Measure of urban-rural transformation in Beijing-Tianjin-Hebei region in the new millennium: Population-land-industry perspective

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ABSTRACT

Since the turn of the new millennium, urban-rural transformation has entered a critical period. Ever-widening gaps between urban and rural areas are common in most parts of China. The Beijing-Tianjin-Hebei (BTH) region, as the capital circle of China, has experienced significant urban-rural transformation with accelerated urbanization. On the basis of space analytic geometry, this study measures BTH's urban-rural transformation by establishing an indicator system from the population-land-industry perspective to capture spatio-temporal variations and explore the internal mechanisms of BTH's urban-rural transformation. The results indicate that the urban-rural system in the BTH region has undergone an intensive and dramatic transformation during 2000–2015. Evolving from basic to advanced and from disorder to order, urban districts in Beijing and Tianjin have always had levels of coordinated transformation degrees (CTD) higher than those of the surrounding high-level counties while the overall coordinated deviation degree (CDD) has exhibited a decreasing trend over time. Four functional zones, which are dominant transition area, key transition area, potential transition area and restricted transition area, of urban-rural transformation were established by adopting the trajectory computing method. This research could track the development process of regional urban-rural change from the essence of an urban-rural system itself. When this indicator system that measures urban-rural transformation is applied in other countries, national differences such as differences in urban-rural structures, as well as the limitations, should be noted.

1. Introduction

Urbanization is a global phenomenon (Seto and Fragkias, 2005) that has had various effects on the structure, function and dynamics of ecosystems. The global population is projected to increase by 1.76 billion and 86% of this growth is expected to occur in the cities and towns of developing countries during 2000–2024 as a result of rapid urbanization. The above projections from the United Nations Population Division suggest that in developing countries during this period, there will be a small rural growth of about 190 million rural dwellers in total (Montgomery, 2008). The emergence of the current post-urban world has meant a fundamental change in urban-rural relations with the transformation from an agricultural to a manufacturing-industrial and to a knowledge economy, which leads to issues on the future of integrated city regions, as well as their internal and external networks (Andersen et al., 2011; Haas and Westlund, 2017; Westlund, 2014). Urban-rural transformation refers to a complicated human process of

mechanism transformation, strategy change and element transfer between urban and rural areas (Ali, 2007; Liu and Yang, 2015; Li et al., 2014, 2015; McGee, 2008). Accompanying rural issues, which include rural decline, rural depopulation and exodus, land abandonment, rural poverty, industrial recession, and environmental pollution in deteriorating countrysides, have swept both developing and developed countries, as well as hindered rural sustainability (Chen et al., 2014; Liu, 2010; Liu et al., 2014; Liu and Li, 2017; Long et al., 2011; Markey et al., 2008; McDonald et al., 2013; McGee, 2008; Ongley et al., 2010; Paniagua, 2013; Parry et al., 2010). In the meanwhile, urban areas are witnessing congestion, air pollution, property bubbles, high living costs, and land wastage due to the overexpansion of urban areas (Douglas et al., 2002; He et al., 2008; Watson, 2009; Yao et al., 2009).

Due to tremendously rapid development since the country's economic reformation and liberalization, China has been witnessing rapid urban growth (Tan et al., 2005), which has created a series of issues influencing the country's socioeconomic development (Cai and Smit,

1994; Long et al., 2011; Xu and Tan, 2002). The most obvious of these issues is the transformation in the economic balance and the widening gap between urban and rural areas with an intensifying trend since the start of the new millennium (Long et al., 2011). The Chinese government has been concerned about urbanization as the urbanization rate has grown from 36.2% in the year 2000 to 58.5% in 2017. Socioeconomic development has also stepped into a critical period of transformation. A series of rural-favoring policies were created to advance rural development by integrating urban-rural systems and intensifying urban-rural mutual linkages. In this context, dramatic transformation has occurred in both urban and rural areas (Long et al., 2011) while industrialization and urbanization simultaneously shape the growth of both areas in this critical transition period. Since the turn of the century, reducing the widening urban-rural gap and achieving urban-rural coordinated development has been among the central concerns of the Chinese government. The quantitative measurement of urban-rural transformation offers a basis for research on urban-rural coordinated development.

Urban-rural systems contain three important elements: population, land, and industry (Li et al., 2014, 2017; Yang et al., 2015). Human behavior is often regarded as one of the direct drivers that influences and changes a system. Land has the three attributes of resources, property, and capital while being the carrier of urban-rural systems and offering the basis for human activities. Industry plays an essential role as the internal impetus for urban-rural system development (Gibson, 2010; Oleti, 2017; Li et al., 2017). With the agglomeration of population and industry into cities, urbanization is often characterized by the expansion of urban scales and the increased numbers of cities and towns in spatial distributions. From the point of view of urban-rural structure, urban-rural transformation is witnessing the increase in the proportions of urban populations, non-agricultural industries, and urban construction land. Thus, we could describe urban-rural transformation according to the changes in population-land-industry. The three elements cannot be separated from each other. The development of secondary and tertiary industries drives the transfer of labor from the primary to the non-agricultural industries and fundamentally promotes the transformation of the population to urban areas for high standards of living. Moreover, as a necessary input factor for industrial development, the flow of labor forces in different departments and regions contributes to the promotion of knowledge spillover, information diffusion, and industrial growth. The adjustment of industrial structure must be realized through population agglomeration (Xu et al., 2015). Due to the accelerated urbanization process and the consequent demand for habitats and production, land, as a derived demand, plays an essential role in the process of urban-rural transformation (Keith, 1988; Liu et al., 2016). So, research on urban-rural transformation from the viewpoint of population-land- industry could facilitate a profound understanding of the patterns and mechanisms of urban-rural systems, as well as offer a theoretical basis for promoting coordinated urban and rural development.

In terms of the existing literature, issues related to measuring urban and rural development have attracted increasing interest from a wide variety of scholars who have tried to explore the spatial patterns and mechanism of urban-rural transformation and development by establishing indicator systems and considering various rule layer factors to examine urban-rural transformation (Cloke, 1977; Cloke and Edwards, 1986; Mann, 2009; Haseeb et al., 2017; Henderson, 2005; Li et al., 2015, 2017; Li and Long, 2015; Li et al., 2014; Long et al., 2009, 2011; Wang et al., 2016; Yang et al., 2015). Most of the research on indicator systems focuses on the forces that drive transformation but there is little literature about measuring urban-rural transformation from the perspective of the urban-rural systems themselves. Yet, it is essential to develop an indicator system of urban-rural transformation based on the perspective of population-land-industry (the three important elements of an urban-rural system). Such a system could measure and track the development process of regional urban-rural change from the essence of

an urban-rural system. In addition, the indicator system could be used to analyze and record the characteristics of the various paths of the urban-rural transformation and development. This type of research could provide the key basis of regulatory policies being executed effectively by the government to achieve urban-rural integration.

As the capital circle of China, the Beijing-Tianjin-Hebei (BTH) region is the largest and most developed region in northern China (Hu et al., 2017). This region is currently undergoing rapid urbanization with an average urban population growth rate of 3.51% during 2000–2012 (Peng et al., 2016; Wu et al., 2015). BTH has also experienced significant urban-rural transformation with its accelerated urbanization. Using the BTH region as the area of focus, this study investigates inequalities in urban-rural development and uses quantitative analysis to measure urban-rural transformation. The aims of this study are to (1) establish an indicator system that can measure urban-rural transformation during 2000–2015 in the BTH region from the viewpoint of population-land-industry, (2) capture the spatio-temporal variations and internal mechanisms of BTH's urban-rural coordinated transformation in the new millennium, and (3) explore some of the major implications of the coordination of urban and rural development in the future.

2. Materials and methods

2.1. Study area

The Beijing-Tianjin-Hebei (BTH) region (36°05′N–42°37′N, 113°11′E–119°45′ E) lies in the North China Plain and at the core of China's Circum-Bohai sea region. BTH covers 134,735 km^2, occupies 1.9% of China's territory, and had a population of 111 million, which accounted for 8.08% of China's total population in 2014. During 2005 and 2014, the proportion of Beijing's population to the region's total population rose from 16.31% to 19.47%, Tianjin witnessed an increase from 11.05% to 13.72%, and this proportion in Hebei decreased from 72.64% to 66.81%. These figures indicate a large population influx to Beijing and Tianjin but a population outflow from Hebei. BTH is the most advanced region in North China (Peng et al., 2017) and has recorded rapid urbanization with the urbanization rate reaching 61.1% in 2014. The total GDP in this region increased rapidly from 4370 billion yuan in 2010 to 6650 billion yuan of GDP in 2014 with an average annual growth of 9.67%, whereas the average increase in China was 8.07% over the same period. With socioeconomic development, increasing numbers of rural dwellers are abandoning traditional agriculture and migrating to cities in attempts to improve their economic conditions. Great changes have occurred in BTH's rural areas during the past decades, so this region could be regarded as a typical case for researching the urban-rural transformation that has occurred in the last 20 years.

As China's county administrative borders frequently change, we used the current (since 2015) borders of the BTH region as the study range, thereby ensuring comparability across different periods of time. The BTH region includes three administrative areas, Beijing, Tianjin, and Hebei, and contains 11 municipal cities, which are Shijiazhuang, Tangshan, Qinhuangdao, Handan, Xingtai, Baoding, Zhangjiakou, Chengde, Cangzhou, Langfang, and Hengshui. By the end of 2015, the BTH region included 202 distinct counties or districts with 16 in Beijing, 16 in Tianjin, and 170 in Hebei (Fig. 1).

2.2. Data sources

Considering the relative integrity of urban-rural economic and social activities in space, as well as the availability of the data, this study takes the county-level administrative unit as the spatial research scale. Monitoring the non-agricultural transformation of "population-land-industry" in the BTH region was done for the years, 2000, 2005, 2010, and 2015, in the new millennium. The data on population and industry