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Exploring Park Quality in Urban Setting with Environmental Justice, Alternative Measurements, and Social Interaction

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EXPLORING PARK QUALITY IN URBAN SETTING WITH ENVIRONMENTAL

JUSTICE, ALTERNATIVE MEASUREMENTS, AND SOCIAL INTERACTION

by

Shuolei Chen

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ABSTRACT

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by

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With rapid urbanization, urban green resources, such as parks have become important assets for quality of life in urban settings. Parks provide urban residents with both physical and psychological health benefits through various mechanisms such as physical activity and social interaction. Quality is an important non-spatial dimension of urban parks and has started to gain attention among researchers. To better understand park quality in an urban setting, additional knowledge should be explored. This dissertation studies the quality of urban parks from three different perspectives: 1) the equal distribution of park quality resources and its relationship to environmental justice issues, 2) the protocols used for measuring the most commonly acknowledged non-spatial dimensions of urban parks, and 3) the association between park quality and social interaction in urban parks.

This study explores park quality from those three different perspectives and presents findings in a 3-part dissertation. The first part determines whether the distribution of park quality was spatially autocorrelated and assessed the associations

between separate park features qualities, overall park quality, and multiple indicators of environmental justice issues via a case study in Cache County, Utah; The second part of this study conducts a systematic study to analyze and synthesize the different developed approaches used for assessing non-spatial dimensions of urban parks including park quality and draws implications for future urban landscape planning, design, and research; The third part uses a case study in Logan and North Logan, Utah, and explores the associations between park quality and people's social interaction in urban parks through an innovatively systematic observational protocol.

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CHAPTER I

INTRODUCTION

1.1 Importance of the Problem

By 2050, 70% of the world's population is projected to live in urban areas, due to the rapid urbanization (UN, 2012). Concurrently, concerns of global urbanization's impacts on quality of life have reinvigorated calls for resiliency as a key component for studying and designing urban places. As contributors to resiliency, urban parks play an essential role in urban systems by providing various health, economic, and social benefits (Bedimo-Rung, Mowen, & Cohen, 2005), ecosystem services (Flocks et al., 2011), and sustainability (Jennings, Larson, & Yun, 2016) that mitigate negative issues commonly associated with urbanization. Especially for urban settings with fewer opportunities for interaction with nature—exacerbated by contemporary technologically-influenced nature deficit disorder (Louv, 2008)—parks provide opportunities for experiencing nature (Loukaitou-Sideris & Stieglitz, 2002).

As the significance of parks in cities is widely recognized, a growing number of studies have examined parks from different perspectives of urban planning and design disciplines for their capacity to promote the well-being of urban populations. Researchers commonly use spatial approaches to understand the relationships between urban green open space and the dwellers (de la Barrera et al., 2016), such as park accessibility and proximity. In addition to the physical and spatial measures, understanding and assessing parks' non-spatial or non-physical dimensions like park quality, are also important

because the spatial approaches cannot fully predict human preferences and behaviors. Some scholars indicate that the quality of a park is a more significant factor to influence people's park use than friendly accessibility or proximity (Kabisch & Haase, 2013; Kemperman & Timmermans, 2014).

The diversity of park quality, such as facility and landscape views, can impact residents' visitation and usage of the resource, which consequently affects their physical and psychological health (Jenkins et al., 2015). Park quality is often correlated directly and significantly with physical activity levels and other activities, which contribute to a community's overall well-being (Mitchell & Popham, 2008). In addition to physical activity, quality of parks is crucial for people to use the park for various purposes like social interaction (Kemperman & Timmermans, 2014), which could mitigate many social issues in urban settings, such as intensive work pressure and social isolation, benefitting urban dwellers' psychological health (Kweon, Sullivan, & Wiley, 1998; Zhou & Parves Rana, 2012).

Although the importance of park quality has been recognized as a non-spatial dimension of urban parks in some disciplines, and some scholars have conducted park quality related research, this field contains existing opportunities for advancing knowledge through future research. To address research gaps, this dissertation will study park quality from these perspectives: 1) the equal distribution of park quality resources considering the environmental justice issues, 2) the protocols that used to measure the most commonly acknowledged non-spatial dimensions of urban parks, including quality; and 3) the association between park quality and people's social interactions in urban parks.

Within the urbanization process, park quality is an important asset in addition to the location, availability, proximity, and accessibility of parks. Urban parks provide opportunities for outdoor physical activity and therapeutic benefits. Although the importance of park quality has been recognized and is well-documented, research on urban parks has traditionally focused on their physical and spatial aspects such as park availability, accessibility, and proximity to residents. The quality of parks is critical in urban areas, though it has received less attention than pars' spatial distribution (Bedimo-Rung et al., 2005). Most current research studies park quality's spatial distribution, how to measure park quality and the relationships between park quality and the relationships between park and physical activities.

According to the literature, park locations are often inequitably distributed. Communities of disadvantaged socioeconomic status (SES) (Hughey et al., 2016; Taylor, Poston, Jones, & Kraft, 2006) and racial and ethnic minorities have lower park quality than those of higher SES. While most SES-oriented studies focus on the spatially unequal distribution of parks such as uneven park proximity and park accessibility, some studies indicated that disparities also existed in park quality, characteristics, and features distributions across socioeconomically, racially, and ethnically diverse communities (Hughey et al., 2016; Vaughan et al., 2013). Environmental justice studies have identified that the distribution of public resources and their features in the built environment, including parks and green open space and their qualities, should be equally distributed among racial and ethnic minorities and the population living in disadvantaged SES (Floyd & Johnson, 2002; Taylor et al., 2006). Multiple indicators can represent the environmental justice issues of a given area, for instance, the percentage of minority,

poverty, and unemployment. The unequal distribution of park quality should be explored in association with the environmental justice issues to ensure the disadvantaged groups of the population could achieve equal opportunities to access quality of the resource.

Studies on park quality should not be limited to distribution issues. As research has shifted their focuses from spatial assessments to the non-spatial ones, methods of measuring these non-spatial dimensions have emerged in the literature on quality and other non-spatial dimensions. Gaps in existing research highlight a need for analysis and synthesis of the different approaches used for assessing non-spatial dimensions of urban parks in order to identify implications for future urban landscape planning, design, and research.

Additionally, public urban parks have become important environmental assets for urban dwellers' physical and mental health. Current research indicates that people can achieve health benefits through physical activities in parks, and the majority of these research measure physical activity as the main or even the only indicator of park use. However, residents can also enjoy other benefits such as aesthetic enjoyment and social interaction, while also promoting both physical and psychological health (Zhou & Parves Rana, 2012). The protocol assessing park use with an emphasis on people's social interaction is still undeveloped, and most importantly, the exploration between park quality and social interaction is ripe for research.

1.2 Research Questions

To advance the knowledge in the park quality research in urban settings, the purpose of this study is to better understand the quality of public parks in the urban setting from the perspectives of their distribution considering the environmental justice issues; the alternative protocols evaluating non-spatial dimensions of urban parks, including park quality; and the associations between park quality and social interactions in urban parks. To support these purposes, the dissertation addresses the following research questions:

1. To what extent park quality is associated with environmental justice indicators?
2. How do the current protocols measure the most commonly recognized non-spatial dimensions of urban parks including park quality, and what are the implications for future scholars?
3. To what extent is park quality associated with people's social interaction in urban parks?

1.3 Definition of Key Terms

Park Quality. It can be described according to the presence of single or multiple park features and characteristics including maintenance and cleanliness (Coen & Ross, 2006; Mowen, 2010); facility (Vaughan et al., 2013) such as playgrounds, athletic facilities, and dog parks (Aytur et al., 2015); amenities like parking, restrooms, walkways, bike paths, benches, tables, and drinking fountains (Hughey et al., 2016); and aesthetic features including plantings, turf lawns, water features, and historical or educational features

(Macintyre et al., 2002). Furthermore, Kaczynski et al. (2012) suggested incivility—which includes characteristics outside the realm of normatively anticipated park features such as the presence of excessive animal waste, litter, noise nuisance, graffiti, vandalism, and perceived lack of safety—should be considered in evaluating park quality.

Separate Park Feature Quality. The presence of single park features, characteristics, and its general condition in a park, such as facilities, amenities, aesthetic features, maintenance and cleanliness, and incivility.

Overall Park Quality. Taking consideration of multiple different park features and characteristics, overall park quality encompasses general conditions in a park, including facilities, amenities, aesthetic features, maintenance and cleanliness, and incivility.

Environmental Justice. This concept is defined as "the fair treatment and meaningful involvement of all individuals in the development, implementation, and enforcement of laws, regulations, and policies about diverse environmental issues" in the profession of landscape and environmental planning (Vaughan et al., 2013, p. S28).

Poverty Rate. It is an indicator of environmental justice issues in this study which defined as the percentage of population below 125% of the federal poverty line.

Unemployment Rate. It is an indicator of environmental justice issues in this study which is defined as the percentage of the labor force that is unemployed.

Low-education Rate. It is an indicator of environmental justice issues in this study, defined as the percentage of the population that has less than a high-school education.

Renter Rate. It is an indicator of environmental justice issues in this study, defined as the percentage of the population that lives in renter-occupied housing

Minority Density. It is an indicator of environmental justice issues in this study which is defined as the population density of racial and ethnic minorities, including Non-White Hispanic, Hispanic or Latino, *Asian, and African American.*

Spatial Autocorrelation. It refers to the degree to which near and distant things are related (Anselin & Bera, 1998), taking into account whether an observation occurring at one location is influenced by other nearby observations (Cliff & Ord, 1973).

Spatial Dimension of a Park. This often refers to park proximity or accessibility which measures the relative opportunities for potential contact with and use of parks based on location theory (Wang, Brown, & Liu, 2015).

Non-Spatial Dimension of a Park. Besides the measures related to location and distance theories, the dimensions that may affect or predict human preferences and behaviors in a park. The most commonly recognized non-spatial park dimensions are park quality, park use, and park benefit.

Park Use. This describes how certain features and characteristics support or restrict the general population's involvement and behaviors in a given environment for a particular purpose (Iwarsson & Ståhl, 2003). Park use often refers to how people visit a park, what activities—such as physical activities—they partake in, and their participation in programs (Aytur et al., 2015).

Park Usability. This is another term which some readers may find confusing, due to its apparent similarity with park use. However, park usability pertains to how individuals with mobility limitations, such as the disability, access a park and fully participate in park-based activities, as compared with users who do not have mobility impairments (Iwarsson & Ståhl, 2003).

Park Benefit. This concept is defined according to the different benefits that people could achieve from parks including psychological, psychophysiological, social/cultural, environmental, and economic dimensions. Psychological benefits include personal development, mental health, and personal appreciation or satisfaction. Psychophysiological health benefits including reduced depression, decreased obesity, increased levels of fitness, reduced incidence of disease, and improved perceived quality of life. Social/cultural benefits include community satisfaction, family bonding, and reduced crime. Environmental benefits include the development of environmental values, heritage preservation, and environmental protection. Economic benefits include reduced health costs, increased productivity, and increased property values (Moore & Driver, 2005).

Social Interaction. This describes people's degree of connectedness and solidarity to their community as well as the relationships and bonds between two or more individuals in a community, particularly in a multi-cultural one (Mahasin & Roux, 2010). This can take many forms in parks and urban green open spaces, including undertaking shared activities, having a conversation, and paying group visits (Maas, Van Dillen, Verheij, & Groenewegen, 2009).

1.4 Summary

This chapter provides an overview of the problems that this study will address, describes the background related to this problem, presents the purpose and research questions for this study, and offers definitions for relevant key terms. Chapter II will provide a review of relevant literature, including an overview of the importance and

research gaps of park quality in an urban setting, interpretation of environmental justice issues and its relationships with park quality, the introduction of the statistical approaches used in analyzing environmental resources, and existing protocols measuring park quality and other non-spatial dimension of urban parks, and justification of the significance of social interaction between the urban park resource and people's health.Chapter III describes the methodology to be used in this study, including a discussion of the application of a spatial regression for park quality variable, a systematic study reviewing the existing protocols, a social interaction scale and a newly developed protocol to assess people's social interaction behaviors in parks, and a multilevel model to analyze the association between park quality and social interaction.

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CHAPTER II

ENVIRONMENTAL JUSTICE AND PARK QUALITY IN AN INTERMOUNTAIN WEST GATEWAY COMMUNITY: ASSESSING THE SPATIAL AUTOCORRELATION

2.1 Abstract

Research on environmental justice issues, particularly unequal park distribution and quality, has found that communities' minority density and socioeconomic status (SES) are often correlated with disparate park qualities. However, most studies of spatial relationships between park quality and socioeconomic factors employ simple statistical analyses, which do not account for potential spatial autocorrelations and their effects on validity.

This study determined whether the distribution of park quality is spatially auto-correlated and assessed the associations among multiple indicators of environmental justice and both separate park features and overall park quality.

This study evaluated spatial relationships between park quality and multiple environmental justice indicators in Cache County, Utah following the spatial regression process conducted in R programming language. Both overall park quality and separate feature qualities were audited by the PARK (Parks, Activity, and Recreation among Kids) tool. Environmental justice indicators included minority density, poverty, unemployment, low-education, renter rate, and yard size.

The results of the study illustrated a spatial autocorrelation existing in park quality distribution, detecting the dependence of the variable for quantitative research. They also showed significant correlations between park quality and environmental justice indicators.

The study's spatial regression model is a model for analyzing the spatial data and avoids the autocorrelation which is overlooked by the normal statistical approaches. Also, variances of park quality can be accounted for by different environmental justice indicators, such as minority, poverty, and yard size. This disclosure of disparate public resource quality treatment among different groups of individuals could inspire the policymakers and city planners to correct the disparity.

2.2 Introduction

Environmental Justice Issues

Within landscape and environmental planning, environmental justice is defined as "the fair treatment and meaningful involvement of all individuals in the development, implementation, and enforcement of laws, regulations, and policies about diverse environmental issues" (Vaughan et al., 2013, p. S28). Environmental justice research has been broadened to explore the inequitable distribution of health-promoting features of the built environment, including parks and green open space among racial and ethnic minorities and the population living in disadvantaged socioeconomic status (SES) (Floyd & Johnson, 2002; Taylor et al., 2006). Minorities were the primary focus in most environmental justice studies (Boone et al., 2009). Numerous studies conclude that

communities of lower-income and minority populations often have less access to environmental resources, including parks and recreational facilities (Estabrooks et al., 2003; Gordon-Larsen, Nelson, Page, & Popkin, 2006; Moore, Roux, Evenson, McGinn, & Brines, 2008; Powell, Slater, Chaloupka, & Harper, 2006; Talen, 1997). Hurst (2016) stated that some minority groups like African Americans refused to visit parks in their community because of perceived racial discrimination and concerns about how they would be treated.

In addition to the minority indicator, researchers suggested SES can also contribute to identifying environmental justice but have not achieved an agreement on its measurement. Some studies used a single measurement such as median household income or education to define the SES of a community (Gordon-Larsen et al., 2006, Powell et al., 2006), while others reported combining multiple factors can be a more appropriate approach (Crawford et al., 2008, Estabrooks et al., 2003). Prior studies stated that multiple socioeconomic factors can represent more than one aspect of an area's social disadvantages (Chen, Christensen, & Li, 2019; Hughey et al., 2016). With the incorporation of more socioeconomic factors, more of a disadvantaged area's aspects can be detected. Researchers have identified different factors that contribute to socioeconomic disadvantages including percent of unemployment, percent of the population under 125% of the federal poverty threshold, percent of the population that has earned less than high school education, and percent of people renting (Kirby & Kaneda, 2005; Sampson, Raudenbush, & Earls, 1997). In addition to those identified in the literature, additional indicators should be explored to detect other factors of a community's environmental justice issues.

Park Quality and the Measurement

Parks and green spaces are beneficial for people to engage in physical activities, benefiting physical and psychological health (Babey, Wolstein, Krumholz, Robertson, & Diamant, 2008; Bedimo-Rung et al., 2005; Kaczynski et al., 2008). In urban settings with fewer opportunities for interaction with nature—exacerbated by contemporary technologically-influenced nature deficit disorder (Louv, 2008)—parks provide opportunities for experiencing nature (Loukaitou-Sideris & Stieglitz, 2002).

As a critical component of park resources, park quality can be described according to the presence of single or multiple park features and characteristics including maintenance and cleanliness (Coen & Ross, 2006, Mowen, 2010); facility (Vaughan et al., 2013) such as playgrounds, athletic facilities, and dog parks (Aytur et al., 2015); amenity like parking, restrooms, walkways, bike paths, benches, tables, and drinking fountains (Hughey et al., 2016); and aesthetic feature including plantings, turf lawns, water features, and historical or educational features (Macintyre et al., 2002). Furthermore, Kaczynski et al. (2012) suggested incivility—which includes characteristics outside the realm of normatively anticipated park features such as the presence of excessive animal waste, litter, noise nuisance, graffiti, vandalism, and perceived lack of safety—should be considered in evaluating park quality.

To address those identified park features to represent park quality, there is an existing protocol: Parks, Activity, and Recreation among Kids (PARK) tool to capture park quality through auditors' direct observation and evaluation. This tool can assess park quality based on separate features and characteristics including facilities, amenities, aesthetic features, maintenance and cleanliness, and incivility (Bird et al., 2015). Even

though the validity that PARK was attractive for children has not yet been established, this protocol was proved reliable as the conceptual model of parks and physical activity for determining park quality (Bedimo-Rung et al., 2005).

Park Quality Disparity

However, parks and green open spaces are often inequitably distributed among communities with concentrations of racial and ethnic minorities and disadvantaged SES (Hughey et al., 2016; Taylor et al., 2006). While most studies focused on physical aspects such as uneven park proximity and park accessibility, some studies also suggest that disparities exist in park quality and features across socioeconomically, racially, and ethnically diverse neighborhoods (Hughey et al., 2016; Vaughan et al., 2013). For example, Kaczynski et al. (2012) found that park incivility—litter, poor maintenance, threatening behaviors—increased as neighborhood minority concentration increased. There is also an unequal distribution of health-promoting features among socially and economically disadvantaged groups, highlighting issues of environmental justice (Floyd & Johnson, 2002; Taylor et al., 2006). Although an increasing number of studies have documented park quality disparities, they mainly focused on a single park quality such as facility (Loukaitou & Stieglitz, 2002) and aesthetic features (Vaughan et al., 2013). Future studies should explore whether overall park quality—including more park features—is equitably distributed across different neighborhoods (Hughey et al., 2016).

Spatial Autocorrelation

Existing studies often employed simple statistical methods to explore the spatial relationships between park quality and socioeconomic factors. For instance, Chen and the co-authors (2019) analyzed relationships between park quality and socioeconomic variables through Multiple Linear Regression in SPSS, and found park quality disparity, but did not find a statistically significant correlation. Exploring spatial data with a simple statistical regression can be biased because the regression analysis assumes all observations in the sample are independent (Anselin & Bera, 1998). However, sample observations for spatial data are usually not independent but spatially autocorrelated (Anselin & Bera, 1998). Spatial autocorrelation refers to the degree to which near and distant things are related (Anselin & Bera, 1998), taking into account whether an observation occurring at one location is influenced by other nearby observations (Cliff & Ord, 1973). Ignoring spatial autocorrelation can be a severe issue and may result in the statistical regressions that draw inaccurate coefficient estimates and changes the results (Anselin, 1988, Cliff & Ord, 1973). As many park quality measurements rely on observation from one location to another (Aytur et al., 2015), close observations on distance may covary more than the distant observations. To avoid inaccuracies arising from the data collection process, further study should consider the spatial autocorrelation of park quality data to fill the research gap.

Most of the environmental justice research has relied on the simple statistical correlation or regression analysis when assessing the associations between environmental justice indicators and demographic and socioeconomic characteristics (Gilbert & Chakraborty, 2011). However, the traditional statistical correlation and regression often

ignore the significant local variations and autocorrelation when exploring the relationships between the dependent and explanatory variable, and the different environmental disparities and race/ethnicity or socioeconomic status in different places also has been overlooked in the environmental justice literature (Gilbert & Chakraborty, 2011). Future scholars need to address the possible spatial autocorrelation issue in environmental justice research.

2.3 Methods

Study Setting and Sample

This study is conducted in Cache County, a semi-urban area of northern Utah, located in the intermountain west of the United States. The county's total area is 3,038 square kilometers (1,173 square miles), and the total population is 124,438, of which 83.7% are Non-Hispanic White, 10.8% are Hispanic or Latino, 2.5% are Asian, and 1% are African American (United States Census Bureau, 2018). The median household income is $53,812 with 15% of the residents living below the U.S. federal poverty level (United States Census Bureau, 2018).

The sampling unit for this study is census block groups, of which there are 87 in the county and only 77 are included in the census survey (United States Census Bureau, 2014). Census block groups have been commonly used in census data collection and analysis because they are consistent county subdivisions containing between 600-3,000 people, depending on the area's population density (United States Census Bureau, 2014).

Because most block groups are concentrated in the Logan metropolitan area, they contain the majority of the county's population served by public resources.

Cache County is along the eastern edge of Cache Valley, bordered by public lands managed by the Cache National Forest and abundant wildland recreation opportunities in the undeveloped Wasatch Mountains. Within its population centers, Cache County contains 91 designated public parks, ranging between .02 and 21.24 hectares (0.04 and 52.49 acres) in size. They reflect a variety of park typologies with multiple functions, such as a mini park, pocket park, natural resource area, greenway, community park, and neighborhood park—most of which are predominated by a pastoral English landscape aesthetic characterized by maintained turf and high-canopied shade trees.

Data Collection and Measures—Environmental Justice Indicators

Indicators of environmental justice—including both socioeconomic factors and some co-variables—are the independent variables in this study. Based on the literature review, we identify the socioeconomic information for Cache County available at the block group level including poverty (defined as the percentage of population below 125% of the federal poverty line), unemployment (labor force percentage of unemployed), low-education (population percentage of low-education), and renter rate (percentage of the population in renter-occupied housing). One co-variable, minority (population density of racial and ethnic minorities), can indicate issues of environmental justice. We also find another co-variable, yard size, which is potentially related to environmental resources—larger yards can provide more private open space for engaging in physical activities at home, potentially reducing residents' need for public parks. Yard size can be an

important indicator of socio-demographic status among communities, as larger yards correlate with lower population densities and higher incomes in urban neighborhoods. The total yard size for each block group is calculated using Cache County Block Parcel GIS data, which results from subtracting the area of the building footprint from the parcel area within each block group. To address the distributive inequality raised by the university in the area, the number of college students needs to be identified as a control variable to maintain constant. All variables for each block group are standardized into z-score scales.

Data Collection and Measures—Park Quality

Park quality is the dependent variable in the statistical analyses in this study. To transfer the qualitative information to a measurable scale for analysis, both overall park quality and separate park feature qualities are measured using the PARK tool (Bird et al., 2015) shown in Appendix A and quantified according to its protocol. Between September 2016 and October 2016, two auditors assessed all the parks with a modified version of PARK Appendix B in Cache County.

Following the PARK instrument protocol, the different park features—facility, amenity, aesthetic feature, cleanliness and maintenance, and incivility—were separately audited and scored. For example, there were 18 total points to assess the facility component, which includes both a number of facilities score (12 points) and a general facility performance score (6 points) evaluated by two questions. The general performance score measured the general condition of the separate feature quality according to the auditors' perspective and is determined by their agreement. The same

auditing method was applied to the examination of other components as follows: 22 points for Amenity (19 item points and 3 general performance points); 9 points for Aesthetic Feature (6 item points and 3 general performance points); 10 points for Cleanliness and Maintenance (7 item points and 3 general performance points); 7 points for Incivilities (4 item points and 3 general performance points).

The dimensionality of the 5 park features is analyzed using maximum likelihood factor analysis. The initial analysis provides a good representation of park quality in this setting. All separate park feature factors account for larger than 80% of the target variance, which illustrates a good empirical and conceptual fit. To calculate the overall quality of each park in Cache County, a standardized sub-score (0 - 100) is created from the sum of the above-calculated separate qualities. As the service areas of some parks correspond with multiple census block groups, and a census block group may contain multiple parks, the average park quality score for each census block group was calculated according to the park service area proportions in Network Analysis of GIS.

Analysis

This study assesses park quality with environmental justice indicators using a spatial regression model (Anselin, 2004). Following the model conducted in R programming language, first, an Ordinary Least Square (OLS) regression is conducted to determine relationships between park quality and the SES factors and the co-variables (minority, poverty, unemployment, low-education, renter rate, and yard size), assuming the spatial independence of the park quality data but minimizing the sum of squared prediction errors. Subsequent OLS regressions explore associations between the separate

park feature qualities (facility, amenity, aesthetic features, maintenance and cleanliness, and incivility) and the SES factors under the same assumptions. With the construction of a particular spatial weight matrix of a “QUEEN” case neighbor under the “W” weight style (Figure 2.1), a researcher can determine how the park quality across different block group polygons was connected with each other.

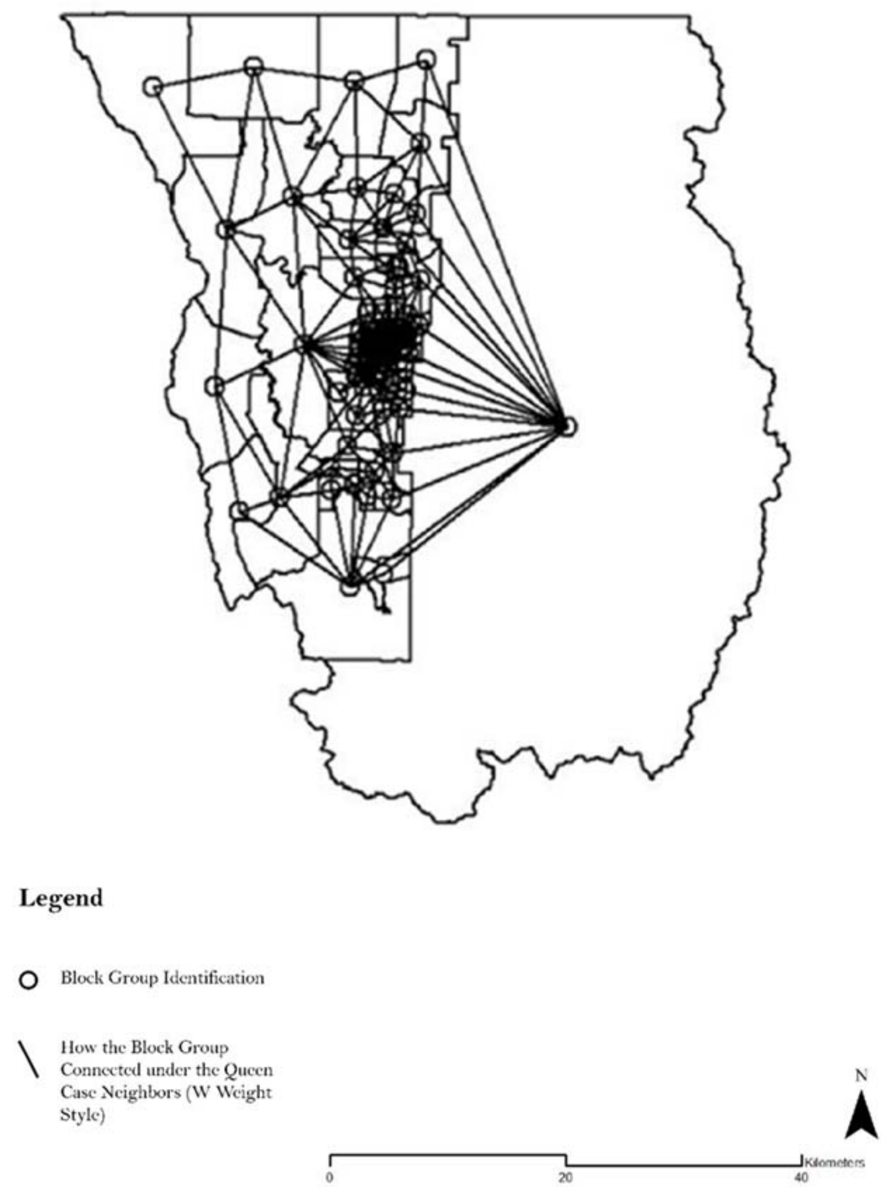

Figure 2.1 Queen Case Neighbors under the W Weight Style across Cache County.

2.4 Results

Sample Characteristics

Within Cache County, SES, co-variables, and the associated park qualities are shown in Table 2.1 based on the 2015 US census information. The average racial and ethnic minority density in Cache County is 1,441 individuals per square kilometer (557 per square mile). The highest density of the minority population is 19,286 individuals per square kilometer (7,475 per square mile). On average, 3.16% of people are unemployed and 0.07% of residents in the area received less schooling than high school education. Building footprints covered an average of 29.32% of the land area within each block group (United States Census Bureau 2015). Most average park quality scores, both separate park feature scores, and overall quality scores are quite similar, around 55%. Only the average facility score (45.11%) is less than the others. The overall Park Quality score for Cache County is 53.3%, ranging from 0% to 78% (Table 2.1).

Table 2.1. Cache County Block Group Environmental Justice Indicators and Park Qualities.

	Mean	SD	Range
Block Group Characteristics			
Racial and ethnic minority density (square	1441.27	2643.37	(0, 19352.31)
kilometer) (standardized*)	(0)	(1)	(-.55, 6.78)
Population below 125% poverty (%)	23.48	19.35	(0, 79.50)
(standardized*)	(0)	(1)	(-1.46, 2.87)
Unemployment (%)	3.16	2.72	(0, 12.45)
(standardized*)	(0)	(1)	(-1.43, 2.75)
Low-Education (%)	0.07	0.07	(0, 0.27)
(standardized*)	(0)	(1)	(-1.09, 3.00)
Renter Rate (%)	34.78	30.65	(0, 100)
(standardized*)	(0)	(1)	(-1.13, 2.13)
Building size (%)	29.32	19.25	(0, 68.5)
(standardized*)	(0)	(1)	(-1.52, 2.04)
Yard size (%)	71.15	21.07	(31.5, 100)
(standardized*)	(0)	(1)	(-2.03, 2.79)
Park characteristics of all block groups			
Facility score*	45.11	17.15	(0, 73.1)
Amenity score*	54.46	19.66	(0, 86)
Aesthetic feature score*	57.16	21.34	(0, 88.9)

Maintenance & cleanliness score*	55.03	18.89	(0, 100)
Incivility score*	55.18	19.17	(0, 86)
Overall park quality score*	53.3	17.15	(0, 78)

*Standardized to z-score scale.

Spatial Autocorrelation of Park Quality

With the “QUEEN” spatial weights matrix across the county set up, a Moran’s I analysis was conducted following the OLS regression’s formula and variables and rejected the null hypothesis that the park quality was randomly independently distributed in Cache County, Utah (p = .022). To support this conclusion, a graphic illustration of the residuals for each block group from the OLS regression also indicated the spatial variations in the dependent variable: park quality (Figure 2.2). There were some patterns in the residual plot that the clustered block group were more likely to have the same colors, which meant the nearby places had more possibility of sharing the same residuals. Both the Moran’s I analysis and the OLS residual plot showed a spatial autocorrelation existing in the park quality distribution in Cache County, Utah.

Correlation between Park Quality and Environmental Justice Indicators

Due to the spatial autocorrelation detected in the park quality, the Lagrange Multiplier Statistics was required to test the spatial dependence of the dataset for studying the associations between park quality and the independent variables. The Lagrange Multiplier Statistics diagnosed that no p-value for the Spatial Error Model or the Spatial Lag Model was significant in the diagnosis. This result suggested that the original OLS model should be used to report the associations between park quality and the indicators (Anselin, 2004).

In the original OLS regression, the explanatory variables were the environmental justice indicators (minority, poverty, unemployment, low-education, renter rate, and yard size) while the college student was the control variable. The dependent variable was the

overall park quality. The combination of the explanatory variables was significantly related to the overall park quality, $F (7, 69) = 3.466$, $p = 0.003$. The $R^2 = 0.26$, indicating that approximately 26% of the variance of the overall park quality can be accounted for by the linear combination of the factors.

All the explanatory variables were tested in separate OLS regression models with different park qualities as the dependent variable, shown in Table 2.2 Overall park quality was only significantly associated with poverty and yard size. The facility was significantly associated with minority and yard size. Amenity and aesthetic features were both related to the minority. Maintenance & cleanliness and incivility were only related to yard size.

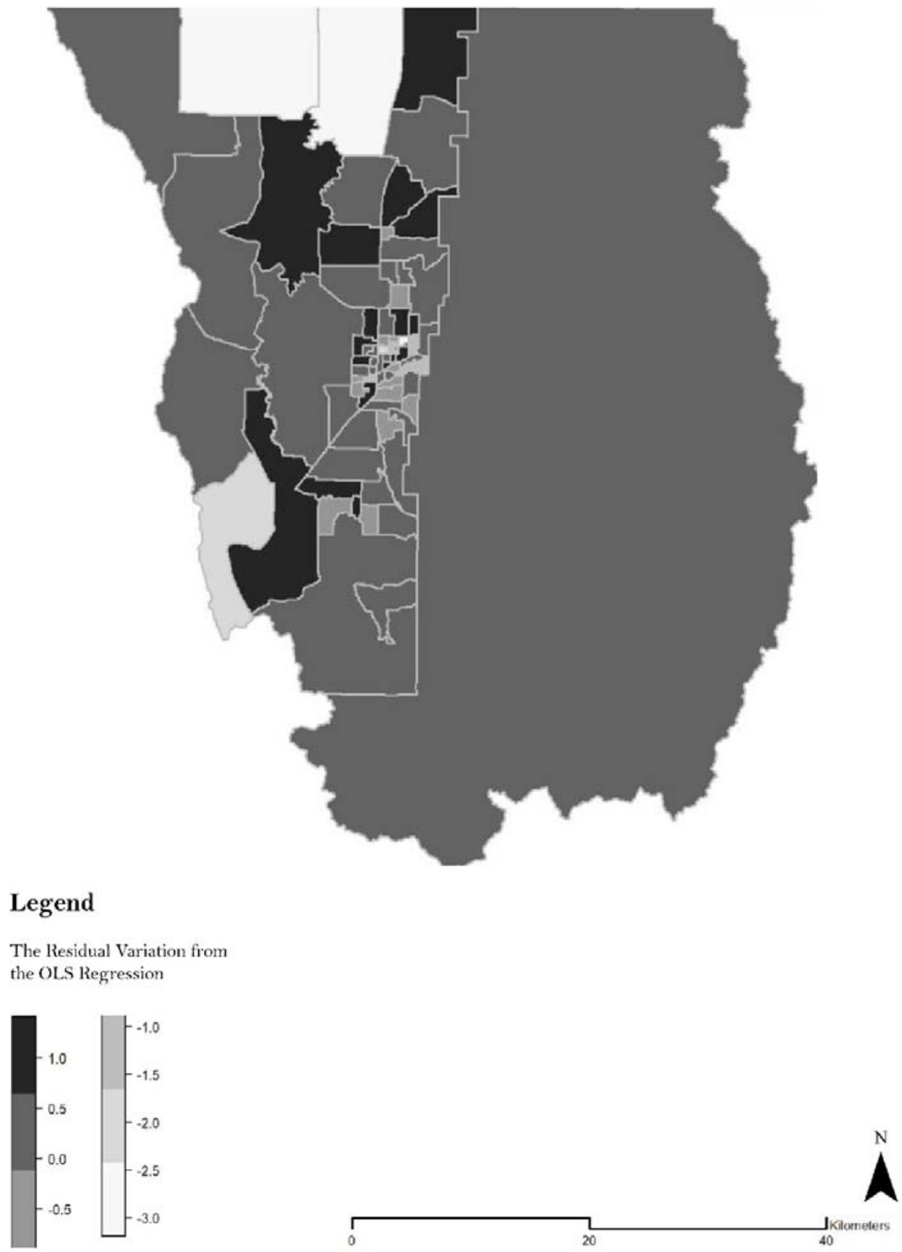

Figure 2.2 The Residuals Variation in the OLS Regression across Cache County.

Table 2.2 The Coefficients between Factors and Different Park Qualities from the OLS Model.

	Park Quality					
	Overall	Facility	Amenity	Aesthetic	Maintenance	Incivility
Minority	-.22	-.26*	-.28*	-.25*	-.23	-.08
Poverty	-.33*	-.13	-.37	-.24	-.37	-.36
Unemployment	-.19	-.14	-.06	-.18	-.15	-.19
Low-education	-.04	-.04	-.06	-.05	-.04	.07
Renter Rate	-.04	-.13	-.14	.07	-.05	-.04
Yard Size	.21*	.21*	.16	.06	.33**	-.27*

**. $P < 0.001$

*. $P < 0.05$

2.5 Discussion

The purpose of this study was to determine whether the distribution of park quality is spatially autocorrelated and assess associations between separate park features, overall park quality, and indicators of environmental justice. Our analysis found clear spatial autocorrelation in park quality distribution and significant relationships between overall park quality and various indicators of environmental justice in Cache County. These findings illuminate issues of unequal public resource quality treatment among different population groups.

Spatial Autocorrelation

When studying the associations between park quality and the indicators, both the Moran's I statistics and residuals plot detected that spatial autocorrelation in park quality caused the dependence of park quality in this study. The quality of parks located close distances to each other co-vary more than those located further distances from each other. Consequently, parks located near each other often share similar qualities; Parks located further away often displayed many different qualities through observation. This finding is understandable given Cache County's block group layout. As most of the block groups are concentrated in the county's central metropolitan area, they have smaller spatial extents and higher population density than outlying areas. As residents are concentrated in the Logan metropolitan area, they are located in proximity to more public resources. Cache County's unique profile resulted in significant spatial variances between centrally located urban block groups and those in outlying areas—park quality distribution and

other public resources. The spatial covariance in park quality makes this study's dependent variable, park quality, not independent. Consequently, a normal statistic regression model would be insufficient for fulfilling the core research objective because it assumes that all variables should be independent. For these reasons, this study employs a spatial regression model to study the associations between park quality and the environmental justice indicators taking consideration of the spatial autocorrelation.

Although the vast variety of population and block group sizes are not typical for many areas in the United States, the spatial autocorrelations that may arise by the interaction on distance are also not unique for Cache County. Dubin (1988) stated as long as the population was involved in their geographic locations, the spatial autocorrelation would happen. The issue has been already highlighted in many other disciplines and other setting areas (Basu & Thibodeau, 1998, Conway et al., 2010, Dubin, 1992). Spatial autocorrelation also exerts great influences on environmental planning and ecology only when studies require spatial data. However, most research in landscape and environmental planning does not account for spatial autocorrelation at the essence of spatial data and instead use the traditional statistical regressions which assume data's independence. In quantitative studies, they persist in applying statistical regression models such as linear regression and poison regression. This study's finding is a clear example of the presence of spatial autocorrelation, and a model of how to use spatial regression addressing autocorrelation, which can be applied in future landscape and urban planning studies. Future studies should identify whether their target dataset has the potential for being spatially auto-correlated before method selection. If the landscape

planning researchers find their dataset contains spatial autocorrelation, spatial regression models will be a more appropriate approach to mitigate data dependence.

Because the spatial autocorrelation was detected in this study, the analysis approach needs to switch to a spatial regression model. After testing the fitness between the dataset and all possible spatial regression models using Lagrange Multiplier Statistics, the Spatial Error Model or the Spatial Lag Model is not suitable because the spatial autocorrelation in this area does not stem from either the correlated errors or spatial diffusion. The other possibility can be the inappropriate choice of the spatial weights matrix that is not indicative of showing how the block groups neighbor one another. After we experimented with other spatial weights matrixes, this possibility can be excluded. Even though we didn’t employ the Spatial Error Model or the Spatial Lag Model, it doesn’t mean that there was no spatial autocorrelation in the area, or the autocorrelation issue doesn’t affect the relationship between park quality and the environmental justice indicators. The spatial autocorrelation is still influencing the park quality distribution in the setting and the OLS regression is suitable in this case. We suggested that future scholars assessed the spatial autocorrelation for their variables and used Lagrange Multiplier Statistics to test the fitness in the dataset for the appropriate statistical approach because there are multiple ways to deal with autocorrelation issue just depending on the characteristics of the dataset.

Park Quality Disparity and Environmental Justice

While prior research has reported inequitable park location distributions in different communities of different SES (Chen et al., 2019, Hughey et al., 2016, Taylor et

al., 2006), this study explored the relationships between physical aspects of parks disparities and non-physical aspects of park quality disparity (Figure 2.3). We found that about 26% of the variance of the overall park quality can be accounted for by the linear combination of the SES factors and the co-variables explored in this setting. Regarding issues of environmental justice, differences in SES across communities may lead to the variation of park quality, resulting in an unequal distribution of public resources. Some SES factors have significant associations with park quality. A negative relationship between poverty and overall park quality indicates that as the percentage of people living under the 125% federal poverty line increased, the overall park quality in their communities decreased (Figure 2.3). Those residents with lower incomes have access to parks of lower quality. The poverty concentrated communities (those that have more than 55% of the population live under the 125% federal poverty line) only account for 9% of the total area of Cache County, but 25 out of 91, about 27% of the parks have been developed in these areas. However, the average overall park quality in these communities (50.6) is much below the general average park quality across the county (53.8). This indicated that even though the number of park resources focused on the disadvantaged population, the quality did not and so may disappoint these people to some extent compared to their counterparts.

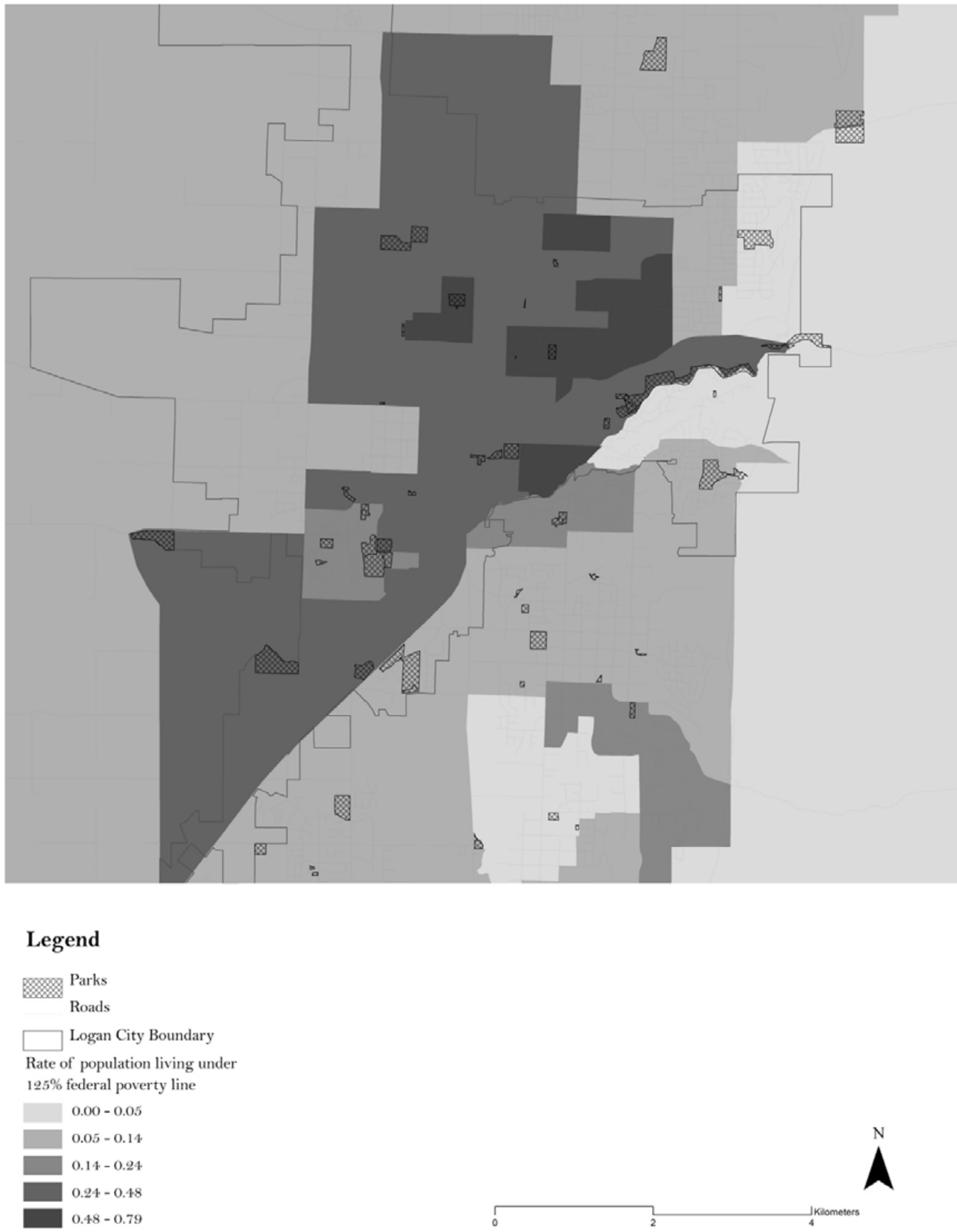

Figure 2.3 Park Locations and Poverty Distribution in Logan Metropolitan Area.

As the primary indicator of the environmental justice studies, racial and ethnic minority density, although not as representative of SES, has been recognized as correlating with socioeconomic dimensions including income level and education (Fang et al., 1998, Williams & Collins, 2001). This study found racial and ethnic minority density is significantly associated with some different deficiencies in park quality, varying from quantitative aspects of fewer facilities and amenities to more qualitative aspects such as lower aesthetic experiences for the visitors. When the minority density increased, those separate park features decreased at the same time. Based on a further spatial and statistical analysis, we found 28 out of 91, more than 30% of the parks, existed in the minority neighborhoods, even though only 1.2% of the area contained the minority population more than 55%. Nevertheless, the various kinds of quality of these parks in the minority neighborhoods incline lower than mean values across the area. These kinds of park quality include amenity, aesthetic features, and maintenance and cleanliness, which are consistent with the findings in the spatial regression. We also found that the averaged overall park quality in the minority concentrated communities (52.3) is inferior to the mean value for the whole area (53.8). As a premise, environmental justice aspires to ensure all individuals in society have equal rights, opportunities, and access to public resources, including park quality. In serving local communities, planners and designers should consider the spatial distribution of parks—and quality of those parks—as a key component in the equitable distribution of public resources. In addition to the equivalent distribution plans, some other actions or policies may also contribute to greater minority visitation in public parks. As minority groups may experience discrimination in public places, they may alter their park use behaviors or

avoid using those parks altogether. To mitigate these factors, some suggest that changing the composition of park management staff to include more people of color may improve group perceptions and increase minority park use (Byrne & Wolch, 2009).

Yard size positively correlated with the overall park quality, as well as most separate feature qualities, including facility, maintenance and cleanliness, and incivility. The quality of the parks in the neighborhoods with more yard size tends to be enhanced than the others. More yard areas can directly reflect the housing types and the socio-demographic situation. With a larger yard, people have more opportunities to do physical activity in their own space and may not have a strong need to go to a public park. More yard space also implies lower population density and often higher income levels as well. However, this study finds block groups with larger yards often have parks with more facilities, services for maintenance and cleanliness, and fewer incivilities such as graffiti, vandalism, unsafety, and garbage. While these residents already own a large outdoor space at home, at the same time, they also have more convenient access to high-quality public parks with better facilities and maintenance. These findings are aligned with the environmental justice issue that the public resources have not been distributed fairly among the individuals who need them but instead focus on some specific groups.

Home to Utah State University, Cache County's demographic diversity, and urban population are associated with the presence of the university. Consequently, while its enrolled students' population may have disadvantages, for many this economic status is a temporary situation on the way toward a dramatically higher income upon graduation as well as a financial dependency on their parents—in contrast with other communities of generational disadvantages. The assessment of environmental justice should consider

distributive inequality, such as the institutions that guide social relations and decision structures (Boone et al., 2009). Due to its availability of data and relative demographic diversity as a university community, Cache County can be a suitable setting in which to assess the associations and study whether the distribution of park quality is spatially autocorrelated while taking into account the influence of the college students.

Limitations and Future Research

While illuminating issues of the spatial autocorrelation of park quality, the study also has several limitations. First, while the PARK tool is designed for assessing the quality of developed parks and green open spaces, it was not designed for assessing large-scale undeveloped or wildland landscapes such as those that form the eastern edge of Cache County's urban population. Consequently, this study focused on the county's 91 developed urban parks and did not include undeveloped public wildlands such as the Cache National Forest and its ad-hoc recreational opportunities. However, as this edge condition is predominated by large and expensive single-family homes with expansive views of the valley, Cache National Forest is in close proximity to residents who already benefit from high park quality. Cache County illustrates an edge condition that is found in many urban communities along Utah's Wasatch Front and in many other gateway communities in the western United States in which public lands characterized by undeveloped and wildland conditions are in close proximity or immediately adjacent to residential development (Howe et al., 2012). Future studies on park quality should expand knowledge on how these very large-scale undeveloped public lands affect the distribution of park quality within gateway communities. Second, due to the unique

layout and profile of Cache County—most of the block groups are concentrated in the Logan metropolitan area, as well as high population density and abundant public resources—the spatial autocorrelation is very obvious in the park quality distribution. Future studies should continue to study spatial autocorrelation in other settings to see whether Cache County is a distinct example or if spatial autocorrelation has been widely occurring in the profession of landscape and environmental planning but ignored for a long time.

Conclusion

This study presents a vivid example of spatial autocorrelation in environmental planning, and how this phenomenon can present validity issues when data analyses fail to acknowledge its presence. Future researchers, within the planning and design disciplines—as well as other professions that employ spatial data, should be aware of spatial autocorrelation issues and select quantitative approaches that account for data dependence at study initiation. Lastly, the improvement of park quality provides greater opportunity for experiencing equitable access to the pursuit of healthy and productive lifestyles, and so we encourage policymakers, city planners, and designers to be cognizant of park quality disparities, especially for the disadvantaged population, and its contribution toward environmental justice.

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CHAPTER III

A SYSTEMATIC REVIEW OF ALTERNATIVE PROTOCOLS FOR EVALUATING NON-SPATIAL DIMENSIONS OF URBAN PARKS

3.1 Abstract

Due to rapid urbanization, parks are important assets for quality of life in urban settings. They provide opportunities for outdoor physical activity and therapeutic benefits. A growing number of park assessment studies are shifting their focus from spatial assessments, such as the availability, proximity, and accessibility, to non-spatial assessments, such as park quality, park use, and park benefits. Consequently, arguments for developing methods of measuring these non-spatial dimensions of urban parks have emerged in the literature. The purpose of this study is to analyze and synthesize the different approaches used for assessing non-spatial dimensions of urban parks and draw implications for future urban landscape planning, design, and research. We explore the research purpose from the perspectives of how the existing protocols measure the non-spatial park dimensions, what limitations they have, and what recommendations for future scholars to choose an existing protocol.

3.2 Introduction

By 2050, 70% of the world's population is projected to live in urban areas, due to rapid urbanization (UN, 2012). Concurrently, concerns around global urbanization's impacts on quality of life have reinvigorated calls for resiliency as a key component of

healthy urban environments. As contributors to resiliency, urban parks play an essential role in urban systems by providing various health, economic, and social benefits (Bedimo-Rung et al., 2005), ecosystem services (Flocks et al., 2011, Reja et al., 2017), sustainability (Jennings et al., 2016), and hydrology (Newman et al., 2017, Thiagarajan et al., 2018) that mitigate negative issues commonly associated with urbanization. Given the trend of denser urban forms for residential, commercial, and industrial areas, the loss of parks and green open space has become a serious problem for the research to address in most of the urban setting nationally and globally (Lin et al., 2015, McPherson et al., 2011). As the importance of parks in cities is widely recognized, a growing number of researchers have studied parks from different perspectives of urban planning and design disciplines for their capacity to better understand the relationships between people and parks as well as promote the well-being of urban populations (Sallis, 2009). For example, Newman et al. (2019) quantified and evaluated the urban green space addressed landscape performance.

Research on urban parks has traditionally focused on their physical and spatial aspects such as park availability, accessibility, and proximity. Physical identification is also known as “park availability,” determined primarily by the number and size of parks (Hughey et al., 2016). Spatial identification—park proximity or accessibility—relies on measuring the relative opportunities for potential contact with and use of parks based on location theory (Wang et al., 2015). Spatial proximity-based research has asserted that the closer a park is to a resident, the more likely they will visit that park. Studies commonly employ Network Analysis via Geographic Information System (GIS) to map the service area of a park to indicate park accessibility (Chen, Christensen, & Li, 2019).

Researchers commonly use spatial approaches to understand the relationships between urban green open space and the dwellers (de la Barrera et al., 2016). In addition to the physical and spatial measures, understanding and assessing parks' non-spatial or non-physical dimensions are also important because the spatial approaches cannot fully predict human preferences and behaviors. For example, park quality is often correlated directly and significantly with physical activity levels, which contribute to a community's overall well-being (Mitchell & Popham, 2008). Prior literature stated that the park quality is a more important factor than a closer distance influencing people's use of parks (Kabisch & Haase, 2013, Kemperman & Timmermans, 2014). To achieve a better understanding of the relationships between parks and quality of life—and shape future environmental planning processes—researchers should include both physical and non-physical, spatial and non-spatial dimensions in their assessments. Recognizing this need, recent studies assessing park quality have coincided with the emergence of new analytical tools from a range of disciplines. In addition to exploring relationships between urban green open space and residents, studies have identified other non-spatial dimensions of urban parks like park use and park benefits. Bedimo-Rung et al.'s (2005) conceptual framework provides insights into potential relationships among park quality, park use, and park benefits that recently used to quantify and reflect non-spatial dimensions of urban parks for green open space design and urban planning.

Scholars measured the non-spatial dimensions of parks for different purposes, such as park design improvement (Evenson et al., 2013), and increasing opportunities for physical activities (Duan et al., 2018). Park quality has been assessed and discovered inequitably distributed across socioeconomically, racially, and ethnically diverse

communities (Chen et al., 2019, Hughey et al., 2016, Vaughan et al., 2013). Studies have measured park use or park benefits to enhance understanding of how associations between population and the built environment should inform urban open space planning and design processes. Following is a detailed explanation of each non-spatial park dimension explored within this study.

Quality of parks can be evaluated according to several attributes such as facilities, general condition, maintenance, features, and fitness for purpose as well as subjective components like human needs and user perceptions (Gidlow et al., 2012). The quality determination of urban landscapes should include comprehensive attributes in addition to spatial factors, such as documentation of interactions between humans and the built environment.

Park use describes how certain features and characteristics support or restrict the general population's involvement in a given environment for a particular purpose (Iwarsson & Ståhl, 2003). Measurement of park use often includes evaluating how people visit a park, what activities—such as physical activities—they partake in, and their participation in programs (Aytur et al., 2015). Within the literature, a similar term of art—park usability—sometimes raises confusion for readers due to its apparent similarity with park use. However, park usability pertains to how individuals with mobility limitations access a park and fully participate in park-based activities, as compared with users who do not have mobility impairments (Iwarsson & Ståhl, 2003).

The concept of park benefits is defined according to psychological, psychophysiological, social/cultural, environmental, and economic dimensions. Psychological benefits include personal development, mental health, and personal

appreciation or satisfaction. Psychophysiological health benefits including reduced depression, decreased obesity, increased levels of fitness, reduced incidence of disease, and improved perceived quality of life. Social/cultural benefits include community satisfaction, family bonding, and reduced crime. Environmental benefits include the development of environmental values, heritage preservation, and environmental protection. Economic benefits include reduced health costs, increased productivity, and increased property values (Moore & Driver, 2005).

Non-spatial dimensions of urban parks are a complicated construct and quality, use, and benefits are the commonest representation according to the literature. The associations among the three identified dimensions suggest that higher park quality could result in greater opportunities for physical activities or more park use, which could contribute to various human well-being and health benefits (Bedimo-Rung et al., 2005). Park quality is directly related to the urban park planning and design processes. Park use is significantly connected to understand interactions between humans and their built environment. Park benefit is a measure of the benefits that people could achieve from the parks, which provided a direct reflection of the relationships between humans and parks.

With the emergence of various protocols for measuring manifold non-spatial dimensions of urban parks, researchers are now facing challenges in selecting appropriate measurement protocols. Some researchers have used existing instruments, while some others developed their own protocols. Researchers who are interested in determining the non-spatial dimensions of parks find a variety of divergent protocols, which present challenges for consistent evaluation. This study systematically reviews, summarizes, and synthesizes the current state of academic literature focused on the protocols used for

evaluating non-spatial dimensions of urban parks and interpret how current protocols measure the three most commonly recognized non-spatial dimensions of urban parks: park quality, park use, and park benefits, and suggest directions for future scholars. To achieve such a research objective, the following research questions will be answered and guide the systematic research:

1. How do the existing protocols measure the non-spatial dimensions of urban parks (park quality, park use, and park benefit)? This question includes:
    a. Which method does the protocol employ?
    b. Where was the protocol first developed?
    c. Who is the target population?
    d. What elements does the protocol measure?
2. What are the limitations of the existing protocols measuring the non-spatial dimensions of urban parks (park quality, park use, or park benefit)?
3. What are the recommendations for future scholars to choose/develop the protocol to measure the non-spatial dimensions of urban parks (park quality, park use, and park benefit)?

3.3 Methods

Search Criteria and Strategy

Eligibility criteria for this study are those English-language peer-reviewed journal articles that developed new approaches for measuring the three identified non-spatial dimensions:1) quality, 2) use, and 3) benefits of green open space, especially parks in

urban settings. Articles that used existing instruments to measure non-spatial dimensions of parks or the applications of any existing protocols were not included in this study. To concentrate its focus on peer-reviewed scholarly research, abstracts, book chapters, project report, and conference proceedings were excluded from the search.

To identify approaches for assessing the non-spatial dimensions of urban parks within the academic literature, this study employed Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Moher et al., 2009) and conducted an online search in Google Scholar and Scopus.

The searching keywords included, for park quality: “park” OR “green space” AND “quality” OR “feature” “character” AND “measure” OR “assess” OR “evaluate” OR “exam” OR “tool” OR “approach” OR “method”; For park use: “park” OR “green space” AND “use” OR “physical activity” OR “usage” OR “usability” AND “measure” OR “assess” OR “evaluate” OR “exam” OR “tool” OR “approach” OR “method”; For park benefit: “park” OR “green space” AND “benefit” OR “service” AND “measure” OR “assess” OR “evaluate” OR “exam” OR “tool” OR “approach” OR “method”.

According to PRISMA, search results were scanned for titles with the primary keywords with an emphasis on urban settings. During the subsequent process of reviewing the full text of those articles identified from the initial keyword search, additional records identified from reference lists of the full-text papers meeting the search criteria were also included for next step screening. The duplicated records screened from the titles were removed. As articles with these keywords in the title were identified, their abstracts and full content including Introduction, Methods, Results, Discussion, and Results were read closely to determine whether the articles measured any of those non-

spatial park dimensions and whether their methodological approach is innovative. The flow and results according to PRISMA through the phases of the systematic review were shown in Figure 3.1.

Data Extraction and Analysis

Following the PRISMA process, the included articles were reviewed and extracted the information to answer the research questions. Besides the basic information, such as tool/protocol name and author and year, we also searched for the methods, context, target population, and measures to answer the first research question——how the existing protocols measuring these non-spatial dimensions of urban parks. Beyond a summary of all protocols, an in-depth review was conducted using a grounded theory approach (Glaser & Strauss, 2017) to identify patterns within the extracted information and synthesize the protocols' apparent purposes, practicability and efficiency, issues of reliability and validity, and how technology advancement informed protocol development. From this analysis, the second research question (the limitation existed in the current protocols) can be identified. To answer the third research question, we provide recommendations for selecting the most suitable instrument among existing protocols for assessing non-spatial park dimensions in urban settings.

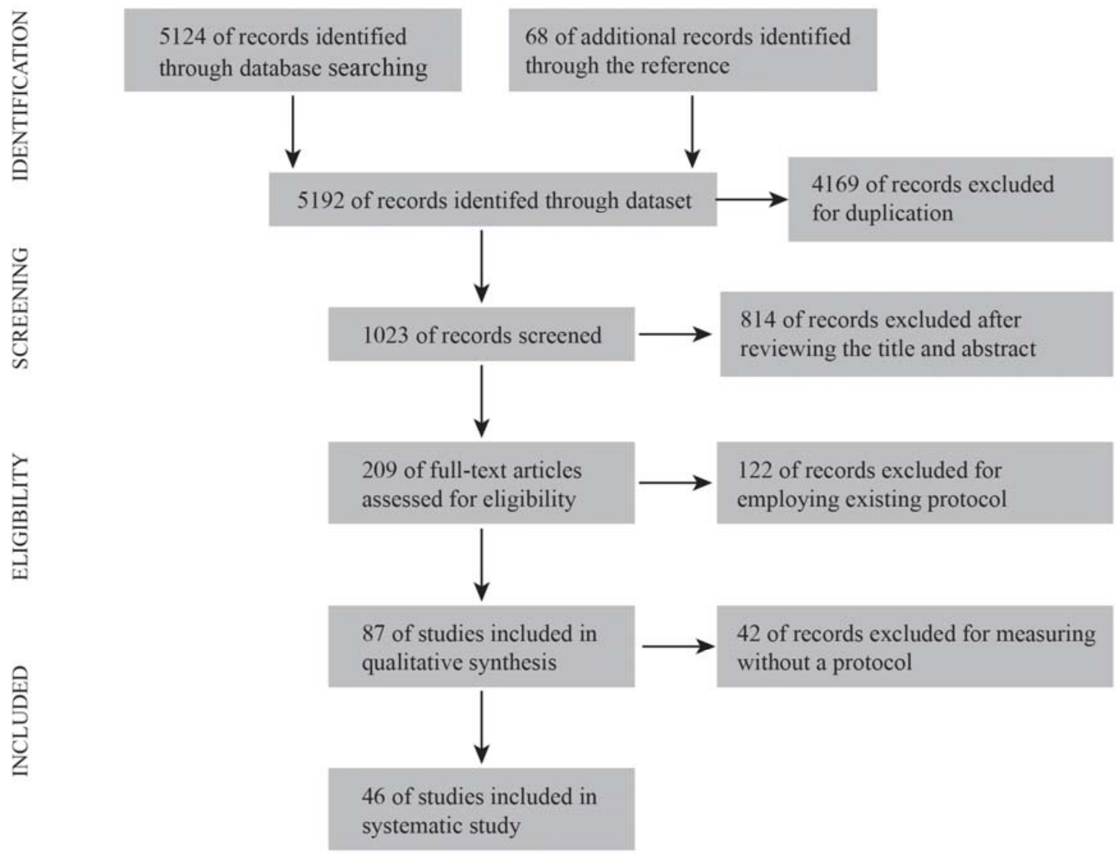

Figure 3.1 Flow of Information through the Phases of the Systematic Review According to PRISMA.

3.4 Results

From the existing literature, we have identified 18 innovative approaches for assessing park quality, 23 assessing park use, and 4 assessing park benefits listed in Tables 3.1, 3.2, and 3.3 to interpret how the existing protocols measure the three non-spatial dimensions of urban parks. The limitations in the current protocols measuring the three non-spatial dimensions are also illustrated in this section followed by the recommendation of the established protocols for the future researcher.

Park Quality

How Did the Protocols Measure Park Quality? The development of the protocols measuring park quality has been constructed based on prior knowledge and continued for specific purposes. The Public Open Space Tool (POST) was initially designed as a validation tool for capturing 49 items covering four key domains of park quality: activities, environmental quality, comfort, and safety through direct observation (Broomhall et al., 2004). After that, a remote-use version (POSDAT) is used for evaluating features of public open spaces and improved from reduced data collection time, especially for large areas and samples from the POST (Edwards et al., 2013). With technological advancement, Hoffimann et al. (2018) recently developed a free smartphone app based on POST, maintained the key components of POST, but added data audits and analysis functions. Parks, Activity, and Recreation among Kids (PARK) (Bird et al., 2015), was created to assess five conceptual domains based on a conceptual model of parks and physical activity, including activities, environmental quality, services, safety, and general impression (Bedimo-Rung et al., 2006) that may appeal to children.

Their predominant methods for evaluating park quality are direct observation or on-site assessment (72%). GIS, remote sensing and aerial photos were employed in some tools to detect the items in the parks. Among the measures of park quality (Figure 3.2), Among the measures represent park quality, sixteen out of eighteen included landscape or aesthetic feature, fifteen out of eighteen included facility or amenity (Figure 3.2). More than half of the protocols assessed the park safety and maintenance/general conditions (Figure 3.2).

What Are the Limitations of the Protocols Measuring Park Quality? A large number of the instruments capturing park quality are primarily from the physical activity perspective (Bedimo-Rung et al., 2006, Broomhall et al., 2004, Kaczynski et al., 2012, Lee et al., 2005, Saelens et al., 2006). All of these park quality assessments are constructed in the global west including 61.1% in the United States or Canada, 22.2% in Australia, and 11.1% in Europe (Table 3.1). Thirteen out of the eighteen approaches were designed for the general population while only some are targeted for a specific group, such as youth. A handful of protocols evaluated park size as a contribution to the quality, and only 2 of 18 evaluated protocols considered visitors' impressions. Figure 3.2 details four tools that include street/surrounding areas/accessibility as part of park quality, and five tools that measure incivility, which reflects some overlap with park safety issues. Some widely recognized park quality measures, such as visitors' impressions have not been considered in most of the current protocols.

Table 3.1 Summary of the Existing Protocols Measuring Park Quality.

Authors	Tool	Methods	Context	Population	Measures/ Description
Broomhall et al., (2004)	Assess public open space, namely the features that foster or limit physical activity (POST)	Direct Observation	None specified	All	activities; environmental quality; comfort; safety
Cavnar et al., (2004)	Evaluate recreation facility quality (RFET)	GIS located, and then in situ audit	medium-sized county, USA	All	Condition items; maintenance; safety
Byrne et al., (2005)	Assess the features of green spaces in Los Angeles (SAGE)	Direct Observation	California, USA	All	Facilities and services; landscape features; condition; safety
Lee et al., (2005)	Describe the features of physical activity resources, including parks (PARA)	Field Assessment	Kansas City, Kansas, and Missouri, USA	All	Features, incivilities, size, cost, signage, amenities
Bedimo-Rung et al., (2006)	Assess the features of parks, focus on physical activity (BRAT-DO)	Direct observation	None specified	All—but includes youth-specific features	Features, condition, access, aesthetics, safety
Troped et al., (2006)	Path Environment Audit Tool (PEAT)	Observation	None specified	All	Design features, amenities, and maintenance/aesthetics

Saelens et al., (2006)	Evaluate public recreation areas for their physical activity potential (EAPRS)	Observation	Hamilton County, USA	All, but partial focus on play spaces (youth)	Trails, water, access, aesthetics, comfort, information, educational, safety, seating, play areas, sport facilities
Crawford et al., (2008)	Children's Public Open Space Tool (C-POST)	Observation	Melbourne, Australia	Children	Recreational facilities; Availability of amenities; Number of playgrounds Club rooms for sporting clubs
Taylor et al., (2011)	Remote method (making use of Google Earth Pro)	Aerial, satellite, and Street View images	Sydney, Australia	All	Features; Street View; smaller objects (litter, play equipment, and some graffiti)
Gidlow et al., (2012)	Assess the quality of neighborhood parks through an easy-to-use tool (NGST)	Independent observation	Stoke-on-Trent, UK	All	Accessibility 18.0%; Recreational facilities 16.0%; Amenities 22.0%; Natural features 20.0%; Incivilities 24.0%.
Kaczynski et al., (2012)	Assess parks for their physical activity potential (CPAT)	Observation	Kansas City, Missouri, USA	Youth-oriented, but not exclusively	Park info, access, and surrounding the neighborhood, park activity areas, and park quality and safety
Edwards et al., (2013)	Evaluate the features of public open space (POSDAT)	Web-based information and remote sensing	Perth, Australia	All	Activities; environmental quality; dogs; amenities; safety
Voigt et al., (2014)	Structural Diversity	Multi-dimensional landscape mapping	Berlin, Germany; Salzburg, Austria.	All	Biotic features; abiotic site conditions; infrastructure facilities

Bird et al., (2015)	Evaluate park features, with a focus on youth (PARK)	Direct observation	Quebec, Canada	Youth	Activities; environmental quality; services; safety; the general impression
Gidlow et al., (2018)	Natural Environment Scoring Tool (NEST)	In situ assessment	Barcelona, Doetinchem, Kaunas	All	Accessibility; Recreational facilities; Amenities; Aesthetics – natural; Aesthetics – non-natural; Significant natural features; Incivilities and Usability; typology-specific
Van Hecke et al., (2018)	Manipulated photographs of parks	6912 photographs of park characteristics	None specified	Adolescents	Naturalness, walking paths, upkeep, outdoor fitness equipment /playground; sports field; benches; drinking fountain; peers; a mother with children, homeless people
Hoffimann et al., (2018)	POST app	A free and open-source app for smartphone-based on POST	None specified	All	The app stays true to the original POST paper instrument but adds several functionalities to facilitate the POS audits and the subsequent data analysis
Rigolon, & Nemeth, (2018)	QUality INdex of Parksfor Youth (QUINPY)	GIS	Denver, USA	Youth	Structured play diversity, Nature, Park size, Park maintenance, and park safety

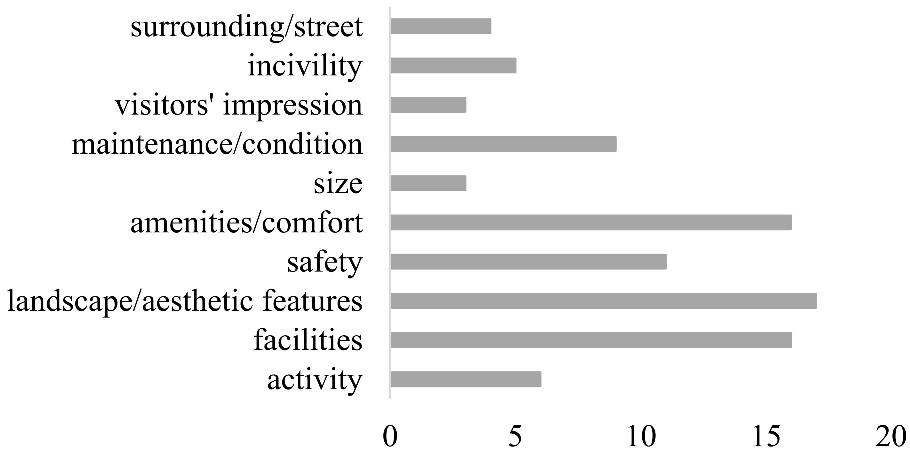

Figure 3.2 Summary of Park Quality Measures.

Park Use

How Did the Protocols Measure Park Use? Studies had diverse survey methods to assess park use until the development of Observing Play and Recreation in Communities (SOPARC) and the System for Observing Play and Leisure Activity in Youth (SOPLAY) by McKenzie et al. in 2006 and 2002. Both SOPARC and SOPLAY were designed to obtain information on the park users and their physical activities, and use momentary time sampling to record their behaviors (McKenzie et al., 2006). In Figure 3.2, even though 37% of the existing tools chose the survey method to assess park use, the majority of the case studies employed observational methods to assess park and almost all observational studies employed an already developed protocol to capture park use (Joseph & Maddock, 2016). As of 2016, 85% of the direct-observation studies captured park use with the SOPARC tool while 11% used SOPLAY (Joseph & Maddock, 2016). In Figure 3.3, some other studies employed global positioning systems (GPS) devices to assess the proportion of time within a day spent at parks, and the proportion of moderate to vigorous physical activities (MVPA) (Jones et al., 2009, Quigg et al., 2010, Wheeler et al., 2010). This protocol required participants' willingness to wear a GPS device and the availability of digital maps to match the GPS data (Evenson et al., 2013).

In Table 3.2, approximately half of the examined park use assessment tools were developed in the North American (48%), 20% were in other western contexts besides North America, 16% were in Asia, and the other 16% protocol did not specify their region of origin. The targeted populations for park use measurement are diverse, including for different age groups ranging from youth to elderly, as well as an array of racial and ethnic groups.

The measures in different park use tools vary mainly according to the selection of the data collection methods. In Table 3.2, most observational tools rely on researchers' collection of the visitors' apparent demographic information (age, gender) and their activities in the park. Twelve out of sixteen observational tools focused on the degree of intensity of physical activities ranging from like sedentary activities to athletic exertion to define visitors' MVPA. The remaining four broaden the measures to different kinds of activities, while not just classifying their level of vigor. In the survey modes, questions are more likely to distribute to the frequency and duration of the park visit and their favorite or most frequent activities. Survey instruments also asked more detailed questions about participants' socio-economic status. Recently developed methods informed by new technology occurred in park use assessment studies, particularly in contexts outside North America. Accelerometers to record the time and intensity of physical activity have illustrated health metrics of park use, used particularly by health scholars (Ries et al., 2009). In addition to accelerometers, some researchers combined the GPS to record the locations of the participants to gain more comprehensive information including both physical activity time and intensity and their locational occurrence (Brown et al., 2017, Quigg et al., 2010). Due to differences in population density and city size, some Asian countries like China developed other means of measuring park use through social media to capture park visitors' attributes and location (Zhang, 2018). A growing number of studies are also employing mixed methods to gather and triangulate multiple aspects of park use to derive a more thorough and complete assessment.

What Are the Limitations of the Protocols Measuring Park Use? Some of the literature measured park use via independently-developed survey instruments but did not

evaluate the validity and reliability of those methods (Payne et al., 2005, Raymore & Scott, 1998, Tinsley et al., 2002, Walker et al., 2009). Most of the developed protocols, including some most popular ones, such as SOPARC (McKenzie et al., 2006) and the recently published ones assessed physical activity or people's intention of doing physical activity as their main or only indicator of park use but did not consider other kinds of park use, such as social contacts and relaxation. For the park use protocols developed in the United States, most of them preferred observation and survey approaches and often focused solely on physical activity levels. Even though there is fast growing in the number of new instruments measuring park use outside North American, such as in some Asian areas and European cities, the development of the methods made the growing lack of some rigorous research examination, for instance testing their validity and reliability.

Table 3.2 Summary of the Existing Protocols Measuring Park Use.

Authors	Tool	Methods	Context	Population	Measures/Description
Raymore, & Scott, (1998)		In-park survey	Cleveland, Ohio, USA	Elderly	Demographic info; frequency of visit; the number of other people in groups; the number of children in group; the number of parks visited; the total number of activities pursued
McKenzie, (2002)	System for Observing Play and Leisure Activity in Youth (SOPLAY)	Direct observation	None specified	Youth	Gender; day; temperature; area accessibility; usability; the presence of supervision, presence and classification of activity (sedentary, walking, or very Active); equipment availability
Tinsley et al., (2002)		Structured interview	Chicago, USA	Elderly	Socio-demographic information; person's park visit; the current activity, the previous activities, and their favorite in-park activities.
Payne et al., (2005)		Survey	USA	Elderly	Park use frequency; park accessibility; respondent's most recent park visit
Sasidharan et al., (2005)		Survey: self-administered questionnaire mailed to samples of residents	Eastern USA (Atlanta, GA and Philadelphia, PA).	Hispanic, Chinese, Japanese, Korean,	When visits occurred; how long they lasted; how many companions were present; the types of activity they engaged

				African American, and White	
McKenzie et al., (2006)	System for Observing Play and Recreation in Communities (SOPARC)	Direct observation (morning, noon, afternoon, and evening a day)	None specified	All	Park users' physical activity levels; gender; activity modes/types; estimated age; ethnicity; park activity areas (levels of accessibility, usability, supervision, and organization)
Ries et al., (2008)		Mixed methods: Face-to-face interview; direct observation	Baltimore, Maryland, USA	Youth	Neighborhood characteristics influencing physical activities; experiences using recreational facilities; time observed; visitor attributes; the activity taking place; facilities, such as activities available, size, and conditions
Ries et al., (2009)	Baltimore Active Living Teens Study (BALTS)	Web-based survey; ActiGraph accelerometers	Baltimore City, Maryland, USA	African American youth	Use of parks for physical activity; total weekly minutes of MVPA; perceived park availability
Walker et al., (2009)	Physical Activity in Parks Setting instrument (PA-PS)	Telephone Survey	California, USA	Adults	Participation in physical activity; duration of their park visit; participation in specific park-based activities; park visitation; park use

					with specific facilities
Loukaitou-Sideris and Sideris (2009)		Survey (children and parents)	Los Angeles, USA	Middle school children	Demographic info; frequency; active/sedentary behavior
Quigg et al., (2010)	Children's Activity in their Local Environment (CALE)	Accelerometers (Actigraph GT1M); global positioning system units (Globalsat DG-100)	Dunedin, New Zealand	Children aged 5 to 10 years	Physical activity level; physical activity location
Evenson et al., (2013)	Measurement Properties of a Park Use Questionnaire	Mixed methods: Survey and GPS monitor	USA	All	Survey: usual park use frequency, duration; activity; mode of travel for the most recent park visit, and past week. GPS: exercise latitude, longitude, and speed every minute to identify park visit
Koohsari et al., (2014)	Space Syntax	Axial lines draw by DepthMap or hand	None specified	All	A “graph theory” in quantifying axial maps; “depth” is the primary measure extracted from the justified graph; Integration is an important measure in space syntax; associations between POSs and physical activity can be enriched by using measures of space syntax in calculating

					the concept of distance.
Edwards et al., (2015)		Survey	Geraldton, Australia	Adolescents	Cross-sectional data of physical activity attitudes and behaviors; perceptions of park availability and the main park used for physical activity
García-Palomares, (2015)	Photo-sharing services	Social media	Athens, Barcelona, Berlin, London, Madrid, Paris, Rome, Rotterdam	All	Location of each of the photographs; spatial distribution patterns; information about the geographic coordinates, the ID of the owner of the photograph, a URL link to the photograph and the date on which it was uploaded
Alivand & Hochmair, (2017)	Respective application programming interfaces (APIs)	geocoded Panoramio and Flickr images	California, USA	All	User name, photo ID, URL, longitude, latitude, date, time, and textual labels; outdoor scenery and urban environments
Brown et al., (2017)		Accelerometer minutes of activity were merged to the first GPS point within each minute	Salt Lake City, Utah, USA	Adults	Participants were effect-coded into four groups based on accelerometer/GPS evidence of use during the one-week measurement periods each year

Chen et al., (2018)	RTUD (real-time Tencent user density)	social media	Shenzhen, China	All	User density in parks (their location and movements)
Duan et al., (2018)		Mixed Methods: SOPARC and a questionnaire survey	Hongkong, China, and Leipzig, Germany	Elderly	Park-based PA, PA areas, urban conditions from an external point of view; overall PA behavior and the perception of the PA environment (e.g., park accessibility) from the individual perspective
Ladle et al., (2018)		Mixed methods: smartphone GPS and survey	City of Calgary, Alberta, Canada	University students	Using a dataset consisting of smartphone GPS location history data volunteered by participants. We ask questions relating to urban greenspace selection by comparing used locations to a set of random locations at multiple spatial extents
Pérez-Tejera et al., (2018)	Observational tool (EXOdES)	Systematic Observation	Barcelona, Spain	All	Observational period, public space, location/activity setting; demographic info; activity, dogs, vehicles, problematic uses, substances use signs, violence; brightness, cleanness, visual control, green space maintenance, litter, graffiti

Tsai & Lin, (2018)	sound pressure level (Leq)	Attendance density in representing the park activity intensity	Chiayi Park, Taiwan	All	Equivalent continuous sound pressure level (Leq) as a novel indicator to represent park activity intensity and investigated the correlation between Leq and sky view factor (SVF) at different Physiologically equivalent temperature (PET) values.
Zhang, (2018)		Social media (Weibo)	Beijing, China	All	Latitude, longitude, names and check-in numbers of the retrieved locations (such as parks)

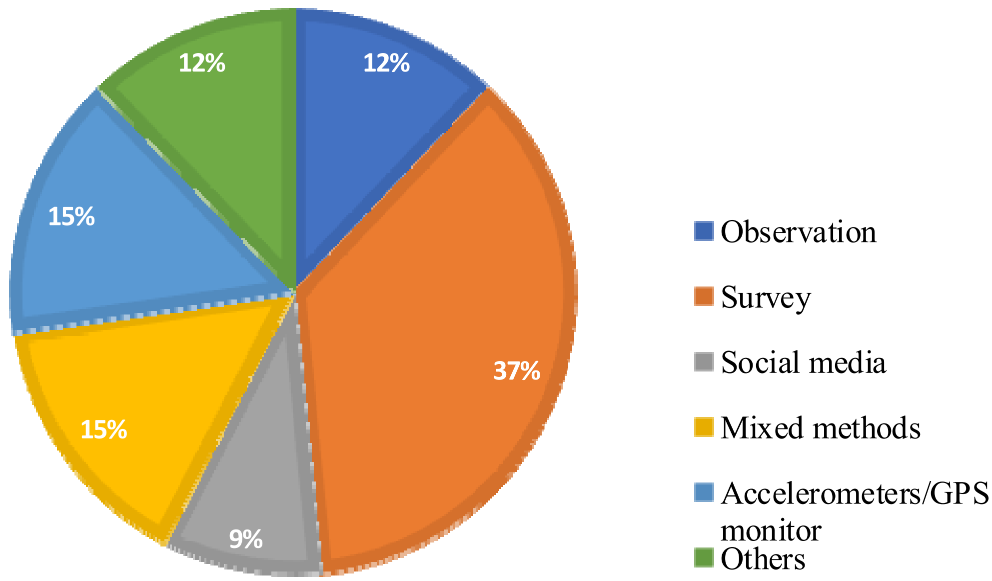

Figure 3.3 Distribution of Park Use Methods.

Park Benefits

How Did the Protocols Measure Park Benefit? It has been reported that extensive literature espouses the various benefits urban residents can achieve from green open space (Van den Berg et al., 2015). Although multiple studies have evaluated specific aspects benefits that urban green resources could provide, such as ecosystem service and on psychological health (Jim & Shan, 2013, Sanesi & Chiarello, 2006, Tyrväinen et al., 2007, Vesely, 2007), no specific tool or protocol was developed to assess this nonspatial dimension until the development of public participation geographic information system (PPGIS) by Brown et al. (2014) in Australia. PPGIS offers an online alternative for park users to identify the locations and levels of physical activities and types of park benefits and has increasingly been used as a protocol for determining park benefits for urban planning (Brown et al., 2014). After the development of PPGIS, most tools measuring park benefits were explored in the areas of Australia with survey methods, varying from interviews to mail-back questionnaires (Table 3.3).

What Are the Limitations of the Protocols Measuring Park Benefit? An apparent geographical limitation existed in the existing protocols assessing park benefit that the majority of them were developed in the contexts of Australia and Europe. The lack of protocols measuring benefits in the other western countries, such as the United States indicated the protocol development needs to be initiated in these areas. PPGIS only focused on social, environmental, psychological and physical benefits, the long-term benefits like psychophysiological and economic benefits are beyond their measurement. Benefits listed in the current tools are often social benefits, environmental benefits, and health benefits, which have not broken through the measurement limitation of PPGIS to

fulfill the inclusive assessment for park benefits. The survey methods are suited for collecting park users' perceptions of the benefits they can achieve from parks. As park benefit measurement protocols with surveys are emergent, most do not yet include tests for protocol's reliability and validity.

Table 3.3 Summary of the Existing Protocols Measuring Park Benefits.

Authors	Tool	Methods	Context	Population	Measures/Description
Brown et al., (2014)	Public participation geographic information system (PPGIS)	PPGIS study website	Adelaide, South Australia	All	Google maps interface instructing the participant to drag and drop different digital icons (markers) on to a map of the area to capture: physical activities and park benefits
Madureira et al., (2015)		Survey	French and Portuguese urban areas (Paris, Angers, Lisbonan dPorto)	aged 15 years or older	Social benefits (contact with nature, opportunities for outdoor sport and recreation, enhance health and well-being, enhance neighbor–social interaction, city image enhancement); environmental benefits (diminution of urban air pollution, diminution of urban air temperature, carbon dioxide sequestration, biodiversity promotion, noise reduction).

Henderson-Wilson et al., (2017)	Mixed methods: (park intercept survey and qualitative interviews)	Victoria, Australia	Adults	Level and extent of the user's engagement with the park; the attitudes and perceptions of park users about use and enjoyment of parks and the link to improved health outcomes; the importance of parks to users; the park user's mental health and wellbeing and the economic value assigned by park users to parks
Schebella et al., (2019)	Mail-back questionnaire	Burnside, Unley, and Mitcham, South Australia	All	Respondents' perceptions and use of urban parks; the physical and psychological health benefits; levels of environmental knowledge and nature connectedness; demographic questions

Recommendations

We reviewed the protocols measuring park quality, use, and benefit to identify those best suited for future studies. A comparative analysis of the existing protocols contrasting the study purpose, efficiency, reliability, validity, and recognition is presented in Table 3.4. Their purposes were derived from descriptions of the protocols. Reliability and validity were dependent on whether researchers have conducted related tests. The efficiency of the selected tools is based on an evaluation of whether the measures in the tools can represent non-spatial park dimensions and if the tool is applicable for the population and the context. Recognition is evaluated based on whether the tool had been used or cited in published research. While more recent tools may lack an established recognition, future assessments of their recognition will likely shift as these tools are applied to future studies and disseminated through peer-reviewed products.

Compared to the protocols measuring park quality and park use, the development of protocols measuring park benefit has not been well-developed as the other ones. As there has not been an established park benefit protocol that could capture all the identified park benefits, we do not recommend any existing benefit protocol to the scholars who have the intention to assess park benefit but recommend more efforts should be placed in this field.

Table 3.4 The Established Protocols Measuring Park Quality, Use, and Benefit.

Non-spatial park dimension	Established Tools	Purpose	Efficiency	Reliability	Validity	Recognition
Park Quality	BRAT-DO	To assess park characteristics that maybe related to physical activity	√	√	√	√
	EAPRS	To characterize the physical environments within public parks and playgrounds	√	√		√
	C-POST	To test the features in the public open space that could influence children's physical activity	√	√		√
	CPAT	To develop a user-friendly tool that enable stakeholders to audit community parks for their potential to promote physical activity	√	√	√	√
	PARK	To describe the development and reliability of a youth-	√		√	√

		oriented direct-observation park audit tool				
	NEST	To develop a tool for feasible, in situ assessment of diverse natural environments that support various uses	√	√		
	QUINPY	To develop a simple and reliable tool relying on publicly available, secondary data and includes variables proven to attract sustained park use by young people	√	√	√	
Park Use	SOPARC	To obtain direct information on community park use, including relevant concurrent characteristics of parks and their users	√	√	√	√

	Measurement Properties of a Park Use Questionnaire	To describe the measurement properties of the park use questionnaire	√	√	√

3.5 Discussion and Recommendation

Park Quality

Park quality measurement has achieved some degree of agreement with commonly employed direct-observation methods. Determinations of park quality can be attributed to the presence of some park features and characteristics. There are strong connections and continuity in the development of park quality measurements. Most of the protocols concur that landscape features, facilities, amenities, and maintenance are indicative of a park's quality. However, which specific items best represent facilities and amenities, and how to evaluate landscape/aesthetic features and maintenance are still under debate.

Simultaneously, the number and physical dimensions of measurable items for each protocol also vary from one protocol to the next, even though they are all assessed within the same category of facilities. For instance, EAPRS (Saelens et al., 2006) is a very comprehensive and detailed tool that included 751 items in 16 sections in its 59-page protocol, while some others have fewer than 50 items to evaluate. The variance between different protocols created more challenges for future researchers who intend to choose one from them. We recommend these researchers to use this article as a reference and compare different protocols to see which one is most applicable for the research purpose, budget, and timeline.

We also have concerns and recommendations for some specific measures of park quality. Some protocols used Activity as a measure of park quality. For example, Rigolon and Nemeth (2018) advocated that the diversity of structured play should be an important

measure of park quality for children's activity and park facilities can support children's physical activity in QUINPY. In most of the protocols like QUINPY, activity and facility are measuring similar items, while activity/play relies more on the potential of the items for physical activity. There are also some overlapping similarities between safety issues and incivility. For example, Bird et al. (2016) considered some dangerous locations in the park as incivility. Although a small number of developed tools assess visitors' impression and street/surrounding/accessibility, we suggest future research should focus more on these two measures for park quality, especially in urban settings. As most of the existing tools measuring park quality rely on counting the presence of some park features and characteristics objectively, subjective measures such as visitors' perceptions of the park are also necessary and need to be considered carefully. For an urban park, the surrounding areas, including adjacent streets and accessibility are extremely important because easy access to a park location can encourage park visitation and use. In addition, the presence of animals in different park quality assessment tools was treated quite differently. In some tools, dogs and their waste were considered as incivility and a "No Dogs" sign could result in credits for the park quality. However, other tools regarded a dog park and the presence of animals in a park as a positive contribution to park quality by enhancing human interactions with the environment. Future studies should identify the roles animals can play in urban park quality within the cultural context of their study settings.

Most of the park quality assessment protocols were developed to test their potential for physical activity from the perspectives of health-related researchers, which restrict their utility for other possible park functions such as socialization, relaxation, and

education. Future development of park quality assessment should consider measuring the other functions of a park to indicate their quality because the urban parks are public green resources that can provide people with different services in addition to physical activity.

With the development of park quality assessment, there are growing numbers of tools focused on specific demographics or age groups, and designing the protocols that can measure park quality for them. The validity of these tools still needs to be determined and remained a fertile area for future research. Additionally, some other vulnerable groups also need to receive more attention on the park quality measurement in urban settings, such as the elderly and disadvantaged groups (e.g. low-income population and people with disabilities). Many European countries, as well as Japan, are having more and more aging populations. Future research should reflect this reality. Specific park features and characteristics valued by elderly people need to be identified and the park quality assessment tools for them also need to be developed with the determination of the tool's reliability and validity. The park quality assessment also needs to broaden to a more equal distribution of environmental resources across different population groups.

While all of the examined tools are developed in the global west, cultural differences can impact the park quality assessment in other contexts and the differences in areas need to be addressed in future studies. We encourage the development of protocols assessing park quality from other contexts, for example, Asia and Africa.

Park Use

Park use is an essential non-spatial dimension of urban parks and has been researched widely and rapidly from perspectives of leisure, health, and planning across the world. Because of the booming growth, the emergence of new approaches measuring park use, especially from Asia and Europe, is required better regulation of establishing the research validity and reliability. Our analysis of the literature revealed that the development of park use protocol in the United States achieved some degree of agreement and observation is one of the most commonly employed methods for assessing park use behaviors in the global west. Among observation protocols, SOPARC (McKenzie et al., 2006) gained most applications and was designed to capture the numbers and frequency of physical activities along with basic socio-demographic information such as age and gender. Contrary to self-reported data, observation is an objective measurement that can provide stronger internal validity and simultaneous generation of information about the physical and social environment where the activity is occurring (McKenzie & van der Mars, 2015). Other park uses such as social interaction, relaxation, and education in parks should be explored for the future park use measurement.

The measurements using GIS allow spatial analysis, linking physical activity in locations where playgrounds and other features are situated within green spaces, but cannot record more actual use of specific features, though some GIS methods cooperated with accelerometers and provide time and intensity of physical activities. However, as human park use extends beyond exercise to include intangible benefits and enjoyment, measurement instruments should accommodate consideration of how the parks and their

features facilitate other activities such as socialization and relaxation (Sallis, 2009). Future scholars should incorporate how people use specific areas and features of parks for different purposes in their protocols.

Physical activity is still the prominent or the only measure of most of the existing park use protocols, including the tools with GPS and accelerometers, SOPARC, and SOPLAY. Although SOPARC includes an audit of sedentary or passive activities, such as picnicking and reading, the criteria of the measurement still rely on the intensity of physical activity, rather than uses of parks for different purposes. Future studies should amplify the categories in the park use assessment to include not only various intensities of physical activity but socialization, relaxation, and even education as well. The relative importance of physical activity could be consistent with others or the importance/scale of different park use categories could be adjusted depending on circumstances, setting, or study purpose.

Survey methods have the advantage of acquiring specific information in accordance with the specific research objectives embodied in the questionnaire. However, they are also subject to low response rates and subjective answers, which can raise implicit bias and limit sample size (Guo et al., 2019). Literature reveals that objectively measured PA is often much lower than self-reported PA (Troiano et al., 2008). The inconsistency of the two methods can lead to data inaccuracy. Future measures of park use should consider employing more than one approach to mitigate these issues. As most existing measurement tools using survey methods do not test for validity and reliability, we recommend future research expand to include these checks. Validity determines whether the questionnaire is assessing what is intended. Criterion-related validity

demonstrates associations between similar measures of interest. Reliability is the ability of the questionnaire to assess what it measures measuring in a consistent, reproducible way (Evenson et al., 2013, p. 528). Test-retest reliability is one type of reliability that examines whether measures applied on different occasions agree with one another. Desirable self-reported measures, such as from questionnaires, will have evidence for both validity and reliability (Evenson et al., 2013, p. 528).

Due to significant differences in demographics and urban densities between developed countries and China, park sizes and capacities may vary due to different cultural expectations, environmental needs, and physical activity behaviors (Jia & Fu, 2014). To address cultural and economic differences, park use measurements in China have started to employ big data—social media-based tools to capture the number and location of the park users rather the systematic observation and survey methods. Social media-based tools can only assess park use through the number of park visitors and predict the attractive park features based on the exact locations of the park visitors. While these kinds of methods are appropriate for assessing park use in some contexts, they cannot achieve accurate data on individual behaviors and use of specific park features. Furthermore, the validity and reliability of using social media to capture park use are questionable because tests and comparisons have not been conducted. Future scholars who are interested in measuring park use via big data or social media need to address these gaps and try to achieve more accurate information in this field while considering broader privacy implications.

Park Benefits

Scholars have amassed a large body of research evaluating human perceptions and preferences towards parks, from an environmental psychology perspective such as Kaplan et al. (1998) and Appleton's (1984) seminal prospect-refuge theory that has shaped the subsequent study of human perceptions of various landscape types, ecological functions, and humankind's relationship to nature (Appleton, 1996, Gobster et al., 2010, Nassauer, 1995). However, their collective work represents a range of divergent views on how parks influence their perceptions and preferences but have not achieved an agreement on how the parks could influence their perceptions and preferences and benefit people's lives. Recreation experience preference scales (Driver, 1983) were an early instrument to examine the benefits of parks and are foundational for most park benefit studies before the 21st century. Relatedly, while Moore and Driver (2005) defined the concept of park benefit, subsequent researchers began measuring the concept across different global contexts using various instruments without a protocol, for example, in New Zealand (Vesely, 2007), Bari (Sanesi & Chiarello, 2006), Finland (Tyrväinen et al., 2007), and China (Jim & Shan, 2013). The development of the protocols measuring park benefit is still at an early stage and more attention is called for the field.

Although the benefit concept has been discussed for decades, it has not been thoroughly assessed using a consistent tool in urban settings until the emergence of PPGIS. As an innovative way to capture people's perceptions of the benefits they can achieve from parks, there are still some benefits not included in PPGIS's measurement. In other fields, the utility of PPGIS has been enhanced with GPS tracking to augment users' perspectives and monitor their travel patterns and frequencies (Wolf et al., 2015).

This method has the potential to be better applied to measure park benefits in urban settings from different perspectives, such as combined with other methods and expended the benefit scopes.

In the western context, most of the studies using social media data including Instagram, Twitter or Flickr tested human preferences or perceptions across large-scale natural environments, such as protected areas (Levin et al., 2015) and national parks (Heikinheimo et al., 2017). As the availability of social media and other big data sources increases, research on how humans interact with the built environment and their perceptions across space and time can be explored (Wood et al., 2013). In addition to traditional survey methods, social media data offers a new way of identifying the benefits of urban parks—and a productive arena for future research.

Currently, studies measuring park benefits are mainly distributed between Australia and Europe. Researchers working in other areas and countries should consider the potential applications of non-spatial dimensions of parks beside park quality and use. Another important finding regarding current park benefits measurements is the reliance on self-reported data within the existing tools including the PPGIS and survey. While information related to park benefits relies on individual perceptions, overreliance on self-reported data introduces the risk of bias due to the unreliability of people accurately understanding or candidly disclosing their behaviors, thoughts, or opinions. Consequently, recent park use measurement tools have increasingly expanded to mixed methods approaches that combine both objective and subjective data. In the future, scholars should explore how to collect the park benefit data among individuals in other ways to ensure the validity and reliability of the process.

Conclusion

To better understand the relationships between humans and the built-environments and to make the park resources distribution equally, scholars started to switch their research focuses on the spatial dimensions to the non-spatial ones. Non-spatial dimensions of urban parks are a complicated construct and quality, use, and benefits are the commonest representation according to the literature. When assessing non-spatial park dimensions, future studies should consider the associations and interdisciplinarity between them, and determine which assessments are fitting for their research purpose and setting. This study detailed how the three primary non-spatial dimensions of urban parks—quality, use, and benefit—have been assessed, the limitation existed in the protocols and the recommendation for future studies.

Park quality measurement has achieved the agreements to the direct-observation method in the western contexts and showed clearly successive patterns in the development. The presence of some specific park features and characteristics, such as park facility, amenity, and aesthetic features have been acknowledged in most protocols to represent park quality, while the consistency and length of the measures between various protocols are still debatable. Future studies also need to dedicated to the development of park quality protocols in other contexts besides the global west, and specific population groups, such as children, elderly, and the low-income should be addressed in the future.

The protocols designed to measure park use are widely varied from the survey, observation, and archival data sets with GIS or GPS, and have not achieved an agreement. A large number of park use protocols often lacked reliability and validity

tests, so the future researchers should be very careful about picking up an existing protocol. The most notable limitation in park use protocols, especially for the observational approaches, is with the development of SOPARC, most of the protocols measuring park use from the perspective of physical activity but ignored uses for another purpose, such as social interaction. An observation protocol assessing park use from another perspective other than physical activity is needed.

Although the concept of park benefit has been raised for a while, the measurement started to be established since the development of PPGIS in 2014 and most protocols developed to assess park benefit are from Australia and Europe. At this point, park benefit assessment is not as well developed as the other non-spatial dimensions—— park quality and park use, and the majority of the protocols are based on the self-reported data which has the potential of bias. But the importance of park benefit assessment should be noticed and we encourage more research to explore the field which directly reflects people's perceptions of the benefits they could achieve from parks.

Through analyzing and synthesizing the protocols used for their assessment, we contrast their measurements, limitations, and recommendations for future research. Although our analysis finds many good protocols for evaluating park quality, park use, and park benefits, we also identify issues that warrant further development to enhance the instruments' research potential. Most importantly, we suggest researchers incorporate multiple aspects of park assessment—both spatial and non-spatial and physical and non-physical—to completely conceptualize and understand the park resources as they continue to build the body of knowledge that will shape our future built environments.

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CHAPTER IV

AN OBSERVATIONAL STUDY TO EXPLORE ASSOCIATIONS BETWEEN PARK QUALITY AND SOCIAL INTERACTION FOR URBAN PARKS

4.1 Abstract

Parks and open space have become important environmental estates for urban dwellers' overall well-being, aiding in the fight against mental health issues, cardiovascular diseases, and mortality. Prior literature states that the quality of parks is more important than a closer distance for people to use the park for different purposes.

The majority of current research claims that people can achieve health benefits through physical activities in parks, assessing park quality primarily from the perspective of physical activity. However, physical activity is not the only mechanism driving the health benefits of green open space, as another important use of parks, social interaction, has become increasingly significant in health studies while still largely ignored by urban planning and landscape researchers.

The purpose of this study is to explore the associations between park quality and social interaction via a case study in Logan, Utah. Park quality was assessed by an established tool, the Parks, Activity, and Recreation among Kids (PARK) tool, and social interaction was evaluated with a newly developed instrument, Protocol for Systematically Observing Social Interaction in Parks (PSOSIP). The hierarchical linear model (HLM) can be employed to analyze the associations between social interaction and park quality by addressing various inaccuracies of the dataset caused by the multilevel data structure.

4.2 Introduction

Parks and Health

With the progress of urbanization, urban dwellers have suffered many physical and psychological health issues stemming from both environmental problems, such as air pollution, and social problems, such as intensive work pressure, less time and opportunity for exercise, and the lack of social communication (Kweon, Sullivan, & Wiley, 1998, Zhou & Parves Rana, 2012). Under these circumstances, parks and green open spaces have been largely acknowledged as public resources designed to mitigate such environmental and social problems in the urban context (Kellert & Wilson, 1993). The existence of parks not only serves to purify air pollution and reduce noise, thereby ameliorating the condition of microclimate, but parks also reduce the impact of social isolation in a community, promote the economic value of space, and ensure social and environmental sustainability (Givoni, 1991, Tzoulas et al., 2007, Zhou et al., 2012).

A large body of research indicates that individuals can achieve various health benefits from urban parks through physical activity. Simultaneously, experimental evidence suggests that park-based physical activity promotes even more physical and psychological health benefits to fight cardiovascular diseases, stabilize blood glucose levels, and mitigate mental health issues than the same amount of physical activity in a non-green setting (Song et al., 2014, Thompson Coon et al., 2011). However, in addition to physical activities, there are many other mechanisms driving the positive relationship between parks and health, including social interaction, noise mitigation, and stress reduction (James, Banay, Hart, & Laden, 2015). Some of these mechanisms can lead to

the same or different health benefits as those propelled by physical activity, thereby contributing to the overall well-being of city residents.

Social Interaction in Urban Parks

It is necessary for residents to meet others and establish relationships, both for the development of the local community and to build social ties within the neighborhood (Völker, Flap, & Lindenberg, 2006), and parks can be an inclusive place for people to make contact and socialize (Kuo, Sullivan, Coley, & Brunson, 1998, Peters et al., 2010). Prior research indicates that most people do not feel comfortable communicating with strangers, so they stay in their familiar social groups (Lofland, 2017, Rasidi et al., 2012). Yet a park environment can make it easier for visitors to meet others and make new friends, thereby promoting connection between people and place and strengthening community cohesion (Peters et al., 2010). Parks have many different resources and features to encourage social activities. The green space, like trees and grass, may inspire more people to go outside and meet others (Coley, Sullivan, & Kuo, 1997). Natural settings are also appealing because they facilitate socialization by providing privacy and some restorative effects (Coley et al., 1997, Kaplan & Kaplan, 1989).

Among the various park uses that could lead to benefitting people's health is social interaction (social contacts), a significant use that's often overlooked within the landscape and urban planning community. Social interaction has been acknowledged as an important potential mechanism driving the relationship between public green open space and health benefits for urban residents (Dadvand et al., 2019, Markevych et al., 2017, Weinstein et al., 2015). It has been postulated that the occurrence of social

interaction in green space can reduce psychiatric morbidities, such as depression and anxiety, and all-cause mortality (James et al., 2015).

Social interaction refers to the degree of connectedness or solidarity between individuals and their community, and it also describes the relationships and bonds between two or more than two individuals, particularly in a multi-cultural social interaction (Mahasin & Roux, 2010). Social interaction or contacts can take many forms in a park, including having a conversation, undertaking joint activities, and paying group visits (Maas et al., 2009). In public space, social interaction is often defined by the number of other people with whom an individual socialized (Dadvand et al., 2019), according to a large number of studies measuring social interaction (Campbell, Svendsen, Sonti, & Johnson, 2016; Hillier et al., 2016, Peters et al., 2010, Rasidi, Jamirsah, & Said, 2012). However, both the level of social interaction and the number of socializing people should be taken into consideration as measurements of social interaction.

The majority of existing research capture social interaction happening in public space through survey methods (Dadvand et al., 2019, Kemperman & Timmermans, 2014, Maas et al., 2009, Mangunsong, 2018, Moulay, Ujang, & Said, 2017, Salih & Ismail, 2018, Schmidt, Kerr, & Schipperijn, 2019, Skjæveland, 2001, Tao, Yang & Chai, 2020, Yamada, & Knapp, 2010). In the meantime, some Scholars assessed people's social interaction in parks and open space including observation of human's activities (Campbell, Svendsen, Sonti, & Johnson, 2016, Hillier et al., 2016, Peters et al., 2010, Rasidi, Jamirsah, & Said, 2012). While the survey methods can subjectively inquire about people's sense of contact and attachment with others, the observational studies often recorded people's behaviors and activities, such as sports, walking, chatting, and resting,

to predict the social interaction in parks but not actually measure it. The observational methods were still from the perspective of counting the number of individuals under different kinds of human activities not really capturing the levels of social interaction. For example, Peters and coauthors (2010) recorded the number of people presented in the park and whether they were interacted with others or not. In another example, Campbell et al. (2016) grouped human activities in parks functionally like sitting, exercise, socializing, and nature recreation.

Most of the research just measured the variable without following an instrument, and there has not been developed a reliable and valid protocol to assess social interaction objectively. Most notably, there is no protocol can measure both people's social interaction level and the number of individuals in the group at the same time. There is no systematic observational protocol to comprehensively quantify and assess people's social interaction behaviors by both the level and number public open spaces. To address the research gap, the development of a systematic observational protocol to capture social interaction through the level and the group size is needed.

Park Quality and Social Interaction

Various uses and behaviors occur in urban parks, including physical exercise, rest, and socializing. Park design can be an important factor in either motivating or impeding specific park uses (Maas et al., 2009). Prior literature states that the quality of parks is a more important factor than a closer distance for people to use the park for different purposes (Kabisch, & Haase, 2013, Kemperman & Timmermans, 2014). However, some researchers began to study whether park design influenced social interaction and found

that both the physical and natural characteristics of a park can affect people's level of social interaction (Rasidi et al., 2012). They also found that the existence of some facilities, like playgrounds, shelters, seats, play courts, and pathways, can bring more people together (Rasidi et al., 2012).

Park quality is a comprehensive concept including various park feature characteristics. It is also a measure that can be quantified, and some park quality researchers considered park design among the features and characteristics of the park, such as facilities and the natural settings. That being said, park quality would be best determined according to both the existence of various park attributes, such as facilities, maintenance, and features, as well as subjective components, such as general park condition and users' perceptions (Gidlow et al., 2012). Based on a solid literature review, most studies assess park quality according to the variety of facilities that can support user activities, such as playgrounds, ball game fields, pools, and fountains. Researchers also found that park amenities like seating, picnic tables, and bathrooms serve as basic features for visitors of all age groups (McCormack, Rock, Toohey, & Hignell, 2010). Aesthetic features and natural elements such as landscaping, tree canopies, water features, and green space are also important to both children and adults (McCormack et al., 2010). Recent research also suggests that park maintenance and cleanliness are key issues for all park users (Rigolon, & Németh, 2018). Research also suggests that park safety is another serious issue affecting park visitation (Rigolon, & Németh, 2018). Hughey et al. (2016) suggested that incivilities that reflected safety concerns (e.g., dangerous spots, excessive animal waste, litter, noise, graffiti, and vandalism) ought to be an aspect of evaluating park quality.

Emerging studies explore the association between park quality and park uses and have developed many protocols to measure park quality. Yet the majority of these protocols assessing park quality focus on the physical activity perspective (Bedimo-Rung et al., 2006, Broomhall, Giles-Corti, & Lange, 2004, Kaczynski et al., 2012, Lee, Booth, Reese-Smith, Regan, & Howard, 2005, Saelens et al., 2006). They tend to define park use primarily by the intensity of human physical activity, like sedentary activity versus active activity or visitors' moderate to vigorous physical activity (MVPA) (Jones, Coombes, Griffin, & van Sluijs, 2009, McKenzie, Cohen, Sehgal, Williamson, & Golinelli, 2006, Quigg, Gray, Reeder, Holt, & Waters, 2010, Wheeler, Cooper, Page, & Jago, 2010), rather than defining park use according to different purposes, like social interaction. Although an awareness of the contributions of urban parks to people's social interaction has emerged, while some studies have discovered the positive relationships between some specific park feature and social interaction, there is still no existing study which explores the association between social interaction and park quality from both the perspective of seperate park features and overall park quality.

4.3 Methods

Study Setting and Sample

To answer the research question, an observational study in Cache County, Utah focusing on urban areas (Logan City and North Logan City) was conducted in order to explore the associations between social interaction and park quality. Both measures were

collected through systematic observational approaches. Logan is the county seat of Cache County, Utah, with a total area of 25.4 square miles, including adjacent municipalities such as North Logan (United States Census Bureau, 2012). The total population in the area of Logan and North Logan is around 61,700, of which 75.6% are Non-Hispanic White, 15.1% are Hispanic or Latino, 3.91% are Asian, and 1.4% are African American (United States Census Bureau, 2018). Within the metropolitan area of Cache Valley and the main campus of Utah State University, the median household income is $39,719 in Logan (United States Census Bureau, 2018), a much lower number than the income level across the county because of the predominance of college students. 25.5% of residents live under 125% of the U.S. federal poverty line (United States Census Bureau, 2018).

According to the Logan Parsk and Recreation office and the North Logan City Office, there are 47 parks in the setting, including various types that differ in their size and functions, including Community Parks, City Parks, Pocket Parks, Neighborhood Parks, Greenways, and Special Use Parks. After studying the public parks identified by the offices, in order to avoid data bias, the small-sized parks (with acreage less than .5) and the parks with limited facilities and amenities will not be included in this research. Sample size in this study was 30 (urban parks) distributed in the selected area after the exclusion, with 28 in Logan City and 2 in North Logan City (Figure 4.1).

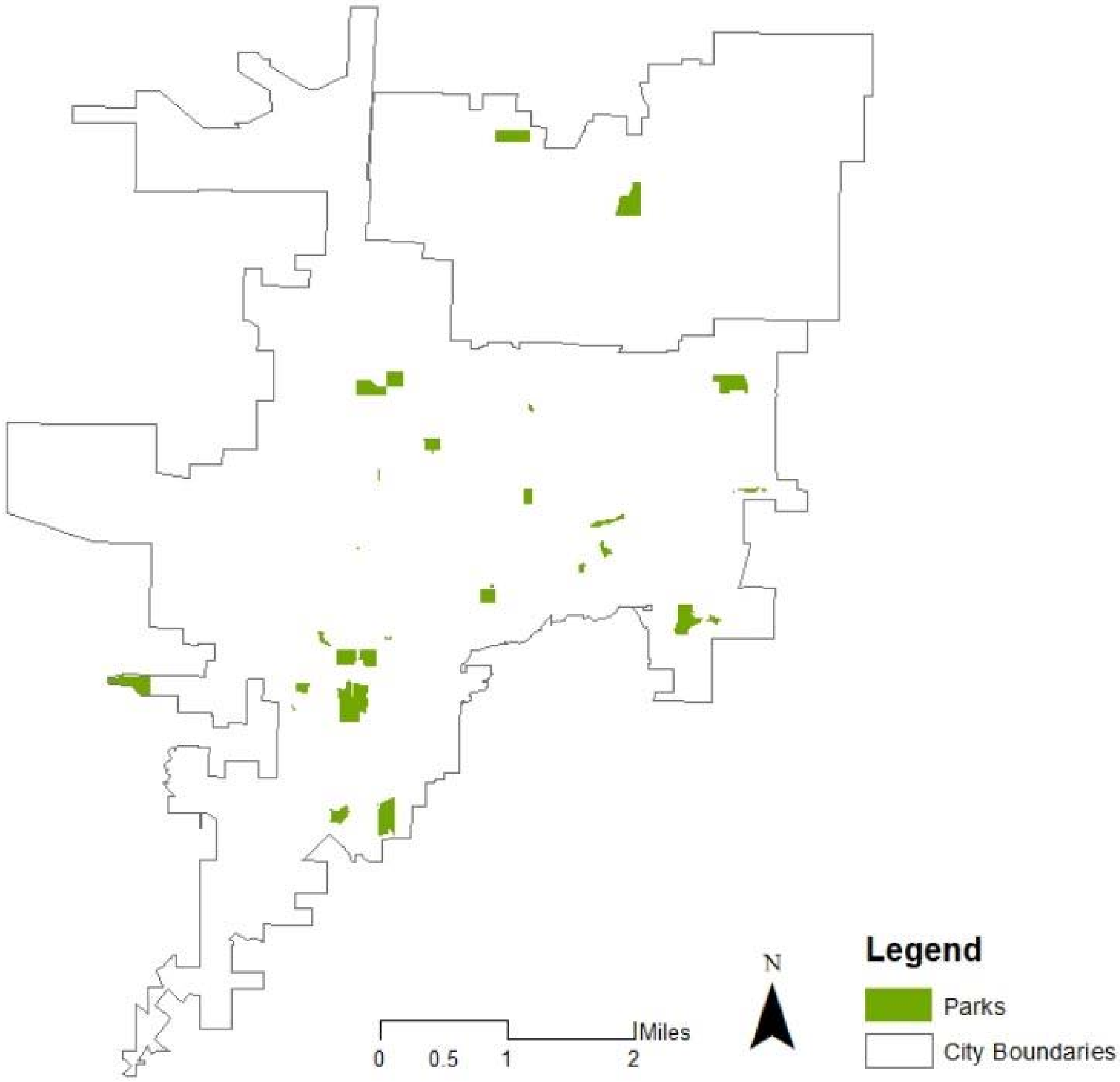

Figure 4.1 Distribution of the Selected Urban Parks in Logan City and North Logan City.

Data Collection and Measures—Park Quality

Park quality is the independent variable in this study. The separate park features and characteristics identified in the literature as significant are facility, amenity, aesthetic feature, maintenance and cleanliness, and incivility. A recently developed direct-observation tool—Parks, Activity, and Recreation among Kids (PARK) (Bird et al., 2015) was modified to measure park quality in this study. This protocol is designed to assess five domains, based on a conceptual model of parks and physical activity, including activities, environmental quality, services, safety, and general impression (Bedimo-Rung et al., 2005). Although the authors stated that the validity of whether PARK was particularly appealing for youth has not yet been established (Bird et al., 2015), the protocol has been proven reliable to assess park quality for the general population from all age groups.

To ensure that both the objective and subjective aspects of a park had been considered, PARK evaluated park quality via the presence of park features and characteristics, the overall conditions of the park, and people's perceptions and impression of the park. The items listed in the PARK tool were classified into five features and characteristics identified as important for park users: facility (e.g. tennis courts, basketball courts, and badminton courts), amenity (e.g. sitting benches, equipment rental, and drinking fountains), aesthetics (e.g. water features, decorative elements), maintenance and cleanliness (e.g. pool condition, toilet condition, and whether adjacent streets have traffic calming measures), and incivility (e.g. safe measures, graffiti, and vandalism) (Appendix A). Additionally, questions raised from the PARK tool to assess

the park’s condition and people's impressions include, for example, “Is the park safe?” “Is this park attractive?” (Appendix A).

We used the modified version of the PARK tool (Appendix B) to assess all the identified parks (n=30) in the setting during Fall 2019. Following the protocol, the different park feature qualities—facility, amenity, aesthetic feature, cleanliness and maintenance, and incivility—were separately audited and scored. For example, there were 18 total points, as evaluated by two questions, to assess the facility component. This included both the score for several facilities (12 points) and a general facility performance score (6 points). The questions transferred subjective information to a measurable scale in order to compute separate park feature qualities with objective measures. The same auditing method was applied to examine the other components as follows: 22 points for amenity (19 item points and 3 general performance points), 9 points for aesthetic feature (6 item points and 3 general performance points), 9 points for cleanliness and maintenance (6 item points and 3 general performance points), and 8 points for incivilities (5 item points and 3 general performance points) (Appendix B).

The dimensionality of the separate park feature qualities was assessed by maximum likelihood factor analysis. All factors account for more than 80% of the target variance, which illustrates a good empirical and conceptual fit. To calculate the overall quality of each park, a standardized sub-score (0 - 100) was created from the sum of the above-calculated separate park feature qualities (Hughey et al., 2016).

Data Collection and Measures—Social Interaction

As the dependent variable, social interaction in the identified urban parks was evaluated via a systematic observation protocol innovatively developed in this study because there is no existing instrument to quantify and measure people's social interaction behaviors in urban parks.

Parten's six stages of play have been widely used to interpret social interaction participation for preschool children. The six stages of play (Parten, 1932) are 1) Unoccupied Play: Child is observing, not playing. This category refers mostly to infants engaged in seemingly random movements; 2) Solitary Play: Child plays alone and is uninterested or unaware of others; 3) Onlooker Play: Child observes other children playing but doesn't take part; 4) Parallel Play: Child plays next to another child. Though side-by-side, they seem in their own worlds and are more interested in the activity than the play partner; 5) Associative Play: Child interacts with other children but in an unorganized and uncoordinated manner. The child is more interested in the other children than the activity at hand; and 6) Cooperative Play: Child engages with other children in an organized activity, wherein each child may have a distinct role. Paten also developed a weight in the sequence to describe the levels of social participation and interaction (Parten, 1932).

Based on the levels of social interaction built into Parten's six stages of play, this study modifies descriptions of the various levels of social interaction to better situate all age groups. This study develops a Social Interaction Scale for systematic observation in open space and classifies the level of people's social interaction behaviors from low to high using 6 weights: 1) Solitary, 2) Unoccupied, 3) Onlooker, 4) Parallel, 5) Associative,

6) Cooperative. The points from 1 to 6 were assigned to the levels respectively in this sequence. Solitary is the lowest level of social interaction in this scale and assigned just 1 point. It is described as an individual who is alone and uninterested or unaware of others. For example, an individual may be working/reading/writing in a park without noticing anyone besides himself/herself. Unoccupied (2 points) is the second level of social interaction in the scale, just higher than Solitary. It is defined as an individual who is alone but is interested in or observing others, such as an individual sitting on a lawn by himself/herself but watching others play. Onlooker is the first level on this scale that defines individuals in a group and is given 3 points. Onlooker includes individuals in a group setting who are observing others playing but not taking part in the activity or communicating with each other. An example would include people sitting next to each other watching a ball game but not talking with each other. The Parallel level is also designed for a group of people in an activity and is attributed a higher level of social interaction than at the Onlooker level. For Parallel (4 points), people are in a group activity, but they are more interested in the activity than the partner beside them. For example, a group of boys may skateboard together in a park, but they are more interested in playing and skateboarding than in the members of the group. The Parallel level is also illustrated when people go fishing together but remain in their own worlds, without communicating with their friends. As the levels of social interaction continue to rise, the main difference between the Associative (5 points) and Cooperative (6 points) levels is whether the group activity is organized. The Associative level refers to individuals in a group, interacting with others, but in an unorganized and uncoordinated manner, such as a group of people randomly gathering for a birthday party in a park. The Cooperative

level depicts a group of people engaged with others in an organized activity like a basketball game, in which each one of them may have a distinct role in the game.

Protocol for Systematically Observing Social Interaction in Parks (PSOSIP) (Appendix C) is innovatively designed in this study to quantify and evaluate social interaction according to the previously described scale. The observations were conducted with the approval of the institutional review board (IRB) from Utah State University in Fall 2019. To ensure that the systematic observation caught spontaneous behaviors, we conducted unobtrusive observations during the period. The observation techniques involved systematic walking across sub-areas of the park and spending 15 minutes in each park to capture the park uses and activities of every park visitor. The microclimate conditions, including the weather and temperature, were also recorded. In this case, the parks (n=30) were observed from 10am - 2pm and 2pm - 6pm for three consecutive days, including a weekday, a Saturday, and a Sunday. The protocol aims to capture the different usage patterns at different times on a single day and different days of a week.

With this protocol in place, researchers must first note whether park visitors are alone (by himself/herself) or in a group (at least two people). If a park visitor is alone, he/she needs to be further classified into Solitary (1 point) or Unoccupied (2 points). If they are in a group, they need to be categorized as Onlooker (3 points), Parallel (4 points), Associative (4 points), or Cooperative (6 points). Like the Social Interaction Scale, different levels of social interaction behaviors were assigned points from 1 to 6: Solitary (1), Unoccupied (2), Onlooker (3), Parallel (4), Associative (5), and Cooperative (6). Researchers must also determine whether individuals are accompanied by animals which

are their pets or wildlife already in the park. Another .5 points are added to the individual(s) if a personal animal is with the park visitor(s).

Auditors following the protocol also need to record how many people join the activity (group size) and their gender—for instance, whether they are all male (M), female (F), both (B), or some other grouping (O). The participants' race and ethnicity is another important piece of information to be captured, classified into the following categories: White (W), Hispanic (H), Black (B), Asian (A), Mixed, referring to people from varied racial backgrounds (M), and Others, referring to previously unmentioned races or mixed blood (O). Age groups of the visitors in the public park are also collected through the protocol, to be observed and categorized as follows: Youth under 18 years old (Y), a group of adults aged 18-65 (A), seniors over the age of 65 (E), or people from different age groups, such as a family (M). How long the activity occurs during the 15 minute maximum observation will be calculated using the starting time and ending time. The sub-area in the park when the activity happened was identified according to the classification in the reference as well. A complete list of categories and codes are included at the end of this document (Appendix D).

The validity of PSOSIP was established through the construction of the Social Interaction Scale. The Social Interaction Scale was developed according to Parten's six stages of play, has been referred to as a solid systematic observation tool to determine levels of social interactions, and has been modified for different studies to fit different research purposes (Bakeman & Gottman, 1997). A preliminary observation with PSOSIP was conducted to test the reliability of the protocol. Four auditors were trained and assigned into pairs to use PSOSIP to assess people's social interaction in the target parks.

Every time, two of them would join the systematic observation simultaneously and independently, so that their results would not be influenced by each other. A total number of 60 observations were implemented with two auditors' records. Different descriptive statistics were conducted to explore the consistency and reliability between the paired results from different auditors following the protocol. A t-test analysis was used to assess the possible differences in mean domain scores. Intraclass Correlation Coefficients (ICC) were calculated to estimate the inter-rater reliability of mean domain scores.

After an individual observation, each park had a social interaction score and each park had a total of six social interaction scores for two times (10:00 am – 2:00 pm and 2:00 pm – 6:00 pm) on three different days (a weekday, a Saturday, and a Sunday), making 180 observations in total and 180 different social interaction scores for analysis. The social interaction score (SIS) for each observation was calculated by the sum of group size times the corresponding level/score in the social interaction scale for that group, as shown in the following expression (i = 1 to 180). By doing this, the research gap of measuring social interaction by only the number of individuals or the level of social contacts can be filled and people's social interaction behaviors can be measured through both their levels of social interaction and the number of the individuals in that group.

$$SIS = \sum (SISUP_i * \text{Group Size}_i)$$

Analysis

The independent variable in this study is park quality, represented as separate park feature quality scores (facility, amenity, aesthetic feature, maintenance and cleanliness, and incivility) and overall park quality score. The dependent variable is social interaction, indicated by the social interaction score for each park at different times. There are 30 parks with independent park quality scores and 180 social interactions scores at the 30 parks for 6 different times.

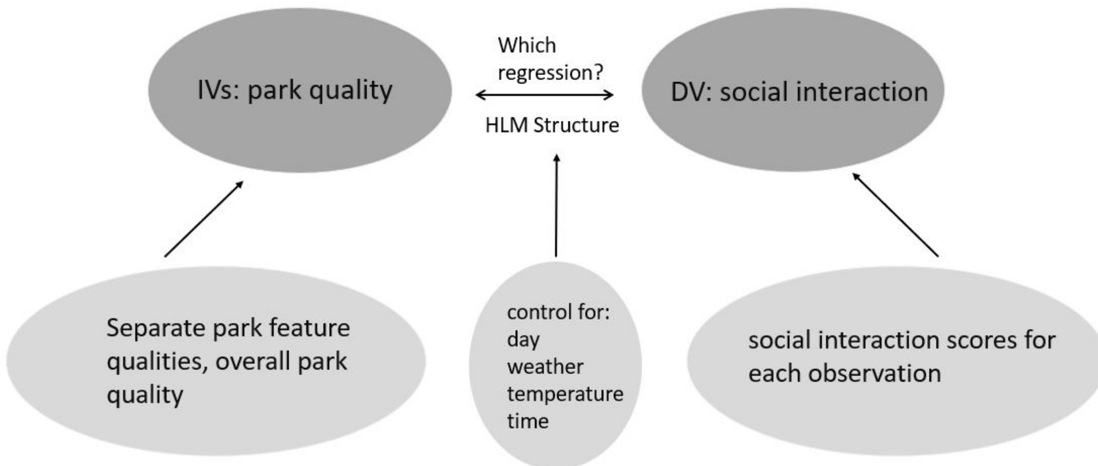

Figure 4.2 Research Methods Framework.

This study explored the association between park quality and social interaction through multilevel modeling (MLM), also known as the hierarchical linear model (HLM), because the variable, social interaction, demonstrates a hierarchical data structure. According to the data characteristics, there are three levels in the HLM. These results need to be observed six different times at each park, in order for the six observations within one park to share the same park quality—both as the separate park feature score and overall park quality score. Simultaneously, social interaction scores for different levels (1-6) must be nested in each observation. That is to say, there are three hierarchies in the dataset: scores for each level of social interaction (Level 1), six observations for each identified urban park, and thirty urban parks as the sample. The dependence within the dependent variable may cause an underestimation of the standard errors of regression coefficients but can be overcome by HLM. HLM addressed the dependence among the different observations within an area and produced accurate coefficients and standard error estimates (Raudenbush & Bryk, 2002). The HLM divides the variance of the dependent variable into Level 1 (the independent observations for each park) and Level 2 (the parks). The sample size of the variable in Level 2 is 30, meeting the minimum number required for a regression analysis, which can account for a good portion of the variance at that level.

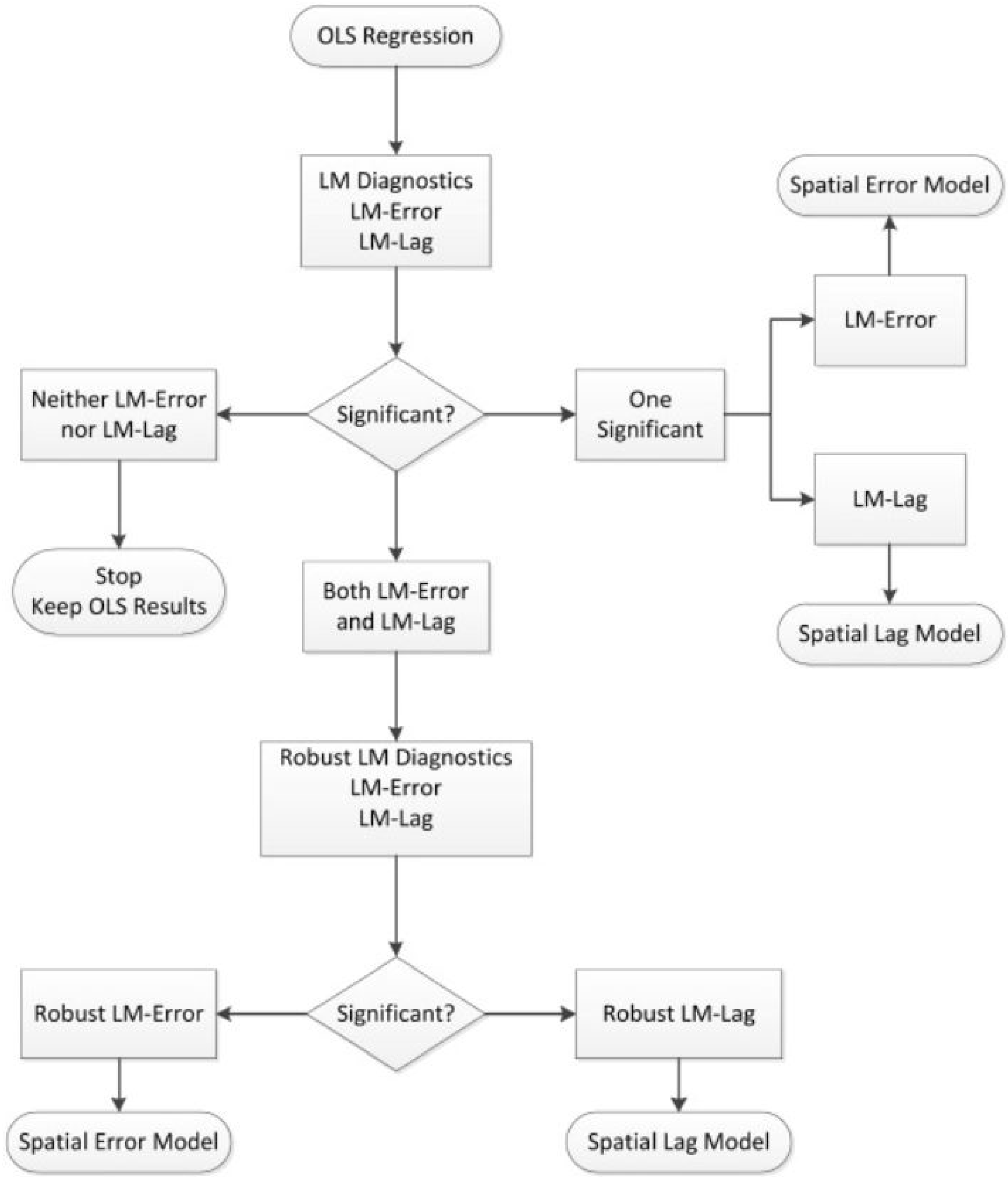

Figure 4.3 The Visualization of the Process of Assessing Spatial Autocorrelation and Determining Spatial Regression (Anselin, 2004).

With the establishment of the HLM, proper regression needed to be determined to study the association between park quality and social interaction. Social interaction is a behavioral variable collected by the systematic observation that can be influenced by multiple spatial factors, such as proximity. People's park usages and activities in different parks can be influenced by the distance between the parks. For example, residents who live between Park A and Park B need to choose between the two parks, which means that the visitors and activities in one park are partly related to another park. As a result, an observation that happened in one park was influenced by a nearby observation, making the social interaction variable not independent anymore (Cliff & Ord, 1973). It can be biased to explore the spatial data with a single statistical regression because the regression analysis assumes that all observations in the sample data are independent (Anselin & Bera, 1998). The sample observations for social interaction in this study are usually not independent but spatially autocorrelated, referring to the degree to which near and distant things are related (Anselin & Bera, 1998). A test of spatial autocorrelation of the dataset is required for the social interaction dataset. If there is spatial autocorrelation, a spatial regression approach is appropriate in order to analyze the social interaction data with the spatial autocorrelation character, rather than a simple statistical regression. The whole process of assessing spatial autocorrelation and determining the right spatial regression is shown in Figure 4.2.

Because of the potential spatial autocorrelation issue, social interaction data needs to be tested for spatial dependence before the establishment of the multilevel model. First, a spatial weights matrix must be selected and constructed to fit the spatial character of the area to indicate how social interaction behaviors across the different parks were

connected, such as a “QUEEN” case neighborhood under the “W” weight style. If there is spatial autocorrelation in the dataset, the Hierarchical Spatial Autoregressive Model with the construction of the matrix, conducted through a package called HSAR in the R programming language, can be used to study the association between social interaction and park quality. This method can deal with the inaccuracies caused by the multilevel data structure and spatial autocorrelation at the same time (Dong, Harris, & Mimis, 2016). If spatial autocorrelation has not been detected in the dataset, HLM analysis can be conducted from the Unconditional Model (Kleiman, 2017).

4.4 Results

Sample Characteristics

The sample characteristics of the Dependent Variable (DVs), Independent Variables (IVs), and the continuous control variables as shown in Table 4.1 were analyzed through the descriptive statistics in SPSS. The other control variables (nominal) which were not shown in the table have been created as the dummy variables and coded as park type (Community Park: C, Greenway: G, Neighborhood Park: N, Special Use park/Facility: S, Pocket Park: P), weather (Sunny: S, Rainy/Cloudy: R), Weekday/Weekend (Weekday: A, Saturday: B, Sunday: C), Time (10:00am – 2:00pm: A, 2:00pm – 6:00pm: B). The dummy variables were also controlled in the statistical analysis. To keep all the variables in a consistent unit, we standardized them into 1 scale. The histograms with normal curves indicated that the skewness of DVs (SIS and SIS for each group) and IVs (park quality) were between -1 and 1, while the control variables of

park size and temperature were normally distributed. For the DVs, the SIS is the aggregated social interaction score for each observation, while the SIS for each group is the social interaction score for each group nested in each observation. The SIS for each group is the DV in the 3-level HLM in the analysis, while the SIS is the DV in a 2-level HLM as a reference.

Table 4.1 Descriptive Statistics of the Variables in the Study.

	Mean	SD	Range
Independent Variables (IVs)			
Park Size	7.7	7.3	(.46, 25.18)
(standardized*)	0	1	(-.96, 2.39)
Facility	45.11	17.15	(0, 73.1)
(standardized*)	0	1	(-2.18, 1.68)
Amenity	54.46	19.66	(0, 86)
(standardized*)	0	1	(-1.63, 1.76)
Aesthetic Feature	57.16	21.34	(0, 88.9)
(standardized*)	0	1	(-2.28, 1.69)
Maintenance & Cleanliness	55.03	18.89	(0, 100)
(standardized*)	0	1	(-2.61, 1.80)
Incivility	55.18	19.17	(0, 86)
(standardized*)	0	1	(-2.24, 1.29)
Overall Park Quality	53.3	17.15	(0, 78)
(standardized*)	0	1	(-2.51, 1.60)
Control Variables (Continuous)			
Temperature	16.62	5.53	(7, 29)
(standardized*)	0	1	(-1.30, 2.25)
Dependent Variable (DVs)			
SIS	78.60	112.30	(0, 873)
(standardized*)	0	1	(-.58, 6.40)
SIS for each group	21.46	46.49	(0, 480)
(standardized*)	0	1	(-.46, 9.86)

*Standardized to 1 scale.

Reliability of POSISP

First, the *P-value* in the t-test was larger than the .01 levels, which implied that there is no statistically significant difference in means. Afterward, a one-way random Intra-class Correlation Coefficient analysis (ICC) was run in the IBM SPSS Statistics 24 because the rates were not collected by the consistent raters. The summary of percent agreement by domain indicated by the ICC score was shown in Table 4.2. When ICC > .75, it was considered to reflect good reliability; when the ICC was between 0.50 to 0.75, it indicated moderate reliability; when ICC < .5, it illustrated a poor reliability score (Portney & White, 2009). Accordingly, the Intra-class Correlation Coefficients for all levels of the Social Interaction Scale (0 -6) indicated good reliability in all the sample sizes under the different levels of the Social Interaction Scale, as collected by the paired auditors. It also indicated good inter-rater reliability of the summed domain scores (Social Interaction Score or SIS) for all observations by the auditors.

Table 4.2 ICC Scores of Data Collected by the POSISP.

	ICC Scores by Domain							
	Social Interaction Scale							SIS
	0	1	2	3	4	5	6	
ICC Score	.99*	.92*	.81*	.83*	.84*	.91*	.92*	.78*

*. $P < 0.001$

Testing of Spatial Autocorrelation

To identify which regression would analyze the dataset under the hierarchical structure, a spatial weights matrix across the setting area needed to be set up, and six Moran's I analyses were run to test whether the dependent variable in the six different observations (two times per one weekday and two weekends) was spatially autocorrelated. From the six Moran's I analyses, only two of six rejected the null hypothesis that the social interaction score was randomly and independently distributed in the setting with a significant *p-value*. The dependent variable—social interaction scores in four observations of the study—was randomly distributed in the area meeting the criteria to be analyzed in the traditional statistic regression. After that, the two observations which rejected the null hypothesis were further tested by Lagrange Multiplier Statistics to identify the extent of the spatial autocorrelation. The Lagrange Multiplier Statistics diagnosed no significant *p-value* for the Spatial Error Model or the Spatial Lag Model for the two observations. These results suggested that the OLS model should be used to analyze the social interaction scores in the other two observations.

After testing the potential spatial autocorrelation in the DV, there was no such spatial issue existing in most of the observations. For the other two groups of observation with the spatial autocorrelation issue, Lagrange Multiplier Statistics illustrated that the OLS analysis was the most suitable regression. Because the HLM is a category based on OLS regression which extends the original OLS to accommodate a multilevel data structure, the HLM analysis with the OLS regression is applicable for the social interaction dataset and effectively overcame the spatial autocorrelation issue.

HLM Analysis

The first step in the HLM analysis was to test the unconditional model in the R programming language. The result of the unconditional model (*p-value* = .003) interpreted a significant between-observation variation under the multilevel structure which supported the use of multilevel modeling for the dataset.

The theoretical context of the research question decided that a random slope would be more appropriate for this study than a fixed slope. Because the independent variable—park quality—was the higher-level unit (Level 2) in the hierarchical structure, it allowed the intercept and/or slope to vary randomly across a higher-level. As the fixed slope assumes the same value as has been given for all higher-level units, when compared with the fixed slope, random coefficients modeling should be used to explore the associations between park quality (Level 2) and social interaction scores (Level 1).

With the "lme4" package in R programming language, the first random coefficients 3-level HLM was conducted to study the statistical relationships between overall park quality and social interaction scores, while another random coefficients 3-level HLM identified which separate park feature qualities were related to the social interaction scores (Table 4.3). Both the overall park quality and separate park feature qualities were included in the third HLM regression and to compare their associations with social interaction.

While making the dependent variable consistent, the independent variable is overall park quality in HLM 1. The estimate for the Level 2 (observation) variance is 220.22 and for Level 1 (park) variance is 78.98. The residual is 1249.79. Thus, the total variance is 220.22 + 78.98 + 1249.79 = 1548.99. The variance partition coefficient (VPC)

is (220.22+78.98)/1548.99 = 0.19, which indicated that 19% of the variance of SIS could be attributed to Level 1 and Level 2 variance. Among the independent variables in HLM 1, overall park quality was the most important predictor of SIS. Park size followed overall park quality as the other important predictor.

In HLM 2, independent variables were included the separate park feature quality but not included in the overall park quality. The Level-2 variance (Intercept) in SIS was estimated at 225.31, while the park (Level 1) variance was estimated as 27.23. The residual is 1649.66. Thus, the total variance is 225.31 + 27.23 + 1649.66 = 1902.2. The variance partition coefficient (VPC) is (225.31 + 27.23)/1902.2 = 0.13, which indicated that 13% of the variance of SIS can be attributed to Level 1 and Level 2 variance. Among the independent variables in HLM 2, the aesthetic feature was the strongest predictor of SIS, followed by cleanliness and maintenance and park size.

Both the overall and separate feature park quality were added as independent variables in the HLM 3 to explore relationships with social interaction. The estimated Level-2 variance—observation (Intercept) was 205.60, while the Level-1 variance—park (Intercept) was estimated as 13.71. The residual is 1635.7. Thus, the total variance is 205.60 + 13.71 + 1635.7 = 1855.01. The variance partition coefficient (VPC) is (205.60 + 13.71) / 1855.01 = 0.12, which indicated that 12% of the variance of SIS can be attributed to Level 1 and Level 2 variance. Among the independent variables in HLM 3, overall park quality was the strongest predictor of SIS, to a statistically significant extent, followed by park size and aesthetic feature. The variable of maintenance and cleanliness was not statistically significant in HLM3.

Table 4.3 Random Coefficients HLM Results of Social Interaction Scores with Overall Park Quality and Separate Feature Park Qualities.

	HLM		
Intercept	HLM1: SIS with overall park quality	HLM2: SIS with separate feature park qualities	HLM3: SIS with both overall and separate park quality
Level 3			
Facility		2.72	2.51
Amenity		-1.5	-2.21
Aesthetic		7.98**	5.42*
M&C		4.83*	3.04
Incivility		-.24	-3.51
Overall	8.58**		11.21**
Park Size	5.12*	5.16*	6.76*
Park Type P	1.90	2.12	2.02
Level 2			
Week B	24.25**	24.23**	24.41**
Week C	10.15**	10.31**	10.52**
Temperature	-.45	-.11	-0.32
Weather S	12.42*	11.56**	10.93**
Time B	1.32	1.02	0.85

**. $P < 0.001$

*. $P < 0.05$

Comparative Statistics

Additionally, we run a 2-level HLMs to test the associations between the aggregated SIS and the overall park quality and found very similar patterns with the 3-level HLM. For the Comparative1, the estimate for the park variance was 413.7 and the Residual is 7132.1. Thus, the total variance is 413.7 + 7132.1 = 7545.8. The variance partition coefficient (VPC) is 413.7/7545.8 = 0.05, which indicated that 5% of the variance of SIS can be attributed to the park level variance. Like the 3-level HLM, we then run two additional 2-level HLM to identify the relationships between the separate park feature qualities and the aggregated SIS. Compared to the separate park feature qualities, the overall park quality is also the strongest predictor of social interaction followed by park size in the 2-level HLM. The aesthetic feature and maintenance and cleanliness are the only two useful predictors among the separate park feature qualities. The only difference is that the coefficient size in the 2-level HLMs is much higher than in the 3-level HLM. The differences in coefficient size are probably due to the different metrics of the dependent variable. In the 2-level models, the DV was calculated by aggregating social interaction in separate groups. In the 3-level one, we were using the social interaction which was coded 1-6.

In the prior observational studies, social interaction was commonly assessed through the number of individuals (Campbell, Svendsen, Sonti, & Johnson, 2016; Dadvand et al., 2019; Hillier et al., 2016; Peters et al., 2010; Rasidi, Jamirsah, & Said, 2012). This study proposed a new method to capture social interaction by both the group size and SISUP. To compare the two methods on the statistical results, another HLM analysis was conducted and set only group size as the DV which kept consistency with

the literature. The other IVs were as same as the original HLM 1 while we added SIS as an additional IV. For the Comparative2, the estimate for the level-2 variance was 11.05 while the level-1 variance was 0.81. The Residual is 70.05. Thus, the total variance is 11.05 + 0.81 + 70.05 = 82.36. The variance partition coefficient (VPC) is (11.05 + 0.81)/82.36 = 0.14, which indicated that 14% of the variance of SIS can be attributed to level 1 and level 2 variance. Like the original HLM, this model also indicated the same significant correlation between park quality and the DV as well as between park size and the DV. Only the coefficient sizes in the new model are smaller than in the HLM 1.

Table 4.4 Comparative HLM Statistic Results.

Intercept	HLM		
	The original HLM1	Comparative1: 2-level HLM	Comparative2: HLM with Group Size as DV
Level 3			
Park quality	8.58**	76.98**	1.58*
Park size	5.12*	27.15**	.97*
Park type P	2.90	36.34**	2.02
Level 2			
Week B	24.25**	98.31**	4.26**
Week C	10.15**	46.88**	1.22*
Temperature	-.45	-6.05	-0.43
Weather S	12.42*	48.31*	2.93*
Time B	1.32	18.11	0.51

**. $P < 0.001$

*. $P < 0.05$

4.5 Discussion

This study made two important contributions to urban planning and health studies. First, it demonstrated an innovative protocol to assess park use from the perspective of social interaction for future applications. Second, with the newly developed protocol, this study assessed the associations between different park qualities and people's social interaction behaviors in urban parks to fill gaps in the data regarding the health benefits of parks.

Development of the Protocol to Assess Social Interaction

People living in urban settings can enjoy both physical and psychological health benefits from the mechanisms of parks, otherwise represented as park uses (Maas et al., 2009). The majority of the existing literature claims that people can enjoy health benefits from doing physical activities in parks and regards physical activity as the only or main mechanism driving health benefits and urban green resources. Additionally, existing protocols capturing park uses have focused primarily on the intensity of and/or category of physical activity (Jones et al., 2009, McKenzie et al., 2006, Quigg et al., 2010, Wheeler et al., 2010), thereby ignoring other important park uses that can benefit public health, such as social interaction. Researchers with leisure and health research backgrounds began to objectively assess social interaction as an alternative park use in addition to physical activity by simply counting the number of individuals performing different kinds of physical activity (Campbell et al., 2016, Rasidi et al., 2012). However, this study took a step further by classifying physical activity into different levels of social interaction and then capturing the number of people involved. Thus, the first contribution

of this study was a design for a systematic observation protocol, POSISP, to measure and quantify people's social interaction in public open space including urban parks. As most existing studies assessing social interaction are based on recording the number of people performing different kinds of human activities to predict social interaction, this protocol allowed users to directly evaluate the degree of social interaction that occured in the public open space according to a Social Interaction Score which captured the total number of individuals at the same time. To ensure the validity of POSISP, the protocol was established according to the Social Interaction Scale, based on Parten's six stages of play, which has been proven valid to indicate people's social interaction behaviors and has been modified several times over decades. Simultaneously, data collected in preliminary observations were later tested through a t-test and ICC analysis for Inter-rater reliability. The results in the t-test and the ICC analysis both indicated consistency in the social interaction scores from different auditors. The POSISP has been established as a valid and reliable protocol for future users to employ to measure both the human count and level of people's social interaction behaviors in public open space.

This paper described the functionalities and development of POSISP. Potential users of the protocol included researchers, practitioners, city planners, park designers, and anyone interested in measuring park use from the perspective of how people socialize, due to both the simplicity of operating the protocol and the low equipment and technology requirements. With this protocol, users do not need to identify how intensive the activities are, or what kind of activities the park users are doing, such as sitting, eating, or exercising. Instead, future users of POSISP can determine which levels of social interaction the individual(s) is/are experiencing (1. Solitary, 2. Unoccupied, 3.

Onlooker, 4. Parallel, 5. Associative, 6. Cooperative), according to the definitions and examples as shown in the Social Interaction Scale. After determining the level of social interaction behaviors, future auditors also need to count the number of people who are under this level. The levels of social interaction behaviors and corresponding number of people are the two key components for the social interaction score that future users of POSISP need to record during observation. Social interaction scores calculated through POSISP have been employed in the case study and act as an effective method of quantitively studying associations between park quality and social interaction. POSISP can also be used by future scholars interested in statistically exploring people's social interaction behaviors or their relationships to other quantitative variables, like park quality.

The social interaction scores calculated via POSISP have been employed in the case study and showed a good example to quantitively study the associations between park quality and social interaction. The results in the comparative statistics demonstrated a good consistency between the proposed measure of social interaction by aggregating level and group size and the traditional measure by only the group size. Both of the HLM models discovered the significant correlation between park quality and social interaction. Compared to the traditional method, POSISP illustrated a more obvious statistical correlation between park quality and social interaction because POSISP established a more comprehensive measure of social interaction including both the level of the social activities and the number of socializing individuals. That is to say, the social interaction data collected by POSISP is statistically align with the data collated with the traditional methods but superior than the traditional one by providing a more inclusive information

and stronger statistical results. We would recommend POSISP to the future scholars who are interested in statistically exploring people's social interaction behaviors or their relationships to any other quantitative variable like park quality.

A limitation of POSISP needs to be addressed for future users because some literature mentions that social interaction should to be measured via the amount of time people spend in the place, thereby reflecting their engagement in a public open space and the intensity of the contact (Carmona, Tiesdell, Heath, & Oc, 2010, Gehl, 2011, Moulay et al., 2017). POSISP allowed auditors to document the persistence of the behaviors, yet the maximum observation period was 15 minutes. Because the level of social interaction (1-6) was determined at the beginning of the observation period, any change in social interaction behavior, while uncommon during the observation period but still inevitable over time, could still lead to inaccuracy within the dataset. Regarding this circumstance, we provided two solutions for future POSISP users, with a different research emphasis on persistence. For users who do not need persistence as a variable in further statistical analysis, we suggested that instead of observing people's social interaction behaviors for 15 minutes, they could conduct a momentary observation for all sub-areas in the park—for example, by taking a picture of the area and then scanning the area from left to right while identifying the level of social interaction and the number of individuals showing up. This momentary observation would be most efficient for researchers who do not need to study persistence, as the social interaction score for each observation is left unaffected because auditors can still record both the level of social interaction and the number of people. When persistence is necessary for the study, researchers can either note changes in social interaction behaviors within the 15-minute observation period as a limitation or

they can conduct a math equation to calculate the exact social interaction level based on the distribution of time for each level. For example, a POSISP auditor found a group of park users sitting and chatting under the tree (Level 5) for the first 10 minutes (10/15 * 100% = 67%), and then said group moved to the soccer field and played soccer (Level 6) for the remaining 5 minutes (5/15 * 100% = 33%). The level for that group would then be calculated as 5 * 67% + 6 * 33% = 5.33.

This study encourages future scholars to consider alternative mechanisms driving the relationship between urban green resources and people's health benefits by paying more attention to social interaction as a significant park use, in addition to physical activity. This paper demonstrates a valid and reliable systematic observational protocol to evaluate and quantify social interaction behaviors by both their numbers and levels. The quantified social interaction variable—the social interaction score captured through POSISP—can be further analyzed and explored with various other environmental variables, including park quality, which illustrates a wide applicability for future research and practice.

The Associations between Social Interaction and Park Quality

The second contribution of the study was the discovery of significant associations between social interaction, overall park quality, and some of the separate park features and qualities. According to the statistical results, the social interaction score was significantly related to overall park quality, followed by park size. With regards to separate park feature qualities, the social interaction score only correlated with aesthetic features and maintenance and cleanliness to a statistically significant extent. Park facility, amenity, and incivility were not correlated with the SIS in the statistical analysis. Another

interesting statistical finding was that when compared with single park feature qualities, the social interaction score was more associated with overall park quality and park size. This study found that overall park quality was the most important factor in promoting social interaction behaviors in urban parks. Higher park quality led to more people socializing and higher levels of social interaction in the parks. Park size was another significant factor influencing people's social interaction behaviors in urban parks. Visitors tended to socialize with others in the more sizable parks. Single park feature qualities were not as important as overall park quality or park size with regard to people's social interaction behaviors in parks, as good single park feature qualities were less likely to encourage more people to socialize, than, for example, good facilities and/or good amenities.

There have already been emerging studies focusing on the associations between park design and social interaction. One such study reported that some specific facilities, such as playgrounds, shelters, seats, play courts, and pathways, can improve levels of social interaction, as indicated by the number of people at the park who stayed together (Rasidi et al., 2012). When compared with such a simple indication of social interaction, the social interaction variable measured in this study via POSISP has demonstrated more solid validity, based on its theoretical background and its reliability in statistical tests. For these reasons, we claim that the levels of social interaction behaviors among park users as represented by the social interaction score via POSISP are more accurate than those in the prior research. Unlike the literature, this study suggests that overall park quality encompassing different aspects of separate park features is more important than single park features or characteristics when promoting people's social interaction. Even park

size is more critical than the presence of specific facilities for people's socialization in parks. We recommend that future planners and designers notice that rather than focusing on a specific park feature or characteristic, focusing on the enhancement of overall park quality by incorporating various perspectives of a park can more effectively improve people's social interaction and consequently benefit urban residents' public health. More importantly, it should be known that it is a complicated process to increase the numbers and levels of social interaction in parks through park planning and design—more efforts should be devoted to advancing knowledge in this field. Unlike physical activity, people do not socialize in parks merely because of a specific facility, amenity, or any other feature or characteristic, but rather because of the overall design and quality of the park, including both the physical and non-physical aspects of the design plan. More efforts must be devoted to studying the complexity of how overall park quality influences social interaction in public parks.

Among the separate park feature qualities contributing to overall park quality, we found that aesthetic feature had the greatest effect on the increase of the number and level of social interaction behaviors. Maintenance and cleanliness acted as an unstable factor when predicting social interaction. It is considered a significant predictor among separate park feature qualities, but not a significant predictor of social interaction, when compared with overall park quality and park size. Although positive relationships existed between specific park facilities and amenities, including playgrounds, seats, play courts and pathways, similar positive relationships with social interaction have not been proven in this study and did not show up in a consistent pattern with the previous study. We found, instead, that aesthetic features, including landscaping, tree canopies/shelters, water

features, and green space could bring more people to the park to participate in higher levels of socialization. It should be noticed that some park features and characteristics categorized as aesthetic features in this study aligned with some of the facilities defined in the literature. We employed an established instrument—PARK (Bird et al., 2016) to scientifically measure park quality from different perspectives, thereby providing more detailed guidance for future research, rather than simply counting the facilities in the parks.

This study concluded with some very interesting findings regarding separate park feature qualities and social interaction. Contrary to the literature, park features like facilities and amenities did not encourage more people to socialize in the parks. The presence of facilities such as playgrounds and ball fields can be supportive of people's physical activities, but not for how people socialize with others or stay within a group. Similarly, park features like amenities, including seating, paths, parking lots, and restrooms, are not valuable elements in park design for attracting more people to socialize. A park equipped with more facilities and better amenities may be more convenient and make it easier for people to do physical activities, but will probably not be the first choice for social interaction. Future stakeholders need to be more careful about investing capital in an urban park focused on facilities and amenities, if they wish to create a more attractive park for people to socialize in and thereby benefit their mental health. For the park designers and city planners, This discovery should inform park designers and city planners to pay more attention to other park features and characteristics besides facility and amenity. In the end, placement of more facilities and

amenities might not be particularly helpful when attempting to inspire park visitors to visit a park for purposes other than physical exercise, such as social interaction.

In this study, aesthetic features and maintenance and cleanliness were the only useful elements to support people's social interaction. Aesthetic features were identified as cultural elements, the environments adjacent to the park, the landscaping/decorative elements, water features, and the attractiveness of the park, as judged by the auditors' perceptions. The assessment of cleanliness and maintenance of a park was according to the condition and cleanliness of the park and its facilities, as well as the adjacent streets. In line with the assessment of aesthetic features, auditors' perception towards the condition of the park accounted for more than 35% of the weight of assessing the maintenance and cleanliness of the park. Yet for facility and amenity, auditors' perceptions accounted for less than 12% of the weight of assessment. The significant differences in the distribution of people's perceptions between useful and useless predictors of social interaction need to be noted. The subjective components, like the general condition of the parks and the visitors' perceptions towards the parks, had greater influence in encouraging people's social interaction behaviors than the objective components, such as the existence of various facilities and amenities. In the future, when park designers aim to improve urban dwellers' health status through improving opportunities for social interaction in parks, devoting more efforts to make a park feel beautiful and clean may be more important than simply placing more facilities and amenities into the same park. In addition to considering visitors' feelings in the park, future planners and designers should also consider more deeply the cultural elements of a park, which may provide more attachment and motivation for people to visit the place

and may provide a good topic for conversation between strangers. Landscaping, water features, and a beautiful surrounding area can also inspire more people to socialize in the park. While the maintenance and cleanliness of parks are largely ignored these days, policy-makers and anyone concerned should be reminded by this paper that follow-up work may sometimes be more important than what has already been placed in public places, especially for those who plan to visit the place for reasons like social interaction.

This study indicates that improvement in overall park quality could substantially contribute to the number of people socializing in urban parks and their levels of social interaction behaviors. Park size was the second-most important factor in promoting social interaction and exhibited greater usefulness in this respect than did separate park feature qualities. Among the separate park feature qualities, only aesthetic feature and cleanliness and maintenance were significant contributors to social interaction. The subjective components of park design weighed more in importance than objective components with regard to attracting more people to socialize in parks. With some degree of inconsistency in the literature, we insist on the accuracy of this study because of the validity and reliability of the protocol we developed, which also made significant progress in the measurement of people's social interaction behaviors in public open space.

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CHAPTER V

SUMMARY AND CONCLUSION

To address the concerns around global urbanization's impacts on urban residents' physical and psychological health, urban green resources, such as urban parks have played an essential role in urban systems by providing various health, economic, and social benefits, which could mitigate negative issues commonly associated with urbanization. As the importance of parks in cities is widely recognized, a growing number of researchers have studied parks from different perspectives of urban planning and design disciplines for their capacity to better understand the relationships between people and parks as well as promote the well-being of urban populations.

While traditional research on urban parks has focused on their physical and spatial aspects such as park availability, accessibility, and proximity, a growing number of studies have shifted their focus from spatial dimensions of such green resources to the non-spatial dimensions. Park quality has been the most acknowledged representation of the non-spatial dimension of urban parks according to the literature. Although more and more scholars from some disciplines have recognized the importance of park quality as a significant non-spatial dimension of urban green resources in addition to the spatial ones, and already initiated some related studies, such as the distribution of park quality with the socio-economic statues, alternative evaluation of such resources, and the associations between park quality and people's physical activities, the deficiency in this profession are still arising and need to be addressed.

To fill the existing research gaps, some issues and topics related to park quality should be explored. This dissertation employed different research methods and studied park quality from these perspectives: 1) the equal distribution of park quality resources considering the environmental justice issues, 2) the protocols that used to measure the most commonly acknowledged non-spatial dimensions of urban parks, including quality, and 3) the association between park quality and people's social interactions in urban parks. Additionally, through the process of studying park quality, this dissertation used park quality as an example of spatial data and ameliorate the research method for this kind of data in quantitative research.

The first part of the dissertation focused on the park quality disparity issues for the disadvantaged groups of people, which addressed the Environmental Justice. This part identified whether the distribution of quality of the urban parks was spatially autocorrelated and assessed the associations among different Environmental Justice Indicators and both separate park features qualities and the overall park quality.

In the second chapter, we followed the spatial regression process in the R programming language and evaluated the spatial relationships between and park quality and in the urban setting. Both overall park quality and separate feature qualities were evaluated through the PARK instrument. Environmental justice indicators included in the study were determined through minority density, poverty, unemployment, low-education, renter rate, and yard size.

The results of the study have disclosed the existence of spatial autocorrelation issue in park quality distribution and detected the dependence of the variable for quantitative research. At the same time, they demonstrated the significant correlations

between the distribution of park quality and environmental justice indicators. The study also showed a model of using a spatial regression model to analyze the spatial data and avoided the potential autocorrelation issue which has been largely ignored by the normal statistical approaches. Variances of the distribution of park quality can be also accounted for by different environmental justice indicators, such as poverty, minority, and yard size. The disclosure of the issue of public resource quality treatment among the disadvantaged groups of people could inspire the city planners and policy-makers to correct the disparity.

In this part of the park quality study, we presented a vivid example of the existence of spatial autocorrelation in environmental planning, and how this phenomenon can influence the validity issues when data analyses fail to acknowledge its presence. Future scholars from various disciplines who need to study the spatial data, should be aware of the potential issue of spatial autocorrelation and choose a quantitative approach that could account for the data dependence at study initiation. Lastly, the improvement of park quality distribution could provide more opportunity for experiencing equitable access to the pursuit of healthy and productive lifestyles among the disadvantaged people. For these reasons, we encouraged city planners, policy-makers, and park designers to be cognizant of the issue of public green resource disparities, especially for the disadvantaged groups, and the influences to environmental justice.

In response to the shifting of research focuses from the spatial dimensions of urban green resources to the non-spatial ones, the second part of the dissertation analyzed and synthesized the different approaches assessing non-spatial dimensions of urban parks including park quality and drew implications for future urban landscape planning, design,

and research through a systematic literature review study. To achieve this research purpose, we explored the non-spatial dimensions of urban parks park quality, park use, park benefits through a systematic literature review. The following research questions were used to guide the systematic study: how the existing protocols measure the non-spatial park dimensions, what limitations they have, and what recommendations for future scholars to choose an existing protocol.

From the literature review study, we discovered that the non-spatial dimensions of urban parks are a complicated construct and quality, use, and benefits are the most recognized representations. We recommended the future researchers ought to consider the associations and interdisciplinarity between the three representations, and determine which assessments are fitting for their research purpose and setting when assessing non-spatial park dimensions. This study also detailed how the three identified non-spatial dimensions of urban parks—quality, use, and benefit—have been assessed, presented the limitations existed in the protocols and the recommendations for the future studies.

For park quality, the measurement has already achieved some agreements with the direct-observation method in the western contexts and displayed some successive patterns in their development. The existence of some specific park features and characteristics like park facility, amenity, and aesthetic features have been acknowledged in most protocols to represent park quality, while the consistency, details, and length of the measures between various protocols are still debatable. Future studies still need to dedicated to developing the park quality protocols in other contexts besides the area of the global west. Additionally, some specific population groups, such as children, the elderly, and the low-income should be addressed in future development.

For the protocols designed to assess the non-spatial dimension of park use, unlike park quality, the methods are widely varied from the survey, observation, and archival data sets with GIS or GPS, and have not achieved an agreement yet. Lots of park use protocols often lacked the tests for their reliability and validity, so if the future scholars would like to employ an existing protocol, they should be very careful about making the choice. The most notable limitation lying in the observational protocols evaluating park use is with the development of SOPARC, most of these protocols measuring park use mainly from the perspective of physical activity but ignored park uses for any other purpose which could be social interaction and education. For future studies, the design of an observation protocol assessing park use from another perspective rather than physical activity is needed.

Although the concept of park benefit has been raised for decades, the development of the protocol assessing this non-spatial dimension just started to be established since the establishment of PPGIS in 2014. Most of the protocols developed to assess park benefits are within the areas of Australia and Europe. From this point, the developments of park benefit protocols is not as well constructed as the other non-spatial dimensions——park quality and park use. Currently, the majority of these protocols are based on the self-reported data which has the potential of being biased. But the importance of the concept of park benefit and the necessity of its assessment should be noticed and we encourage more scholars to explore this field which could directly reflect people's perceptions of the benefits they could achieve from the urban green resources.

Through the analysis and synthesis of the protocols measuring the non-spatial dimensions of urban parks, we contrasted the measurements, limitations, and

recommendations for future studies. Although we discovered many good protocols for evaluating park quality, park use, and park benefits, some issues that warrant further development to enhance the instruments' research potential were also identified from the analysis. Most importantly, we suggested future scholars incorporate more than one aspect of park studies—both spatial and non-spatial and physical and non-physical—to comprehensively understand and conceptualize these resources in urban areas as they will continue to construct the body of knowledge that will shape the built environments in the future.

The third also the last part of the dissertation explored the associations between park quality and social interaction which is another objective of this research via a case study in Logan and North Logan, Utah. In this study, the measure of park quality was assessed by an established tool: Parks, Activity, and Recreation among Kids (PARK) tool, and social interaction (DV) was evaluated through the firstly developed instrument: Protocol for Systematically Observing Social Interaction in Parks (PSOSIP). After tests of the spatial autocorrelation that may exist in the dataset, the hierarchical linear model (HLM) was finally chosen to analyze the relationships between social interaction and park quality addressing the data inaccuracies caused by the multilevel data structure.

This last part of my dissertation made two contributions to urban planning, landscape design, and health studies. We demonstrated an innovatively designated protocol to evaluate people's social interaction behaviors in public open space. Second, with the application of the new protocol, this study assessed the associations between different park qualities and people's social interaction behaviors in urban parks to informing health benefits.

According to the results of the study, we encouraged future scholars to aware of the alternative mechanisms between urban green resources and people's health benefits and regard the social interaction as an alternative park use as important as physical activity. This study developed a valid and reliable systematic observational protocol for evaluating and quantifying people's social interaction behaviors from both the number of individuals and the levels of social interaction. People's social interaction interactions behaviors were captured and quantified through POSISP protocol into social inter action scores. Then the scores can be further analyzed and explored with any other spatial variables, such as park quality, which showed a successful example for wide applicability in future research and practice.

In this part of the dissertation, we also suggested that the improvement in overall park quality could most substantially contribute to both the number of socializing people in urban parks as well as their levels of social interaction behaviors. Park size was the second important contributor to increase social interaction and exerted more importance than the separate park feature qualities. Only aesthetic features and cleanliness and maintenance among the separate park feature qualities were useful factors to people's social interaction. The subjective components in park design played a more important role to encourage people's social interaction behaviors in urban parks. Through this case study, we found it should be a complicated design process to increase social interaction through the enhancement of park quality and more research ought to be devoted to further the pieces of knowledge. Contrary to some contents in the prior research, this study insisted on the accuracy of our findings and methods because of the construction of

validity and reliability POSISP, which also made significant progress in the evaluation of people's social interaction behaviors in urban public open space.

APPENDIX

Appendix A. Parks, Activity, and Recreation among Kids Tool
(PARK Tool)

The Parks, Activity and Recreation among Kids (PARK) Tool	
Family PIN	
Observer ID.	
ID of co-observer	
Observer code. (A or B)	
Date	
Park ID	
Park address	
Start time	
1. Type of Usage	
Physical activity structured	1
PA non-structured	2
PA structured. and non-structured	3
Passive activities – gardens	4
Passive only	5 (skip to Q11)
2A1. Tennis:	
Check if present	
2A2. Check if accessible	
2A3. Check if in good condition	
2A4. Check if restricted	
2B1. Basketball:	
Check if present	
2B2. Check if accessible	
2B3. Check if in good condition	
2B4. Check if restricted	
2C1. Badminton/Volleyball:	
Check if present	

2C2. Check if accessible	
2C3. Check if in good condition	
2C4. Check if restricted	
2D1. Soccer/Football/Rugby:	
Check if present	
2D2. Check if accessible	
2D3. Check if in good condition	
2D4. Check if restricted	
2E1. Baseball/Softball:	
Check if present	
2E2. Check if accessible	
2E3. Check if in good condition	
2E4. Check if restricted	
2F1. Hockey/Cosom/Ringette:	
Check if present	
2K2. Check if accessible	
2F3. Check if in good condition	
2F4. Check if restricted	
2G1. Race Track:	
Check if present	
2G2. Check if accessible	
2G3. Check if in good condition	
2H1. Foot Path:	
Check if present	
2H2. Check if accessible	
2H3. Check if in good condition	
2I1. Bicycle/Rollerblade Path:	
Check if present	
2I2. Check if accessible	
2I3. Check if in good condition	

2J1. Skate Park:	
Check if present	
2J2. Check if accessible	
2J3. Check if in good condition	
2J4. Check if restricted	
2K1. 6+ Play Area:	
Check if present	
2K2. Check if accessible	
2K3. Check if in good condition	
2L1. Multi-Use Space:	
Check if present	
2L2. Check if accessible	
2L3. Check if in good condition	
2M1. School Yard:	
Check if present	
2M2. Check if accessible	
2M3. Check if in good condition	
3.a) Equipment Rental:	
Check if present	
b) Specify:	**TEXT**
4. Pool	
Check if present	
5. Pool Length:	
Under 25m	1
Longer or equal to 25m	2
Impossible to evaluate	3
6. Condition Around the Pool:	
No deterioration	1
Presence of deterioration without need for repairs	2

Significant deterioration requiring repairs	3
Under construction	4
Impossible to evaluate	5
7. Cleanliness of Pool:	
Very clean	1
Clean enough	2
Not at all clean	3
Impossible to evaluate	4
8. Water Sprinklers:	
Check if present	
Water sprinklers under construction	3
9. Water Sprinklers Condition:	
No deterioration	1
Presence of deterioration without need for repairs	2
Significant deterioration requiring repairs	3
Under construction	4
Impossible to evaluate	5
10. Cleanliness of Water Sprinklers:	
Very clean	1
Clean enough	2
Not at all clean	3
Impossible to evaluate	4
11A. Important Body of Water: (if no skip to Q12)	
Check if present	
11B. Sportive Aquatic Activities:	
Check if present	
12A. Pond or Fountain: (if no skip to Q13)	
Check if present	
12B Sportive Aquatic Activities:	
Check if present	

13A. Decorative or Cultural Physical Elements:	
Check if present (if no skip to Q14)	
13B. If present, specify:	**TEXT**
14. Gardens:	
Check if present	
15. Shade:	
Many places	1
Some places	2
None	3
16. No Dogs Allowed Sign:	
Check if present	
17. Graffiti:	
None	1
Some	2
A lot	3
18. Broken Items/ Vandalism:	
None	1
Possibly	2
Definitely	3
19. Litter/Garbage:	
None	1
Some	2
A lot	3
20. Garbage Bins:	
Yes, in usable condition	1
Yes, but unusable	2
No	3
21. Drinking Fountains:	
Yes, in usable condition	1
Yes, but unusable	2

No	3
22. Picnic Tables:	
Yes, in usable condition	1
Yes, but unusable	2
No	3
23. Sitting Benches:	
Yes, in usable condition	1
Yes, but unusable	2
No	3
24. Bleachers:	
Yes, in usable condition	1
Yes, but unusable	2
No	3
25A. Public Toilets:	
Yes	1
No	2 (Skip to Q26)
Impossible to determine	3 (Skip to Q26)
25B. Condition of Toilets:	
Good	1
Bad	2
Impossible to determine	3
26A. Chalet/Change rooms:	
Yes	1
No	2 (Skip to Q27)
26B. Condition of Chalet/Change rooms:	
Good	1
Bad	2
Impossible to determine	3
27. Parking:	

Yes, reserved for the park	1
Yes, on the street only	2
No	3
28. Bicycle Locks:	
Check if present	
29. Public Transportation:	
Check if present	
30. Sufficient Lighting to Light the Majority of the Park:	
Check if present	
31. At least 1 Street Visible from the Centre of the Park:	
Check if yes	
32. At least 1 House Visible from the Centre of the Park:	
Check if yes	
33. Adjacent Streets are Local:	
All	1
Some	2
None	3
34. Adjacent Streets have Traffic Calming Measures:	
All	1
Some	2
None	3
35. Adjacent Streets have Pedestrian Facilitation Measures:	
All	1
Some	2
None	3
36. Is the Park Attractive for Youth?	
Very attractive	1
Attractive enough	2

Not attractive	3
37. Is the Park Safe?	
Very safe	1
Safe enough	2
Not safe	3
38. Is the Park Pretty/ Attractive?	
Very pretty/ attractive	1
Pretty/ attractive enough	2
Not pretty/ attractive	3
39. Is the Park Appealing for Walking?	
Very appealing	1
Appealing enough	2
Not appealing	3
40. Is the Park Appealing for Cycling?	
Very appealing	1
Appealing enough	2
Not appealing	3
41. Is the Park Appealing for Active Play?	
Very appealing	1
Appealing enough	2
Not appealing	3
42. Time of Completion:	

Appendix B. Modified PARK Tool

	Park Name:	
	City:	
	Address:	
	Acreage: Date:	
	Facility: (18)	
1	Tennis Court	
2	Basketball Court	
3	Badminton / Volleyball court	
4	Soccer / Football / Rugby field	
5	Baseball / Softball field	
6	Playground / Play Area	
7	Skate Park	
8	Pool / Important body of water	
9	Pond / Fountain	
10	Garden	
11	Multi-use Space	
12	School Yard	
	Is this park appealing for active play?	
	Is this park appealing for walking?	
	Amenity (22)	
1	Race Track	
2	Foot Path	
3	Bicycle / Rollerblade Path	
4	Equipment Rental	
5	Shade	
6	No Dog Sign	
7	Drinking Fountain	
8	Garbage Bin	
9	Water Sprinkler	
10	Picnic Table	
11	Sitting Benches	
12	Chalet / Change Room	
13	Parking Area	

14	Bicycle lockers	
15	Public Transportation	
16	Lighting	
17	Adjacent Street	
18	Public Toilet	
19	Bleachers	
	Is this park appealing for cycling?	
	Aesthetic Features (9)	
1	Sportive Aquatic Activities	
2	Cultural Elements	
3	At least one house visible from the center of the park?	
4	At least one street visible from the center of the park?	
5	Decorative Elements (Landscaping)	
6	Water Features	
	Is this park attractive for youth?	
	Cleanliness & Maintenance (10)	
1	Adjacent streets have traffic calming measures	
2	Adjacent streets have pedestrian facilitation measures	
3	Safe Measures	
4	Pool condition	
5	Toilet condition	
6	Chalet condition	
7	Water sprinkler condition	
	Is this park safe?	
	Incivilities (7)	
1	Graffiti	
2	Broken items	
3	Litter / Garbage	
4	Vandalism	
	Is this park pretty / attractive?	
	Total Score:	

Appendix C. Protocol for Systematically Observing Social Interaction in Parks (PSOSIP)

Park:	Observer:	Date:	Weekday/weekend:	Weather&Temperature		Time (check)		Total Score:
						10 am - 2 pm		
						2pm - 6 pm		
SISUP	Group size	Gender (M/F/B/O)	Race (W/H/B/A/M/O)	Age group (Y/A/E/M/U)	With animal	Persistance(15min MAX)		Sub-area
						start	end	

Appendix D. Reference of Protocol for Systematically Observing Social Interaction in Parks (PSOSIP)

Reference	
social interaction scale in urban parks	
Individual	
1. Solitary (An individual is alone and uninterested or unaware of others.) e.g working/reading/writing	
2. Unoccupied (An individual is alone but interested in/observing others.) e.g watching others	
In group	
3. Onlooker (Individuals in a group observing others playing, but doesn't take part)	
4. Parallel (Individuals in a group though side-by-side, they seem in their own world and are more interested in the activity than the partner.) e.g fishing	
5. Associative (Individuals in a group and interacts with others, but in an unorganized and uncoordinated manner.) e.g: group socializing (eg. picnic, barbecue, party, celebration, gathering)	
6. Cooperative (Individuals in a group and engage with others in an organized activity, each one may have a distinct role.) e.g sport/exercise/play (e.g. ball games)	
Gender:	**Sub-areas:**
Male (M), Female (F), Both Male and Female (B), Other (O)	1. green space (lawn, tree, garden)
	2. near water (eg. Pond, pool, fountion,)
Race:	3. sports area (eg. Tennis court, basketball court, Volleyball Pit)
White (W), Hispanic (H), Black (B), Asian (A), Mixed (M), Others (O)	4. pavilion
	5. parking lot
Age group:	6. playground
Youth (Y), Adults (A), Elderly (E), Mixed (M)	7. loop/walkways/trails
	8. restroom
Weather:	9. changing/different sub-areas
1. Sunny, 2. Cloudy, 5. Windy, 3. Rainy, 4. Snowy	10. others

Appendix E. Curriculum Vitae

SHUOLEI CHEN

Email: shuolei.chen@aggiemail.usu.edu
Cell: + (801) – 400 8873
Address: 4005 Old Main Hill, Logan, UT, USA, 84322-4005

EDUCATION

Utah State University

May 2020 (Expected)

Doctor of Philosophy in Landscape Architecture,
Dissertation: *"Exploring Park Quality in Urban Settings with Environmental Justice, Alternative Measures, and Social Interaction"*
Committee: Ole Russell Sleipness (Major Professor), Keith Christensen, Keunhyun Park, Ryan Knowles, Bo Yang

May 2017

Master of Landscape Architecture (MLA)
Thesis: "*A Comparison of Park Access with Park Need for Children: A Case Study in Cache County, Utah*"
Committee: Keith Christensen (Major Professor), Shujuan Li, Dennis Nelson

Nanjing Forestry University

June 2014

Bachelor of Landscape Architecture (BLA)
Thesis: "*The Cultivation of Hyacinthud Orientalis under Different Soil and Temperature Conditions*"
Chair: Fengrong Hu

PEER-REVIEWED PUBLICATIONS

Published/Accepted Journal Article

2020

Sleipness, O. R., Powell, J., Anderson, D., Evans, D., McCann, R., **Chen, S.** (2020). Extension-based Community Engagement Project Contributions to Landscape Architecture Core Competencies and Professional Values. *NATCA Journal,* (Accepted)

2019

Chen, S., Christensen, K. M., & Li, S. (2019). A Comparison of Park Access with Park Need for Children: A Case Study in

Cache County, Utah. *Landscape and Urban Planning*, *187,* 119-128

2019 **Chen, S.**, Sleipness, O. R., Christensen, K. M., Feldon, D., & Xu, Y. (2019). Environmental justice and park quality in an intermountain west gateway community: assessing the spatial autocorrelation. *Landscape Ecology*, *34*(10), 2323-2335

2019 Sleipness, O., Powell, J., Anderson, D., Evans, D. McCann, R., **Chen, S.** (2019). Extension-based Community Engagement Project Contributions to Landscape Architecture Core Competencies and Professional Values. *NACTA Journal*

2018 Sleipness, O., Christensen, K., **Chen, S.** (2018). Research Methods within the MLA: Implications for Scholarly Inquiry in Landscape Architecture. *Landscape Research Record.* 7:1

Published/Accepted Conference Proceedings

2019 **Chen, S.**, Sleipness, O. R., Christensen, K. M., Feldon, D., & Xu, Y. (2019). Environmental justice and park quality in an intermountain west gateway community: assessing the spatial autocorrelation. CELA, Sacramento, CA

2019 **Chen, S.**, Sleipness, O., Park, K. A Systematic Review of Alternative Protocols for Evaluating Non-Spatial Dimensions of Urban Parks. CELA, Sacramento, CA

2018 Sleipness, O. R., Christensen, K. M., & **Chen, S.** (2018). Research Methods within the MLA: Implications for Scholarly Inquiry in Landscape Architecture. CELA, Blacksburg, Virginia

2016 **Chen, S**., Christensen, K. M., & Li, S. (2016). A Comparison of Park Access with Park Need for Children. CELA, Beijing, China

2016 Christensen, K. M., Jansuwan, S., Chen, A., & **Chen, S.** (2016). Social Network Characteristics that Influence Individuals with Disabilities' Transportation Choices. CELA, Beijing, China

Under Peer Review

2019 **Chen, S.**, Sleipness, O., Xu, Y., Park, K. Christensen, K. A Systematic Review of Alternative Protocols for Evaluating

Non-Spatial Dimensions of Urban Parks. *Urban Forestry and Urban Greening.* (Reviewed and Resubmitted)

2019 Sleipness, O., Licon, C., Powell, J., **Chen, S.** Designing a Legacy: University Design Engagement in Zion National Park's Eastern Gateway. *Landscape Architecture Frontiers.* (In Review)

Journal Article In Preparation

Chen, S., Sleipness, O. R., Christensen, K. M., & Yang, B. Development of a Systematic Observation Protocol to Assess Social Interaction Behaviors in Urban Green Space. Projected submission to *Landscape and Urban Planning*

Chen, S., Sleipness, O. R., Christensen, K. M., Yang, B., Park, K., Knowles R., &. Social Interaction—Another important use of parks: A case study to explore the relationships between park quality and social interaction for urban parks. TBD

Park, K. & **Chen, S**., Toward an Understanding of the UTA Customer Experience: Focusing on Out-of-Vehicle Environments. TBD

Chen, S. The Interaction between Urban Parks and Population Benefits: A Theoretical Framework for Urban Park Planning. Projected submission to *Cities*

TEACHING EXPERIENCE

Fall 2019 **Instructor of Record**
LAEP 3700, City and Regional Planning, Utah State University *(3 credit hours)*

Fall 2019 **Instructor of Record**
LAEP 6300, GIS for Environmental Planning, Utah State University *(4 credit hours)*

Spring 2019 **Graduate Student Instructor**
LAEP 2720, Site Planning & Design II, Utah State University *(5 credit hours)*

Fall 2018	**Instructor of Record** LAEP 6300, GIS for Environmental Planning, Utah State University *(4 credit hours)*
Spring 2017	**Teaching Assistant** LAEP 4940, Green Infrastructure Construction & Design, Utah State University *(3 credit hours)*

GRANT & FUND

2019	**Research Assistant** Toward an understanding of the UTA customer experience: Focusing on out-of-vehicle environments, Utah Transit Authority (UTA) & Utah Department of Transportation (UDOT). Funded by Utah Transit Authority
2018 – present	**Principal Investigator** Graduate Research Funds. Funded by Utah State University
2017 – 2019	**Research Assistant** Public Transportation System Accessibility for Individuals with Disabilities. Funded by Utah Transit Authority
Fall 2017	**Research Assistant** Department of Landscape Architecture and Environmental Planning Extension Projects. Funded by Utah State University

SCHOLARSHIP & AWARDS

Fall 2019	**Graduate Student Instructor Contribution Badge** Utah State University
Fall 2019	**Graduate Student Travel Award** Utah State University
2017 – present	**Graduate Assistantship** Department of Landscape Architecture and Environmental Planning, Utah State University
2017 – present	**Graduate Agricultural College Tuition Award** Utah State University

2017 – present	**Graduate Research Assistant Tuition Award** College of Agriculture and Applied Sciences, Utah State University
Summer 2015	**Summer Study Abroad Scholarship in Germany** Utah State University
Spring 2014	**Outstanding Graduate Award** Nanjing Forestry University

ACADEMIC EXPERIENCE

2018 – 2019	**Instructor of record,** Department of Landscape Architecture and Environmental Planning, Utah State University
2017	**Teaching Assistant** Department of Landscape Architecture and Environmental Planning, Utah State University
Summer & Fall 2016	**Editorial Assistant** Council of Educators in Landscape Architecture (CELA)
Fall 2016	**Conference Coordinator** The 2nd International Symposium on Ecological Wisdom The University of Texas at Austin
2015 – 2019	**Research Assistant** Department of Landscape Architecture and Environmental Planning, Utah State University

PROFESSIONAL EXPERIENCE

Summer 2015, 2016	**Landscape Designer** WANRONG Landscape Construction Co., Ltd. China,

Summer 2011, 2012 — **Landscape Architect Assistant**
DONGYI Landscape Construction Co., Ltd. China

SERVICE

Fall 2019 — **Guest Speaker**
GrTS Training Workshop for Graduate Student Instructors, Utah State University

Summer 2019 — **Guest Speaker**
An Introduction to Study Abroad, Nanjing Forestry University

2018 – 2019 — **Committee Member**
CREATE 2020 Fund, Department of Landscape Architecture and Environmental, Utah State University

2018 – Present — **Committee Member**
Doctoral Curriculum Committee, Department of Landscape Architecture and Environmental, Utah State University.

Fall 2017 — **Guest Lecturer**
An Introduction to Traditional Landscape Planning and Design in China, LAEP 1030, Introduction to Landscape Architecture, Department of Landscape Architecture and Environmental, Utah State University.

Spring 2016 — **Conference Coordinator**
Council of Educators in Landscape Architecture (CELA), Salt Lake City, Utah

2015 – 2016 — **Speaker Series Coordinator**
Department of Landscape Architecture and Environmental, Utah State University

2010 – 2012 — **Vice-president of Student Union**
Nanjing Forestry University

Fall 2010 — **Student Representative of Class 2010**
Nanjing Forestry University

SKILLS

Geospatial Analysis
Proficient in Geographic Information System (ArcGIS) and R programming language

Digital Graphic & Visualization
Adobe Package (Photoshop, Illustrator, InDesign), AutoCAD, Sketchup, Lumion

Others
SPSS, Microsoft Package, LATEX, R Markdown

Language
English (Fluent), Mandarin (native)