Assessing Available Agricultural Biomass Using Geographical Information Systems

Brittany Crocker
Student at the University of Minnesota, Morris
Biomass Research Intern at the West Central Research and Outreach Center (WCROC)
Introduction

- Rising demand for energy
  - Sustainability
  - Renewable energy source

- Agricultural biomass
  - Crop Residues
  - Energy Crops
Geographic Information Systems (GIS)

- A computer-based technology allowing users to analyze and visualize any spatially-referenced data.
- Aerial photographs, satellite images, Digital Elevation Models (DEM), digitized maps, etc.
- Global Positioning System (GPS)
  - Geographic location
How is GIS Applicable?

- Harvesting locations
  - Soil types
  - Terrain analyses
- Transportation costs
- Storage space
Soil Properties

- Reflects productivity
  - Water
  - Nutrients
  - Erosion
- MN DNR Data Deli and USDA Natural Resources Conservation Service
Terrain Analyses

- Properties of productivity
  - Available Sunlight
  - Water flow
  - Erodibility

- GIS
  - National Elevation Dataset (NED)
NED of Stevens County, MN

Data source: USGS Seamless Server
Hillshade of Stevens County, MN
Slopes of Stevens County, MN
Aspects of Stevens County, MN
Example of Multi-layer Terrain Analysis
Transportation

- Is there an optimal range?
  - Type of feedstock
    - Deterioration rate
    - Density
  - Type and size of industry
    - Bulk discount
    - Small and local
  - Type of contract
    - Producer or purchaser
Using GIS to Assess Transportation

- With private GIS software
  - Online data source
    - Government or scientific, many are available free
  - Download files (e.g. shapefiles)
  - Create a buffer zone
    - Visualize available cities, agricultural sources, biomass energy conversion plants, etc.
Using GIS to Assess Transportation

- With public GIS software
  - Online: MapQuest, Google Maps, Yahoo! Maps, and MSN Live Search Maps
  - On demand interactive maps all around the world.
    - Maps, satellite images, and terrain models
  - Driving directions
    - Distance and estimated travel time

**Total Estimated Time:** 41 minutes  **Total Estimated Distance:** 33.84 miles
Storage

- Amounts of storage space needed and available must be taken into consideration
- Global Positioning System (GPS) to survey the area
How a GPS Works

- Communicates with satellites
  - 21+ satellites
  - Each orbits Earth twice daily
  - Typically 4-8 visible at any given location
- Each satellite sends a radio signal
- The GPS calculates the distance
- Requires a minimum of 3 satellites

Satellite orbits (adapted from Bolstad, 2006)
a) With a range measurement from one satellite, the receiver is positioned somewhere on the sphere defined by the satellite position and the range distance, r.

b) With two satellites, the receiver is somewhere on a circle where the two spheres intersect.

c) With three satellites the receiver is at one of two points where the three spheres intersect.

d) With four satellites, the receiver is at the one point where the four spheres intersect.

Range measurements from GPS satellites (Bolstad, 2006.)
Using GIS to Assess Storage

- Collect Waypoints
- Record tracks
- Calculate areas
- Trimble GPS unit
- North & South lots in Morris, MN
- Walked the perimeter and each row of feedstock

http://www.envisupply.com/rentals/instruments/TrimbleProGPS.htm
## South Storage Lot in Morris, MN

<table>
<thead>
<tr>
<th>Item</th>
<th>Area (m²)</th>
<th># of Bales in Row</th>
<th>Area (m²) per Bale</th>
<th>Area (ft²) per Bale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Bale Row 1</td>
<td>212.71</td>
<td>103</td>
<td>2.07</td>
<td>22.23</td>
</tr>
<tr>
<td>Corn Bale Row 2</td>
<td>216.68</td>
<td>96</td>
<td>2.26</td>
<td>24.30</td>
</tr>
<tr>
<td>Corn Bale Row 3</td>
<td>226.94</td>
<td>108</td>
<td>2.10</td>
<td>22.62</td>
</tr>
<tr>
<td>Corn Bale Row 4</td>
<td>248.47</td>
<td>108</td>
<td>2.30</td>
<td>24.76</td>
</tr>
<tr>
<td>Corn Bale Row 5</td>
<td>202.82</td>
<td>101</td>
<td>2.01</td>
<td>21.62</td>
</tr>
<tr>
<td>Corn Bale Row 6</td>
<td>223.68</td>
<td>107</td>
<td>2.09</td>
<td>22.50</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>221.88</strong></td>
<td><strong>103.83</strong></td>
<td><strong>2.14</strong></td>
<td><strong>23.00</strong></td>
</tr>
</tbody>
</table>

*Based on 3-2-1 stacking*
South Storage Lot in Morris, MN

<table>
<thead>
<tr>
<th>Item</th>
<th>Area (m²)</th>
<th>Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Lot</td>
<td>8,716.00</td>
<td>2.19</td>
</tr>
<tr>
<td>Corn Bale Row 1</td>
<td>212.71</td>
<td>0.05</td>
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<tr>
<td>Corn Bale Row 2</td>
<td>216.89</td>
<td>0.05</td>
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<tr>
<td>Corn Bale Row 3</td>
<td>256.94</td>
<td>0.06</td>
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<tr>
<td>Corn Bale Row 4</td>
<td>248.47</td>
<td>0.06</td>
</tr>
<tr>
<td>Corn Bale Row 5</td>
<td>202.82</td>
<td>0.05</td>
</tr>
<tr>
<td>Corn Bale Row 6</td>
<td>123.68</td>
<td>0.03</td>
</tr>
<tr>
<td>Wood Chips 1</td>
<td>449.51</td>
<td>0.11</td>
</tr>
<tr>
<td>Wood Chips 2</td>
<td>332.52</td>
<td>0.08</td>
</tr>
<tr>
<td>Truck Dugout</td>
<td>123.11</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Total Occupied Space</strong></td>
<td><strong>2,236.44</strong></td>
<td><strong>0.55</strong></td>
</tr>
<tr>
<td><strong>Remaining Unoccupied Space</strong></td>
<td><strong>6,179.56</strong></td>
<td><strong>1.60</strong></td>
</tr>
</tbody>
</table>
North Storage Lot in Morris, MN

<table>
<thead>
<tr>
<th>Item</th>
<th>Area (m²)</th>
<th>Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Lot</td>
<td>3431.54</td>
<td>0.77</td>
</tr>
<tr>
<td>Feedstock Row 1</td>
<td>347.81</td>
<td>0.09</td>
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<tr>
<td>Feedstock Row 2</td>
<td>462.52</td>
<td>0.11</td>
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<tr>
<td>Feedstock Row 3</td>
<td>488.15</td>
<td>0.12</td>
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<tr>
<td>Total Occupied Space</td>
<td>1299.48</td>
<td>0.32</td>
</tr>
<tr>
<td>Total Unoccupied Space</td>
<td>1832.03</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Where Else Can GIS Be Used?

- Weather, climate, water
- Facility emissions
- Mobile GIS and GPS harvesting and tracking
Conclusion

- Precise, accurate, transferable
- Save time & money
Acknowledgements

- Mike Reese
- Lowell Rasmussen
- USDA
- Joel Tallaksen
- Jim Barbour
- Curt Reese
- WCROC Staff
References


