www.cafetinnova.org

Indexed in
Scopus Compendex and Geobase Elsevier,
Geo-Ref Information Services-USA, List B of Scientific Journals, Poland, Directory of Research Journals

ISSN 0974-5904, Volume 09, No. 05

International Journal of Earth Sciences and Engineering

October 2016, P.P.2119-2124

A Research on the Spatio-Temporal Evolution Pattern and Driving Mechanism of China Traditional Rural Settlements

LIU LIN, LIU KEWEI, LI JIANWEI, YANG HAIJUAN AND CHENG YONGHUI
College of Urban and Environmental Sciences, Northwestern University, Xi'an, 710075 China
Email: *78108304@qq.com*

Abstract: The study introduced two concepts (Intensity and Activity of rural construction land) and then divided different intensity and activity regions (High, Medium and Low) to analyze the temporal and spatial evolution driving mechanism of traditional rural settlements with a case study of FuPing County in Northwest China. The study found: The factors between spatial distribution and temporal evolution are different, the landform condition and the inheritance of culture determined the spatial distribution; the construction of industrial zones, distribution of roads and implement of policy promoted the temporal evolution of rural settlement. The internal driving force played more important role than external force in the evolution of traditional rural settlement, and there were different forms and carriers in different intensity and activity regions of rural settlement.

Keywords: *Driving mechanism, Traditional rural settlement, Spatio-temporal evolution, Northwest China*

1. Introduction

Since reform and opening up, With the acceleration of urbanization and the improvement of the level of Agricultural Mechanization, Profound changes have occurred in the rural areas of China, The evolution of rural settlement and its dynamic mechanism has always been the focus of the study of rural geography in China[1][2]. The evolution of the rural settlement space is the visual expression of the changes of rural functions, Influenced by the factors of nature, economy, society, culture and, location[3], The study is divided into three levels: region, group and individual[4].The driving mechanism of evolution can be divided into two types, internal force and external force. The dominant model (top-down or bottom-up) is different in different periods, different regions and spatial scales [5-6]. The ninety's of last century to the beginning of this century, The internal driving force of rural development(such as Agricultural industrialization, Rural industrialization, Rapid increase in rural population [7-8], The pursuit of the quality of life of rural residents [9] etc.) is the main driving mechanism of spatial evolution. In twentieth Century, External force (such as Rapid Urbanization [10], Urban New District Construction [11], The construction of new countryside under the guidance of the policy, Facilities construction, Attraction of the surrounding cities etc.) is the dominant force in the evolution of rural settlement space. At present, China is in a critical period of the development of "rural China" to "urban China", the implementation of the policy of separation between urban and rural, gather the elements to the city, rural is vulnerable.

In recent years, with the rapid spread of the urban boundary to the periphery, "the village in the city", "the village", "cultural tourism village", "urban agriculture village", "hollow village" and other rural functional area changes significantly, which received more attention than traditional agricultural village. Meanwhile, Factors affecting the spatial and temporal evolution of rural settlement played different roles (Power? Forms? Or Carriers?). At present, the previous studies mainly focus on the comprehensive mechanism of the spatial and temporal evolution of rural settlement, neither lack of depth analysis of the function of each factor (For example, which factor determine the initial layout of the settlement? Which directly affect the evolution of the settlement? And which dominates the traditional rural settlement agglomeration or differentiation?) Nor lack of effective analysis the conduction process of factors. Based on the above background, this paper takes Fuping County of Shaanxi Province as a case, study on the spatial and temporal evolution pattern and dynamic mechanism of traditional rural settlements in Northwest China, to enrich the research field of the spatial evolution of rural settlement.

2. Problem Formulation

In this paper, the use of GIS spatial analysis and landscape pattern, based on the two concepts of the intensity and activity of the village construction land, analysis of spatial and temporal distribution pattern and evolution pattern of rural settlement from two dimensions of space and time. From the "power - form - carrier" progressive level to carry out from "function" to "space", systematic study on the dynamic mechanism of the evolution of the traditional rural settlement in the northwest region of China (Fig.1).

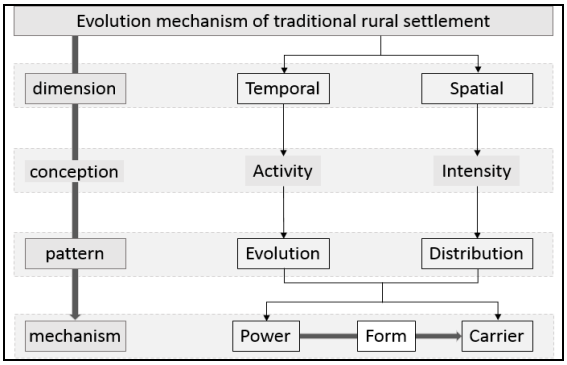

Fig.1: *Framework of the research*

2.1. Study Area

Fuping County adjacent to Xi'an is located in central china, Weinan City, Shaanxi province (Fig.2), and land area 1233km 2. Fuping County is located in Loess Plateau Hilly Gully Region, North to The Qiao Hill, south to the Wei River Plain, divided into four geomorphological interval in northern mountain area, piedmont alluvial sector, loess tableland area and plain area. Since modern times, Fuping County has belonged to Tongchuan, Xi'an, Weinan. There are two highways and two railways through, have a good traffic conditions.

2.2. Data Source

Data mainly include land use data in 2014 and 1999, DEM data and economic and social data about Fuping County. Among them, the land use data (Library) as a data source, can avoid the uncertainty of land use classification, the location and the accuracy of land use, to improve the accuracy and efficiency of landscape pattern analysis [12].Therefore, the land use data of the paper come from the Fuping County Land Use Planning (2006 - 2020), current land use map(2009), that is the second national land survey results, combination of land use change data from 1999 to 2014, Land use data of Fuping County in 2014 and 1999 is obtained. In addition, the number and size of the village are based on the administrative village of the end of 2014.

Fig.2: *The location of Fuping County*

DEM data download from geo spatial data cloud platform (http://www.gscloud.cn/), the spatial coordinate system is WGS84 and the resolution is 30m, load data to ArcGIS 10.2 Destkop, the slope data can be calculated by the three-dimensional extension module.

Economic and social datas of Fuping County from Fuping Xian Zhi and Fuping County statistical yearbook, Fuping County's Statistical bulletin of national economic and social development (1999-2014) Etc.

2.3. Research Method

2.3.1. Landscape Pattern

Landscape pattern index can be highly concentrated landscape information, quantitative indicators of certain features reflecting the structure and spatial configuration, which linking the spatial characteristics and temporal process of rural settlement, in order to find out the characteristics of rural settlement landscape changed [13-15].

This paper select Number of Patches (NP), Class Area (CA), Patch Density (PD), AREA_RA, and LPI.

The process is: extracting the construction land from 2014 and 1999 land use database and excluding urban construction land, then conversing to a unit of 10 TIF format raster file, and analyzing in 60m's spatial granularity [16] with Fragstats 3.4.

2.3.2. GIS

This paper based on the two concepts of construction land use intensity (I) and activity (A) analysis evolution characteristics of rural settlement space from two dimensions of space and time.

(1) Construction land use intensity (I)

Refers to the construction land area occupies the proportion of the total land area, its mathematical expression is:

$$I = \frac{SJ}{SA} \qquad (1)$$

"I" Refers to the construction land use intensity;
"SJ" Refers to the area of rural construction land in a certain area;
"SA" Refers to the total area of a certain area.

In this paper, the construction land use intensity refers to the proportion of the rural construction land area of the total area in an administrative village.

(2) Construction land use activity (A) [17]

Refers to a time period of construction land change (Increased or decreased) the proportion of total land area, its mathematical expression is:

$$A = \frac{\Delta S_u + |\Delta S_v|}{SA} \qquad (2)$$

"A" Refers to the active degree of construction land in a certain area;

"ΔS_u" Refers to the land increased amount of construction land in a certain area in a certain period of time;
"ΔS_v" Refers to the land decreased amount of construction land in a certain area in a certain period of time;
"SA" Refers to the total area of a certain area.

In this paper, the construction land active degree refers to the proportion of the changed amount of rural construction land in the total area of the administrative village of Fuping County from 1999 to 2014.

The process is: extracted rural construction land patches in 1999 and 2014 land use database, calculating the construction land use intensity (I) in 1999 and 2014, respectively and the construction land use activity (A) with administrative village as a unit, visualized with ArcGIS 10.2. According to the proportion of the distribution are divided into three types of areas (high, medium and low) (Fig.3 and Fig.4).

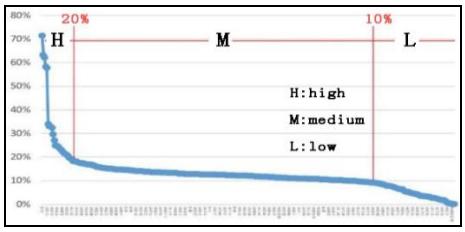

Fig.3: *The intensity of rural construction land distribution in 1999*

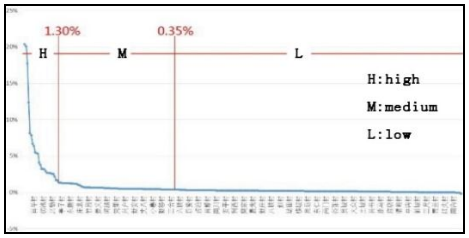

Fig. 4: *The activity of construction land distribution from 1999 to 2014.*

3. Problem Solution

3.1. Intensity of Rural Construction Land

3.1.1. Distribution characteristics of rural settlement

(1) Traditional rural construction land distribution changed insignificantly. The number of villages in the area of high intensity increased slowly in 2014 to 1999, the number of villages in the medium and low intensity areas changed very small (Table 1).

Table 1: *Classification of rural construction land use intensity in Fuping County in 1999 and 2014*

Year	Number of high intensity villages	Number of medium intensity villages	Number of low intensity villages
1999	23	127	86
2014	38	121	76

The number of Patches (NP), Class Area (CA), LPI, and AREA_RA is increased gradually, and Patch Density (PD) is decreased (Table 2), the rural settlement agglomeration distribution.

Table 2: *Rural construction land landscape pattern index of Fuping county in1999 and 2014*

year	CA	NP	PD	LPI	AREA_RA
1999	13996.49	5923	42.32	4.60	643.99
2014	14694.58	6153	41.87	4.80	705.33

(2) The density of settlements in Fuping County showed a trend from north to south. High intensity areas distribute in the southwest and northeast of The County, three settlement centers are formed, the medium intensity areas distribute in the central of The County, and the low intensity areas are distributed in the mountainous area of the north of The County (Fig.5, Fig.6).

3.1.2. The factors of rural settlement distribution

(1) Topography is the basis of the distribution of rural settlements [8]. The land is fragmented and poor condition in northern mountain area and piedmont alluvial sector, the number and area of rural settlements are the least, on the contrary, the number of rural settlements increased significantly in loess tableland area and plain area. Settlement distribution shows typical terrain orientation (Fig.7).

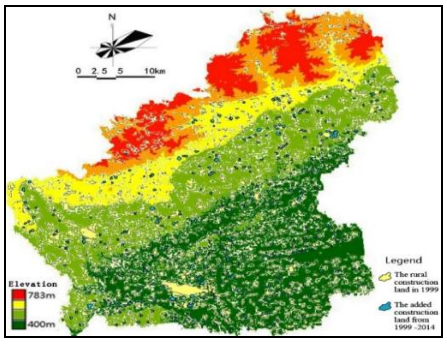

Fig.7: *The relationship between the distribution of rural construction land and elevation in Fuping County*

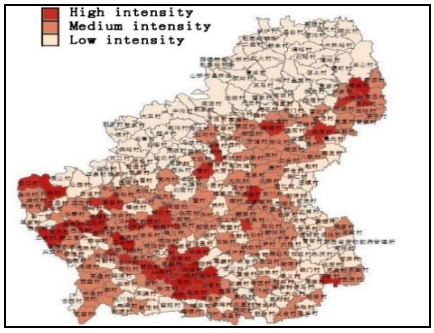

Fig.5: *The intensity of Fuping rural construction land use distribution in 1999*

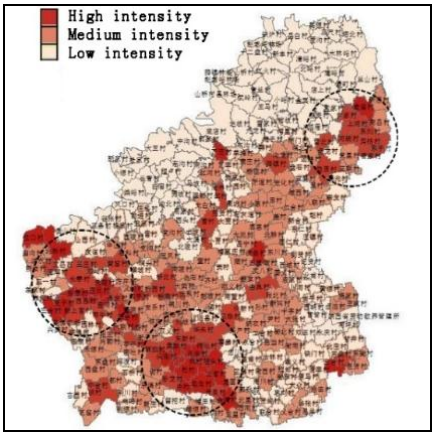

Fig.6: *The intensity of Fuping rural construction land use distribution in 2014*

(2) Social and cultural factors determine the intensity of rural settlement distribution. Fuping had been under the jurisdiction of Tongchuan City to the northwest (from the Tang Dynasty in year 618 to 1949 [18]). The MeiJiaPing and ZhuangLi town located in the west of the county are closely communicated with Tongchuan City which formed high intensity rural construction land. The MeiYuan and LaoMiao town is located in the northeastern of the county, which have been the county seat from the Qin Dynasty to the Republic of China [19] (From about 221 B. C. to 1900 A. D.), its intensity of construction land is significantly stronger than other regions. DuCun Town which is county seat of the county form the southern rural settlement central area. Therefore, cultural inheritance play an important role in rural settlement distribution (Fig.8).

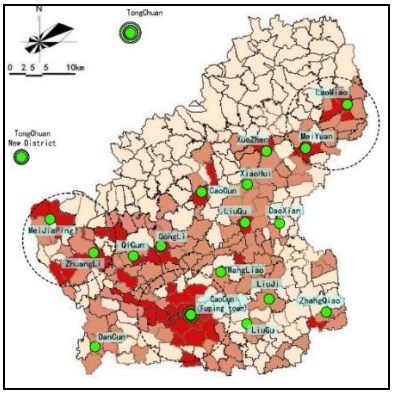

Fig.8: *The relationship between the distribution of rural construction land and Social and cultural factors in Fuping County*

3.2. Activity of Rural Construction Land

3.2.1. Evolution characteristics of rural settlement

(1) the size of rural settlement grow slowly. The rural construction land area increased 6.98km2 from 1999 to 2014, the number of high activity villages is very small (29), the number of low activity villages up to (217) (Table 3).

Table 3: *The characteristics of different activity in Fuping County*

Zones	The number of high activity villages	Area(km2)	Area proportion(%)
High	29	26.66	18.13
Medium	90	44.81	30.48
Low	217	75.53	51.38

The landscape pattern index change is obvious in high activity area. New landscape area (CA) accounted for 90.85% of all. The characteristics reflects large areas and numbers, concentrated and continuous distribution.

The landscape pattern index change is less obvious in medium activity area, the original pattern change insignificantly. “CA” added slowly, “NP” “LSI” and increased fast, “AREA_MN” decreased obviously, patch distribution showed a tendency of fragmentation, the complexity and the degree of irregularity are improved.

The landscape pattern index change is least obvious in low activity area, “CA” and “NP” were both decreased, showing a declining trend (Table 4).

Table 4: *Landscape pattern index of different intensity in Fuping, 1999-2014*

Year	Intensity	CA	NP	PD	LPI	AREA_RA
1999	High	2206.27	1320	30.43	10.36	449.19
	Medium	4319.83	1763	47.43	2.75	102.03
	Low	7475.36	1665	48.26	2.47	85.26
2014	High	2666.26	1419	28.42	10.21	509.63
	Medium	4480.56	1858	49.50	2.74	102.8
	Low	7352.53	1508	49.35	2.46	85.26

(2) The evolution of rural settlement shows the pattern of "center + radiation"(Fig.9). High activity area is distributed in the shape of the spot, medium activity area is distributed in the shape of line, and the low activity area is distributed in the shape of plane. The distribution of activity and the intensity of construction land are basically the same.

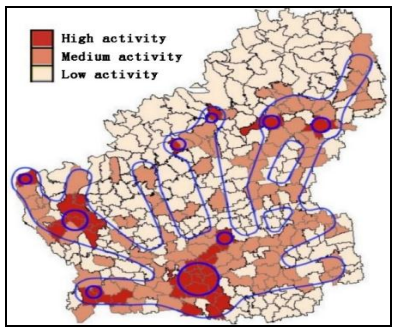

Fig.9: *The activity of rural construction land use distribution from 1999 to 2014*

3.2.2. The factors of rural settlement evolution

(1) the layout of non-agricultural industry (especially the second industry) determines the evolution of high

activity area. Entering in 21 Century, several industrial zones has built in Fuping County, including Zhuangli industrial zone to the west, Emerging industrial zone to the south, Firework industrial zone to the northeast, and Agricultural Products Processing industrial zone to the central section etc.(Fig.10). Industrial zones have often located nearby county or township for more convenient service facilities, which lead to spatial continuous distribution of high activity regions. The industrial buildings have larger area and more regular border than rural resident, as the result of the landscape pattern index. In addition, the industrial zones were built by the government of Fuping County, that is, the internal driving force played an important role in the evolution of high activity region.

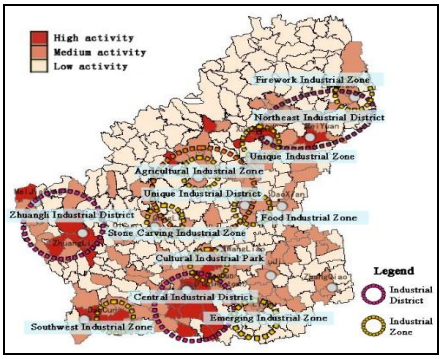

Fig.10: *Fuping county industrial layout planning map Data source: Fuping County Master Planning [19]*

(2) County's roads lead to the development of medium active regions. The medium activity regions are distributed along the road is the main cause of which formed radial pattern, moreover County Road have higher relevance than other kinds of roads (Fig11). In China County Road is invested and constructed by County government, that means the internal driving force dominate the evolution of medium activity region also. LPI, AREA_MN, AREA_RA, and other landscape pattern index basically unchanged, it is proved that the rural resident is the main form of the expansion of construction land in medium activity region.

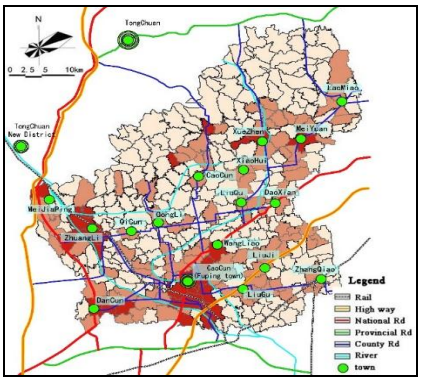

Fig11: *The relationship between the activity of rural settlement evolution and the distribution of road in Fuping County*

(3) Implementation of relocation policy lead to of construction land scale decline of low activity region. Fuping County to implement the policy of the township merge, the number of the towns has declined from 32 in 1999 to 17 in 2015, the number of the administrative villages has declined from 442 in 1999 to 322 in 2015. "Fuping County village layout planning" proposed the number of towns and villages would be reduced to 15 and 179 in 2020. Disaster prevention and poverty alleviation is the main reason for the relocation of villages, geological disasters (such as rainstorm, debris flow, and landslide, etc.) occurred frequently in the northern mountainous area of Fuping County, which is the most important region to relocate, the county government promulgated the "geological disaster prevention and control program", "the northern mountain poverty reduction and mitigation planning" to promote the relocation. Therefore, the number and area of rural settlements in low activity region has declined.

4. Conclusion

The paper introduce two indexes—"Construction land use intensity (I)" and "Construction land use activity (A)" to evaluate the levels of distribution and evolution of rural construction land respectively. According to the calculation results, the villages are divided into three types of intensity area and three types of activity area respectively (High, Medium, and Low). The reasons for the formation and change of the above types of area are studies. The study found that:

(1) The factors between spatial distribution and temporal evolution are different. At the spatial level, landform condition is the premise, social and cultural factors are the basis, and the inheritance of culture determines the intensity of rural settlement distribution. At the temporal level, construction of industrial zones, distribution of roads, and implement of relocation policy promote the evolution of different activity regions.

(2) The dynamic mechanism of the evolution of the traditional rural settlement spatial and temporal pattern has general characteristics. The traditional rural settlement is far away from the central city, less influenced by the city, the size of the settlement has grown slowly. Natural and social conditions determine spatial distribution. The internal driving force played more important role than external force in the evolution of rural settlement which promote the development of rural settlement on the basis of the original spatial pattern, formed the "polarization phenomenon" of rural settlement.

And (3) there are different forms and carriers in different intensity and activity regions of rural settlement. The long term powerful inertia of culture and society gathered residents to form a high intensity area, the harsh natural geographical conditions (especially the terrain conditions) is the decisive

factor that restrict the development of the rural residents, and determine the distribution of the low intensity area, others areas, the natural and cultural conditions are relatively average, forming a medium intensity region.

The development of high active area is mainly in the form of non - agricultural industry, taking the construction of industrial zones as the carrier, Medium active area is relying on County Road development, and immigration policy directly determines the development of low activity area (Fig 12).

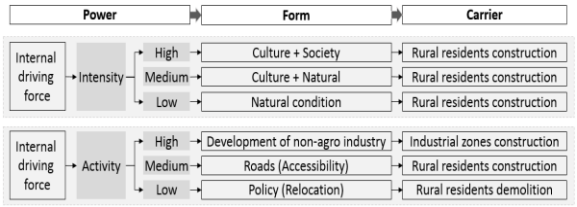

Fig 12: *The Evolution mechanism of traditional rural settlement in Northwest China - Taking Fuping County in Shaanxi Province as an example*

5. Acknowledgements

The paper funded by National Key Technology Support Program (2015BAL01B04).

References

[1] Liu Yansui, Long Hualou, Zhang Xiaolin, Qiao Jiajun, Research Progress and Prospect in the Disciplines of Agricultural Geography and Rural Development in China, *Progress in Geography*, Vol.30, No.12, pp. 1498-1505, 2011.

[2] Long Hualou, Liu Yansui, Zhang Xiaolin, Qiao Jiajun, Recent Progress in Agricultural Geography and Rural Development Research, *Acta Geographica Sinica*, Vol.69, No.8, pp. 1145-1158, 2014.

[3] Tang Guoan, Zhao Mudan. A GIS Based Research on the Distribution of Rural Settlements—Taking YuLin Area as an Example. *Economic Geography*, Vol.20, No.5, pp. 1-4, 2009.

[4] Fan Shaoyan, Cheng Zongxing, Research Contents of the Spatial Structure of Rural Settlements, *Economic Geography*, Vol.15, No.2, pp. 44-47, 1995.

[5] Wang Yong, Li Guangbin, Functional Transformation and Spatial Restructuring of Rural Settlements in Southern JiangSu: a Case Study of SuZhou, *City Planning Review*, Vol.35, No.7, pp. 54-60, 2007.

[6] He Yanhua, Zeng Shanshan, Tang Chengli, Zhou Guohua, Zhang Jie, Li Li, Differentiation Characteristics and Forming Mechanism of Rural Settlements in Central China. *Acta Geographica Sinica*, Vol.68, No.12, pp. 1643-1656, 2013.

[7] Guo Xiaodong, Ma Libang, Zhang Qiyuan, A GIS-based Research on the Spatial Evolution Characteristics and Driving Mechanism of the Rural Settlements in Qin'an County, *Economic Geography*, Vol.32, No.7, pp. 56-62, 2012.

[8] Feng Wenyong, Chen Xinmei, Analysis on the Rural Settlement Expansion of the JinZhong Plain, *Human Geography*, Vol.18, No.6, pp. 93-96, 2003.

[9] Fan Shaoyan. The Evolution Mechanism & Study Contents on the Spatial Strueture about Rural Settlement, *Journal of Northwest University*. Vol.24, No.4, pp. 295-298, 304, 1994.

[10] Xing Gurui, Xu Yilun. Rural Settlement Spatial Evolution Types and Features in Urbanization *Journal of Anhui, Agri.Sci*. Vol.35, No.7, pp. 2087-2089, 2159, 2007.

[11] Li Jianwei, Liu Kewei, Liu Lin, Urban Spatial Expansion Transformation and New Urban District Establishment: an Empirical Analysis and Discussion on Xi'an City, *City Planning Review*, Vol.39, No.4, pp. 58-64, 2015.

[12] Wu Jiangguo, Zhang Xiaolin, Ji Yazhe,Li Hongbo, Transports Influence on Rural Settlement Landscape Pattern at County Scale——a Case Study of Yongqiao of Suzhou, *Human Geography*, Vol.28, No.1, pp. 1-8.110-115, 2013.

[13] Li Xiuzhen, Bu Rencang, Chang Yu. The Response of Landscape Metrics Against Pattern Scenarios. *Acta Ecologica Sinica*, Vol.24, No.1, pp. 123~134, 2004.

[14] Schumaker N. H, Using Landscape Indices to Predict Habitat Connectivity, *Ecology*, Vol.77, No.4, pp. 1210-1225, 1996.

[15] He H. S, DeZonia B. E., Mladenoff D. J, An Aggregation Index (AI) to Quantify Spatial Patterns of Landscape, *Landscape Ecology*. Vol.15, No.7, pp. 591-601, 2000.

[16] Geng Huanxia, Zhang Xiaolin, Li Hongbo, Effects of Changing Grain Size on Landscape Indices of Rural Settlement at County Scale—A Case Study of FengXian in JiangSu Province, *Resources and Environment in The Yangtze Basin*, Vol.23, No.10, pp. 1417-1424, 2014.

[17] Qiao Luyin, Liu Yansui, Yang Ren. Regional Types and Regulating Strategy of Changes for Rural Residential Land in China, *Transactions of the Chinese Society of Agricultural Engineering*, Vol.31, No.7, pp. 1-8, 2015.

[18] Fuping County Local Records Compilation Committee, Fuping County Zhi, *Shaanxi People's Education Press*, 2014.

[19] THUPDi, *Fuping County Master Planning (2011-2030)*, 2013.