



Rural settlements transition (RST) in a suburban area of metropolis: Internal structure perspectives



Wenqiu Ma ^{a,b}, Guanghui Jiang ^{a,b,*}, Deqi Wang ^c, Wenqing Li ^b, Hongquan Guo ^d, Qiuyue Zheng ^{a,b}

^a State Key Laboratory of Earth Surface Process and Resource Ecology, Beijing Normal University, Beijing 100875, China

^b School of Natural Resources, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China

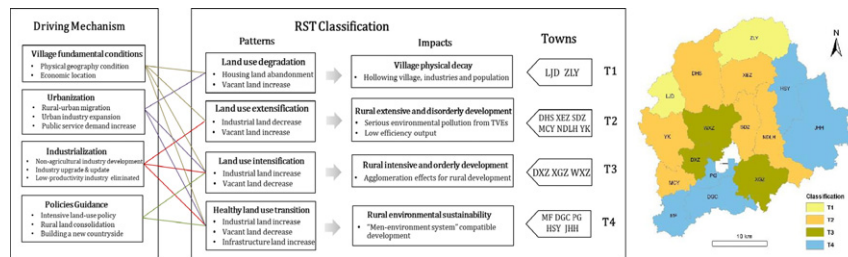
^c College of Urban Economics and Public Administration, Capital University of Economics and Business, Beijing 100070, China

^d Chinese Peasants and Workers Democratic Party Central Committee, Beijing 100011, China

HIGHLIGHTS

- We explore the RST regarding internal structure change characteristics, patterns and impacts on rural environment.
- Regional differentiation in patterns and impacts are significant in the process of RST.
- The gradient effect of urbanization is the major driving factor for the different RST patterns.
- RST in the urban hinterland shows a “men-environment” compatible development pattern.
- Extensive land-use pattern causes the serious rural hollowing and environment pollution in countryside.

GRAPHICAL ABSTRACT



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ABSTRACT

Rural settlements transition (RST) is one of the most significant indices for understanding the phenomena of rural reconstruction and urban-rural transformation in China. However, a systematic overview of RST is missing, and there is a lack of evidence regarding its characteristics from the internal structure perspectives. In this paper, we systematically explore the RST regarding spatio-temporal change characteristics of internal structure, patterns and impacts on rural environment and development by using practical survey internal land-use data from 2005 to 2015. The results show that the temporal change characteristics of the internal structure of rural settlements demonstrate a tendency for housing land to decrease and other land-use types to increase. The spatial change characteristics reveal that the structure inclines to more complexity and diversity from an exurban area to an urban-rural fringe area. Based on this finding, we identify that rapid development of rural industrialization, more agglomerate and effective industrial land-use, and improved public infrastructure construction are the general RST patterns. Spatially, there exists a physical decay pattern in the exurban area, thereby resulting in the hollowing-out of rural industries and of the population. In addition, the extensive and disorderly pattern in the suburban area causes low efficiency output and serious environmental pollution. The RST pattern in the urban hinterland promoted the “men-environment” compatible development. The study concludes that regional differentiation in patterns and impacts are significant in the process of RST. Future adaptive strategies for rural settlements adjustment should be conducted according to regional characteristics, including socio-economic status, physical geography condition and economic location to improve the rural environmental sustainability.

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* Corresponding author at: School of Natural Resources, Faculty of Geographical Science, Beijing Normal University, No. 19, Xijiekouwai Street, 100875 Beijing, China.

E-mail addresses: wqm@mail.bnu.edu.cn (W. Ma), macrophage@bnu.edu.cn (G. Jiang), wq1897@126.com (D. Wang), liwq@mail.bnu.edu.cn (W. Li), ghqmail@126.com (H. Guo), 410401271@qq.com (Q. Zheng).

1. Introduction

Land use transitions are a crucial part of land-use and land-cover change (LUCC), and they are the main research contents of the Global Land Project (GLP) held by IGBP and IHDP (Lambin and Meyfroidt, 2010; Long, 2012; Grau and Aide, 2008). The concept of land use transition was first proposed in forest transition studies (Grainger, 1995; Mather and Thomson, 1995). The concept was later extended to studies on other land use morphologies. Recently, issues related to land use transitions ranged from land conversion to single land use transitions (Villamor et al., 2017; Barbier et al., 2010) and their internal land-use structure change (Jiang et al., 2017a), from modeling spatio-temporal patterns of land use transitions (Izquierdo and Grau, 2009; Nuissl et al., 2009) to exploring the regional differences, causes, and driving factors for land use transitions (Silva et al., 2016; Long, 2015; Zhou et al., 2013). Socio-economic development and political decision-making are the two main factors influencing land-use change (Liu and Yang, 2012; Marull et al., 2010); meanwhile, land-use change often influences socio-economic development (Hussain, 2002; Tian, 2015). The interaction between them has caused land use transitions, as was the case in rural settlements (Bicik et al., 2001; Long et al., 2014; Holmes and Argent, 2016).

With the rural socio-economic transformation and boom, the economic structure and production-living style in the countryside gradually manifested a diversified tendency (Li and Long, 2015). Rural settlements, an important place for rural production and living (Jiang et al., 2007; Yang et al., 2015), have greatly changed their function and structure (Li et al., 2013a; Li et al., 2013b; Wegren et al., 2008), thereby resulting in a dramatic change in their internal land-use structure. In particular, China is experiencing an unprecedented industrialization and urbanization process (Arayama and Miyoshi, 2004), as a consequence, rural settlements transition (RST) demonstrate its typicality (Jiang et al., 2016). In this study, RST refers to the changes in rural settlement land use morphology and patterns of a certain region over a certain period of time that are driven by socio-economic change and innovation (Long et al., 2014; Lambin and Meyfroidt, 2010). Therefore, RST is a critical issue that requires further exploration in the transition period of China. An in-depth investigation can provide practical insights about the RST process and its feedback effect on socio-economic transition.

Between 1920s and 1960s, scholars in Europe and the US began conducting a series of studies on the formation and development of RST, as well as their classification, functions, and planning (Jin, 1988b; Jin et al., 1990). Recently, the studies on RST focused more on the external morphological differences, spatial patterns changes, and rural settlements landscape evolution by using the landscape indices (Jin, 1988a; Marc, 2004; Holmes, 2008). In addition, several authors discussed issues from the driving mechanism, environmental effects and the relationships among the rural population, rural industries and other rural land-use types (Paul, 2009; Zhang, 1989; DeMarco and Matusitz, 2011; Walters, 2017). As the research further develops, the study on RST tends to consist of microanalysis. Some scholars explored the internal structure of RST. For example, Long et al. (2009a, 2012), Li et al. (2015), Liu et al. (2010), Zhu et al. (2014) and Jiang et al. (2016) studied the rural housing land use transitions and discussed the “hollowing-out” of rural settlements in the transition process. Jiang et al. (2007) and Cao et al. (2008) also analyzed the location characteristics change of the internal structure of rural settlements.

Literature indicated that there have been many theoretical and empirical studies on RST from the aspects of external scale (Yang et al., 2016; Li et al., 2015), form (Guo et al., 2012; Long et al., 2009b; Xi et al., 2015), location characteristics (Jiang et al., 2007, 2009), and the dynamic interaction with cultivated land. Most of these studies regarded rural settlements as an integral land-use type and always focused on its spatio-temporal change. Yet, in-depth studies on detecting the internal structure of rural settlements have remained rare, especially for the

depiction of the spatial allocation relationship evolution characteristics of various internal land-use types of rural settlements and the analysis on its coupling relationship with natural, social, economic and political factors. Along with the socio-economic transformation and rural industrial restructuring, rural settlements have changed dramatically. In the short-term, RST is mainly reflected in the internal land use spatial conversion and the change on land-use scale and structure (including the appearance of new land-use types and the change of ratio structure and spatial allocation relationship between different land-use types). To a great degree, the spatio-temporal change of the internal structure is the most crucial issue in RST. Therefore, the study on the spatio-temporal change of the internal structure of rural settlements can enrich the existing literature of RST and cover the shortage of the research on the internal structure evolving laws of rural settlements from the macro-perspective, thereby promoting rural development and spatial restructuring.

Given this background, the aims of this paper were as follows: i) to examine the spatio-temporal change of various internal land-use types and the internal structure of rural settlements in a suburban area of Beijing-Pinggu District, which experienced dramatic economic and spatial restructuring, using practical survey data between 2005 and 2015; ii) to explore the causes and driving mechanism of the different RST patterns; and iii) to analyze the impacts of RST on men-environment systems. Specifically, we attempted to address two questions: 1) How do rural settlements change from the perspective of internal structure during the study period? 2) What are the general patterns of RST in different areas in Pinggu? The results can help provide theoretical support for the study on LUCC and GLP in China, as well as provide adaptive strategies for rural settlements adjustment and rural environmental sustainability.

2. Methodology

2.1. Study area

As the capital of China, Beijing has experienced a rapid growth of urbanization and industrialization in the transition period. The urban sprawl has made central government deliver a more stringent control for the urban, built-up land increase (Zhu et al., 2013). In this case, many local governments and enterprises seek to make use of the collective built-up land in suburban towns or villages to develop their industries, where rural settlements have dramatically changed. Hence, the suburban area-Pinggu District was a good sample to study the RST (McDonnell and Pickett, 1990; Zhu et al., 2014).

Pinggu District (40°02' N–40°22' N, 116°55' E–117°24' E) lies in the northeast suburbs of the city of Beijing (Fig. 1) and on the fringe of Tianjin and Hebei, and it is affected by the economic radiation and driving effects of Beijing and Tianjin. This district is well-known as an agricultural production base and for its industrial parks (e.g., *MF Industrial Park* and *XG Industrial Park*). Moreover, Pinggu District has mountains on three sides and plains in the center. The mountainous area is mainly located in the north, east and south of Pinggu, accounting for 59.7% of the study area, and the rich natural resources provide the foundation for eco-tourism and urban agricultural tourism development.

The district occupies an area of approximately 107,500 ha with a population of 397,517 (Pinggu Statistical Bureau, 2015), containing 2 streets, 16 towns, and 282 administrative villages. During the process of urbanization and industrialization, Pinggu experienced considerable socioeconomic transformation. The total rural population decreased by 18.86% from 2.28 million in 2005 to 1.85 million in 2015. The area of rural settlements decreased by 9.12%, from 6180.12 ha to 5713.96 ha. There is a significant transition phenomenon both on the rural settlements and the rural population in this area.

2.2. Data

The 2005 land-use data of Pinggu were acquired from the China Land Surveying and Planning Institute, which is a cooperation unit of

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