Creating river bathymetry mesh from cross-sections

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May 2011

Introduction

Surface representation of river bathymetry and surrounding topography is required for 2D/3D hydrodynamic modeling and flood inundation mapping. Topographic data in the form of Digital Elevation Models (DEMs) are often available for areas surrounding river channels, but getting a continuous surface for river channels demands resources. Most often old cross-sections are interpolated using GIS techniques to create continuous river bathymetry. Because GIS interpolation techniques do not consider river flow direction and anisotropy, custom tools are required to interpolate cross-sections for creating continuous river bathymetry. Once a bathymetry mesh is created, it must be integrated with surrounding topography to create a coherent river terrain model. The objective of this tutorial is to address the first issue: creating bathymetry mesh from cross-sections using a custom GIS tool, which is provided as a custom GIS command button.

This tool will be constantly under development/improvement. Interested users may contact Venkatesh Merwade at vmerwade@purdue.edu to get updates and additional information. Technical information and concept used in developing this tool are published in the following journal article:

Merwade V., Cook A., and Coonrod J., GIS techniques for creating river terrain models for hydrodynamic modeling and flood inundation mapping. Environmental Modelling & Software, Vol. 23/10-11, pp 1300-1311 (2008).

Comments on the above article, or ideas on how to improve this technique are most welcome.

Computer Requirements

You must have a computer with windows operating system and ArcGIS 10 (with ArcInfo) installed. Having the latest version of .Net framework (available free from Microsoft) installed on your computer will avoid unpleasant messages during installation! .Net framework 3.5 is used during the testing of the tool.

Data Requirements and Description

The custom tool (provided as an installation file) and the data necessary to complete this tutorial are provided as a zip file, which can be downloaded from the following link:

http://web.ics.purdue.edu/~vmerwade/education/Bathymetry.zip

Unzip *terrain_modeling.zip* in your working directory. You must have four files in the *Data* folder: *SampleData.mdb*, setup.exe. *terrain_modeling.mxd, and terrain_setup.exe* as shown below.
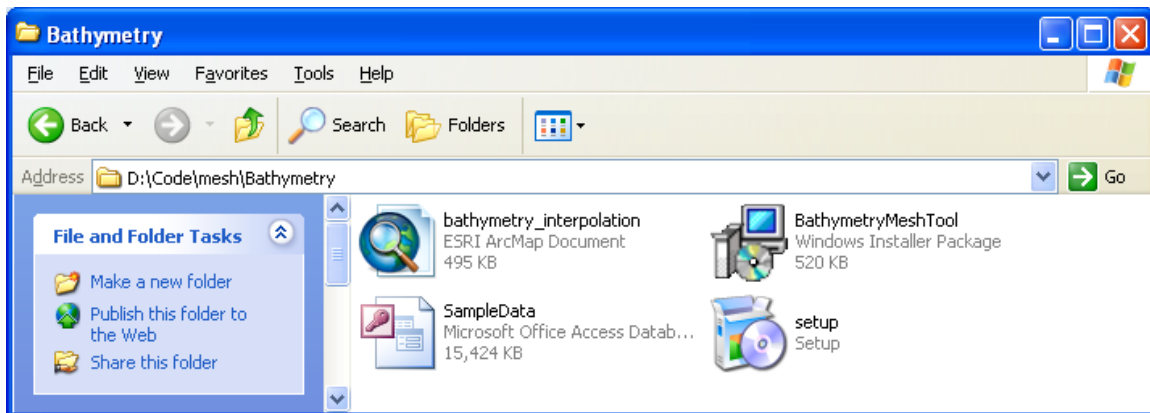
SampleData.mdb contains input data, terrain_modeling is an ArcMap document and setup.exe and terrain_setup.exe are installation files. [**Note**: terrain_modeling.mxd is created and saved using ArcGIS 10. You cannot open it with ArcMap 9.x]

Tool Installation

Please make sure that you have administrative control to run the installation. Next, in windows explorer, **double click** on *setup.exe* or *BathymetryMeshTool.exe*, and follow the installation instructions to install the custom tool for use in ArcMap (see images below). You can choose any directory of your choice to store installed files. By default, the tool is installed in C:\Program Files\BathymetryMeshTool.
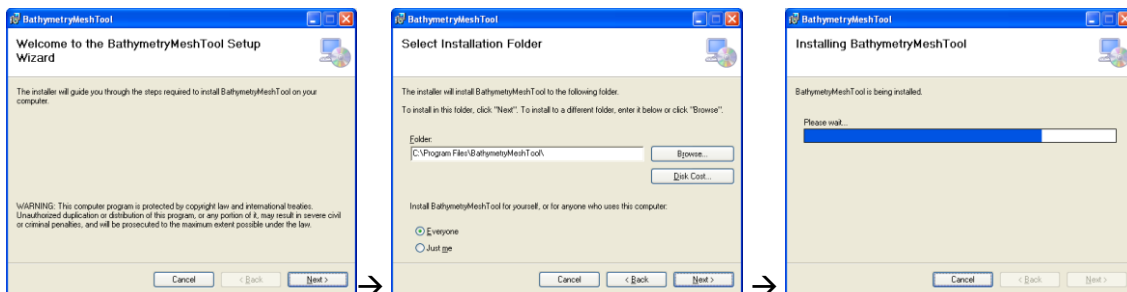
If you want, you can check the files that will be installed in your specified directory (the most important file is mesh.dll).

Creating River Bathymetry Mesh

Double-click on *bathymetry_interpolation.mxd* to open the document in ArcMap. It should look like the following screen-shot.
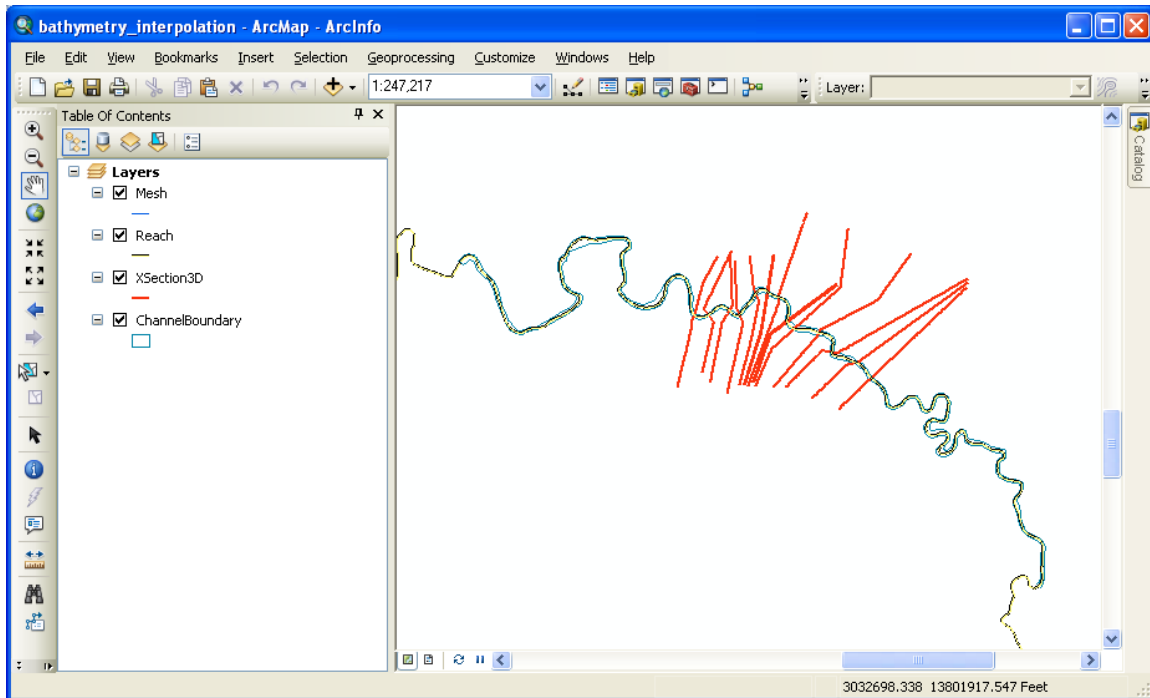

If the data are not loaded in map (or if you see ! next to layer names in ArcMap table of contents), just browse to corresponding feature classes in *SampleData.mdb* in your working directory.

There are four layers in the map document with self-explanatory name: XSection3D, Reach, ChannelBoundary and Mesh. All except Mesh have data in them. *XSection* contains actual surveyed cross-sections for a reach of Brazos River in Texas, *Reach* contains the centerline for this reach, and *ChannelBoundary* contains the main channel boundary for the reach. *Mesh* is empty and will be populated in this tutorial. As you can see *XSection3D* lines cover main channel as well as surrounding floodplain. In this tutorial we will only interpolate *XSection3D* to create a bathymetry mesh (surface) for the main channel. The out-of-channel part of *XSection3D* lines must be integrated with surrounding DEM, which will be added to the next version of this tutorial.

You can open the attribute tables of these feature classes to see what information is stored for each feature. Note that some of these features have z information stored in their shapes (eg. XSection3D features). Also, the current version of the tool uses some of the fields whose names are hard coded in the program. For example, the field "StationNo" in XSection3D is used to sort cross-sections while interpolating. Do not modify the field names or attributes for any feature class otherwise the program will give error messages. To run the tool using other datasets, you must have cross-sections as 3D lines and have "StationNo" attribute populated. StationNo contains the distance of each cross-section along the reach (channel centerline). Similarly, Mesh

must be a 3D Polyline feature class with ProfileID and CrossID fields of type Integer. No attributes from ChannelBoundary or Reach are used by the program, but these feature classes must have features to create the mesh.

To load the tool into the map document, **click** on *Customize→Customize Mode..*
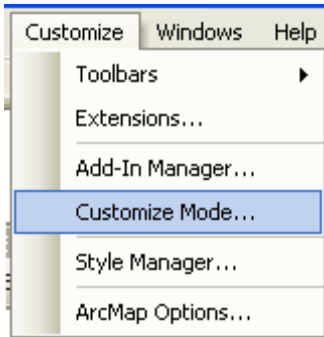
In the customize window, select the Commands tab, and scroll down until you see *Bathymetry Tool* in Categories box and *Create Bathymetry Mesh* in Commands box as shown below.
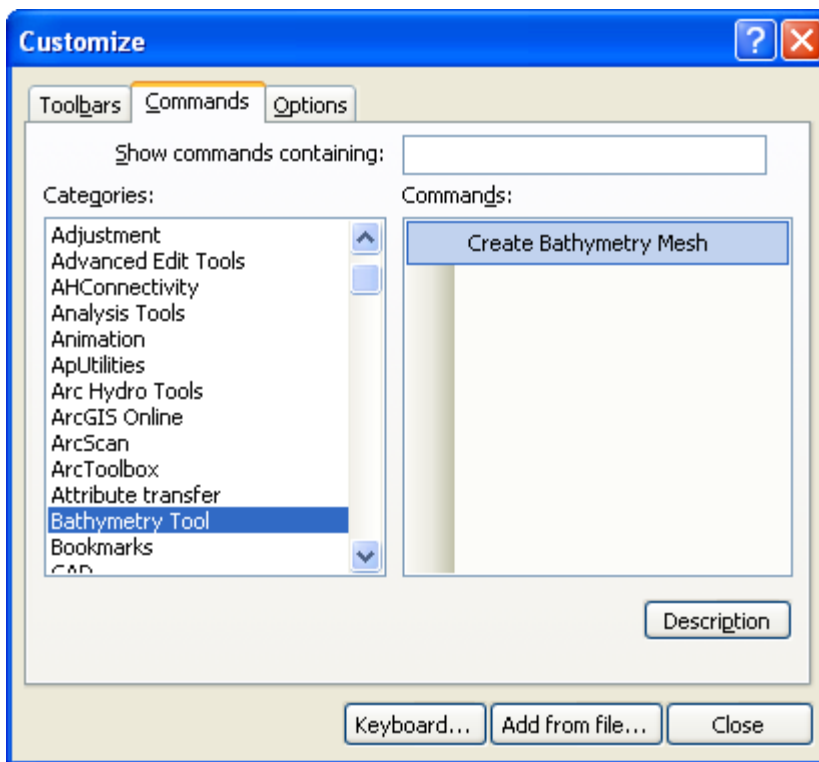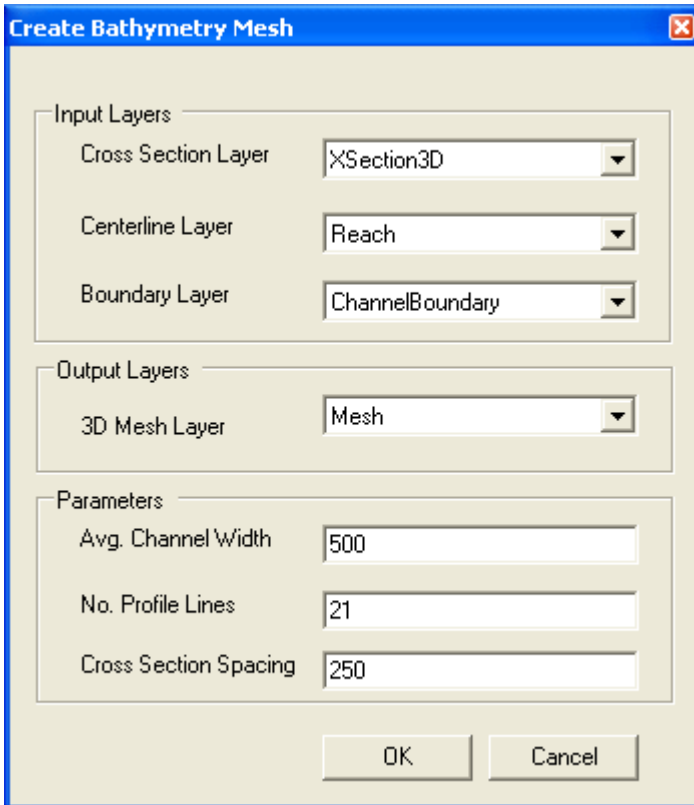

Select Create Bathymetry Mesh command and drag it on any menu bar in ArcMap.

Close the Customize window, and save the map document. You are now ready to use the tool!

Click on *Create Bathymetry Mesh* command button you just added to invoke the user interface:

(Note: for some reason, if the interface is hiding, you will see it on your Taskbar at the bottom of your screen. Just click on it, and you should be able to see it.).

For *CrossSection* layer, choose *XSection3D* (feature class containing surveyed cross-sections), for *CenterLine* layer, choose *Reach* (feature class containing channel centerline), for *Boundary*, choose *ChannelBoundary* (feature class containing main channel boundary), and for *3D Mesh*, choose *Mesh*, which will store the interpolated 3D mesh. Besides specifying GIS layers, three additional parameters needs to be provided to execute the bathymetry mesh tool. These are average main channel width, number of interpolated profile-lines (lines along the channel), and spacing between interpolated cross-sections. A higher number for profile-lines and shorter cross-section spacing will create a finer 3D mesh and vice-versa. For this tutorial, you can keep the default values unchanged, and **press** the *OK* button. Because the data and map has units in Feet, the parameters are interpreted in Feet. If the map is in SI units (meter), the program will interpret all numbers in SI units.

The program may take some time and you will get a final message as shown below (it is taking longer after I migrated from VB to VB.Net, and I looking into resolving this issue):
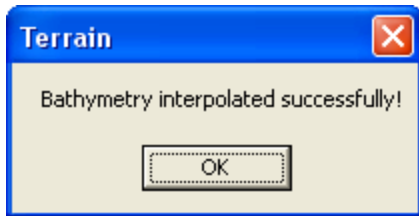

Click OK to terminate the message and zoom-in to see the interpolated mesh.

A zoomed view of the interpolated mesh is shown below:
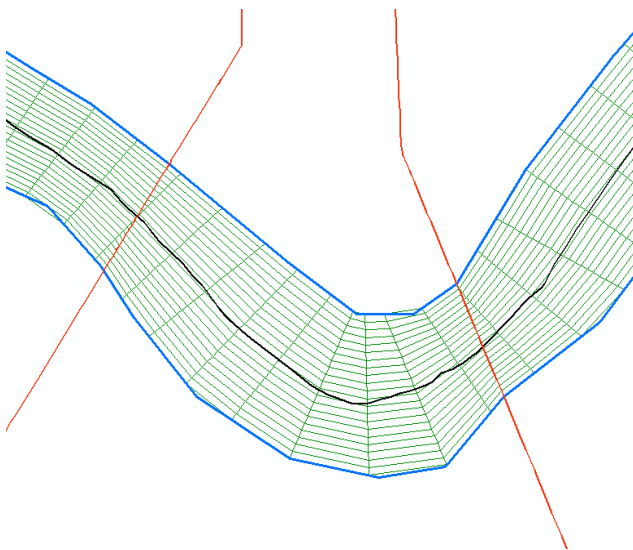
Open the attribute table of Mesh to see each profile-line and cross-section in the interpolated mesh has a identifier (CrossID and ProfileID) that can be use to separate or analyze these lines individually, if needed.

By default, the program interpolates all features in XSection3D, but one can select (using select features tool) two or more lines in XSection3D, and the program will create mesh only between selected lines. An interpolated mesh for the two cross-sections shown in above picture with 10 profile lines and 500 cross-section spacing is shown below:
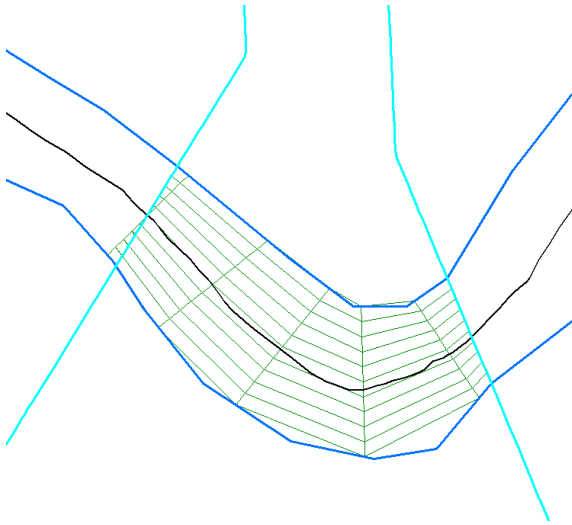
OK, you are done! If you have data for other areas, you can try using the tool with your own data. The program is still under development, and if you have questions/comments/suggestions, please contact Venkatesh Merwade at vmerwade@purdue.edu. Happy bathymetry interpolating!!