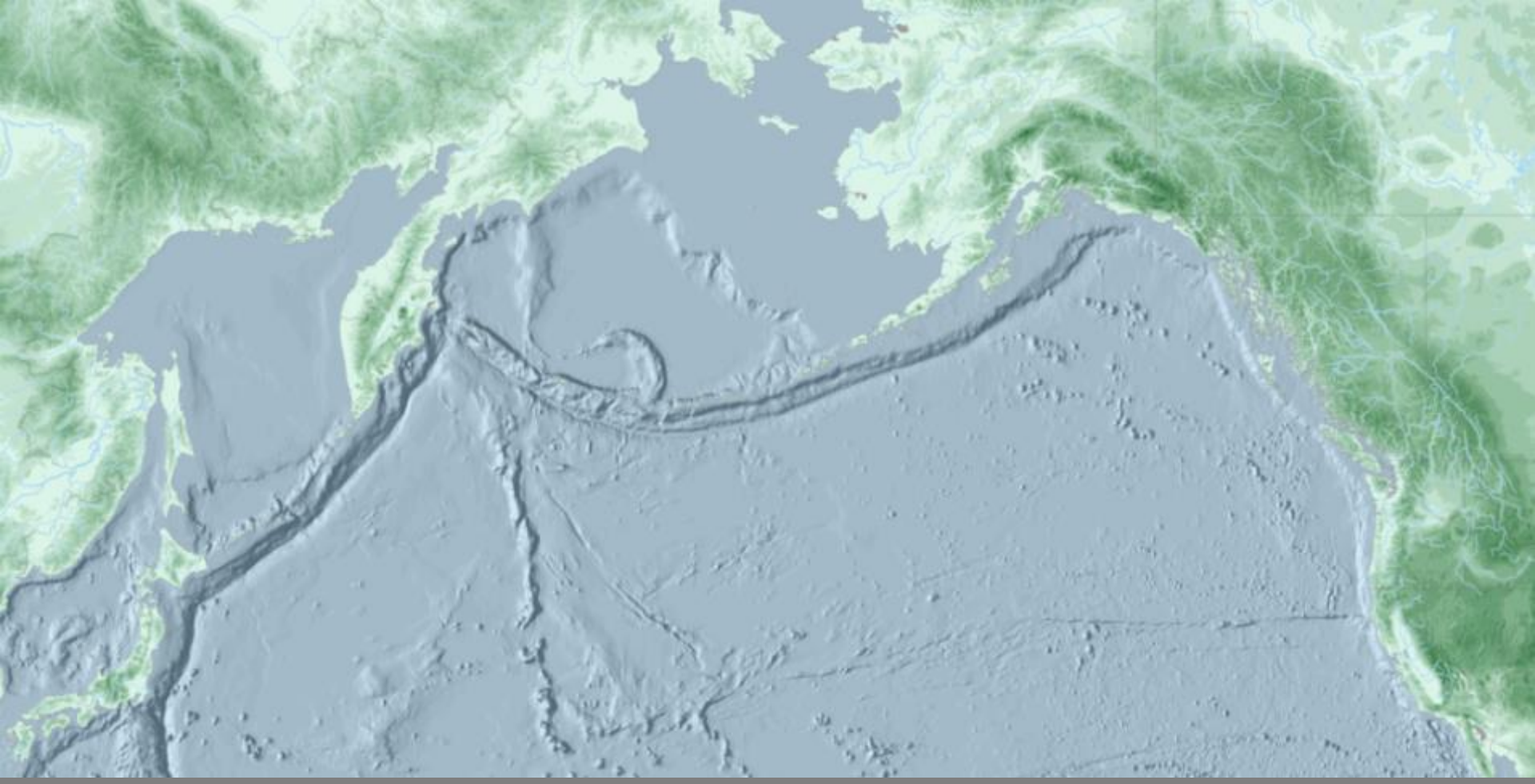


RASTER ANALYSIS

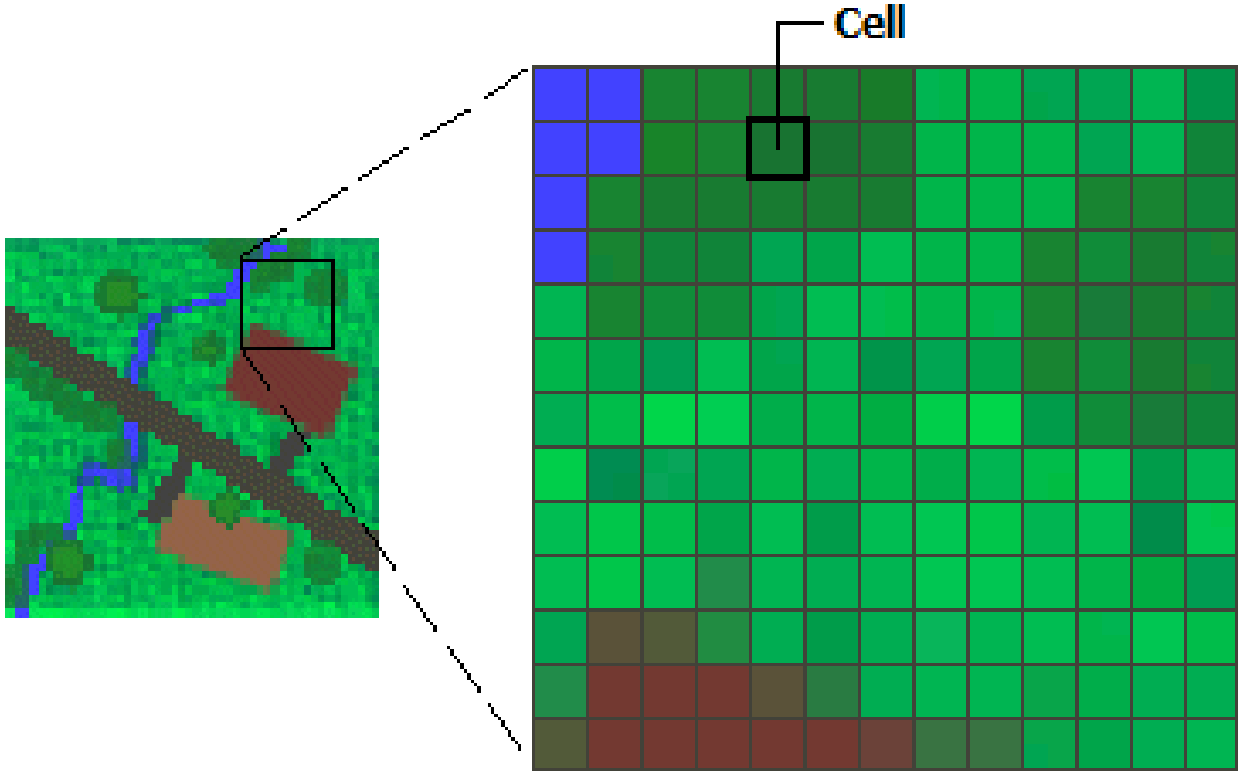
GIS Analysis| Winter 2016

Raster Data

The Basics

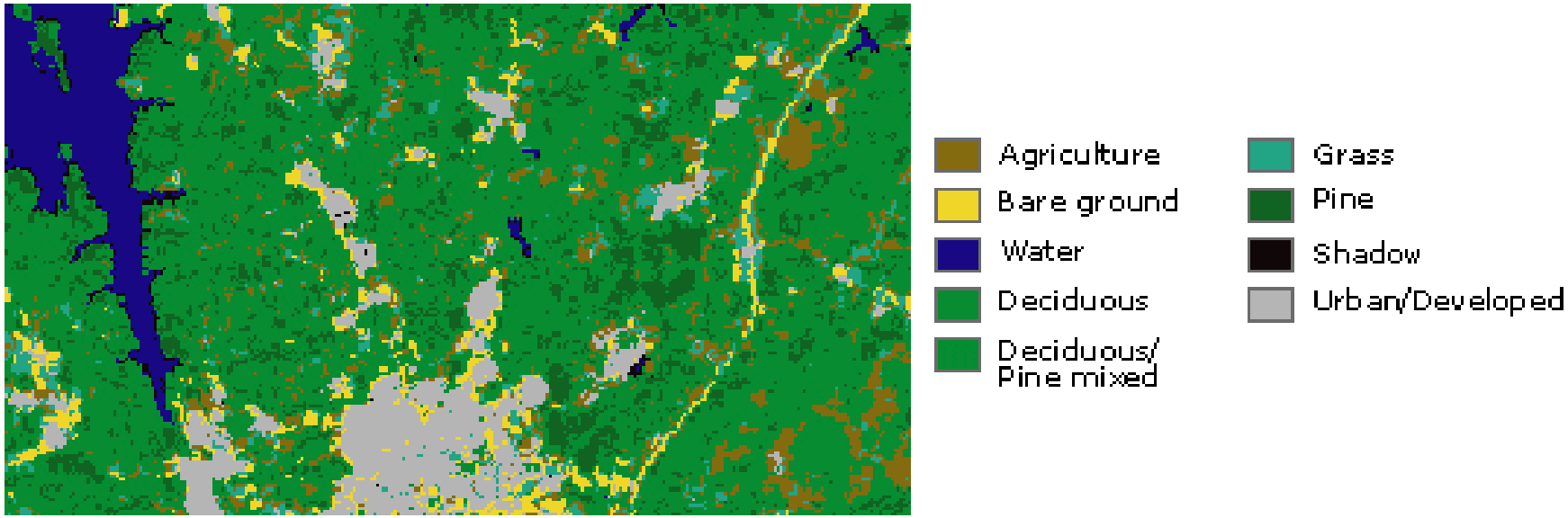
Raster Data Format

- Matrix of cells (pixels) organized into rows and columns (grid); each cell contains a value representing information.



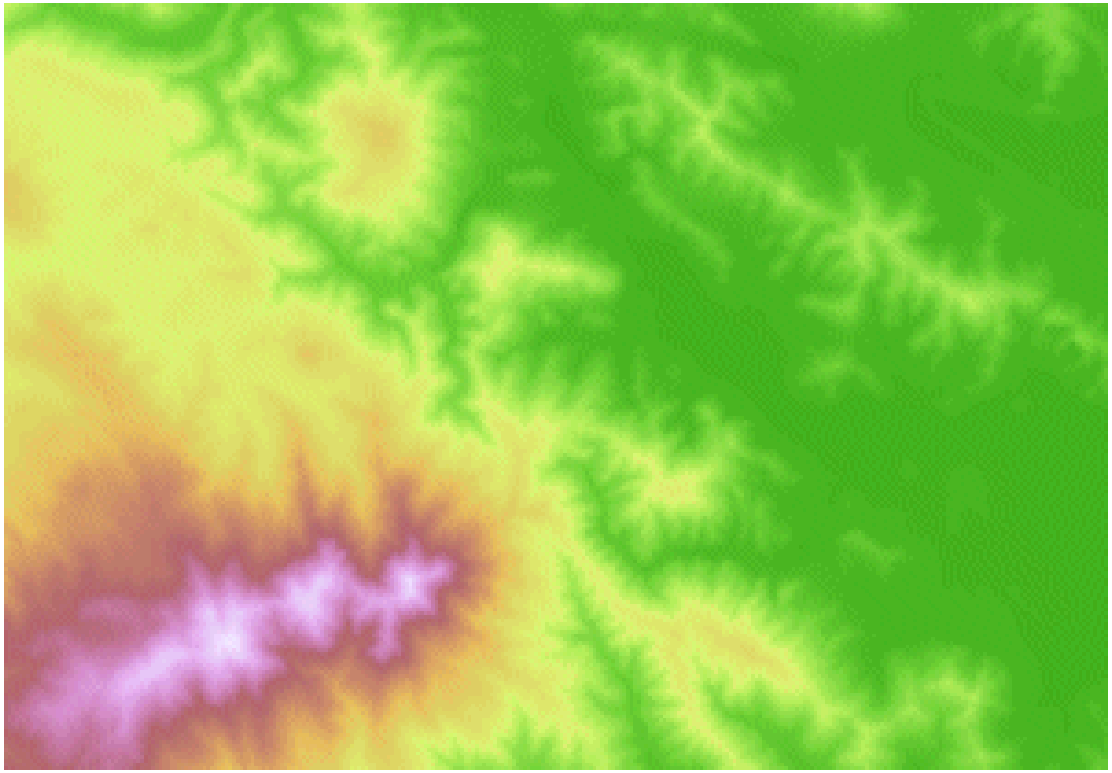
What features can raster format represent?

- **Thematic data** – represents *discrete categories* of features, e.g. land use or soils data



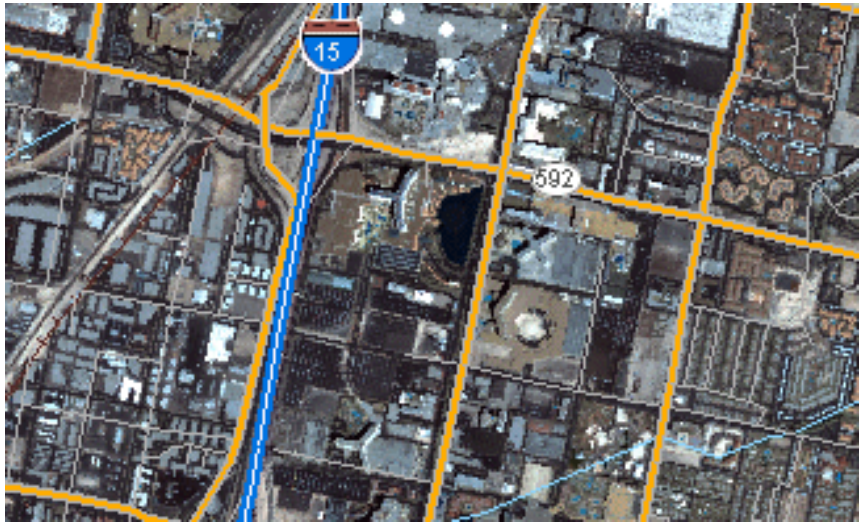
What features can raster format represent?

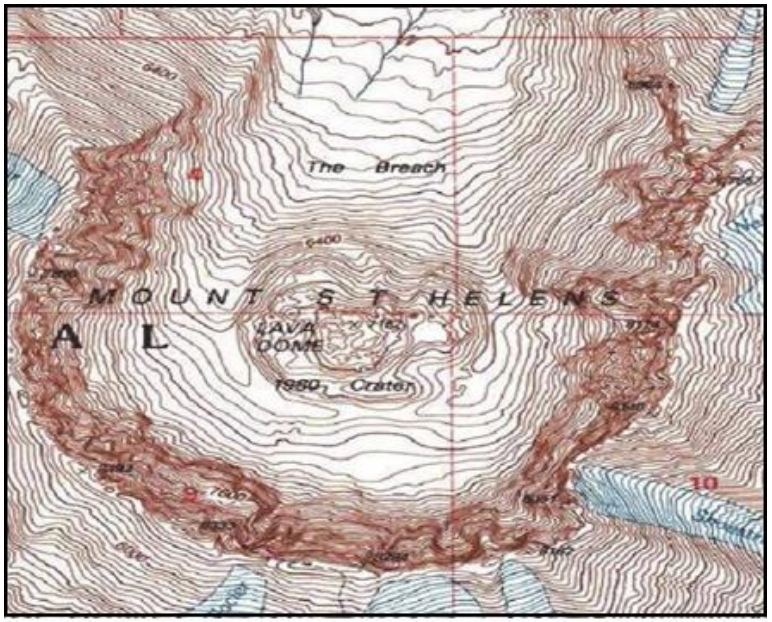
- **Continuous data** – represents phenomena that *changes continuously* across a surface, e.g. temperature, elevation



What features can raster format represent?

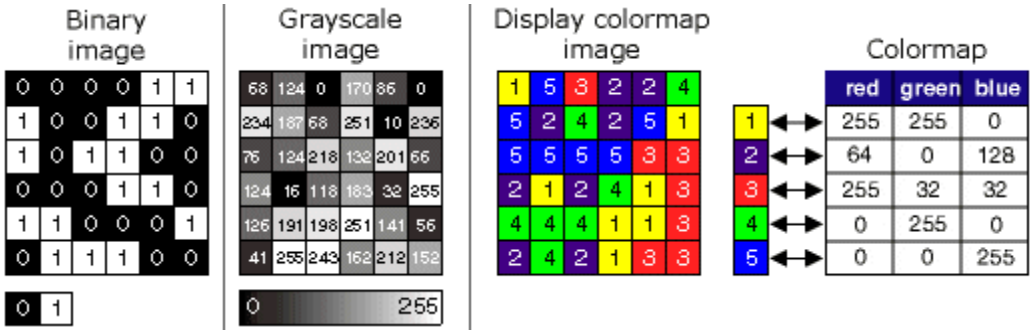
- **Images** – pictures that do not include attribute data about the features they show, e.g. aerial photos, DRGs





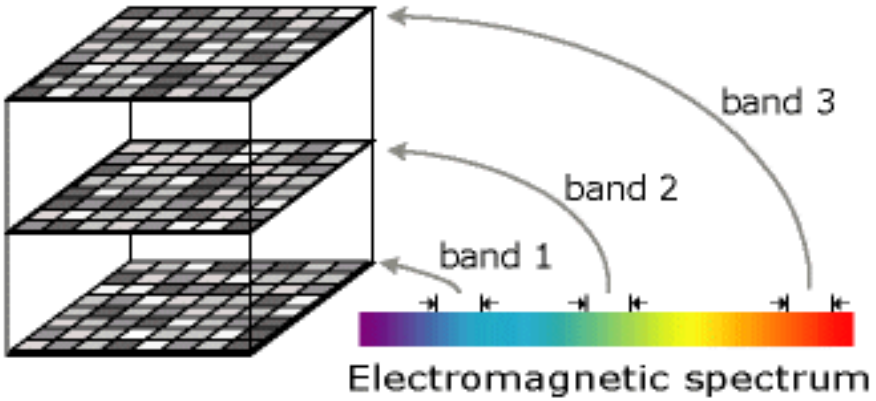
Single-band rasters

- A band is represented by a single matrix of cell
- Digital Elevation Model is a single-band raster
- Three ways to display a single-band raster

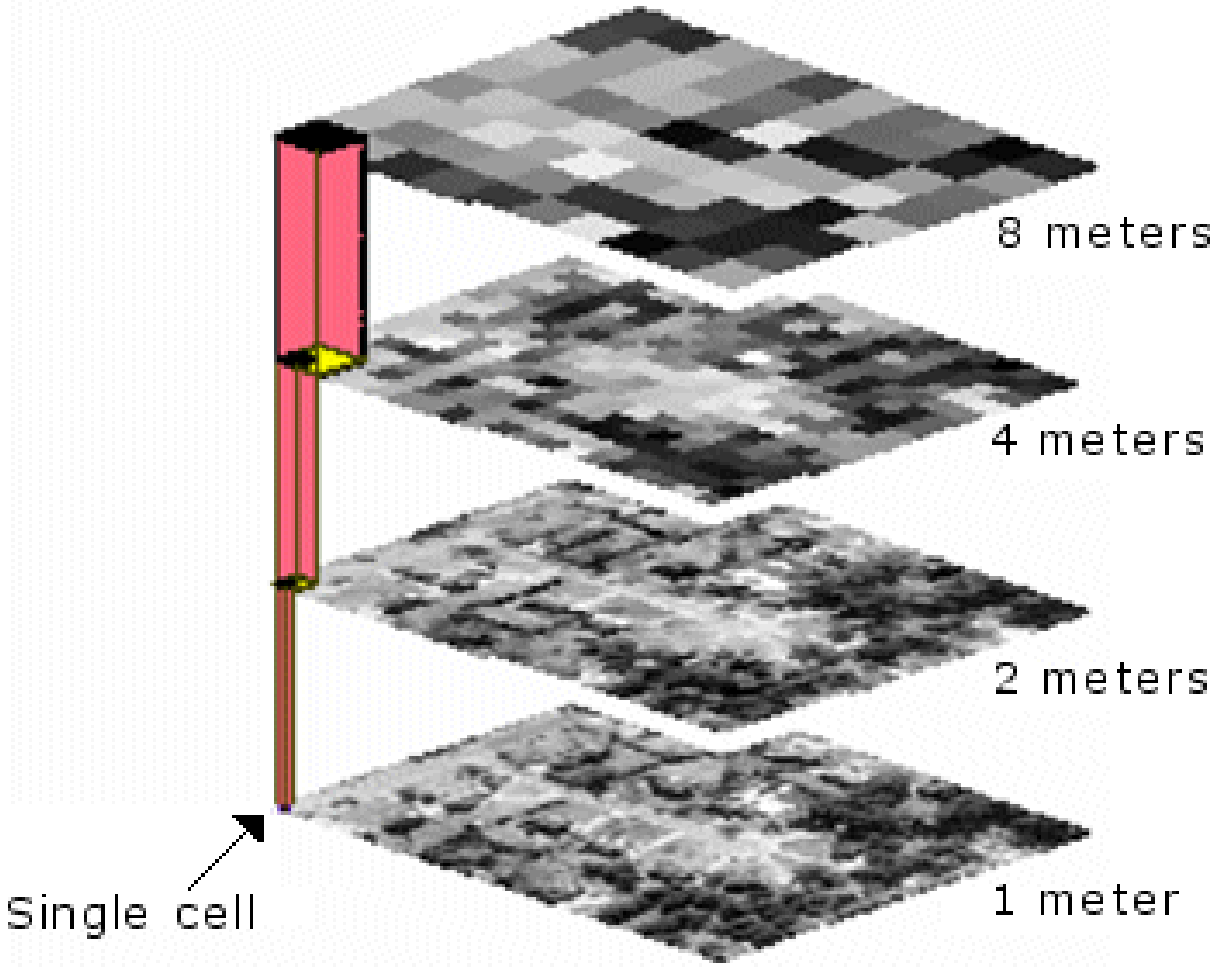


Multiple-Band Rasters

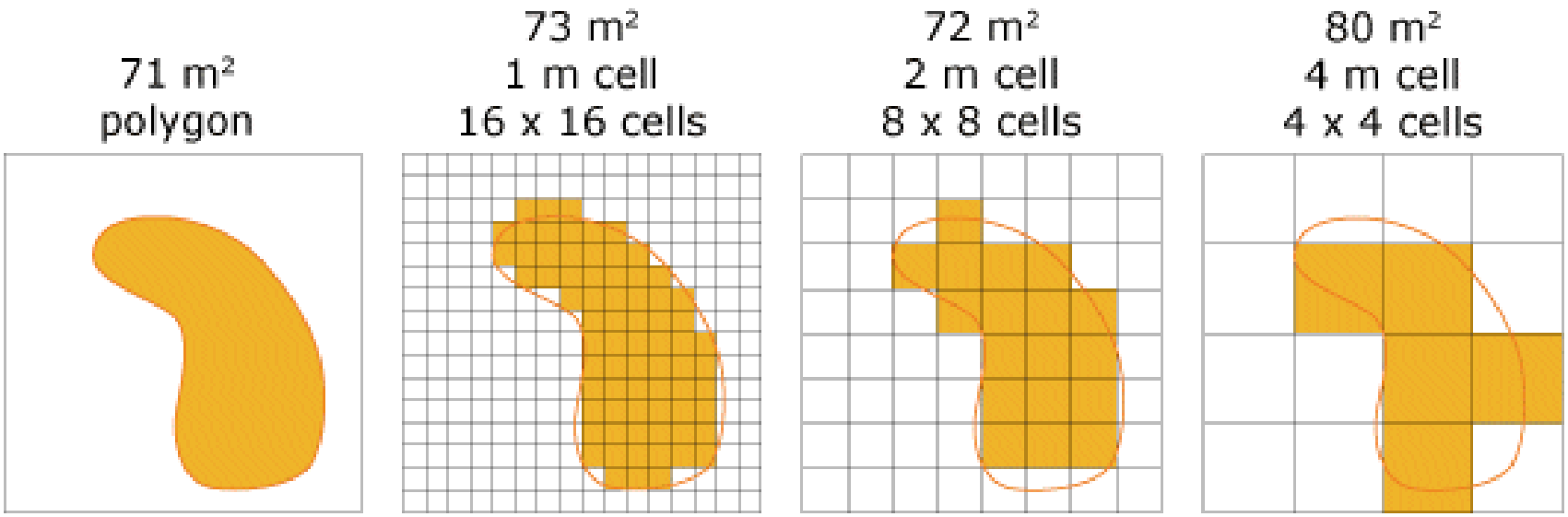
- A *band* is a single matrix or layer of cells.
  - multi-band rasters: every cell location has more than one value associated with it (often representing different segments of the electromagnetic spectrum).
- Common in remotely-sensed satellite imagery



Resolution of a raster = cell size



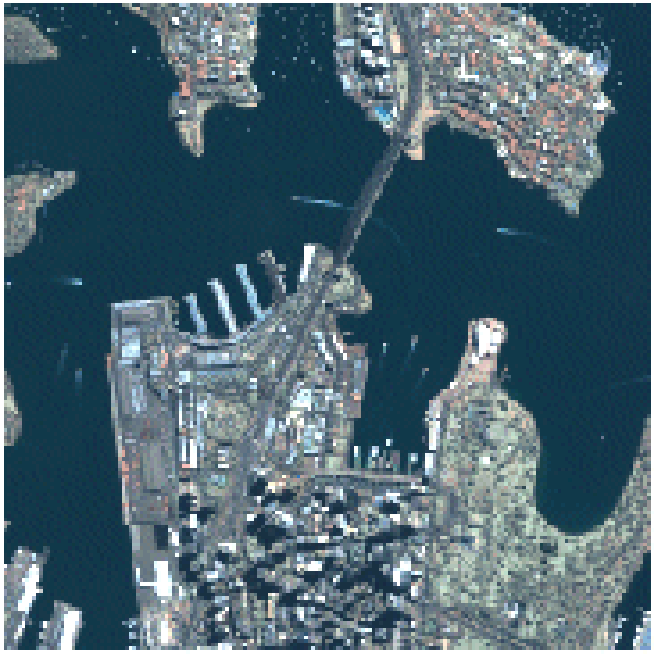
Raster Resolution



- Smaller cell size
- Higher resolution
- Higher feature spatial accuracy
- Slower display
- Slower processing
- Larger file size

- Larger cell size
- Lower resolution
- Lower feature spatial accuracy
- Faster display
- Faster processing
- Smaller file size

Same resolution, Different map scale



Scale 1:50,000
Cell size: 61 cm

Scale 1:2,500
Cell size: 61 cm

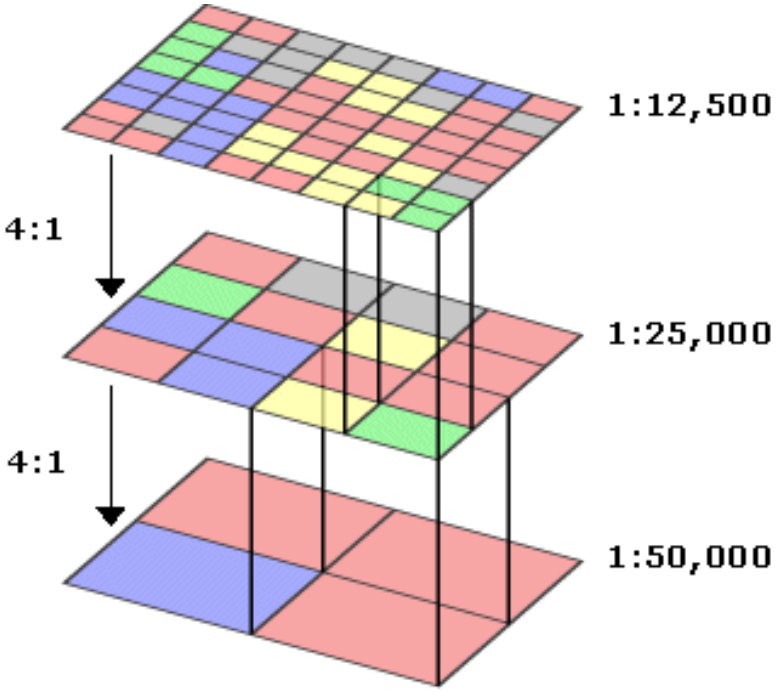
Different resolution, Same map scale

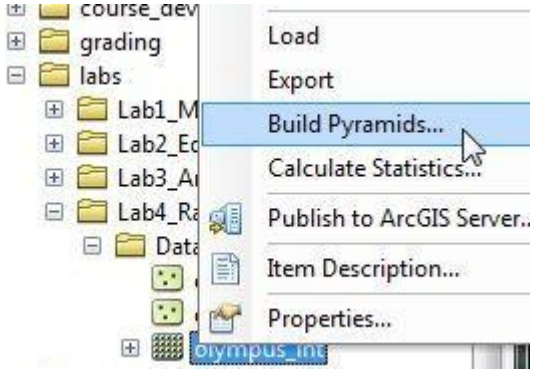
Scale 1:20,000
Cell size: 15 m

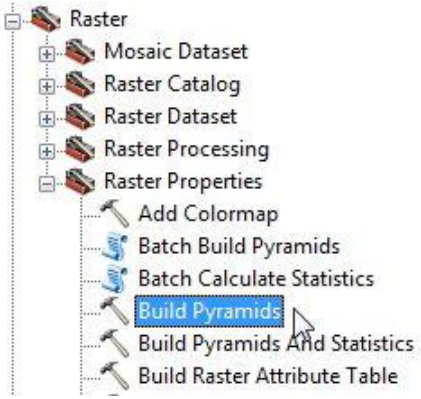
Scale 1:20,000
Cell size: 15.24 cm

Pyramid Layers

- Stacked layers of increasingly coarser resolution
- Speeds up raster display

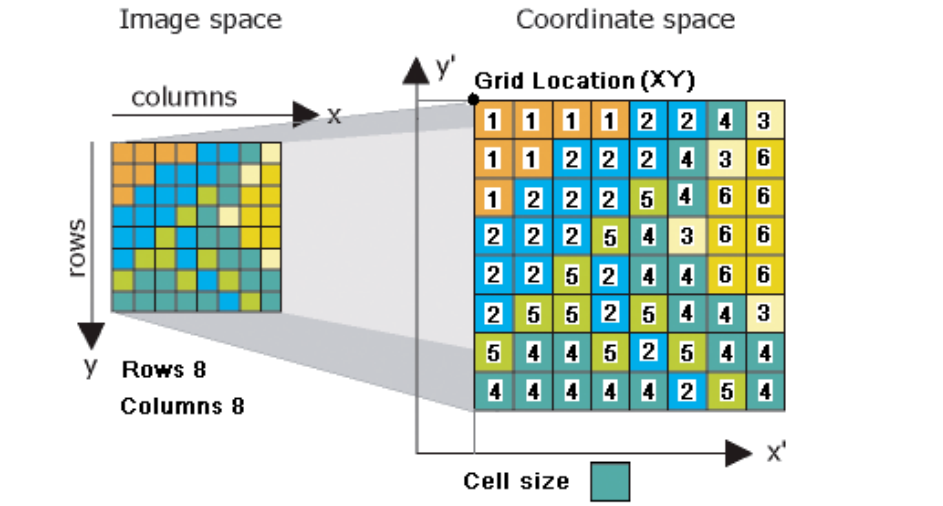






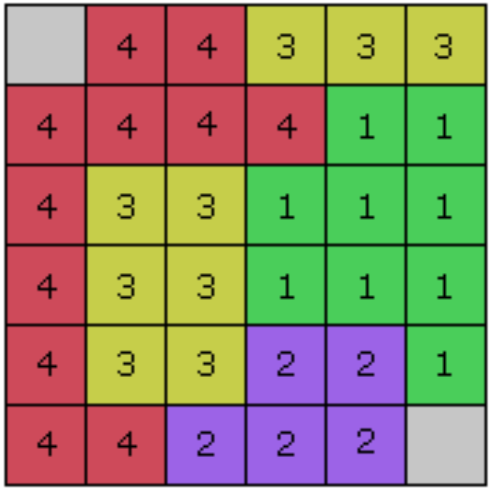
Raster Spatial Extent and Attributes

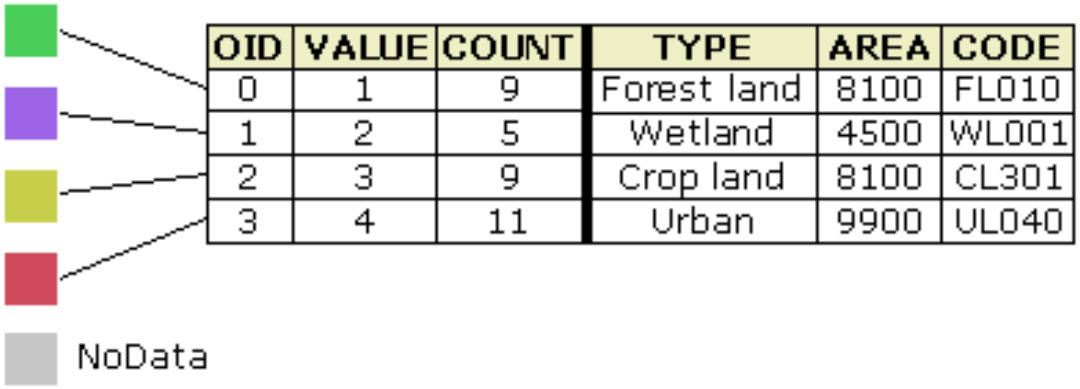
- **No data** means no info available for a particular cell
- *What is the difference between a cell value contain a value of "0" (zero) or "0.0" and NoData?*



Value Attribute Table (VAT)

- Available only for *integer (not decimal point)* rasters
- ArcMap > Right-click on raster layer in TOC > Open Attribute Table.
- ArcCatalog > Select raster layer > Preview tab



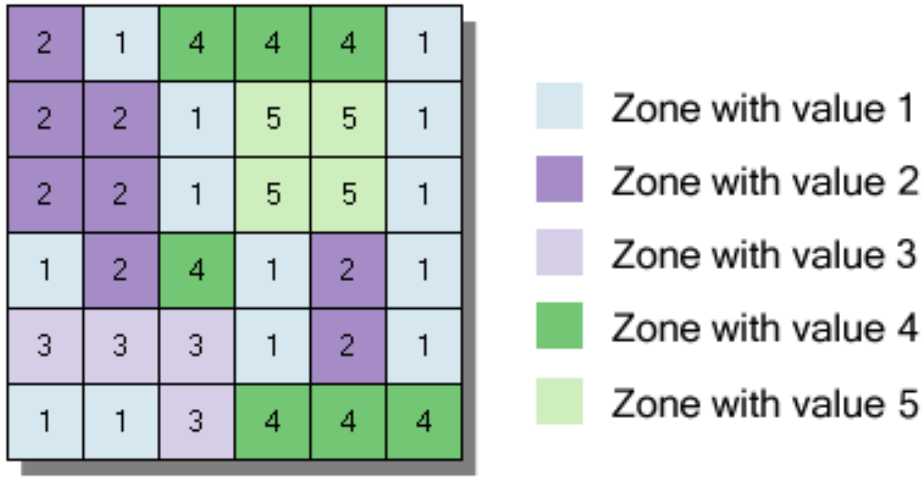


OID	VALUE	COUNT	TYPE	AREA	CODE
0	1	9	Forest land	8100	FL010
1	2	5	Wetland	4500	WL001
2	3	9	Crop land	8100	CL301
3	4	11	Urban	9900	UL040

Grouping Raster Data

Raster data can be analyzed by zones or regions

- **Zones** are cells with the same value
- **Regions** are groups of *contiguous* cells in a zone; a zone can contain multiple regions.



Supported Raster formats

- **Raster datasets.** defines how pixels are stored
  - Number of rows & columns, number of bands, actual pixel values, and other format-specific parameters
- **Raster products.** information in the metadata files that is used to generated vendor-specific products
- **Raster type.** similar to products, but designed to add data to the mosaic dataset

List of file formats: http://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/supported-raster-dataset-file-formats.htm

Raster coordinate systems

- When you define the coordinate system used to store the data, they are permanently resampled to fit the projection
- To change the coordinate system, resampling technique is used to 'transform' the data

Raster Catalogs

- Equivalent to Feature Datasets in a geodatabase, but for storing Raster data
- Can be managed (physically stored in the geodatabase) or unmanaged (links to raster dataset stored elsewhere)
- Can

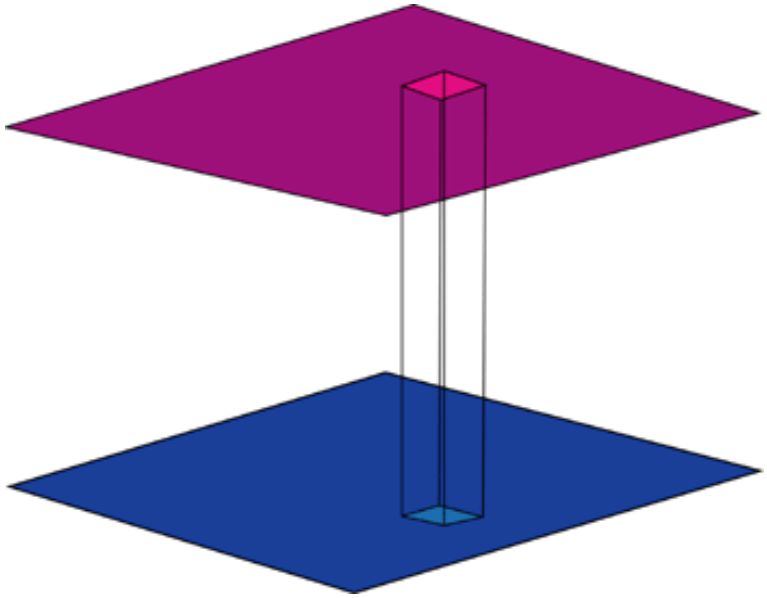
Raster Mosaics

- Allows you to store, manage, view & query collections of raster data
- Created in a geodatabase
- Consists of:
  - A catalog that provides the source of the pixels and footprints of the rasters
  - A feature class that defines the boundary
  - A set of mosaicking rules that are used to dynamically mosaic the rasters
  - A set of properties used to control the mosaicking and any image extraction
  - A table for logging during data loading and other operations
  - Optionally, a seamline feature class for seamline mosaicking
  - Optionally, a color correction table that defines the color mapping for each raster in the raster catalog

Scope of Raster Analysis

Local Functions (i.e. Tools)

- Performed on each raster cell *independently*
- Compares the value of a cell in one layer with the values of the *same cell* in other layers



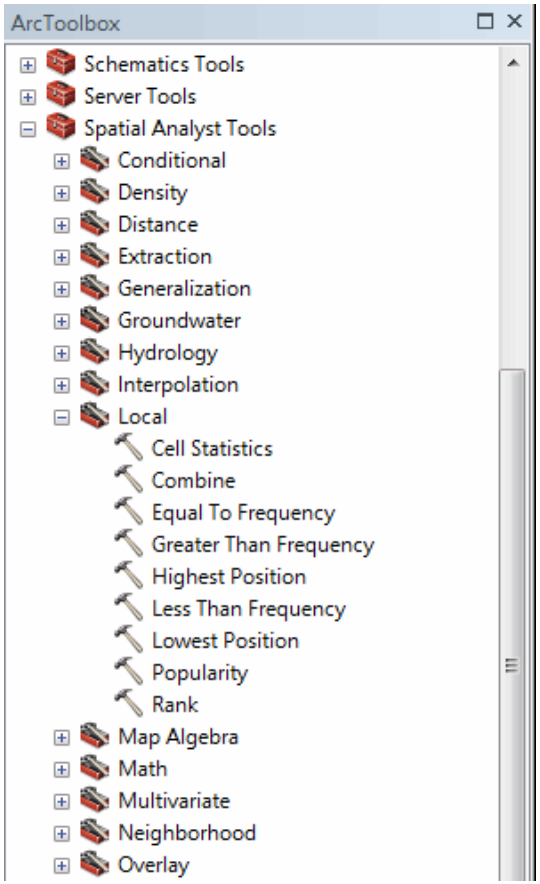
e.g.,

10	12	42
30	9	4
-12	8	15

plus 4

14	16	46
34	13	8
-8	12	19

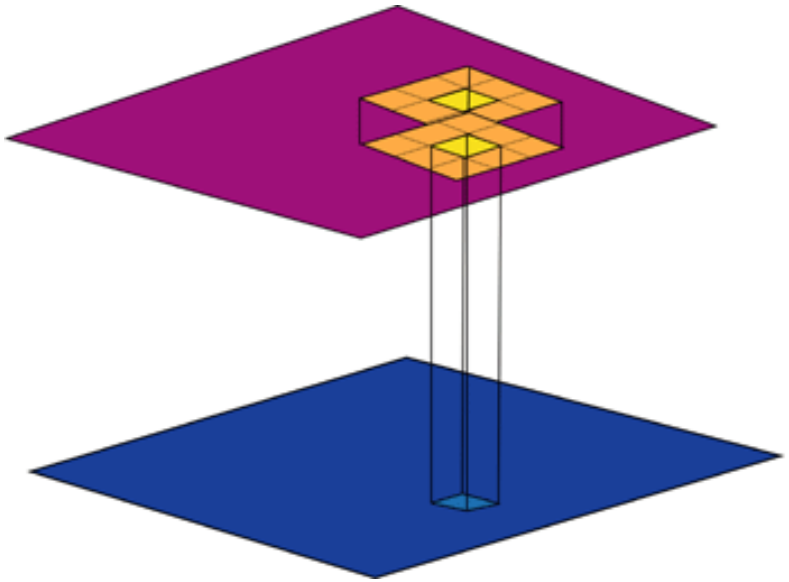
Local Raster Tools

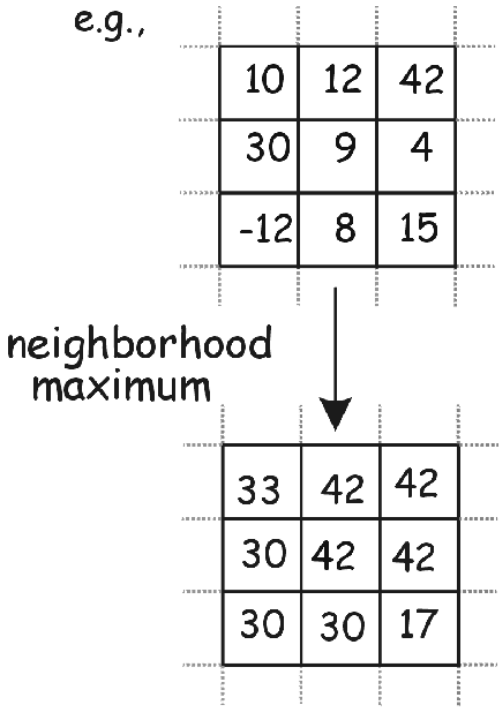


http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/an-overview-of-the-local-tools.htm

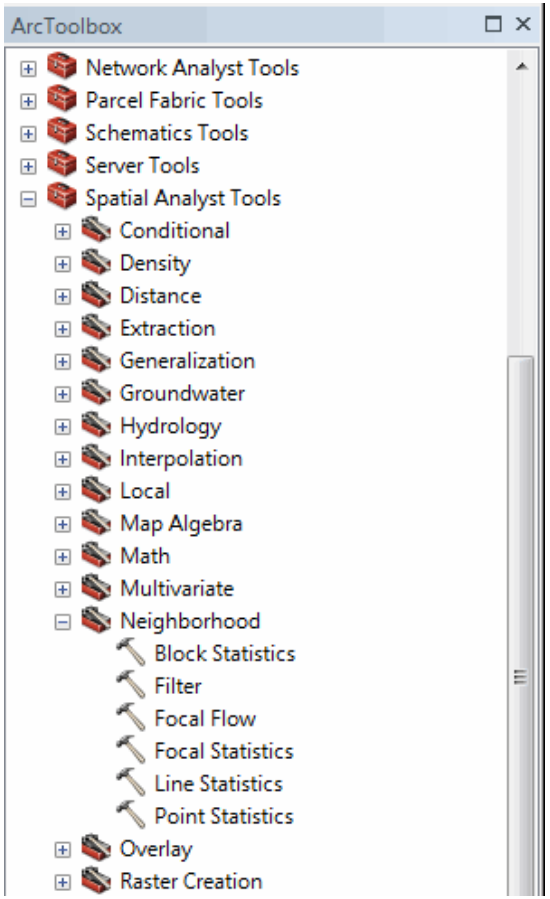
Focal (Neighborhood) Functions

- Compares each pixel with its immediate neighbors
- Most often, the nearest 8 cells are used





Neighborhood Raster Tools

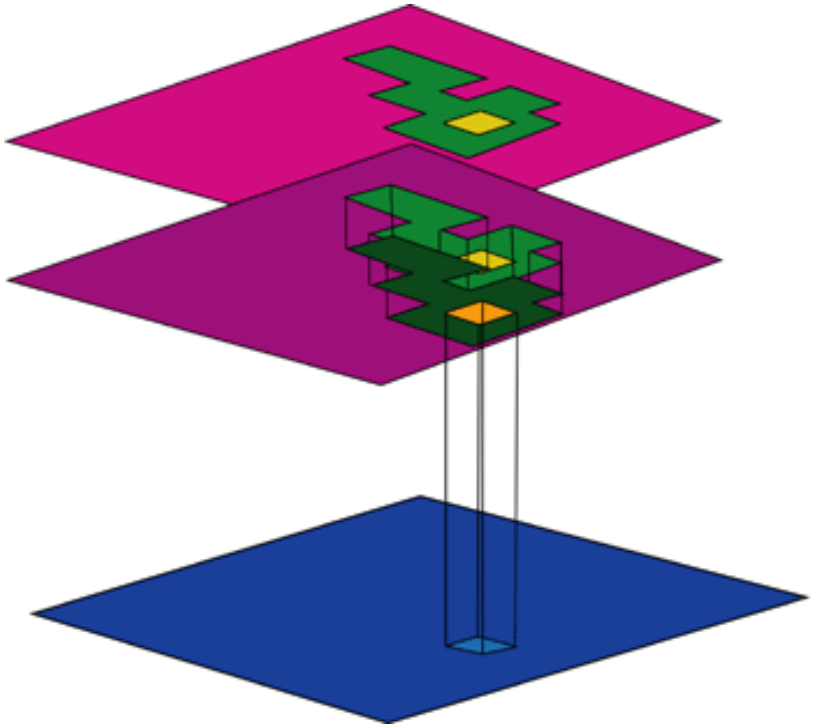


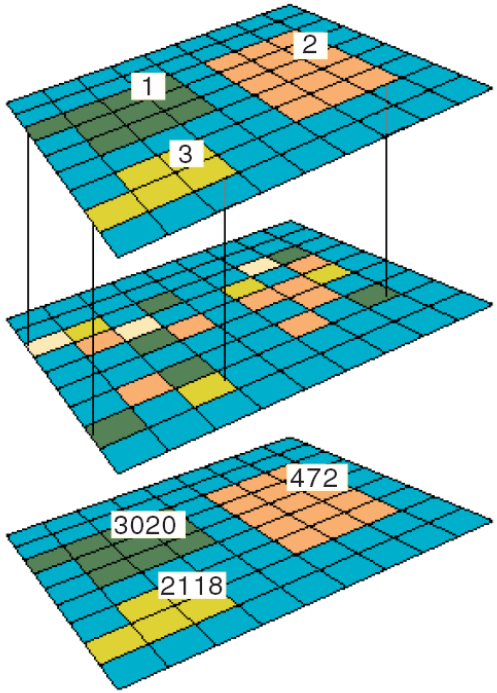
http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/an-overview-of-the-neighborhood-tools.htm

Zonal Functions

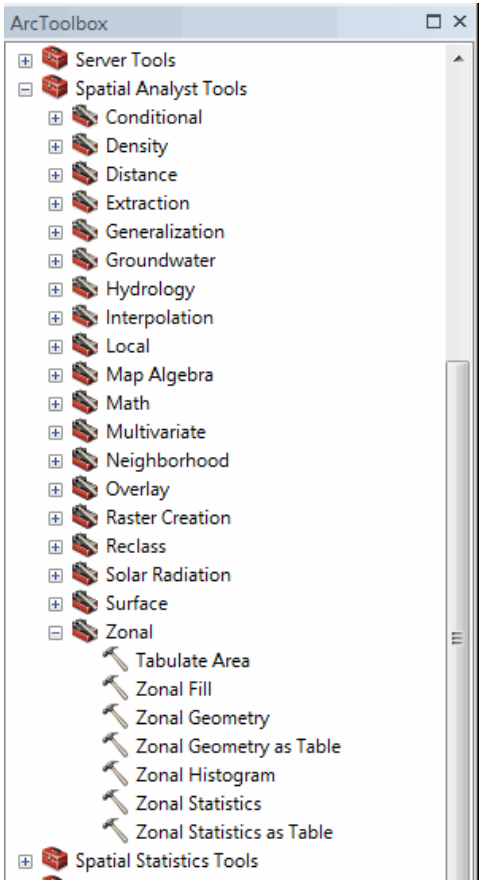
- Computes results for blocks of *contiguous* cells that share a common attribute (i.e. zones)

e.g. Maximum zone value





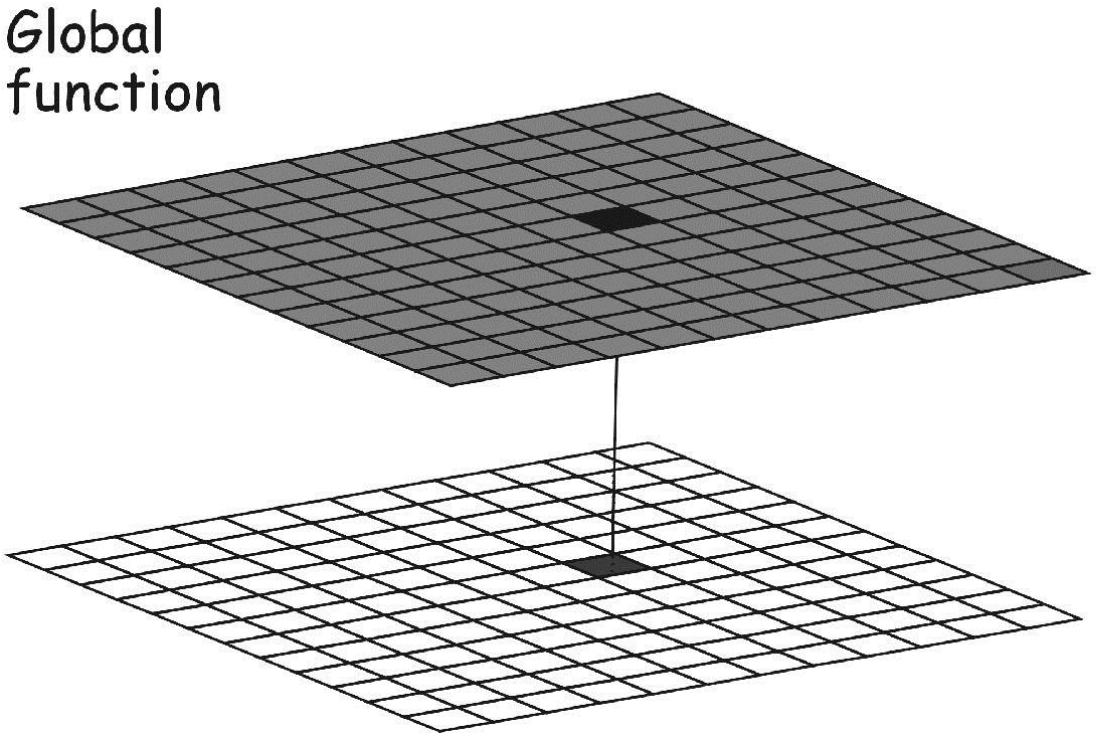
Zonal Raster Tools

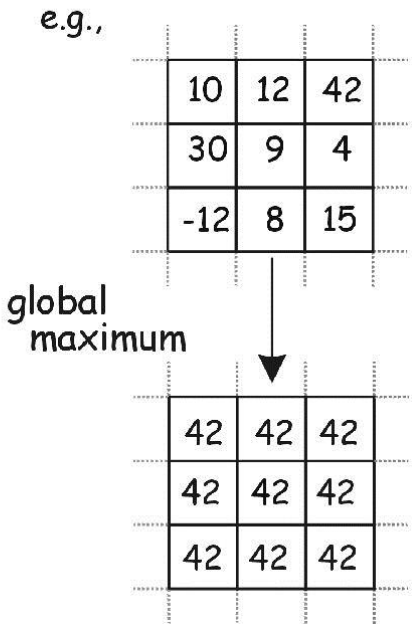


http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/an-overview-of-the-zonal-tools.htm

Global Functions

- Computes results that are a function of *all the cells in the entire layer*; works on an *entire raster all at once*.





Common Raster operations

Raster Operations

- Masking/Clipping
- Euclidean Distance
- Reclassification
- Resampling
- Overlay Analysis
- Surface Analysis
  - Slope
  - Hillshade
- Image Analysis – Processing Window

Masking / Clipping

Input raster

2	2	2	8	8	2	2	2
2	2	2	8	8	8	2	2
2	3	3	3	8	8	8	7
2	3	3	3	8	8	8	7
3	3	3	6	6	6	7	7
3	3	3	3	6	6	6	7
3	6	3	6	6	6	6	6
3	6	6	6	6	6	6	6

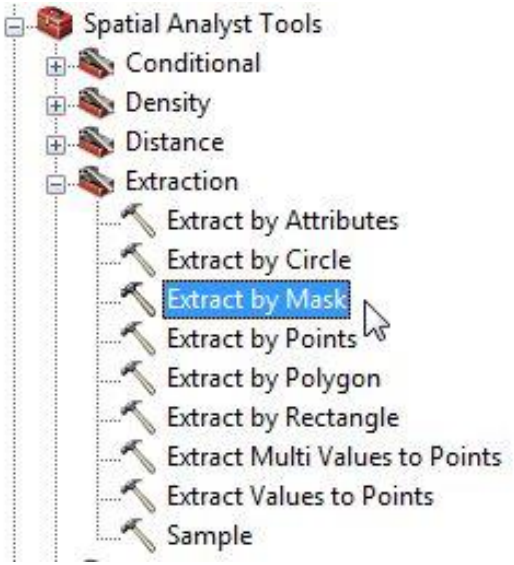
x

Clip raster

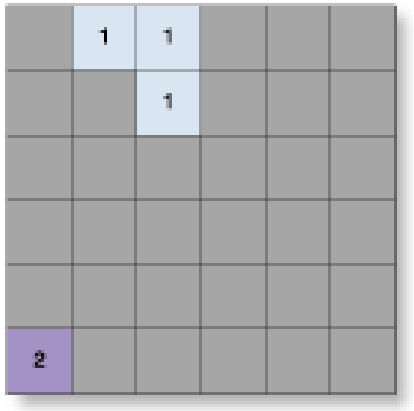
0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0	0	1	1	1	1	1	0
0	0	1	1	1	1	0	0
0	0	1	1	1	0	0	0
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Output raster

0	0	0	0	8	2	2	2
0	0	0	0	8	8	2	2
0	0	3	3	8	8	8	0
0	0	3	3	3	8	0	0
0	0	3	6	6	0	0	0
0	0	3	3	0	0	0	0
0	6	0	0	0	0	0	0
0	0	0	0	0	0	0	0



Euclidean Distance



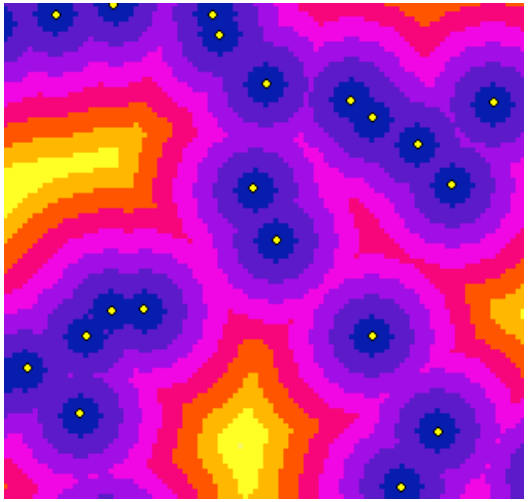
Source_Ras

=

1.0	0.0	0.0	1.0	2.0	3.0
1.4	1.0	0.0	1.0	2.0	3.0
2.2	1.4	1.0	1.4	2.2	3.2
2.0	2.2	2.0	2.2	2.8	3.6
1.0	1.4	2.2	3.2	3.6	4.2
0.0	1.0	2.0	3.0	4.0	5.0

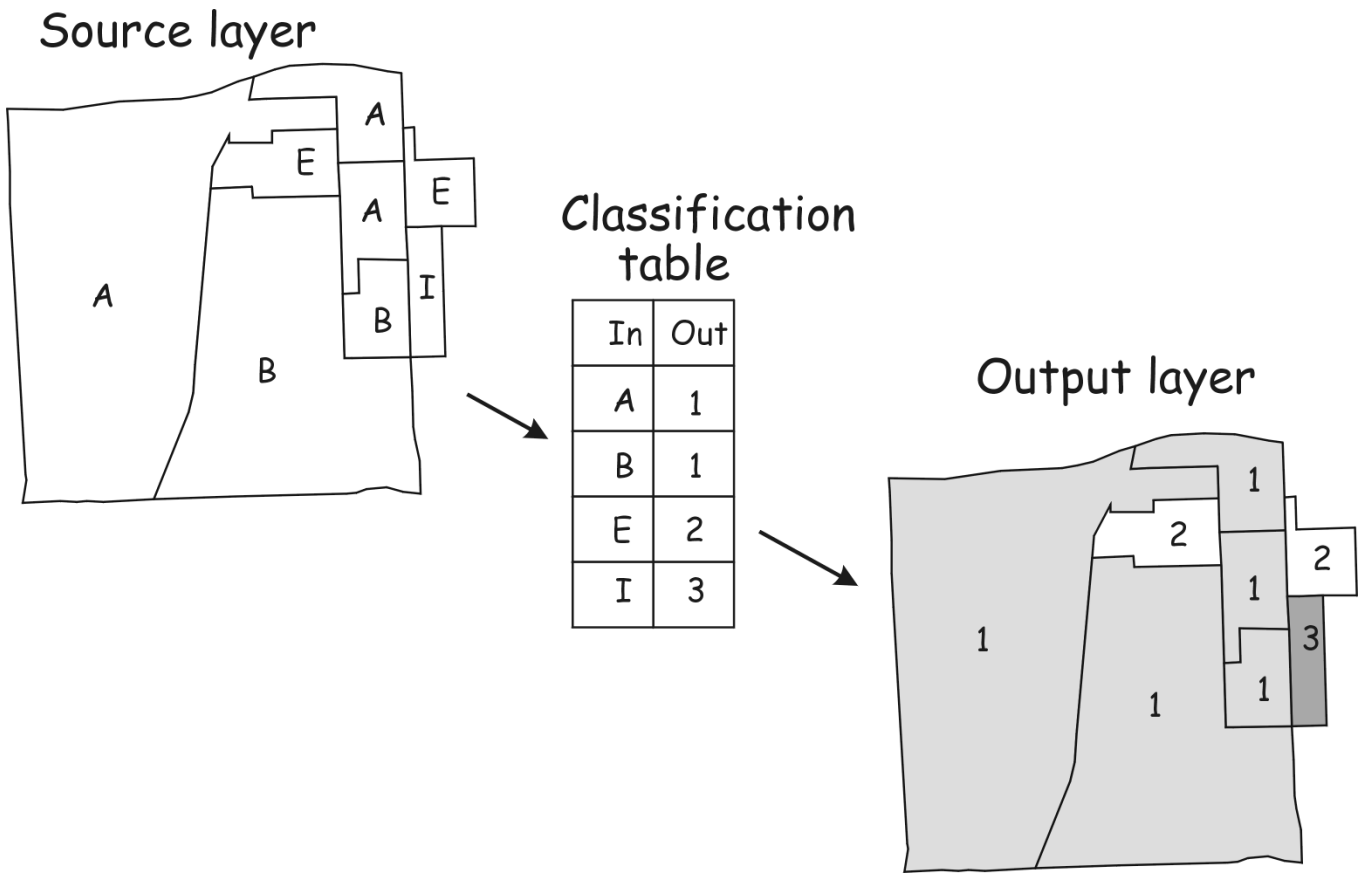
Euc_Dist

e.g. Distance to nearest town

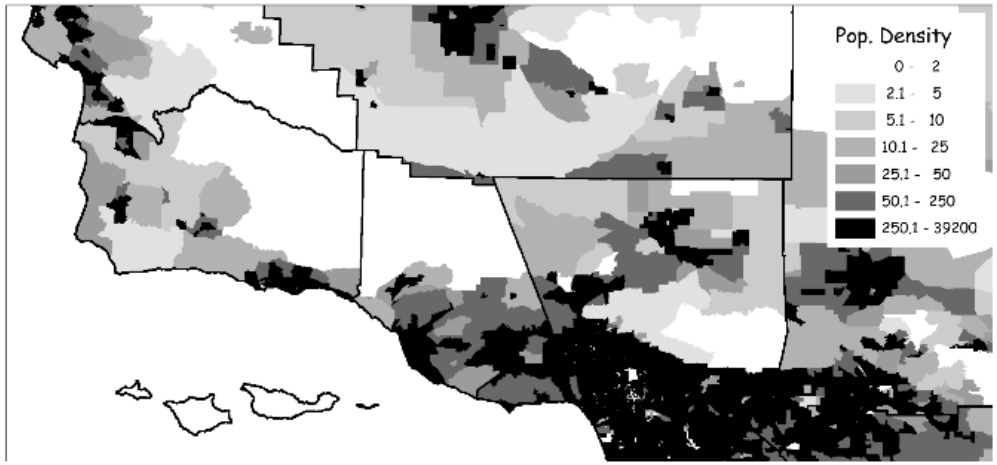


Reclassification

- Reclassify or change cell values to alternative values



Reclassification



Census data

Reclass

population classes

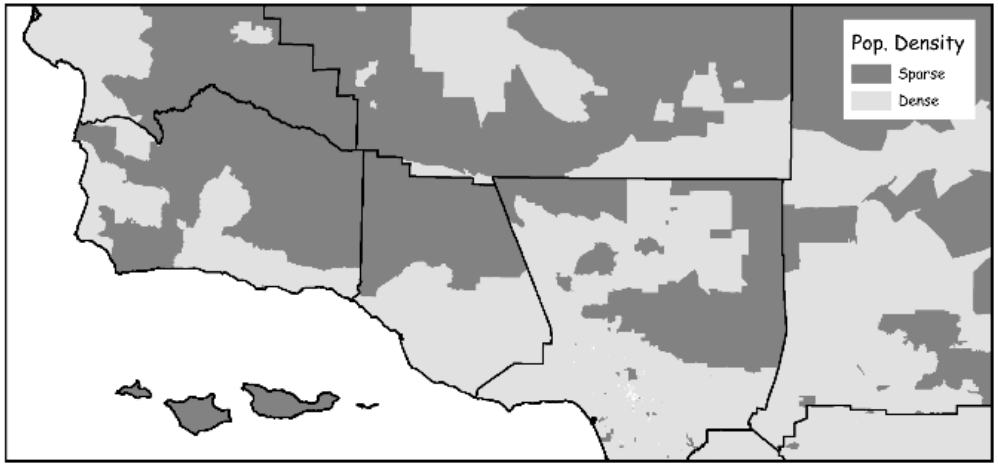
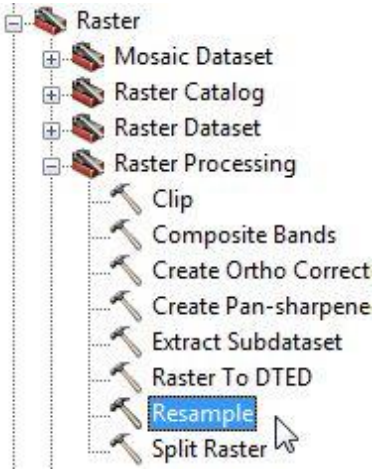
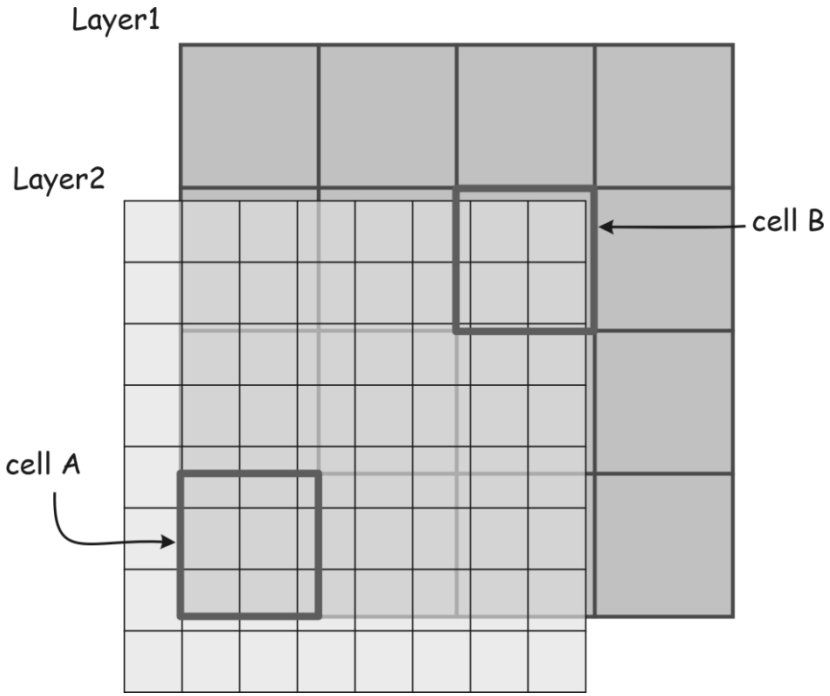


Figure 9-42: Areas with sufficiently sparse populations were identified by reclassifying Census data

Resampling

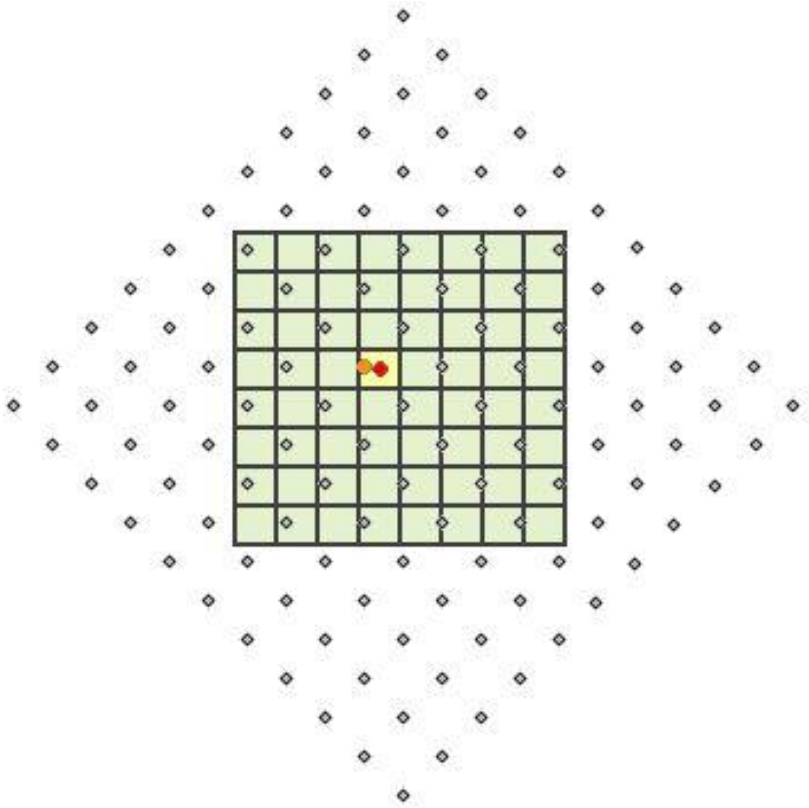
- Determine cell sizes between datasets – are they consistent?
- If not, ***Resample***. Change cell size in one layer to match other
- Cell values will change





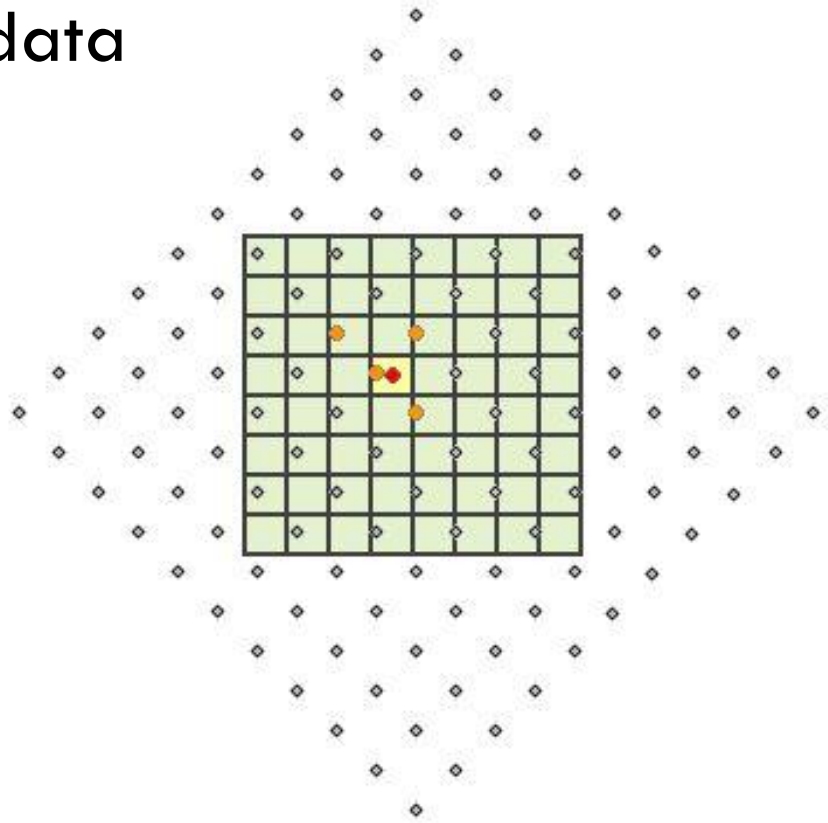
Resampling – Nearest Neighbor

- New value is the location of the ***closest cell center***
- Used for ***categorical (qualitative)*** data



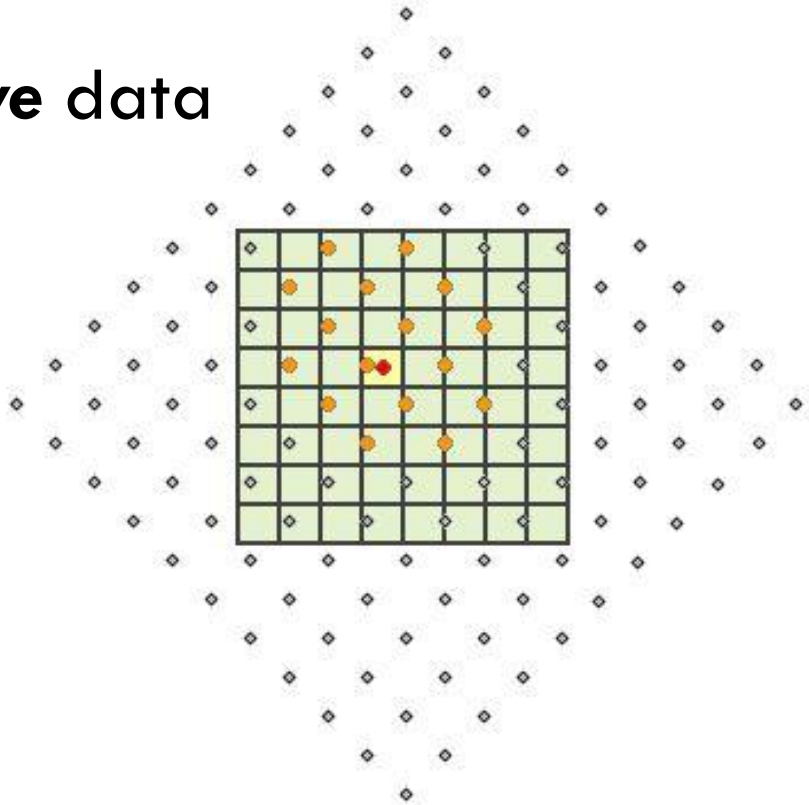
Resampling – Bilinear Interpolation

- New value is based on the weighted distance average of the ***nearest 4 input cell centers***
- Used for ***quantitative*** data

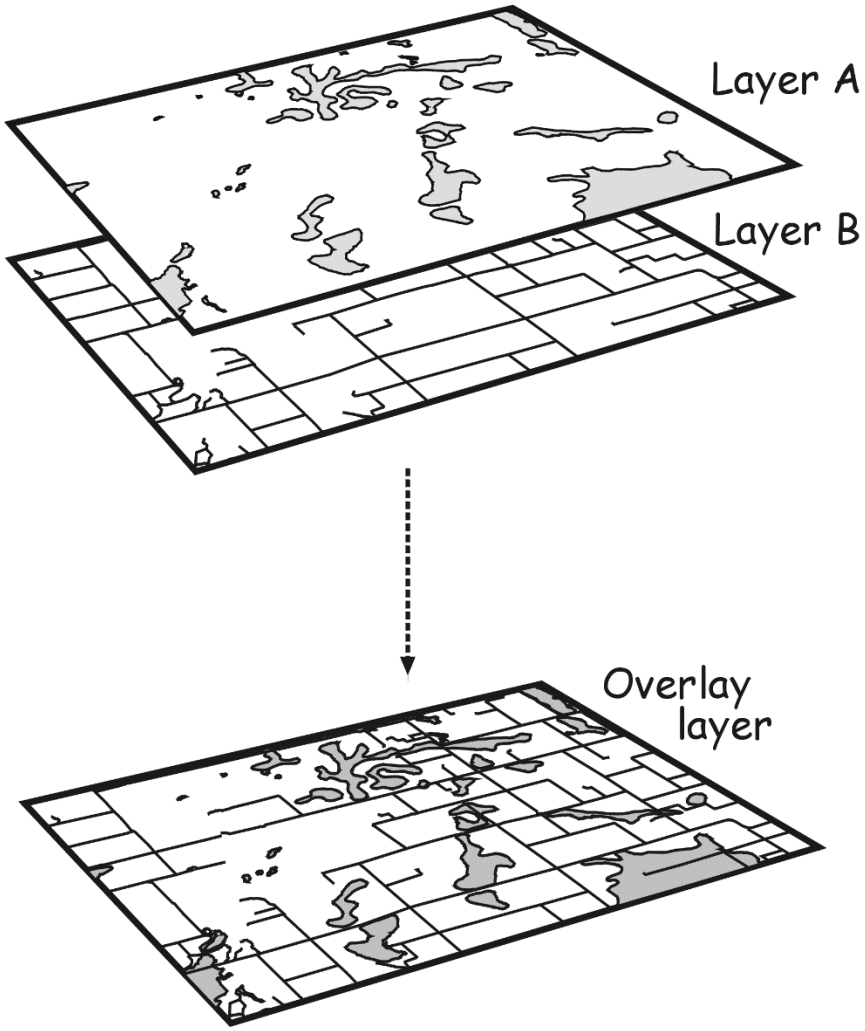


Resampling – Cubic Convolution

- Similar to Bilinear Interpolation, but uses the ***nearest 16 input cell centers*** and produces the smoothest output
- Also used for ***quantitative*** data



Overlay Analysis

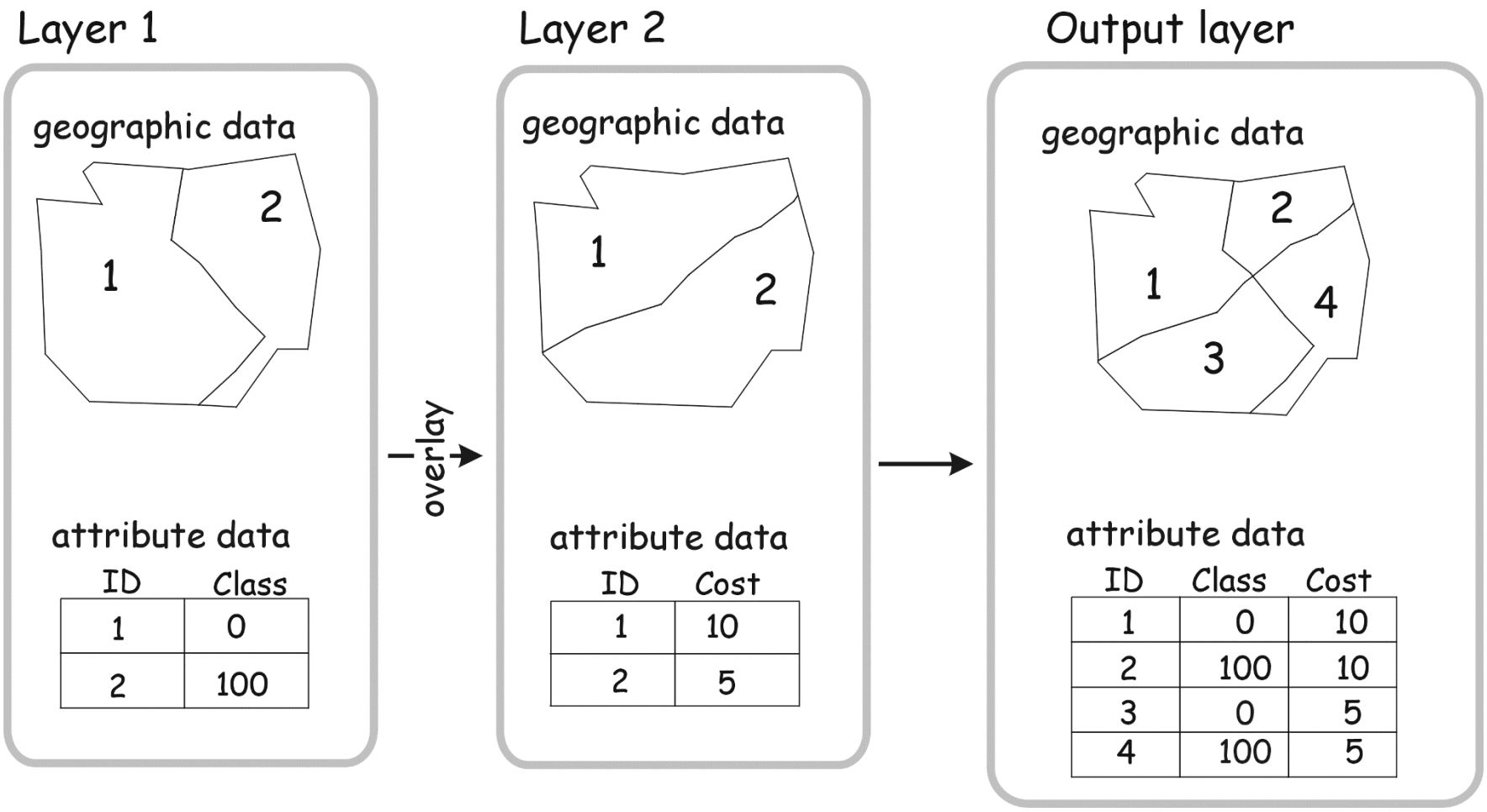


attributes for layer A

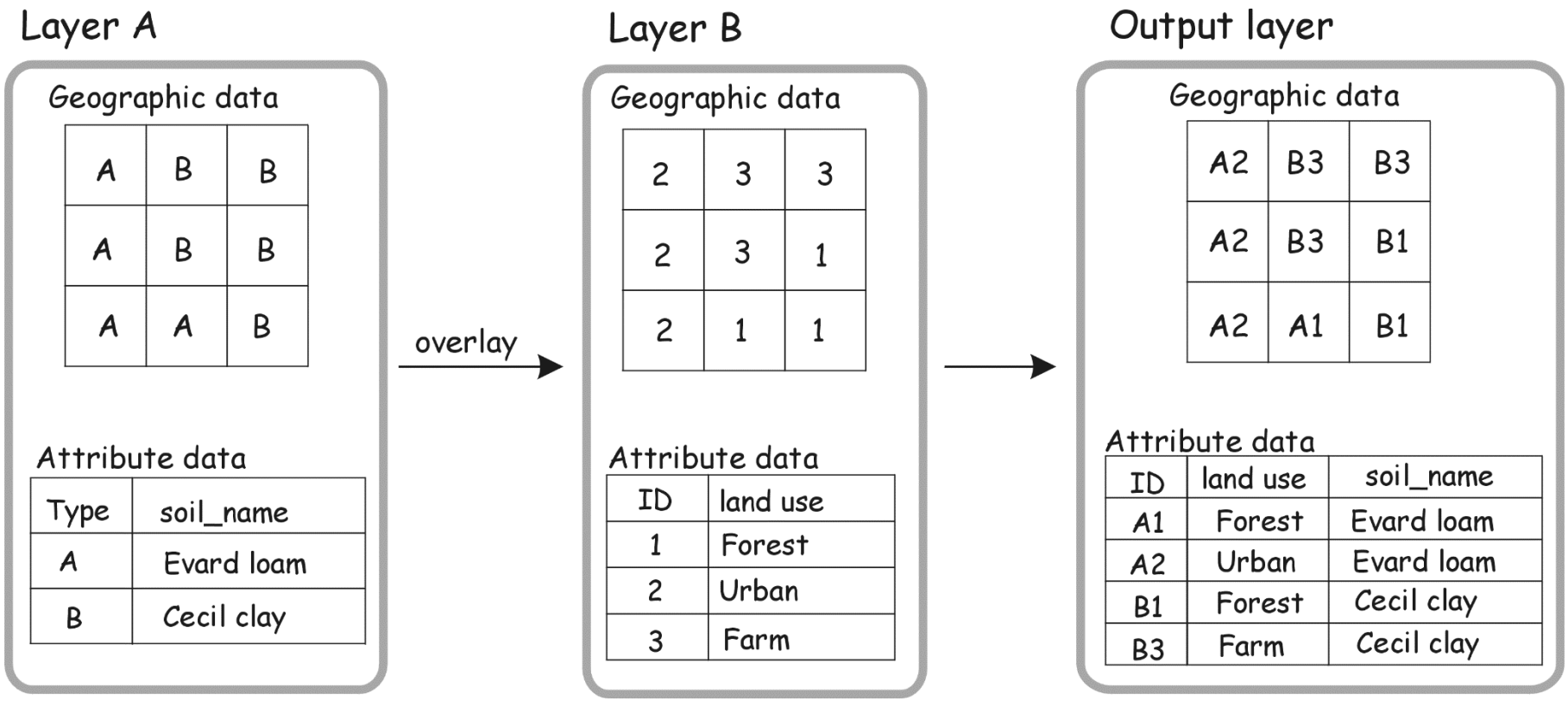
attributes for layer B

overlay attributes, combined attributes for layers A & B

Vector Overlay

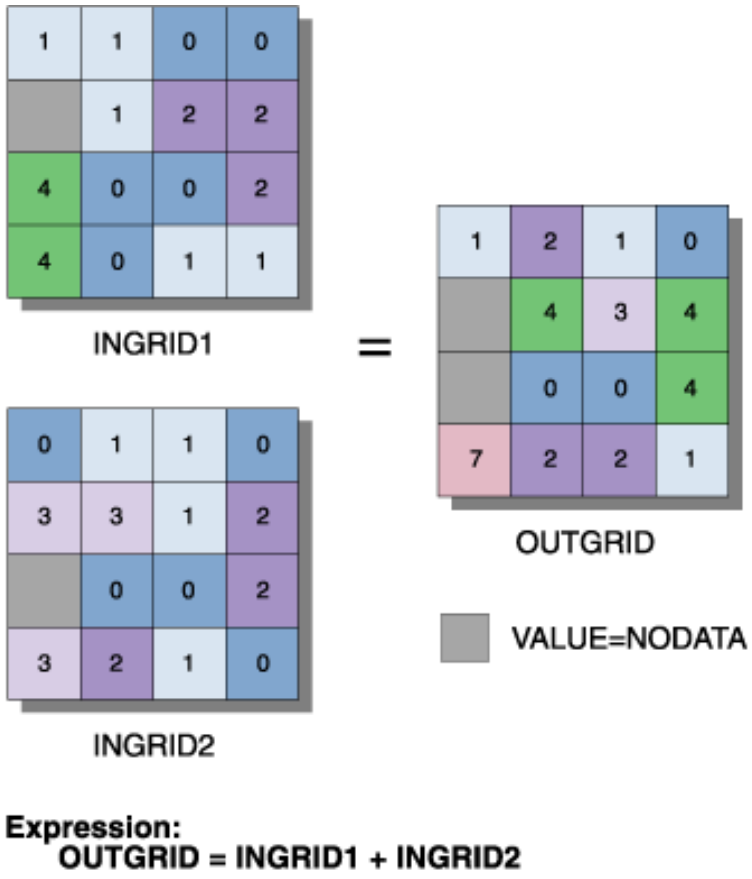


Raster Overlay

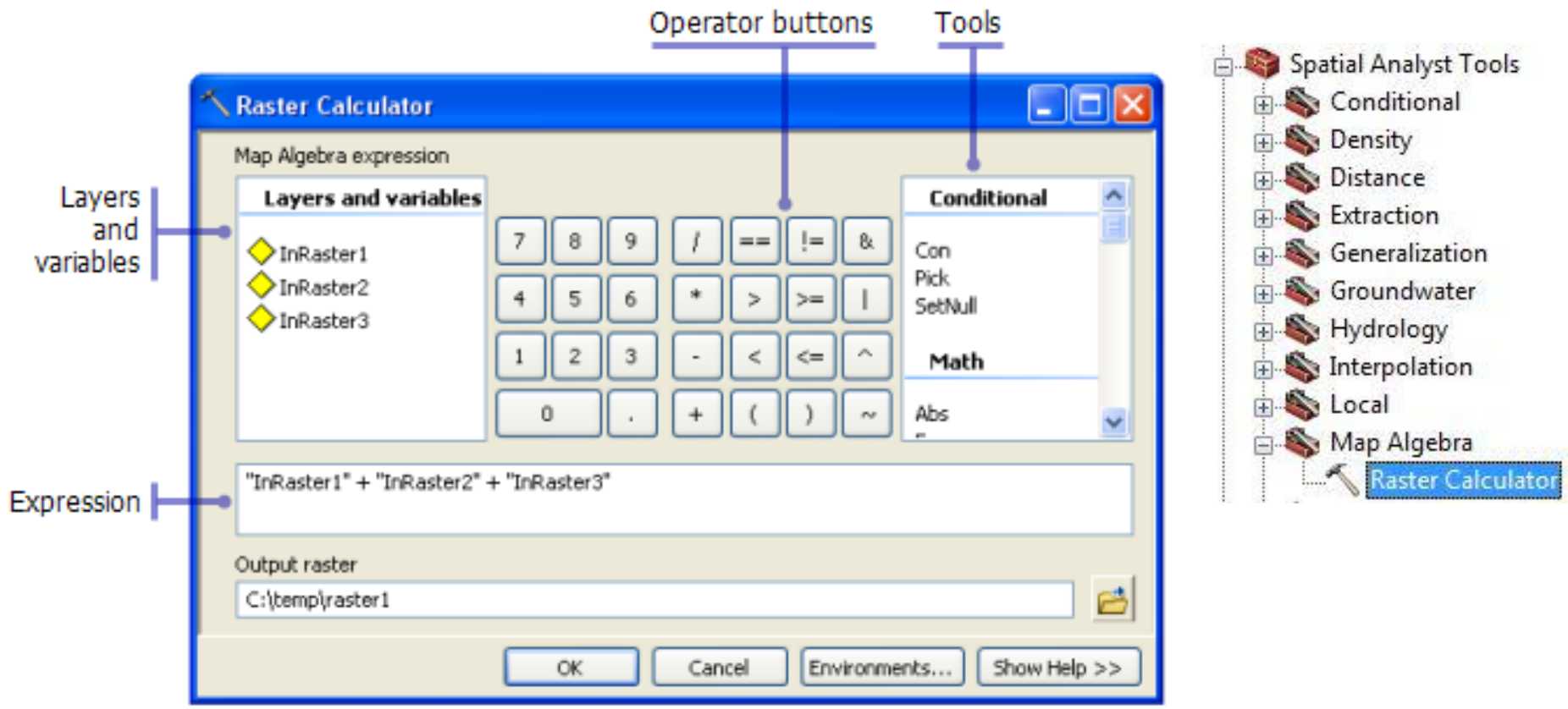


Map Algebra

- Raster overlay; cell-by-cell combination of raster layers
- **Operators:**
  - Mathematical = +, -, *, /
  - Relational ==, <, >, !=
  - Logical = AND, OR
  - Conditional = IF

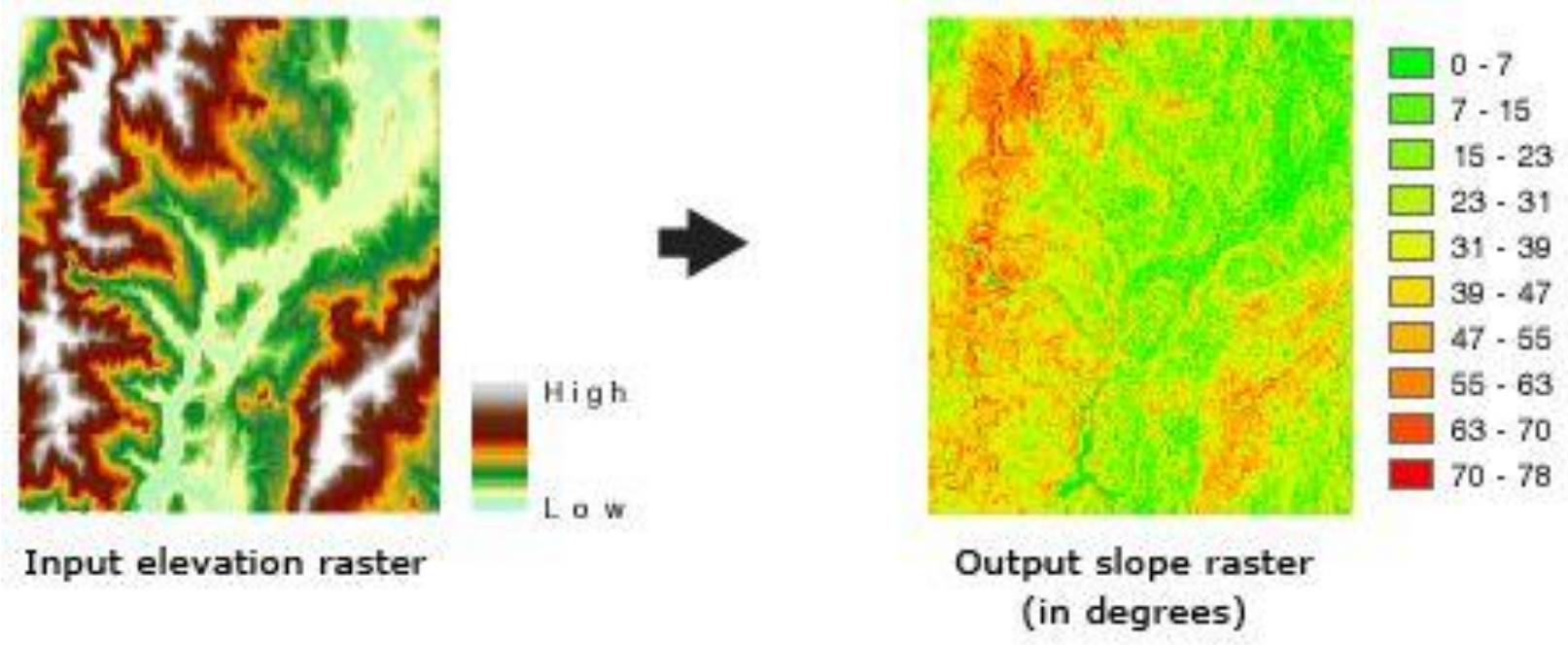


Raster Calculator Tool



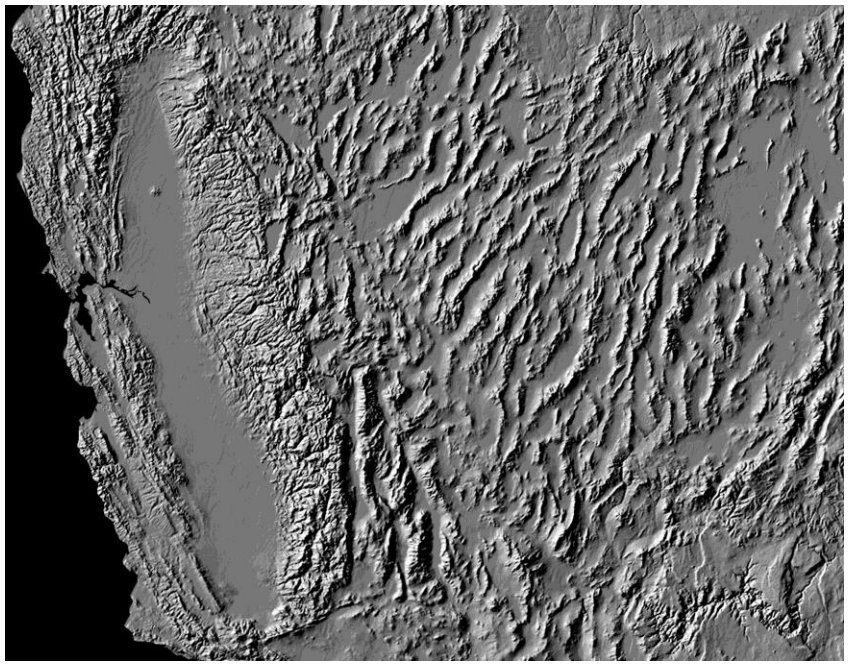
Surface Analysis: Slope

- Calculated as the maximum rate of change between each cell and its neighbors
- Aspect = slope direction

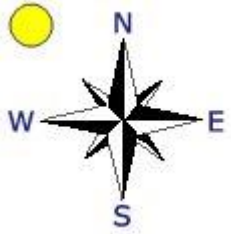


Surface Analysis: Hillshade

- Enhances terrain visualization
- Determines illumination values for each cell based on a hypothetical light source



Azimuth = angular direction of the sun



Altitude = angle of the sun above the horizon

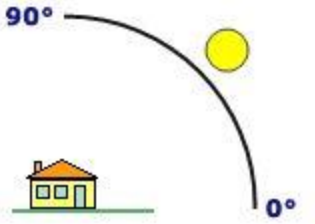
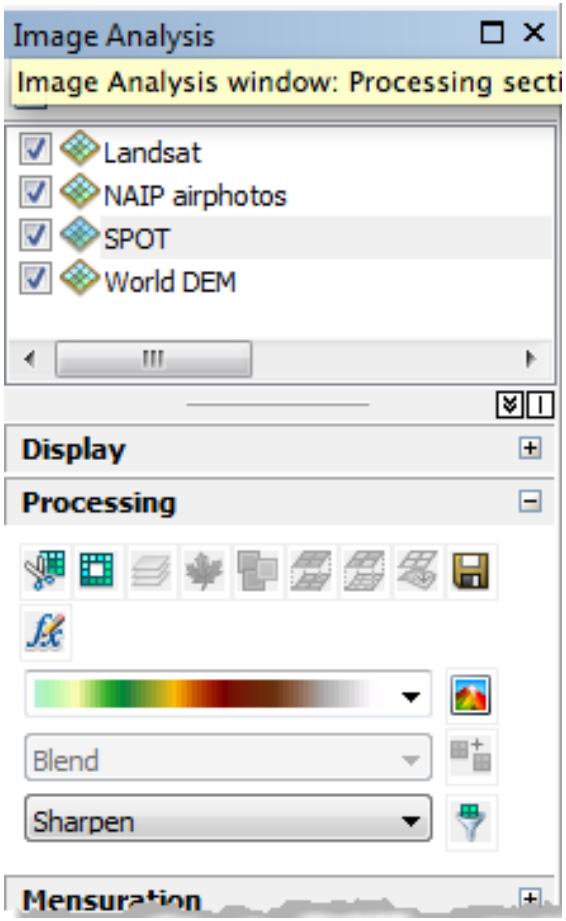


Image Analysis - Processing

- Simplifies the use of using processing and analysis techniques to raster data
- Provides one-click options to apply clipping, normalized difference vegetation index (NDVI) creation, mosaicking, and exporting.
- Creates temporary layers in the table of contents.
- The processing is applied on-the-fly (original data remains unaltered, quick).
- To save the temporary layer, export the raster dataset.

Image Analysis - Processing



http://resources.arcgis.com/en/help/main/10.1/index.html#/Image_Analysis_window_Processing_section/009t000000m7000000/

Raster Geoprocessing Environments

Geoprocessing Environments

- Raster Analysis
  - Cell Size. Setting the size of the output raster cell size (i.e. 1m, 10m). Default is to use the coarsest of the input datasets
  - Mask. Will only consider those cells that fall within the analysis mask when using the tool

Geoprocessing Environments

- Raster Storage
  - **Compression**. Set the compression type when storing output raster datasets (IMG, JPEG, JPEG 2000, TIFF, GRID, Geodatabases)
  - NoData.
  - Pyramid. Raster Statistics.
  - Resampling method.
  - Tile Size.

Geoprocessing Environments

- Raster Storage
  - Compression.
  - **NoData**. Set the 'rule' for which NoData will be transferred to your output dataset (i.e. None, max, min)
  - Pyramid. Raster Statistics.
  - Resampling method.
  - Tile Size.

Geoprocessing Environments

- Raster Storage
  - Compression.
  - NoData.
  - **Pyramid**. Set the resampling method for building pyramids. Pyramid are reduced-resolution representations of your data used to improve performance.
  - Raster Statistics.
  - Resampling method.
  - Tile Size.

Geoprocessing Environments

- Raster Storage
  - Compression.
  - NoData.
  - Pyramid.
  - **Raster Statistics**. Enables you to build statistics for the output raster dataset. Statistics are necessary to apply a contrast stretch or classify your raster data (symbology)
  - Resampling method.
  - Tile Size.

Geoprocessing Environments

- Raster Storage
  - Compression.
  - NoData.
  - Pyramid.
  - Raster Statistics.
  - **Resampling method**. Set resampling method when your raster dataset undergoes a transformation (i.e. pixel size changes, data shifts)
  - Tile Size.

Geoprocessing Environments

- Raster Storage
  - Compression.
  - NoData.
  - Pyramid.
  - Raster Statistics.
  - Resampling method.
  - **Tile Size.** Sets the tile size for rasters that are stored in block of data (only done with TIFF, File GDB, or SDE GDB). Tile size lets you control the number of pixels stored in each block.