Middle States Geographer; 2019, 52:60-69

ZONING FOR CLIMATE CHANGE: LEARNING FROM LEADER SUBURBS IN PENNSYLVANIA

Dorothy Ives-Dewey, Ph.D., AICP, PP
Geography and Planning Department
West Chester University
West Chester, PA 19383

ABSTRACT: *Suburbs could be poised to play a major role in the effort to mitigate the buildup of greenhouse gases and adapt to a new climate future. Using four suburban Pennsylvania counties outside Philadelphia as the study area, this research investigates suburban-level zoning efforts related to climate change. The majority of the U.S. population resides in the suburbs and a high degree of land use control is vested in local suburban municipalities. Many of the potential measures to mitigate and adapt through control of the physical environment, including land use regulations, are in the purview of local governments. Zoning is one of the most powerful and effective tools to implement plans and shape and protect a local suburban community. But how and to what extent are these tools being used? Analysis of the zoning efforts of leader suburbs indicates a variety of regulatory approaches are utilized that coincide with different types of suburbs. While only a small percentage of municipalities are utilizing zoning approaches in climate planning, findings suggest that while some common approaches can work for all suburbs, planning policy recommendations will be most effective if they account for different suburban forms.*

Keywords: *Zoning, Suburb, Land use, Climate planning*

INTRODUCTION

This research investigates suburban-level efforts in metropolitan Philadelphia to zone for climate change. Local communities across the United States are stepping in to contribute to multi-level efforts to address climate change. With little support at the federal level, the responsibility for combatting climate change has shifted to the state and municipal levels, where local officials and planners are becoming more adept at reducing greenhouse gas emissions (Cruce, 2009; Dierwechter, 2010). There has been much attention to the role of cities in responding to climate change, however to date there has been comparatively little attention to the role of suburbs. The majority of the U.S. population resides in the suburbs and a high degree of land use control is vested in local municipalities. Local governments influence many of the potential measures to mitigate and adapt to a changing climate, including regulating land use regulations, managing building codes, and protecting and maintaining critical infrastructure. Suburbs, therefore, could be poised to play a major role in the effort to mitigate the buildup of greenhouse gases and adapt to new climate conditions. The objective of this research is to examine how suburbs on the forefront of climate planning have incorporated climate adaptation and mitigation principles in their zoning ordinances. Called leader suburbs, these are municipalities that have demonstrated a commitment to climate planning, typically by the adoption of a local climate action or sustainability plan. There has been considerable scholarly attention to local climate planning (Measham, et.al., 2011), however, there has been comparatively little focus in the planning literature on the implementation of climate planning goals and policies through land use regulation (Grant, 2009). Zoning is one of the most powerful and effective tools to implement plans and shape a community. Through zoning, communities can take steps to mitigate greenhouse gases and adapt to new climate conditions. An exploration of how zoning is being used by leader suburbs can identify real possibilities for suburban action, and provide a better understanding of the regulatory potential of suburbs to address climate change.

CONCEPTUAL FRAMEWORK

This research draws on scholarship in a number of areas, including the changing demography and form of suburbs, multi-level climate governance, and sustainable suburban development planning. This section summarizes key concepts from each of these areas.

Suburban Variation and Typologies

Suburbs have some features in common. They are predominantly owner-occupied residential, relatively low-density settlements, located outside the core of a metropolitan area, and economically connected to an urban area. A closer look however, reveals extensive variation and there is growing scholarly attention to the physical and social variability in suburbs. Over time many suburbs, even those initially built upon a middle-class, white, nuclear family ideal, have diversified demographically and economically (Hanlon et.at., 2010). They possess different architectural styles and patterns of settlement that reflect different historical periods of development. Across the U.S., suburban areas range from old industrial towns, to classic "bedroom" residential areas, to regional employment centers, to newly suburbanizing communities, to established edge cities, and more. Suburban variation has been characterized with efforts to create suburban typologies to classify differences. Typologies vary along dimensions that include: income, socio-economic status, racial/ethnic composition, employment characteristics, land use, development morphology and density, housing characteristics, population density, and growth trends (Bruegman, 2005; Hayden, 2004; Hasse and Lathrop, 2003; Orfield, 2002; Orfield and Luce, 2010; Mikelbank, 2004; Hanlon, Vicino, and Short, 2006). Most typologies are derived from cluster analysis across dimensions of population, place, economy and government. Selection of a suburban typology for analytical purposes should be driven by a consideration of the characteristics of the region studied and the purpose of the research. Since this research has a primary focus on land regulation in a politically fragmented region, a morphological typology adapted from a study of the Minneapolis/St. Paul was utilized (Orfield and Luce, 2010).

Suburbs and Climate Change

The Fourth Report by the Intergovernmental Panel on Climate Change was the first to emphasize that climate change is not just an international problem, but a multi-scalar one. Greenhouse gas emissions result from individual, local, state, national and international decisions (IPCC 4th Assessment Report, 2007). Suburban communities are important players in addressing climate change (Leichenko and Solecki, 2013, Osofsky, 2012). Suburbs make up much of developed land and are subject to ongoing development pressures. The majority of residents in the U.S. live in the suburbs (Mather et al., 2011). It has been estimated that over the next 30 years, nearly 100 million people are likely to move into suburban locations in the U.S. (Kotkin, 2010). The low-density and automobile-dependent nature of most suburban communities makes them disproportionate contributors to greenhouse gases. Many studies have shown the ways in which suburban zoning and planning – with large individual lots, separation between residential and commercial uses, and limited public transportation – increase vehicle miles traveled and, as a result, overall emissions from that locality (Ewing, et. al. 2002).

Suburbs face a range of climate vulnerabilities. Climate change is expected to bring higher temperatures, especially in the summer, and longer periods of heat and drought. Summer heating will be particularly notable in eastern U.S. cities. Extreme weather events have become more commonplace, and scientists warn that the warming planet will bring about more events (IPCC 5th Assessment Report, 2014). The five extreme weather threats to American metropolitan regions include heavy precipitation and floods, droughts, heat waves, tropical storms combined with sea-level rise, and severe thunderstorms. Impacts are expected to be most severe in coastal locations, but no area will be spared. Local impacts will vary depending on a variety of factors, including: the period in which a community was built and its general morphology; location within a metropolitan area; roadway and transportation characteristics; the existing form and ownership patterns of the physical environment; the mix of land uses; location within different climatic regions and water catchment areas, and; the socio-economic and cultural characteristics of the resident population (Leichenko and Solecki, 2013).

Sustainable Suburban Land Use Planning and Zoning

Sustainable development has been a planning objective for over 20 years (Berke and Conroy, 2000). As the literature has evolved, there has been growing attention to the close connection between sustainable land development planning and climate change mitigation and adaption (Barnett and Beasley, 2015; Williamson, 2013; Bassett and Shandas, 2010). Human patterns, and the greenhouse gas emissions that result from them, are shaped by how buildings are constructed and how they are arranged on the land. It is estimated that location and form of development relates directly to over 66% of net CO2 emissions in the U.S., and land use regulations have been proven as cost-effective climate mitigation techniques (Arnold, 2007). Planning for climate change locally therefore involves changes in the physical environment, a complex process that is largely regulatory. Indeed, suburban municipal officials and planners are predominantly regulators of the development process. Zoning is one of the most powerful land use regulatory tools.

Drawing on literature in each of these areas, a key premise of this research is that effective climate change planning and regulatory strategies will vary by the positionality and characteristics of the suburb.

STUDY AREA

The Philadelphia metropolitan region encompasses a typical U.S. suburban landscape, with a range of settlement patterns. Like most major metropolitan areas, jobs and population have decentralized significantly over the last forty years, with current growth concentrated in the outer suburbs. The region is politically fragmented with 239 separate municipalities on the Pennsylvania side, including two cities, 89 boroughs, and 148 townships. Suburban differentiation has taken place as growth has occurred, with some suburbs reflecting fiscal stresses and racial and poverty concentrations, and others facing the complexities of rapid growth with inadequate infrastructure. The region has experienced similar demographic shifts to those observed across the country, with a suburban population that is growing older in some locations, younger in others, and more diverse overall. The changing form of households has created demand for a variety of housing types and communities with more transit options, recreational opportunities, cultural features, and opportunities for social interaction.

Types of Suburbs in the Study Area

Using a morphological typology adapted from Orfield and Luce (2010), the municipalities in the study area were classified into one of five distinct types of settlement, including: stressed, job center, mature bedroom, developing bedroom, and exurban. Classification was based on hierarchical cluster analysis that initially considered over 20 variables that reflected land use characteristics, population characteristics and trends, socioeconomic conditions, housing characteristics, and existing infrastructure. A variety of data sources were used including the U.S. Census, county land use data, and population projection data from the Delaware Valley Regional Planning Commission (DVRPC), the region's Metropolitan Planning Organization (MPO). A preliminary factor analysis reduced the list to the following six variables that were used in the cluster analysis: percent of undeveloped/agricultural land, population density, percent population change from 1990 to 2010, percent minority, percent poverty, and age of housing. Based on the results of the analysis, following is a general description of each cluster type in the study area:

Stressed. These municipalities have some of the highest population densities, some of the oldest housing stock, the highest rates of poverty and the highest percent minority. Stressed suburbs also have the lowest percent of undeveloped land, and low rates of growth. Spatially, these suburbs tend to be located close to the central city or in outer edges of the region.

Job Center. These municipalities have higher population densities, little undeveloped land, a greater mix of residential uses, and a higher percent minority population. They experience a relatively slow but stable population growth. Municipalities that were classified as job centers in the study area include historic town centers and suburbs with well-established commercial centers, including edge cities.

Mature Bedroom. Compared to other suburban types, they tend to be medium density, and dominated by single-family detached dwellings. They are also characterized by established commercial centers and corridors. The have a relatively small amount of undeveloped land. They had low-to-moderate population growth from 1990-2010. Geographically, these communities are located along major road corridors. Many in the study area are served by rail.

Developing Bedroom. With high rates of growth since the 1990s, developing suburbs are generally low density and residential, with moderate amounts of undeveloped land, but rapid land conversion. These communities tend to be located further from the urban core and are largely automobile-dependent. They contain newer housing and a high number of single-family detached dwellings on large lots.

Exurban. These municipalities have a large percentage of agricultural and undeveloped land. With some new, but disconnected, housing developments, population densities are low. Poverty rates are high, and rates of growth were relatively low. These suburbs are located on the edges of the region.

METHODOLOGY

The research proceeded with three stages. During stage one leader suburbs in the study area were identified. Stage two involved compiling a list specific zoning tools to implement climate planning. Stage three entailed collecting data on the utilization of zoning tools by the leader suburbs, and analyzing patterns of zoning tool use across different suburban types using descriptive statistics. This section details each of these stages.

Stage One: Identification of Leader Suburbs for the Case Study

Twelve municipalities were identified as climate planning leaders and selected as subject suburbs for this study. As early adopters of climate planning, it was reasoned that leader suburbs would be more likely to engage in implementation efforts. To be considered a leader suburb, a municipality had to demonstrate a commitment to climate planning. Municipalities met this condition if they had an adopted climate action or sustainability plan, or if they explicitly addressed climate change as an area of concern in an adopted comprehensive plan. Municipalities also met this condition if they participated in ICLEI.[1] The exurban communities in the region studied did not demonstrate climate planning efforts, they were not included in the analysis. Approximately 25 of the municipalities in the study area met one or more of the conditions, representing only 10.4% of the municipalities in the study area. From that set, municipalities were selected to provide an equal representation across the four suburban types, as well as an equal spatial distribution across the counties in the study area. Figure 1 shows the location of the leader suburbs used in the study.

Stressed communities included the City of Chester, Pottstown Borough and Falls Township. The City of Chester, in 2014, was one of the first municipalities in the region to adopt a climate action plan. Located along the Delaware River in Delaware County, the City has special concerns about sea level rise. Pottstown Borough in Montgomery County adopted a Sustainability Plan in 2017. Falls Township, also located along the Delaware River in Bucks County, is along-time member of ICLEI and an early participant in a multi-municipal climate action plan with four neighboring municipalities in 2011.

Job Centers included West Chester Borough, Media Borough and Upper Merion Township. West Chester, home to West Chester University and county seat, served as an early town center in Chester County. The Borough has a progressive climate planning agenda, and one of the first municipalities to hire a staff-level sustainability coordinator. Media Borough, in Delaware County, also has promoted a variety of climate initiatives, including a formal charge to its Environmental Advisory Council to address climate concerns. Upper Merion Township in Montgomery County, is the largest edge city in the region. Upper Merion has adopted a number of plans and measures to enhance sustainability including energy efficient building incentives, transit use, and walkability. All three suburbs are mostly built out, with new growth coming from redevelopment.

Mature Bedroom suburbs included Haverford Township, Newtown Township and Tredyffrin Township. Haverford Township in Delaware County was one of the earliest local municipalities in the region to join ICLEI and subsequently adopt a climate action plan which included a range of initiatives to reduce motor vehicle emissions. Newtown Township in Bucks County was one of the first municipalities to participate in a joint comprehensive plan with neighboring municipalities, and has been a regional leader in promoting sustainable development. Tredyffrin Township in Chester County was one of the first municipalities in the region to adopt a green-building density incentive in its zoning ordinance.

Developing Bedroom suburbs included the townships of London Grove in Chester County, West Vincent in Chester County, and Northampton in Bucks County. Historically, these communities were largely agricultural, and they still have a considerable amount of land in agricultural use. These suburbs have experienced rapid population growth since the early 2000's, and they all engaged in proactive planning processes effectively to sustainably manage their rapid transitions. Overall population densities are much lower than in the other suburban types, and residential uses are dominated by single-family detached housing developments and each has a small commercial core. The suburbs have considerable woodlands and natural resources.

Stage Two: Identification of Regulatory Items

Local governments have at their disposal a variety of tools that can be used to further climate planning agendas. With the authority to promulgate land use regulations, municipalities in Pennsylvania have considerable potential to reduce carbon footprints by fostering a shift from car-dependent, single-family neighborhoods to higher density, mixed-use and/or transit-oriented settlement patterns. Regulations can require or incentivize increased energy efficiency in buildings and support a shift to renewable energy sources such as wind and solar power. Land use regulation can also be used to reduce development pressures on carbon sequestering resources such as trees, woodlands

and open space. Based on a review of the climate planning literature, regulatory tools and approaches that could be incorporated into zoning were identified. Zoning tools were organized into four categories: protection of local sequestering resources (sequestration); fostering sustainable patterns of growth (sustainable land planning); energy efficient developments and neighborhoods (energy efficiency), and; adaptation of buildings and communities to sea level rise, flooding, and stronger storm events (adaptation). Each of the categories is described below and the regulatory tools are listed in Column 1 of Table 1.

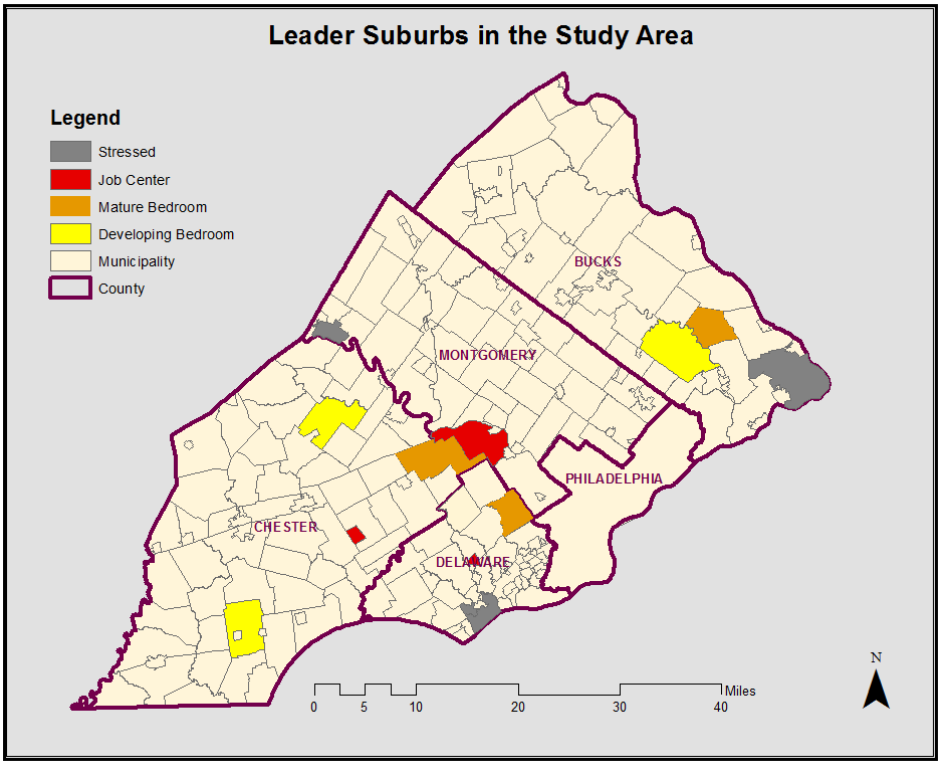

Figure 1. Map showing the regional location of each of the twelve subject municipalities, classified by type of suburb.

Sequestration. Carbon sequestration reduces carbon dioxide (CO_2) emissions by storing, or processing, carbon for the long term. Zoning can be used to implement a range of biological sequestration strategies to preserve and enhance the natural environment and expand landscape features that have significant potential to sequester carbon. Common sequestration strategies include tree canopy protection, urban forestry, and protecting forests and woodlands, open space preservation, and cluster or conservation design development strategies.

Sustainable land planning. Sustainable neighborhood development is integral to climate planning with its focus on reducing vehicle miles travelled through promoting pedestrian and transit-oriented design. Sustainable land planning principles include encouraging higher density and mixed-use development. Alternatives to driving can be provided by appropriate placement of sidewalks, pedestrian paths and bike lanes to provide access to public facilities, businesses, parks and other destinations. Possible zoning strategies include provisions for infill development, mixed-use development, transfer of development rights,[2] transit-oriented development, live-work units, planned unit development (PUD), and LEED-ND provisions.[3] General measures to enhance walkability and biking are also included in this category.

Energy Efficiency. Communities can use zoning to support the installation and operation of renewable energy systems, such as solar access protection, solar panel systems, and wind turbines. Zoning can also be used to incentivize green building, through mechanisms such as density or height bonuses.

Adaptation. Adaptation strategies are directed at the existing impacts of climate change. Strategies will vary depending on geographic location and development patterns. These can address impacts such as heat waves, drought, flooding, sea level rise, and wildfire. Adaptation strategies also include efforts to protect local food production. Common strategies include provisions for green infrastructure, stormwater management, and floodplain protection, as well as provisions for community gardens, urban farming and agricultural land preservation.

Stage Three: Zoning Ordinance Review

The third stage of the research involved researching the zoning ordinances of each of the twelve leader suburbs to identify which zoning tools from Table 1 were in use. Local plans, including comprehensive plans, as well as climate action plans, sustainability plans, and others, were reviewed to understand the vision for growth and development as well as the current planning and policy context for climate action. The main focus during this stage, however, was to determine how policies expressed in plans were implemented as specific zoning regulation, and ultimately to determine if and how use of zoning tools varied across the type of suburb. The data were analyzed using descriptive statistics.

FINDINGS

Table 1 summarizes the findings. The "Summary" column reports the percentage of municipalities overall that adopted a particular tool. The subsequent columns report the percentage of use by type of suburb. In general, the findings indicate that while some tools are widely used, others are utilized little, if at all. Findings also indicate that, for some tools, there is a variation in use across the different types of suburbs.

Widely-Used Zoning Tools

Select sequestration efforts are broadly accepted by suburbs of all types. Nearly all of the subject suburbs had some form of protection of the tree canopy in their ordinances. There was variation over which trees were protected. While every municipality had protection of individual trees in the public rights of way, only three had enacted regulations to protect trees on private property. Open space preservation was also a commonly-used tool, evident in over 90% of the municipalities, and used across all types. The findings also indicate that mixed- use development has gained acceptance as a concept, as evidenced by the fact that all municipalities had provisions for mixed-use development, although allowable densities varied. Mixed-use development was the only sustainable land planning tool that was used widely. Stormwater and floodplain management regulations are well established. Most of the municipalities have stand-alone stormwater management ordinances, and eight of the twelve had stand-alone floodplain ordinances as well.

Little-Used Zoning Tools

Results indicate very limited adoption of some zoning strategies, including: urban forestry, LEED-ND, carbon neutral requirements, green infrastructure, community gardens, and urban farming. Some elements of a system of green infrastructure are evident, but all suburbs could go much further in this area. There is some, but limited use of transfer of development rights, planned unit development, and green building incentives. Tools that are starting to emerge in some localities, but have yet to be used widely include: transit-oriented development, provisions for live/work units, and measures to enhance biking.

Zoning Tools with Variable Use

For some tools, the results indicate variation in use across different suburban types. Variation was determined by identifying tools that showed the greatest dispersion in use across different types of suburbs, relative to the average for all municipalities. For instance, overall 58% of suburbs had zoning tools related to solar access protection. Looking across the different suburban types, however, use of solar access protection ranged from 0% in job centers to 100% in mature bedroom suburbs. The following tools showed the greatest variation in use: forest woodlands preservation, cluster/conservation subdivision, solar access protection, wind turbines, agricultural protection, transit-oriented development, infill development, and live-work units.

DISCUSSION AND CONCLUSIONS

While it is somewhat encouraging to see a number of climate-friendly zoning tools in use, there are real limits to how far suburban zoning has gone in addressing climate change. It bears re-emphasis that only 10% of all the municipalities in the region had demonstrated that climate change was a driving factor in planning. And only rarely was climate indicated as a public purpose for any of the zoning tools explored. Stated public purposes for tools were more commonly related to the protection of property values, vague notions of livability and broadly-stated ecosystem services. The broad use of stormwater and floodplain management tools is likely more reflective of the federal and

Table 1. Zoning Analysis Results

Local Climate Action Zoning Tool	**Summary**	**Stressed**	**Job Center**	**Mature Bedroom**	**Developing Bedroom**
Sequestration					
Protect Tree Canopy	92.0%	66.7%	100.0%	100.0%	100.0%
Urban Forestry	8.3%	0.0%	33.3%	0.0%	0.0%
Forest Woodlands Pres	33.3%	0.0%	33.3%	0.0%	100.0%
Open Space Preservation	91.6%	66.7%	100.0%	66.7%	100.0%
Nat Resources Protection	75.0%	33.3%	66.7%	100.0%	100.0%
Cluster/Conservation Sub	58.3%	0.0%	33.3%	100.0%	100.0%
Sustainable Land Planning					
Infill Development	41.6%	66.7%	66.7%	0.0%	33.3%
Mixed-Use Devt	100.0%	100.0%	100.0%	100.0%	100.0%
Enhancing Walkability	75.0%	66.7%	100.0%	100.0%	33.3%
Enhancing Biking	33.3%	33.3%	33.3%	66.7%	0.0%
Transfer Devt Rights	16.6%	0.0%	0.0%	0.0%	66.7%
Transit Oriented Devt	33.0%	33.3%	66.7%	33.3%	0.0%
Live/Work Units	33.3%	33.3%	66.7%	0.0%	33.3%
LEED-ND	8.3%	0.0%	0.0%	33.3%	0.0%
PUD	25.0%	0.0%	0.0%	33.3%	66.7%
Reduced Parking Stds	50.0%	66.7%	66.7%	0.0%	66.7%
Energy Efficiency					
Solar Access Protection	58.3%	66.7%	0.0%	33.3%	100.0%
Wind Turbines	33.3%	33.3%	0.0%	0.0%	100.0%
Carbon Neutral Reqts	0.0%	0.0%	0.0%	0.0%	0.0%
Green Building	25.0%	33.3%	33.3%	33.3%	0.0%
Adaptation					
Green Infrastructure	0.0%	0.0%	0.0%	0.0%	0.0%
Stormwater Management	100.0%	100.0%	100.0%	100.0%	100.0%
Community Gardens	0.0%	0.0%	0.0%	0.0%	0.0%
Urban Farming	0.0%	0.0%	0.0%	0.0%	0.0%
Agricultural Protection	50.0%	33.3%	0.0%	33.3%	100.0%
Floodplain Protection	100.0%	100.0%	100.0%	100.0%	100.0%

state-level mandates to protect these resources, instead of local concerns about climate change.[4] A considerable number of zoning tools, despite general planning support for them, have not taken hold in local law. It is beyond the scope of this study to fully assess the reasons for the lack of use of certain tools, such as urban forestry, LEED-ND, carbon neutral requirements, green infrastructure, community gardens, and urban farming, but this is an important area for future research. The limited support for biking was one of the more surprising findings that can likely be explained by the larger regulatory structure around biking. All roadways in Pennsylvania are, by law, usable by bicycles (except where expressly prohibited), which might explain why zoning ordinances do not speak to bike lanes, signs, and markings. But while many decisions about biking are made outside the zoning process, certain aspects can be supported by zoning, including volume and placement of bicycle parking and bike racks. To date, these elements have not manifested in zoning.

While the results are somewhat discouraging in regard to suburban zoning potential overall to address climate change, they can provide guidance for suburban planners and officials interested in moving beyond climate planning by identifying appropriate local regulatory pathways. Different types of suburbs have different needs and have to consider different regulatory approaches to mitigate and adapt to a changing climate. In established, mature suburbs, climate mitigation and adaption will require making incremental changes to what is already built. In older, economically struggling suburbs, redevelopment might present opportunities for climate actions. In both settings, change is likely to be a slow process. In newer suburbs, change happens more rapidly, with a greater focus on new building, while protecting natural resources. Stressed suburbs and job centers were more likely to adopt approaches related to infill development. This makes sense as it's consistent with the patterns of settlement found in these established areas. Many of these communities are nearly built out, with little land available for new development. It's also likely that the greater economic challenges in stressed suburbs influence their approach to climate change and sustainability. Their efforts have to be sensitive to economics and can be expected to include an urban redevelopment component. Job center suburbs, with their existing infrastructure and regional location, were most likely to utilize transit-oriented development. In contrast, cluster and conservation tools are little used in the stressed and job-center suburbs, but commonly utilized by mature and developing bedroom suburbs that have more recent experience with new greenfield development. Protection for natural resources, including forested woodlands was a common tool for the newer, developing suburbs and mature suburbs, but not widely utilized with stressed suburbs and job centers. Again, this likely reflects the nature of the communities themselves and the existence of natural features and their value in the suburban landscape. The variation around zoning for solar access and wind turbines does not have an obvious explanation. These provisions can be accommodated in any suburban area. It is likely that the variation in use reflects local political support and advocacy over any differences in the physical environment.

With the large influx of people and their control over the physical environment, suburbs have the potential to play an important role in responding to climate change. Better planning and changes to land development patterns in suburban areas can address the root causes of climate change by reducing further impacts and withstanding ongoing challenges. Exploring the regulatory efforts of leader suburbs offers insight on best practices and opportunities for action. While findings based on twelve subject suburbs is empirically limited, this background work provides insight to better understand the problem of adapting suburbs and shaping the nature of inquiry for a more rigorous quantitative analysis of suburban climate planning. Climate planning and regulatory recommendations regarding strategies and best practices have to be targeted to different types of suburbs. A once-size-fits all approach will inevitably fail as a diversity of suburbs implies need for a varied range of appropriate responses. A menu-driven approach based on an understanding of the key contextual factors and the processes of change in different types of suburbs will work better to identify local-appropriate responses. As suburban communities embrace and plan for new residents and respond to recent technological and economic changes, future research can provide targeted recommendations for different types of suburbs in the range of zoning tools that can be used to develop in a way that is more sustainable and climate friendly.

REFERENCES

Arnold, C.A. 2007. The Structure of the Land Use Regulatory System in the United States; 21 *Journal of Land Use and Environmental Law* 441.

Barnett, J. and Beasely, L. 2015. *EcoDesign for Cities and Suburbs*. Island Press. Washington, D.C.

Bassett, E. and Shandas, V. 2010. Innovation and climate action planning: Perspectives from municipal plans. *Journal of the American Planning Association*. 76(4), 477-495.

Berke, P.R. and Conroy, M.M. 2010. Are we planning for sustainable development? An evaluation of 30 comprehensive plans. *Journal of the American Planning Association*. 66(1): 21-33.

Bruegman. B. 2005. *Sprawl, a Compact History*. University of Chicago Press. Chicago.

Cruce, T.L. 2009. *Adaptation planning: What U.S. states and localities are doing*. Arlington, VA: Pew Center on Global Climate Change.

Dierwechter, Y. 2010. Metropolitan Geographies of US Climate Action: Cities, Suburbs, and the Local Divide in Global Responsibilities. *Journal of Environmental Policy and Planning.* 12(59):79.

Ewing, R., Rendall, R. and Chen, D. 2002. *Measuring Sprawl and its Impact*. Smart Growth America.

Grant, J.L. 2009. Theory and practice in planning the suburbs: Challenges to implementing New Urbanism, Smart Growth, and sustainability principles. *Planning Theory and Practice*. 10(1): 11-33.

Hanlon, B., Short, J.R., and Vicino, T.J. 2010. *Cities and Suburbs: New Metropolitan Realities in the US*. New York; Routledge.

Hanlon, B., Vicino, T.J, and Short , J.R. 2006. The new metropolitan reality in the US: Rethinking the traditional model. *Urban Studies.* 43(12): 2129-2143.

Hasse, J.E. and Lathrop, R.G. 2003. Land resource impact indicators of urban sprawl. *Applied Geography.* 23: 159-175.

Hayden, D. 2004. *A Field Guide to Sprawl*. W.W. Norton & Co. New York.

Intergovernmental Panel on Climate Change. 2014. Fifth Assessment Report: Climate Change 2014. *Synthesis Report, Statement for Policymakers*.

Intergovernmental Panel on Climate Change. 2007. Fourth Assessment Report, Climate Change. *Synthesis Report, Summary for Policymakers.*

Kotkin, J. 2010. *The Next Hundred Million: America in 2015*

Leichenko, R.M. and Solecki, W.D. 2013. Climate change in suburbs: An exploration of key impacts and vulnerabilities. *Urban Climate.* 6:82-97.

Mather, M., Pollard, K., Jacobsen, L. 2011. *Reports on America: First Results from the 2010 U.S. Census*. Washington, D.C.: Population Reference Bureau.

Measham, T., et.al. 2011. Adapting to climate change through local municipal planning: Barriers and challenges. *Mitigation and Adaptation Strategies for Global Change*. 16(8): 889-909.

Mickelbank, B.A. 2004. A typology of U.S. suburban places. *Housing Policy Debate*. 15(4): 935-964.

Orfield, M. 2002. *American Metropolitics: The New Suburban Reality.* Washington, DC: Brookings Institution Press.

Orfield, M. and Luce, T. Jr. 2010. *Region: Planning the Future of the Twin Cities*. Minneapolis: University of Minnesota Press.

Osofsky, H.M. 2012. Suburban climate change efforts: Possibilities for small and nimble cities participating in state, regional, national, and international networks. *Cornell Journal of Law and Public Policy.* 22:395.

Williamson, J. 2013. *Designing Suburban Futures: New Models from Build a Better Burb*. Island Press. Washington, D.C.

---

[1] ICLEI is the International Council for Local Environmental Initiatives is an international organization with more than 1,000 members in 80 countries. ICLEI members were found to have a substantially higher adoption rating for sustainability related actions

[2] Transfer of development rights (TDR) is a zoning technique to protect undeveloped land by redirecting development that could otherwise occur in areas desired for protection (sending areas) to areas better suited to accommodating development (receiving areas).

[3] The LEED for Neighborhood Design Rating System (LEED-ND), a collaboration among the US Green Building Council, the Congress for New Urbanism, and the National Resources Defense Council. integrates principles of smart growth, new urbanism, and green building into a national system for neighborhood design.

[4] Stormwater management is regulated through permits that have to be obtained from the Pennsylvania Department of Environmental Protection (PADEP) through the National Pollution and Discharge Elimination System Phase II (NPDES). To qualify for the Federal Emergency Management Administration (FEMA) National Flood Insurance Program, communities must enact ordinances that regulate construction and certain human activities in floodplains to prevent loss of life and property due to flooding.