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# *FAO Penman Monteith evapotranspiration index*

**User's Manual**

**Updated on 29/08/2007**

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# 1.Introduction

The LSI-Evapotranspiration program calculates the reference evapotranspiration index according to the FAO Penman-Monteith equation, as specified in the document “*Crop evapotranspiration - Guidelines for computing crop water requirements FAO Irrigation and drainage paper 56, FAO - Food and Agriculture Organization of the United Nations Rome, 1998.*”

Evapotranspiration means the water vapor transferred to the air by the ground or vegetation. The processes which cause evapotranspiration are evaporation and transpiration.

Evaporation is the process in which water is transformed from liquid to vapor and is transferred from the ground to the atmosphere. The parameters which influence the evaporation are: temperature, humidity, radiation and air speed. If the ground is not short of water the vapor index depends only on the weather conditions. In case of poor water supply, a controlling mechanism is triggered, thus delaying the evaporative process.

Transpiration means the transfer of water vapor by the vegetable tissues. Plants release water mainly form the stomata located on their leaves. Through transpiration, most of the water retained by the plants is transferred and only a small part is kept for themselves. Transpiration depends on the same weather conditions that influence the evaporation, on the type of culture, techniques employed and ground morphology.

The *ET0* reference evapotranspiration is the evapotranspiration rate of a standard reference surface which is not dry. The reference surface is well represented by a 12-cm high, not dry, widespread culture of green grass which completely overshadows the underlying ground.

With *ET0* users can study the evaporative demands of the atmosphere regardless of the specific culture and its characteristics. *ET0* values obtained in several locations and periods can therefore be compared since they refer to the same reference area.

The LSI-Evapotranspiration calculates the *ET0* evapotranspiration index both on a daily and monthly basis.

## 1.1.Applicability limits

The limits of the environmental quantities for the applicability of the program are the same as the those of the instrument and are:

<i>Quantity</i>	<i>Applicability limit</i>
Temperature (°C)	-30 ÷ 70
Relative humidity (%)	0 ÷ 100
Air speed (m/s).	0 ÷ 50
Radiation (W/m <sup>2</sup> )	-150 ÷ 1500

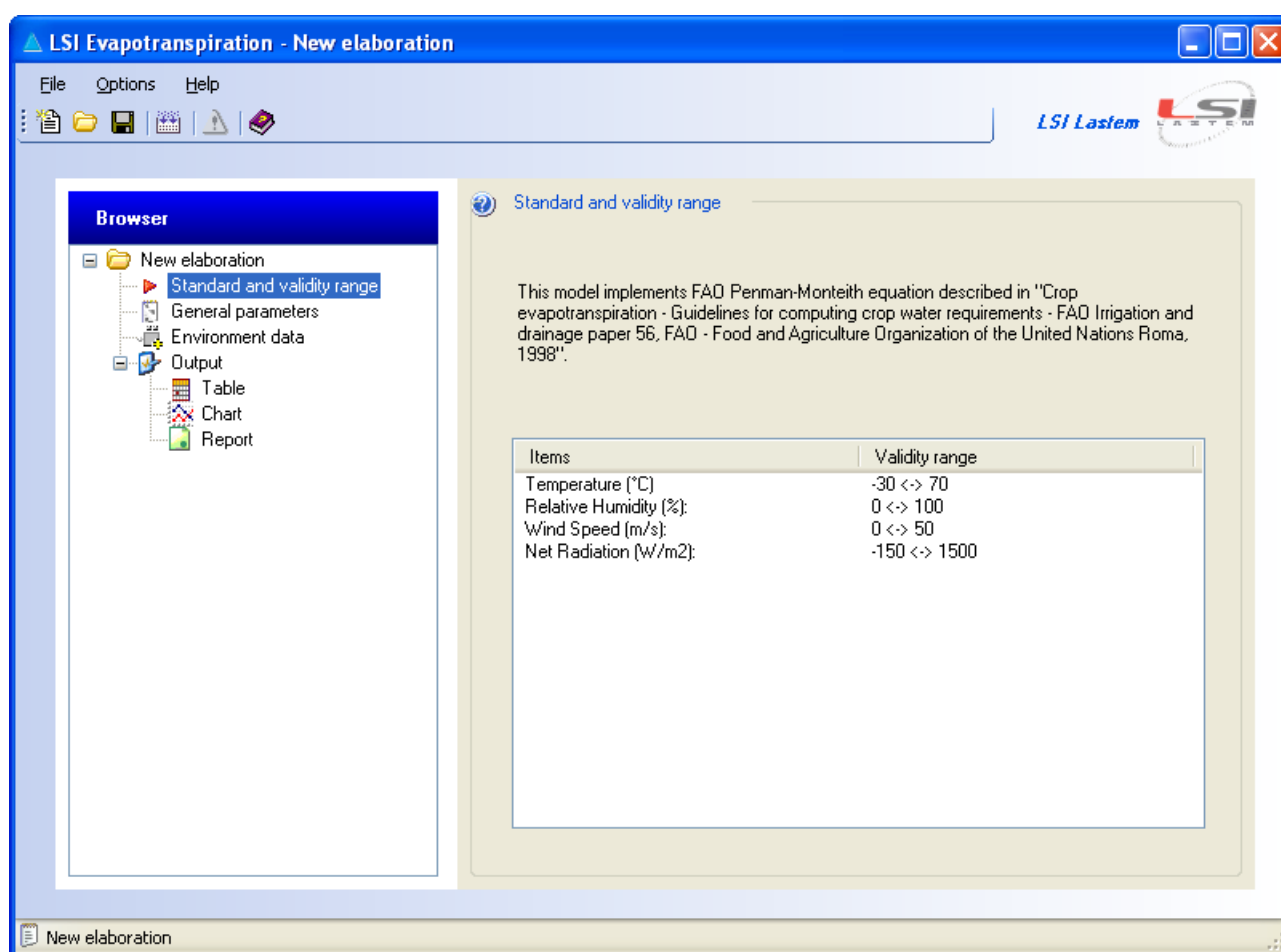
## 2. Using the program

### 2.1. Starting the program

The program *LSI Evapotranspiration* can be directly started from InfoGAP; select menu *Calculation Modules -> Evapotranspiration (Penman) -> New (or Open)*.

### 2.2. Main features of the program

The main window of the program is displayed below:



The *Browser* is located on the left of the window and gathers all the elements of the current elaboration. The details of the item currently selected in the *Browser* are displayed on the right.

#### 2.2.1. Menu structure

Use the menu and the tool bar to select all the functions available in the program.

The menu *File* includes:

- *New*: opens a new elaboration;
- *Open*: opens an existing elaboration;
- *Save*: saves the current elaboration;
- *Save as*: saves the current elaboration with another name;
- *Run*: carries out the calculation;
- *Exit*: quits the program.

The menu *Options* includes:

- *Chart settings*: sets the options to personalize the results chart.



The menu *?* includes:

- *Contents*: shows the current document.
- *Check for Updates*: checks for program updates available on the LSI Lastem site;
- *About this Application*: shows information about the application, including the version.


## 2.3.The elaborations

All data related to the settings of an elaboration are saved on a file with a default extension (.et0). Et0 files contain all settings of the general calculation settings, as well as the environmental data loaded when using the program.

### 2.3.1.Creating or opening an elaboration

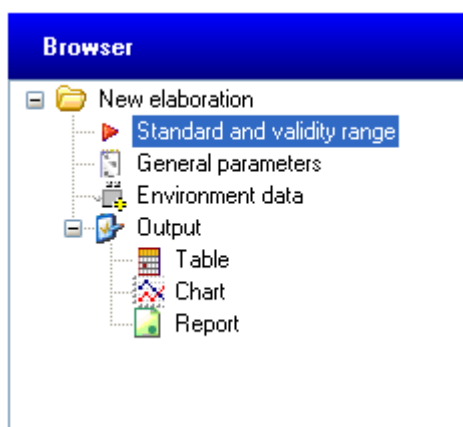
In order to create a new elaboration select *File -> New* or click on . To open an existing elaboration, select *File -> Open* or click on  and select the desired file.

### 2.3.2.Saving an elaboration

To save a current elaboration on the same file it was loaded from select *File -> Save* or click on . To save the elaboration as a new file select *File -> Save as...*

## 2.4. The Browser

The *Browser* gathers all the elements of the current elaboration.



The details of the item currently selected in the *Browser* are displayed on the right side of the main window of the program. The main item contains the name of the elaboration; the other items are:

- *Standard and validity range*: displays the applied norm and the reference limits for all the quantities; the information is only displayed here and is used as reference; the values cannot be modified;
- *General parameters*: contains the general parameters of the elaboration;
- *Environment data*: contains the environmental data used for the calculation;
- *Output*: contains the recapitulatory results of the elaboration which can be viewed as *Table*, *Chart* and *Report*.

All data modified in a selected item are memorized each time another item is selected, when the elaboration is saved or when the program or the calculation is terminated.

## 2.5. General parameters

To define the general parameters of the elaboration select *General Parameters* in the *Browser*.

- *Description*: brief description of the elaboration (used only as information);
- *Daily or monthly elaboration*: calculation of the evapotranspiration index either on a daily or monthly basis; select as requested;
- *Location parameters*: where the calculation takes place (used only as information);
- *Measured wind speed height above ground surface (m)*: indicates the altitude where the wind speed is measured; the calculation of the evapotranspiration index requires that wind speed data be set at a standard altitude of 2 m; for this purpose the program uses the formulae contained in the FAO reference documentation;
- *Instrument altitude above sea-level (m)*: absolute height of the measurement instrument;
- *Latitude of measured data (decimal degree)*: latitude of the location of the measurement instrument.

## 2.6. The environmental data

To define the environmental data select *Environment Data* in the *Browser*. This panel contains a table that displays the selected environmental data.

Environment Data

Available data: 30 Load Data

Net radiation was calculated from global radiation data.

	Year	Day	Tmin (°C)	Tmax (°C)	RHmin (%)	RHmax (%)
▶	✓ 2007	57	4.27	13.73	43.74	100.00
	✓ 2007	58	8.54	18.95	15.29	47.53
	✓ 2007	59	4.45	15.20	40.73	93.86
	✓ 2007	60	4.92	13.64	65.74	100.00
	✓ 2007	61	6.71	17.93	49.27	100.00
	✓ 2007	62	8.11	17.73	35.08	95.50
	✓ 2007	63	4.33	18.84	24.97	79.83
	✓ 2007	64	5.71	19.79	24.75	75.20
	✓ 2007	65	9.36	13.44	59.52	100.00
	✓ 2007	66	9.23	11.63	94.42	100.00

Click on *Load data* to load the data.

The table shows the data required for the calculation for each day of the selected period. The data in the table are:

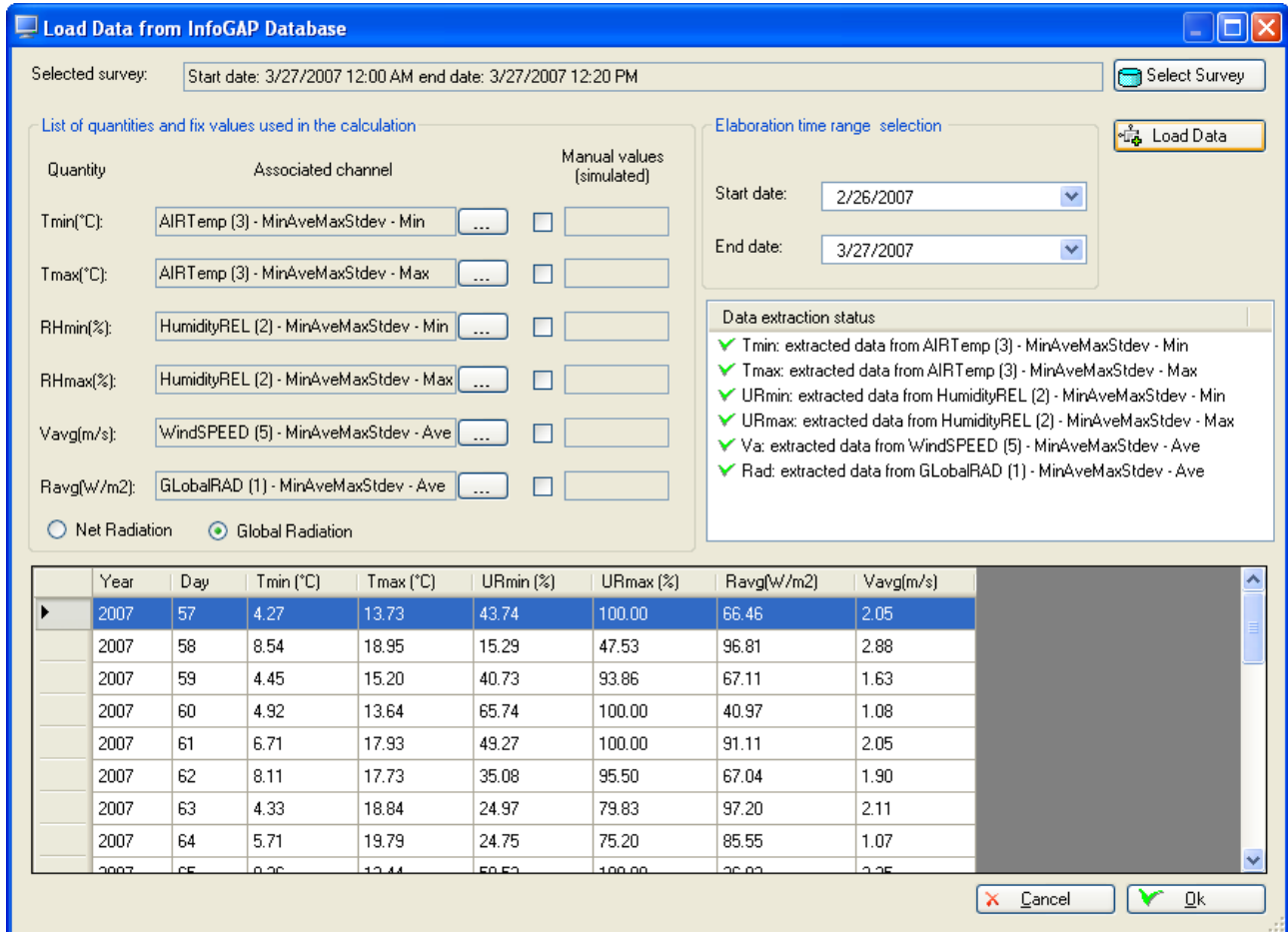
- Year: reference year of the data;
- Day: reference day of the data as of January first;
- Tmin, Tmax: minimum and maximum daily temperature [°C];
- RHmin, RHmax: minimum and maximum daily relative humidity [°C];
- Rn: Net radiation [W/m<sup>2</sup>];
- u2: air speed [m/s].

Besides, the first column reports an indicator showing if the data record can be used for the calculation: a valid data is marked as ✓, whereas an invalid data is marked as ✗ (will not be used for the calculation).

Use the contextual menu on the table to copy the selected cells to the Windows clipboard and then paste the results in another application (for example Word or Excel).

## 2.6.1. Loading the environmental data

Click on *Load data* in the *Environment Data* panel of an environment to load the data. From the window from which the data are loaded it is possible to select the origin survey of the data as well as to define quantities and the extraction and elaboration options of the data.



Once the survey is selected, from which the data are extracted when clicking on *Select survey*, it will be necessary to associate the elaborations which contain the data, in *List of quantities and fix values used in the calculation* panel, to the quantities requested by the calculation. Click on  next to each quantity to perform the association: if there is no suitable elaboration, enter a value manually, as indicated in the picture below:



After choosing the mode of the survey channel, it will be necessary to set the elaboration period in the *Elaboration time range selection* panel.

Upon termination of the settings click on *Load data* to load the data. The *Data extraction status* panel displays useful information on the data load procedure. The table located in the lower part of the window displays, instead, the loaded data.

Click on *Ok* to import the data in the calculation.

*ATTENTION*

*For the radiation, it is necessary to indicate if the selected value refers to a net or global radiation: in the latter case, the program will automatically convert it into net radiation as requested by the norm.*

*After returning to this window, from the panel Environmental Data of the selected environment, once the data are loaded, only the settings will be visible and not the loaded data.*

**2.6.1.1. Selecting the survey**

Click on *Select survey* in the data load window to select the survey to load the data from. The window for the selection of the survey displays all the tools and the surveys memorized in the database of InfoGAP listed according to the instrument's serial number.


*ATTENTION*

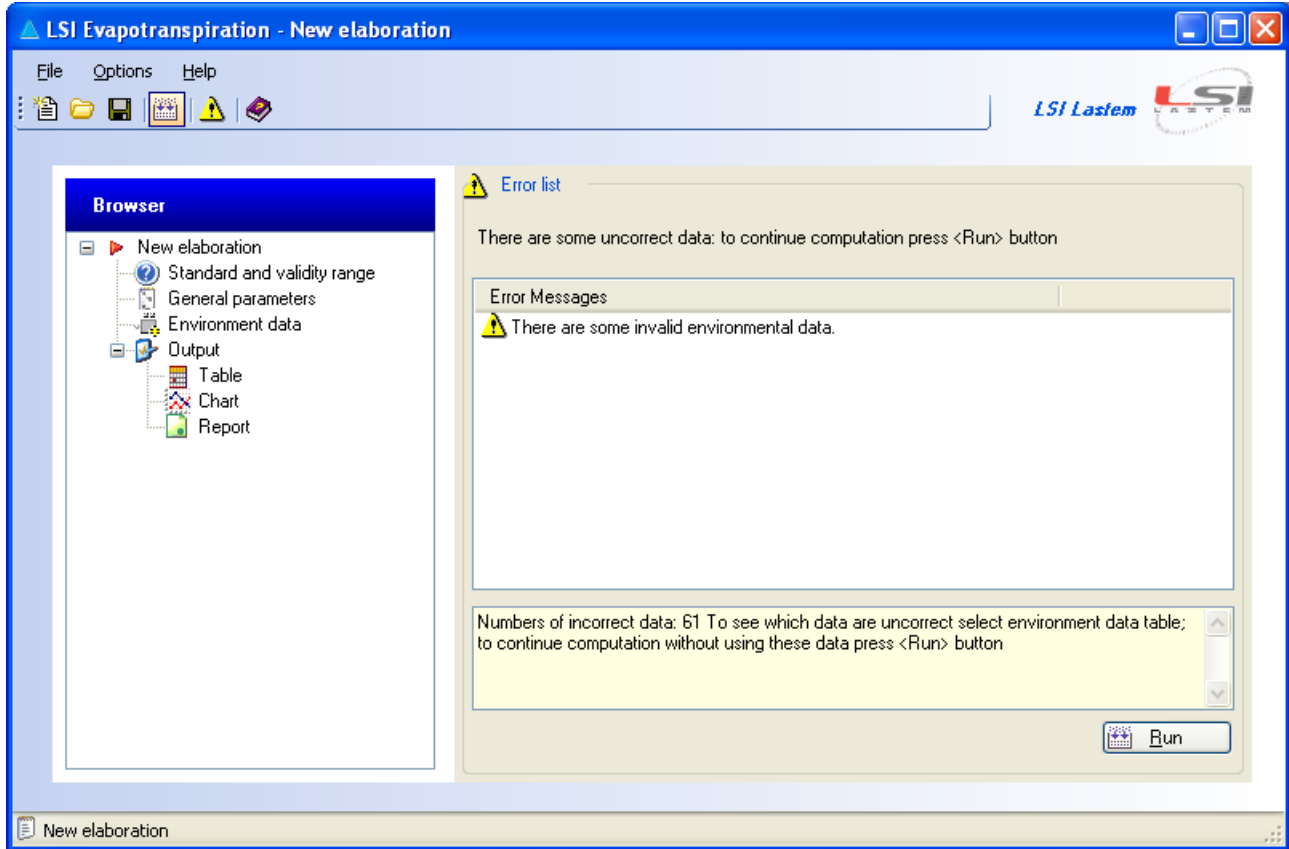
*When selecting the survey, the license for the activation of the calculation module is checked: in case the selected instrument is not activated it is possible to enter the license key directly, otherwise it won't be possible to select the survey.*

**2.6.1.2. InfoGAP database update**


When the contents of the InfoGAP database are updated during an elaboration (by importing instruments and/or surveys, or by unloading new data), it will be necessary to save the current elaboration, close it and open it again to gain access to the new updated data.

## 2.7.The calculation

To carry out a calculation select *File -> Run* or click on . This procedure will check the integrity of the data: in case of failure the panel below will be displayed:



This procedure may generate error messages that will block the calculation or warnings that will advise to proceed with attention. Select an item from the list to display additional information in the text box below the list.

To display the message panel again select the  icon in the icon bar.

### 2.7.1.Daily calculation

The daily calculation of the evapotranspiration index in the selected period is carried out each day for which the extraction of valid data has been possible. Should the selected period contain days without available data, a warning message will be displayed in the *Error Messages* panel; however, the user can decided whether or not to carry out the calculation: in this case, days with missing data will not be included in the calculation and will not be present in the results.

## 2.7.2. Monthly calculation

The monthly calculation of the evapotranspiration index in the selected period is based on the daily environmental data. The minimum and maximum values for temperature, relative humidity, net radiation and air speed are calculated; days with invalid data are not included in the calculation.

Please note the following information for the monthly calculation of the evapotranspiration index in the FAO documentation:

- The first month does not contain results because the monthly calculation for a certain month uses the data of the previous month;
- It is NOT possible to carry out the calculation if there are months with missing data in the selected period.

## 2.8. Visualization of the results of the calculation

After the calculation it is possible to see the results, which can be selected in the *Browser* in *Output*, in three different ways:

- Table with a review of data calculated each minute;
- Chart;
- Report.

### 2.8.1. Results table

The results table (select *Output* --> *Table* in the *Browser*), shows the calculated value and the values used as input for the calculation.

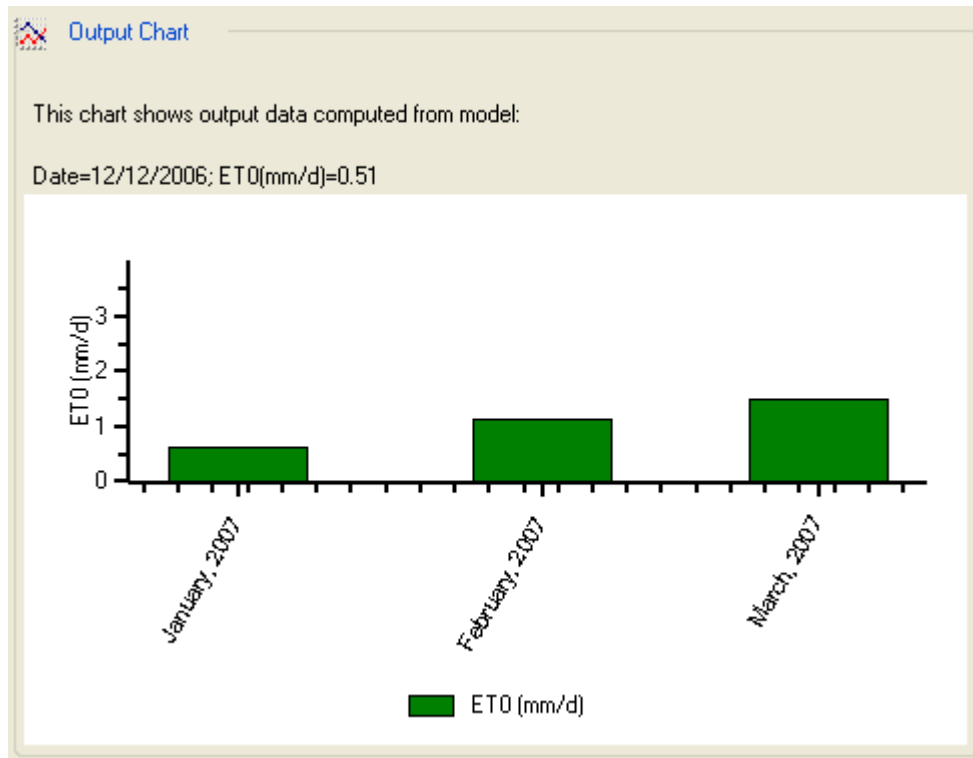
In case of a daily calculation, the results are shown for all the days included in the selected period with valid data; in case of a monthly calculation, the results are shown for all the months included in the selected period.

Use the contextual menu to copy the selected cells to the Windows clipboard and then paste the results in another application (for example a word or spreadsheet processor).

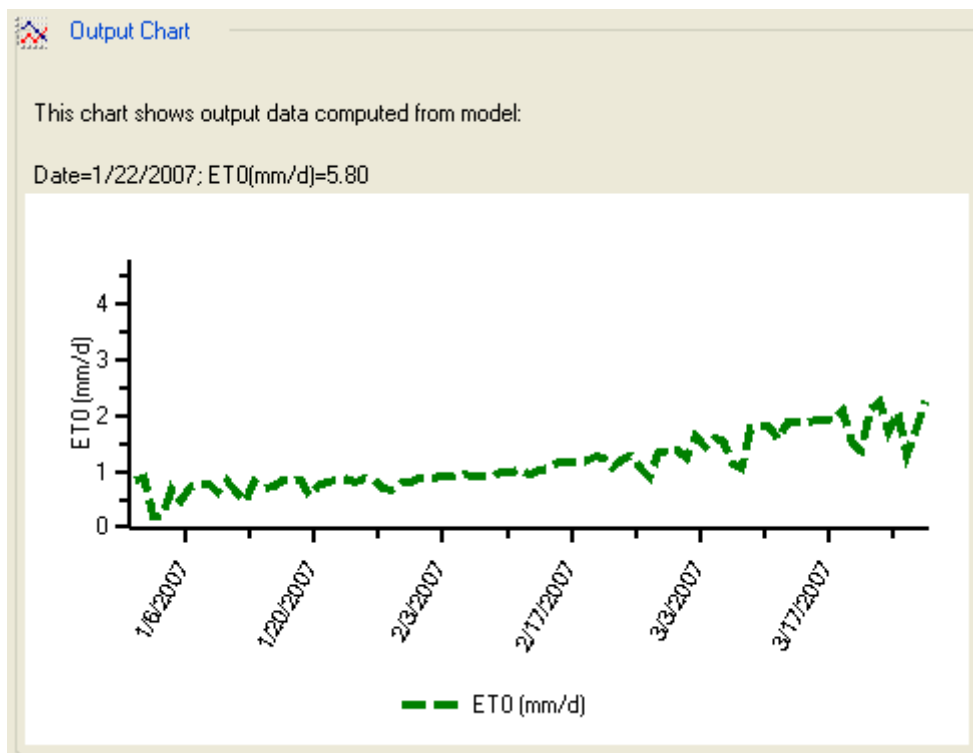
### 2.8.2. Results chart

The results chart (select *Output* --> *Chart* in the *Browser*), shows the calculated values.

In case of a daily calculation, the results are shown for all the days included in the selected period with valid data by means of a chart with lines; in case of a monthly calculation, the results are shown for all the months included in the selected period by means of a chart with bars.



Monthly calculation



Daily calculation

Select *Option* -> *Chart settings* to define:

- Style, thickness and color of the lines representing the calculated index
- Position and visualization of the legend for the data.

Click on the right button of the mouse to activate a contextual menu on the chart to be able to:

- Save the chart as a file;
- Print the chart;
- Copy the image to the Windows clipboard to be able to paste it in other applications.

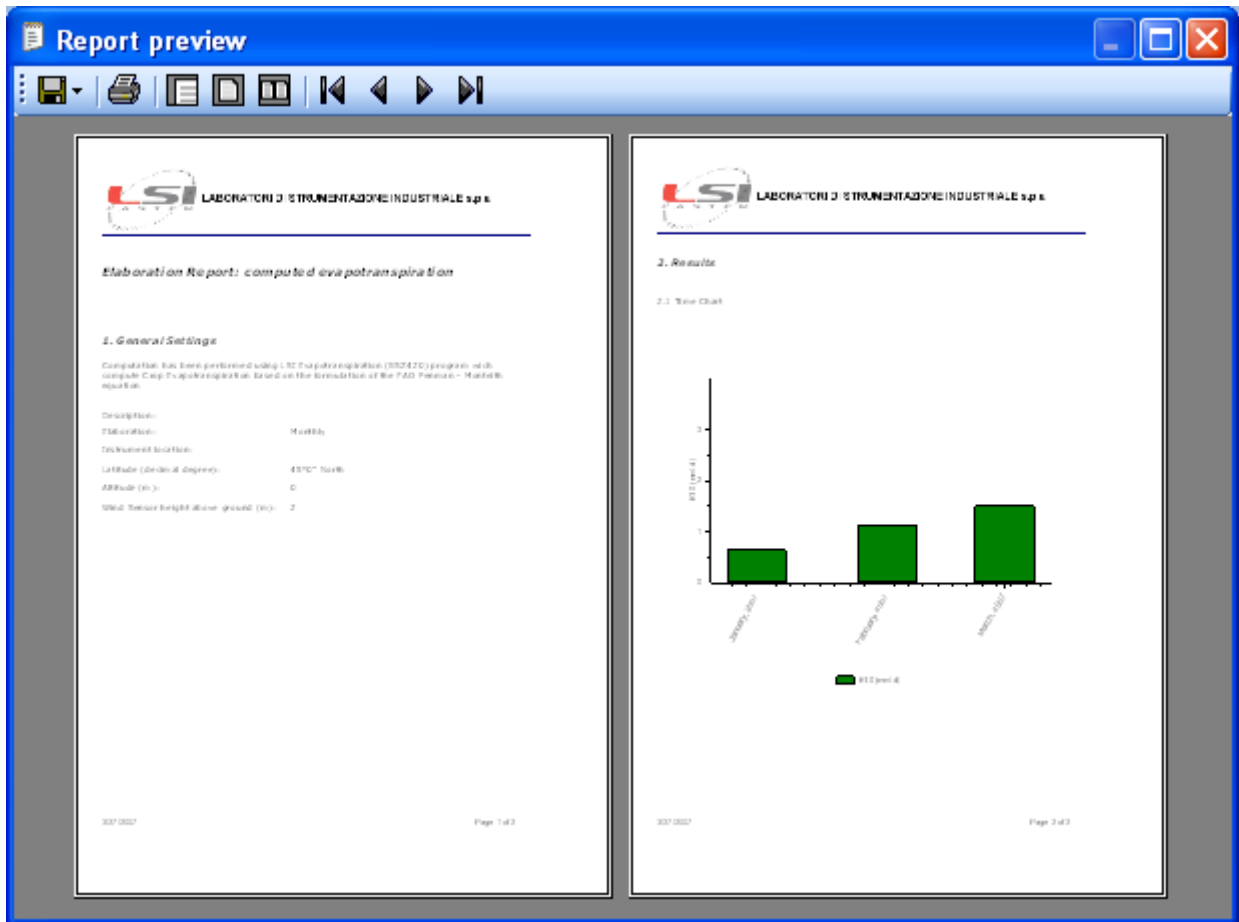
### **2.8.3.Results report**

The results report (select *Output --> Report* in the *Browser*), shows a complete report on the calculation and results. It is based on the printing properties indicated by the default printer, which has to be defined in the system.

The report includes the following information:

- A brief written introduction (optional);
- The normative reference used to carry out the calculation (optional);
- The general settings used for the calculation;
- The results chart;
- The calculated results and environmental data table (optional).

After selecting *Report* in the *Browser* and the optional settings click on *Show Report* to open the preview window.



In this window it is possible to:

- Modify the view in one page, two pages or actual size;
- Navigate throughout the report;
- Print the report;
- Save the report in several formats.

Available formats are:

- pdf;
- html;
- rtf.

### 2.8.3.1.Changing the logo

It is possible to change the logo located in the upper part of each report by replacing the image located in the path below:

C:\Documents and Settings\All Users\Dati applicazioni\LSI-Lastem\LSI.Evapotranspiration\ReportTemplate\en\PHS001\Logo.jpg

If the folder above is not available, set the visualization of the hidden folder by using the option available in Windows *Explore*.