Using the Geodesign to Model Development Trends in Upstate South Carolina

A Template for GeoDesign and Comprehensive Planning

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Outline

• The Geodesign Process
• Process Modeling
  – Land Use and Environment
• Growth Models
  – Development Trends
  – 2030 Vision Plan
• Future Planning
  – The Competition for Land
• 3D Modeling
Emphasis on land use development

Taught planners, landscape architects and developers

Address the urban and rural transition of the Upstate

- The Geodesign process
- Design and quantitative assessment

Worked with Ten at the Top

- Greenville /Spartanburg region
- 10 Upstate counties
- Seneca and Lake Keowee
Spatial Modeling
Visualization for Spatial Thinkers
The Geodesign Process

• Followed Carl Steinitz’s Alternative Futures for Changing Landscapes
  ∙ Developed over 3 decades from his original work at Harvard

• Developed deterministic models for landscape analysis and urban planning
  ∙ Built the database or Representation
  ∙ Find the Process for development and environmental patterns
  ∙ Developed growth scenarios
    • Forecast population and employment
    • Change Models
  ∙ Competition for Land
    • Evaluate the Impacts
  ∙ Downtown Seneca
    • The design is a Decision model

• Used with Ten at the Top
Spatial Modeling

• **Deterministic Models**
  - Models having no random components
  - A given input always produces the same output

• **Stochastic Models**
  - Models whose output is described by a probability distribution

• **Suitability Models Verses Climate Change Models**

Goodchild, 1993
Computer Models

• Human verses Computer
  - Too much emphasis on the machine doing it all
  - It is better to look at a combination of both

• Humans are stronger at understanding spatial patterns than computers

• Models should not be a black or gray box
  - Models must be understood and easily explained
    • Fred Smith, Harvard University (1974)

• Models are really visualization tools for discussion
2010 Development

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2010 Development

- 2010 Development
- Primary Limited Access or Interstate
- Primary US or State Highway
- Secondary State and County Highway
- Urban Areas
- Lakes and Rivers
- Counties

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## Development / Opportunities

- The models explore the criteria underlying land use location
- The models explored:
  - High-end residential
  - Suburban residential
  - Rural residential
  - Mixed Use
  - Commercial
  - Industrial

## Environment / Constraints

- The models explore the constraints of the natural environment
- The models explored:
  - Agriculture Preservation
  - Surface Water Quality
  - Groundwater Quality
  - GAP Analysis
  - Viewshed Analysis

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Development Models
Final Development Model

- High End Housing
- Suburban Housing
- Rural Housing
- Mixed Use
- Commercial
- Industrial

Primary Development Locations

Subwatersheds and Catchments

Mean Development Opportunities

Development Opportunities by Catchments
Development Trends

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Development Trends
- Most Likely Development
- Least Likely Development
- Interstates
- Primary Limited Access or Interstate
- Primary US or State Highway
- Secondary State and County Highway
- Lakes and Rivers

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December, 2010
Raster to Vector - Catchment Level
Environmental Models
Environmental Constraints by Catchments
Change Models

Scenario Planning

Environmental Quality

Development Trend

Change Models
Located in the fifth most sprawling metropolitan region in the United States (Ewing et. al., 2002)

Actual Census figures are:
- 1,362,000 population
- 532,000 households
Lost Forest Land Since 1992

- Lost forest land is nearly the combined size of Greenville and Cherokee Counties
Planning for our Future - Reduce Land Consumption

59% of survey participants called for at least 40% reduction in land consumption over next 20 years

Trend

40% reduction in land used for new development
Environmental Resources

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Environmental Resources

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Development Trends
2030 Trend Plan

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2030 Trend Plan
- Existing Development (2010)
- Urban Development (2011-2030)
- Rural Development (2011-2030)
- Primary Limited Access or Interstate
- Primary US or State Highway
- Urban Areas
- Lakes and Rivers

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2030 Vision Plan

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2030 Vision Plan
- Existing Development (2010)
- New Development (2011-2030)
- Primary Limited Access or Interstate
- Primary US or State Highway
- Urban Areas
- Lakes and Rivers

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Competition for Land

The Spine to Protect the Landscape
Development Zones
Green Infrastructure

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Green Infrastructure

Forest Patches
- 1 to 100 Acres
- 100 to 1,000 Acres
- 1,000 to 10,000 Acres
- 10,000 to 100,000 Acres
- Greater than 100,000 Acres

Riparian Corridors
Steep Slopes
Stewardship Area
Lakes and Rivers
2010 Development

Primary Limited Access or Interstate
Primary US or State Highway
Secondary State and County Highway

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2030 Land Use Plan

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2030 Land Use Plan
- Primary Development Zones
- Secondary Development Zones
- Primary Agricultural Zone
- Stewardship Area
- Primary Environmental Zones
- Secondary Environmental Zones
- Riparian Corridors
- 2010 Development
- Lakes and Rivers
- Urban Areas
- Primary Limited Access or Interstate
- Primary US or State Highway
- Secondary State and County Highway

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## Threat Matrix

<table>
<thead>
<tr>
<th>Development Trend</th>
<th>Environmental Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td>5</td>
<td>5 5 5 4 3</td>
</tr>
<tr>
<td>4</td>
<td>4 5 4 4 3</td>
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<tr>
<td>3</td>
<td>4 3 4 3 2</td>
</tr>
<tr>
<td>2</td>
<td>3 2 2 2 1</td>
</tr>
<tr>
<td>1</td>
<td>2 1 1 1 1</td>
</tr>
</tbody>
</table>

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Conflicting Lands

[Maps showing land use and environmental threats in South Carolina]
Scenarios Planning

Discussion for Balanced Plan
Scenarios Planning

• Scenarios Encourage Discussion
  - Environment
  - Projection
  - Economy

• A Balanced Plan
  - Pro Growth
  - Non Sprawling
  - Protects the Environment
Economic Scenario

- Need **55,919** acres of new development
- Assume a **doubling** of the projected growth rate
- Assume highest household size because the emphasis on jobs
- All land uses are in the top 20th percentile
- Environmentally sensitive lands are not as critical
  - Focused growth in the areas with the moderate environmental constraints
  - The lower 40th percentiles

**Population Forecast**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population, 2030</td>
<td>492,000</td>
</tr>
<tr>
<td>Population, 2000</td>
<td>250,000</td>
</tr>
<tr>
<td>Increase in Population, 2000-2030</td>
<td>242,000</td>
</tr>
<tr>
<td>Average Household Size, 2030</td>
<td>2.0</td>
</tr>
<tr>
<td>Increase in Households, 2030</td>
<td>121,000</td>
</tr>
</tbody>
</table>

**Economic Land Use Forecast (2000-2030)**

<table>
<thead>
<tr>
<th>Type of Development</th>
<th>2030 Density (units/acre)</th>
<th>Percent of Total Units</th>
<th>Distribution of 2030 Households</th>
<th>New Development (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-End</td>
<td>0.50</td>
<td>33%</td>
<td>39,930</td>
<td>19,965</td>
</tr>
<tr>
<td>Suburban</td>
<td>0.75</td>
<td>17%</td>
<td>20,570</td>
<td>15,428</td>
</tr>
<tr>
<td>Rural</td>
<td>0.25</td>
<td>40%</td>
<td>48,400</td>
<td>12,100</td>
</tr>
<tr>
<td>Mixed Use</td>
<td>0.13</td>
<td>10%</td>
<td>12,100</td>
<td>1,573</td>
</tr>
<tr>
<td>Employment Acreage</td>
<td></td>
<td></td>
<td></td>
<td>6,853</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>55,919</strong></td>
</tr>
</tbody>
</table>
Stream Health and Impervious Surface

- Analysis at the subwatershed level
- Affects water quality, habitat, hydrology and stream stability
  - Impacted at 10%
  - Degraded at 25%

Adapted from Arnold Jr.; Chester L and C. James Gibbons, 1996, Modified from Schueler 1992
Impervious Surface
Impacted Watersheds

- Lake Hartwell will be impacted by development from Anderson and Easley

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### Watersheds by Percent Change

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Subwatersheds</th>
<th>Percentage Change</th>
<th>Mean Impervious Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental</strong></td>
<td>42</td>
<td>&gt;25%</td>
<td>2.26</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>&gt;50%</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>&gt;100%</td>
<td>3.94</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>&gt;150%</td>
<td>5.28</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>&gt;200%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Projected Growth</strong></td>
<td>43</td>
<td>&gt;25%</td>
<td>11.78</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>&gt;50%</td>
<td>17.03</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>&gt;100%</td>
<td>20.74</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>&gt;150%</td>
<td>24.27</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>&gt;200%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>174%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>44</td>
<td>&gt;25%</td>
<td>2.26</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>&gt;50%</td>
<td>3.52</td>
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<tr>
<td></td>
<td>31</td>
<td>&gt;100%</td>
<td>3.94</td>
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<tr>
<td></td>
<td>16</td>
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<td>5.28</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>&gt;200%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>174%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Table:**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Category</th>
<th>Subwatersheds</th>
<th>Square Kilometers</th>
<th>Hectares</th>
<th>Square Miles</th>
<th>Acres</th>
<th>Percent of Seneca Watershed</th>
<th>Mean Impervious Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Mean &lt;10%</td>
<td>42</td>
<td>2,864</td>
<td>286,355</td>
<td>1,106</td>
<td>707,584</td>
<td>99%</td>
<td>2.26</td>
</tr>
<tr>
<td>Environmental</td>
<td>Mean &lt;10%</td>
<td>42</td>
<td>2,864</td>
<td>286,355</td>
<td>1,106</td>
<td>707,584</td>
<td>99%</td>
<td>3.52</td>
</tr>
<tr>
<td>Projected Growth</td>
<td>Mean &lt;10%</td>
<td>41</td>
<td>2,761</td>
<td>276,121</td>
<td>1,066</td>
<td>682,295</td>
<td>96%</td>
<td>3.94</td>
</tr>
<tr>
<td>Economic</td>
<td>Mean &lt;10%</td>
<td>39</td>
<td>2,721</td>
<td>272,052</td>
<td>1,050</td>
<td>672,241</td>
<td>95%</td>
<td>5.28</td>
</tr>
</tbody>
</table>

| 2001              | Mean >10%   | 2             | 26                | 2,613    | 10           | 6,455  | 1%                          | 13.56                   |
| Environmental     | Mean >10%   | 2             | 26                | 2,613    | 10           | 6,455  | 1%                          | 18.27                   |
| Projected Growth  | Mean >10%   | 3             | 128               | 12,847   | 50           | 31,745 | 4%                          | 18.14                   |
| Economic          | Mean >10%   | 5             | 169               | 16,916   | 65           | 41,798 | 5%                          | 17.84                   |

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3D Modeling

Visualizing Planning Policy with CityEngine
Seneca Concept

Lake Keowee

Seneca

Oconee Rural and Suburban Housing

New Compact Development
New Urbanist Transects

T5

Open Space

T4

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Street Network

- Primary Corridor
- Primary Street
- Secondary Street
Street Types

- 14 ft
- 9.8 ft
- 12 ft
- 82 ft

- 9.8 ft
- 11.5 ft
- 32 ft
Commercial District
Build Mass and the Street Network
Lake District - T4 and T3

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The Town Center - T5
Integrate with the Existing Land Use
Downtown
Downtown
TOD Site
Downtown
Conclusion

• GIS Training In City and Regional Planning
  Ń Spatial Modeling & Comprehensive Planning
  Ń Land Use Change
    • Growth and Competition for Land
  Ń 3D Modeling
  Ń Using Standard ArcGIS capabilities with Excel
    • Familiar interface
    • All planners can use

• Future
  Ń GIS and Geodesign Certificates
    • Online or on-campus
    • Incorporates planning and design
    • Taking geographic considerations into the design process

Sustainability Index – William Aultman
This Year’s Graduates

- Sam Rubin
- Gregory Gordos
- Chris Clauson
- Heather M. Peterson
- Qianying Wu
- Latoisha Green
- Craig Chandler