Using Deterministic Models for Long Range Future Growth in an Urban/Rural Watershed

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Abstract: *With people, retirees especially, desiring to take advantage of the aesthetic and recreation opportunities afforded by lakeside living, extensive sprawl is becoming apparent along the edges of Lakes Hartwell, Keowee and Jocassee. This is resulting in intense pressure on the region's water resources. Gentrification of the lakes is a major issue confronting planning in South Carolina. The contributions of current development practices to water quality degradation are well known. However, development alternatives need to be explored, as well as, their potential impacts be quantified. To address this need, the Seneca Creek Subdrainage Basin project designed alternative future scenarios for the drainage basin and use spatial models to evaluate the potential consequences on water resources.*

Keywords: Planning Scenarios, Subwatersheds, Growth Models, Green Infrastructure, GIS.

I. INTRODUCTION

This paper presents the first phase of a scenario planning study. It used the general methodology of the "Alternative Futures" process developed originally by Carl Steinitz of Harvard University. The process was tailored to watershed planning. The planning process brought together the region's stakeholders. It used process models and alternative growth scenarios. The results should improve our understanding of the landscape processes, land development, and hydrologic planning policy.

Growth models were developed for alternative development scenarios. The team used a Geographic Information System (GIS) to visualize with maps and images, as well as, assess impacts of land use change. The results indicate innovative development practices targeting hydrologic protection are possible in the drainage basin. This process can become a model to reduce the hydrologic impacts from Lake Gentrification.

This study assessed the potential land use possibilities for the Seneca sub-drainage basin. Center of the study area is Lake Keowee, a lake of exceptional quality and is considered to be among the nation's best. Unfortunately, sediment, heavy metals, and fecal coli-form can impair a number of feeder streams. These impediments can threaten health, recreational opportunities, and property values. They heighten concerns because Keowee is the primary source of the area's rapid economic progress. It serves as a major source of drinking water for local residents and the City of Greenville.

The object of this paper is to present the use of deterministic growth models using GIS and spreadsheets for presenting reliable growth analysis to the region's stakeholders in cost effective way. This approach relied on existing software tools and free government data.

II. THE ISSUES

The project using the "Alternative Futures Assessments" process was presented to the county planning commissioners, local activist groups, residents and the president of the Oconee Homebuilders Association. The issues identified by the participants included:

- Protecting lake water quality and natural resource protection,
- Creating marina mixed-use developments as magnets for tourism,
- Generating jobs,

- Developing programs to protect farm-based communities,
- Encouraging high-density development where there is existing infrastructure.

Using a GIS to create growth models and a green infrastructure plan, over 67,000 housing units were located. Clemson students suggested alternative development patterns to protect the prime agricultural resources.

III. THE APPROACH

The principle objective of the project is to assist the counties and regional leaders in deciding the future planning policy for the watershed. The fragile terrestrial and aquatic areas are likely to undergo considerable change in the coming years. Without introducing effective regulatory controls, the region is in serious danger of damaging its economic and ecological foundation and threatening the sustainability of the area.

Only a multi-disciplinary, regional scale study can include the range and interaction of factors that will shape the future of the region. The framework is proactive and well suited for carrying out a rapid and comprehensive assessment of the major planning options. It incorporates the most important ecological and economic impacts. The central task is to forecast land use patterns based on different sets of assumptions regarding the amount and type of pressures facing the region over the next twenty years under different development and conservation priorities and policies. The team investigated trends and smart growth options in urban development, tourism, transportation, and infrastructure investment. It assessed the economic and ecological consequences. The study assigned conservation priorities to terrestrial and aquatic areas based on habitat, visual, and development criteria. The economic aspect of the study will focus on the employment and income influences of different conservation and development alternatives and possibly to forecast their impacts on land values.

The alternatives include scenarios that represent maximum plausible development and maximum plausible conservation for the region over the next 20 years, as well as an additional scenario that represent less extreme policies, balancing growth and conservation. The Clemson team organized a multi-scale study for the region as a whole and one for the specific urban areas around Lake Keowee and Lake Hartwell. There are clearly contentious issues to be addressed while planning the future economic and ecological landscape for the region. The study set the framework for reflecting the impact of positions taken across the spectrum by all stakeholders, including developers, politicians, farmers, and citizen groups. Rather than recommending one course of action upon the completion of the study, the framework process produced a range of alternatives and assessed the implications of each alternative. The Clemson team found this method compelling and presented information conducive for encouraging better policy decisions.

The team conducted in the first phase a comprehensive assessment using GIS methodologies to analyze the issues, options, impacts, and choices at a level that is informative and visual. The informational basis for the analysis included the results of prior scientific studies and experiences of experts. The expectations included:

- A process to enhanced public participation and awareness of water quality issues and stakeholder knowledge of ecosystem processes.
- New local planning policies to protect water quality by increasing policymakers' willingness to support watershed policy
- Protect and improved the long-term water quality of the sub-basin's water bodies.

The approach's strength is compiling the best existing information, and packaging it in a format that is easily accessible and understandable by policymakers and stakeholders. The study provides a basis for better-informed decisions and highlights the areas that require the greatest concern and perhaps immediate action. One potential outcome was the identification of areas where substantial research programs and policy should be undertaken in the future.

While scientific knowledge is an important input into solid public policy, the project provided a framework to combine and integrate technical information with local values. In this way, the approach addressed both the technical and political sides of the decision-making process, enhancing the prospects for translating the results

of the study into concrete actions. Further, the study approach estimated the future impact of available policy options, rather than creating a hypothetical vision for the future without a clearly specified technical and political path for achieving the same. The analytical tools and data developed in the study provided the basis for future policy analysis, monitoring, and study. Therefore, one of the study objectives is to make the tools and data available to appropriate local and regional organizations at the end of the project.

IV. CONCLUSION

This paper presented the first of three steps the Alternative Futures process. The project resulted in different spatial plans expressed in the three scenarios. They show the spatial pattern and location of the modeled growth. New land use policies and related regulations will exert influence on the pattern of future land use. The ecological, visual, and aquatic impacts of the alternatives will vary according to the alternative land use patterns. The performance of these factors influences the projected economic success for the Seneca region. It will create a situation in which the environmental and economic outcomes are correlated with the economic and environmental outcomes in harmony.

A potential conflict in the watershed's future lies between pursuing actions that entail only short-term benefits while ignoring the more politically difficult medium-term and long-term objectives for water quality and social cohesion. The result of this study points to potential losses expected for all – including landowners – if excessive or under development occurs. This transformed the problem into one of educating the stakeholders on the risks and opportunities, and allocating the development rights in a way that considers both equity and the necessity of incorporating the spatial criteria and water quality in deciding land use rights.

The modeling process is not the traditional black box approach of large university research grants or federal research projects. Using students in class environment, standard tools of GIS and spreadsheet software the Clemson team has shown a replicable process for planning professionals in local planning agencies or consulting firms who have GIS capabilities. It opens the door for using models as conversational tools by stakeholders in a region.

V. KEY REFERENCES

Arnold Jr.; Chester L and C. James Gibbons *Impervious Surface Coverage: The Emergence of a Key Environmental Indicator*, Journal of the American Planning Association, 1939-0130, Volume 62, Issue 2, 1996, Pages 243 – 258

Clarke, K C, and Gaydos L 1998 *Loose-coupling a cellular automaton model and GIS: long-term urban growth prediction for San Francisco and Washington/Baltimore*. International Journal of Geographic Information Science 12 (7): 699-714

Forman, Richard TT 2008. *Urban Regions: Ecology and Planning Beyond the City,* Cambridge University Press, Cambridge/New York

Forman, R. T. T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, Cambridge/New York.

Hulse, S.W., et al, 2000. *Planning alternative future landscapes in Oregon: evaluating effects on water quality and biodiversity*, Landscape Journal, 19(2) 1-19,

Jantz C A, Goetz S J, Shelley M K, 2004, "*Using the SLEUTH urban growth model to simulate the impacts of future policy scenarios on urban land use in the Baltimore – Washington metropolitan area"* Environment and Planning B: Planning and Design 31(2) 251 – 271

Schueler, T. K. 1994a. The Importance of Imperviousness Watershed Protection Techniques 1,3:100- 1 1.

Steinitz, Carl et al, 2003. *Alternative Futures for Changing Landscape,* Island Press, Washington, DC

Waddell P 2000. *A behavioral simulation model for metropolitan policy analysis and planning: Residential location and housing market components of UrbanSim*. Environment and Planning B 27(2): 247-263.