Unmasking Inequities in Park Access: Using GIS to Assess Park Congestion in the Greater Los Angeles Region

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Abstract

The present study examines park congestion rates (i.e., the size of the population served by a park) across the Southern California Region on a *per park* basis. Utilizing tools within GIS and the concept of thiessen polygons, service areas were delineated so that each park at the center is assumed to serve the population within the bounds of such thiessen polygons. Analyses of the park service areas revealed that highly congested parks are usually coincident to low-income and ethnic neighborhoods. The study shows the utility of spatial analysis tools in GIS as well as the concept of Thiessen polygons in elucidating existing inequities in park access. The study further discusses how such inequities might be ameliorated, utilizing technologies in both computers and GIS.

Keywords: GIS, Thiessen Polygons, Parks, Open Space, Environmental Justice, Los Angeles

1 Introduction

While the benefits and value of parks and open spaces are well-recognized, such resources are not always equitably distributed across communities. Older inner city neighborhoods that are low-income and typically communities of color characteristically have park space lower than the national standards. For example, in the City of Los Angeles, park resources are unevenly distributed across racial/ethnic communities (Wolch et al., 2005). While the city has 7.3 park acres per 1,000 population, communities that are predominantly Latino only have 1.6 acres per 1,000 population. Tracts heavily populated by African Americans have 1.7 park acres per 1,000 residents and tracts dominated by Asian-Pacific Islanders have 0.3 park acres per 1,000 residents. In contrast, predominantly White neighborhoods enjoy 31.8 park acres per 1,000 residents. Given that most ethnic neighborhoods have more children per family, the difference in park space becomes even more staggering when the figures are normalized to park areas per capita children.

In places like the greater Los Angeles region where historical discrimination and racial oppression has resulted in deep-rooted inequity in terms of access to amenities, a closer examination of the supply of parks and park resources and how these match up to the need/demand of the population is imperative if we are to redress existing inequities. Most work on equity and access to parks catalogue existing park resources in communities and/or political jurisdictions (e.g., municipalities) and characterizes these sites in terms of demographic characteristics usually based on Census data. The unit of analysis is usually confined to the Census tract level, or to neighborhoods, or municipalities. Delineating the unit of analysis by imposing these pre-defined boundaries (e.g., the census tract, neighborhood, or municipality) may have the consequence of "diluting" differences within, as well as between the units of analysis. For example, one end of a census tract may have more parks closer to it compared to other areas within the tract. As the unit of analysis grows larger, the assumption of homogeneity within the unit may not always hold true.

Access and equity are inherently spatial and it is inevitable that tools within Geographic Information Systems (GIS) will find their way into the examination of these social issues. Using "equity maps", Talen (1998) presented a framework for investigating spatial equity and demonstrated the use of GIS as an exploratory tool to uncover and assess current and potential future equity patterns. She demonstrated the value of the interactive capability of GIS formats facilitating the measurement of shifts in equity given varying geographic configurations of public facilities. Highlighting the importance of accessibility measures in equity studies, Nicholls (2001) presented an approach utilizing simple GIS commands to refine the measurement of accessibility to, and thereby equity, in the distribution of park resources. She utilized the concept of buffers and street networks and incorporated travel cost times in order to better estimate park accessibility. Lindsey et al. (2001) takes on the container approach in measuring equity of access to greenways, defining equity as proximity. They utilized GIS and the concept of buffers in defining a park service area, that is, a specified radius around parks deemed to be within some "accessible" distance (e.g., 0.5 miles). GIS was also useful in integrating various spatial and socioeconomic datasets.

While the various works, such as those mentioned above, effectively demonstrate the utility of GIS in the exploration of equity issues, most of these are largely normative in nature. These studies are very valuable in providing impetus for inquiry, but perhaps there needs to be some complementary work that utilizes GIS to show, in more tangible ways, how existing inequities might be remedied.

The present study examines park congestion rates (i.e., the size of the population served by a park) across the Southern California Region on a *per park* basis. If we are to assume that everyone uses the nearest park at some uniform rate, we can conceivably assign each person in the region to a park. One way to accomplish this is by generating thiessen polygons around each of the 1,830 parks that were identified in our study area. Considering that residents are more likely to utilize parks in closer proximity on a more regular basis, these thiessen polygons can be viewed as "park service areas", with each park at the center servicing most the population within the bounds of the thiessen polygons.

Using park service areas (as defined above) as the unit of analysis, the study seeks to address the following questions:

- Across the Los Angeles metropolitan region, what methods can we use to document which parks are more congested than others?
- Do patterns of congestion relate to certain demographic characteristics (e.g., income, race/ethnicity)?
- Given existing differences in "park congestion" rates across the region, how might these inequities be ameliorated?

2 Methods and Data Sources

2.1 The study site

The area considered in this study is a region in Southern California delineated by the boundaries formed by the Los Angeles River, Calleguas Creek, Santa Clara River, San Gabriel River, and Santa Monica Bay watersheds. Covering an area of over 11,240 km^2, this area includes most of Los Angeles County, a large part of Ventura County, and the northwest portion of Orange County (Figure 1).

Figure 1 The study site

2.2 Methodological approach

If we assume that everyone uses the nearest park at some uniform rate, we can conceivably assign each person in the region to a park and thereby delineate a "service area" for each park. We accomplished this by generating thiessen polygons around each park, assuming that everyone within the bounds of any one polygon uses the park at its center, and that there is no attenuation in park "desirability" or use with increasing distance within thiessen polygons.

For each park service area (i.e., thiessen polygon), we assigned the corresponding population count from LandScan USA's population grid, thus providing an estimate of the potential number of people *each* park is serving—that is, an approximation of "park congestion" per park. The parks were further described in terms of the facilities present or absent in the parks and the population characteristics (i.e., income, race/ethnic composition, and age based on census tract data) of those living within the park service areas in order to elucidate patterns in park congestion as they relate to these population characteristics.

2.3 Parks layer

A GIS "parks layer" was created by pooling together data from the following sources: ESRI's Business Analyst, land use/land cover data from the Southern California Association of Governments (SCAG), coastal access information from the California Coastal Commission, and Thomas Brothers Maps, with the latter used mainly for cross-referencing and verification. From these sources, a total of 1,830 park polygons were identified.

This parks layer was further augmented with audit information on facilities present at each park. Using Trimble Recon units loaded with ArcPad and a screen of specially prepared forms modeled after the SAGE (Systematic Audit of Greenspace Environments, see Byrne et al. 2005) audit instrument, the presence or absence of 72 cultural/community facilities, active and passive recreation facilities, and basic park infrastructure elements was recorded (see Table 1 for additional details). The richness of this data layer allowed us to characterize parks along the following dimensions: small to large, single to many recreational uses, safe-unsafe, and poor-good condition. A detailed description of this data layer can be found in Sister et al. (2006).

Table 1 List of facilities present in the parks layer database

Basic Amenities/ Facilities		**Passive Recreation**
Signs		Restaurant/Café
Water fountain		Retail
Showers		Benches
Restrooms		BBQ Equipment
Trash can		Shade Canopy
Fencing		Dog Park
Lighting (active rec areas)		Amusement (e.g. Ferris wheel)
Lighting (passive rec areas)		Water feature
Lighting (parking lot)		Beach
Parking		Marina
Kitchen/stove		Pier
		Boardwalk
		Campground
Sports/Active Recreation		**Community/Cultural Recreation**
Swimming pool		Meeting rooms, community halls
Basketball		Theater/ Amphitheater
Play Equipment		Senior Center
Tennis		Child care facility
Racquetball court		School
Handball Court		Cultural facility
Volleyball		Historic buildings
Baseball		Museum
Softball		Monument statue
Soccer		Community gardens
Football		Rose, ornamental, botanical garden
Rollerhockey		Nature center
Recreation center/gym		Interpretive (Ecology)
Physical fitness		Monument Interpretive (Cultural)
Bicycle facilities		Library
Skateboard		Youth
Walking/jogging/inline skating		
Climbing Wall		**Safety**
Equestrian trail		
Gymnastics/Par course		On-site Staff
Equipment rentals		On-site Security
Golf course		Emergency Telephones
Club House		
Horseshoes		
Backstop/Batting cage		
Shuffleboard		
Paddle tennis		
Frisbee golf		
Multi-use play/sports field		

Park data (e.g., area, facilities present) were assigned to each park service area (described above) by overlaying the park data layer onto the latter using the <identity> tool in ArcToolbox. In cases when two or more contiguous parks belong to the same park service area (i.e. enclosed in the same thiessen polygon; see preceding section), the facilities present among these parks were summed and the value assigned to the corresponding park service area.

2.4 Delineating "park service areas"

We delineated the park service areas by employing the concept of thiessen polygons and using parks as the center "point" (as outlined in Section 2.1). Thiessen polygons divide a region such that any space inside a polygon is closest to the central point, and assumes that such space takes on the attributes of that data point (Burrough and McDonnell 1998). Since a park, in itself, is a polygon (and not a point), we utilized the vertices around the perimeter of the parks as the data points, and generated thiessen polygons around these points (Figure 2a); the details of these are elaborated below.

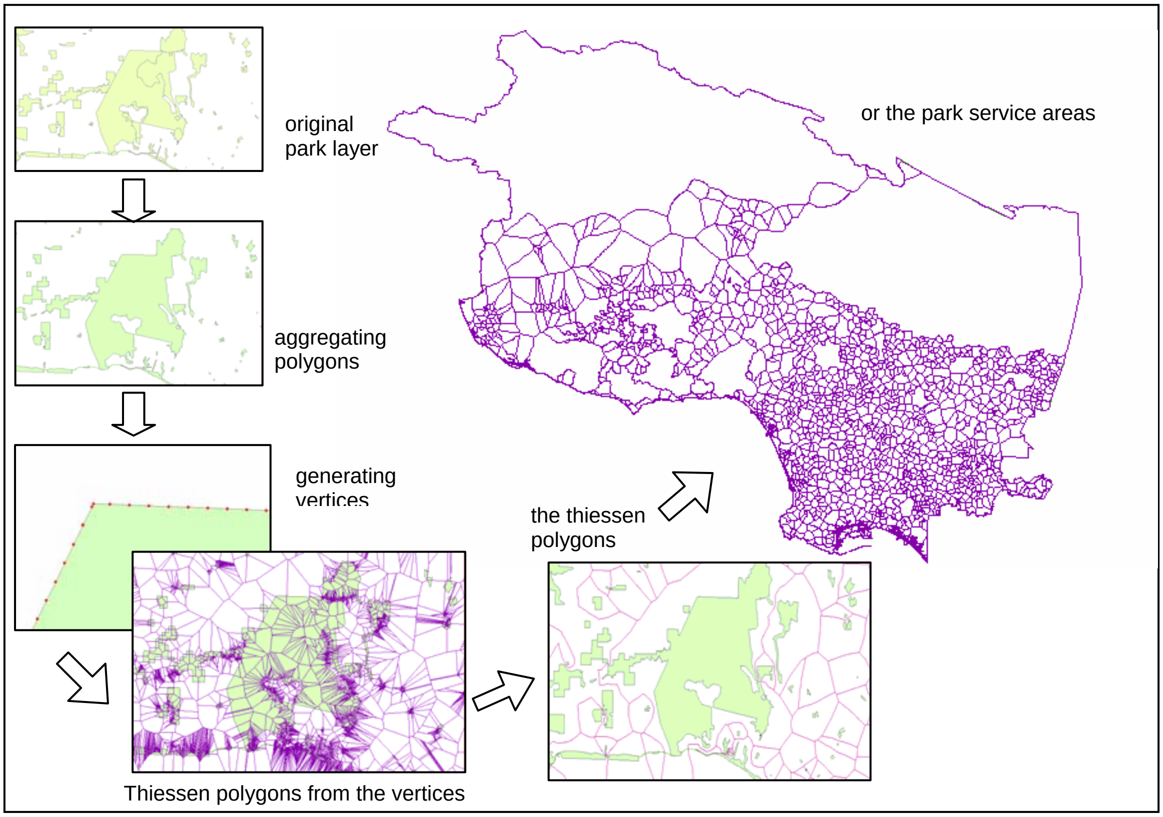

Figure 2 Schematic summarizing procedure used to generate park units and corresponding park service areas utilizing the concept from thiessen polygon

Additional vertices along the perimeter of each park were generated using the <densifyarc> command in ArcInfo. These vertices were then converted into points using <feature vertices to points> under Data Management Tools in ArcToolbox. The points were converted, in turn, into a point coverage from which the thiessen polygons were generated using the <thiessen> command in ArcInfo. Thiessen polygons belonging to the same park (that is, the vertices are from the same park), as well as those that were adjacent (i.e. parks sharing a boundary) were then aggregated using the “dissolve” function in ESRI’s ArcToolbox (Figure 2b). The result is a lattice consisting of 1,626 park service areas, with every space in the region assigned to a single park or series of two or more contiguous parks that is in closest proximity to it.

2.5 LandScan USA population data

The LandScan USA population data is a 3 arc second (approximately 90 m) population grid developed by Oak Ridge National Laboratory (ORNL). Utilizing population data from the Census as control totals, LandScan applies a “likelihood” coefficient to the census count for each LandScan cell based on key indicators of population, namely, land cover, roads, slope, and nighttime lights (Bhaduri et al. 2002). As such, LandScan USA is a more spatially refined population grid compared to the original Census 2000 data organized by census block or tract.

For the present study, we clipped LandScan to the boundaries of the study site and then converted it into an ESRI polygon coverage using the <gridpoly> command in ArcInfo. Population was assigned to each park service area by overlaying the LandScan coverage onto the park service area layer in ArcToolbox (using <identity>). Because the boundaries of the thiessen polygons did not correspond with the LandScan cells, most of the LandScan cells were split among multiple park service areas. In such cases the population counts were weighted according to the size of the area that falls inside the thiessen polygon in order to avoid over counting.

2.6 Park service area demographics

Park service areas were further described according to race/ethnicity, median household income, poverty level, and age. A data layer for each of these demographic characteristics was created by generating a continuous surface estimated from census tract data and the population distribution from LandScan. Each “demographic” surface was estimated using the pycnophylactic interpolation method (Tobler 1999). This method generates maximal smoothed surfaces by minimizing the sum of squares of all the partial derivatives of the density function across the whole area, and achieves mass-preservation by redistributing the difference between the observed mass of the source zone and its interpolated counterpart by the area of the source zone after smoothing (Cai et al. 2006). Having the property of smoothness and mass-preservation, Cai et al. (2006) demonstrated that the method can be used to calculate surface estimates for some population distribution characteristics whose boundaries are different from those from which the population counts were made. Such was especially useful when implemented in small areas where the resolution of Census data can be problematic. As implemented here, the race/ethnicity, income, poverty level, and age are the property to smooth, and the population count is the property to preserve.

After each of these demographic surfaces was created for each of the Census variables of interest, the surface was overlaid onto the park service layer in ArcToolbox to assign the demographic characteristics to the corresponding park service areas.

3. Results and Discussion

3.1 Parks

There were a total of 1,626 parks and "aggregated" parks (i.e. adjacent parks belonging to one and the same park service area; see section 2.4) apportioned to their corresponding service areas in the study site. The parks covered a total area of about 500,000 hectares (5,000 km2), ranging in size from small pocket parks of less than half a hectare in size to the large expanses of the Angeles and Los Padres National Forests. The size distribution of the parks is summarized in Figure 3.

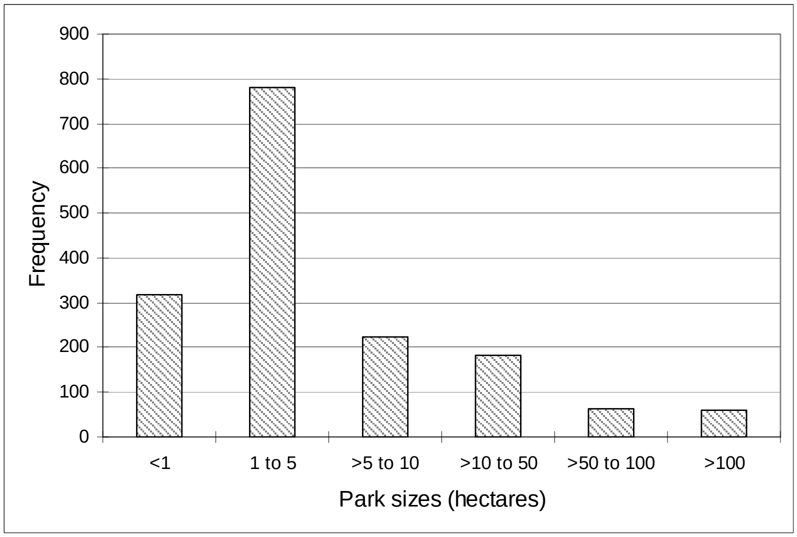

Figure 3 Size distribution of the parks

Broken down to types according to recreational uses, there were 1,466 (90%) parks and recreation areas, 72 (4%) golf courses, 49 (3%) open spaces that were State Park lands, Santa Monica Mountains National Recreation Areas and Open Spaces (referred to an "SPL/SMNR/OS" hereafter), 22 (1.4%) beaches, and 8 (0.5%) nature preserves

(Figures 4a and b). Parks and recreation areas make up the most numerous type of greenspace, but amounts to only 9% of the total park space in the region when areal extent is accounted for. Conversely, the two National Forests in the region (i.e. Los Padres and Angeles National Forests) collectively contribute 85% of park space.

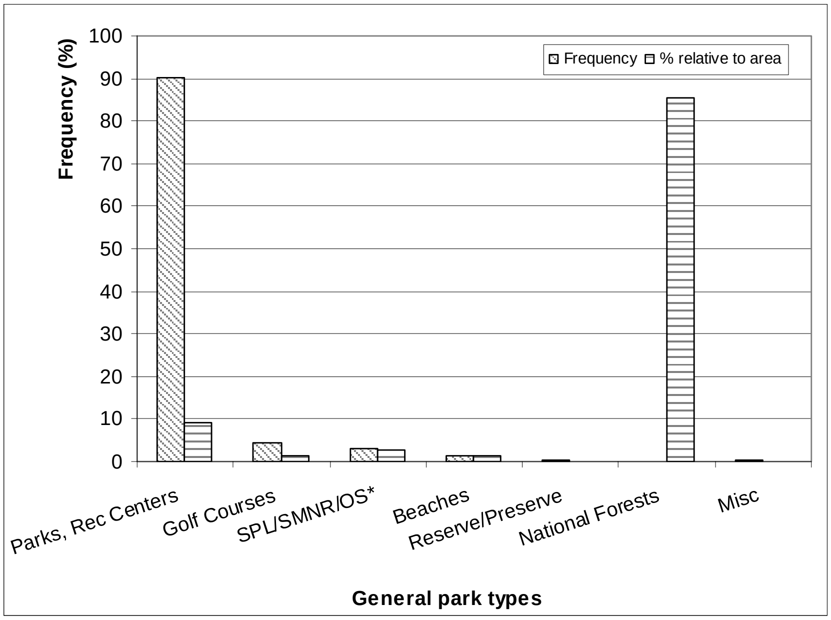

Figure 4 Histogram of the park types

3.2 Park Service Areas

We categorized the park service areas (or PSAs) according to the size of the park contained in each of them; we established six park size classes: <1, 1 to 5, >5 to 10, >10 to 50, >50 to100, and >100 hectares. Figure 5 shows the distribution of these PSAs across the region with the color-scale based on the park size contained in the PSA. Most of PSAs with smaller parks (i.e. the lighter-colored polygons in the map) were located in the metropolitan areas of the region— locations that typically have limited space, and hence greenspaces tend to be neighborhood pocket parks and relatively smaller recreation centers. On the other hand, PSAs with larger parks (i.e. these appear as dark green polygons in the map, Figure 5) tended to be in the northern portion of the region where the Angeles and Los Padres National Forests are, as well as the San Gabriel Wilderness Area are located. A second concentration of PSAs with large tracts of open space occurs on the west side (i.e. along the coast to the north and west of San Monica Bay) given the numerous State Park lands and the Santa Monica Mountains National Recreation areas scattered throughout the Santa Monica Mountains. Also appearing as darker green were some larger county and regional parks such as Griffith Park close to downtown Los Angeles, as well as golf courses scattered about the region (Figure 5).

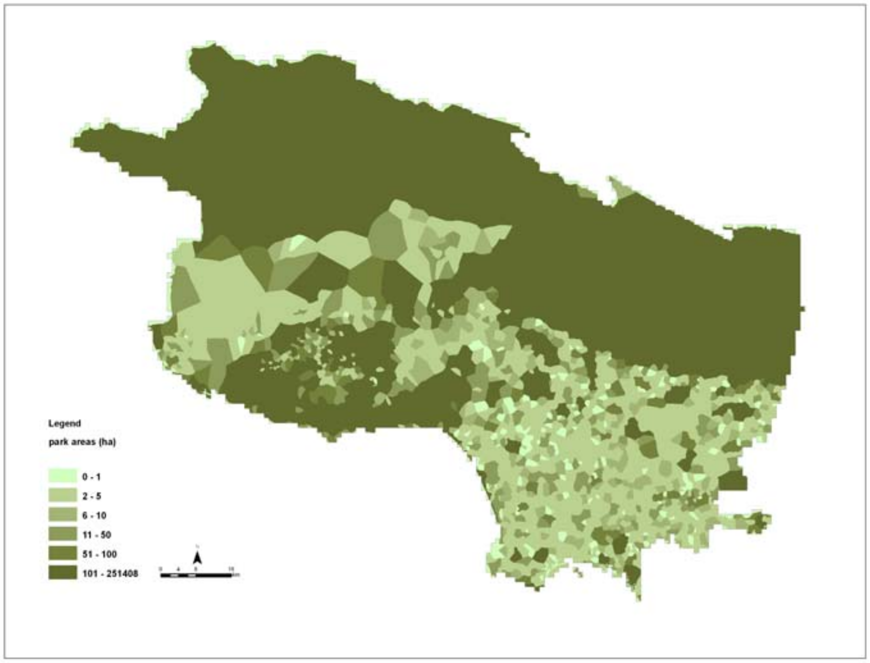

Figure 5 Map of PSA distribution as categorized into park sizes

Table 2 lists the characteristics of the park service areas (PSA) as they are organized into the six size classes of the parks contained in them. There were 338 PSAs that contained parks belonging to the <1 ha size class, making up 21% of the total number of PSAs (Figure 3) delineated in the present study. On average, there were 0.25 hectares of park area per square kilometer in these PSAs, serving 617 people per park hectare (Table 2), two to three times higher than the 247-380 people per park hectare standard recommended by the National Recreation and Park Association (NRPA). Most parks in this size-class are pocket parks that, on average, do not offer nearly as many amenities as larger parks (Table 2). There were no golf courses, forests, nature preserves or beaches in any of the PSAs belonging to this park size-class. These parks were scattered throughout the most densely settled parts of the metropolitan Los Angeles region (Figure 5).

Table 2. Facilities and park types in the park service areas, as organized per different park size classes.

	Park size classes (hectares)					
	<1	**1 – 5**	**> 5 – 10**	**>10 – 50**	**>50 – 100**	**>100**
# parks	338	760	221	184	62	61
park area (ha)	175	1,939	1,533	3,995	4,432	492,178
park ha/ km^2	0.25	2.83	2.24	5.87	6.51	726.1
persons/park ha	617	3,119	254	423	100	18
% of the facilities recorded present						
basic	4.7	21.8	10.7	13.2	11.5	20.5
active	3.4	19.4	12.4	12.1	13.1	19.6
passive	5.3	19.8	10.4	11.5	18.3	30.4
comm/ cultural	0.1	0.4	0.3	0.3	0.2	0.6
safety	1.5	9.5	7.4	8.7	7.0	16.7
Types of parks (#)						
parks & rec centers	333	746	202	127	30	28
golf courses	0	2	7	31	24	8
SPL/SMNR/OS*	0	3	5	8	2	9
forests	0	0	0	0	0	2
reserve/preserve	0	1	0	3	1	3
beaches	3	4	2	8	2	3

The majority of the PSAs (760 or 47%) had parks that were 1 to 5 hectares in size (Table 2). These parks spanned 1,939 hectares but served over 3,000 people per hectare, a ratio three times higher than the recommended national standard. On the other hand, what this park size class lacks in area, it makes up for in terms of the facilities present. These parks contained approximately 20% of the basic as well as passive and active recreation facilities listed in Table 1 on average—some of the highest percentages relative to the other park size classes (Table 2). Parks in this size range consisted largely of parks and recreation centers scattered across the metropolitan Los Angeles area, as well as in the San Fernando Valley and west Ventura areas (Figure 5).

Parks ranging in size from >5 to 10 hectares were found in 221 (14%) of the PSAs, contributing 1,500 hectares of park space (Table 2). These PSAs serve 254 people per park hectare—within the national standard range recommended by the NRPS. In addition, approximately 10-12% of basic, passive, and active recreation facilities were found, on average, in these PSAs (Table 2). Like the other PSAs, there were fewer community/cultural facilities and safety features (3 to 4%). Most PSAs in this size range also had parks and recreation areas (202) and a few had golf courses (7). These parks were mostly scattered about the greater metropolitan Los Angeles area with a few of them concentrated in the southern portion of the San Fernando Valley (Figure 5).

There were 184 PSAs (11%) containing parks that range in size from >10 to 50 hectares, covering a total area of 3,995 ha (Table 2). The ratio of people to park hectares in this PSA is 423—a little more congested than the range recommended by the NRPS (i.e. 247-380 people per park hectare). In these parks, 12-13% of the facilities for basic, passive, and active recreation were found, on average, in the parks audited. In this size range the types of greenspaces were more diverse—parks and recreation centers still make up a large proportion (127), but there were 31 golf courses, eight beaches, eight State Park and Open Spaces, as well as three ecological preserves. While these PSAs were also scattered about the region, most of the larger PSAs containing special amenities (e.g., golf courses, beaches, etc.) and were located in western portion of the study site (Figure 5).

The last two PSA classes, with parks from >50 to 100 and >100 hectares in extent, had average of people-to-park ratios considerably lower than the national standard; that is, park pressure was considerably lower in these PSAs compared to the remainder of the study site. There were 100 PSAs (6%) with parks ranging from >50 to 100 hectares in size. These parks cover 4,431 ha and currently serve 99 people per park hectare (Table 2). Eighteen percent of the facilities for passive recreation were recorded, on average, at the parks in these PSAs; along with 12-13% of the basic, passive, and active recreation facilities. Majority of the greenspaces were golf courses making up 46% of the total, and scattered about the region (Figure 5). Parks and recreation centers made up 31%, open spaces (i.e., SPL/SMNR/OS) made up 9.2%, and beaches 6.2%.

There were 61 PSAs (4%) with park sizes of > 100 hectares. The parks in these PSAs cover 480,000 ha and serve just 8 people per park hectare (using the same logic used for the other PSAs). This size class had the largest numbers and variety of facilities compared to the other PSAs. Thirty percent of the passive recreation facilities on our list were, on average, encountered in this group of parks for example. This size class included numerous state parks, national recreation areas and designated open spaces (21; 35% of parks), golf courses (8, 13%), and beaches (3, 5%) in addition to the traditional park and/or recreation center (28; 47%). The 60 PSAs in this class were concentrated along the northern and southwestern margins of the study site (i.e. Los Angeles Metropolitan Region) which is of course not surprising given earlier comments.

3.3 Levels of Park Pressure

We organized the parks according to four classes of "park pressure" (i.e. potential population served per park hectare); these are in the order of least to highest park pressure: <250, >250 to 400, >400 to 1000, and >1000 people per park acres and will be referred to as "low", "mid", "high", and "very high" in the discussion that follows. Table 3 presents some characteristics of each of these park pressure classes.

Table 3 Characterization of the population served in park service areas as organized into different levels of park congestion.

	Persons served per park hectare			
	<250	**>250 – 400***	**>400 – 1000**	**> 1000**
# parks	421	112	319	774
park area (ha)	480,285	1,252	4,162	18,482
park ha/km^2	56.5	4.7	0.4	0.5
Racial/ethnic composition (%)				
White				
Hispanic				
Black				
Asian				
Other				
Economic characteristics				
Med Household Inc				
Poverty	8.8	11.7	11.7	13.9
% of the facilities recorded present				
basic	13.2	24.6	7.3	7.5
active	10.2	9.3	10.9	7.9
passive	12.5	10.8	12.2	7.8
community/ cultural	3.5	3.5	3.9	3.2
safety	6.7	3.3	5.6	4.5
Types of parks (#)				
parks & rec centers	289	102	307	768
golf courses	59	4	5	4
SPL/SMNR/OS*	23	2	2	0
forests	2	1	0	0
reserve/preserve	7	1	0	0
beaches	19	0	2	1

There were 421 PSAs (26%) with parks serving less than 250 people per park hectare—that is, the available park space is higher than the recommended level. While this park class made up a quarter of the greenspaces in terms of number, the areal extent of the parks totaled 480,000 hectares or 96% of the total park area. The average park size is 1,188 ha and the median is 17 ha, reflecting the large tracts of State parklands, Santa Monica Mountains National Recreation Areas, and designated open spaces. A good number of these greenspaces are also golf courses, neighborhood parks and sports recreation areas. Across all the amenities (i.e. basic, active, passive, cultural, safety), these low density PSAs were highest in terms of the average number of facilities present in any given park (Table 3). These PSAs dominate the north and west parts of the study site (Figure 6). Residents of the low-pressure PSAs are predominantly white, with a median household income of $41,485—second highest after the mid-density PSAs. Less than 9% of the households have incomes lower than the federal poverty threshold—lowest compared to the other PSAs.

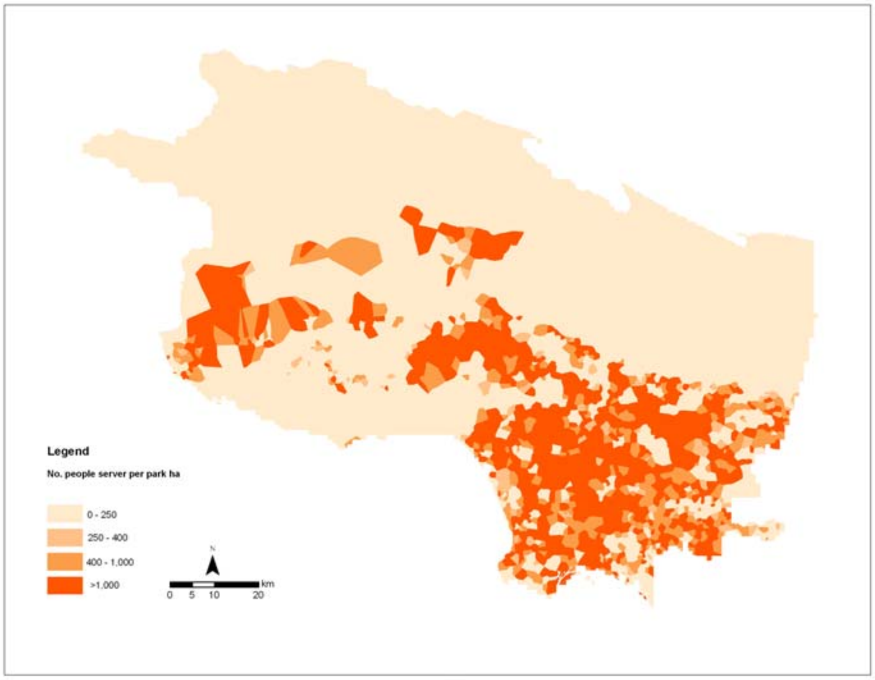

Figure 6 Map of PSA distribution as categorized into park sizes

The mid-density PSA class range (>250-400 people per park hectare) approximates the recommended 6.5 to 10 acres per capita, or 247-380 people per park hectare. There were 112 of these PSAs making up 7% of the service areas in the region in terms of number, and less than 3% in terms of area (1,252 ha). The parks in this class average 7 ha with a median of 5 ha (Table 3). The greenspaces within these PSAs were mostly recreational parks and a few are golf courses having an average of 9-25% of the basic, passive, and active recreation facilities on our checklist (Table 1). Most of these PSAs are located along the coastlines as well as the foothills (Figure 6), neighborhoods which are predominantly white and affluent. Median household income was highest across all the density classes at $42,169. Nine percent of the households have incomes lower than the federal poverty threshold.

There were 319 PSAs that belonged to the high park pressure class (>400 to 1000 people per park acre) —or 20% of the PSAs in the region. In terms of areal extent, the parks cover 4,161 ha, contributing less than one percent of the region’s parklands. Parks in these PSAs are largely neighborhood parks and recreation centers averaging 5 ha in area (median = 4 ha). Seven to 12% of the basic, passive, and active recreation facilities on our list were recorded for the parks in these PSAs. Forty-six percent of the PSAs were white, while 32% were Hispanic. The highest relative percentage of Asian-Americans (16%) belongs to this high density park pressure class. Median household income was $37,000 and 13% of the households have incomes lower than the federal poverty threshold.

Forty-eight percent or 774 of the parks in the region serve more than 1,000 people per park hectare. The parks in this very-high park pressure class have a total areal extent of

18,482 ha. The parks in these PSAs are largely small pocket parks, with an average 2.0 ha and a median of 1.4 ha. On average, we recorded 7-8% of the basic, passive and active recreation facilities in our checklist from among these parks. Relative to the other parks in the region, facilities for both passive and active recreation were lowest in these highly congested PSAs. These very-high pressure PSAs are largely located in the metropolitan Los Angeles region, as well as in the northern portion of Ventura County south of the foothills of Los Padres National Forest. This group of PSAs is the most racially-mixed; neighborhoods belonging to this PSA were largely Hispanic (39%), while Whites make up 35%. This pressure class has the highest percentage of African-American (10%) across the different classes, and the second highest in terms of Asian-Americans (13%). Median household income was lowest ($32,839) compared to the other PSAs, and 27% of the households have incomes lower than the federal poverty threshold.

Figure 7 is a plot of percent racial/ethnic composition versus park pressure class. The four sets of histogram bars show that the Hispanic and African-American, and to a lesser extent, the Asian-American populations, are more likely to be encountered in those parts of the study site currently served by congested parks, and that white populations tend to be more likely encountered in areas where there are less people per park hectare.

4 Discussion and Conclusions

Most of the previous studies of this type have been either confined to detailed investigations of smaller areas (e.g., at the municipality level or on a select few parks) or to extensive studies covering more parks, but in much less detail. The park information presented and utilized here is, to date, the largest most detailed and comprehensive park database assembled for the Los Angeles Metropolitan region. Based on a consistent methodology and set of definitions for facilities and amenities in parks in the region, it affords a consistent language of comparison across different locales in the region.

The results of the present analysis confirm the trends presented by others for smaller areas or with less complete datasets. In the larger Los Angeles metropolitan region, there exist disparities between the location of parks resources and the locations of populations that are disadvantaged and in most need. On one hand are smaller parks located in densely populated inner city neighborhoods, while on the other hand are large tracts of open spaces as well as rolling greenspaces in areas that are sparsely populated. In a sense, Los Angeles is not really park-poor; rather, there exists a classic mismatch where resources are aplenty in places where the intended users are a few, and vice versa.

The paucity of parks in the region is a largely an inner city problem and one that disproportionately affects people of color and those with low incomes. The unequal distribution of park resources can be attributed, in part, to a city's historic development (Wolch et al. 2005). Los Angeles, for example was developed with the conscious effort towards low-density housing, with residents owning their private gardens (Fulton 1997). This, coupled with the passing of Proposition 13, which favored sales-tax-generating land uses, resulted in the decline of public spending for public parks (Galen 1982, Wolch et al. 2005). The creation of recreational open spaces was then relegated to private developers who proceeded to build clubhouses, swimming pools, and playfields inside gated suburban communities.

Inequity in park access is also rooted in historical patterns of racial oppression and discrimination (Floyd 2001, Wolch et al. 2005). For example, the City of Los Angeles'

1904 zoning code protected the affluent, predominantly White Westside from industrial uses. On the other hand, past discrimination in housing and employment, and industrial racism in the siting of undesirable land uses left the low-income and minority neighborhoods side by side and downwind of undesirable land uses, such as factories, industries, toxic storage, and disposal facilities (Weiss 1987, Pulido 2000, Pastor et al. 2001) and largely lacking in terms of parks and open space.

To some extent, the mismatch is, in part, also borne out of the natural topography of the region, exacerbated by real estate law of supply and demand. The mountain ranges to the north and west of the region are large expanses of public open spaces, but are largely inaccessible to the residents of the inner cities who have limited or no access to a car. And if “accessibility to a park” is defined as the half-mile distance (or less) to swing by a park on an afternoon or weekend, these large tracts of forests and shrublands can hardly qualify as accessible open space to a large number of the populace except for the few who could afford to live in adjacent highly-priced real estate settings.

While we are able to present trends from the present analysis, further detailed analysis of the parks in the region was largely limited by the constraints imposed by information from the two types of survey efforts employed to collect the data. The dataset was based on two types of survey efforts—field and web audits (see Sister et al. 2006 for a detailed discussion of the audit effort). Considering the vast size of the study area, field audits were carried out on a representative sample (i.e. 10-15%). In order to complement the representative field surveys, an exhaustive web audit was carried out. The web audits afforded information on 95% of the total parks (i.e. a number of the cities do not have websites, or have websites that do not list park resources). Because of the larger coverage of the website audits in terms of number of parks surveyed, we relied on this particular dataset in this paper. However, while the web audits had a larger coverage of parks audited, it should be noted that the absence of a particular facility in a park web site does not necessarily mean that such facility is indeed not present in the park; that is, the *non*-mention of a facility in websites could mean two possibilities: (1) the facility is absent; or that (2) the facility is present, but the *website* failed to mention the presence of such a facility. The absence of a facility on a park website therefore does not confirm its absence or presence in the parks (the issue is further discussed in detail in Sister 2006). In addition, there was some information that was difficult to ascertain from websites. Equity and accessibility analyses could be enhanced with data on mobility and access points. Such information is not always included on park and recreation websites.

The present analysis reported here provides a framework on which web-based decision support tools will be created. In brief, the web-based tools takes on the park service areas created here as one of its base layers. The tool will have a user-enabled capability to select specific parcels (e.g. brownfields and vacant lands) as candidates for "building" new parks. Using park pressure information from the park service layer, the tool quantifies how the new configuration resulting from an additional park changes congestion levels in the immediate neighborhood around the proposed park site and the existing park service areas. Such tools will offer the opportunity to gather information on both the benefits and costs when planning new park sites.

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References

Bhaduri, B., Bright, E., Coleman, P., and Dobson, J. 2002. LandScan: Locating people is what matters. *Geoinformatics* 5(2): 34-37.

Burrough, P. A., and McDonnell, R. A., 1998. *Principles of Geographical Information Systems*. Oxford University Press, New York, NY

Byrne, J., Wolch, J., Swift, J and Ryan, C. 2005. *SAGE (Systematic Audit of Green-space Environments): Audit Form and Instructions*, University of Southern California Center for Sustainable Cities, Los Angeles, California.

Cai Q 2006 Estimating small-area populations by age and sex using spatial interpolation and statistical inference methods. *Transactions in GIS*

Floyd M. 2001 Managing national parks in a multicultural society: searching for common ground. *The George Wright Forum* 18(31): 41-51

Fulton W 1997 *The Reluctant Metropolis: The Politics of Urban Growth in Los Angeles.* Solano Press, Point Arena, Calif

Galen C 1982 The *Politics of park design, A history of urban parks in America*. The MIT Press, Cambridge, Mass.

Lindsey G, Maraj M, Kuan SC 2001 Access,Equity,and Urban Greenways: An Exploratory. *The Professional Geographer* 55 (3): 332-346

Nicholls S 2001 Measuring the accessibility and equity of public parks: a case study using GIS. *Managing Leisure* 6: 201-219

Pastor M Jr 2001 Racial/ethnic inequality in environmental-hazard exposure in Metropolitan Los Angeles. CPRC Brief 13(2)

Pulido 2000 Pulido, L. 2000 Rethinking environmental racism: white privilege and urban development. *Annals of the Association of American Geographers* 90(1): 12-40

Sister C, Linder A, Seymour M, Wilson J, Wolch J, Byrne J, and Swift J *in progress Parks and Open Space Resources in the Green Visions Plan Area*. University of Southern California GIS Research Laboratory and Center for Sustainable Cities, Los Angeles, California

Talen E 1998 Visualizing fairness: Equity maps for planners. *American Planning Association Journal*. 22-38

Tobler W R 1979 Smooth pycnophylactic interpolation for geographic regions. *Journal of the American Statistical Association 74: 519-30*

Weiss M 1987 *The Rise of the Community Builders*. Columbia University Press, New York, NY

Wolch J, Wilson J P, Fehrenbach J. 2005. Parks and Park funding in Los Angeles: An equity-mapping Analysis. *Urban Geography 26 (1): 4-35*