EFFECTS OF GREEN STORMWATER INFRASTRUCTURE ON RESIDENTIAL LANDSCAPE CARE AND SOCIAL COHESION IN STRESSED NEIGHBORHOODS

By

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Abstract

Non-uniform abandonment of urban areas results in patchy networks of underused and vacant space that if left unmanaged can contribute to social and environmental problems. When vacant land is repurposed as green stormwater infrastructure (GSI), these formerly problematic spaces are transformed into neighborhood assets. This study establishes links between landscape care and social cohesion through a literature review, and addresses whether installing green stormwater infrastructure (GSI) on vacant land contributes to social cohesion in stressed neighborhoods as evidenced in the spatial distribution of landscape cues to care. In 2015, GSI in the form of four bioretention gardens was installed on vacant lots Detroit's Warrendale neighborhood. To analyze changes in landscape care before and after garden installation, I conducted surveys of parcel care within an 800ft buffer of the bioretention gardens in 2013 and 2017 and used GIS to identify any clusters of care within the buffer areas. I hypothesized a relationship between the installation of well-maintained GSI on vacant lots and increased social cohesion nearby as measured through increased clustering of well cared for parcels on blocks with bioretention gardens.

Results did not support the hypothesis, though patterns of abandonment and the dynamic nature of landscape change in the study area pointed to the presence of multiple forces at play. High and variable rates of abandonment and vacancy may counteract or hide the stabilizing, improving, or maintaining effects, if any, of well-maintained GSI. The data do offer insight into the interaction between GSI and residential landscape care. For many occupied parcels, care improved or was consistent between surveys. Future research may focus on these parcels to discern whether the installation of GSI has had an effect on residents' landscape maintenance behaviors. Clusters of these instances of stability and improvement could be seen as strongholds of care and used as anchors for the spread of positive cues to care via GSI installation at their edges. Parcels that exhibited decreased care between surveys may signal further disinvestment or abandonment in the future.

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1. Introduction

Abandonment of urban areas is occurring in many cities all over the world, and this abandonment is almost never uniform across space. This results in patchy networks of underused and vacant space that if left unmanaged can contribute to social and environmental problems. When vacant land is repurposed as green stormwater infrastructure (GSI) through transdisciplinary and participatory processes that address its multi-layered role in urban socio-ecological systems, these formerly problematic spaces are transformed into neighborhood assets that may halt or slow the destructive process of abandonment (Dunn, 2010; Nassauer and Raskin, 2014). A growing body of research reveals that well cared for landscapes may have a positive halo effect on the care of neighboring parcels in residential settings (Nassauer, 2011; Visscher et al., 2014; Krusky et al., 2015; Sadler and Pruett, 2015). Other studies suggest a link between increased landscape care and increased social cohesion (de Vries et al., 2013). Increased social cohesion is an especially significant consideration in legacy cities, where multiple stressors affect residents' health and wellbeing in neighborhoods with high levels of property vacancy and abandonment (Garvin et al., 2013; Cohen et al., 2003; South et al., 2015; Hill et al., 2005). This study establishes links between landscape care and social cohesion in the scholarly literature, explores a possible spatial dimension of social cohesion, and addresses whether GSI contributes to social cohesion in stressed neighborhoods as evidenced in landscape care. If so, GSI might be used as a tool to improve social cohesion in stressed neighborhoods.

GSI is an approach to stormwater management that prioritizes reducing and slowing stormwater flows and managing precipitation close to where it falls. Compared to traditional piped drainage systems (grey infrastructure), GSI is sometimes considered a cost-effective, flexible, and resilient method for managing stormwater in the context of a changing climate with an increased frequency of high-volume storms. Properly designed GSI can help mitigate flooding and the contamination of local water bodies by removing water volume from grey systems through infiltration, retention, and detention before it enters stormwater pipes, and by slowing the velocity of runoff entering grey systems, which reduces 'peak flow.' Vegetation in properly designed GSI may also enhance ecosystem services, which support sustainable and resilient urban development and residents' wellbeing (Groenewegen et al., 2006; Gilchrist et al., 2015; Thompson et al., 2014). Urban green space, appropriately designed, may more generally contribute to climate resilience and the long-term sustainability and habitability of cities (Lovell and Taylor, 2009; Lafortezza et al., 2009).

In this study, I investigate the links between landscape care and social cohesion and the spatial dimension of social cohesion through a literature review and an analysis of cues to care on individual residential parcels in the Warrendale neighborhood of Detroit, Michigan. In 2014, GSI in the form of four pilot bioretention gardens was installed on vacant lots in Warrendale by the Detroit Water and Sewerage Department as part of the Neighborhood, Environment, and Water Research Collaborations for Green Infrastructure (NEW-GI) (Nassauer et al., 2016). Each garden sits on two adjacent properties of formerly abandoned houses that were owned by the Detroit Land Bank Authority. These gardens were designed with local residents' expectations of maintenance, attractiveness, and safety in mind. To analyze changes in landscape care before and after garden installation, I conducted surveys of parcel care within an 800ft buffer of the bioretention gardens in 2013 and 2017.

1.1 Cues to Care

Landscape care can be evaluated by the presence of various 'cues to care.' Cues to care are "evidence of human intention that is visible in the landscape" (Nassauer, 2011). Cues to care may include neatness and order, well-maintained structures, crisp edges between patch types, fences, trimmed trees and hedges or plants in straight rows, mown turf, colorful flowers, lawn ornaments, and signs (Nassauer 1995, 2011). Landscape cues on residential properties send the message that the people caring for the landscape follow and respect social expectations for the appearance of landscapes in their neighborhood (Larsen and Harlan, 2006; Blaine et al., 2012; Nassauer 1993, 2011; Nielson and Smith, 2005; Visscher et al., 2014; Nassauer et al., 2014). Cues to care or the lack of these cues can lead others to make assumptions about a caretakers' investment in the community, and their overall neighborliness and civility.

The presence of cues to care also has a spatial dimension: *clustering* refers to a spatial regularity where "proximal… yards contain more common landscape elements than those that are more distant," (Julien and Zmyslony, 2001). Some studies have concluded that residential properties with positive cues to care are likely to cluster (Nassauer et al., 2009; Julien and Zmyslony, 2001). A 2015 study by Krusky et al. showed that well-maintained produce gardens on vacant lots had a positive effect on surrounding properties' landscape care, including increased clustering of higher landscape maintenance scores around the garden sites, when compared to properties proximate to undeveloped vacant lots. Other studies suggest that the clustering of well-maintained landscapes is indicative of social cohesion, social stratification, and cultural norms within a neighborhood (Sullivan et al., 2004, Roy Chowdhury et al., 2011). Clustering may occur because positively cared-for parcels may have a halo effect on surrounding properties (Nassauer, 2011) with a relationship between distance and level of positive influence (Krusky et al., 2015).

A lack of cues to care, or the presence of negative cues, also has an effect on the care of nearby properties. Negative cues may include litter, unmown turf, structures in disrepair, weeds, and other signs of neglect (Nassauer, 1995). Blighted properties such as abandoned housing in disrepair, or unmaintained vacant lots, can be home to many negative cues. Just as positive cues cluster together, negative cues may spread throughout a neighborhood. This lends support to Krusky et al.'s (2005) *Greening Hypothesis*, wherein improving vacant or abandoned parcels can help to improve surrounding properties in neighborhoods with high amounts of blight (2015). This phenomenon may be used to slow or halt the destructive processes of abandonment and disinvestment in legacy cities.

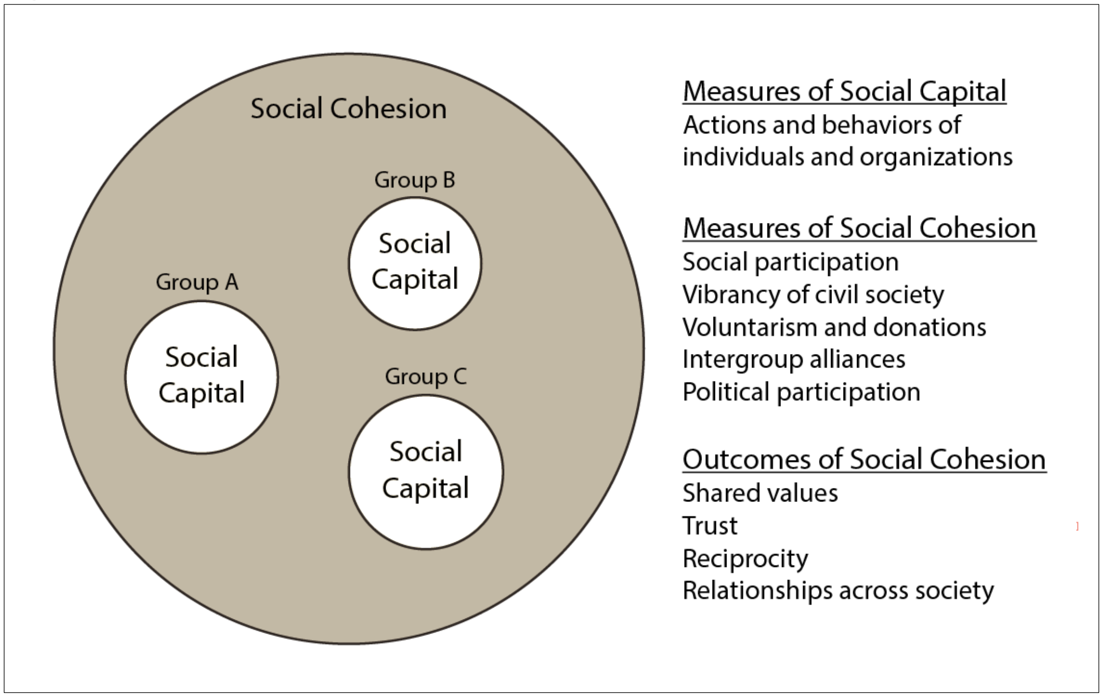
Landscape cues are also an important consideration when planning and designing GSI. When designs do not consider local perceptions, GSI may exacerbate social problems, especially in stressed neighborhoods. For example, if GSI has a messy appearance in an urban neighborhood with expectations of neatness, it may appear uncared for by local residents and could encourage dumping, vandalism, and abandonment, leading to increased fear and even crime (Nassauer and Raskin, 2014). For these reasons, designs must be responsive to local residents' cultural expectations and perceptions and plants must be carefully chosen for their durability and contribution within the local context.

1.2 Defining social cohesion

Social cohesion has been defined in different ways in the fields of sociology and psychology, and in the realm of public policy (Chan et al., 2006). Some general criteria connect these various definitions: the existence of shared values, trust, reciprocity, and relationships across a society (Klein, 2013; Policy Research Initiative of Canada, 1999; Bernard, 1999; Chan et al., 2006). In an effort to hone the definition to achieve 'ordinary usage,' Chan et al. (2006) define social cohesion as springing directly from definitions of "cohere" and "cohesion," which emphasize "stick(ing) together to form an effective or meaningful whole." Under this definition, social cohesion is seen as "a reflection of individuals' state of mind, which will be manifested in certain behavior," and can be measured empirically by observing these manifest behaviors.

Social cohesion is further described as a generalized state of society (Klein, 2013). This distinguishes it from social capital, which Putnam et al. (1993) describe as consisting of actions and behaviors at the individual and organizational level (see Figure 1). This distinction is especially important in societies with multiple ethnic and cultural groups: it is possible for each group to have high levels of social capital within itself, while the greater society simultaneously lacks social cohesion between groups (Chan et al., 2006). The future stability of intercultural societies will require high levels of cohesion between groups in addition to social capital within groups.

Figure 1: Relationship between social capital and social cohesion



Source: Developed by author with criteria from Chan et al. (2006) and Putnam et al. (1993)

Chan et al. (2006) give a limited list of possible objective behavioral manifestations of social cohesion, including social participation and vibrancy of civil society, voluntarism and donations, presence or absence of major inter-group alliances or cleavages, and political participation. These broad categories encompass a multitude of observable behaviors.

1.3 Implications of greening for social cohesion

Urban greening has many possible implications for social cohesion when viewed through scholarship that links urban greening to positive health and wellbeing outcomes (Dyment and Bell, 2007; Branas et al., 2011; Ulrich, 1984; Whear et al., 2014; Rappe, 2005). Increased access to green spaces in urban environments has been shown to have a “protective effect” against anxiety and mood disorders (Nutsford et al., 2013), and access to green space in general is associated with fewer symptoms of depression and anxiety (Beyer et al., 2014). Dinno (2007) showed that participatory green space programs in particular may reduce and promote adaptive responses to depressive symptoms. Visual and physical access to green space may also be beneficial for people experiencing stress (Thompson et al., 2012; van den Berg et al., 2010; Ulrich et al., 1991).

These positive effects of green space on wellbeing may be due to human’s adaptive need for psychological restoration (Kaplan and Kaplan, 1989). Attention Restoration Theory (ART) holds that humans have limited cognitive resources for directed attention and require adequate restoration in order to carry out everyday tasks. Kaplan and Kaplan's Reasonable Person Model (RPM) holds that directed attention fatigue places limits on one's ability to engage in reasonable, civil, or socially expected behavior (2011). RPM suggests that urban greening has the potential to increase reasonable behavior and improve social relations, as exposure to environments that do not require directed attention, such as natural environments, allows reserves of directed attention to replenish (Kaplan and Kaplan, 2011). In this way, replenishing levels of directed attention and therefore the reasonableness of residents may contribute to social cohesion through increased trust, reciprocity and by removing barriers to forming stronger relationships.

Urban greening may support social cohesion in other ways as well. Westphal (2003) found that greening could lead to residents' empowerment if the planning and implementation process was inclusive and community-led. Krasny and Tidball (2009) write that community-led urban greening projects improve communities' skills in self-organization and adaptive learning, leading to increased social capital and resilience in the face of change. These outcomes may be measurable under Chan et al.'s social cohesion framework (2006).

While the benefits of greening are many, criticism of means and methods is helping to expose possible shortcomings and avoid unintended negative impacts on neighborhoods. As with any community development and amenity provision there is the risk of activating gentrification and the displacement of current residents (Wolch et al., 2014). To prevent this, interventions must be planned with and for current residents, and policies must be put in place to maintain affordable and low-income housing, requiring a transdisciplinary approach to planning and implementation. Greenspace should also be equitably provisioned throughout the city and targeted in areas with the highest need for a variety of ecosystem services, not merely sited based on stormwater impacts alone (Meerow and Newell, 2017).

1.4 Linking cues to care and social cohesion

The assertion that cues to care can provide insight to the degree of social cohesion in a community is supported in the literature. A 2013 study by de Vries et al. showed that the quantity and quality of streetscape greenery had a positive effect on social cohesion. To measure the quality of streetscape greenery, they used five point scales to measure variation, maintenance, orderly arrangement, absence of litter, and general impression. These variables align with several of Nassauer's cues to care described above (1995, 2011), providing precedence for linking the presence of cues to care to increased social cohesion. Nassauer and Raskin (2014) write that the presence of cues to care may help to cultivate social cohesion by contributing to social capital. In Eindhoven, the Netherlands, Kamphuis et al. (2010) found that low levels of social cohesion were associated with negative perceptions of neighborhood safety and attractiveness, separately but in addition to their association with objective measures of neighborhood aesthetics. This suggests that the causal link between cues to care and social cohesion may be bidirectional. In addition, literature on the clustering of cues to care reveals that social cohesion has a spatial dimension (Krusky et al., 2015; Nassauer, 2009; Julien and Zmyslony, 2001).

1.5 Effects in stressed neighborhoods

Stressed neighborhoods stand to benefit from urban greening projects in many ways (Dunn, 2010). Vacant land carries a legacy of past use, even when it has returned to a ‘natural’ appearance (Nassauer and Raskin, 2014). This legacy can include soil contaminants, altered soil hydrology, and drainage patterns that unnecessarily overtax embedded grey infrastructure. In addition, green space is often under-provisioned in stressed neighborhoods, which contributes to social inequity in the context of environmental justice (Jennings et al., 2016). For these reasons alone, greening projects are an appropriate and needed intervention for improving the lives of people living in stressed neighborhoods. In addition, the greening of vacant lots was associated with reductions in gun crimes and vandalism in Philadelphia neighborhoods (Branas et al., 2011). Addressing neighborhood blight may also promote health outcomes and reduce stress (South et al., 2015). Studies by Thompson et al. (2012, 2014) showed positive effects of green space improvements on deprived communities, including increased mental wellbeing, lower self-reported stress levels, and reduced diurnal cortisol. Greening also has the potential to provide economic benefits to neighborhoods through raised local property values and decreased household energy costs (Benedict and McMahon, 2002; Jaffe, 2010).

Recent studies in Cleveland, OH, and Milwaukee, WI, have shown that greening efforts are financially feasible and can produce multiple benefits in cities that are experiencing population loss or stagnation and that have severe budgetary constraints (Keeley et al., 2013). GSI in particular can play an important role in easing increasing financial burdens for municipalities dealing with aging grey infrastructure. For example, in a life cycle assessment case study in Cincinnati, OH, Vineyard et al. (2015) found that installing and maintaining residential rain gardens provided cost savings and lower environmental impacts over the installation of grey systems. Greening and GSI in these scenarios can be part of larger efforts to foster economic development and neighborhood revitalization.

This study helps to expand our understanding of the effects of GSI in stressed neighborhoods. Through a review of relevant literature, the links between cues to care and social cohesion are apparent. The following analysis of individual residential parcels in Warrendale provides insight into the effects of well-maintained GSI on landscape care and social cohesion in a stressed neighborhood.

1.6 Definitions

Below are the operational definitions of terms used throughout the thesis.

Clustering: a spatial regularity in managed landscapes where "proximal… yards contain more common landscape elements than those that are more distant," (Julien and Zmyslony, 2001). In this study, clustering was measured by recording changes in cues to care on blocks with bioretention gardens and comparing results to blocks further away without bioretention gardens.

Cues to care: "evidence of human intention that is visible in the landscape" (Nassauer, 2011). In this study, care values were assessed through the presence or absence on parcels in the study area of various cues to care including mown turf, planted flowers, hedges, lawn ornaments, and decorative lighting (see Table 1).

Table 1: Cues to care operationalized for this study (from Nassauer and Dueweke, 2011; Dewar and Dueweke, 2011)

Cue to care	Scale
Flowers Indicates the presence of flowers in pots that appear to have been planted or maintained within the most recent growing season AND/OR annual or perennial flowers beds that indicate intentional care that is visible and apparent	Binomial 1 - present 0 - not present
Hedges Hedges are present that indicate care through trimming or maintenance, including any type of hedge on the property that has been maintained within the past year. Such a hedge should have minimal overgrowth and a shape that indicates intentional care.	Binomial 1 - present 0 - not present
Ornaments Indicates the presence in the private outdoor space of birdhouses, painted rocks, birdbaths, small flags, lawn statues, water fountains, or other decorative lawn ornaments	Binomial 1 - present 0 - not present
Decorative lighting Indicates the presence of decorative lighting in the private outdoor space. This includes a variety of landscape lighting, such as spot or floodlights, low in-ground fixed lighting, tall fixed lighting in the style of streetlights, strung lights such as Christmas lights, path lighting, etc.	Binomial 1 - present 0 - not present
Mowing The parcel appears to have been mown within the last month	Binomial 1 - present 0 - not present

Social cohesion: the existence of shared values, trust, reciprocity, and relationships across a society which are manifested in measurable objective behaviors, including social participation and vibrancy of civil society, voluntarism and donations, presence or absence of major inter-group alliances or cleavages, and political participation (Chan et al., 2006; Klein, 2013). In this study, social cohesion is indicated by the clustering of cues to care.

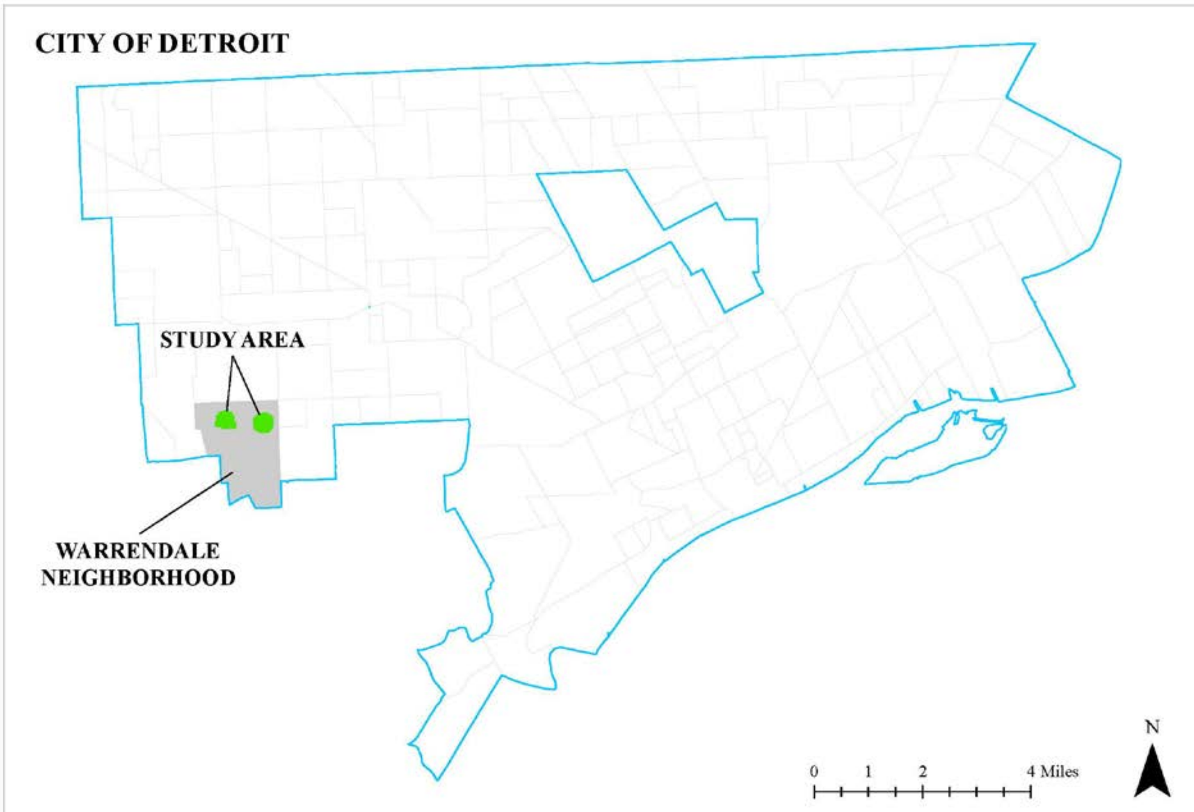
Stressed neighborhood: a neighborhood experiencing disinvestment that may have high levels of property vacancy. A stressed neighborhood may have a high proportion of low-income residents and low property values. The study area for this thesis is within Detroit’s Warrendale neighborhood, which conforms to these criteria.

2. Methods

2.1 Objectives

This study uses an analysis of cues to care on individual residential parcels in the Warrendale neighborhood of Detroit, Michigan (See Figure 2) to addresses this overarching research question: Does green stormwater infrastructure (GSI) contribute to social cohesion in stressed neighborhoods as evidenced in cues to care? If so, GSI might be used as a tool to improve social cohesion in stressed neighborhoods.

Figure 2: City of Detroit boundary, Warrendale neighborhood, and study area



Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016)

More specifically, I examined these questions:

- Do clusters of care exist in the stressed neighborhood that I studied? To find out, I mapped care values for all residential parcels to reveal clustering as an indicator of social cohesion.
- Did these clusters occur around pilot sites where GSI was installed? To analyze clustering around the bioretention garden sites, I collected pre-installation care data from 2013 and post-installation

Figure 3: Warrendale neighborhood study area and bioretention garden locations

Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016)

care data in 2017.

- Were care changes on blocks with GSI different from the study area as a whole? Using care change data and spatial data in GIS, I was able to analyze the presence of cues to care on garden blocks separately from the larger study area to reveal differences in care change. Garden blocks are defined as the contiguous parcels on the same side and facing side of the street where bioretention gardens were installed (see Figure 3).

I hypothesize relationships between the installation of well-maintained GSI in vacant lots and increased social cohesion as measured through increased clustering of well cared for parcels on blocks with bioretention gardens in Detroit's Warrendale neighborhood.

2.2 Study Area

The Warrendale neighborhood is like many neighborhoods in legacy cities in that it is experiencing population loss and disinvestment. Vacancy in this context provides opportunities for installing GSI on city-owned land to address flooding and combined sewer overflows. In this study, I used spatial and care data from Warrendale where four pilot bioretention gardens were installed by the Detroit Water and Sewerage Department as part of the NEW-GI project. The study area consists of two subareas within an 800-foot buffer of GSI facilities in the neighborhood (See Figure 3). Each subarea was defined by NEW-GI to encompass a pair of bioretention gardens as well as an unimproved control site (Nassauer et al., 2016). I analyzed the data at three levels delineated in Figure 3: combined study area, separate Subarea 1 and Subarea 2, and each of the four garden blocks separately. Garden Blocks A and B are located within Subarea 1, and Garden Blocks C and D are in Subarea 2.

2.3 Survey variables

This study operationalizes the relationship between the installation of well-maintained GSI on vacant lots and increased social cohesion by recording cues to care on residential parcels as defined in Table 1, mapping these data using GIS, and analyzing changes in care on garden blocks and non-garden blocks to indicate the degree of social cohesion. Residential parcels were classified as occupied, abandoned, or vacant. To analyze evidence of human intention, care was measured only for occupied parcels. Operational definitions of Residential Property Types (Table 2) were drawn from Dewar, Dueweke, and Nassauer's studies of cues to care in the Brightmoor and Lower Eastside neighborhoods of Detroit (Nassauer and Dueweke, 2011; Dewar and Dueweke, 2011). These operational definitions infer evidence of occupancy from moderate or good house condition. Consequently, some houses that are in very poor condition but could actually be occupied would be classified as "abandoned" in this study.

Table 2: Parcel classification as drawn from Nassauer and Dueweke, 2011; Dewar and Dueweke, 2011

Property Types	
	Residential
	The property appears to be residential, including all currently occupied parcels, abandoned houses, and vacant lots both blotted and not blotted [a]
	Non-Residential
	The property appears to be non-residential, including commercial uses, community uses and parking lots
Residential Property Types	
	Occupied
	House condition moderate: structurally sound, needs 3 or more minor repairs, but no more than 1 major repair; could be rehabilitated fairly inexpensively
	House condition good: structurally sound, well maintained; needs no more than 2 minor repairs, such as replacing window frames or painting; not leaning or tilted, foundation in good shape
	Abandoned
	House condition poor: may not be structurally sound, and needs 2 or more major repairs; may have sagging roof, missing windows or doors, deteriorated porch, deteriorated foundation; should be demolished; building exhibits severe structural damage
	Vacant
	Vacant land: formerly residential parcel with structure removed

[a] Blotted parcels are vacant lots that have been annexed and are managed by residents of a neighboring property

As this study focuses on social cohesion through changes in landscape care by residents, only residential parcels are used in the analysis; non-residential parcels are excluded (see Figure 4). Parcels with bioretention gardens are also excluded, as they are the subject parcels around which I hypothesized clustering of care to occur.

Variables collected for Occupied Residential properties and used in analysis are listed in Table 1. In Warrendale, a number of parcels are 'blotted.' Blotted parcels are vacant lots that have been annexed and are managed by residents of a neighboring property. These parcels are considered 'Occupied' in this analysis, and have been assessed to match the characteristics of the blotting (annexing) parcel. For example, if a blotting parcel had hedges, its blotted parcel was also recorded as having hedges.

Independent variables for the analysis of occupied parcels were calculated from survey data for 2013 and 2017 (see Table 3). The survey data used was gathered through a survey of 2013 Google Street View imagery of all parcels in the study area and through a windshield survey of the same parcels in October 2017. To assess changes in care from 2013 to 2017, change variables were calculated from the Landscape Care, Mowing, and Combined Mowing and Landscape Care variables. Negative values in the change

Figure 4: Residential parcels and occupancy changes between 2013 and 2017

Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016).

scales indicate an increase in care from 2013 to 2017, positive values indicate a decrease in care, and zero values indicate no change.

Table 3: Calculating values for independent variables

Independent variables	Operational definition	Scale
Landscape Care	Flowers, Hedges, Ornaments, Decorative Lighting	1 - No cues 2 - Lights and/or Ornaments OR Hedges 3 - Flowers OR Hedges with Lights and/or Ornaments OR Flowers with Lights and/or Ornaments 4 - Flowers and Hedges OR Flowers, Hedges, Lights, and/or Ornaments
Landscape Care Change	2013 Landscape care value minus 2017 value	Values -3 to 3
Mowing	Mowing	5 - The parcel appears to have been mown within the last month. 1 - The parcel does not appear to have been mown within the last month
Mowing Change	2013 Mowing value minus 2017 value	Values -4, 0, 4
Combined Mowing and Landscape Care	Landscape care plus Mowing	Values 2 to 9
Combined Mowing and Landscape Care Change	2013 Combined Mowing and Landscape care value minus 2017 value	Values -7 to 7

2013 and 2017 surveys

Care data was collected for all properties within the survey area for two years: in 2013 prior to garden installation, and after installation in 2017. The pilot bioretention gardens were installed in November 2015. The 2017 survey was gathered after the gardens' vegetation had filled in and been maintained for nearly two years.

2013 data was collected by postal address using Google Street View imagery from July and August 2013. Some inconsistencies in the dates of imagery were observed. For example, certain streets or parts of streets within the study area were not represented in Google Street View imagery for 2013. These inconsistencies were dealt with by approaching the properties from different angles in Google Street View until an image was available for 2013, then zooming in on the property to record its care state. Some properties required several different angles of approach at different distances in order to collect the needed data. In this way, it was possible to record all variables for all 706 properties within the study area using 2013 data.

2017 data was collected by postal address using the same variables in October 2017 via a windshield survey of all parcels in the study area.

Data were checked for errors and to ensure accuracy. Using postal addresses to link survey and spatial data, all variables were geo-coded to spatial parcel data from the City of Detroit (2018). This allowed for detailed spatial analysis of care data using GIS.

3. Results

Of 706 parcels in the study area, 694 parcels are residential and four parcels are non-residential in 2017. The remaining eight parcels were residential during the 2013 survey but categorized as non-residential in 2017 after bioretention gardens occupied those eight parcels (see Table 4). Each bioretention garden was installed on two adjacent parcels, where abandoned houses had been demolished.

Table 4: Residential and non-residential parcels counts in 2013 and 2017

Survey period	Total parcels	Residential parcels	Non-residential parcels	Parcels used for bioretention gardens
2013	706	702	4	0
2017	706	694	12	8

Of the 694 residential parcels, 480 parcels were occupied in 2013. In 2017, 78 of those parcels had become abandoned or vacant, 402 parcels were still occupied, and 22 parcels that had been classified as abandoned houses in 2013 had become occupied. A total of 502 parcels were occupied in either 2013 or 2017 (see Table 5).

Table 5: Occupied residential parcel counts and occupancy changes in 2013 and 2017

2013	*2017*			
Parcels occupied in 2013	Parcels occupied in both 2013 and 2017	Parcels newly occupied in 2017	Parcels newly abandoned/vacant in 2017	Total parcels occupied in either 2013 or 2017
480	402	22	78	502

In order to observe changes in care of occupied parcels, parcels that were not occupied in both 2013 and 2017 (and consequently did not have care data for both years) were excluded from analysis. Parcels excluded from analysis include newly occupied parcels in 2017 and newly abandoned or vacant parcels in 2017, as care data was not collected for parcels that were abandoned or vacant at the time surveyed. This left 402 parcels that were occupied in 2013 and 2017 and could be analyzed for changes in care (see column 2 in Table 5 and Figure 5).

For the 402 parcels occupied in both 2013 and 2017, nearly all parcels appeared to have been mown in the past month at the time of both surveys. As no significant changes in mowing were observed (see Table 6),

Figure 5: Residential parcels occupied in both 2013 and 2017

Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016).

this variable was left out of analysis.

Table 6: Apparent mowing within the last month of parcels occupied in 2013 and 2017

Total occupied parcels	*Mowing in 2013*		*Mowing in 2017*	
	Mown parcels	Unmown parcels	Mown parcels	Unmown parcels
402	400	2	401	1

Landscape Care and Landscape Care Change scores were compared at three levels: combined study areas, separate Subarea 1 and Subarea 2, and each of the four garden blocks separately (see Figure 3). At each geographic level, average care scores decreased between 2013 and 2017. However, a central tendency is lacking in the data distribution, and this non-normal distribution of care changes indicates that trends and means may provide an overly simplified picture of the variability of occupancy in the neighborhood.

Average landscape care scores also decreased more in the garden blocks than they did at the subarea or combined study area level (see column 13 in Table 7). While this does not support my hypothesis that increased clustering of well cared for parcels would occur on blocks with well-maintained GSI, the data reveals that other factors may be working to mitigate any halo effect the bioretention gardens may have. For example, decreased average landscape care for occupied residential parcels may be related to increased numbers of vacant and abandoned properties at nearly all geographic levels. At all geographic levels, many parcels became abandoned or vacant between 2013-17 (see column 7 in Table 7). 78 residential parcels, 11% of all residential parcels, became abandoned or vacant, raising total abandonment and vacancy of residential properties from 31% of the combined study areas in 2013 to 39% in 2017. Three out of four blocks with bioretention gardens experienced more abandonment and vacancy between 2013-17 than did the combined study area as a whole. For example, six parcels (26% of all parcels) on Garden Block D became abandoned or vacant between surveys (See row 8 in Table 7) compared to 10% in Subarea 2 and 11% of the combined study areas. Garden Block D also had high abandonment and vacancy during the 2013 survey with 39% of parcels either abandoned or vacant compared to 33% at the subarea level and 31% of combined study areas. Garden Blocks A and D had higher total rates of abandonment and vacancy than the combined study area as a whole at the time of the 2017 survey (see column 9 in Table 7), with 43% and 65% total abandonment and vacancy respectively. The installation of the bioretention gardens on two adjacent parcels with abandoned structures may indicate preexisting instability and disinvestment on garden blocks that is not accounted for in the survey variables.

Table 7: Landscape care change for all occupied parcels

		2013				*2013-2017 Changes*		*2017*				
	Total Residential Parcels	Total Abandoned/ Vacant	Total Occupied	Mean landscape care	Std. Dev., min-max	Became Abandoned/ Vacant	Became Occupied	Total Abandoned/ Vacant	Total Occupied	Mean landscape care	Std. Dev., min-max	Landscape care change
Combined Study Areas	694 (100%)	214 (31%)	480 (69%)	2.96	1.052, 1-4	78 (11%)	22 (3%)	270 (39%)	424 (61%)	2.73	1.026 1-4	-.23 (-7.7%)
Subarea A Totals	**310** (100%)	**89** (29%)	**221** (71%)	**2.87**	**1.023 1-4**	**40** (13%)	**5** (2%)	**124** (40%)	**186** (60%)	**2.71**	**.993 1-4**	**-.16 (-5.6%)**
Garden Block A	23 (100%)	6 (26%)	17 (74%)	2.94	.966 2-4	4 (17%)	0 (0%)	10 (43%)	13 (57%)	2.69	.855 2-4	-.25 (-8.5%)
Garden Block B	25 (100%)	1 (4%)	24 (96%)	3.13	1.035 1-4	3 (12%)	0 (0%)	4 (16%)	21 (84%)	2.67	1.065 1-4	-.46 (-14.7%)
Non Garden Blocks	262 (100%)	82 (31%)	180 (69%)	2.83	1.028 1-4	33 (13%)	5 (2%)	110 (42%)	152 (58%)	2.72	.999 1-4	-.11 (-3.9%)
Subarea B Totals	**384** (100%)	**125** (33%)	**259** (67%)	**3.04**	**1.072 1-4**	**38** (10%)	**17** (4%)	**146** (38%)	**238** (62%)	**2.75**	**1.052 1-4**	**-.29 (-9.5%)**
Garden Block C	27 (100%)	4 (15%)	23 (85%)	2.78	1.043 1-4	1 (4%)	1 (4%)	4 (15%)	23 (85%)	2.39	1.118 1-4	-.39 (-14.0%)
Garden Block D	23 (100%)	9 (39%)	14 (61%)	3.07	1.207 1-4	6 (26%)	0 (0%)	15 (65%)	8 (35%)	2.13	1.246 1-4	-.94 (-30.6%)
Non Garden Blocks	334 (100%)	112 (34%)	222 (66%)	3.07	1.068 1-4	31 (9%)	16 (5%)	127 (38%)	207 (62%)	2.82	1.026 1-4	-.25 (8.1%)

At all geographic levels, the standard deviation for Mean Landscape Care is high – ranging from .855 to 1.246 for a care scale with values from 1 to 4. This indicates that individual parcels exhibited a wide range of landscape care values in both 2013 and 2017 at each geographic scale (see Figures 6 and 7). For example, on Garden Block D 2013 care values ranged from 1 to 4, with only two parcels with similar care value located next to one another (see Figure 6). The same garden block had only three parcels with care values that had not changed by 2017, while the remaining parcels decreased in care or had become abandoned or vacant (See Figures 7 and 8). The mosaic patterns in Figures 6 and 7 show the variety of care values at both survey times. Though the pattern of care change appears to have a non-uniform distribution, Figure 9 does show some contiguous areas of consistent care (parcels exhibiting No Change between 2013 and 2017) and increasing care. For example, the blocks of Evergreen north of Tireman and north of Constance appear to have clusters of consistent or improved care. These blocks contrast sharply with others such as Faust north of Belton, which had only two parcels with consistent or increasing care.

Because of the dynamic nature of occupancy and abandonment in the study area, consistently occupied parcels (parcels that were occupied in both 2013 and 2017) were analyzed separately to better reveal changes to landscape care on occupied parcels (see Table 8). Slight differences in each geographic level's average care change emerged when parcels that were not occupied in both years (inconsistently occupied parcels) were removed from the analysis (see column 13 in Table 7 and column 8 in Table 8). These 'inconsistently occupied' parcels include parcels that became abandoned or vacant, or that became occupied between the 2013 and 2017 surveys (see columns 7 and 8 in Table 7). Landscape care change for the combined study area was higher when inconsistently occupied parcels were removed than when these were included, but not considerably so (see row 1 in Tables 7 and 8). In Subarea 1, the removal of inconsistently occupied parcels improved the results for landscape care change at the garden block level, with Garden Block A's landscape care change increasing from -.25 (-8.5%) to .0 (0%) and Garden Block B increasing from -.46 (-14.7%) to -.38 (-12.5%) (see rows 3 and 4 in Tables 7 and 8). In contrast, landscape care change decreased slightly on non-garden blocks in Subarea 1 when inconsistently occupied parcels were removed (see Table 7, row 5, column 13 and Table 8 row 5, column 8). However, results from Subarea 2 are different. In Subarea 2, consistently occupied parcels had lower absolute and percent care change than the result for all occupied parcels (see row 6 in Tables 7 and 8). Garden Block C showed lower absolute and percent care change, while Garden Block D and Non Garden Blocks had similar absolute care change to all occupied parcels and lower percent change.

These differences between the subareas could be attributed to the differences in abandonment and re-occupation observed within each. For example, 13% of parcels became abandoned in Subarea 1 compared

Figure 6: Landscape care values for occupied parcels in 2013

Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016).

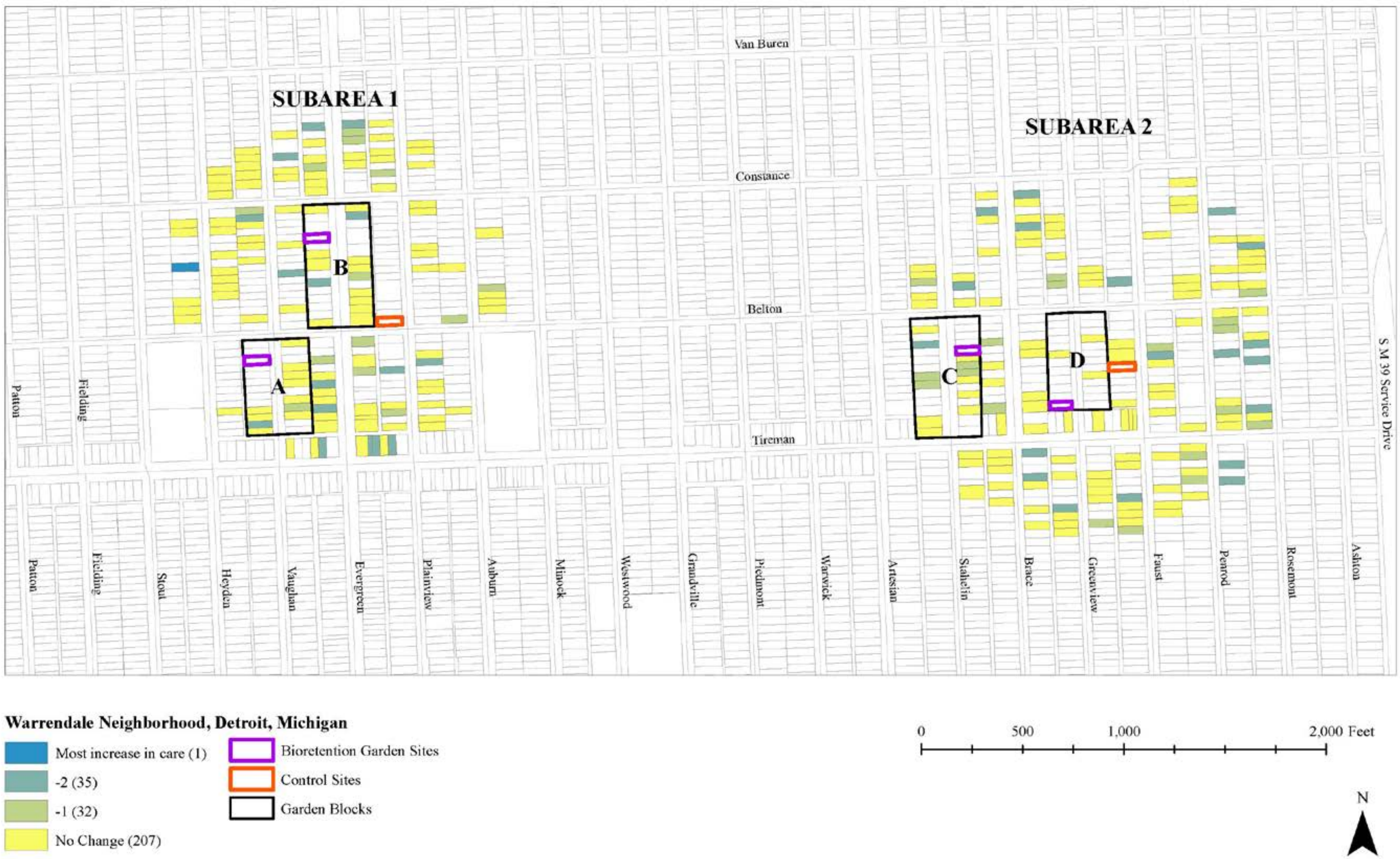
Figure 7: Landscape care values for occupied parcels in 2017

Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016).

Figure 8: Landscape care change 2013-2017 for all residential parcels occupied in 2013 or 2017

Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016).

Figure 9: Parcels occupied in both 2013 and 2017 with consistent care levels or improved care between 2013 and 2017



Source: Developed by author with data from City of Detroit (2018), SEMCOG (2018), and Nassauer et al. (2016).

Table 8: Landscape care change for parcels occupied in both 2013 and 2017

	2013 occupied parcels	Parcels still occupied in 2017	*2013* Mean landscape care	Standard deviation, min-max	*2017* Mean landscape care	Standard deviation, min-max	Landscape care change
Combined Study Areas	480 (100%)	402 (84%)	2.98	1.062, 1-4	2.76	1.016, 1-4	-.22 (-7.4%)
Subarea 1 Totals	**221** (100%)	**181** (82%)	**2.87**	**1.044, 1-4**	**2.73**	**.988, 1-4**	**-.14** (-4.9%)
Garden Block A	17 (100%)	13 (76%)	2.69	.947, 2-4	2.69	.855, 2-4	.00 (0%)
Garden Block B	24 (100%)	21 (88%)	3.05	1.071, 1-4	2.67	1.065, 1-4	-.38 (-12.5%)
Non Garden Blocks	180 (100%)	147 (82%)	2.86	1.051, 1-4	2.74	.994, 1-4	-.12 (-4.2%)
Subarea 2 Totals	**259** (100%)	**221** (85%)	**3.07**	**1.070, 1-4**	**2.78**	**1.040, 1-4**	**-.53** (-17.3%)
Garden Block C	23 (100%)	22 (96%)	2.82	1.053, 1-4	2.32	1.086, 1-4	-.50 (-17.7%)
Garden Block D	14 (100%)	8 (57%)	2.75	1.389, 1-4	2.13	1.246, 1-4	-.94 (-34.2%)
Non Garden Blocks	222 (100%)	191 (86%)	3.11	1.058, 1-4	2.86	1.008, 1-4	-.25 (-8%)

to 10% of parcels in Subarea 2. In Subarea 1, 2% (5 parcels) of parcels became occupied between surveys, while 4% (17 parcels) became occupied in Subarea 2. The exclusion of re-occupied parcels and abandoned parcels reveals that these parcels may contribute to higher and lower landscape care change results respectively (see columns 7, 8 and 13 in Table 7 and column 8 in Table 8). Re-occupied parcels add more cues to landscape care in 2017, while parcels that were occupied in 2013 and abandoned in 2017 exhibited lower landscape care in 2013 prior to their abandonment.

Table 9 compares the absolute and percent landscape care change results for all occupied parcels and parcels occupied in both 2013 and 2017. Percent change statistics in particular reveal stark differences between Subarea 1 and Subarea 2. Garden blocks and non-garden blocks in Subarea 2 decreased by much higher percentages than comparable sections in Subarea 1. Total landscape care decrease for Subarea 2 was more than three times the level in Subarea 1 (-17.3% versus -4.9%). This points to much higher volatility and disinvestment in Subarea 2, despite more instances of reoccupation.

Table 9: Absolute landscape care change and percent change for all occupied (either 2013 or 2017) parcels and consistently occupied (2013 and 2017) parcels

	Change in Mean Landscape Care					
	All occupied parcels			Parcels occupied in 2013 and 2017		
	Count	Change	% Change	Count	Change	% Change
Combined Study Areas	480 (100%)	-.23	-7.7%	402 (84%)	-.22	-7.4%
Subarea 1 Totals	**221** (100%)	**-.16**	**-5.6%**	**181** (82%)	**-.14**	**-4.9%**
Garden Block A	17 (100%)	-.25	-8.5%	13 (76%)	.00	0%
Garden Block B	24 (100%)	-.46	-14.7%	21 (88%)	-.38	-12.5%
Non Garden Blocks	180 (100%)	-.11	-3.9%	147 (82%)	-.12	-4.2%
Subarea 2 Totals	**259** (100%)	**-.29**	**-9.5%**	**221** (85%)	**-.53**	**-17.3%**
Garden Block C	23 (100%)	-.39	-14.0%	22 (96%)	-.50	-17.7%
Garden Block D	14 (100%)	-.94	-30.6%	8 (57%)	-.94	-34.2%
Non Garden Blocks	222 (100%)	-.25	-8.1%	191 (86%)	-.25	-8.0%

4. Discussion

Initial results comparing garden block landscape care values to care values from each study subarea as a whole do not support the hypothesis that the bioretention gardens contribute to improved care. However, the dynamic nature of patterns of residential abandonment and vacancy in the study area point to the presence of multiple forces at play in the care of residential parcels in Warrendale. The bioretention gardens were installed on two adjacent parcels with abandoned structures owned by the Detroit Land Bank Authority. Consequently, they were located on blocks that may have been more vulnerable to vacancy than other blocks in the study area. Variable rates of abandonment and vacancy may counteract or hide the stabilizing, improving, or maintaining effects, if any, of the bioretention gardens. Most garden blocks decreased in care at a higher rate than did their respective subareas. The same was true for the combined garden blocks when compared to the combined study area as a whole. This is in a context of rapid abandonment in the combined study area, with 31% of all residential parcels either abandoned or vacant in 2013, 39% in 2017, and only 84% of all parcels occupied in 2013 still occupied in 2017 (see columns 3, 7 and 9 in Table 7). In comparison, in Subarea 1, abandoned and vacant parcels accounted for 29% of all residential parcels in 2013 and 40% in 2017, while in Subarea 2 the figures were 33% and 38% respectively. For garden blocks, continued occupation ranged from 57% in Garden Block D to 96% in Garden Block C. Abandonment and vacancy for garden blocks ranged from 4% (Garden Block B) to 39% (Garden Block D) in 2013 and from 15% (Garden Block C) to 65% (Garden Block D) in 2017 (See Table 7).

The very small numbers of parcels occupied in both 2013 and 2017 on garden blocks (ranging from only 8 parcels on Garden Block D to 22 parcels on Garden Block C) make it challenging to reliably measure effects of GSI installation as these effects may be mediated by abandonment, vacancy or reoccupation. Increased instances of abandonment point to the dynamic nature of housing occupancy in the study area and make it difficult to isolate any effects the bioretention gardens may have on social cohesion. Landscape care values and landscape care change have non-normal distributions and lack a central tendency, indicating that trends and means likely provide an overly simplified picture of landscape care in the neighborhood.

Despite these inconclusive findings, the data do offer insight into the interaction between GSI and residential landscape care. For many parcels, landscape care improved or was consistent between surveys (see Figure 9). Future research may focus on these parcels to discern whether the installation of GSI has had an effect on residents' landscape maintenance or improvement. Clusters of these instances of stability and improvement could be seen as strongholds of care and used as anchors for the spread of positive cues to care via GSI installation at their edges. Similarly, the spatial organization of parcels that became occupied or abandoned between surveys may inform the placement of future GSI facilities (see Figure 4). Parcels that exhibited decreased landscape care between surveys may signal further disinvestment or abandonment in the future.

5. Conclusions

This study investigates the links between landscape care and social cohesion and the spatial dimension of social cohesion through an analysis of cues to care on individual residential parcels in a study area within Detroit's Warrendale neighborhood, where four well-maintained bioretention gardens were installed on vacant lots in 2014. As the study area has high levels of vacancy and abandonment, the results of this study are particularly relevant for decision makers in legacy cities, where multiple stressors impact residents' health and wellbeing, and therefore social cohesion (Garvin et al., 2013; Cohen et al., 2003; South et al., 2015; Hill et al., 2005). A review of the literature reveals the potential for GSI and urban greening generally to provide multiple social, financial, and ecological benefits in legacy cities, especially within the context of climate change. It also reveals that the long-term success of GSI as an integral part of urban stormwater management systems relies on cultural acceptance and consistent maintenance, management and coordination with grey stormwater systems.

The results from the analysis of cues to care and landscape change in the study area indicate that GSI alone may not fully counteract larger patterns and stronger forces of abandonment and neighborhood disinvestment. This small study suggests that, in areas with decreasing landscape care values, GSI facilities may be inadequate for stabilizing larger processes of disinvestment operating at scales well beyond the neighborhood. However, that does not imply that they will have no effect on social cohesion or on nearby residents' health and well-being. More research is needed to provide insight into the possible contributions of GSI on social cohesion in stressed neighborhoods as evidenced in cues to care. This would ideally be done in multiple neighborhoods with GSI and greening interventions in several legacy cities in order to observe a wider range of neighborhood disinvestment conditions and types of GSI interventions.

References

Benedict, M. A., & McMahon, E. T. (2002). Green infrastructure: smart conservation for the 21st century. *Renewable Resources Journal*, *20*(3), 12-17.

Bernard, P. (1999). La cohésion sociale: Critique dialectique d'un quasi-concept. *Lien Social et Politiques*, *41*, 47–59.

Beyer, K. M., Kaltenbach, A., Szabo, A., Bogar, S., Nieto, F. J., & Malecki, K. M. (2014). Exposure to neighborhood green space and mental health: evidence from the survey of the health of Wisconsin. *International Journal of Environmental Research and Public Health*, *11*(3), 3453-3472.

Blaine, T. W., Clayton, S., Robbins, P., & Grewal, P. S. (2012). Homeowner attitudes and practices towards residential landscape management in Ohio, USA. *Environmental Management*, *50*(2), 257-271.

Branas, C. C., Cheney, R. A., MacDonald, J. M., Tam, V. W., Jackson, T. D., & Ten Have, T. R. (2011). A difference-in-differences analysis of health, safety, and greening vacant urban space. *American Journal of Epidemiology*, *174*(11), 1296-1306.

Chan, J., To, H. P., & Chan, E. (2006). Reconsidering social cohesion: Developing a definition and analytical framework for empirical research. Social indicators research, 75(2), 273-302.

City of Detroit, (2018). Detroit Open Data Portal. Retrieved from https://data.detroitmi.gov/

Cohen, D. A., Mason, K., Bedimo, A., Scribner, R., Basolo, V., & Farley, T. A. (2003). Neighborhood physical conditions and health. *American Journal of Public Health*, *93*(3), 467-471.

de Vries, S., van Dillen, S. M., Groenewegen, P. P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: stress, social cohesion and physical activity as mediators. *Social Science & Medicine*, *94*, 26-33.

Dewar, M., & Dueweke, E. (2011). *Documenting Care and Commitment to Place in CDAD*. Ann Arbor, MI: Graham Environmental Sustainability Institute, 8pp.

Dinno, A. (2007). Loop analysis of causal feedback in epidemiology: an illustration relating to urban neighborhoods and resident depressive experiences. *Social Science & Medicine*, *65*(10), 2043-2057.

Dunn, A. D. (2010). Siting green infrastructure: legal and policy solutions to alleviate urban poverty and promote healthy communities. *Boston College Environmental Affairs Law Review, 37*, 41-66.

Dyment, J. E., & Bell, A. C. (2007). Grounds for movement: green school grounds as sites for promoting physical activity. *Health Education Research*, *23*(6), 952-962.

Garvin, E., Branas, C., Keddem, S., Sellman, J., & Cannuscio, C. (2013). More than just an eyesore: local insights and solutions on vacant land and urban health. *Journal of Urban Health*, *90*(3), 412-426.

Gilchrist, K., Brown, C., & Montarzino, A. (2015). Workplace settings and wellbeing: Greenspace use and views contribute to employee wellbeing at peri-urban business sites. *Landscape and Urban Planning*, *138*, 32-40.

Groenewegen, P. P., van den Berg, A. E., de Vries, S., & Verheij, R. A. (2006). Vitamin G: effects of green space on health, well-being, and social safety. *BMC public health*, *6*(1), 149.

Hill, T. D., Ross, C. E., & Angel, R. J. (2005). Neighborhood disorder, psychophysiological distress, and health. *Journal of Health and Social Behavior*, *46*(2), 170-186.

Jaffe, M. (2010). Environmental reviews & case studies: reflections on Green Infrastructure economics. *Environmental Practice*, *12*(4), 357-365.

Jennings, V., Larson, L., & Yun, J. (2016). Advancing sustainability through urban green space: cultural ecosystem services, equity, and social determinants of health. *International Journal of Environmental Research and Public Health*, *13*(2), 196.

Julien, M., & Zmyslony, J. (2001). Why do landscape clusters emerge in an organized fashion in anthropogenic environments?. *Landscape Research*, *26*(4), 337-350.

Kamphuis, C. B., Mackenbach, J. P., Giskes, K., Huisman, M., Brug, J., & Van Lenthe, F. J. (2010). Why do poor people perceive poor neighbourhoods? The role of objective neighbourhood features and psychosocial factors. *Health & Place*, *16*(4), 744-754.

Kaplan, R., & Kaplan, S. (1989). *The Experience of Nature: A Psychological Perspective*. Cambridge University Press, 341pp.

Kaplan, R., & Kaplan, S. (2011). Well-being, reasonableness, and the natural environment. *Applied Psychology: Health and Well-Being*, *3*(3), 304-321.

Keeley, M., Koburger, A., Dolowitz, D. P., Medearis, D., Nickel, D., & Shuster, W. (2013). Perspectives on the use of green infrastructure for stormwater management in Cleveland and Milwaukee. *Environmental Management*, *51*(6), 1093-1108.

Klein, C. (2013). Social capital or social cohesion: What matters for subjective well-being?. *Social Indicators Research*, *110*(3), 891-911.

Krasny, M. E., & Tidball, K. G. (2009). Applying a resilience systems framework to urban environmental education. *Environmental Education Research*, *15*(4), 465-482.

Krusky, A. M., Heinze, J. E., Reischl, T. M., Aiyer, S. M., Franzen, S. P., & Zimmerman, M. A. (2015). The effects of produce gardens on neighborhoods: A test of the greening hypothesis in a post-industrial city. *Landscape and Urban Planning*, *136*, 68-75.

Lafortezza, R., Carrus, G., Sanesi, G., & Davies, C. (2009). Benefits and well-being perceived by people visiting green spaces in periods of heat stress. *Urban Forestry & Urban Greening*, *8*(2), 97-108.

Larsen, L., & Harlan, S. L. (2006). Desert dreamscapes: residential landscape preference and behavior. *Landscape and Urban Planning*, *78*(1-2), 85-100.

Lovell, S. T., & Taylor, J. R. (2013). Supplying urban ecosystem services through multifunctional green infrastructure in the United States. *Landscape Ecology*, *28*(8), 1447-1463.

Meerow, S., & Newell, J. P. (2017). Spatial planning for multifunctional green infrastructure: Growing resilience in Detroit. *Landscape and Urban Planning*, *159*, 62-75.

Nassauer, J. I. (1993). Ecological function and the perception of suburban residential landscapes. *Managing Urban and High Use Recreation Settings (General Technical Report*). USDA Forest Service North Central Forest Experiment Station, St. Paul, MN, 55-60.

Nassauer, J. I. (1995). Messy ecosystems, orderly frames. *Landscape Journal*, *14*(2), 161-170.

Nassauer, J. I. (2011). Care and stewardship: From home to planet. *Landscape and Urban Planning, 100*(4), 321-323.

Nassauer, J. I., Cooper, D. A., Marshall, L. L., Currie, W. S., Hutchins, M., & Brown, D. G. (2014). Parcel size related to household behaviors affecting carbon storage in exurban residential landscapes. *Landscape and Urban Planning, 129*, 55-64.

Nassauer, J. I., Dewar, M., McElmurry, S., Sampson, N., Alvarez, A., Burton, A., Riseng, C., Schulz, A., Webster, N., & Lichten, N. (2016*). NEW-GI Advisory Brief*. Ann Arbor, MI: University of Michigan Water Center, 32pp.

Nassauer, J. I., & Dueweke, E. (2011). *Documenting and Demonstrating Neighborhood Care Dynamics in CDAD's 'Urban Homesteads' and 'Naturescapes'*. Ann Arbor, MI: Graham Environmental Sustainability Institute, 10pp.

Nassauer, J. I., & Raskin, J. (2014). Urban vacancy and land use legacies: A frontier for urban ecological research, design, and planning" *Landscape and Urban Planning 125*, 245-253.

Nassauer, J. I., Wang, Z., & Dayrell, E. (2009). What will the neighbors think? Cultural norms and ecological design*. Landscape and Urban Planning, 92(3)*, 282-292.

Nielson, L., & Smith, C. L. (2005). Influences on residential yard care and water quality: Tualatin watershed, Oregon. *Journal of the American Water Resources Association*, *41*(1), 93-106.

Nutsford, D., Pearson, A. L., & Kingham, S. (2013). An ecological study investigating the association between access to urban green space and mental health. *Public Health*, *127*(11), 1005-1011.

Policy Research Initiative (Canada). (1999). *Sustaining Growth, Human Development, and Social Cohesion in a Global World: A Report*. Policy Research Initiative, 341pp.

Putnam, R. D., Leonardi, R., & Nanetti, R. Y. (1993). *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton university press, 263pp.

Rappe, E. (2005). *The influence of a green environment and horticultural activities on the subjective well-being of the elderly living in long-term care*. University of Helsinki, Department of Applied Biology, Publication no. 24. Helsinki, 51pp.

Roy Chowdhury, R., Larson, K., Grove, M., Polsky, C., Cook, E., Onsted, J., & Ogden, L. (2011). A multi-scalar approach to theorizing socio-ecological dynamics of urban residential landscapes. *Cities and the Environment (CATE)*, *4*(1), Article 6.

Sadler, R. C., & Pruett, N. K. (2015). Mitigating blight and building community pride in a legacy city: lessons learned from a land bank's clean and green programme. *Community Development Journal*, *52*(4), 591-610.

SEMCOG, (2018). Southeast Michigan Council of Governments (SEMCOG) Open Data Portal. Retrieved from https://maps-semcog.opendata.arcgis.com/

South, E. C., Kondo, M. C., Cheney, R. A., & Branas, C. C. (2015). Neighborhood blight, stress, and health: a walking trial of urban greening and ambulatory heart rate. *American Journal of Public Health, 105*(5), 909-913.

Thompson, C. W., Roe, J., Aspinall, P., Mitchell, R., Clow, A., & Miller, D. (2012). More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning*, *105*(3), 221-229.

Thompson, C. W., Aspinall, P., & Roe, J. (2014). Access to green space in disadvantaged urban communities: evidence of salutogenic effects based on biomarker and self-report measures of wellbeing. *Procedia-Social and Behavioral Sciences*, *153*, 10-22.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201-230.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, *224*, 420–421.

van den Berg, A. E., Maas, J., Verheij, R. A., & Groenewegen, P. P. (2010). Green space as a buffer between stressful life events and health. *Social Science & Medicine, 70*(8), 1203-1210.

Vineyard, D., Ingwersen, W. W., Hawkins, T. R., Xue, X., Demeke, B., & Shuster, W. (2015). Comparing green and grey infrastructure using life cycle cost and environmental impact: a rain garden case study in Cincinnati, OH. *Journal of the American Water Resources Association*, *51*(5), 1342-1360.

Westphal, L. M. (2003). Urban greening and social benefits: a study of empowerment outcomes. *Journal of Arboriculture*, *29*(3), 137-147.

Whear, R., Coon, J. T., Bethel, A., Abbott, R., Stein, K., & Garside, R. (2014). What is the impact of using outdoor spaces such as gardens on the physical and mental well-being of those with dementia? A systematic review of quantitative and qualitative evidence. *Journal of the American Medical Directors Association*, *15*(10), 697-705.

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning*, *125*, 234-244.