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This paper investigates the relationship between spatial planning and urban agriculture (UA) – primarily community gardens and market farms – through an equity lens. Significant research has been done on the benefits and challenges associated with UA, focusing on community food security, social justice, and community development; however, the spatial distribution of UA projects and the relationship between their form and the fabric of the urban built environment requires additional research. Using data from the City of Philadelphia, this paper explores two questions. First, what is the spatial relationship between UA-projects and food-insecure neighbourhoods? Second, how does UA form and landscape fit within the urban built environment? Answering the first question involved GIS-based spatial analysis and statistical tests to explore the relationship between UA access and areas with high food insecurity. Answering the second question led to the development of a spatial-typology of UA projects based upon GIS analysis and a qualitative visual inspection process, allowing for discussion on how various forms of UA fit within urban landscapes. Results show that siting UA projects may lead to spatial mismatch issues, and most unstable or temporary UA projects are located in high food-insecure neighbourhoods. By exploring the connections between urban food production, land use, spatial planning, and the built environment, the design of more equitable urban spaces may be achieved.

This paper investigates the relationship between the built environment, spatial planning, and two major types of urban agriculture (UA) project – community gardens and market farms – through an equity lens. Historically, UA was prominent in colonial city planning in the USA. Early American cities, such as Boston, New York, and Philadelphia, saw UA as a key component in civic life and food supply in the form of planned commons for animal pasturing and gardening (Brinkley and Vitiello, 2014). Regional and international food systems shaped the design of buildings, roads, and urban open spaces in many pre-rail cities (Steel, 2008). Following the 1893–1897 depression, a nearly continuous trend of UA efforts can be traced throughout many US cities, influencing planning and land-use decisions. Concepts such as 'City Beautiful' and 'Garden City' were popular among regional planners of the early twentieth century who wanted to connect urban consumers with food producers (Mukherji and Morales, 2010). Although UA was mostly promoted in places and times of economic and food insecurity, this social planning started to become disconnected from traditional US planning practice in the mid-twentieth century (Vitiello and Brinkley, 2014).

The post-industrial era led many homeowners in cities across the USA to abandon their properties – a trend which continued through the 1980s. Subsequently, community groups often revitalized vacant properties with UA projects, despite the fact that many did not have permits to do so, and many municipal administrations did not support the cultivation of vacant land (Nordahl, 2009). Due to unfavourable policies and regulations, discontinued incentive programmes, land price increases, and development pressures, many decades-old UA projects that had become anchor institutions in lower-income communities were eventually closed or bulldozed (Cahn, 2015; Gottlieb and Joshi, 2010, p. 147). As result, UA has been mostly considered as patchwork – disconnected from other built features, or a placeholder – a temporary, interim, or informal land use (see Cahn, 2015; Horst *et al*., 2017; Meenar *et al*., 2012).

Significant research has been done on UA projects and policies in the last two decades. One major research stream examines household- and community-level benefits and challenges associated with UA (see reviews by Horst *et al*., 2017; Santo *et al*., 2016). Another stream focuses on the built environment and spatial distribution of UA using GIS technology (see Kremer and DeLiberty, 2011; Parece *et al*., 2017). The intersection of UA, the built environment, and spatial planning, however, is vastly unknown. This paper attempts to fill this gap with the aim that such understanding may contribute to designing equitable food environments.

The paper seeks to answer two questions:

1. What is the spatial relationship between UA projects and food-insecure neighbourhoods?

2. How does UA form and landscape fit within the urban built environment?

The goal is to examine whether UA projects are equitably distributed throughout the city, including food-insecure and vulnerable areas. I start with a brief overview of benefits, challenges, and current practices related to UA planning and design in the USA. Data, methodology, analysis, and results based on research in Philadelphia, USA follow, concluding with a discussion of major findings and recommendations.

Spatial Planning and UA Projects: Current Practices

Why is UA Important to the Community?

Research shows UA projects address urban socio-economic problems including community food insecurity, economic inequality, and inner-city disinvestment (Blair *et al*., 1991; Macias, 2008; Meenar and Hoover, 2012; Meenar *et al*., 2012). UA projects increase nutritional knowledge, create restorative spaces, promote physical and mental health, increase quality of life, and build human, social, organizational, financial, and physical capital in their communities (Hodgson *et al*., 2011; Kingsley and Townsend, 2006; Meenar, 2014; Meenar, 2015). Additionally, UA provides environmental benefits such as increasing biodiversity (Taylor and Lovell, 2014) and stormwater drainage (Wortman and Lovell, 2013); recycling organic waste (Brown and Jameton, 2000); and reducing air pollution (Janhäll, 2015) and urban heat island effect (Wolf and Robbins, 2015).

UA with diverse physical forms and social, environmental, and economic benefits can provide neighbourhood amenities and contribute to a positive community image (Mukherji and Morlales, 2010). Strategically locating UA projects is important because they can function as neighbourhood beautification tools or outdoor community centres. Furthermore, they can reduce crime (Kuo and Sullivan, 2001), increase social bonds, community efficacy, and networks among people with diverse background and power status (Alaimo *et al*., 2010; Firth *et al*., 2011; Kingsley and Townsend, 2006; Teig *et al*., 2009), and play a positive role in the most vulnerable communities (see Brown and Jameton, 2000; Okvat and Zautra, 2011; Saldivar-Tanaka and Krasny, 2004).

UA and Spatial Planning

UA projects can be as small as a few raised beds or as big as many acres of farmland;

they can be located in different types of land uses such as residential, institutional, parks and open spaces (Meenar *et al*., 2012). From a spatial planning perspective, UA projects are typically presented as components of a city's recreation and open space plans, part of rural heritage preservation, or a major use for a city's underutilized or vacant property (Felsing, 2002). While urban parks and play areas are usually designed by city governments in a way that follows a citywide planning initiative, UA projects are not designed or distributed that way; most are designed and operated by a group of individuals, non-profit organizations, businesses, or institutions.

Urban planners with various specializations (i.e. food systems planning, spatial or physical planning, land-use planning) interact with UA. Land-use planners, for example, find UA interesting but challenging due to the potential conflict between UA and other more high-value land uses such as housing or commercial development (McClintock *et al*., 2012). Spatial planners focus on sustainability and food access issues following current 'planning trends' of interdisciplinary practice and mixed-use urban forms (Vitiello and Brinkley, 2014). In many communities, planners and city officials have started conversations around UA, land tenure, and land banks (Meenar *et al.*, inpress). The following paragraphs present examples of four major ways spatial planners incorporate UA in their practice: through integration with urban infrastructures, planned unit developments (PUDs), edible landscapes, and housing projects.

Planners, in collaboration with landscape architects, blend UA with urban infrastructure, i.e. alternative transit, green design, open space/wildlife corridor design, and stormwater management. Examples include the use of UA projects as green stormwater infrastructure in New York City (Cohen and Wijsman, 2014). Some PUDs integrate community gardens, organic farms, and community-supported agriculture into housing developments, increasing home values, community identity, and character. Examples include pocket gardens on the Lower East Side of New York (see Mukherji and Morales, 2010).

Examples of edible landscapes include Seattle's Beacon Food Forest, a non-profit-government collaboration consisting of a 7-acre (2.8 ha) edible park, Philadelphia's Orchard Project, which works with community-based groups and volunteers to beautify vacant properties while providing access to fresh food in low-income neighbourhoods, and Davenport's (Iowa) edible landscaping project, which incorporates UA as design elements of public plazas, parking lots, and streets, making UA accessible to everyone (Nordahl, 2009).

UA has been used to address equity issues as some city governments are encouraging developers to build public housing projects that include community gardens, greenhouses, hydroponic systems, and rooftop orchards. Serving as a model, Via Verde in the South Bronx, New York, influenced the city's healthy building design guidelines (Kolleeny, n.d.), and became an inspiration for similar projects across the city. A study conducted in 2004 by EcoCity Cleveland called for the need to change urban development process from 'housing OR community gardens' to 'housing AND community gardens', and identified housing and UA as collaborative, not competing, components of a healthy community (DiMarco Kious, 2004).

These examples underscore the need for planners and city administrators to understand connections between spatial planning, UA locations, and equity. Literature suggests that UA can be beneficial for the most vulnerable communities due to their potential social-economic-environmental benefits, but do these communities have easy access to UA projects, projects that are big enough to serve many residents, projects that have permanent access to land and other resources, or projects that have planning and administrative support to be sustainable? Equity issues around UA have been primarily discussed from a food justice perspective (see

Horst *et al.*, 2017). Researchers are concerned that some UA projects consciously or unconsciously practise social and racial exclusion – disproportionately benefiting young, non-poor, and white UA practitioners (Alkon and Agyeman 2011; Meenar and Hoover, 2012; Reynolds, 2015) – growing and selling produce that is expensive or not reflective of the taste and culture of the community (Kato, 2013; Poulsen, 2017), and even contributing to gentrification (Bedore, 2010; Cadji and Alkon, 2014). Research however is scant on the intersection of UA, equity, and spatial planning.

Study Area, Data, and Analysis

This study used both quantitative and qualitative methods. To address the first question – what spatial relationship exists between UA projects and food-insecure neighbourhoods – GIS-based spatial analysis and statistical tests were used. Analyzing the second question – how UA forms fit within the built environment – included GIS analysis and a qualitative visual inspection process. I examined both questions within the context of Philadelphia – a post-industrial US city well known for its UA history, practices, and challenges. Philadelphia is a city of 1.555 million residents, 26.4 per cent of whom live below the poverty line. 2015 American Community Survey data reveal a diverse population: 42.8 per cent Black, 41.7 per cent White, and 13.4 per cent Hispanic; 12.7 per cent of residents are foreign-born. According to a recent study, 36 per cent of the population is vulnerable to food insecurity or already faces a high-level of food insecurity (Meenar, 2017).

Philadelphia's UA projects range from small lots to 76 acres (30.76 ha) (e.g. Manatawna Farm). The city has close to 400 community gardens and market farms, a sharp decrease from 1,000 plus projects reported in the 1970s and 1980s, but a significant increase from slightly more than 225 reported in 2008 (Vitiello and Nairn, 2009). The reasons for the loss of hundreds of UA projects over the last few decades include unfavourable UA policies and regulations, discontinued incentive programmes, development pressures, generational succession, and abandonment (Meenar and Hoover, 2012). Most UA projects in the city are not protected; however, the Neighborhood Garden Trust (NGT) has close to forty UA and ornamental gardens protected via land trusts. Most UA projects in the city are operated by strong advocacy groups, community-based organizations, and for-profit farms (Cahn, 2015; Meenar, 2015). The city has a Food Policy Council and food issues are generally recognized in city- or region-wide studies and plans.

My research questions required two independent analyses, which are presented in the following sub-sections. Data for 386 UA projects were available, including community gardens (n = 368) and market farms (n = 18). UA location data were collected from the Garden Justice Legal Initiative in 2012 and mapped using a geocoding tool. My field visits to all UA project locations in 2015–2016 yielded 353 active projects, including thirty-one protected NGT projects. Other GIS base data (i.e. parcel boundary, land use) were collected from the City of Philadelphia and Delaware Valley Regional Planning Commission.

Analysis 1: Equitable Spatial Distribution of UA Projects

In order to analyze UA's spatial distribution in Philadelphia's 384 census tracts, tracts were ranked according to their level of access to UA projects, a variable termed UA_ACCESS. Three categories of distances from UA project locations were calculated in GIS according to their level of convenience; locations within a quarter-mile (0.4 km) of UA, locations within a mile (1.6 km) of UA, and locations further than a mile from UA. A quarter mile is commonly considered a reasonable walking distance (see Gordon *et al.*, 2011), and 1 mile has been also considered as convenient access by some researchers (see Berg and Murdoch 2008). These categories were ranked 3 to 1 (high to low), representing the most convenient/walkable access to the least. Analysis followed the methodology used in Meenar (2017) that used a raster-based Euclidean Distance tool, available under the Spatial Analyst tools of ArcGIS ArcToolbox. The resulting raster layer of 100 ft^2 (9.3 m^2) cells, was reclassified into three categories: 1,320 feet or 0.25 mile (0.4 km), 5,280 feet or 1 mile (1.6 km), and the default 57,939 feet (17.66 km), representing the analysis extent (Philadelphia). The resulting map showed the pattern of UA access throughout the city.

To further understand whether UA projects are equitably distributed in different parts of Philadelphia, I compared UA_ACCESS ranks with ordinal ranks of the same tracts, derived from the *Place-Based-Food-Insecurity-and-Vulnerability Index* (*PFIVI*) (Meenar, 2017). The *PFIVI* Index was developed as a participatory spatial planning tool to design urban food environments. It incorporates six indicators to identify tracts with residents facing high levels of hunger and food hardship, lower access to healthy food retail, poor food habits, chronic health conditions related to food, lower community engagement, tracts containing at-risk population (e.g. low-income populations, people of colour, and foreign born population), and vulnerable places (e.g. areas with high crime and vacancy). Based on *PFIVI* score, Philadelphia's tracts were categorized in three ordinal scales – high, medium, and low level of food insecurity and vulnerability (Meenar, 2017). Chi-square and gamma tests were then used to compare *PFIVI* values with UA_ACCESS values of all census tracts to identify possible mismatches or equity issues related to UA spatial distribution in the city.

Analysis 2: UA Spatial-Typology, Built Environment, and Equity

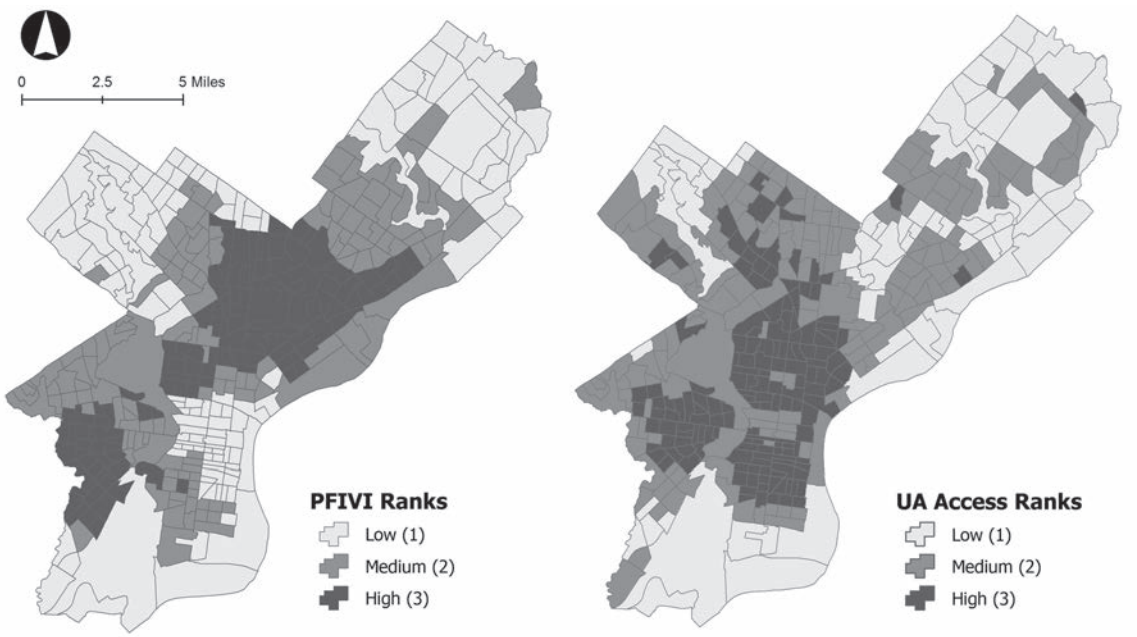
In order to understand the connection between UA forms and the built environment, I categorized Philadelphia's UA-projects according to a spatial typology and then made a comparison with *PFIVI* scores. Scholars have developed categories of UA projects according to their operations (see McClintock, 2014), but there was no existing UA spatial typology available, at least for Philadelphia.

A spatial join of the UA shapefile and the Philadelphia land-use and parcel shapefiles, provided the parcel size for each UA project, identified the land-use category of each parcel and the surrounding area, determined whether the parcel was on a corner of a block, and identified adjacent UA projects. Next, based on a visual inspection of recent ortho-photography available on Google Maps and a review of field verification notes, the extent of UA activity on the parcel and other pertinent information related to its spatial characteristics and its connection to the surrounding built environment were recorded. Finally, a master spreadsheet documenting these data for each UA project allowed for identification of types or themes that were emerging. For example, 137 UA projects were situated on one or two lots, mostly in a residential area, and frequently with UA on the entire parcel; a category 'Small' emerged to represent these projects. All categories were developed based on a qualitative assessment of how closely UA projects could be grouped. Once the typologies were developed, a qualitative assessment of possible relationships between UA project types and three *PFIVI*-ranked census tracts was applied to understand if there is any spatial connection between these typologies and community food insecurity and vulnerability.

Results

The first analysis identified 154 census tracts (about 40 per cent of the total tracts) with high access, 162 tracts (42 per cent) with medium, and 68 tracts (18 per cent) with low access to UA projects. Figure 1 includes two maps displaying ordinal ranks of tracts based on *PFIVI* and UA_ACCESS scores. The embedded table shows that the relationship between *PFIVI* and UA_ACCESS is significant at the 0.01 level (obtained chi square, X^2 = 16.24 (p <0.00) significant (df = 4, α = 0.01), Gamma = 0.25). High *PVIFI* tracts are more likely to have high UA access (48 per cent) than low *PFIVI* tracts (32.3 per cent). As indicated by gamma (0.25), this is a positive relationship; however, the relationship is only moderately strong at best. Spatial mismatch was prominent in ten census tracts with high *PFIVI* scores but low UA_ACCESS scores. Conversely, 40 tracts with low *PFIVI* scores had high UA_ACCESS scores.

The second analysis yielded six major spatial typologies for Philadelphia UA projects: 'Small', 'Corner', 'Large', 'Residential Complex', 'Existing Open Space', and 'Institutional'; 'Other' captured projects which did not fit these typologies. The 'Small' (n = 137) typology is explained in a previous section. 'Corner' (n = 86) projects are larger and often located on several adjacent lots and/or on a corner lot; these projects are mostly in residential areas, often with UA on the entire parcel. 'Large' (n = 32) projects are suburban sized and often located on the outskirts of the city or on vast amounts of vacant land (e.g. a whole block); UA on all or most of the parcel is common. 'Residential Complex' (n = 9) projects are associated with a housing complex. 'Existing Open Space' (n = 58) projects are situated within a park,



Access to Urban Agriculture	*Place-Based-Food-Insecurity-and-Vulnerability* (PFIVI) Index High	Medium	Low	Totals
High access	59 (48.0%)	55 (40.1%)	40 (32.3%)	154 (40.1%)
Medium access	54 (43.9%)	57 (41.6%)	51 (41.1%)	162 (42.2%)
Low access	10 (8.1%)	25 (18.2%)	33 (26.6%)	68 (17.7%)
Totals	123 (100.0%)	137 (100.0%)	124 (100.0%)	384 (100.0%)

Obtained chi square, X^2=16.24 (p<0.00) significant (df=4, α=0.01) Gamma = 0.25

Figure 1. Relationship between place-based food insecurity and convenient access to urban agriculture – comparing *PFIVI* and UA_ACCESS scores of Philadelphia census tracts.

recreational space, arboretum, or cemetery. Finally, 'Institutional' (n = 29) projects are associated with a school, church, or other institution.

Table 1 provides additional information on these UA types, along with examples of each type of UA projects featured in figure 2. The maps of figure 2, all drawn at the same scale, display the existing built environment around UA projects, including buildings, utilized green spaces, rivers, rail tracks, and large paved surfaces.

More than half the 'Small' and 'Corner' type UA projects are located within tracts with high *PFIVI* ranks. 'Large', 'Existing Open Space', and 'Institutional' projects are mostly seen in medium *PFIVI*-ranked tracts. 'Residential Complex' type UA are equally distributed in all three *PFIVI*-ranked tracts. 'Existing Open Space' features the lowest number of UA projects located in tracts with high food insecurity and vulnerability. Only three NGT-owned UA projects can be categorized as 'Small'; these are located in high or medium *PFIVI* tracts. Other types of NGT projects are distributed among all *PFIVI* tracts almost equally. Analysis of projects by land-use category revealed that 126 UA projects were sited on vacant residential land, the most for any land use. Other common

Table 1. Spatial typology of Philadelphia's urban agriculture projects (community gardens and market farms).

UA Spatial-Typology	*Description*	*Count* (n = 353)	*Percentage* (of 353)	*Approximate Parcel Size Range*	*Example* (reference to figure 2)
Small	A project situated on one or two lots, mostly in a residential area, oftentimes with UA on the entire parcel	137	39	400–2,000 ft^2 (37–186 m^2)	Farm 51 (fig. 2A), South St Community Garden (fig. 2B)
Corner	A larger project – oftentimes located on several adjacent lots and/or on a corner lot – that is situated mostly in a residential area, oftentimes with UA on the entire parcel	86	25	2,000–10,000 ft^2 (186–930 m^2)	Aspen Farm Community Garden (fig. 2C)
Large	A suburban-sized project, often located on the outskirts of the city or on vast amounts of vacant land (e.g. a whole block), oftentimes with UA on all or most of the parcel	32	9	10,000–320,000 ft^2 (930–29,730 m^2)	Greensgrow Farm (fig. 2D), Eastwick Community Garden (fig. 2E)
Residential Complex	A project associated with a specific housing complex, oftentimes an apartment complex	9	3	2,500–58,000 ft^2 (230–5,390 m^2)	Garden Court Community Garden (fig. 2G)
Existing Open Space	A project situated within a park, recreational space, arboretum, cemetery, etc. (associated with some type of public/civic space)	58	16	1,000–14,550,000 ft^2 (93–1,351,740 m^2)	Schuylkill River Park Community Garden (fig. 2F), Manatawna Farm/Garden (fig. 2I)
Institutional	A project associated with a school, church, and other institution	29	8	1,000–1,860,000 ft^2 (93–172,800 m^2)	MLK High School Garden (fig. 2H)
Other	None of the above (e.g. rooftop gardens)	2	1	35,000–210,000 ft^2 (3,250–19,500 m^2)	—
Total		353	100	—	—

Figure 2. Examples of urban agriculture spatial typology in Philadelphia.

land-use categories included institutional and parks and open spaces.

Discussion and Concluding Remarks

This equity-based analysis addresses two questions – how UA projects are spatially distributed, and how UA blends with the surrounding built environment. UA projects in Philadelphia can be found in many parts of the city, and generally serve food-insecure areas characterized by low-income populations, people of colour, and refugees. Spatial mismatch issues exist in 50 census tracts, of which 10 with high *PFIVI* scores have no convenient access to UA projects.

As food insecurity and vulnerability increase in a tract, access to UA increases, possibly because UA projects act as interventions in those high-*PFIVI* tracts; another explanation is that there is more vacant land available for UA in those tracts. The positive relationship between UA_ACCESS and *PFIVI* suggests that, in general, census tracts with limited or no access to fresh food receive the most interventions through UA projects; however, these projects are not limited to areas with food insecurity and vulnerability. Many factors unrelated to the *PFIVI* index may influence the establishment of a community garden or a market farm, including community interests, community capacity, land suitability or availability, and capital needs for urban farming (see Meenar, 2015). Of the 18 per cent of Philadelphia census tracts without easy access to UA, 10 have the highest *PFIVI* scores. Located in North (n = 8) and Southwest (n = 2) Philadelphia, these tracts contain at-risk residents facing high levels of hunger and food hardship, lower access to healthy food retail, poor food habits, chronic health conditions related to food, and lower community engagement.

In order to explore UA's connection with the built environment and spatial planning, a spatial-typology of UA projects was developed. Most small- or mid-size projects are located in food-insecure residential areas, often on vacant lots. High *PFIVI* tracts generally have a higher percentage of vacant lots, potentially explaining the reason behind the concentration of 'Small' and 'Corner' type UA projects. This trend is problematic, because these projects are rarely on protected land, often considered a temporary land use, and feature limited organizational structure. 'Existing Open Space' type UA projects are uncommon in areas with the highest need for permanent or protected UA projects potentially due to a lack of open space.

Analysis of how UA integrates with the built environment through an equity lens yielded compelling results. Even though more UA projects are found in low-income areas, they are the most vulnerable among all UA typologies developed. Vulnerability of a UA project may stem from being seen as a temporary land use, location near vacant lots inviting vandalism and other crimes, or being managed with limited organizational structure. These conditions only work to further reinforce the inequities – whether related to community food security, food access, community engagement, community capacity, or access to parks and open spaces – that already exist in these areas (see Meenar, 2017).

These findings are important, as they may help us understand why UA projects need to be (*i*) considered within the dialogues around spatial planning and equity, and (*ii*) incorporated into the planning process more formally to promote the design of more equitable urban spaces and projects. In particular, food planners as well as land banks and other not-for-profit organizations may think more critically about the distribution and impact of planned UA projects. The findings may also prove useful in pursuit of external funds to initiate green infrastructure projects in high *PFIVI* areas.

The development of a spatial-typology of UA projects and the accompanying dataset for Philadelphia may also prove valuable for both existing and future UA projects. Projects with similar typologies may assist one another in facing similar problems; additionally, successful projects and ideas may be exchanged. Long-term, this study may help identify why some projects are more successful than others. Lastly, this dataset may be used to inform policy decisions.

While the key findings and methodology are transferable to other similar cities, the limitations of this study leave room for future research. The spatial distribution analysis considered all projects equally, regardless of their size, type, operation, longevity, and vulnerability. The focus has largely been on access or spatial distribution, not how many local people are involved in such projects and in what capacity. To expand the concept of UA typology from a spatial to a comprehensive one, a future study may include additional spatial and non-spatial factors such as UA site plan and design features, proximity and access to public transportation, access to produce distribution, population density of surrounding areas, location type (e.g. downtown, neighbourhood, and outskirts), user profile (e.g. open to community, membership-based), type of ownership, and ancillary services offered (e.g. community education, workshop, demonstrations, tours).

Researchers have shown that community capacity plays an important role in the spatial allocation of green infrastructure in disadvantaged urban communities (see Mandarano and Meenar, 2017); however, UA projects are designed differently from parks or other green infrastructure. Local residents, local culture, community efficacy, community capacity, organizational capacity, and partnerships play a big role in starting and maintaining a UA project (Meenar, 2015; Teig *et al*., 2009). Longevity or vulnerability of UA projects is dependent on local government policies and regulations, lease time, and community buy-in. A future study may examine the connection between UA locations and community capacity, analyzing issues of community buy-in, power structure, and racial-exclusion.

As a legitimate and beneficial land use with deep historical roots, spatial planners and design professionals should pursue UA by working with municipal governments to identify land bank properties (wherever applicable) and un/underutilized public land suitable for UA (e.g. utility areas, schools, libraries, hospitals, public housing, recreational spaces, preserved spaces, food/earthquake prone areas). Sustaining UA projects beyond the project grant period or initial community interests is a significant problem tied with land tenure problems. Food systems planners, designers, and policy-makers need to design ways to support experimentation in both historic and new UA projects by working closely with food-centric non-profit and grassroots organizations.

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