CAPRA
Probabilistic Risk Assessment Platform

User Manual Software IT-Flood V.2.2

Flood hazard modelling

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Chapter 1

Introduction

1.1. Introduction

IT-Flood software was created for flood analysis (fluvial or overflow), using a probabilistic and deterministic methodology assessment. In the probabilistic approach, *IT-Flood* considers precipitation variability to generate multiple flow scenarios for the same return period. On the other side, in the deterministic approach, *IT-Flood* uses flow estimations associated with return periods extracted from an estimation vs return period curve. The flow estimations by both methodologies are used as input data for HEC-RAS software, in order to perform the hydrodynamic analysis and obtained the depth, mean velocity and/or duration of each scenario.

This manual is a guide to using *IT-Flood*. The manual provides an introduction and overview of the software, installation instructions, how to get started, its commands, a step-by-step example with five modeling scenarios, the problems and limitations of the software.

1.2. Problem description

Each year floods causes major disasters, for that reason a flood analysis software is required to analyze, prevent and mitigate this disasters affectations. *IT-Flood* allows the user simulate series of scenarios and as a result, an AME Flood file is generated. This AME can be used as an input in **CAPRA-GIS** to assess flood risk.

1.3. Theoretical framework

Flood is consider as the invasion of water, for overflow or excess of surface runoff or its accumulation on flat land, caused by the lack of natural or artificial drainage. In general, the magnitude of a flood is caused by hydrometeorological processes, which depends of rain intensity, and their spatial distribution, the size of the affected hydrological basin, soil characteristics and the basin drainage.

Mathematical model

Hydrological and hydrodynamic models allows obtaining intensity parameters associated with a probabilistic occurrence, which defines the hazard in a study area.

Hydrological analysis

Rain excess can cause flood risk by river overflow; this attaches directly the precipitation and the topography characteristics of the surrounding terrain. For this reason, hydrological models are based in precipitation-runoff interactions; if this relation is excessive, flooding is produce.

Hydraulic analysis

Hydraulic models require detailed information of river tributaries, its slope and transversal sections characteristics. Hydrodynamic models can be classify as 1D, quasi-2D, 2D and 3D. The first two although less sophisticate are widely used due to their ability to describe the river behavior and their great computational efficiency (Pappenberger, et al., 2006)

River behavior in 1D models is represented through cross sections; these sections can include the main river and the floodplain. However, floodplains may have complex flow patterns in 2D, so it may be more appropriated to use a model 1D for the river and 2D for the floodplain (Ranzi, et al., 2011). The modeler must have the necessary criteria to select the most appropriate model in base on the particular characteristics of their problem and the information,.

One of the most used 1D models is the HEC-RAS (Hydrologic Engineering Center), which solves the Saint Venant equations through a method of finite differences to discretize the equations of continuity and momentum in the case of non-permanent flow in open channels. As a particular case, the condition of permanent flow can be analyzed.

Hydrological analysis

In the software, the flow estimation for hazard analysis can be done in three ways: a hydrological model in HEC-HMS software, rain-runoff model based on the Triangular Unitary Hydrograph (HUT-acronym in Spanish) and by entering a flow curve vs return period. The first two approaches have the capacity to account stochastic storms contained in the AME rain file and the third approach corresponds to a conventional assessment without sources of uncertainty.

HEC-HMS method

For each precipitation stochastic scenario, the hydrograph generated upstream of the flood zone is determined, using the hydrological model built on the software HEC-HMS (US Army Corps of Engineers). This numerical model allows simulating the processes involved in the transformation of rainfall-runoff in the basin.

The program consists of a generalized modeling system capable of representing a large number of different basins. The basin model is constructed by separating the hydrological cycle into easy manipulated parts and by determining boundaries around the basins of interest. A mathematical model can represent any mass of energy flow, each mathematical model is suitable under different conditions, for this reason it is necessary to have knowledge of the basin and engineering criteria to choose the best methodology in each case. For more information, see http://www.hec.usace.army.mil/software/hec-hms/.

Triangular Unitary Hidrograph method

For each rain stochastic scenario the flow is determined using the information of the basin under study, delimiting the main channel and using information of: depth of precipitation, different types of run-off and general topography of the basin. The procedure uses the curve number method, developed by the Soil Conservation Service (SCS). The general methodology consists of two parts, in the first, an estimate of the run off volume is made and in the second, the runoff distribution time, including the peak flow is determined.

Hydrometric method

The complexity of the physical processes involved in hydraulic events makes it almost impossible to have 100 percent reliable estimates based on the laws of mechanics or physics, either because the methods are insufficient or because the resulting mathematical model is very complicated. An

alternative in hydrological analysis is the application of the concepts of probability theory and statistics.

In the case of the hydrometric method, the information of the flows is obtained directly through flow curves vs Return period. These curves are obtained by analyzing the frequencies of the hydrometric data collected at the site of interest by fitting a probability distribution to the observed data. For details of the adjustment, procedure to the probability distributions see (Chow, Maidment, & Mays, 1994). *IT-Flood* software uses the flow curve vs. Return Period entered by the user, to obtain flows with different return periods through the linear interpolation of the curve. This approach corresponds to the traditional analysis in which uncertainty is not considered in the inflows to the hydrodynamic model.

Hydraulic analysis

To perform the simulation of the flood footprints associated with the routing of swelling through channels, channels or rivers, the hydraulic model of the HEC-RAS program developed by the Hydrologic Engineering Center of US Army Corps of Engineers. This numerical model allows performing the analysis of permanent and non-permanent flow, in one-dimensional flow gradually varying in free lamina. For more information, see http://www.hec.usace.army.mil/software/hec-ras/.

1.4. Analysis flow chart

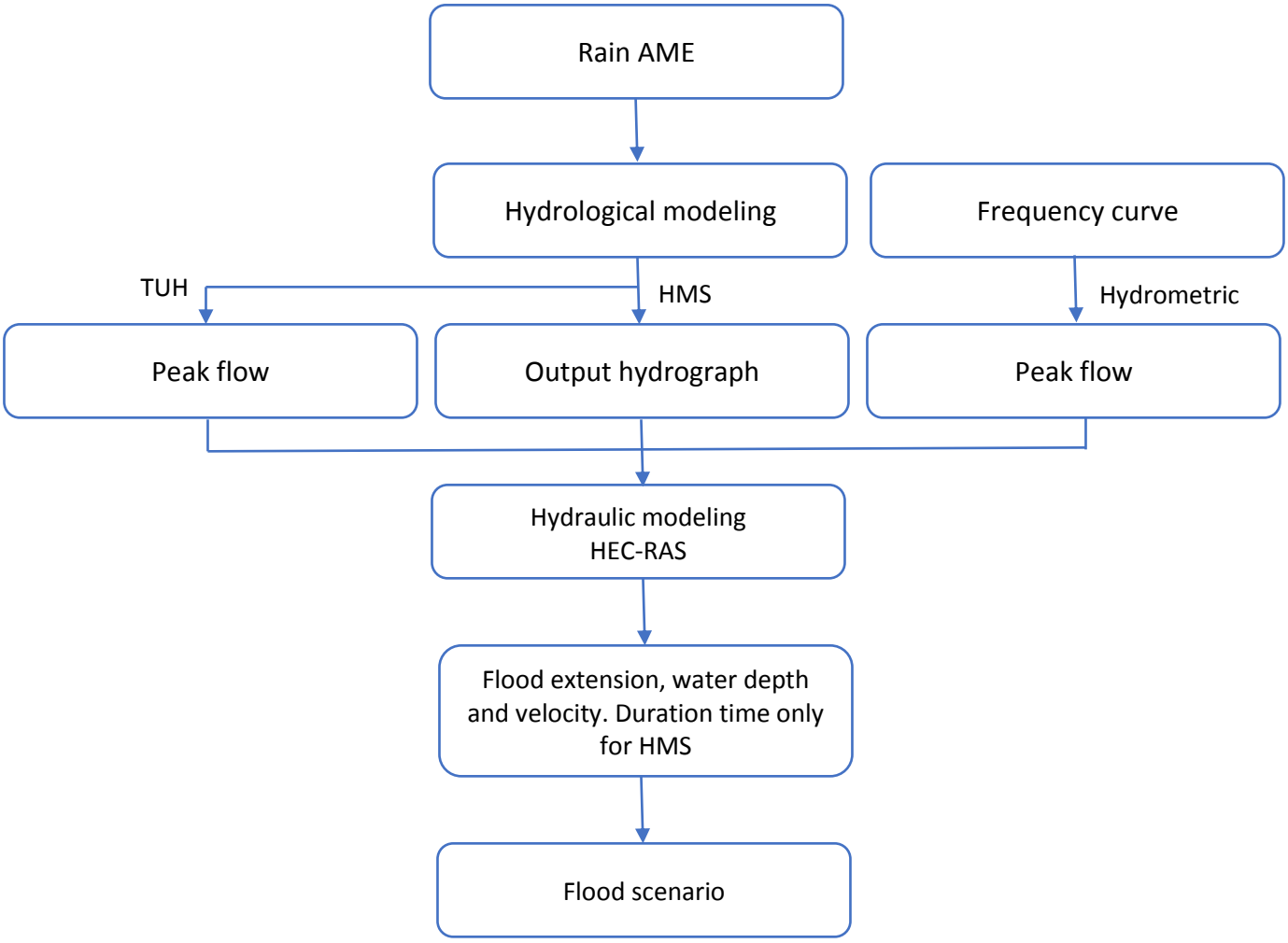


Figure 1. Flow chart analysis

Chapter 2

Software Installation

2.1. Minimum installation requirements

Minimum hardware and software requirements

The following are the minimum hardware requirements for the *IT-Flood* installation:

- PC or compatible computer with Pentium III processor (or higher) and processor speed over 1.5 GHz.
- Operating systems: Microsoft XP or Higher
- Free hard drive capacity of 250 Mb or Higher.
- 512 Mb Extended Memory (RAM)
- CD-ROM or diskette unit (Depending on installers set up).
- Microsoft framework V2.0 or higher and the language package

2.2. Recommended hardware requirements

The following are the minimum hardware requirements for the CAPRA-GIS installation:

Processor

- PC or compatible computer with Pentium III processor (or higher) and processor speed over 1.5 GHz.
- Operating systems: Microsoft XP or Higher

RAM Memory

- Free hard drive capacity of 250 Mb or Higher.
- 512 Mb Extended Memory (RAM).

Removable unit

- CD-ROM or diskette unit (Depending on installers set up)

Other software

- Microsoft framework V2.0 or higher and the language package (if CAPRA-GIS is already installed, this is included)

2.3. Software requirements

IT-Flood requires the following software for its correct operation:

- HEC-RAS 4.1 of the US Army Corps of Engineers. Available in: (http://www.hec.usace.army.mil/software/hec-ras/downloads.aspx)
- HEC-HMS 4.0 of the US Army Corps of Engineers. Available in: (http://www.hec.usace.army.mil/software/hec-hms/downloads.aspx)

2.4. Installation process

1. If you don't have HEC-RAS and/or HEC-HMS installed in the computer, you should download the programs in the versions mentioned above from the following links:
    - HEC-RAS 4.1 (http://www.hec.usace.army.mil/software/hec-ras/downloads.aspx)
    - HEC-HMS 4.0 (http://www.hec.usace.army.mil/software/hec-hms/downloads.aspx)
2. Download the installation package from the CAPRA platform (https://ecapra.org/topics/flood)
3. Enter in windows explorer and select the file where installers are located.
4. Run the setup.exe program. This command starts the installation program; please follow carefully each step indicated by the installation assistant.

2.5. Language configuration

For a correct functioning of the software, it is recommended to use the tool in Spanish. For changing the language in Windows 10, it is required to change the computer parameters as follow:

1. Open the control panel
2. Select the *Clock and Region* option
3. Select *Region*
4. In the Location field select ***Spanish (Mexico)*** as shown in Figure 2
5. Click Ok

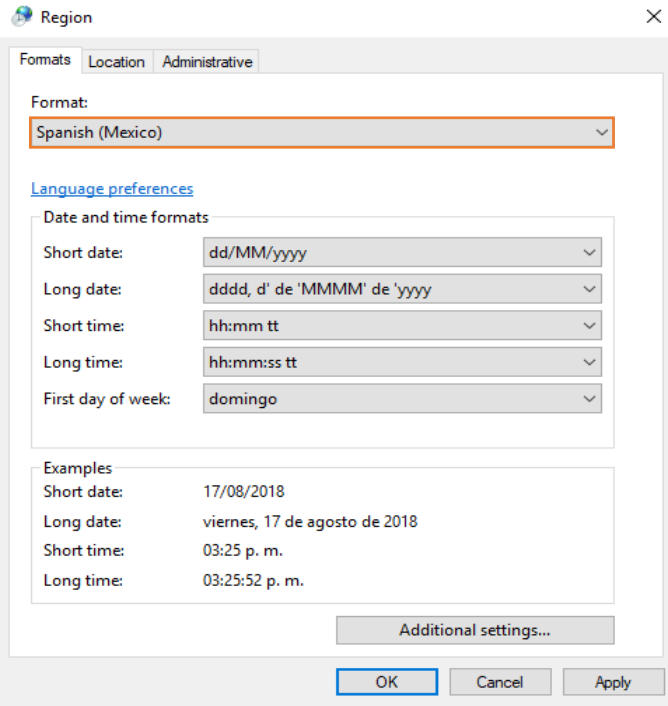


Figure 2. Language configuration

Chapter 3

Graphical User Interface

3.1. General Description

IT-Flood is a software that allows flood hazard modeling, which is made with information provided by the user and consists in a georeferenced map, a model in HEC -RAS 4.1, hydrological information in the software HEC-HMS, rain spatial information and a rain AME either hurricane or not hurricane.

The interface is showed in Figure 3, the tool bar is in the top (red box), and the windows where the user enter data to perform the simulation is the blue box, finally in the green box, the graphic interface is shown.

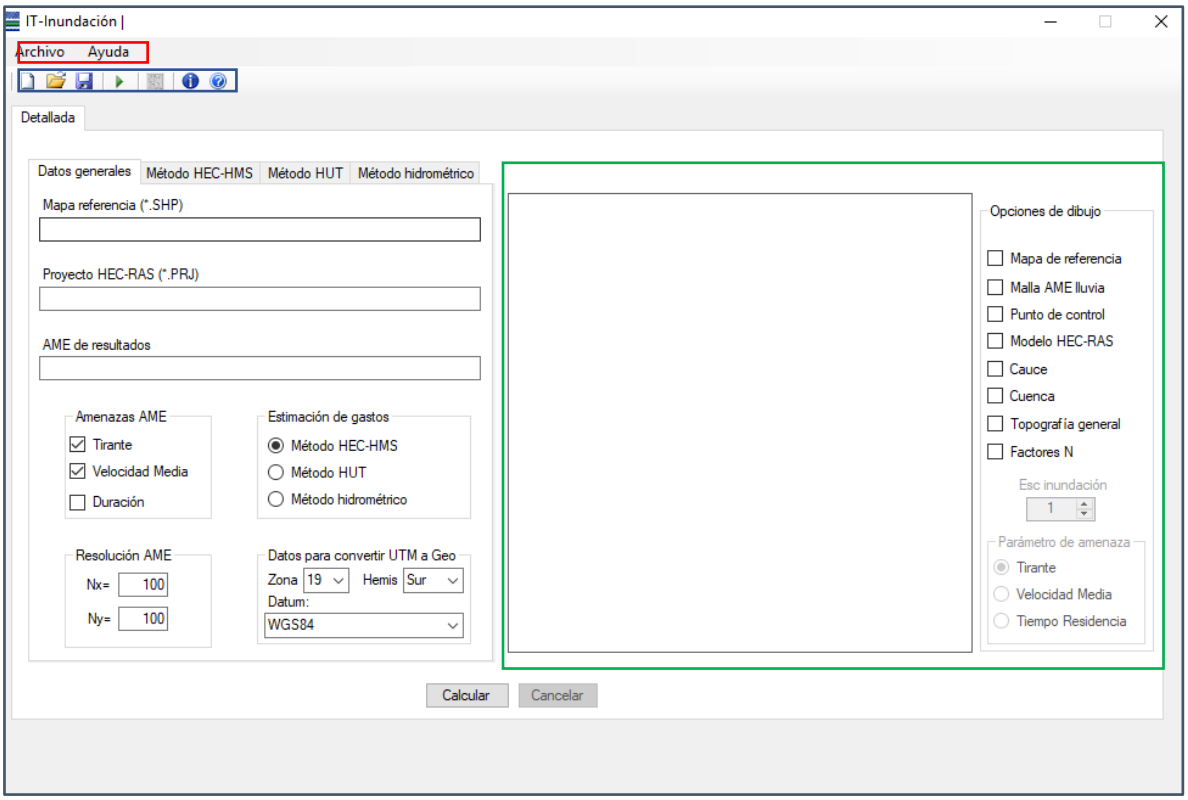


Figure 3. IT-Flood interface

3.2. Tools and Menus

This section presents the different tools, menus and command of the software.

File menu

The following commands from the file menu of *IT-Flood* main window allow the users to create, open, save and exit from the project. The function and localization of each command are explain below.

Table 1. File menu

File menu command	Description
New project	Closes the current project and opens a new project without information
Open existing project	Closes the current project, prompting the user to save the current data, then opens an existing project and the associated files
Save project	Updates the project information and files, saving it with the name the user specifies
Exit	Allows the user close the software

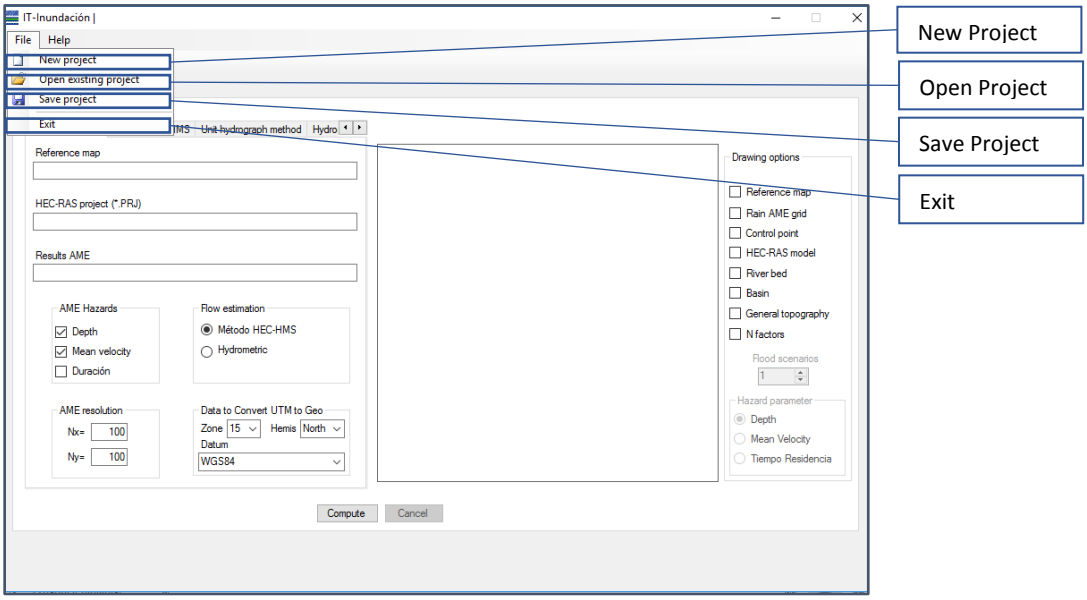


Figure 4. File menu localization and its commands.

Help menu

Help can be accessed by selecting the Help menu option at the top, next to the file menu.

Table 2. Help menu

File menu command	Description
Help About ERN-Inundación	Provides the user information about the software (version and developers)

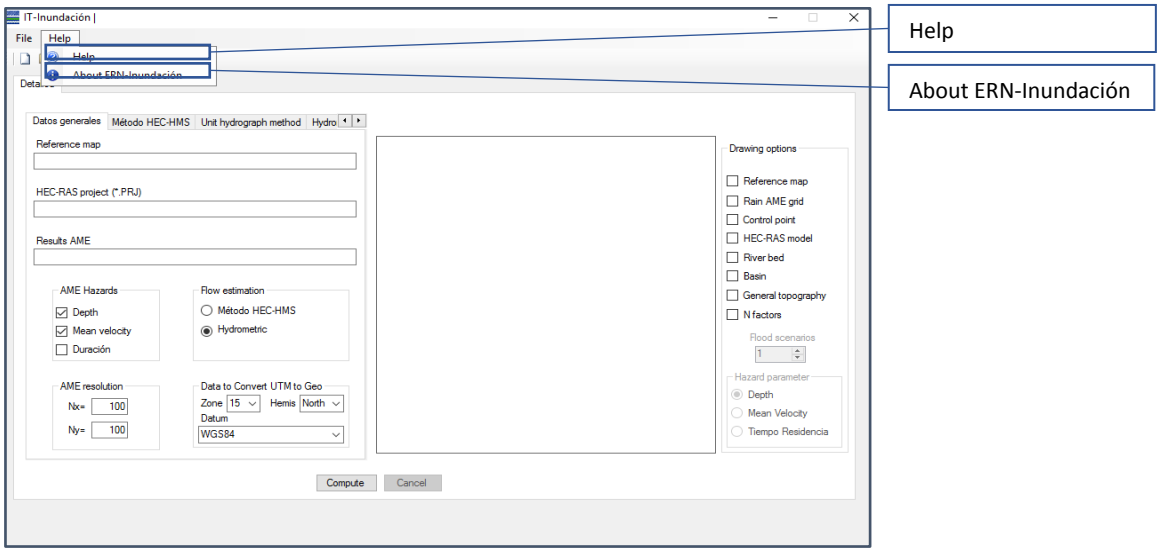


Figure 5. Help menu localization

Tool bar

The tool bar includes a list of icons, the first three icons belongs to the File menu, the forth one is to run the program and computed flood AME, the fifth one open HEC-RAS and the last ones are from the Help menu.

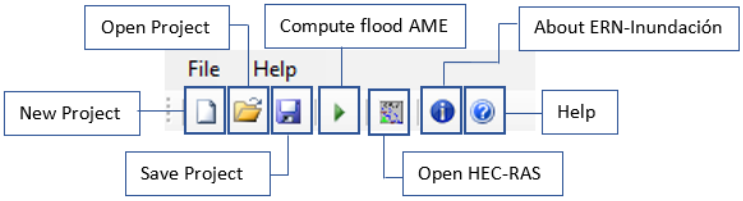


Figure 6. Tool bar

Datos generales window

This contain the basic information the user must enter to the software, in this window the user introduces the reference map, the HEC-RAS project, the folder in which the program should save the results (Results AME), the flow estimation method and the geographic coordinates from the place, as shown in Figure 7.

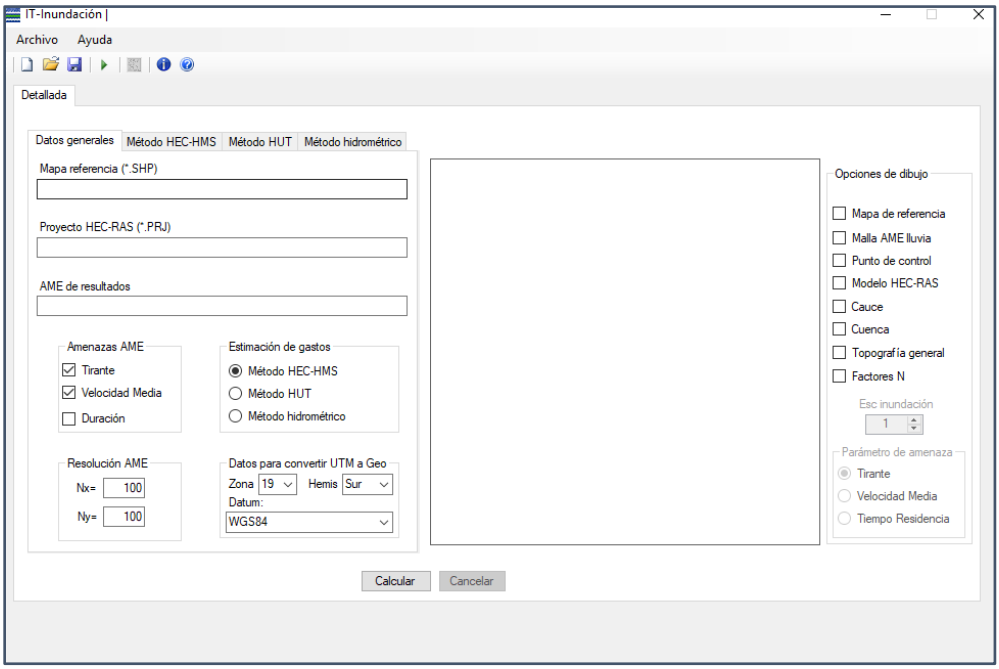
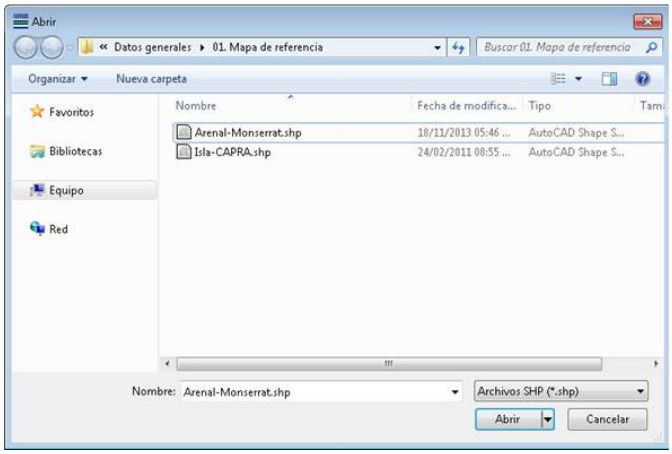


Figure 7. Datos generales window

Mapa de referencia

To enter the information associated with the Mapa de referencia, the user must double-click on the text box below the Mapa referencia legend. The following figure shows the dialog box that will appear to locate the path of the file that contains the reference map information associated with the study area.



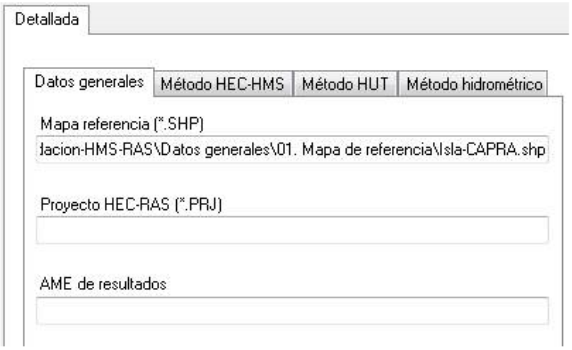


Figure 8. Mapa de referencia selection

Proyecto HEC-RAS

The file containing the HEC-RAS Project must be loaded; this project contains the information associated with the flood analysis referred to the UTM coordinate system.

AME de resultados

The user selects the place where the Project is going to be save and the project´s name. This output file will be generated by IT-Flood after the calculation.

Opciones y parámetros de cálculo

In this section, the user can select the calculation of the depth, medium velocity and/or duration, all as hazards associated with the study area. Analogously in this area, the user will decide between the use of the HEC-HMS method, the triangular unitary hydrograph method, or the hydrometric method to estimate the flow. It will also define the resolution of the AME, where the user assign the number of pixels in X-axis and Y-axis direction for the results AME. Finally, in this section, the user will set both the UTM zone, the hemisphere and the reference geodesic system (Datum) associated with the study area.

Método HEC-HMS window

The user provides the hydrological information of the zone, for this it is required the rainfall AME, the HEC-HMS project, the temporal rain distribution information and the scenarios the user wants to calculate (Figure 9).

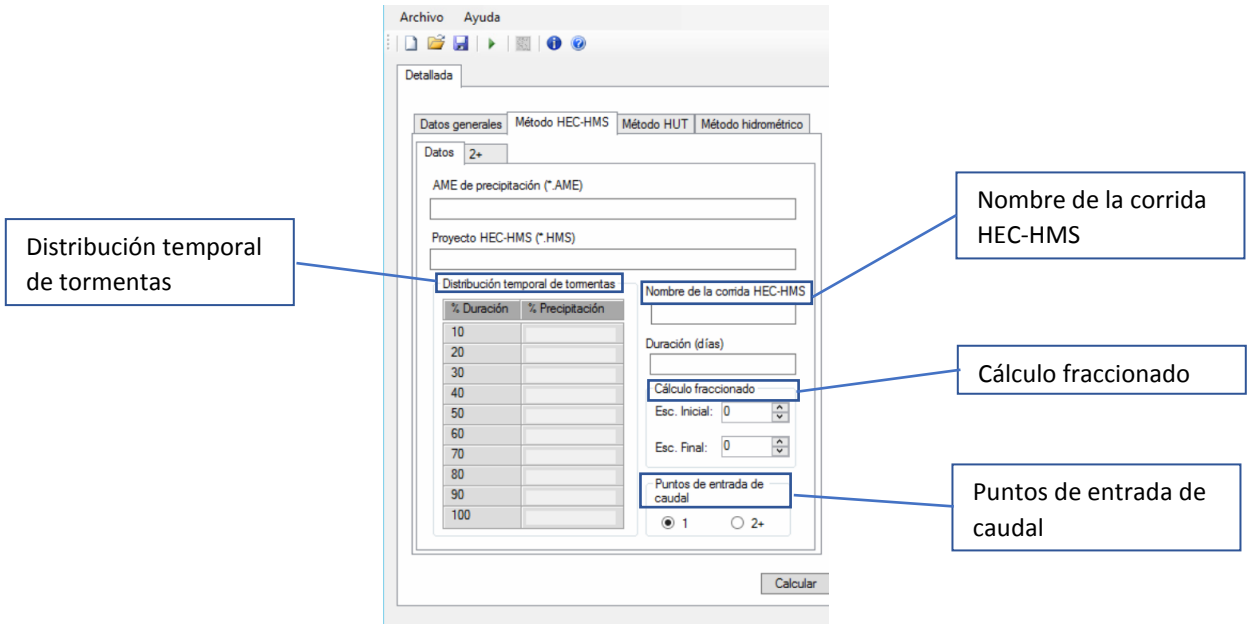


Figure 9. Método HEC-HMS window

Distribución temporal de tormentas

From the precipitation analysis, the user obtains the spatial distribution of the storms; the user must specify the percentage of rainfall with respect to the total depth of water that has fallen in each decile of the total duration of the event.

Cálculo fraccionado

In this section, scenarios to be modeled are written in the box, it is necessary to include the initial and final scenario. If only one scenario is going to be modeled, it is necessary to set this scenario as the initial and final scenario

Puntos de entrada de caudal

If the river has tributaries, the user should select the option 2+, so the program is going to read the HEC-HMS file and the user should introduce the hydrologic element of each one of the tributaries and the main river (the software read and load the River, Reach and Cross Section information)

If there are tributaries in the study area, the 2+ button in the "Puntos de entrada de caudal" box should be marked, like it is shown in Figure 10.

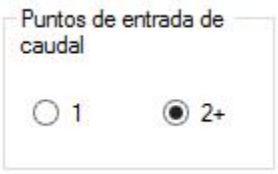


Figure 10. Options in Puntos de entrada de caudal box

By selecting the 2+ button the corresponding tab is activated indicating the cross sections of the hydraulic model that correspond to possible boundary conditions, as shown in the following figure. The last column must be filled out by the user in such a way that each section is related to a hydrological element of the HEC-HMS model.

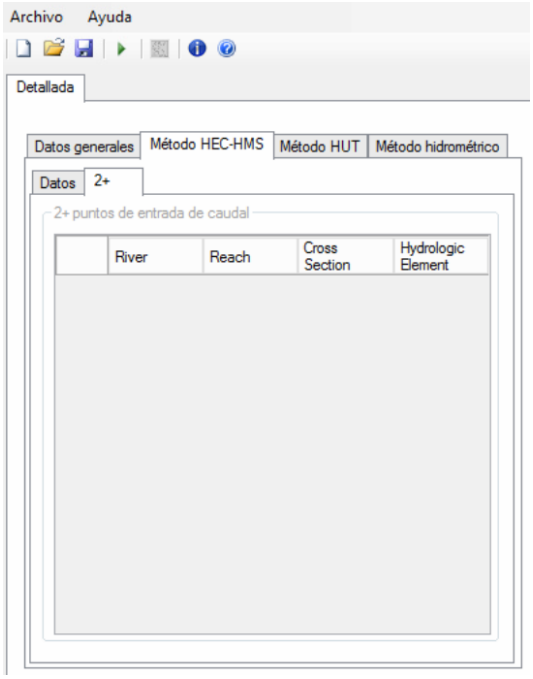


Figure 11. 2+ Windows information

Método HUT window

On the Triangular Unitary Hydrogram Method window, the base information is entered to determine the flood depths of the region under study using the triangular unit hydrograph method, this information consists of:

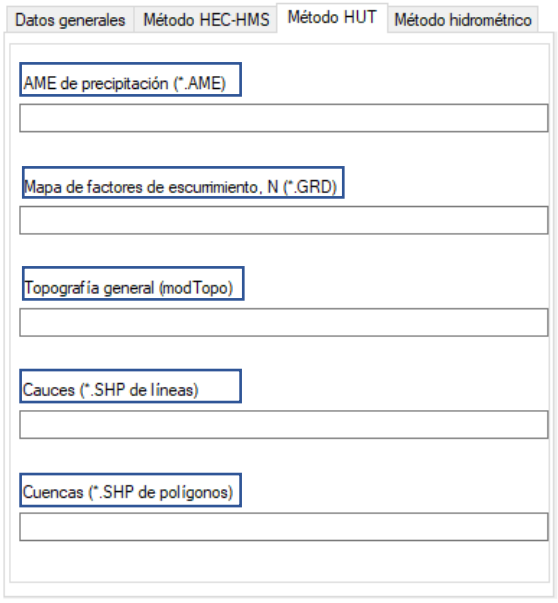


Figure 12. Método HUT window

AME de precipitación

To enter this information, the user must double-click on the text box below the AME legend of precipitation. Once the route is located, select the file that contains the accumulated precipitation information, you must click on the Open button, the file will be loaded and the route with the location of the selected file will be displayed on the HUT Method window.

Mapa de factores de escurrimiento

The file containing the mesh with the runoff factors (curve numbers) should be loaded, the same process is made, but the file must be load in .grd format.

Topografía general

The following information to be included is related to the information associated with the topography of the study area. A file in .dat format must be loaded in geographic coordinates

Cauces

Main channel of the basin in the study area that will be used to estimate the concentration time using the Kirpich formula, the use of this file is mandatory, however the transit time can be modified during the execution of the program.

It is recommended that this shape file be constructed by geographic information systems (GIS) that allow the analysis of the digital terrain model that it is being used in the analysis. The digital terrain model must be processed to obtain a hydrologically corrected digital model and perform the drainage analysis to obtain the alignment of the channel to be used in *IT-Flood*

Cuencas

Corresponds to the delimitation of the hydrological basin in the study area, a file in .shp (polygon). This file must be in geographic coordinates and will only contain the polygon of the basin that will be considered for the calculation of runoff.

Método hidrométrico window

Select the file that contains the flow information associated with the study area, the file must be loaded in .qtr format. In this section, the user will set the value 100 (value assigned "by default" by IT-Flood) as the number of scenarios to be evaluated in this method.

Graphic interface

This window allows the user to observe graphically the data entered, after the modeling is performed and the AME creation is finished, it is shown in the graphical panel as shown below:

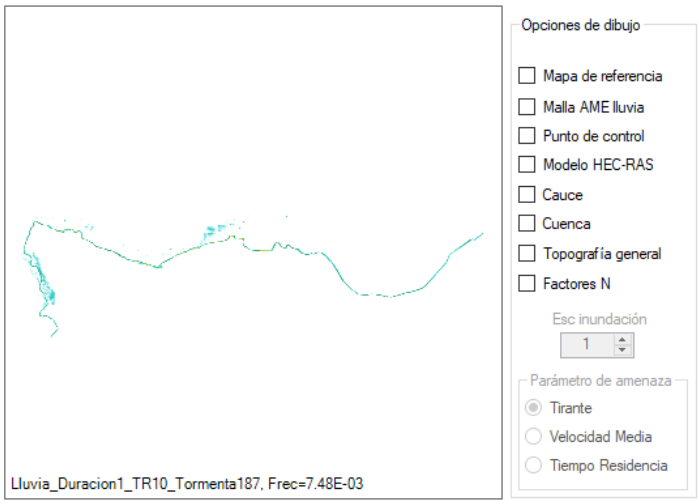


Figure 13. AME result in the graphic interface

Chapter 4

Setting input data and files

4.1. Input parameters setting

IT-Flood software requires multiple parameters and data supplied by the user, so it can be performance. Table 3 describes the input data and the associated file format.

Table 3. Inputs parameters for IT-Flood

Parameter	Description	.file
Datos generales window		
Mapa de referencia (reference map)	Corresponds to the contour map of the region under study, this information is used for the user to interact with the program and can verify that the general information entered is within the limits of the study area.	*.shp
Proyecto HEC-RAS (HEC-RAS Project)	The file containing the HEC-RAS Project must be loaded; this project contains the information associated with the flood analysis referred to the UTM coordinate system.	*.prj
Resultados AME	IT-Flood will generate this output file after the calculation.	*.AME
Resolución del AME	The user defines the resolution for the resulting AME in both directions.	Positive number
Estimación de gastos	The flow estimation can be made through 3 methods, the user select which one it is going to be used.	-
Datos para convertir UTM a GEO	The user will set both the UTM zone, the hemisphere and the reference geodesic system (Datum) associated with the study area.	-
Método HEC-HMS		
AME de precipitación	File that contains the precipitation information for the study area	*.AME
Proyecto HEC-HMS	Contains the information associated with the hydrological analysis of the study basin	*.HMS
Distribución temporal de tormentas	The user must specify the percentage of rainfall with respect to the total depth of water that has fallen in each decile of the total duration of the event.	-
Puntos de entrada de caudal	Related to the boundary conditions given by the hydrological model, which correspond to the inlet flow upstream of the hydraulic model and to the lateral flow inputs produced by different tributaries present in the analysis section. If there are tributaries in the study area, the 2+ button in the "Flow entry points" box should be marked	-

Parameter	Description	.file
Método HUT		
AME de precipitación	File that contains the precipitation information for the study area	*.AME
Mapa de factores de escurrimiento, N	The file containing the mesh should be loaded with the runoff factors (curve numbers).	*.grd
Topografía general	Information associated with the topography of the study area	*.dat
Cauces	Main channel of the basin in the study area that will be used to estimate the concentration time using the Kirpich formula.	*.shp (lines)
Cuencas	Delimitation of the hydrological basin in the study area. This file must be in geographic coordinates and will only contain the polygon of the basin that will be considered for the calculation of runoff.	*.shp (polygons)
Método Hidrométrico		
Curva de caudal vs periodo de retorno	File that contains the flow information associated with the study area.	*.qtr
Número de escenarios	Number of stochastic scenarios to generate in base of the flow vs return period curve.	Positive number

4.2. File formats

Most of the files have universal formats, which are employed by all the commercial software. The only ones with specific format are the general topography of the TUH method and the flow vs return period curve in the hydrometric method. This section explains briefly the require format.

General Topography

The general topography file format corresponds to a *modTopo* file developed by ERN-AL, which is a file that contains information of an ensemble of grid raster files. It is used to define topography of porous zones as the one of Figure 14. The principal file is *.dat file with the next information:

1. First row: Number of sub-grids that compose the general grid.
2. Second row: Type of grid variable format in number (Byte – 1, Short – 2, Integer – 3, Single – 4, Double – 5 and Long – 6).
3. Third row: Xlo, Xhi, Nlo, which are lower X-axis boundary, higher X-axis boundary and number of sub-grids in X direction.
4. Fourth row: Ylo, Yhi, Nlo, which are lower Y-axis boundary, higher Y-axis boundary and number of sub-grids in Y direction.
5. Remaining rows: Each row is the file name that contains the *.grd of the subgrids. It only contains the name and the extension without the file directory information. The order is like the one shown in Figure 14 . If for example there is not associated sub-grid file, the row is left empty. In the figure, the 1,2,8,9 and 12 sub-grids do not have grid information.

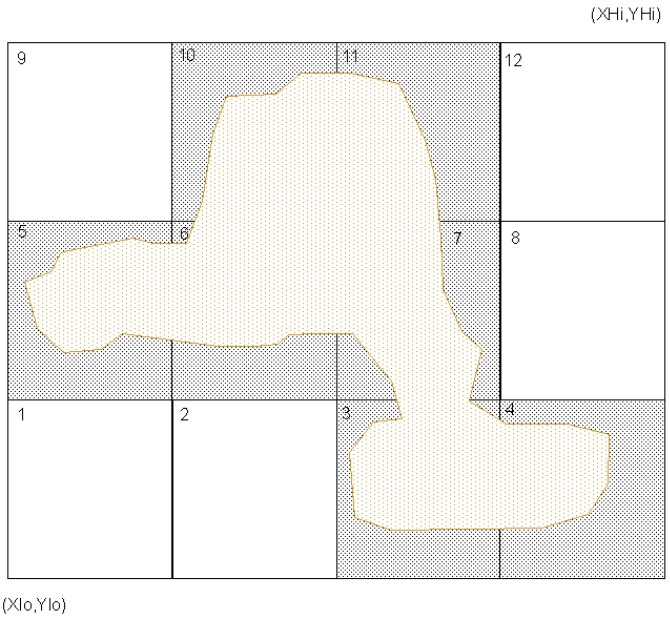


Figure 14. ModTopo general sub-grid order

Flow vs Return period curve

The *.qtr file is a text file with final extension qtr. The file contains the next information:

1. First row: Number of pair groups (Flow and return period) that composed the curve.
2. Remaining rows: Pair of data separated by a comma. First comes the flow and next the return period.

The next figure shows the general format:

n

Q_1, Tr_1

$\dots, \dots$

Q_n, Tr_n

*Figure 15, *.qtr format example*

HEC-HMS PROJECT

The HEC-HMS project contains a basin model, meteorological model and control specification. The proposed methodology employs the following parameters for its operation: an associated grid cell file of the basin in the basin model, a gridded precipitation in the meteorological model and the grid data in the control specification; it is recommended to generate the model with HEC-GeoHMS (http://www.hec.usace.army.mil/software/hec-geohms/downloads.aspx)

Chapter 5

Visualization output files

5.1. Output files and file format

The output file is an .AME, the results depend of the hazards selected by the user in the Datos Generales window (depth. mean velocity and/or duration) and the used method for flow estimation. The Table 4 shows the possible intensities that each method can produced.

Table 4. AME results depending of flow estimation method

Flow estimation method	AME results
HMS	Depth, velocity, and duration
TUH	Depth and velocity
Hydrometric	Depth and velocity

The intensity has two moments, the first one is the mean value and the second is the associated standard deviation. The AME also contains the metadata with the general information. This AME can be use in CAPRA Platform, with an exposure and vulnerability information to obtain the flood risk assessment. The Figure 16 shows the visualization of an AME flood file in **CAPRA-GIS**.

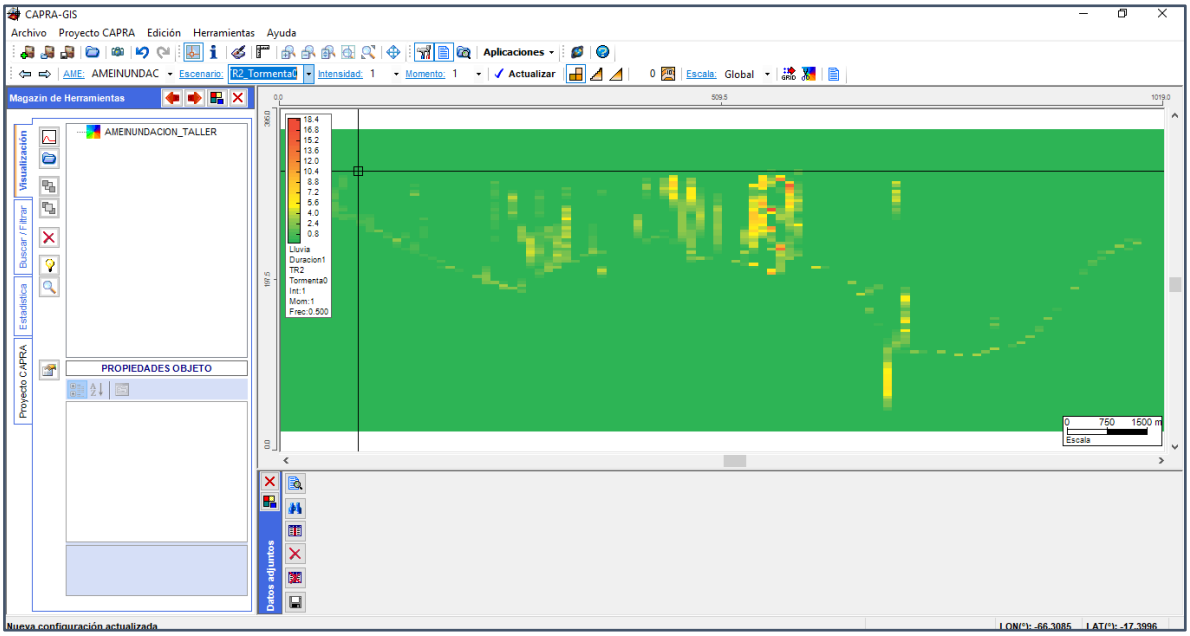


Figure 16. Result AME in CAPRA Platform

Chapter 6

Step by step tutorial

6.1. Step-by-step tutorial

This chapter provides examples how to perform the software with the three possible different methods (HEC-HMS, TUH and hydrometric).

6.1.1. HMS method

For the tutorial it is used a simplified segment of the Rocha River in Bolivia, with 5 different scenarios each one with a different return period (5, 10, 25, 50 and 100 years). The step-by-step process is explained in the next pages. Copy the **Input** folder in C:\. This file contains the necessary files for the example.

Necessary files

- Boundary: MapaReferencia_Rocha.shp
- HEC-RAS project: RioRocha.prj
- Rain AME : AMEPrecipitacion_Rocha.AME
- HEC-HMS project: Rocha.hms

Contents

- Starting a New Project
- Entering required Data
- Performing the simulation
- Viewing Results

6.1.1.1. Starting a new Project

To begin this example, open *IT-Flood* from desktop or start menu and the main window should appear as shown in Figure 17.

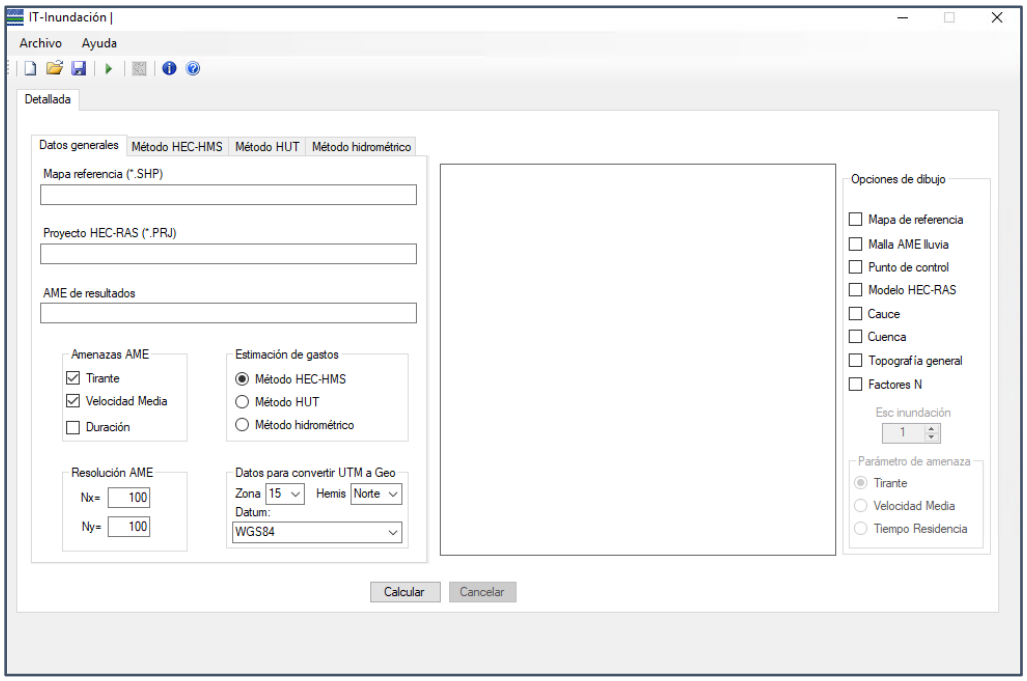


Figure 17. IT-Flood interface

If you have a Project saved, you should go to the file menu and select the command open existing project. A file .dat should be load with the project information. In this case, we are going to load the file **Datos.dat**.

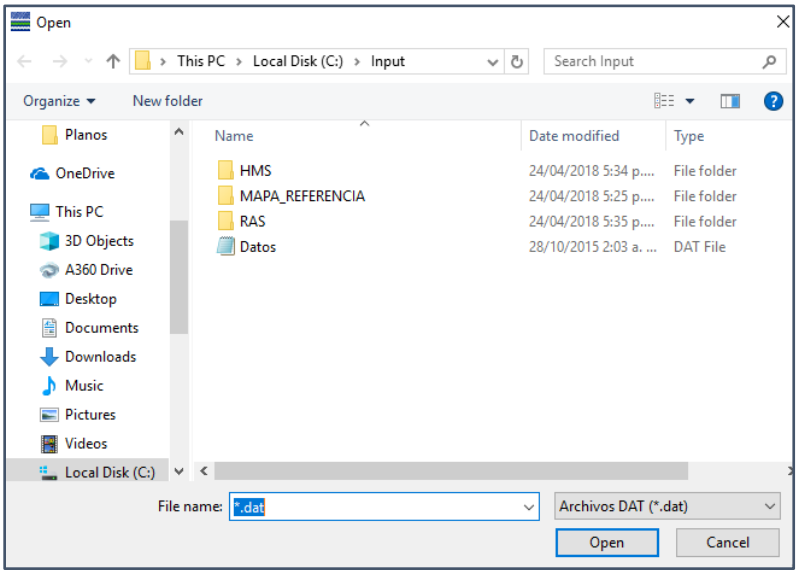


Figure 18. Selecting input data window

If you do not have a project saved previously, you should enter the required data manually.

6.1.1.2. Entering required data

The **Datos generales** and **Método HEC-HMS** Windows must be completed as shown in Figure 19, Figure 20 and Figure 21, with the requirements explain in section 3, so the software can be run.

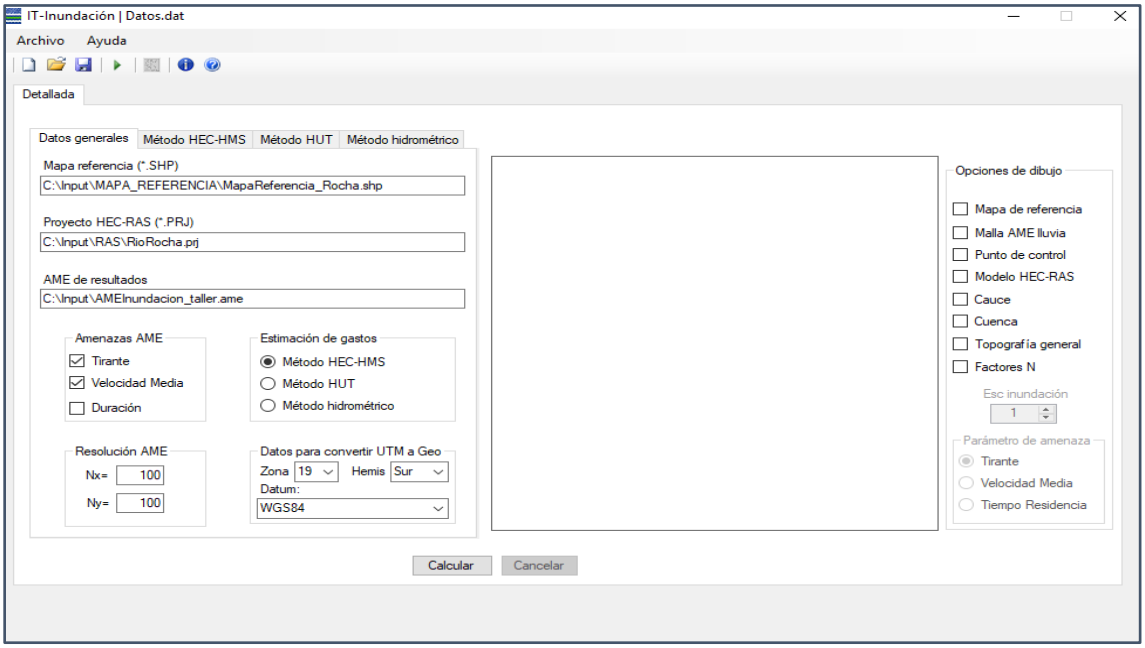


Figure 19. Datos generales window completed – HMS method

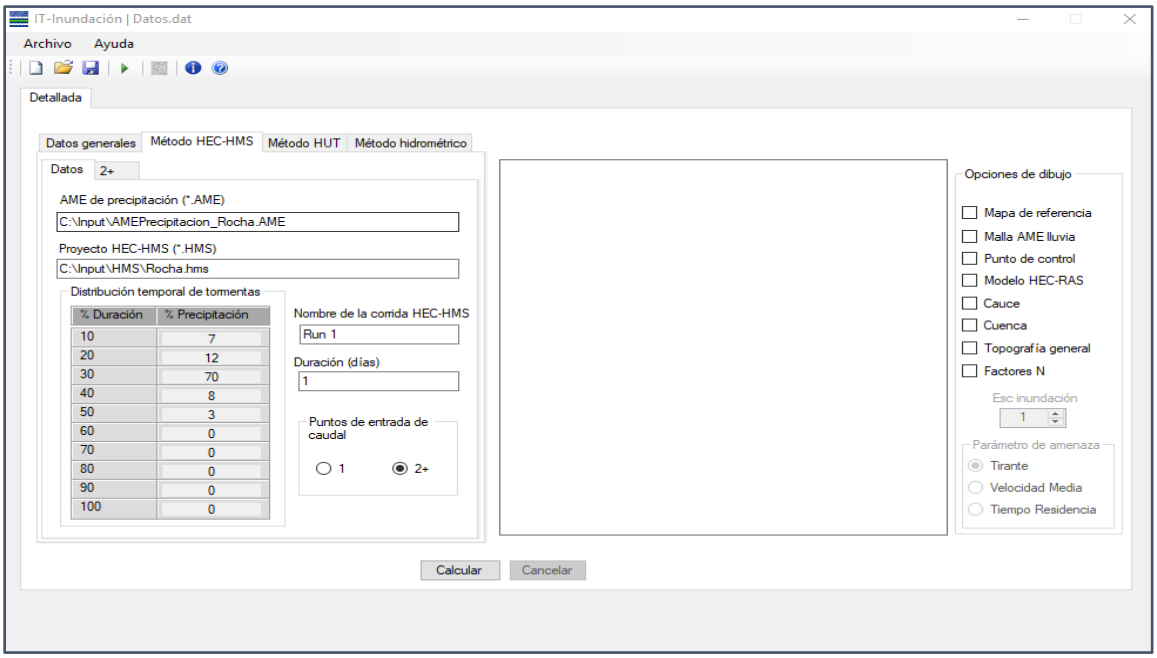


Figure 20. Método HMS window completed

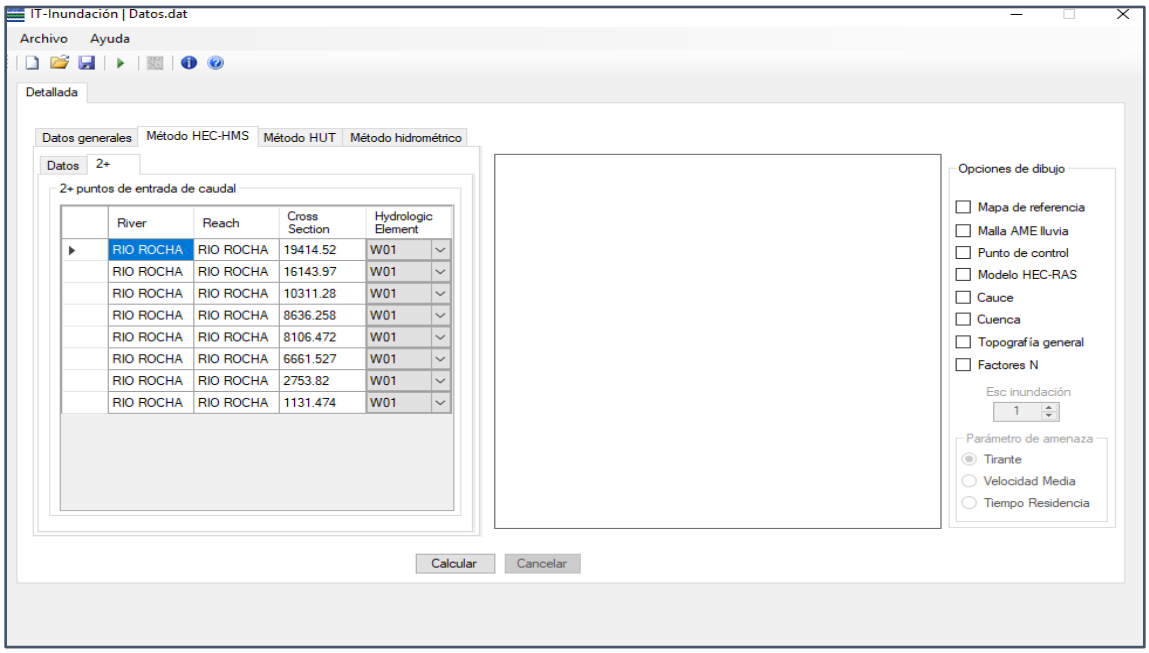


Figure 21. 2+ window completed

6.1.1.3. Performing the simulation

After complete 6.1.1.2. Steps click the **Calcular button** and the software will load the metadata. When this information is loaded the message in Figure 22 appears, click the **Aceptar button** and the calculation of the AME for each scenario starts.

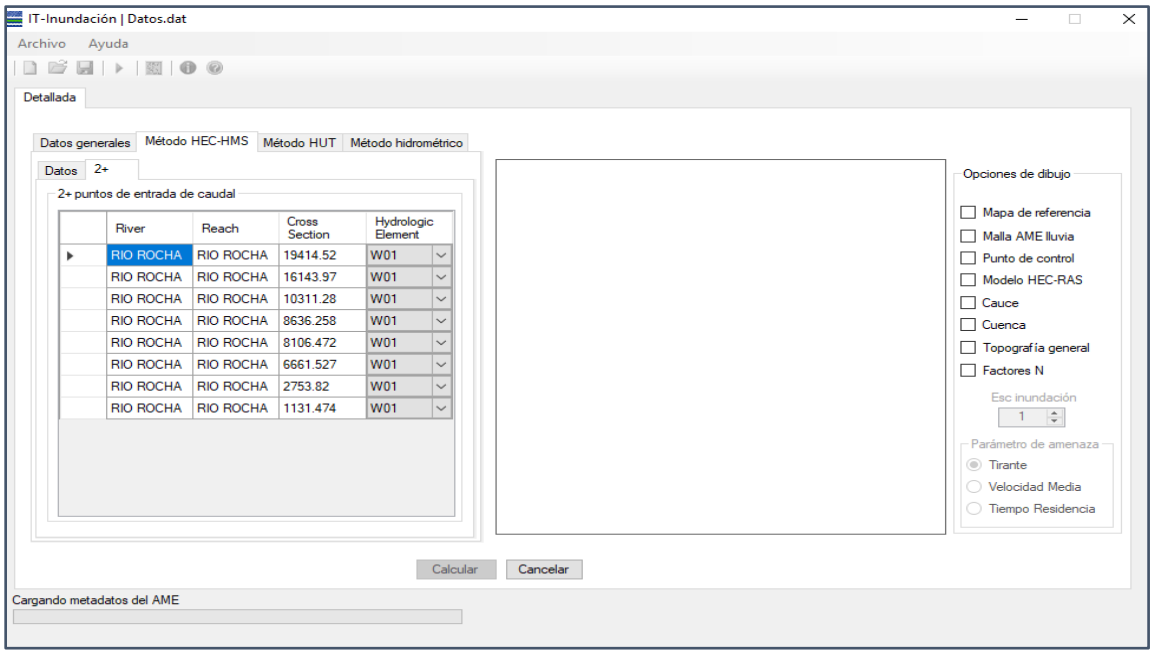


Figure 22. Charging AME metadata in main window – HMS method

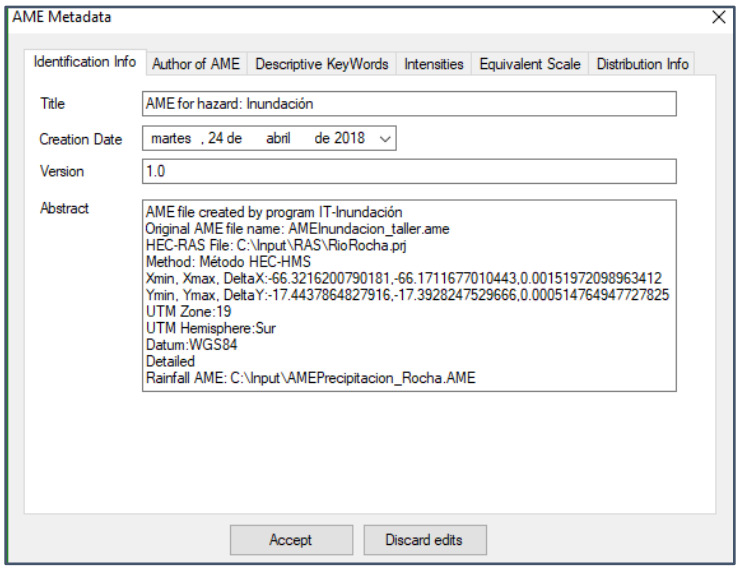


Figure 23. AME Metadata loaded window – HMS method

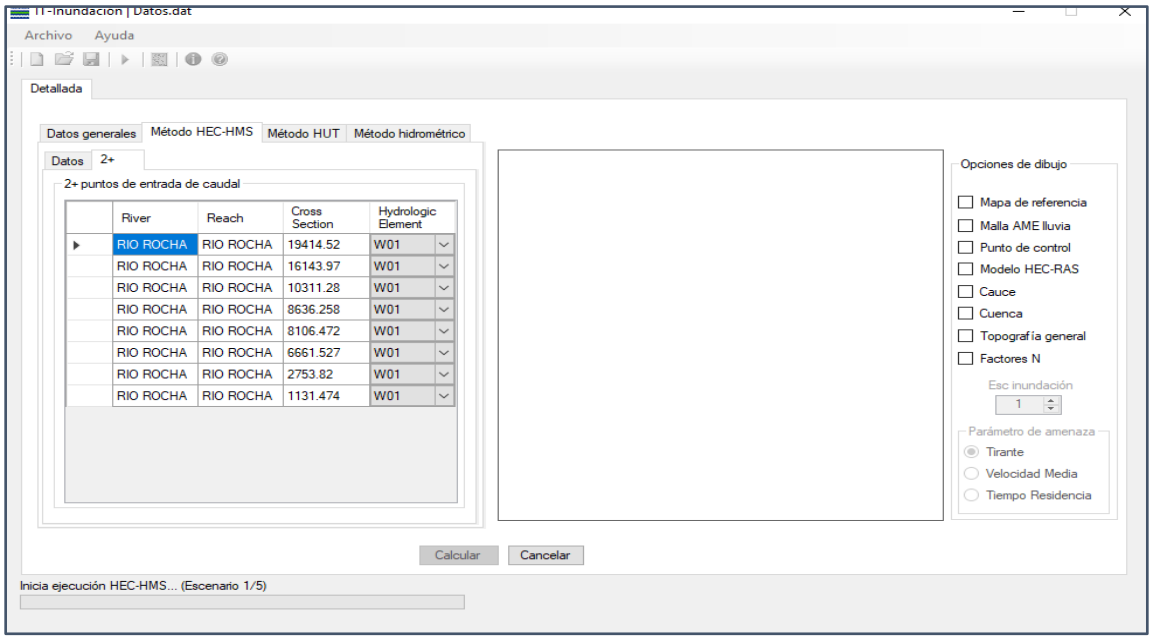


Figure 24. Execution of scenario 1/5 – HMS method

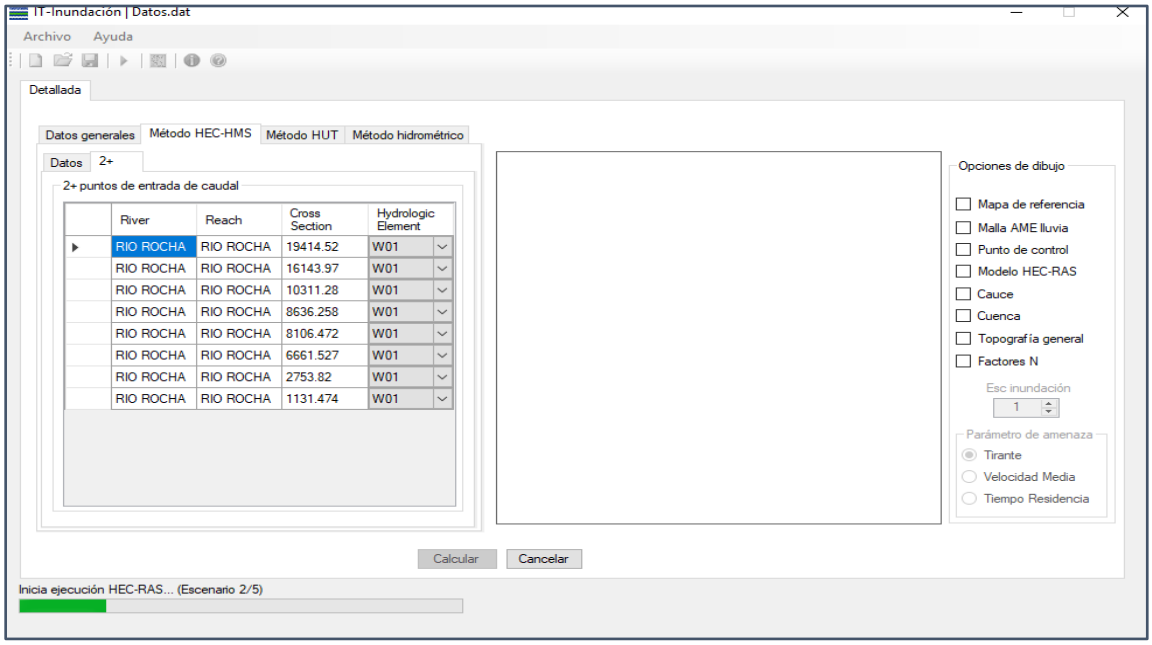


Figure 25. Execution of scenario 2/5 – HMS method

When all the scenarios are executed, the message in Figure 26, should appear and what it says is that the process finish successfully, click **Ok** to display the results in the software and in the results folder.

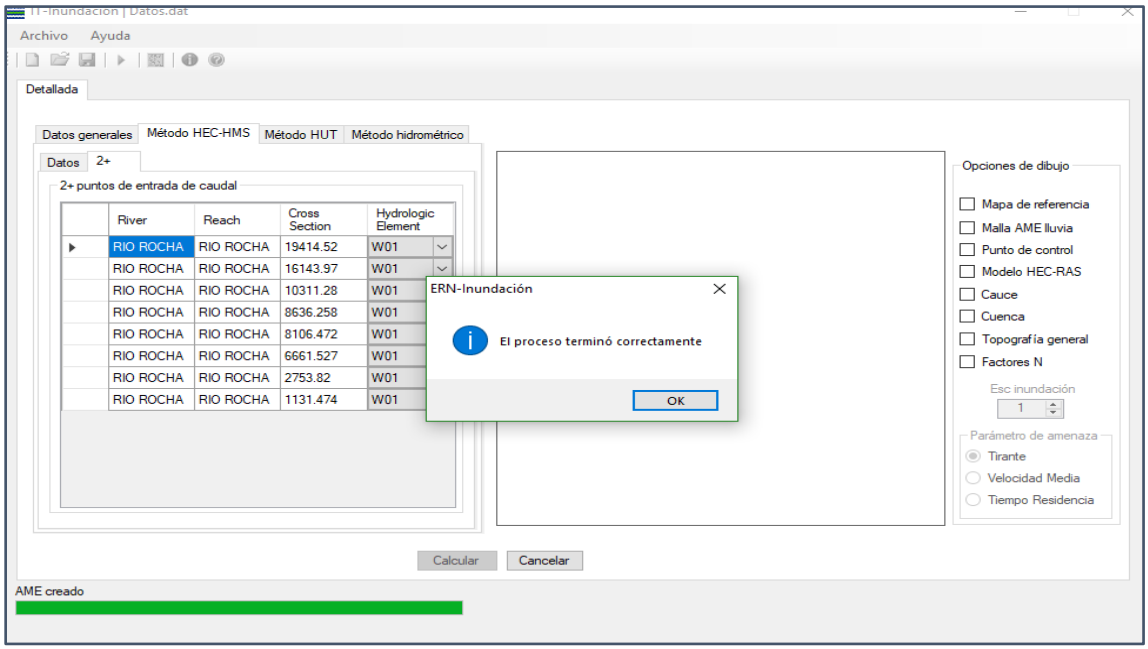


Figure 26. Process finished successfully – HMS method

6.1.1.4. Viewing results

After finishing the process, the result AME flood will appear in the graphical panel of the software as shown in Figure 27. It is also possible to open the AME in CAPRA-GIS.

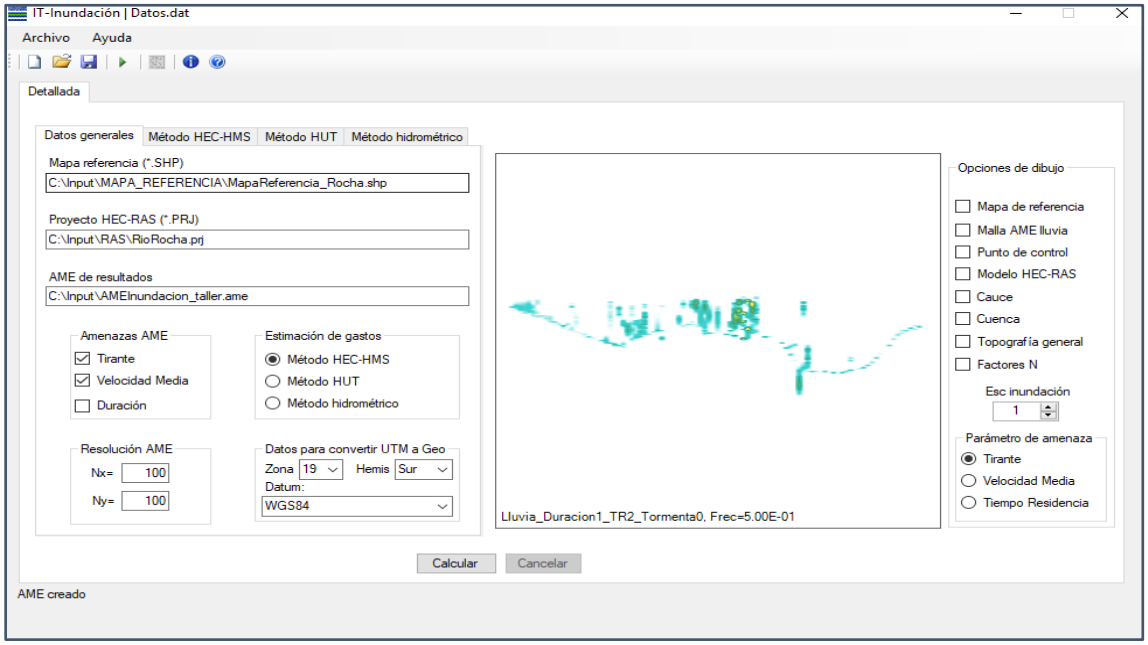


Figure 27. AME Result in the graphic interface – HMS method

6.1.2. TUH method

For this section, it is used a simplified example river with about 50 cross sections employing as entry an AME rain with 5 different scenarios each one with a different return period (5, 10, 25, 50 and 100 years). The step-by-step process is explained in the next pages. Copy the **InputTUH** folder in C:\. This file contains the necessary files for the example.

Necessary files

- Rain AME: AMERain_TUH&Hydrograph.AME
- Basin boundary: Basin.shp
- HEC-RAS project: amss1_V6.prj
- N Factors grid: NC_Example.grd
- Topography: Example_Topography.dat
- River bed polyline: RiverBed.shp
- River basis polygon: River Basin.shp

Contents

- Starting a New Project
- Entering required Data
- Performing the simulation
- Viewing Results

6.1.2.1. Starting a new Project

To begin, open *IT-Flood* from desktop or start menu and the main window should appear as shown in Figure 28.

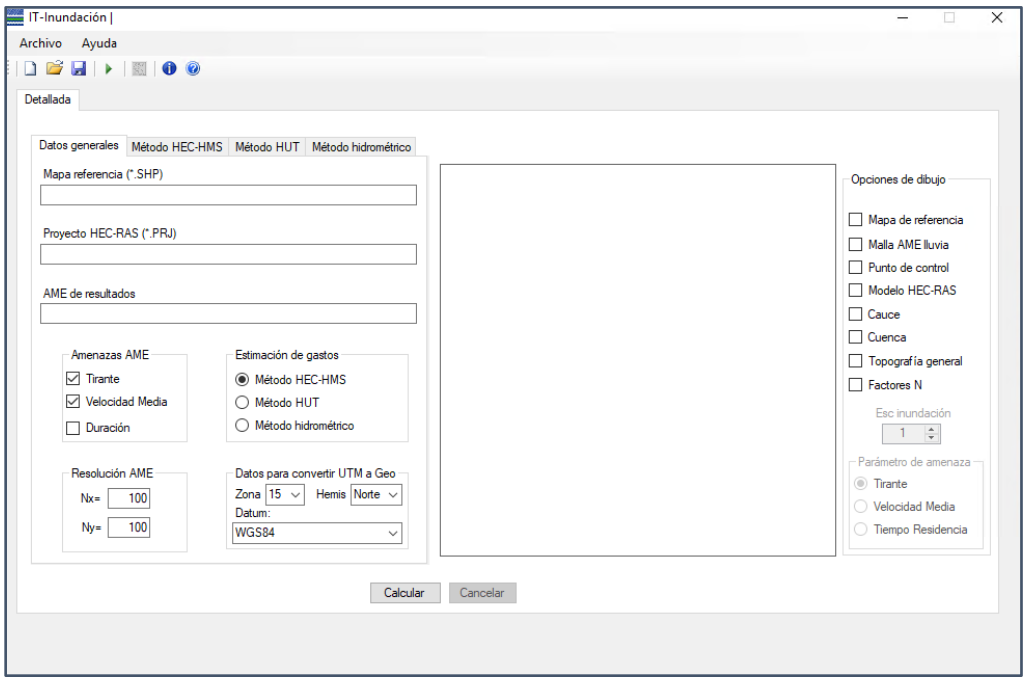


Figure 28. IT-Flood interface

If you have a Project saved, you should go to the file menu and select the command open existing project. A file .dat should be load with the project information. In this case, we are going to load the file **DataProyect_TUH.dat** as shown in the next figure.

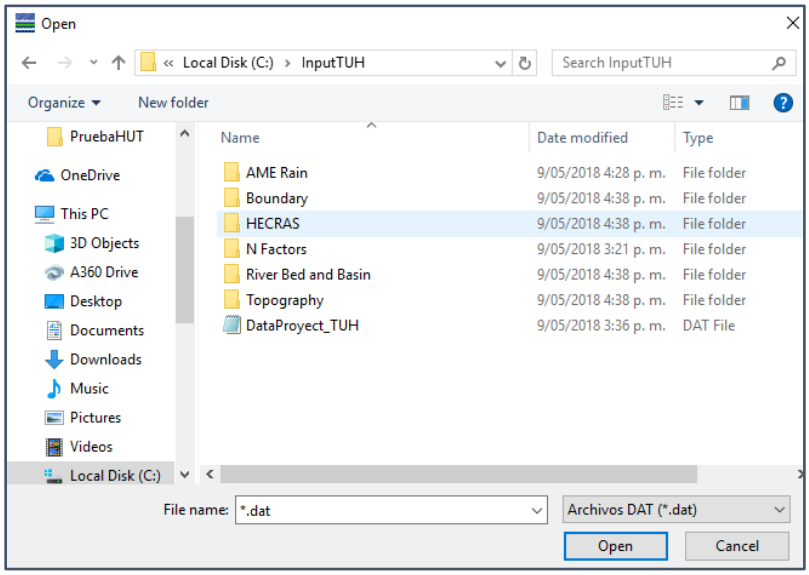


Figure 29. Selecting input data window – TUH method

If you do not have a project saved previously, you should enter the required data manually.

6.1.2.2. Entering required data

The **Datos generales** and **Método HUT** Windows must be completed as shown in Figure 30 and Figure 31, with the requirements explain in section 3, so the software can be run.

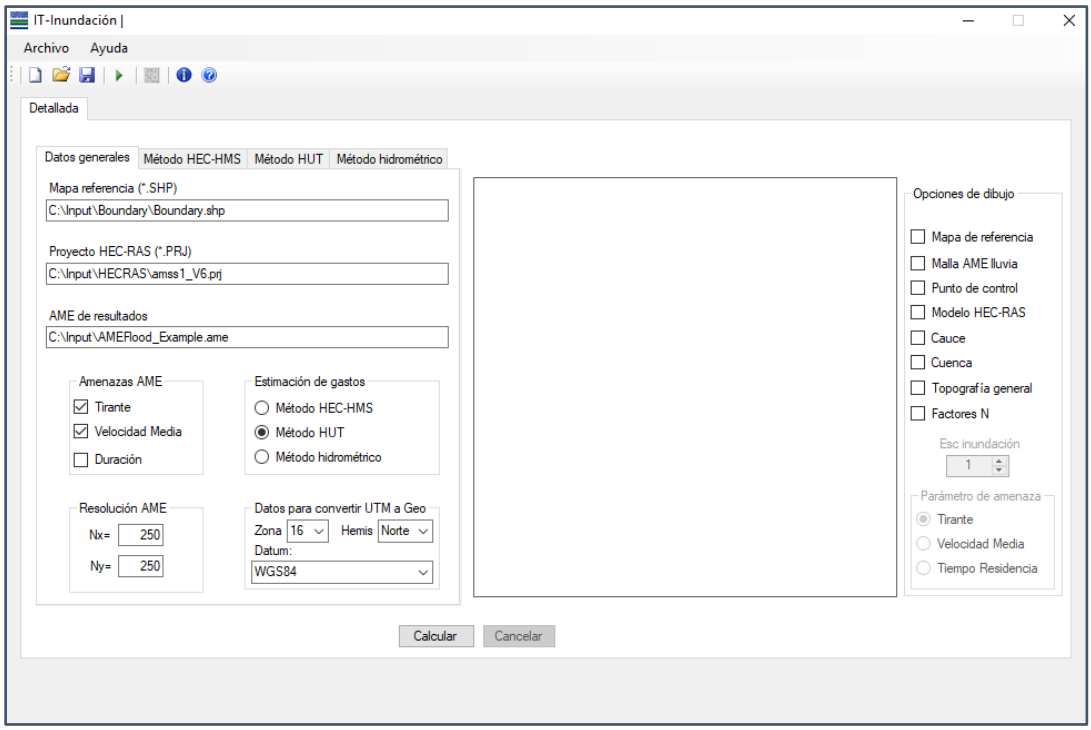


Figure 30. Datos generales window completed – TUH method

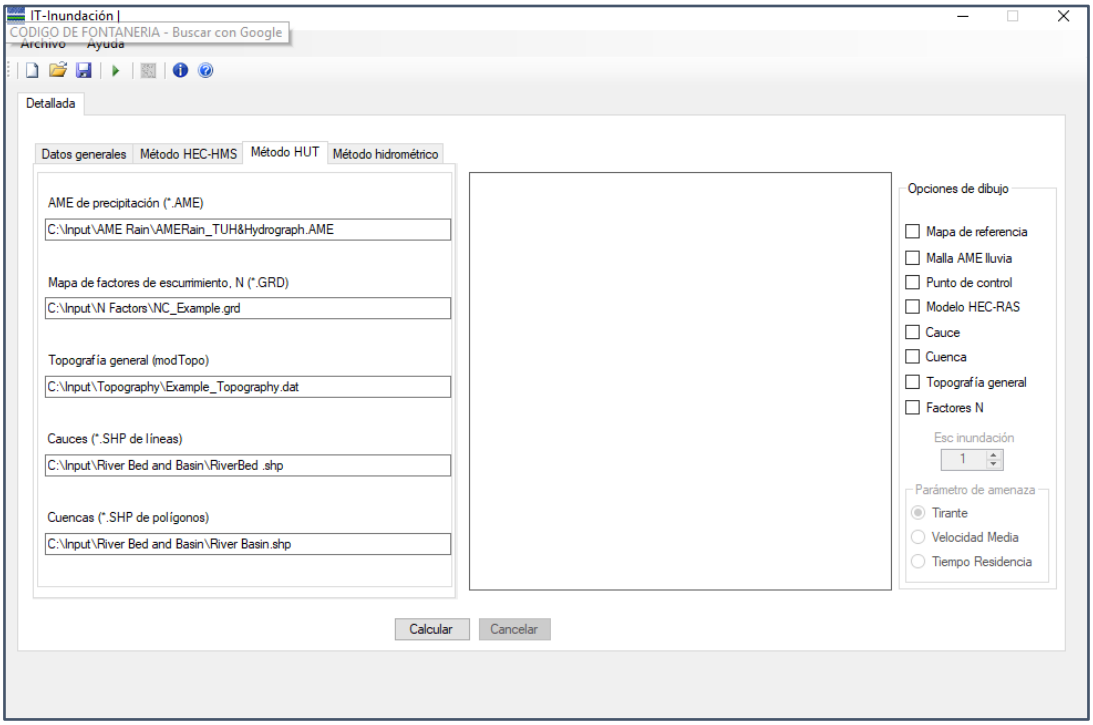


Figure 31. Método HUT window completed

6.1.2.3. Performing the simulation

After complete 6.1.2.2. Steps click the **Calcular button** and the software will load the metadata. When this information is loaded, the message in Figure 32 appears. Edit the AME metadata information if it is necessary.

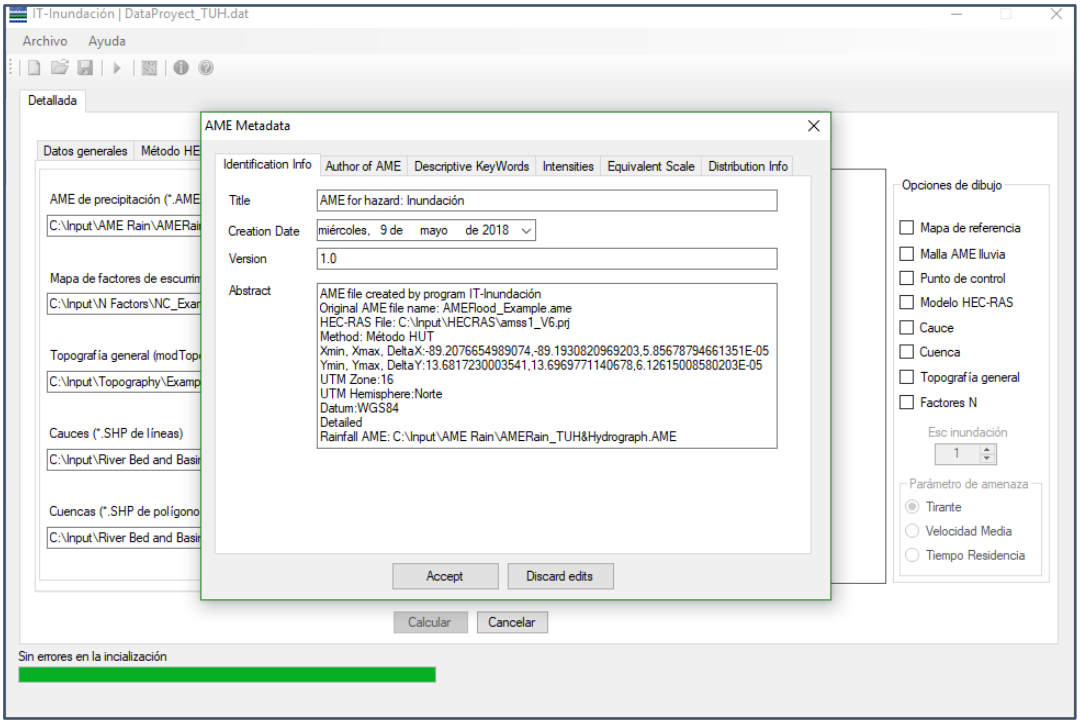


Figure 32. Charging AME metadata in main window – TUH method

Click **Accept button** and the software will ask to introduce a coefficient of variation value as shown in Figure 33. Click the **Ok button** and the program will calculate in base of basin and bed shapefiles the mean slope of the basin. It will pop up a window asking the user if the slope is correct or if not, it gives the possibility that the user edit manually the value as Figure 34 displays.

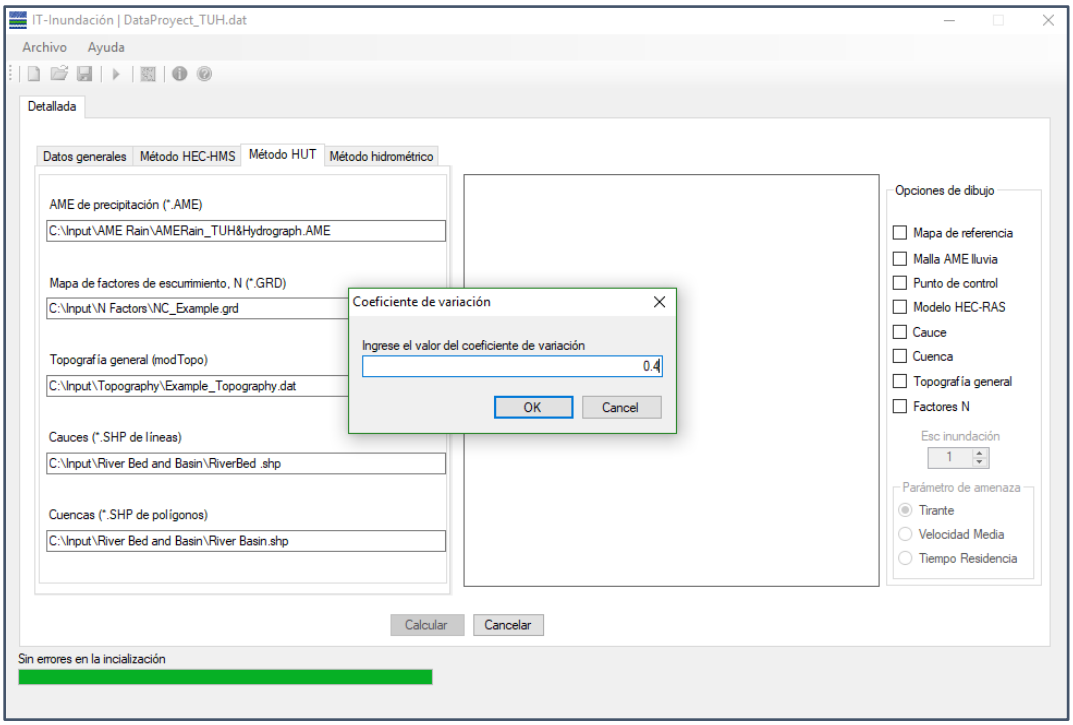


Figure 33. Coefficient of variation window - TUH method

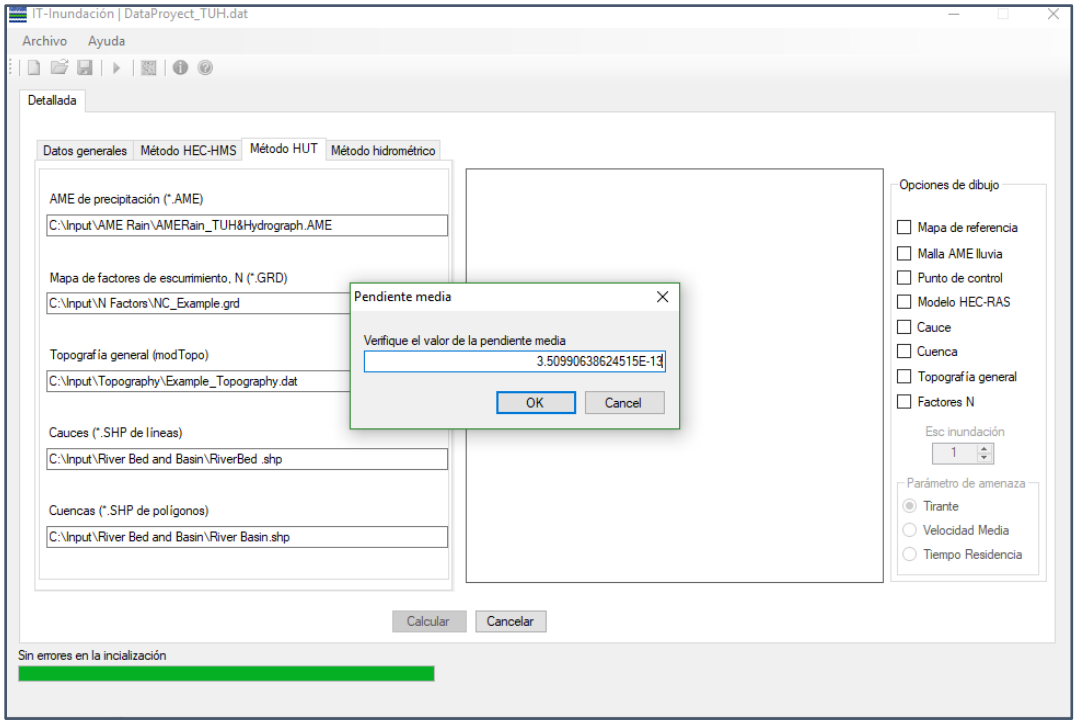


Figure 34. Basin mean slope value window – TUH method

Select the **Ok button** and the software will show the parameters that compose the triangular unit hydrograph of the basin as shown in the next figure. The user can edit each parameter manually if it is necessary.

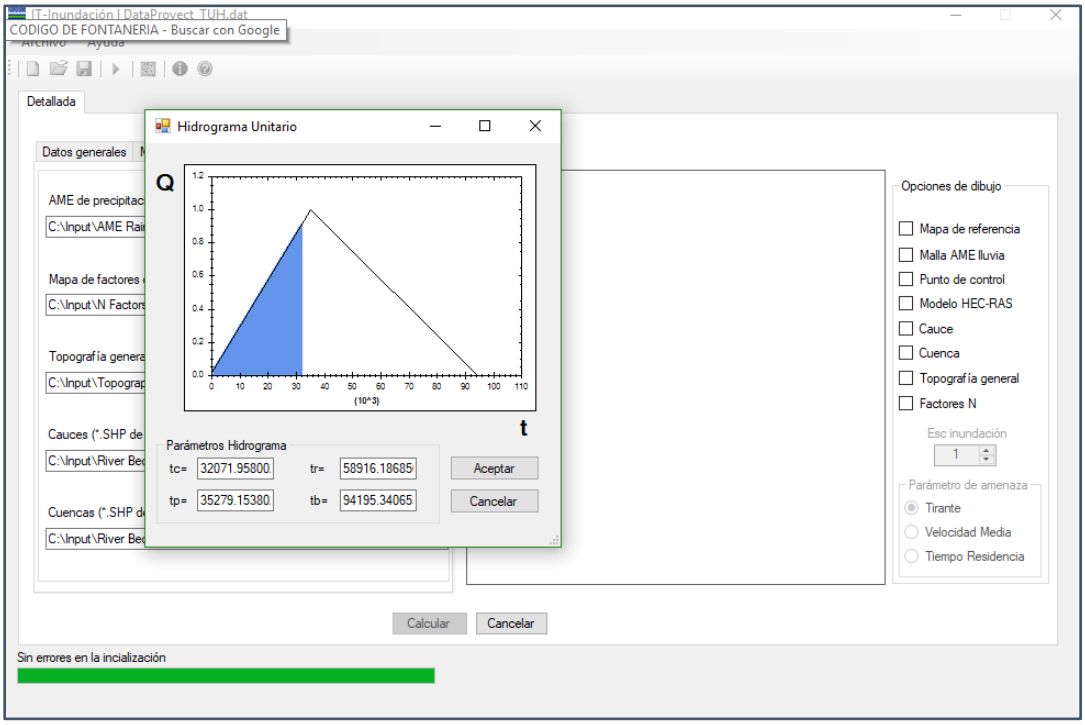


Figure 35. Unit hydrograph parameters window – TUH

Click **Aceptar button** and the calculation of the AME flood for each scenario starts as it can be seen in Figure 36.

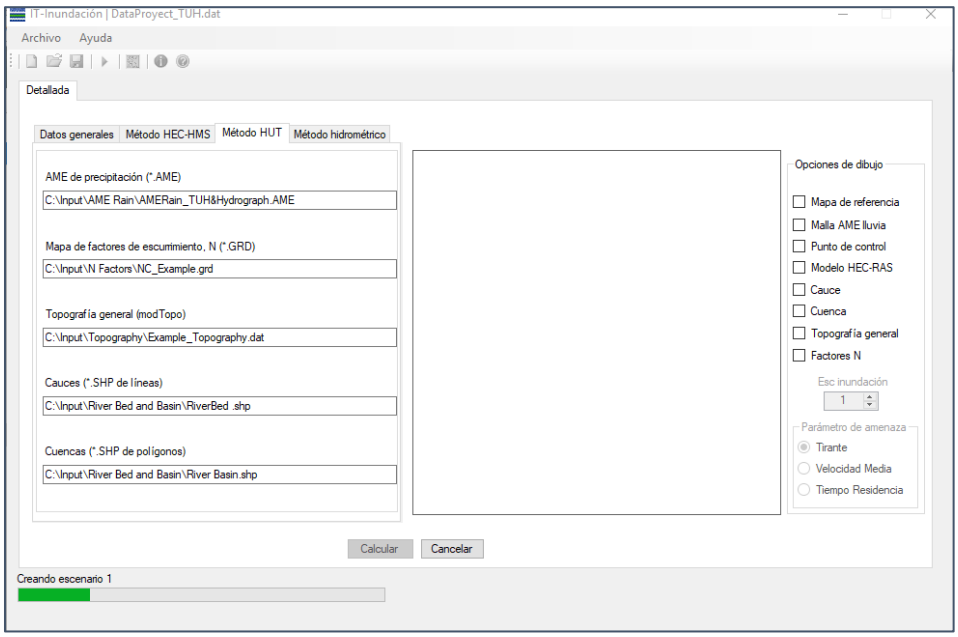


Figure 36. Execution of scenario 1/5– TUH method

When all the scenarios are executed, the message in Figure 37 should appear and what it says is that the process finish successfully, click **Ok** to finish the process.

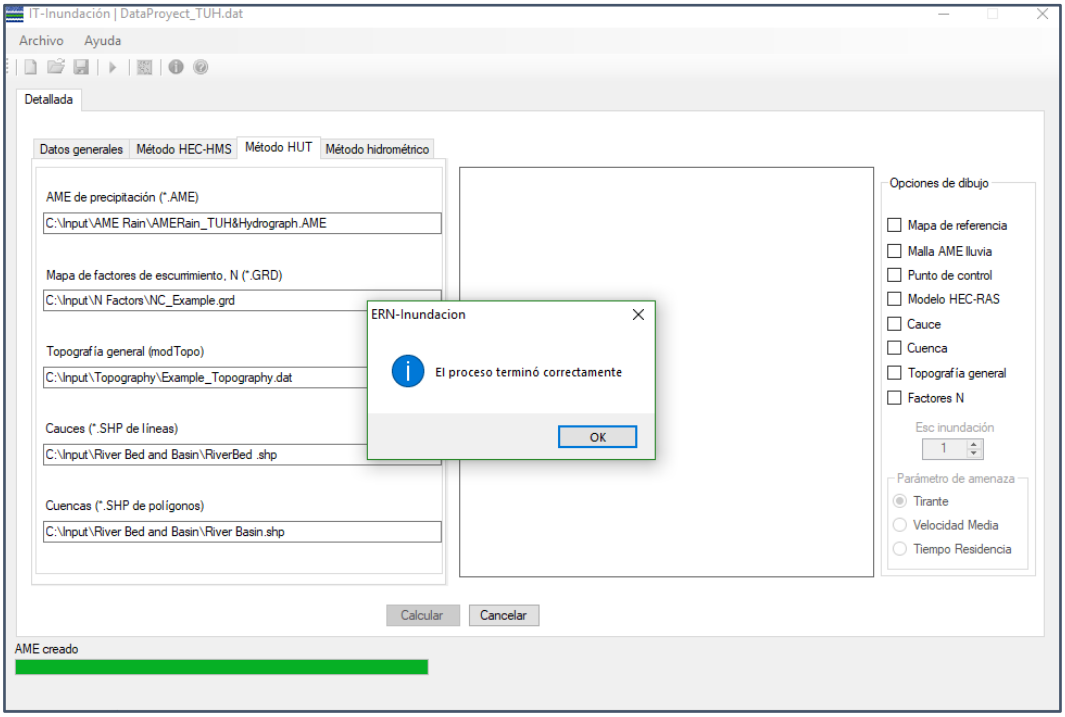


Figure 37. Process finished successfully– TUH method

6.1.2.4. Viewing results

After finishing the process, the result AME flood will appear in the graphical panel of the software as shown in Figure 38. It is also possible to open the AME in CAPRA-GIS.

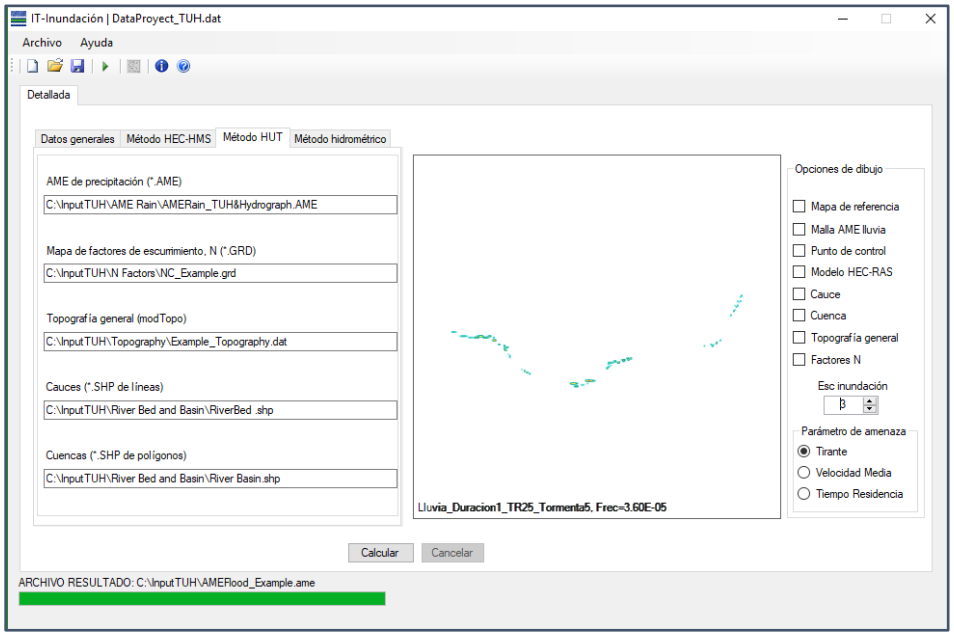


Figure 38. AME Result in the graphic interface – TUH method

6.1.3. Hydrometric method

For this section, it is used a simplified example river with about 50 cross sections as the TUH example. However, the method does not require rain data instead, it uses the flow vs return period curve. It will generate randomly five scenarios for the example. The step-by-step process is explained in the next pages. Copy the **InputHydrometric** folder in C:\. This file contains the necessary files for the example.

Necessary files

- Flow vs return period curve: FlowReturnPeriod.qtr
- HEC-RAS project: amss1_V6.prj

Contents

- Starting a New Project
- Entering required Data
- Performing the simulation
- Viewing Results

6.1.3.1. Starting a new Project

To begin, open *IT-Flood* from desktop or start menu and the main window should appear as shown in Figure 39.

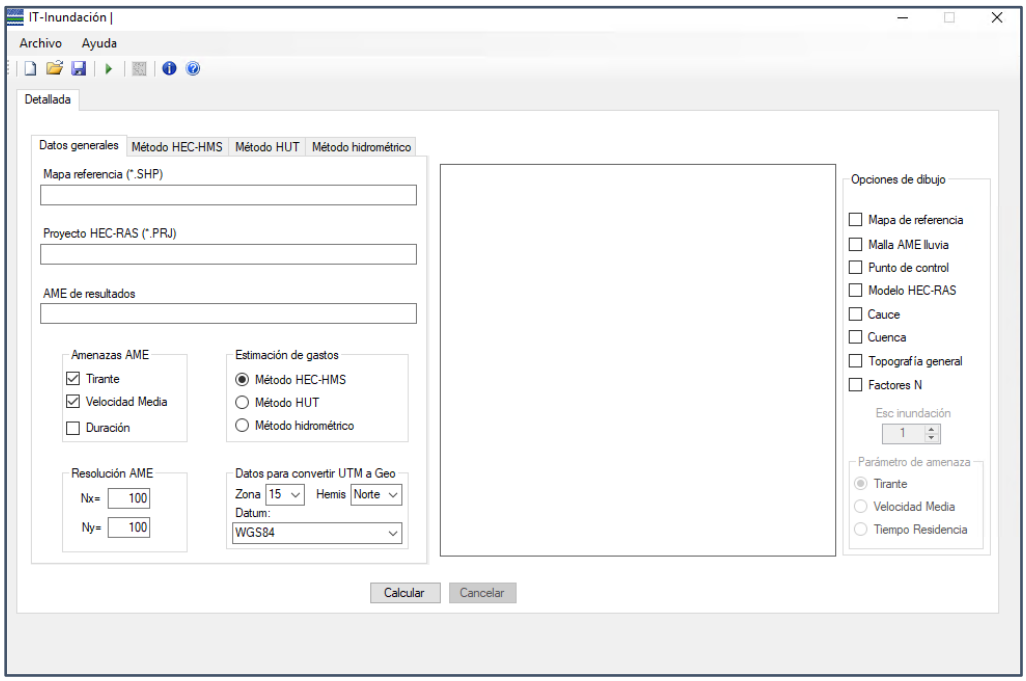


Figure 39. IT-Flood interface

If you have a Project saved, you should go to the file menu and select the command open existing project. A file .dat should be load with the project information. In this case, we are going to load the file **DataProyect_Hydrometric.dat** as shown in the next figure.

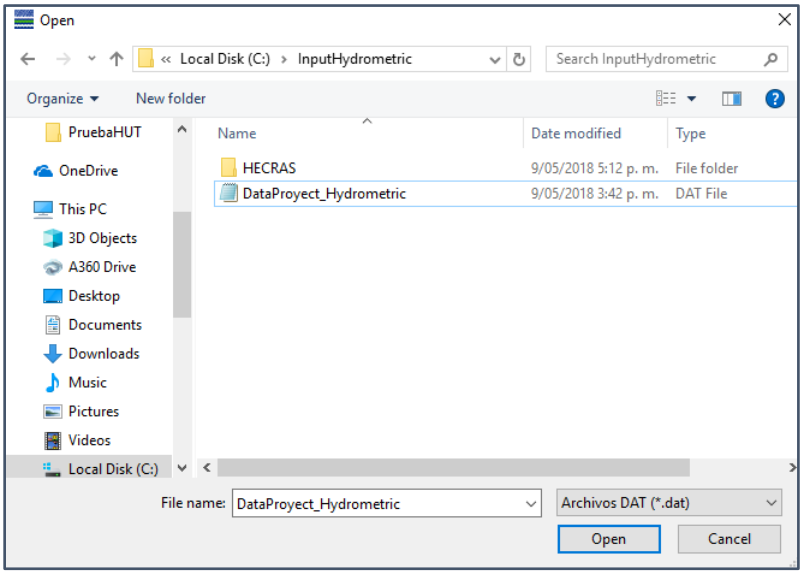


Figure 40. Selecting input data window – Hydrometric method

If you do not have a project saved previously, you should enter the required data manually.

6.1.3.2. Entering required data

The **Datos generales** and **Método hidrométrico** Windows must be completed as shown in Figure 41 and Figure 42, with the requirements explain in section 3, so the software can be run.

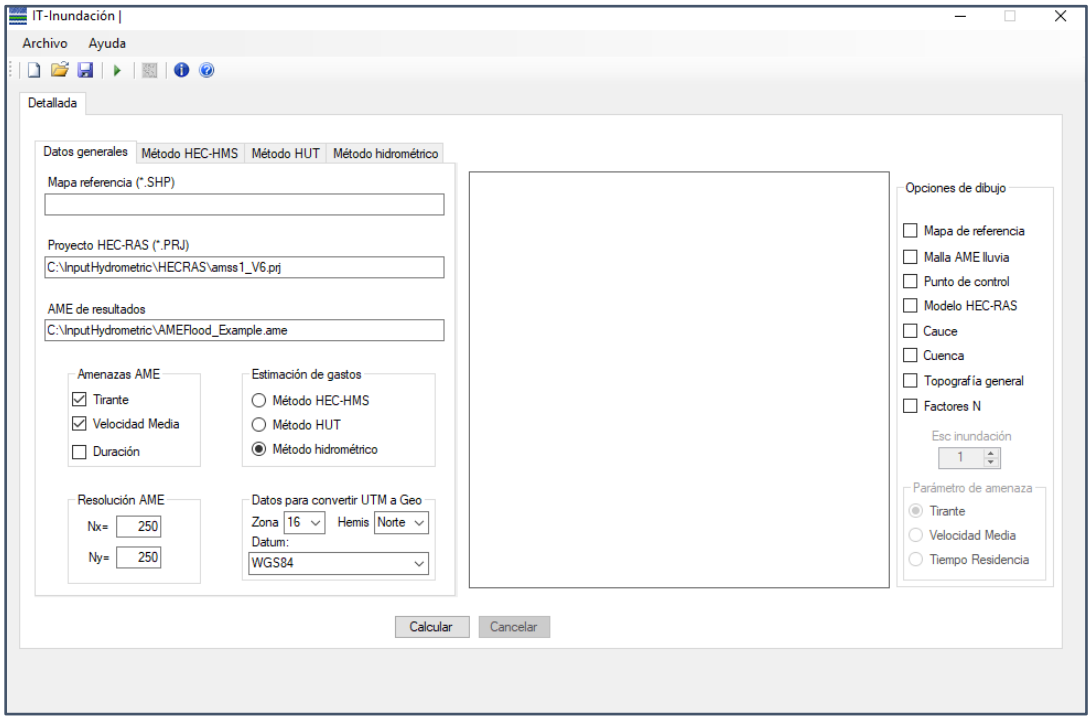


Figure 41. Datos generales window completed – Hydrometric method

When the flow vs return period is loaded, the software will show the curve in the **Método Hidrométrico** window.

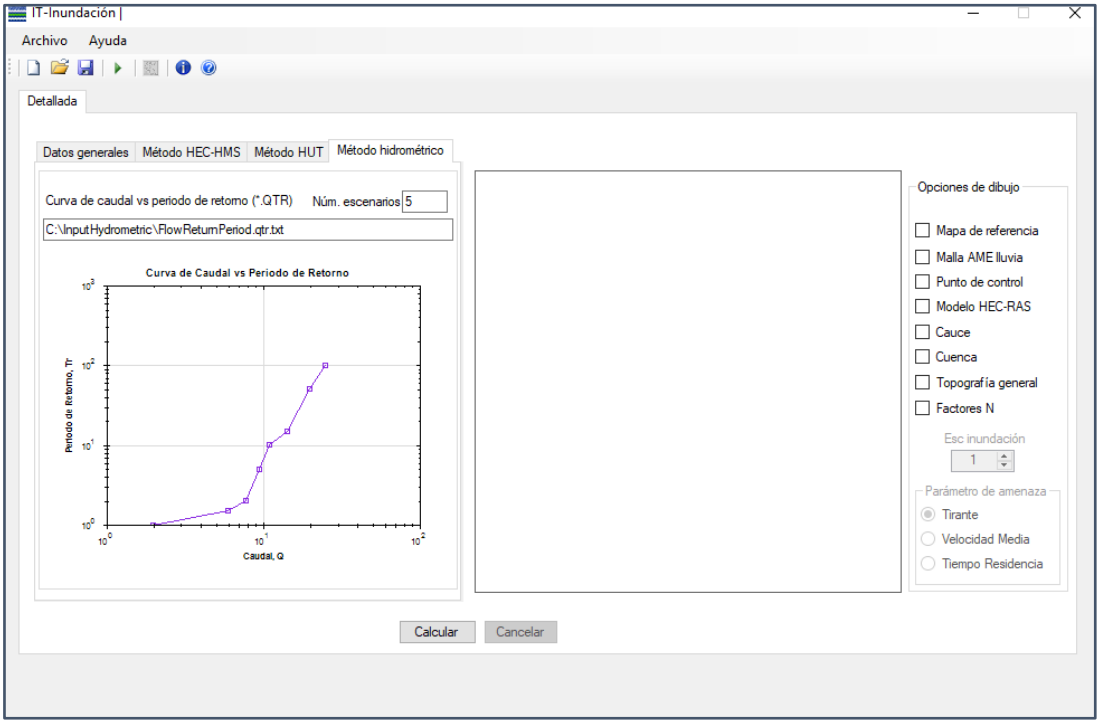


Figure 42. Método hidrométrico window completed

6.1.3.3. Performing the simulation

After complete 6.1.3.2. Steps click the **Calcular button** and the software will load the metadata. When this information is loaded, the message in Figure 43 appears. Edit the AME metadata information if it is necessary.

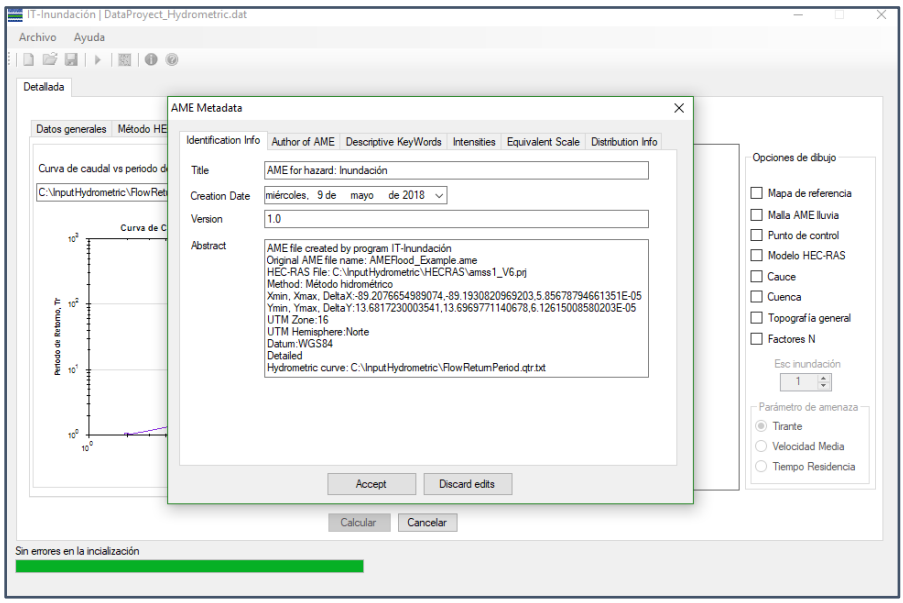


Figure 43. Charging AME metadata in main window – Hydrometric method

Click **Accept button** and the software will ask to introduce a coefficient of variation value as shown in Figure 44. Click Ok **button** and the calculation of the AME flood for each scenario starts.

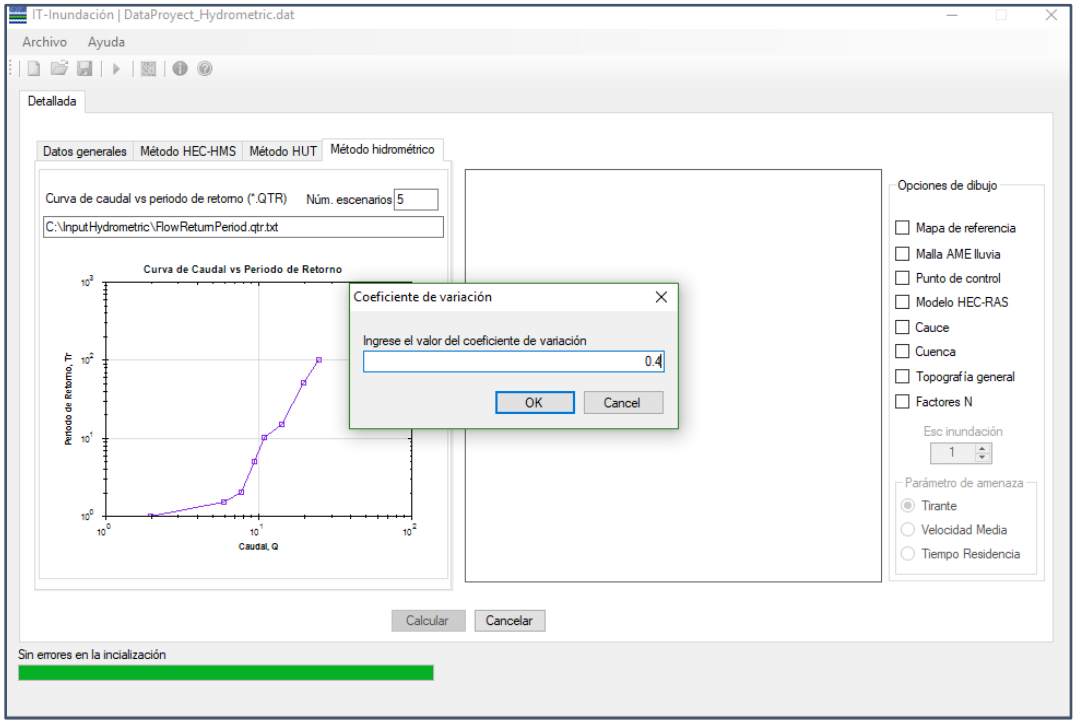


Figure 44. Coefficient of variation window – Hydrometric method

When all the scenarios are executed, the message in Figure 45 should appear and what it says is that the process finish successfully, click **Ok** to finish the process.

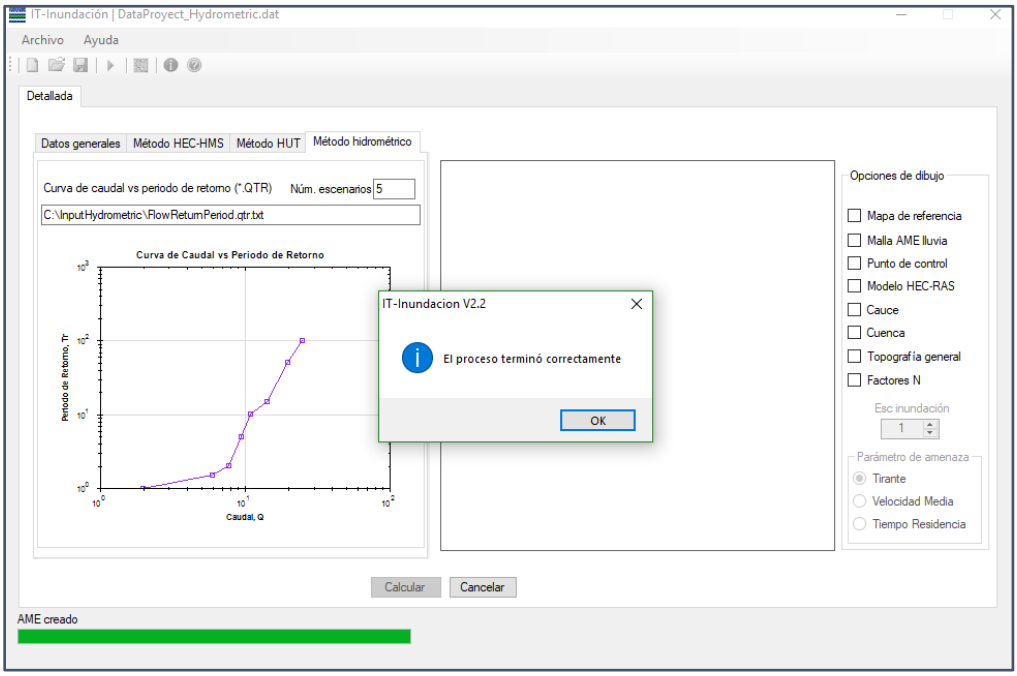


Figure 45. Process finished successfully– Hydrometric method

6.1.3.4. Viewing results

After finishing the process, the result AME flood will appear in the graphical panel of the software as shown in Figure 46. It is also possible to open the AME in CAPRA-GIS.

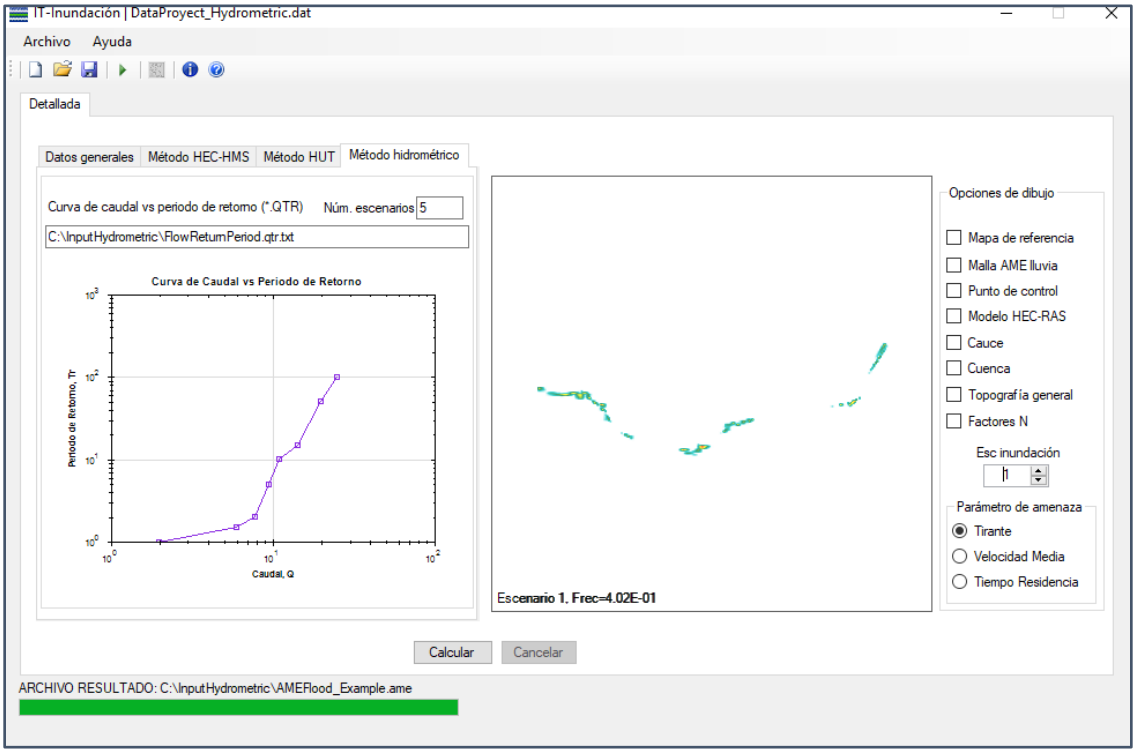


Figure 46. AME Result in the graphic interface – Hydrometric method

Chapter 7

Software limitations

7.1. Software limitations

The most important limitations of the software are listed below:

- The software only works with HEC-RAS 4.1 that means that only allows 1D modeling.
- Currently limited version only runs 20 scenarios.

Chapter 8

Problems and errors

8.1. Problems and errors

The identified problems at the time of creation of this manual are:

- Projection error, when re-projecting to geographic coordinates it is possible that a small misalignment occurs.
- If the computer language is not in Spanish, there are some translate errors in the interface for others languages (i.e. some words remain in Spanish).
- If the HEC-RAS model have lakes or ponds, in the HEC-HMS window: Puntos de entrada de caudal, table 2+ does not appear the name of the hydraulic element, so an error window displays. However, the software is capable of running by dismissing the error.
- At the time of calculations, the program is inefficient and it loads several times the same file/information before proceeding with the calculation.

Chapter 9

References

9.1. References

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