GIS Model to Rank Private Lands for Conservation Opportunity Areas

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Outline

- Brief introduction of the background
- Multi-criteria decision making method
- Automate analyses using GIS model
- Potential for other applications
Brief introduction of the background

- Create a GIS model to rank private land parcels by multiple factors for the Current and Eleven Point Conservation Opportunity Areas
  - Size of tract
  - forest cover
  - Riparian corridor condition
  - Proximity to public lands
  - Presence of heritage records
  - Distance from roads
Multi-criteria decision making method

**Determine Factors**
- Parcel: Area/size
- Forest: Percentage
- Stream: Buffer -> percentage
- Public land: Average distance
- Heritage: Number of records
- Road: Average distance

**Quantify Factors**

**Normalize Factors**

**Weight Factors**

**Overall Index**

Normalize factors:

\[
\frac{\text{Value} - \text{Min}}{\text{Max} - \text{Min}}
\]

Weighting factors:
- Simply assign weights
- AHP method

Calculate overall index:

\[
\text{Index} = \sum_{i=1}^{n} W_i \cdot N_i
\]

- \( W_i \): Weight value for Factor i
- \( N_i \): Normalized value for Factor i
Automate analyses using GIS model

- Started from ArcGIS 9.1, Modelbuilder was provided to streamline GIS spatial processes
- The whole decision making process can be automated by building a GIS model in modelbuilder
- The GIS model developed for this project was mainly based on raster analysis
Overall GIS model

Original data and parameters

Clip data to study area

Quantify and normalize individual factors

Calculate overall index using assigned weight values for different factors
Zonal Raster preparation

- Convert land parcel polygons to raster
- Create a raster of value 1 for factor normalization
- They will be used many times in sub-models
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Quantify/normalize parcel area

- Calculate parcel area (pixels)
- Calculate the minimum area
  
  \[(\text{Value} - \text{Min})\]

- Calculate the area range (Max-Min)

- Normalize area by
  
  \[
  \frac{(\text{Value} - \text{Min})}{(\text{Max-Min})}
  \]
Quantify/normalize parcel area
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Quantify/normalize forest cover

Extract forest from LULC raster

Calculate forest area (pixels) for each parcel

Calculate the minimum value

(Value – Min)

Normalized forest cover
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Quantify/normalize forest cover
Quantify/normalize Stream buffer

1. Create stream buffer
2. Calculate stream buffer area (pixels) for each parcel
3. Calculate the minimum value (Value – Min)
4. Normalize stream buffer area
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Quantify/normalize Stream buffer area
Quantify/normalize distance to public land

1. Calculate distance raster
2. Find the maximum distance
3. Divide each parcel distance with the maximum distance
4. Calculate min distance for each parcel
5. Revise the value so closer distance will rank higher
Quantify/normalize distance to public land

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Quantify/normalize distance to Road

1. Calculate distance raster
2. Calculate min distance for each parcel
3. Find the maximum distance
4. Divide each parcel distance with the maximum distance
Quantify/normalize distance to Road
Quantify/normalize heritage records

1. Convert to raster
2. Make 0/1 raster
3. Calculate heritage records (pixels) for each parcel
4. Find the maximum value of heritage records
5. Calculate percent heritage for each parcel
Quantify/normalize heritage records
Assign weight values for different factors

➢ Determine weight values before performing GIS analysis
  □ Simple assigned weights
  □ AHP (Analytic Hierarchy Process) analysis by pair-wise comparison of factors

➢ Assign weights in the weight sum function

<table>
<thead>
<tr>
<th>Factor</th>
<th>Weight value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land parcel area</td>
<td>3</td>
</tr>
<tr>
<td>Forest area</td>
<td>4</td>
</tr>
<tr>
<td>Stream buffer area</td>
<td>5</td>
</tr>
<tr>
<td>Distance to Public lands</td>
<td>4</td>
</tr>
<tr>
<td>Heritage records</td>
<td>3</td>
</tr>
<tr>
<td>Distance to Roads</td>
<td>0</td>
</tr>
</tbody>
</table>

![Weighted Sum](image)
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Overall ranking map
Potential for other applications

- GIS model and sub-models can be standardized and re-used for other projects or applications
- The overall structure/method can be used for other multi-criteria decision making applications
- GIS model can be integrated with AHP or other weight techniques to get more reasonable results
- Others…