CHaMP TIN Visualization | 2015

Introduction

The ability to visualize a Triangulated Irregular Network (TIN) is important in order to understand the topographic features it represents. Since the process of surveying a sampling site can introduce errors, blunders or mis-interpolated topography, it is important to recognize the characteristics and features of a clean TIN so that these errors can be easily recognized.

This tutorial is designed to guide the user though the features of a relatively clean (error-free) TIN representing a surveyed stream channel.

Site Information:

CHaMP Site Name: CBW05583-203211
Watershed: Tucannon
Visit Year: 2013

Getting Started:

1. **DOUBLE CLICK** on the "TIN_Visualization.mxd" map document file and ArcGIS will open.

TIN Basics

Triangulation

TINs are comprised of nodes (x-y points), which are connected to form triangles, which are known as faces. Each face has 3 edges. The z values of these nodes are interpolated across the triangle face, to form a representative surface. The triangulation algorithm (Delaunay triangulation) uses the XY position of the points (independent of Z) to attempt form roughly equilateral triangles. Equilateral triangles are desirable because it keeps the most area of the triangle face nearer to the sampled points than with other triangle geometries.

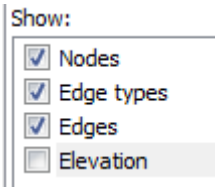
1. **USE** the "PAN" and "ZOOM" tools to navigate around the map and explore the TIN.
   What do the small blue dots represent?

2. TINs do a good job of representing surfaces of varying complexity because the number of nodes can be variable. Areas of more complexity can contain more nodes than do areas of less complexity.
   Based on the density and relative proximity of the nodes, where do you think the stream is located in the TIN?

Breaklines

Breaklines are used to enforce linear breaks in topography in the TIN. When breaklines are included in the TIN construction, extra nodes are inserted (by the TIN algorithm) that adjust the triangulation to keep these linear features. Two types of breaklines can be used when building TINs. Hard Breaklines are fully 3D and enforce the Z value in the TIN along their length. Soft breaklines only add nodes where they cross existing triangle edges, and only slightly modify the TIN surface.

1. To identify the breaklines, we need to adjust how the TIN is displayed in the map.
2. **RIGHT CLICK** on "TIN" in the Table of Contents.
3. **SELECT** "Properties".
4. **SELECT** the "Symbology" tab.
5. **CHECK** the box next to "Edge Types".
6. **CLICK OK** to turn on the breakline symbology.



Based on the arrangements of the Breaklines, is it easier to identify the stream?

Again, using the breaklines, can you (roughly) identify features that might be in this stream?

Interpolation Area

TINs do a good job of representing a surface within a known area of interest, but do a poor job along the boundary outside of the main area of interest. A polygon defining this area of interest can be used to constrain the area of the TIN during its construction.

CHaMP
In CHaMP, this polygon is generally the area where survey points were collected, but some manual adjustments need to be made to allow for stream bends, abnormal topography, etc.

1. **ZOOM OUT** until you see the entire TIN in the display ().
2. **TURN OFF** the "Edge types" in the TIN
   Hint: **Uncheck** the box you checked in the previous section.
3. **TURN ON** the "Full TIN" layer in the Table of Contents. This represents the same TIN if a polygon was not used to constrain the TIN area.
   How to the areas of the two TINs compare?

What is different about the shape of the triangles, and the length of the triangle edges?

Why might we want to exclude these areas from a clean TIN?

TIN Visualization of Topography

Elevation

The representation of the TIN in previous section only showed a very 'flat' view of the TIN. In order to better understand where the highs and lows are, we need to display the elevation information.

1. **TURN OFF** "Full TIN" on the Table of Contents.
2. **RIGHT CLICK** on "TIN" in the Table of Contents.
3. **SELECT** "Properties".
4. **SELECT** the "Symbology" tab.
5. **CHECK** the box next to "Elevation".
6. **UNCHECK** the boxes next to "Edges" and "Nodes".
7. **CLICK OK**.
8. You are now looking at an elevation representation of the same TIN surface. The triangles have 'blended' away, but the data has not changed at all.
   What do the color bands represent?

9. **ZOOM OUT** to the entire TIN ().
   Where is the lowest location in the TIN?

   Logically, where would this be in a survey site?

   Where is the highest location in the TIN?

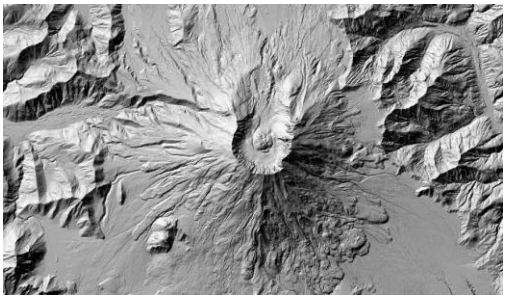
   What feature(s) could this represent?

   What do color bands that are close together represent?

   What about the ones that are further apart?

Aspect

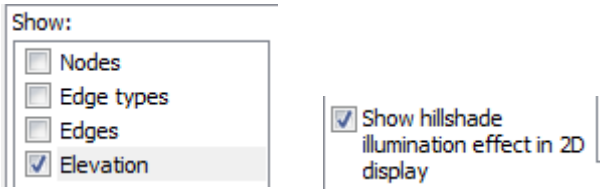
By default, ArcMap uses only two dimensions (2D) to visualize data, so we are always looking straight down on surfaces. In order to give the illusion of three dimensions, a hillshade is applied to the surface. A hillshade simulates how surfaces would appear as if illuminated from a single point source (i.e. the sun). In the Figure below, the volcano is lightest on the surfaces facing the 'sun', and darker in places that point away. The hillshade clearly shows the sides of the volcano and the ridge formed around the top.



http://qcoherent.com/newsletter/November2012/Figure_4_Hillshade_Rural.jpg

The hillshade applied to TINs in ArcMap is not a true hillshade since shadows are not formed (the Illumination effect is only applied to each TIN Triangle), but the effect is powerful enough to make the topography stand out. Let's see what happens when we turn on this effect:

1. **RIGHT CLICK** on "TIN" in the Table of Contents.
2. **SELECT** "Properties".
3. **SELECT** the "Symbology" tab.
4. Make sure "Elevation" is highlighted.
5. **CHECK** the box that says "Show hillshade illumination effect in 2D display". It is in the lower left of the LAYER PROPERTIES window.



6. **CLICK OK.**

What happens to TIN in the map display?

What direction do you think the light is shining from?

NOTE
For the purposes of this exercise, the hillshade was initially turned off. ArcMap by default turns on the hillshade effect when a new tin is created or added to the map.

Slope

Slope is a little more difficult to visualize, but you should try to use both elevation and aspect to interpret steep vs shallow triangle faces. In general, you will find that darker faces tend to be steepest for aspects that face away from the light.

Try to use your hand as an example of illumination on a face in different orientations. With a single light source, rotate your hand towards and away from the light source as well as flat to vertical. The light will not change much if you change the slope when it is facing the light. But when you rotate away from the light and change the slope, the shading is different.

1. Under the BOOKMARKS menu, **SELECT** "Slope Location A".
2. **LOOK** at the feature located in the center of the map.
3. Next, **SELECT** "Slope Location B" (on the BOOKMARKS menu).
4. **COMPARE** this feature with the feature in "Location A".
   Which Location (A or B) is steeper? How did you determine this?

Identifying Stream Features

Banks

Stream banks are fairly easy to identify. Most banks are typically surveyed using two breaklines (Top of Bank and Toe), and generally have a steep slope between. They will have a high degree of shading (in certain aspects) and often span several color bands (depending on the elevation range of the TIN).

1. **RIGHT CLICK** on "TIN" in the table of contents.
2. **SELECT** "Properties".
3. **SELEC**T the "Symbology" tab.
4. **CHECK** the box next to "Edge Types".
5. **CLICK OK.**

NOTE
This is the default symbology for TINs in ArcMap: Elevation with Hillshade effect and Edge type (breaklines). We will use this TIN symbology for the rest of the tutorials.

6. **NAVIGATE** to the bookmark "Bank Location". Identify the banks on both sides of the channel.
   Roughly how tall are the banks on each side of the channel?

HINT
Use the IDENTIFY tool  to compare the elevation of the nodes at the bottom and top of the bank.

Roughly how wide is the stream at this location?

HINT
Use the MEASURE tool  .

Stream Features

The topography stream bed is the most important aspect of a CHaMP survey. Without any other contextual information, you should be able to pick out some of the basic channel units and stream features in the TIN.

1. **NAVIGATE** to each of the following locations using the BOOKMARKS menu to answer the following questions:
   a. Stream Feature 1: Look at the elongate feature in the center of the map. This feature is located in the middle of the channel, and several breaklines were used to define its perimeter.
   What could this feature be?

   b. Stream Feature 2: This feature (white area surrounded by green) is located in the middle of the channel.
   Is the feature lower or higher than the surrounding topography?

   What type of feature is this?

   c. Stream Feature 3: Look at the channel in this section of the map.
   Is the stream bed topography complex or simple?

   What type of channel unit might this be?

   d. Stream Feature 4:
   Is this section of the stream topographically complex, or simple?

   What type(s) of channel units or features do you see?

Close and Finish

You did not make any changes to the TIN data in this tutorial, only the way the TIN layer was displayed in the map. Save the map document and close ArcMap. In the next tutorial, you will learn how to identify and repair errors in the TIN surface.