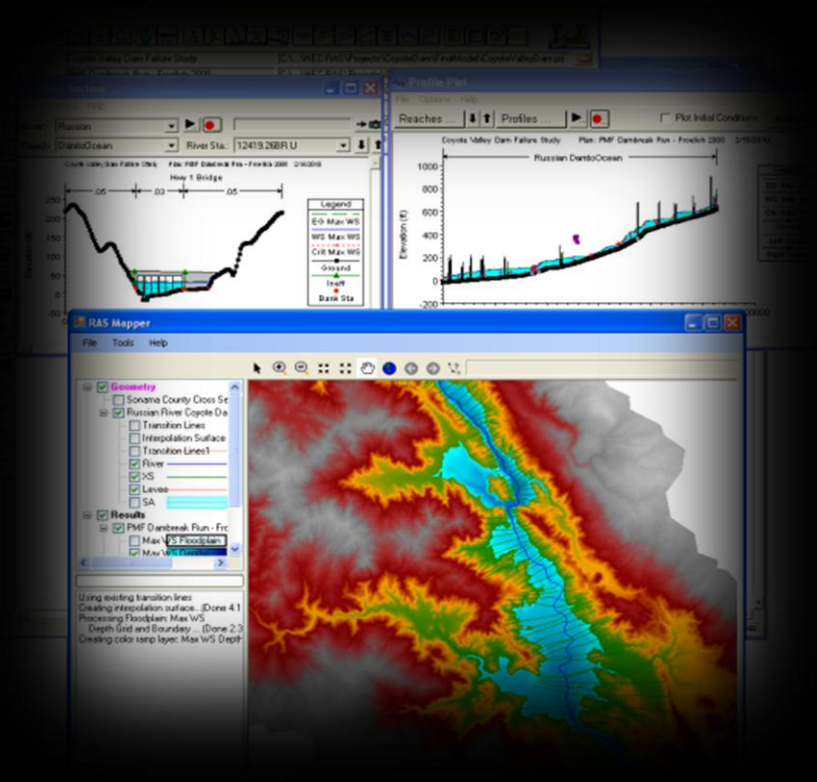


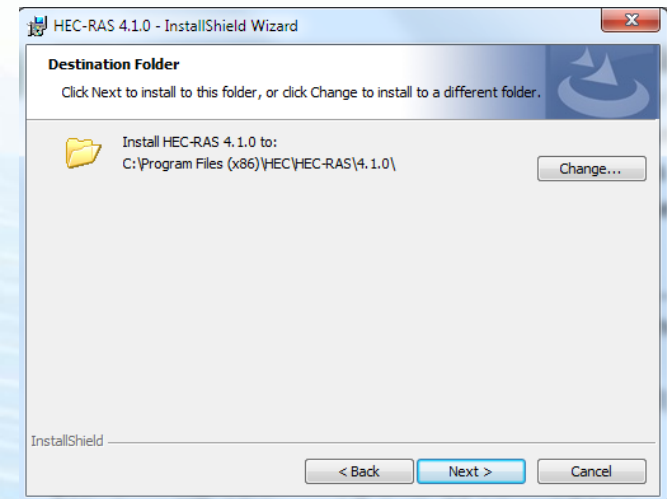
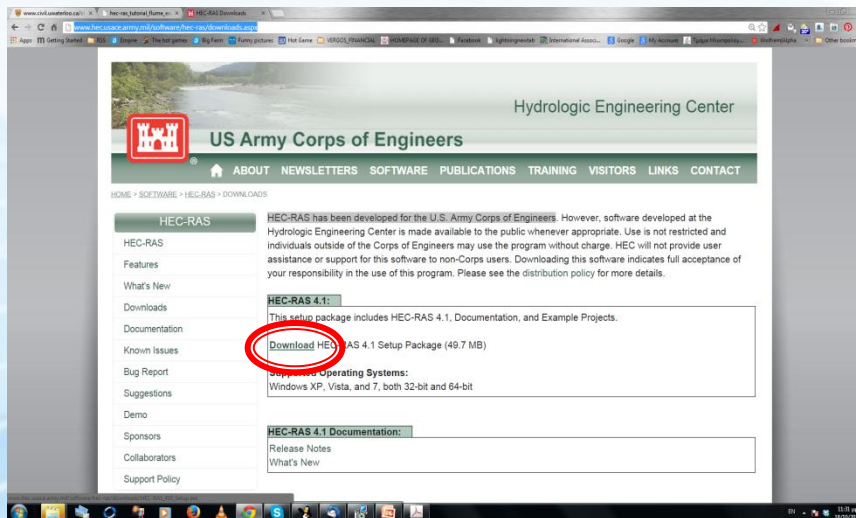
# HEC RAS..... step by step



Eleni Tzanou  
Konstantinos Papatheodorou

Common borders. Common solutions.

- HEC-RAS has been developed for the U.S. Army Corps of Engineers.
- Download from <http://www.hec.usace.army.mil/software/hecras/downloads.aspx> and follow installation instructions



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## Hydraulic Analysis

- **HEC-RAS** performs one-dimensional hydraulic calculations for a full network of natural and constructed channels

Capabilities of **HEC-RAS**:

- Hydraulic Analysis
- Data Storage and Management
- Graphics and Reporting
- RAS Mapper
- HEC-RAS 4.1(among others...new Mapper and Sediment Transport Model)

**This software is free, widely used and scientifically accepted**  
**Large documentation on its use and technical background**

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## HEC-RAS. How to.....

### Structure of HEC-RAS

- Creates and saves project files(.prj file)

Each project includes:

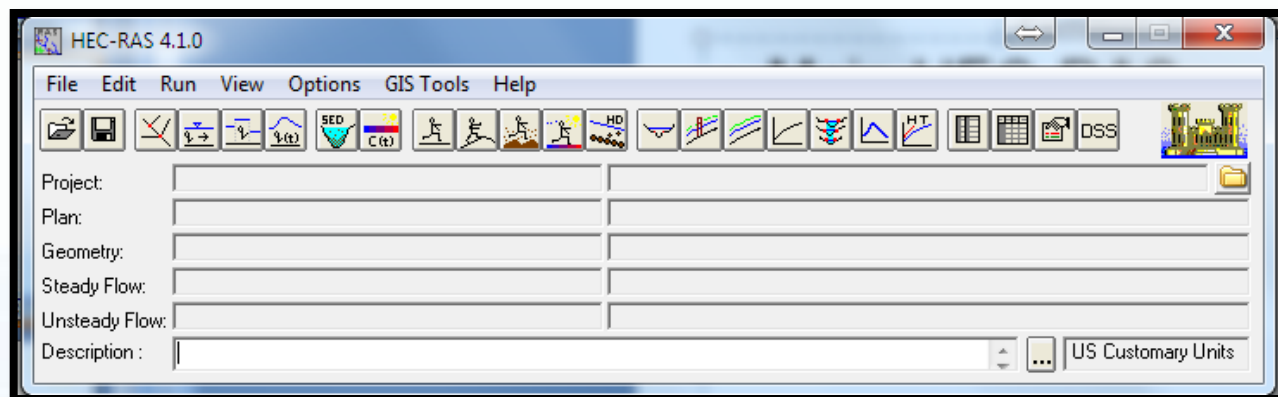
1. Unit system (SI/US customary)
2. Geometry (XS, bridges, weirs, etc.) (.g file)
3. Flow Data (steady, unsteady) (.f file)
4. Plan data(combination of flow/geometry to use for the analysis) (.p file)

**Many geometry flow and plan data can be created!!!!!!!**



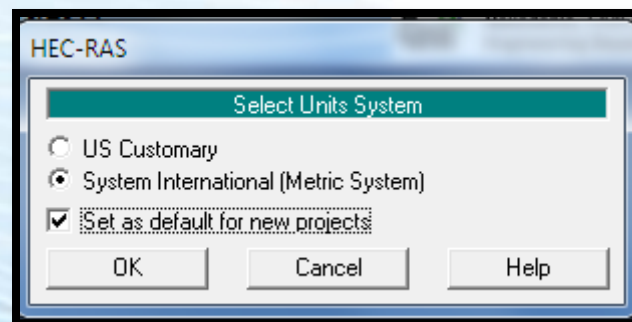
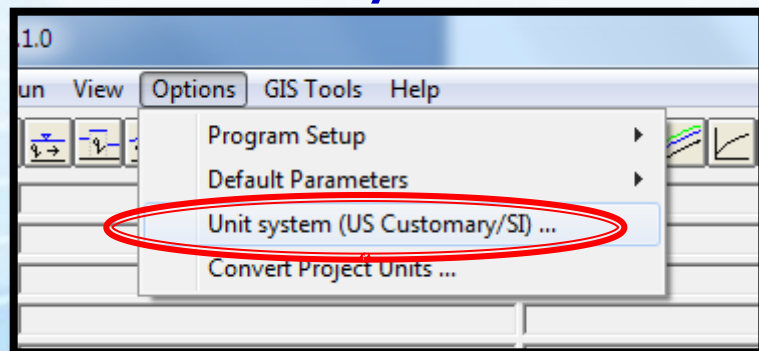
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- Main HEC-RAS Window....start from scratch



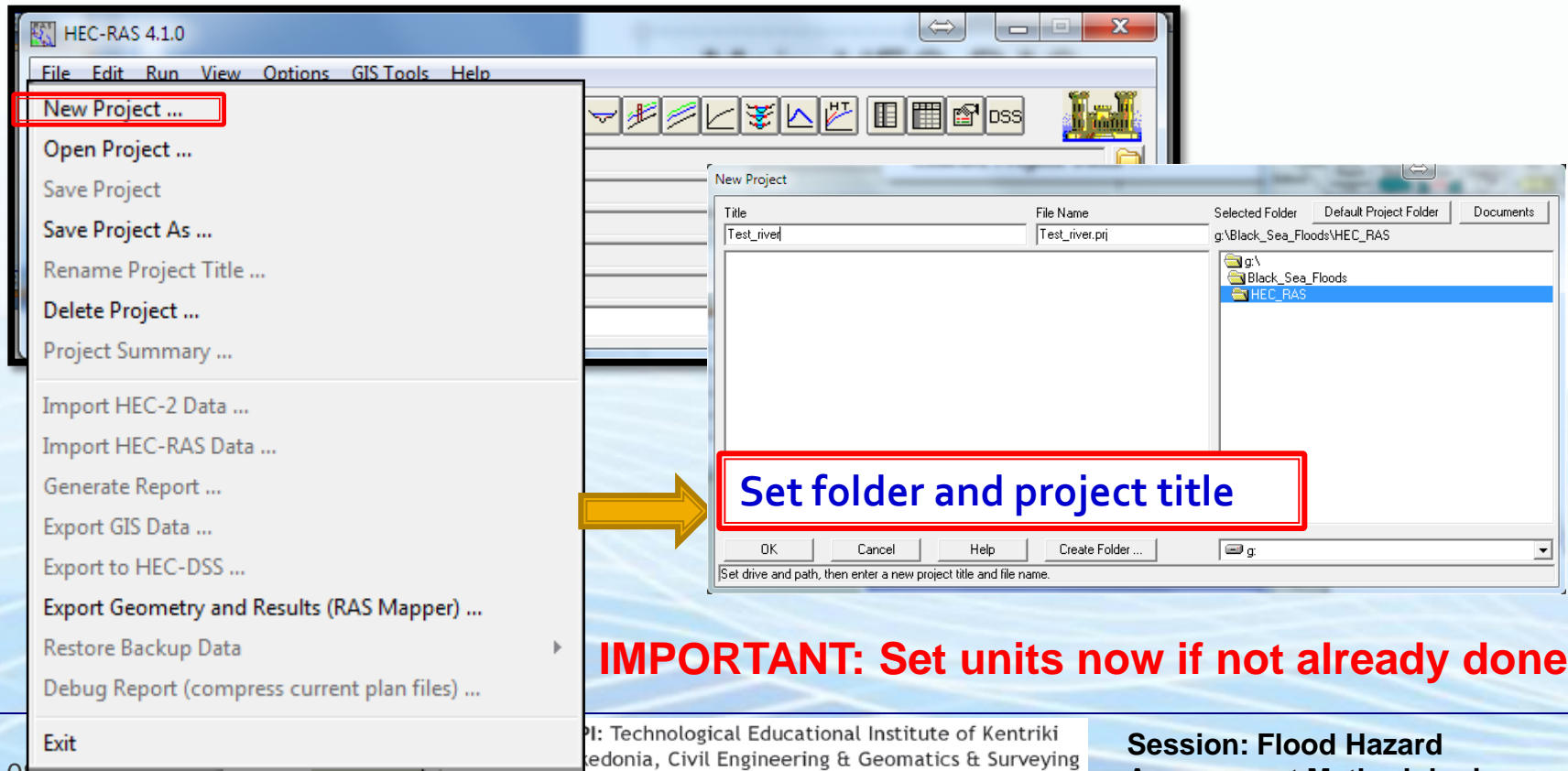
All main functions  
from this menu

- **Set Unit System** (can be done later too)



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**How to Create and Save a New Project (.prj)** (can always be done later on too). Go to **File** and select **New Project**.



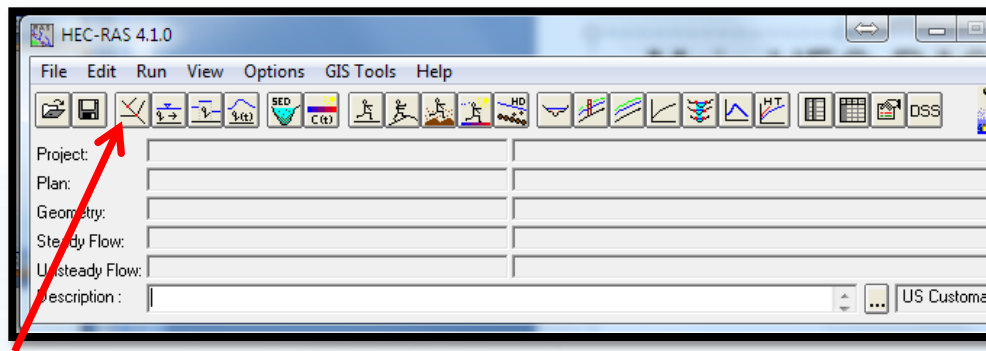
The screenshot shows the HEC-RAS 4.1.0 application window. The 'File' menu is open, and 'New Project ...' is highlighted with a red box. A yellow arrow points from this menu item to the 'New Project' dialog box. In the dialog box, the 'Title' field contains 'Test\_river' and the 'File Name' field contains 'Test\_river.prj'. The 'Selected Folder' is 'g:\Black\_Sea\_Floods\HEC\_RAS', which is also highlighted with a red box. A red box with the text 'Set folder and project title' is overlaid on the dialog box. The 'OK' button is visible at the bottom of the dialog box.

**Set folder and project title**

**IMPORTANT: Set units now if not already done!!!!**

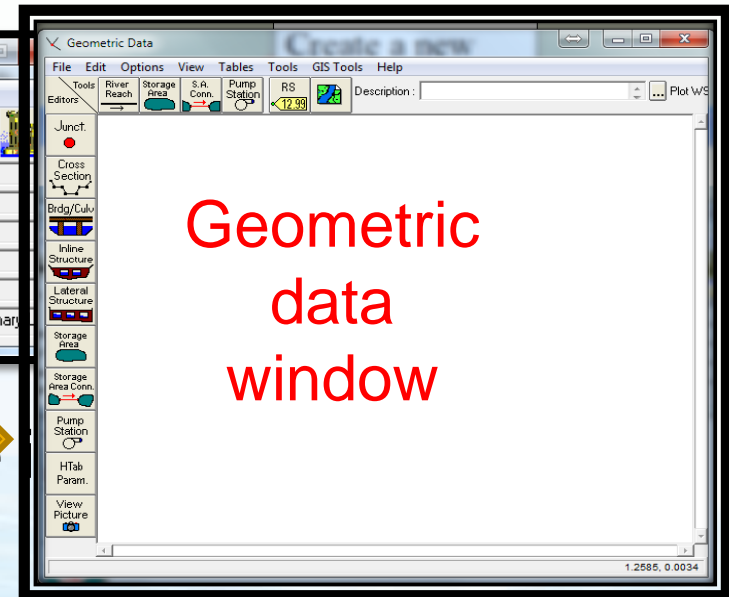
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## How to create and work with Geometry Files (.g)



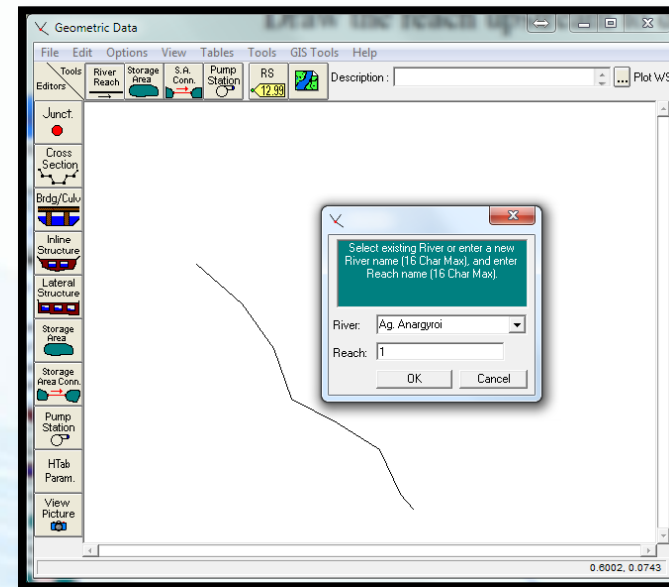
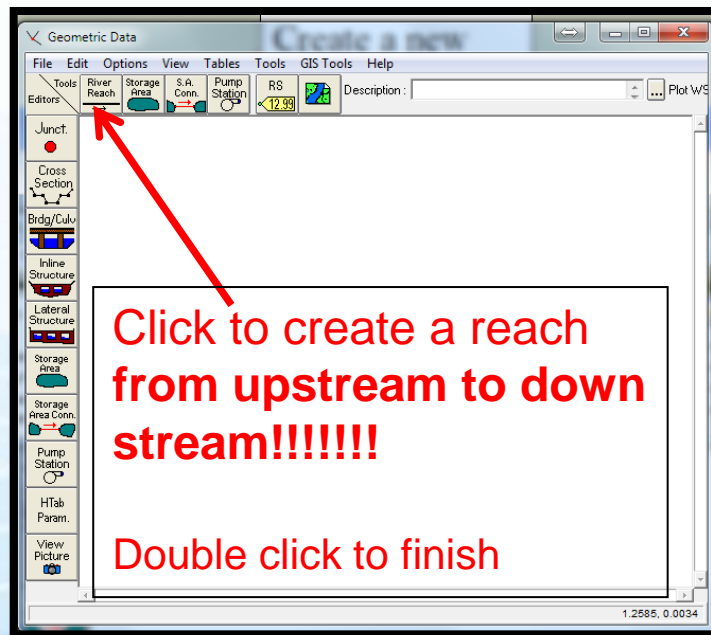
Click to open geometric  
data editor window

All geometric data and edits are  
must be **SAVED**....



## Common borders. Common solutions.

- The first thing in geometry is to create a reach (...one or more intersecting reaches)



Then insert river and reach  
name and click ok



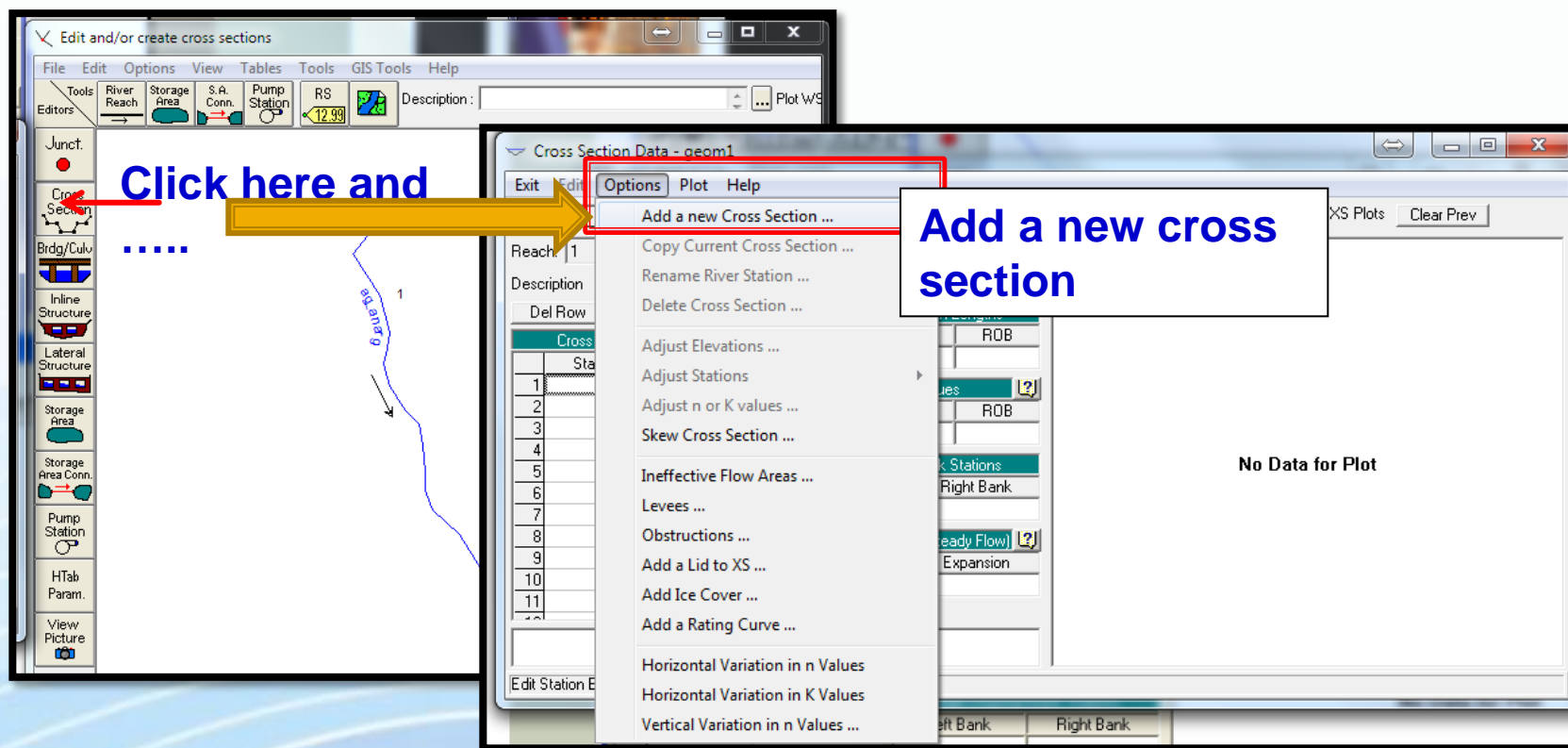
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## Dealing with geometry and Cross Sections

- Cross sections define the **channel geometry**
- Cross sections (among other parameters) define the **channel slope**
- Cross sections are defined by Station(x) and Elevation (y)
- Overbank stations differentiate channel and floodplain characteristics
- **Manning n coefficients** define **resistance to flow**
- **Expansion and contraction coefficients** define **energy losses** associated with velocity head changes between cross sections
- Ineffective flow areas can store but not convey water downstream
- Obstruction areas block flow completely
- Levee elevations confine flow to channel until the levees are overtopped

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## Cross Section data input.



Click here and .....

Add a new cross section

Add a new Cross Section ...

Copy Current Cross Section ...

Rename River Station ...

Delete Cross Section ...

Adjust Elevations ...

Adjust Stations

Adjust n or K values ...

Skew Cross Section ...

Ineffective Flow Areas ...

Levees ...

Obstructions ...

Add a Lid to XS ...

Add Ice Cover ...

Add a Rating Curve ...

Horizontal Variation in n Values

Horizontal Variation in K Values

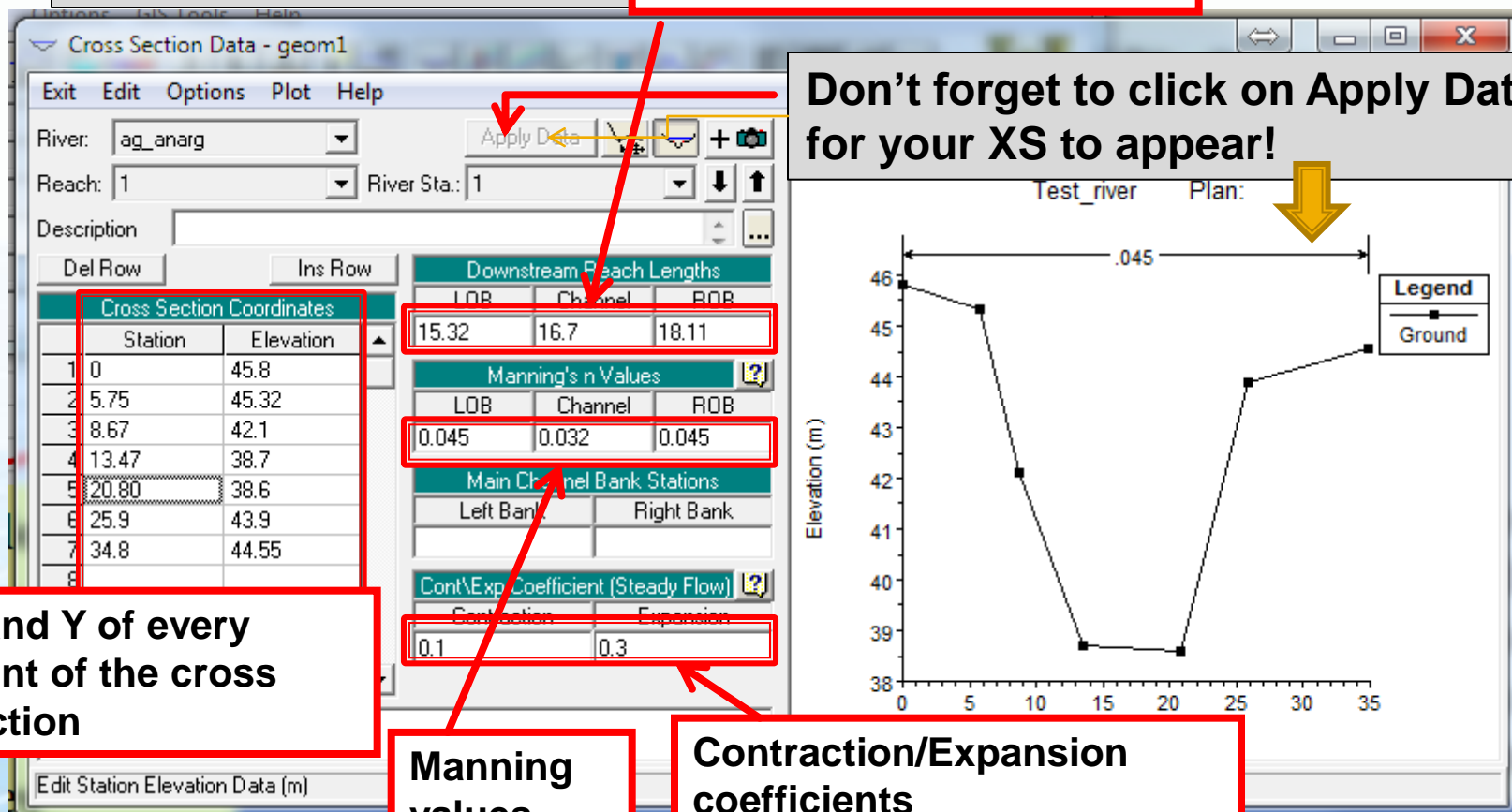
Vertical Variation in n Values ...

No Data for Plot

Cross-sectional data are  
set from left to right  
looking **downstream**

Distance to next  
downstream cross section

Don't forget to click on Apply Data  
for your XS to appear!



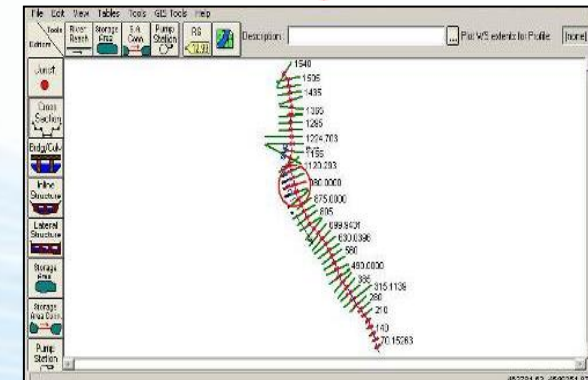
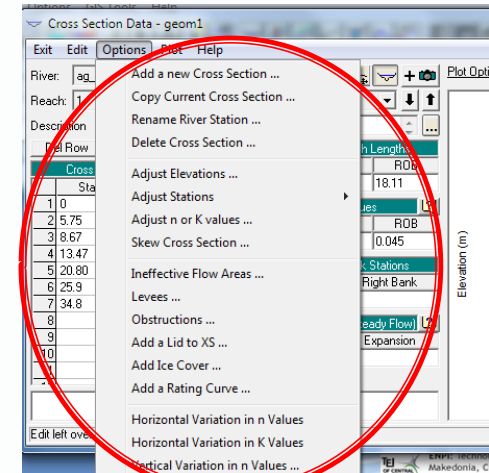
X and Y of every  
point of the cross  
section

Manning  
values

Contraction/Expansion  
coefficients

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- Follow the same steps to create all cross downstream cross sections.
- The geometry in rivers (not culverts) is not uniform so one needs to define all cross sections' characteristics every time manually. If uniform geometry occurs though (i.e. structured channels, culverts) cross sections can be copied.
- Once a cross section is defined all the options become available.



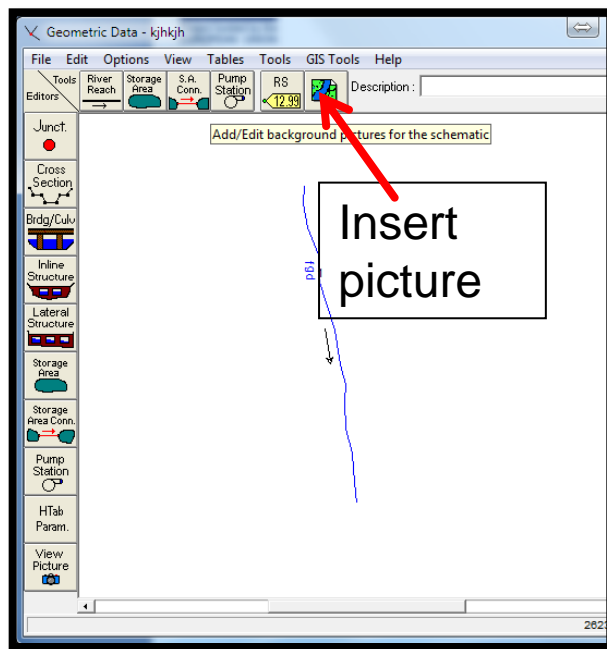
Geometry data with many cross sections added

Once finished, exit cross section Editor and save geometry data.

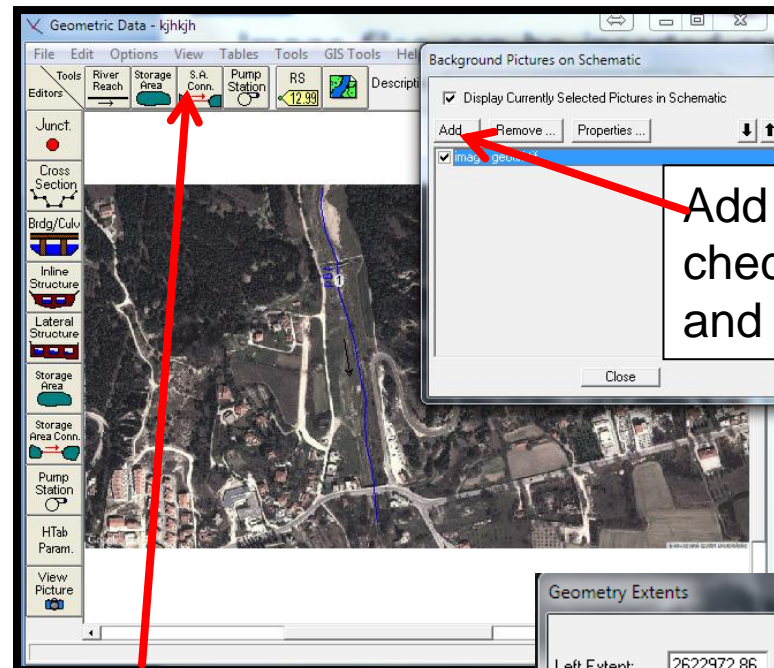




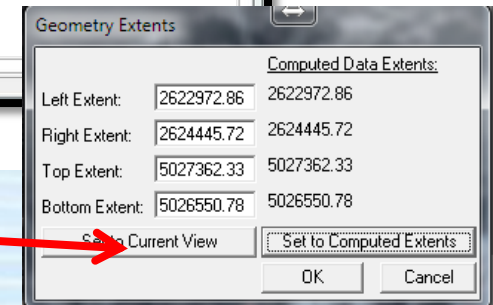
**Georeferenced** Image files can be inserted only as background in HEC-RAS so as to overcome the problem of coordinates (the software does not “accept” or recognize coordinates as a geographic or spatial feature).



Cross sections may be also added through a .csv file format



If the image is not visible set image computed extends from schematic plot extend in view menu



Common borders. Common solutions.

## How to work with Flow data

- Flow data are the .f files
- HEC-RAS can compute the following:
  - **Steady flow** (constant with time)
  - **Unsteady flow** (varies with time)

### Quasi-unsteady flow

- Regimes (supercritical, subcritical, mixed)

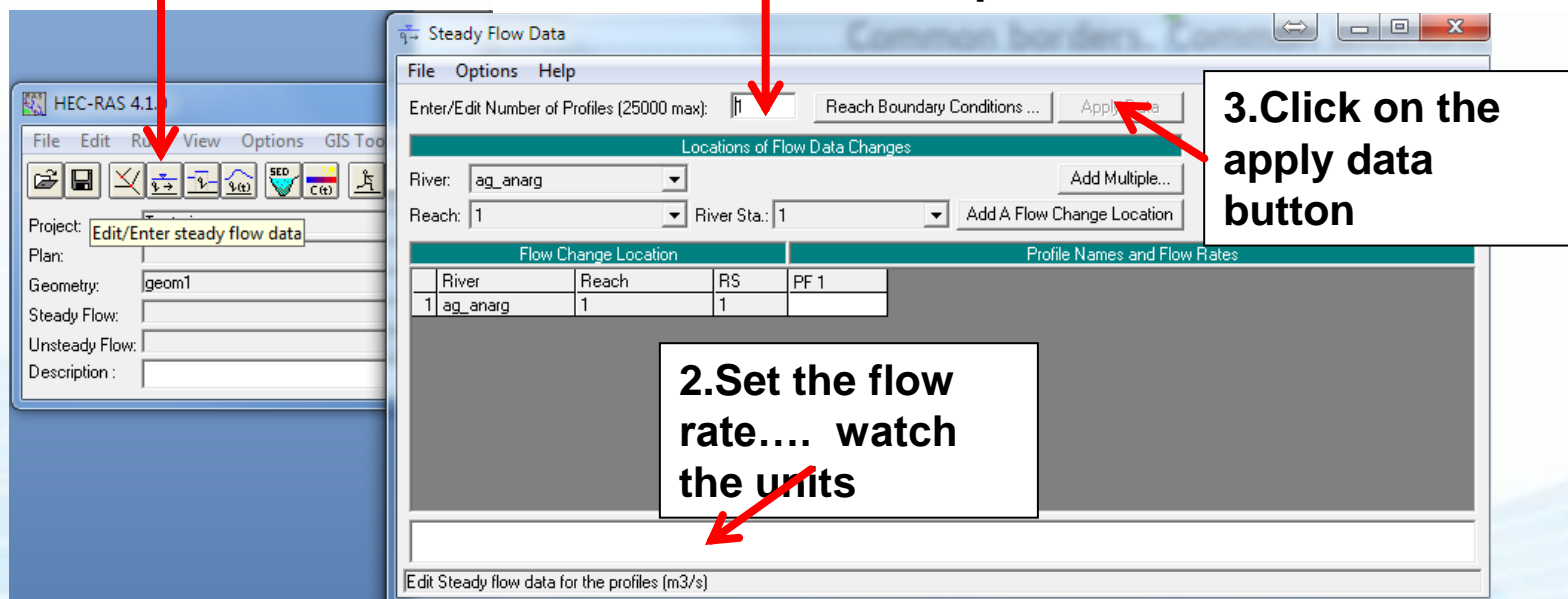
Boundary conditions:

1. Supercritical-upstream
2. Subcritical-downstream
3. Mixed-both

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Click here to open the steady flow data menu

**1. Set the number of profiles...for different flow rates**



HEC-RAS 4.1.0

File Edit Run View Options GIS Tools

Project: **Edit/Enter steady flow data**

Plan:

Geometry: geom1

Steady Flow:

Unsteady Flow:

Description:

**Steady Flow Data**

File Options Help

Enter/Edit Number of Profiles (25000 max): **11** Reach Boundary Conditions ... Apply

Locations of Flow Data Changes

River: ag\_anarg Add Multiple...

Reach: 1 River Sta.: 1 Add A Flow Change Location

Flow Change Location				Profile Names and Flow Rates	
	River	Reach	RS	PF 1	
1	ag_anarg	1	1		

**2. Set the flow rate.... watch the units**

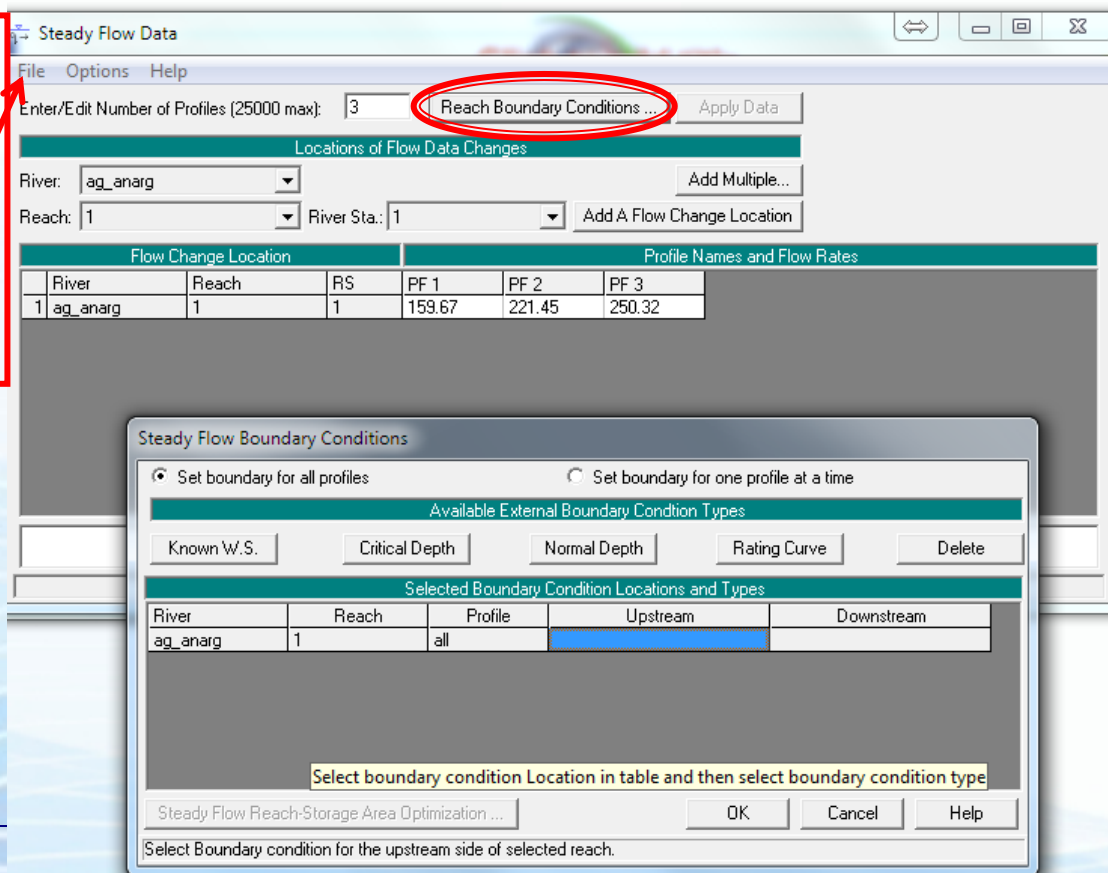
**3. Click on the apply data button**

Edit Steady flow data for the profiles (m3/s)

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Decide on and set the boundary conditions...assume if no other way the condition of flow upstream or downstream

Save the flow Data, (the first time use the “save as” option



The screenshot shows the HEC-RAS software interface. The 'Steady Flow Data' dialog box is open, showing the 'Reach Boundary Conditions ...' button circled in red. Below it, the 'Steady Flow Boundary Conditions' dialog box is also open, showing the 'Set boundary for all profiles' option selected. The 'Available External Boundary Condition Types' section includes buttons for 'Known W.S.', 'Critical Depth', 'Normal Depth', 'Rating Curve', and 'Delete'. The 'Selected Boundary Condition Locations and Types' table is shown below.

River	Reach	Profile	Upstream	Downstream
ag_anarg	1	all		

At the bottom of the 'Steady Flow Boundary Conditions' dialog, there are buttons for 'OK', 'Cancel', and 'Help', and a text box for 'Steady Flow Reach-Storage Area Optimization ...'.

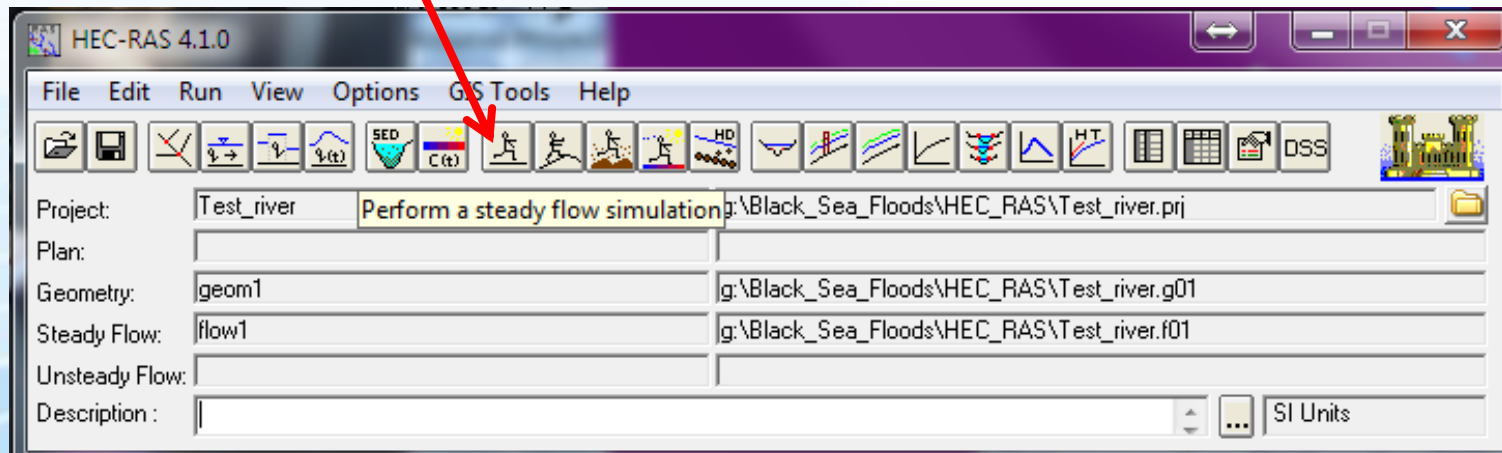
From the main HEC-RAS menu a plan may be saved...but not necessary.



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- Following the last steps unsteady and quasi-steady data can be created and saved.
- Now all the necessary parameters have been created for a successful run.

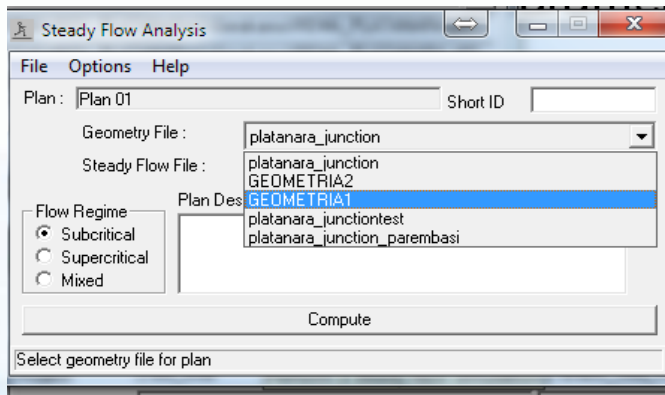
*Click on this button to perform the analysis-simulation for steady flow.*



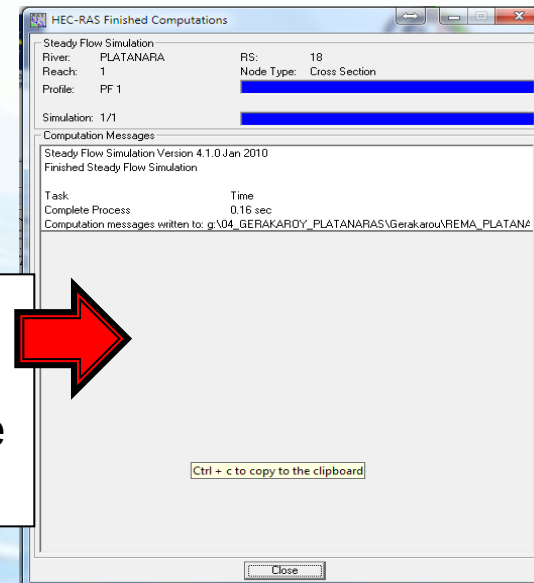
Common borders. Common solutions.

On the Analysis menu different .g files, flow rates and regimes may be chosen. Once they are set click **Compute** to run the simulation

Congrats,  
you did it!

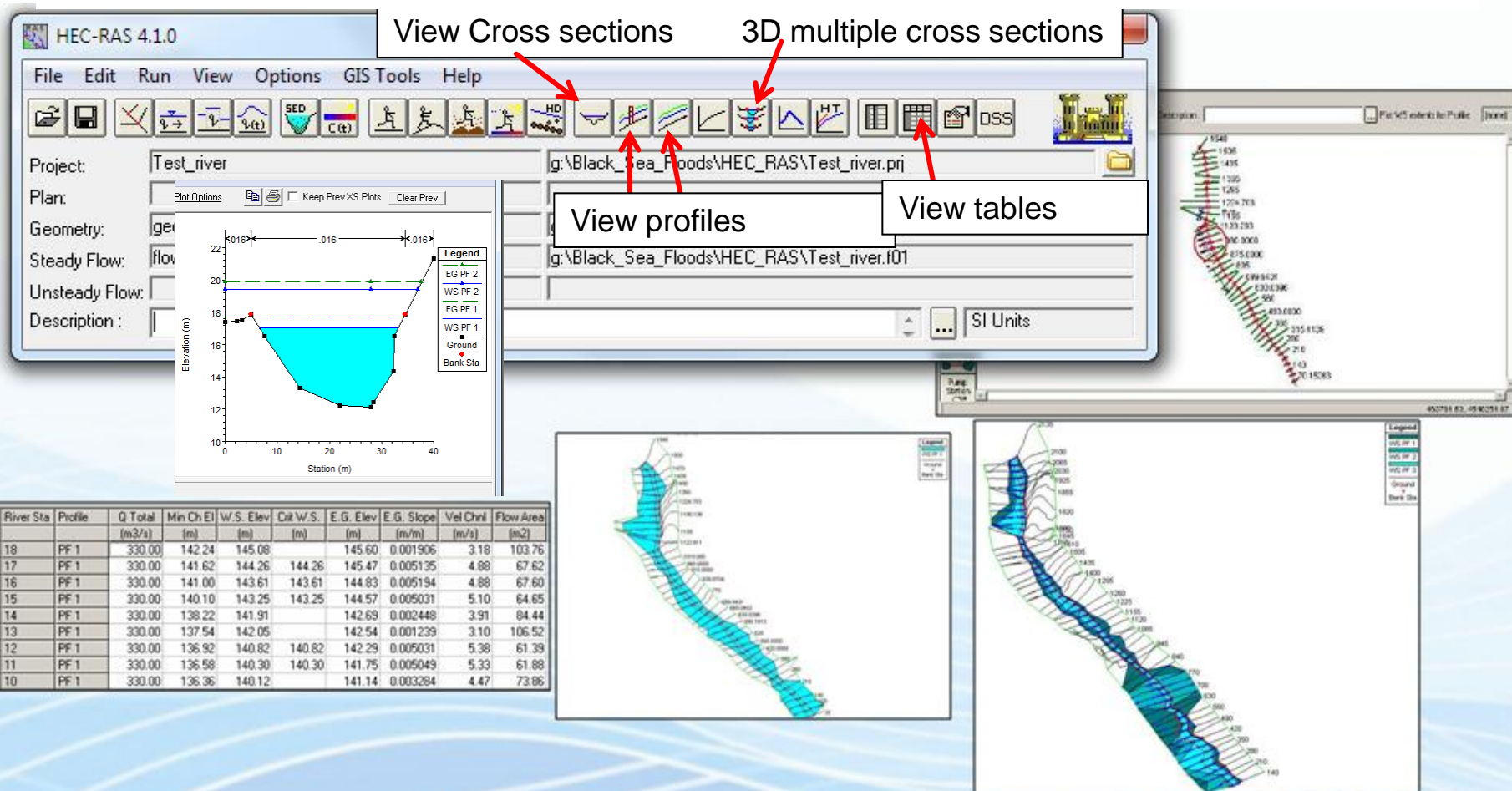


If computations are successful  
the following window appears,  
otherwise...

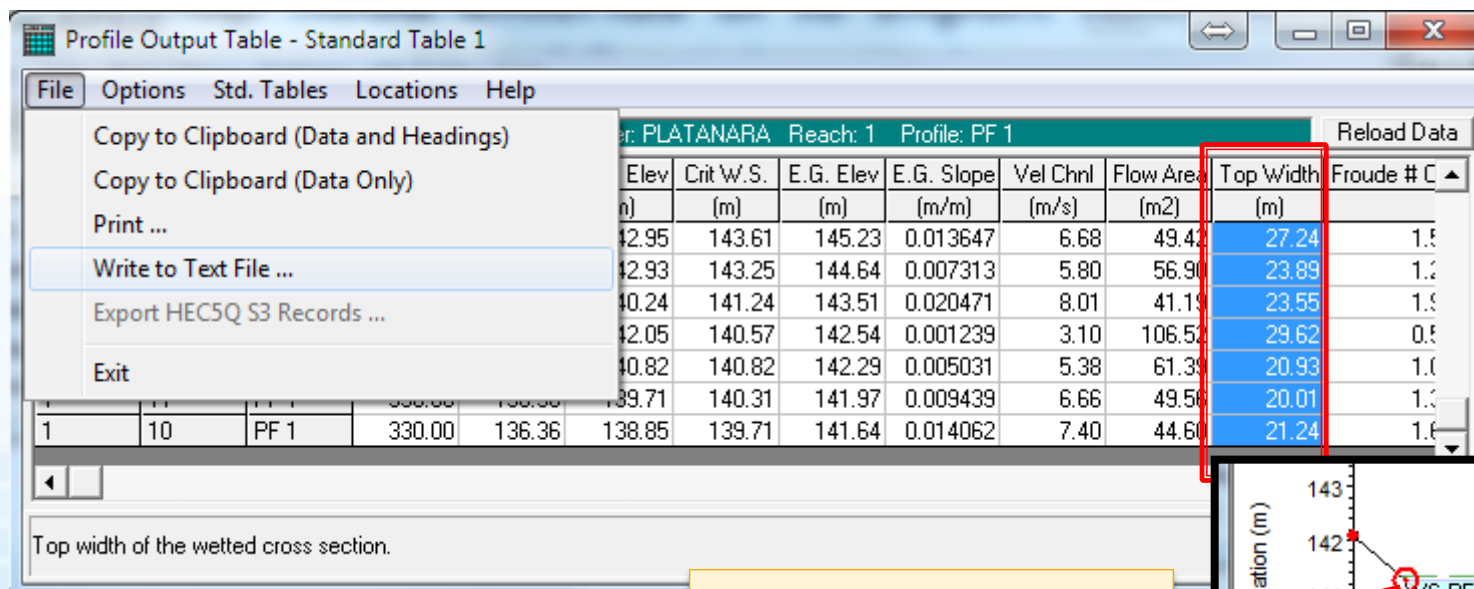


Errors and problems' reports  
appear in this area and everything  
should be corrected... then run the  
simulation again

This is how the simulation results appear in cross sections, profile plots and tables.

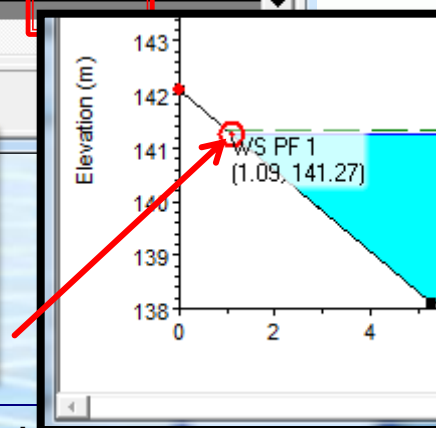


- To map flood extends or to export floodplain results table data (top width of flow) has to be copied in a text editor or .xls file.



**The top width of flow has to be related to the first station of the cross section. That is easy to do from geometry data.**

By clicking on the water surface line the distance from the first station is given.





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- Finally, we need to save the project file we have been working on....and continue in QGIS for floodplain mapping.

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**Thank you!**

**Acknowledgments: The research was partially funded by the EU within the context of the Black Sea Basin Joint Operational Programme 2007-2013**