
# RVR MEANDER – USER'S MANUAL

ArcGIS VERSION

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## ABSTRACT

This document illustrates how to use the RVR Meander Graphical User Interface developed for ArcMap. It provides a description of the current functionalities of the software and shows the user the steps needed to run a simulation and view the output. A standalone version of RVR Meander and its User's Manual are also available.

The present manual is a work-in-progress version of the final one.





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# 1. OVERVIEW

The RVR Meander platform merges the functionalities of the first version of RVR Meander (Abad and Garcia, 2006) and CONCEPTS (Langendoen and Simon, 2008). It is written in C++ language and is composed by different libraries for preprocessing, hydrodynamics, bank erosion, migration, filtering, plotting, and I/O. It runs as stand-alone application on Windows and Linux operating systems and needs 4 input text files, specifying general parameters for simulation, channel centerline, valley centerline, and initial bank properties (geometry and erodibility). Several output files are produced, which describe the migrated centerlines, the two-dimensional (2D) hydrodynamics or bed morphodynamics field, and the evolution of bank geometry. All these files can be visualized in Tecplot or imported in Excel.

RVR Meander also has an ArcGIS-ArcMap interface, written in C # language. Its toolbar can be added to ArcMap, and provides same capabilities as the stand-alone version. In particular, the tab "Layer Definition" defines channel and valley centerlines, now input as shapefile polylines (therefore they can be created and edited inside the GIS environment). The other tabs "Channel Properties", "Preprocessing", "Hydrodynamics", "Bank Erosion", "Migration", "Smoothing", and "Output" specify other required parameters. A menu allows importing input data into the user form, to export input data to text file, to add the initial bank properties as text file, to run the simulation, and to import the results in the GIS environment, in terms of migrated centerlines (shapefile) or 2D representation of hydrodynamics or bed morphodynamics.

In terms of units, the stand-alone version works exclusively with SI (International) Units, while the ArcGIS-ArcMap interface can either work with SI or English Units.

# 2. STANDALONE VERSION

A standalone version of RVR Meander and its User's Manual are also available.

# 3. THE ARCGIS-ARCMAP VERSION

## 3.1. INTRODUCTION

RVR Meander for ArcGIS is basically a toolbar that lets the user access forms to input parameters, run the software and visualize output inside ArcMap. It has been developed for ArcGIS 9.3.1 and is currently being tested on ArcGIS 10.0 in order to support the newest version of ESRI's software. The RVR Meander Graphical User Interface (RVR-GUI) provides different functionalities that facilitate the use of the RVR capabilities available for the standalone version inside ArcMap.

## 3.2. FROM STANDALONE TO GRAPHICAL USER INTERFACE (GUI) IN ARCMAP

RVR Meander can be used in two different modes (see Figure 1). The first one is a standalone mode that can be run on Linux or Windows based systems whereas the second mode is a Graphical User Interface (GUI) built inside ArcGIS. The idea in both cases is the same; the Engine code requires input information which comes from text files but in the case of the GUI, three of those files can be created inside ArcMap.

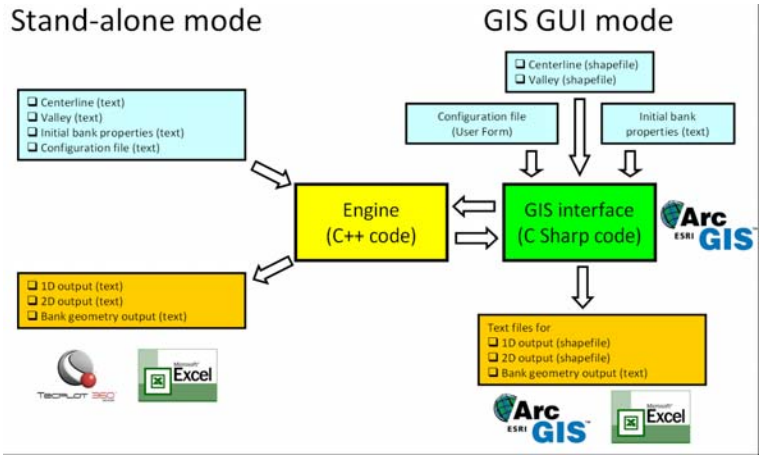


**Figure 1. Stand-alone versus GUI mode diagram.**

Both codes are developed separately which allows including new functionalities in the interface until they have been fully tested in the standalone version. They both interact with the same engine code which then produces output files. The output files for the standalone version are designed to be opened using Tecplot and Excel. In the case of the GUI the files can be directly viewed inside ArcMap with the exception that the current version does not support "Bank geometry output" and therefore Excel needs to be used to view this file.

## 3.3. THE RVR MEANDER TOOLBAR – AN OVERVIEW

The RVR Meander toolbar contains four command buttons and a tool button that provide different functionalities (see Figure 2).


**Figure 2. The RVR Meander Toolbar.**

The “Text to Shapefile” command reads a text file and creates a shapefile with it and adds it into ArcMap (see Figure 3). The shapefile is actually composed of five different files which are only noticeable from Windows Explorer. If the user opens ArcCatalog only the shapefile itself will show up. It’s important to note that the text file must follow a specified format (see Walkthrough Demonstration Section for more information) and only polylines are created with this command. It is meant to create river and valley centerlines from (x, y) coordinates.

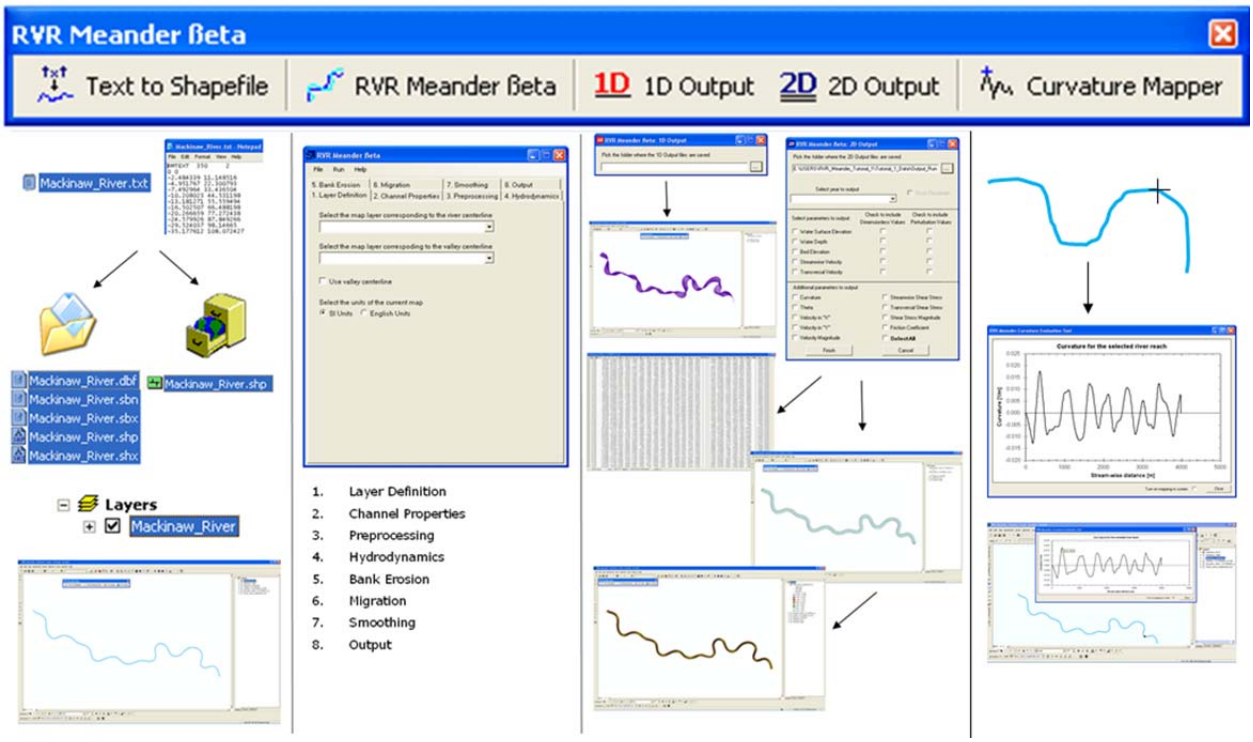


**Figure 3. The RVR Meander Toolbar in a nutshell.**

The “RVR Meander” command provides access to the RVR-GUI which is a window with eight tabs in which the user can input the parameters for the analysis (see Figure 3).

The “1D Output” command button opens the 1D output dialog in which the user can input the folder where the file to output is saved. Clicking on the “Finish” button of the 1D Output form results in a shapefile of “Migrated Centerlines” which is automatically added into ArcMap.

The “2D Output” command opens a window in which the user first needs to specify the folder where the output files are saved. Afterwards, the user can select which variables will be added into the attribute table of the shapefile created and the user also needs to indicate for which iteration (number of years) the output will be created. A shapefile made of points is automatically added once the user clicks the “Finish” button on the 2D output window. Two shapefiles are added to the map; one is a boundary polygon and the other is the point shapefile with all the output values. They’re both needed to create a *TIN* or *Raster* of any of the output parameters.

The “Curvature Mapper” tool lets the user select a polyline feature on the active map and computes the curvature values at every vertex. When the user clicks the tool command the mouse changes to a crosshair with which the user can select a river reach. After doing so a new plot appears on screen which displays the

curvature of the river reach as a function of stream wise distance. A checkbox on the bottom provides an additional capability to observe which specific points on the reach have a given curvature value.

## 3.4. DETAILED DESCRIPTION

### 3.4.1. INTRODUCTION

This section is meant to provide a detailed explanation of the components and use of the RVR-GUI. It begins by showing how to add the RVR Meander toolbar into ArcMap and it then shows step by step how to use its menus and user forms. The description uses images taken from test cases developed for the Mackinaw River in Illinois, USA. The test cases are included in another document called RVR Meander Tutorials. All the screenshots presented were produced with ArcGIS 9.3.1. Full support for version 10.0 is still not available.

### 3.4.2. LOADING THE RVR MEANDER TOOLBAR INTO ARCMAP

Open ArcMap and select "A new empty map". Then open the Customize window (Tools menu) and in the Toolbars tab browse for the RVR Meander toolbar. If the toolbar is not displayed click on the "Add from file" button and browse for the installation folder. Select the file with the ".tlb" extension and click "Open". A new dialog indicating the "Added Objects" will appear on screen. Click "OK" and in the Customize window check the box to include the toolbar. After clicking the "Close" button the toolbar will be displayed on the ArcMap interface (see Figure 6).

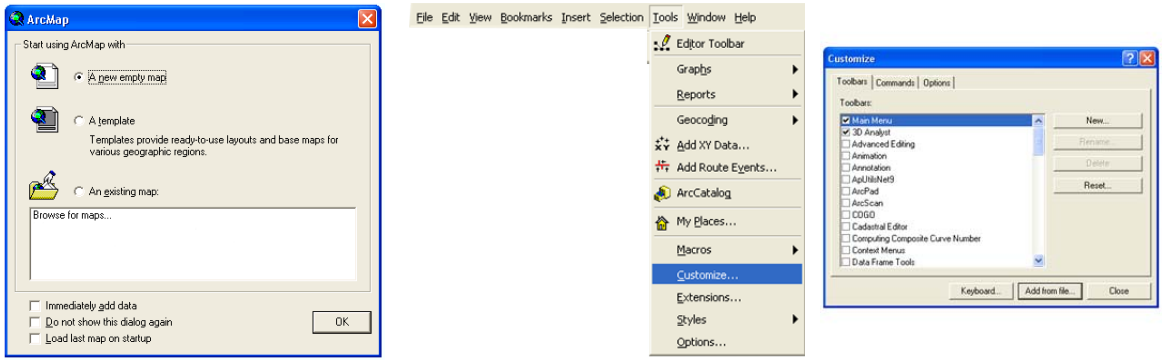


**Figure 4. Open an empty map in ArcMap and add the RVR Meander toolbar using the Customize window.**

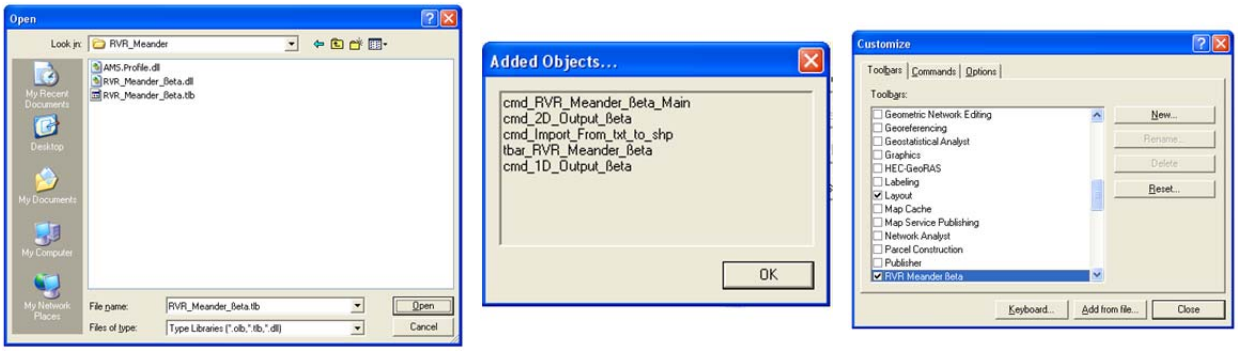


**Figure 5. Browse to installation folder and select the file with the ".tlb" extension (left). Added Objects dialog will be shown on screen (center) and the RVR Meander Toolbar will be visible on the Customize window (right).**

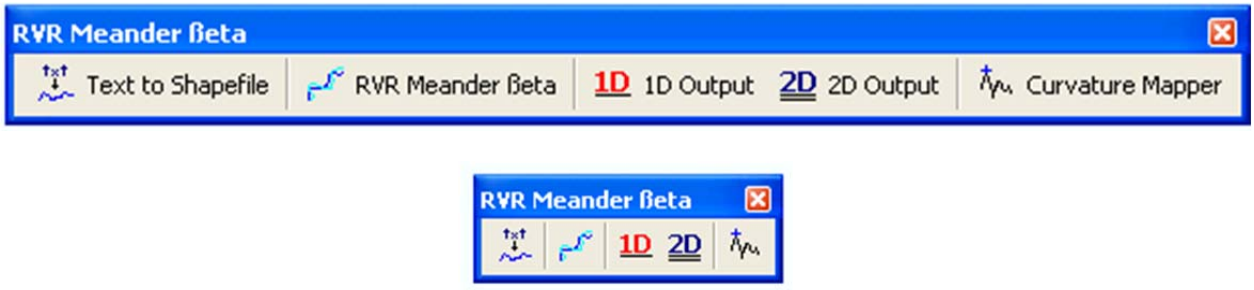


Figure 6. RVR Meander Toolbar with "Image and Text" (top) and with "Image Only" (bottom).

### 3.4.3. FROM TEXT FILE (.TXT) TO SHAPEFILE (.SHP)

The first command button in the toolbar creates a shapefile from a text file (see Figure 7). It first displays an "Open File Dialog" that lets the user browse for the required text file (see Figure 8). Then it displays a "Save File Dialog" in which the user selects the folder to save the new shapefile (see Figure 9).


Figure 7. Create shapefile from a text file.

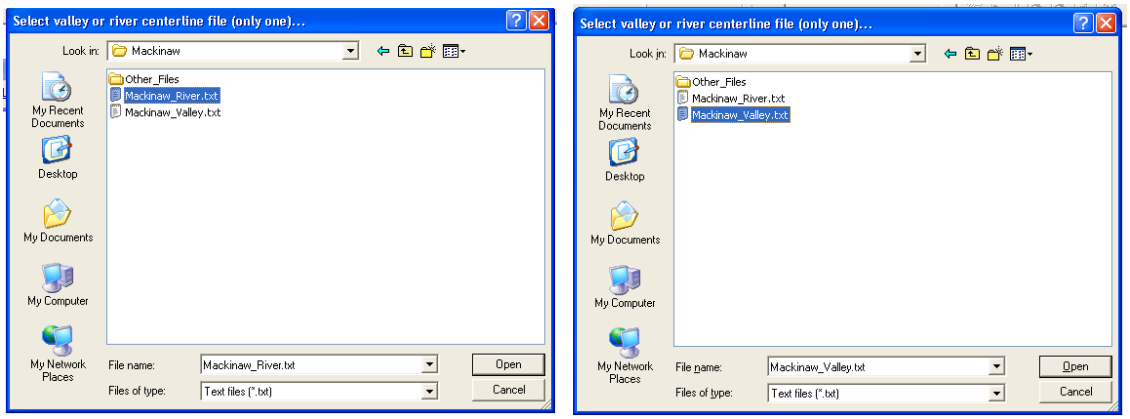


Figure 8. Select either the river or the valley centerline to input. Currently only one file at a time is supported.

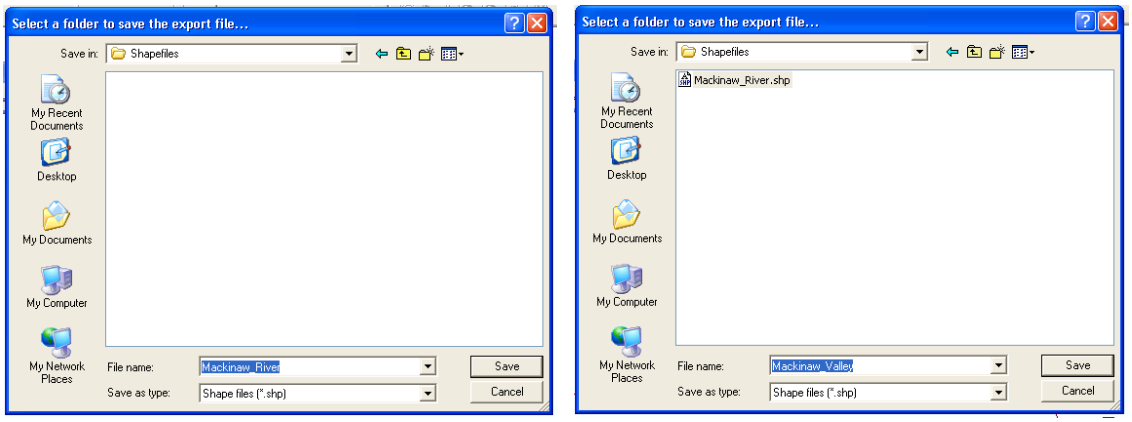


**Figure 9. Browse to the folder where the shapefile will be created, give it a name and select Save.**

After the user clicks "Save" for either the river or the valley the shapefile will be created and added into the current map. Figure 10 shows both the River and Valley shapefiles inside ArcMap.

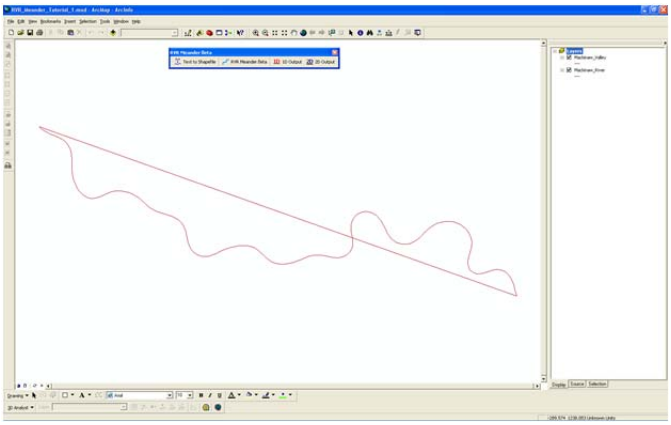

**Figure 10. River and valley centerlines displayed in ArcMap.**

### 3.4.4. THE RVR MEANDER USER INTERFACE

The main user interface can be accessed by clicking on the second button on the toolbar (see Figure 11). It loads the RVR-GUI which is made up of eight tabs in which the user can input the different parameters for the analysis.


**Figure 11. Open RVR-GUI by clicking on the RVR Meander command button.**

#### 3.4.4.1. LAYER DEFINITION TAB

The first tab (see Figure 12) is used to select which layers from the current map correspond to the river and valley centerlines. The map can be either in SI or English Units and if the user doesn't select the "use valley centerline" checkbox, the code will assume a straight line from the first to the last point of the river centerline. This is the case for the example shown but the valley centerline is not required to be a straight line.

#### 3.4.4.2. CHANNEL PROPERTIES TAB

The second tab is used to input the channel properties. The user can input all values in SI or English Units (see Figure 13).

#### 3.4.4.3. PREPROCESSING TAB

The third tab has three dropdown menus for preprocessing purposes (see Figure 14). They deal with the ways in which curvature is computed at the different nodes of the river centerline.

#### 3.4.4.4. HYDRODYNAMICS TAB

The fourth tab corresponds to the hydrodynamics parameters. Currently only the Ikeda et al. (1981) model is implemented for the hydrodynamic computations. Three additional parameters are required (see Figure 15).

#### 3.4.4.5. BANK EROSION TAB

The fifth tab has two main options. The traditional approach that used the migration coefficient (see Figure 16) which is empirically based and a physically based approach that might be used for analyses of meander migration in engineering time scales (Motta et al. 2011). The second approach has two additional tabs that correspond to main and advanced options for the physically-based bank erosion model (see Figure 17).

#### 3.4.4.6. MIGRATION TAB

The sixth tab is used for migration parameters. Here's where the user indicates the length in years for the analysis and the frequency for the computations (see Figure 18).

#### 3.4.4.7. SMOOTHING TAB

The seventh tab contains two main dropdown menus that allow indicating the method to be used for smoothing purposes during the computations. If centerline smoothing is selected, the panel shown below for the Savitzki-Golay method becomes active (see Figure 19).

#### 3.4.4.8. OUTPUT TAB

The eight tab is the last one and its main purpose is for the user to indicate which parameters used inside the computation will be saved into as output files. In the case of the Migration Coefficient approach (see 3.4.4.5) the last three output files will not be available (see Figure 20).

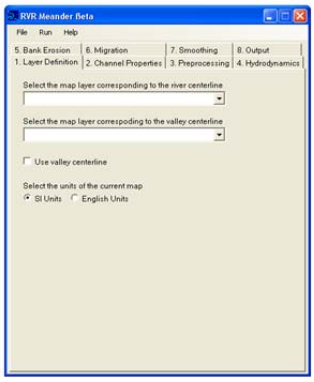


Figure 12. RVR-GUI Layer Definition tab.


Figure 13. RVR-GUI Channel Properties tab.

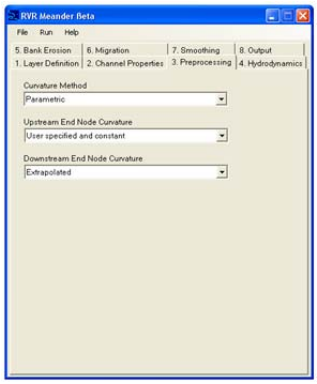


Figure 14. RVR-GUI Preprocessing tab.

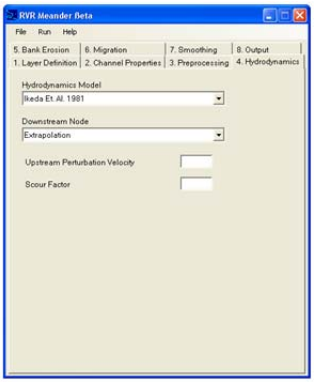


Figure 15. RVR-GUI Hydrodynamics tab.

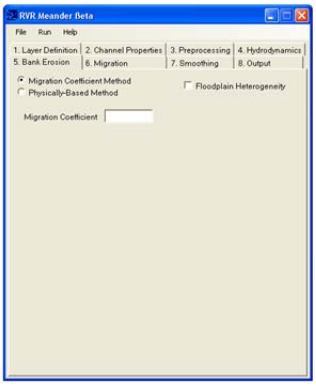


Figure 16. RVR-GUI Bank Erosion tab; Migration coefficient approach

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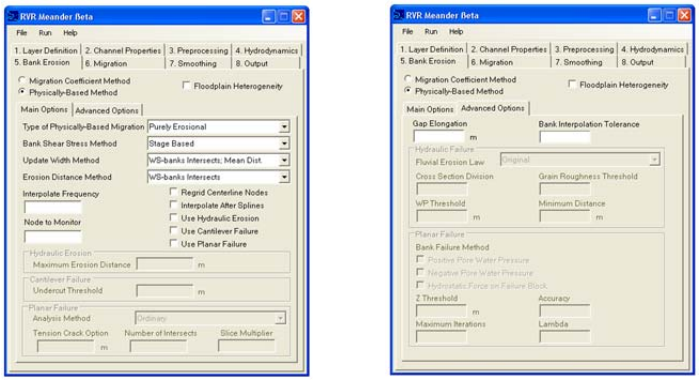


Figure 17. RVR-GUI Bank Erosion tab; Physically-based approach Main Options (left) and Advanced Options (right).

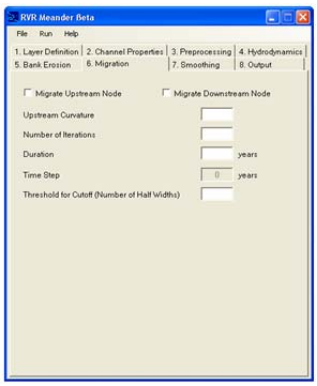


Figure 18. RVR-GUI Migration tab.


Figure 19. RVR-GUI Smoothing tab.

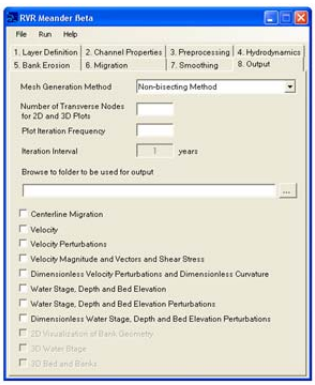


Figure 20. RVR-GUI Output tab.

### 3.4.4.9. THE FILE MENU

The File Menu has three main options that let the user either Export/Import or Close the RVR-GUI (see Figure 21). The Export option displays a sub-menu that provides the possibility of exporting to text file either the shapefiles (River and Valley Centerlines) or the Configuration (parameters in all the tabs). In the case that a user wants to run several times but needs to change only few parameters from one run to another it's a good idea to export the configuration and import it back again for the next runs. All fields in the eight tabs will be populated with the appropriate values.

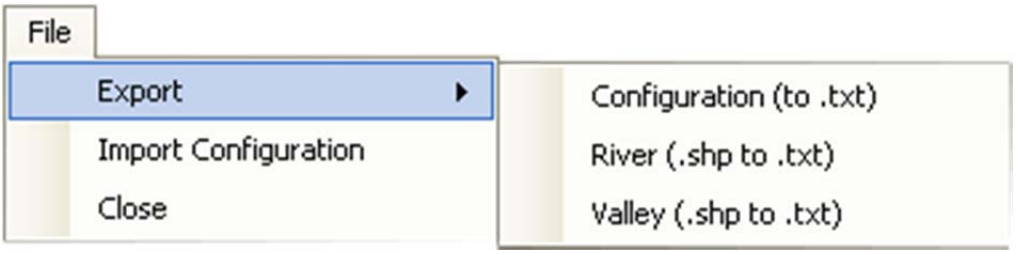


Figure 21. RVR-GUI File Menu.

All export options display a "Save File Dialog" asking where the text file should be saved. Figure 22 shows this dialog for an "Export Configuration" case. Figure 23 shows the configuration file in .txt format. This file can be imported back into the RVR-GUI with the difference that what appears on screen is an "Open File Dialog" prompting the user to select the corresponding text file.

Figure 24 shows both an exported River centerline and a Valley centerline in .txt format. That's the same format required to create a shapefile from text file when using the RVR Toolbar.

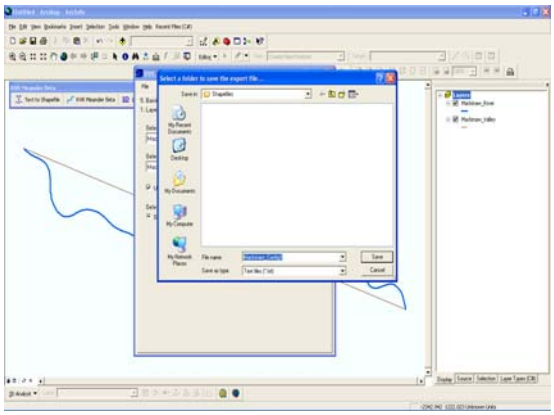

**Figure 22.After clicking the Export Configuration option the user should specify the location to save the exported text file. In this case the given name is Mackinaw_Config1.txt.**

**Figure 23. Configuration File in .txt format. It can be opened with the Notepad.**

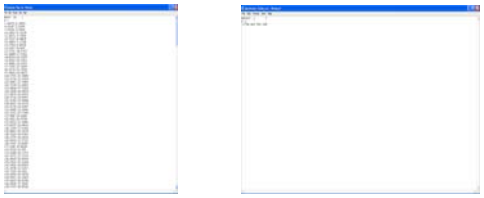

**Figure 24. Exported River and Valley centerlines in .txt format.**

### 3.4.4.10. THE RUN MENU

The Run Menu is a simple one which only contains the option to "Run Simulation" (see Figure 25). When the user clicks it a new window appears on screen. This window is a "Log File Watcher" (see Figure 26) which displays on screen preliminary results from the computations of the model. When the model finishes the run the Log File Watcher will notify the user which can then choose whether to "Save" the log file or just "Close" and delete it.

Temporary files are created during the run and deleted immediately after it finishes. If the user wants detailed information of the computations it's important to save the log file. If the user decides to save, a "Save

File Dialog" will appear prompting the user to browse to the folder where that log file in .txt format should be saved. An example of this file is shown in Figure 27.

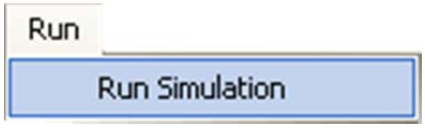


**Figure 25. RVR-GUI Run Menu.**

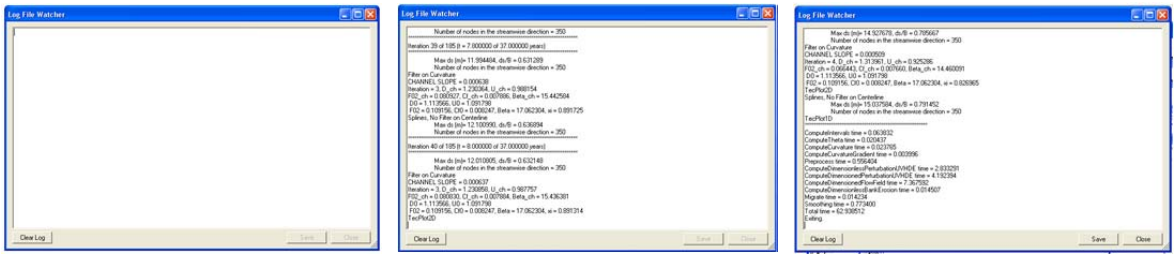

**Figure 26. Log File Watcher before the run (left) during a run (center) and after the run finishes (right).**

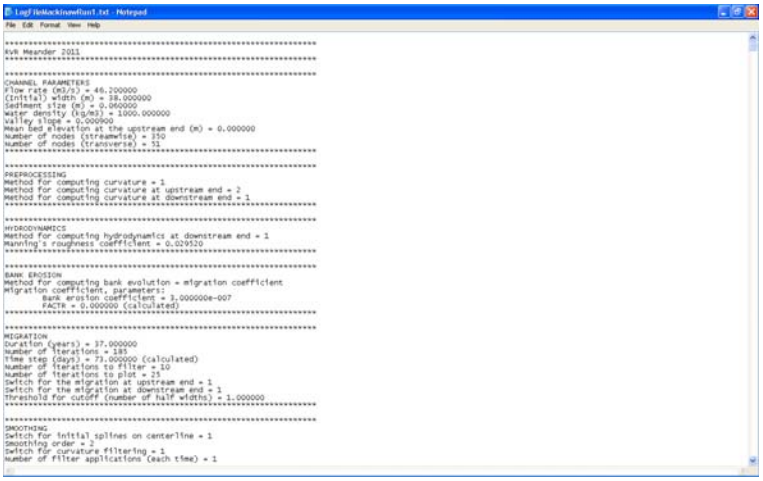

**Figure 27. Log File in .txt. format.**

### 3.4.4.11. THE HELP MENU

The Help Menu has three options (see Figure 27). It provides access to the User's Manual, it allows displaying a window with information About RVR (see Figure 28) and it also displays a message box on screen with the e-mails to which users might send feedback (see Figure 29).

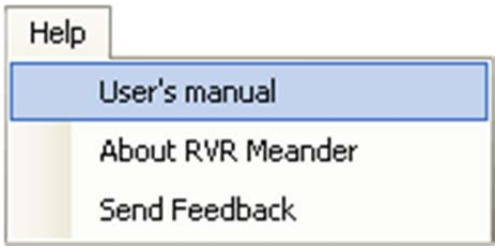


**Figure 28. RVR-GUI Help Menu.**

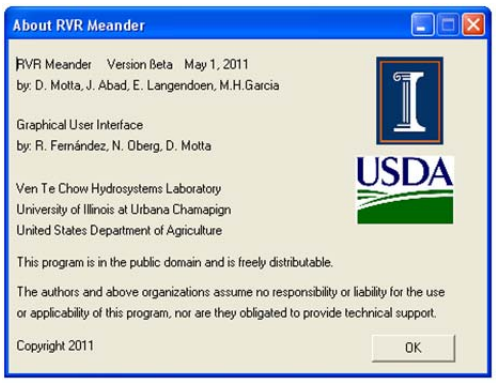


Figure 29. RVR-GUI About RVR Meander.


Figure 30. RVR-GUI Send Feedback To.

### 3.4.5. 1D OUTPUT

The "1D Output" command (see Figure 31) displays a window that will let the user specify in what folder is the file with the output information saved (see Figure 32). If the folder specified does not contain a 1D output file a message will be displayed warning the user (see Figure 33). If the folder contains the appropriate file then the window will expand and the user will be able to click the "Finish" button two create the shapefile. Depending on the number of iterations used during the run it might take some seconds before the shapefile is added and displayed into the map. While the 1D Output is being processed a message will be displayed on ArcMap's status bar - at the bottom of the screen (see Figure 35). When the process ends a "Migrated Centerlines" shapefile will be added to the map (see Figure 36).


Figure 31. Import a 1D Output file of Migrated Centerlines.

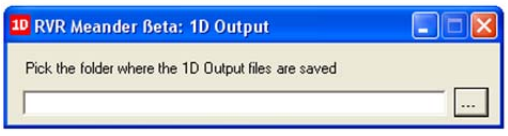


Figure 32. 1D Output user form.

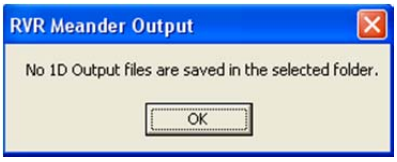


Figure 33. 1D Output – No file found message.

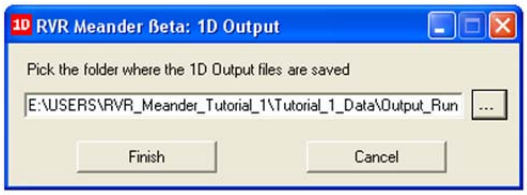


Figure 34. 1D Output expanded user form.


Figure 35. 1D Output – Status bar messages while processing.

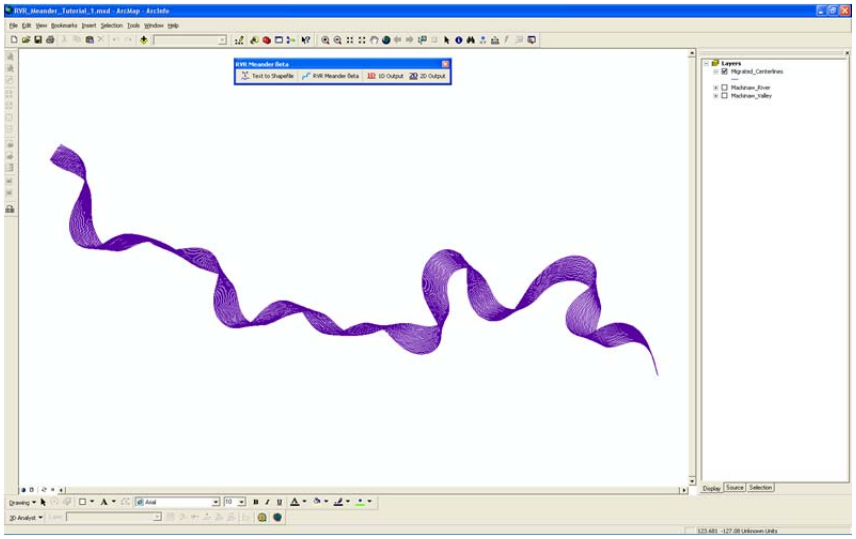

Figure 36. 1D output - Migrated Centerlines shapefile added into ArcMap.

### 3.4.6. 2D OUTPUT

The "2D Output" command (see Figure 37) displays a window (see Figure 38) that will let the user specify in which folder are the 2D output files saved. If the folder specified does not contain output information a message will appear warning the user (see Figure 39). If the folder contains appropriate output files then the window will expand (see Figure 40) and let the user indicate which parameters will be outputted in ArcMap and for what iteration-number of years (see Figure 41). If some of the parameters are not available because they weren't saved during the run, their respective checkboxes will appear disabled.


Figure 37. Opens user form to import 2D Output parameters.

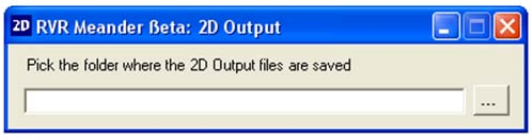


Figure 38. 2D Output user form

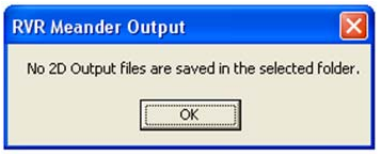


Figure 39. 2D Output – No file found message

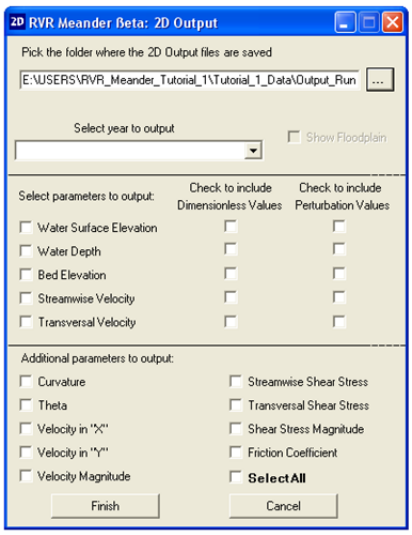


Figure 40. 2D Output user form – expanded.

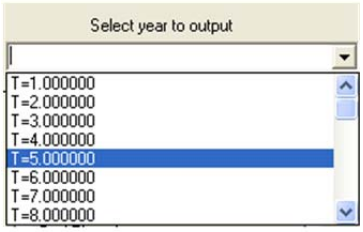


Figure 41. Select iteration – number of years to output.

When the user clicks the "Finish" button two or three shapefiles are created. While they are being created a message will be displayed in ArcMap's status bar (bottom of the screen) letting the user know that output is being processed (see Figure 42). If the Floodplain checkbox was not checked only two shapefiles will be created. The first one is the 2D Output shapefile (see Figure 43) which will have all the parameters that the user checked in the Attribute Table (see Figure 44) and the second one is a boundary polygon for the corresponding iteration (see Figure 45). This boundary polygon is necessary to create a TIN or Raster to visualize different parameters in ArcMap. Figure 46 shows a close up view of the 2D output shapefiles. Display properties were changed for both layers. The boundary is just a polygon and the 2D output is made up of points. Each point is located on a given cross section and contains the value for the different parameters at that specific location in space. Finally if the Floodplain option was checked a shapefile of points (see Figure 47) with the floodplain's properties in the Attribute Table (see Figure 48) will be created and added into the map.

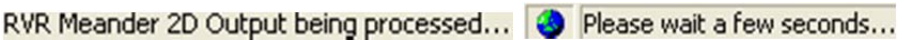


Figure 42. 2D Output – Status bar messages while processing.

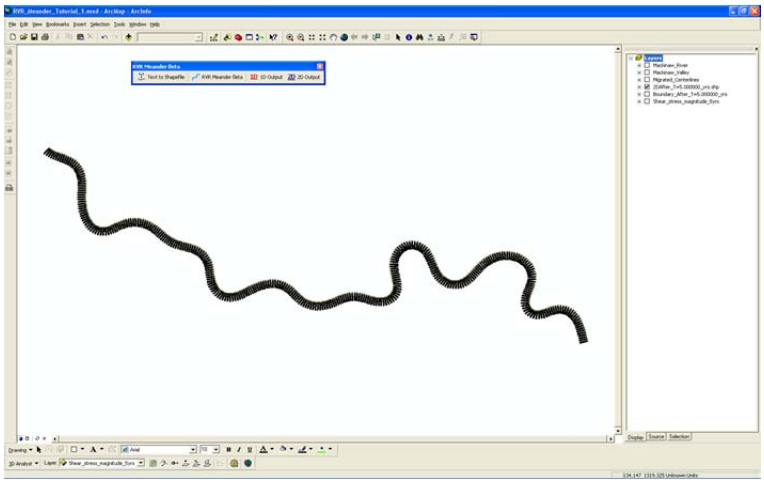

Figure 43. 2D Output shapefile added into ArcMap.

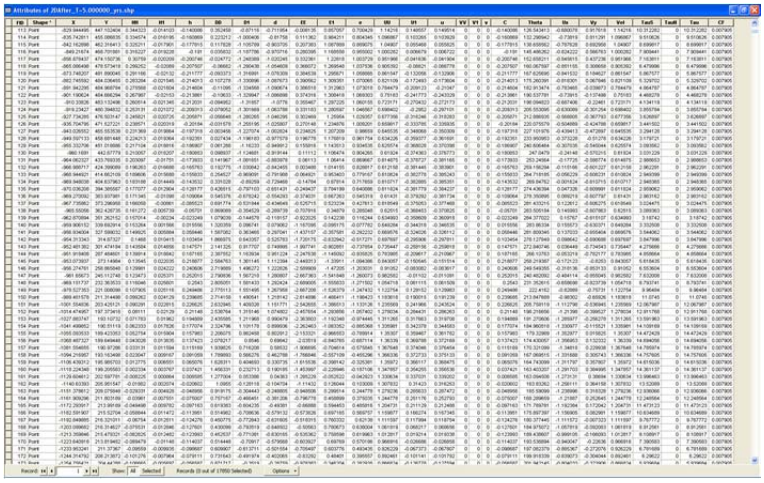

Figure 44. Attribute Table for the 2D Output including all selected parameters.

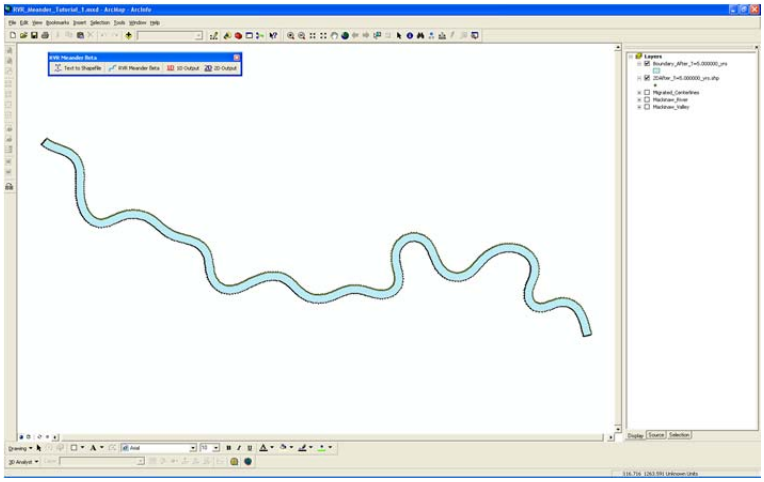

Figure 45. 2D Output Boundary Polygon added into ArcMap.

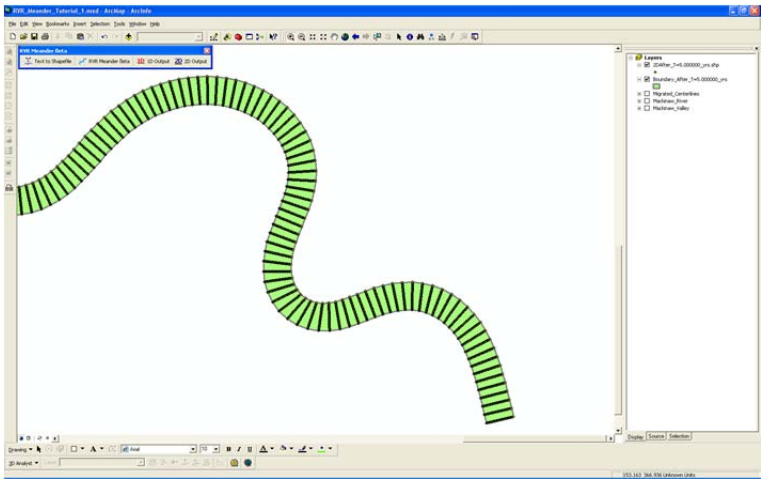

Figure 46. 2D Output – Close up to see the detail of the created shapefiles.

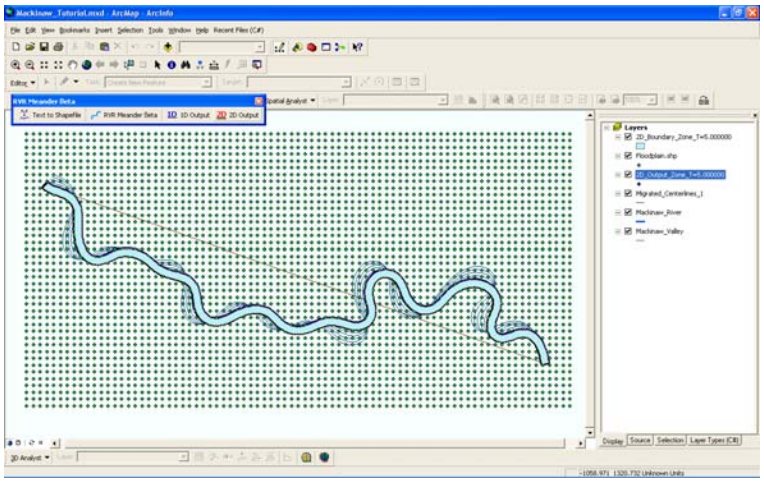

Figure 47. Floodplain Heterogeneity shapefile added into ArcMap.

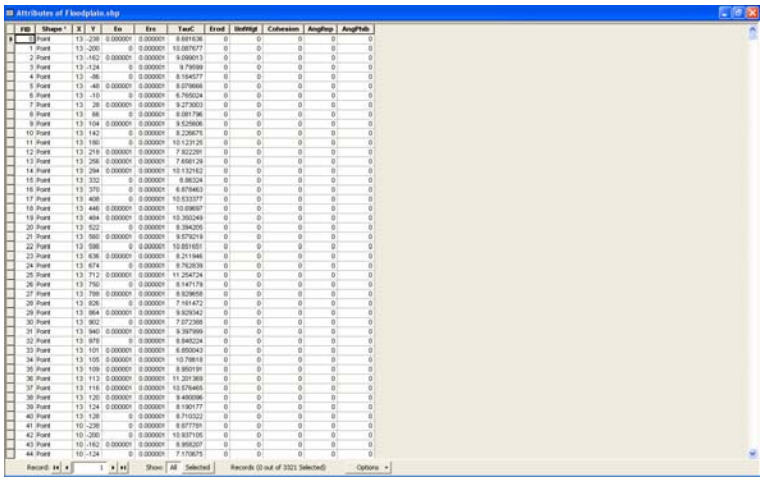

Figure 48. Attribute Table for the Floodplain Heterogeneity shapefile.

In order to create a TIN for any given parameter the user must use the "3D Analyst" extension of ArcMap. If not yet activated, the user must do so by going to the Tools Menu and then Extensions (see Figure 49). Once it's activated the user can add the toolbar in the same way that the RVR Meander Toolbar was added.

To create a TIN for any specific parameter the user should follow these steps: Click on the "3D Analyst" command and select "Create/Modify TIN" and then "Create TIN From Features" (see Figure 50). A new window appears in which the user should select both the 2D Output shapefile and the boundary polygon. The example shown will create a TIN for the parameter "TAU" (see Figure 51) using the "5 years" iteration and the corresponding boundary polygon. Note that for the 2D Output file the "Height source" for the TIN is the desired parameter (shear stress magnitude in this case) and in the case of the boundary polygon the option "None" should be selected as well as the "Soft Clip" option. User should also specify the folder to save the TIN (see Figure 52). Failure to use the boundary polygon in the creation of TINs will still create a TIN but it won't follow the river's migrated centerline (see Figure 53). Once the user click's "OK" the TIN will be created and displayed in ArcMap (see Figure 54).

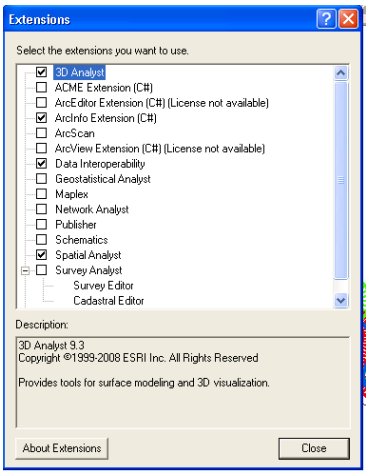


**Figure 49. Enabling the 3D Analyst extension for ArcMap.**

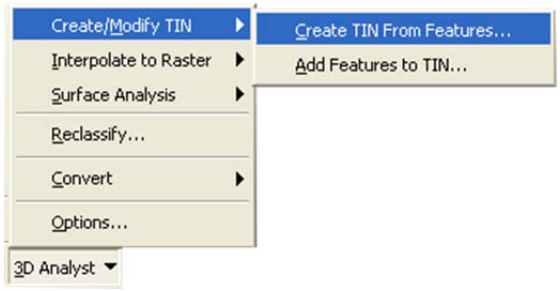


**Figure 50. Accessing the "Create Tin from Features" window with the 3D Analyst toolbar.**

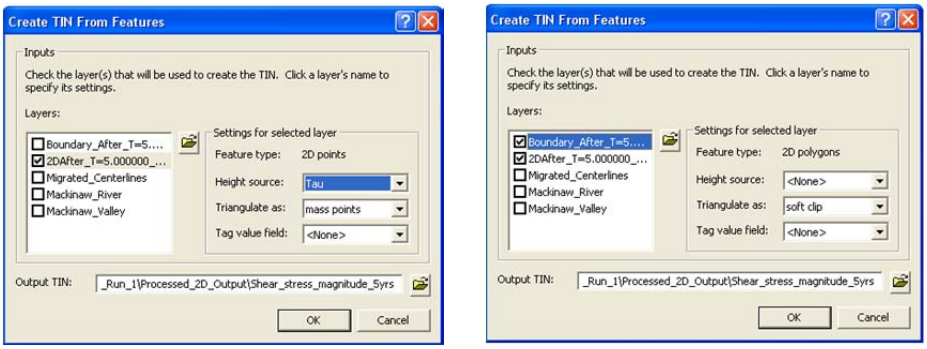


**Figure 51. Required parameters to Create a TIN from features using the 2D Output produced with the RVR-GUI.**

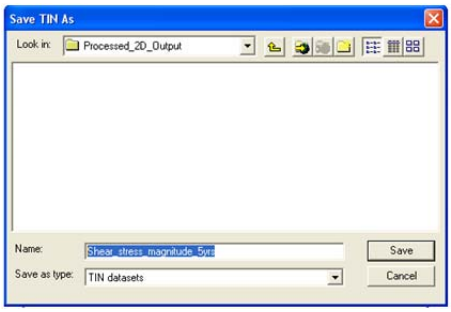


**Figure 52. Select folder to Save the TIN.**

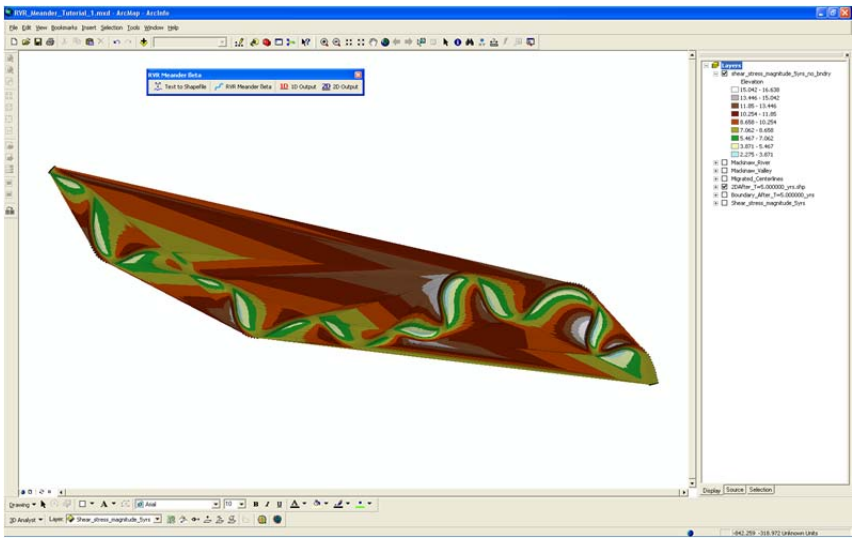

Figure 53. 2D Output – TIN created without specifying the boundary polygon.

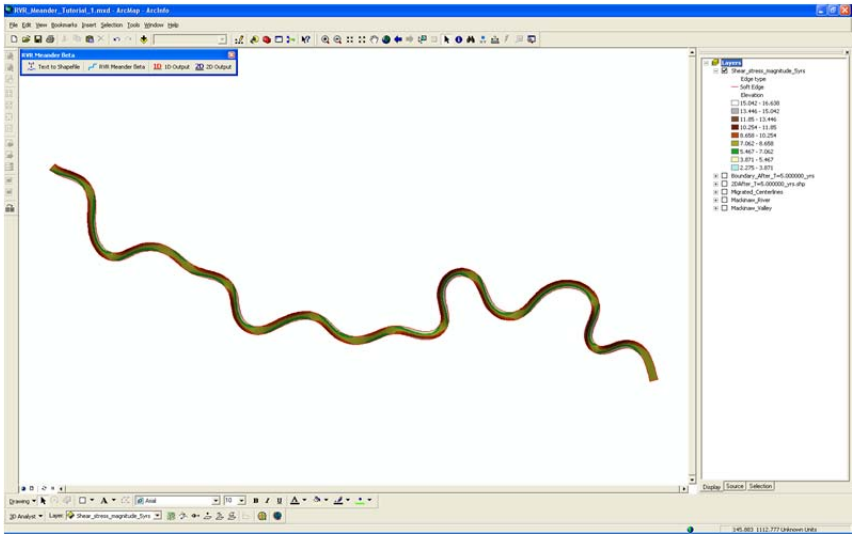

Figure 54. TIN created and added into ArcMap.

In the case of the Floodplain shapefile, the user can use either the Spatial Analyst, the 3D Analyst or even the Geostatistical Analyst to create a raster to show the properties. An example is shown here using the 3D Analyst toolbar (see Figure 55) to create a floodplain Raster using the "Inverse Distance Weighted – IDW" algorithm (see Figure 56). The parameter used is the critical shear stress (TauC). The resulting raster is shown in Figure 57.

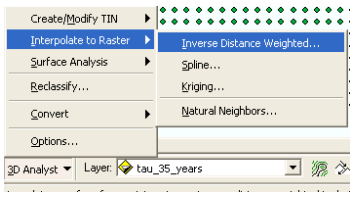


Figure 55. Create a Raster using the IDW method from the 3D Analyst toolbar.

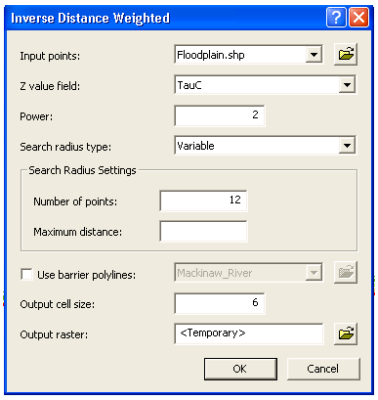


**Figure 56. IDW parameter definition window for the Floodplain raster.**

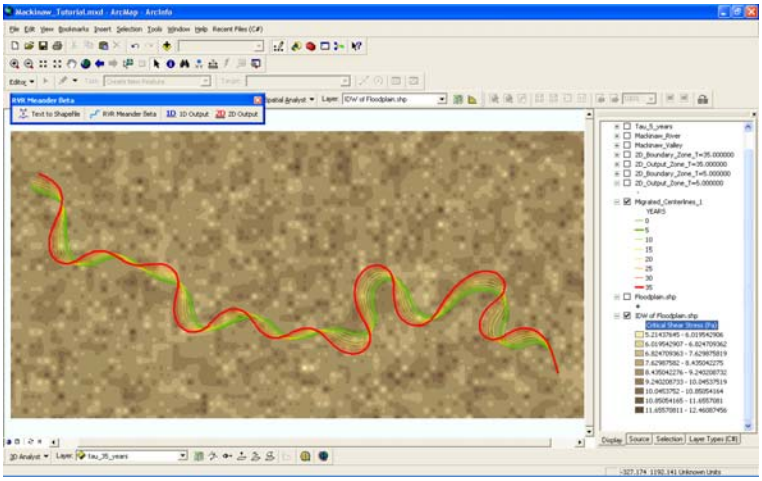

**Figure 57. Floodplain Heterogeneity Raster using the Critical Shear Stress TauC.**

## 3.4.7. THE CURVATURE MAPPER TOOL

The "Curvature Mapper" tool (see Figure 58) changes the mouse icon to a cross hair with which the user can select a polyline feature, say the original river reach or any of the 1D migrated centerlines, and visualize the curvature as a function of stream wise distance (see Figure 59).


**Figure 58. Curvature Mapper Tool**

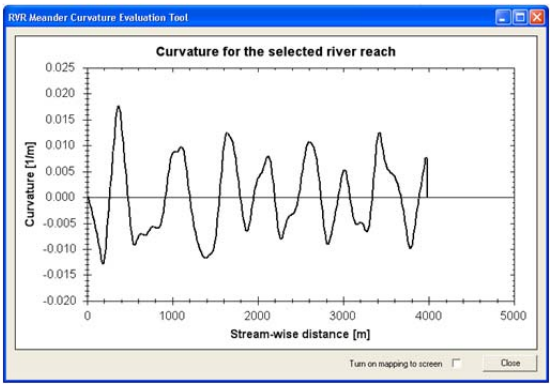


**Figure 59. Curvature mapper plot for the original river reach.**

The user can enable the mapping to screen feature by clicking on the corresponding checkbox. The mapping to screen functionality lets the user get a better idea of the parts of the river reach that have specific curvature values. While active, the feature displays a black circle over the selected river reach and it moves as the user moves the mouse on the Curvature Mapper plot. Figure 60 shows the case for the highest curvature value on the selected river reach. (X, Y) coordinates are displayed on the plot and the black dot on screen shows where that specific point is located. The curvature mapper tool is meant to aid the user in both the process of river reach digitalization and in the analyses of migrated centerlines.

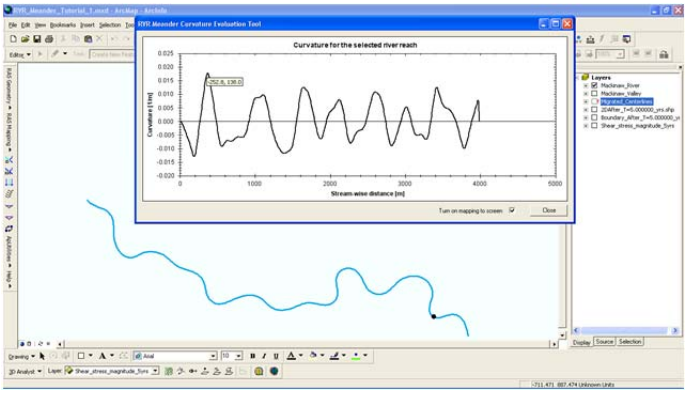

**Figure 60. Curvature Mapper with mapping to screen future enabled.**

## 3.5. EXAMPLE OF POST-PROCESSED OUTPUT USING ARCMAP'S CAPABILITIES

The RVR-GUI in ArcMap allows using all the built in functionalities which is an added future for the interface. Quality output can be made with some post processing effort with ArcMap's tools. An example is shown below (see Figure 61).

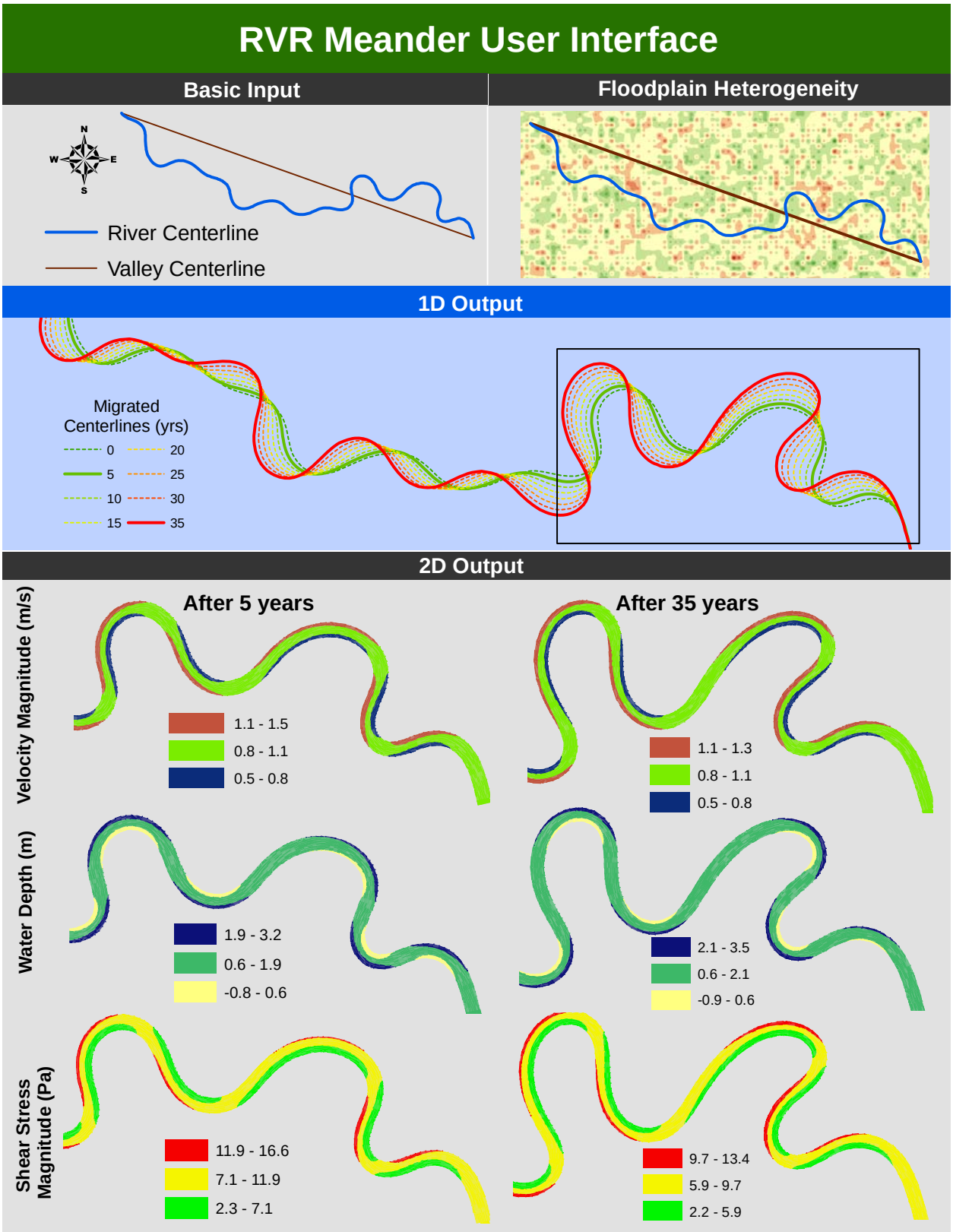


Figure 61. Example of post-processed output using RVR-GUI and ArcMap.