Shorelines: Mapping and Elevation Measurement

Julia Howe U.S. Bureau of Reclamation Seismology, Geomorphology, and Geophysics Group Lakewood, CO

Lake Bonneville

- Largest Pleistocene pluvial lake in the Great Basin
- Major shorelines are laterally continuous and well time-constrained
- Shorelines preserve a record of surface deformation:
 - tectonic deformation
 - isostatic rebound



Shapefiles provided by Ken Adams (Adams and Bills, 2016)

Locating and Mapping Shorelines

- Slopeshades vs. Hillshades
- Curvature



Profile curvature



• Paleoelevation:

the elevation of the shoreline at the time of formation



Jewell and Bruhn, 2013

The PaleoElev Tool

- Goals:
- Automate measurement of shoreline paleoelevation.
- Analyze swaths instead of profiles (taking into account an entire surface)

• Written using the Python 2.7 IDLE



Example Analysis – Bonneville Shoreline



Inflection Points Script



Inflection Points Script – Single Swath



5 m x 5 m

10 m x 10 m

15 m x 15 m

20 m x 20 m

Concave · Inflection Point

Convex

Inflection Points Script - Output



Convex

Swath Profiles Script



Shoreline Elevations Script



Shoreline Elevations Script – Single Swath

- Requires minimum of 2 inflection points on both the sea cliff and platform surfaces
- Currently no R² parameter
 - Possibility for outliers





Takeaways:

- Use multiple lidar derivatives (not just hillshades) to help identify geomorphic features
- Using swath profiles instead of traditional 2D profiles takes into account an entire surface feature, which is a better overall representation of the feature

Demo for Curvature Rasters

Setup

• Extensions:

- You need Spatial/3D Analyst
- Go to Customize → Extensions at the top of ArcMap
- Check boxes for "3D Analyst" and "Spatial Analyst"

• Toolbar:

- You need 3D Analyst
- Go to Customize → Toolbars and click "3D Analyst" to turn it on

Customize \rightarrow Extensions GUI

Extensions		X
Select the extensions you want to use.		
3D Analyst ArcScan Geostatistical Analyst Network Analyst Publisher Schematics Spatial Analyst Tracking Analyst		
Description:		
3D Analyst 10.4.1 Copyright ©1999-2016 Esri Inc. All Rights Reserved		
Provides tools for surface modeling and 3D visualization.		
	Clos	se

Load a lidar DEM and create rasters

- Use ArcCatalog or the "Add Data" button
 at the top of ArcMap to load "Shoreline_DEM.tif"
- Create slope raster using the Slope Arc Tool
- Create curvature using Focal Statistics and Curvature Arc Tools



Shoreline_DEM.tif loaded into ArcMap

Create a Slope Raster

Slope Input raster Shoreline_DEM Output raster C:\Users\jhowe\Documents\UNAVCO_2017\PVS_Shoreline\slope_raster Output measurement (optional) DEGREE Z factor (optional)	Ident Ident (grac maxii value a ras	be ifies the slope tient, or rate of mum change in z- b) from each cell of ter surface. Symbology Parameters
OK Cancel Environments << Input Parameters	Layer Properties	ey Metadata Extent Display Symbology Stretch values along a color ramp Image: Color Value Label Labeling Color Value Label Labeling Image: Color 86.6156 Image: Color Image: Color </td



Slope Raster viewed in ArcMap

Create a Curvature Raster

• Step 1: Focal Statistics

Focal Statistics	S		
Input raster		A	Ignore NoData in
Shoreline_DE	M	▼ 200	calculations
Output raster			(optional)
C:\Users\jhowe	Documents\UNAVCO_2017\PVS	Shoreline\focal_15m	
Neighborhood (o	ptional)		Denotes whether NoData
Rectangle	· · · · ·		the statistic calculation
Neishbarde			
Height:	30 30		Checked— Specifies that if a NoData value ovicts within a
Units:	© Cell 🔘	Мар	exists within a neighborhood, the NoData value will be ignored. Only cells within the
Statistics type (o	ptional)		have data values
MEAN		-	will be used in
Ignore NoDa	ata in calculations (optional)	*	output value. This is the default.
(OK Cancel	Environments	Tool Help

Input Parameters



Curvature Raster viewed in ArcMap

Create a Curvature Raster

• Step 2: Curvature

N Curvature	
Input raster C:\Users\jhowe\Documents\UNAVCO_2017\PVS_Shoreline\fs_1 Output curvature raster C:\Users\jhowe\Documents\UNAVCO_2017\PVS_Shoreline\useless2 Z factor (optional) 1	Output profile curve raster (optional) Output profile curve raster dataset.
Output profile curve raster (optional) C:\Users\jhowe\Documents\UNAVCO_2017\PVS_Shoreline\curvature_15m Output plan curve raster (optional)	This is the curvature of the surface in the direction of slope. It will be floating point type.
OK Cancel Environments << Hide Help	Tool Help



Curvature Raster viewed in ArcMap

Input Parameters

Create a Curvature Raster

• Step 2: Curvature

Layer Properties		Con Maria	X
General Source Key Metad Show: Vector Field	data Extent Display Symbology		
Unique Values Classified Stretched	Color Volum 1		^
	Edit High/Low Values	High : 1	E
C	Display Background Value:		
About symbology	Use hillshade effect Z: 1 Stretch Type: Minimum-Maximum	Display NoData as	
	Apply Gamma Stretch:	Invert	Ŧ
		OK Cancel	Apply

Symbology Parameters



Curvature Raster viewed in ArcMap