Enhancing Urban Green Space in Xuzhou Quanta District

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ABSTRACT:
This study uses the Xuzhou Quanta District of China as its research object. First, the supply level of green space was assessed using the two-step floating catchment area method. Next, the fairness of the spatial distribution of urban green space was assessed using the Gini coefficient and the Lorentz curve. Finally, a three-stage optimization layout strategy was proposed. The findings revealed that the provision of green space in each sub district varies substantially, with a larger degree of supply in the south than the north.

KEYWORDS:

Green Space Resources, Layout Urban Green, Optimized Layout Urban, Supply Model Upgs, Urban Green Space.

I. INTRODUCTION

Urban green space is a crucial component of the urban ecosystem that can safeguard the city's biodiversity and enhance the environment's ecological quality by regulating the microclimate attenuating noise, and purifying the air. Urban green space is also a crucial location for urban inhabitants to unwind and engage in social activities, which can enhance their physical and mental well-being. Urban green space should not only meet the needs in terms of quantity but also take into account the harmony of spatial distribution in the context of constrained public resource. One of the criteria for evaluating the urban environment's quality has been established by the European Environment Agency as green space that can be reached in under 15 minutes. While the UK's Natural England organization suggests that all inhabitants be able to access green space larger than 2 hm2 within 300 m, the US 10-Minute Walk project seeks to ensure that residents can reach the park within 10 minutes.

According to Zhang et al. for a very long time, the indicators of per capita green space area and greening rate were used to evaluate urban green space in China. These evaluation metrics have shown numerous flaws as China's urban population, disposable income, and quality of life have all continued to increase. The real geographical distribution of green spaces cannot satisfy the demands of people, despite the fact that these evaluation indicators can guarantee the existence of a certain amount of green areas. Therefore, professional researchers and urban administrators should place a high priority on the shortage of urban green space and the mismatch between its supply and demand. Evaluation of the supply equity of urban green space and layout optimization are beneficial to enhancing the urban ecological environment and promoting the health of residents which may ensure the equitable distribution of urban green space resources. In recent years, research on the supply of fair urban green space has mostly focused on the following two aspects: on the one hand, spatial analysis, which primarily takes accessibility into account when evaluating the fairness of green space supply [1], [2].

The vast majority of the aforementioned research omitted to consider the city's many neighborhood parks and tiny gardens. In order to illustrate the fairness of urban green space supply in smaller space units, the population statistics used street-scale census data rather than the actual population data of residential neighborhoods. Furthermore, the majority of the studies that are currently available stop at the supply and demand evaluation stage and do not go on to suggest optimal layout techniques, making them useless as practical guides for the design of urban green spaces. As a result, this study uses the Xuzhou Quanta District of China as its research object and gathers information on 453 residential districts and the road system. First, the supply level of green space in the research region was assessed using the 2SFCA (two-step floating catchment area, 2SFCA) approach. Finally, the optimization layout method was presented in three steps to remove the service blind area of urban green space. The geographical distribution fairness of urban green space was evaluated using the Gini coefficient and Lorentz curve. In order to give data references and a scientific foundation for optimizing the system of urban green space and raising the level of service provided by urban green space.

Materials and Procedures

In China's Xuzhou City, the Quanta District is situated in the southwest and is connected to the Yun long District to the east, the Gluon District to the north, and the Tangshan District to the south. In the northern temperate zone, the Quanta District has primarily flat topography and a warm temperate humid and sub humid monsoon climate. It has four distinct seasons, an annual average temperature of 14.5 degrees, a 210-day annual frost-free period, and an 802.4 mm annual precipitation total. Yun long Lake, Yun Long Mountain, and Quanta Forest Park are just a few of the well-known scenic locations in Quanta District. With a high residential density, it serves as Xuzhou's economic, educational, and medical hub. The research area has a total area of 78.2 km2, which includes 453 residential areas and 11 sub-district offices.

Data Processing and Sourcing

In order to create the distribution vector map of urban green space, manual visual interpretation was utilised to understand the urban green space data that were acquired from the Google Map 2020 remote sensing photos with a resolution of 0.25 m. Urban green space in China is categorized into four categories neighborhood parks, neighborhood comprehensive parks, community comprehensive parks, and special comprehensive parks. Each form of green space in the research region along with its description, size, service area, and area ratio. Roadside green space and belt green space with a width of less than 6 meters were excluded as research subjects.

II. DISCUSSION

Fairness and justice are essential components of human civilization and serve as a benchmark for gauging how civilized a nation or community has become. Adams first put forth the theory of perceived fairness in 1965. In other words, people constantly assess the fairness or unfairness of social exchanges by comparing what they receive to that of others and passing judgment. Fairness is a criterion used to assess the harmony of social livelihood and is based on how residents perceive the fairness of opportunity, procedure, and distribution in daily life. The fundamental dichotomy in Chinese society in 2017 waste contradiction between the people's growing need for a better life and unbalanced and insufficient development. Imbalances, such as unequal development between regions, social divisions between groups, and mismatches between physical space and social groups, are unfairness-related difficulties. People cannot equally enjoy public resources, notably urban park green space (UPGS), as a result of recent socioeconomic stratification and housing division brought on by rapid economic growth. In cities, UPGS can significantly impact the quality of life by addressing issues like the heat island effect, controlling microclimates, containing water, lowering noise levels, and more. But as urban dwellers' demand for UPGS grows, the supply cannot keep up, and the issue of UPGS unfairness becomes more and more evident. Residents' requirement for access to UPGS is what is meant by their needs in this study.

In general, socioeconomic data and data from surveys of service recipients' perceptions are frequently used to assess demand indicators. Social media data, cell phone signaling data, and other sources of big data are also gradually being used to represent the actual needs of citizens for recreational space. To determine inhabitants' demand, some researchers still use data from socioeconomic demographic grids, the gross domestic product, and nighttime lighting. In this study, the population of a sub district is employed as a proxy for the demand of potential inhabitants. The development of UPGS has the burden of creating social justice as an essential means of enhancing urban environments and citizens' quality of life. In order to resolve the existing conflict between the rising demand for housing among residents and the imbalanced growth of UPGS, China urgently needs to build a mechanism for assessing the fairness of UPGS. Many academics are already worried about how far the UPGS is. The three stages of the research on the fairness of UPGS are geographical fairness, social fairness, and social justice. Spatial fairness is the equitable distribution of UPGS supply.

It is an idealized condition that disregards the requirements of city dwellers. At the moment, researchers mostly employ the Lorenz curve and Gini coefficient to assess geographic fairness. In economics, the Gini coefficient and the Lorenz curve are frequently employed to calculate the income inequality between citizens of a nation or region. The Gini coefficient is gradually being used to assess the fairness of the spatial distribution of public resources like education and UPGS as disciplines begin to cross-fertilize. The spatial match between the allocation of green space resources and the residential population is the key component of social justice. Social justice is focused on social fairness and emphasizes that diverse groups have distinct needs and talents. It argues for greater access to public resources for disadvantaged groups and thinks that different socioeconomic groups should have equal access to them. Evaluation is based on indicator measures. When measuring the availability of UPGS, academics frequently employ metrics like green space per catnapers within a certain distance, and accessibility of parkland, which are still in a single dimension and do not entirely capture the characteristics of UPGS [3], [4].

Currently, researchers primarily use time- and money-consuming field questionnaires to evaluate the quality of UPGS and less frequently take big data into account. He and his collaborators integrated UPGS's quality and service capacity to create a supply metric model. However, this model's quality index for the UPGS is not quantifiable, and the evaluation process is not exact. Furthermore, there is no distinction in the service capacities of the various varieties of UPGS. As a result, this study enhanced the UPGS supply model that He et al. had suggested. Big data have recently offered fresh approaches to the practice of social science. For this work, we used large datasets including AOI, POI, and OSM to get the UPGS quality factor data. The Badu heat map was then used as a new data source to represent UPGS visits and serve as the foundation for calculating the weights of UPGS's quality characteristics. The previous subjectivity in determining the UPGS quality parameters was diminished by this method. This study also analyzed the supply of UPGS of various sorts, calculated the service radius of UPGS depending on their scale, and enhanced the UPGS supply model to aid in optimal urban management.
China's capital, Beijing, has seen quick economic growth and a clear pattern of an imbalance between the supply and demand for public services. In order to quantify the supply of UPGS, this study used Beijing as a case study and combined the amount, service capacity, and quality of UPGS. The Gini coefficient was then used to assess the supply of UPGS from the perspectives of social and spatial fairness. In order to pinpoint the locations with an inadequate supply of UPGS, this study analyzed the link between resident demand and the supply of UPGS in Beijing's central urban district. The empirical investigation of fairness in UPGS in China can strengthen the pertinent theoretical framework of fairness in green spaces and offer comparative findings for earlier investigations. Additionally, it serves as the foundation for municipal governments to maximize social benefits, particularly for various social groups.

Big map was used to gather the detailed data for 453 residential districts in Quanta District in 2020. Each residential district's entrances and exits served as the source point, from which the demographic data of the district was then matched. The A juke website, the Ten cent real estate website, the 58 City website, and the Fangtianxia website are the main sources of demographic information from the Internet. A map of each residential district's population distribution in the study area. Xuzhou city's main urban roads were used to extract the road network data, and the shortest distance between the residential area and the urban green space was determined using the OD cost distance in Arc GIs [5], [6].

Technique of STUDY

A 2SFCA: The availability of urban green space is assessed using the 2SFCA from an accessibility standpoint. By estimating the spatial distance between two things, the 2SFCA method determines which object is more accessible. Under the ArcGIS platform, it can be implemented using Python programming. The 2SFCA takes both supply and demand considerations into account when evaluating how accessible urban green space is, and the results of this consideration are a more thorough and straightforward computation. By applying the 2SFCA approach, it is possible to determine the supply capacity within each type of urban green space service range according to the varying service radius. where Run is the category M green space's per-person supply capacity, Son is the patch's area, dam is the service radius, dim is the separation between the itch residential district and green patches, H is the number of residential districts within the service radius, Ki is the population of the itch residential district, and F is the Gauss equation taking the space friction problem into account.
In order to determine the cumulative supply level, the second step is calculating the total area of green space contained within the boundaries of each residential district. Where GI is the entire amount of supply for residential district is the total number of green patches whose distance from residential district is less than the service radius; and other characters have the same meaning as formula 1. The Lorentz curve and the Gini index Economic notions like the Lorentz curve and the Gini coefficient are often used measures of fairness. These two measures are gradually being utilised to determine whether the allocation of social resources is equitable when discipline borders are widened. According to this study, the Lorentz curve is a function of the total share of residents and the share of local residents who possess green space resources. The proportion of the community's total population is represented by the Lorentz curve's horizontal axis, and the proportion of the total amount of available green space is represented by its vertical axis. The degree of geographical misalignment between the availability of green space resources and the distribution of the population, as well as the degree of inequality, increases with decreasing curve slope. The Lorentz curve can be used to derive the Gini coefficient, which ranges from 0 to 1.

The comprehensive park, the community park, and the neighborhood park should all be reachable by inhabitants in less than 30 minutes, 15 minutes, and 5 minutes, respectively, in accordance with the planning guidelines provided by China and pertinent academic studies. Adults typically walk at a speed of 1.2 m/s, covering around 70 meters in a minute. As a result, in this study the service radius for the neighborhood park is set at 300 meters, while the service radius for the comprehensive park is set at 2000 meters. The community park's service radius is set at 500 meters for areas that are 1 to 5 hectares in size and at 1000 meters for areas that are 5 to 10 hectares. Following a field assessment, it was determined that the size of the research area's special parks is comparable to that of community parks; therefore, a 1,000 m service radius was also established for these parks. The findings of the calculation for the availability of urban green space in Xuzhou City's Quanta District based on accessibility can be found and are in accordance with equation 1 of the 2SFCA.

On the overall, the south has a high level of availability, while the north has a low level. In Jinan Sub-district, which is part of Quanta District and has a supply level of up to 43.625 m2 per person, the highest level is found. The following two sub-districts are Tayshaun and Hub in, with supply levels of 21.505 m2 and 20.695 m2, respectively, per person. Five sub-districts have a supply of green space that ranges from 5.5 square meters per person to 14.6 square meters per person. Haitian Sub-district has the highest supply at 14.250 square meters per person, followed by Krishna Sub-district, Young'un Sub-district, Young'un Sub-district, Qiligou Sub-district, and Hoo-ha Sub-district. Three Sub-districts, namely Dunhuang Sub-district (5.127 m2 /person), Wangling Sub-district (5.119 m2 /person), and Hoping Sub-district (2.684 m2 /person), fall below the 5.5 m2 per capita green space standard set by the National Ecological Garden City. A large service radius is provided by the comprehensive parks Yun long Lake, Binue Park, and others in the Jinan Sub-district, where there is also a low construction density and tight development intensity regulation.

Tayshaun Sub-district has Tayshaun Park, Penghu Garden, and Krishna Park, and the population density is quite low. Hub in Sub-district, on the other hand, has a lot of greenery surrounding it, including Yun long Lake and Shushing Park on the right and Won Mountain on the left. As a result, compared to other sub districts, these three have a higher supply of green space. Hoping Sub-district, Wangling Sub-district, and Duanzhuang Sub-district are three examples of northern old urban regions where there is a poor quantity of natural space. The primary causes of this are that the old urban area was developed before its time, that the residential area had a high building density, that there were numerous business establishments, and that there were few neighborhood gardens and expansive, all-encompassing parks. It is possible to determine the per capita supply of urban green space in each of Quanta District's 453 residential zones by using formula 2 to the calculations. A total of 453 residential areas have an average supply of 12.66 m2 of green space per resident, with Jincaijiayuan Community having the highest value at 88.2 m2/resident. As a result, there is a high per capita supply of urban green space in these areas. Around 181 residential areas, or 40.0% of the total, had less than 5.5 m2 /person, falling short of the 14.6 m2 /person benchmark set forth in the 13th Five-Year Plan of China. This represents a total of 68.3% of the residential areas that did not reach this level [6], [7].

Study Area

China's political, cultural, and international interaction hub is Beijing, which is situated at latitude 39°56′ North and longitude 116°20′ East. The rapid economic growth of Beijing in recent years has led to an increasing trend of supply and demand imbalances for public services. 21,893,000 people called Beijing home in 2020, a rise of 2,281,000 over the number who called it home in 2010. Beijing's average yearly population growth is estimated to be 228,000, and there is a strong demand for residents. The core urban district of Beijing, which includes Chatoyant, Haitian, Dongcheng, Niching, Fantail, and Shijingshan District, is the subject of this study. Less than 10% of Beijing's total territory is occupied by this region, yet more than 50% of Beijing's entire population lives there. The Beijing Municipal Government has fiercely extended the city's green covering, as seen by the increase in per capita park green space from 5.1 m2 in 1978 to 16.4 m2 in 2019, according to survey data from the Beijing Municipal Bureau of Statistics. We contend, however, that green coverage and green space per capita only accurately reflect the quantitative aspects of UPGS without taking its quality into account. The socioeconomic advantages of public green space are not greatly improved by increasing green space per capita. For the refined management of confined cities like Beijing, a thorough investigation of the supply of UPGS of various sorts is necessary taking into account the quality of UPGS, UPGS's service capability, and other aspects [8], [9].

Data Description and Pre-Processing

The WGS 1984 UTM Zone 50N projection coordinate system was used for all geographic data in this investigation.

Population Information for the Sub district and Its Vector Boundary

The sub-district served as the analytic unit for this study, and the boundaries were derived from information released in the National Basic Geographic Information Database in July 2020. 133 sub-districts in the research area were ultimately extracted after topological analysis of this data. Among them, 17 are in the Dongcheng District, 15 in the Niching District, 42 in the Chatoyant, 29 in the Haitian, 21 in the Fantail, and 9 in the

Shijingshan. The sub-district level, which is comparable to the U.S. census district level, is the smallest administrative unit in China's three-level administrative division system. Data from the 7th Census in 2020, which were collected from the Beijing Municipal Bureau of Statistics were used to calculate the sub-districts' total population. By adjusting the data from the 6th Census and the 7th Census announcement data, we were able to get information on the elderly, young, and female categories in the sub-districts.

Area of Interest (AOI)

For urban facilities, AOI can offer precise geographic position and comprehensive attribute data. The AOI data for Beijing was crawled by this study using Python on the Badu map platform (https://lbsyun.baidu.com, accessed on 10 October 2020), after which the scenic spot types were extracted from the AOI and corrected by comparing them with the GF-1 satellite image data. Finally, non-UPGS structures like temples and pavilions were removed through filtering, cleaning, and topology checking, and the vector boundaries of 340 parks and their attribute data were obtained. The park's name, longitude, latitude, and acreage are all included in the attribute information.

Points of Interest (POI)

The specific location of urban facilities can also be reflected through POI. The public service facility class was chosen after this study scraped POI data from the Badu Map platform (https://lbsyun.baidu.com, visited on 10 October 2020). After processing the overlay analysis, the total number of public service facilities in all Beijing parks was discovered. These facts served as the park quality factor's input.

Data from the Road Network

First, we collected the road data from the OSM website (accessed on 18 October 2020 at https://www.openstreetmap.org), which included details like the route's name, length, and slope. An open street map is accessible on the OSM website. Next, we checked the principal, secondary, tertiary, trunk, and residential road types that we had filtered out of the data. Then, using the Beijing 13th Five-Year Plan and integrating the Geode and Badu maps, we adjusted them. Additionally, the OSM was used to get the water and green space boundaries as well as their features, which were then used as inputs for the park quality criteria.

Population Heat Value

A type of internet open-source data called a Badu heat map can dynamically show the traits of urban population collecting. At the moment, it is frequently used to depict the vitality of urban space, park accessibility, and the practical intensity characteristics of urban space. According to studies, individuals prefer to travel in the late afternoon and evening on rest days, reaching the day's high about 15:00; on weekdays, population activity clearly exhibits a morning peak and evening peak of commuting. Based on the Badu Maps platform the original data used to create the Badu heat map in this study consists of a collection of spots that are roughly 100 m apart. On the Badu thermal data at each of the six moments, we first did kernel density analysis using the ArcGIS 10.2 platform, with a spatial resolution of 2 m. Then, using the UPGS to spatially mask the Badu thermal map, we used the spatial masking tool in ArcGIS 10.2. We next determined the overall thermal values inside each UPGS for six distinct moments using the zonal statistics tool. In order to indicate the number of people visiting the park on Friday and Saturday, respectively, we determined the average heat value within the UPGS.

Park Quality Factor

It is well acknowledged that being close to UPGS does not necessarily guarantee that a location is sufficiently alluring to people. The park's quality frequently influences users' choice of UPGS and how long they remain. It is well known that park composition, spatial configuration, and other micro-features, such as UPGS size, water presence or absence, walkable environment within UPGS, and canopy cover within UPGS, influence how frequently residents are exposed to UPGS and how long they stay in UPGS. In this study, the amount of green space in the UPGS relative to the total park area, the amount of water bodies relative to the total UPGS area, the total UPGS area, and the quantity of public services in the UPGS were chosen as the UPGS quality factors. Finally, the four elements were reassessed and rated using the natural interruption approach. In this study, the ratio of the area of water bodies to the total area of the UPGS and the ratio of the area of green space to the total area of the UPGS were chosen to assess the quality of the UPGS, thereby removing the impact of the scale of the UPGS on the area of water bodies and the area of green space.

Technique

The following sections make up the technique utilised in this study: The supply model of UPGS can be improved by using Pearson correlation analysis and Analysis Hierarchical Process determining the fairness of UPGS using the Gini coefficient; and using the supply and demand relationship to assess the spatial alignment between UPGS supply and resident demand.

UPGS Supply Metric Model Improvement

The supply model of UPGS put forth by He et al. It was enhanced by this work. When creating the supply model for UPGS, He et al. neglected to take the classification of UPGS into account and did not outline a particular approach to determining the quality of UPGS. As a result, this study took into account the explicit quality measurement technique of UPGS based on big data and the service radius of UPGS of different types while building the supply model of UPGS, which makes the evaluation model more objective.

The UPGS's Service Capacity

The size of UPGS and the road network both affect how much service the system can provide. Based on the service area analysis in the ArcGIS platform, this study determined the UPGS service area. This study categorized UPGS into small parks (S 1 hm2), community parks (1 hm2–10 hm2), regional parks (10 hm2–25 hm2), and city parks (S > 25 hm2) in accordance with the Urban Land Classification and Planning and Construction Land Standard (GB50137–2011). The service radius of a local, community, regional, and city park is 500, 1000, 1500, and 3000 meters, respectively.

III. CONCLUSION

The exact findings and outcomes of the study would determine how to conclude the investigation into supply fairness assessment and optimized layout of urban green space in Xuzhou Quanta District. Since I'm an AI language model, I don't have access to the precise research you referred to, but I can give a broad overview of what the result would be based on accepted research procedures. Here is an illustration of one that might be reached the objective of the study on supply fairness evaluation and optimized layout of urban green space in Xuzhou Quanta District was to determine the distribution and accessibility of green spaces within the district and to suggest methods for enhancing the fairness and efficiency of the provision of green space. To gather information and assess the state of urban green areas in the district, the study used a variety of approaches, including spatial analysis, GIS mapping, and stakeholder interaction.

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