City in Transition: The Structure of Social Space in Tianjin in 2000

Zi-wei Liu, Rui-bo Han and Li-qin Zhang

Abstract Adapting neighborhood-level census data from 2000, this chapter uses factorial ecological analysis method (principal component analysis, PCA) to examine Tianjin's social spatial structure and its formulation mechanisms in 2000. The result shows that principal factors under consideration for the components of social structure in Tianjin include the influx of the salaried class, economic status, retirees and minorities, marital status, and family structure. Every factor has its spatial distribution pattern in the city of Tianjin. Generally, the advanced geographical location, distinctive historical development process, rapid socioeconomic development, and ever-changing government policies and urban planning have worked together to compose the formulation mechanisms of Tianjin's social space in 2000.

Keywords Social space · Sociospatial dynamics · Factorial ecology · PCA · Tianjin metropolitan area

1 Introduction

With the rapid growth of urban populations and supporting infrastructure in the last century, cities have played a vital role in the development of modern society. In recent years, large number of people migrating from rural areas to cities seeking economic opportunities and better lives has caused remarkable urbanization rates. Such rapid urbanization process leads to increased complexity of cities'

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sociospatial dynamics, which is affected not only by the physical environment, but also by individual behavior culture, politics, economics, as well as social organization (social environment). The emergence of human ecology (known as the "Chicago School") in the United States in the 1920s encouraged a developing awareness of the social, economic, and political significance of cities [1]. As early as the first half of the twentieth century, three classic models were proposed by western countries as the foundation of urban sociospatial structure studies. In the 1960s, following on the Chicago School's ecological approach, factorial ecology provided a new method to study urban sociospatial structure. The factorial ecology approach is widely applied to studies of urban sociospatial structure for it represents the complexity of urban social by space. The main theoretical contribution to the origin of this approach comes from Shevky and Bell [2], who developed a three-dimensional (socioeconomic status, family status, and ethnic status) model to describe how urban populations differ in industrial societies. Subsequent studies using a wide variety of measures confirmed the significance of the three statuses. Although it has criticisms, the factorial ecological approach of social-area analysis increases understanding of residential differentiation in cities and is an important instrument for studying intra-urban social–spatial structure. However, all these current studies are not universal: They are simply suitable to the given case cities, especially the cities in Western countries, which means most of the work took place in capitalist cities. Very few studies about urban transformation from an ecological perspective have focused on socialist countries, especially China, which is identified as the one on the transition.

China's economic reforms in 1978 ushered in a phase of accelerated urbanization, which has involved increases in social infrastructure and housing [3]. This is especially evident after the country's transition from a centrally planned economy to a market-oriented economy in 1992, which led to significant urban socioeconomic changes due to four particular policy adjustments. The adjustment of these four policies includes Hukou Reform, Housing Allocation System change, Land Use Policy adjustment, and Urban Planning adjustment. Furthermore, the significant urban sprawl and reorganized process also have impact on urban sociospatial structure transformation. Therefore, more and more scholars are dedicating themselves to the study on such process as well as its transformation mechanism. The history of when the Chinese scholars began to measure Chinese cities' sociospatial structure can be dated back to late 1980s. The first relevant studies related to China are Lo's work about Hong Kong [4, 5] and Hsu's research on Taipei [6]. Yu's study about the sociospatial characteristics of Shanghai urban area and its formation as well as its relevance to urban planning is the first one to quantitatively examine mainland Chinese cities' sociospatial structure [7]. Gan [8] studied Beijing's urban structure and its historic and cultural background in his doctoral dissertation. In 1989, Xu et al. [9] explained Guangzhou's urban sociospatial structure model and its mechanisms. Yang [10] applied census data from 1985 to 1990 to study Beijing's sociospatial structure. After that, many scholars began to apply and compare census data to research regarding the urban sociospatial structures of Beijing, Shanghai, and Guangzhou [11–13]. Due to

inadequate or incomplete data, all these studies were limited. With the release of the fifth population census in 2000, more Chinese cities were examined by scholars, and the methodology for applying factor analysis to Chinese cities became more developed.

Tianjin, the second major metropolis in northern China, is one of the four provincial-level municipalities in China. As part of the economic center of northern China (together with Beijing) as well as a concession city, Tianjin has a distinctive cultural, economic, and historical importance. More particularly, after the central government decided to support the development of the port area (Binhai New Area), the overall social space of Tianjin has changed significantly. Increased levels of foreign investment have contributed to the construction of a World Financial Center, the hosting of the summer Davos Forum, and the idea of Tianjin as a global city. Due to its unique historical development, Tianjin certainly has its characteristic urban development process.

Therefore, adapting spatial analysis method, this research has as its objective to understand the urban sociospatial pattern and its mechanisms, in the case of Tianjin, using neighborhood-level census data from 2000.

2 Study Area, Data Sources, and Methodology

2.1 Study Area

Tianjin (the "Heavenly Ford"), a traditional industrial city near Beijing, is the second major metropolis in northern China. It is the third largest city in China after Shanghai and Beijing as well as one of four provincial-level municipalities in China. Tianjin is located 130 km southeast of Beijing in the North China Plain, bounded to the east by the Bohai Gulf portion of the Yellow Sea. As part of the economic center of northern China (together with Beijing) as well as a concession city, Tianjin has a distinctive cultural, economic, and historical importance.

Tianjin comprises 18 administrative subdivisions, which are county-level units governed directly by the municipality (second-level divisions). Of these, 15 are districts and three are counties. The study area of this research covers Tianjin's 15 districts (Heping District, Hedong District, Hexi District, Nankai District, Hebei District and Hongqiao District, Tanggu District, Hangu District, Dagang District, Dongli District, Xiqing District, Jinnan District, Beichen District, Wuqing District, and Baodi District), excluding the three counties (Jinghai, Ninghe, and Jixian). The study area had a total population of 7,746,700; the overall study area is 7,378 km^2. According to Tianjin's administrative division, Heping, Hedong, Hexi, Nankai, Hebei, and Hongqiao comprise the urban core of Tianjin; the region composed of Tanggu, Hangu, and Dagang is referred to as the "Binhai New Area"; Dongli, Xiqing, Jinnan, Beichen, Wuqing, and Baodi constitute the suburb of Tianjin (Fig. 1).

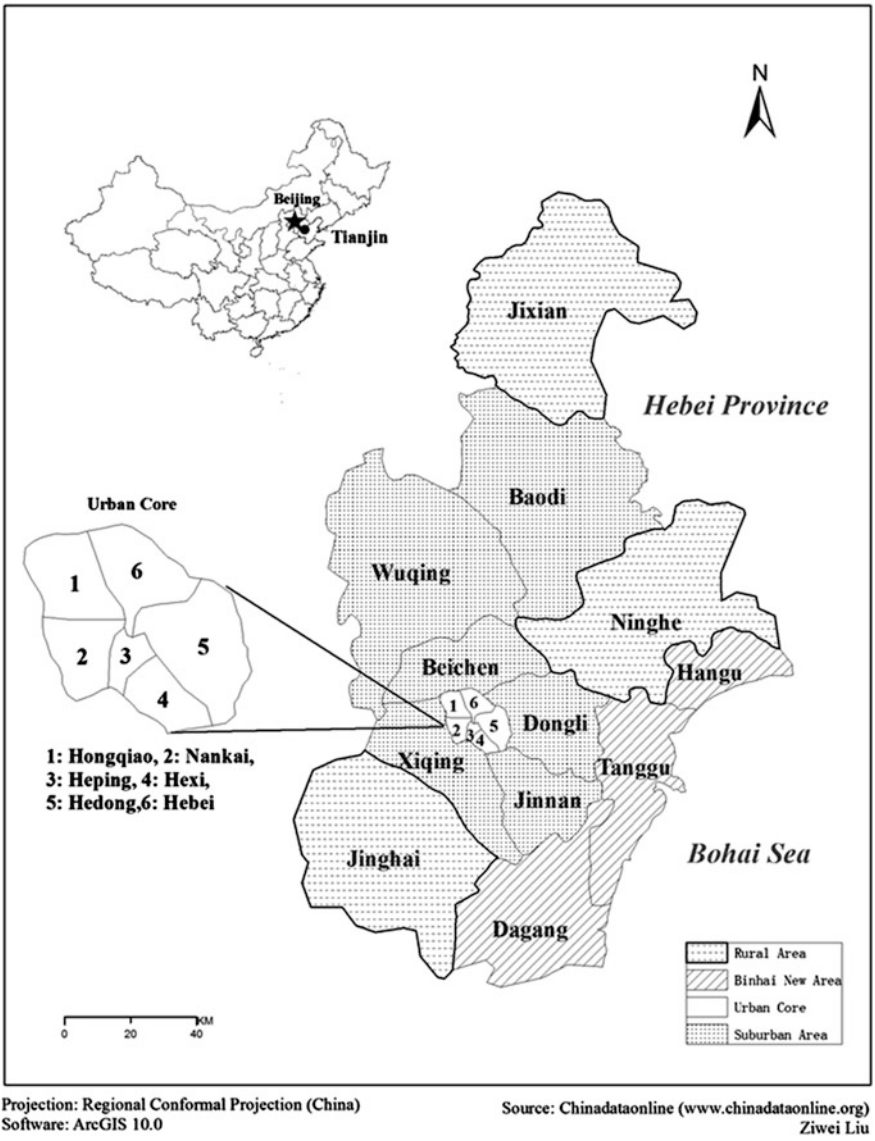

Fig. 1 Location and administrative divisions of Tianjin

Subdistricts or neighborhoods have been the basic administrative unit reported in publically accessible government reports in Chinese cities for decades [14]. As such, it was unit of analysis for this research. The GIS coverage of subdistricts was downloaded from Chinadataonline (www.chinadataonline.org).

2.2 Data Sources and Methodology

In this study, the "factorial ecology" approach is used to demonstrate the urban spatial structure of Tianjin in 2000. The factorial ecology as a mode of analysis of the sociospatial structure of cities has been used for more than 40 years [15]. Factor analysis, which is employed in data reduction process to identify a small number of factors to explain variances in the original data file, which is usually composed of a much larger number of variables [16], is the method adopted by factorial ecology. It provides a systematic way to identify the main dimensions that shape the social geography of cities. The principal components extraction (PCA) method is adopted in factor analysis to reduce the dimension of the data file. PCA is used to identify the factors (principal components) and give them scores relative to their importance for Tianjin's internal social transformation in 2000 at the neighborhood level [17]. In principal component analysis (PCA), the components are uncorrelated with each other, but they capture the same variance contained in the original data set. By ranking the components by the proportions of the total variation, one may see that few components account for the majority of the total variation.

Neighborhood-level data of 190 neighborhoods were collected from the 2000 census of Tianjin, with 63 variables initially. Based on previous literature, and in order to obtain a more significant result, some variables were regrouped and highly correlated variables are eliminated. Ultimately, 22 variables were selected, and a 190×22 matrix was made. Generally speaking, these 22 variables can be classified into six categories [14].

1. Population and demographic structure: In this category, four variables are selected: age group 15–64, age group 65+, non-agricultural population, and sex ratio.
2. Family structure: five variables are collected, including family of two generations, family of three generations, one-person family, two-person family, and three-person family.
3. Marital status: two variables are used: married rate and single rate.
4. Neighborhood stability: temporary population rate.
5. Education level: three integrated variables are included: basic education level (primary school and junior school), higher education level (higher than senior school), and illiteracy rate.
6. Occupation: three variables: unemployment rate, secondary industry workers, and tertiary industry workers.
7. Economic status: two variables are selected: higher expenditure on houses and higher monthly rent.
8. Ethnic status: three minorities are selected: Manchu, Uygur, and Hui.

Data on housing were collected for the first time in 2000. SPSS Statistics 19.0 was used to analyze the original matrix of factor analysis. Meanwhile, because there is correlation among some variables and due to inefficiency in mapping each

variable individually, a technique is required to either remove highly correlated variables (correlation coefficient greater than 0.6) or represent the data file using a smaller number of uncorrelated factors [18].

3 Analysis Result

Factor analysis was used to examine underlying dimensions of residential differentiation from different variables. In this research, in order to interpret and label different components, the popular varimax rotation technique was used to maximize the loading of a variable on one factor and minimize the loadings on all others. According to a PCA requirement that only eigenvalues greater than one are significant as well as the scree plot (Fig. 2), we retained five factors. Table 1 reports the eigenvalues from the PCA.

The cumulative variance of the five factors has reached 72.350 %. Table 2 presents the rotated factor structure.

Factor 1: Flowing Salaried Class

This factor was by far the most important factor, explaining 22.202 % of the total variance as well as Tianjin's social space in 2000. It includes six variables, which are population living in the family with three generations and over, temporary population, population aged 15–64, population living in two-person family, secondary industry workers, and population living in three-person family. Since the scores of these variables are all positive except the first one, this factor represents the temporary labor force population working as the secondary industry workers and living in two- to three-person family, which is known as the "salaried class" (*gongxin jiecheng*) in China. Figure 3 A shows the spatial pattern of it, displaying a concentric zonal pattern which is, contrary to the common one, with the lowest score in the center. It demonstrates that the longer the distance from urban core, the more people illustrated by this factor distribute. Most of them live in the suburban areas and Binhai New Area. As explained in the classic urban land use theory, central areas possessed better locations with easy access to various services and the urban transportation network and thus corresponded to high housing prices. Therefore, considering temporary populations are more inclined to live in areas where housing prices are comparative low, they prefer to live in suburban areas. Binhai New Area is a high-tech industrial zone that attracts large amount of labor force to migrate to there.

Factor 2: Socioeconomic Status

This factor accounted for 17.138 % of the total variance and included six variables: population in higher education level, population spending more money on housing, illiteracy rate, tertiary industry workers, non-agricultural population, and population paying higher monthly rent. Among the scores of these variables,

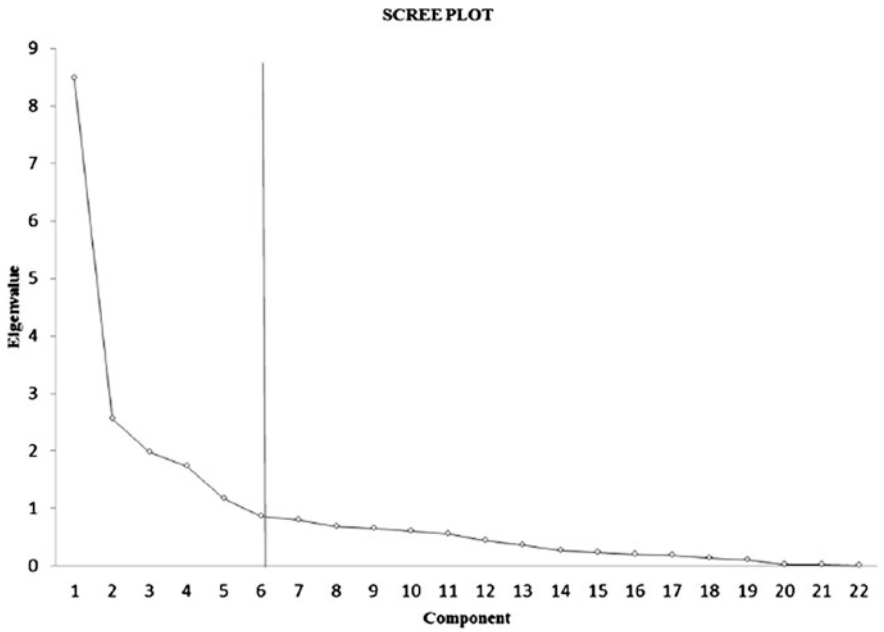

Fig. 2 Scree plot from principal component analysis

Table 1 Eigenvalues from principal component analysis

Component	Eigenvalue	Proportion (%)	Cumulative (%)
1	4.884	22.202	22.202
2	3.770	17.138	39.339
3	2.998	13.627	52.966
4	2.278	10.353	63.319
5	1.987	9.030	72.350

all are positive except the illiteracy rate. Therefore, this factor represents the well-educated population working in tertiary industry with a higher economic status. Figure 3b shows the spatial distribution of this factor, which is more concentrated at the urban core, especially the southwestern area and neighboring suburban area.

Factor 3: Retirees and Minorities

This factor accounted for 13.627 % of the total variance and included five variables: population aged 65 and over, unemployment rate, Uygur population, one-person family, and Hui population. The scores of all the variables are positive demonstrates this factor represents elderly people aged over 65 who live alone.

Table 2 Factor loading in Tianjin, 2000

Variable (%)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Family of three generations	**−0.827**	−0.135	−0.194	−0.068	−0.015
Temporary population	**0.771**	0.234	0.130	0.248	0.184
Age group 15–64	**0.764**	0.422	0.110	0.275	0.025
Two-person family	**0.726**	0.090	0.190	−0.070	0.510
Secondary industry workers	**0.673**	0.173	−0.036	0.101	−0.221
Three-person family	**0.642**	0.502	0.324	−0.052	−0.315
Higher education level	0.348	**0.754**	0.481	0.036	0.064
Higher expenditure on houses	0.234	**0.712**	0.058	−0.066	−0.128
Illiteracy rate	−0.069	**−0.697**	−0.223	−0.234	0.011
Tertiary industry workers	0.440	**0.661**	0.337	−0.027	−0.132
Non-agricultural population	0.519	**0.551**	0.538	−0.100	0.177
Higher monthly rent	−0.009	**0.514**	−0.047	0.366	0.067
Nationality, Manchu	0.301	0.483	−0.112	0.251	0.441
Age group 65 and over	−0.338	0.170	**0.716**	−0.230	0.350
Unemployment rate	0.505	0.212	**0.669**	−0.063	0.192
Nationality, Uygur	0.033	0.132	**0.659**	0.342	−0.018
One-person family	0.437	0.190	**0.594**	0.079	0.523
Nationality, Hui	0.229	0.049	**0.543**	0.049	−0.221
Married rate	0.047	−0.148	−0.109	**−0.880**	0.092
Single rate	0.267	0.463	0.147	**0.676**	0.058
Sex ratio	0.450	−0.191	−0.094	**0.653**	−0.034
Family of two generations	0.078	0.168	−0.040	0.093	**−0.884**

These people were mostly unemployed. Some of them are from Uygur minority and Hui minority. Figure 3c shows the spatial pattern of this factor. This factor mostly distributes mainly in the northwestern urban core and suburban area. The northwestern urban area is where the old city is located.

Factor 4: Marital Status

This factor accounted for 10.353 % of the total variance and included three variables: married population, single population, and sex ratio. It mainly represents the single population. Figure 3d shows the spatial pattern of this factor, displaying a sectoral pattern. This demographic is mostly located in the suburban area.

Factor 5: Family Structure

This factor accounted for 9.030 % of the total variance and included one variable: population living in family of two generations. Figure 3e shows the spatial pattern of this factor, displaying a concentric zonal pattern. The concentration of this factor in Baodi district and northern Wuqing district is comparatively high.

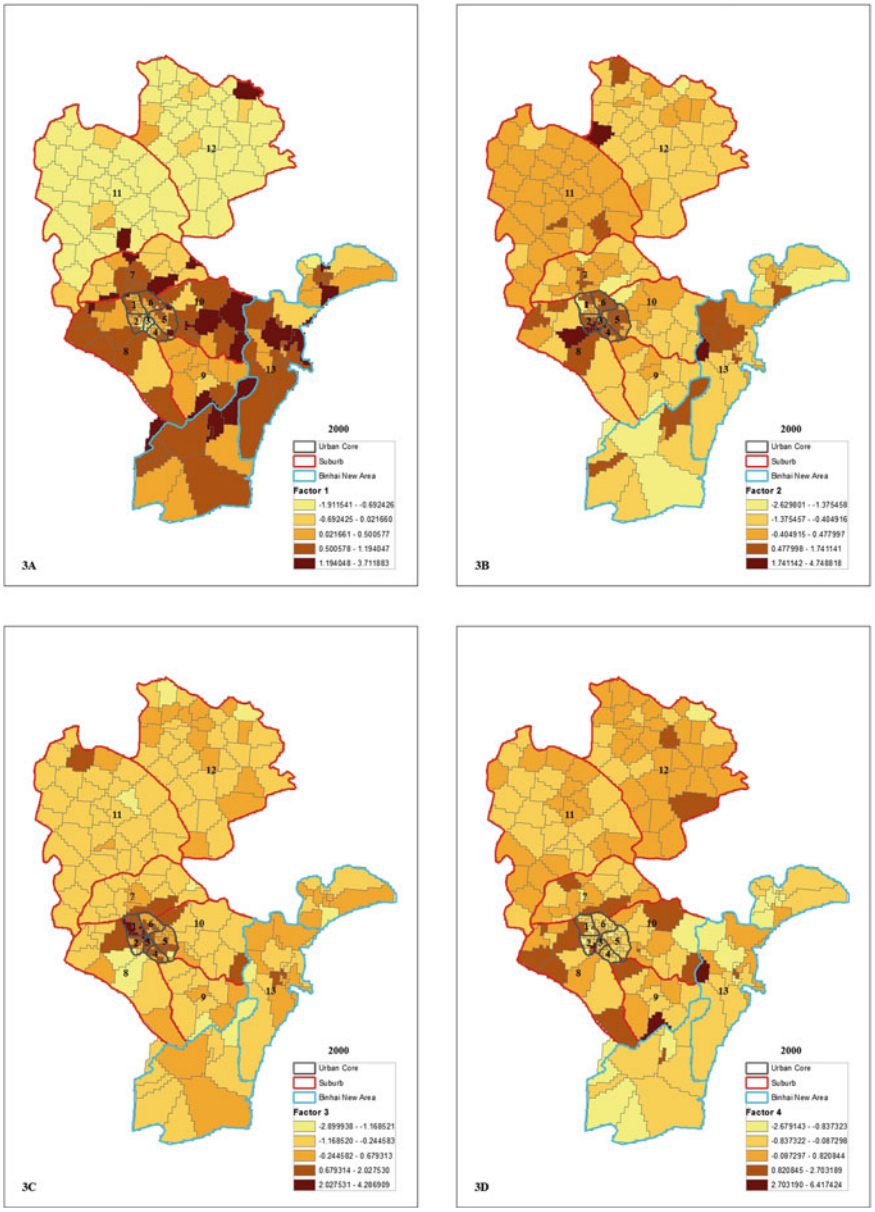

Fig. 3 Social space of Tianjin, 2000

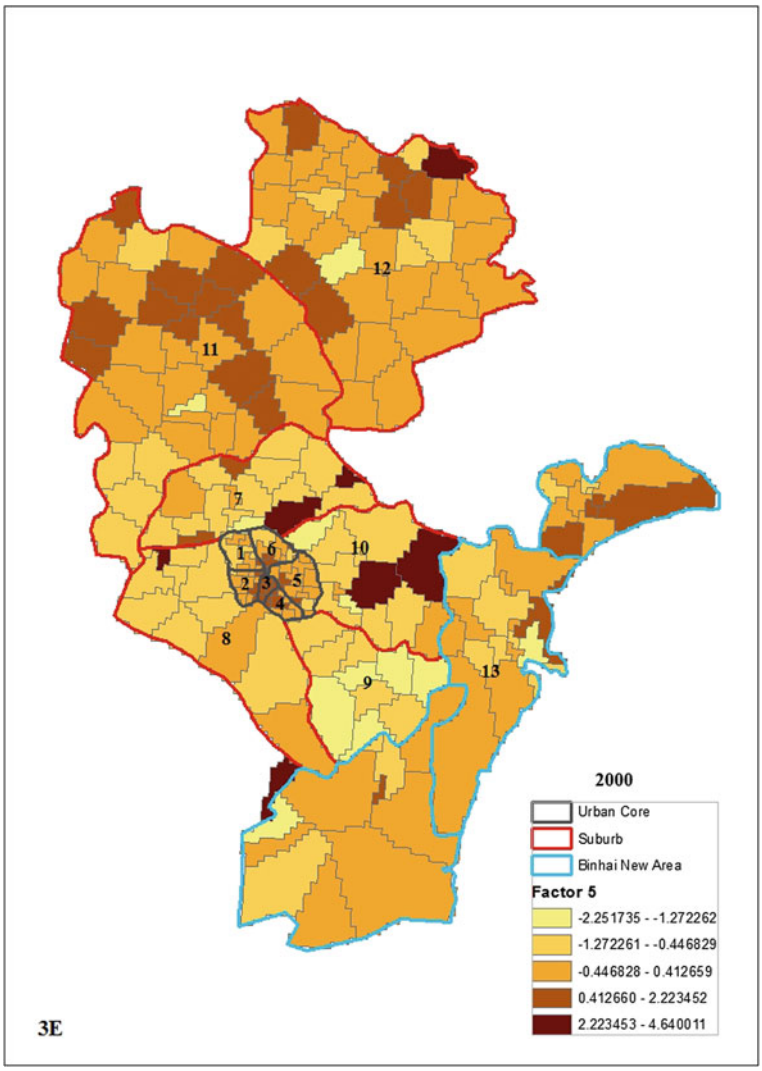

Fig. 3 continued

4 Conclusions and Discussion

As above discussion, the main factors that shape Tianjin's social space are the influx of the salaried class, economic status, retirees and minorities, marital status, and family structure. The overall social space of Tianjin can also be classified into five categories based on these factors. The salaried class are more heavily located in the suburban areas and Binhai New Area. On the contrary, the well-educated

population working in tertiary industry and having good economic status are more concentrated at the urban core and suburban area that are close to urban core as well as the retirees and minorities.

4.1 Mechanisms of Tianjin's Social Space in 2000

Different from inland cities in China, Tianjin is built along the Hai River. The opening of the Grand Canal during the Sui Dynasty prompted the development of Tianjin. During the same period, a town along the Hai River and a rectangular "old city" nearby it with a crossed street inside began to shape their form. The main function of the town is commercial activities, while that of the old city is political activities. Until the creation of the PRC, the old town and old city areas had extremely high population densities. The population in these two areas is mainly composed of permanent working class whose income is relatively low, and the living conditions there are comparatively poor.

The invasion of the Western countries contributed to Tianjin's transformation. In 1860, with the signing of the Peking Treaty, Tianjin was forced to open up to colonists and foreign investors as a treaty port. This change influenced two aspects of Tianjin. First, it dramatically altered the industrial structure due to the increasingly flourishing foreign investment activities. Modern industries such as machinery, chemicals, metallurgy, textiles, and food processing industries were built in Tianjin. In the early twentieth century, Tianjin was the second largest city in China in terms of population, industrial production, banking, and port shipment (just behind Shanghai). During this period, Tianjin's industrial factories were majorly located in urban areas. Secondly, as a result of colonization, Tianjin's urban space expanded rapidly and was segregated by the establishment of nine foreign concessions (British, American, German, Japanese, French, Russian, Belgian, Italian, and Austrian), with a land area eight times greater than the old built-up area. The concessions not only stimulated the development of the real estate market and a reorganization of land resources, but also introduced the modern technologies of urban planning to the city. The construction of the "Hebei New Area" moved the urban center northward; meanwhile, the area between the old city and the concessions was not subject to any administration. At the same time, due to the construction of the concessions, people residing in the area were forcefully evicted.

Generally speaking, the populations living in concessions are from the upper class. In old cities and other sections outside the concessions, the middle class lived there. In the urban fringe, a squatter settlement was formed by the poorest people in the city. Therefore, during this period, the overall pattern of Tianjin is scattered and chaotic.

Chronologically speaking, three urban expansions occurred in Tianjin. The first one is during the colonial period. During this period, the commercial center of urban was located at the southeast part of the city; then, with the development of

modern industry, the manufacturing district has been formed at the periphery of the urban area which was concentrated in the southeast and north. The second one is the "Great Leap Forward" (dayuejin), in which period, Tianjin was identified as an important industrial base of northern China [3]. In 1984, the third expansion period began with the opening up of 14 coastal cities to the outside. Drawing support from its geographic location and natural resources, being one of the 14 open coastal cities, the Tianjin Economic–Technological Development Area (known as TEDA) was established. In 1985, the Tianjin Master Plan announced that further industrial development be concentrated in TEDA. Then, in 1991, China announced the establishment of several duty-free districts in coastal cities. Tianjin's Duty-free District was established during this period. Emphasizing the importance of opening up of Tianjin in 1993, the city government announced the development of the Binhai District. In early 1994, the People's Congress of Tianjin approved the decision to develop the Binhai District as the key area of Tianjin's development [19]. According to Lichang Zhang, who is the Party Secretary of Tianjin at the time, "the key goal is to build the Binhai District into a modern industrial base…high level of agglomeration effect, with concentrated clusters and integrated production infrastructure." Obviously, with the process of the replacement of old industrial areas in urban spaces with residential and commercial areas, almost all the industries (both secondary industry and tertiary industry) were located in Binhai District. Furthermore, the district has established basic living conditions, including housing and schools, making the district potentially attractive to immigrations as well as young professionals and foreign investors. Therefore, more and more secondary industrial workers are now living in suburban areas, especially in Binhai New Area. Meanwhile, due to the urban reforms in 1984, an urban land market and a housing market have been introduced to Chinese cities accompanied by adjustment policies which laid out foundation for urban residential differentiation in China [14]. The adjustment of Hukou phenomenon is one of the policies' adjustments. Houkou is a strict household registration system used by Chinese government to control migration and resource allocation. Reforms to this household registration policy made it more flexible and made it easier for people to migrate. The migration of people from rural to urban areas strongly influenced the growth of the urban population and the increased complexity of Tianjin's urban sociospatial structure. After the Hukou reform, the amount of transient population in Tianjin increased rapidly. In the suburban area, the agglomeration of temporary labors has been formed. Besides, as discussed above, the building and development of Binhai New Area made the industrial zones move from the old city to the coastal area, which led to the transformation of industrial workers' residential locations.

At the same time, the implementation of the rehabilitation and the progress of gentrification in old city created the significant functional aggregation and segregation in the overall space. Much of the housing in the old city area of Tianjin is 140 years old. The concentration of population in these density areas is so high: Often, several families live sharing one internal courtyard. Many houses were found to be substandard and in danger of collapse. The living conditions are

unimaginably poor, and therefore, land prices in this area are relatively low. Due to the "Rehabilitation Project," more and more administrative, cultural, and commercial buildings concentrated in the old city area, accompanying population mobility. After the project, land and housing prices in the old city doubled. The economic status of the population living in the urban core has improved. Meanwhile, according to Tianjin's Master Plan, an upper-scale residential area was built in Hexi District, which belongs to urban area neighboring Xiqing District that belongs to suburb. Therefore, in Tianjin's social space, people with a higher socioeconomic status are more concentrated at the urban core and neighboring suburban area.

In conclusion, taking its geographic and historical conditions as the foundation, Tianjin's social space pattern has formed by the interactions between the socioeconomic development and policy adjustments such as Hukou reform, house reform, urban land use policy adjustment, and urban planning change.

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