Exercise 2: Basic visualization of LiDAR Digital Elevation Models using ArcGIS

Introduction

This exercise covers activities associated with basic visualization of LiDAR Digital Elevation Models using ArcGIS. Topics include a description of the standard tiled DEMs available from http://www.opentopography.org, loading them into ArcMap and mosaicking them, and producing color gradient maps, hillshades, slope maps and slopeshades, and contour maps.

Data included

We start with the uncompressed downloaded archives from <u>http://www.opentopography.org</u> -> Standard DEMs.

The DEMs in this example are for Sanborn Park area in the Santa Cruz Mountains, California (archive names are 583 4120, 583 4121, 582 4120 and 582 4121).

(
Data	Data	Resolution	Coordinate System
	format	(m)	
GeoEarthScope Lidar data	ArcGrid	0.5	UTM Zone 10N, WGS84
tiles—unfiltered (all the data)			ellipsoid heights
and filtered (just ground			
returns) interpolated by kriging			
to make DEM. Includes			
hillshades			

Data source, type, and file naming convention

OpenTopography delivers the Standard DEMs as delivered from the National Center for Airborne Laser Mapping (<u>http://www.ncalm.org/</u>). In this demonstration, we will play with the filtered and unfiltered 1km x 1km ArcInfo grids @ 0.5m cell size and their shaded relief maps (NO overlap).

Due to ArcInfo file naming limitations, the grids contain only the significant digits from the lower left coordinate of their originating tile. For example, the ASCII tile named "f571000_4130000.xyz" corresponds to the ArcInfo elevation grid named "fg571_4130" and shaded relief map "fg571_4130shd". Filtered elevation grids are prefixed by "fg" and the hillshades end in "shd". Unfiltered elevation grids are prefixed by "ug" and the hillshades end in "shd."

ArcGIS activities

Introduction

The ArcGIS software suite has many useful capabilities for handling geospatial data including LiDAR DEMs. We use ArcMap 9.3 (with its extensions Spatial Analyst and 3D Analyst) to produce map view visualizations. For some introductory lessons in ArcGIS, you should check the ESRI web sites (<u>http://www.esri.com/</u> and <u>http://www.esri.com/what-is-gis/index.html</u>) and you may also try Ramon's lectures at <u>http://arrowsmith410-598.asu.edu/GLG410_598--Lectures.html</u>.

Launch ArcMap and load data

Under the Start Menu, navigate to ArcGIS and launch ArcMap. Once the software is launched, you can click on the yellow plus to add the DEMs:

💸 Untitled - ArcMap - ArcInfo		
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>B</u> ookmarks <u>I</u> nsert	<u>Selection Tools Window H</u> elp	
D 🖻 🖬 🚭 X 🖻 🛍 🗙	∽ ≃ ♦	🔄 📝 🔌 🕲 🐂 😽
Eayers		

Note that the first time you navigate for the data, you may need to "Connect to the folder" and navigate to where they are located:

Add Data		×
Look in:	😰 Catalog	
🔯 C:\		GIS Serve Connect To Folder

Mosaicking the DEM tiles

Before adding too many files, let's mosaic the 4 contiguous square kilometer tiles that we downloaded. For this, you need to open up the ArcToolbox (red toolbox symbol):





Input Rasters	
C: \Users \ramon\Desktop\temp\Projects\SCEC\Workshop\Exercise2Tutorial\582_4120 C: \Users \ramon\Desktop\temp\Projects\SCEC\Workshop\Exercise2Tutorial\582_4121 C: \Users \ramon\Desktop\temp\Projects\SCEC\Workshop\Exercise2Tutorial\583_4120 C: \Users \ramon\Desktop\temp\Projects\SCEC\Workshop\Exercise2Tutorial\583_4121	
Output Location C:\Users\ramon\Desktop\temp\Projects\SCEC\Workshop\Exercise2Tutorial	
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Raster dataset name with extension	
Raster dataset name with extension fullmos	
Raster dataset name with extension fullmos Coordinate system for the raster (optional)	
Raster dataset name with extension fullmos Coordinate system for the raster (optional) WGS_1984_UTM_Zone_10N	
Raster dataset name with extension fullmos Coordinate system for the raster (optional) WGS_1984_UTM_Zone_10N Pixel type (optional)	1
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Raster dataset name with extension fullmos Coordinate system for the raster (optional) WGS_1984_UTM_Zone_10N Pixel type (optional) 32_BIT_FLOAT Cellsize (optional) Number of bands Mosaic Method (optional) [.AST Mosaic Colormap Mode (optional)	

Open the toolboxes: Data Management Tools->Raster->Raster Dataset->Mosaic to New Raster.

Select the files to be mosaicked by clicking the open folder at the upper right and progressively select them.

• The Output Location is a directory (folder) into which the mosaic will go. •

Provide a mosaic name.

The coordinate system can be defined by clicking the small button

() and either Selecting by choosing the coordinate system into which you want the mosaic projected, or Importing which will pull the projection from an existing file (in this case, I used one of the DEM tiles) if you navigate to the file and select it.

The Pixel Type should be 32 bit • float.

The other boxes can be left optional.

 Click OK to launch the mosaicking process and after a few seconds to minutes, you will have your mosaic added to the ArcMap project. Mosaic both the full feature and the bare earth DEMs.

How to visualize the DEM

Color gradients



Display Bac
 Use hillshar
 Stretch

Type:

Standard Deviations

2

•

Invert

OK Cancel

To visualize the topography color coded by elevation (with a different color ramp than the default grayscale), right click on the DEM file name in the Table of Contents (left portion of the ArcMap window) and choose Properties.

Choose the symbology tab and select the color ramp of interest

Hillshade

Hillshades are a commonly used visualization of topography. They are a simulated reflection of a light source of specified azimuth and zenith angles from the topography (with set reflective properties) toward the viewer who is looking straight down.



To produce the hillshade, you first may need to display the Spatial Analyst toolbar (View->Toolbars)



Hillshade		? <u>x</u>
Input surface:	fullmos	• 🖻
Azimuth:	315	
Altitude:	45	
Model shadows		
Z factor:	1	
Output cell size:	0.5	
Output raster:	C:\Users\ramon\D	esktop\temp
	ОК	Cancel

In Spatial Analyst, select Surface Analysis->Hillshade

In the Hillshade dialogue box:

- define the input surface (one of your DEMs)
- select the azimuth (315 is default, but try 45 for some variety as well)
- specify the altitude (this is the zenith angle from vertical for the simulated light source)
- Choose Model Shadows (this does a fancier computation which can be annoying at times in LiDAR data with small and tall features). Experiment with this checked and not.
- We don't usually change the Z factor or output cell size.
- Provide a file name to make the hillshade permanent

Combine color gradient and hillshade into a map

A nice visualization combines the colored elevations semi-transparently over the hillshade. Make sure that the hillshade is underneath the colored dem (both were produced in the last two steps).

Layer Properties	? 💌 R
General Source Extent Display Symbology Fields Joins & Relates	fi
Show Map Tips (uses primary display field) Display raster resolution in table of contents	C A
Allow interactive display for Effects toolbar	c
Resample during display using:	tl
Nearest Neighbor (for discrete data)	0
Contrast: 0 Brightness: 0 0 % Tragsparency: 50 0 % Display Quality Z factor: Coarse Medium Normal Geoid:	e tı o
OK Cancel	Apply

Right click on the DEM file name in the Table of Contents (left portion of the ArcMap window) and choose Properties. Select the Display tab and type 25 or 50% (do some experimenting) in the transparency box and click ok.

Switch from the data view to layout view by clicking the small piece of paper shaped button at the



lower right of the table of contents in ArcMap:

You now will see your view of the map as it would appear on a piece of paper once printed. Move the view around with the hand tool and zoom (Tools toolbar).

Add a north arrow (Menu->Insert->North Arrow). Move it and resize it as desired.

Add a scale bar (Menu->Insert->Scale bar [click on properties to change the units if necessary]). Move it and resize it as desired.

Add a text box and other annotation using the Drawing toolbar.

end Wizard					
Choose which layers you want to include	e in your le	gend			
Map Layers:	L	egend Items			
fullmos	>	fullmos			T
baremos	>>				
					T
					<u>+</u>
	<				
					100
Set the number of columns in your lege	end: 1	•			
Preview					
		< Back	Next	>	Cancel
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end Wizard		< Back	Next	>	Cancel
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Add a legend (explanation): (Menu->Insert->Legend). Use the left pointing arrow to move all the layers except the DEM out of the Legend Items column. Click Next.

Rename it to Elevation (m). Click Next.

Click through the rest of the screens, leaving the defaults and finish.



Now you have an Explanation/Legend, but it should be cleaned up:

Right click on the Legend and choose Properties. Then click Style at the right of Legend Properties dialogue and then Properties in the Legend Item Selector. Turn off Show Layer Name and Show Heading in appearance. Click OK back through the dialogues.

Legend Properties	1		<u> </u>		2 53
		Legend Item Selector			
Specify Legend Items	_	Legend Heading	Legend	Preview Legend fullmos	
Map Layers: Legend Items: fullmos fullmos fullmoshd set fullmos		Horizontal Bar with Heading,	Description Horizontal Single Symbol	Value High :7	798.241 80.381
	Style	Legend	Legend	-	
<u><</u>	Place in new	Label	Description		
< Colu	umns:	Horizontal Single Symbol	Horizontal Single Symbol		
Change text		Label Only	Layer Name and Description		
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Add a new item to the legend when a new layer is added to the				More Sty	/les 🔻
▼ Reorder the legend items when the map layers are reordered		how <u>H</u> eading	Show <u>D</u> escriptions	Save	Reset
Scale symbols when a reference scale is set		Heading Symbol	Description Symbol	ОК	Cancel
ОК (ine:	Override default patch size Width: 36 pt		
	A	vea:	Height: 24 pt		
	Only sho	w classes from this heading: Va	lue v		
		ОК	Cancel <u>A</u> pply		



We are getting there **Low**: 280.361. To finish off the labeling more cleanly, now go back to the Table of Contents in the left side of the main ArcMap Window and right click on the DEM and choose Properties and then the Symbology tab. Edit the labels to be more appropriate.

Layer Properties	
General Source Extent Display Symbology Fields Joins & Relates	
Show: Unique Values Unique Values Import Import	
Stretched	
798.241394 280.361420	
Color Ramp:	
Display Background Value: 0 as -	Elevation (m)
Use hillshade effect Z: 1 Display NoData as	and the second second second
Stretch Type: Standard Deviations Histograms	798
n: 2 Invert	
	280
OK Cancel Apply	

Export the map as a PDF file if desired for other documents.



0 125 250 500 Meters Sanborn Park

The final map showing the bare earth dataset with the San Andreas Fault trace clearly cutting from upper left to lower right.

Slope and slopeshade

Computing the local slope of the DEM is done similarly as hillshade and contours: Spatial Analyst->Surface Analysis->Slope. Check that the input surface is correct. Usually we compute slope in Degrees. Don't change the Z factor or Output cell size. Give the Output raster an appropriate name and save it with related files.



The default green to orange color ramp shows the slope distribution well.



Visualizing the landscape as a "slopeshade" can be useful. Your brain treats it similarly as it does a hillshade, except here it looks as if the illumination comes from all directions. The slopeshade simply takes the slope map and colors it with steep slopes dark and low slopes white (black to white *inverted* color ramp) and stretches the range nonlinearly. Right click on the slope map and choose Properties. You may get request to compute unique values



An error message about there being too many values may pop up. Click ok. In the Layer Properties, click the Symbology tab. Choose Stretched for what to Show and then choose a color ramp that goes black to white with the high slopes being white. Choose "Standard Deviations" - typically we start with n=5 (default is n=2), but a range of values work depending on what you want to emphasize. You can also tweak the curve on the histogram page to pull out details in certain ranges of slope values.

Layer Properties	S X	
General Source Extent	t Display Symbology Fields Joins & Relates	
Show: Unique Values Classified Stretched	Draw raster stretching values along a color ramp	JA-
	Color Value Label 79.802292 High: 79.8023 0.001382 Low: 0.00138233 Color Ramp: Display Background Value: Use hillshade effect Z: Use hillshade effect Z: Type: Stretch Type: Standard Deviations Type: Ramping Filter	
	OK Cancel Apply	

Contours

Use Spatial Analyst to compute contours from one of your DEMs: Surface Analysis->Contour.

In the Contour dialogue box (below right), make sure you choose the correct input surface. Specify the desired contour interval. The base contour should be 0 and keep the Z factor 1. The process will produce an Arc shapefile. You should save it in the same directory as your other DEM data.

		Contour		
		Input surface:	baremos	• 🖻
Spatial <u>A</u> nalyst Layer: fullmos	•	Contour definition		
Distance		Input height range:	Z min: 281.202728 Zma	ax: 762.3!
D <u>e</u> nsity		Contour interval:	10	
Interpolate to Raster		Base contour:	0	
Surface Analysis	<u>C</u> onto ur	Z factor:	1	
Cell Statistics	<u>S</u> lope		,	
Neighborhood Statistics	Aspect	Output information based on input conto	our definition	
Zonal Statistics	<u>H</u> illshade	Minimum contour:	290	
Zonal Histogra <u>m</u>	<u>V</u> iewshed	Maximum contour:	760	
<u>R</u> eclassify	<u>C</u> ut/Fill	Total number of contour values:	48	
R <u>a</u> ster Calculator		Output features:	C:\Users\ramon\AppData\	
Convert	11 A	ouput reduites.		
Options			ОК	Cancel

To label the contours, right click on the contours shapefile and select Label Features. Usually, the contours will first be labeled by the feature number and not the elevation. To change the labeling to elevation, right click on the shapefile and click Properties. Select the Labels tab. Change the Label field to CONTOURS. Change other characteristics of the label display while you are there as well. For example, under Placement Properties, you can move the labels onto the contour lines.

Method:	Label all the feature	es the same way.		•		
All features will	be labeled using the optic	ons specified.				
Text String				_	1	
Label Field:	ID		-	Expression	on	
Text Symbol	ID					
	CONTOUR		امر ک	-		
	AaBbYyZz	B	IU	Symbol		
Other Options			Pre-defined	Label Style		
Placeme	ent Properties	Scale Range		Label Styles		

