

A Study on the Supply-Demand Relationship of Recreational Services Supported by Ecological Public Spaces: A Case Study of Nanjing, Jiangsu Province, China

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Abstract

This study explores the supply-demand dynamics of recreational services in Nanjing, China, using 2020 data on land use and population. Key findings include: (1) A spatial mismatch exists between high-demand and high-supply areas. (2) Expanding the accessible radius from 2 km to 10 km improves the supply-demand balance, reducing deficit areas and unmet needs. (3) Nanjing's districts are classified into four types—locally satisfied, medium-distance satisfied, long-distance satisfied, and unsatisfied—with tailored planning recommendations. The study advocates for rational ecological land planning, decentralized management, and enhanced ecological compensation and economic cooperation to ensure fairness in recreational services and promote green development, offering insights for urban planning and ecological civilization.

Keywords: Ecological public space; Supply-demand relationship; Planning and management; Recreational services

I. Introduction

Recreational services, as a vital component of cultural services within ecosystem services, significantly contribute to enhancing human well-being (Li Xiang et al., 2019). However, amid economic development and rapid urbanization, the supply-demand contradiction of regional recreational services has become increasingly pronounced, manifesting distinct temporal and spatial characteristics. To date, research on the evolving supply-demand dynamics of recreational services remains limited, with most studies employing semi-quantitative methods that fail to effectively align regional supply and demand in both time and space. Consequently, there is an urgent need to advance research in this area. This study quantitatively assesses the supply, demand, and balance of recreational services, while leveraging spatial analysis techniques to illustrate the spatial distribution characteristics of the supply-demand relationship within the study area from a geographical perspective. This approach enhances the intuitiveness and comprehensibility of the findings, establishing a foundation for subsequent investigations into the changing patterns of supply-demand balance and offering targeted recommendations to improve these dynamics. Focusing on Nanjing City as a case study, this research examines the supply-demand conditions of recreational services within the ecosystem services of its 11 administrative districts in 2020. By employing methods such as supply-demand measurement assessments and spatial analysis, the study analyzes the supply-demand situation across these districts during this period and explores the spatial distribution characteristics of recreational services in each administrative district in 2020. Investigating the spatial supply-demand features of regional recreational services provides a practical basis for urban land planning and ecological civilization construction, addressing urban residents' aspirations for an improved quality of life and, in turn, elevating their well-being.

II. Theoretical Foundation and Literature Review

Ecosystem Services (ES) refer to the diverse benefits that ecosystems provide to humanity. Since its introduction in the 1990s, this concept has emerged as a research hotspot across disciplines such as ecology, economics, and environmental management. This chapter reviews the literature from four key perspectives—concept definition, supply-demand relationships, types and characteristics, and assessment methods—to establish a theoretical foundation for subsequent research.

2.1 Concept Definition of Ecosystem Services

The concept of ecosystem services was first articulated by Costanza et al. (1997), who defined it as the material and non-material support humans derive from ecosystem functions. This definition gained broad acceptance within the academic community and was further refined by the United Nations Millennium Ecosystem Assessment

(MA, 2005) as “the benefits ecosystems provide to humans,” highlighting their direct and indirect contributions to human well-being. Subsequent studies by TEEB (2010) and USEPA (2012) emphasized that ecosystem services encompass a wide range of economic, social, and ecological benefits, underscoring their role as a cornerstone of human welfare.

2.2 Evolution of Supply-Demand Relationships

Research on ecosystem services has progressively evolved from focusing solely on supply to analyzing the balance between supply and demand. Xiao Yu and Xie Gaodi (2003) pioneered the exploration of spatial flows in ecosystem services, elucidating the linkage between supply and utilization. Zhen Lin (2008) defined demand as the consumption and appropriation of ecosystem services in human production and daily life. Li Shuangcheng (2019) proposed a comprehensive service process comprising formation, transportation, and consumption. Wolff (2015) highlighted that service flows connect supply areas to beneficiary regions, transforming ecosystem outputs into usable products for humans. Mou Xuejie and Wang Xiahui (2019) differentiated between direct consumption (e.g., provisioning services) and indirect consumption (e.g., regulating and cultural services), noting that supporting services are indirectly manifested through other service types.

2.3 Types and Characteristics of Ecosystem Services

The classification of ecosystem services provides a critical basis for their assessment. Daily (1997) categorized them into three groups: providing material resources, sustaining life systems, and enhancing life enjoyment. Costanza (2017) expanded this framework, identifying specific services such as food production, climate regulation, waste treatment, nutrient cycling, and recreational activities. Drawing on the MA classification, Wu Xiao and Zhou Zhongxue (2019) classified urban green infrastructure services into regulating, cultural, and supporting categories. Geng Nianzi and Zheng Hua (2023) outlined key characteristics, including quality dependence, spatial heterogeneity, scale correlation, and trade-offs and synergies. Guo Baoxiang and Nie Yuming (2022) observed that service distribution tends toward “spatial homogenization” as scales expand, emphasizing the significance of scale in analysis.

2.4 Development of assessment methods

The development of assessment methods is a core component of research on the supply and demand relationship of ecosystem services, for which scholars have developed a variety of methods. Indicator assessment methods quantify ecosystem services by constructing an indicator system, for example, (Layke et al. 2009) assessed provisioning, regulating, and cultural services, but demand indicators are relatively understudied (Fu Berger et al., 2017). The ecological modeling approach is favored for its ability to reveal ecological processes, and commonly used models include the InVEST model, the SolVES model, and the ARIES model, of which the InVEST model is suitable for water resources and environmental quality assessment due to low data requirements (Ma Lin et al. 2017), but its algorithms are relatively simple and require field data validation (Huang Conghong et al. 2013); The SolVES model focuses on the social value assessment of cultural services, quantifying aesthetic and leisure values through public surveys (Huang Conghong et al., 2013); the ARIES model, on the other hand, is suitable for comprehensively assessing supply and demand, but its application is limited due to its complexity and closed nature (Huang Conghong et al., 2013). The value assessment method quantifies the value of services through monetization, such as the unit area value equivalent factor method proposed by Xie Gao Di et al. (2015), which was pioneered by Costanza et al. (1997) and later optimized to adapt to China’s national conditions (Xie Gao Di et al., 2008), and the unit service function price method is divided into the real market method, the alternative market method, and the virtual market method, which are applicable to different types of services (Liu Yao et al. 2017). In addition, the participatory method and empirical statistical modeling method are also important tools, in which the expert assessment matrix method (Burkhard, 2009) assesses supply and demand through expert scoring, which is simple to operate but highly subjective; the questionnaire survey method can accurately reflect the demand, but the cost is high and the scope is limited (Yan Yan et al., 2017); and the empirical statistical modeling method assesses the balance between supply and demand by using socio-economic data, which is easy to get the data but ignores ecological processes (LarondelleN et al., 2016). Each of these methods has its own advantages and disadvantages, and researchers need to choose appropriate assessment tools according to specific objectives and conditions.

III. Overview of the Study Area and Data Sources

3.1 Overview of the Study Area

Nanjing City, as the capital of Jiangsu Province, is situated in the southwestern part of Jiangsu and the lower reaches of the Yangtze River. Its geographical coordinates range from 31°14'N to 32°37'N and from 118°22'E to 119°14'E. The city's maximum east-west extent is approximately 70 kilometers, while its maximum north-south extent is about 150 kilometers. On the municipal plane, Nanjing exhibits a pattern of being elongated from north to south and narrow from east to west, with a total area of 6,587.04 square kilometers, encompassing 11 districts and one national-level Jiangbei New Area. In recent years, the Nanjing Municipal Party Committee, Municipal Government, and planning and construction departments have successively announced and implemented a series of highly targeted initiatives to strengthen the development of urban green spaces and ecological infrastructure, thereby enhancing Nanjing's cultural appeal and quality of life.

In 2002, the "Green Nanjing" strategy was implemented, and in 2004, Nanjing launched the "Greening the Old City" campaign (Li Zhong, 2006). By the end of 2021, the city's built-up area achieved a green coverage rate of 44.96%, a green space rate of 40.79%, and a per capita park green space of 16.18 square meters, all ranking among the highest in cities of similar type across China. With the rapid development of the economy and society, residents' living standards have continuously improved, leading to a growing demand for recreational services. Particularly in the context of urban expansion, urban residents have an increasingly urgent need for nearby natural environments, cultural experiences, and other recreational services. However, due to constraints in urban planning and land resources, the supply capacity of recreational services in Nanjing has not kept pace with demand, and in some respects, has even declined. This has resulted in a significant contradiction between supply and demand. Meanwhile, with the improvement of transportation infrastructure, residents' travel options have become more diversified. In addition to traditional modes such as walking and cycling, transportation options like metro, buses, taxis, and ride-hailing services have provided greater convenience to residents. Consequently, as the accessible range of residents' recreational activities has expanded, the spatial layout of the supply and demand for recreational services in Nanjing has adjusted accordingly (Tong Lige et al., 2013).

3.2 Research Data

In this paper, we utilized various data, including land use and population spatial data.

(1) Regarding the 30m land use raster data for Nanjing City in 2020, this information was obtained from the Resource and Environment Science Data Center of the Chinese Academy of Sciences. In the process of creating "China's 20th Century LUCC Spatiotemporal Platform," Liu Jiyan and his team referenced the LUCC classification system.

Based on the actual conditions of the study area, land use was meticulously categorized into eight distinct types, including paddy fields, dry land, forest land, grassland, water bodies, wetlands, construction land, and bare land.

(2) Regarding population spatial data: These data were based on 1km grid information from the Science and Environment Data Center of the Chinese Academy of Sciences.

3.3 Research Methods

1. Quantifying the Supply of Recreational Services

Past research has primarily focused on areas such as oceans, marine landscapes, urban greening, and forests, with the aim of assessing the potential value of these ecosystems in providing leisure and recreational services. Therefore, this study identifies ecological lands such as forests, grasslands, water bodies, and wetlands as specific areas capable of offering leisure and recreational services.

This research project plans to use a **1km×1km grid structure** as the primary research framework and conduct an in-depth analysis of five different modes of transportation: walking, cycling, electric vehicles, public transportation, and self-driving. During this research, **2 km, 5 km, and 10 km** were selected as the accessible radii for ecological lands, assuming that within a specific grid, ecological lands can provide various leisure and recreational activities to residents within that radius. At the same time, residents within the grid are also eligible to access all ecological lands within that radius (Tao Qin et al., 2021). The calculation process is as follows:

(1) The ecological land within the grid can provide recreational services to each person within the radius.

$$A_i = S_i / P_i (1)$$

where S_i is the area of ecological land in grid i , P_i is the total population within the reachable radius corresponding to grid i , A_i is the per capita usable area of ecological land in grid i .

(2) In the grid environment, people can experience the services = services provided by all ecological lands within the accessible radius.

$$R_{Si} = \sum k_{Aj} \times POP_i (2)$$

where R_{Si} is the supply of recreational and leisure services in grid i ; j is all the grids within the corresponding buffer radius of grid i ; and POP_i is the total number of people in grid i . When the reachable distance is not considered, i.e. when the reachable distance is 0km, the supply of recreational and leisure services is the ecological land area of the grid.

2. Quantifying the Demand for Recreational Services

Based on previous studies (Prance GT et al., 2014; Xie Zilai, 1999), this research establishes the per capita ecological land standard as **60 m²/person** and defines the demand for recreational services as:

$$RD_i = 60 \times POP_i (3)$$

where RD_i denotes the demand for recreational and leisure services in grid i .

3. Assessment of Supply and Demand of Leisure and Recreation Services

This research program is based on the research method proposed by Zhao et al. (2015), which uses the metric of supply-demand ratio (R) to quantify the supply-demand balance of leisure and recreation services. In the case where the R value exceeds 1, the supply and demand in the study area shows a surplus situation, which means that the supply exceeds the demand, thus making the supply and demand of leisure and recreation services perform quite well; in the case where the R value reaches 1, the supply and demand in the study area reaches equilibrium, which means that the supply and demand are equal; in the case where the R value is lower than 1, the supply and demand show a deficit situation, which represents that the demand exceeds the supply, thus creating an imbalance between the supply and demand for leisure and recreation services.

$$R_i = R_{Si} / RD_i \times 100\% (4)$$

where R_i denotes the ratio of supply and demand of leisure and recreation services in grid i .

IV. Research Results and Analysis

4.1 Recreation and leisure service supply in Nanjing under different accessible radius of each administrative district

In 2020, the highest value of leisure and recreation service supply of ecological land in Nanjing is 1.0404km². In terms of spatial distribution, the supply of leisure and recreation services in Nanjing shows different characteristics under different reachable radius, but with the expansion of reachable radius, the distribution of the supply of leisure and recreation services in Nanjing gradually expands and tends to be uniform. Under 0km accessibility radius, the supply of leisure and recreation services in Nanjing shows the characteristics of high in the south and low in the north, and the supply of Gaochun District, Lishui District and Yangtze River Valley in the south is especially high, while the supply of ecological land in the central urban area and Liuhe District is relatively small; under 2km accessibility radius, the supply of leisure and recreation services in Nanjing tends to be scattered, but it is still concentrated in Gaochun District, Lishui District and Yangtze River Valley in the south,

and the supply of Luhe District is still relatively small. The supply is still relatively small; under the 5km and 10km accessibility radius, the supply of leisure and recreation services in Nanjing tends to be uniform, but the supply in Luhe District in the north is still small compared with other administrative districts.

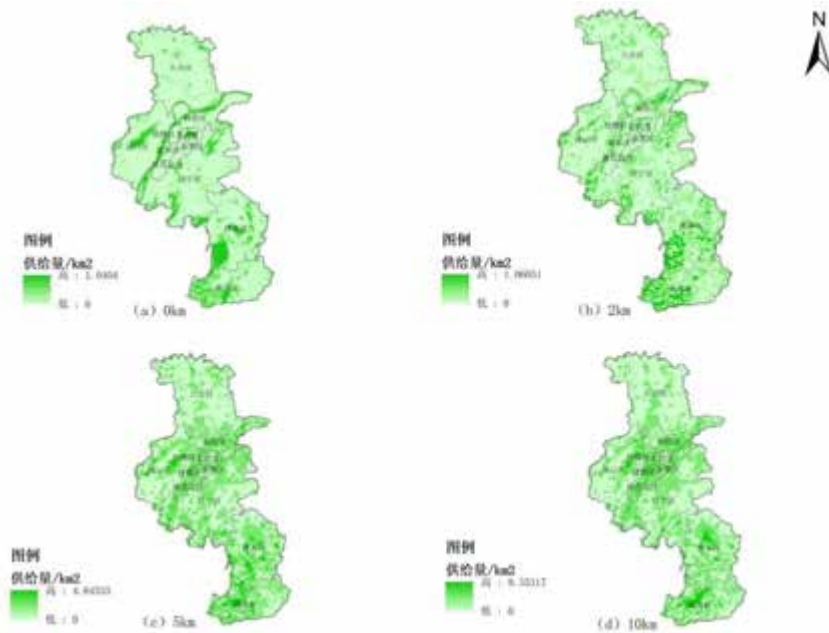


Figure 1 Supply of Leisure and Recreation Services under Different Reachable Radii in Various Administrative Regions of Nanjing City in 2020

4.2 Demand for Leisure and Recreation Services in Various Administrative Districts in Nanjing

In 2020, the highest value of leisure and recreation service demand for ecological land in Nanjing is 1.78503km². In terms of spatial distribution, the demand for recreational and leisure services is higher in the central region and relatively lower in the north and south regions. The core urban areas of Nanjing are the main concentration of high-demand zones, such as Gulou, Qinhuai, and Jianye Districts. These administrative districts have good economic development and convenient transportation, and due to the large proportion of built-up land, this has led to a large increase in the population, and consequently, a rise in the demand for recreation and leisure services. Liuhe District is the main distribution area of low-demand zones, Jiangning District, Lishui District and Gaochun District. These administrative districts are sparsely populated and have low population density, thus the demand for leisure and recreation services is low.

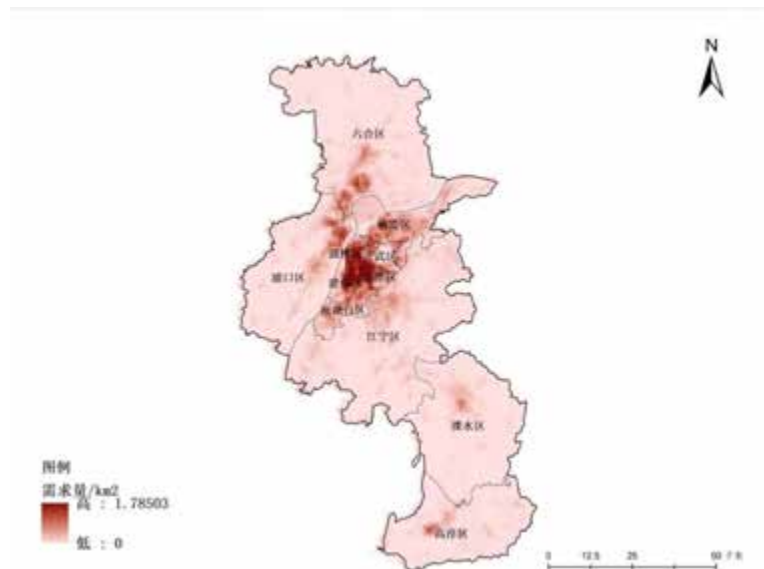


Figure 2 Demand for Leisure and Recreation Services in Various Administrative Regions of Nanjing City in 2020

4.3 Supply and demand of leisure and recreation services in Nanjing administrative districts

In 2020, the supply and demand of recreational and leisure services in Nanjing's ecological land under different accessible radii showed different characteristics, with significant heterogeneity in the spatial distribution of supply and demand, and an obvious mismatch in the location between areas of high supply and high demand, resulting in a serious spatial mismatch problem. Under 0km and 2km reachable radius, the supply of central and northern administrative districts and southern Gaochun district of Nanjing is much smaller than the demand, while the supply of Lishui district is much larger than the demand; under 5km and 10km reachable radius, the supply of central and northern administrative districts of Nanjing is much smaller than the demand, while the supply of southern Jiangning, Lishui and Gaochun districts is much larger than the demand. Overall, when the reachable radius gradually expands from 2km to 10km, the relationship between supply and demand in Nanjing is gradually improving, the deficit area continues to shrink, and the number of people failing to meet the demand for recreation and leisure services is also gradually decreasing. However, the central administrative districts of Gulou, Qinhuai, Jianye and Xuanwu have a small area of ecological land due to the concentration of population, and the number of people with unmet demand for recreation and open space services is decreasing.

However, Gulou District, Qinhuai District, Jianye District and Xuanwu District in the central part of the city have a small area of ecological land due to the concentration of population, so the decrease in the number of people with unmet demand for recreational and leisure services is relatively flat, and the relationship between supply and demand is always in a deficit. Under the 0km reachable radius, the deficit ecological land area for leisure and recreation services in Nanjing is 48.35%, and the deficit population is 82.79%; under the 2km reachable radius, the deficit ecological land area for leisure and recreation services in Nanjing is 65.1%, and the deficit population is 94.67%, which further aggravates the contradiction between supply and demand; under the 5km and 10km reachable radii, the deficit ecological land area for leisure and recreation services in Nanjing is 65.1%, and the deficit population is 94.67%, which further aggravates the contradiction between supply and demand. In 5 and 10km accessible radius, the deficit ecological land area of leisure and recreation services accounted for 24.52% and 21.63% respectively, and the deficit population accounted for 68.12% and 64.11% respectively, the supply and demand relationship improved significantly, and the relationship of leisure and recreation services in Gaochun District turned from deficit to surplus, the overall supply and demand relationship of leisure and recreation services in Nanjing is better, and the leisure and recreation services provided by ecological land basically meet the demand of the people.

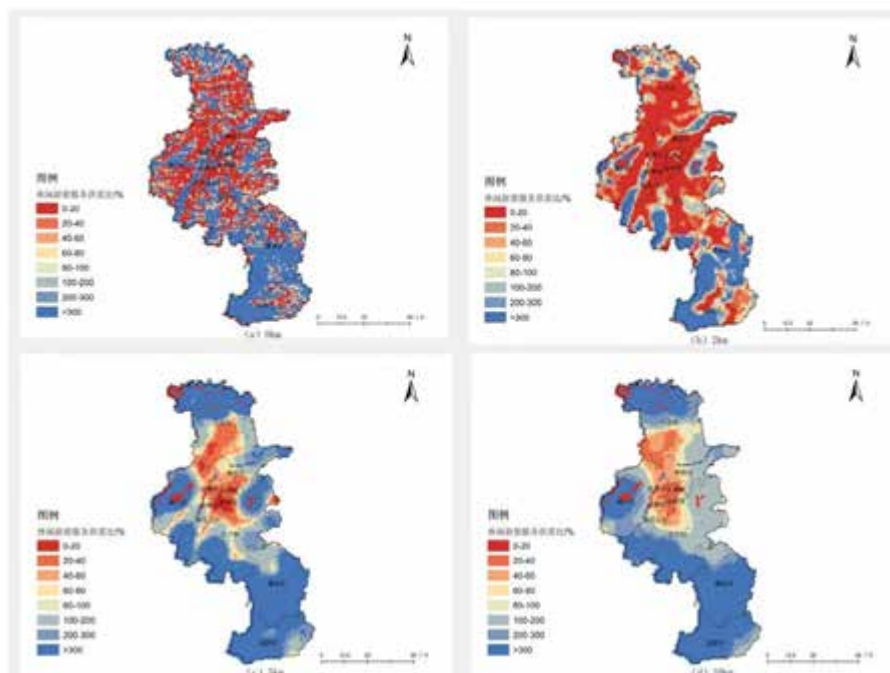


Figure 3 Supply and demand ratio leisure and recreation services under different reachable radii in various administrative regions of Nanjing in 2020

4.4 Analysis of the changing pattern of supply and demand of recreational and leisure services in Nanjing's administrative districts

The city center is generally the most prosperous area for economic, cultural and transportation development of a city. Under the background of industrialization, the proportion of ecological land has been decreasing, and as the proportion of construction land gradually rises, the number of leisure and recreational services that can be provided by ecological land also decreases accordingly. At the same time, due to the high population density in the urban core area, the residents have a high demand for quality life, which, of course, covers the urgent need for leisure and recreation services. On this basis, the study selects the grids with more than 50% of built-up land in Nanjing as the research objects, and statistically analyzes their supply and demand ratios of leisure and recreation services under different accessible radii, in order to demonstrate the supply and demand situation of leisure and recreation services in various administrative districts in Nanjing. Considering the changing pattern of supply and demand of leisure and recreation services in Nanjing under different conditions of reachable radius, this study divides the administrative districts of Nanjing into four different categories.

Locally satisfied administrative districts refer to the administrative districts with supply and demand ratios close to 100% under the 2km accessibility radius, and there is one such district, i.e. Lishui District. Lishui District has a large area of ecological land and a good relationship between the supply and demand of leisure and recreation services. It should continue to maintain this favorable trend and vigorously develop tourism and ecological industries to meet the increasing demand of residents for leisure and recreation services.

Medium-distance-satisfying administrative districts refer to those administrative districts with balanced supply and demand within a 5km accessibility radius, and there are three of them, mainly located in the suburbs of Nanjing. Some of these administrative districts have a large area of ecological land, but the population density of the area is small, the total demand for recreational and leisure services is low, and the layout of ecological land is unreasonable, so that residents can enjoy the recreational and leisure services provided by ecological land less conveniently, such as in Gaochun District, while some of the area of ecological land is smaller, but the population density of the area is even smaller, such as in Pukou and Jiangning Districts. In the future ecological land use planning, not only should the decentralized layout of green spaces in the administrative districts be

strengthened to enhance the accessibility of the region, but the supply of recreational and leisure services in the deficit areas of the region should also be expanded, e.g., by adding more recreational and leisure venues.

Distance-satisfying administrative districts refer to those administrative districts where a balance between supply and demand exists within a 10-km accessible radius, of which there is one, i.e. Qixia District. The relatively small area of ecological land in Qixia District has resulted in a serious imbalance between supply and demand of leisure and recreational services. Therefore, the construction of pocket parks should be actively promoted and a dedicated tourism line should be established with the geographically close Liuhe District to meet the diversified demand for leisure and recreation services of residents in Qixia District.

Unsatisfiable administrative districts refer to areas where the supply and demand for leisure and recreation services is always below 100% within an arbitrary radius, and there are 6 such districts, which are mainly concentrated in the central urban area of Nanjing, and the leisure and recreation services provided by ecological land in the area are always unable to satisfy the demand of the residents. These districts should develop areas that can provide leisure and recreation services without affecting the city's economic development, create pocket parks and micro-green spaces, expand leisure and recreation spaces within the neighborhoods, and increase the area's green coverage rate, so as to improve the contradiction between the supply and demand of leisure and recreation services in the area and enhance the well-being of the residents.

District Name	0km	2km	5km	10km
Gaochun District	45.92	24.35	504.53	867.11
Gulou District	54.93	3.91	36.3	40.66
Jian YE District	22.63	4.88	45.8	49.41
Jiangning District	82.17	13.75	149.98	154.31
Lishui District	94.05	14.35	288.42	392.65
Liuhe District	44.11	9.68	60.11	65.05
Pukou District	56.71	13.54	146.67	145.14
Qixia District	51.52	11.36	93.57	100.97
Qinhuai District	18.65	1.18	19.22	44.55
Xuanwu District	42.96	3.96	41.01	57.58
Yuhuatai District	25.26	7.93	85.89	91.11

Figure 4 Supply and demand ratio fleisure and recreation services under different reachable radii in Nanjing administrative region in 2020

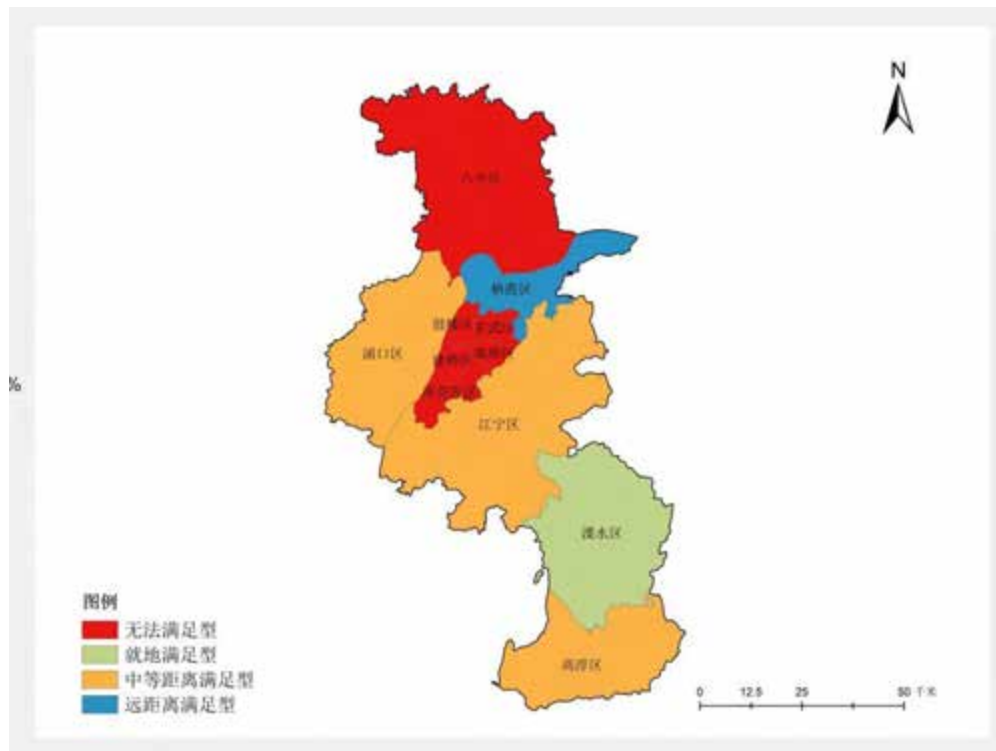


Figure5 Supply and Demand of Leisure and Recreation Services in Various Administrative Regions of Nanjing City in 2020

V. Conclusion and Outlook

This study utilizes land use and demographic data, and utilizes a methodology for assessing the supply and demand relationship of regional recreational and leisure services under different accessibility radii. It also examines the changes in the supply and demand relationship of recreational and leisure services in various administrative districts of Nanjing in 2020, and explores the spatial distribution of the supply and demand relationship under different accessibility radii, and the following are the main findings:

The supply and demand relationship of leisure and recreation services in Nanjing is characterized by very obvious regional characteristics, which is mainly closely related to the geographic location, population density, ecological land layout and urban planning of different regions. Firstly, high demand areas are mainly concentrated in the administrative districts of the city center. These districts are usually the centers of economic, cultural and social activities, attracting a large number of people to gather. Due to the limited nature of land resources, the area of ecological land in these districts is relatively small, and the construction of leisure and recreational facilities is also restricted. As a result, despite the high demand for leisure and recreation services, the supply is relatively low, leading to an imbalance between supply and demand. In contrast, high supply areas are located in the urban outskirts. These areas are less densely populated and relatively rich in land resources, and hence have more space for leisure and open space facilities. However, the layout of ecological land in these areas may not be rationalized. For example, some of the recreational open spaces may be too dispersed or far away from the residential areas, making it inconvenient for residents to use them. In addition, some of the leisure and open spaces may lack the necessary ancillary facilities and services, thus affecting their service quality and attractiveness.

When the reachable radius gradually expands from 2km to 10km, the supply and demand relationship in NJ shows a significant improvement. Such an improvement is mainly manifested in the gradual reduction in the size of the deficit area and the continuous decline in the number of people with unmet demand for leisure and recreation services. Firstly, the expansion of the accessibility radius means that residents can enjoy leisure and

recreation service facilities more conveniently, and service areas that might have been difficult to reach due to long distances are now within reach due to the expansion of the accessibility radius. As a result, the imbalance between supply and demand in the service areas has been effectively alleviated, and the size of the deficit areas will naturally be reduced accordingly. Secondly, with the reduction in the size of the deficit areas, those residents who were originally unable to enjoy leisure and recreation services due to the distance problem are now provided with more choices and their needs are better met, thus the number of people with unmet demand for leisure and recreation services is also decreasing. In addition, the expansion of the radius of accessibility may bring about a series of knock-on effects. For example, as the accessibility of service facilities improves, more people may be willing to visit these facilities for consumption, thus further stimulating the development of related industries. At the same time, the utilization rate of service facilities will also be improved, which will help to achieve optimal allocation of resources.

Based on the spatial distribution characteristics of leisure and recreation services in Nanjing administrative districts under different accessibility radii, we subdivided them into four different categories of areas: locally satisfied, moderately satisfied, distantly satisfied, and unsatisfied, and put forward targeted development proposals respectively. The supply and demand of leisure and recreation services in locally satisfying and moderately satisfying regions are relatively balanced, and can meet the basic leisure and recreation needs of residents, and the creation of urban "green space" should be continuously strengthened to enhance the connection with the city center administrative region, and create a more attractive leisure and recreation brand by combining with the regional characteristics; the long-distance satisfying and unable to satisfy regions should strengthen infrastructure construction and rationalize the distribution of leisure and recreation services. Distance-supporting and non-supporting regions should strengthen infrastructure construction, rationalize the distribution of ecological land, improve connectivity and accessibility between different administrative regions, and at the same time, strengthen ties and cooperation with the outside world, introduce high-quality recreation and leisure resources and technologies, and promote the improvement of the relationship between supply and demand of regional recreation and leisure services.

At the same time, this study is innovative in terms of research perspectives and ideas: on the one hand, it fills the gap of research on the supply and demand relationship of recreation and leisure services at the level of city districts; on the other hand, it systematically analyzes the characteristics of changes in the supply and demand and puts forward suggestions for improvement, which is of practical guidance significance. However, there are some shortcomings in the study: the assessment of supply is only based on area, ignoring the quality of service; road accessibility is not taken into account, which may overestimate the actual supply; the determination of the accessible radius does not adequately reflect the willingness of the residents to travel; and the standard of demand lacks uniformity. Future research should construct a comprehensive supply evaluation system, introduce road accessibility analysis, incorporate residents' willingness to travel surveys, and improve the demand volume standard, in order to enhance the scientific and applicability of the assessment and provide more accurate support for urban planning.

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