

Monitoring Land Supply

with **Geographic
Information
Systems**

Theory, Practice, and Parcel-Based Approaches



Edited by Anne Vernez Moudon
Michael Hubner

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Parcel-Based Approaches*

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John Wiley & Sons, Inc.

NEW YORK / CHICHESTER / WEINHEIM / BRISBANE / SINGAPORE / TORONTO

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Published simultaneously in Canada.

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ISBN 0-471-37163-7

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

To Louisa and Cota

Anne Vernez Moudon

*To all the members of my family, especially to the memory of my
grandfather, Henry Bellinger, and to
Miriam Hirschstein for her support and affection*

Michael Hubner

Acknowledgments

This book were made possible by the generous support of the Lincoln Institute of Land Policy, which has long championed research and education on land monitoring. We especially want to thank Roz Greenstein, Director of the Institute Program in Land Markets, who played a dual role as infallible advisor and enthusiastic advocate of the project. Her help in setting the research program as an integral part of the Lincoln Institute's educational agenda was invaluable. She was also instrumental in turning the project into a book.

The study entailed extensive review of the literature on land monitoring and GIS as well as interviews with numerous scholars and practitioners in these fields. We are very grateful to those who generously shared their knowledge and experience with us during the course of this project: many of the people contacted during the course of the research are listed in Appendixes B and C. The project also depended on early inputs from an advisory board, which included Nicholas Chrisman, Bob Filley, Gary Pivo, and Paul Waddell of the University of Washington; Nancy Tosta of the Puget Sound Regional Council; and Carol Bason and Tom Nolan of the City of Seattle. Sharing facilities and equipment with the Center for Community Development and Real Estate at the University of Washington for the duration of the project brought an untold number of benefits.

Some of the chapters originated as papers presented at a seminar, "Parcel-Based GIS for Land-Supply and Capacity Monitoring," at the University of Washington in May 1998. Lively exchanges during the course of the seminar led to substantial revisions of the early drafts as well as to additional papers covering the new issues and topics raised. The seminar discussions greatly benefited from the input of practiced professionals involved in land monitoring

at Portland Metro and at various agencies and jurisdictions of the central Puget Sound region. We would like to thank all the participants for their rich contributions and enthusiastic support of the project—a list of seminar participants is provided in Appendix D. We also wish to thank the staff of the College of Architecture and Urban Planning and the Department of Urban Design and Planning at the University of Washington for their help in organizing the seminar, especially Sandy Houser and Dorothy Sjaastad.

The book also gleans much material from the fruits of Michael Hubner's nine months of independent research, which culminated in a master's thesis in June of 1999.

Louisa Seferis helped transform the early research report into book chapters by expertly entering the numerous revisions made.

From the outset, we conceived of this work as an effort to bring an "user's" critical perspective to bear on the technical realm of GIS in planning. Our own backgrounds in the study of urbanization and development processes, the evolution of urban form, and land use and growth management planning methods, informed our research on urban land supply monitoring. However, the process was not painless, especially in the need to quickly catch up with several decades of GIS development and land monitoring practice. Our express gratitude to all of the people and organizations that freely lent their support does not take away from our final responsibility for this book. We hope that this work fulfills some of our original intent, namely to help planners improve their understanding of how cities are made, and thereby improve the quality of those cities in the future.

ANNE VERNEZ MOUDON AND MICHAEL HUBNER

Seattle, July 1999

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Introduction

Anne Vernez Moudon and Michael Hubner

This book documents the use of geographic information systems (GIS) in monitoring urban land supply. Monitoring land is a well-established activity of many local governments in the United States. Recent developments in parcel-based GIS are now opening up new opportunities. This work explores how these new GIS can serve the purposes of current land monitoring efforts and how they may change them.

A first focus for this book is land monitoring in urbanized regions, as opposed to areas in primarily rural or agricultural use and wilderness areas. Urbanized regions differ from other land areas in that the use of land—both actual and potential—is defined by a complex web of market forces and public policies. The use of land in urbanized regions is highly dependent on the level at which the land is serviced with infrastructure, including electricity, water, sewers, communications and transportation systems, and educational and recreational facilities. Urban land is also characterized by comparatively small spatial units of ownership and a high rate of change in ownership and use. In addition, it is subject to elaborate land use regulations and land management practices (Kivell 1993; Kaiser et al. 1995).

Concern about the continued spread of cities in the United States and the growing inability to cover the associated costs of providing urban infrastructure have raised the profile of land monitoring within urban and regional planning. At issue are both the available *supply* of land and the *capacity* of that land to accommodate future development. Land supply and capacity monitoring—LSCM for short—comprises the multiple activities involved in measuring, analyzing, and evaluating supply and capacity over time.

Monitoring Land Supply with Geographic Information Systems, edited by Anne Vernez Moudon and Michael Hubner ISBN 0 471371673 © 2000 John Wiley & Sons, Inc.

The practice of LSCM has required the use of increasingly sophisticated land information systems (Dale and McLaughlin 1988). In turn, the use of these systems has allowed planners to reach beyond a traditional focus on land use and zoning and to consider causal relationships between land utilization, land and infrastructure development, fiscal impacts, and market forces (Bollens and Godschalk 1987; Jacobs 1988).

The tax-lot parcel is an increasingly essential building block of land information systems. Previous efforts to describe a preferred model for collecting land data have emphasized the parcel as a central element, suggesting specifically the maintenance of a "parcel file" for land supply monitoring (Godschalk et al. 1986) or referring to a more generic "multipurpose cadastre" (Dueker and Kjerne 1989; Dueker and DeLacey 1990). Because it is the smallest unit of geography that can be managed and controlled by one person or entity, the parcel continues to be considered an important unit of data collection and analysis, which must be considered along with other levels of geography (Enger 1992; Bollens 1998).

Parcel-based geographic information systems—or PBGIS—are a second focus of this book. These relatively new systems are defined by the inclusion of parcels as a primary spatial layer. The digitization of parcel boundaries allows parcels to be represented and analyzed as discrete areas in a PBGIS. Tabular data files containing land records and assessor's files can thereby be linked to individual parcels via a unique identifier such as the parcel identification number (PIN). In addition, overlaying parcels with nonparcel spatial layers allows many variables, such as soil conditions and transportation infrastructure, to be considered precisely in relation to spatial patterns of land ownership, regulation, and development. PBGIS therefore provide a means for representing and analyzing various data about land at a higher level of spatial resolution than achieved with previous applications of GIS based on relatively coarse geographies, such as analysis zones, planning areas, or generalized land use polygons. The parcel level of resolution also corresponds closely to real-world transactional activity related to urban land.

THE PAST TEN YEARS

The state of the art in land supply monitoring and land information systems was last reviewed more than ten years ago (Godschalk et al. 1986). Since then, technological advances have continued at a rapid pace, highlighted by an increasingly comprehensive and widespread integration of GIS into the Automated Land Supply Information System described by these authors. At the same time, however, these advances are only slowly being met with the changes in the organizational structures that are required to apply the new information technology to planning analysis. Indeed, the current state of practice reflects the findings of the aforementioned authors. Although, on one hand, "computerized land supply tracking systems increase the comprehen-

siveness and currency of both public and private land-related information," technical capabilities appear "more advanced than the institutional capacity of governments to use land information systems effectively" (Bollens and Godschalk 1987, 315).

Three primary areas of change have affected the state of practice in land use monitoring and capacity analysis over the past decade. One is the extraordinarily rapid geographic spread of urban areas relative to increases in population. As urban sprawl, the conurbation of historically separate urban centers, the emergence of new suburban centers, and leapfrog development patterns have continued apace, many cities have evolved into city-regions. Land planning and, consequently, land monitoring have become regional in scope, involving numerous jurisdictions and multiple levels of government. The size and complexity of these urban areas pose significant challenges to developing appropriately detailed regional land supply databases (Kivell 1993; Downs 1994).

A second area of change is the increased level of concern for and awareness of how patterns of contemporary urbanization affect both natural and human-made systems. These concerns have spurred a multitude of legislative actions, both to alter urbanization patterns and to mitigate their impacts through a variety of mechanisms. It has become common for governments to encourage dense and compact urban development via urban containment strategies, ordinances to ensure the provision of adequate public facilities, farmland and open space preservation programs, shoreline and watershed management programs, and so on. Cast under the label of growth management or "smart growth," the new orientation in land use planning reflects a recognition that not only is urban land a finite resource, but that current land development patterns impose costs that local governments are increasingly unable, or unwilling, to bear (De Grove 1992; Peirce 1997; American Planning Association 1998). In this context, monitoring land and its development has become an integral, and often legally mandated, aspect of many jurisdictions' managerial responsibilities.

A third area of change relates to significant advances made in information technology. The rapid evolution of GIS technology has been marked by an exponential increase in the availability of spatial and spatially referenced data, as well as by increased possibilities to integrate a multiplicity of databases (Chrisman 1997; Klosterman 1997). In particular, the profusion of parcel-level data now enables planners to analyze in great detail the locational and spatial characteristics of a land area, along with its social, economic, and environmental dimensions. Improvements in both hardware and software have increased capacities for data storage, processing, and manipulation, allowing land monitoring programs to collect and manage land-related data at high levels of detail over large metropolitan regions.

CASE STUDIES OF "BEST" PRACTICES

Technical advances and policy reorientations notwithstanding, this book projects a context for land monitoring that is in advance of practice. A review

of the literature on GIS and land monitoring, complemented by numerous phone interviews with people involved in both fields, indicates that, with major exceptions, relatively few jurisdictions in the country have used PBGIS for land monitoring and capacity analysis. At the same time, however, it is estimated that 25 percent or more of jurisdictions across the country are in the process of building a PBGIS, including most cities with populations of more than 100,000 (Crane 1997; Huxhold 1997; Kollin et al. 1998). As parcel-based systems become more widely available, planners will increasingly utilize these data, both for daily tasks and for long-range monitoring and analyses related to land supply.

Given the anticipation of widespread use of PBGIS and the significant changes they are projected to make in methods of land use monitoring, this book highlights three case studies to illustrate "best" practices and advanced applications of PBGIS for land supply and capacity monitoring. First, Portland Metro, Oregon, has a 20-year history of growth management, an established legal and institutional apparatus to monitor land supply, and a sophisticated information system to manage its lands. This multijurisdictional effort offers a well-engineered and tested set of tools and methods, which include the use of mixed spatial units (including parcels), the integration of raster and vector GIS, the periodic application of aerial image data, and ongoing monitoring of regional "Performance Measures" related to land use, land development, and housing.

Second, Montgomery County, Maryland, has a distinguished history of land planning and a tested system of releasing land for development in accordance with infrastructure delivery. Although the county has historically used a variety of non-parcel-level and non-GIS computerized land monitoring tools, it is now in the process of incorporating PBGIS analysis in support of its growth management program. Furthermore, the State of Maryland itself recently enacted legislation to encourage "smart growth" land planning practices. To support this effort at the local jurisdictional level, the state has developed and made available a GIS database that incorporates parcel data, along with guidelines for a suggested land supply analysis methodology.

A third case study describes a recent effort to evaluate the supply of and demand for industrial land in the central Puget Sound region. Conducted by the Puget Sound Regional Council (PSRC) and the University of Washington Center for Community Development and Real Estate (CCDRE), this work seeks to improve methods of forecasting the future demand for industrial land. A small piece of a much broader set of regional growth management monitoring efforts, this case study offers methodological insights into the analysis of employment-based land uses, as well as the development of regional land management systems. In contrast to the other two cases, land monitoring in the central Puget Sound region is largely decentralized, causing this regional study to rely on land supply inputs from many local jurisdictions.

The three case studies are complemented by two appendixes. Appendix A is a detailed analysis of the findings of the survey of LSCM in jurisdictions nationally. Appendix B consists of summaries of land monitoring ap-

proaches in eleven selected jurisdictions. These cases further illustrate the various aspects of GIS and land monitoring discussed in the main chapters of this book.

BOOK STRUCTURE

The book has three parts. In Part I, the first chapter summarizes the state of practice and the challenges faced by land monitoring programs in this country. A second chapter introduces essential definitions and elements of land monitoring. It puts forward a generalized methodological framework for land supply monitoring and land capacity analysis, outlining the steps to be followed, variables to be considered, and critical issues. This chapter helps the reader conceptualize all of the elements of a land monitoring process.

Part II contains three chapters relating to the three principal case studies: Portland Metro, Montgomery County and the State of Maryland, and the Puget Sound Regional Council and University of Washington study. Chapter 3 reviews conceptual issues in land monitoring, business inventory methods as applied to monitoring, database design alternatives, and preferred units of analysis. It provides a framework for assessing Portland Metro's database and land monitoring approach. Chapter 4 discusses growth management and land supply monitoring programs in Montgomery County, as well as the State of Maryland Smart Growth Program and the MdProperty View GIS database. Chapter 5 explains the planning context for the central Puget Sound industrial lands study and discusses the methodological basis used to establish supply and demand for industrial land in the region.

Part III turns to thematic issues about the future of LSCM. Chapter 6 discusses technical advances and methodological responses to the need for accurate and timely land monitoring. Using the Portland Metro case for illustrative purposes, it focuses on conceptual issues in land use classification and tracking land use change over time. Chapter 7 describes inter- and intraorganizational conditions for cooperative efforts to use PBGIS for land monitoring. Chapter 8 reviews the potential role of urban land simulation models in refining the demand assumptions that inform estimates of land supply and development capacity. The focus is on UrbanSim, a disaggregated land use change model incorporating parcel-level data.

The chapters in Parts II and III include commentaries by experts in the fields of land use planning and GIS. Reflecting the nature of land use monitoring with GIS, these commentaries enrich the chapters' contributions by introducing different and sometimes even conflicting interpretations of the issues involved.

BASIC ISSUES

The use of parcel-based GIS in land supply and capacity monitoring generates many issues encompassing methodological approaches, the organizational and

institutional parameters within which land monitoring takes place, and the promise and limitations of the technology itself. Two broad themes frame a discussion of the basic issues. First, land supply monitoring is a politically grounded activity that embraces the full array of interests engaged in the implementation of land use controls in general, and in growth management in particular. As such, the assumptions and criteria that define land "supply" and "capacity" are subject to continual debate and reassessment in the private and public arenas. Second, land monitoring is a data-driven activity that depends on an appropriate data collection, management, and analysis technology—for example, GIS, remote sensing, and spreadsheet and database management software. There is an evident dynamic in land monitoring between methodology and information system resources. Within these themes, five issues stand out. As they recur throughout this book, references are provided to pertinent chapters.

Issue 1: Defining Land Supply and Capacity

Land supply and capacity monitoring is an exercise in measuring the way land is used, and not used, in order to address the potential future use of land based on its physical and social attributes. It consists of much more than a running inventory of land utilization and commonly includes information on legal definitions of how land can be used, depending on environmental and physical factors affected by development, infrastructure levels, and land and real estate markets (Godschalk et al. 1986).

Decisions shaping the development of urban land involve a large number of participants and interests in a highly politicized process. Consequently, there are many definitions of the supply of land and its capacity (Dearborn and Gyri 1993; Bollens 1998). Naturally, the contentiousness of this process increases according to the relative scarcity of land deemed "developable." The need to establish "definition(s) of available land supply agreed on by both private interest and the government" (Godschalk et al. 1986) continues to be a major issue within land monitoring.

What constitutes demand for land is also a major area of contention. Although demand technically does not have to be considered in order to determine land supply and estimate its capacity, in practice, the adequacy of a given land supply is assessed relative to expected demand. Typically, this entails comparisons of aggregate supply and demand, such as dwelling unit capacity versus household increases, or square feet of nonresidential capacity versus employment growth. Other considerations of demand for land include consumer preferences for housing type, sectoral employment growth, and changes in construction and land development practices. As may be expected, there are significant differences between the public and private sectors about the time horizon over which the balance between supply and demand should be assessed.

The political nature of LSCM makes it subject to frequent, and indeed often sudden, changes. As a result, definitions of supply and capacity may change over time, reflecting both methodological shifts and the ongoing influence of the different interests involved in the process.

In Chapter 2, a framework for LSCM is proposed that builds on current thinking and best practices in the field and provides a consistent conceptual structure and a related set of definitions.

Issue 2: Measuring Land Supply and Capacity—Negotiated Processes Based on Plans and Data

In principle, approaches to LSCM do not have to rely on either large data sets or sophisticated models of urban development. Indeed, many cases of current practices surveyed do not. Instead, they rest on gross, aggregate inventories of land available for development—primarily vacant land at the fringe—projecting its full build-out capacity under current zoning and commonly adjusting these totals via areawide percentage deductions for land deemed “unavailable” for development. However, such efforts provide only rough estimates of land supply, generally on a one-time basis, and do not constitute an adequate foundation for ongoing “monitoring” of land supply and development.

For land monitoring purposes, establishing the appropriate criteria to define land supply and capacity *and* devising ways to quantify land capacity according to these criteria are delicate and difficult tasks. For example, categories such as “developable” or “redevelopable” land may seem, at the outset, to be simple to establish. Yet, for instance, although defining vacant land as that without improvements is easily achieved, it is more problematic to establish what constitutes vacant land that is “developable.” Questions pertaining to the determination of sufficient levels of urban infrastructure needed to make land developable illustrate the potential complexities involved in making this determination: Is land developable when it is not serviced? What level of service is necessary for vacant land to be developable? How is the geographic extent of serviced land actually measured? What services are considered essential for developability—sewer, water, parks, schools, transportation infrastructure? By what criteria is unserviced land deemed “serviceable”? Is serviceable land, land that is “planned” to be serviced? According to which plans? Or is serviceable land that which private sector developers are willing to service at their own costs?

Negotiating the complexities of defining land supply and capacity is a process that increasingly involves input, and usually some measure of agreement, from many stakeholders. To be successful, this negotiated process depends on two elements: (1) a framework provided by a set of *plans* defining how land should be used in the future and (2) an *information base* about the land itself, including all of the factors that can influence its use. The most sophisticated LSCM systems today have evolved through the give-and-take