Land Suitability Models and Maps for Sustainable Sandhills Technical Summary

Background

Sustainable Sandhills is a nonprofit organization leading a planning effort in the Sandhills region of North Carolina. The US Environmental Protection Agency awarded a grant to support a three-year project for Sustainable Sandhills to engage local communities and businesses in the creation of custom regional models and maps that will be the basis for sustainable land use and related policies and collaborative actions. The Division of Community Assistance (DCA), the US Fish & Wildlife Service (FWS) and the NC Center for Geographic Information and Analysis (CGIA) developed critical GIS datasets to support regional sustainability planning. CGIA is providing technical services in support of a regional modeling effort.

Conceptual Design

Land suitability analysis is a method for evaluating, classifying and mapping a regional landscape. Suitability represents potential for a type of land use, not actual use or predicted use. The conceptual design relies on specification of criteria to apply to the best available geospatial datasets. Before looking at data, the concepts and criteria are developed by project stakeholders within the framework of answering key questions about sustainable land use. For this project, the key questions are:

- What makes an area most suitable for each land use type? (criteria)
- Where are the most suitable areas? (map)
- How much area? (table)
- Where are locations that are suitable for more than one land use type? (interpreting and combining maps)

Sustainable Sandhills used a rule-based, expert-opinion approach to developing criteria. This approach relies on the experience and judgment of local experts in economic development, business, planning, conservation, forestry, farming, and environmental protection. The project organized land suitability analysis around six land use types: industrial development, commercial development, residential development, natural areas, working forests, and working farmland.

The rule-based approach poses questions about each type of land use. What makes a particular location highly suitable for land use A? What land characteristics are most important? What features are most important to be in or near? Does suitability depend on satisfying an entire set of rules (e.g., near a road, and in a sewer service area, and near dense settlements) or satisfying any one of a set (e.g., in an endangered species habitat or next to a stream)? Are the suitability factors equally important or are some more important than others (e.g., more weight on the ratings for roads than sewer service)?

The stakeholders considered specific land features and qualities (e.g. tree cover, soil type, water features) and location relative to factors that can be represented on a map (e.g., major roads, streams, public sewer service areas, wildlife habitat, factories, dense settlements). Local experts developed specific criteria (how near is near, how far is far, what are the relative values or ratings based on coincidence and proximity, and what are the relative weights of different factors (e.g., prime farmland soils versus cropland).

Creating Models to Represent the Concepts

The project created models to produce the maps and numbers needed to inform the region about suitability in the context of sustainability. The guiding principles for modeling were to make the processes simple, transparent, and replicable. The project team applied Model Builder, a tool within ArcGIS 9.1, Spatial Analyst Extension (ESRI). The diagram and report features as well as the familiarity of the project team with the software tools from previous projects made this tool suitable for the modeling process. The modeling steps may be summarized as the following:

- Clarify and record in spreadsheet format the criteria and rules
- Determine best available geospatial data to represent the concepts and express the criteria in geospatial terms (i.e., data layers, selections, distance)
- Group the data layers to represent the concepts (e.g., land features, location factors, assets, constraints)
- Specify the ratings (1 to 9 with 9 the highest suitability) to represent the rules
- Specify relative weights for combining layers within groups
- Prepare the geospatial datasets (layers)
    - One meaningful value field per layer
    - Create buffers around features to represent proximity
    - Convert to grid cells (cell size = 98.4 feet = 30 meters on a side)
- Create models to process the grids (raster data)
    - Organize the datasets
    - Reclassify to represent the 1-9 ratings
    - Use map algebra to assign maximum or minimum values from a group of layers
    - Weighted overlays combine layers within a group or combine groups
    - Extract by mask to exclude cells or trim to region boundaries
- Symbolize the results in map designs
- Export tables from the grid results to count cells and convert to acres
- Review results and refine based on stakeholder comments

Using Models to Analyze the Results

The land suitability maps display areas in the region that have distinct suitability for one of the land use types. More common are areas that are suitable for more than one land use type. Using the grid results from the six suitability models, comparisons of one suitability type versus another and comparisons of grouped types are structured by reclassifying the cell values to distinguish the cells for which suitability types (or groups) overlap. These are just a few of the analyses that are practical using Model Builder tools and grid data for the 11-county region. Other (vector) datasets mapped on top of models results also provide insights into current land use and future scenarios.

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