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Greenway Non-mortorized System Planning from the Perspective of Public Health

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Abstract The important role of greenway non-mortorized systems in urban sustainable development was summarized, pointing out their potential value in improving the ecological environment, promoting healthy living, and enhancing community connections. Based on the analysis on some cases of urban greenway construction in China, specific transformation models and strategies were proposed for greenway construction, which could integrate green spaces with non-mortorized system, so as to enhance the comprehensive efficiency of urban linear spaces.

Keywords Non-mortorized system, Public health, Urban Greenway

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With the acceleration of urbanization, the rational utilization of urban space and sustainable development of environment have become important issues faced by urban planners and decision-makers. Public health, as an important component of urban development, is not only related to the physical form of the city, but also to the quality of life of residents and the ecological balance of the city. Therefore, the design and research of greenway non-mortorized system, as an important component of urban public spaces, are of particular importance.

Urban greenway is a trinity of urban public resources, public infrastructure, and public service facilities[1]. The greenway non-motorized system, also known as the green slow traffic system, is a new type of transportation mode that combines natural landscapes and urban transportation. By building a continuous network of green spaces, the system can provide citizens with a slow mode of transportation, promote sustainable development, improve the living environment of residents, and enhance the ecological function of the city by building .

There have been many studies on the construction of urban greenway non-motorized system, which emphasizes the priority of non-motorized traffic, finding that landscape design and environmental improvement can enhance the safety and comfort of the non-motorized system[2]. In the context of public health, the design and implementation of greenway non-motorized systems need to constantly adapt to the needs of urban development. Based on public health theory and non-motorized systems, this research aims to provide theoretical support and practical guidance for urban planners and decision-makers, promote the rational use of urban space, improve the quality of life of urban residents, and promote sustainable development of cities.

1 Related concepts

1.1 Modern public health

Different from what people often refer to as physical health, "public health" refers to community health aimed at preventing physical and mental illnesses, prolonging public life, and promoting community health. After the outbreak of the COVID-19, more and more attention has been paid to health, so public health has gradually changed from a narrow focus on individual physical and mental health to a broad focus on the multi-dimensional health model of the common development of community, environment and social health[3].

1.2 Urban greenway

Through the review of relevant literature, it is found that foreign scholars have conducted research on greenways earlier, covering a wide range of research fields. *The Guidelines for Greenway Planning and Design* define greenways as green open spaces that rely on natural elements, connect urban and rural areas with recreational and leisure functions, mainly for entertainment and leisure, which can meet the ecological travel needs of urban residents, and promote the migration of biological populations. In terms of composition, urban greenways consist of green corridors and manual systems. In terms of functions, the corridor system has functions such as ecological conservation and environmental beautification; manual systems have greenway recreational functions, providing residents with non-motorized road systems[4]. Located in the urban built-up environment, urban greenways have functions of connecting urban units, assisting urban transportation, and undertaking leisure and recreation.

1.3 Non-mortorized system

Non-motorized system is a low-speed, low-carbon, and low pollution transportation mode emphasized in modern urban planning, mainly including pedestrian walkways, bicycle lanes, and wheelchair access. Its goal is to create a safe, comfortable, and convenient environment for pedestrians and non-motorized vehicles to travel. With safety, convenience, health, and environmental friendliness as the core concept, the non-motorized system generally refers to the transportation mode with a speed not exceeding 15km/h, mainly for walking and non-motorized vehicles (mainly bicycles), and is a comprehensive urban network with multiple functions[5-7].

2 Greenway cases in China for reference

2.1 Greenway construction in Guangzhou

Due to its unique geographical location, Guangzhou has formed a unique urban spatial pattern of mountain-city-sea. In addition, the subtropical monsoon climate and coastal location are conducive to plant growth and lay the foundation for greenway ecological construction. *The Guangzhou Greenway Plan* fully embodies the concepts of ecological priority, green development, and humanism. The plan not only focuses on ecological restoration and protection, but also on enhancing the experience of citizens and tourists, establishing additional facilities for leisure, entertainment, sports and fitnes, ensuring that the greenway not only improves environmental quality but also meets the public's demand for a healthy lifestyle. Greenway system planning is not limited to a single walking or cycling path, but also integrates multiple functional uses to form a high-quality greenway system. This integration not only enhances the ornamental value of greenways, but also enriches the activity choices of citizens and tourists, achieving the integration of multiple functions

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such as ecology, leisure, culture, and education. The construction of greenways in Guangzhou has spanned multiple periods, and its evolution reflects the gradual integration and deepening of urban planning and ecological protection concepts. From 2001 to 2006, the protection of green open areas was clearly defined in the form of laws. In 2009, the construction of greenway network was proposed, clarifying the planning plan for the Pearl River Delta greenway network. In 2011, the Pearl River Delta Greenway Network was successfully connected, enabling the rapid development of Guangzhou's greenway system and enriching its cultural landscape resources. *The Outline of the Overall Planning of the Greenway Network in the the Pearl River Delta*, prepared in 2010, proposes to follow the "five-sphere integrated plan" (comprehensive improvement of political, economic, social, cultural and ecological fields in a coordinated, balanced and sustainable manner) to build an ecological service network. In 2023, the Guangzhou Municipal People's Government issued the *Guangzhou Green Space System Plan* (*2021–2035*), which clarifies and improves the construction of the greenway network, proposes upgrading strategies for greenway functions, and connecting parks and greenways to build an urban and rural leisure and entertainment system.

2.2 Characteristics of greenway cons–truction in Guangzhou

Urban green spaces can provide stronger social exposure opportunities than other public facilities, and are a general carrier for residents' sports, leisure, and activities[8-9]. Greenways are not only pathways, but also display windows for urban culture and stages for community activities. In order to enhance the Guangzhou greenway brand, efforts have been made to improve the greenway system construction, continuously connect regional greenways and urban greenways, and strengthen community greenway construction, which has promoted the linkage construction of greenways with green roads, ancient post roads in southern Guangdong, forest trails and other spaces. Guangzhou plans to have no less than 4,000 km of greenways throughout the city by 2035. At present, there are greenways passing through the city, connecting the most beautiful mountains, waters, and cultural landscapes in Guangzhou. The main characteristics of greenway cons-truction in Guangzhou are: strengthening the construction of dynamic green corridors such as greenways, connecting various parks and urban units, and forming a leisure and recreation network. It is expected that the proportion of park connectivity will increase from 58% in 2020 to over 80% in 2035.

The greenway system of Guangzhou has been optimized with reasonable layout, complete supporting facilities and rich functions. Relying on the opportunity of the construction of the green road, focus has been laid on connecting the riverside public spaces such as the Pearl River West Channel and the the Pearl River Back Channel, accelerating the construction of greenways such as Huandao Road, Yanjiang Avenue and Shawan Waterway, and creating a central urban and suburban green ecological space with blue and green interwoven; greenways have been built to connect the central urban area to Nansha District based on major rivers and streams; more community greenways are established orderly along Liwan District, Tianhe District, and Nansha District to serve residents' daily travel. The diversity of greenway themes also promotes the diversity of service users, such as ecological greenways, consumer greenways, and leisure and sightseeing greenways. In addition, there are urban greenways that are integrated with the non-motorized vehicle system for low-carbon travel in the city.

2.3 Impact of greenway construction in Guangzhou

Guangzhou regards greenway construction as infrastructure construction and learns some advanced ideas with complete greenway construction, planning and design through the international collaboration and communication. The continuous exploration of innovative greenway types has enriched the connotation of greenways. Various greenways, such as park greenways, fruit greenways, wetland greenways, are connected in series. The greenways are built into a connected network with a wide coverage area and beautiful scenery along the route. In the greenway planning, post stations are added and convenient facilities such as shared bicycles and mobile phone charging are equipped. The construction of greenways is aimed at increasing green space and protecting the ecological environment. With the national goal of carbon peaking and carbon neutrality in China, the construction of greenways has a great effect on carbon emissions and absorption, and is conducive to carbon cycling. The construction of greenways promotes the integration of urban and rural areas, drives an increase in tourist numbers, enhances economic growth, and narrows the urban-rural gap. In summary, the construction of greenways in Guangzhou not only improves the urban ecological environment and enhances the quality of life of residents, but also promotes economic development and social progress, becoming an important component of urban sustainable development.

3 Case study of urban greenway route selection and planning in Qingshanhu District, Nanchang, China

3.1 Data sources

Bigemap map was used to obtain point of interest (POI) data of the public space on May 20, 2024, and then ArcGIS was used to process the data, obtaining the POI data of Qingshanhu public space. Based on this, kernel density was used to analyze the spatial distribution of commercial, medical, cultural, and office spaces in Qingshanhu area, obtaining the distribution of potential non-motorized nodes in the greenway selection of Qingshanhu area.

3.2 Selection of key connection nodes for greenway

3.2.1 Density of public service space usage. Firstly, the POI data of 4 main selected types of public services, namely, commercial, office, medical, and cultural, were collected. Subsequently, ArcGIS software was used for kernel density analysis to quantify the spatial distribution characteristics of various public service facilities in Qingshanhu District. Through this method, a heat map of the distribution density of public service spaces in Qingshanhu District was generated (Fig.1), and the overall distribution characteristics of public service spaces in the area were comprehensively analyzed. This study provides a scientific basis for optimizing the layout of urban public service facilities.

3.2.2 Key potential spaces in greenways. In addition to the improvement of health through the addition of external materials of environmentally friendly social infrastructure, the construction of urban greenways promotes social interaction and various leisure activities, thereby enhancing social cohesion and trust[10-12]. Users can also get the optimization of physical and mental health. No matter for physical and mental health, social recognition, or regional development effects, the social benefits of urban green spaces have characteristics that are difficult to directly quantify. Thus, based on accessibility analysis, correlation analysis and factor influence degree analysis are still the main mechanism exploration methods[13]. Belt shaped green spaces and linear infrastructure spaces in urban built-up areas are considered key available resources for urban greenway construction. By analyzing POI data on the spatial distribution of green spaces in Qingshanhu District, the travel route preferences of citizens were collected

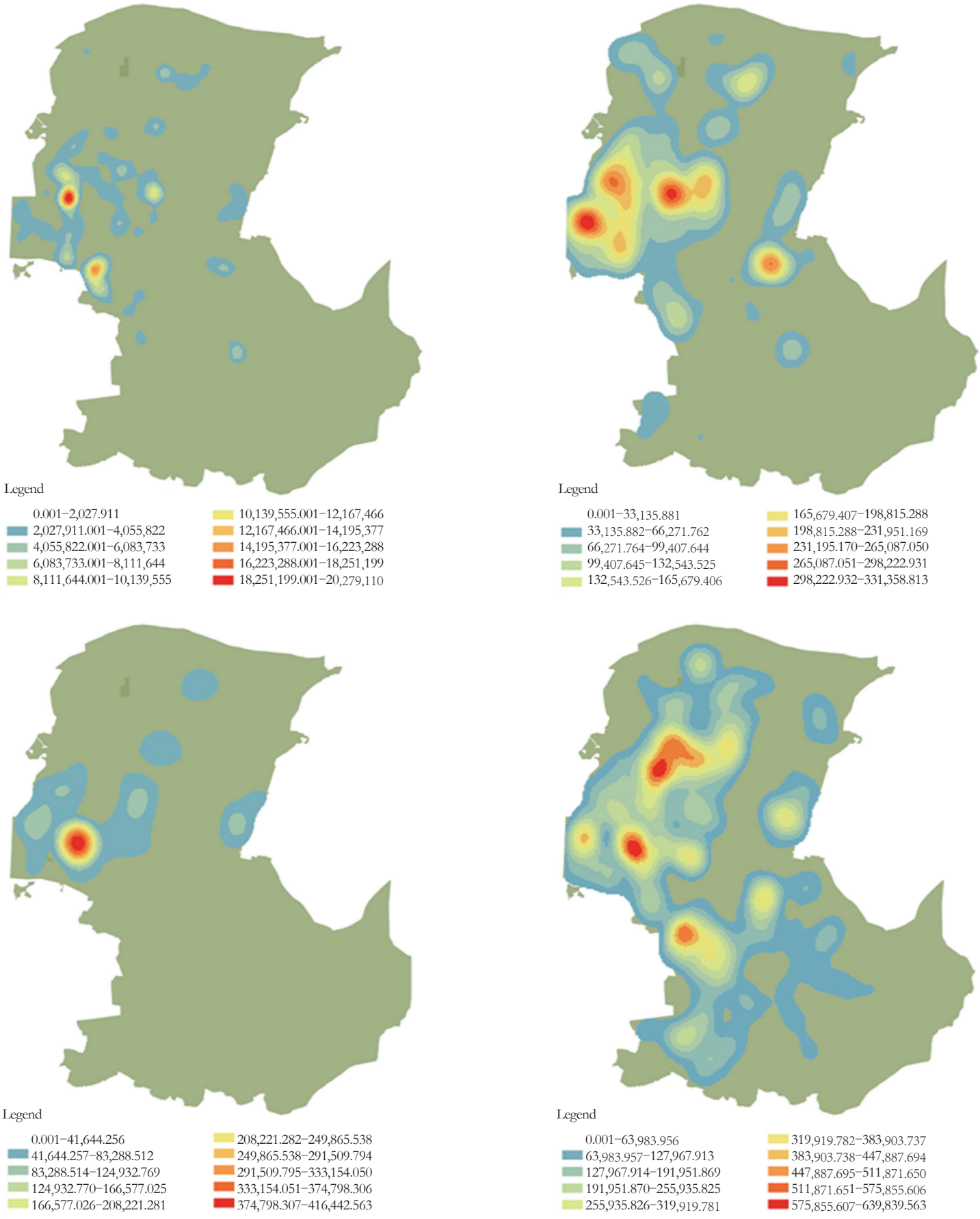

Fig.1 Heat map of the distribution density of public service spaces in Qingshanhu District

and analyzed. Then, ArcGIS software was used for kernel density analysis to reveal the spatial distribution patterns of public service facilities, thereby generating corresponding heat maps. The research results indicate that high-frequency usage areas identified by kernel density analysis should be given higher priority for renovation and service improvement in greenway planning and optimization of non-motorized systems. This method provides a scientific basis for the selection and layout of urban greenways, which helps to optimize urban spatial functions and enhance citizens' travel experience.

4 Construction mode of green–way non–mortorized system based on public health

4.1 Urban greenway construction model based on roads

The main purpose of road renovation is to provide urban residents with a safer and more comfortable non-motorized travel experience. This type of renovation is usually achieved through the redistribution of ground-level road usage rights and the layered design of roads. Redistributing the usage rights of ground-level roads means giving more road resources to walking and cycling, representing a significant shift in the concept of urban transportation development. In specific implementation, various strategies can be adopted: in areas with limited space and insufficient non-motorized facilities, some motorways can be converted into non-motorized areas; in areas with ample space and beautiful scenery, a multifunctional pathway for walking and cycling can be planned in the center of the road; in streets where commercial or scenic areas are concentrated on one side, non-motorized systems can be set up only on one side. Such approach can not only ensure the improvement of the urban non-motorized system, but enhance the public vitality of the roads. This transformation helps promote diversified and environmentally friendly non-motorized traffic modes in urban development, and reduces reliance on motor vehicles. For urban roads with high traffic volume, the semi-sinking method can be used to effectively divide the road space into layers and create more space for non-motorized traffic. Although this renovation method has higher costs and more complex technical requirements, it has been increasingly adopted by cities, especially in areas with high land value.

4.2 Urban greenway construction model based on river channels

In the study area, where river is the region with a good ecological environment, corresponding measures can be taken to improve the traffic and environment on both sides of the river. The layout of local urban roads can be adjusted to provide waterfront walkways and bike lanes in river sections that lack space. For river sections with abundant space, corresponding renovations should be carried out according to local culture and residents' needs. In addition, a hydrophilic platform can be constructed by combining steps and trails to form an ecological embankment. In suburban areas, if the space on both sides of the river is spacious, a linear park can be constructed and connected to the urban greenway system to enhance the connection between the city and nature. This measure aims to enrich the construction of urban greenways based on rivers, while increasing the number of leisure spaces for residents.

4.3 Development model of urban green–ways along railways

For elevated railways, the space beneath the bridge can be fully utilized to construct greenways and public leisure areas. For ground railways, greenways can be established above the railway. For the planning and construction of underground and semi-underground railway greenways, the linear space above the railway can be utilized. The combination of greenways and railway corridors in international urban planning has become a new trend, and it has been proven in practice that the design of greenways combined with railway corridors is not limited by the height of buildings along the railway. Therefore, in greenway planning and design, utilizing railway corridors not only improves the efficiency of urban space utilization, but also provides more green leisure spaces for citizens.

5 Conclusion

Starting from the dimension of spatial potential, this study analyzes the spatial utilization needs of urban greenways from the perspective of public health, aiming to explore the route selection methods for planning urban greenways in complex urban environments. With Qingshanhu District in Nanchang City as the example, the planning framework is studied, and a series of renovation strategies are proposed for the main spaces, such as roads, rivers, railway corridors, and linear green spaces, which can be used to construct greenways. Moreover, the coupling between greenways and non-motorized system can optimize the design of urban linear spatial functions. Meanwhile, with the integration of more data, the proposed route selection framework can be continuously improved and expanded to make it more scientific and accurate, so as to provide references for urban greenway construction in other regions.

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