

Low-Carbon-Transport-Oriented Suburb Towns Sustainable Development Planning Studyⁱ

—A Case Study of Yuhang Town, Hangzhou City

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Abstract: By analyzing the spatial structure, the road traffic characteristics and the residents travel characteristics of Yuhang Town, Hangzhou City, this research aims to put forward sustainable development strategies and urban planning measures suitable for every specific suburb town represented by Yuhang Town on the premise of the concept of low-carbon-transport.

Key words: low-carbon-transport, suburb town, spatial structure, residents travel, planning strategy

1. INTRODUCTION

1.1 Research Background and Purpose

With the rapid development of urbanization and motorization in China, many suburb towns located near large cities gradually become the main land of population agglomeration and land expansion. At the same time, the "sleeping city" features begin to emerge in these suburb towns, which not only results in the large increase of long-distance commute and vehicles quantity, but also causes the decline of road traffic and living environment in these towns. These trends contradict the pursuit of low-carbon city construction which is paid attention to reduce energy consumption and save resources, and is the necessary path towards sustainable urban development. Reasonable urban spatial structure planning and high efficiency and low emission transportation mode under low-carbon-transport concept are important measures to achieve the goal of low-carbon city construction. For this purpose, the study analyzed the present situation faced by suburb towns to develop under low-carbon-transport concept and discussed the significance and measures to promote low-carbon-transport based on the investigation of typical case of Yuhang town, in order to promote the further sustainable development of suburb towns in China.

1.2 Research Subject

Yuhang town belongs to Yuhang district, Hangzhou city, with a distance of about 23 kilometers west of the city center. Before Yuhang district was merged into Hangzhou in the year 2001, Yuhang town was developing relatively independently, and it was one of the major towns in the west of Hangzhou which was dominated by traditional industries such as electronics, machinery, etc. After the merger, along with the rising of central city status and functional concentration of Hangzhou, its effects on surrounding towns are increasing rapidly. As a typical suburb town of Hangzhou, Yuhang is under growing influence of central city, and all types of residential develop gradually with the industrial economy improvement.

By 2012, the construction land area of Yuhang town arrived at 54 square kilometers and the population reached 32.1 million, respectively increased by 1200% and 500% to 2001.

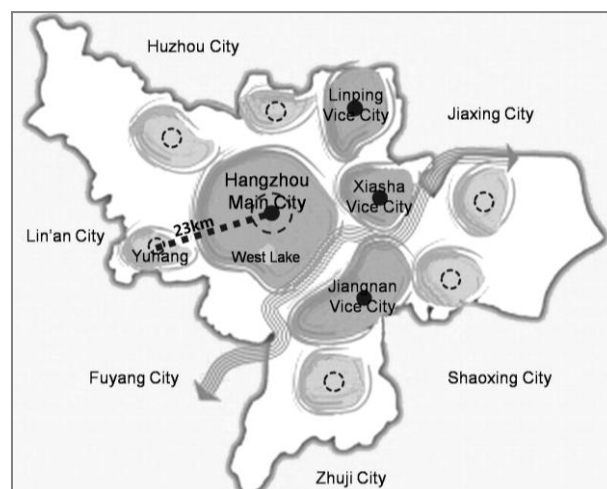


Figure 1: Location of Yuhang Town, Hangzhou City

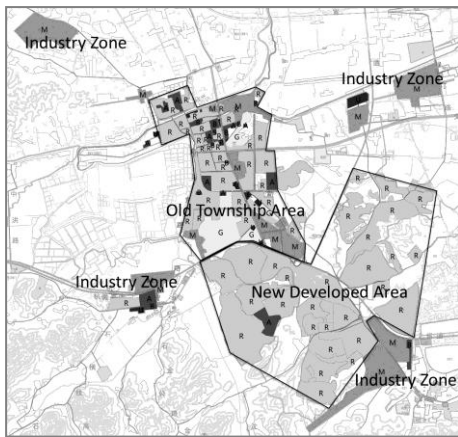


Figure 2: Present Land Use of Yuhang Town

2. ANALYSIS ON SPATIAL STRUCTURE & ROAD TRAFFIC CHARACTERISTICS OF YUHANG

2.1 Spatial Structure & Land Development of Yuhang

2.1.1 Spatial Structure

The spatial development of Yuhang town can be roughly divided into three stages (figure 2). In the first stage the development was based on traditional industry like agriculture and handicraft (before 1995), when urban development was mainly concentrated along the Yuhang-road in the old town. In the second stage it benefited from modern industrial development (1995-2001), when urban development still depended on the old town but was starting to develop in the surrounding areas and many industry concentration blocks. In the third stage now, it is being dominated by regional transportation construction and real estate development (2001 to present), especially residential construction, which is centrally located along the regional transport lines that link closely to Hangzhou city center.

During the third stage, the spatial development of Yuhang town is affected more and more by the Hangzhou city center. For example, the residential construction in the southeast area is closely tied to the open of 02-provincial-highway. It means that Yuhang town has already transferred from a traditional self-sufficient town to a typical suburb town relied on the central city.

Currently, the spatial structure of Yuhang town mainly presents as single-center and block-cluster. The town center is still located in the north, however, due to the influence of central city--Hangzhou, its attractiveness is relatively weaker. On the other hand, the new developed areas concentrated on the east and south of the town have more convenient connection to the city center.

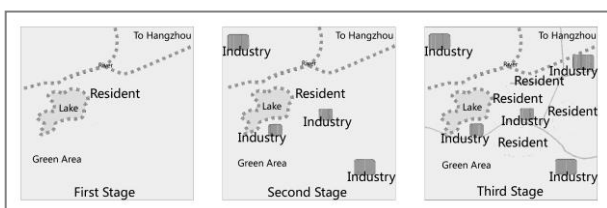


Figure 3: Three Development Stages of Yuhang

2.1.2 Land Development

Rapid Transition of Land-Use Structure: With the continuing urban function transformation in Yuhang, the internal composition of land construction has also changed a lot (table 1). From 2004 to 2012, the constitute rate of industrial land in Yuhang town has decreased by 15%, at the same time, constitute rate of residential land has rose by 19%. It is obvious that land-use has gradually turned from industrial to residential development. Besides, the proportion of roads and squares increased dramatically, which fully embodies the strengthening traffic connection with central city for resent years.

Table 1: Construction Land Constitute Proportion of Yuhang

Land Use Type	2004	2008	2012
Residential Land	35.7%	47.8%	56.4%
Industrial Land	27.4%	19.6%	12.1%
Public Facilities	6.2%	4.8%	4.5%
Municipal Utilities	1.8%	1.2%	1.3%
Roads and Squares	12.3%	16.7%	18.2%
Green Space	15.6%	9.9%	7.5%

Poor Quality of Public Facilities: Seeing from the composition of land-use changes, the proportion of land for public facilities dropped a lot. It means that public service function is not corresponded with the expanding of urban scale. The town's main facilities (hospitals, government agencies, schools, etc.) are concentrated in the north of the old town with small scales. However in the new developed area, there are almost no public facilities expect for a piece of sports land in the south. It would not only reduce the attractiveness of Yuhang town, but also enhance the degree of the reliance on central city, thus make the "sleeping city" features more obvious.

Large-Scale and/but Low-Density Development of Residential Construction: From 2004 to 2012, there are about 13 real estate constructions. Among them, low density development predominantly villa/row houses account for 7, with a total area of 3.3 square kilometers and an average volume rate of 0.63 (the lowest is only 0.27). Residential development like these not only is unfavorable to the formation of compact city, but also become the obstacles for realizing low-carbon-transport. In addition, these residential areas occupied large amount of good land resources in the town, thus even caused certain damage to the local landscape.

Table 2: Typical Residential Development in Yuhang (2004-1012)

Real Estate Name	Housing Type	Total Area	Volume Rate
The Peach Garden	row	933.8km ²	0.27
Xixi Villa	villa/row	1333.3km ²	0.56
Baoyi Lijingshan	villa/row	127.1km ²	1.20
Xinghu Guoling	villa/row	358.3km ²	1.20
Yurongzhuang	villa/row	98.0km ²	1.07
Xixi Sea	villa/row	278.0km ²	0.67
windsor county	villa/row	199.3km ²	1.17

2.2 Current Situation of Road Traffic in Yuhang

2.2.1 Characteristics of Road Network

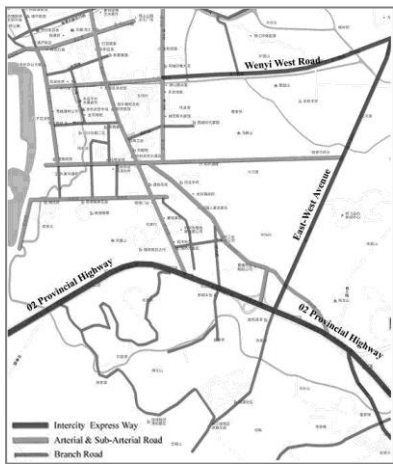


Figure 4: Urban Road System of Yuhang

Intercity Transportation is Closely Linked to the City Center: The rapid development of Yuhang town is inseparable to the construction of regional transportation. Construction of Wenyi-west-road, 02-provincial-highway and East-west-Avenue has strengthened the transport link between Hangzhou city center and Yuhang town, thus thrive the development of urban development along the way.

Internal Road System is Dominated by Motor Vehicle Traffic: Under the influence of the large-scale and enclosed residential development and motorization, Yuhang's road network system construction is basically give priority to motor vehicles, therefore the density of arterial road and sub-arterial road network are conformed to the index. However, the density of branch road network is below standard, and due to large numbers of enclosed settlements, accessibility of branch road network is poor and can't form into a system, thus cause difficulties to make use of public transportation, like buses, bicycles, walking and other ways.

Table 3: Calculation of Road Network Density

	Express way	Arterial Road	Sub-Arterial Road	Branch Road
Length	4.3km	9.8km	15.8km	27.6km
Area	10.3km ²	48.6km ²	77.8km ²	42.1km ²
Density	0.42km/km ²	1.07km/km ²	1.95km/km ²	2.55km/km ²
Index	0.4~0.5 km/km ²	0.8~1.2 km/km ²	1.2~1.4 km/km ²	3.0~4.0 km/km ²

2.2.2 Public Transport System

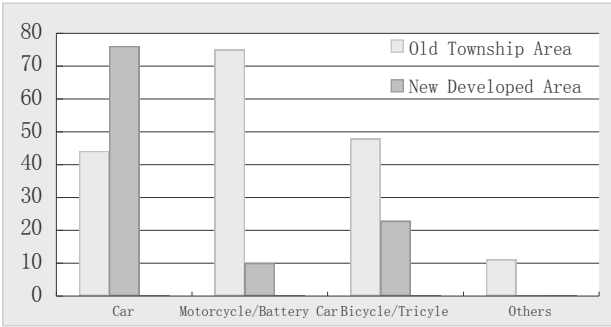
The way of public transportation in Yuhang is relatively simple which mainly relies on the bus. Regarding Yuhang bus station as the core, the bus system can be divided into three types of lines: township buses (4 lines), shuttle buses between the villages and town (17 lines), and buses to Hangzhou (6 lines). At present, because of the factors including few numbers of buses, short operating time, travel habits of residents, etc., it is difficult for public transportation to get its share rate increasing.

2.3 Analysis of Residents Travel Characteristics

In order to further understand the situation of residents daily commute and travel in Yuhang town, this research adopt the method of questionnaire which take household as the unit and respectively investigated residents in new developed area and old township area. Each area distributed 100 questionnaires and recycled valid questionnaires 94 and 90 respectively.

2.3.1 Residents Present Vehicle Ownership

Table 4: Residents Vehicle Ownership



As shown in table 4, compared with various vehicles used in the old township area, residents in the new developed area prefer to use car as main means of transport. At the same time, due to the strong willing to buy a car shown both in old and new areas (27% & 36%), it can be predicted that the dependence of private car will rise dramatically in the future.

2.3.2 Residents Commute Characteristics

Table 5: Residents Commute Distribution and Traffic Tool Selection

	Way of Commute	Total	Commute Destination		
			Hangzhou	Yuhang	Other
Old Area	Total	100%	30%	53%	17%
	Private Car	42%	21%	11%	10%
	Public Bus	25%	9%	13%	3%
	Battery Car/Motorcycle	28%	0%	24%	4%
	Bicycle/On Foot	5%	0%	5%	0%
New Area	Total	100%	78%	9%	13%
	Private Car	78%	69%	2%	7%
	Public Bus	17%	9%	4%	4%
	Battery Car/Motorcycle	5%	0%	3%	2%
	Bicycle/On Foot	0%	0%	0%	0%

As shown in table 5, residents living in the old township mainly work in Yuhang town (53%), they prefer to choose ways of travel with low-cost and high-flexibility like battery car, motorcycle (24%) and so on. At the same time, there are 30% residents working in Hangzhou city, with two-thirds of the commuters take private car as main traffic tool. It suggested that the development of old township area also affected by the central city radiation to a certain extent.

However, in the new developed area, about 78% residents work in Hangzhou and most of them prefer to use private car as the way to commute. Only 11.5% of them choose public bus for travel. It can be seen that commute distance for residents in the new developed area is much further than that in the old township area, therefore caused exist issues like over-reliance on motor vehicles, low share rate of public transport and so on.

In addition, bicycling, walking and other low-carbon ways of travel haven't been fully used for residents in Yuhang, and average share rate of public bus is even lower than Hangzhou city (43.6%).

2.3.3 Residents Travel Characteristics

In view of residents travel in daily life activities (including medical treatment, entertainment, leisure, etc.), the study also investigated the ways of travel and destinations in both areas. Seeing from the table 6, the results are similar to commute. New developed area relies much more on central city than old township area and the usage of private cars is much more frequent. However, relatively speaking, the dependence of daily travel in both areas is lower than commute travel.

Table 6: Residents Daily Activity Distribution and Traffic Tool Selection

	Way of Commute	Total	Daily Activity Destination		
			Hangzhou	Yuhang	Other
Old Area	Total	100.0%	35.2%	54.7%	10.1%
	Private Car	31.8%	22.1%	5.2%	4.5%
	Public Bus	30.3%	13.1%	14.2%	3.0%
	Battery Car/Motorcycle	26.6%	0.0%	24.7%	1.9%
	Bicycle/On Foot	11.2%	0.0%	10.5%	0.7%
New Area	Total	100.0%	58.2%	35.7%	6.1%
	Private Car	66.0%	48.4%	13.5%	4.1%
	Public Bus	28.3%	9.8%	16.4%	2.0%
	Battery Car/Motorcycle	4.1%	0.0%	4.1%	0.0%
	Bicycle/On Foot	1.6%	0.0%	1.6%	0.0%

Viewing from statistical results obtained from both commute and daily travel, more than half of the residents' travel destinations are in Hangzhou city, and among them, more than half choose private cars to travel. In addition, the reliance on private cars are much more serious in new developed area than old township area, and commute travel is more serious than daily activity.

3. PROSPECTS OF LOW-CARBON-TRANSPORT DEVELOPMENT IN YUHANG

3.1 Necessity for Low-Carbon-Transport Development

Nowadays in China, there are more than 100 cities aiming at low-carbon development, and low-carbon transport pilot cities have arrived at 26. In February 2011, Hangzhou became one of the top 10 pilot cities for low-carbon transport construction. From that time, the pursuit of developing low-carbon transport has expanded to the surrounding areas of Hangzhou.

However, Yuhang as a typical suburb town of Hangzhou city, its "sleeping city" feature caused by the current expanding development mode not only changed the traditional pattern of town life, but also gave huge pressure to the construction of low-carbon transport.

High dependence on private car makes the low-carbon transport development pattern, which giving priority to public transport, not be fully supported. Therefore, strengthening the construction of low-carbon transport, which has great significance for the sustainable development for the suburb towns, has become one of the important tasks for the cities.

3.2 Advantages of Low-Carbon-Transport Construction

On one hand, present land-use layout of Yuhang town appears as single-center and block-cluster. The old township area basically meets the two necessary premises of low-carbon development: the mixed function of land-use and relatively high density of development. At the same time, the spatial relations between the existed four industrial areas and the residential areas are appropriate, for these reasons, it is conducive to develop a balanced low-carbon town for both living and working.

On the other hand, construction situation of the intercity transportation facilities and road system of Yuhang town are relatively well. So there is plenty of room for public traffic lanes and non-motor vehicle lanes to develop. In addition, town bus system also has preliminary formed. All above have positive effects to develop a low-carbon transport oriented town.

3.3 Disadvantages of Low-Carbon-Transport Construction

The disadvantages of low-carbon transport construction of Yuhang are mainly display in two aspects: the lack of slow space and the lag of urban function transformation.

Firstly, the lack of slow space includes not only the occupation of non-motor vehicle lanes and pedestrian space by motor vehicles, but also the destruction of public landscape space caused by enclosed residential construction. Above all, the lack of slow space is not conducive for residents to form good habits on low-carbon travel.

Secondly, the present industry and service are lagging behind the urban development in Yuhang town. The existed four industrial functional areas in Yuhang town are basically traditional industries like machinery manufacturing with high energy consumption and high pollution. It not only can't meet the employment requirements of residents evacuated from the city, but also affects the formation of livable environment in Yuhang town. Besides, due to the real estate construction booming, the only driving factor for the development of Yuhang recent years, construction of local infrastructure especially large public service facilities supported by the government is extremely lagging behind, which leads to the current situation that Yuhang town can't provide residents with high quality urban life. Thus making Yuhang town less attractive and gradually become a "sleeping city" attached to Hangzhou, which violate the concept of low-carbon city construction.

4. PLANNING STRATEGIES PUTTING FORWARD

4.1 Adjusting Urban Functions & Reducing the Demand for Long-Distance Commute

For satellite towns, traditional rural industry not only can't form into driving force for further development, but also can't meet the needs of residents in towns. Therefore, urban function transformation is urgent. In case of Yuhang town, by collaborating with the high-tech industries in the west region of Hangzhou and taking advantages of traditional industries like electronics, machinery and so on, Yuhang will successfully transforms and upgrades into a

town dominated by high-tech industries. As the result, the attractiveness of Yuhang town will be improved, and the reliance on central city will be reduced.

In addition, the lifestyle and requirement of residents in suburb towns are very different from that in rural areas. While planning, we should pay attention to the construction of public facilities to match the urban life pursuit, especially in health care, education, entertainment and so on. Through the urban function transformation, it is possible to reduce the demand for long-distance commute to the central city.

4.2 Optimizing the Land-use Structure & Improving the road traffic system

Nowadays, there are many suburb towns in China facing problems like Yuhang, such as big gaps between old and new developed areas, chaotic road transport and so on. In order to solve these problems, planning and construction in new developed area shall ensure appropriate scale and volume rate and avoid single-function, large-scale and low-density residential development. At the same time, planning and construction in old township area shall retain and improve the public space and strengthen the construction of public facilities, thus improve the mixing degree of land-use and enhance the charm of the town.

We should also enhance the construction of large capacity bus lines between the town and the city. Recently, the construction of BRT system benefits the town. In the future, with the outspread of Hangzhou metro line 3 and line 5, the contact between Yuhang and Hangzhou will be improved further more.

Urban public transport system should pay attention to the connection between old and new township areas. During planning and construction, we should make full use of existing roads to improve the urban transport system (especially the branch roads surrounded by enclosed residential areas), and increase the share rate of public transport by improving the accessibility of it. Meanwhile, public-bicycle-system in Hangzhou can be extended to Yuhang town, providing residents a new way to travel.

4.3 Improving the current Situation of Slow Space & Importing Low-Carbon Transport Way

If the two planning measures above are long time proposals for improving the attractiveness of suburb towns and realizing low-carbon sustainable development, then improving the situation of slow-spaces and importing the low-carbon transport ways are focused on the near future.

From the perspective of planning management, we should pay more attention to the issue that motor vehicles now occupied many non-motor vehicle lanes and pedestrian spaces, and ensure the continuity of existing slow spaces. From the perspective of planning construction, by constructing underground and stereo garages, we can tidy up open spaces around the public buildings like Yuhang bus station, and use the spaces to design squares, parks, and so on. Therefore residents and travelers can enjoy more on slow-spaces in Yuhang town.

Last but not the least, suburb towns should synthetically

use 5D land development pattern¹, speeding up the import of low-carbon transport ways such as public bicycle, BRT, rail transit and so on. It is also necessary to appropriately develop battery cars and private cars considering unique local conditions. Above all, we shall make full use of every possible way of travel to form up a composite transport system guided by public transport.

5. CONCLUSION

As a typical suburb town, Yuhang presents many features which are shared with other towns, such as the excessive reliance on central city, the lag of urban function transformation compared with residential development, residents' higher dependence on motor vehicles compared with those lived in traditional villages, and the construction of branch roads and slow space of the town are far behind the construction of urban roads system, etc. All these common features bring harm to create a livable, low carbon and sustainable town.

The pattern of low-carbon-oriented development is one of the effective methods to solve a series problem of urban issues due to large scale, low density expansion, and it also has positive significance for the sustainable development of suburb towns.

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¹ 5D land development pattern refers to the concept of POD(pedestrian)>BOD(bicycle)>TOD>XOD>COD(car).