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Fresh food, new faces: community gardening as ecological gentrification in St. Louis, Missouri

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Abstract
A largely qualitative body of literature has contributed to understanding the contradictory dimensions of community gardening as a social justice tool. Building on this literature through a city-wide, quantitative intervention, this paper focuses on community gardening as a facilitator of ecological gentrification in St. Louis, Missouri. Combining the analytical lenses of spatial justice, urban political ecology, and the rent gap theory of gentrification, I deploy spatial regression analysis to show that community gardening was positively associated with gentrification in St. Louis between the years 2000 and 2010, as measured by the growth of high socioeconomic status residents in each neighborhood. This result suggests that a sociospatial dialectic exists in which the implementation of a community garden, a change in the use of urban space, leads to unintended social outcomes. Contextualizing this finding within the broader literature, I conclude that the potential of community gardening as an instrument for spatial justice is contingent on institutional support against larger-scale processes, like gentrification, that lead to spatially unjust outcomes.

Keywords Community gardening · Gentrification · Spatial justice · Urban political ecology · GIS

Abbreviations

LRA	Land reutilization authority
LTDB	Brown University's Longitudinal Tract Data Base
UPE	Urban political ecology

Introduction

Urban community gardens, lauded as an effective tool for promoting social justice, have continued to proliferate and receive scholarly attention across cities in the Global North. One area of study that has emerged from the growing popularity of community gardening is its relationship to ecological gentrification, or the redevelopment of neighborhoods and the potential displacement of marginalized people that results from inserting greenspace into previously blighted places (Dooling 2009; Gould and Lewis 2016). Previous research has sought to determine the extent to which the social justice orientation of community gardening is challenged by making neighborhood spaces more attractive to predominantly white, higher socioeconomic status gentrifiers (Quastel 2009; McClintock 2018; Ramirez 2015). However, whether or not community gardens are a facilitator of ecological gentrification has been subjected to little quantitative investigation. This paper builds on the existing body of literature, which is largely qualitative, by putting forward a critical, quantitative analysis to determine whether community gardening has been a facilitator of ecological gentrification in St. Louis, Missouri.

An ideal site for this study, St. Louis is a shrinking city with a history of tensions along the lines of race and class, which are exacerbated by the uneven development trajectories between its neglected north side and its relatively more prosperous southern half. St. Louis, like other industrial rust belt cities, has experienced steady population decline since 1960 (Schilling and Logan 2008), and the racism embedded in its development history has been well-documented (Gordon 2009, 2013; Tighe and Ganning 2015). Along with development practices that have systematically excluded parts of the city, political fragmentation has led to competition for resources between St. Louis City and St. Louis County, contributing to the flight of city residents, both black and white, to the County and other regions (Gordon 2009, 2013).

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Making use of the City's ample vacant properties (see Prener et al. 2018), community gardens have spread throughout St. Louis, both north and south of Delmar Boulevard, a historic dividing line between the haves and have-nots (Gordon 2009, 2013). Given St. Louis's history of spatial inequality and the recent links drawn between community gardening and gentrification in local press (Chen 2018; Moore 2018), it is important to investigate whether community gardens have played a role in exacerbating its existing spatial injustices. Reflective of this, this paper focuses on a social externalities of St. Louis's community gardening movement. Specifically, combining the lenses of Soja's (2010) spatial justice framework with urban political ecology (UPE) and Smith's (1979, 1982) rent gap theory of gentrification, this paper utilizes spatial regression analysis to show that community gardening, a use of a neighborhood's physical space, was significantly associated with gentrification in St. Louis from the years 2000 to 2010, as measured by the growth of high socioeconomic status residents in each neighborhood. Contextualizing this finding within the broader literature and with the other correlates of gentrification found in this analysis, I discuss the potential of community gardening as a spatial justice tool in light of its association with gentrification, a process that can produce spatially unjust outcomes.

Background

Conceptual framework: spatial justice and urban political ecology

Spatial justice, closely related to discourse surrounding the "Right to the City" (see Harvey 2003; Lefebvre 1996; Mitchell 2003), means overcoming exclusionary, "uneven geographies of power and privilege" (Soja 2010, p. 73) and the processes that produce them. Beyond achieving more geographically just outcomes through intervening in the institutions that produce space unevenly, spatial justice is an interpretive framework. Emphasizing the role of space in social processes, Soja asserts that space is not just a passive container for social activity. A dialectic exists between the social and the spatial: the social world encompasses the spatial world, and inherited spaces (i.e., forms of urban built environments, infrastructures. See Brenner and Schmid 2015; Weber 2002) shape social relations. From this sociospatial dialectic, it follows that just as social processes produce spatial injustices (i.e., unequal access to transit, concentrated vacancy, capital flight), successful social movements can (and must) actively produce more spatially just geographies, including a more equitable distribution of resources and social outcomes.

Although Soja theorizes spatial justice without the help of UPE, a framework for analyzing human–environment interactions, UPE is useful in that it reveals how the assumption of passive space is ideologically maintained and in that it can shed light on possibilities for spatial justice. Cities are often viewed as existing strictly in the realm of the social, with city boundaries serving as clear delineations between the social world, occupied by humans, and the natural world, completely external to the social (Smith 1984). UPE challenges this view, arguing that cities are the result of processes that are simultaneously social and environmental. Humans use their labor power to *metabolize* nature, or physically transform raw materials, producing commodities that culminate into the urban environments humans generally refer to as "cities" (Swyngedouw 2006). In this framework, cities are an agglomeration of metabolized natural resources, as much a part of nature as forests, bodies of water, or any other natural entity (Heynen et al. 2006). As suggested by the sociospatial dialectic, cities are a spatial and historical socionatural process—metabolizing nature effects changes to space, dictating metabolic interactions in the future. Because the metabolization of nature is socially mediated, social power dynamics determine what kinds of commodities are produced, where and how those commodities are distributed, and who ultimately profits (Heynen et al. 2006).

UPE therefore rejects passive notions of space, revealing a socially constructed, spatial organization of capitalist society in which cities only *seem* to be the dominant sphere of social activity. Rather, space is actively produced by exchange value-driven processes that drive an unequal geographical distribution of metabolized natural resources at multiple scales (Lefebvre 1992 [1974]; Smith 1984; Soja 2010). At the macro and meso scales, there exists an international and inter-urban competition for capital and natural resources (Brenner 2004; Peck and Tickell 2002; Rice 2007). At the micro scale, the natures that are metabolized from hinterlands and brought into the city are distributed unevenly, on the basis of power structures defined along the lines of race, class, and space (Soja 2010).

Through making visible the society-nature divide, UPE shows how the city becomes an ideological, normalized container in which exchange value-driven processes dominate. Metabolized natures are distributed unequally in accordance with market dynamics, which lead to the mutually constitutive outcomes of uneven geographical development and social stratification. In the context of UPE, spatial justice entails disrupting the ideological society-nature divide that makes possible an urban space organized by exchange value rather than use value.

Urban community gardening and ecological gentrification

Community gardens are collaborative uses of space in which food and non-food items are grown. By explicitly inserting

nature back into the city, reclaiming urban space for use values, urban community gardens have been a key element in discussions regarding spatial justice (Barron 2017; Eizenberg 2012; Stehlin and Tarr 2017). While much of the literature focuses on urban agriculture and its relation to food access and food sovereignty (Alkon and Agyeman 2011; Alkon and Mares 2012; Block et al. 2012; Barron 2017; White 2011), other positive outcomes of community gardening include claiming local sovereignty over urban space (Eizenberg 2012; Safransky 2017; Schmelzkopf 2002; Staeheli et al. 2002), educational value (Irazábal and Punja 2009), health promotion (Wakefield et al. 2007), and community cohesion and integration among marginalized groups (Beckie and Bogan 2010; Wakefield et al. 2007; Flachs 2010).

Amid these benefits, other scholars have taken a more critical approach, discussing how community gardens can be co-opted by structures of neoliberal governance that they often are trying to resist (Drake 2014; McClintock 2011, 2014; Pudup 2008; Ramirez 2015). Further, motivations for urban gardening and agriculture vary, without always having a clear social justice initiative (Birky and Strom 2013; McClintock and Simpson 2018). Another roadblock is access to resources, and while external organizations can help community members develop a community garden, such assistance can lead to uneven power dynamics (Block et al. 2012; Ghose and Pettygrove 2014; Slocum 2007). Finally, the long-term future of individual community gardens is often unclear, as broader development plans can jeopardize the use of urban space for gardening (Drake and Lawson 2014; McClintock 2010; Pothukuchi 2017).

A specific tension within community gardening is ecological gentrification, which occurs when gentrification happens in conjunction with an ostensibly positive environmental change (Dooling 2009; Quastel 2009; Gould and Lewis 2016), potentially resulting in the displacement of marginalized people for whom community gardens are supposed to benefit. Recalling Soja's (2010) sociospatial dialectic, a change in neighborhood space that results from implementing a community garden leads to a social change in the community by attracting predominantly white, higher socioeconomic status people (Lebowitz and Trudeau 2017; McClintock 2018; Naylor 2012; Quastel 2009; Ramirez 2015). Therefore, though transforming urban space into a community garden has the potential to foster spatial justice through the explicit insertion of nature into the city, reclaiming space for use values, community gardens can also reproduce spatial inequalities by facilitating processes like gentrification. A large gap in the literature exists for assessing the relationship between community gardening and gentrification quantitatively (see Voicu and Been 2008, who found a positive relationship between community gardens and neighboring property values, for a notable exception). Following the background on this paper's study site, St. Louis, Missouri, the analysis presented here begins to fill that gap through spatial regression analysis.

Contextualizing St. Louis: the rent gap

For a case study of how multiscalar processes of uneven geographical development manifest as local spatial injustices, one has to look no further than St. Louis, Missouri. A combination of macro-economic forces (Swanstrom 2011), suburbanization and white flight (Gordon 2009, 2013), a history of planning practices biased against African Americans (Gordon 2009, 2013; Tighe and Ganning 2015), and a triage approach to revitalization (Tighe and Ganning 2015) has created a decidedly spatially differentiated city landscape, with social ills like poverty, vacancy rates, and long-term population loss being concentrated on the City's northern side (Prener et al. 2018).

Due to the steady migration of St. Louis residents to the suburbs and other regions, the Gateway City has large swaths of vacant and unused plots of land, which has initiated multiple programs aimed at transforming blighted areas into socially desirable spaces. For example, the *Mow to Own* program allows City residents to acquire publicly-owned vacant lots by agreeing to maintain the land and pay property taxes for a period of 24 months (St. Louis City 2017a). Another program, offered by the Land Reutilization Authority (LRA), a public land bank, authorizes residents, neighborhood associations, and community organizations to lease vacant lots for a dollar a year (up to 5 years), incentivizing the lessee to turn the plot into a vegetable or flower garden. Over 500 lots have been leased since the program's implementation in 1994 (St. Louis City 2017b).

However, the garden lease program was not established with the explicit goal of promoting spatial justice among excluded populations. To quote the program's website, "Some individual lots are not for sale because they are needed for larger, planned development. Until that development happens, a garden lease gives the lessee site control so that they can fence it to prevent foot traffic, build a community garden or just enjoy the extra space" (St. Louis City 2017b). Therefore, while the program may temporarily provide space for a community garden, such gardens do not necessarily fit into the City's long-term vision. These gardens serve as beautifying placeholders until the City is ready to carry out its broader plans for development.

I use a rent gap framework to suggest that community gardens, including those from the garden lease program, may have a role in facilitating gentrification. Developed by Smith (1979, 1982), the rent gap is a gentrification theory that emphasizes the role of capital in gentrification, as opposed to a demand-side analysis that places an emphasis on the decision-making process of individual consumers.

The rent gap explanation of gentrification describes a historical process under which capital moves and people follow. As a city first develops, capital is centralized into a central business district. However, capital is immobile and immediately begins to lose value. At this point, capitalists can choose to invest in the upkeep of existing capital or expand outwards. Because outward expansion has potential for higher revenues than maintaining existing capital, developers opt for building new capital on the urban periphery to the detriment of existing capital, leading to the creation of and subsequent migration to suburbs. This expansion continues until capital in the inner city has deteriorated to a point when redevelopment is more profitable than collecting rents in its current state. Capital flows back to the city, people follow, and gentrification occurs.

I hypothesize that community gardens in St. Louis are serving as part of the capital flow back to the city in St. Louis's historically neglected neighborhoods. If this is the case, an in-migration of higher socioeconomic status people should follow, indicating that community gardens are a facilitator of ecological gentrification. Following Tornaghi's (2014) call for research to examine the critical geographies of urban agriculture and the work of Paddeu (2017) and Pothukuchi (2017), who took a critical approach to urban agriculture as a planning strategy in similarly vacancy-inundated Detroit, the analysis that follows is dedicated to examining the relationship between community gardening and gentrification in St. Louis.

Data and methods

To determine whether community gardens facilitate gentrification, two primary sources of data were used: a geocoded list of all known community gardens in St. Louis City and census tract-level socioeconomic data. Gateway Greening, a well-known St. Louis community gardening organization, provided me with a list of every known community garden within the City limits, from which I used those that existed between 2000 and 2010 (N = 127; includes both Gateway Greening member gardens [N = 116] and all known non-member gardens [N = 11]).

The second data source used was Brown University's Longitudinal Tract Data Base (LTDB; see Logan et al. 2014, 2016). Because census boundaries often change for administrative reasons, monitoring demographic changes over time can be difficult. The LTDB is a dataset that accounts for these changes. By normalizing older census data to the most recent boundaries, the LTDB makes it possible to track neighborhood change between each decennial census. I used the LTDB to account for neighborhood change in St. Louis City between the intervals of 1990–2000 and 2000–2010. Other data, such as the location of historic housing and central business districts, came from St. Louis City's open data website (St. Louis City 2017c).

Choosing the appropriate unit of analysis for tracking neighborhood change can be difficult. Census tracts, while convenient because they come with readily available data, are arbitrary administrative boundaries that may not function as real-world neighborhoods. Real-world neighborhood boundaries, on the other hand, are constantly fluctuating and generally do not have accessible socioeconomic data. Therefore, I pursued a different route altogether. In the geographic information science program ArcMap, I used a method called spatial interpolation to divide the City into one square kilometer grid squares. Using the LTDB data, I estimated socioeconomic characteristics of each grid square based on the census tract(s) that intersects it. Estimates of this sort open the door to some level of error, and grid squares do not represent a real-world, functional neighborhood, but they provide a uniform (except for those on the City's edges, which vary in size), stable unit of analysis through time. Moreover, by giving each unit roughly the same number of neighboring units, grid squares allow for a more robust spatial regression analysis (Maimaitijiang et al. 2015) (Fig. 1).

Defining gentrification

According to Smith (1982, p. 139), gentrification is the "… process by which working class residential neighborhoods are rehabilitated by middle class homebuyers, landlords, and professional developers." Implicit in this definition is the relative lack of middle class residents and business interest from landlords and professional developers in one time compared with a future time. Because a rent-gap framework posits gentrification as a "back to the city movement by capital" and people merely follow (Smith 1979), a measure of gentrification with the least lag time might focus on recent building permits in historically deprived areas. However, because I hypothesize that community gardens are serving as part of the initial capital flow back to the city that attracts higher socioeconomic status residents, the best measure of gentrification is one that emphasizes demographics.

Having decided to measure gentrification through demographic changes instead of property redevelopment, it is necessary to discuss the role of displacement in the gentrification process. Citing Atkinson (2000) and Vigdor (2002), Eckerd (2011) notes variation in the results of gentrification studies based on whether displacement is treated as an inherent part of the process or as a byproduct. Given Eckerd's (2011) precedent and St. Louis's high vacancy rate theoretically suppressing rent prices, I chose to treat displacement as a byproduct rather than an inherent part of gentrification. As noted in the later discussion on model building, I controlled for population loss during

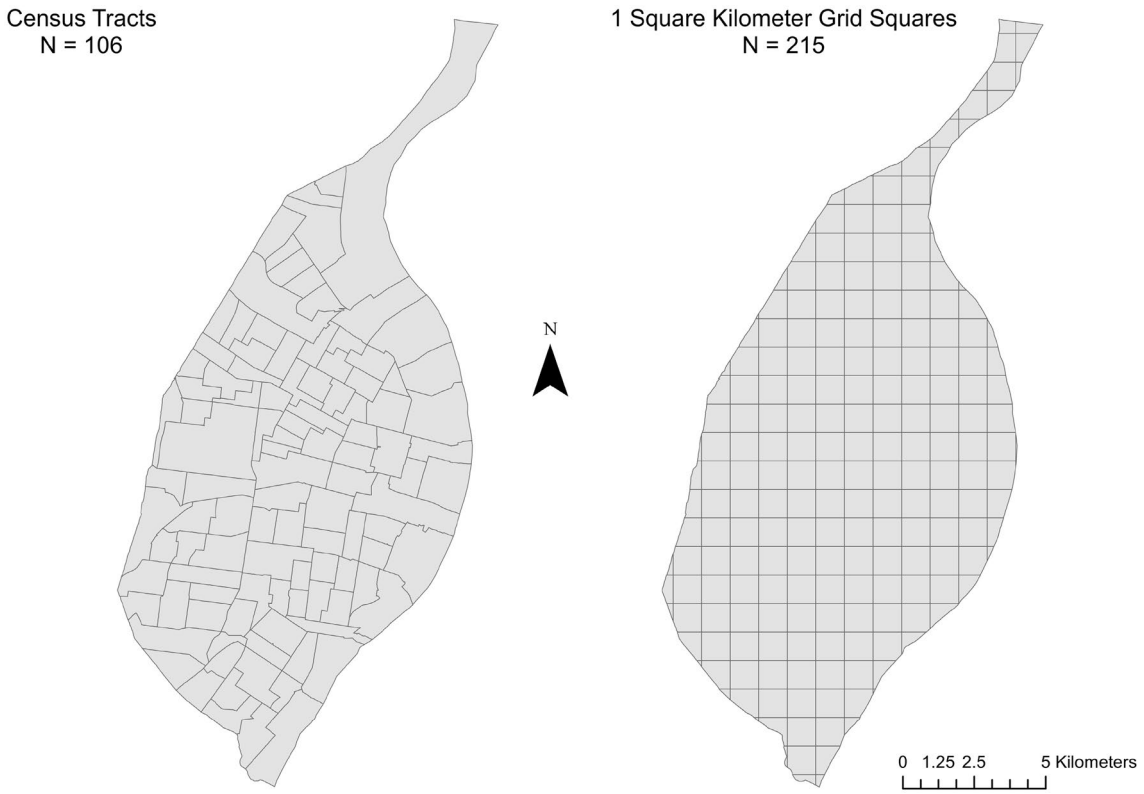

Fig. 1 St. Louis City census tracts versus grid squares

regression analysis, but I did not incorporate displacement within the dependent variable itself.

Given this study's focus on demographic change and methodological choice to use regression analysis, I again follow Eckerd's (2011) precedent and adopt the gentrification index created by Ley (1986, 1996). Ley's gentrification index is a −1 to 1 ratio scale that measures change in socioeconomic status between two periods of time. The index uses the average of the proportion of residents aged 25 or older with at least a bachelor's degree and the proportion of residents in a professional or managerial class job in Time B and subtracts from it the same figure in Time A. The result is a scale in which positive values indicate an increase in socioeconomic status (gentrification), negative values show a decrease in socioeconomic status (decline), and a value of 0 reveals no change. Using this index, a gentrification score was assigned to each of the 215 grid squares that compose St. Louis. In the below equation, P refers to the proportion of the labor force with professional or managerial class positions and E refers to the proportion of the population aged 25 and older with a bachelor's degree.

$$\textit{Gentrification Index} = \left[\left(P_{2010} + E_{2010}/2\right)\right] - \left[\left(P_{2000} + E_{2000}/2\right)\right]$$

Controlling for time

This analysis models gentrification between the years 2000 and 2010, and therefore includes gardens that existed during that time frame. Because I used a demographic measure for gentrification, theorizing that there will be a lag time between the creation of a garden and an influx of higher socioeconomic status residents, I assumed that community gardens created in the year 2000 had more time to affect a neighborhood's demographics in 2010 than one created later, such as in 2009. As such, I applied a temporal weight to each garden. Gardens created in or before 2000 were multiplied by 1, gardens created in 2001 by 0.9, gardens created in 2002 by 0.8, and so on. For the twelve gardens that did not have a listed year founded, I imputed the mean year founded (the range spanned from 1983 to 2015) for all gardens in the raw dataset provided by Gateway Greening: 2005. Models that factored in unique characteristics of each garden, such as member counts, whether or not there was a waiting list to join, whether the garden grew food (N = 96) or was strictly ornamental (N = 31), and whether the garden was associated with a school (N = 34) also were analyzed. However, these variables often had incomplete data and the results of the analyses with the additional weights applied were

Table 1 Temporal weight for community gardens

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1

Table 2 Variables used in regression analysis

Variable name	Description
Gentrification index 2000–2010 (dependent variable)	Proportional change in high socioeconomic status residents (professional/managerial class workers, college-educated residents)
Weighted garden count	Community gardens per grid square, with the temporal weight applied
Vacancy rate 2000	Proportion of housing units vacant
Median household income 2000	Median household income (thousands of dollars)
Proportion population change 2000–2010	Proportional change in population per grid square
Proportion African American population change 2000–2010	Proportional change in African American population per grid square
Gentrification index 1990–2000	Proportional change in high socioeconomic status residents (professional/managerial class workers, college-educated residents)
Historic housing district	Square kilometers of historic housing within grid square
Central business district	Distance from central business district (kilometers)

not significantly different from those that included only the temporal weights, so they are not included here (Table 1).

Spatial error modeling

To account for the role of space in St. Louis's gentrification process, it was necessary to move beyond ordinary least squares regression and use a technique that accounts for spatial autocorrelation, which is present when the dependent variable is correlated with itself throughout space. A spatial error regression[1] incorporates another error term, lambda, which can be thought of as an error-adjustment variable that controls for residuals that are correlated throughout space (Anselin and Rey 2014). Analyses were conducted in the spatial statistics software GeoDa 1.8.16.4, using the rook spatial weighting method.[2]

As a base model, I used the vacancy rate in the base year (2000), median household income in the base year, proportional change in population between 2000 and 2010, and proportional change in the African American population over the same interval. In neoclassical economics, due to excess supply driving costs down, a high vacancy rate should theoretically lead to enterprising professional and managerial class people taking advantage of cheap rents and home prices, leading to an influx of higher socioeconomic status people. The inclusion of income is related to a neighborhood's initial economic health—one would expect a neighborhood that is already economically healthy to have only so much room to gentrify. The population variables were included due to the failure of the gentrification index to account for displacement. If no displacement occurred, one would expect gentrification to be associated with a significant increase in population as higher socioeconomic status residents move in. If displacement did occur, given the racialized development history of St. Louis, it is likely that gentrification would be associated with a significant decline in a neighborhood's African American population.

Other predictors used are the gentrification index for the previous decade, the distance from the central business district (Downtown St. Louis), and the square kilometers of historic housing in each grid square. I included the gentrification index of the previous decade because, like cities themselves, gentrification is a historical process. A neighborhood cannot grow in high socioeconomic status residents in perpetuity. Thus, if a neighborhood gentrified heavily in the 1990s, it may be less likely to continue gentrifying in the 2000s. Because neighborhoods with historic housing stock or that are near the central business district have been linked with gentrification (Brueckner and Rosenthal 2009; Kolko 2007), I calculated the distance of each grid square's centroid from the centroid of the central business district, as well as the cumulative area of historic housing districts within each grid square (Table 2).

[1] Spatial error modeling was used over the spatial lag method in accordance with Anselin and Rey's (2014, p. 110) spatial specification decision tree.

[2] This means that only grid squares that touched each grid square's edges (and not corners) were counted as neighbors in determining spatial dependence.

Table 3 Raw and weighted garden counts

Raw garden count	Frequency	Weighted garden count	Frequency	Mean
0	140	0	140	0
1	48	0.01–0.30	11	0.18
2	14	0.31–0.60	15	0.51
3	7	0.61–0.90	8	0.79
4	3	0.91–1.50	25	1.06
5	1	1.51–2.10	6	1.85
6	1	2.11–2.70	5	2.3
7	1	2.71+	5	3.52
Total	215	Total	215	

Results

Descriptive statistics

Table 3 shows both the raw and weighted frequencies of gardens in each grid square. About 65% (N = 140) of the grid squares contained no gardens, while the remaining 35% (N = 75) contained between one and seven gardens. Among grid squares with community gardens, the modal number is one. After applying the temporal weight to each garden, the numbers change but the overall distribution is similar. Grid squares with few or no gardens are more prevalent than grids with many gardens. If a grid square has a weighted garden count of one, then it contains the equivalent of one garden that has been active since the year 2000 or earlier. Among grid squares with gardens, the majority (N = 41) have the equivalent of one or more such gardens. Twenty-five grid squares have a weighted count between 0.91 and 1.50, and sixteen grid squares have a weighted garden count exceeding 1.5. As shown in Table 4, the mean weighted garden count is 0.383, with a maximum of 5.3.

Descriptive statistics for each variable are shown in Table 4. The dependent variable—the gentrification index from 2000 to 2010—has a mean score of 0.040. Put differently, the average grid square had a 4% increase in socioeconomic status (professional/managerial class residents and people 25 or older with bachelor degrees) from 2000 to 2010. The gentrification index from 1990 to 2000, with a mean of 0.047 is not dissimilar, but the difference in standard deviation is noteworthy. The 1990–2000 index has a standard deviation of 0.038, whereas the 2000–2010 index has a much larger standard deviation of 0.073. This disparity, along with the geographic dispersion shown in Fig. 2, indicates much more polarization, particularly between the northern and southern parts of the city, in socioeconomic status change from 2000 to 2010 than from 1990 to 2000.

Figure 3 overlays the distribution of gardens throughout the city on to each grid square's 2000–2010 gentrification score. As a reference point, the map includes Delmar Boulevard, a historic segregation line, north of which has higher proportion of African American neighborhoods and more concentrated economic deprivation (Gordon 2009, 2013). The mean geographic center of all community gardening in St. Louis lies just south of Delmar. Of the 127 gardens in the dataset, 57 are north of the Delmar divide and 70 are located to its south. Sixty-eight percent of community gardens fall within the standard deviational ellipse, which covers sizeable areas on both sides of Delmar. While most of the grid squares that experienced decline in socioeconomic status were in the northern part of the city, several grid squares above Delmar did gentrify between 2000 and 2010 and have gardens located inside of them. Overall, gardens were located both in grid squares that gentrified and in grid squares that experienced decline.

Spatial regression results

Table 5 shows spatial regression results for gentrification between 2000 and 2010. Model 1 is the base model,

Table 4 Descriptive statistics

Variable	N	Mean	Standard deviation	Minimum	Maximum
Gentrification 2000–2010	215	0.040	0.073	−0.098	0.216
Weighted gardens 2000–2010	215	0.383	0.748	0	5.3
Proportion change in population 2000–2010	215	−0.052	0.230	−0.381	1.80
Proportion change in African American population 2000–2010	215	0.005	0.078	−0.253	0.202
Median income 2000	215	$26,197	$6708	$11,512	$42,707
Vacancy rate 2000	215	0.174	0.084	0.027	0.389
Gentrification 1990–2000	215	0.047	0.038	−0.078	0.133
Historic housing district (square kilometers)	215	0.136	0.248	0	0.931
Distance from central business district (km)	215	7.29	3.35	0.489	16.2

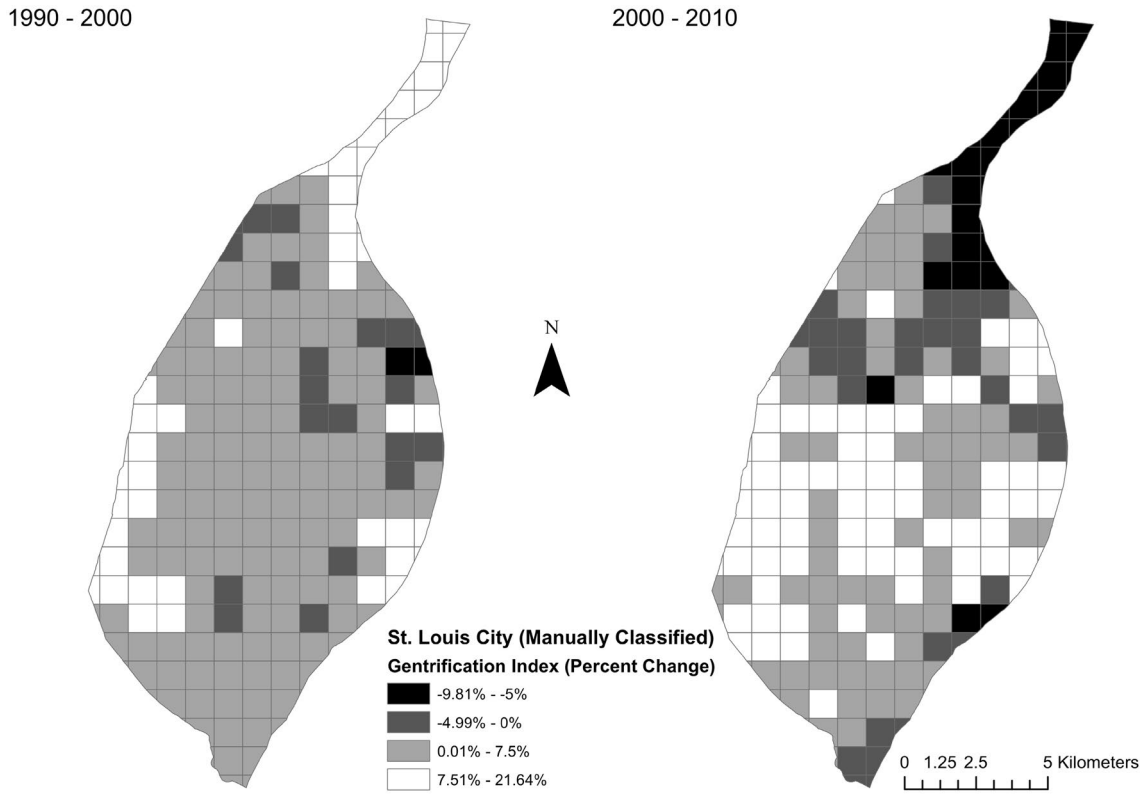

Fig. 2 Gentrification indices from 1990–2000 and 2000–2010

consisting of the 2000 vacancy rate, 2000 median household income, the proportional change in population between 2000 and 2010, and the proportional change in the African American population between 2000 and 2010. In this model, only the vacancy rate and proportional change in the African American population were significant, with both negatively associated with gentrification. Model 2 included only the primary explanatory variable of interest, the weighted community garden count. After accounting for spatial effects, community gardening on its own was not significant. Community gardening remained insignificant in Model 3, which included the base model, but became significant in Model 4, which accounted for the base model and the gentrification index from the 1990s. Model 4 also yielded significant, negative associations between the gentrification index for the 2000s and the vacancy rate, proportional change in the African American population, and gentrification in the 1990s. Model 5 includes the square kilometers of historic housing districts in each grid square and distance from the central business district. The direction and significance of the associations from Model 4 remain, though community gardening narrowly lost its statistical significance ($p = 0.052$). Each square kilometer of historic housing was associated with 25% more gentrification, and each kilometer in distance from the central business district was associated with 0.56% less gentrification. In each model, lambda is very strong and significant, indicating that factors not controlled for are correlated throughout space. However, the test for spatial dependence remained significant throughout all five models, suggesting that some spatial effects were not accounted for.

Although Model 5 has marginally more explanatory power, it is not the best linear unbiased estimate because it violates the assumption of homoscedastic errors. Model 4 does not violate this assumption, as evident by its statistically insignificant Breusch–Pagan test. Model 5 incorporates historic housing districts and distance from the central business district, both statistically significant variables, but they do not substantially add explanatory power (an R-squared increase of only 0.0020) to account for the variance in gentrification from 2000 to 2010. Thus, of the five models shown, Model 4 is the best linear unbiased estimate.

Discussion

The above results provide support for the claim that community gardens are a facilitator of ecological gentrification: a positive association existed between community gardening and gentrification in St. Louis, Missouri between 2000 and 2010. These results fit neatly into the rent gap approach to

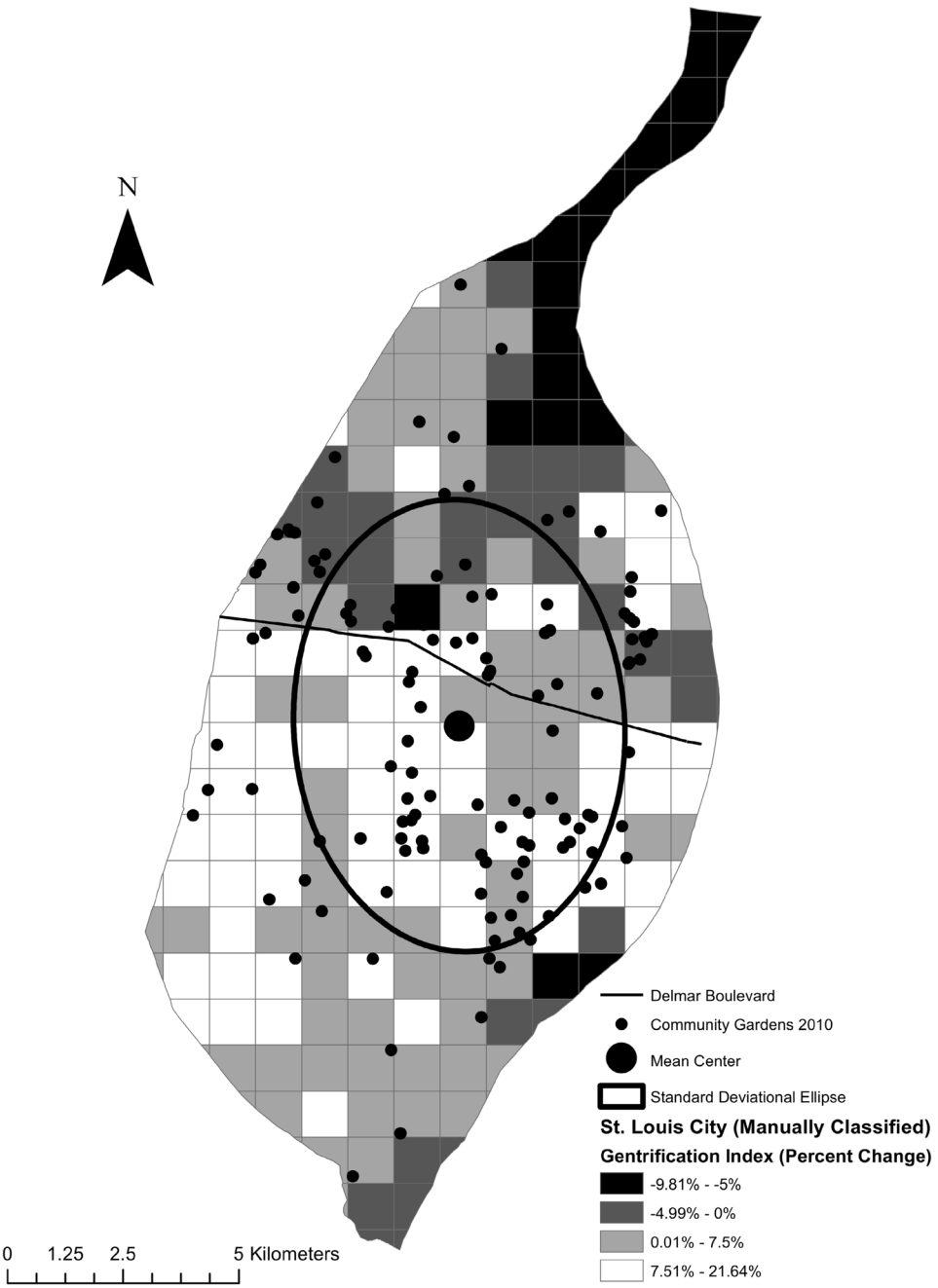

Fig. 3 Community gardens and gentrification

theorizing gentrification. In the rent gap approach, gentrification occurs when it becomes more profitable for developers to redevelop deteriorating capital in the inner city than to continue collecting rents on capital in its existing state. Following this redevelopment, professional and managerial class people move to the city, raising the socioeconomic status of the neighborhood and potentially forcing out the previous residents. In accordance with the sociospatial dialectic, transforming the *physical* environment leads to an unintended change in the *social* makeup of the community.

In St. Louis, community gardens are part of the return of capital to the city in its gentrification process. The City's garden lease program allows community members and organizations to use vacant plots of land for gardening until that land is needed for broader development plans. Community gardens are associated with an influx of high socioeconomic status residents, for whom spatial justice for marginalized groups may or may not be a priority, to neighborhoods where they may have otherwise chosen not to live. This externality of community gardening—gardening's role in the gentrification process—conflicts with community

Table 5 Spatial error models for gentrification

Gentrification index, 2000–2010	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.0670 (0.0407)	0.0384 (0.0185)*	0.0666 (0.0406)	0.1028 (0.0333)**	0.1369 (0.0371)***
Vacancy rate, 2000	−0.2377 (0.0807)**		−0.2444 (0.0808)**	−0.3301 (0.0673)***	−0.3423 (0.0662)***
Median household income 2000 (thousands of dollars)	0.0006 (0.0011)		0.0006 (0.0011)	0.0014 (0.0009)	0.0016 (0.0009)
Proportion population change, 2000–2010	−0.0082 (0.0169)		−0.0092 (0.0169)	0.0157 (0.0142)	0.0171 (0.0140)
Proportion African American population change, 2000–2010	−0.5038 (0.0630)***		−0.5065 (0.0628)***	−0.5223 (0.0518)***	−0.4872 (0.0510)***
Weighted garden count		0.0019 (0.0035)	0.0033 (0.0030)	0.0057 (0.0025)*	0.0049 (0.0025)
Gentrification index, 1990–2000				−0.8545 (0.0856)***	−0.8507 (0.0846)***
Historic housing district					0.250 (0.0119)*
Central business district					−0.0056 (0.0027)*
Lambda	0.8665 (0.0320)***	0.8692 (0.0315)***	0.8658 (0.0321)***	0.8482 (0.0348)***	0.8148 (0.0396)***
Observations	215	215	215	215	215
R-squared	0.8236	0.7620	0.8245	0.8777	0.8790
Breusch–Pagan	24.06***	0.2843	25.54***	9.90	24.41**
AIC	−817.995	−758.980	−817.215	−896.721	−900.582
BIC	−801.142	−752.239	−796.991	−873.126	−871.246
Log likelihood	413.998	381.490	414.607	455.360	459.791
Test for spatial dependence	233.428***	235.896***	224.783***	183.169***	139.045***

*p < 0.05, **p < 0.01, ***p < 0.001

gardening's, in many cases, ideal function: promoting spatial justice in neighborhoods that have been subjected to spatially unjust outcomes.

Despite de-commodifying urban space by explicitly inserting nature into the city, community gardens exist within the context of the broader market system, in which all kinds of natures are produced and commodified, creating markets for everything from basic survival needs to luxury goods. Community gardens can challenge the neoliberal order by returning the relationship between communities and select urban spaces to one characterized by use values. There is no mechanism to prevent broader processes from co-opting a community garden, however, leading to a spike in the symbolic, cultural, and eventual economic value of the neighborhood as a whole (McClintock 2018). As Stehlin and Tarr (2017) suggest, the localized nature of community gardening creates a 'scalar mismatch' in which processes that produce spatial injustice are occurring at broader scales than the local level on which community gardens operate. The findings presented in this paper indicate that this may be precisely what happened with community gardens in St. Louis during the study period. Though they insert nature into the perceived "unnatural" city, connecting residents to the metabolic process with their local space, community gardens can be co-opted by the real estate market, facilitating an increase in demand by higher socioeconomic status people and ultimately increasing the exchange value of the surrounding space. This outcome of the sociospatial dialectic represents a structural constraint of community gardening. Regardless of the primary function of each community garden and the good intentions of the community gardening movement, while broader market forces are still at work, the potential exists for community gardens to be co-opted for the reproduction of racialized, market-driven spatial injustices.

To the extent that the above research can provide insight on the degree to which community gardens are an effective tool for achieving spatial justice, I will do so here. If community gardens are simply associated with increase in socioeconomic status of the population, it could be argued that no harm is being done—the original residents can still reap the benefits of having and working in a community garden in their neighborhood. But due to the displacement of low income people of color being an often byproduct of gentrification, further examination of the association between the population change variables and the gentrification index can shed light on how community gardening's role in gentrification may affect marginalized people.

If no displacement effects were occurring, one would expect to see a positive association between population change and gentrification, but none of the five models showed a statistically significant relationship between the two variables. Proportional change in the African American population, however, was negatively associated with gentrification. While this effect is not causal (in theory, causality would go the other way), it does hint at a displacement effect between gentrification and African American residents. Community gardens play a role in gentrification which, in turn, is associated with a loss of the residents who might benefit most from community gardening.

Another association of interest is between the vacancy rate and gentrification. Because of the LRA garden-lease program (about 31% of the gardens in the analysis are LRA-owned; N = 40) and the fact that idle land is needed to start a community garden, one would expect an interaction between community gardening and the vacancy rate. A neighborhood with more vacant properties has the potential for more community gardens. But here, high vacancy rates were negatively associated with the gentrification index. To this end, the relationship between vacancy and gentrification may not be precisely linear. Moderate vacancy areas may be ripe for the addition of community gardens, but high vacancy areas might simply be too blighted for successful growth-oriented redevelopment, leading modeling efforts to show a negative association between vacancy and gentrification. In the cases of high vacancy and declining socioeconomic status, the gentrifying externality of community gardens could be a positive outcome. Not only would gardens promote spatial justice in these parts of the city that have been most neglected, but they could slow the decline in existing high socioeconomic status residents.

Recalling Model 4, community gardening did not have a significant relationship with gentrification from 2000 to 2010 until the inclusion of the gentrification index from 1990 to 2000. A possible reason for this is that after a certain amount of time, a decaying relationship exists between community gardens and gentrification. The inclusion of gentrification in the 1990s may have captured an effect from the older gardens (i.e., established before the year 2000) that did not exist for gardens established in the 2000s. This would suggest that the gentrification externality of community gardening lessens if a garden can achieve long-term durability.

Lastly is the individual impact of each community garden. While the association between gardening and gentrification is positive and significant, the actual increase in gentrification associated with each community garden was relatively small. The increase in the model's explanatory power due to the inclusion of community gardening was comparatively minor. This is to say that community gardening does not contribute to gentrification in isolation. Indeed, in framing the relationship between community gardening and gentrification through the rent gap framework, I argue that community gardens are only *part* of an initial capital flow back to the city. The gentrifying externality of community gardening is only one contribution to the redevelopment process.

Going forward: urban community gardening and spatial justice

In short, there are many nuanced factors at play when accounting for the effect community gardens have on people in marginalized neighborhoods. Because this research does not measure each community garden's ability to achieve spatial justice, but rather an externality in their contribution to gentrification, fully measuring their net benefit is beyond the scope of this work. But this paper can provide context for the broader community gardening movement going forward. By having a clearer understanding of the externalities associated with community gardening, community gardeners can adjust to its limitations and implement community gardens in such a way that maximizes their utility and minimizes unintended outcomes. I put forward suggestions based on two criteria: location and institutionalization.

Schukoske (2000) advocates for implementing community gardens in areas with high vacancy rates. The results here support that case. Not only do these areas have large swaths of unused land, but they are associated with decline in the population's socioeconomic status. Incorporating community gardens in these places can put the idle land to work, provide a potential source of food to its residents, foster a sense of control over public spaces and strengthen community identity for those who can participate (Ghose and Pettygrove 2014), and even serve as a counterweight to the decline in high socioeconomic status residents. Areas such as these have the most to benefit from a rich community gardening movement and, compared with areas that have lower vacancy rates, a smaller risk of being harmed by its gentrifying externality.

However, community gardening in high vacancy areas is not without challenges. Similar to the temporary nature of gardens started through St. Louis's garden lease program, Pothukuchi (2017) notes that urban agricultural practitioners in Detroit's high-vacancy areas worry that urban agriculture is not in the City's long-term plans, and even with the assistance of land banking programs and garden-friendly policies, long-term access to land is an ongoing struggle. As Paddeu (2017) argues, urban agriculture initiatives are not socially just uses of space in a vacuum, but rather neighborhood and city planners must explicitly account for the spatial injustices associated with urban decline when creating institutionalized environments for growing food in urban spaces. This again speaks to Stehlin and Tarr's (2017) contention that urban gardening initiatives have limitations as

spatial justice tools due to an incongruence of scale. While community gardens can promote spatial justice on the local level, they cannot on their own contend with broader forces that produce spatial injustice, like capital flight driven by meso and macroeconomic forces, discriminatory planning practices, or the displacement of marginalized residents due to gentrification. To deal with these larger-scale forces, institutionalized, democratic planning efforts committed to addressing the neglected needs of marginalized communities are needed, in addition to a spatially just proliferation of community gardens.

Limitations and future research

As with any study, accounting for certain factors could have strengthened the analysis presented in this paper. One such factor is dual causality. This paper tested whether community gardening is associated with gentrification. The implications of that question are important, but it is only half of the equation. In addition to facilitating gentrification, it is possible that community gardens are more likely to appear in areas that are already gentrifying. If that is the case, the question then becomes how much a city's community gardening movement is centered on promoting spatial justice versus the extent to which it is simply a lifestyle choice for its gentrifiers. While past work has sought to determine the motivations underlying urban agricultural initiatives (McClintock and Simpson 2018), future research may seek to determine whether community gardens are more likely to appear in neighborhoods that are undergoing gentrification.

Methodologically, the statistical analysis conducted here is only a high-level view with limited data. While my dataset contained limited characteristics specific to each garden, incorporating them into the garden weighting system did not yield significantly different results than simply accounting for temporal variation. An ideal dataset would include specific demographic information on the individuals who work in each garden (such as whether or not they live in and are representative of the neighborhood in which the garden is located), the motivations underlying the establishment of each garden, and qualitative differences between gardens, such as variation in what they grow or in how aesthetically pleasing they are to observers. Future research would do well to combine quantitative methods with qualitative field work. Through qualitative methods, a researcher would be able to fill in these gaps and create more a more robust weighting system for the type of quantitative analysis conducted here.

Conclusion

In this paper, I combined the lenses of spatial justice, urban political ecology, and the rent gap theory of gentrification into a framework for studying the relationship between community gardening and gentrification in St. Louis, Missouri. Spatial error regression modeling showed a positive, significant association between community gardening and gentrification between the years 2000 and 2010. Thus, despite their many possibilities for helping to achieve spatial justice through explicitly inserting nature into the city and reclaiming urban space for use values, community gardens are associated with an influx of higher socioeconomic status residents, opening avenues for spatial injustices to occur via gentrification. As such, I argued that community gardening meets structural constraints as a tool for spatial justice. Although they provide a mechanism for rejecting the normalized assumption that city boundaries are a passive container for purely social, exchange value processes, the gentrifying externality of gardening's sociospatial dialectic shows that community gardens are not immune from co-option by the broader forces that produce spatial injustices. To overcome these scalar incongruences, larger-scale policy mechanisms must be enacted to ensure that community gardens with a spatial justice orientation can achieve spatially just outcomes.

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