CHINESE GEOGRAPHICAL SCIENCE
Volume 12, Number 3, pp. 212 – 217, 2002
Science Press, Beijing, China

A CASE STUDY ON CONCENTRATION AND DECENTRALIZATION: BEHAVIOR AND DYNAMIC MECHANISM OF SPATIAL EVOLUTION IN METROPOLITAN AREA, NANJING, CHINA

ZHU Xi-gang, ZHANG Jing-xiang, CHEN Hu
(Department of Urban and Resources Sciences, Nanjing University, Nanjing 210093, P. R. China,)

ABSTRACT: In rapid socio-economic development, the process of concentration and dispersal of various elements tends to be more dramatic, tremendously influencing the shaping and transformation of the space in metropolitan area. Survey of spatial concentration and decentralization has thus become a basic method in examining metropolitan spatial evolution. In this research, three elements were selected as the essential indicators of the process: demographic density distribution, employment density distribution and business office location. Performance of these elements in Nanjing City was examined historically. As Nanjing City could be regarded as a representative of metropolitan areas in China, its situation largely suggestes the general characteristics in similar areas of China. Hence based on the investigation of Nanjing City, four general implications were highlighted. First, metropolitan areas in China are in a violent process and shift of spatial concentration and decentralization. Second, from now to at least the near future, concentration will continue to be the central feature. Third, the landscape of metropolitan areas basically exhibits a dual structure character. The gap in environmental and ecological qualities among different districts will continue for a long time. Fourth, Central Business District (CBD) is playing an important role in helping to convert the traditionally single-centered city structure into a polycentric one.
KEY WORDS: concentration; decentralization; dynamic mechanism; Nanjing Metropolis

CLC number: F204 Document code: A Article ID: 1002-0063(2002)03-0212-06

Many elements of production, such as capital, land, labor force and technology have been playing a more and more important role in economy since the adoption of the open policy in China, with the establishment of marketing economy. In the mean time, the internationalization of economy activities, globalization of technology, and new international division of labor are becoming increasingly apparent. Studies on the mechanism and law of urban spatial evolution based on an open system concept, especially in terms of the metropolitan areas, where intensive concentration and decentralization of productive elements happen, have provided not only a new theoretical approach to the real world, but also an important linkage between urban studies of Chinese domestic and the international(GU *et al.*, 2000). The twin paradoxical trends transforming urban space, concentration and decentralization, have been a basic approach in studies of urban space (CUI *et al.*, 1992). Concentration and decentralization of various elements are performing an active role in formation and transformation of metropolitan landscape.

Nanjing City, with a history of more than 2000 years, is now experiencing comprehensive changes: rapid economic growth and social development, and startling expansion of urban space, with various productive elements intensively and frequently concentrating and decentralizing. The macroscopic location and industrial characteristics of the city have demonstrated a representativeness among metropolitan areas in China. Therefore study on its behavior and mechanism of concentration and decentralization suggest the up-to-date general status of metropolitan areas in China.

Received date: 2001-12-20
Foundation item: Under the auspices of the National Natural Science Foundation of China(No. 40001007).
Biography: Zhu Xi-gang(1959 –), male, a native of Taicang City of Jiangsu Province, Ph. D., associate professor. His main research interests include urban planning and urban spatial structure.

1 HISTORIC PROCESS OF SPACE CONCENTRATION AND DECENTRALIZATION OF NANJING CITY

1.1 Before 1949 A. D.

Capital Chronicle state a whole history of Nanjing City, which pointed out Nanjing "belonged to Yangzhou in Xia, Shang and Yu Dynasties, (c. 21st – c. 11th century B. C.), Wu in the Zhou Dynasty (c. 11th century – 256 B. C.), Yue in the Spring-Autumn Dynasty Period(770 – 476 B. C.), and was set up as Jinling County in the Warring States Period (475 – 221 B. C.), belonging to Jingdong Area". In the Qin Dynasty(221 – 207 B. C.), Nanjing was named "Moling County", while in Song, Qi, Liang, Chen Dynasties(420 – 589 A. D.), set up as the national capital "Jiankang". In the Southern Tang Dynasty(923 – 936 A. D.) Nanjing was named "Jiangning government office". In the Southern Song Dynasty (1127 – 1279 A. D.) it was changed to "Jiankang" again. When the Taiping Heavenly Kingdom (1644 A. D.) conquered it, it was again set the capital named "Tianjing", but soon recovered to "Nanjing" till now.

The Republic of China set up its capital in Nanjing after Xinhai Revolution(1911 A. D.). Since then, Nanjing has been the political and cultural center of China until 1949 A. D. The capital was moved to Beijing until the victory of Northern Expedition (1926 A. D.). Then the new national government of the Republic of China re-established Nanjing capital and began a period of planning and constructing Nanjing systematically, which laid a modern city foundation for Nanjing. The space image of Nanjing City, as we see today, is very different from other cities that also developed from old capitals because of its particular geomorphology. Moreover, the longest city wall in the world, built in the Ming Dynasty, had limited the expansion of Nanjing City. Till now, it is still obvious that old city(southern part from Xinjiekou) is more concentrated than new city (Northern part from Xinjiekou).

1.2 1949 A. D. to 1980 A. D.

Since the establishment of the People's Republic of China (1949 A. D.), Nanjing City has experienced a huge change. Within two years from 1950 to 1951, urban population of Nanjing City dropped so much that in 1951, it reached the lowest in the 20th century. This was totally reverse to the population increase in other cities of the same time. Many reasons contributed to this phenomenon: the exodus of the rich, peasants without jobs moving back to countryside, students being absorbed into the army or transferred to cadres, and workers moving up to inland to meet the call of the government. At that time, the boundary of Nanjing city shrinked a lot, giving a loose image of space pattern. In past, there were many vegetable plots and open grounds in the central part of the city, with the concentration index (*CI*)① being only 0.23. (Fig. 1).

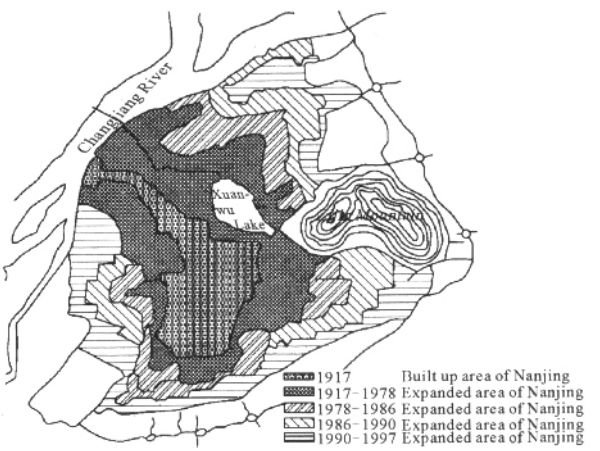


Fig. 1 The expansion of construction land during different periods in Nanjing City

The space in Nanjing City expanded much quickly from 1951 to 1965. On the one hand, the average population growth rate reached about 2.7% per year. On the other hand, some heavy industry firms were settled down to the suburb. Railway and highway were extended to the outskirt in order to meet the communal need of the pendulum population and vice versa. The city axis was largely stretched from the north to the south. Nanjing City came to an expanding stage at large scale. It is on this period that heavy industries were developed at the northern part of the Changjiang (Yangtze) River, chemical industries were broadened in Qixia District, and light industries spread in downtown districts. However, in the rapid increase of land for industrial purpose, residential area only developed a little. This unbalanced expansion dominated the side of decentralization in spatial evolution during the 15 years. The reconstruction and extension happened in downtown area had substituted for those vegetable lands and open grounds, which causing *CI* increased a lot. It is spec-

① Urban image concentration index = Area of urban construction land / Area of mini-circumcircle, ($CI = A/\pi R^2_{min}$)

ulated that *CI* reached 0.41 in 1965.

In the 1970s, especially in 1978, people moving back to cities had reached a high point . Drastic influence had been placed on urban space by the population undulation, following the high rise of population density in downtown area. Emerging of many squatter settlements had destroyed the original symmetric arrangement, inappropriate concentration beginning to appear in some part of the main city. Myriad factories were operated to meet the employment need of young people while taking the place of most residential lands. Most of these concentrations happened inside the city wall since the "threshold" Qinhuai River had limited the expansion to the western part of Nanjing City. However, the city expansion axis wanted downstream along the Changjiang River caused by industry development: axis from Banqiao to Longtan reached 40km, axis from Yanziji to Andemei counted 20km. Three suburbs, Pukou, Jiangpu, Yanjiang, at the northern part of the Changjiang River had been developed as a downtown part of Nanjing City. City image want back to decentralization again, with *CI* declining to 0.32.

After 1980, city's expansion and transformation began in order to meet the residential demands. Construction occurred in the southern part of the city, Nanhu district and the northern part, Jinling district, which belonged to large scale residential districts, causing the south-north extension axis to go to full-grown gradually. Industry area in the northern part of the Changjiang River and many commercial centers around that area also contributed to the maturation of a multi-central metropolis.

It is obvious that urban space image of Nanjing has experienced decentralization, concentration, more concentration and decentralization again based on *CI* during the four periods (Table 1). Since 1990, the urban space has involved in concentration again owing to the expansion on east-west axis. However, owing to the development in Xianxi district, east part, and Jinling district, south part declined the concentration again in some scale.

Table 1 *CI* of different periods in Nanjing City

Before 1949	1949 – 1957	1958 – 1965	1966 – 1980
0.23	0.30	0.41	0.32

2 BEHAVIOR AND MECHANISM OF CONCENTRATION AND DECENTRALIZATION IN URBAN SPACE, NANJING

The GDP growth rate of Nanjing City reached 16% annually during the last 20 years; it was even over 20% from 1985 to 1995. Drastic increase of economy has resulted in growth of urban land, rapid expansion of urban space and urban concentration declination. However, the unbalance between concentration and decentralization also turns apparent in urban central area and sub-central area due to the relatively higher average of productive output per urban area.

Distribution of population, employment and business district are primary tokens of expressing concentration and decentralization of urban space in metropolitan area. The following part will present these aspects and analyse the behavior and mechanism of concentration and decentralization of urban space in Nanjing.

2.1 Concentration and Decentralization Analyses of Population Distribution

People living in Nanjing City reached 5 320 000 in 1998, composed of 1 880 000 in central area, 880 000 in suburbs and 2 560 000 in rural counties nearby. The growth rate in 1999 was separately 1.5%, 2.2%, and 0.8% comparing with that of 1998, which showed strong concentration in urban part. Based on statistical data, population density is divided into 122 small units, each of which counts for both the land distribution and its population density, so as to get three-dimension map by GIS(Fig. 2). Fig. 2 drawn from the population density looks like a point heel that shows the nearer to urban central area, the higher of population density, such as Baixia unit (No. 48) reaches the peak value while in Xinjiekou unit, the population density is about 500 000 person/km^2.

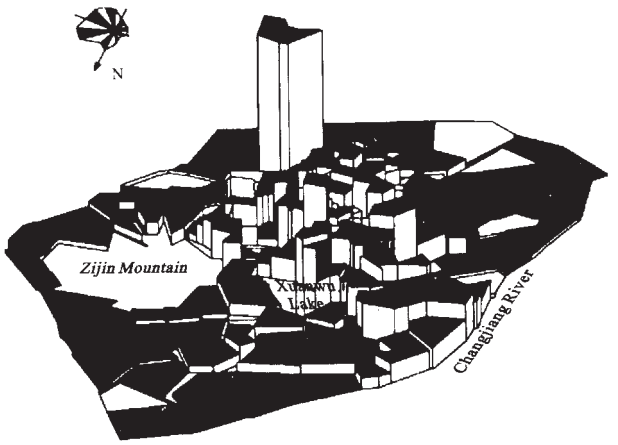
Analyses of open space population concentration and decentralization in major part of Nanjing show that the descending sorts are the following due to spatial concentration index (I)① from 1979 – 1999:

In 1979: Qinhuai, Jianye, Baixia, Gulou, Xuanwu, Xiaguan;

In 1989: Baixia, Qinhuai, Jianye, Gulou, Xuanwu, Xiaguan;

In 1999: Gulou, Baixia, Jianye, Qinhuai, Xuan-

① Open space concentration index: $I = \left(\frac{E_i}{E}\right) \Big/ \left(\frac{T_i}{T}\right)$, if $I > 1$, concentration; $I < 1$, decentralizatipn; $I = 1$, balance.



turns S – N for clean show

Fig. 2 Three-dimension figure of population density in central urban area, Nanjing

wu, Xiaguan.

This suggests the correspondence with urban population moving up to the north of the city. Analyses based on the same approach shows that population in Qixia, Pukou, Yuhua, Dachang also have their different trends during different periods. Before the mid-1980s, population concentration in Yuhua and Dachang was stronger than that in Qixia and Pukou. The reason seems that expansion elements of central area were very limited in the past time. Qixia and Pukou, far from the major area, developed slowly because local elements (such as capital and labor force) were washed away to major area. After 1989, the attracting force in Pukou was mighty with the establishment of Pukou High-tech Development Zone, new campuses of Nanjing University and Southeast University. In addition, the city government has invested very much money to the High-tech Development Zone and relevant projects.

These seem to be the earliest of overflow of central area elements. However, concentration tendency in Yuhua and Qixia was also strong due to their accessibility to CBD. What's more, a new trend came out during 1990 – 2000: population moving from major area to suburbs was increasing with development of the east and west parts of the city as well as Jiangning area. Nevertheless, the population density in the central part did not really decline. This even had little impact of population center. The explanation is that recreation and investment propose predominate those residence-buy. But the trend shall shift the urban population distribution in the near future. This implies that spatial concentration and decentralization are being developed simultaneously in Nanjiang. Various space elements are combined intensely again. This process may continue for a long time, which also suggests that spatial evolution in China's metropolises is deferent from the experiences in the Western where the process of suburbanlization dominated.

2.2 Concentration and Decentralization Analyses of Employment Distribution

The urban central area of Nanjing City has an area of 242.43km^2, which consists of East, West, South, North and Center divisions since 1995. A comparison of population and employment density among different parts shows that the employment and population density in the center part is about three times as much as the average. This demonstrates obvious unbalance of residence and employment distribution (Table 2).

Table 2 Population and employment density in urban central areas, Nanjing

	Center	East	West	South	North	Total
Area(km^2)	53.36	63.48	41.00	32.24	52.35	242.43
Population($\times 10^4$)	131.20	14.50	17.67	12.38	20.40	196.06
Employment($\times 10^4$)	81.50	12.67	9.52	8.95	15.11	127.75
Population density($\times 10^4$/km^2)	2.45	0.22	0.43	0.38	0.39	0.81
Employment density($\times 10^4$/km^2)	1.53	0.20	0.23	0.28	0.29	0.53
Population density/Employment density	1.60	1.10	1.87	1.36	1.34	1.53

Source: collected by a fieldwork survey, 1999.

Some characteristics can be drawn from the data:

(1) Population density is in descending gradient from South to North: in Baixia, Qinhuai, Jianye, it is about 30 000/km^2, while in Gulou districts, it is 25 000/km^2, and in Xuanwu, Xiaguan, not more than 15 000/km^2 before the rearrangement of administrative boundaries.

(2) In urban central area, population and employment are over-concentrated, especially in the central devision, an area only occupy one fifth of the urban downtown part. Intensive land development results in the high rise of land and house price. The number of its

tall buildings is only below that of Shanghai, Beijing, Shenzhen and Guangzhou.

(3) Concentration in other four divisions does not meet their demands: population and employment density are far lower than that in the center division, this demonstrates the sharp dual landscape between urban core area and urban fringe area(CATHY, 1997).

(4) Serious unbalance of population and employment distribution in urban central area brings about drastic increase in urban traffic density, length, pollution, and noise, and declination of its organic concentration structure.

Now, things have taken on a new aspect in which employment density shot up in the urban central and its fringe (suburbs) area at the same times, with the transformation of urban industrial structure, especially, the policy of "move back the secondary industry and move forward the tertiary industry" is being used to a reform of industrial structure in Nanjiang central area last years. Commercial and business employment density are being continued leap forward in urban fringe, such as Xianling, Cangbomen and Banqiao, some industrial town combinations are steadily expand, and many wholesale supermarkets are steadily gathered in these areas. The employment density is being shot up, different from urban central, these jobs meet the local people accomplishment and demands.

2.3 Concentration and Decentralization Analyses of Business Open Space

One thousand two hundred and eighty-two business companies (including foreign companies) belonging to 6 departments(Trade, Finance, Electronics, Architecture, Real estate, Automobile) distributing in 10 districts of Nanjing are calculated according to its location based on Nanjing Telephone Handbook 2000 (Table 3).

Business buildings most concentrate in Gulou, Xuanwu, Baixia and Jianye districts, each of which

Table 3 Business companies in urban districts, Nanjing

	Gulou	Xuanwu	Baixia	Jianye	Xiaguan	Qinhuai	Yuhua	Qixia	Pukou	Dachang	Total
Trade	89	42	76	34	21	15	9	7	5	5	303
Percentage(%)	29.37	13.86	25.08	11.22	6.93	4.95	2.97	2.31	1.65	1.65	100
Finance	37	17	18	11		1	1	2	1		88
Percentage(%)	42.04	19.31	20.45	12.5		1.14	1.14	2.27	1.14		100
Electronics	51	58	58	28	22	17	3	10	18	1	266
Percentage(%)	19.17	21.80	21.80	10.53	8.27	6.39	1.12	3.76	6.76	0.37	100
Architecture	47	33	46	25	17	9	11	26	13	8	235
Percentage(%)	20	14.04	19.57	10.64	7.23	3.83	4.68	11.06	5.53	3.40	100
Real estate	58	48	41	38	15	5	6	6	7	2	226
Percentage(%)	25.66	21.24	18.14	16.81	6.64	2.21	2.65	2.65	3.10	0.88	100
Automobile	21	59	15	8	24	7	21	6	9	1	171
Percentage(%)	12.28	34.50	8.77	4.68	14.03	4.09	12.28	3.50	5.26	0.58	100
Total	303	257	254	144	99	54	51	57	53	17	1289
Percentage(%)	23.50	19.94	19.70	11.17	7.72	4.19	3.96	4.42	4.11	1.32	100

occupies 23.63%, 20.05%, 19.81%, and 11.23%, adding up to 74.72% totally, while other six only take 25.18%. Yuhua and Qixia districts only set 8.43% since they are on the urban fringe area. Business buildings in Gulou district are near 6 times as many as that in Yuhua district. CBD of Nanjing City (Xinjiekou) is located on the interface of Gulou, Xuanwu, Baixia and Jianye, where most companies choose their offices. Another business building concentrated area is the Shanxi-Hunan street(sub-center of the city), settled in Gulou district. This leads Gulou district to be the most commercialized one among all divisions.

The dominating factors affecting the business center distribution are as follows:

(1) The urban space has been gradually expanding to the north of the city. Before 1949, Qinhuai, Baixia and Jianye were in the southern part of the city, which accommodated its business and commercial centers. The National Government officials settled in Gulou district, where population and space density were the lowest among all divisions. However, after 1949, most residents moving up to Gulou and Xuanwu districts led to the economic center shift, following intensive land usage in the northern urban area bet declination in the southern part.

(2) The pursuit of business offices after the best location. Accessibility and high quality environmental are the two basic conditions of modern business centers. Gulou division possesses the two aspects. It meanwhile accommodates many universities and institutes, whose population are of the best education background in Nanjing.

(3) Huge environmental gap between urban central area space and suburbs. The gap is in correspondence with business center distribution. However, the number of business companies in Pukou division, a fringe district, is not less than that in Qinhua, Yuhua and Qixia. This is due to the development of Pukou High-tech Zone. Dachang division, at the north of the Changjiang River, has less business centers due to poor accessibility and low quality environment. It is estimated that the situation could be improved after the Second Changjiang River Bridge being opened in the near future.

There is about 3km location gradient from Xinjiekou district to Baixia and Jianye. This is identical to the population, employment and business distribution. It is similar to the Multi-core Structure addressed by C. D. Harris-Elullman. This implies that a metropolitan multi-core structure is under formation.

3 CONCLUSION

According to the above analyses, some implications about the spatial evolution in Nanjing can be drawn below. As Nanjing is a representative of Chinese metropolises, the implications derived from its experiences can be extrapolated to similar areas in the whole country.

(1) Metropolitan areas in China are still in a drastic era of concentration and decentralization, affected by both the international and domestic factors. These factors, the type, strength and location of their concentration and decentralization hold the driving force of the re-construction of urban space.

(2) Concentration will continue to dominate in spatial evolution of metropolitan areas in the near future. This needs particular discussions at both a macro scale and micro scale.

(3) The dual landscape structure, environmental gap and ecological gap, will be in existence for a long period, caused by unbalanced distribution of concentration and decentralization. The gap can be a block to the smoothing of urban spatial evolution. But it could also be a drive and orientation to its future shift.

(4) CBD has been vital in transforming the single-centered urban structure to a polycentric one in metropolitan area, although it unites social factors of both the traditional and modern economy. The location of different factors' concentration and decentralization shows characteristics of nonconformity. This is due to the difference of mechanisms of concentration and decentralization.

REFERENCES

CATHY Mcllwaine, 1997. Third-world development: urbanizing for the future[J]. *Progress in Human Geogrpahy*, (21) 3: 1121 – 1124.

CUI Gong-hao *et al.*, 1992. *Urban Geography*[M]. Nanjing: Jiangsu Education Press, 120 – 131. (in Chinese)

GU Chao-lin *et al.*, 2000. *Concentration and Decentralization — New Study on Urban Spatial Structure*[M]. Nanjing: Southeast University Press, 1 – 3. (in Chinese)

LIANG Zhen-hai, 1995. Revised urban general planning of Nanjing City[J]. *City Planning Review*, (6): 37 – 39. (in Chinese)

ZHU Xi-gang, 2000. Reflects on urban compatibility[J]. *Journal of Nanjing University (Social Sciences)*, (5): 68 – 72. (in Chinese)