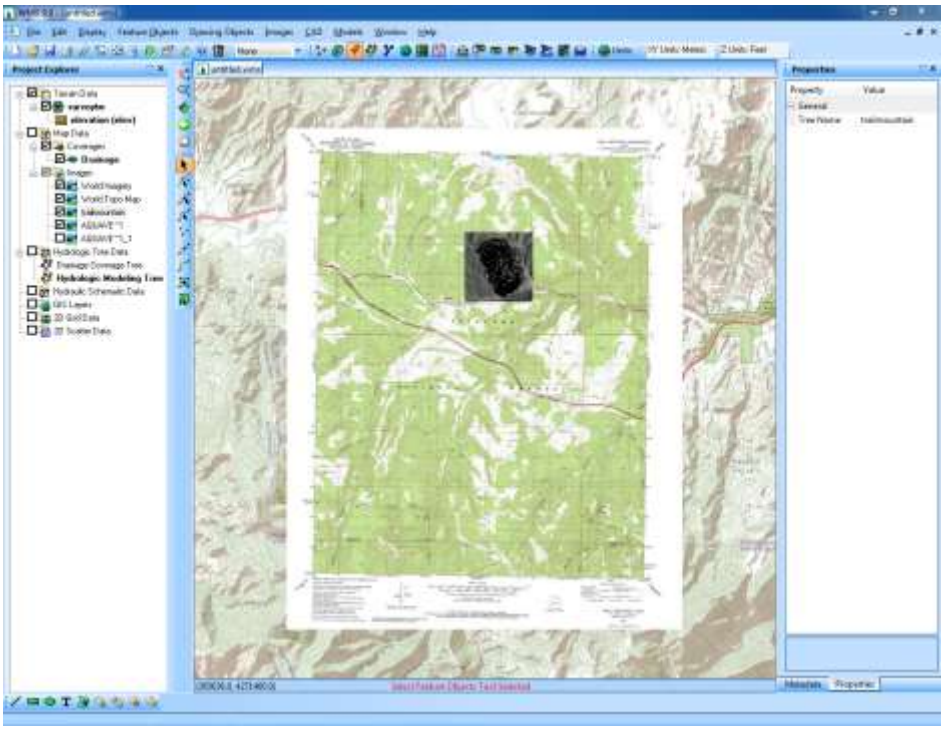
WMS

v. 10.0

WMS 10.0 Tutorial

Editing Elevations – Using TINs

Import, view, edit, convert, and digitize triangulated irregular networks using a variety of methods



Objectives

Import survey data in an XYZ format. Digitize elevation points using contour imagery. Edit and merge TINs and convert between DEMs and TINs. Export TIN contours to a CAD file.

Prerequisite Tutorials

- None

Required Components

- Data
- Map

Time

- 30-60 minutes

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1 Introduction

Triangulated Irregular Networks (TINs) are constructed from a scattered set of xyz vertices. They can be used for visualization, as background elevation maps for generating new TINs or DEMs, or to obtain cross sections for hydraulic models. WMS has powerful tools for importing and manipulating TIN data.

2 Objectives

The following topics will be covered in this exercise:

1. Importing survey data
2. Digitizing data
3. Triangulation
4. Automated TIN editing
5. Manual TIN editing
6. Creating a TIN using a conceptual model
7. Converting a TIN to a DEM
8. Exporting data to CAD

3 Importing Survey Data

1. Close all instances of WMS.
2. Open WMS.
3. Select *File* | **Open** .

4. In the *Open* dialog, locate the "tins" folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
5. Select "surveytm.txt" and click **Open**.
6. The *File Import Wizard* will appear. Leave the default settings. This is a tab delimited file exported from Excel. Select **Next**.
7. In the WMS data type dropdown menu, choose "Survey Data".
8. In the File preview spreadsheet, ensure that the first, second, and third column types are mapped to X, Y, and Z, respectively.
9. Select **Finish**.
10. Right-click on "surveytm" under "Terrain Data" in the Project Explorer and select **Display Options** from the pop-up menu.
11. In the *Display Options* dialog, toggle on *Unlocked Vertices*.
12. Select **OK**.

Users should now see the points from the "surveytm.txt" file.

13. Select *Display* **| Display Projection...** to set the user's current coordinates.
14. In the *Display Projection* dialog, select the *Global Projection* option.
15. Select **Set Projection**.
16. In the new *Set Projection* dialog box, set *Projection* to "UTM", *Datum* to "NAD 27", *Planar Units* to "Meters", and *Zone* to "12 (114°W - 108°W – Northern Hemisphere)".
17. Select **OK**, closing the *Set Projection* dialog.
18. Set *Vertical Units* to "U.S. Survey Feet".
19. Select **OK**.
20. Select **Yes** if a message appears saying that the horizontal and vertical units are inconsistent.

4 Getting a Background Image

Skip section 4.1 and 4.2 if an Internet connection is not possible at this time.

4.1 Getting a Background

Using an Internet connection, users can load a background image (Aerial photo or a topo map) for the project site. WMS uses the built in web services tool to load such images.

1. Select the arrow next to the **Add GIS Data** button and select **Get Online Maps** from the dropdown menu; this will open the *Get Online Maps* dialog.
2. Select *World Imagery* and click **OK**. WMS will load the background image file. It will take few moments depending upon the internet connection. Once done, users can see an aerial photo added to the background.

3. Select the arrow next to the **Add GIS Data** button and select **Get Online Maps** from the dropdown menu again.
4. This time, when the *Get Online Maps* dialog opens, select the *World Topo Map* and click **OK.**

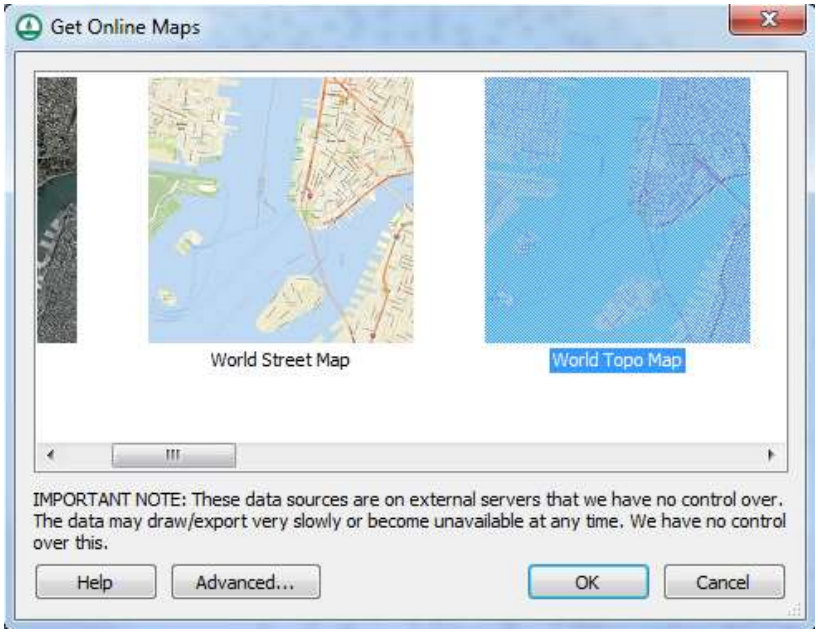

Figure 1 Get Online Maps dialog

4.2 Create a local copy of the images

The images users just loaded are read in from a server and sometimes take a long time to zoom and pan around. Users can create a local copy of the images to expedite such navigations.

1. In the project explorer, under the "GIS Data" folder, right-click one of the images and select **Export**.

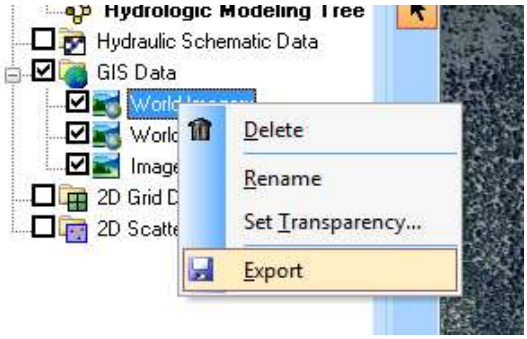

Figure 2 Export Image from Project Explorer

2. The *Export Image* dialog will appear. Select **OK** to accept the suggested value of resample magnification. A resample magnification factor of 1 means that the image will have exactly as many pixels as it is being displayed on the screen. Users can increase the factor if they need a higher resolution image. But, note that it will take a longer time to download.

3. Assign a name to the image and the location where it will be saved. WMS will download and save the image in the specified location in the local drive. Users can see the download progress.
4. Repeat the same process for the other image (steps 1-3).

If users are able to successfully complete all the steps in sections 4.1 and 4.2 they can skip section 4.3.

4.3 Open Background Image

5. Select *File* | **Open** .
6. Open "trailmountain.tif".
7. Zoom in around the TIN vertices. Users can turn the "trailmountain.tif" file off and select the **Frame** button to zoom to the TIN vertices. Turn "trailmountain.tif" on after zooming.

5 Digitizing Data

1. Select *Display* | *Toolbars* | **Digitize** to turn on the *Digitize* toolbar at the bottom of the screen.
2. Click on the **Digitize Mode** button, which is located on the *Digitize* toolbar, to turn on the digitize mode.
3. Enter a Z value of "6800" ft in the white box next to the **Digitize Mode** button.
4. In the **terrain data** module, select the **Add Vertices** tool from the TIN toolbar (make sure the Create Feature Point tool from the Feature Objects toolbar is not selected—it looks the same as the Add Vertices tool. Add Vertices is further down.).
5. Digitize the 6800 ft contour by using the background image to add vertices.
6. Click on the **Digitize Mode** button, which is located on the *Digitize* toolbar, to turn off the digitize mode.
7. Select *Display* | *Toolbars* | **Digitize** to turn off the *Digitize* toolbar at the bottom of the screen.

6 Converting CAD Data to a TIN

Often terrain data is stored or processed in a CAD program in the form of contours or triangles. In either case the 3D data points (x,y,z) can be converted from the CAD data to TIN points and triangulated in WMS.

1. Select *File* | **New** .
2. Select **No** when asked to save changes.
3. Select *File* | **Open** .

4. In the *Open* dialog, locate and open "contours.dwg".
5. Switch to the **Map** module.
6. Select *CAD* | **CAD→TIN.**
7. A *CAD→TIN* dialog will pop up. Select **OK**.

The points defining the contour lines contain x, y, and z coordinates so when the points are converted to TIN points and retriangulated, users are left with a 3D TIN surface. Users can zoom in, rotate, change the display or contour options in order to better visualize their TIN if they would like. Users can also read other CAD files with 3D points and convert them to a WMS TIN.

7 Merging TINs

Sometimes, especially when building a hydraulic model, users will want to merge elevation data from different sources together into a single TIN or DEM. For example, users might have survey data that represents the bathymetry of a stream channel stored as contours in a CAD program that users want to merge with DEM data from the USGS. Merging data from several sources can be especially useful for hydraulic modeling applications. In many hydraulic modeling applications users need to "cut" cross sections that include both the channel geometry (obtained from a survey of the channel) and the floodplain (obtained from a USGS DEM).

Merging two or more elevation data sources into a single TIN is a 3-step process. First, users need to make sure the coordinate systems of each set of elevation data match each other…all the elevation data needs to "line up" and all the elevations should either be in US Customary or SI units. Second, convert each set of elevation data to a separate TIN. Third, merge all of the TINs into a single TIN using the merge TINs command. This section of the tutorial will show how these three steps are used to merge separate elevation sources in the WMS.

1. Select *File* | **New**.
2. Select **No** if asked to save changes.
3. Select *File* | **Open**.
4. In the *Open* dialog, locate and open "tmcontours.dwg".

"tmcontours.dwg" is a DWG file from a CAD program containing contours for a small area. Users will want to merge the elevation data in this file with data from a DEM. First, users will convert this DWG file to a TIN. To convert this file, users first want to convert these contour lines to arcs. Then, redistribute vertices on the arcs. Finally, users will convert the arcs with the redistributed vertices to a TIN. When there are contour lines, users normally do not want to convert them directly to a TIN because the vertices along each contour line might be at a random or undesirable spacing to generate a quality TIN.

5. Switch to the **Map** module.
6. Select *CAD* | **CAD → Feature Objects**.
7. In the *CAD → Feature Objects* dialog, turn off all the layers except *CAD layers_arcs*.

8. Select **OK**.
9. A *Clean Options* dialog will appear. Select **OK**.
10. A *Coverage Properties* dialog will appear. Change the *Coverage type* to "General".
11. Select **OK** to create the *CAD layers* coverage.
12. Select *CAD* | **Delete** back in the main window.
13. Select the **Select Feature Arc** tool.
14. Use *Edit* | **Select All** to select all feature arcs.
15. Select *Feature Objects* | **Redistribute**.
16. In the new *Redistribute Vertices* dialog, enter an *Average Spacing* of "20".
17. Select **OK**.

When users redistribute the vertices, WMS interpolates elevations for any new vertices on the arc from existing arc vertices. Users have now redistributed the vertices on the arcs to a good spacing and are ready to convert the contours to a TIN.

18. Select *Feature Objects* | **Arcs → TIN Vertices.**
19. Right-click on the TIN that was created ("New tin") in the Project Explorer and select *Triangles* | **Triangulate** on the pop-up menu.
20. Switch to the **Map** module.
21. Select *Feature Objects* | **Delete** to delete all of the original contour data from this session of WMS.
22. In the pop up window, select **OK** to clear all of the map module data.
23. Select *File* | **Open**.
24. In the *Open* dialog, locate and open "trailmountain.dem".
25. Select **OK** in the *Importing USGS DEMs* dialog.

Users have now read a USGS DEM. To merge this DEM with the new TIN created from the CAD contours, users need to convert the DEM to a TIN and make sure all their TINs are in the same coordinate system. Currently, the XY projection of the user's DEM and TIN are in meters in the same UTM coordinate system, but the elevations on the DEM are in Meters while the elevations on the TIN are in feet.

26. Under "Terrain Data" in the project explorer, right-click on the New tin and select **rename**.
27. Rename the TIN to "CAD Contours".
28. Right-click on the DEM named "trailmountain" in Project Explorer and select *Convert* | *DEM → TIN* | **All**.
29. In the *DEM Conversion Options* dialog, turn on the *Delete DEM* option (leave everything else as originally set) and select **OK**.
30. In the project explorer, right-click on the "CAD Contours" TIN and select *Projection* | **Projection**.

31. Select the *Global Projection* radio button in the *Projection* dialog. Then click **Set Projection**.
32. In the *Select Projection* dialog, set *Projection* to "UTM", *Datum* to "NAD 27", *Planar Units* to "Meters", and *Zone* to "12 (114°W - 108° W – Northern Hemisphere)".
33. Select **OK**. This will close the *Select Projection* dialog.
34. Back in the *Projection* dialog, set the Vertical Projection to "NGVD 29(US)" and the Units to "U.S. Survey Feet".
35. Select **OK**.
36. Select **Yes** if the dialog about inconsistent units pops up.
37. In the Project Explorer, right-click on the "CAD Contours" TIN and select **Merge**.
38. In the *Merge TINs* dialog, select the **All** → button.

To merge these TINs together and delete any regions of overlap between the TINs, users must order their TINs in the correct order in the list of TINs to merge. They should be ordered in the priority used for merging TINs. Put the least accurate TIN at the top, the most accurate at the bottom.

39. Select the *Delete overlapping regions* button.
40. Move the TINs up or down so the "CAD Contours" TIN is at the bottom and the TIN from the DEM ("New tin") is at the top.
41. Select **OK** and wait while a merged TIN is generated from the existing TINs.
42. In the Project Explorer, select the "CAD Contours" and "New tin" TINs and hit the **Delete** key to remove these TINs now that the users are done with them.

Users have now created a merged TIN that is a combination between their CAD contours and their USGS DEM. Users could use this TIN for hydraulic modeling or could convert this TIN to a DEM so it can be used for hydrologic modeling.

8 Triangulation

In order to edit the TIN according to the steps in this exercise, users will delete the existing data and read in a TIN file before they triangulate the data.

1. Select *File* | **New**  .
2. Select **No** if asked to save changes.
3. Select *File* | **Open**  .
4. In the *Open* dialog, locate and open "digitizetm.tin".
5. Right-click on the TIN ("New tin") in the Project Explorer and select *Triangles* | **Triangulate** on the pop-up menu.

9 Automated TIN Editing

WMS has automated methods of editing TINs to provide a representation of terrain that is useful for drainage analysis. These methods include data transformations and eliminating flat triangles and pits. Data transformations may be useful for repositioning data if it is not originally located in the correct position because of survey errors or an unknown coordinate system. After transforming coordinates, users should always set their current projection system if it is known. Capabilities to eliminate flat triangles and pits still exist in WMS, but they are seldom needed since flat triangles and pits pose few problems when using the DEM-based watershed delineation tools in WMS.

9.1 Transformations

Run the cursor over the TIN and notice that the z values in the help strip at the bottom of the WMS window are in feet. The XY values on this particular TIN are in meters, and users want the X, Y, and Z units all in meters so they match when they delineate a watershed. In this section, users will convert the Z values from feet to meters. Users would normally do this using the coordinate conversion tool. This section simply demonstrates how the transform tool works.

1. Select *TIN* | *Vertices* | **Transform**.
2. In the *Transform Tin* dialog, enter "0.3048" for the Z Scale value to scale the elevations in feet to meters.

Notice that there are several other options for transforming TIN vertices, including options to translate and rotate vertices on the entire TIN.

3. Toggle on the *Frame image after transformation* option.
4. Select **OK**.

Run the cursor over the TIN and notice that the z values in the help strip are now in meters. Elevation values should be in the 1900-2300 range.

10 Converting a TIN to a DEM

If users are delineating a watershed, they will want to convert their TIN to a DEM. This section demonstrates how to delineate a watershed from a TIN by converting the TIN to a DEM.

1. Right-click on the TIN ("New tin") in the Project Explorer and select *Convert* | **TIN → DEM** on the pop-up menu.
2. In the new *Convert TIN to DEM* dialog which just opened, enter a cell width and cell height of "10".
3. Select **OK.**
4. If asked to delete existing TIN data, select **Yes**.
5. Switch to the **Drainage** module.
6. Select *DEM* | **Compute Flow Direction/Accumulation…**

7. In the *Flow Direction/Accumulation Run Options* dialog, select **OK** at the bottom of the dialog.
8. A *Units* dialog will open. Select **OK**.
9. If a dialog box pops up saying the horizontal and vertical units must be the same click **OK.** If this dialog box does not pop up, simply continue to step 13.
10. Click on **Current Projection** under *Model Units* in the *Units* dialog.
11. In the *Display Projection* dialog, change *Vertical Units* to "Meters", then click **OK**.
12. Click **OK** again in the *Units* dialog.
13. Select **Close** once TOPAZ finishes running (this may take a minute or so).
14. Select *Display* **| Display Options** .
15. In the *Display Options* dialog, select "DEM Data" from the menu on the left and change the *Minimum Accumulation For Display* to "0.05" mi^2.
16. Select **OK.**
17. Select the **Create Outlet Point** tool.
18. Create an outlet as shown in Figure – the contour lines won't be in color yet.

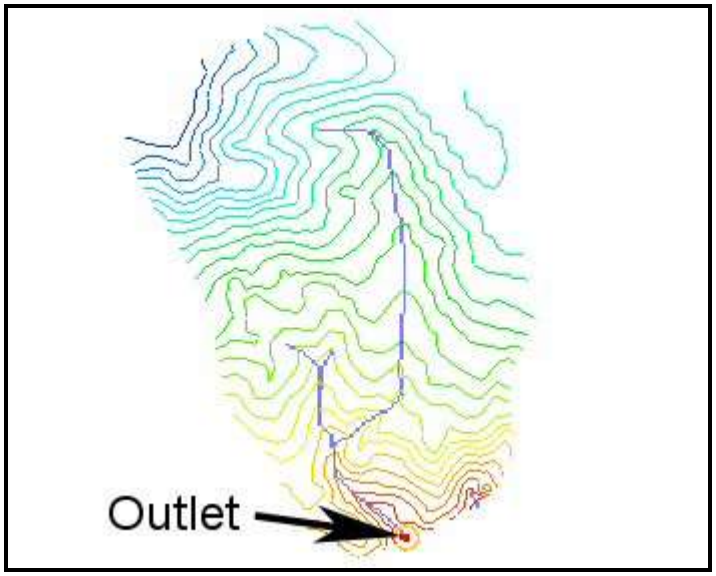

Figure 3 DEM outlet

19. Select *DEM* **| Delineate Basins Wizard**.
20. Select **OK** in the *Stream Feature Arc Options* dialog.
21. Select **OK** in the *Units* dialog to delineate the watershed and compute the basin data.
22. A drainage boundary is created using the DEM data and the basin data for this drainage basin is computed.

11 Exporting Data to CAD

Data that is visible on the screen can be converted to CAD data and then saved for use in CAD programs.

1. Switch to the **Map** module.
2. Select *CAD* | **Data → CAD.**

In order to view only the newly created CAD data users will hide all other data.

3. Hide the "Map Data Coverages" folder in the Project Explorer by toggling its visibility check box off.
4. Hide the "Terrain Data" folder in the Project Explorer.
5. Select *Display* | **Display Options**.
6. In the *Display Options* dialog, select "DEM Data" from the menu on the left and toggle *Color Fill Drainage Basins* and *Fill Basin Boundary Only* off.
7. Select **OK**.
8. Select *CAD* | **Display Options.**
9. In the *Display Options* dialog, locate the Visibility column and toggle *Drainage_arcs* off.
10. Select **Apply**. Notice the CAD data that disappears when selecting this button.
11. Select **Cancel**.
12. Select *File* | **Save As**.
13. In the *Save As* dialog, choose the Save as type *DWG files (*.dwg)* filter.
14. Enter a filename and select **Save.**

12 Conclusion

In this tutorial, users should have learned:

The following topics will be covered in this exercise:

1. How to import survey data
2. How to digitize data
3. Triangulation
4. Automated TIN editing
5. Manual TIN editing
6. How to create a TIN using a conceptual model
7. How to convert a TIN to a DEM
8. How to export data to CAD