ASSESSING THE FEASIBILITY OF A GIS-INTEGRATED FISCAL IMPACT MODEL FOR LOCAL GOVERNMENTS

by

BETH LINNEA NIELSEN

(Under the Direction of Jeffrey Dorfman)

ABSTRACT

This case study assessed the potential of a Geographic Information Systems-integrated fiscal impact model as an analytical tool to assist local governments in growth, development, and planning decisions. The financial statements of Athens-Clarke County, Georgia were first analyzed to produce a cost of community services study and identify figures from the Comprehensive Annual Financial Report and the Department of Finance for spatial representation. Financial figures were uniquely allocated on a per parcel basis to produce a visual representation of the spatial variation in revenues, expenditures, and net effects for fiscal year 2011 financials. Results indicate that, despite government investment in GIS technology, the capabilities of a GIS-integrated fiscal impact model are limited by inaccuracy within currently available datasets and inconsistency across departments.

INDEX WORDS: fiscal impact model, GIS, geographic information systems, cost of community services study, local government, planning, growth, management

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CHAPTER 1

INTRODUCTION

URBAN SPRAWL AND SMART GROWTH

The past quarter century has seen a remarkable change in the responsibilities and authority delegated to local government, and in some cases, the unintentionally negative consequences of unpreparedness. Beginning in the late 1970s, there has been an increasing need for reliable and expedient local-level information due to changes such as deregulation, welfare reform, education reform, health care reform, and block grants that have populated national policy dialogue in recent years (Thomas *et al.,* 1996). Communities across the nation and especially in rural and agriculturally-dependent areas face the pressure of continuous economic expansion without the security that once protected local public sectors from financial risk. Economic growth has long been at the forefront of public policy, but never more so than after the recession of the late-2000's. Persistently high levels of unemployment and low consumer confidence have elevated "economic growth" to buzz word status on campaign trails, promising prosperity and job creation in the near future. But is growth the answer?

For this discussion, Kinsley and Lovins' (1995) distinction between growth as actual expansion in a community's size and development as "vigorous enterprise and a decent standard of living" will be used, as economic stability requires development but not necessarily growth. Many communities unfortunately do not recognize or consider the costs associated with expanding their tax base, arguing correctly that new growth provides jobs, and choose expansion over enhancing existing assets as the solution to long-term economic sustainability. This type of hasty, poorly planned and/or uncoordinated growth is characteristic of urban sprawl, defined by Carruthers et al. (2003) as "low-density, discontinuous, suburban-style" communities. Growth may not always be wrong, but time must be taken to consider whether it is in the best interest of the public, and especially when dealing with public infrastructure; it is the "seminal role that public works play in social formation and their ubiquitous influence in our everyday lives that make an understanding of public infrastructure policy important" (Perry, 1995). Failures in public infrastructure often stem from hastily made decisions, jeopardize the community, and dramatically alter its economic future. On the other hand, "sustainable development (development that can endure for the foreseeable future) also offers jobs without the problems of growth...enhancement and modernization of existing structures (development) employs people without necessarily requiring increases in public services" (Kinsley and Lovins, 1995). Similar to enhancement and modernization, the concept of urban or suburban infill aims to increase population density by promoting development or growth in spaces previously outdated or unoccupied.

Concern about hasty, uncoordinated growth and its effects on municipal revenues and expenditures have been at the forefront in recent years, particularly because of popular eco-centric smart growth policies designed to curb and/or remedy urban sprawl. There has been a significant amount of literature on sprawl, the results of which suggest it undermines the cost-effective provision of urban services, decreases the quality of those services while increasing local tax burdens for established residents, and is thought to be associated with various health problems in adults and degraded air quality (Carruthers and Ulfarsson, 2003; Ewing *et al.,* 2002;

Ladd 1992,1994; Speir and Stephenson, 2002). While the efficacy of smart growth is a contentious issue stemming largely from its vague definition and sensationalized use, its underlying goal of intelligent community maturation is sound; discussions of what is or is not smart growth in the sensationalized sense of the phrase are beyond the scope of this paper, and evidence suggests the externalities associated with sprawl are great enough that policy and planning decisions which alleviate or avoid urban sprawl are clearly justified.

The goal of economic stability coupled with devolution of responsibility puts pressure on local governments to make the “right” decisions, to grow intelligently and to develop sustainably. Since the urban sprawl phenomenon emerged in the 1960s, several analytical tools and methodologies have been developed to help municipalities understand the relationship between land use, revenues, and expenditures, and to make the decisions that are right for their community; as the saying goes, however, the only constant is change and to maintain a stable economy the tools available to government officials must evolve in efficiency, accuracy, and usability.

At present, there is no comprehensible or universal answer to the question, “How much development and/or growth does my community require,” and thus this paper neither seeks it nor attempts to define or measure smart growth and sprawl; both concepts differ across and even within communities, and no single planning, growth or development decision fits all. There have been significant increases in our ability to understand and make sense of a community’s unique relationship between fiscal impacts and land use, but there is an ever-present and growing need for reliable and logical tools to aid in municipal growth and development decisions. This paper attempts to provide one such tool to communities, by integrating fiscal impact models with spatial data to create an interactive geographic information system (GIS) designed to visually illustrate a community's current fiscal situation and the impact proposed growth and/or development would have on it. This has not been attempted before in the literature, and so this paper serves as an investigation into the possibility of GIS-integrated fiscal impact models, the availability of logical spatial components, and ultimately as a guideline for future designs. The beginning of this paper will present a review of the tools historically used in community planning decisions, follow with an extensive methodology documenting the process of integration, and finish with recommendations for future developers.

THE COST OF COMMUNITY SERVICES STUDY

Land-use planners and government officials have long turned to impact analyses in order to understand the fiscal implications of development and land use; specifically, whether the planned development will generate enough revenue in new taxes to cover the cost of providing municipal services (Muller, 1975). Two notable publications in the late 1970s, *The Fiscal Impact Handbook* (Burchell and Listokin, 1978) and *Cost of Sprawl* (Real Estate Research Corporation, 1974), acknowledged the gravity of cost-effective land-use planning, prompting the American Farmland Trust to develop a method for measuring the fiscal contributions of agricultural lands in the mid-1980s, the so-called cost of community services study. A subset of fiscal impact analysis, cost of community services studies reorganize the financial documents of a community, allocating expenditures and revenues collected to reflect the budgetary impacts of specified land uses.

The study methodology is straightforward, but ensuring that the final figures are accurate and reliable requires explicit definition. The Farmland Information Center (2010) describes three basic steps involved in a cost of community services study:

1. Collect data on local revenues and expenditures.
2. Group revenues and expenditures and allocate them to the community's major land use categories.
3. Analyze the data and calculate revenue-to-expenditure ratios for each land use category.

The inherent idiosyncrasies between communities and the differing study methodology require each COCS review to be conducted in close collaboration with the community itself, beginning with initial meetings between local representatives and case study directors to determine the scale of the project and establish the precision with which land uses will be categorized; typically, land uses are organized into farm/forest, commercial/industrial, and residential, at which point researchers begin allocating municipal revenues and expenditures to reflect such land uses.

While there are no formal guidelines for allocation and methods differ from study to study, the final result is always a ratio of revenues to expenditures, a snapshot of the community's average fiscal flows associated with specific land uses. The conclusion of most cost of community services studies is that residential ratios are less than one, indicating they require more expenditures by the local government than they generate in revenue; a ratio of 0.86, for example, implies that for every dollar spent providing services just $0.86 is generated. Similarly, ratios for agricultural and commercial/industrial are typically greater than one, suggesting that such land uses are an economic gain for communities. Appendix A is a compilation of all cost of community services studies conducted as of August 2010, from the American Farmland Trust's Farmland Information Center.

Advocates of land conservation, the American Farmland Trust, and regional planners have long used cost of community services studies to argue in favor of protecting open lands, and against the common misperception that residential growth and development decreases the tax burden on current residents by increasing the tax base (Kotchen and Schulte, 2009). From the community's perspective, agricultural and open space land uses are preferable, as most COCS studies show residential property requires more costly public services than it generates in property tax revenue (Kotchen and Schulte, 2009).

The popularity of cost of community services studies is due in part to the relative ease with which they may be conducted and their straightforward, intelligible results. With the growing popularity of commercial/residential mixed-use property, there is a growing need for more in-depth land use classifications. Averaging across landscapes into a three-category classification system glosses over many of the distinctions between land uses, creating unintentional bias in the results (Deller, 1999). Residential, commercial/industrial, and agricultural/open space are all-inclusive categories, but the issue lies in their inability to differentiate between different types of residential, commercial/industrial, and open spaces.

Residential development includes everything from mobile homes and pre-fabricated housing to apartment complexes, neighborhoods with quarter-acre lots, and retirement communities; commercial/industrial provides no distinction between factories and warehouses, "big-box" stores, and high-end retail shops. The cost of providing community services varies considerably depending on the type of development, and not just whether it is or is not residential. It is becoming clear that such general classification provides little insight into the actual budgetary impacts of current land uses.

There are a few key limitations inherent to a cost of community services study that are crucial to interpreting results correctly. A cost of community service study measures demand for services, rather than benefits to society. Consider workforce housing, generally defined as affordable housing for households whose earned income is insufficient to secure quality housing in reasonable proximity to their place of employment; there is little, if any, chance for a community to gain economically from such development, but not providing housing for these residents may be socially and politically unpopular. Similarly, certain types of industrial development are great revenue-generators for communities given their relatively low cost of service provision, but the ecological and public health implications of said industry are non-market goods, the values of which are unaccounted for in a COCS study. Cost of community services studies also introduce base measure bias in that ratios of expenditures to revenue does not reflect intensity of land use, or magnitudes of surplus or deficit (Deller, 1999). While agricultural and open space uses appear profitable in ratio form, when comparing dollar per acre values commercial/industrial development prove more important. Similarly, while it is agreed that residential land use is typically unprofitable, for a discussion on urban sprawl it would be beneficial to have revenue-to-expenditure ratios for high density housing versus the lower density, less compact residences typical of sprawl.

Finally, and perhaps most importantly, COCS studies cannot with any precision predict future costs, revenues, or impacts of planned growth, as the methodology does not consider changes at the margin. Cost of community services studies base their final ratios on average expenditures and revenues, rather than marginal figures; it may be possible to theorize the marginal costs and fiscal impacts of proposed development and land use transition from the reported average costs, though caution must be used if such judgments are to be made. The ease with which studies can be conducted and their results understood has made COCS studies extremely popular, and susceptible to misinterpretation as information on impacts of land-use change. Cost of community services studies are one of many analytical tools available to gain insight into the fiscal relationships between land uses; understanding, interpreting, and predicting the impacts of land-use change requires information about marginal costs and benefits (Deller, 1999).

IMPACT MODELING

Fiscal impact modeling is both a step beyond and an integration of fiscal impact analyses and cost of community services studies. Fiscal impact models are intended to provide local governments the ability to estimate the budgetary repercussions of planned growth, policy changes, or other effects while accounting for exogenous factors that influence fiscal flows; factors such as the density of development, location of growth, jurisdictional limitations, or projects incorporating multiple types of land use, among others.

Modeling systems have long been an important resource for authorities, valued for their ease of applicability and diversity; models are built for many reasons and at various levels of scale, scope, and complexity. As this paper focuses on modeling at the county-level, discussion will be limited to regional or local-level systems. Treyz (1993) presents two basic classifications for existing regional models: nonstructural and structural. A discussion of nonstructural versus structural models inherently becomes a debate of static versus dynamic prediction.

Nonstructural models base their predictions on historical trends and analysis of regional changes and shifts in local industry share in response to national adjustments; they are a predictor of future values based on present figures, unable to account for changes and shocks to the system. Structural models include behavioral relationships explaining how individual supply and demand shift when affected by change. The fiscal impact models discussed hereafter can be considered examples of structural models; they contain a number of variables at the discretion of government, known as policy handles, which allow researchers to forecast under alternative policy scenarios rather than simply projecting future values (Deller and Shields, 1998).

In the last quarter century, an incredible effort has been made to produce inexpensive and widely accessible models. With the creation of the impact model for planning (IMPLAN) system in the late 1970s, community and regional modeling quickly became a demanded tool among local governments for understanding and predicting financial impacts of land-use decisions. The IMPLAN system, introduced by the U.S. Forest Service, is a network of secondary data input-output models at the county level designed specifically to meet the obvious demand for inexpensive and timely impact analysis projections; today, it is a privatized system responsible for expanding research in regional economic modeling, exposing students of economics to the field, and fostering development of other, similarly accessible models (Otto *et al.,* 2006). Table 1.1 details major features of three common approaches to modeling local economies.

Table 1.1. MAJOR FEATURES OF THREE FORECASTING AND IMPACT MODELS

Input-output	Econometric	CGE
Static	Dynamic	Static (some dynamic adjustment mechanism)
Linear functions	Nonlinear functions	Nonlinear functions
Fixed technology	Technological change	Fixed technology
Demand driven	Some supply constraints	Demand and supply
No price effects	Some price effects	Full price effects
Partial equilibrium (quantity only)	Long-term equilibrium, short-term disequilibrium	General equilibrium (price and quantity)
Impact model	Impact and forecasting model	Impact model
Full employment (labor supply infinitely elastic)	Allows unemployment	Either full employment or unemployment
Household expenditure determined by average expenditure patterns	Household expenditure determined by dynamic consumption function	Household expenditure determined by utility maximization
All factor demands determined by Leontief function	Intermediate and final demands econometric	Intermediate demands; Leontief primary, Cobb-Douglas or CES (cost minimization)

Source: (Otto *et al.,* 2006)

Progression towards attainable modeling systems continued through the 1980s, when a project funded by the Western Rural Development Center produced a list categorizing all impact models by dimension or characteristic: temporal, spatial, sectoral, public service, and model building (Halstead and Johnson, 1986; Halstead *et al.,* 1991). Efforts in the last two decades have been significant in moving towards more reliable and egalitarian impact modeling systems, especially in the analysis of rural issues; beginning in 1995, the Rural Policy Research Institute (RUPRI) began promoting a nationwide, interdisciplinary system of support, outreach and communication known as the community policy analysis network (CPAN); additional research and infrastructure development led to the manifestation of a class of community policy analysis systems, or COMPAS models (Otto *et al.,* 2006). The following table contains some of the most commonly cited applications of the COMPAS modeling framework; it is an employment driven, input-output/econometric modeling framework using cross-sectional relationships to forecast changes in demographic, economic, and fiscal conditions under exogenous changes in economic activity (Adhikari and Fannin, 2011). A few commonly cited applications of the COMPAS framework are the Virginia Impact Projection (VIP; Johnson, 1991), Missouri Show Me model (Johnson *et al.,* 1996), the Iowa Economic/Fiscal Impact Model (IE/FIM; Swenson and Otto, 1998), the Wisconsin Economic Impact Modeling System (WEIMS; Shields, 1998), and the Small Area Fiscal Estimation Simulator for Texas (SAFESIM; Evans and Stallmann, 2006). Similar modeling systems have been developed in several states throughout the country, as community officials recognize their utility and the models themselves become increasingly cost-effective for local governments.

GIS-INTEGRATED IMPACT MODELING

Geographic information systems (GIS) are designed to store, display, transform, archive, communicate, capture and analyze georeferenced information (Goodchild, 1988). The utility of a geographic information system lies in its ability to represent three aspects of real world features: their location on the Earth's surface using coordinate systems, the attributes known about them, and any relationships of importance between them (Goodchild, 1988). Advances in technology will continue to make geographic information systems more affordable and accessible on a local and even individual level. Geographic information systems have shifted the social sciences, bringing new power to the analysis of cross-sectional data and integration of multiple datasets. The potential for GIS to manage and assist in municipal growth and development decisions is evident in the literature: the LandScape Information System, for instance, is a tool for managing urban landscape information and analyzing visual impacts of proposed development projects (Oh, 2001), and the Land use Evolution and Impact Assessment Model (LEAM) is a collaborative environment that "describes land use changes across a landscape that result from the spatial and dynamic interaction among economic, ecological, and social systems in the region" (Deal and Schunk, 2004). These modeling environments demonstrate the capacity for GIS and a visual interface to assist with decision-making in urban and landscape planning, however, their dominant ecological perspectives limit their ability to serve as analytical tools fostering intelligent, sustainable development and growth. The LandScape Information System, for example, is simply a viewshed and visual impact analysis tool estimating the "degree of view obstruction caused by development projects" (Oh, 2001); though Deal and Schunk's (2004) Land use Evolution and Impact Assessment Modeling environment includes an economic/fiscal impact assessment submodel, it is a growth simulation model based on land use transformation probabilities that predicts the future costs associated with alternative patterns of growth. It is a complex and admirable effort, but provides no insight as to current land use patterns, their relative fiscal impacts, and the effect a proposed building project would have in real time.

What integration of fiscal impact models with GIS will provide is a simpler, more precise, and infinitely more customized tool built upon the preferences and goals of the community itself. Fiscal impact modeling is an intricate process involving high levels of cooperation between officials and analysts, the end result of which is an instrument customized to the community's preferences and accurately representing its current land use composition; its power lies in its reflection of the community, limited only by the efforts of the model's designers and community officials. Working close with community officials, one should be able to reliably allocate revenue and expenditures to land use categories defined according to their preferences.

Integration with geographic information systems provides several benefits to the standard fiscal impact model. With the spatial accuracy afforded by GIS, measuring the effects of a proposed development's location will be more precise, and government officials and community planners will be able to easily and quickly estimate the budgetary impact of a development across several alternative locations. Arguably the greatest benefit to the community itself is that a geographic information systems-integrated model will create an interactive educational tool capable of illustrating in real time areas of net surplus or deficit within the community and modeling the spatially variable impact of a proposed building project. The so-called development impact model will give community planners, commissioners, and authorities the ability to easily use and interpret the results of impact analyses, as "mapped images are extremely powerful for displaying the spatial interactions and dynamic movement of human development patterns" (Deal and Schunk, 2004). The ability to see exactly where services are demanded within a community and estimate the cost of service delivery will allow officials to plan development and growth in an efficient manner, as well as make informed and logical decisions regarding the location of proposed and future government buildings. The location of delivered municipal services such as police protection, waste management, and fire safety is critical in communities. These service costs can be reduced given the right tools to assist in their location decisions; GIS-integrated fiscal impact models could assist community planners in determining the location of government buildings that maximizes the benefits to consumers while minimizing the cost to the community.

The literature on urban sprawl and discussion of smart growth is extensive and likely to continue, but the issue remains that smart growth policies are more often than not talked about rather than implemented. Effective policy begins with effective analysis, and with a development impact model communities have an intelligible and accurate tool to assist with the growth and development necessary for economic stability. The dynamic modeling and representation of growth and development is likely to become a key analytical tool and starting point in future work focusing on efficient growth control and impact modeling. This paper serves to establish a framework and guide for the development of tools that incorporate dynamic modeling and visual representation by focusing on a community familiar and convenient to the authors.

CHAPTER 2

METHODS

Athens, Georgia is located approximately 65 miles northeast of Atlanta and is the smallest of Georgia's 159 counties by area, yet the 18th most populous. It is home to the University of Georgia Bulldogs and boasts a student population of well over 33,000 as of Fall 2010. Population grew from 107,578 in 2004 to 116,617 in 2011, including students. As of 2000, 91.3% of the county was urban and 8.7% was rural. Because it is an attractive shopping destination for residents of the surrounding Jackson, Barrow, Oconee, Oglethorpe, and Madison counties as well as a large number of University of Georgia students coming from either outside the county or the state, Clarke County has a pull factor of 1.62 (Kriesel, 2011). The pull factor is a ratio of trade area capture to population; Clarke County, therefore, attracts 62% more customers than expected.

Athens-Clarke County (ACC) was chosen as the study area for a variety of reasons. A previously conducted cost of community services study in FY 2004 by Jeffrey Dorfman served as a reference and proved the community was familiar with the process and level of cooperation required; in addition, an updated cost of community services study and the added benefit of a GIS-integrated fiscal impact model were appealing to government officials. A summary of the FY 2004 COCS findings is included in Table 2.1.

Table 2.1. COCS STUDY FINDINGS, ATHENS-CLARKE COUNTY FY 2004

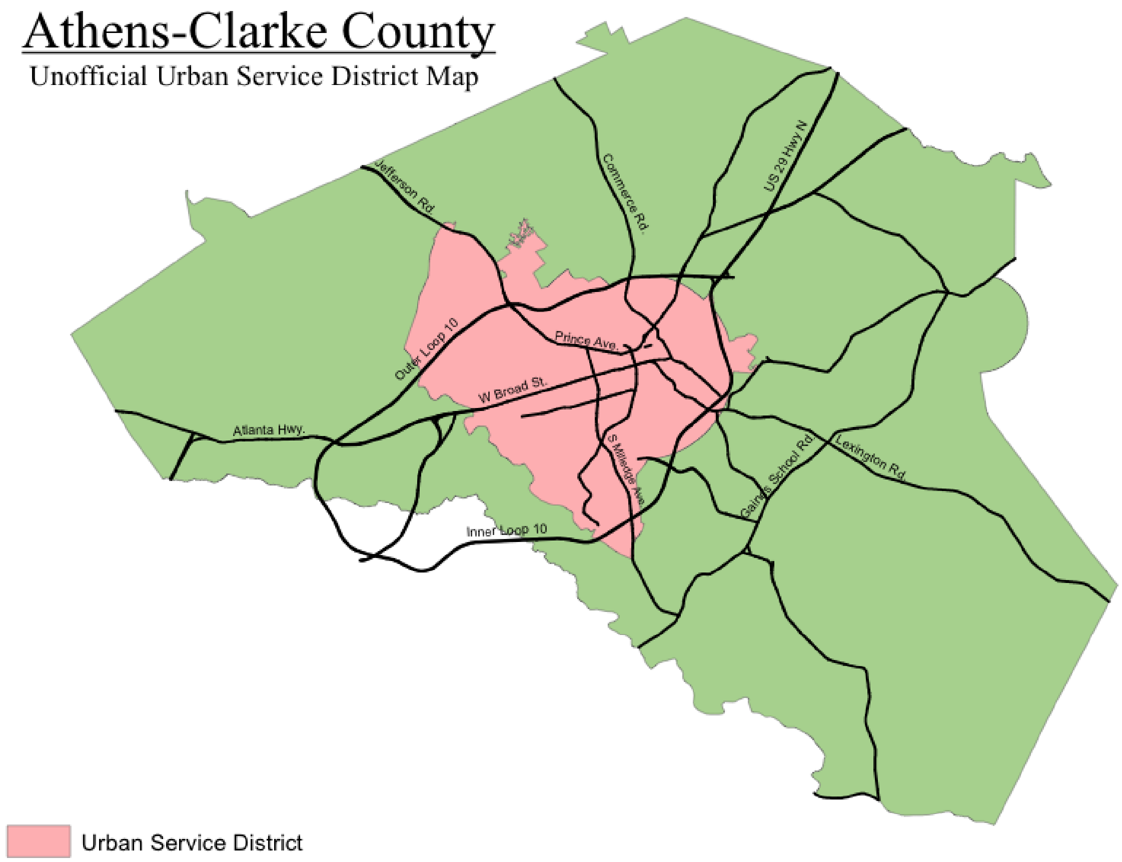
	Revenues	Expenditures	Ratio
Residential	$ 51,656,628	$ 63,312,737	$0.86 : $1.00
Commercial/Industrial	$ 31,133,534	$ 22,388,848	$1.46 : $1.00
Farm/Forest	$ 464,167	$ 1,148,383	$0.42 : $1.00
Outside	$ 4,225,150	$ --	
Total	$ 87,479,480	$ 86,849,968	

Ratios expressed as revenues to expenditures; i.e., for every $1.00 spent, $0.86 is generated in revenue.
(Source: Dorfman, 2005)

Consistent with the findings of other COCS studies, residential property costs more for ACC than it generates in revenues while commercial/industrial property is generally profitable. The FY 2004 study was unable to separate commercial and industrial land use categories and was heavily relied upon in the design of the updated study. As a result, the commercial/industrial category was unable to be separated for the FY 2011 cost of community services study for ACC. Farm/forest, typically found to generate revenue for a community, appears to be an area of net loss for Athens-Clarke County, however.

ACC land use is dominated by urban and suburban residential and commercial/industrial property, particularly within the county's Urban Service District (USD; Figure 2.1). The USD encompasses the old Athens city limits and receives additional municipal services, such as weekly trash, recycling, and leaf-and-limb collection. Residents outside of the USD are responsible for disposing of their own waste.

Figure 2.1. ATHENS-CLARKE COUNTY URBAN SERVICE DISTRICT



Due to the University's presence, much of the property in the heart of the county's service area is zoned multi-family residential and serves as rental property for University of Georgia students. As you move further away from the Urban Service District, the density of existing residential, commercial, and industrial property becomes increasingly dispersed and eventually gives way to the rural residential and agricultural land use characteristic of Clarke County's greenbelt, sweeping around the county's urban center along its borders. Athens-Clarke County is not known for large-scale agricultural production; as of 2007, 50% of farmers worked 200+ days off of their farm, as opposed to the statewide 39.9% (Kriesel, 2011). Much of the land in

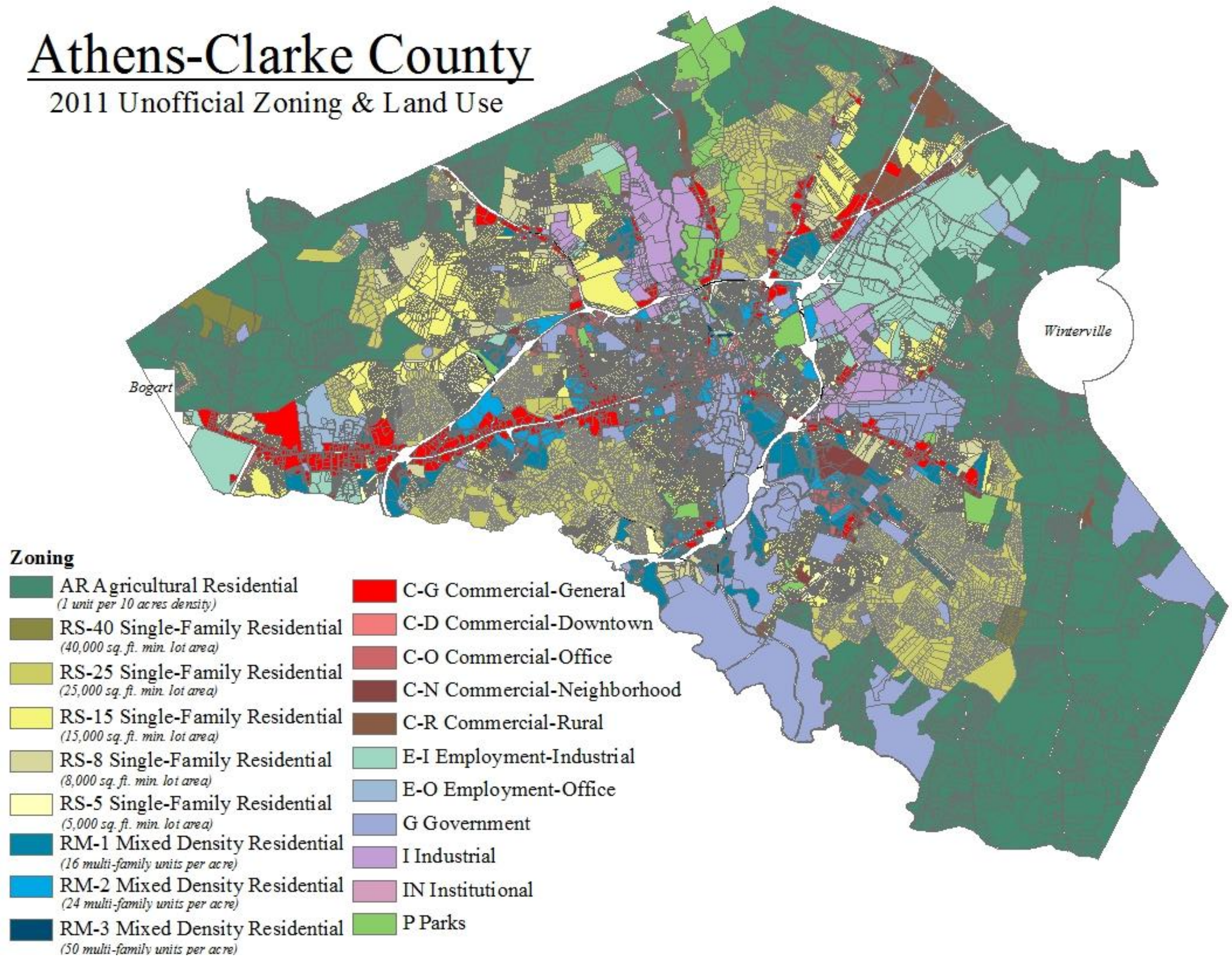
Clarke County’s greenbelt is hobby farms, other small-scale agricultural producers, or University of Georgia property.

Since 2004, farm and forestland has gained acreage, increasing from 19.64% of total acreage to 28.53% in 2011, while residential and commercial/industrial acreage decreased from 29,138 and 9,734 to 26,167 and 7,316, respectively (Dorfman, 2005). These apparent shifts in land use pattern are most likely due to changes in zoning. A map of current parcel zoning is included in Figure 2.2.

Completing a cost of community services study requires cooperation from the community in question, as the inclusion of financial figures beyond the department-wide total and any enterprise or other accessory funds is largely determined by the community in question. In the FY 2004 study, land uses were designated as either residential, commercial/industrial, or farm/forest, with an additional revenue category accounting for any fiscal flows originating outside of the county. For clarity, and because an eventual goal of this project was to separate commercial and industrial land uses to better understand their individual net fiscal impact, the catch-all term “all business” was used in place of the commercial/industrial category; all categories, however, are defined the same as in the FY 2004 study:

- ***Residential*** – property used for dwellings, mobile homes, and rental units.
- ***All Business*** – property actively used for business purposes other than agricultural or forestry and including retail, industrial, and wholesale production.
- ***Farm/Forest*** – property used for agricultural purposes, conservation uses, or timber production and including some farmhouses.

Figure 2.2. UNOFFICIAL ATHENS-CLARKE COUNTY ZONING



The FY 2011 cost of community services study, similar to FY 2004, focused mostly on General and Service Enterprise Fund operations. The format reflected that of the FY 2011 Comprehensive Annual Financial Report (FY 2011 CAFR), grouping department expenditures by government branch (i.e., General Government, Judicial, Public Safety, etc.) and revenues by source (i.e., taxes, license and permits, fines and forfeitures, etc.). Preliminary financial figures were obtained from the FY 2011 CAFR Statement of Revenues, Expenditures, and Changes in Fund Balances for the General Fund, providing the total actual amount received (spent) within the General Fund by each source (department) for the fiscal year ended June 30, 2011.

The decision to break individual departments' expenditures down by their respective divisions was left to either the government or the availability of appropriate data. It is likely that the Administration, Construction Inspection, Community Protection, and Other General Administration divisions making up the Department of Building Permits and Inspection would not allocate expenditures the same across the entire department; unfortunately, some data are simply not available or would be too costly in terms of time and/or money to come by. A variety of local officials assisted in providing figures for divisions within the departments, and later in allocating data to specific land use.

Expenditures were allocated according to either *a priori* knowledge, FY 2004 allocations, or proportional unit splits. For departments whose activities benefit exclusively one land use category, 100% of expenditures were allocated to that category; the Board of Elections, for example, provides services exclusively to residents and therefore is allocated 100% residential. Other expenditures were based on the current land use pattern and were allocated according to the percentage of property value, total parcels, acreage, and population of each land use; tax commissioner expenditures, for instance, were allocated according to the percentage of total parcels attributed to each land use. For all government support units, such as Landscape Management, Internal Support, and Facilities Management, expenditures were allocated based on a proportional unit split: the ratio of allocated expenditures by land use to total expenditures across all non-support units. These proportional unit splits for 2011 were 75% residential, 24% business, and 1% farm/forest.

FY 2011 General Fund revenues of greater detail were received and allocated directly from the ACC Department of Finance, while revenues for the Airport, Landfill, Water and Sewer, Transit, Solid Waste Collection and Storm Water Enterprise Funds were obtained from the Combining Statement of Revenues, Expenditures, and Changes in Fund Net Assets for Nonmajor Enterprise Funds from the FY 2011 CAFR. To allocate revenues associated with property taxes, the 2011 Clarke County tax digest summary codes were grouped into residential, business, and farm/forest land uses less their state exemptions to determine the percentage of taxable property in Clarke County associated with each land use. The property tax allocations for 2011 are 57.78% residential, 42.01% all business, and 0.21% farm/forest. The completed FY 2011 COCS for Athens-Clarke County is included in the Appendix.

At the time of this paper ACC did not have a fiscal impact model, but their progressive views on planning and managing growth and development have resulted in datasets unique to the county. In 2006, Athens-Clarke County and the City of Winterville developed a Comprehensive Plan consisting of the community’s assessment of current socioeconomic issues and opportunities and the agenda for future development, containing the summarized vision statements, issues and opportunities, and ensuing policy and work plan items from the assessment. The development of the Comprehensive Plan emphasized the use of GIS as a tool for managing growth, and the Planning Department developed parcel-specific land use classifications based on the American Planning Association's (APA) Land-Based Classification Standards (LBCS). The LBCS model was developed in 1996 by APA and six other federal agencies as an effort to update the only existing national-level attempt to classify land uses, the 1965 Standard Land Use Coding manual (Jeer, 1997). LBCS provides a consistent, characteristic-based model for land use classification across five dimensions: activity, function, structure type, site development character, and ownership. Table 2.2 summarizes the LBCS dimensions and classifications. Because ACC had no fiscal impact model, it was decided to work backwards by designing the fiscal impact model within ArcGIS, relying heavily upon the Athens-Clarke County LBCS layer for identifying parcel-specific land uses. The ACC Planning Department has maintained an active and detailed spatial database for the county containing planimetric and orthophoto layers; all data was uniformly projected as Transverse Mercator referencing the State Plane Georgia West FIPS 1002 coordinate system in feet. State Plane projected coordinate systems exist in East-West pairs for most of the United States, and are ideal when working at the individual county level or other small scales. The two most critical components in the design of the ACC development impact model were the existence of the LBCS layer and an active, uniform GIS database. Having access to shapefiles projected correctly and identically significantly reduces the amount of data management that must be done in order to obtain a spatially accurate picture of the community, and the LBCS layer was an integral component in allocating parcel-specific revenues and expenditures.

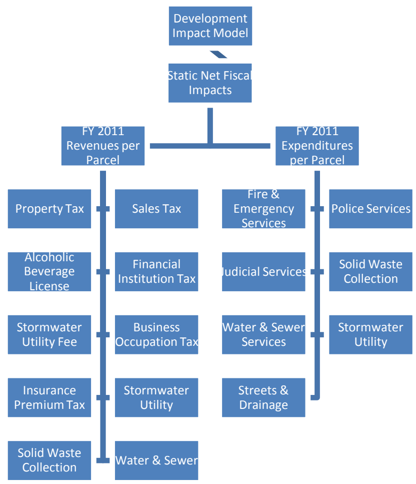
Table 2.2. LBCS DIMENSIONS

Activity	**An observable characteristic of land based on actual use.** Activity refers to the actual use of land based on its observable characteristics. It describes what actually takes place in physical or observable terms (e.g., farming, shopping, manufacturing, vehicular movement, etc.). An office activity, for example, refers only to the physical activity on the premises, which could apply equally to a law firm, a nonprofit institution, a courthouse, a corporate office, or any other office use. Similarly, residential uses in single-family dwellings, multifamily structures, manufactured houses, or any other type of building, would all be classified as residential activity.
Function	**The economic use or type of establishment using the land.** Function refers to the economic function or type of establishment using the land. Every land-use can be characterized by the type of establishment it serves. Land-use terms, such as agricultural, commercial, industrial, relate to establishments. The type of economic function served by the land-use gets classified in this dimension; it is independent of actual activity on the land. Establishments can have a variety of activities on their premises, yet serve a single function. For example, two parcels are said to be in the same functional category if they serve the same establishment, even if one is an office building and the other is a factory.
Structure	**Type of structure or building type on the land.** Structure refers to the type of structure or building on the land. Land-use terms embody a structural or building characteristic, which indicates the utility of the space (in a building) or land (when there is no building). Land-use terms, such as single-family house, office building, warehouse, hospital building, or highway, also describe structural characteristic. Although many activities and functions are closely associated with certain structures, it is not always so. Many buildings are often adapted for uses other than its original use. For instance, a single-family residential structure may be used as an office.
Site	**The overall physical site development character of the land.** Site development character refers to the overall physical development character of the land. It describes "what is on the land" in general physical terms. For most land uses, it is simply expressed in terms of whether the site is developed or not. But not all sites without observable development can be treated as undeveloped. Land uses, such as parks and open spaces, which often have a complex mix of activities, functions, and structures on them, need categories independent of other dimensions. This dimension uses categories that describe the overall site development characteristics.
Ownership	**Legal and quasi-legal ownership constraints of the land.** Ownership refers to the relationship between the use and its land rights. Since the function of most land uses is either public or private and not both, distinguishing ownership characteristics seems obvious. However, relying solely on the functional character may obscure such uses as private parks, public theaters, private stadiums, private prisons, and mixed public and private ownership. Moreover, easements and similar legal devices also limit or constrain land-use activities and functions. This dimension allows classifying such ownership characteristics more accurately.

Source: (American Planning Association, 2001)

The development impact model consists of two interactive environments: one static representation of the current fiscal scenario and a dynamic component wherein previously determined adjustment factors interact with the community's current financial situation. The interaction between these two environments is the core of the development impact model, which allows the user to select characteristics of proposed developments and returns a virtual representation of its fiscal impact. Figure 2.3 illustrates the model framework.

Figure 2.3. MODEL SCHEMATIC



Interpretation of results and methods of this paper depend on the reader's awareness of the following: for the remainder of the Methods section, unless otherwise noted, reference to "residential zoned parcels" includes all parcels zoned RM-1, RM-2, RS-40, RS-25, RS-15, RS-8, or RS-5 in addition to parcels zoned AR, agricultural residential; this is a total of 35,586 parcels and 49,196 acres "Commercial/industrial zoned parcels" includes all parcels zoned C-G, C-D, C-O, C-N, C-R, E-I, E-O, or I; this is a total of 5,104 parcels and 10,259 acres. For clarification, any processes that correspond to actual tools within the ArcMap geoprocessing environment have been capitalized.

Note that University of Georgia, Athens-Clarke County Unified Government, City of Winterville, United States Government, and Clarke County School District owned parcels have not been taken into consideration for this study and are treated as holes (Table 2.3). There are 598 total parcels not considered for this study, approximately 1.4% of the county.

Table 2.3. SUMMARY OF EXCLUDED PARCELS

Owenership	Parcels
Athens-Clarke County Unified Government	340
Clarke County School District	47
State of Georgia	31
United States Government	9
University of Georgia	150
City of Winterville	21

REVENUES

Using GIS, revenues and expenditures were designated at the individual parcel level. The base of the revenues per parcel module was the property tax layer. In order to exclude all exempt property from the layer, a relationship was established between the LBCS layer and FY 2011 tax assessment table. Parcels exempt from property tax in ACC correspond to real and personal property exempt from taxation under state law; these types of properties were assigned descriptive LBCS dimension codes in order to identify them in the GIS. Relating the LBCS layer to the Tax Assessment attribute table based on the parcel number allows features in either table to be related to their corresponding attributes in the other, on-the-fly; a relationship was also established between the Zoning and Parcel layers based on the parcel number. Features were then selected from the LBCS and Zoning layers based on the descriptive zoning and LBCS codes and related to the features from the Tax Assessment attribute table; the selected results from the Tax Assessment table were removed. Table 2.3 summarizes the criteria for selection and removal of tax exempt property. The resulting layer contained taxable parcels with their current assessed value from the FY 2011 tax assessment; for all agricultural parcels, the Conservation Use Value Assessment (CUVA) exemptions are accounted for by the assessor. Using the 2011 Clarke County Incorporated M&O millage rate of 13.7 in 2011 property tax revenue per parcel (*PT_i*) was calculated based on:

$$PT_i = \{(CAV_i * 0.40) - HE_i\} * \frac{MR}{1{,}000} \qquad \text{(Equation 1)}$$

Where: CAV_i = current assessed value of each parcel, *i = 1…n*

HE_i = homestead exemption of each parcel, *i = 1…n*

MR = millage rate

Table 2.4. CRITERIA FOR SELECTION OF PROPERTY EXEMPT FROM ANNUAL AD VALOREM TAXATION

Exempt Property	Selected Layer	Selected Attribute	Criteria	Definition
General state headquarters of a nonprofit for promoting the education and welfare of children	LBCS	Function 6561	--	Child and youth services
All places of religious worship and burial	LBCS	Function 6600 Function 6720	OR	Religious institutions Cremation services and cemeteries
Property owned by religious groups used as single-family houses	LBCS	Ownership 6000 Activity 1000	AND	Nonprofit ownership Residential activities
Institutions of purely public charity	LBCS	Function 6560 Function 6563 Function 6566	OR	Social assistance, welfare, and charitable services Community food services Services for elderly and disabled
Buildings used as colleges, incorporated academies, or other seminaries of learning open to general public	LBCS	Function 6120 Function 6121 Function 6122 Function 6123 Function 6130	OR	Grade schools Elementary Middle Senior Colleges and universities
Property of nonprofit hospitals used in connection with operation	LBCS	Function 6500 Function 6510 Function 6530	OR	Health and human services Ambulatory or outpatient care services Hospitals
Public libraries and any other literary associations	LBCS	Structure 4300	--	Library building
Property of nonprofit homes for the aged and mentally disabled	LBCS	Ownership 6000 Function 1200 Function 1210 Function 1220 Function 1230 Function 1240 Function 1250	AND OR	Nonprofit ownership Housing services for elderly Retirement housing services Congregate living services Assisted living services Life care or continuing care services Skilled-nursing services
Veterans organization chartered by U.S. Congress	LBCS	Function 6567	--	Veterans affairs
Local, state, federal and institutional zoned parcels	Zoning	G IN	OR	Government zoned parcels Institutional zoned parcels

Table 2.5. LOCAL EXEMPTION CODES AND VALUES

Exemption Code	Definition	County M&O
S0	Not exempt	$0
S1	Regular - Owner-occupied principal residence	$10,000
S4	Age 65 - Net income of applicant and spouse < $10,000	$10,000
S5	100% disabled veteran; surviving spouse of disabled veteran who has not remarried	$50,000
SC	Age 65	$10,000
SD	Age 65 - 100% disabled veteran; surviving spouse of disabled veteran who has not remarried	$50,000
SG	Surviving spouse of firefighter or peace officer killed in the line of duty who has not remarried	100%

The homestead exemption value of each parcel corresponded to the recorded exemption codes for each parcel in the FY 2011 Tax Assessment (Table 2.4). 41,275 parcels were considered taxable, and estimated aggregate property tax revenues for ACC were $43,195,297.

ACC Finance Department reported $45,469,375.91 in property tax revenue from the FY 2011 CAFR. The approximately $2.2 million difference between estimated and actual property tax revenue was attributed to inconsistencies within the data; assessed parcel values were obtained directly from the FY 2011 Tax Assessment, while much of the development impact model's GIS was designed from the Planning Department's publicly available data. The Planning Department's database has been managed for the specific purpose of use by the general public within a GIS, and the Parcel layer contained 42,191 unique features with identifying parcel numbers; the Tax Assessor's data was raw, not intended for use within a GIS, and contained just 42,022 unique features with identifying parcel numbers. Additionally, the inaccuracies within the LBCS layer likely overestimated the number of parcels exempt from taxation.

Athens-Clarke County levied a tax upon state and national banking associations at the rate of twenty-five hundredths of one percent (0.25%) of their Georgia gross receipts in FY 2011. Without access to individual receipts, the financial institution tax revenue was equally divided between banking associations in ACC. Banks and financial institutions were selected from appropriate LBCS Function codes and extracted from the Parcels layer based on a parcel number relationship. Table 2.6 summarizes the LBCS codes used. The FY 2011 financial institution tax revenue, $215,663, was split equally between the 200 parcels determined to be banking or other institutions of finance; each bank in ACC was assumed to have contributed $1,078.32 in revenue.

Table 2.6. SELECTION CRITERIA FOR FINANCIAL INSTITUTION TAX

Dimension	Code	Criteria	Definition
Function	2200	OR	Finance and insurance
Function	2210		Bank, credit union, or savings institution
Function	2220		Credit and finance establishment
Function	2230		Investment banking, securities, and brokerages
Function	2250		Fund, trust, or other financial establishment

The business occupation license was a nonrefundable, annual occupation tax levied upon “businesses and practitioners of professions and occupations with one or more locations” in ACC based on the number of full-time equivalent employees of the business or practitioner (Code of Ordinances 6-1-1). Without information at the individual business level on the number of full-time equivalent employees, business occupation tax revenues were allocated equally to all commercially zoned parcels in ACC. According to ACC, there were approximately 5,000 businesses subject to the business occupation tax; the selection criteria found 4,318 properties. Given the university presence, this was considered a reasonable figure; occupations such as music teachers, or consulting businesses managed by professors with academic-year teaching appointments, are typically run from the licensee’s home and business occupation license revenues would not be attributable to commercial parcels in ACC. The FY 2011 business occupation tax revenue, $1,433,208.92, was split equally between the 4,318 selected businesses in ACC; each commercially zoned property contributed $331.91 to total revenues.

The fees associated with alcoholic beverage licenses differ based on the type of establishment; there are 16 licenses ranging from retail liquor package stores to hotel in-room service, three supplementary permits for wine-tastings and Sunday sales, and additional fees based on gross sales for all retail package and by the drink establishments. With no business-level data available, the FY 2011 revenue from alcoholic beverage licenses and permits was split equally amongst establishments identified from LBCS codes as potential servers of alcohol. Table 2.7 details the LBCS selection criteria. ACC Finance Department reports 319 active alcoholic beverage licenses; 257 were selected from the above criteria. In FY 2011, these 257 establishments were assumed to have contributed $5,141.99 each to total revenues.

Table 2.7. SELECTION CRITERIA FOR ALCHOLIC BEVERAGE LICENSE

Dimension	Code	Criteria	Definition
Activity	2200	OR	Restaurant-type activity
Activity	2210		Restaurant-type activity with drive-through
Function	2150		Grocery, food, beverage, dairy, etc.
Function	2151		Grocery store, supermarket, or bakery
Function	2153		Specialty food store
Function	2155		Beer, wine, and liquor store
Function	2510		Full-service restaurant
Function	2540		Bar or drinking place

As part of the Comprehensive Plan, ACC developed a stormwater utility fee to adequately fund the expansion of their stormwater management services throughout 2003 and 2004. The Equivalent Runoff Unit (ERU) is the base unit for a stormwater utility, defined as a measure of the amount of impervious surface on a property. A single ERU is equal to 2,628 square feet of impervious surface, the average area of impervious surface found at a single-family property in ACC. The monthly utility fee charged to all parcel owners (government buildings excepted) in ACC is composed of three separate charges: a base charge, a quantity charge, and a quality charge. The stormwater fee per parcel (*STW_i)* is calculated according to:

$$STW_i = \left(\frac{IS_i}{2{,}628} * R_b\right) + \left(\frac{IS_i}{2{,}628} * R_{QN}\right) + \left(\frac{IS_i}{2{,}628} * ID * R_{QL}\right) \qquad \text{(Equation 2)}$$

Where: IS_i = ft^2 impervious surface per parcel for all $i = 1 \ldots n$

R_B = Base Rate, \$2.07

R_{QN} = Quantity Rate, \$0.86

R_{QL} = Quality Rate, \$0.57

ID = Intensity of Development Factor

The base, quantity, and quality rates were determined by the ACC Stormwater Management division prior to this paper. The Intensity of Development factor accounts for the land use of the property in determining the stormwater utility fee, and is separated into five categories:

1. Low Density Residential Development = 0.5
2. Medium Density Residential Development = 1.0
3. Agricultural = 1.0
4. High Density/Multi-Family/Institutional Development = 1.3
5. Commercial/Industrial Development = 1.9
6. Undeveloped = 0.0

The Intensity of Development designations were created based on land use descriptions in the Comprehensive Plan, which were not available at the time of this paper. Based on discussions with ACC employees in Stormwater Management and Planning, Low Density Residential was determined to be all RS-40 and RS-25 zoned parcels, Medium Density Residential to be RM-1 and RS-15 zoned parcels, High Density/Multi-Family/Institutional to be RS-5, RS-8 and RM-2 zoned parcels, and Commercial/Industrial to be all C, E, and I zoned parcels. Agricultural parcels were selected using LBCS Function codes 9000 – 9510; these codes relate directly to crop production, support functions for agriculture, animal production, forestry, fishing, and game preserves. Undeveloped parcels were selected using the LBCS Structure code 9000 for no structure. Once all parcels were classified, the square feet of impervious surface was calculated and divided by 2,268 to obtain each parcel's Equivalent Runoff Units for calculation of the stormwater utility fee per month and for the entire year. In FY 2011, $3,438,033 in revenue was generated from stormwater utility fee collections; in the GIS, stormwater utility fee revenues were estimated to be $3,957,056. This overestimation was attributed to coarseness in the data caused by hand digitizing and exacerbated by analysis at the county level.

The insurance premium tax is a state-levied fee on all insurance policies, which is then returned to the county. Parcels were selected based on their zoning to obtain the most complete representation of the county; while zoning codes do not accurately reflect the current land use, it was found through this process that the LBCS layer was more effective for small, specific selections of land use, such as banking or financial institutions, rather than entire land use categories. In total, 35,586 residential and 5,104 commercial/industrial zoned parcels were selected, and insurance premium tax revenue per parcel (IPT_i) calculated according to:

$$IPT_i = \left(IPT * \gamma_j * \frac{PT_i}{\sum_{i=1}^{n} PT_i}\right) \qquad \text{(Equation 3)}$$

Where: IPT = FY 2011 insurance premium tax revenue

γ_j = residential = 0.75, commercial/industrial = 0.25 for all $j = 1,2$

PT_i = property tax per parcel for all $i = 1 \ldots n$

Because residents purchase life insurance policies, it was assumed that 75% of insurance premium tax revenues were attributable to residential land uses. Residential and commercial/industrial shares of tax revenue were then allocated according to a parcel's percentage share of the total property tax value for their respective land uses based on the assumption that property tax bills were positively related to the amount of insurance purchase by a property owner. In FY 2011, residential and commercial/industrial attributed an estimated $4,317,999.62 and $1,025,524.91, respectively, to total revenues.

At the time of this study, the Local Option Sales & Use Tax was a $0.01 tax for every dollar spent. Allocation of LOST revenue was based on Clarke County's reported pull factor of 1.62, indicating they attract 62% more customers than expected. The ratio of unexpected customers, or customers residing outside of Clarke County, to the overall pull factor indicated 38% of sales tax revenue comes from purchases by non-county residents; commercial/industrial land uses were assumed to contribute 4% to LOST revenue in FY 2011, leaving 58% of LOST revenue attributable to residential land uses. Actual FY 2011 LOST revenues were $18,954,566.97; nearly $11 million of this was attributed to residential land uses, $7.2 million to outside sources, and $758,000 to commercial/industrial. As with allocation of the insurance premium tax, to ensure the most complete representation of the county, all residential zoned and commercial and industrial zoned parcels were selected for their respective land uses. Residential revenues were allocated on a per parcel basis by assuming each parcel spent at least $10,000 for FY 2011, generating $100 in LOST revenue per parcel.

The remaining difference between estimated residential LOST revenues of $3,558,600 and actual FY 2011 revenues was allocated according to a parcel's share of total property tax, so that total per parcel sales tax revenue ($LOST_i$) was equal to:

$$LOST_i = 100 + \left(TR_R - \widehat{TR}_R\right)\left(\frac{PT_i}{\sum_{i=1}^{n} PT_i}\right) \quad \text{(Equation 4)}$$

Where: TR_R = FY 2011 actual residential LOST revenues

$\widehat{TR}_R$ = FY 2011 estimated residential LOST revenues

PT_i = property tax bill per parcel for all $i = 1 \ldots n$

This was used because it was assumed that spending per parcel would increase as the share of total property value increased. Because no additional information was available to more accurately reflect the differences in spending patterns of retail businesses and industry, commercial/industrial parcels were allocated an equal portion of their $758,182.68 in revenue, thus in FY 2011 each was assumed to have contributed $148.55 to LOST revenue. Sensitivity analysis on LOST allocation was performed and included in Appendix B; all following figures and results, however, were interpreted based on the previously stated methodology.

The number of bedrooms in a residence, a suitable estimate of a parcel's water and sewer utility use, was not information included in ACC's Buildings layer, a summary of the permanent and semi-permanent structures for every parcel in ACC. Residential and commercial/industrial zoned parcels were selected and managed separately in an effort to distinguish between land uses. In the FY 2011 COCS study, 18% of total Water & Sewer Enterprise Fund revenues were attributed to 5,311 commercial/industrial parcels, a total of $9,695,049.75, with the remaining $29,085,149.25 attributed to 35,592 residential parcels.

These respective figures were allocated according to Equation 6 to obtain water and sewer utility revenue per parcel (WS_i):

$$WS_i = (TR_{WS})\left(\frac{BA_i}{\sum_{i=1}^{n} BA_i}\right) \quad \text{(Equation 5)}$$

Where: TR_{WS} = FY 2011 actual water and sewer utility revenues

BA_i = square footage of all structures on each parcel for all $i = 1 \ldots n$

At the time of this study, the ACC Department of Solid Waste provided service only to residential parcels within the Urban Service District and commercial/industrial parcels throughout the county via individual contracts, charging different rates dependent upon their location relative to the Central Business District, or downtown Athens (Table 2.8).

Table 2.8. ATHENS-CLARKE COUNTY SOLID WASTE COLLECTION RATES

Applicable To	Frequency	Rate
Commercial outside CBD	2/week	$26.60
Commercial inside CBD	3/week	$32.60
Residential inside CBD	2/week	$40.60
Commercial (general)	7/week	$82.60
Commercial (general)	14/week	$161.60

Residential customers outside of the Central Business District were charged under a pay-as-you-throw rate depending upon the level of service they chose. It was assumed that businesses outside of the USD used private collection services, and businesses within the USD used ACC municipal services. At the time of this study, there was no information available as to the location of commercial customers based on service level, and, because of the types of businesses in downtown Athens, it was assumed that commercial parcels inside the CBD chose seven collections per week while businesses outside the CBD and within the limits of the USD chose two collections per week. The FY 2011 COCS study attributed 75%, or $2,727,894.75, of revenues to residential customers, which was distributed equally amongst 12,664 residential zoned parcels within the USD because information on service level at the parcel scale was not available. The remaining 25%, or $909,298.25, attributed to commercial/industrial land uses was divided based on the ratio of the *Commercial outside CBD two collections per week* rate of $26.60 to the *Commercial (general) seven collections per week* rate of $82.60, approximately 0.322. 495 commercial zoned parcels outside the CBD and within the USD were then selected and allocated an equal share of the $292,794.04, and 2,255 commercial zoned parcels inside the CBD were selected and allocated an equal share of the remaining $616,504.21. This method of allocation does not account for commercial dumpster customers, who were charged under an entirely different rate structure according to collection frequency and dumpster size.

The final layer of per parcel revenues was a catchall, accounting for the revenue sources unable to be represented spatially and thus not previously allocated. Residential and commercial and industrial zoned parcels were again selected to obtain the most complete representation of the county. Athens-Clarke County received $157,401,703.62 in revenues for FY 2011 and based on the updated COCS study, residential land uses accounted for 62.8% and commercial/industrial (or All Business, as it is referred to in the COCS) for 32.8% of this total. The allocated revenue figures, nearly $99 million for residential and $52 million for commercial/industrial, were used to create a layer for residential and commercial/industrial land uses of catchall revenues per parcel (CAR_i) according to:

$$CAR_i = \frac{\widehat{TR}_j - \sum_{i=1}^{n}(\widehat{PT}_i + LOST_i + \widehat{STW}_i + BT_i + AB_i + IPT_i + SW_i + WS_i)}{n} \qquad \text{(Equation 6)}$$

Where: $\widehat{TR_j}$ = FY 2011 estimated land use allocated revenues for all *j = 1,2*

$\widehat{PT\imath}$ = estimated property tax revenue per parcel for all *i = 1…n*

$LOST_i$ = sales tax revenue per parcel for all *i = 1…n*

$\widehat{STW_\imath}$= stormwater utility fee revenue per parcel for all *i = 1…n*

BT_i = business occupation tax revenue per parcel for all *i = 1…n*

AB_i = alcoholic beverage license revenue per parcel for all *i = 1…n*

IPT_i = insurance premium tax revenue per parcel for all *i = 1…n*

SW_i = solid waste utility fee revenue per parcel for all *i = 1…n*

WS_i = water and sewer utility fee revenue per parcel for all *i = 1…n*

BT_i, AB_i, and IPT_i were equal to zero for residential parcels and SW_i was equal to zero for residential parcels outside of the USD. Each parcel was found to generate $598.07 in catchall revenue. AB_i and IPT_i were equal to zero for commercial parcels that were not classified, respectively, as alcoholic beverage serving establishments or financial institutions, and SW_i was equal to zero for parcels outside of the USD. Commercial/industrial parcels each contributed $3,058.39 to overall FY 2011 revenues.

EXPENDITURES

The allocation of expenditures focused on identifying the costs of municipal service provision per parcel. Without detailed service call locations, it was necessary to make assumptions about the nature of service provision; for example, that ACC employees departing on a service call were always dispatched from main headquarters. The Department of Fire & Emergency Services has nine active fire stations throughout Athens-Clarke County. All fire stations were first identified in the Parcels layer of the GIS based on the LBCS Structure code for fire station and manual location by address. The Near Distance tool was used to generate a table containing the Euclidean distances from each parcel to the nearest identified fire station. Per parcel fire and emergency service (FES_i) figures were derived according to:

$$FES_i = (TF_{FES})\left(\frac{PS_i}{\sum_{i=1}^{n} PS_i}\right) \quad \text{(Equation 7)}$$

Where: TC_{FES} = FY 2011 Department of Fire and Emergency Services expenditures

PS_i = distance from parcel to station for all $i = 1 \ldots n$

In FY 2011, Fire and Emergency Services expenditures totaled $12,735,080.59.

The Department of Solid Waste provided trash and recycling collection for commercial and industrial customers throughout the county and for residential customers within the USD. Residential parcels were assumed to represent 82% of expenditures because the number of residential customers far outweighs commercial and industrial. Residential zoned parcels lying completely within the USD were selected based on location, resulting in 12,664 parcels assumed to be receiving solid waste collection services. According to Athens-Clarke County, there were nearly 10,000 residential customers; this discrepancy was attributed to inconsistencies within the data and the inability to pinpoint service rates on a parcel level. FY 2011 Residential Solid Waste Collection expenditures, $2,779,596.58, were allocated equally across the assumed 12,664 customers, with each accounting for $219.48 of total expenditures. Commercial/industrial land uses were assumed to contribute the remaining 18% of FY 2011 expenditures, a total of $622,602.42. For solid waste expenditures, differentiation of costs depends largely on collection frequency; based on the collection rates in Table 2.7, above, and assuming commercial customers choose either *Commercial outside CBD two collections per* *week* or *Commercial (general) seven collections per week*, the cost per collection (X) was determined according to:

$$FY\ 2011\ Expenditure/Week = 2X(CBD_{OUT}) + 7X(CBD_{IN}) \qquad \text{(Equation 8)}$$

Where: CBD_{OUT} = commercial parcels outside CBD, inside USD assumed to receive 2 collections per week at $26.60 service level

CBD_{IN} = commercial parcels inside CBD and assumed to receive 7 collections per week at $82.60 service level

X = cost per collection

The cost to ACC per collection was found to be $78.07. Based on location, 2,255 parcels were selected and assumed to receive two collections per week at the $26.60 service level and 495 parcels were selected and assumed to receive seven collections per week at the $82.60 service level. Customers receiving two collections, then, cost an estimated $156.14 per year and customers receiving seven collections an estimated $546.49 per year; these costs per year were then allocated to their respective 2,255 and 495 assumed customers.

The Streets & Drainage Division of the Department of Transportation & Public Works maintained safe and efficient roadways, walkways, bikeways, and stormwater systems for ACC residents. A parcel's share of road frontage was determined an adequate proxy for allocating the FY 2011 Streets & Drainage expenditures of $1,200,415.23, as it was assumed that the more road frontage a parcel has, the more likely they were to have received services from the Streets and Drainage Division. To determine a parcel's feet of road frontage, the Parcels layer was Dissolved so that individual parcels formed contiguous polygons separated by the location of roads and paved areas. A clean Parcels layer was transformed from Feature to Line, in order to break each polygon representing a parcel into line segments delineating the parcel. Features were then Selected by Location based on line segments shared by the Dissolved Parcels and Line Parcels layer; this operation would select only the exterior line segments of each parcel, which were split at the interior segments bordering each parcel polygon. The resulting figures for per parcel road frontage were used to calculate per parcel streets and drainage expenditures (SD_i) according to:

$$SD_i = (TC_{SD})\left(\frac{RF_i}{\sum_{i=1}^{n} RF_i}\right) \qquad \text{(Equation 9)}$$

Where: TC_{SD} = FY 2011 Streets & Drainage expenditures

RF_i = feet of road frontage per parcel for all $i = 1 \ldots n$

Existing water and sewer line data was not available at the time of this study. As a proxy for this infrastructure, the share of road frontage of each parcel was used under the assumption that greater length of frontage implied lower density development that was more costly to service. Water and sewer expenditures per parcel (WS_i) were derived according to:

$$WS_i = (TC_{WS})\left(\frac{RF_i}{\sum_{i=1}^{n} RF_i}\right) \qquad \text{(Equation 10)}$$

Where: TC_{WS} = FY 2011 Water & Sewer Enterprise Fund expenditures

RF_i = feed of road frontage per parcel for all $i = 1 \ldots n$

In FY 2011, expenditures for the Department of Police totaled $19,101,291. For this study, the coordinates of police service calls generalized to 1/8th of a mile for the year 2009 were available for allocating expenditures. These point features were converted to raster data and Focal Statistics were used to count the frequency of service calls within a 50’ x 50’ pixel. Zonal Statistics were run using a 27 pixel search radius, the approximate number of 50’ x 50’ pixels in ¼ of a mile, to produce the number of pixels within the approximately ¼ of a mile pixel search radius of each parcel in the county. In FY 2011, the Department of Police's expenditures were $19,101,291; these were allocated according to Equation 11 to obtain per parcel police services expenditures (PS_i):

$$PS_i = (TC_{PS})\left(\frac{SCF_i}{\sum_{i=1}^{n} SCF_i}\right) \quad \text{(Equation 11)}$$

Where: TC_{PS} = FY 2011 Department of Police expenditures

SCF_i = per parcel service call frequency within ¼ of a mile for all $i = 1 \ldots n$

Prior to the unification of Clarke County and the city of Athens, the Department of Police and the Sheriff had separate jurisdictions and different responsibilities; at the time of this study and since unification, the separate jurisdictions were dissolved and both departments share many of the same responsibilities. Because of this, FY 2011 expenditures for the Sheriff, all court systems not including probate court, the Solicitor General, the Clerk of Courts, and the District Attorney, a total of $22,132,251.16, were allocated using the same method as the Department of Police to obtain per parcel judicial services expenditures (JS_i):

$$JS_i = (TC_{JS})\left(\frac{SCF_i}{\sum_{i=1}^{n} SCF_i}\right) \quad \text{(Equation 12)}$$

Where: TC_{JS} = FY 2011 judicial services expenditures

Stormwater utility expenditures for FY 2011 were $3,438,033. It was assumed that the larger a parcel's square footage of impervious surface, the greater likelihood that ACC spent more on maintenance. The Impervious Surface layer was joined spatially to the Parcels layer to obtain an estimate of the total square footage of impervious surface accounted for by each parcel. A layer of stormwater utility expenditures per parcel (STW_i) was created based on each parcel's share of total impervious surface:

$$STW_i = (TC_{STW})\left(\frac{IS_i}{\sum_{i=1}^{n} IS_i}\right) \quad \text{(Equation 13)}$$

Where: TC_{STW} = FY 2011 Stormwater Utility expenditures

The final layer of the expenditures was the catchall layer, accounting for all FY 2011 expenditures that were not represented spatially. Athens-Clarke County spent $138,420,583.38 in FY 2011: nearly 104 million on residential and around 33 million on commercial/industrial land uses. Over 41 million dollars of residential and 12 million dollars of commercial/industrial was allocated at the per parcel level; the remainder was accounted for in a catchall expenditure per parcel layer according to:

$$CAC_i = \frac{\widehat{TC}_j - \sum_{i=1}^{n}(FES_i + SW_i + SD_i + WS_i + PS_i + JS_i + STW_i)}{n} \quad \text{(Equation 14)}$$

Where: TC_j = FY 2011 actual land use allocated expenditures for all $j = 1,2$

FES_i = fire and emergency services expenditures per parcel for all $i = 1 \ldots n$

SW_i = solid waste expenditures per parcel for all $i = 1 \ldots n$

SD_i = streets and drainage expenditures per parcel for all $i = 1 \ldots n$

WS_i = water and sewer expenditures per parcel for all $i = 1 \ldots n$

PS_i = police services expenditures per parcel for all $i = 1 \ldots n$

JS_i = judicial services expenditures per parcel for all $i = 1 \ldots n$

STW_i = stormwater utility expenditures per parcel for all $i = 1 \ldots n$

STATIC NET EFFECTS

Constructing the net effects layer began by aggregating the revenue and expenditure layers that had been separated by residential and commercial/industrial parcels or land uses at a smaller scale using the Merge tool; this resulted in ten separate revenue layers (Water & Sewer, Solid Waste, Insurance Premium Tax, Local Option Sales & Use Tax, Stormwater Utility Fee, Alcoholic Beverage License, Business Tax, Financial Institution Tax, Property Taxes and Catchall) and eight individual expenditure layers (Judicial Services, Stormwater Utility, Police Services, Streets & Drainage Services, Water & Sewer Services, Solid Waste Services, Fire Services, and Catchall). Each revenue layer was joined based on parcel number to the Property Taxes layer (containing 41,265 parcels) and the Field Calculator used to populate columns in the its attribute table containing values for per parcel revenues from each. A new field was created and calculated the sum of these revenues per parcel; this layer was exported as Total Revenues and subsequently used as the base layer for aggregating all summarized expenditure layers and excluding any parcels that, due to inconsistencies within datasets, contain only information on municipal service expenditures. Each expenditure layer was similarly joined based on parcel number and the Field Calculator used to permanently append the individual and aggregate expenditures per parcel data to the Total Expenditures attribute table. The Total Revenues and Total Expenditures were Merged, and the Field Map was simultaneously used to create a final attribute containing per parcel net revenues for Athens-Clarke County.

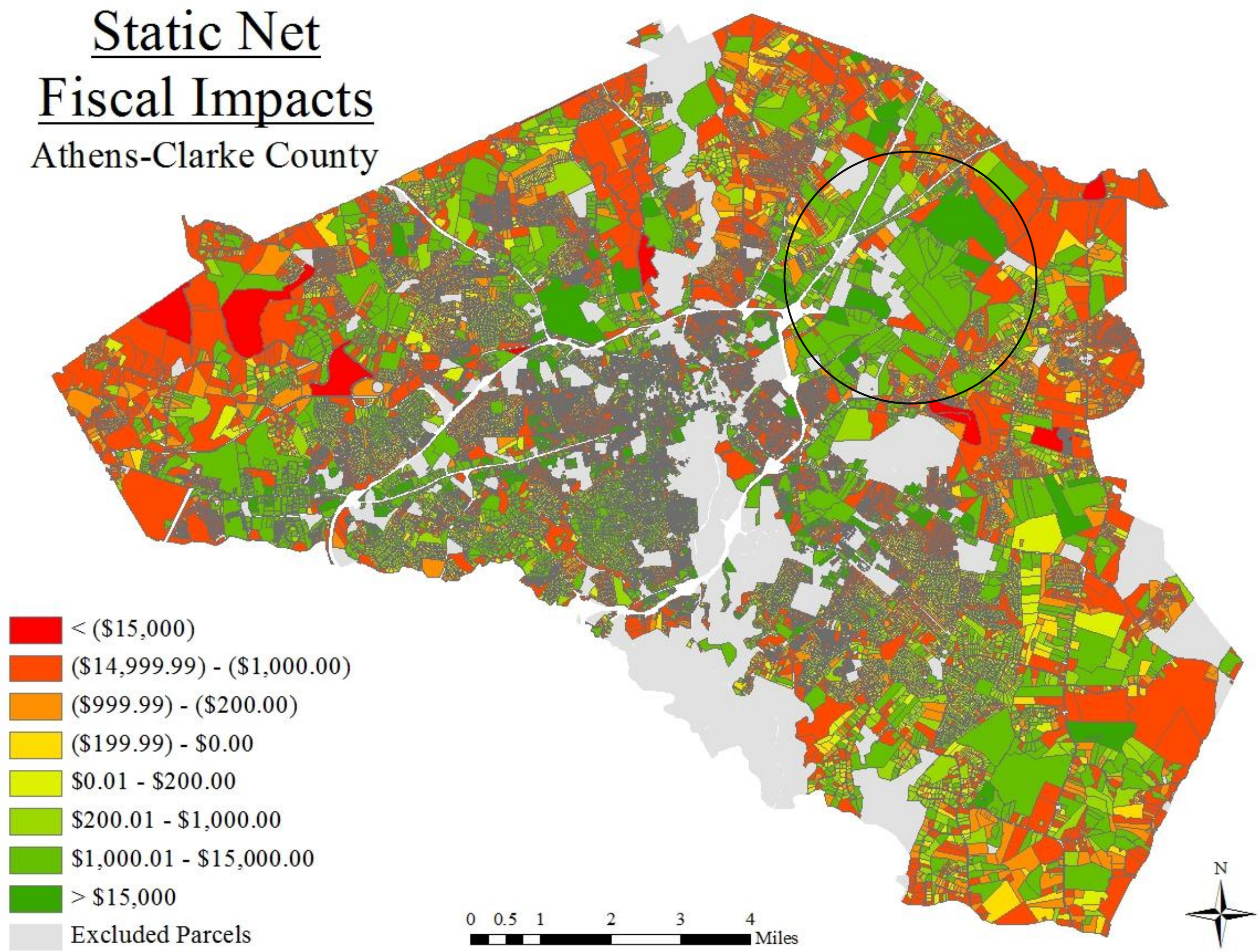
CHAPTER 3

RESULTS

The result of this feasibility assessment is a personal ArcMap geodatabase of individual, summarized, and aggregate layers detailing spatially representable expenditure and revenue figures from the Athens-Clarke County FY 2011 Comprehensive Annual Financial Report. This thesis also serves as a presentation of methodologies for consideration in future work on impact modeling and investigations into GIS as a tool for planning, growth, and development management for local governments. Given the currently available data and database management techniques, it is not feasible to integrate a fiscal impact model with GIS in Athens-Clarke County, and so this study serves as a framework for what can and should be done within local government to maximize the capabilities of their existing GIS.

Figure 3.1 illustrates the final product of the study, the Static Net Fiscal Impacts module of the development impact model. Of particular interest is the so-called greenbelt of Athens-Clarke County, the band of Agricultural Residential zoned parcels on the outskirts of the county (see Figure 2.2); in ACC, farm and forest land uses are an area of net loss for the community according to previous and current COCS studies, a trend which is identifiable in the following map. The circle on the map draws attention to another area of interest; these parcels are mainly used for industrial manufacturing, and appear to generate upwards of $1,000 in revenue each for ACC. This result is consistent with the FY 2011 COCS study, which reports commercial/industrial land uses generate $2.48 for every dollar of expenditure.

Figure 3.1. STATIC NET FISCAL IMPACTS IN ACC



At smaller scales, the information supplied by the static fiscal impacts layer is increasingly apparent. Figure 3.2 shows the Woodlands of Athens, a 33 acre condominium community of townhomes, flats, and cottage homes on a frequented thoroughfare in ACC. Of particular interest here and in other high-density residential parcels throughout the county is that, while the profitability between individual residences varies, the common area of the community is highly profitable, generating over $50,000 in revenues for ACC. This is desirable for the county; common areas defined as parcels in apartment complexes and other residential communities are taxable but require little to no municipal service expenditures.

Figure 3.2. WOODLANDS OF ATHENS

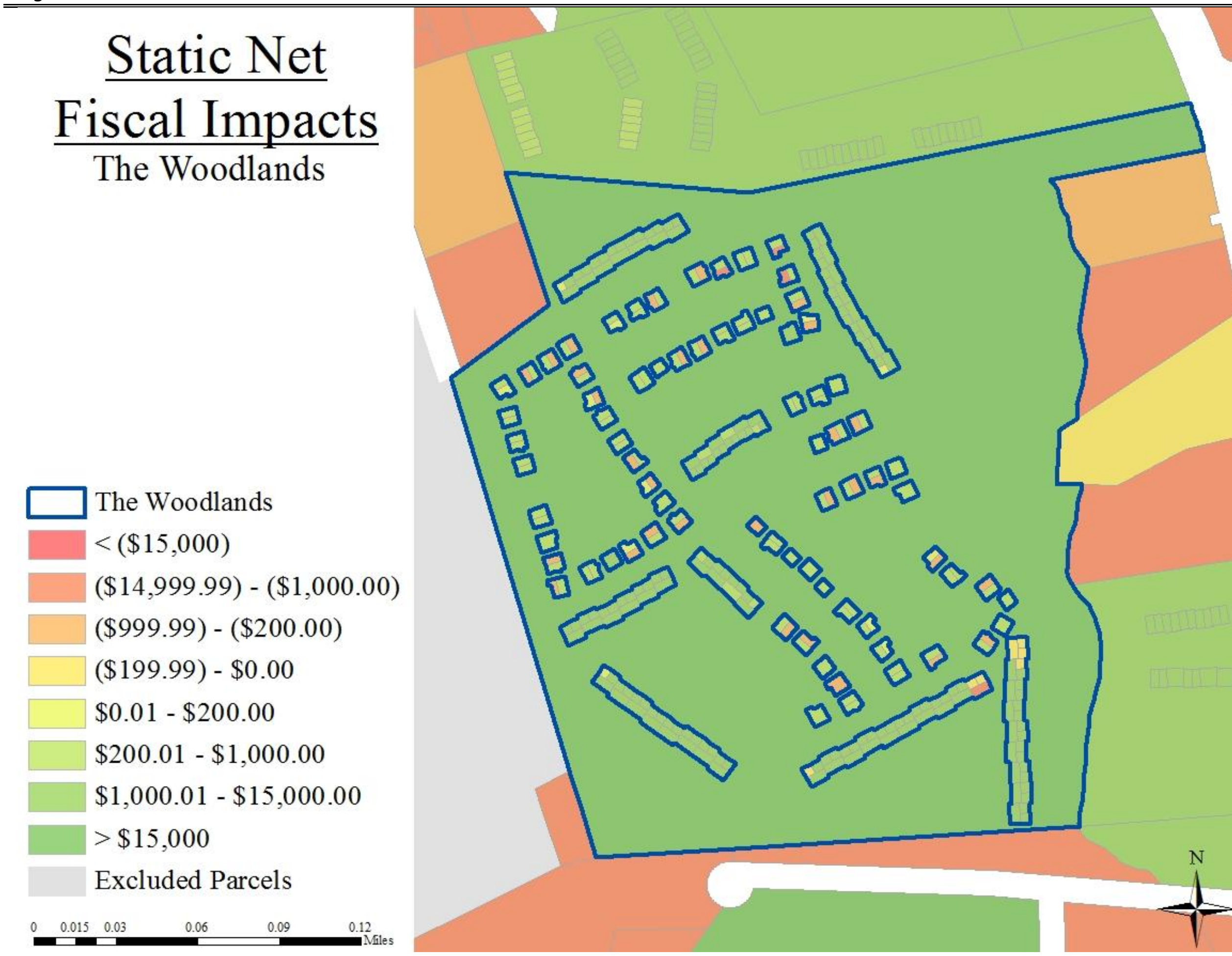
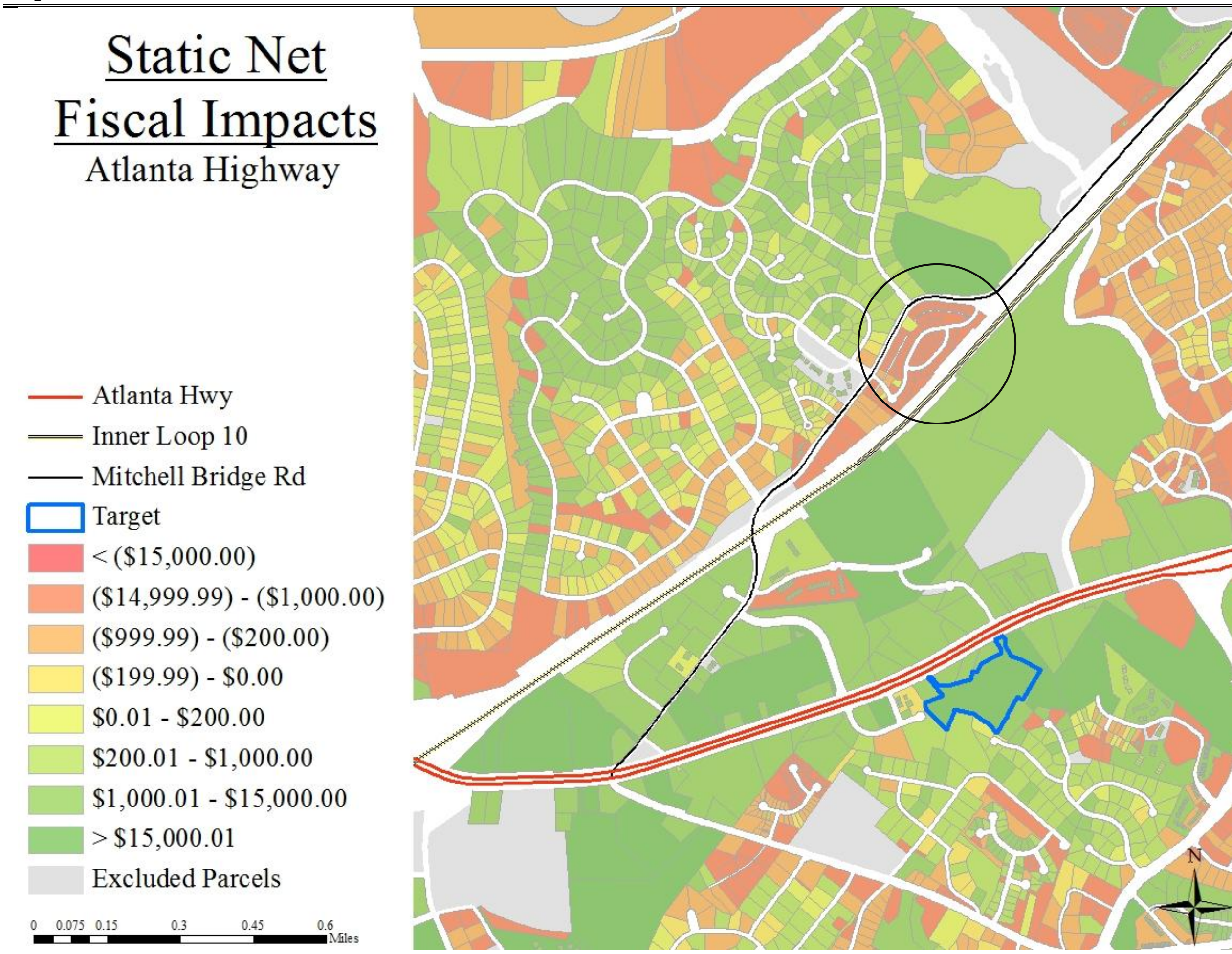


Figure 3.3 serves as a successful representation of the relationship between location and profitability. The large triangle of parcels created by the intersection of Atlanta Highway, Mitchell Bridge Road, and the Inner Loop 10 is a largely commercial area with retail shops, restaurants, car rental agencies, grocery stores, and auto dealerships; the parcel highlighted in blue is Target, and by itself generates nearly $80,000 in revenue for the county. This is a highly profitable area for the government but, there is a significant and visually apparent effect on the profitability of the residential zoned parcels surrounding the area. Most of these parcels are either generating between $0 and $1,000 or losing money for the county, a result consistent

with other findings. The real story here, however, is the difference in profitability between parcels located on any of these three major roadways. The circled area indicates a neighborhood of residential parcels located between Inner Loop 10 and Mitchell Bridge Road; the county loses $1,000 each year on these parcels, most likely because their undesirable location has negatively affected the assessed values. Moving north, away from this group as well as the band of parcels lining the Inner Loop 10 roadway, property values are significantly higher and the area overall appears much more profitable for ACC.

Figure 3.3. ATLANTA HIGHWAY



A significant contribution of this study lies in the layers subordinate to the Static Net Fiscal Impacts module. Several of the summarized expenditure and revenue layers represent successes in either the efficacy of their methods, their ability to intelligibly communicate the spatial variation of cost, or both. These layers are proof that the integration of fiscal impact modeling with GIS is possible and have the potential to provide local governments with infinite information as to how the profitability of land uses in their community vary across space and characteristics.

Figure 3.4 illustrates the spatial variation of Fire and Emergency Services expenditures across ACC. Recalling Equation 7, Fire and Emergency Services expenditures are allocated based on each parcel's share of the Euclidean distance to the nearest fire station; with additional resources and data, it would be simple to incorporate road centerlines and calculate distance to the closest facility on a network, producing an even more accurate estimate of the per parcel cost of providing fire and emergency services. What this map does provide, however, is tangible evidence that it is possible given the tools afforded by GIS to produce an easily understood, visual representation of the financial situation a community faces. As a tool for use by local governments and community planners, a development impact model must be easily interpreted and understood by users who are not familiar with GIS software.

Figure 3.4. FIRE & EMERGENCY SERVICES

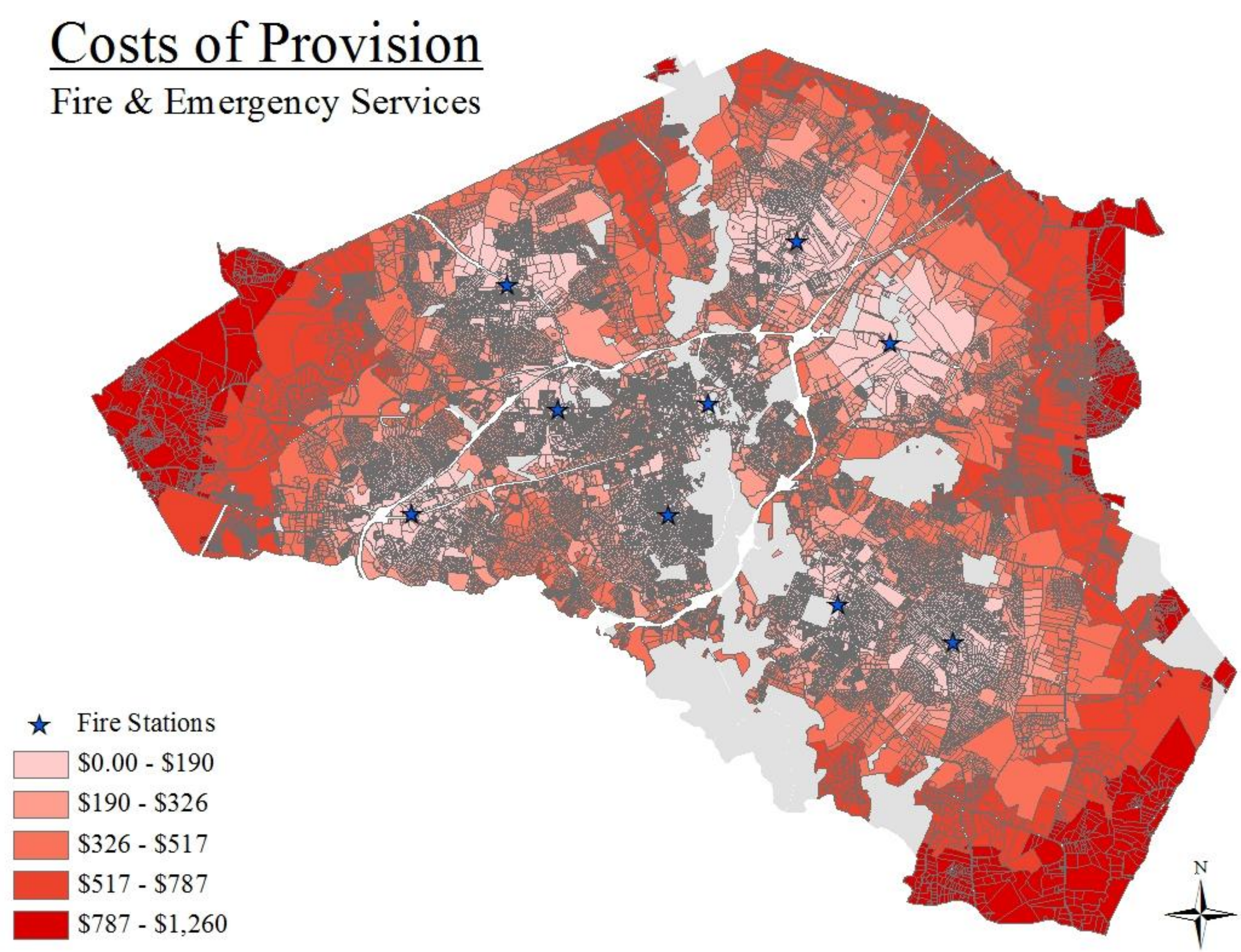


Figure 3.5 shows the Police Services expenditures layer, and is successful not only its representation of the spatial variation police service costs but also demonstrates how the capabilities of a development impact model are enhanced with cooperation from local government departments. There is inevitably data that must be withheld from a non-county employee for security purposes, but, as in the case of the Department of Police, the cooperation and generosity of the Assistant Police Chief allowed for geocoordinates generalized to ½ block for all service calls in one year to be released and included in the model; had this data not been made available, the Police Services expenditures would be uniformly allocated between all residential and commercial/industrial parcels. Figure 3.5 is a map of service call locations for 2009, included for the purpose of illustrating the relationship between call density and expenditure share per parcel.

Figure 3.7. POLICE SERVICE CALLS

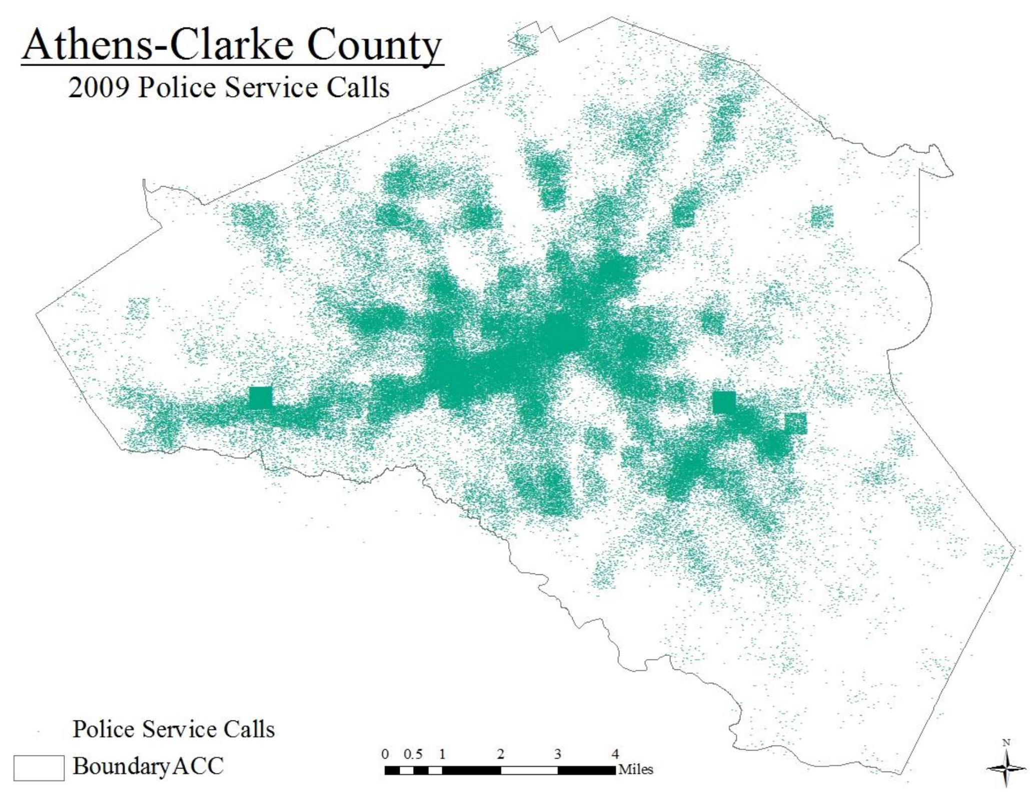
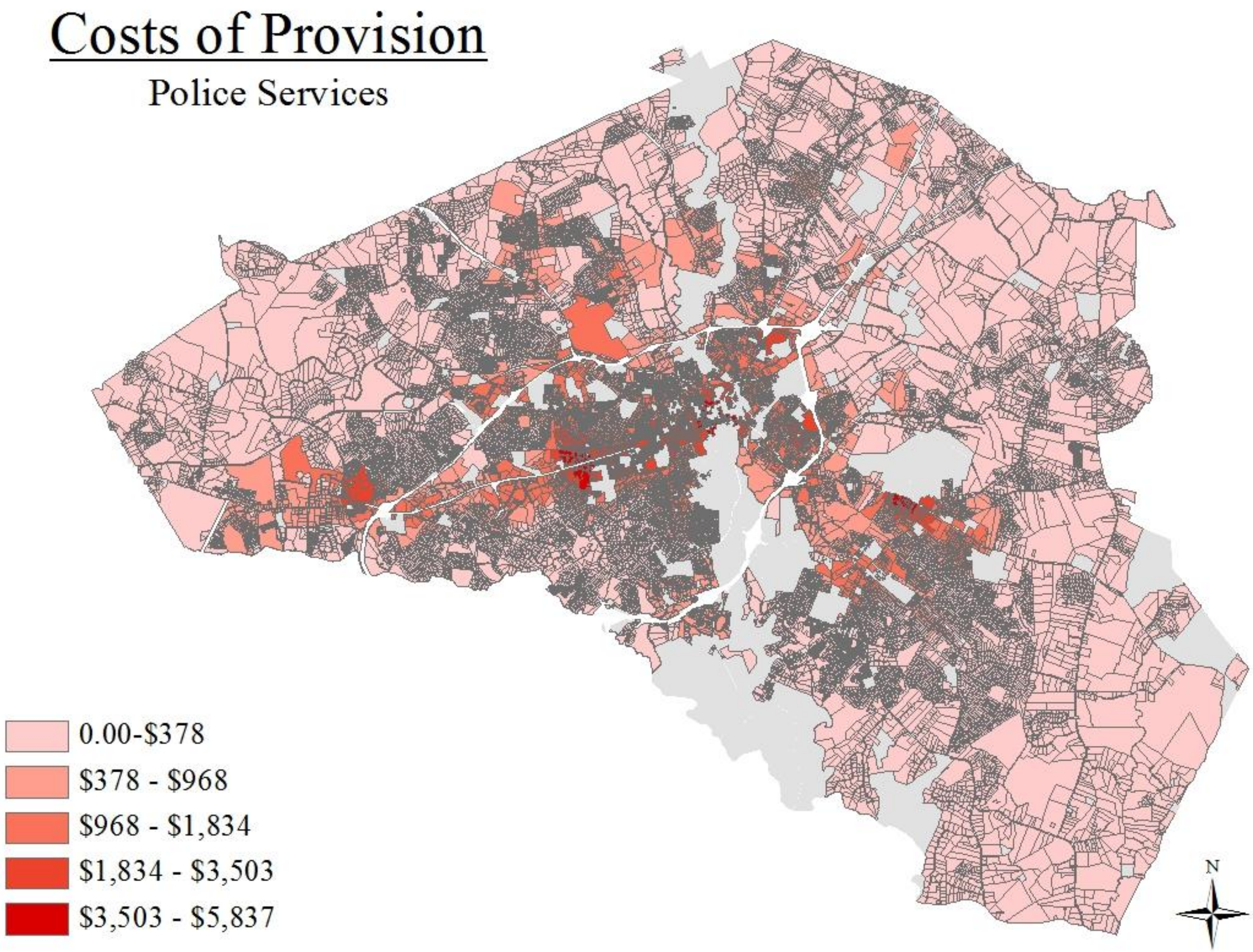


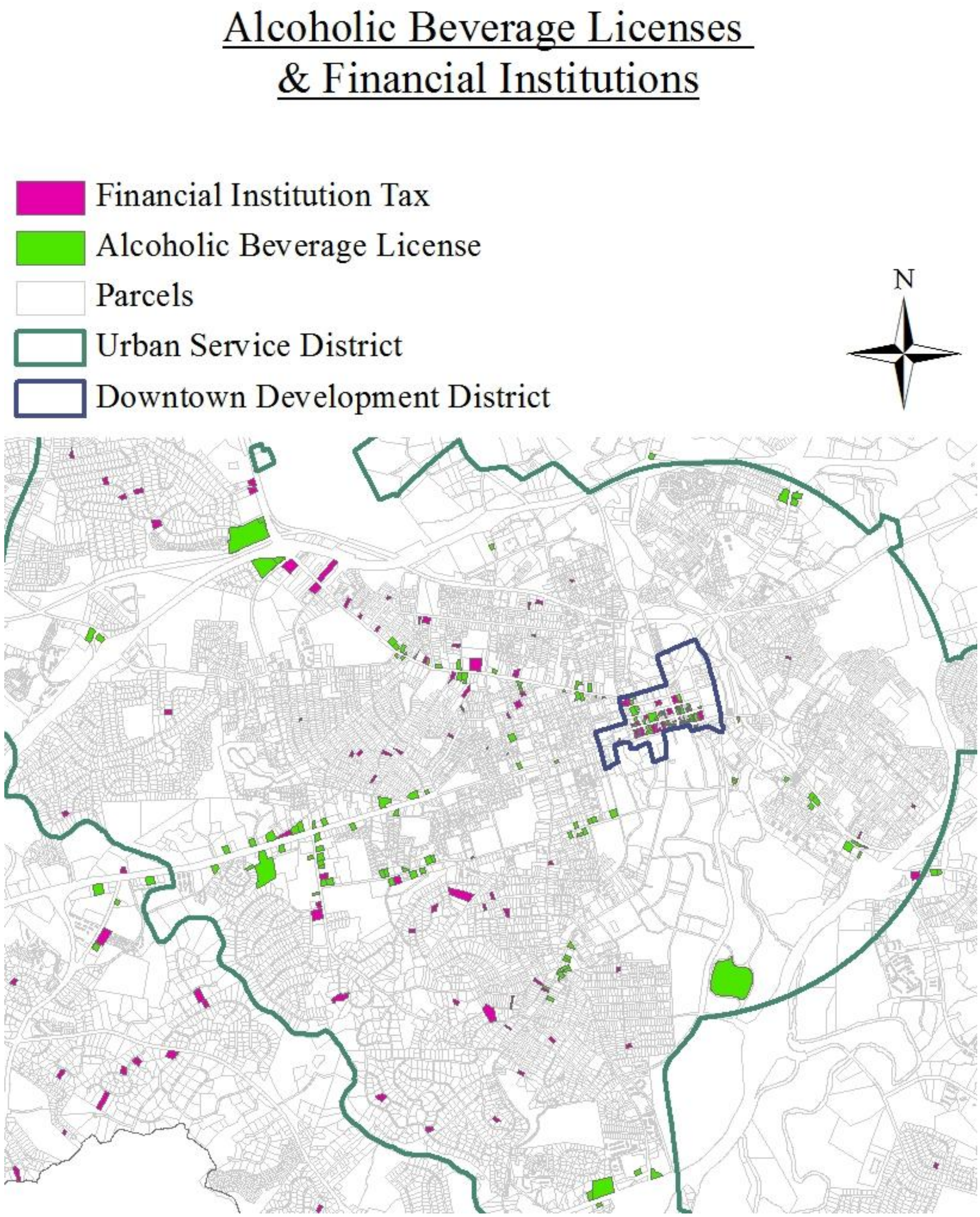
Figure 3.6. POLICE SERVICES



While this trumps not being able to vary them spatially, the likelihood that all areas within the county cost the same to service is extremely low.

This feasibility assessment identifies several revenue and expenditure components of the ACC budget that can be represented spatially, and their allocation within a GIS using the LBCS or Zoning layers provides a basic framework to build from in the future. The Financial Institution Tax and Alcoholic Beverage License layers as demonstrative of the potential a GIS has for use within local governments (Figure 3.7). These layers are possible because of the existence of the Land Based Classification System layer, which classifies parcels based on several different dimensions of land use and is promising for studying the development impacts of varying land uses. The current ACC LBCS layer is incomplete, outdated, or inconsistent in its information; however, a properly and uniformly classified layer would add countless capabilities and accuracy to a GIS-integrated fiscal impact model.

Figure 3.7. FINANCIAL INSTITUTION TAX & ALCOHOLIC BEVERAGE LICENSE



CHAPTER 4

CONCLUDING REMARKS AND RECOMMENDATIONS

The conclusions drawn from this feasibility assessment can be summarized in three mission statements for future work:

1. Consistency and cooperation is critical for local governments that either have GIS infrastructure in place or plan to implement it in the future.
2. Simple data management techniques will significantly increase the capabilities and efficacy of a development impact model.
3. The principle of parsimony is key for producing a comprehensible, user-friendly tool for local governments.

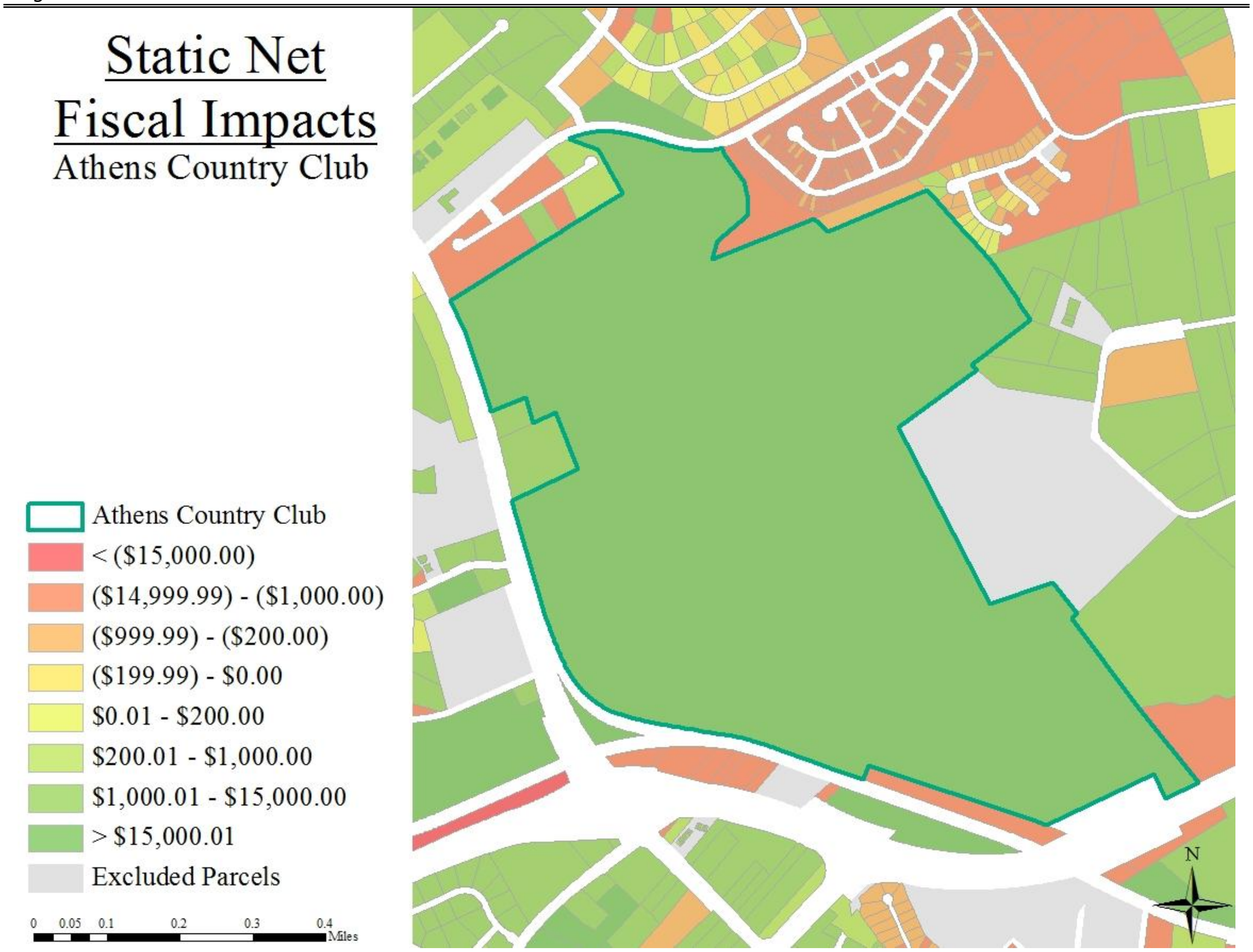
The most limiting factor in this study is the lack of parcel-specific data that is spatially accurate, consistent across departments, and available to use. When designing an active GIS based on multiple joins and relationships, it is imperative to have one consistent, unique identifier throughout. This feasibility assessment uses the parcel number to uniquely identify and locate specific parcels; while sufficient for this assessment, uniquely identifying parcels based on parcel number will require excellent data management techniques that are uniform across government departments. One issue, and probably attributing to the error in estimated property taxes, is that parcel numbers, zoning codes, and homestead exemption codes are not consistent from the Department of Planning's Parcels layer and the FY 2011 Tax Assessment table; as two of the most important datasets in the model, it is crucial that information be interchangeable between the two.

Consistency and cooperation are also critical in layers such as the LBCS. It is crucial that a layer attempting to classify land uses across an entire county be constructed in exactly the same manner, and that plans for construction are available to users and interpreters of the layer. Consistency in this layer will greatly improve the spatial accuracy of the Financial Institution Tax as well as the Alcoholic Beverage License; there are, for example, 319 active alcoholic beverage licenses in ACC, however, only 257 parcels were identified as beer, liquor, or wine serving establishments.

This feasibility assessment also brought to light the need for a unique identifier, be it the parcel number or some arbitrary tag, to identify the costs and revenues associated with a parcel. The results of this study illustrate that spatial representation of a large portion of a community's expenditures and revenues is possible; the challenge now is to devise a way to make these layers increasingly accurate at smaller scales. Take, for example, the Alcoholic Beverage License layer again; if developing a complete and comprehensive LBCS layer allowed for selection of parcels associated with all 319 active licenses, then, in a community with 16 different licenses and 3 types of permits, allocating total Alcoholic Beverage License revenues equally does not accurately reflect its spatial variability. The same is true of the Business Occupation Tax, where businesses are charged based on the number of full-time equivalent employees; the ability to represent business occupation tax revenues will be significantly improved if information on the number of full-time equivalent employees were associated with parcels serving as business establishments.

It is possible to extend this concept to utility layers such as Water & Sewer and Solid Waste. Maintaining a database, updated once per year, with average annual revenue generated by the water and sewer use per parcel is more effective than current allocation methods; at this time, residential properties receive their respective share of the total building square footage on the parcel, and commercial properties receive an equal distribution of the commercial/industrial water and sewer revenue. The Athens Country Club, shown in Figure 4.1, is likely a large generator of water and sewer revenue for ACC, with landscaping, food services facilities, and a golf course on the premises; the golf course, however, may be irrigated by the Country Club's own retention ponds. Without parcel-specific information on their average water use, the current proxy of water and sewer revenue may be over or under estimating actual use.

Figure 4.1. ATHENS COUNTRY CLUB



Including basic and non-sensitive information such as the level of Solid Waste services a parcel is receiving, the existence of a stormwater utility fee exemption, and all of the suggestions above in a database linked by some unique tag or identifier will increase the ability of a development impact model to accurately reflect the spatial variability of revenues and expenditures in a community. Data management techniques are simple and cost-effective for local governments; in order to increase the accuracy of this model, a municipality must be able to generate parcel-specific data that can be linked across departments by either the parcel number or another unique identifier. The results of this feasibility assessment indicate that, with effective planning and preparation, the right data and framework can be available to integrate a fiscal impact model with GIS and produce a logical, intelligible tool for use by local governments in planning and decision making; at present, however, there is much to be done in order to increase the model's accuracy. Efforts should be made within local governments to maximize the efficiency and usability of their current, in progress, or planned geographic information system technology.

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Appendix A. SUMMARY OF COST OF COMMUNITY SERVICES STUDIES

Community	Residential (incl. farm houses)	Commercial & Industrial	Working & Open Land	Source
Colorado				
Custer County	1 : 1.16	1 : 0.71	1 : 0.54	Haggerty, 2000
Sagauche County	1 : 1.17	1 : 0.53	1 : 0.35	Dirt, Inc., 2001
Connecticut				
Bolton	1 : 1.05	1 : 0.23	1 : 0.50	Geisler, 1998
Brooklyn	1 : 1.09	1 : 0.17	1 : 0.30	Green Valley Institute, 2002
Durham	1 : 1.07	1 : 0.27	1 : 0.23	Southern New England Forest Consortium, 1995
Farmington	1 : 1.33	1 : 0.32	1 : 0.31	Southern New England Forest Consortium, 1995
Hebron	1 : 1.06	1 : 0.47	1 : 0.43	American Farmland Trust, 1986
Lebanon	1 : 1.12	1 : 0.16	1 : 0.17	Green Valley Institute, 2007
Litchfield	1 : 1.11	1 : 0.34	1 : 0.34	Southern New England Forest Consortium, 1995
Pomfret	1 : 1.06	1 : 0.27	1 : 0.86	Southern New England Forest Consortium, 1995
Windham	1 : 1.15	1 : 0.24	1 : 0.19	Green Valley Institute, 2002
Florida				
Leon County	1 : 1.39	1 : 0.36	1 : 0.42	Dorfman, 2004
Georgia				
Appling County	1 : 2.27	1 : 0.17	1 : 0.35	Dorfman, 2004
Athens-Clarke County	1 : 1.39	1 : 0.41	1 : 2.04	Dorfman, 2005
Brooks County	1 : 1.56	1 : 0.42	1 : 0.39	Dorfman, 2006
Carroll County	1 : 1.29	1 : 0.37	1 : 0.55	Dorfmand and Black, 2002
Cherokee County	1 : 1.59	1 : 0.12	1 : 0.20	Dorfman, 2004
Colquitt County	1 : 1.28	1 : 0.45	1 : 0.80	Dorfman, 2004
Columbia County	1 : 1.16	1 : 0.48	1 : 0.52	Dorfman, 2006
Dooly County	1 : 2.04	1 : 0.50	1 : 0.27	Dorfman, 2004
Grady County	1 : 1.72	1 : 0.10	1 : 0.38	Dorfman, 2003
Hall County	1 : 1.25	1 : 0.66	1 : 0.22	Dorfman, 2004
Jackson County	1 : 1.28	1 : 0.58	1 : 0.15	Dorfman, 2008
Jones County	1 : 1.23	1 : 0.65	1 : 0.35	Dorfman, 2004
Miller County	1 : 1.54	1 : 0.52	1 : 0.53	Dorfman, 2004
Mitchell County	1 : 1.39	1 : 0.46	1 : 0.60	Dorfman, 2004
Morgan County	1 : 1.42	1 : 0.25	1 : 0.38	Dorfman, 2008
Thomas County	1 : 1.64	1 : 0.38	1 : 0.67	Dorfman, 2003
Union County	1 : 1.13	1 : 0.43	1 : 0.72	Dorfman and Lavigno, 2006
Idaho				
Booneville County	1 : 1.06	1 : 0.84	1 : 0.23	Hartmans and Meyer, 1997
Canyon County	1 : 1.08	1 : 0.79	1 : 0.54	Hartmans and Meyer, 1997
Cassia County	1 : 1.19	1 : 0.87	1 : 0.41	Hartmans and Meyer, 1997
Kootenai County	1 : 1.09	1 : 0.86	1 : 0.28	Hartmans and Meyer, 1997
Kentucky				
Campbell County	1 : 1.21	1 : 0.30	1 : 0.38	American Farmland Trust, 2005
Kenton County	1 : 1.19	1 : 0.19	1 : 0.51	American Farmland Trust, 2005
Lexington-Fayette County	1 : 1.64	1 : 0.22	1 : 0.93	American Farmland Trust, 1999

Oldham County	1 : 1.05	1 : 0.29	1 : 0.44	American Farmland Trust, 2003
Shelby County	1 : 1.21	1 : 0.24	1 : 0.41	American Farmland Trust, 2005
Maine				
Bethel	1 : 1.29	1 : 0.59	1 : 0.06	Good, 1994
Maryland				
Carroll County	1 : 1.15	1 : 0.48	1 : 0.45	Carroll County Dept. of Management & Budget, 1994
Cecil County	1 : 1.17	1 : 0.34	1 : 0.66	American Farmland Trust, 2001
Cecil County	1 : 1.12	1 : 0.28	1 : 0.37	Cecil County Office of Economic Development, 1994
Frederick County	1 : 1.14	1 : 0.50	1 : 0.53	American Farmland Trust, 1997
Harford County	1 : 1.11	1 : 0.40	1 : 0.91	American Farmland Trust, 2003
Kent County	1 : 1.05	1 : 0.64	1 : 0.42	American Farmland Trust, 2002
Wicomico County	1 : 1.21	1 : 0.33	1 : 0.96	American Farmland Trust, 2001
Massachusetts				
Agawam	1 : 1.05	1 : 0.44	1 : 0.31	American Farmland Trust, 1992
Becket	1 : 1.02	1 : 0.83	1 : 0.72	Southern New England Forest Consortium, 1995
Dartmouth	1 : 1.14	1 : 0.51	1 : 0.26	American Farmland Trust, 2009
Deerfield	1 : 1.16	1 : 0.38	1 : 0.29	American Farmland Trust, 1992
Deerfield	1 : 1.14	1 : 0.51	1 : 0.33	American Farmland Trust, 2009
Franklin	1 : 1.02	1 : 0.58	1 : 0.40	Southern New England Forest Consortium, 1995
Gill	1 : 1.15	1 : 0.43	1 : 0.38	American Farmland Trust, 1992
Leverett	1 : 1.15	1 : 0.29	1 : 0.25	Southern New England Forest Consortium, 1995
Middleboro	1 : 1.08	1 : 0.47	1 : 0.70	American Farmland Trust, 2001
Southborough	1 : 1.03	1 : 0.26	1 : 0.45	Adams and Hines, 1997
Sterling	1 : 1.09	1 : 0.26	1 : 0.34	American Farmland Trust, 2009
Westford	1 : 1.15	1 : 0.53	1 : 0.39	Southern New England Forest Consortium, 1995
Williamstown	1 : 1.11	1 : 0.34	1 : 0.40	Hazler et al., 1992
Michigan				
Marshall Twp., Calhoun County	1 : 1.47	1 : 0.20	1 : 0.27	American Farmland Trust, 2001
Newton Twp., Calhoun County	1 : 1.20	1 : 0.25	1 : 0.24	American Farmland Trust, 2001
Scio Twp., Washtenaw County	1 : 1.40	1 : 0.28	1 : 0.62	University of Michigan, 1994
Minnesota				
Farmington	1 : 1.02	1 : 0.79	1 : 0.77	American Farmland Trust, 1994
Independence	1 : 1.03	1 : 0.19	1 : 0.47	American Farmland Trust, 1994
Lake Elmo	1 : 1.07	1 : 0.20	1 : 0.27	American Farmland Trust, 1994
Montana				
Carbon County	1 : 1.60	1 : 0.21	1 : 0.34	Prinzing, 1997
Flathead County	1 : 1.23	1 : 0.26	1 : 0.34	Citizens for a Better Flathead, 1999
Gallatin County	1 : 1.45	1 : 0.16	1 : 0.25	Haggerty, 1996
New Hampshire				
Brentwood	1 : 1.17	1 : 0.24	1 : 0.83	Brentwood Open Space Task Force, 2002

Deerfield	1 : 1.15	1 : 0.22	1 : 0.35	Auger, 1994
Dover	1 : 1.15	1 : 0.63	1 : 0.94	Kingsley et al., 1993
Exeter	1 : 1.07	1 : 0.40	1 : 0.82	Niebling, 1997
Fremont	1 : 1.04	1 : 0.94	1 : 0.36	Auger, 1994
Groton	1 : 1.01	1 : 0.12	1 : 0.88	New Hampshire Wildlife Federation, 2001
Hookset	1 : 1.16	1 : 0.43	1 : 0.55	Innovative Natural Resource Solutions, 2008
Lyme	1 : 1.05	1 : 0.28	1 : 0.23	Pickard, 2000
Milton	1 : 1.30	1 : 0.35	1 : 0.72	Innovative Natural Resource Solutions, 2005
Mount Vernon	1 : 1.03	1 : 0.04	1 : 0.08	Innovative Natural Resource Solutions, 2002
Stratham	1 : 1.15	1 : 0.19	1 : 0.40	Auger, 1994
New Jersey				
Freehold Township	1 : 1.51	1 : 0.17	1 : 0.33	American Farmland Trust, 1998
Holmdel Township	1 : 1.38	1 : 0.12	1 : 0.66	American Farmland Trust, 1998
Moddletown Township	1 : 1.14	1 : 0.34	1 : 0.36	American Farmland Trust, 1998
Upper Freehold Township	1 : 1.18	1 : 0.20	1 : 0.35	American Farmland Trust, 1998
Wall Township	1 : 1.28	1 : 0.30	1 : 0.54	American Farmland Trust, 1998
New York				
Amenia	1 : 1.23	1 : 0.25	1 : 0.17	Bucknall, 1989
Beekman	1 : 1.12	1 : 0.18	1 : 0.48	American Farmland Trust, 1989
Dix	1 : 1.51	1 : 0.27	1 : 0.31	Schuyler County League of Women Voters, 1993
Farmington	1 : 1.22	1 : 0.27	1 : 0.72	Kinsman et al., 1991
Fishkill	1 : 1.23	1 : 0.31	1 : 0.74	Bucknall, 1989
Hector	1 : 1.30	1 : 0.15	1 : 0.28	Schuyler County League of Women Voters, 1993
Kinderhook	1 : 1.05	1 : 0.21	1 : 0.17	Concerned Citizens of Kinderhook, 1996
Montour	1 : 1.50	1 : 0.28	1 : 0.29	Schuyler County League of Women Voters, 1992
North East	1 : 1.36	1 : 0.29	1 : 0.21	American Farmland Trust, 1989
Reading	1 : 1.88	1 : 0.26	1 : 0.32	Schuyler County League of Women Voters, 1992
Red Hook	1 : 1.11	1 : 0.20	1 : 0.22	Bucknall, 1989
Rochester	1 : 1.27	1 : 0.18	1 : 0.18	Bonner and Gray, 2005
North Carolina				
Alamance County	1 : 1.46	1 : 0.23	1 : 0.59	Renkow, 2006
Chatham County	1 : 1.14	1 : 0.33	1 : 0.58	Renkow, 2007
Henderson County	1 : 1.16	1 : 0.40	1 : 0.97	Renkow, 2008
Orange County	1 : 1.31	1 : 0.24	1 : 0.72	Renkow, 2006
Union County	1 : 1.30	1 : 0.41	1 : 0.24	Dorfman, 2004
Wake County	1 : 1.54	1 : 0.18	1 : 0.49	Renkow, 2001
Ohio				
Butler County	1 : 1.12	1 : 0.45	1 : 0.49	American Farmland Trust, 2003
Clark County	1 : 1.11	1 : 0.38	1 : 0.30	American Farmland Trust, 2003
Hocking Township	1 : 1.10	1 : 0.27	1 : 0.17	Prindle, 2002
Knox County	1 : 1.05	1 : 0.38	1 : 0.29	American Farmland Trust, 2003

Liberty Township	1 : 1.15	1 : 0.51	1 : 0.05	Prindle, 2002
Madison Village, Lake County	1 : 1.67	1 : 0.20	1 : 0.38	American Farmland Trust, 1993
Madison Township, Lake County	1 : 1.40	1 : 0.25	1 : 0.30	American Farmland Trust, 1993
Madison Village, Lake County	1 : 1.16	1 : 0.32	1 : 0.37	American Farmland Trust, 2008
Madison Township, Lake County	1 : 1.24	1 : 0.33	1 : 0.30	American Farmland Trust, 2008
Shalersville Township	1 : 1.58	1 : 0.17	1 : 0.31	Portage County Regional Planning Commission, 1997
Pennsylvania				
Allegheny Twp., Westmoreland County	1 : 1.06	1 : 0.14	1 : 0.13	Kelsey, 1997
Bedminster Twp., Bucks County	1 : 1.12	1 : 0.05	1 : 0.04	Kelsey, 1997
Bethel Twp., Lebanon County	1 : 1.08	1 : 0.17	1 : 0.06	Kelsey, 1992
Bingham Twp., Potter County	1 : 1.56	1 : 0.16	1 : 0.15	Kelsey, 1994
Buckingham Twp., Bucks County	1 : 1.04	1 : 0.15	1 : 0.08	Kelsey, 1996
Carroll Twp., Perry County	1 : 1.03	1 : 0.06	1 : 0.02	Kelsey, 1992
Hopewell Twp., York County	1 : 1.27	1 : 0.32	1 : 0.59	The South Central Assembly for Effective Governance, 2002
Kelly Twp., Union County	1 : 1.48	1 : 0.07	1 : 0.07	Kelsey, 2006
Lehman Twp., Pike County	1 : 0.94	1 : 0.20	1 : 0.27	Kelsey, 2006
Maiden Creek Twp., Berks County	1 : 1.28	1 : 0.11	1 : 0.06	Kelsey, 1998
Richmond Twp., Berks County	1 : 1.24	1 : 0.09	1 : 0.04	Kelsey, 1998
Shrewsbury Twp., York County	1 : 1.22	1 : 0.15	1 : 0.17	The South Central Assembly for Effective Governance, 2002
Stewardson Twp., Potter County	1 : 2.11	1 : 0.23	1 : 0.31	Kelsey, 1994
Straban Twp., Adams County	1 : 1.10	1 : 0.16	1 : 0.06	Kelsey, 1992
Sweden Twp., Potter County	1 : 1.38	1 : 0.07	1 : 0.08	Kelsey, 1994
Rhode Island				
Hopkinton	1 : 1.08	1 : 0.31	1 : 0.31	Southern New England Forest Consortium, 1995
Little Compton	1 : 1.05	1 : 0.56	1 : 0.37	Southern New England Forest Consortium, 1995
West Greenwich	1 : 1.46	1 : 0.40	1 : 0.46	Southern New England Forest Consortium, 1995
Tennessee				
Blount County	1 : 1.23	1 : 0.25	1 : 0.41	American Farmland Trust, 2006
Robertson County	1 : 1.13	1 : 0.22	1 : 0.26	American Farmland Trust, 2006
Tipton County	1 : 1.07	1 : 0.31	1 : 0.57	American Farmland Trust, 2006
Texas				
Bandera County	1 : 1.10	1 : 0.26	1 : 0.26	American Farmland Trust, 2002

Bexar County	1 : 1.15	1 : 0.20	1 : 0.18	American Farmland Trust, 2004
Hays County	1 : 1.26	1 : 0.30	1 : 0.33	American Farmland Trust, 2000
Utah				
Cache County	1 : 1.27	1 : 0.25	1 : 0.57	Snyder and Ferguson, 1994
Sevier County	1 : 1.11	1 : 0.31	1 : 0.99	Snyder and Ferguson, 1994
Utah County	1 : 1.23	1 : 0.26	1 : 0.82	Snyder and Ferguson, 1994
Virginia				
Augusta County	1 : 1.22	1 : 0.20	1 : 0.80	Valley Conservation Council, 1997
Bedford County	1 : 1.07	1 : 0.40	1 : 0.25	American Farmland Trust, 2005
Clarke County	1 : 1.26	1 : 0.21	1 : 0.15	Piedmont Environmental Council, 1994
Culpepper County	1 : 1.22	1 : 0.41	1 : 0.32	American Farmland Trust, 2003
Frederick County	1 : 1.19	1 : 0.23	1 : 0.33	American Farmland Trust, 2003
Northampton County	1 : 1.13	1 : 0.97	1 : 0.23	American Farmland Trust, 1999
Washington				
Okanogan County	1 : 1.06	1 : 0.59	1 : 0.56	American Farmland Trust, 2007
Skagit County	1 : 1.25	1 : 0.30	1 : 0.51	American Farmland Trust, 1999
Wisconsin				
Dunn	1 : 1.06	1 : 0.29	1 : 0.18	Town of Dunn, 1994
Dunn	1 : 1.02	1 : 0.55	1 : 0.15	Wisconsin Land Use Research Program, 1999
Perry	1 : 1.20	1 : 1.04	1 : 0.41	Wisconsin Land Use Research Program, 1999
Westport	1 : 1.11	1 : 0.31	1 : 0.13	Wisconsin Land Use Research Program, 1999

All ratios expressed in revenues to expenditures.

Source: American Farmland Trust Farmland Information Center

The ratio of unexpected customers, or customers residing outside of Clarke County, to the overall pull factor indicated 38% of sales originate outside of the county; commercial/industrial land uses were assumed to contribute 4% to LOST revenue in FY 2011, leaving 58% of LOST revenue attributable to residential land uses. Sensitivity analysis was performed by adjusting the outside share to 33% and 43%, leaving commercial/industrial land uses accountable for 4%, or $758,182.68, or FY 2011 LOST revenues.

1. 63% residential, 4% commercial/industrial, 33% outside

Revenue Allocations in $US			
FY 2011 Total LOST	**Residential**	**Commercial/Industrial**	**Outside**
$18,954,566.97	$11,941,377.19	$758,182.68	$6,255,007.10

2. 53% residential, 4% commercial/industrial, 43% outside

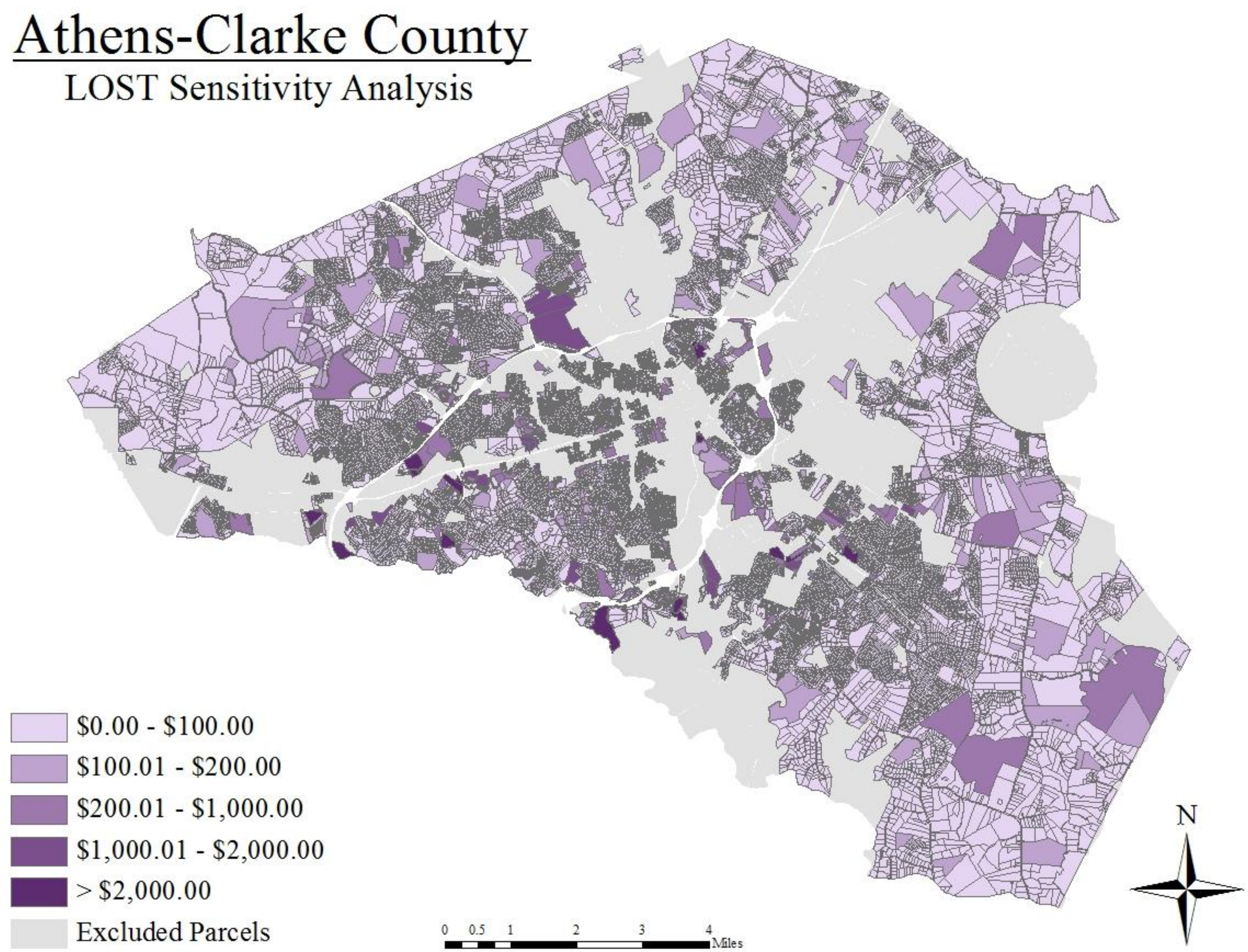
Revenue Allocations in $US			
FY 2011 Total LOST	**Residential**	**Commercial/Industrial**	**Outside**
$18,954,566.97	$10,045,920.49	$758,182.68	$8,510,463.80

As before, all residential parcels were assumed to have spent at least $10,000 in the fiscal year, generating $100 each in LOST revenue, for a total of $3,558,600. The difference between this estimate and actual FY 2011 revenues was allocated according to:

$$LOST_i = 100 + \left(TR_R - \widehat{TR}_R\right)\left(\frac{PT_i}{\sum_{i=1}^{n} PT_i}\right) \quad \text{(Equation 4)}$$

Commercial/industrial parcels continued to receive an equal share of their allocated revenue, $148.55 each. Parcels were selected in the same manner as the initial allocation. Figures B.1 illustrates the per parcel difference in revenues between the baseline 38% outside allocation and the 33% and 43% allocations for this sensitivity analysis.

Figure B.1. LOST SENSITIVITY ANALYSIS



With a 43% outside revenue allocation, the share of residential revenue drops to 53% and so the legend values will be negative. The result of this analysis illustrates that residential parcels are moderately sensitive to shifts in revenue allocation, with the majority of parcels showing changes of less than $200. This analysis again emphasizes the need for management techniques that allow for distinction between land uses.