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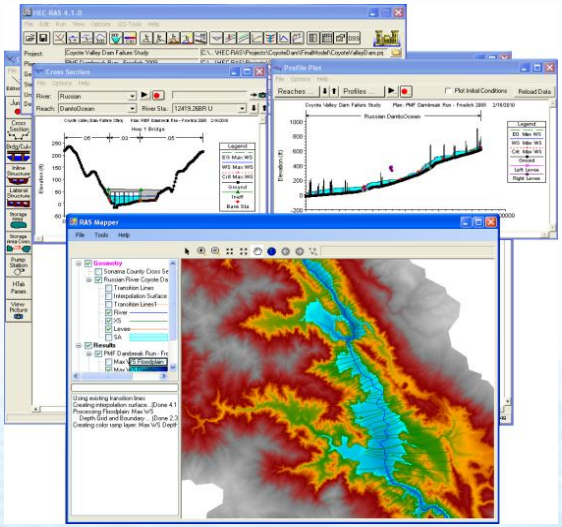
Common borders. Common solutions.

# HEC RAS…… step by step



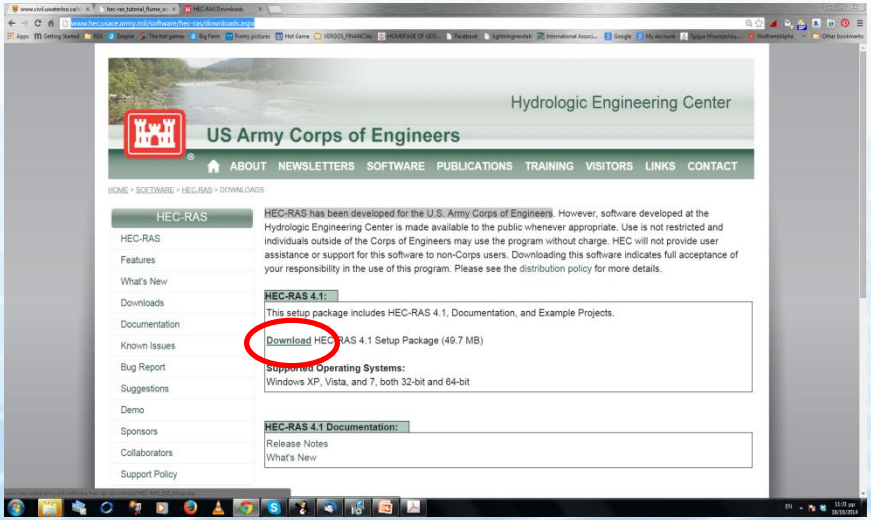
**Dr Eleni A. Tzanou**

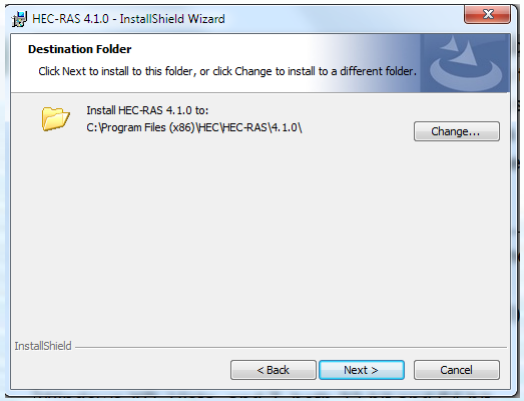
TEI OF CENTRAL MACEDONIA SERRES GREECE

**ENPI:** Technological Educational Institute of Kentriki Makedonia, Civil Engineering & Geomatics & Surveying Engineering Department, Greece.

**Session: Flood Hazard Assessment Methodologies**

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



# 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**

# HEC-RAS. How to…..

**Structure of HEC-RAS**

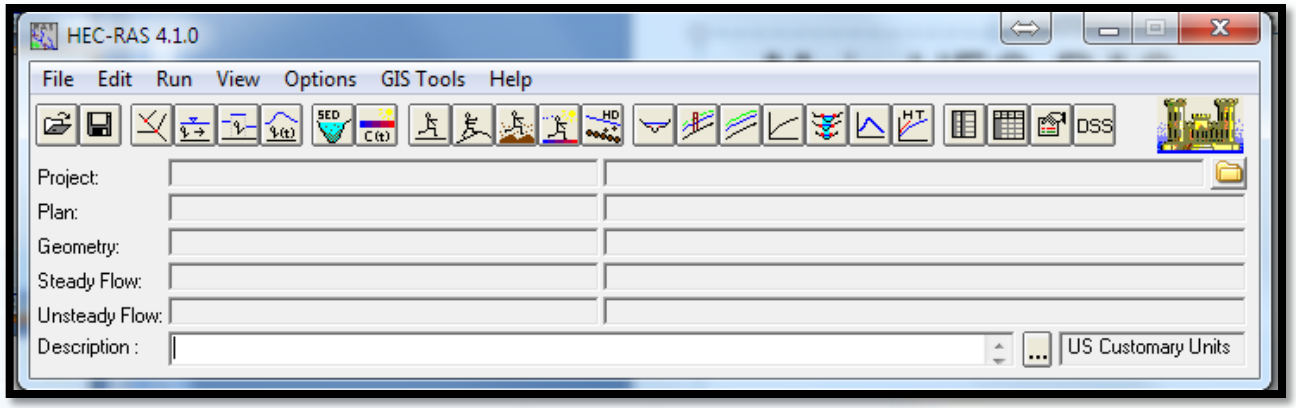
- Creates and saves project files(.**prj** file)

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)

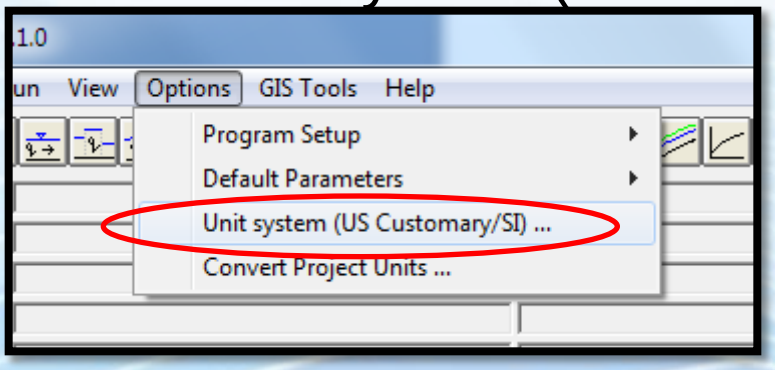
**Many files of geometry flow and plan data can be created!!!!!!!**

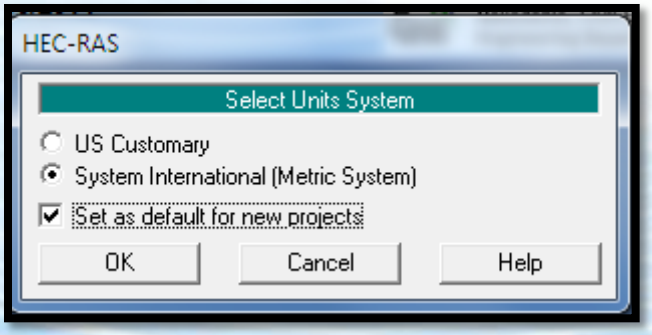
- Main HEC-RAS Window….start from scratch



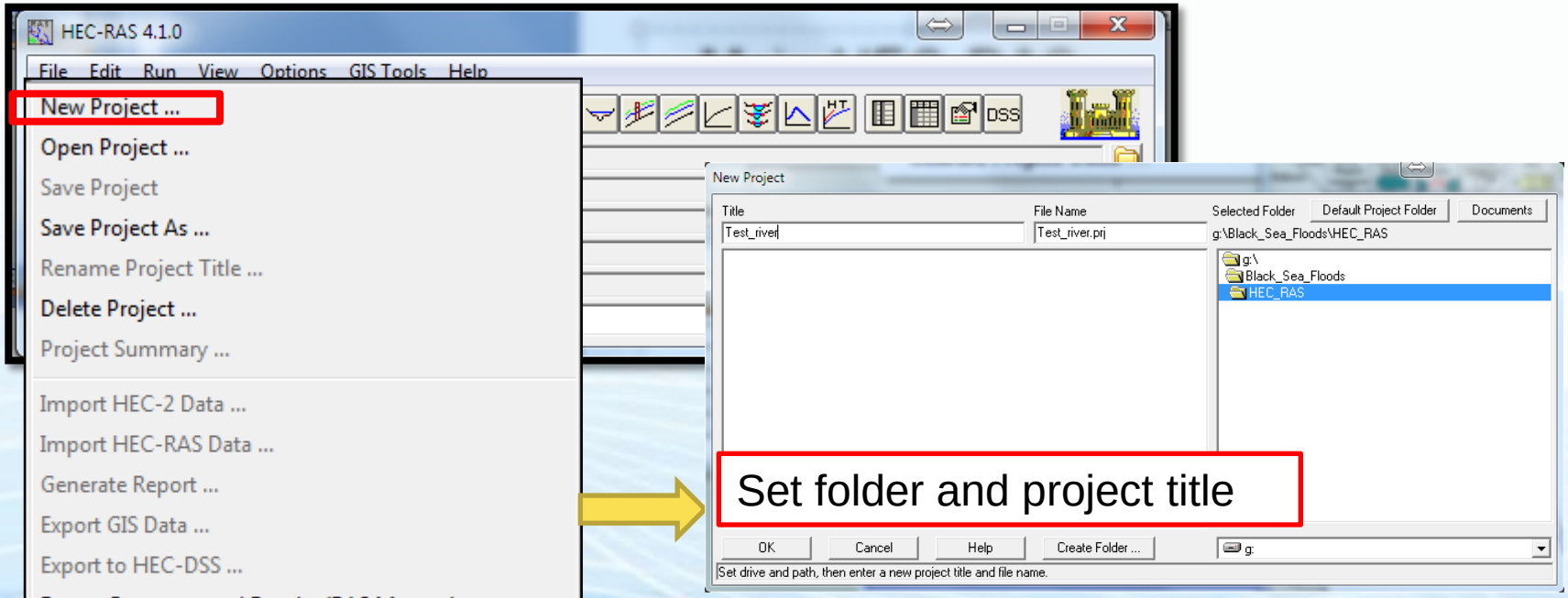

All main functions are accessed from this menu

- Set Unit System (can be done later too)



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




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

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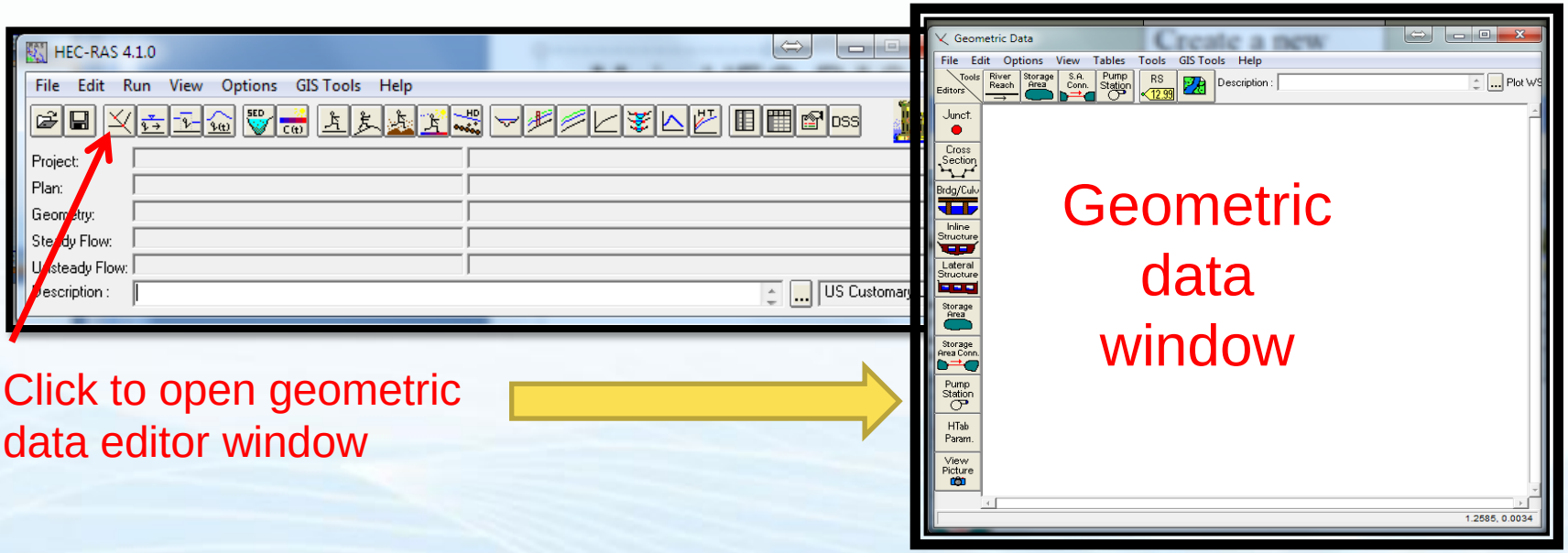
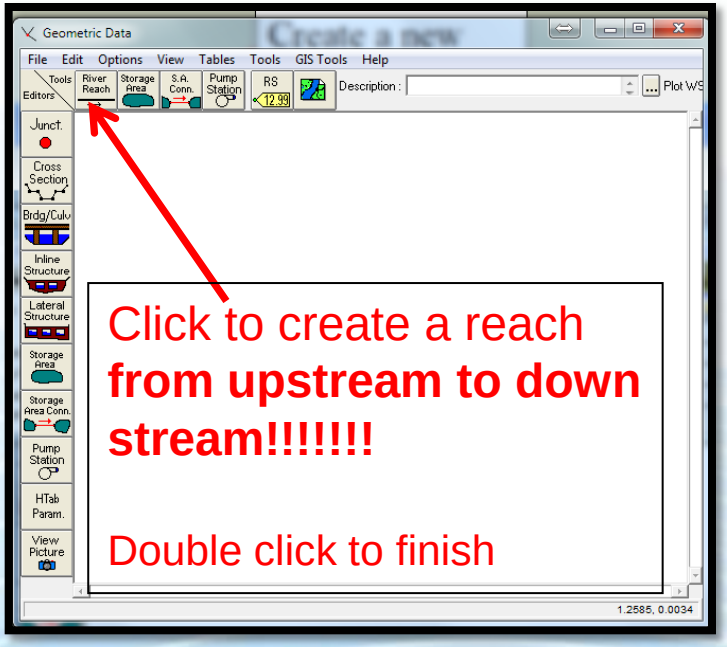
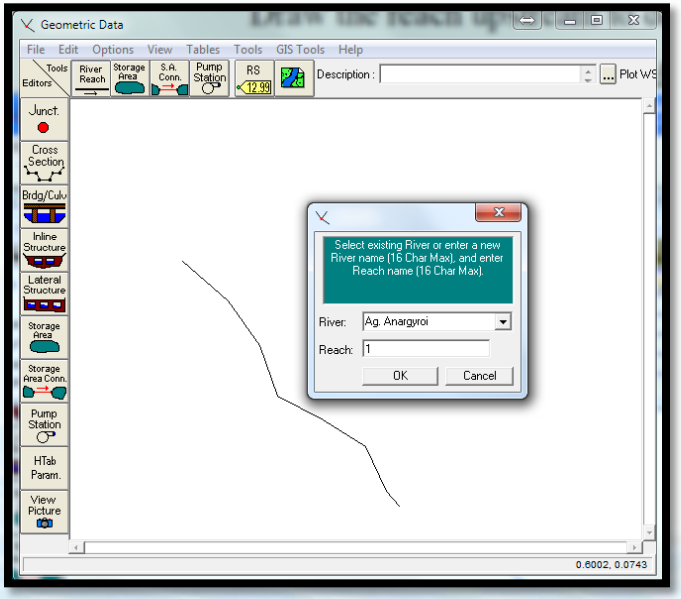
# How to create and work with Geometry Files (.g)




All geometric data and edits are inserted here and must be SAVED….

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



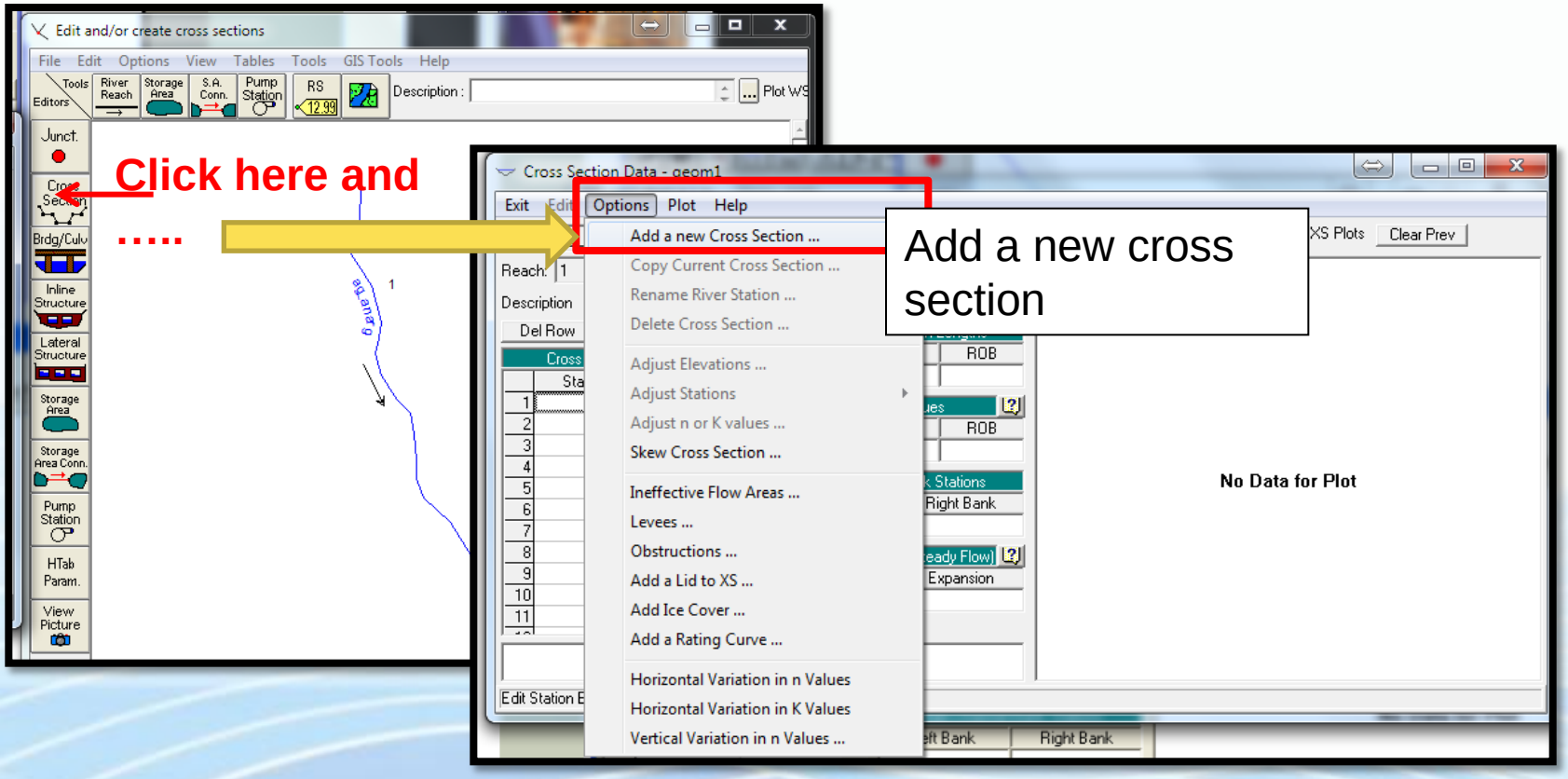

Then insert river and reach name and click ok

# Dealing with geometry and Cross Sections

Common borders. Common solutions.

- Cross sections define the channel geometry
- Cross sections are defined by Station(x) and Elevation (y)
- Cross sections (among other parameters) define the channel slope
- 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

- Cross Section data input.



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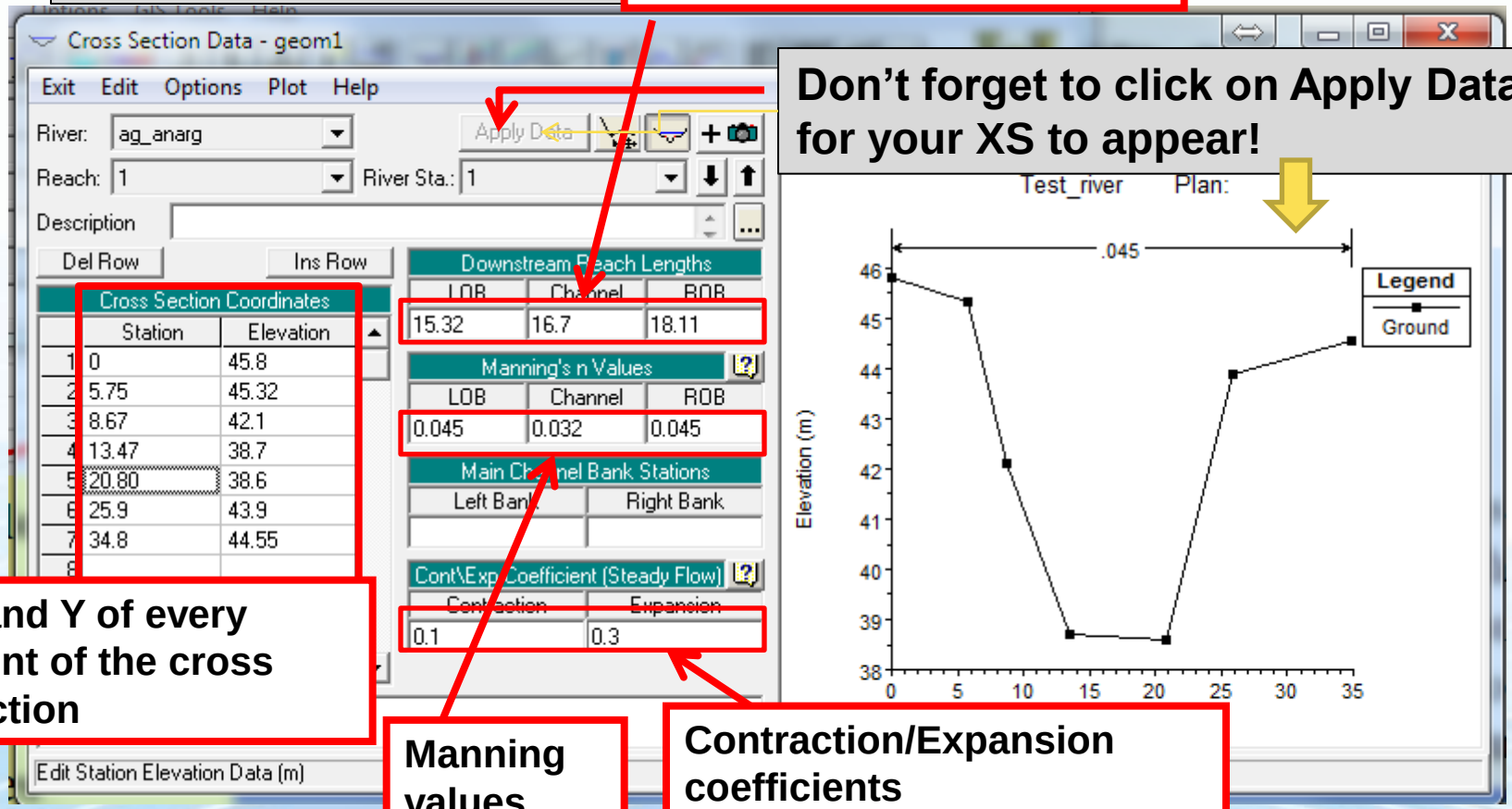
**Cross-sectional data are set from left to right looking downstream**

**Distance to next downstream cross section**




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

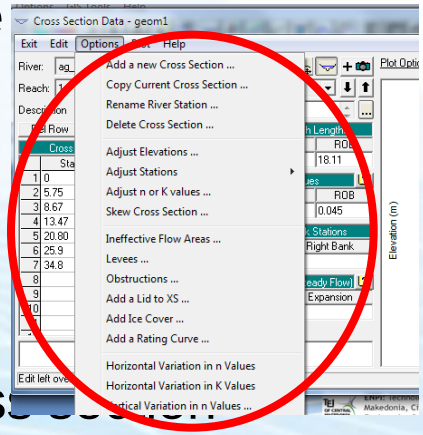
**X and Y of every point of the cross section**

**Manning values**

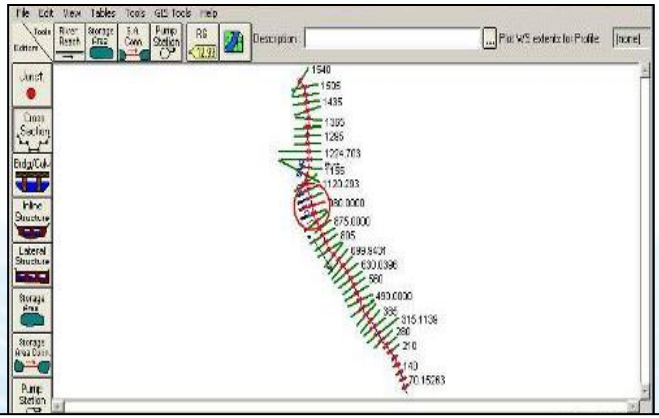
**Contraction/Expansion coefficients**

- Follow the same steps to create all cross 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.

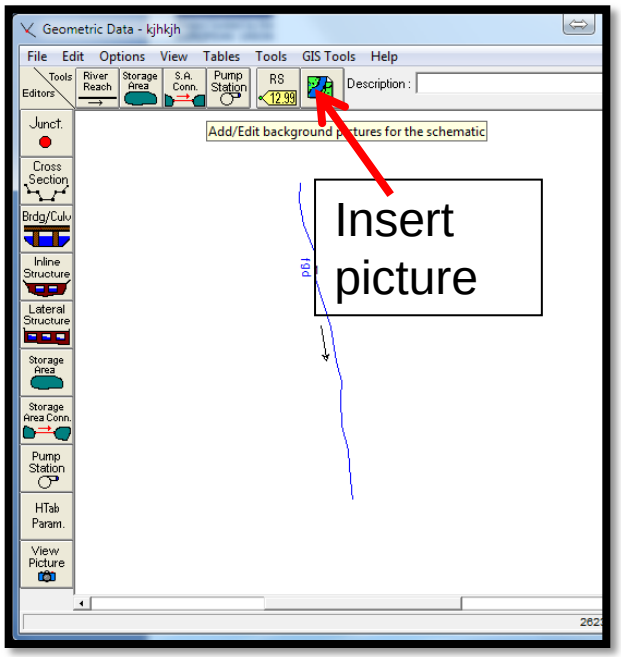


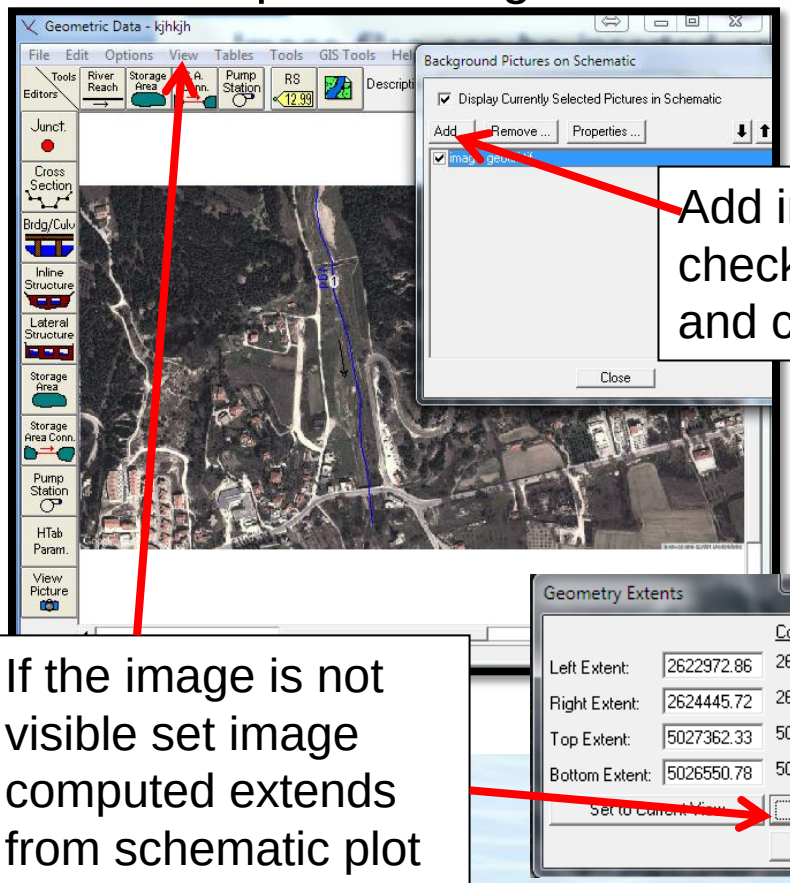

When finished exit cross section Editor and save geometry data.



This is how the geometry data looks with many cross sections added

Image files can be inserted only as background (but already georeferenced!!) 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.



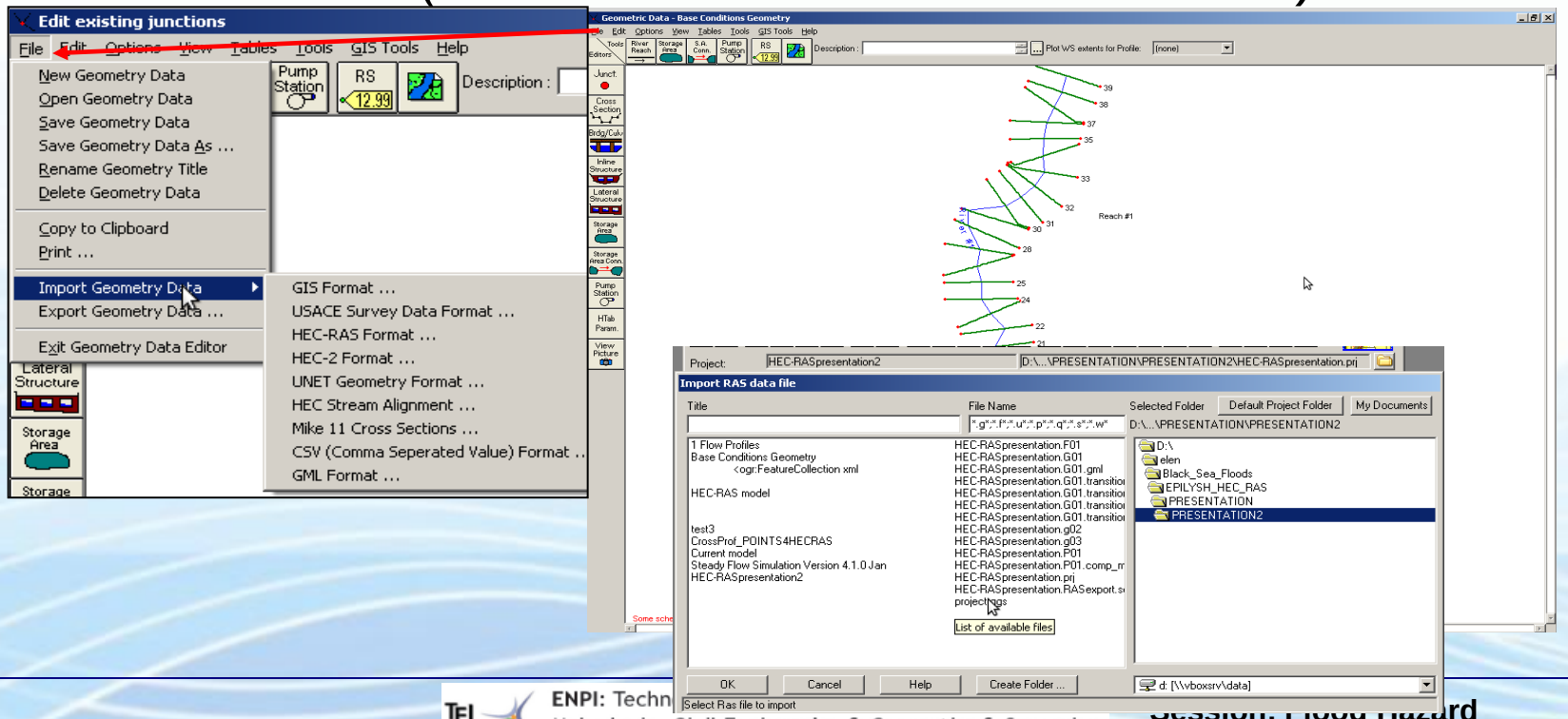




Cross sections may be also added through a .csv file format

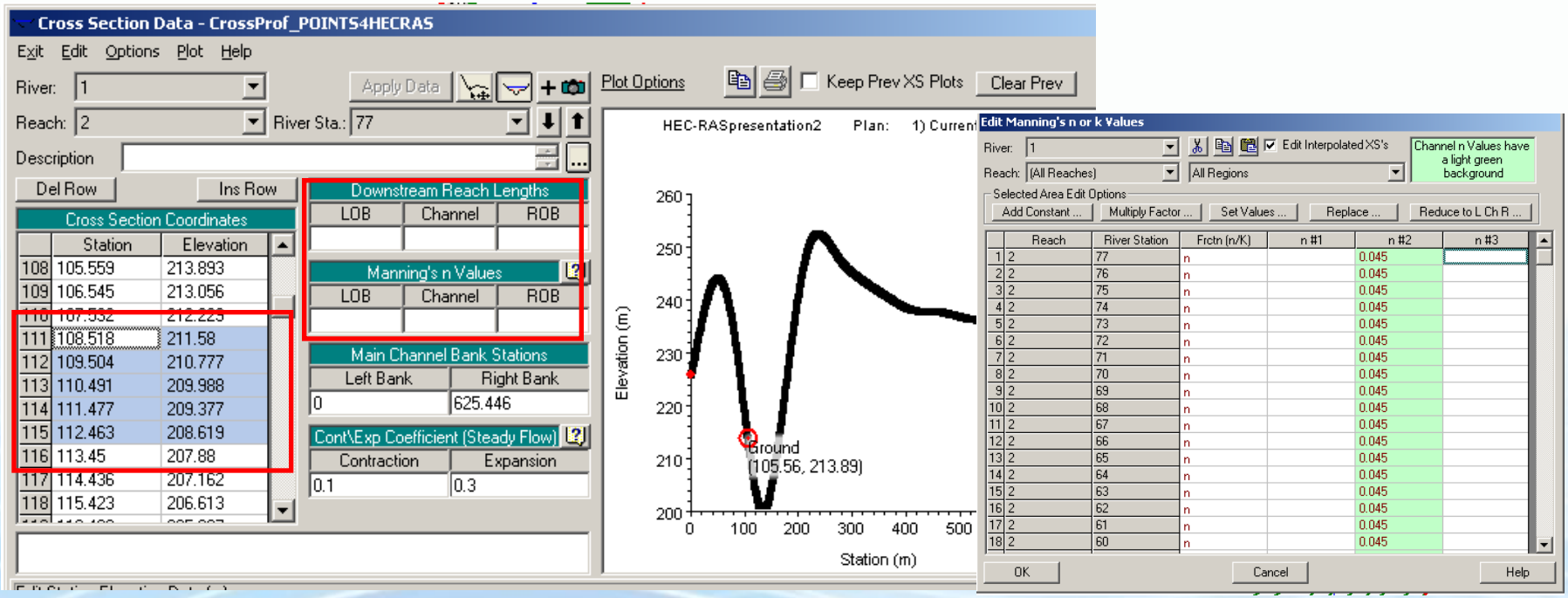
# CREATE GEOMETRY

Common borders. Common solutions.

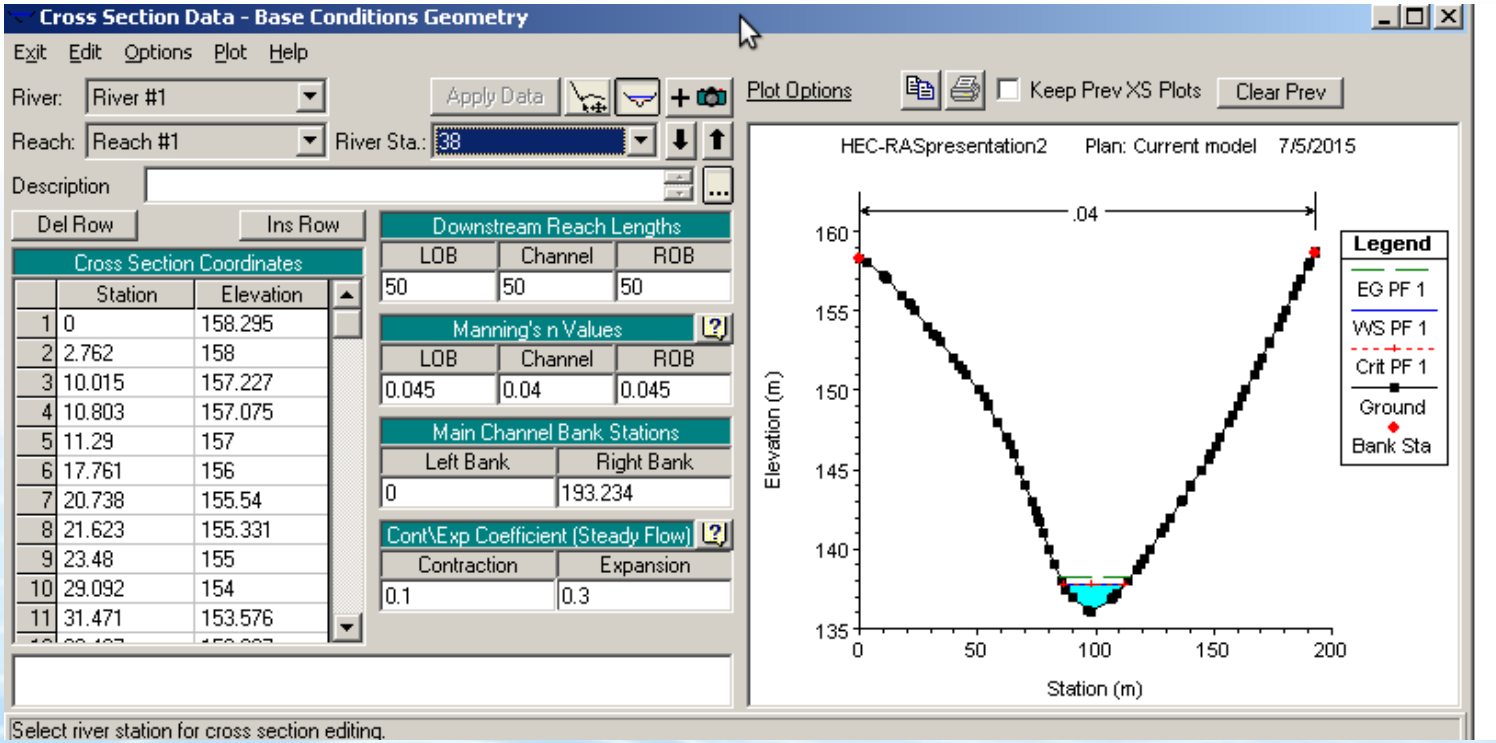
- Or….import the XS geometry exported from QGIS.
- Or…. use Plugin QGIS2RAS
- Or….csv file (see format in HEC-RAS manual)



- Pay attention to**….blank data** and number of **XS stations.**



- Check geometry and save the correct file



# 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

# FLOW DATA

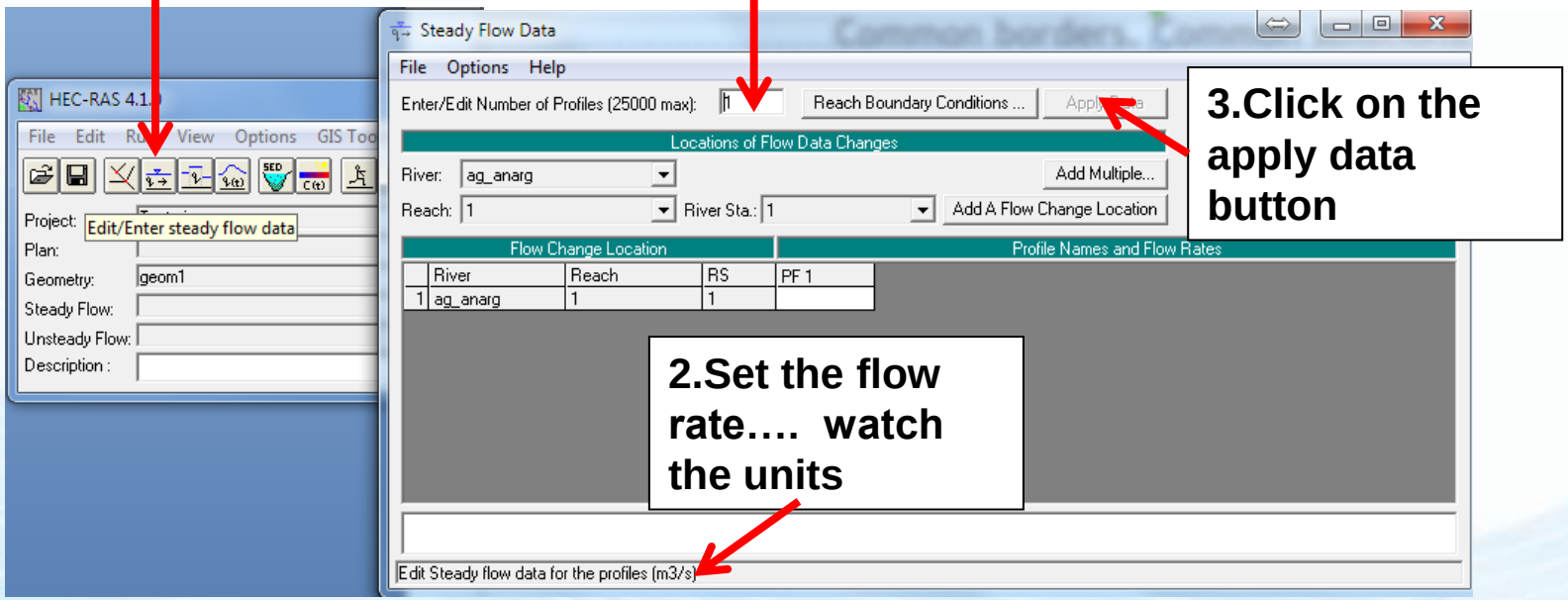
Common borders. Common solutions.

- Flow data is obtained from appropriate precipitation data collection for each region and the creation of a Unit Hydrograph.
- Flow measurement data
- Rainfall Intensity Duration Frequency Curves,
- STEEL equation,
- Peak Stormwater Runoff Rate Equations
- In our case …

| | **10y** | **50y** | **100y** |
|---|---|---|---|
| **Flow Discharge ($m^3/s$)** | 64.50 | 117.46 | 240.85 |
| **Sediment Discharge($m^3/s$)** | 14.15 | 25.77 | 52.84 |

# Click here to open the steady flow data menu

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



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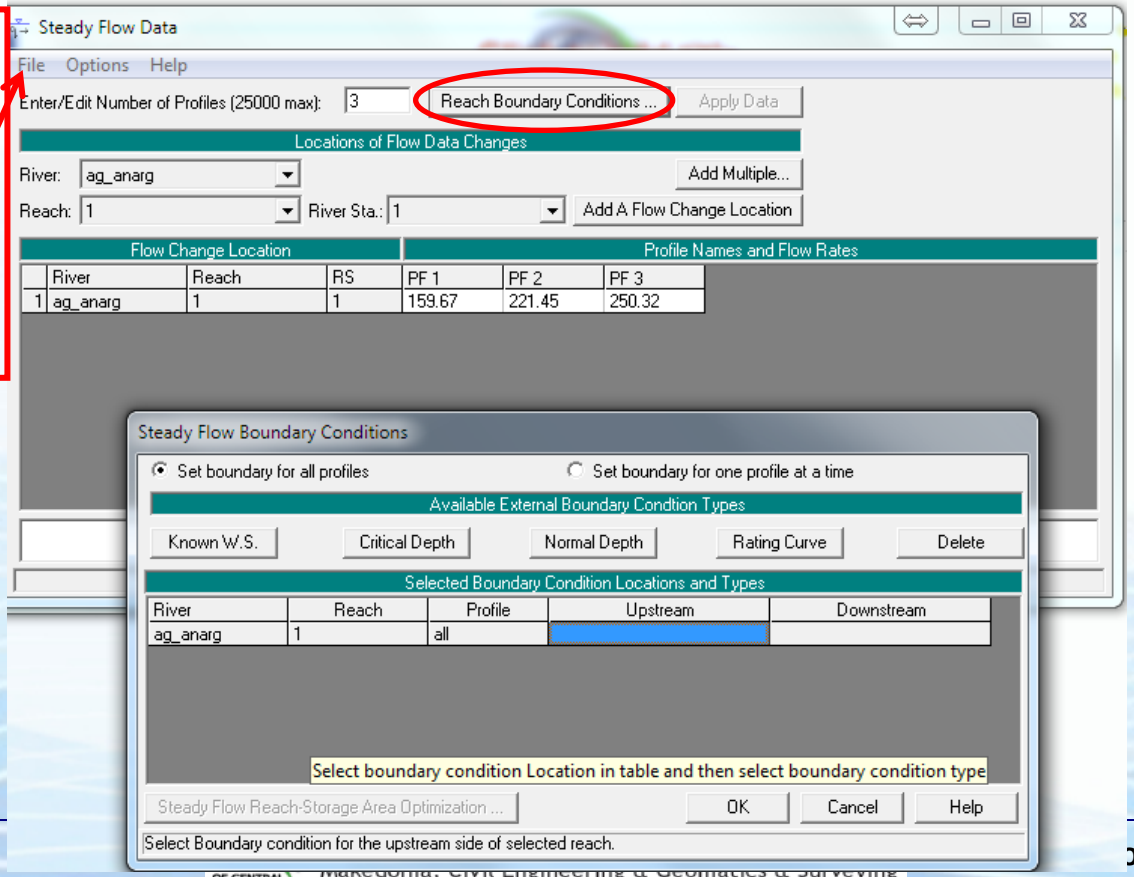
# Decide on and set the boundary conditions…assume if no other way the condition of flow upstream or downstream

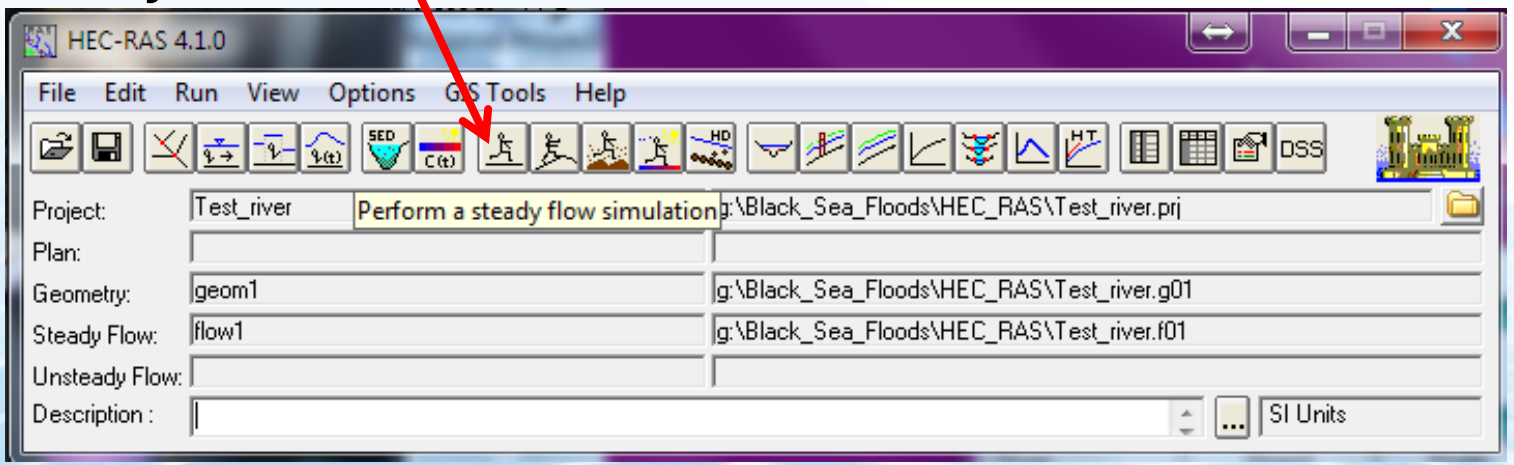
Save the flow Data, (the first time use the "save as" option



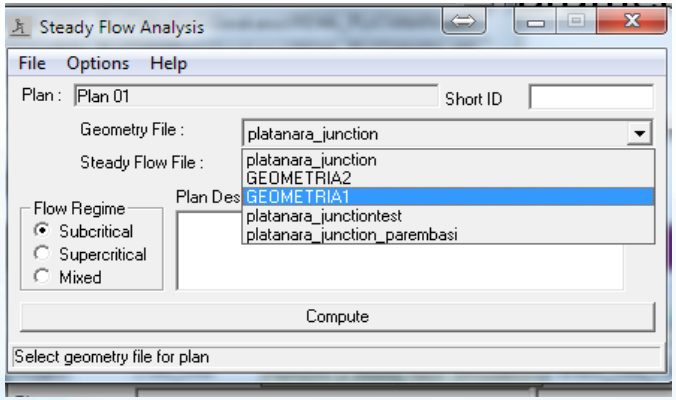

From the main HEC-RAS menu a plan may by saved…but not necessary.

- 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.

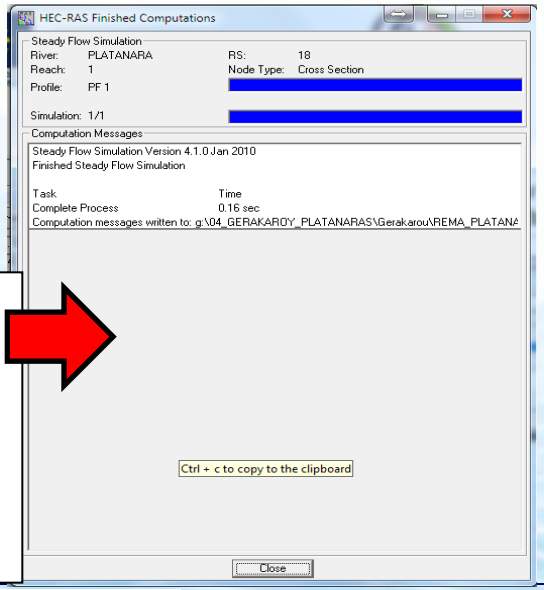


On the Analysis menu different .g files, flow rates and regimes may be chosen. Once they are set click **Compute** to run the simulation




If computations are successful the following window appears, otherwise…

Congrats , you did it!




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

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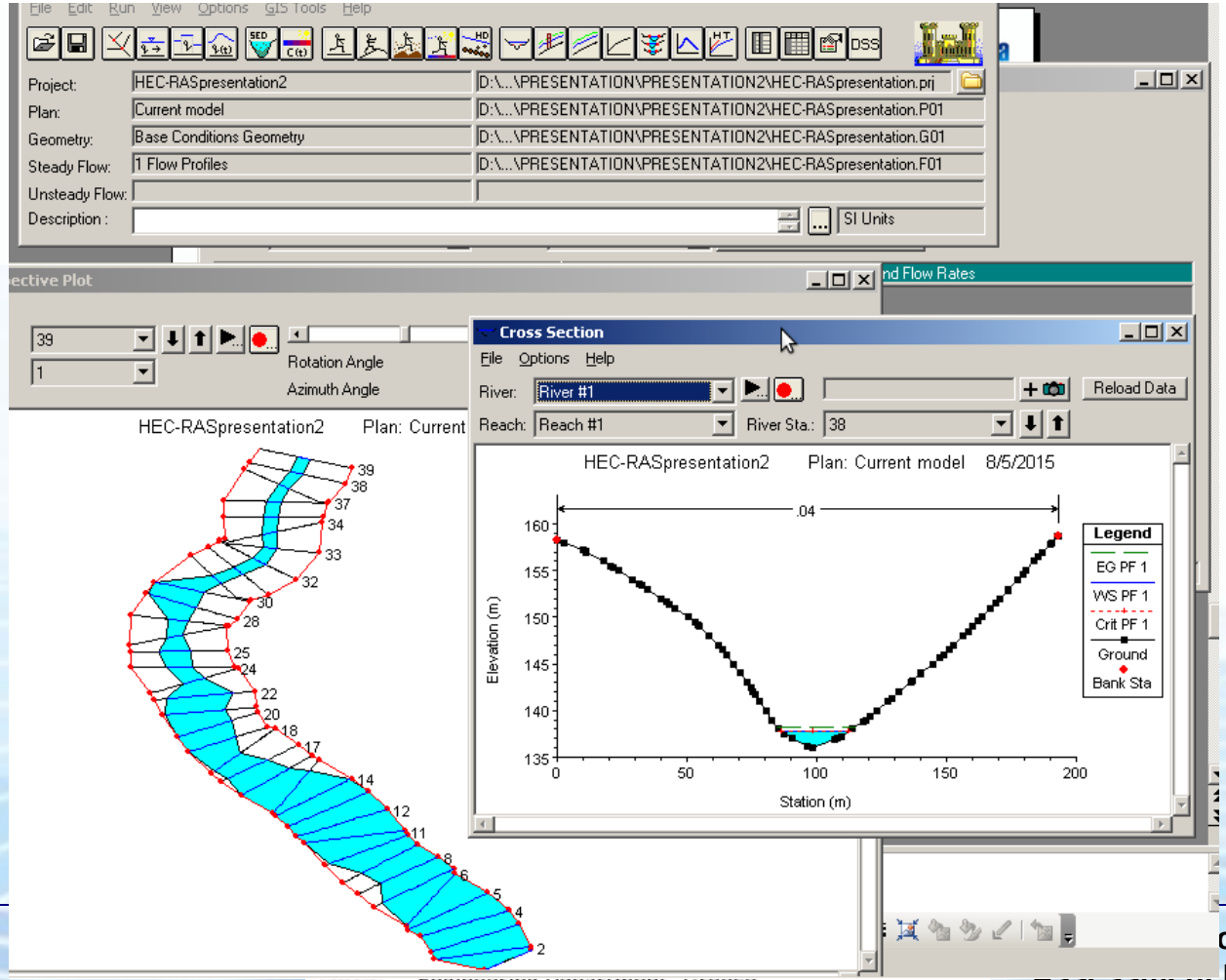
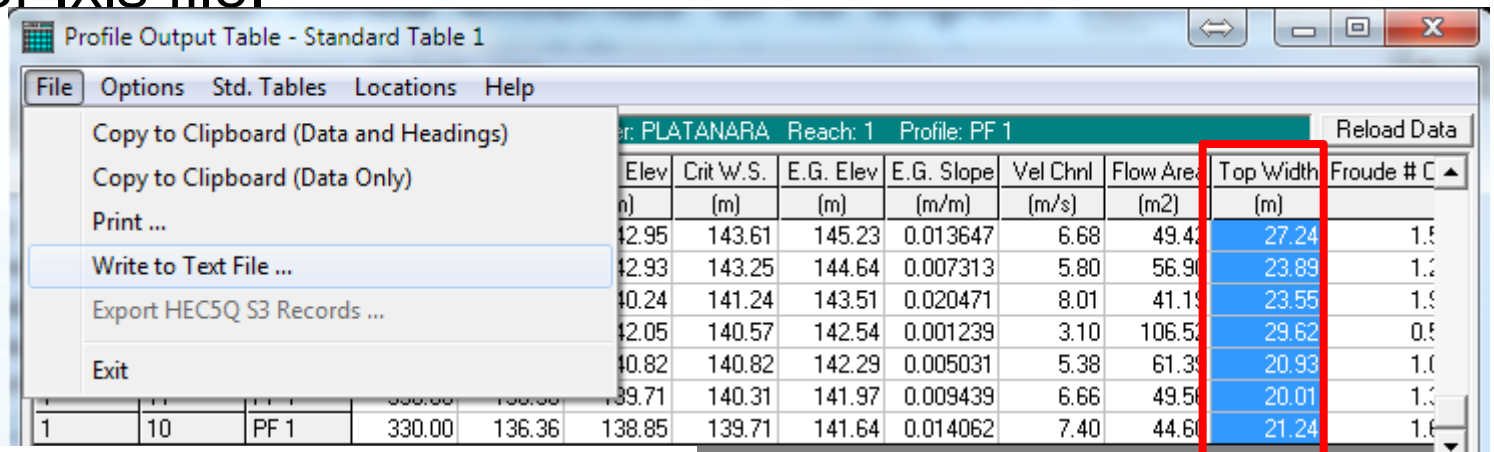
# This is how the simulation results appear in cross sections, profile plots and tables.

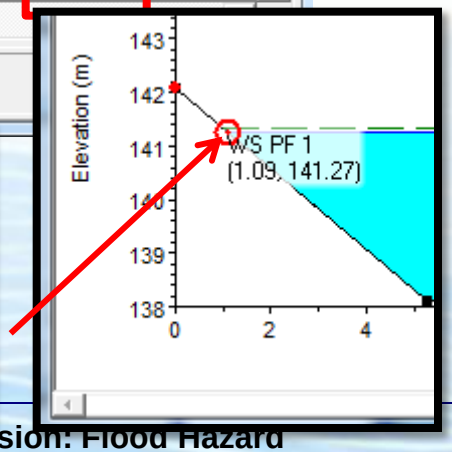


- To map flood extends or to export floodplain results table data (top width of flow) has to be copied in a text editor or .xls file.



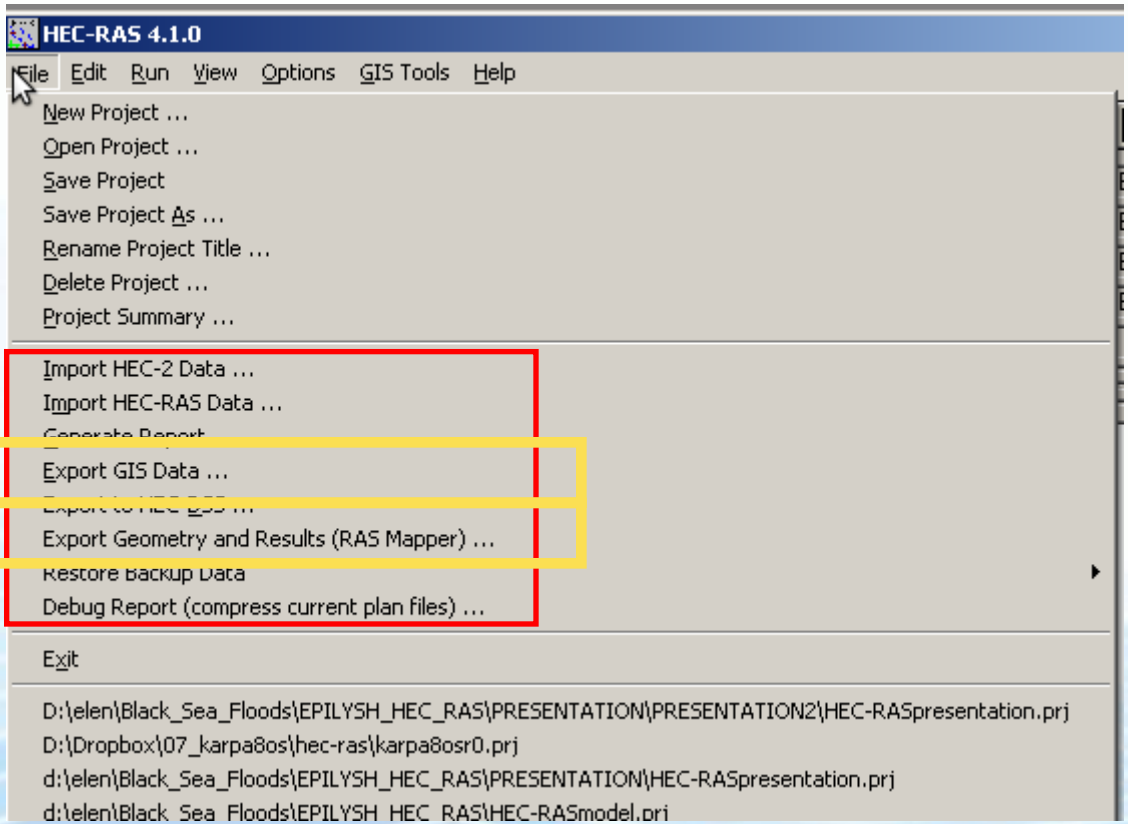

- The top width of flow has to be related to the first station of the cross section. That is easy to do from geometry data.

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

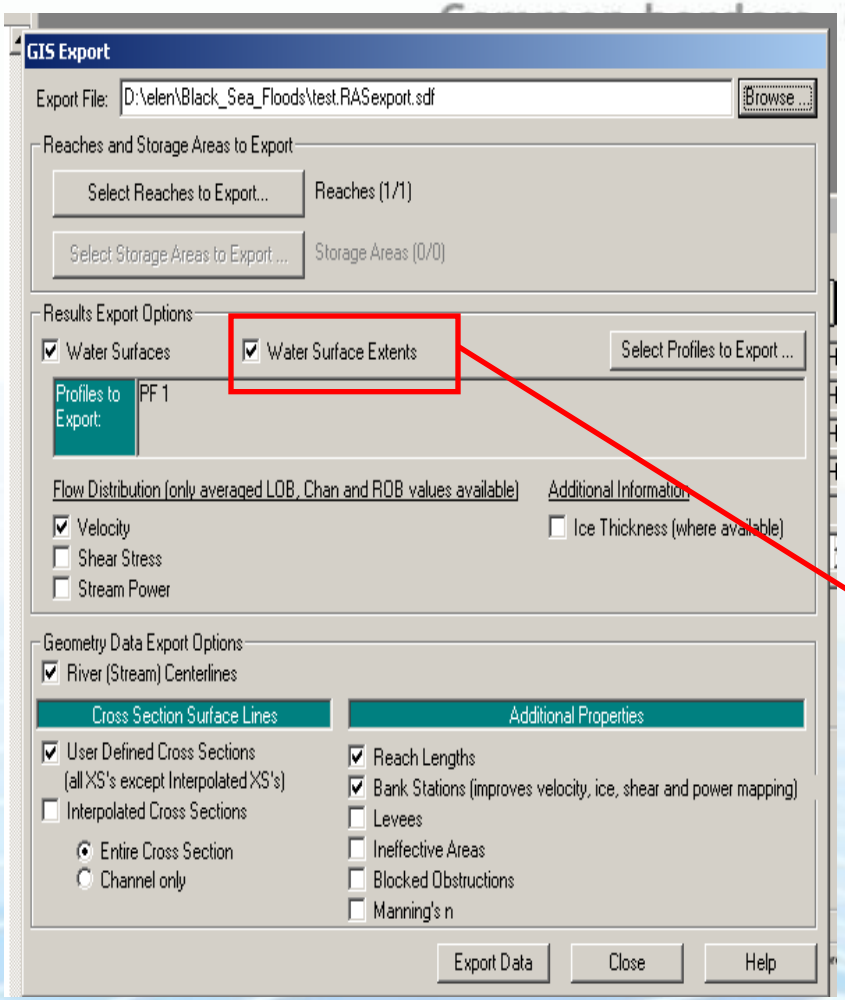


- Finally, we need to save the project file we have been working on….and continue in QGIS for floodplain mapping.

- # How to Export HEC-RAS to QGIS

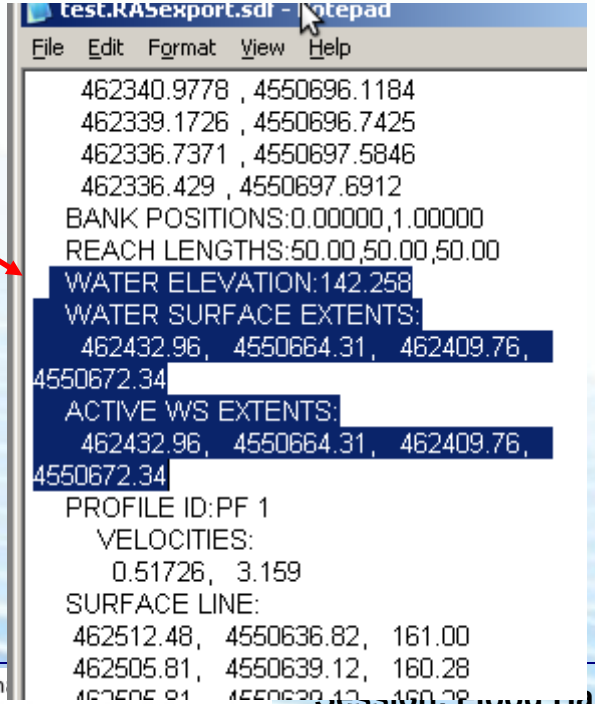


Common solutions.

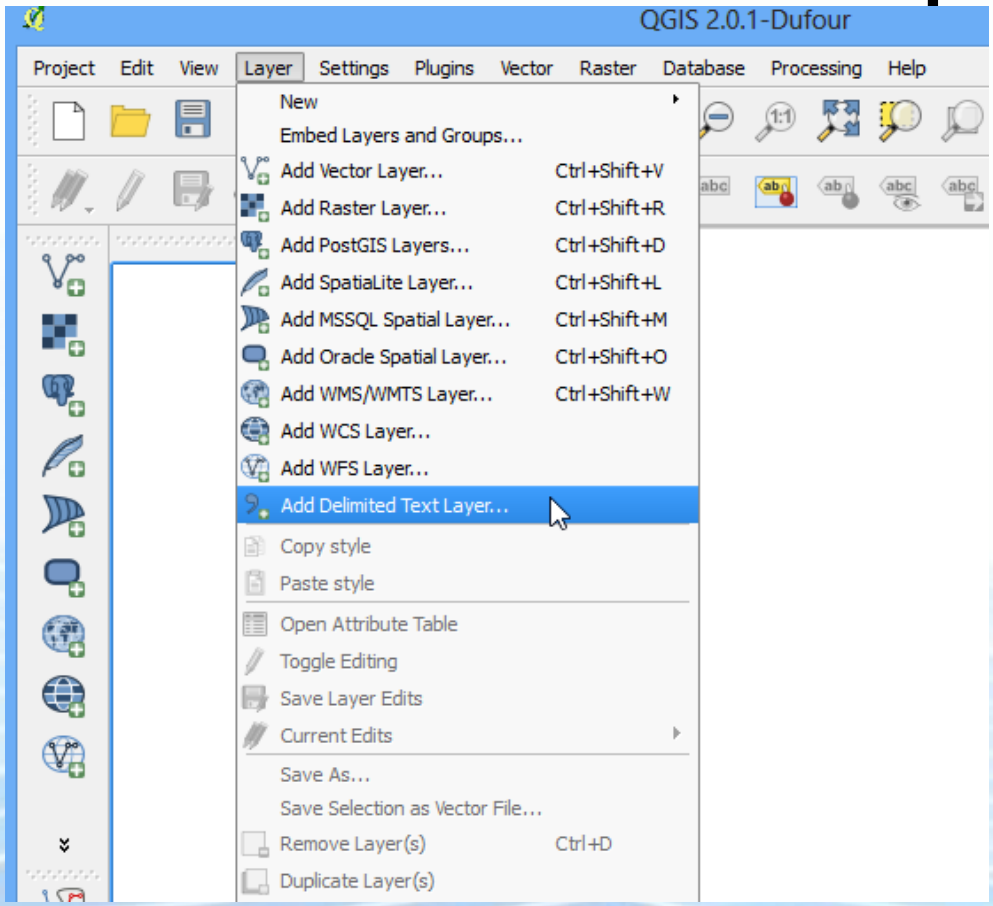



- The .sdf file is for ArcGIS only….but contains all information needed !!!

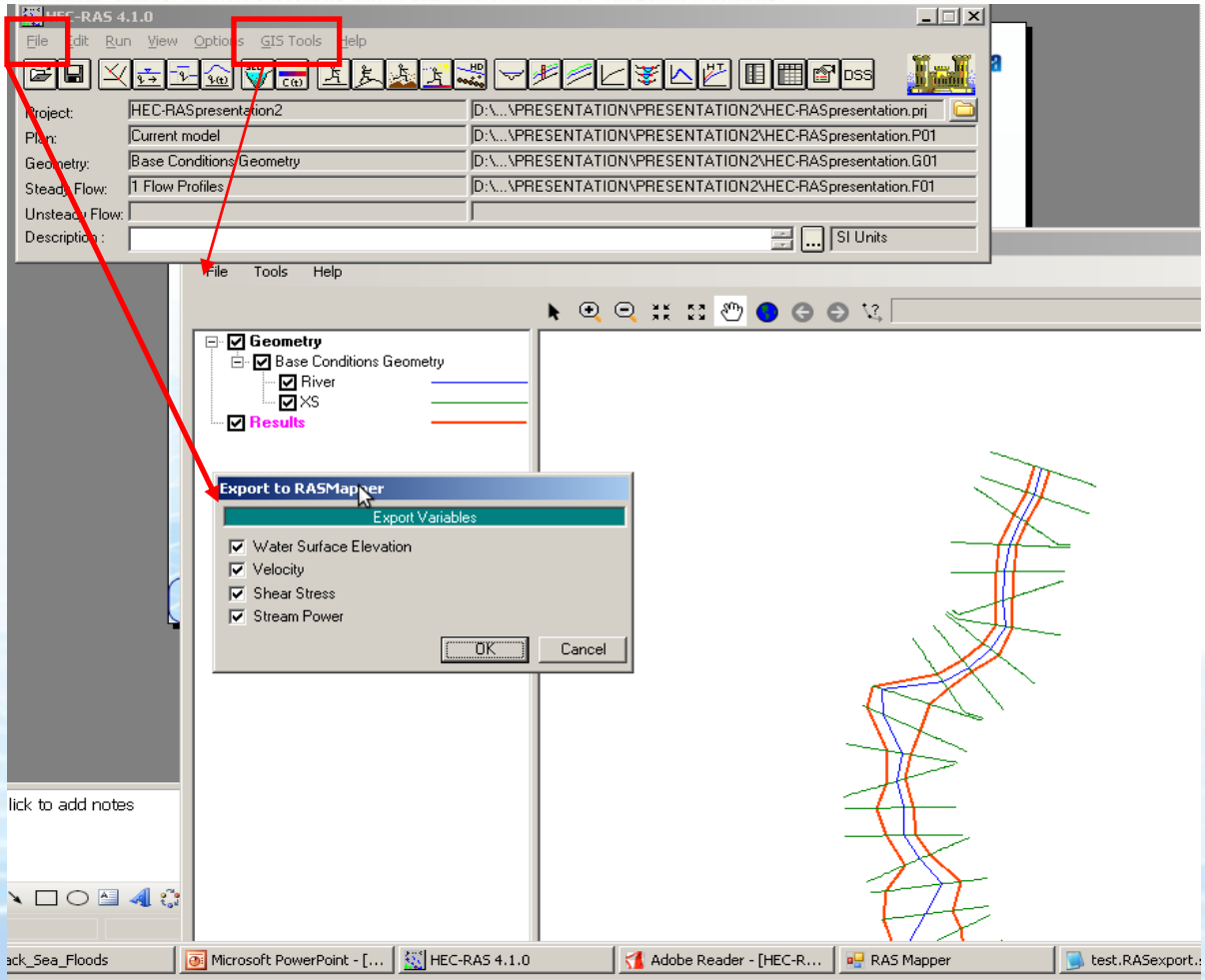
(open with notepad)



- **Prepare a .csv or .txt file and import to QGIS**



- **RAS Mapper**


HEC-RAS 4.1.0
File Edit Run View Options GIS Tools Help
Project: HEC-RASpresentation2
Plan: Current model
Geometry: Base Conditions Geometry
Steady Flow: 1 Flow Profiles
Unsteady Flow:
Description:
SI Units
File Tools Help
Geometry
Base Conditions Geometry
River
XS
Results
Export to RASMapper
Export Variables
Water Surface Elevation
Velocity
Shear Stress
Stream Power
OK
Cancel
lick to add notes
Microsoft PowerPoint - [...
HEC-RAS 4.1.0
Adobe Reader - [HEC-R...
RAS Mapper
test.RASexport...

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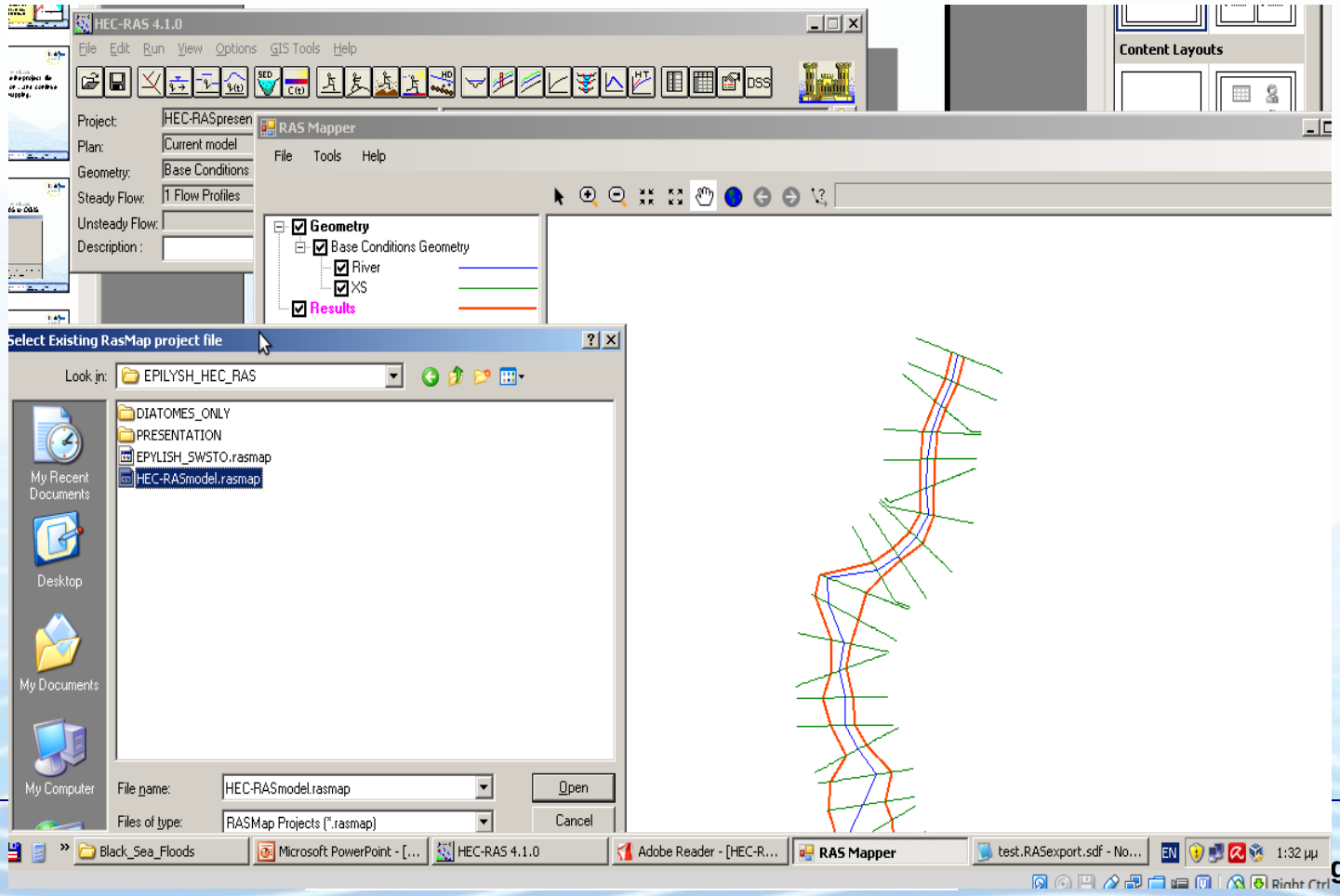
# Create a .rasmap file and import it to RAS Mapper



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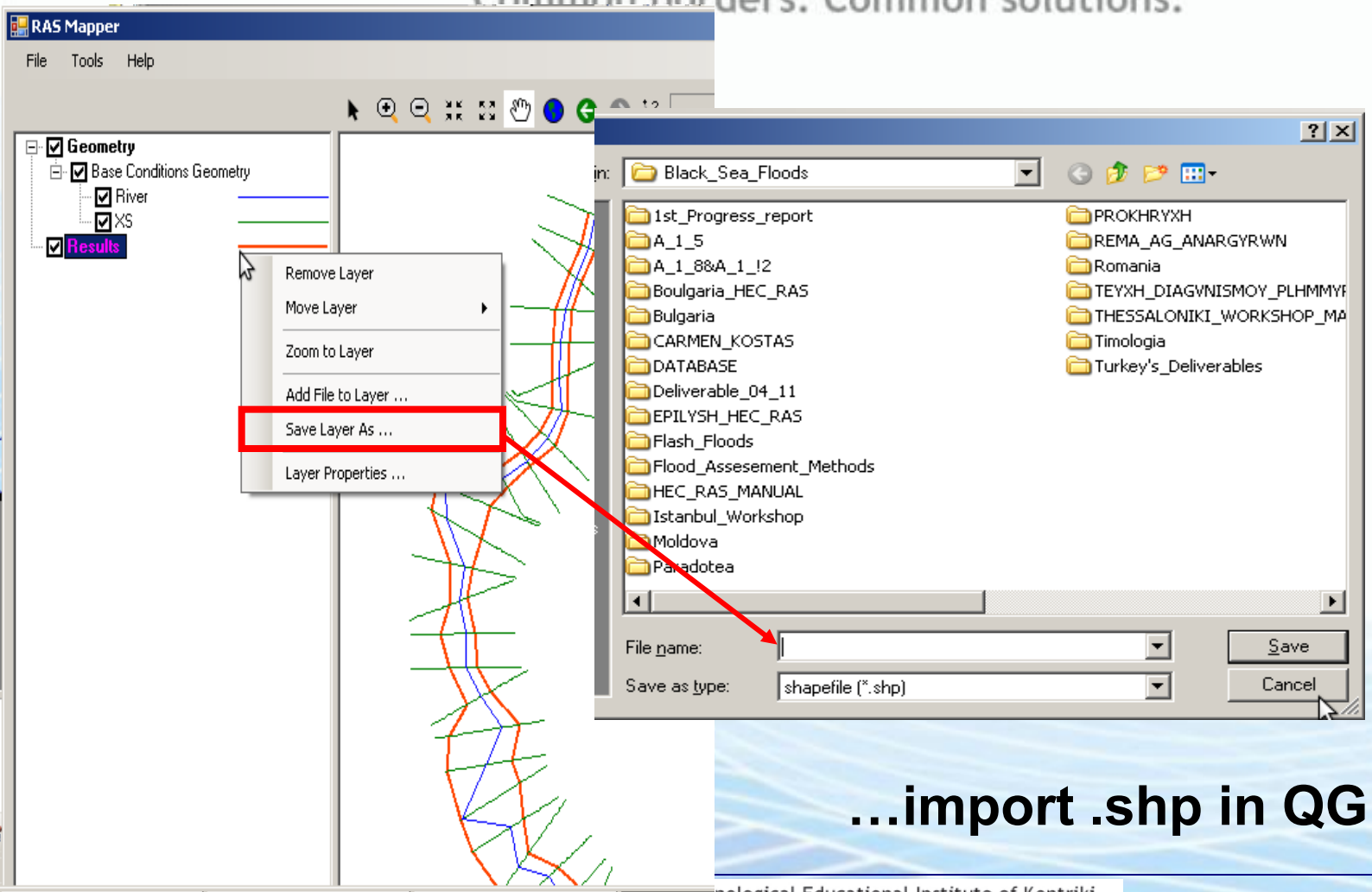


# …import .shp in QGIS….

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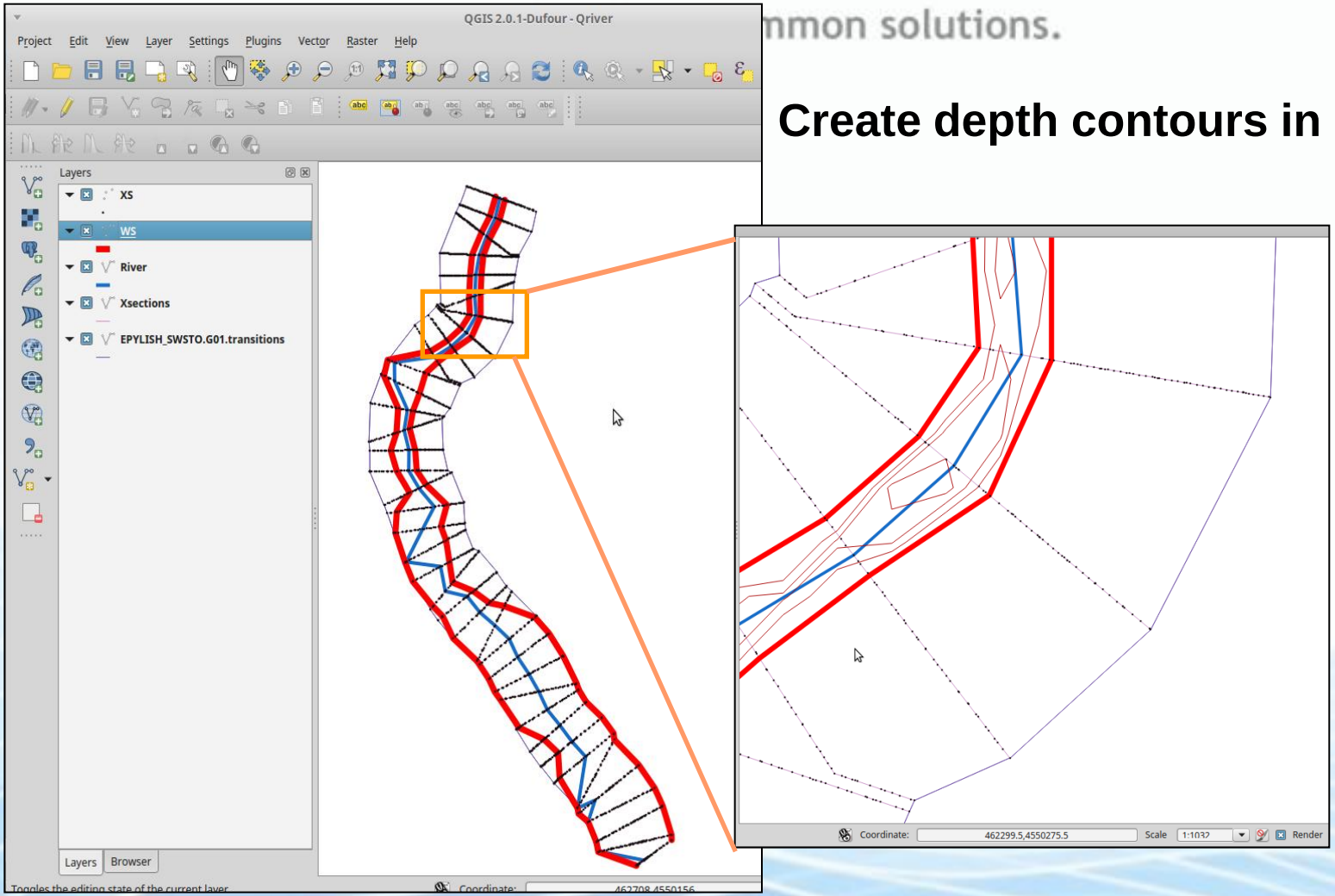
mmon solutions.

# Create depth contours in GGIS



# Alternative method to create results in QGIS

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- Another way to create results…
- Copy as image the XYZ Perspective Plot from HEC-RAS save it as png, or another image format.
- In QGIS go to Raster Georeferencer and georeference the image.
- Import the image and use the tools to georeference by matching the cross sections of the image to the ones created and extracted at the beginning of the process from QGIS.

- More time-consuming method that needs to add elevation data for each point…but it works too.

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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** and partially by **National funds**