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Strategic Spatial Opportunities for Local Food Distribution: Urban Accessibility of Community Gardens in Christchurch, Aotearoa New Zealand

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Abstract

This study explores strategic opportunities for improving access to and distribution of locally produced food. Food consumption in urban areas often depends on long and distant supply chains and corporate distribution points such as supermarkets. Poor integration of local urban food production is a source of food insecurity as much as an ecological, social, and infrastructural problem. It creates pressures on the supply and logistics of food distribution, challenging the resilience of the entire system, particularly in the context of sudden (e.g., earthquakes, floods, bushfires) and slow-onset disasters, such as climate change. This article explores how strategic spatial opportunities for community-oriented, urban food production sites could make cities more resilient from a food security and social accessibility perspective. With the help of a case study—urban community gardens in Christchurch, Aotearoa New Zealand—and geographic information system (GIS) analysis, the article proposes a method to examine spatial accessibility to urban community gardens and examines associated socio-demographic factors, in comparison to commercial food outlets (supermarkets). The results suggest that the applied method is useful in examining the spatial accessibility of gardens within their specific demographic context. They reveal that urban community gardens in Christchurch are mainly located in more deprived areas and that walkable access to gardens is provided to about one-fifth of the city's total population. The article discusses the results within the context of specific spatial and demographic urban characteristics, including low density, car dependency, and disaster susceptibility, and provides suggestions for further research and urban planning policy.

Keywords

15-minute city; community garden; food access; food distribution; food resilience; food security; urban agriculture

1. Introduction

Community gardens (CGs) have been broadly defined as community-managed, shared, green open spaces for mainly horticultural uses that may comprise allotment-style and collectively operated gardens providing a broad variety of social, economic, environmental, and cultural benefits (American Community Garden Association, 2024; Guitart et al., 2012; Zheng & Chou, 2023). The many benefits of CGs have been widely discussed, and it goes beyond the scope of this study to reiterate them in detail. They range from physical and mental health to economic, food security, agrobiodiversity, and social interaction benefits (American Community Garden Association, 2024; Raneng et al., 2023). Several authors have highlighted the role of urban CGs in the context of disasters and disaster resilience (Chan et al., 2015; Kato et al., 2014; Okvat & Zautra, 2014; Shimpo et al., 2019; Sims-Muhammad, 2012; Wesener, 2020). The National Research Council (2011, pp. 13–14) defines resilience as "the continued ability of a person, group, or system to adapt to stress—such as any sort of disturbance—so that it may continue to function, or quickly recover its ability to function, during and after stress." CGs offer many resilience-related benefits, including the mitigation of food shortages following the disruption of supply chains, social and mental health services, post-trauma therapy, positive emotions, and the provision of safe spatial settings. Benefits are often created incrementally, e.g., through daily routines and social interactions that may help people prepare better for future crises and thus increase the overall resilience of (urban) systems (Wesener, 2020). Benefits can often be enjoyed by community gardeners and local communities alike (Anderson et al., 2019; Dubová & Macháč, 2019). The "spatial spread" of CG benefits beyond the immediate boundaries of a garden is also the focus of this study through investigating the spatial accessibility of CGs to neighbouring urban areas and associated communities.

Food consumption in urban areas depends often on long and distant supply chains and corporate distribution points such as supermarkets. Poor integration of urban food production with the built environment and associated problems with spatial accessibility are sources of food insecurity (Jensen & Orfila, 2021) as much as an ecological and a social problem (Oscilowicz et al., 2022). While urban CGs are often not able to produce enough food to supply even their immediate neighbouring communities, they provide spatial potential as alternative food distribution points. This study does not assess the production capacities of CGs, rather, we undertake a spatial analysis of urban CGs to investigate their potential as alternative urban food production and distribution locations. The study follows the hypothesis that urban CGs could provide accessible, community-oriented food production and distribution points based on local supply chains as part of a wider strategic vision that may include collaborations with peri-urban food producers. Creating an alternative food distribution network could make cities more resilient from a food security perspective, more specifically, moving towards the direction of "all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy and active life" as defined by the World Health Organisation, as cited in Toi te ora (2023).

Access to food sources has been examined by past studies showing that access to healthy and affordable food, such as fresh fruits and vegetables, is influenced by residential distribution, including disparities between neighbourhoods based on race and income (Block & Kouba, 2006; Chen, 2017; Giang et al., 2008; Glanz et al., 2007; Hendrickson et al., 2006; Larson et al., 2009; Powell et al., 2007; Raja et al., 2008; Walker et al., 2010; Zenk et al., 2006). Many urban areas do not have reasonable access to food sources, limiting access to healthy food and food choice (Walker et al., 2010). Limited access to healthy food was found to correlate

with poorer health outcomes—in areas with the poorest access to food, residents experience greater health challenges with diet as a risk factor (Giang et al., 2008; Hendrickson et al., 2006; Schafft et al., 2009; Walker et al., 2010). For the residents who lack access to a personal vehicle for travelling to food sources beyond their immediate neighbourhood, living in a "food desert" can be even more detrimental (Lake & Townshend, 2006; Walker et al., 2010).

In addition to studies investigating spatial access to grocery stores, recent studies have also examined the spatial and social access to alternative food sources such as CGs. Limerick et al. (2023), for example, examined the percentage of the population who have 15-minute walking access to a CG in New York City, and how demographical characteristics were related to the geographical distribution of the gardens. The results show that over half of New Yorkers have 15-minute walking access to a CG. Neighbourhoods characterised by lower income, a smaller proportion of white residents and homeowners, and higher rates of educational attainment have even better access to a CG (Limerick et al., 2023).

While the literature on spatial and social access to food sources is extensive (Chen, 2017; Hendrickson et al., 2006; Larson et al., 2009; Li, 2022; Limerick et al., 2023; Powell et al., 2007; Raja et al., 2008; Schafft et al., 2009; Walker et al., 2010), much responds to the North American context, where the social and infrastructural context is significantly different from Aotearoa New Zealand—the context in which this study is conducted. Most Aotearoa New Zealand urban settlements have a much lower population density than major urban settlements in North America and, indeed, many other countries in the world (World Bank, 2020). In 2018, Christchurch, the study area of this research, had 369,006 residents at a density of 260 people/km² compared to New York City's 10,772 people/km² (Environmental Health Intelligence New Zealand, n.d.; Open Data Network, 2018). Aotearoa New Zealand also has one of the highest rates of car ownership in the world, with 818 light vehicles per 1,000 people in 2019 (Hipgrave, 2021). And among Aotearoa New Zealand cities, the Greater Christchurch area has the highest rate of car ownership nationally, with only 7% of households not owning a motor vehicle (Christchurch City Council, n.d.; Greater Christchurch Partnership, n.d.). In comparison, more than half of New York households do not own a car (United States Census Bureau, 2023b). However, in comparison to Christchurch, New York City has a highly developed public transportation system, with a high proportion of residents relying on it for their daily commute: 1.87 million New Yorkers use public transportation to commute to work, while only 1.06 million travel by car, either driving alone or in a carpool (United States Census Bureau, 2023a). While Aotearoa New Zealand's cities and towns were built around cars following World War II, car ownership in Aotearoa New Zealand is not universal (Pawson, 2014). In a society where cars and driving are the norm, individuals without access to a car may experience inequities, particularly when it comes to accessing essential living resources. From an environmental, social, and health perspective, active forms of urban transport in Christchurch—particularly walking and cycling—have been recommended and promoted (Christchurch City Council, 2012; Wesener et al., 2022).

In addition to promoting walking and cycling, the Christchurch City Council has also been promoting CGs as a part of the city development through its Food Resilience Policy with a vision "for Christchurch to become the 'best edible garden city in the world'" (Christchurch City Council, 2016, p. 1). One of the goals of the Food Resilience Policy is to have "physical and economic access, by all people, at all times, to enough food to maintain an active and healthy life" (Christchurch City Council, 2014). According to Hanna and Wallace (2022), among the major cities in Aotearoa New Zealand, Christchurch offers the most supportive regulatory

framework for urban agriculture. The urban agriculture practices in Christchurch are facilitated by a collaborative food resilience network and food resilience policy, CG guidelines, an action plan, and tools such as a food foraging map and the Edible Canterbury web portal, demonstrating strong community and institutional leadership and advocacy for urban food cultivation (Hanna & Wallace, 2022). These policies and initiatives reflect Christchurch's reforming identity of "garden city"—a legacy rooted in its abundance of public parks and gardens, historically low-density living, early 20th-century ties to the Garden City movement, as well as the long traditions of the communal gardening history of Indigenous Māori before European settlement, which, while may not directly link to the "garden city" concept, resonate in its contemporary practices (Hanna & Wallace, 2022; Morris, 2006, 2020).

Like many countries in the world, Aotearoa New Zealand is largely urbanised, with 87% of the population living in urban areas (World Bank, 2023). The current zoning policies manage food production and urban housing in a dichotomic way, with habitable land largely classified as either rural or urban (Davis et al., 2023, 2024). This zoning approach deepens the urban–rural divide and thereby poses challenges to the management of food flows from rural commercial agriculture to urban areas (Davis et al., 2023). Aotearoa New Zealand cities, like most modern cities worldwide, rely almost solely on profit-driven commercial food distribution, which provides efficiency but raises concerns about resilience and equity (Chan et al., 2015; Kato et al., 2014; Kharel et al., 2024; Okvat & Zautra, 2014; Shimpo et al., 2019; Sims-Muhammad, 2012; Wesener, 2020).

The distinctive social, infrastructural, political, and historical context of Christchurch provides a unique lens for studying the "physical and economic access" to food sources, as outlined in the aforementioned Food Resilience Policy (Christchurch City Council, 2014). This study, therefore, takes a similar methodological approach as Limerick et al.'s (2023) study in New York City to examine how well sites of urban food access are connected to people in Christchurch and how the connection is influenced by demographic factors. By addressing these questions, we aim to gain a deeper understanding of the spatial distribution and resulting accessibility of urban CGs and their potential as alternative urban food distribution spaces. Additionally, we also seek to better understand how the existing spatial arrangement relates to various socio-demographic groups, with a particular focus on deprived communities. Based on geographic information system (GIS) analysis, the article proposes a method to examine spatial access to urban CGs and associated socio-demographic factors in comparison to commercial food outlets (supermarkets). Based on the 15-minute city concept (Moreno et al., 2021), the method has been developed with the help of a pilot case study. The choice of Christchurch as a case study is meaningful to acquire a better understanding of (walkable) food accessibility patterns in a low-density, car-dependent city.

2. Methods

Christchurch is the largest urban settlement in the South Island of Aotearoa New Zealand. It is home to a population of approximately 396,200 (Christchurch City Council, n.d.). For the purpose of this study, the boundary of the case study has been defined by Stats NZ's definition of the major urban area of Christchurch (Urban Accessibility Indicator), as shown in Figure 1.

The first step of this study involved mapping urban CGs and major commercial food outlets—supermarkets. A list of CGs in Christchurch was obtained through the Canterbury Community Gardens Association, a regional support network for CGs. Street addresses of gardens were verified via satellite maps and mapped in ArcGIS

Figure 1. The urban boundary of Christchurch, defined by Stats NZ's Urban Access Indicator. Source: Adapted from Stats NZ Geographic Data Service (2020) and Land Information New Zealand (2024), licensed under CC Attribution 4.0 International.

Pro using the "Geocode addresses" tool. Thirty-four CGs were included in the analysis. In order to determine how well these gardens can serve as food sources and potential food distribution points, we mapped the catchment area of their 15-minute walking access. The "Network analysis" tool was employed to map the "service areas" of the "facilities"—the CGs. The 15-minute walking access is defined as 800 meters on the network, as an accepted standard (Limerick et al., 2023).

We overlaid the latest Stats NZ census data onto the service areas to link them with population and demographic information. The dataset was based on Statistical Area 1 (SA1) units—the finest-grained census zoning of the New Zealand census output geography. SA1s normally encompass populations of 100–200 residents, with a maximum of approximately 500 residents (Stats NZ, 2021). This fine-grained zoning provides more detailed information about population characteristics than at the mesh block level. In total, there were 2,290 tracts within the urban boundary of Christchurch City at the New Zealand census SA1 level. We estimated the number of residents who were covered by 15-minute service areas in each SA1 tract according to the percentage of areas with the service area. The "Tabulate intersection" tool was employed to determine the percentage of each SA1 tract covered by the service area. The resulting number of residents who have or do not have 15-minute access to a CG at the SA1 level was then summed to determine the accessibility status at the city level. The percentage of the population serviced by 15-minute supermarket access was determined following a similar procedure as for CGs. As all the large supermarkets in Christchurch are owned by two corporations and are running under four brands, they can be easily identified using Google Maps. In total, 35 supermarkets were included in our analysis.

In order to explore the connections between food accessibility and demographics, we tested the correlations between the accessibility to the two types of food sources (i.e., CG and supermarket) and a range of relevant demographic variables of the SA1 tracts, including population density, the percentage of European descendants, the percentage of the population with tertiary education degrees (bachelor's degree and above), the percentage of New Zealand-born and overseas-born residents, the percentage of unemployed residents, and median personal income. These demographic characteristics have been considered relevant to CGs in previous research (Hawes et al., 2022; Limerick et al., 2023). The Euclidean distance between the centroids of each SA1 tract and their nearest gardens and supermarkets was calculated using the "Near" tool in ArcGIS Pro to indicate the typical accessibility of the residents in each tract to these facilities.

The percentages of the SA1 population for categorial variables such as ethnical groups, unemployment, and education level were calculated using the census data. Some of the census categories were grouped to create a single variable of correlation testing. For example, the categories for "bachelor's degree," "post-graduate and honours degree," "master's degree," and "doctorate degree" were grouped into "bachelor's degree and above." The population density was calculated by dividing the population in each tract by the total area of each SA1 tract.

We tested all the variables for the assumptions of Pearson's correlation (Table 1). While the scores of most of the variables were approximately normally distributed, as assessed by visual inspection of Normal Q-Q Plots, the distribution of the scores of distances to the nearest supermarket, distance to the nearest CG, population density, the percentage of unemployed residents, and the percentage of overseas-born residents were found positively skewed. To normalise these skewed data, a square root transformation was applied to each of these variables. The transformed variables were then retested for their normality and found to meet the normality assumption. Also, all demographic variables exhibited a monotonic linear relationship to the accessibility variables and there were no significant outliers. Meeting all the assumptions, Pearson's correlation tests were run to assess the relationship between the proximity to CGs/supermarkets and the demographical characteristics of each SA1 tract.

3. Results

About 20% of Christchurch's population have 15-minute walkable access to a CG, while approximately 22% have walkable access to a supermarket. The walkable service areas of both CGs and supermarkets together serve about 35% of the overall population. However, only about 7.7% of Christchurch's population have access to both CGs and supermarkets within a 15-minute walking distance. The spatial distribution of CGs and supermarkets are shown in Figures 2 and 3 respectively. While the percentages of the population served by their 15-minute catchments are about the same, their spatial distribution patterns are different. While the supermarkets are spread around the city relatively evenly, the CGs exhibit a more clustered spatial pattern (as shown in Figures 2 and 3). Figures 2 and 3 also show that densely populated areas are more likely to fall within the 15-minute catchment zones of CGs, whereas the spatial distribution of supermarkets appears to be less relevant to population density. Also, most gardens are situated in areas with poorer socioeconomic status and higher levels of deprivation, as shown in Figure 4. This pattern is echoed by statistical correlations. The level of deprivation is defined by the NZDep 2018 index of deprivation, an index developed to measure socioeconomic deprivation in Aotearoa New Zealand (Atkinson et al., 2019). A range of sociodemographic factors were taken into account to determine the deprivation score, including lack of

access to the internet, receiving a means-tested benefit, unemployment, lack of educational qualification, etc. (Atkinson et al., 2019).

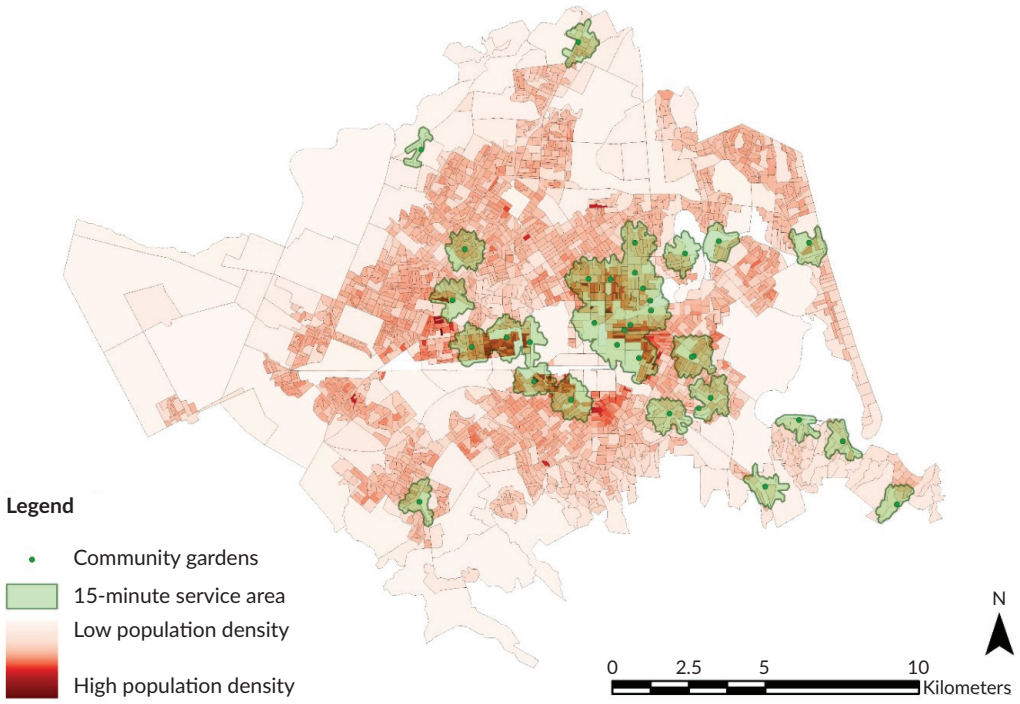

Figure 2. CGs and their 15-minute walk service areas. Source: Stats NZ (2020), licensed under CC Attribution 4.0 International.

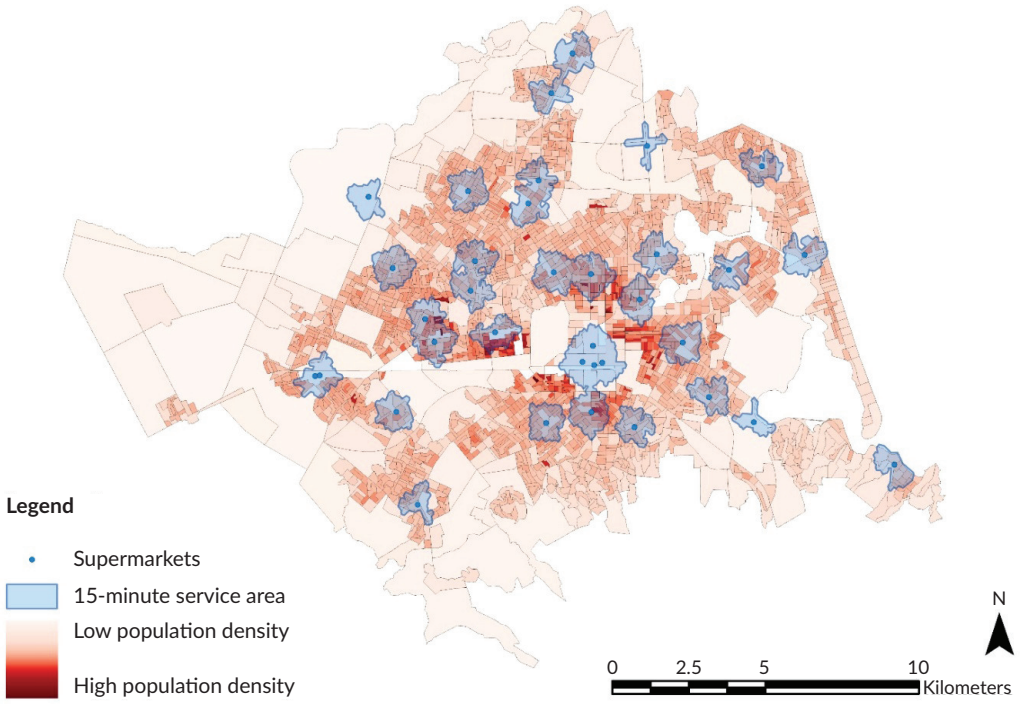

Figure 3. Supermarkets and their 15-minute walk service areas. Source: Stats NZ (2020), licensed under CC Attribution 4.0 International.

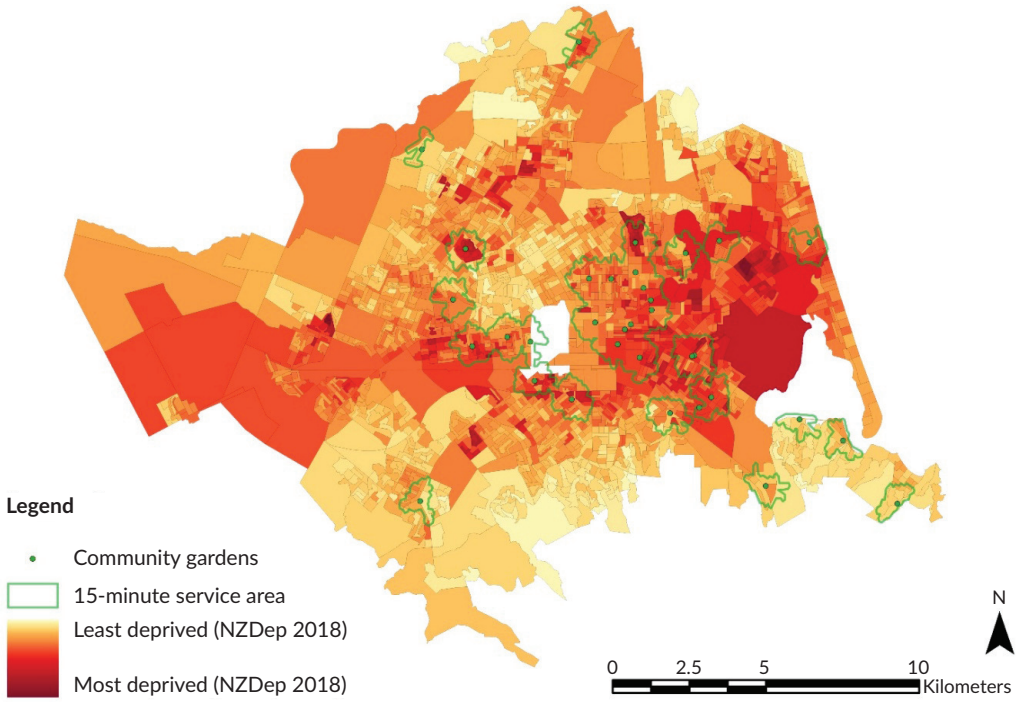

Figure 4. Deprivation score and the service areas of CGs. Source: Stats NZ (2020) and University of Otago (n.d.), licensed under CC Attribution 4.0 International.

Figure 5 illustrates the spatial distribution of the CGs and supermarkets, as well as their 15-minute walking service areas. While the overlapped service areas (CG and supermarket) cover 7.72% of the Christchurch population, the population covered only by the supermarket catchment and only by CGs account for 14.39% and 12.91%, respectively, of the total population.

As for the statistical correlations, the results of the Person's correlation tests reveal that there were statistically significant, small correlations between proximity to CGs and all the factors outlined in Table 1. It is worth noting that some of the correlations involve square root-transformed variables, including the percentage of unemployed, the percentage of residents born overseas, and the population density.

Communities with a lower percentage of European descendants and New Zealand-born residents, as much as a higher percentage of tertiary education (bachelor's degree and above), unemployment, overseas-born residents, lower median age, lower median personal income, and higher population density can be expected to have better access to CGs.

The results for supermarkets reveal a pattern similar to the correlations between demographical variables and access to CGs. All variables, except for education level, show statistically significant correlations with supermarket access. These correlations exhibit the same correlation directions and similar correlation strength (correlation coefficient between .1 and .4) to those observed for CG access. The correlation between proximity to supermarkets and the percentage of residents who have a bachelor's degree or above is negligible and not statistically significant.

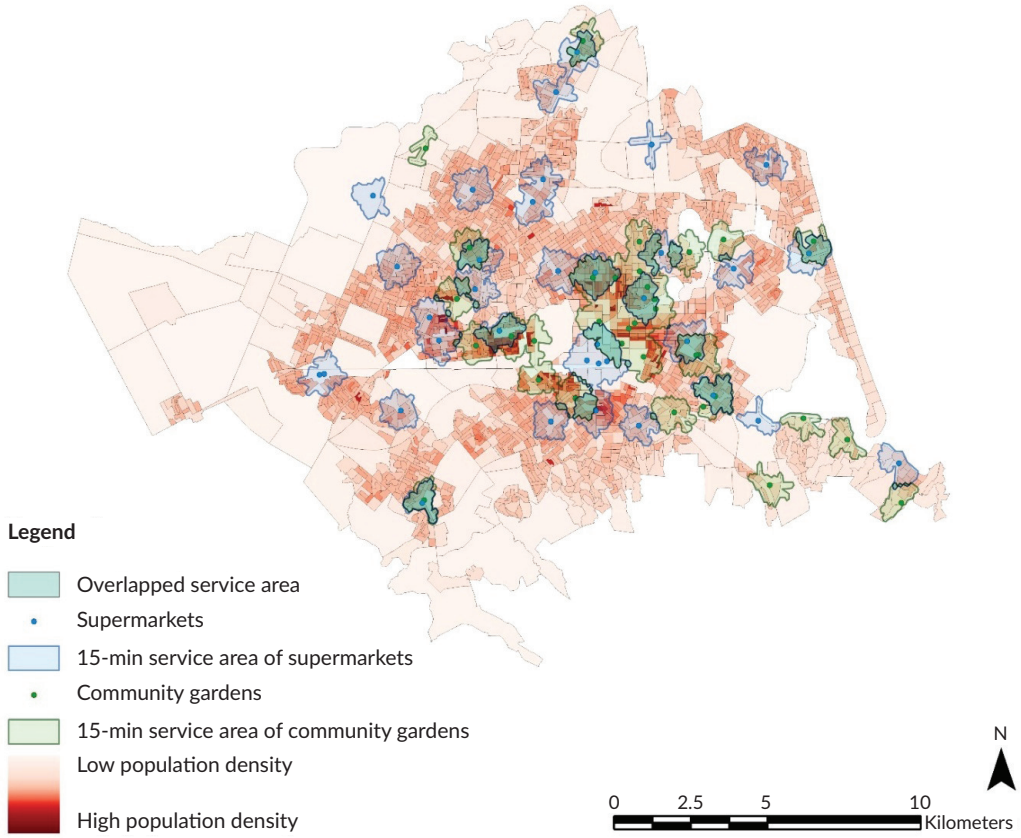

Figure 5. Spatial relationships between the service areas of CGs and supermarkets. Source: Stats NZ (2020), licensed under CC Attribution 4.0 International.

This means that the communities with a lower percentage of European descendants, New Zealand-born residents, as well as a higher percentage of unemployment, overseas-born residents, lower median personal income, and higher population density can be expected to have better access to supermarkets.

4. Discussion

The study explored the question if urban CGs are accessible (walkable) distribution points for local food production and potentially peri-urban production. The article developed a GIS-based research method to examine and compare spatial access to urban CGs and supermarkets and analysed associated socio-demographic factors. The selected case study (Christchurch) is an example of a low-density, car-dependent city. The applied method provided detailed information on the spatial accessibility of urban CG sites in Christchurch, as well as demographic details of the population catchment of 15-minute walking proximity.

Only about 35% of Christchurch's urban population have walkable access to supermarkets or CGs. This relates to the city's low population density and high car dependency. However, spatial distribution patterns for CGs and supermarkets vary across Christchurch. Our spatial analyses revealed that the majority of CGs are located in areas with higher levels of deprivation. CGs have often been observed in lower-income neighbourhoods (Butterfield, 2020; Limerick et al., 2023; Opitz et al., 2016; Voicu & Been, 2008). However,

Table 1. Pearson correlations between distance variables and demographical variables.

		Distance to supermarket (sqrt)	Distance to community garden (sqrt)
% European descendant	Pearson correlation	.211**	.112**
	Sig. (2-tailed)	< .001	< .001
	N	2,289	2,289
% Bachelor's degree and above	Pearson correlation	–.037	–.169**
	Sig. (2-tailed)	.075	< .001
	N	2,282	2,282
% Unemployed (sqrt)	Pearson correlation	–.126**	–.117**
	Sig. (2-tailed)	< .001	<;.001
	N	2,285	2,285
% New Zealand born	Pearson correlation	.214**	.212**
	Sig. (2-tailed)	< .001	< .001
	N	2,289	2,289
% Overseas born (sqrt)	Pearson correlation	–.201**	–.190**
	Sig. (2-tailed)	< .001	< .001
	N	2,289	2,289
Median personal income	Pearson correlation	.204**	.135**
	Sig. (2-tailed)	< .001	< .001
	N	2,289	2,289
Population density (sqrt)	Pearson correlation	–.262**	–.221**
	Sig. (2-tailed)	< .001	< .001
	N	2,289	2,289

Notes: * $p < .05$, ** $p < .01$ (2-tailed).

Hawes et al. (2022), differently, found that CGs in Detroit tend to cluster in affluent neighbourhoods. This different pattern may relate to the geographical context such as low-density living and high vacancy rates of shrinking post-industrial cities. In the case of Christchurch, we found lower median personal income to be correlated with accessibility to CGs. The reasons may be twofold: Firstly, CGs, unlike other channels for acquiring food (e.g., supermarkets), are often established and managed following a bottom-up approach (Fox-Kämper et al., 2018). They serve as a means of self-sufficiency in response to urban disinvestment, economic challenges, or limited food access (Limerick et al., 2023; Reynolds & Cohen, 2016; Taylor & Lovell, 2012). CGs often function as an economic opportunity for vulnerable communities to acquire cheap and healthy food. Secondly, many socioeconomically deprived areas have more vacant land available for the development of urban agriculture, which may contribute to the observed correlation.

However, our statistical analysis revealed also correlations between deprivation indicators and supermarket access. In Christchurch, communities with a higher percentage of unemployed residents and lower median personal income have better access to supermarkets than less deprived communities. Thus, our supermarket-related analysis exhibits a different pattern from what was observed in previous studies, particularly in the North American context, and associated discussions around food deserts (e.g., Walker et al., 2010). This seems like an oddity—supermarkets are usually driven by higher profit margins, which can be achieved more easily in wealthy communities. Possible explanations include the low-density, car-dependent characteristics of Christchurch. Both supermarkets and CGs in Christchurch are located in areas with higher population densities. However, wealthy areas in Christchurch tend to be located in

low-density areas with predominantly residential land uses. In these areas, access to amenities is highly car-dependent; most residents do their shopping by car. In a city where an overwhelming majority of the population travels by car (Christchurch City Council, 2023), people base their locational choices more often on factors such as land prices and school zones. Outside rush-hour traffic, many amenities in Christchurch can be reached within a 5 to 10-minute car ride; driving is easy, and parking is often free.

CGs in Christchurch tend to be located in areas of a higher density, less affluent population, and higher education degrees. Education attainment is another key but contradictory factor that often exhibits a correlation to urban food accessibility. While higher education attainment is often associated with higher median income, there are also correlations between lower-income, higher-education neighbourhoods and CG accessibility (Butterfield, 2020; Li, 2022; Limerick et al., 2023). Two studies conducted in New York observed that the communities of low income and the ones of higher education attainment tend to have better access to CGs (Butterfield, 2020; Limerick et al., 2023). However, the interpretation of this interesting observation varies. Li (2022) argued that while both groups exhibit the same food acquisition pattern, the reasons behind the pattern are likely different. For example, Butterfield (2020) argued that in low-income communities, CGs are often developed as a means of resisting disinvestment and improving access to healthy food. In contrast, communities of higher education attainment are more likely to develop CGs for addressing local sustainability concerns. Butterfield (2020) further suggested that the presence of CGs nearby may indicate early signs of gentrification in these neighbourhoods, a trend also observed in Denver, Colorado (Sbicca, 2019). Neighbourhoods that undergo gentrification show often—at least to a certain point—low-income and high-education patterns. While our study observed similar patterns, we did not analyse gentrification and related demographics for Christchurch. Further research would be needed to better understand the mechanisms of gentrification and how related factors contribute to the formation of CGs.

Ethnic groups are another key demographical factor often considered relevant to the accessibility of CGs. Evidence shows that the CGs in Detroit and Portland tend to be located closer to white populations (Hawes et al., 2022), while studies conducted in Philadelphia (Meenar & Hoover, 2012), Toledo (Burdine & Taylor, 2018), and New York (Butterfield, 2020; Limerick et al., 2023) found that CGs tend to be located in communities with a higher proportion of non-white population. Our results reiterate the latter and find that the communities with a higher percentage of non-European descendants tend to live closer to urban CGs.

In 2010 and 2011, the Canterbury region experienced two major earthquakes and a series of devastating aftershocks. CGs provided a range of benefits including becoming places for social exchange, sources of food when supply chains were disrupted, and post-disaster learning spaces (Shimpo et al., 2019; Wesener, 2020). Following the earthquakes, various bottom-up garden projects sprung up (e.g., Montgomery et al., 2016; Wesener, 2015), and new policy frameworks such as the Food Resilience Policy (Christchurch City Council, 2014) and related network organisations such as the Food Resilience Network were created. While the Canterbury earthquakes accelerated community action around urban gardening, Christchurch remains prone to slow-onset disasters related to climate change including floods, extreme weather events, and sea-level rise. Such events do disproportionally affect urban populations that suffer already from socioeconomic deprivation. Vulnerable communities would benefit from walkable access to affordable food access points. For about 13% of Christchurch's population, CGs are the only accessible food distribution point within a 15-minute walk. This strengthens the argument that CGs could potentially become more

relevant in providing alternative facilities for urban food distribution. Promoting local systems and food distribution infrastructure that are not as prone to supply chain interruptions and related price hikes as, for example, supermarkets, would make local food supplies in Christchurch less susceptible to disasters and (economic) crises. Local, walkable food distribution points would remain more accessible in the case of major disasters and global crises. In addition, urban gardens help mitigate climate change effects, e.g., by reducing and sequestering carbon emissions (Edmondson et al., 2020; Okvat & Zautra, 2011; Richter et al., 2020), reducing urban heat effects (Rost et al., 2020), or supporting stormwater retention and filtration (Pauleit & Duhme, 2000). CGs could play a pivotal role in increasing disaster resilience and mitigating the effects of climate change if their role as accessible distribution points for locally grown food were enhanced and strategically promoted. Our analysis shows that, currently, only a minority of Christchurch's population has walkable access to urban CGs.

It would be advisable to not only support new gardens but also improve their potential benefits in terms of accessibility and offer. This has potential implications for urban planning and design. For example, establishing and promoting collaboration between urban CGs and peri-urban farms could increase the availability of locally grown food distributed through CGs, particularly for vulnerable communities. In Aotearoa New Zealand, peri-urban farms (food production landscapes that sit within the urban hinterland), have greater production capacities, but due to their peripheral location and disconnection with local distribution opportunities they often export their produce instead of selling it locally (Davis et al., 2023). While production capacity and urban–peri-urban collaboration are important topics for future research, this study focussed on the spatial potential of CGs to increase urban food resilience. Compared to supermarkets, CGs in Christchurch are spatially as well as socially well-connected to act as local food production distribution centres, even if walkability could be further improved to serve larger parts of the community.

5. Conclusion

The method developed within this research allowed for the spatial exploration of food access sites within our case study site of Christchurch, and how their spatial location correlated to demographic and social conditions. It is envisioned that this method could be applied to other cities and settlements within Aotearoa New Zealand, and internationally, to better understand the distribution and catchment population of food access sites.

Returning to the topic of urban food security, our research has shown that through analysing the spatial configuration of food access sites, urban authorities and decision-makers will be better equipped to respond to issues such as addressing urban food resilience through both urban policy and design. Like many countries globally, the majority of Aotearoa New Zealand's population lives in urban areas today. Over the past few decades, the urban–rural dichotomy has been exacerbated by zoning policies segregating agricultural-oriented and urban living-oriented land uses. This creates challenges in managing and organising food inflows from rural areas—where large-scale, commercially driven agricultural production is possible—to urban areas—where urban agriculture is emerging but will remain limited in scale of production and quantity of produce. Food security in Aotearoa New Zealand, in essence, is not driven by a lack of food production, but rather a lack of access (defined by low disposable household income and material deprivation). A common solution in most major cities is to rely on profit-driven commercial facilities for food distribution. While these market-driven approaches facilitate efficient distribution services, they also present challenges related to resilience and equity. Our study examined the spatial opportunity of using CGs as alternative

distribution points for food produced in nearby peri-urban or rural zones, where large-scale production aligns with current legislative frameworks. The findings highlight that CGs are not only physically and socially well-connected to a considerable proportion of urban residents but are particularly accessible to vulnerable communities. This underscores the potential of CGs to contribute to addressing food security and equity challenges. By integrating food infrastructure into a walkable urban form, cities and settlements would have the opportunity to create a more food-secure urban population. Urban planning and design policies need to support the development of new urban gardens in strategic locations to establish accessible, walkable food distribution points. Including urban gardening as a strategic urban intervention into a more holistic urban resilience policy framework could provide new opportunities for public funding and private investment benefitting both gardens and local communities.

Limited by the availability of current and accurate data relating to the number and location of CGs, this project sought to develop a method for understanding the spatial relationship of CGs and supermarkets, and their social catchments. Results indicated that the method provides relevant spatial analysis, that when inputted with up-to-date data, will have value in informing future urban planning. Although part of the required dataset has limited temporal relevance in our case, this approach for analysing spatial catchments and accessibility of urban food distribution infrastructure remains generalisable and applicable to similar contexts where spatial data on food distribution points are available. Moreover, this approach enables the investigation of correlations between the spatial patterns of food networks and geographical demographics in contexts where census data are accessible and geospatially archived. Further research focused on applying this method to other urban settlements or other types of food distribution facilities, such as farmers' markets, for example, will allow for a greater understanding of the spatial impact that location and walkability of food distribution sites have on urban food security and resilience. Surveying urban populations around their food access habits and strategies would allow for the testing and ground-truthing of our hypothesis that spatial proximity to places of food distribution positively impacts food security. While we interpreted the correlations between the spatial distribution patterns of food sources and the relevant demographic factors through a review of existing literature, we acknowledge the need for a deeper exploration of the mechanisms by which these demographic factors influence the distribution patterns, particularly in the case of CGs. A more comprehensive understanding could be achieved by conducting interviews with stakeholders of the CGs and supermarkets to gain firsthand and context-specific insights into the correlations. Such interviews could also offer valuable perspectives on the feasibility of utilising CGs as distribution points for food produced in urban peripheries, as viewed by the stakeholders themselves. Additionally, a comparative study examining the differences and commonalities between supermarkets (as an example of commercial food distribution places) and CGs (as an example of community not-for-profit distribution places) would also be instrumental in better understanding the range of opportunities and limitations of different urban food distribution places, in terms of their contribution to urban food security. Further research into the social "ground-up" and policy "top-down" contexts of CGs will further expand our understanding of the determinants impacting spatial distribution. Finally, future research into the potential mutual benefit of peri-urban growers distributing their produce through a local network of urban CGs will further allow for a better understanding of the opportunities of local food networks to positively impact urban food security and resilience.

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Conflict of Interests

The authors declare no conflict of interests.

References

American Community Garden Association. (2024). *What is a community garden?* https://web.archive.org/web/20071204082111/http://www.communitygarden.org/learn

Anderson, E. C., Egerer, M. H., Fouch, N., Clarke, M., & Davidson, M. J. (2019). Comparing community garden typologies of Baltimore, Chicago, and New York City (USA) to understand potential implications for socio-ecological services. *Urban Ecosystems*, *22*(4), 671–681. https://doi.org/10.1007/s11252-019-00855-9

Atkinson, J., Salmond, C., & Crampton, P. (2019). *NZDep2018 index of deprivation, interim research report*. University of Otago. https://www.otago.ac.nz/__data/assets/pdf_file/0025/327481/nzdep2018-index-of-deprivation-research-report-interim-dec-2019-730394.pdf

Block, D., & Kouba, J. (2006). A comparison of the availability and affordability of a market basket in two communities in the Chicago area. *Public Health Nutrition*, *9*(7), 837–845. https://doi.org/10.1017/PHN2005924

Burdine, J. D., & Taylor, D. E. (2018). Neighbourhood characteristics and urban gardens in the Toledo metropolitan area: Staffing and voluntarism, food production, infrastructure, and sustainability practices. *Local Environment*, *23*(2), 198–219. https://doi.org/10.1080/13549839.2017.1397614

Butterfield, K. L. (2020). Neighborhood composition and community garden locations: The effect of ethnicity, income, and education. *Sociological Perspectives*, *63*(5), 738–763. https://doi.org/10.1177/0731121420908902

Chan, J., DuBois, B., & Tidball, K. G. (2015). Refuges of local resilience: Community gardens in post-Sandy New York City. *Urban Forestry & Urban Greening*, *14*(3), 625–635. https://doi.org/10.1016/j.ufug.2015.06.005

Chen, X. (2017). Take the edge off: A hybrid geographic food access measure. *Applied Geography*, *87*, 149–159. https://doi.org/10.1016/j.apgeog.2017.07.013

Christchurch City Council. (n.d.). *Facts, stats and figures*. https://ccc.govt.nz/culture-and-community/statistics-and-facts/facts-stats-and-figures

Christchurch City Council. (2012). *Christchurch Transport Strategic Plan 2012–2042*. https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Strategies/ChristchurchStrategyTransportPlan2012.pdf

Christchurch City Council. (2014). *Food resilience policy*. https://ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/strengthening-communities-policies/food-resilience-policy

Christchurch City Council. (2016). *Christchurch City Council community gardens guidelines*. https://www.ccc.govt.nz/assets/Documents/Environment/Sustainability/CouncilCommunityGardensGuidelines2016.pdf

Christchurch City Council. (2023). *Transport survey results*. https://ccc.govt.nz/the-council/how-the-council-works/reporting-and-monitoring/life-in-christchurch/transport

Davis, S., Chen, G., & Darvill, N. (2023). Housing and food production: Resident and grower perceptions of peri-urban food-production landscapes. *Land*, *12*(12), Article 2091. https://doi.org/10.3390/land12122091

Davis, S., Chen, G., Darvill, N., & Robinson, M. (2024). Peri-urban landscapes and the potential of integrated foodscapes to support healthy cities: An Aotearoa New Zealand case study. *Cities & Health*, *8*(5), 899–917. https://doi.org/10.1080/23748834.2024.2348284

Dubová, L., & Macháč, J. (2019). Improving the quality of life in cities using community gardens: From benefits for members to benefits for all local residents. *GeoScape*, *13*(1), 68–78. https://doi.org/10.2478/geosc-2019-0005

Edmondson, J. L., Childs, D. Z., Dobson, M. C., Gaston, K. J., Warren, P. H., & Leake, J. R. (2020). Feeding a city—Leicester as a case study of the importance of allotments for horticultural production in the UK. *Science of the Total Environment*, *705*, Article 135930. https://doi.org/10.1016/j.scitotenv.2019.135930

Environmental Health Intelligence New Zealand. (n.d.). *Population size and change*. https://www.ehinz.ac.nz/indicators/population-vulnerability/population-size-and-change

Fox-Kämper, R., Wesener, A., Münderlein, D., Sondermann, M., McWilliam, W., & Kirk, N. (2018). Urban community gardens: An evaluation of governance approaches and related enablers and barriers at different development stages. *Landscape and Urban Planning*, *170*(Suppl. C), 59–68. https://doi.org/10.1016/j.landurbplan.2017.06.023

Giang, T., Karpyn, A., Laurison, H. B., Hillier, A., & Perry, R. D. (2008). Closing the grocery gap in underserved communities: The creation of the Pennsylvania Fresh Food Financing Initiative. *Journal of Public Health Management and Practice*, *14*(3), 272–279. https://doi.org/10.1097/01.PHH.0000316486.57512.bf

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition Environment Measures Survey in Stores (NEMS-S): Development and evaluation. *American Journal of Preventive Medicine*, *32*(4), 282–289. https://doi.org/10.1016/j.amepre.2006.12.019

Greater Christchurch Partnership. (n.d.). *Trends and issues—Transport*. https://www.greaterchristchurch.org.nz/our-work/background/background-2007/trends/transport#:~:text=The%20Greater%20Christchurch%20area%20has,we%20want%20for%20our%20future

Guitart, D., Pickering, C., & Byrne, J. (2012). Past results and future directions in urban community gardens research. *Urban Forestry & Urban Greening*, *11*(4), 364—373. https://doi.org/10.1016/j.ufug.2012.06.007

Hanna, C., & Wallace, P. (2022). Planning the urban foodscape: Policy and regulation of urban agriculture in Aotearoa New Zealand. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *17*(3), 313–335. https://doi.org/10.1080/1177083X.2021.1996403

Hawes, J. K., Gounaridis, D., & Newell, J. P. (2022). Does urban agriculture lead to gentrification? *Landscape and Urban Planning*, *225*, Article 104447. https://doi.org/10.1016/j.landurbplan.2022.104447

Hendrickson, D., Smith, C., & Eikenberry, N. (2006). Fruit and vegetable access in four low-income food deserts communities in Minnesota. *Agriculture and Human Values*, *23*(3), 371–383. https://doi.org/10.1007/s10460-006-9002-8

Hipgrave, P. (2021). *Number of motor vehicles*. Environmental Health Intelligence New Zealand.

Jensen, P. D., & Orfila, C. (2021). Mapping the production–consumption gap of an urban food system: An empirical case study of food security and resilience. *Food Security*, *13*(3), 551–570. https://doi.org/10.1007/s12571-021-01142-2

Kato, Y., Passidomo, C., & Harvey, D. (2014). Political gardening in a post-disaster city: Lessons from New Orleans. *Urban Studies*, *51*(9), 1833–1849. https://doi.org/10.1177/0042098013504143

Kharel, S., Sharifiasl, S., & Pan, Q. (2024). Examining food access equity by integrating grocery store pricing into spatial accessibility measures. *Transportation Research Record*. Advance online publication. https://doi.org/10.1177/03611981241254382

Lake, A., & Townshend, T. (2006). Obesogenic environments: Exploring the built and food environments.

Journal of the Royal Society for the Promotion of Health, *126*(6), 262–267. https://doi.org/10.1177/1466424006070487

Land Information New Zealand. (2024). *New Zealand 10m satellite imagery (2022-2023)*. https://data.linz.govt.nz/layer/116323-new-zealand-10m-satellite-imagery-2022-2023

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: Disparities in access to healthy foods in the U.S. *American Journal of Preventive Medicine*, *36*(1), 74–81. https://doi.org/10.1016/j.amepre.2008.09.025

Li, T. (2022). *Modeling the efficacy of the 15-minute city using large-scale mobility data from the perspective of accessibility and user choice: A case study on the urban food environment* [Unpublished master's thesis]. Massachusetts Institute of Technology.

Limerick, S., Hawes, J. K., Gounaridis, D., Cohen, N., & Newell, J. P. (2023). Community gardens and the 15-minute city: Scenario analysis of garden access in New York City. *Urban Forestry & Urban Greening*, *89*, Article 128107. https://doi.org/10.1016/j.ufug.2023.128107

Meenar, M. R., & Hoover, B. M. (2012). Community food security via urban agriculture: Understanding people, place, economy, and accessibility from a food justice perspective. *Journal of Agriculture, Food Systems, and Community Development*, *3*(1), 143–160. https://doi.org/10.5304/jafscd.2012.031.013

Montgomery, R., Wesener, A., & Davies, F. (2016). Bottom-up governance after a natural disaster: A temporary post-earthquake community garden in central Christchurch, New Zealand. *Nordic Journal of Architectural Research*, *28*(3), 143–173. http://arkitekturforskning.net/na/article/view/858

Moreno, C., Allam, Z., Chabaud, D., Gall, C., & Pratlong, F. (2021). Introducing the "15-minute city": Sustainability, resilience and place identity in future post-pandemic cities. *Smart Cities*, *4*(1), 93–111. https://doi.org/10.3390/smartcities4010006

Morris, M. (2006). *A history of Christchurch home gardening from colonisation to the Queen's visit: Gardening culture in a particular society and environment* [Unpublished doctoral dissertation]. University of Canterbury. https://doi.org/10.26021/4409

Morris, M. (2020). *Common ground: Garden histories of Aotearoa*. Otago University Press.

National Research Council. (2011). *Building community disaster resilience through private–public collaboration*. The National Academies Press. https://doi.org/10.17226/13028

Okvat, H. A., & Zautra, A. J. (2011). Community gardening: A parsimonious path to individual, community, and environmental resilience. *American Journal of Community Psychology*, *47*(3/4), 374–387. https://doi.org/10.1007/s10464-010-9404-z

Okvat, H. A., & Zautra, A. J. (2014). Sowing seeds of resilience: Community gardening in a post-disaster context. In K. G. Tidball & M. E. Krasny (Eds.), *Greening in the red zone* (pp. 73–90). Springer.

Open Data Network. (2018). *Population density of New York* [Data set]. https://www.opendatanetwork.com/entity/1600000US3651000/New_York_NY/geographic.population.density?year=2018

Opitz, I., Berges, R., Piorr, A., & Krikser, T. (2016). Contributing to food security in urban areas: Differences between urban agriculture and peri-urban agriculture in the Global North. *Agriculture and Human Values*, *33*(2), 341–358. https://doi.org/10.1007/s10460-015-9610-2

Oscilowicz, E., Anguelovski, I., Triguero-Mas, M., García-Lamarca, M., Baró, F., & Cole, H. V. S. (2022). Green justice through policy and practice: A call for further research into tools that foster healthy green cities for all. *Cities & Health*, *6*(5), 878–893. https://doi.org/10.1080/23748834.2022.2072057

Pauleit, S., & Duhme, F. (2000). Assessing the environmental performance of land cover types for urban planning. *Landscape and Urban Planning*, *52*(1), 1–20. https://doi.org/10.1016/S0169-2046(00)00109-2

Pawson, E. (2014). *Cars and the motor industry*. Te Ara: The Encyclopedia of New Zealand. http://www.teara.govt.nz/en/cars-and-the-motor-industry/print

Powell, L. M., Slater, S., Mirtcheva, D., Bao, Y., & Chaloupka, F. J. (2007). Food store availability and neighborhood characteristics in the United States. *Preventive Medicine*, *44*(3), 189–195. https://doi.org/10.1016/j.ypmed.2006.08.008

Raja, S., Ma, C., & Yadav, P. (2008). Beyond food deserts: Measuring and mapping racial disparities in neighborhood food environments. *Journal of Planning Education and Research*, *27*(4), 469–482. https://doi.org/10.1177/0739456X08317461

Raneng, J., Howes, M., & Pickering, C. M. (2023). Current and future directions in research on community gardens. *Urban Forestry & Urban Greening*, *79*, Article 127814. https://doi.org/10.1016/j.ufug.2022.127814

Reynolds, K., & Cohen, N. (2016). *Beyond the kale: Urban agriculture and social justice activism in New York City*. University of Georgia Press.

Richter, S., Haase, D., Thestorf, K., & Makki, M. (2020). Carbon pools of Berlin, Germany: Organic carbon in soils and aboveground in trees. *Urban Forestry & Urban Greening*, *54*, Article 126777. https://doi.org/10.1016/j.ufug.2020.126777

Rost, A. T., Liste, V., Seidel, C., Matscheroth, L., Otto, M., Meier, F., & Fenner, D. (2020). How cool are allotment gardens? A case study of nocturnal air temperature differences in Berlin, Germany. *Atmosphere*, *11*(5), Article 500. https://doi.org/10.3390/atmos11050500

Sbicca, J. (2019). Urban agriculture, revalorization, and green gentrification in Denver, Colorado. In T. Bartley (Ed.), *The politics of land* (pp. 149–170). Emerald Publishing Limited. https://doi.org/10.1108/S0895-993520190000026011

Schafft, K. A., Jensen, E. B., & Hinrichs, C. C. (2009). Food deserts and overweight schoolchildren: Evidence from Pennsylvania. *Rural Sociology*, *74*(2), 153–177. https://doi.org/10.1111/j.1549-0831.2009.tb00387.x

Shimpo, N., Wesener, A., & McWilliam, W. (2019). How community gardens may contribute to community resilience following an earthquake. *Urban Forestry & Urban Greening*, *38*, 124–132. https://doi.org/10.1016/j.ufug.2018.12.002

Sims-Muhammad, T. Y. (2012). After the storms: South Louisiana sustainable food system assessment in light of environmental natural disasters Hurricanes Katrina & Rita. *International Journal of Humanities and Social Science*, *2*(3), 129–135.

Stats NZ. (2020). *Statistical area 1 dataset for 2018 Census*. https://www.stats.govt.nz/information-releases/statistical-area-1-dataset-for-2018-census-updated-march-2020#regional

Stats NZ. (2021). *Statistical Area 1 2022 (generalised)* [Data set]. https://datafinder.stats.govt.nz/layer/106708-statistical-area-1-2022-generalised

Stats NZ Geographic Data Service. (2020). *Urban accessibility 2018 (generalised)*. https://datafinder.stats.govt.nz/layer/105022-urban-accessibility-2018-generalised

Taylor, J. R., & Lovell, S. T. (2012). Mapping public and private spaces of urban agriculture in Chicago through the analysis of high-resolution aerial images in Google Earth. *Landscape and Urban Planning*, *108*(1), 57–70. https://doi.org/10.1016/j.landurbplan.2012.08.001

Toi te ora. (2023). *Food security*. https://toiteora.govt.nz/health-topics/food-security

United States Census Bureau. (2023a). *Means of transportation to work by selected characteristics (Table S0802)* [Data set]. https://data.census.gov/table/ACSST1Y2023.S0802?q=means%20of%20transportation%20to%20work

United States Census Bureau. (2023b). *Physical housing characteristics for occupied housing units (Table S2504)* [Data set]. https://data.census.gov/table?q=vehicle%20ownership

University of Otago. (n.d.). *Socioeconomic deprivation indexes: NZDep and NZiDep*. https://www.otago.ac.nz/wellington/departments/publichealth/research-groups-in-the-department-of-public-health/hirp/socioeconomic-deprivation-indexes-nzdep-and-nzidep-department-of-public-health#2018

Voicu, I., & Been, V. (2008). The effect of community gardens on neighboring property values. *Real Estate Economics*, *36*(2), 241–283. https://doi.org/10.1111/j.1540-6229.2008.00213.x

Walker, R. E., Keane, C. R., & Burke, J. G. (2010). Disparities and access to healthy food in the United States: A review of food deserts literature. *Health & Place*, *16*(5), 876–884. https://doi.org/10.1016/j.healthplace.2010.04.013

Wesener, A. (2015). Temporary urbanism and urban sustainability after a natural disaster: Transitional community-initiated open spaces in Christchurch, New Zealand. *Journal of Urbanism*, *8*(4), 406–422. https://doi.org/10.1080/17549175.2015.1061040

Wesener, A. (2020). Growing resilient cities: Urban community gardens and disaster recovery after the 2010/11 Canterbury/Christchurch earthquakes. In D. Brantz & A. Sharma (Eds.), *Urban resilience in a global context: Actors, narratives, and temporalities* (pp. 77–100). transcript Verlag. https://doi.org/10.14361/9783839450185-005

Wesener, A., Vallance, S., Tesch, M., Edwards, S., Frater, J., & Moreham, R. (2022). A mobile sense of place: Exploring a novel mixed methods user-centred approach to capturing data on urban cycling infrastructure. *Applied Mobilities*, *7*(4), 327–351. https://doi.org/10.1080/23800127.2021.1893941

World Bank. (2020). *Population density (people per sq. km of land area)* [Data set]. https://data.worldbank.org/indicator/EN.POP.DNST?end=2021&most_recent_value_desc=true&start=1961&view=chart

World Bank. (2023). *Urban population (% of total population)—New Zealand* [Data set]. https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=NZ

Zenk, S. N., Schulz, A. J., Israel, B. A., James, S. A., Bao, S., & Wilson, M. L. (2006). Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan. *Ethnicity and Disease*, *16*(1), 275–280.

Zheng, Z.-W., & Chou, R.-J. (2023). The impact and future of edible landscapes on sustainable urban development: A systematic review of the literature. *Urban Forestry & Urban Greening*, *84*, Article 127930. https://doi.org/10.1016/j.ufug.2023.127930

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