INFINITE

SUBURBIA
4.6 GREENING SPRAWL
LAWN CULTURE AND CARBON STORAGE IN THE SUBURBAN LANDSCAPE

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Suburban residential landscapes are popularly understood to be socially and environmentally homogeneous places where expanses of mown lawn appear in an alternating rhythm of driveways and predictably similar houses. Much has been made of suburban social pressures for conformity, epitomized by the pressure to have a perfect lawn: even, green, and weed-free. More recently, the environmentally detrimental effects of lawn irrigation, pesticides, fertilizers, leaf blowing, and mowing have been widely discussed. Beyond these immediate environmental impacts of lawn culture, the more insidious societal costs associated with car-dependent suburban transportation systems are of growing concern. Social and health effects of sedentary lifestyles and long commuting times, social equity effects of jobs beyond the reach of public transportation, as well as climate effects of greenhouse gases emitted by cars—all contribute to arguments for adopting more dense urban settlement patterns as alternatives to suburbia.

Yet suburban development is massive and growing. In the United States, large-lot residential development covered a total area fifteen times larger than did dense urban settlement in 2000, and suburbs have continued to grow more quickly than cities. The market for suburban residential development remains a vital driver of metropolitan landscape patterns. Even if market demand for new suburban development were to disappear today, the legacy effects of the more than 5 percent of the US land area in suburban development would remain. This reality suggests that, rather than only critiquing suburbia, we should consider how low-density suburban development patterns can provide broader societal benefits.

Viewed through another lens, the lawn culture landscape of suburban "sprawl" looks like "greening." In city neighborhoods, greening means bringing maintained turf, trees, and gardens back into a largely paved landscape. In contrast, suburban neighborhoods, typified by expansive lawns, canopy trees, and flowers and shrubs, are green. But suburban green landscapes could provide far more substantial ecosystem services related to human health, biodiversity, stormwater management, and carbon storage to contribute to climate change mitigation. How do we "green" sprawl to deliver these societal benefits? Could design and planning guide the resources expended on keeping suburbia green differently—to achieve a stronger balance in favor of ecosystem services compared with environmental costs?

Understanding the vernacular aesthetics of suburban landscapes as part of the land development process can suggest some answers. Respecting what residents want their landscapes to look like could help planners and designers devise development patterns that nudge suburban residents and developers to want landscapes that provide greater ecosystem services. To make suburban sprawl a deeper shade of green, designers can use the nudge concept that has become familiar in the fields of psychology and behavioral economics: giving people what they want in a landscape pattern that also embodies what society needs.

This essay examines how suburban residential landscape patterns could be designed to give developers and residents what they want and also mitigate climate change by storing more carbon. It synthesizes findings from several of our past studies in metropolitan southeastern Michigan, in the United States, to identify social drivers of sprawl and suburban lawn culture that suggest clues about how and where carbon can be stored in suburban residential landscapes. Ecosystems store carbon in soil and vegetation including wood, litter, foliage,
or roots. Importantly, landscape management also critically affects how much carbon is stored and for how long. Because the wood of trees lasts many years—sometimes centuries—it is particularly helpful in storing carbon to mitigate climate change. Mature trees that were in place before development, retained during land development, and maintained by homeowners, for example, store much more carbon than more recently planted trees. Similarly, relatively undisturbed soils have proportionately larger carbon stores than more recently cultivated or graded soils. In temperate forest biomes that were formerly used for agriculture, as in much of southeastern Michigan, if trees volunteer as early successional vegetation or are planted as part of the development process, carbon storage increases in vegetation as well as in associated soil, and in litter such as leaves or needles mulched in place.  

Suburban landscapes that have all these characteristics—more mature trees, more area in dense trees with shrubs, more area of undisturbed soil, more area with litter left in place—are likely to store more carbon. The higher the proportion of the suburban landscape that has trees, especially mature trees or dense trees, the more carbon will be stored.  

Our past studies in southeastern Michigan have shown us that we can learn about ecosystem services in suburban landscapes by examining exurbia, a particularly extensive type of suburbia where lots are larger in order to accommodate private wells and septic systems. It may be surprising to consider exurbia, the most sprawling type of suburbia, as having great potential to mitigate climate change by storing carbon. However, exurbia by its very nature has more extensive areas of unused landscape. Our studies have found that, in the temperate forest biome that characterizes Michigan, larger lots have more trees and a disproportionately larger area in dense trees and shrubs that store carbon at a level approaching that of trees in mature northern hardwood forests.  

By giving exurban homeowners larger lots, designers and planners may be able to nudge the suburban development process to store more carbon in the landscape. Are larger lots what homeowners want?

**Homeowner Preferences**

Describing homeownership—an overarching cultural reality of the suburban development process—the geographer Richard Walker says that the planning of suburbia must aim “to reconcile private property as a commodity circulating in a full-blown land market (bent on realizing rents and investors’ profits), and private property as personal possession (for the enjoyment of one’s riches) .” Developers largely determine what property characteristics are available to homebuyers in the suburban residential land market. Designing suburban landscapes to increase carbon storage would require understanding differences among various developers’ and homeowners’ perceptions of market values and homeowners’ preferences for enjoying their own property. Homeowners’ own aesthetic preferences (what they would personally enjoy) may be different from what they believe to be reflected in the value of their home as a commodity (what they believe future buyers for their home would prefer). In addition, developers may believe that buyers will not be willing to pay for certain landscape characteristics regardless of their preferences.

To find enduring suburban landscape patterns that will foster more trees, tactics must be found to reconcile these sometimes-contradictory perspectives. The suburban home landscape that developers offer must be a landscape that will have enough buyers. The landscape that homeowners enjoy must also be a landscape that they are sufficiently confident...
they can sell. Preserving, planting, and maintaining trees over time may not motivate the commodity calculus of either the homeowner or the developer, so designers and planners must find tactics that complement the calculus.

What have my collaborators and I learned about the cultural realities that can contribute to finding design tactics to store more carbon in suburban landscapes? First, everyday landscape aesthetics powerfully affect suburban landscape patterns and management. Furthermore, the design and management of a homeowner's yard may be affected more by the appearance of neighbors' yards than by broader cultural norms for lawn culture. Where neighbors have many trees, individual homeowners may be more likely to have many trees. This tendency to mimic aesthetic characteristics of neighbors' yards in one's own yard may reflect the overriding power of the conception of the suburban home as commodity. Designing and managing the yard for personal enjoyment is typically subordinate to ensuring its acceptability to neighbors, whose apparent landscape preferences may be interpreted as representing broader market preferences. Second, developers recognize the value that homeowners place on trees in their neighborhood, but they believe that the cost of protecting or planting trees often is greater than what homebuyers are willing to pay. Last, both developers and homeowners recognize the value of and market demand for the larger lots that typify exurbia. Importantly, in the forest biome of southeastern Michigan, these larger lots nudge developers and homeowners to retain more trees, homeowners to plant more trees, and, compared with smaller lots, result in a disproportionately larger area of dense trees. Very large lots, greater than one acre, have the largest proportionate area in dense trees and have more trees. Consequently, they store the largest amount of carbon to mitigate climate change.

Homesteads' Cultural Aesthetic of Care and Neighborhood Norms

Homeowners want their home landscapes and their neighbors' home landscapes to look well cared for. The appearance of care is both an aesthetic preference (a pleasurable response to the appearance of the landscape) and a cultural norm (an understanding that the character of the homeowner can or will be judged by the care that is apparent in the landscape). Neatness is an essential aspect of the cultural aesthetic of care because it conveys an immediately recognizable sense of order and because it displays regular human presence and the intention to invest time or other resources in a place. In suburban landscapes, care is conveyed by elements that I have described as "cues to care," for example, mown turf, trimmed trees, hedges in rows, and colorful flowers. These cues connote marketability or productivity, civility or neighborliness, and safety. Suburbia epitomizes the aesthetic of care as displayed by neatness.

To some suburban homeowners, trees and woodlands do not look sufficiently neat, at least not on their own property. Trees growing on a mown lawn may be beautiful, but the seeds, fruits, leaves, and branches that fall look messy and require maintenance. Dense trees and shrubs lacking a mown understory, particularly with the weedy appearance and uneven growth habits of early successional vegetation, can dramatically violate norms for neatness. While many studies have found that canopy trees contribute to the aesthetic value of a neighborhood, homeowners may prefer to see trees beyond their own property—as borrowed scenery or a "natural area" that does not require their own care. Such a preference suggests that planning for trees and woodlands to predominate in the public

and quasi-public open spaces of suburbia should be a core tactic for enhancing carbon storage in suburban landscapes.

Our studies suggest that another tactic is to plan for trees at the scale of neighborhoods rather than individual properties. In their own yards, homeowners’ preferences may be more influenced by what they see in their neighbors’ yards than by broader cultural norms of lawn culture. They may be more likely to prefer trees for their own properties in neighborhoods where neighbors have trees or are planting trees. In an experiment with nearly five hundred southeastern Michigan exurban homeowners, we found that they adjusted their choice of an “ideal” home landscape to match images of hypothetical neighbors’ yards. When they saw images of neighbors’ yards that exemplified lawn culture, they chose a turf-dominated yard as their own ideal. When they saw images of neighbors’ yards that had less turf, they chose a yard with less turf as their own ideal. In subsequent in-depth interviews and surveys of exurban homeowners, we found that their own yard styles actually tended to match those of nearby neighbors. Possibly, suburban homeowners see their neighbors’ landscapes as market signals, suggesting the preferences of future buyers for their homes. Perhaps they are matching neighbors’ behavior or preferences for other more immediately social reasons, a tendency that has been examined in the fields of behavioral economics and psychology.
### Design Alternatives

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4.6.2 Lower-priced homes (<$450,000) in conventional subdivision designs compared with alternative designs that would store more carbon.

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### Developers' Perceptions of the Market for Suburban Homes

Providing ecosystem services is not yet a leading aim of residential developers in suburban America. Developers and their financial backers may see market demand, local regulations, zoning ordinances, and financial risks as limiting their capacity to provide ecosystem services. However, several studies have concluded that suburban and exurban residential developers underestimate homebuyers' interest and willingness to pay for ecological design features.  

We investigated developers' perceptions of homebuyers' market preferences in one-on-one in-depth interviews with representatives from twenty development firms in southeastern Michigan. Each firm had constructed more than two subdivisions per year between 2000 and 2002 for a range of homebuyer market segments in both suburban and exurban settings. During the interviews, the developers described how they thought homebuyers would perceive four different subdivision design alternatives, depicted in visualizations. Then, we compared developers' responses with the actual perceptions of southeastern Michigan homeowners in their market segment, in which we defined homes priced over $400,000 in 2002 as higher priced.

The four subdivision design alternatives could be described as conventional, ecological open space (emphasizing increased public or quasi-public open space), ecological private yards...
4.6.3 Higher-priced homes (> $450,000) sited to retain remnant areas of dense trees that store more carbon than turf or agricultural land uses

(emphasizing less turf) or ecological remnants (emphasizing protection of existing trees and woodlands). (figs. 4.6.1–3)

Compared with conventional designs, ecological open space designs reduced lot size and/or the number of lots in order to increase the amount of shared open space. Ecological private yard designs did not vary in lot size or the number of lots but changed the landscape pattern and composition within each private lot to increase the number of trees or area in prairie gardens. Ecological remnant designs avoided removing woodlands, streams, or wetlands, and consequently had road and lot configurations different from the other alternatives.

We found that developers’ perceptions of homebuyers’ preferences generally matched homebuyers’ actual preferences. They ranked all of the “ecological” designs higher than they ranked conventional alternatives. The developers believed these subdivision characteristics were desired by homebuyers: larger lots, lower density, nearby woodlands or wooded lots, and homes that back up to open space.

Concerning trees, one developer noted about the ecological design alternatives for subdivision 6, “Trees definitely improve the value of the neighborhood.” Developers for the higher-priced market noted that subdivision 3 where remnant woodlands were retained “is more desirable because of vegetation...[it] gets a premium for trees.” Of subdivision 2, one developer said, “[Homebuyers] like trees, and trees bring in some extra money.” However, another developer described “a trade-off between vegetation and density.”

Although homeowners ranked some ecological private yard designs higher than ecological open space alternatives, many developers not in the higher-priced market discussed potential problems with the trees and prairie gardens in private yards: One said that it “would be too expensive to do all the plantings.” Another said, “The [homebuyer] prefers the vegetation, but I don’t want to deal with the landscape requirement.” Developers who built higher-priced subdivisions stated: “Natural buffers [like those shown in private yards] are preferred...but not appropriate for a traditional buyer [meaning those who are not in a higher-priced market].”

In our study, developers who did not build for the higher-priced market recognized homebuyers’ preference for ecological designs, but they did not perceive these alternatives as profitable in their markets. One explained, “More profit [comes with] with more density,” and another said, “The one with the most number of units will have the most profits.” Developers for higher-priced markets, however, believed that remnant woodlands, wooded open spaces, or more trees
on private lots throughout the neighborhood would be profitable in their markets.

Our study suggests that developers do know that many homebuyers prefer more trees in their neighborhoods. However, the developers we interviewed tended to believe that subdivisions that were designed to retain areas of dense trees or to consistently incorporate more trees on private lots throughout the neighborhood were suitable only for the higher-priced market. This may be partly a failure of imagination, as well as a lack of sufficient precedents for affordable wooded residential developments. It raises the question: how can the very large lots where more expensive homes are located deliver more carbon storage as a broad societal benefit?

Lot Size: Nudging Suburban Landscapes toward More Trees

Larger lot sizes may include a proportionately larger treed area because, as the geographer Derek Robinson has suggested, there are “limits to anthropogenic management of land within parcels with increasing size.” Examining land cover in three southeastern Michigan townships, he found that the proportion of the lot in turf or impervious surfaces decreased with increased lot size. He also observed that large lots with large proportions of forest were likely to be adjacent to similar lots, and as lot size increased, connected habitat patch size increased. Looking at large lots from the perspective of property owners’ attitudes and behavior, another study found that Vermont exurban homeowners with

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4.6 The zone of care is very small in the backyard of this large lot (> 1 acre), and there are more trees beyond the zone of care.

larger properties were more willing to have forests than were those with smaller properties. What social drivers might help to explain the effect of lot size on the area in trees?

Our studies suggest that larger lots have proportionately more trees partly because social norms for visible care to residential landscapes are limited to an area of approximately 1 acre including the house, which we described as the “zone of care.” (fig. 4.6.4) Beyond that threshold, homeowners are unlikely to regularly mow or prune. Dense trees and shrubs, dead wood, and leaves characterize the area beyond the zone of care in southeastern Michigan, and this type of land cover tended to be similar throughout neighborhoods of large lots. Since most exurban lots are larger than 1 acre and have an area beyond the zone of care, they inherently store proportionately more carbon per area.

Large lots may have an area beyond the zone of care because the lot size exceeds homeowners' management capacities, but large lots also may relieve social pressures of neighborhood norms. The size of the zone of care varies little on smaller lots, where the entire lot is visibly maintained, but varies dramatically on lots larger than one acre, where the zone of care sometimes is smaller than on small lots (fig. 4.6.5). Since much of a large property may not be visible to neighbors and the public passing by, homeowners may feel relieved of social norms for neatness. Supporting this interpretation, our studies and many others suggest that social norms allow the backyard, which often is not visible to passersby, to be maintained more casually than the front yard—even on small properties. In addition, social pressure to visibly maintain a large area may be relaxed because of apparent neighborhood norms for the landscape aesthetics of care. Owners of large lots tend to live in neighborhoods of other large lots that have an area beyond the zone of care where dense trees and shrubs can grow.

Placing trees also contributes to carbon storage, and we found that more trees were planted on large lots. In our studies, owners of lots even as small as 0.5 acre planted more trees than owners of smaller lots. (figs. 4.6.6-7) Lots 0.5–1.0 acre typically were in neighborhoods with very neat landscape styles and little or no area beyond the zone of care. On lots of this size, trees were planted to exhibit norms for neatness, in canopied lawns and border plantings.

Our studies suggest that lot sizes larger than the zone of care (1 acre in southeastern Michigan) may effectively nudge developers and homeowners to behaviors that result in more trees. The larger the lot, the larger the area beyond the zone of care, and the more carbon stored in densely wooded areas in suburban landscapes of forest biomes. Our studies also indicate carbon storage benefits of lots as small as 0.5 acre, where homeowners plant more trees than in smaller lots. Social mechanisms may drive behaviors that result in more trees on large lots, where social pressure for neatness may be relieved by visual privacy and neighborhood yard care norms that incorporate an area beyond the zone of care.

Tactics for Greening Sprawl by Storing Carbon in the Suburban Landscape
The sprawling suburban development that continues to expand across America can be more truly “green” by storing more carbon in trees. While mown lawns dominate much of suburbia, larger areas of tree cover, especially mature trees and dense trees with shrubs, would provide the essential ecosystem service of climate change mitigation. Our studies suggest the following tactics for increasing tree cover in suburban residential landscapes.

*Make lot size larger than the zone of care.* Especially in exurban areas, where local governments commonly require large minimum lot sizes to protect potable water supplies from septic system pollution, protect agricultural land uses, or protect “rural character,” minimum lot
Harnessing Ecological Potential

sizes larger than the zone of care (about 1 acre in southeastern Michigan) would nudge homeowners to store more carbon in trees. The size of the zone of care may vary with regions and cultures, but the concept of a zone of care surrounding the dwelling may be generally useful wherever residential landscapes can provide more ecosystem services beyond the zone of care. On very large lots, relief from social norms for visible maintenance may nudge carbon storage by leading developers to clear smaller areas of trees and undergrowth and by leading homeowners to retain trees and allow dense trees and shrubs to grow beyond the zone of care.

Deeper understanding of the physical characteristics of the zone of care and social motivations for homeowners to maintain it may help to shrink it by design. Shrinking only the zone of care in low-density development would allow for a larger area in dense trees and shrubs. Shrinking both the zone of care and lot size to achieve higher-density development could reduce other inevitable societal costs of suburban sprawl as well.

What might nudge developers and homeowners to incorporate more trees on private lots of different sizes? Plans for higher density neighborhoods could replicate “nudge” characteristics of more treed large lots: visual screening to promote a smaller zone of care and neighborhood yard care norms that include areas beyond a zone of care. This can happen in subdivision designs that shrink the front yard, allowing for a much smaller requisite zone of care in the front and more private backyards, designed to have a small zone of care within an armature of dense trees and shrubs that connect lots throughout the block.

Change neighborhoods, not individual lots. In the suburban landscape, a more wooded landscape will be more acceptable to homeowners if it is introduced at the scale of neighborhoods, where landscapes with more trees and dense woodlands can be the norm for the neighborhood. The implications for design and planning are clear: make wooded areas predominate in suburban open space systems and bring trees into yards and streetscapes at the scale of neighborhoods. While developers may be more inclined to include wooded open spaces rather than wooded yards in new subdivisions (and some homeowners are, in fact, reluctant to maintain trees in their own yards), consistency across a neighborhood is likely to make trees on private lots desirable to more homeowners. Governance (e.g., local government requirements, homeowners’ association rules), subdivision design, or a particular landscape ethos within the neighborhood could tip the balance to nudge homeowners to have more trees because they are surrounded by neighbors who have more trees.

Promote innovation by residential developers. From the standpoint of developers, suburban landscapes are a product that they manufacture for sale at the right price. From the standpoint of homeowners, a suburban landscape is a commodity to occupy as they anticipate its sale as well as a home to enjoy. These commodity values of suburban residential landscapes may appear to create little incentive for developers to provide ecosystem services like carbon storage in trees. Climate change mitigation has rarely been incorporated in land-use law in the United States so far. However, government
regulations by a few states and local governments as well as more informal incentives like certification programs can and do affect whether developers innovate to produce larger societal benefits. Developers, who understand smaller lots as suitable for less expensive homes, may be nudged to innovate further by new design conceptions of suburban residential development featuring smaller lots in a predominantly wooded landscape. While the developers we interviewed thought that homebuyers desired nearby woodlands or wooded lots and homes that back up to open space, they thought that most homebuyers could not afford these characteristics. There is a need for sufficient, replicable precedents to demonstrate that wooded residential developments can be affordable.

Expect societal benefits from large suburban lots. In our studies we examined sprawl from the perspective of those who live in exurban homes and those who develop exurban subdivisions. From that perspective, the most immediate way to “green” sprawl is to fully use the legacy pattern of large exurban lots to accommodate more ecosystem services, including more trees to store carbon. Even if, going forward, new suburban development reformed to consist solely of affordable homes on smaller lots in thickly wooded neighborhoods, the legacy of very large lots would remain significant for carbon storage in biomes like southeastern Michigan, where untended areas become successional woodlands and most development occurs on former agricultural land. It may seem counterintuitive to recognize that large lots—the larger the better—do provide a societal benefit by storing carbon in trees. But where very large lots characterize a landscape, the societal benefit of carbon storage should be recognized and expected. More could be done on large lots. The way in which homeowners manage their forests could be more fully explored for all their potential ecosystem services: for example, reducing fire risks, managing hydrologic systems, absorbing airborne pollutants, and building biodiversity. Governance incentives and certification programs may be helpful.

What we learned suggests how suburban development patterns could be changed and adapted to store more carbon in trees and contribute to mitigating climate change. Exurban residential landscapes may be the epitome of sprawl, but they are also the realization of certain societal desires and values, and they may be a buffer against some environmental risks. If design and planning can use those desires and values to nudge suburbia to store more carbon in trees, society benefits.

In this essay, I draw on my colleagues’ work in our collaborative project, Spatial Land Use Change and Ecological Effects, from the National Science Foundation’s (NSF) program on the Dynamics of Coupled Natural and Human Systems (grants #GEO-0813799 and #GEO-0814542). I have been very fortunate to learn from them over the past decade of our work together, and we all benefited from the outstanding leadership of Dan Brown. In addition, Rachel Visscher’s Environmental Protection Agency Science To Achieve Results (EPA STAR) STAR Fellowship (Assistance Agreement FP91750901-1) supported her work. I am grateful for the support of the NSF and EPA. In addition to my coauthors whose work I cite here, I thank Cristy Watkins, whose work in my lab advanced our understanding of the superb developer interview data gathered by Liz Westbrook.