Watershed Sciences 4930 & 6920
GEOGRAPHIC INFORMATION SYSTEMS

WEEK SEVEN - Lecture
ANALYSES COMBINING VECTOR AND RASTER DATA

Joe Wheaton

WHAT DOES ‘COMBINING’ MEAN?

We’ve worked with raster & vector data throughout the semester...
• Does it mean preserving data type but using both:
  - Convey information?
  - Perform analyses?
• Does it mean conversion?
  - e.g. Raster -> Vector
  - e.g. Vector -> Raster

TODAY’S PLAN

I. Review
II. Using Vector & Raster Data Simultaneously to:
   I. Convey Information
   II. Perform Analyses
III. Converting Between Raster & Vector Data Types
   I. Types of Conversions
   II. Classification
   III. Interpolation
   IV. Analysis
IV. Summary & Reminders

REVIEW - DISCRETE vs. CONTINUOUS

• Spatially Continuous Fields
  - Only rasters can represent continuous fields
• Spatially Discrete Objects
  - Vector data (points, polygons, polylines) are always spatially discrete
  - Raster data can be discrete (only when represented as an integer)
REVIEW - POINT VECTOR DATA

- A collection of points with attributes: Point Number, Easting (x), Northing (y), Elevation (z), Description, etc.
- Variety of acceptable formats: Ascii text (*.txt or *.asc or *.dat), tab or comma delaminated (*.csv), excel (*.xls), or shape files (*.shp and *.shx).

Important to have a header & know units.

REVIEW - RASTER DATA

- On a pre-specified uniform grid
- From the header or world file, you have all the necessary information to georeference the raster
- Why raster? Can be smaller file sizes, easier computationally.
- Arc Ascii Grid common:

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USING VECTOR & RASTER DATA SIMULTANEOUSLY

- Overlaying information for better context...
- LAYERS!

A GEOLOGY MAP: JUST GEOLOGY...

A GEOLOGY MAP: MORE VECTOR DATA
A GEOLGY MAP: ADD DRG USGS BASE

A GEOLGY MAP: ADD HILLSHADE RASTER

CONTEXT OF AN AERIAL PHOTO...

• These vector data are draped (elevated) according to a raster DEM
• Combining the data with an orthophoto helps set the context

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PERFORMING ANALYSES

Most examples are of using vector data to analyze or sample raster data
• Extraction: Using points to extract raster values at specific locations on a raster
• Profiling: Using polylines to extract raster values along a route
• Spatial Masking: Using polygons to perform a segregated raster analysis
• Clipping: Using polygons to trim a dataset down...

EXTRACTION

• Use points showing spawning locations to extract water depth values from the raster

Spawning locations of Chinook Salmon (red) overlaid on a water depth map – Mokelumne River
**SAMPLING**

- Extraction for multiple layers

**PROFILING**

- Extract raster values (DEM elevations) along a polyline at every vertex...

**MASKING**


**CLIPPING**

- Use a polygon to clip a raster dataset

**LEAST-COST PATH**

- A cost raster identifies the cost of traveling through each cell.

  - So steep and forested is expensive; flat & urban cheap

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TYPES OF CONVERSIONS

**Vector to Raster**
- Point to Raster
- Polyline to Raster
- Polygon to Raster

**Raster to Vector**
- Raster to Point
- Raster to Polyline
- Raster to Polygon

**Point to Raster**
- Various ways to convert points to a raster
- When multiple points are in a cell, its based on combination of most frequent & priority
- When points are sparse, just the cells with a point get a value, the rest are no data
- Choice of raster resolution critical!

**Polyline to Raster**
- A common method of going from one discrete representation to another
- Applications:
  - Classifications
  - Boundaries
  - Masks
  - Boolean Logic

**Polygon to Raster**
- Extracts the raster value and assigns it to a point located at the center of each grid cell
- Useful if you need to have continuous data discretized to finite number of points (e.g. a uniform stakeout)

**WHY BOTHER CONVERTING TO RASTER?**
- Raster Math (allowing global cell-by-cell calculations using raster calculator)
- Rasters are easy to export and many spatial models are raster based
- There are a plethora of raster-based analyses available
RASTER TO POLYLINE: DRAINAGE NETWORK DEFINED

- Connect cells above threshold
- Stream Order

We’ll talk about this in next Tuesday’s Lecture

RASTER TO POLYGON

- Only works for discrete (integer) or classified rasters
  - Can’t convert DEM
  - But a reclassified DEM into elevation bands can be...
  - Watershed delineations can also be converted

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CLASSIFICATION TENDS TO BE RASTER -> VECTOR

- If manual, we call this digitizing

A special case of raster -> polygon

IMAGE CLASSIFICATION

- Buildings
- Streets
- Sidewalks
- Landscaping
- Water
- Vegetation

Primarily raster-based classification of continuous surfaces into discrete integer surfaces; then converted to vectors

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**INTERPOLATION...**

- Many types of interpolation
- Based on assumption of spatial correlation

![Image](image1.png)

We'll talk about this in next Thursday's Lecture (week from today).

**BUILDING A TIN FROM VECTOR DATA**

A Triangular Irregular Network (TIN) is the simplest and most common interpolation technique for building surfaces with irregularly spaced elevation data (McCullagh, 1981)

![Image](image2.png)

**TIN TO DEM**

What is an appropriate grid resolution?

- Should be fine enough to resolve ______
- Should not be too much finer than the resolution of available data
- Some f(topographic complexity, point density)

**THE N-SQUARED PROBLEM**

<table>
<thead>
<tr>
<th>Resolution (m)</th>
<th>Dimensions</th>
<th>Total # of Cells</th>
<th>Bytes (Double 64 bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2 x 2</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>50</td>
<td>4 x 4</td>
<td>16</td>
<td>128</td>
</tr>
<tr>
<td>25</td>
<td>8 x 8</td>
<td>64</td>
<td>512</td>
</tr>
<tr>
<td>20</td>
<td>10 x 10</td>
<td>100</td>
<td>800</td>
</tr>
<tr>
<td>10</td>
<td>20 x 20</td>
<td>400</td>
<td>3200</td>
</tr>
<tr>
<td>5</td>
<td>40 x 40</td>
<td>1600</td>
<td>12,800</td>
</tr>
</tbody>
</table>

- Doubling the resolution squares the number of cells!
- Arbitrary increases in resolution lead to larger file sizes and longer computational time...

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**ANALYSIS**

- Conversions, classifications and interpolation have all been shown to be useful forms of analysis
- Are there any other analyses that result in a conversion between vector and raster, but that are not direct conversions, classifications or interpolation?
  - Density
    - Kernel Density
    - Line Density
    - Point Density
**SURVEY POINT DENSITY**

A unique type of moving window analysis that produces a density raster from point vector data.

**ANOTHER DENSITY EXAMPLE...**

- Bonneville Cutthroat Trout

  Can we identify hot spots where these fish are found in high densities?

**PIT TAG LOCATIONS**

- Mobile antennae surveys
- PIT tags plotted from Lat/Long coordinates
- What’s wrong with these?

**THE NEAR TOOL**

- Analysis Tools > Proximity > Near
- Location must be checked

**PIT TAGS SNAPSED**

Points “snapped” to the stream by plotting the new coordinates from the Near tool.

**POINT DENSITY TOOL**

The Point Density Tool creates a raster based on characteristics of an input point feature.
POINT DENSITY OUTPUT
This doesn’t do much good without better symbology or a reclassification.

RECLASSIFICATION
• Density units odd… so just used 10 equal interval breaks and turned zeros into NoData

BROWN & CUTTHROAT TROUT HOTSPOTS
What if I wanted to go back to line?
• I want to attribute the line...
• So instead of density being points per area, they'd be Points per unit or Points per length of line...

FLUVIAL AUDIT... POOL INVENTORY
• How many pools are in each reach?
• OR What reach are the pools in?
• Isn’t this just a vector data question?

WHAT I WANT IS...
• A new column that has how many poos (i.e. points) in each reach (just counts)
• Then I can use field calculator to divide by reach length...
ACTUALLY...

• Deciding exactly what you want/need to address a question is the challenge...
• Lots of ways to get there...

To get what reach pools are in:
• Ran a Buffer Analysis on stream polyline to create a polygon buffer with Flat End type of 10 m around stream reach
• Did a Spatial Join to bring the column from the reach file over to the point features (pools in this example)...

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TODAY’S SUMMARY

Analysis combining raster and vector data can:
• preserve data type but use both to:
  - Convey information more clearly
  - Perform analyses otherwise not possible
• mean converting between
  - Raster -> Vector
  - Vector -> Raster

READING FOR TUESDAY

Reading for Tuesday, March 1st
Read Chapter 10 on Tissue Analysis from Rubble's (2003).