Lecture 9: Raster Data Operations/Analysis

Geography 373
Fall, 2006

Contents of Lecture
- Map Algebra

Raster or Vector
- While most GIS systems can handle raster, vector data, only one is used for the internal organization of spatial data

Raster Data
- Represent reality through selected surfaces arranged in a regular pattern
  - Uniform, regular cells: rectangular, triangular
- Each cell (pixel) is identified by row and column
  - Geometric resolution depends on cell size
- Raster data model uses a grid
  - One grid cell is one unit holding one attribute
  - Every cell has a value: missing, n.a.
  - Cell contains either number or letter (index)

Raster Data
- Best for continuous data
- No complex data structure
- Embedded spatial relationships
  - Adjacency
  - Connectivity
- Overlay operation
  - Arithmetic: +, -, *, /

Raster Data Value Encode
- Nominal data
  - Tree species, soil type, parcel owner names
- Ordinal data
  - Class with poor, moderate, good order
- Interval data
  - Temperature
- Ratio data
  - Precipitation, income
**Raster Data Type**
- Satellite imagery
- Digital Elevation Model (DEM)
- Digital Orthophoto Quads (DOQ)
- Digital Raster Graphics (DRG)
- Binary scanned files
- Graphic files

**Image Pixel**
- Derived from picture element
- Tiny square that represents the smallest elements into which a digital image is divided
- Numerical value to each pixel
  - 0-255
- DPI
  - Dot per inch

**LANSAT TM Image**
- TM band 2 – visible green
- TM band 4 – near IR

**LANSAT 7 ETM 30 m**

**IKONOS 4 m**

**Description of Raster Grid**
- Green = 19/48
Map Overlay

Local Operator

- At the same location
- Input and Output
  - The output value at each location is a function of the value associated with one or more grids at that location
  - The value of the single cell has a direct influence of the value of the output
  - A per-cell function can be applied on a single grid or on multiple grids
- e.g.
  - Single grid: trigonometric, exponential, logarithmic
  - Multiple grids: minimum, maximum, majority, minority value

Map Algebra

- A language specifically designed for geographic cell-based systems
- The algebra maintains the power of the mathematical base underlying the cell-based structure
- Developed by C. Dana Tomlin
- 3 types of operations
  1. Local operators: work on single cells
  2. Focal operators: work on cells within a neighborhood
  3. Zonal operators: work on cells within zones

Local Operator

- Assignment
  - Assign new values to cells
- Reclassify
  - Change specific values or ranges of values
- Recode
  - Change measurement scales
  - Use only one input layer
  - Binary masking: Letter → 1, 0
  - Classification ranking: number → index
- Overlay
  - Use multiple input layers
  - Boolean operations
  - AND, OR

Recode
Focal Operator

- Within a neighborhood
- Input and Output
  - The output value at each location is a function of the input value at that location and values of the cells in a specified neighborhood around the location
  - A neighborhood configuration determines which cells surrounding the processing cell should be used in the calculation of each output value
  - Nearness, window
  - e.g.
    - mean, standard deviation, sum within immediate or extended neighborhoods

Focal Operator

- Neighborhood types
  - Rectangle
  - Circle
  - Doughnut
  - Wedge
  - Irregular

Focal Operator

Input grid

Output grid

Zonal Operator

- Input and Output
  - The output value at each location depends on the value of the cell at that location and the association that location has within a cartographic zone
  - Similar to focal functions
    - except that the definition of the neighborhood in a zonal function is the configurations of the zones or features of the input zone grid
    - Not a specified neighborhood shape
  - e.g.
    - mean, standard deviation, sum from the first layer that falls within a specified zone of the second

Zonal Operator
Comparison of Vector vs. Raster based data Analysis

- Same Operations can be used for both data, but cannot run them together.
  - distance measure operation, overlay, buffering, and map manipulation for both data
- Differences existing between them

<table>
<thead>
<tr>
<th>Vector</th>
<th>Raster</th>
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<tbody>
<tr>
<td>Create point, line, and polygon.</td>
<td>Create points, lines, and polygons. Combine geometries, and create more complex geometries and spatial analysis.</td>
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<tr>
<td>Create spatial relationship, such as overlap.</td>
<td>Create spatial relationships, such as overlap, proximity, and spatial relationships.</td>
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<tr>
<td>Create buffer zones.</td>
<td>Create buffer zones. Use vector processing for creating buffer zones.</td>
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<tr>
<td>Create continuous distance measure.</td>
<td>Create continuous distance measure. Use raster processing for creating distance measures.</td>
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<tr>
<td>Create overlay.</td>
<td>Create overlay. Combine geometries and attributes, compute intersection and union.</td>
</tr>
<tr>
<td>Create new geometries, such as intersect and union.</td>
<td>Create new geometries, such as intersect and union.</td>
</tr>
<tr>
<td>Create attributes, such as area and extent.</td>
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</tbody>
</table>

Homework

- Read Chapter 13