Chin. Geogra. Sci. 2013 Vol. 23 No. 4 pp. 482–491
doi: 10.1007/s11769-013-0615-8

Springer Science Press
www.springerlink.com/content/1002-0063

Spatial Pattern and Regional Types of Rural Settlements in Xuzhou City, Jiangsu Province, China

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Abstract: This paper principally focuses on the morphological differences, spatial pattern and regional types of rural settlements in Xuzhou City of Jiangsu Province in China. Using satellite images of Xuzhou City taken in 2007 and 2008 and models of exploratory spatial data analysis (ESDA) and spatial metrics, the paper conducts a quantitative analysis of the morphological pattern of rural settlements, and finds significant characteristics. First, rural settlements in Xuzhou City are significantly agglomerated in terms of their spatial distribution; meanwhile, there is significant variation in the geographical density distribution. Second, the scale of rural settlements in Xuzhou City is larger than the average in Jiangsu Province, and the histogram of the scale data is more even and more like a gamma distribution. There are a significant high-value cluster in the scale distribution, and local negative correlation between the scale and density distribution of rural settlements in Xuzhou City. Third, the morphology of rural settlements in Xuzhou City shows relative regularity with good connection and integrity, but the spatial variation of the morphology is anisotropic. Finally, according to the characteristics of density, scale, and form of rural settlements, the rural settlements of Xuzhou City are divided into three types: A high-density and point-scattered type, a low-density and cluster-like type and a mass-like and sparse type. The research findings could be used as the scientific foundation for rural planning and community rebuilding, particularly in less-developed areas.

Keywords: rural settlements; spatial pattern; regional types; exploratory spatial data analysis (ESDA); Xuzhou City

Citation: Ma Xiaodong, Qiu Fangdao, Li Quanlin, Shan Yongbin, Cao Yong, 2013. Spatial pattern and regional types of rural settlements in Xuzhou City, Jiangsu Province, China. *Chinese Geographical Science*, 23(4): 482–491. doi: 10.1007/s11769-013-0615-8

1 Introduction

Rural settlements are places of habitation, production and living for rural people, and are affected profoundly by the natural conditions and factors of rural society, economy and culture. The geography of rural settlements relates to the structural type, distribution characteristics, evolution, environmental (natural and social) relations and transformation and reconstruction of these settlements (Li and Zhang, 2012). Research on rural settlements will not only improve the land-use planning and layout of residential areas but also reveal the relationships among the settlement form, the environment and production (Jin, 1982).

In the research area of the morphological differences and spatial patterns of rural settlements, relevant studies abroad have focused on: 1) the relationships among the rural population, rural industries and settlements (Smailes *et al*., 2002; Neil *et al*., 2005; Paul, 2009); 2) the effects of the form of rural settlements on public service facilities (Halseth and Ryser, 2006; Holmes, 2008); 3) the evolution of the landscape of rural settlements (Paquette and Domon, 2003; Marc, 2004); and 4) the behavior of rural settlements (Hall, 1996; Jensen,

Received date: 2012-11-12; accepted date: 2013-03-26
Foundation item: Under the auspices of National Natural Science Foundation of China (No. 41071116), Humanity and Social Science Foundation of Ministry of Education (No. 09YJC790225, 11YJA630008)
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2006; Sevenant and Antrop, 2007; Njoh, 2011). Rural settlement geography abroad is increasingly paying attention to the socialization and reconstruction of rural settlements (Terry, 1996; Keith and Angel, 2001). Domestically, recent researches have investigated: 1) the system and structure of rural settlements in typical areas (Wang *et al.*, 2001; Guo *et al.*, 2012); 2) geographical types of rural settlements (Long *et al.*, 2009a; Shan *et al.*, 2012); 3) the evolution of rural settlements in the process of Chinese industrialization and urbanization (Zhen *et al.*, 2008; Liu and Zhang, 2009); and 4) rural settlement ecology (Liu *et al.*, 2001; Chen *et al.*, 2005). In response to the government policy of building a new socialist countryside implemented in recent years, studies have increasingly focused on rural urbanization, rural communities, the 'hollowing out' of rural settlements, and the optimized regulation of rural settlements (Wang *et al.*, 2005; Long *et al.*, 2009b). Consequently, the characteristics of the spatial reconstruction and typical patterns of rural settlements have become hot research topics in academia. Remote sensing and geographic information systems could be useful tools for the research (Xu and Wan, 1997), however, the application of these tools is still at a preliminary stage. For example the extraction and temporal comparison of the land-use information of settlements based on remote sensing imagery neglect spatial patterns of rural settlements that could be extracted by spatial analysis (Tian *et al.*, 2003).

There are significant regional differences in the natural environment, economic development and cultural context in Jiangsu Province (Ma *et al.*, 2012). Xuzhou City, as an administrative region in the northern Jiangsu, has a pattern of rural settlements that is typical for the region's unique natural, economic and cultural environment. Using satellite remote-sensing imagery of Xuzhou City, we analyze the spatial data of rural settlements, and find characteristics of the scale, structure, spatial distribution, and morphological variation of rural settlements in Xuzhou City, and moreover, classify types of rural settlements by spatial clustering analysis. The research findings could be used as the scientific foundation for rural planning and community rebuilding, particularly in less-developed areas. And exploratory spatial data analysis (ESDA) which we employed in this paper can be referenced for rural geography and will assist in the innovation of new research methods.

2 Materials and Methods

2.1 Study area

Xuzhou City is located in the northwest of Jiangsu Province and the southeast of the North China Plain, and it is mostly comprised of plains, with small areas of hillocks and mountains in the central and eastern regions. Xuzhou City consists of one city proper, three countries (Fengxian County, Peixian County and Sunning County), and two county-level cities (Pizhou City and Xinyi City) (Fig. 1). In 2010, the total land area of the city was 11 258 km^2, of which rural settlements covered 962.15 km^2. The total population of the city was 9.5761×10^6, including a rural population of 6.9881×10^6. There were a total of 2400 administrative villages and 11 438 natural villages, and cultivated land covered an area of 590 992 ha.

2.2 Data sources

The basic data were obtained from the image fusion (multi-spectrum, 10 m spatial resolution) of SPOT 2/4 satellite remote-sensing imagery and LANDSAT TM satellite remote-sensing imagery taken in 2007 and 2008, following geometric correction and coordinate registration based on 1∶50 000 topographic map. Then the data were further processed by interpretation and vectorization to extract the borders of rural settlements in Xuzhou City, which were used as the main data sources in the research.

2.3 Methods

The vector data of rural settlements in Xuzhou City were converted to grid data using an ArcGIS platform. Then, a quantitative analysis of the spatial pattern of rural settlements was conducted by using models of ESDA and spatial metrics. Finally, types of rural settlements were classified by means of hierarchical cluster analysis.

2.3.1 Indexes of metrics of landscape pattern

Fragstats 4.1 software was used to calculate the landscape shape index (LSI), mean landscape area (AREA-MN), patch size coefficient of variation (PSCV), patch size standard deviation (PSSD), cohesion index (COHESION), aggregation index (AI), and split index (SPLIT) of rural settlements. The definition, calculation formula and unit of each index are explained in detail in *Fragstats Help*.

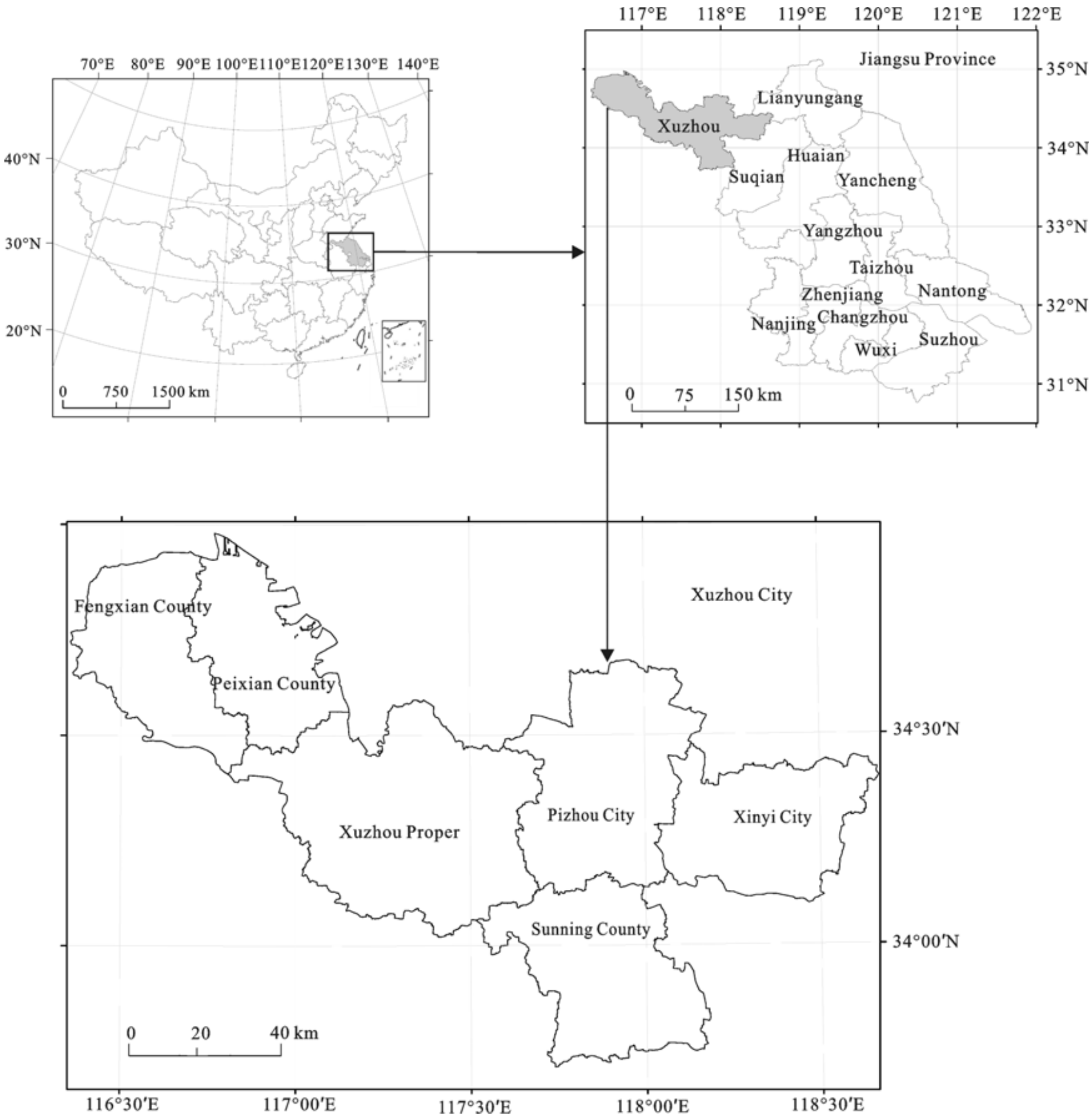


Fig. 1 Location of study area

2.3.2 ESDA

Using data of land use of rural settlements interpreted from the remote-sensing imagery, the central positions of rural settlements and attributes of the land area were abstracted. We used various tools in ESDA, namely the average nearest-neighbor index (ANN), Ripley′s K, kernel density estimation (KDE), Getis-Ord General G and Getis-Ord Gi* to analyze the spatial distribution, spatial variation, spatial agglomeration, and other heterogeneous characteristics of the pattern of rural settlements. The specific formulas are as follows.

(1) ANN. The average distance between the center of each rural settlement and the nearest neighboring rural settlement is compared with the expected average distance that is assumed to have a random distribution, so as to judge whether rural settlements have a random distribution or aggregated distribution. The measure is calculated as follows.

$$ANN = \frac{\overline{D_o}}{\overline{D_e}} = \frac{\sum_i d_i / n}{\sqrt{n/A}/2} \tag{1}$$

where $\overline{D_o}$ is the observed mean of the distance between each rural settlement and their nearest neighbor; $\overline{D_e}$ is the expected average distance that is assumed to have a random distribution; d_i equals the distance between settlement i and nearest settlement; n is the total number of settlements; and A is the area of the research region. If ANN is smaller than 1, rural settlements have an agglomerated distribution; if ANN is larger than 1, they tend to have a random distribution.

(2) Ripley′s K. This statistic is mainly used to determine the spatial distribution law of rural settlements at different scales. The formula is as follows:

$$K(d) = A\sum_{i=1}^{n}\sum_{j=1}^{n}\frac{\delta_{ij}(d)}{n^2} \quad (i, j = 1, 2, 3,\ldots, n;\ i \neq j,\ d_{ij} \leq d) \tag{2}$$

$$L(d) = \sqrt{\frac{K(d)}{\pi}} - d \tag{3}$$

where A is the area of the research region; n is the number of settlements; d refers to the spatial scale; $\delta_{ij}(d)$ is a weight; d_{ij} represents the distance between settlement i and settlement j, and $\delta_{ij}(d) = 1$ ($d_{ij} \leq d$) or $\delta_{ij}(d) = 0$ ($d_{ij} > d$). To linearize the expected value and maintain the stability of the standard deviance, Besag proposed to replace $K(d)$ with $L(d)$, whose expected value is zero under the assumption of a totally random spatial distribution (Besag, 1977). The graph of $L(d)$ versus d can be used to analyze and examine the spatial pattern of a multi-scale landscape. When $L(d) > 0$, rural settlements have an agglomerated distribution; when $L(d) < 0$, they have a uniform distribution; and when $L(d) = 0$, they have a completely random distribution.

(3) KDE. It is a statistical method of nonparametric density estimation. A smooth round surface is established at each point (the central point of rural settlement) in the region. The distance from the point to the reference position is then calculated by using a mathematical function, the sum of all surfaces in the reference position is obtained, and the peak and kernel of these points are established to create a smooth and continuous surface. KDE is described as follows:

$$f(x, y) = \frac{1}{nh^2}\sum_{i=1}^{n} k\left(\frac{d_i}{n}\right) \tag{4}$$

where $f(x, y)$ is the estimated density at position (x, y); n is the number of observation point; h represents the bandwidth or smoothing parameter; K is a kernel function; and d_i refers to the distance from position (x, y) to observing position i.

(4) Getis-Ord General G. This index is used to test the general spatial distribution pattern of attribute values of rural settlements, i.e., a high-value agglomeration or low-value agglomeration. Its formula is as follows.

$$G(d) = \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(d) X_i X_j \Big/ \sum_{i=1}^{n}\sum_{j=1}^{n} X_i X_j \tag{5}$$

$$Z(G) = G(d) - E(G) \Big/ \sqrt{Var(G)} \tag{6}$$

where $W_{ij}(d)$ is the spatial weight between settlement i and settlement j, defined by the distance range (d); X_i and X_j are the attribute values of settlement i and settlement j , respectively; and n is equal to the total number of settlements. $Z(G)$ is obtained after the normalization of $G(d)$, in which $E(G)$ and $Var(G)$ are the expected value and variance of $G(d)$. When $G(d)$ is higher than $E(G)$ and $Z(G)$ is significant, a high-value cluster appears in the study area; when $G(d)$ is lower than $E(G)$ and $Z(G)$ is significant, a low-value cluster appears in the study area; and when $G(d)$ approaches $E(G)$, variables in the study area have a random distribution.

(5) Getis-Ord Gi*. This index is used to test whether there exists an obvious high-value or low-value cluster in local areas. The statistic reveals ′hotspots′ and ′coldspots′ in a visual way, and is calculated as

$$G_i^* = \sum_{j=1}^{n} W_{ij}(d) X_j \Big/ \sum_{j=1}^{n} X_j \tag{7}$$

$$Z(G_i^*) = G_i^* - E(G_i^*) \Big/ \sqrt{Var(G_i^*)} \tag{8}$$

where $W_{ij}(d)$, n and X_j are the same as in Equation (5). For the sake of explanation and comparison, $Z(G_i^*)$ is obtained after the normalization of G_i^*, in which $E(G^*_i)$ and $Var(G^*_i)$ are the expected value and variance of G_i^*. If $Z(G^*_i)$ is positive and statistically significant, values around settlement i are high (higher than the mean), and the area is a hotspot of a high-value cluster; if $Z(G^*_i)$ is negative and statistically significant, values around settlements i are low (lower than the mean), and the area is a coldspot of a low-value cluster (Ma *et al.*, 2008).

2.3.3 Cluster analysis

Cluster analysis is an important method of spatial data mining, and a multivariate statistical means for multi-element classification and geographical division. The basic principle is to find a close relation between sampled data quantitatively with a certain similar or difference index, and then cluster the data with this relation.

3 Results

3.1 Characteristics of spatial distribution of rural settlements

We use the ANN, Ripley′s K, and KDE to reveal the characteristics of the spatial distribution of rural settlements in Xuzhou City.

Table 1 Index of spatial metrics of rural settlements in Xuzhou City

	Distribution of rural settlements	Scale of rural settlements			Form of rural settlements			
	ANN	AREA-MN	PSSD	PSCV	LSI	COHESION	AL	SPLIT
Value	0.570	4.387	5.472	126.557	180.798	89.804	84.260	2357437

Notes: ANN, the average nearest-neighbor index; AREA-MN, mean landscape area (ha); PSSD, patch size standard deviation (ha); PSCV, patch size coefficient of variation; LSI, landscape shape index; COHESION, cohesion index; AL, aggregation index; SPLIT, split index

(1) Rural settlements are significantly agglomerated in terms of their spatial distribution since the ANN in Xuzhou City is 0.57 (Table 1). Ripley′s K curve (Fig. 2) shows that $L(d)$ is larger than values on the upper envelop, indicating that there is a significant agglomerated distribution at different spatial scales. However, there are changes in the agglomeration level of rural settlements in Xuzhou City. $L(d)$ maintains a rising trend over 0–63 km and shows higher increases. $L(d)$ reaches an approximate maximum at 63 km and then changes little, indicating that the agglomeration level firstly increases and then keep smooth as the distance increases.

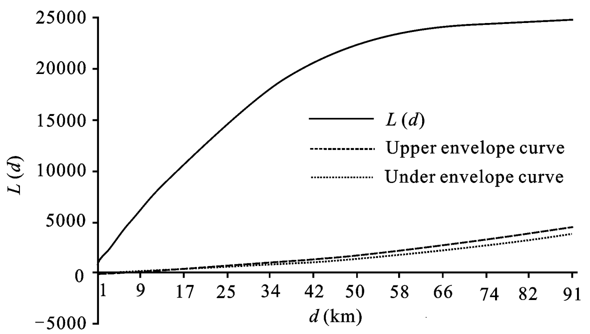


Fig. 2 Ripley′s K curve of rural settlements in Xuzhou City

(2) Rural settlements have great regional differences in terms of their density distribution. KDE is employed to generate a density map of rural settlements in Xuzhou City (Fig. 3). From the density map, we found the following characteristics. First, the average density of rural settlements in Xuzhou City is only 1.97 settlements/km^2, which is lower than the average level of 4.98 settlements /km^2 in Jiangsu. Second, the rural settlements in Suining, Peixian and Pizhou have higher density; the average density is 2.45 settlements /km^2 and there is a center of high density exceeding 3.5 settlements/km^2 in the southeast of Suining. Finally, the rural settlements in Xuzhou proper, Xinyi and most parts of Fengxian having a sparse distribution, with average density of 1.51 settlements/km^2, are a low-density area of rural settlements in Xuzhou City.

3.2 Characteristics of scale distribution of rural settlements

We use the patch size of rural settlements as the variable to analyze the pattern of the scale distribution in Xuzhou City. Employing the frequency histogram, the Getis-Ord General G, Getis-Ord Gi*, and landscape indexes such as

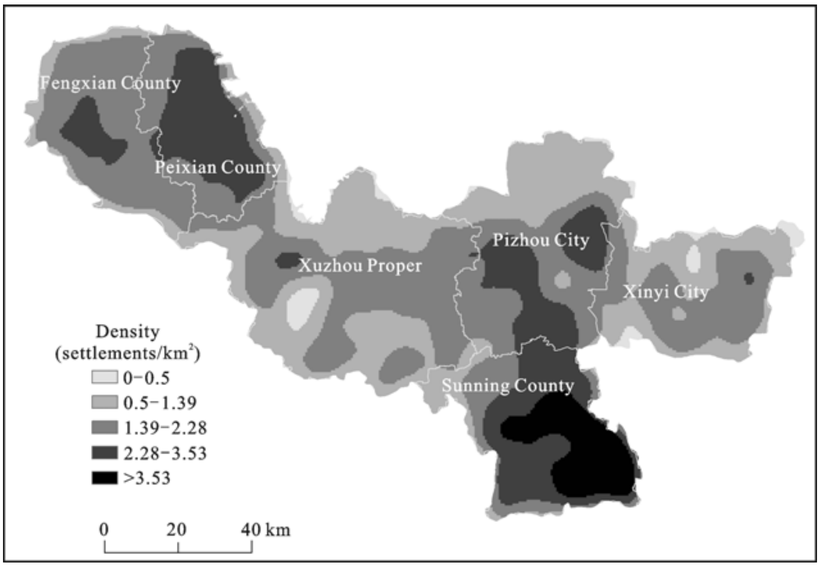


Fig. 3 Density map of rural settlements in Xuzhou City

AREA-MN, PSSD and PSCV, we find the overall characteristics of the scale distribution of rural settlements in Xuzhou City. The results are as follows.

First, AREA-MN and PSSD in Xuzhou City are 4.387 and 5.472 ha, respectively, both of which are higher than the averages of 1.462 and 4.048 ha in Jiangsu. Furthermore, the former is about three times that in Jiangsu, which indicates that rural settlements in Xuzhou City tend to have a larger scale compared with the average in Jiangsu. Meanwhile, we see that PSCV in Xuzhou City is only about 50% of the average for Jiangsu, showing that the scale gap between the rural settlements in Xuzhou City is relatively small (Table 1).

Second, from the frequency histogram of the scale data for rural settlements in Xuzhou City (Fig. 4), we find skewness of 0.22 and kurtosis of –0.533, and the median value approaches the mean. The above results indicate that the distribution of data is more like a Gamma distribution with skewness towards the left. The distribution of the scale data of rural settlements in Xuzhou City is even.

Third, using the results of the Getis–Ord General G (Table 2), we find that $G(d)$ of the scale of rural settlements in Xuzhou City is higher than $E(G)$, and $Z(G)$ is 19.827974, which indicates that the possibility that the agglomeration model results from a random process is no more than 1%. The spatial distribution of rural settlements in Xuzhou City shows significant high-value clustering.

Finally, from the visualization of Getis-Ord Gi* (Fig. 5), we find the following spatial pattern. 1) There is a significant regional difference in the scale distribution of rural settlements in Xuzhou City, where rural settlements in the northwest of Fengxian, the north of Xuzhou Proper, and the north of Pizhou have significant high-value clustering. 2) Small villages are mainly distributed in Suining and the central Peixian, the hilly areas in the southeastern Xuzhou Proper, and the eastern Xinyi. 3) There is local negative correlation between the scale and density spatial distribution of rural settlements. This negative correlation with small size and high density of rural settlements is more significant in Suining, which is located in the south of Xuzhou Proper.

3.3 Characteristics of morphological difference of rural settlements

We use the LSI, COHESION, AI and SPLIT as the qualitative metrics of the morphological difference of rural settlements (Table 1). The results are as follows.

(1) The LSI measures the irregularity or complexity of the morphology (border) of rural settlements. The LSI of Xuzhou City is 180.78, which is much lower than the average for Jiangsu (861.491), showing that the morphology of rural settlements in Xuzhou City is regular and simple.

(2) To study the characteristics of the morphology difference of rural settlements from a micro perspective, we further generate the spatial trend chart of the morphology based on the LSI of rural settlements in each village and town(Fig. 6). We find that there is an inverted U-type trend in the south-north and east-west directions, the rangeability of which is higher in the east-west direction than in the south-north direction. This pattern demonstrates significant anisotropy in the morphology variation of rural settlements in Xuzhou City.

(3) In the morphological pattern of rural settlements, COHESION reflects the level of connection or continuity, AI reflects the level of agglomeration, while SPLIT reflects the level of fragmentation. SPLIT increases as

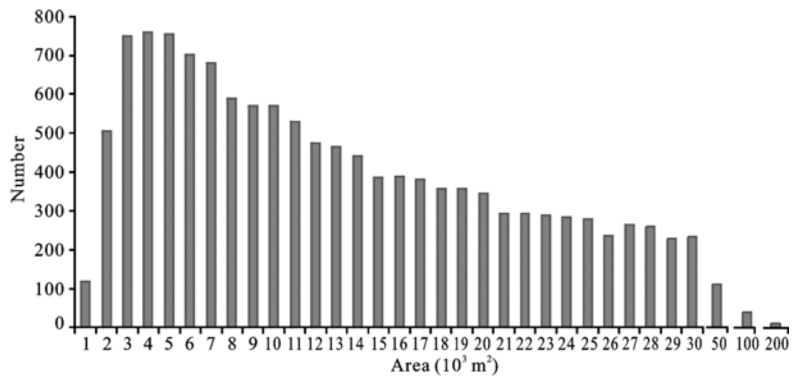


Fig. 4 Frequency histogram of scale of rural settlements in Xuzhou City

Table 2 Estimation of Getis-Ord General G for scale of rural settlements in Xuzhou City

	$G(d)$	$E(G)$	$Z(G)$	p
Value	0.000049	0.000045	19.827974	0.000000

the patch size reduces or the number of patch increases. Table 1 shows that rural settlements in Xuzhou City have a relative high degree of COHESION and AI, but a low level of SPLIT. These results indicate good connection and integrity.

3.4 Regional types of rural settlements

According to the characteristics of density, scale, and form of rural settlements, we adopt seven indexes for cluster analysis: patch density (PD), mean landscape area (AREA-MN), patch size coefficient of variation (PSCV), patch size standard deviation (PSSD), mean shape index (MSI), area-weighted mean patch fractal dimension (AWMPFD), and mean nearest neighbor distance (MNN). Employing the hierarchical cluster (Ward′s method, squared Euclidean distance) and using 4 km × 4 km grid cells as analysis units, we classify the rural settlements of Xuzhou City into three types (Fig. 7, Table 3).

4 Conclusions

Most studies that have analyzed rural settlements have considered the spatialization of attribute data while neglecting the spatial association rules hidden in data. In this study, we use different tools of comprehensive analysis, such as ESDA and spatial metrics, to find characteristics of the spatial pattern of rural settlements in Xuzhou City. The comprehensive analysis helps us better describe the spatial pattern of rural settlements and to make up for the deficiency of research on rural

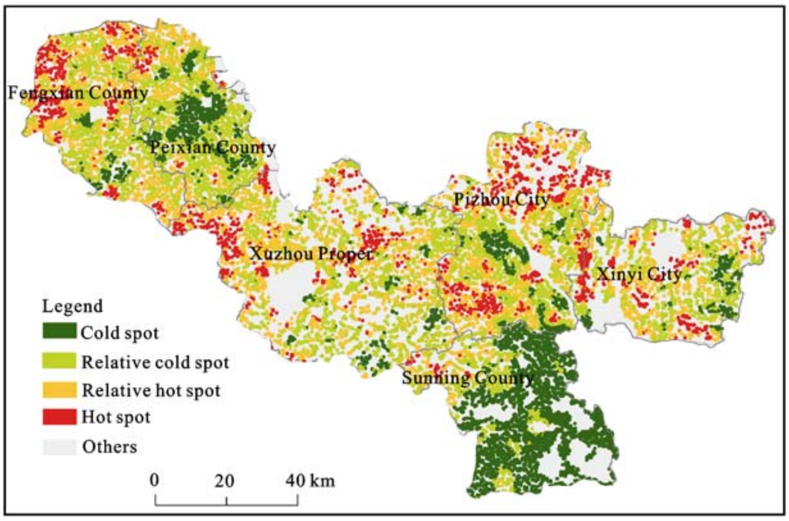


Fig. 5 Hot spots mapping for scale of rural settlement in Xuzhou City

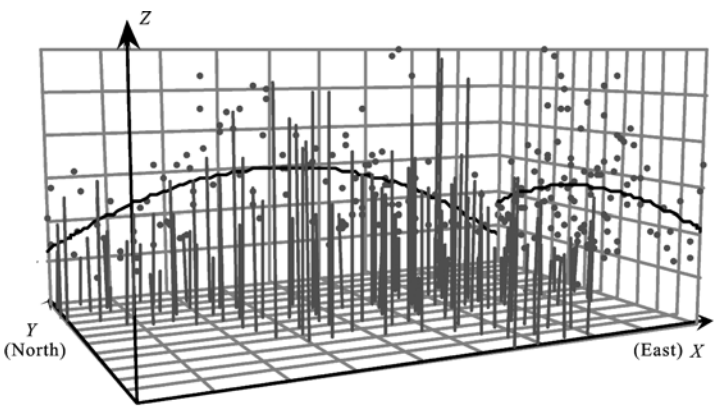


Fig. 6 Spatial trend for morphology of rural settlement in Xuzhou City

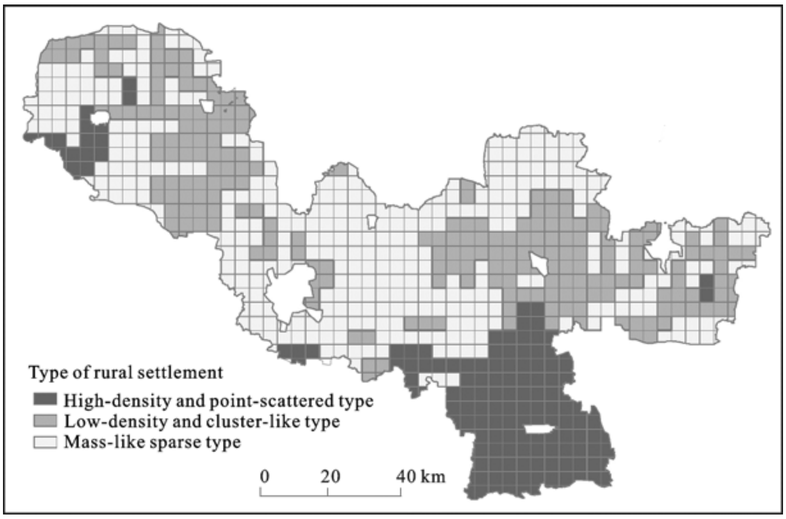
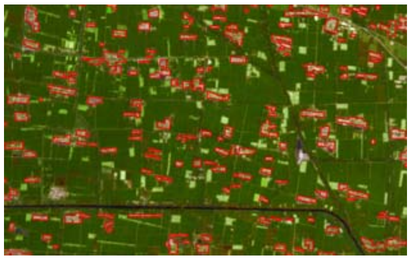
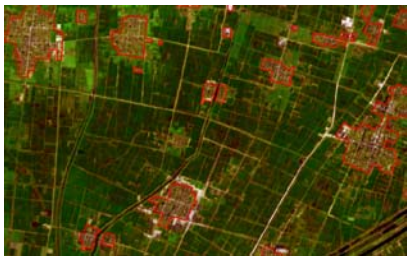


Fig. 7 Types of rural settlements in Xuzhou City

Table 3 Types and characteristics of rural settlements in Xuzhou City

Types	Distribution range	Characteristics	Typical image
High-density and point-scattered type	This type is mainly distributed in west of Suining and Fengxian. This type covers an area of 2050.3 km^2, accounting for 19.1% of rural area.	Density of rural settlement is higher but size is smaller, and connectivity and integrity of their form are poor. Area is mainly traditional agriculture region with small farming radius, and regional economic development is relatively backward. Intensity of land use is low, and has great potential of exploration.	
Low-density and cluster-like type	This type is mainly distributed in Peixian, south and central part of Pizhou and parts of Xinyi. This type covers an area of 3382.8 km^2, accounting for 31.5% of rural area.	Density of rural settlements is lower than Suning and Fengxian, and scale is medium-sized. Boundary of rural settlement is relatively fragmentized, but spatial distribution presents mostly cluster-like. This region has a relatively higher level of agriculture and industrial development.	
Mass-like and sparse type	This type is mainly distributed in Xuzhou Proper, north of Pizhou, and parts of Xinyi and Fengxian. This type covers an area of 5321.9km^2, accounting for 49.5% of rural area.	Density of rural settlements is very low, and form presents bigger mass with sparse distribution. Settlements mainly located in higher terrain or hilly land. Local agricultural production is mainly dry farming with large farming radius.	

settlements with traditional analysis.

We obtained important findings for Xuzhou City in the case study: 1) In terms of their spatial distribution, rural settlements in Xuzhou City are significantly agglomerated. However, there are changes in the agglomeration level at different spatial scales. The agglomeration level firstly increases and then remains almost constant as the distance increases. The average density of rural settlements in Xuzhou City is lower than that in Jiangsu, but its spatial distribution has significant variation. There is a higher density of rural settlements in Suining, Peixian, and Pizhou and a lower density in Xuzhou Proper, Xinyi , and most parts of Fengxian. 2) In terms of scale, rural settlements in Xuzhou City are larger than the average in Jiangsu Province. There is significant high-value clustering in the scale distribution.

Large-scale villages are mainly located in the northwest of Fengxian, the north of Xuzhou Proper and the north of Pizhou. while small villages are mainly distributed in Suining and central Peixian, the hilly areas in southeastern Xuzhou Proper, and eastern Xinyi. 3) In terms of the morphological distribution, rural settlements have relative regularity with good connection and integrity, but the spatial variation of the morphology is anisotropic.

Overall, the spatial pattern of rural settlements in Xuzhou City is profoundly affected by the geomorphology, agricultural production mode, and regional culture. This region mainly comprises denudation plains and hilly land, has rich arable land and a sparse river network, and has local agricultural production based mainly on traditional dry farming with two crops a year and a large farming radius. Therefore, the rural settlements tend to have a centralized distribution. Moreover, rural residents are inclined to live within their clans influenced by the regimen of kinship ties, leading to large-scale settlements with good regularity and connection.

According to the characteristics of density, scale, and the form of rural settlements, the rural settlements in Xuzhou are divided into three types: a high-density and point-scattered type, a low-density and cluster-like type, and a mass-like and sparse type. For the first type, we must accelerate consolidation of rural settlements, optimize the spatial layout, and improve the intensity of land use; for the second type, we must accelerate agricultural industrialization, put forward the construction of new rural communities, and raise the level of rural public service; for the third type, we must advance rural urbanization, push population and industry to gather in small towns, and construct a system of new villages and small towns.

We should point out that there are weaknesses to the study presented in this paper. For example, we only used morphological data of rural settlements to quantitatively analyze the morphological differences, spatial pattern and regional types of rural settlements in Xuzhou City. Our future research will focus on how to combine social and economic analyses in an effort to study optimal regulation models for a rural settlement system in this area more comprehensively and systematically.

References

Besag J E, 1977. Comments on Ripley′s paper. *Journal of Royal Statistic Society*, *Series B*, 39: 193–195.

Chen Yong, Chen Guojie, Liu Shaoquan *et al.*, 2005. Ecological studies of human settlements of ethnic groups in southwestern Sichuan — A case study of maidi village, Miyi County. *Journal of Mountain Science*, 23(1): 108–114. (in Chinese)

Guo Xiaodong, Zhang Qiyuan, Ma Libang, 2012. Analysis of the spatial distribution character and its influence factors of rural settlement in transition-region between mountain and hilly. *Economic Geography*, 32(10): 114–120. (in Chinese)

Hall D R, 1996. Albania: Rural development, migration and uncertainty. *GeoJournal*, 38(2): 185–189. doi: 10.1007/BF00186668

Halseth G, Ryser L, 2006. Trends in service delivery: Examples from rural and small town Canada, 1998 to 2005. *Journal of Rural and Community Development*, 1(2): 69–90.

Holmes J, 2008. Policy issues concerning rural settlement in Australia′s pastoral zone. *Australian Geographical Studies*, 23(1): 3–27. doi: 10.1111/j.1467-8470.1985.tb00475.x

Jensen L, 2006. New immigrant settlements in rural America: Problems, prospects, and policies. Reports on rural America, Carsey Institute, University of New Hampshire.

Jin Qiming, 1982. The geographic study of rural settlements: Taking Jiangsu Province as an example. *Geographical Reseach*, 1(3): 11–20. (in Chinese)

Keith H, Angel P, 2001. What rural restructuring. *Journal of Rural Studies*, 17(1): 41–62. doi: 10.1016/S0743-0167(00)00036-X

Li Hongbo, Zhang Xiaolin, 2012. A review and trend on rural settlement geography abroad. *Human Geography*, 21(4): 103–108. (in Chinese)

Liu Yansui, Zhang Fugang, 2009. Appraisal of typical rural development models during rapid urbanization in the eastern coastal region of China. *Journal of Geographical Sciences*, 19(5): 557–567.

Liu Shaoquan, Chen Guojie, Chen Zhijian, 2001. Ecological and environmental warning on rural habitat ecosystem—A case study of group five of Cizhu Village in Wanxian City. *Acta Ecologica Sinica*, 21(2): 295–301. (in Chinese)

Long Hualou, Liu Yansui, Zou Jian, 2009a. Assessment of rural development types and their rurality in eastern coastal China. *Acta Geographica Sinica*, 64(4): 426–434. (in Chinese)

Long Hualou, Li Yurui, Liu Yansui, 2009b. Analysis of evolutive characteristics and their driving mechanism of hollowing villages in China. *Acta Geographica Sinica*, 64(10): 1203–1213. (in Chinese)

Ma Xiaodong, Li Quanlin, Shen Yi, 2012. Morphological difference and regional types of rural settlements in Jiangsu Province. *Acta Geographica Sinica*, 67(4): 515–524. (in Chinese)

Ma Xiaodong, Zhu Chuangeng, Ma Ronghua *et al.*, 2008. Urban spatial growth pattern and its evolution in Suzhou, Jiangsu Province, China. *Acta Geographica Sinica*, 63(4): 405–416. (in Chinese)

Marc A, 2004. Landscape change and the urbanization process in Europe. *Landscape and Urban Planning*, 67(3): 9–29. doi: 10.1016/S0169-2046(03)00026-4

Neil M A, Peter J S, Trevor G, 2005. Tracing the density impulse in rural settlement systems: A quantitative analysis of the factors underlying rural population density across South-Eastern Australia, 1981–2001. *Population & Environment*, 27(2): 151–190. doi: 10.1007/s11111-006-0018-1

Njoh A J, 2011. Municipal councils, international NGOs and citizen participation in public infrastructure development in rural settlements in Cameroon. *Habitat International*, 35(1): 101–110. doi: 10.1016/j.habitatint.2010.04.001

Paquette S, Domon G, 2003. Changing ruralities, changing landscapes: Exploring social recomposition using a multi-scale approach. *Journal of Rural Studies*, 19(4): 425–444. doi: 10.1016/S0743-0167(03)00006-8

Paul O, 2009. Rural settlement and economic development in Southern Italy: Troia and its contado. *Journal of Medieval History*, 31(4): 327–345. doi: 10.1016/j.jmedhist.2005.09.001

Smailes P J, Argent N, Griffin T L C, 2002. Rural population density: Its impact on social and demographic aspects of rural communities. *Journal of Rural Studies*, 18(4): 385–404. doi: 10.1016/S0743-0167(02)00033-5

Sevenant M，Antrop M, 2007. Settlement models, land use and visibility in rural landscapes: Two case studies in Greece. *Landscape and Urban Planning*, 80(4): 362–374. doi: 10.1016/j.landurbplan.2006.09.004

Shan Yongbing, Ma Xiaodong, Qiu Fangdao, 2012. Distribution Patterns Characteristics and Type Classification of the Rural Settlements in Central Jiangsu Province. *Scientia Geographica Sinic*, 32(11): 1340–1347. (in Chinese)

Terry Marsden, 1996. Rural Geography Trend Report: The social and political bases of rural restructuring. *Progress in Human Geography*, 20(2): 246–258. doi: 10.1177/030913259602000209

Tian Guangjin, Liu Jiyuan, Zhang Dafang, 2003. The temporal-spatial characteristics of rural residential land in China in the 1990s. *Acta Geographica Sinica*, 58(5): 651–658. (in Chinese)

Wang Cheng, Wu Hong, Xu Huacheng *et al*., 2001. Analysis on characteristics and distribution pattern of settlement in river valley: A case study in Fuping County of Hebei Province. *Scientia Geographica Sinica*, 21(2): 170–176. (in Chinese)

Wang Chengxin, Yao Shimou, Chen Caihong, 2005. Empirical study on 'Village-Hollowing' in China. *Scientia Geographica Sinica*, 21(3): 257–262. (in Chinese)

Xu Xueren, Wan Qing, 1997. A Quantitative study on spatial distribution of rural settlement in floodplains discussion of its application. *Geographical Research*, 16(3): 47–54. (in Chinese)

Zhen Feng, Zhao Yong, Zheng Jun *et al*., 2008. New rural construction and rural development: Case study of villages in Tangshan and Qinhuangdao. *Scientia Geographica Sinica*, 28(4): 464–470. (in Chinese)