A Study of Social Equality in Parks

A case study of New York City

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***Abstract*— Parks are some of the most accessible and readily available outlets for every people to exercise and connect to nature. The equality in parks is one of the most important of social equality which effects every citizen's daily life. In this paper, the author aims to evaluate the equality in parks on two aspects. One is spatial distribution of park accessibility. The other one is the relationship between park accessibility and house hood income. In the analysis, two indexes have been defined ---- percentage of accessible park area and accessible park area per capita. Spatial analysis and regression analysis have been used.**

Keywords—social equality, green space, accessibly

I. INTRODUCTION

It always be considered that open space is one of the most important factors to create healthy urban environments. Parks, in particular, are important in increasing opportunities to enjoy nature and to engage in recreational activities. Parks can improve the aesthetic and environmental quality of urban environments and provide public space for recreation and play increasing overall quality of life for urban populations [1].

Every public park bears a significant responsibility of social equality because parks are some of the most accessible and readily available outlets for every people to exercise and connect to nature. Several studies assume equitable cities are those where green open space equally benefits every citizen [2-4]. As the National Recreation and Park Association (NRPA) claims, public parks including the maintenance, safety, and accessibility of parks and facilities, should be provided on an equitable basis to all citizens of communities served by public agencies.

Parks bring a lot of significant benefits for individuals and communities, including public enjoyment and engagement, quality recreation place with family and friends, improvement of mental and physical health as well as measurable decreases in rates of crime and other detrimental activities. It is an important welfare and a right for global people to have safe, healthful access to parks.

Public parks should be equally accessible and available to all people regardless of income level, ethnicity, gender, ability, or age. Spatial equity is an important measure of sustainability [5] and thus, sustainable cities should seek to offer equitable access to public facilities and amenities to all cohorts of their population [6].

So how is the equality of parks for New York citizen? Could people with different income embrace the benefits of parks equally. This report explores the the equality of parks in New York city in terms of different income groups. The hypothesis to be tested, which is expected to be true, is: There is no significant difference between different income groups with the number or the area of parks they can easily access to.

The result would be the correlation between income and parks accessibility, which represents the social equality in parks of New York city. With this finding, the government and citizens could catch a glimpse of the situation of social equality of this city. The related agencies could take measures according to the result if the reality is not as expectation.

II. LITERATURE REVIEW

In 2001, Sarah Nicholls, a professor of Texas A&M University, publishes a paper titled Measuring the accessibility and equity of public parks: a case study using GIS[7]. The paper demonstrates a measurement of levels of accessibility and distributional equity offered by a system of public parks in Bryan, Texas. It identifies poorly parks served areas, and suggest where new facilities might best be sited so as to maximize access and equity. The result shows less than 40% of Bryan residents have good access to any form of everyday open space, with only 12% being able to reach a neighborhood park within the distance specified.

In 2011, Yingling Fan, a McKnight Land-Grant assistant professor at University of Minnesota, conducts a research to quantify the incidence of park use among communities of color in Minneapolis[8]. The three study areas were racially and culturally diverse, with a higher than average population of families living below the poverty level, as well as single-parent and minority families. Through research, Fan identified several impediments to park use with the top results including weather, time and a general lack of information.

In 2013, Emily Talen, an assistant professor of West Virginia University, offers a methodological and an empirical contribution to the assessment of equitability in facility distribution[9]. Utilizing data on parks in Pueblo, Colorado, and

Macon, Georgia, the paper analysis the equitability of park distribution by comparing the spatial clustering of park access scores with the spatial clustering of selected socioeconomic variables. The results of the analysis shows against to the notion of "unpatterned inequality" in urban service distribution.

In 2014, the Minnesota Metropolitan Council (MMC) produced the study, Regional Park Use among Select Communities of Color, which sought to identify barriers to regional park among communities of color[6]. Participants were interviewed about their preferred outdoor activities, their concepts of what a “park” entailed, whether they had visited a regional park in the past, what barriers prevented them from visiting regional parks, their concerns related to parks and trails, and their suggestions for ways to enhance the park system. The result suggests solutions like producing various informational materials in different languages, making sure parks are safe and well-maintained, and diversifying programmatic offerings, among others.

Recently in 2015, Joseli Macedo, a professor of University of Florida, publishes a research examining the spatial distribution of urban parks in the city of Curitiba, Brazil, and how it relates to the socioeconomic conditions of surrounding neighborhoods [4]. The research focus on equitable distribution, and spatial evolution of parks and social equity. Variables include measurable walking distances from census tracts to parks, income data from the 2000 and 2010 Brazilian decennial censuses, and qualitative data of urban parks in Curitiba. The result shows that spatial equity has been promoted in the city in the past 10 years. However, it is still a fact that most parks are located in more affluent neighborhoods.

III. Data & Methods(2)

A. Questions and Hypotheses

According to the background above, the question this report foucing on is what the difference is between neighborhoods in NYC in terms of accessibility of parks. Is it equal for citizens living in this city with different income accessing to same quality and quantity parks.

The hypotheses being tested is the accessibility of parks would not be effected when the median income of neighberhood vary.

B. Data

The data used here is the dictionary of parks properties which contains the information of each park in New York city with its name, location and area. The data is in two types: spatial type as shapefile and table type as csv file. This data is a open data from Department of Parks and Recreation (DPR).

Besides, the income data by each zip code in New York city is required. This data also includes the population information. The data form is table type as csv file. The source of the data is 2010-2014 American Community Survey 5 Year Data available on Social Explorer.

C. Methods

To achieve the goals above, two methods are mainly used here----Visualization of park accessibility distribution and regression model for neighborhood income versus park accessibility.

In the analysis process, spatial analysis including geocoding, buffer analysis and spatial join is used to analysis the spatial data in GIS and the simple linear regression is used to test the correlation between income and the area of accessible parks by Python statistic package. The regression method is ordinary least squares. ArcGIS and python is the main analysis tool.

In detail, in the first step, the income data is imported to GIS as spatial data through geo coding. Then the polygon executes buffer analysis as 0.5 miles’ buffer, which is reported as the best distant for people to access by walk, to produce the areas that people could easily reach by work in each zip code.

In next step, the parks data is joined into the buffer area by spatial join. At the mean time, the area of parks in each buffer area is calculated which represents the total area of parks citizens in certain zipcode could esaily access to.

Then the area of parks citizens in certain zip code could easily access to is normalized by two factors. One is the area of the zip code zone and the other one is the population in the zip code. These two output indexes turn out to be the percentage of accessible park area and accessible park area per capita of each zip code.

Then the two indexes are symbolism visualized in ArcGIS for observing the distribution of parks accessibility in New York city. The visualizations could show the region diversity on the aspect of park accessibility.

In the last step, the data is exported from ArcGIS and imported into python to conduct the regression analysis. Two regressions model are built here in this analysis. The first one is a regression model of median income versus the percentage of accessible park area by zip code. The second one is a regression model of median income versus park area per capita of each zip code. The result of these two regression models are proposed to represent the correlation between region income and park accessibility as well as social equality in parks. Outliers are removed before conducting the regression.

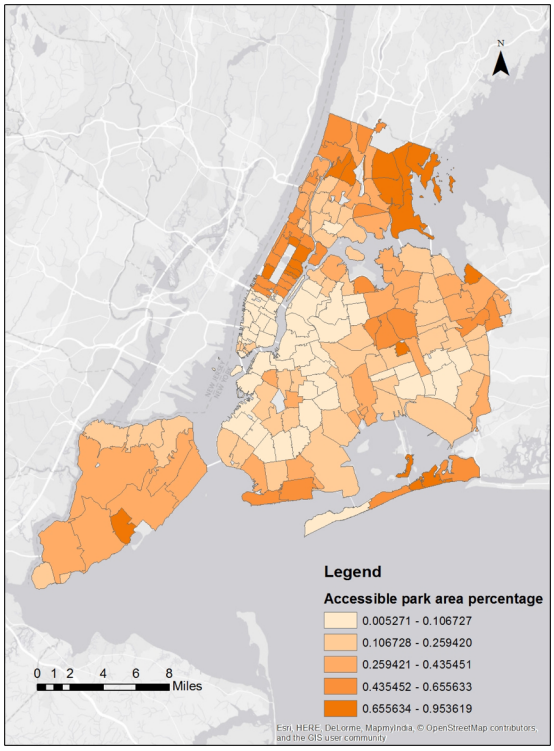
IV. Results and Implications

A. Visualization of park accessibility distribution

1) Distribution of accessible park area percentage

Fig. 1. Park accessibility distribution based on the percentage of accessible park area

In figure 1, the distribution of the percentage of accessible



park area is shown in five ranks. According to the figure above, it can be told that the diversity of park accessibility in New York City in terms of the percentage of accessible park area is distinct. Some areas share a high accessible park area percentage value and some others own a much lower one.

It also can be recognized that the park accessibility in Manhattan, Bronx, and Staten Island is better than the situation in Brooklyn and Queens on the whole. Especially, almost all of the areas in Bronx and Staten Island have a high value. That means citizens in Bronx and Staten Island could easily access to a large amount of green space around their living spaces.

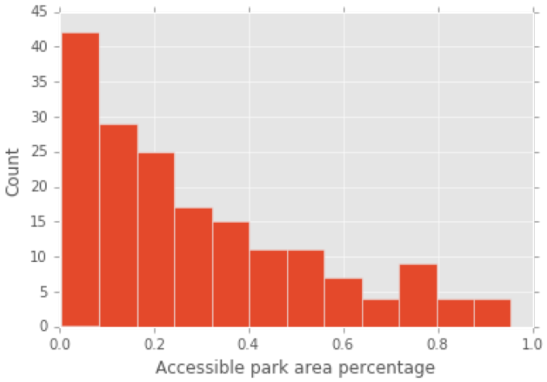
In Manhattan, it's obvious that the zip code regions around Central Park show a high percentage of accessible park area. In midtown and downtown Manhattan, the value is much lower. It can be inferred that the effect of Central Park is significant for citizens living in Manhattan. However, in other places beside central park in Manhattan, the green space amount is not sufficient. These two kind of areas shape sharp contrast.

In Brooklyn, the situation is similar with that in Manhattan. The areas around Prospect Park have a high value in percentage of accessible park area. In the south of Brooklyn, the value is high as well because of the parks around Coney Island. In other areas in Brooklyn, the situation is not as good as above. Specially, in the areas in Brooklyn close to east river, such as Williamsburg or Long Island City, the value of the percentage of accessible park area is very low, and the areas connecting together composing a large area in a poor park accessibility.

In Queens, the situation is better than that in Brooklyn. Most areas in Queens has a value of the percentage of accessible park area higher than rank 2 in 5 ranks. In the middle of Queens the park accessibility is the best which is due to several large parks such as Forest Park is there. Besides, the situation in east of Queens is better than the west, especially the situation of the areas close to Long Island is even better. In Far rockaway, park accessibility is good.

Overall, the best regions in terms of park accessibility in New York City is the areas around Central Park, the areas in Bronx close to up states, the most areas in Staten Island and the areas in the middle of Queens. On the other side, the poorest regions of park accessibility in New York City is part areas of the Midtown and Downtown in Manhattan, the areas faraway from Prospect Park and Coney Island, the areas in Brooklyn and Queens close to East River, and part areas in deep Queens.

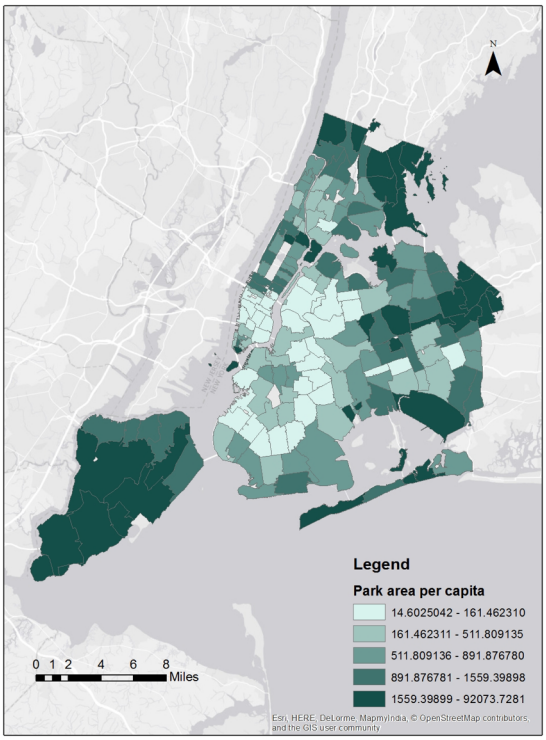
Fig. 2. Histogram of accessible park area percentage



For statistics information, the mean of the percentage of accessible park area of all zip code areas in New York City is 0.31, the median value is 0.22. As figure 2, the count of zip code areas which have a percentage of accessible park area lower than 0.1 is the most. With the percentage of accessible park area increasing, the amount of zip code areas having the similar value decreases.

2) Distribution of accessible park area per capita

Fig. 3. Park accessibility distribution based on the percentage of accessible park area



In figure 3, the distribution of the park area per capita of each zip code area is shown in five ranks in which deeper color represent more park area per capita. As this figure, it can be told that the diversity level of accessible park area per capita by zip code is similar with it of the percentage of accessible park area. In some areas, accessible park area per capita could reach as high as 1560 square ft. On the other side, some areas only have accessible park area per capita less than 200 square ft.

On the whole, the distribution of accessible park area per capita is in consistent with the distribution of the percentage of accessible park area. In the meantime, population show its significant effect in some certain areas.

In Bronx and Staten Island, most areas have high accessible park area per capita. That means each person living in these areas could take more advantage of the green space nearby. Especially in Staten Island, the park accessibility is even better in terms of accessible park area per capita. Most areas of Staten Island have the value in the highest rank----rank 5. This means Staten Island has not only more green space area than average but also lower population. As a result, living in Staten Island could enjoy the benefits of green space better than living in other regions.

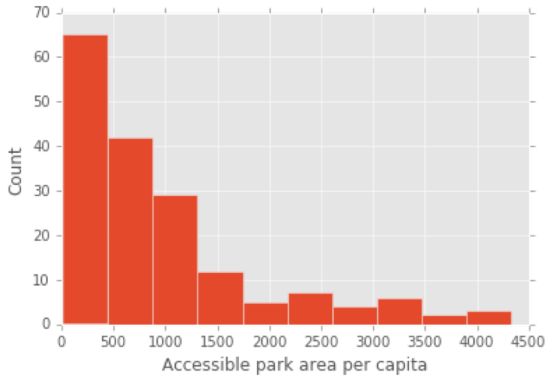
In Manhattan, the high values of accessible park area per capita are in the areas around Central Park as well. However, because of the population's effect, the park accessibility is not that high by each individual. In other words, in these regions, although the green space area is larger, the population is more as well. On the other side, in part area of Downtown Manhattan, the park accessibility increases because the population there is relatively lower.

In Brooklyn, most of the areas' situations maintain the same. The population factor doesn't effect the park accessibility much. However, in some certain areas such as Dumbo and Williamsburg, due to the population in these places are relatively low, the park accessibility is better by each individual. That means although the amount of green space is not that large, the people living in these places could also enjoy relatively sufficient green space benefits

In Queens, park accessibility is better by individual as a whole due to the low population of Queens. Especially in the east and south of Queens, the park accessibility is much better by individual.

Overall, park accessibility in terms of accessible park area per capita are more equal to different zip code areas than the accessibility in terms of percentage of accessible park area. The best regions on the aspect of accessible park area per capita are the areas in north east of Bronx, most areas in Staten Island and the areas in East and South of Queens. The poorest regions on the aspect of accessible park area per capita are the part areas in Midtown Manhattan, part areas in Brooklyn such as Carroll Gardens, and part areas in Queens close to east river such as Long Island City.

Fig. 4. Histogram of accessible park area per capita



For statistics information, the mean of accessible park area per capita of all zip code areas in New York City is 946.59 square ft. per capita, and the median value is 652.43 square ft. per capita. As figure 4, the count of zip code areas which have a accessible park area per capita lower than 500 is the most. With the accessible park area per capita increasing, the count of zip code areas having similar value decreases.

From the visualization and statistics information above, it can be recognized that the distribution of park accessibility is varied distinctly in different places. Especially in Manhattan, the park accessibility of areas around Central Park are much higher than the areas far away from Central Park. The situation is similar in Brooklyn around the Prospect Park. The best place for park accessibility is Staten Island, which has both the high

percentage of accessible park area and high accessible park area per capita.

B. Regression model

1) Regression of Income vs percentage of accessible park area

After visualizing the park accessibility distribution, the regression model is conducted to verify the correlation between income and park accessibility

Fig. 5. First degree linear regression fit for income vs. percentage of accessible park area

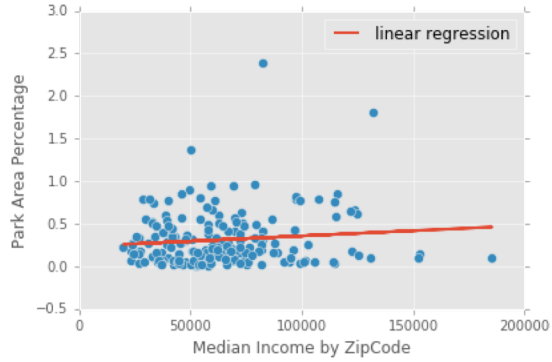
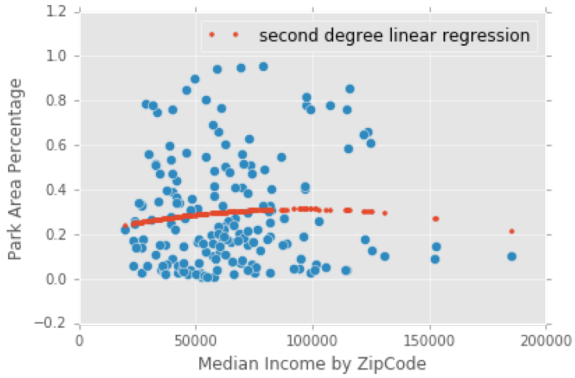


Fig. 6. Second degree linear regression fit for income vs. percentage of accessible park area



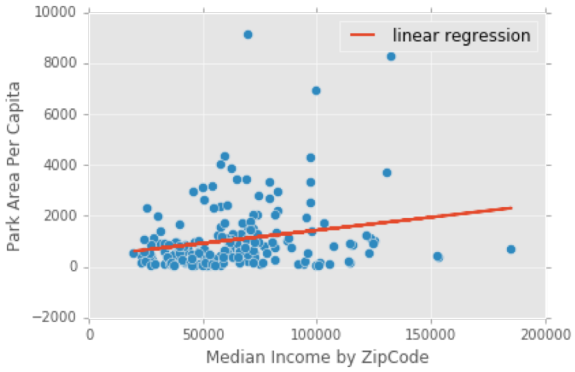
The result of regression of median income and percentage of accessible park area by each zip code is as follow: The R square is 0.012, and the P value of independent variable is 0.137.

After trying remove outliers and fit second degree linear regression, it shows no better regression fit.

The result above indicates that the median income and the percentage of accessible park area are not significant correlated.

2) Regression of Income vs accessible park area per capita

Fig. 7. Linear regression fit for income vs. accessible park area per capita



The result of regression of median income and accessible park area per each zip code is as follow: The R square is 0.049, the P value of independent variable is 0.003, and the coefficient of independent variable is 0.01. The result is after removing outlier.

According to the regression result above, although the R square is small, but the p value is smaller than 0.05. That means the correlation between median income and accessible park area per capita is significant. The coefficient of independent variable is 0.01, which means when median income increase by 10000, the accessible park area per capita would increase with 100 square ft.

From above regression analysis, it can be inferred that on the aspect of accessible park area per capita by zip code in New York City, park accessibility is correlative with the house hood median income. Citizens with high income are more likely to live in a space which have more accessible park area by each individual.

V. Conclusions and Next Steps

conclusion synthesizing your analysis/insights, laying out the limitations and commenting on how you could improve the analysis, etc. with additional data and opportunities for future analysis

A. Conclusions

The analysis above defines two methods to evaluate the social equality in parks.

The first method is visualizing the distribution of park accessibility on two aspects. One aspect is the percentage of accessible park area by each zip code. The other one is the accessible park area per capita by each zip code. In this method, the social equality in terms of spatial distribution of parks can be detected.

From the visualizations, it can be found that the park accessibility in New York City is not quite equal. The diversity is distinct between different locations. It is obvious that the locations around large parks could be accessed to very easily, however, the regions far away from large parks do not have relatively equal amount or total area of green space around them. That means the equality in parks distribution should be improve in the future.

The difference is clearly shown on the two maps. In Bronx and Staten Island, most area have a high park accessibility. A large amount of green space around the citizens living in these two boroughs and due to the low population of these two area, each individual could enjoy a large amount of green space. In Manhattan, citizens living around Central Park could access to a large amount of green space. However, ones living far away from Central park could access much fewer green space around them. In Brooklyn, citizens living around Prospect Park or Coney Island could access lots of green space around their home, at the meantime, ones living far away from these two space could enjoy much fewer around them. The diversity of park accessibility in Queens is not that distinct relatively.

The second method is the regression model base on the two indexes with median income. The result turns out to be there is no significant correlation between household median income and percentage of accessible park area, however, there is significant correlation between household median income and accessible park area per capita. The second regression shows that the people with more income lives in the area with more accessible park area per capita.

The regression results imply that there is some relationship between neighborhood income and park accessibility. This means it is not quiet equal for citizens in New York City on the aspect of parks because the opportunity they can access to a park is somehow based on how much many they can make.

Overall the two methods, it could be concluded that the social equality in parks is not that good on either the spatial distribution or the relationship with house hood income.

B. *Implement*

The results show the unequal for citizens in terms of parks, therefore it's important to change the situation and make it better. For New York agencies, through the results, they can figure out what is the reason of this unequal of parks accessibility in certain areas and which areas need to be improve in the future.

In the area with low percentage of accessible park area or low accessible park area per capita, agencies could set more parks to increase the amount of green space making more citizens could assess to more. For example, in part area of Downtown Manhattan which is lack of green space, agencies could build some street park or gardens or public open space to increase the amount the parks.

Besides, park accessibility could also be relieving by increasing the convenience of public transport. For example, citibike stations could be set in the areas with low park accessibility.

In addition, the un-equality in parks may also be relaxed by increasing the population in the areas with sufficient green space source and decreasing the population in the areas with unsufficient green space source. This will increase the park area per capita in regions with unsufficient green space source and increase the park area per capita in regions with sufficient green space. In other words, it will make the green space more balance for the population.

At last, agencies could improve the equality of parks by policy. They could make some policy to effect the rent of the houses, making the rent of house around great green policy lower or more equal to other places.

C. *Limitations and future analysis*

For the limitations in the analysis, it only takes one kind of transportation into consideration which is by work in 0.5 miles. In future analysis, it should take more kind of transportations such as by bike, by bus or by subway. It should also consider the real transportation situation which could make the analysis more accurate.

To evaluate the social equality in parks. There are also many other aspects beside spatial distribution and income. More variables such as age and race could be taken into account for conducting the relationship between them. By such ways, the results could be more specific, and agencies could do more improve on certain area or certain kind of people to make New York City a more social equal place.

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