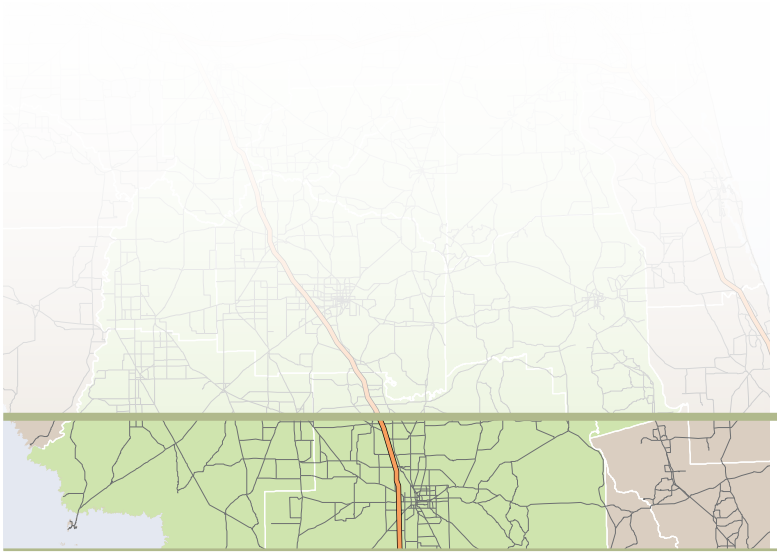

chapter one

Introduction

Imagine a woman—we'll call her Mrs. Smith—who lives near the historic center of her north Florida community. Most of her daily needs can be met within a 2-mile radius of her home, where the third wave of urban settlement passed at least 25 years ago. Consequently, the degree and pace of change in her daily environs is reasonably modest: a new facade, a new restaurant on the corner to replace the old unsuccessful one, or the purchase of a local business by a national franchise. All in all it's not too much to absorb; it's easy to keep her bearings and embrace the minor changes as necessary improvements. However, occasionally she ventures beyond these limits to outer parts of her growing community. When she does, she is regularly amazed that the frontier of suburban expansion has continued to advance, and the character and detail of her native landscape has changed yet again. The corner where her favorite fruit and vegetable stand used to be is now occupied by the community's tenth edition of a regional grocery store chain. The field where she took horseback riding lessons as a girl is now subdivided into acre lots with houses that are at least 3,000 square feet. The cropland where watermelons and soybeans grew

has been transformed into the newest elementary school to educate the children who live in the new homes. The wetland where cypress and tupelo used to grow has been cleared, drained, and is now awaiting the arrival of the suburban fringe. The two-lane rural roads leading to smaller outlying communities are mostly now four lanes and are usually clogged with traffic at peak travel times. These landscape transformations are not so easy to assimilate. They represent fundamental changes in the area's historic landscape. Besides waxing nostalgic, it causes her to wonder if the suburbanization is inevitable, much less optimal. Are the costs associated with it being fairly distributed? Are decisions being made for short-term gain or long-term stability? Is it the best alternative when it comes to human health? Are there alternatives to the rampant change?

Figure 1.1 A growing population requires new amenities such as schools and stores.

The fundamental regional land-use equation

The transformations Mrs. Smith observes are the result of three present realities, all of which are inexorably linked to what we call the *fundamental regional land-use equation.* The first reality is increasing population. In some locales, population growth results from the number of births exceeding the number of deaths; however, in most of the United States, it is increasingly attributed to immigration, domestic migration, or both. Between 1990 and 2000, the population of the United States grew by almost 33 million people to an estimated 281.4 million, the largest increase for a 10-year period in American history. In 2006, headlines nationwide read, "U.S. Population Tops 300 million." In the 1990–2000 decade, the West and South grew more rapidly than the rest of the country at 10.4 million (a 19.7 percent increase) and 14.8 million (a 17.3 percent increase), respectively. Statistics reveal between 1950 and 2000 the South's portion of the overall population increased from 31 to 36 percent, and the West's portion increased from 13 to 22 percent. For this same period, the Midwest's percent declined from 29 to 23, and the Northeast's percent from 26 to 19. These numbers indicate the West and South regions are destinations of domestic migration as well as immigration. Regardless of these shifts, however, no state lost population between 1990 and 2000. Nationwide a few counties are experiencing declining populations, mostly due to lack of economic opportunity, but these are definitely the exception (Perry and Mackun 2001).

population ÷ gross urban density
= acres of land needed to support human settlement

Figure 1.2 The fundamental regional land-use equation.

The second land-use reality is a trend toward lower gross urban density largely driven by lower residential densities. A 2002 survey by the National Association of Realtors (NAR) and National Association of Home Builders (NAHB) reveals the preferences of recent homebuyers (NAR and NAHB 2002). Single-family detached homes were the choice of 76 percent of them. The most important consideration when choosing their new home was price, followed by location/neighborhood. When asked how they would rank 16 criteria for choosing their next home, after price, the feature receiving the greatest percentage of very important/important responses, 62 percent, was "houses spread out." "Bigger house" received 47 percent, and "bigger lot" received 45 percent. "Away from the city" received 39 percent, "closer to work" 28 percent, "smaller house" 10 percent, and "smaller lot" 9 percent. Given the combination of homeowner preference and lower land prices beyond the urban fringe, it is no wonder that residential densities appear to be declining.

The third land-use reality is related to the issue of density. The average household size is decreasing (household is defined as "a person or group of people who occupy a housing unit"

[Simmons and O'Neill 2001]). Between 1990 and 2000 the national average dropped from 2.63 to 2.59 people per household. This is attributable to a range of social changes within the United States, including an increasing number of single person households (27.2 million, or 26 percent of all households in 2000 [ibid.]), fewer children per household, and fewer elderly living in the homes of their children. The result of all these changes is that more housing units are required to accommodate the same population. Add to this an increasing rate of families with second and even third homes, and the number of housing units and the land they occupy grows even more.

Because of current trends in gross urban density and household size, it's clear that more land is required by fewer individuals than ever before. Add to this the population boom, and the fundamental land-use equation shows us the acres of land required for human settlement is an ever-burgeoning number. This is the reason for *sprawl,* the rapid and inefficient expansion of urban/suburban land use. The NAR and NAHB survey previously cited asked the same new home buyers who they thought was responsible for sprawl. The survey allowed for more than one response to the question, and the results were as follows: 49 percent of the respondents placed the blame with builders/developers, 48 percent with elected planning officials, 43 percent with consumers who want a larger and less expensive home, and 37 percent with local government. While some appear willing to accept at least part of the responsibility for sprawl, others do not appear to agree with Pogo, the once-popular comic strip character, who declared famously, "We have met the enemy, and he is us."

Figure 1.3 Lower residential densities and household sizes mean more space is required for homes.

Combine the trend of sprawl with the well-documented reality of incrementalism in land-use change—in other words, lots of small changes separated by time and space—and you can see why it's difficult to comprehend the cumulative effects of individual land-use decisions. This reality is sometimes compounded by jurisdictional boundaries. A city government may diligently track and anticipate land-use changes within their own boundaries, but it may be quite difficult to also track the changes occurring within adjacent jurisdictions, much less affect those decisions. When land use changes one parcel at a time, those individual changes, when aggregated and reviewed over intervals of five to ten years, can reveal unanticipated and rapid transformation of astonishingly large areas. Sometimes the public and private entities engaged in land-use decision making may foresee the results of incremental land-use decisions and the cumulative changes they bring about; however, it is a premise of this book that the cumulative reality of individual land-use decisions is rarely, if ever, understood.

This book has been written in order to share a technique that reveals the spatial reality of incremental land-use change. If the public and their elected officials can visualize the cumulative effects of incremental land-use decisions, then there is hope the decisions will be more carefully deliberated and the criteria considered will include both short-term and long-term implications. For example, if the spatial reality of 3,000 new residential units per year for the next 10 years can be clearly mapped, then the lost agricultural and conservation opportunities will be more easily understood and the need for additional public infrastructure in the form of roads, sewage treatment systems, and schools will be more obvious. Unfortunately, at the moment there is little funding and sparse opportunity to project the long-term view, but with the tools described in this book, any land-use professional will be well-armed to generate these projections and create a demand for them as an essential component of sound decision making. Land-use professionals, whether planners, architects, landscape architects, attorneys, public administrators, or elected officials, all surely sense the inadequacy of current tools and their impotence at stemming the tide of sprawl. This book describes an analysis process that adds spatial representation of future land-use trends into their arsenals. It advocates and delineates *smart* land-use analysis for enlightened planning and decision making.

The subject of this book evolved in response to the desire to visualize and analyze regional land-use change and to project into the future the spatial pattern that results from existing and proposed land-use policies. Visualization and analysis of land use in major metropolitan urban areas that doesn't consider the larger regional context is ineffective. Regardless of one's philosophical view on urban/suburban expansion, we contend the public will be best served when the cumulative effect of land-use policies can be translated into comprehensible visualizations of the future; in other words, when what-if scenarios can be simplified to the point where they may be easily and satisfactorily understood.

This goal is now clearly within our grasp, thanks to the advent of geographic information system (GIS) technology, and to the evolution of software that easily supports cell-based suitability analysis, specifically the ModelBuilder window embedded in ArcGIS software, produced by ESRI. The ability of ModelBuilder to link ArcGIS tools in a structured visual environment is powerful, and it facilitates the development of complex land-use models without requiring the user to learn a programming language. These advances in technology, along with the process we outline in this book, called the Land-Use Conflict Identification Strategy, or *LUCIS* for short, form a manageable foundation for visualizing future land use. The strategy explores optimal suitabilities for three broad land-use categories (agriculture, conservation, and urban) and compares them to identify where conflict among them exists. This approach is balanced and flexible—balanced in that it evaluates suitabilities for more than just the politically and economically dominant urban land-use category, and flexible because the criteria used to determine the suitabilities can be customized to fit each region's unique characteristics. LUCIS also has the potential for many other applications, including strategic conservation planning, real estate investment, infrastructure planning (for new schools or roads, for example), and general market analysis. Regardless of the chosen application, one must first understand the details of the LUCIS model, as well as the underlying GIS techniques and analysis principles. To that end, we have organized the book into three parts.

Part I Foundations

Part I is a review of the fundamental principles necessary for understanding and applying LUCIS. In chapter 2, the origins and structure of LUCIS are described. In chapter 3, essential GIS concepts and the ArcGIS framework are reviewed.

Please note that this book is not intended for beginning GIS users, but rather for users who have been exposed to basic GIS concepts and techniques and who are ready to try their hands at land-use analysis. It should also prove interesting to those well-versed in land-use analysis but who may not have considered multiple suitabilities simultaneously and the conflicts that arise among them. A familiarity with basic statistics will be helpful to readers of this book, but is not necessary. The review of GIS that takes place in chapter 3 is therefore not for beginners, and yet does review some basic concepts because of their importance to proper land-use analysis. We will discuss vector and raster data formats, and describe some specific vector and raster analysis tools contained in ArcToolbox, the storage container for geoprocessing tools in ArcGIS. Simply put, chapter 3 teaches users how to use the ArcGIS tools needed to create LUCIS models.

Chapter 4, perhaps the single most important chapter in the book, is a review of rules for data manipulation and logic that must be followed for raster analysis to be valid. As a unit, part I can be considered the lecture portion or knowledge base of the book, because it lays the foundation for the explanation and application of LUCIS found in parts II and III.

Part II The LUCIS model

Part II focuses on the nuts and bolts of the five steps of LUCIS. Chapter 5 describes the character of the LUCIS case study area—nine counties in north central Florida—including demographics and information about the local economy and existing patterns of land use. In chapters 6 through 10, the individual steps of LUCIS are carefully described, both in general terms and as they relate specifically to the case study area.

Part III Seeing the future

Part III, encompassed in chapter 11, includes a simple demonstration of one of many potential LUCIS applications: visualizing future land use in the case study area.

In chapter 12, we summarize key concepts of LUCIS, draw conclusions about the case study results, and describe other possible LUCIS applications.

Assignments

Many chapters include recommended software assignments designed to demonstrate key concepts of GIS, data manipulation, and LUCIS methods in order to embolden the reader to embrace and apply the process for their own ends. It should be understood that minimal guidance is provided; they are not step-by-step exercises, but rather challenges that should prompt readers to explore the software and figure out solutions on their own. Hints and solutions are presented on the accompanying *Smart Land-Use Analysis* DVD found at the back of the book.

The LUCIS mission

Increasingly, sprawl is described as a negative phenomenon. Health problems resulting from increased dependence on the automobile, high rates of energy consumption, and loss of pristine lands are among the problems attributed to it. Yet despite this recognition of the disadvantages of sprawl, the NAR/NAHB survey cited earlier clearly demonstrates a disconnect between that comprehension and the myriad individual land-use decisions made incrementally over time. In other words, there is an inability to see the connection between individual land-use decisions and the long-term spatial consequences of the accumulation of those individual decisions. It is our belief that smart land-use analysis using a combination of GIS, ModelBuilder, and LUCIS has the power to clearly and accurately represent the highly probable spatial consequence of those incremental decisions. Further, once the magnitude and distribution of potential problems are more clearly understood, the community will be compelled to explore alternative land-use futures and the policies necessary to achieve them.

References

National Association of Realtors (NAR) and National Association of Home Builders (NAHB). 2002. Consumers' survey on smart choices for home buyers, April 2002.

Perry, Marc J., and Paul J. Mackun. 2001. Population change and distribution 1990 to 2000, Census brief 2000. U.S. Department of Commerce, U.S. Census Bureau www.census.gov/prod/2001pubs/c2kbr01-2.pdf.

Simmons, Tavia, and Grace O'Neill. 2001. Households and families: 2000. U.S. Department of Commerce, U. S. Census Bureau www.census.gov/prod/2001pubs/c2kbr01-8.pdf.