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The software HALTFLOOD

The software tool HaltFlood, is capable of estimating flood hydrograph entering the reservoir and propagating downstream dam, implements mathematical modules relevant to most important processes and data involved e.g. meteorological data, runoff estimate at watershed scale, reservoir operation, the propagation of forecast floods over river downstream dams.

1 SOFTWARE AND HARDWARE REQUIREMENTS AND INSTALLATION GUIDE

The HALTFLOOD tool is written in VisualBasic 6.0 language, the following programs/OS are needed to be installed:

Microsoft Windows XP o 2000 (Haltflood is not tested with "Vista"); Microsoft Excel.exe and MSAccess.exe (Microsoft Office Package); ESRI ArcGis 9.2 with the Spatial Analyst extension (*) international decimal separation must be set to the "dot" "." PC pentium 4 with almost 1 GB ram Free Memory Disk almost 2 GB

It is recommended to have ESRI ArcGis 9.2 with the *3D Analyst* and *Spatial Analyst extensions*. The GIS is useful in managing data for new project and in editing Geodatabase in which are stored the data for Haltflood.

In order to run the installer program you must have Administrator privileges on your computer. You only need the privileges during installation; once installation is complete the program can run successfully without Administrator privileges.

After you have obtained the Setup Package and Administrator privileges, use the following steps to install the program:

- 1. Run the Setup.exe
- 2. Run the HaltFlood.exe program
- 3. Create the HaltFlood.ini file (only during the first HaltFlood use), choosing "yes" (Si):





4. Choosing "Yes" it appears the following form

	IMPORTANT NOTICE		
OR A PROPER VIEW THE F	OLLOWING CONFIGURATION	IS RECOMMENDED	
Characters dimension	small	on : Monitor properties	
Desktop area	1152 x 864 pixels	on : Monitor properties	
Date format	dd/mm/yyyy	on : International configuration	
Decimal separator	point	on : International configuration	
Applications bar	hidden	on : Bar properties	
Select the folders where the executables for the following programs are			
ArcGis			

- 5. Verify the screen and international properties and setup the "EXCEL" and "ARCGIS directory paths in your disk.
- 6. Then click "Ok"

It is also possible to update the data from the Project menu, choosing the option HaltFlood.ini

🕷 Haltflood 🛛 - No Project loaded					
Project	Events	Update Data			
Data S	chemes				
New Open Delete					
	5hed's data gum's parameters				
Load XY Curves for the Dams MAIUSC+F2					
	an Event er Tab to Event				
	istorical series cal series Graphic/Ti	MAIUSC+F1 ransfer			
Create	a Forecasts' DataB	}ase			
Visualiz	e the place's Map	Þ			
Haltflo	od.Ini				
Exit					

2 THE MENU SYSTEM

The menu system contains four menus to help you use the program. Each menu contains a list of related commands.

The four menus are: Project, Events, Update Data, Real time forecasts.

- the **Project menu** contains a list of commands for open and managing projects, to update or edit the geodatabase that is the container for all the different objects that form the complete representation of the study area such: watersheds, dams, stream etc.;
- the **Events menu** contains a list of commands to run HaltFlood to study historical events;
- the **Update Data menu** allows, if available, to download from internet real time rainfall forecast;
- the **Real time forecasts menu** contains a list of commands to run HaltFlood for real time flood forecasting.

3 The project menu

As in the shown in the previous figure the project menu contains different menu commands.

3.1 Data Schemes

This command allows to input the schema code, given by the Forecast Office, for download the rainfall forecasts from internet.

In Haltflood the schema is just a unique name that uniquely identifies a geographical area divided into several sub-areas. If this name has been agreed with an Office that provides weather forecasts, then the office can provide the average precipitation expected in the same sub-areas used by Haltflood

In you don't have the code you must insert one of your choice, but you cannot download the forecasts from internet and you must enter the forecasts data manually.

s D	ata entry WaterSh	eds scheme's codes	×		
Exis	ting codes				
	Code	Description			
adig	je	Adige a Trento: suddivisione in 10 sottobacini			
anie	ene	Aniene a Tivoli: suddiv in 1 sottobacino			
anie	ene2	Aniene a Lunghezza suddivisione in 2 sottobacini			
gius	giustina Noce a Santa Giustina: schema 1 sottobacino				
Nic	Nicodemo Sinni a Masseria Nicodemo: schema 1 sottobacino				
_					
New	schemes entering				
Piav	Piave Piave River to the town of Bellund				
		Save			

To create a new project using the next command menu, you need perforce an existing scheme code to link to the project. If the scheme list is empty it is impossible to create a new project.

3.2 New

This command menu allows creating a new project.

To create a new project you choose New . After this command is selected, the Create a New Project window will open were you can input the name of new project.

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	HaltFlood	
	Enter the name of the new project	
	Annulla	
	Piave	

RSF

Pressing the OK button it will open the Select scheme windows to select the scheme to link the project.

Select a scheme code from the following	
Piave = Piave River to the town of Belluno	•
Cancel	ОК

After the OK button is pressed the program makes a new project directory with the same name of the project in the default location on your computer to store the project. The default projects location is a folder named *Progetti* in the installation location of the *HaltFlood.exe* program.

In the project directory will be automatically create an empty Personal Geodatabase (*ProjectName_GDB.mdb*) were you will store the date concerning the project.

This following message reminds you that you must enter additional data into the Geodatabase.



To enter data in the Tables is useful to use ArcGis. The different steps to do with ArcGIS are described in Appendix A.

If you don't have ESRI ArcGis you can still load the data manually, but only alphanumeric data. The tool Haltflood uses only alphanumeric data, so you can run simulations, but you can not control the congruence between geographical and alphanumeric data.

3.3 Open

This command menu allows opening a project.

To open an existing project you must select the Open menu option.



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Select a project from the followings	
Piave	•
Cancel	OK

When a project is opened in the menu system, the menus for witch there are valid data are enabled.

🚟 HaltFlood - Loaded project : Piave				
Project	Events	Update Data	Real time forecasts	?
Example of project without valid data of events				

🕷 HaltFlood - Loaded project : Adige				
Project	Events	Update Data	Real time forecasts	?

Example of project with valid data of events

After you have insert valid data into the tables *Dam*, *MonitoringPoint* and *Watershed* of the project GeoDataBase the list of commands of Project menu will be enabled.

🕷 HaltFlood - Loaded project : Adige 👘				
Project	Events	Update Data		
Data	Schemes			
New				
Open				
Deleti	e			
Wate	rShed's data			
Muski	ngum's parameters			
Load	XY Curves for the D	ams MAIUSC+F2		
Creat	e an Event			
Trans	fer Tab to Event			
Load	historical series	MAIUSC+F1		
Histor	ical series Graphic/	Transfer		
Creat	e a Forecasts' Data	Base		
Visual	ize basin model map	o ►		
Haltfle	ood.Ini			
Exit				

3.4 Delete

The command *Delete* allows the user to remove a project: this procedure requires attention as its elimination is irrevocable.

Selecting the Delete option from the *Project* menu, a new window will be opened to choose the project to delete:



If the user answers OK, a confirmation of the choice will be required, as the deleted data can not be recovered:

HALTFLOOD			
⚠	Do you really want to delete the project Piave?		
	Sì No		

Answering "**Yes**" (Sì), the project selected is deleted not only from the general database, but also physically from the disk.

3.5 Watershed data

This option lets the user to assign the required parameters for each watershed previously defined, to implement the rainfall-runoff model.

A new window is opened presenting the parameter values already stored in the Geo Database and let, if necessary, to change them and save the new values.



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ENTERING W	ATERSHED DATA FOR THE MODEL OF FLOW	
Working GeoD	Adige_GDB.mdb	
Select I	the desired WaterShed Adige_Isarco	
CDEFLUSSO SC SC_MAX C_I KS BETA ALFAS ALFASUB Qb unit	 Runoff coefficient [dimensionless] Field capacity of soil [mm] Storage capacity of the soil [mm] Empirical coefficient, depending on the speed of sub-surface runoff [1/h] Permeability at saturation [mm/h] Eagleson's formula dimensionless coefficient, 1978 Constant depletion of surface runoff [1/h] Constant depletion of sub-surface runoff [1/h] Unit basic flow [m3/s/km2] 	0.85 36 0.05 77 5.8 0.045 0.015 0.01 10.9766
Tc Tc * ALFAS Tc * ALFASUB	- Giandotti's concentration time [h] - Dimensionless product of Tc for ALFAS - Dimensionless product of Tc for ALFASUB	0.4939
	Save	

3.6 Edit Muskingum's parameters

i Edit Muskingum's Parameters 🛛 🗙								
Working GeoDataBase								
Adige_GDB.mdb								
-Muskingum's Paramet	ers							
Records of Sc	hematicLink Tab w	vith TypeRouting	parameter = 3					
Hydrocode	Musk_K [h]	Musk_X [adim]	NumSubReach [adim]					
Adige2_asta	6	0.25	1					
Noce2_asta	1	0.25	1					
Noce3_asta	2.5	0.25	1					
Adige3_asta	0.33	0.3	1					
Avisio2_asta	4.77	0.25	1					
Adige4_asta	1.4	0.25	1					
To edit table data:	1) highligh	t the cell / the celles	concerned;					
2) place in the due field the correct value								
confirm by pressing the Insert key								
Corre	ct value	Insert						
	Save in	GDB						

This form shows the HydroCode, reading the data from the *SchematicLink* Tab of the project GeoDataBase, when the TypeRouting parameter is set to the value 3 (it means that the wave propagation is estimated by the Muskingum routing method). In the *SchematicLink* Tab are reported the following parameters of the Muskingum-Cunge model:

- K, factor that approximately corresponds to the propagation time of flood waves along the channel;
- X, weighting factor ranging between 0 and 0.5.

There is the possibility to change these values and store them in the geo-database.

3.7 Loading curve XY dams

This function allows the user to upload some data regarding the dams in the GeoDataBase. The following form will appear:

🖻 Loading curves XY dams 🛛 🛛 🔀					
Data File					
Select Data File See Data File					
D:\documenti\Piene10\HaltFlood2010\EsempioFileInput\Ese					
Sheet with reservoir data					
Sheet with withdrawal data CurvePrelievo					
✓ Overwrite any existing data					
Type of data to be loaded					
Reservoirs Vol.s and disch.s					
Load data in the GDB					

The form let the user to upload two different Excel files:

- reservoir capacity curves + any automatic opening rules of the outlet works depending on the water level in the reservoir;
- possible withdrawal standard curves from the reservoirs;

An example of the data structure of the two different excel sheets is shown below. The first line contains the headers and the data begin from the second row.

ReservoirsCurves / CurveInvasi

	A	В	С	D	E	F
1	FeatureID	HydroCode	TbTypeID	TbValX	Tb∨alY	TipoCurva
2	100005	S.GIOVANNI	1	209	0	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
3	100005	S.GIOVANNI	1	213.1		CurvaVolumi X=quota (m s.m.); Y: volume (mc)
4	100005	S.GIOVANNI	1	213.2	11000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
5	100005	S.GIOVANNI	1	213.3	18000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
6	100005	S.GIOVANNI	1	213.4	24000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
- 7 -	100005	S.GIOVANNI	1	213.5	30000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
8	100005	S.GIOVANNI	1	213.6	36000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
9	100005	S.GIOVANNI	1	213.7	42000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
10	100005	S.GIOVANNI	1	213.8	48000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
11	100005	S.GIOVANNI	1	213.9	54000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
12	100005	S.GIOVANNI	1	214	60000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
13	100005	S.GIOVANNI	1	214.1	70000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
14	100005	S.GIOVANNI	1	214.2	80000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
15	100005	S.GIOVANNI	1	214.3	90000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
16	100005	S.GIOVANNI	1	214.4	100000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
17	100005	S.GIOVANNI	1	214.5	110000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
18	100005	S.GIOVANNI	1	215	160000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
19	100005	S.GIOVANNI	1	215.5	210000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
20	100005	S.GIOVANNI	1	216	260000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
21	100005	S.GIOVANNI	1	216.5	310000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
22	100005	S.GIOVANNI	1	217	360000	CurvaVolumi X=quota (m s.m.); Y: volume (mc)
23	1282	Scarico_luce1	8	214	0	Legge apertura scarichi X=livello serbatoio ; Y=apertura %
24	1282	Scarico_luce1	8	214.5	0	Legge apertura scarichi X=livello serbatoio ; Y=apertura %
25	1282	Scarico luce1	8	215	10	Legge apertura scarichi X=livello serbatoio ; Y=apertura %
26	1282	Scarico_luce1	8	215.5	20	Legge apertura scarichi X=livello serbatoio ; Y=apertura %
27	1282	Scarico luce1	8	216	20	Legge apertura scarichi X=livello serbatoio ; Y=apertura %
28	1282	Scarico_luce1	8	216.5		Legge apertura scarichi X=livello serbatoio ; Y=apertura %
29	1282	Scarico luce1	8	218		Legge apertura scarichi X=livello serbatoio ; Y=apertura %
30	1283	Scarico luce2	8	214		Legge apertura scarichi X=livello serbatoio ; Y=apertura %
31	1283	Scarico_luce2	8			Legge apertura scarichi X=livello serbatoio ; Y=apertura %
I4 4	► ► / Sc	arichiDighe / Curve	relievo / D	ighe / Cod	CurInvasi 👌 Cur	veInvasi / · · · · · · · · · · · · · · · · · ·

Where the meaning of each field is the following:

- **FeatureID**: HydroID code used in the Geodatabase for the dam or the outlet work. In the Geodatabase each feature has a unique identification code called HydroID, to load data for a certain feature you should indicate their HyodroID. The HydroID is assigned at the time of creation of feature;
- **HydroCode:** alphanumeric code of the dam or of the outlet work;
- **TbTypeID:** data type code (1 = volume curve; 8: rule of the opening percentage in function of the water level);
- **TbValX:** X abscissa value (height for data type = 1; water level for data type = 8)
- **TbValY:** Y ordinate value (volume in cubic meters for type = 1; percentage of the opening for type= 8)
- Tipo Curva: optional description.



WithdrawalCurves / CurvePrelievo

	A	В	С	D	E	F
1	FeatureID	HydroCode	TbTypeID	TbValX	Tb∀alY	TipoCurva
2	500001	DerivaAcquoria	210	1	0	water demand cyclical daily X=hour, Y=Qmcs
3	500001	DerivaAcquoria	210	2	0	water demand cyclical daily X=hour, Y=Qmcs
4	500001	DerivaAcquoria	210	3	0	water demand cyclical daily X=hour, Y=Qmcs
5	500001	DerivaAcquoria	210	4	0	water demand cyclical daily X=hour, Y=Qmcs
6	500001	DerivaAcquoria	210	5	0	water demand cyclical daily X=hour, Y=Qmcs
7	500001	DerivaAcquoria	210	6	0	water demand cyclical daily X=hour, Y=Qmcs
8	500001	DerivaAcquoria	210	7	20	water demand cyclical daily X=hour, Y=Qmcs
9	500001	DerivaAcquoria	210	8	20	water demand cyclical daily X=hour, Y=Qmcs
10	500001	DerivaAcquoria	210	9	20	water demand cyclical daily X=hour, Y=Qmcs
11		DerivaAcquoria	210	10		water demand cyclical daily X=hour, Y=Qmcs
12		DerivaAcquoria	210			water demand cyclical daily X=hour, Y=Qmcs
13		DerivaAcquoria	210	12		water demand cyclical daily X=hour, Y=Qmcs
14		DerivaAcquoria	210	13		water demand cyclical daily X=hour, Y=Qmcs
15	500001	DerivaAcquoria	210	14		water demand cyclical daily X=hour, Y=Qmcs
16		DerivaAcquoria	210	15		water demand cyclical daily X=hour, Y=Qmcs
17	500001	DerivaAcquoria	210	16	20	water demand cyclical daily X=hour, Y=Qmcs
18		DerivaAcquoria	210	17		water demand cyclical daily X=hour, Y=Qmcs
19		DerivaAcquoria	210	18	20	water demand cyclical daily X=hour, Y=Qmcs
20	500001	DerivaAcquoria	210	19	20	water demand cyclical daily X=hour, Y=Qmcs
21	500001	DerivaAcquoria	210	20	0	water demand cyclical daily X=hour, Y=Qmcs
22	500001	DerivaAcquoria	210	21	0	water demand cyclical daily X=hour, Y=Qmcs
23	500001	DerivaAcquoria	210	22	0	water demand cyclical daily X=hour, Y=Qmcs
24	500001	DerivaAcquoria	210	23	0	water demand cyclical daily X=hour, Y=Qmcs
25	500001	DerivaAcquoria	210	24	0	water demand cyclical daily X=hour, Y=Qmcs
26	500001	DerivaAcquoria	220	1		water demand cyclical weekly X=hour, Y=Qmcs
27	500001	DerivaAcquoria	220	2	0	water demand cyclical weekly X=hour, Y=Qmcs
28	500001	DerivaAcquoria	220	3	0	water demand cyclical weekly X=hour, Y=Qmcs
29	500001	DerivaAcquoria	220	4	0	water demand cyclical weekly X=hour, Y=Qmcs
30	500001	DerivaAcquoria	220	5	0	water demand cyclical weekly X=hour, Y=Qmcs
31	500001	DerivaAcquoria	220	6	0	water demand cyclical weekly X=hour, Y=Qmcs
I •	► N / Sc	arichiDighe \CurvePrel i	ievo / Dighe	e / CodCur	Invasi 🖌 Cu	irveI <

Where the meaning of each field is the following:

- **FeatureID**: HydroID code used in the Geodatabase for the current withdrawal;
- **HydroCode**: alphanumeric code of the withdrawal;
 - **TbTypeID**: data type code, which could assume the following values:
 - TbTypeID =210: WaterDemand cyclical daily (one day, hour by hour)
 - TbTypeID =220: WaterDemand cyclical weekly(one week, hour by hour)
 - TbTypeID =230: WaterDemand cyclical monthly (one month, day by day)
 - TbTypeID =240: WaterDemand cyclical yearly (one year, month by month)
 - TbTypeID =250: WaterDemand constant each year
 - **TbValX**: X abscissa value (could be: time, day or year);
- **TbValY**: Y ordinate value (discharge in cubic meters per second);
- Tipo Curva: optional description.

3.8 Create Event

_

This function allows the user to create an "Event" associated to the Project. The following window is shown:

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CREATE EVENT							
Already existin	ig events :						
Event's ID 200211 20021100	Description Evento Novembre 2002 Evento Novembre 2002: calibrazione						
-1							
Event to be created Event's ID (Long Integer) 200505							
Event's description (max 60 characters)							
May 2005 event							
	CREATE EVENT						

The list of the events already created appears at the top of the form, while in the bottom part is possible to create a new event, by means of an appropriate *frame*, assigning the desired identifier (ID, is unique and therefore is not possible, for a given project, create two events with the same ID). It is also possible add a brief event description in the appropriate form. At the end, the user should click on "*Create Event*"

Actually, with this function only the name of the new event is stored in an appropriate table of the project GeoDataBase. The creation of the event itself occurs with the following function (*Transfer tables to Event*), as explained below.

3.9 Transfer tables to Event'GDB

This feature allows the user to transfer prefixed tables from the Project GeoDatabases to the GeoDataBase of an event associated to the Project; these tables are necessary for the further processing of the discharge and rainfall data associated to the event.

The following window appears:

🖣 Tabs transf. From Project_GDB to Event_GDB 💦 🔀							
Select an event							
200211 - Evento Novembre 200	12 💌						
Choose the tables to be tra	nsferred deselect all						
₩aterShed	CurveXY						
C SchematicNode	🔽 DerivazDighe						
🔽 SchematicLink	🔽 ScarichiDighe						
MonitoringPoint	🔽 TabSorveglianza						
🔽 Dam	✓ TabRientro						
Transfer							

The selection of the chosen event is made by means of the Combo Box. Clicking on the "Transfer" button, in the Project directory, a new folder will be created with the name of the Project and Event,

in which the tool copy from the folder "Generali" a template Geodatabase and rename it with the name of the event..

In this GeoDataBase, the folders previously selected will be copy.



3.10 Load monitoring data

This option let the user to upload in the project GeoDataBase the time series of precipitation, discharge, levels, etc.. The following form appears:

i Historical Series Loading - Monitoring data 🛛 🛛 🗙				
Data File				
Select data file		See data file		
D:\documenti\Piene	10\HaltFlood2010)\EsempioFileInput\Ese		
Worksheet with the data	Dati_orari	•		
Type of data to be lo	aded			
🔽 Rain 🕅 T	emperatures 🔲 Sn	ow 🔽 Reservoir's levels		
Inlet flows	🔽 Outlet flows	Freezing quote		
Requested withdrawa	al			
L	oad data in the G	iDB		

The first step is the selection of the data file, you can find the file by clicking the "**Select data file**" button.

The data file must be in excel format and have a fixed format, as shown in the figure below.

The first five rows are fulfilled with the identification data of each sub-basin and / or monitoring stations and the type of data to be loaded: the codes must match with those reported in the GeoDataBase.

In the subsequent rows (from line 6) are reported: in the first column, the date and hour, and in the following columns the hourly data corresponding to the sizes of its respective header lines.

After choosing the datasheet (the combo will be automatically filled), if that data are in the requested format, the program determines the different types of data and active options (in our case: Precipitation, Water Levels, Outlet Discharge).

It is possible to see the file including the data by clicking on "See data file".



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Hy Hy FT Tij	J709 ▼ A /droCode /droID /ype	3055 ScaricoDighe Discharge_obs 7.18 7.18 7.18 7.18 7.18 7.18 7.18 7.18	CASUALE()) K AdigeMonteTrento 3052	L Adige_[sarco 1000001 Watershed Precipitation 70 0 0 0 0.034634987 0.101781103	M Giustina 1000004 Watershed Precipitation 70 0 0 0.034634987 0.101781103	Precipitation 70 0 0	O Noce 1000006 Watershed Precipitation 70 0 0	P Stramentizzo 1000008 Watershed Precipitation 70 0 0	Q Adige_Avisio 1000007 Watershed Precipitation 70 0	R Adige_Fersina 1000010 Watershed Precipitation 70 0	1000002 Watershed Precipitation 70
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Hy FT Tij	rdrolD ype poDato taOra/TSType 2/11/02 10.00 2/11/02 11.00 2/11/02 12.00 2/11/02 13.00 2/11/02 15.00 2/11/02 15.00 2/11/02 15.00 2/11/02 15.00 2/11/02 19.00	3055 ScaricoDighe Discharge_obs 7.18 7.18 7.18 7.18 7.18 7.18 7.18 7.19 7.19 7.19 7.19 7.19	3052 Idrometro Discharge_obs 120 96.32 96.32 96.32 96.32 96.32 96.33 96.33 96.33	1000001 Watershed Precipitation 0 0.034634987 0.101781103 0.084249416	1000004 Watershed Precipitation 0 0 0.034634987 0.101781103	1000005 Watershed Precipitation 70 0 0 0.035537523	1000006 Watershed Precipitation 70 0 0	1000008 Watershed Precipitation 70 0 0	1000007 Watershed Precipitation 70 0	1000010 Watershed Precipitation 70 0	100000 Watershed Precipitation 7
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Tij	PoDato ttaOra,TSType 2/11/02 10.00 2/11/02 11.00 2/11/02 11.00 2/11/02 13.00 2/11/02 15.00 2/11/02 15.00 2/11/02 16.00 2/11/02 18.00 2/11/02 18.00	Discharge_obs 120 7.18 7.18 7.18 7.18 7.18 7.18 7.18 7.19 7.19 7.19 7.19 7.19 7.19	Discharge_obs 120 96.32 96.32 96.32 96.32 96.33 96.33 96.34	Precipitation 70 0 0 0.034634987 0.101781103 0.084249416	Precipitation 70 0 0 0.034634987 0.101781103	Precipitation 70 0 0 0.035537523	Precipitation 70 0 0	Precipitation 70 0 0	Precipitation 70 0	Precipitation 70 0	Precipitation 7
	taOra/TSType 2/11/02 10.00 2/11/02 11.00 2/11/02 12.00 2/11/02 13.00 2/11/02 13.00 2/11/02 15.00 2/11/02 15.00 2/11/02 16.00 2/11/02 18.00 2/11/02 18.00	120 7.18 7.18 7.18 7.18 7.18 7.18 7.18 7.19 7.19 7.19 7.19	120 96.32 96.32 96.32 96.32 96.32 96.33 96.33 96.34	70 0 0.034634987 0.101781103 0.084249416	70 0 0.034634987 0.101781103	70 0 0 0.035537523	70 0 0	70 0 0	70 0		7
	2/11/02 10.00 2/11/02 11.00 2/11/02 12.00 2/11/02 13.00 2/11/02 15.00 2/11/02 15.00 2/11/02 15.00 2/11/02 16.00 2/11/02 18.00 2/11/02 18.00	7.18 7.18 7.18 7.18 7.18 7.18 7.19 7.19 7.19 7.19	96.32 96.32 96.32 96.32 96.32 96.33 96.33 96.34	0 0.034634987 0.101781103 0.084249416	0 0 0.034634987 0.101781103	0 0 0.035537523	0	0	Ō	0	
	2/11/02 11.00 2/11/02 12.00 2/11/02 13.00 2/11/02 14.00 2/11/02 15.00 2/11/02 16.00 2/11/02 17.00 2/11/02 18.00 2/11/02 19.00	7.18 7.18 7.18 7.18 7.18 7.19 7.19 7.19 7.19	96.32 96.32 96.32 96.32 96.33 96.33 96.34	0 0.034634987 0.101781103 0.084249416	0 0.034634987 0.101781103	0.035537523	Ō	0		2	
	2/11/02 12:00 2/11/02 13:00 2/11/02 14:00 2/11/02 15:00 2/11/02 16:00 2/11/02 16:00 2/11/02 17:00 2/11/02 18:00 2/11/02 19:00	7.18 7.18 7.18 7.18 7.19 7.19 7.19	96.32 96.32 96.32 96.33 96.33 96.34	0.034634987 0.101781103 0.084249416	0.034634987	0.035537523			0	i in	2
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	2/11/02 16.00 2/11/02 17.00 2/11/02 18.00 2/11/02 19.00	7.19 7.19 7.19	96.34	0.032141883					0.13637843	0.15611814	0.1527109
	2/11/02 17.00 2/11/02 18.00 2/11/02 19.00	7.19 7.19		0.018541771	0.032141883	0.058419791 0.026922538	0.052783265	0.052913396	0.050479933	0.045095644	0.04159995
	2/11/02 18.00 2/11/02 19.00	7.19		0.010541771		0.026922536	0.030301118	0.026153122	0.021666336	0.029303676	0.0272000
	2/11/02 19.00		96.34	1			0.0240539	0.026654672			
		7.19	96.34	0.013001200		0.022303000		0.020034072			0.01700300
	2/11/02 20:00	7.18	96.34	0		1		0			
_	2/11/02 21.00	7.18	96.34	0				0			
-	2/11/02 22.00	7.18	96.33	0		-		0			
	2/11/02 23.00	7.18	96.33	0		2		Ő		2	
-	3/11/02 0.00	7.18	96.33	Ő				Ű			
	3/11/02 1.00	7.18	96.33	õ		- 7.	Ő	õ			
	3/11/02 2.00	7.18	96.33	0	0	0	0	Ō	0	0	
	3/11/02 3.00	7.18	96.33	0	0	0	0	0	0	0	
	3/11/02 4.00	7.18	96.33	0	0	0	0	0	0	0	
	3/11/02 5.00	7.18	96.33	0.009877776	0.009877776	0.012648772	0.019087608	0.015450599	0.012751869	0.015809922	0.01245054
	3/11/02 6.00	7.18	96.33	0.109387914	0.109387914	0.119960077	0.178790006	0.202315585	0.126681471	0.158130659	0.17652229
	3/11/02 7.00	7.19	96.36	0.264340926	0.264340926	0.311914402	0.364748463	0.387764292	0.405174436	0.349482919	0.27565860
	3/11/02 8.00	7.22	96.45	0.153272601	0.153272601	0.208182325		0.171495072	0.207039393	0.296024912	0.16600523
	3/11/02 9.00	7.25	96.52	0.050594149	0.050594149	0.092307697	0.093253816	0.096705695	0.054690701	0.054798017	0.08570414
	3/11/02 10.00	7.25	96.54	and the second		0.096806892			0.090953925	0.072265831	0.05820682
	3/11/02 11.00	7.26	96.56	0.18036234	0.18036234	0.290951668		0.29862994	0.32121536	0.263202513	
_	3/11/02 12.00	7.30	96.68		0.013373411	0.018327891	0.014513791	0.017113236	0.015909487	0.018867849	
	3/11/02 13.00	7.28	96.66	0			0	0			
_	3/11/02 14.00	7.27	96.63	0				0			
_	3/11/02 15.00	7.25	96.60	0				0			
	3/11/02 16:00	7.24	96.58	0				0			
_	3/11/02 17:00	7.23	96.56	0				0			-
_	3/11/02 18:00	7.22	96.54	0		0	0	0		0	
-	3/11/02 19.00 3/11/02 20.00	7.22	96.53	and the second				a second a second second second second	the second s	which we have a stand of the last and if you	
_	3/11/02 20:00	7.21	96.51	0.035592354	0.035592354					0.055477051 3.042041556	
-	3/11/02 22.00	7.77	96.53		0.670206452		0.725578318				
	► ► Sottob.		1	and the set of the set			0.725578318	1.100700938	0.794939078	0.096320399	1.03978222

The data uploading in the project GeoDataBase is activated by pressing the dedicated button.

3.11 Plot/transfer historical time series

This tool allows you to draw graphs of time series stored in the project Geodatabase.

From the graph you can select all or part of the data to copy them to another database (the event Geodatabase) in order to use them for the analysis.

The tool opens a form like that in the figure in which there are two listview and a picturebox. The listview in top, lists the types of data stored in the database.

In this listview, you can select the type of data (maximum two) to display in the listview below. The listview below lists the stations that have data types as those selected in the top listview. You choose up to a maximum of six stations: the graph of their data appears in the space below. When you draw together the graph of rainfall and flow, the precipitation is represented by the y-axis pointing downwards.

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RSE



nitial Date		Final Date	# of data	Data type				
1/11/2002	1.00.00	30/11/2002 23.00.00	7190	Rain	1 			-
1/11/2002		30/11/2002 23:00:00	12223	Q out				
1/11/2002	1.00.00	30/11/2002 23.00.00	2157	Levels				
17/11/2002	1.00.00	30/11/2002 23.00.00	1438	Q demand				
st of data	for each station	(It is possible to select si	multaneously up to six stations	- keep key Ctrl p	ressed)			
HydroID	HydroCode	Name	Initial D		Final Date	# of data	Data type	
000004	Giustina			2002 1.00.00	30/11/2002 23.00.00	719	Rain	
000005	Mollaro			2002 1.00.00	30/11/2002 23.00.00	719	Bain	
000006	Noce			2002 1.00.00	30/11/2002 23.00.00	719	Rain	3
000008 000007	Stramentizzo Adige Avisio			2002 1.00.00 2002 1.00.00	30/11/2002 23.00.00 30/11/2002 23.00.00	719 719	Rain Rain	
000007	Adige_Avisio Adige_Fersina				30/11/2002 23:00:00	719	Rain	
000002	Isarco		01/11/2002 1.00.00 01/11/2002 1.00.00			719	Bain	
000002	Adige_Noce		01/11/	30/11/2002 23.00.00 30/11/2002 23.00.00	719	Rain		
000009	Avisio			2002 1.00.00	30/11/2002 23.00.00	719	Bain	1
400 n ³ /S]			Maria	. As		<u>, </u>	0 [mm]	1
300						k	5	
200			M.			<u> </u>	10	
			$/\lambda$		<u>М</u>	hard	٥	
100					- May 1		15	
0	<u></u>	in monain	www		P	0.00		
01/11/2002		2002 00 11/11/2002	00 16/11/2002 00	21/11/	2002 00 26/11/200	2 00	01/12/2002 00	1
· · ·	ale Chart							

Pressing the "**Transfer to the Events'GDB**" button, it's possible to copy data to a GeoDatabases event, helped by the following mask, which allows, if you want, to limit the time range of data to copy.

🖣 Transfer to Event's GDB 🛛 🔀							
Select an Event							
200211 - Evento Novembre 2002 🔹							
┌ Type of data to transfer							
🔽 Rainf	all 🗌 Temperatur	res 🗖 Snow					
Freez	ting 🔲 reserv. Lev	els 🔽 Output flows					
🗖 Input	Input flows Requested supply flows						
Event's dates and hours							
	dd/mm/yyyy	hh.mm.ss					
initial	01/11/2002 • •	00.00.00					
final	30/11/2002 • •	23.59.59					
	Transfer						

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3.12 Create a Forecasts'DataBase

It allows to create a database event dedicated to real-time forecasts.

Under the project folder is created a folder called NomeProgetto_Evento_Previsioni, within which the tool copy from the folder "*Generali*" a template Geodatabase to store real time data. In this GeoDatabase all the needed data are copied from the GeoDatabase project.

3.13 Visualize basin model map

It allows to view the site map.

There are different opportunities to display, as shown by the menu items.

Visualize basin model map	with ArcGIS
Haltflood.Ini	with ArcExplorer
	with Quantum GIS

So it's possible to open ArcGIS project on the current project or display by ArcExplorer o Quantum GIS.

Please note that only with ArcGIS it's possible to display data contained in GeoDatabase and actually used by the program HaltFlood. ArcExplorer and Quantum GIS can display a copy of data of GeoDatabase previously exported as shapefiles through ArcGIS.

Should be aware that, HaltFlood uses the data in the Geodatabase. If you change the geographic data in the Geodatabase, shape files are no longer update on: this may necessitate the re-export to shape files the features of the Geodatabase to see the update with ArcExplorer and Quantum GIS. Below there is an example of displaying the map with ArcGIS.



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In the absence of the program ArcGIS (in which case the corresponding menu item is disabled) is possible to view the map through ArcExplorer.

ArcExplorer, to store map informations, uses a project file called myname. Axl.

To open directly from HaltFlood the name's map of ArcExplorer must be myname.axl = Name of Project + "_mappa.axl "(in our case: Adige_mappa.axl) and must be located in the same folder where is the current project GeoDatabase.



Similarly, if there is a Quantum GIS installation, having created the relative project file on standard name: Name of Project + "_mappa.qgs "

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It must be remembered that, Quantum Gis unlike ArcExplorer, allows also to modify the data of ShapeFiles, but this has no effect on the data of GeoDatabase used by HaltFlood. The geographic data of GeoDatabase be changed only by ArcGIS, while the alphanumeric by Access.

4 THE EVENTS MENU

The processing are performed on the data contained in GeoDatabase event. The function **"Events"** of the main menu has several items:

Events	Update Data 🛛 🖡	Real I
Select Even	t	
	s data	
Dams mane Observed d	nfall-runoff model	÷
	sts at Monitoring Points ater surface Forecasts at Reservoir	's
Forecast / h	istorical data comparison graph	

It is only after the selection of the event (option "Select an Event") that the following options are enabled.

4.1 Select an Event

The event is chosen by selecting the corresponding record in the window presented and confirming the choice.

:	Select an Evo	ent (only the events with an existing GDB are listed)	
	Event's ID	Description	
	200211	Evento Novembre 2002	
	20021100	Evento Novembre 2002: calibrazione	
		Cancel	

The name of the event s printed on the top of the screen:

🗮 HaltFlood - Loaded project : Adige					
Project	Events	Update Data	Real time forecasts	?	
	201	See Trible		Hanning Event : 200201	

4.2 Clean Event'sGDB

This option "cleans" the GeoDataBase event, eliminating any double data.

4.3 WaterShed Data

For each of WaterShed event, this mask allows to see or possibly change (saving changes) data of WaterShed to use in the rainfall-runoff model applied to one event (in this way you can keep save the original copy stored in the project Geodatabase.):



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S ENTERING WATERSHED DATA FOR THE MODEL OF FLOW	X
Working GeoDatabase Adige_Evento_200211.mdb	_
Select the desired WaterShed Adige_Isarco	
CDEFLUSSDRunoff coefficient [dimensionless]SCField capacity of soil [mm]SC_MAXStorage capacity of the soil [mm]C_IEmpirical coefficient, depending on the speed of sub-surface runoff [1/h]KSPermeability at saturation [mm/h]BETAEagleson's formula dimensionless coefficient, 1978ALFASConstant depletion of surface runoff [1/h]ALFASUBConstant depletion of sub-surface runoff [1/h]Qb unitUnit basic flow [m3/s/km2]	0.85 36 80 0.05 17 5.8 0.045 0.015 0.01 0.01
Tc - Giandotti's concentration time [h] Tc * ALFAS - Dimensionless product of Tc for ALFAS Tc * ALFASUB - Dimensionless product of Tc for ALFASUB	0.4939
Save	

4.4 Dam options

It allows to change, for each of the dams included in the project, the display mode of calculation form of the reservoir model, select the calculation step and select if outlet works must be opened automatically when the water rises above a safety level.

DAMS OPTIONS				×
List of available options	0 - Hidden mode calculation 1 - Form calculation is visible Empty field	1 - time step 1 hour 2 - time step 30 minutes 3 - time step 20 minutes 4 - time step 15 minutes 6 - time step 10 minutes	0 - No Emergency maneuvers 1 - Evaluating Emergency maneuv	
Dam's name	Visualize the calculation	Maneuvering time step	Emergecy option	SubOn
STRAMENTIZZO	0	1	1	Vero
MOLLARO				Falso
SANTA GIUSTINA	0	1		Vero
	add or change a field (you can a highlight it, then click the desired	•	•	
	Store the data in	the GeoDataBase		



Il the last column of each row you can see if you have selected the option to make the calculation for the dam. The option is to put it in field "Subroutine" of the table SchematicNode the value "**Diga**" (Dam). If you do not want to do the calculation you can choose the value "**SommaIdrogrammi**" (sum hydrographs).

	III Attributes of SchematicNode							×
	Shape *	OBJECTID *	HydrolD	HydroCode	FeatureID	SrcType	Subroutine	^
	Point	1	3007	Adige1	1000001	Sorgente	sorgente	
	Point	2	3008	Isarco	1000002	Sorgente	sorgente	
	Point	3	3009	Confluenzalsarco	5	Confluenza	Sommaldrogrammi	
	Point	4	3010	Noce1	1000004	Sorgente	sorgente	=
E	Point	5	3011	DigaSantaGiustina	8	Derivazione	Diga	\supset
	Point	6	3012	Noce2	1000005	Sorgente	sorgente	
	Point	7	3013	DigaMollaro	4	Derivazione	Sommaldrogrammi	\geq
	Point	8	3014	ConfluenzaNoce	6	Confluenza	Sommaldrogrammi	
	Point	9	3015	Avisio1	1000008	Sorgente	sorgente	
	Point	10	3016	DigaStramentizzo	1	Derivazione	Diga	
	Point	11	3017	Avisio2	1000009	Sorgente	sorgente	
	Point	12	3018	ConfluenzaAvisio	7	Confluenza	Sommaldrogrammi	
	Point	13	3020	ConfluenzaFersina	2	Foce	Sommaldrogrammi	
	Point	14	3026	Adige2	1000003	Sorgente	sorgente	~
<							>	
	Record:	II I 5	5 F FI	Show: All Selected	Records	(0 out of 21 Selec	ted) Opti	ions

Note that the rainfall-runoff model is set to run the calculation with time step of one hour and this step provides the inlet discharges to the reservoir. If the rate of change in the level of the reservoir is small during one hour, is recommended to choose for the reservoir model the hourly time step. However, if the reservoir volume is small compared to its discharge capacity (eg in case of Barrage) it's necessary to use a smaller time step calculation. In this way the model, can apply, with adequate time step, the rules of operation of discharges included in the geodatabase and update the degree of opening of floodgates to adapt them to rapid changes in the level.

4.5 Withdrawal options

This functions allows to select options concerning the withdrawal from the intake works of the dam. Selecting it activates the mask below.



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WITHDRAWAL OPTION	S					
List of available options	2 - search on	ekly y curves ol ly curves	f hourly withdrawal of demanded withdrawal of historical withdrawal			
Dam Name	Intake		Withdrawal Curve			
STRAMENTIZZO	Presa Stramentizzo	r		1		
SANTA GIUSTINA	Presa Taio			240		
Store the data in the 0	GeoDataBase	Grap	hic of withdrawal curves			

The mask shows the list of the intake works presented in the geodatabase and for each is possible to choose a curve sampling. With the yellow button at the bottom right is possible to activate the graph of standard curves loaded into geodatabase.

lydrolD	HydroCode	Dam		Data type		
002 001	Presa Stramentizzo Presa Taio	STRAMENTIZZO SANTAGIUSTINA		Drawing Curves Drawing Curves		
t of data	for each element (It	's possible to select simult	aneously up to six	x stations - keep key Ctrl pressed)		
lydrolD	Intake	Dam	# of data	Data type	CODEX	QUANTITY
002 002	Presa Stramentizzo Presa Stramentizzo	STRAMENTIZZO STRAMENTIZZO	24 168	Hourly daily withdrawal data Hourly weekly withdrawal data	QH_DAILY QH_WEEKLY	Flow Flow
002	Presa Stramentizzo	STRAMENTIZZO	366	Daily yearly withdrawal data	QD_YEARLY	Flow
002	Presa Stramentizzo	STRAMENTIZZO	12	Mean monthly withdrawal data	QM_MONTHLY	Flow
002	Presa Stramentizzo	STRAMENTIZZO	2	Mean yearly withdrawal data	QY_YEARLY	Flow
J						
50	- 5002 - QH_WEEKLY			1)
50	- 5002 - QH_WEEKLY		iii			
50 40	- 6002 - QH_WEEKLY					
50	- 6002 - OH_WEEKLY					
40	- 6002 - OH_WEEKLY					
50 40 30	- 6002 - QH_WEEKLY					
50 40 30 20		03/01/2002 D8		2002 12 06/01/2002 16	06/01/2002 20	03/01/2002 0



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4.6 Muskingum's parameters

For the meaning of the tool see section 3.6. In this case, however, the change of parameters is only valid for the event. In this way you can keep save the original copy stored in the project Geodatabase.

4.7 Load monitoring and forecast

This function allows to load in the event GeoDatabase, observed or forecast data, in addition to any historical data already transferred from GeoDataBase project, as seen.

Events	Update Data	Real time forecasts	?
Select Event		and the second	Ranning Event 200201
Clean Event's GI	ЭВ		Even 220020
WaterShed's dat	ta	and the state of the	
Dams' options		1	
Dams withdrawa	l's options		
Muskingum's par	ameters	10.00	
Load monitoring	and forecast	Load monito	oring data from a XLS file
Dams maneuver:	s and rain forecasts Graphic	Load rain for	precast from a XLS file
Observed data (Graphic	Load Dams	time series from a XLS file
Execute rainfall-	runoff model	Load reserv	oir flood rountig plan from a XLS file
Compute flow ro	outing	Load rain m	easures and forecasts by WEB (from a XLM file)
Flow Forecasts a	at Monitoring Points	Section 2.	
	surface Forecasts at Reserv	oirc	

As shown, there are different modes of transfer. For each of them is presented an appropriate mask that allows to choose the desired file, possibly open it to check it and then upload the data. For the Excel files containing time series, the format must be identical to that already seen for the series.

🖣 Historical Series Loading - Monitoring data 🛛 🛛 🔀	
Data File	
Select data file See data file	Forecasts loading - Excel format
D:\documenti\Piene10\HaltFlood2010\EsempioFileInput\Ese	Data File
	Select data file See data file
Worksheet with the data Dati_orari	D:\Haltflood\ArchivioDati\Test_Previsione_7_10_agosto2
Type of data to be loaded	Worksheet with the data Dati_orari
Rain Temperatures Snow Reservoir's levels	Worksheet with the data Dat_oran
🔽 Inlet flows 🔽 Outlet flows 🔲 Freezing quote	Type of data to be loaded
Requested withdrawal	🔽 Rain 🔲 Temperatures 🗖 Snow 🔲 Reservoir's lev
	☐ Inlet flows
Load data in the GDB	
	Load data in the GDB



Rev.00

Forecast Loading - XML format
 Select data file
 See data file
 See data file
 Verwrite existing data
 Load data in the GDB

The function **"Load monitoring data from a XLS file"** is designed for loading observed data of hydro-meteorological provided from Regional Office. It can load data for:

- Watershed
- Monitoring Point
- Water Withdrawal

The following data types are expected:

- TSTypeID=70 : hourly observed rainfall
- TSTypeID=80 : hourly observed temperatures
- TSTypeID=90 : hourly observed freezing level
- TSTypeID=100 : hourly observed runoff
- TSTypeID=110 : hourly observed height snow
- TSTypeID=120 : hourly observed discharges
- TSTypeID=130 : hourly observed levels
- TSTypeID=200 : observed water demand

The function **"Load rain forecast from a XLS file"** is designed for loading, instead of xml file, data of rainfall forecasts. It can load data for:

- Watershed
- Monitoring Point

•

•

•

•

The following data types are expected:

- TSTypeID=71, 72, 73 : hourly rainfall forecast (min, mean, max)
 - TSTypeID=81, 82, 83 : hourly temperatures forecast (min, mean, max)
 - TSTypeID=91, 92, 93 : hourly freezing level forecast (min, mean, max)
 - TSTypeID=101, 102, 103 : hourly calculated runoff (min, mean, max)
 - TSTypeID=111, 112, 113 : hourly height snow forecast (min, mean, max)
 - TSTypeID=121, 122, 123 : hourly calculated discharges (min, mean, max)
 - TSTypeID=131, 132, 133 : hourly calculated levels (min, mean, max)

The function **"Load Dams time series from a XLS file"** is designed for observed data of dams. It can load data for:

- Water Withdrawls Dams
- Monitoring Point
- Outlet Works Dams

The following data types:

- TSTypeID=70 : hourly observed rainfall
- TSTypeID=80 : hourly observed temperatures
- TSTypeID=90 : hourly observed freezing level
- TSTypeID=100 : hourly observed runoff
- TSTypeID=110 : hourly observed height snow
- TSTypeID=120 : hourly observed discharges
- TSTypeID=130 : hourly observed levels
- TSTypeID=200 : observed water demand
- TSTypeID=300 : hourly level demand
- TSTypeID=400 : hourly opening percentage discharges demand

The function **"Load reservoir flood rountig plan from a XLS file"** is designed for loading data of reservoir flood rountig plan prescribed by control authority for the:

• Dam

The following types of routing plans:

PrTypeID	PrCode	Description
1	EMPTYING	Emptying the reservoir up to a given level
		in a given time and with a flow rate limit
2	CLOSING	Closing outlets
3	FILLTOLEVEL	Fill the reservoir up to a given level
4	RELEASEFROMLEVEL	Release a given discharge when it reaches
		a given level
5	RELEASETOLEVEL	Release a given discharge
		until you reach a given level
6	AUTOMATIC	Sets gates in automatic mode

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The function **"Load rain measures and forecasts by WEB** (from a XML file)" allows to load, in GeoDataBase, observed data of rainfall and forecasts on various sub-basins acquired from Internet in the form of XML files.

4.8 Execute rainfall-runoff forecasting model

The tool allows you to run the rainfall-runoff model.

If the study area was divided into several sub-watershed the model runs for each sub- watershed. At the end the tool store the results in the GeoDatabase of the current event.

Is first presented with the following mask:

🖻 Rainfall-runoff forecasting model 🛛 🛛 🔀	Rainfall-runoff forecasting model
Type of simulation Run using input rain forecasts Run using input observed rain	Type of simulation C Run using input rain forecasts F Run using input observed rain
Date Select one date from the available forecasts 14/11/2002 22.00.00	Input the starting date of simulation 11/11/2002 1.00.00 input Number of simulation hours 72
Initial conditions Previous hours of rain Previous hours of runoff 48 Check previous data	Initial conditions Previous hours of rain 240 Previous hours of runoff 48 Check previous data
Selection of Qb: base flow	Selection of Qb: base flow
○ Use GDB data ○ Use recalculated values	C Use GDB data C Use recalculated values
Determines the initial conditions	Determines the initial conditions
Model Show results O Stores results to the GDB Run Model	Model Show results O Stores results to the GDB Run Model

Then it's important to operate as follows:

- Choose if you want run the model using rainfall forecast or observed rainfall
- Choose the starting date of
- Specify data from previous hours of rainfall and discharge that are used to assess the initial condition of soil moisture (values shown here are the default).
- Press the button "Check previous data".

It shows the following Table:

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	: average precipitation dat	a on the various sub-basin	s (watershed)			
HydrolD	HydroCode	Initial Date	Final Date	# of data Data	type	
1000001	Adige Isarco	13/11/2002 23.00.00	23/11/2002 23:00:00	241 Rain		
1000002	Isarco	13/11/2002 23.00.00	23/11/2002 23.00.00	241 Rain		
1000003	Adige Noce	13/11/2002 23.00.00	23/11/2002 23.00.00	241 Rain		
1000004	Giustina	13/11/2002 23:00:00	23/11/2002 23.00.00	241 Rain		
1000005	Mollaro	13/11/2002 23:00:00	23/11/2002 23.00.00	241 Bain		
000006	Noce	13/11/2002 23.00.00	23/11/2002 23.00.00	241 Rain		
1000007	Adige Avisio	13/11/2002 23.00.00	23/11/2002 23.00.00	241 Bain		
1000008	Stramentizzo	13/11/2002 23:00:00	23/11/2002 23.00.00	241 Rain		
1000009	Avisio	13/11/2002 23.00.00	23/11/2002 23.00.00	241 Rain		
1000010	Adige Fersina	13/11/2002 23.00.00	23/11/2002 23.00.00	241 Rain		
	oint : data flows and levels (n		P		(normalized in the second sec	1.
			Initial Date	Final Date		Data type
	HydroCode	Ftype			# of data	and the second
3053	NoceValleSantaGiustina	ScaricoDighe	21/11/2002 23.00.00	23/11/2002 23.00.0	0 49	Flow
3053 3054	NoceValleSantaGiustina NoceValleMollaro	ScaricoDighe ScaricoDighe	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	00 49 00 49	Flow Flow
3053 3054 3055	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo	ScaricoDighe ScaricoDighe ScaricoDighe	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	0 49 00 49 00 49	Flow Flow Flow
3053 3054 3055	NoceValleSantaGiustina NoceValleMollaro	ScaricoDighe ScaricoDighe	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	00 49 00 49 00 49 00 49 00 49	Flow Flow
3053 3054 3055 50033 50036	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	00 49 00 49 00 49 00 49 00 49 00 49	Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	00 49 00 49 00 49 00 49 00 49 00 49 00 49	Flow Flow Flow Flow
3053 3054 3055 50033 50036 50037 50038	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	00 49 00 49 00 49 00 49 00 49 00 49 00 49 00 49 00 49 00 49 00 49 00 49	Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50037 50038 50056	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50037 50038 50056 50059	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50037 50038 50056 50056 50059 500036	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50036 50038 50056 50059 50059 500036 1050033	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezzolombardo_parz	ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50037 50038 50038 50056 50059 500036 1050033 1050037	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezcolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezcolombardo_parz SMicheleAdige_parz	ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50037 50038 50056 50059 50059 500056 1050033 1050033 3056	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezzolombardo_parz SMicheleAdige_parz InvasoSantaGiustina	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 50033 50036 50036 50037 50038 50056 50059 500036 1050033 1050033 3056 3058	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezzolombardo_parz SMicheleAdige_parz InvasoSantaGiustina InvasoMollaro	ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50036 50038 50056 50059 500036 1050033 1050037 3058 3058 3058	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezzolombardo_parz SMicheleAdige_parz InvasoSantaGiustina InvasoStramentizzo	ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Invaso Invaso	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49 100 49	Flow Flow Flow Flow Flow Flow Flow Flow
HydroID 3053 3054 3055 50033 50036 50037 50038 50056 50059 500036 1050033 1050037 3056 3059 3059 3059	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S. Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezzolombardo_parz SMicheleAdige_parz InvasoSantaGiustina InvasoSantaGiustina InvasoSantaGiustina	ScaricoDighe ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Invaso Invaso Invaso	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow
3053 3054 3055 50033 50036 50036 50036 50059 500036 500036 1050033 1050037 3056 3059 3059	NoceValleSantaGiustina NoceValleMollaro AvisioValleStramentizzo Mezzolombardo Lavis S.Michele all'Adige Trento AdigePonteAdige IsarcoBolzano Lavis_parz Mezzolombardo_parz SMicheleAdige_parz InvasoSantaGiustina InvasoStramentizzo	ScaricoDighe ScaricoDighe Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Idrometro Invaso Invaso	21/11/2002 23.00.00 21/11/2002 23.00.00	23/11/2002 23.00.0 23/11/2002 23.00.0	10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49 10 49	Flow Flow Flow Flow Flow Flow Flow Flow

It shows if there are the necessary data for calculating the model.

If at some point were present monitoring less data than needed (in the Table are marked in red those Monitoring Point for which data must exist), it's possible to enter them manually:

- select desired record;
- press button "Entering values manually";
- enter desired value in dedicated mask.

Forecast of 23/11/2002 23.00.00	
For the station 3053 (NoceValleSantaGiustina) insert the out-flow at the date-time forecasting	OK Annulla
60	

- confirm the operation.

• Press the button "Determines the initial conditions".

It shows the following Table:

	Forecast Date 23/11/2002 23.00.00						
WaterShed Name	Sini [mm]	Ws_ini [mm]	Wsub_ini [mm]	Sini/SC_max [%]		QbGDB [mc/s]	Qb Monit [mc/s]
Adige_Isarco	29.32	0.19	0.46	36.65		27.17	65.85
Giustina	30.78	0.12	2.54	34.20		6.23	24.85
Mollaro	31.09	0.89	0.98	38.86		0.30	0.00
Noce	32.41	0.03	0.32	40.52		5.70	17.56
Stramentizzo	81.25	0.00	0.39	22.73		8.62	23.20
Adige_Avisio	39.33	0.01	0.01	39.33		0.16	0.24
Adige_Fersina	10.14	0.07	1.72	12.68		0.03	0.03
Isarco	39.51	0.01	10.77	18.03		29.14	39.58
Adige_Noce	23.98	0.08	0.05	29.25		9.12	0.33
Avisio	31.81	0.12	1.42	37.42		0.00	0.00
	Adige_Isarco Giustina Mollaro Noce Stramentizzo Adige_Avisio Adige_Fersina Isarco Isarco Adige_Noce	Adige_Isarco 29.32 Giustina 30.78 Mollaro 31.09 Noce 32.41 Stramentizzo 81.25 Adige_Avisio 39.33 Adige_Fersina 10.14 Isarco 39.51 Adige_Noce 23.98	Adige_Isarco 29.32 0.19 Giustina 30.78 0.12 Mollaro 31.09 0.89 Noce 32.41 0.03 Stramentizzo 81.25 0.00 Adige_Avisio 39.33 0.01 Adige_Fersina 10.14 0.07 Isarco 39.51 0.01 Adige_Noce 23.98 0.08	Adige_Isarco 29.32 0.19 0.46 Giustina 30.78 0.12 2.54 Mollaro 31.09 0.89 0.98 Noce 32.41 0.03 0.32 Stramentizzo 81.25 0.00 0.39 Adige_Avisio 39.33 0.01 0.01 Adige_Fersina 10.14 0.07 1.72 Isarco 39.51 0.01 10.77 Adige_Noce 23.98 0.08 0.05	Adige_Isarco 29.32 0.19 0.46 36.65 Giustina 30.78 0.12 2.54 34.20 Mollaro 31.09 0.89 0.98 38.86 Noce 32.41 0.03 0.32 40.52 Stramentizzo 81.25 0.00 0.39 22.73 Adige_Avisio 39.33 0.01 0.01 39.33 Adige_Fersina 10.14 0.07 1.72 12.68 Isarco 39.51 0.01 10.77 18.03 Adige_Noce 23.98 0.08 0.05 29.25	Adige_Isarco 29.32 0.19 0.46 36.65 Giustina 30.78 0.12 2.54 34.20 Mollaro 31.09 0.89 0.98 38.86 Noce 32.41 0.03 0.32 40.52 Stramentizzo 81.25 0.00 0.39 22.73 Adige_Avisio 39.33 0.01 0.01 39.33 Adige_Fersina 10.14 0.07 1.72 12.68 Isarco 39.51 0.01 10.77 18.03 Adige_Noce 23.98 0.08 0.05 29.25	Adige_Isarco 29.32 0.19 0.46 36.65 111111 27.17 Giustina 30.78 0.12 2.54 34.20 111111 6.23 Mollaro 31.09 0.89 0.98 38.86 1111111 0.30 Noce 32.41 0.03 0.32 40.52 111111 0.30 Stramentizzo 81.25 0.00 0.39 22.73 111111 0.16 Adige_Avisio 39.33 0.01 0.01 39.33 101111 0.16 Adige_Fersina 10.14 0.07 1.72 12.68 111111 29.14 Adige_Noce 23.98 0.08 0.05 29.25 111111 9.12

This operation also enables the lower current mask, with the frame "Model", initially disabled:

Model Show results	C Stores results to the GDB			
Run Model				

• Choose the option "Show results", then press "Run Model".

It is presented the following mask, which gives the performance graph of the forecasts of rainfall and discharge in different sub-basins (Watershed), the black vertical line indicates, in this as in other similar graphics, the "actual" start of the forecasts.



• If calculated data are incorrect, is possible store them in GeoDataBase. Select the option "Store results to the GDB", then press "Run Model".

4.9 Compute flow routing

Is first asked to choose the date of the forecasts for which make the network calculation:

Network calculation	×
Select a date from the available forecasts	
23/11/2002 23.00.00 💌	
Frank	
Execute	

Pressing the button **"Execute"**, the program reads data of the network scheme from the database and the inflow hydrograph to the network itself, and then calculates their propagation and sums the inflows at different nodes. In case a node of this network is a reservoir, it enables the calculation module for calculating the transition in it and the resulting flow downstream.

If in the options of the dams, the user has chosen to display the calculation, when the calculation of a reservoir is enabled, the following mask will be opened for each dam:

Calculates flood routing at the reservoir	
Choosed dam:	Reservoir flood routing plan
28 - SANTAGIUSTINA	<dam>, DAM=SANTAGIUSTINA <geodb>, Name=D:\documenti\Piene10\HaltFloodAgo <hydroid>, Value=28 <start>, DateHour=22/11/2002 15.46.00 <end>, DateHour=26/11/2002 23.00.00 <= <instruction>, ID=1, PrTypeID=1, Type=SVU0TAMI <start>, DateHour=22/11/2002 15.46.00 <</start></instruction></end></start></hydroid></geodb></dam>
Volume of the reservoir = 182.81 Mmc	<t argettime="">, DateHour=23/11/2002 18.00.00 <t argetlevel="">, Level=523.9 <withdrawal>, Turbine=-1 <maximumdischarge>, Flow=100 EINSTRUCTION>, ID=2, PrTypeID=2, Type=CHIUSURA <start>, DateHour=26/11/2002 10.58.00</start></maximumdischarge></withdrawal></t></t>
Initial date 23/11/2002 23.00.00	<pre><withdrawal>, Turbine=-1</withdrawal></pre>
Initial level [m m.s.l.] 523.90	
Forecast 1	Apply reservoir flood routing plan • Apply C Do not apply
LIST OF OUTLETS IN THE OPENING SEQUENCE OUTLET - 1: QOUT OUTLET - 2: SPIL OUTLET - 3: SPIL OUTLET - 4: TAGA OUTLET - 5: TAGA	Evaluating Emergency maneuvers Not evaluating Emergency maneuvers Visualize
	C Null C Operating rules
Perform Calculation END	 Reservoir flood routing plan

Pressing the button **"Perform Calculation"**, the program reads data from the database of the dam and performs the calculation of transition in the reservoir and the resulting flow downstream.



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All the results are stored in the database.

4.10 Forecast graph at Monitoring points

It allows to obtain the graph of the inflows and outflows to the measuring stations of type "hydrometer" and "reservoir".

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For the current measurement station, the frame **"Tresholds"**, at the bottom right of the mask, appear, if there are, certain threshold values of flows, which can be indicated on the graph. You can add or remove a line on the graph that shows the threshold by selecting or un-selecting the relative name on the list. These threshold values are stored in the table CurveXY GeoDatabases Project.

If the frame **"Contributions to the flow"** is enabled, as in the case stated above, is also possible to see on the graph (with dotted line) the contribution of flow, at the current station, due to individual discharges of dams upstream. Is necessary to activate the function, selecting the appropriate check, and then select, from dedicated Combo Box, the contribution wanted.

- Co	ntributions to the flow	
•	1 - Scarico Diga di Stramentizzo	•
	1 - Scarico Diga di Stramentizzo	
	4 - Scarico Diga di Mollaro 8 - Scarico Diga Santa Giustina	1
	8 - Scarico Diga Santa Giustina	

4.11 Graphs of forecasts at reservoirs

This option opens a mask where there are two graphs, both related to measured and forecast data about reservoirs. The top graph shows the rainfall and flow (both in and out), while in the bottom graph appear the levels of the reservoir, in conjunction with the maximum level of regulation and the maximum level of reservoir.

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4.12 Forecasts and historical data comparison

The choice of this option opens the following mask, where, for each Monitoring Point, is possible to have a comparison, for each date of the forecast start, between historical data (black line) and those forecasted by the models (colored lines).

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In this graph you can also show threshold values and contribution flows due to upstream reservoirs. (see "Graph of forecasts at stations").

If Monitoring Point is a type "Reservoir", the frame "Graphs of reservoir" is enabled, in which case is possible to graph both the inflows and the outflows, or only the inflows, and finally the levels:





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5 THE UPDATE DATA MENU

This function is developed to allow users to download by Internet data of monitoring networks external to own organization.

Assuming, in current version, that the program is installed by a reservoir owner which uses their own measurements of inflow and reservoir level and upload them into the Geodatabase through the Project menu (for historical events) and Events (in case of an event in real time) organized as Excel files, the function **"Update Data"** is designed to update the other data types, so:

• Data of hydrometric network of stations located upstream and especially downstream of the dam;

• Data of rainfall measures and average forecast on the sub-basins of geographic area where the dam is located.

The "Update Data" function is therefore divided into two menus:

- Check for updates hydrometric monitoring
- Control measures and forecasts updates by web



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The first of two menus is not yet active, and it's possible to it activate only after agreement with the operators of the monitoring network of the area where the dam is located.

The second menu is activated in the event of sample basins, for which, on an experimental basis, the Laboratory of Meteorology RSE, provides measurements of rainfall by radar and forecasts of precipitation from meteorological model.

The menu allows to activate the program HaltFlood-WS client that connects to the web.service of the RSE server and download the update of the measures and forecasts available of the calculation scheme which is associated with the current project.



The files are in XML format and are downloaded in a special subfolder.

This subfolder has the name of the code scheme (eg **adige**) and it is in a subfolder named **wsdati** that must be present in that of HaltFlood's installation.

For example, if the program HaltFlood.exe is installed on:

d:\HaltFlood

The data of "adige" scheme are downloaded in:

d:\Haltflood\wsdati\adige

If the folder doesn't exist, is necessary to create it before running the HaltFlood –WS Client.

To calculate the forecasts, the first task is downloading forecast data to your computer the second task is loading them into the GeoDataBase using the menu:
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Events $\ Load monitoring and forecast \ Load rain measures and forecasts by WEB (from a XML file)$

Events	Update Data	Real time forecasts	?
Select Event		and the second	Fluinning Event 200201
Clean Event's G			rounnig Event Coocer
WaterShed's da	ta		
Dams' options			
Dams withdrawa	al's options		
Muskingum's par	rameters		
Load monitoring	and forecast	Load monitori	ng data from a XLS file
Dams maneuver	s and rain forecasts Graphic	Load rain fore	cast from a XLS file
Observed data	Graphic	Load Dams tim	ne series from a XLS file
Execute rainfall-	runoff model	Load reservoi	r flood rountig plan from a XLS file
Compute flow ro	outing	Load rain mea	sures and forecasts by WEB (from a XLM file)
Flow Forecasts	at Monitoring Points	Same and	
	surface Forecasts at Reserve	oirs	
Forecast / histor	rical data comparison graph	and the second	

In the figure below, is possible to choose if upload past measures: this option is recommended in real-time analysis to always have the latest update, however, if analysis of historical events, whose measurement data are already in the geodatabase, is possible to omit loading them to speed up processing.

When you make a new loading data, is recommended to overwrite any old data in the geodatabase.

Forecast Loading - XML formation	t 🔀
Select data file	See data file
✓ Load past rain measures	Overwrite existing data
Load data in th	e GDB

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Select a File		
Choose the file for loading into project's GL Directory:)B File name:	
D:\Haltflood\wsdati\adige	RdS_Adige_2002-11-23.xml	
C:\ Carlot Haltflood Carlot wsdati Carlot Adige	RdS_Adige_2002-11-11.xml RdS_Adige_2002-11-12.xml RdS_Adige_2002-11-13.xml RdS_Adige_2002-11-13.xml RdS_Adige_2002-11-15.xml RdS_Adige_2002-11-16.xml RdS_Adige_2002-11-16.xml RdS_Adige_2002-11-16.xml RdS_Adige_2002-11-17.xml RdS_Adige_2002-11-18.xml RdS_Adige_2002-11-19.xml RdS_Adige_2002-11-19.xml RdS_Adige_2002-11-20.xml RdS_Adige_2002-11-21.xml RdS_Adige_2002-11-22.xml RdS_Adige_2002-11-23.xml	
Unit:	File type: File XML (*.xml)	
ОК	Exit	

In the picture above, for example, is loaded a forecast in **"adige"** scheme, on November 23, 2002. The name of the xml file, estimates forecast date.

6 THE REAL TIME FORECASTS MENU

This function is planned to use HaltFlood in real time.

It is a function similar to that of the events menu, with the only difference that it uses the forecast event contained in geodatabase Event Name Progetto_Evento_Previsioni.

Compared to the function event, in this case is choosed "Load rain measures and forecasts by WEB" that automatically loads the latest forecasts available.

In this case, there isn't commands menu for comparing the forecasts with historical data: this option is only available after the event has happened. If you want to study historical events, you should load the observed data into an event Geodatabase and use the Events menu.

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7 APPENDIX A: GETTING STARTED ON A NEW PROJECT

This appendix describes how to create, with ESRI ArcGIS, the geographic data for a new HaltFlood project and store them in a Personal Geodatabase.

7.1 Creating an empty project geodabase

To store a project in you computer, you need an empty Personal Geodatabase in then project directory : this is done automatically with the command menu New, after you have insert the name of new project.

The command makes a copy of the template Geodatabase, after that it renames the copy as the name of the project GeoDataBase.

The project geodatabase data model is derived from the standard ArcGIS Hydro Data Model (<u>http://www.crwr.utexas.edu/giswr/hydro/index.html</u>) which have been added fields and tables to take account of the special needs of the application HaltFlood.

7.2 Modify/Update coordinate system and Domain

In the empty geodatabase there three Feature DataSet:

- 1. Drainage
- 2. Hydrography
- 3. Network

These Feature DataSet are by default the follow coordinate system useful for Italy:

```
Projected Coordinate System:
Name: WGS_1984_UTM_Zone_32N
 Alias:
 Abbreviation:
 Remarks:
Projection: Transverse_Mercator
Parameters:
 False_Easting: 500000.000000
 False_Northing: 0.000000
 Central_Meridian: 9.000000
 Scale_Factor: 0.999600
 Latitude_Of_Origin: 0.000000
Linear Unit: Meter (1.000000)
Geographic Coordinate System:
 Name: GCS_WGS_1984
 Alias:
 Abbreviation:
 Remarks:
 Angular Unit: Degree (0.017453292519943299)
 Prime Meridian: Greenwich (0.000000000000000000)
 Datum: D_WGS_1984
  Spheroid: WGS_1984
   Semimajor Axis: 6378137.0000000000000000000
   Semiminor Axis: 6356752.31424517930000000
   Inverse Flattening: 298.257223563000030000
X/Y Domain:
 Min X: -1387362.287268
 Min Y: 2445888.317314
 Max X: 213361002.212733
 Max Y: 217194252.817315
 Scale: 10.000000
M Domain:
 Min: 0.000000
 Max: 2147483645.000000
 Scale: 1.000000
```



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If you need a different "*XY Coordinate system*", you must change it for each Feature Dataset. In this case you also need to change the "*Domain*". This can be done with AraCatalog

This can be done with ArcCatalog.



If you have a shape file or an existing geodatabase of your study area you can simply import the coordinate and the X/Y,Z domains from it.

7.3 Append new record, if necessary, in some dictionary tables

In the following tables of the geodatabase, there are some initial data needed for subsequent loading operations:

- TSType: table that lists the types of time series
- TSQuality: table that lists the types of data quality acquired
- CurveType: table that lists the types of curve XY

These tables, in the *Progetto_GDB.mdb* empty file, already contain records that relate to the most common types of data: if you want to load into the geodatabase more data types you must first enter the description of these new types and assign them a univocal number of TSTypeID and/or TSQualityID and/or TbTypeID.

7.4 Upload initial geographical data

The starting geographic data consist of the following feature classes:

- In the Feature DataSet Hydrography: features that represent the river system
 - 1. *HydroEdge*: these features are typically represented in hydrography as a blue line and in general they represent such features as streams, rivers, canals and pipelines that can be represented by a single line on a map.
 - 2. *HydroJunction* : are the locations at which Hydro Edge intersect each other.
 - 3. *SchematicNode* : the SchematicNode Point feature class contains the points in a Schematic Network, which may represent any feature within an Arc Hydro geodatabase. Typical types of SchematicNodes are: drainage area centroids, drainage area outlets and stream confluences.
 - 4. *SchematicLink* : are Polyline feature class that provide a connection between the upstream noto to downstream node. Typically they represent a stream or a channel.

About the table *SchematicNode*, is listed below the meaning of some fields:

- **HydroID** integer: A unique feature identifier within a geodatabase.
- **FeatureID**: it contains the number of HydroID of the HydroFeature from which the node was created. This enables the SchematicNode to connect to the attribute information of the feature it describes. Typical feature connected to the SchematicNode are **Watersheds** and **HydroJunctions**.
- **SrcType**: it contains the CodedValueDomain number of the type of node. CodedValueDomain are the follow:

-	1	Sorgente	(Source)
-	2	Confluenza	(Confluence)
-	3	Foce	(Outfall)
-	4	Derivazione	(Water withdrawal)
-	5	Centrale idroelettrica	(Hydroelectric power plant)
-	6	Utenza Irrigua	(Irrigation user)
-	7	Utenza Industriale	(Industrial user)
-	8	Utenza Idropotabile	(Drinking water user)
	4.		

• **Subroutine**: it contains the CodedDomain number of the type of subroutine call at the node. CodedValueDomain are the follow:

-	1	sorgente	(Source: input runoff hydrographs from the connected watershed)
-	2	SommaIdrogrammi	(Sum hydrographs: sum the discharge from upstream schematiclinks)
-	3	Diga	(Dam: call the dam tool performing flow routing at the connected dam)
-	4	Diversion	(Diversion: call the subroutine <i>Diversion</i> that calculate the outflow into the downstream schematiclinks)
-	5	Utenza	(Users: sub. non yet implemented)

About the table *SchematicLink* you must note the meaning of some fields:

- HydroID integer: A unique feature identifier within a geodatabase
- **FromNodeID** integer: Indicates the HydroID of the SchematicNode at the upstream end of the Link

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- **ToNodeID** integer: Indicates the HydroID of the Schematic Node at the downstream end of the Link.
- **LinkType**: it contains the CodedValueDomain number of the type of node. CodedValueDomain are the follow:
 - 1 affluente (tributary)
 - 2 principale (main river) - 3 canale (channel)
 - 3 canale (channel)
- **Subroutine**: it contains the CodedValueDomain number of the type of subroutine call at the link. CodedValueDomain are the follow:

-	1	traslazione	(transfer: trasfers the inflow hydrograph to the
			downstream node unchanged)
-	2	Muskingum	(Muskingum: call the Muskingum subroutine to routing
			the inflow hydrograph to the downstream node using
			the Muskingum method)
-	3	IdrogrammaUnitario	(Unit hydrograph: not yet implemented)
-	4	InvasoLineare	(Linear reservoir: not yet implemented)

The section 7.6 describes the proposed methodology for the creation of this set of data and watershed below mentioned

- Feature DataSet Hydrography
 - 1. *Dam* : in contains the data of dams (NOTE: In the table Dam, are considered in the simulation only those dams which is assigned the value of the field JunctionID that defines the *HydroJunction* of the hydrographic network in which the work is located);
 - 2. *MonitoringPoint* : it contains data from the monitoring stations in the area concerned. The stations must correspond to points where instruments are or where you plan to save the results of calculation. (NOTE. For each reservoir which you makes the simulation it is necessary to include at least two monitoring points: one reservoir and one type Dam Outlet)

About the table *MonitoringPoint* you must note the meaning of some fields:

- **HydroID** integer: A unique feature identifier within a geodatabase
- **JunctionID**: it contains the number of HydroID of the *HydroJunction* of the HydroNetwork from which is related. This enables the MonitoringPoint to connect to the attribute information of the **SchematicNode** that have the same value in the **FeatureID** field.
- **FtypeID** it contains the CodedValueDomain number of the type of Monitoring Station. CodedValueDomain are the follow:
 - 1 Streamgage
 - 2 Reservoir
 - 3 Dam Outlet
 - 4 Rain Gauge
 - 5 Snow gauge
 - 6 Weather station
 - 7 Avalanche safety
 - 8 Other

- Feature DataSet Drainage
 - 1. *Watershed* : feature class which contains a landscape subdivision into selected drainage areas, which drain to a point on a river network. It also contains the calibrated parameters of rainfall-runoff Bucket model.

About the table *Watershed* you must note the meaning of some fields:

- **HydroID** integer: A unique feature identifier within a geodatabase
- **JunctionID**: it contains the number of HydroID of the *HydroJunction* of the HydroNetwork from which is related. This enables the *Watershed* to connect to the attribute information of the **SchematicNode** that have the same value in the **FeatureID** field.

7.5 Upload initial alphanumeric data

Alphanumeric data I dati alfanumerici can be divided into:

- Configuration data
- Time series

7.5.1 Configuration data

- Fields of Watershed feature class Campi dei **watershed** containing the calibration parameters of Bucket model: these fields must be fill in (there is an automatic calibration tool that allow to evaluate parameters from historical data. The tool for automatic calibration uses the geodatabase of historical events)
- Dam's data
 - 1. Fields of *Dam* table: as an example, the field values of **QuotaMaxRegolaz**; **QuotaMaxInvaso** are used to show reference levels in the graphs
 - 2. Table *DerivazDighe* : contains, for all dams, the data of intake works.
 - 3. Table *ScarichiDighe* : contains, for all dams, the data of the outlet works.
 - 4. Table *CurveXY*: contains, for all dams, the data of elevation-storage relationship, curve of automatic outlet opening, curve of standard withdrawal from intake works.
 - 5. Table *TabSorveglianza*: contains, for all dams, the data about how much open the outlet works during the flood events;
 - 6. Table *TabRientro*: contains, for all dams, the data of outlet works closure when the flood decreases;

7.5.2 Time Series

The geospatial feature of the Arc Hydro data model describe the water environment, that is, the physical environment through which water flows. Also important are the water properties at any geographic location: precipitation, discharge and water surface elevation. These properties are contained in the TimeSeries component of the data model.

The project Geodatabase contains observed time series. To perform the analysis we use a second type of GeoDataBase: the event Geodatabase. We create an event Geodatabase for each event, where an event is a time period within much precipitation falls, it causes runoff, which discharging along successive streams can rapidly swell the flows of the main river. Then, in the main river flows propagate downstream.

The Event geodatabase stores the rainfall forecast, calculated and observed runoff.

The data model of both geodatabase is expected that all time series are contained in table TimeSeries, this have a relationship with other tables that are used to define the data type.

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A list of time series in the geodatabase is as follows:

- 1. Observed data during various events of rainfall on each watershed;
- 2. Observed values of flow in the closing sections of river with streamgauge;
- 3. Observed values of inflow in reservoirs;
- 4. Observed values of water elevation in reservoirs;
- 5. Observed values of outflow from reservoirs.

The historical time series are listed by event according to a list contained in a schedule of events (table TSEvent) and are related to a monitoring point (streamgauge, reservoir) or area (watershed)

The TimeSeries table has two key fields:

- *FeatureID*: field that contains the value of HydroID of Watershed or MonitorigPoint wich is related.
- *TSEventID*: field that contains the value of TSEventID referred to the list in TSEvent table.

It is possible upload time series data from an excel sheet having the follow format. The tool L'interfaccia takes care of assigning the proper TSEventID.

	Aicrosoft Eycel - E	sempio_File_caric	amento serie st	nriche vls							_ [
		Visualizza Inserisci			Finestra	2			Digita	re una domanda		_
<u>_</u>	0.0.0				T ILIESU a	-						5
	💕 🛃 💪 🖨	i 🔁 - 🝼 👘	- 🎧 X - 🛄	🕜 🚆	Arial	- 10	- G C S		🔠 🖳 € %	,00 ,00 ⊡ ▼	🖄 - <u>A</u>	
	B104 👻	<i>f</i> ≈ 11.6496										
	Α	B	С)	E	н	1	J	N	0	
1		– InvasoStramentizzo	InvasoStramentizzo	AvisioValleS	- tramentizzo	AdiaePonteAdiae		IsarcoBolzano	Mezzolombardo	Adige Isarco	Isarco	
2	HydrolD	3059	3059		3055	50056	50038	50059	50033	1000001	100000	2
				ScaricoDigh		Idrometro	Idrometro	Idrometro	Idrometro	Watershed	Watershed	
			Reservoir_level_ob:	Discharge_c		Discharge_obs	Discharge_obs			Precipitation	Precipitation	
	DataOra/TSType	120	130		120			120	120			
99	4/11/02 22.00	16.50	787.00		6.50			81.10	12.60			
100	4/11/02 23.00	12.38	787.00 787.00		2.38		179.90	85.70	13.70			
101 102	5/11/02 0.00 5/11/02 1.00	10.92 10.92	787.00		0.92		156.30 143.10	89.70 70.80	17.80			
102	5/11/02 2.00	10.92	787.00		0.92		143.10	46.90	13.20			
103	5/11/02 3.00	11.65	787.00		1.65		132.20	35.55	13.70			
105	5/11/02 4.00	10.19	787.00		0.72		132.20	34.85	13.20			
106	5/11/02 5.00	10.92	787.00		0.92		132.20	33.02	13.20			
107	5/11/02 6.00	10.19	787.00		0.72	32.20	123.40	30.32	14.30			
108	5/11/02 7.00	10.92	787.00		0.92	30.20	113.10	27.95	13.20	0.000	0.000	.0
109	5/11/02 8.00	10.92	787.00		0.92	29.30	101.60	28.46	13.70	0.000		
110	5/11/02 9.00	10.19	787.00		0.72			28.96	59.40			
111	5/11/02 10.00	10.19	787.00		0.72			28.96	71.00			
112	5/11/02 11.00	11.65	787.00		1.65		92.10	47.83	74.70			
113	5/11/02 12.00	17.35	787.00		7.35			86.60	61.70			
114	5/11/02 13.00	17.35	787.00		7.35	48.40	119.90	83.20	59.40			
115	5/11/02 14.00	16.50	787.00		6.50	66.50	116.50	72.90	59.40			
116 117	5/11/02 15:00	15.65	787.00 787.00		5.65		113.10 116.50	77.60	60.50			
117 118	5/11/02 16.00 5/11/02 17.00	16.50	787.00		5.65		116.50	87.10	59.40 57.20			
118 119	5/11/02 17:00	15.65	787.00 787.00		7.35	55.10	125.10	79.10	57.20			
120	5/11/02 19:00	17.35	787.00		5.65		146.70	94.00	74.70			
120	5/11/02 20.00	20.14	787.00		10.14	52.20	198.50	95.90	62.80			
122	5/11/02 21.00	16.50	787.00		6.50	60.90	194.30	86.00	34.80			
123	5/11/02 22.00	15.65	787.00		5.65	68.00	186.00	82.00	13.20			
124	5/11/02 23.00	13.11	787.00		3.11	66.50	162.00	90.50	12.60			
125	6/11/02 0.00	10.92	787.00		0.92		143.10	91.00	13.70			
126	6/11/02 1.00	10.92	787.00		0.92		134.00	58.00	13.20			
127	6/11/02 2.00	10.92	787.00		0.92		134.00	42.09	13.20			
H 4	၊ 🕨 💽 🔪 Sottobaci	ni / MonitoringPoin	t / TSType / Cod	ici) Dati_o	rari / 💶							۲ſ

In the first five rows, there are the identification data of sub-basins and / or of monitoring stations and the data type you want to upload: codes must match those in geodatabase.

In particular are important:

• **HydroID:** identification code of station or of sub-basin that must correspond to that presented in Geodatabase respectively in:

column HydroID of the table MonitoringPoint

column HydroID of the table Watershed

• **TSType:** identification code of data type that must match to the field TSTyeID of the table TSType



In subsequent lines (ie from the sixth row) are shown, in the first column, the date and hours and in the following columns, relative hourly data correspond to the variables of respective header lines.

7.6 Methodology for determining the hydro network and the schematic network

The Arc Hydro data model provides a basic database design for water resources which describes geospatial and temporal data on surface water resource features of the landscape.

The standard ArcGIS Hydro data model describes only natural water systems, and does not support constructed water infrastructure: therefore the data model has been integrated by adding additional tables and fields to meet the needs of HaltFlood.

One of the most important components Hydro Data model is the Network. This component contains a water resources network of streams, rivers and the centerlines of water bodies. Its main purpose is to describe the connectivity of water movement through the landscape.

The Network is contained in the *Network* feature dataset of Geodatabase. In this Feature Data Set there are:

- **HydroNetwork** is the principal feature class of this dataset: it is an ArcGIS geometric network, whose components are HydroEdges and HydroJunctions. Water flows along HydroEdges, and HydroEdges are connected by HydroJunctions. The Hydro Network describes flow through rivers and streams, and the centerlines of waterbodies.
- SchematicNetwork, which consists of the SchematicLink and SchematicNode feature classes. These features are used to symbolise the connection of drainage areas to HydroJunctions, and to provide a simplified view of water flow through the landscape.

About **HydroNetwork** it should be noted that there are two type of junction::

- 1. **HydroJunction**: junctions that may have particular behaviors and attributes and have relationship to other feature in Geodatabase (hydro feature)
- 2. **HydroNetwork_Junction**: locations that are anonymous points on the network with no attributes or user interests. These junctions are required only for the network connectivity.

In Hydro Data Model, the geographical points of reference are **HydroJunction** which in geodatabase have a unique number named **HydroID** that is key field for relationtip to other objects (the connection of any objects to the HydroJunction is obtained by inserting in the key field JunctionID of the object the HydroID value of the related HydroJunction). In particular are related to HydroJunction the features:

- Watershed
- MonitoringPoint
- Dam

Creating a new project, you must choose a list of points of interest. For each point you need to create a **HydroJunction.**

At the **HydroJunction** there may be works such as dams or points of interest where the runoff is calculated (in this case it is a drainage point of watershed).

Once the **HydroJunction** of interest was selected in the network, the following steps need to be done to create the necessary calculation scheme:

1. defining the watershed that have the closing section at these HydroJunction;

- 2. should be fill in the field JunctionID, of the Dam table, with the HydroID value of the HydroJunction
- 3. Building the **SchematicNetwork** establishing the appropriate SchematicNode SchematicLink and in particular:
 - Creating a SchematicNode at each *HydroJunction* (will be nodes of type confluence ScsType=2, except the final network node that will be of type outfall ScsType=3) and fill in the field FeatureID with the HydroID value of relative HydroJunction;
 - Creating a *SchematicNode* at area centroids of *watershed* (will be nodes of type ScsType=1 source)) and filling the HydroID value of relative watershed in the field FeatureID;
 - Link with a **SchematicLink** the SchematicNode of type ScsType= 1 source to the SchematicNode of relative drainage area outlet (the sequence of steps for finding the SchematicNode of confluence is the following: 1) select the watershed related to the initial SchematicNode using the key field FeatureID, 2) the field JunctionID of the watershed contains the HydroID value of arrival HydroJunction and at this point you can select the arrival SchematicNode searching where FeatureID= HydroID of HydroJunction). This ShematicLink will be of type LinkType=1 tributary (*affluente*).
 - Link with a *SchematicLink* the SchematicNodes of type ScsType=2 confluence or ScsType=3 outfall: This ShematicLink will be of type LinkType=2 main river (*principale*)

For all these operations, is very useful to use the software for ArcGIS Arc Hydro Tools, downloadable from the internet site of ESRI (http://www.esri.com/) in download area. To use all the functions of the software, is necessary to have, for the same geographical area, a digital terrain model, for example, is possible to use the IGM, or extract the part that affects the data published by Consortium for Spatial Information (CGIAR-CSI) on the digital model of the world with step 90 meters produced by NASA Shuttle Radar Topographic Mission (SRTM) and downloadable from the website http://srtm.csi.cgiar.org/Index.asp.

Having the terrain model, the hydrographic network and the software Arc Hydro Tools, it is possible to do automatically using ArcGIS:

- Automated perimetry of Watershed closed on sections of selected HydroJunction
- The automatic creation of **Schematic Node** and **Schematic Link**

Below, it is shown the toolbar and a description of the data input and output menus used to perform the two calculations above.

Terrain Preprocessing 🔻 Terrain Morphology 💌 Watershed Processing 💌 Attribute Tools 💌 Network Tools 💌 ApUtilities 💌 🎋 🔌 👟 😪 😫 🐌 Help

To perform the data preprocessing for the automatic perimeter of Watershed, you must perform the calculations indicated in the submenus of the figure below:



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	Terrain Preprocessing 👻 Terrain Morphology 💌	
	Data Management Terrain Preprocessing	
	DEM Reconditioning	
	Build Walls	
	Fill Sinks	
	Flow Direction	
	Elow Accumulation	

Here are represented input/output data of menu Terrain Preprocessing.

(Stream Definition)

🔮 Data Management		×
Raw DEM	clip_dem1	•
AGREE Stream	HydroEdge	•
AGREE DEM	AgreeDEM	•
DEM	AgreeDEM	•
Outer Wall Polygon	Null	•
Inner Wall Feature	Null	•
Breach Line	Null	•
Walled DEM	Null	•
Sink Polygon	Null	•
Hydro DEM	Fil	•
Flow Direction Grid	Fdir	•
Flow Accumulation Grid	Fac	•
Stream Grid	Str	•

Were:

- **Raw DEM** is the original elevation grid (DEM) of the area;
- AGREE Stream: are the vector hydrography lines of the area;
- AGREE DEM: is output of AGREE, a surface reconditioning system for Digital Elevation Models. The system adjusts the surface elevation of the DEM to be consistent with a vector coverage. The system has been developed by Ferdi Hellweger at the University of Texas at Austin in 1997. For a full reference to the procedure refer to the web link (http://www.ce.utexas.edu/prof/maidment/GISHYDRO/ferdi/research/agree/agree.html).
- **DEM:** is the input of Fill sinks function. If a cell is surrounded by higher elevation cells, the water is trapped in that cell and cannot flow. The Fill Sinks function modifies the elevation value to eliminate these problems. This input can be a copy of Raw DEM or, as in the example above, a copy of AGREE DEM.

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- **Hydro DEM**: is the output of Fill sinks function;
- Flow Direction Grid: is the output of the Flow Direction function. The values in the cells of the flow direction grid indicate the direction of the steepest descent from that cell.
- Flow Accumulation Grid: is an output and represents, for each points, the dimension in cells for upstream contributing basin.
- Stream Grid: is an output and represents the difference between points considered river cells and basin cells, where river cells are those that have an upstream contributing area more extensive than a typical threshold defined by the user.

For automatic perimeter of Watershed, run submenus shown in the following figure:



Input and output of menu *Watershed Processing* are represented below:



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🔮 Data Management	×
Raw DEM	clip_dem1
Flow Direction Grid	Fdir
Flow Accumulation Grid	Fac 💌
Stream Grid	Str
Catchment	Null
Drainage Line	Null
Adjoint Catchment	Null
Longest Flow Path Catchment	Null
Longest Flow Path Adjoint Catchment	Null
Batch Point	BatchPoint 🗨
Watershed Point	HydroJunction 💌
Watershed	Null
Subwatershed Point	SubwatershedPoint 💌
Subwatershed	Subwatershed 🗨
Batch Polygon	Null
Point Source	Null
Drainage Area	Subwatershed 🗨
Centroid	Null
Longest Flow Path	LongestFlowPath

Where:

- **Raw DEM**, **Flow Direction Grid**, **Flow Accumulation Grid** e **Stream Grid** are the result of elaborations shown above;
- **Batch Point**: are input and are points to set in Stream Grid immediately upstream of watershed Point using the tool *Batch Point Generation*
- Watershed Point: are input and particulary HydroJunction chosen like closing sections of interest.
- **SubWatershed Point**: are output and are the closing points in the centre of Stream Grid cells more nearest to Batch Points.
- **SubWatershed**: are output and are sub-basins closed to Batch Points. They can be used like watershed of our project.
- **LongestFlowPath**: is an output of function *Longest Flow Path* and represents the drainage path longer than each drainage area; it's important for the time of concentration of watershed.

In the figures below are descrive the parameters to assig respectively to the functions *Batch Subwatershed Delineation* and *Longest Flow Path*.



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🔮 Batch Subwatershed Delineation 🛛 🛛 🔀			
Flow Direction Grid	Fdir 🗨		
Stream Grid	Str		
Batch Point	BatchPoint 💌		
Subwatershed	Subwatershed		
Subwatershed Point	SubwatershedPoint		
OK	Help Cancel		

🔮 Longest Flow pat	h 🔀
Drainage Area	Subwatershed
Flow Direction Grid	Fdir
Longest Flow Path	LongestFlowPath
ОК	Help Cancel

Node/Link Schema genaration

🔮 Node/Link Schema Generation		×
Watershed Polygons	Subwatershed	•
Junctions	HydroJunction	•
Schema Link	SchemaLink	
Schema Node	SchemaNode	
OK Help Cancel		

On each node and each branch, is expected to be activated a subroutine of calculation: the possible subroutines of calculation are different depending on the type of node or branch. A list of possibilities is as follows:

Type nodes:

- SchematicNode.ScrTye=source
 - Subroutine=source : calculation of rainfall runoff model applied to corresponding watershed.

- SchematicNode.ScrTye=confluence and SchematicNode.ScrTye=outlet
 - Default -Subroutine=SommaIdrogrammi : calculation of the sum, instantaneously of the outflows of branches that converge in the node.
 - Optional Subroutine=dam : sum of inflows in the node and calculation of routing at the dam that is in correspondence to the node.

Types of branches:

- SchematicLink.LinkType=tributary
 - Default TypeRouting=**translation** : calculation of the outflows from the branch like that inflows but translated in time for a number of hours identical to the value of translation associated to respective field.
 - Optional TypeRouting=**Muskingum** : calculation of outflows from the branch with Muskingum method using parameters Musking_K, Musking_X and NumSubReach contained in respective fields.
- Optional TypeRouting=Unit Hydrograph : calculation of outflows from the branch with Unit Hydrograph method using data represented in table UnitHydro.
- SchematicLink.LinkType=principal
 - Optional TypeRouting=translation : calculation of the outflows from the branch like= inflows translated in time of a number of hours identical to the value of translation time associated to respective field.
 - Default TypeRouting=Muskingum : calculation of the outflows from the branch with Muskingum method using parameters Musking_K, Musking_X e NumSubReach contained in respective fields.
 - Optional TypeRouting=Unit Hydrograph : calculation of the ouflows from the branch with Unit Hydrograph method using data represented in table UnitHydro.