

Urban Sprawl And Public Policy: A Complexity Theory Perspective

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Göktu? Morçöl, Goktug Morcol

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Abstract

The epistemological and methodological implications of complexity theory for understanding urban sprawl are discussed. It is argued that urban spatial forms, such as sprawl, emerge from nonlinear, self-organizational, and dynamic urban processes. Because of this, there cannot be a universal theory of sprawl and each case should be investigated within its context. The micro—macro problem provides the conceptual grounding for these investigations. Agent-based simulations can be used to investigate the micro—macro transformations in urban systems. Implications of complexity theory for understanding the role of urban policies are discussed.

Introduction

Urban sprawl has concerned urban scholars, planners, and policymakers in the United States for decades now. An increasing number of scholars, planners, and policymakers in Europe, Australia, and Canada have turned their attentions to this issue in the last couple of decades. The definitions, causes, and consequences of sprawl have been debated in the urban planning and policy literatures since the 1930s in the United States (Bruegmann, 2001). This literature indicates that sprawl is a complex theoretical policy problem, with multiple and even contending definitions and conceptualizations. These contending conceptualizations are behind the heated policy debates on urban sprawl. In this paper I will review the conceptualizations in the literature, illustrate the complexity of the sprawl phenomenon with examples, and propose a complexity theory-based alternative conceptualization.

There are roughly two sides in the theoretical and policy debates on sprawl. There are those policy and planning theorists and researchers who hold sprawl responsible for a series of problems: from the loss of valuable farmlands to residential and commercial development, to the increased costs of local government services, the spatial segregation of racial and ethnic groups, and air pollution and consequent global warming (e.g., Dreier *et al.*, 2001: 30-55; Newman & Kenworthy, 1989; Miller, 2008). These critics of sprawl cite among its causes the lack of appropriate governmental policies to curb sprawl, or the presence of misguided governmental policies that promote sprawl; they propose policy alternatives like “smart growth,” “new urbanism,” “urban containment,” or creating centralized metropolitan governments as solutions (e.g., Katz, 1994; Orfield, 1997; Rusk, 1999).

On the other side of the debate are those who question the evidence the critics use to support the argument that sprawl causes all the above-cited problems (e.g., Bruegmann, 2005; Nivola, 1999). Some argue that sprawl has actually desirable outcomes (e.g., Barnes, 2000; Bruegmann, 2008; Easterbrook, 1999). Others argue that regardless of the problems it might create, sprawl is a natural outcome of individuals making rational decisions: Whenever they have the ability, people tend to move away from the congestion and blight of the cities toward the larger and well-maintained houses and yards in suburbs (primary examples of this approach are public choice theorists, as cited in Dreier *et al.*, 2001: 97). Another argument is that anti-sprawl policies are undesirable, because they distort the land markets in urban areas by making housing less affordable for large numbers of people (e.g., Bruegmann, 2005: 204).

Implicit in the conceptualizations on both sides of the debate are the notions that urban sprawl can be defined universally and that its linear causes and consequences can be identified. While the critics aim to find out the definitive causes of sprawl and devise policy solutions accordingly, their opponents make the assumptions that universal laws guide human behavior (such as that all individuals make utility maximizing rational choices) and that any restrictive governmental intervention will have undesirable consequences. Both sides acknowledge that the phenomenon of sprawl is more complex than their own theories. However, because they both theorize in the deductive-nomological mode and make linear assumptions about human behaviors, economy, and policy, they fall short of offering conceptualizations that would help us understand the complexity of sprawl. My argument is that complexity theory, with its epistemological bases and methodological tools, is better equipped to do that.

Complexity theory encourages us to think in systemic and dynamic terms. Complexity theory counters assumptions such as that policy problems can be defined categorically and definitively (e.g., “Urban sprawl is....”), that their linear causes can be discovered (e.g., “Wrong policies cause sprawl.”), and that public policy tools can be deployed to solve these problems in a linear fashion (e.g., urban containment policies or laissez faire policy approaches would solve the problem). As I explain briefly

later in the paper, and discuss more extensively elsewhere (Morçöl, 2012), complexity theory suggests that social problems defy categorical universal definitions and linear solutions. Researchers should instead understand them contextually. Also, public policies should be understood as actions of governmental actors that contribute, together with the actions of other actors, to the emergence the macro properties of complex urban systems, such as sprawl.

In this paper I present an outline of how complexity theory can be applied to studying urban sprawl and discuss the conceptual and methodological problems that need to be addressed in doing so. In the following section, I discuss the definitions and causes sprawl that are cited in the literature. I illustrate the problems with these definitions and attributed causes in a separate section. In the final section, I present the complexity framework in understanding sprawl and discuss its implications for public policy.

Is There A Theory Of Sprawl?

There is no universally accepted definition of urban sprawl; nor are there universally accepted causes of it. As Bruegmann (2001) notes, actually the term “sprawl” is used in the literature in an “imprecise and highly evocative” manner (16087). The most general definition of urban sprawl is that it is a form of the expansion of urban lands. Then, one might ask, is it merely another name for the natural growth pattern of urban areas? After all, as human populations grew, so did the land they occupied in throughout history (Mumford, 1961: 482-483).

There are more specific, but still problematic, definitions of sprawl in the literature. Bruegmann (2005) defines urban sprawl as “low-density, scattered, urban development without systematic large-scale or regional public land-use planning” (18). There are problems with the universal applicability of this definition. First of all, density is a geographically and historically relative term. “Low-density” by European standards may be relatively high-density by American standards (Bruegmann, 2001). Also, a settlement that is low-density at one time may become denser at a later time. Density is also historically relative term: The ancient Egyptian and Mesopotamian cities were not as densely populated compared to today’s New York, Paris, or London, for example (Mumford, 196: 482-483).

The problem with citing the lack of “regional public land-use planning” as part of the definition of urban sprawl, as Bruegmann does, is that there is a wide range of policies and planning tools applied in urban areas (regulating land use, taxation policies, etc.) and each may have different consequences.

Bruegmann’s definition of sprawl as “scattered development” seems to follow Mumford’s (1961) observation that suburbs in America have developed without a form (he calls this “formless urban exudation,” p. 505). This was a result of the mass production of uniformly styled houses since the early 20th century (p. 486). The problem with defining sprawl in terms of “scattered developments,” or as “formless exudation,” is that it does not help us understand the problems experienced in the high-density and well-organized “new downtowns” in suburbia (Lewis, 1996: 2). Some of these problems are similar to those experienced in “scattered” suburbia, such a long commuting times and consequent air pollution, as I will illustrate with the examples of Portland and British cities in this paper.

There are also numerical definitions of sprawl. Couch and his colleagues (2007) define it in terms of the “urban population density gradient.” Population density declines as one moves away from urban centers to suburbs and exurbs. In their definition, an urban area would be considered sprawled if the gradient is less steep than the “normal gradient” (5-6). The problem with this definition is that, as the authors recognize, what is a “normal” gradient is relative. What is “normal,” for example, is different between America and Europe and between northern and southern parts of Europe (16).

Urban sprawl is also defined in terms of the differences between cities and suburbs in their rates of population and economic growth. Batty (2007) notes that in the early 19th century suburban fringes began growing faster than urban centers in America and Britain; he points to this relatively faster rate of growth of suburbs as the signature of sprawl (386). This observation needs to be qualified, however: There are variations among the rates of growth not only between cities and suburbs, but also among various cities and among various suburbs, as Batty also notes (387).

Although it is not possible to elicit a common and precise definition of sprawl from the above discussions, a general working definition can be proposed: A sprawled urban area is one where outer settlements have relatively lower population densities and grow faster than core urban areas; these areas may take on various spatial forms. Government policies can influence, but do not necessarily determine, these forms.

Different authors mention different causes of sprawl. Nivola (1999), for example, cites natural factors (e.g., availability of large open spaces), demographic factors (higher rates of population growth in the United States), social factors (e.g., destabilizing effects of urban violence), cultural factors (e.g., tendency of ethnic groups to separate themselves from others geographically), and technology (e.g., wide availability of cars), as the causes of sprawl in American urban areas (4-11). Bruegmann (2005) identifies a few more causes that are commonly cited in the literature: from the American individualistic culture that encourages people to live in their separate lands, to the unfettered capitalism and lack of governmental regulations in the United States (96-112). Others find various governmental policies responsible for the sprawl in the US urban areas: from the federal homeowner subsidies, to the federal tax code, the building of the Interstate Highway system, to the local zoning ordinances that segregated

urban functions into geographically distinct areas (Dreier *et al.*, 2001; Rusk, 1999).

Bruegmann (2005) argues that affluence and democracy are the main causes of suburbanization. These two conditions allow individuals to be more mobile and give them the choice to move to places where they can have privacy (109-112). He admits, however, that these two cannot universally explain sprawl, because so many wealthy citizens of democratic countries choose to live in dense urban areas, such as Park Avenue, New York, and the Sixteenth Arrondissement in Paris.

One can find some commonalities in the causes of sprawl that are cited in the literature, but there is no definitive list. The lack of a common and precise definition of sprawl and the multiplicity of its explanations in the literature indicate that it is a complex phenomenon that poses conceptual and methodological challenges.

I further illustrate these challenges with the summaries of three cases in the next section: the metro areas of Atlanta and Portland in the United States and the national case of Britain. These cases are selected because the urban areas in the United States are generally considered the most sprawled in the world and British governments developed the most-well known anti-sprawl policies in the world. Atlanta and Portland are known as the examples of two opposite policy approaches to sprawl in the United States. These cases will illustrate that urban sprawl is actually more complex than its categorical characterizations and that it takes on different forms that emerge in the particular historical and political contexts of the cities and nations.

Case Summaries

Atlanta

The information in this section is based on the case studies conducted by Morçöl and his colleagues (2003) and Zimmermann and his colleagues (2003), unless noted otherwise. If there is a “poster child of sprawl,” metro Atlanta can be considered a primary candidate for this title. It is called “the fastest-growing human settlement in history regarding land consumption” (Leinberger, 2008). The details of how this came about are not straightforward, nor are the current outcomes definitive.

The population of metro Atlanta increased from 1.7 million in 1970 to 5.7 million in 2010, while the population of the city declined from 495,000 in 1970 to 395,000 in 1990 and then steadily increased to 420,000 in 2010. The city’s share of the metro area population declined from 29% in 1970 to 7% in 2010. The Atlanta metropolitan statistical area covered five counties in 1970; this has expanded to 20 counties in 2000. The built environment of the metro area stretches about 100 miles from one end to the other. If sprawl is defined as “formless urban exudation” with low population density, Atlanta’s suburbs with no, or little, discernible areas of concentration fit this definition. The population densities in the city and the metro area (3,160 per square mile and 1,800 per square mile respectively) are much lower compared to some major metro areas in the United States, such as New York and San Francisco (<http://2010.census.gov/2010census/>), but higher compared to others like Denver, Seattle, Minneapolis-St. Paul, and New Orleans (Jaret, 2002: 169).

Atlanta’s rapid expansion can be attributed partly to the gradual shift of the manufacturing base and population in the United States from the Northeast and Midwest to the South and Southwest since the 1960s. The pro-growth policies of the state government in Georgia and the “urban regime coalitions” that controlled the city’s politics in Atlanta since the 1950s (Stone, 1989) can also be cited as reasons. Key aspects of these policies were to keep building highways stretching to farther geographic areas and to allow building new suburban subdivisions with little or no restrictions. Also, as the percentage of the black population increased in the city, large sections of the affluent and middle-class whites moved out and settled in suburbs, which contributed to the suburban expansion. These economic and demographic shifts created self-organizational dynamics: Suburban economic growth attracted more growth in suburbs, while the economic activities and population in the city declined until the early 1990s.

An important consequence of the rapid growth was the decline in the air quality in the metro area. As more highways were built, metro Atlantans settled in distant locations, commuted longer distances, the traffic congestion intensified, and large amounts of pollutants were emitted to the atmosphere. In the late 1990s the US Environmental Protection Agency (EPA) declared the Atlanta region a serious violator of the National Ambient Air Quality Standards, and threatened to cut federal funds for further road building. Equally important, Atlanta’s image would be tarnished because of the pollution and traffic problems and further economic growth could be stymied. Metro Atlanta’s business leaders and the state government reacted to EPA’s threat quickly. In 1999, with the support of the metro business leaders, the governor and the state general assembly created the Georgia Regional Transportation Authority (GRTA) and authorized it to review large construction projects, including transportation projects. The GRTA board initially drafted plans to expand the mass transit system throughout the region. However, when the governor lost the 2002 elections for unrelated reasons (i.e., the backlash of voters to the governor’s leadership in replacing the state’s flag, which had the “Confederate Battle Flag” as part of it, with a new flag in 2001) this created new dynamics. Under the new governor GRTA’s mass transit initiatives were slowed down and even halted, while the road construction continued.

Arguably the policy intervention to curb sprawl in the early 2000s failed, but the effects of this failure are not clear cut. On the one hand, suburbs continued to grow faster than the city (the city’s share of the metro area population continued to decline from 10% in 2000 to 7% in 2010). On the other hand, the city’s population increased, albeit slowly, between the 1990 and 2010, as

noted above, and the city's neighborhoods have become denser and the occupancy rates in residential and commercial units in the central areas increased (Leinberger, 2008).

Britain

The British "urban containment" policies that have been implemented in the last half a century represent a contrast to the pro-growth policies implemented in metro Atlanta in the same period. Champion's (2003) case study of the British policies show that these policies did have effects on the evolutions of the spatial and social forms of urban areas, but in nonlinear ways, with both intended and unintended consequences.

The British policies were rooted in the Greater London Plan of 1945, which imposed an urban development boundary and an area beyond this boundary was designated as the "green belt," where urban development would be controlled tightly. The excess population growth in London would then be directed to the concentrated "new towns" outside this belt (Milward, 2006). Successive policies of the national governments in the following decades expanded this initial London model to other cities in Britain.

The British containment policies led to the relatively high densities in urban cores, as well as in self-contained distant settlements, as intended (Champion, 2003: 14, 64, 74). There have been unintended consequences as well. As the outmigration from cities intensified, more people began to commute longer distances, which increased the traffic congestion and air pollution in London and other cities. The nation's economic base moved out of cities at rates faster than population growths in outer regions (48). Champion also observes that two kinds of separation happened in urban areas: the separation of residential and commercial functions and the separation of affluent "shire" counties and deprived cities (75). Champion also argues that the policies increased land and housing prices (15).

Portland

The British containment policies have been emulated in Japan, Canada, and the United States (Milward, 2006). Over a hundred US cities have adopted similar policies since the 1950s (Nelson *et al.*, 2008: 9). Portland, Oregon, is the most prominent of these cities and its experience has been debated most intensely in the literature. If Atlanta is the poster child of sprawl, then Portland is the poster child of the systematic efforts to curb sprawl.

Oregon adopted a state-wide urban growth and management policy with its 1973 Conservation and Development Act (Bruegmann, 2005: 204). This state law was implemented on the largest scale in Portland. Two key components of the implementation in Portland were setting an "urban growth boundary" and shifting the priorities in transportation from constructing new highways to making investments in public transit (Bruegmann, 2005: 204). A metropolitan area-wide special district, known as Metro, was charged with drawing the urban growth boundary initially; over time Metro became an elected body and granted wider authority (Bruegmann, 2005: 205-206).

Have policies in Portland been successful? The answer depends on who answers the question and which set of statistics they use to support their arguments. General population statistics indicate that the Portland metro area has expanded geographically without interruptions since the 1950s. The population density declined until the early 1980s, when the "urban growth boundary" policy went into effect, and since then it has increased slightly (Abbott, 2002: 221). It is not clear if this increase was a result of the containment policy, because in the 1980s the population densities of some other US metro areas either stabilized or increased as well, while in some others it continued to decline (Bruegmann, 2005: 62-63). The city's population density continued to decline in the 1980s, but it began to increase in the 1990s (Bruegmann, 2005: 62-63, 205-206). Even in the 1990s, population grew relatively slowly in the city, while the populations of metro Portland's outlying areas (Vancouver, Washington and other nearby towns) grew faster (Bruegmann, 2005: 209). Meanwhile, the share of the central business district employment in the metro area increased significantly in the 1980s, contrary to the trend in other US cities in the same period (Lewis, 1996: 169).

In the area of transportation, again, there are mixed and even conflicting results. The car usage rates in the city and the metro area have increased since the 1970s and the market share of the public transit has declined (Bruegmann, 2005). Because of the population shifts to nearby towns, the number of daily car commutes to Portland increased in these decades as well (209). Lewis (1996) provides a set of statistics that depict a different picture: Bus, rail, bike, and walking accounted for 40% of the commutes to Portland's central business district and in Portland metropolitan statistical area public transportation accounted for 9.2% of work trips in the mid-1990s (195). Bruegmann, on the other hand, notes that the percentage of people using public transit declined to less than 1% by the mid-2000s (212).

Bruegmann compares Portland to Phoenix, Las Vegas, and Houston and notes that in Portland housing values have risen much faster (210). Lewis (1996) compares Portland to San Diego, Sacramento, and Seattle and says that Portland is three times more affordable than the other three (181).

Lessons Learned From The Cases

The above case summaries show that urban sprawl does not have a universal form. The effects of public policies on urban expansion are not uniform or linear either. There are some commonalities among different cases, however. Metro Atlanta sprawled in a way that fits Mumford's description of "formless urban exudation." In Britain urban areas expanded, but they did so in denser pockets around major cities. Similar to the process in Atlanta, in Britain the populations of outer settlements grew faster than cities, economic activities moved outside cities, socio-spatial separation happened between cities and outer settlements, and traffic congestion and air pollution increased.

The Atlanta example may be cited to support the argument that laissez faire pro-growth policies of the business leaders/elites and local and state governments encourage demographic and geographic expansion. The experiences in Britain and Portland show that their containment policies did have some effects, but there are similarities between them and Atlanta in some important respects as well. For example, the degrees of dependence on cars in daily commutes have increased in all the metro areas studied. The Portland experience shows that the containment policies did not have clearly discernible effects on population growth, employment patterns, or the utilization of the modes of transportation. The population densities in the cities and surrounding areas in Atlanta and Portland decreased and increased over time in no direct correlation with the respective policy changes. Sprawl is a dynamic phenomenon

A Complexity Theory Of Urban Sprawl

The case summaries above illustrate that sprawl is a complex phenomenon. The lack of precise definition of sprawl and the inability of researchers to identify definite and linear causes are due to this complexity. The summaries also indicate that in each case multiple factors and actors played roles in the expansions of urban areas in somewhat different forms with some similarities. As Bruegmann (2005) points out, sprawl is generated by "innumerable forces, always acting on each other in complex and unpredictable ways" (112). This complexity defies the efforts to define sprawl universally and finding universal causes of it. It also defies the efforts to fix social problems such as sprawl with "policy solutions."

Complexity theory offers an alternative conceptual understanding of these systems and the roles policies play in them and provides a set of methodological tools to investigate these systems. Urban sprawl can be better investigated and understood within this alternative view.

Applying Complexity Theory Concepts And Methods

Complexity theory suggests that urban spatial forms, such as sprawl, are emergent properties of complex urban systems. These systems are self-organizational in the sense that the patterns of urban social and spatial processes cannot be dictated or prevented by external interventions, such as government policies. They are dynamic in the sense that urban spatial and social forms change over time, as urban systems and urban actors interact with natural, economic, and cultural systems. Because the relationships among the actors of urban systems are nonlinear, the emergent properties of these systems (e.g., how and to what extent urban areas expand) cannot be defined categorically, nor can their causes be identified with certainty.

Each urban actor (politicians, businesses, home owners etc.) has complex belief systems and motivations, which makes predicting their behaviors and their interactions nonlinear (Haag, 2002: 14). These complex belief systems and nonlinear interactions limit researchers' ability to single out a simple and universal explanation of sprawl and devise policies accordingly. As Batty (2007) puts it, complex systems defy the "conventional view of science," which seeks simplicity. Within the complexity view: "[P]redictability and certainty, the traditional hallmarks of science, indeed the traditional hallmarks of urban theory a generation or more ago, are in question" (515). The unpredictability and uncertainty in knowledge processes limit researchers' abilities to make generalizations.

This is why, from the perspective of complexity theory, it is not possible to define sprawl universally or identify a set of universal causes of sprawl in the deductive-nomological sense of the term. Neither the case studies summarized earlier in this paper, nor others described in other sources suggest that there is a universal form sprawl or a set of causes attributable to it. Instead, complex urban processes and the emergent properties of urban systems, such as sprawl, should be studied within their contexts. Researchers can factor the similarities observed among different urban areas into their models, but they should also aim to understand the individual characteristics of each case.

This contextual investigation involves two theoretical and empirical problems/questions. First, how do the relationships of an urban system with other systems (e.g., national economy; ecological environment) affect urban sprawl? This is the problem of coevolution of systems. Second, how do macro-level (systemic) properties, such as urban sprawl, emerge from micro-level interactions (i.e., the interactions among individual and collective actors)? This is the "micro—macro problem" or the "agency—structure problem."¹

As early as in the 1960s, scholars like Forrester (1969) used system dynamics modeling to investigate the effects of the

interactions among social systems and natural systems on urban expansions. Haase and Seppelt's (2010) work is a more recent example. As useful as these macro-level analyses are, to understand complex urban processes better, researchers should investigate the micro—macro transformations in urban systems. As Ocelli (2006) observes, beginning with the 1980s, urban researchers have made some advances in doing so.

To understand the importance of these advances, we need to define the micro—macro problem first. Coleman (1986) defines it as the problem of understanding how “individual preferences become collective choices” (1321). Its philosophical roots go back to Hobbes, Adam Smith, Locke, Rousseau, and Mill. Talcott Parsons posed it as the central problem of sociology in the 1930s. Since then scholars from various theoretical perspectives have adopted it as their core intellectual problem (e.g., Jessop, 1991; Ostrom, 1990, 2005). Some complexity researchers have done so as well. Haag's (2002) formulation of the problem of the complexity of urban sprawl in micro—macro terms is of particular relevance here:

[U]rban sprawl is the result of an interlocked process of spatial interactions where different agents (households, accommodation agencies, employees, firm, etc.) with different, partly inconsistent interests, are involved. The multiple decisions of the different agents result in migration flows of...people, changes in commuter flows and...in a redistribution of workplaces in an extending spatial region. (13)

Then, how can we know how the decisions by multiple urban agents and their interlocked spatial interactions result in migration flows, commuter flows, the redistribution of workplaces, affect the extension of urban areas? The primary methodological tool of complexity researchers in investigating micro—macro problems is agent-based simulations, or multi-agent simulations. Batty's (2007: 403-415) cellular automata simulations of urban growth processes, Hass's (2002: 34-42) simulations of the population dynamics in Stuttgart, and Lüdeke and his colleagues' (2007) comparative simulations of several urban areas in Europe are good examples of the applications of these methods to urban problems. Hass's and Lüdeke and his colleagues' simulations are particularly illustrative of the observation I made above that the causes and forms of sprawl cannot be generalized to all countries or urban areas; instead cases should be investigated within their contexts.

Implications For Policymakers And Planners

What are the implications of complexity theory for those policymakers, policy analysts, and planners who are concerned about urban problems in general, and sprawl in particular? The most obvious implication is that they should recognize the limits of their ability to shape urban processes. This is particularly because complexity theory challenges the presumed causal relationship between policy decisions and actions on one side and “policy outcomes” on the other (Salzano, 2008: 186). Such a causal relationship cannot be established, as I pointed out earlier, because of the nonlinearity of the relationships among multiple policy actors and the self-organizational nature of complex systems, such as urban systems. Instead, policymakers and planners should recognize the emergent nature of urban systems.

This complexity theory insight into complex urban systems has precedents in the 1960s. Jacobs (1993, first published in 1961) argued against the massive “urban renewal” projects of her time and for letting neighbors of “blighted areas” organize themselves to renew their neighborhoods. Forrester (1969) observed that urban systems are self-organizational and that they resist interventions by governments: They are uncontrollable and unplannable.

The case studies summarized above demonstrate that anti-sprawl policies, such as greenbelts, cannot control urban expansions in the exact ways that were intended by policymakers. British cities and Portland expanded geographically and the traffic congestion increased in their respective metropolitan areas, despite the policies. The Atlanta experience demonstrates that the sprawl process may slow down despite the policy failures, like the failure of GRTA. These cases do not indicate, however, that there is no relationship between policies and outcomes; they rather illustrate that the relationships are nonlinear.

Then what should policymakers and planners do? A generic answer to this question is that they should adopt the concepts and methodological tools of complexity theory in their policymaking and planning activities. I must stress, however, that complexity theorists have not offered a coherent and unified set of concepts and tools for policymakers and planners yet. There is a work in progress.

The most intuitively appealing concept of complexity theory is self-organization. In Portugali's (2000) view urban planning should be self-organizational in the sense that planners and policymakers should adopt general planning principles and let urban agents plan for themselves, instead of imposing specific land-use plans on them. In this bottom-up approach, urban actors would provide planning ideas and planning parameters would emerge from them. The role of planners would be to provide information and technical expertise to urban actors and let them interpret the information and make and update their plans.

Self-organization is not a uniform process, nor is it a panacea, however. As Buijs and his colleagues' (2009) case study of the Randstad Holland metropolitan region in the Netherlands demonstrate, self-organizational policymaking and planning is a highly complex process. To curb the urban sprawl in the region, the Dutch central government created mechanisms of collaboration in land-use planning among the local governments in this region. Buijs and his colleagues' study shows that self-organization may

take on multiple forms and the broader economic and political context (e.g., the framework set by the central government) matter in enabling self-organization. Many decades of studies by Elinor Ostrom and her colleagues also show that self-organization is not a uniform process and that certain conditions should be created for self-organizational policy/planning processes to be effective (see Ostrom, 2005: 244-245).

Although complexity theory encourages us to think of policy and planning processes in nonlinear and self-organizational terms, this does not mean that effective policy or planning mechanisms cannot be devised. Complex policymaking and planning processes can be effective if governmental and private actors together create and maintain “robust but adaptive governance systems” (Banks, 2008) or “resilient and adaptive governance systems,” which would “withstand shocks and surprises, absorb extreme stresses, and maintain [their] core functions, through perhaps in...altered form[s]” (Innes & Booher, 2010: 205). If the expansion of urban land and decreasing population density in metropolitan areas are problems, for example, governmental actors and non-governmental actors together can affect land-use patterns and densities.

How can complex policy systems be made “robust” or “resilient” is a major area of research. In their studies Elinor Ostrom and her colleagues identified a set of principles of “designing robust social-ecological systems” (see Ostrom, 2005: 258-279). Their studies provide guidelines to policymakers and planners in areas such as how to make collective-choice arrangements, establish accountability and sanctions, and resolve conflicts. Miller and Page (2007) point out that complexity researchers need to do more research to understand better the robustness and adaptability of complex systems in the face of the changes in their environments and the changes in their actors and their relationships (236-237).

Current and future studies by complexity researchers in these areas will help us better understand how urban spatial forms emerge in general and how urban sprawl occurs in particular. They will also help us develop better guidelines to enable the creation of robust and adaptable urban systems to make our communities more livable and less harmful to their natural environments.

Note

1. Actually this question represents only one aspect of the micro—macro problem. The problem includes the following questions as well: Are the properties of the emergent structures irreducible to those of agents? (How) do emergent properties influence the actions of agents? These questions and their implications are discussed extensively elsewhere (Morçöl, 2012).

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