

Step-by-Step Tutorial for How to Operate the SICCM Toolbox

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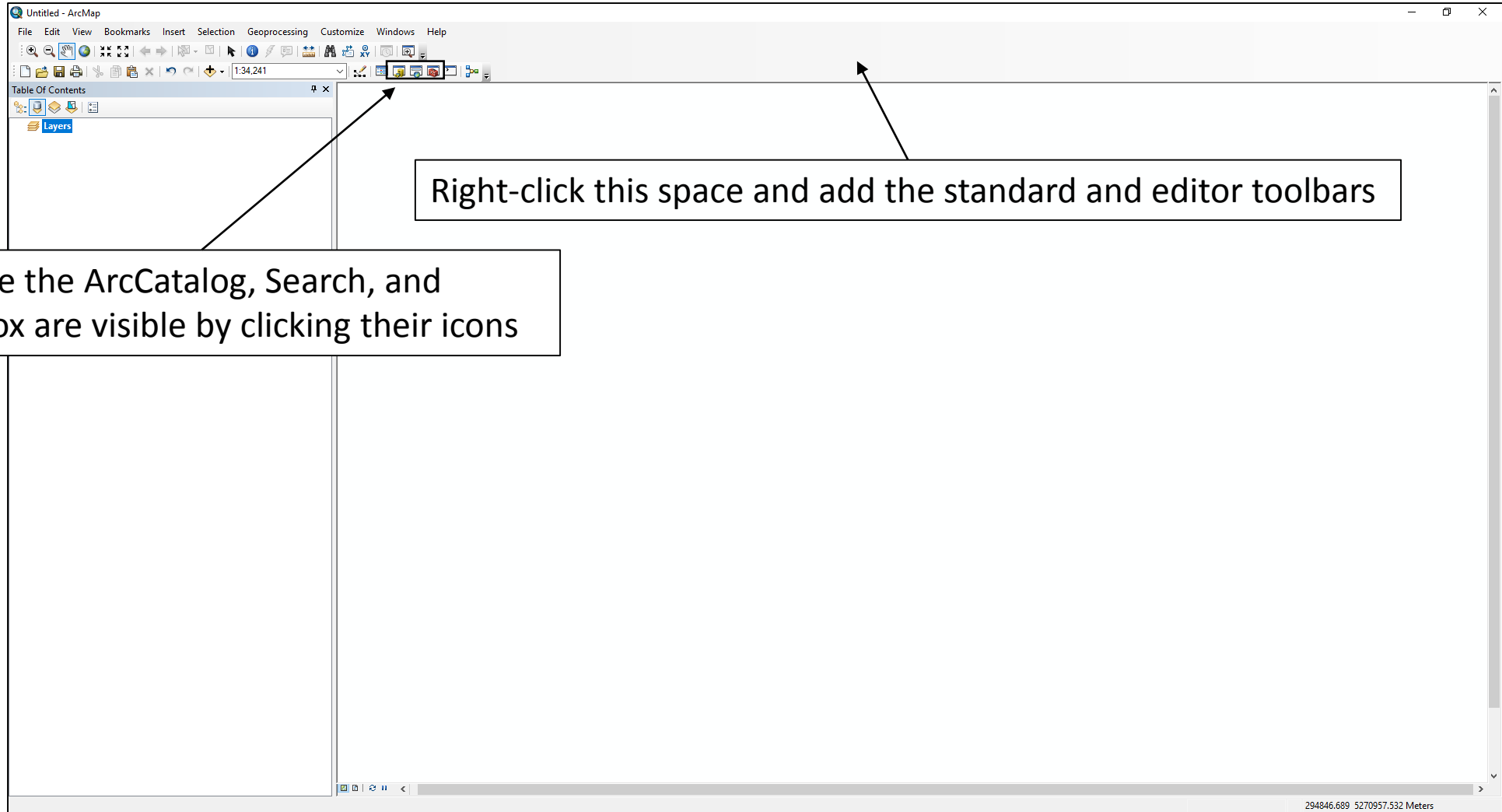


December 2018

Introduction

- This slideshow illustrates how to implement the SICCM Toolbox
- The toolbox may be used to produce preliminary landslide inventory maps
- In order to perform the tutorial, you will need a computer with ArcGIS, version 10.3 or greater
- If you would like to know more about the SICCM Toolbox, please read the ***Guide to Operation of the Scarp Identification+Contour Connection Method (SICCM) ArcGIS Toolbox***

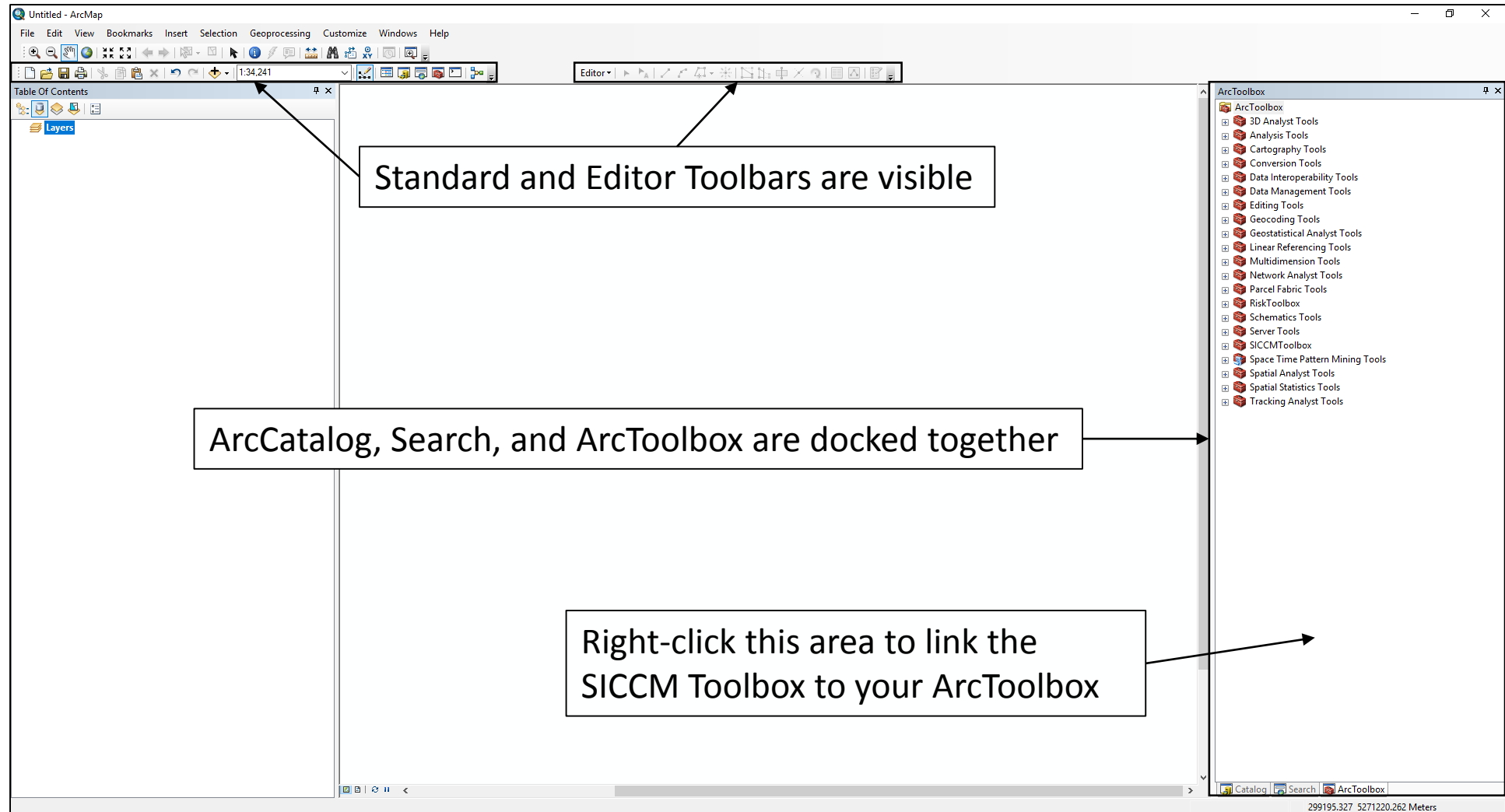
Familiarize yourself with ArcMap



Make sure the ArcCatalog, Search, and ArcToolbox are visible by clicking their icons

Right-click this space and add the standard and editor toolbars

ArcMap should look something like this



Save your Map Document

The screenshot shows the ArcMap interface with the File menu open. The 'Save' option is highlighted, and a tooltip indicates 'Save (Ctrl+S) Save the current map document.' A callout box with an arrow pointing to the 'Save' option contains the following text:

Saving your map as a Map Document (.mxd) will maintain the symbology and organization of layers created by the toolbox when you close ArcGIS.

The ArcToolbox on the right side of the screen is visible, showing a list of tool categories and specific tools. The status bar at the bottom indicates the coordinates 286098.952 5271938.231 Meters and the date/time 3:22 PM 12/13/2018.

Add your DEM to the map

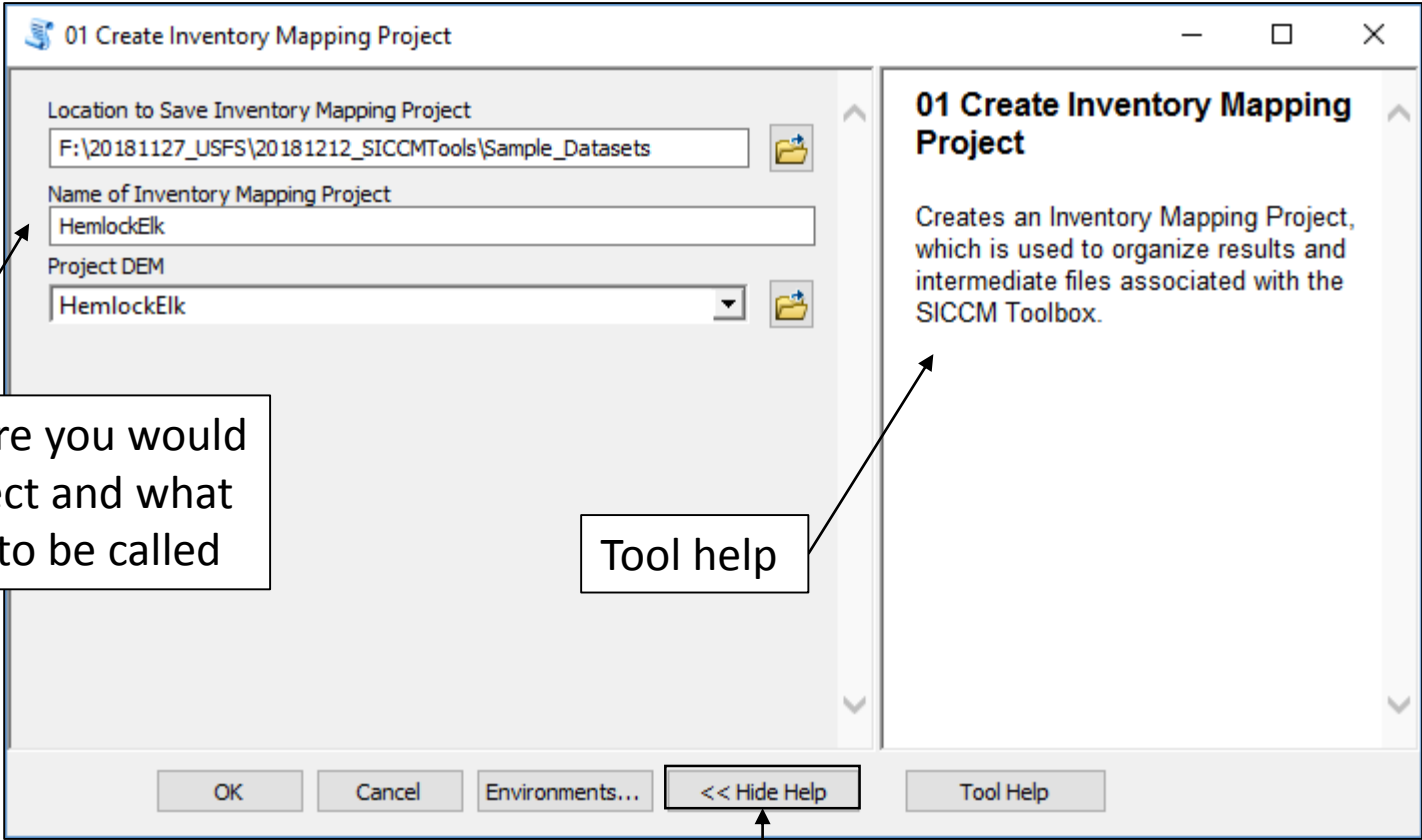
The image shows a screenshot of the ArcMap software interface. The main window displays a map with a grayscale DEM (Digital Elevation Model) overlay. The interface includes a menu bar at the top, a toolbar, and several panels. The 'Table Of Contents' panel on the left shows a layer named 'HemlockElk' with a value range from 1111.42 to 1705.81. The 'ArcToolbox' panel on the right is open, showing a list of toolboxes, including the 'SICCMToolbox' which contains various tools for scarp analysis. Three callout boxes with arrows point to specific elements: one points to the 'Add Data' button in the toolbar, another points to the 'HemlockElk' layer in the Table of Contents, and a third points to the 'ArcToolbox' panel.

Use **Add Data** to import DEM

We will work on the HemlockElk DEM from the sample dataset geodatabase

Notice the toolbox

Run Tool 1



You can choose where you would like to save the project and what you would like for it to be called

Tool help

Toggle tool help visibility

Output of Tool 1

Table Of Contents

- Layers
 - FA\20181127_USFS\20181212_SICCMTools\Sample_Datasets\Hemlo
 - Raw_DEM
 - Value
 - High : 1705.81
 - Low : 1111.42
 - HemlockElk
 - Value
 - High : 1705.81
 - Low : 1111.42

Switch to ArcCatalog to see the newly created project

If desired, you can remove the original DEM by right-clicking it in the Table of Contents

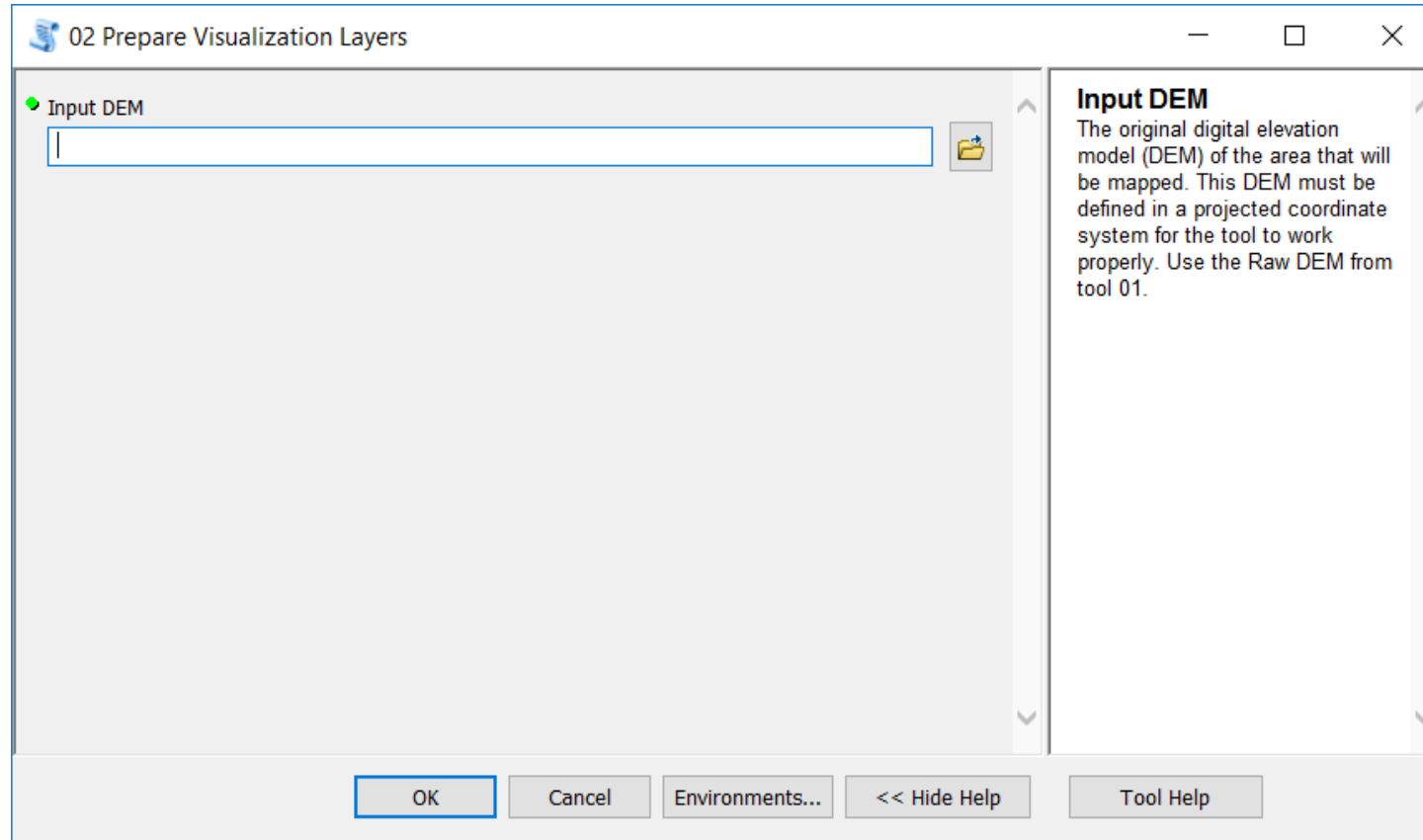
Catalog

Location: HemlockElk.gdb

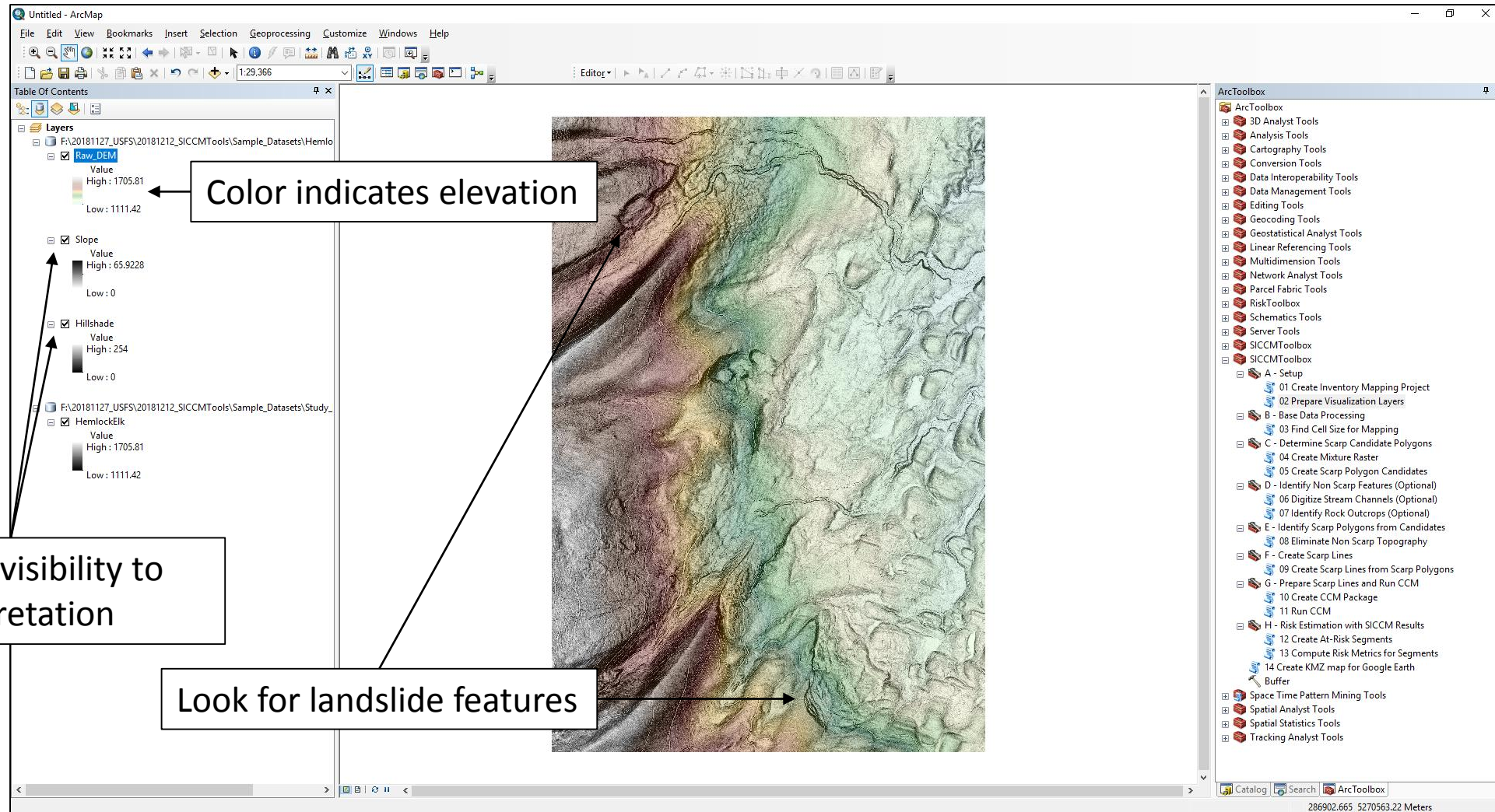
- Home - My Documents\ArcGIS
- Folder Connections
- F:\
- FA\20181127_USFS
- 20181212_SICCMTools
- Required_Files
- Sample_Datasets
- HemlockElk
 - HemlockElk.gdb
 - Raw_DEM
- LowerMonture
- Study_DEMs.gdb
- SICCMToolbox.tbx
- L:\
- Toolboxes
- Database Servers
- Database Connections
- GIS Servers
- Add ArcGIS Server
- Add ArcIMS Server
- Add WCS Server
- Add WMS Server
- Add WMTS Server
- arcgis on arcweld.engr.oregonstate.edu_6080 (publisher)
- arcgis on gis.apfo.usda.gov (user)
- arcgis on gis.dogami.oregon.gov (user)
- My Hosted Services
- Ready-To-Use Services

289466.68 5271518.898 Meters

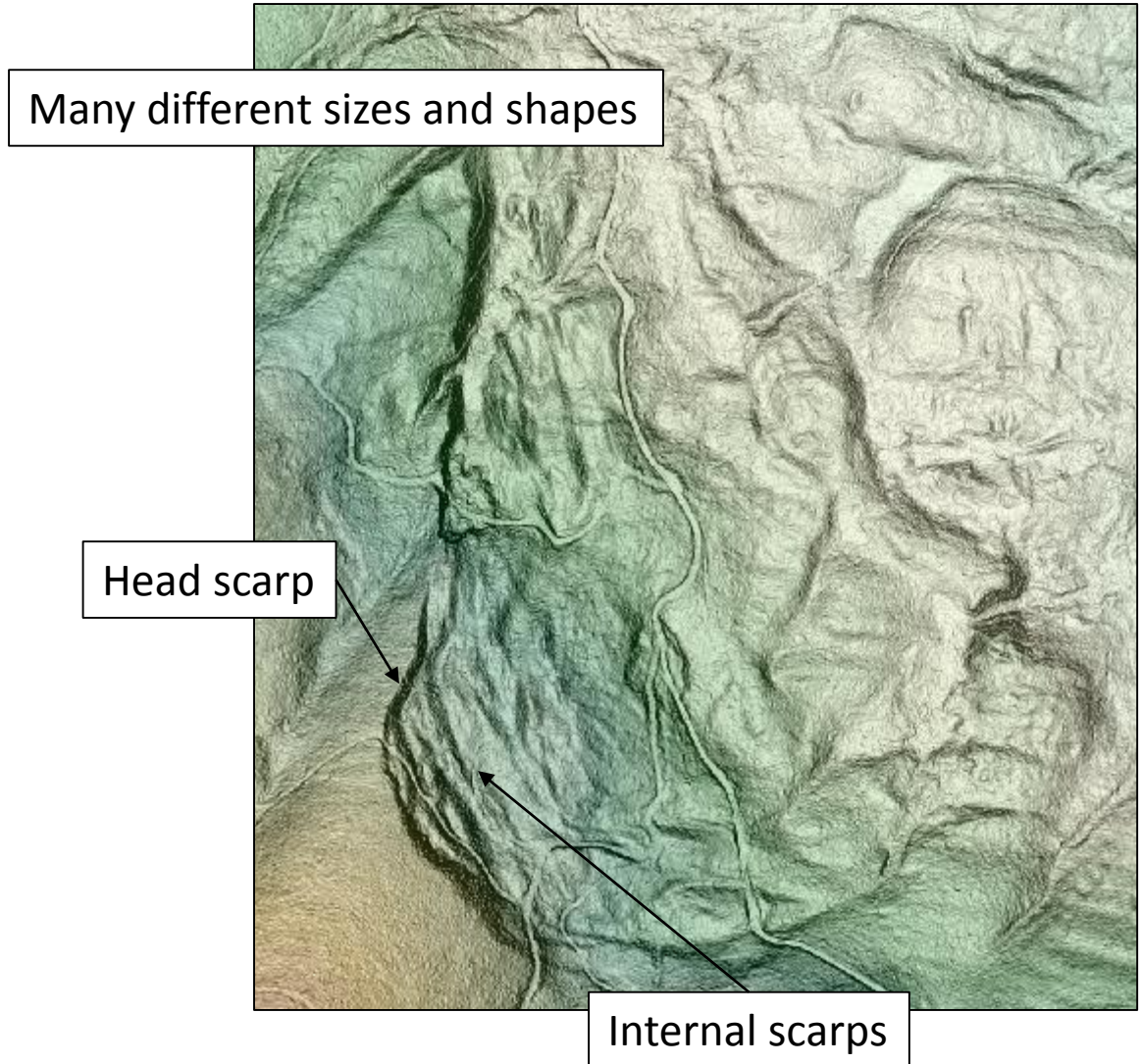
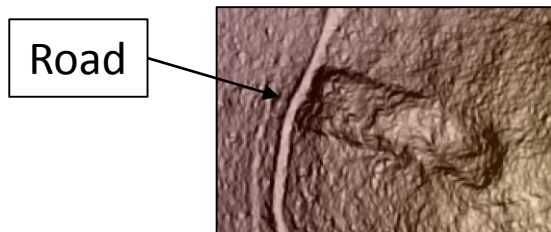
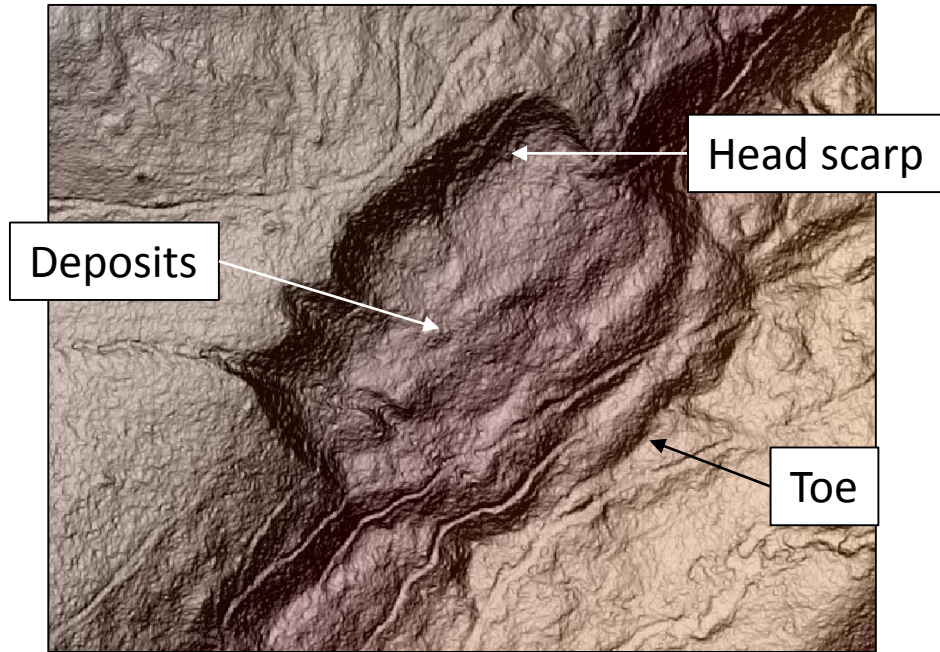
Run Tool 2



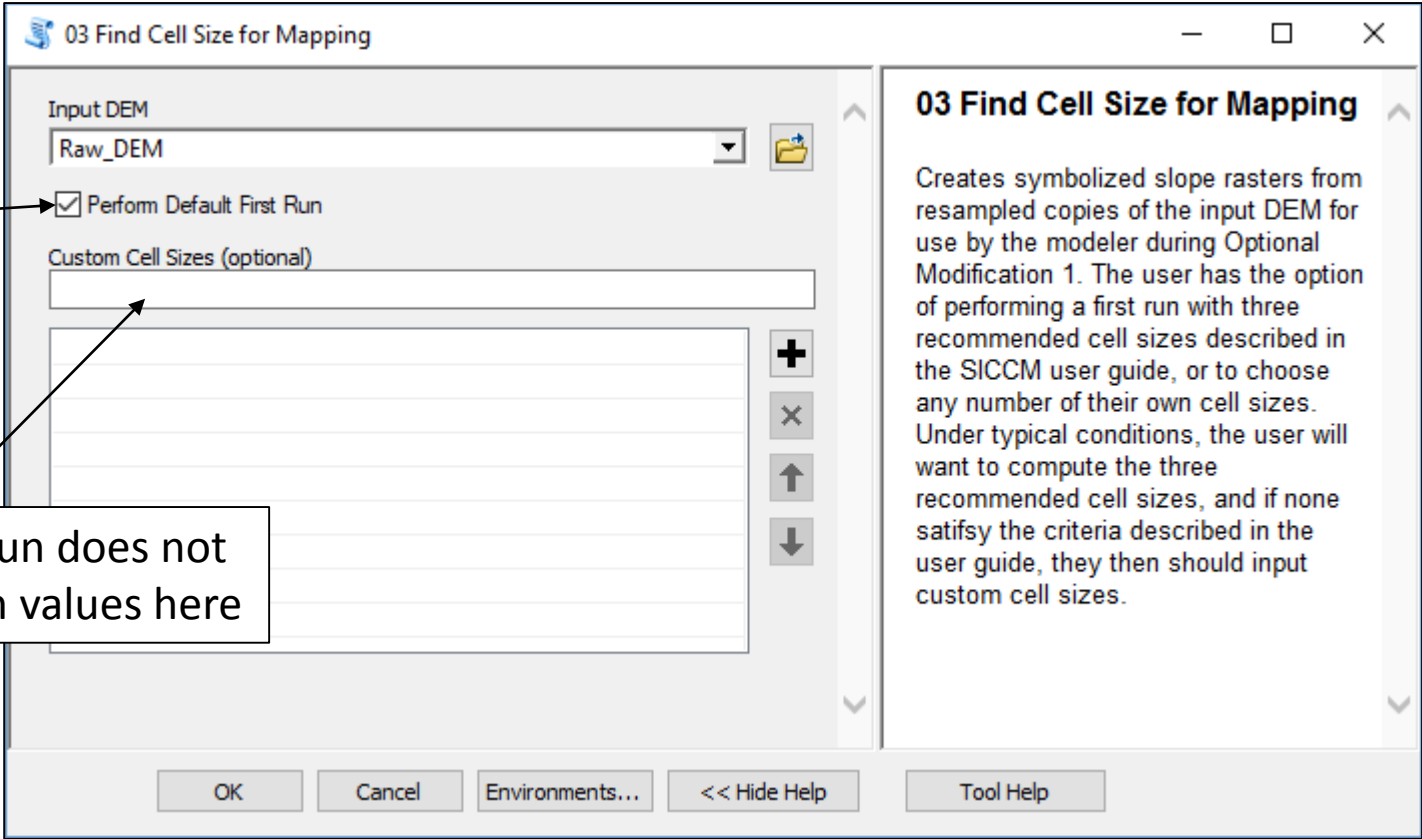
Output of Tool 2



Some landslide features visible in the terrain



Run Tool 3



Do this first

If the default first run does not work, enter custom values here

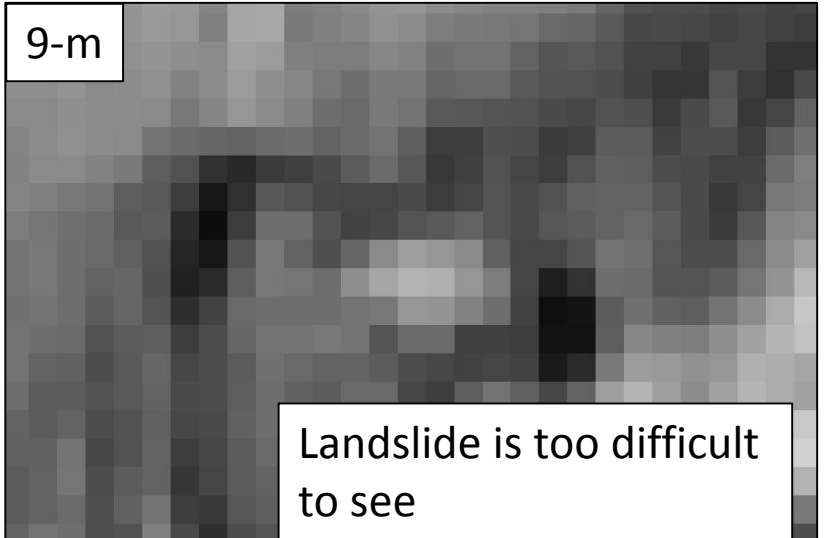
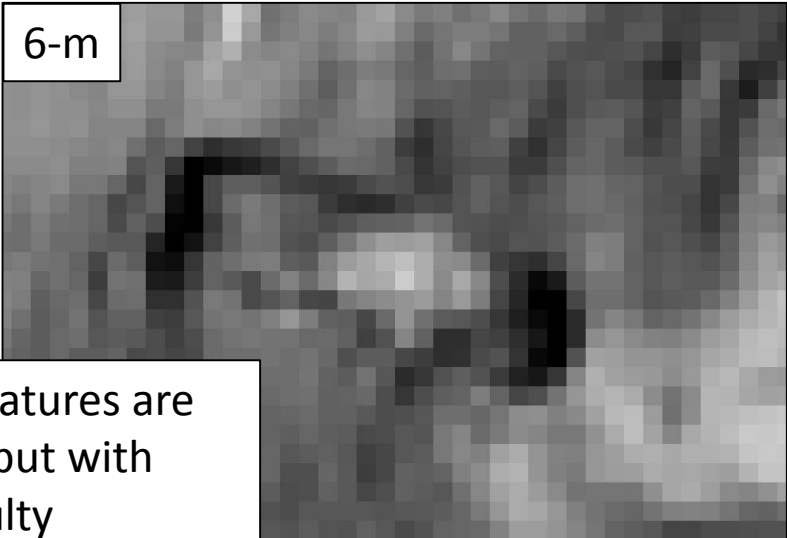
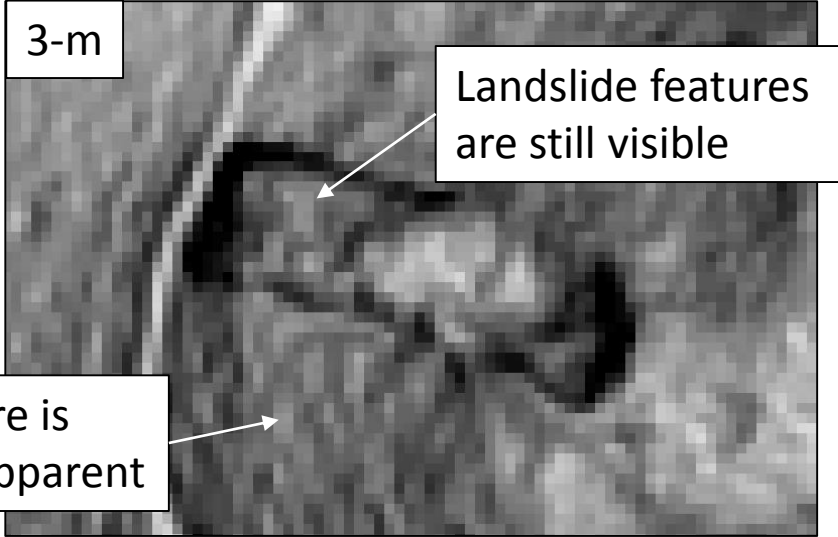
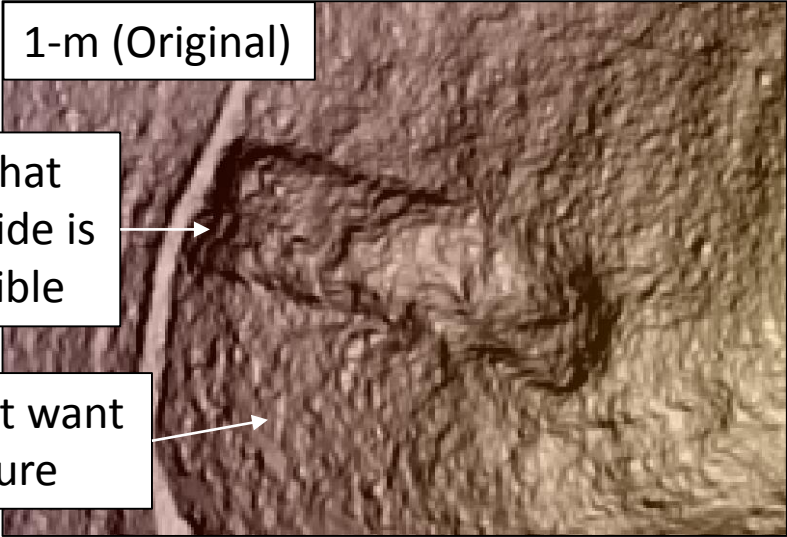
Output of Tool 3

The screenshot displays the ArcMap interface with a 3D terrain model in the center. The 'Layers' panel on the left lists several layers, including 'Raw_DEM' which is highlighted. The 'ArcToolbox' panel on the right shows a list of tools, with '04 Create Mixture Raster' through '14 Create KMZ map for Google Earth' visible. A callout box with an arrow points to a specific area on the terrain model.

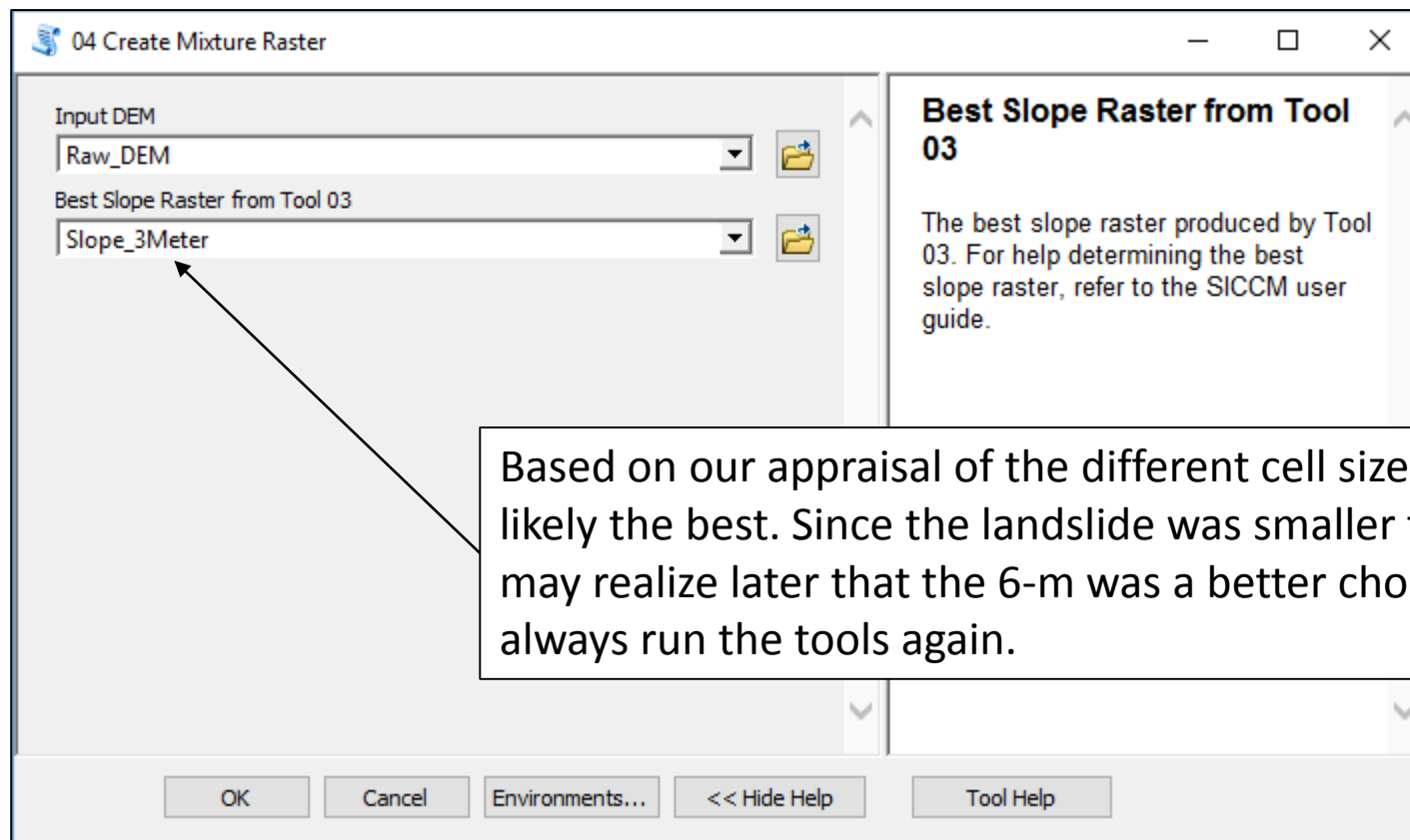
Look at previously observed landslides to determine the best cell size

291378.038 5271759.761 Meters

Comparing cell sizes



Run Tool 4

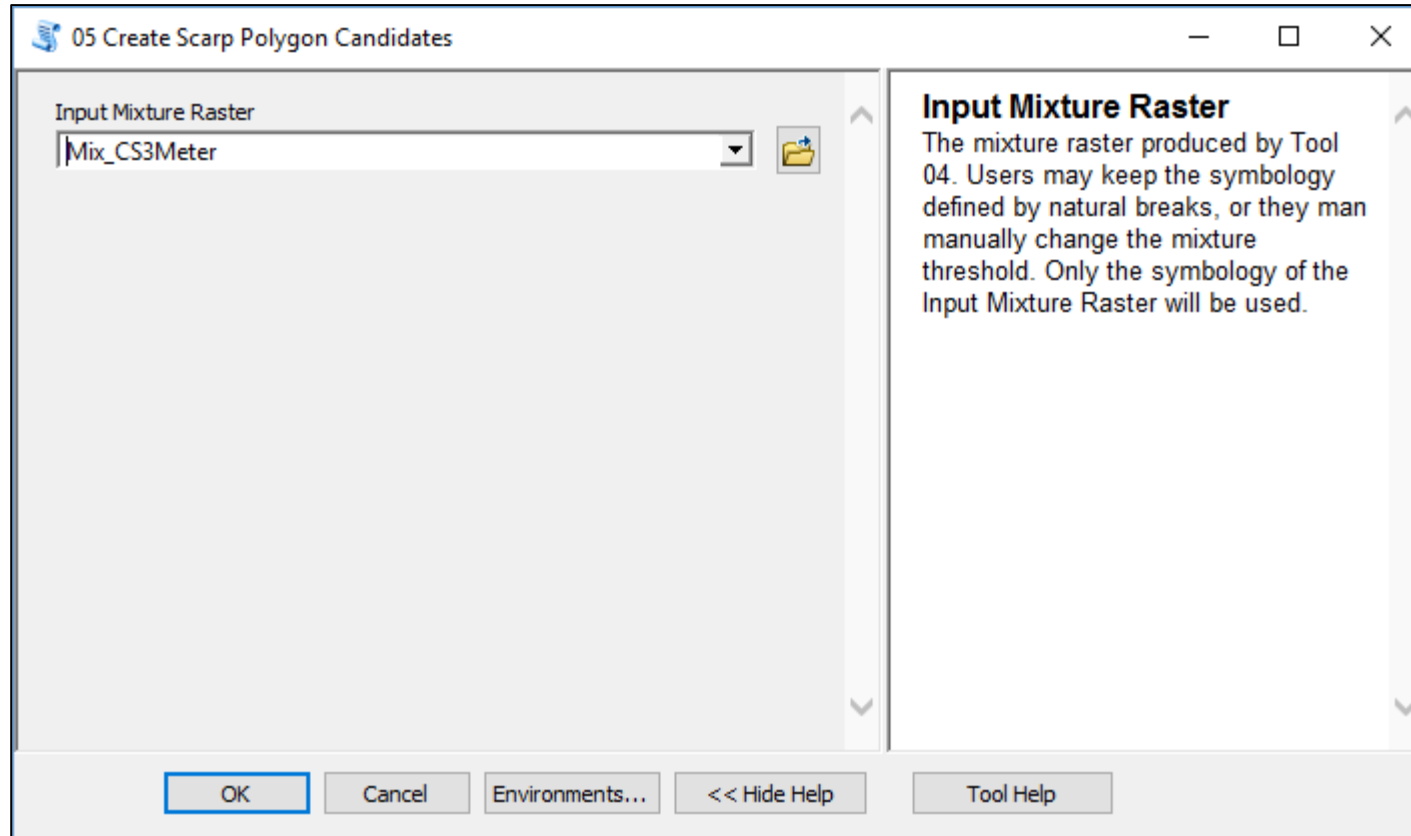


Output of Tool 4

Mixture Raster
Negative values = convex terrain
Positive values = concave terrain

Automatically generated results are generally acceptable (here, for example), but there are cases where they may not be. See the User Guide for more information regarding the special cases

Run Tool 5



Results of Tool 5

The concave mixture raster pixels have been converted into polygons

The next few tools will decide which of these polygons are associated with landslide scarps

Table of Contents:

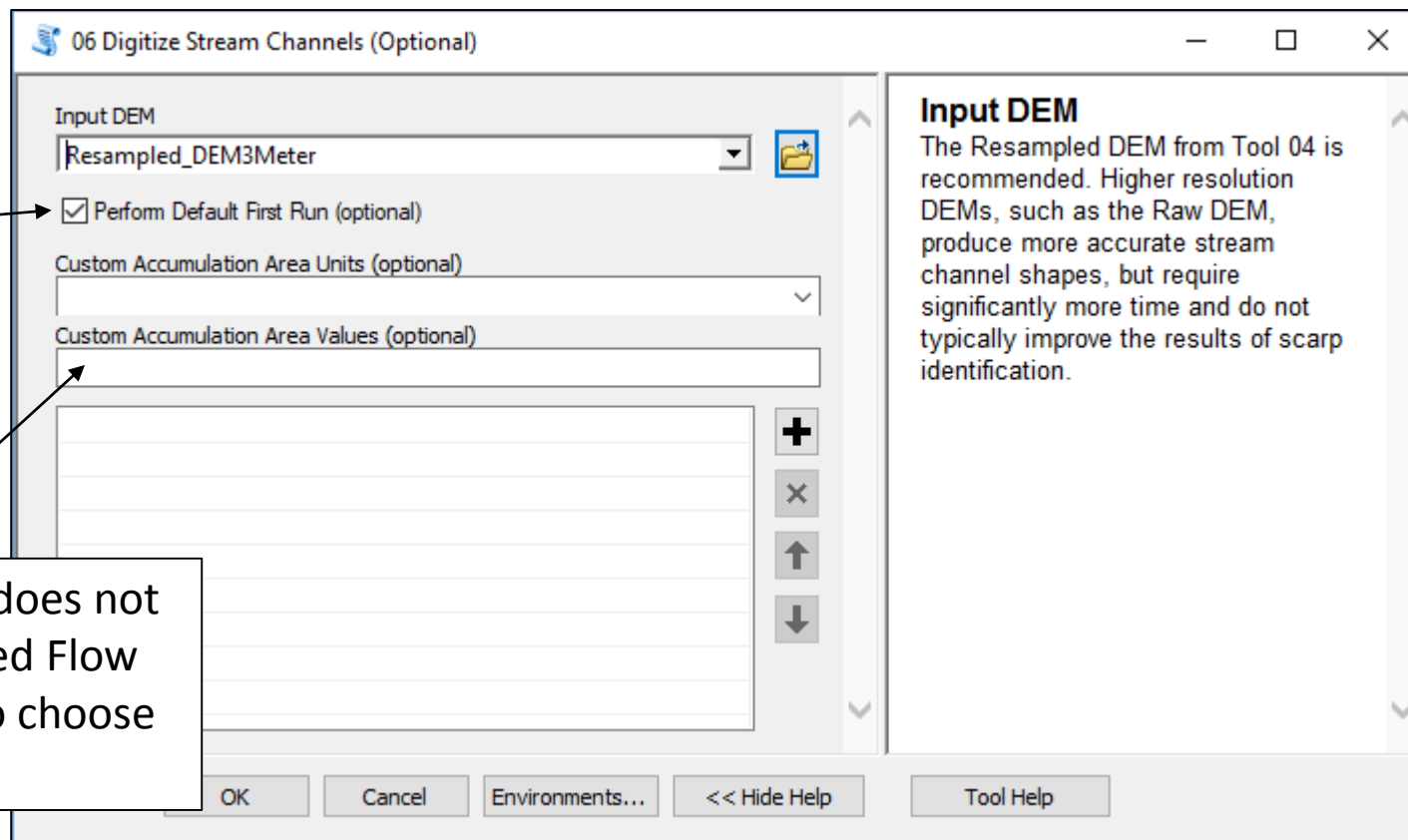
- Layers
 - FA\20181127_USFS\20181212_SICCMTools\Sample_Datasets\Her
 - Cand_CS3Meter_MTT13
 - <all other values>
 - LS
 - 0
 - 1
 - Mbx_CS3Meter<VALUE>
 - 223.5707855 - -16.72327767
 - 16.72327766 - 13.36363256
 - 13.36363257 - 255.9393463
 - Resampled_DEM3Meter
 - Value
 - High : 1705.32
 - Low : 1111.47
 - Slope_9Meter
 - Value
 - High : 40.6468
 - Low : 0.0112649
 - Slope_6Meter
 - Value
 - High : 45.3382
 - Low : 0.00803922
 - Slope_3Meter
 - Value
 - High : 51.1202
 - Low : 0
 - Raw_DEM
 - Value
 - High : 1705.81
 - Low : 1111.42
 - Slope
 - Value
 - High : 65.9228
 - Low : 0

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
 - RiskToolbox
 - Schematics Tools
 - Server Tools
 - SICCMToolbox
 - SICCMToolbox
 - A - Setup
 - 01 Create Inventory Mapping Project
 - 02 Prepare Visualization Layers
 - B - Base Data Processing
 - 03 Find Cell Size for Mapping
 - 04 Create Mixture Raster
 - 05 Create Scarp Polygon Candidates
 - D - Identify Non Scarp Features (Optional)
 - 06 Digitize Stream Channels (Optional)
 - 07 Identify Rock Outcrops (Optional)
 - E - Identify Scarp Polygons from Candidate
 - 08 Eliminate Non Scarp Topography
 - F - Create Scarp Lines
 - 09 Create Scarp Lines from Scarp Polygons
 - G - Prepare Scarp Lines and Run CCM
 - 10 Create CCM Package
 - 11 Run CCM
 - H - Risk Estimation with SICCM Results
 - 12 Create At-Risk Segments
 - 13 Compute Risk Metrics for Segments
 - 14 Create KMZ map for Google Earth
 - Buffer
 - Space Time Pattern Mining Tools
 - Spatial Analyst Tools
 - Spatial Statistics Tools
 - Tracking Analyst Tools

288232.92 5269680.425 Meters

Run Tool 6



Do this first

If the default first run does not work, use the outputted Flow Accumulation raster to choose custom values

Output of Tool 6

The screenshot displays the ArcMap interface with a map showing a stream network in cyan. The interface includes a menu bar, a toolbar, a Table of Contents, a Layers panel, a main map area, and an ArcToolbox. Three callout boxes provide instructions:

- Three default runs**: Points to the 'Channels_3_0Acres' layer in the Layers panel.
- Focus of next slide**: Points to a specific area of the stream network on the map.
- Toggle visibility of each channel network and explore the map**: A general instruction for the user.

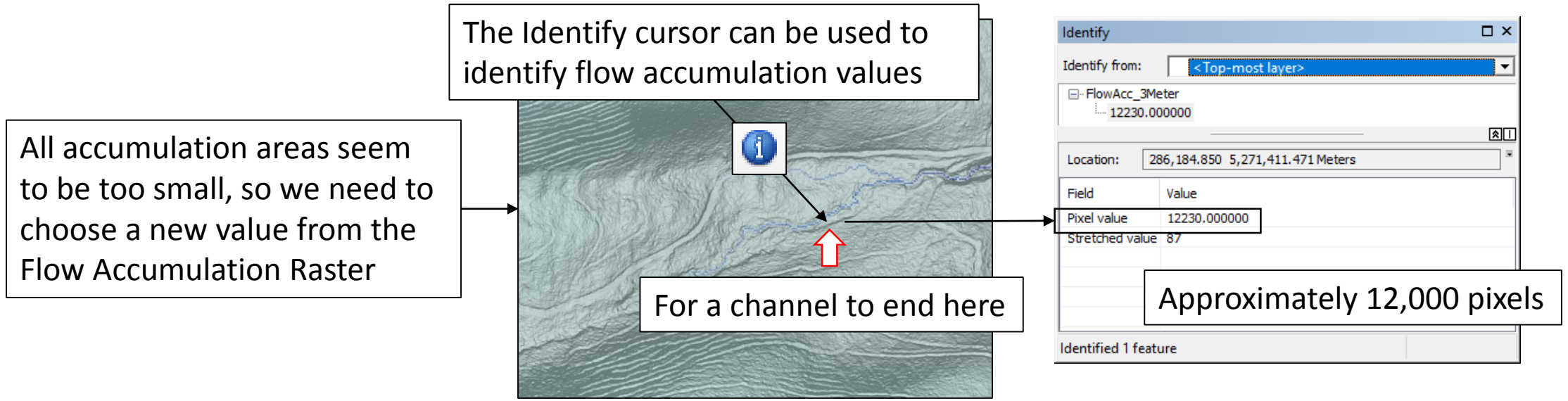
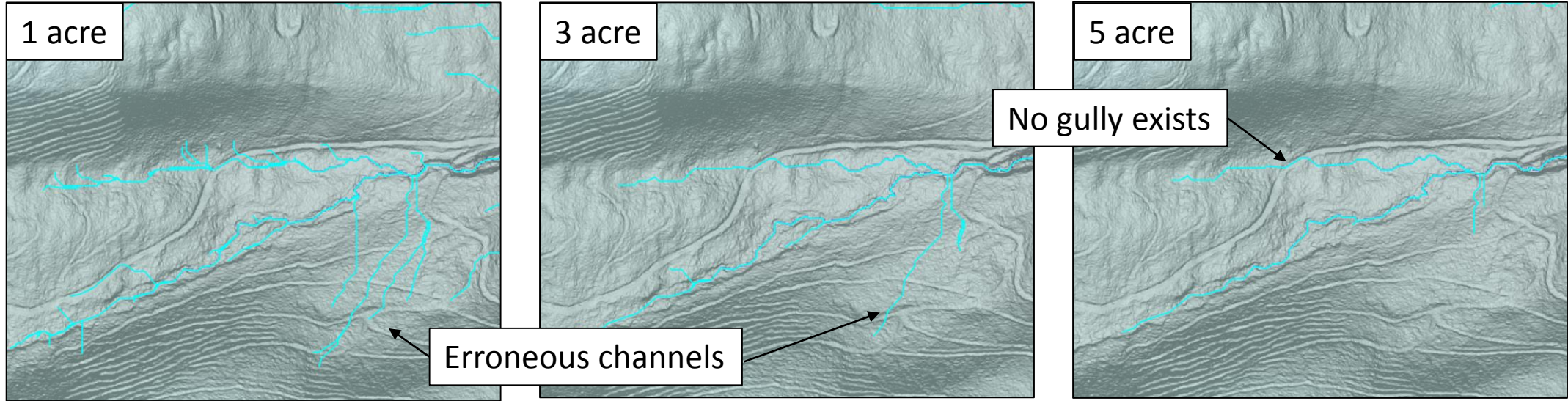
The Layers panel on the left shows the following layers and their properties:

- Channels_5_0Acres
- Channels_3_0Acres
- Channels_1_0Acres
- Cand_CS3Meter_Mt13
 - <all other values>
 - LS
 - 0
 - 1
- FlowAcc_3Meter
 - Value
 - High : 1.30322e+006
 - Low : 0
- Mix_CS3Meter
 - <VALUE>
 - 223.5707855 - -16.72327767
 - 16.72327766 - 13.36363256
 - 13.36363257 - 255.9393463
- Resampled_DEM3Meter
 - Value
 - High : 1705.32
 - Low : 1111.47
- Slope_9Meter
 - Value
 - High : 40.6468
 - Low : 0.0112649
- Slope_6Meter
 - Value
 - High : 45.3382
 - Low : 0.00803922
- Slope_3Meter
 - Value
 - High : 51.1202
 - Low : 0

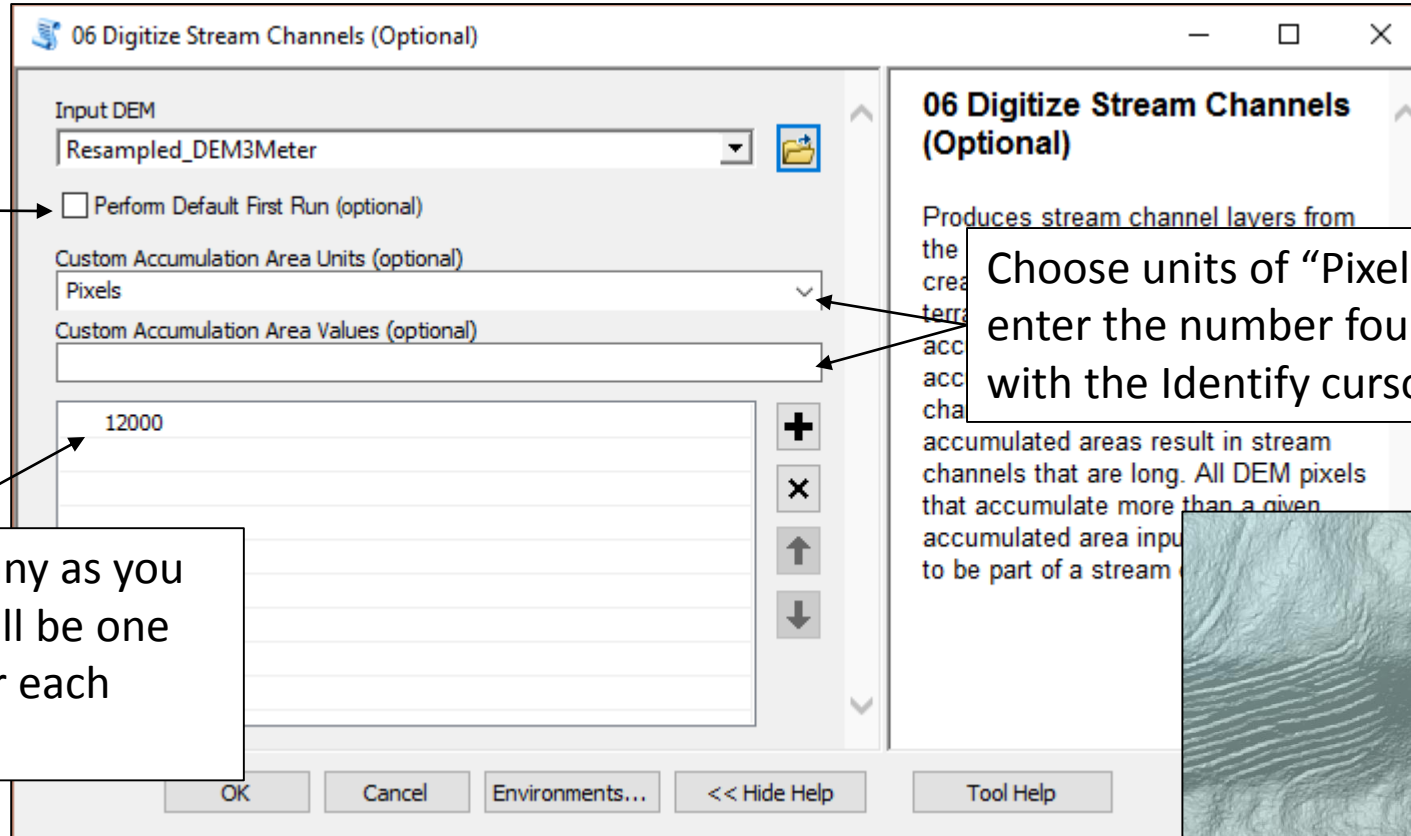
The ArcToolbox on the right contains the following categories and tools:

- 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
- RiskToolbox
- Schematics Tools
- Server Tools
- SICCMToolbox
- SICCMToolbox
 - A - Setup
 - 01 Create Inventory Mapping Project
 - 02 Prepare Visualization Layers
 - B - Base Data Processing
 - 03 Find Cell Size for Mapping
 - C - Determine Scarp Candidate Polygons
 - 04 Create Mixture Raster
 - 05 Create Scarp Polygon Candidates
 - D - Identify Non Scarp Features (Optional)
 - 06 Digitize Stream Channels (Optional)
 - 07 Identify Rock Outcrops (Optional)
 - E - Identify Scarp Polygons from Candidates
 - 08 Eliminate Non Scarp Topography
 - F - Create Scarp Lines
 - 09 Create Scarp Lines from Scarp Polygons
 - G - Prepare Scarp Lines and Run CCM
 - 10 Create CCM Package
 - 11 Run CCM
 - H - Risk Estimation with SICCM Results
 - 12 Create At-Risk Segments
 - 13 Compute Risk Metrics for Segments
 - 14 Create KMZ map for Google Earth
 - Buffer
- Space Time Pattern Mining Tools
- Spatial Analyst Tools
- Spatial Statistics Tools
- Tracking Analyst Tools

Comparison of channel networks



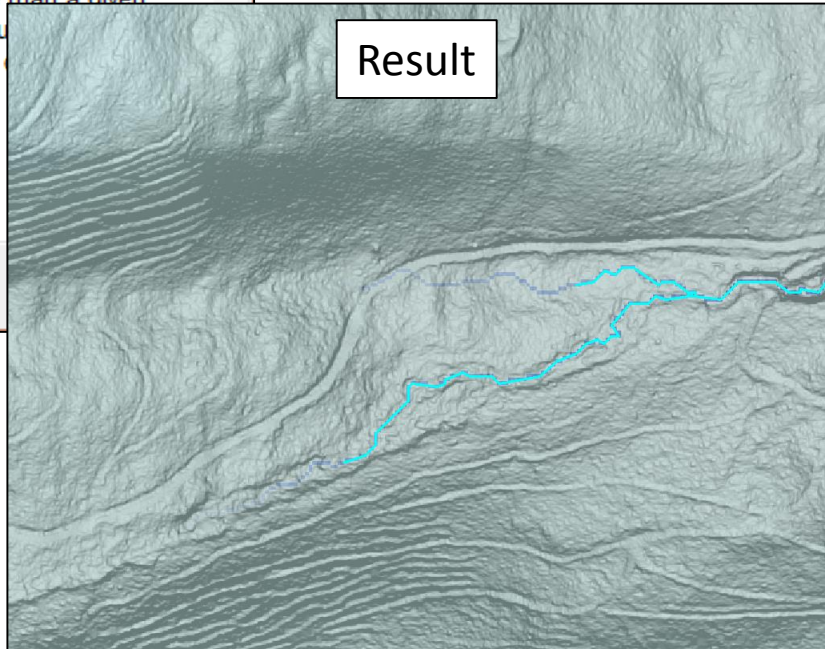
Rerun Tool 6



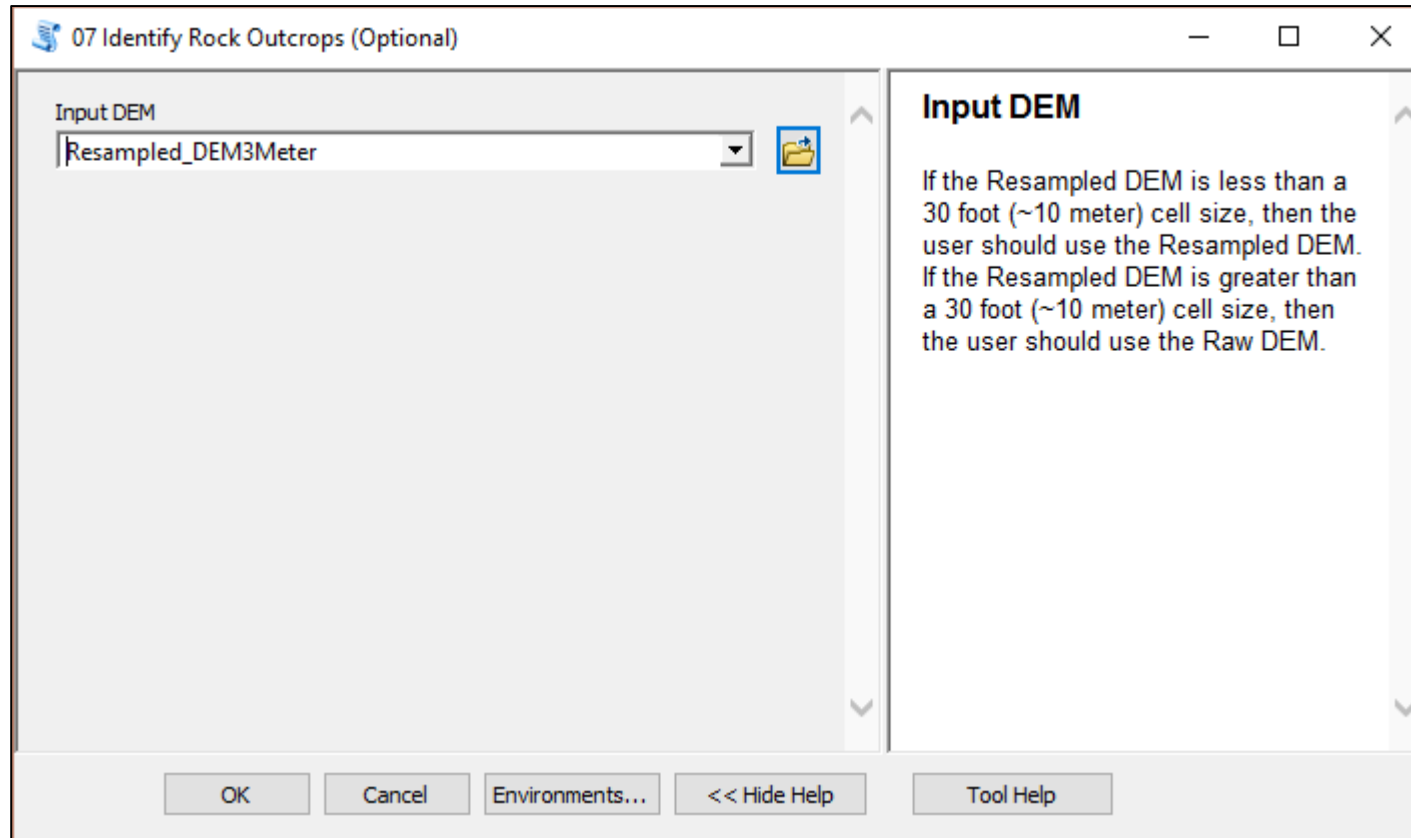
Uncheck this

Choose units of "Pixels" and enter the number found with the Identify cursor

You can enter as many as you would like. There will be one channel network for each value.



Run Tool 7



Output of Tool 7

The screenshot displays the ArcMap interface with the following components:

- Table of Contents:** Lists several layers including Channels, rock_polygons (checked), Cand_CS3Meter_MTI3, FlowAcc_3Meter, Mix_CS3Meter, Resampled_DEM3Meter, Slope_9Meter, Slope_6Meter, Slope_3Meter, and Raw_DEM.
- ArcToolbox:** Shows a list of tool categories and specific tools, including '07 Identify Rock Outcrops (Optional)'.
- Map View:** Displays a grayscale terrain map with a cyan line overlay. A text box overlaid on the map reads: "No rocks were identified".
- Status Bar:** Shows the coordinates 289242.037 5272079.868 Meters.

No rocks were identified

A quick inspection of the terrain shows no obvious rock outcrops, so we can move on

Add road layer to map

The image shows a screenshot of the ArcMap software interface. The main map area displays a grayscale terrain map with several overlaid layers. A cyan-colored network of lines represents the existing USFS road network. A callout box points to this network with the text "Existing USFS road network features available online". Another callout box points to a road that is not perfectly digitized, with the text "Roads are not always perfectly digitized". A third callout box points to a road that is not included in the cyan network, with the text "Road layers do not always include all roads". The Table of Contents on the left lists several layers, including "National_Forest_System_Roads", "HemlockElk", "Channels_12000_0Pixels", "Channels_5_0Acres", "Channels_3_0Acres", "Channels_1_0Acres", "rock_polygons", "Cand_CS3Meter_MTT13", "FlowAcc_3Meter", "Mix_CS3Meter", and "Slope_9Meter". The Catalog window on the right shows the file structure, including "National_Forest_System_Roads" and "HemlockElk.odh".

Existing USFS road network features available online

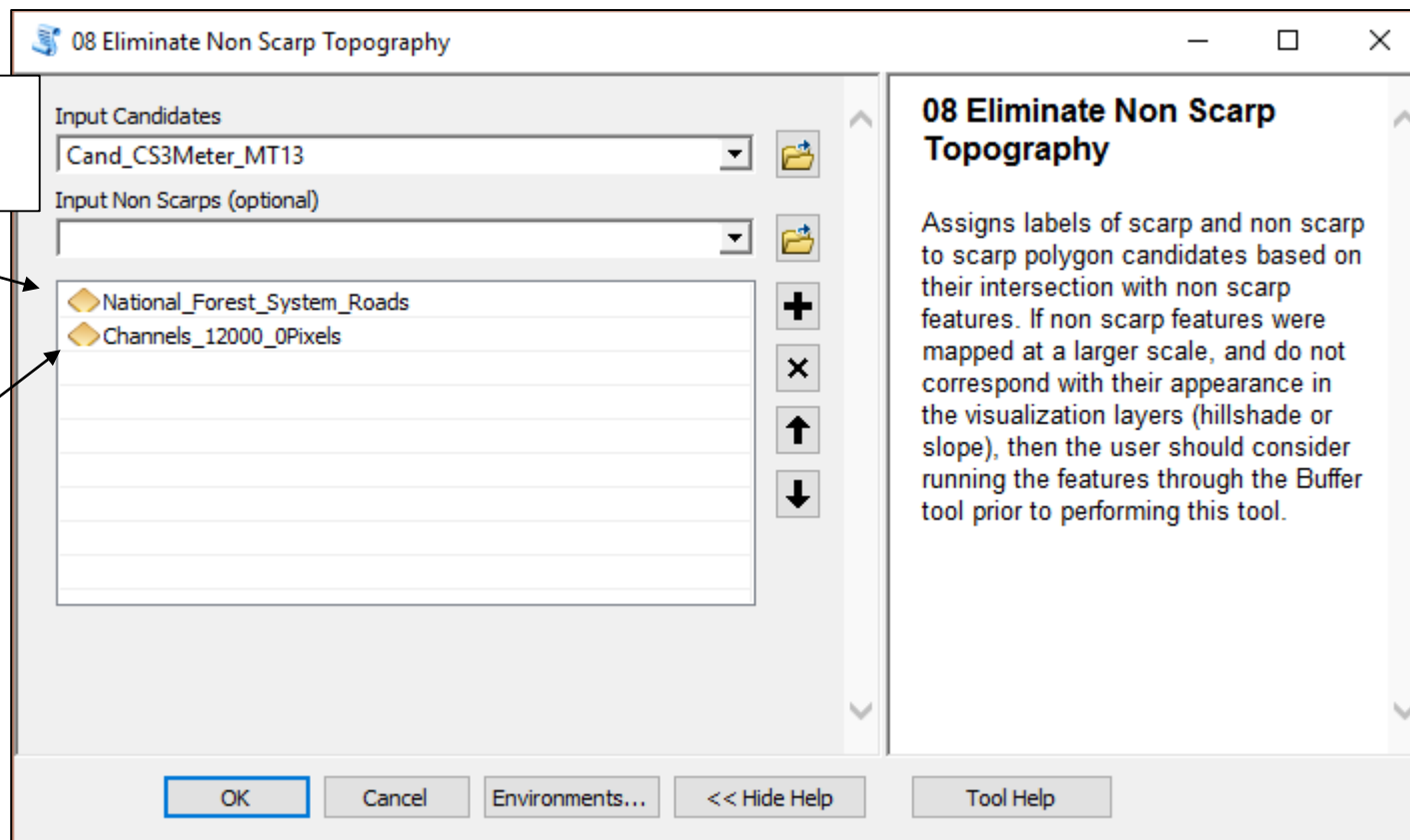
Road layers do not always include all roads

Roads are not always perfectly digitized

Run Tool 8

Only include roads if they are not poorly digitized

Best channel network



Tool 8 Output

Untitled - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:29,383

Editor

Table Of Contents

- FA20181127_USFS
- National_Fores
- HemlockElk
 - Value
 - High : 1705.3
 - Low : 1111.4
- FA20181127_USFS
- Channels_1200
- Channels_5_0A
- Channels_3_0Acres
- Channels_1_0Acres
- rock_polygons
- Cand_CS3Meter_MTI3**
 - <all other values>
 - LS
 - 0
 - 1
- FlowAcc_31Meter
 - Value
 - High : 1.30322e+006
 - Low : 0
- Mix_CS3Meter
 - <VALUE>
 - 223.5707855 - -16.72327767
 - 16.72327766 - 13.36363256
 - 13.36363257 - 255.9393463
- Resampled_DEM3Meter
 - Value
 - High : 1705.32
 - Low : 1111.47
- Slope_9Meter
 - Value
 - High : 40.6468
 - Low : 0.0113640

Candidates are now classified:
0 = Non Scarp
1 = Scarp

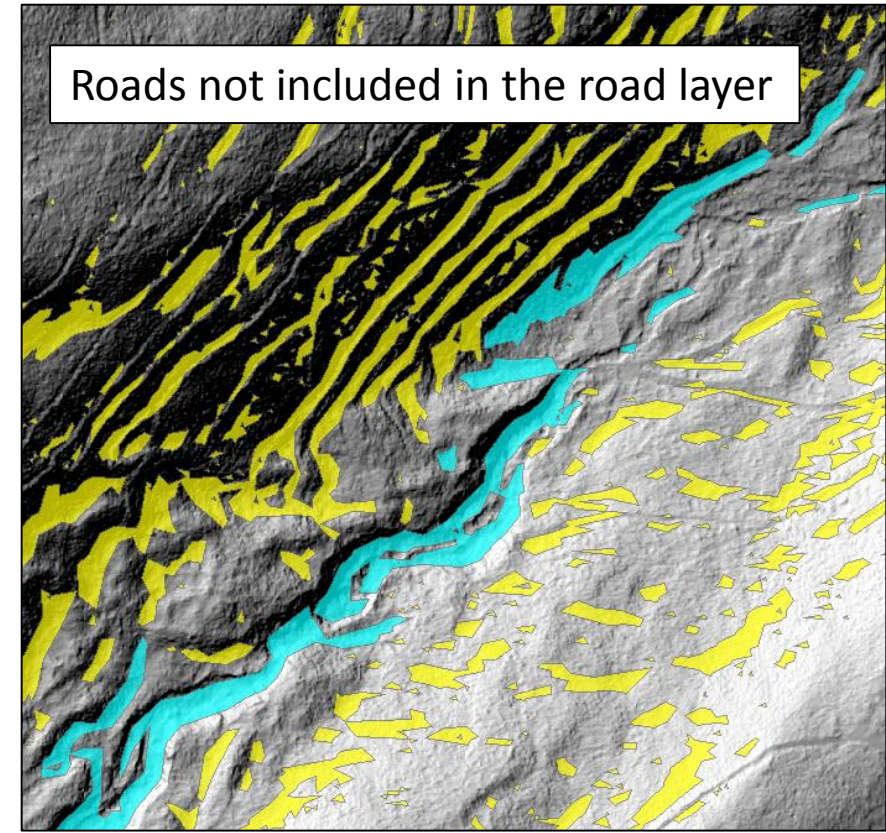
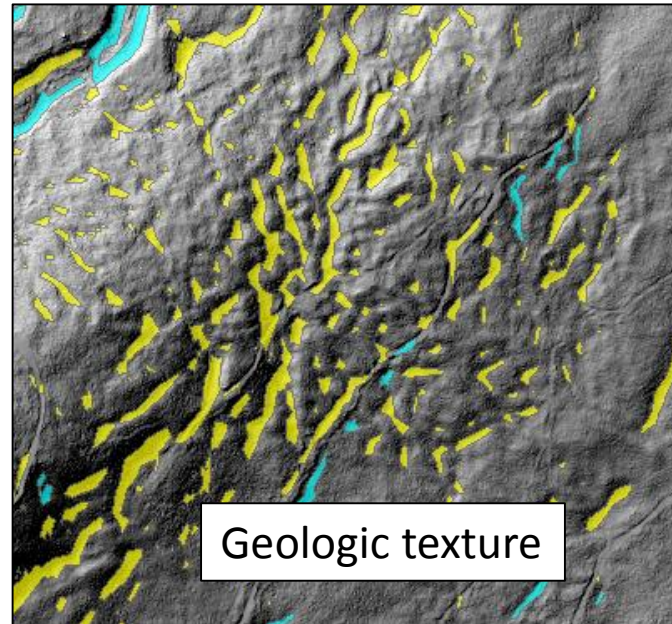
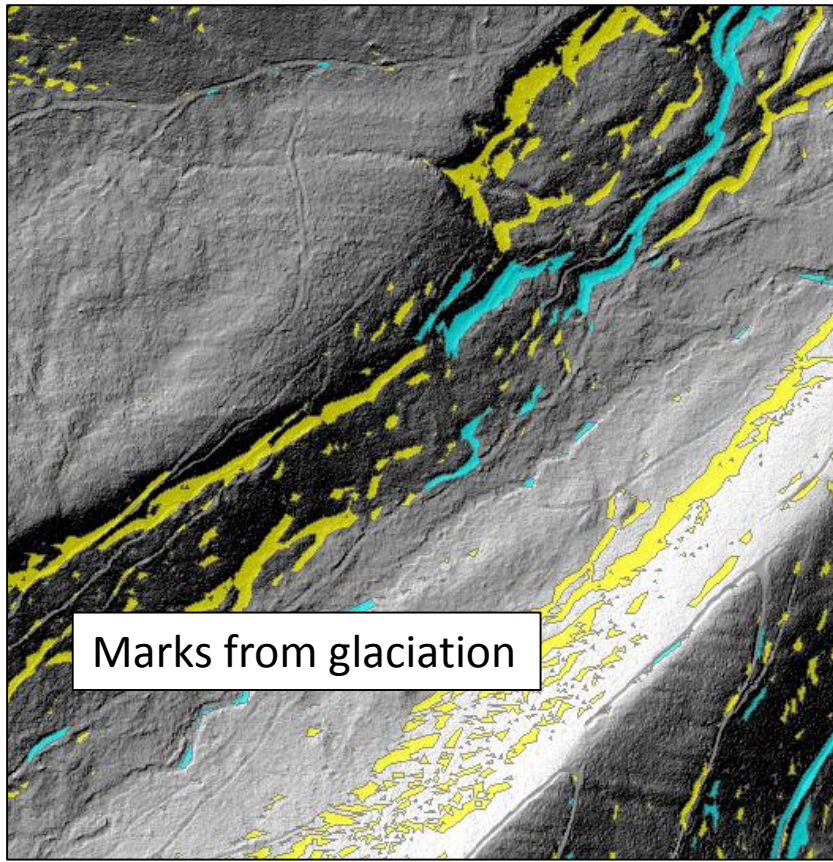
Inspect the results in search of poor behavior

Catalog

Location: 08 Eliminate Non Scarp Topography

- Home - My Documents\ArcGIS
- Folder Connections
- F:\
- FA\20181127_USFS
- 20181212_SICCMTools

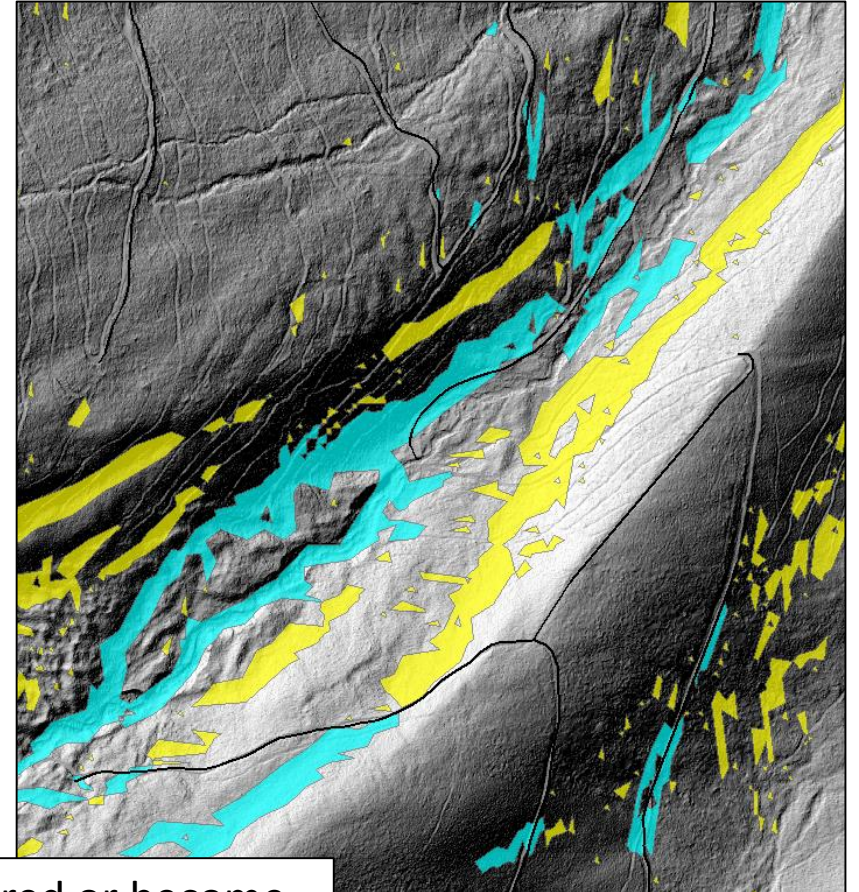
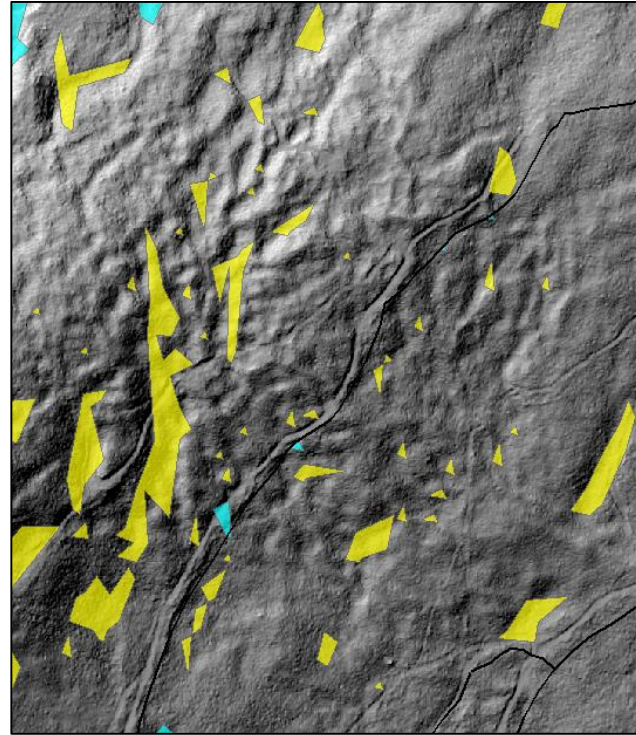
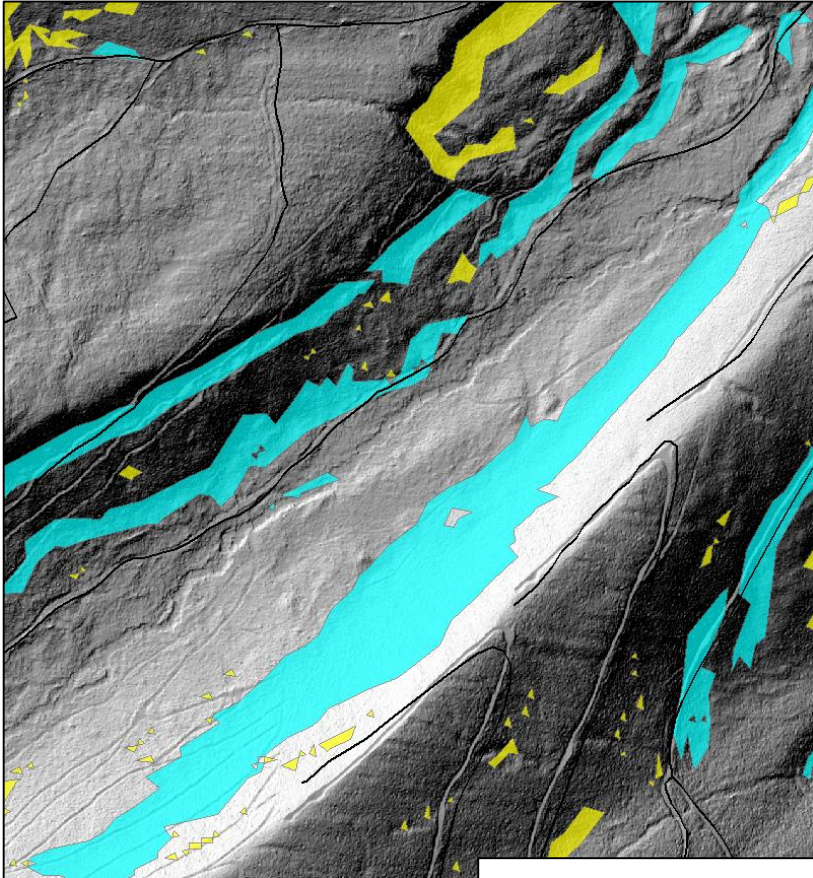
There are too many scarp polygons!



We have to step back to Tool 4 and repeat the process with a larger cell size

Tools 6 and 7 should not change much, so don't repeat them

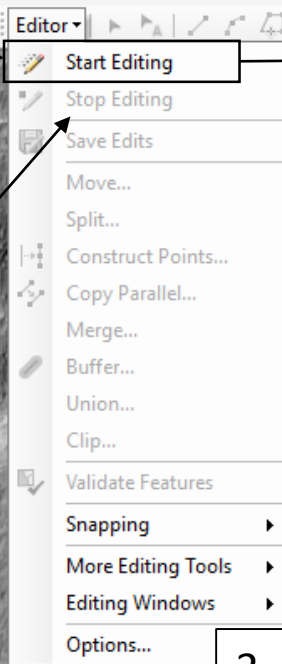
Revised Tool 8 Output



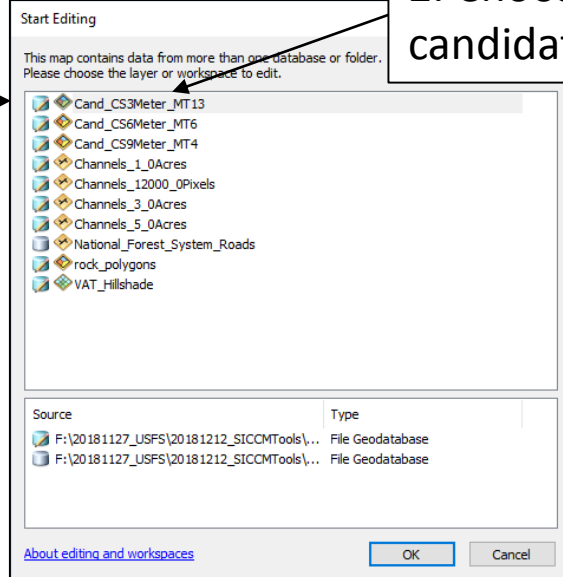
Many of the problem features have either disappeared or become non scarps by using a cell size of 9-meters instead of 3-meters

Manually editing polygons

1. Click on the Editor toolbar to Start Editing



2. Choose the 9-m candidates layer



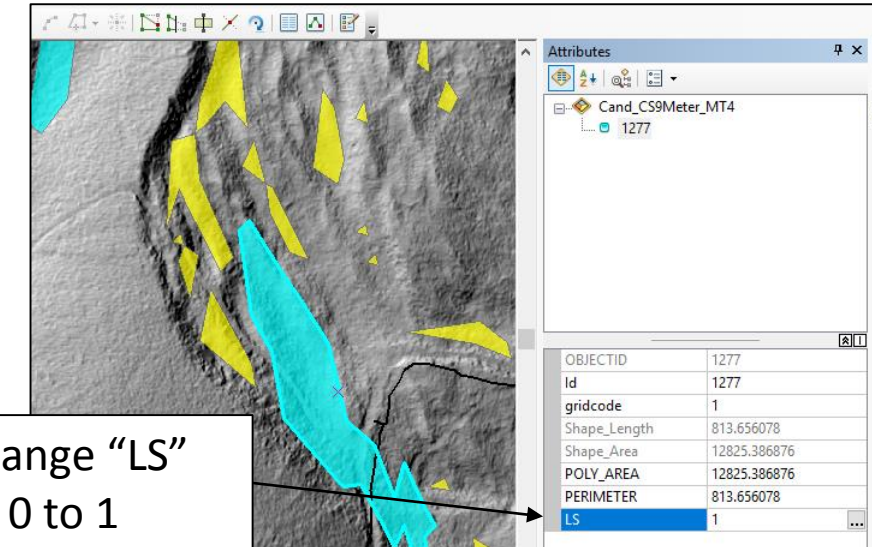
5. Click stop editing

3. Edit attributes



Scarp misclassified because it intersects a road

4. Change "LS" from 0 to 1



Editing groups of polygons

1. Select features

2. Open Attribute Table

3. Right-click "LS" and choose **Field Calculator**

4. Type 1 to change selected features to scarps, or 0 to change selected features to non scarps

Glacial scars (not landslides)

OBJECTID *	Shape *	Id	gridcode	Shape_Length	Shape_Area	POLY_AREA	PERIMETER	LS
1	Polygon	1	1	33.955706	55.457284	55.457284	33.955706	1
2	Polygon	2	1	50.929749	110.597658	110.597658	50.929749	1
3	Polygon	3	1	110.717796	617.429765	617.429765	110.717796	1
4	Polygon	4	1	68.283195	167.199805	167.199805	68.283195	1
5	Polygon	5	1	68.283195	167.199805	167.199805	68.283195	1
6	Polygon	6	1	68.283181	167.199586	167.199586	68.283181	1
7	Polygon	7	1	68.283181	167.199586	167.199586	68.283181	1

Field Calculator

Parser: VB Script Python

Type: Number String Date

Fields: OBJECTID, Shape, Id, gridcode, Shape_Length, Shape_Area, POLY_AREA, PERIMETER, LS

Functions: Abs (), Atn (), Cos (), Exp (), Fix (), Int (), Log (), Sin (), Sqr (), Tan ()

Show Codeblock:

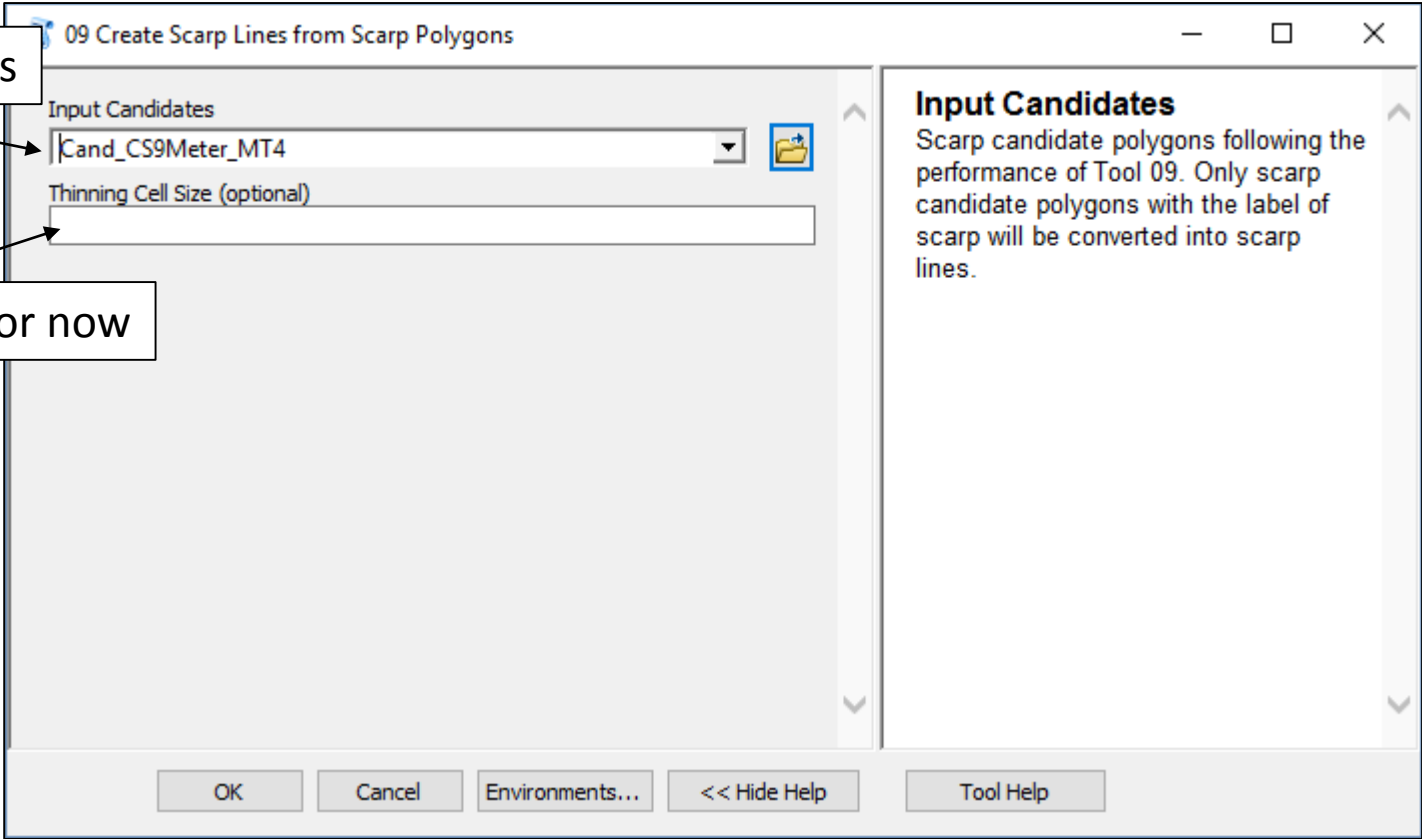
LS = 0

Buttons: Clear, Load..., Save..., OK, Cancel

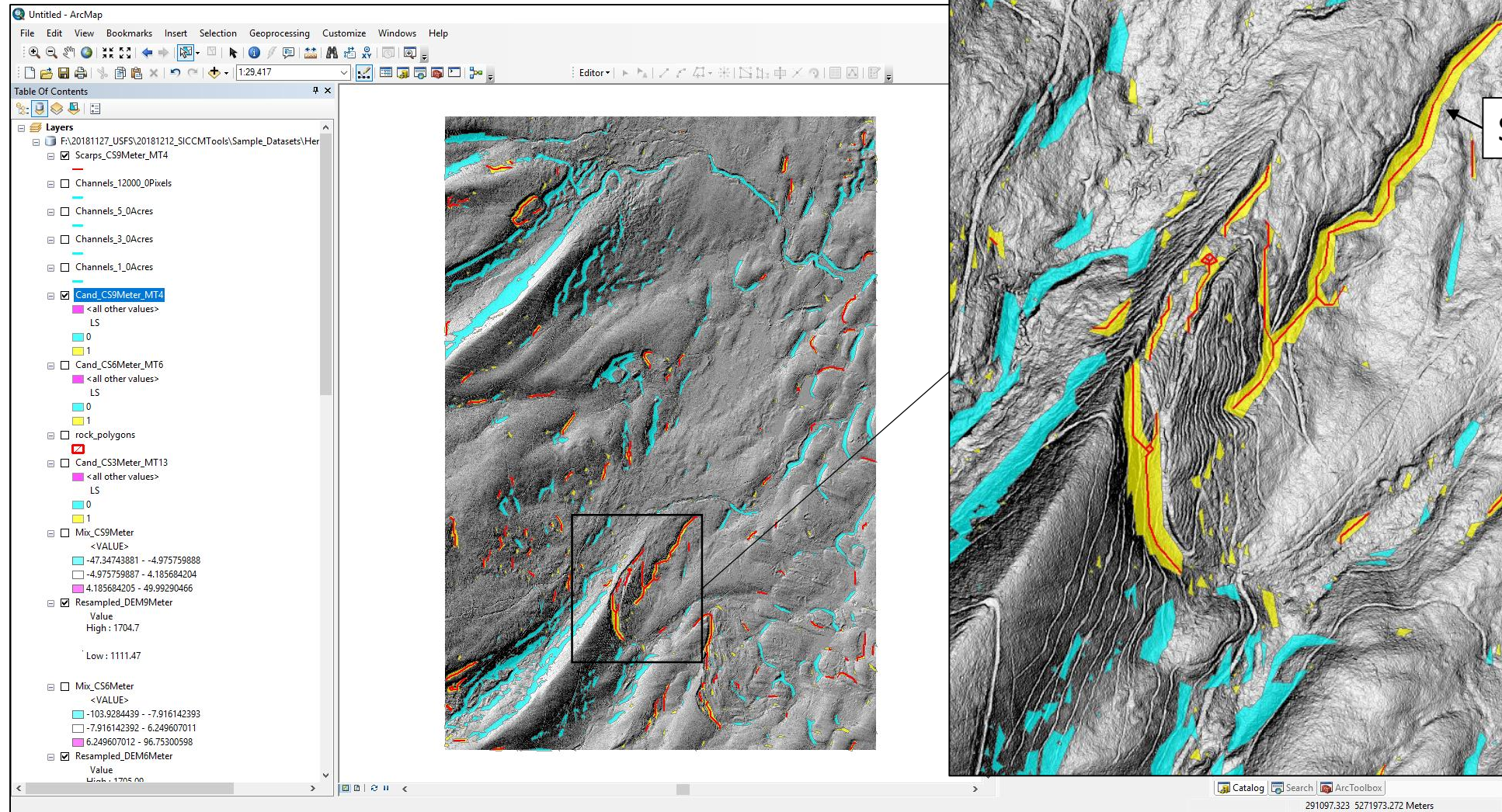
Run Tool 9

The 9-meter polygons

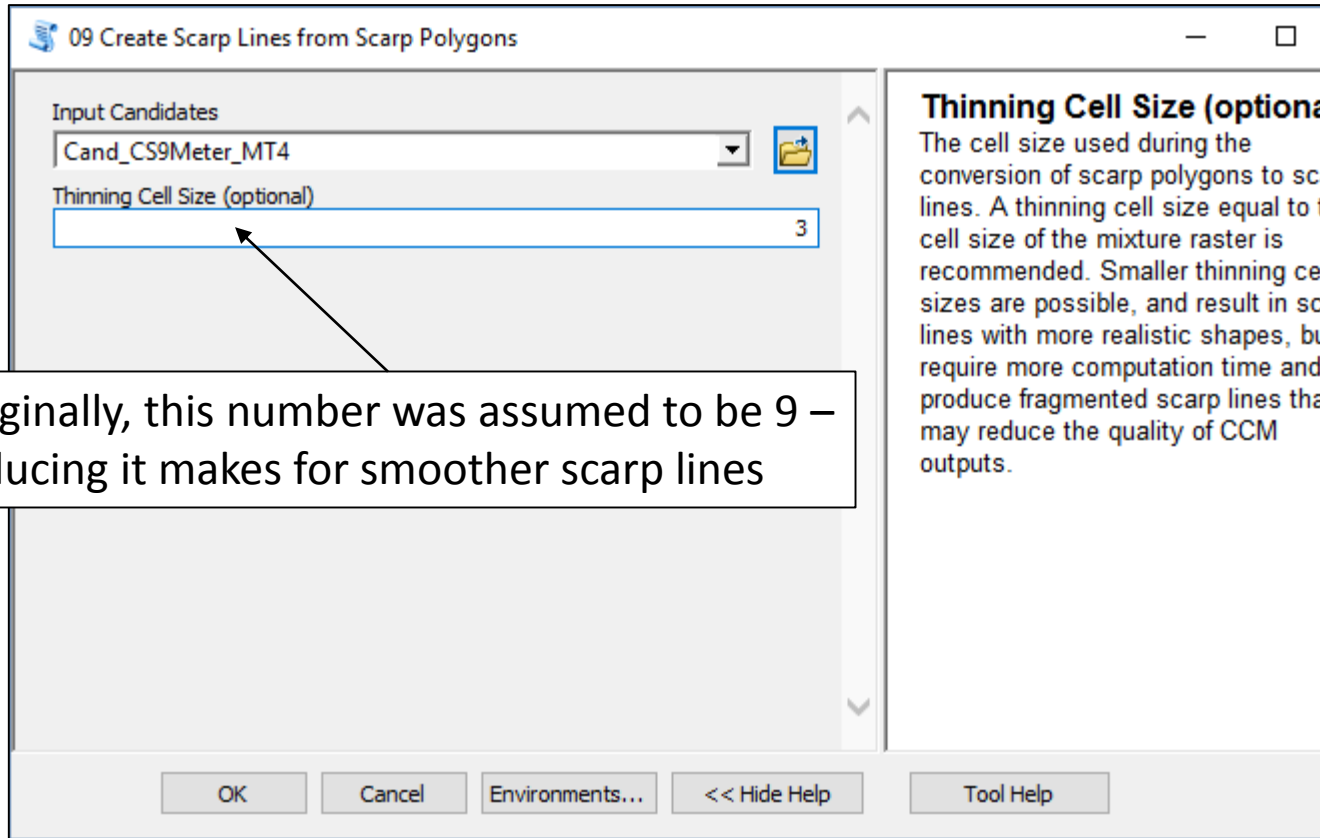
Leave this blank for now



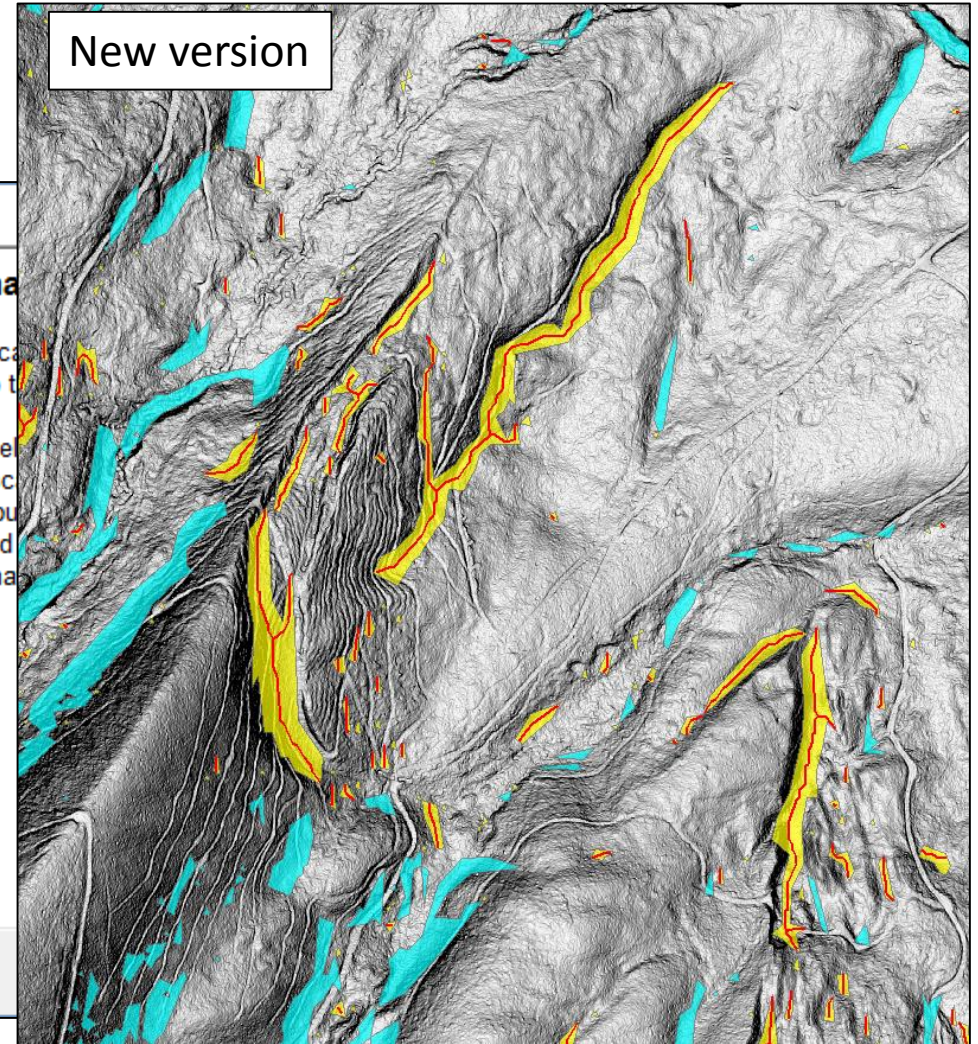
Tool 9 Output



Rerun Tool 9

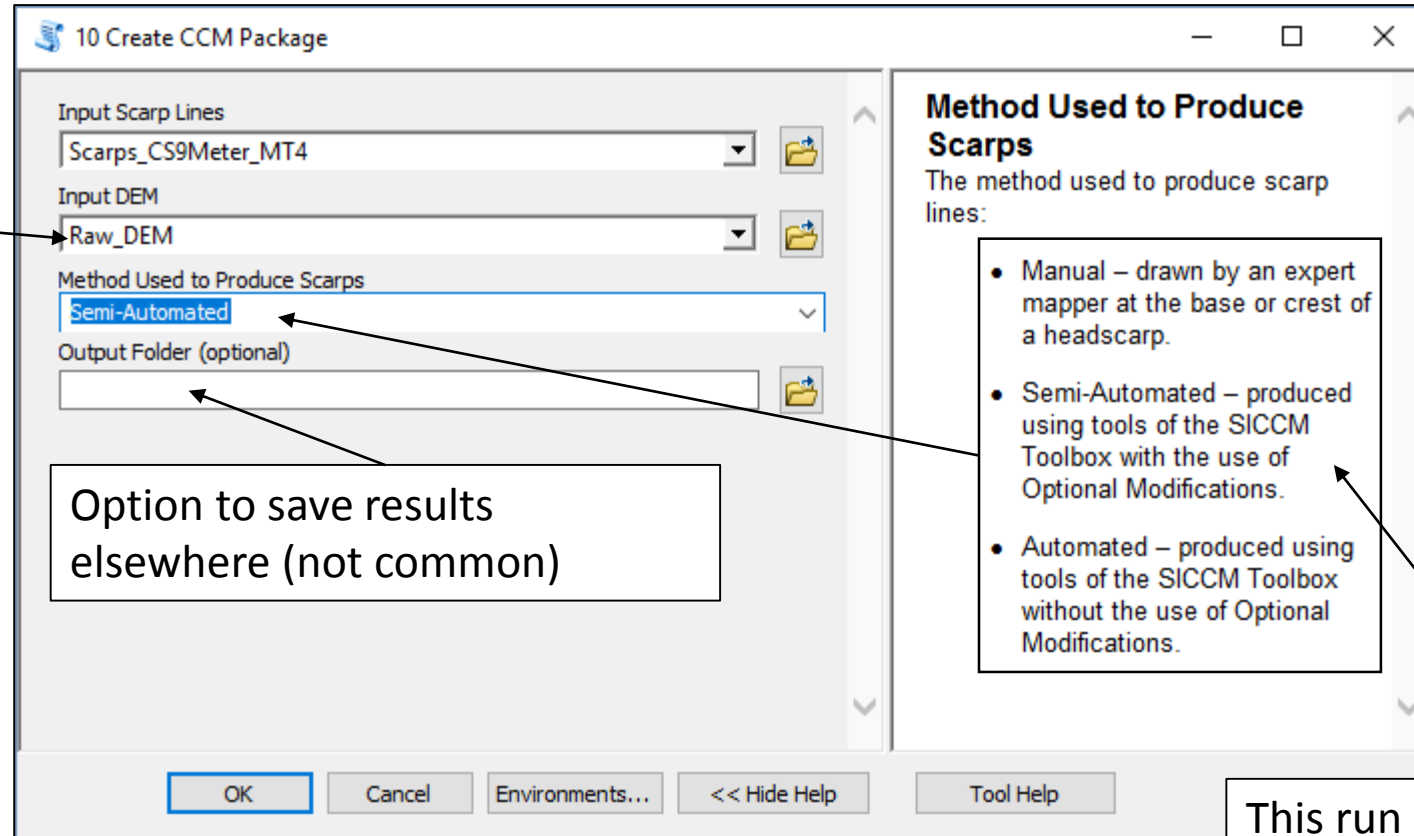


Originally, this number was assumed to be 9 – reducing it makes for smoother scarp lines



The user should choose the thinning cell size only if they feel that the scarp lines are too roughly drawn

Run Tool 10



Raw DEM (1-meter)

Option to save results elsewhere (not common)

This run is semi-automated because of how we manually changed polygon classifications and stream channel lengths

Tool 10 Output

The screenshot shows the ArcMap interface with a map of a terrain. A new folder named 'HemlockElk' has been created, containing the following files:

- SemiAuto_Package_CS9Meter_MT4
- CCM_DEM.tif
- CCM_scarps.shp
- HemlockElk.gdb

The Catalog window on the right shows the project structure, including the 'HemlockElk' folder and its contents. The Table of Contents on the left lists the layers loaded in the map, including 'Mbx_CS9Meter' and 'Resampled_DEM9Meter'.

A new folder was created to store CCM results

No new files were added to the map

Run Tool 11

11 Run CCM

CCM Package
F:\20181127_USFS\20181212_SICCMTools\Sample_Datasets\HemlockE

Contour Interval
20 Meters

Node Spacing
20 Meters

Active Slope
4

Branch Parameter
3

Number of Nodes used to Cutoff Tails (optional)
15

Number of Contours to skip during Cutoff (optional)
3

Nodes, Connections, and Statistics for Individual Landslides (optional)

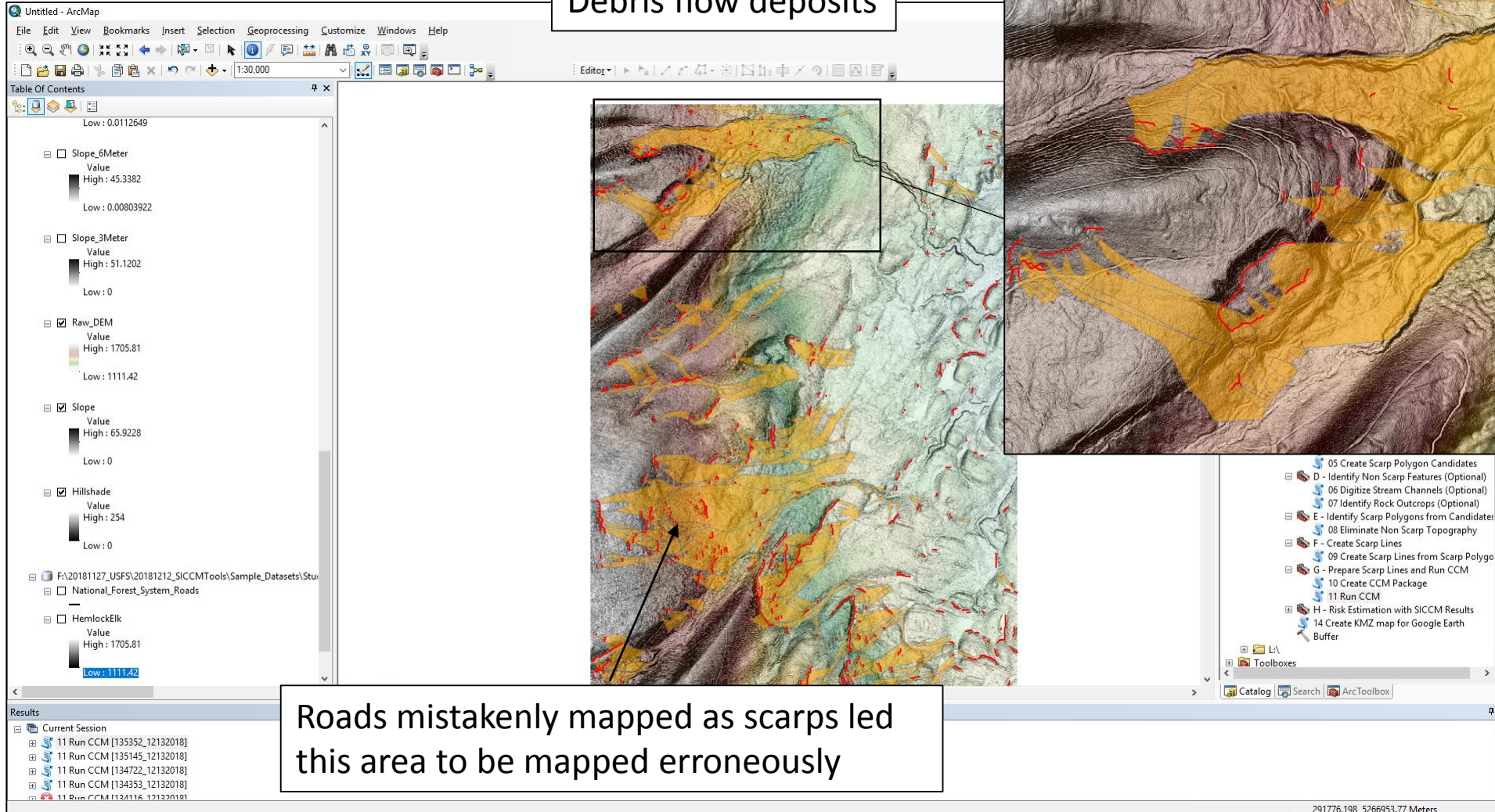
11 Run CCM
Uses the Contour Connection Method (CCM) to draw landslide deposits.

Read User Guide for help choosing these inputs

OK Cancel Environments... << Hide Help Tool Help

Tool 11 Output

Debris flow deposits

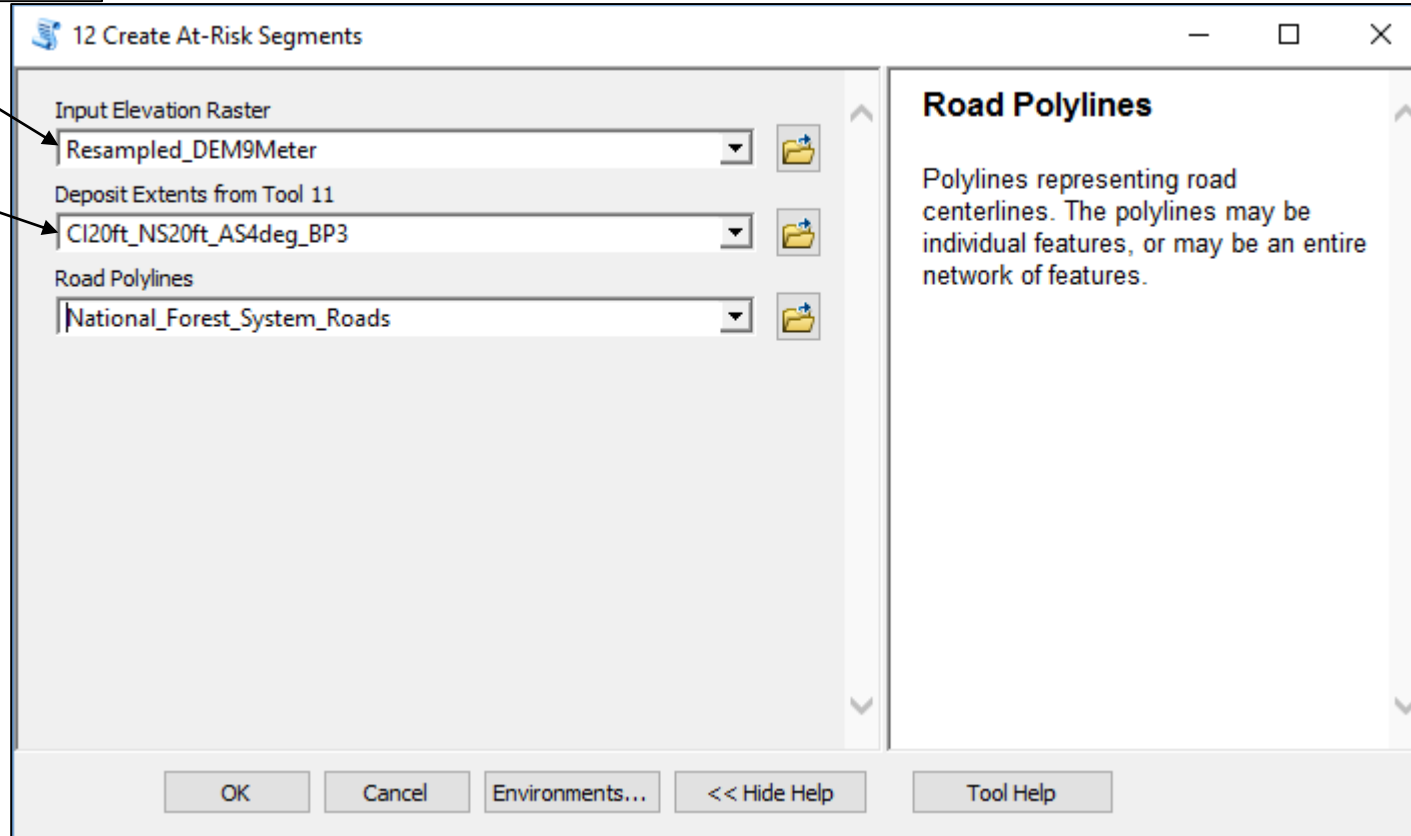


Roads mistakenly mapped as scarps led this area to be mapped erroneously

Run Tool 12

The resampled DEM runs more quickly, but does not consider smaller features

CCM output polygons



Tool 12 Output

The screenshot displays the ArcMap interface with the following components:

- Table of Contents:**
 - Slope_6Meter (Value: High: 45.3382, Low: 0.00803922)
 - Slope_3Meter (Value: High: 51.1202, Low: 0)
 - Raw_DEM (Value: High: 1705.81, Low: 1111.42)
 - Slope (Value: High: 65.9228, Low: 0)
 - Hillshade (Value: High: 254, Low: 0)
 - F:\20181127_USFS\20181212_SICCMTools\Sample_Datasets\Stu...
 - National_Forest_System_Roads
 - HemlockElk (Value: High: 1705.81, Low: 1111.42)
- 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
 - RiskToolbox
 - Schematics Tools
 - Server Tools
 - SICCMToolbox
 - SICCMToolbox
 - A - Setup
 - 01 Create Inventory Mapping Project
 - 02 Prepare Visualization Layers
 - B - Base Data Processing
 - 03 Find Cell Size for Mapping
 - C - Determine Scarp Candidate Polygons
 - 04 Create Mixture Raster
 - 05 Create Scarp Polygon Candidates
 - D - Identify Non Scarp Features (Optional)
 - 06 Digitize Stream Channels (Optional)
 - 07 Identify Rock Outcrops (Optional)
 - E - Identify Scarp Polygons from Candidates
 - 08 Eliminate Non Scarp Topography
 - F - Create Scarp Lines
 - 09 Create Scarp Lines from Scarp Polygons
 - G - Prepare Scarp Lines and Run CCM
 - 10 Create CCM Package
 - 11 Run CCM
 - H - Risk Estimation with SICCM Results
 - 12 Create At-Risk Segments
 - 13 Compute Risk Metrics for Segments
 - 14 Create KMZ map for Google Earth
- Results:**
 - Current Session
 - 12 Create At-Risk Segments [141645_12132018]
 - 11 Run CCM [135352_12132018]
 - 11 Run CCM [135145_12132018]
 - 11 Run CCM [134722_12132018]
 - 11 Run CCM [132453_12132018]

Run Tool 13

13 Compute Risk Metrics for Segments

Input At-Risk Segments
Risk_Segments_Meter

Rebuilt Embankment Slope (Degrees) (optional)

Maximum Rebuilt Roadway Width (Feet) (optional)

Repair Rate (cubic yards/day) (optional)

Excavation Cost (dollars/cubic yard) (optional)

Fill Cost (dollars/cubic yard) (optional)

13 Compute Risk Metrics for Segments

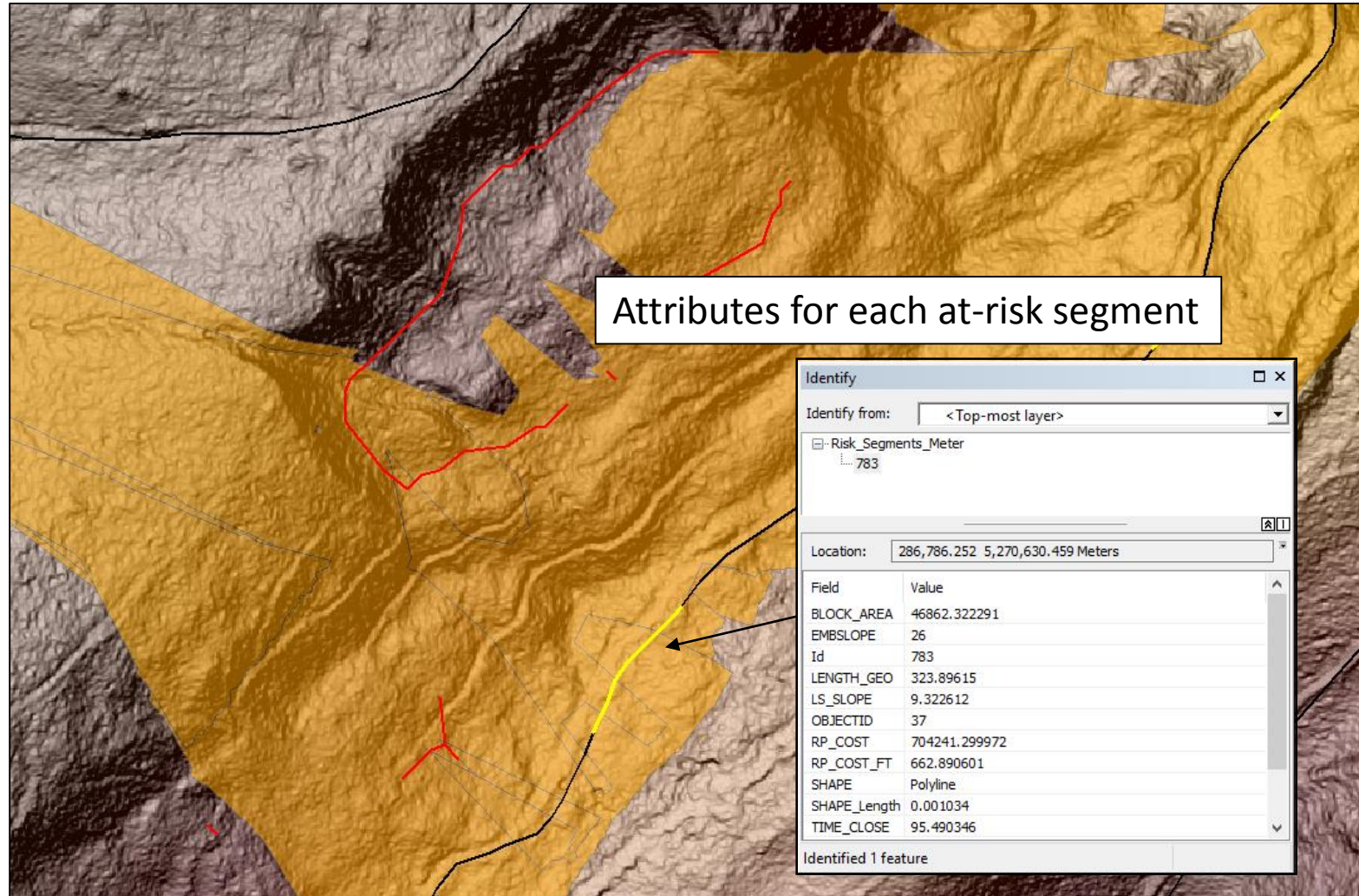
Examines the volumes of unstable soil masses intersecting roadways and assigns costs associated with failure of each soil mass. Costs include repair cost in dollars and the expected duration of road closures.

OK Cancel Environments...

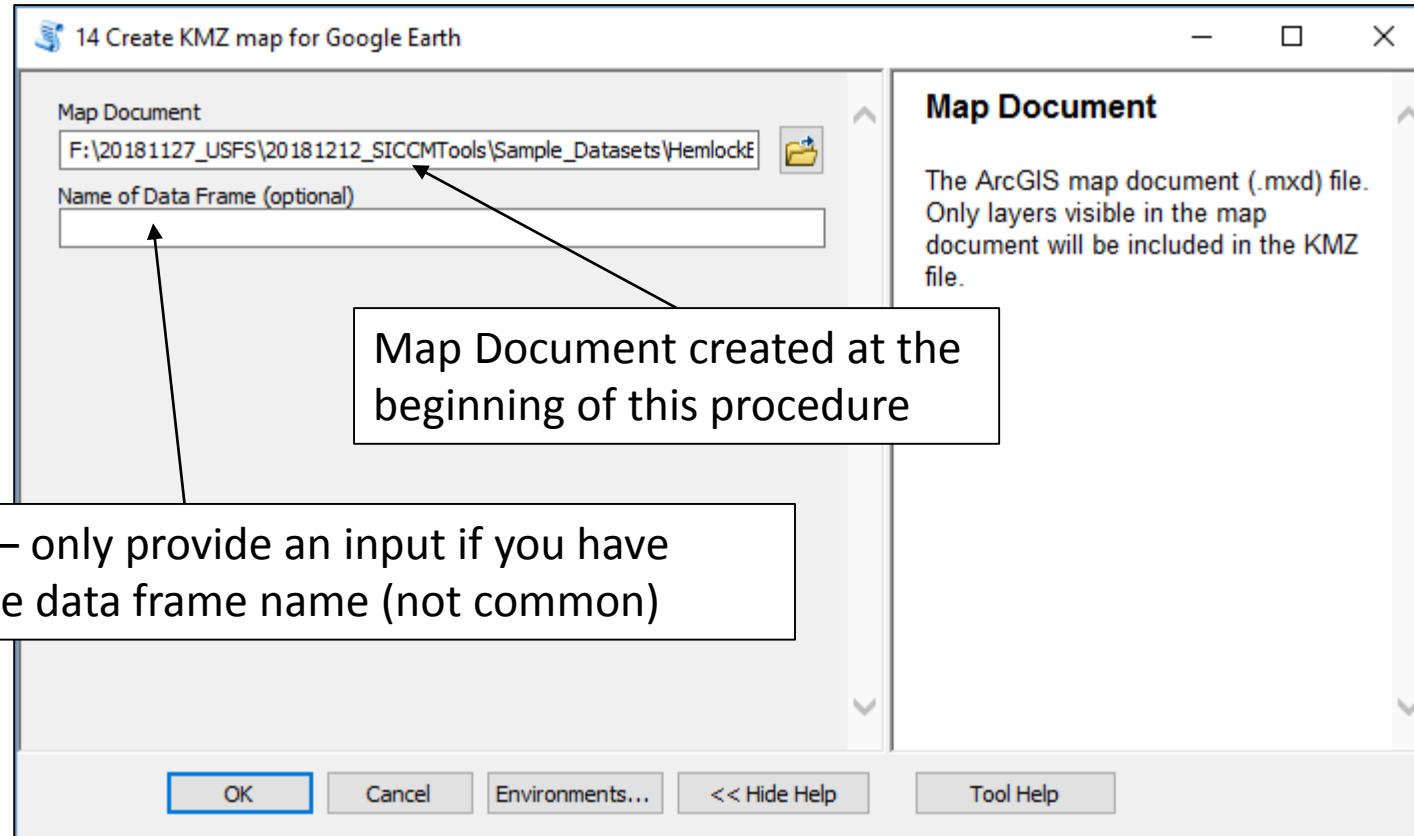
Each input has a default value, but it is recommended that users input their own best estimates

Default values are based on two-lane paved highways in close proximity to urban areas. See Leshchinsky et al. (2018) for more information.

Tool 13 Output



Run Tool 14



Tool 14 Output

The screenshot displays the Google Earth Pro interface. The main window shows a 3D terrain model of a mountainous region, overlaid with a grid of latitude and longitude coordinates. The terrain is rendered in shades of gray, with red and yellow lines highlighting specific features. A yellow placemark labeled "Untitled Placemark" is visible on the terrain. The interface includes a search bar, a "Places" panel on the left, and a "Layers" panel at the bottom left. The "Layers" panel shows various data layers, including "Raw_DEM" and "Slope". The status bar at the bottom indicates the imagery date as 6/5/2016 and provides coordinates: 47°32'01.75" N, 113°48'28.80" W, with an elevation of 3897 ft and an eye altitude of 30679 ft. A "Sign in" button is located in the top right corner. A text box in the bottom right corner reads: "See the User Guide for some Google Earth tips".

Google Earth Pro

File Edit View Tools Add Help

Search

Search

ex: 94043

Get Directions History

Places

My Places

- Sightseeing Tour
 - Make sure 3D Buildings layer is checked
- Untitled Placemark

Temporary Places

Layers

- Risk_Segments_Meter
- Scarps_CS9Meter_MT4
- National Forest System Road
- CI20ft_NS20ft_AS4deg_BP3
- Resampled_DEM9Meter
- Resampled_DEM6Meter
- Raw_DEM
- Slope

Layers

- Primary Database
 - Borders and Labels
 - Places
 - Photos
 - Roads
 - 3D Buildings
 - Ocean
 - Weather
 - Gallery
 - Global Awareness
 - More
 - Terrain

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Google Earth

Imagery Date: 6/5/2016 47°32'01.75" N 113°48'28.80" W elev 3897 ft eye alt 30679 ft

See the User Guide for some Google Earth tips

You have completed the tutorial

If you have any questions with the steps described during this tutorial, please refer to the ***Guide to Operation of the Scarp Identification+Contour Connection Method (SICCM) ArcGIS Toolbox*** for more information

Acknowledgements

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Reference:

Leshchinsky, B., Olsen, M.J., and Bunn, M.D. (2018). "Enhancing Landslide Inventorying, Lidar Hazard Assessment and Asset Management". Final Technical Report, Oregon Department of Transportation, SPR786.