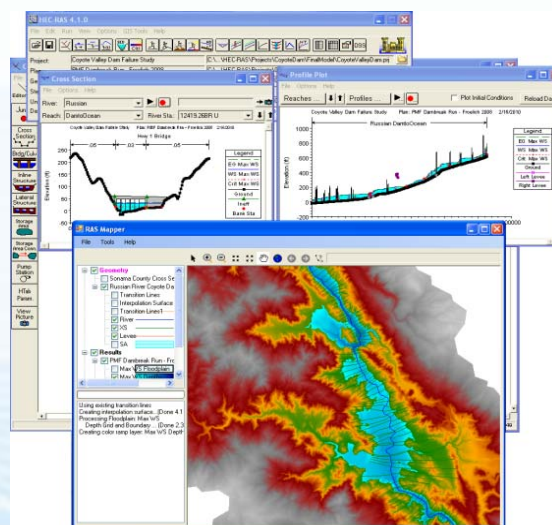


Common borders. Common solutions.

# HEC-RAS for local scale Hydraulic Analysis



Dr Eleni A. Tzanou



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## Assessment on local scale....WHY?

- Prevention flood disasters in **particular locations-sites**
- Adjustment of developmental programs regarding **planning of buildings and facilities** concerning safety....**Safety comes first**
- **Targeted measures** for flood hazard elimination
- **Preparedness** of authorities dealing with **crisis situations** in potential flooding
- Assessment of **Flash Flooding** by worst-case precipitation scenarios
- **Compliance** with the EU and National Guidelines and Legislation.

## To Whom It May Concern.....?

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- **Public Sector, Regional Authorities, Public services etc** dealing with hydraulic analyses, water management, environmental control, natural disaster assessment, decision making and support systems, urban planning.....
- **Private sector and Construction sector** for the correct dimensioning of hydraulic works

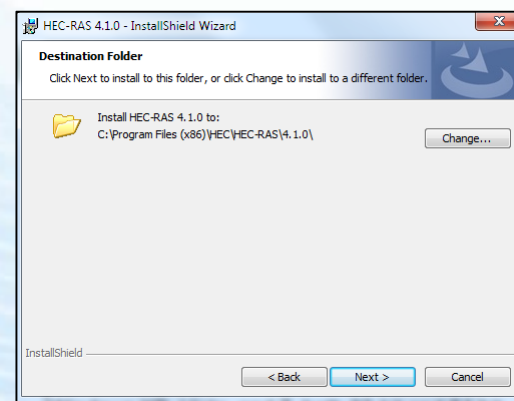
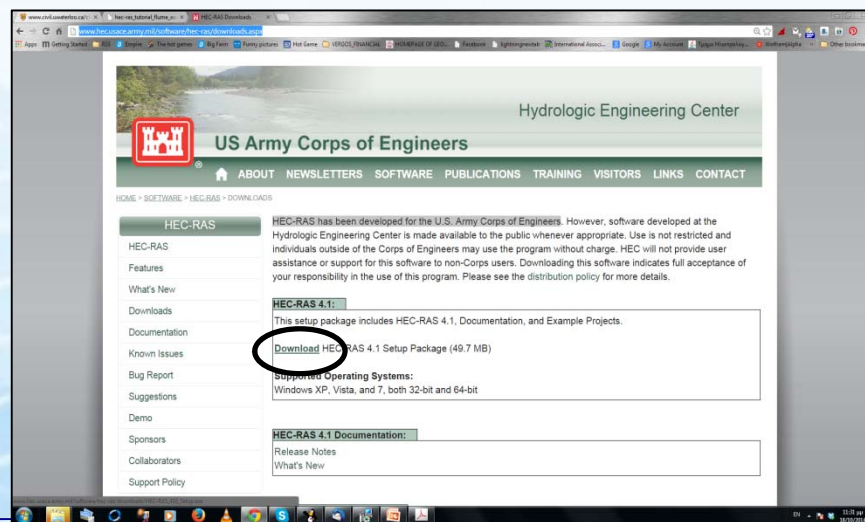
### Regional to local.....difference

1. Local scale analysis requires knowledge and experience in hydraulic analysis.

**Multi-purpose use of results. The same results may be used by a large number organizations and people.**

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- 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 and technical background on its use**



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

## HEC-RAS. How it was done.....

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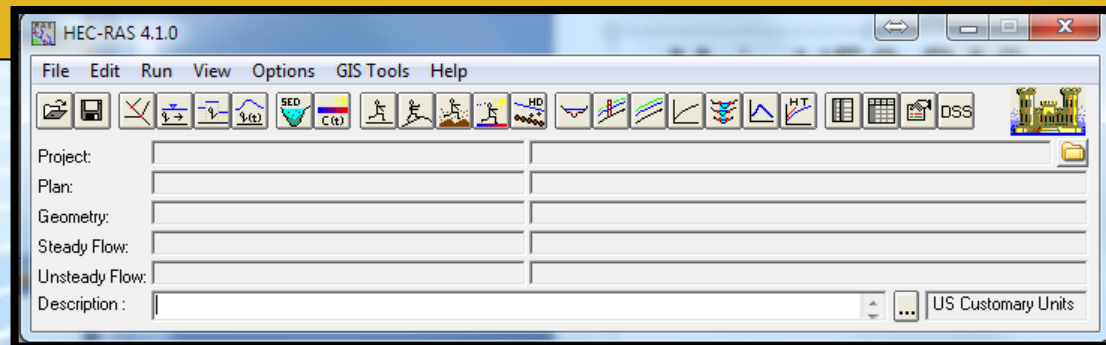
### Structure of HEC-RAS

- 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!!!!!!**

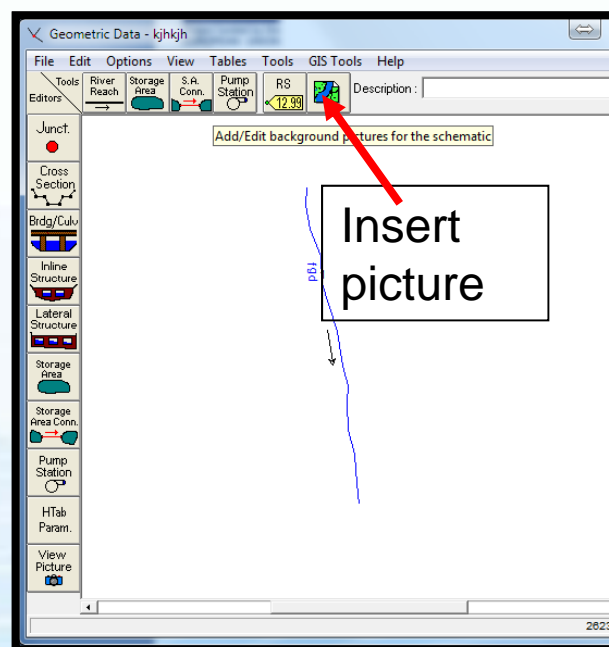


# Dealing with geometry and Cross Sections

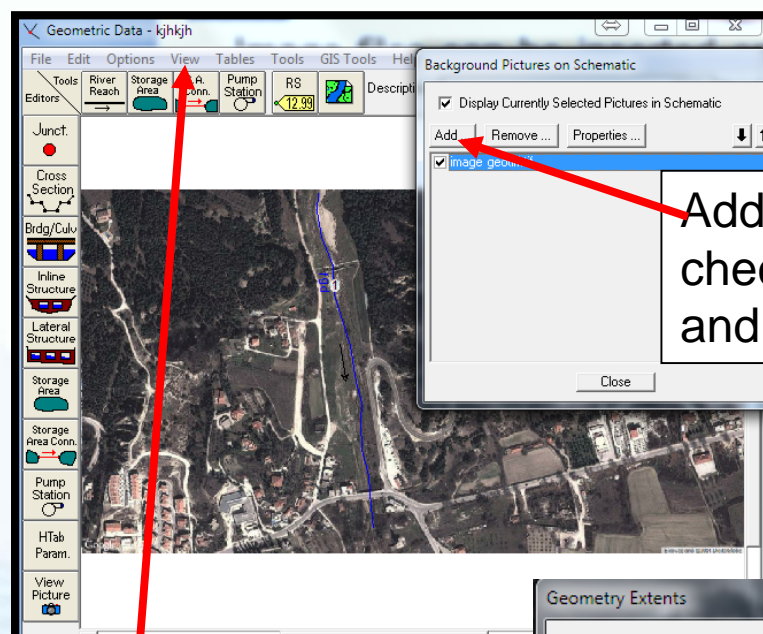
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- Cross sections define the channel geometry
- Cross sections are defined by Station(x) and Elevation (y)
- Cross sections (among other parameters) define the channel slope
- Overbank stations differentiate channel and floodplain characteristics
-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

## Easy-to- use multiple window Interface

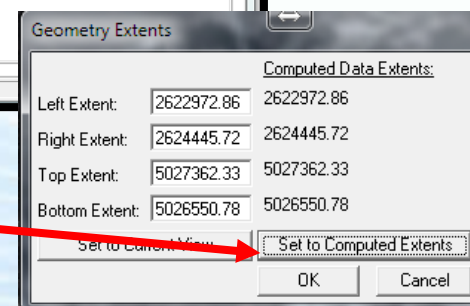


Cross sections may be also added through a .csv file format



Add image file,  
check image file  
and close

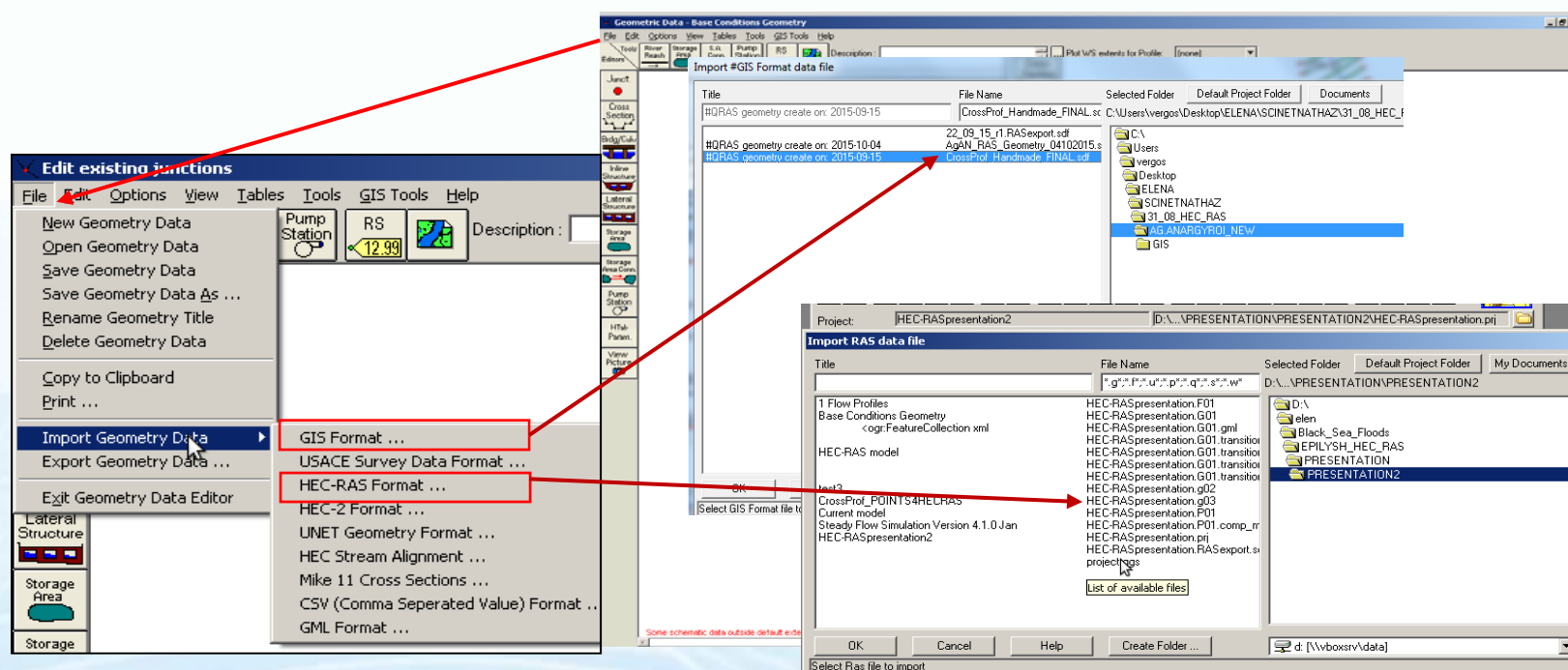
If the image is not visible set image  
computed extends  
from schematic plot  
extend in view menu



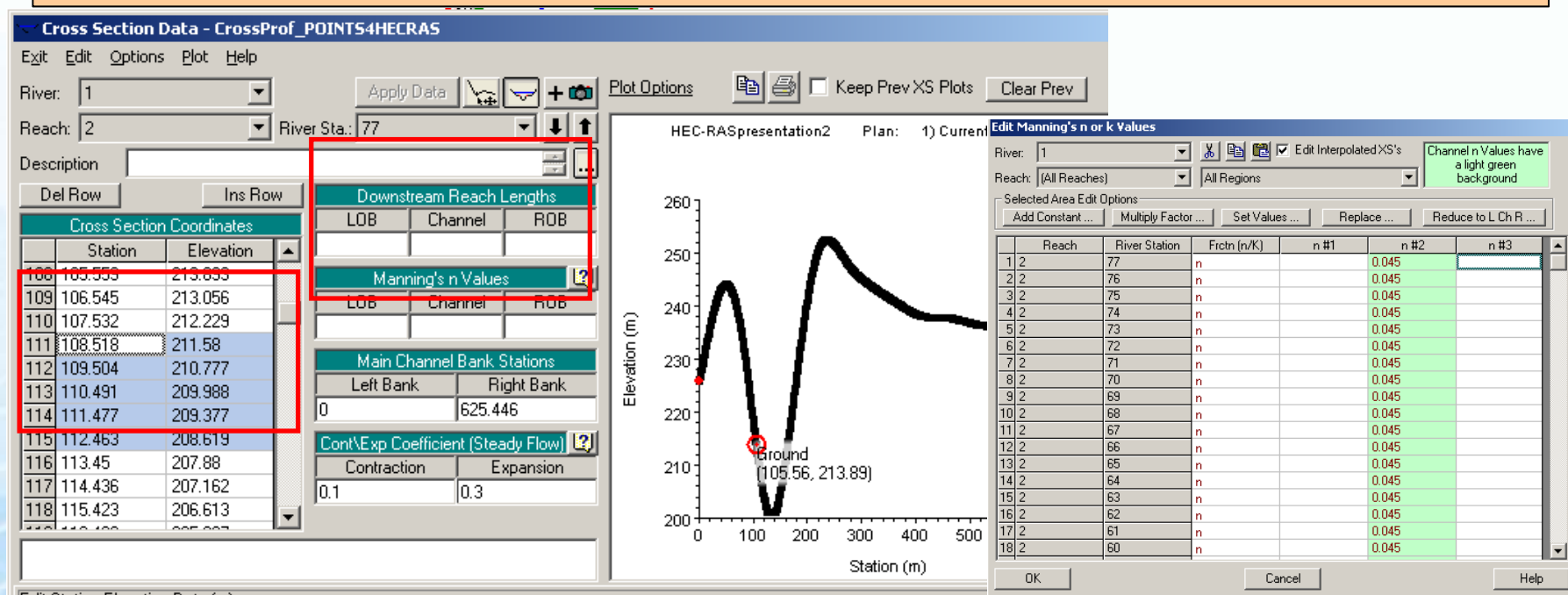


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- **Import Geometry → \*.sdf files from QGIS**



- **Geometry check!!!!**
- Add necessary data (banks, levees, obstructions, inefficient areas etc, Input coefficients.....
- Manning Values, Con/Exp coefficients, boundary conditions !!!!!



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## Flow data Input in flow data window....many profiles- flows were assessed.

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

3. Click on the  
apply data  
button

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

| River      | Reach | RS | PF 1 |
|------------|-------|----|------|
| 1 ag_anarg | 1     | 1  |      |

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

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## Set the boundary conditions

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

Steady Flow Data

File Options Help

Enter/Edit Number of Profiles (25000 max): 3 **Reach Boundary Conditions ...** Apply Data

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                         | PF 2   | PF 3   |
| 1 ag_anarg           | 1     | 1  | 159.67                       | 221.45 | 250.32 |

Steady Flow Boundary Conditions

☒ Set boundary for all profiles ☐ Set boundary for one profile at a time

Available External Boundary Condition Types

Known W.S. Critical Depth Normal Depth Rating Curve Delete

Selected Boundary Condition Locations and Types

| River    | Reach | Profile | Upstream        | Downstream |
|----------|-------|---------|-----------------|------------|
| ag_anarg | 1     | all     | <b>Upstream</b> |            |

Select boundary condition Location in table and then select boundary condition type

Steady Flow Reach-Storage Area Optimization ... OK Cancel Help

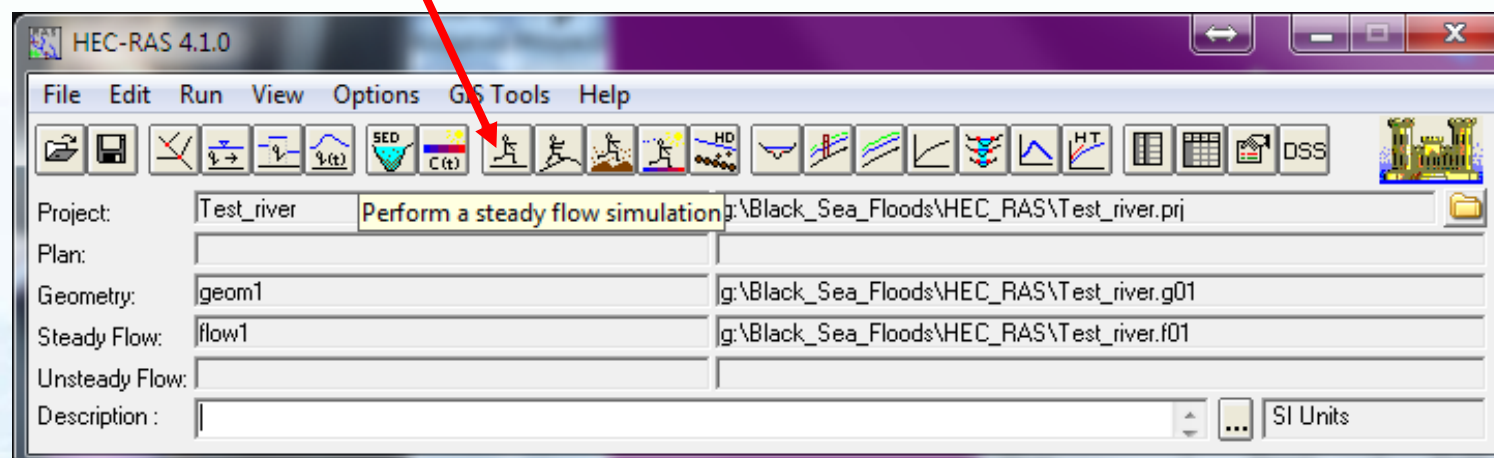
Select Boundary condition for the upstream side of selected reach.

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

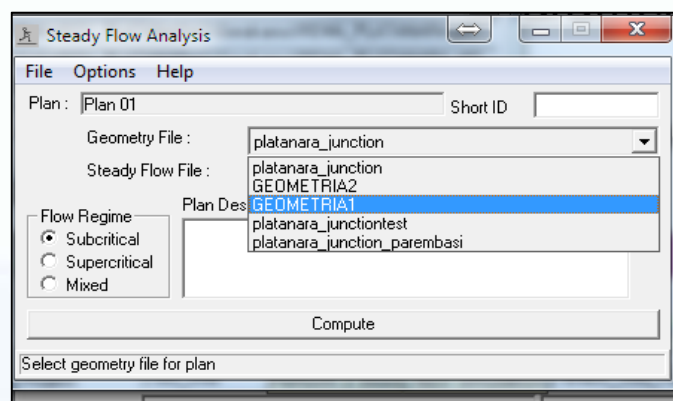


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**ALL parameters have been checked  
for a successful analysis.**

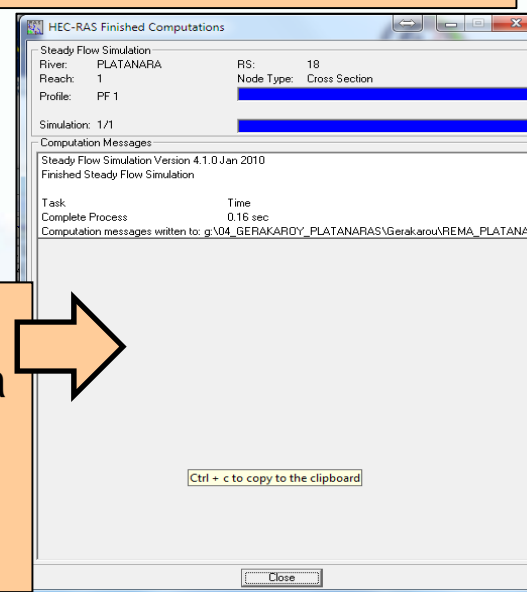


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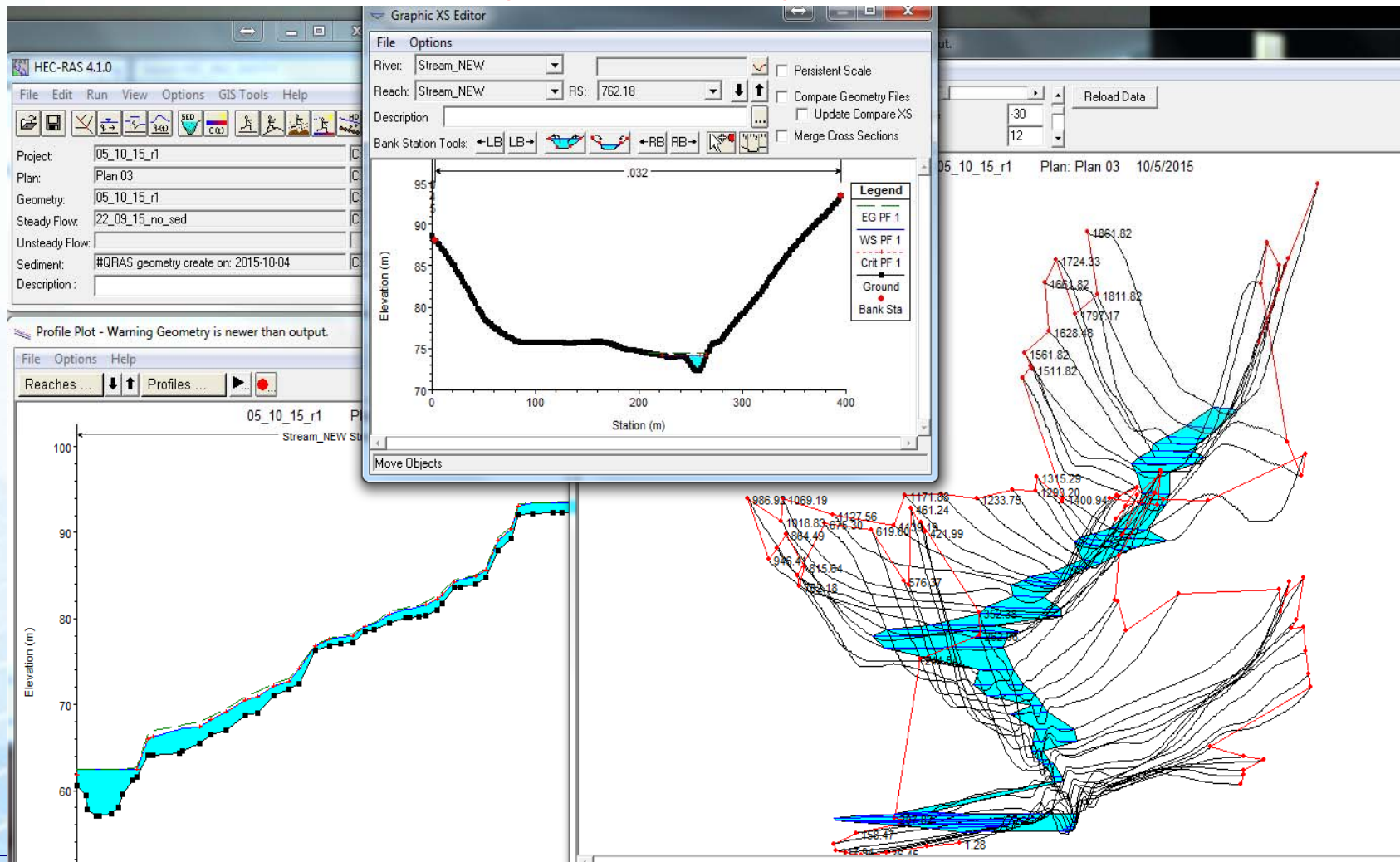
If computations are successful  
the following window appears,  
otherwise...

Congrats ,  
you did it!



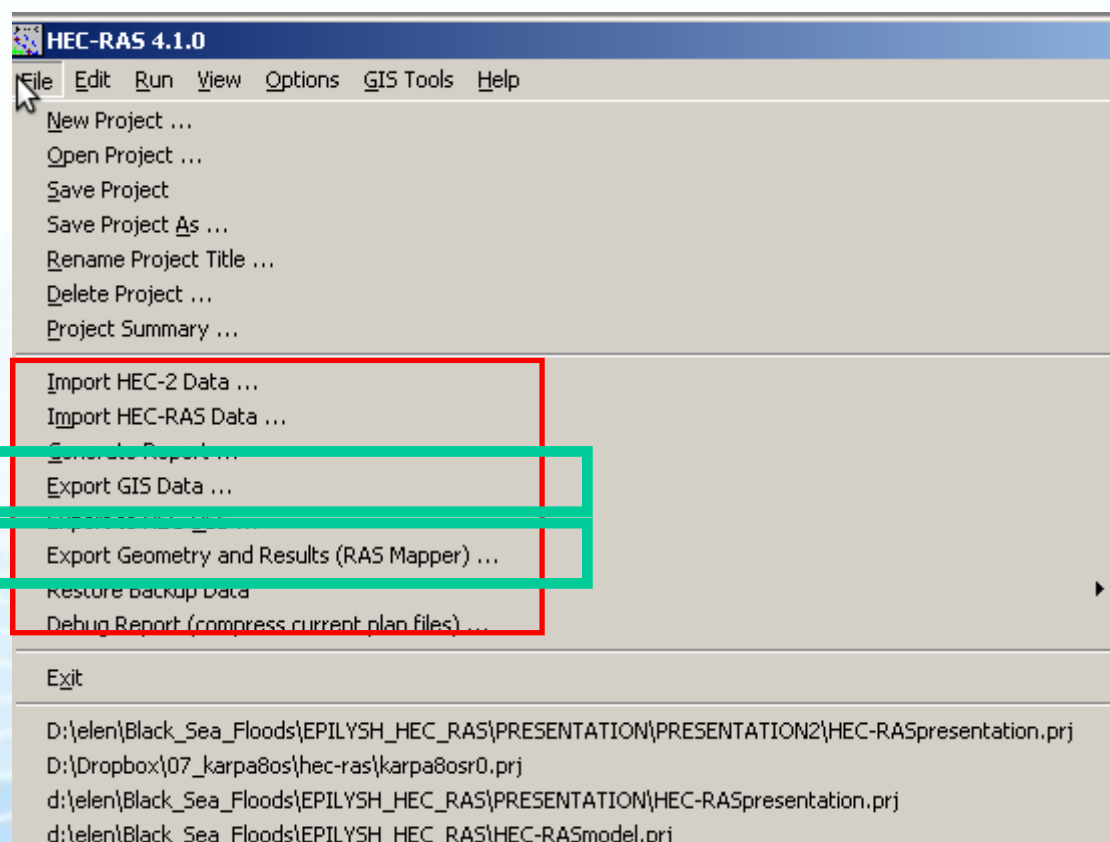
Errors and problems'  
reports appear in this area  
and everything should be  
corrected... then run the  
simulation again

## Hydraulic Analysis Results.



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## From HEC-RAS back to QGIS





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**GIS Export**

Export File: D:\elen\Black\_Sea\_Floods\test.RASexport.sdf Browse...

Reaches and Storage Areas to Export

Select Reaches to Export... Reaches (1/1)

Select Storage Areas to Export... Storage Areas (0/0)

Results Export Options

☒ Water Surfaces ☒ Water Surface Extents Select Profiles to Export...

Profiles to Export: PF 1

Flow Distribution (only averaged LOB, Chan and ROB values available) Additional Information

☒ Velocity ☐ Ice Thickness (where available)

☐ Shear Stress

☐ Stream Power

Geometry Data Export Options

☒ River (Stream) Centerlines

| Cross Section Surface Lines  | Additional Properties   |
|--|---|
| <input checked="" type="checkbox"/> User Defined Cross Sections<br>(all XS's except Interpolated XS's) | <input checked="" type="checkbox"/> Reach Lengths   |
| <input type="checkbox"/> Interpolated Cross Sections   | <input checked="" type="checkbox"/> Bank Stations (improves velocity, ice, shear and power mapping) |
| <input type="checkbox"/> Entire Cross Section  | <input type="checkbox"/> Levees   |
| <input type="checkbox"/> Channel only  | <input type="checkbox"/> Ineffective Areas  |
|  | <input type="checkbox"/> Blocked Obstructions   |
|  | <input type="checkbox"/> Manning's n  |

Export Data Close Help

- **HEC-RAS creates .sdf files containing all information necessary**

test.RASexport.sdf - Notepad

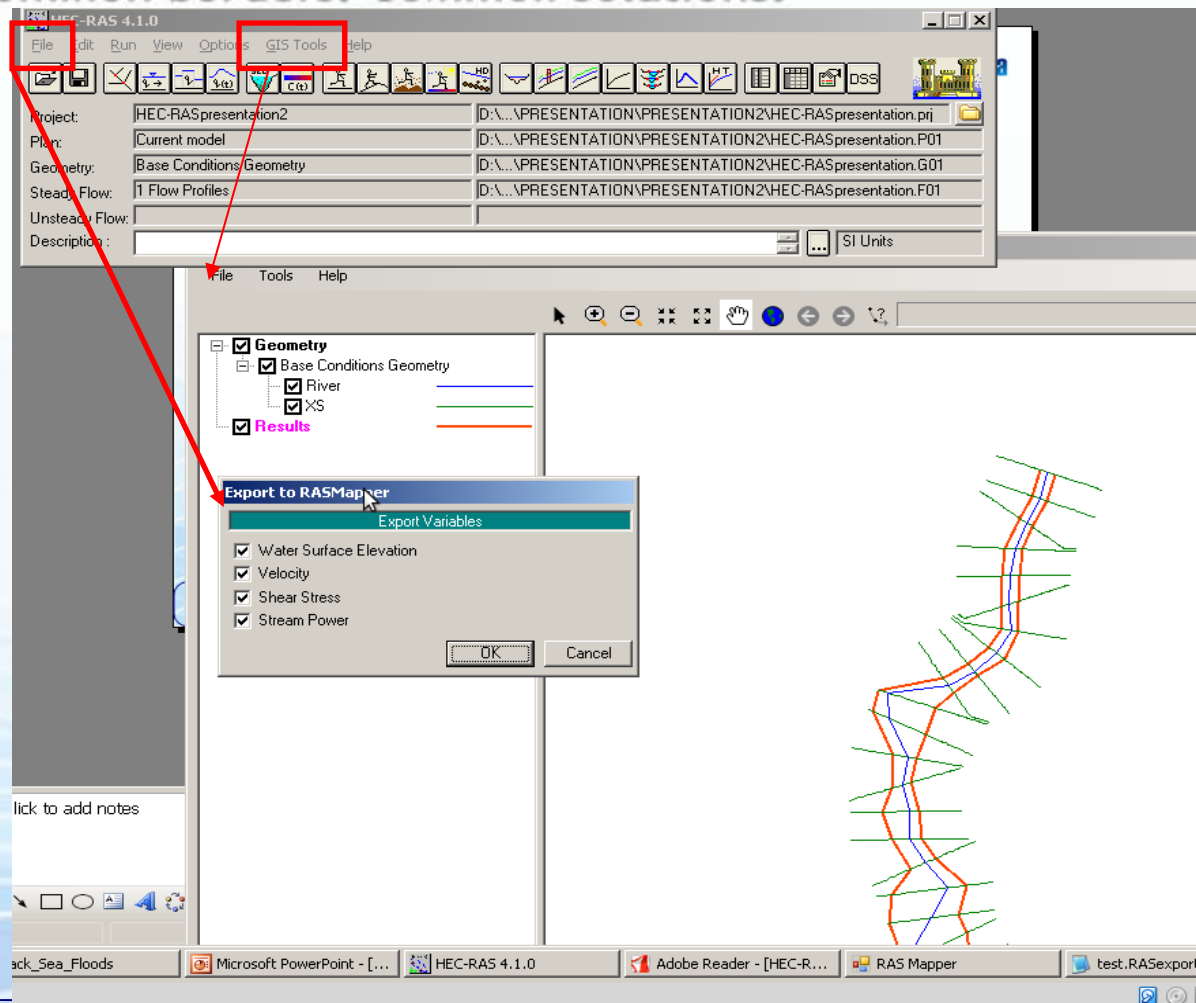
File Edit Format View Help

```

462340.9778 , 4550696.1184
462339.1726 , 4550696.7425
462336.7371 , 4550697.5846
462336.429 , 4550697.6912
BANK POSITIONS:0.00000,1.00000
REACH LENGTHS:50.00,50.00,50.00
WATER ELEVATION:142.258
WATER SURFACE EXTENTS:
462432.96, 4550664.31, 462409.76,
4550672.34
ACTIVE WS EXTENTS:
462432.96, 4550664.31, 462409.76,
4550672.34
PROFILE ID:PF 1
VELOCITIES:
0.51726, 3.159
SURFACE LINE:
462512.48, 4550636.82, 161.00
462505.81, 4550639.12, 160.28
462505.81, 4550639.12, 160.28
  
```

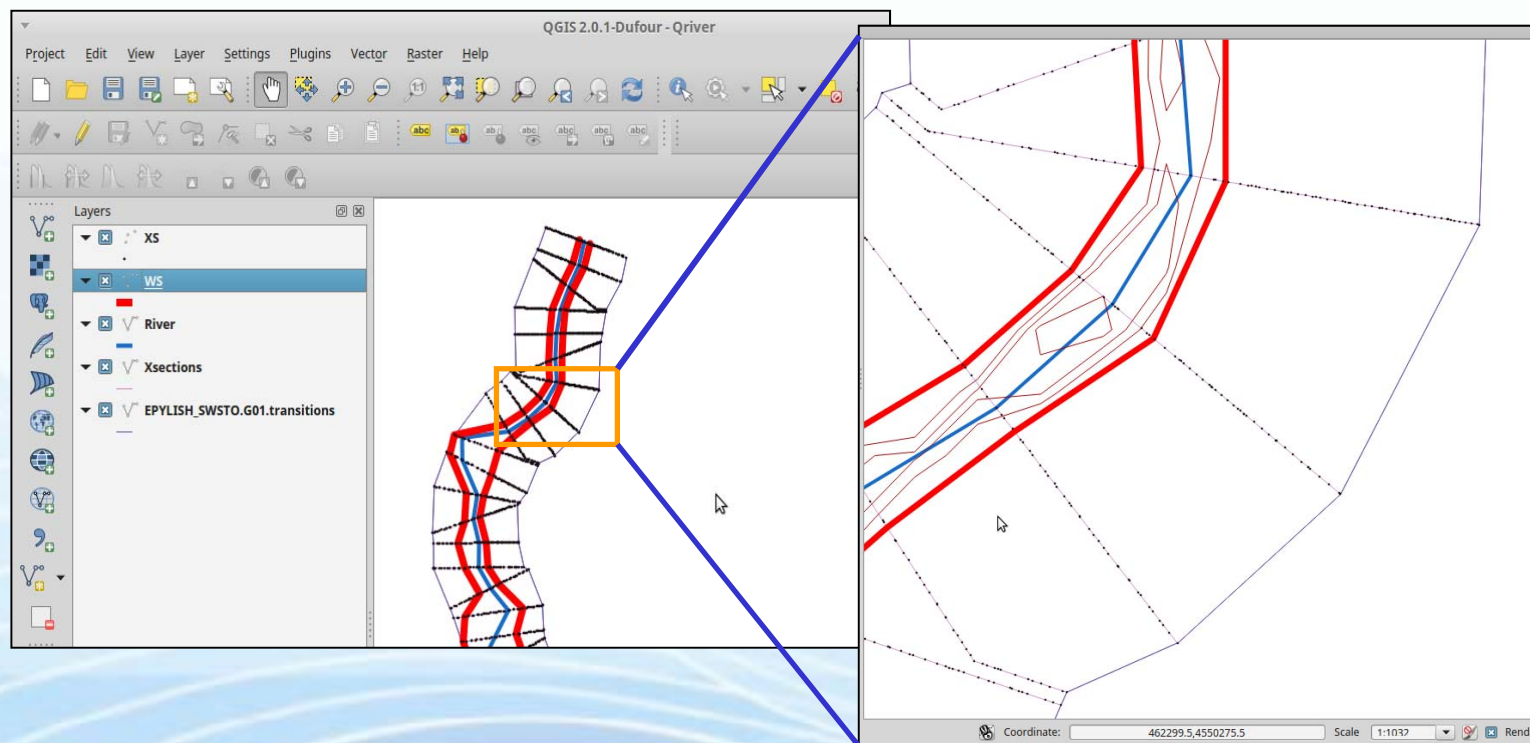
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## RAS Mapper



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**By georeferencing the HEC\_RAS image output one can create (digitize) flooding areas.**



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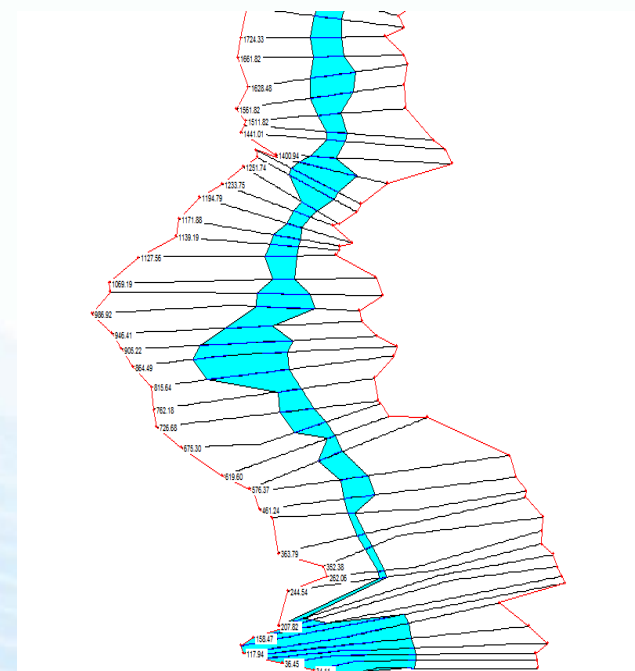
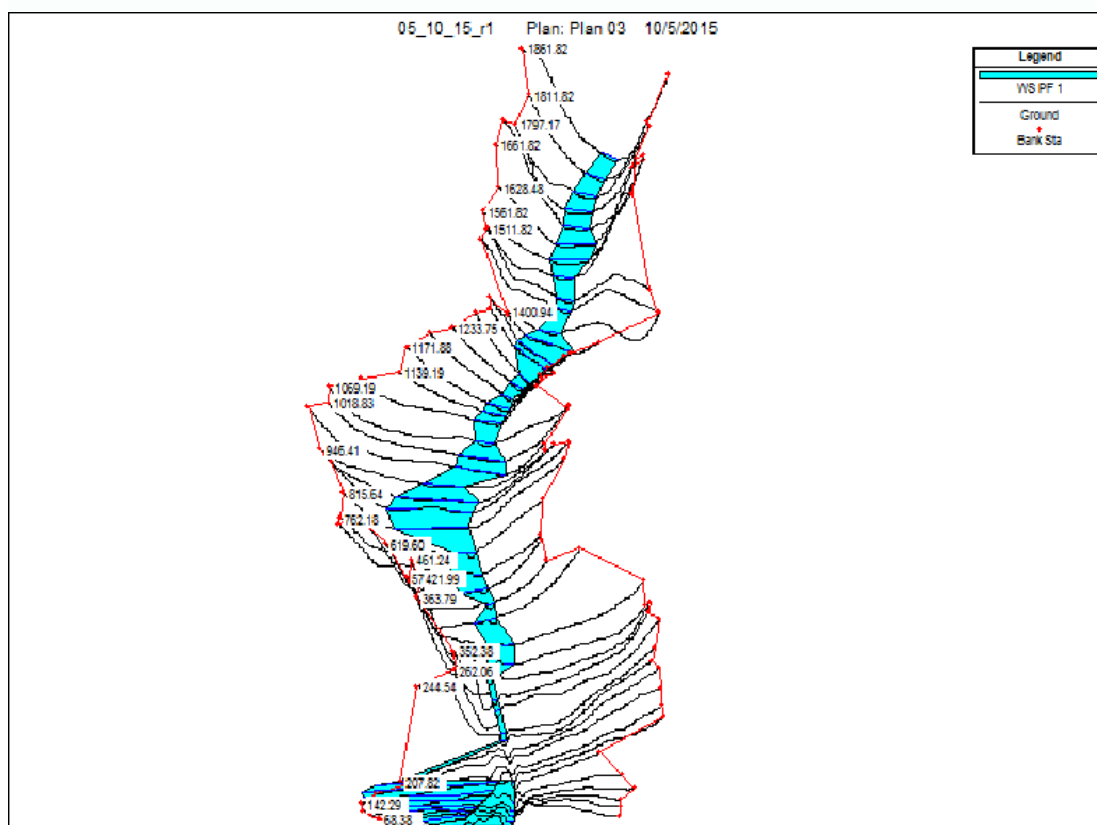
## Results in tabular format

| Profile Output Table - Standard Table 1 |           |                                |                  |                  |                  |                  |                     |                   |                                |                  |              |
|---|-----------|--------------------------------|------------------|------------------|------------------|------------------|---------------------|-------------------|--------------------------------|------------------|--------------|
| File Options Std. Tables Locations Help |           |                                |                  |                  |                  |                  |                     |                   |                                |                  |              |
| Reach                                   | River Sta | Q Total<br>(m <sup>3</sup> /s) | Min Ch El<br>(m) | W.S. Elev<br>(m) | Crit W.S.<br>(m) | E.G. Elev<br>(m) | E.G. Slope<br>(m/m) | Vel Chnl<br>(m/s) | Flow Area<br>(m <sup>2</sup> ) | Top Width<br>(m) | Froude # Chl |
| Stream_NEW                              | 1861.82   | 64.50                          | 95.94            | 96.97            | 96.97            | 97.31            | 0.01160             | 2.55              | 25.33                          | 38.41            | 1.00         |
| Stream_NEW                              | 1811.82   | 64.50                          | 93.63            | 94.59            | 94.59            | 94.89            | 0.01225             | 2.42              | 26.69                          | 45.65            | 1.01         |
| Stream_NEW                              | 1797.17   | 64.50                          | 92.55            | 93.71            |                  | 93.81            | 0.00220             | 1.40              | 45.95                          | 48.78            | 0.46         |
| Stream_NEW                              | 1724.33   | 64.50                          | 92.46            | 93.57            |                  | 93.66            | 0.00190             | 1.28              | 50.42                          | 55.23            | 0.43         |
| Stream_NEW                              | 1661.82   | 64.50                          | 92.36            | 93.45            |                  | 93.53            | 0.00197             | 1.31              | 49.07                          | 53.02            | 0.44         |
| Stream_NEW                              | 1628.48   | 64.50                          | 92.26            | 93.46            |                  | 93.49            | 0.00052             | 0.74              | 86.64                          | 81.04            | 0.23         |
| Stream_NEW                              | 1561.82   | 64.50                          | 92.17            | 93.42            |                  | 93.45            | 0.00055             | 0.77              | 83.68                          | 77.17            | 0.24         |
| Stream_NEW                              | 1511.82   | 64.50                          | 92.08            | 93.03            | 93.03            | 93.35            | 0.01196             | 2.50              | 25.78                          | 41.09            | 1.01         |
| Stream_NEW                              | 1487.04   | 64.50                          | 89.30            | 90.39            | 90.39            | 90.74            | 0.01150             | 2.62              | 24.58                          | 35.38            | 1.00         |
| Stream_NEW                              | 1441.01   | 64.50                          | 87.94            | 89.08            | 89.08            | 89.44            | 0.01132             | 2.66              | 24.28                          | 33.87            | 1.00         |
| Stream_NEW                              | 1400.94   | 64.50                          | 84.75            | 85.66            | 85.66            | 85.95            | 0.01208             | 2.40              | 26.89                          | 45.98            | 1.00         |
| Stream_NEW                              | 1366.34   | 64.50                          | 83.97            | 84.86            | 84.86            | 85.06            | 0.01389             | 1.96              | 32.97                          | 85.11            | 1.00         |
| Stream_NEW                              | 1315.29   | 64.50                          | 83.66            | 84.55            |                  | 84.63            | 0.00369             | 1.24              | 52.08                          | 98.74            | 0.54         |
| Stream_NEW                              | 1293.20   | 64.50                          | 83.63            | 84.28            | 84.28            | 84.48            | 0.01380             | 1.99              | 32.46                          | 81.43            | 1.00         |
| Stream_NEW                              | 1251.74   | 64.50                          | 81.69            | 82.74            | 82.74            | 83.08            | 0.01166             | 2.60              | 24.84                          | 36.68            | 1.01         |
| Stream_NEW                              | 1233.75   | 64.50                          | 81.01            | 82.19            | 82.19            | 82.56            | 0.01143             | 2.72              | 23.75                          | 32.30            | 1.01         |
| Stream_NEW                              | 1194.79   | 64.50                          | 80.38            | 81.61            | 81.61            | 82.00            | 0.01118             | 2.79              | 23.14                          | 29.73            | 1.01         |
| Stream_NEW                              | 1171.88   | 64.50                          | 80.20            | 81.39            |                  | 81.53            | 0.00417             | 1.69              | 38.16                          | 49.65            | 0.62         |
| Stream_NEW                              | 1139.19   | 64.50                          | 80.16            | 81.17            |                  | 81.36            | 0.00659             | 1.95              | 33.09                          | 48.99            | 0.76         |
| Stream_NEW                              | 1127.56   | 64.50                          | 80.11            | 81.14            |                  | 81.28            | 0.00471             | 1.67              | 38.57                          | 55.94            | 0.64         |
| Stream_NEW                              | 1069.19   | 64.50                          | 79.50            | 80.52            | 80.52            | 80.85            | 0.01179             | 2.56              | 25.23                          | 38.48            | 1.01         |
| Stream_NEW                              | 1018.83   | 64.50                          | 78.75            | 79.38            |                  | 79.47            | 0.00467             | 1.36              | 47.52                          | 93.67            | 0.61         |
| Stream_NEW                              | 986.92    | 64.50                          | 78.51            | 79.05            | 79.05            | 79.22            | 0.01473             | 1.85              | 34.96                          | 103.02           | 1.01         |



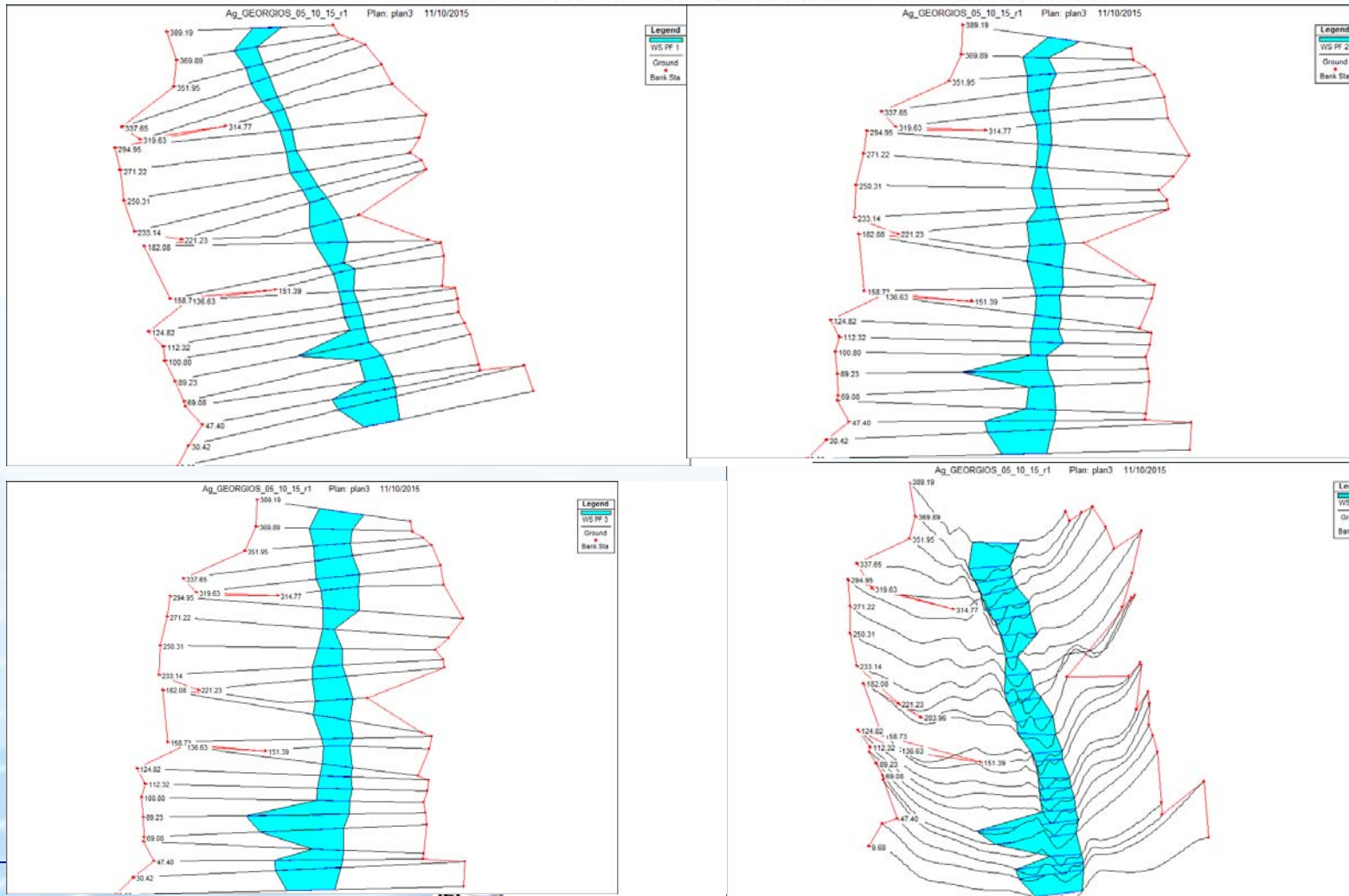
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# Ag. Anargyroi Stream, Serres



# AI-GIORGIS stream-Serres

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**Thank you!**

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