

Tutorial 18: 3D and Spatial Analyst - Creating a TIN and Visual Analysis

Module content

18.1. Creating a TIN

18.2. Spatial Analyst

Viewsheds, Slopes, Hillshades and Density.

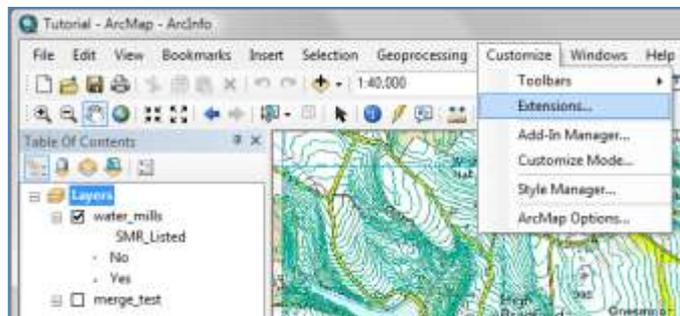
18.1 Creating a TIN

Sometimes it is useful to display a continuous surface from a table of points or breaklines (contours). A continuous surface layer is often used when visualising terrain, and provides estimates of the values between gaps in the dataset.

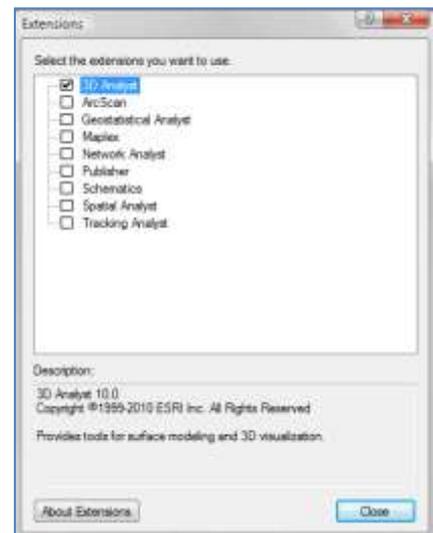
Surfaces can be created in a number of ways. The primary methods in ArcMap are to create a TIN (Triangulated Irregular Networks) or interpolated grids. TINs are triangulated 3D surfaces that are defined by points and their individual Z values (height).

To create a TIN, you need a contour map. Add **dtmloxley.shp** from the 'Edina Digital Terrain' folder in the 'GIS Tutorial Data Folder'.

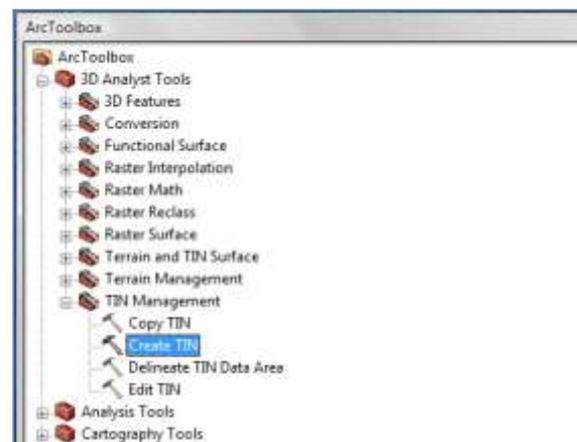
Go to the **Customize** menu, select **Extensions**.



In the 'Extensions' window, make sure the '3D Analyst' checkbox is ticked. Close the Extensions window.



Using ArcToolbox, double click on 3D Analyst Tools, then TIN Management, then Create TIN.



Specify a location to save the TIN you will create.

Open the Spatial Reference Properties and import an XY coordinate system, as you do when creating a new shapefile.

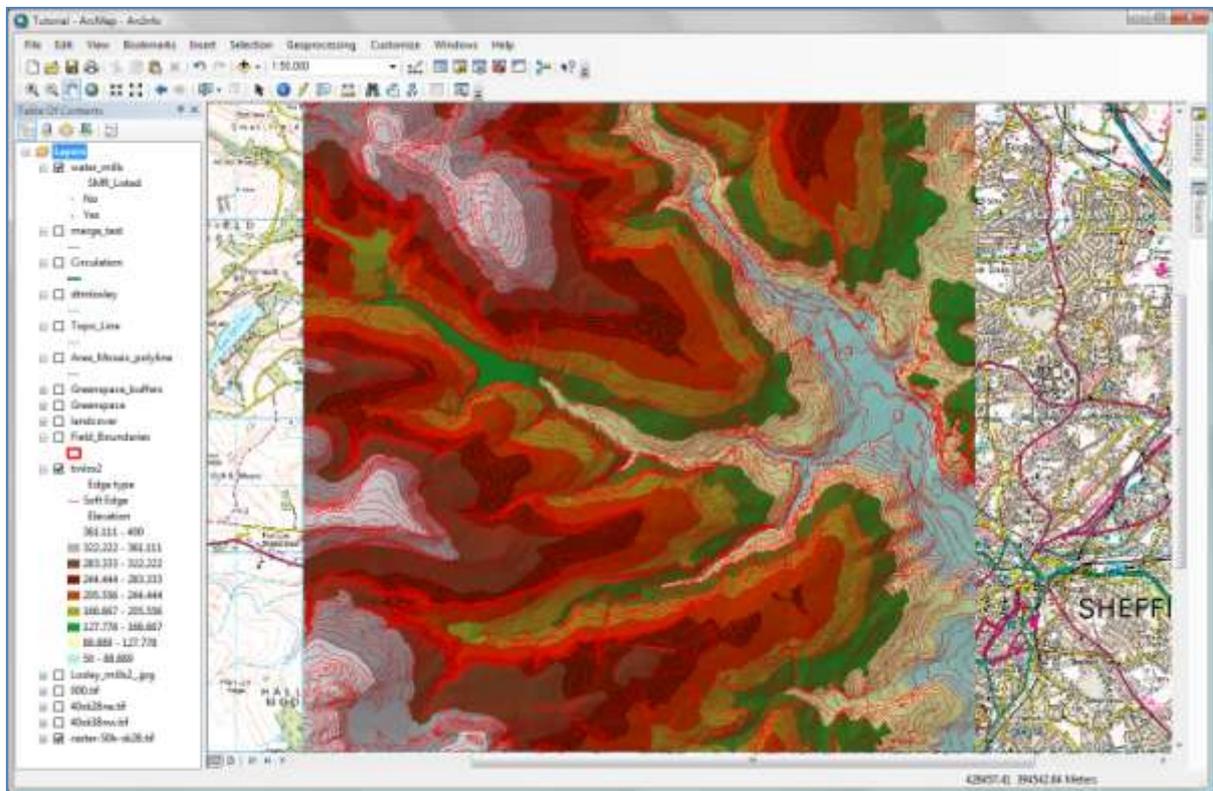
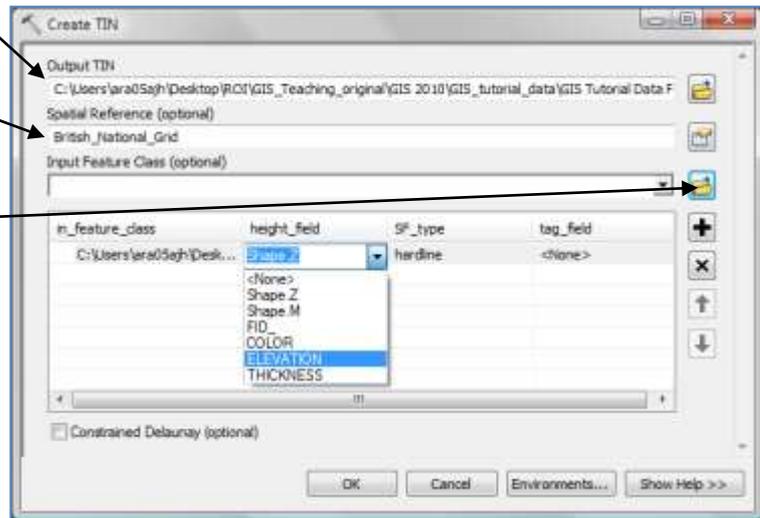
Navigate to the dtmloxley shapefile that you will use to create the TIN.

The file will show up in the table below. In the column height_field, choose 'elevation' from the drop down list. We will use this because the data on height for the contour lines is stored in that column in the layer attribute table.

In the SF_type column choose softline rather than hardline.

Click OK.

The TIN will be added to your .mxd project.

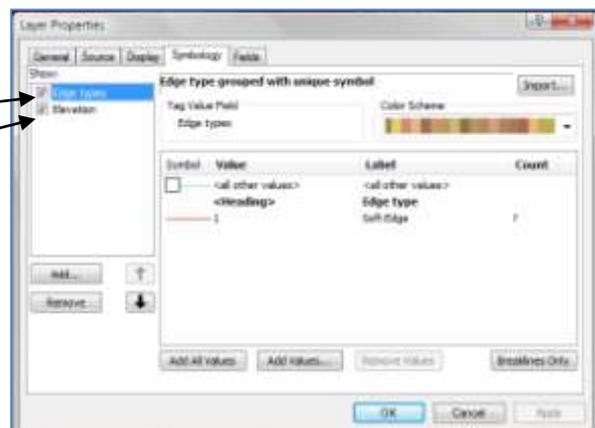


Ordnance Survey Map Data: © Crown Copyright/database right 2011. An Ordnance Survey/EDINA supplied service.

You can now set the layer's symbology. Double click on the layer name in the table of contents to open the 'Layer Properties' window. Select the 'Symbology' tab.

Click on 'Edge types' to set the line colour.

Click on 'Elevation' to set the fill colours.



Example: Creating a Map to represent Flooding

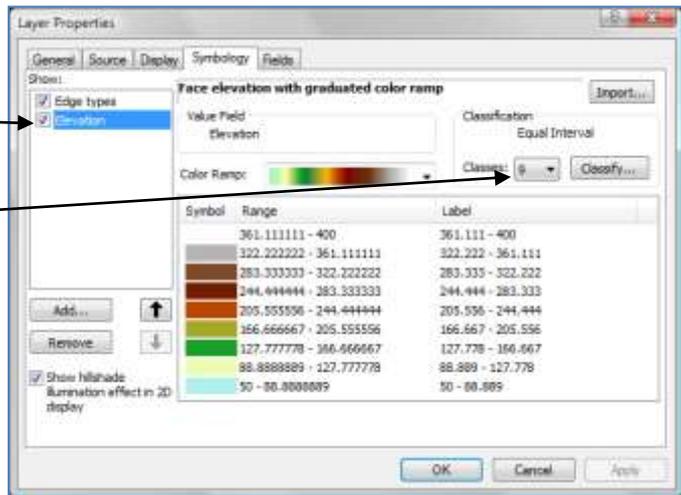
You can create a map to represent flooding by clicking on Elevation.

There are currently 9 classes.

It is possible to change the colour ramps, manually edit the ranges for each ramp and remove some ramps completely.

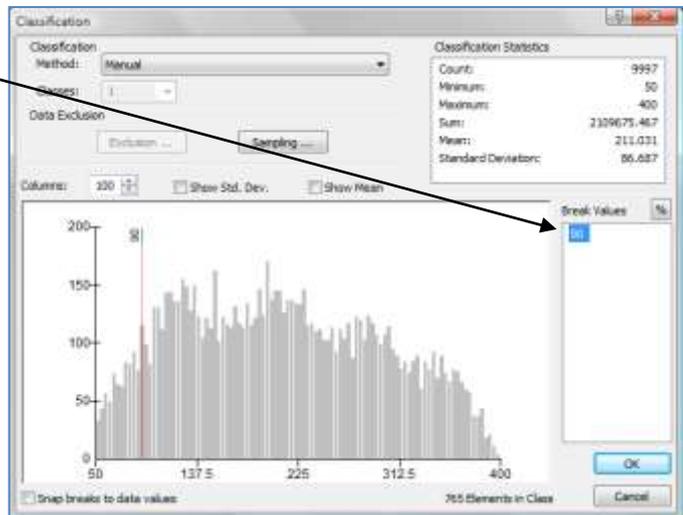
Change the classes to just '1'.

Click **Classify...**



Change the Break Value to '90'.
Click **OK**.

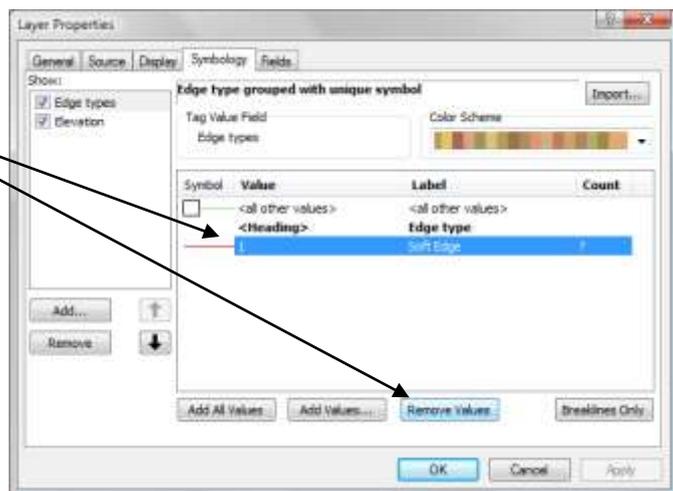
Click **Apply**, and then click **OK**.



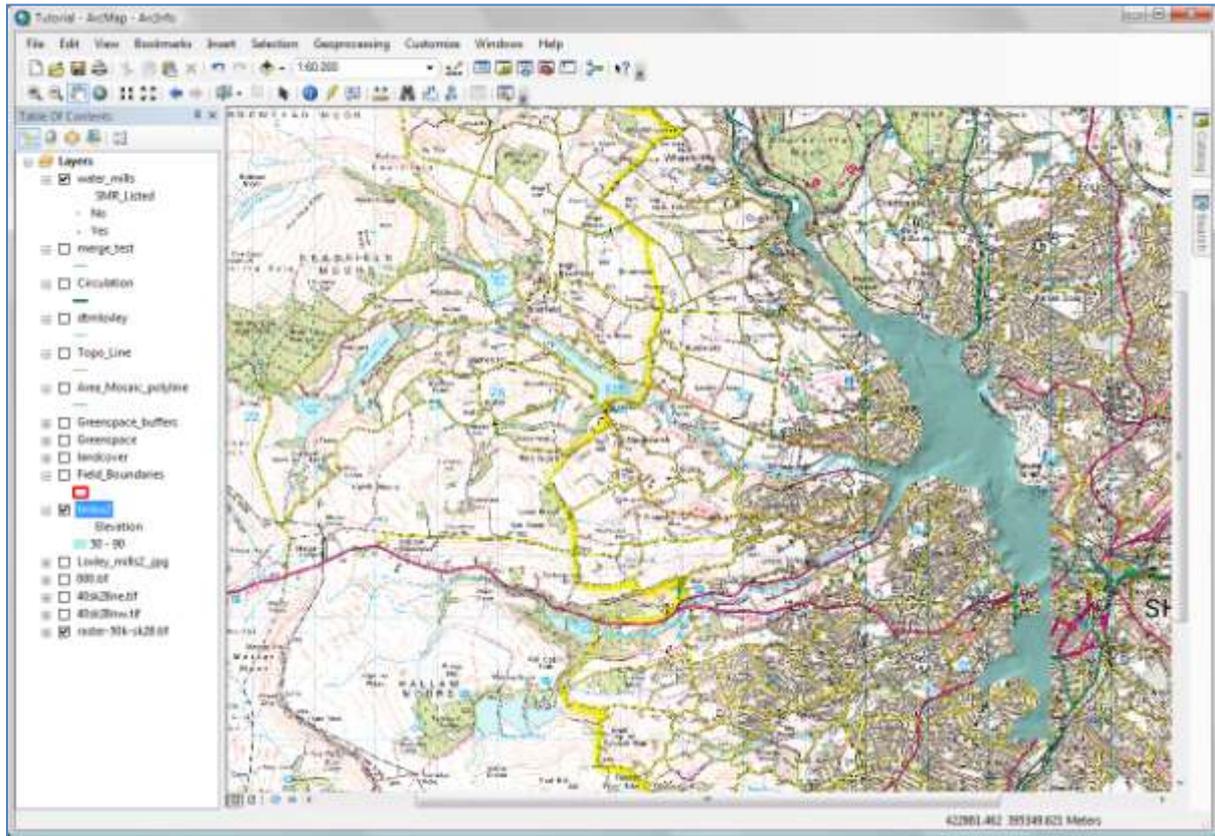
If you want to delete or turn off the Edge Lines then again double click on the layer name in the table of contents to open the 'Layer Properties' window. Select the 'Symbology' tab.

Click on **'Edge types'** to set the line colour.

Select **'Soft Edge'** and click on **Remove Values**, then click **Apply** and **OK**.



The map now shows all the areas up to 90m above sea level.



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Other Uses for TINs

This example visualised height information. The same method could be used to plot any type of measured information and can be used to plot moisture levels, plant densities, soil acidity or any measured attribute you may wish to plot onto a map.

18.10. The Spatial Analyst Toolbox

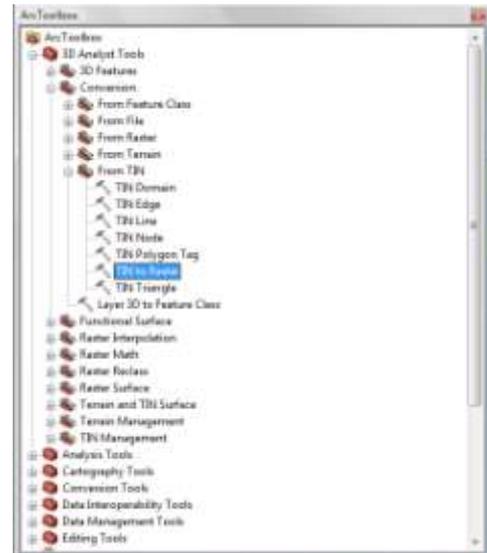
The Analyst toolbox allows querying, mapping and analysis of cell-based raster data. Using raster data with elevation information it is possible to analyse viewsheds, hillshades and slopes among other things.

a) Creating cell-based raster data layer.

A 'raster data' layer will be created from the 'TIN' previously produced. This 'raster data' will be the base for visual analysis.

Open a new .mxd project and add the TIN recently created.

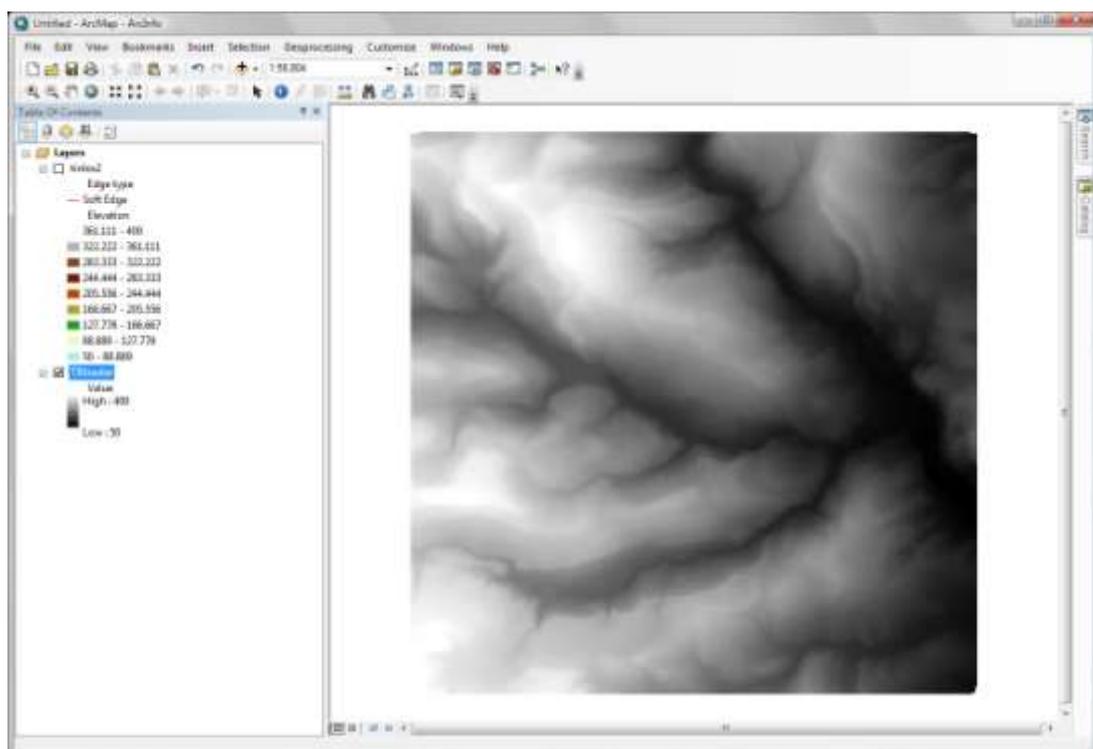
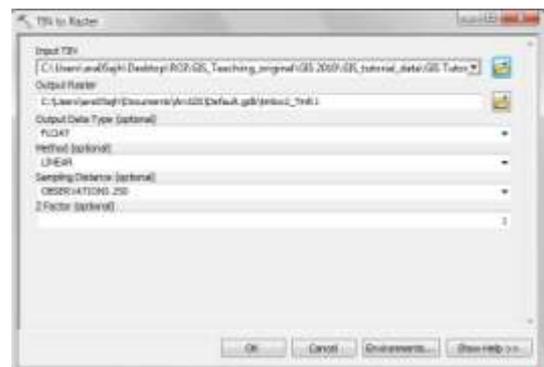
From the ArcToolbox, double click 3D Analyst Tools, then Conversion, From TIN, and then TIN to Raster.



The 'TIN to Raster' window will open. Make sure that the 'Input TIN' is the one you want to convert. In 'Output raster' select where to save the raster file and name it. For the other drop down menus, keep the default options.

Click **Ok**.

The raster layer will be created.



b) Viewshed Analysis.

A viewshed analysis will identify and inform what cells from the 'raster' can be seen or not seen from one or more observation points.

First, you need to create a point shapefile that will be the observation point(s). Therefore name it: 'Observer'.

Add it to the project, and start editing it to add a data point somewhere in the map display. Save edits.

The "Observer" visibility can be controlled by certain parameters. The default settings are:

Parameter	Default Value	Definition
OFFSETA	1 (unit)	The vertical distance of the observation point from the ground level, i.e. vertical offset from ground.
OFFSETB	0	
AZIMUTH1	0	Specific horizontal angle of visual analysis. This runs clock wise
AZIMUTH2	360	
VERT1	90	Vertical angle of the analysis (Upper limit and lower limit respectively)
VERT2	-90	
RADIUS1	0	Specify the search distance (buffer), cells beyond and closer to any RADIUS distance will not be included in the output raster, however still can limit the visibility of the observer.
RADIUS2	Infinity	

To control the 'visibility' then these parameters need to be added to the observer's Attribute Table, so that when running the 'viewshed tool' they will be automatically used. For more information about visibility parameters go to: <http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=How%20Viewshed%20works>.

In this case try adding just OFFSETA and RADIUS2 to the attribute table. Add each parameter as a separate field in the table. For OFFSETA select the type as float, precision as 2 and scale as 1. For RADIUS2 select the type as short integer.



Then start editing the layer to add the data to each field for the data point you have created. For OFFSETA add 1, and for RADIUS2 add 5000. This will allow us to see the viewshed from 1m vertically off the ground, for a distance of 5000m around the observer. Once done save the edits.

The table should look like this:

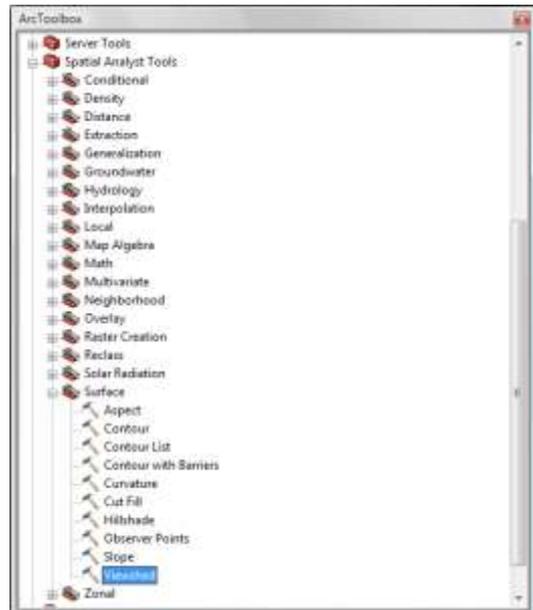
FID	Shape *	Id	OFFSETA	RADIUS2
0	Point	0	1	5000

***Note:** Do not write any other parameters in the attribute table if you are going to use the default settings. Make sure all your units (shapefiles and raster) are the same: e.g. meters, feet.etc. Check this in the Source tab in the layer properties.

Click the Customize menu, select Extensions.

In the 'Extensions' window, make sure the 'Spatial Analyst' checkbox is ticked.

From the ArcToolbox, double click **Spatial Analyst Tools**, then **Surface**, and then **Viewshed**.



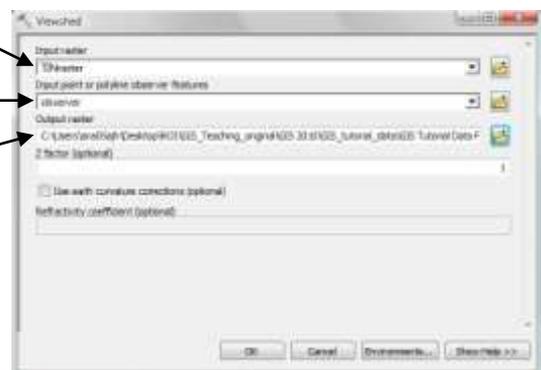
The 'Viewshed' window will open. Click the 'Input Raster' dropdown arrow and select the input surface to be analysed, i.e. your TIN 'raster'.

Click the 'Input point or polyline observer features' dropdown arrow and select the 'Observer' shapefile just created.

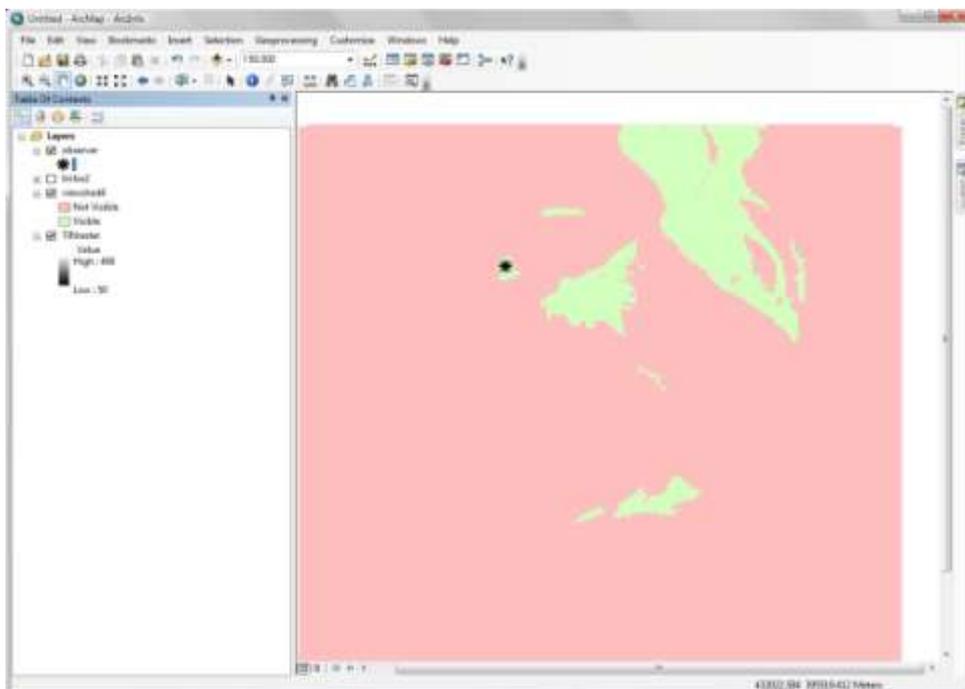
Name and select where to save the **output raster**.

Leave '**Z-factor**' as the default.

Click OK.



The output raster will give be added and it will have two values: 'Visible' or 'Not-Visible'



You can modify the symbology in the raster's properties. This raster can be imported to 'ArcScene' for a 3D visualization, see Tutorial 20.

c) How to calculate Slopes.

The **'Slope tool'** can help you to calculate how steep the terrain is. The output raster can represent a percentage or the degrees of slopes.

***Note:** Make sure all your units (shapefiles and raster) are the same: meters, feet...etc.

From the ArcToolbox, double click **Spatial Analyst Tools**, then **Surface**, and then **Slope**.

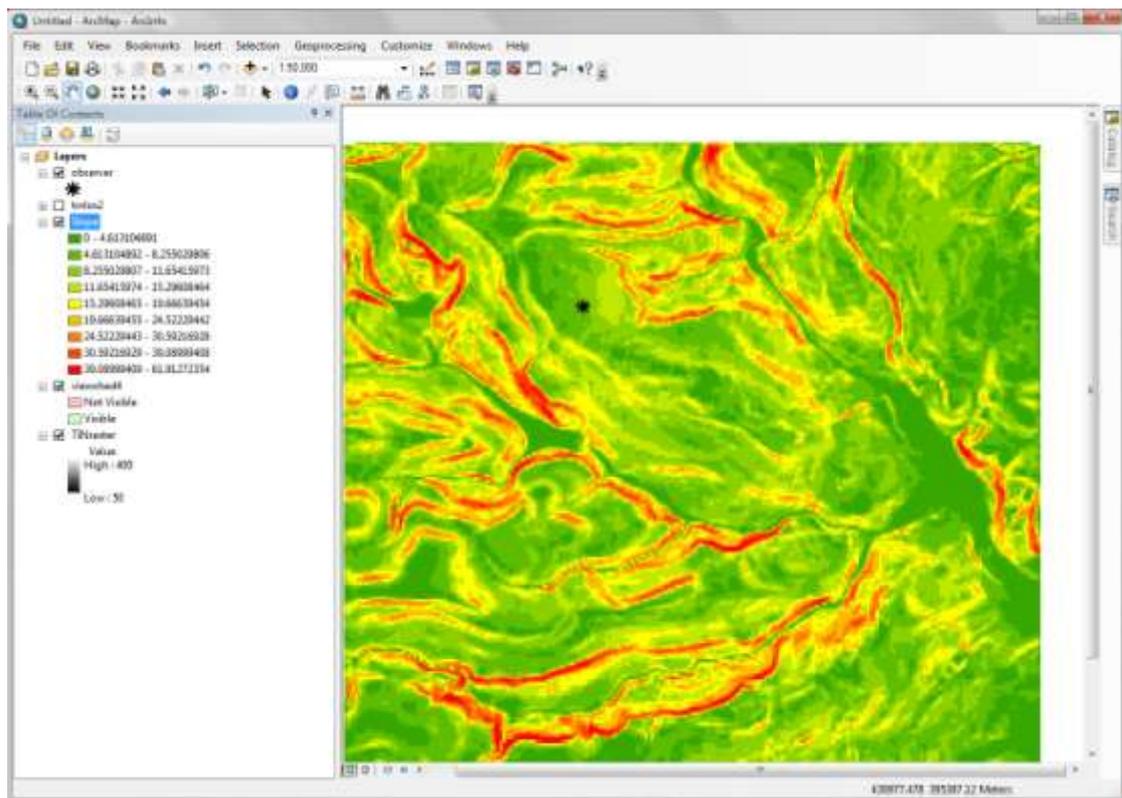
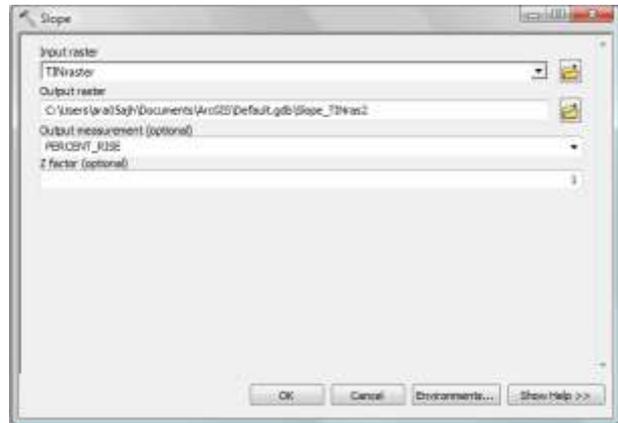
Click **'Input Raster'** arrow and choose the TIN raster to be analysed.

In **'Output Raster'** name and select where to save the output raster.

Select the **'Output measurement'** as either 'degree' or 'percent_rise'.

Leave **'Z-factor'** as default.

Click **OK**.



d) How to calculate Hillshades.

The **'Hillshade'** tool reproduces the illumination of a surface from a light source (in this case the sun). The output raster will have a 3D look because of the light and shade values.

The parameters required to calculate a 'Hillshade' are: 'Altitude' and the 'Azimuth' of the sun (light source). You can find those from this web page:

<http://www.timeanddate.com/worldclock/astronomy.html?n=1316&month=9&year=2010&obj=sun&afl=-1&day=1>.

From the ArcToolbox, double click **Spatial Analyst Tools**, then **Surface**, and then **Hillshade**.

Click the **'Input Raster'** arrow and choose the TIN raster to be analysed. In **'Output Raster'** name and select where to save the output raster.

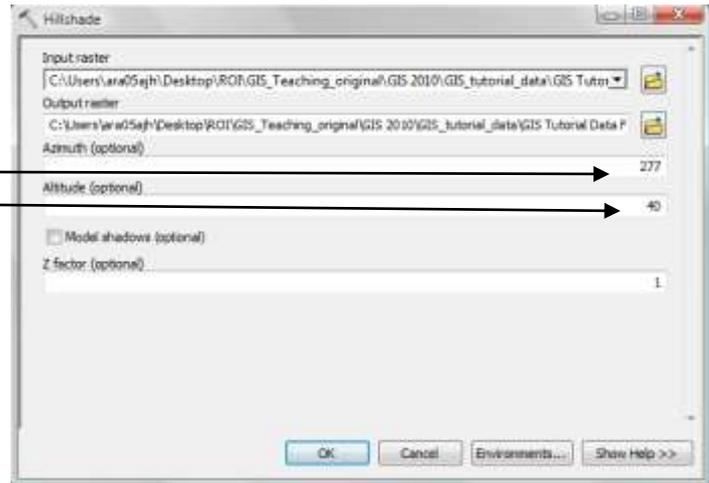
In this example we will be using the values for the Sunset time: 14th Sept 2010, Sheffield, which is:

Azimuth: 277°

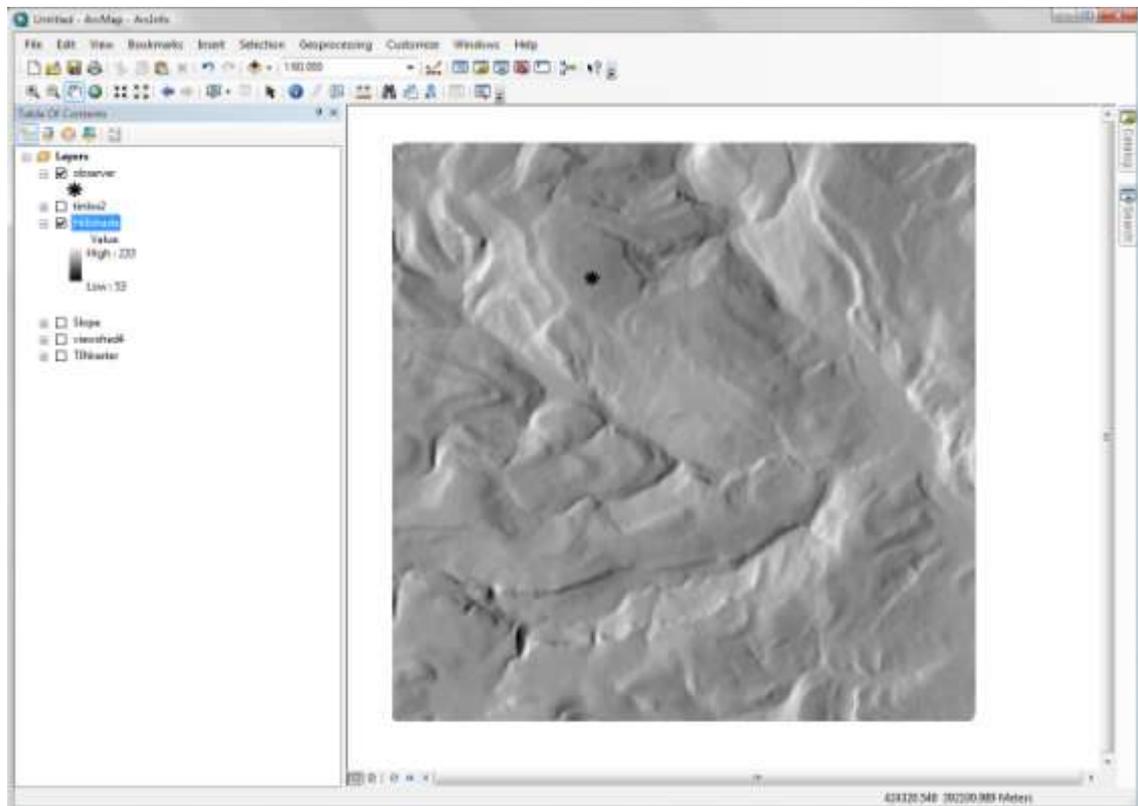
Altitude: 40°

Leave the **'Z-factor'** as default.

Click **Ok**.



Contrast, colours and transparency can be modified in the raster's properties.



e) How to Map Tree Density.

You can generate a raster **'density'** surface from a point shapefile. For example, tree density can be mapped from a tree survey and their canopy dimensions.

From the ArcToolbox, double click **Spatial Analyst Tools**, then **Density**, and then **Point density**.

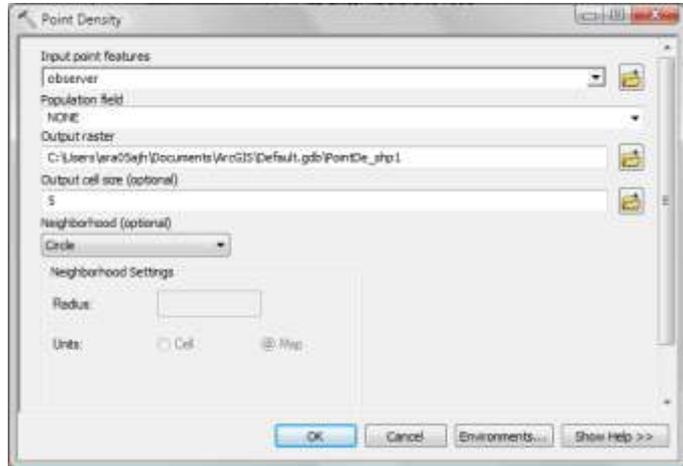
From the **'Point Density'** window, click **'Input point features'** and choose the shapefile to be analysed.

If the shapefile contains a value (e.g. canopy size) that will help to weight the density then in **'Population field'** choose the field with this value.

In **'Output Raster'** name and select where to save the output raster.

For **'Output cell size'** choose an appropriate value depending on the scale of your site.

Click, **OK**.



The result will be a raster image with the density of trees represented as surface.

You can also map density using the **Kernel Density** option from the ArcToolbox, Density options.