Research Paper

Research on low-carbon renewal strategy of large-scale residential communities from the perspective of “climate positive”

a case study of Huilongguan Street area in huitian area

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Abstract

As cities grow, climate change becomes one of the major issues facing the world. As large residential communities are important exploration areas and urban residents gathering places in the healthy climate plan initiated by C40, how to update them with low carbon to cope with climate change and rapid urbanization has become an important issue. From the perspective of "Climate Positive", the research object is based on the area of Huilongguan Street in the Huitian area of Beijing, the largest residential community in Asia, and summarizes community problems based on environmental characteristics, including road system, spatial structure, and public services. Based on this, a low-carbon renewal strategy at the macro, meso and micro levels is proposed, including the construction of a road network system with a complete system and dense density; Improve the public transportation system and build a diversified and multi-level public service facility system; Build a slow travel system that connects multiple living places to reduce carbon emissions. In order to promote carbon emission reduction in urban communities, mitigate climate change, and provide new ideas for improving the environmental quality and quality of life of residents in large residential communities.

Keywords

Climate positive, large residential community, low-carbon renewal

1. Introduction

Climate change is becoming an important issue facing the world. In the 2016 Paris Agreement, controlling greenhouse gas emissions became the consensus of all countries[1]. In 2020, China officially proposed the "dual carbon" development goal, and reducing urban carbon emissions has become an important starting point for achieving the "dual carbon" goal. In 2021, the State Council commissioned the Action Plan for Peaking Carbon Emissions before 2030, which clarifies that economic and social development is based on green and low-carbon development. The 26th session of the United Nations Climate Change Conference in 2021 urgently called for unified action to combat climate change. Urban renewal initiatives have become mainstream. Cities are the most human-intensive regions, accounting for 75% of global greenhouse gas emissions[2]. China's CO2 emissions from 287 cities above the prefecture level account for 58% of China's total. 84%, and more than 80% in cities and towns [3].

In 2020, China's urbanization rate has reached 63.9%, and in the same year, the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China clearly proposed the strategic deployment of "implementing urban renewal actions", and the urban development model changed from "incremental expansion" to "stock renewal". In June 2022, the Ministry of Housing and Urban-Rural Development and the National Development and Reform Commission issued the Notice on Printing and Distributing the Implementation Plan for Carbon Peaking in the Field of Urban and Rural Construction, which further clarifies the guiding ideology of "taking green and low-carbon development as the guide, promoting urban renewal actions and rural construction actions, accelerating the transformation of urban and rural construction methods, and improving the quality of green and low-carbon development". Therefore, low-carbon urban renewal will become an important issue to cope with climate change and rapid urbanization. The construction of green and low-carbon communities is one of the important parts of building a green and low-carbon city [4].

As the largest residential community in Asia, the Huitian area of Beijing is representative, so some of the neighborhoods are used as the research object to study how to renew the community from the perspective of "Climate Positive". Therefore, based on the characteristics of the built environment and climate environment, including wind environment, thermal environment, architecture, road network and public space, and investigating and interviewing the needs of local residents, the lack of public service facilities, the serious problems of work-housing balance, less green space in parks, road network density and road width were summarized. Based on this, a three-level low-carbon renewal strategy is proposed.

2. A way to respond to climate change from the perspective of " Climate Positive "

At the end of the 20th century, the practice and research of low-carbon communities began abroad, such as Hammarby Lake City, Sweden[5]; The BedZED, UK, known as the Zero Carbon Community [6]; The Freiburg solar community, known as the carbon-negative community, is [7]. Low-carbon community practices have also promoted a range of technical and theoretical innovations[8][9]. China's exploration of low-carbon renewal of settlements is gradually advancing, but it is not yet mature[10].

The continuous increase in carbon emissions has caused a huge threat to the global ecological environment, and reducing carbon emissions is a focus issue of concern to all countries in the world[11]. In order to address climate change, in 2005, the then mayor of London initiated the establishment of the Urban Climate Leadership Alliance, or C40, a non-governmental international organization composed of major cities in the world, aiming to halve carbon emissions by 2030 and explore a path to the Paris

Agreement[4]. The climate is derived from C40's 2009 initiative with the Clinton Climate Initiative (CCI) and the U.S. Green Building Council[12], which aims to offset or absorb some carbon emissions on top of achieving the goal of carbon neutrality in response to the dual challenges of rapid urbanization and climate change.

Rapid urbanization has also exacerbated climate change and increased carbon emissions. There is no direct relationship between cities and carbon emissions, but are related to carbon emissions through intermediary factors [13], including city scale[14], energy transmission[15], urban land use (density and mixed land use, etc.) [16], climate and urban heat island effect[15][16][17], transportation energy consumption[18], carbon sink and carbon capture[19].

Carbon emissions are mainly concentrated in cities, so cities are the main places to achieve green and low-carbon development. As the basic unit of the city, the community is the main place of people's life, and it is also an important place to form a simple and moderate, green and low-carbon, civilized and healthy lifestyle, and the main space to promote carbon emission reduction and mitigate climate change in urban communities. Therefore, from the perspective of "Climate Positive", Longzeyuan Street in the Huitian area of Beijing, the largest residential community in Asia, is the research object, and based on the characteristics of the built environment and climate environment, the community environment is understood by investigating and interviewing the needs of local residents.

3. Environmental characteristics of the area of Huilongguan Street in the Huitian area of Beijing

Located between the North 5th Ring Road and the North 6th Ring Road, Huitian area covers an area of 62.8 km2 and has a population of 796,000, which is an important expansion area extending from the central urban area along the central axis to the north, and is a concentrated bearing area for the functional relief of the central city. As the largest residential community in Asia, the early development and construction of the Huitian area provided a large number of affordable housing for Beijing's local low- and middle-income people and immigrants[20].

Urban spatial structure and road network are the mainstay of urban development, directly related to people's production and life, therefore, reasonable determination of regional spatial layout and reasonable road network design is of great significance to reduce carbon emissions and build low-carbon cities. For residents living in Longzeyuan Street in the Huitian area of Beijing, the largest residential community in Asia, it is necessary to meet not only their living needs, but also the needs of transportation, medical care, greening and other aspects. Therefore, public service facility planning is also essential [21].

3.1. Macro level, road analysis, land use layout

3.1.1 Road analysis

Huilongguan Street area is located in Changping District, Beijing, is part of Huitian area, Huitian area is located between the North 5th Ring Road, North 6th Ring Road, belongs to Changping District, is an important expansion area extending from the central urban area along the central axis to the north, is a centralized bearing area for the function dredging of the central city, is an important node area of the northern green corridor and ventilation corridor, and is an important hub area connecting Zhongguancun Science City and Future Science City. There is a Beijing-Tibet Expressway on the west side of the site, and the interior is divided into north and south parts by Huilongguan Street. There are many secondary trunk roads in the site, and there are very few branch roads. Although there are parking spaces on both sides of

the road, they are still insufficient, and there are cases where motor vehicles occupy non-motorized lanes, and there are cases where pedestrians walk on non-motorized lanes.

Figure 1 Current situation road analysis. Source: Author drawing.

3.1.2 Land use layout

Part of the Huitian area, the site is a reservoir of talent and labor, providing living space for the surrounding major functional areas. On the land, the residential function is the mainstay, and commercial facilities and public relations service facilities are arranged along the street.

Figure 2 Current land layout. Source: Author drawing.

3.2. Meso-level, public transportation and public facilities

3.2.1 Public transportation

Line 8 and Line 13 pass through the subway within the site, and the Changping Line passes near the site. The bus line network can basically cover the entire site, and it leads to all directions, which shows that the bus network is relatively developed.

Figure 3 Analysis of current subway lines. Source: Author drawing.

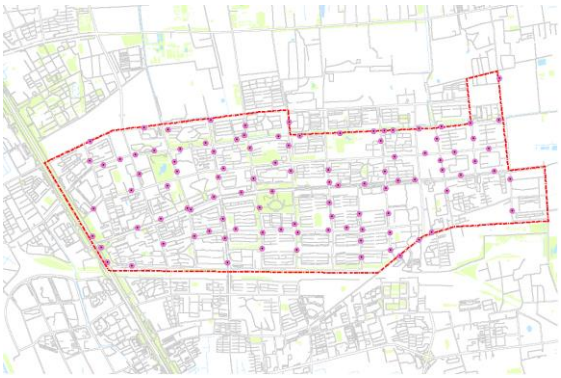

Figure 4 Analysis of current bus stops. Source: Author drawing.

3.2.2 Public Facilities

There are 3 middle schools, 7 primary schools and kindergartens in the site; The site includes Longze Garden, Huoying Street Office, Longze Garden of Beijing Municipal Public Security Bureau, Huoying Police Station Branch, and some neighborhood committees of communities; Beijing Changping District Library Huoying Street Branch, Changping District Library (Huilongguan First Branch), and some libraries in the community, cultural facilities are insufficient; There are many hospitals in the site, including first-level hospitals, tertiary hospitals (Jishuitan Hospital, Kyoto Children's Hospital, Beijing Changping District Hospital of Integrated Traditional Chinese and Western Medicine), and some community health service stations, with sufficient medical resources; Most of them are community-level elderly care service stations and nurseries, and there is a lack of elderly care facilities; Commercial facilities are mainly distributed around Hualian Huilongguan Shopping Center and Beidian Times Square on the west side. The infrastructure conditions in the region are weak, most of the sewer pipe network is a combination of rain and sewage, the overflow phenomenon is prominent in some parts of the rainy season, and there are many water accumulation points on the road, which on the one hand affects traffic and causes greater safety hazards on the other hand.

Figure 5 Distribution of current primary schools. Source: Author drawing.

Figure 6 Distribution of current elderly care facilities. Source: Author drawing.

Figure 7 Distribution of current medical facilities . Source: Author drawing.

Figure 8 Distribution of current kindergartens. Source: Author drawing.

Figure 9 Distribution of current secondary schools. Source: Author drawing.

Figure 10 Distribution of current commercial facilities. Source: Author drawing.

3.3. Micro level, slow traffic analysis

3.3.1 Slow traffic

The non-motorized roads in the site are very perfect, except for a few roads without non-motorized roads, there are basically them, and a relatively complete bicycle slow travel system has been formed. Bicycle rental sites are more evenly distributed in the venue, but from field research, it is found that most people use shared bicycles, and few people rent cars at bicycle rental points. There is also a dedicated bicycle path on site.

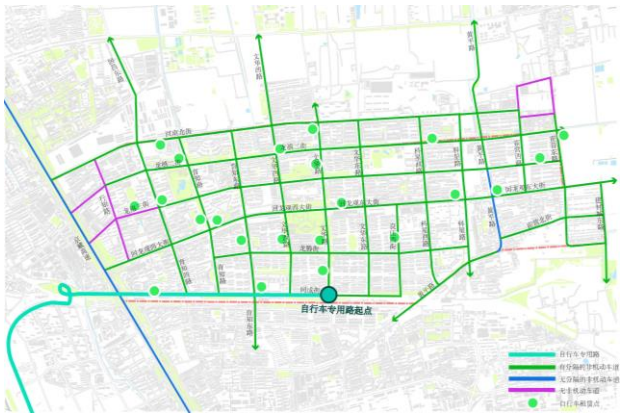

Figure 11 Analysis of current slow traffic. Source: Author drawing.

Overall, there are the following problems: insufficient capacity to support transportation and municipal infrastructure; The proportion of land gaps for medical, cultural and elderly care facilities is large; The slow travel system is not perfect. According to the Climate Positive Framework published by the C40 Alliance, the purpose of the Climate Positive Plan is to explore the development path of environmental sustainability and economic growth. Based on this, a low-carbon renewal strategy in two dimensions is proposed, including the carbon emission reduction strategy of "building a 15-minute low-carbon living circle, road system, and slow travel system" and the strategy of "building a park green space system" to increase carbon sinks.

4. Low-carbon renewal strategy of Huilongguan Street area based on the perspective of positive climate

4.1. Build a well-structured and dense road network system to advocate green travel

Strategy 1: Regional interconnection, breaking administrative segregation, and building an integrated road transportation system. Strategy 2: Add the connecting lines on both sides of the Beijing-Tibet Expressway and Metro Line 13 to smoothly connect the functions of the two sides. Advocate green travel, take advantage of the opportunity of the renovation of the existing suburban railway of the Northeast Ring Line, strengthen the relationship between the Huitian area and key functional areas such as Zhongguancun Science City, Future Science City, Wangjing, and CBD, and balance the relationship between employment and housing in the Huitian area on a larger scale. Increase industrial land, improve the relationship between employment and housing, and realize local employment. Strategy 3: Encrypt the branch road network, open up microcirculation, build a complete road transportation system, and balance the relationship between employment and housing on a larger scale.

4.2. Build a diversified and multi-level public service facility system and improve the public transportation system

Strategy 1: Prioritize high-quality resources to supplement the allocation of public service facilities, and establish a public service facility system that meets the convenience, fairness, diversity, safety, and livability of early childhood education, learning and education, housing and housing, and support for the weak. Strategy 2: Layout major public service facility centers along the public service facility belt, mainly including regional commercial centers and regional cultural and sports centers (Huilongguan Sports and Cultural Park). The facility network is basically formed, and some node facilities are lacking, and it is urgent to break through the blockage, improve the system, and improve the overall support capacity

through meridian dredging, detail update and repair. Strategy 3: Combined with the No. 13 capacity expansion and promotion, set up a site micro-center to achieve integrated development.

4.3. Build a slow travel system that connects multiple living places to reduce carbon emissions

Strategy 1: Implement the relevant requirements of Changping District's slow travel system planning, and build a complete network of internal and external connectivity, continuous and diverse pedestrian and bicycle transportation systems. Strategy 2: Connect the main public service facilities through the slow corridor to achieve the walking out of the main body within 1 km, the bicycle traffic out of the main body within 1-5 km, and the "walking + bus" or "bicycle + bus" travel mode of more than 5 km. Strategy 3: Strengthen the slow-moving traffic links between the region and the green spaces of the central axis and improve the accessibility of country parks; At the same time, it is connected to the main work places of the surrounding residents, providing diversified options for commuting.

5. Conclusion

Climate change has become one of the major issues facing the world, and how to update large residential communities as an important exploration area and urban residents in the climate plan launched by C40 has become an important issue. From the perspective of "Climate Positive", taking the Huilongguan Street area in the Huitian area of Beijing, the largest residential community in Asia, as the research object, based on environmental characteristics, including road system, spatial structure and public services, this paper proposes a low-carbon renewal strategy at the macro, meso and micro levels, in order to promote carbon emission reduction in urban communities, mitigate climate change, and provide new ideas for improving the environmental quality and quality of life of residents in large-scale residential communities.

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