RASTER ANALYSIS – 3

Su Zhang, Ph.D., GISP, CMS-RS

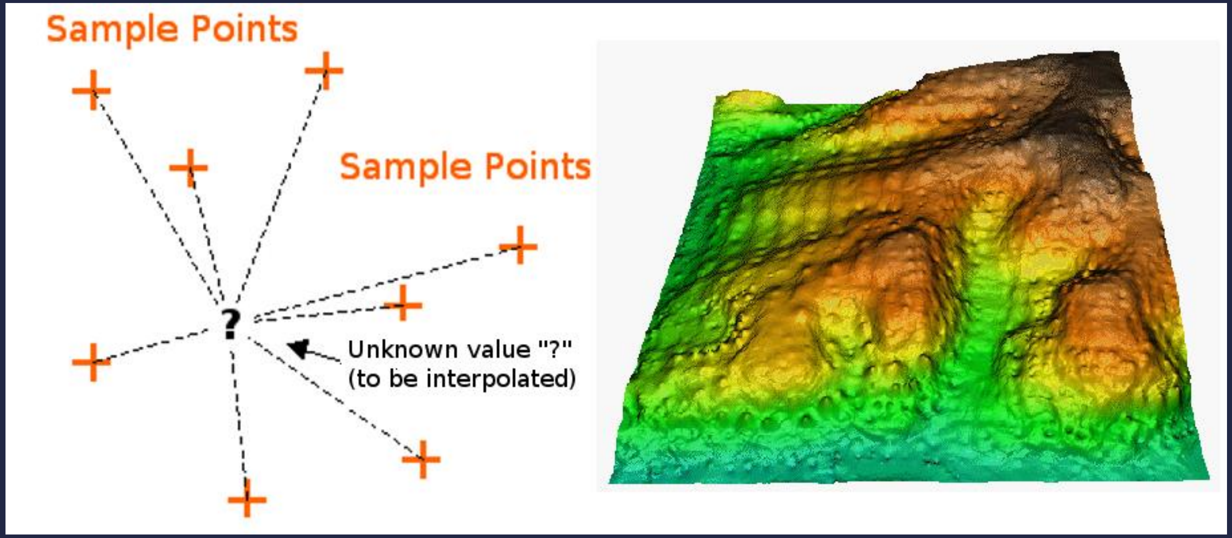
UNM CONTINUING EDUCATION

INTERPOLATION

Creating continuous surfaces

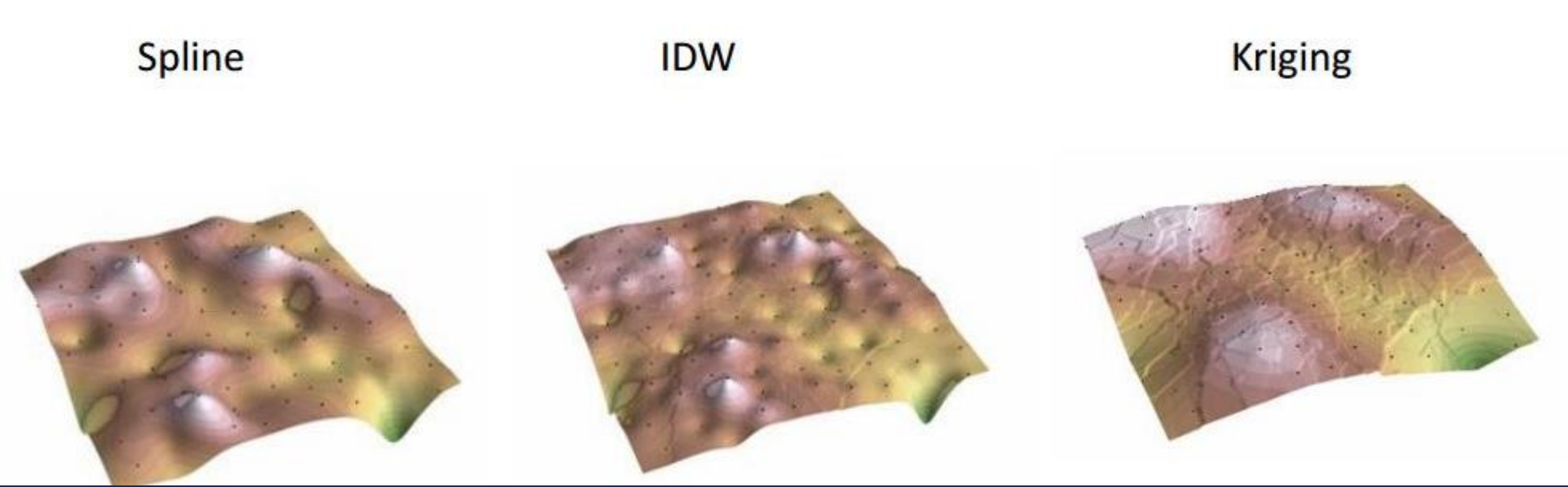
INTERPOLATION

- Interpolation predicts values for cells in a raster from a limited number of sample data points
- Interpolation is the prediction of variables at unmeasured locations based on a sampling of the same variables at known locations
- Interpolation tools create a continuous surface from discrete point values (e.g., temperature)
- It can be used to predict unknown values for any spatially continuous data, such as elevation, rainfall, chemical concentrations, and noise levels, but not spatially discrete data
- Tools in ArcGIS
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Spline with Barriers
  - Topo to Raster
  - Topo to Raster by File
  - Trend



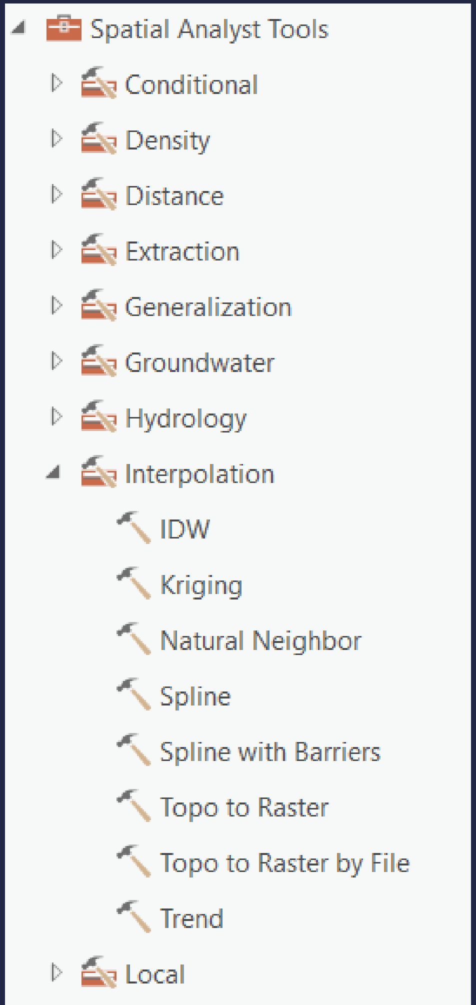
gisresources.com

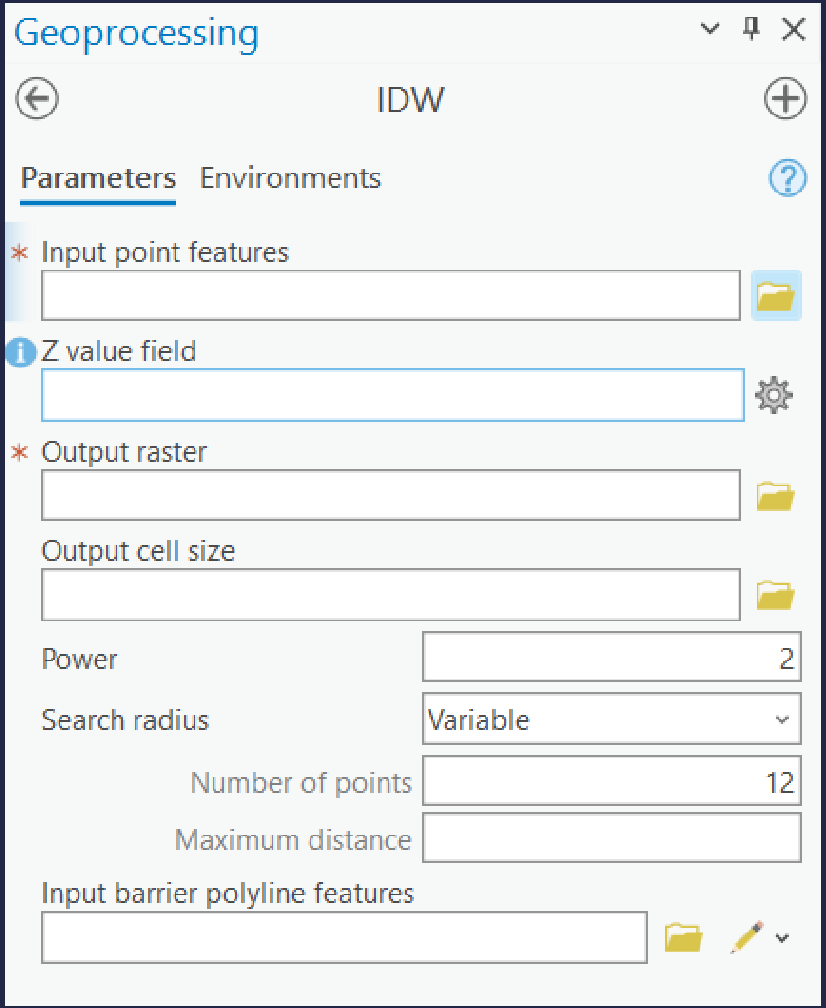
INTERPOLATION



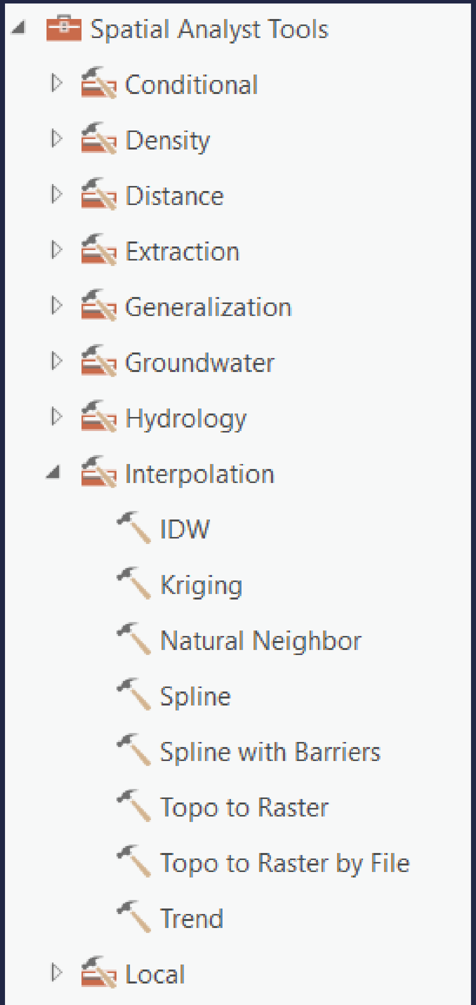
artemavdeenko.weebly.com

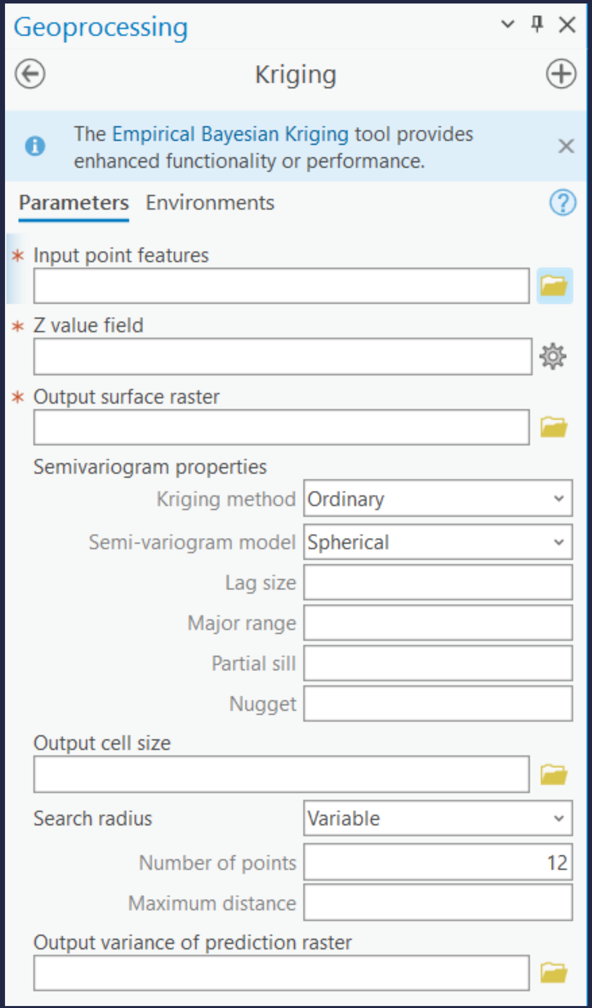
INTERPOLATION



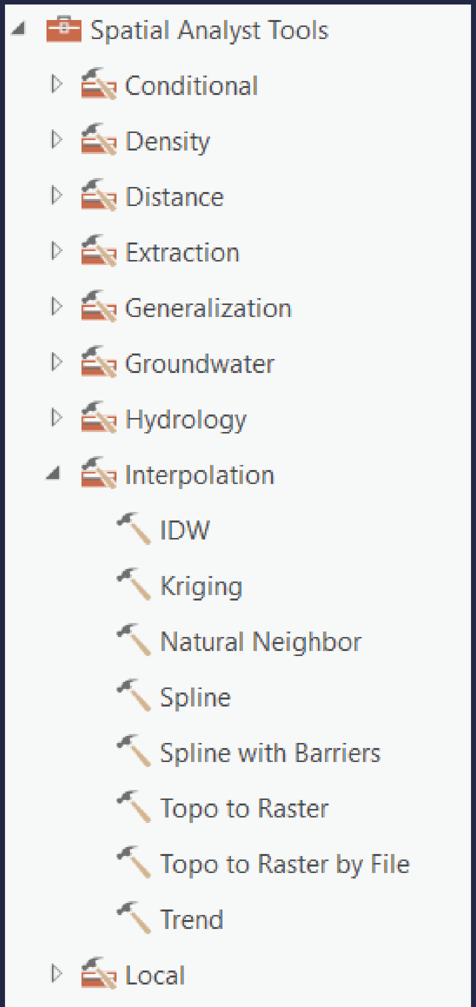


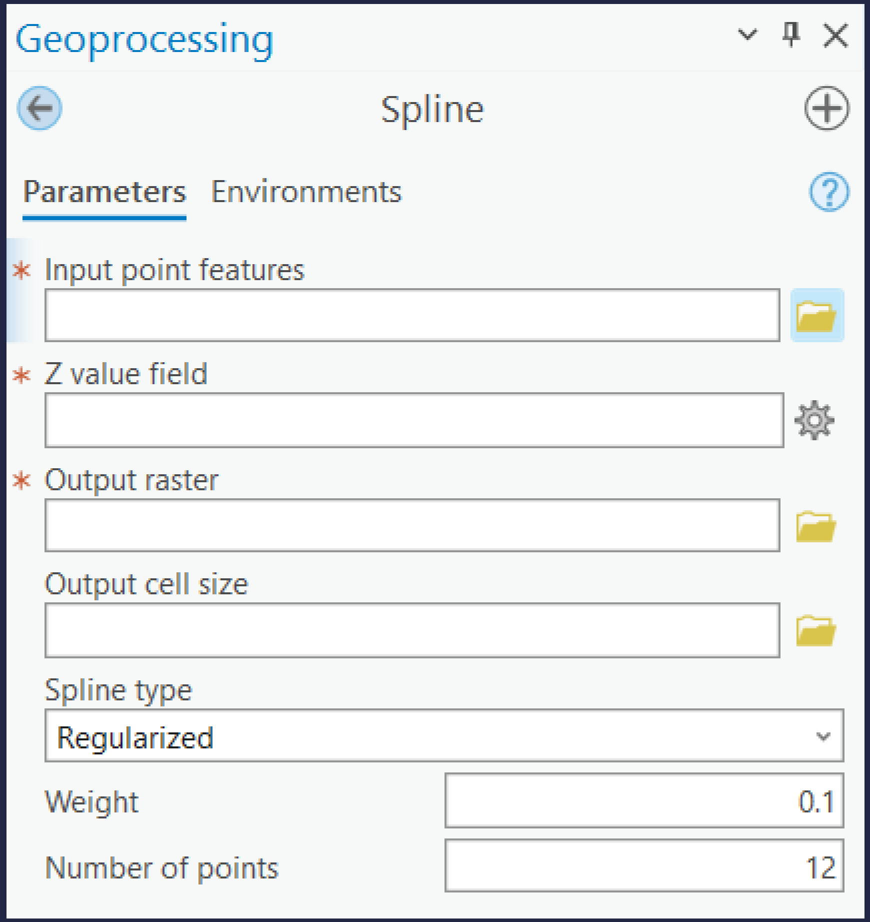
INTERPOLATION





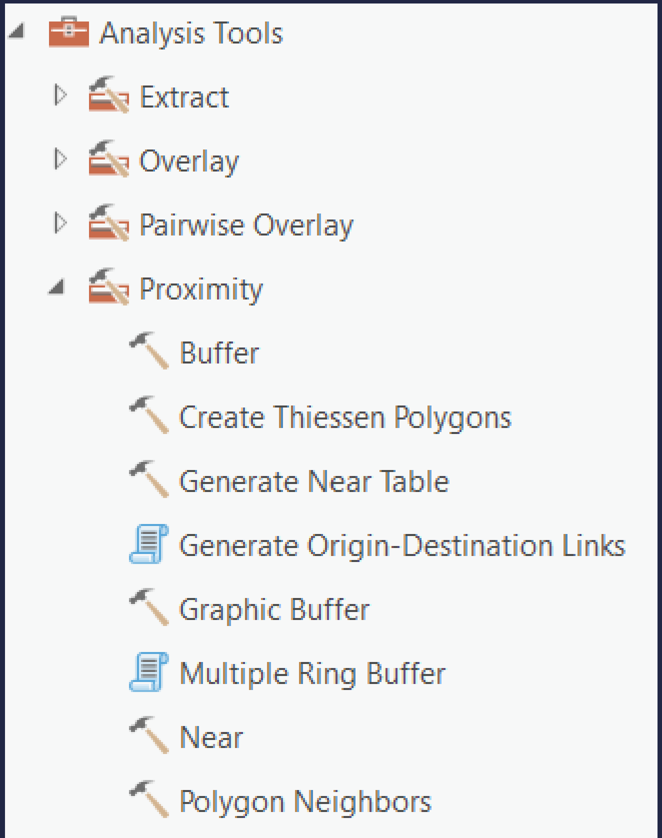
INTERPOLATION

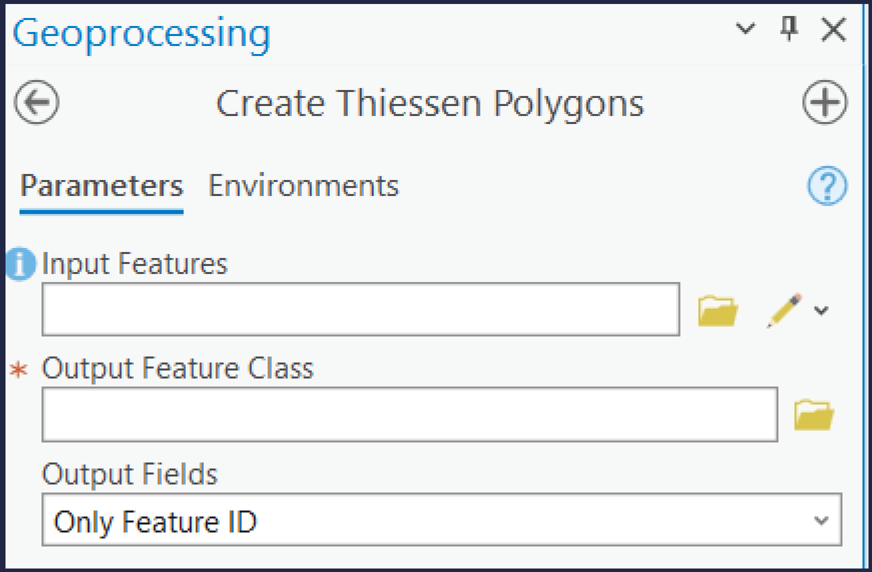




INTERPOLATION VS. PROXIMITY

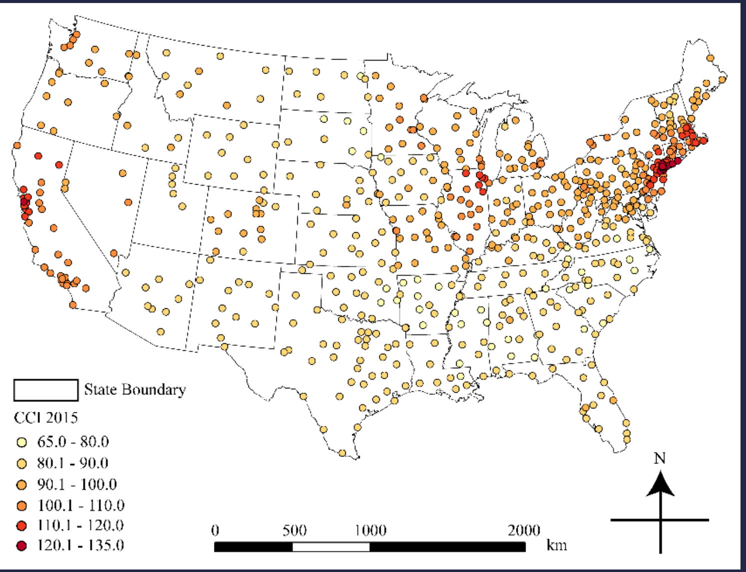
Proximity only considers nearness in space



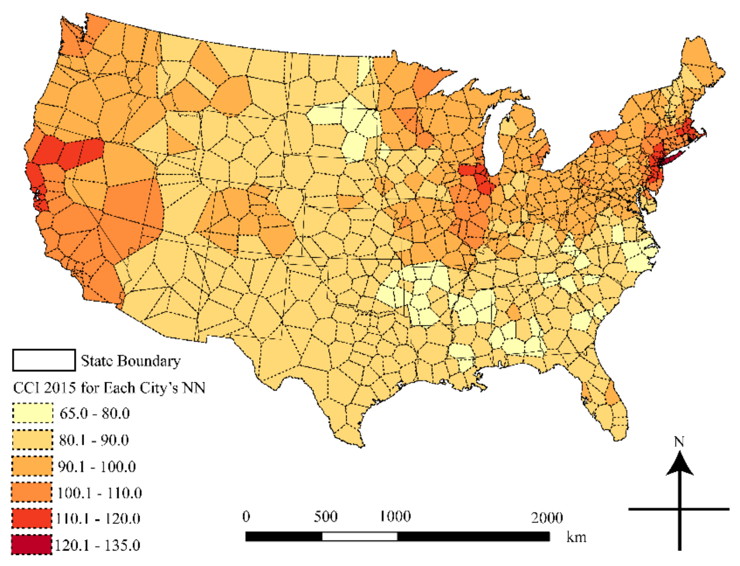


INTERPOLATION VS. PROXIMITY

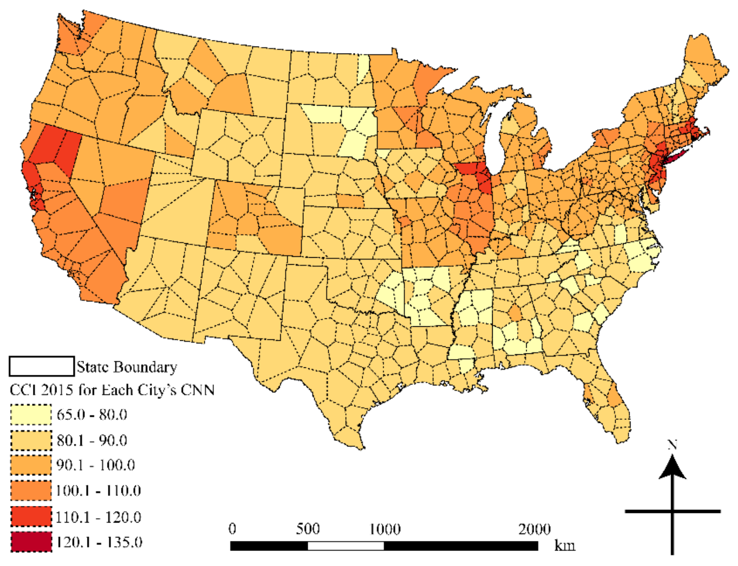
Original



Nearest Neighbor

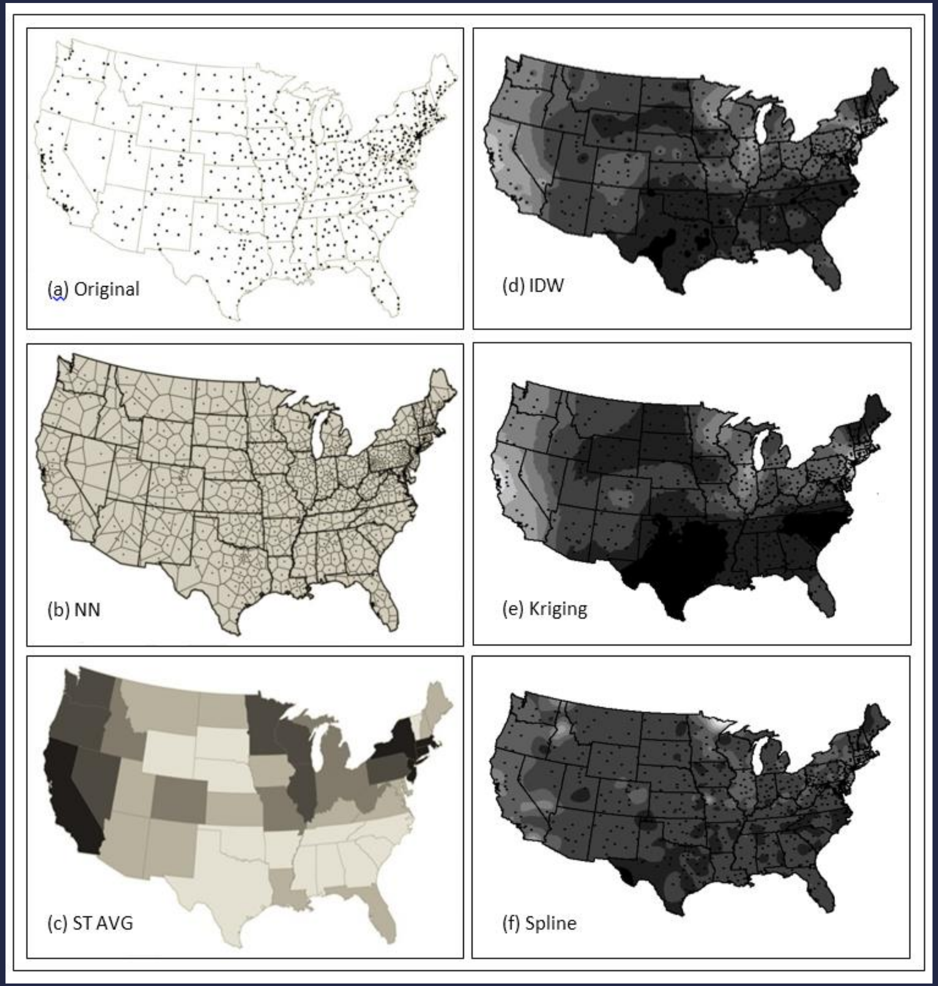


Conditional Nearest Neighbor



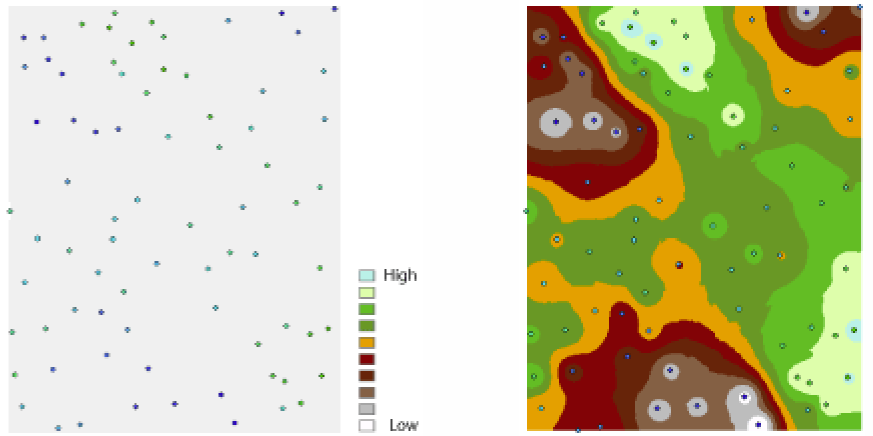
INTERPOLATION AND PREDICTION

Prediction also involves the estimation of variables at unsampled locations, but differs from interpolation in that estimates are based at least in part on other variables, and often on a total set of measurements



EXAMPLES

Interpolating an elevation surface

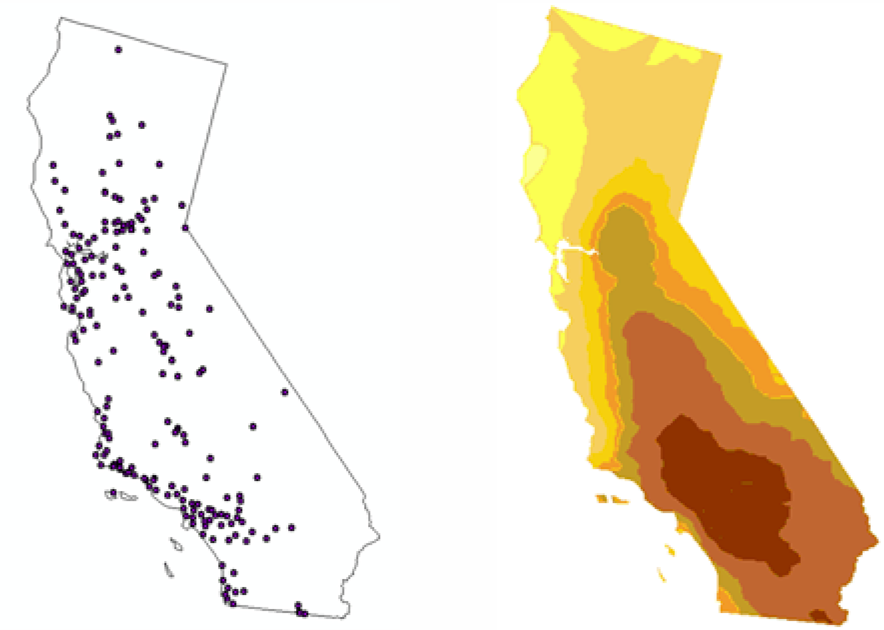


Input elevation point data

Interpolated elevation surface

desktop.arcgis.com

Interpolating a concentration surface



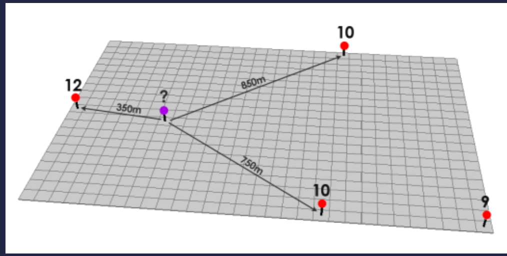
Point locations of ozone monitoring stations

Interpolated prediction surface

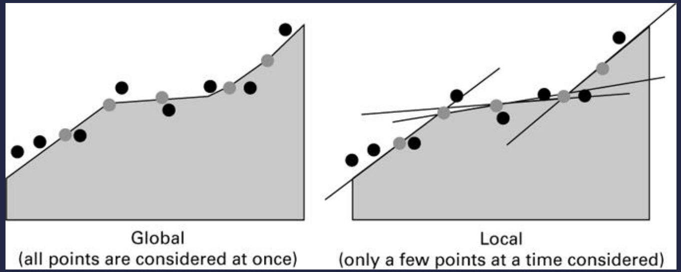
desktop.arcgis.com

INTERPOLATION METHODS

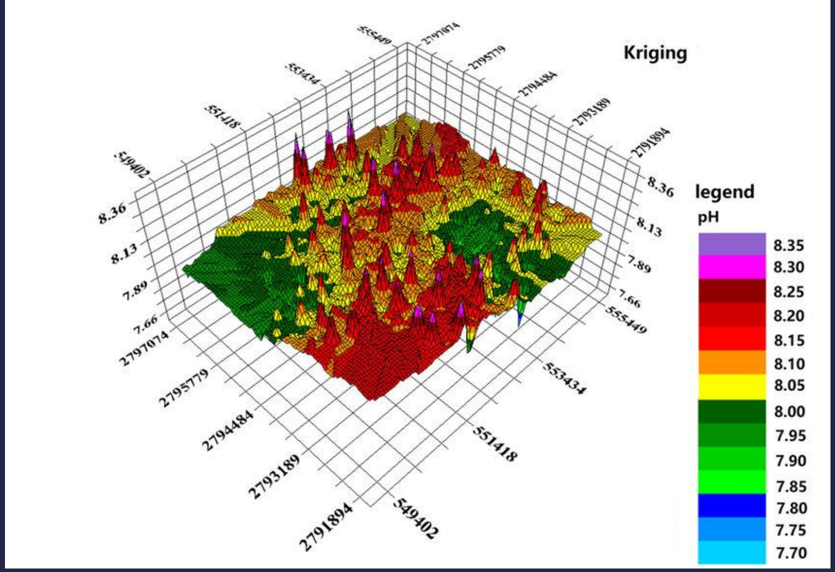
- Deterministic
  - Create surfaces from measured points, based on either the extent of similarity or degree of smoothing
  - Global vs. local
  - Examples: IDW (inverse distance weighting), Natural Neighbor, Trend, and Spline
- Geostatistical
  - Based on geostatistical models that include autocorrelation (the statistical relationship among the measured points). Because of this, geostatistical techniques not only have the capability of producing a prediction surface but also provide some measure of the certainty or accuracy of the predictions
  - Example: Kriging
- Topo to Raster and Topo to Raster by File, use an interpolation method specifically designed for creating continuous surfaces from contour lines, and the methods also contain properties favorable for creating surfaces for hydrologic analysis



gisgeography.com



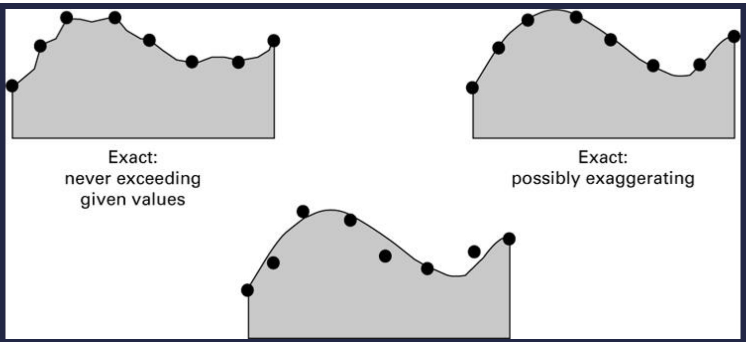
Albrecht 2007



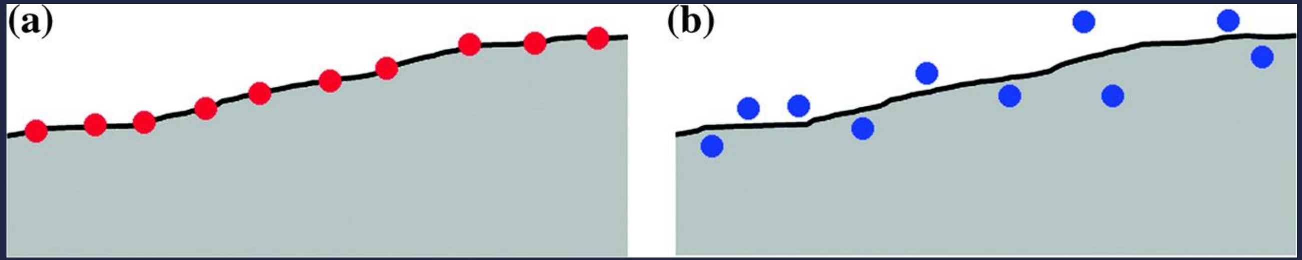
Yan et al. 2018

INTERPOLATION METHODS

- Exact Interpolation
  - Predict a value that is identical to the measured value at a sampled location
  - Examples: IDW and Spline and Kriging
- Inexact Interpolation
  - Predict a value that is different from the measured value at a sampled location
  - Example: Kriging



Albrecht 2007



Martin and Dominguez 2019

INTERPOLATION METHODS

- IDW is usually better when
  - You know that your sample data points represent the minimum and maximum values of your surface; because IDW is an averaging process, all interpolated values are within the sample range
  - You have line data that you want to use to interrupt the interpolation process; for example, you would not want to interpolate elevation data across over a cliff, or animal habitat data across a river the animal could not cross; IDW lets you set interpolation barriers of this kind
  - You are more interested in the spatial variation near your sample points than in the smoothness of the overall surface
  - You have a large set of sample values

- Spline is usually better when
  - The range of sample values may not include the extremes of the phenomenon being interpolated
  - The number of sample values is relatively small; spline generally produces better surfaces than IDW with sparse sample datasets
  - You want to see a surface with smooth distribution of values

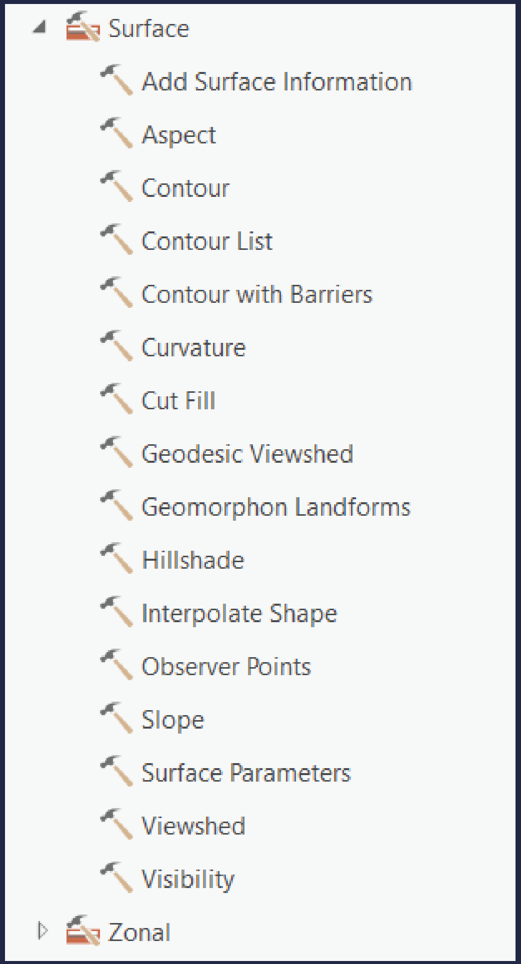
SURFACE ANALYSIS

Visualize and analyze a DEM

SURFACE ANALYSIS

- To visualize and analyze a terrain landform represented by a DEM
- Slope – shows the gradient and steepness of the terrain
- Aspect – shows the compass direction of the slope
- Hillshade – shows surface using an illumination source
- Viewshed – determines what parts of surface can be seen from a specified point(s)
- Curvature – calculates the curvature of a raster surface, optionally including profile and plan curvature
- Contour – creates contour lines from a raster surface
- Cut Fill – calculates the volume change between two surfaces

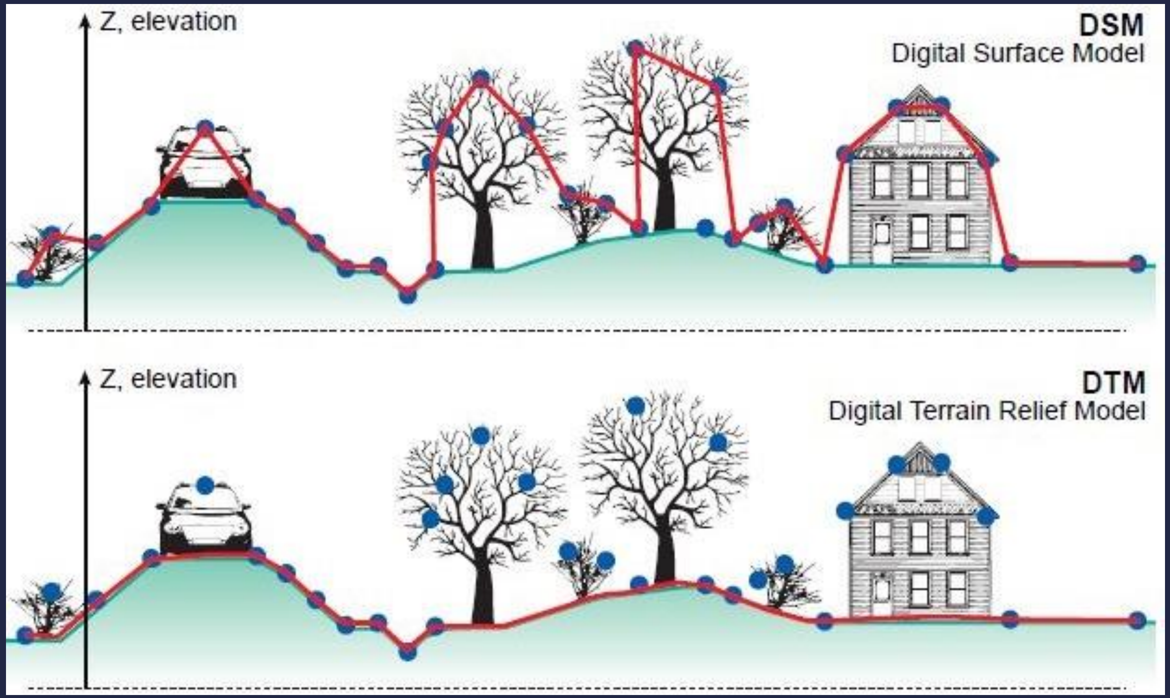
SURFACE ANALYSIS



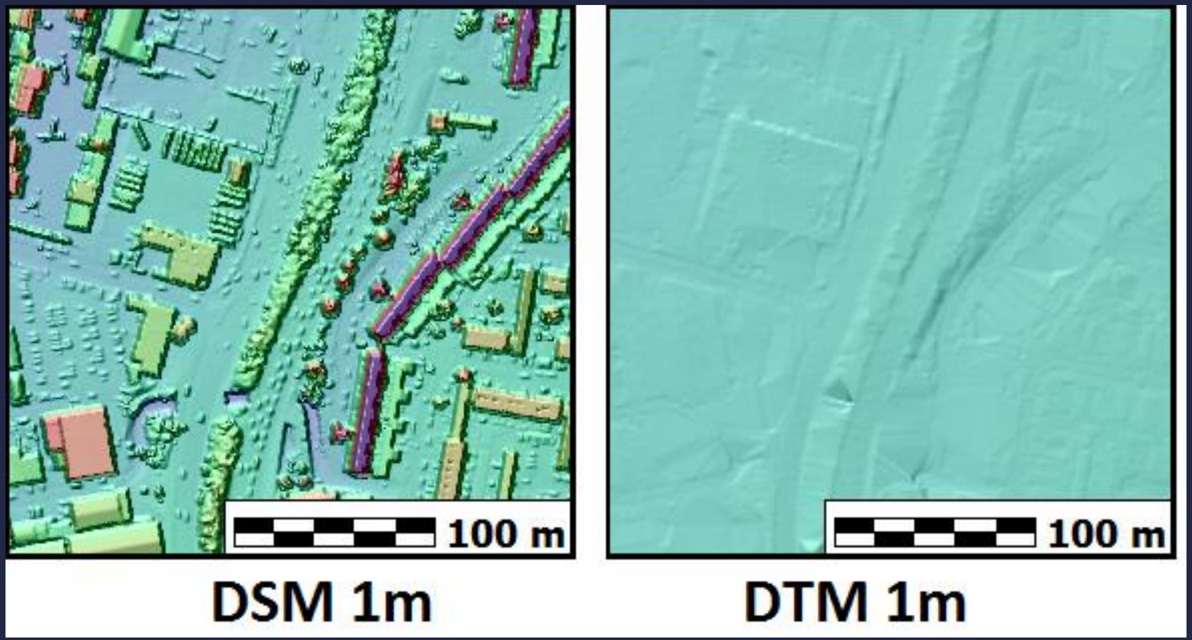
- Starting with a digital elevation data (DEM) as input
- You can gain information by producing a new dataset that identifies a specific pattern within an original dataset
- You can derive patterns that were not readily apparent in the original surface, such as contours, angle of slope, steepest downslope direction (Aspect), shaded relief (Hillshade), and visibility

SURFACE ANALYSIS

- Digital Surface Model (DSM)
- Digital Terrain Model (DTM)
- Digital Elevation Model (DEM)



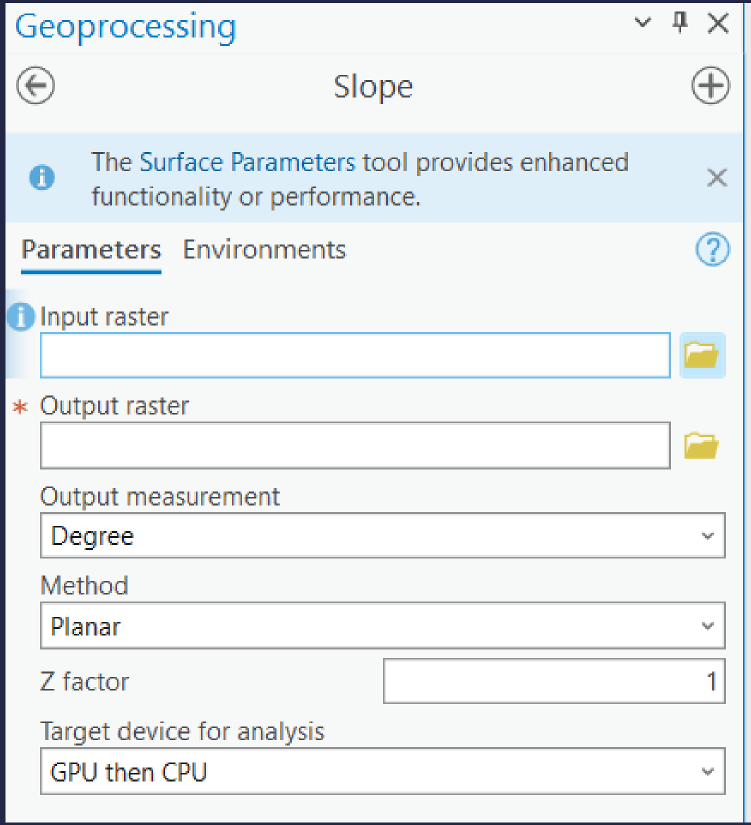
Provided by 3DMetrica



Provided by USNA

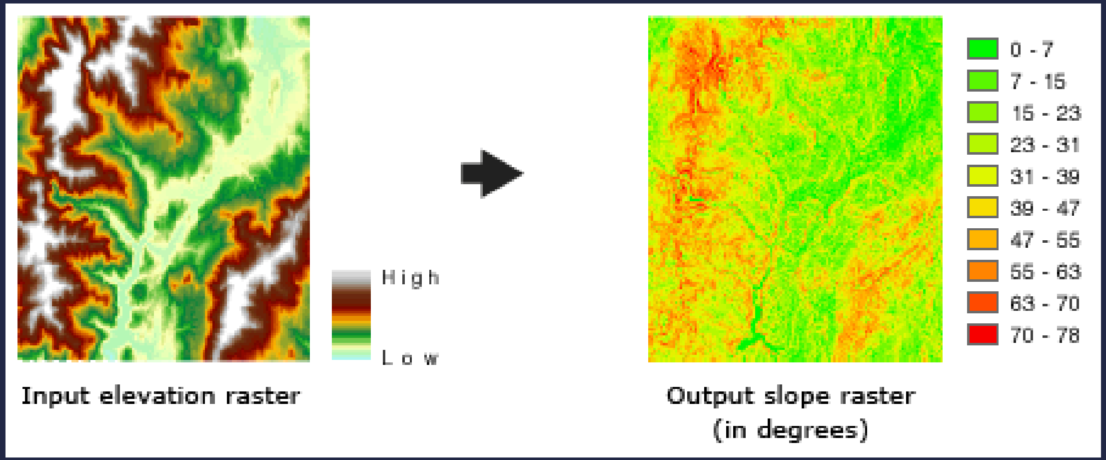
EXAMPLES

Slope shows the gradient degree of incline and steepness of the terrain



Output reported in degrees or percentages

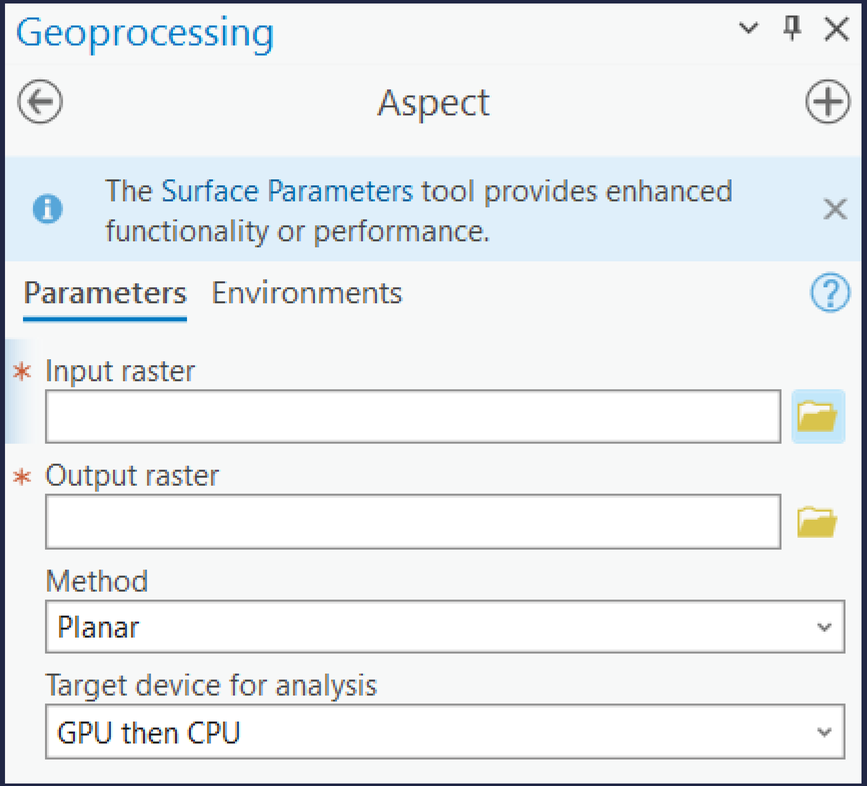
- Degree: 0 (flat) – 90 (vertical)
- Percentage: 0 (flat) – infinite (vertical)



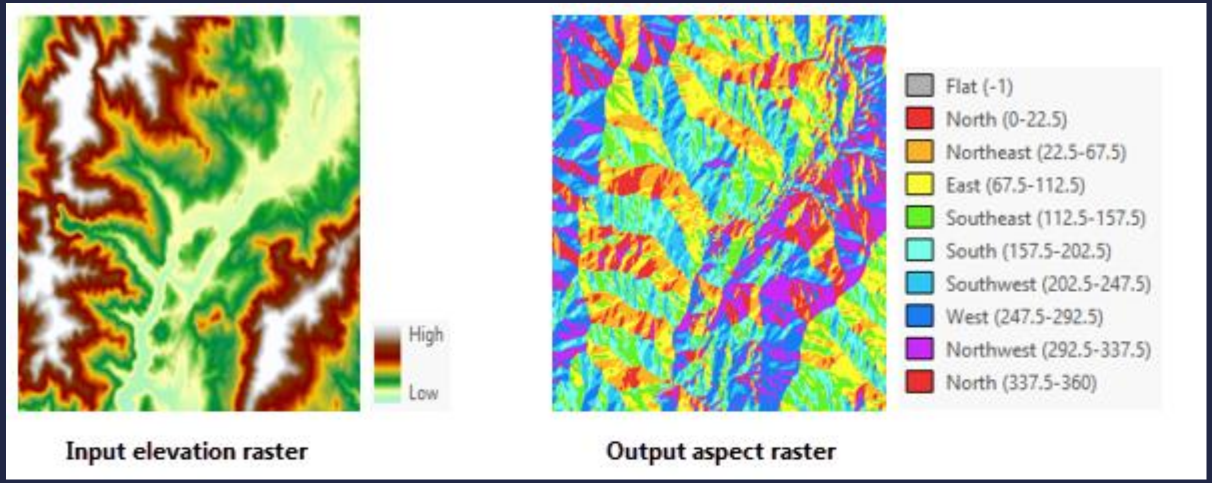
desktop.arcgis.com

EXAMPLES

Aspect shows the compass direction of the slope



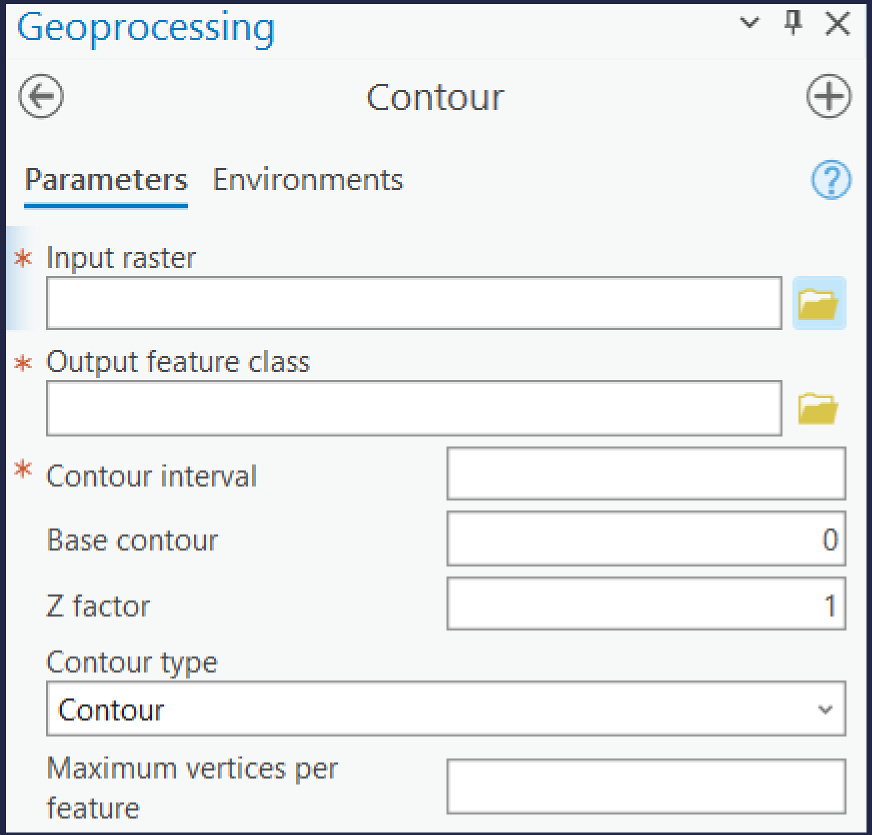
- Defines the direction of water flow, the amount of sunlight a site may receive, line-of-sight
- Measured in degrees from 0 to 360
  - 0˚ is north-facing
  - 90˚ is east-facing
  - 180˚ is south-facing
  - 270˚ is west-facing

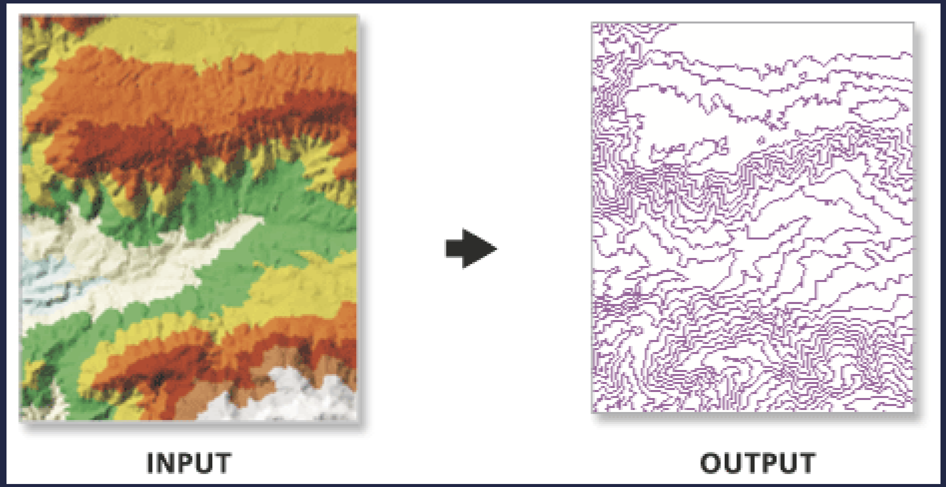


desktop.arcgis.com

EXAMPLES

Contours are lines that connect locations of equal value in a raster dataset that represents continuous phenomena such as elevation, temperature, precipitation, pollution, or atmospheric pressure

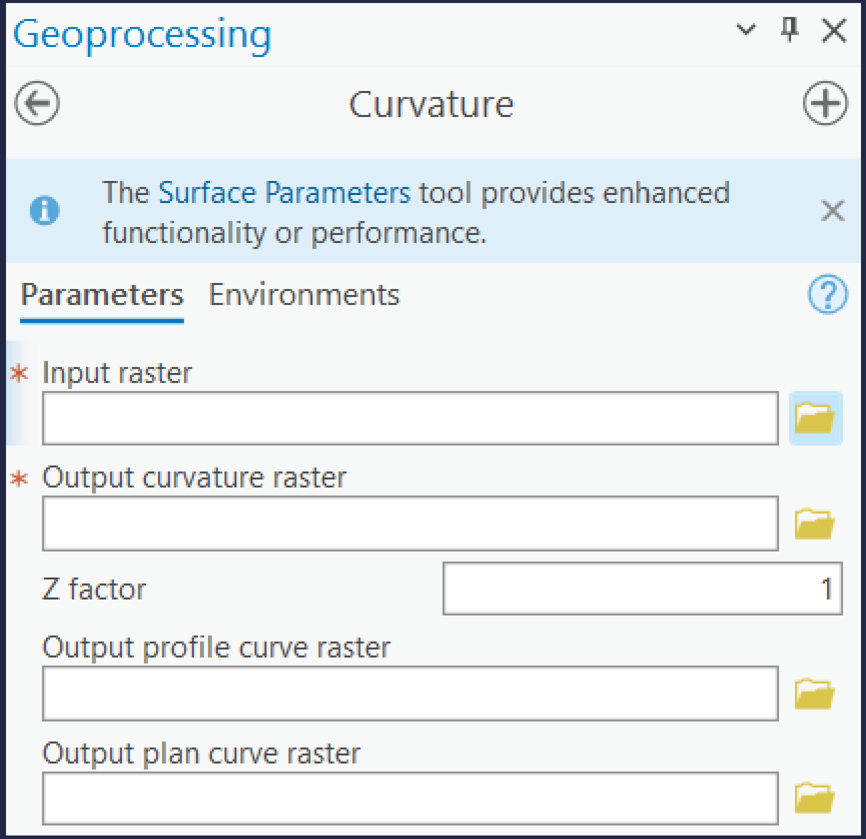


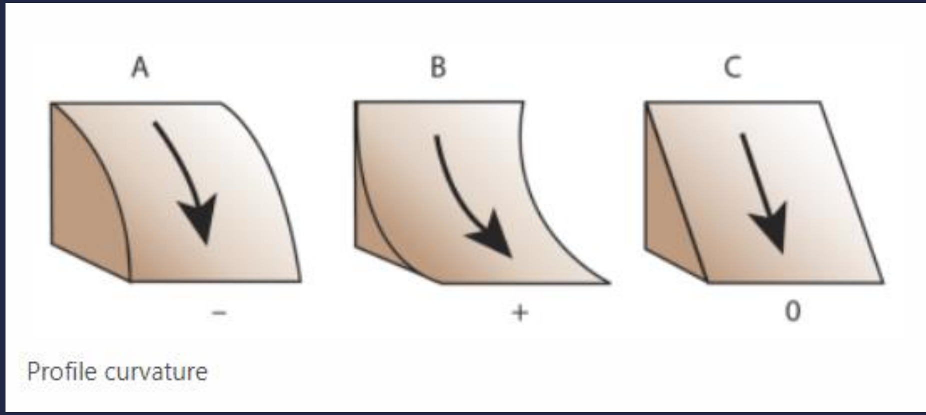


pro.arcgis.com

EXAMPLES

Curvature is the amount by which a curve deviates from being a straight line, or a surface deviates from being a plane



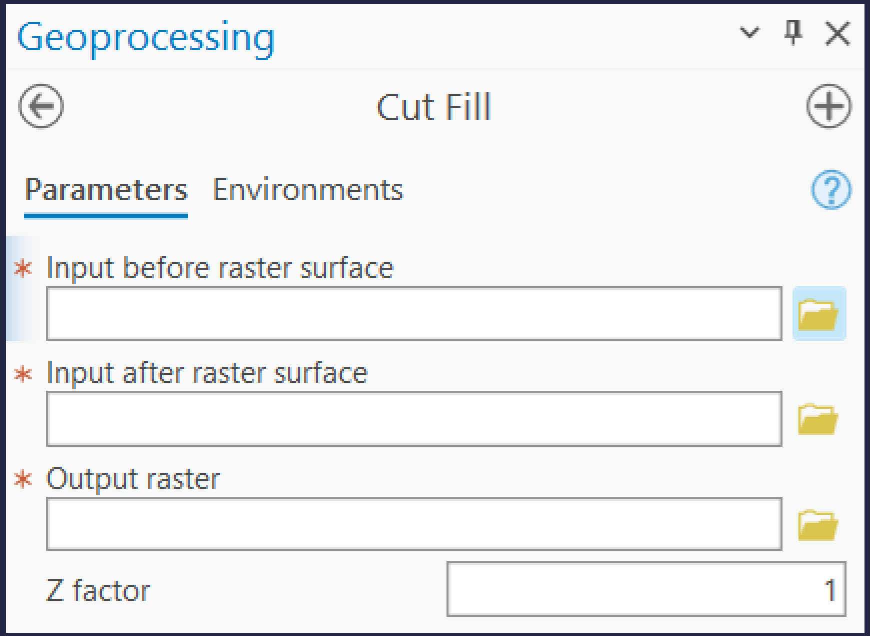


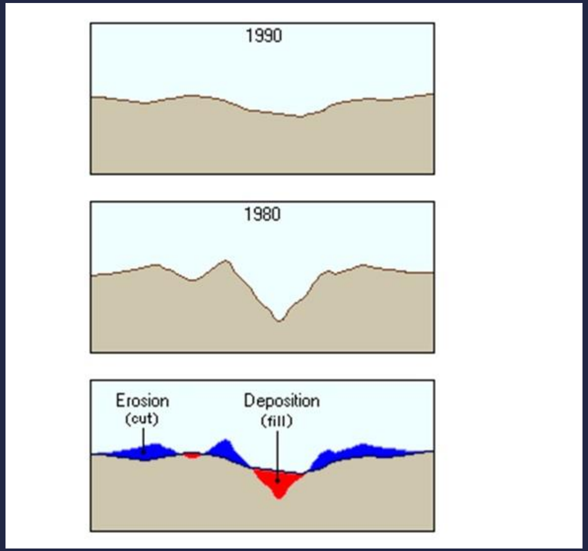
desktop.arcgis.com

desktop.arcgis.com

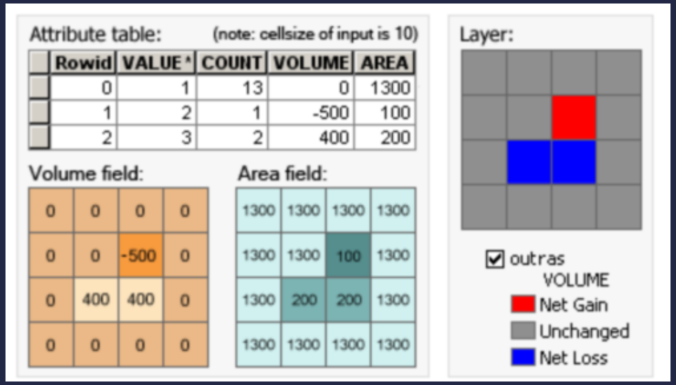
EXAMPLES

Cut Fill Calculates the volume change between two surfaces; this is typically used for cut and fill operations





gis.stackexchange.com

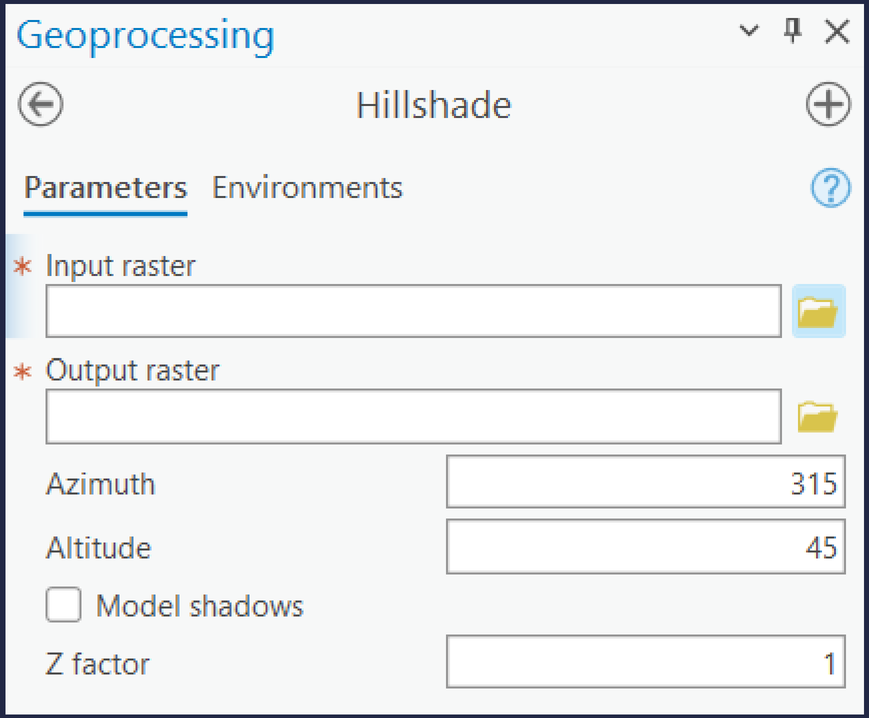


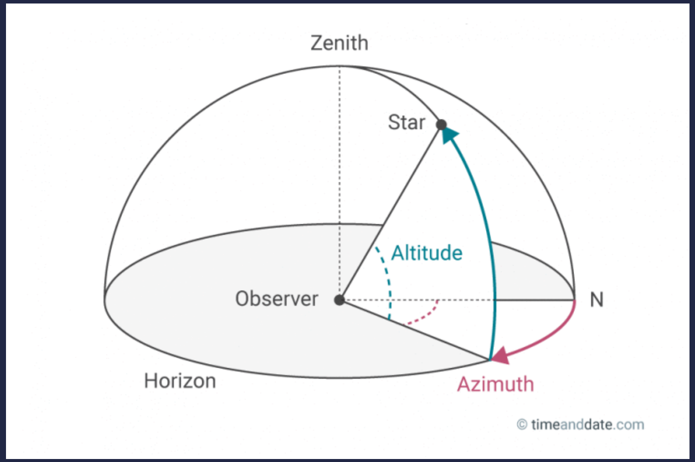
desktop.arcgis.com

EXAMPLES

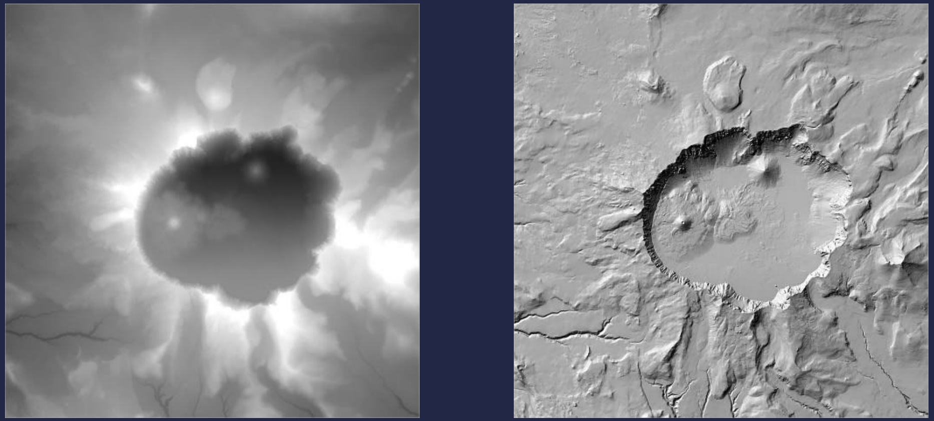
Hillshade, also known as shaded relief, a technique to visualize terrain using an illuminated hypothetical light source

Used for visualization rather than analysis





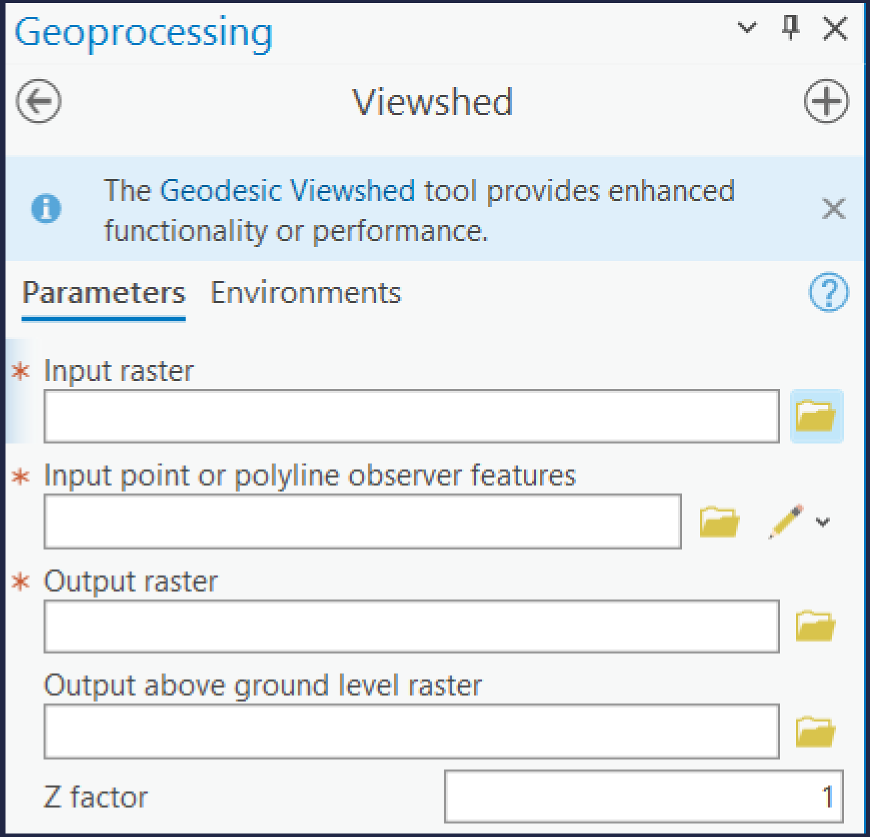
pinterest.com

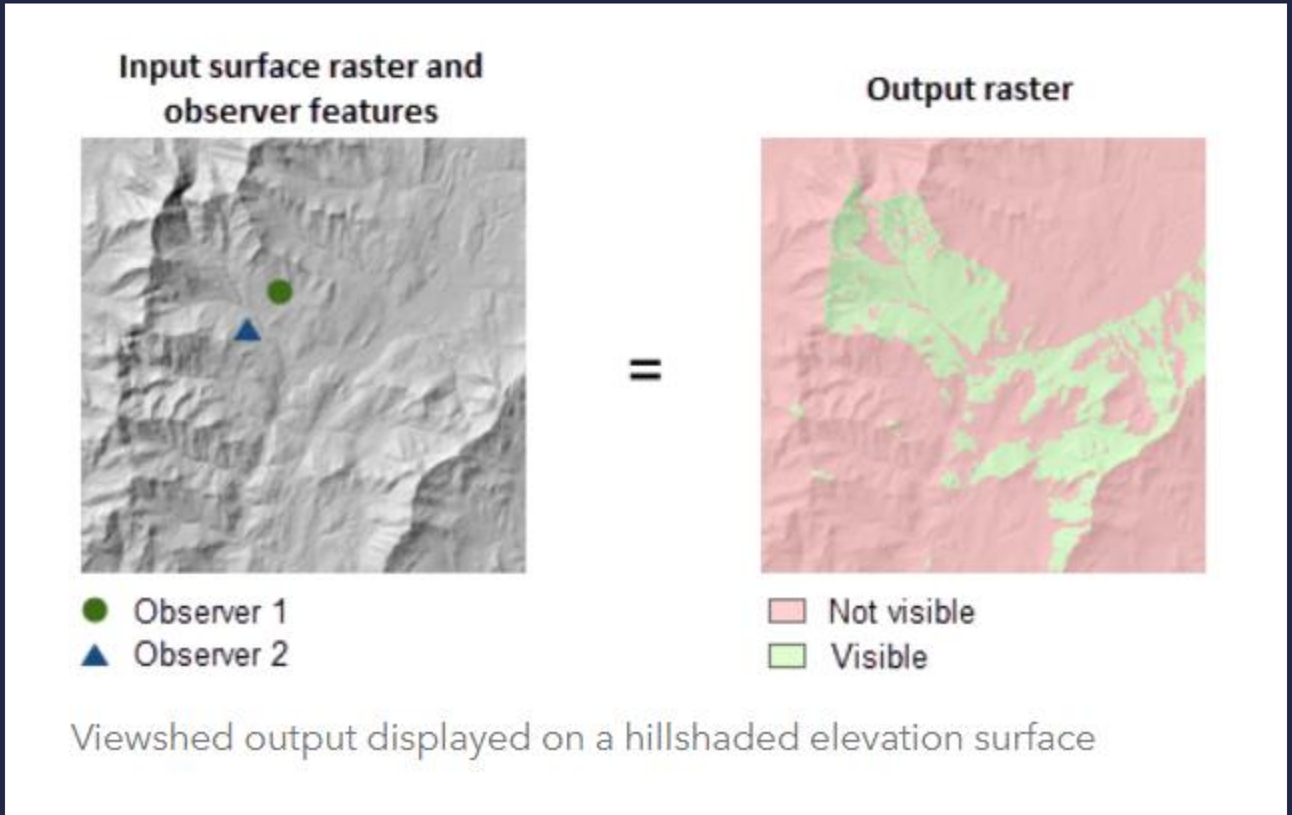


esri.com

EXAMPLES

Visibility





Viewshed output displayed on a hillshaded elevation surface

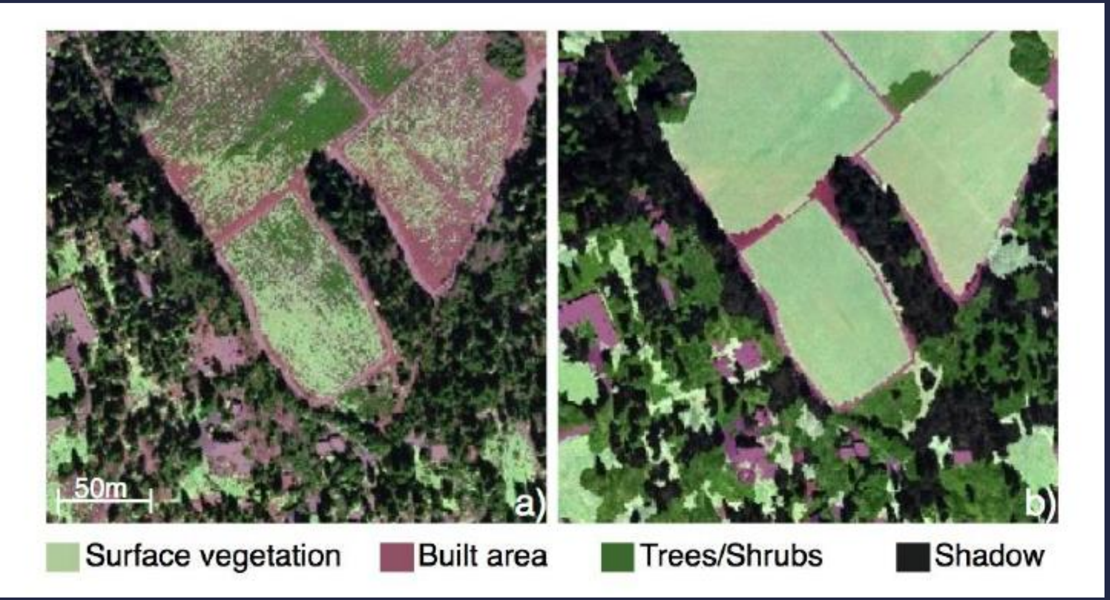
pro.arcgis.com

GENERALIZATION

Visualize and analyze a DEM

GENERALIZATION

- Used to either clean up small erroneous data in the raster or generalize the data to get rid of unnecessary detail for a more general analysis
- Common sources for the erroneous data
  - Classified satellite imagery may contain many small areas of misclassified cells
  - Images that are scanned paper maps may contain unnecessary lines or text
  - Conversion issues from rasters in different format, resolutions, or projection may exist
- With generalization tools, you can identify such areas and automate the assignment of more reliable values to the cells that make up the area



Kelly et al. 2011

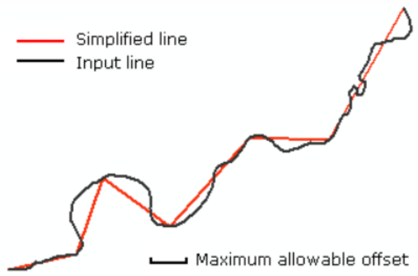
GENERALIZATION

- Spatial Analyst Tools
  - Conditional
  - Density
  - Distance
  - Extraction
  - Generalization
    - Aggregate
    - Boundary Clean
    - Expand
    - Majority Filter
    - Nibble
    - Region Group
    - Shrink
    - Thin

- Editing Tools
  - Conflation
  - Densify
  - Erase Point
  - Extend Line
  - Flip Line
  - Generalize
  - Simplify By Straight Lines And Circular Arcs
  - Snap
  - Trim Line
  - Update COGO

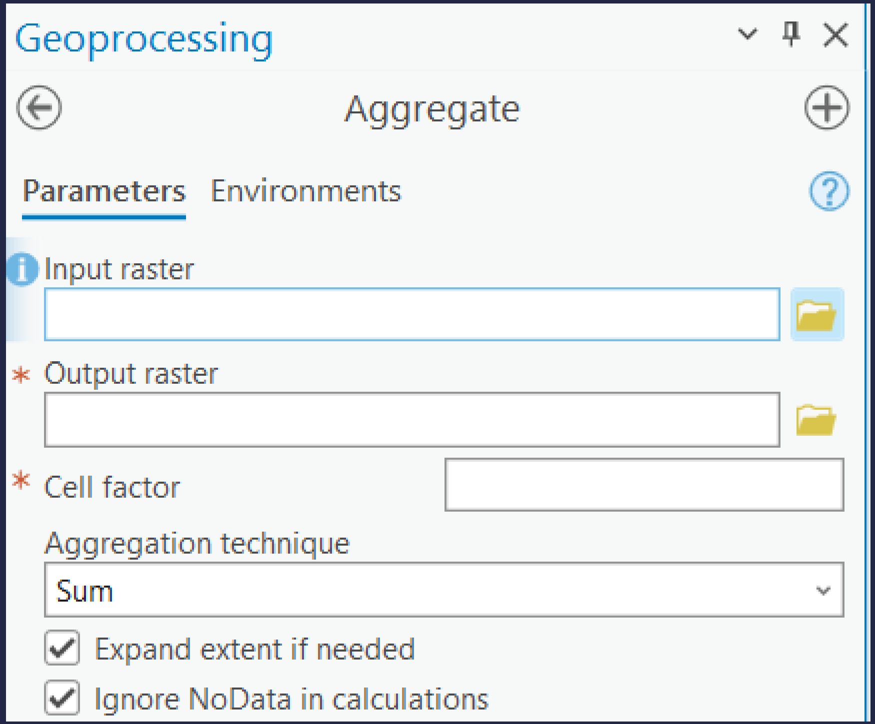
- Cartography Tools
  - Annotation
  - Cartographic Refinement
  - Generalization
    - Aggregate Points
    - Aggregate Polygons
    - Collapse Hydro Polygon
    - Collapse Road Detail
    - Create Cartographic Partitions
    - Delineate Built-Up Areas
    - Merge Divided Roads
    - Simplify Building
    - Simplify Line
    - Simplify Polygon
    - Simplify Shared Edges
    - Smooth Line
    - Smooth Polygon
    - Smooth Shared Edges
    - Thin Road Network

- Data Management Tools
  - 3D Objects
  - Archiving
  - Attachments
  - Attribute Rules
  - Catalog Dataset
  - Contingent Values
  - Data Comparison
  - Distributed Geodatabase
  - Domains
  - Feature Binning
  - Feature Class
  - Features
  - Fields
  - File Geodatabase
  - General
  - Generalization
    - Dissolve
    - Eliminate
    - Eliminate Polygon Part

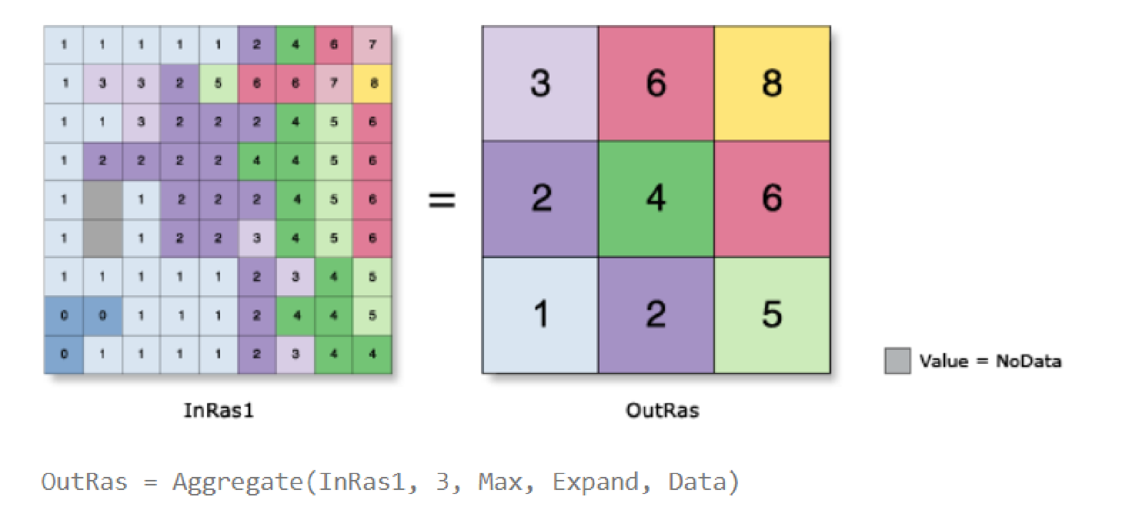


The line is simplified within the boundary of the maximum allowable offset

GENERALIZATION



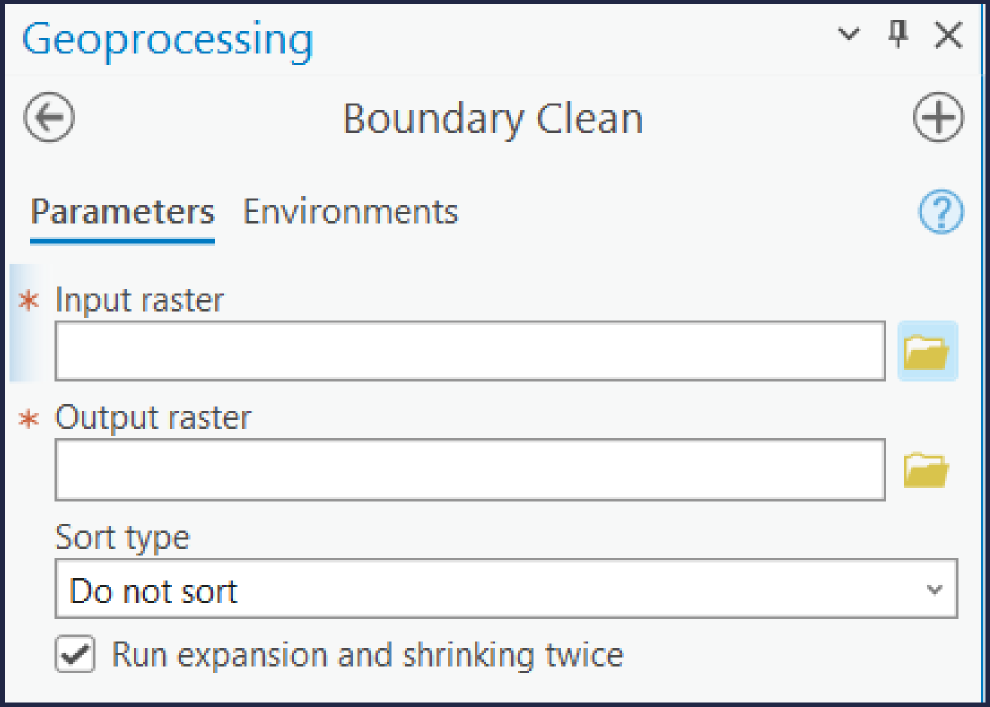
Generates a reduced-resolution version of a raster. Each output cell contains the Sum, Minimum, Maximum, Mean, or Median of the input cells that are encompassed by the extent of that cell

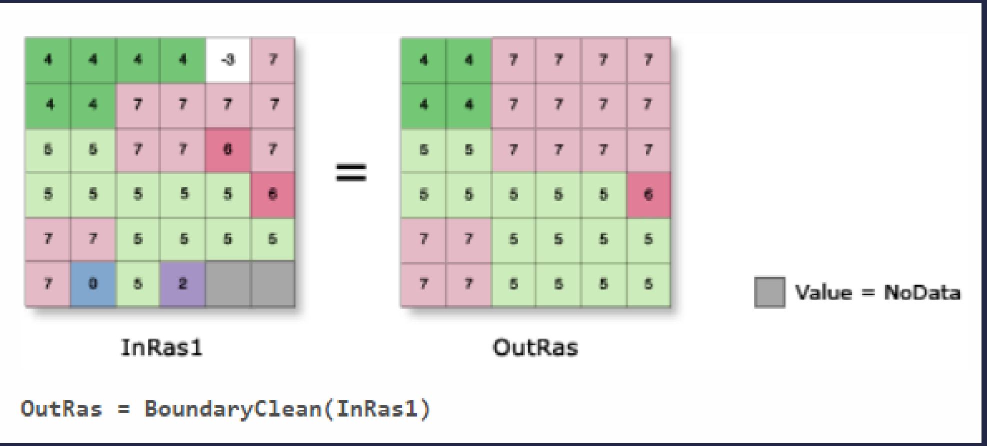


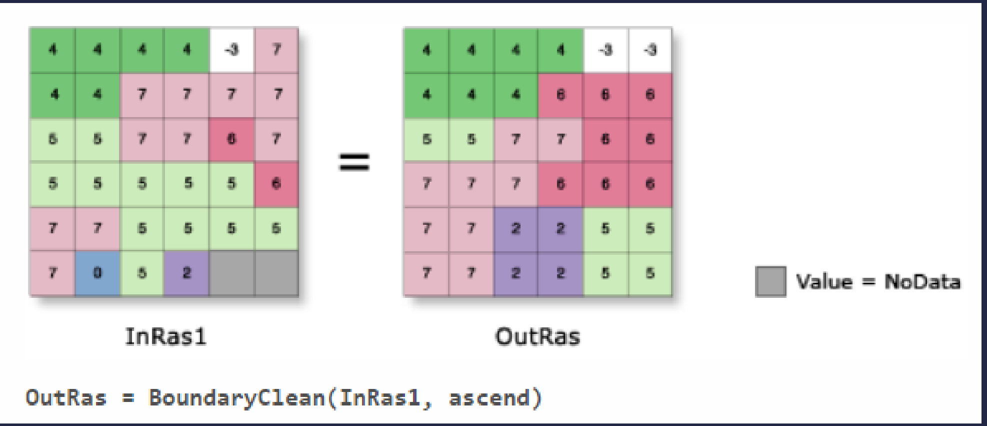
pro.arcgis.com

GENERALIZATION

Smooths the boundary between zones by expanding and shrinking it

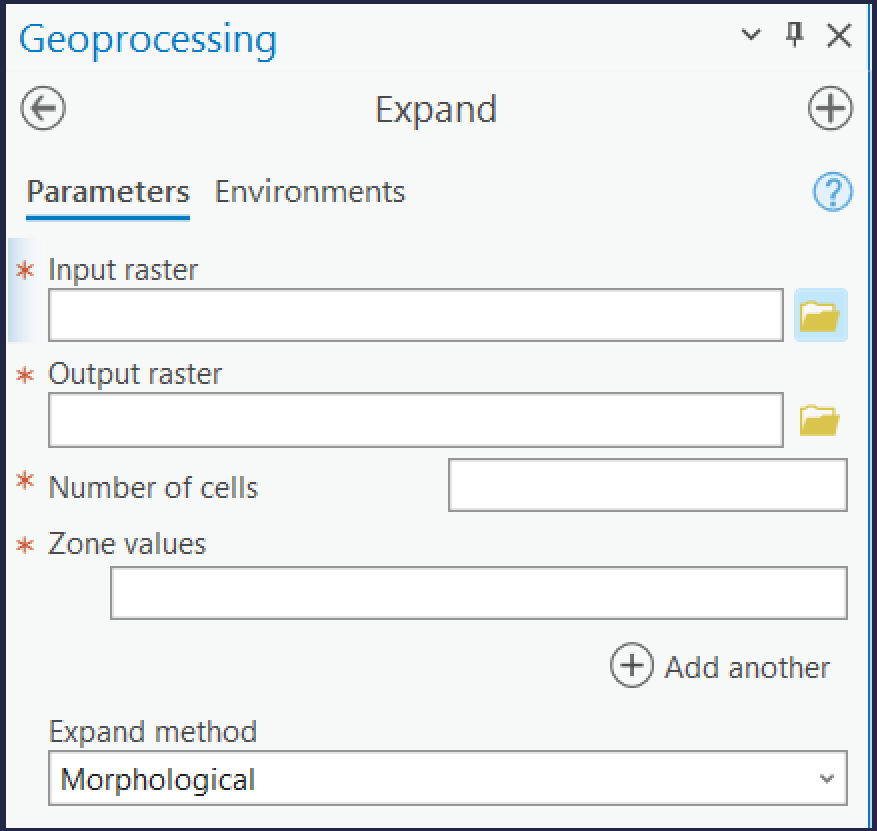




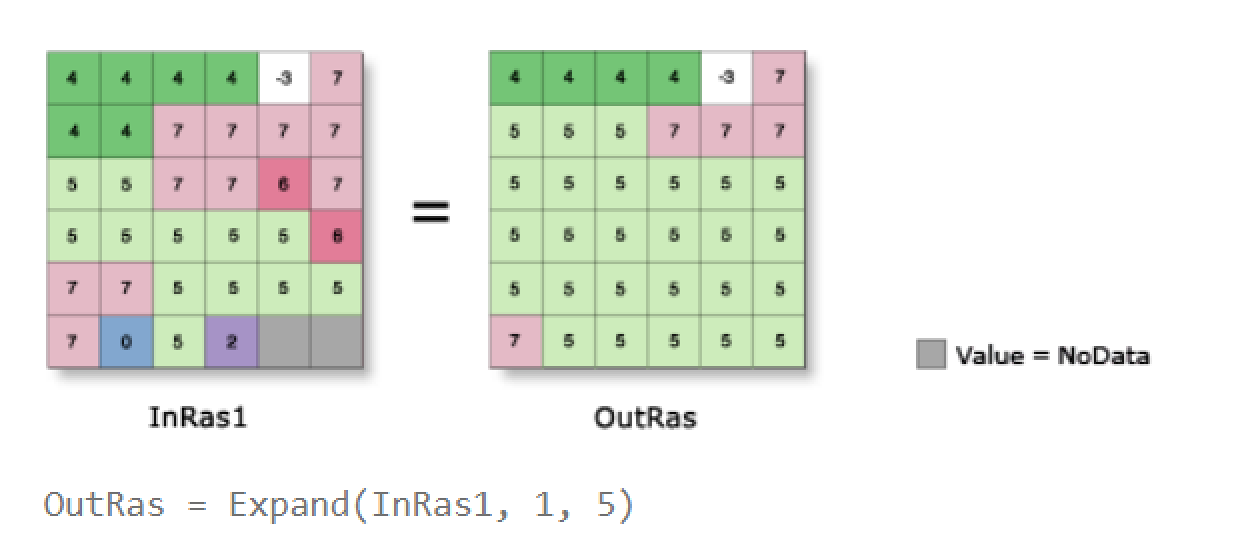


pro.arcgis.com

GENERALIZATION

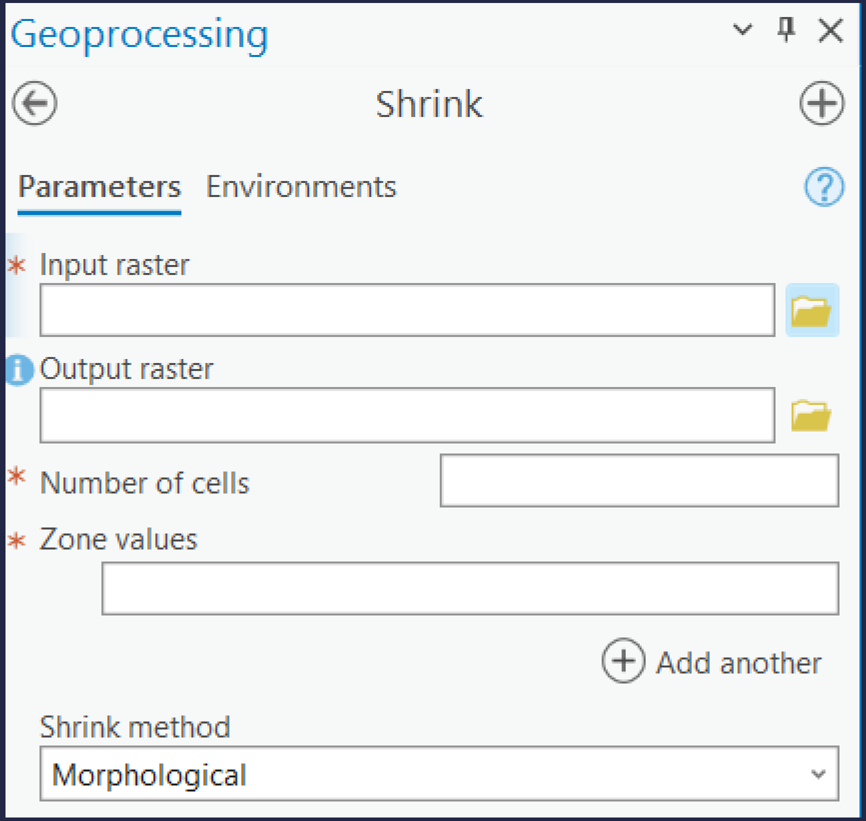


Expands specified zones of a raster by a specified number of cells.

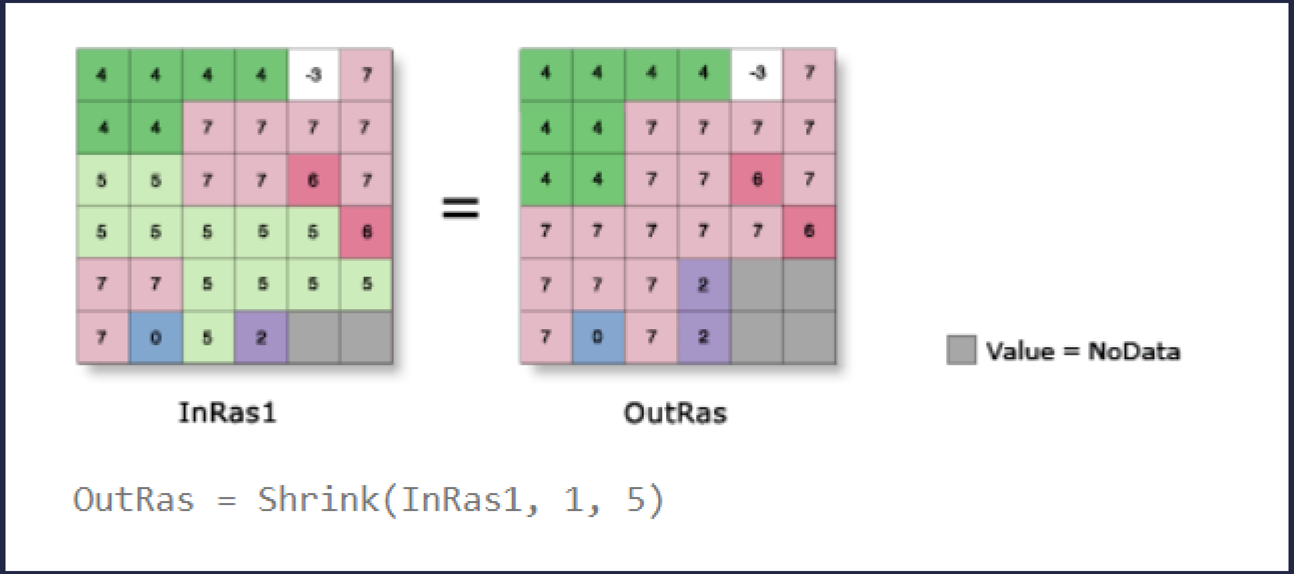


pro.arcgis.com

GENERALIZATION



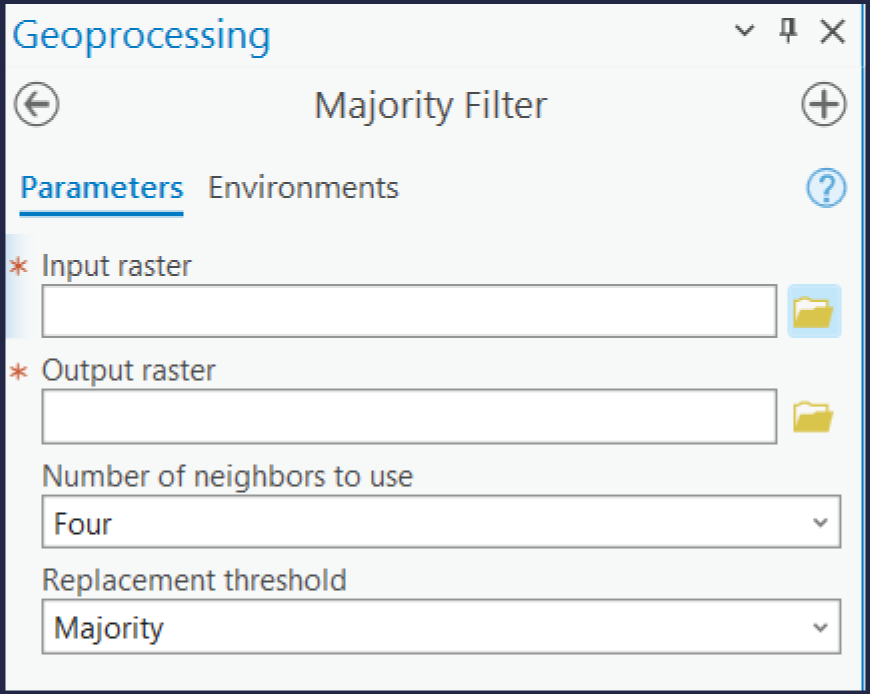
Shrinks the selected zones by a specified number of cells by replacing them with the value of the cell that is most frequent in its neighborhood

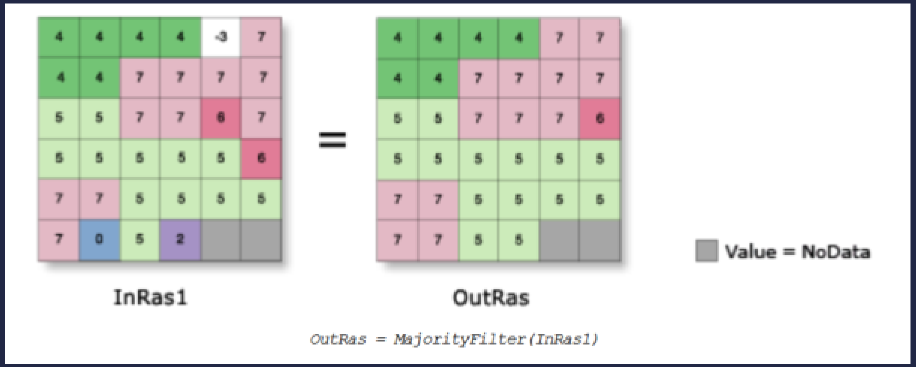


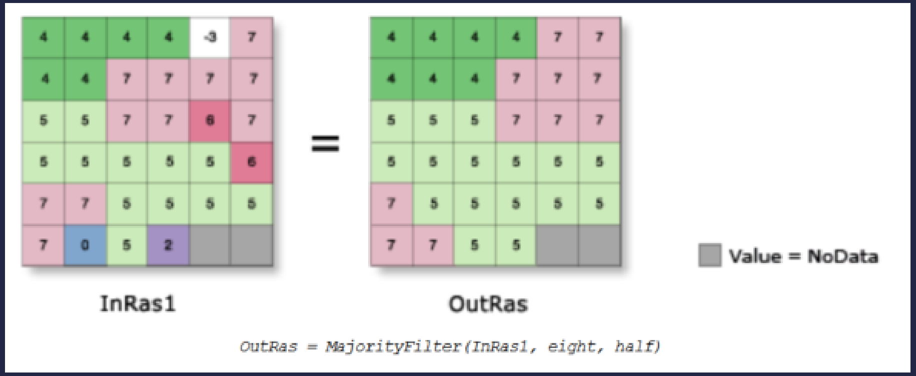
pro.arcgis.com

GENERALIZATION

Replaces cells in a raster based on the majority of their contiguous neighboring cells

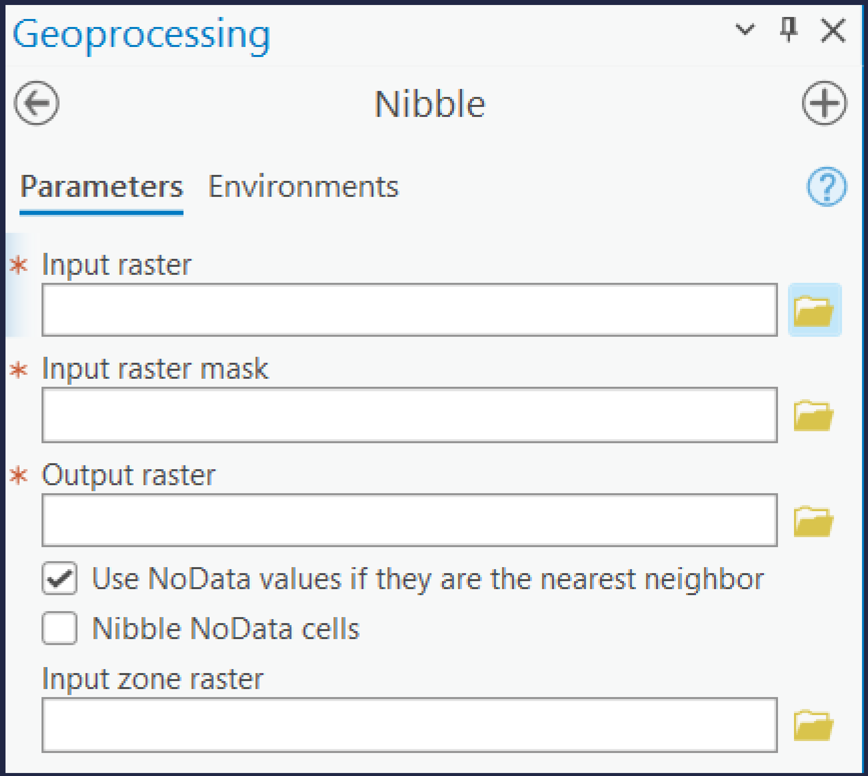




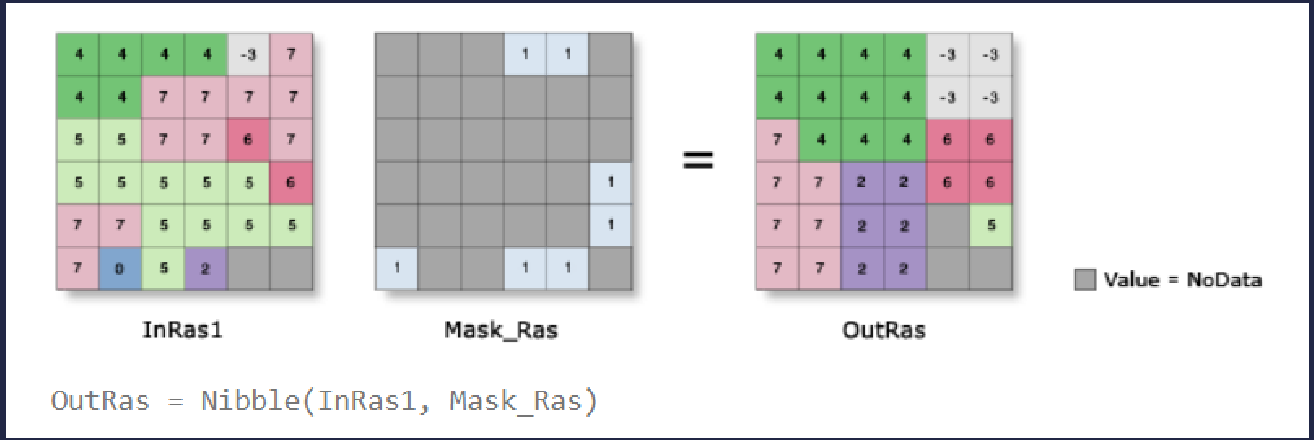


pro.arcgis.com

GENERALIZATION

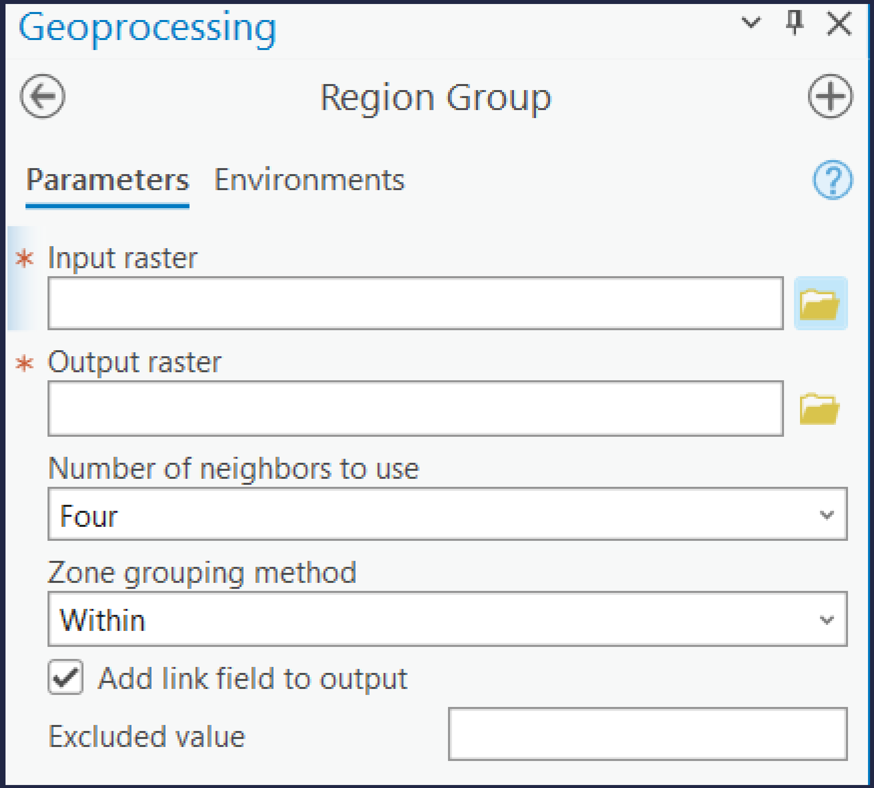


Replaces cells of a raster corresponding to NoData cells of a mask with the values of the nearest neighbors

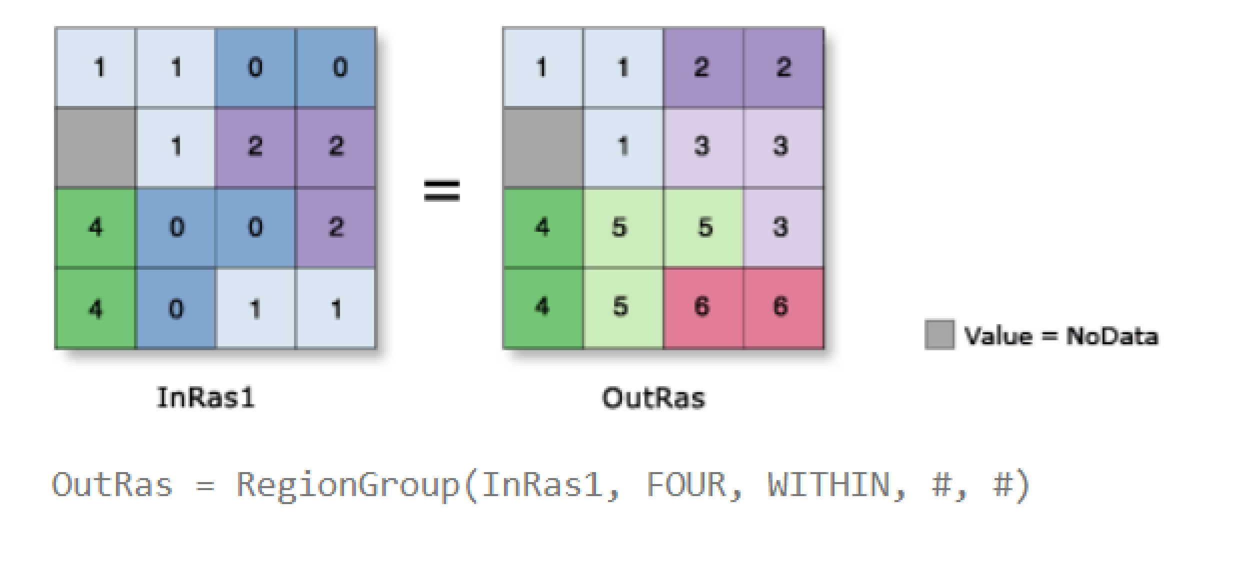


pro.arcgis.com

GENERALIZATION

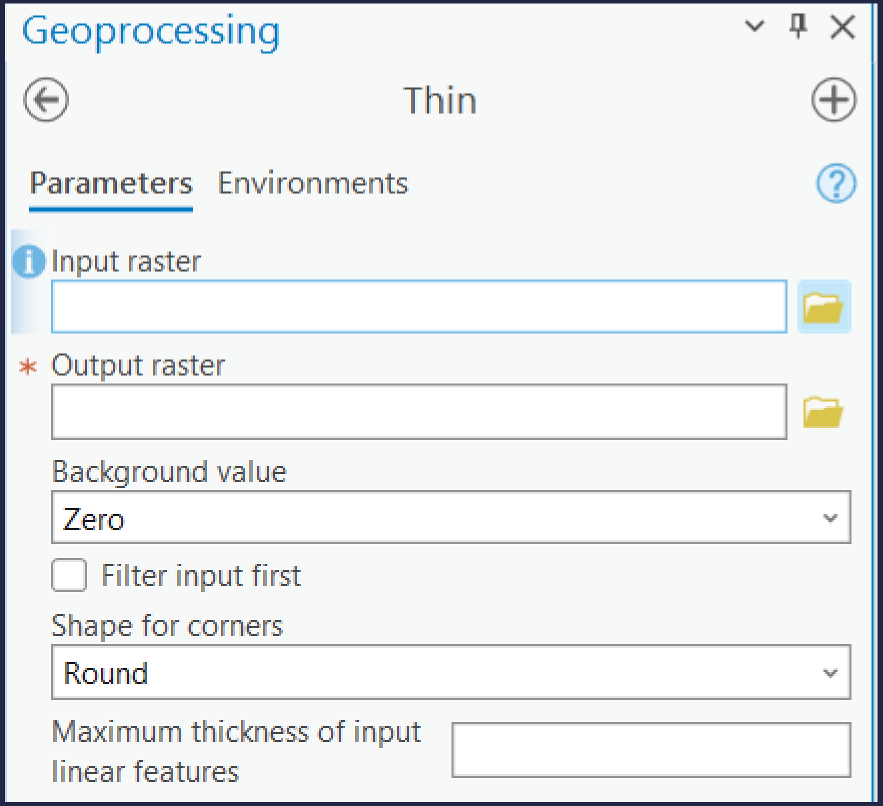


For each cell in the output, the identity of the connected region to which that cell belongs is recorded; a unique number is assigned to each region

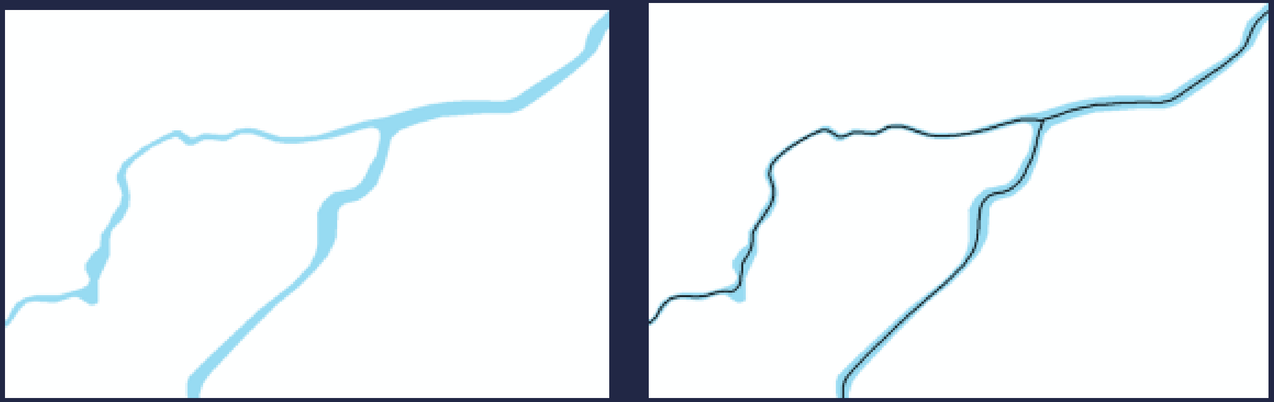


pro.arcgis.com

GENERALIZATION



Thins rasterized linear features by reducing the number of cells representing the width of the features



desktop.arcgis.com