the analysis of flow duration curves for streams and rivers. This module contains a number of tools for comprehensive and effective work with flow duration curves. The duration curves can be processed for the entire time-series, e.g. for individual years, months, or for the filtered data. FDC 2.1 includes tools for bulk data processing and results can be analysed in tabular or graphical form. The module allows the processing of weekly, daily or hourly time-series.

To prepare the input file of time-series values it is necessary to study the manual – [How to prepare input data for modules](#). This manual briefly describes the preparation of input data for individual modules. The great advantage of HydroOffice 2010 is that all modules use the same structure of input data. Therefore prepared data for one module can be used in other modules.

Individual modules of HydroOffice 2010 use the same structured graphical user interface, so if you learn to use one module, the next transition to others will be greatly simplified.

For further study on the use of modules [video-tutorials](#) can be located on the [HydroOffice website](#). In the case you have any other questions, please use the [user forums](#) on the website, so that other users can give advise and receive advise on the solution to any problems. Also if you know a solution to a problem brought forward by another user, do not hesitate to help. The more you can help towards the forum, the sooner modules can be updated.

If you are using the HydroOffice tools, please quote them. If you not know what work you can cite, you can find them on [this site](#). If you quoted something, you can send me a citation to your work and I will add this to [citation page](#) with the reference to your work site.

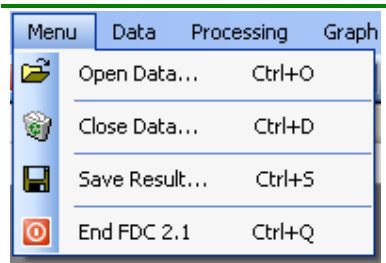
**Miloš Gregor**

(hydrogeologist, HydroOffice developer)

**HydroOffice**

## MAIN FUNCTIONS

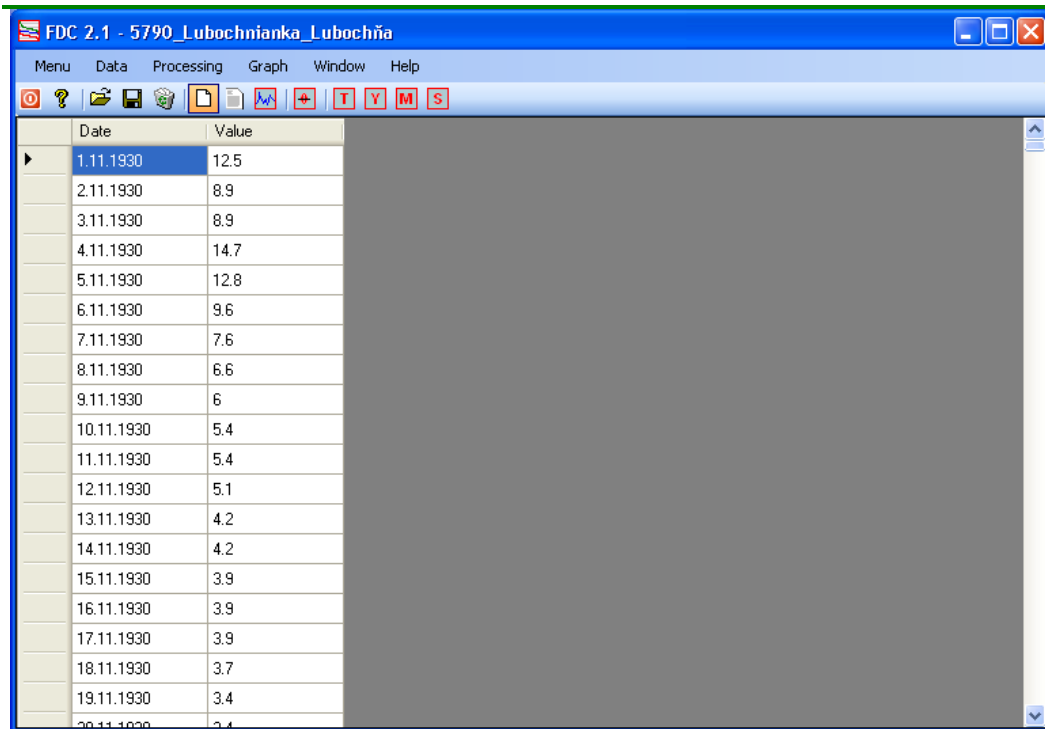
The basic features of the program are listed under **Menu** (*fig.1*) or the first buttons in the application toolbar. The function **Open Data** serves to import input data to the program. After entering the input file, data is stored in the table (*fig.2*).



**Fig. 1: Basic commands in FDC 2.1 module.**

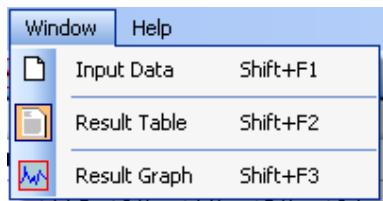
If the input file is formatted correctly, the dates, measurements and values are automatically divided into separate columns. Also at the end of the table there should not be more than one blank row. If there are more after the selection, pressing the **Delete** button will delete them. Prepared data can be used for further processing, which will be explained in the next chapter (*fig.3*).

In addition to the described functions in the menu there are also three other functions. **Close Data** serves to completely remove all data in the application. This command clears the input data table, the result data table and all chart results. **Save Result** function serves for the saving of calculated results. The program allows you to save the results into four types of files (\*.txt, \*.xls, \*.doc and \*.rtf). Due to difficulties with compatibility between different programs (e.g. MS Office), the results are not saving to selected file formats (e.g. \*.xls). It's always basically just a text file (\*.txt) that is automatically opened and processed in an associated program (e.g. \*.txt.xls). **End** function serves to force module termination.



Date	Value
1.11.1930	12.5
2.11.1930	8.9
3.11.1930	8.9
4.11.1930	14.7
5.11.1930	12.8
6.11.1930	9.6
7.11.1930	7.6
8.11.1930	6.6
9.11.1930	6
10.11.1930	5.4
11.11.1930	5.4
12.11.1930	5.1
13.11.1930	4.2
14.11.1930	4.2
15.11.1930	3.9
16.11.1930	3.9
17.11.1930	3.9
18.11.1930	3.7
19.11.1930	3.4
20.11.1930	3.4

**Fig. 2: The input data window of FDC 2.1 module.**

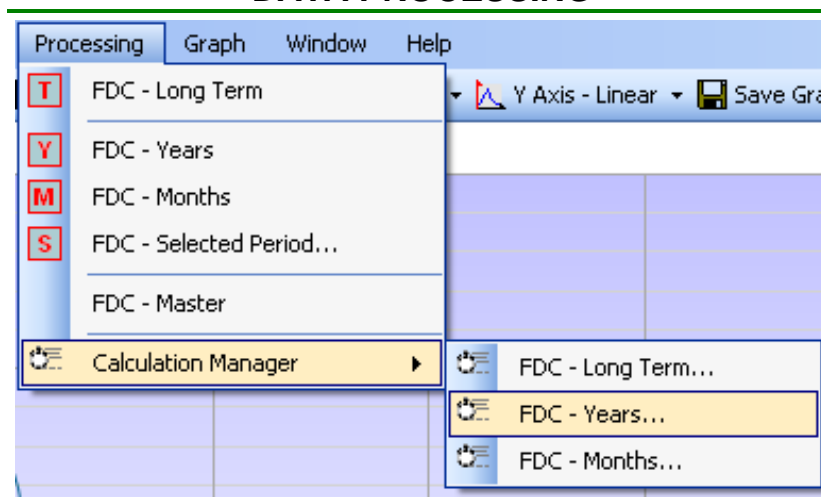


**Fig. 3: The commands for main tools switching.**

The main window can display three main parts. These parts can be selected by using commands in the **Window** menu (*fig.3*).

The **Data Input** command is used to show the table for imported input data. The **Result Table** command is used to display a table with the calculated results and the command **Result Graph** shows the calculated results in the form of a graph. In addition to the functions in the menu you can also find the same commands in the application toolbar.

## DATA PROCESSING



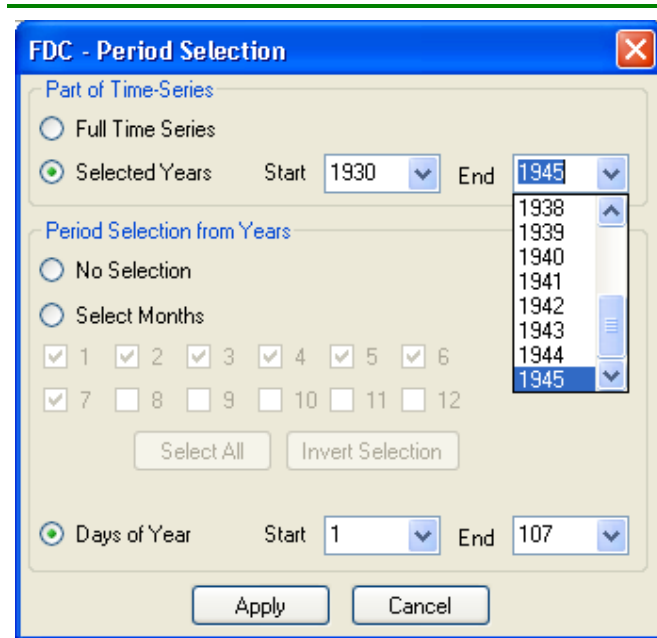
**Fig. 4: Main commands in FDC 2.1 program.**

As mentioned in the Introduction, this program was created primarily for the purpose of hydrological drought analysis on surface rivers and streams. Therefore, the module analysis options are designed for this purpose. All commands for data processing are in the **Processing** (*fig.4*) menu.

The module FDC 2.1 allows the processing of five types of flow duration curves.

- **FDC - Long Term.** This command begins generating the flow duration curves from whole imported time-series. The module generates a table with a percentage of flow probability. Individual percentiles are calculated in steps of 0.5 percentile.
- **FDC - Years** creates the flow duration curves for each single year.
- **FDC – Months** generates a flow duration curve for individual months from the imported time-series.
- **FDC – Master** generates a master flow duration curve. When this command is running, the flow duration curves are generated for a single year and the results for each percentile are averaged. When this function ends, a specific flow duration curve is created.
- The last function is **FDC - Selected Period.** This command starts the window shown in figure 5. This window is used to filter the imported

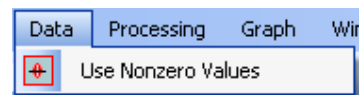
data. The displayed settings configure data, from which the program will then generate a flow duration curve. Users can select a range of years, months or select days of the year. Then when you press the button **Apply**, the program generates a flow duration curve from the filtered data.



**Fig. 5: Tool for generating flow duration curve from filtered data.**

In addition, the program also allows processing of the selected command for larger quantities of input data at once. This function will be explained in the last chapter of this manual.

Non zero values calculates the flow duration curve often used for the ephemeral streams and rivers in the time-series without zero values. To use



**Fig. 6: The function to delete the zero flow in time-series.**

this function in the program select - **Use Nonzero Values** from the **Data** menu (*fig.6*). This function deletes the imported time-series records with zero flow.

It is important that if you want to revert to the use of zero values, it is necessary to re-import time-series in the program.

The following text describes tabular and graphical results for the FDC 2.1 module.

## TABLE RESULT

This chapter aims to present a tabular form of the results. An example table of the results for the module is shown in figure 7.

Percentil	1	2	3	4	5	6	7	8	9	10	11	12
0	5.8	9.6	11.6	16.6	10.9	8	10.3	16	13.3	14	14.7	11.1
0.5	4.4	5.1	9.5	12.9	8.5	7.5	6.5	8.1	7.5	7.6	9.6	7.5
1	3.8	4.1	9	12.4	8.4	6.2	5.4	7.7	6.2	6.6	9	7
1.5	2.8	4.1	8.6	11.9	8.2	6	4.9	7.5	5.7	6	8.5	6
2	2.6	3.8	8.2	11.1	8	5.7	4.4	6.2	5.2	5	8.3	6
2.5	2.6	3.4	8	10.3	7.5	5.7	4.3	6	4.9	5	7.5	5.5
3	2.6	3.2	7.7	10.1	7.5	5.5	4.2	5.7	4.8	4.6	6.6	5.1
3.5	2.5	3.2	7.6	9.8	7	5.2	4.1	5.5	4.5	4.5	6.1	5
4	2.4	3.1	7.5	9.6	6.7	5.2	3.8	5.4	4.3	4.1	6	4.8
4.5	2.4	3	7.3	9.3	6.5	5.2	3.4	5.3	4	4.1	6	4.5
5	2.2	3	7.2	9.2	6.4	5	3.4	5.2	4	3.8	5.7	4.5
5.5	2.2	2.8	7	9	6.2	5	3.3	4.9	3.7	3.7	5.7	4
6	2.2	2.7	7	9	6.2	4.8	3.2	4.8	3.7	3.6	5.6	3.8
6.5	2.2	2.4	6.7	8.8	6	4.8	3.2	4.8	3.6	3.5	5.5	3.7
7	2.2	2.4	6.6	8.7	6	4.5	3	4.3	3.5	3.4	5.4	3.6
7.5	2.2	2.4	6.5	8.5	6	4.5	3	4.2	3.4	3.4	5.4	3.6
8	2.1	2.3	6.2	8.3	5.7	4.5	2.9	4.1	3.4	3.4	5.1	3.6
8.5	1.99	2.2	6	8.2	5.7	4.4	2.8	4	3.4	3.4	5	3.4
9	1.99	2.2	5.9	8	5.7	4.1	2.8	3.8	3.4	3.4	4.8	3.4
9.5	1.99	2.2	5.7	8	5.5	4.1	2.8	3.7	3.4	3.4	4.8	3.4

**Fig. 7: The example of calculated results in FDC 2.1 module.**

Percentil	Value
0	16.6
0.5	9.3
1	8.5
1.5	7.9
2	7.5
2.5	7
3	6.5
3.5	6.1
4	6
4.5	5.7
5	5.5
5.5	5.4
6	5.2
6.5	5.1
7	5
7.5	4.8
8	4.8
8.5	4.6
9	4.5
9.5	4.4

**Fig. 8: The basic structure of results table.**

If the user runs commands **FDC - Long Term**, **FDC - Selected Period** and **FDC - Mater**, they will have a table structure similar to that as shown in figure 8.

The structure of the table is simple. The first column shows the different percentiles of probability and the second column onwards are set for the calculated values. The above three commands will create a table structure as shown in figure 8.

If the user enters the command **FDC - Months**, the table will look like that of figure 9. The difference with the previous example that results are in twelve columns, each column contains values for a single month.

If the **FDC - Years** command is used, the table structure will be shown as in figure 10, where the number of columns will depend on the number of years in the imported time-series.



Percentil	1	2	3	4	5	6	7	8	9	10	11	12
0	5.8	9.6	11.6	16.6	10.9	8	10.3	16	13.3	14	14.7	11.1
0.5	4.4	5.1	9.5	12.9	8.5	7.5	6.5	8.1	7.5	7.6	9.6	7.5
1	3.8	4.1	9	12.4	8.4	6.2	5.4	7.7	6.2	6.6	9	7
1.5	2.8	4.1	8.6	11.9	8.2	6	4.9	7.5	5.7	6	8.5	6
2	2.6	3.8	8.2	11.1	8	5.7	4.4	6.2	5.2	5	8.3	6
2.5	2.6	3.4	8	10.3	7.5	5.7	4.3	6	4.9	5	7.5	5.5
3	2.6	3.2	7.7	10.1	7.5	5.5	4.2	5.7	4.8	4.6	6.6	5.1
3.5	2.5	3.2	7.6	9.8	7	5.2	4.1	5.5	4.5	4.5	6.1	5
4	2.4	3.1	7.5	9.6	6.7	5.2	3.8	5.4	4.3	4.1	6	4.8
4.5	2.4	3	7.3	9.3	6.5	5.2	3.4	5.3	4	4.1	6	4.5
5	2.2	3	7.2	9.2	6.4	5	3.4	5.2	4	3.8	5.7	4.5
5.5	2.2	2.8	7	9	6.2	5	3.3	4.9	3.7	3.7	5.7	4
6	2.2	2.7	7	9	6.2	4.8	3.2	4.8	3.7	3.6	5.6	3.8
6.5	2.2	2.4	6.7	8.8	6	4.8	3.2	4.8	3.6	3.5	5.5	3.7
7	2.2	2.4	6.6	8.7	6	4.5	3	4.3	3.5	3.4	5.4	3.6
7.5	2.2	2.4	6.5	8.5	6	4.5	3	4.2	3.4	3.4	5.4	3.6
8	2.1	2.3	6.2	8.3	5.7	4.5	2.9	4.1	3.4	3.4	5.1	3.6
8.5	1.99	2.2	6	8.2	5.7	4.4	2.8	4	3.4	3.4	5	3.4
9	1.99	2.2	5.9	8	5.7	4.1	2.8	3.8	3.4	3.4	4.8	3.4
9.5	1.99	2.2	5.7	8	5.5	4.1	2.8	3.7	3.4	3.4	4.8	3.4
10	1.99	2.2	5.7	8	5.5	4.1	2.8	3.7	3.4	3.4	4.8	3.4

**Fig. 9: The flow duration curves calculated for single months.**

Percentil	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1
0	14.7	15	9.2	6.8	11	12.5	9.6	13.3	16	11.1	8.6	1
0.5	12.8	6.6	7.9	4.7	6.5	8	8	10.2	9.8	10.3	7.2	1
1	12.8	5.4	7.3	3.8	6	8	7.5	9.9	7.6	9.8	6.5	11
1.5	12.8	5.2	6.6	3.7	4.9	7.2	7	9.6	7.5	9.6	6.5	11
2	12.5	5.1	6	3.6	4.4	6.6	6.4	8.8	7	8.8	6.2	9
2.5	12.5	5	5.4	3.3	4.2	6.5	6.2	8.4	6.7	8.5	6.1	8
3	12.5	4.8	5.1	3.2	3.9	6	6.1	8.2	6.5	8	5.7	7
3.5	12.5	4.6	4.8	3.1	3.7	6	6	8	6.5	7.5	5.5	7
4	11	4.6	4.8	3	3.7	5.9	6	8	6.5	7.5	5.5	7
4.5	11	4.5	4.5	3	3.7	5.7	5.8	7.8	6	7	5.4	7
5	11	4.5	4.3	2.9	3.4	5.6	5.7	7.7	5.9	6.7	5.1	6
5.5	10	4.2	4.2	2.8	3.4	5.5	5.7	7.5	5.7	6.5	5	6
6	10	4.2	4.2	2.8	3.2	5.3	5.5	7.5	5.5	6	4.9	6
6.5	10	4.1	4.2	2.7	3.2	5.3	5.4	7.2	5.2	6	4.8	6
7	10	3.9	4.2	2.7	3	5.1	5.4	7.2	5	5.8	4.8	5
7.5	9.6	3.8	4	2.7	3	5	5.3	6.5	4.8	5.7	4.7	5
8	9.6	3.7	3.8	2.7	2.9	4.8	5.2	6.1	4.8	5.5	4.5	5
8.5	9.6	3.4	3.7	2.5	2.9	4.7	5.2	6.1	4.5	5.5	4.4	5
9	9.6	3.4	3.6	2.5	2.8	4.4	5.1	6	4.5	5.5	4.2	5

**Fig. 10: The flow duration curves calculated for single months.**

Percentil	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
0	14.7	15	9.2	6.8	11	12.5	9.6	13.3	16	11.1	8.6	14	10.1	10.3	16.6	9.5
0.5	12.8	6.6	7.9	4.7	6.5	8	8	10.2	9.8	10.3	7.2	11.4	8	6.2	9.8	8.5
1	12.8	5.4	7.3	3.8	6	8	7.5	9.9	7.6	9.8	6.5	10.3	7.7	5.7	9.3	8.4
1.5	12.8	5.2	6.6	3.7	4.9	7.2	7	9.6	7.5	9.6	6.5	10.1	7.2	5.5	9	7.5
2	12.5	5.1	6	3.6	4.4	6.6	6.4	8.8	7	8.8	6.2	9	7	5.2	9	6.7
2.5	12.5	5	5.4	3.3	4.2	6.5	6.2	8.4	6.7	8.5	6.1	8.8	6.7	5.2	8.8	6.1
3	12.5	4.8	5.1	3.2	3.9	6	6.1	8.2	6.5	8	5.7	7.7	6.2	5	8.5	6
3.5	12.5	4.6	4.8	3.1	3.7	6	6	8	6.5	7.5	5.5	7.7	6.2	4.8	8	5.5
4	11	4.6	4.8	3	3.7	5.9	6	8	6.5	7.5	5.5	7.5	6	4.5	7.7	5.4
4.5	11	4.5	4.5	3	3.7	5.7	5.8	7.8	6	7	5.4	7	5.7	4.3	7.7	5.3
5	11	4.5	4.3	2.9	3.4	5.6	5.7	7.7	5.9	6.7	5.1	6.7	5.7	4.1	7	5.1

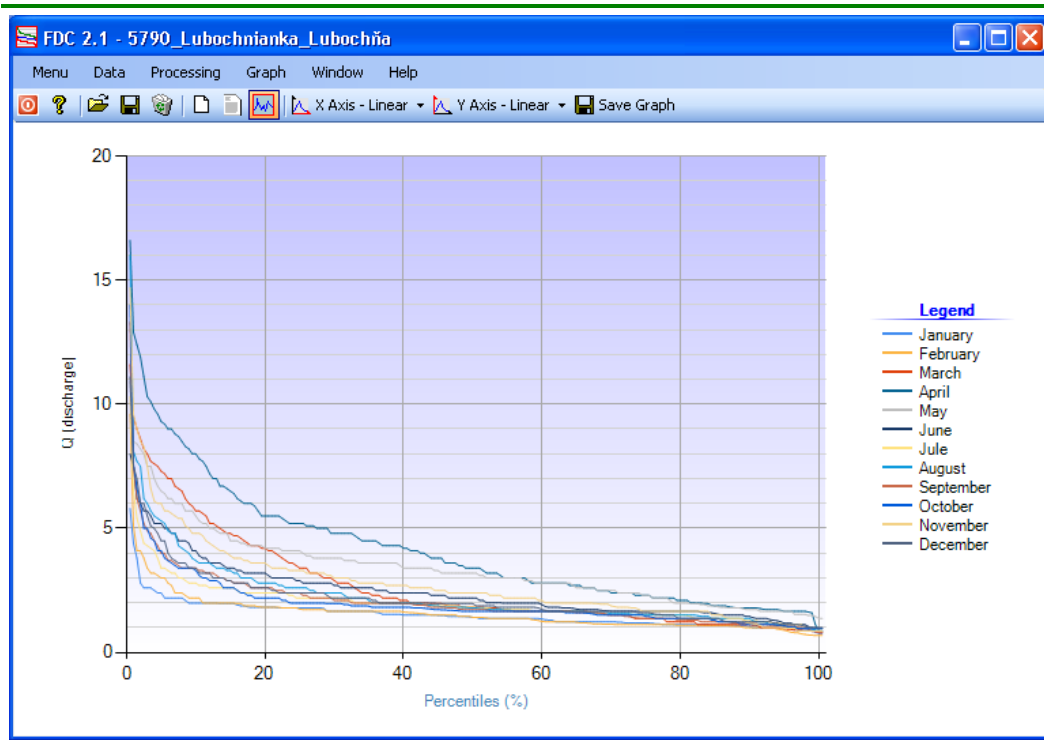
**Fig. 11: The results data example exported from FDC 2.1 module into text file.**

All tabular results can be exported by using - **Save** found in the command menu. Figure 11 is a result example exported from the module to a text file.

In addition to tabular results, results can be analysed in graphical form.

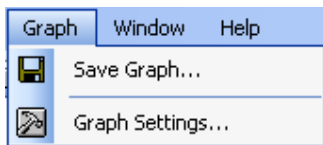
## GRAPH RESULT

After you run the selected command in addition to tabular results it generates a graph (**fig.12**). Number of series in the graph is dependent on the number of columns in the results table.



**Fig. 12: The example of results visualization in graph form.**

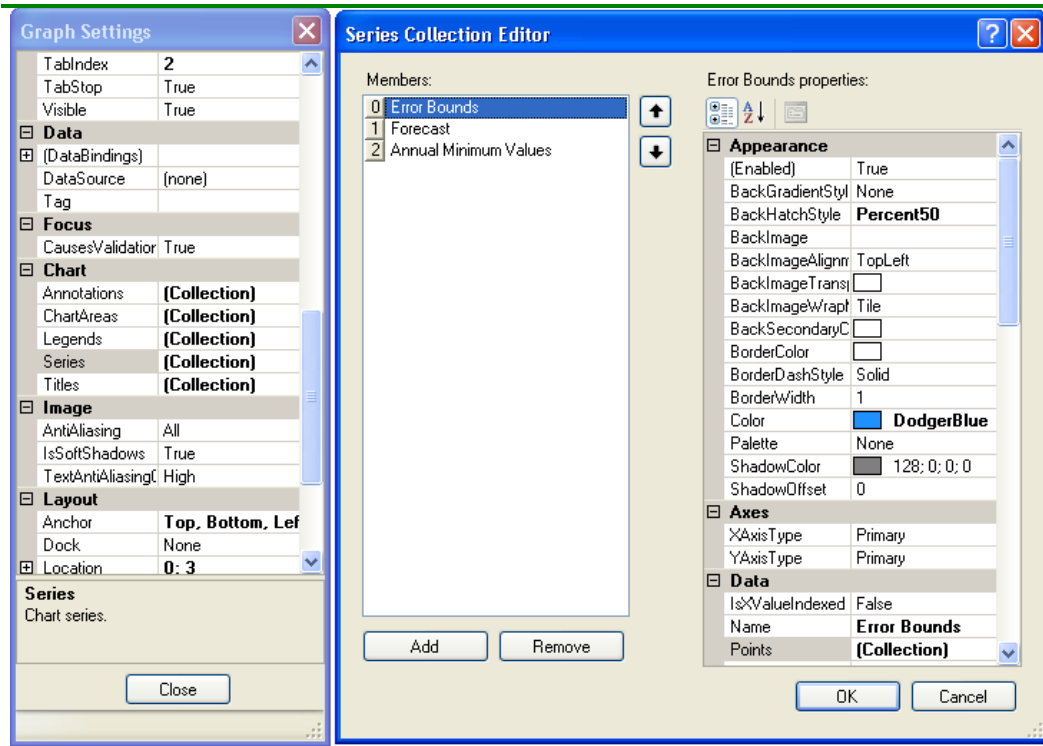
The advantage of this module is that the user can see a graph visually before exporting. Run the graphical tool commands in the menu **Graph** (**fig.13**).



**Fig. 13: The commands for graph editing.**

This menu contains a feature **Save Graph**. The FDC 2.1 module allows you to export generated charts from the program in six formats (\*.bmp, \*.emf, \*.gif, \*.jpeg, \*.png, \*.tiff).

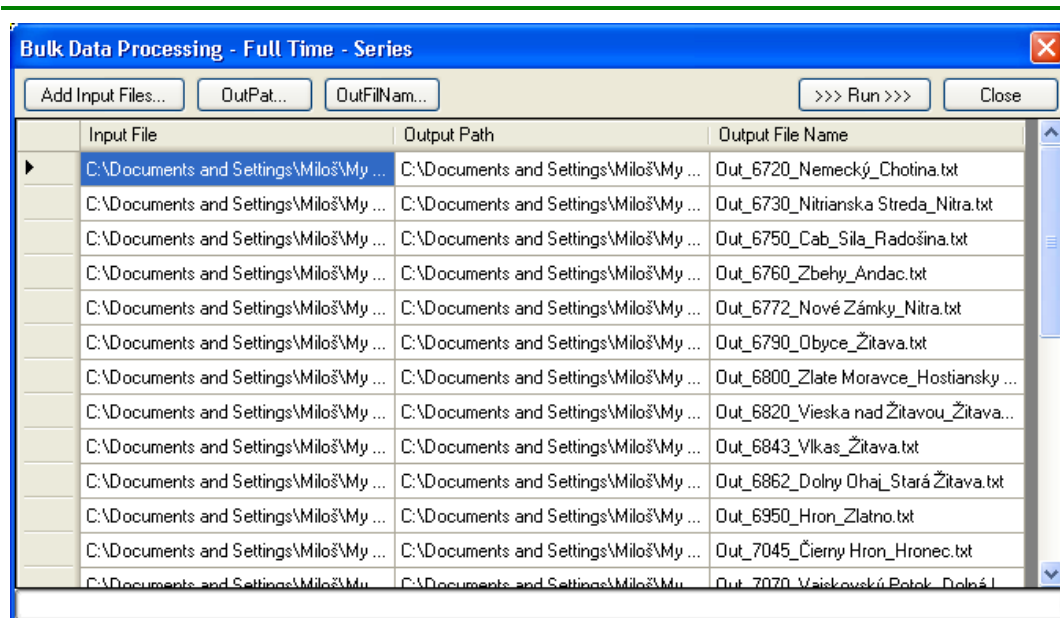
The second function **Graph Settings** is for visual adjustment of an automatically generated chart. For the adjustments, the **Graph Settings** window is shown. Visible contents can be set for the graph by using this setting (e.g. legend, lines, chart area, axis, chart title, etc.).



**Fig. 14: Tools for graph settings.**

## BULK DATA PROCESSING

The last chapter of this manual deals with an interesting feature - mass processing of data (*fig.15*).



**Fig. 15: The window for setting of mass data processing algorithm.**

For the purposes of mass data processing, the module includes three tools. These tools can calculate the flow duration curves for the entire time-series, in years or months.

Each type of calculation runs in a separate window. These functions can be run from the menu **Processing - Calculation Manager**. The procedure to run bulk calculation is as follows:

1. Setting the path to input files.

With the button **Add Input Files**, load the input data into the table that you want to process. The input data time-series must be prepared according to the manual **How to prepare input data**. They will then be processed correctly.

2. Setting the path, save the results.

The second column contains the path for saving the result files. The selection **OutPat** can set these paths collectively.

3. Setting the name and type of results files.

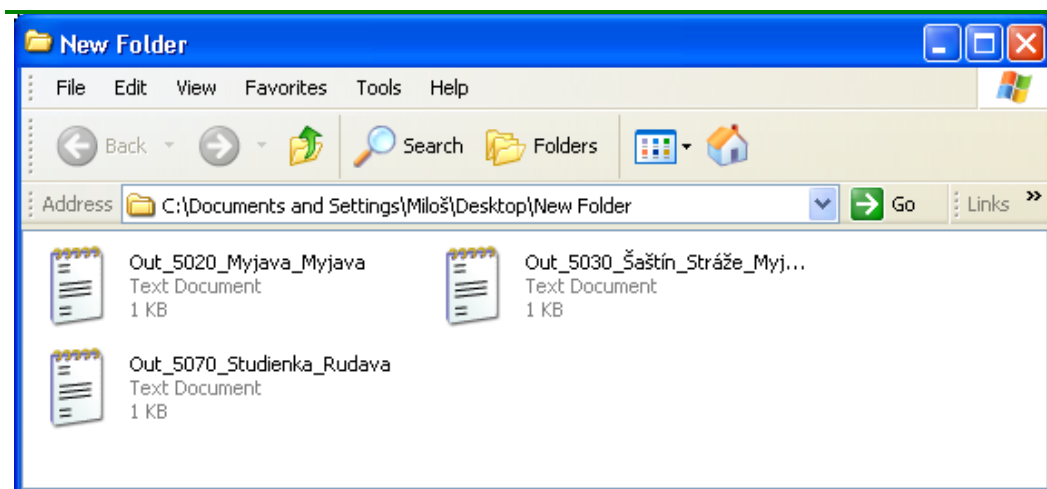
The last column serves to set the path and file type in which calculated results will be stored. In these table cells, you can set the file name and file type (\*.txt, \*.xls, \*.rtf, \*.doc). Depending on what type of file you write to, the results are saved. The import file name and type is set automatically by the imported input file name. The algorithm takes the input file name and adds the string "Out\_". As the file type is predefined \*.txt. This means that if user import input file is named **River**, then it is automatically generated to an output file named **Out\_River.txt**. If you want to automatically add the string in a whole table, for this purpose you can use the **OutFilNam** button.

4. Running of a mass-processing algorithm.

Using the button **>>>Run>>>** starts the algorithm for mass processing of the input files.

Individual entries in the table can be adjusted separately, either manually or by double-clicking on the selected cell in the table. If you double click on the cells in the **Input File** and **Output Path** columns, a window for automated editing will be displayed.

After running calculations, the progress of calculation is showing in the bottom progress bar of the window. After the calculations are completed the results are automatically saved in the selected computer directory (**fig.16**).



**Fig. 16: Automatic saving of analysis results on computer disk.**

## CONCLUSION

This manual describes the functionality and uses of the FDC 2.1 modules focused to hydrological analysis.

The module serves to calculate and analyse flow duration curves. It contains more tools that make the data processing easier and faster.

The application has several features that are described in the text. In case of problems with the module a user's forum on the [HydroOffice.org](http://HydroOffice.org) website can be found. To further study the modules functionality [video-tutorials](#) are available and can be downloaded from the [Downloads section](#) of website.

If you find a bug within the program, I would be grateful for notification. You can inform me about it via the [forum](#) or by [email](#). If you use this module, it would be good to cite it in your work. If you do not know what to quote, you can find publications focused on the HydroOffice software and its modules on [this page](#). If you would like to quote something about the HydroOffice project, I would be happy if you inform me and give me a quote from your work. I can add a link to your site via [this page](#) of the HydroOffice website. This can also help you with a better placement in search engines.

## REFERENCES

- TALLAKSEN, L., M., VAN LANEN, H., A., J., van eds., 2004: Hydrological Drought – Processes and Estimation Methods for Streamflow and Groundwater. Developments in Water Science, 48. Amsterdam, Elsevier Science B.V, ISBN 0-444-51688-3, pp. 579