

**Care of residential landscapes:
Cadastral measures of proximity effects in Detroit, MI, USA**

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Abstract

While many studies have investigated proximity effects of greening, we know of no previous study that has employed a cadastral measure to examine proximity effects for urban residential landscapes. Cadastral refers to property boundaries, which is a different way to measure proximity compared with Euclidean measures, which are typically used. We assumed that each residential property would be managed homogeneously for cues to care (Nassauer, 2011) in visible front and side yards, and that consequently, measurement units delineated by residential properties boundaries would be more valid than units defined by Euclidean distance for measuring heterogeneity in landscape care.

We investigated whether cadastral locations for surrounding residential properties significantly affect care for occupied residential parcels in two neighborhoods of Detroit, MI, USA, that are characterized by high levels of vacancy and abandonment of residential property. We used data describing cues to care for 8967 residential parcels information in the Brightmoor and Eastside neighborhoods. These data were collected by inspection of Google Street images checked by field inspection in summer 2011. We tested the relationship between each occupied parcel's front yard cues to care and its surrounding parcels' occupancy and care characteristics at eight cadastral locations. We describe these cadastral locations in Fig. 1.

We hypothesized that for all surrounding parcels' characteristics, cadastral locations that were adjacent, face-face and rook-face locations relative to the case parcels would influence the care of case parcels, and that adjacent parcels would have the greatest influence on care of case parcels. We hypothesized that back-back parcels and rook-back parcels, in contrast, would have no significant relationship with care of the case parcels, despite having similar Euclidean distances from the case parcels. Considering different care characteristics of surrounding parcels, we hypothesized that positive care of surrounding parcels would more powerfully affect cues to care of case parcels than would abandoned houses or vacant land on surrounding parcels (Table 2). We further hypothesized that, compared with vacant land, abandoned houses on surrounding parcels would have a stronger negative effect on care of case parcels.

Results show that cadastral measures are an important way to analyze and interpret the influence of people's behavior to cities' appearance, and the results may guide city planners and policy makers to find a more effective way to revitalize high-vacancy city areas.

Key words

Vacancy, greening, urban ecology, aesthetics, socio environmental, GIS

1. Introduction

In American legacy cities characterized by high property abandonment and land vacancy (Brachman, L., Mallach, A., 2013), living in a block with positive physical cues such as good housing condition, presence of property care, and low frequency of abandoned buildings may be associated with higher levels of perceived safety, less fear of crime, and greater neighborhood satisfaction (Basolo, V., & Strong, D., 2002). These feelings may counteract residents' propensity to move away from neighborhoods with property abandonment and support growth of neighborhood social capital, helping to stabilize neighborhoods and maintain property values (Brown, B., Perkins, D. D., & Brown, G., 2003) (Nassauer, J. I., & Raskin, J., 2014). On the other hand, lack of positive physical evidence cues may increase residents' propensity to move, resulting in a vicious cycle of abandonment and vacancy. (Wood, L., & Giles-Corti, B., 2008) This study investigates how physical cues of neighboring residential properties might be related to care of occupied properties in two highly vacant neighborhoods of Detroit, MI, USA.

Residential landscapes are privately owned and managed urban green spaces that are seen by the public but directly used only by their residents. In the US, front yards of residential landscapes are designed to be seen by the public (Visscher, Nassauer, & Marshall, 2016) and more than any other part of the yard, they are understood to reflect social characteristics of their residents (Nassauer 1998, 2011; Clayton, 2007; Larson, Casagrande, Harlan and Yabiku, 2009; Larson et al 2016). For example, residents of a home with a front yard that does not look neat may be understood to have little concern for the well-being of their neighbors or to lack the capacity to care for their property (Nassauer, 2011).

Why cadastral measures

While many studies have investigated proximity effects of greening, none has employed a "cadastral" measure to examine proximity effects for urban residential landscapes. "Cadastral" is derived from the word, cadaster, which defines the dimension, location and ownership of land parcels (US Bureau of Land Management). It is a different proximity measure compared with Euclidean distance, which measures distance between a pair of points at two-dimension plane. We hypothesize that residents' behavior to care for their own front yards may be influenced by the appearance of front yards of neighbors across the street or adjacent to them, more than the appearance of neighbors' yards that are behind their own. These backyard neighbors are similarly distant from them but are linked by backyards rather than front yards, with different social implications for apparent care.

Some of previous studies measured the proximity effect to nearest green space by using Euclidean distance (Melichar & Kaprová, 2013) (Krekel, Kolbe, & Wüstemann, 2016). Kondo's paper compared the health and safety effects within multiple geographic extents surrounding urban green stormwater infrastructure sites by using multiples of average width of parcel in Philadelphia (Kondo, Hohl, Han, & Branas, 2016). Other papers compared Euclidean distance with other linear distance measures. Two papers compared network distance, which is the shortest route along street between two locations, with Euclidean distance to look for more accurate analysis. (Koohsari, Kaczynski, Giles-Corti, & Karakiewicz, 2013) (Netusil, Levin, Shandas, & Hart, 2014). Wang's paper compared perceived travel distance to parks with Euclidean distance to see which is the more important factor for perceived park accessibility (Wang, Gregory, & Liu, 2015).

Some studies defined density variables based on the occurrence of cases within different Euclidean distances (van den Berg et al, 2010; Hunter & Brown, 2012; Netusil et al, 2014). One paper created a heterogeneity index according to the means of Bray–Curtis distance values to express degree of dissimilarity of front garden type within a suburb (Kirkpatrick, Daniels, & Davison, 2009).

Three papers found a radius threshold for local neighborhood level characteristics (Krusky, Heinze, & Reischl, 2015; Hunter & Brown, 2012; Kruger, 2008). Hunter's paper found similarities between yards within 100 meters.

Some previous studies also looked at green spaces' effect at the zip code level, census tract level and block, which were larger units than parcel level. Both of Krusky's paper and Kruger's paper thought census tract was too large to find neighborhood level characteristics. Hippi's paper found that local micro-neighborhood: a single double-sided street block with more than 5 households, appeared to more strongly affect neighborhood satisfaction important than those of the broader neighborhood of census tract (Hipp, 2010). Only one paper visually judged adjacent parcels according to Cadastral location to test the contagion effect in front yard easement gardening styles among adjacent neighbors (Hunter & Brown, 2012). They reported greatest clustering in terms of esthetic quality occurred between pairs of adjacent easement gardens.

Study areas

Detroit, MI, population declined from over 1.86 million in 1950 to under 0.67 million in 2015. Its occupancy decreased from 87.7% in 1950 to 40.3% in 2015. Currently Detroit also has a concentration of poverty. It's city-wide Median Household Income (MHI) in 2015 is 25980, only about 45.9% of US wide MHI. (US Census Bureau, 1950, 2015)

We investigated study areas in two neighborhoods in Detroit: Brightmoor and Eastside (Fig. 1), both of which currently have a dynamic pattern combining occupied properties, abandoned properties, and vacant land that formerly occupied.

The frequency analyses on census data (Fig. 2) show that both Brightmoor and Eastside had lower income and higher vacancy compared to Detroit's other neighborhoods. Their population densities and poverty percent almost consistent with Detroit average, Brightmoor's median household income is only 58.8% of Detroit median and Eastside's MHI is 76.1% of Detroit median. Brightmoor's vacancy is almost same with Detroit, but Eastside's vacancy is 33.3% higher than Detroit average.



Fig. 1. Two study areas: Brightmoor and Eastside neighborhood in Detroit, MI, USA

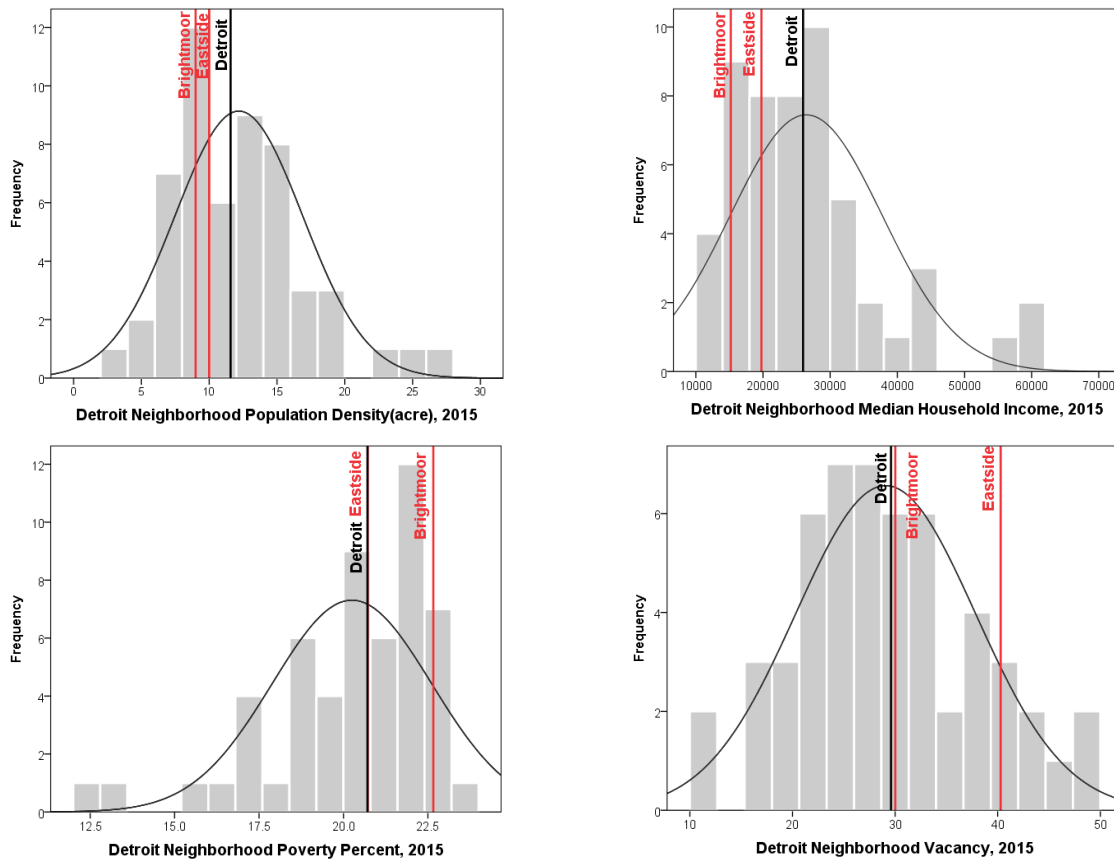


Fig. 2. The frequency Analyses on Detroit Neighborhoods' Census Data showed that Brightmoor and Eastside neighborhoods had similar poverty percent and population density, but lower income and higher vacancy compared to Detroit's other neighborhoods. (Data Source: <https://factfinder.census.gov>)

We chose our dependent variables and independent variables based on literatures reviews regarding residential landscape cues to care, and residential care and occupancy characters.

1.1. Front yard cues to care

Cues to care include mown turf, trimmed trees and hedges, lights, lawn ornaments, colorful flowers and any other landscape characteristics that visibly demonstrate presence of human intention to care for a place. Cues to care imply a broader attention to societal or neighborhood norms (Nassauer, 1995) (Nassauer, 2011). Residents might particularly design or maintain their front yards which are publicly visible and perceivable by others because residents want to show respect for their neighbors and they care about other's perception as well as the value of their property (Clayton, 2007) (Nassauer, 2011) (Blaine, Clayton, Robbins, & Grewal, 2012) (Belaire, Westphal, & Minor, 2016). These norms shape landscaping and management beyond individual lots because residents' actions are affected by the landscapes they see nearby, and this "halo effect" influences visual qualities of the entire neighborhood (Nassauer, Wang, & Dayrell, 2009) (Nassauer, 2011).

1.2. Why mowing is important

Several studies shown that mowing is an essential cue to care. Mowing is distinct from other cues in that it must be done frequently (several times a month in Michigan) to maintain a neat appearance because it does not require particular skill or knowledge of plants or structures. Consequently, it represents a minimum threshold expectation for care. Maintaining neat appearance by mowing turf has consistently preferred and dominant in residential neighborhoods across US cities (Nassauer, 1988) (Nassauer, Wang, & Dayrell, 2009). Especially, low-income homeowners were more likely to prefer mowed lawn for their front yard (Larsen & Harlan, 2006) (Zheng, Zhang, & Chen, 2011). Also, Mown turf is associated with a greater sense of personal safety (Nassauer, 1995) (Jorgensen, Hitchmough, & Calvert, 2002) (Sullivan & Kuo, 2001). Thus in our study we consider mowing separately from other landscape cues to care.

1.3. Well-cared-for properties

Residents' choices about their easement' landscape appearance are strongly influenced to be similar to the choices of their nearby neighbors. (Hunter & Brown, 2012). Studies across the United States and Australia indicate that the appearance of surrounding lots of, particularly front yards, strongly influences residents' landscaping decisions by indicating what types of landscape care are socially acceptable within a neighborhood (Clayton, 2007) (Visscher, Nassauer, & Marshall, 2016) (Yu, Prell, Skaggs, & Hubacek, 2015) (Belaire, Westphal, & Minor, 2016) The evidence of residents' care of their own property could encourage nearby neighbors to care for their properties as well, increasing overall social capital (Nassauer, 2011) (Nassauer, J. I., & Raskin, J., 2014).

1.4. Abandonment

Abandonment has been described as the phenomenon of uninhabited structures (Nassauer and Raskin 2014). People might feel surprise when their neighbors nearby are suddenly gone (Nassauer, J. I., & Raskin, J., 2014). An abandoned structure is subject to quick vandalizing and high risk of fire and crime after its residents abandon it and stop watching and maintenance. People living or walking nearby abandoned structure, especially who are more vulnerable (e.g., the elderly, children, single parents), may have legitimate concerns for their safety (Branas et al., 2011; Galster & Raleigh, 2012). Property abandonment may discourage neighborhood stability. (Nassauer, J. I., & Raskin, J., 2014)

1.5. Vacancy

Further, even when abandoned structures are demolished and properties become vacant, an improvement over abandoned properties, could also deter care for landscapes and undermine social capital (Curley, 2010) (Mair, Kaplan, & Everson-Rose, 2012). Illegal dumping of litter, debris and with unmown grass is common for vacant properties in US (Beauregard, 2009) (Mallach & Brachman, 2013) (Nassauer, J. I., & Raskin, J., 2014). The disorderly appearance of vacant land does not appear to be “watched” and, consequently, might invited crime (Wilson & Kelling, 1982) (Hong & Farley, 2008) (Perkins, Meeks, & Taylor, 1992). It might also burden residents with other stressors including increased feelings of hopelessness, stigmatization, and a sense of isolation, which undermine neighborhood social capital (Curley, 2010) (Mair, Kaplan, & Everson-Rose, 2012).

Krusky’s study selected produce gardens requiring intensive maintenance as greening indicator. While he found that when vacant lots are visibly greened, the residential properties near them exhibited higher levels of maintenance than those located near unmaintained vacant lots in a high-vacancy neighborhood of Flint, Michigan (Krusky, Heinze, & Reischl, 2015). From the stand point of social capital, visible maintenance behaviors may not only discourage dumping, but also build bonding capital by signifying the presence of watchful people who care about their neighborhood and by enhancing perceptions of safety. (Nassauer, J. I., & Raskin, J., 2014)

Based on the database we used, we chose both vacant parcels and poorly-cared-for vacant parcels as independent variables to test the difference on effect of vacant parcels’ maintenance.

Research questions

The aim of this paper is to understand the relationship between each occupied parcel’s front yard cues to care and the occupancy and care characteristics of the parcels surrounding it at cadastral locations. Our research will answer three questions as follow:

- How does the count of each kind of parcel characteristic at all cadastral locations affect care of occupied parcels?
- For each cadastral location, which parcel characteristic could significantly affect care of occupied parcels?
- For each parcel characteristic, which cadastral location could significantly affect care of occupied parcels?

Our research was based on the assumption that each residential property would be managed homogeneously for cues to care (Nassauer, 2011) in visible front and side yards, and that consequently, property boundaries would significantly affect heterogeneity in landscape care.

We hypothesized that for all parcels’ characteristics, cadastral locations that were directly across the street, diagonally across the street or directly adjacent to the case parcels would influence the care of case parcels, and that adjacent parcels would have the greatest influence on care of case parcels. We hypothesized that the parcels with its backyards directly or diagonally facing to case parcels, in contrast, would have no

significant relationship with care of the case parcels, despite having similar Euclidean distances from the case parcels.

Considering different care characteristics of surrounding parcels, we hypothesized that the surrounding parcels with visible care would more powerfully affect mowing as well as other landscape cues to care of case parcels than surrounding abandoned or vacant parcels. We further hypothesized that, compared with vacant parcels, surrounding abandoned parcels would have a stronger negative effect on care of case parcels.

2. Methodology

Data collection

We employed cues to care data from 8967 parcels in two neighborhoods in Detroit, Michigan, USA: Brightmoor and Eastside. These data were developed by assessing images from Google Street view that were dated from August 2009. In August 2011, these assessments were checked by field inspection and then data were updated for parcels with building structures and the adopted vacant parcel associated with them. If the condition of the structure within a parcel had changed, the structure and the property associated with it would be reassessed. Vacant parcels were not updated by field inspection.

This study employs two categorical variables: care level and land use, within the database we used in this paper. The land use types were residential abandoned, residential occupied, residential vacant, and other (non-residential) land uses. The land use types are independent to each other. Each parcel is only assigned with one kind of land use type. Two variables express care level of parcels: well-cared-for, poorly-cared-for. Well-cared-for was defined as occupied parcels with nicely maintained front yards. Poorly-cared-for was defined as disordered vacant parcels. We will articulate detailed definition in “dependent variable” part. We conducted cross tabulation to understand relationships between care level and land use (Table 1).

We found 39 (0.4% of total sample of 8967) abandoned parcels to be wrongly coded as well-cared-for occupied parcels. We removed these parcels from the dataset and conducted our analysis of the remaining 8928 parcels (Table 1). The ‘Other Land Use’ parcels were also removed from those 8928 parcels before the beginning of analysis because we only focused on residential parcels.

Table 1

Cross tabulation to test relationships between two groups of categorical variables within the database: care level and land use. Well-cared-for was inclusive in the land use ‘occupied’. Poorly-cared-for was inclusive in the land use ‘vacant’. Abandoned parcel and other landuse did not have care data. The occupied parcels not well-cared-for and vacant parcels not poorly-cared-for were coded as ‘Not well or poorly cared’. Total parcel number analyzed was 8928.

		Care level			Total
		Well-cared-for	Poorly-cared-for	Not well or poorly cared	
Land use	Occupied	982	-	2236	3218
	Abandoned	-	-	-	393
	Vacant	-	329	4538	4867
	Other Land Use	-	-	-	450
Total		982	329	7167	8928

Independent variables

Our independent variables were four dichotomous variables two care variables including Well-cared-for and Poorly-cared-for, two occupancy variables including Abandoned and Vacant (Table 2). According to the cadastral system in our study areas, we named eight cadastral locations relative to case parcels (Fig. 3). For each parcel in our study areas, we used ArcGIS to identify its surrounding eight cadastral locations' values of these four variables and create thirty-two new variables for each occupied parcel case.

Dependent variables

Two dependent variables described characteristics of each occupied parcel case: mowing within the past month, and other cues to care, operationalized in the following ways:

Mowing within the past month: we measured it as a dichotomous variable: whether one occupied parcel's front yard or easement appeared to have been mown within the past month

Other cues to care: We treated occupied parcels' cues to care (besides mowing) as an ordinal variable and measured it with a four-point scale according to the number of cues to care:

- No visible cues of care besides mowing (1)
- With one kind of cue to care, such as lights, ornaments, or trimmed hedges (2)
- Flowers OR Hedges with Lights and/or Ornaments OR Flowers with Lights and/or Ornaments
- Flowers and Hedges OR Flowers, Hedges, Lights, and/or Ornaments

Sampling





To select case parcels, I used ArcGIS to identify all occupied parcels surrounded by other residential parcels in all eight Cadastral locations (Fig. 4).



Fig. 3 Eight cadastral locations relative to a case: 1) adjacent: two parcels nearby each case at both left and right side; 2) face-face: the parcel with its front yard directly facing across road to each case; 3) rook-face: two parcels with their front yards diagonally facing across the road to each case; 4) back-back: the parcel with its backyard directly facing across alley to each case; 5) rook-back: two parcels with their backyards diagonally facing across alley to each case.

Table 2

The four parcel characteristics in representative photos with the observed characteristics used in data collection.

Photos	Parcel characteristics	Observed characteristics
	<i>Well-cared-for</i>	<p>The occupied parcels' front yards at least with hedges having been maintained within the past year. Other cues to care including:</p> <ul style="list-style-type: none">Flower in pots have been planted or maintained within the most recent growing seasonFlowers beds have apparent intentional careOrnaments: e.g. bird boxes, painted rocks, bird baths, small flags, lawn statues, water fountainsDecorative lighting: landscape lightings, e.g. spot or flood lights, low in-ground fixed lighting, tall fixed lighting in the style of street lights, strung lights, e.g. Christmas lights, path lighting
	<i>Poorly-cared-for</i>	<p>The vacant parcels have one of the follow visible characters:</p> <ul style="list-style-type: none">The presence of garbage dumped. The garbage is defined as all man-made objects or materials that appear to be unused and meant for disposal, e.g. concrete, bags of trash, shopping cartsNo evidence of maintenance or mown within the most recent growing season, such as over grown
	<i>Abandoned</i>	<p>The residential parcels with houses in poor or badly deteriorated conditions such as:</p> <ul style="list-style-type: none">May not be structurally sound, and needs 2 or more major repairsMay have sagging roof, missing windows or 3 doors, deteriorated porch, deteriorated foundation. Should be demolishedBuilding exhibits severe structural damage.
	<i>Vacant</i>	<p>The residential parcels on which the houses have been demolished and has not taken over by other parcels using fences or hedges.</p>

*All photos were taken in Detroit in 2016. Photo credits: Mark Lindquist

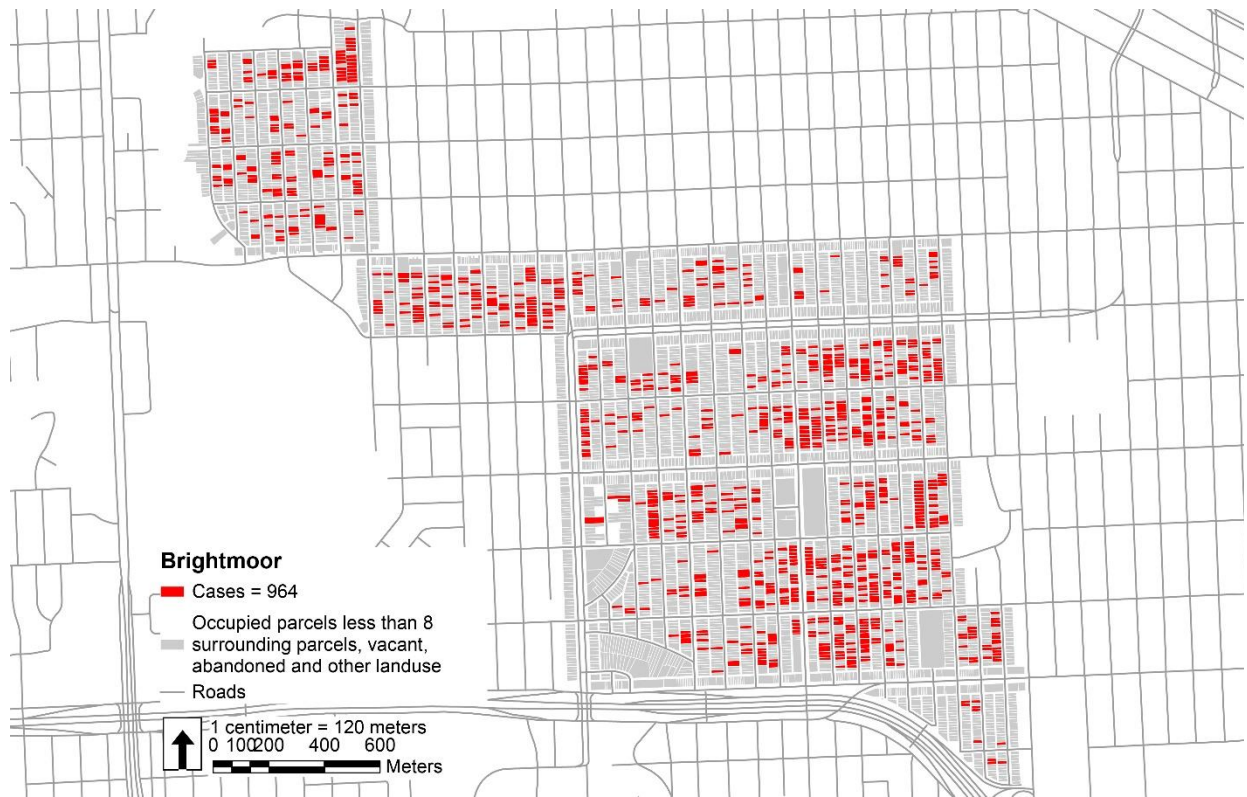


Fig. 4. I selected all occupied parcels surrounded by residential parcels at all eight cadastral locations as cases in our analysis. There are 964 cases in Brightmoor and 587 cases in Eastside, Detroit. Total count is 1551.

Data analysis

For the analyses with the dependent variable ‘Mowing within the past month’, I used binary logistic regression model instead of linear regression because it is a dichotomous variable. My interpretation is based on the value of $\text{Exp}(B)$, the odds ratio which is defined as the ratio of the probability of success and the probability of failure. For the analyses with the ordinal dependent variable ‘Other cues to care’, I used linear regression model. The value of unstandardized coefficient “b” used to assess the influence of independent variable.

3. Result

Our results support our hypothesis about the parcels directly facing across the street (face- face), directly adjacent and diagonally facing to cases parcels (rook-face). Specifically, the adjacent parcels have greater influence on cases than face-face and rook-face locations. Both the parcels with its backyards directly (back-back) or diagonally facing to (rook-face) case parcels have no significant relationship with mowing and other landscape cues to care.

Our results also show that when adjacent to case parcels, well-cared-for occupied parcels have positive influence to both mowing and the increase of cues to care besides mowing. Vacant parcels adjacent to case parcels are related to an increase of cues to care other than mowing. Adjacent well-cared-for parcels have greater positive influence on cues to care than do well-cared for parcels that are face-to-face with case parcels. The abandoned parcels have negative influence to both mowing and other cues to care on case parcels. We did not find that abandoned parcels would have a stronger negative effect on care of case parcels than vacant parcels. Whether vacant parcels are poorly-cared or not do not influence care of case parcels.

3.1. Count of each parcel character

This analysis measured the influence of the count of each independent variable at all eight cadastral locations to front yard cues to care in occupied parcel. The independent variables are the count of surrounding well-cared-for parcels, the count of surrounding vacant parcels, the count of surrounding abandoned parcels and the count of surrounding bad-cared-for parcels. Each independent variable is ranging from 1 to 8.

By analyzing the frequencies of these variables, count of surrounding well-cared-for, vacant and poorly-cared-for parcels are highly skewed (Table 3), which is against linear regression’s hypothesis of normal distribution. Thus, the counts of surrounding well-cared-for parcels from 5 to 8 were aggregated to 5. The counts of surrounding poorly-cared and abandoned parcels from 3 to 8 were aggregated to 3 (Table 4).

Table 3 Statistics of frequency analysis on surrounding parcel counts at eight cadastral locations

		Surrounding Parcel Counts			
		Well-cared-for	Abandoned	Vacant	Poorly-cared-for
N	Valid	1551	1551	1551	1551
	Missing	0	0	0	0
Skewness before recode		.865	1.964	.196	2.993
Std. Error of Skewness		.062	.062	.062	.062
Skewness after recode		.740	1.703	.196	2.449
Std. Error of Skewness		.062	.062	.062	.062

Table 4 Frequency analysis on recoded surrounding parcel counts at eight cadastral locations

Counts	Well-cared-for		Abandoned		Vacant		Poorly-cared-for	
	Frequency	Cum %	Frequency	Cum %	Frequency	Cum %	Frequency	Cum %
0	482	31.1	1078	69.5	97	6.3	1256	81.0
1	396	56.6	313	89.7	150	15.9	195	93.6
2	292	75.4	124	97.7	223	30.3	80	98.7
3	195	88.0	36*	100.0	328	51.5	20*	100.0
4	114	95.4			272	69.0		
5	72**	100.0			197	81.7		
6					151	91.4		
7					87	97.0		
8					46	100.0		
Total	1551	100.0	1551	100.0	1551	100.0	1551	100.0

* The count of cases with 3 and more of this kind of parcel surrounded

** The count of cases with 5 and more of this kind of parcel surrounded

The count of well-cared-for parcels was significantly related to the case's mowing. We found that cases with one additional well-cared-for parcel surrounding are 17.7% more likely to be mowed compared to other cases ($n = 1551$, odds = 1.18, $P < .05$) (Table 5). We did not find a significant relationship between an occupied parcel's front yard mowing and its surrounding vacant, abandoned and poorly-cared-for parcels counts.

I suspected the effect of vacant parcel on cases' cues to care might vary in high vacancy area and low vacancy area, thus I divided the value of vacant parcels counts into two subsets to see if there is a threshold. I found that when counts of vacant parcels ranging from 0 to 3, each additional vacant parcel's effect on other cues to care score is highest ($n = 798$, $b = 0.09$, $P < .05$) compared to other range (Table 6). But well-cared-for parcels still has higher positive effect on cases' cues to care than vacant parcels. For each additional well-cared-for parcel surrounding a case, the case's cues to care score is 0.14 higher on average compared to cases without an additional well-cared-for parcel ($n = 798$, $b = 0.14$, $P < .05$). In contrast, for each additional poorly-cared-for vacant parcel surrounding a case, the case's cues to care score is .097 lower on average compared to cases without an additional poorly-cared-for vacant parcel ($n = 798$, $b = -.097$, $P < .05$). We did not find a significant relationship between an occupied parcel's front yard other cues to care and its surrounding abandoned parcel counts.

The model with independent variable vacant parcel count ranging from 4 to 8 was not significant.

3.2. For the same cadastral location

This analysis measured for each cadastral location, which parcel characteristics would significantly affect care on the occupied parcels.

For the parcel face-face with a case, its well-cared-for character was significantly related to the case's both mowing and increase of other cues to care. If a case faces a well-cared-for parcel, it was 33.3% more likely to be mowed than if it faced a not well-cared-for occupied parcel (e.g. poor-cared-for occupied parcel, vacant or abandoned parcel) ($n = 1551$, odds = 1.33, $P < .05$) (Table 5), its cues to care score was 0.30

higher on average than if it faced a not well-cared-for occupied parcel, such as poor-cared-for occupied parcel, vacant or abandoned parcel ($n = 1551$, $b = 0.30$, $P < .05$) (Table 6). However, we did not find significant relationship between a case's care and its face-face abandoned, vacant, poorly-cared-for vacant parcel.

For the parcels adjacent to a case, both their well-cared-for and vacant character were significantly related to the case's mowing. Cases adjacent to one additional well-care-for parcel are 52.5% more likely to be mowed compared to cases without an additional adjacent well-cared-for parcel. ($n = 1551$, odds = 1.53, $P < .05$) On the contrast, cases adjacent to one additional vacant parcel are 16.1% less likely to be mowed compared to cases without an additional adjacent vacant parcel. ($n = 1551$, odds = 0.84, $P < .05$) (Table 5) We did not find significant relationship between a case's mowing and its adjacent abandoned and poorly-cared-for vacant parcels.

Only adjacent well-cared-for character were significantly related to the increase of other cues to care. For each additional well-cared-for parcel adjacent to the case, the cues to care score is 0.38 higher on average compared to cases without an additional adjacent well-cared-for parcel. ($n = 1551$, $b = 0.38$, $P < .05$) (Table 6) For the parcels adjacent to a case, we did not find significant relationship between their abandoned, vacant, poorly-cared-for vacant characters and their cases' cues to care.

For the parcels rook-facing with a case, their well-cared-for characters were significantly related to both the case's mowing and the increase of other cues to care. Cases rook-facing with one additional well-cared-for parcel are 30.0% times more likely to be mowed compared to cases without a rook-face well-cared-for parcel. ($n = 1551$, odds = 1.30, $P < .05$) (Table 5) For each additional well-cared-for parcel rook-facing with the case, the case's cues to care score is 0.20 higher on average compared to cases without an additional rook-face well-cared-for parcel. ($n = 1551$, $b = 0.20$, $P < .05$).

While there is no significant relationship between a case's mowing and its rook-face abandoned parcels, rook-face abandoned character was significantly related to the decrease of other cues to care. For each additional abandoned parcel rook-facing with the case, the case's cues to care score is 0.16 lower on average compared to cases without an additional rook-face abandoned parcel. ($n = 1551$, $b = -0.16$, $P < .05$) (Table 6) For the parcels rook-facing with a case, we did not find significant relationship between their vacant and poorly-cared-for vacant characteristics and their cases' care.

We did not find a significant association between cases' cues-to-care and their back-back and back-rook parcels' characteristics.

3.3. For the same parcel characteristic

This analysis measured for each parcel characteristic, which cadastral location could significantly affect care on the occupied parcels.

For the well-cared-for characteristics, both adjacent and face-face locations were significantly related to care of cases. If a case is adjacent to a well-cared-for parcel, it is 55.1% more likely to be mowed than if the well-cared-for parcel is at any other location around the case ($n = 1551$, odds = 1.55, $P < .05$). The adjacent well-cared parcel ($n = 1551$, $B = 0.35$, $P < .05$) has a greater positive influence on a case's cues to

care score than when the well-cared-for parcel is facing the case ($n = 1551$, $b = 0.20$, $P < .05$). For well-cared-for character, we did not find significant relationship between a case's care and its rook-face, back-back and rook-back locations.

For vacant character, only adjacent location was significantly related to care of cases. If a case adjacent to one or two vacant parcels, it is 36.1% less likely to be mowed than if the vacant parcels are at any other location around the case. ($n = 1551$, odds = 0.64, $P < .05$) If one or two vacant parcels adjacent to a case, this case's cues to care score would be 0.14 lower on average than if the vacant parcels are at any other location. ($n = 1551$, $b = - 0.14$, $P < .05$) For vacant character, we did not find a significant relationship between a case's care and its face-face, rook-face, back-back and rook-back locations.

For poorly-cared-for and abandoned characteristics, we did not find significant relationship between any cadastral location and care of case parcels.

Table 5 Logistic regression models: with case parcels' mowing as dependent variable

Model	Chi-square	n	Variables in model	Exp(B)	95% C.I. for EXP(B)	
					Lower	Upper
Parcel counts in 8 cadastral locations*	23.774	1551	Count of surrounding well-cared-for parcels	1.177*	1.081	1.282
			Count of surrounding vacant parcels	.980	.921	1.043
			Count of surrounding poorly-cared-for parcels	.937	.782	1.122
			Count of surrounding abandoned parcels	.921	.796	1.067
Face-face*	7.787	1551	Face-face well-cared-for parcel or not	1.333*	1.007	1.765
			Face-face vacant parcel or not	.951	.749	1.208
			Face-face abandoned parcel or not	.825	.523	1.304
			Face-face poorly-cared-for parcel or not	.794	.469	1.342
Back-back	1.212	1551	Back-back well-cared-for parcel or not	1.039	.758	.424
			Back-back vacant parcel or not	1.073	.843	1.367
			Back-back abandoned parcel or not	.874	.566	1.350
			Back-back poorly-cared-for parcel or not	.829	.490	1.404
Adjacent*	32.778	1551	Count of adjacent well-cared-for parcels	1.525*	1.234	1.885
			Count of adjacent abandoned parcels	.841	.570	1.239
			Count of adjacent vacant parcels	.839*	.710	.992
			Count of adjacent poorly-cared-for parcels	.807	.444	1.465
Rook-face*	11.580	1551	Count of rook-face well-cared-for parcels	1.300*	1.079	1.567
			Count of rook-face vacant parcels	.990	.848	1.156
			Count of rook-face poorly-cared-for parcels	.873	.587	1.297
			Count of rook-face abandoned parcels	.863	.635	1.173
Rook-back	1.599	1551	Count of rook-back well-cared-for parcels	1.092	.876	1.361
			Count of rook-back poorly-cared-for parcels	1.032	.720	1.479
			Count of rook-back abandoned parcels	1.004	.727	1.387
			Count of rook-back vacant parcels	.955	.822	1.109
Well-cared-for*	8.087	1551	Adjacent to well-cared-for parcel or not	1.551*	1.212	1.983
			Rook-back well-cared-for parcel or not	1.226	.924	1.626
			Face-face well-cared-for parcel or not	1.196	.884	1.617
			Rook-face well-cared-for parcel or not	1.104	.847	1.439
Vacant*	19.357	1551	Back-back well-cared-for parcel or not	.928	.666	1.293
			Back-back vacant parcel or not	1.155	.894	1.493
			Rook-face vacant parcel or not	1.021	.782	1.331
			Face-face vacant parcel or not	.921	.712	1.192
			Rook-back vacant parcel or not	.864	.651	1.147
Poorly-cared-for	4.490	1551	Adjacent to vacant parcel or not	.639*	.512	.797
			Rook-back poorly-cared for parcel or not	1.033	.676	1.578
			Back-back poorly-cared for parcel or not	.864	.489	1.525
			Rook-face poorly-cared for parcel or not	.840	.518	1.362
			Face-face poorly-cared for parcel or not	.827	.463	1.476
Abandoned	2.790	1551	Adjacent to poorly-cared for parcel or not	.625	.341	1.146
			Rook-back abandoned parcel or not	1.034	.719	1.488
			Face-face abandoned parcel or not	.894	.547	1.461
			Rook-face abandoned parcel or not	.875	.614	1.247
			Back-back abandoned parcel or not	.851	.544	1.333
			Adjacent to abandoned parcel or not	.821	.548	1.232

*Levels of statistical significance are $p < .05$

Table 6 Linear regression models: with case parcels' other cues to care besides mowing as dependent variable

Model	Adjusted R ²	n	Variables in model	B	95% C.I. for B	
					Lower	Upper
Parcel counts in 8 locations*	.034	798	Count of surrounding well-cared-for parcels	.142*	.102	.182
			Count of surrounding poorly-cared-for parcels	-.097*	-.188	-.006
			Count of surrounding abandoned parcels	-.042	-.115	.031
			Count of surrounding vacant parcels (0-3)	.041*	.011	.072
Face-face*	.018	1551	Face-face well-cared-for parcel or not	.295*	.160	.430
			Face-face poorly-cared-for parcel or not	-.263	-.535	.010
			Face-face abandoned parcel or not	-.196	-.429	.037
			Face-face vacant parcel or not	-.025	-.144	.094
Back-back	.002	1551	Back-back poorly-cared-for parcel or not	-.156	-.426	.113
			Back-back vacant parcel or not	.145	.024	.266
			Back-back abandoned parcel or not	.097	-.126	.319
			Back-back well-cared-for parcel or not	-.003	-.161	.154
Adjacent*	.018	1551	Count of adjacent well-cared-for parcels	.375*	.281	.469
			Count of adjacent poorly-cared-for parcels	-.247	-.556	.062
			Count of adjacent abandoned parcels	-.079	-.273	.116
			Count of adjacent vacant parcels	.027	-.056	.111
Rook-face*	.017	1551	Count of rook-face well-cared-for parcels	.201*	.112	.289
			Count of rook-face abandoned parcels	-.157*	-.313	-.001
			Count of rook-face poorly-cared-for parcels	-.143	-.346	.060
			Count of rook-face vacant parcels	.001	-.076	.078
Rook-back	.003	1551	Count of rook-back vacant parcels	.112	.037	.187
			Count of rook-back poorly-cared-for parcels	-.056	-.236	.125
			Count of rook-back abandoned parcels	.051	-.110	.211
			Count of rook-back well-cared-for parcels	.034	-.074	.142
Well-cared-for*	.039	1551	Adjacent to well-cared-for parcels or not	.351*	.236	.467
			Face-face well-cared-for parcel or not	.196*	.053	.340
			Rook-face well-cared-for parcels or not	.097	-.031	.226
			Back-back well-cared-for parcel or not	-.050	-.211	.112
			Rook-back well-cared-for parcels or not	-.005	-.141	.130
Vacant*	.013	1551	Rook-back vacant parcel or not	.181*	.041	.320
			Adjacent to vacant parcel or not	-.136*	-.245	-.026
			Face-face vacant parcel or not	-.083	-.210	.044
			Rook-face vacant parcel or not	-.079	-.209	.052
			Back-back vacant parcel or not	.050	-.078	.177
Poorly-cared-for	.003	1551	Adjacent to poorly-cared-for parcel or not	-.300	-.622	.021
			Face-face poorly-cared-for parcel or not	-.282	-.582	.018
			Back-back poorly-cared-for parcel or not	-.099	-.388	.190
			Rook-face poorly-cared-for parcel or not	-.069	-.317	.180
			Rook-back poorly-cared-for parcel or not	.037	-.175	.249
Abandoned	.002	1551	Adjacent to abandoned parcel or not	-.156	-.365	.053
			Rook-face abandoned parcel or not	-.150	-.331	.031
			Face-face abandoned parcel or not	-.113	-.364	.139
			Back-back abandoned parcel or not	.047	-.182	.276
			Rook-back abandoned parcel or not	.021	-.161	.203

*Levels of statistical significance are $p < .05$

4. Discussion

We found that the overall count of vacant parcels surrounding each occupied case parcel would have more influence to both mowing and cues to care than the specific cadastral location of a vacant parcel. We found that when counts of vacant parcels ranging from 0 to 3, each additional vacant parcel was related to increase of other cues to care. While we did not find significant relation between the ranging of 4 to 8 vacant parcels and cases' other cues to care. This finding might indicate a threshold to define vacant parcels' influence. Among cadastral locations, only adjacent of vacant parcels affected care of occupied case parcels, and that effects were slightly positive. This finding suggests that people living adjacent to a vacant parcel nearby might use certain cues, like hedges and mowing, to mark their territories. At the beginning of the spreading of vacancy, residents might tend to maintain their front yard well to convey that people in the neighborhood do care. When vacancy become more severe, their sense of the efficacy of their own efforts for their own homes may decrease.

Poor care of vacant parcels at each cadastral location did not significantly affect the care of case parcels. However, with each additional poorly-cared-for vacant parcel surrounding, case parcels, case parcels themselves exhibited fewer cues to care compared to other case parcels.

Compared with other parcel characteristics like vacancy or abandonment, well-cared-for occupied parcels face-to-face or diagonally (rook-face) facing across a road or adjacent to case parcels, had the greatest influence on both mowing and other cues to care. Especially, well-cared-for parcels adjacent to cases had a strong positive influence on care of case parcels. Those findings support that people's front yard maintenance behavior might partly depend on the neighbors they could talk to and see, and how their neighbors treat their front yard. People might be more likely to talk with and be influenced by their adjacent neighbors rather than by those who live across a street.

We also found that both the parcels with its backyards directly (back-back) or diagonally facing to (rook-face) case parcels have no significant relationship with care of cases' front yard. This finding supports that people make gardening decision according to the public visible front yards surrounding them, not the private back yards usually enclosed with dense trees or shrubs. People might tend to obey the neighborhood norm with other properties facing with same road as their home.

To look at the difference between mowing and other cues to care, we found that the count of poorly-cared-for vacant parcel and rook-face abandoned parcels had no significant relation with mowing of case parcels, but had a negative influence to other cues to care on case parcels.

5. Conclusion

Results show that cadastral measure is an important way to analyze and interpret the influence of people's behavior to cities' appearance, and the results may guide city planners and policy makers to find a more effective way to revitalize high-vacancy city areas. Below are some possible implications for policy making and urban planning:

- The occupied parcels with 3 or fewer vacant parcel surrounding might be priority for revitalization.
- For occupied parcels with 4 or more vacant parcel surrounding, residents may be more inclined to move.
- Providing support for residents living in high vacancy neighborhood to mow and add more cues to care in their front yard might greatly help with neighborhood revitalization.
- Abandoned and poorly-cared-for properties might let residents feel more unsafe than well-cared-for vacant properties. Demolishing face-face and rook-face abandoned properties to occupied parcels might be prior in demolishing or cleaning plan.
- Because back-back and rook-face parcels' characters have no significant relationship with care of occupied parcels, only one side of block having high-vacancy or high proportion of abandonment might not affect stabilization of this block.

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