



SPATIAL ANALYSIS

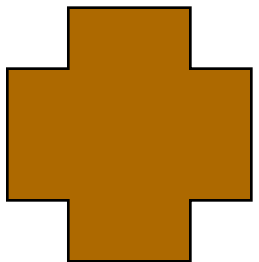
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Analysis



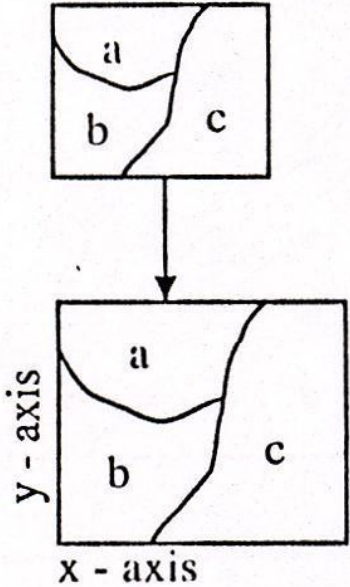
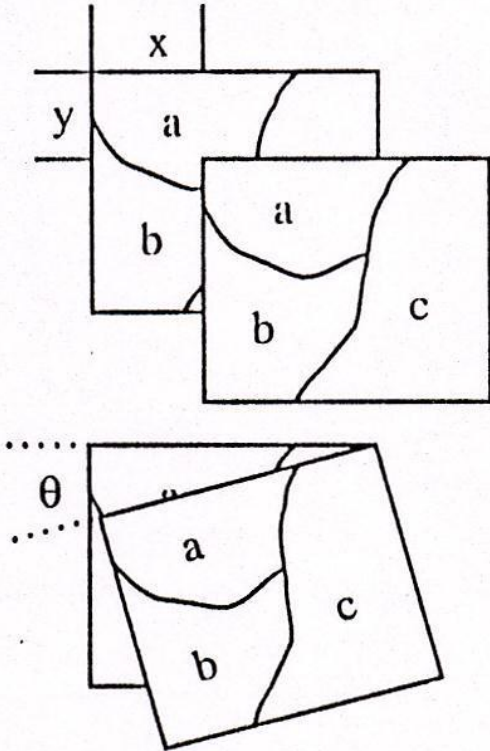
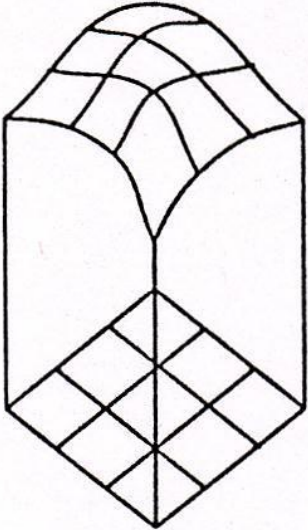
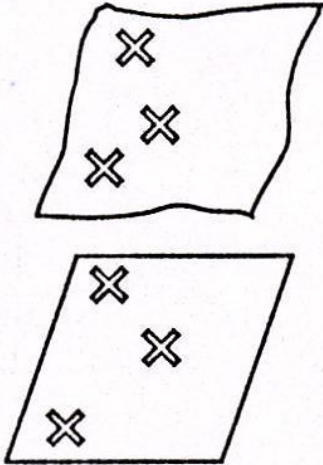
Decisions



Data Storage and data base management

- Ways of data storage, linkage, and retrieval
- Some variation due to different GIS software but generally compatible to each other and convertible
- Each variable is archived in digital format as a geographically referenced plane -GIS LAYER
- All layers registered to each other digitally –database of ‘n’ layers that can be queried to answer questions

Data Analysis: GIS capabilities

			
<p>Scale change</p>	<p>Translation and rotation</p>	<p>Projection change</p>	<p>Distortion removal (linear and non-linear rectification)</p>

- **Line coordinate thinning**
- **Line dropping – boundary between two polygons are deleted**
- **edge matching – large no. of map sheets are composited**



Digitizing

- Tablet digitizing



- Heads-up digitizing

Often “drawing” features over an orthophoto base

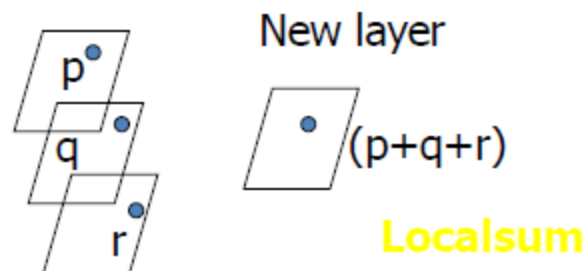
Cartographic Modeling

- Cartographic modeling:
 - Decomposition of data sets, data processing capabilities and data processing control specifications into elementary components
 - recombines for easy handling and greater flexibility
- Map algebra:

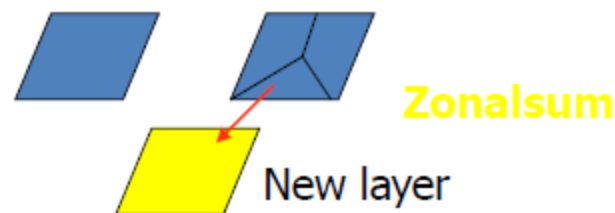
NEW LAYER = f (OLD LAYER) how
Data  Information

Data Transformations

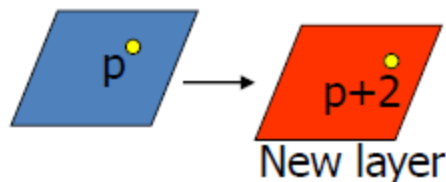
- Local Operations: new value for each location
e.g. localsum



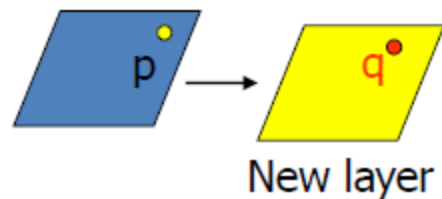
- Zonal Operations: new value for each location
as a function of existing value from a specified
layer e.g. zonalsum



- Incremental Operations: characterize each
location as an increment of 1, 2, 3....
e.g. IncrementalGradient (computes slopes at
each location on a 3D surface)



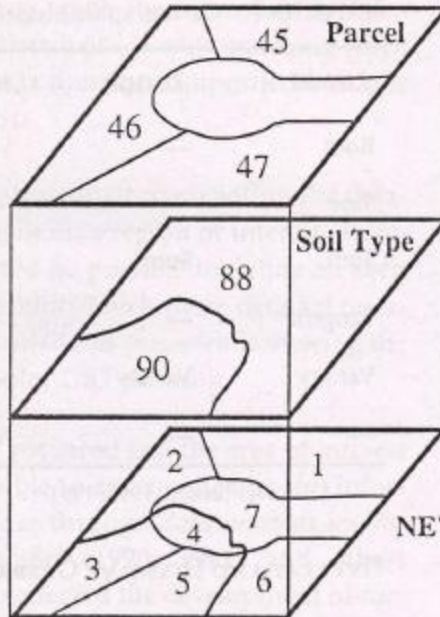
- Focal Operations: computes each location's
new value as a defined function
New value = $fn(\text{existing value, distance, and/or}$
difference of neighbouring locations on a
specified map layer)



Cartographic Operations

- Measurement operations: Point, lines, area, volume
- Overlay and dissolve operations
 - Vector polygon overlay
 - Raster polygon overlay
- Neighborhood operations
 - Geographic search
 - Topographic functions
 - Interpolation
- Connectivity function (Network Analysis)

Vector Polygon Overlay



Parcel Polygon Attribute Table

Parcel-ID	Parcel_No
45	501
46	502
47	503

Soil Polygon Attribute Table

Soil-ID	Stability
88	Stable
90	Unstable

Stability Polygon Attribute Table

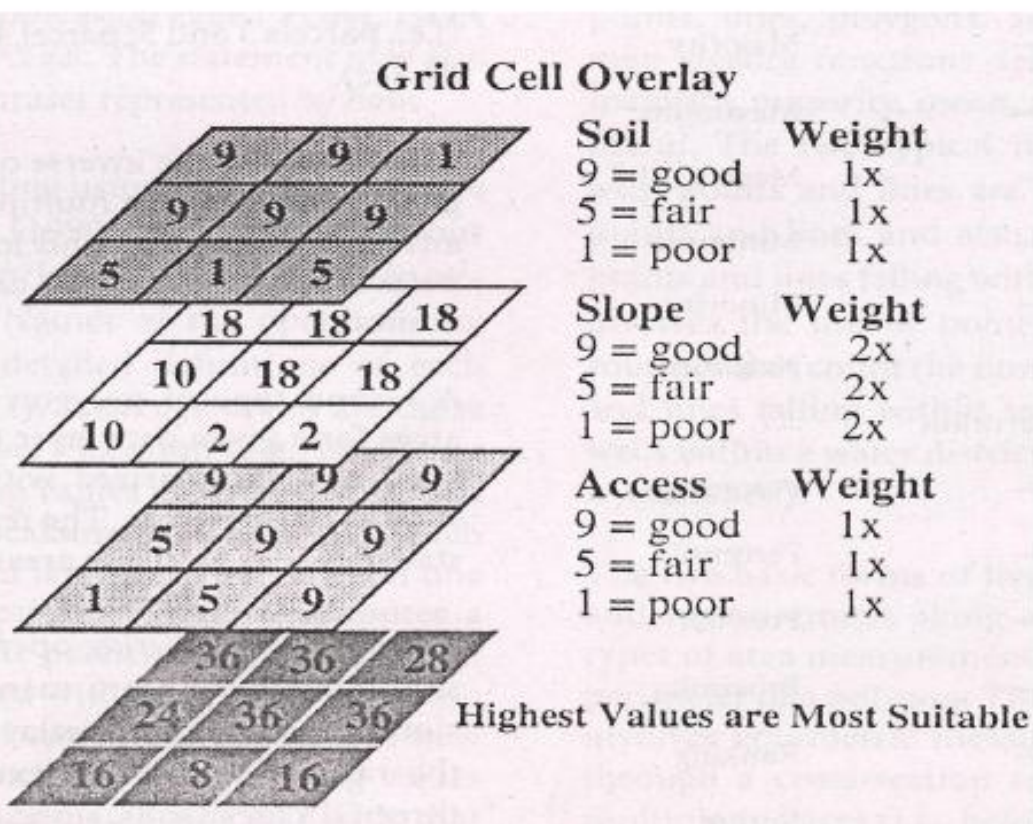
Stability-ID	Parcel -ID	Parcel_No	Soil-ID	Stability
1	45	501	88	Stable
2	46	502	88	Stable
3	46	502	90	Unstable
4	-	-	90	Unstable
5	47	503	90	Unstable
6	47	503	88	Stable
7	-	-	88	Stable

Map dissolve:
inverse of polygon
overlay; extracts single
attribute from multiple
attribute polygon

Area statistics survey:
Areas for a given data
layer to be calculated and
summarized within a
second layer of polygons



Raster Polygon Overlay



Algebraic Manipulation

New Layer (Suitability) =

1 (Soil) + 2 (Slope) + 1 (Access)

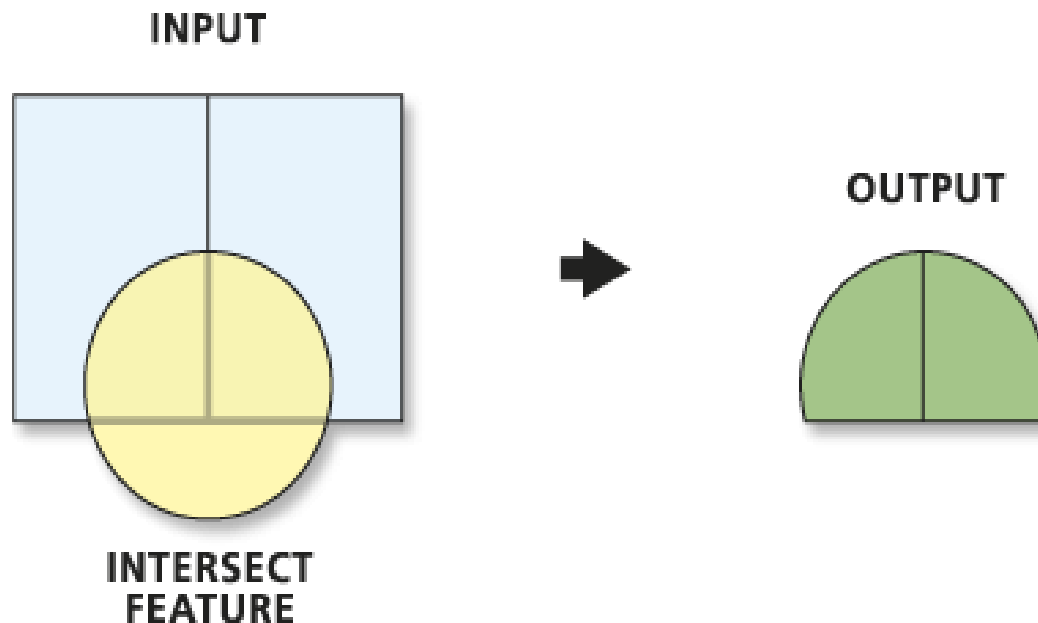
Local Product Function

Map Overlay Tools

- Intersect
- Union
- Identity
- Erase
- Symmetrical Difference
- Update

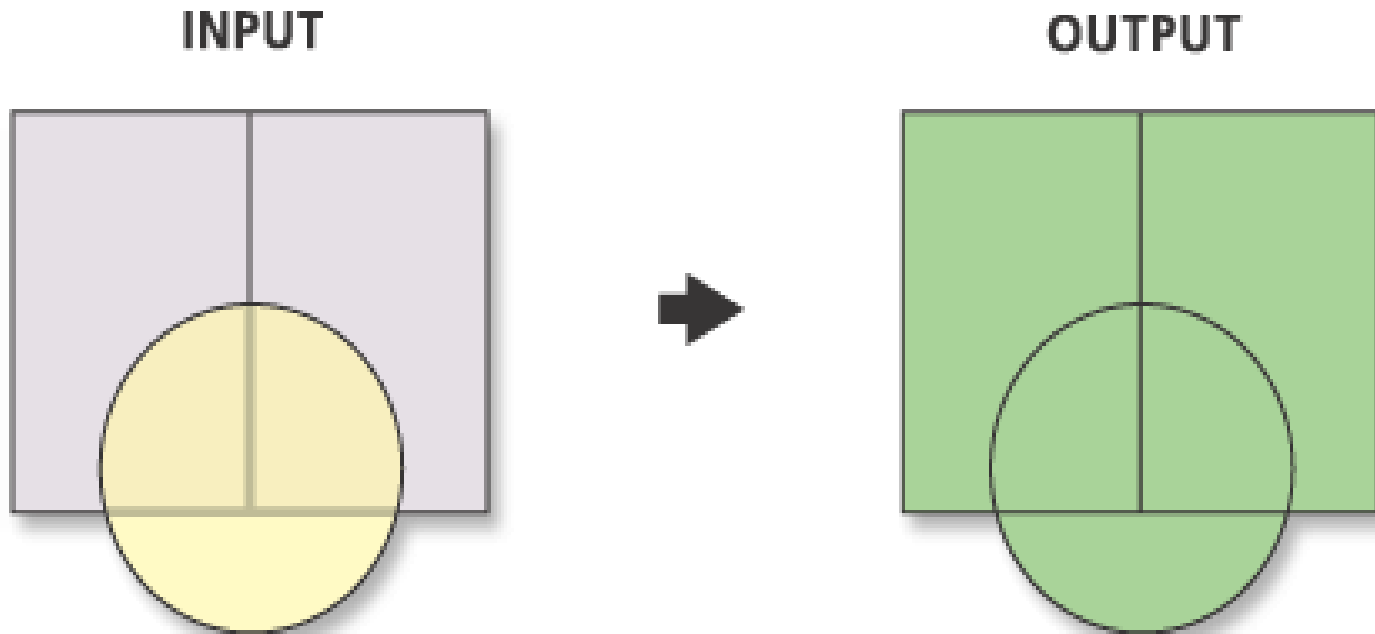
Intersect

- This tool builds a new feature class from the intersecting features common in both feature classes. Available with any ArcGIS license



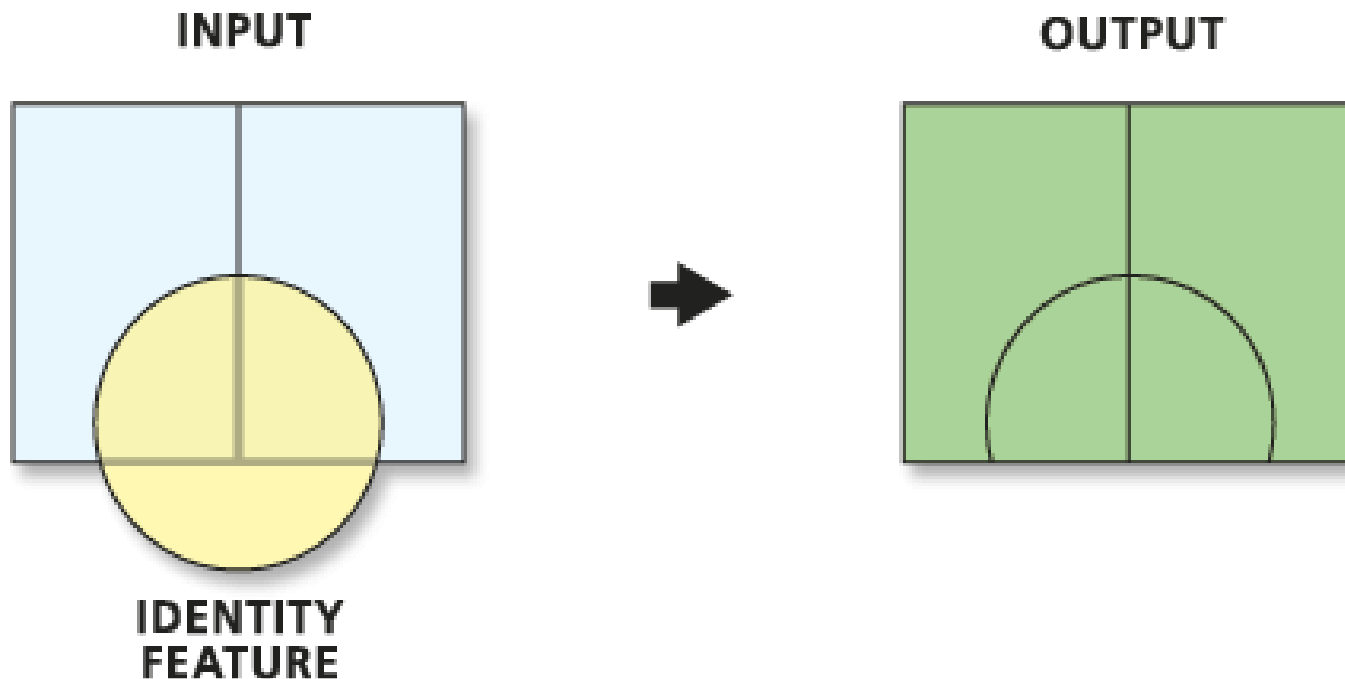
Union

- This tool builds a new feature class by combining the features and attributes of each feature class. Available with any ArcGIS license.



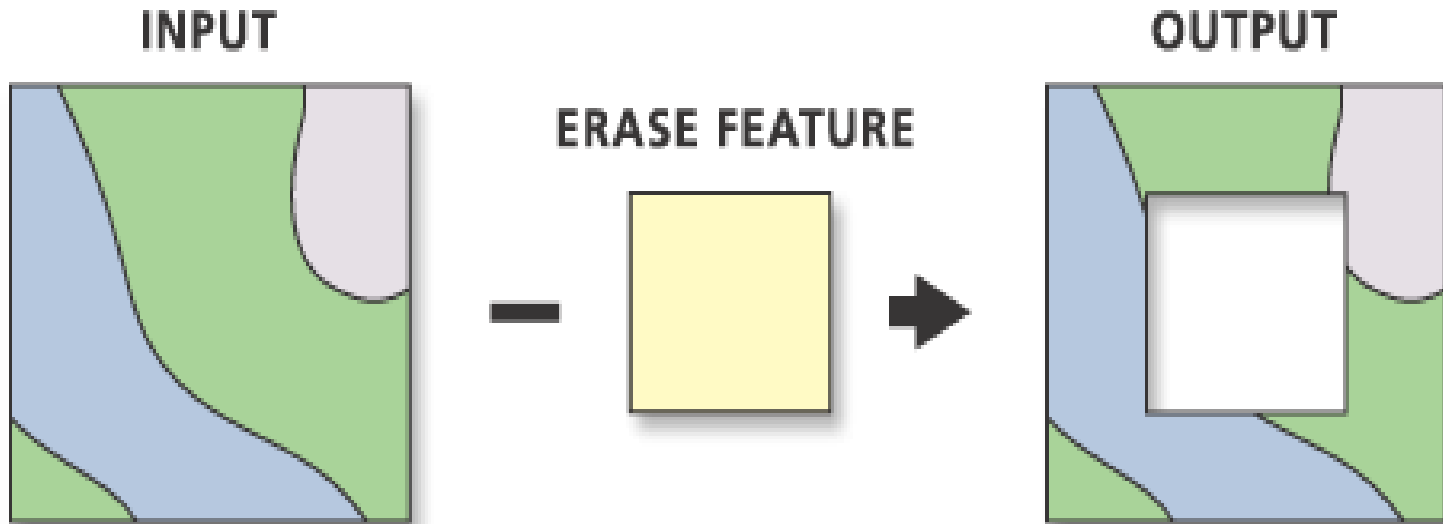
Identity

- This tool combines the portions of features that overlap the identity features to create a new feature class. Requires an ArcInfo license.



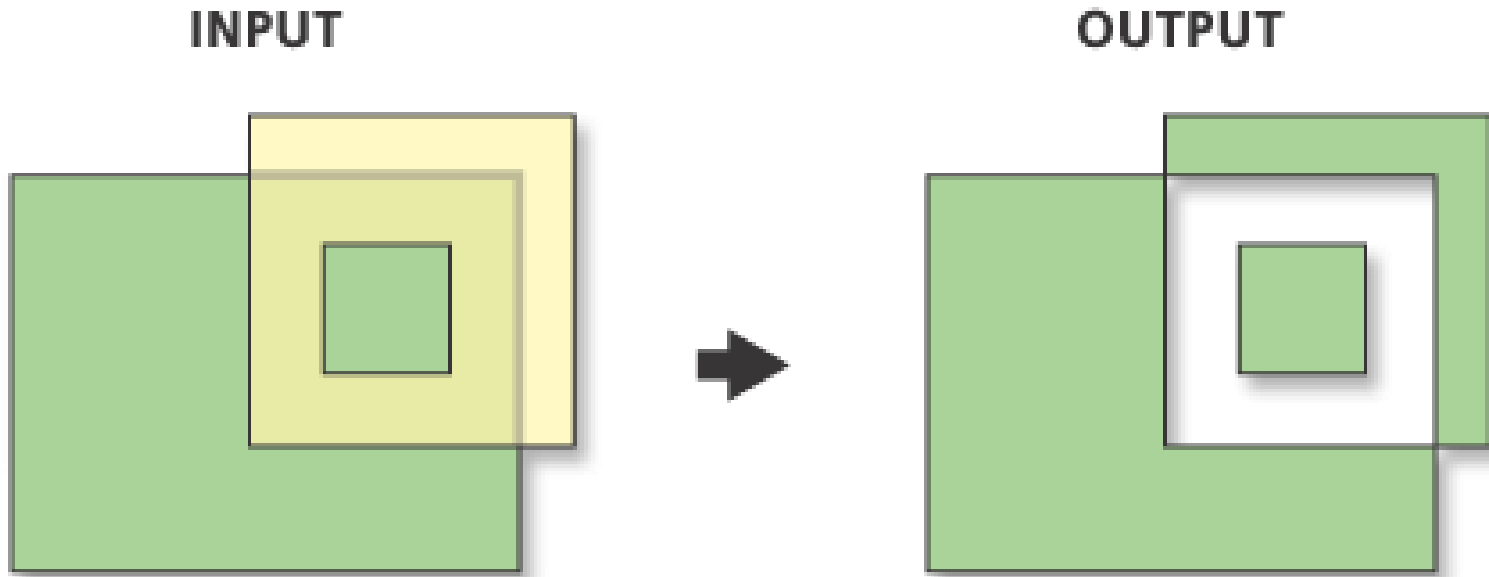
Erase

- This tool creates a feature class from those features or portions of features outside the erase feature class. Requires an ArcInfo license.



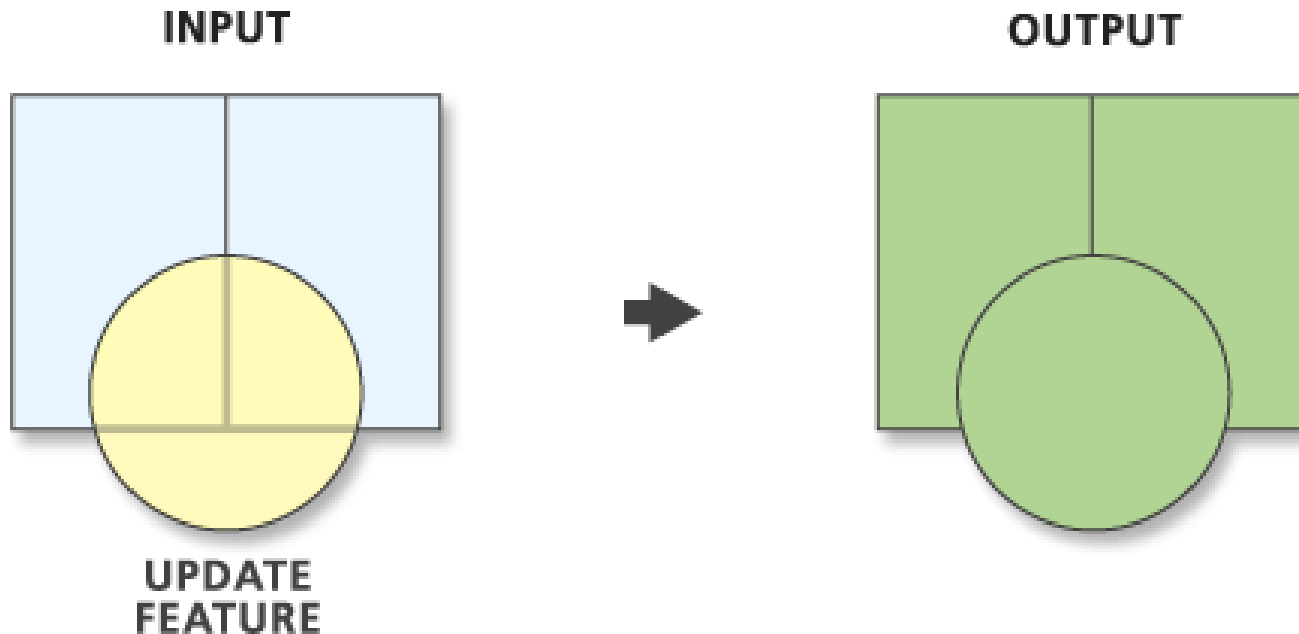
Symmetrical Difference

- This tool creates a feature class from those features or portions of features that are not common to any of the other inputs. Requires an ArcInfo license.



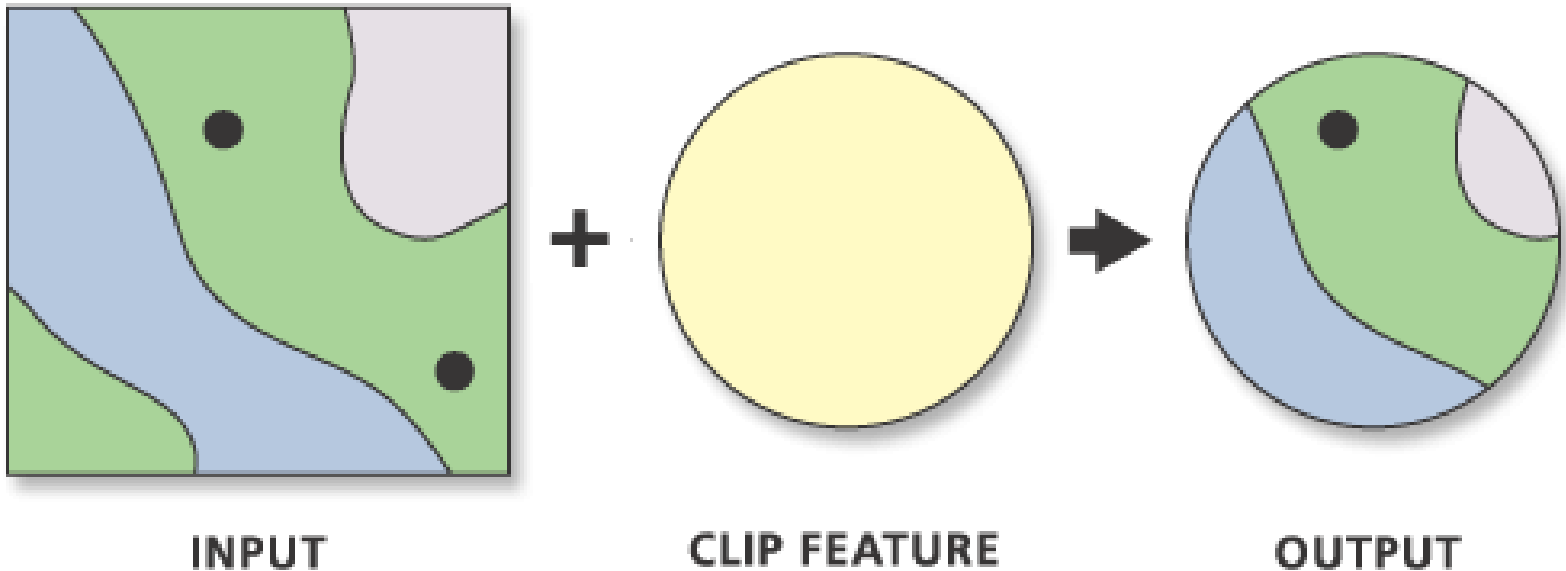
Update

- This tool updates the attributes and geometry of an input feature class or layer by the Update feature class or layer that they overlap. Requires an ArcInfo license.



Clip

- Extracts those features or portions of features from an input feature class that overlap with a clip feature class. The Clip tool is similar to the Intersect tool, however, the Clip tool does not transfer any attributes from the clip feature class to the output. Available with any ArcGIS license.



Select

- Extracts features from an input **feature class** or input **feature layer** and stores them in a new output feature class. The output feature class may be created with a subset of features based on a Structured Query Language (SQL) expression.

Split

- The spatial extraction of features by clipping portions of the input feature class into multiple feature classes. Requires an ArcInfo license.

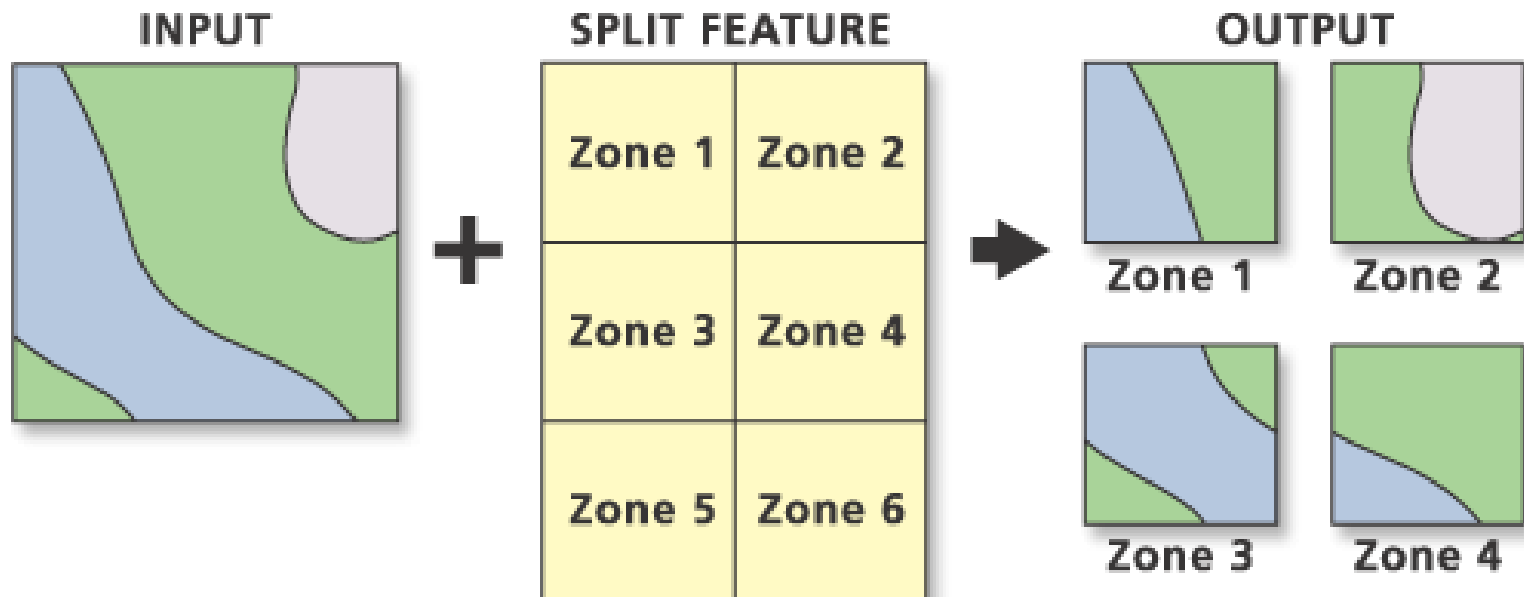


Table Select

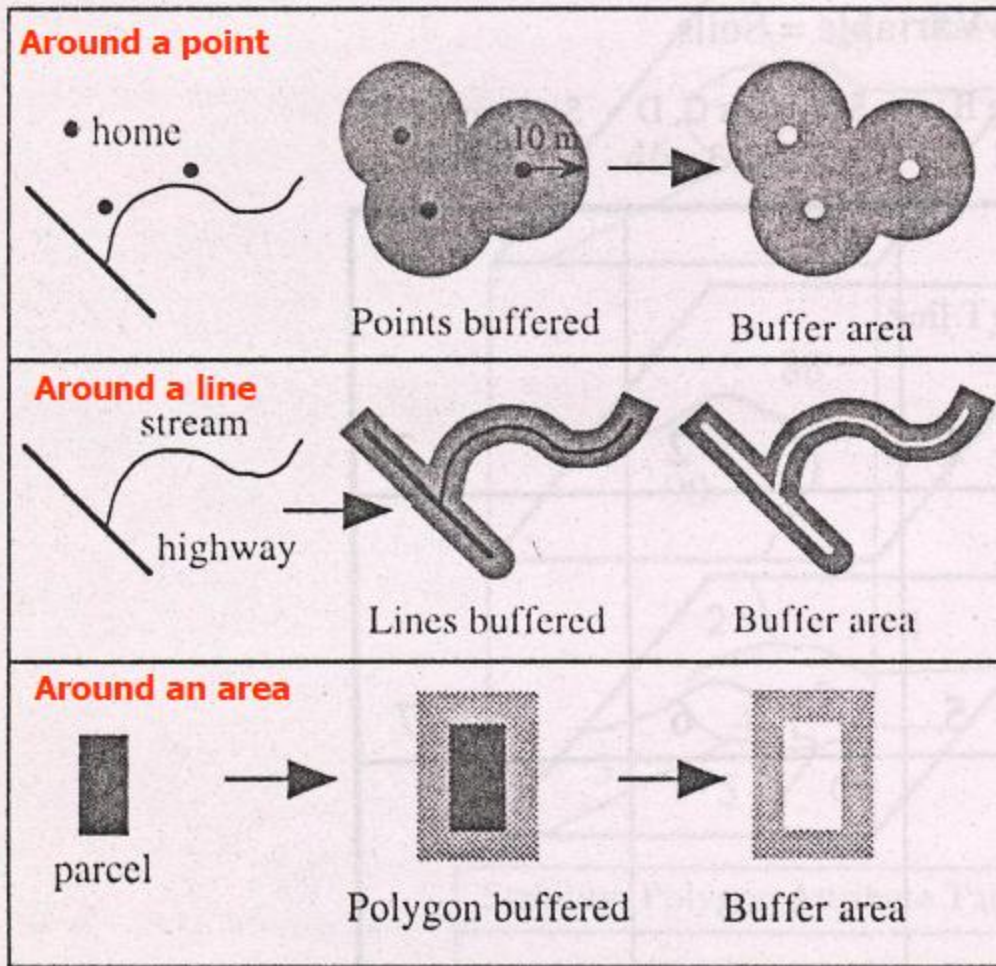
- Extracts selected attributes from an input table based on an attribute query and stores them in the output table. Available with any ArcGIS license.

Geographical Search

Proximity Tools BUFFER

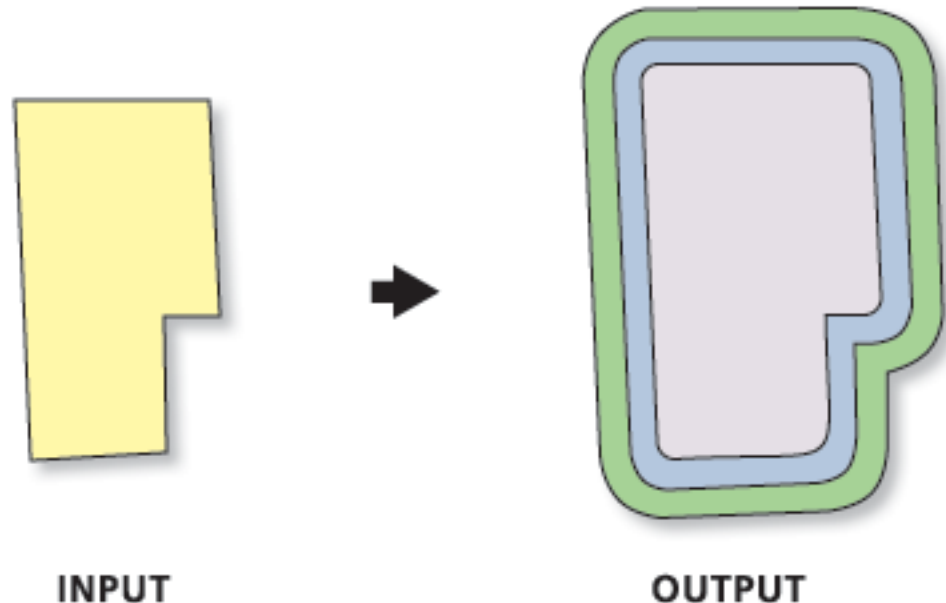
The construction of area features by extending outward from point, line, or polygon features over a specified distance. Available with any ArcGIS license.

- ✓ Create buffered areas using a search distance
- ✓ specific operations Search region in terms of pixels in a raster environment



Multiple Ring Buffer

- Creates a new feature class of buffer features using a set of buffer distances. The new features may be dissolved using the distance values or as a set of individual features. Available with any ArcGIS license.



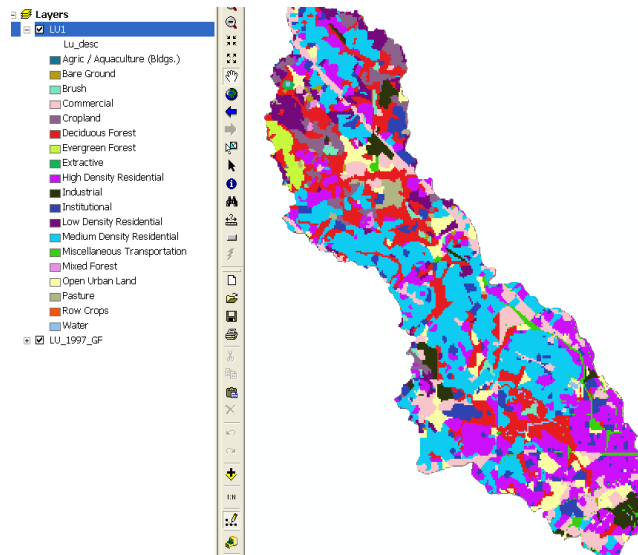
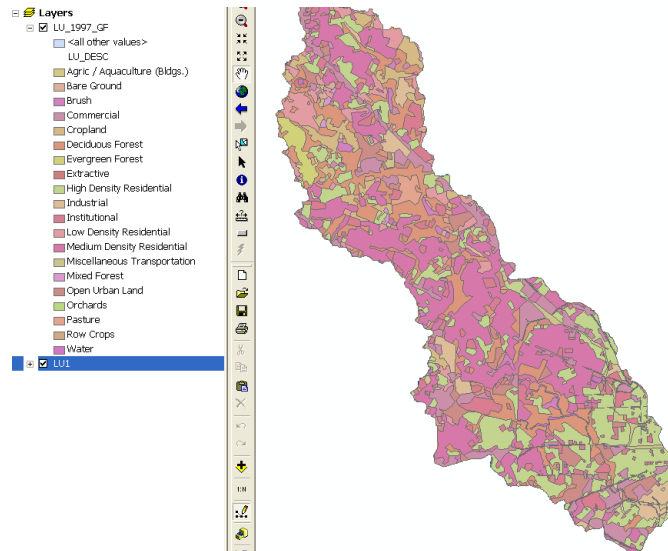
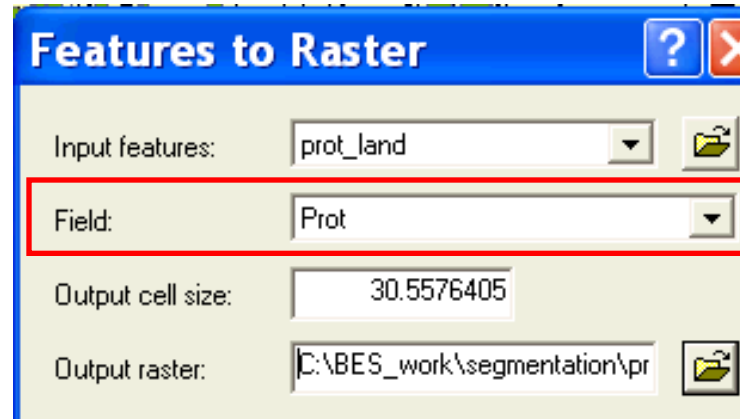
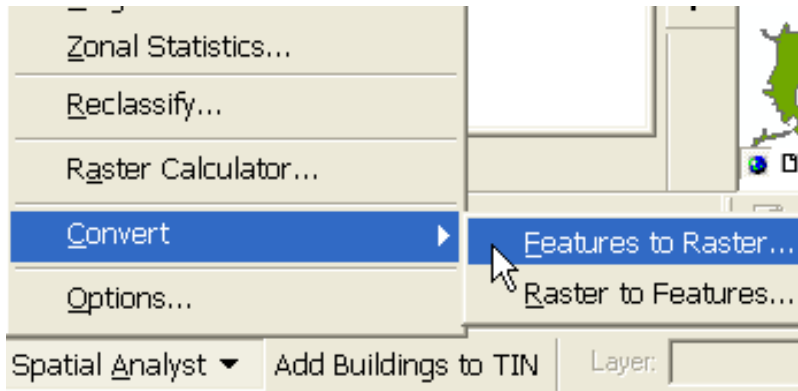
Topographic Functions

- Very important in remote sensing investigations
- Elevation, slope and aspect –often correlated with other spatial variables
- Map algebra function –most useful
 - Increment Gradient –compute slope
 - Increment Aspect –compares direction of the steepest descent at each location

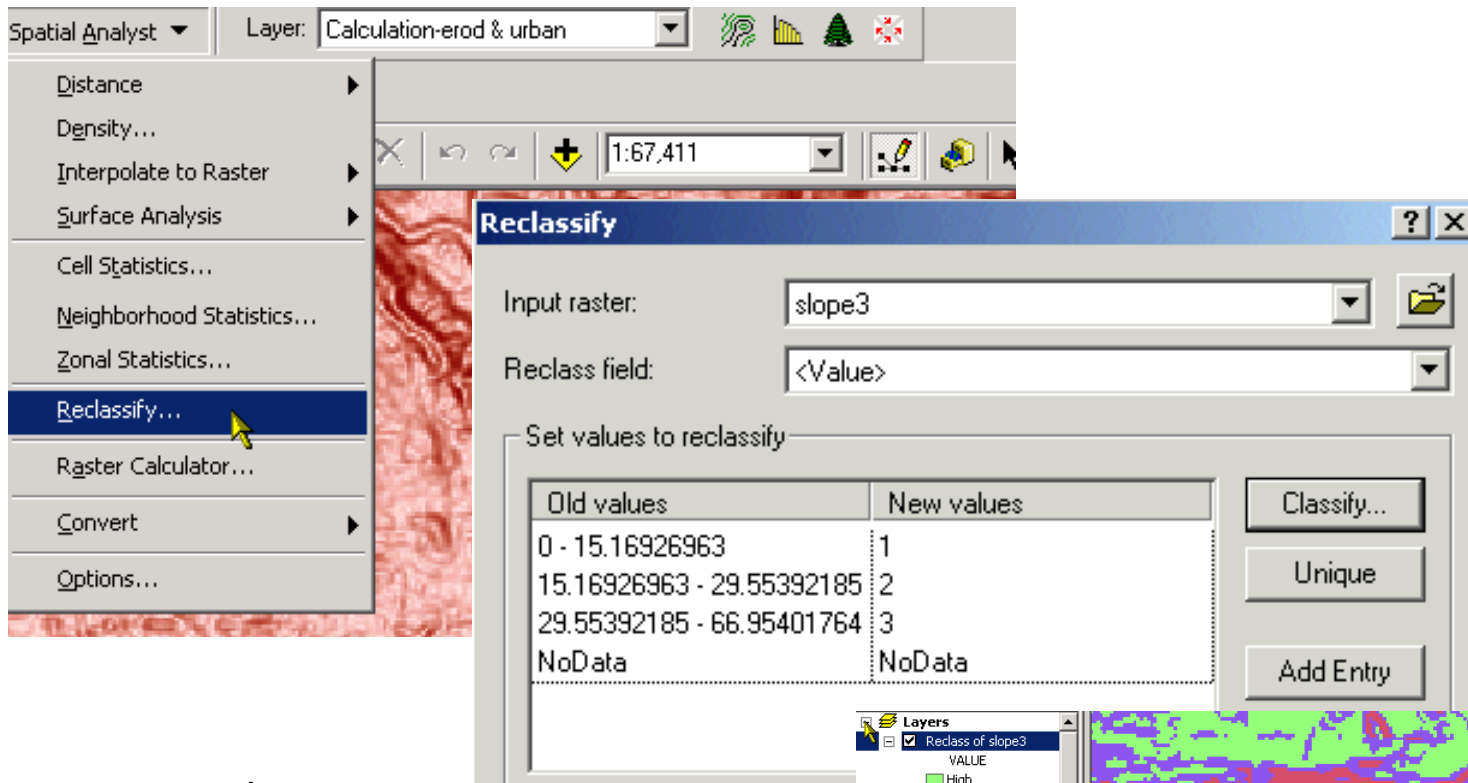
Network Analysis Operations: Common applications

- Finding the shortest distance from one feature to another to optimize vehicle routing
- Use of spread function to evaluate travel transportation time or cost over a complex surface
- Use of seek function to trace the path of water flow over a DEM
- Determining the interrelationship of various features in the landscape

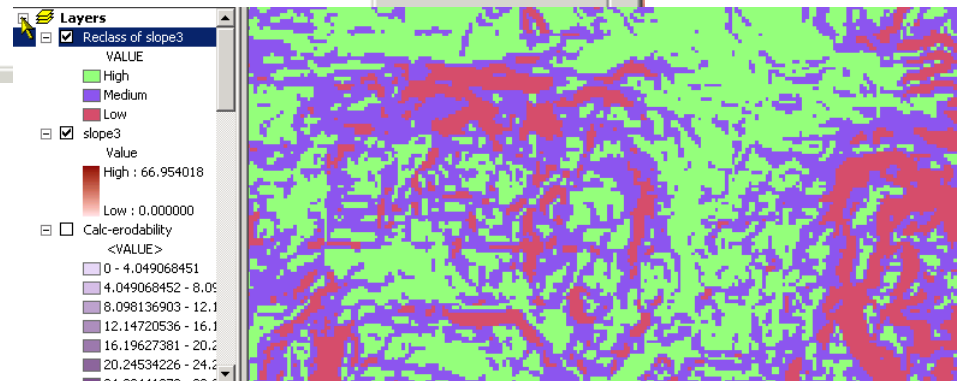
Converting vector to raster



Reclassification with Grids



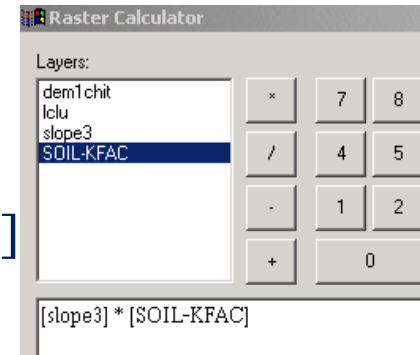
Here we reclass to 3 classes, based on natural breaks



Raster Analysis Overview

RASTER CALCULATOR

- Raster overlay queries
 - Example: [elevation > 2500] AND [slope > 20]
- Raster overlay calculations
 - Example: [soil_depth_1990] – [soil_depth_2000]
- Zonal Statistics

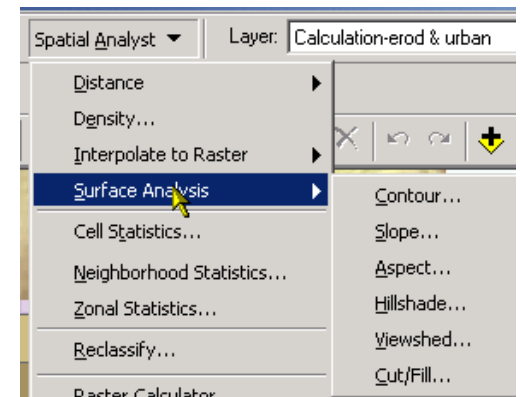
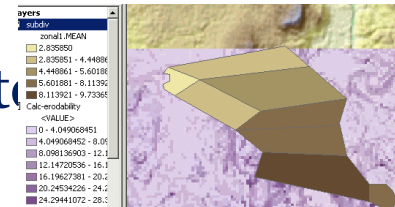


- Raster terrain functions (hillshade, slope, aspect, contour)

- Viewshed Analysis

Terrain + Points = Visibility raster

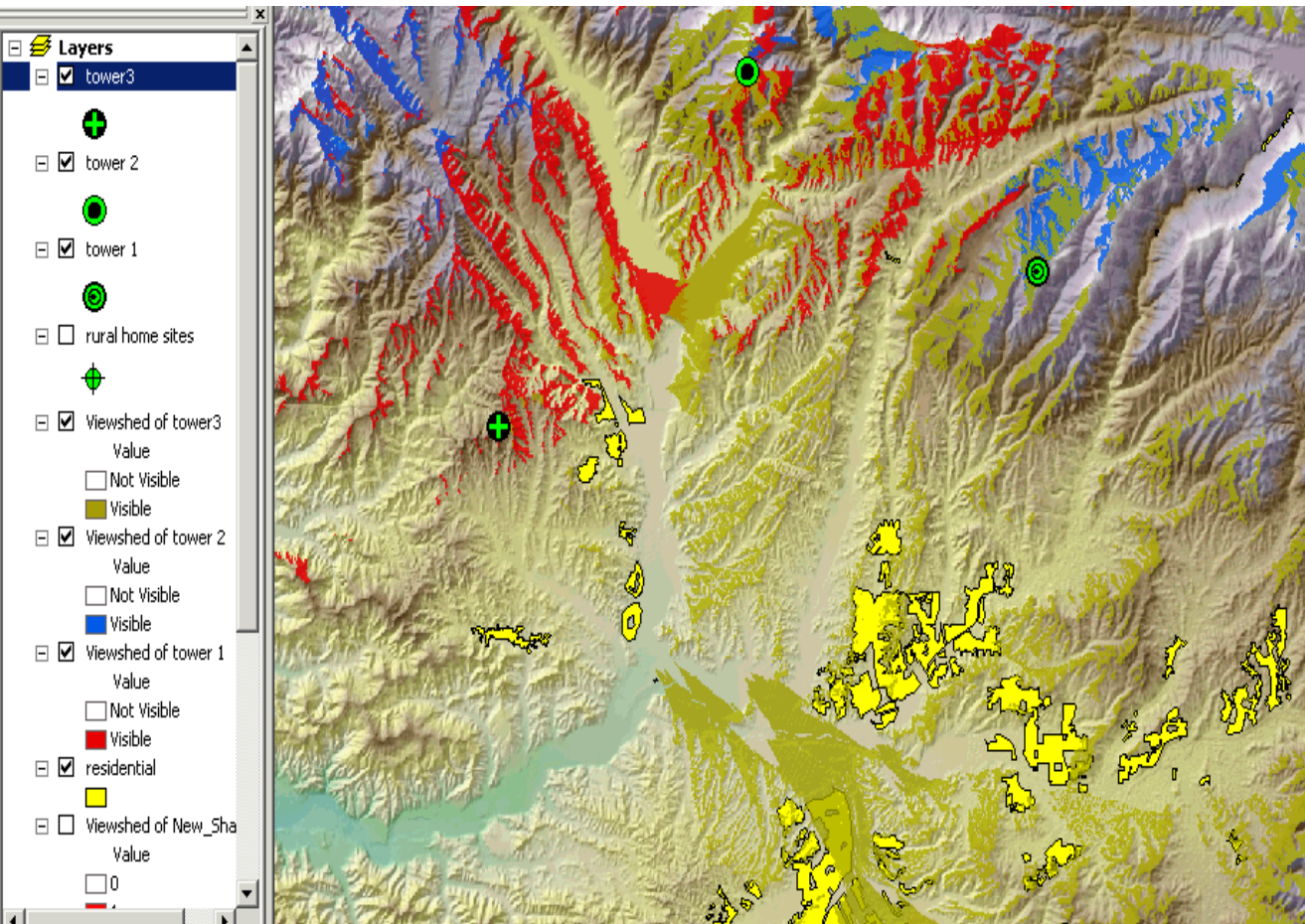
- Neighborhood Statistics & Filters
- Distance Functions & Density



Viewshed analysis

Inputs/outputs? Parameters?

In this case, red is for tower 1, blue for 2 and green for 3

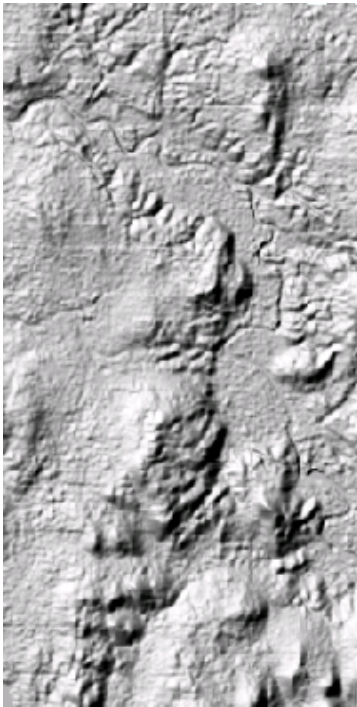


Viewshed identifies the cells in an input raster that can be seen from one or more observation points or lines.

It is useful for finding the visibility. For instance, finding a well-exposed places for communication towers

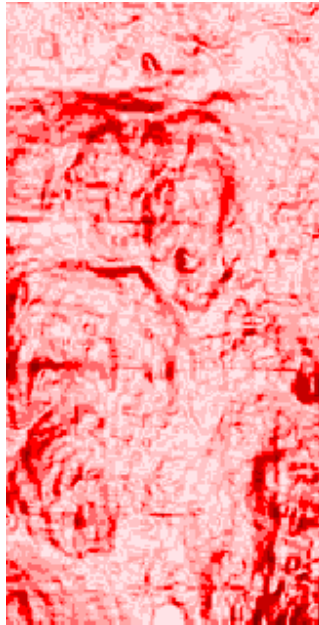
Raster terrain functions in ArcGIS

Hillshade:



Illumination /
brightness values

Slope:



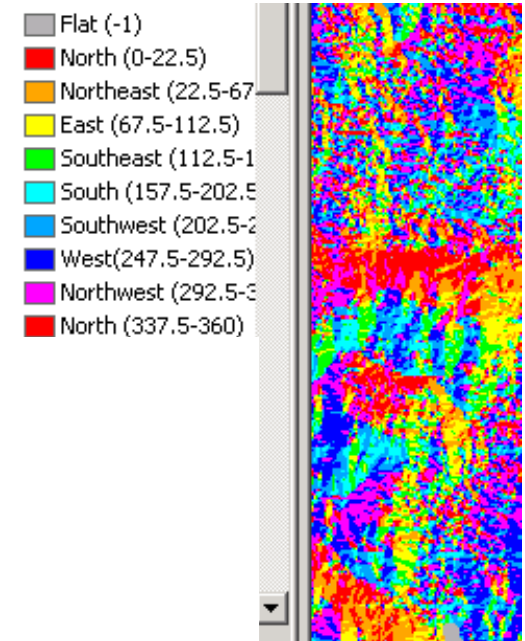
Rise / run
expressed as
percent slope OR
as angle
(degrees)

Contours:



User-defined
interval and
base contour

Aspect:



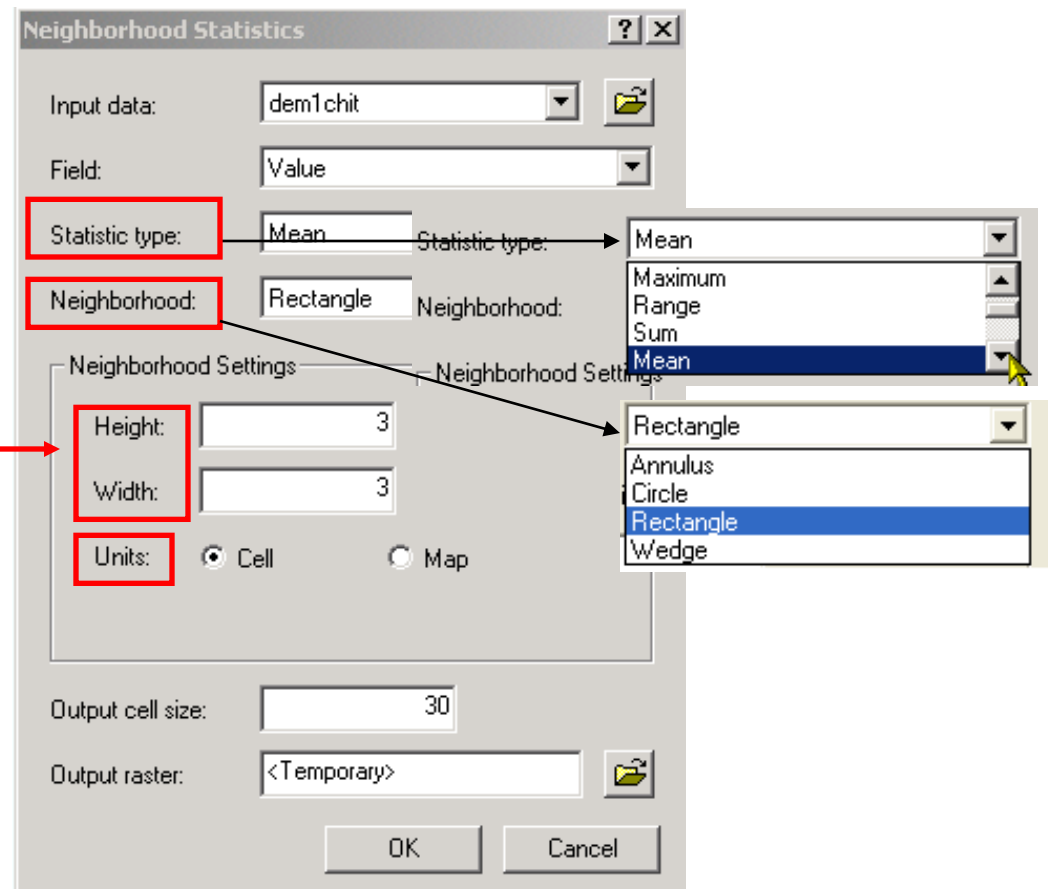
Azimuth angle of
steepest path
(orientation or
bearing of the
slope direction)



Neighborhood Statistics

- A “local” method of summarizing raster data within a neighborhood by a statistical measure, like mean, std dev.

- Statistic types
- Neighborhood shape
- Neighborhood settings
 - Window size
 - Units

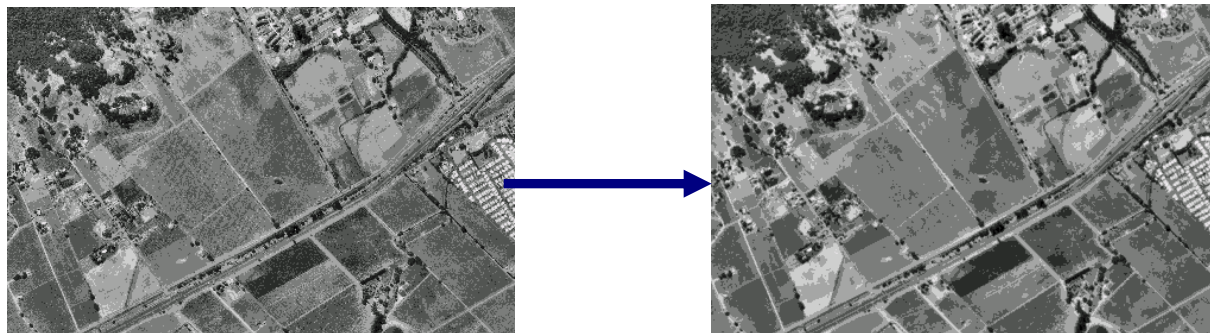




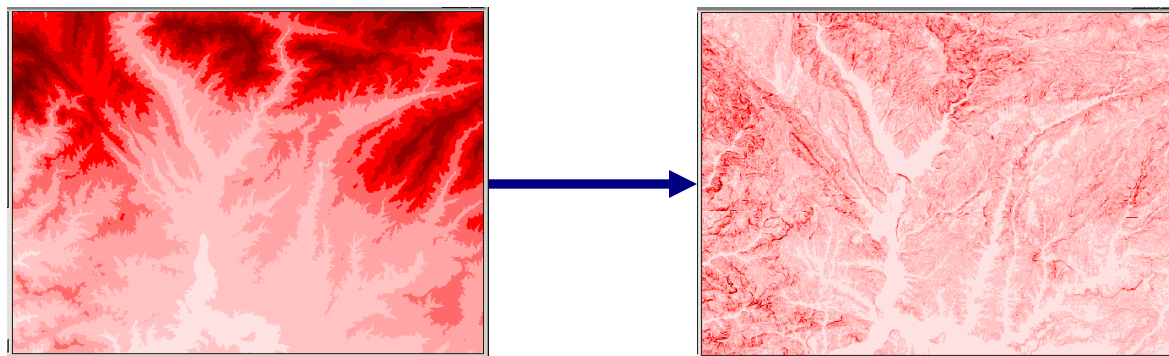
Neighborhood Filters

Filter types

- Low pass filters – remove noise (emphasize trends)



- High pass filters – edge enhancement (emphasize local detail)

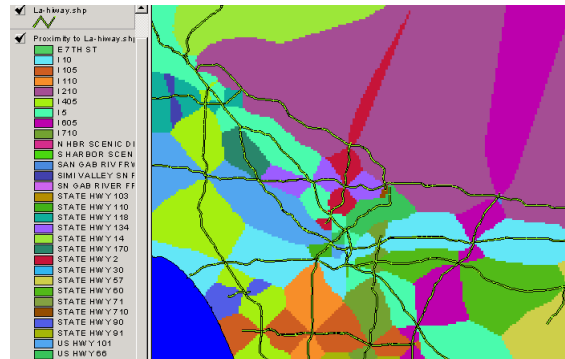




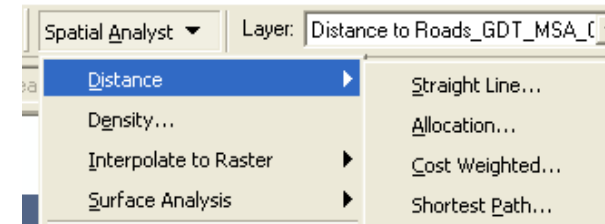
Distance Analysis

Used to answer questions related to distance

— Proximity

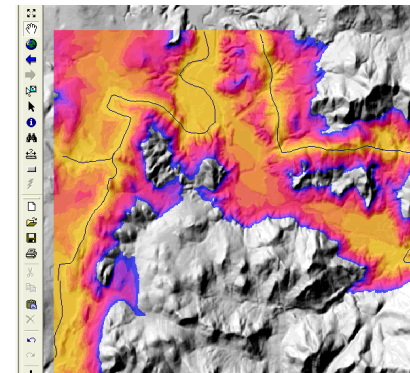
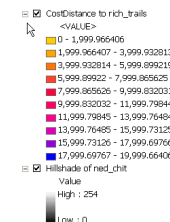


— Straight Line Distance Measurement



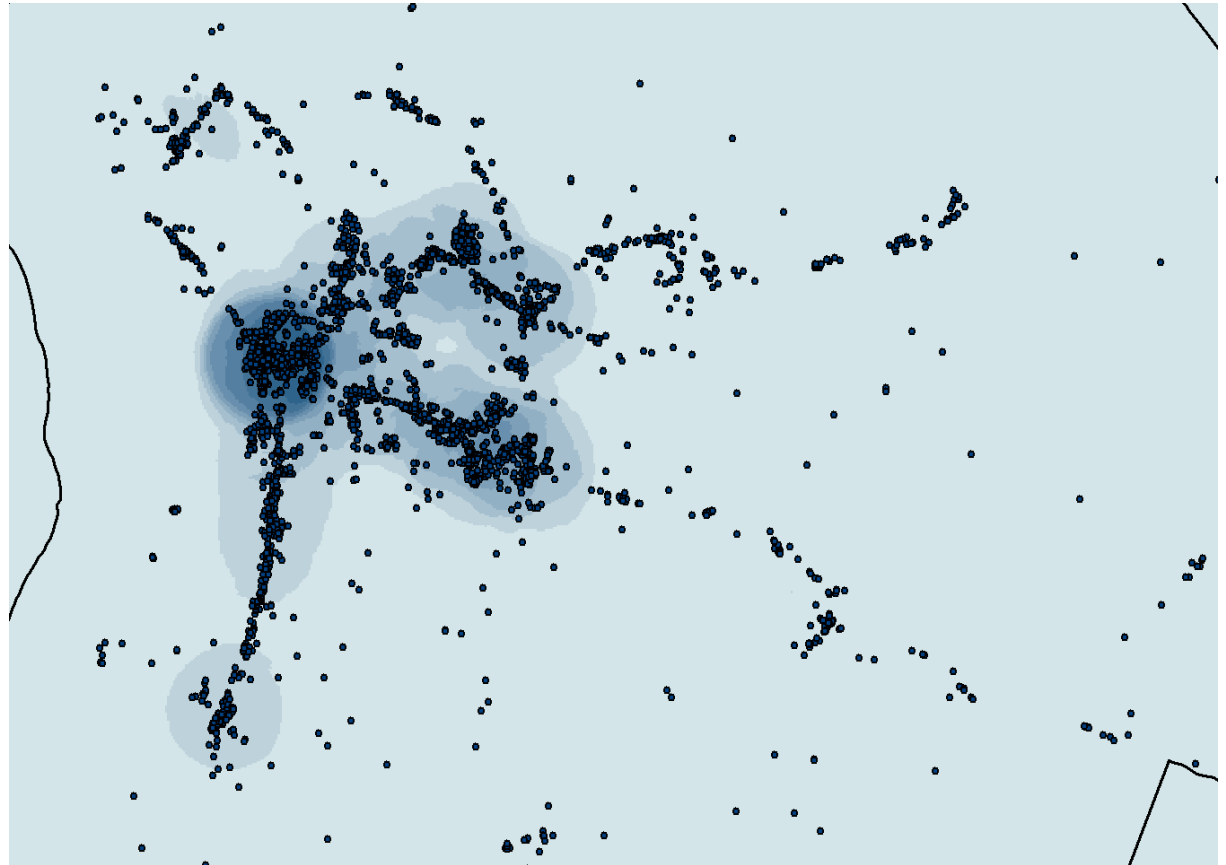
— Cost Weighted Distance Measurement

— Shortest Path



Density Functions

- Use sample points to create density surfaces
- Can use a z value, or it can simply be based on the abundance and distribution of points.
- Output: number of points per unit area of a designated neighborhood

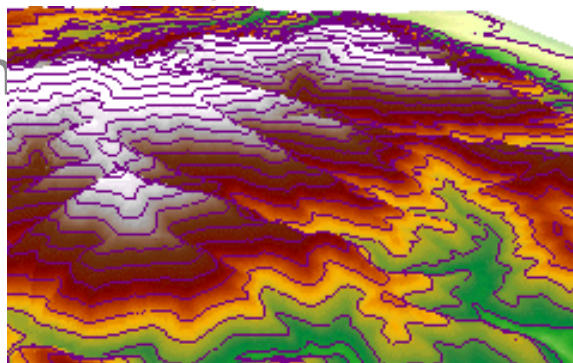




Slope, Aspect, Contours

- Raster slope is calculated by steepest path in neighborhood
- Aspect is direction of steepest path (azimuth in degrees)
- Critical for flow path analysis, watershed generation, drainage network and watershed analysis, etc.
- Contour generation

55	51	48
54	43	36
53	45	38



Contour

Input surface: ned_chit

Contour definition:

Input height range: Z min: 69 Z max: 4385

Contour interval: 100

Base contour: 0

Z factor: 1

Output information based on input contour definition:

Minimum contour: 100

Maximum contour: 4300

Total number of contour values: 43

Output features: C:\Temp\ctour2.shp



Three Dimensional data – TIN

- **Triangulated Irregular Network**
- **Irregular** distribution of elevation sample points
- Break lines
- Z-tolerance (~resolution)

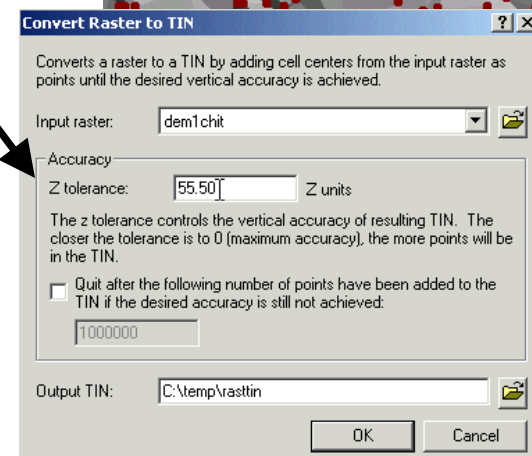
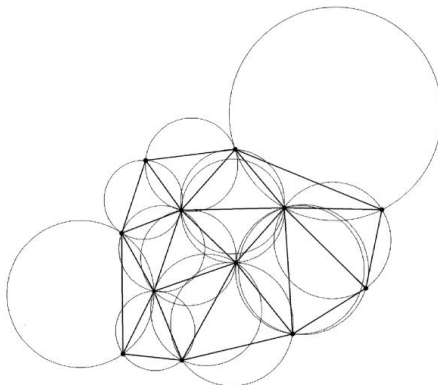
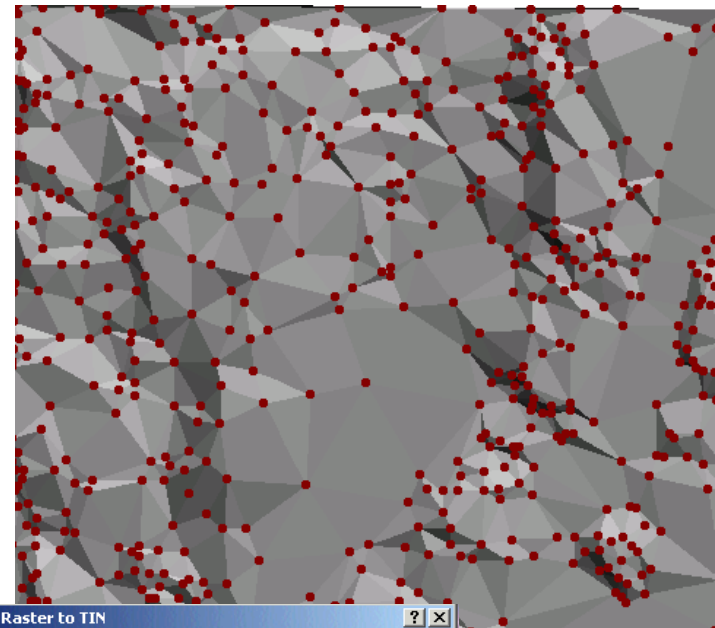
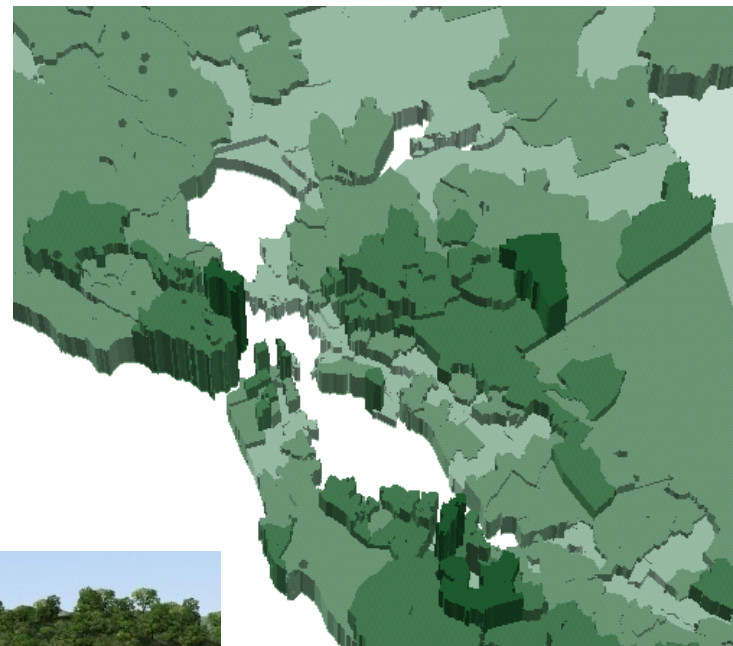


Figure 1 The circumcircle method for generating the DT



ArcScene

- 3D visualization
- Extrude a third dimension
- Drape thematic layers on elevation
- Create animations (fly-through)





3D Visualization

