

User Manual Software IT-Flood V.2.2

Flood hazard modelling

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Contents

Intro	oduc	tion	. 5
1.	.1.	Introduction	. 6
1.	.2.	Problem description	. 6
1.	.3.	Theoretical framework	. 6
	Mat	hematical model	. 6
	Hyd	rological analysis	. 7
	Hyd	raulic analysis	. 8
1.	.4.	Analysis flow chart	. 8
Soft	ware	e Installation	. 9
2	.1.	Minimum installation requirements	10
	Min	imum hardware and software requirements	10
2	.2.	Recommended hardware requirements	10
	Pro	cessor	10
	RAN	۸ Memory	10
	Ren	novable unit	10
	Oth	er software	10
2	.3.	Software requirements	10
2	.4.	Installation process	11
2	.5.	Language configuration	11
Graj	ohica	Il User Interface	12
3	.1.	General Description	13
3	.2.	Tools and Menus	13
	Dat	os generales window	15
	Mét	todo HEC-HMS window	17
	Mét	todo HUT window	19
	Mét	todo hidrométrico window	20
	Gra	phic interface	20
Sett	ing i	nput data and files	21
4	.1.	Input parameters setting	22
4	.2.	File formats	23
	Gen	eral Topography	23
	Flov	v vs Return period curve	24



HEC	C-HMS	PROJECT	24
5.1.	Outp	ut files and file format	26
Step by s	step tu	torial	27
6.1.	Step	by-step tutorial	28
6.1.	1. H	HMS method	28
6.1.	2. 1	۲UH method	34
6.1.	.3. ł	Hydrometric method	41
Software	e limita	itions	46
7.1.	Softw	vare limitations	47
Problem	s and e	errors	48
8.1.	Prob	lems and errors	49
Referenc	ces		50
9.1.	Refe	rences	51





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 <u>http://www.hec.usace.army.mil/software/hec-ras/</u>.

1.4. Analysis flow chart







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



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

🔗 Region		\times					
Formats Location Admi	histrative						
Format:							
Spanish (Mexico)	~						
Language preferences	te						
Short date:	dd/MM/yyyy						
Long date:	dddd, d' de 'MMMM' de 'yyyy						
Short time:	Short time: v						
Long time:	hh:mm:ss tt 🗸 🗸 🗸						
First day of week:	domingo \checkmark						
Examples							
Short date:	17/08/2018						
Long date:	viernes, 17 de agosto de 2018						
Short time:	03:25 p. m.						
Long time:	03:25:52 p. m.						
	Additional settings						
	OK Cancel Apply	/					

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.

IT-Inundación	– 🗆 X
Archivo Ayuda	
Detallada	
Datos generales Método HEC-HMS Método HUT Método hidrométrico	
Mapa referencia (*.SHP)	Opciones de dibujo
Proyecto HEC-RAS (".PRJ) AME de resultados	Mapa de referencia Malla AME Iluvia Punto de control Modelo HEC-RAS Cauce
Amenazas AME Estimación de gastos Tirante Velocidad Media Duración	Cuenca Topografía general Factores N Esc inundación 1 \$
Resolución AME Datos para convertir UTM a Geo Nx= 100 Ny= 100 WGS84 ~	Parámetro de amenaza Imante Velocidad Media Tiempo Residencia
Calcular	Cancelar

Figure 3. IT-Flood interface

3.2. Tools and Menus

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

<u>File menu</u>

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		

IT-Inundación - - × File Help - - ×	New Project
Vee project Save project	Open Project
Exit THIS Unit-hydrograph method Hydro () Reference map	Save Project
HEC-RAS project (* PRJ)	Exit
Control point Control point HEC-RAS model Results AME Reverbed	
AME Hazards	
AME resolution Data to Convert UTM to Geo Flazard parameter Nx= 100 Zone 15 v Hemis Noth v Ny= 100 WGS84 V	
Compute Cancel	

Figure 4. File menu localization and its commands.

<u>Help menu</u>

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)			



Λ	Universidad de
	los Andes
~	Colombia

T-Inundación File Help About ERM.Inundación	- · · · · Help
Datos generales Método HEC-HMS Unit hydrograph method Hydro	About ERN-Inundación
Reference map	Drawing options
Results AME	Rain AME grid Control point HEC-RAS model
AME Hazards Flow estimation ☐ Depth Metodo HEC.+IMS ☐ Metodo HEC.+IMS	reverbed Beain General topography N factors
AME resolution Data to Convert UTM to Geo	Flood aconarios Total Hazard parameter (iii) Depth
Noca 100 200e [15] Hemis [noul 5] Nyre 100 Datum WGS84 V	Mean Velocity Tempo Residencia
Compute Cancel	

Figure 5. Help menu localization

<u>Tool bar</u>

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.



T-Inundación		—
chivo Ayuda		
) 🚅 🛃 🕨 🔟 🕘 🥥		
etallada		
Datos generales Método HEC-F	IMS Método HUT Método hidrométrico	
Mapa referencia (*.SHP)		Oneinere de divis
		Opciones de albujo
		Mapa de referencia
Proyecto HEC-RAS (*.PRJ)		Malla AME Iluvia
		Punto de control
AME de resultados		Modelo HEC-RAS
		Cauce
		Cuenca
Amenazas AME	Estimación de gastos	Topografía general
✓ Tirante	Método HEC-HMS Mánda HHT	Factores N
	Metodo HUI	Esc inundación
Duración		1 🔹
Resolución AME	- Datos para convertir LITM a Geo	Parámetro de amenaza
Ne 100	Zona 19 V Hemis Sur V	Tirante
100	Datum:	Velocidad Media
Ny= 100	WGS84 V	 Tiempo Residencia
	Calcular Cancelar	

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.

Abrir							
🔵 🔵 – 📕 « Dato	s generales 🔸 01. Mapa de referencia	✓ 4→ Buscar OL Mapa de	e referencia 👂	D			
Organizar 👻 Nue	va carpeta	88 -	- 🛯 0	Detallada			
🚖 Favoritos	Nombre	Fecha de modifica Tipo	Tami	S	2.3		
and American	Arenal-Monserrat.shp	18/11/2013 05:46 AutoCAD	Shape S	Datos generales	Método HEC-HMS	Método HUT	Método hidr
🙀 Bibliotecas	s Dista-CAPRA.shp 24/02/2011 08:55 AutoCAD Shape S Mapa referencia (*.SHP)						
📜 Equipo				Jacion-HMS-RAS	5\Datos generales\01	1. Mapa de refe	rencia\Isla-CA
🗣 Red				Proyecto HEC-F	RAS (*.PRJ)		
				AME de resultad	dos		
	· (т	•	1			
٨	lombre: Arenal-Monserrat.shp	- Archivos SHP (*.shp)					
		Abrir 🔽	Cancelar				

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.

Puntos de caudal	entrada de
01	2+

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.

Iada Método HEC-HMS Método HUT Método hidrométri Jatos 2+					
atos generales Método HEC-HMS Método HUT Método hidrométri Datos 2+ -2+ puntos de entrada de caudal River Reach Cross Hydrologic Section Element	💕 🔒		()		
atos generales Método HEC-HMS Método HUT Método hidrométri Datos 2+ - 2+ puntos de entrada de caudal River Reach Cross Hydrologic Section Element	allada				
atos generales Método HEC-HMS Método HUT Método hidrométri Datos 2+ - 2+ puntos de entrada de caudal River Reach Cross Hydrologic Bernent					
Datos 2+ - 2+ puntos de entrada de caudal - River Reach Cross Section Hydrologic Element)atos den	erales Méte	odo HEC-HMS	Método HUT	Método hidrométric
2400 24	Datas [2			
- 2+ puntos de entrada de caudal River Reach Cross Section Hydrologic Bement	Datos 4				
River Reach Cross Hydrologic Section Element	-2+ pun	tos de entrad	a de caudal		
		River	Reach	Cross	Hydrologic Element

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:

Datos generales	Método HEC-HMS	Método HUT	Método hidrométrico
AME de precipit	ación (*.AME)		
Mapa de factore	s de escurrimiento, N	(*.GRD)	
Topografía gene	eral (modTopo)		
Cauces (*.SHP o	de líneas)]
Cuencas (*.SHP	de polígonos)		

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*



<u>Cuencas</u>

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.

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	-

Table 3. Inputs parameters for IT-Flood





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.
- 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:

п Q_1, Tr_1 ...,... 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.

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

Table 4. AME results depending of flow estimation method

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

- <u>Boundary</u>: MapaReferencia_Rocha.shp
- <u>HEC-RAS project</u>: RioRocha.prj
- <u>Rain AME</u>: 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.

IT-Inundación		- 🗆 X
Archivo Ayuda		
🗋 💕 🛃 🕨 🔣 🔀 🥝		
Detallada		
Detallada Datos generales Método HEC- Mapa referencia (* SHP) Proyecto HEC-RAS (* PRJ) AME de resultados Amenazas AME Trante Velocidad Media Duración Resolución AME Nx= 100 Ny= 100	HMS Método HUT Método hidrométrico Estimación de gastos Método HEC-HMS Método HUT Método HUT Método hidrométrico Datos para convertir UTM a Geo Zona [15 Hemis Note v Datum:	Opciones de dibujo Mapa de referencia Malla AME lluvia Punto de control Modelo HEC-RAS Cauce Cuenca Topografia general Factores N Esc inundación Temo de amenaza @ Trante Velocidad Media Temoo Residencia
	Colorita Consulta	
	Carcular Cancelar	

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**.

MIN O			~
Upen Upen			×
$\leftarrow \rightarrow \cdot \uparrow$	> This PC → Local Disk (C:) → Input	 O Search Input 	Q
Organize 🔻 New	folder		?
- Planos	^ Name	Date modified Type	
a OneDrive	HMS	24/04/2018 5:34 p File folder	
T 1: DC	MAPA_REFERENCIA	24/04/2018 5:25 p File folder	
This PC	RAS	24/04/2018 5:35 p File folder	
3D Objects	Datos	28/10/2015 2:03 a DAT File	
💿 A360 Drive			
E Desktop			
Documents			
👆 Downloads			
👌 Music			
Pictures			
Videos			
🟪 Local Disk (C:)	v <		3
	File name: *.dat	✓ Archivos DAT (*.dat)	\sim
		Open Cance	1

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.

IT-Inundación Datos.dat	– 🗆 X
Archivo Ayuda	
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Detallada	
Datos generales Método HEC-HMS Método HUT Método hidrométrico	
Mapa referencia (*.SHP)	
C:\Input\MAPA_REFERENCIA\MapaReferencia_Rocha.shp	
	Mapa de referencia
Proyecto HEC-RAS (PRJ)	Malla AME lluvia
	Punto de control
AME de resultados	Modelo HEC-RAS
C:\Input\AMEInundacion_taller.ame	Cauce
America AME	Cuenca
Amenazas AME Estimación de gastos	Topografía general
Velocidad Media	Factores N
	Esc inundación
Besolución AME Datos para convertir UTM a Geo	Parámetro de amenaza
Nx= 100 Zona 19 V Hemis Sur V	Tirante
Datum:	Velocidad Media
WGS84 ~	Ilempo Residencia
Calcular	Cancelar

Figure 19. Datos generales window completed – HMS method



IT-Inundación Datos.dat			– 🗆 🗙
Archivo Ayuda			
i 🗋 😂 🛃 🕨 🎫 🚯 🎯			
Detallada			
Detailada Datos generales Método HEC-HMS N Datos 2+ AME de precipitación (* AME) C:\hput/AME/Precipitación_Rocha.AM Proyecto HEC-HMS (* HMS) C:\hput/AME/Precipitación Rocha.AM Distribución temporal de tormentas Distribución temporal de tormentas 10 7 Distribución temporal de tormentas 10 7 20 12 30 70 40 8 50 3 66 0 70 0 80 0 90 0 100 0 90 0 100 0 90 0 100 0 90 0 100 0 90 0 100 0 100 0 100 0 100 0 100 0 100 100 0 100	Nétodo HUT Método hidrométrico	r Cancelar	Opciones de dibujo Mapa de referencia Malla AME Iluvia Punto de control Modelo HEC-RAS Cauce Cuenca Topografía general Factores N Esc inundación Terrante Velocidad Media Tiempo Residencia

Figure 20. Método HMS window completed

IT-Inu	ndació	n Datos.dat							– 🗆 X
Archivo	Ау	uda							
🗋 📂		Image:	0						
Detallad	la								
Dato	s gener	ales Método	HEC-HMS M	étodo HUT	Vétodo hidrométric	0			
Det									1
Date	JS 2.	e de entrede d	a anudal						Opciones de dibujo
	+ punto	s de entrada d	e caudai						Mapa de referencia
		River	Reach	Cross Section	Hydrologic Element				Malla AME Iluvia
	•	RIO ROCHA	RIO ROCHA	19414.52	W01 ~				Punto de control
		RIO ROCHA	RIO ROCHA	16143.97	W01 ~				Modelo HEC-RAS
		RIO ROCHA	RIO ROCHA	10311.28	W01 ~				Cauce
		RIO ROCHA	RIO ROCHA	8636.258	W01 ~				Cuenca
		RIO ROCHA	RIO ROCHA	8106.472	W01 ~				Topografía general
		RIO ROCHA	RIO ROCHA	6661.527	W01 ~				Factores N
		RIO ROCHA	RIO ROCHA	2753.82	W01 ~				Esc inundación
		RIO ROCHA	RIO ROCHA	1131.474	W01 ~				1 🔺
									- Parámetro de amenaza -
									Tirante
									Velocidad Media
									Tiempo Residencia
					Calc	ular Cancel	lar		

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.



📕 IT-Inunda	ción Datos.dat					– 🗆 X
Archivo	Ayuda					
	▶ €	0				
Detallada						
Detailada						
Datos ge	nerales Método	HEC-HMS M	étodo HUT	Vétodo hidrométrico		
	2.					
Datos	2+					Opciones de dibujo
2+ pu	itos de entrada d	e caudai				Mapa de referencia
	River	Reach	Cross Section	Hydrologic Element		Malla AME Iluvia
•	RIO ROCHA	RIO ROCHA	19414.52	W01 ~		Punto de control
	RIO ROCHA	RIO ROCHA	16143.97	W01 ~		Modelo HEC-RAS
	RIO ROCHA	RIO ROCHA	10311.28	W01 ~		Cauce
	RIO ROCHA	RIO ROCHA	8636.258	W01 ~		Cuenca
	RIO ROCHA	RIO ROCHA	8106.472	W01 ~		Topografía general
	RIO ROCHA	RIO ROCHA	6661.527	W01 ~		Factores N
	RIO ROCHA	RIO ROCHA	2753.82	W01 ~		Esc inundación
	RIO ROCHA	RIO ROCHA	1131.474	W01 ~		1 🚖
						Parámetro de amenaza
						Tirante
						Velocidad Media
						 Tiempo Residencia
				Calci	r Cancelar	
Cargando met	adatos del AME					

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

AME Metadata					:
Identification Info	Author of AME	Descriptive KeyWords	Intensities	Equivalent Scale	Distribution Info
Title	AME for hazard:	nundación			
Creation Date	martes , 24 de	abril de 2018 $ \smallsetminus $			
Version	1.0				
Abstract	AME file created Original AME file HEC-RAS File: C Method: Método Xmin, Xmax, Delt UTM Zone: 19 UTM Zone: 19 UTM Lemispher Datum: WGS84 Detailed Rainfall AME: C:	by program IT-Inundació name: AMEInundació Niput/RAS/NioRocha, HEC-HMS ax:-66.3216200790181, ax:-66.3216200790181, ax:-17.4437864827916, e:Sur	n aller.ame orj -66.1711677 -17.3928247 _Rocha.AM!	010443.0.0015197 529666.0.0005147 E	2098963412 64947727825
		Accept D	iscard edits		

Figure 23. AME Metadata loaded window – HMS method



atos ge	nerales Método	HEC-HMS M	étodo HUT	Método hidr	ométrico	
Datos	2+					Opciones de dibujo
2+ pu	ntos de entrada de	e caudal				
	River	Beach	Cross	Hydrolo	gic	Mapa de referencia
			Section 10414 E2	Elemen	t	Malla AME Iluvia
-			10414.02	W01	× ·	Punto de control
			10143.37	W01	× ×	Modelo HEC-RAS
	RIO ROCHA		0000.050	W01	×	
			0030.230	W01	× ×	Cuenca
	RIO ROCHA		0100.472	W01	×	Topografía general
	RIO ROCHA		0001.027	10/01	×	Factores N
	RIO ROCHA		2/03.82	W01	×	Esc inundación
	RIO ROCHA	RIO ROCHA	1131.474	WUT		1 🔹
						- Parámetro de amena:
						Tirante
						Velocidad Media
						 Tiempo Residenci

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

IT-Inundaci	ón Datos.dat						- X
Archivo A	yuda						
🗅 💕 🖬	▶ 🕅 🗨	0					
Detallada							
Datos gen	erales Método	HEC-HMS M	étodo HUT	Método hidron	étrico		
Datos 2	·+						Oneinen de divie
2+ punt	os de entrada de	e caudal					Opciones de dibujo
			Cross	Lhuden la aiu			Mapa de referencia
	River	Reach	Section	Element			Malla AME Iluvia
•	RIO ROCHA	RIO ROCHA	19414.52	W01	\sim		Punto de control
	RIO ROCHA	RIO ROCHA	16143.97	W01	\sim		Modelo HEC-RAS
	RIO ROCHA	RIO ROCHA	10311.28	W01	~		Cauce
	RIO ROCHA	RIO ROCHA	8636.258	W01	~		Cuenca
	RIO ROCHA	RIO ROCHA	8106.472	W01	~		Topografía general
	RIO ROCHA	RIO ROCHA	6661.527	W01	~		Factores N
	RIO ROCHA	RIO ROCHA	2753.82	W01	~		Esc inundación
	RIO ROCHA	RIO ROCHA	1131.474	W01	~		1 🜲
							Parámetro de amenaza
							Tirante
							O Velocidad Media
							 Tiempo Residencia
					Jalcula	ar Cancelar	
Inicia ejecución	HEC-RAS (Es	cenario 2/5)					

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.



tallada Datos ge	enerales Método	HEC-HMS M	étodo HUT I	Método hidro	métrico	
Datos	2+					Opciones de dibujo
2+ pt	untos de entrada d	e caudal				
	River	Beach	Cross	Hydrolog	jic	Mapa de referencia
			Section	Element		Malla AME Iluvia
1			10414.02	10/01		Punto de control
			10143.37	W01	EBN-Inundación X	Modelo HEC-RAS
	RIO ROCHA		9636 359	W01		
	BIO BOCHA	BIO BOCHA	8106.472	W01		Cuenca
	BIO BOCHA	BIO BOCHA	6661 527	W01	El proceso terminó correctamente	
	BIO BOCHA	RIO ROCHA	2753.82	W01		Factores N
	BIO BOCHA	RIO ROCHA	1131.474	W01	OK	Esc inundación
						1 🚖
						Parámetro de amenaza
						Tirante
						Velocidad Media
						 Tiempo Residencia
					Calcular Cancelar	

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

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

IT-Inundación		- D X	(
Archivo Ayuda			
🗋 💕 🛃 🕨 🎆 🕕 🎯			
Detallada			
Datos generales Método HEC-HMS Método HUT	Método hidrométrico		
Mapa referencia (*.SHP)		Opciones de dibuio	
Provente HEC PAS (* PP I)		Mapa de referencia	
rioyedu nec-nas (rio)		Malla AME Iluvia	
		Punto de control	
AME de resultados		Modelo HEC-RAS	
		Cauce	
- Amenazae AME	rastos	Cuenca	
		Topografía general	
Velocidad Media	IT	Factores N	
	rométrico	Esc inundación	
Resolución AME Datos para cor	vertir UTM a Geo	- Parámetro de amenaza	
Nx= 100 Zona 15 ~	Hemis Norte 🗸	Iirante	
Datum:			
WGS84	~		
	Calcular	Cancelar	

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.

Open			×
\leftarrow \rightarrow \checkmark \uparrow \square « Loc	al Disk (C:) → InputTUH	✓ O Search InputTUH	P
Organize 🔻 New folder			?
PruebaHUT	Name	Date modified Type	
a OneDrive	AME Rain	9/05/2018 4:28 p. m. File folder	
	Boundary	9/05/2018 4:38 p. m. File folder	
This PC	HECRAS	9/05/2018 4:38 p. m. File folder	
3D Objects	N Factors	9/05/2018 3:21 p. m. File folder	
🔿 A360 Drive	River Bed and Basin	9/05/2018 4:38 p. m. File folder	
E. Desktop	Topography	9/05/2018 4:38 p. m. File folder	
Documents	DataProyect_TUH	9/05/2018 3:36 p. m. DAT File	
🖶 Downloads			
👌 Music			
Pictures			
🚆 Videos			
🟪 Local Disk (C:) 👻	<)
File na	me: *.dat	 Archivos DAT (*.dat) 	\sim
		Open Cancel	

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.



🚟 IT-Inundación			- 🗆 X
Archivo Ayuda			
🗋 💕 🔒 🕨 🏼 🛛 🚳			
Detallada			
Datos generales Método HEC	HMS Método HUT Método hidrométrico		
Mana referencia (* SHP)			
C:\Input\Boundary\Boundary	90		Opciones de dibujo
	*		Mana de referencia
Proyecto HEC-RAS (*.PRJ)			
C:\Input\HECRAS\amss1_V6,	<u>d</u>		
AME de regultados			Modelo HEC-RAS
C:\Input\AMEFlood_Example.a	me		Cauce
			Cuenca
Amenazas AME	Estimación de gastos		Topografía general
Tirante	O Método HEC-HMS		Factores N
Velocidad Media	Método HUT		Escinundación
Duración	O Método hidrométrico		
Resolución AME	- Dates para convertir LITM a Geo		Parámetro de amenaza —
Ne 250	Zona 16 V Hemis Norte V		 Tirante
104- 230	Datum:		Velocidad Media
Ny= 250	WGS84 V		 Tiempo Residencia
	·		
	Calcular Cancel	ar	



lada	
atos generales Método HEC-HMS Método HUT Método hidrométrico	
ME de precipitación (*.AME)	Opciones de dibujo
:\Input\AME Rain\AMERain_TUH&Hydrograph.AME	Mapa de referencia
	Malla AME Iluvia
/lapa de factores de escurrimiento, N (*.GRD)	Punto de control
:\Input\N Factors\NC_Example.grd	Modelo HEC-RAS
	Cauce
Fopografia general (modTopo)	Cuenca
:\\nput\Topography\Example_Topography.dat	Topografía general
	Factores N
Cauces (*.SHP de líneas)	Esc inundación
:\Input\River Bed and Basin\RiverBed .shp	1 🛓
	Parámetro de amenaza
Cuencas (*.SHP de polígonos)	 Tirante
:\Input\River Bed and Basin\River Basin.shp	Velocidad Media
	⊖ Tiempo Residencia
Calcular Cancelar	

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.

A	ME Metadata		×	
Datos generales Método HE				
	Identification Info	Author of AME Descriptive KeyWords Intensities Equivalent Scale Distribution Info		
AME de precipitación (*.AME	Title	AME for hazard: Inundación		Opciones de dibujo
C:\Input\AME Rain\AMERaii	Creation Date	miércoles, 9 de mayo de 2018 ∨		Mapa de referencia
	Version	1.0		Malla AME Iluvia
Mapa de factores de escurrin	Abstract	ANAC 61a and a day and a start for the start for		Punto de control
C:\Input\N Factors\NC_Exar	/ waruut	Original AME file name: AMERIood_Example.ame		Modelo HEC-RAS
		HEC-RAS File: C:\Input\HECRAS\amss1_V6.prj Method: Método HUT		Cauce
Topografía general (modTop		Xmin, Xmax, DeltaX:-89.2076654989074,-89.1930820969203,5.85678794661351E-05		Cuenca
C:\Input\Topography\Examp		UTM Zone:16		Topografía general
		U I M Hemisphere:Norte Datum:WGS84		Factores N
Cauces (*.SHP de líneas)		Detailed Rainfall AME: C:\Input\AME Rain\AMERain_TUH&Hvdrograph AME		Esc inundación
C:\Input\River Bed and Basir				1
				- Parámetro de amenaz
Cuencas (*.SHP de polígono				 Tirante
C:\Input\River Bed and Basir				Velocidad Media
				 Tiempo Residencia
		Accept Discard edits	-	
L				
		Calcular Cancelar		

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.



Archivo Ayuda Cetalada Detalada Detalada Detalada Detalada Detalada Detalada Detalada Copciones de dbujo C.\nput\AME Rain\AMERain_TUH8Hydrograph.AME Mapa de factores de escurimiento. N (*GRD) C.\nput\N Factors\NC_Example_grd Coeficiente de variación C.\nput\N Factors\NC_Example_Topography.dat Caucea (*SHP de lineas) C.\nput\Rectarger (SHP de lineas)	×
Detallada Detallada Detallada Deta generales Método HEC-HIMS Método HUT Método hidrométrico AME de precipitación (*AME) C:\input\AME Rain\AMERain_TUH&Hydrograph AME Mapa de factores de escuminiento, N (*.GRD) C:\input\N Factors\NC_Example.grd C:\input\N Factors\NC_Example.grd C:\input\Topography\Example_Topography.dat Cauces (*.SHP de lineas) C:\input\River Bed and Basin\RiverBed.shp	
Detallada Datos generales Método HEC-HMS Método HEC-HMS Método hidrométrico AME de precipitación (*AME) Opciones de dibujo C:\input\AME Rain\AMERain_TUH&Hydrograph.AME Mapa de referencia Mapa de factores de escuminiento, N (*.GRD) Coeficiente de variación C:\input\N Factors\NC_Example.grd Coeficiente de variación Topografia general (modTopo) 0.4 C:\input\Topography\Example_Topography.dat OK Cauces (*.SHP de líness) Esc inundación C:\input\River Bed and Basin\RiverBed shp 1 \$	
Datos generales Método HEC-HMS Método HUT Método hidrométrico AME de precipitación (*AME) Opciones de dibujo Image: Civinput VAME Rain VAMERain_TUH8Hydrograph AME Image: American Am	
Datos generales Método HEC-HMS Método hidrométrico AME de precipitación (*AME) Opciones de dibujo C:\hput\AME Rain\AMERain_TUH8Hydrograph AME Mapa de referencia Mapa de factores de escurimiento, N (*.GRD) Oeficiente de variación C:\hput\N Factors\NC_Example.grd Coeficiente de variación Topografía general (modTopo) 0.4 C:\hput\Topography\Example_Topography.dat OK Cauces (*.SHP de líneas) Eac inundación C:\hput\River Bed and Basin\RiverBed.shp 1 \$	
AME de precipitación (* AME) Opciones de dibujo C:\input\UME Rain\AMERain_TUH8Hydrograph AME Mapa de referencia Mapa de factores de escurimiento. N (* GRD) Punto de control C:\input\UN Factors\NC_Example.grd Coeficiente de variación Topograf ia general (mod Topo) 0.4 C:\input\Topography\Example_Topography.dat OK Cauces (*, SHP de líneas) Esc inundación C:\input\River Bed and Basin\RiverBed .shp 1 \$	
C:\hput\AME Rain\AMERain_TUH&Hydrograph AME Image de referencia Mapa de factores de escurimiento, N (*.GRD) Image de variación C:\hput\W Factors\WC_Example.grd Coeficiente de variación Topograf ia general (mod Topo) Image de loceficiente de variación C:\hput\Topography\Example_Topography.dat OK Cauces (*,SHP de líneas) Esc inundación C:\hput\River Bed and Basin\RiverBed.shp 1 \$	
Mapa de factores de escurimiento, N (*GRD) Image: mail of the security of the secure security of the security of the security of	
Mapa de factores de escurimiento. N (*.GRD) Punto de control Culput/W Factors/NC_Example.grd Coeficiente de variación Modelo HEC-RAS Cauce Cunput/Topography/Example_Topography.dat Cauces (*.SHP de líneas) Culput/Nerver Bed and Basin/RiverBed .shp Determinante Culput/NerverBed and Basin/RiverBed .shp Punto de control Modelo HEC-RAS Cauce Cuenca Comportante Cancel Cancel Esc inundación Topografia Punto de control <	
C:\nput\W Factors\WC_Example.grd Coeficiente de variación X Topografia general (modTopo) 0.4 Cuenca C:\nput\Topography\Example_Topography.dat 0.4 Topografia general Cauces (*.SHP de líneas) C:\nput\River Bed and Basin\RiverBed .shp Esc inundación	
Topografia general (mod Topo) Ingrese el valor del coeficiente de variación Cuenca C:\lnput\Topography\Example_Topography.dat OK Cancel Cauces (*.SHP de líneas) Esc inundación 1 \$ C:\lnput\River Bed and Basin\RiverBed .shp 1 \$\$ 1 \$\$	
Topografia general (mod Topo) 0.4 C:\lput\Topography\Example_Topography.dat 0.4 Cauces (*.SHP de lineas) 0K C:\lput\River Bed and Basin\RiverBed.shp 1 \$\$\$	
C:\nput\Topography\Example_Topography.dat I Topography.dat Cauces (*.SHP de lineas) I Factores N C:\nput\River Bed and Basin\RiverBed .shp I \$\$	
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- Parámetro da amenan	
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Chond Silver Red and Basin River Rasin sho	
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Calcular Cancelar	
Sin errores en la incialización	

Figure 33. Coefficient of variation window - TUH method

Archivo Ayuda		
Detallada Datos generales Método HEC-HMS Método HUT AME de precipitación (* AME) Colonardo AME Debio AMEDebio TURISHadageneto AM	Método hidrométrico	Opciones de dibujo
Mapa de factores de escurimiento, N (*.GRD) C:\hput\N Factors\NC_Example.grd	Pendiente media X	Majla AME Iluvia Punto de control Modelo HEC-RAS
Topografia general (mod Topo) C:\hput\Topography\Example_Topography.dat	Verfique el valor de la pendiente media 3.50990638624515E-13 OK Cancel	Cauce Cuenca Topografia general Factores N
Cauces (.SHP de infeas) C:\Input\River Bed and Basin\RiverBed.shp Cuencas (".SHP de polígonos)		Parámetro de amenaza
C:\hput\River Bed and Basin\River Basin.shp	Calcular	Tiempo Residencia
δin errores en la incialización		

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.

Datos generales	Método HEC-HMS	Método HUT	Método hidrométri	00			
AME do omoio	tación (* AME)					 	Opciones de dibujo
C:\Input\AME	Rain\AMERain TUH&H	lvdrograph.AM	E				Mana de referencia
				_			Malla AME Iluvia
Mapa de facto	res de escurrimiento. N ((* GRD)					Punto de control
C:\loout\N Fac	tore/NC Example and	(.unby					Modelo HEC-BAS
o. anpat arr rat	tora into_Example.gra			_			Cauce
Topografía ger	neral (modTopo)						Cuenca
	aranhu\Example, Topog	ranhu dat		_			Topografía general
C. anpac (ropo)	graphy (Example_Topog	rapny.dat		_			Factores N
Cauces (*.SHP	de líneas)						Esc inundación
C:\Input\River	Bed and Basin\RiverBe	ed sho					1 🜲
							- Parámetro de amenaz
Cuencas (* SH	P de políconos)						Tirante
C:\Input\Biver	Bed and Basin\Biver B	asin shn					Velocidad Media
				_			 Tiempo Residencia

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.

Datos generales Método HEC-HMS Método HU	Método hidrométrico	
AME de precipitación (*.AME)		Opciones de dibujo
C:\Input\AME Rain\AMERain_TUH&Hydrograph.A	ME	Mapa de referencia
		Malla AME Iluvia
Mapa de factores de escunimiento, N (*.GRD)		Punto de control
C:\Input\N Factors\NC_Example.grd		Modelo HEC-RAS
	ERN-Inundacion X	Cauce
Topografía general (modTopo)	Cuenca	
C:\Input\Topography\Example_Topography.dat	Topografía general	
		Factores N
Cauces (*.SHP de líneas)	ОК	Esc inundación
C:\Input\River Bed and Basin\RiverBed .shp		1 🚖
		Parámetro de amenaz
Cuencas (*.SHP de polígonos)		 Tirante
C:\Input\River Bed and Basin\River Basin.shp		Velocidad Media
		 Tiempo Residencia

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.

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Datos generales Método HEC-HMS Método HUT Método hidrométrico	
AME de precipitación (*.AME)	Opciones de dibujo
C:\InputTUH\AME Rain\AMERain_TUH8Hydrograph.AME	Mapa de referencia
	Malla AME Iluvia
Mapa de factores de escurimiento, N (*.GRD)	Punto de control
C:\InputTUH\N Factors\NC_Example.grd	Modelo HEC-RAS
4	Cauce
Topografía general (modTopo)	Cuenca
C:\InputTUH\Topography\Example_Topography.dat	Topografía general
and the second se	Factores N
Cauces (*.SHP de líneas)	Esc inundación
C:\InputTUH\River Bed and Basin\RiverBed .shp	3 📫
	Parámetro de amenaza
Cuencas (*.SHP de polígonos)	 Tirante
C:\InputTUH\River Bed and Basin\River Basin.shp	Velocidad Media
Lluvia Duracion1 TR25 Tormenta5. Frec=3.60E-05	O Tiempo Residencia
Calcular Cancelar	
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normal include new comparison vendenoud_example ane	

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

- <u>Flow vs return period curve:</u> FlowReturnPeriod.qtr
- <u>HEC-RAS project: amss1_V6.prj</u>

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.

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etallada		
Datos generales Método HEC-1 Mapa referencia (*.SHP) Proyecto HEC-RAS (*.PRJ) AME de resultados Amenazas AME Tirante Velocidad Media Dursción	IMS Método HUT Método hidrométrico	Opciones de dibujo Mapa de referencia Malia AME Iluvia Punto de control Modelo HEC-RAS Cauce Cuenca Topografía general Factores N Esc inundación
Resolución AME Nx= 100 Ny= 100	Datos para convertir UTM a Geo Zona 15 V Hemis Note V Datum: WGS84 V	Parámetro de amenaza Trante Velocidad Media Tiempo Residencia
	Calcular Cancelar	

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.



Open					×
← → → ↑ 📙 « Local	Disk (C:) > InputHydrometric	~ Ū	Search InputHydr	ometric	9
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PruebaHUT ^	Name	D	ate modified	Туре	
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This PC	DataProyect_Hydrometric	9/	05/2018 3:42 p. m.	DAT File	
3D Objects					
🔿 A360 Drive					
🛄 Desktop					
🔮 Documents					
🖶 Downloads					
👌 Music					
Pictures					
Videos					
🟪 Local Disk (C:) 🗸 <					>
File nam	e: DataProyect_Hydrometric	~	Archivos DAT (*.	dat)	\sim
			Open	Cancel	

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.

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Detallada			
Datos generales Método HEC-H	MS Método HUT Método hidrométrico		
Mapa referencia (* SHP)			
			Opciones de dibujo
			Mapa de referencia
Proyecto HEC-RAS (*.PRJ)			Malla AME Iluvia
C:\InputHydrometric\HECRAS\an	nss1_V6.prj		Punto de control
AME de resultados			Modelo HEC-RAS
C:\InputHydrometric\AMEFlood_E	Example.ame		Cauce
			Cuenca
Amenazas AME	Estimación de gastos		Topografía general
✓ Tirante	Método HEC-HMS		Factores N
✓ Velocidad Media	O Método HUT		Esc inundación
Duración	 Método hidrométrico 		1
			Parámetro de amenaza
Resolución AME	Datos para convertir UTM a Geo		 Tirante
Nx= 250	Datum:		O Velocidad Media
Ny= 250	WGS84 V		 Tiempo Residencia
	Calcular	Capacitar	
	Calcula		

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.

tallada			
A Datos generales Método HE Curva de caudal vs periodo d (C:\InputHydrometric\FlowRet 10 ²	ME Metadata Identification Info Title Creation Date Version Abstract	Author of AME Descriptive KeyWords Intensities Equivalent Scale Distribution Info AME for hazard: hundación mércoles, 9 de mayo de 2018 10 AME file croated by program IT-hundación AME file croated by program IT-hundación Microsoft Sile C-Sample anne HEC-RAS File: C-Vinput-Hydrometric VHECRAS sams 1_V6 prj Method: Medo Mindometrico Xmin, Xmax, DetaX-39 207655439307.4.39 130822045203.5 856787346613515-05 Xmin, Ymax, DetaX-138 027200431.13 6589771401678.5 12515100056020326-05	Opciones de dibujo Mapa de referencia Mala ANE lluvia Purto de control Modeio HEC-RAS Cauce Cuenca
Horizon and Alexandrian Alexandri Alexandrian Alexandrian Alexandrian Alexandrian Alexandr		U HI Zone is to UTM Aemippinghere Note Datum, WiSS4 Deated Hydrometric curve: C:\InputHydrometric\FlowRetumPeriod.gtrbt	Focus a general Factores N Esc inundación 1 1 0 Trante Velocidad Media Tierno Residencia
		Accept Discard edits Calcular Cancelar	

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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