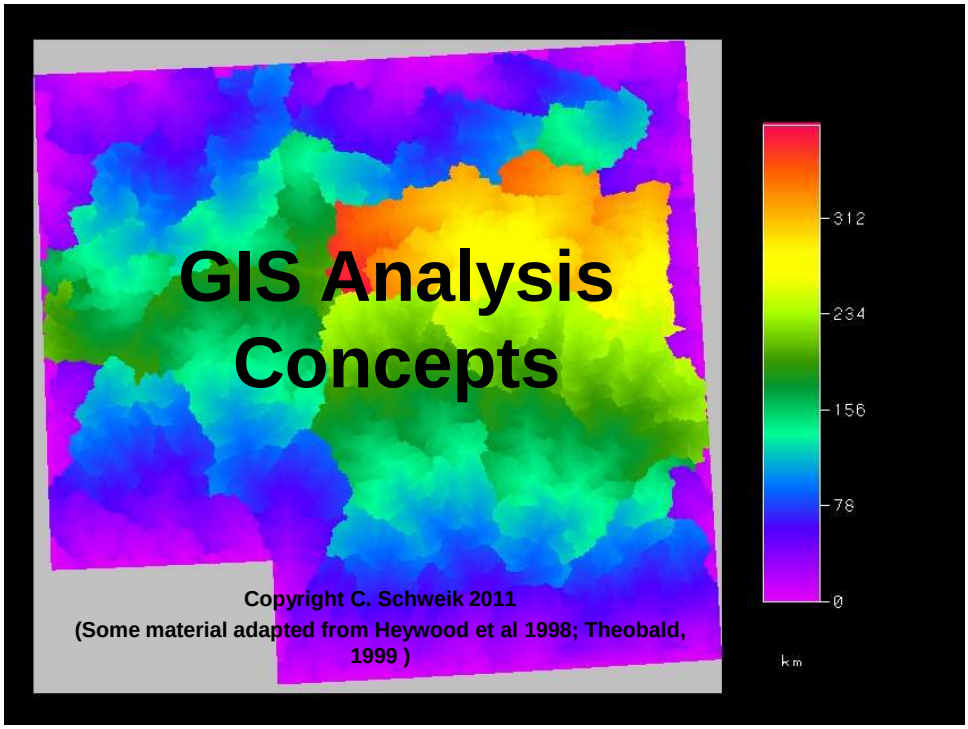


What kinds of analysis can we do with GIS?

1. Measurements
2. Layer statistics
3. Queries
4. Buffering (vector); Proximity (raster)
5. Filtering (raster)
6. Map overlay (layer on layer selections)
7. Transformations
8. Reclassification

2

What kinds of analysis can we do with GIS?

1. Network analysis
2. Spatial interpolation
3. Grid (raster) analysis
4. Surface analysis
5. Analytic modeling

3

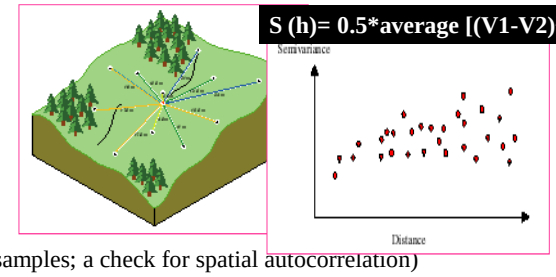
1. Measurements of a layer

- Distance (e.g., measure tool in ArcMap, a little “measure” icon on the main tool bar)
- Perimeters (sometimes stored in the attribute table)
- Areas (sometimes stored in the attribute table)

4

2. Layer Statistics

- Statistics of a layer's "attribute"
  - **In ArcMap**, right-click on layer, open attribute table. Choose field of interest, right-click on blue heading, choose statistics symbol "∑"
- Ratios of some attribute (e.g., proportions, density, average)
- Geostatistics
  - Histogram
  - Trend analysis
  - Semivariograms



(Variance based on nearby samples; a check for spatial autocorrelation)

  - **In ArcMap**,
    - Customize menu, Extensions, Geostatistical analyst extension
    - Customize, toolbars, geostatistical analyst
    - Geostatistical analyst, explore data option

5

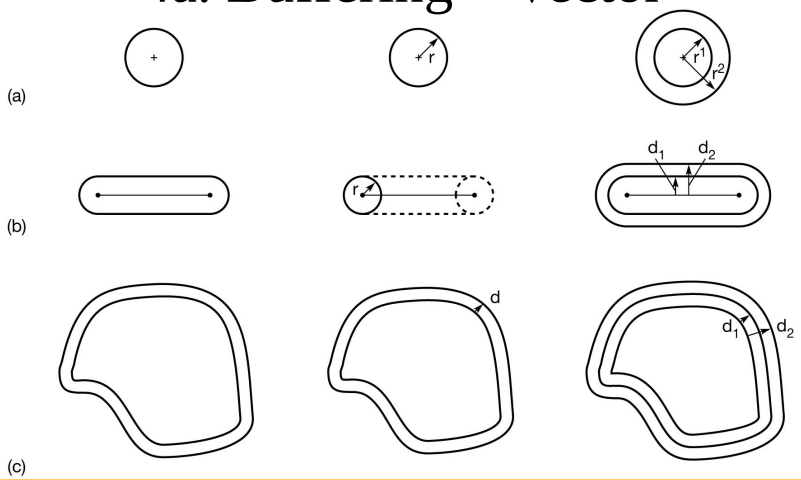
3. Queries

- **Select queries on the layer's attribute table**
  - **ArcMap** – selection menu, "select by attribute" queries
- **Neighborhood analysis** (queries)
  - What's adjacent?
    (**In ArcMap** – selection menu, "select by location" queries)
  - What's nearby?
    (**In ArcMap** – selection menu, "select by location" queries)
  - We'll do some exercises later in the semester
- **Sampling** (select some features and create a new layer based on the selected features)
  - For example, useful if you want to randomly select records in an attribute table

6

Buffer zones around (a) point, (b) line, and (c) area features

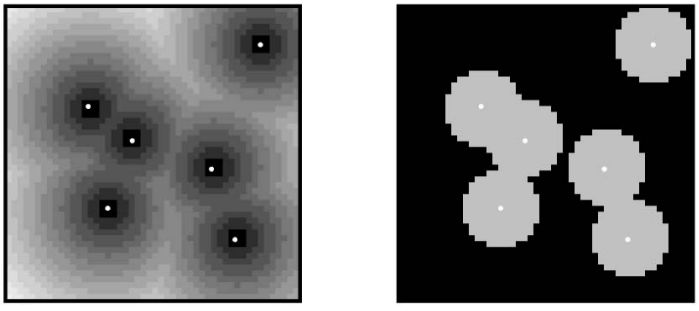
4a. Buffering – Vector



• Buffer at a specified distance; At a distance from an attribute field; and As multiple rings at a defined increment.
• **In ArcMap**: Geoprocessing, buffer; In ArcToolbox: Analysis tools, Proximity, Buffer;

Proximity map for hotels: (a) distance surface; (b) 125 m buffer zones

4b. Proximity - Raster



(a) (b)

• Concentric equidistant zones established around a starting point
• Uses one raster layer, result is another raster layer where the attribute of each cell is a measure of distance.
• **In ArcMap** – Spatial Analyst Tool, distance, allocation (ArcTools refers to this as “Euclidian allocation)

Raster GIS filter operations

5. Filtering (raster)

- Value of a cell are changed based on attribute values of other cells
- Example: recalculating a value for cell c4
- Different approaches: min value, max, mean, modal
- Often used to “smooth” noisy data (e.g., seams between two digital elevation models)
- **For seams, in Spatial Analyst, Raster calculator, “mosaic”**

	a	b	c	d	e	f
6	3	3	2	1	2	2
5	3	3	2	1	1	2
4	3	2	2	2	1	1
3	2	2	2	1	1	1
2	1	2	1	1	1	1
1	1	1	1	0	0	0

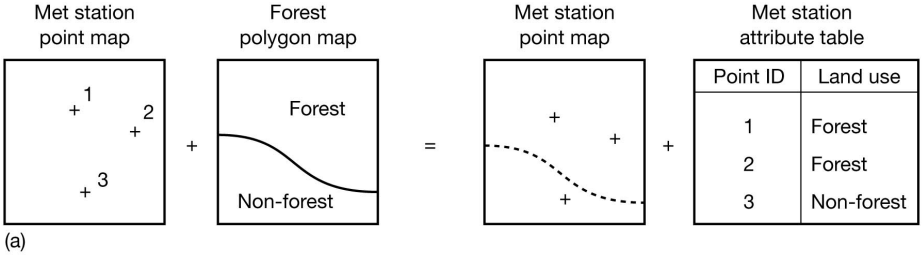
Example: Forest data in Happy Valley GIS

– Applying 3×3 square filter to recalculate value for cell c4:

minimum filter c4 = 1
maximum filter c4 = 3
mean filter c4 = 1.89
modal filter c4 = 2
(most frequently occurring class)
diversity filter c4 = 3
(number of different classes)

Vector overlays: (a) point-in-polygon

6a. Vector Overlay – Point-in-Polygon



(a)

- Point-in-Polygon is used to find out the polygon in which a point falls.
- Example: Which landcover does each meteorological station fall into?
- Why is there a problem in the alternative order – polygon to point? Hint: What would the attribute table look like?

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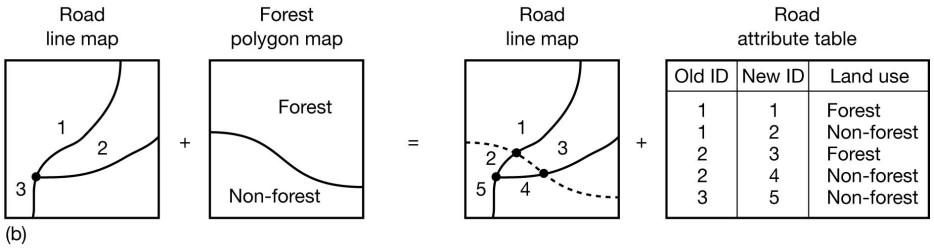
Vector overlays: (b) line-in-polygon

6b. Vector Overlay – Line-in-Polygon



Old ID	New ID	Land use
1	1	Forest
1	2	Non-forest
2	3	Forest
2	4	Non-forest
3	5	Non-forest

(b)

- Line-in-Polygon: Used to find out what polygons a line falls within.
- More complicated than point, because one line can be in more than one polygon
- Example: Which roads pass through forest areas? What parcels might be affected by a new bike trail design?

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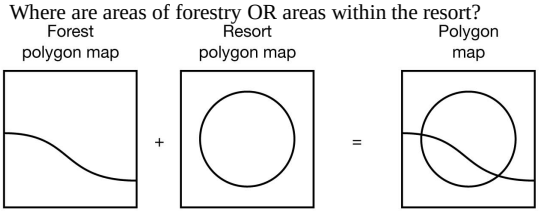
Vector overlays: (c) polygon-on-polygon

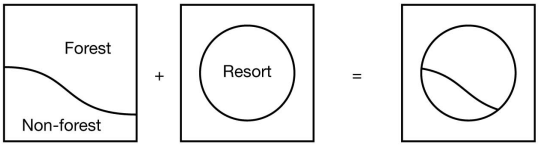
6c. Vector Overlays: Polygon on Polygon

Where are areas of forestry OR areas within the resort?



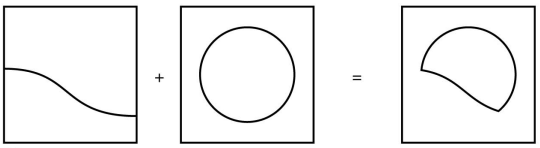
Union (OR)

Where is the resort boundary and where is there forest within the resort?



Erase (NOT)
('cookie cutting')
Also called "clipping"

Where is there forest within the resort?



Intersect (AND)

(c)

Note: Problem of "sliver polygons" – when boundaries don't coincide exactly

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Another example of Polygon-to-Polygon Intersection (Source: ArcMap help)

Suppose you are researching areas where it may be hazardous to perform new building construction.

1 layer - areas prone to flooding,
2 layer - areas where the soil is prone to erosion.

You would like to be able to analyze those areas that are common to both.

By ***intersecting*** the two layers, you'll create a new layer containing polygons which represent the areas that are prone to both flooding and erosion, and which have all the attributes of both sets of input features.

With this new layer, it's easy to perform your analysis. You can now use the Select By Attributes command to select polygons in the new layer that have some particular combination of flooding and erosion attributes.

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6d. Vector Overlay – In ArcMap

- ArcToolbox
- Available Functions:
  - Union – see slide 6c. "Atbox-An Tools-Overlay-Union"
  - Intersect – see slide 6c. "Atbox-An Tools-Overlay-Intersect"
  - Clip ("cookie cutting") – see slide 6c. "Atbox-An Tools-Extract-Clip"
  - Merge – appends two or more layers together to create a new layer (e.g., side by side). "Atbox-Data Management Tools-General-Append"
  - Dissolve – reduces number of features by merging adjacent features with the same attribute value. Creates a new layer. "Atbox-Data Management Tools-Generalization-Dissolve"
- In ArcMap – all under Geoprocessing menu

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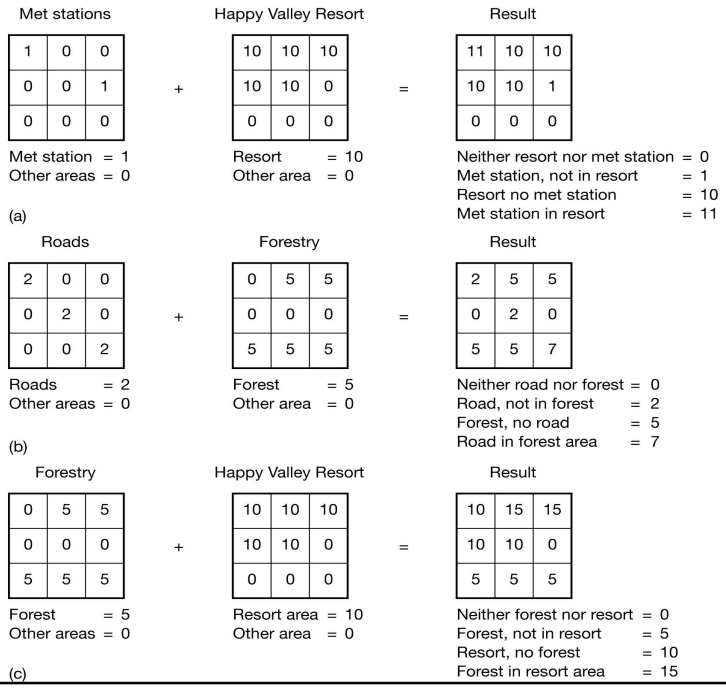
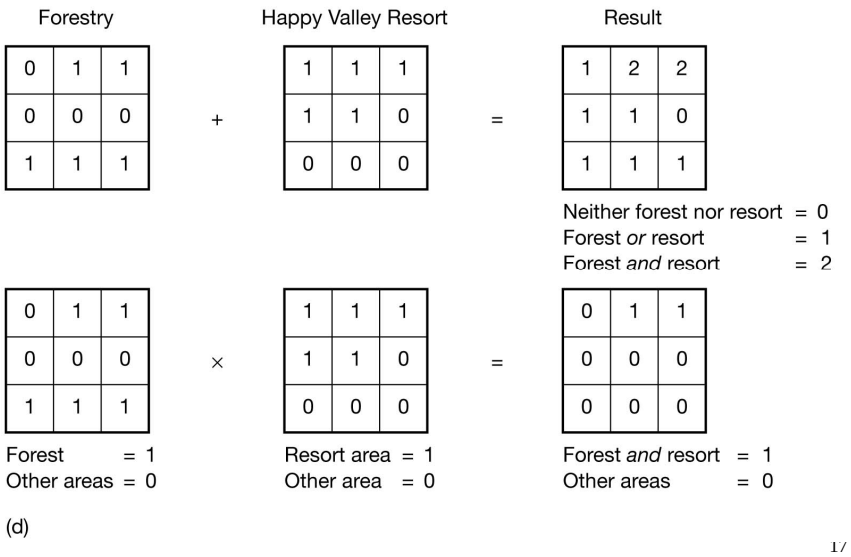
6e. Raster Overlay

- "Map Algebra" or "Mapematics"
- Two raster layers with same cell size
- Can add, subtract, multiply, divide them to produce a new layer
- **In ArcMap: Spatial Analyst extension, "Raster Calculator"**

Raster overlays: (a) point-in-polygon (using add); (b) line-in-polygon (using add); (c) polygon-on-polygon (using add)



Raster overlays: (d) polygon-on-polygon (Boolean alternatives)



(d)

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7. Transformations

- Functions to transform a layer of one feature type to another. Some examples:
  - Point to line: interpolation (contour mapping) (Bolstad ch. 13)
  - Point to polygon: buffering
  - Polygon to polygon: dissolve/merge
- Raster to vector conversion
  - **In ArcMap**, 3-D analyst extension, convert, raster to features. OR ArcToolbox, 3-d Analyst Tools, Conversion, from raster
- Vector to raster conversion
  - **In ArcMap, ArcToolbox**, Conversion Tools, to Raster
- Raster to Triangular Irregular Network (TIN)
  - **In ArcMap**, 3-D analyst extension, conversion, raster to TIN
- Resampling a raster grid – convert one cell size to another cell size

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8. Reclassification

- Converting attribute table field values to some new field and values
  - Example: Converting a landuse layer with 21 different landuse categories to a layer that is just "forest (1) or no forest (0)." Polygons with value of 10 (forest) should get a value of 1 (yes); otherwise 0 (no).
  - Example: Satellite image classification
- Can be done in vector or raster
- In ArcMap:
  - "Reclassification" in ArcMap help refers to raster…
  - Vector – 1) edit the layer using the editor toolbar; (2) Open its attribute table; (3) options, add new field; (4) right click on new field heading, choose **field calculator**
  - Raster – either: (1) Spatial analyst, reclassify or raster calculator options; or in 3-D analyst "Reclassify"

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9. Network Analysis

- Networks are sets of interconnected lines through which resources can flow.
  - E.g., roads, rivers, powerlines
  - Concept of "Impedance values" (attributes of line segments such as speed limits of roads, etc)
- Classic networking problems:
  - Shortest path
  - Traveling salesman problem (visit many locations in a day – what is the quickest route to them all?)
  - Location-Allocation modeling (e.g., matching supply of services with demand through a road network)
  - Route tracing (ability to trace the flow of goods, people, services or information through a network of lines)
- ArcGIS - Network Analyst extension

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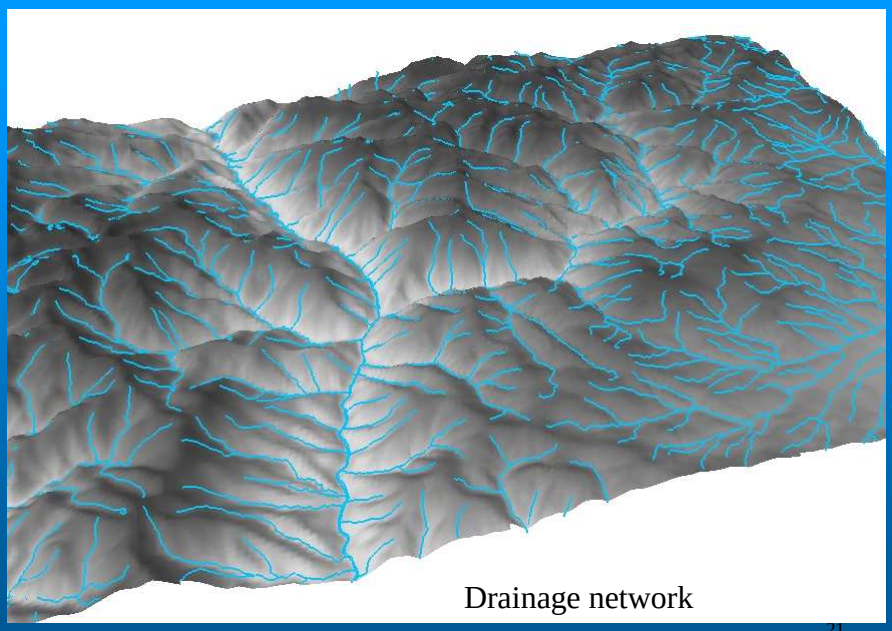

Drainage network

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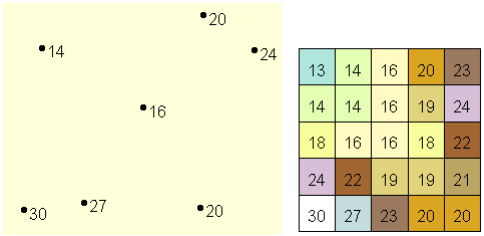
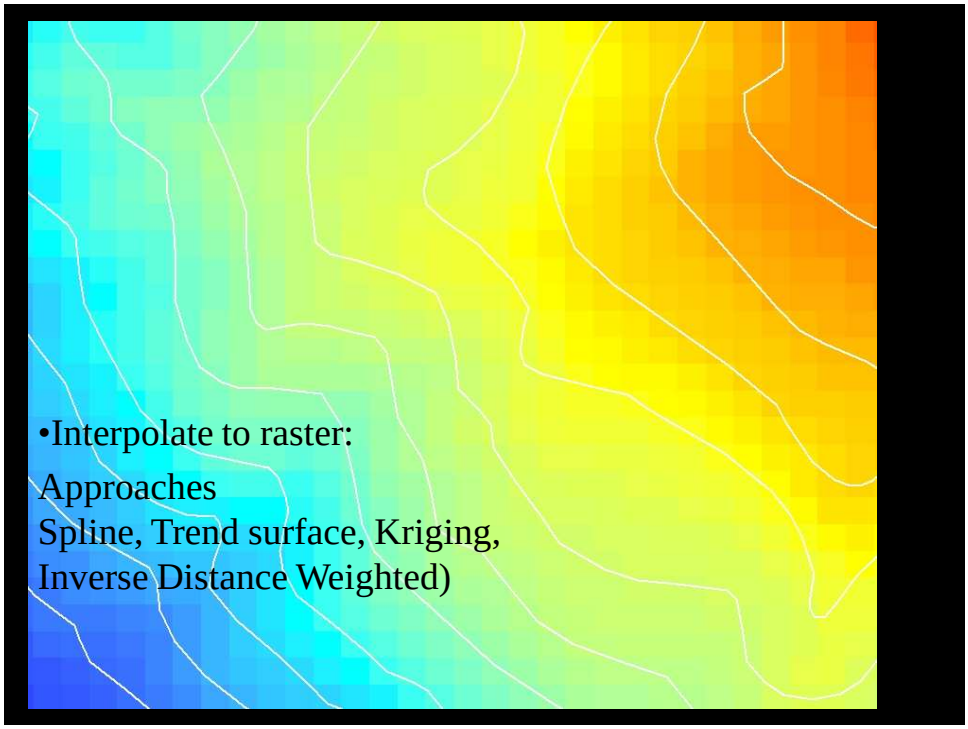
10. Spatial Interpolation

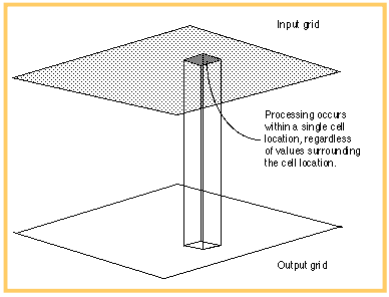
- Procedure of estimating values of properties at unsampled sites within an area covered by existing observations (Waters, 1989)
  - Example: Develop height contour map based on sampled points where elevation is known
- Bolstad, Chapter 12
- **In ArcMap,** "geostatistical analyst" extension or ArcToolbox "geostatistical analysis tools"
- **Also available in** Spatial Analyst extension, "interpolate to raster"





11a. Grid Analysis – Local Functions

- Calculate output grid values based on the values from multiple grids at the same location (raster calculator – see slide 6e)



- Local statistics on two or more grid themes
  - Majority, maximum, mean, median, minimum, sum, etc.
- **In ArcMap**, spatial analyst, cell statistics

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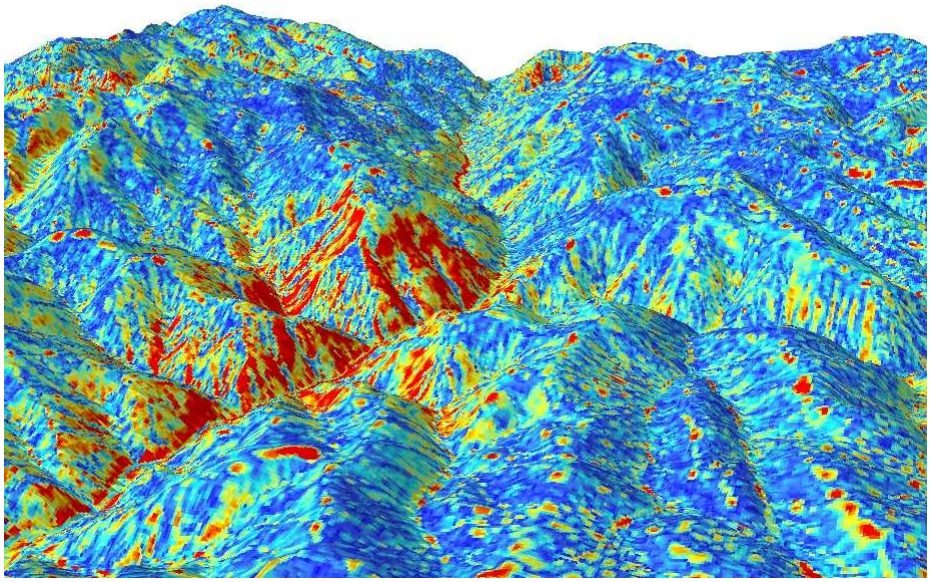
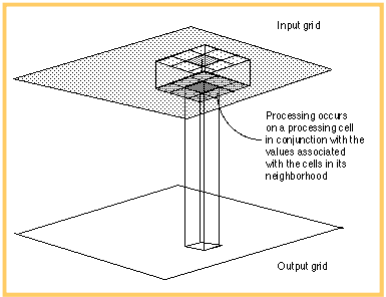
Standard deviation of 5 DEMs calculated with different methods



11b. Grid Analysis – Neighborhood Functions

- Can also calculate statistics on cells that are found within a neighborhood. Neighborhood shapes:
  - Rectangle
  - Circle
  - Doughnut
  - Wedge
  - Irregular



- Statistics produced:
  - Majority, maximum, mean, median, minimum, sum, etc.
- **In ArcMap**, spatial analyst, neighborhood statistics

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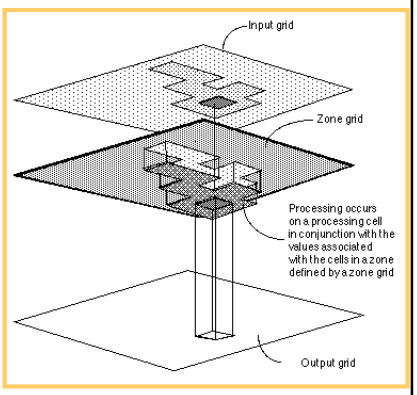
11c. Grid Analysis – Zonal Functions

- Zonal functions produce an output grid where the value of each cell depends on the value of the input raster at that location and the association of that value with other cells of the same value across the input raster.



- **In ArcMap**, spatial analyst, zonal statistics

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12. Surface Analysis

- Contour
- Slope
- Aspect
- Hillshade
- Visibility analysis… (“Viewshed” in ArcMap)
- **In ArcMap**, Spatial Analyst extension, “Surface analysis”; Also in 3-D analyst.

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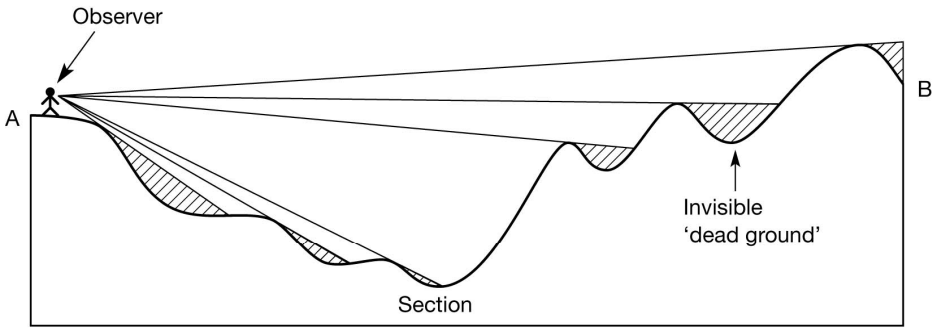
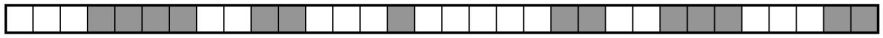
Ray tracing for visibility analysis

Visibility Analysis



Single line through section A–B in intervisibility matrix



Visible Not visible

In ArcMap: 3-D Analyst, surface analysis, viewshed

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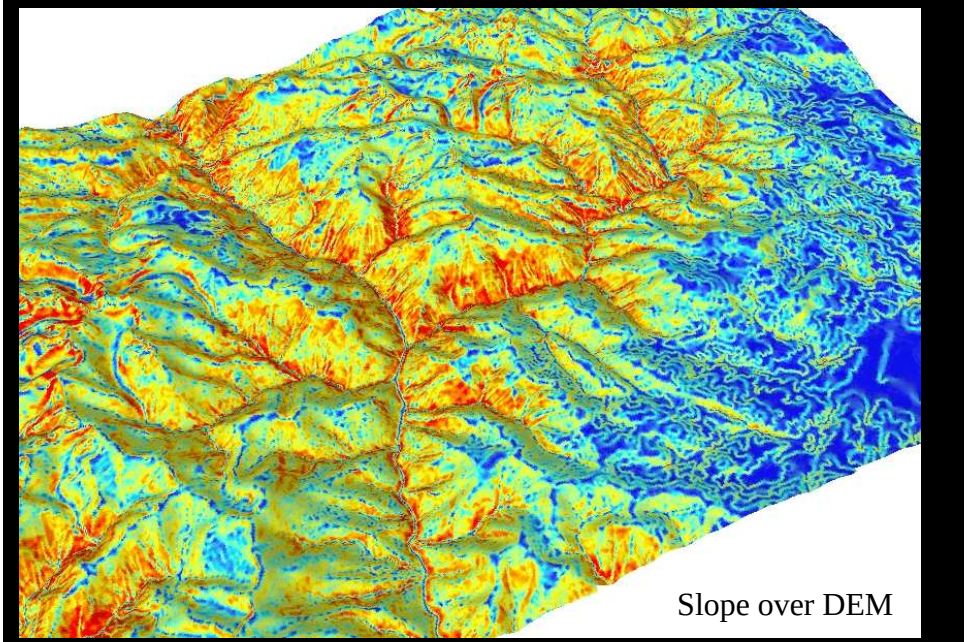
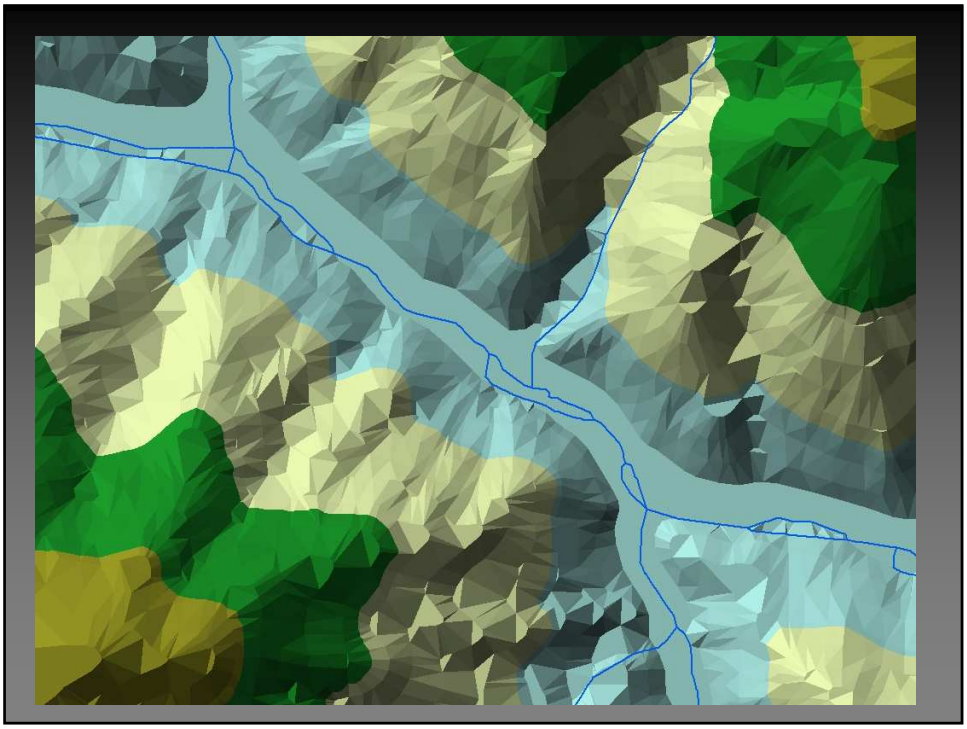
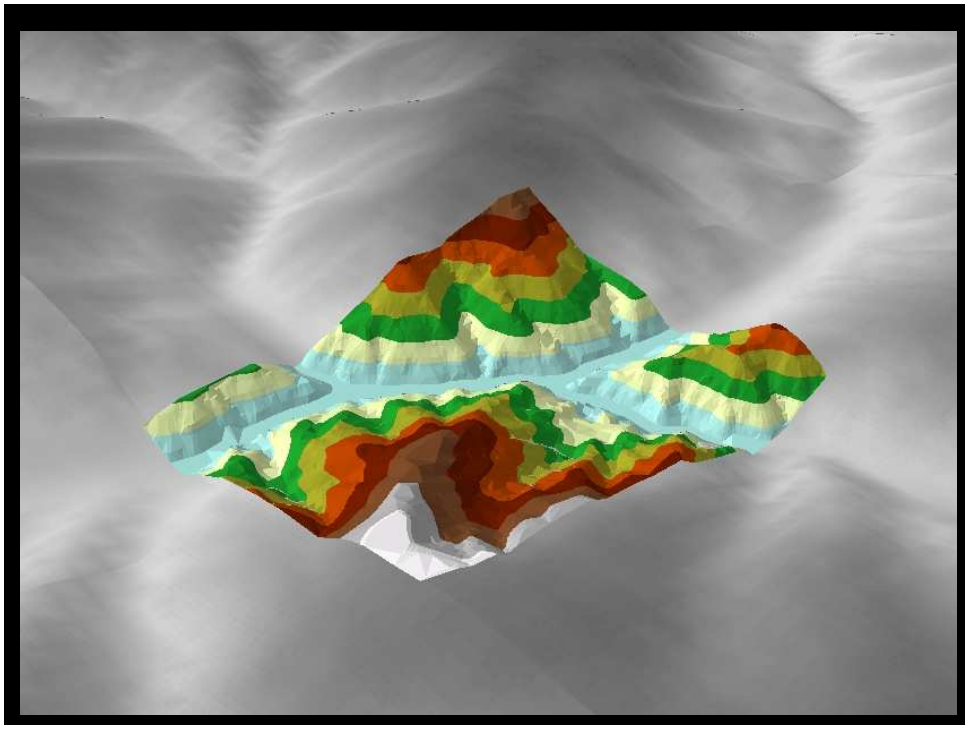


TIN derived from contour data





13. Other ArcGIS Spatial Analyst functions

- Hydrologic Analysis
- Density mapping
- Multivariate statistics (e.g., classification, principle component analysis,

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3 Dimensional
visualization/city planning

(ArcScene)