Assessing Urban Green Spaces in Berkeley, California as an Equity Mechanism

Meghan Chau Cruz

ABSTRACT

Green spaces are natural or man-made areas that have tree coverage and/or grass/herbaceous coverage. In contrast, urban environments are typically population dense with man-made infrastructure that is conducive to artificial warming, rainwater runoff, and air flow patterns that trap nonpoint source pollution. Green spaces in urban environments have the potential to provide space for environmental pollution mitigation, community cohesion, mental health improvement, physical fitness development, and biosphere regulation. There currently exists a gap in knowledge about quantitative analysis for urban green spaces, as well as a causative relationship between green spaces and improved public health measures. Through geo-spatial analysis using iTree and ArcGIS, I assessed the urban green space coverage in amount, type, quality, frequency, and accessibility to determine if there is a relationship with median household income in Berkeley, CA. I found a positive association between the two study variables, and I also conducted a case study with the U.S. Census tracts to explore social distancing potential for urban green spaces within a ½ mile radius of the perimeter. The lowest median household income census tract, $30,494-46,432, had the least amount of accessible green space while the highest median household income census tract had the most amount of accessible green space. These findings suggest a need for further quantitative and qualitative research surrounding urban green spaces within the context of environmental justice and public health.

KEYWORDS

environmental justice, accessibility, geographic information systems, public health, income

INTRODUCTION

As population-dense urban areas are subject to more rapid development, this can lead to gentrification and subsequently, greater health inequities for poorer populations that are displaced (Zuk et al. 2017). Fortunately, increasing the number of open green spaces and improving access to green spaces can facilitate goals of environmental justice and ultimately, more equitable health outcomes (Jennings et al. 2012). Green space is defined as "land that is partly or completely covered with grass, trees, shrubs, or other vegetation" in an urban area (EPA 2017). Therefore, green spaces should be prioritized in urban planning due to their inextricably linked benefits to public health.

The Center for Disease Control and Prevention (CDC) defines conditions that are known to impact health risks and outcomes are known as the social determinants of health (CDC 2020). Social determinants of health may include access to quality healthcare, access to quality education, the sociability of community, economic stability, and the built environment. Green spaces fall under the category of the built environment and access to green spaces can have positive physical and psychological effects on the population as the environment mitigates air pollution, reduces noise, and keeps population stress levels at a manageable level (Braubach 2017). Moreover, in studies such as Braubach (2017), researchers pointed out that proximity to green spaces had an impact as well on the intensity of benefits.

Further, ecological benefits can be derived from Biodiverse Urban Green Spaces (BUGS), which create the potential to greatly impact immune health in humans by exposing the population to a variety of microorganisms (Flies et al. 2017). However, there is a gap in knowledge about the relationship between the environmental and human microbiomes and which components of the environmental microbiome have the biggest effect on the human microbiome is unknown. Although Flies et al. (2017) lacked empirical evidence, it made the case for the prioritization of green spaces in urban areas through current events.

Finally, a cross-sectional study reported that populations with an abundance of green space in close proximity (within 3 km) had lower treatment incidence for anxiety and mood disorders, suggesting that green spaces may help protect against negative mental health instances (Nutsford et al. 2013). Furthermore, there are also associations between the treatment count and green space accessibility. Researchers concluded that decreased distance to green spaces and increased frequency of green spaces decreased the overall anxiety and mood disorder treatments for the study population. As an ecological study, only population conclusions could be made and researchers recognized that the number of anxiety or mood disorder treatments was most likely an underestimate as treatment first requires a diagnosis of a mental health illness. Nutsford et al. 2013 adjusted for socioeconomic status and geographic location of participants, as both factors play a role in mental health, ultimately contributing to the value of green spaces.

Overall, there is a gap in knowledge surrounding the causal relationship between green spaces and public health. However, there is strong evidence to support this relationship. The acknowledgment of the reality surrounding the current state of research is motivation to further advocate and explore the longitudinal benefits of these green spaces.

A case study: Berkeley, California

Berkeley, California has a diverse population dynamic as the city consists of undergraduate students, graduate students, and residents, resulting in a mix of varying demographics. In April 2021, the occupation of People's Park, a well-known green space for homeless individuals, sparked controversy as the University of California, Berkeley attempted to reclaim the land for housing projects (Ruggiero 2021). Connected to this controversy is the stark wealth gap that exists in the city, which is further motivation to understand the equity of accessibility, quality, and amount of green spaces. Additionally, as a student, I am aware of multiple housing complex constructions in progress, suggesting that the city population is growing. Growing populations is just one more reason to preserve and maintain green spaces for communities.

Green spaces in a world of coronavirus

As I write this Spring 2021 senior thesis, the world is still experiencing the devastating effects of the novel Coronavirus with India being hit the hardest in the current state of the pandemic. As per CDC guidance, six feet apart is considered a safe distance from people outside of your household. I apply this distance buffer to the green spaces surface area to determine if communities with access have enough space to social distance properly during the pandemic. I chose to give my senior thesis context with COVID-19 to understand how green spaces could impact health as the United States is seeing a disproportionate impact on low-income people of color. Based on my literature review, I found that green spaces during COVID-19 could have (1) positive effects on mental health, (2) promote good physical health, (3) regulate air quality and temperature and (4) act as a buffer for lockdown. I postulate that enough space to social distance may have profound implications on disease transmission and mental health in the community.

In this study, I will use the U.S. Census demographic and geospatial data to estimate the types, frequency, and quality of green spaces for Berkeley, CA with the objective to determine whether there is a relationship between median household income and green spaces.

METHODS

Visualizing green spaces

Green spaces exist in the form of tree canopies, parks, fields, community gardens, marinas, lawns, street medians, and curbsides. To better understand green spaces, I sorted green spaces into two categories: formal and informal spaces. Formal spaces are what we traditionally imagine green space to be, such as parks and fields. In contrast, informal spaces are unconventional green areas like gardens on medians. Both contribute to the benefits of green spaces and neither is more important than the other, however some are less publicly accessible. .

Using the Trust for Public Land ParkServe data on ArcGIS, I visualized the formal public green spaces within the city of Berkeley (The Trust for Public Land 2018 and Esri 2021). This dataset was particularly useful in gaining a holistic understanding of the spread and distribution of green land area in Berkeley, CA before analyzing case studies.

By applying the vector shape and measure tool in ArcGIS, I calculated the total area in acres for each specified formal green space identified by the prior data set and noted the jurisdiction, such as the city of Berkeley. I chose to exclude the Aquatic Park and Berkeley Open Space from census tract calculations because they were much larger than any other green space under the City of Berkeley. Additionally, I chose to exclude McLaughlin Eastshore State Park and Tilden Regional Park from census tract calculations as they were not under the jurisdiction of the City of Berkeley.

Finally, to understand overall coverage, I utilized i-Tree, which classified land cover through GIS technology and randomly selected pinpoints on a satellite map layer (USDA Forest Service 2006). Each colored pinpoint is linked to a type of cover class: grass/herbaceous, impervious buildings, impervious other, impervious road, soil/bare ground, tree/shrub, and water. For the city of Berkeley, I categorized the cover of 200 randomly generated points within Berkeley as a control to compare with three study sites.

City of Berkeley study sites

I chose three study sites after reviewing U.S. Census tracts in the city (City of Berkeley 2021). To determine the study sites, I created a layer of median household income per census tract to visualize the income distribution for the city (Figure 1). I ensured that the study sites were not only varying in median household income but also far away enough from each other so that the radius of accessibility (0.5 miles) would not overlap (Table 1, Figure 2). For each study site, I created 0.5 mile radius vector circle shapes on the perimeter of each census tract on ArcGIS to simulate accessibility for green spaces (Figure 3).

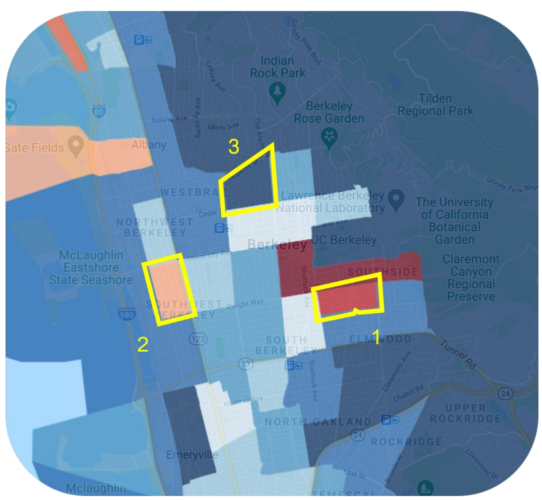


Figure 1. Mapped study sites. Chosen study sites are the highlighted census tracts based on median household income as well as geographic location in the city. The dark red color signifies low income, the orange signifies middle income, and the dark blue significant higher income.

Table 1. Summary of study sites. Data was collected from the U.S. Census reports.

Study Site	Census Tract	Population	Median Household Income	Largest Racial Group
City of Berkeley	N/A	120,926	$80,912	White
1 - South Berkeley	4236.02	5,659	$30,494-46,432	Non-white
2 - West Berkeley	4232	2,794	$21,570-72,372	Non-white
3 - North Berkeley	4218	2,007	$109,987-144,513	White

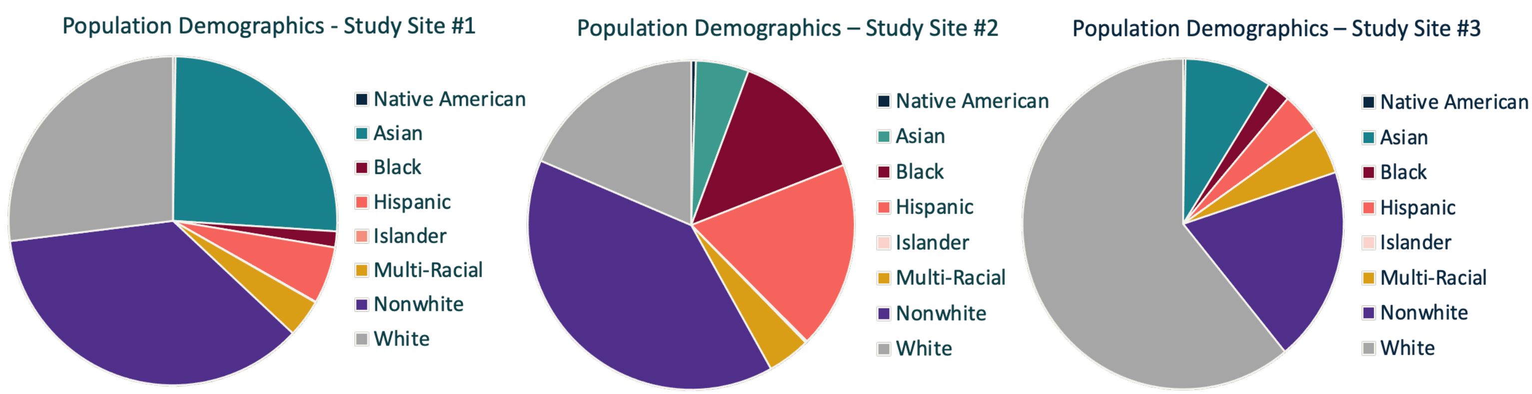


Figure 2. Study site information. Data in the table and pie charts related to census tract number, population, median household income range, and racial or ethnic makeup.

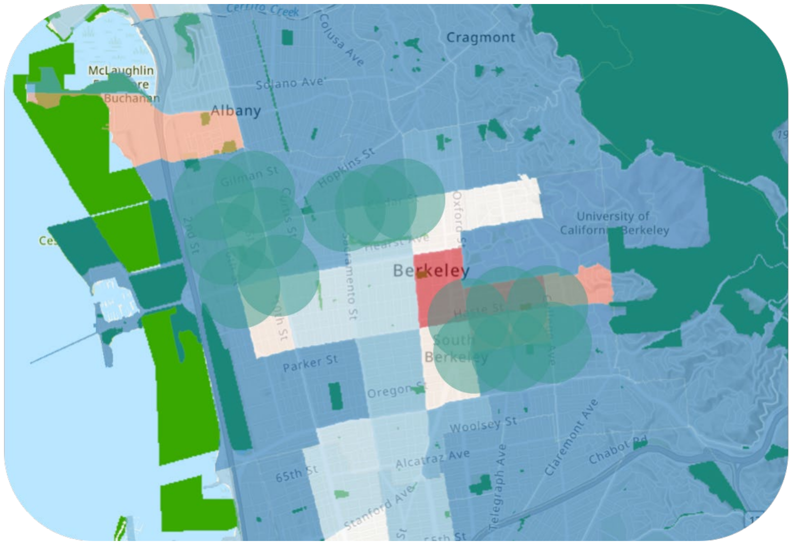


Figure 3. Accessibility for each census tract. Circle vector shapes with 0.5 mile radii were placed along the perimeter of each census tract study site to simulate accessibility for residents (green translucent circles) overlaid on the median household income census tract map layer and ParkServe layer.

Median household income and green spaces

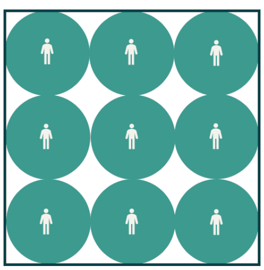
To explore further, I examined how household income could explain the amount of green space in acres. I first calculated total green space acreage by household income and then graphed the number of census tracts by household income to see if there was a similarity in shape between the two. After doing so, I realized that the number of census tracts by household income was not the same (Table 2). So, I separated the census tracts into four even bucket groups instead: upper quarter, upper middle quarter, lower middle quarter, and lower quarter so that I could more directly compare my results.

Table 2. Initial median household income ranges in bins. Unfortunately, these bins were varying in sizes so I had to re-bin the data into quarters instead.

Classification	Income Range (in U.S. dollars)
Top 5%	150000 or more
Upper	100000-15000
Upper Middle	67500-10000
Lower Middle	35000-67500
Lower	35000 or less

Green spaces in a world of coronavirus

Using the CDC and WHO guidance of six feet of social distancing as of 2019, I calculated the maximum person capacity per acreage of accessible green space for each study site to determine the effectiveness of green spaces in our current reality (Figure 4).



6 feet apart = 36π ft^2 per person

Formula for acre to sq ft = 3860.08 times 43560

Divide by $36\ \pi$ ft^2 = max capacity

Round down for people! ==> 1,486,728

City of Berkeley population = 121,485

Figure 4. Graphic representation of social distancing. Proper radii per individual within a confined space is required for social distancing within CDC guidelines. To the right of the graphic is the breakdown of the quantitative analysis applied to the City of Berkeley and the three study sites.

RESULTS

The City of Berkeley

The city of Berkeley has a median household income spread that is relatively high, as shown by the darker blue census tracts surrounding the University of California, Berkeley (Figure 3). Nonwhite, White, and Asian are the three largest racial and ethnic groups as shown by purple, grey, and teal sections of the pie charts (Figure 2). After calculating the total acreage of the city of Berkeley and the total formal green space acreage, I found that 9.13% of the City of Berkeley is formal green space (Table 3).

Table 3. Formal identified green spaces. Each space is classified within the City of Berkeley jurisdiction and the associated acreage is listed. Rows highlighted in red signify exclusion from calculations.

No.	Green Space Name	Acres	Jurisdiction
1	Presentation Mini-Park	0.11	City of Berkeley
2	Marina Mall	0.12	City of Berkeley
3	Becky Temko Tot Park	0.16	City of Berkeley
4	Prince St Mini-Park	0.16	City of Berkeley
5	Contra Costa Park	0.17	City of Berkeley
6	Solano-Peralta Park	0.17	City of Berkeley
7	Grizzly Peak Park	0.2	City of Berkeley
8	Charlie Dorr Mini-Park	0.21	City of Berkeley
9	Mortar Rock Park	0.28	City of Berkeley
10	Berkeley Way Mini-Park	0.34	City of Berkeley
11	Virginia-McGee Totland	0.36	City of Berkeley
12	Grotto Rock Park	0.39	City of Berkeley
13	George Florence Park	0.5	City of Berkeley
14	Contra Costa Rock Park	0.63	City of Berkeley
15	Great Stoneface Park	0.7	City of Berkeley
16	Horseshoe Park	0.83	City of Berkeley
17	Adventure Playground	0.85	City of Berkeley
18	Terrace View Park	0.93	City of Berkeley

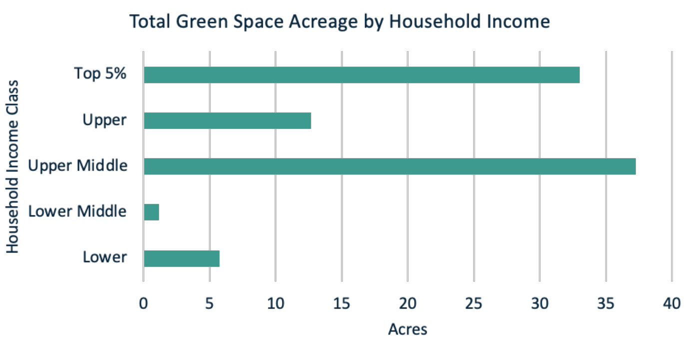
19	Dorothy Bolte Park	0.98	City of Berkeley
20	Indian Rock Park	1.09	City of Berkeley
21	Remillard Park	1.74	City of Berkeley
22	Willard Park	2.57	City of Berkeley
23	People's Park	2.75	City of Berkeley
24	MLK Memorial Park (Civic Center)	2.98	City of Berkeley
25	Grove Park	3.12	City of Berkeley
26	Cragmont Rock Park	3.16	City of Berkeley
27	Strawberry Creek Park	3.3	City of Berkeley
28	James Kennedy Park	3.73	City of Berkeley
29	Berkeley Rose Garden	3.77	City of Berkeley
30	Cedar-Rose Park	4.38	City of Berkeley
31	John Hinkel Park	4.62	City of Berkeley
32	Live Oak Park	4.88	City of Berkeley
33	Glendale-La Loma Park	5.55	City of Berkeley
34	Harrison Park	5.58	City of Berkeley
35	Ohlone Park	9.08	City of Berkeley
36	Codornices Park	9.16	City of Berkeley
37	San Pablo Park	11.36	City of Berkeley
38	Aquatic Park	97.59	City of Berkeley
39	Berkeley Open Space	424.86	City of Berkeley
40	Eastshore State Park	1167.72	State of California
41	Tilden Regional Park	2079	East Bay Regional Park District

City of Berkeley = 6720 acres *9.13% of Berkeley is Green Space*

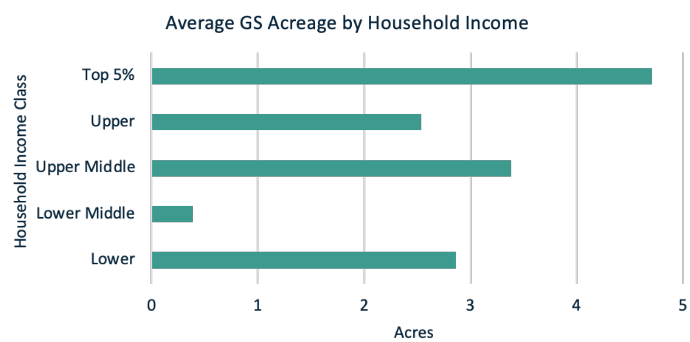
Median household incomes and green spaces

I realized that the number of census tracts by household income was not the same so I decided to bin my data (Figure 5). Therefore, I binned the median household incomes into equal quartiles. After regraphing the data, I found that the upper quarter household income had cumulatively and on average, more green space than the other quarters (Figure 6). Finally, I graphed median household income on a continuous axis against green space acreage to establish whether a relationship between the two variables existed. I calculated an R^2 value of 0.0265 (Figure 7).

(a)



(b)



Classification	Income Range (U.S. dollars)
Top 5%	150000 or more
Upper	100000-15000
Upper Middle	67500-10000
Lower Middle	35000-67500
Lower	35000 or less

(c)

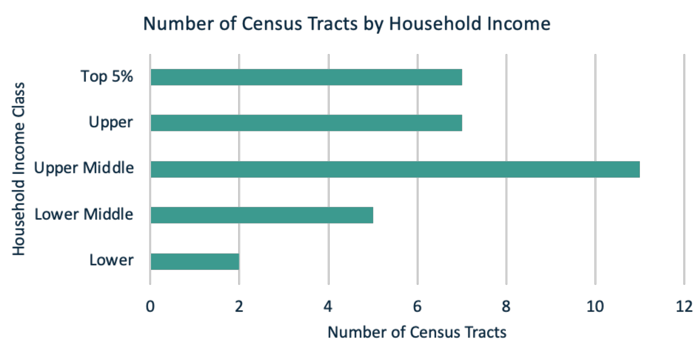


Figure 5. Green space by household income. Initial Median Household Income bins visualization of green space acreage and frequency. (a) Total green space in acres by household income. (b) Average green space in acres by household income. (c) Number of census tracts by household income.

(a) **(b)**

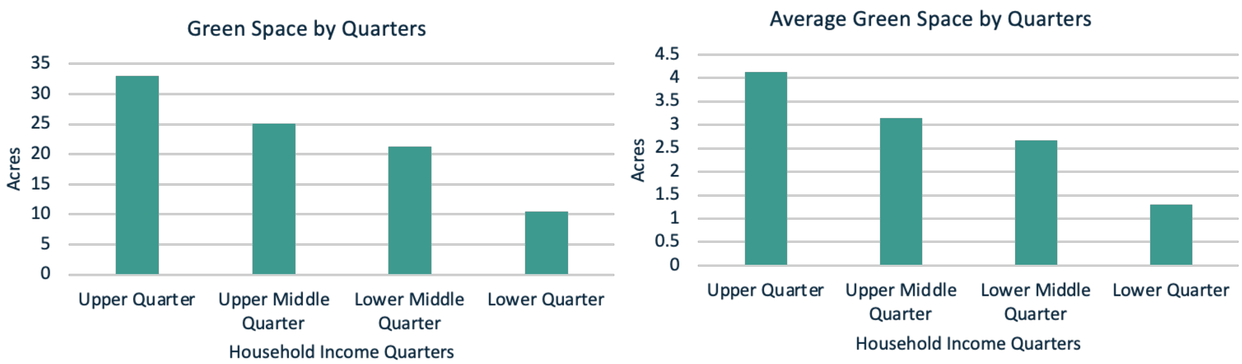


Figure 6. Green space acreage by household income. Census tracts split up into four even median household income bins. (a) Green space in acres by household income quarters. (b) Average green space in acres by household income quarters.

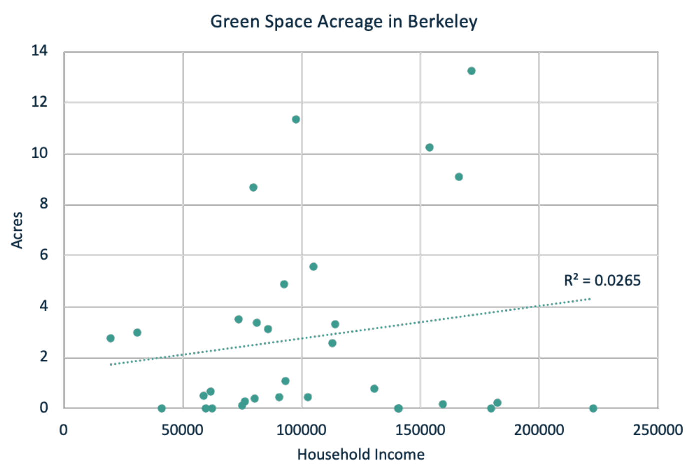


Figure 7. Graph of green space acreage in Berkeley. Median household income graphed compared to green space acreage to explore a possible relationship between the two variables.

i-Tree Canopy

For each study site, I used i-Tree to estimate coverage and then compared it to the City of Berkeley statistics. North Berkeley has the most grass/herbaceous and tree/shrub cover. South Berkeley has the most impervious buildings (IB), with over 45% of the randomly sampled points categorized as IB with over 70% of the remaining points being impervious other (IO) or impervious road (IR) (Figure 8).

Overall, the cover class from highest to lowest percentage for the city of Berkeley was impervious buildings (IB), tree/shrub (T), water (w), impervious road (IR), impervious other (IO), soil/bare ground (S), and grass/herbaceous (H). For South Berkeley, the cover class from highest to lowest percentage was impervious buildings (IB), imperious road (IR), impervious other (IO), tree/shrub (T), grass/herbaceous (H), and soil/bare ground (S). For West Berkeley, cover class from highest to lowest percentage was impervious buildings (IB), impervious road (IR), impervious other (IO), tree/shrub (T), grass/herbaceous (H), and soil/bare ground (S). For North Berkeley, cover class from highest to lowest percentage was impervious buildings (IB), impervious road (IR), impervious other (IO), tree/shrub (T), grass/herbaceous (H), and soil/bare ground (S).

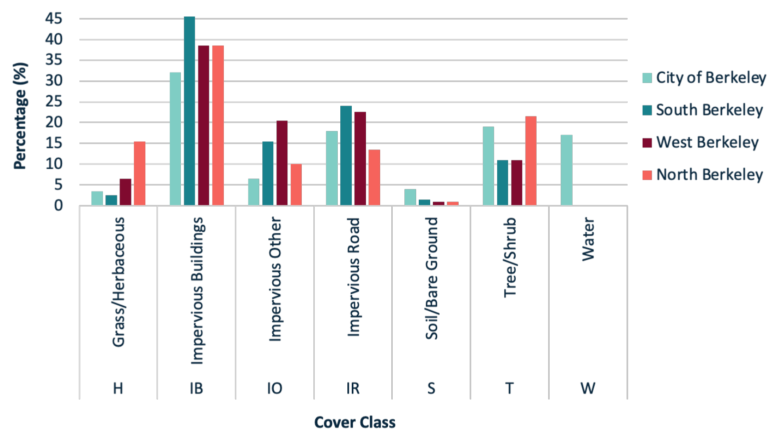


Figure 8. i-Tree coverage results. Cover classifications for the City of Berkeley and the three study sites.

City of Berkeley study site comparisons

Compared to the City of Berkeley statistic of 9.13% of coverage being classified as green space, all three sites surpassed city-wide percentage (Figure 11). But study site #3 has almost double the amount of green space acreage in proportion to the tract acreage for study site #1. Study site #2 has almost as much green space acreage in proportion to the tract acreage compared to study site #3 which was unexpected as the gap in median household income was over $30,000.

Table 4. Study site comparison. Chart comparing study sites' green spaces frequency, accessible acreage, census tract acreage, and the green space acreage as a proportion of the tract acreage.

Study Site Name	# of GS within ½-mile radius	Acres of GS within ½-mile radius	Census Tract Acreage	GS acreage as a proportion of the tract acreage
Study Site #1: Census Tract 4236.02 "South Berkeley"	6	11.42	97	11.77%
Study Site #2: Census Tract 4232 "West Berkeley"	7	19.44	112.12	17.34%
Study Site #3: Census Tract 4218 "North Berkeley"	8	21.04	110.1	19.11%

Green spaces in a world of coronavirus

I found that the higher median household income study sites allowed for higher maximum person capacity (Table 5). Additionally, the maximum person capacity for acres of Green Space within a ½ mile radius of each study census tract surpassed the census tract population for only the study site with the highest median household income. Study site #1 and #2 had more people per census tract than the green spaces, within the accessibility radius, could handle.

Table 5. Study site comparison of green space capacity. Maximum person capacity per total green space accessible by each study site.

Study Site Name	Census Tract Population	Acres of GS within ½-mile radius	Max Person Capacity per Total GS
Study Site #1: Census Tract 4236.02 "South Berkeley"	5,659	11.42	Approx. 1,400
Study Site #2: Census Tract 4232 "West Berkeley"	2,794	19.44	Approx. 2,383
Study Site #3: Census Tract 4218 "North Berkeley"	2,007	21.04	Approx. 2,579

DISCUSSION

Findings

City of Berkeley study sites

Berkeley has at least 41 formal green spaces and a variety of informal spaces. North Berkeley has the most trees, shrubs, grass, and herbaceous cover derived from iTree. North Berkeley, as a region, is also composed of higher median income households as shown by the dark blue census tracts, suggesting a possible relationship between household income and green space. Additionally, upper middle household incomes have the most acreage of green space. Current literature cites that green space preservation can often accelerate gentrification due to property value and quality of living adjustments (Richards 2020). This explanation could explain the trends between median household income and green space accessibility in Berkeley as the population demographics may have shifted in the census tracts as green space was preserved in the city.

Finally, although my statistical analysis did not yield a high enough R^2 value to establish a definitive positive relationship between household income and green space acreage, I believe that more quantitative and geo-spatial analysis is required as current literature also suggests an unknown relationship between race, income, ethnicity and green space in the greater context of health outcomes (Browning and A. Rigolon 2018).

Green spaces in a world of coronavirus

In the context of COVID-19, based on my study sites, there is insufficient space for social distancing at green spaces in Berkeley for the lowest and middle median household income census tracts. This finding is significant as it may have substantial impacts on the equity of health outcomes related to COVID-19, mental health, and physical health for lower income communities. Lower income communities are often compounded with additional environmental risks that put them at further risk for disease incidence (Gochfeld and J. Burger 2011). In contrast, the upper median household income census tract had a surplus of green space relative to its population, which could yield insight into the overall results of COVID-19 transmission. Current literature advocates for social distancing as one of the best ways to hinder COVID-19 transmission (Qian and J. Jiang 2020). In addition, literature cites green spaces as a way to curb the health impacts of COVID-19 as well as the associated risks (Slater et al. 2020).

Limitations of my study and future directions

To start, I changed my topic in February, which ultimately gave me less than one semester to execute my entire senior thesis. In addition, there is a gap of knowledge with quantitative methods and quantitative data for analysis as evident in my literature reviews. This topic is intersectional and thus, I was limited with my approaches. Also, Berkeley was my entire scope with three study sites and the city is managed by the university and local government, making the issue more complex. Additionally, due to my scope, it is difficult to make any broad generalizations about any region larger than the city of Berkeley.

Finally, for the future, I am interested in expanding my scope to allow for broader generalizations. I would like to analyze the impact of green spaces on perception of health in relation to physical and mental health through surveys and collected public health data. Additionally, I would like to learn more programs to run quantitative, spatial, and qualitative analyses as i-Tree was limited with the results it yielded and my knowledge of ArcGIS could be expanded. Finally, I would like to collaborate with others from different disciplines to diversify and increase the intersectionality of my approach, to best capture and account for any variables.

A path to greener spaces

Prioritizing green spaces in urban planning can be achieved by integrating current evidence about the various benefits of a participatory, organized approach to capacity building. The following steps have been conceived through literature reviews and case studies: conducting multifaceted geospatial analysis, building public support, and obtaining political support, all the while monitoring the process in the scope of the greater goal. The last two steps involve other entities and assess the outcomes, where the green space policies objectives are compared to reality and future directions are established for continuity.

Conducting Multifaceted Geospatial Analysis

To start, conducting multifaceted geospatial analysis is an integral part of urban planning as this methodology can provide insight into disparities and subsequently, green space needs in terms of type, quality, size, location, and overall accessibility (Cetin 2015). One of the most important aspects of green spaces to consider is accessibility in terms of distance from low-income, Black, Indigenous, People of Color (BIPOC) households as green spaces can be an equity mechanism for community health outcomes.

The two following steps: building public support and obtaining political support can be spearheaded simultaneously or in succession as one step can foster progress in another step.

Building Public Support

Building public support requires firstly, gaining the public's trust, and secondly, appealing to their preferences within the context of green spaces. One way that trust can be established is through proper education by involving the public in forestry programs, natural conservation agendas, and decision-making processes (Jim 2004). Through a participatory approach, communities may be more invested in their environment and each other. Finally, appealing to the public is the key to solidifying support. A study by Australian researchers found success, after educating the public, by marketing green spaces as places that integrated wildlife or allowed for outdoor recreation (MacKenzie et al. 2018). By educating and then appealing to the public, decision-making bodies may find that the community participates as informed citizens.

Obtaining Political Support

Obtaining political support is key for ensuring that policies are implemented in favor of the preservation and creation of green spaces for wildlife and the public. Political support can be achieved through stakeholder participation in public commentary sessions as well as vertical and horizontal (power structure) teamwork (Bengston et al. 2004). Public figures are elected to represent the community's needs and different levels of government have varying jurisdictions so they can complement each other's actions. By obtaining political support, the public can work with governing bodies to bring to fruition green spaces that they envision and ultimately benefit from, regardless of race or socioeconomic class.

Involving Other Entities

Besides the public and municipalities, private companies can play a large role in the state of a community. Private companies can get involved by funding or sponsoring green space management in return for visible advertising or tax benefits (Sanesi and F. Chiarello 2006). As a result, the community and municipality may not be solely responsible for the finances and thus, this makes green space implementation and management more favorable.

Assessing Outcomes

The final step of the process requires identifying project objectives, reflecting on the processes, and acknowledging reality. Assessments of outcomes can vary from public comment to community surveys to environmental studies to public health research (EPA 2016). Assessments should require stakeholder, government, and academic engagement to account for as many variables as possible. Ultimately, the goal of any green space project is to provide something along lines of equitable access and quality environments. Through the establishment of more equitable, quality green spaces, communities can move towards more environmentally just living conditions.

ACKNOWLEDGEMENTS

Thank you to the ESPM 175B Faculty Team for guiding me through this three-semester long process without a mentor and with multiple topic changes. Thank you to my fellow Environmental Sciences classmates for their support and feedback. Thank you to the GIF Lab at Berkeley for answering all my questions about GIS. Thank you to Professor Stein and Professor Dillow at Oakton Community College for teaching me GIS and helping me with layering and measuring. Finally, thank you to my family and friends for their unconditional support.

REFERENCES

Barragan, N. D. 2017. Actions - H.R.2943 - 115th Congress (2017-2018): Outdoor Recreation Legacy Partnership Grant Program Act. https://www.congress.gov/bill/115th-congress/house-bill/2943/actions.

Bengston, D. N., J. O. Fletcher, and K. C. Nelson. 2004. Public policies for managing urban growth and protecting open space: policy instruments and lessons learned in the United States. Landscape and Urban Planning 69:271–286.

Braubach, M., A. Egorov, P. Mudu, T. Wolf, C. Ward Thompson, and M. Martuzzi. 2017. Effects of Urban Green Space on Environmental Health, Equity and Resilience. Nature-based Solutions to Climate Change Adaptation in Urban Areas, Theory and Practice of Urban Sustainability Transitions:187–205.

CDC. 2020, August 19. About Social Determinants of Health (SDOH). https://www.cdc.gov/socialdeterminants/about.html.

Cetin, M. 2015. Using GIS analysis to assess urban green space in terms of accessibility: case study in Kutahya. International Journal of Sustainable Development & World Ecology:1–5.

City of Berkeley. 2021. Bay Area Census. http://www.bayareacensus.ca.gov/cities/Berkeley.htm.

EPA. 2020, September 17. What is the National Environmental Policy Act? Environmental Protection Agency. https://www.epa.gov/nepa/what-national-environmental-policy-act.

EPA. 2017, April 10. What is Open Space/Green Space? | Urban Environmental Program in New England. Environmental Protection Agency. https://www3.epa.gov/region1/eco/uep/openspace.html.

EPA. 2016. . Estimating Greenspace Exposure and Benefits for Cumulative Risk Assessment Applications. rep.U.S. Environmental Protection Agency.

Esri. 2021. ArcGIS Online. https://www.arcgis.com/index.html.

Flies, E. J., C. Skelly, S. S. Negi, P. Prabhakaran, Q. Liu, K. Liu, F. C. Goldizen, C. Lease, and P. Weinstein. 2017. Biodiverse green spaces: a prescription for global urban health. Frontiers in Ecology and the Environment 15:510–516.

Food and Agriculture Organization (FAO), and L. Knuth. 2005. . Pages 1–40 Legal and institutional aspects of urban, peri-urban forestry and greening: A working paper for discussion. FAO Legal Papers Online.

Gochfeld, M., and J. Burger. 2011. Disproportionate Exposures in Environmental Justice and Other Populations: The Importance of Outliers. American Journal of Public Health 101.

Hevia, J. 2021. NEPA and Gentrification: Using Federal Environmental Review to Combat Urban Displacement. Emory Law Journal 70:712–752.

Jennings, V., and O. Bamkole. 2019. The relationship between social cohesion and urban green space: an avenue for health promotion. International Journal of Environmental Research and Public Health 16:1–14.

Jennings, V., C. Johnson Gaither, and R. S. Gragg. 2012. Promoting Environmental Justice Through Urban Green Space Access: A Synopsis. Environmental Justice 5:1–7.

Jim, C. Y. 2004. Green-space preservation and allocation for sustainable greening of compact cities. Cities 21:311–320.

Lee, A. C. K., H. C. Jordan, and J. Horsley. 2015. Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning. Risk Management and Healthcare Policy 8:131–137.

Maas, J., R. A. Verheij, P. P. Groenewegen, S. de Vries, and P. Spreeuwenberg. 2006. Green space, urbanity, and health: how strong is the relation? Journal of Epidemiology & Community Health 60:587–592.

MacKenzie, A., L. J. Pearson, and C. J. Pearson. 2018. A framework for governance of public green spaces in cities. Landscape Research 44:444–457.

Nutsford, D., A. L. Pearson, and S. Kingham. 2013. An ecological study investigating the association between access to urban green space and mental health. Public Health 127:1005–1011.

Qian, M., and J. Jiang. 2020. COVID-19 and social distancing. Journal of Public Health.

Ruggiero, A. 2021, April 13. Berkeley wants to hear from residents about Cal housing plans, including People's Park. https://www.mercurynews.com/2021/04/10/berkeley-wants-to-hear-from-residents-about-cal-housing-plans-including-peoples-park/.

Sanesi, G., and F. Chiarello. 2006. Residents and urban green spaces: The case of Bari. Urban Forestry & Urban Greening 4:125–134.

Schukoske, J. E. 2000. Community Development through Gardening: State and Local Policies Transforming Urban Open Space. New York University Journal of Legislation and Public Policy:351–392.

Shobe, W. M. 1979. Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc. Environmental Law 9:653–661.

Siikamäki, J., and K. Wernstedt. 2008. Turning brownfields into greenspaces: examining incentives and barriers to revitalization. Duke University Press Journal of Health Politics, Policy and Law 33:559–593.

Slater, S. J., R. W. Christiana, and J. Gustat. 2020. Recommendations for Keeping Parks and Green Space Accessible for Mental and Physical Health During COVID-19 and Other Pandemics. Preventing Chronic Disease 17.

The Trust for Public Land. 2018. ParkServe®. https://www.tpl.org/parkserve.

USDA Forest Service. 2006. . USDA Forest Service. https://www.itreetools.org/.

Zuk, M., A. H. Bierbaum, K. Chapple, K. Gorska, and A. Loukaitou-Sideris. 2017. Gentrification, Displacement, and the Role of Public Investment. Journal of Planning Literature 33:31–44.