Construction and Improvement of Urban Greening Space in Old Town Core Area Based on GIS Spatial Analysis Technology

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Abstract

As China's urbanization process continues to accelerate, the land for urban construction is becoming increasingly tight, green spaces in urban landscapes are continuously eroded, and the ecological patches are seriously fragmented. It seems relevant to use community greenways as a platform for the path of urban ecological space integration and restoration. Taking the core area of the old city of Hefei as an example, the study applies the idea of eco-city as a guide, applies GIS spatial analysis technology, and derives a community greenway network based on the minimum landscape resistance value by selecting the resources of patches in the core area of the old city and calculating the landscape resistance value of urban land to improve the ecological quality of the city.
Keywords*: Eco-city, Core areas of old cities, Community greenways*

I.Eco-city Planning and the Connotation of Community Greenways

The idea of the eco-city has a long history. The prototype of eco-city can be traced back to ancient Chinese habitats, ancient European cities and American Indian villages[1]. In the 1970s, eco-city theory and its related practices entered a phase of rapid development. Many urban planning experts in Europe and the United States drew on the then-popular environmental concepts to promote urban environmental improvements. The 21st century has witnessed a new development of eco-city thinking. The construction of eco-cities is not just a reordering of the physical structure of cities, but also aims to improve their social and environmental well-being[2].

Greenway is a corridor that relies on natural elements as the basis of composition, links urban and rural recreation, leisure and other green open space, focusing on recreation and fitness, as well as green travel for the public and biological migration and other functions. China's greenways are divided into regional greenways, city (county) level greenways and community level greenways. Community greenways refer to the greenways that connect urban and rural settlements with their surrounding green open spaces within the scope of urban communities and facilitate community residents to use them nearby[3]. Therefore, community greenways are the micro-circulation system of the urban greenway network, which is closely associated with the daily life of urban residents.

With the accelerated urbanization process in China, various "urban diseases" have emerged one after another and are becoming more and more serious. Especially in the densely built-up urban areas represented by old cities, the long-term unreasonable structures of construction land and excessive construction density have led to the fragmentation of urban green space patches and humanitarian patches. Therefore, ecologists and bioconservationists have begun to advocate maintaining and increasing the connectivity of green spaces by planning urban green space ecological corridors [4]. At the scale of urban communities, community greenways are naturally the main building blocks of the ecological network at the community scale, connecting the scattered "points" and "surfaces" in the

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community with the linear spaces in the urban green space system, forming the green skeleton of the urban community[5]. In addition, community greenways, as an important part of the city's slow walking system, provide a beautiful and comfortable travel environment for the majority of the city's residents to commute to school, work and other commuting activities.

II. Methods of Community Greenway Planning and Route Selection from an Eco-city Perspective

(1) Overview of the study scope

This paper takes the core area of the old city of Hefei as the study area to explore the community greenway planning based on the eco-city concept. The core area of the old city of Hefei is located within the ring road, between 117°15'20.24 "E-117°17'44.12 "E and 31°52'35.77 "N-31°51'10.31 "N. The core area of the old city is about 5.6 square kilometers. Due to the long-term high overlapping of urban functions, the urban land in the core area of the old city is extremely tight. Coupled with the distribution of more old closed communities, the fragmentation of urban green space patches is more serious in the core area of the old city.

(2) Data sources

The data of this study are remote sensing images and the current land use map of the core area of the old city of Hefei. According to the current land use map of the core area of the old city, its current land was divided into residential land, park land, square land, administrative office land, business land, commercial land, medical land, education and research land, cultural facilities land, sports land and transportation land. Later on, different landscape resistance values were assigned to the transportation land in the core area of the old city, so the transportation land was then subdivided into main roads, secondary roads and bypasses. Using the above classification criteria, the remote sensing images of the core area of the old city were visually interpreted to produce vector maps of the current site in preparation for subsequent analysis.

(3) Research methodology

1) Selection of ecological patches in the core area of the old city

According to the relevant principles of landscape ecology and community greenway planning objectives, the ecological patches in the core area of the old city were divided into two categories: source patches and target patches. The source patches are mainly the existing large urban parks, squares and other green areas in the core area of the old city and the main river systems. These patches are larger in size, clustered and less fragmented, and play the role of metapoints in the flow of urban ecological material and energy, so they are defined as source patches. In this study, 25 landscaped green areas such as Huancheng Park and City Hall Square in the core area of the old city were directly selected as source patches for community greenway connections.

Target patches are urban green space patches other than source patches, and are points through which the potential flow of urban ecological material and energy passes and reaches. The target patches connected by the community greenways are more inclined to the green areas of various residential clusters in the core area of the old city. The community greenway connects the source patches with the target patches, plays the social function of a greenway, and facilitates green travel for residents.

The 64 residential areas in the core area of the old city were used as potential target patches, and the residential areas with small green area clusters (less than 3,500 m^2) in the group were excluded. The final target patches were then selected by gravitational analysis between patches. The gravitational force between the source patches and the potential target patches was calculated based on the implication principle of the gravitational force model. The expression of gravitational force calculation is __, where _ denotes the gravitational force between patches 1 and 2; _ denotes the area of patches 1 and 2, and D 12 denotes the distance between the center of mass of patches 1 and 2. After calculating the gravitational force between the source and potential target patches using ArcMap10, a number of potential target patches with too small gravitational force values were removed.

2) Calculation of the landscape resistance value of the land in the core area of the old city

The community greenway network carrier in the core of the old city is an urban linear space with different attributes between the source and target patches. Of course, as a community greenway used by urban residents in their daily life, its corridor system is necessarily close to each residential area of the city. The non-motorized paths of arterial roads of urban living type and the roads below the grade can be used as important components of community greenways[6]. Therefore, before assigning landscape resistance values to each urban site in the core area of the old city, the landscape resistance values of various types of transportation sites were systematically analyzed. Through on-site research and statistics of public infrastructure in the core area of the old city in Baidu Maps, a public infrastructure kernel density analysis map along both sides of the street in the core area of the old city was generated. According to the public infrastructure nuclear density analysis map, reclassification was carried out and the area was divided into five classes (see Figure 1).

The smaller the score, the less public infrastructure there is on both sides of the transportation site. Based on this, 7 urban road segments were eliminated. The remaining 85 urban roads were evaluated by AHP (Analytic Hierarchy Process) for landscape resistance value. The evaluation index system is shown in Table 1.

Tab 1: Evaluation system of landscape resistance value of urban transportation land

Primary indicators	Secondary indicators	Weight	Score		
			5	10	15
Road profile	Road type Parking zone setting TOD tightness	0.1 0.08 0.1	Branch roads Two-way stop, one-way drive No connection	Secondary roads One-way parking, one-way drive Adjacent to rail station	Main road No parking zone Through the rail station
Greening factor	Levels of plant landscape Canopy width	0.1 0.05 0.05 0.03	Only one level of arbor <4m None	Two levels of arbor and shrubs 4-6m 1.2-2m	Three levels of arbor, shrubs, flowering plants and trees

	of street trees Green belt width of street trees Ornamental features of plant landscape		No significant changes in color, morphology, seasonality, etc.	Ordinary in terms of color, morphology, seasonality, etc.	≥6m ≥2m Good in terms of color, morphology, seasonality, etc.
Hard pavement factor	Sidewalk width	0.2	＜2m	2－4m	≥4m
	Walking comfort	0.06	Poor in continuous and smooth pedestrian network and rhythm of pavement form	Ordinary in continuous and smooth pedestrian network and rhythm of pavement form	Good in continuous and smooth pedestrian network and rhythm of pavement form
	Safety	0.04	Poor in anti-slip pavement material, clear route guidance information, and barrier-free design	Ordinary in anti-slip pavement material, clear route guidance information, and barrier-free design	Good in anti-slip pavement material, clear route guidance information, and barrier-free design
	Urban furnishings	0.03	Poor in content, volume, scale and location of urban furniture	Ordinary in content, volume, scale and location of urban furniture	Rational in content, volume, scale and location of urban furniture
Urban appearance factor	Openness of buildings along the street	0.06	Poor openness	Fair openness	Good openness
	Distribution of public infrastructure	0.05	Sporadic distribution of public infrastructure	Local distribution of public infrastructure	Uniform distribution of public infrastructure
	Aesthetics of the façade along the street	0.05	Poor in space combination, façade form, roof profile and material color of the building	Ordinary in space combination, façade form, roof profile and material color of the building	Good in space combination, façade form, roof profile and material color of the building

The landscape resistance values were then assigned according to the degree of association of other

urban land uses with the community greenway (see Table 2). Finally, the vector map of land use types in the core area of the old city was transformed into raster data based on the landscape resistance values.

3) Formation of community greenway network in the core area of the old city

Based on the landscape resistance raster of the core area of the old city and the previously determined source and target patches, ArcMap10 was used to generate a community greenway network based on the minimum landscape resistance value. Based on the preliminary greenway planning results formed, the community greenways were considered comprehensively as a functional carrier for seamless green connections under the TOD model, and the community greenways were linked to each station of rail transit line 2 within the core area of the old city. In addition, in order to better make the community greenway close to the life of urban residents, the accessibility of the community greenway was evaluated by using the standard that citizens can reach the community greenway within a 5-minute walk (about 200 m) [7]. A 200-m buffer zone of community greenways was generated, and in its uncovered area, the greenway routes were appropriately added to make the community greenway network in the core area of the old city fully covered to all residential areas. Through the above optimized layout of the routes, combined with the master plan for the construction of the spatial greenway network system in Hefei (2012-2020), the final community greenway network in the core area of the old city was generated (see Figure 2).

Tab 2: Landscape resistance values for other types of urban land

Type of urban land	Landscape resistance value
Residential land	15
Park green space	5
Square land	30
Land for administrative offices	70
Business land	70
Commercial land	40
Medical land	40
Land for education and research	30
Land for cultural facilities	12
Land for sports	10

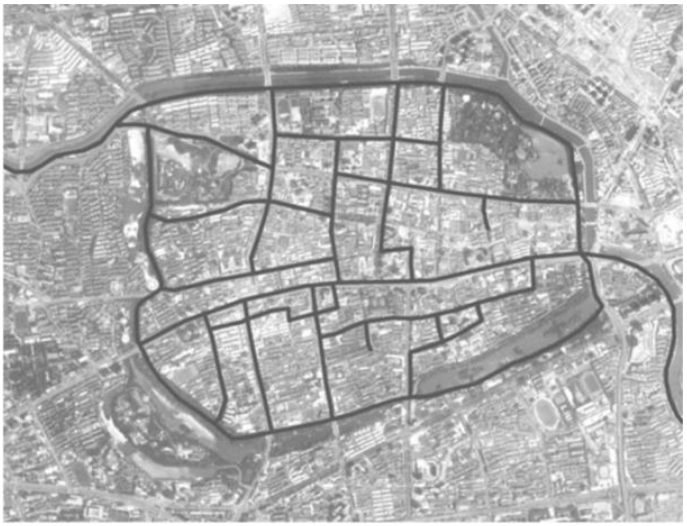

Fig 2: Community greenway network planning in the core area of the old city

III. Community Greenway Design and Construction Methods from an Eco-city Perspective

(1) Principles of community greenway design and construction

First of all, the community greenway design and construction should follow the principle of livability. In order for community greenways to truly come into the lives of citizens, they must be connected to each community center and take on the function of a place to carry out community services, leisure, social and recreational activities with community greenways as a carrier. From this perspective, the design of the green corridor system of community greenways should not only pay attention to the conservation of biodiversity, but also to the principle of people-oriented [8], so that the composed greenway network can provide more convenient green travel and green life for citizens. Therefore, the width of community greenways should not be limited to a certain type, but should be combined with factors such as specific land use and human activities. Community greenways should adopt different section designs for different land use properties along the route.

Second, community greenway design and construction should follow the principle of aesthetics. The greatest significance of community greenway construction is to make a seamless connection between the "concrete boxes" in the city and nature, and to provide the nearest channel for citizens to appreciate the beauty of nature. Therefore, the design and construction of community greenways must reflect the pursuit of urban aesthetics, allowing citizens to live in the landscape, activating various aesthetic senses of the body and gaining a high degree of spiritual enjoyment[9]. According to different styles and types of community greenways in the core area of the old city of Hefei, they can shape their own "personality", which is a necessary condition for the greenway to have deep feelings with pedestrians. For example, depending on the nature of the surrounding land, the community greenways in the core area of the old city of Hefei can win with natural ecological landscapes and humanistic landscapes, or create features based on the surrounding places of interest and regional culture, or create something out of nothing with modern public art as the theme.

(2) Specific methods of community greenway design and construction

The community greenway network is composed of green corridor system, slow walking system, service facility system, signage system and other support systems. Among these systems, the green corridor system and the slow walking system are the core elements of the community greenway network, and are also the systems that are more closely related to the construction of an eco-city.

IV.Conclusion

With the accelerated urbanization in China, urban construction land is becoming increasingly tight and ecological patches are severely fragmented. Therefore, it is especially important to establish interconnected ecological corridors to protect urban ecological security patterns with the guidance of the eco-city idea in cities where it is difficult to free up large areas of land for planning ecological patches. The community is the smallest component unit of the city and the core of the ecological city. Taking the construction of community greenways as an opportunity, we can start from the smallest scale ecological corridor and connect the green areas of residential clusters with the urban green space system, which will certainly help to build a livable urban environment with balanced social resources and perfect urban functions. In the construction of an eco-city, a community greenway is no longer just an independent green slow walking system, but a green channel network that connects with urban open space, with urban green space system, and with urban public transportation[14]. It is believed that community greenways enable a better life for the city.

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