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Research Article

Research on Population Spatial Distribution to Food Industry on its Evolvement Model

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Abstract: Aiming at the spatial distribution of food industry and its evolving model, this study carries out research on the change characteristics of inner spatial distribution of food industry in Wuhan City and the growth of scale of urban land use. Taking Wuhan City as example, from the perspective of micro-level, this study adopts analyzing technologies and statistic analyzing methods about GIS/SPSS and other space. The results show that, during the period of 2000-2010, the spatial distribution of food industry in Wuhan City is featured by "rapid growth in old towns and main city zones, slow growth in metropolitan areas", descending of food industry in core circle part and decentralizing towards outside of the old towns, as well as obvious phenomenon of suburbanization.

Keywords: Evolving model, spatial distribution of food industry, Wuhan city

INTRODUCTION

After the reform and opening up, with the fast development of Chinese cities, sudden rise of social and economic development level in metropolises, as well as rapid growth of urban scale and food industry gross, the urban spatial structure is transforming from mono-center to multi-center based on the demand of urban development (Jian and Zhou, 2002). However, sometimes dislocations take place in the construction centers of urban planned and formed from spontaneous gathering of city people, pendulum traffic, residential segregation and a series of social issues are caused. Under the background of unordered extension of land and unceasing re-construction of urban space, these issues become the confusion to urban construction thought and spatial distribution of food industry (Anmin, 2004; Clark, 1951). Therefore, starting from measuring the evolving model to spatial distribution of food industry, this study defines the evolving characteristics and tendency of spatial distribution of urban food industry and provides corresponding strategies for urban development in future.

The researches about spatial distribution of food industry in western countries started from the 1950s. Combining with the urban scale and structure in that period, Burgess (1925), Hoyt (1939) and Clark (1951) and other sociologists took the city had sole core as the assumed condition, explored research on spatial distribution of food industry and put forward a series of evolving models, which included Clark model, Tanner model, Smeed model, Newling model, etc. They carried out a variety of measuring simulations and deduced perfection towards the relationship between spatial distribution of urban food industry and urban spatial structure (Tanner, 1961; Smeed, 1961).

Since the 1990s, metropolises in China became to turn up early-phase suburbanization. Afterwards research methods and regression models were taken as reference. Meanwhile, from the perspective of spatial distribution of food industry density, researches on urban morphology towards some metropolises in our country had been developed. Taking Shenyang, Shanghai, Guangzhou (Newling, 1969; Wang and Zhou, 1999) and other cities as instance, regarding the food industry data during 1980-2000 as the principal support, this study conducts research on the evolving model of spatial distribution of food industry in our metropolises. The results prove that the variation tendency of food industry distribution has started to transfer to suburb from downtown and the food industry density presents the phenomenon of circle-layer degradation (White *et al*., 1997; Yanguang, 1999). However, the disposing to research data is mostly staying in the level of mesoscopic regional level, taking the self-drawing circle as the research unit, so this study has not got deep into the microcosmic streets. There is big error with the true value during data integration of food industry and big deviation may be caused to the model regression results.

To sum up, based on the summary of the research on spatial distribution of food industry density from European, America and our country, this study plans to analyze the matching relation among the spatial distribution of food industry density, growth, urban morphology and scale of urban land use in metropolises of Wuhan. According to this result, it reveals the spatial distribution of food industry and variation characteristics in Wuhan during 2000-2010, as well as offers basis for the establishment of food industry administrative decision, urban space development and land construction in metropolises of the next phase.

MATERIALS AND METHODS

General situation in the research areas: Taking Wuhan City as the research object, according to the Urban Comprehensive Planning of Wuhan City (1996-2020), it designates metropolitan development area in Wuhan City as the research scope, which includes Jiangan, Jianghan, Qiaokou, Hanyang, Wuchang, Hongshan and Qingshan Districts, respectively in central downtown, as well as some suburban streets and avenues surrounded central downtown. The research scope covers total area by 3261 km^2 and 121 streets. Based on the development history of urban construction in Wuhan City, partitioning the 5th and 6th nationwide census data, as well as the Urban Comprehensive Planning of Wuhan City, the development area in Wuhan's metropolises could be divided into three circle layers: old town, main city and metropolitan development.

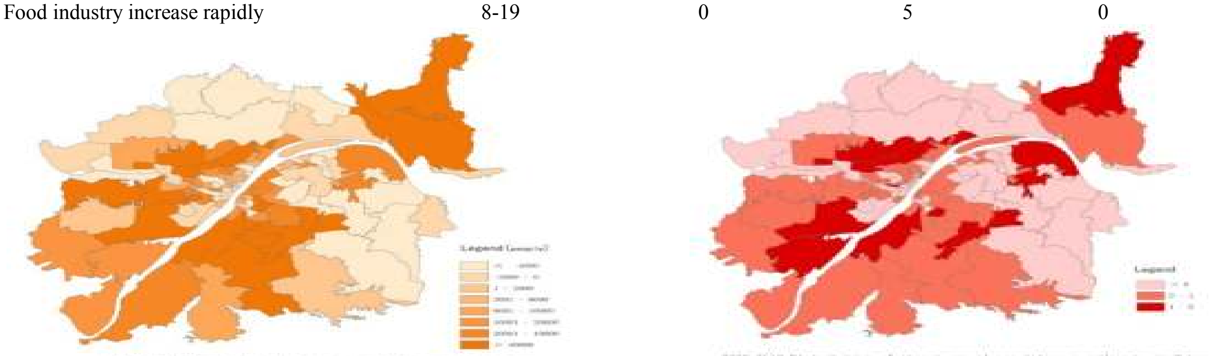
Data sources and application: The demographic data adopted in this research comes from the 5th food industry census in 2000 and the 6th food industry census in 2010 by Wuhan City. The area data comes from the geographic information system software GIS, of which all metropolitan development areas and blocks' coordinates of mass point are extracted. Namely this study uses GIS to spatialize the food industry scale data of street-level in Wuhan City and then defines the spatial distribution conditions towards the food industry density and food industry growth rate. In the meantime, it carries out regression analysis towards the food industry density model and classified statistics towards the food industry change situation in each street, explores the evolvement rule of the food industry density in urban circle layer.

Evolvement of growth of food industry scale in Wuhan circle layer: During the period 2000-2010, the food industry size in metropolitan area of Wuhan increases by about 1.2633 million and the average annual growth rate reaches by 1.83%. Among the three circle layers, the main city gets the highest amplification, next are circle layers of metropolitan development and old town. The average annual growth rates are ranked as 3.24% in the main city, 1.37% in metropolis and 0.3% in old town, which reflects that during the period 2000-2010, the food industry migrates towards circle layer of main city with large scale (Table 1). Generally speaking, the average annual growth rates to the streets of metropolises in Wuhan are not high universally and the distribution is not even. The circle layer of old town to the north of Yangtze River declines obviously, the growth in main city and metropolitan area presents "fast in south and slow in north", the food industry gathers quickly in developed areas and the streets in high-speed growth show combined distribution of "dot-area". As far as the growth distribution of food industry scale is concerned, Wuhan City has already entered into the phase of old towns are decentralizing towards outside, the main cities are well coordinated and driving positively, the metropolitan areas are developing synergistically.

Evolvement of food industry density of circle layers in Wuhan city: The food industry density to 121 streets in metropolitan development area has risen by 385 persons/km^2 within 10 years. The food industry density in metropolitan area decreases progressively from old town center to the surrounded areas. The food industry density in old towns holds the highest, next are main cities and metropolitan areas. Meanwhile the food industry density among these three circle layers reaches to 5 times difference successively. During the period

Table 1: 2000-2010 annual growth rate of food industry of 121 streets (townships) in Wuhan

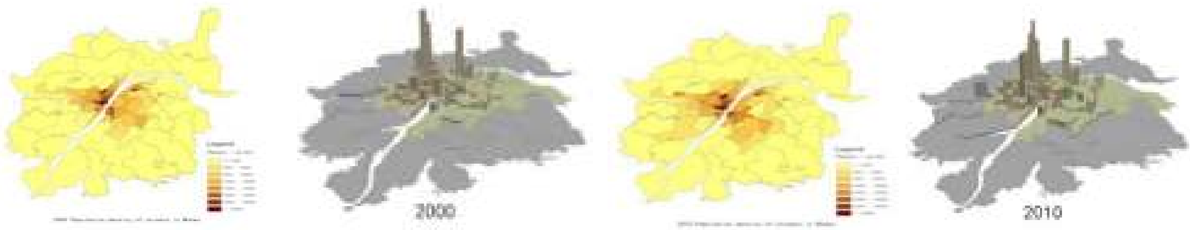
Category of food industry growth	Scope of annual growth rate (%)	Circle layer of ld town	Circle layer of main city	Circle layer of metropolitan development area
Food industry decline	-21-0	26	8	10
Food industry increase slowly	0-1	11	14	9
Food industry increase relatively fast	1-8	24	9	5
Food industry increase rapidly	8-19	0	5	0



Township, town and street data from food industry census in 2000/2010, which has been organized and drawn by the author

Table 2: 2000/2010 food industry density of streets in Wuhan

	Food industry density (person/km^2)	Circle layer of old town		Circle layer of main city		Circle layer of metropolitan area	
		2000	2010	2000	2010	2000	2010
Low density	<10000	11	10	23	22	28	27
Medium density	10000-20000	14	14	7	5	0	0
High density	20000<40000	22	22	1	3	0	1
Super-high density	>40000	15	16	0	1	0	0



Township, town and street data from food industry census in 2000/2010, which has been organized and analyzed by the author

Table 3: Models of the monocentric food industry density

Model name	Formula	Parameter significance	Parameter range
Linear model	$D(r) = a+br$	r is the distance to city center, D (r) is the food	a>0, b<0
Logarithmic model	$D(r) = a+b\ln r$	industry density in r, a, b are general parameters	a>0, b<0
Clark model	$D(r) = ae^{br}$		a>0, b<0
Smeed model	$D(r) = ar^{b}$		a>0, b<0
Newling model	$D(r) = ae^{br+cr2}$	C is general parameter	a>0, b>0, c<0

2000-2010, the circle layer of main city is the fastest in the growth of food industry density, next is the circle layer of old town and the one who gets the minimum growth is the metropolitan circle layer. Seeing from the picture, in 2000, the confluence between Yangtze River and Han River in metropolitan development area of Wuhan reaches highest food industry density, the old towns to the north of Yangtze River is obviously higher in food industry density than that to the south of Yangtze River. In 2010, with the decentralization of food industry, the food industry density on the both sides of Yangtze River distributes more evenly. The streets with high and super-high density within the circle layer of old town hold beyond 60% and the streets with low density in the circle layers of main city and metropolises hold beyond 80%. In general, the distribution regions of food industry density in Wuhan City could be concluded to: the center-axial pattern, as to the center, it refers to the regions surrounded confluence between Yangtze River and Han River; as to the axis, it refers to Yangtze River and Han River. As shown in Table 2.

In the meantime, during the period of 2000-2010, the streets with super-high density have been slightly increased. In 2000, the streets with “super-high” distribution of food industry density are Dazhi Street, Minzu Street, Shuita Street, etc., most of which are located along the river in Jianghan District and there is basically no change during the 10 years; the number of streets with “high” density has increased and they are mainly Siwei Street, Yijiadun Street, Hanjiadun Street, Qingchuan Street, Liangdao Street, etc., all of which are relatively evenly located in the main cities of Wuhan, or surrounded the streets with the super-high density, or scattered nearby the inner margin of central cities that take dwelling as the main function.

RESULTS AND DISCUSSION

Regression method and process: According to the research from domestic and abroad, the distribution models of food industry with mono-center that are commonly seen include linear, logarithmic, Clark, Smeed and Newling models, respectively (Table 3). Referring to the process of researching on food industry distribution from domestic and abroad references, taking Jianghanguan of Wuhan as the first-class city center (which is universally accepted by all researches), this study extracts coordinates of mass point to each street, calculates the radius from each street to city center and food industry density through GIS software. Finally it develops regression analysis by using SPSS software and obtains parameters to the spatial distribution model of food industry.

Measuring results and analysis: After carrying out regression according to spatial distribution models of food industry towards the street food industry density (2000 and 2010) from three circle layers in metropolitan areas of Wuhan separately, it finds that the regression effects in the distribution models of three circle layers (old town, main city and metropolis area) are poor. Therefore after combine the circle layers of main city and metropolis area, it conducts regression towards the distribution of food industry as per inner and outer circle layers, the detailed results are as below.

Table 4: Regression for monocentric models of spacial distribution of food industry in Wuhan inner and outer circle in 2000

Circle layer	Model	Street parameter a	Parameter b of food industry density	Measuring coefficient R^2	Test value of regression F
Inner circle layer	Linear model	51368.189	-3.813	0.390	39.986
	Logarithmic model	Inf	-19931.111	0.640	94.033
	Clark model	10.836	0.000	0.463	53.698
	Smeed model	6569839.757	-0.688	0.533	70.501
	Newling model	78511.469	0.000	0.528	35.175
Outer circle layer	Linear model	1.651343e+04	-0.597	0.151	11.346
	Logarithmic model	Inf	-12521.100	0.258	21.200
	Clark model	9.542000e+00	0.000	0.505	60.159
	Smeed model	9.880508e+11	-2.100	0.551	72.298
	Newling model	4.334731e+04	0.000	0.535	34.321

The parameter c in the Newling model of inner and outer circle layers in 2000 is 0.0001

Table 5: Regression for monocentric models of spacial distribution of food industry in Wuhan inner and outer circle in 2010

Circle layer	Model	Street parameter a	Parameter b of food industry density	Measuring coefficient R^2	Test value of regression F
Inner circle layer	Linear model	49822.032	-3.541	0.344	32.956
	Logarithmic model	Inf	-17717.758	0.487	59.000
	Clark model	10.816	0.000	0.359	35.115
	Smeed model	5193923.798	-0.668	0.346	33.238
	Newling model	67305.686	0.000	0.373	19.126
Outer circle layer	Linear model	1.648404e+04	-0.586	0.354	32.838
	Logarithmic model	Inf	-11766.625	0.540	69.039
	Clark model	9.895000e+00	0.000	0.546	70.638
	Smeed model	1.379049e+13	-2.361	0.612	92.506
	Newling model	1.343226e+05	0.000	0.633	51.098

The parameter c in the Newling model of inner circle layer in 2010 is 0.0003; The parameter c in the Newling model of outer circle layer in 2010 is 0.0001

Seeing from this Table 4 and 5, the models that are well expressed spatial distribution of food industry in 2000 and 2010 include linear model, logarithmic model and Smeed model. Among those three models, Smeed model has the best effect in regression towards inner and outer circle layers.

In Smeed model, the value of parameter a does not have explicit definition; the absolute value of parameter b signifies the slope of food industry density, which declines along with the increase of distance. The bigger the absolute value of b, the bigger the declining gradient to food industry density with the distance increases.

Seeing from the regression results from Smeed model to inner circle layer in 2000 and 2010, the absolute value to parameter b declines to 0.668 in 2010 from 0.688 in 2000, which indicates that in this period, the food industry distribution further decentralizes towards the inner circle layer from city center, the distribution of food industry is more evenly and the phenomenon of suburbanization is more obvious; seeing from the regression results from Smeed model to outer circle layer in 2000 and 2010, the absolute value to parameter b raises to 2.361 in 2010 from 2.1 in 2000, which indicates that the distribution of food industry is firstly gathered in outer circle layer and then the urban center area. That is to say, the food industry in metropolitan area migrates towards main cities and old towns, causing the food industry density in old towns higher than that in main cities and metropolitan areas. It proves that at present the suburbanization of food industry within the scope of metropolitan area is still staying in the suburban areas nearby city and decentralization towards outer suburbs has not been realized.

In addition, regression effects for monocentric models of spatial distribution of food industry in Wuhan inner and outer circle in 2000 and 2010 are not good; it proves that the spatial distribution of food industry density is not closely related to the monocentric measuring of the city. Meanwhile it indicates that the mono-center could not be used for explaining the relation between spatial distribution of food industry density and evolvement of urban spatial structure in that period within the metropolitan areas of Wuhan.

CONCLUSION

Through the spatialization of food industry data, as well as developing the regression of model towards the food industry density in metropolitan area of Wuhan in 2000 and 2010, this study analyzed the spatial distribution characteristics and rules of food industry in Wuhan City and obtains the results as below:

- During 2000-2010, the spatial distribution of food industry in Wuhan City is featured by "rapid growth in old towns and main city zones, slow growth in metropolitan areas".
- Through the regression analysis to the model, it discovers that Smeed model is the optimal one in regression effect for distribution of food industry density in circle layers of old towns and

metropolises. Meanwhile the phenomenon of suburbanization in Wuhan gets increasingly obvious, however the distribution of food industry is mainly concentrated in suburbs nearby city, presenting “near suburbs”, but not “outer suburbs”. If things go on like this, big pressure will be brought to the circle layer of old town in terms of traffic, life and production and measures shall be taken for the sake of balancing the spatial distribution of urban inner food industry, such as, improving the dwelling environment in old towns through planning and governmental behaviors, strengthening the urban center construction in the circle layer of main city, trying to perfect large-scale production areas and bases in the circle layer of metropolis.

REFERENCES

Anmin, L., 2004. City food industry density model based on remote sensing image. J. Geogr. Sci., 59(6): 158- 164.

Burgess, E.W., 1925, The Growth of the City: An Introduction to a Research Project. In R.E. Park, E.W. Burgess and R.D. McKenzie (Eds.), The City. The Chicago University Press, Chicago, pp: 47-62.

Clark, C., 1951. Urban food industry densities. J. R. Stat. Soc., 114: 490-496.

Hoyt, H., 1939. The Structure of Growth of Residential Neighborhoods in American Cities. Federal Housing Authority, Washington, DC.

Jian, F. and Y. Zhou, 2002. Spatial variability and food industry suburbanization research in hangzhou. Urban Planning, 26(1): 58-65.

Newling, B.E., 1969. The spatial variation of urban food industry densities. Geogr. Rev., 59: 242-252.

Smeed, R.J., 1961. The traffic problem in towns. Manchester Statistical Society Papers. Norbury Lockwood, Manchester.

Tanner, J.C., 1961. Factors affecting the amount travel. Road Research Technical Paper No.51, HMSO (Department of Scientific and Industrial Research), London.

Wang, F.H. and Y.X. Zhou, 1999. Modeling urban food industry densities in Beijing 1982-90: Suburbanisation and its causes. UrbanStudies, 36(2): 271-287.

White, R., G. Engelen and I. Uljee,1997. The use of constrained cellular automata for high-resolution modeling of urban-land dy-namics. Environ. Plann. B, 24: 323-343.

Yanguang, C., 1999. Fractal model of the urban food industry density attenuation and its alienation form - on the synthesis and development of Clark model and Sherratt model. J. Xinyang Norm. Univ., 12(1): 60-64.