CHAPTER SEVEN

The Role of Regulations and Norms in Land Use Change

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IN BRIEF

- Legacy effects and past social objectives, including efforts to reinforce segregation patterns, have created path dependencies in land use dynamics and are important determinants of current land use patterns.
- Established in 1967, Baltimore County's Urban-Rural Demarcation Line (URDL) is considered a fundamental planning achievement and has provided a critical foundation for later Smart Growth initiatives.
- The primary effect of downzoning has been not to reduce development but to shift the type and location of development; in some cases this has led to greater infill, but in other cases to less dense, more scattered development that has extended the urban footprint.
- Environmental regulations that focus on protection of a single resource can generate unintended effects that result in a trade-off between enhancing one ecosystem service while degrading others.
- Urban redevelopment programs that demolish vacant and blighted housing appear to spark local housing market activity but are effective only if multiple demolitions occur in the same neighborhood.

INTRODUCTION

Human uses of land produce large social benefits in the form of food, fiber, shelter, and other essential goods and services, but they also generate a range

of environmental impacts, including carbon emissions, soil and water degradation, alterations of habitat and hydrologic cycles, and loss of biodiversity. The scale of land use impacts has increased dramatically over time with growing global population and development. Many scientists believe that current global land use practices are undermining the Earth's long-term ability to sustain food production, freshwater and forest resources, and other provisioning ecosystem services. While these concerns are global, land use decisions occur in local settings in response to local, regional, and global factors. Thus, achieving more sustainable land use practices relies on policies that can effectively manage land use and land change processes at local and multiple scales. Because the impacts vary across space, an understanding of the spatial pattern of land use and land change at local scales is also important.

The framework for modeling land use change in the Baltimore Ecosystem Study (BES) derives from an interdisciplinary set of theories that address locational choice, urbanization, neighborhood change, social norms, and the evolution of regulation. The approach is innovative not only because of this diverse set of theories that ground the research but also because of the emphasis that is placed on long timeseries and clear linkages to biogeophysical processes. In this chapter we review these economic, social, and geographical theories and the contributions BES researchers have made to studying the evolution of urban-suburban-exurban land use dynamics within the social-ecological context of Baltimore. Specifically, we focus on BES research that has traced the evolution of urban land use change from a pre-zoning era through the current time period, in which zoning and environmental regulations are the primary tools of land use planners and sustainability managers.

BES research relies on long timeseries data that provide detailed historical accounts of land use and regulation changes over time. Archival data, including newspaper accounts, Board of Park Commissioners reports, neighborhood association meeting minutes and promotional materials, planning documents, and government records, such as the maps and notes generated by the federal Home Owners' Loan Corporation (box 7.1) in the 1930s, have allowed BES researchers to uncover at least some of the processes that influenced land use decisions in the past. In some cases the legacy effects of past decisions are still evident in today's urban landscape. Spatial data sets have proven invaluable as well. For example, much of our

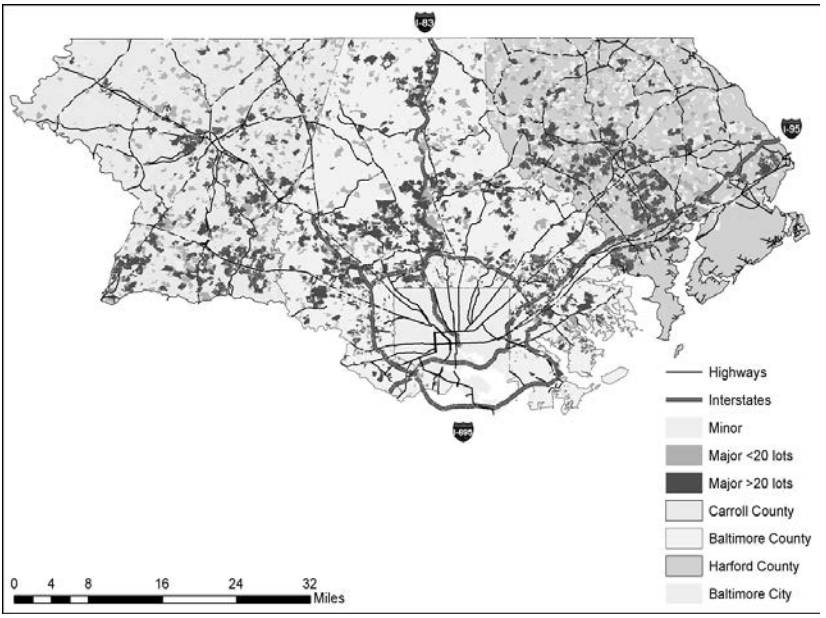

FIGURE 7.1 Subdivision development in Baltimore, Carroll, and Harford Counties by decade, 1960–2007.

research uses residential subdivision histories for Baltimore, Carroll, and Harford Counties as well as subdivision plat image files from the Maryland State Archives and county tax assessors' GIS databases. We have recreated these data from 1960 onward. Across Carroll, Harford, and Baltimore Counties a total of 7,370 subdivisions containing a total of 208,131 land parcels were developed between 1960 and 2008, leading to a mix of clustered and scattered patterns of residential development (figure 7.1). We have also linked other data to these parcels, including information on the timing of approvals by the county of subdivision plans; the timing and location of agricultural preservation; zoning; distances to nearby towns and large cities; surrounding land uses and other amenities; soil quality and slope data. As we emphasize throughout our discussion, these and other historical, highly detailed data that we highlight here are critical to understanding the relationships among individual choices, community norms, heterogeneous regulations, and spatial spillovers.

In what follows we first provide an overview of land use theories that constitute the theoretical framework for our research. We then review the

BOX 7.1. KEY TERMS

CWA: The federal Clean Water Act, established in 1972.

Downzoning: A planning strategy reducing the density of development in particular areas.

Endogenous: Factors operating within an area that are influenced by other factors in that same area.

Home Owners' Loan Corporation (HOLC): A federally chartered body to refinance mortgages compromised by the Great Depression. Established in 1933, it classified the loan-worthiness of neighborhoods in major cities across the United States, including criteria now judged to be prejudicial based on race and national origin.

Legacy: The effect of past decisions or prior conditions on current system state and processes.

Locational choice: The study of the mechanisms shaping where households and firms locate within an urban region. The term "choice" in this theoretical realm also includes how the available locations may be constrained by formal and informal means.

Redlining: The HOLC-mapped neighborhoods and other areas in cities during the 1930s using red shading to indicate those areas judged to be unworthy of mortgage lending. Green and yellow (and sometimes, in various cities, other colors) indicated good versus more risky areas for lending.

Spillover: A spatially correlated influence. May be positive or negative.

URDL: Urban-Rural Demarcation Line, established by Baltimore County in 1967 to set a boundary of intense urban development and promote smart growth.

V2V: Baltimore City's Vacants to Value program, aimed at revitalizing neighborhoods experiencing high levels of building abandonment.

major findings that relate to the social, economic, and environmental factors that have influenced the evolution of community norms and zoning regulation and, in turn, the influence of zoning and other land development policies on economic and environmental outcomes in the region. The chapter concludes with a discussion of current and future research directions.

THEORETICAL BACKGROUND

Theories of land use and location provide the backbone for land change models. The theoretical foundations of land economics were laid long ago with the concept of land rents that are generated by differences in land quality and that are capitalized into output prices. In addition, because transporting people and goods is costly, distance from economically valuable locations, such as a central business district or a high-amenity coastline, also plays a fundamental role in determining the value of location. The theory of land rent provides the foundation for the spatial equilibrium framework that underlies theories of urban spatial models, including the notion that heterogeneous households reveal their demand for public goods by "voting with their feet" (chapters 4 and 15). Households and firms have higher demand for land and housing in more desirable areas, which bids up land and housing prices and bids down wages in those locations. More recent theories build on these foundations by considering other sources of spatial differentiation, intertemporal decision making, and the endogenous relationships among many of the factors that influence land use and location outcomes. For example, the standard urban economic model of land development posits a fundamental relationship among economic growth, distance to urban centers, and urban land rents, which generates predictions regarding the location, timing, and pattern of urban development.

Heterogeneity in land, in land use, or in expectations is hypothesized to generate scattered or leapfrog development, a pattern in which vacant land is skipped over while land farther from the city center is developed first. For example, when there are multiple types of land use that differ in their expected returns (high versus low density residential land use is one instance), developers have the incentive to withhold land closer to the city from development at lower density for lower returns in anticipation of future development at higher density for higher returns. This can generate temporary leapfrog development that will decrease over time as the region fills up. Other explanations of leapfrog development include the presence of positive or negative open space or social spillovers and heterogeneous production costs, all of which can lead to varying patterns of clustered versus scattered development.

Economic models of land change begin with a model of the underlying microeconomic behavior (utility or profit maximization, for instance) that

determines demand and supply relationships. Fundamental to models of land markets is the price mechanism, which determines individual choices and, in turn, is determined by the cumulative choices of individuals within a given market area. The concept of a price equilibrium is used to ensure that individual choices and aggregate outcomes are consistent with each other. Although equilibrium can be defined in various ways, the condition of market clearing, meaning that prices adjust such that markets clear (that is, excess demand and excess supply are zero in all factor and output markets), is standard. Equilibrium may be static, in which agents are myopic and prices and land use patterns are unchanging, or dynamic, in which agents are typically forward looking and prices and land uses are changing over time subject to a market-clearing condition. A common misperception is that economic equilibrium necessarily implies a static condition, which is not the case. For example, in a dynamic model of landowners, the forward-looking expectations of landowners over future costs and returns influence their land use decision today. Economic models of land use and land change differ in how equilibrium in the relevant input and output markets is defined. In local land and housing markets, prices are distinguished by space and depend not only on the quantity of land in alternative uses but also on the spatial distribution of land uses.

Land use regulations play a critical role in determining the outcome of housing markets, including the spatial pattern of housing and the use of land resources in the production of residential development. Spatially explicit parcel-level models of residential land use change are useful for analyzing the effect of zoning regulations on the rate of development and residential density. Some empirical evidence shows that minimum lot size zoning may actually exacerbate sprawl because when zoning is binding, homeowners are required to consume larger lots than desired. In addition, land-preservation programs may have unintended effects that can exacerbate scattered development patterns.

An empirical challenge in identifying the effect of land use zoning is that zoning itself is not a random process and, indeed, co-evolved with land use and location patterns over a longer period of time. This implies that zoning is endogenous to land use conversion, and therefore estimating the effect of zoning may be susceptible to selection bias. In this case, additional econometric techniques are needed to control for these sources of

bias to identify the causal effect of zoning. Techniques that employ quasi-experimental designs or instrumental variables provide a potential means of identifying causality.

THE CO-EVOLUTION OF LAND USE AND REGULATION IN THE BALTIMORE REGION

BES researchers have sought not only to identify the causal effects of zoning on land use outcomes, but also to explicitly study the co-evolution of land use and zoning over a long timeframe. Here we synthesize BES research on the influence of neighborhood associations prior to passage of zoning legislation, and on the evolution of the region's first growth management regulation, the urban-rural demarcation line (URDL) in Baltimore County. We then summarize BES research on the subsequent effects of this and other zoning regulations on land use patterns, focusing on how these regulations have influenced the location and density of new residential subdivision development.

Pre-Zoning Evolution of the City: The Role of Neighborhood Associations

The 1904 fire that destroyed much of Baltimore's downtown served as an important catalyst for change. Indeed, as BES researchers have shown, it was during the first two decades of the twentieth century that the city took steps to install a modern sewer system, improve its transportation infrastructure, commission a plan intended to create a world-class system of parks, and inaugurate a new urban forestry program. In time, Baltimore would also adopt strict zoning regulations.

Prior to the passage of Baltimore's first zoning ordinance, in 1923, and the significant amendments that were enacted in 1931, Baltimoreans contended with land use regulations that were uneven and poorly enforced. To deal with this uncertainty, concerned residents banded together to advocate for the needs of their neighborhoods and to protect themselves from a variety of perceived threats. Organized into neighborhood improvement associations, of which there were some seventy at the beginning of the twentieth century, these citizen groups exerted a great deal of influence when it came to city planning and development.

Homeowners associations and other neighborhood groups have long played an important part when it comes to shaping patterns of settlement and land use in urban areas. As Marcia England reminds us, neighborhoods

are often viewed by residents as "sites to be protected from outside interests," and when they believe "spatial boundaries are threatened" they are inclined to act. In addition to pressuring city officials into providing much-needed infrastructure and services, such as paved roads, modern sewers, streetlamps, and telephone lines, BES research shows that Baltimore's neighborhood improvement associations proved adept at attracting such amenities as parks and street trees into their districts, while deflecting unwanted land uses to other parts of the city. Several groups also figured prominently in the effort to pass the nation's first segregation ordinance and, later, to promote and pass zoning legislation. BES researchers rely on numerous historical data sets to uncover the role that improvement associations played in guiding city development during the pre-zoning era.

As these data show, perhaps no neighborhood organization wielded greater power than the Peabody Heights Improvement Association. The association was formed when the neighborhood was absorbed by the city after the annexation of 1888. Its founding members sought to protect what they had created—a residential enclave far removed from the hustle and bustle of commercial and industrial activity. The mission of the group focused on five key areas. First, the group promoted street-tree planting and neighborhood beautification. Notable among their accomplishments was mayoral approval of Ordinance No. 154, in 1912, which established a Division of Forestry under the direction of a trained forester to manage the city's trees. Second, members of the association took every opportunity to expand and enhance green space within its borders, most notably Wyman Park. A third issue that resonated with the Peabody Heights membership was air pollution abatement. Given the location of Peabody Heights—a few blocks from Baltimore's busy Penn Station—it is not surprising that smoke from coal-powered steam locomotives was a concern. The fourth issue that worried residents was commercial development. Wishing to remain a strictly residential quarter, the association worked closely with the city's inspector of buildings to prevent businesses from locating in the neighborhood. Finally, like other improvement associations at the time, the Peabody Heights group used a variety of means to ensure that African Americans, Jews, and recent immigrants could not buy or rent homes in the district.

While neighborhood groups did, on occasion, work together to beautify the city, for example, by assisting the Women's Civic League with its beautification campaigns, it was issues like segregation that often spurred

them into action. For instance, BES researchers use entries from the Peabody Heights Association's meeting minutes as evidence to indicate that the group actively supported the city's efforts to pass a segregation ordinance. When the Supreme Court struck down such ordinances in 1917, neighborhoods like Peabody Heights, Mount Royal, and Mount Washington used restrictive covenants to preserve segregation. In the 1930s the Home Owners' Loan Corporation and various lending institutions reinforced patterns of segregation and disinvestment via redlining and other practices. Another issue that drove neighborhood associations to cooperate with one another was the threat of business encroachment. This issue in particular led members of the Peabody Heights Association, in 1929, to support a new comprehensive zoning ordinance that would create residential, commercial, and industrial use districts in the city.

Prior to the passage of comprehensive zoning, neighborhood improvement associations played an important role in city planning and development, influencing where investments were made and where certain land use activities took place. As the meeting minutes of the Peabody Heights Association as well as other historical data show, however, many of these groups also had social objectives in mind as they advanced their respective agendas.

Evolution of Zoning: The Urban-Rural Demarcation Line in Baltimore County

The wartime economy of the first half of the twentieth century sparked an economic and population boom in the City of Baltimore and adjacent suburbs. As early as 1937, ten years before Maryland would pass enabling legislation to give counties the authority to plan, the State Planning Commission sought to contain growth by introducing garden suburbs contained within a web of greenbelts. Although the concept was never deployed, it served as a foundation for later efforts, most notably in 1960 and 1962. Finally, in 1967, inspired by the environmental design and planning firm Wallace and McHarg, whose Plan for the Valleys responded to a period of massive manufacturing redistribution and rapid suburban growth, Baltimore County established an urban growth boundary. The boundary drew a line on the ground separating urban land uses from rural land uses (see also chapter 16). One of the first in the nation, the Urban-Rural Demarcation Line (URDL) resulted in almost 90 percent of the population living on just one-third of the county's land area (figure 7.2).

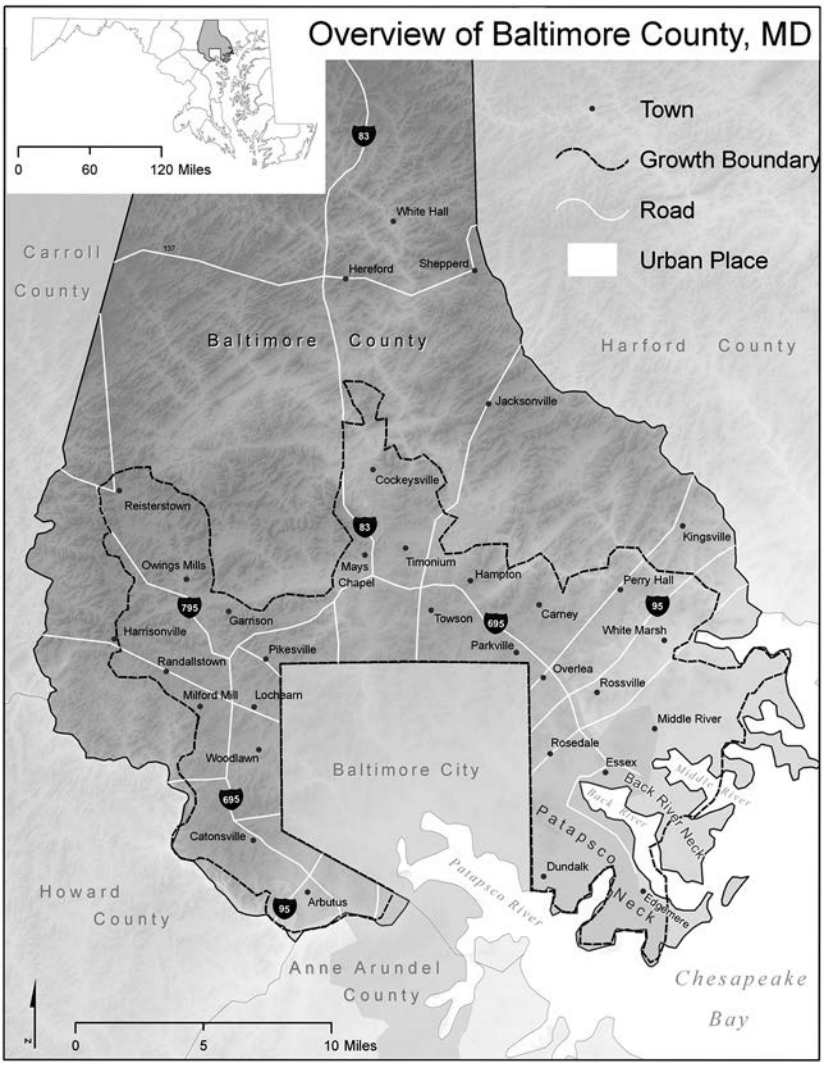

FIGURE 7.2 The Urban-Rural Demarcation Line (URDL = Growth Boundary in the legend), established in 1967, which limits the extent of public water and sewer services and divides urban and rural land uses in Baltimore County. (U.S. Geological Survey)

Baltimore County considers this tool to be one of its fundamental planning achievements—one which laid the groundwork for later "Smart Growth" efforts that are credited with preserving over fifty-five thousand acres of productive farmland and ecologically significant forest, planting almost ten thousand trees, and promoting compact development—but it

has had negative consequences as well. In particular, concentrated environmental externalities in the form of urban runoff contribute significantly to the pollution of Chesapeake Bay. Over the years, the county has added teeth to the URDL by improving zoning regulations and implementing other growth management schemes, such as the Agricultural Preservation Program for farmland preservation in the 1970s, the Critical Areas Program for aquatic resources protection in the 1980s, and the Priority Funding and Rural Legacy Areas programs of the 1990s.

The Effects of Downzoning

After implementing the URDL in 1967, Baltimore County further restricted growth in the non-URDL areas by adopting resource conservation zoning areas in the Comprehensive Plan that became effective in late 1976. Prior to 1976, the zoning allowed subdivisions at one housing lot per acre throughout the entire rural area covering two-thirds of the county. After 1976 the downzoning policy in Baltimore County created three main resource conservation (RC) zoning types. The most dramatic was the creation of agricultural preservation (RC2) zoning that downzoned to allow one housing lot per fifty acres and covered about half of the rural area. Watershed protection (RC4) zoning allows one housing lot per five acres and was designated to protect those watersheds and major rivers and streams associated with three regional reservoirs (Liberty, Loch Raven, and Prettyboy), which supply water to 1.8 million residents in the Baltimore metropolitan area. Rural residential (RC5) zoning allows one housing lot per two acres and serves as the baseline-zoning category.

The effectiveness of downzoning depends on regional growth pressures and the degree to which future development patterns are affected by the downzoning. We use BES long-term data on housing sales and residential subdivision development over a forty-five-year time period, from 1960 to 2005, to examine the impacts of downzoning in three suburban counties—Baltimore, Harford, and Carroll Counties—on the pattern of leapfrog development. All three counties implemented a significant downzoning policy between 1976 and 1978. These policies, which impacted about 75 percent of the developable land in the metro region, converted land that was previously zoned to accommodate one house per acre to several new zoning classes ranging from one house per three acres to one house per fifty acres.

We developed a new measure to calculate the amount of leapfrog devel-

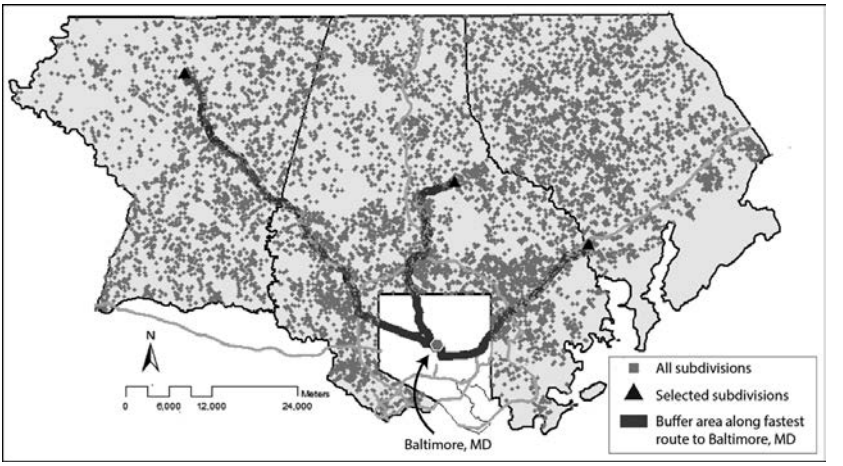

FIGURE 7.3 New measure of leapfrog development that is specific to the location and timing of each new subdivision. The amount of leapfrog development associated with a specific subdivision (black triangles) is measured as the percentage of developable vacant land that is more accessible to the city center than the subdivision itself and located within a buffer along the most expedient commuting route to Baltimore City.

opment that resulted from the creation of each new subdivision at a particular time and location in the study region. The amount of leapfrog development associated with a specific subdivision is measured as the percentage of developable vacant land that is more accessible to the city center than the subdivision itself and located within a given buffer along the most expedient commuting route to the outer boundary of Baltimore City. The leapfrog measure is expressed in percentage terms relative to the total amount of developable land that is either developed or vacant within each subdivision-specific buffer and varies between zero (no remaining developable land) to one (all land is developable).

The analysis reveals a pattern of leapfrog and infill development that is consistent with urban economic theory and that underscores the influence of zoning on the evolution of these patterns (figure 7.3). We find that the relative amount of leapfrog development is high but declines over time from 80 percent in 1960 to 36 percent in 2005. In other words, about 80 percent of developable land deemed more accessible than existing subdivisions was undeveloped in 1960. This amount declined by more than 50 percent over our forty-five-year study period at an annual rate of approximately 1 percent. In comparing this observed pattern to the unconstrained hypothetical pat-

tern predicted by the basic intertemporal urban growth model, we find that it closely matches the predictions, but only in the early years before the downzoning policy. After the downzoning, the observed amount of leapfrog development is significantly less than the unconstrained predicted pattern. Empirical results from a first difference model show that after controlling for distance to urban centers, the spatial pattern of infill development is significantly influenced by local variations in the maximum allowable development density. Specifically, the downzoning policies enacted in the late 1970s significantly slowed the rate of infill development in more rural areas of the metro area and increased the rate of infill development in areas closer to the urban centers. These results are consistent with the hypothesis that downzoning, agricultural preservation, and other commonly used policies that restrict development introduce a substantial reduction in the relative returns to land development in these areas.

Evidence by other BES researchers suggests that the downzoning policy adopted in 1976 in Baltimore County did not have a significant effect on the probability of development but did strongly affect the density of development. A long timeseries on spatially disaggregated data was used to characterize the evolution of residential development in the pre-zoning era (1967–76) versus post-zoning era (1977–86). The average treatment effects show a reduction in the density of development of 54 percent and 60 percent, respectively, in agricultural and watershed protection zoning areas. These results indicate that the 1976 downzoning policy did not reduce the rate of acreage developed to low-density exurban development, but it did reduce the number of households living in those developed areas. An important reason for the low effectiveness of reducing the likelihood of development is the minor exemption rule. As a political compromise in the 1976 downzoning process, parcels in the agricultural zoning areas with two to one hundred acres are still allowed to be split into two housing lots to create a minor subdivision.

The Effect of Regulatory Delay and Spatially Heterogeneous Zoning

Regulatory delays in the time to complete a development project create so-called implicit costs that indirectly increase costs by extending the time required to tie up capital and delaying revenue generation. Although the explicit costs of regulation, including impact fees and required infrastructure improvements, can substantially increase development costs, real op-

tions theory suggests that increases in implicit costs can have an even larger impact on the timing, density, and location of development. We use the historical subdivision data from Carroll County with data on the timing of individual subdivision plan approvals by the local county planning authority to investigate the influence of regulatory delay on development timing, intensity, and patterns.

The most substantial difference in subdivision approval times is between major subdivisions, which are four lots or greater and typically located in higher-density suburban areas, and minor subdivisions, which are two to three lots and primarily located in the agriculturally zoned areas of the county. We hypothesize that "time is money" and that the substantial difference in the implicit regulatory costs arising from the approval time necessary for a major versus minor subdivision causes developers to substitute away from major subdivisions and build more minor developments. This hypothesis is tested by constructing a dynamic variable that predicts an ex-ante expected approval time for each undeveloped parcel and for each time period of the model, 1995–2007. With this variable, a sample selection model of land development is estimated in which the landowner chooses the optimal density of development conditional on the discrete choice to subdivide the parcel. The regulatory delay hypothesis is confirmed by the econometric model results. Specifically, we find that the regulation-induced implicit costs reduce the probability of subdivision development on any given parcel and have resulted in a substantial increase in the likelihood of exurban development relative to higher-density development.

We conclude that spatially heterogeneous costs generated by differences in the regulation of differently sized residential subdivisions have contributed to greater scattering of residential land development in exurban areas. Previous empirical studies focused on the role of demand-side amenities and disamenities and the role of these local land use spillovers in generating scattered exurban development. This work provides a new explanation of scattered residential development based on how developers respond to regulatory delay and spatially heterogeneous zoning.

The Effect of Wetlands Protection on Land Development

Environmental regulations frequently target land development activities due to their negative impacts on water quality, biodiversity, and other ecosystem services. However, these regulations have varying levels of efficacy as well

as frequent unintended consequences. These offsetting effects can reduce the net benefits of an environmental policy, which, given the irreversibility of most development projects, can have long-lasting consequences. We consider a wetlands protection policy to examine the potential unintended consequences on land development in Harford County. Specifically, Section 404 of the Clean Water Act (CWA) regulates dredging and filling of water features to minimize degradation of wetlands. In 1985 the definition of the "waters of the United States" under Section 404 was expanded in an effort to specifically reduce environmental damage caused by new residential developments. The expansion of the CWA's jurisdiction was the result of a 1985 United States Supreme Court ruling, *United States v. Riverside Bayview,* 474 U.S. 121 (hereafter RBH). The ruling redefined the "waters of the United States," increasing the jurisdiction of the U.S. Army Corps of Engineers in the enforcement of the CWA. Interviews with environmental and development planners from Harford County during this time period provide evidence of a shock to the subdivision approval process as a result of the county's implementation of the ruling. The county implemented these CWA regulations by limiting modification to streams and nontidal wetlands, requiring new developments that impacted these water features to gain permit approval through the corps.

We treat the implementation of the RBH ruling as an exogenous effect and estimate its impact on the timing and density of subdivision development in Harford County. Using parcel-level data on new residential subdivision development from 1980 through 1990, we use a difference-in-difference estimator with a duration analysis to identify changes in the rate of development between the five-year period prior to the Supreme Court decision (1980–84) and a five-year period (1986–90) following the ruling. The results demonstrate that the regulation significantly delayed the development of parcels with water features. The rate of development decreased by 33 percent for affected parcels. However, the density of development also decreased for new developments, suggesting that the regulation may have also contributed to an increase in the urban footprint by lowering overall density of new development.

Urban Land Redevelopment: Baltimore's Vacants to Value Program

Between 1960 and 2010 the population of Baltimore City shrank nearly 34 percent despite a 60 percent increase in the population of the surrounding

metro region. Given the durability of housing, this has resulted in a tremendous number of vacant housing and lots—an estimated fourteen thousand vacant properties at last city count. As a former industrial city with a still functioning major seaport, Baltimore continues to feel the aftereffects of its history as an industrial hub with approximately 4 percent of all available land in the city in brownfield status.

To address the problems of urban vacancy and spark urban renewal, the City of Baltimore began a unique urban renewal program in 2010 called Vacants to Value (V2V). V2V is a comprehensive, city-led effort to revitalize neighborhoods that specifically targets areas of high vacancy through increased code enforcement, providing homebuyer incentives, expediting the sale of city-owned properties, and promoting green, sustainable communities. The centerpiece of the program is the use of targeted demolition of vacant properties in distressed neighborhoods with high vacancy and crime (figure 7.4). Previous literature has revealed the disamenity effects that vacant and blighted houses can have on nearby properties, leading to suboptimal outcomes in the market. However, whether or not the removal of such housing effects positively impacts local housing markets is an empirical question.

BES researchers have provided the first empirical evidence of the effects of publicly funded demolitions on neighborhood housing activity by investigating the outcomes of the V2V program in the City of Baltimore. We take advantage of the program's unique structure to build a quasi-experimental design with treated groups—neighborhoods funded one time by the program and neighborhoods funded multiple times by the program—and a control group—unfunded but shortlisted neighborhoods. In 2013 V2V created a shortlist of possible demolition sites in targeted neighborhoods based on Baltimore's 2011 Housing Market Topology, a large-scale housing study created by and for the city to help identify and strategically match limited public resources in neighborhoods based on vacancy, occupancy rates, and housing market activity in 2009 and 2010. From the initial shortlist, selected projects were funded each year during the study period, 2013–15. Funding decisions were made by city officials using the same criteria as above, and only projects on the initial shortlist were funded. Some neighborhoods had multiple projects funded while others had none despite the presence of multiple shortlisted projects during the study period.

We find that neighborhoods targeted by the program have housing

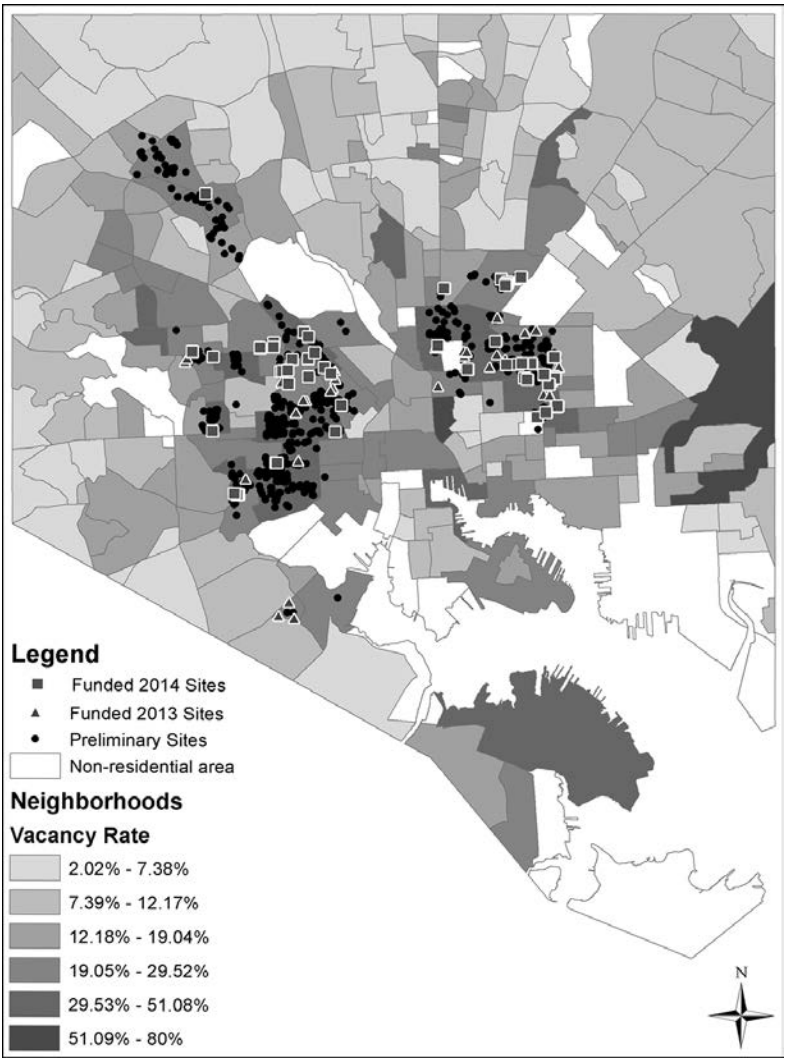

FIGURE 7.4 The City of Baltimore's Vacants to Value (V2V) preliminary and funded sites (2013–15) and neighborhood vacancy rates. (Based on data from the American Community Survey and the City of Baltimore Department of Planning, 2006–10)

renovations that are 82.7 percent higher and that total rental housing sales are 31 percent higher, but only if the neighborhood had multiple V2V-funded sites during the study period. No significant effect is found in the neighborhoods that had only a single funded site. To put these findings in

context, the increase in renovations corresponds to an additional twenty-one neighborhood renovations while the increase in housing sales corresponds to fifty additional housing sales over the study's two-year time period. We also find that high levels of crime can diminish the effects of the V2V program on neighborhood housing markets.

SUMMARY AND CONCLUSIONS

Urban ecosystems are complex systems composed of many interacting areas—from the built-up and redeveloped city to suburban areas to sparsely settled exurban regions connected by commuting and economic flows—and many interacting social, economic, and biophysical processes. Like any component parts of such a complex system, land use and land regulations cannot be understood in isolation. Land use regulation generates both direct and indirect effects as well as intended and unintended consequences. Local land use regulations are not a random occurrence but instead evolve from the social, political, and environmental realities of a community or region. In turn, these regulations can have both intended and unintended impacts on environmental, social, and economic outcomes that impact individual and community well-being and the sustainability of the region. Identifying these effects requires long timeseries of spatially disaggregated data that can account for individual choices, neighborhood change, heterogeneous regulations, and spatial spillovers. BES researchers have unpacked several of these complex interactions among community norms, local regulations, land use change, and land and housing market outcomes. This research has focused on the evolution of regulations in both the pre-zoning and zoning phases of the Baltimore region as well as the effects of historical and more recent regulations and policies on land development and land use patterns. Several synthetic findings emerge from this research:

- The legacy effects of past decisions are clearly manifested in today's urban landscape. Prior to the passage of comprehensive zoning, neighborhood improvement associations seeking to reinforce segregation played an important role in influencing investments that determined where certain land use activities took place. Many of these investments are extremely durable, for example, infrastructure and local parks, and generate amenities and disamenities that continue to influence household location and housing values today.

- In addition to preserving open space and guiding development, the establishment of the URDL in Baltimore County had unintended consequences, namely, the concentration of urban runoff that ultimately drains to Chesapeake Bay.
- Autonomy in local land use regulations, but economic interdependence via regional labor and housing markets, creates unintended consequences in terms of land development spillovers. For example, downzoning in one area reduces the supply of new development in that area and leads to increased demand and development in lesser-regulated adjacent areas. These spillovers may occur within the same county, for example, as the result of spatial heterogeneity in zoning of minor versus major subdivisions, or across counties as the result of uncoordinated local policies. The primary effect of downzoning and other local growth management regulations has been to shift the type and location of development across the region. While downzoning in Baltimore County led to localized growth spillovers and increased the likelihood of low-density development in these neighboring areas, the combined effect of all downzoning policies across multiple counties appears to have worked in the intended direction by reducing the overall amount of leapfrog development across the region and increasing the overall amount of infill development.
- Regulations that focus on protection of a single resource can generate unintended effects that result in a trade-off between enhancing one ecosystem service while degrading others. For example, we find that the wetlands protection policy enacted under Section 404 of the Clean Water Act resulted not only in a significant delay in development on the affected parcels but also in a reduction in their density of development. Thus while the regulation was successful at limiting modification to streams and nontidal wetlands, it also fostered a lower density of development. These offsetting effects reduce the net benefits of an environmental policy, which, given the irreversibility of most development projects, can have long-lasting consequences. As the research on downzoning has shown, a reduction in the amount or density of development in one area often results in displacing development to other, as-yet-undeveloped areas.
- Preliminary work based on analysis of the V2V program in the City of Baltimore indicates that targeted demolitions may be an effective

renewal strategy in urban neighborhoods with excessive housing supply and urban blight. This suggests that public policy can achieve the intended spillover effects that generate positive multiplier effects that can magnify across broader spatial scales.

- Because of the complexity of the many spatial processes that underlie land use/land cover change and the inevitable limitations of available data in terms of measuring these processes, identifying causal effects of land use change is extremely challenging. Techniques that employ quasi-experimental designs or instrumental variables provide a potential means of drawing causal inferences and can be extremely useful in isolating the effects of a spatially varying policy or heterogeneous landscape feature on land use change. This also underscores the importance of long timeseries of spatially disaggregated data that can account for individual choices, neighborhood change, heterogeneous regulations, and spatial spillovers.

Our current and future work continues to examine the implications of spatially heterogeneous zoning and urban redevelopment on land use change within the city and across city-suburban-exurban gradients. In addition, we are working with other BES researchers to develop integrated models of land use change, nutrient flows, and water quality to model policy scenarios. The goal of this work is to develop spatial land change models that account for market conditions and human-biophysical linkages to generate predictions of policy impacts on land use and ecosystem services. Such an approach is necessary for moving beyond the spatial heterogeneity that characterizes human and biophysical components to an integrative understanding of how these spatially heterogeneous processes interact with each other across multiple spatial and temporal scales. Understanding how such interactions influence the dynamics of urban systems is critical to achieving resilient urban futures.