# Simple landscape morphometry and stream network delineation

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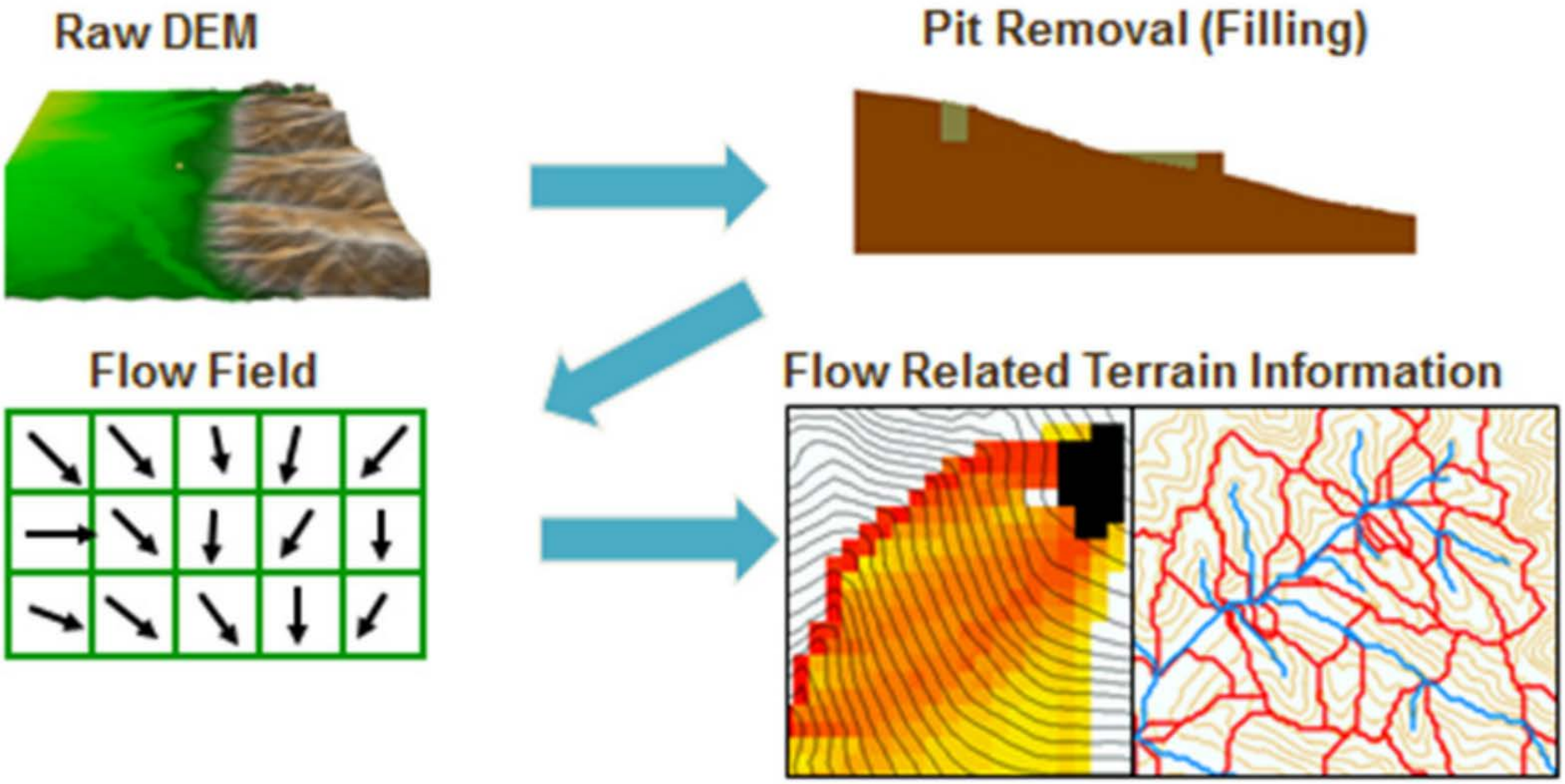
UNAVCO

Tutorial notes (April 2016)

OpenTopography
*High-Resolution Topography Data and Tools*

# Morphometry

- Slope, curvature, relief
- Drainage network properties
- Wavelets (e.g., Hilley, et al., 2010)
- Spectral analysis (e.g., Delong, et al., 2010; cf. T. Perron pubs)




# TauDEM 5.0

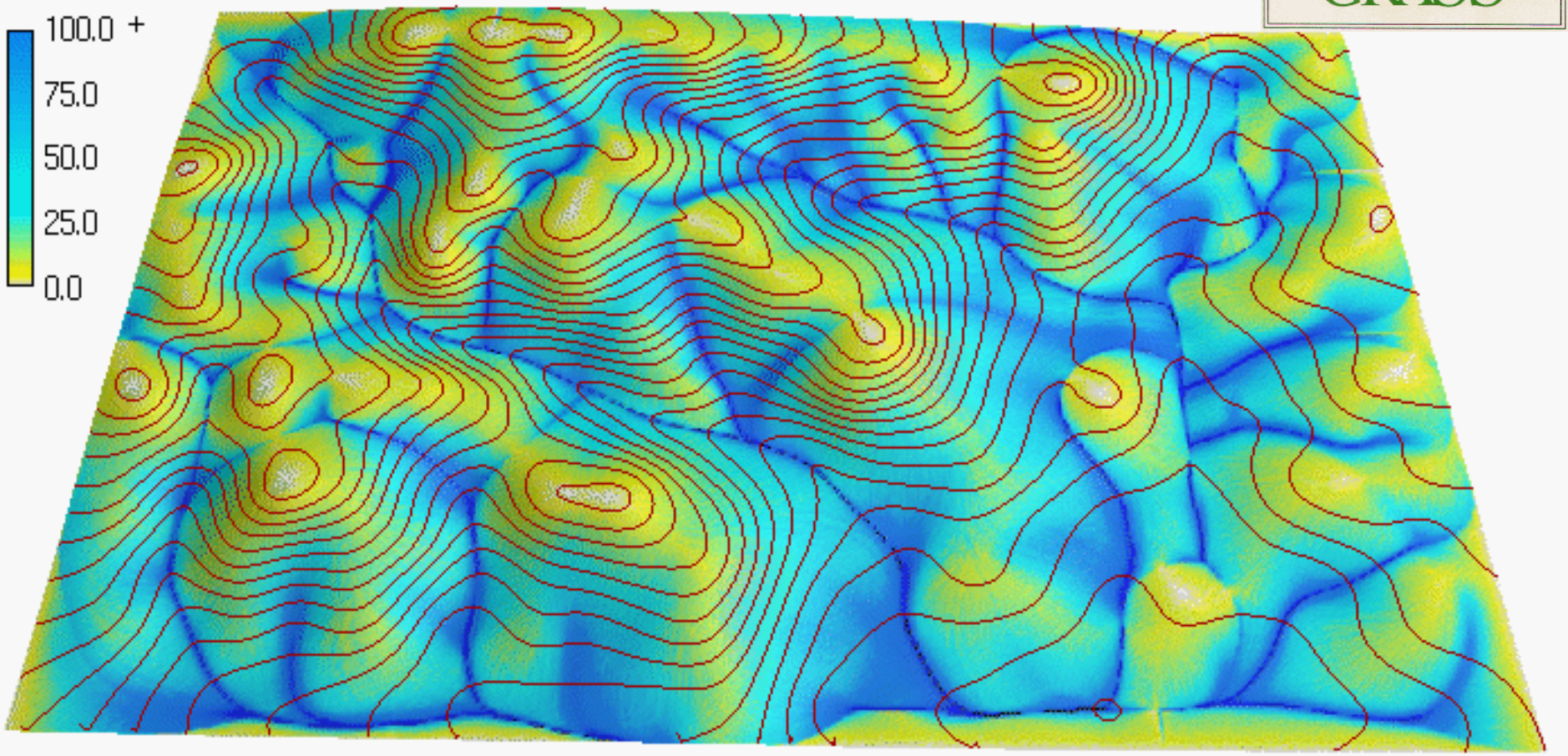
http://hydrology.usu.edu/taudem/taudem5/

# WATERSHED DELINEATION USING TAUDEM

A tutorial for using TauDEM to delineate a single watershed

Geographic Modeling Systems Laboratory
University of Illinois at Urbana-Champaign

GRASS



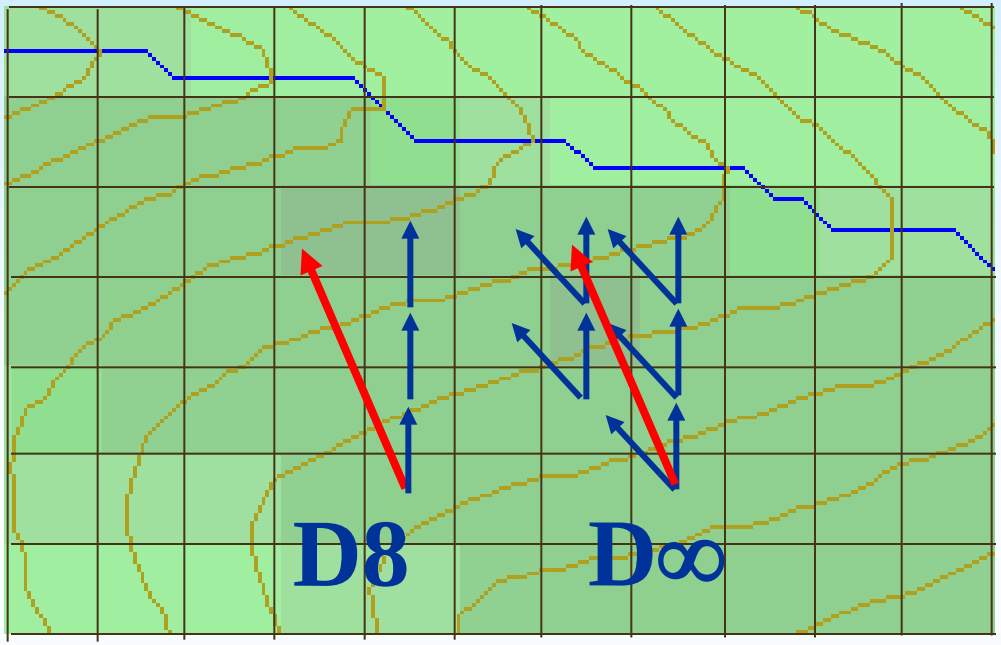

http://www4.ncsu.edu/~hmitaso/gmslab/pfarm/farm1.html

# Representation of Flow Field

Steepest single direction

| | |
|---|---|
| 48 | 52 |
| 56 | 67 |

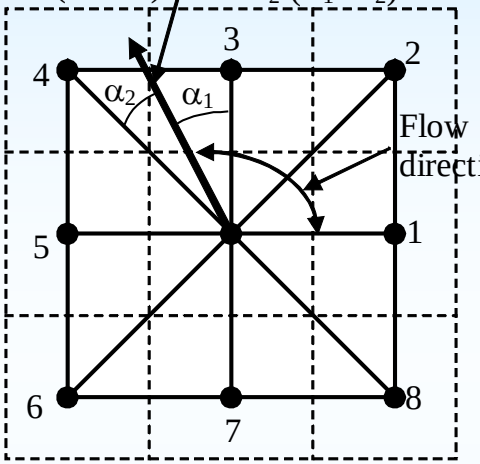
$$\frac{67-52}{30}=0.50$$

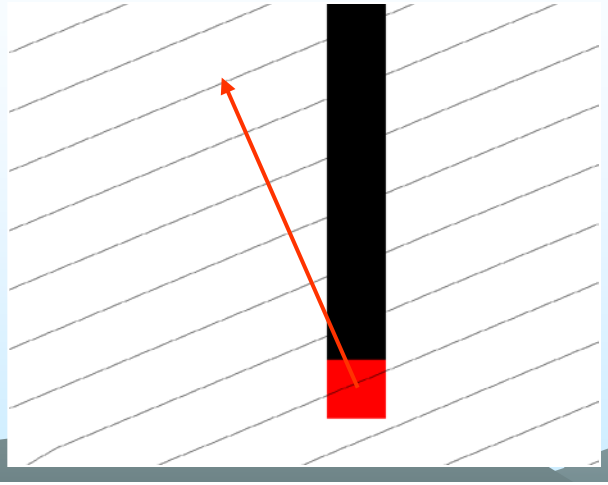


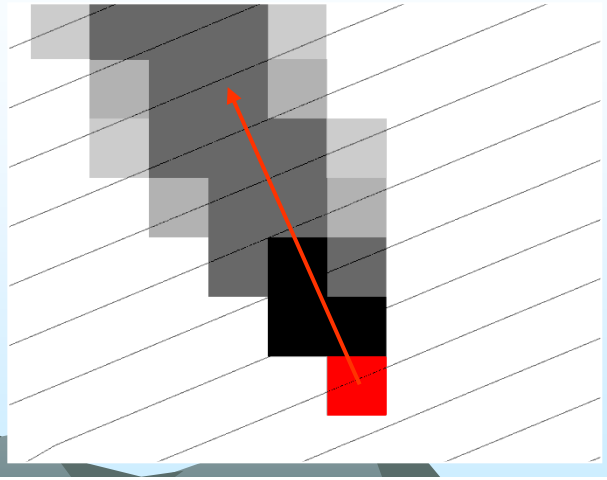

Proportion flowing to neighboring grid cell 4 is $\alpha_1/(\alpha_1+\alpha_2)$

Steepest direction downslope

Proportion flowing to neighboring grid cell 3 is $\alpha_2/(\alpha_1+\alpha_2)$



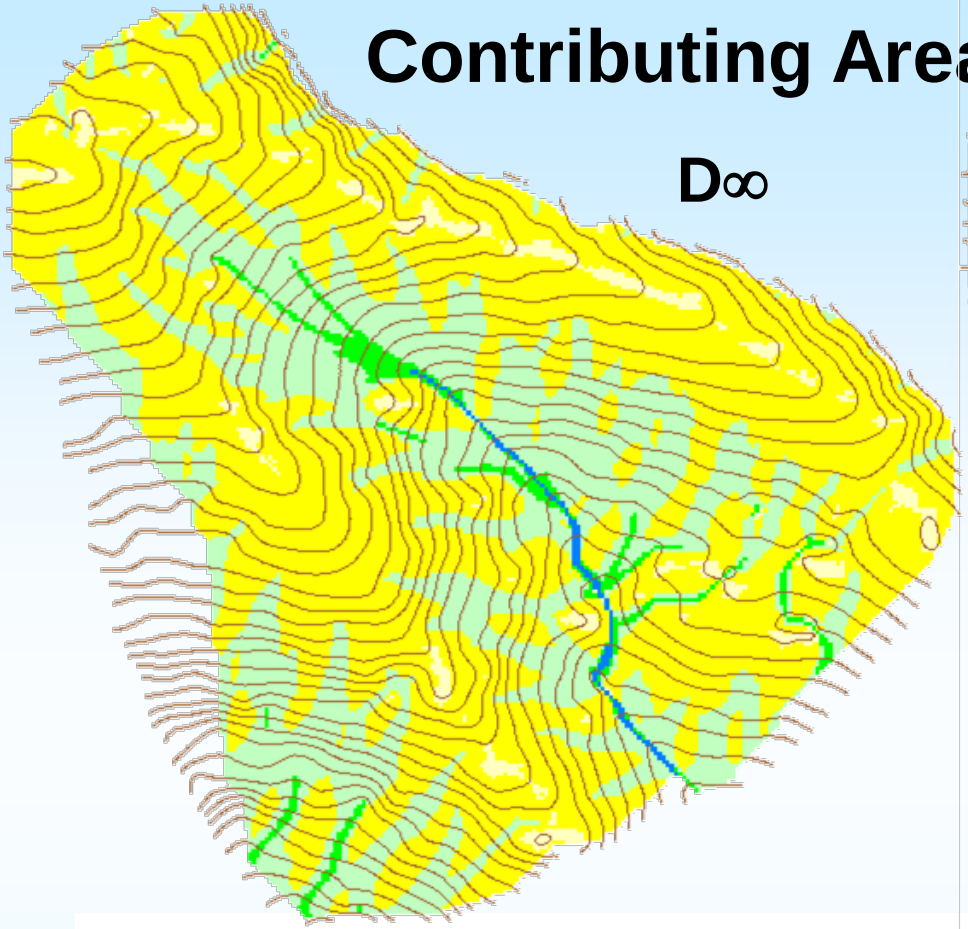





Tarboton, D. G., (1997), "A New Method for the Determination of Flow Directions and Contributing Areas in Grid Digital Elevation Models," Water Resources Research, 33(2): 309-319.)

# Contributing Area

D∞



D8

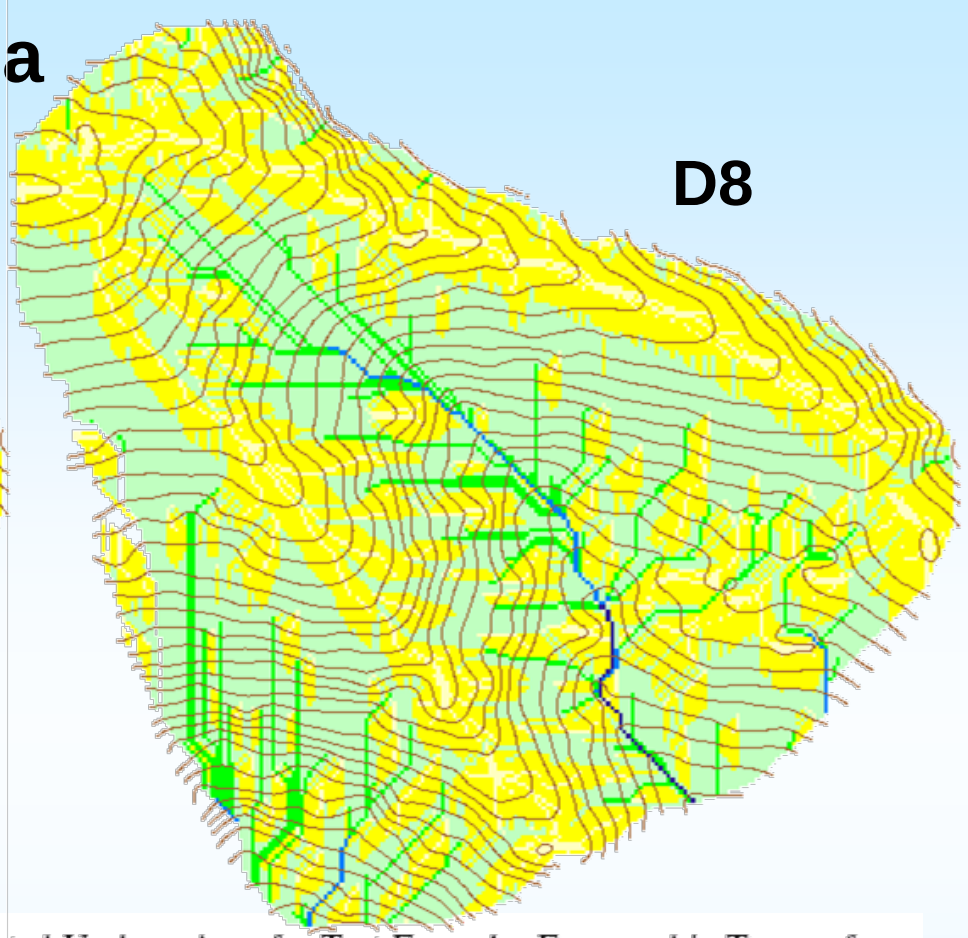


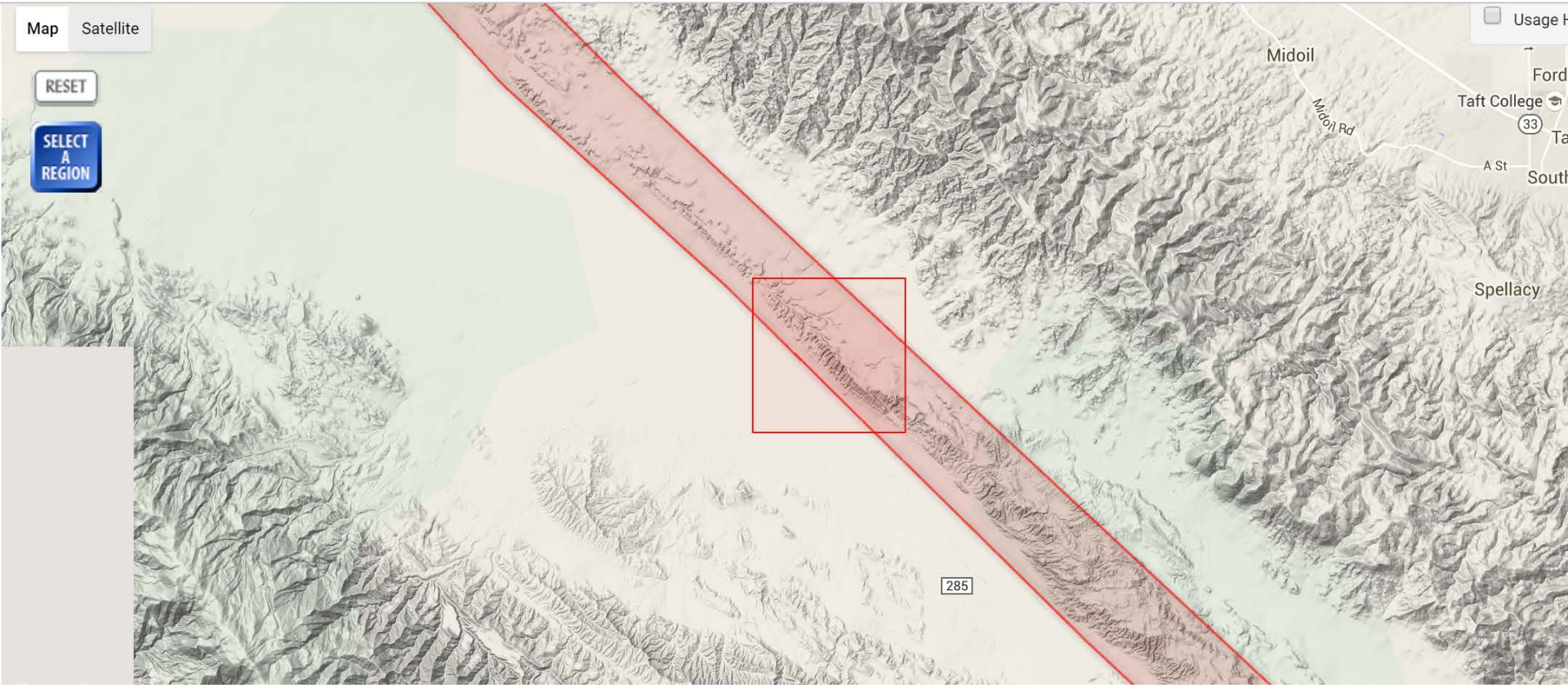
**Table 2.** Differences Between Theoretical and DEM-Computed Upslope Area for Test Examples Expressed in Terms of the Mean Error and Mean Square Error

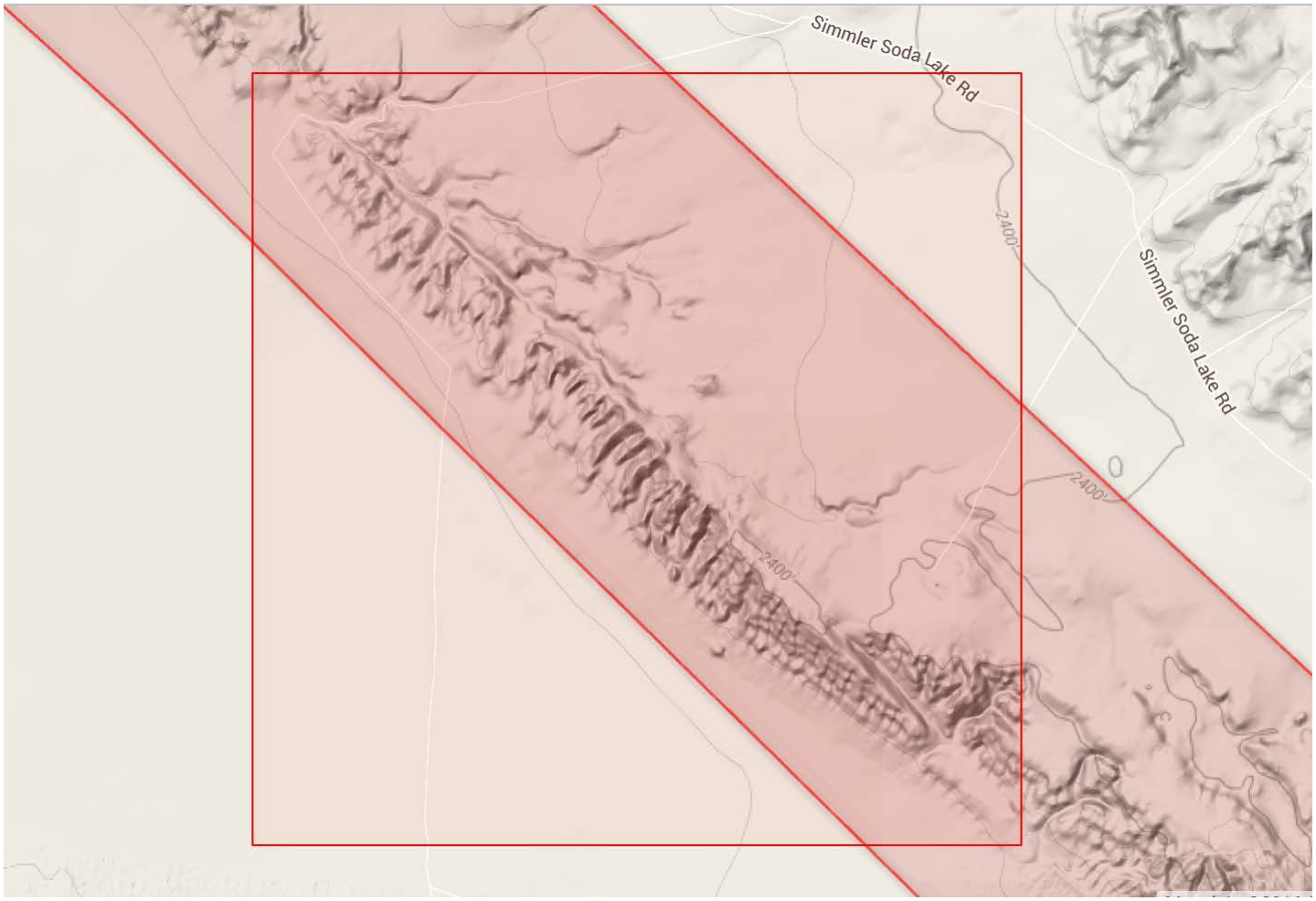
| | Outward Cone | | Inward Cone | | Plane | |
|---|---|---|---|---|---|---|
| | Bias Mean $(A - \hat{A})$ | MSE Mean $((A - \hat{A})^2)$ | Bias Mean $(A - \hat{A})$ | MSE Mean $((A - \hat{A})^2)$ | Bias Mean $(A - \hat{A})$ | MSE Mean $((A - \hat{A})^2)$ |
| D8 | −0.13 | 2.13 | 1.76 | 118.88 | −0.17 | 0.065 |
| MS | −0.81 | 0.69 | −1.07 | 5.70 | −1.37 | 2.065 |
| *Lea*'s [1992] method | −1.29 | 2.41 | −4.05 | 44.00 | −2.57 | 7.912 |
| DEMON | −0.37 | 0.17 | −0.37 | 19.23 | −0.40 | 0.161 |
| D∞ | −0.13 | 0.20 | 1.87 | 30.58 | −0.17 | 0.065 |

WATER RESOURCES RESEARCH, VOL. 33, NO. 2, PAGES 309–319, FEBRUARY 1997

OpenTopography

HOME ABOUT DATA TOOLS LEARN COMMU




Simmler Soda Lake Rd
Simmler Soda Lake Rd
2400'
2400'
2400'

## 2. Point Cloud Data Download

- [x] Point cloud data in LAS format
- [ ] Point cloud data in LAZ format
- [ ] Point cloud data in ASCII format

## 3A. DEM Generation (Streaming TIN)

**Gridding Method**

- [x] Calculate TIN

**Gridding Parameters**

Grid Resolution (Default = 1 meter): 1

Max. triangle size (Default 50 units): 50

**Grid Format**

GeoTiff

## 4. Derivative products

- [x] Generate hillshade and slope grids in grid format

GeoTiff

## 5. Visualization

- [x] Generate hillshade images and Google Earth files from DEMs
- [x] Generate additional color-relief and colored hillshades
- [x] Generate additional KMZ files

Altitude of the light, (in degrees): 45

Azimuth of the light, (in degrees): 315

## 6. Hydrologic Terrain Analysis Products (tauDEM)

- [x] Hydrologically correct DEM with pits filled
- [x] D-Infinity Flow Direction
- [x] D8 Flow Direction:
- [x] D-Infinity Specific Catchment Area
- [x] D8 Contributing Area
- [x] Topographic Wetness Index

## Job Description

These options allow users to describe and keep track of their jobs. Information entered below is recorded along with other job parameters in your personal lidar Job archive accessed via myOpenTopo (available only to registered OpenTopography users).

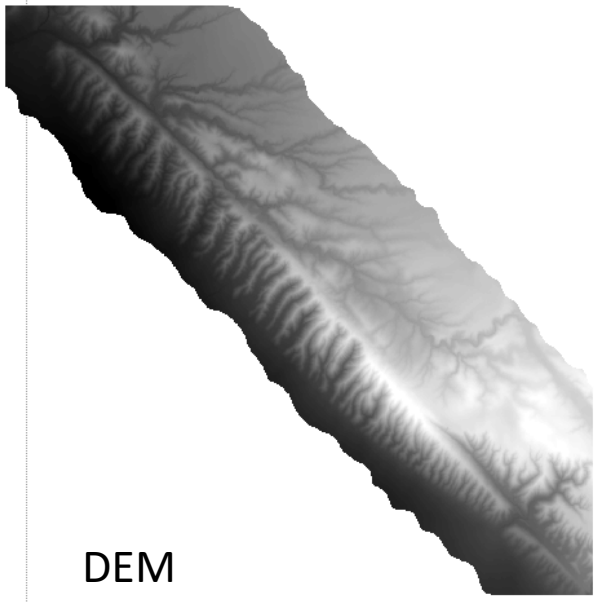
**Job title** (up to 100 characters): B4 demo

**Job description** (up to 500 characters): For UNAVCO workshop

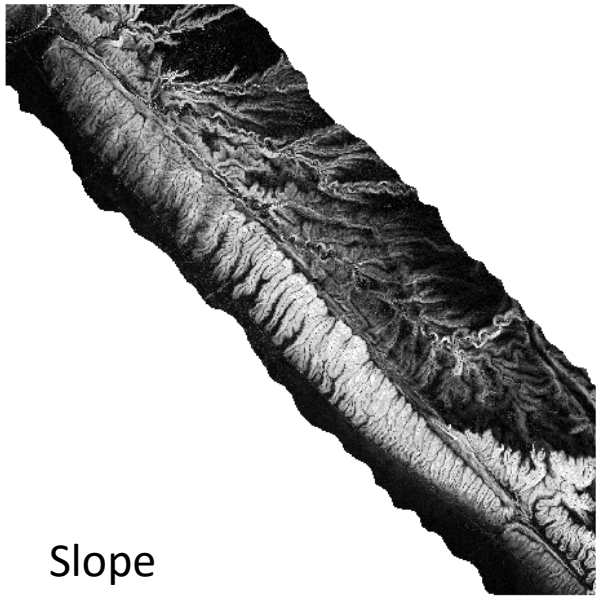
**Enter your e-mail address** for notification upon completion of processing: ramon.arrowsmith@asu.edu

# Download Job Results

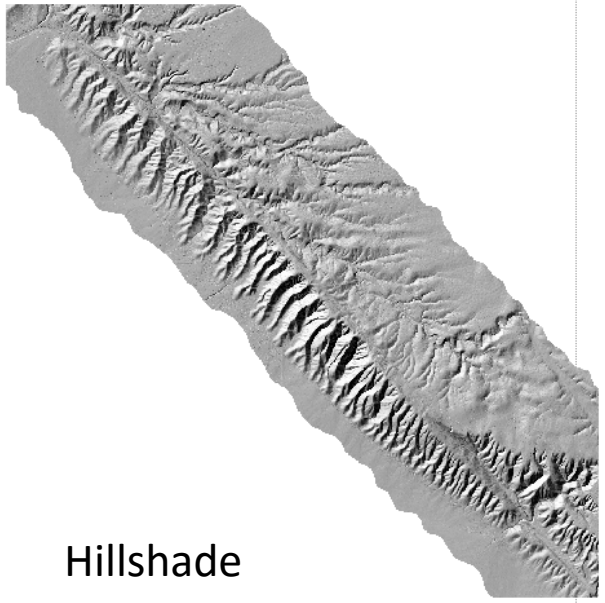
| | |
|---|---|
| Point Cloud Results | • Download point cloud data in LAS format points.las (454.6 MB) |
| DEM Results | • Download DEM (TIN) dems.tar.gz (11.6 MB) |
| Derivative Products | • Download Hillshade & Slope Products (TIN) viz.tar.gz (21.8 MB) |
| TauDEM Products | • Download PitRemove file pitRemove.tar.gz (11 MB)<br>• Download D-Infinity: Flow Direction file dinfFlowDirection.tar.gz (11.9 MB)<br>• Download D-Infinity: Slope file dinfSlope.tar.gz (12.6 MB)<br>• Download D-Infinity - Area Contribution file Dinfarea.tar.gz (16 MB)<br>• Download Topographic Wetness Index file TWI.tar.gz (16.8 MB)<br>• Download D8 - Flow Direction file d8FlowDirection.tar.gz (1.7 MB)<br>• Download D8: Slope file d8Slope.tar.gz (8.5 MB)<br>• Download D8 - Area Contribution file D8area.tar.gz (5.2 MB) |



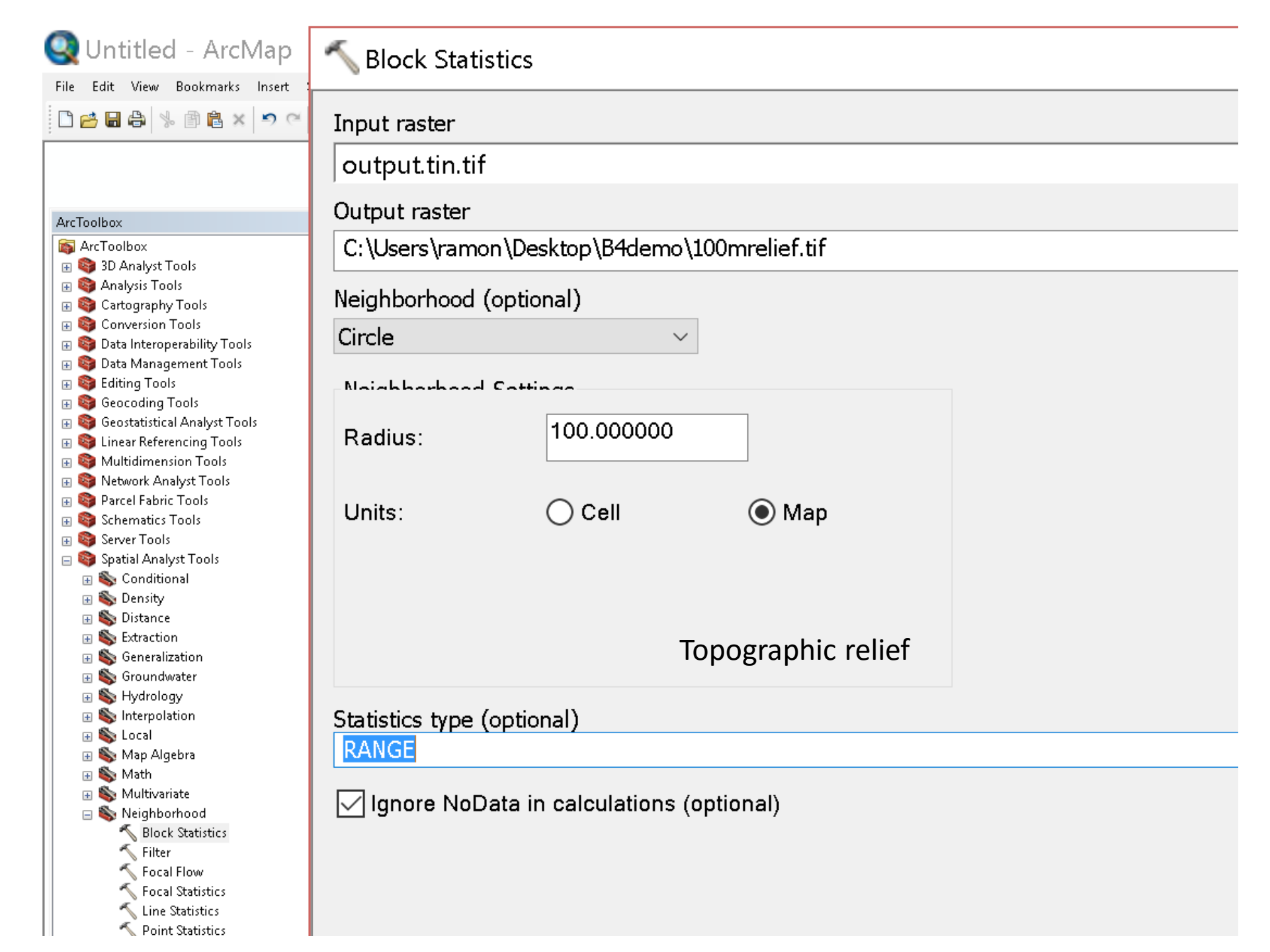
DEM



Slope



Hillshade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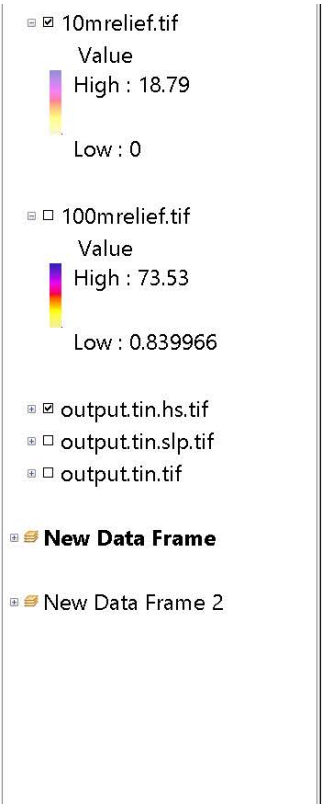
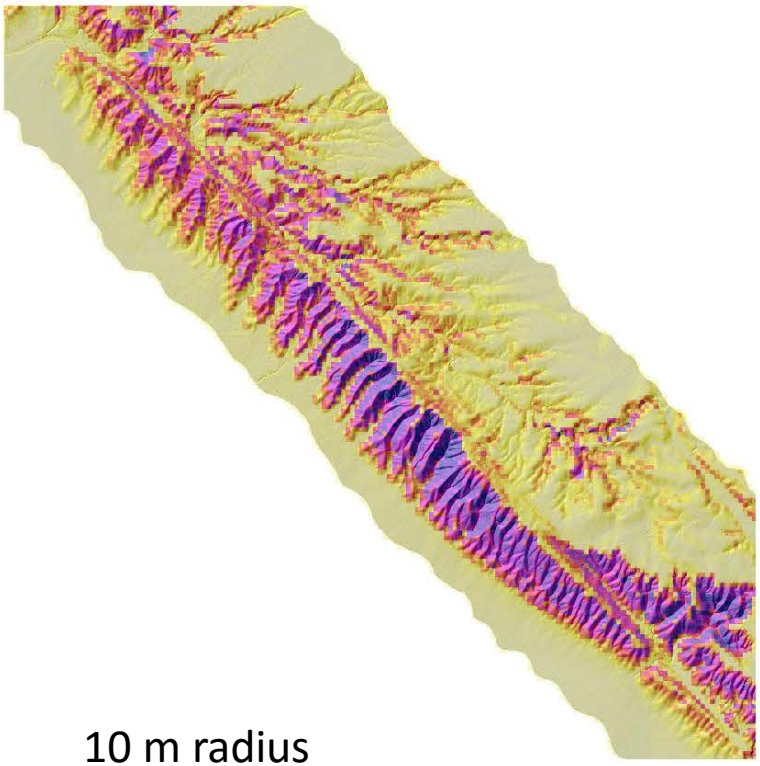
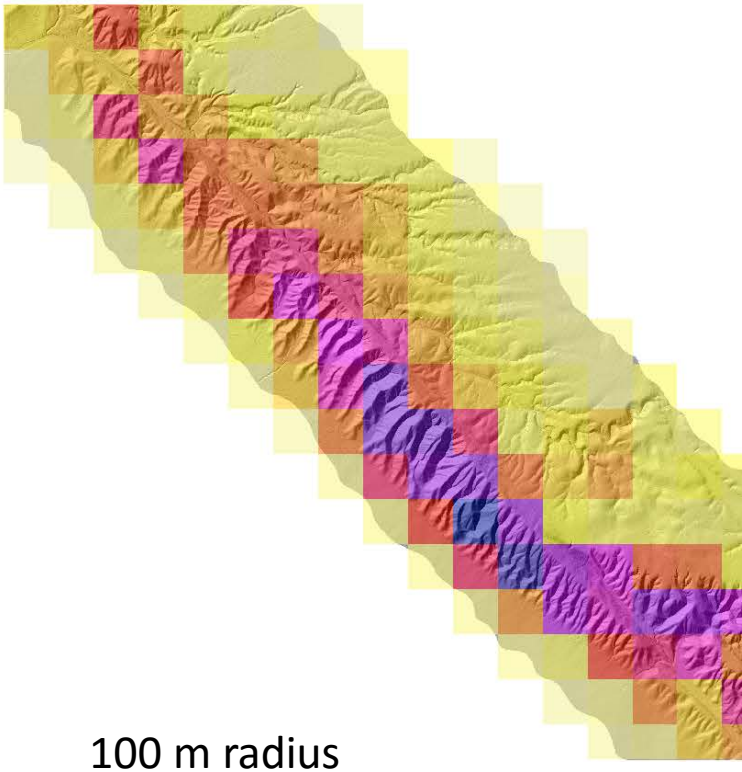
File Edit View Bookmarks Insert
ArcToolbox
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Editing Tools
Geocoding Tools
Geostatistical Analyst Tools
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Parcel Fabric Tools
Schematics Tools
Server Tools
Spatial Analyst Tools
Conditional
Density
Distance
Extraction
Generalization
Groundwater
Hydrology
Interpolation
Local
Map Algebra
Math
Multivariate
Neighborhood
Block Statistics
Filter
Focal Flow
Focal Statistics
Line Statistics
Point Statistics
Block Statistics
Input raster
output.tin.tif
Output raster
C:\Users\ramon\Desktop\B4demo\100mrelief.tif
Neighborhood (optional)
Circle
Radius:
100.000000
Units:
Cell
Map
Topographic relief
Statistics type (optional)
RANGE
Ignore NoData in calculations (optional)



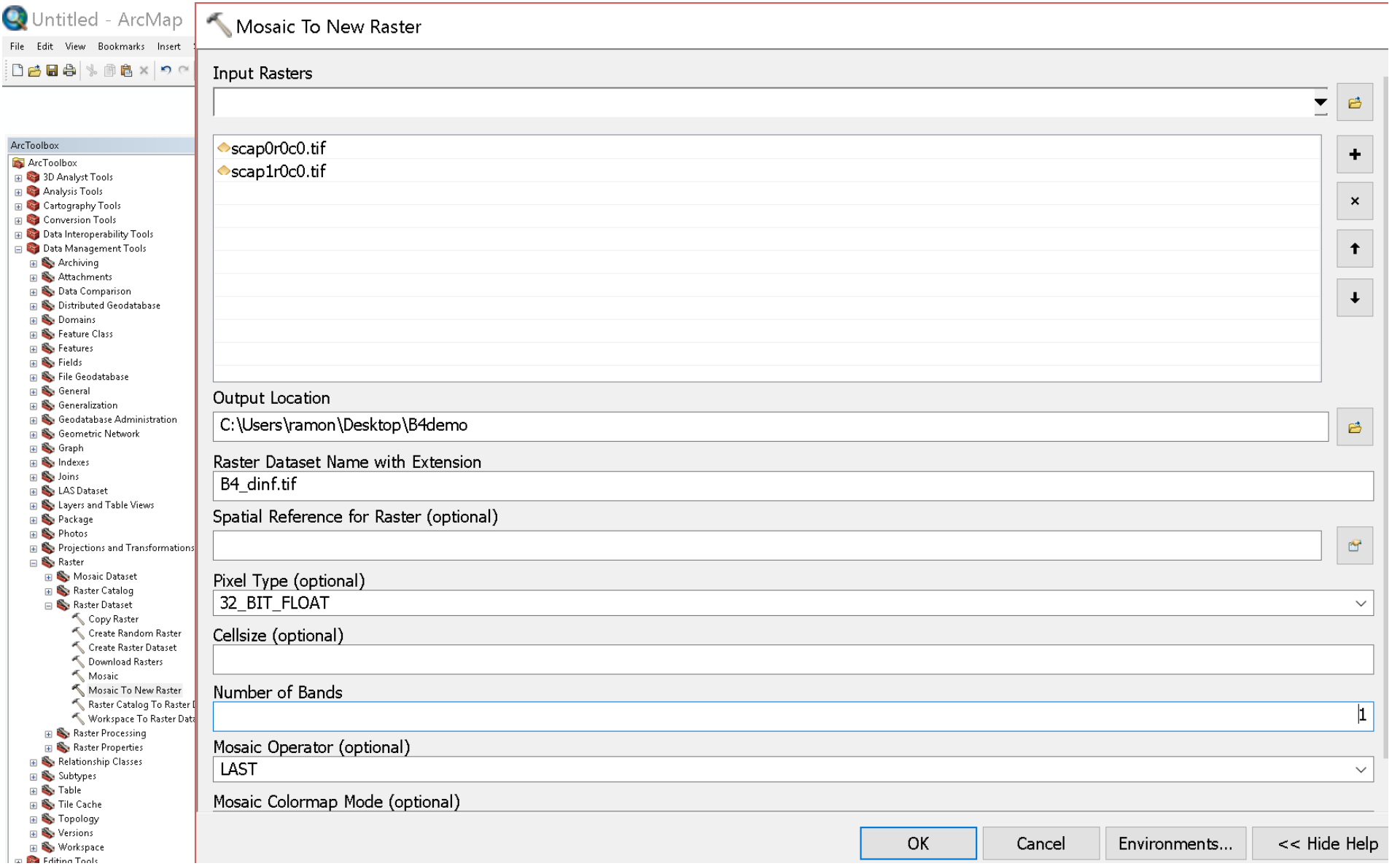



10 m radius



100 m radius

# Need to mosaic the grids



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File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:23,477

3D Analyst

scap0r0c0.tif

Table Of Contents

Layers

B4_dinf.tif

Value

High : 277780

Low : 1

scap0r0c0.tif

Value

High : 113107

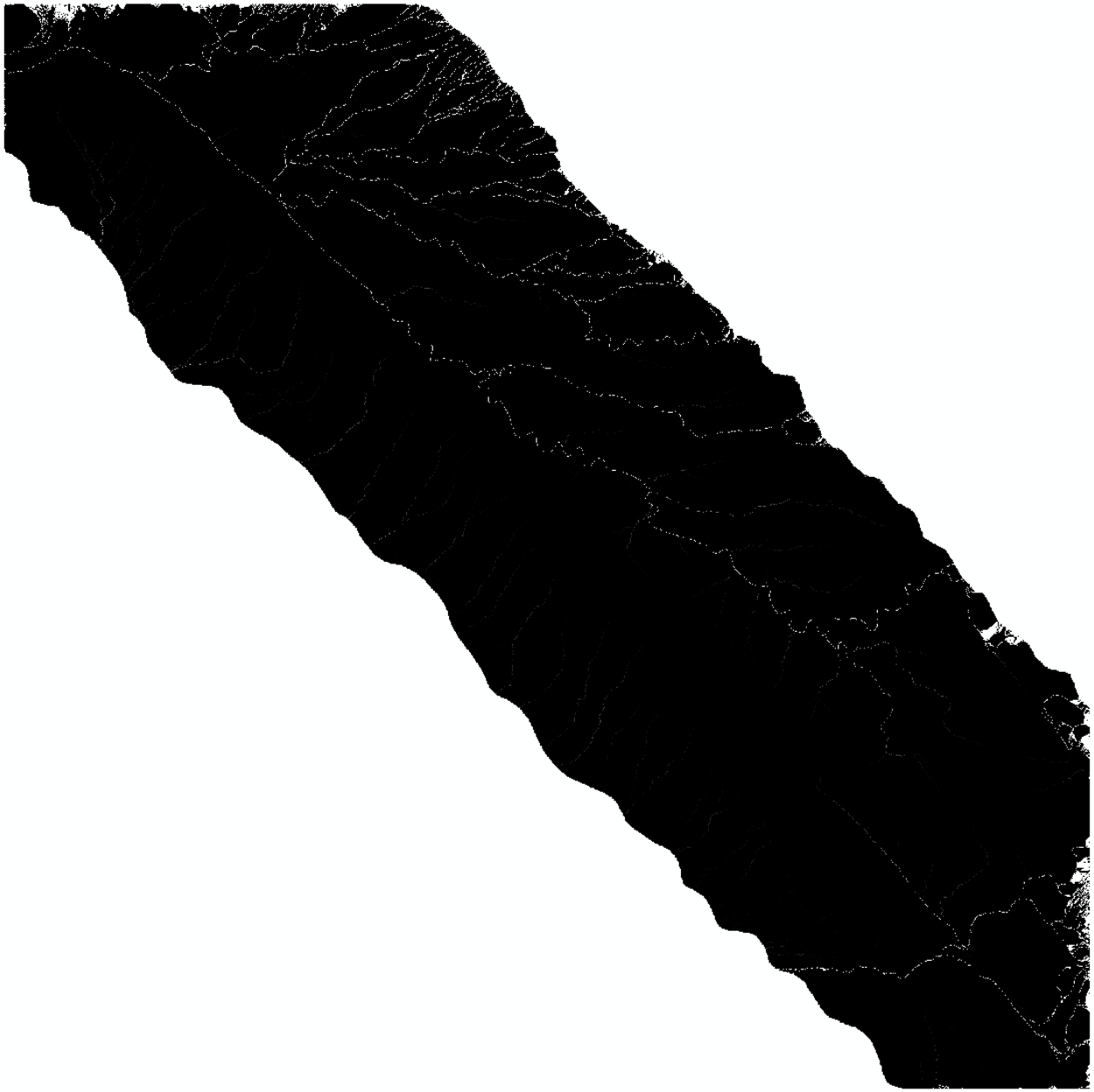
Low : 1

scap1r0c0.tif

Value

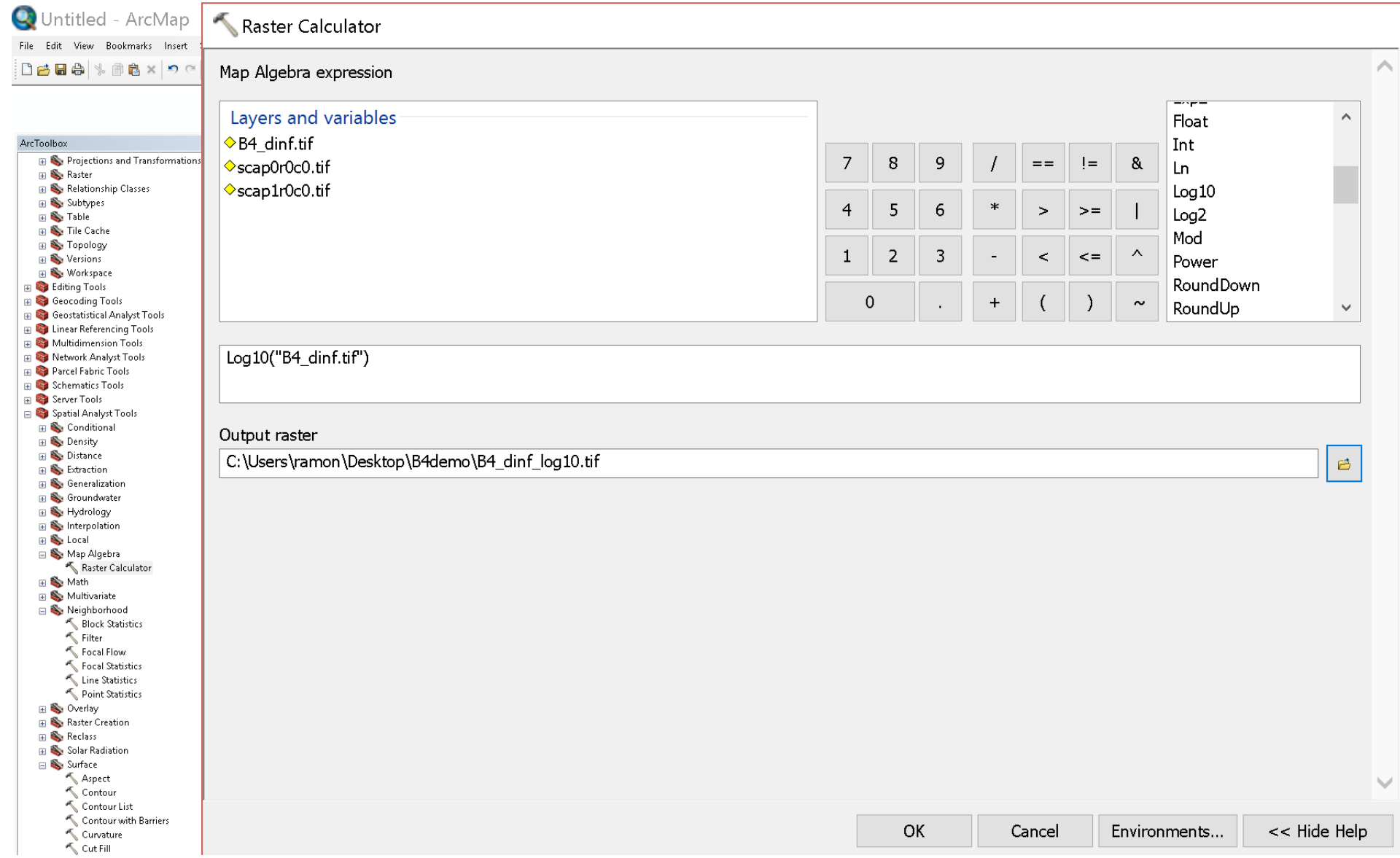
High : 277773

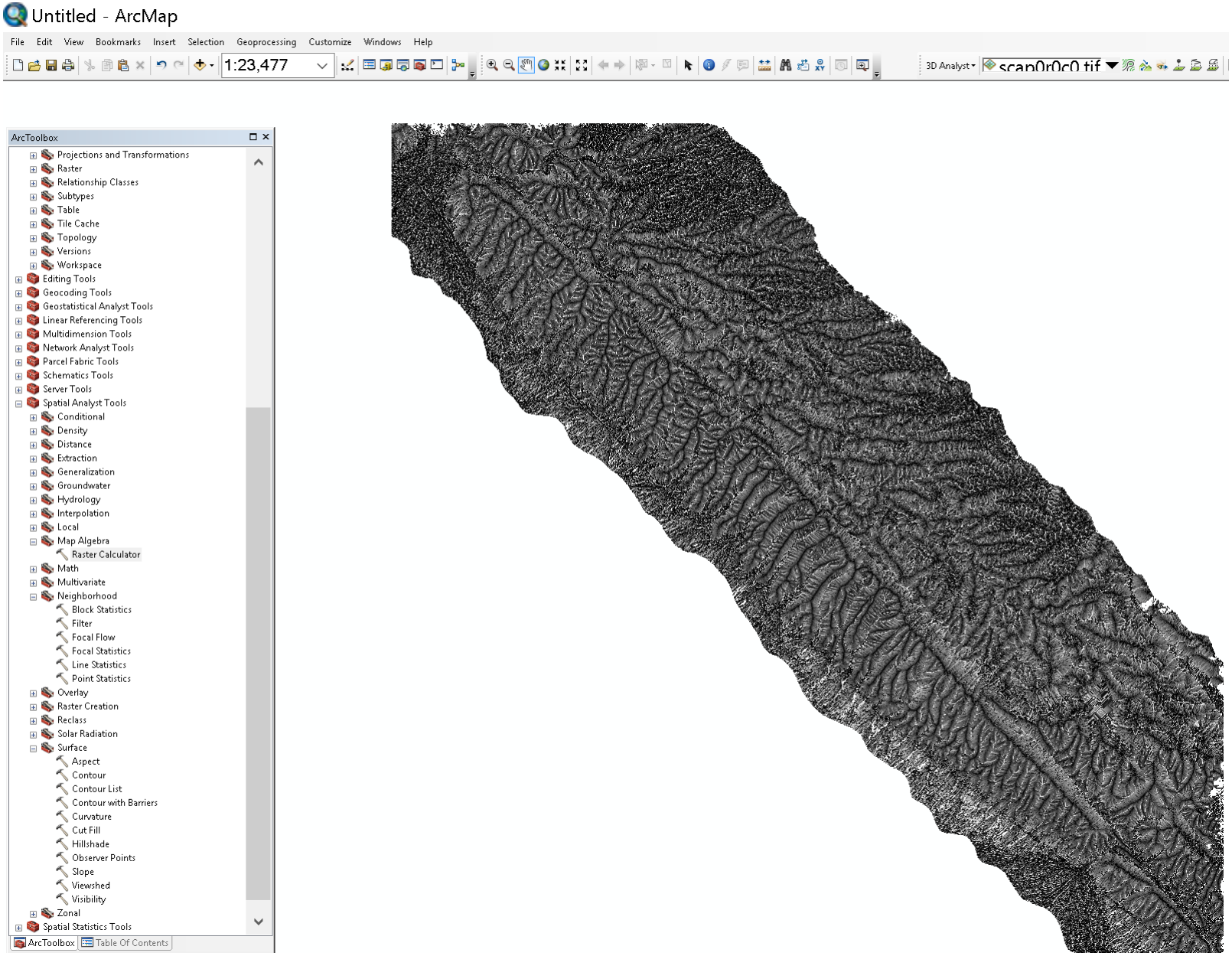
Low : 1



ArcToolbox Table Of Contents

# Log10 of the drainage area

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File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:23,477
3D Analyst
ArcToolbox
Projections and Transformations
Raster
Relationship Classes
Subtypes
Table
Tile Cache
Topology
Versions
Workspace
Editing Tools
Geocoding Tools
Geostatistical Analyst Tools
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Parcel Fabric Tools
Schematics Tools
Server Tools
Spatial Analyst Tools
Conditional
Density
Distance
Extraction
Generalization
Groundwater
Hydrology
Interpolation
Local
Map Algebra
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Neighborhood
Block Statistics
Filter
Focal Flow
Focal Statistics
Line Statistics
Point Statistics
Overlay
Raster Creation
Reclass
Solar Radiation
Surface
Aspect
Contour
Contour List
Contour with Barriers
Curvature
Cut Fill
Hillshade
Observer Points
Slope
Viewshed
Visibility
Zonal
Spatial Statistics Tools
ArcToolbox
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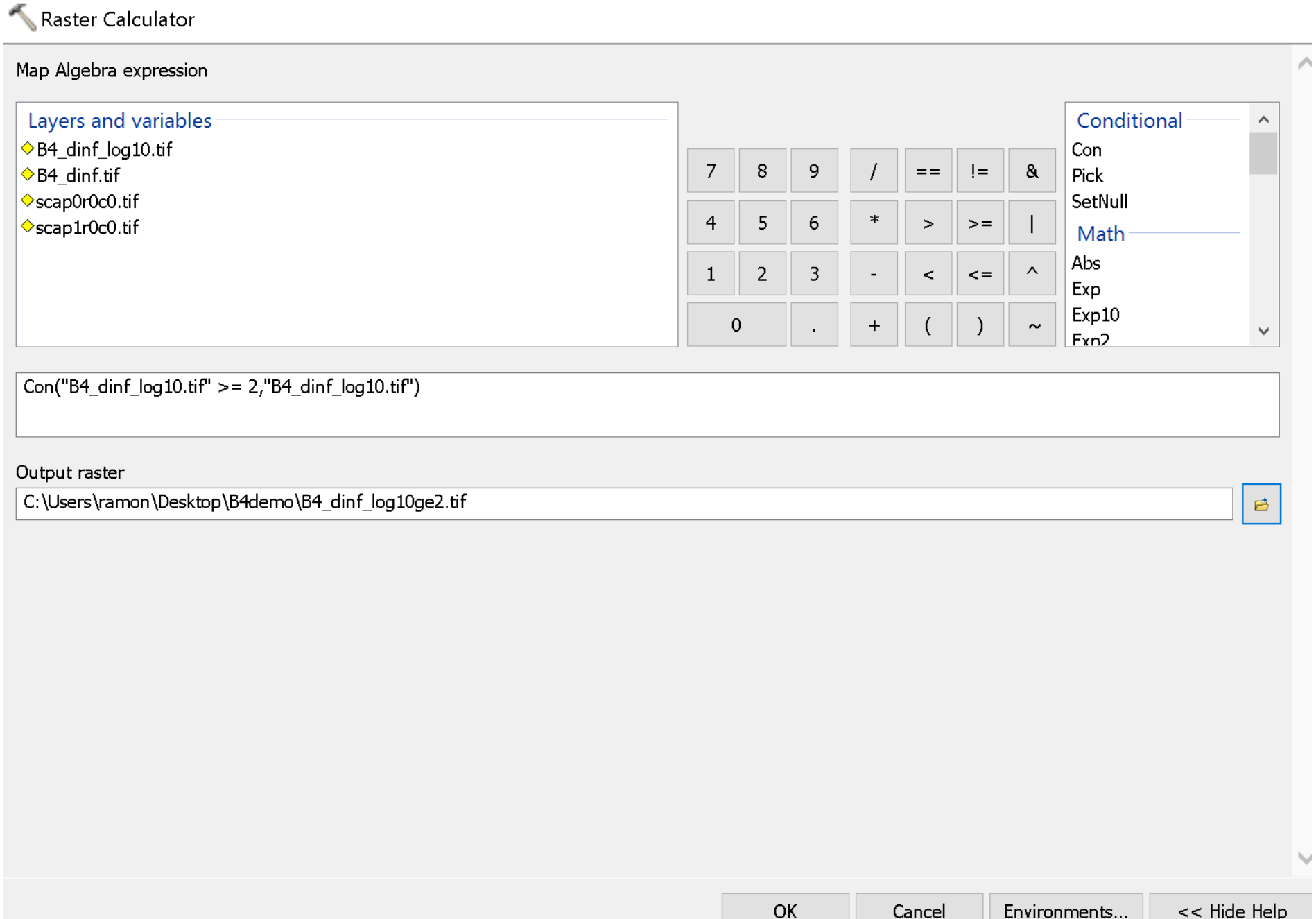
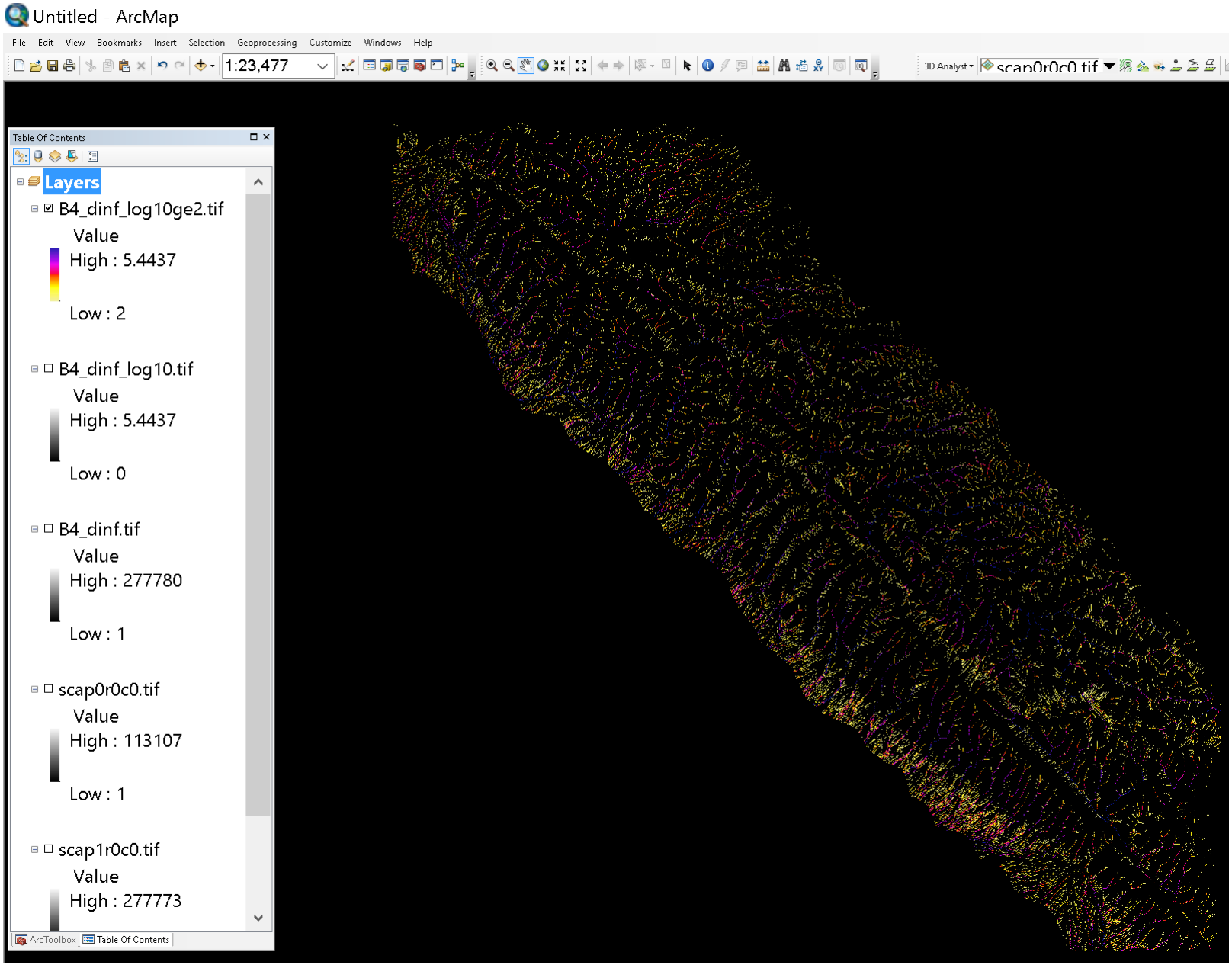
# Drainage area >= 100m$^2$

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3D Analyst
scap0r0c0.tif
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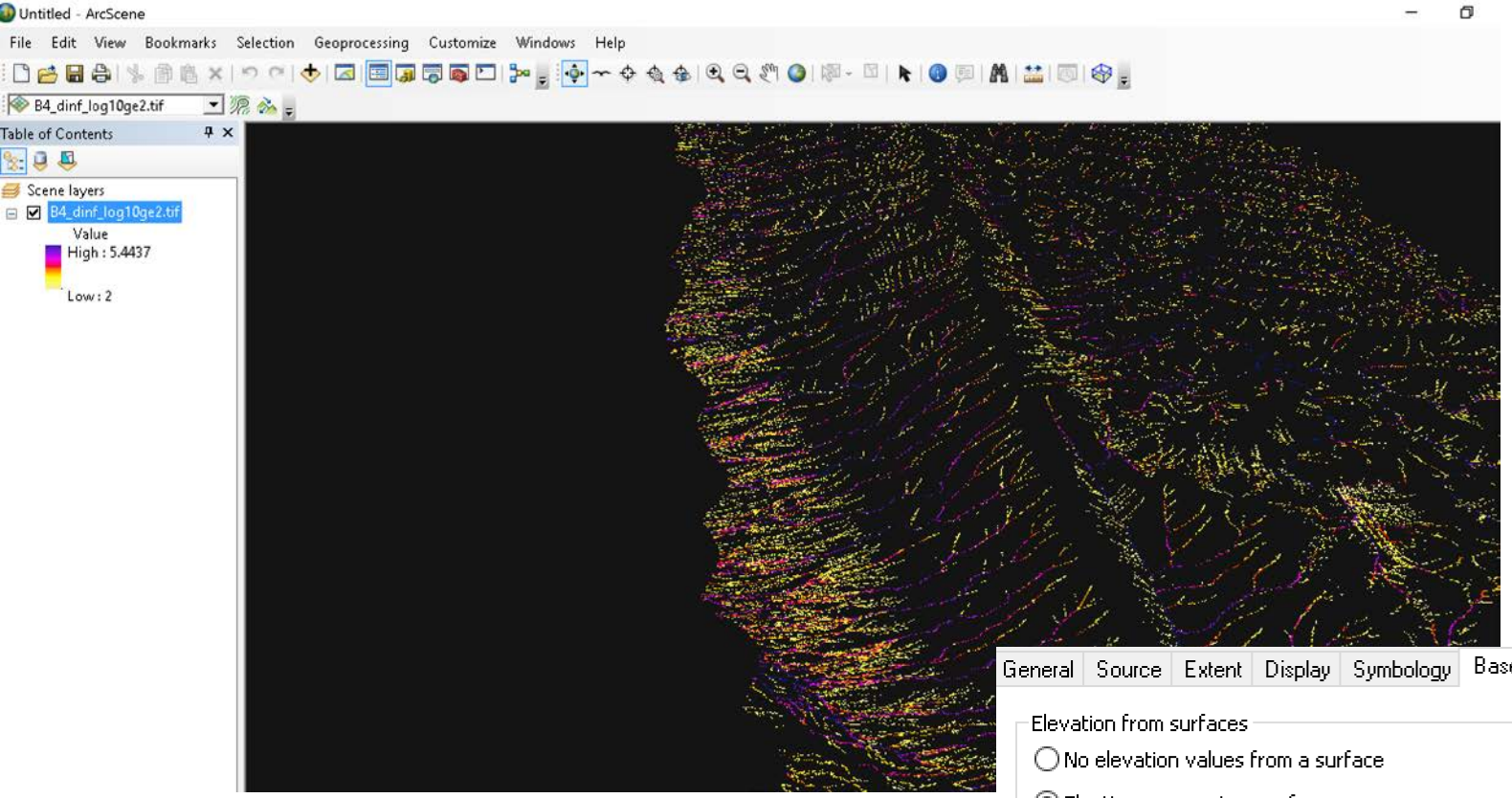
Low : 0
B4_dinf.tif
Value
High : 277780
Low : 1
scap0r0c0.tif
Value
High : 113107
Low : 1
scap1r0c0.tif
Value
High : 277773
ArcToolbox
Table Of Contents




Scene layers background black