

STUDY ON ECOLOGICAL SPACE OF URBAN AGGLOMERATION —Taking Wuxi City as an Example

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ABSTRACT: From the angle of ecology, urban agglomeration presents relevant types of landscape structure, which include Patch, Corridor and Matrix. There are different landscape features and different problems in different development phases. This paper has put forward five basic conditions for security pattern of landscape ecology of urban agglomeration, described quantitatively the features for landscape ecology in Wuxi, and analyzed ecological background of spatial expansion and spatial organization of urban development in Wuxi. From the angle of ecological land use and non-ecological land use, the paper has analyzed the features of land use and ecological distribution of land in the urban area. The spatial model of cities and towns in Wuxi is composed of one metropolis, two urban zones and three development axes. This thesis has planned preliminarily ecological protection network at four levels in the urban region according to four layers. At last, combining landscape ecology with urban space, a tentative security pattern of landscape ecology has been planned in Wuxi, namely Source-Buffer Zone and Metropolis, Radiating Routes and Expansion Direction of City, Strategic Point and Interaction between Cities and Towns, Inter-Source Linkage-Corridor of a Stable Landscape Structure.

KEY WORDS: urban agglomeration; spatial structure; landscape structure; security pattern of landscape ecology

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In essence, urban agglomeration contains many aspects, such as economy, society, environment and so on. The highest goal and final aim of sustainable urban agglomeration are realizing the unity of economical effect, social effect and ecological effect. The study on the features and rules about the evolution of urban agglomeration, from the angle of ecology, conforms to the evolution trend of urban agglomeration. Taking Wuxi as an example, which lies in the coastal area of East China, its rapid economic development leads to the contradiction between economy and ecology. Because it is very difficult for us to solve the problems in microcosmic construction layer and traditional planning layer, this paper tries to reexamine the intrinsic problems from a new angle. Firstly we should plan urban agglomeration from the angle of all the city, then lay out urban agglomeration from the angle of landscape ecology, at last construct regional system of urban agglomeration

basing on the future, macroscopic view and landscape ecology.

1 SPATIAL LANDSCAPE STRUCTURE OF URBAN AGGLOMERATION

From the angle of ecology, city is a man-made ecosystem in specific area, which takes mankind behavior as main force, environment as backing, all kinds of flows as carriers and impetus, circulation network and social system as main channels, so it is the summation for a new ecological relation, which is different from “between mankind and nature”, “between mankind and mankind”, “between mankind and other living things” in the countryside. Urban ecosystem has two features, one is emphasizing the unity of cities and environment around them, and the other is emphasizing close relationship between cities, between mankind and

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cities, between cities and environment. Urbanization is the process that changes from natural or half natural ecosystem to man-made ecosystem; strengthening quantity and quality of mankind race as well as the change of its ecological position; simplifying the relation of ecological network and strengthening the relation of economic and social network; changing from natural or half natural ecosystem that is self-stability to man-made ecosystem that is not self-stability (ZHONG, 1998). Some studies have made clear that urbanization process accords with Logistic curve, which has three phases, namely, periods of rising slowly, rising quickly and rising stably. Urban expansion process has periodic changes with acceleration, deceleration and relative rest. The spiral development happens to have the same process with the evolution of ecosystem and its race, and the track of regional sustainable development.

Landscape ecology is a primary, comprehensive causality between bio-community and environment in a certain area (DONG, 1993). Study on ecological problems in urbanized areas is finding the in-out relations of all kinds of flows in urban agglomeration, and seeking balance in the function of the system by the principles of ecology and ecosystem. Landscape is made up of Patch, Corridor and Matrix from the angle of spatial structure, which is called a joint name "Tessera". Matrix is the most broad area in landscape of urban agglomeration, which includes farmland, water area, forest, pasture and so on, whose area accounts for above 50 percent in landscape area at least; Corridor presents narrow belt, which includes natural Corridor and man-made Corridor, such as rivers, forest belts, roads and so on; Patches are different function regions that are distributed in the shapes of continuous islands through inlaying, which are relative homogeneity, and usually are constructions and built-up areas. From the angle of urban ecology and urban agglomeration space, spatial structure of urban agglomeration, taking central city as the core, presents irregular urban density alternating with dense irregularly, which forming the fan with sparse cities or concentrated cities similar to economic landscape in "market location theory" (XU, 1997). Landscape of urban agglomeration is the spatial range where urban agglomeration is located, namely, its spatial combination of factors and outward appearance.

2 ECOLOGICAL SPACE OF URBAN AGGLOMERATION

Ecological space of urban agglomeration is adjusting the proportion connection and function structure

from core to periphery in different levels of space on the layer of urban agglomeration. Its essence is moulding spatial effect for industry, inhabitation, communication and so on, redistributing spatial unities, realizing the conformity of structure and function through the unity of planning, controlling and managing (WU, 1995). The stability of urban landscape ecology is motive force for the development of urban and regional economy. There are two aspects that landscape factors operate regularly in the area of urban agglomeration, one relies on natural adjustment, the other relies on man-made adjustment (DONG, 1993). There is a threshold that the ability of urban agglomeration is attacked by environment. Natural adjustment can restore its function; man-made adjustment can coordinate relations among urban agglomeration, environment and region. The planning and controlling for the ecological space of urban agglomeration should combine closely the planning of urban agglomeration and land management with environment management through ecological adjustment. Ecological adjustment is compensation for a loss of ecological maladjustment because of exploitation and development through combining economic, social and management decision with engineering measures (DONG, 1993).

2.1 Land Use and Ecological Land Division

Ecological space of urban agglomeration expresses quantity, structure and its spatial relation of all kinds of land in the aspect of land use. Regional ecological land can be divided into tract and belt, the former include forest, lake and wetland, agricultural land as well as opening wide space, the latter includes rivers, traffic corridors and so on. Urban land can be divided into nine types, they are living land, public building land, industry land, storage land, traffic land, road and square land, municipal facility land, public greenbelt, special land. Functional region forms gradually on the basis of land types. Ecosystem is stable only when ecological land takes up enough proportion. Definite land types and its spatial combination can form urban functional regions, whose structure, spatial distribution and harmony features reflect essential attribute of urban land, further more reflect reasonable degree for the structure between ecological land and non-ecological land. Up to now, several obvious functional regions have formed in Wuxi, such as culture and education district in the western city, tourism and vacation district in the western city and southern city, industry district in the middle city and eastern city, business district and administration district in the central region. In general,

Wuxi has some obvious function districts, but there are two problems: one is that kinds and quantity of function districts need to be formed and perfected, such as storage district; another is that industry districts are mixed with other function districts, although industry district has formed, a lot of corporations are still distributed there. Table 1 and Table 2 are respectively land use structure of built-up area and whole city region. There ecological economic zones have formed, such as development region of central city, comprehensive economic region of hills and mountains in south Yixing, exploitation region along the Changjiang River, economic region in plain area.

2.2 Landscape Structure of Regional Cities and Towns

There is consanguineous relation between development phase and landscape feature of urban agglomeration (Table 3). Urban evolution of Wuxi follows the law on the whole. There are four phases in urban evolution and landscape change. Before 1957, many cities and towns have formed in whole urban area, where there are several bigger centers, such as Wuxi, Xishan, Jiangyin, Yixing and so on. Roads with a lower rank are linked between cities and towns except Wuxi and Xishan that are connected by railway. In this period, cities and towns had a smaller patches, the biggest patch is Wuxi

Table 1 Urban land structure and function districts in Wuxi City

	Industry land	Municipal facility land	Storage land	Public building land	Living land	Public greenbelt	Traffic land	Road and square land
Area of land(km ²)	18.70	1.80	2.10	9.80	20.50	6.50	2.40	6.50
Proportion(%)	27.38	2.64	3.07	14.35	30.01	9.52	3.51	9.52
Function district	Industry district	Complex district	Storage district	Culture and education district, business district and administrative district	Living district	Tourism and vacation district	Complex district	Complex district

Table 2 Land partition in Wuxi City

	Whole City	Development region of central city			Comprehensive economic region of hills and mountains in southern Yixing		Exploitation region along the Changjiang River		Economic region in plain area	
		Area (×10 ³ ha)	Area (×10 ³ ha)	Proportion (%)	Area (×10 ³ ha)	Proportion (%)	Area (×10 ³ ha)	Proportion (%)	Area (×10 ³ ha)	Proportion (%)
Total		490.80	59.04	12.03	61.87	12.61	28.92	5.89	340.87	69.47
Agricultural land	Plowland	177.41	8.56	4.83	12.58	7.09	13.82	7.79	142.45	80.29
	Gardenplot	14.72	1.56	10.60	6.77	45.99	0.61	4.14	5.78	39.27
	Woodland	42.22	5.03	11.91	29.19	69.14	0.90	2.13	7.10	16.82
	Water area	163.22	28.21	17.28	3.63	2.22	6.33	3.88	125.05	76.62
Construction land	Residential area, industry and mining land	72.93	13.67	18.74	6.55	8.98	5.97	8.19	46.74	61.09
	Traffic land	15.37	1.53	9.96	1.51	9.82	1.10	7.16	11.23	73.06
Non-used land		4.93	0.48	9.74	1.64	33.27	0.19	3.85	2.62	53.14

Source: Overall Plan of Land Use in Wuxi(1997 – 2010).

Table 3 Development phases and landscape features and problems in urban agglomeration

Development phases	Population change	Landscape features	Landscape problems
Expansion of isolated cities with multi-center cities	Population increase	Thin Patches on the Matrix	Decentralization of Patches, scarcity of Corridors
Directional sprawl of urban space	Population convergence	Development of Patches along with the Corridors	Decrease of landscape factors in part (such as farmland and greenbelt)
Centripetal and centrifugal expansion between cities	Population migration	Order structures of Patches and Corridors as well as its unity	Unity of Matrix has been destroyed and proportion of man-made Corridors has been increased
Complex expansion in urban interlock area	Population concentration	Concentration features of landscape structure	Imbalance of landscape factors in distribution leads to economic problems, ecological problems, environmental problems and social problems

with an area of 12.2km²; from 1957 to 1963, cities and towns developed rapidly along traffic corridors, population accumulated to big cities, for example, in Wuxi City, built-up area enlarged to 20km², population increased to 600 thousand; from 1964 to 1982, centralization and diffusion existed simultaneously in cities and

towns, more population concentrated to there. Communication lines became main framework of corridors, such as Hu – Ning highway, Jing – Hu railway, No.104 and No.312 national highways, built-up area enlarged to 37.5km², the population increased to 800 thousand; from 1983 to now, expansion of cities and towns has a

stretching trend, population concentrated to capital city, for example, in Wuxi City, built-up area enlarged to 97.8 km², population increased to 1117 thousand in city proper. Because of increasing of man-made landscape and decreasing of natural landscape, ecological environment has been destroyed to some extend, it need not give unnecessary details here.

A concept about landscape security pattern and landscape factors have been put forward by Yu Kong-jian, which are Source (habitat of local species, beginning of diffusion and maintain for species), Buffer zone (lower resistant region for the diffusion of species surrounding Source), Inter-source linkage (lower resistant passageway which contact easiest between two nearby sources that are linked together), Radiating routes (lower resistant passageway that radiate from Source to periphery landscape), Strategic point (the stepping stone that has key function for communicating between two Sources that are linked together) (YU, 1998). Hereby, Security pattern for ecological space of urban agglomeration should have conditions as follows: 1) it has a central fragment with a enough scale, namely core city(or Metropolis); 2) there are distribution region with fragments in the periphery of the core city, namely Secondary Metropolis; 3) buffer belt from dense cities to the edge of urban agglomeration; 4) cities in the edge belt; 5) there are convenient and efficient Corridors between the area of urban agglomeration and periphery, between core fragments and around fragments, cities in edge belt, periphery of urban agglomeration, between units of urban agglomeration.

Change rate of grades about cities density in urban agglomeration can express sensitivity and stability in landscape of urban agglomeration and change of land

use. When it has a higher change rate, there is a compact spatial structure of urban agglomeration and intensive land use. Whatever change of landscape or land use types is, it will bring about fluctuation of system structure and function maladjustment; when it has a lower change rate, the threshold of landscape structure has a larger scale, a wider space of factors change, a better stability of the system, which expressed by proportion of non-agricultural land on different distance from core cities. Corridor can control landscape structure of urban agglomeration. A lot of studies have expressed that cities and urban agglomeration expand along main communications artery mostly, which is called Corridor effect. Just like above all, Corridor often takes a decisive part in landscape structure of urban agglomeration. From the angle of economy in general, landscape of urban agglomeration expands along with main Corridors irregularly taking core city as a center and forms circling distribution at last. In a new succession, it will cycle again and again, form continuous expansion in urbanized area gradually, and become out of order for landscape ecological structure. In order to avoid this, to cultivate landscape factors is imperative under the situation. Firstly, we should cultivate natural Corridor (such as rivers) and make them become the link between all circles, all factors; secondly, we should construct or retain natural landscape factors (such as green belts, farmland, water areas, mountains) and make them have full landscape structure factors; thirdly, we should give consideration to economic effect and ecological effect, and coordinate between development of man-made Corridors and growth of natural landscape factors. Table 4 has described the basic features of landscape ecology in Wuxi.

Table 4 The basic features of landscape ecology in Wuxi City

	Whole Wuxi City (1996)	Whole Wuxi City (1999)	City proper of Wuxi (1999)	Jiangyin City (1999)	Yixing City (1999)	Xishan City (1999)
Diversity index	2.0166	2.1527	2.0207	1.8288	2.1883	1.9517
Uniformity index(%)	67.22	71.76	71.98	65.14	77.95	68.52
Patch density (patch/100km ²)	—	2.301	2.463	2.857	1.668	2.962
Average distance between Patches(km)	—	5.5	3	6.5	7	6
Urbanization index	0.3876	0.4718	1.475	0.451	0.352	0.481

Source: Over planning about land use in Wuxi City (1995 – 2010), Wuxi Statistical Yearbook (1999); Urbanization index = (residential area and industrial, mining land + traffic land) / agricultural land, agricultural land = farmland + garden plot ; Diversity index

$H = - \sum_{i=1}^n (P_i) \times \log(P_i)$, in the formula: P_i : proportion of land-use types, n : amount of land-use types; Uniformity index

$E = (H/H_{\max}) \times 100\%$, in the formula: the most diversity index $H_{\max} = \log(n)$.

3 ECOLOGICAL BACKGROUND AND SPATIAL ORGANIZATION OF URBAN EXPANSION IN WUXI

Wuxi lies in corridor part between river and lake in the Changjiang River Delta, which is close to Taihu Lake in the south, facing the Changjiang River in the

north. Plain account for a most part in terrain, low mountains and hills scattered there. There are a wide plain and a developed network of rivers, sloping from west to east slowly with an elevation of 1 – 5m in the eastern plain. There is plain with a network of rivers in the south, sand plain with a higher elevation in the

north, farmland and reclaiming land from a lake with a lower elevation in the middle area. There are rising and falling hills, continuous mountains along the lake in the southwest of city proper, briefly mountains and hills accounting for 16.8 percent, water areas accounting for 16.5 percent. There are over 3100 rivers of varying sizes totally 2480km in Wuxi, which is beneficial to form the urban system with a network of rivers. It has provided wide space for urban expansion at all levels because most part are plain.

After adjusting administrative district, the central city zone has expanded to the area encircled by Shanghai – Nanjing expressway and Wuxi – Yixing expressway, along with Dongting Town, Fangqian Town, Chaqiao Town and Dongbeitong Town. There are almost plain in the region, mountains and hills in the west, a part of water in the south. There are three expansion directions in Wuxi. There is a large land for urban development, which can meet expansion of construction land in central city in the future. Expansion direction of Jiangyin is the model of “T” and east-west is main direction because it is separated by mountains in southeast and southwest, restricted by the Changjiang River in the north. Yixing has several expansion directions except southwest, southeast is main direction at present. According to the theory of landscape ecology and present pattern of urban development in Wuxi, expansion pattern of the city is one metropolis, two urban areas and three concentrated axes.

3.1 Metropolis

Metropolis includes core zone and built-up area within outer ring road; extended zone, the area encircled by Shanghai – Nanjing expressway and Wuxi – Yixing expressway, including 14 counties; periphery zone, new district of city proper. Wuxi should be built a metropolis with several radiating directions, form city groups, and open widely to outside. Its development bases on the following features: the city zone of Wuxi is one of the important economic centers, an important high-tech industry and export-oriented manufacturing base in China; an important traffic and communication hinge as well as material flow and information center in the middle area of the Changjiang River Delta; a famous tourist city at home and abroad.

3.2 Urban Zones

Namely Jiangyin City and Yixing City, which both will have become big cities according to city planning by

the end of 2020. City proper of Jiangyin will be constructed into a city famous for its historical and cultural associations in China, a developing hub of communications in East China, an important gateway of opening to the outside world, an important port and industrial city of Jiangsu Province, a secondary center in the north of Wuxi, which should include Chengjiang, Yaosai, Shanguan, Xiangang, and Nanzha. City proper should form the spatial pattern just like belts and groups taking the Changjiang River as development axis. Yixing is a famous ceramic city in China, comprehensive commerce and trade service center in contiguous area of Jiangsu, Zhejiang and Anhui provinces, an industrial and tourist city of Jiangsu Province, secondary center in the south of Wuxi. City proper of Yixing includes Yicheng and Dingshu Town. Jiangyin should develop high-tech industry taking environmental protection as the dominant factor; Yixing should set up the industrial base taking ceramic industry as characteristics.

3.3 Concentrated (development) Axis

Urban system of Wuxi will form expansion axes with “two horizontal lines and one vertical line”, according to communication network and industry layout, considering the pattern of “three circles and five axes” in urban system of Jiangsu Province, which are the Changjiang River expansion axis, Shanghai-Nanjing expansion axis and Xinyi-Yixing expansion axis.

Expansion direction of Wuxi is in the south (Fig.1). It is becoming “city closing to lake” and “landscape city”. The spatial pattern of the city should adopt “the metropolis of radiating and groups, open widely”. City proper of Jiangyin should expand along the river and form the spatial pattern just like belt and groups, taking the Changjiang River as expansion axis. Yixing should maintain the model of “one city and two towns”, Yicheng and Dingshu form two groups in the north and south respectively separated by Longbeishan forest park. Because of environmental pollution, lagging infrastructure as well as unreasonable use on minerals, forest and water resources, ecological and environmental function have been severely maladjusted, and intrinsic factors of natural landscape have been separated. The functions of ecological fence of natural eco-system are losing gradually. The factors that have the function of ecological fence in environment are plant, soil, land, water, wetland, atmosphere and so on, and the spatial form and their combination affect the effect of ecological control. Ecological control includes these aspects: adjusting the balance between carbon and oxygen, cutting

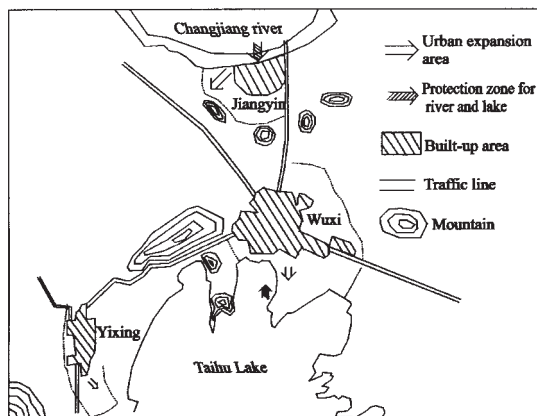


Fig. 1 Sketch map of expanding direction of Wuxi City

air pollution, weakening the effect of heat island, improving climate and so on (DONG, 1999). Planning for ecological fence network in urban area should consider natural features and development direction of the region. It must be considered from four levels as to Wuxi area. First level is taking landscape as the background; second level is considering fully the features that Wuxi is history and culture city as well as tourism city; third level is forecasting the future that Wuxi will become key city with an export-oriented economy and developed economy; fourth level is paying attention to ecological fence of key city, such as Wuxi, Jiangyin and Yixing. We should build ecological fence network with four levels for Wuxi City, according to the model of one metropolis, two city areas and three development axes, as well as basic factors for a safe structure of landscape ecology, which are source, buffer zone, strategic point and corridor. Ecological fence network of first class includes hills and mountains, water, protection zone, farmland, garden plot and so on, such as the Taihu Lake, the Changjiang River, the Ge Lake, as well as a vast stretch of agricultural land. Second class includes hills and water in a small scale or in an isolated state, such as Hua Mountain, Ding Mountain, Tongguan Mountain, west Jiuhu Lake and east Jiuhu Lake. Third class includes Corridors in linear state, small waters, such as the Grant Canal, Wuxi – Yixing freeway, Hu – Ning freeway, Wuxi – Chengjiang freeway, Beijing-Shanghai railway and so on. Forth class includes waters, parks and greenbelts in inner city, such as Li Lake, Xi Mountain and Dafu Mountain. In this planning, it has improved the occasion, which not only support present situation of urban area, but also consider its development in the future, at the same time, ecological fence network of four classes can be connected integrally. On the basis of these, we should set up opening space, such as type of ecological corridor,

type of traffic corridor, type of groups or patches.

4 PLANNING AND DESIGNING FOR SECURITY PATTERN OF LANDSCAPE ECOLOGY

Proportion of Matrix and non-Matrix space in area should be controlled by marginal utility of landscape ecological value. Landscape utility is a kind of ability that landscape units satisfy the needs of the people. Marginal utility of landscape is the utility it brings when per unit of landscape is added. Landscape ecological value can be measured by marginal utility. According to progressive decrease rate of marginal profit, in the area of landscape unit of urban agglomeration with single function, corresponding to the most profitable spot, is the spot that marginal profit is equal to 0, which express that marginal profit is equal to 0 through expanding area of landscape unit of urban agglomeration, under the circumstance of the steadiness in other conditions. We can simulate marginal profit and loss curve about environmental economy and calculate the grades of marginal profit and loss in urban region under different proportions of area, in the light of the study of Zong Yao-guang.

From the angle of virescence, the degree of profit and loss in the built-up area of Wuxi is 2.09 – 2.64, Jiangyin is 1.36 – 1.67, Yixing is 2.65 – 3.44, Xishan is 7.01 – 12.33, average condition of our country in cities is similar to Wuxi; from the angle of Matrix and non-Matrix space in city proper, Wuxi is 0.21 – 0.36, Jiangyin, Yixing and Xishan are less than 0.07, average condition of our country in cities is less than 0.13, Jiangsu is in the range of 0.14 – 0.20; from the angle of Matrix and non-Matrix space in Wuxi, area of Patches and man-made Corridors in Wuxi amounts to 19 percent, degree of profit and loss is 0.21 – 0.36 (Table 5).

Patch, Corridor and Matrix is a basic structural model of landscape ecology, which form landscape pattern by permutation and combination in space, which include farmland, forest, pasture, highway, railway, waterway, construction land of city, water area in the city area. Security pattern of landscape ecology in city area stems from maintenance and control of ecosystem. The goal is to monitor the process of landscape ecology in city area, to make it have a evolution, to realize the unity of economic result, social result and ecological result, through controlling key factors and distribution in the potential spatial pattern of landscape ecology. Security pattern of landscape ecology in city consists of Source, Buffer zone, Inter-source linkage, Radiating routes and Strategic point. The city area should have

Table 5 Degree of profit and loss about environmental economy under the area proportion of different Matrix space

		Proportion of Matrix space(%)									
		< 5	5 – 10	10 – 15	15 – 20	20 – 25	25 – 30	30 – 35	35 – 40	40 – 5	45 – 50
Degree of profit and loss	> 39	12.34 –	7.01 –	4.72 –	3.45 –	2.65 –	2.09 –	1.68 –	1.36 –	1.11 –	
		39.00	12.33	7.00	4.71	3.44	2.64	2.08	1.67	1.35	
		Proportion of Matrix space(%)									
		50 – 55	55 – 60	60 – 65	65 – 70	70 – 75	75 – 80	80 – 85	85 – 90	90 – 95	> 95
Degree of profit and loss	0.90 –	0.74 –	0.60 –	0.48 –	0.38 –	0.29 –	0.21 –	0.14 –	0.08 –	<0.07	
	1.10	0.89	0.73	0.59	0.47	0.37	0.36	0.20	0.13		

these basic thoughts for security pattern of landscape ecology as a ecosystem: 1) top priority is to construct large Patches and main Corridors(such as primacy city, expressway), to ensure the basic source for matter motion, energy flow and information transmission in the system; 2) to ensure heterogeneity of landscape space. According to the principle of diversity resulting in stability, one is the diversity of landscape factors, such as many types of Corridors(natural Corridors, man-made Corridors), the other is the diversity of factor type(scale and shape of city); 3) aggregate-with-outliers (FORMAN, 1995a,; 1995b). Distribution of cities interlocks by aggregate-with-outliers. We should construct exclaves of cities in periphery of big cities.

4.1 Source-Buffer Zone and Metropolis

Source is the habitat of local species, beginning of diffusion and maintain for species. Buffer zone is lower resistant region for the diffusion of species surrounding Source. Source in urban area is every large-scale Patches (core city), Buffer Zone is its periphery. The structure type is different in approach but equally satisfactory in result with Metropolis. The city proper of Wuxi, Jiangyin and Yixing are centers of the region, which make up of the source of the urban area. For example, built-up area of Wuxi (include Xishan), Yixing and Jiangyin are 105.8km², 26.8km² and 28.3 km² respectively at present, adding up to 160.9km², proportion of non-agricultural land in whole Wuxi City and the city proper are respectively 18.36% and 24.82%. All kinds of factors and flows produced from source spread to outside along corridors at all levels, maintaining normal operation for ecosystem. Source and Buffer Zone form a whole because of heterogeneity, transition and relativity between them. For Wuxi whole city, the area of Buffer Zone is identically planning zone by the end of 2010 and 2020, planning area of Wuxi City will have been respectively 170km² and 200km². It has built an ecological base for the expansion of cities. Larger Patch of city has more bearing-capacity, which can ensure heterogeneity, stability of social economy and particularity in the region. A city cannot bear social

and economic activities merely in the urban region (considering bearing-capacity and security): it is imperative under the situation to construct Metropolis and small towns system around the Metropolis. This is based on two aspects, one is ecological security, and the other is forming better mechanism as well as reasonable direction and position of urban development. At present, there have 76 towns in whole city, the city proper of Wuxi (include former Xishan City), Jiangyin City, Yixing City have respectively 49, 21 and 26 towns, the density of towns is 2.3 towns/100km² in whole city area.

4.2 Radiating Routes and Expansion Direction of City

Radiating Route is the lower resistant passageway that radiate from Source to periphery landscape. It is the basic direction of urban expansion for cities. The spot with the least resistance is the position with the most economic result, ecological result and social result. Above all, Radiating Routes of the city proper in Wuxi have two directions that are southward and northward, especially southward Radiating Route has a weaker resistance. Expansion Directions of Jiangyin and Yixing are respectively southwest and southeast. Thereby, Radiating Route with a weaker resistance becomes main direction of urban expansion, because urban expansion has not only lower cost, but also higher comprehensive benefit (including economic effect, social effect and ecological effect) in this direction. Ecological protection in city area is not to adapt passively and closely, but to construct openly and actively. Reasonable evolution of urban system lies not in the scale and quality of land, but in whether the process and direction of urban evolution can be standardized under the guidance of landscape ecological principle.

4.3 Strategic Point and Interaction Between Cities and Towns

Strategic Point is the stepping-stone which had key function for communicating between two Sources linked together. They include traffic nodes, mountains, and

secondary towns between two cities and so on in city area. In the whole city of Wuxi, Xi Mountain, Hui Mountain, Ding Mountain, Xuanyan Town, Fenshui town and so on are Strategic Points that produce material exchange and information communion between the separated regions or less correlative regions. For example, there is a close connection between Yixing and Wuxi through Xi Mountain, Hui Mountain, Xuanyan Town, Fenshui Town. Interaction between cities is finished mostly by all kinds of flows; some core areas take an important part of connecting link between the preceding and the following. There are two goals to study deeply for cities and towns at all levels, one is to construct new growth point in favorable location (Strategic Point), the other is to form reasonable urban system in the region.

4.4 Inter-Source Linkage-Corridor and the Stability of Landscape Structure

Inter-Source Linkage-Corridor is the lower resistant passageway, which contacts easiest between two Source that are linked together, and all kinds of Corridors realize the function. There is direct ratio between the grads of Corridors and its efficiency, and positive correlation between quantity and kind of Corridor and Stability of Landscape Structure. The Corridors that link between cities in Wuxi are Jing-Hu railway, Hu-Ning freeway, Xicheng freeway, Xiyi freeway, the Grant Canal and so on. From the angle of spatial distribution, main Corridors concentrate middle part taking Wuxi as the center; from the angle of Corridor kind, there are natural Corridors and man-made Corridors, among them man-made Corridors include railway and highway at all ranks; from the angle of Corridor density, there is a high density and an obvious regional difference, for example, density of road network of whole city, the city proper, Jiangyin City and Yixing City are respectively 1.12, 2.18, 0.71 and 0.87km/km². Existence and development of Corridors have realized Interaction between cities, and formed the evolution of urban agglomeration. To realize the stability of Landscape Structure, one is to achieve multiplicity on the type of Corridor(natural Corridor, man-made Corridor, grads, type), the other is to guarantee the density of Corridors and a reasonable quantity.

5 CONCLUSIONS

1) Taking urban agglomeration in ecological community, its landscape structure is composed of Patch (built-up areas), Corridor(rivers roads and so on) and

Matrix(farmland, water area and so on) with interlocking form, and every factor corresponds a different unit of urban agglomeration. 2) Landscape factor and structure, landscape problems have different features in different development phase of urban agglomeration. 3) Having ecology in mind and starting with space, specific ecological spatial structure of urban agglomeration will be formed so that the features of landscape ecology can be described quantitatively. Corridors take a controlling part for landscape structure of urban agglomeration. 4) Security pattern of ecological space of urban agglomeration should have defined conditions. Evolution of urban agglomeration follows the basic principle of landscape evolution, which follows the order of metropolis, urban zones and expansion axis. 5) Planning and controlling for urban agglomeration should accord with the principle of landscape ecological security. Top priority is to construct large patches and main corridors, ensuring heterogeneity of landscape space, aggregate-with-outliers. Namely, Source-Buffer Zone and Metropolis, Radiating Routes and Expansion Direction of city, Strategic Point and Interaction between cities and towns, Inter-Source Linkage-Corridor and Stability of Landscape Structure. 6) We should build up four class ecological fence network in whole city taking Wuxi, Jingyin and Yixing as the core, considering fully the features for landscape, history and culture city, metropolis with rapid development.

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