Construction of ombrian curves using Hydrognomon software system

1. Abstract

Hydrognomon is an application for the analysis of hydrological data and includes several applications for time series processing, such as step time aggregation and regularization, interpolation, regression analysis and infilling of missing values, consistency tests, data filtering, graphical and tabular visualization of time series, etc. Both its source code and the executable program are freely available. The new version of Hydrognomon includes a module for the construction of ombrian (intensity-duration-frequency) curves. It is based on a mathematical framework that expresses ombrian curves with unified relationships giving rain intensity in terms of duration and return period, either for a single gauging station or for a station group over a specified area. In the latter case, it supports either single parameter sets or spatially varying parameters. The framework is completed with raw rainfall data processing, data management and storage, graphical user interface, and output data graphs and export facilities.

2. Introduction

Hydrognomon is provided under the terms of the GNU GPL v3 License and is part of the open source Hydrognomon framework, whose source code can be obtained from www.openmeteo.org.

Hydrognomon has been developed to serve the research activities of the ITA research group, which is responsible for the design and maintenance of the open-source software. The complete software is also available from the Hydrognomon website.

3. Case study area

Andravida is a town and a former municipality in the Pindos Regional Unit of the department of Ilia. It is a municipal unit. Its population is about 4,500 people. It is located in the plains of Northern Elis, which is one of the most touristic regions of Greece, due to its beautiful landscapes and archaeological heritage.

The study area is located in Andravida. A rain gauge is used as an instrument to measure precipitation at specific areas. The data used is provided by the Meteorological Service and are composed from 57 years data records.

4. User Data Set

The user can input data to Hydrognomon, in order to create annual maximum time series of different time scales. Hydrognomon, as a tool, enables the user to simultaneously introduce and process several data time series.

5. Construction of ombrian curves

The user must first determine the time series variables (either single or several gauging stations or a station group) and the specific return period. Then, the precipitation height-time series have to be introduced time series.

An additional function that can be set is the temporal resolution (Time step, min). The definition of the ombrian curves is based on the resolution selected.

6. Multiple Curves

In the first tab (shown in the figure above), the user can form multiple graphs of predefined return periods (2, 5, 10, 20, 50, 100, 200, 500, 1000, 10000 and 100000 years). As it is shown, the ombrian curves do not intersect.

7. Single curve

In the second tab, the user specifies a particular period to observe. The program, through the options print/copy helps the user to export the results.

8. Data

The third tab displays the general equation of ombrian curves (DF curves equation), the name of the distribution function, the parameters of the distribution function (Statistical distribution parameters), the parameters of the time series, and the statistical properties of the consolidated sample.

9. Distribution Plot

In the fourth tab, the user controls the adjustment of the theoretical statistical distribution in the sample. From the last “Displayed durations” the selection of duration will be displayed in the chart.

10. Type of statistical distribution

The type of the statistical distribution applied to analysis is determined through the menu Distribution. The default option is the GEV (peak) with a fixed parameter value, and 1st moment “GEV-Max kappa specified, L-moments”.

By selecting “Specify GEV” the user can specify the parameter values of the GEV distribution, and the “L-moments” gives the default value of $k = 5.13$.

11. Time resolution effect - Additional functions

The user may include in the analysis the effect of time definition. The selection is made via the menu Options → Consider time resolution effect.

Additional functions are controlled through the following menu options:

- **File → Print**: printing capabilities of graphs.
- **File → Single ID**: curve evaluation, several ID curves, specific return period with the classical methodology: minimum block.
- **Edit → Copy**: copying tables and graphs to clipboard (initially Microsoft Excel and then in software, e.g. Microsoft Excel type or editors (fixed processors). For example, plot the distribution map for design ombrian curves exactly the same with the unit “Pythia”.

12. Conclusions

The main conclusions of our study are:

- Hydrognomon is an open software which has automated the construction of ombrian curves.
- Time series extracted from Andravida station, for 17 years time period and for several time scales indicated that the same process could be followed for several time stations in Greece in order to construct a map of ombrian curves at a specific area.
- Hydrognomon offers the tools for simulating several statistical distributions and facilities the user to choose the one that applies best to the data set.
- The program through the options print/copy helps the user to export the results of the analysis for further process to other software (e.g. Microsoft Excel).

The ombrian curves must not intersect because in this case we would have for the same intensity (per month) and for the same duration (days) different return periods, which is irrational.