Research on Means and Spatial Features of Collaborative Development of Cities in Yangtze River Delta at the Urbanization Ratio over 50%

YANG Xiu[1, A1]*, TENG Yuwei[2, A2], LU Tianzan[3, A3]

[1, A1]Candidate for Doctoral Degree at the School of Architect
Planning ,Tongji University, China, email:2011yangxiu@tongji.edu.cn
author

[2, A2] Candidate for Doctoral Degree at the School of Archite
Planning , Tongji University, China, email:2011yangxiu@tongji.e
41715186@qq.com

[3, A3] Master's degree at the School of Architecture and Urban
University, China, email: 287996326 @qq.com

Abstract:

Studies show that, after the urbanization ratio in the Yangtze River Delta exceeded 50% in 2000, the urban construction space in the region continues to expand rapidly, which has brought about such problems as land use and environment constraining the urbanization process. To address the many problems seen in the urbanization process, and stand together against the competition from other city clusters in the world, the Yangtze River Delta has been enhancing the efforts in collaborative development after its urbanization ratio exceeded 50%. To maintain the environmental survival bottom-line and obtain the benefits of joint efforts against the external competition, though it has been lacking in the cultural environment of collaboration and in the strong institutional support, the Yangtze River Delta, since Year 2000, has made considerable practice in the collaborations of environment harnessing, building of infrastructures, land use and development, and knowledge innovation in the region. Studies show that, after the urbanization ratio exceeded 50% in the Yangtze River Delta, the collaborative development among cities, in terms of geographic territory, has been shifting from the collaborative development in the multiple points to that in the belt of neighboring regions and in the network structure with layers. At the same time, it is also developing from the collaborative development of physical space to that of virtual space.

Keywords: Yangtze River Delta, city, urbanization ratio of 50%, Cooperative Development; spatial features

1. Introduction（research background）

According to the 1978-2012 statistics of urbanization ratio of permanent population in Shanghai Municipality, Zhejiang Province and Jiangsu Province (Table 1), the urbanization ratio in the Yangtze River Delta in 2000 stood at 49.6% and exceeded 50% in the following year. In 2000-2010, the urbanization ratio of permanent population in the region rising rapidly by 1.6 percentage points annually. Even after it exceeded 50%, it still rose by nearly 1 percentage point after 2010 (see Table 1). The 2012 data show that, the territory in the Yangtze River Delta (1 municipality and 2 provinces) accounted for 2.19% of the total in China, its population took 11.65% (157.77 million) of the total in China and its GDP accounted for 20.96% (RMB 10.8904

trillion)of that in the whole country[1]. The rapid urbanization has triggered the booming economy in the region. At the same time, it has also aroused many problems in the structure of economy and capacity, immigration of population, and harnessing of environmental pollution, which seriously impact on the quality of urbanization in the region. The urbanization ratio in the Yangtze River Delta exceeded 50% in Year 2000 when China entered WTO and the Chinese people began their full awareness of taking joint efforts to address the globalization competition and getting into collaborative development among different regions.

Table 1 Table of Urbanization Ratio of Permanent Population in the 2 Provinces and 1 Municipality in Yangtze River Delta in 1978-2012

Population in 10,000

	Shanghai	**Zhejiang Province**	**Jiangsu Province**	**Yangtze River Delta (2 provinces and 1 municipality)**		
	Urban population	**Urban population**	**Urban population**	**Total population**	**Urban population**	**Urbanization ratio (%)**
1990	868.73	1516.57	1458.94	12338.90	3844.24	31.16
1995	1262.13	-	1929.09	12869.02	-	-
2000	1478.00	2235.66	3040.81	13615.75	6754.47	49.61
2005	1684.00	2742.00	3832.06	14469.40	8258.06	57.07
2010	2056.00	3354.06	4767.63	15618.51	10177.69	65.16
2011	2096.30	3403.00	4889.36	15709.26	10388.66	66.13
2012	2126.	3461.00	4990.00	15777.41	10577.00	67.04
2013	2164.000 0	3519.00	5090.01	15852.64	10773.01	67.96

Source: 2011-2014 Zhejiang Statistical Yearbook, Jiangsu Statistical Yearbook and Shanghai Statistical Yearbook, as well as 2006 China Public Health Statistical Yearbook.

2. Scope and methods of the study

Studies of regional collaboration in the Yangtze River Delta have the following focuses: the studies focusing on regional economic integration (e.g., Li Jian, Ning Yuemin and Shi Song, 2006; Han Jia, 2008); studies cored on integration of city clusters (e.g. Wang Guixin, 2005; Yu Hongsheng, 2010); studies centered on empirical city relational degree (e.g., Tang Zilai, 2010; Wang De, 2003); and studies pillared on spatial changes (e.g., Chen Jianjun, 2007; Zhao Miaoxi, 2011). These studies emphasize on analysis of industries, economy, population, space and development of city clusters. Nevertheless, the analysis is rarely combined with the problems and needs of urbanization process. At the same time, because local administrations in China lack the cultural atmosphere and institutional guarantee of collaboration, the integration is really a very difficult target for regional development. And the collaborative development is the ideal choice of making joint efforts to address the negative external factors in the condition of existing policies. The study, at first, states that it is necessary to engage in collaborative development among cities so as to address the problems brought by the rapid urbanization after the urbanization ratio exceeds 50% in the Yangtze River Delta. Then it adopts the method of comprehensive analysis to analyze the process of collaborative development among cities after the 50% urbanization ratio before reaching the needs and means of collaborative development

[1] Source: 2011-2014 Zhejiang Statistical Yearbook, Jiangsu Statistical Yearbook and Shanghai Statistical Yearbook, as well as 2006 China Public Health Statistical Yearbook.

among cities after the 50% urbanization ratio in the Yangtze River Delta. In the end, it uses both the case analysis and GIS analysis to analyze the spatial characteristics of collaborative development among cities in the region after the 50% urbanization ratio.

For the sake of convenience, the thesis mainly studies the statistics of administrative zones and the overall analysis of the Yangtze River Delta is mainly made in the scope of 2 provinces and 1 municipality, namely, Zhejiang Province, Jiangsu Province, and Shanghai Municipality. And the data used in the study are mainly those ranging from 2000 till today.

3. Fundamental problems that need to be addressed in collaborative development among cities after the urbanization ratio exceeds 50%

Problems of land and environment are fundamental problems that need to be solved in the urbanization process because land is the carrier of urbanization and environment constitutes the bottom-line guarantee of urbanization. In this section, we will focus on analyzing the problems of rapid land expansion and serious environmental pollution that need to be solved in the regional collaboration in Yangtze River Delta after its urbanization ratio exceeds 50%.

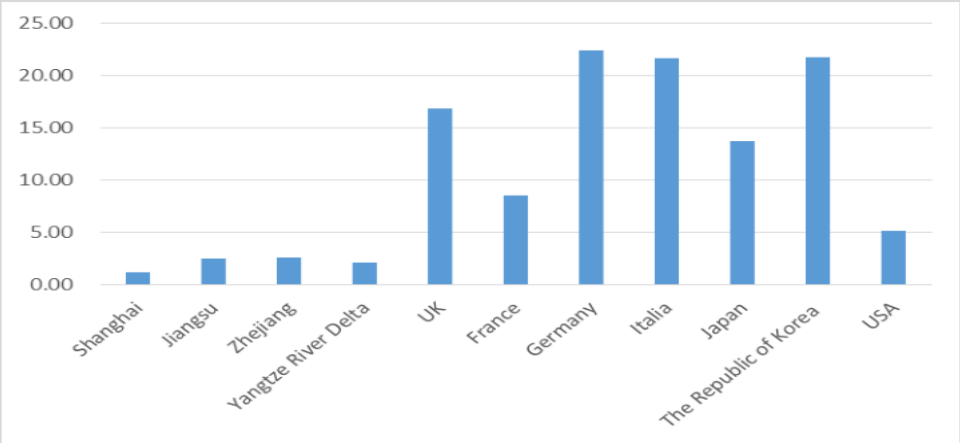
3.1 Problem of rapid expansion of urban construction land

Urban construction land in the Yangtze River Delta expands rapidly but inefficiently with limited quantity of new land for construction. (See Table 2) In 1980-2013, the built-up area in the Yangtze River Delta, which is the most important city cluster in East China, grew from 2,260km2 in 1980 to 2,896km2 in 2000, with average annual growth rate of 1.25%. However, after Year 2000, the built-up areas in the cities started to expand rapidly with the annual growth rate in 2000-2013 standing as high as 7.27%. Nevertheless, in the 13 years in the same period, the annual growth rate of urban population in the 2 provinces and 1 municipality in the Yangtze River Delta is only 3.66% (Table 2). It shows the rate of urban construction land expansion is far higher than that of population growth. Evidently, the growth pattern which is oriented towards land development instead of human needs is not sustainable. And the comparison of GDP per area of construction land in 2013 shows the GDP per area in the Yangtze River Delta is far less than that in the developed countries in the world, which demonstrates that urban construction land in the Yangtze River Delta is expanding in an inefficient way (see Graph 1).

Table 2 Urban population and urban built-up areas in the Yangtze River Delta

Year	Total urban population	Annual growth rate of population	Urban built-up area	Annual growth rate of urban built-up area
1980	1568.81	-	2260.00	-
2000	6754.47	7.57%	2896.30	1.25%
2013	10773.01	3.66%	7208.00	7.27%

Source: Statistical Yearbook



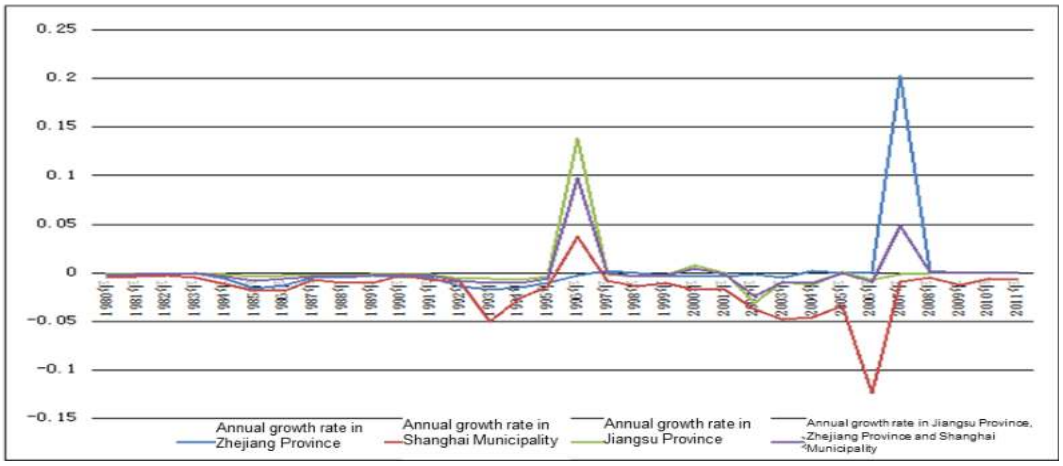
Graph 1 Comparison of GDP per area of construction land in 2013
Note: GDP per area of urban construction land = GDP aggregate/total quantity of urban construction land in the region with the unit at USD100 million per km2. Source: The overseas urban construction land area comes from http://www.demographia.com/calculation of urban areas in different countries; data of GDP of various countries come from WB database; and the data of China come from statistical yearbooks of different localities in China.

At the same time, the urban land expands extensively and rapidly occupies the farmland. According to the studies made by Chen Wen, et al (2007), after Year 2000, the urban construction land was expanded at considerable rate in both scale and speed in the central cities and secondary cities (see Table 3). However, the expansion degree in central cities was evidently lower than that in the secondary cities (county and county-level cities). And we can conclude that construction land expansion not only happened in central cities, but also moved from the central cities gradually to the secondary cities, thus bringing about the spread and expansion of hot points in land use. The spread built-up development environment in the high-density regions has caused problems of life quality and social risks in the region as a whole.

Table 3 Intensity and speed of urban construction land expansion in the Yangtze River Delta in 1980-2007

		1980 1995	1995 2000	2000 2007
Intensity of urban construction land expansion	Overall	0.07	0.08	0.46
	Central cities	0.16	0.11	0.91
	County(city)	0.04	0.04	0.3
Speed of urban construction land expansion	Overall	3.20%	5.80%	15.85%
	Central cities	2.90%	3.50%	11.54%
	County(city)	3.60%	6.70%	16.80%

Though the urban construction land expanded rapidly, the farmland area fell down year by year (Graph 2). In the 31 years in 1980-2011, the farmland area in the Yangtze River Delta fell down almost every year. In particular after Year 2000, the farmland reduction happened at a faster rate.

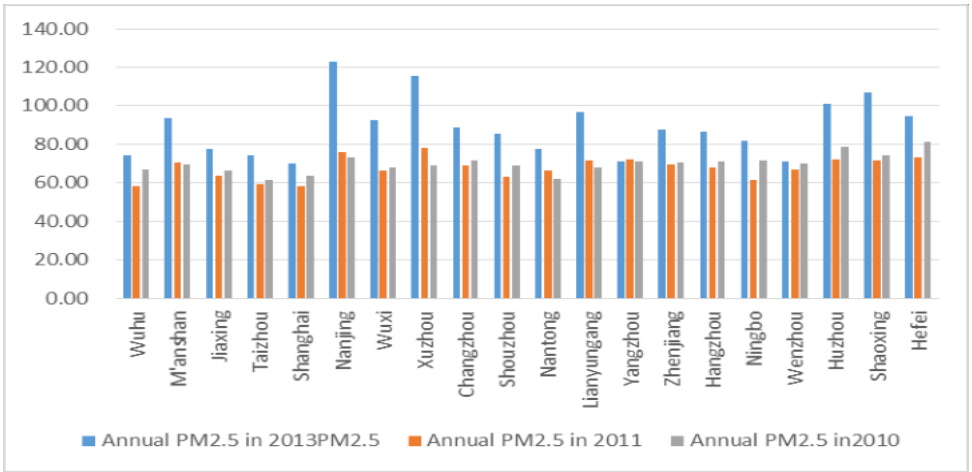


Graph 2 Annual growth rates of farmland area in the Yangtze River Delta in 1980-2011

3.2 Problem of regional environmental development

In terms of ecological environment, the environmental problems in the Yangtze River Delta featured by high-density development mainly include the atmospheric and water environmental pollution, as well as the 3 urban wastes (waste gas , waste water and industrial residue) and mammoth energy consumption.

First of all, air pollution in the Yangtze River Delta has been very serious and there is no sign of alleviation in the recent years. In 2010-2013, the annual PM2.5 index in the Yangtze River Delta had been rising considerably. In major regions in the Yangtze River Delta in 2013, the annual PM2.5 index was higher than 60 while that in Nanjing, Xuzhou and Shaoxing stood at above 100 respectively, showing the air pollution had been very serious (see Graph 3). According to the Air Quality Performance of 74 Chinese cities released by the Ministry of Environmental Protection for 2014, in the 25 cities at and above the prefecture level in the Yangtze River Delta, the average period of qualified air quality was only 254 days in that year and 2.9% of days in the year had air pollution rated as serious and above.



Graph 3 Annual PM2.5 index in major cities in the Yangtze River Delta in 2011-2013
Source: Database of China Intelligent Urbanization Co-creation Centre for High Density Region

Second, water pollution in the Yangtze River Delta is serious. The waterfall in the region is abundant because of the Yangtze River Delta. However, as the cities develop and the explosive growth of population, the water consumed for life and production has been rising sharply and producing pollution, thus posing great challenge against water environment and threatening, in an indirect way, the other systems in cities. In 2004, in the 21 monitored points in Taihu Lake, 19% had grade-IV water quality, 24% had grade-V water quality and 57% had bad-grade-V quality. In 2012, the sewage discharges in Shanghai, Jiangsu and Zhejiang reached 2.205 billion tons, 5.982 billion tons and 4.21 billion tons respectively. Besides, the pollution of water systems has led to a few ecological problems such the water eutrophy, sharp reduction in the aquatic species and land subsidence caused by the over-exploitation of underground water in the built-up areas. For instance, in Shanghai, the maximum land subsidence over the past 7 decades has reached 2,630 mm[4].

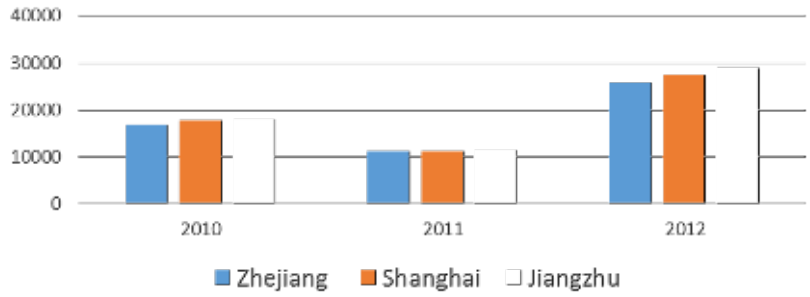
Third, the 3 urban wastes (waste gas , waste water and industrial residue) are discharged in large quantity in the Yangtze River Delta, which are difficult to be disposed of. In 2010-2012, the sewage discharge in the Yangtze River Delta reached 12.3966 billion tons and 1.696525 trillion tons of solid wastes were produced in the same period, bringing great pressure on the infrastructures in the Yangtze River Delta disposing of the 3 urban wastes (waste gas , waste water and industrial residue). Take Year 2011 as an example, the urban sewage treatment ratio in Shanghai was 84.42%, meaning 360.5367 million tons of sewage were not treated. The urban sewage treatment ratio in Jiangsu Province was 85.1%, representing that 319.389 million tons of sewage were not treated. And the urban sewage treatment ratio in Zhejiang Province was 89.92%, meaning 380.892 million tons of sewage were not treated.

Table 4 Discharge of 3 urban wastes (waste gas , waste water and industrial residue) in the Yangtze River Delta in 2010-2012

Provinces	Year	Discharge of waste gas (in 100 million tons)	Discharge of waste water(in 100 million cubic meters)	Production of industrial solid waste (10,000 tons)
Zhejiang	2010	42.2618	24435	4843
	2011	42.0417	24940	4529
	2012	42.0960	23967	4542
Shanghai	2010	24.82	12969	2448.36
	2011	19.86	13692	2442.2
	2012	22.05	13361	2198.81
Jiangsu	2010	55.55	-	9063.83
	2011	59.28	-	10475.5
	2012	59.82	-	10224.44

Fourth, high energy consumption in the Yangtze River Delta with low self-sufficiency rate Graph 4 . Graph 4 shows that total energy consumption in the Yangtze River Delta continued to grow and reached 408,009,030 tons of petroleum equivalents in 2012 alone, close to the total energy consumption of Japan in 2012 at 451,500,800 tons. However, the self-sufficiency rate of energies in Yangtze River Delta was relatively low. And the crude oil, coal, natural gas and other major energies consumed in the region were mainly purchased out of the region. Take the coal supply in 2009 as an example, all the crude coals in Shanghai were bought from outside Shanghai. And the self-sufficiency rate of crude coal in Jiangsu Province was only 11.2% while that in Zhejiang Province was 0.1%. The energy consumption per RMB 10,000 GDP in the

Yangtze River Delta had been decreasing year by year. However, in 2012, it still stood at about 0.54 tons of coal equivalent per RMB 10,000, which was higher than the 0.4 tons of coal equivalent per RMB 10,000.



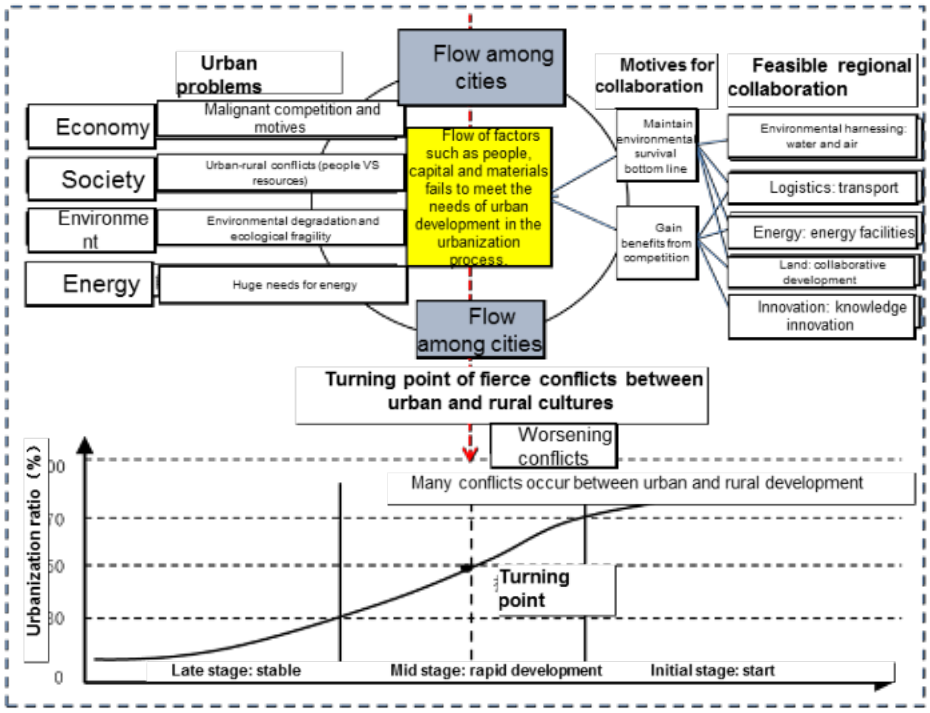
Graph 4 Total energy consumption (in 10,000 tons of coal equivalents) in 2010-2012

4. Needs and means of regional collaboration after 50% urbanization ratio in the Yangtze River Delta

4.1 Needs of collaboration

As mentioned above, when urbanization ratio exceeded 50% in Year 2000 in the Yangtze River Delta, we have seen the fierce conflict between the urban and rural civilizations. The region had entered the period of intensive conflicts of urbanization (e.g., Gao Peiyi, 1990; Bao Shusong, 2012). Within the region, it is necessary to address the series of problems accompanying the rapid urbanization. In terms of economy, we need to face the malignant competition caused by the assimilation of industrial structures, lack of economic development forces and other problems. In terms of society, we need to face the problems such as the social conflicts and competition for the public-service facilities and resources caused by the excessive cluster of urban and rural population. In terms of environment, we have to face the problems of worsening environment and overload of ecological capacity. In terms of energies, we have to face the problem of huge energy needs and consumption. And these problems are mainly caused by the fact that the allocation of human, capital and materials , the 3 urbanization cannot meet the needs of urbanization in the Yangtze River Delta. It is very difficult to solve the above-mentioned problem of urbanization factor flow within the single city administrative region. As a result, it is urgent for cities to join hands and solve the urbanization problems in the region (see Graph 5).

Since Year 2000, the collaborative development among cities in the Yangtze River Delta has had the following purposes: based on the stimulus for common public or market interest, engage in trans-reginal collaboration; keep optimizing the allotment of people, capital, land, environment and other resources in the urbanization in the region; keep solving problems of rapid urbanization; provide certain guarantee for the healthy urbanization; and work jointly to improve the holistic competitiveness in the region. The study believes that regional collaboration is the major means and inevitable process of regional integration.



Graph 5 Process analysis of cities needing collaborative development after the 50% urbanization ratio

4.2 Means of collaboration

Based on the above analysis, the reginal collaboration, after the urbanization ratio exceeds 50%, has the following major motives: to maintain the environmental survival bottom line and gain the common benefits of competition against competitors beyond the region. (See Graph 5), when the Yangtze River Delta now lacks in the cultural environment of collaboration and in the strong institutional support, the Yangtze River Delta has made collaboration practice in the following ways:

(1) Collaboration in regional environmental harnessing. It mainly refers to the collaborative harnessing of regional environment cored on water environment preservation and atmospheric harnessing. For instance, the environmental harnessing in the Taihu Lake waters involve the collaborative efforts of Suzhou, Wuxi, Yixing, Huzhou and Jiaxing.

(2) Collaboration in the building of regional infrastructures. It mainly refers to the development of inter-city transport (including transport hub) major municipal infrastructures and energy infrastructures in the region. For example, the Hangzhou Bay Bridge was built by Shanghai, Hangzhou and Ningbo. And the Inter-city Metro Line 11 was built by Shanghai and Kunshan of Suzhou.

(3) Collaboration in land development. It refers to the collaborative development of land in and close to cities, for instance, the collaborative development of Kunshan and Anting; the collaborative development of enclaves of cities, such as the collaborative development made by Zhangjiang Group in Pinghu City of Zhejiang Province; and the collaborative development made by cities along the Yangtze River and along the East China Sea.

(4) Collaboration in regional knowledge innovation. It mainly refers to the collaboration cored

on talent training, talent free flow and sharing of research results among the cities. For instance, Shanghai Tongji University has established research institutes in Jiaxing and Taicang to realize the collaboration among cities between the industries, colleges and research institutions.

5. Spatial Features of regional collaboration after 50% urbanization ratio in the Yangtze River Delta

5.1 Neighborhood nature of collaborative development space

In the beginning, the reginal collaboration in Yangtze River Delta was featured by the collaborative development of a few neighboring nodes in the region. Then the collaborative development gradually expanded to larger areas to form the block-shaped and belt-shaped regions of collaborative development.

In the 1990s, Jiangsu Province and Zhejiang Province adopted the development philosophy of collaborating with Shanghai , hoping to stimulate development of their regi with Shanghai. At that time, Jiaxing, Kunshan and Taicang in the adjacency to Shanghai had wonderful opportunities of development. However, they were limited to the point-to-point collaboration with Shanghai. After Year 2000, the cities began to recognize the concept of collaborative development. The regions close to Shanghai, to the Yangtze River and to the East China Sea went into the block-shaped, belt-shaped and piece-shaped collaborative development with the neighboring cities. Kunshang, which neighbors with Shanghai, is in collaborative development with Anting New Town in Shanghai. At the same time, it is connected to the inter-city railway of Shanghai, thus becoming an influential destination for Taiwan investors in China (see Graph 5). In the around-Taihu-Lake region, the neighboring Suzhou, Wuxi, Yixing, Huzhou and Jiaxing have re-positioned their urban functions because of their joint efforts to harness the aquatic environment in the Lake. Most of the regions around Taihu Lake are no longer pillared on manufacturing industry. Instead, they focus on leisure tour. After 1-decade development, the ecological environment in Taihu Lake has been evidently improved. And the around-Hangzhou-Bay city cluster, consisting of Hangzhou, Ningbo, Shaoxing, Jiaxing, Huzhou and Zhoushan, has formed the collaborative development layout in urban economic belt, ecological reserve, transport network and talent flow (see Graph 6).

Figure 6. Kunshan Jiangsu and Anting Shanghai collaborative planning

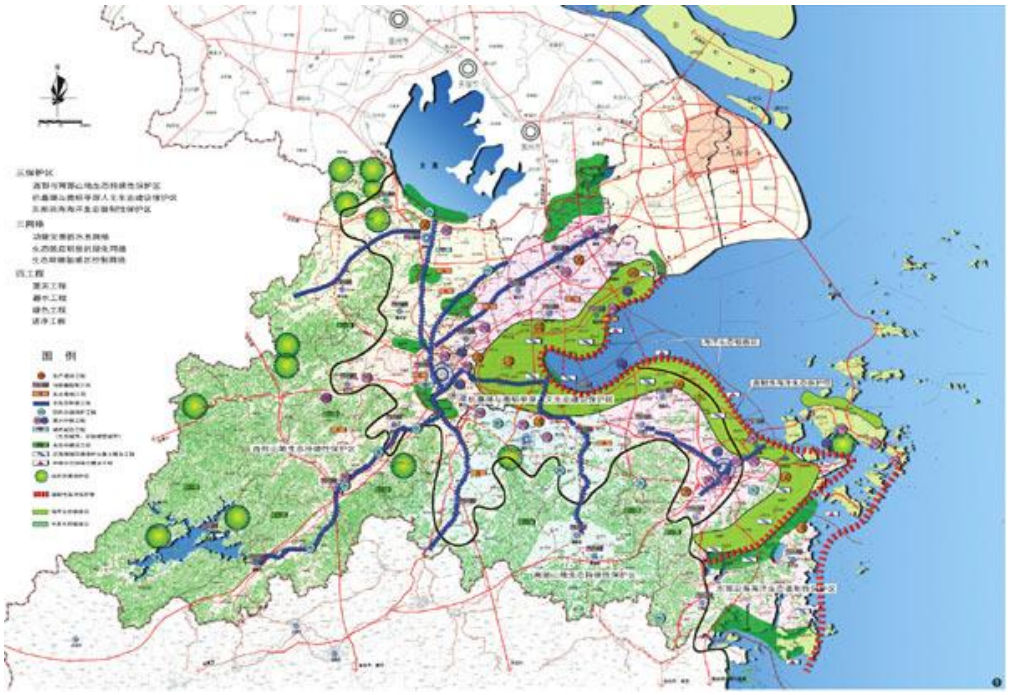


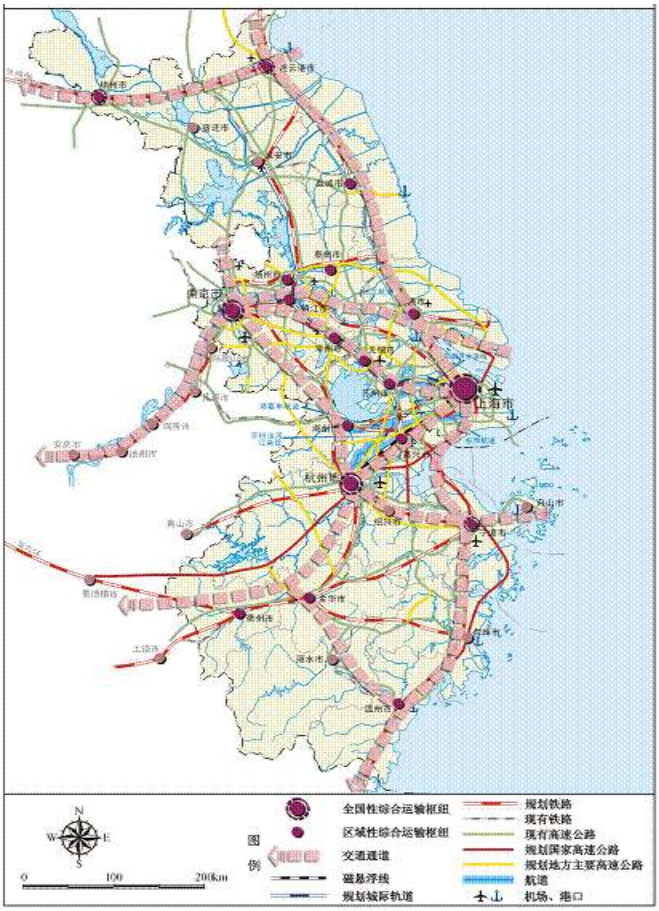
Fig. 7 Schematic diagram of the cooperative development of ecological protection in the Gulf of Hangzhou

5.2 Network feature of collaboration in regional infrastructures

Based on the collaborative development of neighboring regions, the enhanced building of network-shaped facilities has promoted flow and exchanges of people, materials, capital and information in the region. And the accelerated flow of these elements has triggered a few influences such as polarization and expansionary effects. The greater capacity in transport accessibility has extended the scope reached by urban functions, changed the original time-space concept and expanded the scope of collaboration scope among cities. At the same time, the inter-city high-speed railways have enlarged and highlighted the inherent competitive advantages and disadvantages of cities, sped up the formation of new urban networks, promoted the restructuring of regional spatial structures and enhanced the collaboration and collaboration among the cities in the Yangtze River Delta.

Judging from the layout of transport infrastructures in the Yangtze River Delta, the comprehensive transport & traffic system has been basically formed, presenting the urban development axis pillared on four major transport channels, namely, Shanghai-Nanjing, Shanghai-Hangzhou, Nanjing-Nantong and Hangzhou-Wenzhou, which are cored in Shanghai with port cities as the hub. In terms of the length of transport and traffic routes, we have seen rapid growth in various means of transport. In 2010, the total highway mileage, mileage of inland river waterways, operating railway mileage and highway mileage in the Yangtze River Delta stood at 272,458 km, 36,157 km, 4,118.2 km and 8,217 km respectively, accounting for 6.79%, 29.1%, 4.52% and 11.09% of the total in China respectively. Compared with fact that Yangtze River Delta territory accounts for only 1% of the total territory in China, the length of transport routes take a higher percentage in the country and the transport infrastructure network is taking shape in the Yangtze River Delta. In the future, the region will continue to improve development of its transport channels by completing the Shanghai-Nanjing and Shanghai-Hangzhou channels, the along-Yangtze River channel, coastal channel, Nanjing-Huzhou-Hangzhou channel and many other trunk channels within the region. At the same time, it will speed up the development of comprehensive hubs and enhance the network support capacity

for the regional collaborative development.



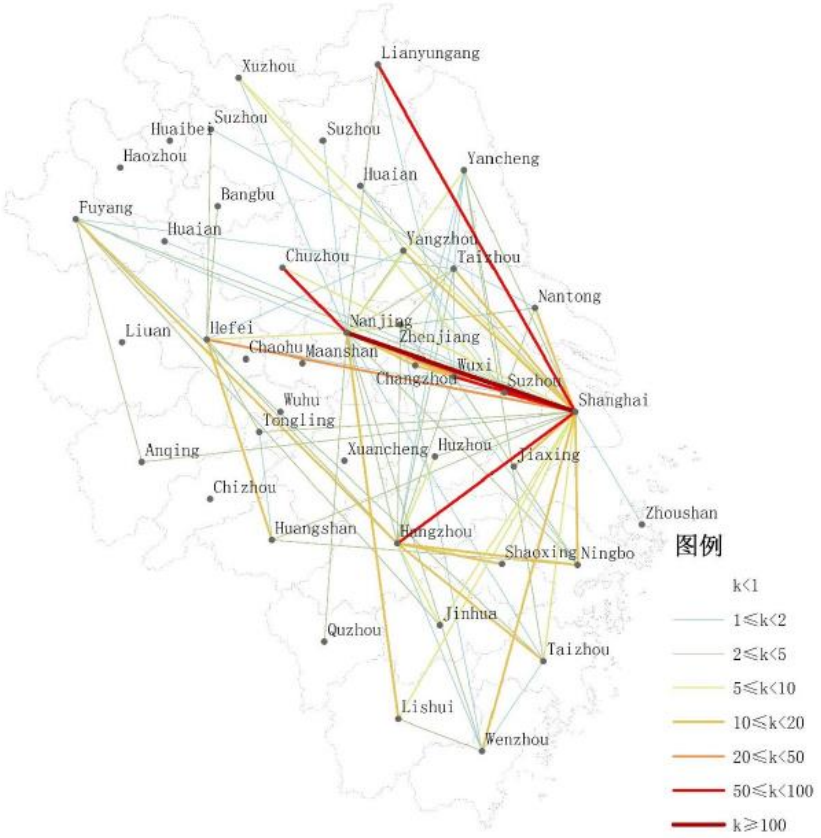
Graph 8 Map of planned transport channels in the Yangtze River Delta 2009-2020
Source: Regional Plan in the Yangtze River Delta 2009-2020

5.3 Network feature of collaboration in knowledge innovation

In 2013, the urbanization ratio of permanent population in the Yangtze River Delta reached 67.96%, meaning the region would enter the mature stage of urbanization. As a result, it is necessary to shift from the factor-driven development relying on the bonus of cheap land and labor force to the innovation-driven development. Alfred Marshall once pointed out, Knowledge is the most powerful production force, which ensures we can conqu and meet our own needs . The collaboration in knowledge innovation can promot high-quality talents, improve the research capacity and help shift the physical extension focusing on quantity to the connotation development focusing on quality in the urbanization process in the Yangtze River Delta.

By using the analytic method of GIS partnership and based on the data of 2000-2015 partnership patents (substitution parameter of innovation partnership) applied and publicized by WIPO in the PCT system, the author analyzes the collaboration in city knowledge innovation in the Yangtze River Delta. The studies show that, in the innovation partnership in 2000-2015 in the Yangtze River Delta, the major nodal cities, such as Shanghai, Nanjing, Hangzhou, Hefei, Taizhou, Fuyang, Taizhou, Ningbo and Yancheng, etc., have close and extensive innovation partnership with other cities. Of these cities, we see the highest intensity of innovation partnership between Shanghai and Nanjing, Hangzhou, Suzhou, Wuxi and Liangyun-gang and

between Nanjing and Chuzhou. In terms of space, the grid network has been formed that consists of the core + multiple nodes . Shanghai plays an evident role as th in the innovation in the Yangtze River Delta (Graph 9).



Graph 9 Spatial organizing features of innovation partnership in the Yangtze River Delta in 2000-2015

Prepared by LU Tianzan

6. Conclusion

To make joint efforts to address the many problems brought by urbanization and stand against the competition from the other city clusters in the world, the Yangtze River Delta has been enhancing its collaborative development after its urbanization ratio exceeded 50%. The collaboration among cities has shifted from the point-to-point collaboration among neighboring regions to diverse collaboration. Till today, we have seen such major collaborative development as in the environmental harnessing, building of infrastructures, land use and development and in knowledge innovations in the region. And the spatial features of collaboration are represented by the multiple points to that in the belt of neighboring regions and in the network structure with layers. At the same time, it is also developing from the collaborative development of physical space to that of virtual space. It is worth pointing out that, the topic of the study is relatively macro with each section having the potential to make further explorations and empirical studies. Besides, the integrity of collaboration and regional differentiation in the Yangtze River Delta are worth in-depth studies. The thesis only summarizes the needs, means and spatial features of regional collaboration in the Yangtze River Delta after the 50% urbanization ratio, thus providing certain reference for the people wishing to learn about the urbanization and regional collaboration in the Yangtze River Delta.

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